



While gorse is a current invasive threat, with a warming climate different species are likely to become invasive threats to the iconic Australian Alps.
Photo: Sarah Clement

A framework to identify future invasive plant species

- The spread of invasive plants and animals is regarded as one of the greatest current threats to global biodiversity. This threat is likely to change in the future as the climate changes
- The Australian Alps are likely to be highly susceptible to climate change. The alps have already warmed at a rate of about 0.2 °C per decade in recent decades, a higher rate than the global mean temperature rise (0.12 °C per decade since 1951).
- Park managers now have a framework for identifying plant species that may become invasive under future climate conditions in the Australian Alps.

Research summary

We developed a framework to identify plant species that may become invasive under future climate conditions.

The framework is an extension of current weed risk assessment procedures used to assess the likelihood of invasiveness. The framework can be used in any region and for any plant, anywhere in the world.

By considering invader attributes and biogeography, in combination with projections of future climate, the framework can help managers assess the likelihood of future invasiveness of introduced species that are currently in an area, as well as species that may be introduced in the future.

Understanding the future spread of invasive species under climate change

Invasions by pest plants and animals are regarded as one of the greatest current threats to global biodiversity. This threat is likely to change in the future as species' distributions shift in response to changing climate conditions, introduction and dispersal patterns shift and productivity of native species declines.

Alps managers will need more proactive approaches to manage invasions, as the rates and patterns of invasions change. Knowing which species may be invasive in the future could help managers prevent invasion by reducing the likelihood of movement of that species into an area.

A useful step towards prioritising management responses is knowing future climate suitability based on how species respond to changes in temperature and rainfall.

Current frameworks

Current frameworks do not incorporate projections of future climate to assess the likelihood of future invasiveness of a species.

However, by accounting for invader attributes and biogeography, in combination with projections of future climate, we rank the likelihood of future invasiveness of a species, and the immediacy of concern for alps managers.

Understanding invasive processes

Climate is not the only factor that determines a species' invasive potential. Other factors include the distribution of the species in its native and invasive range (biogeography), its reproductive and dispersal characteristics, and relatedness to other invasive species (phylogeny). We use the CLIMEX model to include these factors in the modelling.

A new framework that includes future climate conditions

We developed a framework to identify plant species that may become invasive under future climate conditions.

By following the framework, we identify future climate suitability for:

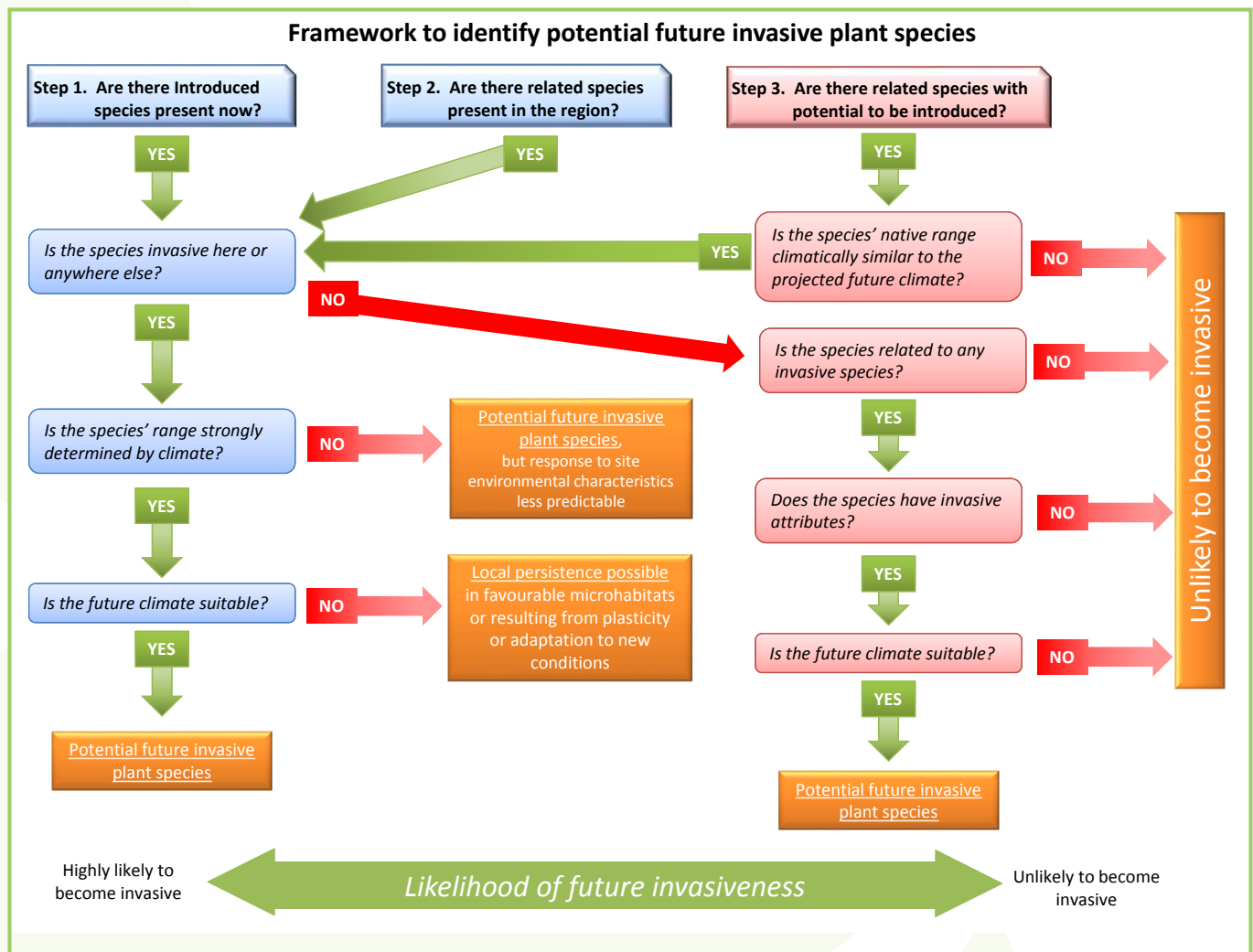
- i) introduced species that are currently present in a region of interest (in our example, the Australian Alps);
- ii) related species that may be absent now, but are present in the broader region; and
- iii) related species that may not be present in the region, but are present in areas of the world where the current climate is similar to the climate that is projected for the future in the region of interest.

The pathway to understanding

The first step in the framework considers the biogeography of introduced species that are currently present in the region of interest, to identify invasive potential and the extent to which the species' range is determined by climate. The future climate suitability is then modelled with CLIMEX.

The second step considers related species that are absent from the region of interest, but have potential to disperse from the broader region. We ask the same questions as in step one. For the Australian Alps, these are the species that have the most immediate potential to spread into the higher altitude areas as the climate becomes warmer and drier.

The final step is to match the current and future climate of the region of interest with the rest of the world, to identify regions where related species with similar invasive attributes may come from in the short and medium term.



A case study in the Australian Alps

We illustrate the framework by identifying plant species most likely to be invasive under future climate change in the Australian Alps. Many millions of dollars are currently spent annually attempting to reduce the establishment and spread of invasive species in the alps.

Invasive plant species that currently pose the greatest threat to biodiversity in the alps region include Broom species, Willow species, and Hawkweed species.

Known invasive species with distributions strongly determined by climate, for whom the projected future climate is highly suitable, are those that have the greatest potential to be future invasive in the region (for example *Hieracium pilosella*).



Hawkweeds: Future climate will become less suitable for some Hawkweed species (Orange Hawkweed, at left) and more suitable for others (Mouse ear Hawkweed, on right)

In contrast, species for whom climate suitability is projected to decline (for example *Hieracium aurantium*) may be of less concern in the future.

The Australian Alps are warming

The Australian Alps region is likely to be highly susceptible to climate change. The Australian Alps have warmed at a rate of about 0.2 °C per decade over the past 35 years. Average temperatures are projected to increase by 4–5°C under a high emissions scenario.

A changing climate changes the invasive stakes

Our results demonstrate that changing climatic conditions may reduce the suitability for current invasive species, but improve it for others. This suggests that there may be opportunities as well as risks for alps managers and today's invasive management programs.

As climate suitability for current invasive species declines, targeted eradication may become increasingly feasible. At the same time, the establishment of future invasive species may be limited by early intervention, to prevent their spread into an area.

Where to from here?

We describe the framework using the Hawkweeds in the Australian Alps, but the same approach can be applied to any species or region of the world.

We are working in collaboration with alps managers to run the framework for other species with potential invasive threat in the alps, including Broom and Willow.

Who are the researchers?

Dr Rebecca Harris



Bec has an extensive background in field ecology and thermal biology. As part of our Climate Futures Project, she works closely with researchers across the hub to extract, analyse and interpret climate projections for species under threat from climate change.

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Prof Nathan Bindoff



Nathan is a physical oceanographer, specialising in ocean climate and the earth's climate system. He was the coordinating lead author for the ocean chapter in the Intergovernmental Panel on Climate Change Fourth Assessment Report and Fifth Assessment Report.

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Collaborators

Gill Anderson and Peter Jacobs (People in Nature), Tom Remenyi (Antarctic Climate & Ecosystems Cooperative Research Centre, Darren Kriticos (Centre for Australian Weather and Climate Research - CSIRO)

Further reading

Harris RMB, Remenyi T, Kriticos DJ & Bindoff NL (submitted) The Invasion Pyramid - a framework to identify future invasive plant species (Diversity and Distribution)

Porfiro LL, Harris RMB, Lefroy EC, Hugh S, Gould SF, Lee G, Bindoff NL & Mackey B (2014) Improving the use of species distribution models in conservation planning and management under climate change. *PLoS ONE*, vol 9, no 11, doi: 10.1371/journal.pone.0113749.

About the NERP Landscapes and Policy Hub

The Landscapes and Policy Hub is one of five research hubs funded by the National Environmental Research Program (NERP) for four years (2011–2014) to study biodiversity conservation.

We integrate ecology and social science to provide guidance for policymakers on planning and managing biodiversity at a regional scale. We develop tools, techniques and policy options to integrate biodiversity into regional-scale planning.

The University of Tasmania hosts the hub.

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