Riparian woodlands in crisis? Disturbance ecology on the Condamine floodplain

Kate Reardon-Smith¹, Andrew Le Brocque¹, Alan House²

1. Sustainable Landscapes (Agro-Ecology Group), Australian Centre for Sustainable Catchments (ACSC), University of Southern Queensland, Toowoomba, Queensland, Australia.
2. CSIRO Sustainable Ecosystems, St Lucia, Queensland, Australia
Study area:
Upper Condamine Floodplain
Floodplain ecosystems:

• dynamic non-equilibrial disturbance-driven systems
• hydrological connectivity (longitudinal, lateral, vertical, temporal)
• species & ecological communities adapted to historical disturbance ‘regimes’ (scale, intensity & frequency)

Modified floodplains:

• altered extent and integrity of natural habitats with development
• altered streamflow regimes (regulation, allocation & harvesting of in-stream & overland flow and/or groundwater) & hydrological connectivity
• changes in resource availability & changes in the frequency & extent of species dispersal/immigration events
• changes in abiotic & biotic interactions/feedbacks & resilience
Woodland condition:
Key questions:

* what is the status of health & function of riparian woodlands on this highly modified floodplain landscape?

* what is the native vegetation response to landscape context, hydrological status and weeds?

* what is the potential for retaining function & resilience through time with increasingly variable climate?
Research activities:

→ multi-faceted approach to investigate processes involved in the decline (and restoration) of these ecosystems:

- ground-based survey of current community composition and condition (27 sites), including germinable soil seedbank
- landscape (spatial) context
- hydrological (time-series) analyses
- tree-condition study – response to arboreal herbivory
- groundcover studies – tree condition, lippia and management
- riparian woodland system dynamics models (state and transition frameworks; Bayesian networks)
### Scoring tree health:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Score</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foliage Index (FI) (%)</td>
<td>25</td>
<td>reduced crown</td>
</tr>
<tr>
<td>Percent tree remaining (PTR) (%)</td>
<td>75</td>
<td>Loss evident</td>
</tr>
<tr>
<td>Crown structure (CS)</td>
<td>3</td>
<td>Recent epicormic growth</td>
</tr>
<tr>
<td>Crown Dieback (CD)</td>
<td>3</td>
<td>Top of tree/tips of branches</td>
</tr>
<tr>
<td>Foliage colour</td>
<td>1</td>
<td>Healthy foliage colour</td>
</tr>
<tr>
<td>Dropped branches</td>
<td>2</td>
<td>evident</td>
</tr>
<tr>
<td>Mistletoe</td>
<td>0</td>
<td>No (live) mistletoe</td>
</tr>
<tr>
<td>Canopy proportion</td>
<td>0.66</td>
<td>11.6/17.5</td>
</tr>
<tr>
<td>Canopy density</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Tree Health Class</td>
<td>Definition</td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>(i) very healthy</td>
<td>&gt;= 95% FI – vigorous; full habit; few or no stags</td>
<td></td>
</tr>
<tr>
<td>(ii) healthy</td>
<td>75-94% FI – vigorous</td>
<td></td>
</tr>
<tr>
<td></td>
<td>few stags; little epicormic growth</td>
<td></td>
</tr>
<tr>
<td>(iii) dieback: moderate to severe</td>
<td>30-74% FI – loss of vigour</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stags; generally epicormic regrowth present</td>
<td></td>
</tr>
<tr>
<td></td>
<td>moderate to poor health</td>
<td></td>
</tr>
<tr>
<td>(iv) dieback: very severe</td>
<td>&lt;= 30% FI – loss of vigour</td>
<td></td>
</tr>
<tr>
<td></td>
<td>recent epicormic shoots along trunk and branches from main canopy; Stags; very poor condition</td>
<td></td>
</tr>
<tr>
<td>(v) dead</td>
<td>No foliage; apparently dead crown</td>
<td></td>
</tr>
</tbody>
</table>

* definition of health classes as per Banks 2006
Condamine Floodplain tree health survey (% of sites). Dieback severity scored using the Wylie Index.

Dieback severity
- no dieback: 0%
- slight to moderate: 11.1%
- moderate to severe: 33.3%
- severe: 33.3%
- very severe: 22.2%
- dead: 0%

* Dieback severity index as per Wylie et al. 1992
Tree decline processes:

- invasive weeds
- arboreal herbivory
- floodplain hydrology

Figure 4. A model of initiation and development of dieback of rural trees in southern Queensland.

Source: Wylie et al 1992
Mean monthly rainfall (mm.) at Dalby Airport (composite data over 133 years; error bars are Standard Deviation)

Annual rainfall (mm.) recorded at Dalby Airport, 1870-2002. (Trendline is a 5 year moving average)

Rainfall:

Cumulative Rainfall Departure from longterm average rainfall, 1870-2005, for Dalby

Drying trend 1910-1932
Wetting trend 1953-1990

Departure (mm)

Year
Mean monthly streamflow (ML), Condamine River at Loudon Bridge, Dalby (1970-2000).

Error bars are Standard Deviation.

Annual streamflow (ML), Condamine river at Loudon Bridge, Dalby (1970-1999). Trendline is the 5 year moving average.

Monthly streamflow (Condamine River at Loudon Bridge, Dalby) vs mean monthly rainfall (Warwick, Cambooya, Dalby), 1970-2000.

R² = 0.6195
Groundwater:

42230012C: GW levels (1971-2008)

Date
GW depth (m)

Bore 42230011A: GW levels 1971-2008

Date
GW depth (m)

Monitoring bore 42230011B: GW levels (1971-2008)

Date
GW depth (m)
Upper Condamine floodplain system:

- Highly variable rainfall pattern
- Major drying and wetting trends evident
- Ephemeral river system
- Hydrological extremes (drought, flooding)
- Groundwater – important ecological buffer in extended dry periods?

- Major land and water use development during 1950-1990 “wetting phase”
- Reduced hydrological connectivity?
- Decline in extent and condition of dependent ecological systems
- Potential tipping point for agri-ecological system
Preliminary Bayesian Belief Network (BBN) model:
Bayesian Belief Networks:

- modelling tool (Netica™ software, Norsys Software Corporation 1998)
- organisation of current thinking into testable hypotheses
- updating with new knowledge and data

Advantages:
- synthesis of data from a variety of sources
- accommodates uncertainty (conditional probabilities)
- dynamic, quantitative models
- can be rerun with different assumptions (scenario analysis)
- supports adaptive management
- useful communication tool

Limitations:
- cannot incorporate system feedbacks
Significance:

• dynamic quantitative models enable updated prediction with greater knowledge and/or altered conditions (e.g. climate change)

• retain capacity for flexibility & improvement with updated knowledge (adaptive management)

• better management for remnant ecosystem health in complex production landscapes

Knowledge gaps:

• ecosystem responses to hydrological change (climate variability; environmental water allocations; surface-groundwater interactions)

• response times (time lags with long-lived species)