Change is the new stability:

disturbance ecology & riparian woodlands on the Condamine floodplain

Kate Reardon-Smith[1]
Andy Le Brocque[1], Alan House[2]

1. Faculty of Sciences / Australian Centre for Sustainable Catchments, University of Southern Queensland
2. CSIRO Sustainable Ecosystems

Research topic overview

Floodplain (defn.):

- landscape element associated with a well-defined river channel, built of sediments & inundated when the river overflows its banks

Floodplain ecosystems/landscapes:

- dynamic non-equilibrial disturbance-driven systems
- hydrological connectivity
- high spatial and temporal heterogeneity
- species & ecological communities adapted to historical disturbance regimes
- range of flood-dependent wetland types, flood-tolerant & terrestrial spp.

Floodplain development:

- low slope, fertile deep soils → agricultural development (cropping)

- proximity to water → irrigated cropping & pasture production

Modified floodplain landscapes:

- altered extent & integrity of natural habitats

- altered streamflow regimes & hydrological connectivity

- changes in resource availability

- changes in frequency & extent of species dispersal events

- changes in abiotic & biotic interactions/feedbacks & resilience

Broad research question:

What are the key drivers of condition & function of riparian woodlands in a highly modified floodplain landscape?

Study location:

Murray Darling Basin

Brigalow Floodplain
Jimbour Floodplain
Upper Condamine Floodplain

Dalby
Toowoomba
Warwick

N

~ catchment boundary
~ floodplain
~ drainage lines

0 — 50km

Condamine River:

Annual streamflow (ML) at Cecil Weir, Cecil Plains (1947-2006)
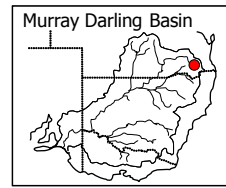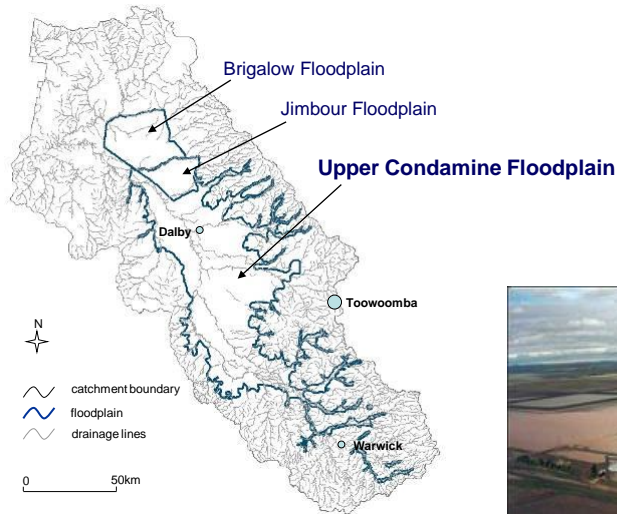
- MDB headwater

- ephemeral streamflow

- hydrological extremes
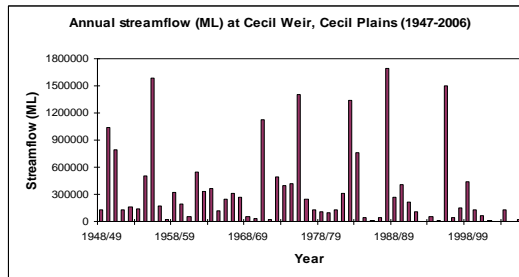
Upper Condamine Floodplain production landscape:

- renowned Darling Downs cropping region

- intensive agricultural landuse (dryland & irrigated cropping)

- highly productive (sig. pptn. of Qld's wheat & irrigated cotton)

- significant water extraction for production purposes

Land use (1999), Upper Condamine Floodplain
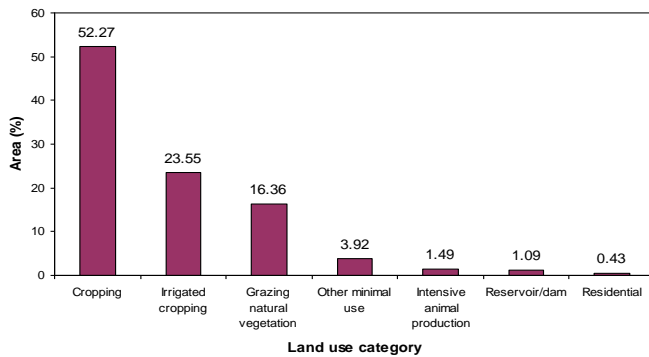
Water resource development* (CSIRO 2008):

Surface water harvesting:

- Streamflow: 718GL/yr (55% of avge. surface water availability)
- Overland flow harvesting: not quantified

Groundwater harvesting (160GL/yr):

- Upper Condamine GMU extraction (47GL/yr) exceeds recharge by 38%
- additional 30GL/yr reduction in streamflow

* Values are for the entire Condamine-Balonne

Rainfall trends:

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

- **Drying trend 1910 -1932**
- **Wetting trend 1953 -1990**
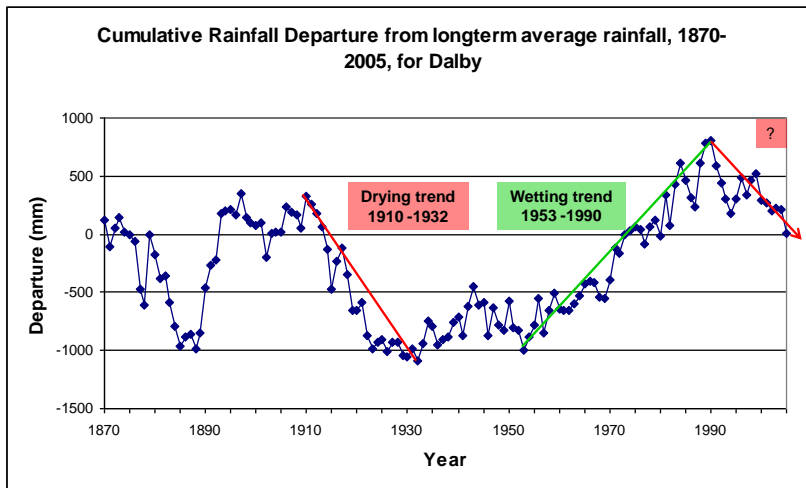
Data source: Bureau of Meteorology: composite data for stations 513041023 (Dalby Post Office; 1870-1992) & 513041522 (Dalby Airport; 1992-2005)
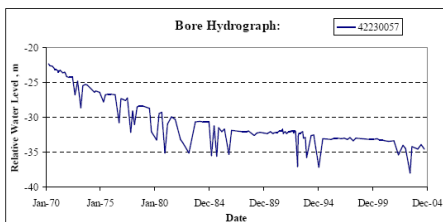

Biodiversity issues on the UC Floodplain

- *extent:* < 22% of riparian eucalypt woodlands remain on the floodplain (Qld Herbarium 2003)

- *condition:* 'very poor to moderate riparian condition' with 29% mean exotic spp. abundance (Upper Condamine State of the Rivers Report 2002)

- increasing extent & abundance of lippia, *Phyla canescens* (Earl 2003)

- increasing evidence of eucalypt dieback in floodplain woodlands (Voller 1996)

- links between high possum numbers & arboreal herbivory in dieback eucalypts? (Voller & Eddie 1995)

Native ecosystem futures in complex landscapes?

- probability of retention under current passive (at best reactive) management approaches?

- potential for improved prospects with active adaptive (experimental) management?

Questions:

* What is the present state of vegetation (composition & condition) in relation to landscape & hydrological contexts?

* What influence do altered species interactions have on native vegetation composition & condition?

* What is the potential for enhancing function & resilience within an increasingly variable climate?

1: Survey
riparian woodland composition & condition

↓

2: Banded tree trial
tree health responses to arboreal herbivory

3: Lippia transects
Lippia/groundcover responses to tree presence & condition

4: G'cover trials
Lippia/groundcover responses to management

↓

5: Resilience
riparian woodland response (S&T; BBN) models

1. Survey:

- $\sim$ streams
- ▮ riparian remnants
- • survey sites (n=27)
- ⬠ storage dams
- • groundwater bores
- $\sim$ floodplain boundary
- ▮ irrigated cropping
- ▮ dryland cropping

N

0   20km

Floristic composition

Survey MDS plot   Stress: 0.21

▲ *grazed*   □ *ungrazed*

Total species richness:

- 186 spp. (125 native, 58 alien)

Survey:

- 146 spp. (104 native, 42 alien)

Seedbank:

- 99 spp. (61 native, 38 alien)

Survey vs Seedbank composition:

- not sig. correlation (RELATE)
- most abundant species *Phyla canescens* (lippia)

Seedbank MDS plot   Stress: 0.22

Explanatory variables (Survey floristics, BIOENV):

Patch scale:

- lippia cover, floodscore, irrigation cropping UQ500, elevation, geology (Rho = 0.484)

Landscape scale:

- GW production bores 2000, GW trend 5000, grazing 5000, drainage 2000, RE 2000 (Rho = 0.488)
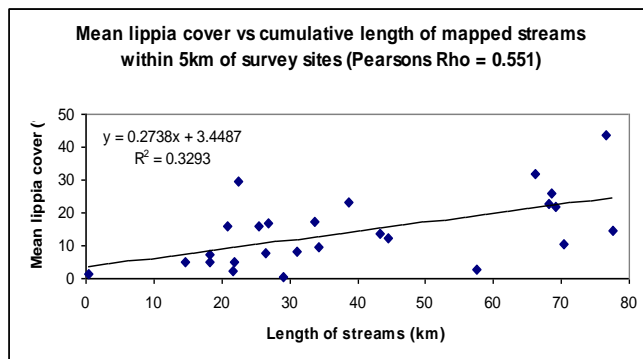
Hydrological:

- GW depth 5000, GW allocations 2000, irrigation cropping UQ500, floodscore, northing (Rho = 0.480)

Spatial:

- remnant area 5000, RE 2000, grazing 5000, northing, geology (Rho = 0.475)
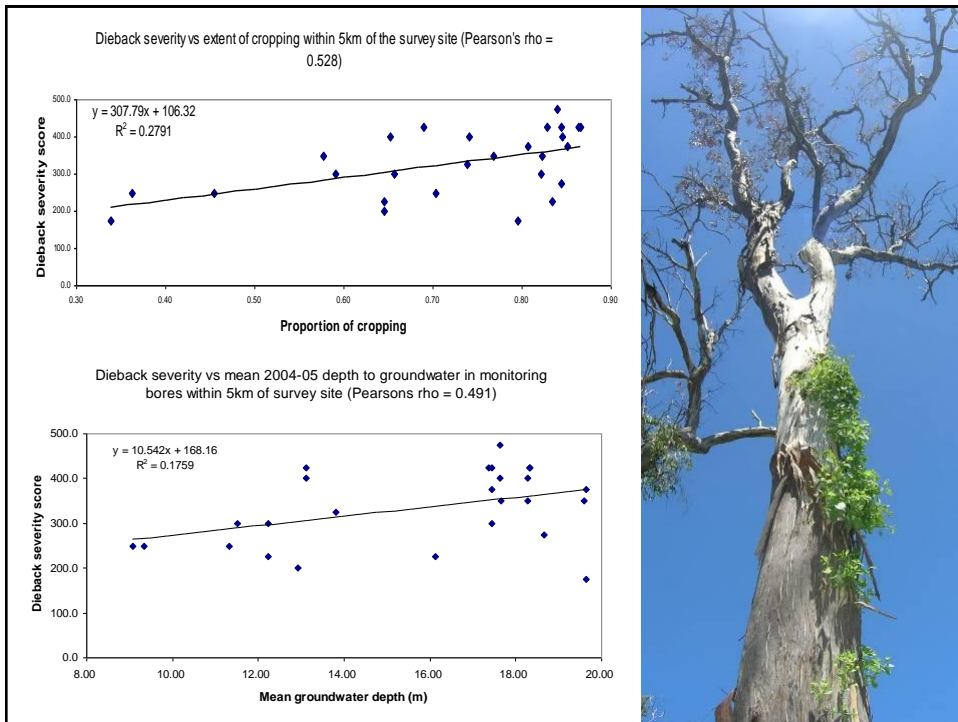

Lippia correlations (Pearsons Rho):

Mean lippia cover vs cumulative length of mapped streams within 5km of survey sites (Pearsons Rho = 0.551)

$y = 0.2738x + 3.4487$
$R^2 = 0.3293$

Mean lippia cover (

Length of streams (km)

- mean diameter of trees (D_{130}) per site (0.467)
- number of registered groundwater production bores within 2 km of a survey site (0.454)
- total frequency of native wetland-dependent species per site (0.396)

Dieback severity vs extent of cropping within 5km of the survey site (Pearson's rho = 0.528)

$y = 307.79x + 106.32$
$R^2 = 0.2791$

Dieback severity vs mean 2004-05 depth to groundwater in monitoring bores within 5km of survey site (Pearsons rho = 0.491)

$y = 10.542x + 168.16$
$R^2 = 0.1759$

2: Banded tree trial (13 years):

Study design:

- established 1994 (DPI&F)

- 6-10 paired trees x 5 study sites

- tagged, one of each pair banded

Sampling design:

- 25 tree pairs sampled (2007)

  ✓ canopy condition

  ✓ evidence of herbivore visitation
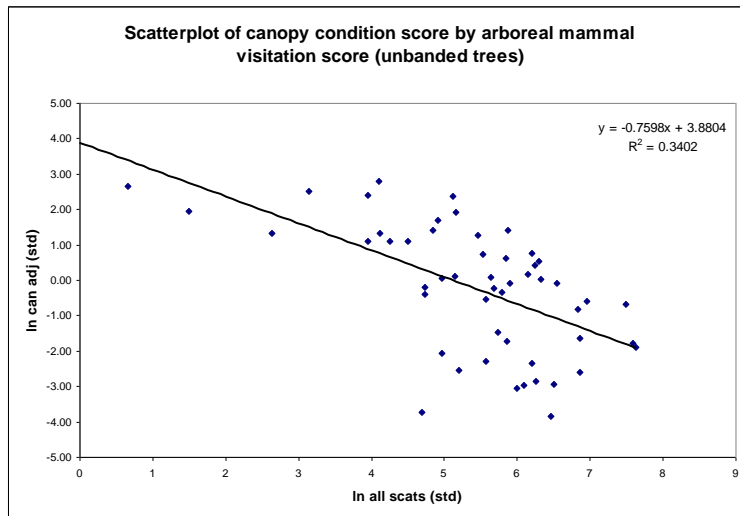
  ✓ beneath-canopy groundcover

Banded-unbanded comparisons:

- no significant differences between treatments & homogeneous, but large, variances

- significant difference for PTR (percentage tree remaining) by sites ($p < 0.05$)

- smaller trees (<40cm DBH130) may be responding differently to larger trees ($p < 0.05$)


Total scat counts (koala & possum) per unbanded tree
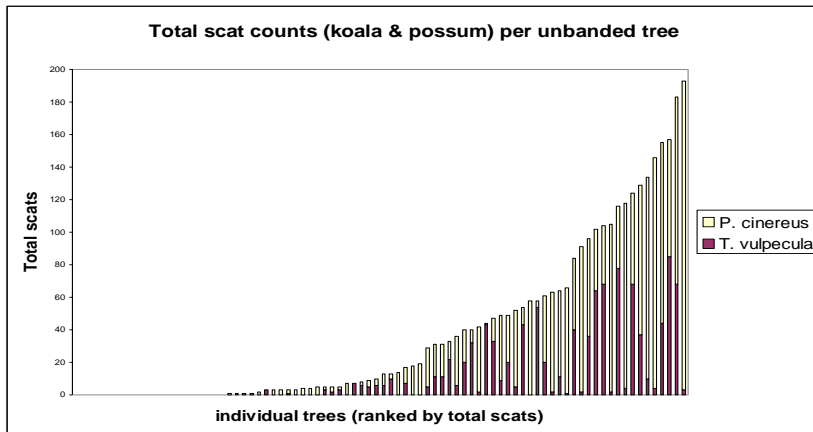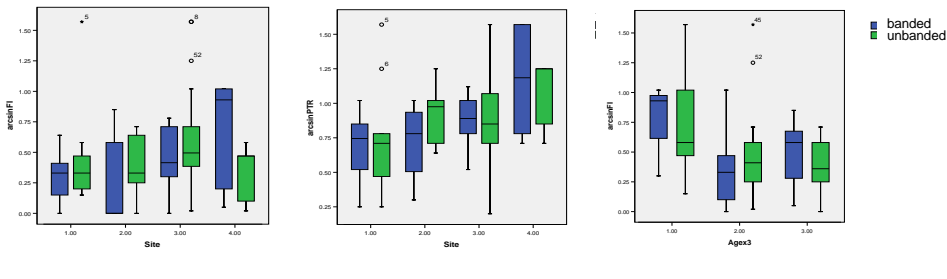
- unbanded trees are not equally visited

  ➢ different levels of physiological stress in individual trees?

 ➢ other factors that make trees unattractive to herbivores?

10

Scatterplot of canopy condition score by arboreal mammal visitation score (unbanded trees)

$y = -0.7598x + 3.8804$
$R^2 = 0.3402$

ln can adj (std)

ln all scats (std)

---

3. Lippia transects:

- tree-based transects (n = 12):

  ◦ lippia abundance & condition

  ◦ relative abundance & condition of other species

  ◦ light intensity, soil moisture & nutrient status

- lippia abundance, condition & reproductive status greater under trees → refugia


© KRS 2005
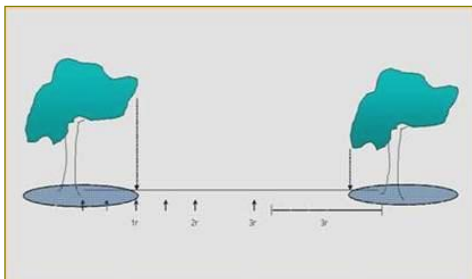
4. Simulated grazing & lippia removal trial:

- complete randomised block design (n = 8)

- treatments (6):
  - ✓ control (no treatment)
  - ✓ clipping to 30%
  - ✓ clipping to 10%
  - ✓ clipping to 10% + litter removal
  - ✓ lippia removal – hand
  - ✓ lippia removal - chemical
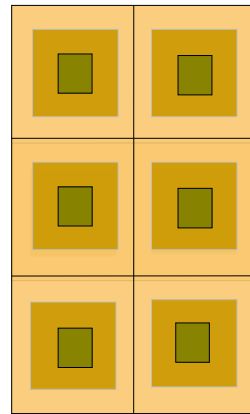
buffer zone – untreated

treatment area

treatment sampling area

Changes in lippia cover

Mean lippia cover (%) x treatments, April 2008
(Error bars are SE)
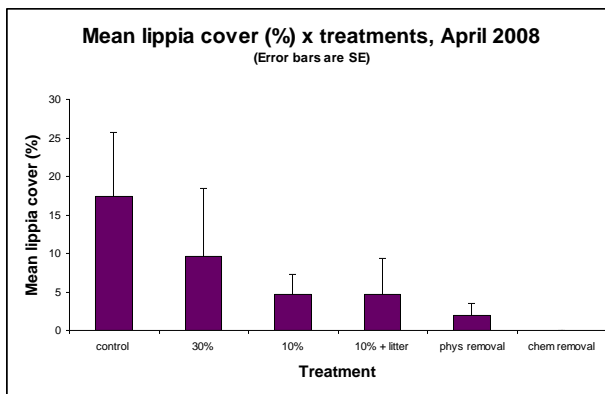
- grazing intensity a probable driver of lippia abundance at the patch scale

- interaction with climate

© KRS 2005

© KRS 2005

Key indications:

- system degraded with potential for further decline (e.g. lags in response times of long-lived species)

- complex drivers – multiple scales, spatial & hydrological

- species interactions vary with patch management & climate

Next step:

- woodland condition response (Bayesian Belief Network) model

    ✓ dynamic quantitative predictive models

    ✓ experimental approach (adaptive management cycles)

    ✓ enhanced prediction with updated knowledge

→ better management for remnant ecosystem condition in complex production landscapes

Thanks to the many landholders who willingly allowed access to their properties and happily shared their views on factors contributing to tree decline along the river . . .

&

to our many hard-working field assistants

Email: reardons@usq.edu.au

Ph: (07) 4631 5445