



A risk assessment
of the tropical weed
Mimosa pigra in
Northern Australia

Paper and presentation
to the 3rd International
Symposium on the Management
of *Mimosa Pigra*, Darwin,
September 22–28, 2002

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A risk assessment of the tropical weed *Mimosa pigra* in Northern Australia – Paper and presentation to the 3rd International Symposium on the Management of *Mimosa Pigra*

Darwin, September 22–28, 2002

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1 1st Circular and call for Abstracts

3rd International Symposium on the management of *Mimosa pigra*

Darwin, Australia – Sunday 22 September – Friday 28
September 2002

The Australian Mimosa Management Committee invites you to attend the third International Symposium on the management of *Mimosa pigra*. The first Symposium on *Mimosa pigra* was held in Chiang Mai, Thailand in 1982. The second Symposium on *Mimosa pigra* was in Darwin in 1992 and resulted in Harley, KLS, 1992, A Guide to the Management of *Mimosa pigra*. Now, ten years later, we will hold the third symposium with the aim to share and document advances in the management of this significant weed. The workshop will be extremely relevant to representatives from both the agriculture and environment sectors.

Further information will shortly be available on the web:
<http://www.nt.gov.au/dbird/dpif/> and information about Darwin and the Northern Territory is available on <http://www.ntholidays.com/home.asp>.

Preliminary Program

Day 1 – Monday 23/9/2002:

Field trip (all day)

Day 2 – Tuesday 24/9/2002:

1. Impacts of *Mimosa pigra* (ecological, environmental, agricultural, sociological)
2. Ecology and biology of *Mimosa pigra* (autecology, phenology, habitat ecology)

Day 3 – Wednesday 25/9/2002

3. Prevention and Eradication (pre-border controls, surveillance, detection, early intervention)
4. Community Involvement (public awareness)

Day 4 – Thursday 26/9/2002

5. Management Tools (biological, herbicidal and mechanical controls, fire, revegetation, grazing management)
6. Integrated Management (general application, economics)

Day 5 – Friday 27/9/2002

7. Surveying and Mapping
8. Technology Transfer

pm – field trip

Call for Participation and Abstracts

Participants wishing to attend the symposium are requested to fill out the form below. Participants wishing to present a paper and/or a poster should also submit abstracts, preferably electronically using the following guidelines:

- **Due date – 30 June 2002.**
- Length - **maximum 300 words** in a word or text document.
- Format – times roman in 12 point.
- Presenting author indicated with an asterisk (*).
- Identify session by number (refer to timetable above).

PARTICIPATION AND ABSTRACT SUBMISSION FORM

☒

I would like to attend the symposium.

☒

I would like to present a paper(s) and/or a poster(s) at the Symposium.

Name: Dave Walden

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Paper Title: A RISK ASSESSMENT OF THE TROPICAL WETLAND WEED *MIMOSA PIGRA* IN NORTHERN AUSTRALIA

Author(s) Dave Walden*, Rick van Dam, Max Finlayson, Michael Storrs, John Lowry & Darren Kriticos

Abstract (maximum 300 words) attached

This paper relates to session(s): 1, 2, 3, 4, 5, 6, 7, or 8. Session 1

Please submit by 30 June 2002 to one of the following:

Mr Mic Julien; e-mail; Mic.Julien@csiro.au; (Fax) +61 (0)9 3214 2882; Postal address: Project Co-ordinator, Tropical Weeds Project, CSIRO Entomology, Long Pocket Laboratories, 120 Meiers Road, Indooroopilly 4068 Australia

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- *Further details including information about accommodation will be sent to those expressing interest in attending.*

2 Abstract

A risk assessment of the tropical wetland weed *Mimosa pigra* in northern Australia

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ABSTRACT

Information on the biology and management of *Mimosa pigra* (mimosa) has been collated and analysed in a risk assessment in the regional context of northern Australia. Much of the information for this assessment has come from northern Australia where mimosa has been seen as a major weed for more than two decades, and has consequently attracted substantial research and management attention. The approach of this assessment adheres to the wetland risk assessment framework adopted under a formal resolution of the Ramsar Wetlands Convention. This framework provides guidance for environmental managers and researchers to collate and assess relevant information and to use this as a basis for management decisions that will not result in adverse change to the ecological character of the wetland.

The risk assessment aims to determine:

What wetlands across northern Australia are at risk of mimosa invasion?

What are the likely consequences of mimosa invading these wetlands?

What management actions are being, or need to be undertaken to minimise the risks of further mimosa invasion across northern Australia?

The major wetland categories in northern Australia are briefly described and a summary of the effects of mimosa on native fauna, flora and socio-economic factors is presented. The current and potential distribution of mimosa in northern Australia is discussed along with factors influencing establishment, density and distribution, ie invasion rates and pathways, preferred habitats and environmental conditions and greenhouse considerations.

The prediction of the potential distribution compares annual rainfall zones with CLIMEX modelling, overlaid with potentially vulnerable wetlands and land tenure. These are discussed in the context of the current management of mimosa in northern Australia. Uncertainty and information gaps relating to the extent and effects of mimosa are also highlighted. An estimated 4.2–4.6 million ha of wetlands in northern Australia are under threat from mimosa, though the actual area of suitability within this range is unclear and dependent on further research. Resolving such uncertainty is seen as a priority task as it will provide a stronger basis for strategic research and control activities.

3 Submitted Paper

A risk assessment of the tropical wetland weed *Mimosa pigra* in northern Australia

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Introduction

Tropical wetlands are renowned for providing many values and benefits for people and for supporting a diverse and plentiful biota (Finlayson & Moser 1991, Dugan 1993). There is also increasing pressure on such wetlands as the pressure of human populations' increase and development impacts both the wetlands themselves and their catchments. Responses to such pressures have varied and as a consequence many wetlands have been lost and degraded.

For some invasive species, the extent of their invasion of wetlands has been described although often incompletely. In many instances the biology of the species may also be known or is being studied. Surprisingly, however, vital information on the ecological changes wrought by these species is often confined to a few isolated studies, if any, and/or anecdotal evidence. Economic analyses of the losses caused by pest species are also not common. Additionally, studies on the social and cultural impacts of weeds have not been done (Finlayson & Spiers 1999).

Given that weeds are an increasingly serious problem in tropical wetlands, there is a need for management prescriptions to be developed at several levels. Critically, for managers and users of wetlands, practical techniques and options are required that take into account local differences, priorities and resource levels. However, for localised effort to be effective a strategic framework is required that provides the necessary options and places particular weed infestations and their control into a regional perspective. A means of ensuring that the above aspects are not forgotten is through the adoption of ecological or wetland risk assessment procedures as the basis for effective weed management.

Within this context, information on the biology, ecology and management of *Mimosa pigra* (mimosa) has been collated and analysed in a risk assessment of the weed in the regional

context of northern Australia. Much of the information for this assessment has come from northern Australia where mimosa has been seen as a major weed for more than two decades, and has consequently attracted substantial research and management attention (Cook et al 1996, Finlayson et al 1998, Douglas et al 1998).

Project aims

The risk assessment was concerned with answering three main questions:

- What wetlands across northern Australia are at risk of invasion by mimosa; and
- What are the likely consequences of mimosa invading these wetlands?
- What management actions are being undertaken or need to be undertaken to minimise the risks of further mimosa invasion across northern Australia?

Approach

Wetland risk assessment framework

Over the last decade the concept of environmental risk assessment has developed and expanded from a narrow and precise analysis of quantitative ecotoxicological data to more general and qualitative/semi-quantitative analyses of environmental problems (van Dam et al 1999). This has led to the Ramsar Convention on Wetlands recommending a model for wetland risk assessment (Figure 1) coupled with advice on the deployment of early warning systems for detecting adverse ecological change in wetlands. The model provides guidance for environmental managers and researchers to collate and assess relevant information and to use this as a basis for management decisions that will not result in adverse change to the ecological character of the wetland. Our objective has been to provide a framework for informed decision-making. Thus, it is not prescriptive.

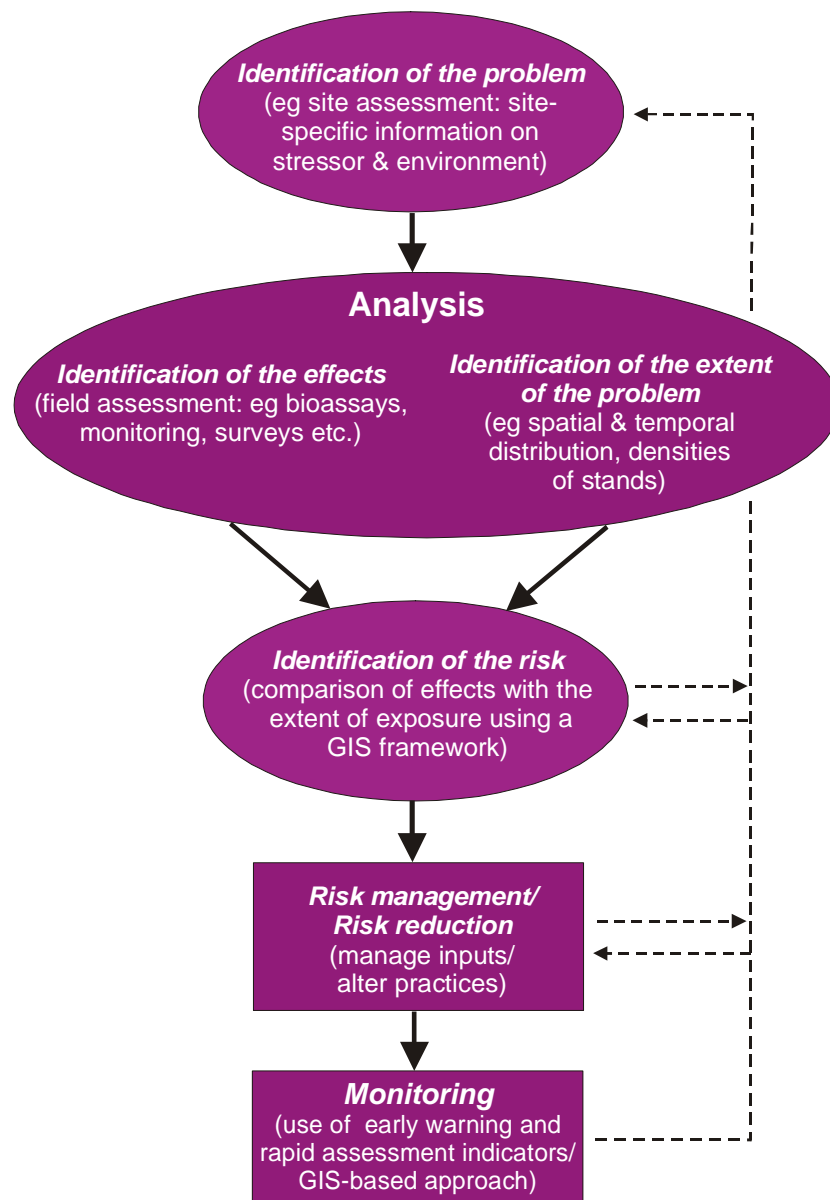


Figure 1 Wetland risk assessment framework (adapted from van Dam et al 1999)

Identification of the problem

Advantageous features

- Mimosa has many features that are generally considered 'advantageous' to a weed. These include:
- Mimosa can withstand the anaerobic conditions of inundation and flooded soils by sprouting adventitious roots near the surface where they can take up oxygenated water (Miller et al 1981).
- If chopped down mimosa will easily resprout from the stump (Wanichanantakul & Chinawong 1979). If mimosa is burnt, the foliage may become desiccated and fall, but up to 90% of mature plants and up to 50% of seedlings may regrow.

- The plants mature quickly and can set seed in their first year of growth (Lonsdale et al 1985). The seedpods are covered with bristles that enable them to adhere to animals and clothing, and to float on water for extended periods (Miller et al 1981). The seeds are also dispersed in soil and mud, adhering to vehicles and other machinery (Lonsdale et al 1985). Livestock and native animals sometimes graze mimosa plants (Miller 1988) and pass the seeds in their dung (Miller & Lonsdale 1987).
- The lifespan of the seeds in the ground depends greatly on their depth in the soil and the soil type, and may be up to 23 years in sandy soils (SE Pickering pers comm. in Lonsdale 1992).
- Seed rate production has been measured between 9000 and 12 000 m⁻² per year depending on the conditions (Lonsdale et al 1988). The most productive plant observed in the field produced about 220 000 seeds per year (Lonsdale 1992).
- Under the right conditions mimosa grows quickly at a rate of about 1 cm per day, and infestations can double in area in one year. It can also withstand droughts (Lonsdale 1993a).
- Mimosa has low nutrient requirements and consequently can grow within a wide range of soil types including nutrient poor sands, alluvial red and yellow earths, silty loams and heavy black cracking clays (Miller 1983).

Conceptual model

A conceptual model, based on known information on mimosa, and the potential ecological, cultural and socio-economic impacts is shown in figure 2. This formed the basis of the risk assessment.

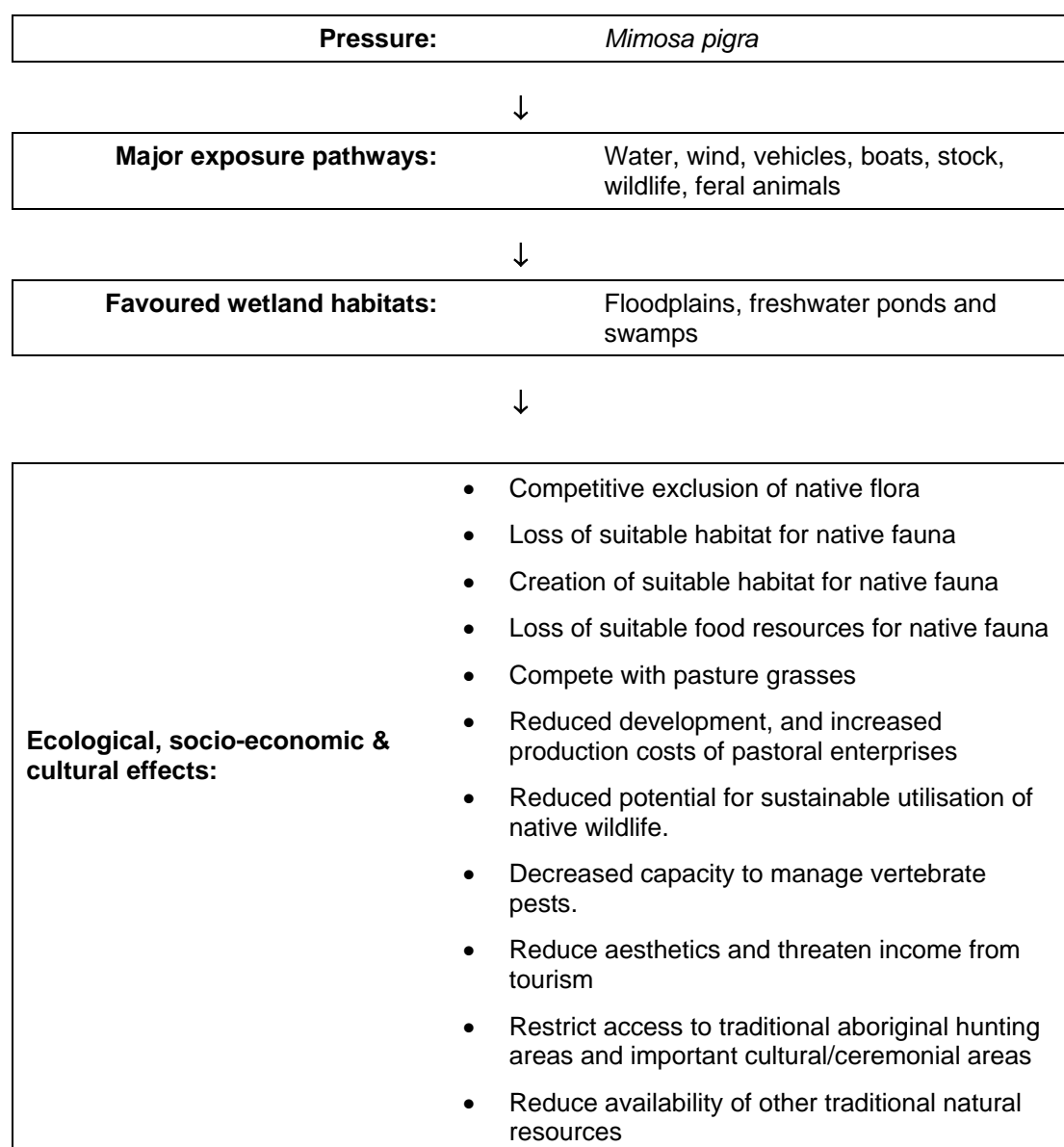


Figure 2 Conceptual model of *Mimosa pigra* in northern Australia

The potential effects of mimosa in northern Australia

Effects on ecosystems

Mimosa poses an enormous problem for conservation. In the Northern Territory, a largely intact natural landscape is being completely altered, with floodplains and swamp forest being covered by dense monospecific stands of mimosa, which have little understory except for mimosa seedlings and suckers (Braithwaite et al 1989). The severity of the impact of mimosa results from the following: (1) the high dominance by the invading species; (2) the gross change in vegetation structure; and (3) the conversion of a wide range of structural types of vegetation to a homogeneous tall shrubland (Braithwaite et al 1989).

Effects on native flora

Very few studies have been done to determine the effects of mimosa on native flora and fauna. Unless cited otherwise the following information is summarised from Braithwaite et al (1989).

Once established, mimosa is able to out compete native herbaceous layer vegetation for light moisture and nutrients, although the relative importance of these three factors has not been determined. A comparison of incident light measurements beneath the mimosa canopy at two study areas found that the sedge-land sites, received between 62% and 81% of the incident light when mimosa was present.

The *Melaleuca* dominated swamp forests fringing the floodplains have a rather open canopy and mimosa has also penetrated this habitat, preventing seedlings of the native forest trees from establishing themselves. Incident light measurements in this environment revealed that only 26% reached the ground flora with the additional presence of a mimosa canopy. Due to the demonstrated exclusion of native tree seedlings, it is proposed that the mature native tree canopy would eventually die out, and these swamp forests, like the sedgelands would become mimosa-dominated shrubland. The light measurements were taken during the dry season when the weed has a relatively sparse canopy. The impacts could possibly be exacerbated in the wet season, when the denser canopy of a lush mimosa thicket may prevent around 90% of the incident light from reaching the ground.

Effects on native fauna

Effects on native fauna result from the dramatic floristic and hydrological changes brought about by mimosa invasion. Braithwaite et al (1989) identified a number of species that were affected both adversely and favourably by mimosa invasion.

Birds

The abundance and species richness of terrestrial birds was positively related to the presence of mimosa. Waterbird abundance and species richness related negatively to mimosa. Treeless, species-rich, deep-water sedgeland is the prime habitat for waterbird populations, which rely on it for breeding and feeding. Further loss of this habitat through mimosa invasion would see an increasing negative impact on waterbird populations.

The main rookery sites for species such as ibis, spoonbills and cormorants, and the main roosting and nesting sites of most of the raptors are found in the wet forests (paperbark, riparian and monsoon). As for the sedgelands, destruction of these habitats would impact greatly on these and other similar bird species.

Mammals

Small mammals seemed to favour the dense mimosa canopy. The rodent (*Rattus colletti*) greatly favoured the Adelaide River mimosa sites, whilst the small insectivorous dasyurid (*Sminthopsis virginiae*) was particularly abundant in the Finnis River mimosa sites. Analyses showed that mammal abundance, related positively to mimosa cover/abundance and negatively to woody species diversity. It is thought that these small mammals will probably survive only as long as the mimosa occurs in patches from which they can make forays into the surrounding sedgelands for food (Lonsdale & Braithwaite 1988).

Reptiles and Amphibians

Mimosa appeared to provide an unsatisfactory microhabitat for lizards as few were found in mimosa-dominated areas. Amphibians showed no distinct pattern with respect to mimosa.

Vulnerable species

Fauna

There are a number of species that are rare and/or have a limited distribution that may be threatened via habitat loss as a result of mimosa infestation. Northern Territory species identified by the Northern Territory Parks and Wildlife Commissions' (PWCNT) list of threatened species, and the Environment Protection and Biodiversity Conservation (EPBC) Act (1999) include:

- false water-rat (*Xeromys myoides*)
- yellow-rumped Mannikin (*Lonchura flaviprymna*)
- grass owl (*Tyto capensis*)
- red goshawk (*Erythrorhynchus radiatus*)
- subspecies of yellow chat (*Epthianura crocea tunneyi*) – now recognised as endangered (Garnett & Crowley 2000)

Flora

The herbarium of the Parks and Wildlife Commission of the Northern Territory (PWCNT) identified nine rare or vulnerable floodplain species (Northern Land Council 1991). Some taxonomic uncertainty and data deficiency still exists with these species, thus only the following species were recommended for inclusion at this stage (Ian Cowie, pers. comm. 2002).

- *Aldrovanda vesiculosa*
- *Lemna tenera*
- *Monochoria hastata*
- *Goodenia quadrifida*

Species lists for Queensland and Western Australia are currently being compiled.

Socio-economic effects

In addition to adversely affecting native flora and fauna, mimosa can also impact upon the activities of humans. It interferes with stock watering, irrigation projects, tourism, recreational use of waterways and the traditional lifestyles of indigenous peoples. It can also smother pastures, reduce the available grazing areas and make mustering difficult (Miller et al 1981), thus reducing the development of pastoral enterprises in addition to increasing the production costs.

The potential extent of mimosa in northern Australia

Current distribution

In the Northern Territory mimosa is found in most major Top End river systems from the Victoria River in the west (approximately 50 km from the Western Australia border), to the Phelp River in southeast Arnhemland, and the Arafura swamp to the northeast. The size of infestations varies between river systems, with the largest infestations on the Adelaide, Mary and Finnis Rivers and in the Daly River/Port Keats ALT. In February 2001 a small infestation of 800 to 1000 plants was discovered at Peter Faust dam, approximately 25 km west of Proserpine (just below 20°S) in Queensland.

Preferred habitats and environmental conditions

Mimosa has been introduced into most tropical regions of the world where it grows in comparatively open, moist sites such as floodplains, coastal plains and riverbanks (Lonsdale et al 1985). In the introduced range mimosa infests naturally or anthropologically disturbed places such as reservoirs, canal and riverbanks, roadside ditches, agricultural land and floodplains. In its native range mimosa occupies similar habitats, especially in areas which have been disturbed, but usually occurs as small thickets or individual plants (Harley 1985).

Potential distribution in northern Australia

Mimosa has the potential to expand its area considerably in Australia. Miller (1983) made the conservative prediction that except around dams and watercourses mimosa would probably not be a major problem in regions with less than 750 mm annual rainfall (see inset of figure 3).

Earlier attempts at predicting the potential distribution of mimosa in Australia using CLIMEX (Sutherst and Maywald 1985) have been further refined by Kriticos (Agriculture & Resource Management Council 2001) by incorporating the climate information with growth and stress indices. The current boundaries for the habitat suitability classes are somewhat arbitrary, being based on experience associated with the more subjective descriptions of habitat suitability.

Comparison of the predicted distribution based on the rainfall zone and southern latitudinal limit (figure 3 inset) and the 'suitable' category of the predicted distribution based on the CLIMEX model (figure 3) indicated reasonable concordance. This is not unexpected as the soil moisture indices, for example, would correlate with the higher rainfall.

Greenhouse effect implications

There are a number of climate change projections for northern Australia, depending on which climate scenarios are used. The greatest uncertainties in projecting climate changes are associated with the politico-economic issues affecting future global emissions of greenhouse gases. It is predicted that temperatures and possibly summer rainfall will increase over northern Australia. It is also predicted that extreme events will change in magnitude and frequency more rapidly than the averages (eg more very hot days, fewer frosts, more floods and dry spells) (CSIRO 1998, IPCC 2001).

Under these scenarios, the potential range of mimosa is will likely be extended by climate change (Williams et al, 1995), with some inland areas becoming more favourable to its establishment. Increased flooding would most likely enhance its rapid spread; however sea level rises may inundate and destroy some existing infestations in low-lying coastal areas (DASETT 1990).

Identification of the risks

Wetlands at risk of mimosa infestation

Given the broad scale of this assessment (ie across northern Australia), information from 1:250 000 digital topographical data (Topo250K data - AUSLIG 1999) were used to identify relevant wetland areas as it was the only dataset which was consistently available across the whole of northern Australia at a standard, useful scale. The wetland habitats represented in the Topo250K data by the classifications '*Land subject to inundation*' and '*Swamp land*' were considered as representing suitable mimosa habitat. This was supported by the fact that the

majority of documented locations of mimosa in the NT occur on the above two wetland habitats.

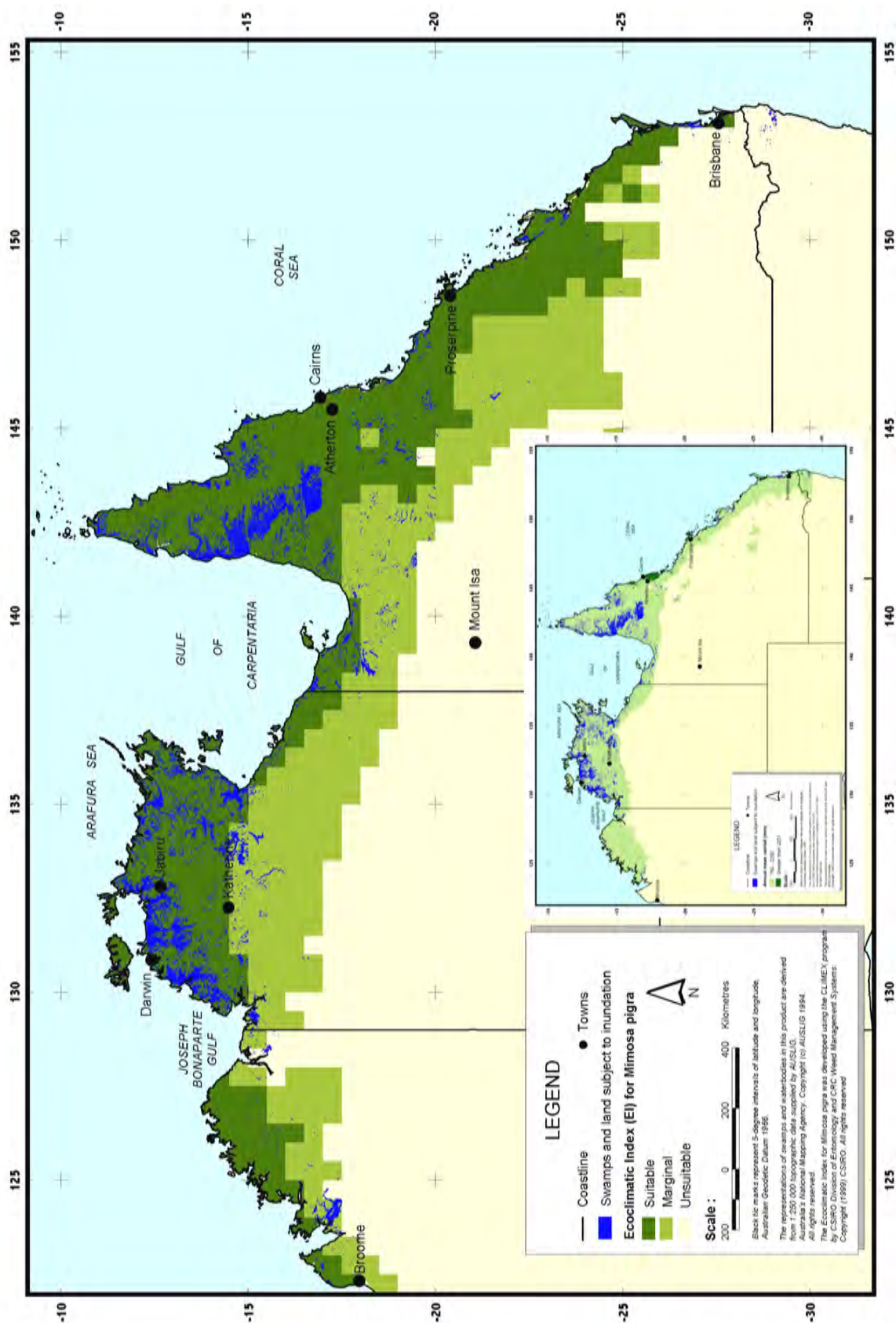
Using the ArcView desktop Geographic Information System (GIS), the wetland types were overlaid on the potential distribution of mimosa in northern Australia based on (i) the >750 mm rainfall zones and (ii) the CLIMEX model (figure 3). These represent the wetlands in northern Australia that may be at risk of infestation by mimosa. The area estimates are detailed in table. The rainfall model of potential mimosa distribution provided a slightly more conservative estimate of the wetland area potentially at risk of mimosa infestation than the 'suitable' category of the CLIMEX model, although the total wetland area using CLIMEX (ie wetland in 'suitable' + 'marginal' areas) was greater. However, further work is required to better define the largely arbitrary suitability categories used with the CLIMEX model.

Overall, it appears that approximately 4 000 000 ha of natural wetland habitat in northern Australia is potentially at risk of infestation by mimosa. However, it is acknowledged that actual habitat suitability will vary amongst these wetlands, and there will be areas that are more or less suitable for mimosa due to a range of factors including hydroperiod, soil type, local topography, plant communities and land use.

Table 1 Estimates of wetlands potentially at risk of mimosa infestation using two predictive models of mimosa distribution

Potential distribution model	Category	Wetland area (ha)*	Total (ha)
> 750 mm rainfall + southern latitudinal limit of 29°S	750 – 2250 mm	4 216 855	4 231 154
	>2250 mm	14 299	
CLIMEX	Suitable	3 959 800	4 628 000
	Marginal	668 200	

* wetlands are represented by 'land subject to inundation' and 'swamp land' from 1:250K topographical maps (AUSLIG 1999.)



Nationally and internationally important wetlands

Within the wetland areas identified as being potentially at risk, there exist a number that are of particular ecological importance (Environment Australia 2001).

- In the Northern Territory there are 21 important wetlands within the northern most bioregions where mimosa is present and still spreading (ie above 16°S). Three of the 21 sites are internationally important Ramsar listed sites that include Kakadu National Park stages I and II, parts of stage III and the Coburg Peninsular. Twelve of the 21 sites already have mimosa infestations varying from minor to extensive.
- In Queensland there are 121 important wetlands within the potential range of mimosa. Four of the wetlands are Ramsar listed sites, and although they are listed as coastal areas, all have some freshwater habitat.
- In Western Australia there are 13 important wetlands within the predicted range of mimosa. Four of these are Ramsar listed sites.

Land tenure implications

Land tenure may influence the likelihood of mimosa actually arriving at an area, and subsequently on the ease of establishment. It may also determine how the consequences of the threat and impacts of mimosa are perceived.

For the purposes of this risk assessment three broad types of land use are identified:

- Cultural – Aboriginal lands and culturally or historically significant areas
- Ecological – heritage, national park and other conservation areas
- Economic – pastoral/agricultural lands and areas of concentrated tourism

There are obviously overlaps among these broad categories. Culturally significant areas can have both economic value, such as supporting enterprises for Aboriginal economic independence, and gain revenue from tourism. Ecological areas are also often a source of revenue from tourism, and thus have an economic value, while many, including nationally important wetlands, also have considerable pastoral activity. There are also sites of cultural significance within ecological areas, with KNP being a prime example.

Mechanisms of seed transport

Within the scope of this risk assessment it is only possible to generalise how different land tenure may influence the likelihood of establishment and colonisation of mimosa. To give some examples – pastoral properties could be considered to be at high risk if there is significant movement of stock, vehicles and machinery to and from the property. Areas of concentrated tourism could also be at high risk if there is a large movement of vehicles and in particular fishing boats. Aboriginal lands could be at higher risk if animals were imported for food or for stocking toward an economic enterprise. All of the land tenure types are at risk from seed importation by vehicles as both the Aboriginal and European population of northern Australia is highly mobile and vehicles (in particular four wheel drives) regularly traverse between river catchments. All areas are also at risk as feral and native animals (including waterbirds) move between catchments.

Factors affecting colonisation

The major factor that affects the colonisation of mimosa is disturbance. Once the native or pasture vegetation is removed, mimosa seedlings can readily establish in the absence of competition. Disturbance could be caused by feral or domesticated animals, fire, agriculture or the type of disturbance associated with areas such as roadsides, quarries, logging areas and high-use recreation. Throughout the NT, mimosa largely infests and continues to colonise areas that are currently, or have been in the past, highly disturbed by feral or domesticated animals. Both Queensland and northern WA also have vast pastoral cattle properties, and feral animals including buffalo, pigs, donkeys and horses remain in high numbers throughout much of northern Australia. Table 2 outlines the areas of land use types within the predicted range of mimosa as identified by the two models.

Table 2a Areas of land use types within the predicted range of mimosa based on rainfall

Land use	Area within lower rainfall zone (ha)	Area within higher rainfall zone (ha)	Total area (ha)
Aboriginal	1 311 214	1 775	1 312 989
Forestry	16 143	96	16 239
Nature conservation	519 806	3 023	522 829
Private lands	2 196 863	8 270	2 205 133
Reserved Crown	28 022	166	28 188
Vacant Crown	51 673	426	52 099

Table 2b Areas of land use types within the predicted range of mimosa based on CLIMEX

Land use	CLIMEX – Suitable category (ha)	CLIMEX – Marginal category (ha)	Total area (ha)
Aboriginal	1 316 176	10 476	1 326 652
Forestry	15 165	< 1	15 165
Nature conservation	511 808	7 735	519 543
Private lands	1 963 397	61 1501	2 574 898
Reserved Crown	18 175	21 615	39 790
Vacant Crown	49 744	5 915	55 659

Consequences of the threat and impacts of mimosa

Although mimosa has broad ranging impacts, the specific consequences of these are perceived in different ways according to the type of land use of a given area. These perceived consequences are listed in table 3.

Table 3 Perceived consequences of the impacts of mimosa for different types of land use

Land use	Consequences
Cultural	<ul style="list-style-type: none">➤ reduction of species and numbers available as traditional foods➤ restriction of access to traditional hunting and gathering grounds➤ contamination of sacred, historical and other culturally important sites➤ reduced capacity for economic independence of Aboriginal people
Ecological	<ul style="list-style-type: none">➤ reduction in biodiversity of flora and fauna➤ loss of habitat for feeding, breeding and roosting of birds and bats➤ reduced status as a nationally important or Ramsar wetland➤ restriction of access to watering holes for native animals➤ provides protective habit for feral pigs
Economic	<ul style="list-style-type: none">➤ reduces available grazing land➤ restriction of access to watering holes for stock➤ interferes with irrigation projects eg access and siltation➤ restricts recreational use of waterways eg fishing and tourism

Uncertainty and information gaps

Extent of mimosa

- The 1:250 000 scale topographic map information used in this assessment represents a broad view of identifying the wetland habitats in question. 1:50 000 data for example, may define some of the smaller waterbodies.
- For the purposes of this risk assessment, the classifications of *land subject to inundation* and *swamp land* have been used as suitable mimosa habitat. There may be other suitable areas such as rainforest margins, riparian zones and areas under irrigation that would not be represented by the classifications used. In addition, it cannot be assumed that all areas within these classifications will be suitable mimosa habitat, due to factors including hydroperiod, soil type, local topography, plant communities and land use. Greater understanding of these factors would need to be gained in more detailed, site-specific assessments.
- There are also assumptions about what land use practices promote invasion and/or establishment of mimosa, and to what extent. The issue of disturbance is probably the main issue, with natural versus non-natural disturbance further exacerbating the uncertainty.
- While the current distribution of mimosa in the NT is reasonably well known, the actual area is uncertain and probably misquoted. The majority of mimosa infestations

have been recorded, however there is a need for detailed mapping of the distribution and the density of the stands.

- Another uncertainty is the precise relationship between climate change and the distribution of mimosa. It is possible to hypothesise about the likely influence of climate change based on projected changes in temperature, rainfall, seasonal and interannual variation and extreme events, but the actual effect and extent of these remains unclear. A sensitivity analysis using CLIMEX may be informative.

Effects of mimosa

- A lack of quantitative data on the effects of mimosa on the native flora and fauna. The aspects of severe habitat alteration are acknowledged but the resulting effects on flora and fauna seem to be poorly understood.
- A lack of quantitative data on the economic losses caused by mimosa.
- The impacts on social and cultural values are recognised, but no studies have been done to determine the effects.
- The assumptions of land use practices influencing the extent of mimosa, also apply to the effects. Again, due to the overlaps in land use, it is difficult to be certain what the effects and consequences of the impact will be and how the tenants will perceive them.
- There is scant information on the impacts of the control methods used for mimosa. The main concern here is for the large volumes of herbicides that have been used for control in the NT.

Management implications

- Even prior to the discovery of mimosa at Peter Faust Dam in Queensland there has been increasing interest in the mimosa problem by the Queensland and WA Governments. Large areas of Queensland and WA are potentially at risk of mimosa invasion and many of these areas are often remote, difficult to access and lowly populated.
- The Mimosa Strategic Plan (Agriculture & Resource Management Council [2001]) has evolved over many years and represents the planning strategies to prevent further spread of mimosa in northern Australia and reduce the impacts of current mimosa infestations, coordinating Government and Aboriginal agencies from the NT, Queensland and WA as well as the CSIRO. The management programs in the strategic plan formed the basis of the recent funding submission to the National Weeds Program, where the seven components of the submission were developed to address the critical gaps in knowledge and operational capability to fully implement the programs.
- The four programs of the mimosa strategic plan are prioritised to:
- inform and educate stakeholders and the community about mimosa, its adverse impacts and the strategy for its control;
- prevent mimosa from spreading to and impacting on new areas;
- further develop the knowledge base and methods for effective and efficient management of mimosa; and
- reduce the current adverse impacts of mimosa infestations.

Information and education

Education and awareness is given the highest priority as it is the most powerful and cost effective form of weed management. In the NT, members of the public have reported most of the new infestations. Very few new infestations have been discovered by systematic surveys. Perhaps the most significant information and education program on Aboriginal owned lands has been the recent development of groups of indigenous rangers across the Top End of the Northern Territory. Landholders and land managers have primary responsibility for weed management and they need to be trained in the eradication of new outbreaks and to develop effective weed management plans. Communicating the best land management practices that reduce the susceptibility of an area to mimosa invasion is also essential.

Prevention of spread

Perhaps the most important aspect of the prevention of spread is the ability to locate and eradicate satellite outbreaks before they become unmanageable. For areas not currently surveyed, increased surveys are planned for the state/Territory border areas at risk and other high risk areas at the eastern and western limits of the current mimosa distribution. The risk of seed spread can be greatly reduced by ensuring that transport corridors remain mimosa free and livestock to be transported are quarantined for several days. Vehicle, boat and machinery wash down facilities may also be appropriate for some areas. It is important to note that the prevention of spread is largely dependent on the success of information and education programs.

It is also important to decrease the susceptibility of the land to mimosa invasion and establishment. This method of preventative management usually utilises the competitive qualities of wetland plant communities, and of course reiterates the needs for best land management practices as mentioned earlier.

Research and development

Much of the research and development program focuses on the efficiency, methodology improvement and impact assessment of the control methods. The issues that are more relevant to this risk assessment are those that deal with research into the aspects of mimosa ecology that will ultimately aid in reducing the spread. These include, for example, the factors that limit distribution, causes of invasiveness, modes of dispersal, revegetation and competition species, and vulnerable habitats. As stated earlier, site-specific assessments of vulnerable habitat types involving factors such as plant communities, topography, hydrology, soil type and land use can be used as a valuable predictive tool for land management. Further research into the ecological impacts of mimosa control methods, in particular the use of herbicides, is also needed to assess the risks. Other important areas of proposed research include: 1) how to integrate grazing onto post mimosa controlled floodplains; 2) determine the factors that affect successful revegetation; and 3) how the timing of burning affects mimosa management.

Impact reduction

By definition, the impact reduction program is primarily concerned with the control of mimosa in those catchments where large stands already occur, thus reclaiming the land for its intended use, and as such is largely beyond the scope of this risk assessment. Many thousands of hectares of land have been reclaimed due to the efforts of the various NT government agencies, Aboriginal land councils/associations and other private landowners or leaseholders. Although the risk assessment doesn't detail control options, the biological control program

should be mentioned in the context of long-term management. The program has been running for over 20 years and in that time 13 agents have been released and more are presently being studied. Although the results have been variable, four of these have become effective predators of mimosa and are showing some impact on the population. Apart from potential ecological impacts, traditional control methods are expensive, as continual follow-up control is needed in nearly all circumstances. For a limited amount of investment, biological agents can ultimately maintain mimosa at a level where the impact is lessened or minimal. Spread and growth of infestations can be greatly reduced and the technique is ideal for large and small remote and inaccessible infestations.

Conclusions

Other than the considerable area of mimosa infestation in the NT (estimated at about 80 000 ha), a great number of other wetlands of northern Australia, including nationally and internationally important wetlands remain under threat from mimosa. The total area is estimated at between 4.2 and 4.6 million ha. The actual area of suitability within this range is unclear and dependent on further research into the characteristics and land management practices of the habitats. Climate change due to the greenhouse effect will most likely see an increase in localised spread of mimosa and expansion of the predicted potential range in northern Australia.

Because the current area of mimosa in the NT is uncertain, it cannot be assumed that the available resources and control strategies are keeping pace with mimosa. The expanding human population and advancing climate change will most likely result in an increase in the spread of mimosa. Without maintaining or increasing resources for mimosa management, it will continue to spread throughout the NT and eventually spread to parts of WA and Queensland. In addition to the considerable cultural and conservation value impacts, the NT loses a component of its primary industry, tourism and recreational activity revenue every year that mimosa is present. Similar infestation in other areas of northern Australia would likely see similar impacts.

The current estimated distribution of mimosa represents only about 1.8 % of the estimated potential distribution. Although the control of large infestations is seen as important from a local perspective, the prevention of spread to clean areas must be given the highest priority. The preventative strategies of education and awareness, control of the deliberate or accidental movement of plants and seeds, surveillance and early intervention and the minimisation of ecological disturbance are essential in achieving the prevention of further spread.

References

- Agriculture & Resource Management Council of Australia & New Zealand, Australian & New Zealand Environment Council and Forestry Ministers 2001. *Weeds of National Significance Mimosa (Mimosa pigra) strategic plan*. National Weeds Strategy Executive Committee, Launceston.
- Australian Surveying and Land Information Group (1999). *GEODATA TOPO-250K ARC/INFO Application Form Guide*. Vector, topographic data for GIS. Source scale 1:250,000. Australian Surveying and Land Information Group, Department of Industry, Sciences and Resources, Canberra.
- Braithwaite RW, Lonsdale WM & Estbergs JA 1989. Alien vegetation and native biota: The spread and impact of *Mimosa pigra*. *Biological Conservation* 48, 189–210.

- Cook GD, Setterfield SA & Maddison JP 1996. Shrub invasion of a tropical wetland: implications for weed management. *Ecological Applications* 6(2), 531–537.
- CSIRO 1998. Climate Change under Enhanced Greenhouse Conditions in Northern Australia, third annual report 1996 – 1997. Technical supplement to the final report for the three year consultancy. Commonwealth Scientific and Industrial Research Organisation, Division of Atmospheric Research, Aspendale, Victoria, Australia 93 pp.
- DASETT 1990. *Mimosa Pigra* control, Northern Territory Report for the Department of the Arts, Sport, the Environment, Tourism and Territories. Dames and Moore International.
- Douglas M, Finlayson CM & Storrs MJ 1998. Weed management in tropical wetlands of the Northern Territory, Australia. In *Wetlands in a dry land: Understanding for management*. Environment Australia, Biodiversity Group, Canberra ACT, 239–251.
- Dugan P (ed) 1993. *Wetlands in Danger*. IUCN – The World Conservation Union, Mitchell Beazley, London, UK, 191 pp.
- Environment Australia 2001. *A Directory of Important Wetlands in Australia*. 3rd edn, Environment Australia, Canberra.
- Finlayson CM & Moser M (eds) 1991. *Wetlands*. International Waterfowl and Wetlands Research Bureau, Oxford UK 224 pp.
- Finlayson CM & Spiers AG (eds) 1999. *A compendium of information for managing and monitoring wetlands in tropical Australia*. Supervising Scientist Report 148, Supervising Scientist, Canberra.
- Finlayson CM & Spiers AG (eds) 1999. *Techniques for enhanced wetland inventory and monitoring*. Supervising Scientist Report 147, Supervising Scientist, Canberra.
- Finlayson M, Thurtell L, Storrs M, Applegate R, Barrow P & Wellings P 1998. Local communities and wetland management in the Australian wet-dry tropics. In *Wetlands in a dry land: Understanding for management*. Environment Australia, Biodiversity Group, Canberra ACT, 299–311.
- Garnett ST & Crowley GM 2000. *The action plan for Australian birds 2000*. Environment Australia, Canberra.
- Harley KLS 1985. Suppression of reproduction of woody weeds using insects which destroy flowers or seeds. *Proceedings of the 6th International Symposium on Biological Control of Weeds*, Vancouver 1984, 749–756.
- IPCC 2001. Climate change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on climate change. eds McCarthy JJ, Canziani OF, Leary NA, Dokken DJ & White KS, Cambridge University Press, Cambridge, United Kingdom and New York USA, Chapter 10, 591–640.
- Lonsdale WM & Braithwaite RW 1988. The shrub that conquered the bush. *New Scientist* 1364, 52–55.
- Lonsdale WM 1992. The Biology of *Mimosa pigra* L. In *A guide to the management of Mimosa pigra*, ed KLS Harley, Commonwealth Scientific and Industrial Research Organisation, Canberra, 8–32.
- Lonsdale WM 1993a. Rates of spread of an invading species- *Mimosa pigra* in northern Australia. *Journal of Ecology* 81, 513–521.

- Lonsdale WM, Harley KLS & Gillett JD 1988. Seed bank dynamics of *Mimosa pigra*, an invasive tropical shrub. *Journal of Applied Ecology* 25, 963–976.
- Lonsdale WM, Harley KLS & Miller IL 1985. The biology of *Mimosa pigra*. Proceedings (2), 10th Asian Pacific Weed Science Society Conference, Chiangmai Thailand, 484–490.
- Miller IL & Lonsdale WM 1987. Early records of *Mimosa pigra* in the Northern Territory. *Plant Protection Quarterly* Vol 2(3), 140–142.
- Miller IL 1983. The distribution and threat of *Mimosa pigra* in Australia. Proceedings of an International Symposium *Mimosa pigra* Management, Chiangmai Thailand, International Plant Protection Centre, Corvallis, 38–50.
- Miller IL 1988. Aspects of the biology and control of *Mimosa pigra* L. Msc Agr Dissertation, University of Sydney, Sydney, Australia.
- Miller IL, Nemestothy L & Pickering SE 1981. *Mimosa pigra* in the Northern Territory. Technical Bulletin No 51, Northern Territory Department of Primary Production, Darwin.
- Northern Land Council (NLC) 1991. Proposal to control *Mimosa pigra* on Aboriginal lands in the Northern Territory by chemical and mechanical methods. Public Environment report.
- Sutherst RW & Maywald GF 1985. A computerised system for matching climates in ecology. *Agriculture, Ecosystems and Environment* 13, 281–299
- van Dam RA, Finlayson CM, & Humphrey CL 1999. Wetland risk assessment: A framework and methods for predicting and assessing change in ecological character. In CM Finlayson & AB Spier (eds), *Techniques for enhanced wetland inventory and monitoring*. Supervising Scientist Report 147, Supervising Scientist, Canberra, 83–118.
- Wanichanantakul P & Chinawong S 1979. Some aspects of the biology of *Mimosa pigra* in northern Thailand. In *Proceedings of the Seventh Asian-Pacific Weed Science Society Conference*, Sydney 1979, 381–383.
- Williams RJ, Cook GD, Braithwaite RW, Anderson AN & Corbett LK 1995. Australia's wet and dry tropics: identifying the sensitive zones. In *Impacts of climate change on ecosystems and species: terrestrial ecosystems*, eds Pernetta JC, Leemans R, Elder D & Humphrey S, IUCN, Gland Switzerland, 39–65.

4 Slides from PowerPoint presentation

A risk assessment of the tropical wetland weed *Mimosa pigra* in northern Australia

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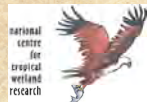
- A published SSR of the risk assessment will soon be available

The risk assessment attempts to answer:

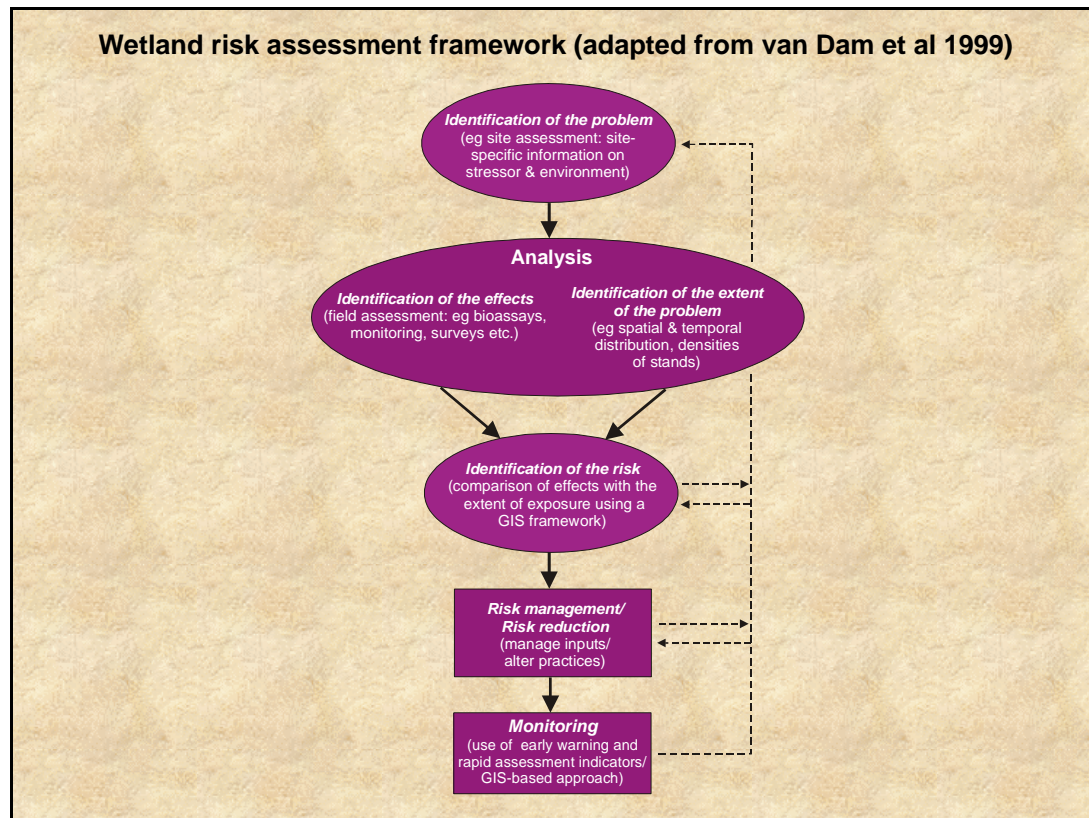
What wetlands across northern Australia are at risk of invasion by mimosa; and

What are the likely consequences of mimosa invading these wetlands?

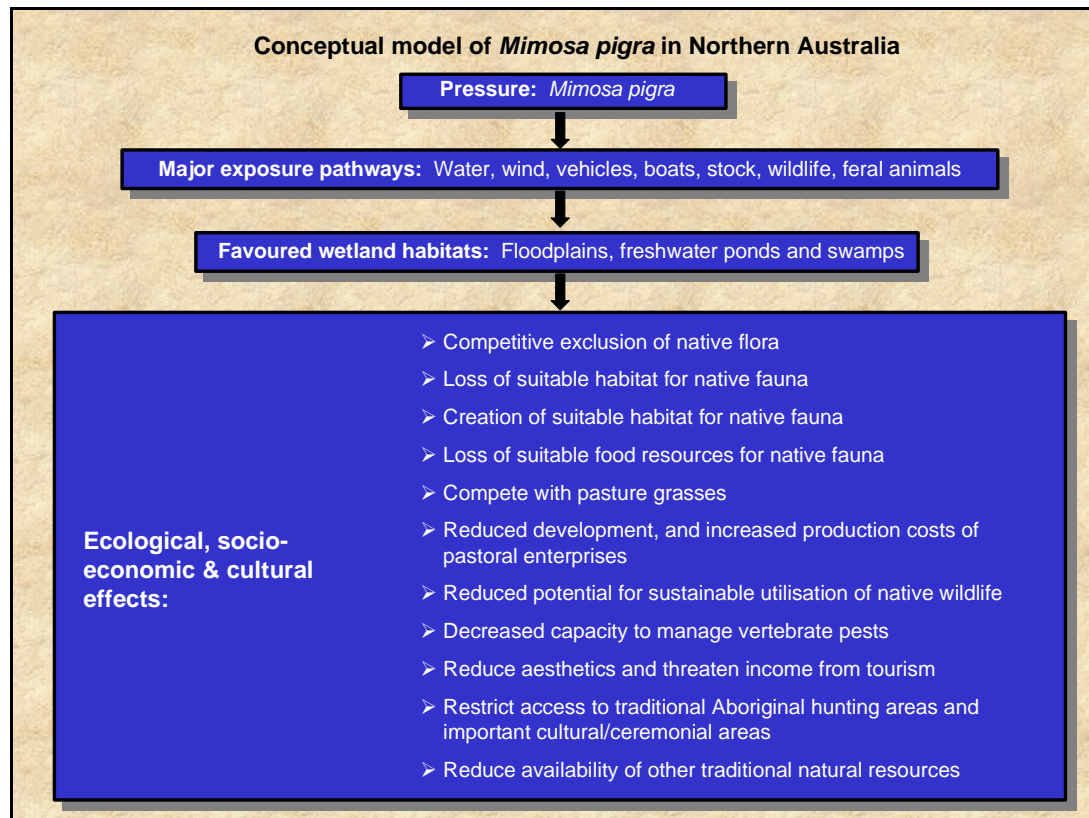
What management actions are being undertaken or need to be undertaken to minimise the risks of further mimosa invasion across northern Australia?



- The aims of the risk assessment and what it attempts to answer....



- This is the approach used
- Being a risk assessment framework developed by eriss and formally accepted by the ramsar convention
- It represents a standardised approach to risk assessment using logical steps to collate and assess relevant information to use as a basis for management decisions



- This conceptual model summarises what is covered in more detail in the risk assessment.
- There is a considerable amount of information available covering the first three sections here..... And indeed some good work has been done in the area of ecological effects.....
- however, based on manuscript comments I've received there seems to be some controversy regarding the need to do more on this topic
- pause
- With regard to the socio-economic and cultural impacts - there seems to be little quantitative data available

Vulnerable species in the Northern Territory

Fauna

False Water-rat

Yellow-rumped Mannikin

Grass Owl

Red Goshawk

Yellow Chat

Flora

Aldrovanda vesiculosa

Lemna tenera

Monochoria hastata

Goodenia quadrifida

- Any risk assessment should cover vulnerable species, and these are some that could be at risk based on their inclusion in the PWCNT list of threatened species and/or the EPBC act
- Most of these species have limited distributions within mimosa affected floodplains.... and it's possible that only extensive mimosa coverage over the longer term might see any impacts here - but it's important to note that there is still considerable data deficiency and taxonomic uncertainty, particularly with the flora
- Also remember that habitat loss due to mimosa might exacerbate other existing and potential threats such as feral cats, salt intrusion and cane toads
- The subspecies of yellow chat (...tunneyi) is worthy of note as it is now recognised as endangered, and concern has been expressed about loss of its habitat
- I should add that the next task is to incorporate any QLD species of concern

Potential extent of mimosa

- Current Distribution
- Invasion rates and pathways
- Preferred habitats and environmental conditions

climate

geomorphology and soils

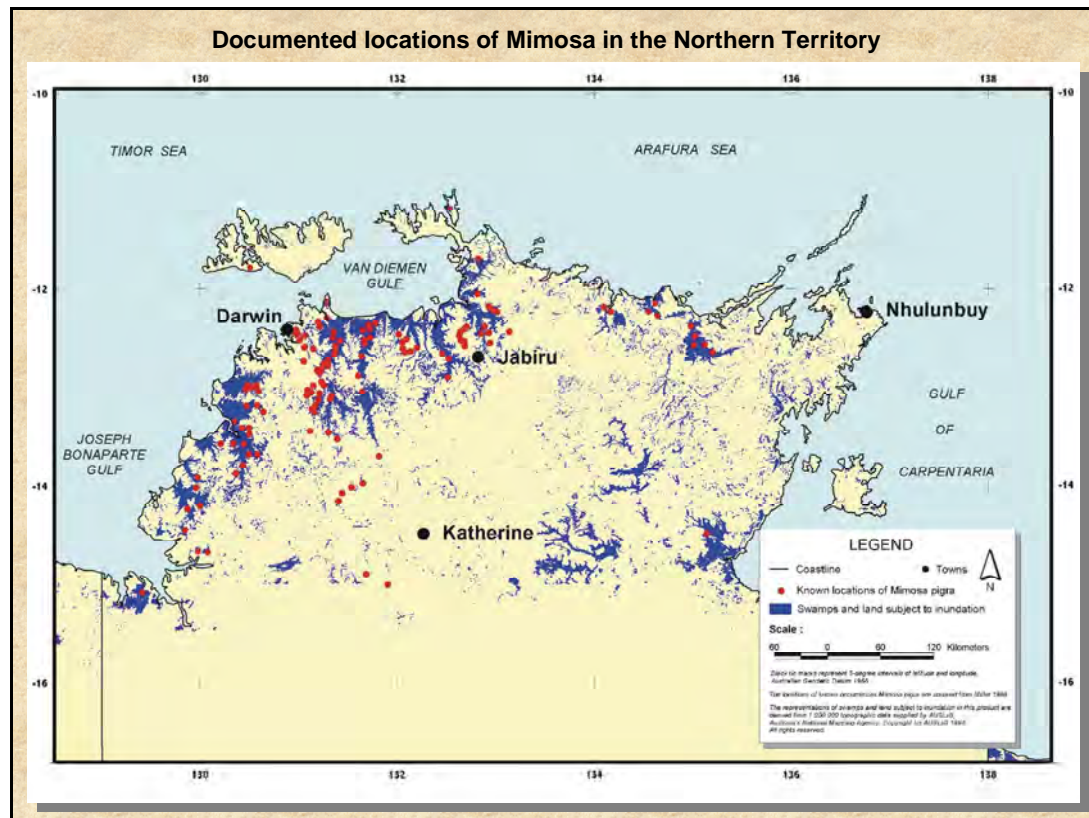
inundation

salinity

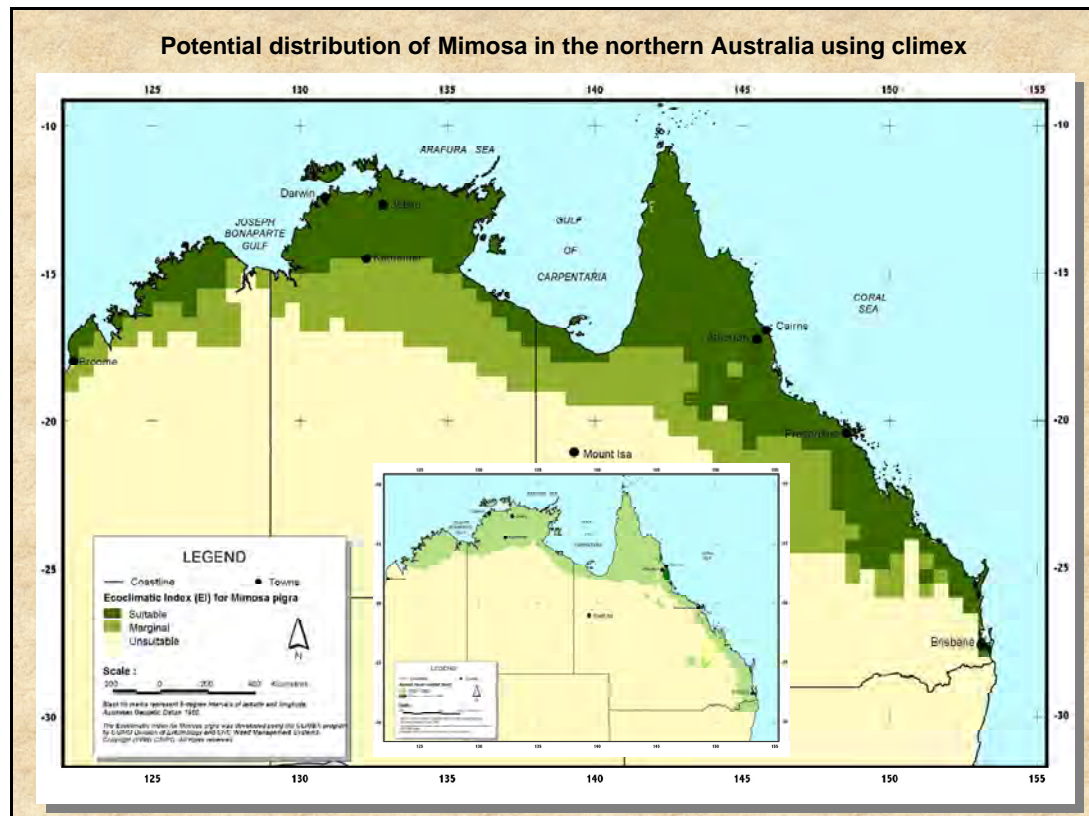
topography

fire

- When dealing with potential extent we need information on a number of things
- We know the current distribution of mimosa but the actual area of infestation which is still often quoted at around 80 000 ha, is not based on quantitative data
- The risk assessment outlines what is known about the following points here, and acknowledges that some information gaps still remain



- For those of you not familiar with the current distribution of mimosa - this shows the past and present documented locations
- I got a quick update from Guy McSkimming last week, and he thought that it looked up to date, but I'll certainly welcome any comments
- The Queensland infestation near Proserpine is omitted here, not because we don't care about it, but because its inclusion made these areas of infestation indiscernible on the larger map



- So onto the potential distribution.....
- Climex is just one of a number climate modelling programs that examine the potential distribution of a species
- The legend is a bit small here, but the dark green area is classified as the suitable zone, and the lighter green is considered marginal suitability
- Some of the climex input values used are based on known information and some are based on anecdotal info or calculated guesses
- For reference, I'll just bring in Ian Millers earlier prediction based on >750mm annual rainfall
- As you can see, it concurs pretty well with the suitable climex zone which isn't that surprising based on the moisture indices correlating with the higher rainfall

Climate change implications

- Increase in temp of between 0.3 – 1.0°C (coastal) and between 0.4 to 1.4°C (inland) by 2030 (more than double this by 2070)
- Increases in summer rainfall of between 2 – 12 % by 2030 (between 4 – 30 % by 2070)
- Extreme events predicted to change in magnitude and frequency more rapidly than the averages eg:
 - more very hot days
 - fewer frosts
 - more floods and dry spells

- Just before we get to the risks, a quick mention of how climate change may influence the potential distribution
- There are a number of climate change projections depending on which scenarios are used
- In a brief summary we could see some of these effects
- Under these conditions the potential range of mimosa could be expected to extend..... and note that the effects of the last point here could most likely assist seed distribution and germination
- As we speak, Darren is looking at climex in relation to climate change and we hope to include this information in the final report
- Information based on IPCC 3rs assessment i.e. most recent scenarios

Five major wetland categories in northern Australia as defined by Finlayson & Spiers (1999)

Coastal salt marshes

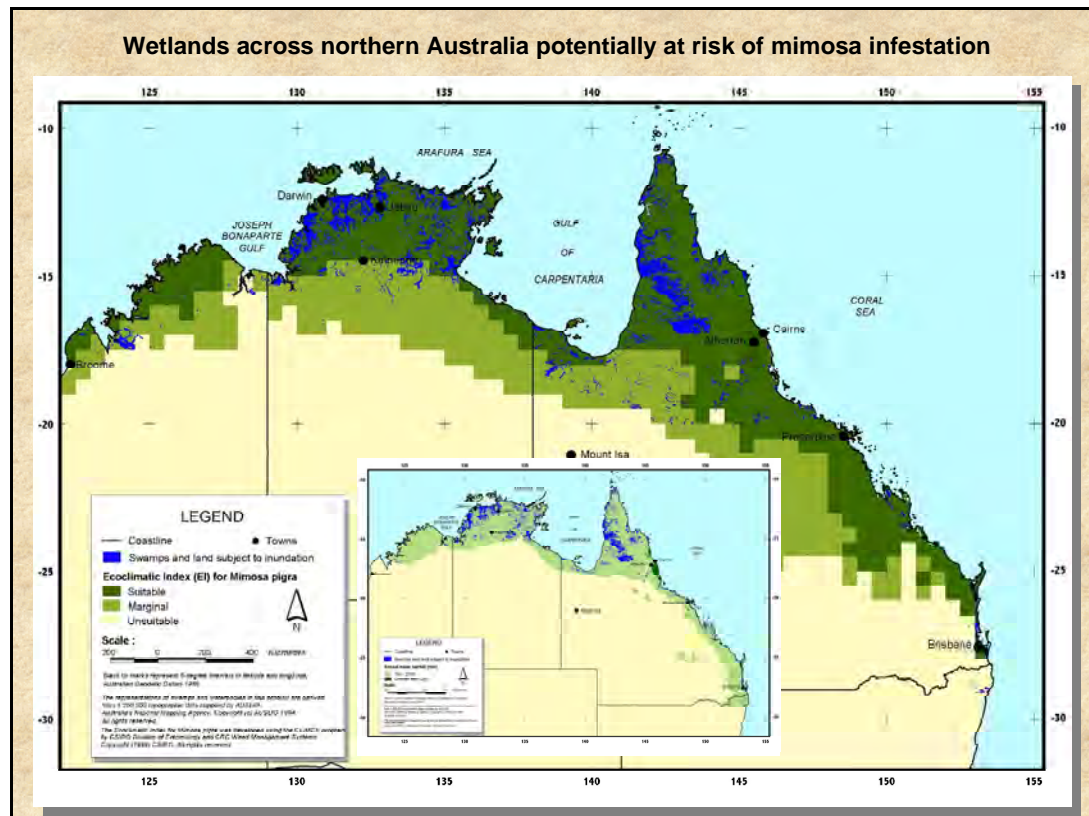
Mangrove swamps

Freshwater Lakes

Floodplains

Freshwater ponds and swamps

- OK – so onto the risks
- Across the many data sources that are available, there can be up to 47 different classes of wetland in northern Australia
- We chose the topographic 1 in 250 000 dataset, as it was the only one that is consistently available across the whole of northern Australia at a standard, useful scale
- The classifications of '*Land subject to inundation*' and '*Swamp land*' were chosen as representing suitable mimosa habitat. (i.e. the last 2 classes shown here)
- This choice is supported by the fact that the majority of mimosa infestations already occur on these 2 wetland types



- Those classifications of wetland just mentioned that lie within the potential climex distribution are shown here in blue
- For the purposes of the next slide, I'll just bring in the wetlands within the >750 mm rainfall zone potential distribution

Estimated areas of wetlands in northern Australia potentially at risk of mimosa

Potential distribution model	Category	Wetland area (ha)	Total (ha)
>750 mm rainfall + southern latitudinal limit of 29°S	750 – 2250 mm	4 216 855	4 231 154
	>2250 mm	14 299	
CLIMEX	Suitable	3 959 800	4 628 000
	Marginal	668 200	

- Ok – so what does that mean in terms of area
- This table shows the wetland areas within the two potential distribution models
- Of course, it is acknowledged that the actual habitat suitability of these wetlands will vary due to a range of factors such as hydroperiod, soil type, local topography, plant communities and land use, to name a few
- Greater understanding of these factors would need to be gained in more detailed, site-specific assessments

Nationally and internationally important wetlands

Northern Territory

21 (of 33) lie within potential distribution, 12 already have mimosa infestations varying from minor to extensive, 3 are Ramsar listed sites

Queensland

126 (of 181) lie within potential distribution, 4 are Ramsar sites

Western Australia

13 (of 120) lie within potential distribution, 5 are Ramsar sites

- As per the vulnerable species mentioned earlier, it is important to recognise the status of particular wetlands...
- Within the predicted range of mimosa there are a number of important wetlands that have been selected using criteria outlined in the directory of important wetlands (at a national level) and the list of wetlands of international importance (these being the Ramsar sites)
- Some of these wetlands here are coastal but all have some freshwater components ranging from small to extensive
- The number in parentheses here is of course the total of important wetlands within the territory or state

For the purposes of this risk assessment, three broad land use categories are identified:

Cultural – Aboriginal lands and culturally or historically significant areas

Ecological – heritage, national park and other conservation areas

Economic – pastoral/agriculture lands and areas of concentrated tourism

- Ok.... Some land use issues...
- The type of land use may greatly influence the likelihood of mimosa actually arriving at any given area and subsequently on the ease of establishment
- Three categories are defined here and obviously there will be overlap of land use amongst them
- For example, some of the nationally important wetlands, as mentioned earlier, that could be considered as ecological land use, actually sustain pastoral activities
- And KNP is a prime example of an overlap between ecological and cultural land use

Areas of land use within the predicted range of mimosa

Land use	Area within lower rainfall zone (ha)	Area within higher rainfall zone (ha)	Total area (ha)
Aboriginal	1 311 189	1 775	1 312 964
Forestry	16 141	102	16 243
Nature conservation	468 172	3 023	471 195
Private lands	2 196 813	8 272	2 205 085
Reserved Crown	28 018	165	28 183
Vacant Crown	51 672	426	52 098

- This slide shows the areas of different land uses of the wetlands within the >750 mm rainfall distribution
- The rainfall distribution model was used here because the data was easier to extract than from the climex model, but suffice to say that the values across the two models are fairly similar
- We can see here that Aboriginal lands represent about 30% of the total area and private lands represent about 50% of the total

Land use implications

Mechanisms of seed transport

- Animals – mud, dung, fur
- Vehicles and machinery
- Movement of earth and sand
- Waterbirds
- Deliberate introductions

Factors affecting colonisation

- Disturbance
 - Feral or domesticated animals
 - Agriculture
 - Roadsides, quarries, logging areas, high-use recreation

- The risk assessment discusses some of these factors in relation to land use and how different land uses can influence spread and colonisation
- One simple example is, those wetlands that sustain pastoral activities could be at greater risk due to the movements of stock and vehicles, compounded with a greater level of ground disturbance
- Heavily infested rice paddies in Asia are an example of how agriculture can affect colonisation
- There are at least 2 observations where waterbirds appear to have been responsible for seed spread... and with potential vectors of spread like this...it makes preventative weed management pretty difficult
- Another thing to consider here, is of course the proximity of a clean area to an existing infestation

Perceived consequences of the impacts of mimosa for different land uses

Land use	Consequences
Cultural	<ul style="list-style-type: none"> ➤ reduction of species and numbers available as traditional foods ➤ restriction of access to traditional hunting and gathering grounds ➤ contamination of sacred, historical and other culturally important sites ➤ reduced capacity for economic independence of Aboriginal people
Ecological	<ul style="list-style-type: none"> ➤ reduction in biodiversity of flora and fauna ➤ loss of habitat for feeding, breeding and roosting of birds and bats ➤ reduced status as a nationally important or Ramsar wetland ➤ restriction of access to watering holes for native animals ➤ provides protective habit for feral pigs
Economic	<ul style="list-style-type: none"> ➤ reduces available grazing land ➤ restriction of access to watering holes for stock ➤ interferes with irrigation projects eg access and siltation ➤ restricts recreational use of waterways eg fishing and tourism

- This slide somewhat reiterates what was said about general effects of mimosa infestation, but presents it in a land use context
- And of course, just as there are overlaps in the land uses, there will also be overlaps in the consequences

Uncertainty & information gaps (extent of mimosa)

- Broad scale of assessment (use of 1:250K scale)
- Classifications of *land subject to inundation* and *swamp land*
- Assumptions about which land use practices promote invasion/extent
- Role of disturbance (natural vs non-natural)
- CLIMEX model assumptions
- Refinement of CLIMEX model based on field study data
- Lack of detailed mapped area and density
- Precise relationship between climate change and mimosa distribution

- Although the 1 in 250 000 scale offered the best coverage, a finer scale such as 1 in 50 000 could possibly pick up some of the smaller water bodies and further refine the area of the wetlands
- The 1 in 50 000 coverage is steadily increasing, but it's not presently available for the whole of northern Australia
- The points on climex here reinforce the fact that a model is only as good as the input data

Uncertainty & information gaps (effects of mimosa)

- Effects on flora and fauna are poorly understood
- Lack of quantitative data on economic losses caused by mimosa
- Lack of quantitative data for impacts on social and cultural values
- Assumptions of effects on different land use practices
- Lack of information on the impacts of the control methods for mimosa

- With regard to the information gaps for the effects.....some of these have already been mentioned
- With regard to the last point..... Recent attempts to gain funding for herbicide toxicity studies on local native species have all been unsuccessful

Management strategy

Education and awareness

Prevention of spread

Research and development

Impact reduction

- I won't dwell too long here as many of you here have been responsible for the development and implementation of this strategy. Suffice to say that much has been achieved and continues to be achieved in these areas, and the risk assessment outlines as much of this as possible
- As for impact reduction... the original intention with the risk assessment was not to get too much into the actual control side of things....
- But following comments from reviewers of the report, we intend to highlight more about past and current impact reduction and include information on biocontrol in the context of long term management

To manage mimosa we need to know:

- How do we integrate grazing onto post mimosa controlled floodplains?
- What are the factors that affect successful revegetation?
- How does the timing of burning affect mimosa management?

We also need to have:

- An ability to find new infestations while they are eradicable
- The area and density of mimosa mapped
- A knowledge of the impact of mimosa removal on biodiversity
- An ability to fine tune current best practice integrated management regimes

- And finally I would just like to conclude with these comments which were expressed by Grant Flanagan in his review of the risk assessment
- I'm certainly not qualified to discuss them, so I would like to leave you with these thoughts and look forward to catching up with you over the course of this week

**The authors would like to thank the following
people for their valuable advice and input:**

Grant Flanagan
Mark Ashley
Mic Julien
Ian Brown
John Woinarski
Guy McSkimming
David Parry
Scott McIntyre
Murray Nivet
Joy Maddison
Tony Searle



5 Discussion session & Recommendations – 25/9/02

	Topic	Details	Recommendation	Proposed by	Who will be involved
1	Eradication in Wasur National Park	<p>A relatively small infestation requires urgent delineation and eradication to protect the integrity of Wasur NP and prevent spread to nearby Tonda Conservation Area in PNG.</p> <p>There is a tripartite arrangement between Kakadu, Wasur and Tonda, a good basis on which to develop a project considering the mimosa experience in Kakadu. Buck Salau, EA, is scheduled to visit Wasur soon for a 6 months period.</p>	Through appropriate authorities encourage a project to eradicate Mimosa pigra from Wasur NP.	Mic Julien	The international committee, see item 10 below
2	Continue biological control to its logical end point	<p>There is concern that funding for biological control of Mimosa pigra may cease before all potential biological control agents have been assessed.</p> <p>There are five potential agents yet to be assessed and this work will require about three years to complete.</p> <p>A strategy to complete this work and to stage reductions in resources required for biological control of mimosa has been drafted.</p>	Funding for biological control and the development of integrated strategies to be continued while there are natural enemies available that are suitable for assessment as potential agents, and to include these agents into integrated strategies.	Mic Julien	CSIRO Mic Julien, Tim Heard, Quentin Paynter NT DIPE Blair Grace
3	Implementing legislation	<p>There are concerns that efforts to manage mimosa are being jeopardized by lack of management elsewhere in catchments.</p> <p>Legislation has not been used to enforce landholders to undertake control strategies.</p>	NT Government to be more proactive in implementing legislation for enforcement of mimosa control.	Colin Devereaux	NT DIPE Mike Burgess

	Topic	Details	Recommendation	Proposed by	Who will be involved
4	Strategic control of mimosa	Reinvasion from seeds washed in from upstream is a major problem following control. Some landholders have expressed frustration that other landholders upstream are not controlling mimosa. The biological control agent Carmentia mimosa, which can reduce seed production by 90%, is absent at the tops of catchments eg near Adelaide River. Carmentia and other agents should be released in upper catchments to help reduce seed production and limit downstream spread.	Carmentia and Malacorhinus are to be released at the top of all catchments	Quentin Paynter	NT DIPE Blair Grace
5	Disparity of control versus economic potential	Development of cost effective actions for controlling mimosa. Cost sharing between landholders where each contributes to their ability within catchments. Recognition in implementing legislation of the capacity of a group/property/person to fulfil their requirements.		??	???
6	People Issues	Capacity and will to carry out control	??	??	??
7	Community management/Best practice	Education and awareness.	Condense proceedings into a booklet. Establish a [LH1]mimosa 'portal' on the CSIRO web site where all info on mimosa can be placed for www access	Mic Julien Leslee Hills	NT DIPE Leslee Hills, CRC AWM Who? Grant Flanagan CSIRO Quentin Paynter, Kate Smith Mic Julien Tim heard

Topic	Details	Recommendation	Proposed by	Who will be involved
8	Continuity of funding (linked with catchment management)	Work on catchments	Mark Ashley	??
9	Research	9.1 Utilisation of biomass	Tran Triet	Sri Lanka Buddhi Marambe GGC Premalal
	Herbicide recommendations for Asia	Recommended herbicides in the 1992 guide are still generally valid for Australia. Review current recommendations in Australia and Thailand for applicability to other countries.	Ian Miller	DBIRD Who? DIPE Who?? Thailand Royal Irrigation Department Thailand who? Sri Lanka Buddhi Marambe Dr L Amarasinghe
	Chemical rates - Tony Searle noted that seedlings regenerating after fire are killed with much lower doses of herbicide than those in the current registration, which is more relevant for mature plants.	Carry out above review before starting new trials. Conduct research to enable registration of chemicals to allow legal use of lower dose rates.	Tony Searle	NT DIPE Who? Should companies pay for this? Still requires someone to drive it. Who?
	Herbicide resistance[QEP2]		??	?? Sri Lanka Buddhi Marambe

Topic	Details	Recommendation	Proposed by	Who will be involved
	Herbicide toxicology and pollution	Determine herbicide toxicity using organisms and testing protocols suitable for tropical conditions.		CRC AWM Who? NT DIPE Steve Wingrave ERISS/NCTWR Peter Bayliss
	9.6 Improve the selection of biological control agents by understanding the ecology and growth of mimosa in its native range[QEP3]		Bertie Hennecke (since it is unlikely that we will attract funds to increase work in the native range Bertie is happy to drop this)	CSIRO Quentin Paynter[QEP4]
	Vectors of seed		Jason Williams	??
	DNA technology There are phonological differences between mimosa growing in Australia and in Asia. Are these differences genetically based or are they due to the environment and plant plasticity?	Determine if there are genetic differences between populations of the weed growing in Australia and Asian countries. If so, determine the source of the different populations. Conduct a literature review – see notes below.	Mic Julien	??[QEP5]
	9.9 Re-vegetation. Develop economical methods to harvest and plant native grasses as pasture and replacement for olive hymenachne.		Tony Searle	??[QEP6]

Topic	Details	Recommendation	Proposed by	Who will be involved
	<p>9.10 Seed banks – The studies by Barrat et al (these proceedings) should be extended to improve our understanding of seed longevity and the decline of soil seed banks following control of mimosa. Studies should include areas a) where mimosa has been controlled for longer to further assess seed bank decline, and b) where control has occurred but sites are isolated from reinvasion so we may be better able to determine seed bank longevity in absence of seed reinvasion.</p>	<p>Extended the soil seed bank studies that were conducted by Barrat et al these proceedings).</p> <p>Determine seed dynamics in established stands with or without control measures and assess differences between soil types, in Asia and Australia</p>	Colin Deveraux	<p>CSIRO</p> <p>Quentin Paynter</p> <p>NT DIPE</p> <p>Blair Grace</p> <p>ERISS & NTU/NCTWR</p> <p>Peter Bayliss</p> <p>Max Finlayson</p> <p>Sean Bellairs</p> <p>Vietnam</p> <p>Tran Triet</p> <p>Sri Lanka</p> <p>Buddhi Marambe</p> <p>AHK Balasooriya</p>
	9.11 Surveys and mapping		Dan McIntyre	<p>NTU</p> <p>Dan McIntyre</p> <p>Mekong</p> <p>Prof Tony Milne, UNSW?</p> <p>Sri Lanka</p> <p>Buddhi Marambe</p> <p>Dr L Amarasinghe</p>

	Topic	Details	Recommendation	Proposed by	Who will be involved
10	International cooperation	Develop processes to assist information flow and communication between mimosa researchers and managers and especially internationally..	<p>Form a working group to encourage awareness of mimosa, to assist training and to help develop projects to manage mimosa in developing countries.</p> <p>This could:</p> <ul style="list-style-type: none"> Assist existing actions eg project development in Sri Lanka, biological control in Thailand. Build on previous training, eg. MRC planning session, encourage education and awareness about the weeds at all levels of government Assist with project development Provide expertise Provide specific training courses covering ecology and management Make representations to governmental and supranational agencies 		<p>CSIRO</p> <p>Mic Julien</p> <p>Quentin Paynter</p> <p>NLC</p> <p>Mark Ashley</p> <p>Michael Storrs</p> <p>Vietnam</p> <p>Tran Triet</p> <p>Cambodia</p> <p>Chin Samouth</p> <p>Sri lanka</p> <p>Buddhi Marambe</p> <p>ERISS/NCTWR and Wetlands International</p> <p>Max Finlayson</p> <p>Thailand</p> <p>Wiwat Suars-ard</p> <p>Sathaporn Jaiarree</p> <p>NTU</p> <p>Dan McIntyre</p> <p>(B Marambe comment – need to identify a coordinator)</p>

	Topic	Details	Recommendation	Proposed by	Who will be involved
11	Information flow	The material presented at the symposium to be made generally available. This might assist raising the awareness about mimosa. All presenters at the meeting agreed.	Presentations to be burnt onto CD and copies distributed to all on the International committee and others who request a copy.	Leslee Hills	NT DIPE Leslee Hills

The heading "Who will be involved" should be for an initial person or persons to take the lead (or coordinate actions) on that issues, and it should not necessarily be restricted to persons who were at the symposium.

9.8 DNA Technology. (comments by Ian Miller) It would be useful to verify the research by J. Burdon. I summarised the situation in my 1988 thesis based on a personal communication from Burdon. Preliminary results showed that populations in Thailand are fairly uniform and there is evidence that populations in Australia are derived from Asia. Brazilian populations are quite distinct from those in Australia and Thailand, and have greater genetic variation. This has implications for biological control if agents are highly selective for genotype. (See Levin 1975; Burdon et al. 1980; Burdon and Marshall 1981; Sands and Harley 1981).