

Climate-based prediction of *Asparagus asparagoides* and *A. declinatus* distribution in Western Australia

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Abstract

The potential distributions of *Asparagus asparagoides* and *A. declinatus* in the south-west of Western Australia are predicted from the climate of their known distribution in South Africa and elsewhere in Australia. Both species show the potential to considerably expand their range in the south-west. Recommendations are made that both weeds be declared noxious and that an eradication program be undertaken against outlying northern populations of *A. asparagoides* and the two known infestations of *A. declinatus*.

Introduction

Asparagus asparagoides (= *Myrsiphyllum asparagoides*) is recognized as a major environmental weed in Australia that has not reached the limits of its potential distribution in Western Australia (Scott and Pigott 1993). The weed is present as isolated but severe infestations throughout the south-west of the State, particularly associated with older settlements and townsites (Scott and Pigott 1993). *Asparagus declinatus* (= *Myrsiphyllum declinatum*) has

been collected from two sites in Western Australia, the townsite of Bunbury and Kings Park and Botanic Garden in Perth. It is increasingly important as a weed in South Australia (Weidenbach 1994) and is potentially a serious threat in Western Australia.

Computer based programs have been used to predict the potential distribution of organisms in Australia on the basis of climate. One such program is CLIMEX (Sutherst and Maywald 1985) which is used to develop a predictive model based upon the temperature and moisture requirements of a species. The model is then fine tuned to the known species distribution before being used to make a prediction to new areas.

An alternative approach, particularly where detailed biological information on the species is lacking, is to generate a prediction based only on the climate of the known distribution. A method for predicting distributions, called the Climate System, has been developed by Agriculture Western Australia. This method adopts some of the principles of the BIOCLIM system (Nix 1986).

In this paper we use these techniques to predict the potential distribution of *A. asparagoides* and *A. declinatus* in the south-west of Western Australia by using information from South Africa to build models and by verifying the models against the known distributions in eastern Australia. We then make recommendations for the management of these weeds in Western Australia based on these predictions.

Methods

Development of a CLIMEX model for *A. asparagoides* is described in Scott (1995). The parameters used are repeated in Table 1. A CLIMEX model for *A. declinatus* was developed from a general model for a species associated with a Mediterranean type climate (given in CLIMEX), which was then matched to the known distribution in South Africa as given in Obermeyer (1984, Figure 15). The final parameters are given in Table 1.

The Climate System uses meteorological station data from around the world as input. Stations within the range of the known distribution of the species were individually matched to grid points in Australia. Meteorological data at the grid points were generated by the BIOCLIM system (Nix 1986). The known distribution of both species, outside of the area of interest, was used to predict the potential distribution in Australia or Western Australia using the Climate System. The South African distribution was taken from Obermeyer (1984) and Edwards and Witt (1995). The South Australian distribution for *A. declinatus* was taken from Weidenbach (1994).

Table 1. Parameters used for CLIMEX predictions.

Parameter	<i>A. asparagoides</i>	<i>A. declinatus</i>
DV0	10°C	10°C
DV1	15°C	16°C
DV2	18°C	24°C
DV3	30°C	28°C
SMO	0.3	0.45
SM1	0.5	0.55
SM2	1.2	1.5
SM3	1.5	2.0
TTCS	6.0°C	7.0°C
THCS	0.001	0.005
TTHS		30°C
THHS		0.002
SMDS		0.02
HDS		0.05
SMWS		1.6
HWS		0.0015
TTHW	20.0°C	20.0°C
MTHW	1.2	0.5
PHW	0.1	0.075

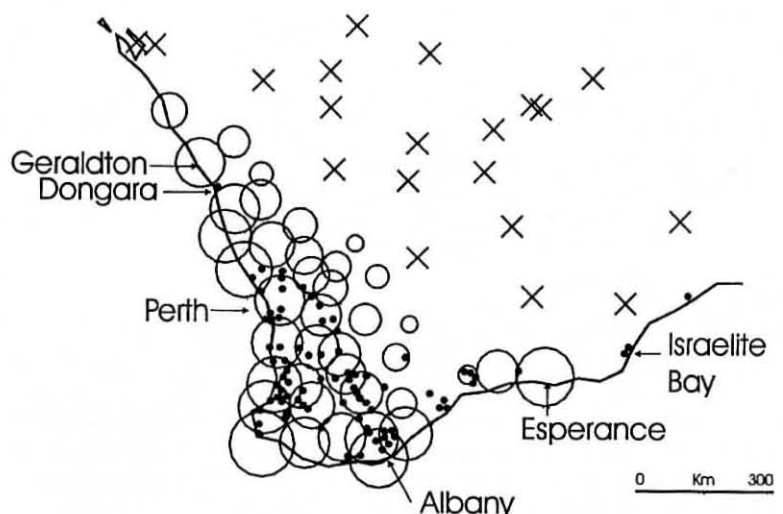


Figure 1. The known distribution of *Asparagus asparagoides* in the south-west of Western Australia shown as dots and based on Scott and Pigott (1993). The circles and crosses give the CLIMEX prediction of the distribution of *A. asparagoides* (based on the Australia wide map given in Scott 1995). The larger the circle, the more suitable the climate station for development of the plant. Crosses signify climate stations where the plant would not survive.

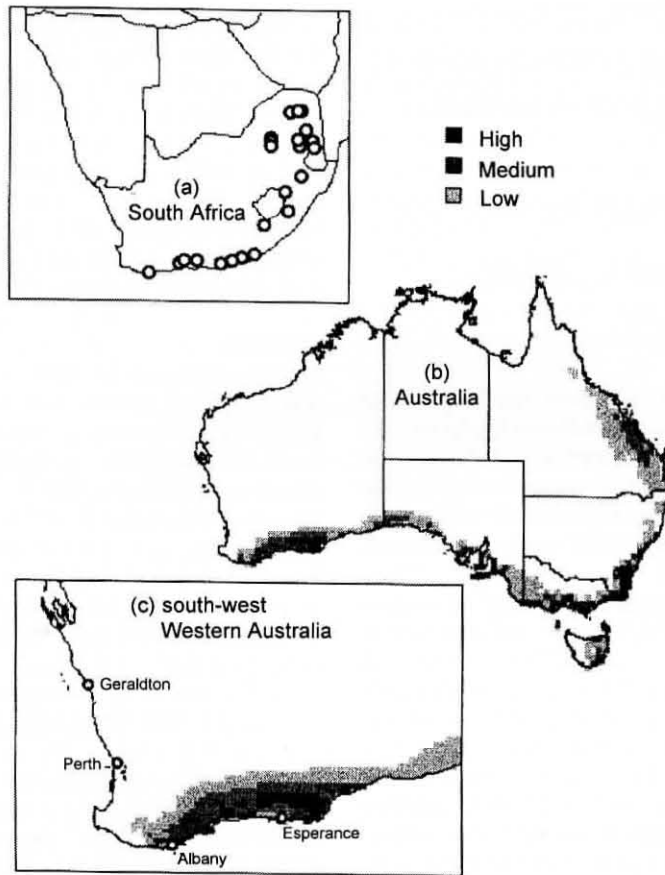


Figure 2. Regions of Australia with similar climate to locations where *Asparagus asparagoides* is found in South Africa. South African meteorological stations (a) were used to generate the predicted Australian distribution (b) and the south-west Western Australian distribution (c).

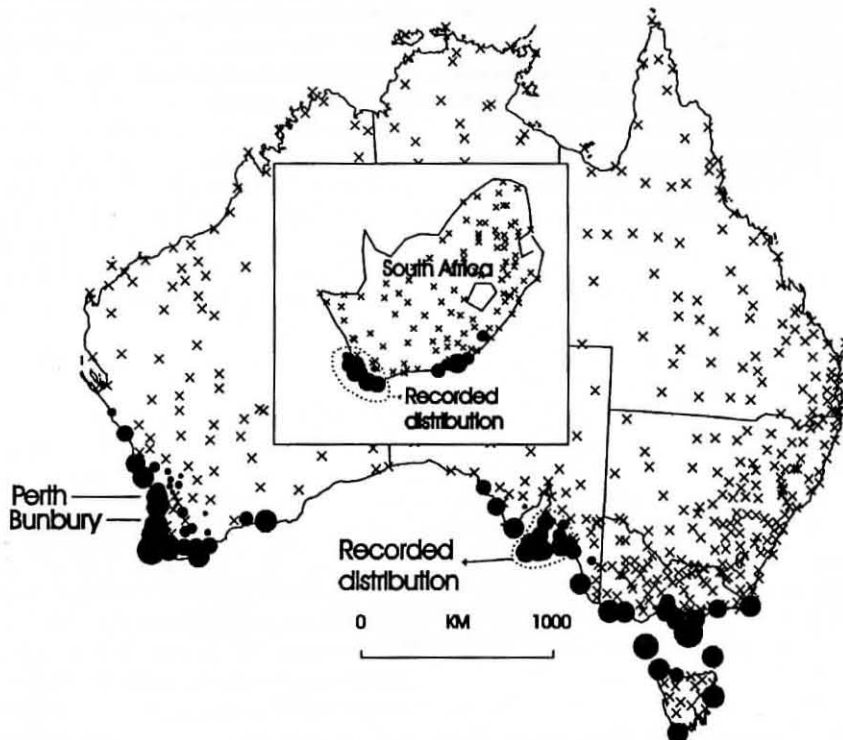


Figure 3. CLIMEX prediction of the distribution of *Asparagus declinatus* shown by solid dots. Crosses signify climate stations predicted to be unsuitable for plant survival. The inserts show the CLIMEX predicted and observed distribution in South Africa and the distribution in South Australia given by Weidenbach (1994). Perth and Bunbury indicate the two known infestations in Western Australia.

Results

A. asparagoides

CLIMEX predictions given in Figure 1 show that *A. asparagoides* has the potential to spread to the north, east and to a lesser extent to the south of the current distribution. The drier inland regions of Western Australia were not predicted to be suitable for the plant.

The Climate System prediction is confined to southern coastal parts of Western Australia (Figure 2). Much of the current distribution, as shown in Figure 1, is not predicted, but an extension of the range east along the south coast of Western Australia is probable.

A. declinatus

The CLIMEX model successfully predicts the known distribution of *A. declinatus* in South Africa (Obermeyer 1984), South Australia (Weidenbach 1994) and the two known sites in Western Australia (Figure 3). The model also predicted a wider distribution for *A. declinatus* in South Africa and shows that a wider area in South Australia, Victoria and Tasmania would be suitable for the plant. Similarly, a wide area of south-west Western Australia would be susceptible to invasion by *A. declinatus*. Drier and northern regions of Australia are predicted to be not suitable for the plant.

The Climate System, in close agreement with CLIMEX, predicts a widespread potential distribution in the south-west of Western Australia (Figure 4), coastal parts of South Australia, Victoria and eastern Tasmania.

Discussion and recommendations

The predictions shown here are based on the assumption that species distribution is limited by climate. In some cases a species may be responding to a particular microclimate. In other cases a species distribution could be limited by biotic or edaphic factors. This may explain why the actual distribution for *A. declinatus* and *A. asparagoides* in South Africa is more restricted than the predicted distribution. Clearly, *A. asparagoides* is suited to Mediterranean climates since it has colonized so successfully in the south-west of Western Australia. Its absence from comparable climates in South Africa (e.g. the Cape region) may be due to an edaphic or biotic factor; the close relative, *A. declinatus*, and other relatives occupy the appropriate habitats (Obermeyer 1984). The two approaches used here show that reasonable predictions of potential plant distributions are possible.

A. asparagoides

Isolated populations north of the current distribution, for example, the population at Dongara, represent a threat to the

surrounding districts including a number of National Parks. Elsewhere in Western Australia, it would appear that *A. asparagoides* colonies have reached the limits of its potential distribution, but scattered infestations in the south-eastern coastal regions of Western Australia could expand substantially. In these areas the infestations should be contained and controlled.

Recommendations are:

- That the isolated population at Dongara be eradicated.
- That *A. asparagoides* be declared a noxious weed in areas where it is predicted to colonize.

A. declinatus

Weeds can often be present for a long period before the naturalized population increases to noticeable levels (Mack 1985). *A. declinatus* has been present as a garden plant in Australia since 1870 however it is only recently that the species has become a significant environmental weed in South Australia (Weidenbach 1994). The known Western Australian infestations in Perth

and Bunbury correspond to the regions of low climate suitability, as predicted by the Climate System. This could account for the slow growth of the infestations in these areas. However, the established populations may become sources of infestation in areas of higher suitability. The significant threat to Western Australia, as indicated by both climate prediction systems, is cause for considerable concern.

The species is often used as a garden plant. To prevent this, it may be necessary to declare the species under noxious weed legislation to help prevent its sale and spread. An education program is necessary to raise awareness of this problem. Little is known of the biology of *A. declinatus*. The study of temperature and moisture requirements for growth would improve the CLIMEX prediction and would help decisions being made for control using fire, herbicides and other techniques.

Recommendations are:

- That autecological studies be undertaken of *A. declinatus* to provide information on the temperature and mois-

ture requirements suitable for growth.

- That *A. declinatus* be declared a noxious weed throughout the south-west of Western Australia.
- That an education program be undertaken so that *A. declinatus* is removed from plant nurseries and gardens, as well as disposed of in a manner preventing further spread.
- That urgent attention be given to controlling and eventually eradicating the known *A. declinatus* infestations in Western Australia.

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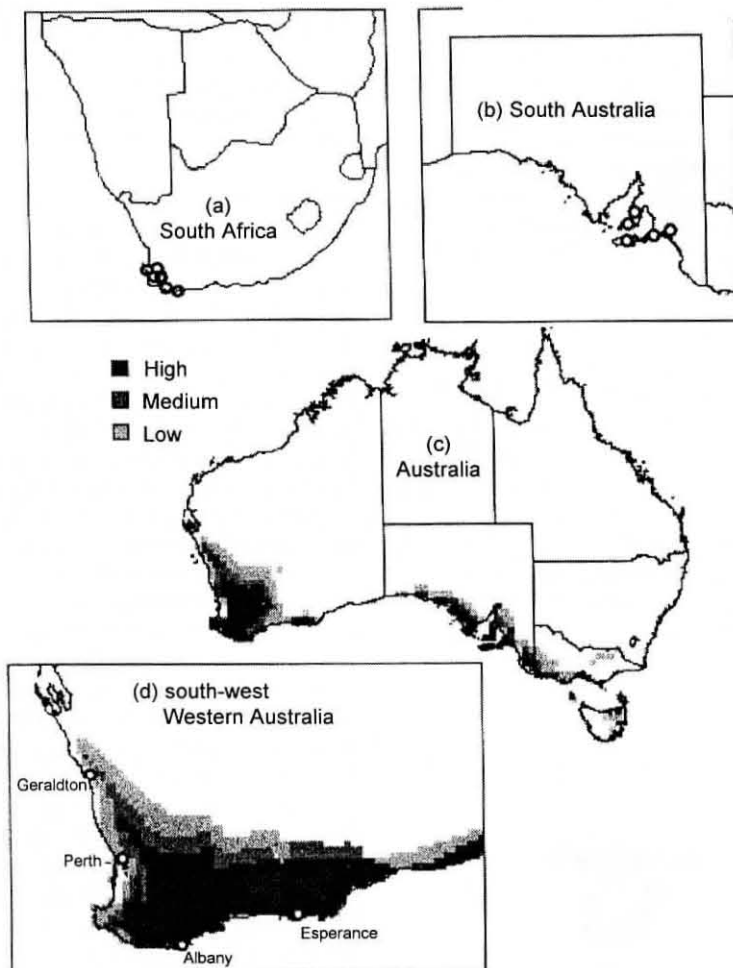


Figure 4. Regions of Australia with similar climate to locations where *Asparagus declinatus* is found. South African meteorological stations (a), based on Obermeyer (1984), were used to generate the predicted Australian distribution (c). South Australian infestations (b), based on Weidenbach (1994), were also included to generate the south-west Western Australian prediction (d).