

Managing environmental flows to an Australian Ramsar wetland, the Macquarie Marshes: flooding regimes for wetland vegetation

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Flow and flooding variability

- ❑ Floodplain wetlands in semi-arid regions of Australia rely on highly variable river flows
- dynamic flooding regime of wet and dry phases
- supports a diverse mosaic of flood dependent vegetation



❑ **Located in semi-arid region of the Murray-Darling Basin (MDB).**

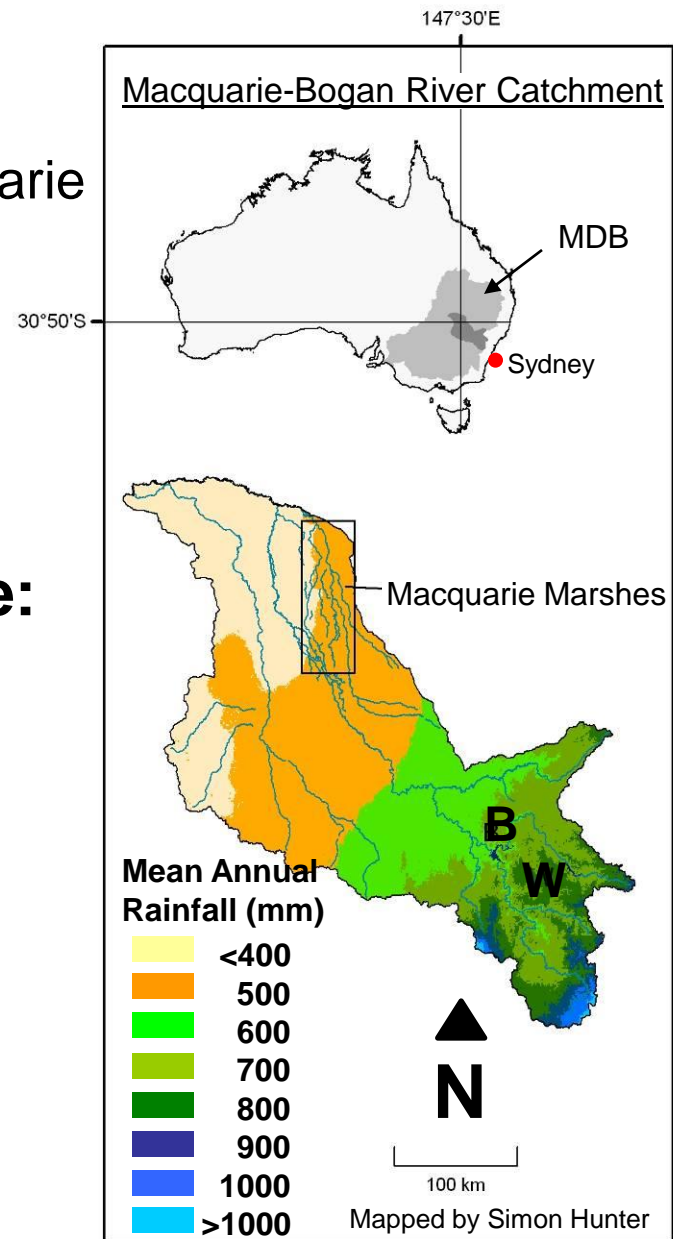
➤ rely on river flows from the regulated Macquarie River.

❑ **A long history of river regulation:**

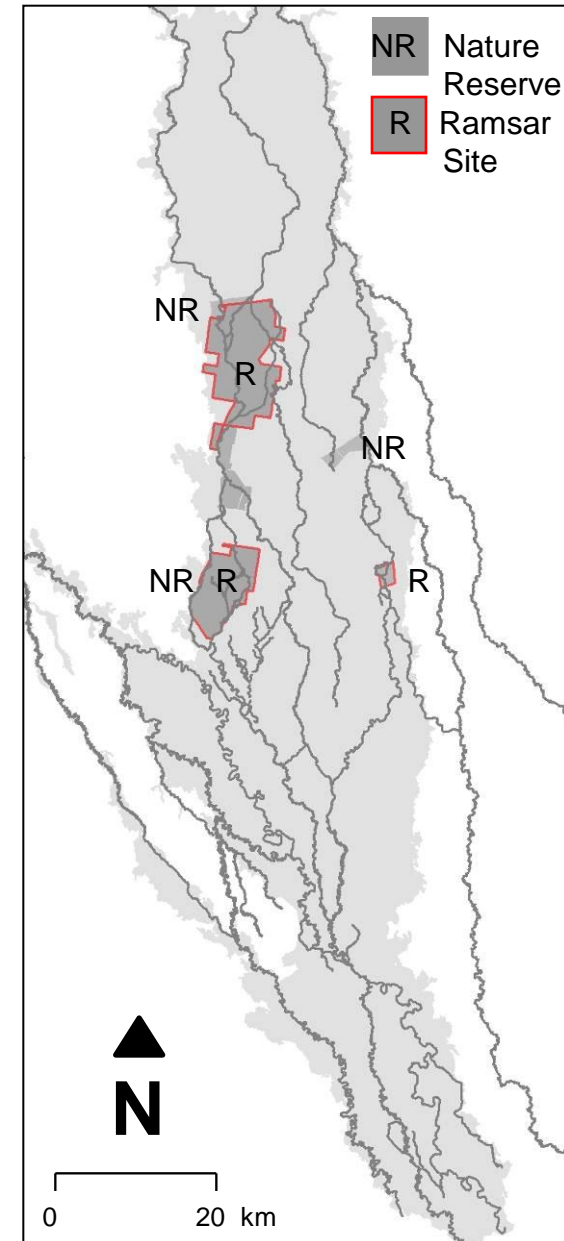
➤ Burrendong (B) (1967) and Windamere (W) (1984) Dams

➤ alters flow regimes and reduces variability

❑ **Macquarie River supports agriculture:**



- ❑ Are a dryland alluvial plain with anastomosing and distributary channels.
- ❑ Nature Reserve (NR) (1971) (IUCN category IV).
- ❑ Recognised in 1986 as an international wetland of importance under the Ramsar Convention criteria:
 1. **Representative example of inland floodplain wetland**
 2. **Nationally threatened species**
 3. **Regionally significant populations of plants and animals**
 4. **Significant waterbird breeding events**
 5. **Large waterbird abundance and diversity**



- ❑ Semi-arid region wetlands:
 - vulnerable to river regulation and extended drought,
 - **ecological integrity compromised**

- ❑ Article 3.2 of Ramsar Convention
 - notification that the ecological character of a wetland:
 - has changed,
 - is changing, or
 - is likely to change
 - evidence based



(Thomas et al. (2011) IJRS, 32(16) 4545-4569; Bowen, S. and Simpson, S. (2010); Thomas et al. (2010); Ren, et al. (2010) Environmetrics, 21 549-561; CSIRO, (2008); Kingsford, R. and Thomas, R. (1995) Environmental Management, 19(6) 867-878.)

❑ Macquarie Marshes have a long history of environmental flow management:

➤ first allocation 1980

❑ Managed to maintain and restore ecological structure and function.

❑ Restoration of environmental flows to rivers of the Murray-Darling Basin:

➤ AUD\$3.1 billion buyback of irrigation entitlements plus AUD\$5.8 billion in infrastructure

❑ Management requires a quantitative understanding of water requirements.



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- ❑ Floodplain wetlands are large and diverse and river flows are highly variable
 - landscape scale (>2000km²), and
 - water regime scale (long-term data e.g. 20 years).

(Ward *et al.* 2002; Puckridge *et al.* 1998)

- ❑ Flooding regime variables critical for flood dependent vegetation include:

- flood frequency
- dry interval

(Roberts and Marston 2000; Rogers 2011; Casanova and Brock 2000;)



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❑ Vegetation responses are relative to structural growth form, longevity and flood dependencies.








(Roberts *et al.* 2000; Brock and Casanova 1997)

- ❑ Response variables include:
- species composition
 - tree canopy health

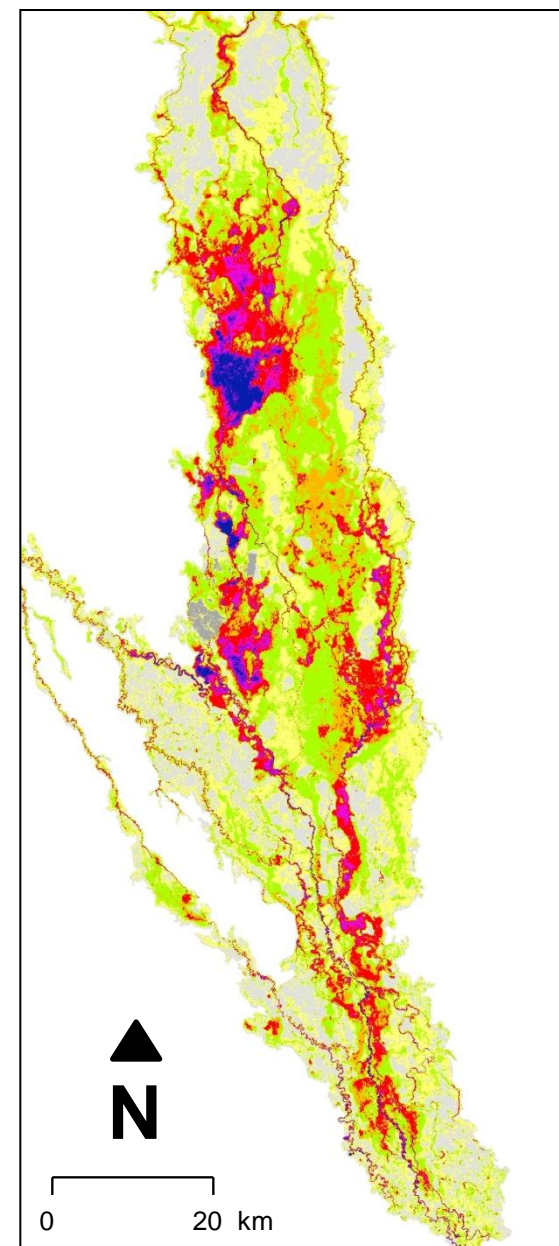


Flood Frequency

□ Average Return Interval (ARI) zones

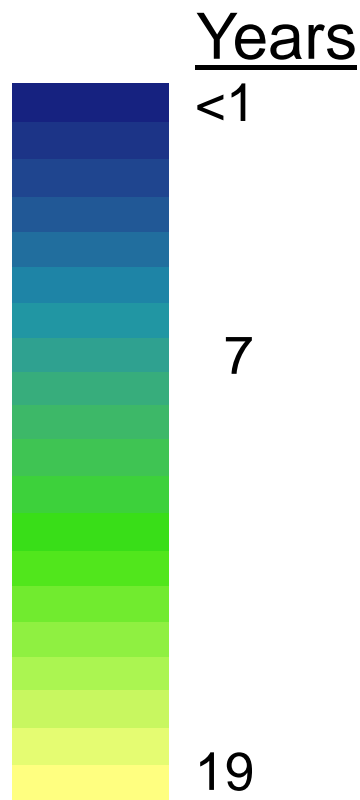
<u>Probability</u>		<u>ARI (years)</u>
0.65-0.99		>1 in 1
0.49-0.63		1 in 1
0.37-0.48		1 in 1-2
0.22-0.35		1 in 3-4
0.15-0.20		1 in 4-5
0.05-0.14		1 in 6-8
0.01-0.04		1 in 10 -20

Source data: Thomas, R.F., Lu, Y., Cox, S and Hunter (2010)
Inundation maps of the Macquarie Marshes 1989-2008. DECCW,
Sydney

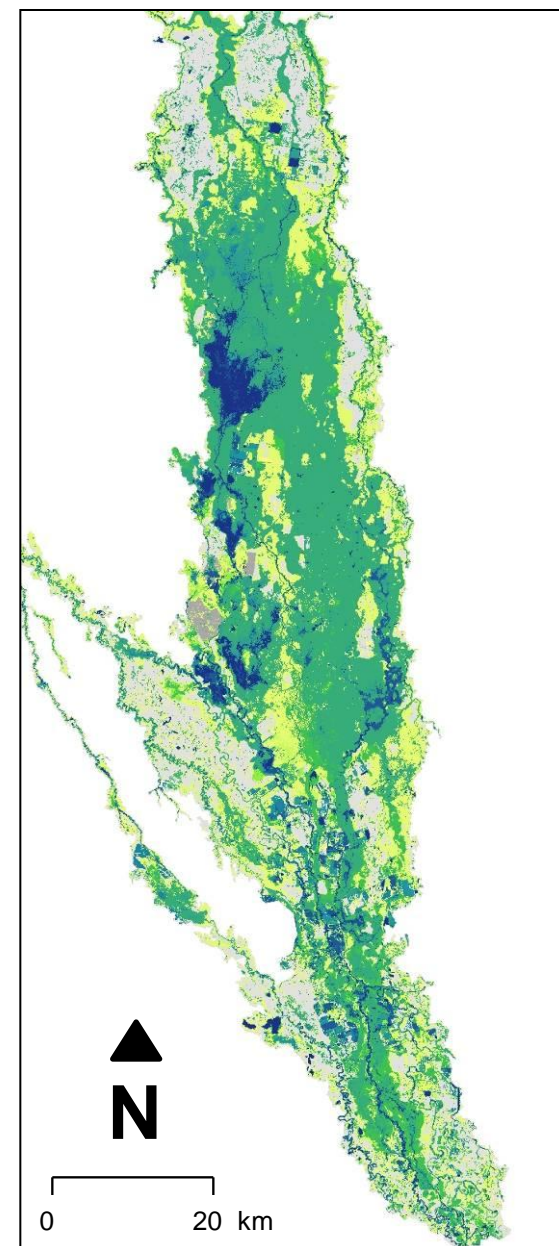


Dry Interval

- Number of dry years prior to the vegetation observations (May 2008)



Source data: Thomas, R.F., Lu, Y., Cox, S and Hunter (2010) Inundation maps of the Macquarie Marshes 1989-2008. DECCW, Sydney



Vegetation Communities

➤ Grouped according to relative flood dependencies and structural growth forms:

Aquatic



Semi-permanent wetland (1991)



River Red Gum



Lignum - River Cooba



Coolibah - Black Box

↓

Terrestrial



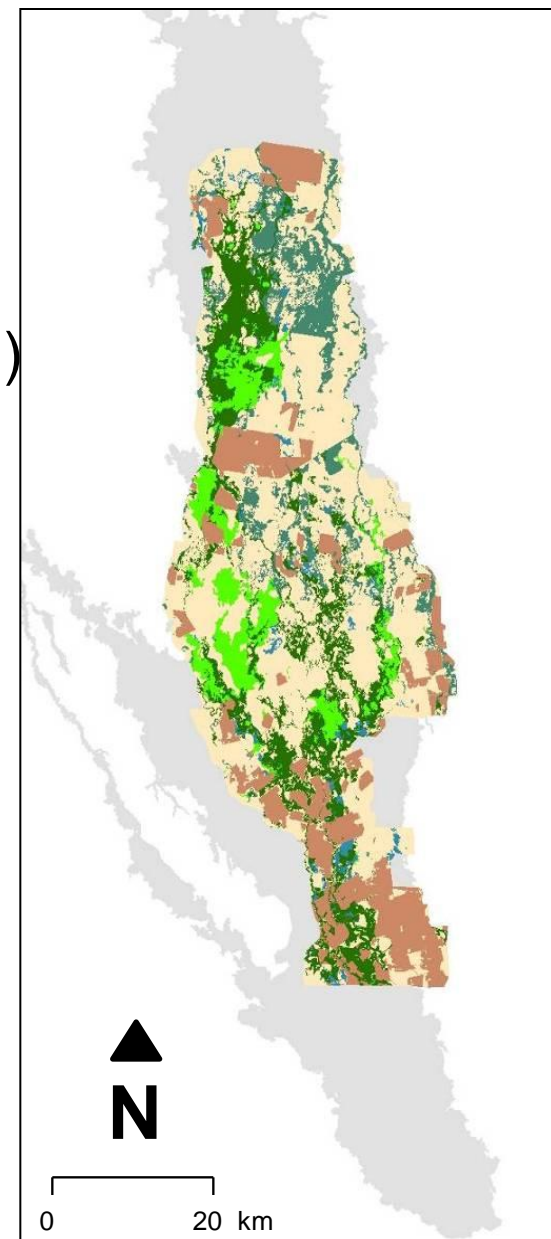
Dryland floodplain



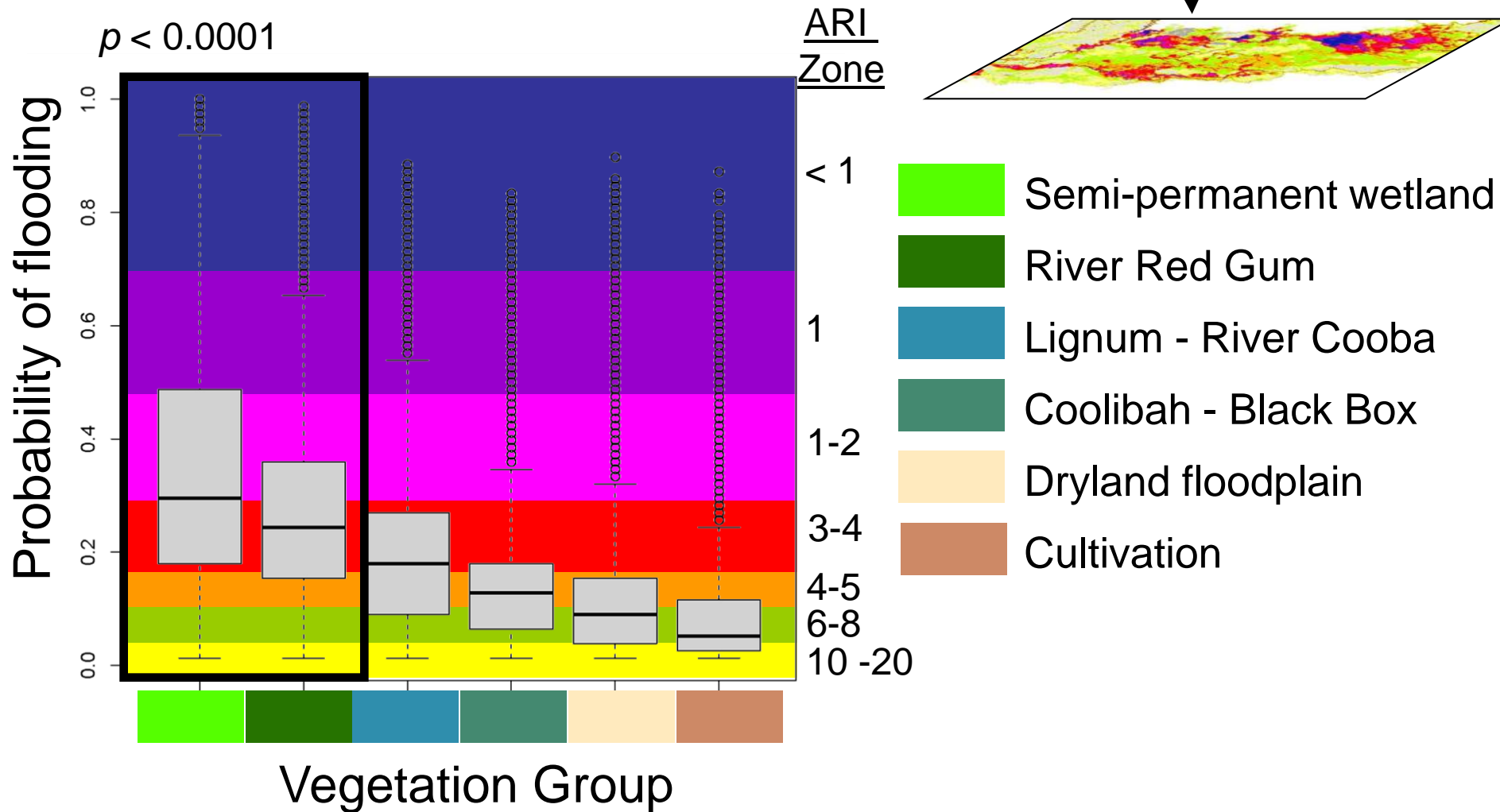
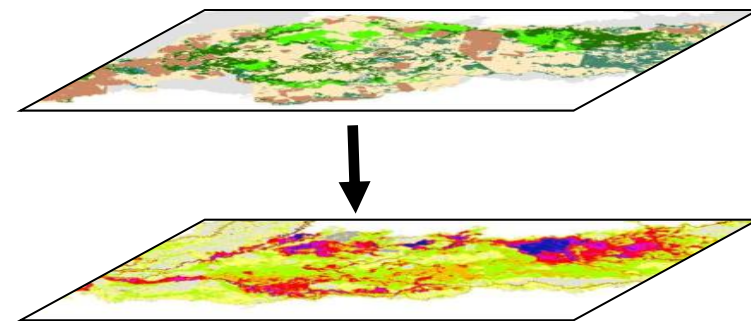
Cultivation

Source Data:

- **1991 Map:** Wilson (1992) Vegetation Map of the Macquarie Marshes 1991. NSW National Parks and Wildlife Service.
- **2008 Map:** Bowen & Simpson (2009) Vegetation Map of the Macquarie Marshes and Floodplain 2008. DECCW



☐ Among vegetation groups



Semi-permanent wetland

□ Response variable: % cover/abundance of terrestrial opportunistic colonising chenopods:
(*Sclerolaena muricata* and *Salsola kali*)



<u>Health Class</u>	<u>Chenopod %</u>
Good	0-10
Moderate	10-50
Poor	>50

Good

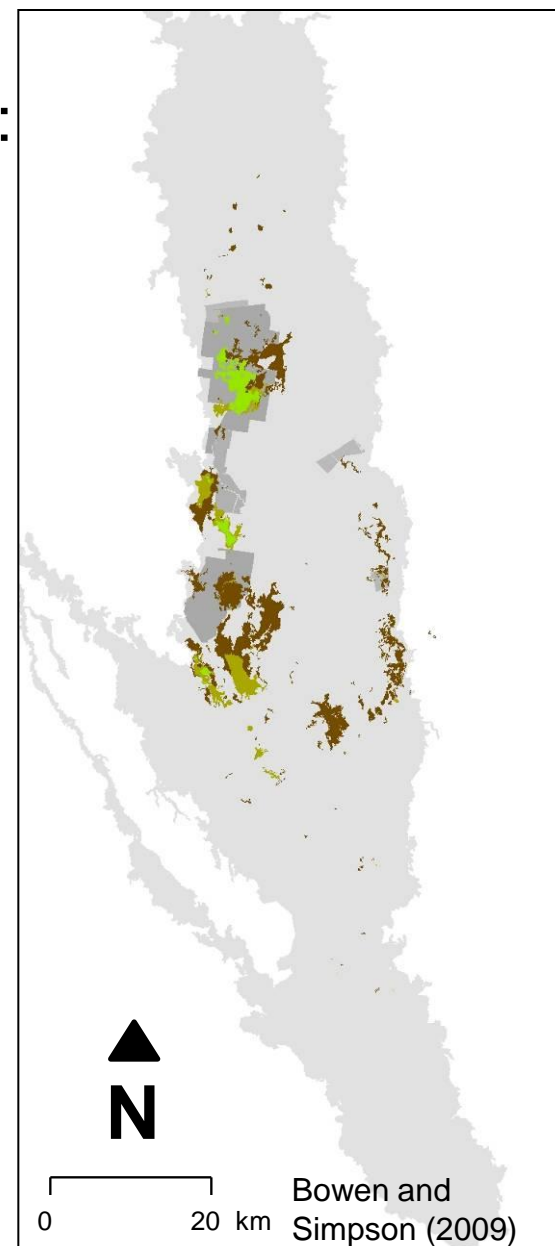
0-10

Moderate

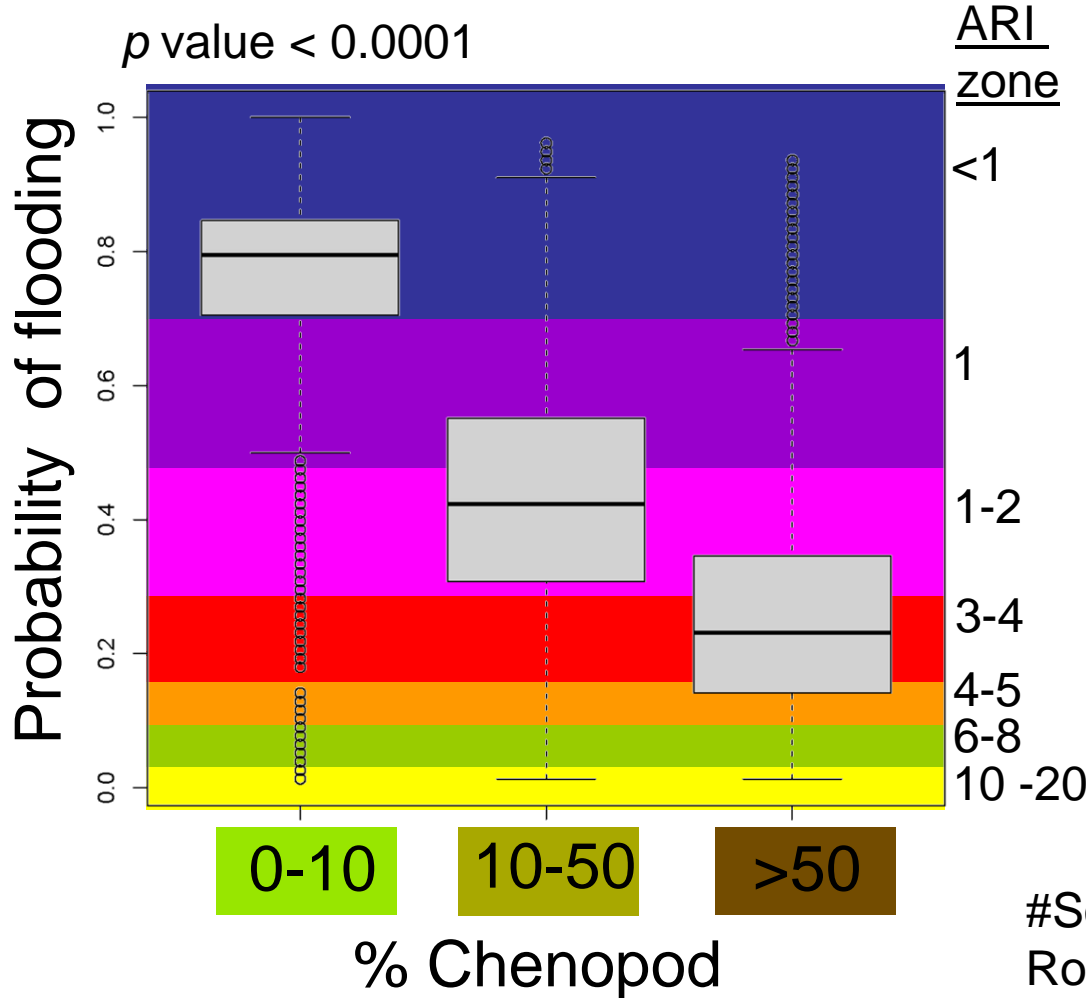
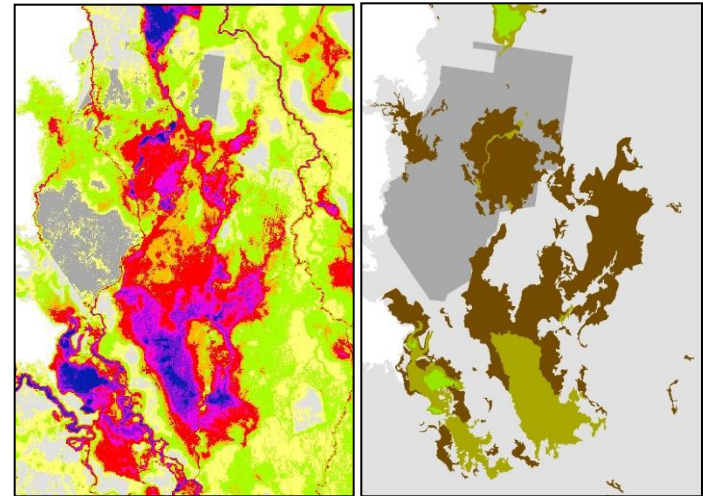
10-50

Poor

>50



☐ Among semi-permanent wetland health classes



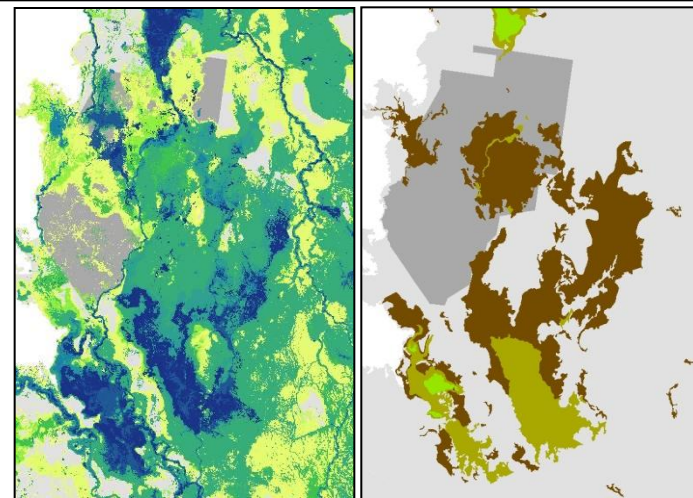
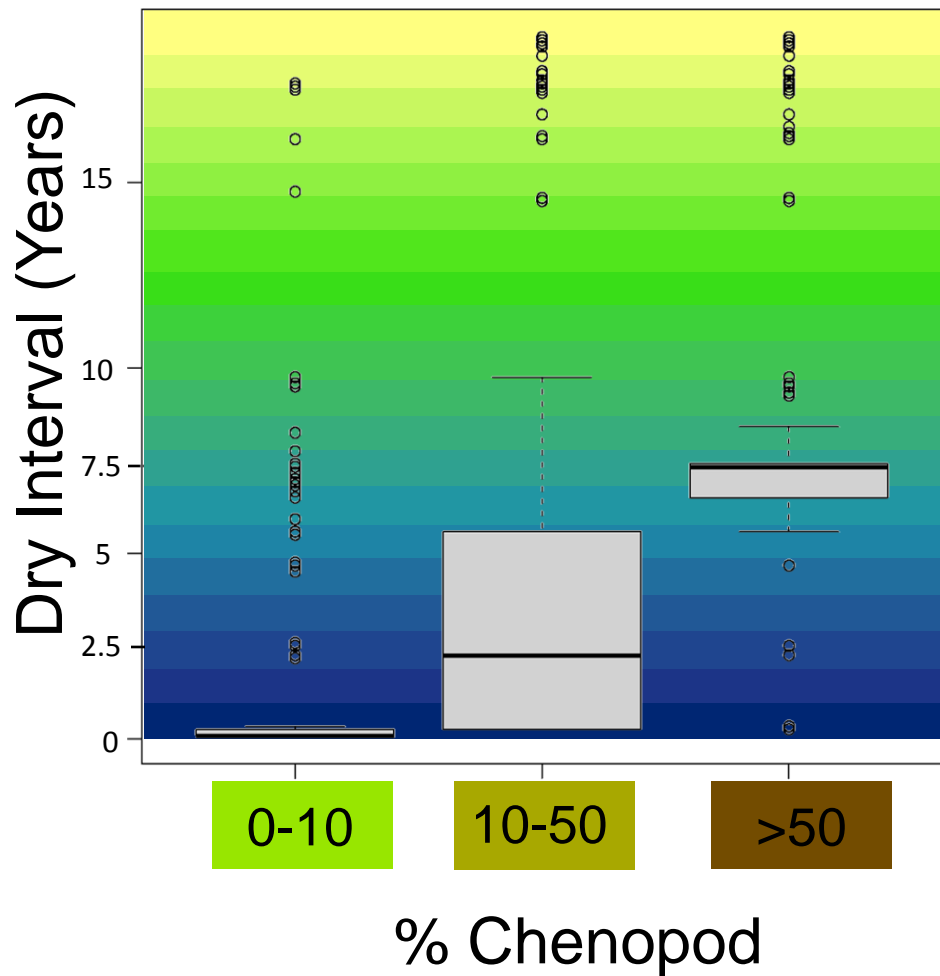
Reported frequency requirements[#]

Plant species	Ideal flood frequency
Common reed*	1-2 years
Water couch	Annual
Cumbungi	Annual

#Source: Roberts and Marston (2011); Rogers, K. (2011)

☐ Among semi-permanent wetland health classes

p value < 0.0001



Published dry period requirements[#]

Vegetation community	Ideal (months)	Maximum (months)
Common reed	A few	12 OR extended drought?
Water couch	7-8	9-10
Cumbungi	0-3	3-4

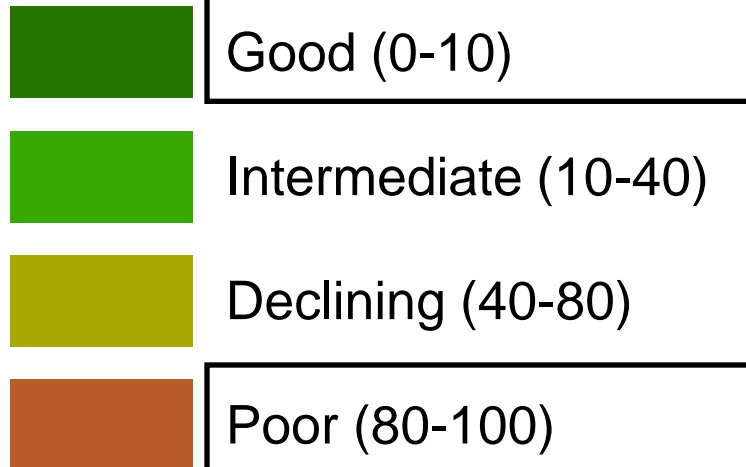
[#]Source: Roberts and Marston (2011); Rogers, K. (2011)



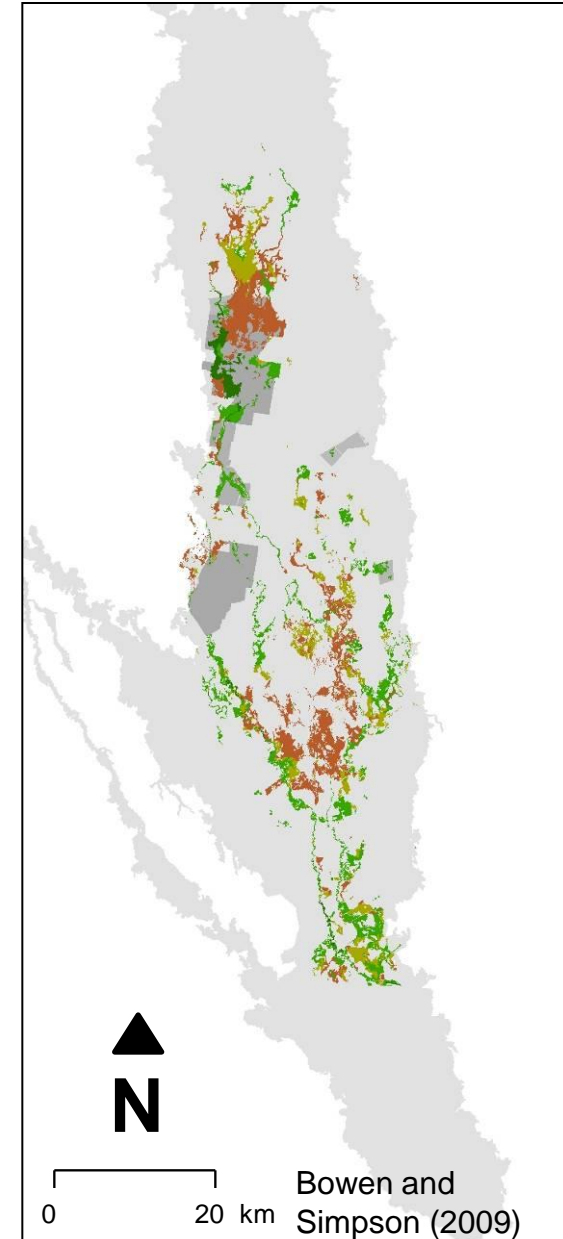
☐ Response variable: % dead canopy



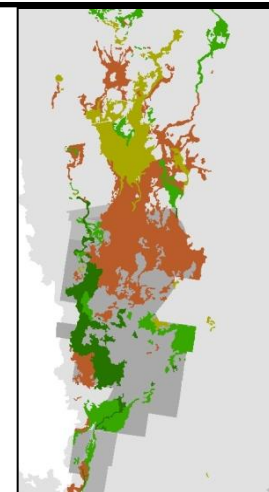
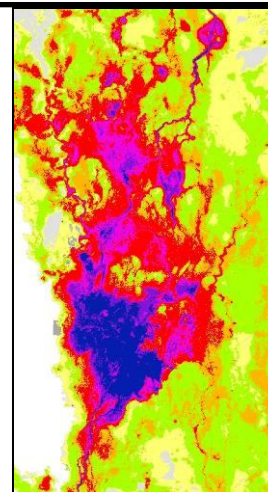
Health Class (% canopy dead)



• Delineated from high resolution imagery (ADS40) and validated on-ground (Nairn 2008; Bowen and Simpson 2010)



☐ Among River Red Gum canopy health classes



ARI zone

< 1

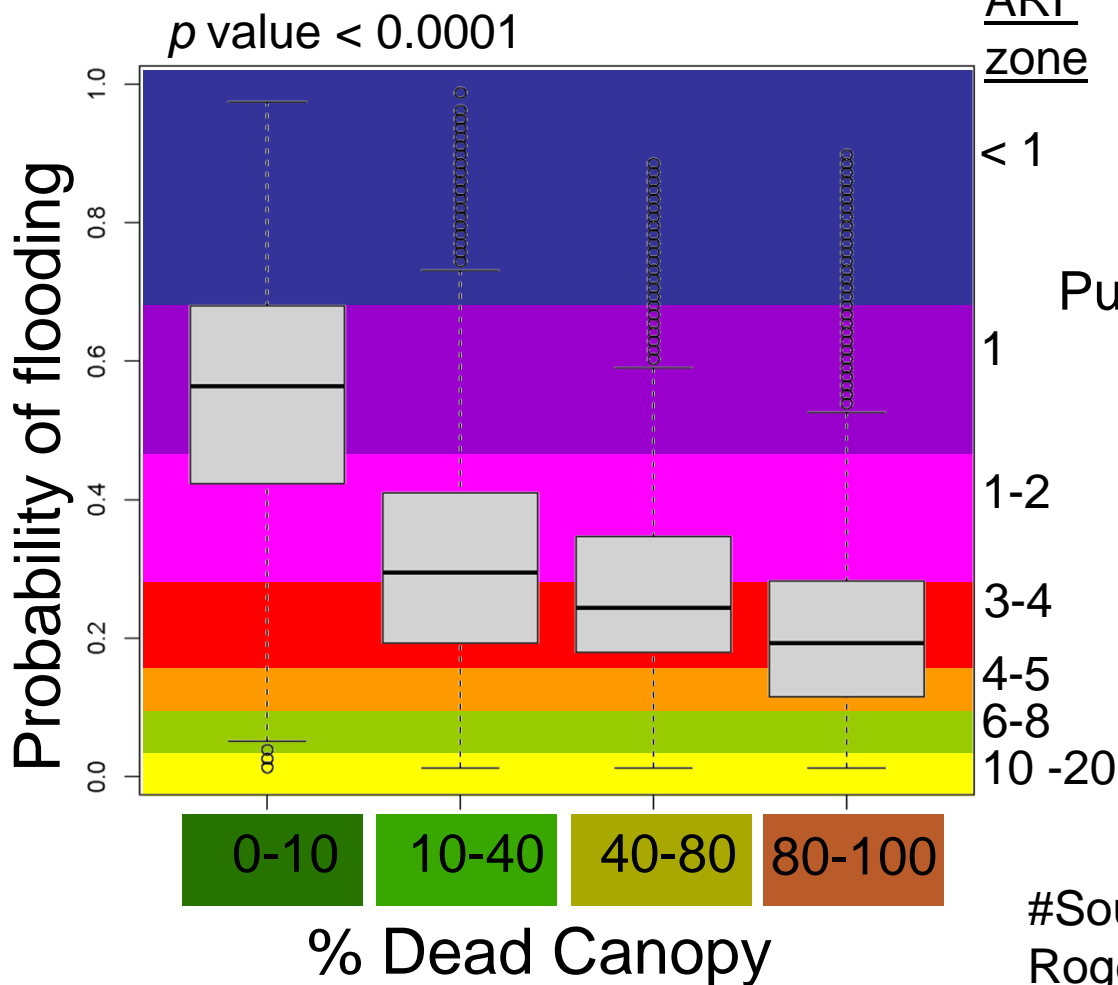
Published frequency requirements#:

Plant species	Ideal flood frequency
River red gum	1-3 years*

* Reduced when:

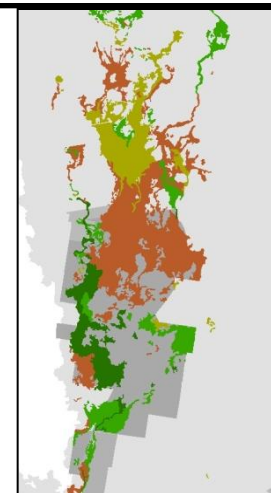
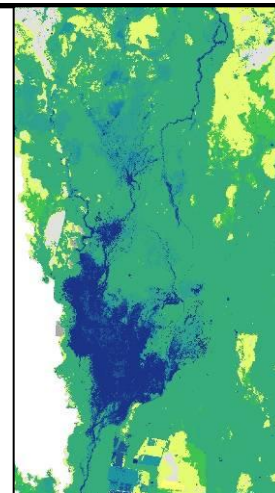
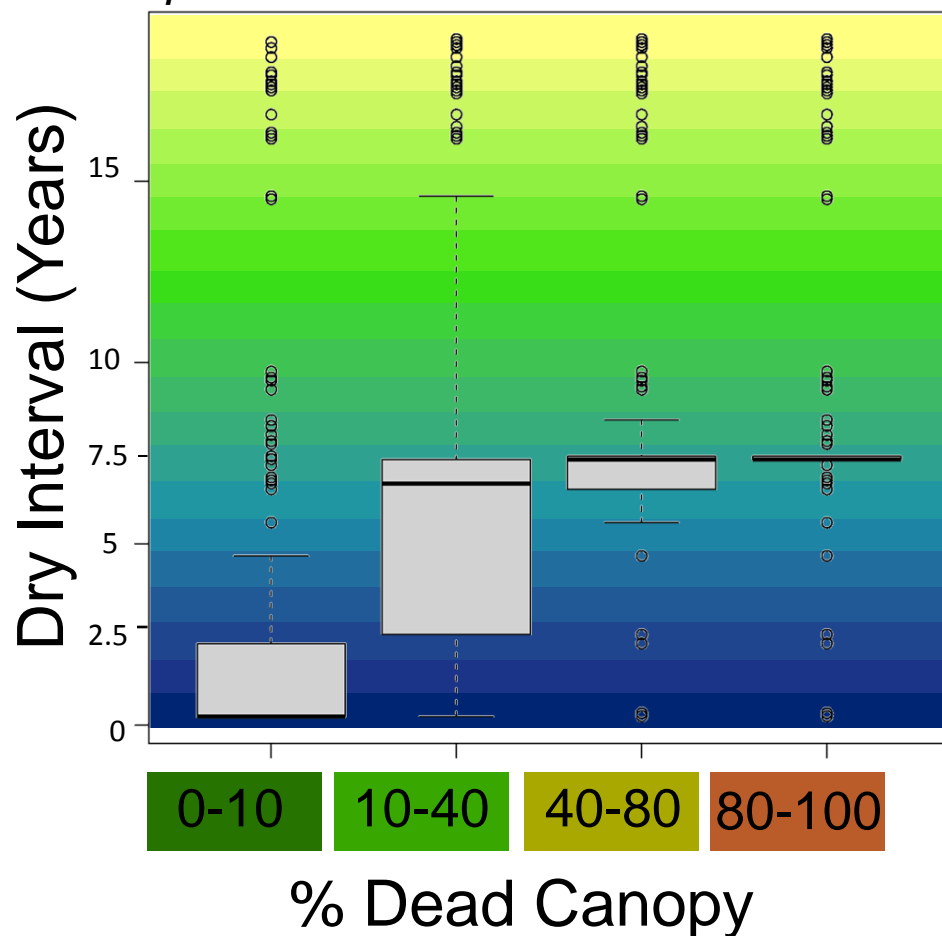
- watertable is shallow or trees have access to permanent water
- community characterised as a woodland

#Source: Roberts and Marston (2011); Rogers, K. (2011)



☐ Among River Red Gum canopy health classes

p value < 0.0001



Published dry interval requirements[#]

Plant species	Ideal	Maximum
River red gum	5-15 months*	3-4 years

* Reduced when:

- watertable is shallow or trees have access to permanent water
- community characterised as a woodland

[#]Source: Roberts and Marston (2011); Rogers, K. (2011)

□ For environmental flow management:

❖ Semi-permanent wetland

- Ideally requires flooding at least once a year.
- As dry period extends from 3 to 6 years there is significant colonisation of terrestrial species.
- Significant replacement by terrestrial species at extended periods (>6 years) of no flooding.



❑ For environmental flow management:

❖ River red gum

- Ideally requires flooding once in 1 to 3 years.
- Must receive adequate flooding within a six year period to maintain moderate health.
- Health is compromised (i.e. significant canopy death (>40%)) if the dry interval extends over a 6 year period.



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Office of Environment and Heritage

- Simon Hunter, Debbie Love, Alison Curtin, and Ray Jones

MDBA

- Bill Johnson

UNSW

- Prof. Richard Kingsford, Dr Lucy Nairn and Jo Ocock

Landholders of the Macquarie Marshes



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Water Smart Australia

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