

The Australian Ecosystem Models Framework

A national framework for dynamic ecosystem models

The Australian Government Department of Agriculture, Water and the Environment is collaborating with the CSIRO to develop a national framework of dynamic ecosystem models - the Australian Ecosystem Models (AusEcoModels) Framework.

This project is collating and synthesizing scientific knowledge of ecosystem dynamics and capturing this in a series of conceptual models.



Fire in tropical savanna. Image credit: Barbara McKaige

What are ecosystem dynamics?

Ecosystem characteristics are regulated by environmental features such as soil type, climate and topography, as well as by disturbance regimes, such as fire and flooding.

All ecosystems and their constituent parts are dynamic. Ecosystem dynamics can be defined as the relationships between and among biotic and abiotic components of ecosystems, as well as their responses to disturbances. Such responses can include changes to nutrient and energy cycling or patterns of species recruitment.

In this project we make a distinction between endogenous and exogenous disturbances. *Endogenous disturbances* are defined as those which support ecosystem integrity and to which ecosystems have adapted. They include

disturbance regimes managed by Indigenous people, such as cultural burning. *Exogenous disturbances* are those which are not integral to ecosystem function and are mostly driven by human activity. These disturbances are often threatening processes which directly impact ecosystem integrity, such as land clearing, or indirectly such as climate change. Alternatively, exogenous conservation actions can be used to mimic endogenous disturbance regimes (e.g. replacing macropod grazing with strategic livestock grazing) and improve ecosystem integrity. Aside from conservation actions, ecosystems and biodiversity may struggle to adapt to both direct and indirect exogenous disturbances.

What models are in the framework?

The models in this framework describe the characteristic attributes and dynamics of ecosystems in their reference state, including relationships between different expressions of ecosystems that manifest at various times since disturbance (e.g. recently burnt vs long-unburnt).

The framework also contains state and transition models (Westoby et al, 1989). State and transition models are premised on the idea that ecosystems manifest as multiple, alternative condition states and transition between states via exogenous disturbances. State and transition models are powerful conceptual and communication tools, organising and distilling expert knowledge of ecosystem dynamics, including responses to human interventions in simple, readily understandable formats. The models identify the theoretical thresholds for resilience of ecosystems under different land use regimes and in different condition states. They highlight actions that can maintain an ecosystem state or drive its transition to another state. This knowledge supports significant, but simple discrimination in designing management interventions or prioritising investment.

Why do we need this framework?

The State of the Environment Report 2011 identified that inadequate knowledge, information and decision support

systems constrain the capacity of government to develop and enact evidence-based environmental policy.

While summaries and mapping products exist describing the characteristics and distribution of major Australian ecosystem types, as well as state and territory-based vegetation condition benchmarks systems, there is a need to develop consistent national approaches to summarising ecosystem dynamics and benchmarking in order to support national ecosystem health assessment and reporting. The framework provides a basis for systematic ecosystem services assessment and integrated ecosystem management approaches.

As global change drivers intensify, ecosystems are also likely to change. The knowledge captured within this framework is an essential structural underpinning for forecasting the likely future direction and nature of change to Australia's ecosystems.

How will the models be used?

The AusEcoModels Framework will provide realistic reference points for assessing the status of ecosystems and monitoring long term directional change.



Feral pig disturbance of floodplain grasslands, Murray Flats.
Image credit: Dan Metcalfe

The models will support flexible and responsive natural resource management and help managers to more readily identify influences that may be positively or negatively impacting on environmental assets.

In addition, the framework may provide the conceptual architecture for prioritisation strategies for natural resource management investment and related monitoring, evaluation and reporting strategies.

How will the project build on existing vegetation benchmarking approaches?

Condition benchmarks or reference states provide a way to consistently assess the condition of ecosystems. They generally quantify the range of values characteristic of

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mature and relatively undisturbed (or reference) examples of an ecosystem type.

The AusEcoModels Framework will expand on these approaches by characterising ecosystems in a range of reference and modified condition states, as well as the disturbance processes that transition ecosystems between different states.

How will the models be developed?

Individuals within the science community, state and territory governments and science institutions have a wealth of knowledge about the characteristics of ecosystems and their responses to disturbance. If systematically captured, this knowledge provides a foundation for a new era of understanding about ecosystems and their dynamics.

The project will gather, organise and optimise this critical scientific understanding for reuse in order to inform and support evidence-based decisions underpinning environmental policy.

The project team will therefore seek to collaborate with individuals, research institutions and organisations involved in understanding processes driving the dynamics of Australian ecosystems to develop the models.

What will the project deliver?

- an approach for classifying Australian ecosystems characterised by responses to disturbance regimes
- documentation of the Australian ecosystem science community's current understanding of ecosystem dynamics
- a national framework for dynamic ecosystem models, including state and transition models

What is the future?

The models will have the potential to:

- provide the conceptual architecture for a national system of environmental accounts
- be developed into detailed, quantitative / mechanistic models
- be used for environmental forecasting
- provide a network information architecture for ecosystem knowledge
- conceptualise ecosystem dynamics over time, including ecosystem responses to climate change

If you would like to know more, please contact us or visit <https://research.csiro.au/biodiversity-knowledge/>

For further information

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