National Environmental Research Program

LANDSCAPES & POLICY hub

Researchers Melanie Bottrill and Peter McQuillan search for the Ptunarra Brown Butterfly at Tunbridge in the Tasmanian Midlands. The species is listed as vulnerable under state legislation. Photo: Peter Mathew

The fate of species under climate change: why we cannot ignore uncertainty

- Models that project the possible distribution of species under future climate scenarios can produce different outcomes ranging from little change to near extinction. The differences can arise from using different climate variables in the species distribution models as well as from using different climate models.
- This means that to identify the full range of plausible futures that a species might face, conservation managers need to consider more than one species distribution model, with different climate variables and different climate models.
- Conservation managers then need to implement ongoing monitoring programs so that the appropriate conservation plans can be adapted to changes as they occur.

Research summary

Over the past two centuries, habitat destruction, changed fire regimes and introduced pests have led to widespread extinctions of animal and plant species in Australia. For some species, conditions are set to worsen with climate change.

Species distribution models are commonly used to project the future ranges of species and help managers set conservation goals. But these models can give a range of results depending on the climate variables selected, increasing the uncertainty associated with projecting species distribution under a future climate.

Our research highlights the need for conservation managers to consider several species distribution models to estimate the range of plausible futures that a species might be facing, to monitor changes and to adapt their conservation program accordingly.

Understanding the fate of a species under climate change

Government agencies responsible for species conservation are looking for ways to understand how plant and animal populations will change in response to climate change, especially for species that are listed as vulnerable or threatened.

Species distribution models are commonly used by scientists and conservation managers to project changes in geographic range, estimate extinction rates and plan conservation investment. They correlate historical records of where species have been observed with environmental and climatic variables such as rainfall distribution and seasonal maximum and minimum temperatures. The models can then be used to indicate the location of other areas likely to be suitable, now and into the future.

Moving the Ptunarra Brown Butterfly to a location that seems suitable now may not work if it becomes climatically unsuitable in the future. Photo: Forest Practices Authority

Uncertainty is not confined to climate models

It is important to understand the limitations of the models we use to plan for future conservation, and recognise that uncertainty in species distribution models is not only due to the range in climate models — there is also uncertainty in the climate variables we select to run the models.

A case study — Tasmania's Ptunarra Brown Butterfly

To illustrate the impact of using different climate variables in species distribution models, we used the Ptunarra Brown Butterfly (*Oreixenica ptunarra*) as a test case.

Found only in Tasmania, the Ptunarra Brown Butterfly is listed as vulnerable under the state's *Threatened Species Protection Act 1995*. Its natural habitat of grasslands and grassy woodlands is disappearing due to land clearing, stock grazing and competition from introduced pasture grasses. Less than 3% of the butterfly's original habitat remains.

The Tasmanian Government has developed a recovery plan for the butterfly, which includes the possibility of restoring habitat patches and moving butterflies to more favourable areas. However, the strategy of moving butterflies to a location that seems suitable now may not work if it becomes climatically unsuitable in the future.

Expert opinion may help in selecting the climate variables, but surprisingly little is known about some species, including the Ptunarra Brown Butterfly. Photo: Forest Practices Authority

Three approaches to selecting climate variables, three vastly different results

Projections from global climate models, which are usually at resolutions of several hundred kilometres, can be downscaled to the fine scales required by ecologists. Our group at the University of Tasmania used the Maxent species distribution model with fine-scale climate data to generate projections for the butterfly.

We used three approaches to select climate variables:

a) **The lot** – We selected all 35 commonly used climate variables, representing the annual trends, seasonality and extremes that influence a species' success (for example, annual mean temperature, amount of rainfall, radiation in the driest period).

b) **Expert selection** – We selected a subset of climate variables that experts thought were the most important measures influencing habitat suitability for the butterfly.

c) **Monthly variables** – We selected climate variables that affect the butterfly during the period when adults are active (for example, the coldest temperature during March and April).

We found that, regardless of the climate model used, the three sets of climate variables gave very different projections.

When we used all climate variables (option a), the area of climatically suitable habitat shrank but did not disappear.

When we used the expert selection (option b), the area of climatically suitable habitat shrank so much that the butterfly could be close to extinct by the end of the century.

When we used the monthly climate variables (option c), the area of climatically suitable habitat remained similar to the present.

We need to use more than one model

The approach to selecting climate variables for use in a species distribution model is always, to some extent, subjective. A range of statistical diagnostics is available, but these diagnostics are unable to indicate whether a model makes good ecological sense, and they often give conflicting results.

In addition, there can be no guarantee that the relationship between the climate variables and the distribution of the species will stay the same in an already changing climate. Expert opinion may help in selecting the most relevant variables, but there is surprisingly little known about some species, including the Ptunarra Brown Butterfly.

Though the different variable selection methods can generate very different projections of future distribution, species distribution models are still very useful tools because they give us some knowledge of where climatically suitable habitat is likely to persist under changing climatic conditions. This knowledge is essential if we are to conserve threatened and vulnerable species into the future.

By using a range of species distribution models, we can define the range of possible trajectories a species may be on.

Ongoing monitoring can detect change as it occurs and managers can then take the appropriate conservation measures to protect our most vulnerable and threatened native animals.

Less than 3% of the Ptunarra Brown Butterfly's original habitat remains.

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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Luciana is a geographer and remote-sensing specialist based at the Fenner School of Environment & Society at the Australian National University. She is part of the Bioregional Futures team applying tools and techniques to study characteristics of landscape ecosystems and the patterns of diversity under scenarios of natural and human-induced change.

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Collaborators

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Further reading

Harris RMB, Porfirio LL, Hugh S, Lee G, Bindoff NL, Mackey B & Beeton NJ (2013) To be or not to be? Variable selection can change the projected fate of a threatened species under future climate. *Ecological Management & Restoration*, vol 14, no 3, pp 230–34, doi: 10.1111/emr.12055.

Porfirio 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.

www.nerplandscapes.edu.au

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