**Notes about traits**

RMF / BIOMASS ALLOCATION & eCO2

Poorter et al. 2000 The role of biomass allocation in the growth response of plants to different levels of light, CO2, nutrients and water: a quantitative review

"Changes in allocation pattern are relatively strong when light or nutrient supply is varied, modest in the case of varying water supply and almost absent when the atmospheric CO2 concentration is increased."

Wang et al. 2010 - interactive effects of elevated carbon dioxide and environmental stresses

"For this synthesis, we used RMF as a measure for biomass allocation or partitioning in plants. RMF was used instead of the more commonly used root:shoot ratio (RSR) because RMF is less sensitive to small changes in root production and should be preferentially used in assessing patterns of biomass production (Ko¨rner 1994; Poorter and Nagel 2000)."

"An examination of RMF at three levels of CO2 showed little effect of magnitude of CO2 enrichment on biomass allocation in plants."

"RMF tended to increase by a greater magnitude at elevated than at ambient CO2 for both woody and herbaceous species at lower soil water"

Sullivan et al. 2010 - growth of three cattail (typha) taxa in response to elevated CO2

Arenque et al. 2014 - responses of Senna reticulate, a legume tree from the Amazonian floodplains, to elevated atmospheric CO2 concentration and water logging.

FINE ROOTS & eCO2

<http://onlinelibrary.wiley.com/doi/10.1111/j.1469-8137.1995.tb03025.x/abstract>

<http://www.esajournals.org/doi/abs/10.1890/1051-0761(2000)010%5B0018:IEOACA%5D2.0.CO%3B2>

<http://onlinelibrary.wiley.com/doi/10.1046/j.1365-2486.2000.00374.x/abstract?deniedAccessCustomisedMessage=&userIsAuthenticated=false>

<http://onlinelibrary.wiley.com/doi/10.1111/gcb.12609/abstract?deniedAccessCustomisedMessage=&userIsAuthenticated=false> references

eCO2 increases fine root production and mortality

"fine root tissue density"

Does flooding or CO2 change the relationship between root and leaf DMC ???

**CO2 enrichment increases carbon and nitrogen input from fine roots in a deciduous forest**

* CO2 enrichment had no effect on root tissue density or [N] within a given diameter class. Root biomass production and standing crop were doubled under elevated [CO2]. Though fine-root turnover declined under elevated [CO2], fine-root mortality was also nearly doubled under CO2 enrichment. Over 9 yr, root mortality resulted in 681 g m−2 of extra C and 9 g m−2 of extra N input to the soil system under elevated [CO2]. At least half of these inputs were below 30 cm soil depth.

SPecies and community level patterns in fine root traits along a 120000 year soil chronosequence in temperate rainforest. Not ultra relevant but interesting discussion of variation in root traits along environmental gradients.

<http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2745.2011.01821.x/full>

SLA & eCO2

Saplings have higher SLA than adults <http://www.esajournals.org/doi/full/10.1890/ES14-000159.1>

But this has only been shown where light is limiting… (Trade-offs between net assimilation rate and specific leaf area in determining relative growth rate: relationship with daily irradiance. Functional Ecology 16:682–689)

Leaf traits are most strongly related to regeneration niche (rather than the adult niche), so SLA is important! (Poorter 2007)

http://www.jstor.org/discover/10.1086/512045?uid=2&uid=4&sid=21106056247053

Poorter et al 2003 - plant growth and competition at elevated CO2: on winners, losers and functional groups

"The change in SLA is much stronger ([Fig. 2a](http://onlinelibrary.wiley.com/doi/10.1046/j.1469-8137.2003.00680.x/full#f2)) and a decrease occurs in almost all C3 plants under a wide range of environmental conditions. SLA depends on differences in leaf anatomy, and should be reflected in the chemical composition on a leaf area basis. Although a meta-analysis is lacking, accumulation of nonstructural carbohydrates is likely to be the main factor for the decrease in SLA ([Wong, 1990](http://onlinelibrary.wiley.com/doi/10.1046/j.1469-8137.2003.00680.x/full#b59); [Roumet*et al*., 1996](http://onlinelibrary.wiley.com/doi/10.1046/j.1469-8137.2003.00680.x/full#b27)) resulting in an increase in leaf density ([Roumet](http://onlinelibrary.wiley.com/doi/10.1046/j.1469-8137.2003.00680.x/full" \l "b64) [*et al*., 1999](http://onlinelibrary.wiley.com/doi/10.1046/j.1469-8137.2003.00680.x/full#b64))."

Flooding & root:shoot ratio

<http://www.jstor.org/discover/10.2307/1940668?sid=21105929369893&uid=2&uid=4>

Megonigal, baldcypress

Flooding & root tissue density:

[Covariation in leaf and root traits for native and non-native grasses along an altitudinal gradient in New Zealand](http://link.springer.com/article/10.1007/s00442-002-1155-6)

[JM Craine](https://scholar.google.com.au/citations?user=92V6c9AAAAAJ&hl=en&oi=sra), [WG Lee](https://scholar.google.com.au/citations?user=XguDYYIAAAAJ&hl=en&oi=sra)

"The only trait strongly associated with water use efficiency was tissue density. The low leaf and

**root** **tissue** **density** of “wetter” plants could be due to the need for aeration and the formation of

**aerenchyma** in roots (Visser et al. 2000; Eissenstat et al. 2000)"

Responses to Root-Zone CO2 Enrichment and Hypoxia of Wheat Genotypes Differing in Waterlogging Tolerance

* **Bingru Huang , Jerry W. Johnson and D. Scott NeSmith**

When compared with the aerated control, the combination of elevated CO2 and hypoxia caused significant reductions in Pn, gs, leaf water potential, and leaf chl content for Bayles, and in shoot and root growth for both Bayles and Savannah. Photosynthetic rate and leaf chi content of Savannah were increased when roots of hypoxic plants were exposed to elevated CO2, but this was not true for Bayles. Root-zone CO2enrichment at ambient O2 had no significant effects on shoot growth, but reduced root growth in both genotypes. The results showed that CO2 enrichment under root hypoxia can alleviate some negative effects of hypoxia on Pn, leaf chi content, and shoot growth, the effect being larger for waterlogging tolerance Savannah.

Hypotheses:

-eCO2 will be associated with higher photosynthetic rates irrespective of flooding

-Flooding will reduce the stimulation of biomass production by eCO2 (i.e. metabolic costs of flooding tolerance will offset fx of enhanced photosynthesis on biomass)

-Stimulation of fine root turnover by eCO2 will result in accelerated recovery from flooding

eCO2 is associated with increased fine root proportion

eCO2 is associated with

eCO2 is associated with lower SLA

Something about the relationship between fine root proportion and fine root DMC.

- are increases in fine root biomass associated with increased DMC (as proxy for tissue density?)

- measure of root consolidation vs. rapid expansion

**General notes**

Root waterlogging induces low O2, low C and N uptake, and toxic ion formation, which leads to aerenchyma formation (Voesenek et al 2015).

“There is a broad consensus that lysigenous aerenchyma formation in waterlogged roots is triggered by accumulation of ethylene (He et al., 1996; Shiono et al., 2007; Rajhi et al., 2011; Yamauchi et al., 2014).

Webb et al. 2012 – waterlogging of wetland plants does not necessarily decrease plant growth

“Similarly, most of the evidence concerning effects of waterlogging on growth either supported increased growth in waterlogged substrates, or found no consistent effects. The inconsistency is mostly caused by species-specific differences, including inconsistent results between species in the same study ([Kirkman and Sharitz, 1993](http://www.sciencedirect.com/science/article/pii/S0304377012001167" \l "bib0310), [Lenssen et al., 2000](http://www.sciencedirect.com/science/article/pii/S0304377012001167" \l "bib0335) and [Visser et al., 2000](http://www.sciencedirect.com/science/article/pii/S0304377012001167" \l "bib0615)). One study found decreased growth in waterlogged treatments ([Banga et al., 1995](http://www.sciencedirect.com/science/article/pii/S0304377012001167" \l "bib0040)), but this study again showed minor inconsistency in the effect among four species of *Rumex*.”

Water stress decreases the rate of plant CO2 assimilation, at both saturating and sub-saturating Ci, as a consequence of the reduced stomatal conductance and/or by direct damage to carbon metabolism ( [Johnson et al., 1987](http://www.sciencedirect.com/science/article/pii/S0098847202000655#BIB24) and [Gimenez et al., 1992](http://www.sciencedirect.com/science/article/pii/S0098847202000655" \l "BIB23)).