Monitoring in State Forests of NSW

Chris Slade: Senior Ecologist

Forestry Corporation

Acknowledgements / Partners

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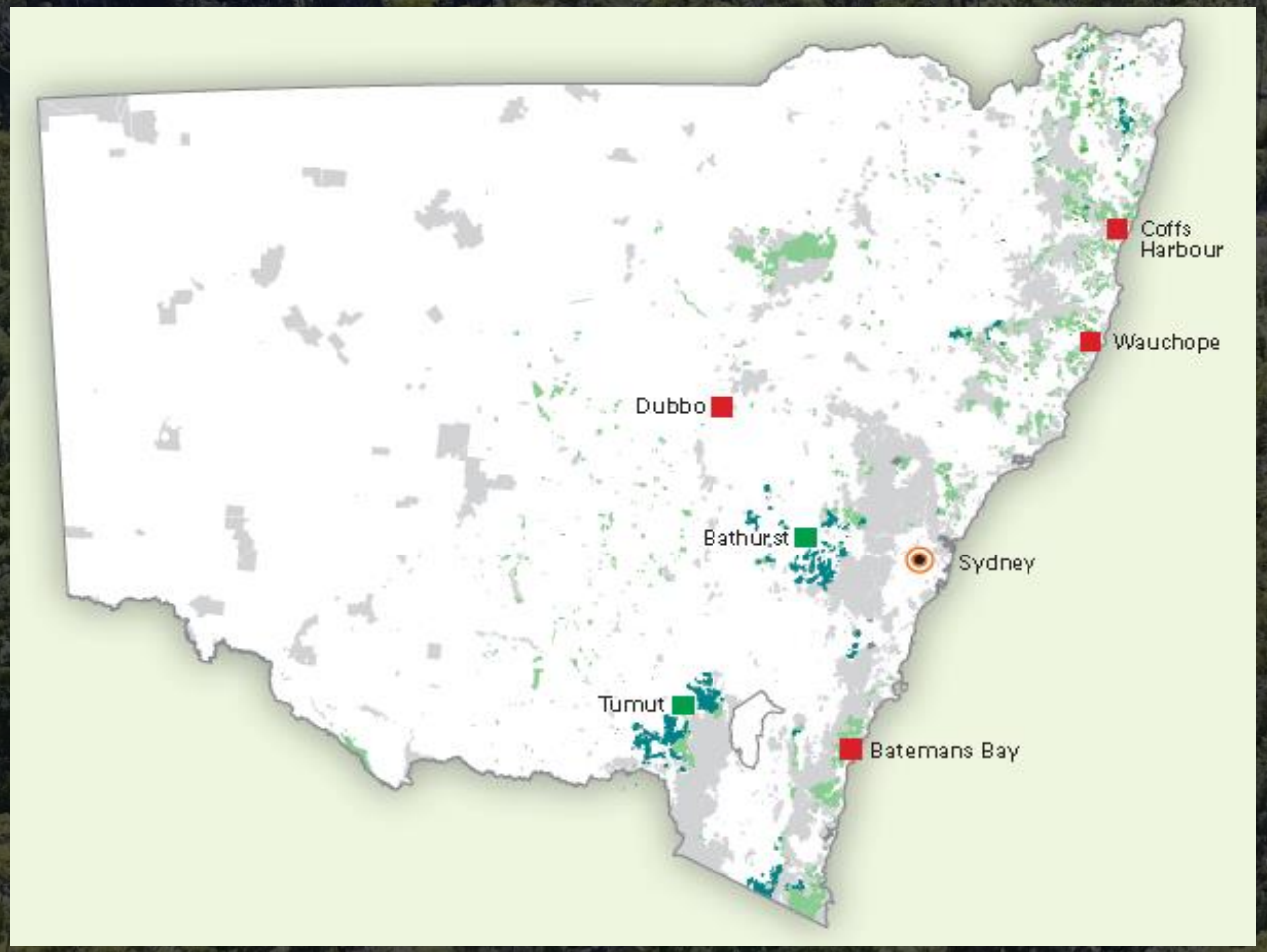
- Design & Data analysis
  - Dr Brad Law
  - Traecey Brassil
  - Dr Leroy Gonsalves
  - And team

FCNSW Ecology team

- Natural Resources Commission
- Steering Committee Chair and support
  - Todd Maher
  - Michael Parsons
  - Dr Mina Basserova

State Forest Footprint



~2 million hectares of native hardwood forests

~ 35 thousand hectares of hardwood plantations

~ 225 thousand hectares of softwood (pine) plantations

All managed to produce multiple benefits

Forestry Corporation

CONSERVATION CONTEXT

National Park estate – large areas set aside for conservation

State Forest reserved areas

Flora Reserves	Rainforest	Owl landscape exclusion	Ridge & Headwater corridors	Stream exclusion	Wetlands, Heath	Wildlife habitat and tree protection clumps

Site based protection

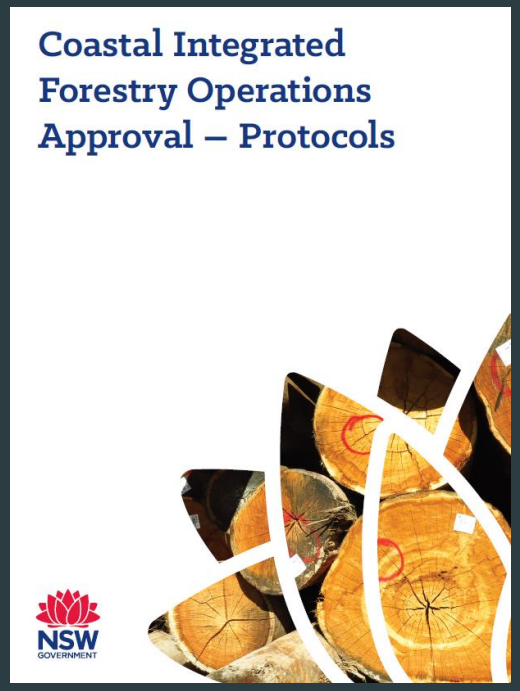
Individual habitat trees (glider dens, sap feed trees)	Flora exclusion zone	Koala feed trees, Nectar feed trees, species specific exclusion zones

CONSERVATION CONTEXT (cont)

IFOA REGION	NP Area	SF Reserve	SF Available	Public Land	% Protected	% SF Area Protected
Eden	252,383	81,717	125,213	459,312	73%	39%
South Coast Sub Region	572,334	70,965	141,674	784,973	82%	33%
Tumut Sub Region	806,910	156,302	51,855	1,015,067	95%	75%
Lower North East	1,373,726	193,333	302,182	1,869,241	84%	39%
Upper North East	664,414	173,400	257,666	1,095,481	76%	40%
Total	**3,669,767**	**675,717**	**878,590**	**5,224,074**	**83%**	**43%**

Now increased to 50-60% under the CIFOA

Slade, C. and Law, B. (2016) The other half of the coastal State Forest estate in New South Wales; the value of informal forest reserves for conservation. Australian Zoologist



NEW Coastal IFOA

- Single IFOA for Coastal NSW
- Replaces 5
  - Upper NE
  - Lower NE
  - South Coast
  - Tumut
  - Eden
- Simplified conditions
- More focus on biodiversity monitoring

Biodiversity Management

Landscape based protection –

Protect habitat across the landscape

Site-based, species-specific protection –

Conduct surveys and / or habitat now trigger additional protections

Monitoring to determine occupancy trends –

Multi-tiered:

- Broad cross-State Forest program
- Species Specific program – eg YBG, GBF, SBB etc
- Research Questions

Monitoring

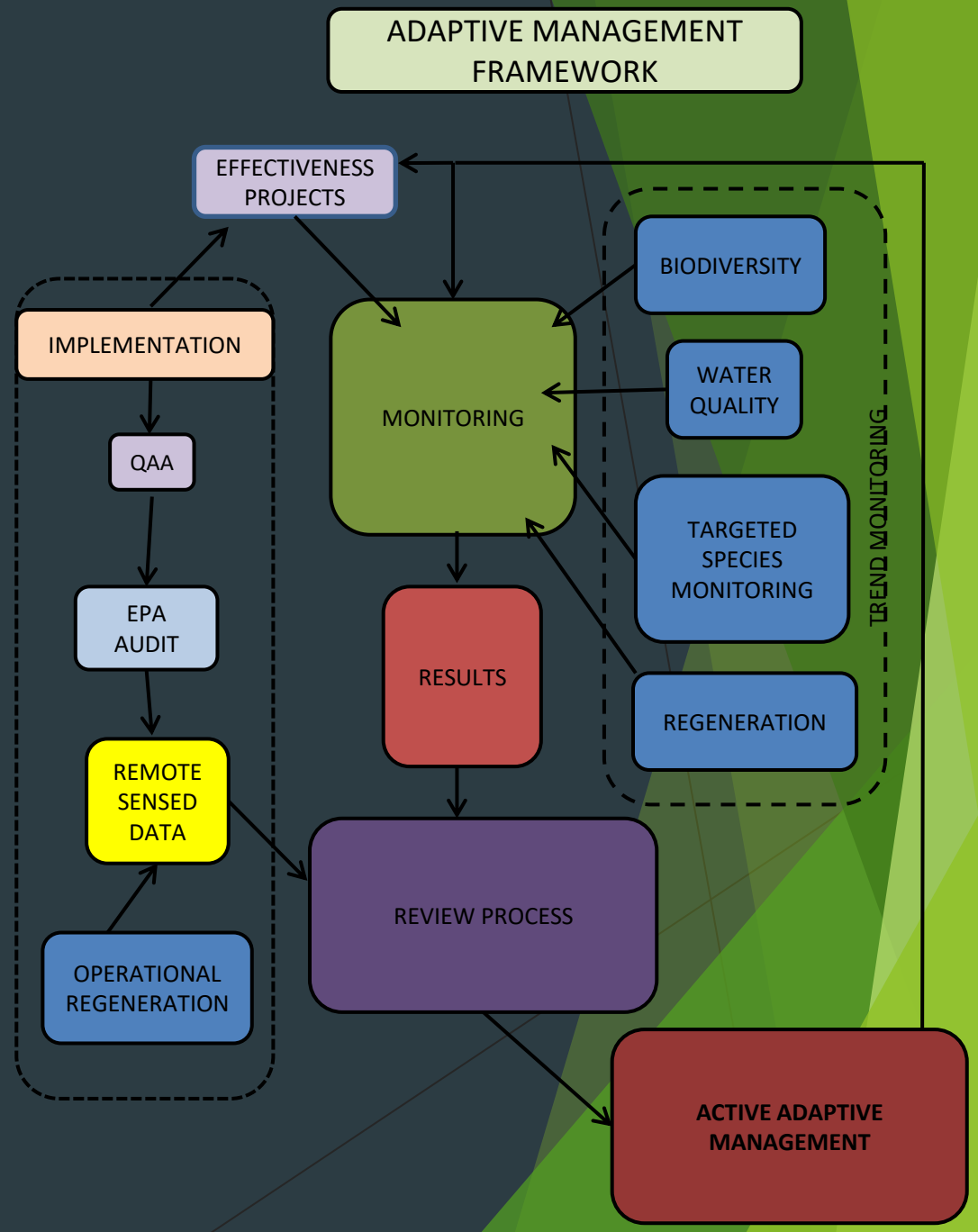
Intent:

Coastal IFOA rules evaluated on delivery of their intended outcomes.

- Recognition that forest monitoring needs to improve.
- Allows the IFOA to be adaptively managed to ensure it is fit for purpose.

Governance:

- NRC oversight & Management.
- Report on annual basis and for 5-year reviews.
- Effectiveness, trend and target species projects.
- Includes fire recovery monitoring



MONITORING

Coastal IFOA monitoring program

Forest health

Biodiversity

Water quality

Research and evaluation

Wood supply

Reporting and adaptive mngt

BIODIVERSITY Plot Establishment

Each Region

- 100 Plots
- 200 sub-plots
- 3 devices per sub-plot (sites)

3 regions

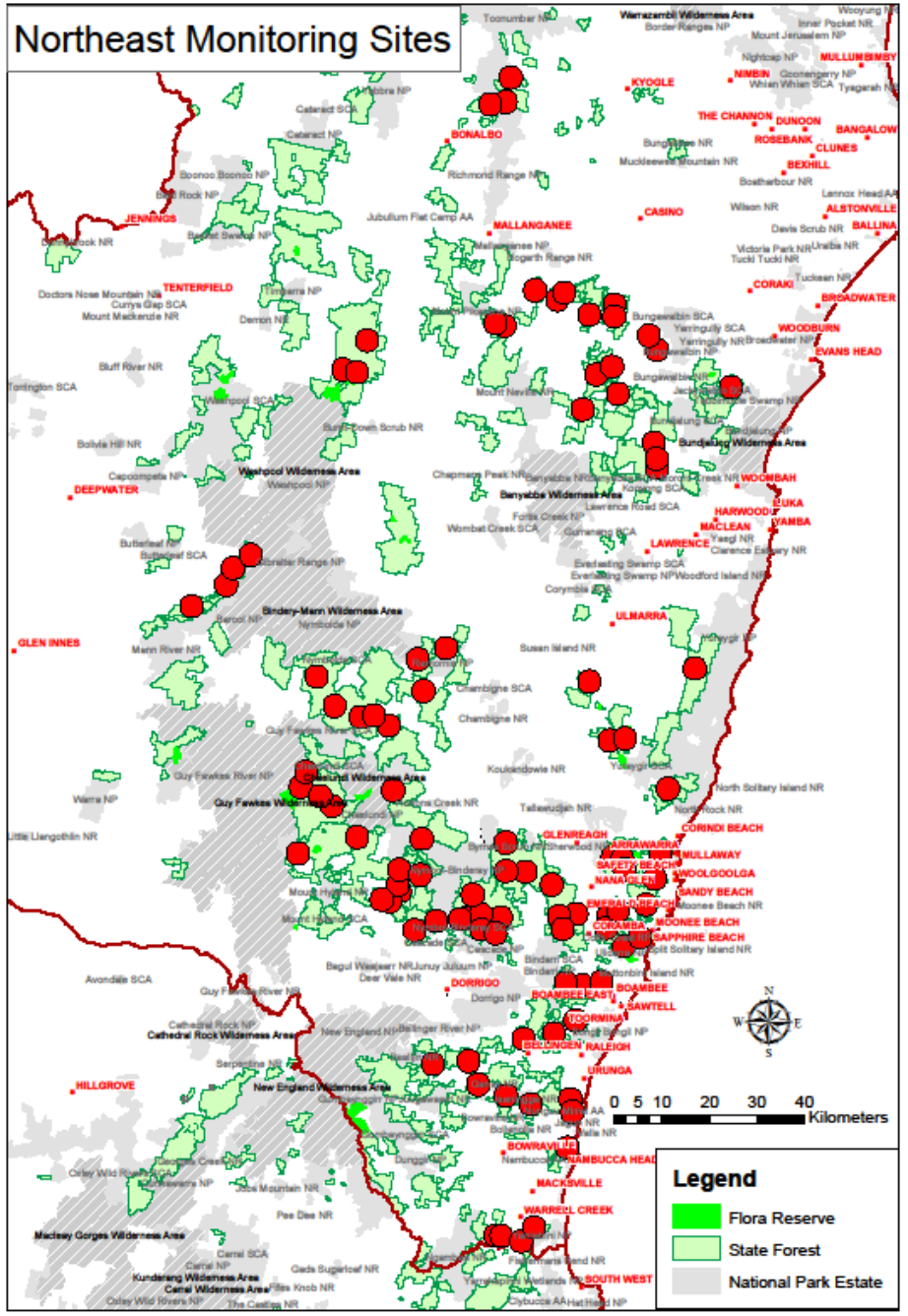
- Upper north east
- Lower north east
- Southern

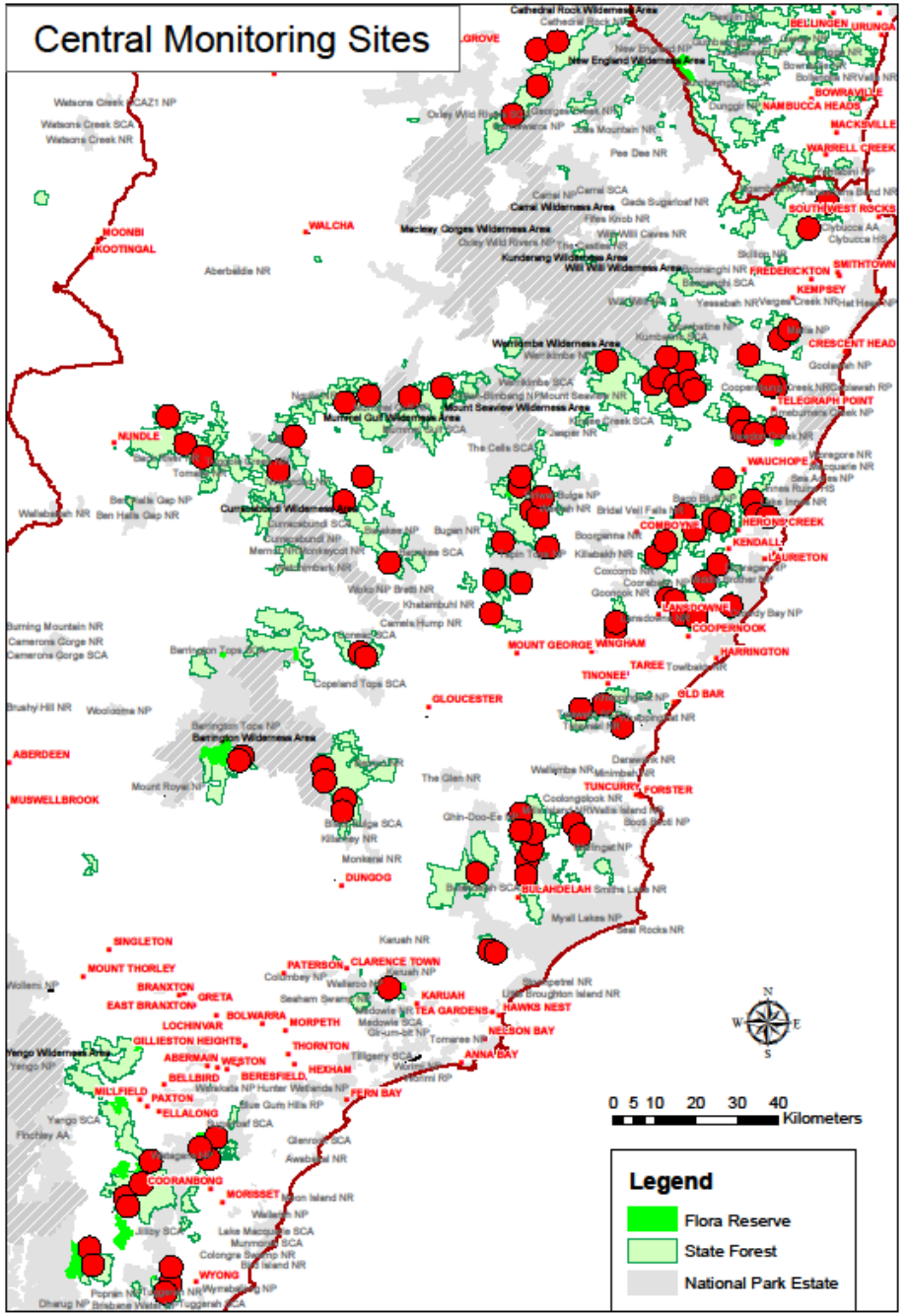
TOTAL 300 Plots - 600 subplots

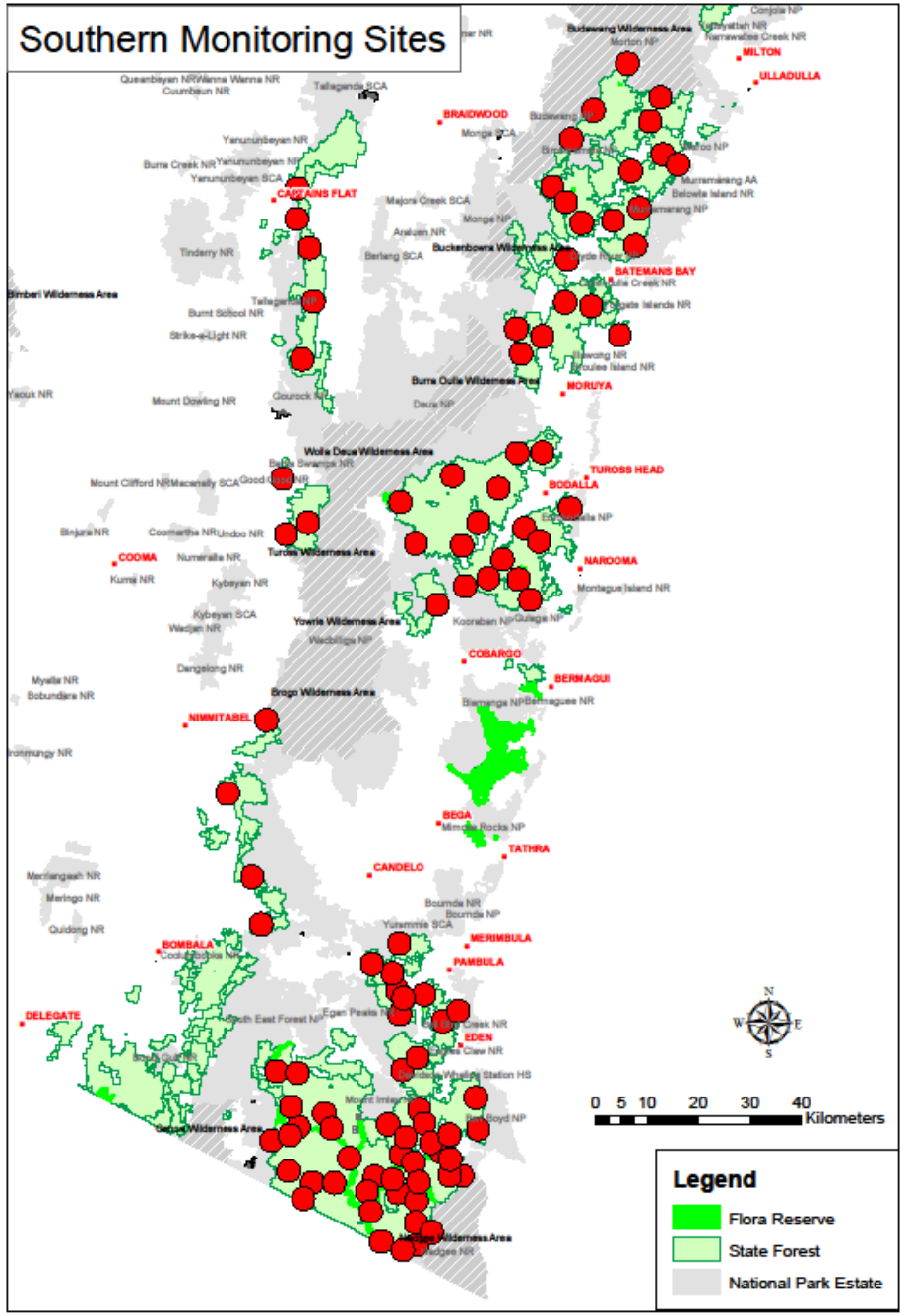
Plot Selection

- Incorporated several long-term programs
  - Southern brown bandicoot - Eden
  - Large forest owls – Eden
  - Koala – north coast

- Range of factors:
  - Disturbance histories
  - Landscape position
  - Site access / remoteness


Northeast Monitoring Sites
Legend
Flora Reserve
State Forest
National Park Estate
0 5 10 20 30 40
Kilometers
N
S
E
W


Central Monitoring Sites
Legend
Flora Reserve
State Forest
National Park Estate
0 5 10 20 30 40
Kilometers
N
W
E
S


Southern Monitoring Sites
MILTON
ULLADULLA
BRAIDWOOD
CANBERRA
BATEMANS BAY
MORUYA
TUROSS HEAD
BODALLA
NAROOMA
COOMA
COBARGO
BERMAGUI
NIMMITABEL
BEGA
TATHRA
CANDELO
MERIMBULA
PAMBULA
BOMBALA
DELEGATE
EDEN
Budawang Wilderness Area
Buckenbowra Wilderness Area
Burra Outlie Wilderness Area
Wolla Deua Wilderness Area
Tuross Wilderness Area
Yowrie Wilderness Area
Brogo Wilderness Area
Bemboka Wilderness Area
Simbari Wilderness Area
N
W
E
S
0 5 10 20 30 40
Kilometers
Legend
Flora Reserve
State Forest
National Park Estate

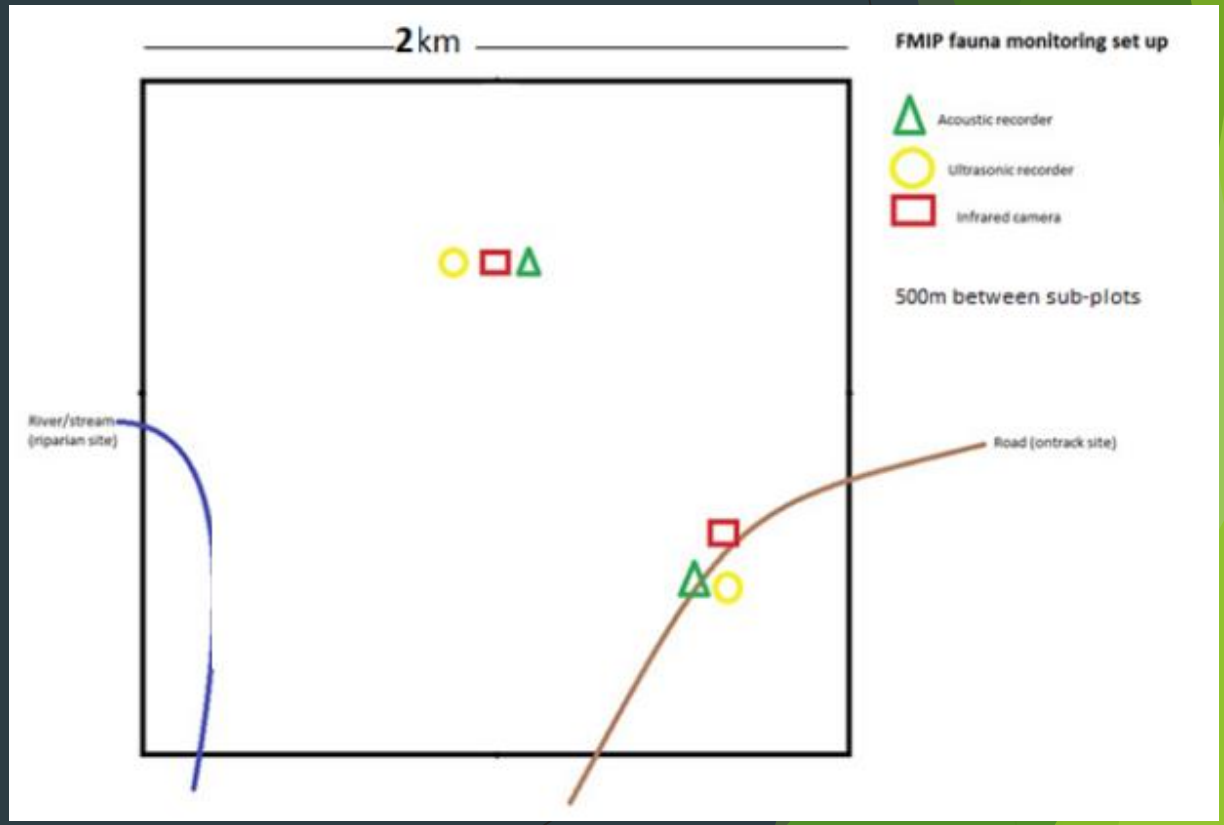
Plot / Sub-plot

- Plot = 2 sub-plots

- On-Track
  - Remote camera
  - Ultrasonic sound recorder
  - Audio sound recorder

- Off-Track
  - Remote camera
  - Ultrasonic sound recorder
  - Audio sound recorder

- Matches Long-term similar program in the Pilliga near Coonabarabram



Sampling Regime

- 50 annual plots (100 sub-plots) / region / year
- 10 panel plots (20 sub-plots) {sampled once every 5 years}
- TOTAL = 60 / region

- Seasonal split
  - 45 plots (90 sub-plots) sampled each year in spring / region
  - 15 plots (30 sub-plots) sampled each year in autumn / region

- Annual total (East Coast CIFOA area) = 180 plots (360 sub-plots)
- 300 plots (600 sub-plots) sampled over 5 years

- All devices set for 14 nights

  - Noting similar program underway in Pilliga for last 10 years

SiteID	SiteSchedule	FY22_23	FY23_24	FY24_25	FY25_26	FY26_27
N_001	Annual	Spring	Spring	Spring	Spring	Spring
N_010	Annual	Spring	Autumn	Spring	Spring	Spring
N_100	Once Every 5 Years	0	0	0	0	Spring
N_011	Annual	Spring	Spring	Autumn	Spring	Spring
N_012	Annual	Spring	Spring	Spring	Spring	Spring
N_013	Annual	Spring	Autumn	Spring	Spring	Spring
N_014	Annual	Spring	Spring	Spring	Spring	Spring
N_015	Annual	Autumn	Spring	Spring	Spring	Spring
N_016	Annual	Autumn	Spring	Spring	Spring	Spring
N_017	Annual	Spring	Autumn	Spring	Spring	Spring
N_018	Annual	Autumn	Spring	Spring	Spring	Spring
N_019	Annual	Spring	Spring	Spring	Spring	Spring
N_002	Annual	Autumn	Spring	Spring	Spring	Spring
N_020	Annual	Spring	Autumn	Spring	Spring	Spring
N_021	Annual	Spring	Spring	Spring	Spring	Autumn
N_022	Annual	Spring	Spring	Spring	Autumn	Spring
N_023	Annual	Spring	Autumn	Spring	Spring	Spring
N_024	Annual	Spring	Spring	Spring	Autumn	Spring
N_025	Annual	Spring	Spring	Spring	Spring	Autumn
N_026	Annual	Spring	Spring	Spring	Spring	Spring
N_027	Annual	Spring	Spring	Spring	Spring	Autumn
N_028	Annual	Spring	Spring	Spring	Autumn	Spring
N_029	Annual	Spring	Autumn	Spring	Spring	Spring
N_003	Annual	Autumn	Spring	Spring	Spring	Spring
N_030	Annual	Spring	Spring	Spring	Spring	Autumn
N_031	Annual	Spring	Spring	Spring	Autumn	Spring
N_032	Annual	Spring	Spring	Spring	Autumn	Spring
N_033	Annual	Spring	Spring	Spring	Spring	Spring
N_034	Annual	Spring	Spring	Spring	Spring	Spring
N_035	Annual	Spring	Spring	Spring	Spring	Spring
N_036	Annual	Autumn	Spring	Spring	Spring	Spring
N_037	Annual	Spring	Spring	Autumn	Spring	Spring
N_038	Annual	Spring	Spring	Spring	Spring	Autumn
N_039	Annual	Autumn	Spring	Spring	Spring	Spring
N_004	Annual	Spring	Spring	Spring	Autumn	Spring
N_040	Annual	Spring	Autumn	Spring	Spring	Spring
N_041	Annual	Spring	Spring	Autumn	Spring	Spring
N_042	Annual	Spring	Spring	Autumn	Spring	Spring
N_043	Annual	Spring	Spring	Spring	Spring	Spring
N_044	Annual	Spring	Spring	Autumn	Spring	Spring
N_045	Annual	Spring	Spring	Spring	Spring	Autumn
N_046	Annual	Spring	Spring	Spring	Spring	Autumn
N_047	Annual	Spring	Spring	Autumn	Spring	Spring
N_048	Annual	Spring	Spring	Spring	Autumn	Spring
N_049	Annual	Spring	Spring	Autumn	Spring	Spring
N_005	Annual	Spring	Spring	Autumn	Spring	Spring
N_050	Annual	Spring	Spring	Spring	Spring	Spring

SiteID	SiteSchedule	FY22_23	FY23_24	FY24_25	FY25_26	FY26_27
N_065	Once Every 5 Years	0	Spring	0	0	0
N_066	Once Every 5 Years	0	Spring	0	0	0
N_067	Once Every 5 Years	0	Autumn	0	0	0
N_068	Once Every 5 Years	0	Autumn	0	0	0
N_069	Once Every 5 Years	0	Autumn	0	0	0
N_007	Annual	Spring	Spring	Spring	Autumn	Spring
N_070	Once Every 5 Years	0	Spring	0	0	0
N_071	Once Every 5 Years	0	0	Autumn	0	0
N_072	Once Every 5 Years	0	0	Autumn	0	0
N_073	Once Every 5 Years	0	0	Autumn	0	0
N_074	Once Every 5 Years	0	0	Spring	0	0
N_075	Once Every 5 Years	0	0	Autumn	0	0
N_076	Once Every 5 Years	0	0	Autumn	0	0
N_077	Once Every 5 Years	0	0	Spring	0	0
N_078	Once Every 5 Years	0	0	Spring	0	0
N_079	Once Every 5 Years	0	0	Autumn	0	0
N_008	Annual	Spring	Spring	Spring	Spring	Autumn
N_080	Once Every 5 Years	0	0	Autumn	0	0
N_081	Once Every 5 Years	0	0	0	Autumn	0
N_082	Once Every 5 Years	0	0	0	Autumn	0
N_083	Once Every 5 Years	0	0	0	Spring	0
N_084	Once Every 5 Years	0	0	0	Spring	0
N_085	Once Every 5 Years	0	0	0	Autumn	0
N_086	Once Every 5 Years	0	0	0	Spring	0
N_087	Once Every 5 Years	0	0	0	Autumn	0
N_088	Once Every 5 Years	0	0	0	Autumn	0
N_089	Once Every 5 Years	0	0	0	Autumn	0
N_009	Annual	Spring	Autumn	Spring	Spring	Spring
N_090	Once Every 5 Years	0	0	0	Autumn	0
N_091	Once Every 5 Years	0	0	0	0	Autumn
N_092	Once Every 5 Years	0	0	0	0	Autumn
N_093	Once Every 5 Years	0	0	0	0	Autumn
N_094	Once Every 5 Years	0	0	0	0	Autumn
N_095	Once Every 5 Years	0	0	0	0	Spring
N_096	Once Every 5 Years	0	0	0	0	Spring
N_097	Once Every 5 Years	0	0	0	0	Autumn
N_098	Once Every 5 Years	0	0	0	0	Autumn
N_099	Once Every 5 Years	0	0	0	0	Autumn

Remote Camera

- Reconyx Hyperfire
- Camera and bait station
- Lure – Peanut butter / rolled oats / truffle oil / tuna oil

Target species:

Rufous Bettong, Long-nosed bandicoot, Southern brown bandicoot, Spotted-tailed Quoll, Long-nosed Potoroo

Ultrasonic call recorder

Song meter mini bat

- Target bat species:
  - Eastern false pipistrelle
  - Eastern freetail bat
  - Greater broad-nosed bat
  - Bent-wing Bat species
  - Southern myotis
  - Yellow-bellied Sheath-tailed bat

Audio call recorder

- Song meter mini

Target species:

- Barking Owl
- Masked Owl
- Powerful Owl
- Sooty Owl
- Boobook Owl
- Glossy Black-cockatoo
- Brown Treecreeper*
- Rufous Scrub-bird*
- Varied Sittella*
- Grey-headed Flying Fox
- Koala
- Squirrel Glider
- Sugar Glider
- Yellow-bellied Glider

**Recognisers still to be developed*

Sampling Protocols

- Ensuring consistent equipment set up
- Consistent data capture

HARDWOOD FOREST DIVISION

Standard Operating Procedure

Forestry Corporation

SONG METER MINI BAT

FIRMWARE VERSION – *3.4* – to be used until 2027 unless otherwise advised.

The Song Meter Mini Bat utilizes an ultrasonic microphone for recording bat calls. The Song Meter Mini Bat device will be set up and configured prior to field deployment for acoustic recording.

The following is a quick set up method for the device in the office:

1 Remove the lid from the Song Meter Mini recorder.
2 Insert four or NiMH batteries and a 64 (128) GB SD card.
3 Switch the recorder's power switch to On.
4 If the Bluetooth LED flashes red this indicates that the recorder's internal clock is not set. It will be set when pairing.
5 Make sure Bluetooth is enabled on your mobile device.
6 Launch the app.
7 The Song Meter Mini bat will be detected by the app and will appear in the Recorders screen.
8 Press and hold the Pair button on the Song Meter Mini bat recorder for three seconds. The Bluetooth LED on the recorder will blink green, indicating it is ready to pair.
9 In the app, tap the Pair icon when it appears in the Recorders screen. The recorder's details will turn green, indicating successful pairing.
10 A pop-up asks if you want to set the recorder's time zone to your mobile device's time zone. Tap Yes. Next, a pop-up asks the same about location. Tap Yes.
11 After pairing, tap the Configure icon for the paired Song Meter Mini recorder in the Recorders screen. The Configuration Editor screen will open.
12 Select a preset recording schedule from the dropdown menu and make any desired setting changes.
13 The recording schedule and settings changes load onto the recorder after each change.
14 Format data card.
15 Ensure the Recorder Name is adjusted to the sub-plot name eg C-001-off-BA for each new deployment.
16 Tap the Unpair icon on the Recorders screen and the Song Meter Mini is now ready to deploy and record.

NOTE:
It is important that high quality, new lithium batteries must be used on each equipment deployment. Battery failure is a major cause of data loss in passive devices. Ensuring that you have a good battery management procedure is essential to ensuring good data quality and minimising the risk of having to redeploy gear.

Songmeter mini bat detector settings for the Fauna Monitoring

Time	Set from your device (Ipad or Iphone)	
Ultrasonic settings	Recording Format	Full Spectrum
	Full Spectrum Sample rate	256 kHz
	Minimum trigger frequency	8 kHz
	Max recording length	15 secs
	Trigger window	2 secs
	Save noise files?	YES
	Left channel gain	12 dB
Location	Set to general region	Use pinpoint to set office location
	Time zone	UTC +10.00 or use the configurator app to set to your phone
Delay start	Off	
Schedule	Record bats 30 min before sunset to 30 min after sunrise	
	Mode	Ultrasonic
	Start	Time 00:00
	Duty Cycle	Always
	End	Time 00:00

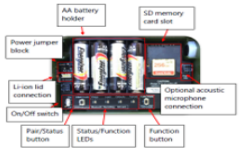


Figure 8: Song Meter Mini Bat

SETTING IN THE FIELD

- Chest height 1.5 – 1.7 m –
- On track sites
  - ~5m from track- theft – Tree selection
  - Small tree so not to block mic
  - Rough bark
  - No shrubs in front of mics- block signal
  - Not obvious from track- theft – Turn on
- Attach to tree
- Aim mic
  - horizontal and slightly down - rain
- Place on south side of trunk if possible – overheating in summer

Figure 12: Song Meter Mini Bat. A python lock or strap may be fitted through the top loops in the unit. Photograph: Anna McConville

Ensure to Aim at road or nearby open space flyway

*********WARNING – MAKE SURE LIDS ARE CLOSED TIGHT AND CLICK INTO POSITION, AS THEY ARE FICKLE********

CAPTURING SITE IN IPAD

A monitoring plan should already by linked in the IPAD through the PLAN PORTAL

At site, capture new **SITE** for the SM Mini Bat(as well a site each for the camera and SM Mini)

Site NAME:
Region (N – North, C – Central, S – Southern),
site number (001 – 100),
location ("**on**" or "**off**"),
device (BA – song meter mini Bat) –
eg *C-002-off-BA* – same details as put into songmeter.

(Note use an underscore between region, site number, location, device)

Capture new census – date, people and
In Census notes – add serial number of device being used.
For subsequent seasons/years keep the sites the same just add new census and details

PICKUP SONG METER MINI

17 Open cover. The unit should be still recording and will show a display when you open it. If it is not recording, use the check status button to see if it will power on. Check that it is switched on. Record the error in the form.
- Switch off and replace cover

18 Remove from tree.

AT CAR:

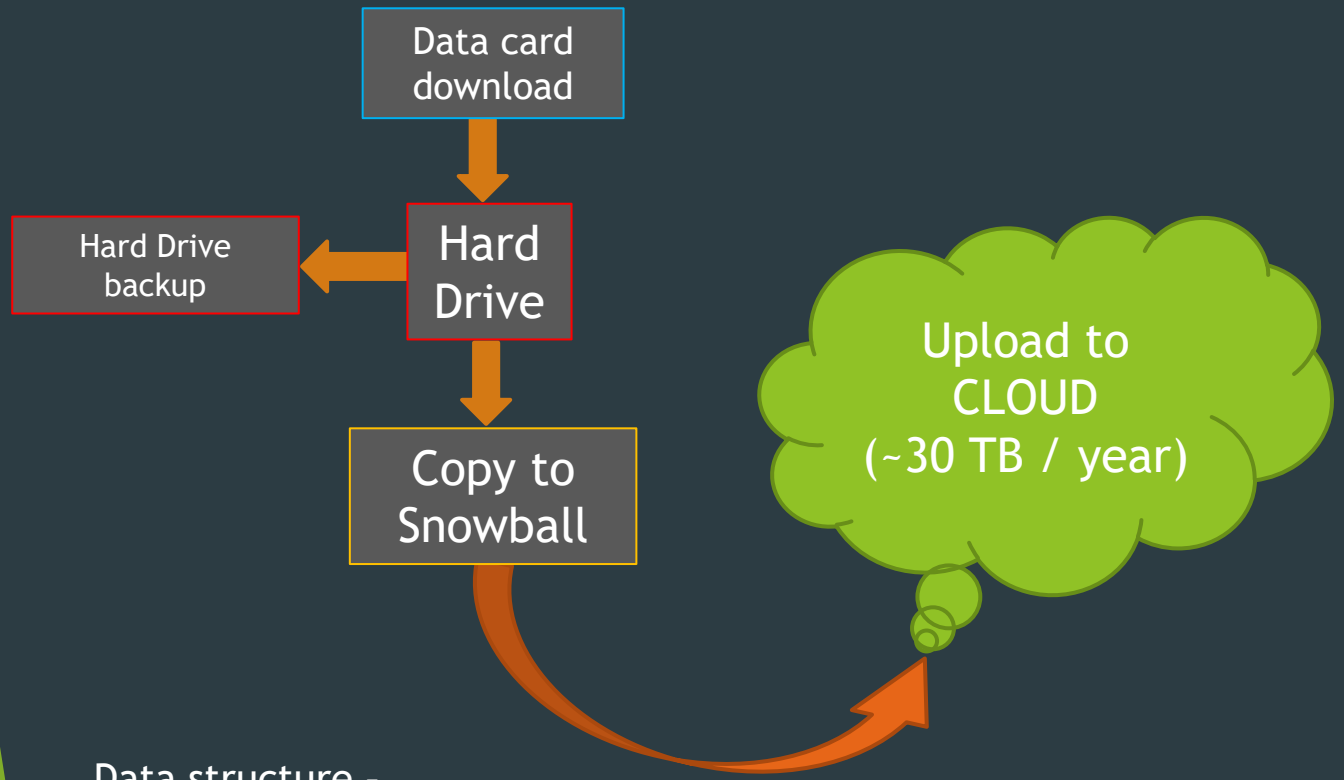
- Open cover
- Remove SD data card by pressing and sliding card into slot – listen for click – and then slide card out
- Place SD data card into Zip Lock bag with label – ensure label has site name, date, name of person picking up equipment and device type (Song meter Mini BAT - BAT)
- Place Zip lock bag in container in safe place in car.

Label:
- Site name – eg C-001-on-BA or C-001-off-BA
- Date –
- Name of person:
- Device Type:
- Device serial number

Species Specific programs

- Southern Brown Bandicoot – Eden
- Yellow-bellied Glider – Bago Plateau
- Smoky Mouse – Eden
- Giant Burrowing Frog – Eden
- Large forest owls - Eden
- Hastings River Mouse – northern tablelands
- Koala – northern forests
- Greater Glider – southern & northern tablelands
  - In development
- Multiple flora species

BIG DATA



Data structure –

- Device
  - Year
    - Season
      - Region
        - Sub-Plot
          - on track
          - off track

Camera Trap Results – Northern

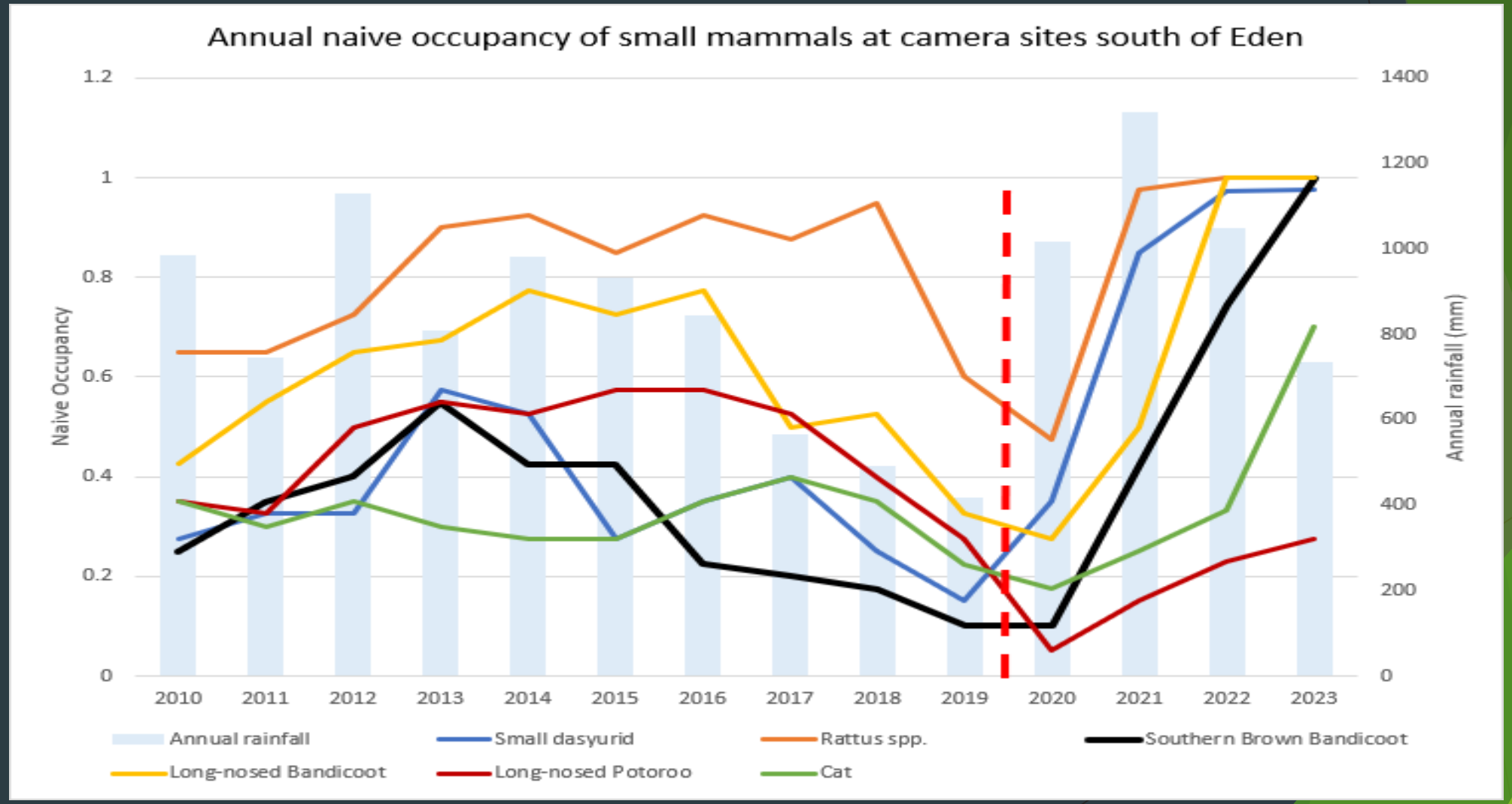
North East 102 Sites – 7,009 detections

region	group	Detections	Sites	Occupancy
N	rodent	2446	69	69%
N	small Dasyurid	1632	41	41%
N	Northern Brown Bandicoot	903	64	64%
N	bird	793	67	67%
N	Common Brushtail Possum	278	29	29%
N	Long-nosed Bandicoot	197	40	40%
N	Australian Brush-turkey	127	19	19%
N	Swamp Wallaby	127	34	34%
N	European cattle	105	4	4%
N	Cat	102	24	24%
N	Lace Monitor	64	15	15%
N	Short-eared Brushtail Possum	54	22	22%
N	Superb Lyrebird	41	17	17%
N	Spotted-tailed Quoll	35	6	6%
N	Dingo/domestic dog	25	9	9%
N	Parma Wallaby	25	3	3%
N	Red-necked Pademelon	14	4	4%
N	Short-beaked Echidna	9	6	6%
N	Red Fox	8	2	2%
N	Long-nosed Potoroo	7	4	4%
N	Land Mullet	5	3	3%
N	Koala	3	2	2%
N	Brush-tailed Phascogale	2	2	2%

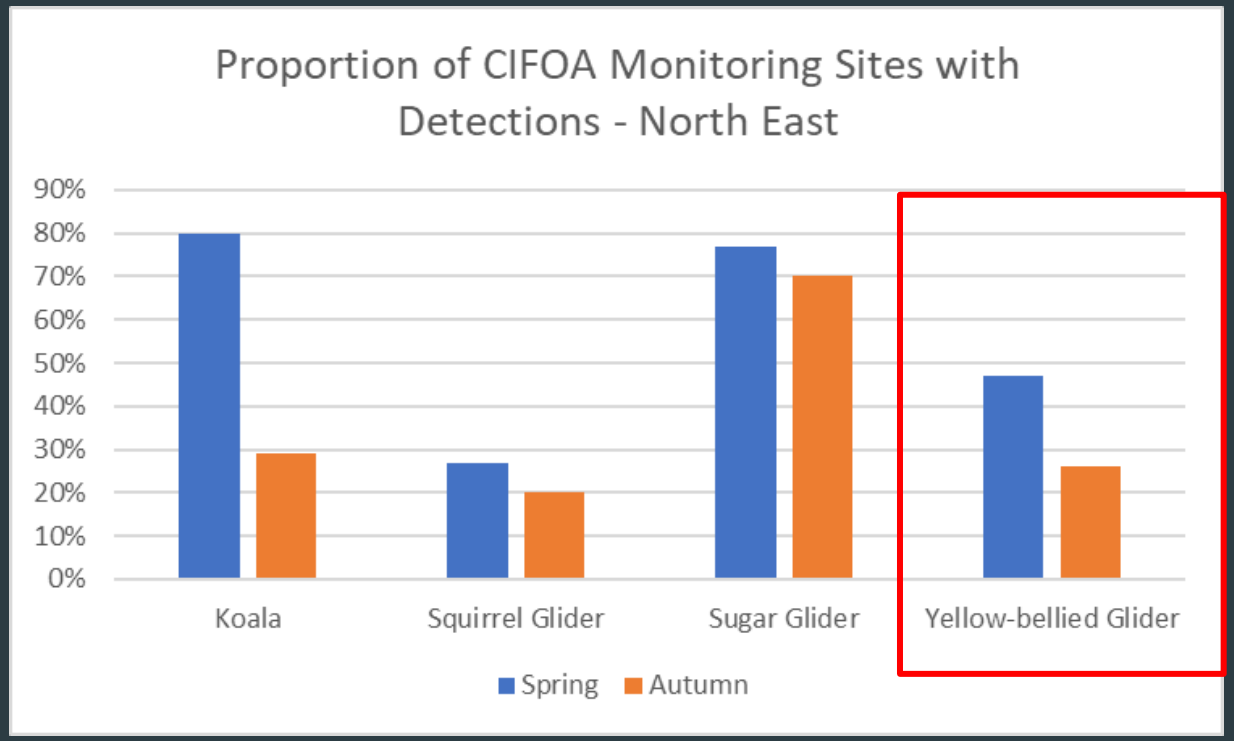
Central 109 Sites – 3,509 detections

region	group	Detections	Sites	Occupancy
C	rodent	1434	79	69%
C	bird	350	70	61%
C	small Dasyurid	309	48	42%
C	Swamp Wallaby	258	57	50%
C	Northern Brown Bandicoot	246	36	31%
C	Long-nosed Bandicoot	162	57	50%
C	Short-eared Brushtail Possum	151	22	19%
C	Lace Monitor	112	27	24%
C	Common Brushtail Possum	100	31	27%
C	Australian Brush-turkey	98	36	31%
C	Superb Lyrebird	74	28	24%
C	Cat	39	15	13%
C	Red-necked Wallaby	36	6	5%
C	Common Wombat	35	11	10%
C	Spotted-tailed Quoll	33	12	10%
C	Long-nosed Potoroo	30	13	11%
C	Red-necked Pademelon	24	9	8%
C	Eastern Grey Kangaroo	17	5	4%
C	Short-beaked Echidna	15	10	9%
C	Red Fox	14	3	3%
C	Dingo/domestic dog	11	6	5%
C	Land Mullet	8	5	4%
C	Unknown mammal	6	5	4%
C	Koala	5	4	4%
C	Red-legged Pademelon	5	1	1%

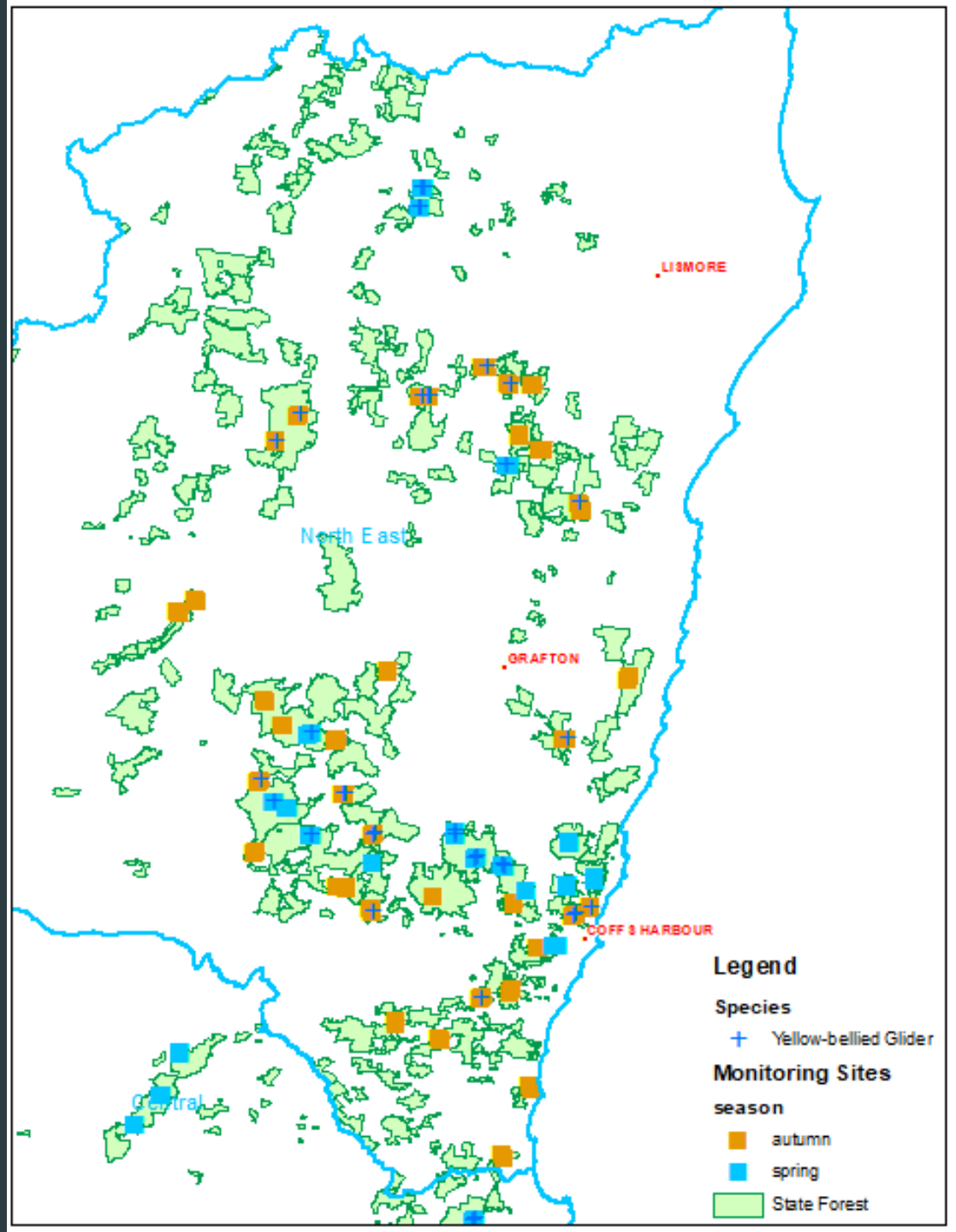
Southern Brown Bandicoot



Yellow-bellied Glider



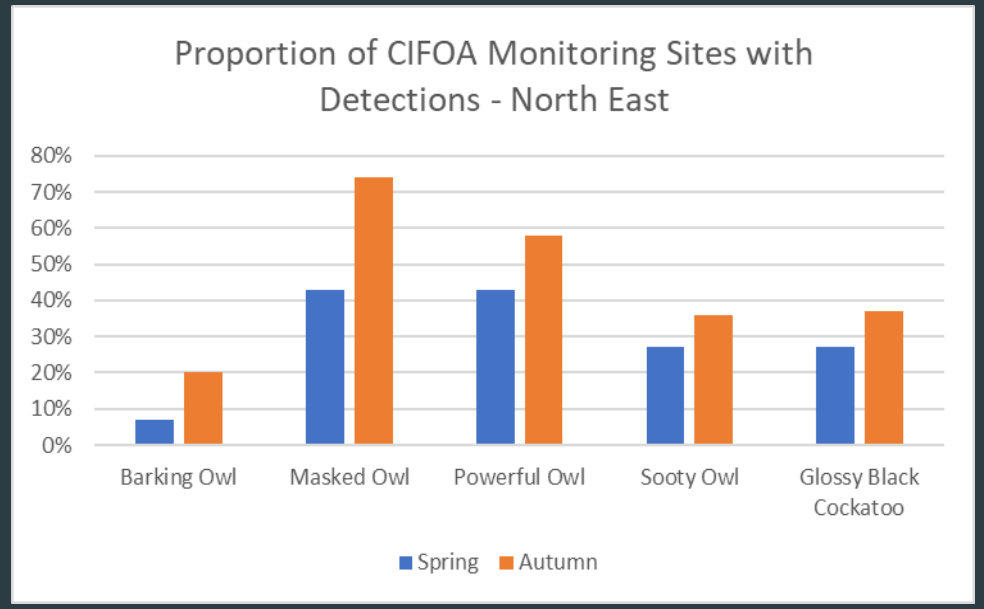
DPI Modelled Occupancy North Coast – 0.62 (2015-19)
NRC Baseline 1990s modelled occupancy – 0.39

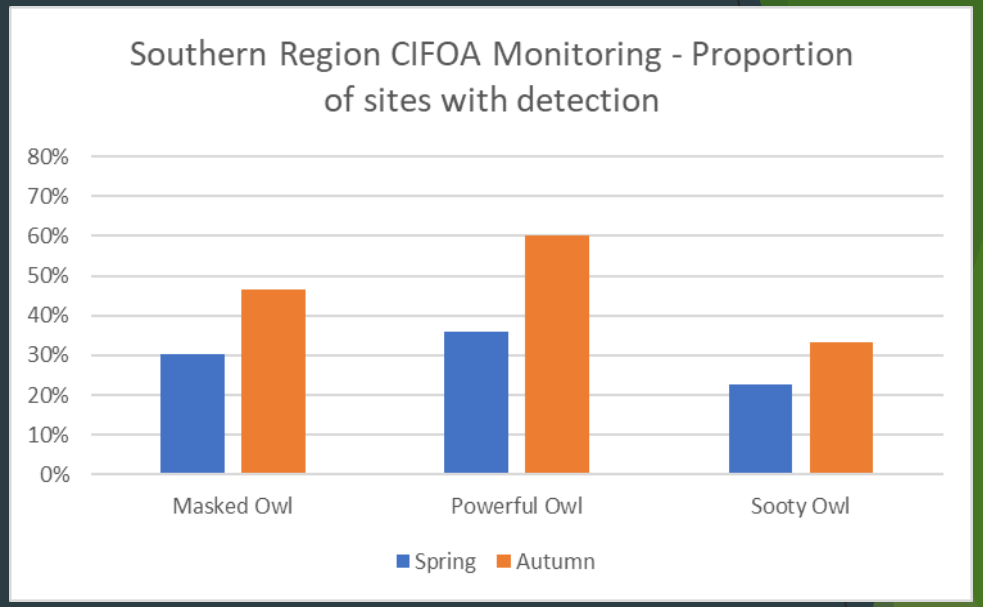


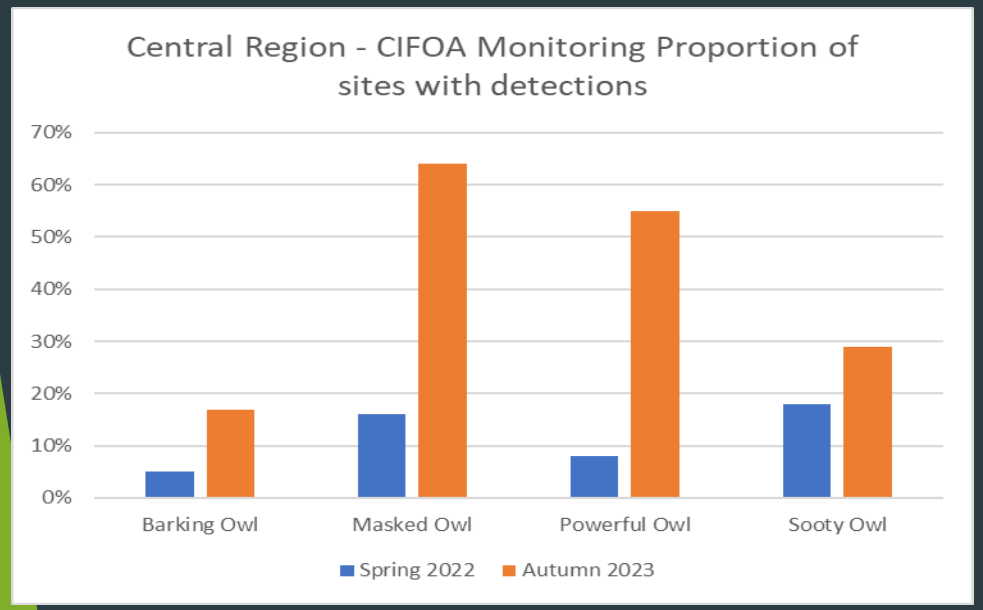
Glossy Black-Cockatoo - Central

NRC Baseline 1990s modelled occupancy- Diurnal bird – 0.156

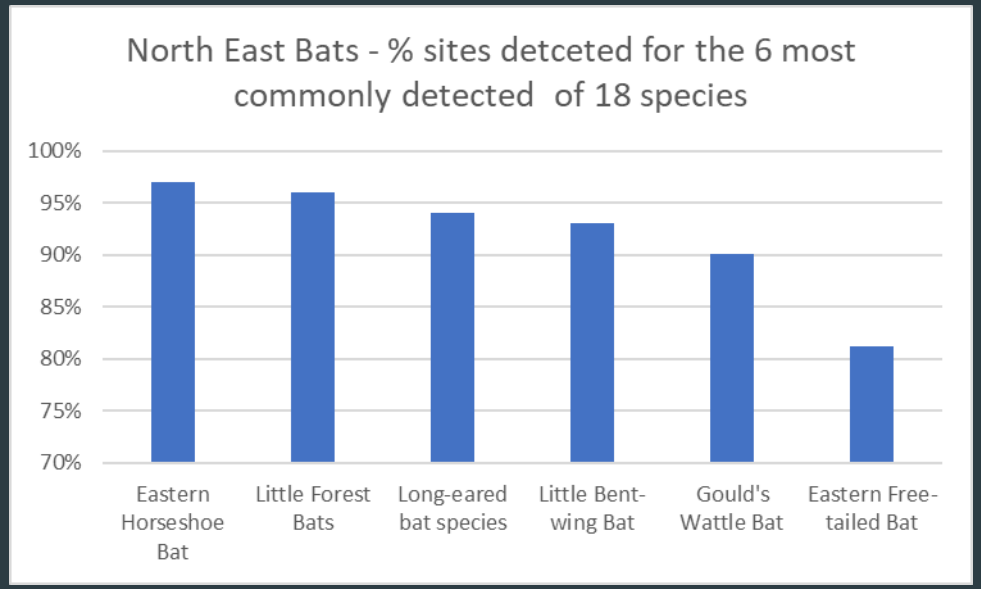
Forest Owl Seasonal Detections by Region

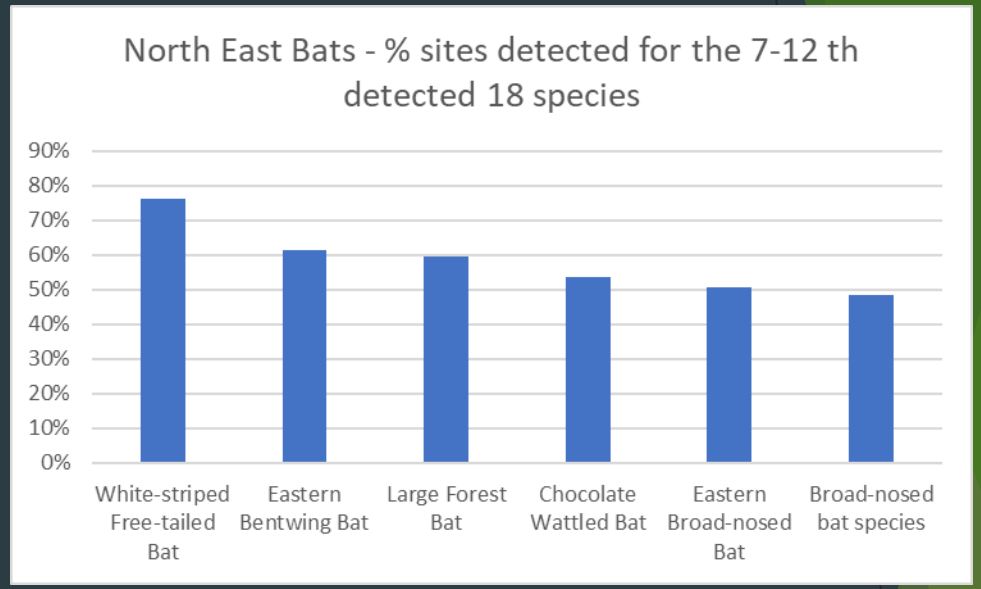


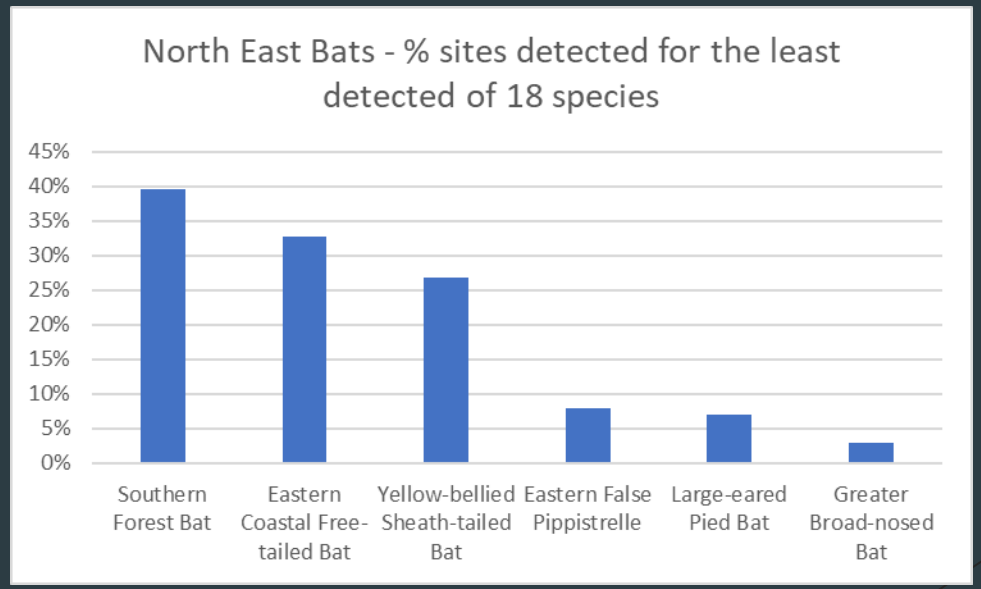




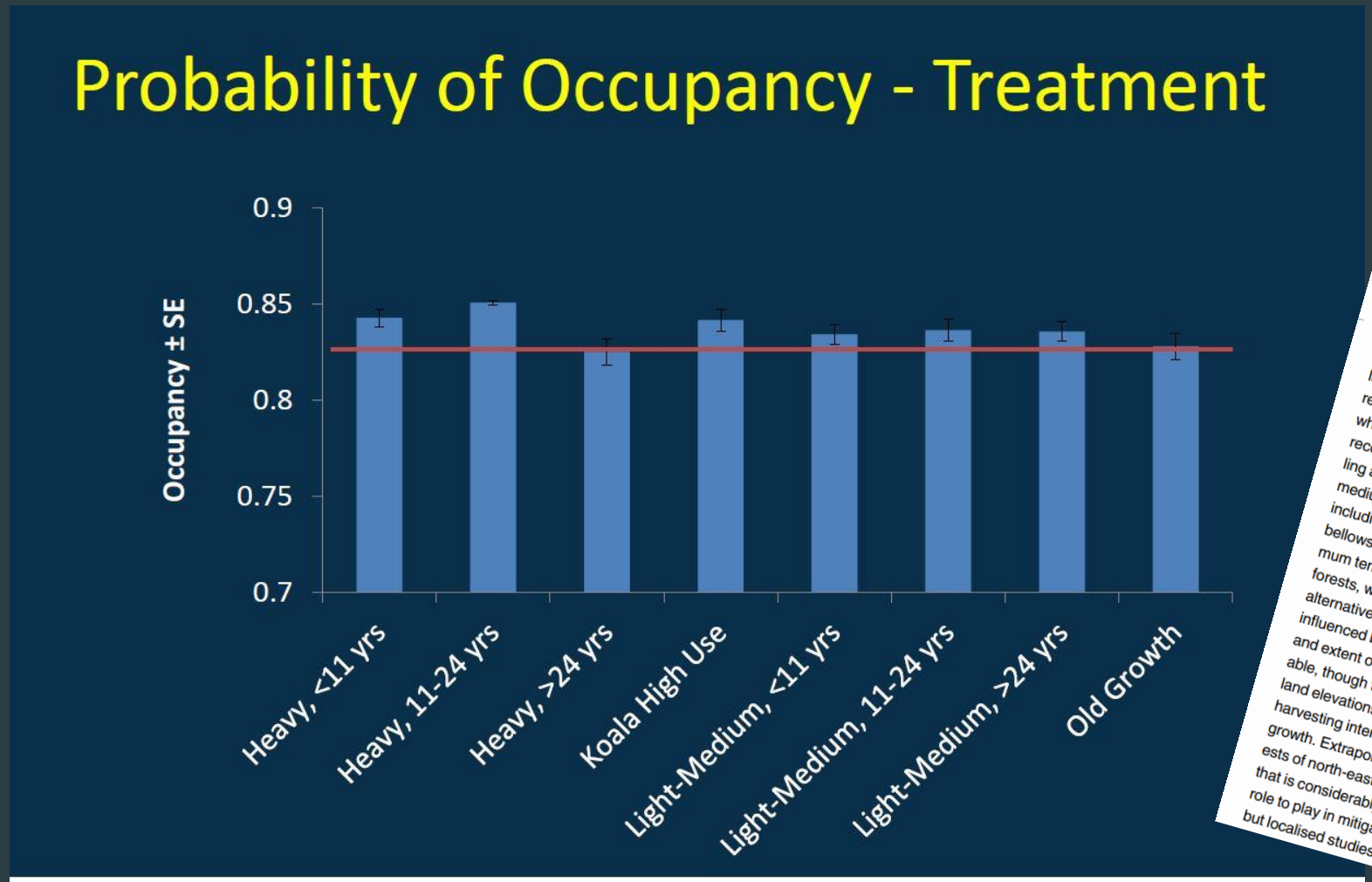
North-East Bats







Koala occupancy and timber harvesting



RESEARCH ARTICLE

Passive acoustics and sound recognition provide new insights on status and resilience of an iconic endangered marsupial (koala *Phascolarctos cinereus*) to timber harvesting

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Abstract

Retention forestry aims to mitigate impacts of native forestry on biodiversity, but data are limited on its effectiveness for threatened species. We used acoustics to investigate the resilience of a folivorous marsupial, the koala *Phascolarctos cinereus*, to timber harvesting where a key mitigation practice is landscape exclusion of harvesting. We deployed acoustic recorders at 171 sites to record male bellows (~14,640 hours) for use in occupancy modelling and for comparisons of bellow rate (bellows night^{-1}). Surveys targeted modelled medium-high quality habitat, with sites stratified by time since logging and logging intensity, including old growth as a reference. After scanning recordings with software to identify koala bellows, we found a high probability of detection (~0.45 per night), but this varied with minimum temperature and recorder type. Naïve occupancy was ~ 64% across a broad range of forests, which was at least five times more than expected based on previous surveys using alternative methods. After accounting for imperfect detection, probability of occupancy was influenced by elevation (-ve), cover of important browse trees (+ve), landscape NDVI (+ve) and extent of recent wildfire (-ve, but minor effect). Elevation was the most influential variable, though the relationship was non-linear and low occupancy was most common at table-land elevations (> 1000 m). Neither occupancy nor bellow rate were influenced by timber harvesting intensity, time since harvesting or local landscape extent of harvesting or old growth. Extrapolation of occupancy across modelled habitat indicates that the hinterland forests of north-east NSW support a widespread, though likely low density koala population that is considerably larger than previously estimated. Retention forestry has a significant role to play in mitigating harvesting impacts on biodiversity, including for forest specialists, but localised studies are needed to optimise prescriptions for koalas.

Koala density and timber harvesting

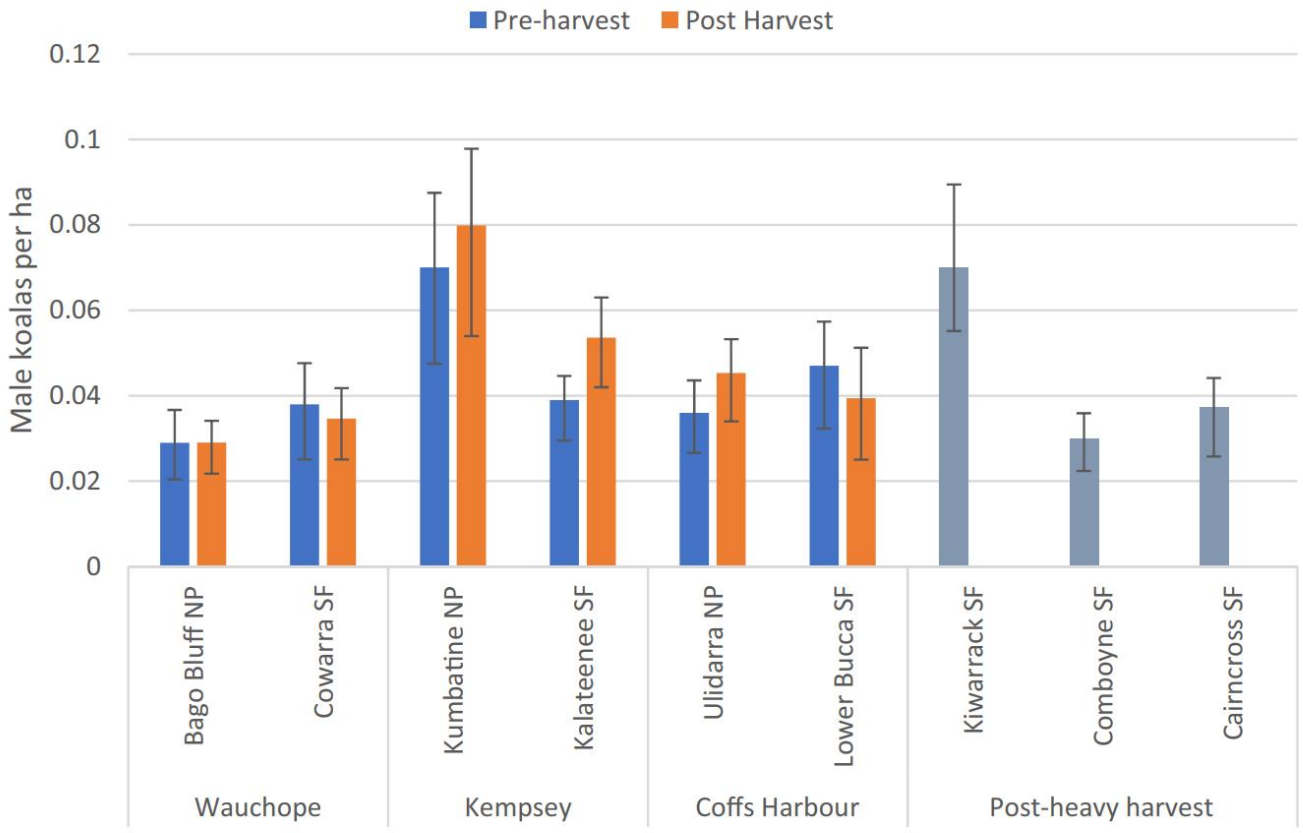
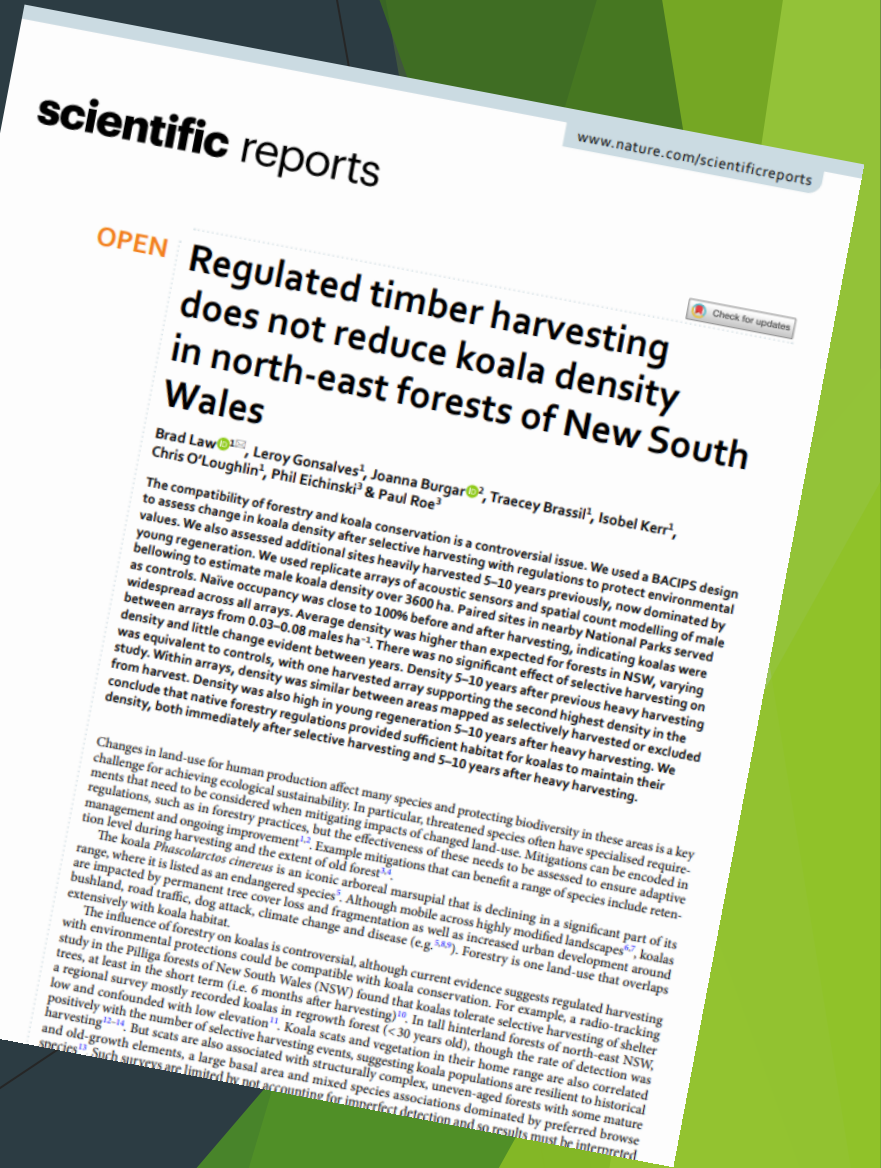


Figure 1. Male koala density before and after harvesting. Modelled male koala density (mean ± 50% credible interval) in pre- and post-harvest years at BACIP sites and three additional sites 5–10 years post-heavy harvest. Density was estimated by Spatial Count analysis of acoustic data collected from arrays.



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Regulated timber harvesting does not reduce koala density in north-east forests of New South Wales

Brad Law[1], Leroy Gonsalves[1], Joanna Burgar[2], Traecey Brassil[1], Isobel Kerr[1], Chris O'Loughlin[1], Phil Eichinski[3] & Paul Roe[3]

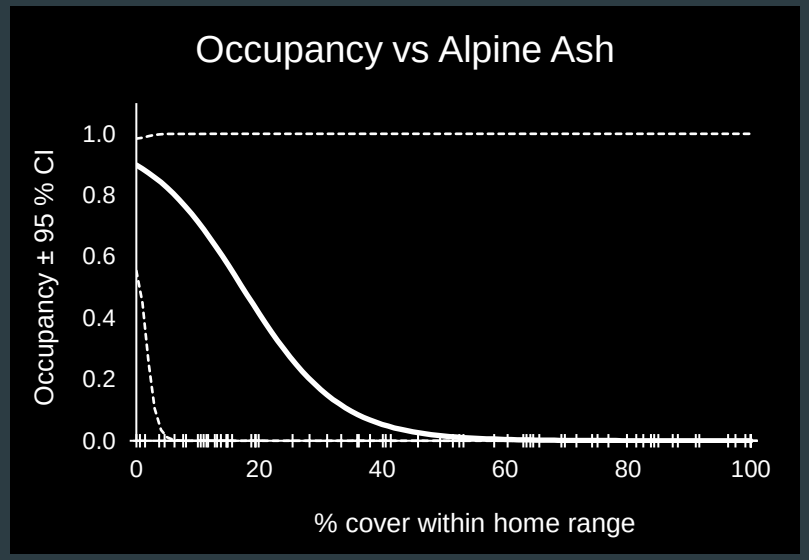
The compatibility of forestry and koala conservation is a controversial issue. We used a BACIPS design to assess change in koala density after selective harvesting with regulations to protect environmental values. We also assessed additional sites heavily harvested 5–10 years previously, now dominated by young regeneration. We used replicate arrays of acoustic sensors and spatial count modelling of male bellowing to estimate male koala density over 3600 ha. Paired sites in nearby National Parks served as controls. Naïve occupancy was close to 100% before and after harvesting, indicating koalas were widespread across all arrays. Average density was higher than expected for forests in NSW, varying between arrays from 0.03–0.08 males ha^{-1}. There was no significant effect of selective harvesting on density and little change evident between years. Density 5–10 years after previous heavy harvesting was equivalent to controls, with one harvested array supporting the second highest density in the study. Within arrays, density was similar between areas mapped as selectively harvested or excluded from harvest. Density was also high in young regeneration 5–10 years after heavy harvesting. We conclude that native forestry regulations provided sufficient habitat for koalas to maintain their density, both immediately after selective harvesting and 5–10 years after heavy harvesting.

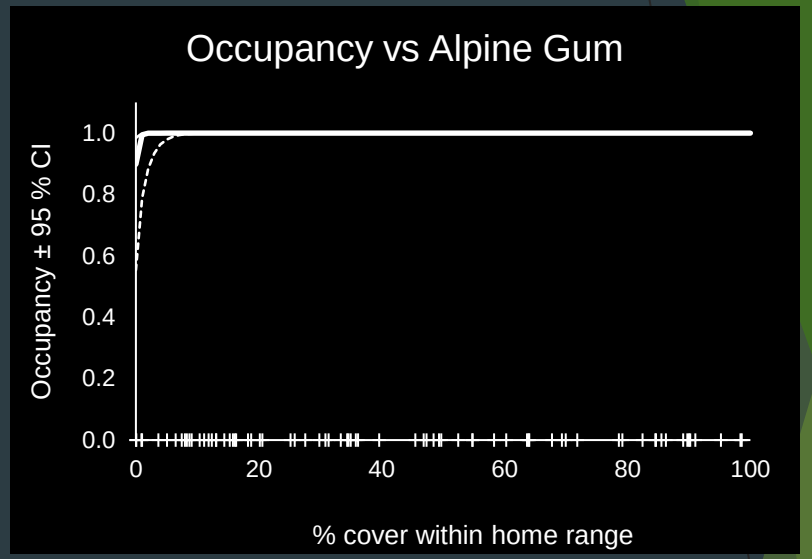
Changes in land-use for human production affect many species and protecting biodiversity in these areas is a key challenge for achieving ecological sustainability. In particular, threatened species often have specialised requirements that need to be considered when mitigating impacts of changed land-use. Mitigations can be encoded in regulations, such as in forestry practices, but the effectiveness of these needs to be assessed to ensure adaptive management and ongoing improvement[1,2]. Example mitigations that can benefit a range of species include retention level during harvesting and the extent of old forest[3,4].

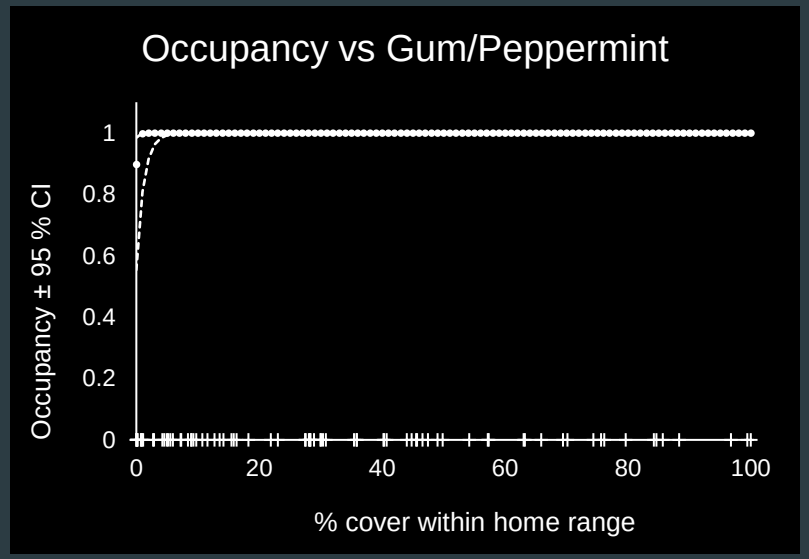
The koala *Phascolarctos cinereus* is an iconic arboreal marsupial that is declining in a significant part of its range, where it is listed as an endangered species[5]. Although mobile across highly modified landscapes[6,7], koalas are impacted by permanent tree cover loss and fragmentation as well as increased urban development around bushland, road traffic, dog attack, climate change and disease (e.g.[5,8,9]). Forestry is one land-use that overlaps extensively with koala habitat.

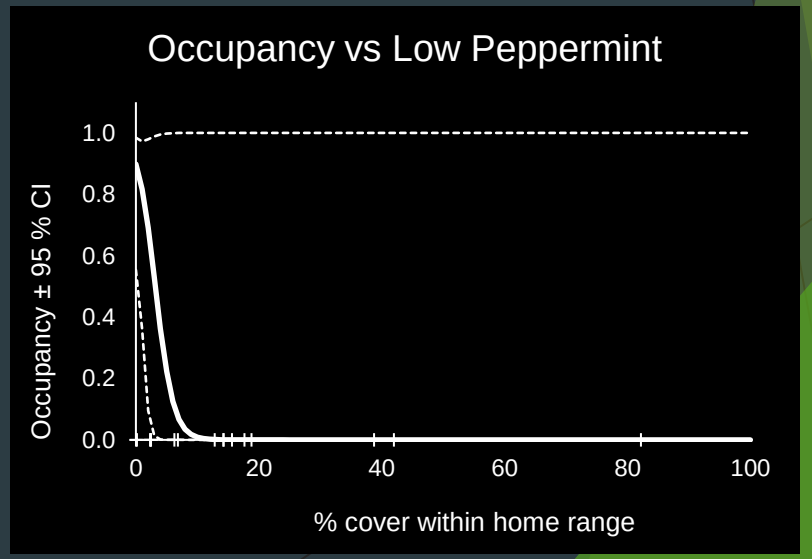
The influence of forestry on koalas is controversial, although current evidence suggests regulated harvesting with environmental protections could be compatible with koala conservation. For example, a radio-tracking study in the Pilliga forests of New South Wales (NSW) found that koalas tolerate selective harvesting of shelter trees, at least in the short term (i.e. 6 months after harvesting)[10]. In tall hinterland forests of north-east NSW, a regional survey mostly recorded koalas in regrowth forest (< 30 years old), though the rate of detection was low and confounded with low elevation[11]. Koala scats and vegetation in their home range are also correlated positively with the number of selective harvesting events, suggesting koala populations are resilient to historical harvesting[12–14]. But scats are also associated with structurally complex, uneven-aged forests with some mature and old-growth elements, a large basal area and mixed species associations dominated by preferred browse species[15]. Such surveys are limited by not accounting for imperfect detection and so results must be interpreted

MONITORING – YELLOW BELLIED-GLIDER







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