Discussion:

While resolution between hydrologically similar classes of river was weak, these results lend credibility to broad-scale ecohydrological classification as a coarse but useful tool in riparian functional ecology. Where river systems belong to different hydrological classes but are spatially or climatically close, it makes sense to dig deeper than lumped categorical comparisons and compare continuous hydrological parameters.

We found that wood density increased with intensity of flooding disturbance. Wood density was not correlated with the frequency of high flow periods, which individually may not correspond to significant disturbance events, depending on the hydrological characteristics of the given river. Rather, it was the actual magnitude of flow during high flow periods that was important. The observation that variability but not average values of flood rise and fall rates predicted wood density, indicates the influence of low frequency, intensely flashy outlier flow events not captured by the mean. A pattern is apparent then, in which wood density in riparian communities is driven by powerful but relatively rare flow events. The abundance of high wood density strategies in these environments indicates that infrequent but high-stakes events are a greater force of selection in riparian plant communities than average conditions. We therefore suggest that a ‘brick house’ ecological strategy is selected for in riparian environments that experience intense flooding. This suggestion concurs with findings that trees tend to overcompensate for mechanical stress, with investment in defences increasing cumulatively in response to rare, extreme events (Cohen & Mangel 1999, Telewski 1995).

Predictability of water availability in the riparian zone was also strongly predictive of mean wood density. We can extend the observation about the influence of intense ‘pulse’ flow events on wood density: plants living in environments where flow occurs unpredictably and largely within specific events, rather than being evenly distributed throughout time, will experience more intense pulses of water stress.

High wood density may be symptomatic of wood anatomy strategies that allow plants to tolerate water stress (Hacke et al 2001, Jacobsen 2005, 2007a). Numerous studies have discussed the role of various anatomical components of woody tissue in stabilising xylem against cavitation when plants are under severe water stress, but the exact role that woody fibres play in stabilising xylem vessels appears to be inconsistent (Martinez-Cabrera 2009). Overall, resistance against cavitation appears to result from complex interactions between wood anatomical traits Lens 2010, Zieminska 2013) and/or aboveground biomass production traits (Cochard et al. 2007), both of which are tangentially related to wood density.

A more compelling rationale for our findings is that riparian woody plants are again overcompensating for the possibility of rare life-or-death stress events. In the absence of predictable cues about timing of watering flows, broad phenotypic plasticity in resource use traits may in fact be maladaptive in highly unpredictable environments (Valladares 2002, Valladares 2005), and conservative resource-use phenotypes such as high wood density would be favoured (Valladares et al. 2007). Traits associated with conservative resource use and better recovery following periods of extreme stress actually confer as much or greater fitness than traits associated with tolerating the event itself, such as thermotolerance (Gutschick & BassiriRad 2003).

Strategies in which species avoid harsh hydrological conditions by completing their lifecycles in between extreme events may also be successful. Pioneer species employing a fast relative growth rate, low wood density ecological strategy are benefitted by repeated setbacks to early successional conditions. Abundance weighted means may obfuscate the true pattern where differentiation in ecological strategy is strong, due to their inability to capture multimodality in trait distributions. In this case, higher abundance of these species would drive down mean wood density values through the upper ranges of disturbance intensity. This observation offers a potential explanation for the goodness of fit of quadratic models which begin to dip after reaching an apex at three quarters of their maximum value, rather than simply approaching an asymptote (e.g. Figs XYZ).

Another further for coping with harsh conditions is possible. Some species also have the ability to radically change their wood density throughout their life history. *Casuarina cunnhinghamiana*, for instance, is an obligate riparian species whose entire life history revolves around response to flooding disturbance. After seeding *en masse* onto fresh substrate, dense stands of flexible-stemmed saplings emerge, protecting each other from flood flows. Self-thinning subsequently occurs, and stem wood density increases in the maturing plant to help it withstand its environment. This strategy is likewise difficult to capture using abundance weighted means.

The gradient we identified by Principal Components Analysis integrates predictability of water availability, seasonality and flood intensity into a single axis of hydrological variation. It is not possible to tease out individual drivers of variation in wood density, however as they become more harsh, the sets of hydrological conditions associated with both environmental unpredictability and mechanical disturbance act in unison to constrain community wood density to higher mean values. Based on our findings, hydrological regionalisation frameworks that distinguish between rivers according to predictability and perenniality of flow provide a basis for predicting wood density.

Hydrological classification therefore becomes useful in projecting changes to the functional attributes of riparian plant communities under changing flow conditions.

In the south-eastern Australian context, changing flow conditions are caused by damming and water extraction, and the changing climate (Australian State of the Environment Committee 2011). Artificial flow modification by damming and water extraction reduces overall flow volume and the magnitude and frequency of high flow events, while increasing flow predictability and altering seasonality. The converse of this situation is presented by predictions of future climatic conditions: in Australia, warming of 0.4 – 0.7oC has occurred since 1950, attended by a reduction in rainfall across southern and eastern regions of the continent, and an increase in intensity of droughts. Increases in flooding and drought are predicted with high confidence over the next century (Hennessy *et al.* 2007). Overall, climate change projections highlight increasing climatic variability and unpredictability, and intensification of the ENSO phenomenon that is an integral driver of eastern Australia’s climate patterns (Hennessy 2008). If changes in spatial extent of climate zones can be related to changes in runoff - a complicated, but progressing area of research in hydroclimatology (Peel et al. 2011) – functional approaches to ecohydrology can give insight into the changing ecology of riparian plant communities.

Our study emphasises the importance of hydrological conditions – particularly disturbance and environmental unpredictability, as determinants of ecological strategy in riparian plants. This is likely to hold important ecological consequences for riparian plant communities in south-eastern Australia, where increasing climatic variability and frequency of extreme events are hallmarks of climate change predictions.