A guide to the

Long Term Ecological Research Network, Australia
The Long Term Ecological Research Network (LTERN) is an integrated community of eminent researchers who undertake long-term research at established plot networks across Australia.

LTERN enables researchers to tackle critical questions associated with the effects of disturbance and change on Australian ecosystems.

LTERN’s collaborative approach provides important scientific knowledge and data to allow Australians to better understand and interpret environmental change.

Cover image
Comb-crested Jacana chick (Aaron Greenville)

Flame Robin (David Blair)
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Effectively adapting to environmental change is critical to a healthy, sustainable and prosperous Australia. Long-term ecological monitoring enables us to better understand environmental change and to inform management of Australia’s natural environment in a more meaningful way. Initiatives such as the Long Term Ecological Research Network (LTERN) help Australia to make intelligent responses to emerging environmental challenges.

The formation of LTERN as a Facility within the Australian Government’s Terrestrial Ecosystem Research Network in 2012 has presented us with challenges and opportunities. We have been fortunate to work with some of the world’s best ecologists, statisticians and data scientists. Through the creation of LTERN we have tried to establish a culture of collaboration, reciprocity and productivity. Our activities fall broadly into the three areas: Data Collection; Data Publication and Archiving; and Science Communication and Education. It is with much pride that we showcase in this brochure some of LTERN’s achievements. Significant contributions have also been made by LTERN staff and volunteers (past and present), whilst undertaking field-based data collection, curation and publication of data or whilst administering and communicating the outcomes and learnings from LTERN’s research within the LTERN Office. We have also benefited greatly from ongoing guidance and contributions received through our External Reference Group and through our colleagues within TERN.

In coming years, we look forward to building on our successes and continuing to advocate the need for long-term ecological research in Australia. We envisage a future where more of Australia’s invaluable long-term research projects can be supported by LTERN. A future where the value of ecological monitoring is demonstrable because plot-based monitoring data makes a unique and important contribution to the nation’s ability to produce environmental accounts, environmental reports (e.g. the State of the Environment, State of the Forests) and to fulfil reporting obligations under international agreements, such as the Convention on Biological Diversity. To enable this future, we will continue to advocate for the stable policy settings and adequate recurrent funding needed to sustain Australian long-term ecological research.
### LTERN Monitoring Themes and Spatial Distribution

LTERN Plot Network infrastructure extends across a remarkably wide range of ecosystems and focusses on a wide range of monitoring themes.

## Core LTERN monitoring themes

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<thead>
<tr>
<th>Ecosystem</th>
<th>Monitoring Themes</th>
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<tr>
<td>Victorian Tall Eucalypt Forest</td>
<td>Vegetation structure, Plant species composition, Plant species abundance, Individual plants, Carbon, Plant phenology, Invertebrates, Birds, Mammals, On plot weather, Hydrology, Soil, Fire, Cyclones, Invasive plants, Grazing domestic livestock, Logging forestry, Land clearing, Restoration, Genetics, Climate change, Behaviour</td>
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<td>Nanangroe Plantation</td>
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### LTERN Monitoring Themes and Spatial Distribution

Plot Network Leaders:
- Lindenmayer
- Metcalfe
- Dickman & Wardle
- Russel-Smith & Gillespie
- Green
- Hoffmann

The map illustrates the distribution of various ecosystems and their associated monitoring themes across Australia. Each ecosystem is represented with a specific color, indicating the focus areas for monitoring.

- **Tropical Rainforest**
- **Connell Rainforest**
- **Desert Uplands**
- **Mallee**
- **Nanangroe Plantation**
- **Woodland Restoration**
- **Upland Heath Swamps**
- **Jervis Bay Booderee National Park**
- **Victorian Alpine**
- **Three Parks Savanna Fire-effects**

The map highlights the geographic spread of these ecosystems and the core areas where LTERN monitoring themes are of particular interest.
PLOT LEADER

Professor David Lindenmayer
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David has worked on biodiversity conservation issues for over 25 years. He is a Fellow of the Australian Academy of Science and has won numerous awards for his work, including the Eureka Prize for Environmental Research, the Whitley Award, The Australian Ecological Society Research Award, the DaimlerChrysler Australian Environmental Research Award and the Australian Natural History Medallion. David has written over 35 books and 900 scientific publications.

PLOT NETWORKS

Victorian Tall Eucalypt Forest Plot Network, Central Highlands of Victoria

Aims
Quantify the inter-relationships between human and natural disturbances and changes in vegetation condition and biodiversity response.

Key research questions
• How does natural disturbance and/or management intervention alter vegetation condition, and, in turn, the response of biodiversity?
• What is the relationship between vegetation and carbon biomass?

Surveys
• Birds and marsupials every year.
• Vegetation every two years.
• In operation since 1983.
Nanangroe Plantation Gundagai, New South Wales

Aims
Quantify the inter-relationships between human disturbance, landscape-based management intervention, and changes in vegetation condition and biodiversity response.

Key research questions
• What are the relationships between vegetation condition and biodiversity?
• How does management intervention (e.g. plantation establishment) influence the response of biodiversity?

Surveys
• Frogs, reptiles, mammals and birds are surveyed every two years.
• Vegetation plots are surveyed approximately every five years.
• In operation since 1997.

Jervis Bay Booderee National Park, Jervis Bay Territory

Aims
Quantify the inter-relationships between disturbance and changes in coastal vegetation condition and the response of biodiversity.

Key research questions
• What is the relationship between vegetation condition and biodiversity, and is this relationship consistent across vegetation types?
• How does natural disturbance and/or management intervention (including weed and feral animal control and prescribed burning) alter vegetation condition and the response of biodiversity?

Surveys
• Small mammals, birds and reptiles - annually.
• Arboreal marsupials - every two years.
• Vegetation - every three years.
• In operation since 2002.
**PLOT LEADER**

**Professor David Keith**
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David's primary expertise is in botany, with particular interests in processes that govern the dynamics of plant populations and communities. Much of David's research concerns the application of theory and empirical advances in plant population and community ecology to the development of strategies for conservation and management of biodiversity. This has led him to expand his research through collaborations to address the conservation biology of invertebrate and vertebrate animals, and to explore the consequences of alternative management scenarios through risk analysis and development of ecological models.

**PLOT NETWORKS**

**Upland Heath Swamps, Greater Sydney Basin**

**Aim:** Improve understanding of the roles of climate and fire regimes in the dynamics and persistence of upland swamps and their biodiversity.

**Key research questions**

- What structural and compositional changes are occurring in upland swamps?
- What is the nature of co-variation and feedback between vegetation and soil properties?
- What are the effects of alternative fire regimes and how can responses be characterised by trends in functional groups of species?

**Surveys**

- Vegetation and soils are systematically surveyed on an irregular basis determined by the occurrence of fires.
- In operation since 1983.
Woodland Restoration, Greater Sydney Basin

**Aim:** Develop robust methods to evaluate the success of native woodland restoration on retired agricultural land.

**Key research questions**
- What are the appropriate methods and metrics for detecting change in the biodiversity values of restoration plantings?
- How do alternative management strategies influence the pace and direction of restoration trajectories?

**Surveys**
- Surveys of vegetation are undertaken every four years.
- Invertebrates are surveyed every seven years.
- Soil samples are taken every five years.
- Precipitation, evaporation and temperature are recorded daily.
- In operation since 1992.

Mallee, western New South Wales

**Aim:** Improve understanding of the mechanisms that influence vegetation change, including fire, grazing regimes and climatic variation, and the ability of the ecosystem to sustain its characteristic biota.

**Key research questions**
- How do survivorship and fecundity of different plant species vary with time since fire?
- Do different herbivore species have contrasting effects on standing vegetation?

**Surveys**
- Surveys of vegetation and fauna have been undertaken systematically in relation to fire and herbivore exclusions since 1997.
- Automatic weather stations and manual pluviometers recording daily precipitation, evaporation and temperature have been established progressively since 1994.
PLOT LEADER
Dr Dan Metcalfe
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Dan has a PhD in plant ecology and ecophysiology from the University of Cambridge. He held a postdoctoral position with CSIRO in Atherton, Queensland, from 1994 to 1997, working on aspects of root competition and its effects on seedling recruitment in lowland rain forest, funded by the Natural Environment Research Council through the University of Cambridge. From 1998-2004 he lectured in ecology at the University of Brighton in the UK and continued his interest in tropical research with field work in eastern and southern Africa and South-east Asia before returning to Atherton in 2004. Dan now heads up CSIRO’s Ecology Program, but still maintains research interests in fire ecology, management of threatened species and communities, biogeography of northern Australia and long-term forest dynamics.

PLOT NETWORKS
Desert Uplands, Northern Desert Uplands of Queensland

Aim
Assess bird diversity across a range of variation in woody vegetation structure.

Key research questions
• How does intensity of mechanical disturbance affect bird diversity and abundance?
• How do populations recover after cessation of such disturbance?
• What is the size and direction of the natural population fluctuations detected, and how do they compare with human-induced disturbance?

Surveys
• Birds and vegetation structure are surveyed.
• In operation since 2004.
Tropical Rainforest, Rainforest of North-eastern Australia, centred in the Wet Tropics of North-Queensland, but extending from Iron Range on Cape York to the Mackay–Whitsunday region.

**Aim**
Understand natural forest dynamics in the absence of logging disturbance.

**Key research questions**
- How do forests recover from landscape-scale disturbance events such as cyclone and disease outbreaks?
- What can we infer about the impacts of climate change on tree growth from studying altitudinal and latitudinal variation, and how does the composition of the canopy layer change with time – does the proportion of rare and common species remain stable over time?

**Surveys**
- Trees with diameters greater than 10 cm are re-measured every 2 to 4 years.
- Full species inventories, individual heights and basal area data are also recorded for each plot.
- Soil characteristics have been measured, and in some plots detailed climate records have been maintained.
- In operation since permanently reserved plots were set up in primary rainforest between 1971 and 1980.
Chris has explored the processes that maintain and shape patterns in biodiversity for much of the last 30 years, focusing most effort in arid Australia. Chris is the recipient of the Ellis Troughton Memorial Award and C. Hart Merriam Award for his research and the Whitley Medal for the best natural history book (A Fragile Balance, 2007). He was the inaugural chair of the NSW Government Scientific Committee from 1996 – 2002 and NSW Plant and Animal Scientist of the Year 2010. Chris has written or edited 20 books and monographs and authored over 300 journal articles and book chapters.

Glenda’s research explores the dynamics of populations, species and ecological interactions in relation to ecological drivers such as unpredictable rainfall, changing climates, fire, and grazing. From initial interests in forests and evolutionary dynamics of life histories, Glenda started working in arid systems 18 years ago. Glenda is Chair of the Ecosystem Science Council, Associate Editor of four journals and has trained over 40 research students. Her interests in conservation and management extend to serving on expert panels and advising on the management of conservation reserves.
PLOT NETWORK
Desert Ecology
8000 km² in the north-eastern Simpson Desert, western Queensland

Aim
Track long-term shifts in biodiversity in relation to key drivers, both intrinsic to the resource-pulse dynamics and due to human disturbance. These drivers include unpredictable rainfall and droughts, fire, feral predators and grazing.

Key research questions
• How will increased climate extremes impact on the dynamic network of interactions among species and their role in maintaining biodiversity?
• How do complex predator-prey interactions regulate vertebrate diversity in arid Australia?

Surveys
• Surveys of flora and fauna are undertaken several times each year and manipulative experiments are conducted to disentangle the multiple interacting processes.
• Climatic variables of rainfall and temperature are recorded continuously by 13 automatic weather stations installed in 1995.
• In operation since 1990.
PLOT LEADER (VEGETATION AND FIRE)
Dr Jeremy Russell-Smith
jeremy.russell-smith@cdu.edu.au

Jeremy is a landscape ecologist with 30 years experience in the fire-prone savannas of northern Australia and neighbouring Asian regions. He has been involved with research into monsoon rainforest, savanna, and tropical heath ecology and conservation, medicinal plant conservation, Aboriginal fire and land management, and associated livelihood applications. In 2007, Jeremy’s research team was awarded the inaugural Australian Eureka Prize for Innovative Solutions to Climate Change in recognition of the savanna burning emissions abatement program established in Western Arnhem Land.

PLOT LEADER (FAUNA)
Dr Graeme Gillespie
graeme.gillespie@nt.gov.au

Dr Graeme Gillespie is Director of the Terrestrial Biodiversity Section of the Northern Territory Department of Land Resource Management, based in Darwin. Graeme has 29 years’ experience in the biodiversity field, working in both applied research and management with government agencies and non-government organisations, both in Australia and Southeast Asia. Graeme’s background has provided him with extensive experience developing and coordinating a range of biodiversity research and monitoring projects, linked to tangible management and policy outcomes in a range of environments and cultural settings. Graeme manages the Three Parks Savanna Fire-effects Plot Network (Fauna) in the Northern Territory.

PLOT NETWORKS
Three Parks Savanna Fire-effects, Three Northern Territory National Parks

Aim: Deliver research infrastructure to inform how to effectively manage imposed fire regimes in tropical savanna landscapes.

Key research questions
• What are the effects of management-imposed fire regimes on the responses of the savanna matrix, flora and fauna species?
• What are the effects of management-imposed fire regimes on vegetation and associated biomass dynamics?

Surveys
• The occurrence of fire is assessed bi-annually on-ground and satellite derived fire mapping is conducted three times a year.
• A full inventory of vegetation is undertaken every five years.
• Terrestrial vertebrates are monitored systematically but on an irregular and less frequent basis.
• In operation since 1994.
Peter teaches ecology and conservation biology and has been working in the tropics for over 20 years. His research focuses on a variety of projects including long-term demographic studies of tropical trees, mechanisms maintaining species diversity in species rich tropical forests, the role of consumers in determining patterns of seedling abundance and diversity on the forest floor, and the impact and management of invasive species. Peter is the recipient of a Banksia Foundation Environmental Award, and much of his research underpins effective conservation and management outcomes.

PLOT NETWORK
Connell Rainforest, South-east and Northern Queensland

Aim
Improve our understanding of the mechanisms that maintain diversity in complex, species rich tropical and subtropical rainforests.

Key research questions
• How do long-term demographic patterns vary across life stages within and between species?
• Is this variation correlated with plant functional traits?
• Can interspecific variation in key demographic processes explain the maintenance of species diversity in these forests?

Surveys
• Surveys of recruitment, growth and mortality are undertaken across all size classes of trees, from tiny seedlings to canopy giants, every few years.
• The network has been in operation since 1963.
Aim
Monitor the dynamics of the major alpine ecosystems, and understand fundamental ecological processes by assessing the effects of disturbance by fire, climate change and invasive alien species on the alpine biota.

Key research questions
• What are the long term changes in the major vegetation types and faunal assemblages?
• What are the likely long term effects on the alpine biota of human disturbance, climate change, drought, fire and altered biotic interactions?

Surveys
• All major vegetation types including heathlands, grasslands, wetlands and rare snow-patch herbfields.
• Small mammals and invertebrates.
• Genetics and phenology.
• The frequency of surveys generally ranges from every 3 to 10 years; some plots are surveyed annually during initial monitoring.
• The original plots in this network were established in the 1940s; additional plots were set up in the 1980s and following decades. Plots associated with an international climate change experiment were established in 2003.
The LTERN Data Portal

Field-data and metadata from the plot networks is published to the LTERN Data Portal at www.ltern.org.au


Metadata Data

Identifier

docid Item.80.26

Data Creators

Individual: Professor David Keith

Position: Plot Leader

Organization: Centre for Ecosystem Science, University of New South Wales

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Phone: 02 9385 2101

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Abstract

The Upland Heath Swamps Plot Network: Hydrological Climate data are monitored at automatic weather stations established by the University of NSW in 2013 within the study area. In addition, three soil probes placed along local soil moisture gradients in the vicinity of each station record soil moisture, conductivity and temperature at various depths below the surface at 30-minute intervals, which are averaged to produce daily mean estimates. The Upland Heath Swamps Plot Network research plots commenced in 1983 and have been revisited in 2004, 2009 and again in 2014. A synopsis of related data packages which have been collected as part of the Upland Heath Swamps Plot Network’s full program is provided at http://www.ltern.org.au/index.php/item-plot-networks/upland-heath-swamps.
LTERN Publications

Fit-for-purpose, consistent, long-term monitoring is crucial to measure and understand key attributes of ecosystems—and the human and natural process that affect them. This need, its challenges, and their potential solutions have been written about by members of LTERN in a range of publications.

LTERN is also centrally engaged with the development of a global ecosystem risk assessment protocol. The IUCN developed this protocol to support a global Red List of Ecosystems. A recent special issue of Austral Ecology showcases the application of LTERN expertise and data in providing detailed risk assessments for a diverse selection of Australia ecosystems. In applying the IUCN criteria to these ecosystems, researchers aimed to:

- identify the defining features of their systems and the processes that threaten them
- evaluate trends in key variables relevant to the persistence of the ecosystems
- assess the risk of ecosystem collapse in the 21st century.
Question-driven research underpins every plot network

To learn more about LTERN’s conceptual design, consult *LTERN: Objectives, design and methods*, which documents the objectives of LTERN, the research questions being examined, and the field methods being employed.

The conceptual design of LTERN enables researchers to:

- quantify the responses to a range of mechanisms that influence ecosystem change
- understand processes that occur over long periods of time
- investigate theoretical and simulation models with the collection of relevant, structured datasets
- provide relevant, topical advice to advance the development and implementation of evidence-based policy.
LTERN is a facility within the Terrestrial Ecosystem Research Network (TERN). TERN is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy.

This brochure has been produced by The Australian National University. We acknowledge and thank all photographers, LTERN and TERN for their contributions and permission to reproduce content provided.

www.tern.org.au/ltern