Climate Change and MDB Wetlands: Scales of Adaptation and Relevant Tools

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Outline

- Hydrological regimes and flow variability
- Projected changes to flood volumes and inter-flood dry periods
- Spatial scales of climate change adaptation
- Water and habitat requirements database
- Tools in ecosystem response modelling
- Conclusions
Distribution and hydrology of floodplain wetlands in the MDB

- Wide distribution
- Catchment-fed, low relief, dryland floodplain settings
- Climate variability and hydrology drive inundation regimes
- Dynamic species and ecosystem responses over multiple scales

Source: Ralph and Rogers, in press 2010.
Hydrological regimes and variability

- Seasonal, intermittent or ephemeral regimes
- Generally have high flow variability
- Flood modulation by yearly, decadal and multi-decadal climate cycles

Source: Ralph and Hesse, 2010.
Projected change in average flood volume per year and per event, median 2030 climate

Data source: CSIRO, 2008. Figure adapted from: Rogers and Ralph, in press 2010.

Reduced water availability
Projected change in average and maximum period between floods, median 2030 climate

Data source: CSIRO, 2008. Figure adapted from: Rogers and Ralph, in press 2010.

- Longer droughts
Scales of Adaptation

- Basin-wide: Strategic decisions about conservation priority informed by climate change projections

- Catchment-scale: Water sharing plans—use of flow-ecology models to quantify environmental requirements. Optimisation of flow rules

- Wetland-scale: Re-engineering of wetlands to maximise inundation efficiency
Species water requirements and responses to hydrological change

- Flora and fauna respond to characteristics of the flood pulse, including timing, duration, depth, rates of rise and fall, and inter-flood dry period.

- Responses vary depending on character and adaptations of species, the characteristics of the flood or drought, and the degree of subsidy or stress.

- Species included:
  - 49 plants
  - 51 waterbirds
  - 17 native, 4 alien fish
  - 15 frogs
  - 15 crustaceans and molluscs
Species water requirements database

<table>
<thead>
<tr>
<th>Taxonomy</th>
<th>Type</th>
<th>Common Name</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flora</td>
<td></td>
<td>Eucalyptus camaldulensis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Life Stage</th>
<th>Seedling</th>
<th>Longevity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Stage Duration</td>
<td>Not known</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood frequency similar to mature, but maximum frequency less due to poorly developed root systems. Maximum flood duration based on older seedlings. Flood depth varies depending on the age and height of seedlings.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal Germination Time</td>
</tr>
<tr>
<td>Maximum Germination Time</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not known</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flooding Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal Flood Frequency: 1 - 1 Years</td>
</tr>
<tr>
<td>Maximum Flood Frequency: 2 - 2 cm</td>
</tr>
<tr>
<td>Large Flood Frequency: 3 - 3 cm</td>
</tr>
<tr>
<td>Ideal Flood Duration: 2 - 2 months</td>
</tr>
<tr>
<td>Minimum Flood Duration: 3 - 3 months</td>
</tr>
<tr>
<td>Maximum Flood Duration: 4 - 4 months</td>
</tr>
<tr>
<td>Ideal Flood Timing: November - December</td>
</tr>
<tr>
<td>Maximum Flood Timing: August - January</td>
</tr>
<tr>
<td>Flood Depth: 0.06 - 0.15 cm</td>
</tr>
<tr>
<td>Downstream Erosion: Not known</td>
</tr>
<tr>
<td>Maximum Flood Depth: 2 - 2 cm</td>
</tr>
<tr>
<td>Ideal Inter-Flood Dry Period: 2 - 2 months</td>
</tr>
<tr>
<td>Maximum Inter-Flood Dry Period: 3 - 3 months</td>
</tr>
<tr>
<td>Functional Group: Not known</td>
</tr>
<tr>
<td>Minimum Lag Time: 4 - 4 months</td>
</tr>
<tr>
<td>Ideal Lag Time: 5 - 5 months</td>
</tr>
<tr>
<td>Rate Of Water Fall: Not known</td>
</tr>
</tbody>
</table>
Species water requirements database

Habitat
- Prefers shallow, terrestrial, freshwater, permanent or ephemeral wetlands including lakes, swamps, billabongs, river pools, reservoirs, large dams, sewage ponds, flooded saltmarsh

Refugia Habitat
- Not known

Roosting Habitat
- Muddy spits and banks, among dense reeds or perched on the branches of dead trees, logs and fence posts.

Foraging Habitat
- On terrestrial wetlands in permanent swamps or floodwaters with vegetated margins or emergent vegetation such as grasses, sedges, reeds and rushes. Foraging may also

Breeding Habitat
- In temporarily flooded terrestrial wetlands among inundated vegetation such as lignum, carex, grasses, reeds or floating ribbon weed. Floating nests are constructed and attached to

Note
- Breeding occurs rapidly after arrival when conditions are suitable. They require a gradual rise of water. Inter-flood drying is essential, however the duration is unknown

Habitat
- Not known

Refugia Habitat
- Not known

Roosting Habitat
- Maximum flood duration based on 235 days in 2 years from Blench et al. (1999). Maximum flood frequency based on the survival of rhizomes for some time without flooding
Species water requirements database: 
river red gum

### Maintenance

<table>
<thead>
<tr>
<th>Flood frequency</th>
<th>Ideal flood timing</th>
<th>Max flood timing</th>
<th>Ideal flood duration</th>
<th>Max flood duration</th>
<th>Ideal inter-flood dry-period</th>
<th>Max inter-flood dry-period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3 years</td>
<td>Winter-spring</td>
<td>Winter-early summer</td>
<td>2-8 months</td>
<td>24 months</td>
<td>5-15 months</td>
<td>36 months</td>
</tr>
</tbody>
</table>

### Regeneration

<table>
<thead>
<tr>
<th>Ideal flood depth</th>
<th>Max flood depth</th>
<th>Ideal flood duration</th>
<th>Max flood duration</th>
<th>Ideal germination timing</th>
<th>Max germination timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-50 cm (deep)</td>
<td>200 cm</td>
<td>2-5 weeks</td>
<td>14 weeks</td>
<td>Late spring-early summer</td>
<td>Late winter-mid summer</td>
</tr>
</tbody>
</table>
Response of plants to hydrological change: decline in flood frequency

- Trees such as river red gum and black box will exhibit stress and decline in reproduction. Conditions will suit dryland species such as bimble box, belah and wilga.

- Provided flooding occurs at least 1:10 years, lignum may be maintained. Some migration is possible.

- Vegetatively expanding species such as common reed may be able to migrate to core wetland habitat.

- Long-lived seed bank species such as nardoo will respond opportunistically when flooding occurs.

- Dispersal dependant species such as water primrose and river buttercup have limited ability to adapt.
RERP Floodplain Wetlands

- Narran Lakes
- Gwydir wetlands
- Macquarie Marshes
- Great Cumbung Swamp
- Lowbidgee floodplain

Mean Annual Rainfall:
- 200-400
- 400-500
- 500-700
- 700-900
- 900-1000
- >1000
Flooding frequency
1988-2005
Species response to hydrological change: Bayesian approach

Bayesian network
- Components:
  - Structure
  - Probabilities
- Links between variables represent causal relationships (~conceptual model)

Flood attributes
- Flood timing (month)
- Flood duration (number of months)
- Rate of fall
- Flood area index
- Inter-flood dry period

Species response to flood attributes

Total species response
Gwydir Wetlands
IBIS (Prototype Decision Support Software)
Supported by a hydrology model...

- **Waterbody**
- **Reach**
- **Floodplain / Wetlands**
- **Junction Node**
- **Point (e.g. flow gauge)**
...which drives ecosystem response models.
.....to compare scenarios
Conclusions

- Adaptation can be managed at Basin, Catchment and Wetland scales using different levers.
- Continually modified understanding of water and habitat requirements of species provides a basis for improved ecosystem response modelling.
- IBIS DSS provides a tool for the assessment of climate change impacts at the catchment scale.
Acknowledgements and Further reading

- Jennifer Spencer, Baihua Fu, Carmel Pollino, Bruce Chessman, Wendy Merritt

CSIRO Publishing 2010