Australian LTER and its potential to contribute to the Asia Pacific - BON


https://www.wildlifeacoustics.com

Framing statement for AOGEO

Scaling up successful Earth Observation activities for all of Asia-Oceania.

https://geobon.org/bons/national-regional-bon/

Presentation by :
Associate Professor Mike Liddell
James Cook University
email: michael.liddell@jcu.edu.au
ph: 61 7 4232 1275

Australian Long Term Ecological Research
Some Background

Gosz 1996 TREE: International LTER: priorities and opportunities

'*At this point, the following countries have* ***established funded LTER programs*** *that are participating in an ILTER Network:* ***Australia****,…'*

TERN LTER Network (LTERN) 2010 - 2017: A national network of 12 pre-existing LTER sites – each LTERN plot network = **multiple ILTER Satellite Sites**

TERN Australian SuperSite Network 2010 - 2018:

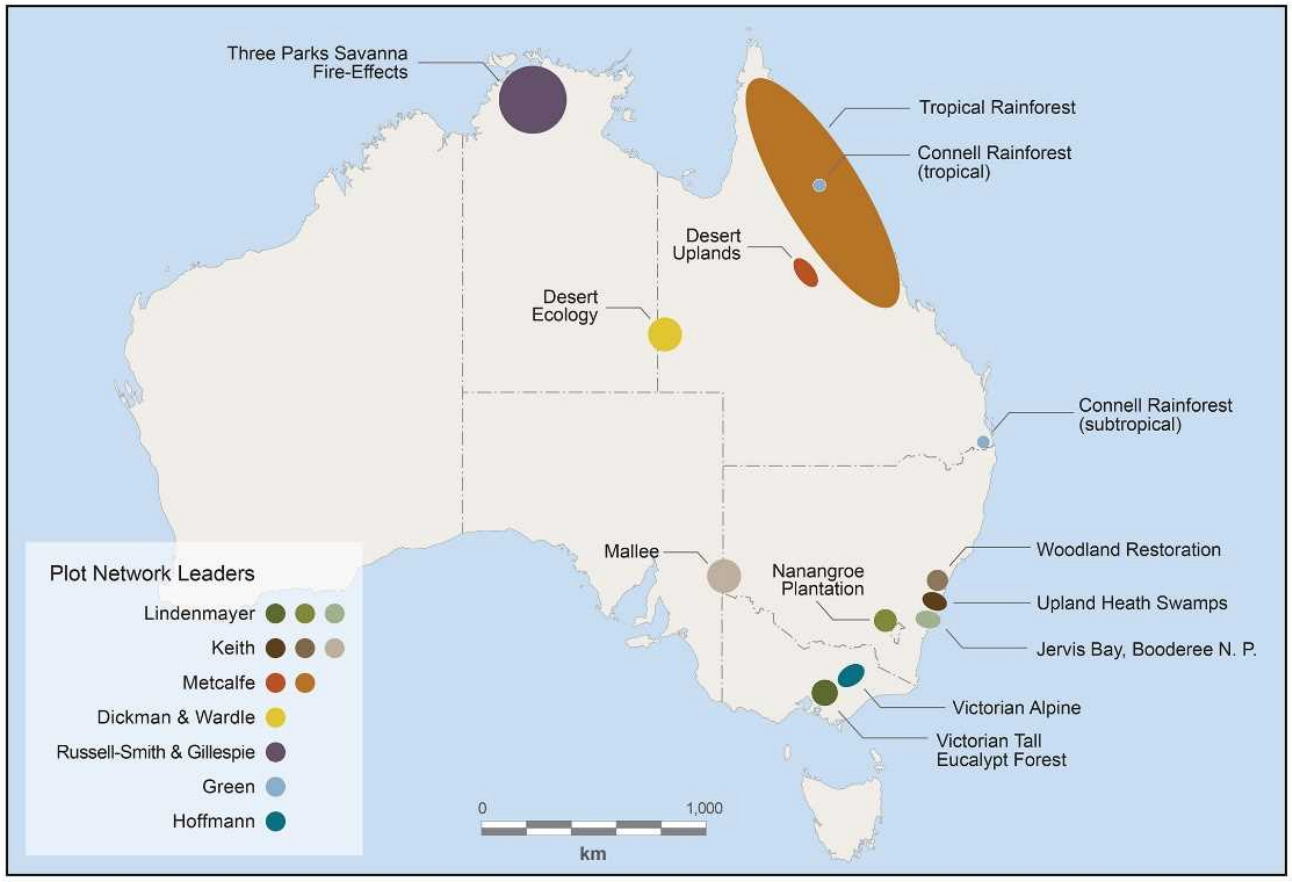
A national network of pre-existing and new LTER sites that = **ILTER Master Sites**.

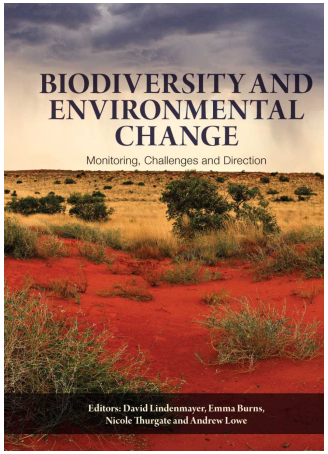
AusLTER 2019? -

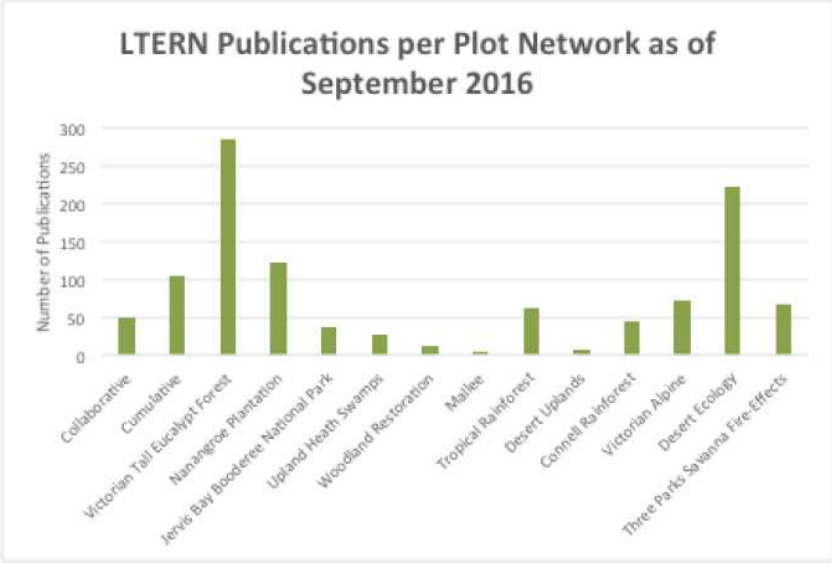
Planning is underway involving Ecological Society of Australia, Ecosystem Sciences Council and TERN to establish AusLTER as a neutral, inclusive community of practice. ESA will consult with the Australian LTER community to identify their wishes / needs and provide non-financial support. Current planning is focused on developing a website for AusLTER to be hosted by ESA to serve as a communication vehicle.

TERN LTERN

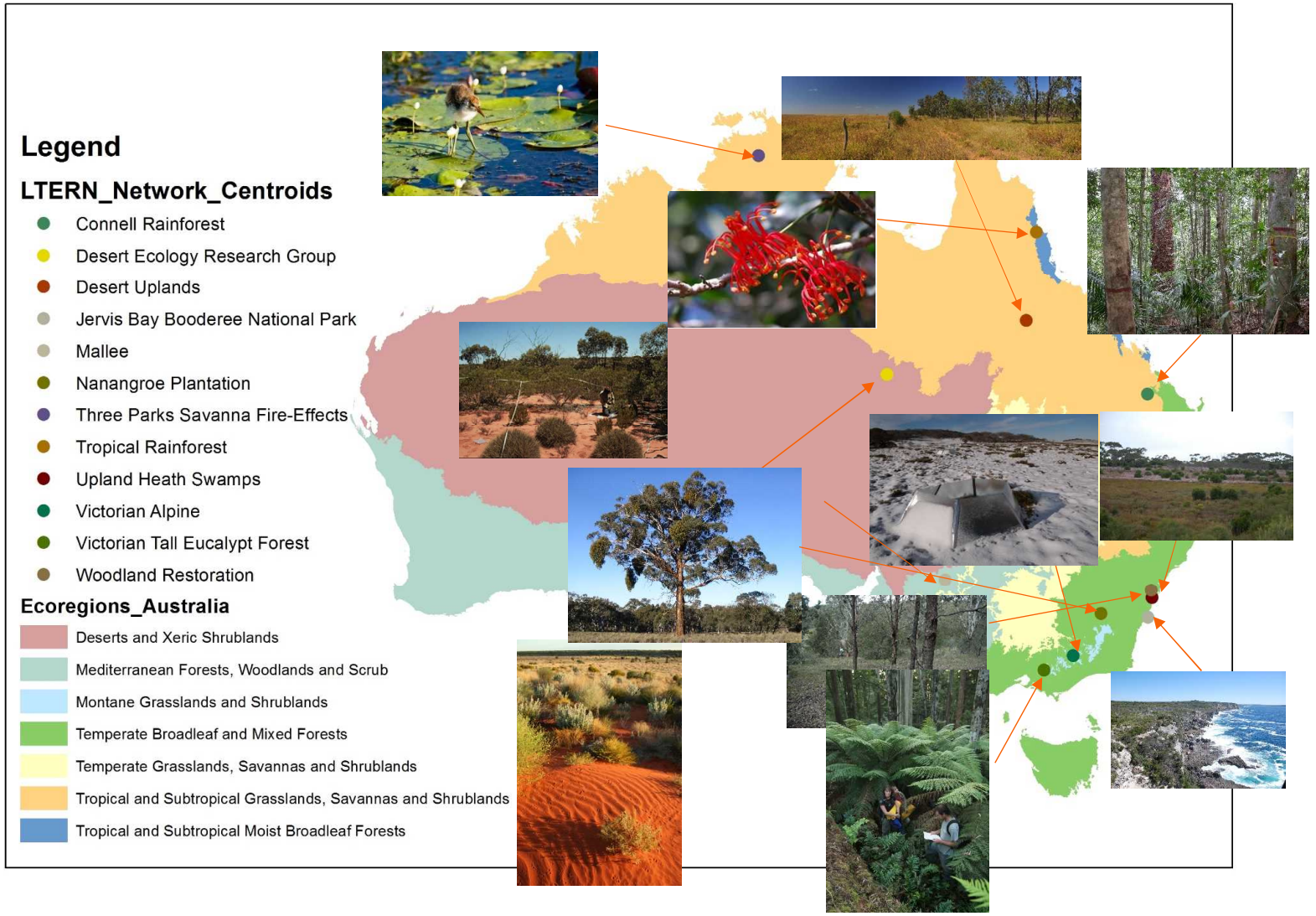
TERN LTER Network (LTERN) 2010 - 2017:



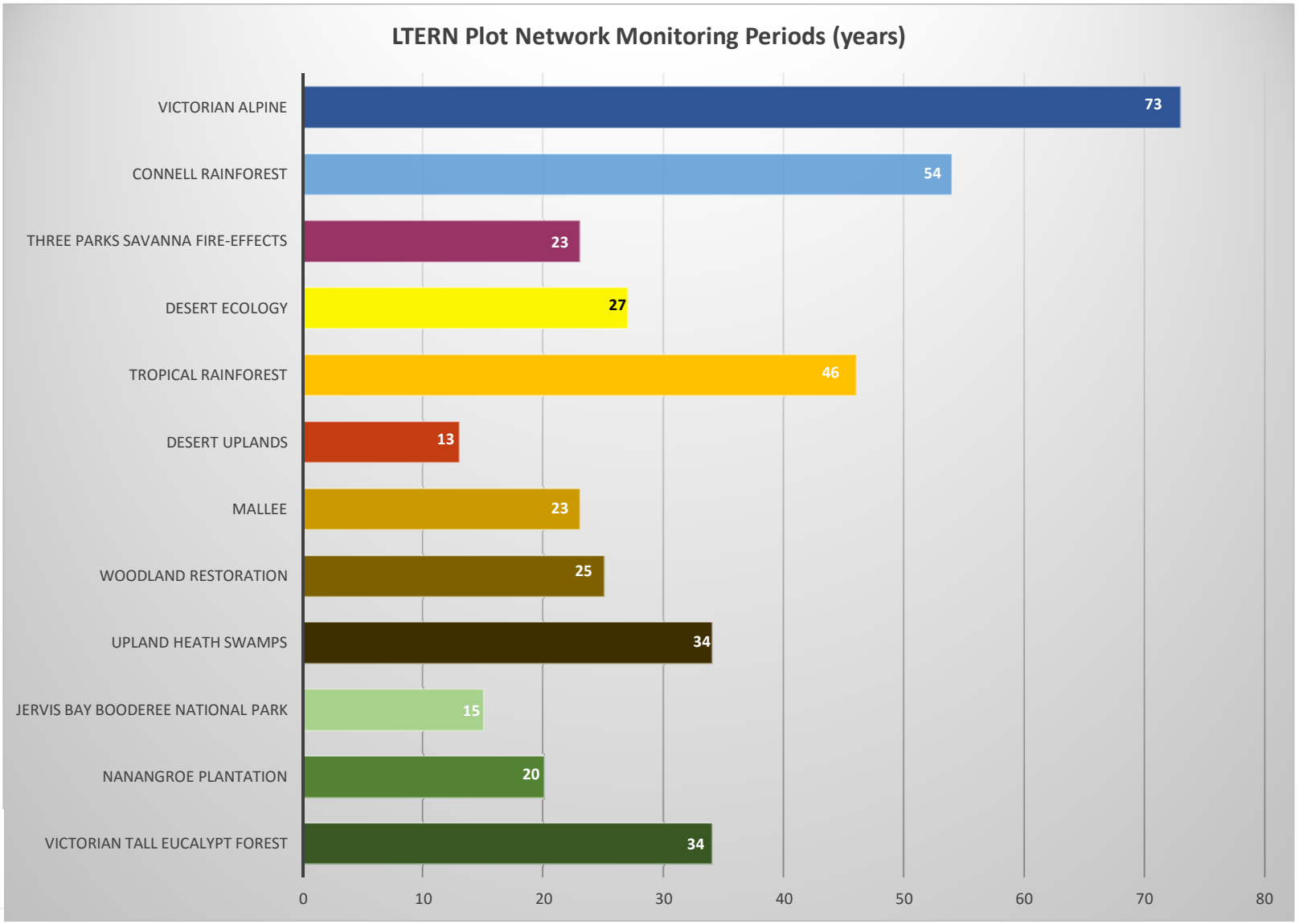




Data Collection: Plot network locations relative to Eco-Regions



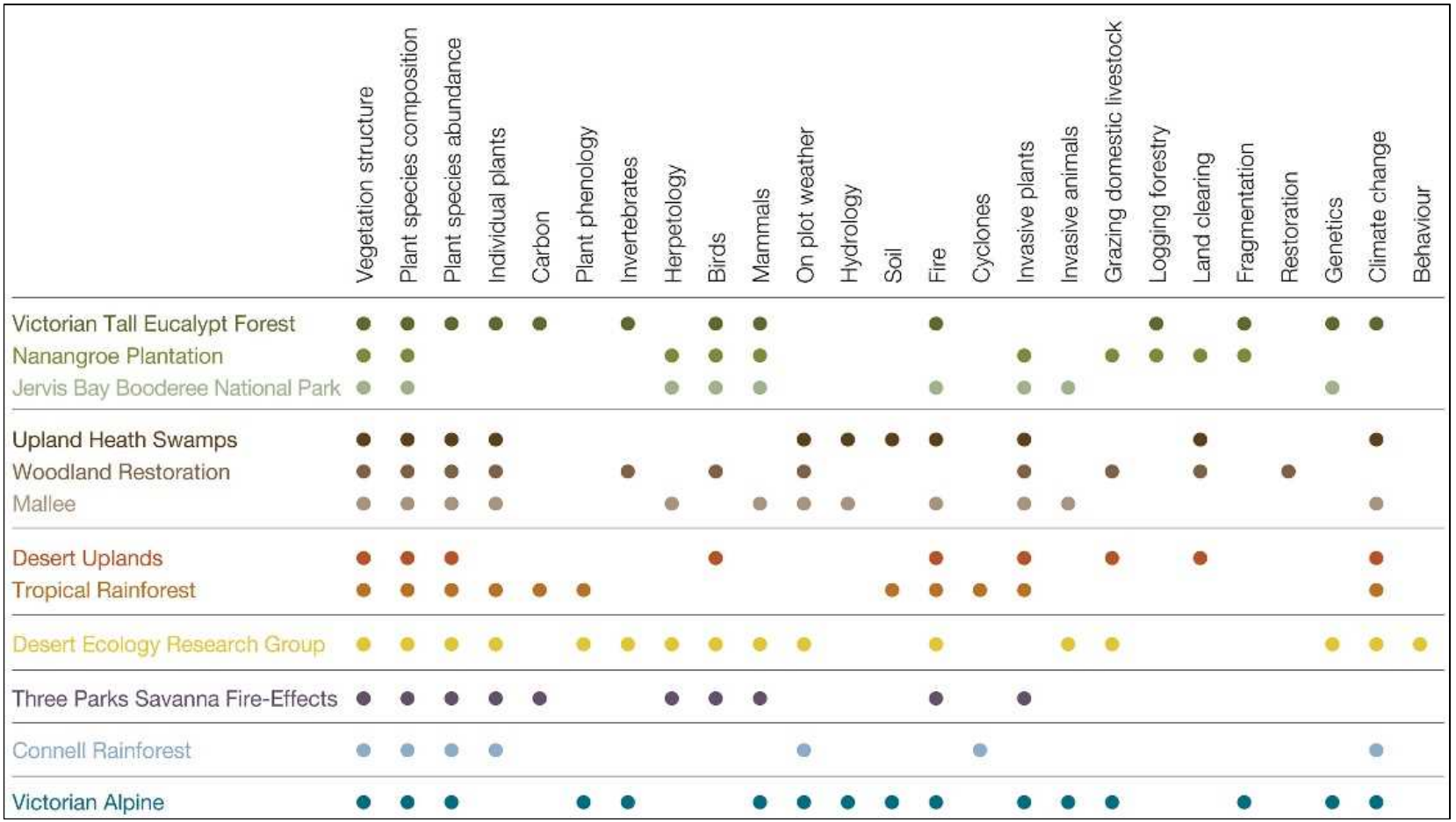
LTERN
Long Term Ecological Research Network



LTERN

Long Term Ecological Research Network

25 Monitoring Themes



LTERN
Long Term Ecological Research Network

TERN Australian SuperSite Network

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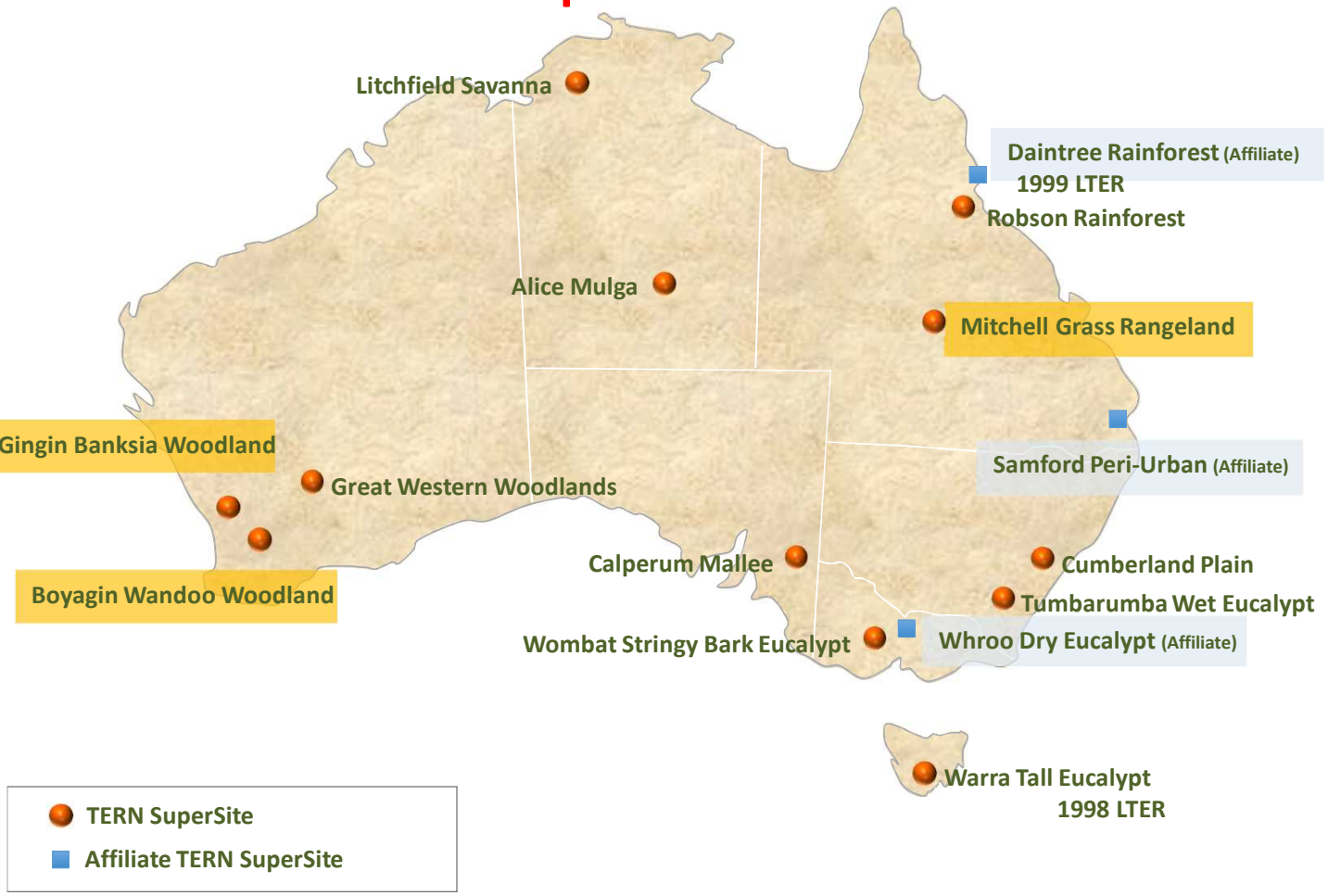
TERN Australian SuperSite Network 2010 - 2018:



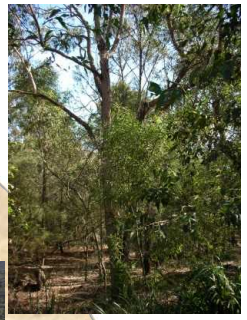
TERN SuperSites was also a very successful component of TERN. It was linked strongly to OzFlux. The joint networks published a large number of papers and generated data of wide use to the ecosystem community. Strongly linked to remote sensing – reference sites.

TERN SuperSites was shut down
- no announcement of why
- no publicity in 2018.

Data Collection: SuperSite locations – biome coverage














TERN SuperSite

Affiliate TERN SuperSite

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Australian SupersiteNetwork

TERN Ecosystem Processes Sites

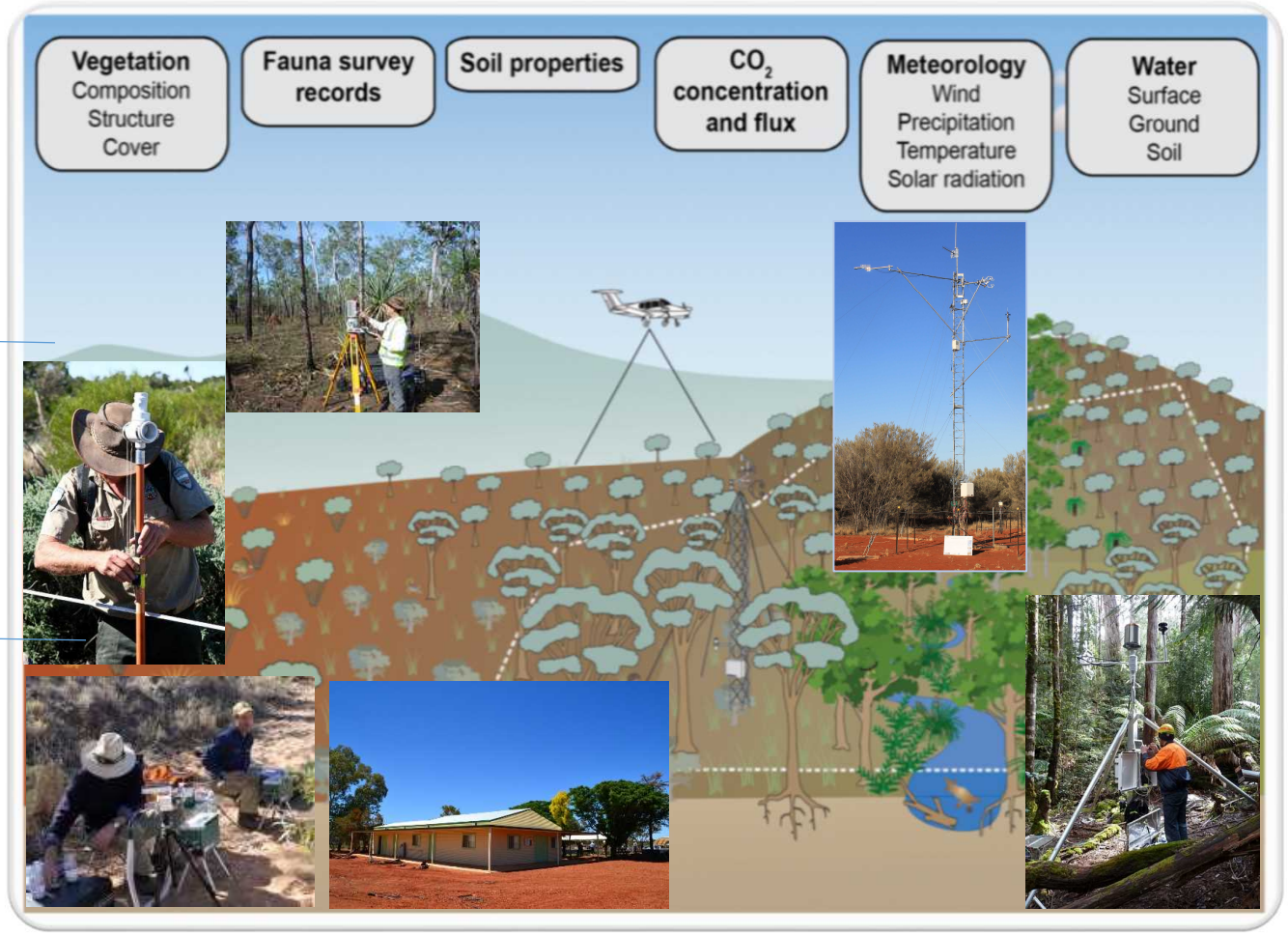
What was a SuperSite?

Research Infrastructure

1) An **intensive field station** in a typical and important biome
2) Physical instrumentation (**Ozflux station as core**)
3) **Scientists and technical support staff to support Long Term monitoring**
4) **Transect or Contrasts** (10- 400km)
5) **Remote sensing** (**Auscover** 5km x 5km **is core**)
6) **Ecophysiology**

Consistent core measurements

Open data



Australian SupersiteNetwork

What do we have now?

A LARGE NUMBER OF LTER ASSETS IN AUSTRALIA

All of the LTER sites that existed in LTERN and SuperSites are still in existence but many have mothballed their programs.

Eucalypt Woodlands, 3 Parks Savanna Vegetation fire plots, Desert Uplands.

David Lindenmayer has successfully managed to maintain activity at his 3 plot networks through chasing down external funding.

Most ex-TERN LTERN plot networks and SuperSites have scaled back LTER biodiversity activities - operating in '**funding drought mode**' waiting for the next '**funding rains**'.

Other LTER sites exist that were not involved in TERN as there was an unfunded **intensive LTER** category. These sites are keen to participate in coordinated LTER activity across Australia.

All of the LTER sites have **long term biodiversity data**.

Where is this biodiversity data? **The Database Problem**.

TERN, ANU, State government databases, hard drives..

https://sciences.adelaide.edu.au/biological-sciences/

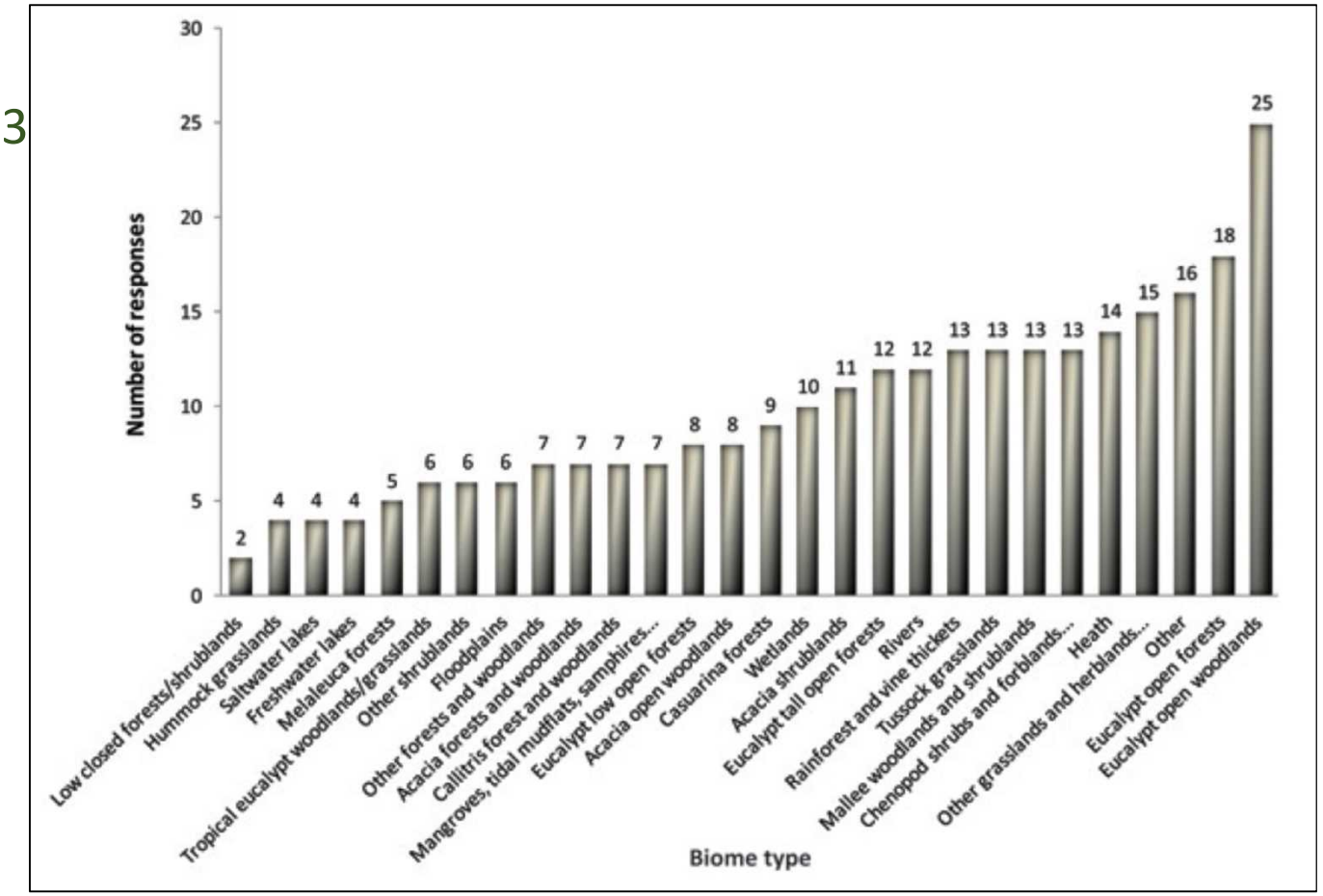
What sort of coverage?

Australian LTES SURVEY

Youngentob et al. *Austral Ecol.* 2013

Large number of sites carrying out LTES Long term ecological studies.

Needs an update as many of these sites have shut down – new ones have sprung up.



Biodiversity in Australia

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Biodiversity – what do we mean?

1) species diversity— variety of species.
2) ecosystem diversity - variety of habitats, ecological communities & ecological processes.
3) genetic diversity— variety of genetic information in individual plants, animals and micro-organisms.

Southern corroboree frog
http://www.australiangeographic.com.au

Wollemi pine
http://www.smh.com.au

Australian Species biodiversity

Australia is home to around 560,000 species.

Endemics:

92% higher plant species
93% reptiles
45% bird
87% mammal species,
94% frogs
(Chapman 2009).

Western ringtail possum
http://www.smh.com.au

Australia – the biodiversity problem

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Biodiversity decline – a national crisis

- 1,700 species & ecological communities are threatened and **known** to be at risk of extinction (DSEWPaC 2010)

Bramble Cay melomys 2015

Species extinctions…

- **#1 in world** – last 200 years 30 mammal extinctions. (threatened species commissioner)

Short Spider-orchid 1988
http://ala.org.au

Christmas-island-forest-skink 2017

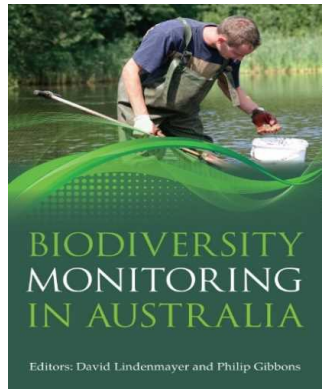
Federal inquiries….

- 2018 Inquiry into Australia's faunal extinction crisis

* adequacy of existing monitoring practices in relation to threatened fauna assessment & adaptive management responses.

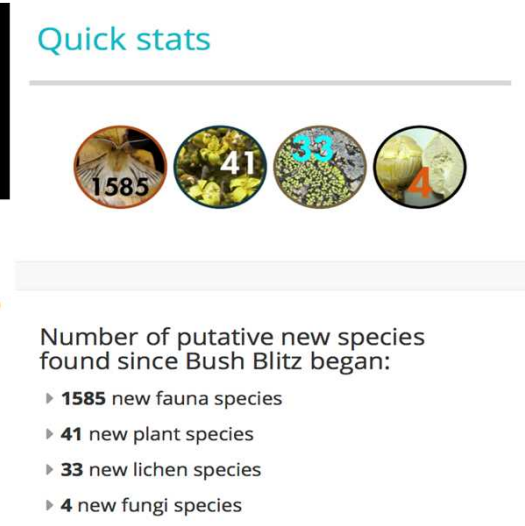
Thylacine– Tasmanian Tiger 1982

Biodiversity monitoring in Australia



What is currently being done? - terrestrial on the ground

1) Federal – TERN/Surv/EP ALA/Bushblitz
   - **AusPlots** – 1Ha veg. surveys, rangelands/mesic, 600+ plots
   - **Ecosystem Process** – 12 flux towers, phenocams, LAI, 5 year veg.
   - **BushBlitz** (Fed, BHP, Earthwatch) – survey.
2) State & Territory Based. QLD: CoreVeg / SLATS
3) AusLTER – details TBA
4) NGO: Australian Wildlife Conservancy, Birdlife Australia,
   Bush Heritage 37 reserves covering 1.2 million hectares
5) Indigenous Ranger Program
6) ARC Project based – Australian Acoustic Observatory



'Many disparate kinds of biodiversity monitoring programs around Australia …characterized by marked differences in experimental or survey design, field protocols, entities targeted for measurement, & spatial/temporal scale of implementation.'

National Biodiversity Conservation Strategy

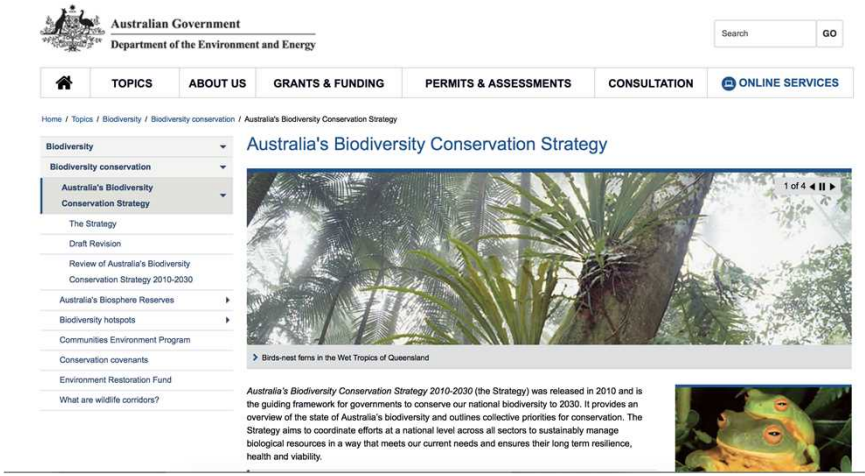
Three national priorities for action.

Priority 3. Getting measurable results through:

• implement **robust national monitoring** & reporting

Target 10. By 2015, establish a national long-term biodiversity monitoring and reporting system.

THIS HAS NOT HAPPENED.



NBCS 2018 – 30 – Revision in Draft

Objective 10: Increase knowledge about nature to make better decisions. . through a concerted and sustained effort across all levels of government, and improved partnerships with community groups and business.

Objective 12: Effective measurement to demonstrate our collective efforts

$billion National Landcare Program

Using an **adaptive management framework** without a robust on-going monitoring across the country **THIS IS COMPROMISED**.


Opinion

Cell

Adaptive monitoring: a new paradigm for long-term research and monitoring

David B. Lindenmayer[1] and Gene E. Likens[1,2]

[1] Fenner School of Environment and Society, The Australian National University, Canberra, ACT 0200, Australia
[2] Cary Institute of Ecosystem Studies, Millbrook, NY 12545, USA

Long-term research and monitoring can provide important ecological insights and are crucial for the improved management of ecosystems and natural resources. However, many long-term research and monitoring programs are either ineffective or fail completely owing to poor planning and/or lack of focus. Here we propose the paradigm of adaptive monitoring, which aims to resolve many of the problems that have undermined previous attempts to establish long-term research and monitoring. This paradigm is driven by tractable questions, rigorous statistical design at the outset, a conceptual model of the ecosystem or other entity being examined and a human need to know about ecosystem change. An adaptive monitoring framework enables monitoring programs to evolve iteratively as new information emerges and research questions change.

Why long-term ecological research and monitoring are needed

Ecologists and managers of natural resources readily acknowledge the importance of long-term research, which often includes monitoring, for the improved understanding and management of complicated ecological systems. Long-term data are important for many reasons, including evaluating responses to disturbances such as climate change or experimental manipulations; providing baselines to evaluate change; and detecting and evaluating changes in ecosystem structure and function, as can occur in response to management interventions.

Numerous scientific articles, books, management plans and other documents have been written about the need to do long-term research and monitoring (e.g. [1–11]). Although there have been some successful long-term ecological research and monitoring programs (e.g. [12–16]; Box 1), there is also a prolonged history of poorly planned and unfocused monitoring programs that are either ineffective or fail completely [17–19].

Here we briefly outline some of the deficiencies in long-term research and monitoring programs. Then, based upon our collective experience spanning 70 years in establishing natural resource monitoring programs, we propose a new paradigm, adaptive monitoring, to resolve some of the problems underlying poorly planned and unfocused monitoring programs.

Perceived and real problems in long-term research and monitoring

Monitoring programs often have a bad reputation [10], and many fail. Norton [18] described how nearly half of all the monitoring programs undertaken in New Zealand went unreported, indicating that the failure rate can be high. Some members of the scientific community have traditionally viewed monitoring as a management activity that is unrelated to scientific research (e.g. Ref. [20]). However, many other authors, including us, have argued that well-conceived and well-executed monitoring is an important component of long-term scientific research programs and, as such, is very useful to natural resource managers and policymakers [8,10,21]. As we argue here, the features of good science and, hence, good research are often the same features that characterize good monitoring and good environmental management.

Many factors have undermined the credibility of long-term research and monitoring programs. Here we outline what we consider to be three of the key ones. First, they have often been driven by some short-term funding opportunity or a political directive rather than being underpinned by carefully posed questions and objectives [22]. Roberts [23] argued that too often monitoring has been 'planned backwards on the collect now (data), think-later (of a useful question) principle.' Two examples of this are the Alberta Monitoring Biodiversity Program [24] and the Programa de Pesquisa em Biodiversidade (PPBio program) for biodiversity monitoring in southeastern Queensland, Australia [25].

A second problem (related to the first) has been that long-term research and monitoring programs have often been poorly designed at the beginning of a study. Although good design is an inherently statistical process, professional statisticians are often left out of the experimental design phases of monitoring programs. Key issues are then overlooked, such as calculations of statistical power to detect trends, the importance of contrasts between treatments (e.g. where there is a human intervention and where there is not) and the value of innovative rotating sampling to increase the number of sites in a monitoring program and improve power for detecting effects [26].

A third issue is that the design of long-term research and monitoring programs is often prefaced by protracted (and usually unresolved) arguments about what to monitor. One response has been to monitor a large number of things (the so-called laundry list), but resource and time constraints frequently mean that this approach is done

Corresponding author: Lindenmayer, D.B. (david.lindenmayer@anu.edu.au).

0169-5347/$ – see front matter © 2009 Elsevier Ltd. All rights reserved. doi:10.1016/j.tree.2009.03.005 Available online 4 May 2009

Australia – the scale problem

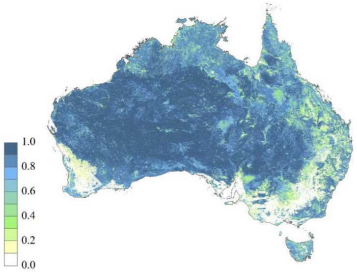
The only continent operating as a single country.

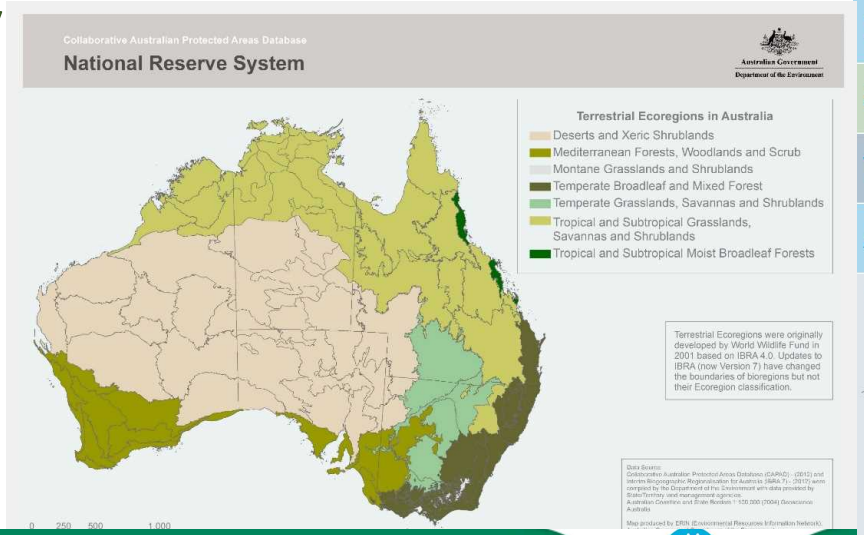
The 6th largest country.

Biodiversity: one of the 17 megadiverse countries.

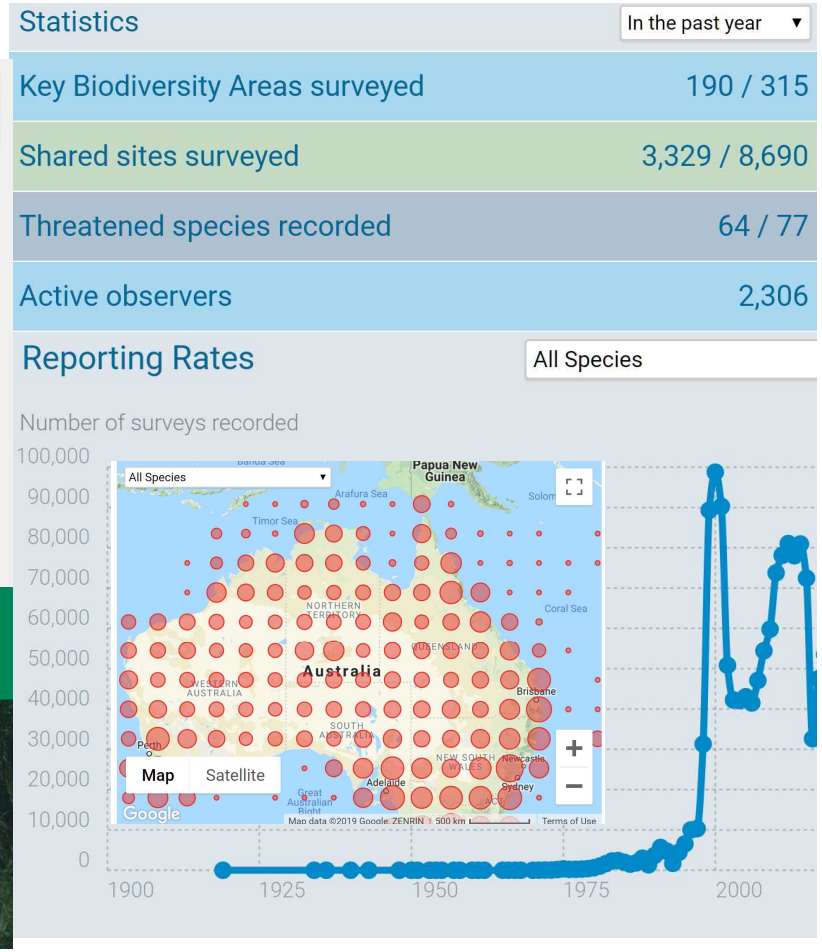
One of the lowest population densities on the planet

– eg Northern Territory (1.4×10^6 km^2) has 0.2 people/km^2





https://birdlife.org.au/projects/atlas-and-birdata



ABSNET
Australian Biodiversity Sensor Network

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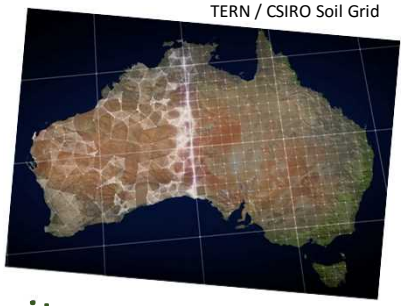
Grand challenge problem

What is an appropriate way to collect national, consistent, time series biodiversity data to enable effective responses to rapid environmental change in Australia?

TERN / CSIRO Soil Grid

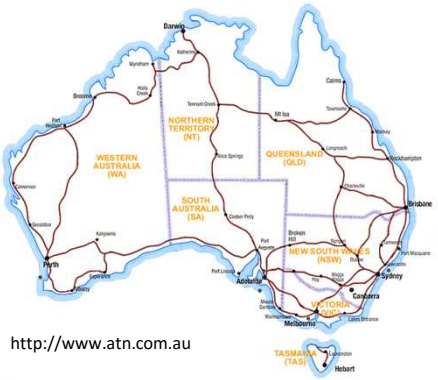


The proposed solution:

A large scale national distributed biodiversity sensor network
– 1000+ monitoring sites across the continent.

How to make it moderately affordable?

Instead of funding the establishment of new sites take a whole of community approach and **'add-on' sensor suites** to **existing long term 'sites'**
– state/territory, TERN, NGO, council, agricultural… LTER.
Bring in so many 'sites' that a thorough design can be built that will enable change detection and robust forecasting.



http://www.atn.com.au

A large infrastructure/data problem

Biodiversity monitoring across the country becomes a **large scale infrastructure problem** - like building a continental highway system.

ABSNET – scoping an early model I

Hybrid suite of sensors at each 'site'

Commercial stand alone biodiversity sensors : camera trap, acoustic, bat.
– periodic 'sneaker ware' downloads of data from SD cards.

Pros: well understood reliability, user base of practical experience

Cons: two downloads/year raw data

http://www.reconyx.com.au/

Intelligent wireless multi-sensor biodiversity nodes (3G,4G, satellite)
– near real-time transfer of data to cloud from base node/gateway

Pros: near real-time, pre-processed data

Cons: stability of the system: energy, communications, hardware

CSIRO Fleck 3b

P. Corke Proc IEEE (2010) doi:0.1109/JPROC.2010.2068530

Commercial environmental and biodiversity sensor stations (3G,4G, sat.):
meteorological, soil moisture, water quality, phenocam

Pros: well understood reliability, near real-time data

Cons: they can still fail, need to be calibrated… like any other sensor

http://hydroinnova.com/

ABSNET – scoping an early model II

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Campaign mode at each 'site'

With appropriate training for 'site' operators it will be possible to add-on campaign measurements which do not add substantial hours of field data collection but add substantially to biodiversity data collection. eg : soils, eDNA: surface water – larger faunal assemblage, integrated over time

drones: VHR near-field remote sensing - larger spatial coverage

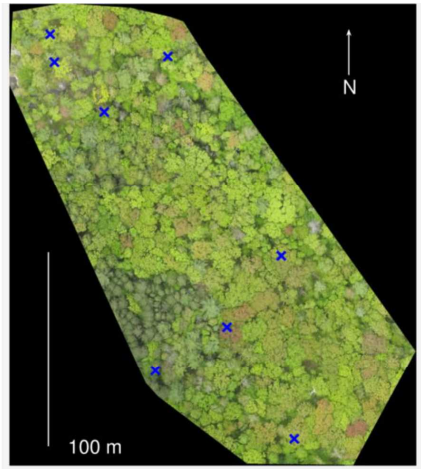

Figure 1. Study area at Harvard Forest on 5/21/17 (DOY 141). Location of microsite temperature loggers indicated as blue "×" symbols.

Richardson, A. Sensors (2017) doi:10.3390/s17122852

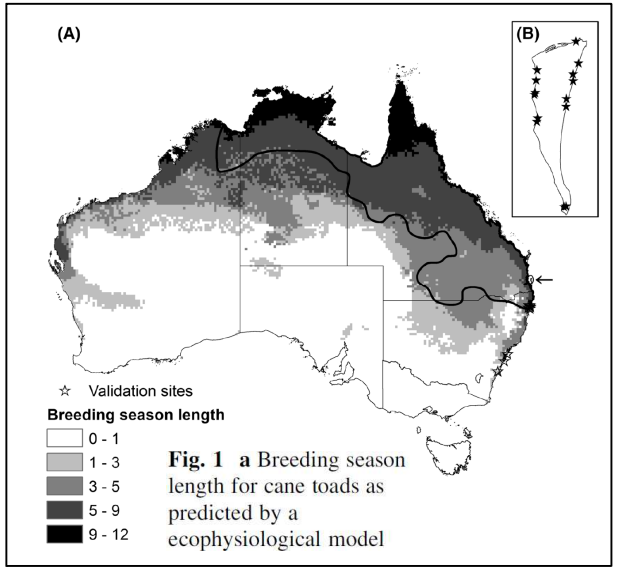

Fig. 1 **a** Breeding season length for cane toads as predicted by a ecophysiological model

Tingley, R. Biol Invas (2018) doi.org/10.1007/s10530-018-1810-4

How much experience do we have to draw on?

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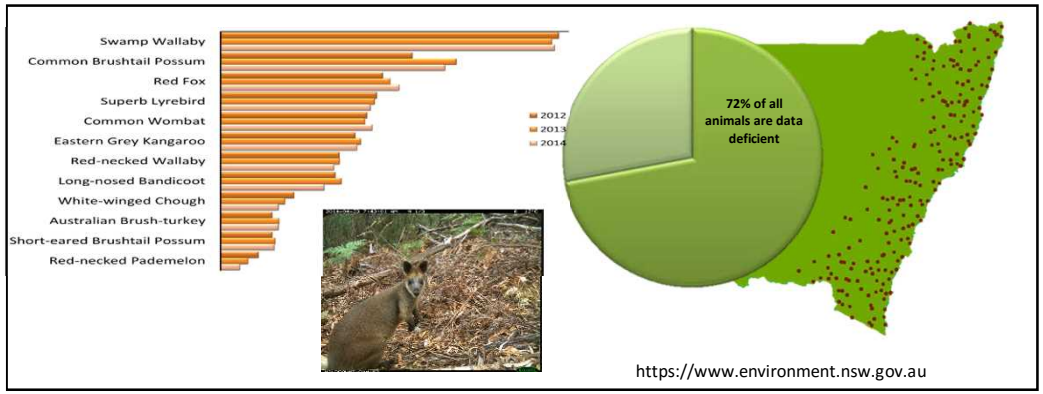
Camera traps

Wildcount *– park camera trap monitoring system for faunal biodiversity.*
(NSW DPIE, DOEH, NPWS):
WildCount can already confidently detect changes in occurrence of 12 species over ten years. 800 Cameras deployed.



https://www.environment.nsw.gov.au

Indigenous Protected area monitoring
- *annual large scale camera trap biodiversity surveys*
(Milerrelerre, NT Warddeken Rangers, NTGov.)


https://www.warddeken.com

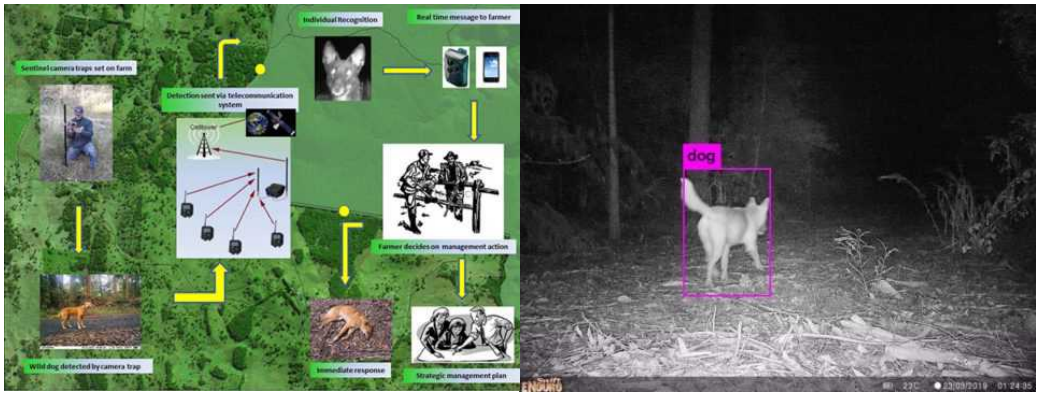
https://www.nespnorthern.edu.au

Biodiversity monitoring using camera traps

JAMES COOK UNIVERSITY AUSTRALIA

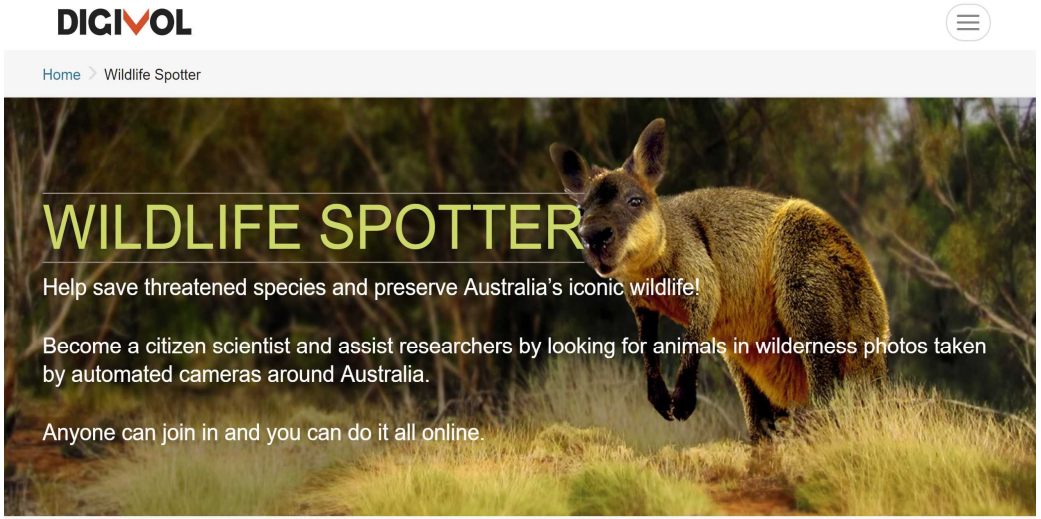
Camera traps

Wilddog Alert – *real time alert system for feral dogs - used by landowners .*
(NSW Centre for Invasive Species Solutions):



https://www.pestsmart.org.au

Camera trap data analytics:
Both AI and citizen science expert analysis platforms exist and are extensively used.
Digivol / Wildlife spotter
(ALA / Australian Museum)



https://volunteer.ala.org.au/wildlife-spotter

Biodiversity monitoring using acoustic sensors

JAMES COOK UNIVERSITY AUSTRALIA

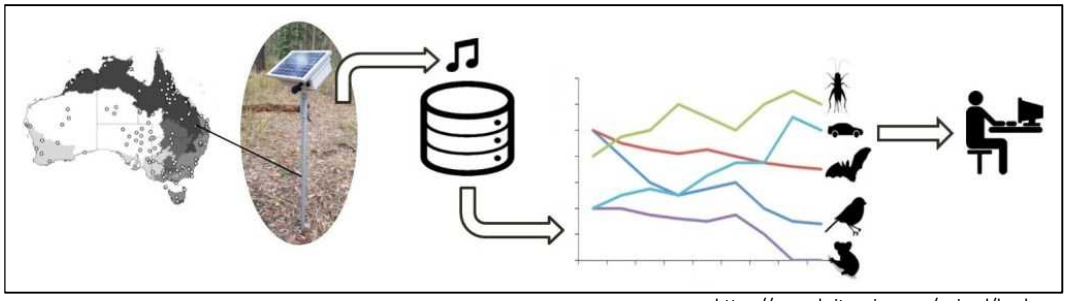
Acoustic sensors (recorders)

A2O. Australian Acoustic Observatory

- *monitoring birds, frogs, toads, invertebrates, audible fauna* [6]
- ARC Funded Project (QUT, SCU, JCU, UNE, UQ) … 400 sensors
– in build phase.

https:// acousticobservatory.org

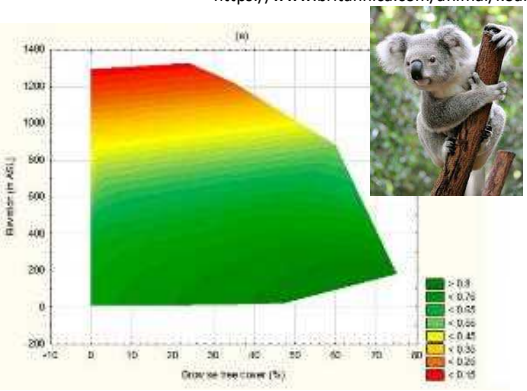
http://www.frontierlabs.com.au



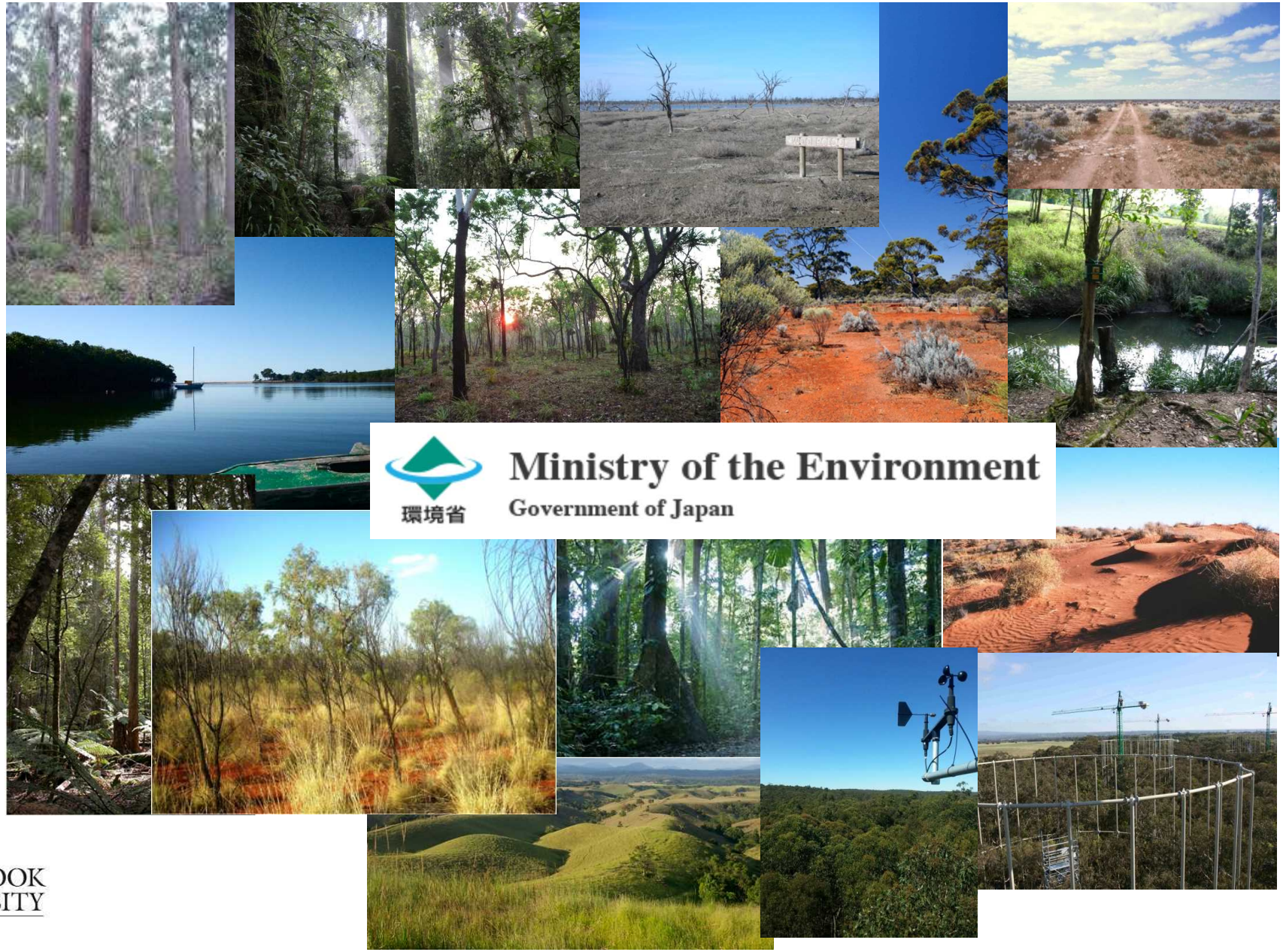
https://www.britannica.com/animal/koala

Monitoring of koalas to examine their resilience to timber harvesting

- NSW Department of Primary Industries, QUT



https://www.dpi.nsw.gov.au Law, B.S. PLoS One. 2018 doi: 10.1371/journal.pone.0205075



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