

# Climate Change Adaptation Research Grants Program

## - Terrestrial Biodiversity Projects

### Project title:

Determining future invasive plant threats under climate change: a decision tool for managers.

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### Objectives:

- To determine the potential threat from naturalised but not yet invasive alien plants under climate change
- To determine how these naturalised species may interact with other key stressors
- To develop a decision tool for managers that prioritises eradication programs towards those naturalised species that could become invasive with climate change and/or through the interaction with other key stressors

### Project design & methods:

1. The global distribution records of ~400 naturalised plant species will be collated, representing ~200 species each in categories (2) & (3) of the naturalised plants in Australia Records will be compiled from the Global Biodiversity Information Facility & the Atlas of Living Australia, supplemented with other sources where available.

2. We will use future climate scenarios for 2020 & 2050 generated from 4 Global Circulation Models (GCMs) produced for the IPCC 4th Assessment Report, based on the A2 emissions scenario. These four GCMs have been shown to model 20<sup>th</sup> century climate in the Australian region with comparatively high accuracy. Raw climatic data (monthly maximum & minimum temperature, & monthly precipitation for all months & years from 2000 to 2100) have already been downloaded from the Coupled Model Inter-comparison Project website. We have used bicubic spline interpolation to estimate monthly maximum & minimum temperature & monthly rainfall for each GCM grid on the 5 arc minute resolution grid defined by the WorldClim current climate dataset. To generate climate surfaces for 2020 & 2050, we have created a baseline climate for current conditions for each GCM based on maximum & minimum monthly temperature & precipitation from 1960 to 2000. Average values of monthly temperature & precipitation data were determined for five years on either side of 2020 & 2050 for each GCM to create future climate anomalies. These averaged values have been used to calculate projected 2020 & 2050 values for the seven bioclimatic variables used to define the climate envelopes.

3. The species distribution model MaxEnt (v.3.3.3e) will be used to produce continent-wide maps of climate suitability under current, 2020 & 2050 climates for each species. We have already developed & used this methodology to assess potential future bioclimatic envelopes of all the Weeds of National Significance (WoNS), the National Alert listed species, & a few other major weeds. Species Distribution Models (SDMs) such as MaxEnt describe the association between a known species occurrence & environmental conditions at these locations. These tools thus seek to describe the realised niche of the species. SDMs are not without some limitations. It is rare that we can be confident that a species distribution has been completely mapped & we often do not have the full range of environmental data that might be important determinants of a species distribution. Further, biotic interactions, which are known to have a direct influence on species distributions, are rarely included in SDMs. Notwithstanding these caveats, SDMs remain one of the most useful tools in the climate change prediction toolkit. When used judiciously, robust high-performance SDM tools such as MaxEnt are considered to provide useful indications of changes in predictor variables & permit reliable ranking of ensembles of species.

With respect to the invasive species SDMs proposed for this study, correlative SDMs will be particularly useful because:

- (i) We will avoid over-interpretation of models developed using herbarium data. In particular, we regard model outputs as indications of climate suitability that will permit (a) the identification of species expected to face either climate stress or increased climate suitability, & (b) indications of the spatial distribution of current & future climate suitability of individual species.

- (ii) We will use occurrence data from the entire known distribution of the species as it has been shown that the most complete representation of the realised niche is provided by this approach.
- (iii) Our modelling tool of choice (MaxEnt), has been found to be robust to many of the problems affecting SDM performance including the impact of many factors that may degrade model quality including low numbers of occurrence records, errors in geographic coordinates of locations, & selection of grid cell size for the climate predictors, and;
- (iv) Because of the computing efficiency of the MaxEnt program, we have the opportunity to conduct sensitivity analyses & “tune” MaxEnt models for maximum predictive performance on test data. That is, we can conduct effective sensitivity analyses to ensure highest model quality.

4. We will expand our existing database of introduced plant species' attributes to incorporate all additional species examined. This database includes information on impacts, & traits. We will collate additional data, where available, on environmental tolerances & soil associations. The invasion success of many introduced plants is linked to other key stressors such as fire & other disturbances such as land clearing. For example many legumes have fire responsive seeds & thus their invasive potential is greatly aided by fire. Thus it is critical that the interaction between invasive potential & other key stressors be examined. We will therefore include information on how each species is likely to interact with other key stressors to terrestrial biodiversity, especially the impacts of extreme events & human land use. This information will include potential impacts of changes in fire regimes; drought; salinity; competition & growth response to elevated atmospheric CO<sub>2</sub>; nutrient loading of soil by leguminous weeds; water quality; use of the species as habitat for invasive animals or crop pests; grazing; & habitat degradation. Much of this information has been recorded for individual species by various state government agencies but has not been collated nationally. Our database will thus be the most comprehensive national collation for these naturalised plants.

5. We will assess areas of invasion potential for each of the ~400 species at a number of spatial scales & for a number of different jurisdictions by spatially overlaying in ArcGIS their potential future distribution with layers containing (i) major vegetation types of Australia; (ii) Australian protected areas; (iii) the 56 NRM regions; (iv) local government areas; (v) Endangered Ecological Communities, and; (vi) other sites of conservation significance such as RAMSAR sites & locations listed as critical habitat for endangered species under federal & state legislation. We will use two major sources of spatial data for these analyses (i) the Present Major Vegetation Groups of Australia, developed by the former Australian Government Department of the Environment & Water Resources (DEWR) as part of the National Vegetation Information System (NVIS). The categorisation of vegetation communities follows the NVIS framework, which outlines national standards for describing vegetation types in Australia at a variety of scales. Thirty major vegetation groups (MVGs) are recognised, and; (ii) Land Use of Australia, Version 3 - 2001/2002, produced by the Bureau of Rural Sciences (BRS). These data were collated by the BRS from a combination of satellite information, Australian Bureau of Statistics resources, land tenure information, protected area data, & a suite of established spatial datasets related to vegetation & land uses, produced by various Australian Government departments

6. Based on the data collated from 2-5 above, we will assign a threat category to each species & each potential area of invasion using the triage system which allocates priorities to (a) the species based on their threat to biodiversity, & (b) the sites based on the ability to deliver effective weed control, the level of threat present, & the importance of the site. The potential for interactions with other key stressors will be incorporated into (a). This approach, developed by NSW DECCW, is similar to other approaches in Australia, but is yet to be adapted to naturalised plants that are not yet invasive.

7. A searchable database will be developed that can be interrogated by species name, area, threat category, & potential for interaction with other key stressors. The NSW Wildlife Atlas provides a useful template for the database.

8. A website will be built as a front end to the database enabling it to be used as a decision support tool for land managers. We will seek to host the website at Weeds Australia.

9. Our communication strategy (including ongoing engagement) includes: (i) media releases about the website during its launch, (ii) presentations to natural resources managers & other stakeholders about the website & its use & benefit to them, (iii) information sheets about the website & its use & value in establishing priorities for weed management under climate change, & (iv) publication in local practitioner journals such as Ecological Management & Restoration, & more broadly in peer-reviewed journals & at conferences.