Are bioclimatic niche models useful in predicting invasions?

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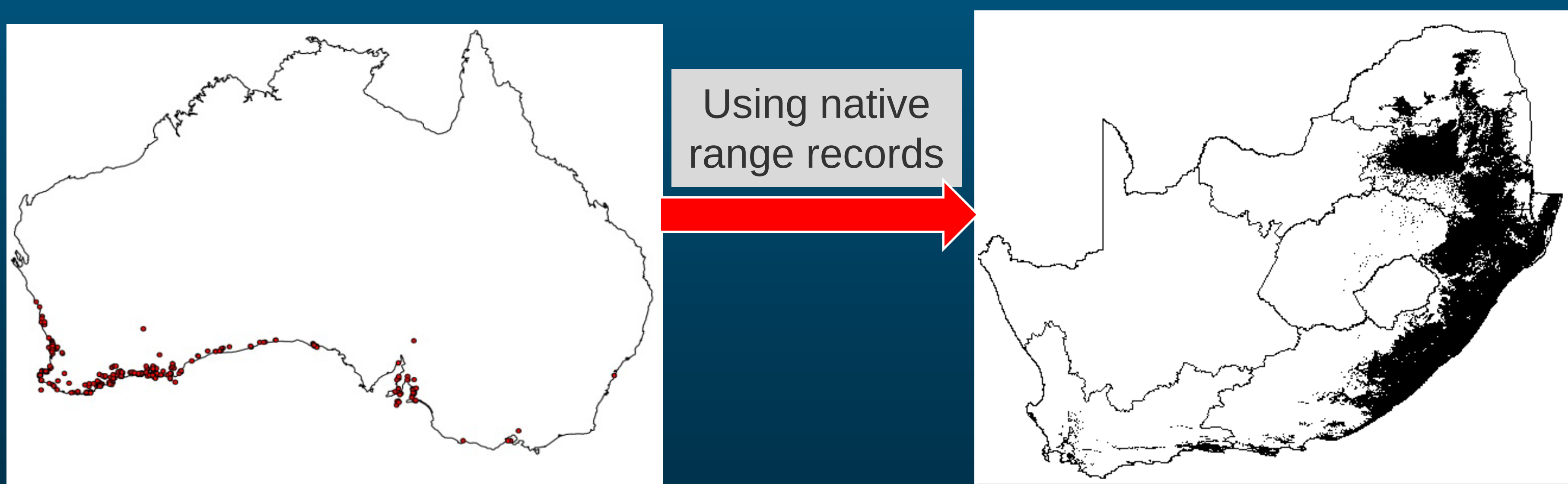
Biodiversity for Life

Why bioclimatic niche models?

- Basic models used to predict species distributions
- Successful establishments in areas that match a set of ecological conditions in native



Aim

- To evaluate how useful bioclimatic niche models are in predicting invasions

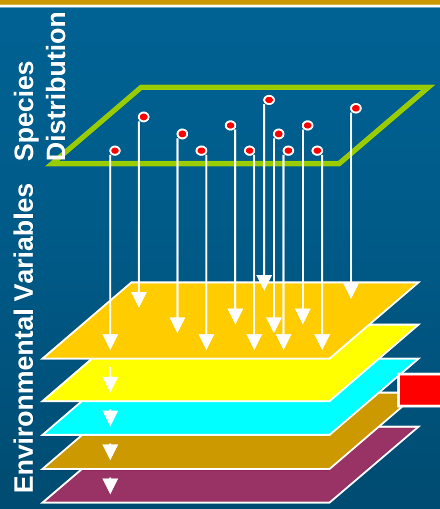
Methods

Australian acacias in Southern Africa

- 69 species introduced into southern Africa
- Government introduced 46 species for forestry
- Currently 14 invasive and 5 are naturalized

Bioclimatic modelling

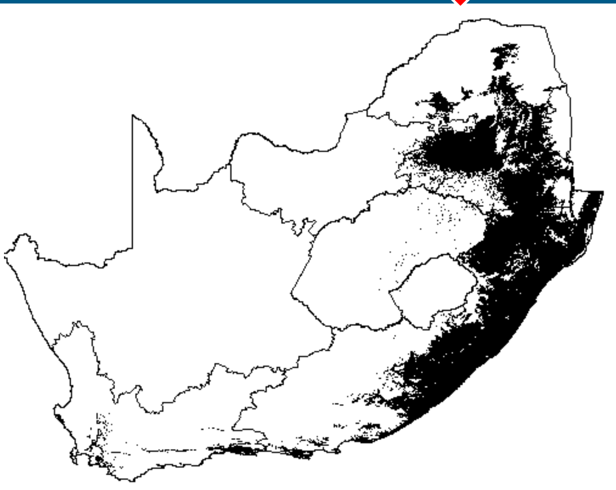
Australia



Southern Africa

To identify regions suitable for Australian acacias

Annual mean temperature
Min. Temp. of the coldest month
Max. Temp. of the Warmest Month
Annual Precipitation



Model evaluation

Southern African Plant Invaders Atlas
11 species (3471)

Government forestry trials
14 species (129)

Government forestry trials

- Experimental introductions since 19th century
- Failures and establishments recorded
- Invasion biology aspects
  - Presence and absence data
  - Gives indication of invasion (seedlings spreading from plantations)
- We used 14 species
- Can the models predict introduction outcome?

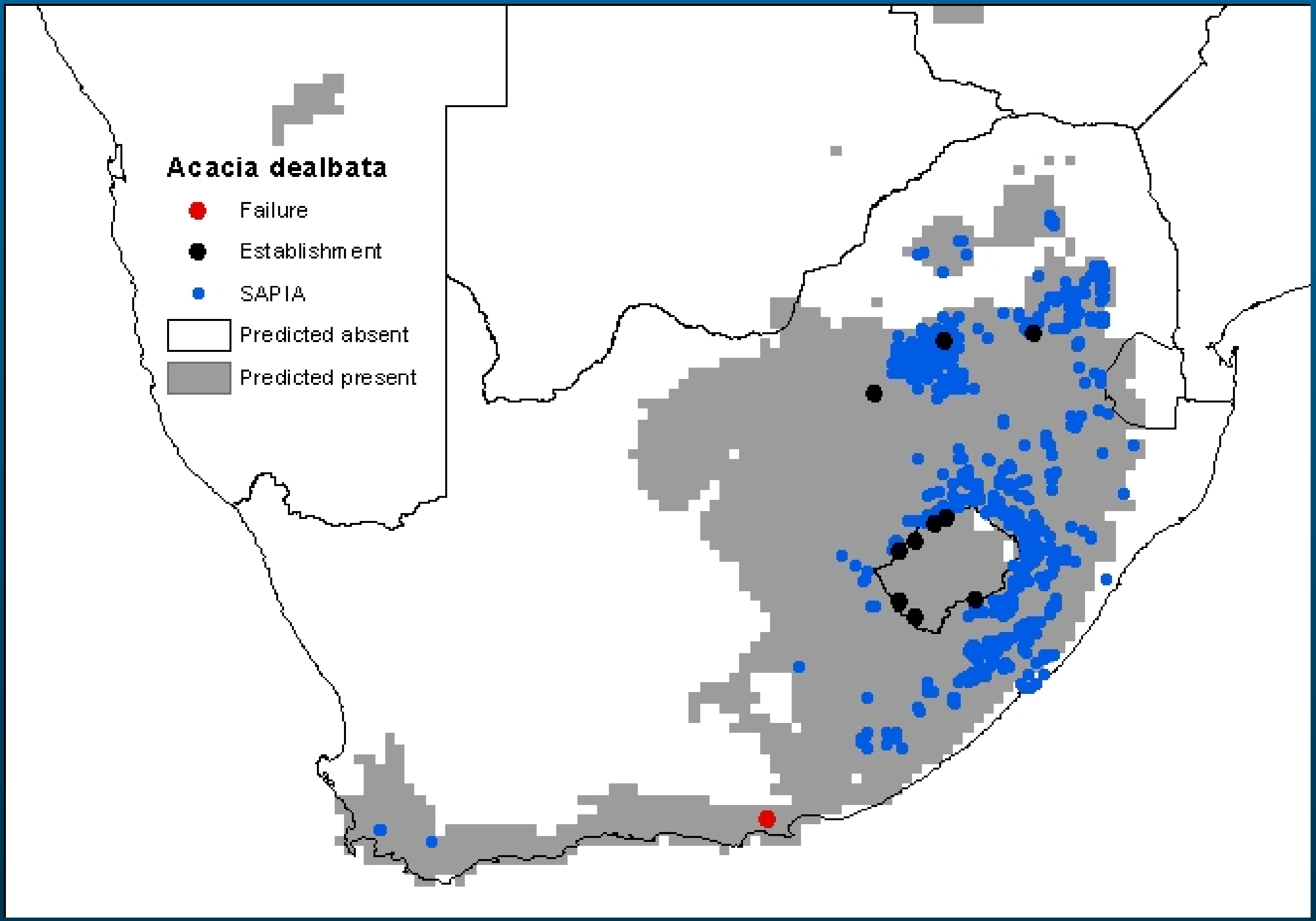
Poynton (2009)

Southern African Plant Invaders Atlas (SAPIA)

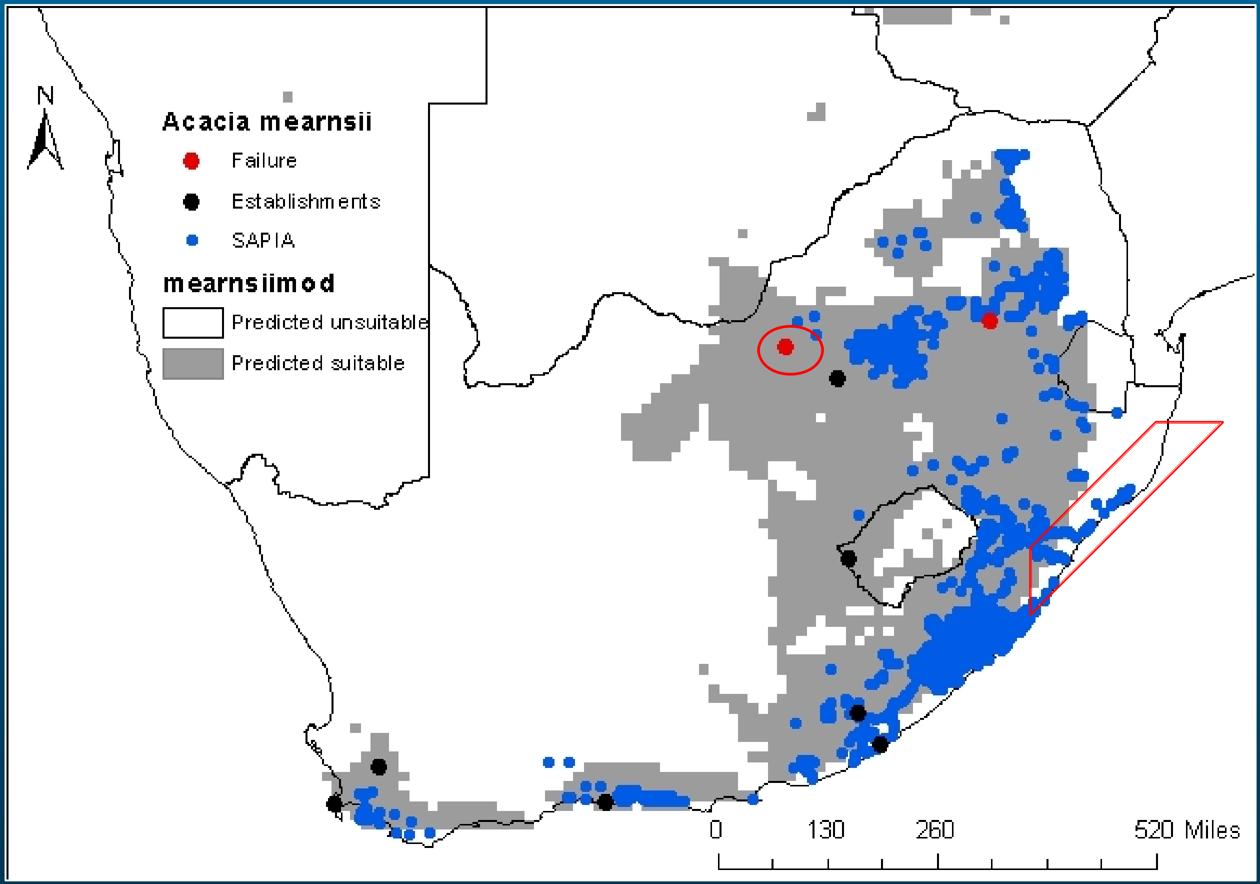
- Naturalized or invasive species in Lesotho, Swaziland & South Africa
- 11 Well established species
- Could the models have predicted the spread of these species?

Acacia dealbata

Representative species



Acacia mearnsii

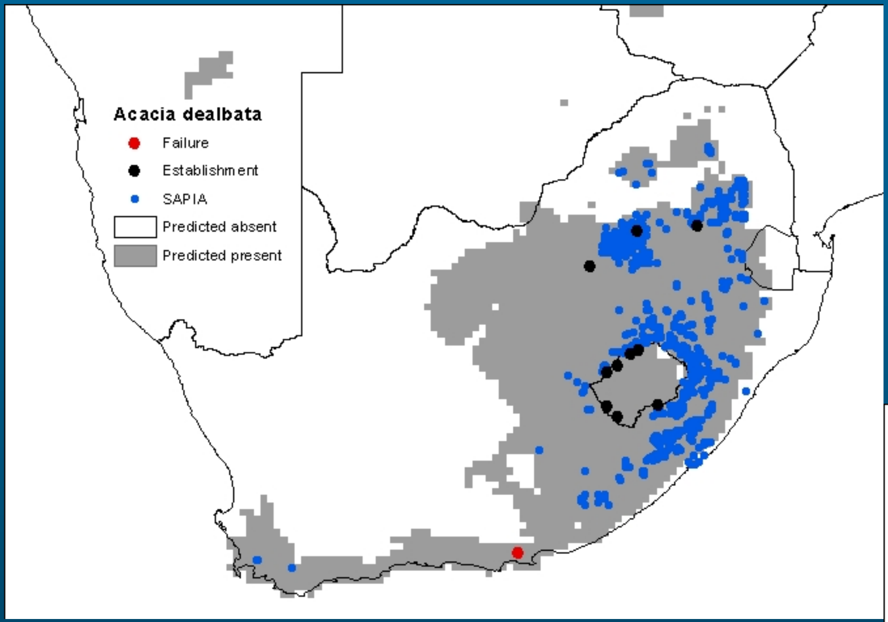


Model evaluation

The higher the value the closer the match

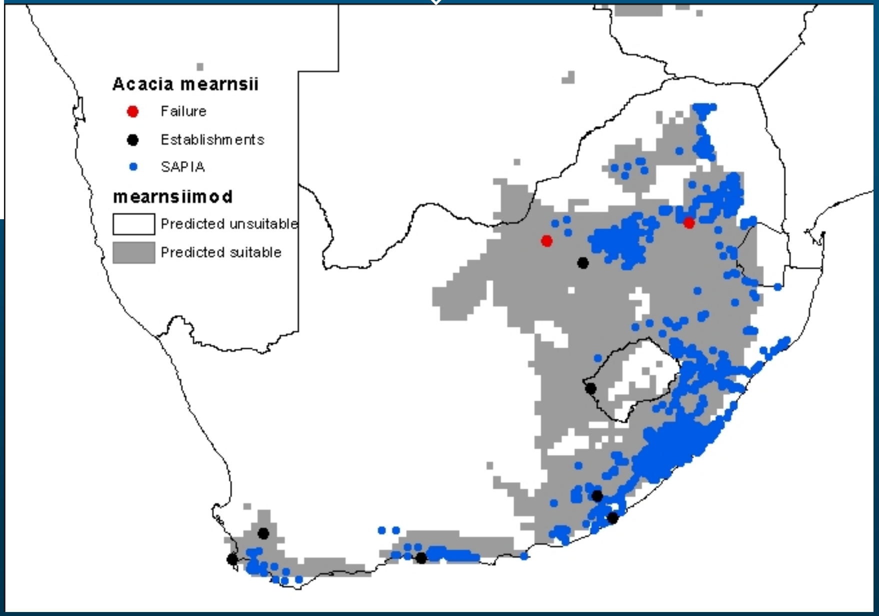
- Sensitivity - proportion of actual presences predicted present (omission error)
- Specificity - proportion of observed absences predicted absent (commission error)
- True skill statistics quantifies omission and commission errors

Representative species



Acacia dealbata
Sensitivity = 0.91 (GFT) and 0.99 (SAPIA) & specificity = 1

Acacia mearnsii
Sensitivity = 0.70 (GFT) & 0.78 (SAPIA) specificity = 0.33



Prediction of introduction outcome

- Government forestry trials
  - Sensitivity value = 0.80
  - There is a good overall agreement between model prediction and successful introductions
  - Of all129 records (63%) were correctly predicted

Model performance

Species	Number of trials	Sensitivity	Specificity	TSS
A. acuminata	13	0.50	0.54	0.04
A. aneura	4	0.33	0.00	-0.67
A. baileyana	5	1.00	0.00	0.00
A. cultriformis	5	0.00	0.50	-0.50
A. dealbata	13	0.91	1.00	0.91
A. decurrens	7	1.00	0.20	0.20
A. elata	9	0.50	0.20	-0.30
A. falciformis	4	1.00	0.00	0.00
A. longifolia	5	1.00	0.00	0.00
A. mearnsii	13	0.70	0.33	0.03
A. melanoxylon	28	1.00	0.00	0.00
A. pendula	6	0.33	0.67	0.00
A. pycnantha	9	0.88	0.00	-0.20
A. saligna	8	0.40	1.00	0.40
Overall	**129**	**0.80**	**0.35**	**0.15**

Model evaluation with forestry trials

Prediction of invasion success

- SAPIA
  - The overall sensitivity value = 0.87
  - Overall agreement between invaded range and model prediction is good
  - Of all 3000 records (87%) were correctly predicted

Models performance

Species	Number of records	Sensitivity
A. baileyana	86	0.95
A. cyclops	141	0.97
A. dealbata	717	0.99
A. decurrens	157	0.99
A. elata	20	0.85
A. longifolia	79	1.00
A. mearnsii	1916	0.78
A. melanoxylon	163	1.00
A. podalyriifolia	56	0.91
A. pycnantha	83	0.99
A. saligna	53	0.98
Overall	**3471**	**0.87**

Model evaluation with SAPIA data

Current and potential distributions

- A large portion of southern Africa is climatically suitable for Australian acacias
- Most biomes are predicted to be suitable with Fynbos as the most susceptible
- Suitable climates extending well beyond current distributions for species

Discussion

- Bioclimatic models accurately identified currently invaded range
- Models identified successful establishments in trials
- Climate is an important factor while explaining invasions

Implications for biodiversity planning

- Invasions second threat to biodiversity
- Models identify suitable areas for species
- Potential invaders can be identified and excluded
- Reduce impacts caused by invasions
- So models are useful as pro-active tool for invasion risk assessment

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