www.csiro.au

Control of Environmental Weeds: an Integrated Framework for Natural Resource Management

Matt Colloff

Floodplain Ecosystem Function Project
CSIRO Water for a Healthy Country Flagship

National Research FLAGSHIPS Water for a Healthy Country CSIRO

Outline

- Weeds and ecosystem function;
- Weeds of floodplains – effects of flooding and drying;
- Weeds and ecosystem resilience;
- Integrated planning processes for management of environmental weeds

Weeds and Floodplain Ecosystem Function

- **Weeds as Drivers of Changes of Ecosystem Function –**
  - **Nutrient Cycling;**
  - **Food Webs;**
  - **Plant community structure;**
  - **Habitat availability for animals**
  - **Hydrology and sediments (flow, channel morphology, sediment deposition);**
  - **Fire regimes.**
- **Integrating weed management into broader NRM is not the same as 'integrated weed management'**

Weeds & Ecosystem Function

Photo: Rieks Van Klinken, CSIRO Entomology

Lippia

- **out-competes plants by smothering and allelopathy;**
- **wedged tap root causes erosion;**
- **toxic to grazing animals;**
- **soil drying effect from cracking;**
- **5.5 mn ha of MDB affected**
- **reduced water quality;**

Black Willow

- **altered channels & streamflow;**
- **increased erosion;**
- **leaf fall – alters decomposition & ground cover;**
- **reduced water quality;**
- **massive water use – creek drying;**
- **reduced aquatic biodiversity;**

Photo: Kate Stokes, CSIRO Entomology

Weeds & Ecosystem Function

Photo: Shon Schooler, CSIRO Entomology

Salvinia

- **water loss via transpiration;**
- **lowered DOC & water quality;**
- **reduced aquatic biodiversity;**
- **food web disruption;**
- **OM accumulation;**
- **shading out of native aquatic plants;**

Blackberry

- **simplified plant community structure;**
- **habitat for foxes & rabbits;**
- **altered OM inputs & decomposition;**
- **increased fire hazard;**
- **accelerates soil erosion;**
- **9 mn ha invaded (size of TAS);**

Photo: Louise Morin, CSIRO Entomology

Weeds on Floodplains – key questions

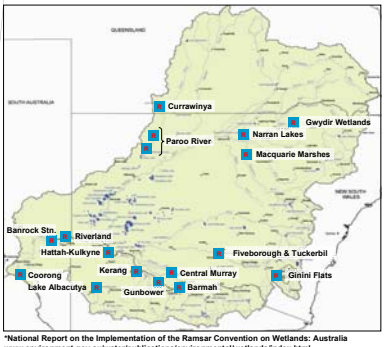
- **Will environmental water allocations just result in lots of weeds?**
- **Can weed distributions be predicted from flood patterns?**
- **Are floodplain weeds mostly dry-loving or wet-loving?**
- **Are there site risk indicators for invasibility?**
- **How are floodplain vegetation communities changing?**
- **Why are floodplains under threat and which threats are manageable;**
- **What can be done to improve condition/halt decline?**

Policy drivers

- **National Water Initiative:** Water Act 2007: water buy-back & allocations: DEWHA, National Water Commission;
- **Murray Darling Basin Plan:** NRM, environmental flows and water management - draft due 2009; Murray Darling Basin Authority;
- **International Convention on Ramsar Wetlands** DEWHA reports on character and condition of the 64 Australian Ramsar sites;
- **The Living Murray Initiative** ongoing monitoring and assessment of Living Murray Icon Sites; Murray Darling Basin Commission);

Ramsar Wetlands in the Murray-Darling Basin -

rare or unique wetland types; of international importance for biodiversity



- 16 Ramsar sites in MDB;
- 201 important wetlands, many in private ownership;
- 2 notifications to Ramsar Secretariat under Article 3.2 (change in ecological character): Coorong and Gwydir Wetlands*; Macquarie Marshes - 'concerns raised'.
- Several other sites have undergone change in ecological character.

*National Report on the Implementation of the Ramsar Convention on Wetlands: Australia www.environment.gov.au/water/publications/environmental/wetlands/index.html

Weeds at Murray Darling Basin Ramsar Sites – A Quick Roundup

- **Barmah-Millewa:** spread of giant rush into Moira grass plains due to soil drying; increase in *Sagittaria* in creeks;
- **Gunbower:** spread of *Sagittaria*, Lippia;
- **Kerang Wetlands:** Boxthorn, willows, *Sagittaria*;
- **Hattah-Kulkyne:** spread of Thornapple, Horehound & Noogoora Burr;
- **Macquarie Marshes & Wilgara Wetlands:** Invasion of river red gum understorey by weedy chenopod shrubs; Lippia, Alligator weed;
- **Gwydir Wetlands:** water hyacinth; control of Lippia by ploughing & seeding grasses: compliance with NSW Native Vegetation Act;
- **Narran Lakes:** Burrs, Lippia; Salvinia & Golden Dodder in wetlands.

Macquarie Marshes

Dead Red gums and understorey of invasive chenopods:
Buckbush (*Salsola kali*) and Black Rolypoly (*Sclerolaena muricata*)
Photo courtesy of Rachael Thomas, DECCW.

Invasives can be Natives too – Giant Rush at Barmah Forest

Photo: Keith Ward, GBCMA

Invasion of Plains and Red Gum Forest

- Moira grass probably an important ecosystem engineer – nutrient buffering, habitat;
- Moira grass productivity ca. 10 t ha^{-1}: impact of rush on C & N dynamics;
- Rush provides waterbird nesting habitat but forms a dense understorey under edge of forest;
- Rush may outcompete younger red gums for water;
- Invasion associated with alteration of flow regimes.

Photo: Kim Pullen, CSIRO Entomology

Giant Rush Characteristics

- native, invasive emergent macrophyte;
- likes shallow summer floods & saturated soils;
- cannot withstand prolonged complete submersion;
- deep-rooted (~1.5 m); rhizomatous; dioecious;
- prolific seed producer;
- appears to survive prolonged drying;
- regenerates from fire;
- low palatability for herbivores & insects;

An invasive native: giant rush (*Juncus ingens*) at Barmah Forest

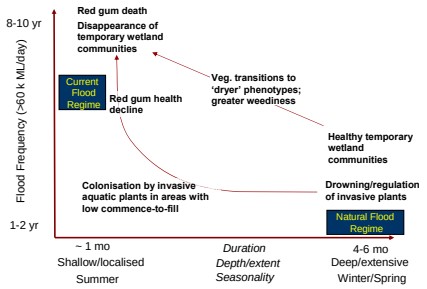
Management Issue

Major change in ecological character
Out-completes red gums for water
Forms an impenetrable understorey
Area of Moira grass plains reduced

Research

options for control;
ecohydrological research;
biodiversity implications;
ecosystem function changes

Barmah-Millewa Floodplain Ecosystem Vegetation Responses to Changes in Flooding

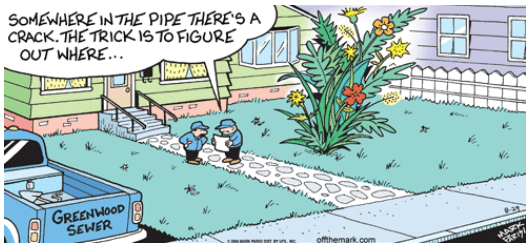


Weeds & Environmental Flows: Datasets Used

- **Large-scale plant dataset: Murray Valley**
  - Predictive models of diversity 'hotspots' and vegetation mapping, based on consolidated herbarium records, post-1950 (Sophie Bickford, David Penton and Judy West, CSIRO Plant Industry)
- **Hydrological data derived from River Murray Floodplain Inundation Model (RiM-FIM)**
  - Data from RimFIM Zones relevant to Living Murray Icon Sites (Ian Overton)
- **Small-scale plant dataset – Barmah Forest**
  - Long-term monitoring of understorey vegetation (Keith & Paula Ward)

Species allocated to a plant functional group classification, i.e. species with similar life-history characteristics grouped accordingly

All plants have their hydrological niche….



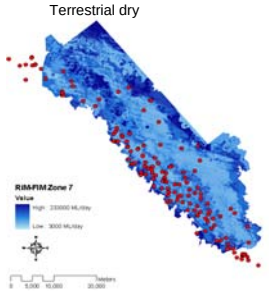
Plant functional groups based on responses to water

	*Nymphoides crenata* (Wavy Marshwort)	Amphibious fluctuation responders. Species with floating leaves ARf
	*Potamogeton Tricarinatus* (Floating Pondweed)	Amphibious fluctuation responders. Morphologically plastic species ARp
	*Typha orientalis* (Broadleaf cumbungi)	Amphibious fluctuation tolerators. Emergent species ATe
	*Conyza bonariensis* (Flaxleaf Fleabane)	Terrestrial species (damp). (damp) Tda
	*Cirsium vulgare* (Spear Thistle)	Terrestrial species (dry). (dry) Tdr

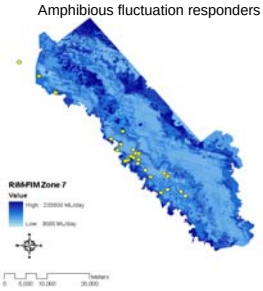
*Brock M.A. and Casanova M.T. (1997) Plant life at the edges of wetlands; ecological responses to wetting and drying patterns. In: N. Klomp & I .Lunt (eds.) *Frontiers in Ecology: Building the Links*. Elsevier, Oxford, pp. 181-192.

Distribution of Functional Groups at Gunbower in Relation to Flooding

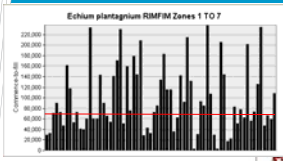
Terrestrial dry



Amphibious fluctuation responders

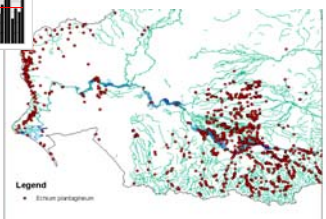


Species-specific hydrological profiles

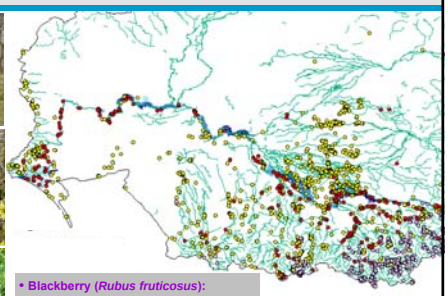


Patterson's Curse

Echium plantagnium



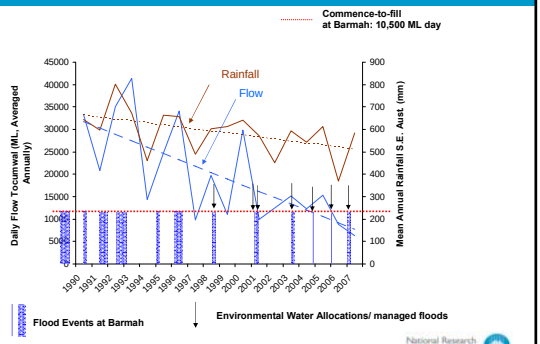
Weed Functional groups – contrasts in distributions



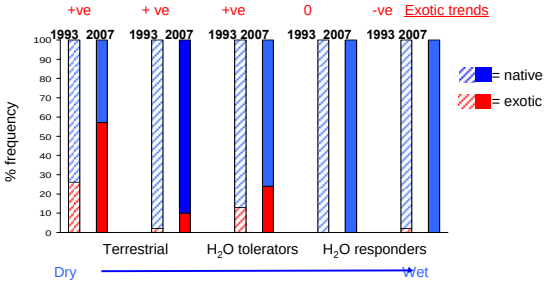
- Blackberry (*Rubus fruticosus*): Terrestrial dry
- Capeweed (*Arctotheca calendula*): Terrestrial dry
- Water Couch (*Paspalum distichum*): Amphibious fluctuation tolerator

Dispersal over time – Lippia (*Phyla canescens*)

Flood History & Rainfall Barmah-Millewa Forest

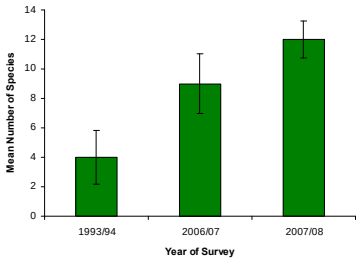


Temporal Trends in Plant Functional Groups – Barmah Forest



Mean changes in abundance (number of quadrats occupied) for the 5 functional groups recorded in Barmah Forest, 1993 and 2007

Asteraceae Invasion at Barmah: effect of drying

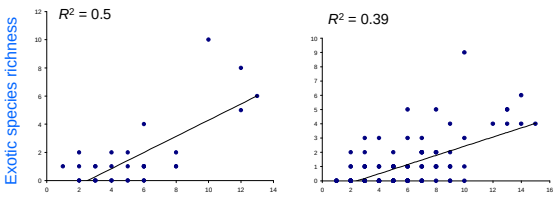


Asteraceae are the plant family that includes thistles, dandelions, milkweeds ragworts and daisies: many are major weeks in Australia, including Parthenium (WoNS), *Senecio* spp. and thistles (Nodding, Scotch, Star, Variegated, Saffron, Spear).

Do weeds outcompete natives on floodplains?

Spring 2006

All seasons combined 2006/7



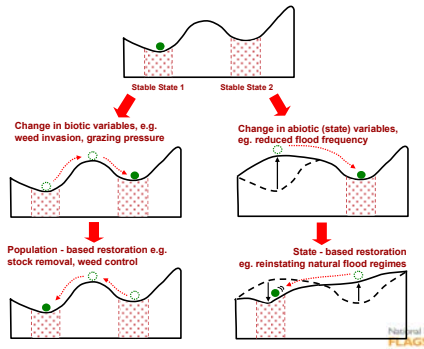
- Positive relationship at small scale: flooding resets the system
- Competition not the main driver of community composition

Ecosystem Resilience

The capacity of an ecosystem to undergo disturbance, but still recover and maintain its core functions

- NRM policy - urge to 'manage for resilience';
- High resilience systems → re-configure after disturbance;
- Low resilience systems → shift to alternative stable states;
- Flexible alternative to 'equilibrium management' of ecosystems;

Ecosystem Resilience, Management and Restoration



Alternative stable states can be 'good' or 'bad'

healthy temporary wetland

drying

drying + oxidation of sediment pyrite

alternative stable state 1; grassland

alternative stable state 2: acid sulphate swamp

Bad alternative stable state: highly resilient to restoration

A Planning Process for Management of Environmental Weeds

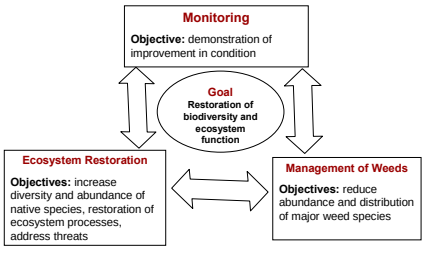
- Identify the ecological assets in the system
  What will be protected & enhanced?
- Identify the threats to the system
  (e.g. altered hydrology, soil nutrients). Which threats require priority management?
- Identify the feasibility of managing threats
  Is it possible to manage all the threats? Are some too big/out of scope? Will managing threats result in benefit-for-investment?
- Identify weed threats
  Determine weed species currently present; potential invaders, sources of weeds and how they reproduce and disperse.
- Determine management objectives
  Why is weed management being undertaken? What long-term outcomes are sought? Will monitoring data from previous management activities inform the objectives?

Holistic Management - Parks Victoria

Park Vegetation Management Plans

- Identify values;
- Indentify threats;
- Scope and plan actions to mitigate threats;
- Whole-of-park planning within catchment and regional framework
- Approach being trialled in current review of the Alpine Parks management plan

Weed Management in a Broader NRM Framework



Control of Environmental Weeds: an Integrated Framework for Natural Resource Management

Where to from here?

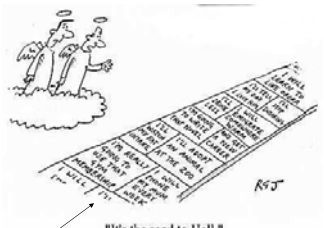
- **Take the theory and convert it into practice: "develop cost-effective, integrated approaches to manage key components of natural ecosystems".**

Questions & Challenges

- **How does a manager practically and realistically take a holistic approach?**
- **What tools and data are required?**
- **How do we undertake real adaptive management on-ground?**
- **Is it feasible, within resource constraints, to expect to achieve such management?**
- **How do you do all this in a framework of resilience thinking?**

Agency partners for case studies currently being investigated

Weed Management in a Broader NRM Framework - The Adaptive Management Cycle



'I will use the adaptive management cycle properly'

Acknowledgements

- Goulburn-Broken Catchment Management Authority: Keith Ward
- Victorian Government Department of Primary Industries: Fiona Ede
- CSIRO: Louise Morin, Liz Lindsay, Shon Schooler, John Scott, David Penton
- Land and Water Australia, Defeating the Weeds Menace Programme: Jim Donaldson, Judy Lambert, Nolani McColl, Teresa Oppy and Nadeem Samnakay

Lin Onus. Barmah Forest, 1994