Table 1 Key approaches used for managing alien species and weed populations with recommendations for use in riparian zones

Approach	Description	Advantages	Disadvantages	Resources	Examples	Recommendations for riparian zones
Physical	Physical destruction or removal of alien species using machines, hand weeding, mulch or weed mats, shading, ring barking, tilling, slash, burn.	Can be used immediately after incursion; R and D often not required before use; hand weeding is targeted; eradication possible if treated early enough; can target single or multiple species.	Acts as disturbance with potential for future invasion; some access issues especially with machines; increased probability of soil erosion and bank destabilisation if sites not revegetated.	Labour intensive; machinery and equipment often required.	Patchy Mimosa infestations successfully treated (Rea and Storrs 1999); large-scale weed removal project in South Africa that provides work for unemployed and aims to increase water supply (Working for Water: Hobbs 2004).	Act early; suitable for small or patchy infestations; revegetate sites after weed removal or leave innocuous roots in ground.
Chemical	Alien species poisoned with toxic herbicides; application methods: spot spraying, boom spraying, aerial spraying, cut stump, stem injection, basal bark application,	Access issues vary depending on application method; effective at times; roots remain in ground, so bank destabilisation is minimal; eradication possible if treated early enough; can target single or multiple species.	Non-target effects on native plants and aquatic organisms can cause death or bioaccumulation; water quality pollution if soil is eroded, herbicide washes off or if herbicide spray drifts or is misdirected (Ainsworth and Bowcher 2005); success of herbicide dependent on application time and method; variable	Financial cost of herbicide; human effort varies depending on application method; regulatory approval.	Herbicide largely unsuccessful on mimosa (Lane *et al.* 1997); potential hazard associated with granulated herbicide use in the Top End on floodplains during the wet season (Rea and Storrs 1999).	Only use during periods of drawdown or on terrestrial component of riparian zone; treat when lowest amount of herbicide is required; if herbicide is to be used, act early; see Ainsworth and Bowcher (2005) for

			herbicide use in aquatic areas.			
Biological control agents	Plant pathogens and herbivores limit density of alien species populations; enemies may be native or alien (often from home range of the invader in question); grazers are usually insects.	Targeted; very effective at times; agents can often access areas inaccessible to humans and machines; gradual reduction in alien species population size; no direct physical disturbance; stringent regulations in place to ensure that agents are species-specific; research and testing is rigorous and thorough.	Long delay between alien species incursion and biocontrol agent release; chance that agent will fail or have non-target effects on native plants; agent may become invasive; agents cannot eradicate alien species, only limit their population density; only targets one alien species.	Research and regulatory approval consumes considerable resources and time; often labour-intensive to release agent; the need for continued releases varies with agents.	*Maravalia cryptostegiae* rust can cause defoliation and death of *Crystostegia grandifolia* (Panetta *et al.* 1998); *Cyrtobagous salviniae* weevil can control *Salix* spp. (Julien and Griffiths 1998).	Because of great expense and time involved to identify suitable agents, only suitable for the most invasive species; can be effective for keeping populations in check, especially where other methods have failed.
Biotic resistance	Increase competition from native vegetation to limit alien species success; enhance resistance and resilience of native vegetation to alien species.	No non-target risks from control method; sites remain vegetated; ensures maintenance of ecosystem functions and processes (e.g. nutrient processing, bank stability).	Does not eradicate alien species, but reduces colonisation opportunities, and limits dominance and spread; partial success likely, which would lead to coexistence of native and alien species.	Revegetation may be costly depending on scale and current ecosystem condition, but multiple benefits gained, so direct weed management cost is relatively low.	Approach advocated by Funk *et al.* (2008) for restoration.	Ecosystem-level approach that would have multiple benefits as well as alien species management.
Environmental	Manage abiotic	Widespread control; not	Feasibility of overcoming	Considerable	Restoration of a pre-	May not cause an

conditions	conditions to discourage alien species and encourage native plant species.	harmful if conditions are consistent with 'natural' conditions.	considerable socio-economic and political hurdles; changing one environmental regime (e.g. flooding) may not necessarily control alien species if other regimes remain modified (e.g. grazing); effects are subtle, long-term and will be hard to detect, making cost-benefit analysis and assessment of effectiveness difficult; requires healthy seedbank or availability of suitable recruits in region.	political and logistic costs to enable management of environmental conditions; compensation for stakeholders may be required (e.g. flooding of land or livestock removal).	regulation flow regime along the regulated Murray River may help to decrease alien species abundance and increase native plant abundance in floodplain wetlands (Catford *et al.* 2011); ideas consistent with Moles *et al.* (2008).	immediate reduction in alien species population sizes, but it offers a long-term, broad-scale approach that would have multiple ecosystem-wide benefits; particularly suitable for an adaptive management approach.
Integrated weed management	A range of control methods tailored to the local problem and conditions that are used concurrently (Rea and Storrs 1999).	Comprehensive approach that has the potential to be very effective because alien species are less able to adapt to different control practices; adaptable and can be site/incursion-specific.	Most effective when there is detailed knowledge of problem and environment.	Resource requirements depend on combination of methods selected, but costs likely high (i.e. potentially all of the resources listed in previous sections)	Integrated management advocated as the best approach to controlling mimosa infestations (Paynter and Flannagan 2004)	Highly recommended and widely supported approach because it tackles alien species incursion from multiple angles.