12. Weeds

Weeds are one of the main threats to biodiversity and agriculture but under climate change, management of this threat will be increasing in two ways.

Firstly, the suite of weed species will change. Secondly, some weeds will become more invasive.

The main drivers for climate change impacts on weeds include increased temperatures, changed rainfall, increased CO2 levels, more extreme weather, more frequent frosts, changed phenology and changed land use. The rate of response of invasive plants and weeds is expected to be faster than for other plants, including native species and crops. Secondly, climate change is likely to foster the appearance of a new set of weed species.

One of the main effects of climate change is its influence on species' distribution. There is extensive modelling of species distributions for southern Australia, mostly indicating a southern shift.

A major adaptation response to climate change is increased landscape connectivity, but this presents a major opportunity for increased weed invasion. Adaptation responses include quarantine and filtering methods to monitor species displacement.

General components of weed management planning through an adaptation lens are described below (taken from the AdaptNRM Weeds and climate change: supporting weed management adaptation).

Step 1: Assessment

Under climate change, assessment may need to include:

- new weed threats from outside the region
- existing weed threats that may get worst
- new weed threats from changing land uses and other adaptation responses

Step 2: Strategy & Priorities

Under climate change, strategic planning and prioritisation may be different because:

- increasing number of potential weed problems may require stricter prioritisation to focus on weeds that impact what communities value
- Priorities may need to shift substantially over time as new threats emerge
- Increased coordination with national and state level strategies will be helpful for

Step 5: Reflection

Under climate change, reflection may need to be different because:

- It may need to happen more frequently to ensure new threats detected by monitoring can be acted on quickly

Step 3: Monitoring

Under climate change, monitoring may need to be different because:

- A cost-effective approach may involve lots of monitoring for new threats rather than immediate management of any new species detected
- Widespread monitoring for new threats could

Step 3: Implementation Planning & Action

Under climate change, implementing weed management may need to be different because:

- the effectiveness of some forms of weed control is expected to decrease
- New weeds may need new forms of control

The first step in thinking about planning for weed management in a changing climate is to undertake an assessment based on the considerations raised above.

12.1 Weed Modelling

The aim of modelling a species' potential distribution is to better understand the geographical area in which that species may be found, survive, thrive, or remain absent now or in the future. Combined with the species present known distribution, this information can be particularly useful for informing strategic management efforts aimed at reducing current and future weed impacts in a rational manner.

Models of potential distribution of weeds projected to current climates and future (2070) climate scenarios for Australia and the world have been compiled and are available from CSIRO's data access portal www.data.csiro.au/dap/.

These projections were generated by the mechanistic modelling software, CLIMEX, using previously published parameters and were run with data for the CSIRO Mk3.5 GCM sourced from CliMond archive and a RCP A1B (medium emissions scenario).

Climatic suitability (Ecoclimatic Index, EI) was calculated for each species currently (since 1975) and under the future climate scenario at 2070. Maps are available showing these outputs per species https://data.csiro.au/dap/landingpage?execution=e4s2&_eventId=viewDescription and summarised in a table in Appendix 4.

AdaptNRM provides some examples of modelled suitability change for weeds in future climates and potential adaptation responses on page 28 of their weeds and climate change guidelines. The adaptation responses are at national scale, but could also be applied at the regional scale.

Examples:

Asparagus asparagoides (bridal creeper)

1. There is an increased risk in Tasmania which supports the strategy of maintaining Tasmania free of this weed.
2. Inland in NSW and Queensland is currently free of the weed and is likely to remain so with climate change.

CMIP3 GCM used in this weed modelling.

Mimosa pigra (mimosa)

1. The Kimberley region shows a declining risk. This would make it more feasible to eradicate any populations that appear.
2. Limit the spread of mimosa southward through Queensland. This is a no regrets climate adaptation policy.
3. There is potential for the plant to spread into NSW, so it should be treated as a quarantine issue for this state.

12.1.1 New weed threats from outside the region

Modelling highlights several weeds species whose climatic suitability is not currently within the SWCC Region but is projected to be in the future (at 2070 under CSIRO Mk3.5 GCM; RCP A1B). This is not to say that the species currently occurs just outside the SWCC Region but the region's climate in the future is projected to be more suitable than it is at present.

NRM Region	Common Name	Significance	Distribution (maximum Ecoclimatic Index, EI)			
			Currently (since 1975) within SWCC (incl Peel)	Projected distribution (2070) to remain in SWCC (incl Peel)	Projected distribution (2070) to enter SWCC (incl Peel)	Projected distribution (2070) no longer within SWCC (incl. Peel)
Acacia catechu	Cutch tree	Alert List for Environmental Weeds	0		8	
Acacia nilotica	Prickly acacia	Weed of National Significance	0		12 - very northern boundary (City of Mandurah)	
Cryptostegia grandiflora	rubber vine	Weed of National Significance	0		11 - northern peel boundary	
Koelreuteria elegans ssp. formosana	Golden rain tree		0		2	
Mikania micrantha	Bitter Vine or Climbing Hemp Vine or American Rope		0		27 - northern SCP	
Mimosa pigra	Mimosa; Giant Sensitive Tree	Weed of National Significance	0		8 - very northern coastal boundary Peel	

12.1.2 Existing weed threats that may get worst

Modelling highlights several weeds species whose climatic suitability is currently within the SWCC Region and it is projected to continue to be and to become more suitable in the future (at 2070 under CSIRO Mk3.5 GCM; RCP A1B). This isn't to say that the weed is or isn't currently occurring within the SWCC Region, but the current climate would be considered suitable for that species and the future climate, even more so.

NRM Region	Common Name	Distribution (maximum Ecoclimatic Index, EI)			
		Currently (since 1975) within SWCC (incl Peel)	Projected distribution (2070) to remain in SWCC (incl Peel)	Projected distribution (2070) to enter SWCC (incl Peel)	Projected distribution (2070) no longer within SWCC (incl. Peel)
Alternanthera philoxeroides	Alligator weed	50	64		

NRM Region	Common Name	Distribution (maximum Ecoclimatic Index, EI)			
		Currently (since 1975) within SWCC (incl Peel)	Projected distribution (2070) to remain in SWCC (incl Peel)	Projected distribution (2070) to enter SWCC (incl Peel)	Projected distribution (2070) no longer within SWCC (incl. Peel)
Asparagus declinatus	Bridal Veil	36 - Leeuwin Nat Ridge and Wheatbelt	45 - retraction away from the ridge and only occurring in the lower southern Wheatbelt		
Asystasia gangetica ssp. micrantha	Chinese violet	5	14 - spread for the length of the swan coastal plain and Leeuwin Naturaliste ridge		
Bassia scoparia	Kochia	74	85 - intensifies on the south coast		
Cenchrus ciliaris	Buffel grass	24 - only around peel-harvey	36 - spread south and east to include SCP, Wheatbelt and Leeuwin Nat ridge (Scott coastal plain remains free)		
Nassella charruana	Lobed needle grass	51	60 - retraction to the south coast		
Phoenix dactylifera	date or date palm	54 - currently eastern Wheatbelt	66 - spread west slightly		
Solanum elaeagnifolium	Silver-leaved Nightshade	21	27		
Sorghum halepense	Johnson grass	72	81		

12.1.3 Existing weed threats that may lessen

Modelling highlights several weeds species whose climatic suitability is currently within the SWCC Region and it is projected to lessen to become less suitable in the future (at 2070 under CSIRO Mk3.5 GCM; RCP A1B). This isn't to say that the weed is or isn't currently occurring within the SWCC Region, but the future climate would be considered less suitable for that species than it is currently.

NRM Region	Common Name	Distribution (maximum Ecoclimatic Index, EI)			
		Currently (since 1975) within SWCC (incl Peel)	Projected distribution (2070) to remain in SWCC (incl Peel)	Projected distribution (2070) to enter SWCC (incl Peel)	Projected distribution (2070) no longer within SWCC (incl. Peel)
Hieracium aurantiacum	Orange hawkweed	76	67 - retraction to the south coast		
Hypericum tetrapterum	St. Peter's Wort, Peterwort, Square Stemmed St. John's Wort, and Square Stalked St. John's Wort.	75	66 - retraction from northern Wheatbelt boundary		
Pueraria lobata	kudzu	5 - Scott coastal plain only			0
Zantedeschia aethiopica	Arum lily	56 - widespread except Wheatbelt	36 - retraction to the south coast		

12.1.4 New weed threats from changing land uses and other adaptation responses

The dispersal pathways for weeds have already been highly modified from what happens naturally in their native range. On one hand, long distance dispersal abilities have been improved, through the deliberate and accidental movement of plants via vehicle, trade, horticulture and agronomy. This has helped pants and their propagules (seeds, suckers, cuttings etc.) to increase distances travelled, increase the number, size and severity of barriers crossed and the volume of plants or propagules moved.

On the other hand, shorter distance dispersal opportunities have been reduced due to an increase in the size and frequency of barriers, such as habitat fragmentation, changes in land use and the construction of artificial barriers. Climate change is unlikely to directly influence or change dispersal pathways. Instead, changed land use patterns as adaptations to climate change may improve dispersal opportunities and provide new dispersal pathways.

Climate adaptation responses such as restoration of landscape connectivity, refugia protection and managed relocation, may change weed dispersal pathways in new ways.

An unintended consequence of improving landscape connectivity (e.g. by providing vegetation corridors) is improving the opportunity for invasive plants to spread. Adaptation responses to combat invasion from corridors include monitoring, pinch points and translocation.

Similarly, as native species shift their distributions in response to climate change or managed relocation, they have the potential to negatively impact other native species in their newly expanded range, thus becoming weeds themselves. The best adaptation response is to monitor the consequences of distribution shifts of native species to recognise negative impacts when they arise.

Refugia have an increased risk of invasion under climate change with potentially greater consequences for biodiversity. The key climate adaptation response to protect refugia is to maintain and enhance current invasive plant quarantine, surveillance and control measures.

13. Coastal and Marine

The Peron Naturaliste Partnership has identified possible climate change impacts on the coastal zone:

- Sea level rise
- Increasing rates of coastal erosion marine inundation
- Changes in movement of sand
- Coastal Flooding and increased water levels
- Decline in fresh water entering the estuarine system.

The PNP is an active group focusing on:

- identifying the inevitable economic, social and environmental risks of climate change in the coastal zone
- Developing measures to adjust and adapt to these impacts to reduce risk and our vulnerability

13.1 Sea level Rise – storm surge and inundation; marine intrusion;

As part of CSIRO's report *Climate Change in Australia. Information for Australia's Natural Resource Management Regions: Technical Report (2015)*, CSIRO and BoM have identified the following projections for the South West coast.

Higher sea levels and more frequent sea level extremes.

- *Very high confidence – sea level will continue to rise during the 21st century.*
- Relative sea level has risen around Australia at the average rate of 1.4 mm/year between 1966 and 2009 and 1.6mm/year after the influence of the El Nino Southern Oscillation (ENSO) on sea level is removed. By 2030, the projected range of sea level rise at Fremantle is 0.07 to 0.17 m above the 1986-2005 level, with only minor differences between emission scenarios. As the century progresses, projections are sensitive to emissions pathways. By 2090, RCP4.5 gives a rise of 0.28 to 0.65 m and RCP8.5 gives a rise of 0.39 to 0.84m. These ranges are considered likely (at least 66% probability). However, if a collapse in the marine based sectors of the Antarctic ice sheet were initiated, these projections could be several tenths of a metre higher by late in the century.
- Taking into account the nature of extreme sea levels along the southern and south-west flatlands coastlines and the uncertainty in the sea level rise projections, an indicative extreme sea level 'allowance' is provided. The allowance being the minimum distance required to raise an asset to maintain current frequency of breaches under projected sea