Plan for Riparian Functional Diversity paper

“Functional diversity of riparian communities varies across hydrological gradients”

Riparian ecosystems are wonderful (in terms of their biodiversity values)

* Biophysically complex, highly diverse (Nilsson and Svedmark 2002, Poff 2002 management climate change, naiman et al. 2003), provide disproportionate amount of ecosystem services with respect to surface area (Capon et al 2013) heavily modified (Nilsson and Berggren 2000) & threatened
* How to go about understanding them? What sort of processes or interactions generate patterns of diversity and drive ecosystem functioning in riparian communities?

Hydrology is the master variable (Poff?) determining riparian plant assemblages

* Has 5 components (Poff)
* Disturbance (bendix hupp, shafroth et al 2002), water availability – important for drier or variable environments (hupp osterkamp, lite bagstad Stromberg 2005, seasonality (really variable from strongly seasonal to aseasonal)
* Induces strong spatial and temporal gradients in riparian landscapes
* Interacts with geomorphology and vegetation (gurnell 2012, corenblit 2009) to produce patch mozaics / environmental heterogeneity (hupp osterkamp)
* Dispersal of propagules, colonisation and establishment of many riparian species is intimately tied with flooding disturbance and temporal variability of flows (Gurnell et al 2008, Merritt et al 2010).
* For adult plants, extreme flows or extreme absences of flow are strong selective pressures.

Flow modification has changed the entire global hydrological cycle over the last 150 years, and climate change will cause equally extensive changes in the future.

* Changes to seasonality, mean annual runoff, climatic variability, and frequency / magnitude of extreme events
* This is likely to have significant consequences for diversity and functional composition of riparian assemblages
* Dam / climate change studies (perry, Stromberg, ELOHA, ELOHA SEQLD etc.) Catford 2014 (Of the four hypotheses, hydrological modification (indicated by flood magnitude) most likely drives invasion. Flow regulation may inhibit native species adapted to the historical hydrological regime, facilitating exotic species with different environmental ranges. A symptom of environmental change, invasion may have been exacerbated by drought, although it is unclear why.)
* Effects of climate-induced increases in summer drought on riparian plant species: a meta-analysis (Annemarie G. Garssen\* 2014). Catford 2014 drought
  + What sort of things have these studies been looking at?
  + Do they address questions about diversity?

We a fairly good understanding of how hydrological patterns influence population dynamics in some specific model systems (mostly north American or European), and to some extent species composition.

Relationships between environmental gradients and community species composition can be difficult to generalise across landscapes where the distributions of individual species are patchy. Compressed TAXONOMIC descriptors of communities such as species richness or species-oriented metrics of diversity are widely used to compare communities across landscapes, but do not provide information about how species in a community are related to each other. or ecosystem functioning, or functional redundancy/divergence, or provision of ecosystem services, or resillience.

Describing communities in terms of functional traits dissolves species distinctions and emphasises ecological strategies: what species do within their community and how they do it. This allows for direct comparisons between communities that do not necessarily contain matching assemblages. In such a manner, communities can be compared in terms of how their component species interact with their environment and each other.

* Functional ecology is largely unexplored in riparian context. Merrit & Catford call for more. Lawson et al. on extreme events & wood density. Can be predictive – give example of Garssen metaanalysis and how traits can help understand the results.

Functional traits form the basis for mechanistically based assessments of diversity that ask about the range and distribution of ecological strategies within a community.

* These metrics of functional diversity are highly generalizable and allow us to explore fundamental questions about how environmental change might affect community composition and functionality across broad spatial and ecological scales.
* Correlated with ecosystem functioning  *Hooper, D. U., et al. 2005. Effects of biodiversity on ecosystem functioning: a consensus of current knowledge. Ecological Monographs 75:3–35., Oecologia*
* *March 2014, Volume 174, Issue 3, pp 609-621*
* *Advancing biodiversity–ecosystem functioning science using high-density tree-based experiments over functional diversity gradients - Tobner, et al (see refs inside.)*
* (from Lavorel et al 2013) Recent syntheses of empirical studies have highlighted that functional diversity more often determines ecosystem functioning than does species richness per se (Díaz et al. [2006](http://onlinelibrary.wiley.com/doi/10.1111/jvs.12083/full#jvs12083-bib-0007)).
* Correlated with ecosystemcoi services –
  + see “A novel framework for linking functional diversity of plants with other trophic levels for the quantification of ecosystem services” refs
  + (Dı´ az, S., S. Lavorel, F. de Bello, F. Que´ tier, K. Grigulis, and T. M. Robson. 2007. Incorporating plant functional diversity effects in ecosystem service assessments. Proceedings of the National Academy of Sciences (USA) 104:20684–20689.),
* Correlated with resilience
  + Depends which metric – functional originality / functional reduncancy (Standish et al 2014)
* Multiple metrics with different strengths and weaknesses
  + Argument for FDis. Clark 2012
* Important to not be too dependent on species richness
* Nobody has done anything like this for riparian systems (except Biswas & Malik 2010) or hydrology (what about wetlands?)

What traits to use?

* Requirements for a useful FD
  + Rach’s reference
* Which traits for riparian systems?
  + See Bornette et al 2008 – a model of plant strategies in fluvial hydrosystems

Australian hydrology is already highly variable and flashy flow regimes are common (refs from WD paper).

* Provides the sandbox within which to ask ecohydrological questions.
* We asked: what components of hydrology are the most important determinants of functional diversity?

FUNCTIONAL REDUNDANCY THE OPPOSITE OF FUNCTIONAL DIVERSITY? FUNCTIONAL REDUNDANCY => RESILIENCE? Standish et al. 2014 – in biological conservation

* Holling’s resilience is the capacity of a system to undergo disturbance without switching to a qualitatively different state that is controlled by a different set of processes.
* Pimm’s resilience is more a measure of recovery – time taken to return to pre-disturbance state.
* You’d think riparian communities would have plenty of holling’s resilience. How is resilience related to functional diversity in riparian communities then?

This is a particularly useful paradigm for describing and predicting changes in composition over environmental gradients

The derivation and utility of plant functional groups as a means of describing and predicting changes in composition over environmental gradients has been the subject of much debate in the ecological literature over the last two decades. Despite their attractive conceptual simplicity, plant functional groups tend to be derived from *a priori*, situationally specific understanding of plant communities, or using statistical clustering methods that are open to interpretation.

What hasn’t really been studied so much is influence of hydrology on ecosystem functioning

Why didn’t FDis decrease again with CVAnnHSPeak?

* No massively erosional environments (except perhaps some of the sand environemtns such as Genoa). All in middle process zone (PCVS rivers). Coarse substrate is an intense environmental filter as it reduces nutrient and moisture availability.