

Risk Assessment:

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ACACIA SALIGNA

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| 8 | | |
| 9 | | |
| 10 | Contents | |
| 11 | Summary of the Express Pest Risk Assessment for <i>Acacia saligna</i> | 4 |
| 12 | Stage 1. Initiation | 6 |
| 13 | 1.1 - Reason for performing the Pest Risk Assessment (PRA) | 6 |
| 14 | 1.2 - PRA area | 6 |
| 15 | 1.3 - PRA scheme | 6 |
| 16 | Stage 2. Pest risk assessment | 7 |
| 17 | 2.1 - Taxonomy and identification | 7 |
| 18 | 2.1.1 - Taxonomy | 7 |
| 19 | 2.1.2 - Main synonyms | 8 |
| 20 | 2.1.3 - Common names | 8 |
| 21 | 2.1.4 - Main related or look-alike species | 8 |
| 22 | 2.1.5 - Terminology used in the present PRA for taxa names | 9 |
| 23 | 2.1.6 - Identification (brief description) | 9 |
| 24 | 2.2 - Pest overview | 9 |
| 25 | 2.2.2 - Habitat and environmental requirements | 10 |
| 26 | 2.2.3 Resource acquisition mechanisms | 12 |
| 27 | 2.2.4 - Symptoms | 12 |
| 28 | 2.2.5 - Existing PRAs | 12 |
| 29 | Socio-economic benefits | 13 |
| 30 | 2.3 - Is the pest a vector? | 14 |
| 31 | 2.4 - Is a vector needed for pest entry or spread? | 15 |
| 32 | 2.5 - Regulatory status of the pest | 15 |
| 33 | 2.6 - Distribution | 17 |
| 34 | 2.7 - Habitats and where they occur in the PRA area | 22 |
| 35 | 2.8 - Pathways for entry | 24 |
| 36 | 2.9 - Likelihood of establishment in the natural environment in the PRA area | 25 |
| 37 | 2.10 - Likelihood of establishment in managed environment in the PRA area | 26 |
| 38 | 2.11 - Spread in the PRA area | 26 |
| 39 | 2.11.1 - Natural spread | 26 |
| 40 | 2.11.2 - Human-mediated spread | 27 |
| 41 | 2.12 Impact in the current area of distribution | 28 |
| 42 | 2.12.1 - Impacts on biodiversity | 28 |
| 43 | 2.12.2 - Impact on ecosystem services | 29 |
| 44 | 2.12.3 - Socio-economic impact | 31 |
| 45 | 2.13. Potential and actual impact in the PRA area | 32 |
| 46 | 2.14 Identification of the endangered area | 34 |
| 47 | 2.15 Climate change | 34 |

| | | |
|----|--|----|
| 48 | 2.15.1 - Define which climate projection is being used from 2050 to 2100 | 35 |
| 49 | 2.15.2 - Components of climate change considered most relevant for <i>A. saligna</i> | 36 |
| 50 | 2.15.3 - Influence of projected climate change scenarios on <i>A. saligna</i> | 36 |
| 51 | 2.16 - Overall assessment of risk | 37 |
| 52 | Uncertainty | 38 |
| 53 | Remarks | 38 |
| 54 | 2.21 – REFERENCES | 39 |
| 55 | Appendix 1. Relevant illustrative pictures (for information) | 51 |
| 56 | Appendix 2. Biological traits and soil factors for <i>Acacia saligna</i> subspecies | 55 |
| 57 | Appendix 3. Impact of Australian acacias on ecosystem functioning and services | 57 |
| 58 | Appendix 4. Projection of climatic suitability for <i>Acacia saligna</i> establishment | 59 |
| 59 | 4.1 - Aim | 59 |
| 60 | 4.2 - Data for modeling | 59 |
| 61 | 4.4 – Results: current climate | 63 |
| 62 | 4.5 – Results: future climate projection | 63 |

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67

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71 Dufour-Dror for the information they provided concerning the impact, the public perception and
72 the management of this exotic tree in South Africa and Israel, respectively. Useful comments
73 and suggestions were also provided on a previous version of this text by Robert Tanner and two
74 anonymous peer reviewers.

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Summary of the Express Pest Risk Assessment for *Acacia saligna*

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80 **PRA area:** *European Union excluding outermost territories*

81

82 **Main conclusions**

83 The results of the PRA show that *A. saligna* poses a **high risk** to the endangered area within the European
 84 Union under current climate (i.e. significant parts of the Mediterranean Biogeographical region, but also
 85 countries along the Atlantic and the Black sea coasts for the '*pruinescens*' subspecies), with a low
 86 uncertainty (figure 5 in Appendix 4). Impacts in the current introduced range are high, and although the
 87 risk of further introduction in the European Union is considered as low, there is a moderate perceived risk
 88 of spread from established populations, facilitated by water and movements of soils contaminated by
 89 seeds or fragments of root suckers. Furthermore, the endangered area is likely to increase a lot during the
 90 coming decades due to climate change (figure 6 in Appendix 4).

91 **Entry and establishment**

92 *A. saligna* is already established in the endangered area within the European Union. It is a
 93 widespread IAS in the coastal areas of Cyprus, Italy, Portugal and Spain; it is also recorded from
 94 Croatia, France, Greece and Malta, but on a more sporadic basis. *A. saligna* is still absent from
 95 Bulgaria, Slovenia and Romania, although appropriate climatic conditions and habitats are
 96 encountered. The risk of further entry into the region as seeds and plant for planting is considered low
 97 with a low uncertainty. The potential for establishment in both the natural and managed environment is
 98 high with a low uncertainty. This potential is known to be favoured by fire and soil disturbance that create
 99 suitable conditions for germination (breaking seed dormancy) and establishment of seedlings of *A.*
 100 *saligna*.

101 **Potential impacts in the PRA area**

102 Impacts on biodiversity are likely to be similar in the PRA area as to those documented in the current area
 103 of distribution (high with a low uncertainty). In Cyprus, Italy, Malta and Portugal, *A. saligna* forms
 104 extensive dense stands which can exclude most native plant species and change community composition,
 105 especially in coastal sand dune and riparian ecosystems. Impacts on several Red Data Book species in the
 106 EU are expected such as for *Aegilops bicornis*, *Anchusa crispa* subsp. *maritima* and *Anthyllis hermanniae*
 107 subsp. *brutia*.

108 Impacts on ecosystem services will be similar to those seen in the current area of distribution (high with a
 109 moderate uncertainty). *A. saligna* persistently transforms ecosystems and their disturbance regime
 110 through reinforcing feedback processes. It affects provisioning (reduction of surface runoff and soil water
 111 reserves), regulating and supporting (modification of nutrient cycling and soil properties) and cultural
 112 services (reduction of aesthetic and recreational landscape quality). It may also increase fire intensity and
 113 frequency under extreme climatic conditions.

114 Socio-economic impacts will be similar in the PRA area as to those seen in the current area of distribution
 115 (high with moderate uncertainty), due e.g. to the very high costs caused by a strong hydrological impact
 116 (loss of water provision) and its long-term management.

117 **Climate change**

118 Climate change scenario RCP8.5 is predicted to increase suitability dramatically and to cause a strong
 119 expansion of the endangered area within the European Union. Major parts of the Mediterranean, Black
 120 Sea, Atlantic and Continental biogeographical regions will be at risk for all the different subspecies; it is
 121 also predicted that the '*lindleyi*' and the '*pruinescens*' subspecies will be able to establish in a wider
 122 range, including a larger part of the Continental biogeographical region and most of the Pannonian
 123 biogeographical region (see figure 6 in Appendix 4). Climate change is also expected to alter the

124 geographic distribution of wildfire, a process that could promote further establishment of *Acacia saligna*
125 close to plantations and invaded sites.

126 **Socio-economic benefits**

127 While the plant is traded as an ornamental, as forestry species or for other uses including honey
128 production, the value it currently generates within the European Union is limited and benefits it produces
129 are unlikely to exceed the cost of negative impacts it causes. Moreover, alternative species are available.
130 Future profits generated by biomass production on marginal soils are expected to be limited due to
131 suboptimal growth conditions and accompanied by high profitability uncertainty.

132 **Phytosanitary risk for the endangered area: HIGH**

133 **Level of uncertainty of assessment: LOW**

134 ***Other recommendations:***

135 With the exception of South Africa, very limited efforts have been conducted in the invaded range and in
136 the European Union to distinguish among the different subspecies or variants described for *Acacia*
137 *saligna*. Other Australian acacia species (e.g. *A. dealbata*, *A. longifolia*, *A. mearnsii* and *A. melanoxylon*)
138 are introduced and planted for various purposes within the European Union and some of them are
139 reported to colonise natural environments. An accurate assessment of their invasiveness should be
140 conducted before further use.

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Express Pest Risk Assessment

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ACACIA SALIGNA

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Stage 1. Initiation

150

1.1 - Reason for performing the Pest Risk Assessment (PRA)

151

Acacia saligna (Labill.) H.L.Wendl *s.l.*¹, (Coojong wattle) is considered the most widely planted non-timber woody species for multiple purposes including afforestation/reforestation, ornamental use and soil protection, but also for fuelwood, charcoal, fodder, tannin and biomass production and other uses (Maslin and McDonald, 2004; Griffin *et al.*, 2011; Kull *et al.*, 2011). This evergreen species covers an estimated 600,000 hectares worldwide and has been widely cultivated within and outside its native range also in Australia (Maslin and McDonald, 2004; Griffin *et al.*, 2011). However, it is considered an invasive alien species in several regions in the world characterized by Mediterranean-type climate, such as parts of Australia, Algeria, Chile, Cyprus, Israel, Italy, Kenya, Morocco, Portugal, South Africa and Spain where it causes strong and persistent impacts on biodiversity and ecosystem services (e.g., Thompson *et al.*, 2015). Similarly, within the European Union, *A. saligna* has been introduced in a significant number of Member States. It is often considered invasive and many LIFE projects are actively promoting local eradication and control of *A. saligna* in protected areas to restore native plant communities or endemic and endangered native species. Therefore, the present PRA aimed to collect and analyse information on the invasive risk of further introduction and spread of *A. saligna* in the PRA area, *i.e.* in the European Union as defined in the framework of the Regulation (EU) No. 1143/2014².

156

1.2 - PRA area

157

The PRA area being assessed is the European Union, as defined in the framework of the Regulation (EU) No. 1143/2014.

158

1.3 - PRA scheme

159

This Express Pest risk assessment document follows EPPO Standard PM 5/5(1) **Decision-Support Scheme for an Express Pest Risk Analysis**, with modification and integrations for section 12 and section 15, to take into account the criteria for risk assessment required by the Reg. (EU) No. 1143/2014 (see Roy *et al.* 2014, Invasive alien species – framework for the identification of invasive alien species of EU concern. ENV.B.2/ETU/2013/0026 and Roy *et al.*, 2017). This amended scheme has been utilised during the LIFE project IAP-RISK (<http://www.iap-risk.eu/>) on sixteen alien plants; it is not yet an EPPO standard, but it is under consideration to be formally approved as such. The authors of this PRA consider this scheme as reliably suitable to fulfil all the requirements of the Reg. (EU) No. 1143/2014. The biogeographical regions are herewith considered according to the official delineations used in the Habitats Directive (92/43/EEC) and for the EMERALD Network set up under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention).

160

¹ (*s.l.* = *sensu lato* - in the broad sense), *Cf.* sections 2.1.1 – 2.1.5 for details.

² Regulation (EU) No. 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species.

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Stage 2. Pest risk assessment

183

2.1 - Taxonomy and identification

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2.1.1 - Taxonomy

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| | |
|---------------|--|
| Kingdom | <i>Plantae</i> |
| Subkingdom | <i>Tracheobionta</i> (Vascular plants) |
| Superdivision | <i>Spermatophyta</i> (Seed plants) |
| Division | <i>Magnoliophyta</i> (Flowering plants) |
| Class | <i>Eudicotyledons</i> |
| Subclass | <i>Fabids</i> |
| Order | <i>Fabales</i> Bromhead, Edinburgh New Philos. J. 25: 126. (1838) |
| Family | <i>Fabaceae</i> Lindl., Intr.Nat.Syst.Bot. Ed. 2: 148 (1836), <i>nom. cons.</i> = <i>Leguminosae</i> Juss., <i>nom. cons.</i> <i>Leguminosae</i> , LPWG (2017) |
| Subfamily | <i>Caesalpinioideae</i> – <i>Acacia</i> clade, LPWG (2017) |
| Genus | <i>Acacia</i> Mill. <i>s.l.</i> , Gard. Dict. Abr. ed. 4 (1754), <i>nom. et typ. cons.</i> |

188

189 *Acacia saligna* (Labill.) H.L.Wendl., Comm. Acac. Aphyll. 26. 1820 (Family *Leguminosae*, LPWG,
190 2017) is a native (endemic) Western Australian very polymorphic species (Maslin, 1974) with a
191 widespread but naturally patchy distribution currently circumscribed by four to five informal subspecies
192 (Millar *et al.*, 2010; WorldWideWattle ver. 2, 2017). The accepted name is based on *Mimosa saligna*
193 Labill., Nov. Holl. Pl. 2: 86, t. 235. 1806 (basionym). The lectotype for the name was selected by B.R.
194 Maslin (1974) among the samples collected by Labillardiere and stored at the herbarium of Florence, Italy
195 (FI). The specimen selected as lectotype represents the taxon later described as *Acacia cyanophylla* Lindl.
196 (Edwards's Botanical Register 25 1839 Misc. 45, Misc. 45, No. 64) which is therefore a taxonomic
197 synonym (homotypic synonym) of *A. saligna*.

198 As a result of its polymorphism, four genetic lineages or subspecies have been described, consistent with
199 the morphological groupings of the species complex: *Acacia saligna* (Labill.) H.L.Wendl. subsp. *saligna*
200 (autonym), *Acacia saligna* (Labill.) H.L.Wendl. subsp. *stolonifera* M.W.McDonald & Maslin ms, *Acacia*
201 *saligna* (Labill.) H.L.Wendl. subsp. *pruinescens* M.W.McDonald & Maslin ms [and *Acacia saligna*
202 (Labill.) H.L.Wendl. subsp. *lindleyi* (Meisn.) M.W.McDonald & Maslin ms (Maslin *et al.*, 2006;
203 <https://florabase.dpaw.wa.gov.au/>). These four subspecies can be distinguished by a combination of
204 morphological differences including phyllode appearance, the shape of the inflorescence bud, the length
205 of racemes and the diameter, colour and number of flower heads (M. McDonald personal communication,
206 in Millar *et al.* 2011). According to this morphological grouping of the species complex, each subspecies
207 is geographically associated with a particular ecological habitat as described in the pest overview section
208 (Section 2.2) (Thompson *et al.*, 2011, 2015). The taxonomy and nomenclature of *Acacia saligna* s.l. is
209 under ongoing revision in Australia. At the same time, the concept of ‘variant’ is found in the scientific

210 literature and in technical reports, or in provenance trials. Importantly, (1) subsp. *lindleyi* is also referred
 211 to as the 'typical' variant; (2) subsp. *pruinescens* is referred to as the 'Tweed River' variant; (3) subsp.
 212 *saligna* is referred to as the 'cyanophylla' variant and (4) subsp. *stolonifera* is referred to as the 'forest'
 213 variant (Maslin *et al.* 2011) (Table 2, Section 2.2.2).

214 Genetic divergence is evident between these subspecies (Millar *et al.*, 2012 and references cited therein),
 215 which encompass a wide range of morphological variation and show a high degree of morphological
 216 plasticity. Natural hybridization is uncommon in Australia due to the disjunct distribution of populations
 217 and limited areas of natural sympatry of the subspecies but has been confirmed in mixed plantations using
 218 molecular markers (Millar *et al.*, 2012 and references cited therein). The *A. saligna* subspecies can be
 219 distinguished by a combination of morphological differences including phyllode appearance, the shape of
 220 the inflorescence bud, the length of racemes and the diameter, colour and number of flower heads (Millar
 221 *et al.*, 2008b and references cited therein); however, these characteristics can only be assessed when
 222 plants are suitably mature and only while plants are developing buds or flowering (Millar *et al.*, 2008b
 223 and references cited therein). The subspecies of *A. saligna* display variation in key traits, such as seed set,
 224 fecundity and suckering (Millar *et al.*, 2008b and references cited therein) that are all important aspects to
 225 consider both for the identification and for assessing the invasion risk and the phytosanitary measures.

226 These four informal subspecies were recently and tentatively reclassified into three major subspecies
 227 lineages: subsp. *lindleyi*, 'subsp. *pruinescens* + subsp. *saligna*' and subsp. *stolonifera* (Maslin *et al.*,
 228 2011; Millar *et al.*, 2011;). However, according to the inflorescence characters Maslin *et al.* (2011), have
 229 proposed also only two-groups ('subsp. *pruinescens* + subsp. *saligna*' and 'subsp. *lindleyi* + subsp.
 230 *stolonifera*'). As a result, the identification of *A. saligna* subspecies is challenging (Le Houerou and
 231 Pontanier, 1987; Maslin and McDonald, 2004; Millar *et al.*, 2008b; Millar *et al.*, 2011).

232 Finally, *Acacia provincialis* was described from cultivated material and was said by its original authors to
 233 represent a hybrid between *A. retinodes* and *A. cyanophylla* (= *A. saligna*); having inspected these
 234 original specimens Maslin & McDonald (2004) state that they appear to be *A. retinodes* 'swamp' variant;
 235 these authors - in fact - consider very unlikely that hybrids between *A. retinodes* and *A. saligna* would
 236 naturally occur.

237

238 **2.1.2 - Main synonyms**

239 The main synonyms have been retrieved from the web site "The Plant List"³, as follows:

240 *Mimosa saligna* Labill., Nov. Holl. Pl. 2: 86, t. 235 (1807) (basionym);

241 *Acacia bracteata* Maiden & Blakeley, Roy. Soc. W. Australia 13: 18, t. 10, figs 7–11 (1928);

242 *Acacia cyanophylla* Lindl., Edward's Bot. Reg. 25: Misc. 45 (1839);

243 *Acacia lindleyi* Meissner, in J.G.C. Lehmann, Pl. Preiss. 1: 14 (1844);

244 *Racosperma salignum* (Labill.) Pedley, Austrobaileya 2: 355 (1987).

245

246 **2.1.3 - Common names**

247 Coojong wattle, golden-wreath wattle, orange wattle, blue-leafed wattle, Port Jackson willow; *Acacia*
 248 azul (Spanish) Akacja (Maltese); *Acacia saligna* (Italian); *Mimosa bleuâtre* (French).

249

250 **2.1.4 - Main related or look-alike species**

251 *A. saligna* has no known close relatives in the European Union, but it resembles, superficially, a number
 252 of other introduced *Acacia* species including *A. pycnantha* (Maslin, 1974), however the latter is
 253 distinguished by its stouter raceme axes and peduncles, its prominently tapered phyllode bases, its smaller
 254 pulvinus, and its smaller glands. In its growth habit, phyllode morphology, glabrous raceme, and large

³ <http://www.theplantlist.org/tpl1.1/record/ild-591> [Accessed 15 December 2017].

255 flower heads, *A. saligna* superficially resembles *A. amplices* B.R.Maslin; however, the flowers, legumes,
 256 and seeds of these two species are quite different. Finally, *A. saligna* can be occasionally confused with *A.*
 257 *microbotrya* Benth. and *A. rostellifera* Benth. (Maslin, 1974). It might also be superficially confused with
 258 *Acacia retinodes* Schldtl. Importantly, *A. pycnantha* (native to Australia) is considered invasive in many
 259 Mediterranean countries, including Italy (e.g., Giovanetti et al., 2015) thus it should not be considered as
 260 a substitute species.

261

262 2.1.5 - Terminology used in the present PRA for taxa names

263 In the present PRA the terms “*Acacia saligna*” and/or “*Acacia saligna* s.l.” (s.l. = *sensu lato* - in the
 264 broad sense) (also abbreviated as *A. saligna*) both indicate the species complex, i.e. the whole group of
 265 subspecies (or lower taxa, such as, e.g. cultivated varieties, cultigens and provenances) that have been
 266 described for the entity *Acacia saligna* (Labill.) H.L.Wendl., Comm. Acac. Aphyll. 26. 1820⁴. Whenever
 267 the PRA refers to a subspecific entity (*cf.* section 2.1.1), its full name is reported. The present PRA
 268 addresses the risk posed by *Acacia saligna* s.l.

269

270 2.1.6 - Identification (brief description)

271 The following description has been retrieved from the web site “Flora of Australia On Line”⁵.

272 Evergreen bushy shrub or tree mostly 2–6 (10) m high. Bark grey. Branchlets often pendulous, normally
 273 slightly flexuose, often pruinose (especially when young), glabrous. Phyllodes often pendulous, variable
 274 in shape and size, linear to lanceolate, straight to falcate, 7–25 cm long, (2–) 4–20 mm wide, often larger
 275 towards base of plant, green to glaucous, glabrous, with prominent midrib, finely penninerved (absent on
 276 very narrow phyllodes); gland ±disciform, 1–2 mm wide, 0–3 mm above pulvinus; pulvinus mostly 1–2
 277 mm long, coarsely wrinkled. Inflorescences mostly 2–10-headed racemes, enclosed when young by
 278 imbricate bracts, with bract scars evident at anthesis; raceme axes mostly 3–30 mm long, glabrous;
 279 peduncles 5–15 mm long, glabrous; heads globular, mostly 7–10 mm diam. at anthesis and 25–55-
 280 flowered, golden. Flowers 5-merous; sepals c. 4/5-united. Pods linear, flat, shallowly constricted between
 281 seeds, 8–12 cm long, 4–6 mm wide, thinly coriaceous, glabrous. Seeds longitudinal, oblong to slightly
 282 elliptic, 5–6 mm long, shiny, dark brown to black; aril clavate.

283

284 2.2 - Pest overview

285 2.2.1 - Introduction

286 *Acacia saligna* is an evergreen shrub or small tree which grows to a height of 2–6 (10) m (Maslin, 1974;
 287 Degen *et al.*, 1995; Virtue and Melland, 2003), native and endemic to Western Australia. It is a fast-
 288 growing species characterized by both clonal propagation and sexual reproduction; it is well adapted to
 289 semiarid environments and is fire-resilient. *A. saligna* has a mixed mating system, preferential
 290 outcrossing, but also with a certain level of selfing (George *et al.*, 2008). Under cultivation, it tends to
 291 have a short lifespan: typically, less than 10 years and in some instances less than 5 years in Australia
 292 (World Wide Wattle 2017⁶). However, an average lifespan of 30–40 years has been reported for South
 293 Africa (Milton and Hall, 1981 as reported in Wood and Morris, 2007) The age of the flowering is two-
 294 three years. *A. saligna* has bright and dense yellow, globular flowerheads with a generalist floral
 295 morphology. Flowers are visited most frequently by bees, wasps, flies and beetles (Gibson *et al.*, 2013).
 296 Actually, the fundamental floral morphology shared by all Australian acacias identifies a generalist
 297 entomophilous pollination syndrome as it provides accessible floral rewards to almost any insect visitor
 298 (Gibson *et al.*, 2011).

⁴ *Acacia saligna* was described by Wendland, Heinrich Ludwig, in 1820 in “*Commentatio de Acaciis Aphyllis. Hannoverae*”, vol. 4, pp. 26–27.

⁵ <http://www.anbg.gov.au/abrs/online-resources/flora/redirect.jsp>

⁶ <http://worldwidewattle.com/infogallery/projects/saligna.php> [Accessed 19 December 2017].

299 *A. saligna* s.l. flowers from (August) September to October (November) in the native range (Henderson,
300 2001; Australia Florabank 2017⁷). Flowering periods in the invaded range are reported in the following
301 table:

302

303 Table 1: Flowering periods reported from the invaded range of *Acacia saligna*.

304

| Location | Flowering period | Source |
|-----------------------------|--------------------|---|
| Chile (alien range) | July - October | Perret <i>et al.</i> (2001) |
| Italy, Sicily (alien range) | March - May | http://www.dipbot.unict.it/orto-botanico/scheda.aspx?i=356 |
| Spain (alien range) | March - May | Flora Iberica – Paiva (1999) |
| South Africa (alien range) | August - September | Milton and Moll (1981) |

305 Field observations in Portugal reported more hermaphrodite and male flowers which are easily identified
306 by the presence or absence of a well-developed pistil. *A. saligna* showed lower investment in flower head
307 production (despite the higher number of flowers per flower head) and the fecundity of all ovules in a
308 flower is rare (e.g. mostly had only one seed per pod) (Correia *et al.*, 2014).

309 The maximum recorded value of annual seed rain of *Acacia saligna* in the invaded range (South Africa) is
310 5,443 seeds/m² (Milton and Hall, 1981 as reported by Richardson and Kluge, 2008). The vast majority of
311 the seeds are added to the seed bank where they remain dormant until the testa is damaged or weathered
312 sufficiently to be permeable to water and germinate (Milton and Hall, 1981). As a result, the maximum
313 recorded value of seed bank of *A. saligna* in South Africa is 46,000 seeds/m² (Holmes *et al.*, 1987 as
314 reported by Richardson and Kluge, 2008). In **Cyprus**, as reported in the final Report of the project
315 LIFE12 NAT/CY/000758⁸, several samples (25 x 25 cm) were taken from soil in three layers. The
316 average number of seeds per square meter at the soil surface was estimated to be 1,648 seeds, at 0-10 cm
317 depth was 2,160 seeds and at 10-20 cm was 400 seeds.

318 As for many *Acacia* species, seed biology syndromes are largely shaped by fire driven ecosystems that
319 are present throughout much of Australia and the introduced range (Mediterranean-type climate regions).
320 Fire-adaptive traits include: production of large quantities of hard-coated, heat-tolerant and long-lived
321 seeds with the capacity for long dormancy in the soil (even for decades); stimulation of germination by
322 heat and/or smoke; seed dispersal and burial by ants (Holmes, 1989, 1990b; Richardson and Kluge, 2008;
323 Le Maitre *et al.*, 2011; Dufour-Dror, 2012).

324 Fire is a key part of the life cycle of *A. saligna*. Fire stimulates seed germination in several invasive
325 acacias such as *A. melanoxylon*, *A. dealbata* and *A. saligna* (García *et al.*, 2007; Lorenzo *et al.*, 2010a;
326 Wilson *et al.*, 2011). On the contrary, the plant itself is absolutely fire sensitive, although resilient thanks
327 to vegetative resprouts.

328

329 2.2.2 - Habitat and environmental requirements

330 **In the native range** *Acacia saligna* s.l. is widespread and often locally abundant and occurs principally in
331 dry sclerophyll forest or temperate woodlands (Hall and Turnbull, 1976). In south-east Australia, *A.*
332 *saligna* s.l. has established in coastal scrublands, grassy woodlands, heathlands, warmer moist forests and
333 riparian areas (Muyt, 2001). However, according to the morphological groupings of the species complex

⁷ http://www.florabank.org.au/lucid/key/species%20navigator/media/html/Acacia_saligna.htm [Accessed 22 December 2017].

⁸ Final Report Covering the project activities from 01/09/2013 to 28/02/2017, Reporting Date, 28/02/2017, LIFE-RIZOELIA: Improving the conservation status of the priority habitat types *1520 and *5220 at the Rizoelia National Forest Park (<http://www.life-rizoelia.eu/>).

334 (see table 2), each subspecies is geographically associated with a particular habitat type: *A. saligna* subsp.
 335 *lindleyi* (watercourses, sand dunes, coastal plains), subsp. *pruinescens* (deep soil in swamp-like areas), *A.*
 336 *saligna* subsp. *saligna* (coastal plains) and *A. saligna* subsp. *stolonifera* (watercourses and forest-like
 337 areas) (Thompson *et al.*, 2011).

338
 339 Table 2. An assessment of traits considered important from a domestication perspective for the *Acacia saligna*
 340 variants, based on observations from natural populations in native range (McDonald *et al.*, 2007).

341

| | <i>A. saligna</i> subsp. <i>lindleyi</i> | <i>A. saligna</i> subsp. <i>pruinescens</i> | <i>A. saligna</i> subsp. <i>saligna</i> | <i>A. saligna</i> subsp. <i>stolonifera</i> |
|--------------------|---|--|--|--|
| Variants | ‘Typical’ | ‘Tweed River’ | ‘Cyanophylla’ | ‘Forest’ |
| Size | Low-tall | Low-tall | Tall | Low-tall |
| Biomass production | Poor-good | Fair-good | Excellent | Poor-good |
| Coppicing ability | Poor-good | Fair | Excellent | Fair |
| Suckering ability | Weak-moderate | Strong | Weak-moderate | Strong |
| Lowest minimum t° | 0 °C | -5 °C | -4 °C | -4 °C |

342
 343 As noted by Doran and Turnbull (1997) and Hobbs *et al.* (2009), *A. saligna* s.l. occurs on many soil
 344 types, especially deep poor and calcareous sands, but also on moderately heavy clays. In its natural
 345 habitat, the species is normally found near water courses and other wet areas. It mainly grows on coastal
 346 sand plains but extends to a wide variety of situations from swampy sites and river banks to small or
 347 rocky hills (often granitic) (Groves, 1994). Simmons (1981) reported that *A. saligna* tolerates alkaline and
 348 saline soils and a grows under a wide range of soil water regimes. However, its ability to fix nitrogen and
 349 its growth performances are greatly reduced by drought (< 350 mm annual precipitation), water-logging
 350 and shading (Nakos, 1977; NAS, 1980a; Maslin and McDonald, 2004; Hobbs *et al.*, 2009).

351 In its natural range within south-western Australia, *A. saligna* grows under a Mediterranean climate type,
 352 with a mean annual temperature range between 11 and 23 °C, minimum temperature range between 2 and
 353 10 °C and maximum temperature range between 25 and 35 °C. The long-term average rainfall is 580 mm,
 354 with a range of 240 to 1160 mm, falling mostly in the winter months (Maslin and McDonald, 2004;
 355 Hobbs *et al.*, 2009).

356 **In its introduced range**, *A. saligna* is reported as established (i.e., naturalised⁹) in many semi-natural
 357 habitats within Mediterranean-type regions all over the world, such as riparian habitats, shrublands,
 358 fynbos (South Africa), forests, grasslands and sand dunes (Le Maitre *et al.*, 2000; Hadjikyriakou and
 359 Hadjisterkotis, 2002; Lorenzo *et al.*, 2010a; Del Vecchio *et al.*, 2013; Hernández *et al.*, 2014; Lazzaro *et*
 360 *al.*, 2014; Celesti-Grapow *et al.*, 2016; Souza-Alonso *et al.*, 2017).

361 Soil and climatic preferences observed in the introduced range are close to those described from the
 362 native range (Hobbs *et al.*, 2009; Thompson *et al.*, 2011). It has however been often planted in more arid
 363 conditions than those encountered in its native range, as it is the case in North Africa. In those conditions,
 364 *A. saligna* is reported to have a lower capacity to sucker and make dense thickets; its invasiveness and
 365 competitiveness are reduced by suboptimal growth conditions and possibly also absence of fire

⁹ Naturalised = capable of establishing a viable population and spreading in the environment under current conditions and in foreseeable climate change conditions at least in one biogeographical region shared by more than two Member States (*sensu* Art. 4.3.b., Reg. EU No. 1143/2014).

366 perturbation (Tiedeman and Johnson, 1992; Le Houerou, 2000; Derbel *et al.*, 2009; Amrani *et al.*, 2010;
367 Reubens *et al.*, 2011; Wilson *et al.*, 2011).

368

369 2.2.3 Resource acquisition mechanisms

370 *A. saligna* is especially competitive because of faster root and shoot growth amongst the group of
371 Australian acacia species (Witkowski, 1994; Atkin *et al.*, 1998). In South African fynbos and in
372 Australian drylands, it was shown to grow taller and faster than native vegetation due to very efficient
373 resource acquisition mechanisms. It develops horizontal roots up to 12 m long as well as vertical roots
374 that reach depths of 3.5 m, and up to 16 m in sandy habitats; its roots penetrate earlier and deeper in the
375 soil profile than most other plants (Witkowski, 1991a; Musil, 1993; Dufour-Dror, 2012; Knight *et al.*,
376 2002). It also has efficient mycorrhizal and N₂-fixing symbioses that allows it to easily colonise nutrient
377 poor soils (Hoffman and Mitchell, 1986; Musil, 1993; Stock *et al.*, 1995). Furthermore, sclerophylly and
378 plant ability to remobilize limiting nutrients enable efficient nutrient conservation (Witkowski, 1991b;
379 Morris *et al.*, 2011).

380 Field observations and laboratory experiments suggest that *A. saligna* also releases persistent allelopathic
381 compounds in the soil from fallen leaves and flowers, plant leachates or root exudates (e.g. low vegetation
382 cover and strong decrease of *Artemisia monosperma* plants in the vicinity of the tree) as also observed for
383 other acacia species (El-Bana 2008, Abd El-Gawad and El-Amier, 2015).

384 2.2.4 - Symptoms

385 One of the primary symptoms of *A. saligna* in the non-native ranges is the tendency to make dense and
386 persistent thickets and to cause a reduction in the species richness, native species cover, and changes in
387 community structure (e.g., Holmes and Cowling, 1997; Richardson *et al.*, 1989). In many cases, the
388 formation of dense stands occurs close to existing plantations with *A. saligna*, or can be the result of
389 wildfires (Musil, 1993; Holmes and Cowling, 1997) or even prescribed fires. *A. saligna* not only
390 outcompetes indigenous plant species by growing faster and taller, but it also transforms the environment
391 by creating shady canopy cover and by altering soil properties through a combination of fixing nitrogen
392 and its high input of leaf litter (Witkowski 1991; Holmes and Cowling, 1997). Dense litter layers under
393 acacias also prevent native seed contact with the soil (Appendix 1, Figure 7). With a smaller proportion of
394 seeds in the seed bank, many native species might regenerate poorly after a fire in comparison to *A.*
395 *saligna*.

396

397 2.2.5 - Existing PRAs

398 **Australia:** Melland and Virtue (2002) applied the Animal and Plant Control Commission (APCC) Weed
399 Assessment Scoresheet (Virtue, 2000) was used to rank the potential weed threats of *A. saligna* to native
400 vegetation in the seven regions of South Australia. Scoresheet consists of a series of multiple choice
401 questions, grouped into three criteria; Invasiveness, Impacts and Potential Distribution. Scores for the
402 criteria (each ranging from 0 to 10) are then multiplied to give a Weed Importance score. On a state-wide
403 scale, *A. saligna* scored a very high weed risk to native vegetation. More precisely, *A. saligna* poses a
404 very high weed risk in the Eyre, Northern Agricultural Districts, Mt. Lofty Ranges/Metro and South East
405 regions. The species poses a high weed risk in the Murray Darling Basin, and a negligible risk in the other
406 regions, due to poor climate matches. In addition, *A. saligna* features among the most invasive garden
407 plants in each state, territory and the whole of Australia that were available for sale in NSW in 2006
408 according to Coutts-Smith and Downey (2006). In Australia, 43 native acacias are naturalised beyond
409 their native range (Adair, 2008).

410 **France:** Using the risk assessment system developed by Weber and Gut (2004) for central Europe (W-G -
411 WRA), *A. saligna* has been identified as priority for a national PRA. *A. saligna* scored 31 out of 39
412 highlighting a high risk to the Mediterranean biogeographical region of France (Fried, 2010).

413 **Hawaii:** Pacific Island Ecosystems at Risk (PIER)¹⁰. This risk assessment predicts the likelihood of
 414 invasions of species in Hawaii, and the high islands of the Pacific. The risk assessment for Hawaii scored
 415 *A. saligna* as 17, indicating that the species poses a high risk of invasion.

416 **Italy:** Crosti *et al.* (2010) used a modified version of the Australian Weed Risk Assessment (A-WRA)
 417 adapted for the Mediterranean region of Central Italy, to assess the risk for a number of invasive alien
 418 plants in Lazio (Italy, Mediterranean biogeographical region). *A. saligna* scored 12, resulting in a “reject”
 419 decision according to the A-WRA.

420 **Spain:** Gassó *et al.* (2010) applied the Australian Weed Risk Assessment scheme (A-WRA) of Pheloung
 421 *et al.* (1999), modified for Spain, to 100 invasive and 97 casual¹¹ species in Spain. *A. saligna* scored 22,
 422 indicating a high risk and rejecting its import.

423

424 **Socio-economic benefits**

425 Introduction and use of *A. saligna* within the **European Union** mostly occurred in the past for
 426 reforestation, firewood production, erosion control, soil stabilisation and protection purposes, especially
 427 in coastal dune ecosystems in the Mediterranean region and islands (Hadjikyriakou and Hadjisterkoti,
 428 2002; Celesti-Grapow *et al.*, 2010; Marchante and Marchante, 2014), honey production and other
 429 secondary uses. Since recent years, its introduction for biomass production (short rotation coppicing
 430 systems) in marginal soil conditions under Mediterranean climates is under investigation in the European
 431 Union (Crosti *et al.*, 2010; Facciotto and Nervo, 2011) as in the rest of the world (Goslin and McDonald,
 432 2006; Hobbs *et al.*, 2009; Griffin *et al.*, 2011).

433 So far, few studies have specifically quantified both the resprouting capacity and the impact of nutrient
 434 and water availability on the biomass yields of the different subspecies of *A. saligna* (Maslin and Mc
 435 Donald, 2004; Hobbs *et al.*, 2011). However, it is known that their growth rates and biomass production
 436 can vary markedly between and even within sites (Hobbs *et al.*, 2011). Field trials conducted in Chile
 437 (Perret *et al.*, 2001), in Israel (Zegada-Lizarazu *et al.*, 2007) and in Italy (Facciotto and Nervo, 2011)
 438 suggest that water is an important limiting factor to the growth of *A. saligna* and that irrigation and
 439 potentially also fertilization will have to be applied to guarantee a high sustained yield in short rotation
 440 coppicing systems under Mediterranean climates. As in the cases of *Jatropha curcas*, *Robinia*
 441 *pseudoacacia* and other energy woody crops (Gasol *et al.*, 2010; Dauber *et al.*, 2012; Blanco-Canqui,
 442 2016), it may be expected that *A. saligna* may not provide substantial economic benefits as a bioenergy
 443 crop due to limited growth and high installation costs in these conditions.

444 Similarly, *A. saligna* was widely planted for drift sand control and tannin production following its
 445 introduction to South Africa’s Cape Floristic Region (CFR) in the 19th century. Mayer (1995) reports that
 446 the massive introduction of *A. saligna* took place in sand dune areas under the direction of the local
 447 Forestry Administration, with the initial aim of stopping the sand from moving. However, it has been also
 448 observed that Australian acacias often fail to adequately prevent soil erosion in several regions because of
 449 topsoil loss when harvesting as a consequence of absence of herbaceous vegetation beneath them;
 450 plantations for dune stabilisation may also destabilise the coastline and trigger massive beach erosion
 451 (Lubke, 1985; Carruters *et al.*, 2011; Low, 2012). In South Australia, it is also planted with other deep-
 452 rooted perennial plant species to reverse or control salinity in dryland habitats (Bennett and Virtue, 2005,
 453 Hobbs *et al.*, 2009).

454 More in general, *Acacia saligna* has a long history of **multi-purpose use** in Australia and overseas. Of
 455 the 25 most exported Australian acacias, this medium-sized tree is the most widely planted non-timber
 456 species covering 600,000 ha worldwide (Griffin *et al.*, 2011; Thompson *et al.*, 2015). Under cultivation
 457 this species is capable of developing into a robust woody shrub or small tree, growing on a wide range of
 458 soils and producing a large quantity of woody biomass, foliage, (green) pods and seeds. Since the past it
 459 has been used for soil protection and desalination, mine site rehabilitation, revegetation, agroforestry,

¹⁰ http://www.hear.org/pier/wra/pacific/Acacia_saligna.pdf

¹¹ Casual = Alien plants that may flourish and even reproduce occasionally in an area, but which do not form self-replacing populations, and which rely on repeated introductions for their persistence (from Richardson *et al.*, 2000).

460 amenity plantings, firewood, windbreaks and shade and as a fodder plant for livestock (Crompton, 1992;
 461 Le Houerou, 2000; Maslin *et al.*, 2006; Maslin and McDonald., 2007; Griffin *et al.*, 2011; Carruthers *et*
 462 *al.*, 2011; Kull *et al.*, 2011; Reubens *et al.*, 2011). In its natural range, *A. saligna* is considered a
 463 successful farm tree for reduction of water tables and mitigation of salinity, provision of shelter and
 464 reduction in farm nutrient run-off (Bennett and George, 1993; Hobbs *et al.*, 2009). In the semiarid
 465 Coquimbo Region, Chile, *Acacia saligna* is used particularly where **reforestation** has been promoted
 466 with the objective of recovery of degraded soils, production of fodder for livestock, fuelwood and erosion
 467 control. This alien species also has potential use as an important source of human food, because the seeds
 468 of the trees are harvested and processed for the production of breads and biscuits with nutraceutical
 469 properties (Rojas *et al.*, 2016).

470 The primary reason for planting *A. saligna* in Libya and Ethiopia was related to the **production of**
 471 **fuelwood/charcoal** and as a minor uses site rehabilitation (Griffin *et al.*, 2011). Over 200,000 ha of *A.*
 472 *saligna* have been planted in north Africa and a few thousand ha in West Asia and southeast Spain where
 473 the species is highly valued as food for sheep and goats (El-Lakany, 1987; Crompton, 1992; Le Houerou,
 474 2002). Fuelwood may be produced at a rate of up 3.5 t dry wood 1/ha 1/year on deep sandy-loam (El-
 475 Lakany, 1987 in Midgley and Turnbull, 2003).

476 The phyllodes of *A. saligna* are used as a source of **fodder**, particularly for small ruminant production;
 477 the tree is often integrated into agroforestry systems in dry environments or degraded rangeland as in
 478 Kenya, Algeria (Droppelmann *et al.*, 2000; Boufennara *et al.*, 2013) and Chile (Meneses *et al.*, 2012).
 479 However, the food intake and the digestibility of dry matter (DM), organic matter (OM) and energy
 480 contents of fresh *A. saligna* has been reported to be generally low mainly due to presence of anti-
 481 nutritional factors, such as tannins whose contents range from 47 to 55 g/kg DM. It means that the shrub
 482 could not be used as a sole dietary source for small ruminant in spite of some potential as a supplementary
 483 fodder due to its high crude protein content (Degen *et al.*, 1995; Ben Salem *et al.*, 1997 as reported by
 484 Tamir and Asefa, 2009).

485 *A. saligna* seeds are edible after heat treatment or cooking and can be used as a **source of human food** to
 486 combat hunger in semi-arid lands. Seeds are easily harvested and processed into flour using simple,
 487 existing local technologies; the flour can be incorporated into local dishes and in ‘non-traditional’ foods
 488 such as spaghetti, bread and biscuit (Rinaudo *et al.*, 2002; Maslin and McDonald, 2004).

489

490 **2.3 - Is the pest a vector?**

491 **YES:** *Xylella fastidiosa*, a xylem-limited fastidious bacterium (EPPO A1 list, quarantine pathogen), is the
 492 recognized agent of a large number of diseases including Pierce’s disease of grapevine, citrus variegated
 493 chlorosis (CVC), plum leaf scald, phony peach, pear leaf scald, alfalfa dwarf and coffee, almond, and
 494 oleander leaf scorch. Until few years ago, the presence of this bacterium was confined to the American
 495 continent, except for few sporadic reports of interception on commodities in some Asian and European
 496 countries (EFSA, 2015, 2016). As first report in the European and Mediterranean region, *X. fastidiosa*
 497 was associated to the severe olive quick decline syndrome (OQDS) in Lecce province (Apulia, southern
 498 Italy), where it is rapidly spreading (Saponari *et al.*, 2013). The Apulian *X. fastidiosa* isolate was
 499 identified as a strain of the subspecies *pauca*, to which the name Codiuro was assigned (Cariddi *et al.*,
 500 2014; Elbeaino *et al.*, 2014)¹².

501 Besides olive (*Olea europaea*), *Xylella fastidiosa* subsp. *pauca* - Codiuro strain can infect several other
 502 plant species, i.e., *Polygala myrtifolia*, *Westringia fruticosa*, and *Acacia saligna* (Saponari *et al.*, 2013;
 503 Yaseen *et al.*, 2015). Entry of the pathogen into EU territory by the movement of plants for planting is
 504 considered to be the most important pathway, since *Xylella fastidiosa* has approximately 300 reported
 505 host plant species, which include *Acacia saligna* (EFSA, 2015). Importantly, *Olea europaea* and *Acacia*
 506 *saligna* are very commonly closely cultivated or planted in the Mediterranean region in the European
 507 Union (e.g., Perrino and Calabrese, 2014).

508

¹² https://ec.europa.eu/food/sites/food/files/plant/docs/ph_biosec_legis_emergency_db-host-plants_update09.pdf

509 **2.4 - Is a vector needed for pest entry or spread?**510 **NO**

511

512 **2.5 - Regulatory status of the pest**513 **Australia**

514 Although this species is native only in one part of Australia, it is not declared or considered noxious by
 515 any state or territory government in Australia¹³. “*It cannot be made a proclaimed plant under the APC*
 516 *Act as this specifically excludes “native plants” as defined in the National Parks and Wildlife Act, 1972.*”
 517 In this latter Act the following actions are recommended: implement weed management strategies to
 518 control existing infestations and discourage the use of *A. saligna* for revegetation and landscaping (Virtue
 519 and Melland, 2003).

520 **Europe**

521 In **Malta**, the “Trees and Woodland Protection Regulations, 2011” (LN 200 of 2011) lists a number of
 522 species of trees deemed to cause damage to biological diversity of trees or woodlands in Malta, or to the
 523 natural environment in general. The propagation, sowing, planting, import/export, transport and selling of
 524 these 24 species (incl. *A. saligna*) are hence prohibited (MEPA 2013).

525 Importantly, due to the fact that besides olive (*Olea europaea*), *Xylella fastidiosa*-Codiro strain can infect
 526 *Acacia saligna* (as detailed above), there are ongoing restrictions on the movement of *A. saligna* in
 527 Europe and in the European Union. For example, in the **Republic of Montenegro**, pursuant to Article 12,
 528 paragraph 5 of the Law on Plant Health Protection (“Official Gazette of the Republic of Montenegro”,
 529 number 28/06 and “Official Gazette of Montenegro”, number 2 8/11 and 48/15), the Ministry of
 530 Agriculture and Rural Development passed the Order on prohibition of introduction of a list of plant
 531 (including *Acacia saligna*) for the purpose of preventing the introduction and spreading of *Xylella*
 532 *fastidiosa*.

533 In **Portugal** *Acacia saligna* is listed in the annex I of Decreto-Lei n. 565/99, of the 21st December 1999
 534 (under the name of *Acacia cyanophylla* Lindley). This law regulates the introduction of non-native
 535 species and lists the non-native species in Portugal, indicating which are considered invasive and
 536 prohibiting the introduction of new species (with some exceptions). Furthermore, the legislation prohibits
 537 the possession, cultivation, growing and the trade of species that are considered invasive or of ecological
 538 risk.

539 In Cyprus, in an effort to minimise the impacts of invasive plant species on biodiversity, the Department
 540 of Forests has banned the use of known invasive species (i.e. *Acacia saligna*, *Ailanthus altissima*,
 541 *Dodonaea viscosa*) in all kinds of plantations, including those in inhabited areas and disturbed sites
 542 (Tsintides and Christou, 2011).

543 **Israel**

544 *Acacia saligna* is considered to be an invasive species in Israel and is included in a recent list of “Israel's
 545 Least Wanted Alien Ornamental Plant Species”. Although this “black list” does not currently appear to
 546 have any legislative basis, it is being used by the Israel Ministry of Environmental Protection to advise
 547 planners on non-native species to avoid in planting schemes (Dufour-Dror, 2013b).

548 **South Africa**

549 South Africa has several regulations on invasive alien species. In particular, the art 70 of the National
 550 Environmental Management: Biodiversity Act, 2004 (Government Gazette, Republic of South Africa,
 551 Vol. 467, 7 June 2004 No. 26436) required the Minister to publish a national list of invasive species
 552 which require a range of control measures, including monitoring, removal and permits if these plants are
 553 found on private property. On the basis of the Biodiversity Act, and according to the Conservation of

¹³ https://keyserver.lucidcentral.org/weeds/data/media/Html/acacia_saligna.htm

554 Agriculture Resources Act 1983 (Act 43 of 1983) *Acacia saligna* is listed as “CARA 2002 – Category 2
555 NEMBA¹⁴ – Category 1b”¹⁵.
556
557

¹⁴ Invader plants may be grown under controlled conditions in permitted zones. No trade in these plants.

¹⁵ <http://www.invasives.org.za/component/k2/item/209-port-jacksons-willow-acacia-saligna> - **Category 1b**: invasive species that may not be owned, imported into South Africa, grown, moved, sold, given as a gift or dumped in a waterway. Category 1b species are major invaders that may need government assistance to remove. All Category 1b species must be contained, and in many cases, they already fall under a government sponsored management programme.

558

559 **2.6 - Distribution**

560

| <i>Continent</i> | <i>Distribution</i> | <i>General comments on the pest status in the different countries where it occurs according to the cited references</i> | <i>References</i> |
|------------------|---------------------|---|--|
| <i>Africa</i> | Algeria | Introduced in the 1870s, widely planted/cultivated and naturalized | El Lakany (1987); Le Houerou (2000); Amrani <i>et al.</i> (2010); Boufennara <i>et al.</i> (2013); Thompson <i>et al.</i> (2015) |
| | Angola | Introduced, only-planted | Rejmánek <i>et al.</i> (2017) |
| | Botswana | Introduced, Naturalised and Invasive | Mmolotsi <i>et al.</i> (2013) |
| | Cape Verde | Introduced in 1988 for provenance trials | Sandys-Winsch and Harris (1992) |
| | Egypt | Introduced and Invasive | El Lakany (1987); El Shaer (2000); Abd El-Gawad and El-Amier (2015) |
| | Ethiopia | Introduced in 1870 | Tamir and Asefa, (2009); Thompson <i>et al.</i> (2015) |
| | Kenya | Introduced around 1934, recorded still surviving in 1962 in the Nairobi Arboretum | Street (1962); Lehmann <i>et al.</i> (1999); Droppelman <i>et al.</i> (2000) as reported by Thompson <i>et al.</i> (2015) |
| | Libya | Introduced in 1870, widely cultivated and Naturalised, but not considered Invasive | Le Houerou (2000); Thompson <i>et al.</i> (2015) |
| | Morocco | Introduced, cultivated and Naturalised. By 1926 about 500,000 plants were planted to stabilise dunes near Mogador. | Jaccard (1926) as reported by Pavari and De Philippis (1941); Le Houerou (2000); Chambouleyron (2012). |
| | Somalia | Introduced | Bowen (1988); Thulin (1993) |
| | South Africa | Introduced to South Africa since 1833 and on at least five further separate occasions between 1845 and 1922, with over 200 million seeds introduced during this period. Naturalized and Invasive. | Poynton (2009) as reported by Thompson <i>et al.</i> (2011, 2015) |
| | Tanzania | Introduced for forest trials but not successfully established in Zanzibar with seeds from Cyprus and South Africa | Streets (1962); Kessy (1987) |
| | Tunisia | Introduced in the 1930s, widely cultivated and Naturalised, but not considered Invasive | Tiedeman and Johnson (1998); Le Houerou (2000); Derbel <i>et al.</i> (2009) |
| | Uganda | Introduced and cultivated/planned in the savannah zone and dry north-eastern lands | Dale (1953); Streets (1962) |

| | | | |
|-------------------------------|---------------------|---|--|
| | Zimbabwe | Introduced for reclamation of mine dumps and as ornamental | Biegel (1977); Gwaze (1987) |
| North America | Arizona | Introduced, only cultivated | Ebinger and Seigler (2014) |
| | California | Introduced and Naturalised | http://www.hear.org/pier/wra/pacific/Acacia_saligna.pdf |
| | Florida | Introduced, only cultivated | Atlas of Florida Plants, at: http://florida.plantatlas.usf.edu/Plant.aspx?id=4383 |
| | Hawaii | Introduced in 1959-1960 in the Waiakea Arboretum | Richmond (1963) |
| Central America | Mexico | Introduced in forest trials and plantations in 1919 and in the period 1934-1940 | Carabias <i>et al.</i> (2007); CONABIO (2008) |
| South America | Bolivia | Introduced and cultivated/planted | Killeen <i>et al.</i> (1993) |
| | Brazil | Introduced in 1883 | Albuquerque (1889) |
| | Chile | Introduced in 1908, Naturalised and Invasive | Perret <i>et al.</i> (2001); Rojas <i>et al.</i> (2011); Gutierrez <i>et al.</i> (2011); CABI (2017) |
| Asia & Middle East | Turkey | Introduced and Naturalised | Uludağ <i>et al.</i> (2017) |
| | Iran | Introduced and Naturalised | Irian <i>et al.</i> (2013) |
| | Iraq | Introduced and Invasive | Ministry of Environment, Republic of Iraq (2014) |
| | Israel | Introduced in 1920 and Invasive | Thompson <i>et al.</i> (2015); Cohen and Bar (2017) |
| | Jordan | Introduced and Invasive | Odat <i>et al.</i> (2011) |
| | Saudi Arabia | Introduced and Naturalised | Fadl <i>et al.</i> (2015) |
| Europe | Albania | Introduced and Naturalised | Rakaj <i>et al.</i> (2013) |
| European Union | Croatia (EU) | Introduced, cultivated, becoming casual | Flora Croatica Database, as reported by Giovanetti <i>et al.</i> (2014) |
| | Cyprus (EU) | Introduced, Naturalised and Invasive | Unwin (1926) reported by Pavari and De Philippis (1941); Streets (1962); Meikle (1977); Christodoulou (2003); Gutierrez <i>et al.</i> (2011); Hand <i>et al.</i> (2011); The Administration is the civil |

| | | | |
|----------------|---|---|--|
| | | | government of the Sovereign Base Areas (SBBA, 2017); Pescott et al. (2018) |
| | France (EU) including the island of Corsica | Introduced, Naturalised and Invasive | Fried (2012); http://www.gt-ibma.eu/espece/acacia-saligna/ For Corsica: Jeanmonod (2015) |
| | Greece (EU) including the islands of Crete; Kithira and Rhodes | Introduced and Naturalised | Arianoutsou <i>et al.</i> (2010), <i>cf.</i> Galanos (2015) for Rhodes, for Yannitsaros (1998) for Kithira |
| | Italy (EU) including the islands of Sardinia & Sicily and many other small islands | Introduced since 1827 and later on widely planted for reforestation and dune stabilization (e.g. in Sardinia), Naturalised and Invasive | Maniero (2000); Celesti-Grapow <i>et al.</i> (2009, 2010); Bazan and Speciale (2002); Del Vecchio <i>et al.</i> (2013): for small Italian islands see Domina and Mazzola (2008); Celesti-Grapow <i>et al.</i> (2016) |
| | Malta (EU) | Introduced and Invasive | Shine <i>et al.</i> (2008) |
| | Portugal (EU) including Azores and Madeira | Introduced in 1869, Naturalized becoming Invasive | Gutierrez <i>et al.</i> (2011); Thompson <i>et al.</i> (2015) For Madeira Menezes (1914) as reported by Da Silva Vieira (2002). |
| | Spain (EU) including Balearic Islands. & Canary Islands | Introduced in the XIX century, Naturalized and Invasive | San-Elorza <i>et al.</i> (2004); Gutierrez <i>et al.</i> (2011); For Mallorca: http://herbarivirtual.uib.es/cas-uv/especie/4142.html For Canary Islands see, e.g., Kukel (1969); García Gallo <i>et al.</i> (2008) |
| Oceania | Australia (Western) Australia (New South Wales, Queensland, Tasmania and Victoria) | Native/endemic Translocated, Naturalised and Invasive. | Maslin (1974); Virtue and Melland (2003); Maslin <i>et al.</i> (2006) |
| | New Zealand | Introduced and Naturalised | Heenan <i>et al.</i> (2004); Thompson <i>et al.</i> (2015); (GBIF, 2017) |

561

562 **2.6.1 Distribution: generalities**

563 *Acacia saligna* is native (endemic) to Western Australia. It has been introduced in many other regions of
564 the world and has naturalised mostly in Mediterranean basin, in South Africa and California (USA)
565 (CABI, 2017). It is one of the most invasive woody species in Spain (Sanz-Elorza *et al.*, 2004), in Israel
566 (Dufour-Dror, 2013a, b), in Cyprus and Portugal, invading sand dunes (Marchante and Marchante, 2005).

567 *A. saligna* was exported from Australia on a few occasions in the 1800s, but widespread dissemination
 568 only occurred with the formation of the Australian Tree Seed Centre in 1962 (Griffin *et al.*, 2011). The
 569 global distribution of *A. saligna* was ascertained from a wide variety of sources as reported in the table.
 570 Additional information on its distribution outside the European Union can be retrieved also from the
 571 GIASIPartnership¹⁶ web site.

572 Africa

573 It was introduced in North Africa (e.g., in 1870 in Algeria), in other African countries and in the Middle
 574 East and largely used for stabilizing dunes, for combating desertification (Amrani *et al.*, 2010) and for
 575 agroforestry, due to its ability to thrive on sand and soils of high pH and in dry areas (Midgley and
 576 Turnbull, 2003). It is considered invasive or potentially invasive only in parts of North Africa (e.g.
 577 Algeria and Morocco) and Kenya (Thompson *et al.*, 2015). In the driest regions, such as Egypt, small
 578 plantations or trials/experimental fields are occasionally irrigated.

579 *Acacia saligna* was introduced to South Africa on at least five separate occasions between 1845 and 1922,
 580 with over 200 million seeds introduced during this period (Cronk and Fuller, 1995; Poynton, 2009;
 581 Thompson *et al.*, 2011) but it might have been introduced even earlier, around 1833, according to Cronk
 582 and Fuller (1995). It is now considered as one of the most important invasive alien plant species in the
 583 Cape Fynbos floristic region of South Africa (Thompson *et al.*, 2011, 2015).

584 Asia and the Middle East

585 *Acacia saligna* was introduced to many Countries both in Asia and the Middle East. The introduction of
 586 *A. saligna* from Australia into Israel was started by the British at the beginning of the twentieth century
 587 and continued by the Jewish National Fund's (JNF) forestation department for about 50 years. Due to its
 588 rapid growth rate over a broad ecological range, it was chosen for preventing soil erosion, stabilisation of
 589 mobile dunes and as a legume fodder plant in semi-arid and arid regions (Leher *et al.*, 2011). Since being
 590 planted in Israeli coastal sand dunes, *A. saligna* has spontaneously spread rapidly. This has caused
 591 significant undesired changes, from the biodiversity and conservation point of views, to the entire features
 592 of the ecosystem and to the regional biodiversity as a whole (Leher *et al.*, 2011 and reference cited
 593 therein).

594 Europe and the European Union

595 *Acacia saligna* was introduced in the coastal areas of several European countries (e.g., Pescotte *et al.*,
 596 2018), mainly for sand dunes stabilisation, and for afforestation, in the Mediterranean biogeographical
 597 region. It is considered naturalised and, in many cases, also invasive, for example in sand dune habitats
 598 (e.g., Gutierrez *et al.*, 2011; Arrigoni, 2010; Meloni *et al.*, 2013). The distribution for the European Union
 599 is provided in the above table (Cf Table 2.6). **There is available information for 8 Member States** (over
 600 28). Importantly, the information on the presence and distribution herewith reported is in accordance with
 601 the Euro+Med PlantBase (The information resource for Euro-Mediterranean Plant Diversity)¹⁷.
 602 According to the available literature, **we can exclude (with low uncertainty) the presence of**
 603 **naturalised populations of *A. saligna* in the following 20 EU Member states:** Austria, Belgium,
 604 Bulgaria, Czech Republic, Denmark, Estonia, Finland, Germany, Hungary, Ireland, Latvia, Lithuania,
 605 Luxembourg, Netherlands, Poland, Romania, Slovakia, Slovenia, Sweden and United Kingdom. However,
 606 we cannot exclude, for these 20 countries, the presence of *A. saligna* in confined environment (Botanic
 607 Gardens, Arboreta etc.), or in forest trials or for other purposes.

608 In the Mediterranean region, two apparently different 'morphs' of *A. saligna* were recognized by Le
 609 Honerou (2002), i.e. an arborescent form with broad phyllodes and a form with a bushy habit and narrow
 610 phyllodes, but in the lack of further investigations these can simply be two forms of *A. saligna* subsp.
 611 *saligna*.

612 North, Central and South America

¹⁶ <http://giasipartnership.myspecies.info/en>

¹⁷ <http://ww2.bgbm.org/EuroPlusMed/PTaxonDetail.asp?NameId=20743&PTRefFk=8500000> [Accessed 28 October 2017].

613 As reported in the table, *A. saligna* has been introduced in many States in the American continent. In
614 particular, according to Mora *et al.* (2010) the Chilean governmental agencies have projected a potential
615 surface of more than a million hectares for plantations with this species; most of them susceptible to be
616 covered with the Law Decree 701 for forest foster (Mora and Meneses, 2004).

617 **Oceania**

618 *Acacia saligna* is native (endemic) to Western Australia, and has been translocated to southern and
619 eastern Australia, and is now naturalized and locally invasive from South Australia and Victoria to
620 Queensland (Stanley and Ross, 1983).

621

622

623

624 **2.7 - Habitats and where they occur in the PRA area**

625

| Habitat type (main) | EUNIS/HD habitat types | Status of habitat (e.g. threatened or protected) | Is the pest present in the habitat in the PRA area (Yes/No) | Comments (e.g. major/minor habitats in the PRA area) | Reference |
|-------------------------|---|--|---|--|---|
| Coastal habitat | <p>B1: Coastal dunes and sandy shores (Partly threatened)</p> <p>Code HD 2130*: Fixed coastal dunes with herbaceous vegetation (grey dunes)</p> <p>Code HD 2150*: Atlantic decalcified fixed dunes (<i>Calluno-Ulicetea</i>)</p> <p>Code HD 2230: <i>Malcolmietalia</i> dune grasslands</p> <p>Code HD 2250*: Coastal dunes with <i>Juniperus spp</i></p> <p>Code HD 2260: <i>Cisto-Lavenduletalia</i> dune sclerophyllous scrubs</p> <p>Code HD 2270*: Wooded dunes with <i>Pinus pinea</i> and/or <i>Pinus pinaster</i></p> | <p>Annex I of EU Habitats Directive (92/43/EEC):</p> <p>2130, 2250 and 2230.</p> <p>(Particularly vulnerable to disturbance and habitat modification)</p> <p>2130, 2150 and 2250 are considered a priority habitat for conservation.</p> | Yes | Common habitat type within PRA area | <p>Gutierrez <i>et al.</i> (2011); Del Vecchio <i>et al.</i> (2013); Stanisci <i>et al.</i> (2014); Farris <i>et al.</i> (2013)</p> <p>For Portugal: Marchante and Marchante (2005)</p> |
| Heathlands Scrub | <p>EUNIS F5 (Maquis, arborescent matorral and thermo-Mediterranean brushes)</p> <p>Code HD 5140*: <i>Cistus palhinhae</i> formations on maritime wet heaths</p> <p>Code HD 5220*: Arborescent matorral with <i>Zyziphus</i></p> <p>Code HD 1520*: Gypsum steppes, <i>Gypsophiletalia</i></p> <p>Code HD 5410; West Mediterranean clifftop phrygas (<i>Astragalo-Plantaginetum subulatae</i>)</p> | <p>Annex I of EU Habitats Directive (92/43/EEC):</p> <p>1520, 5140, 5220 and 5410.</p> <p>1520, 5140 and 5220 are considered a priority habitat for conservation.</p> | Yes | Common habitat type in the PRA Area | <p>Hadjikyriakou and Hadjisterkotis (2002);</p> <p>Fried (2010), Manolaki <i>et al.</i> (2017);</p> <p>For Portugal: Marchante and Marchante (2005)</p> |

626

627

| | | | | | |
|---|---|--|-----|-------------------------------------|--|
| Riparian wetlands and salt marshes | Code HD 1310: <i>Salicornia</i> and other annuals colonizing mud and sand | | | | |
| | Code HD 1410 Mediterranean salt meadows (<i>Juncetalia maritimi</i>) | Annex I of EU Habitats Directive (92/43/EEC): 1310, 1410 and 1420. | Yes | Common habitat type in the PRA Area | Hadjichambis (2005); Peyton and Mountford (2015) |
| | Code HD 1420: Mediterranean and thermo-Atlantic halophilous scrubs (<i>Sarcocornetea fruticosi</i>) | | | | |

628

629 HD habitats (* = priority habitat): Council Directive 92/43/EEC of 21 May 1992 on the conservation of
630 natural habitats and of wild fauna and flora. Codes in the table follow The Interpretation Manual of
631 European Union Habitats - EUR 28 (April 2013)¹⁸. Information about the EUNIS classification can be
632 found at: <http://eunis.eea.europa.eu/about>.

633

634 As summarised in the above table, a wide range of habitat types are currently invaded and threatened by
635 *A. saligna* within the PRA area, such as coastal dunes, heathlands, scrub formations, riparian wetlands and
636 salt marshes (see e.g Hadjikyriakou and Hadjisterkotis, 2002; Christodoulou, 2003; Gutierrez *et al.*, 2011;
637 Del Vecchio *et al.*, 2013; Souza-Alonso *et al.*, 2017).

638

639

¹⁸ http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf

640

641 **2.8 - Pathways for entry**

| Possible pathway | Pathway: Plants for planting |
|--|--|
| Short description explaining why it is considered as a pathway | <p><i>Acacia saligna</i> is commonly available on the market (and on-line) as seeds and live plants in pots. It is used in the PRA area as an ornamental species and for other purposes and therefore often planted also in the environment. According to the CBD terminology (UNEP/CBD/SBSTTA/18/9/Add.1, 26 June 2014) this pathway (plants for planting) can therefore be linked both to escape and release.</p> <p>For example (plants for planting):</p> <p>http://www.murgivivai.it/ita/piante-flora-mediterranea.asp</p> <p>http://www.jardin-du-sud.com/</p> <p>http://site.plantes-web.fr/cavatore/785/notre_histoire.htm</p> <p>No documented evidence and quantitative data of recent (last 10 years) imports of <i>Acacia saligna</i> from Australia to the European Union was found. However, as documented by Griffin <i>et al.</i> (2011), the Australian Tree Seed Centre (ATSC) had and still has a very important role in the international dissemination of Australian acacias. The ATSC despatched samples of 322 taxa (or roughly a third of <i>Acacia</i> species native to Australia) between 1980 and 2010 to 149 countries¹⁹. According to Griffin <i>et al.</i> (2011), in the period 1980-2010 the ATSC despatched 29 seeds lots of <i>Acacia saligna</i> to Europe and North America, and 56 to the Mediterranean region and Middle East, thus, very likely, also to Member States of the European Union.</p> <p>In addition, on the web, such as in internet <i>fora</i> of garden hobbyists, in many cases, information of direct imports of seed from Australia to the European Union is found. A plethora of Australian nursery do sell on-line <i>Acacia saligna</i> seeds, for example:</p> <p>https://www.nindethana.net.au/Product-Detail.aspx?p=274</p> <p>http://www.australiannativenursery.com.au/</p> <p>http://www.australianplants.com/plants.aspx?id=1501</p> <p>http://australianseed.com/shop/item/acacia-saligna</p> <p>https://www.austrahort.com.au/shop/product/233-acacia-saligna</p> <p>http://www.csiro.au/ATSCOrdering/AvailableSeedlots.aspx?SpeciesId=314</p> |
| Is the pathway prohibited in the PRA area? | In some Meber States Yes, as reported in section 2.5. |
| Has the pest already intercepted on the pathway? | Yes |
| What is the most likely stage associated with the pathway? | Seeds and plants. |
| What are the important factors for association with the pathway? | <i>Acacia saligna</i> is commonly available on the market (and on-line) as seeds and live plants in pots. |

¹⁹ Among those 149 countries, the following EU Member States imported *Acacia* spp. seeds: Austria, Cyprus, Belgium, Denmark, Italy, France, Germany, Hungary, Ireland, The Netherlands, Portugal, Spain, Sweden and United Kingdom.

| | |
|---|--|
| Is the pest likely to survive transport and storage along this pathway? | Yes, seeds will easily survive transport and storage |
| Can the pest transfer from this pathway to a suitable habitat? | Yes. The species is often planted close to or inside natural habitats where the species can establish. |
| Will the volume of movement along the pathway support entry? | <i>Acacia saligna</i> is already introduced and established in significant part of the PRA area. There is only limited available information on the quantity of germplasm (mostly seeds) that is presently imported in the EU from the native range. Importantly, very likely, and due to its old introduction, <i>A. saligna</i> is mostly propagated within the PRA area. However, new provenances, new cultivated varieties or intra-specific hybrids might be introduced in the PRA in the near future, e.g., for bioenergy related purposes. |
| Will the frequency of movement along the pathway support entry? | Yes (we consider herewith “further entry” as <i>A. saligna</i> is already introduced and established in significant part of the PRA area). |

642

| Pathways for entry: Plants for planting | | | |
|---|-----|----------|------|
| Rating of the likelihood of entry for the pathway, plants or seeds for planting | LOW | Moderate | High |
| Rating of uncertainty | LOW | Moderate | High |

643

644 2.9 - Likelihood of establishment in the natural environment in the PRA area

645 *Acacia saligna* has already established and has been described as invasive in different natural ecosystems
646 within the Mediterranean biogeographical region of the European Union as detailed in sections 2.6-2.7,
647 especially in **Cyprus**²⁰, **Italy**, **Portugal** and **Spain**. Establishment in coastal dunes, heatlands, scrub
648 formations, riparian wetlands and salt marshes is well documented (e.g., Hadjikyriakou and
649 Hadjisterkotis, 2002; Christodoulou, 2003; Gutierrez *et al.*, 2011; Del Vecchio *et al.*, 2013; Souza-
650 Alonso *et al.*, 2017). In addition, many LIFE projects are dedicated to *A. saligna* local eradication or
651 control in protected areas.

652 Domina and Mazzola (2008) studied the ornamental flora of the islands surrounding Sicily (Italy). They
653 reported the presence of *Acacia saligna* as cultivated species in the following islands: **Ustica**, Alicudi,
654 **Filicudi**, Salina, Lipari, **Vulcano**, **Panarea**, **Stromboli**, Linosa, Lampedusa, **Pantelleria**, Marettimo,
655 **Favignana** and **Levanzo**. In particular, *Acacia saligna* was recorded as naturalised over 8 of the 14
656 investigated islands (highlighted in bold). Similarly, Celesti-Grapow *et al.* (2016), showed that *Acacia*
657 *saligna* was one of the most widespread non-native vascular plant species in a set of 37 Italian small
658 islands, being recorded as naturalised or invasive on 16 of those islands.

659 The present establishment in the PRA area is due to *A. saligna* specific characteristics, such as
660 adaptability to many environmental conditions, high seed production, large seed bank, vegetative
661 propagation, resiliency to fires, rapid growth rates, ornamental value and many other uses that certainly
662 promote a higher propagule pressure (Maslin and McDonald, 2004). The increase in fire frequency and
663 intensity in the Mediterranean biogeographical region (Jolly *et al.*, 2013)²¹ is likely to reinforce its

²⁰ Cf. e.g., the Fourth National Report to the United Nations Convention on Biological Diversity, dated 2010, prepared by the Cyprus Department of Environment, Ministry of Agriculture, Natural Resources and Environment (<https://www.cbd.int/doc/world/cy/cy-nr-04-en.pdf>).

²¹ According to the study of Jolly *et al.* (2013), the European Mediterranean forests are susceptible to significant changes: the inner-quartile range of fire weather season length trends indicated a lengthening of 12 to 19 days, with

664 populations. There is a high likelihood of further establishment in the environment in the Southern part of
 665 the European Union; it is however unlikely to establish in northern Europe because it is unlikely to grow
 666 in areas that regularly experience temperatures below freezing (Hobbs *et al.*, 2009).

667

| Rating of the likelihood of establishment in the natural environment in the PRA area | | | |
|--|------------|----------|-------------|
| <i>Rating of the likelihood of establishment in the natural environment</i> | Low | Moderate | HIGH |
| <i>Rating of uncertainty</i> | LOW | Moderate | High |

668

669 2.10 - Likelihood of establishment in managed environment in the PRA area

670 *Acacia saligna* has also established and become invasive in managed environments within the European
 671 Union, including in tree plantations, in agricultural fields, in dunes and along road verges, where it has
 672 been planted e.g. for windbreak, soil protection and landscaping functions (Hadjikyriakou and
 673 Hadjisterkotis, 2002; Christodoulou, 2003; Gutierrez *et al.*, 2011, del Vecchio *et al.*, 2013).

674 As for other Australian acacias, periodic soil disturbances by man from road and other infrastructure
 675 works are assisting *A. saligna*'s establishment by breaking dormancy, scrying the hard seed coat,
 676 providing an ideal substrate for seedling establishment and promoting re-sprouting. In managed
 677 environment, soil disturbance by man play a role similar to periodic disturbance from a natural fire
 678 regime (Spooner *et al.*, 2004; Hobbs *et al.*, 2009).

679

| Rating of the likelihood of establishment in the managed environment in the PRA area | | | |
|--|------------|----------|-------------|
| <i>Rating of the likelihood of establishment in the managed environment</i> | Low | Moderate | HIGH |
| <i>Rating of uncertainty</i> | LOW | Moderate | High |

680

681 2.11 - Spread in the PRA area

682

683 2.11.1 - Natural spread

684 *A. saligna* can flower within 2-3 years and set profuse seed crops from 6 years; it is extremely fecund,
 685 with an annual seed-fall exceeding 2,000 seeds/m² in dense infestations (Holmes, 1990b; Virtue and
 686 Melland, 2003; McDonald *et al.*, 2007)²². The vast majority of seeds are rapidly shed underneath parent
 687 trees and declines rapidly when moving away from the canopy; they are adapted to dispersal by ants that
 688 carry them over a few meters and bury them in subterranean nests generating soil-stored seed banks
 689 (Milton and Hall 1981, O'Dowd and Gill, 1986; Holmes, 1990a, b; French and Major, 2001). Seeds may
 690 also be transported over longer distances by water due to buoyant pods, as highlighted by rapid invasion
 691 of riparian areas. Rodents and birds (e.g., starlings and doves) may also play some role in plant dispersal

a maximum increase of nearly a month (29 days) from 1979 to 2013. This is consistent with a lengthening of the fire weather season in Spain during 2012 where fires burned more area than any year in the previous decade.

²² The maximum recorded value of annual seed rain of *Acacia saligna* in the invaded range (South Africa) is 5,443 seeds/m² (Milton and Hall, 1981 as reported by Richardson and Kluge, 2008).

692 (Cronk and Fuller, 1995; Mehta, 2000; Muyt, 2001). Pods with seeds might be dispersed by wind (Danin,
693 2000).

694 *A. saligna* also reproduces vegetatively. Following cutting, fire and soil disturbance, it resprouts
695 vigorously from stump and produces root suckers that could trigger the establishment of large and dense
696 clonal stands (Virtue and Melland, 2003; Gibson *et al.*, 2011; Souza-Alonso *et al.*, 2017) [Figure 4 –
697 Appendix 1]. However, the suckering capacity is highly dependent on subspecies. Clonal reproduction via
698 root suckering is exhibited most strongly in *A. saligna* subsp. *stolonifera* and *A. saligna* subsp.
699 *pruinescens*; reproduction predominantly via seed production and low propensity for root suckering are
700 traits associated with *A. saligna* subsp. *saligna* and *A. saligna* subsp. *lindleyi* (see Table 1). As a result,
701 there may be little evidence of clonal reproduction in some naturalised populations such as those found in
702 the Fleurieu peninsula in South Australia originating from *A. saligna* subsp. *saligna* Eastern populations
703 (Maslin *et al.*, 2006; McDonald *et al.*, 2007; Millar and Byrne, 2012).

704

705 2.11.2 - Human-mediated spread

706 The spread of *A. saligna* is strongly enhanced by both deliberate and accidental introduction by humans.
707 Long-distance movements mostly result from intentional plantations for soil protection, amenity and the
708 production of wood, fodder, tannin and other uses (Maslin and McDonald, 2004). Seeds and root sucker
709 fragments are frequently transported on long distances with soil movements, wherein they can survive for
710 long periods in a dormant stage before germinating. Human disturbance in suburban areas and along
711 roads and railways, road works and constructions also favour species spread and local establishment
712 (Cronk and Fuller, 1995; Muyt, 2001; Spooner *et al.*, 2004; Hobbs *et al.*, 2009; Gibson *et al.*, 2011;
713 Wilson *et al.*, 2011; Millar and Byrne, 2012).

714 Importantly, as documented in the Report on the implementation of the Action Points of
715 Recommendation No. 155 (2011) of the Standing Committee to the Bern Convention on the Illegal
716 Killing, Trapping and Trade of Wild Birds²³, *Acacia saligna* in **Cyprus** is nowadays mainly planted by
717 illegal bird trappers.

718 *A. saligna* is known to expand into large areas while creating homogenous landscapes (Witkowski,
719 1991a; Lehrer *et al.*, 2013). In Israeli coastal dunes, its cover grew by 166% over 34 years, at an annual
720 growth rate of 2.92% which exceeds this of native vegetation; in this area, *Acacia* expansion is strongly
721 facilitated by the exploitation of sand quarries causing topsoil movements and runoff of surface water
722 (Bar *et al.*, 2004). In South Africa's Agulhas Plain, an active dispersion is observed from initial plantation
723 sites to undisturbed shrublands; local regression models predicted a cover of 50% and 5% for *A. saligna*,
724 respectively at 450 m and 5,000 m from sites of initial introduction as a result of combined effect of
725 natural and human assisted spread (Rouget and Richardson, 2003; Yelenik *et al.*, 2004).

726 **Where planted or established far from watercourses and in absence of human mediation, *A. saligna***
727 **seeds will not be dispersed on long distances and the plant is unlikely to spread very fast in the**
728 **environment. On the contrary, a much faster spread is expected in riparian zones and because of**
729 **soil movements from invaded areas. As a consequence, the overall rate of spread within the**
730 **European Union is assessed as moderate.**

731

| Magnitude of spread in the PRA area | | | |
|--|------------|-----------------|-------------|
| <i>Rating of the magnitude of spread</i> | <i>Low</i> | MODERATE | <i>High</i> |

²³ Council of Europe, Bern Convention, document T-PVS/Inf (2013) 13, Strasbourg, 22 July 2013, Second Conference on the Illegal killing, Trapping and Trade of Wild Birds, Tunis (31 May 2013). As reported in Scalera *et al.* (2017), *Acacia* spp. are favored by locals involved in illegal bird trapping activities (lime-sticks) due to their ability to vigorously grow and occupy an area. It is a common practice for them to plant and tend these species since they provide resting places for birds and a perfect spot for placing limesticks. Bird-trapping creates a negative image for the island abroad, with serious impact on tourism (LIFE13 NAT/CY/000176).

| Rating of uncertainty | LOW | Moderate | High |
|-----------------------|-----|----------|------|
|-----------------------|-----|----------|------|

732

733 **2.12 Impact in the current area of distribution**

734 The belief in ‘miracle’ plants like Australian acacias that can lift people quickly out of poverty is
735 problematical, because such plants have the attributes of weeds - vigorous growth in degraded conditions
736 - and often escape human control, degrading rather than improving land (Low, 2012). As described in
737 section 2.2, Australian acacias often acquire, utilize and conserve limiting resources in invaded
738 ecosystems better than native plants, which give them a strong competitive advantage and allows them to
739 faster reach high size and biomass both as seedlings and as adults. Their initial high relative growth rates
740 allow them to overtop native vegetation and outcompete natives for light that can hardly survive under its
741 dense canopy (*A. saligna* is 123 % taller than a fynbos biome species in South Africa, *Protea repens*).
742 Greater below-ground investment combined with mycorrhizal and N₂-fixing symbioses enables access to
743 both water and nutrients needed to sustain growth (Witkowski, 1991b; Morris *et al.*, 2011). Another
744 important invasive key trait of *A. saligna* is the accumulation of massive persistent seed banks in the soil
745 that may exceed 40,000 per m² under tree canopy²⁴ and which enables it to rapidly accumulate biomass
746 and become dominant after soil and fire disturbances promoting seed germination, thus establishing a
747 reinforcing feedback loop that promotes its own abundance (Holmes *et al.*, 1987; Le Maitre *et al.*, 2011;
748 Gaertner *et al.*, 2014).

749 *A. saligna* strongly impacts native biodiversity and ecosystems it invades, especially where it makes
750 dense thickets. Negative consequences of its establishment and spread are documented from different
751 regions in the world, mainly from South Africa where it is recognized as a major invader (Nel *et al.*,
752 2004), but also from Eastern Australia, Middle East and Chile (CABI, 2017).

753 Similarly to other Australian acacias (see Figure 1 in Appendix 3), *A. saligna* is considered as a
754 transformer species that affects the ecosystems functions and processes as: structural and chemical soil
755 modifications, nitrogen fixation (which provide a competitive advantage over the indigenous vegetation
756 in the impoverished soils of the fynbos), and litter accumulation (Witkowski and Mitchell, 1987;
757 Witkowski, 1991; Musil, 1993; Stock *et al.*, 1995; Yelenik *et al.*, 2004; Jovanovic *et al.*, 2009; Abd El
758 Gawad and El-Amier, 2015). In general, acacias provide litter with different C-sources composition that
759 can affect nutrient cycling and decomposition (Ens *et al.*, 2009). In particular, *A. saligna* modifies
760 nitrogen cycling through the production of higher amounts of litter, resulting in more N being returned to
761 the soil and an increase in the availability of inorganic nitrogen (Yelenik *et al.*, 2004).

762

763 **2.12.1 - Impacts on biodiversity**

764 The invasion of natural habitats by *A. saligna* strongly affect biodiversity. In the species-rich fynbos
765 vegetation (shrublands) of the **Cape Floristic Region of South Africa**, tall, dense and persistent acacia
766 stands that develop and regenerate after fire strongly reduce abundance, species richness and diversity
767 both of the standing vegetation and the seed bank. Native species richness exhibits a marked declining
768 trend with increasing invasion cycles; dense *A. saligna* thickets threaten endemic plant species adapted to
769 a nutrient impoverished environment due to both shading and a strong increase of soil N, available P, pH
770 and organic matter (Musil and Midgley, 1990; Musil, 1993; Holmes and Cowling, 1997; Richardson and
771 van Wilgen, 2004; Yelenik *et al.*, 2004, 2007; Gaertner *et al.*, 2009; Mostert *et al.*, 2017). Areas cleared
772 of *A. saligna* in this area hardly recover in terms of soil chemical properties and vegetation composition;
773 the increase in soil pH and N availability favours the development of secondary invasion of weedy
774 grasses (e.g. *Cynodon dactylon* and *Ehrharta calycina*) and fossorial mammals after acacia stands are

²⁴ The maximum recorded value of seed bank of *A. saligna* in South Africa is 46,000 seeds/m² (Holmes *et al.*, 1987 as reported by Richardson and Kluge, 2008). In Cyprus, as reported in the final Report of the project LIFE12 NAT/CY/000758, several samples (25 x 25 cm) were taken from soil in three layers. The average number of seeds per square meter at the soil surface was estimated to be 1,648 seeds, at 0-10 cm depth was 2,160 seeds and at 10-20 cm was 400 seeds.

775 cleared for restoration purposes (Yelenik *et al.*, 2004; Holmes, 2008; Le Maitre *et al.*, 2011; Mostert *et al.*, 2017, Nsikani *et al.*, 2017). In this region, Gibson *et al.* (2012, 2013) demonstrated that prolifically
 776 flowering *A. saligna* were very attractive to honeybees and caused reduced flower visitation rate of at
 777 least one native plant species (*Roepora fulva*) with similar flowering time due to competition for
 778 pollinators whose reproductive success may be subsequently jeopardised. Its dense canopies along
 779 watercourses (35% of records in South Africa are found in riparian habitats after Morris *et al.* (2011) also
 780 shade out the habitat and threaten several species of endemic dragonflies (Samways and Taylor, 2004).
 781 Lastly, encroachment of the fynbos ecosystem by *A. saligna* affect both richness and composition of
 782 avian communities (Dures and Cumming, 2010).
 783

784 Similar effects were observed in **Israeli and Egyptian coastal sand dune ecosystems** invaded by *A.*
 785 *saligna* spreading from nearby plantations. Invasion substantially modify the structure of vegetation cover
 786 and consequently the character of these habitats. It leads the formation of a dense cover of trees instead of
 787 an open, discontinuous, dwarf shrubs and herbaceous cover and causes a strong decrease of native plant
 788 species abundance and richness and the replacement of endemic taxa accustomed to open habitats by
 789 opportunistic species due to shading, leaf-litter accumulation, modification of soil properties and
 790 groundwater level decrease (Bar *et al.*, 2004; El-Bana, 2008; Dufour-Drop, 2012; Cohen and Bar, 2017).
 791 Invasion of coastal dunes by *A. saligna* also affects small mammal communities; the stabilization of sand
 792 dunes by the alien shrub favours human commensals such as mice and rats at the expense of the
 793 psammophile rodents (e.g. *Gerbillus pyramidum*, *G. andersoni allenbyi* and *Jaculus jaculus*) (Anglister *et al.*, 2005; Manor *et al.*, 2008). Similar impacts have been reported in halophytic wetlands in Cyprus
 794 (Christodoulou, 2003).
 795

796 In **South Australia**, *A. saligna* is known to spread outside plantations, easily establishing amongst
 797 existing vegetation, make dense thickets, become dominant and outcompete native plants, incl. the local
 798 *Acacia pycnantha*. It is considered as an invasive weed with a very high WRA score in 4 different regions
 799 (Muyt, 2001; Melland and Virtue, 2002; Virtue and Melland, 2003).
 800

| Impact on biodiversity | | | |
|---|------------|----------|-------------|
| Rating of the magnitude of impact in the current area of distribution | Low | Moderate | HIGH |
| Rating of uncertainty | LOW | Moderate | High |

801

802 2.12.2 - Impact on ecosystem services

803 *Acacia saligna*, as other Australian acacias, is a typical example of an alien plant species that modify
 804 ecosystems and their disturbance regimes in ways that enhance their own persistence and suppress that of
 805 native species through reinforcing feedback processes (Mehta *et al.*, 2000; Gaertner *et al.*, 2014, 2017). It
 806 causes a wide range of impacts on ecosystems that increase with time and disturbance, transform habitats
 807 and originate modifications that are difficult to reverse (regime shift). It affects the delivery of ecosystem
 808 services and the benefits that society derives from them; it is known to disrupt provisioning, regulating,
 809 supporting and cultural services as demonstrated by studies performed in South African fynbos and
 810 riparian areas (e.g. Le Maitre *et al.*, 2011; Gaertner *et al.*, 2014).

811 In **South Africa**, several studies highlighted that economic benefits derived from the use of *A. saligna*
 812 and other Australian acacias are often exceeded by the cost of negative impacts. For example, the benefits
 813 associated to black wattle (*Acacia mearnsii*) use by commercial growers (pulp, tannin and charcoal
 814 industry) and rural users (firewood) amounted to 512 US\$ million in 1998 (1 US\$ = approximately 7
 815 South African Rands) while the costs of lost streamflow (see below) are valued at 1 371 US\$ million,
 816 which result in a benefit-cost ratio far below 1 (De Wit *et al.*, 2001; van Wilgen *et al.*, 2012). In
 817 comparison to *A. mearnsii*, *A. saligna* is much less planted and used by industrial growers in South Africa
 818 and in other regions of the world, the benefit-cost ratio is likely to be even lower and landowners often
 819 consider it as highly problematic. There are however two major exceptions to this general trend, where
 820 benefits typically exceed negative impacts: (i) *A. saligna* is used in its **native range** for revegetation and

821 restoration purposes without causing substantial environmental damage and (ii) it is also used as a multi-
 822 purpose species in arid ecosystems of **northern Africa**, where is not reported to cause adverse
 823 environmental impacts so far (Hobbs *et al.*, 2009; Kull *et al.*, 2011; Griffin *et al.*, 2011; Wilson *et al.*,
 824 2011).

825

826

827

828 *Provisioning services*

829 The strongest documented impact of Australian acacias on ecosystem services is the reduction of both
 830 river flow (surface runoff) and groundwater recharge - termed water flows - which reduces the amount of
 831 water available for agriculture, industry and other human uses in Mediterranean areas, as well as for the
 832 flows required to sustain ecosystems downstream. Invasion in riparian habitats may even lead to complete
 833 cessation of flow during the dry season (van Wilgen *et al.*, 2008; Le Maitre *et al.*, 2015; Gaertner *et al.*,
 834 2017). Due to high biomass, persistent foliage, high leaf area index and deep root system compared to
 835 native species, these invasive trees better intercept precipitation, have greater access to groundwater and
 836 have increased evapotranspiration rates which cause water flows reduction (Le Maitre *et al.*, 2000, 2011;
 837 Morris *et al.*, 2011; Catford, 2017). van Wilgen *et al.* (2008) assessed that acacias (*A. cyclops*, *A.*
 838 *longifolia*, *A. mearnsii*, *A. melanoxylon* and *A. saligna*) and other woody plants (*Eucalyptus* spp., *Hakea*
 839 spp., *Pinus pinaster* and *Prosopis glandulosa*) reduce river flow in **fynbos ecosystems** by 15% (1 064
 840 million m³ per year) and could potentially reduce it up to 37% (2,494 million m³ per year) if infestation of
 841 alien plants were to reach their full potential (see graphs in Appendix 3). Similarly, alien woody plants
 842 established in riparian ecosystems in the fynbos biome cause an annual recharge reduction of
 843 groundwater aquifers of 4.4 million m³, which can extend to 36.1 million m³ for future levels of
 844 infestations. Depending on sources, time considered, and model used, the reduction of surface water
 845 runoff due to *Acacia saligna* alone ranges from 11.7 million m³ to 209.9 million m³; although being
 846 highly significant, this reduction is less than this estimated for *A. cyclops* (28.9-487.6 million m³) and *A.*
 847 *mearnsii* (483.2-1077.4 million m³), both of them covering larger areas (Le Maitre *et al.*, 2000; Le Maitre
 848 *et al.*, 2016).

849 Australian acacias are also known to affect other provisioning services. They have been shown to increase
 850 vegetation biomass (Milton and Siegfried, 1981; Le Maitre *et al.*, 2011), but decrease the grazing capacity
 851 of pristine vegetation in South Africa (van Wilgen *et al.*, 2008).

852

853 *Regulating and supporting services*

854 Studies in dense stands of *A. saligna* in the **South African fynbos** have documented drastic changes in
 855 litterfall dynamics and nutrient cycling leading to a strong increase in organic matter and soil and
 856 groundwater nitrogen levels (Witkowski, 1991b; Richardson and van Wilgen, 2004; Yelenik *et al.*, 2004;
 857 Jovanovic *et al.*, 2009). It has been suggested that these changes may have marked effects on fire regime
 858 and that fires will be more difficult to contain and potentially more damaging to ecosystems than fires in
 859 natural vegetation because of the strong increase of fuel loads caused by the high biomass of *A. saligna*
 860 and the relative accumulation of soil organic matter. But invasion is not likely to increase significantly
 861 fire hazard compared to native shrubland under current normal weather conditions because of lower fuel
 862 energy contents and higher moisture content of foliage; however, *A. saligna* may act to enhance fire
 863 intensity under extreme weather conditions in fynbos ecosystems, that may be favoured by climate
 864 change (i.e. air temperature > 30 °C, relative humidity < 20% and windspeed > 35 km/h) (van Wilgen and
 865 Richardson, 1985; van Wilgen and Scott 2001; Richardson and van Wilgen, 2004; Le Maitre *et al.*, 2011).

866

867 *Cultural services*

868 The presence of *A. saligna* also reduces the aesthetic and recreational quality of the fynbos due to
 869 disappearance of its beautiful ericaceous flowers which attract tourists and nature photographers (Mehta,
 870 2000). Acacia invasion is also considered to have strongly reduced the aesthetic value of 2,000 ha of the

871 Nizzanim LTER nature reserve, a unique coastal dune ecosystem in Israel, and have affected tourism
872 industry in this region (Lehrer *et al.*, 2013).

873

874

| Ecosystem service (ES) | Does the pest impact on this ES | Short description of impact | Reference |
|---------------------------|---------------------------------|--|--|
| Provisioning | Yes | Decreased diversity of fibre and food resource available, wood supply increased, water supply reduced. | Le Maitre (2000); Richardson and van Wilgen (2004); van Wilgen <i>et al.</i> (2008); Le Maitre <i>et al.</i> (2011) |
| Regulating and supporting | Yes | Nutrient cycling enhanced, alteration of native soil bacterial communities, microclimate altered, flood mitigation altered, habitats simplified and original ecosystem processes disrupted | Witkowski (1991b); Richardson and van Wilgen (2004); Yelenik <i>et al.</i> (2004); Jovanovic <i>et al.</i> (2009); Le Maitre <i>et al.</i> (2011); Crisóstomo <i>et al.</i> (2013) |
| Cultural | Yes | Recreational areas degraded and tourist experience reduced | Mehta (2000); Le Maitre <i>et al.</i> (2011); Lehrer <i>et al.</i> (2013) |

875

| Impact on ecosystem services | | | |
|--|------------|-----------------|-------------|
| <i>Rating of the magnitude of impact in the current area of distribution</i> | <i>Low</i> | <i>Moderate</i> | HIGH |
| <i>Rating of uncertainty</i> | <i>Low</i> | MODERATE | <i>High</i> |

876

877 2.12.3 - Socio-economic impact

878 The cost of invasion of **South African fynbos** shrublands by invasive woody plants is huge. It has been
879 assessed that they have reduced the value of those ecosystems by over US\$ 11.75 billion amongst which
880 streamflow lost caused by *Acacia mearnsii* invasion amounts to US\$ 1.4 billion (Higgins *et al.*, 1997; van
881 Wilgen *et al.*, 2001). The annual loss of ecosystem services due to current level of infestation by *A.*
882 *cyclops*, *A. longifolia*, *A. mearnsii* and *A. saligna* in fynbos ecosystems amounted to 210 US\$ million for
883 water provisioning, 21 US\$ million for the provision of grazing for livestock and 22 US\$ million for
884 biodiversity support (data calculated from tables 3 and 4 in De Lange and van Wilgen, 2010).
885 Unfortunately, no detailed assessment is available for the cost of *A. saligna* only regardless of the huge
886 surfaces it covers in South Africa (i.e. 1 850 000 ha invaded in 2000, for a condensed area of 108 000
887 ha²⁵) (Le Maitre *et al.*, 2000).

888 The strong hydrological impact of Australian acacias in **South Africa** (see above) led to the
889 implementation of a highly coordinated program to control invasive alien tree called 'Working for
890 Water'. It was initiated by the national government in 1995 to alleviate poverty (20,000 employment

²⁵ The condensed area is the mathematical equivalent of the total invaded area with the canopy cover adjusted to 100%.

891 opportunities over 15 years) and restore hydrological services by cutting down invasive woody species.
 892 Over 1.2 million hectares were cleared within the first 8 years of the program, at a yearly cost of US\$ 35
 893 million. Management costs to clear one hectare invaded by *A. saligna* including the use of fire to deplete
 894 the soil-stored seed bank are greater than the costs of 1 man-year of labour. Clearing costs of *A. saligna* in
 895 the fynbos biome incurred through the working for water program between 1995 and 2008 were valued
 896 around US\$ 1 million per year (MacDonald and Wissel, 1992; van Wilgen *et al.*, 2008; van Wilgen *et al.*,
 897 2012; Catford, 2017). The total cost of bringing invasive alien trees and shrubs under control in South
 898 Africa is estimated to be around US\$ 1.2 billion, or roughly US\$ 60 million per year for the estimated 20
 899 years that it will take to deal with the problem. However, by introducing biological control as a factor, it
 900 was estimated that clearing costs over 20 years could be reduced to US\$ 400 million (or US\$ 20 million
 901 per year), a far more manageable target. Concerning specifically *A. saligna*, it has been assessed that the
 902 introduction of biocontrol agents since 1987 has effectively eliminated the need to proceed with
 903 expensive mechanical control programmes, yielding a return on investment of \$ 800 for every \$ 1
 904 invested in the research (van Wilgen *et al.*, 2000, 2001; Impson *et al.*, 2011).

905 Less data concerning the socio-economic impact of *A. saligna* are available from other regions. Lehrer
 906 and Bar (2011) and Lehrer *et al.* (2013) conducted a cost-benefit analysis of the conservation
 907 management program developed to reduce the risk of *A. saligna* invasion at the Nizzanim LTER nature
 908 reserve in **Israel**. Depending on technique adopted, the total eradication treatment costs ranged from 774
 909 to 1,590 US\$ per acre; one-time cost to contain or eradicate the alien tree ranges between US\$ 195,000
 910 and US\$ 400,000 which is less expensive than the annual mean willingness to pay (WTP) by visitors to
 911 protect this nature reserve.

912 In the **European Union** *A. saligna* is tackled by many LIFE projects, thus a piece of information exists
 913 on control costs, e.g., LIFE08NAT/IT/000353 (€9.40 per square meter), LIFE13 NAT/IT/000433
 914 (€17,000.00 per ha) or LIFE13 NAT/CY/000176 (€10,000.00 per ha labor cost, excluding the costs of the
 915 herbicide) (data from Scalera *et al.*, 2017), while reports from another project from Cyprus have
 916 estimated the labor cost of control at €8,630 per ha (www.care-mediflora.eu).

917 Among potential socio-economic impacts of *A. saligna*, it is important to take into account that this alien
 918 tree can be a host for *Xylella fastidiosa*-Codiroid strain. Importantly, *Olea europaea* and *Acacia saligna* are
 919 very commonly closely cultivated or planted in the Mediterranean region in the European Union.

920 Finally, *A. saligna* pollen grains have shown to be allergenic in Iran, according to Irian *et al.* (2013).

921

| Impact on socio-economics | | | |
|---|-----|-----------------|-------------|
| Rating of the magnitude of impact in the current area of distribution | Low | Moderate | HIGH |
| Rating of uncertainty | Low | MODERATE | High |

922

923 2.13. Potential and actual impact in the PRA area

924 In the European Union, *A. saligna* impacts on biodiversity mirrors the negative consequences documented
 925 in Mediterranean-type shrublands and littoral dunes of the current areas of distribution (South Africa,
 926 Middle East and Eastern Australia). Especially, sand dune ecosystems and riparian habitats are known to
 927 be invaded by large and dense thickets of the invasive shrub (i.e. the so-called ‘wattle forests’). In the
 928 **European Union** *A. saligna* is tackled by many LIFE projects, such as LIFE13 NAT/CY/000176,
 929 LIFE13 NAT/ES/000586, LIFE08NAT/IT/000353, LIFE13 NAT/IT/000433, LIFE12 NAT/MT/000182
 930 (data from Scalera *et al.*, 2017).

931 In **Cyprus**, the species has been widely planted and is currently considered amongst the most problematic
 932 invasive alien plants in the country. It creates wattle forests replacing natural vegetation and threatens
 933 several red listed plant species (e.g., *Aegilops bicornis* (Forssk.) Jaub. & Spach, *Anthemis tomentosa*,
 934 *Argyrolobium uniflorum* Jaub. & Spach, *Cladium mariscus* (L.) Pohl, *Crypsis factorovskyi* Eig, *Filago*
 935 *mareotica* Delile, *Isolepis cernua* (Vahl) Roem. & Schult., *Juncus maritimus* Lam., *Linum maritimum* L.,

936 *Malcolmia nana* (DC.) Boiss. var. *glabra* Meikle, *Neurada procumbens* L., *Ononis diffusa* Ten., *Tamarix*
 937 *hampeana* Boiss. & Heldr., Tsintides *et al.*, 2007) in sand dune ecosystems but also in riparian wetlands
 938 and salt marshes on the margins of the Akrotiri and the Larnaka lakes (EC habitats 1310, 1410 and 1420)
 939 and in arborescent matorrals with *Ziziphus* (EC habitats 5220*) (Hadjikyriakou and Hadjisterkotis, 2002;
 940 Christodoulou, 2003; Hadjichambis, 2005; Delipetrou *et al.*, 2008; Peyton and Mountford, 2015;
 941 Manolaki *et al.*, 2017). Importantly, all subpopulations of the endangered plant *Aegilops bicornis*
 942 (Forssk.) Jaub. & Spach growing on sandy beaches and stabilized dunes near sea level are threatened by
 943 *A. saligna* invasion and by tourism development (Tsintides *et al.*, 2007; Della *et al.*, 2007; Christou *et al.*,
 944 2014). In addition, Lansdown *et al.* (2016) report the risk posed by *A. saligna* on *Callitriche pulchra*
 945 Schotsm.

946 In **Italy**, as a result of frequent escape from plantations established during the 1950s for
 947 reforestation/afforestation and for sand dune stabilization purposes, it forms dense monospecific stands in
 948 Italian Mediterranean dune ecosystems (especially coastal pine dune wood (EC habitat 2270*) but also
 949 Juniper dune scrublands (EC habitat 2250*) and dune sclerophyllous scrubs (EC habitat 2260*) where it
 950 favours the development of ruderal grass species at the expense of plants typical of those protected
 951 habitats (Del Vecchio *et al.*, 2013). In **Sardinia** (Italy) it outcompetes the endemic species (Endangered
 952 according to IUCN classification) *Anchusa crispa* Viv. subsp. *maritima* (Vals.) Selvi et Bigazzi (Farris *et*
 953 *al.*, 2013) on fixed coastal dunes with herbaceous vegetation ("grey dunes", HD 2130*). Similarly, in the
 954 island of **Sicily** (Italy), *Acacia saligna* plantations are outcompeting the endemic species *Anthyllis*
 955 *hermanniae* L. subsp. *brutia* Brullo et Giusso, which is Critically Endangered (according to IUCN
 956 classification, IUCN 2001, 2003, 2006) in its Sicilian type locality (*locus classicus et unicus*), as reported
 957 by Caruso (2012). A significant number of LIFE projects in Italy are locally eradicating or controlling *A.*
 958 *saligna* in protected areas, e.g. from the habitat 2270* (HD, Wooded dunes with *Pinus pinea* and/or *Pinus*
 959 *pinaster*) as in the case of the LIFE project LIFE NAT/IT/000262 "MAESTRALE", where the presence
 960 of the non-native acacia reduces the total native diversity within the *Pinus* stands (Stanisci *et al.*, 2012),
 961 and in the Life PROVIDUNE (LIFE07NAT/IT/000519) and LIFE RES MARIS Project (LIFE13
 962 NAT/IT/000433), both in the island of Sardinia (Italy) aiming to reduce negative impacts due to the
 963 presence of *A. saligna* in the priority habitats 2250* and 2270* (Pinna *et al.*, 2015; Acunto *et al.*, 2017).
 964 In the case of the LIFE NAT/IT/000262, the presence of *A. saligna* was shown to determine an increase
 965 of the presence of ruderal and nitrophilous species such as *Geranium purpureum* e *Oryzopsis miliacea*
 966 while reducing the presence of the species that typically characterize the dune habitats *2270 and *2250,
 967 such as *Smilax aspera* and *Pistacia lentiscus* (Calabrese *et al.*, 2017).

968 In **Malta**, *Tetraclinis articulata* (Regionally Endangered, IUCN) is jeopardized by habitat modification
 969 and/or destruction (including land reclamation and the clearance of the vegetation) and human-induced
 970 disturbance, including the introduction of alien species such as *Acacia saligna* and *Eucalyptus* spp.
 971 Afforestation and reforestation programmes in its distribution range with indigenous and alien trees,
 972 which do not form part of its biotope are also important threats. Competition from invasive species such
 973 as alien *Pinus* spp. and particularly the native *P. halepensis* are also seen as threats (Sánchez Gómez *et*
 974 *al.*, 2011).

975 In Sesimbra County, **Portugal**, after being introduced for afforestation purposes, *A. saligna* has proven to
 976 be very invasive in riparian habitats and sand dunes ecosystems and threatens several priority
 977 conservation habitats: fixed coastal dunes with herbaceous vegetation (EC habitat 2130*), Atlantic
 978 decalcified fixed dunes (EC habitat 2150*) and also Juniper dune scrublands (EC habitat 2250*)
 979 (Gutierrez *et al.*, 2011). Crisóstomo *et al.* (2013) conducted a study to assess the diversity of symbiotic
 980 root-nodulating bacteria associated with *Acacia saligna*, in newly colonized areas in Portugal and
 981 Australia. their results supported the hypothesis that exotic *Bradyrhizobia* might have been co-introduced
 982 with *A. saligna* in Portugal. This result highlights the risks of introducing exotic inoculants that might
 983 facilitate the invasion of new areas and modify native soil bacterial communities, hindering the recovery
 984 of ecosystems.

985 Although no study specifically addresses the effect of *A. saligna* on ecosystem services or its socio-
 986 economic impacts within the European Union, the authors of the present PRA consider that they are
 987 similar to those documented within the current area of distribution because of similar ecological
 988 conditions and plant's behaviour. It is also assumed that *A. saligna* has a strong effect on water
 989 provisioning services and alters water balance (i.e. soil water depletion caused by increased

990 evapotranspiration) in coastal dune ecosystems of the Mediterranean basin, as it was shown for another
 991 invasive Australian acacia (*A. longifolia*) in the same habitat (Rascher *et al.*, 2011). Depending on
 992 invasion stage, shrub density and management objective (eradication, containment or mitigation), control
 993 costs may take very different values but is always dependent on the availability of substantial budgets
 994 (Dufour-Dror, 2013a; Reynolds, 2017).

995

996 Will impacts be largely the same as in the current area of distribution? **YES**

997

998 2.14 Identification of the endangered area

999 According to the climatic modelling (Appendix 4, Figure 5. a b c d) the endangered area in the European
 1000 Union is composed by significant parts of the land included in the Mediterranean Biogeographical region
 1001 in **Croatia, Cyprus, France, Greece, Italy, Malta, Portugal, Slovenia** and **Spain** and in the generality
 1002 of the Mediterranean islands (with the exception of the highest mountainous regions in Sicily, Sardinia,
 1003 Corsica, Crete). In addition, the endangered area includes also part of the Atlantic Region in Northern
 1004 Portugal and Spain and in Western France. Part of the Continental Region in Italy is included as well. The
 1005 suitability maps for the 4 *Acacia saligna* subspecies have a very similar trend and shape; however, the
 1006 total size of endangered area is higher for *A. saligna* subsp. *lindleyi*, *A. saligna* subsp. *pruinescens*, *A.*
 1007 *saligna* subsp. *stolonifera*, than in the case of *A. saligna* subsp. *saligna*. For example, the Continental
 1008 region in Italy and the Atlantic region in France are very likely not at risk from the *A. saligna* subsp.
 1009 *saligna* but only from the other three subspecies. The Black sea coast (**Bulgaria** and **Romania**) also
 1010 appears to be marginally suitable for the establishment of the '*pruinescens*' subspecies.

1011 The main limiting factor preventing further predicted suitability appears to be low winter temperatures.
 1012 Broad habitat types at risk in the endangered area include coastland, riparian wetlands, salt marshes,
 1013 heathland and scrub.

1014 We considered in the modelling the four subspecies commonly described for *Acacia saligna*.
 1015 Nevertheless, *A. saligna* subsp. *saligna* is the most important subspecies that has been commonly used as
 1016 an ornamental and in re-vegetation programmes and is likely to be the subspecies most commonly utilised
 1017 for agroforestry worldwide. Genetic contamination among the different genotypes are very likely to occur
 1018 in the native and invasive range (Millar *et al.*, 2008a). Importantly, the genetic studies in South Africa
 1019 show introduction efforts of *A. saligna* have led to an invasion that is characterized by unstructured, high
 1020 genetic diversity that is divergent from that found in pure native lineages in Western Australia (Thompson
 1021 *et al.*, 2012).

1022

1023 2.15 Climate change

1024 Climate change is altering - and will modify also in the long run - vital aspects of the environment like
 1025 temperature and precipitation, the frequency of extreme weather events, as well as atmospheric
 1026 composition and land cover. The temperature, atmospheric concentration of carbon dioxide (CO₂) and
 1027 available nutrients are the key factors that will drive species survival; changes in these factors will most
 1028 likely stress the ecosystems and the chances of invasions (Dukes and Money, 1999; Simberloff, 2000;
 1029 Dainese *et al.*, 2017). Many scientists agree that climate change will alter destination habitat and increase
 1030 vulnerability to invasion because of resource scarcity and increased competition among native fauna and
 1031 flora. It remains uncertain whether increasing concentrations of CO₂ in the atmosphere will generally
 1032 favour non-native plant species over native plant species. Some research is suggesting that elevated CO₂
 1033 concentrations might hinder the pace of recovery of some native ecosystems after a major disturbance,
 1034 like flood or fire. This could potentially lead to increased dominance of invaders in some regions (Dukes
 1035 and Money, 1999).

1036 In addition, global environmental changes could create novel environments and directly increase the
 1037 availability of plant resources. Alien plants often exhibit broad environmental tolerance and high
 1038 phenotypic plasticity, facilitating their successful growth in novel environments with high resource
 1039 availability (Jia *et al.*, 2016 and references cited therein).

1040 According to the **climatic projection for 2070**, the endangered area in the European Union will increase
 1041 compared with the projection in the current climate (**Appendix 4, Figure 6**). The model outputs
 1042 highlighted a high suitability for *Acacia saligna* s.l. in the Mediterranean Biogeographical region in
 1043 Croatia, Cyprus, Italy, France, Greece, Malta, Portugal, Slovenia and Spain, and in the generality of the
 1044 Mediterranean islands, as well as in the Black Sea Biogeographical region in Bulgaria and Romania. In
 1045 addition, the model outputs showed a high suitability also in the Atlantic Region of Belgium, Denmark,
 1046 France, Netherlands, North Germany and Southern England. Part of the Continental Region in Denmark,
 1047 Poland and Boreal Region in South Sweden are included as well. The Alpine Region is unsuitable to the
 1048 establishment of *A. saligna*. The suitability maps for the four *Acacia saligna* subspecies have a very
 1049 similar trend and shape, however, the total size of endangered area is higher for *A. saligna* subsp. *lindleyi*
 1050 and *A. saligna* subsp. *pruinescens*, than in the case of *A. saligna* subsp. *saligna* and *A. saligna* subsp.
 1051 *stolonifera*. For example, for *A. saligna* subsp. *saligna* and *A. saligna* subsp. *stolonifera* in East Europe
 1052 are very likely not at risk, possibly because they may be conditioned by low temperatures. On the
 1053 contrary, *A. saligna* subsp. *lindleyi* and *A. saligna* subsp. *pruinescens* are likely to occupy a larger part of
 1054 the Continental biogeographical region and are also predicted to be able to establish in the Pannonian
 1055 biogeographical region (Hungary).

1056 In the current climate the main limiting factor preventing further suitability appears to be low winter
 1057 temperatures. Nevertheless, this factor in the future projection has been overcome, since it is shown a
 1058 high suitability in colder regions. For example, *A. saligna* subsp. *lindleyi* and *A. saligna* subsp.
 1059 *pruinescens*, would have in the future a high probability of establishment in Germany, Poland, Denmark
 1060 and South Sweden, i.e. where the suitability was almost zero before. The 2070 model projection may
 1061 underestimate the suitable range in the colder areas, since the key factor limiting spread in the EU is
 1062 considered to be the severity and frequency of frosts. This may be linked to the coarse-scale modelling
 1063 that does not capture local/habitat environmental conditions. Certain changes would favour *Acacia*
 1064 species, however, if frosts are still likely to occur, or increase in severity and frequency, then this will
 1065 more than counter any positive effects or global warming.

1066 Important insight can be drawn for Mediterranean islands from an experiment conducted in the island of
 1067 **Sardinia (Italy)** by Meloni *et al.* (2013). They showed that the optimal temperature range for germination
 1068 of all populations of *A. saligna* (seeds collected in Sardinia) was 15–20 °C, but germination was also
 1069 rather high at 25 °C. Increasing salt concentration influenced the germination capacity, causing a
 1070 decrease in final percentages. In the presence of salt *A. saligna* germination is higher at low temperatures
 1071 and it progressively decreases as the temperature increases. This is ecologically significant, in particular
 1072 in coastal areas, since it indicates a need for a reduction in soil salinity for seed germination to occur,
 1073 because the germination in saline environments usually occurs in spring when the temperatures are lower
 1074 and soil salinity is reduced by precipitation in the late winter and spring. The investigations carried out by
 1075 the Meloni *et al.* (2013) suggest, on the one hand, that the projected increase in temperatures and in
 1076 summer drought length could limit the distribution of this species. On the other hand, *A. saligna* shows a
 1077 tolerance to NaCl at the germination stage. *A. saligna* germination capacity is therefore one among the
 1078 factors that will likely contribute, both in Sardinia and in other Mediterranean countries and territories, to
 1079 an expansion of its populations in the framework of the future global change. In humid regions like
 1080 Sydney, projected changes in the climate caused by atmospheric CO₂ enrichment (Clarke *et al.*, 2011)
 1081 have implications for dormancy in *A. saligna* and thus its potential to develop dormant seed banks.

1082 Finally, climate change is expected to alter the geographic distribution of wildfires, a complex abiotic
 1083 process that responds to a variety of spatial and environmental gradients (Krawchuk *et al.*, 2009), a
 1084 process that could promote further establishment of *Acacia saligna* close to plantations and invaded sites
 1085 and may also increase species flammability and reinforce a positive feedback loop between fire
 1086 disturbance and invasion (van Wilgen and Richardson, 1985; Gaertner *et al.*, 2017).

1087

1088 **2.15.1 - Define which climate projection is being used from 2050 to 2100**

1089 *Climate projection RCP 8.5 2070*

1090 **Note:** RCP²⁶ 8.5 is the most extreme of the RCP scenarios, and may therefore represent the worst-case
 1091 scenario for reasonably anticipated climate change.

1092

1093 **2.15.2 - Components of climate change considered most relevant for *A. saligna***

1094 *Temperature (YES)* *Precipitation (YES)* *CO₂ levels (YES)*

1095 *Sea level rise (NO)* *Salinity (YES)* *Nitrogen deposition (NO)*

1096 *Acidification (NO)* *Land use change (YES)*

1097

1098 **2.15.3 - Influence of projected climate change scenarios on *A. saligna***

1099

| | |
|---|--|
| Are the pathways likely to change due to climate change? (If yes, provide a new rating for likelihood and uncertainty) | Reference |
| The pathways are unlikely to change due to climate change | Expert opinion |
| Is the likelihood of establishment likely to change due to climate change? (If yes, provide a new rating for likelihood and uncertainty) | Reference |
| The likelihood of establishment is likely to increase in certain areas as a result of the increase in wildfires and winter and summer temperatures, but there is no specific evidence to support a new rating | Expert opinion; Webber <i>et al.</i> (2011); Gallardo <i>et al.</i> (2017) |
| Is the magnitude of spread likely to change due to climate change? (If yes, provide a new rating for the magnitude of spread and uncertainty) | Reference |
| The magnitude of spread is unlikely to change due to climate change | Expert opinion |
| Will impacts in the PRA area change due to climate change? (If yes, provide a new rating of magnitude of impact and uncertainty for biodiversity, ecosystem services and socio-economic impacts separately) | Reference |
| The impacts in the PRA may change due to climate change but there is no specific evidence to support a new rating | Expert opinion |

1100

²⁶ RCP stands for representative concentration pathways. The RCP8.5 combines assumptions about high population and relatively slow income growth with modest rates of technological change and energy intensity improvements, leading in the long term to high energy demand and GHG emissions in absence of climate change policies. Compared to the total set of Representative Concentration Pathways (RCPs), RCP8.5 thus corresponds to the pathway with the highest greenhouse gas emissions (Riahi *et al.*, 2011).

1101

1102 **2.16 - Overall assessment of risk**

1103

| | | | |
|---|------------|-----------------|-------------|
| Pathways for entry: Plants for planting | | | |
| <i>Rating of the likelihood of entry for the pathway, plants or seeds for planting</i> | LOW | <i>Moderate</i> | <i>High</i> |
| <i>Rating of uncertainty</i> | LOW | <i>Moderate</i> | <i>High</i> |
| Rating of the likelihood of establishment in the natural environment in the PRA area | | | |
| <i>Rating of the likelihood of establishment in the natural environment</i> | <i>Low</i> | <i>Moderate</i> | HIGH |
| <i>Rating of uncertainty</i> | LOW | <i>Moderate</i> | <i>High</i> |
| Rating of the likelihood of establishment in the managed environment in the PRA area | | | |
| <i>Rating of the likelihood of establishment in the managed environment</i> | <i>Low</i> | <i>Moderate</i> | HIGH |
| <i>Rating of uncertainty</i> | LOW | <i>Moderate</i> | <i>High</i> |
| Magnitude of spread in the PRA area | | | |
| <i>Rating of the magnitude of spread</i> | <i>Low</i> | MODERATE | <i>High</i> |
| <i>Rating of uncertainty</i> | LOW | <i>Moderate</i> | <i>High</i> |
| Impact on biodiversity | | | |
| <i>Rating of the magnitude of impact in the current area of distribution</i> | <i>Low</i> | <i>Moderate</i> | HIGH |
| <i>Rating of uncertainty</i> | LOW | <i>Moderate</i> | <i>High</i> |
| Impact on ecosystem services | | | |
| <i>Rating of the magnitude of impact in the current area of distribution</i> | <i>Low</i> | <i>Moderate</i> | HIGH |
| <i>Rating of uncertainty</i> | <i>Low</i> | MODERATE | <i>High</i> |
| Impact on socio-economics | | | |
| <i>Rating of the magnitude of impact in the current area of distribution</i> | <i>Low</i> | <i>Moderate</i> | HIGH |
| <i>Rating of uncertainty</i> | <i>Low</i> | MODERATE | <i>High</i> |

1104

Will impacts in the PRA area be largely the same as in the current area of distribution? **YES**

1105

1106

1107 **Uncertainty**

1108 *Acacia saligna* is a well-studied species (a large number of scientific papers are available on the Web of
1109 Science database) and has been introduced since a long time in the PRA area, where is presently
1110 described as naturalised and/or invasive in many sites, therefore the Authors would rank the uncertainty
1111 of the present PRA, in the whole document, as **LOW**.

1112

1113 **Remarks**

1114 A significant number of other *Acacia* species (e.g., *A. dealbata* and *A. longifolia*) are present and affect
1115 biodiversity and the related ecosystem services in the European Union, therefore the Authors of the
1116 present PRA would suggest to consider them in the context of the Regulation (EU) No. 1143/2014.

1117

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Appendix 1. Relevant illustrative pictures (for information)

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Figure 1. *Acacia saligna* - inflorescences (Brundu 2017, Sardinia, IT)

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Figure 2. *Acacia saligna* - glands at the base of the phyllode (Brundu 2017, Sardinia, IT)

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Figure 3. *Acacia saligna* – pods and seeds (Brundu 2017, Sardinia, IT)

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Figure 4. *Acacia saligna* resprouts after a wildfire (Brundu 2017, Sardinia, IT)

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Figure 5. *Acacia saligna* in South Africa (Brundu 2009, South Africa)

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Figure 6. *Acacia saligna* biological control in South Africa (Brundu 2009, South Africa)

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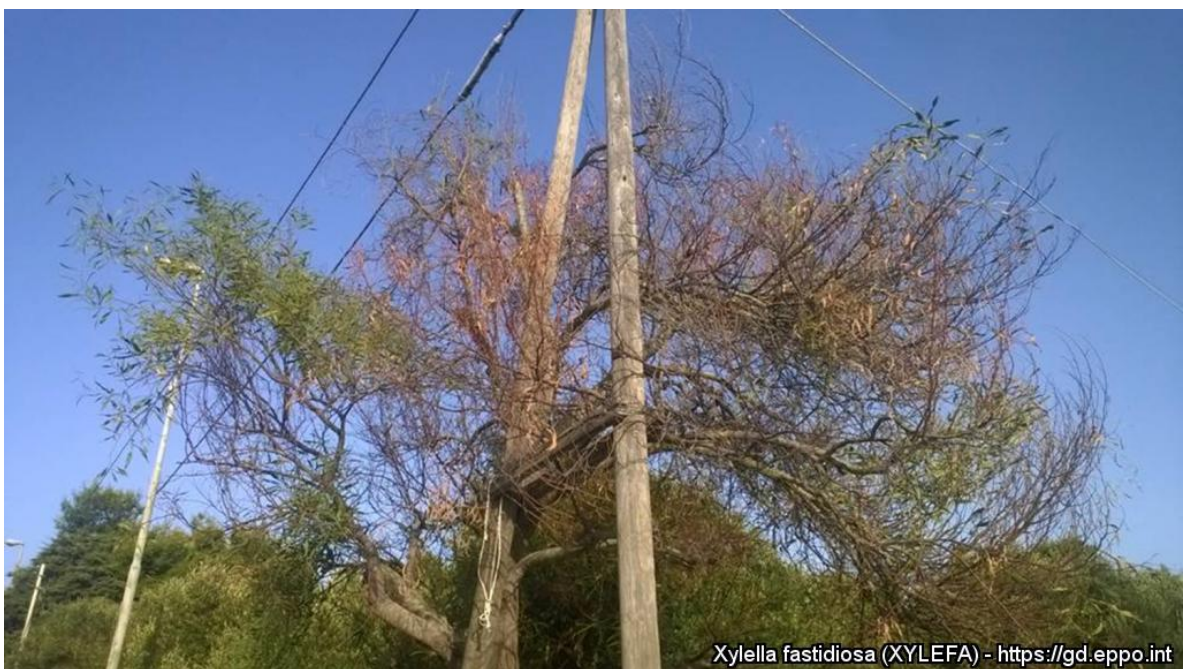
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Figure 7. Dense litter layer of *Acacia saligna* in Sardinia, Italy (Brundu 2017)

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Figure 8. Courtesy of EPPO, EPPO Global database

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Appendix 2. Biological traits and soil factors for *Acacia saligna* subspecies

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Table 1. Biological traits and potentially undesirable attributes for the four subspecies of *Acacia saligna*, in the **native range**, as reported in the FloraBank web-site [Accessed 25 October 2017].

| <i>Acacia saligna</i> subspecies | Biological traits under cultivation | | | | | Potentially undesirable attributes | | | | | |
|---|--|-----------------------|-------------|-------------------------------|---|------------------------------------|--------------------------------|--|---|---|---------------------------------|
| | Habit | Longevity | Growth rate | Coppicing ability | Root system | Erosion control potential | Carbon sequestration potential | Fire sensitivity | Foliage | Growth habit | Weediness |
| <i>A. saligna</i> subsp. <i>lindleyi</i> | evergreen shrub < 2 m, 5 m or tree 5–10 m tall | short-lived <15 years | fast | nil or negligible | fixes nitrogen via root symbiot, forms root suckers | excellent for clayey - sandy sites | moderate- high | killed by severe fires | highly (susceptible to browsing by animals) | shallow roots may outcompete adjacent plants | declared weed or high potential |
| <i>A. saligna</i> subsp. <i>pruinescens</i> | evergreen shrub or small tree < 5 m tall | short-lived <15 years | fast | vigorous, responds to pruning | fixes nitrogen via root symbiot, forms root suckers | excellent for sandy sites | high | killed by severe fires | low - moderate (susceptibility to browsing) | shallow roots may outcompete adjacent plants | declared weed or high potential |
| <i>A. saligna</i> subsp. <i>saligna</i> | evergreen shrub or small tree < 5 m or shrub or tree 5–10 m tall | short-lived <15 years | fast | vigorous, responds to pruning | fixes nitrogen via root symbiot, forms root suckers | excellent for sandy sites | high | killed by severe fires | low - moderate (susceptibility to browsing) | shallow roots may outcompete adjacent plants | declared weed or high potential |
| <i>A. saligna</i> subsp. <i>stolonifera</i> | evergreen shrub < 2 m or shrub - small tree < 5 m tall | short-lived <15 years | fast | nil or negligible | fixes nitrogen via root symbiot, forms root suckers | excellent for sandy sites | moderate | some plants coppice back or killed by severe fires | low - moderate (susceptibility to browsing) | propensity to root sucker or shallow roots may outcompete adjacent plants | declared weed or high potential |

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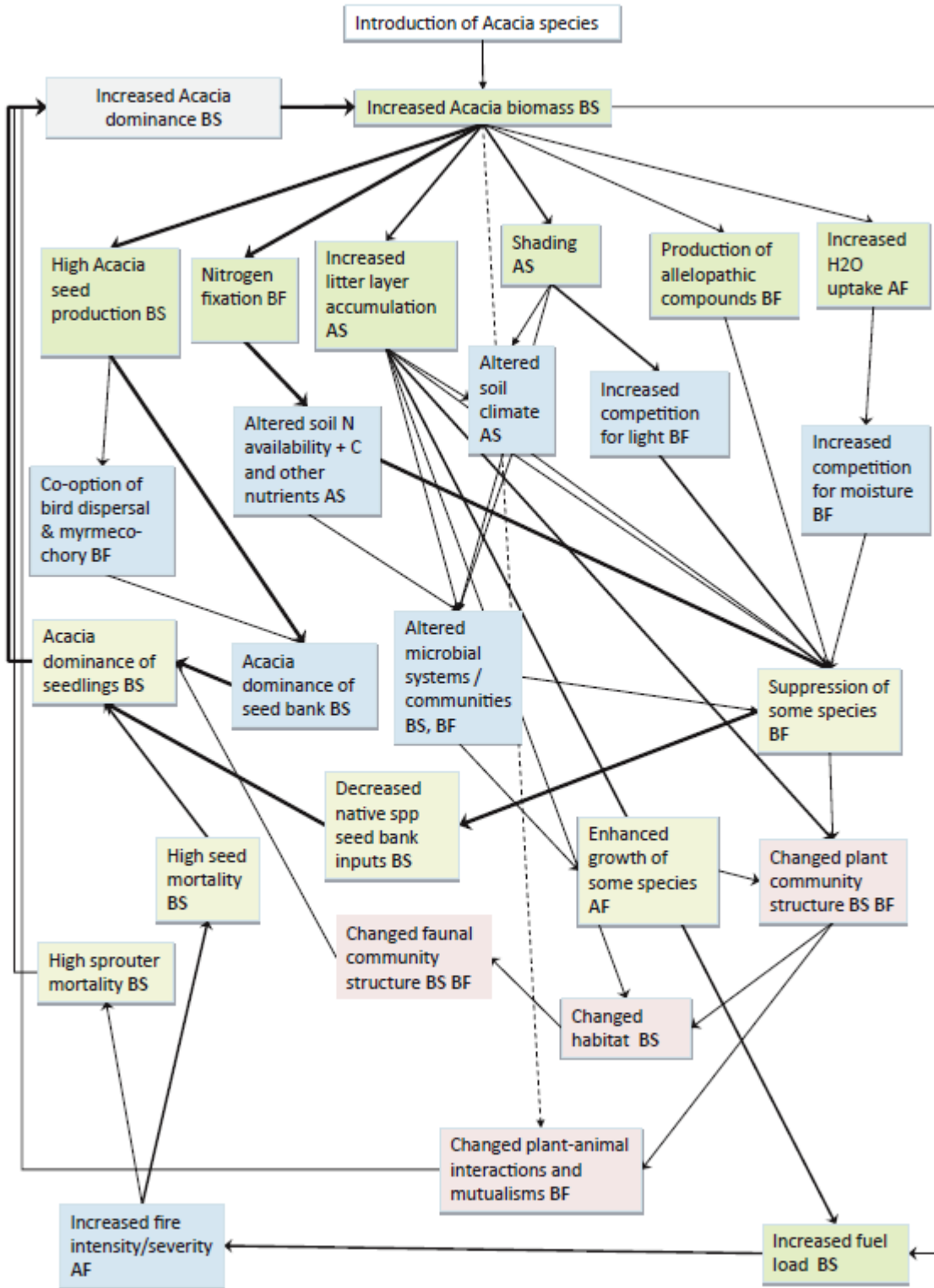
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1794
1795Table 2. Soil factors and tolerances for the four subspecies of *Acacia saligna*, in the **native range**, as reported in the FloraBank web-site [Accessed 25 October 2017].

| <i>Acacia saligna</i> subspecies | Soil factors | | | | Tolerance of adverse soils | | |
|--|----------------------------------|---|---|--|----------------------------|---|---|
| | Texture | Soil pH reaction | Drainage | Salinity | Extremes in pH | Salinity (dS m ⁻¹) | Soil waterlogging tolerance |
| <i>A. saligna</i> subsp. <i>lindleyi</i> | sandy, clay, loam, or sand | acidic (< 6.5) neutral (6.5–7.5) | well-drained | highly-moderately saline, or non-saline | acidity | high (9–16), moderate (–8) or slight (2–4) | nil - sensitive to waterlogged soils |
| <i>A. saligna</i> subsp. <i>pruinescens</i> | sandy, clay, loam | acidic (<6.5) neutral (6.5–7.5) | well-drained or poorly to imperfectly drained | slightly-moderately saline, or non-saline | acidity | moderate (– 8) or slight (2–4) | drainage may be sluggish at times |
| <i>A. saligna</i> subsp. <i>saligna</i> | sandy, clay, loam, or sand | neutral (6.5–7.5) or alkaline (>7.5) | well-drained | highly-moderately saline, or non-saline | alkalinity | moderate (– 8) or slight (2-4) | nil - sensitive to waterlogged soils |
| <i>A. saligna</i> subsp. <i>stolonifera</i> | sandy, clay, loam | acidic (<6.5) neutral (6.5–7.5) | well-drained | non-saline | acidity | nil - sensitive to saline soils or slight (2–4) | nil - sensitive to waterlogged soils |

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1799 **Figure 1:** A cause-and-effect network diagram of the main impacts of Australian acacias (Le Maitre *et al.*,
 1800 2011). B = biotic, A = abiotic, S = structure and F = function.
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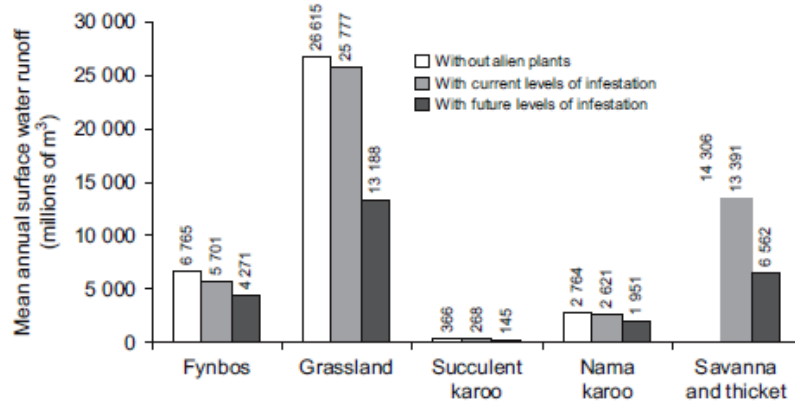


Fig. 2. Estimates of the current and potential impacts of invasive alien plants on surface water runoff in five biomes in South Africa.

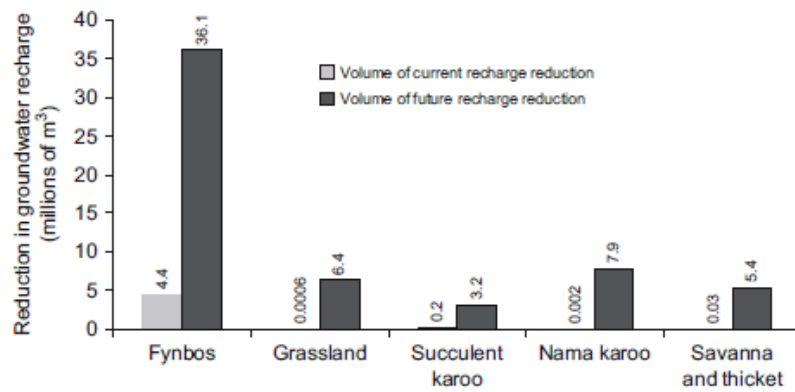


Fig. 3. Estimates of the current and potential impacts of invasive alien plants on groundwater recharge in five biomes in South Africa.

1803
 1804
 1805 **Figure 2:** Effect of invasive woody species on water provisioning services in South Africa after van
 1806 Wilgen *et al.* (2008).
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Appendix 4. Projection of climatic suitability for *Acacia saligna* establishment

1815

1816 4.1 - Aim

1817 To project the suitability for potential establishment (naturalisation) of the four subspecies of *Acacia*
 1818 *saligna*: *Acacia saligna* (Labill.) H.L.Wendl. subsp. *saligna* (autonym) ‘**Cyanophylla**’ variant, *Acacia*
 1819 *saligna* (Labill.) H.L.Wendl. subsp. *stolonifera* M.W.McDonald & Maslin ms ‘**Forest**’ variant, *Acacia*
 1820 *saligna* (Labill.) H.L.Wendl. subsp. *pruinescens* M.W.McDonald & Maslin ms ‘**Tweed River**’ variant
 1821 and *Acacia saligna* (Labill.) H.L.Wendl. subsp. *lindleyi* (Meisn.) ‘**Typical**’ variant, in the European
 1822 Union, under current and predicted future climatic conditions.

1823

1824 4.2 - Data for modeling

1825 Climate data were taken from ‘Bioclim’ variables contained within the WorldClim database (Hijmans *et*
 1826 *al.*, 2005) originally at 5 arcminute resolution (0.083 x 0.083 degrees of longitude/latitude) and
 1827 aggregated to a 0.25 x 0.25 degree grid for use in the model. Based on the biology of the focal species, the
 1828 following climate variables were used in the modelling:

1829● Mean minimum temperature of the coldest month (Bio6) reflecting exposure to frost. *A. saligna*
 1830 subspecies exhibits frost sensitivity, and damage is likely to be severe if the temperature falls below –5
 1831 °C, suggesting this is its minimum tolerance (see climate profile in table 1).

1832● Mean temperature of the warmest quarter (Bio10) reflecting the growing season thermal regime. *Acacia*
 1833 *saligna* is reported to require annual mean temperatures between 15 and 21°C under natural and
 1834 cultivated conditions (see climate profile in table 2).

1835● Precipitation of warmest quarter (Bio18 log+1 transformed mm), also reflecting a preference for arid and
 1836 semi-arid environments but not prolonged dry periods. The mean annual rainfall for the semi-arid zone is
 1837 low as 300 mm (Doran and Turnbull 1997). Mean annual precipitation requirement range from 250–1200
 1838 mm, length of dry season 0-12 months (see climate profile in table 1 and 2).

1839● Precipitation of Coldest Quarter (Bio19 log+1 transformed mm).

1840 The variables were also chosen based on *Acacias* modelling by Richardson *et al.* (2011) and Thompson *et*
 1841 *al.* (2011).

1842 To estimate the effect of climate change on the potential distribution, equivalent modelled future climate
 1843 conditions for the 2070s under the Representative Concentration Pathway (RCP) 8.5 were also obtained.
 1844 This assumes an increase in atmospheric CO₂ concentrations to approximately 850 ppm by the 2070s.
 1845 Climate models suggest this would result in an increase in global mean temperatures of 3.7 °C by the end
 1846 of the 21st century. The above variables were obtained as averages of outputs of eight Global Climate
 1847 Models (BCC-CSM1-1, CCSM4, GISS-E2-R, HadGEM2-AO, IPSL-CM5A-LR, MIROC-ESM, MRI-
 1848 CGCM3, NorESM1-M), downscaled and calibrated against the WorldClim baseline (see
 1849 http://www.worldclim.org/cmip5_5m). RCP8.5 is the most extreme of the RCP scenarios, and may
 1850 therefore represent the worst-case scenario for reasonably anticipated climate change.

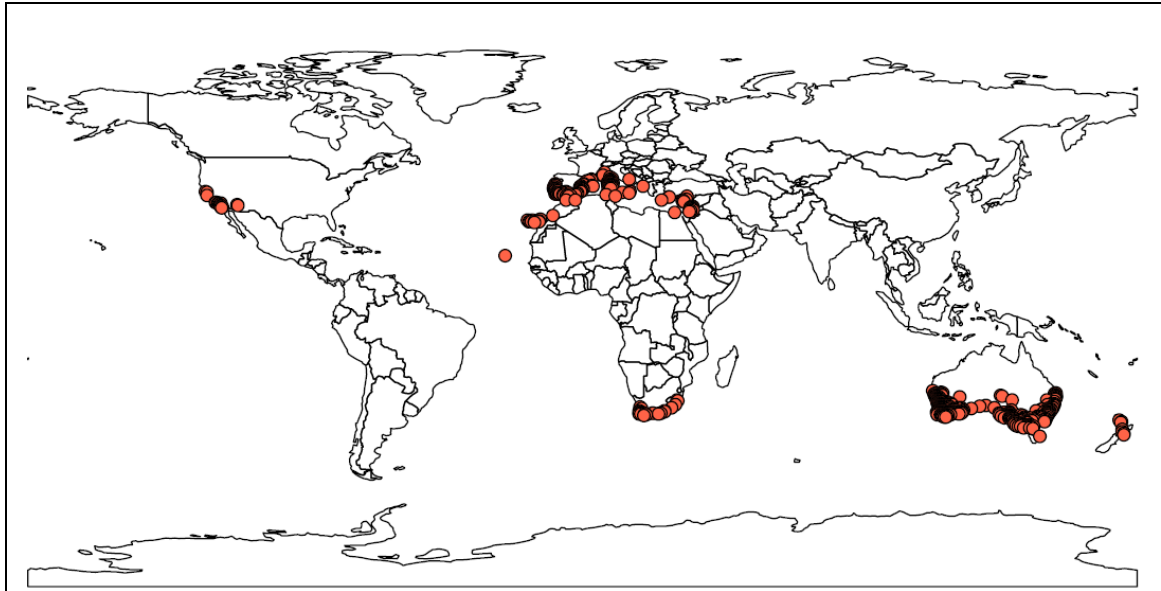
1851 In the models we also included the following variable:

1852● Human influence index as *A. saligna*, like many invasive species, is likely to associate with
 1853 anthropogenically disturbed habitats. We used the Global Human Influence Index Dataset of the Last of
 1854 the Wild Project (Wildlife Conservation Society - WCS & Center for International Earth Science
 1855 Information Network - CIESIN - Columbia University, 2005), which is developed from nine global data
 1856 layers covering human population pressure (population density), human land use and infrastructure (built-
 1857 up areas, night-time lights, land use/land cover) and human access (coastlines, roads, railroads, navigable
 1858 rivers). The index ranges between 0 and 1 and was log+1 transformed for the modelling to improve
 1859 normality.

1860 Species occurrence data were obtained from the Global Biodiversity Information Facility (GBIF),
 1861 iNaturalist, USGS Biodiversity Information Serving Our Nation (BISON), Integrated Digitized
 1862 Biocollections (iDigBio) and supplemented with data from the literature and from **original data collected**

1863 **by the authors** of this PRA in the field in the period 2015–2017. We scrutinised occurrence records from
 1864 regions where the species is not known to be well established and removed any that appeared to be
 1865 dubious or where the georeferencing was too imprecise (e.g. records referenced to a country or island
 1866 centroid) or outside of the coverage of the predictor layers (e.g. small island or coastal occurrences). The
 1867 remaining records were gridded at a 0.25 x 0.25-degree resolution for modelling (Figure 1). Following
 1868 this, there were 4490 georeferenced records and 707 grid cells with established occurrence records
 1869 available for the modelling (Figure 1).

1870



1871
 1872 **Figure 1.** The selection of occurrence records of *Acacia saligna* (naturalised and casual occurrences) used
 1873 in the modelling of climatic suitability in current and future climate.

1874

1875 *Species distribution model*

1876 A presence-background (presence-only) ensemble modelling strategy was employed using the BIOMOD2
 1877 R package v3.3-7 (Thuiller *et al.*, 2009; Thuiller *et al.*, 2014). These models contrast the environment at
 1878 the species' occurrence locations against a random sample of the global background environmental
 1879 conditions (often termed 'pseudo-absences') in order to characterise and project suitability for occurrence.
 1880 This approach has been developed for distributions that are in equilibrium with the environment. Because
 1881 invasive species' distributions are not at equilibrium and subject to dispersal constraints at a global scale,
 1882 we took care to minimise the inclusion of locations suitable for the species but where it has not been able
 1883 to disperse to. Therefore, the background sampling region included:

- 1884
- 1885 • The area accessible by native *A. saligna* populations, in which the species is likely to have had
 1886 sufficient time to disperse to all locations. To define the native range, we divided Australian
 1887 records into native west coast populations and non-native populations on the south east. Then the
 1888 accessible region was defined as a polygon bounding all native occurrences in Australia; AND
 - 1889 • A relatively small 25 km buffer around all non-native occurrences (including Australian ones),
 1890 encompassing regions likely to have had high propagule pressure for introduction by humans
 1891 and/or dispersal of the species; AND
 - 1892 • Regions where we have an *a priori* expectation of high unsuitability for the species (see Figure
 1893 2). Absence from these regions is considered to be irrespective of dispersal constraints. The
 1894 following rules were applied to define a region expected to be highly unsuitable for *A. saligna* at
 1895 the spatial scale of the model:
 - 1896 • Mean minimum temperature of the coldest month (Bio6). *A. saligna* is sensitive to severe frosts
 1897 and the coldest occurrence has Bio6 = 0 to −5 °C suggesting this is its minimum tolerance.
 - 1898 • Mean temperature of the warmest quarter (Bio10). All *A. saligna* were in regions warmer than
 this, with the exception of a single outlying record that had Bio10 = 15 °C.

1899 Within this sampling region there will be substantial spatial biases in recording effort, which may
 1900 interfere with the characterisation of habitat suitability. Specifically, areas with a large amount of
 1901 recording effort will appear more suitable than those without much recording, regardless of the
 1902 underlying suitability for occurrence. Therefore, a measure of vascular plant recording effort was made
 1903 by querying the Global Biodiversity Information Facility application programming interface (API) for the
 1904 number of phylum Tracheophyta records in each 0.25 x 0.25-degree grid cell. The sampling of
 1905 background grid cells was then weighted in proportion to the Tracheophyte recording density. Assuming
 1906 Tracheophyte recording density is proportional to recording effort for the focal species, this is an
 1907 appropriate null model for the species' occurrence.

1908 To sample as much of the background environment as possible, without overloading the models with too
 1909 many pseudo-absences, ten background samples of 10,000 randomly chosen grid cells were obtained
 1910 (Figure 2).

1911

1912 **Table 1.** Climate profiles for the four main 'variants' described for *Acacia saligna* based on
 1913 meteorological data representative of natural populations in the native range (data generated from
 1914 Houlder *et al.*, 2000 and the Bureau of Meteorology website as reported by McDonald *et al.*, 2007).

1915

| Variant | Altitudinal range (m) | Mean max. hottest month (°C) | Mean min. coldest month (°C) | Lowest min. temperature recorded (°C) | Mean annual rainfall (mm) |
|---------------|-----------------------|------------------------------|------------------------------|---------------------------------------|---------------------------|
| 'Typical' | 100–350 | 28–39 | 5–9 | –5 | 250–650 |
| 'Tweed River' | 150–300 | 30–31 | 4–6 | –4 | 700–1000 |
| 'Cyanophylla' | 0–90 | 28–33 | 8–10 | 0 | 750–900 |
| 'Forest' | 5–300 | 27–30 | 6–8 | –4 | 800–1000 |

1916

1917

1918 **Table 2.** Climate profiles for the four subspecies described for *Acacia saligna* in the **native range** based
 1919 on FloraBank [Accessed 25 October 2017].

1920

Climate parameters / tolerances

| <i>Acacia saligna</i> subspecies | Mean annual rainfall (mm) | Mean annual temperature (°C) | Mean max. temperature of the hottest month (°C) | Mean min. temperature of the coldest month (°C) | Frosts per year |
|--|---------------------------|------------------------------|---|---|-----------------|
| <i>A. saligna</i> subsp. <i>lindleyi</i> | 250–650 | 15–21 | 28–39 | 5–9 | up to 20 |
| <i>A. saligna</i> subsp. ' <i>pruinescens</i> ' ms | 350–1200 | 15–18 | 26–30 | 4–9 | up to 20 |
| <i>A. saligna</i> subsp. <i>saligna</i> | 500–900 | 15–21 | 26–33 | 7–10 | frost free |
| <i>A. saligna</i> subsp. ' <i>stolonifera</i> ' ms | 800–1200 | 15–18 | 27–30 | 6–8 | frost free |

1921

Climate parameters / tolerances

| <i>Acacia saligna</i> subspecies | Frost intensity | Altitude (metres) | Drought | Fire |
|--|-----------------------------|-------------------|------------|-------------------------|
| <i>A. saligna</i> subsp. <i>lindleyi</i> | light–moderate (0 to –5 °C) | 100–350 | moderately | killed by damaging fire |
| <i>A. saligna</i> subsp. ' <i>pruinescens</i> ' ms | light–moderate (0 to –5 °C) | 80–420 | sensitive | killed by damaging fire |
| <i>A. saligna</i> subsp. <i>saligna</i> | light–moderate (0 to –5 °C) | 0–90 | sensitive | killed by damaging fire |
| <i>A. saligna</i> subsp. ' <i>stolonifera</i> ' ms | light–moderate (0 to –5 °C) | 5–300 | – | killed by damaging fire |

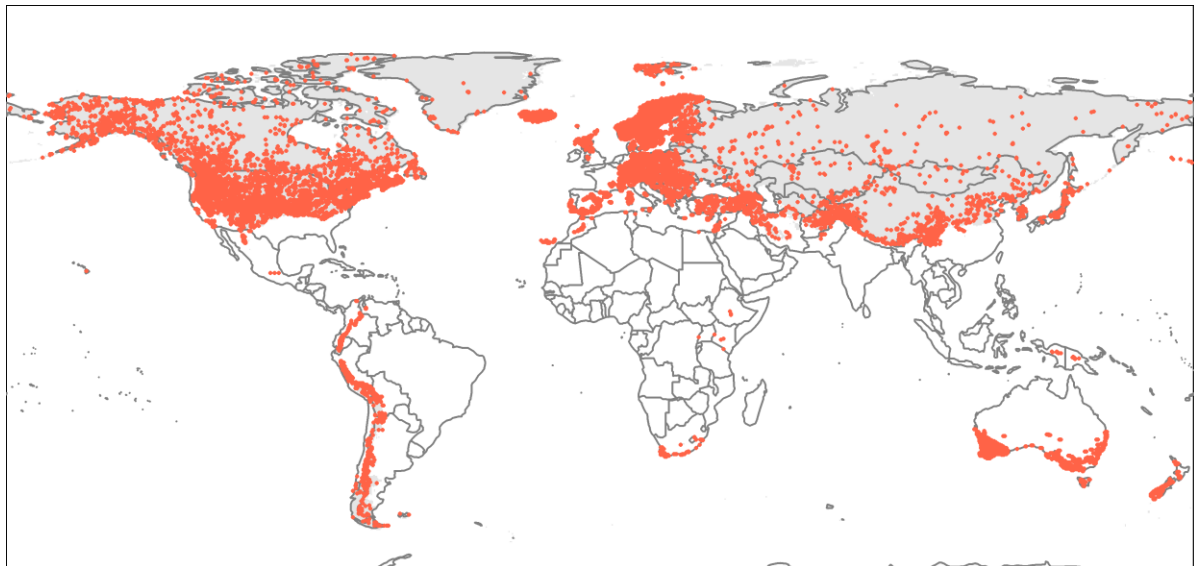
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1930 **Figure 2.** Randomly selected background absences in the modelling of *Acacia saligna*, mapped as red
1931 points. Points are sampled from the native range, a small buffer around non-native occurrences and from
1932 areas expected to be highly unsuitable for the species (grey background region) and weighted by a proxy
1933 for plant recording effort.

1934

1935 Each dataset (i.e. combination of the presences and the individual background samples) was randomly
1936 split into 80% for model training and 20% for model evaluation. With each training dataset, nine
1937 statistical algorithms were fitted with the default BIOMOD2 settings and rescaled using logistic
1938 regression, except where specified below:

- 1939• Generalised linear model (GLM)
- 1940• Generalised boosting model (GBM)
- 1941• Generalised additive model (GAM) with a maximum of four degrees of freedom per smoothing spline.
- 1942• Classification tree algorithm (CTA)
- 1943• Artificial neural network (ANN)
- 1944• Flexible discriminant analysis (FDA)
- 1945• Multivariate adaptive regression splines (MARS)
- 1946• Random forest (RF)
- 1947• MaxEnt

1948 Since the background sample was much larger than the number of occurrences, prevalence fitting weights
1949 were applied to give equal overall importance to the occurrences and the background. Normalised
1950 variable importance was assessed and variable response functions were produced using BIOMOD2's
1951 default procedure. Model predictive performance was assessed by calculating the Area Under the
1952 Receiver-Operator Curve (AUC) for model predictions on the evaluation data, that were reserved from
1953 model fitting. AUC can be interpreted as the probability that a randomly selected presence has a higher
1954 model-predicted suitability than a randomly selected absence.

1955 An ensemble model was created by first rejecting poorly performing algorithms with relatively extreme
1956 low AUC values and then averaging the predictions of the remaining algorithms, weighted by their AUC.
1957 To identify poorly performing algorithms, AUC values were converted into modified z-scores based on
1958 their difference to the median and the median absolute deviation across all algorithms (Iglewicz and
1959 Hoaglin, 1993). Algorithms with $z < -2$ were rejected. In this way, ensemble projections were made for
1960 each dataset and then averaged to give an overall suitability.

1961

1962 **4.4 – Results: current climate**

1963 The ensemble model suggested that suitability for *A. saligna* was most strongly determined by the
 1964 minimum temperature of the coldest month, mean temperature of the warmest quarter, and precipitation
 1965 of warmest quarter (Table 1). From figure 3, the ensemble model estimated the optimum conditions for
 1966 occurrence at approximately:

- 1967• Minimum temperature of the coldest month = >50% suitability for 0 - 12 °C;
- 1968• High Mean temperature of the warmest quarter;
- 1969• Low precipitation of the warmest quarter.

1970 Precipitation of coldest quarter and Human influence index had little influence on the model predictions
 1971 (Table 1, Figure 3). All these estimates are conditional on the other predictors being at their median value
 1972 in the data used in model fitting.

1973 There was substantial variation among modelling algorithms in the partial response plots (Figure 3). In
 1974 part this will reflect their different treatment of interactions among variables. Since partial plots are made
 1975 with other variables held at their median, there may be values of a particular variable at which this does
 1976 not provide a realistic combination of variables to predict from. It also demonstrates the value of an
 1977 ensemble modelling approach in averaging out the uncertainty between algorithms.

1978 Global projection of the model in current climatic conditions indicates that the native and known invaded
 1979 records generally fell within regions predicted to have high suitability (Figure 4). The model predicts
 1980 potential for further expansion of the non-native range of the species into southeast Australia, south
 1981 Africa, temperate and Mediterranean regions of South America, Mexico and the west coast of USA.
 1982 Interestingly, several regions with unreliable records of *A. saligna* (see Figure 1) were also modelled as
 1983 potentially suitable, including the east coast of USA and southeast Brazil. Elsewhere, large areas of
 1984 Africa, the Middle East, India, south Asia and north Australia were projected as being potentially
 1985 climatically suitable for *A. saligna* invasion (Figure 4).

1986 The projection of suitability in Europe and the Mediterranean region suggests that *A. saligna* may be
 1987 capable of establishing further populations in Portugal and southern Spain, coast of France, Italy, the
 1988 Adriatic coast, Cyprus and Greece (Figure 5). There are also areas of marginal suitability predicted for
 1989 coastline of North Africa (Figure 5). The main limiting factor preventing further predicted suitability
 1990 appeared to be low winter temperatures.

1991

1992 **4.5 – Results: future climate projection**

1993 According to the climatic projection in 2070, the endangered area in the European Union will increase
 1994 compared with the projection in the current climate. The model includes a high suitability in the
 1995 Mediterranean Biogeographical region in Croatia, Cyprus, Italy, France, Greece, Malta, Portugal,
 1996 Slovenia and Spain, and in the generality of the Mediterranean islands, as well as in the Black Sea
 1997 Biogeographical region in Bulgaria and Romania. The model includes a high suitability in the Atlantic
 1998 Region in France, Southern England, Belgium, Netherlands and North Germany. Part of the Continental
 1999 Region in Denmark is included as well. The Alpine Region is unsuitable to establishment of *A. saligna*.
 2000 The suitability maps for the 4 *Acacia saligna* subspecies have a very similar trend and shape, however,
 2001 the total size of endangered area is higher for *A. saligna* subsp. *lindleyi* and *A. saligna* subsp. *pruinescens*,
 2002 than in the case of *A. saligna* subsp. *saligna* and *A. saligna* subsp. *stolonifera*. For example, for *A. saligna*
 2003 subsp. *saligna* and *A. saligna* subsp. *stolonifera* in East Europe are very likely not at risk, possibly
 2004 because they may be conditioned by low temperatures. On the contrary, *A. saligna* subsp. *lindleyi* and *A.*
 2005 *saligna* subsp. *pruinescens* are likely to occupy a larger part of the Continental biogeographical region
 2006 and are also predicted to be able to establish in the Pannonian biogeographical region (Hungary).

2007 In the current climate the main limiting factor preventing further predicted suitability appears to be low
 2008 winter temperatures. Nevertheless, this factor in the future projection has been overcome, since is shown
 2009 a high suitability in colder regions. For example, for *A. saligna* subsp. *lindleyi* and *A. saligna* subsp.
 2010 *pruinescens* where before the suitability was almost zero, in the future would seem an event with high
 2011 probability of establishment, e.g., in **Germany, Poland, Denmark** and **South Sweden**. In this way, the
 2012 2070 model projection may underestimate the suitable range in the colder areas like mentioned before,

2013 since the key factor limiting spread in the EU is considered to be the severity and frequency of frosts.
2014 This may be linked to the coarse-scale modelling that does not capture local/habitat environmental
2015 conditions. Certain changes would favour *Acacia* species, however, if frosts are still likely to occur, or
2016 increase in severity and frequency, then this will more than counter any positive effects.
2017
2018

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2024
2025**Table 3.** Summary of the cross-validation predictive performance (AUC) and variable importance of the fitted model algorithms and the ensemble (AUC-weighted average of the best performing seven algorithms) for the four subspecies of *A. saligna*. Results are the average from models fitted to ten different background samples of the data.

| Algorithm | Predictive AUC | Variable importance for <i>A. saligna</i> subsp. <i>lindleyi</i> | | | | |
|-----------|----------------|--|-------------------------------------|----------------------------------|----------------------------------|-----------------------|
| | | Minimum temperature of coldest month | Mean temperature of warmest quarter | Precipitation of warmest quarter | Precipitation of coldest quarter | Human Influence Index |
| GLM | 0.9460 | 66.7 | 33.0 | 0.1 | 0.0 | 0.1 |
| GBM | 0.9436 | 62.7 | 36.2 | 0.1 | 0.1 | 0.9 |
| GAM | 0.9502 | 62.9 | 36.8 | 0.2 | 0.0 | 0.1 |
| CTA | 0.9420 | 62.9 | 37.1 | 0.0 | 0.0 | 0.0 |
| ANN | 0.9462 | 62.6 | 32.6 | 1.4 | 0.5 | 1.4 |
| FDA | 0.9474 | 83.2 | 6.3 | 4.8 | 3.0 | 0.2 |
| MARS | 0.9470 | 70.9 | 27.9 | 0.4 | 0.5 | 0.0 |
| RF | 0.9072 | 58.6 | 19.4 | 7.9 | 5.1 | 5.1 |
| MAXENT | 0.9426 | 72.2 | 7.6 | 15.5 | 0.5 | 0.1 |
| Ensemble | 0.9476 | 68.7 | 25.8 | 3.2 | 0.7 | 0.4 |

2026

| Algorithm | Predictive AUC | Variable importance for <i>A. saligna</i> subsp. <i>pruinescens</i> | | | | |
|-----------|----------------|---|-------------------------------------|----------------------------------|----------------------------------|-----------------------|
| | | Minimum temperature of coldest month | Mean temperature of warmest quarter | Precipitation of warmest quarter | Precipitation of coldest quarter | Human Influence Index |
| GLM | 0.9450 | 68.2 | 31.3 | 0.2 | 0.0 | 0.2 |
| GBM | 0.9420 | 63.3 | 35.6 | 0.2 | 0.1 | 0.8 |
| GAM | 0.9464 | 64.4 | 35.1 | 0.3 | 0.0 | 0.1 |
| CTA | 0.9396 | 62.9 | 37.1 | 0.0 | 0.0 | 0.0 |
| ANN | 0.9482 | 65.0 | 30.5 | 1.6 | 0.4 | 1.2 |
| FDA | 0.9438 | 84.9 | 5.4 | 4.6 | 2.5 | 0.2 |
| MARS | 0.9432 | 72.5 | 26.5 | 0.4 | 0.5 | 0.0 |
| RF | 0.9066 | 58.6 | 19.9 | 8.0 | 4.5 | 5.0 |
| MAXENT | 0.9396 | 73.0 | 7.1 | 15.2 | 0.3 | 0.0 |
| Ensemble | 0.9454 | 68.7 | 28.8 | 1.0 | 0.5 | 0.3 |

2027

| Algorithm | Predictive AUC | Variable importance for <i>A. saligna</i> subsp. <i>saligna</i> | | | | |
|-----------|----------------|---|-------------------------------------|----------------------------------|----------------------------------|-----------------------|
| | | Minimum temperature of coldest month | Mean temperature of warmest quarter | Precipitation of warmest quarter | Precipitation of coldest quarter | Human Influence Index |
| GLM | 0.9504 | 76.2 | 22.6 | 0.7 | 0.0 | 0.0 |
| GBM | 0.9480 | 71.3 | 28.0 | 0.2 | 0.1 | 0.2 |
| GAM | 0.9514 | 74.0 | 25.0 | 0.8 | 0.1 | 0.0 |
| CTA | 0.9406 | 70.6 | 28.7 | 0.0 | 0.1 | 0.3 |
| ANN | 0.9506 | 70.5 | 22.6 | 2.8 | 0.7 | 0.6 |
| FDA | 0.9490 | 92.9 | 2.4 | 3.1 | 0.8 | 0.0 |
| MARS | 0.9508 | 79.8 | 19.6 | 0.4 | 0.2 | 0.0 |
| RF | 0.9212 | 66.2 | 14.9 | 7.9 | 3.6 | 3.5 |
| MAXENT | 0.9450 | 76.3 | 6.3 | 12.2 | 0.1 | 1.0 |
| Ensemble | 0.9500 | 77.3 | 18.1 | 2.9 | 0.3 | 0.3 |

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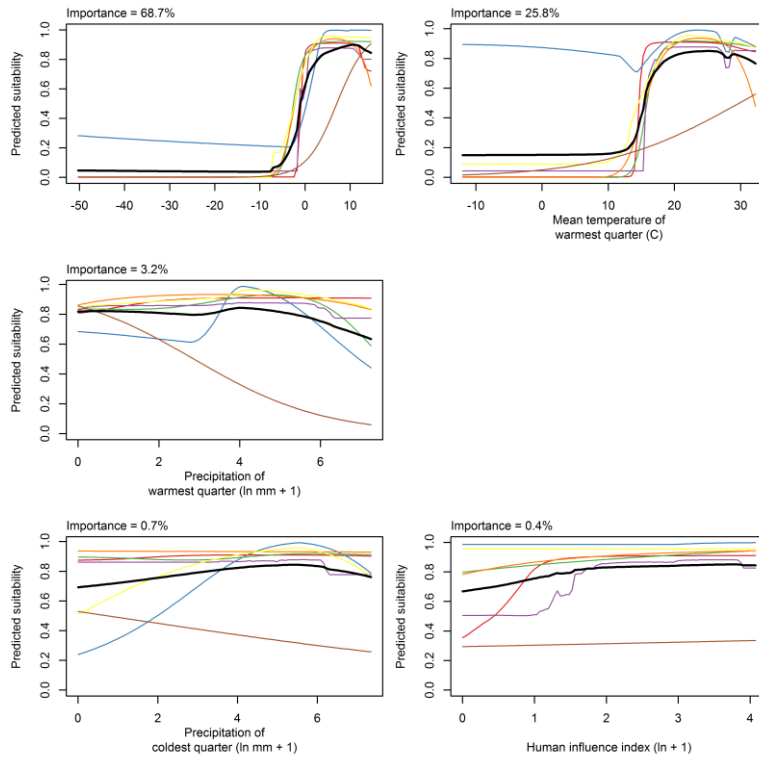
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| Variable importance for <i>A. saligna</i> subsp. <i>stolonifera</i> | | | | | | |
|---|----------------|--------------------------------------|-------------------------------------|----------------------------------|----------------------------------|-----------------------|
| Algorithm | Predictive AUC | Minimum temperature of coldest month | Mean temperature of warmest quarter | Precipitation of warmest quarter | Precipitation of coldest quarter | Human Influence Index |
| GLM | 0.9480 | 69.1 | 30.5 | 0.1 | 0.0 | 0.2 |
| GBM | 0.9448 | 63.9 | 34.7 | 0.1 | 0.1 | 1.0 |
| GAM | 0.9516 | 65.6 | 34.0 | 0.2 | 0.1 | 0.1 |
| CTA | 0.9440 | 63.6 | 36.4 | 0.0 | 0.0 | 0.0 |
| ANN | 0.9494 | 65.3 | 29.5 | 1.9 | 0.6 | 1.5 |
| FDA | 0.9484 | 84.8 | 5.6 | 4.5 | 2.5 | 0.2 |
| MARS | 0.9486 | 73.0 | 25.8 | 0.5 | 0.5 | 0.0 |
| RF | 0.9134 | 58.9 | 19.8 | 7.6 | 5.0 | 4.8 |
| MAXENT | 0.9444 | 74.0 | 7.4 | 14.2 | 0.6 | 0.0 |
| Ensemble | 0.9488 | 70.8 | 23.9 | 3.1 | 0.6 | 0.4 |

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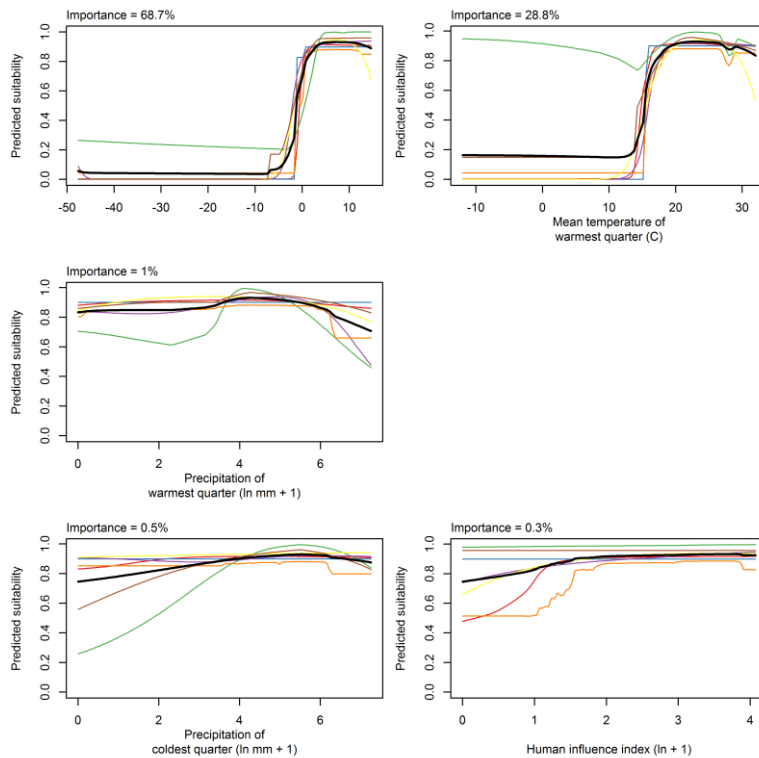
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A. saligna subsp. *lindleyi*



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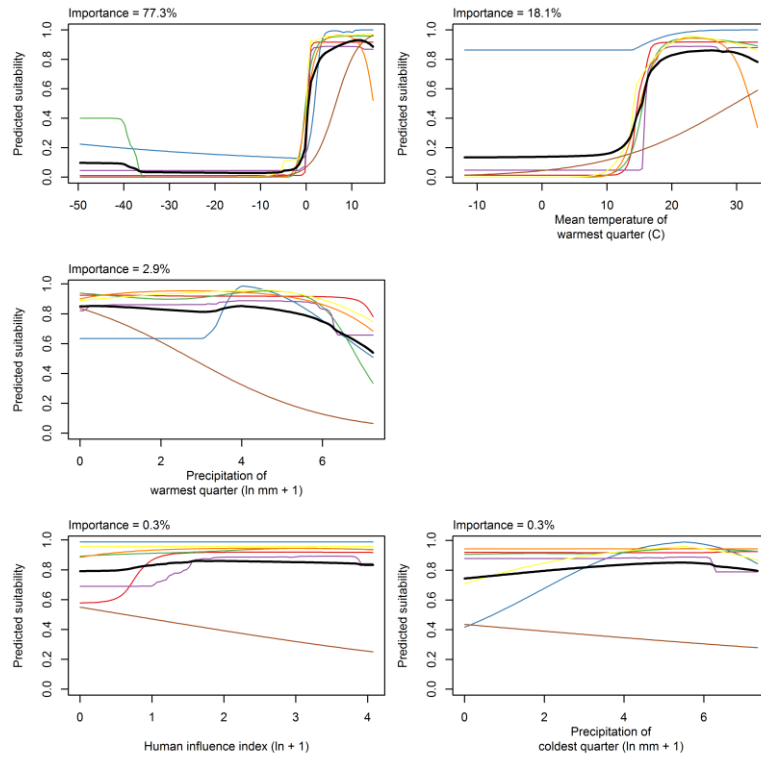
A. saligna subsp. *pruinescens*



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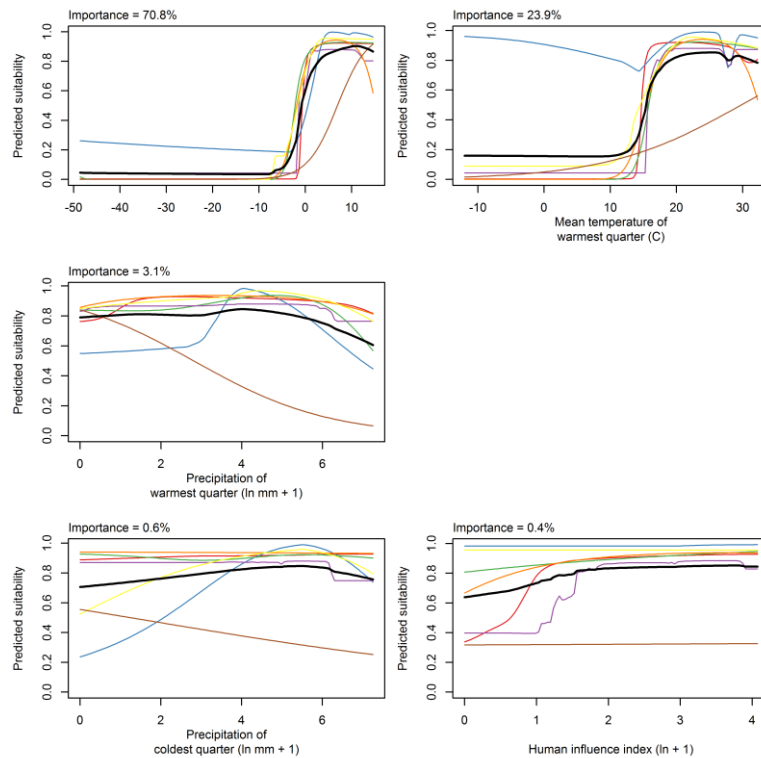
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A. saligna subsp. *saligna* (right)



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A. saligna subsp. *stolonifera*



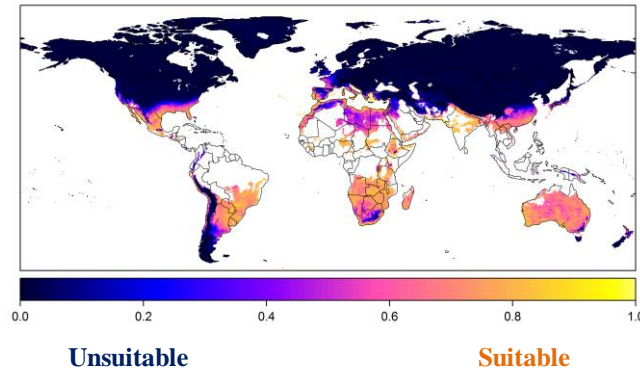
2052

2053 **Figure 3.** Partial response plots from the fitted models for the four subspecies of *A. saligna*, ordered from
2054 most to least important. Thin coloured lines show responses from the seven algorithms, while the thick
2055 black line is their ensemble. In each plot, other model variables are held at their median value in the
2056 training data. Some of the divergence among algorithms is because of their different treatment of
2057 interactions among variables.

2058

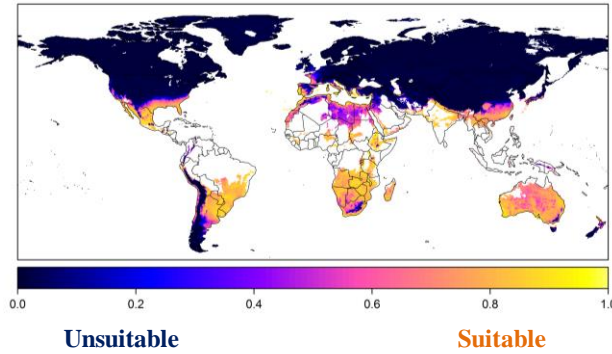
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(a) *A. saligna* subsp. *lindleyi*



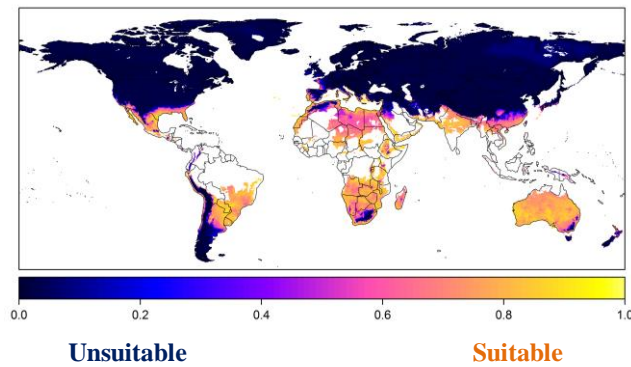
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(b) *A. saligna* subsp. *pruinescens*



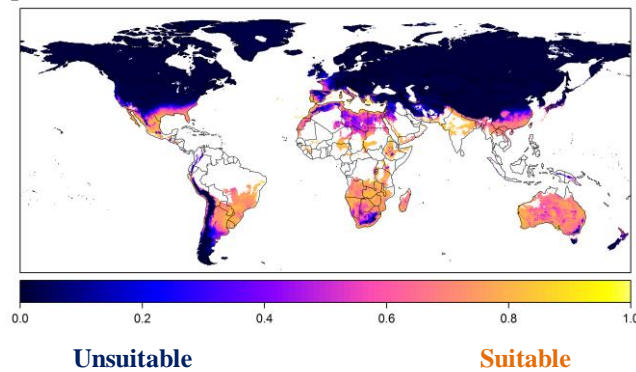
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(c) *A. saligna* subsp. *saligna*



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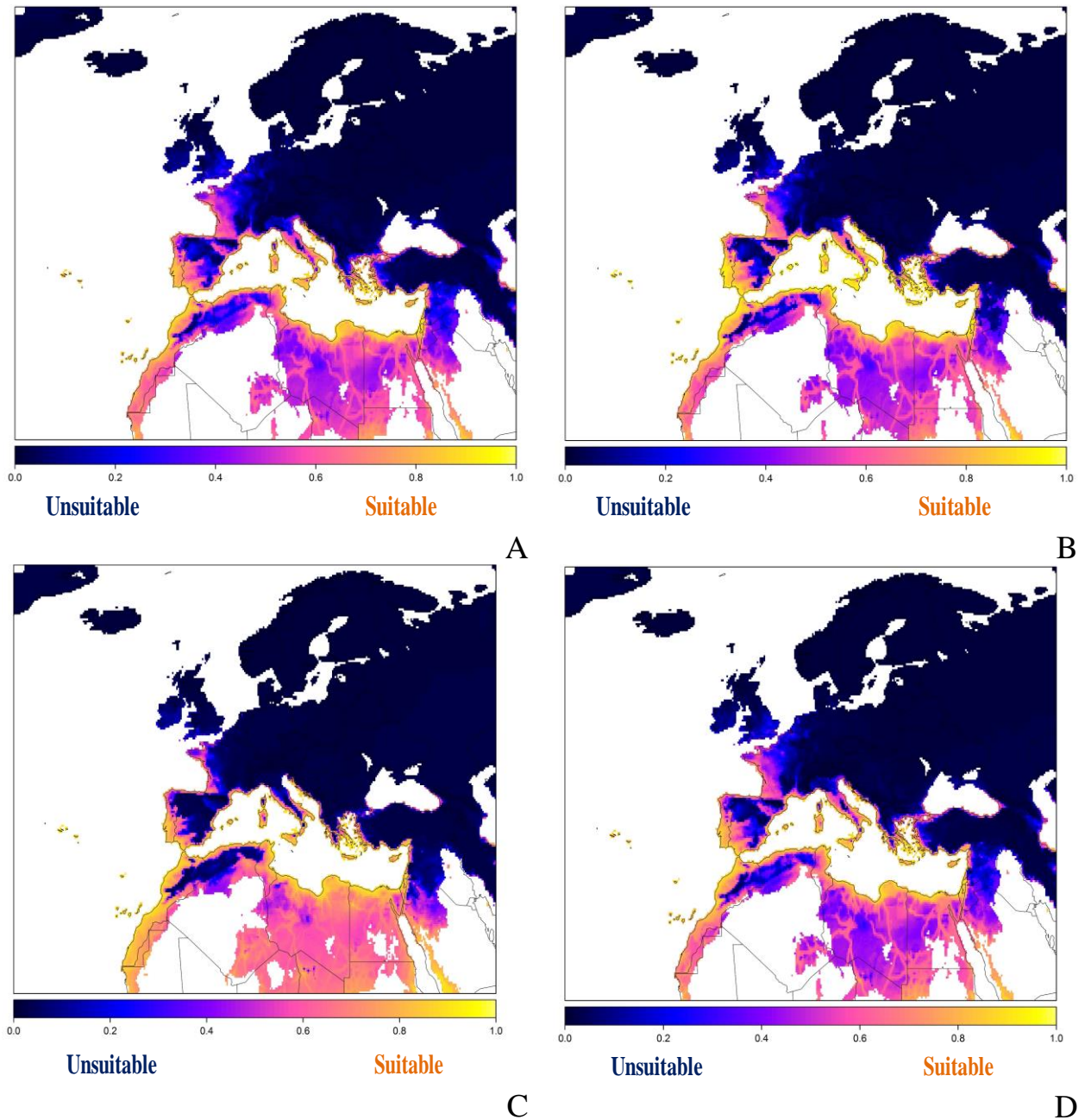
(d) *A. saligna* subsp. *stolonifera*



2067

2068 **Figure 4.** Projected global suitability for the four subspecies of *Acacia saligna* establishment in the
2069 current climate. For visualisation, the projection has been aggregated to a 0.5 x 0.5-degree resolution, by
2070 taking the maximum suitability of constituent higher resolution grid cells. Values > 0.5 may be suitable
2071 for the species. The white areas have climatic conditions outside the range of the training data so were
2072 excluded from the projection.

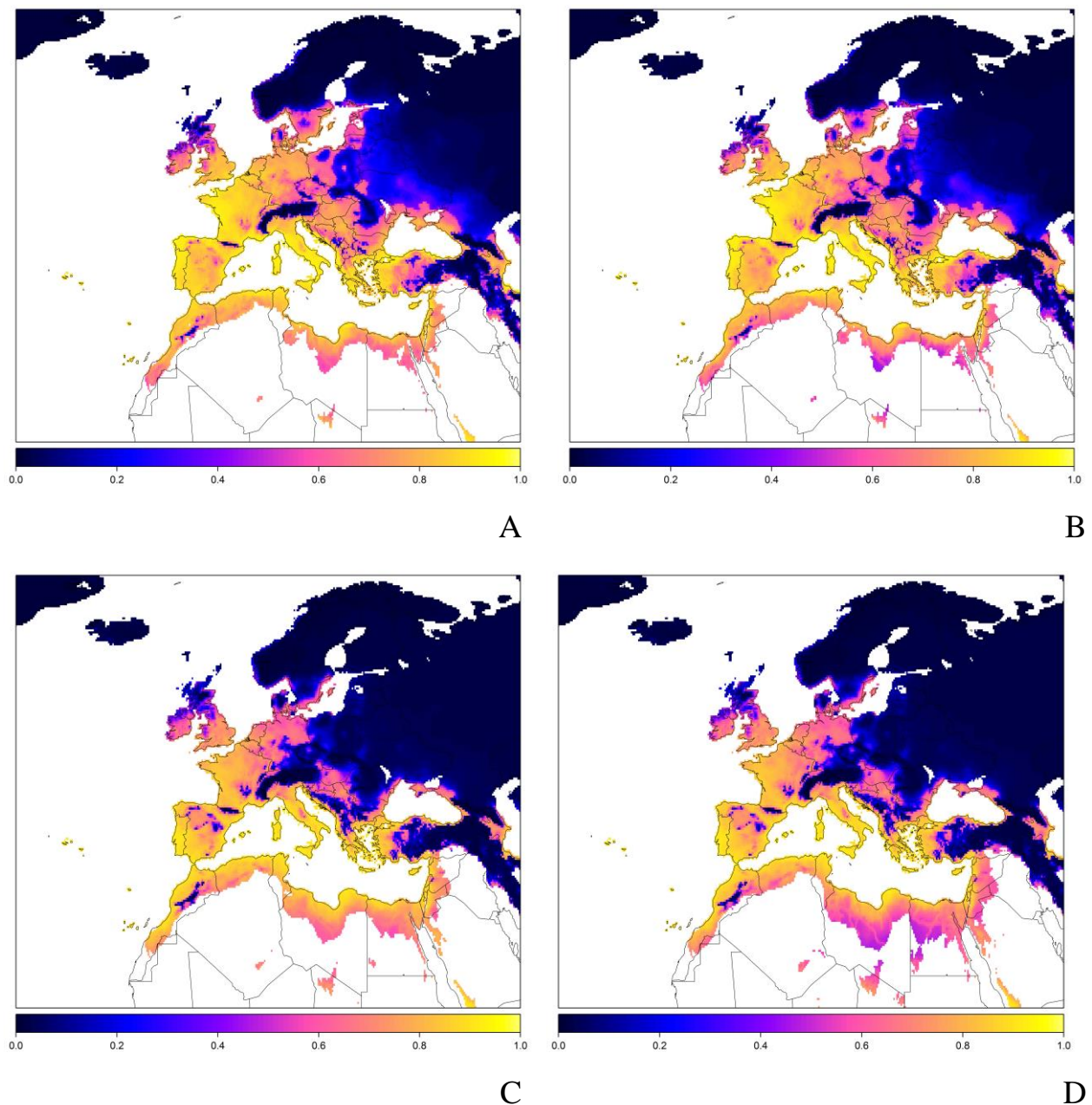
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2076 **Figure 5.** Projected current suitability for the four subspecies of *Acacia saligna* establishment in Europe
 2077 and the Mediterranean region. The white areas have climatic conditions outside the range of the training
 2078 data so were excluded from the projection. (A) *A. saligna* subsp. *lindleyi*, (B) *A. saligna* subsp.
 2079 *pruinescens*, (C) *A. saligna* subsp. *saligna* and (D) *A. saligna* subsp. *stolonifera*. There are also areas of
 2080 marginal suitability predicted for coastline of North Africa, as well as for the Black sea coast for the
 2081 ‘*pruinescens*’ subspecies (Bulgaria and Romania).

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2087 **Figure 6.** Projected suitability for the four subspecies of *Acacia saligna* establishment in Europe and the
2088 Mediterranean region in the 2070s under climate change scenario RCP8.5. (A) *A. saligna* subsp. *lindleyi*,
2089 (B) *A. saligna* subsp. *pruinescens*, (C) *A. saligna* subsp. *saligna* and (D) *A. saligna* subsp. *stolonifera*.

2090

2091 MAPS DISCLAIMER

2092

2093 The presentation of maps therein does not imply the expression of any opinion whatsoever by the Authors and the
2094 PRA itself concerning the legal status of any country, area or territory or of its authorities, or concerning the
2095 delimitation of its borders. The depiction and use of boundaries, geographic names and related data shown on maps
2096 and included in lists, tables, documents, and databases on this PRA are not warranted to be error free nor do they
2097 necessarily imply official endorsement or acceptance by the PRA document.

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2099

- 2100
- 2101 **Caveats to the modelling**
- 2102 There was considerable uncertainty as to the status of the *A. saligna* distribution records obtained from
2103 global databases such as GBIF. We used expert opinion to filter out records that were potentially
2104 unreliable, but it is possible that some true *A. saligna* were lost. The potential effect of this could be to
2105 underestimate the range of conditions under which the species could establish.
- 2106 To remove spatial recording biases, the selection of the background sample was weighted by the density
2107 of Tracheophyte records on the Global Biodiversity Information Facility (GBIF). While this is preferable
2108 to not accounting for recording bias at all, a number of factors mean this may not be the perfect null
2109 model for species occurrence:
- 2110• The GBIF API query used to did not appear to give completely accurate results. For example, in a small
2111 number of cases, GBIF indicated no Tracheophyte records in grid cells in which it also yielded records of
2112 the focal species.
 - 2113• We located additional data sources to GBIF, which may have been from regions without GBIF records.
- 2114 Other variables potentially affecting the distribution of the species, such as soil nutrients or soil pH were
2115 not included in the model.
- 2116 Model outputs were classified as suitable or unsuitable using a threshold of 0.5, effectively a ‘prevalence
2117 threshold’ given the prevalence weighting of model-fitting. There is disagreement about the best way to
2118 select suitability thresholds, so we evaluated the threshold selected by the commonly-used ‘minROCdist’
2119 method. This would have selected a threshold of 0.48, slightly increasing the region predicted to be
2120 suitable.
- 2121 In an expected global warming scenario with higher temperatures and CO₂ levels (IPCC 2013), with
2122 acacias growing at higher rates and producing canopies with denser foliage, reducing light availability for
2123 understory species, the invasiveness of these species could be severely increased (Souza-Alonso *et al.*
2124 2017).
- 2125
- 2126
- 2127