Science for Saving Species

Research findings factsheet

Project 4.4.10

Threatened Species Recovery Hub

National Environmental Science Programme

Modelling distributions of species under environmental change

In brief

The Department of Agriculture, Water and the Environment relies on versatile, indicative species distribution models to show the likely distribution of species and their habitat to support environment decision making under the EPBC Act (1999). It is also desirable for these models to be extended to account for climate change, habitat changes and changes in the range of species, so that analysts, policy-makers and managers can predict future distributions of threatened species. We reviewed DAWE's current practice of SDM, finding that its approaches are generally best practice, and used a literature review and some worked technical examples to make recommendations for some improvements.

Background

Making good decisions about conservation depends on good information about the current and predicted future distributions of threatened species. This information is used to inform policy, conservation and recovery planning, offsets, environmental impact and strategic assessments. Modelling approaches need to be able to be broadly and swiftly applied across thousands of species (including those for which limited data are available). This helps enable policy-makers, analysts and managers to make more reliable predictions about species distributions under a range of future climate change scenarios.

The Geospatial & Information Analytics (formerly ERIN), a group within the Australian Government Department of Agriculture, Water and the Environment (DAWE), uses species distribution modelling (SDM) to produce maps for EPBC Act listed threatened and migratory Australian flora and fauna which are two of the nine Matters of National Environment Significance under the Act. Given the important role these maps play in environmental decisions, DAWE aspires to best practice SDM, and to extend their use of SDM to account for landscape change, climate change and shifts in species' ranges.

DAWE therefore requires models that are as versatile as possible and fit-for-purpose to predict species distributions under future conditions and at varying scales. This will enable the department to appropriately advise stakeholders on how best to protect threatened species into the future.

DAWE incorporated the recommendations from a report on SDM prepared by Jane Elith in 2008. This report helped to set the standards and methodologies for SDM used by DAWE to the present day. More recently, DAWE partnered in a pilot Collaborative Species Distribution Modelling project with several state government agencies to critique and standardise SDM practice. This project focused on Maxent as a modelling method.

Research aims

Our research had three main aims:

- To review the current SDM practice of DAWE, highlighting any areas where improvements could be made
- To examine the literature on SDM practice, and provide contemporary sources that support our recommendations for improving SDM practice
- To suggest additional modelling methodologies that would help describe the distributions of species under changing environmental conditions (chiefly various climate change scenarios).

THE UNIVERSITY OF MELBOURNE

Cited material

Elith, J. (2008). *Threatened Species Map Updates: Species Distribution Modelling*. Unpublished Report.

Visintin, C & Wintle B (2020). *Modelling Distributions of Species under Environmental Change*. NESP Threatened Species Recovery Hub.

Further Information

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What we did

We reviewed DAWE's current SDM practices. In particular, we assessed its performance as contemporary best practice by looking at key modelling practices that were identified in the original report (Elith, 2008) and providing updates to the advice provided in that report.

Through our review of current literature and by providing worked examples, we were able to identify some limitations to DAWE's current modelling practices. We proposed ways to improve the ability of the modelling to support good environmental decisions.

We introduced several new modelling operations. These consider shifts in species' ranges based on contemporary literature and software for spatially explicit population modelling that has been newly developed by the Threatened Species Recovery Hub at The University of Melbourne.

Northern Corroboree Frog. Photo: Adam Parsons.

Key findings

Our key finding was that the approaches currently used by DAWE are still, in many ways, best practice for SDM. We confirm that Maxent is a reliable, well-documented and well-supported modelling method.

However, we identified and demonstrated that SDM has a limited ability to represent species' distributions under changing climates. To meet these objectives, DAWE will need to employ alternative SDM methods.

We recommended some methodological updates to address sampling bias and small sample sizes – both could be done better in current DAWE SDM practice.

Implications

Key implications of our findings for an SDM analyst include:

- Correlative SDM models (e.g., Maxent) can't incorporate some things like how species disperse, so they can only make incomplete predictions about distributions.
- SDM uses environmental information, which is tied to geographical information. This can lead to inaccuracies; however, spatial information about species' distributions can be added to the modelling to address this issue.
- IIt should be understood and acknowledged that predictions from models will be approximate and that any model uncertainty should also be visually represented in maps. For example, predictions can be shown as a range to indicate high and low likelihoods of species occurrence.
- DAWE modelling procedures use presence-only data, and only about a third of the species have sufficient data to support Maxent modelling. This has theoretical and practical limitations for species distribution models. Whenever possible, presence/absence and abundance data should be collected, archived in suitable database, and used for modelling, noting that absence data is severely limited in availability for most species of interest.
- It is important to take into account the time scales relevant to the presence data and environmental predictors. If models are fitted with species observations from before and after major disturbances, but the environmental variables do not account for these events, this could lead to serious errors in making predictions about future distributions.
- Given the very uncertain nature of predicting the distributions of species into the future, it is useful to perform analyses on the model that help to identify, and potentially control for, sources of uncertainty.

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