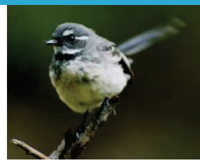




NCCARF
National Climate Change Adaptation Research Facility
Adaptation Research Network
TERRESTRIAL BIODIVERSITY

INFORMATION SHEET FIVE

Species Distribution Modelling as a Tool for Climate Change Adaptation Management

Species distribution models are widely used to predict the geographical distribution of habitat suitability and species occurrence. In climate change science, they are most often used to predict species occurrence under particular climate change scenarios.

Statistical and computer models are sometimes regarded with scepticism by decision- and policy-makers due to uncertainties in parameter estimates. However, quantitative modelling is one of our most transparent and science-based tool for the prediction of range shifts as a result of climate change, and resulting models and predictions are used to inform adaptation management strategies for species and ecosystems.

This information sheet explains the concepts and methodologies behind distribution modelling and explains how these models can guide both policy and management for those working on the ground.

What are Species Distribution Models?

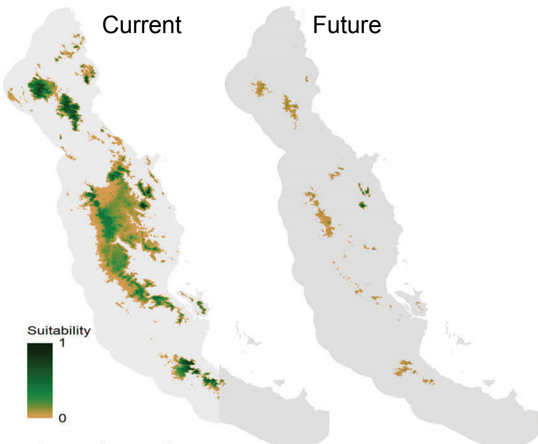
Species distribution models, also known as environmental niche models, habitat suitability models or bioclimatic envelope models, utilise associations between environmental variables and known species' occurrence records to identify environmental conditions where populations could potentially occur.

Base data layers use information including temperature, vegetation, rainfall and other weather parameters to map occurrences using Geographical Information System (GIS).

These data can then be employed to predict where a species might move to, or be able to persist, given a particular climate change scenario.

Commonly applied SDMs include early programs such as BIOCLIM and DOMAIN, which were key in developing the field. Contemporary programs, considered more robust, include MaxEnt (Maximum Entropy Modelling) ENFA (Environmental Niche Factor Analysis), and BRT (Boosted Regression Trees).

Endemic to the Wet Tropics rainforests, distribution models indicate the range of the golden bowerbird will decline under climate change



Model outputs showing the current habitat suitability in the Wet Tropics Bioregion for the golden bowerbird, compared to predicted habitat suitability under future climate change.
The distribution model predicts a drastic decline in habitat suitability with an increase in temperature.

Model Inputs and Outputs

Predictive occurrence maps are created through a series of stages;

- The current distribution of a species is mapped using known occurrence data from field research.
- Most models use a correlative approach, relating the presence of species to measured environmental variables at a site. Some models use absence of a species at a site.
- A model is built by combining this information with digital layers on climatic variables and landscape attributes (physical and biological). Between two to ten layers are usual, although more can be used.
- Barriers to dispersal, such as oceans, can also be included.
- When current distribution has been mapped, the potential distribution of the species under climate change is predicted, by changing the climatic variables according to the forecast scenarios produced by a global climate model (see over).
- Due to uncertainty in the degree of climatic change, a number of emissions scenarios are run.
- The final outputs show where a species may occur, or move to, given different climate change scenarios, in say, 50, 70 or 100 years.

Emissions Scenarios

A key factor in an SDM is the emissions scenario used in the global climate model.

This is an estimate of the amount of greenhouse gases likely to be produced under various future scenarios, specified by the IPCC Special Report on Emissions Scenarios (**SRES**):

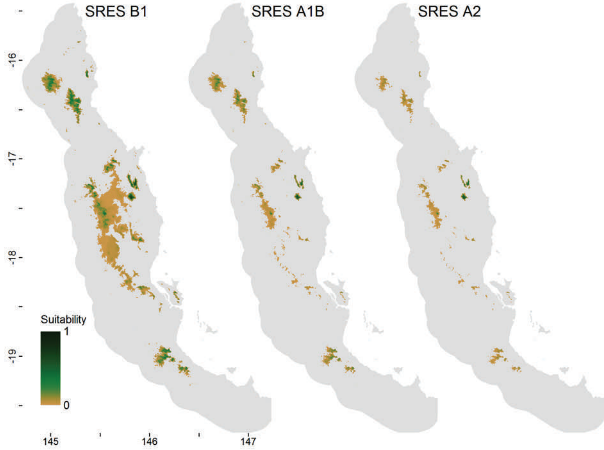
A1 - Global economic growth, increases of 1.4 - 6.4°C (including A1F1, A1B and A1T variants)

A2 - Regional economic growth, increases of 2.0-5.4°C

B1 - Global sustainability, increases of 1.1 - 2.9°C

B2 - Regional sustainability, increases of 1.4 - 2.8°C

Coupled ocean-atmosphere Global Circulation Models use climate simulations to predict climate change into the future; a period of time is simulated with continuously-varying concentrations of greenhouse gases, as estimated from the IPCC SRES described above.



Varying emission scenario alters model output for habitat suitability in the Wet Tropics for golden bowerbirds. With strong emissions control (B1), large tracts of habitat remain, but with weak control (A2) the species will have little suitable habitat left.

Limitations and Assumptions of Models

Whether modelled data accurately reflects real world species distributions depends on a variety of factors, including**:**

- The quality of the species occurrence data entered into the model. If field data on a species is sparse, the resulting distribution model may be highly uncertain.
- The occurrence of competing species or other factors that may prevent a species from occupy all niches in real life, when it appears to in the model.
- Within-region distributions can be modelled with relative certainty, but extrapolation to new environments is uncertain.

Transferring observed impacts and range shift projections to predictions of increased extinction risk at the species level has proven difficult, with most methods only considering climate-driven changes in the quantity of suitable habitat. In reality, species persistence will be influenced by interactions with many other processes. Recent work has aimed to move beyond climate-envelope models to incorporate mechanisms and interactions that drive species distribution and abundance—a 'whole ecology' approach to risk assessment under global change. However, such models are not currently widely used as they are data demanding.

Implications for Managers and Decision-makers

Species distribution models are flexible tools which can be used to guide management and policy on climate change adaptation. In particular, distribution models can aid with individual species management plans and also identify potential habitat refugia and key regions for protection or corridors. For example, SDM's can be used to predict the value of future reserve areas and plan species translocations.

However, lack of information on basic biology and ecology can impede SDM's for some rare and understudied species, and thus effort should be made to increase field studies on such species. Greater biological knowledge of species can also aid in the use of more robust mechanistic models.

When used in combination with assessments of demographic viability (extinction risk) and spatial structuring of populations within the landscape (e.g. metapopulations), SDM's can be used for ranking alternative management options for climate change adaptation, and for conservation prioritisation.

About the Adaptation Research Network for Terrestrial Biodiversity

The Adaptation Research Network for Terrestrial Biodiversity is one of eight research networks administered by the National Climate Change Adaptation Research Facility. It is hosted by James Cook University in Townsville, North Queensland.

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For more information on the Climate Change Adaptation Research Facility and other Research Networks, please visit www.nccarf.edu.au

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