Using State and Transition Simulation Models to Assess the Future of Tasmania's Wet Forests

State and Transition Simulation Models (S&TSMs) have been used internationally to make fine-scale estimates of future ecosystem change, especially due to climate change and bushfires. Their use in Australia, however, has been limited. This project aims to develop S&TSMs for operational use in Australian environments, using Tasmania's southern forests (including sclerophyll forest, rainforest, and buttongrass) as a case study.

State and Transition Models

State and Transition Simulation models (S&TSMs) are powerful tools for projecting ecological and vegetation changes, as they move beyond simple successional models and can represent dynamic and novel ecological responses to disturbance (Figure 1). S&TSMs are particularly useful at integrating expert knowledge and empirical data to make predictions. Developing operational S&TSMs typically involves a two-step process:

1. an expert elicitation exercise to describe both reference and novel states (e.g. vegetation structure and floristics) and transitions (e.g. succession and disturbance), and to estimate the probability of each occurring in a particular landscape
2. refining parameter estimates (e.g. probabilities of states and transitions) through analysis of existing empirical data and further collection of field data.

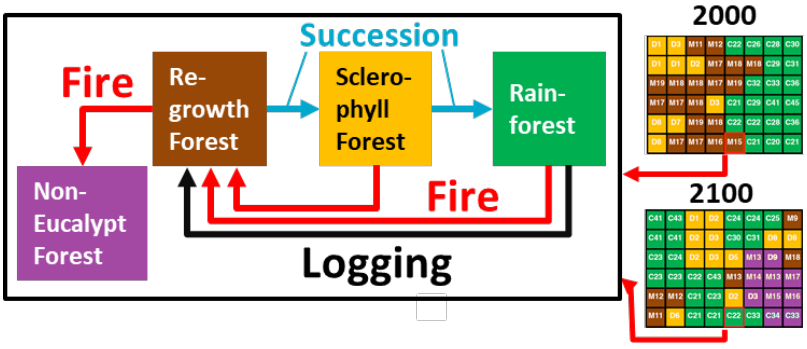

Figure 1: A simplified state and transition simulation model for obligate-seeder wet eucalypt forest (for demonstration only). Flowchart (left) represents potential pathways of change within a given landscape cell (right). Outputs can be applied to answer questions about land use change and vegetation dynamics over time.

Diagram adapted from: Daniel, C. J., Frid, L., Sleeter, B. M., & Fortin, M. J. (2016). State-and-transition simulation models: a framework for forecasting landscape change. *Methods in Ecology and Evolution*, 7(11), 1413-1423. doi: https://doi.org/10.1111/2041-210X.12597

Why State and Transition Simulation Models?

- Traditional models are one-dimensional, e.g. predicting biomass as a function of time since disturbance.
- S&TSMs are dynamic models that can account for ecosystem changes and uncertainty due to management, natural disturbances and climate variability, including climate change (Figure 2).
- S&TSMs can answer important ecological and land-management questions at a landscape scale.
- S&TSMs can be used in unison with other models, such as fire behaviour models, carbon accounting models, and plant growth models, to incorporate the effects and feedbacks associated with these ecological processes.

Project Plan

We aim to use Tasmania's southern forest landscape (surrounding the Warra experimental forest) as a case study for how to robustly build operational S&TSMs. Existing conceptual models from the Australian Ecosystems Models (AusEcoModels) Framework (Box 1) will be used as a starting point for expert elicitation. Experts from across the Tasmanian Government, the Tasmanian forest industry, and the University of Tasmania will be invited to participate in a two-day workshop, to be held in mid-late 2023, to identify and develop relevant S&TSM parameter estimates. An extensive existing dataset describing the effects of the 2019 Tasmanian fires, along with additional field data collection, will then be used to further refine parameter estimates. These fully parameterised conceptual models will be used to simulate future scenarios under climate change and answer specific research questions, as identified by end users, about Tasmania's southern forests. A software platform called ST-Sim, which is designed for use by both researchers and managers, will be used to make these future projections. Outputs of ST-Sim are easily understood by non-experts and hence it is ideal for operational use.

Figure 2 State and Transition Simulation Models can be used to represent dynamic changes between states

Source: James Furlaud

Box 1: The Australian Ecosystems Models Framework

The Australian Ecosystem Models (AusEcoModels) Framework project is collating, synthesising, and summarising scientific knowledge of ecosystem dynamics and is capturing this knowledge in a set of dynamic ecosystem models. These models will describe the dynamic characteristics and drivers of Australian ecosystems in unmodified and modified states.

What kinds of questions can S&TMs answer?

S&TSMs can be used to answer ecological and land management questions, especially in the context of fire regimes and climate change. Experts at the workshops will be asked to identify questions important to end users, examples could include:

- What are the long-term effects of different proposed forest management regimes on future fire risk and on the extent and condition of different types of forest?
- Where is rainforest or other refugia most at risk from increased landscape flammability given different management and climate scenarios?
- How will climate variability (e.g. climate change, drought, and wet year cycles) affect fire risk and vegetation extent?

Project Funding

This project is funded by a CSIRO Early Research Career (CERC) Fellowship and the National Bushfire Intelligence Capability (NBIC). NBIC is preparing for a changing Australia by connecting local and national understandings of bushfire hazard and risk. NBIC is bringing together large amounts of data and information to develop national bushfire programs and policies. These will help states and territories manage the growing threats of bushfires and support longer-term climate adaptation decision making. This project will help NBIC achieve three goals: developing a model to predict future fuels and fire risk in wet forests across Australia, using it to produce a nationwide fire-risk map, and helping communities build capacity to predict and manage future bushfire risk.

For further information

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