

1   **Appendix S1 Search terms for the systematic review and references for papers included in the meta-**  
 2   **analysis.**

3   **Search terms**

4   Each search included strings of descriptors for (1) non-native species, (2) taxa (in some cases by habitat),  
 5   and (3) environmental drivers of climate change. Searches were carried out using ISI Web of Knowledge.  
 6

7   (1) *Non-native species descriptors*

8   invas\* OR invad\* OR alien OR non-nativ\* OR nonnativ\* OR exotic\* OR introduced OR non-indigenous  
 9   OR naturalized

10   (2) *Taxonomic descriptors*

11   Plants (terrestrial and aquatic): plant or vegetat\* OR tree\* OR shrub\* OR grass\* OR forest\* OR forb\*  
 12   OR herb\* OR vine\*

13   Marine animals: marine OR ocean\* OR sea OR intertidal OR subtidal OR mudflat OR estuarine OR  
 14   pelagic OR saltmarsh

15   Freshwater animals: fish OR snail OR crayfish

16   Terrestrial animals: insect\* OR beetle\* OR mammal\* OR bird\* OR reptile\* OR amphibian\*

17   (3) *Environmental driver descriptors*

18   Temperature: temperature OR warm\* OR heat\*

19   CO<sub>2</sub>: CO<sub>2</sub> OR carbon dioxide

20   CO<sub>2</sub> for aquatic studies: CO<sub>2</sub> OR carbon dioxide OR pH OR ocean acidification

21   Precipitation: precip\* OR rain\* OR snow\* OR water\*

22   For example, a search for temperature impacts on terrestrial autotrophs was entered as:

23   TOPIC = (invas\* OR invad\* OR alien OR non-nativ\* OR nonnativ\* OR exotic\* OR introduced OR non-  
 24   indigenous OR naturalized OR naturalized) AND (temperature OR warm\* OR heat\*) AND (plant or  
 25   vegetat\* OR tree\* OR shrub\* OR grass\* OR forest\* OR forb\* OR herb\* OR vine\*).

26   **References**

27   Allen, E.B. (1982). Germination and Competition of *Salsola kali* with native C3 and C4 species under  
 28   three temperature regimes. *Bull. Torrey Bot. Club*, 109, 39-46.

29   Anderson, L.J., Maherali, H., Johnson, H.B., Polley, H.W. & Jackson, R.B. (2001). Gas exchange and  
 30   photosynthetic acclimation over subambient to elevated CO<sub>2</sub> in a C3-C4 grassland. *Glob. Change  
 31   Biol.*, 7, 693-707.

32   Arnone, J.A., Jasoni, R.L., Lucchesi, A.J., Larsen, J.D., Leger, E.A., Sherry, R.A., Luo, Y., Schimel, D.S.  
 33   & Verburg, P.S.J. (2011). A climatically extreme year has large impacts on C4 species in tallgrass

- 52 prairie ecosystems but only minor effects on species richness and other plant functional groups. *J.  
53 Ecol.*, 99, 678-688.
- 54 Ashby, W.C. & Hellmers, H. (1959). Flowering and growth responses to photoperiod and temperature for  
55 six southern California grasses. *Bot. Gazette*, 120, 151-157.
- 56 Bahrani, M.J., Bahrami, H. & Haghghi, A.A.K. (2010). Effect of water stress on ten forage grasses native  
57 or introduced to Iran. *Grassl. Sci.*, 56, 1-5.
- 58 Bakker, J. & Wilson, S. (2001). Competitive abilities of introduced and native grasses. *Plant Ecol.*, 157,  
59 119-127.
- 60 Baruch, Z. & Jackson, R. (2005). Responses of tropical native and invader C<sub>4</sub> grasses to water stress,  
61 clipping and increased atmospheric CO<sub>2</sub> concentration. *Oecologia*, 145, 522-532.
- 62 Belote, R.T., Weltzin, J.F. & Norby, R.J. (2004). Response of an understory plant community to elevated  
63 [CO<sub>2</sub>] depends on differential responses of dominant invasive species and is mediated by soil  
64 water availability. *New Phytol.*, 161, 827-835.
- 65 Blicker, P.S., Olson, B.E. & Wraith, J.M. (2003). Water use and water-use efficiency of the invasive  
66 *Centaurea maculosa* and three native grasses. *Plant Soil*, 254, 371-381.
- 67 Blumenthal, D., Chimner, R.A., Welker, J.M. & Morgan, J.A. (2008). Increased snow facilitates plant  
68 invasion in mixedgrass prairie. *New Phytol.*, 179, 440-448.
- 69 Boschma, S.P., Hill, M.J., Scott, J.M. & Rapp, G.G. (2003). The response to moisture and defoliation  
70 stresses, and traits for resilience of perennial grasses on the Northern Tablelands of New South  
71 Wales, Australia. *Anglia*, 54, 14.
- 72 Braby, C.E. & Somero, G.N. (2006). Following the heart: temperature and salinity effects on heart rate in  
73 native and invasive species of blue mussels (genus *Mytilus*). *J. Exper. Biol.*, 209, 2554-2566.
- 74 Brock, M.T. & Galen, C. (2005). Drought tolerance in the alpine dandelion, *Taraxacum ceratophorum*  
75 (Asteraceae), its exotic congener *T. officinale*, and interspecific hybrids under natural and  
76 experimental conditions. *Am. J. Bot.*, 92, 1311-1321.
- 77 Buckland, S.M., Thompson, K., Hodgson, J.G. & Grime, J.P. (2001). Grassland invasions: effects of  
78 manipulations of climate and management. *J. Appl. Ecol.*, 38, 301-309.
- 79 Bunting, D.P., Kurc, S.A. & Grabau, M.R. (2011). Using existing agricultural infrastructure for  
80 restoration practices: Factors influencing successful establishment of *Populus fremontii* over  
81 *Tamarix ramosissima*. *J. Arid Environ.*, 75, 851-860.
- 82 Cabin, R.J., Weller, S.G., Lorence, D.H., Cordell, S. & Hadway, L.J. (2002). Effects of microsite, water,  
83 weeding, and direct seeding on the regeneration of native and alien species within a Hawaiian dry  
84 forest preserve. *Biol. Conserv.*, 104, 181-190.
- 85 Carveth, C.J., Widmer, A.M. & Bonar, S.A. (2006). Comparison of upper thermal tolerances of native  
86 and nonnative fish species in Arizona. *Trans. Am. Fish. Soc.*, 135, 1433-1440.
- 87 Cox, J.A. & Conran, J.G. (1996). The effect of water stress on the life cycles of *Erodium crinitum* Carolin  
88 and *Erodium cicutarium* (L.) L'Hérit. ex Alton (Geraniaceae). *Aust. J. Ecol.*, 21, 235-240.
- 89 Domènec, R. & Vilà, M. (2008). Response of the invader *Cortaderia selloana* and two coexisting  
90 natives to competition and water stress. *Biol. Invasions*, 10, 903-912.
- 91 Dukes, J.S. (2002). Comparison of the effect of elevated CO<sub>2</sub> on an invasive species (*Centaurea  
92 solstitialis*) in monoculture and community settings. *Plant Ecol.*, 160, 225-234.
- 93 Duyck, P.-F., David, P. & Quilici, S. (2006). Climatic niche partitioning following successive invasions  
94 by fruit flies in La Réunion. *J. Anim. Ecol.*, 75, 518-526.
- 95 Engel, E.C., Weltzin, J.F., Norby, R.J. & Classen, A.T. (2009). Responses of an old-field plant  
96 community to interacting factors of elevated [CO<sub>2</sub>], warming, and soil moisture. *J. Plant Ecol.*, 2,  
97 1-11.
- 98 Findlay, H.S., Kendall, M.A., Spicer, J.I. & Widdicombe, S. (2010). Post-larval development of two  
99 intertidal barnacles at elevated CO<sub>2</sub> and temperature. *Mar. Biol.*, 157, 725-735.
- 100 Funk, J. & Zachary, V. (2010). Physiological responses to short-term water and light stress in native and  
101 invasive plant species in southern California. *Biol. Invasions*, 12, 1685-1694.

- 102 Garcia-Serrano, H., Josep, E. & Sans, F.X. (2004). Factors that limit the emergence and establishment of  
 103 the related aliens *Senecio inaequidens* and *Senecio pterophorus* and the native *Senecio*  
 104 *malacitanus* in Mediterranean climate. *Can. J. Bot.*, 82, 1346-1355.
- 105 Geng, Y.-P., Pan, X.-Y., Xu, C.-Y., Zhang, W.-J., Li, B. & Chen, J.-K. (2006). Phenotypic plasticity  
 106 of invasive *Alternanthera philoxeroides* in relation to different water availability, compared  
 107 to its native congener. *Acta Oecol.*, 30, 380-385.
- 108 Gray, A.J. & Mogg, R.J. (2001). Climate impacts on pioneer saltmarsh plants. *Clim. Res.*, 18, 105-112.
- 109 Gutiérrez, J.R. (1992). Effects of low water supplementation and nutrient addition on the aboveground  
 110 biomass production of annual plants in a Chilean coastal desert site. *Oecologia*, 90, 556-559.
- 111 Hättenschwiler, S. & Körner, C. (2003). Does elevated CO<sub>2</sub> facilitate naturalization of the non-indigenous  
 112 *Prunus laurocerasus* in Swiss temperate forests? *Func. Ecol.*, 17, 778-785.
- 113 Hellmers, H. & Ashby, W.C. (1958). Growth of native and exotic plants under controlled temperatures  
 114 and in the San Gabriel mountains California. *Ecology*, 39, 416-428.
- 115 Hely, S.E.L. & Roxburgh, S.H. (2005). The interactive effects of elevated CO<sub>2</sub> temperature and initial  
 116 size on growth and competition between a native C<sub>3</sub> and an invasive C<sub>3</sub> grass. *Plant Ecol.*, 177,  
 117 85-98.
- 118 Hill, J.P., Germino, M.J., Wraith, J.M., Olson, B.E. & Swan, M.B. (2006). Advantages in water relations  
 119 contribute to greater photosynthesis in *Centaurea maculosa* compared with established grasses.  
 120 *Int. J. Plant Sci.*, 167, 269-277.
- 121 Holway, D.A., Suarez, A.V. & Case, T.J. (2002). Role of abiotic factors in governing susceptibility to  
 122 invasion: a test with Argentine ants. *Ecology*, 83, 1610-1619.
- 123 Horton, J.L. & Clark, J.L. (2001). Water table decline alters growth and survival of *Salix gooddingii* and  
 124 *Tamarix chinensis* seedlings. *For. Ecol. Manag.*, 140, 239-247.
- 125 Hoya, A., Shibaike, H., Morita, T. & Ito, M. (2004). Germination and seedling survivorship  
 126 characteristics of hybrids between native and alien species of dandelion (*Taraxacum*). *Plant  
 127 Species Biol.*, 19, 81-90.
- 128 Huxman, T. & Smith, S. (2001). Photosynthesis in an invasive grass and native forb at elevated CO<sub>2</sub>  
 129 during an El Niño year in the Mojave Desert. *Oecologia*, 128, 193-201.
- 130 Hwang, B. & Lauenroth, W. (2008). Effect of nitrogen, water and neighbor density on the growth of  
 131 *Hesperis matronalis* and two native perennials. *Biol. Invasions*, 10, 771-779.
- 132 Ignace, D.D., Juxman, T.E., Weltzin, J.F. & Williams, D.G. (2007). Leaf gas exchange and water status  
 133 responses of a native and non-native grass to precipitation across contrasting soil surfaces in the  
 134 Sonoran desert. *Oecologia*, 152, 401-413.
- 135 Janion, C., Leinaas, H.P., Terblanche, J.S. & Chown, S.L. (2010). Trait means and reaction norms: the  
 136 consequences of climate change/invasion interactions at the organism level. *Evol. Ecol.*, 24,  
 137 1365-1380.
- 138 Kim, H.-R. & You, Y.-H. (2010). Effects of elevated CO<sub>2</sub> concentration and increased temperature on  
 139 leaf related-physiological responses of *Phytolacca insularis* (native species) and *Phytolacca*  
 140 *americana* (invasive species). *J. Ecol. Field Biol.*, 33, 195-204.
- 141 Leishman, M.R. & Thomson, V.P. (2005). Experimental evidence for the effects of additional water,  
 142 nutrients and physical disturbance on invasive plants in low fertility Hawkesbury Sandstone soils,  
 143 Sydney, Australia. *J. Ecol.*, 93, 38-49.
- 144 Lenssen, G.M., Lamers, J., Stroetenga, M. & Rozema, J. (1993). Interactive effects of atmospheric CO<sub>2</sub>  
 145 enrichment, salinity and flooding on growth of C<sub>3</sub> (*Elymus athericus*) and C<sub>4</sub> (*Spartina anglica*)  
 146 salt marsh species. *Plant Ecol.*, 104-105, 379-388.
- 147 Levine, J.M., McEachern, A.K. & Cowan, C. (2010). Do competitors modulate rare plant response to  
 148 precipitation change? *Ecology*, 91, 130-140.
- 149 Manea, A. & Leishman, M. (2011). Competitive interactions between native and invasive exotic plant  
 150 species are altered under elevated carbon dioxide. *Oecologia*, 165, 735-744.
- 151 Mangla, S., Sheley, R.L. & James, J.J. (2011). Field growth comparisons of invasive alien annual and  
 152 native perennial grasses in monocultures. *J. Arid Environ.*, 75, 206-210.

- 153 Maron, John L. & Marler, M. (2008). Effects of native species diversity and resource additions on invader  
154 impact. *Am. Nat.*, 172, S18-S33.
- 155 Miller, A.W., Reynolds, A.C., Sobrino, C. & Riedel, G.F. (2009). Shellfish face uncertain future in high  
156 CO<sub>2</sub> world: Influence of acidification on oyster larvae calcification and growth in estuaries. *PLoS  
157 ONE*, 4, e5661.
- 158 Morecroft, M.D., Stokes, V.J., Taylor, M.E. & Morison, J.I.L. (2008). Effects of climate and management  
159 history on the distribution and growth of sycamore (*Acer pseudoplatanus* L.) in a southern British  
160 woodland in comparison to native competitors. *Forestry*, 81, 59-74.
- 161 Nagel, J.M., Huxman, T.E., Griffin, K.L. & Smith, S.D. (2004). CO<sub>2</sub> enrichment reduces the energetic  
162 cost of biomass construction in an invasive desert grass. *Ecology*, 85, 100-106.
- 163 Naumann, J., Bissett, S., Young, D., Edwards, J. & Anderson, J. (2010). Diurnal patterns of  
164 photosynthesis, chlorophyll fluorescence, and PRI to evaluate water stress in the invasive species,  
165 *Elaeagnus umbellata* Thunb. *Trees – Struct. Func.*, 24, 237-245.
- 166 Nernberg, D. & Dale, M.R.T. (1997). Competition of five native prairie grasses with *Bromus inermis*  
167 under three moisture regimes. *Can. J. Bot.*, 75, 2140-2145.
- 168 Parker, L.M., Ross, P.M. & O'Connor, W.A. (2010). Comparing the effect of elevated pCO<sub>2</sub> and  
169 temperature on the fertilization and early development of two species of oysters. *Mar. Biol.*, 157,  
170 2435-2452.
- 171 Patterson, D.T. (1993). Effects of day and night temperature on goatsrue (*Galega officinalis*) and alfalfa  
172 (*Medicago sativa*) growth. *Weed Sci.*, 41, 38-45.
- 173 Patterson, D.T., Russell, A.E., Mortensen, D.A., Coffin, R.D. & Flint, E.P. (1986). Effects of temperature  
174 and photoperiod on Texas panicum (*Panicum texanum*) and wild proso millet (*Panicum  
175 miliaceum*). *Weed Sci.*, 34, 876-882.
- 176 Petes, L.E., Menge, B.A. & Murphy, G.D. (2007). Environmental stress decreases survival, growth, and  
177 reproduction in New Zealand mussels. *J. Exper. Mar. Biol. Ecol.*, 351, 83-91.
- 178 Raizada, P., Singh, A. & Raghubanshi, A.S. (2009). Comparative response of seedlings of selected native  
179 dry tropical and alien invasive species to CO<sub>2</sub> enrichment. *J. Plant Ecol.*, 2, 69-75.
- 180 Rao, L. & Allen, E. (2010). Combined effects of precipitation and nitrogen deposition on native and  
181 invasive winter annual production in California deserts. *Oecologia*, 162, 1035-1046.
- 182 Reich, P.B., Tilman, D., Craine, J., Ellsworth, D., Tjoelker, M.G., Knops, J., Wedin, D., Naeem, S.,  
183 Bahauddin, D., Goth, J., Bengtson, W. & Lee, T.D. (2001). Do species and functional groups  
184 differ in acquisition and use of C, N and water under varying atmospheric CO<sub>2</sub> and N availability  
185 regimes? A field test with 16 grassland species. *New Phytol.*, 150, 435-448.
- 186 Reynolds, L.V. & Cooper, D.J. (2010). Environmental tolerance of an invasive riparian tree and its  
187 potential for continued spread in the southwestern US. *J. Veg. Sci.*, 21, 733-743.
- 188 Sareyka, J., Kraufvelin, P., Lenz, M., Lindström, M., Tollrian, R. & Wahl, M. (2011). Differences in  
189 stress tolerance and brood size between a non-indigenous and an indigenous gammarid in the  
190 northern Baltic Sea. *Mar. Biol.*, 158, 2001-2008.
- 191 Sasek, T.W. & Strain, B.R. (1991). Effects of CO<sub>2</sub> enrichment on the growth and morphology of a native  
192 and an introduced honeysuckle vine. *Am. J. Bot.*, 78, 69-75.
- 193 Schneider, K.R. (2008). Heat stress in the intertidal: comparing survival and growth of an invasive and  
194 native mussel under a variety of thermal conditions. *Biol. Bull.*, 215, 253-264.
- 195 Schneider, K.R. & Helmuth, B.S.T. (2007). Spatial variability in habitat temperature may drive patterns  
196 of selection between an invasive and native mussel species. *Mar. Ecol. Prog. Ser.*, 339, 157-167.
- 197 Schumacher, E., Kueffer, C., Tobler, M., Gmür, V., Edwards, P.J. & Dietz, H. (2008). Influence of  
198 drought and shade on seedling growth of native and invasive trees in the Seychelles. *Biotropica*,  
199 40, 543-549.
- 200 Smith, S.D., Huxman, T.E., Zitter, S.F., Charlet, T.N., Housman, D.C., Coleman, J.S., Fenstermaker,  
201 L.K., Seemann, J.R. & Nowak, R.S. (2000). Elevated CO<sub>2</sub> increases productivity and invasive  
202 species success in an arid ecosystem. *Nature*, 408, 79-82.

- 203 Song, L., Wu, J., Li, C., Li, F., Peng, S. & Chen, B. (2009). Different responses of invasive and native  
204 species to elevated CO<sub>2</sub> concentration. *Acta Oecol.*, 35, 128-135.
- 205 Song, L.-Y., Li, C.-H. & Peng, S.-L. (2010). Elevated CO<sub>2</sub> increases energy-use efficiency of invasive  
206 *Wedelia trilobata* over its indigenous congener. *Biol. Invasions*, 12, 1221-1230.
- 207 Sorte, C.J.B., Fuller, A. & Bracken, M.E.S. (2010). Impacts of a simulated heat wave on composition of a  
208 marine community. *Oikos*, 119, 1909-1918.
- 209 Sorte, C.J.B., Williams, S.L. & Zerebecki, R.A. (2010). Ocean warming increases threat of invasive  
210 species in a marine fouling community. *Ecology*, 91, 2198-2204.
- 211 Steen, H. & Rueness, J. (2004). Comparison of survival and growth in germlings of six fucoid species  
212 (Fucales, Phaeophyceae) at two different temperature and nutrient levels. *Sarsia*, 89, 175-183.
- 213 Steiner, J.J., Brewer, T.G. & Griffith, S.M. (2001). Temperature effects on interspecific interference  
214 among two native wetland grasses and tall fescue. *Agron. J.*, 93, 1020-1027.
- 215 Sullivan, L., Wildova, R., Goldberg, D. & Vogel, C. (2010). Growth of three cattail (*Typha*) taxa in  
216 response to elevated CO<sub>2</sub>. *Plant Ecol.*, 207, 121-129.
- 217 Sun, Y., Ding, J. & Frye, M.J. (2010). Effects of resource availability on tolerance of herbivory in the  
218 invasive *Alternanthera philoxeroides* and the native *Alternanthera sessilis*. *Weed Res.*, 50, 527-  
219 536.
- 220 Tang, Y.Q. & Yokomi, R.K. (1995). Temperature-dependent development of three hymenopterous  
221 parasitoids of aphids (Homoptera: Aphididae) attacking citrus. *Environ. Entomol.*, 24, 1736-1740.
- 222 Verlinden, M. & Nijs, I. (2010). Alien plant species favoured over congeneric natives under experimental  
223 climate warming in temperate Belgian climate. *Biol. Invasions*, 12, 2777-2787.
- 224 Werner, C., Zumkier, U., Beyschlag, W. & Máguas, C. (2010). High competitiveness of a resource  
225 demanding invasive acacia under low resource supply. *Plant Ecol.*, 206, 83-96.
- 226 Williams, A.L., Wills, K.E., Janes, J.K., Vander Schoor, J.K., Newton, P.C.D. & Hovenden, M.J. (2007).  
227 Warming and free-air CO<sub>2</sub> enrichment alter demographics in four co-occurring grassland species.  
228 *New Phytol.*, 176, 365-374.
- 229 Williams, D.G. & Black, R.A. (1994). Drought response of a native and introduced Hawaiian grass.  
230 *Oecologia*, 97, 512-519.
- 231 Willis, A.J., Berenton, P.R. & Ash, J.E. (2003). Impacts of a weed biocontrol agent on recovery from  
232 water stress in a target and a non-target *Hypericum* species. *J. Appl. Ecol.*, 40, 320-333.
- 233 Wilson, S.B., Wilson, P.C. & Albano, J.A. (2004). Growth and development of the native *Ruellia*  
234 *caroliniensis* and invasive *Ruellia tweediana*. *HortScience*, 39, 1015-1019.
- 235 Wu, Y.P., Hu, X.W. & Wang, Y.R. (2009). Growth, water relations, and stomatal development of  
236 *Caragana korshinskii* Kom. and *Zygophyllum xanthoxylum* (Bunge) Maxim. seedlings in  
237 response to water deficits. *New Zealand J. Agric. Res.*, 52, 185-193.
- 238 Xu, B., Li, F., Shan, L.U.N., Ma, Y., Ichizen, N. & Huang, J.I.N. (2006). Gas exchange, biomass  
239 partition, and water relationships of three grass seedlings under water stress. *Weed Biol. Manag.*,  
240 6, 79-88.
- 241 Yazaki, K., Sano, Y., Fujikawa, S., Nakano, T. & Ishida, A. (2010). Response to dehydration and  
242 irrigation in invasive and native saplings: osmotic adjustment versus leaf shedding. *Tree Physiol.*,  
243 30, 597-607.
- 244 Zerebecki, R.A. & Sorte, C.J.B. (2011). Temperature tolerance and stress proteins as mechanisms of  
245 invasive species success. *PLoS ONE*, 6, e14806.
- 246 Zhang, C., Wei, L., ZhiFang, X., HongLin, C. & WanHui, Y. (2006). Responses of vegetative growth and  
247 photosynthesis to temperature in the invasive species *Alternanthera philoxeroides* and its  
248 indigenous congener *A. sessilis*. *J. Trop. Subtrop. Bot.*, 14, 333-339.
- 249 Zukowski, S. & Walker, K.F. (2009). Freshwater snails in competition: alien *Physa acuta* (Physidae) and  
250 native *Glyptophysa gibbosa* (Planorbidae) in the River Murray, South Australia. *Mar. Freshw.  
Res.*, 60, 999-1005.