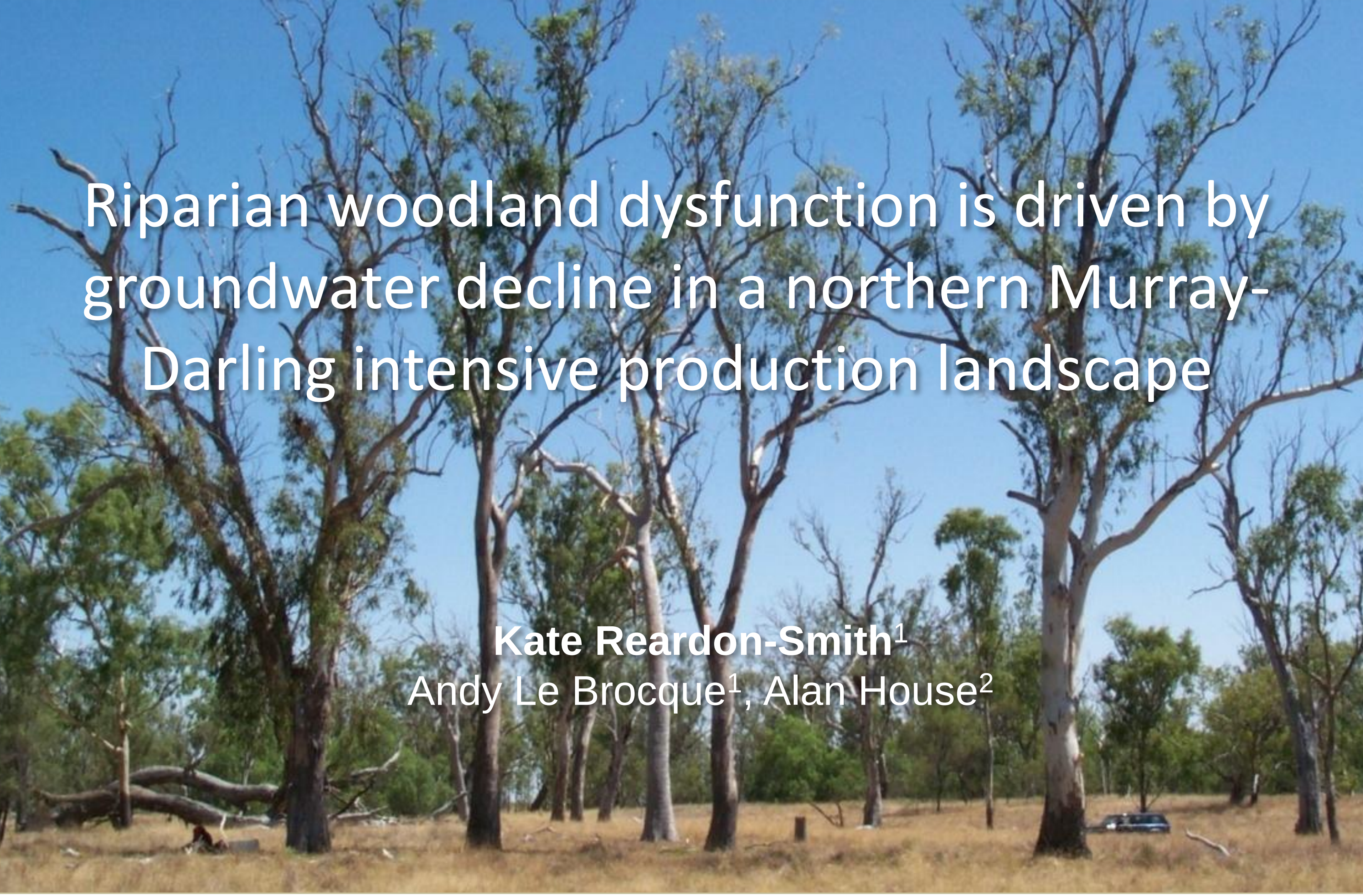

Riparian woodland dysfunction is driven by groundwater decline in a northern Murray-Darling intensive production landscape

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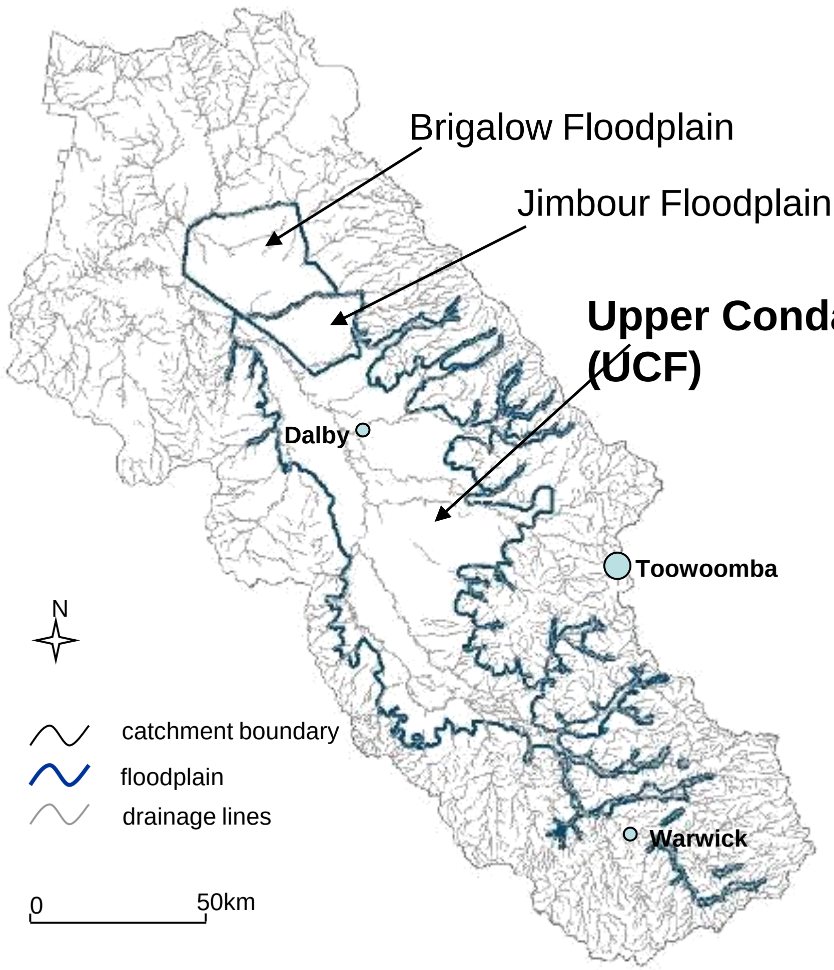
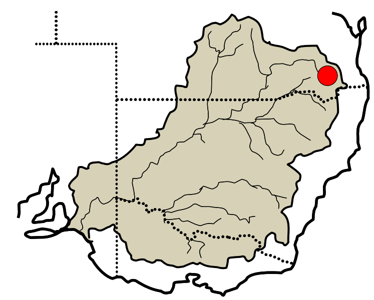
Background & Questions

- Murray-Darling under stress – dieback, loss of diversity and function ...
- most understanding of floodplain ecosystem responses to altered hydrological regimes is based on southern MDB
- northern MDB characterised by:
  - highly variable summer-dominant rainfall regime
  - ephemeral streamflow
  - different cropping/production systems
  - different disturbance regimes & resource availability

- <u>Question:</u>
  - what are the key drivers of dieback & function in floodplain ecosystems in northern MDB?

Darling Downs, southern inland Queensland





- significant landcover change and land use intensification
- dieback and exotic species (e.g., lippia: *Phyla canescens*) in riparian woodlands

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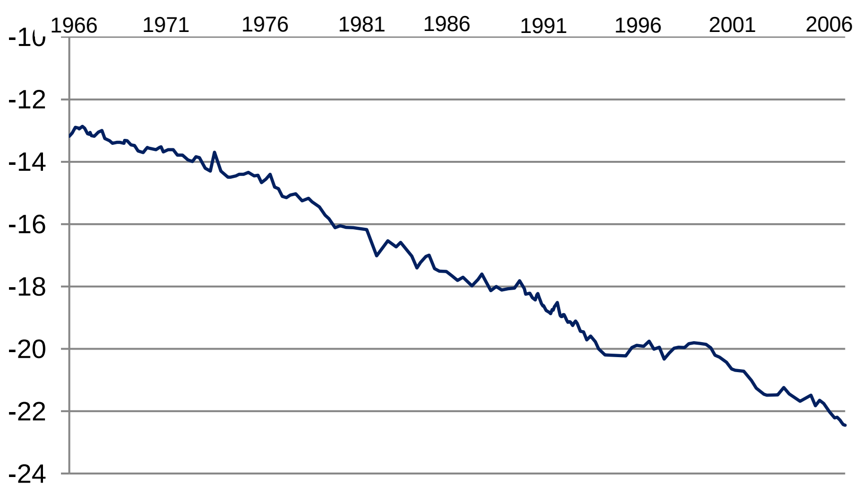
Floodplain hydrology

Loss of connectivity with floodplain development:

- streamflow harvesting (increased duration of no-flow periods, reduced flood magnitude)
- overland flow harvesting (reduced runoff volumes, disconnected floodplain)
- groundwater extraction (disconnected alluvial aquifer, chronic groundwater decline)



Groundwater decline, 1966 - 2008
(UC-GMU3 bore #42230071)

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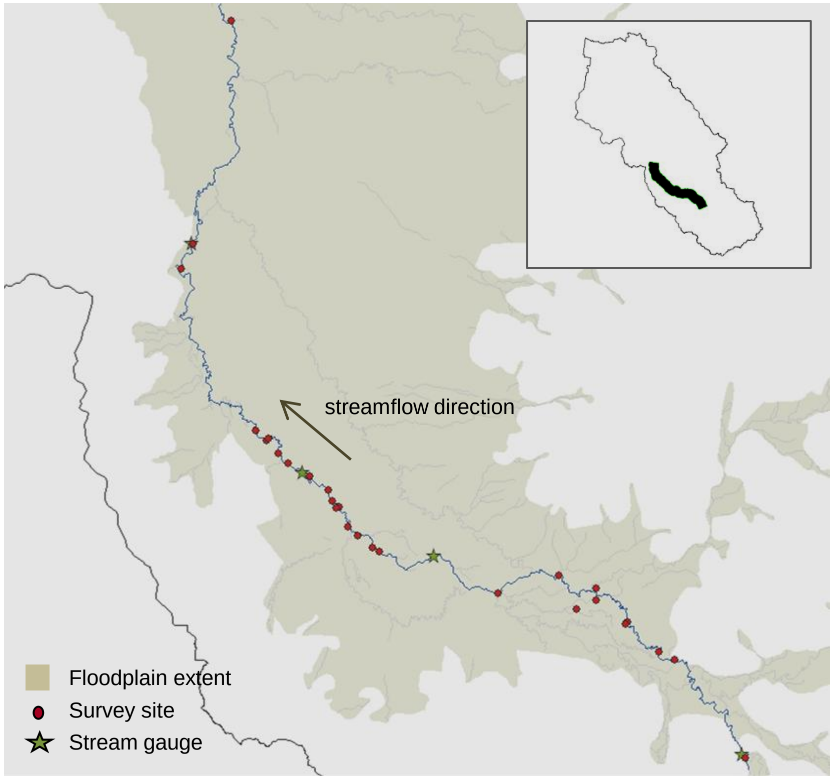
Methodology

- 27 sites

Response variables

- floristic composition
- lippia abundance
- stand structure & recruitment



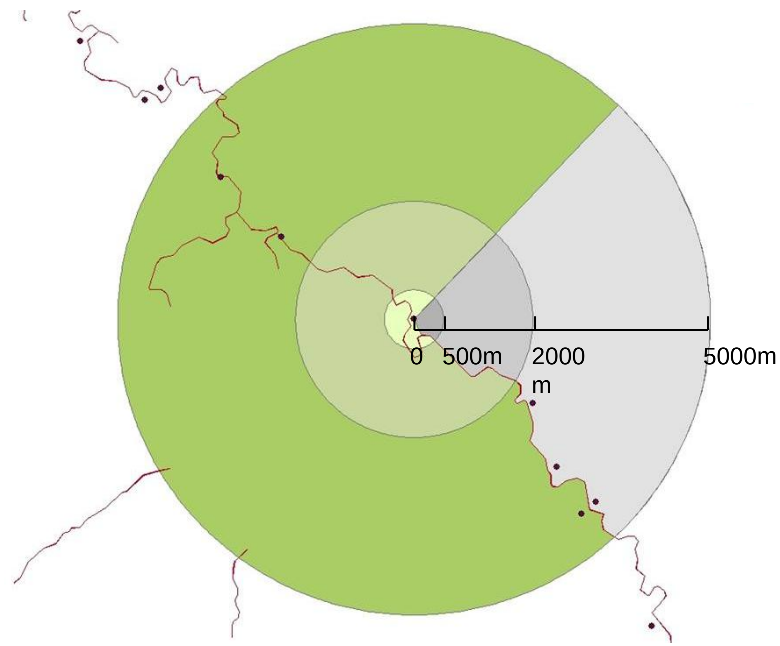
- canopy condition
  - *Eucalyptus camaldulensis/tereticornis* species complex
  - tree condition indices (foliage index, structural integrity index, health class)
  - site-level dieback severity index (Wylie *et al.* 1992)

Methodology

Explanatory variables (88):

- Hydrological
- land use & land cover

3 scales, 2 categories



Variables include:

- hydrological (GW depth, GW trend, overland flow diversions …)
- land use (cropping, irrigated cropping, grazing …)
- land cover (remnant extent, riparian width …)
- biotic (lippia abundance, dieback severity)

E. camaldulensis/tereticornis dieback severity model

Bayesian Model Averaging (R)

Response variable	**Key explanatory variables** (posterior effect probability > 0.75)	**Min BIC**	n_{models}	**Max r^2** (best 5 models)
Dieback severity (WWI)	**GW depth$_{5000}$ (1.00*)**, grazing$_{500}$ (0.99), GW bores$_{5000}$ (0.80)	-8.177	63	**0.627**

* values in parentheses are posterior effect probabilities

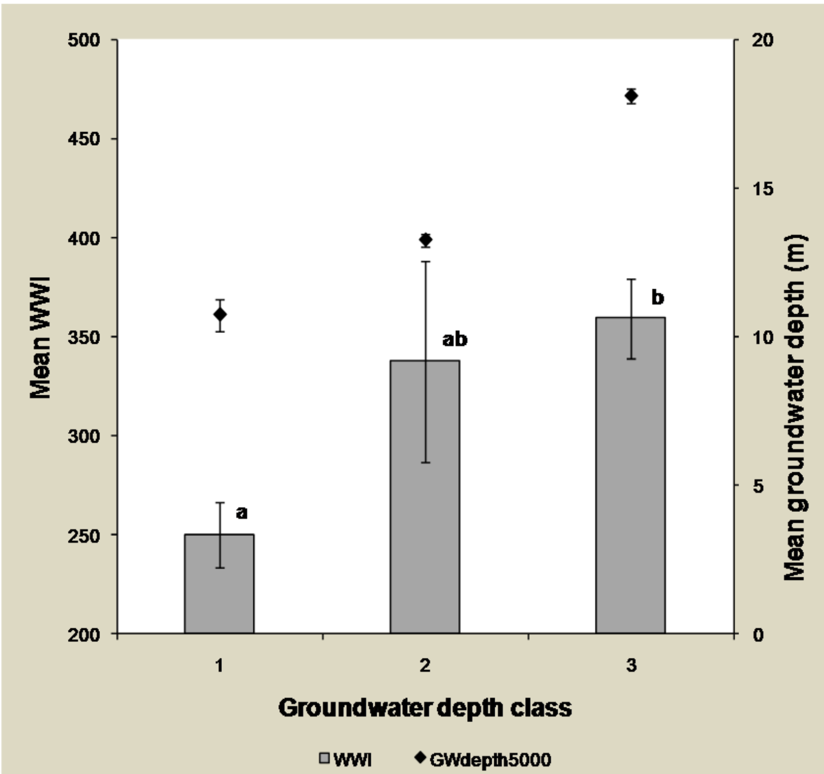
Floristic composition model

Multivariate pattern analysis (PRIMER-BIOENV)

Response variable	**Key Explanatory variables** (**best single** & best set of 6)	**Spearman's r** (best single)	**Spearman's r** (best set of 6)
Floristic composition	**GW depth$_{5000}$**, lippia cover, GW trend$_{5000}$, remnant$_{2000}$, GW bores$_{5000}$	**0.307**	0.449

- Groundwater depth … associated with tree condition & floristic composition

Dieback severity & groundwater depth



Groundwater depth classes

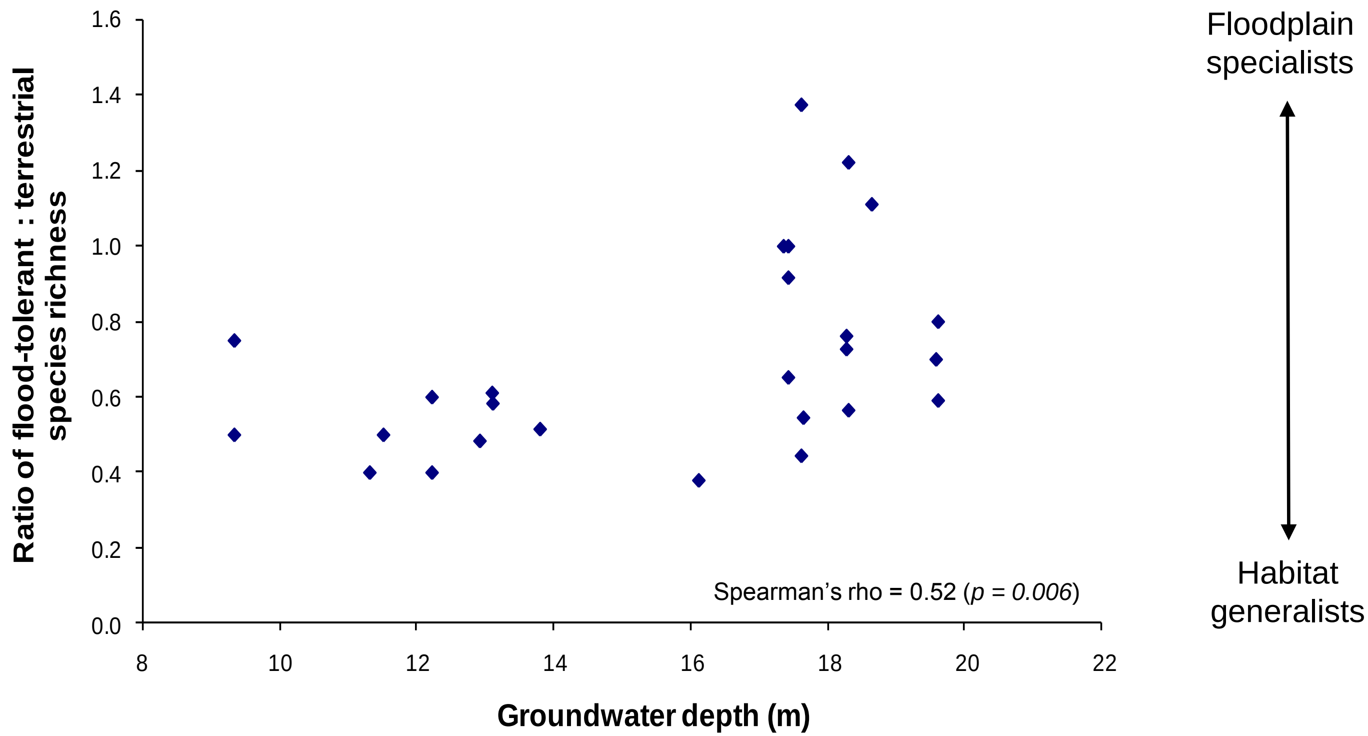
1: 9.1 – 12.6 m;

2: 12.6 – 16.1 m;

3. 16.1 – 19.6 m

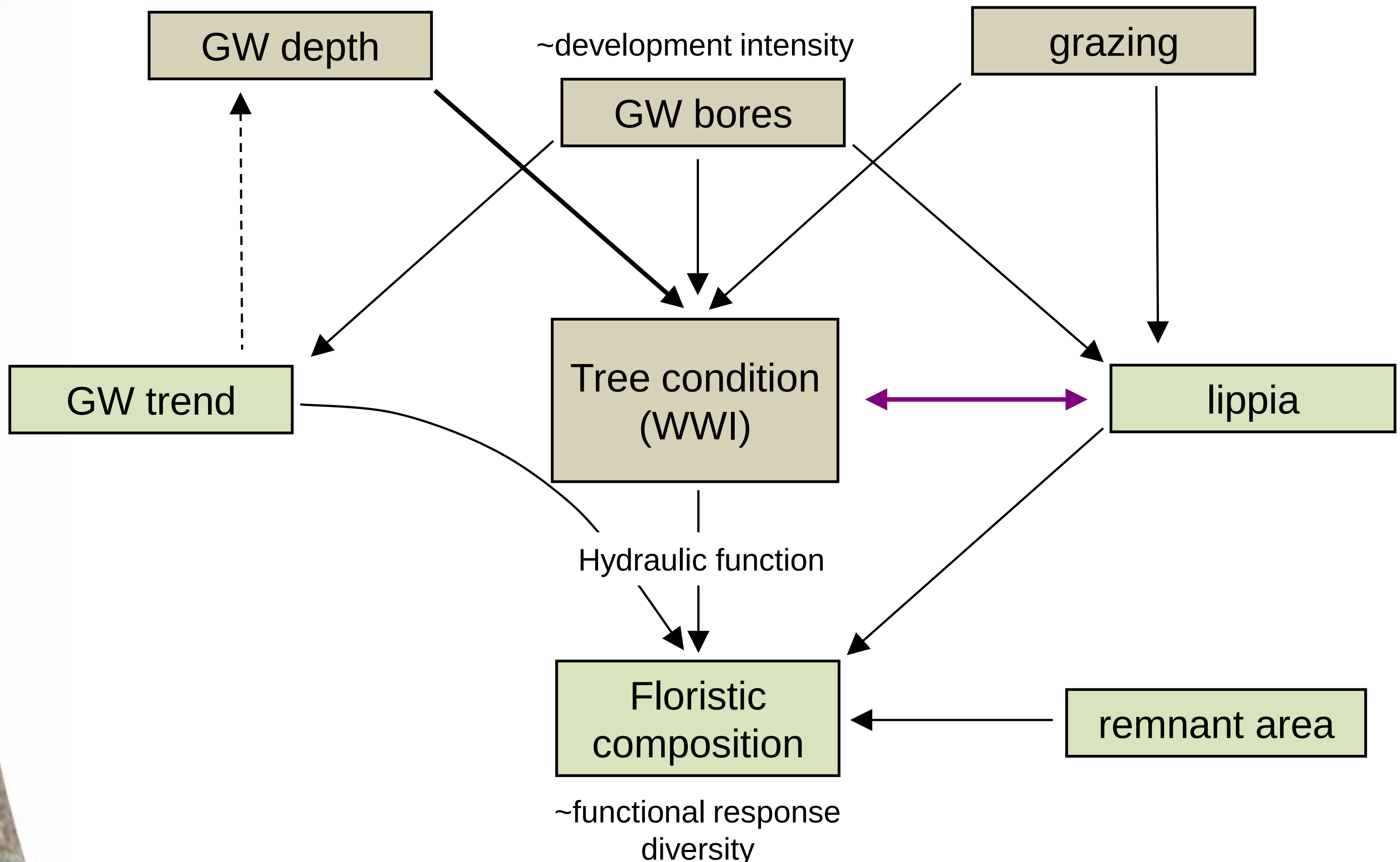
Eucalyptus camaldulensis

- obligate groundwater use during drought (Thorburn & Walker 1993)
- groundwater depth threshold for condition between 13 and 16 m (this study)
- support from literature:
  - 15 m max lateral root extension (Mensforth *et al.* 1994)
  - increased mortality with groundwater decline 12 to 15 m (Horner *et al.* 2009).



- greater relative richness of floodplain species (loss of generalist species)
- Other significant ($p < 0.005$) functional group correlations with:
  - groundwater trend (native:alien SR & N, perennial:short-lived SR)
  - WWI (floodplain:generalist N)
- *E. camaldulenis* as intermediary (e.g., hydraulic lift; Burgess *et al.* 1998)

Conceptually …



Significance?

- altered hydrological regimes & resource availability
  - poor condition & function of older eucalypts in riparian woodlands in a dryland river system in the northern MDB
  - altered riparian ecosystem composition (+/- resilience?)
  - alternative ecosystem states (e.g., floodplain grassland, acacia-dominant low woodland, ...)
  - altered ecosystem function & service provision

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Functional groups & environmental relationships

‘Functional’ group	Environmental gradient(s)	References
origin (*native, alien*)	nutrient availability, disturbance	Hobbs & Huenneke 1992 Prober *et al.* 2002, 2005 Dorrough *et al.* 2004
life history (*annual, perennial*)	nutrient availability, disturbance	Prober *et al.* 2002, 2005 McIntyre & Lavorel 2001, 2007 Dorrough *et al.* 2004
life form (*forb, graminoid, woody species, etc.*)	disturbance, water availability	Breshears & Barnes 1999 Lavorel *et al.* 1999 McIntyre & Lavorel 2001 Briggs *et al.* 2005
physiology (C_3, C_4)	water availability	Epstein *et al.* 1997 Yu *et al.* 2005
clonality (*clonal, nonclonal*)	flood/grazing disturbance, resource availability	McIntyre & Lavorel 2007 Armioud *et al.* 2008 De Kroon & Hutchings 1995 Rosenthal & Lederbogen 2006
habitat specificity (*wetland, floodplain, generalist*)	flooding disturbance, water availability	Turner *et al.* 2004 Lite *et al.* 2005

Canopy species health assessment

- *Eucalyptus camaldulensis/tereticornis* species complex
- foliage index, structural integrity, evidence of dieback/epicormic regrowth
- 5 tree health classes(HC):

  1: very healthy

  2: healthy

  3: moderate^{+} dieback

  4: severe^{+} dieback

  5: dead

Site dieback severity index:

Weighted Wylie Index (WWI) =

$\sum(\% \text{ trees in } HC_i \text{ x } i)$

WWI range*	Site Dieback category*
0 - 100	No dieback
101 - 200	Slight to moderate dieback
201 - 300	Moderate to severe dieback
301 - 400	Severe dieback
401 - 500	Very severe dieback

*Adapted from Wylie *et al.* (1992, 1993), Banks (2006)

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Tree condition & eucalypt recruitment models

Bayesian Model Averaging

NB: Red type indicates a negative relationship and values in parentheses are posterior effect probabilities

Response variable	**Key explanatory variables** (posterior effect probability > 0.75)	n_{models}	**Max r^2 (best 5 models)**
Mean Foliage Index	grazing$_{5000}$ (1.00), grazing$_{500}$ (0.78)	25	0.433
Structural integrity (mean PTR)	**GW depth$_{5000}$ (1.00),** bare ground (1.00), north (1.00), weir distance (0.98), irrigated cropping$_{UQ2000}$ (0.89), GW bores$_{5000}$ (0.88), tree density (0.83)	56	0.837
Dieback severity (WWI)	**GW depth$_{5000}$ (1.00),** grazing$_{500}$ (0.99), GW bores$_{5000}$ (0.80)	63	0.627
Dead tree density	grazing$_{500}$ (1.00), lippia cover (0.99), irrigated cropping$_{5000}$ (0.97), GW trend$_{5000}$ (0.86)	35	0.792
Euc. recruitment	-	-	-

- GW depth strongly associated with dieback severity & poor structural integrity in *E. camaldulensis/tereticornis*

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Floristic composition models

(Bayesian Model Averaging)

NB: Red type indicates a negative relationship; values in parentheses are posterior effect probabilities

Response variable	**Key explanatory variables** (posterior effect probability > 0.80)	n_{models}	**Max r^2** (best 5 models)
Lippia cover	irrigated cropping$_{2000}$ (0.94), north (0.86), grazing$_{5000}$ (0.80)	38	0.585
Functional group species richness transitions			
C4:C3	lippia cover (0.84)	65	0.422
floodplain:terrestrial	**GW depth$_{5000}$ (1.00),** remnant$_{UQ500}$ (0.95), weir distance(0.90)	28	0.562
wetland:terrestrial	**GW depth$_{5000}$ (0.99),** weir distance(0.94), remnant$_{UQ500}$ (0.90)	28	0.465
clonal:non-clonal	weir distance (0.87), tree density (0.87)	42	0.364
Functional group abundance (frequency) transitions			
shortlived:perennial	bare ground (1.00), **WWI (0.97),** ringtanks$_{UQ2000}$ (0.81)	102	0.810
C4:C3	bare ground (1.00), lippia cover (0.99) …….	77	0.807
floodplain:terrestrial	**WWI (1.00),** Cropping:remnant$_{UQ500}$ (0.89)	42	0.608
wetland:terrestrial	**WWI (0.99)**	53	0.412

Hydrological models/variables

Land use models/variables