Don't wave the river red gums goodbye.

The role of environmental flows in restoring river water quality and riparian zones along the Wimmera River.

Photo Courtesy of Dean Shaw

Paul Julian II[1] and Greg Fletcher[2]

[1] University of Florida, Soil and Water Sciences, Ft. Pierce, FL, USA
[2] Wimmera Catchment Management Authority, Horsham, Vic, AUS

Acknowledgements

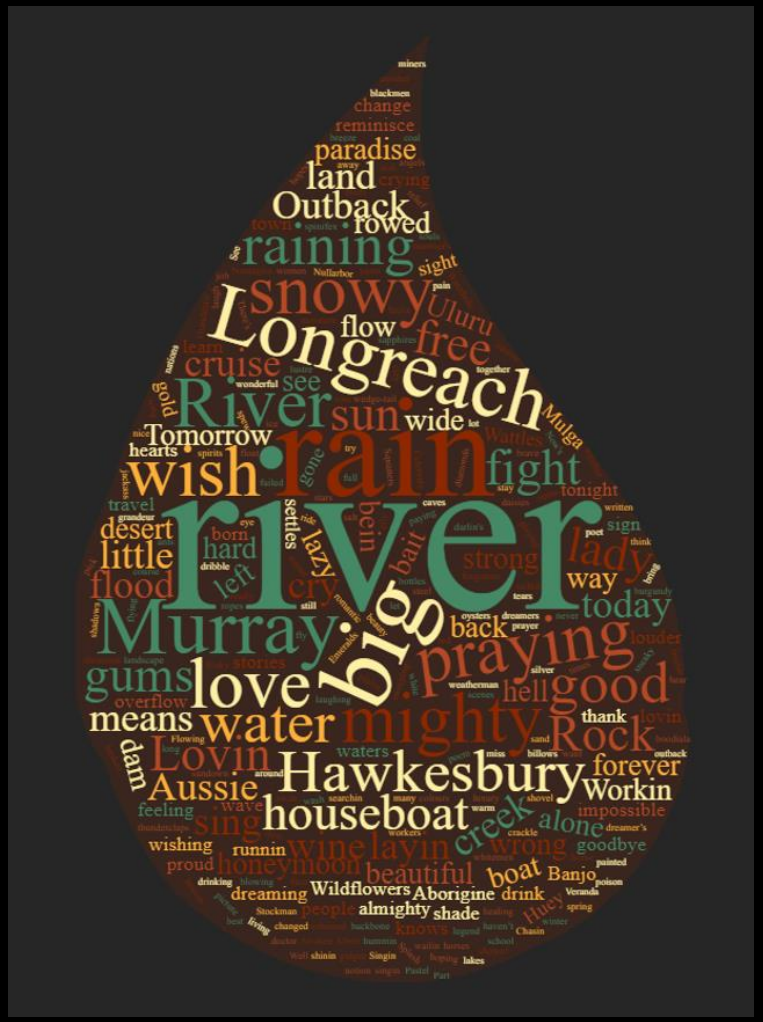
- Anne-Maree Westbury (EPA Victoria) and staff.

Culture and Environment

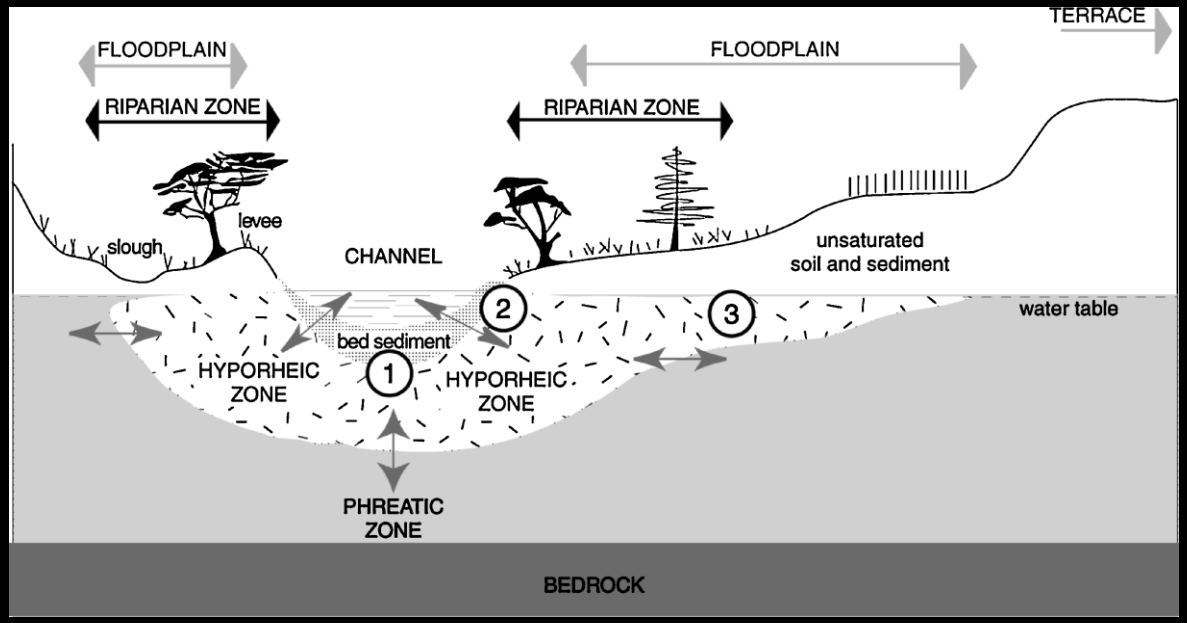
…
Don't wave the river gums goodbye
Just thank 'em for the shade and the stories
…

Salisbury Street, John Williamson

https://youtu.be/r6N80kn6IM4



Floodplain 101



Steiger, et al (2005) River Research and Applications 21:719–737.

- Floodplains are ecotone ecosystem between terrestrial and aquatic environments.
- Dynamic spatial environment shaped by the flow of water and material.
- Transport large fluxes of energy and material from upstream.

Floodplain 101

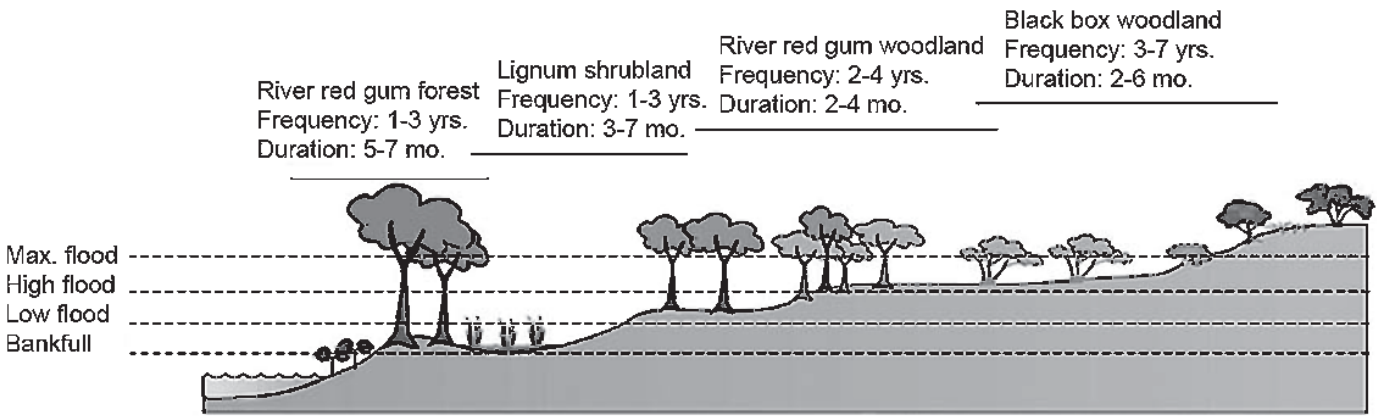
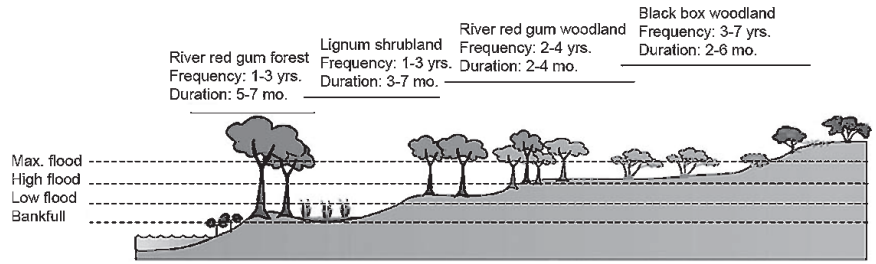


Figure 10.6: Diagram showing the ecotonal nature of floodplain vegetation communities in relation to the frequency and duration of flooding required to maintain vigorous growth. Flood frequency and duration data from Roberts and Marston (2011).

- Water level influences the distribution of vegetation along the floodplain.

- Capon S, James C, Reid M (eds) (2016) Vegetation of Australian Riverine Landscapes. CSIRO PUBLISHING, Clayton South, VIC Australia

Floodplain 101



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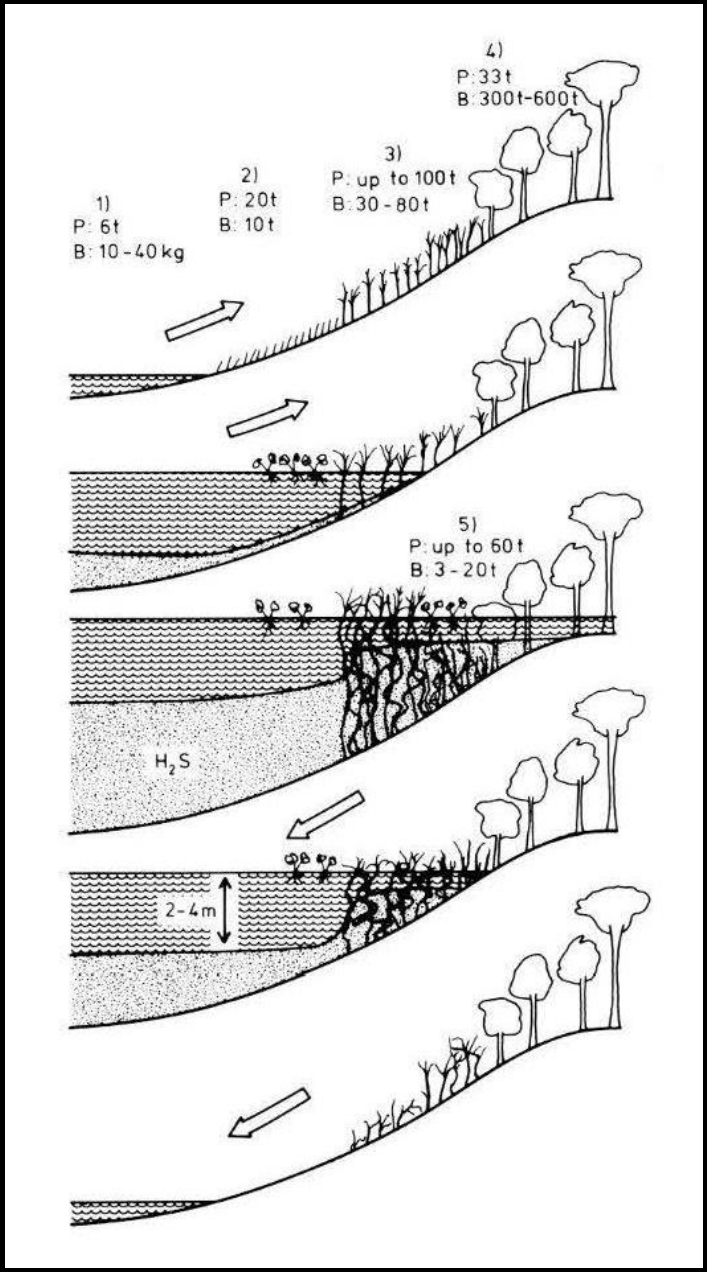
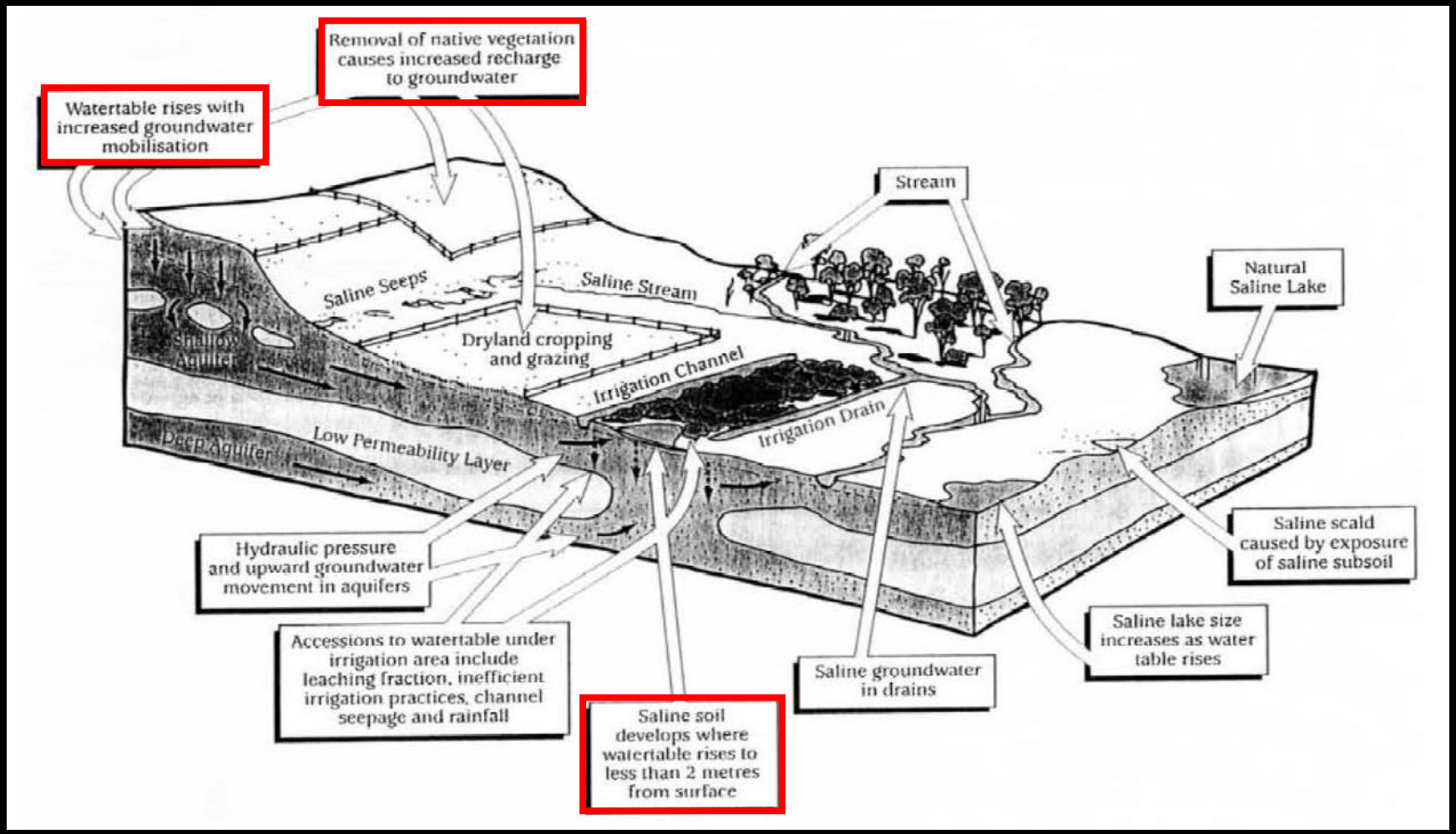
- Water level influences the distribution of vegetation along the floodplain.
- Flood pulse regime are major controlling forces in floodplain ecosystems.

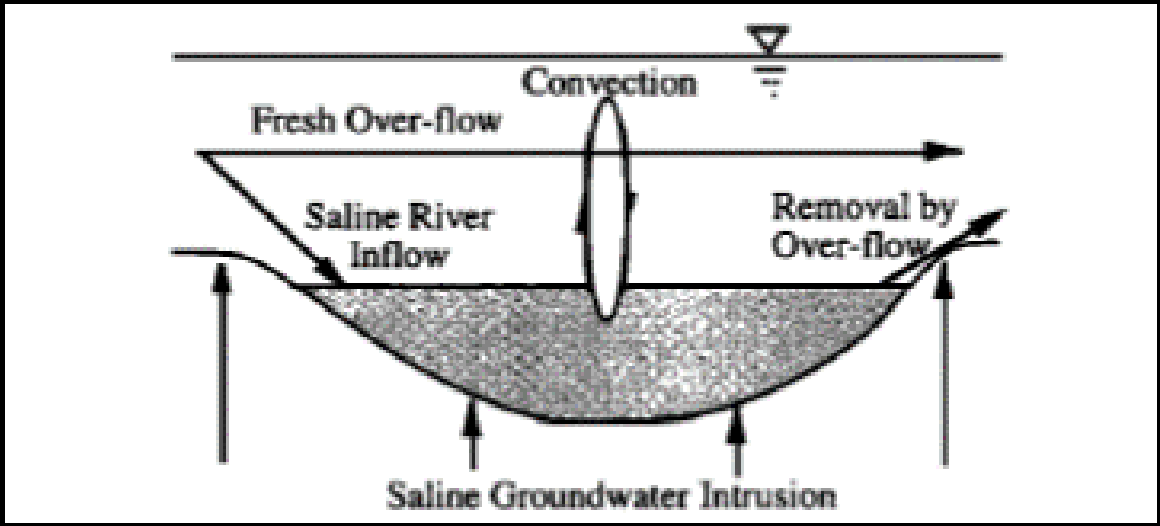


- Capon S, James C, Reid M (eds) (2016) Vegetation of Australian Riverine Landscapes. CSIRO PUBLISHING, Clayton South, VIC Australia
- Bayley, P. B., and R. E. Sparks. 1989. The flood pulse concept in river-floodplain systems. Pages 110–127 in D. P. Dodge (editor). Proceedings of the International Large River Symposium. Fisheries and Oceans, Ontario, Canada.



Factors influencing surface water salinization in Australian dryland agricultural areas (Williams 2001)

- WILLIAMS, W. D. 2001. Anthropogenic salinisation of inland waters. Hydrobiologia 466:329–337.

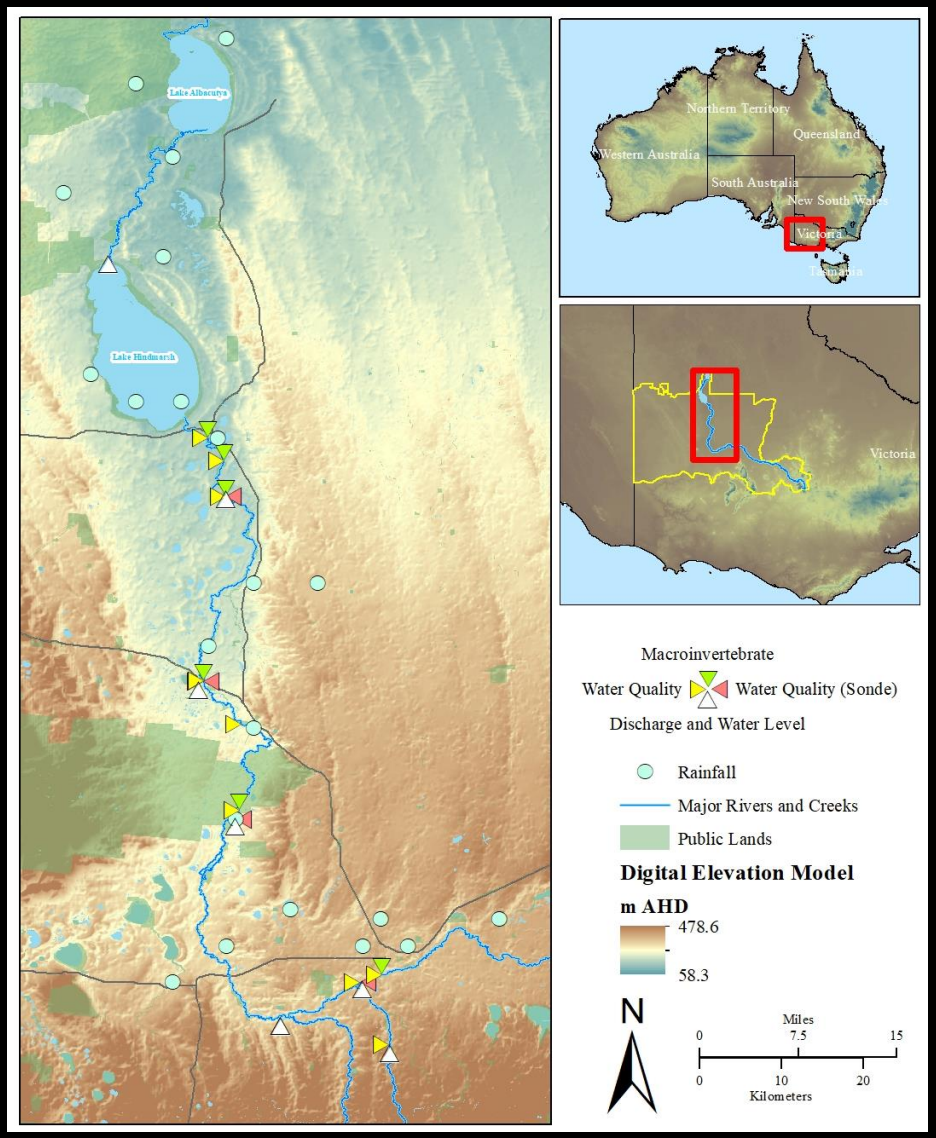


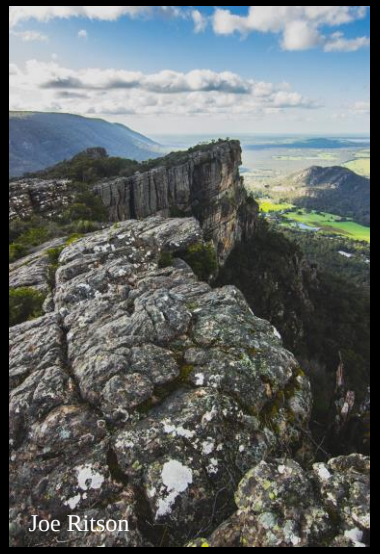
Formation and mixing processes associated with saline pools (Western et al. 1996)

- During low flow, groundwater seeps into stream (hyporheic flow).
- During high flow, freshwater flows over more dense saline water.

- WESTERN, A. W., I. C. O'NEILL, R. L. HUGHES, AND J. B. NOLAN. 1996. The behavior of stratified pools in the Wimmera River, Australia. Water Resources Research 32:3197–3206.

Study Area





- Wimmera River originates in the Grampian ranges.
- Wimmera River terminates at Lake Hindmarsh.
- Basin covers ~10% of Victoria.
- ~85% of native vegetation was cleared for agricultural production.

Wimmera Floodplain

March 2017

January 2011 (Big Flood)

Wimmera Floodplain

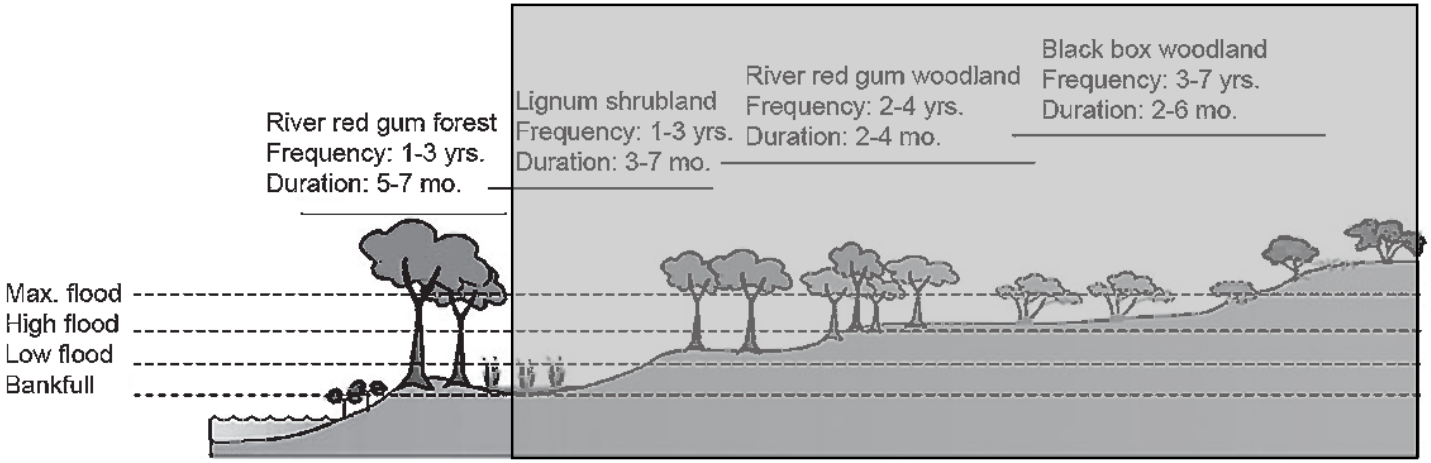


Figure 10.6: Diagram showing the ecotonal nature of floodplain vegetation communities in relation to the frequency and duration of flooding required to maintain vigorous growth. Flood frequency and duration data from Roberts and Marston (2011).

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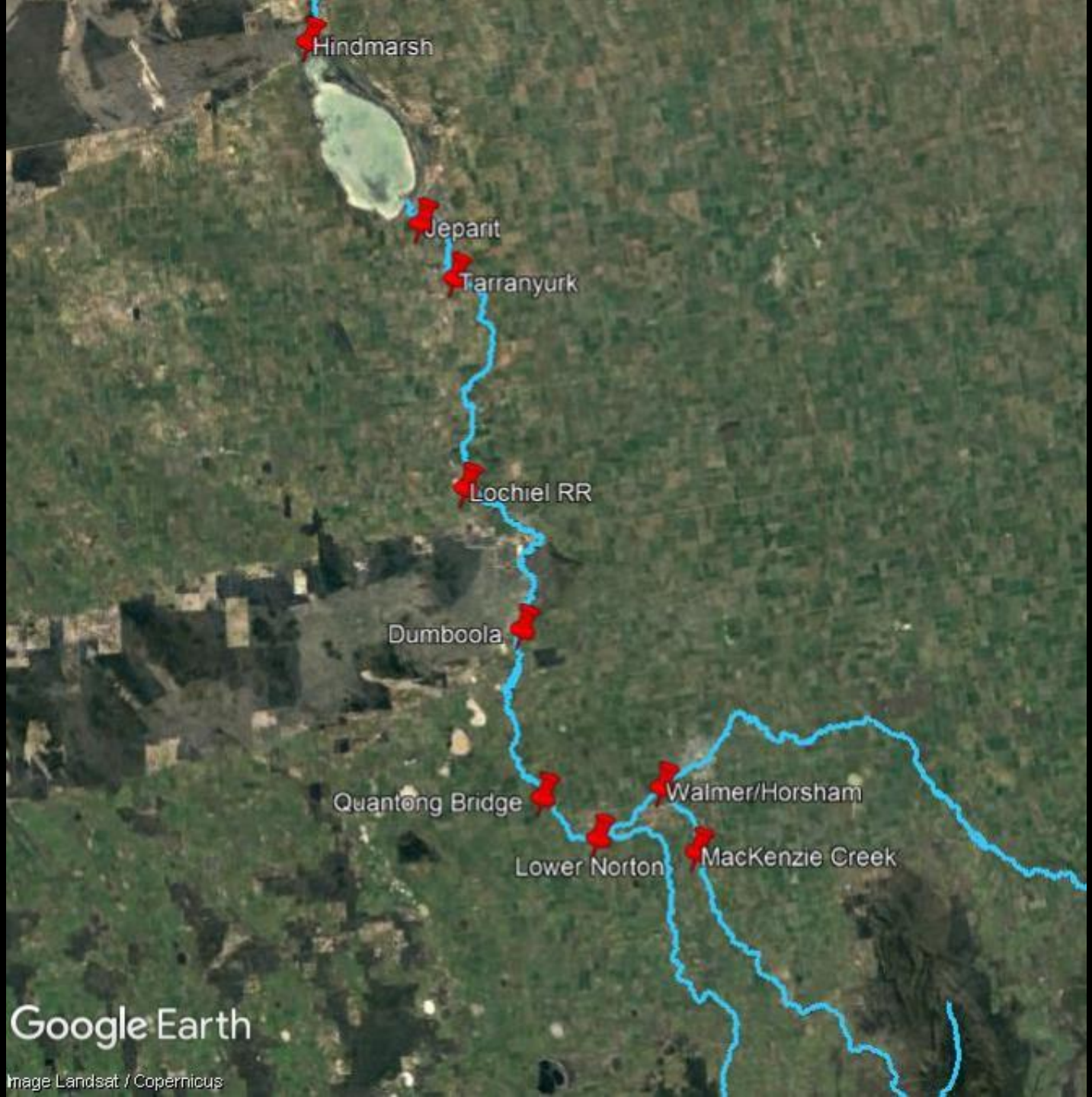
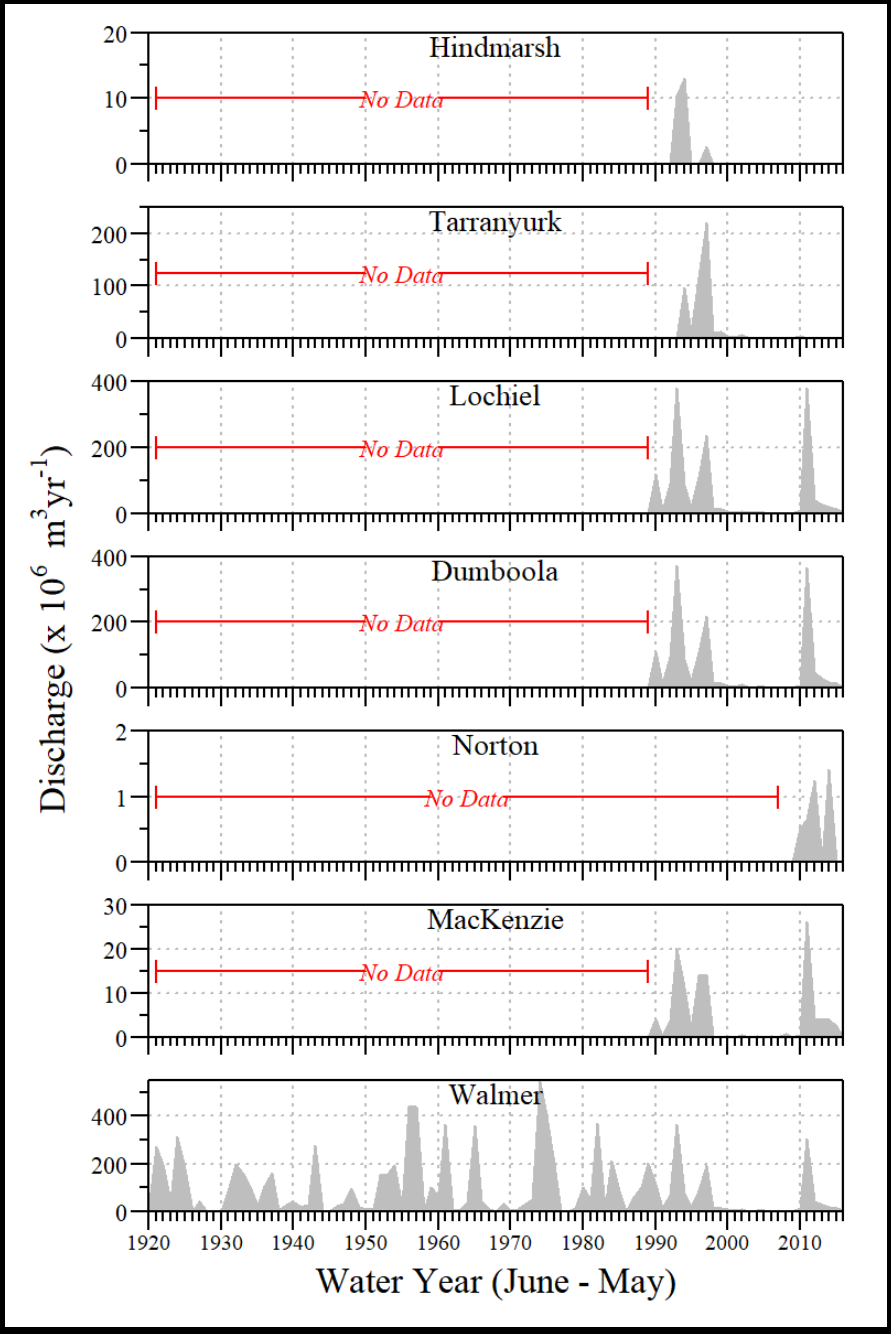
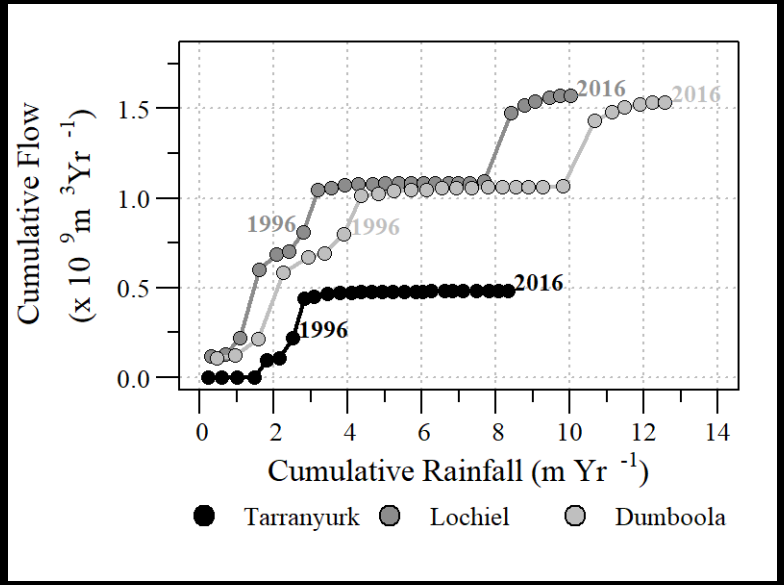
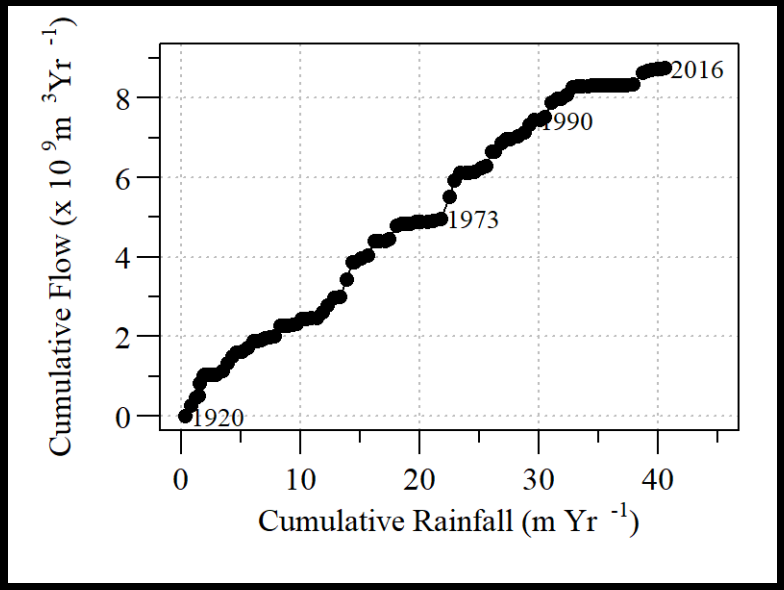
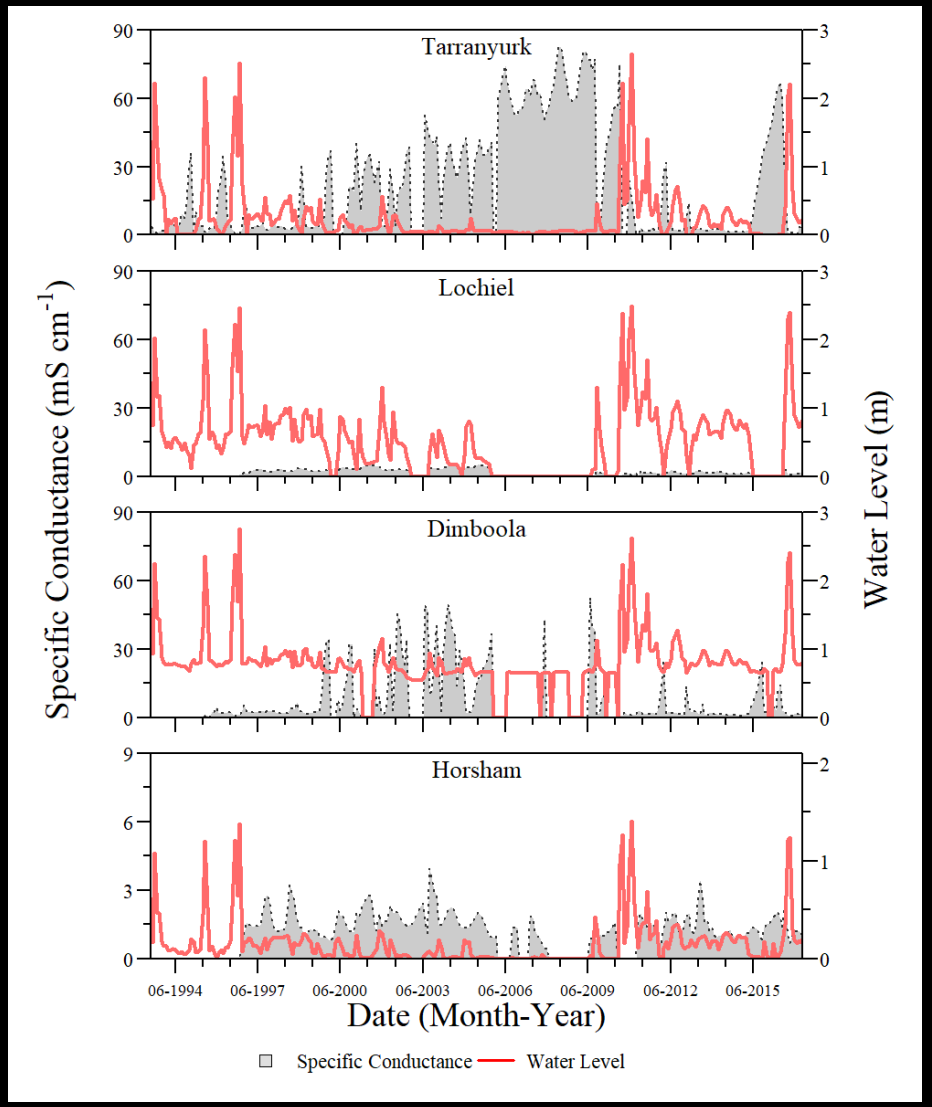

Hindmarsh
Jeparit
Tarranyurk
Lochiel RR
Dumboola
Quantong Bridge
Walmer/Horsham
Lower Norton
MacKenzie Creek
Google Earth
Image Landsat / Copernicus


Hindmarsh
No Data
Tarranyurk
No Data
Lochiel
No Data
Dumboola
No Data
Norton
No Data
MacKenzie
No Data
Walmer
Discharge (x 10^6 m^3yr^-1)
Water Year (June - May)


Cumulative Flow (x 10^9 m^3Yr^-1)
Cumulative Rainfall (m Yr^-1)
1996
1996
2016
2016
1996
2016
Tarranyurk
Lochiel
Dumboola

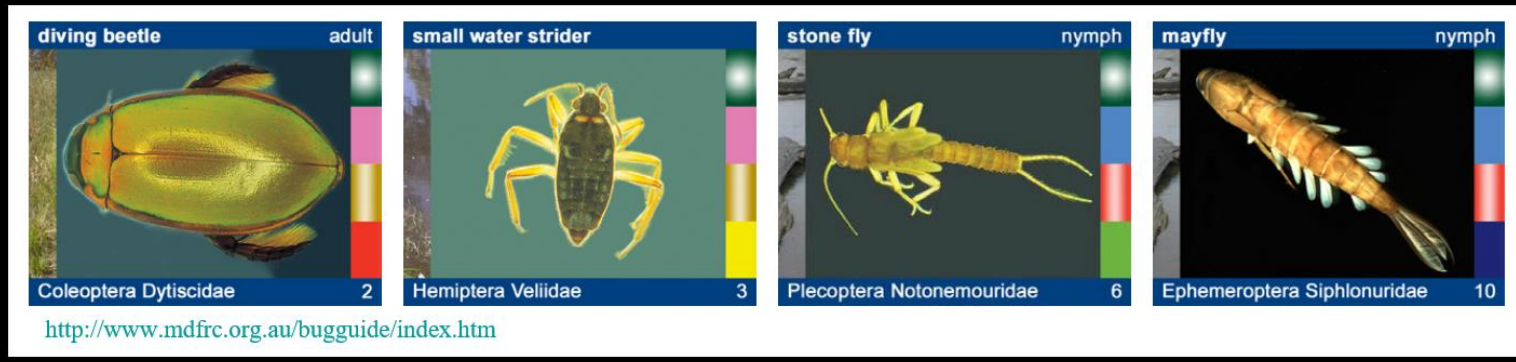
Horsham


Cumulative Flow (x 10^9 m^3Yr^-1)
Cumulative Rainfall (m Yr^-1)
1920
1973
1990
2016



Monthly mean specific conductance and water level

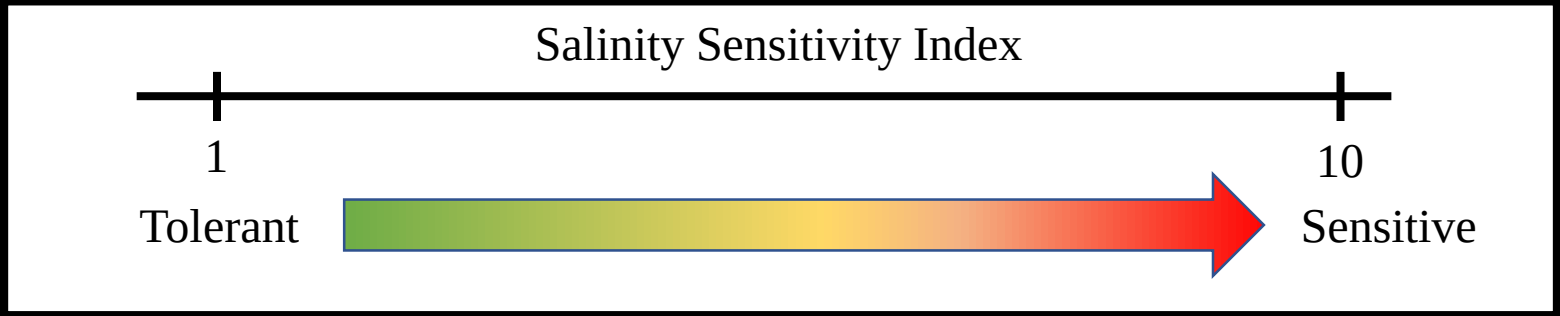
- Low water level high conductivity.
- Salinity “hotspots” along the river.



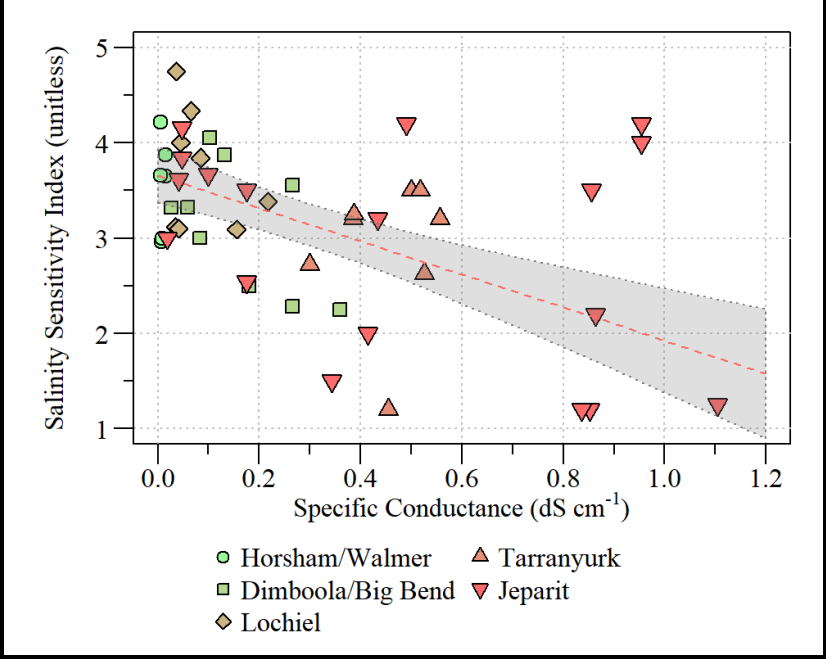
http://www.mdfrc.org.au/bugguide/index.htm

$$SSI = \frac{\sum X_i \times SSS_i}{n}$$

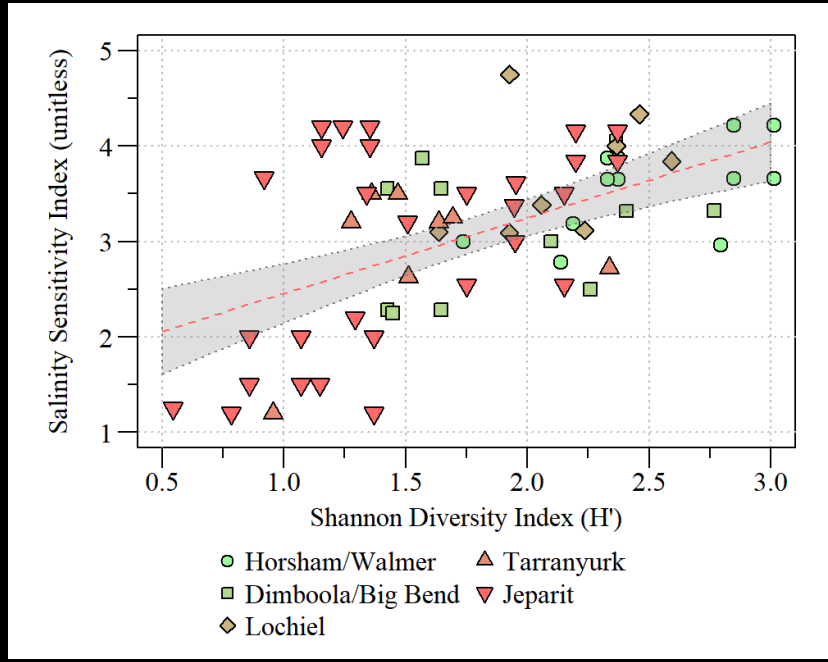
SSI = Salinity Sensitivity Index
X_i = 1 if taxon i is present
SSS_i = Salt Sensitivity Score of taxon i
n = total number of taxa in sample



Horrigan, et al (2005) Response of stream macroinvertebrates to changes in salinity and the development of a salinity index. Marine and Freshwater Research 56:825–833.

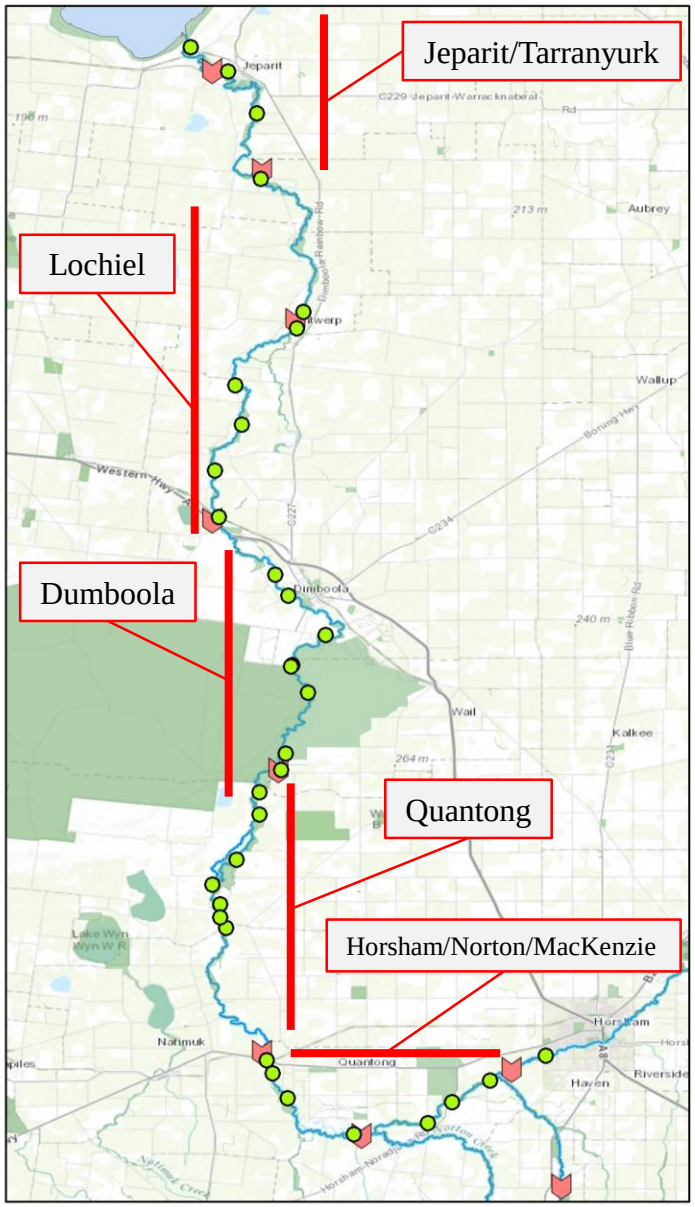


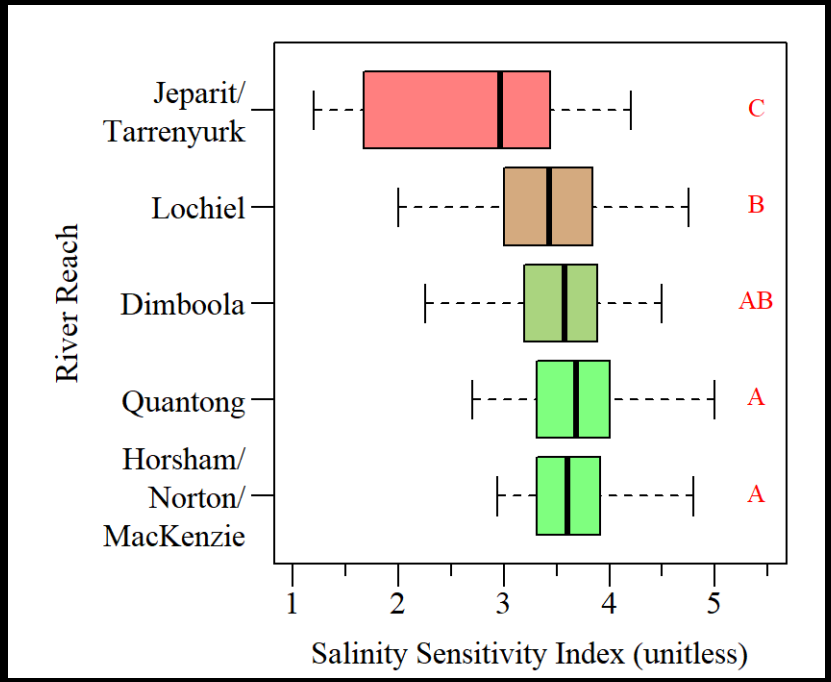
Negative correlation
(N=68, r-value=-0.33, ρ-value<0.05)



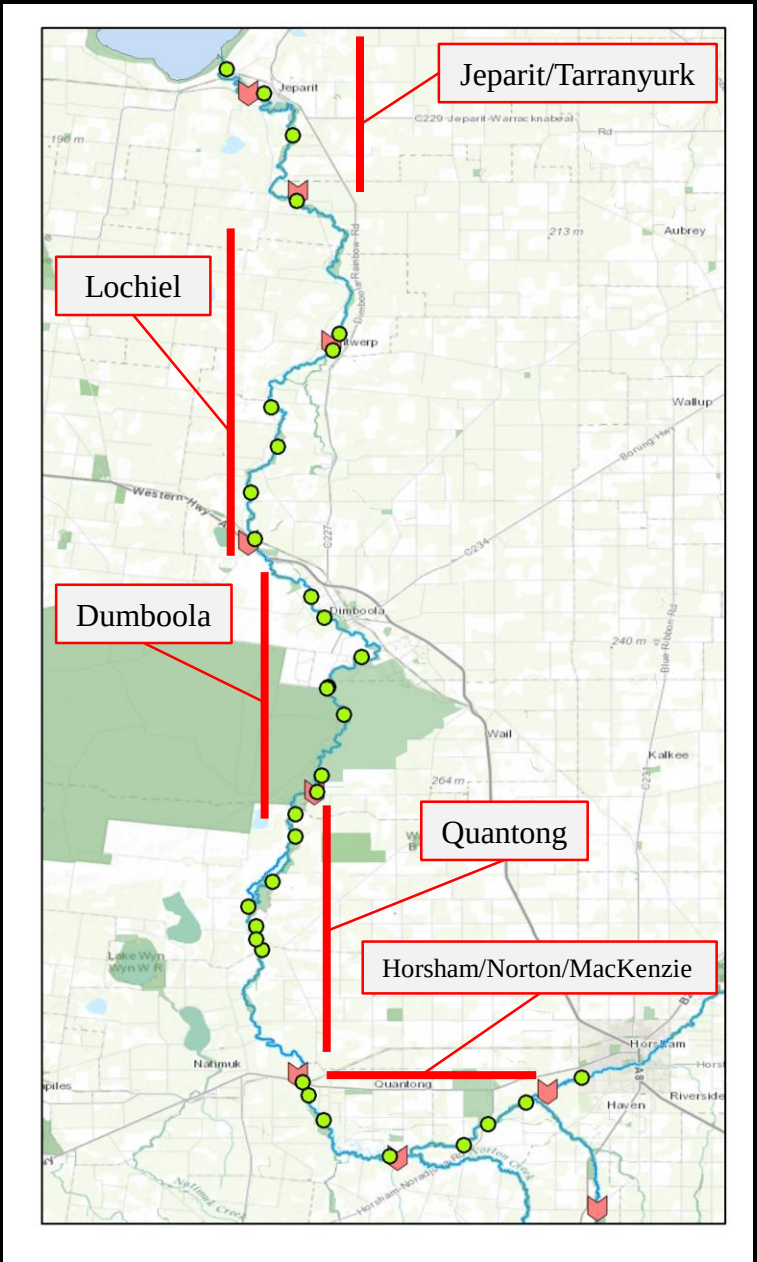
Positive correlation
(N=68, r-value=0.45, ρ-value<0.01)

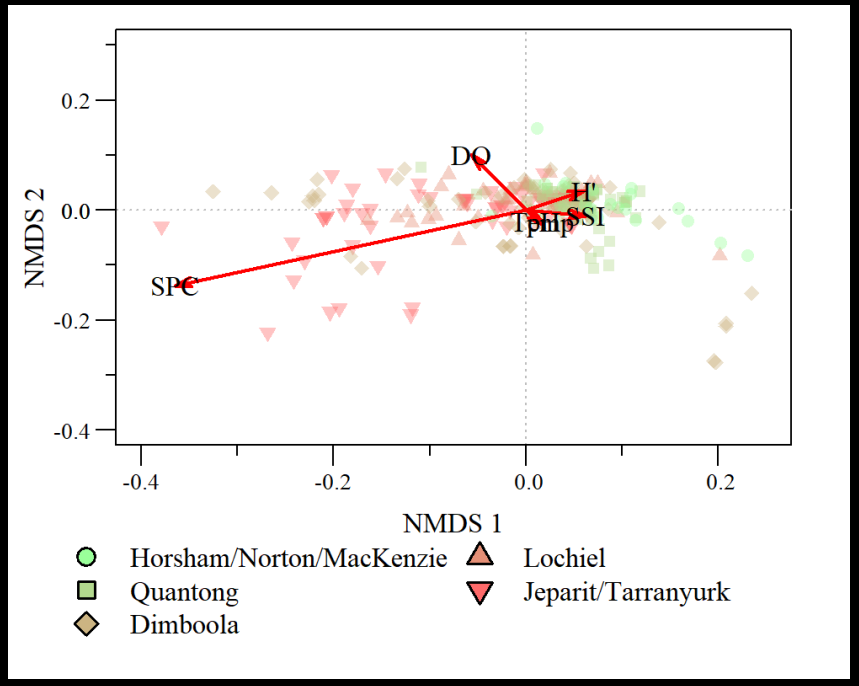
- Periods of high salinity within the river influences macroinvertebrate diversity.
- As expected, opportunistic taxa (less salinity sensitive species) were present at both impacted and unimpacted sites while high salinity sites corresponded with lower diversity





Significant difference between river reaches (χ^2 =21.4, df =4, ρ<0.01)


Jeparit/Tarranyurk
Lochiel
Dumboola
Quantong
Horsham/Norton/MacKenzie
Jeparit
Aubrey
Wallup
Dimboola
Wail
Kalkee
Natimuk
Quantong
Horsham
Haven
Riverside


DO
H'
SSI
SPC
NMDS 1
NMDS 2
Horsham/Norton/MacKenzie
Lochiel
Quantong
Jeparit/Tarranyurk
Dimboola

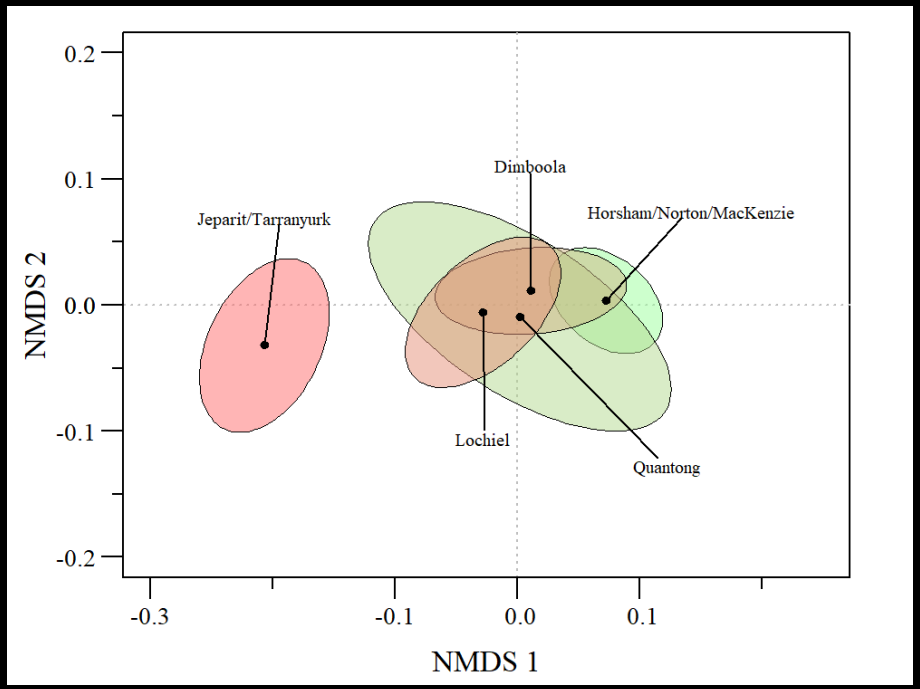
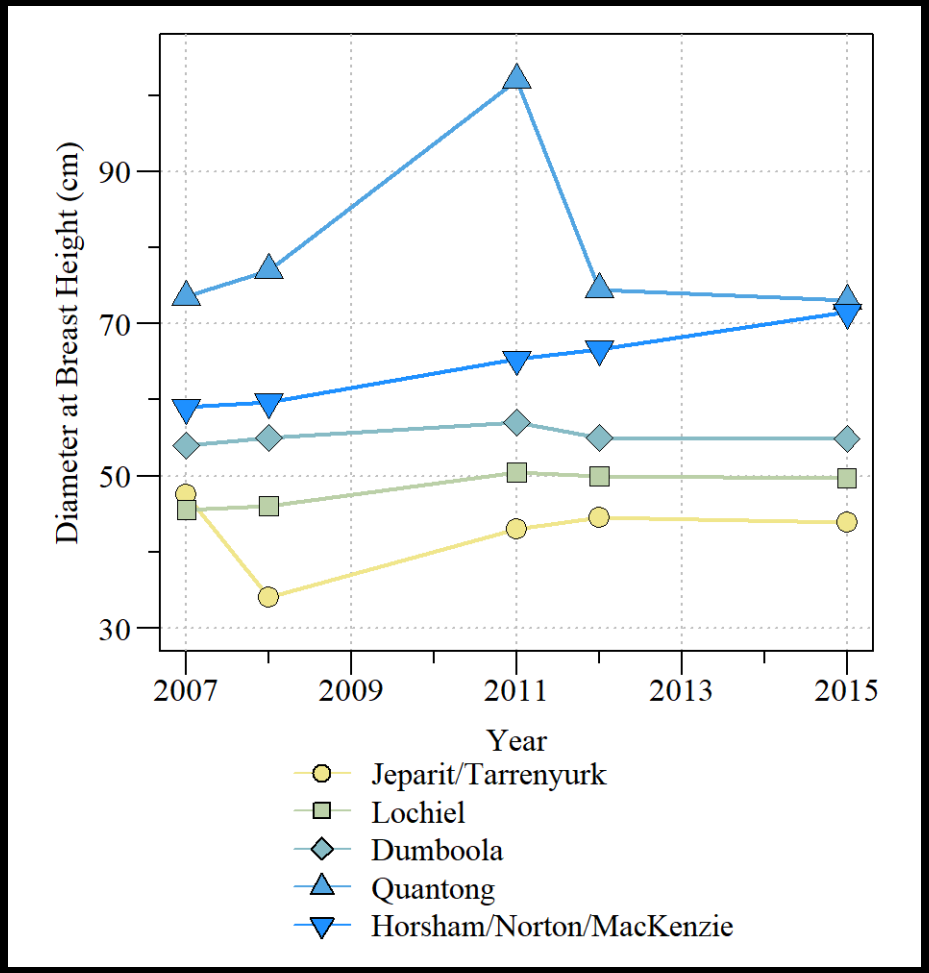

Dimboola
Jeparit/Tarranyurk
Horsham/Norton/MacKenzie
Lochiel
Quantong
NMDS 1
NMDS 2

Photo Courtesy of Aidan T Kereopa



- Stead increase in DBH over the years observed along the Horsham reach.
- Lower reaches have stayed relative consistent.
- However, general canopy health is severally impacted downstream (especially Jeparit and Lochiel reaches).

Data from: Carr G, et al (2015) Victorian Environmental Flows Monitoring and Assessment Program. 58.

- Discharge volume is highly variable year-to-year along the Wimmera River.
- Specific conductance significantly varies along the river with some notable “hotspots” correlated with water level.
- Macroinvertebrate diversity and salinity sensitivity also varies along the river.
- River red gum canopy health is significantly impacted along the lower reaches of the Wimmera River.

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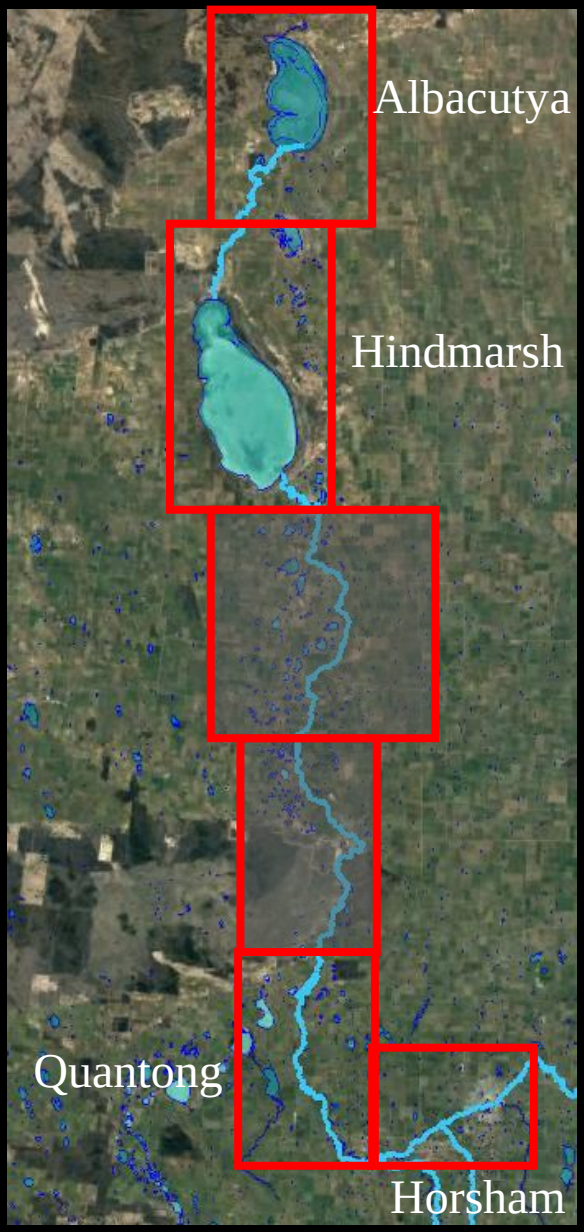
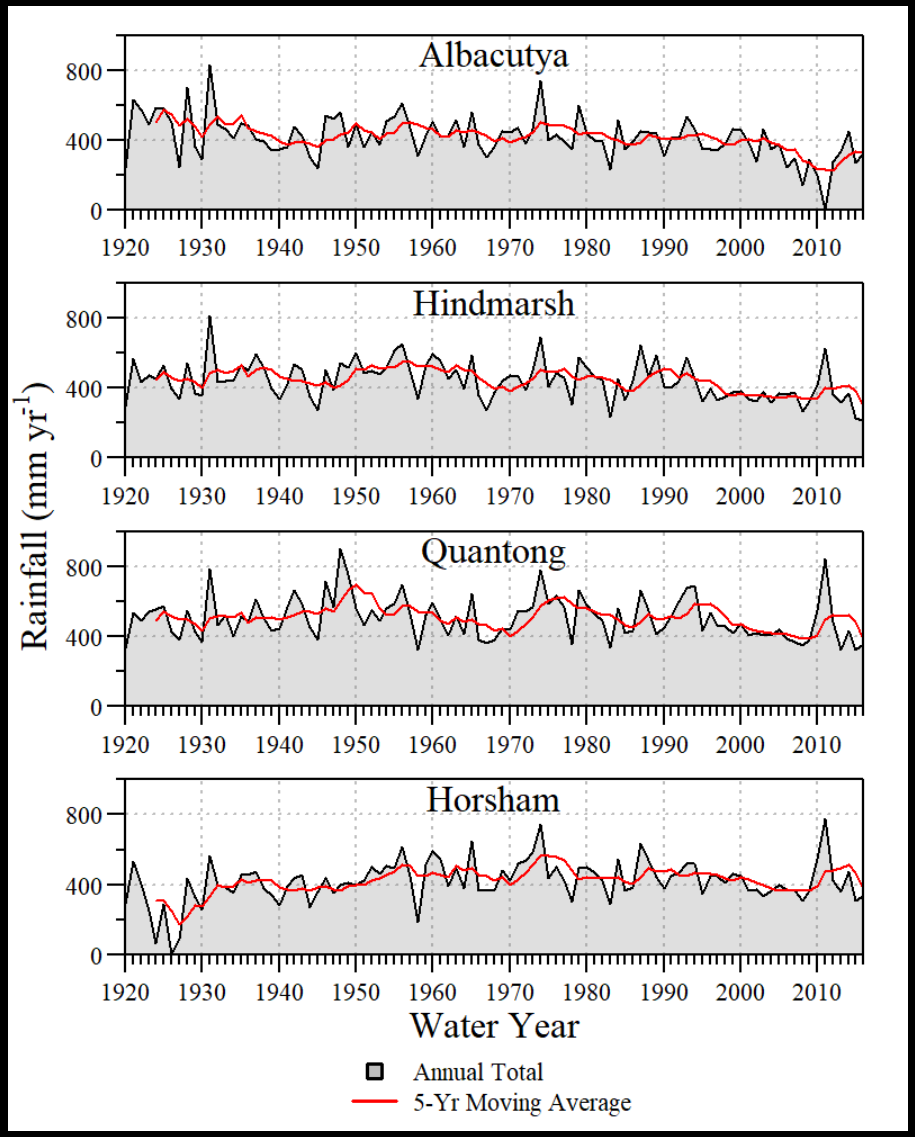
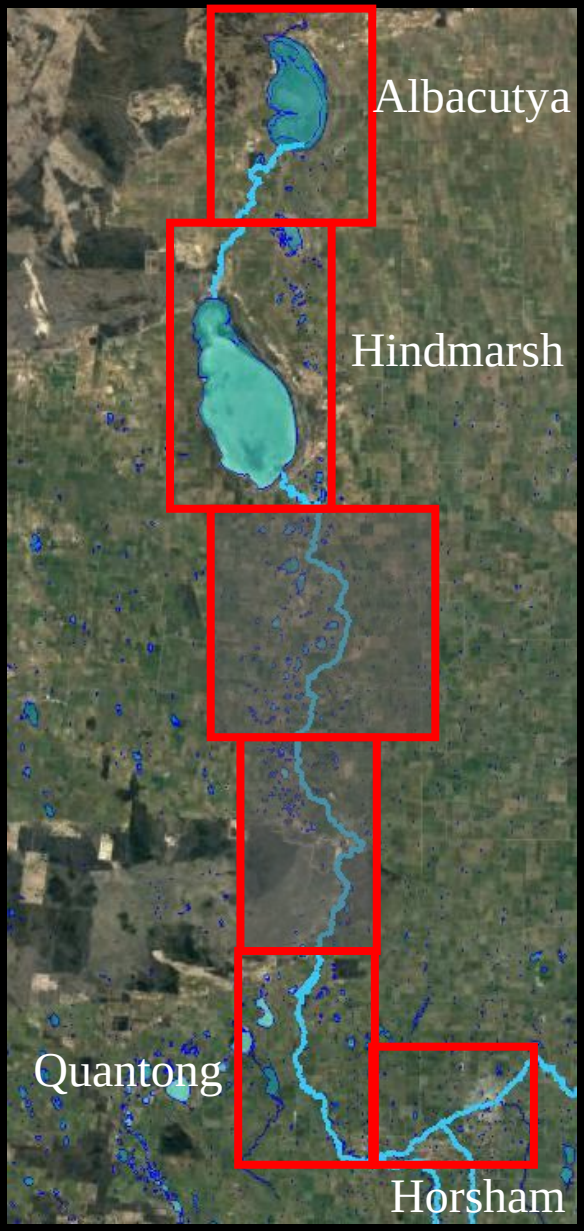
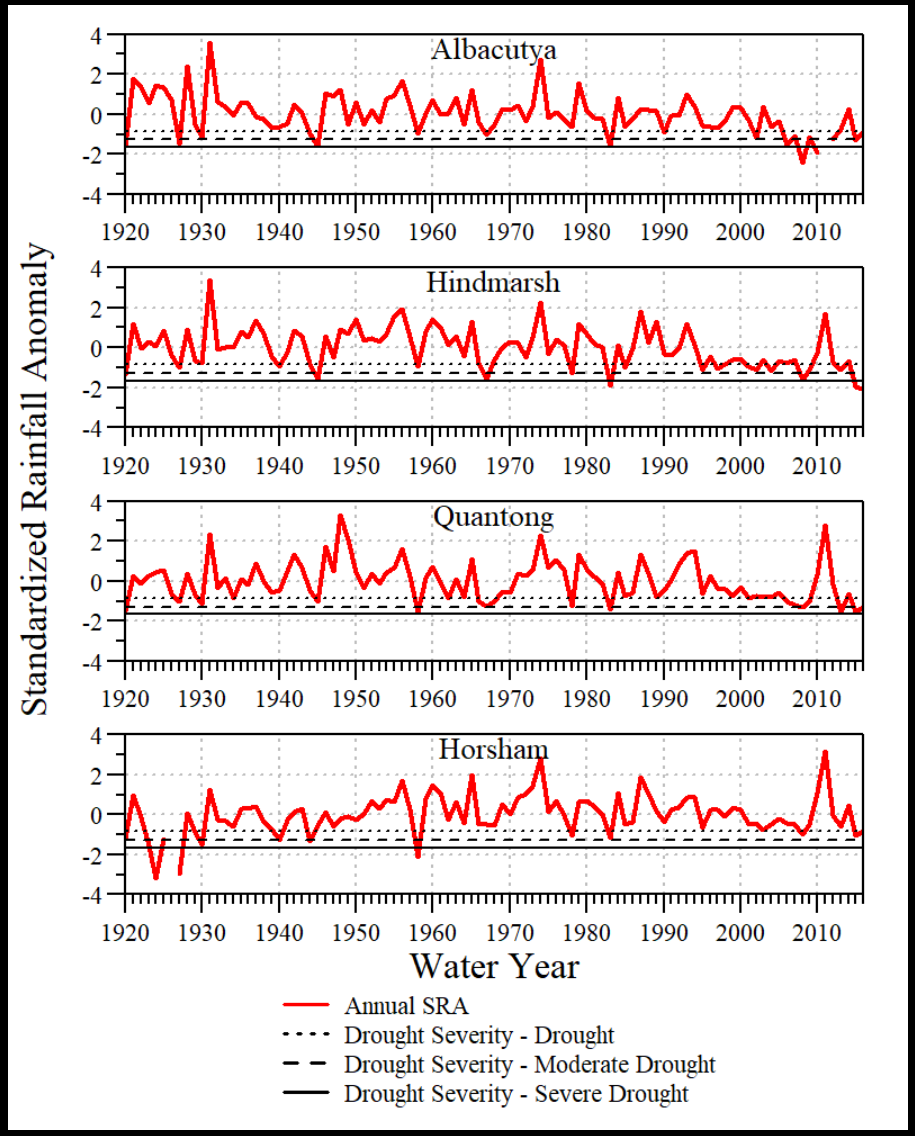
@SwampThingPaul

Photo Credit: Unknown

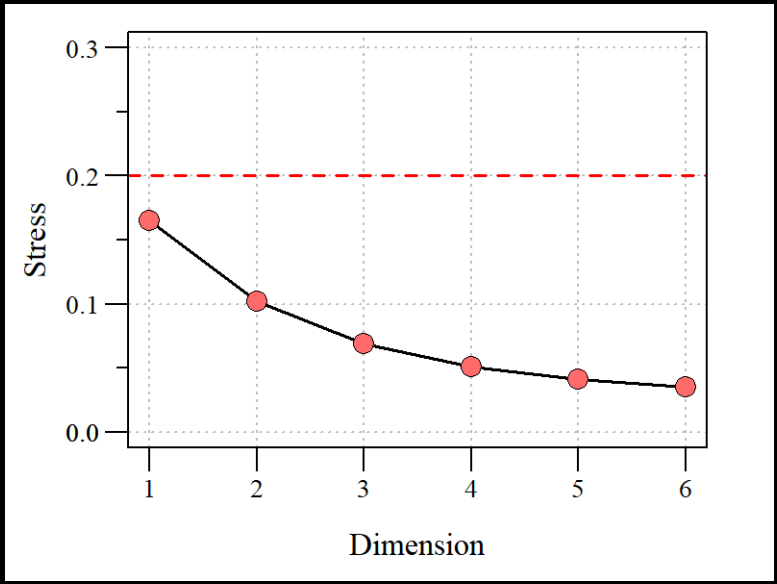

Albacutya
Hindmarsh
Quantong
Horsham

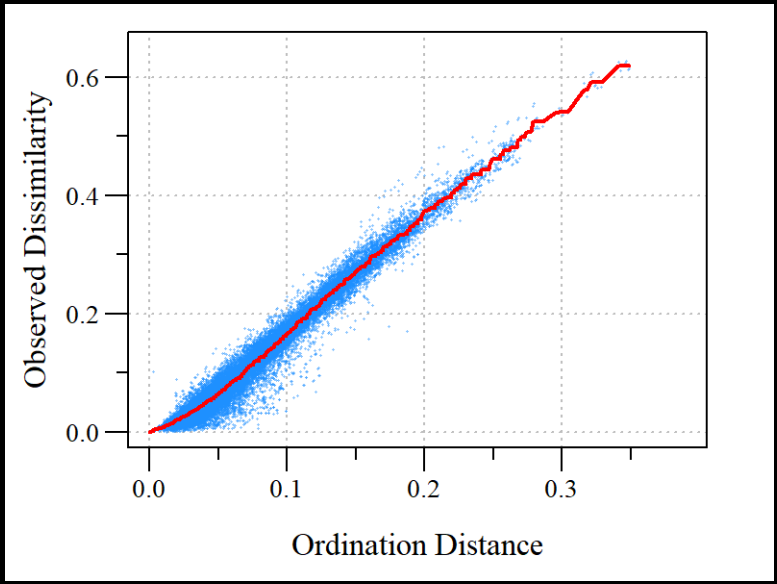

Albacutya
Hindmarsh
Quantong
Horsham
800
400
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Rainfall (mm yr-1)
Water Year
Annual Total
5-Yr Moving Average


Albacutya
Hindmarsh
Quantong
Horsham


Albacutya
Hindmarsh
Quantong
Horsham
Standardized Rainfall Anomaly
4
2
0
-2
-4
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Water Year
Annual SRA
Drought Severity - Drought
Drought Severity - Moderate Drought
Drought Severity - Severe Drought

NMDS Diagnostic Plots





- Diagnostic plots to explore both, dimensionality and interpretative value.
- Stress values <0.20 are considered acceptable stress values (Clark 1993).

- Stress plot or Shepard diagram to evaluate goodness-of-fit between ordination distance and dissimilarity.

Non-Metric Fit $R^2 = 0.99$
Linear Fit $R^2 = 0.97$

Clarke KR (1993) Non-parametric multivariate analyses of changes in community structure. Austral Ecology 18:117–143.