A call to scale up biodiversity monitoring from idiosyncratic, small-scale programmes to coordinated, comprehensive and continuous monitoring across large scales

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ABSTRACT

Conservation managers cannot manage what they don't know about, yet our existing biodiversity monitoring is idiosyncratic and small in scale. One of Australia's commitments to the Convention for Biological Diversity in 2015 was the creation of a national biodiversity monitoring programme. This has not yet occurred despite the urgent need to monitor common and threatened species, as highlighted by the challenges of determining the biodiversity impacts of the Black Summer fires of 2019/20. In light of improvements to automation, miniaturisation and powering devices, the world urgently needs to scale-up biodiversity monitoring to become coordinated, comprehensive and continuous across large scales. We propose the BIOMON project that could achieve this where individual sensor nodes use machine learning models to identify biodiversity via sound or photos onboard. This could be coupled with abiotic data on temperature and humidity, plus factors such as bushfire smoke. Nodes would be set within networks that transmit the results back to a central cloud repository where robust analyses are conducted and provided free to the public (along with the raw data). Network arrays could be set up across entire continents to measure the change in biodiversity. No one has achieved this yet, and significant challenges remain associated with training the algorithms, low power cellular network coverage, sensor power versus memory trade-offs, and sensor network placement. Much work is still needed to achieve these goals; however we are living in the 21st Century and such lofty goals cannot be achieved unless we start working towards them.

Key words: threatened species, biodiversity monitoring, IoT, Sensor Network, common species, birds, frogs, calls, camera trapping, sound recording, Microchiroptera

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Introduction

Biodiversity monitoring involves the collection of species' occupancy and abundance data across broad landscapes and over extended periods of time. These data can be collected via repeat surveys in person, or via remote data collection methods such as camera traps or sound recording devices. While each of these methods can only detect a portion of the species present, the goal of each method is to collect data on as many species as possible to build information profiles on ecosystem integrity, rather than the status of a single target species. There are several reasons to monitor biodiversity. Firstly, we need to understand what species are present at a site and how their population numbers are faring, as this is the basis for evaluating the integrity of ecosystems. It was broad-scale monitoring that led to the serendipitous re-discovery of Gilbert's potoroo *Potorous gilberti* in Two People's Bay Nature Reserve in the mid-1990s (Sinclair *et al.* 1996). Secondly, monitoring can enable us to investigate the impact of perturbations on biodiversity. When the conclusions of research that identified the impact of introduced red foxes *Vulpes vulpes* on rock wallabies (Kinnear *et al.* 1988) were questioned on statistical grounds (Hone 1994), a broad-scale impact assessment monitoring program was designed over half a million hectares of the jarrah forest in Western Australia to test the faunal response to fox control (de Tores 1999). Thirdly, conservation management actions need to be monitored to ascertain their success. For example, the reintroduction of large predators to the Eastern Cape Province of South Africa over a long period of time has illustrated the success of such conservation translocations, but also the challenges of establishing some species (Banasiak *et al.* 2021; Hayward *et al.* 2007). Finally, targeted monitoring to assess the status of individual species is critical to enable conservation managers to assess the need for action. For example, the quokka *Setonix brachyurus* persisted at very low densities in the *Taxandria* swamps of the northern jarrah forest in the face of threats from foxes and altered fire regimes (Hayward *et al.* 2003). Clearly monitoring is essential, however the absence of large-scale monitoring has been identified as a major failure of conservation practice historically (Legg and Nagy 2006) and inadequate monitoring methods have led to questionable conclusions for conservation managers (Hayward and Marlow 2014). This paper seeks to act as a call-to-arms for scientists, engineers, computing specialists and conservation managers to work in partnership to develop a coordinated, comprehensive and continuous monitoring programme across large scales to enable us to identify in real-time when conservation action is needed.

The Black Summer fires highlighted Australia's lack of national monitoring for a broad suite of species. To determine the impact of the fires, the best that could be done was to overlay the burnt area with the historical distribution of species and their potential densities (Legge *et al.* 2020). This revealed that within the 30 million hectares of vegetation burnt, an estimated 3 billion vertebrates and 240 trillion invertebrates were affected, from 832 vertebrate species and 37 threatened ecological communities (Dickman In press). With limited adequate biodiversity monitoring before the fires and many historical distributions outdated, it is difficult to ascertain the true impact of the fire on many populations or draw more fine-scale conclusions.

Among the many species thought to be impacted were species like the parma wallaby that was last studied in the 1970s and where the IUCN Red List status assessment since the turn of this century has cited a population estimate of between 1000 and 10,000 that was derived in the '70s almost entirely from guesswork ("In 1992, the total number of adults was estimated at between 1,000 and 10,000 individuals. There appears to be no evidence of a decline"; Lunney and McKenzie 2008). This out of date and absurdly broad population estimate is of little practical use to the conservation management of this species and exemplifies the lack of ecological knowledge reflective of a general absence of monitoring. Numerous species are in the same boat, but how can we manage the conservation of Australia's biodiversity if we don't know how most species are faring? Other species do have well designed monitoring programmes, but as a national monitoring programme, the random assortment of species that have such well designed monitoring is clearly idiosyncratic.

Australia's understanding of the impacts of the Black Summer fires were inhibited by COVID-19 restrictions, but also "by a diminution in ecological monitoring capacity that occurred before the last fire season" (Dickman In press). Yet Australia has long sought to develop adequate monitoring of its biodiversity. For example, Target 10 of Australia's commitment to the Convention on Biological Diversity in 2015 was to set up a 'national, long-term biodiversity monitoring and reporting system' (https://www.cbd.int/countries/targets/?country=au). To date, this does not seem to have occurred, and this paper aims to initiate discussion to drive Australia to achieve this goal.

Existing large-scale monitoring programmes

Monitoring programmes can and do occur at large scales. Operation Foxglove tested the response of biodiversity to aerial and ground baiting of foxes in a variety of treatments over 544,000 ha of the northern jarrah forest in Western Australia (de Tores 1999; de Tores and Marlow 2011). Fifty-five (55) survey sites were monitored via 25 wire cage traps, 15 Elliot traps, and 15 pitfall traps seasonally for four consecutive nights over several years (de Tores 1999). In addition to this, 492 woylies *Bettongia penicilata* were translocated into each treatment area to determine their survivorship in the face of different fox densities, and common brushtail possums *Trichosurus vulpecula* were collared *in-situ* to assess the survivorship of arboreal fauna (de Tores 1999). Bird surveys, spotlighting transects and bait uptake trials were also incorporated into the study design. They concluded that higher intensity fox control yielded substantial improvements in wildlife survivorship and densities, and this led to discoveries of mesopredator release whereby cats *Felis catus* and native predators increased in the absence of foxes (Sutherland *et al.* 2011).

The Australian Wildlife Conservancy conducts annual monitoring programmes across its estate (Legge and Fleming 2012). These programmes involve similar activities to Operation Foxglove, but also a rigorous reporting process through sanctuary health reports that incorporate peer review. This programme has expanded to include the joint venture sites in association with the NSW government (e.g., Pilliga National Park Gilgai Section).

There are also large-scale camera trapping programmes that could be used for monitoring. The Snapshot Serengeti programme involved camera trapping in the Serengeti National Park of Tanzania with photographs identified by citizen scientists and validated by species experts (Swanson *et al.* 2016; Swanson *et al.* 2015) that trained machine learning algorithms to identify the species captured in the photos (Norouzzadeh *et al.* 2018). This has morphed into Snapshot Safari and expanded to more sites throughout eastern and southern Africa that incorporates citizen scientists to identify the photographs via the Zooniverse platform (https://www.zooniverse.org/) (Pardo *et al.* 2021). Snapshot Wisconsin has followed these principles to develop a monitoring programme for the US State of Wisconsin (Townsend *et al.*). In Australia, individual groups are using these same practices with their camera trapping networks, including the New South Wales Department of Primary Industries/University of New England, and the World Wildlife Fund (WWF). WildCount is a version of such programmes that involves four camera traps placed at 200 sites in 146 national parks since 2010 (https://www.environment.nsw.gov.au/topics/animals-and-plants/surveys-monitoring-and-records/native-animal-monitoring). WildCount detected 157 species over the first 5 years of operation. Coordination of these activities seems likely to yield major benefits and reduce the duplication of effort.

India's national tiger *Panthera tigris* census may be the largest biodiversity survey in the world (Carbone *et al.* 2019) as it seeks to estimate the distribution, occupancy and density of wildlife across India every four years. For the 2018 census, over half a million kilometres of transects were walked to measure wildlife signs to use as covariates in occupancy models and spatially explicit capture recapture models arising from almost 27,000 camera trap locations from 141 sites that yielded 35 million animal photographs (Jhala *et al.* 2020). A total of 2461 individual tigers over a year of age were photo-captured, and the total population size was 2967 (2603 – 3346), which is an increase of 6% per annum (Jhala *et al.* 2020). Beyond the success for tiger conservation, this quadrennial national monitoring programme has yielded a suite of benefits in improving our understanding of wildlife ecology, conservation management and community engagement (Jhala *et al.* 2021).

The Australian Museum's FrogID phone app enables citizen scientists to record frog calls and send them to scientists for identification (Rowley *et al.* 2019). As of the 31st of August, 2021, FrogID had received over 250,000 frog call recordings of 405,699 verified frogs from 204 species across Australia (www.frogid.net.au). This is an amazing data collection exercise, however it still relies on people sifting through massive numbers of sound files to identify the species present. Machine learning offers vast advantages over this in terms of time and financial costs, but requires large datasets to train the algorithms.

Birdlife Australia and its affiliates, such as the Hunter Bird Observers Club, run many monitoring programmes for Australia's avifauna using citizen scientists and staff scientists, including Birds in Backyards, Aussie BirdCount, Twitchathon, migratory shorebird monitoring, threatened beach-nesting birds, threatened woodland birds, and key biodiversity areas. These generally incorporate the birddata app and webpage (https://birdata.birdlife.org.au/).

Paul Roe has led a team that set up the Australian Acoustic Observatory (https://acousticobservatory.org/) of 360 continuously operated audio sensors across Australia that store data on the cloud that are freely available to everyone. Yet this still requires the sounds to be identified manually, and the sound cards to be collected from often remote sites.

These large-scale monitoring programmes illustrate that national biodiversity monitoring is entirely feasible, and are already performing important monitoring functions (e.g., State of Environment or State of Forests reports). Yet they often require experts to spend long periods of time in the field detecting the wildlife, and then longer periods in the lab/office identifying the wildlife from remote sensing devices. This leads to long delays in converting data collection to results, but ultimately the data collected are added to repositories like the NSW BioNet, Atlas of Living Australia and/or the Global Biodiversity Information Facility.

Many of these programmes also rely heavily on citizen scientists. This has benefits, in that it provides extra hands to collect more data, although the quality of the data can be questionable (Aceves-Bueno *et al.* 2017). Citizen science may also engage the public and increase scientific literacy, although the people who engage with these programmes tend to be self-selecting groups of people already engaged and scientifically literate. However, a technology-led solution does not negate the need for citizen scientist involvement, but rather provides an alternative activity for them to participate in.

These programmes highlight areas where technology can assist in monitoring biodiversity. Automation capacity has increased vastly in the past decade due to reductions in the size of low-powered computing devices, advances in wireless communications, and the explosion in automated data-recognition algorithms via machine learning (Keitt and Abelson 2021). It really is time to move biodiversity monitoring into the 21st Century.

BIOMON – a technology-led biodiversity monitoring platform

The Biosensor Monitoring project (BIOMON) we envisage offers a way to conduct permanent, continuous biodiversity monitoring across broad landscapes of Australia, and the world. BIOMON involves using arrays of solar-powered sensor nodes using different sensors that collect biological (sounds, photographs, pollen samples) and abiotic data (smoke particles, temperature, humidity), and use edge computing to automatically identify them as far as practicable onboard the sensor, and then deliver the results to a central data repository for further processing until identifiers are suitably accurate to yield precise species data (Fig. 1). The sensor nodes will automatically collect data from deployed locations and transmit those data to the central data repository. Ground sensor nodes will be equipped with multiple sensors to capture and pre-process different data that will be automatically identified by machine learning algorithms located in a cloud server. A cloud server will store all data and can be distributed to different users by employing a subscription process. Obviously machine learning requires vast amounts of data to train the software, and we will achieve this by training the algorithms using citizen scientists and species experts

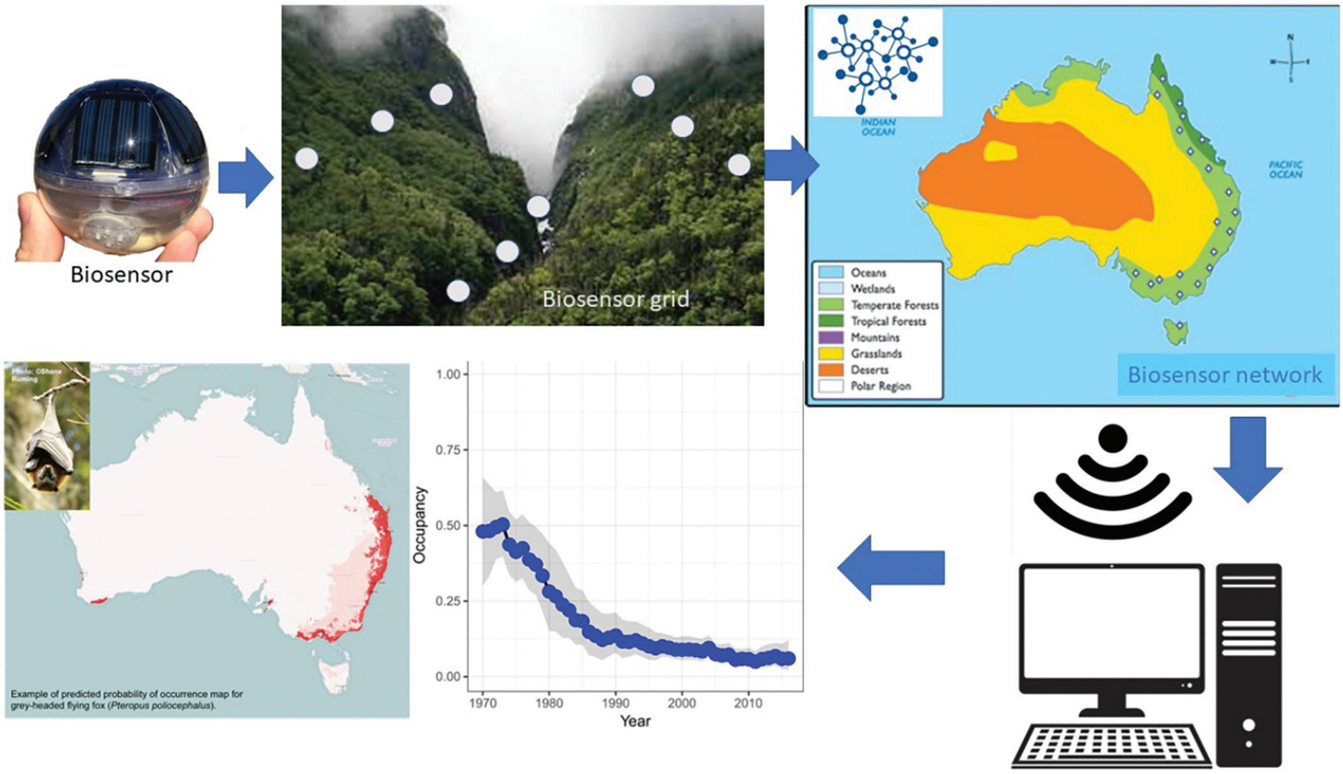

Fig. 1. Schematic representation of the BIOMON biosensor network. Individual, stationary, solar-powered biosensors will be trained to identify calls and images from birds, frogs, bats, mammals and other fauna onboard using machine learning algorithms. Grids of biosensors will be set up in representative areas where monitoring is sought, and these will be connected via telecommunications networks into a national-level biodiversity monitoring network. These networks will send their data of identified species records to a central data repository, which will have a user-friendly system of identifying species records, distribution and occupancy over time. Hence, the BIOMON project uses cutting edge technology with world-leading machine learning practices and robust statistical methods to create a landscape-scale biodiversity monitoring system.

from university partners, government agencies, Birdlife Australia/Hunter Bird Observers Club, and the Frog and Tadpole Society via a web-based platform as occurs with Zooniverse in Snapshot Safari (Pardo *et al.* 2021).

Ultimately, these sensor nodes and edge computing devices could detect animals via vision (any animal that can be camera trapped), and sound (all species that emit species-specific sounds, such as frogs, some geckoes, most birds, echolocating bats, and mammals that vocalise). An expansion of the sensor node deployment could incorporate detection and monitoring of flowering plants via the unique shapes of their pollen granules (Martin and Harvey 2017; Oswald *et al.* 2011) and fungi via the unique shapes of their spores (Galán *et al.* 2021; Shivas *et al.* 2014; Vernes *et al.* 2004). These sensor nodes can already detect smoke particles, which means they can provide immediate detection of bushfires and thereby increase the chances of fires being successfully extinguished where necessary.

We believe the BIOMON system could ultimately be used to monitor 223 (70%) of Australia's 319 threatened terrestrial vertebrate species with 159 species producing unique sounds and 68 by camera trapping (with 4 ostensibly detected by both methods) (Appendix 1). Yet we must also be cognisant of population declines in currently common species, so these common species will also need to be accommodated in the programmes. This should be an easier task as they are likely to have greater detectability than rarer species and by focusing on the full suite of threatened species we should be able to capture change in more common species.

These sensor nodes can be placed in grids to capture the diversity of species found there. Sensor grids will be situated randomly within key habitats (random stratification monitoring design) to create a biosensor network across a region, state or country. Sensor grids will be connected to the nearest mobile telecommunication tower or connected to the satellite network in remote areas to transmit captured data to a cloud data server for identification. This cloud server will compute summary data for access via the web to all interested parties including species locations, species distribution models (MaxEnt) and occupancy estimates over time.

While this whole project is novel, the most exciting aspect is the ability of the advanced sensors to identify the calls or photos of wildlife onboard, rather than saving the raw data on an SD card for manual identification back in the office. The sensor networked system will capture and identify data/signals as soon as it detects target animals in different locations. This will save vast amounts of labour, and hence time, resulting in real-time biodiversity monitoring information. Data may be lost until the recognisers are sufficiently accurate, but this bias will be set against the large amounts of data that could be detected.

Coupling the automated detection and identification of biodiversity with robust analysis is also critical to avoid problems associated with weak analytic methods leading to questionable conclusions (Hayward *et al.* 2015). These data are ideally suited to enable real time calculation of range-wide occupancy models that will enable changes in species occupancy to be detected quickly (MacKenzie *et al.* 2006). Furthermore, species distribution modelling (Peterson 2001; Peterson *et al.* 2000) or occupancy maps could be incorporated into the system to enable change in distributions to be detected. There could also be scope to scale-down these analyses to smaller areas provided there are sufficient detectors.

Obviously, we are not the first to hit upon this idea. Brad Law has been using machine learning to identify koala *Phascolarctos cinereus* bellows to validate his ecological niche models for the species (Law *et al.* 2017) and has continued as an acoustic monitoring program currently focused on koalas (https://www.dpi.nsw.gov.au/forestry/science/forest-ecology/koala-research-in-nsw-forests). He has also done similar projects on microbats in the Pilliga (Law *et al.* 2021). The frogging and birding communities have also used the results of machine learning and deep neural networks with sound identifiers to target their focal species. The novel aspects of the BIOMON project is that animals are identified via an onboard sensor, the results are transmitted to a central repository where basic analyses are provided, but where data are available to all interested parties, and there is coordination of the monitoring programme.

Future needs

Automated data collection and machine learning systems are set to revolutionize the study of natural systems (Keitt and Abelson 2021) and change our expectations of environmental monitoring, but we are not there yet. No one has achieved this yet, and significant challenges remain. Large investments are still needed. Machine learning requires vast training sets of labelled data to train the deep learning models to accurately identify sounds and images (Russakovsky *et al.* 2015). Citizen scientists can greatly assist in this process, however we still need to collect large numbers of sound recordings.

The biosensors need to be designed, tested and manufactured at scale, recognising that more data requirements necessitate larger sensors with greater power needs and concomitant price. There will also be a trade-off between sensor strength to detect sounds/images from further afield, and power requirements of the sensors. Optimising this relationship will be important, and will need to account for solar recharging of the sensors in a variety of habitats (e.g., rainforests vs grasslands) and climatic conditions (e.g., tropics vs desert)

In this process, ecologists will lead the initial critical collection and labelling of large training data sets of image and sound files, while also capitalizing on existing repositories of labelled recordings whenever possible. Later in the process, they will apply big data techniques in collaboration with data scientists while the large multimodal sensor network is operating. It is envisaged that the outcome of this collaboration will solve some of the big questions of biodiversity and ecology. More work will be needed to define the situation of biosensor grids within a biosensor network (Fig. 1) to ensure they are optimally situated to maximise detections and statistical power to answer management questions.

The layout of the sensor network will be constrained by that of the low power telecommunications network, which focuses on areas of higher population density leaving much of Australia's interior still lacking connectivity, although this is improving (Fig. 2). This will bias the species that can be adequately monitored. The sensors are also likely to need maintenance.

Strategic planning will also be required to determine the optimal placement and spacing of the sensor grid arrays. A national monitoring network is needed, and there needs to be sufficient sensors in the landscape to detect changes in distribution or occupancy of even the rarest of species. This will necessitate placing sensors at sufficient densities to enable the calculation of robust statistics to detect change, but stratification is likely to be important to ensure key landscapes and habitat features are accounted for. The spatial density of sensors may need to be greater around the distribution of rarer species compared to the densities needed to detect change in more common species. Optimising their placement is fundamental in the same way it has occurred for other conservation initiatives (Bode *et al.* 2012; Ringma *et al.* 2017; Wilson *et al.* 2007), yet we must acknowledge that some sites will not be accessible during the early phases of the programme and so covariates need to be incorporated into models to extrapolate to such areas, as has occurred with the Indian tiger census (Jhala *et al.* 2021).We need to invest sufficiently in the number of sensors so that we do not run into the limitations of programmes like WildCount that cannot monitor the majority of species detected because of insufficient investment in the monitoring network.

Improved knowledge and understanding of biodiversity may also be important. Regional calls may hinder call identification, and improved knowledge of the behaviour of wildlife (e.g., calling phenology) may also be required to ensure adequate detectability.

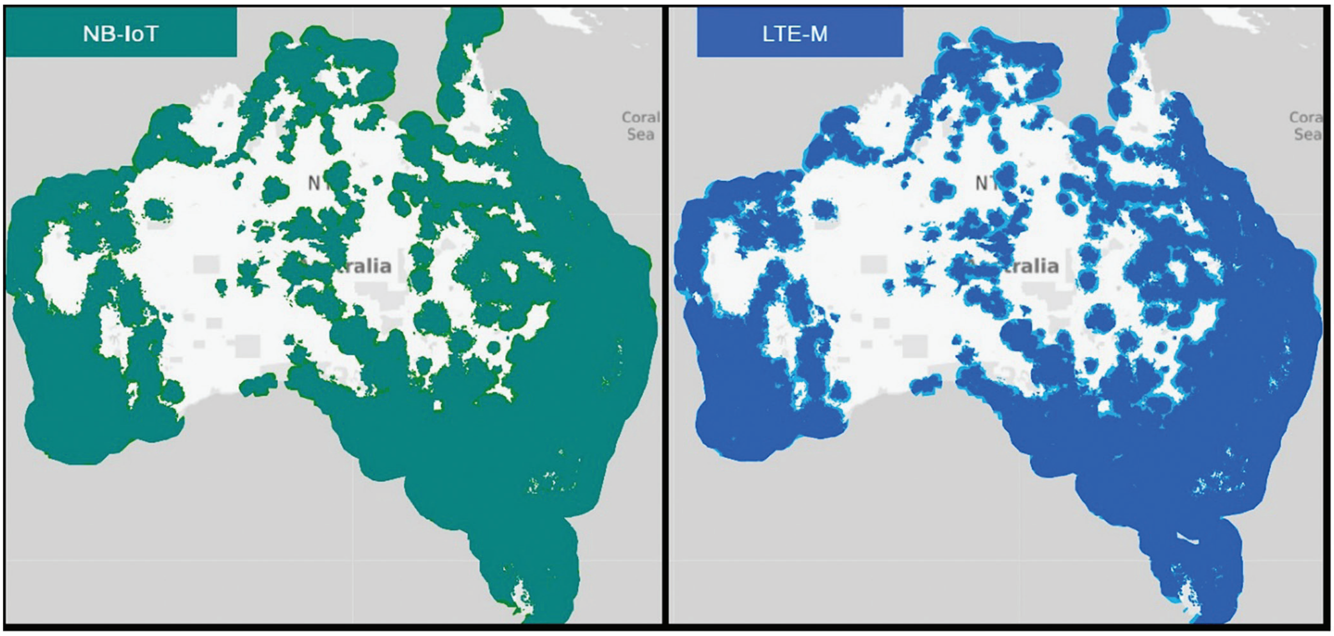

Fig. 2. Network coverage of Telstra's LTE-M, covering 3 million square kilometres, and NB-IoT, covering 4 million square kilometres,Cellular Low Power Wide Area Networks (from https://www.telstra.com.au/business-enterprise/about-enterprise/our-network/iot-coverage-map) that are best suited to the BIOMON sensor network.

Adequate storage of the accumulated data will also be critical (Robinson *et al.* 2018), along with a system to enable access and use of the data by all interested parties. This will remove the risk that long-term monitoring data remains concealed in the diaries of the people involved and that intensive detective work to collate the data is needed (Alley *et al.* 2022). The implementation of a large-scale monitoring programme will also necessitate engagement with ethicists to consider the implications of personal privacy issues when people are detected by the BIOMON system.

The large-scale monitoring programme proposed here can monitor the majority of Australia's terrestrial vertebrate fauna, however some taxa will still be missed and will need more targeted monitoring. Platypus *Ornithorynchus anatinus* is a silent aquatic species that is unlikely to be detected with cameras or audio recorders, hence large-scale national monitoring will need alternative methods and eDNA seems a promising option (Brunt *et al.* 2021; Lugg *et al.* 2018). Similarly, it may be possible to estimate the population size and change of various bat species with doppler radar (Horn and Kunz 2008; Meade *et al.* 2019) and Australia's National Flying-fox Monitoring Programme could validate the method (Westcott *et al.* 2018). The full variety of monitoring methods should be incorporated into a national monitoring programme with the results freely available to all interested parties.

Conclusion

Calls to develop long-term monitoring in Australia are over 20 years old (Lindenmayer 1999), but we are still waiting. Achieving this project will change the way biodiversity is monitored in Australia (and globally) – offering feasible, on-going monitoring for the vast majority of our bird, frog and bat fauna, and a large percentage of our larger terrestrial mammal fauna, as well as flowering plants and fungi - coupled with abiotic variables (notably smoke) and other potential biotic variables (like pollen and human disturbance levels). Remote sensing products could also be incorporated into the cloud analytics. This knowledge would benefit multiple stakeholders. Conservation managers in national, state and local governments can have biosensor networks across their protected areas and receive real-time information on wildlife locations and status trends, flowering phenology, which will help them manage threatened species and understand the ecological condition of the landscape. They can also receive bushfire alerts as soon as smoke particles are detected, which would drastically minimise response times, potentially saving critical ecological communities, lives, and property. Ecological consultants can place biosensor grids at sites of potential impact (coupled with control sites) to detect if any threatened biodiversity is present. Industry and compliance authorities may use biosensor networks to measure impacts on biodiversity, or the success of restoration activities. The sensors would also be a game changer for ecology researchers, as they would be able to gather data on a greater scale than has ever been possible. Indeed, with sufficient training it might be possible for the machine learning to perform call recognition of individuals, leading to great leaps forward in our understanding of population dynamics and animal behaviour. All of society could have access to real-time assessments of the status of our national natural heritage. These examples of stakeholder usage are likely to yield both economic and conservation benefits. We urgently need investment in a national biodiversity monitoring program as envisaged here. There is clearly an opportunity for the National Research Infrastructure Roadmap and the National Environmental Science Hub for Environmental Resilience to get involved in supporting this programme.

Effective monitoring is essential to improve our conservation outcomes (Robinson *et al.* 2018). This seems a relatively cheap opportunity to improve conservation management given the other costs necessary to conserve Australia's biodiversity (Wintle *et al.* 2019).

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APPENDIX 1

Appendix Table 1. List of Australia's terrestrial threatened species from the Environment Protection and Biodiversity Conservation Act 1999 (https://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl#frogs_critically_endangered), their conservation status (CE – critically endangered; EN – endangered, VU – vulnerable) and whether they could be monitored via the BIOMON system of sound recorders and a general camera trap array.

Scientific name	Common Name	Taxa	Sound	Vision	Status
Cophixalus concinnus	Elegant Frog	Amphibians	1		CE
Cophixalus hosmeri	Hosmer's Frog, Rattling Nursery-frog	Amphibians	1		CE
Cophixalus mcdonaldi	McDonald's Frog, Mt Elliot Nursery-frog	Amphibians	1		CE
Cophixalus monticola	Mountain-top Nursery-frog	Amphibians	1		CE
Cophixalus neglectus	Neglected Frog, Bellenden Ker Nursery-frog	Amphibians	1		CE
Geocrinia alba	White-bellied Frog, Creek Frog	Amphibians	1		CE
Litoria castanea	Yellow-spotted Tree Frog, Yellow-spotted Bell Frog	Amphibians	1		CE
Litoria kroombitensis	Kroombit Treefrog	Amphibians	1		CE
Litoria lorica	Armoured Mistfrog	Amphibians	1		CE
Litoria myola	Kuranda Tree Frog	Amphibians	1		CE
Litoria nyakalensis	Mountain Mistfrog, Nyakala Frog	Amphibians	1		CE
Philoria frosti	Baw Baw Frog	Amphibians	1		CE

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Scientific name	Common Name	Taxa	Sound	Vision	Status
Pseudophryne corroboree	Southern Corroboree Frog	Amphibians	I		CE
Pseudophryne pengilleyi	Northern Corroboree Frog	Amphibians	I		CE
Taudactylus pleione	Kroombit Tinker Frog, Pleione's Torrent Frog	Amphibians	I		CE
Cryptoblepharus egeriae	Christmas Island Blue-tailed Skink	Reptiles	*		CE
Lepidodactylus listeri	Christmas Island Gecko, Lister's Gecko	Reptiles			CE
Nangura spinosa	Nangur Spiny Skink	Reptiles			CE
Phyllurus gulbaru	Gulbaru Gecko	Reptiles			CE
Acanthornis magna greeniana	King Island Scrubtit, Scrubtit (King Island)	Birds	I		CE
Amytornis modestus obscurior	Grey Range Thick-billed Grasswren	Birds	I		CE
Anthochaera phrygia	Regent Honeyeater	Birds	I		CE
Calidris ferruginea	Curlew Sandpiper	Birds	I		CE
Calidris tenuirostris	Great Knot	Birds	I		CE
Cinclosoma punctatum anachoreta	Mt Lofty Ranges Spotted Quail-thrush	Birds	I		CE
Epthianura crocea macgregori	Capricorn Yellow Chat, Yellow Chat (Dawson)	Birds	I		CE
Lathamus discolor	Swift Parrot	Birds	I		CE
Lichenostomus melanops cassidix	Helmeted Honeyeater, Yellow-tufted Honeyeater	Birds	I		CE
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	Birds	I		CE
Melanodryas cucullata melvillensis	Tiwi Islands Hooded Robin, Hooded Robin (Tiwi Islands)	Birds	I		CE
Neophema chrysogaster	Orange-bellied Parrot	Birds	I		CE
Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	Birds	I		CE
Pedionomus torquatus	Plains-wanderer	Birds	I		CE
Pezoporus flaviventris	Western Ground Parrot, Kyloring	Birds	I		CE
Pterodroma arminjoniana	Round Island Petrel, Trinidade Petrel	Birds	I		CE
Pterodroma heraldica	Herald Petrel	Birds	I		CE
Crocidura trichura	Christmas Island Shrew	Mammals		I	CE
Gymnobelideus leadbeateri	Leadbeater's Possum	Mammals		I	CE
Lasiorhinus krefftii	Northern Hairy-nosed Wombat, Yaminon	Mammals		I	CE
Miniopterus orianae bassanii	Southern Bent-wing Bat	Mammals	I		CE
Petrogale concinna concinna	Nabarlek (Victoria River District)	Mammals		I	CE
Potorous gilbertii	Gilbert's Potoroo, Ngilkat	Mammals		I	CE
Pseudocheirus occidentalis	Western Ringtail Possum	Mammals		I	CE
Pteropus natalis	Christmas Island Flying-fox, Christmas Island Fruit-bat	Mammals	I		CE

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Scientific name	Common Name	Taxa	Sound	Vision	Status
Zyzomys pedunculatus	Central Rock-rat, Antina	Mammals		I	CE
Cophixalus aenigma	Tapping Nursery-frog	Amphibians	I		EN
Crinia sloanei	Sloane's Froglet	Amphibians	I		EN
Litoria booroolongensis	Booroolong Frog	Amphibians	I		EN
Litoria spenceri	Spotted Tree Frog	Amphibians	I		EN
Mixophyes fleayi	Fleay's Frog	Amphibians	I		EN
Mixophyes iteratus	Giant Barred Frog, Southern Barred Frog	Amphibians	I		EN
Taudactylus eungellensis	Eungella Day Frog	Amphibians	I		EN
Taudactylus rheophilus	Tinkling Frog	Amphibians	I		EN
Uperoleia mahonyi	Mahony's Toadlet	Amphibians	I		EN
Bellatorias obiri	Arnhem Land Egernia	Reptiles			EN
Cryptoblepharus gurrmul	Arafura Snake-eyed Skink	Reptiles			EN
Cyclodomorphus praealtus	Alpine She-oak Skink	Reptiles			EN
Cyrtodactylus sadleiri	Christmas Island Giant Gecko	Reptiles			EN
Egernia stokesii badia	Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink	Reptiles			EN
Eulamprus leuraensis	Blue Mountains Water Skink	Reptiles			EN
Eulamprus tympanum marnieae	Corangamite Water Skink, Dreeite Water Skink	Reptiles			EN
Lerista allanae	Allan's Lerista, Retro Slider	Reptiles			EN
Lerista nevinae	Nevin's Slider	Reptiles			EN
Liopholis guthega	Guthega Skink	Reptiles			EN
Liopholis slateri slateri	Slater's Skink, Floodplain Skink	Reptiles			EN
Lucasium occultum	Yellow-snouted Gecko, Yellow-snouted Ground Gecko	Reptiles			EN
Tiliqua adelaidensis	Pygmy Blue-tongue Lizard, Adelaide Blue-tongue Lizard	Reptiles			EN
Tympanocryptis condaminensis	Condamine Earless Dragon	Reptiles			EN
Tympanocryptis pinguicolla	Grassland Earless Dragon	Reptiles			EN
Acanthiza pusilla archibaldi (magnirostris)	King Island Brown Thornbill, Brown Thornbill (King Island)	Birds	I		EN
Accipiter hiogaster natalis	Christmas Island Goshawk	Birds	I		EN
Amytornis barbatus barbatus	Bulloo Grey Grasswren, Grey Grasswren (Bulloo)	Birds	I		EN
Amytornis dorotheae	Carpentarian Grasswren	Birds	I		EN
Amytornis merrotsyi pedleri	Gawler Ranges Short-tailed Grasswren, Short-tailed Grasswren	Birds	I		EN
Aquila audax fleayi	Tasmanian Wedge-tailed Eagle	Birds	I		EN
Atrichornis clamosus	Noisy Scrub-bird, Tjimiluk	Birds	I		EN
Atrichornis rufescens	Rufous Scrub-bird	Birds	I		EN
Botaurus poiciloptilus	Australasian Bittern	Birds	I		EN

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Scientific name	Common Name	Taxa	Sound	Vision	Status
Calamanthus pyrrhopygius parkeri = Hylacola pyrrhopygia parkeri	Chestnut-rumped Heathwren (Mt Lofty Ranges)	Birds	I		EN
Calidris canutus	Red Knot, Knot	Birds	I		EN
Calyptorhynchus banksii graptogyne	South-eastern Red-tailed Black-Cockatoo	Birds	I		EN
Calyptorhynchus baudinii = Zanda baudinii	Baudin's Cockatoo, Long-billed Black-Cockatoo	Birds	I		EN
Calyptorhynchus lathami halmaturinus	Kangaroo Island Glossy Black-Cockatoo	Birds	I		EN
Calyptorhynchus latirostris = Zanda latirostris	Carnaby's Cockatoo, Short-billed Black-Cockatoo	Birds	I		EN
Casuarius casuarius johnsonii	Southern Cassowary, Australian Cassowary, Double-wattled Cassowary	Birds	I		EN
Ceyx azureus diemenensis	Tasmanian Azure Kingfisher	Birds	I		EN
Chalcophaps indica natalis	Christmas Island Emerald Dove	Birds	I		EN
Charadrius mongolus	Lesser Sand Plover, Mongolian Plover	Birds	I		EN
Cyanoramphus cookii	Norfolk Island Green Parrot, Tasman Parakeet, Norfolk Island Parakeet	Birds	I		EN
Cyclopsitta diophthalma coxeni	Coxen's Fig-Parrot	Birds	I		EN
Dasyornis brachypterus	Eastern Bristlebird	Birds	I		EN
Dasyornis longirostris	Western Bristlebird	Birds	I		EN
Diomedea amsterdamensis	Amsterdam Albatross	Birds			EN
Diomedea dabbenena	Tristan Albatross	Birds			EN
Diomedea sanfordi	Northern Royal Albatross	Birds			EN
Epthianura crocea tunneyi	Alligator Rivers Yellow Chat, Yellow Chat (Alligator Rivers)	Birds	I		EN
Erythrura gouldiae	Gouldian Finch	Birds	I		EN
Fregata andrewsi	Christmas Island Frigatebird, Andrew's Frigatebird	Birds	I		EN
Hypotaenidia philippensis andrewsi	Buff-banded Rail (Cocos (Keeling) Islands), Ayam Hutan	Birds	I		EN
Hypotaenidia sylvestris	Lord Howe Woodhen	Birds	I		EN
Macronectes giganteus	Southern Giant-Petrel, Southern Giant Petrel	Birds	I		EN
Malurus coronatus coronatus	Purple-crowned Fairy-wren (western)	Birds	I		EN
Manorina melanotis	Black-eared Miner	Birds	I		EN
Neochmia phaeton evangelinae	Crimson Finch (white-bellied), White-bellied Crimson Finch	Birds	I		EN
Neochmia ruficauda ruficauda	Star Finch (eastern), Star Finch (southern)	Birds	I		EN

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Scientific name	Common Name	Taxa	Sound	Vision	Status
Ninox novaeseelandiae undulata	Norfolk Island Boobook, Norfolk Island Morepork, Southern Boobook (Norfolk Island)	Birds	I		EN
Papasula abbotti	Abbott's Booby	Birds	I		EN
Pardalotus quadragintus	Forty-spotted Pardalote	Birds	I		EN
Pezoporus occidentalis	Night Parrot	Birds	I		EN
Phaethon lepturus fulvus	Christmas Island White-tailed Tropicbird, Golden Bosunbird	Birds			EN
Poephila cincta cincta	Southern Black-throated Finch	Birds	I		EN
Psephotus chrysopterygius	Golden-shouldered Parrot, Alwal	Birds	I		EN
Psophodes nigrogularis nigrogularis	Western Heath Whipbird	Birds	I		EN
Pterodroma leucoptera leucoptera	Gould's Petrel, Australian Gould's Petrel	Birds	I		EN
Rostratula australis	Australian Painted Snipe	Birds	I		EN
Sterna vittata bethunei	New Zealand Antarctic Tern, Antarctic Tern (New Zealand)	Birds			EN
Stipiturus malachurus intermedius	Fleurieu Peninsula Southern Emu-wren, Mount Lofty Southern Emu-wren	Birds	I		EN
Stipiturus mallee	Mallee Emu-wren	Birds	I		EN
Thalassarche cauta	Shy Albatross	Birds			EN
Thalassarche chrysostoma	Grey-headed Albatross	Birds			EN
Thalassarche eremita	Chatham Albatross	Birds			EN
Turdus poliocephalus erythropleurus	Christmas Island Thrush	Birds	I		EN
Turnix olivii	Buff-breasted Button-quail	Birds	I		EN
Tyto novaehollandiae melvillensis	Tiwi Masked Owl, Tiwi Islands Masked Owl	Birds	I		EN
Antechinus argentus	Silver-headed Antechinus	Mammals			EN
Antechinus arktos	Black-tailed Antechinus	Mammals			EN
Arctocephalus tropicalis	Subantarctic Fur-seal	Mammals		I	EN
Bettongia penicillata ogilbyi	Woylie	Mammals		I	EN
Bettongia tropica	Northern Bettong	Mammals		I	EN
Burramys parvus	Mountain Pygmy-possum	Mammals		I	EN
Dasyurus hallucatus	Northern Quoll, Digul, Wijingadda, Wiminji	Mammals		I	EN
Dasyurus maculatus gracilis	Spotted-tailed Quoll (North Queensland), Yarri	Mammals		I	EN
Dasyurus maculatus maculatus (SE mainland population)	Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (SE mainland population)	Mammals		I	EN
Dasyurus viverrinus	Eastern Quoll, Luaner	Mammals		I	EN
Hipposideros inornatus	Arnhem Leaf-nosed Bat	Mammals	I		EN

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Scientific name	Common Name	Taxa	Sound	Vision	Status
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	Mammals		I	EN
Lagorchestes hirsutus Central Australian subspecies	Mala, Rufous Hare-Wallaby (Central Australia)	Mammals		I	EN
Mesembriomys gouldii gouldii	Black-footed Tree-rat, Djintamoonga, Manbul	Mammals		I	EN
Myrmecobius fasciatus	Numbat	Mammals		I	EN
Neophoca cinerea	Australian Sea-lion, Australian Sea Lion	Mammals		I	EN
Notomys aquilo	Northern Hopping-mouse, Woorrentinta	Mammals		I	EN
Onychogalea fraenata	Bridled Nail-tail Wallaby, Bridled Nailtail Wallaby	Mammals		I	EN
Parantechinus apicalis	Dibbler	Mammals		I	EN
Perameles bougainville bougainville = *Perameles bougainville*	Western Barred Bandicoot (Shark Bay)	Mammals		I	EN
Perameles gunnii Victorian subspecies	Eastern Barred Bandicoot (Mainland)	Mammals		I	EN
Petaurus australis Wet Tropics subspecies	Yellow-bellied Glider (Wet Tropics), Fluffy Glider	Mammals	I		EN
Petaurus gracilis	Mahogany Glider	Mammals			EN
Petrogale coenensis	Cape York Rock-wallaby	Mammals		I	EN
Petrogale concinna canescens	Nabarlek (Top End)	Mammals		I	EN
Petrogale concinna monastria	Nabarlek (Kimberley)	Mammals		I	EN
Petrogale lateralis kimberleyensis	Wiliji, West Kimberley Rock-wallaby	Mammals		I	EN
Petrogale lateralis lateralis	Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby	Mammals		I	EN
Petrogale persephone	Proserpine Rock-wallaby	Mammals		I	EN
Potorous longipes	Long-footed Potoroo	Mammals		I	EN
Pseudomys fumeus	Smoky Mouse, Konoom	Mammals			EN
Pseudomys oralis	Hastings River Mouse, Koontoo	Mammals		I	EN
Pseudomys shortridgei	Heath Mouse, Dayang, Heath Rat	Mammals			EN
Pteropus conspicillatus	Spectacled Flying-fox	Mammals	I		EN
Sarcophilus harrisii	Tasmanian Devil	Mammals		I	EN
Sminthopsis griseoventer aitkeni	Kangaroo Island Dunnart	Mammals			EN
Sminthopsis psammophila	Sandhill Dunnart	Mammals			EN
Tachyglossus aculeatus multiaculeatus	Kangaroo Island Echidna	Mammals		I	EN
Zyzomys palatalis	Carpentarian Rock-rat, Aywalirroomoo	Mammals			EN
Geocrinia vitellina	Orange-bellied Frog	Amphibians	I		VU
Heleioporus australiacus	Giant Burrowing Frog	Amphibians	I		VU

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Scientific name	Common Name	Taxa	Sound	Vision	Status
Litoria aurea	Green and Golden Bell Frog	Amphibians	I		VU
Litoria dayi	Australian Lace-lid, Lace-eyed Tree Frog, Day's Big-eyed Treefrog	Amphibians	I		VU
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	Amphibians	I		VU
Litoria olongburensis	Wallum Sedge Frog	Amphibians	I		VU
Litoria piperata	Peppered Tree Frog	Amphibians	I		VU
Litoria raniformis	Growling Grass Frog, Southern Bell Frog	Amphibians	I		VU
Litoria verreauxii alpina	Alpine Tree Frog, Verreaux's Alpine Tree Frog	Amphibians	I		VU
Mixophyes balbus	Stuttering Frog, Southern Barred Frog (in Victoria)	Amphibians	I		VU
Pseudophryne covacevichae	Magnificent Brood Frog	Amphibians	I		VU
Spicospina flammocaerulea	Sunset Frog	Amphibians	I		VU
Acanthophis hawkei	Plains Death Adder	Reptiles			VU
Anomalopus mackayi	Five-clawed Worm-skink, Long-legged Worm-skink	Reptiles			VU
Aprasia parapulchella	Pink-tailed Worm-lizard, Pink-tailed Legless Lizard	Reptiles			VU
Aprasia pseudopulchella	Flinders Ranges Worm-lizard	Reptiles			VU
Carinascincus palfreymani	Pedra Branca Skink, Pedra Branca Cool-skink, Red-throated Skink	Reptiles			VU
Christinus guentheri	Lord Howe Island Gecko, Lord Howe Island Southern Gecko	Reptiles			VU
Coeranoscincus reticulatus	Three-toed Snake-tooth Skink	Reptiles			VU
Ctenophorus yinnietharra	Yinnietharra Rock-Dragon	Reptiles			VU
Ctenotus lancelini	Lancelin Island Skink	Reptiles			VU
Ctenotus zastictus	Hamelin Ctenotus	Reptiles			VU
Delma impar	Striped Legless Lizard, Striped Snake-lizard	Reptiles			VU
Delma mitella	Atherton Delma, Legless Lizard	Reptiles			VU
Delma torquata	Adorned Delma, Collared Delma	Reptiles			VU
Denisonia maculata	Ornamental Snake	Reptiles			VU
Egernia rugosa	Yakka Skink	Reptiles			VU
Eretmochelys imbricata	Hawksbill Turtle	Reptiles			VU
Furina dunmalli	Dunmall's Snake	Reptiles			VU
Hoplocephalus bungaroides	Broad-headed Snake	Reptiles			VU
Lerista vittata	Mount Cooper Striped Skink, Mount Cooper Striped Lerista	Reptiles			VU
Liasis olivaceus barroni	Olive Python (Pilbara subspecies)	Reptiles			VU

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Scientific name	Common Name	Taxa	Sound	Vision	Status
Liopholis kintorei	Great Desert Skink, Tjakura, Warrarna, Mulyamiji	Reptiles			VU
Liopholis pulchra longicauda	Jurien Bay Skink, Jurien Bay Rock-skink	Reptiles			VU
Notechis scutatus ater	Krefft's Tiger Snake (Flinders Ranges)	Reptiles			VU
Oligosoma lichenigerum	Lord Howe Island Skink	Reptiles			VU
Ophidiocephalus taeniatus	Bronzeback Snake-lizard	Reptiles			VU
Ramphotyphlops exocoeti	Christmas Island Blind Snake, Christmas Island Pink Blind Snake	Reptiles			VU
Uvidicolus sphyrurus	Border Thick-tailed Gecko, Granite Belt Thick-tailed Gecko	Reptiles			VU
Acanthiza iredalei rosinae	Slender-billed Thornbill (Gulf St Vincent)	Birds	I		VU
Amytornis merrotsyi merrotsyi	Short-tailed Grasswren (Flinders Ranges)	Birds	I		VU
Amytornis modestus	Thick-billed Grasswren	Birds	I		VU
Amytornis textilis myall	Western Grasswren (Gawler Ranges)	Birds	I		VU
Amytornis woodwardi	White-throated Grasswren, Yirlinkirrkirr	Birds	I		VU
Anous tenuirostris melanops	Australian Lesser Noddy	Birds			VU
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo, Karrak	Birds	I		VU
Cereopsis novaehollandiae grisea	Cape Barren Goose (south-western), Recherche Cape Barren Goose	Birds	I	I	VU
Charadrius leschenaultii	Greater Sand Plover, Large Sand Plover	Birds	I		VU
Diomedea antipodensis	Antipodean Albatross	Birds			VU
Diomedea antipodensis gibsoni	Gibson's Albatross	Birds			VU
Diomedea epomophora	Southern Royal Albatross	Birds			VU
Diomedea exulans	Wandering Albatross	Birds			VU
Erythrotriorchis radiatus	Red Goshawk	Birds	I		VU
Falco hypoleucos	Grey Falcon	Birds	I		VU
Falcunculus frontatus whitei	Crested Shrike-tit (northern), Northern Shrike-tit	Birds	I		VU
Fregetta grallaria grallaria	White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian)	Birds	I		VU
Geophaps scripta scripta	Squatter Pigeon (southern)	Birds	I		VU
Geophaps smithii blaauwi	Partridge Pigeon (western)	Birds	I		VU
Geophaps smithii smithii	Partridge Pigeon (eastern)	Birds	I		VU
Grantiella picta	Painted Honeyeater	Birds	I		VU
Halobaena caerulea	Blue Petrel	Birds			VU
Hirundapus caudacutus	White-throated Needletail	Birds	I		VU

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Scientific name	Common Name	Taxa	Sound	Vision	Status
Leipoa ocellata	Malleefowl	Birds			VU
Leucocarbo atriceps nivalis	Imperial Shag (Heard Island), Heard Shag	Birds	I	I	VU
Leucocarbo atriceps purpurascens	Imperial Shag (Macquarie Island)	Birds	I		VU
Limosa lapponica baueri	Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit	Birds	I		VU
Macronectes halli	Northern Giant Petrel	Birds			VU
Malurus leucopterus edouardi	White-winged Fairy-wren (Barrow Island)	Birds	I		VU
Malurus leucopterus leucopterus	White-winged Fairy-wren (Dirk Hartog Island)	Birds	I		VU
Mirafra javanica melvillensis	Horsfield's Bushlark (Tiwi Islands)	Birds	I		VU
Ninox natalis	Christmas Island Hawk-Owl, Christmas Boobook	Birds	I		VU
Pachycephala pectoralis xanthoprocta	Golden Whistler (Norfolk Island)	Birds	I		VU
Pachycephala rufogularis	Red-lored Whistler	Birds	I		VU
Pachyptila turtur subantarctica	Fairy Prion (southern)	Birds			VU
Petroica multicolor	Norfolk Island Robin, Pacific Robin	Birds	I		VU
Phoebetria fusca	Sooty Albatross	Birds			VU
Platycercus caledonicus brownii	Green Rosella (King Island)	Birds	I		VU
Polytelis alexandrae	Princess Parrot, Alexandra's Parrot	Birds	I		VU
Polytelis anthopeplus monarchoides	Regent Parrot (eastern)	Birds	I		VU
Polytelis swainsonii	Superb Parrot	Birds	I		VU
Probosciger aterrimus macgillivrayi	Palm Cockatoo (Australian)	Birds	I		VU
Psophodes leucogaster leucogaster	Mallee Whipbird	Birds	I		VU
Pterodroma mollis	Soft-plumaged Petrel	Birds			VU
Pterodroma neglecta neglecta	Kermadec Petrel (western)	Birds			VU
Sterna vittata vittata	Antarctic Tern (Indian Ocean)	Birds			VU
Sternula nereis nereis	Australian Fairy Tern	Birds	I		VU
Stipiturus malachurus parimeda	Southern Emu-wren (Eyre Peninsula)	Birds	I		VU
Strepera fuliginosa colei	Black Currawong (King Island)	Birds	I		VU
Strepera graculina crissalis	Lord Howe Island Currawong, Pied Currawong (Lord Howe Island)	Birds	I		VU
Thalassarche bulleri	Buller's Albatross, Pacific Albatross	Birds			VU

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Thalassarche bulleri platei	Northern Buller's Albatross, Pacific Albatross	Birds			VU
Thalassarche carteri	Indian Yellow-nosed Albatross	Birds			VU
Thalassarche impavida	Campbell Albatross, Campbell Black-browed Albatross	Birds			VU
Thalassarche melanophris	Black-browed Albatross	Birds			VU
Thalassarche salvini	Salvin's Albatross	Birds			VU
Thalassarche steadi	White-capped Albatross	Birds			VU
Thinornis cucullatus cucullatus	Eastern Hooded Plover, Eastern Hooded Plover	Birds	I		VU
Turnix melanogaster	Black-breasted Button-quail	Birds	I		VU
Turnix varius scintillans	Painted Button-quail (Houtman Abrolhos)	Birds	I		VU
Tyto novaehollandiae castanops (Tasmanian population)	Masked Owl (Tasmanian)	Birds	I		VU
Tyto novaehollandiae kimberli	Masked Owl (northern)	Birds	I		VU
Zoothera lunulata halmaturina	South Australian Bassian Thrush, Western Bassian Thrush	Birds	I		VU
Antechinus bellus	Fawn Antechinus	Mammals			VU
Antechinus minimus maritimus	Swamp Antechinus (mainland)	Mammals			VU
Bettongia lesueur Barrow and Boodie Islands subspecies	Boodie, Burrowing Bettong (Barrow and Boodie Islands)	Mammals	I	I	VU
Bettongia lesueur lesueur	Burrowing Bettong (Shark Bay), Boodie	Mammals	I	I	VU
Chalinolobus dwyeri	Large-eared Pied Bat, Large Pied Bat	Mammals	I		VU
Conilurus penicillatus	Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma	Mammals		I	VU
Dasyuroides byrnei	Kowari, brushy-tailed marsupial rat, Byrne's crest-tailed marsupial rat	Mammals		I	VU
Dasyurus geoffroii	Chuditch, Western Quoll	Mammals		I	VU
Dasyurus maculatus maculatus (Tasmanian population)	Spotted-tail Quoll, Spot-tailed Quoll, Tiger Quoll (Tasmanian population)	Mammals		I	VU
Hipposideros semoni	Semon's Leaf-nosed Bat, Greater Wart-nosed Horseshoe-bat	Mammals	I		VU
Isoodon auratus auratus	Golden Bandicoot (mainland)	Mammals		I	VU
Isoodon auratus barrowensis	Golden Bandicoot (Barrow Island)	Mammals		I	VU
Isoodon obesulus nauticus	Southern Brown Bandicoot (Nuyts Archipelago)	Mammals		I	VU

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Lagorchestes conspicillatus conspicillatus	Spectacled Hare-wallaby (Barrow Island)	Mammals		I	VU
Lagorchestes hirsutus bernieri	Rufous Hare-wallaby (Bernier Island)	Mammals		I	VU
Lagorchestes hirsutus dorreae	Rufous Hare-wallaby (Dorre Island)	Mammals		I	VU
Lagostrophus fasciatus fasciatus	Banded Hare-wallaby, Merrnine, Marnine, Munning	Mammals		I	VU
Leporillus conditor	Wopilkara, Greater Stick-nest Rat	Mammals		I	VU
Macroderma gigas	Ghost Bat	Mammals	I		VU
Macrotis lagotis	Greater Bilby	Mammals		I	VU
Mastacomys fuscus mordicus	Broad-toothed Rat (mainland), Tooarrana	Mammals		I	VU
Mesembriomys gouldii melvillensis	Black-footed Tree-rat (Melville Island)	Mammals		I	VU
Mesembriomys gouldii rattoides	Black-footed Tree-rat (north Queensland), Shaggy Rabbit-rat	Mammals		I	VU
Mirounga leonina	Southern Elephant Seal	Mammals		I	VU
Notomys fuscus	Dusky Hopping-mouse, Wilkiniti	Mammals			VU
Nyctophilus corbeni	Corben's Long-eared Bat, South-eastern Long-eared Bat	Mammals	I		VU
Osphranter robustus isabellinus	Barrow Island Wallaroo, Barrow Island Euro	Mammals		I	VU
Perameles gunnii gunnii	Eastern Barred Bandicoot (Tasmania)	Mammals		I	VU
Petauroides volans	Greater Glider	Mammals			VU
Petrogale lateralis centralis	Warru, Central Australian Rock-wallaby	Mammals		I	VU
Petrogale lateralis hacketti	Recherche Rock-wallaby	Mammals		I	VU
Petrogale penicillata	Brush-tailed Rock-wallaby	Mammals		I	VU
Petrogale sharmani	Mount Claro Rock Wallaby, Sharman's Rock Wallaby	Mammals		I	VU
Petrogale xanthopus celeris	Yellow-footed Rock-wallaby (central-western Queensland)	Mammals		I	VU
Petrogale xanthopus xanthopus	Yellow-footed Rock-wallaby (SA and NSW)	Mammals		I	VU
Phascogale calura	Red-tailed Phascogale, Red-tailed Wambenger, Kenngoor	Mammals		I	VU
Phascogale pirata	Northern Brush-tailed Phascogale	Mammals		I	VU
Phascogale tapoatafa kimberleyensis	Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley)	Mammals		I	VU
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)	Koala	Mammals	I		VU

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Scientific name	Common Name	Taxa	Sound	Vision	Status
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE Mainland)	Mammals		I	VU
Pseudomys australis	Plains Rat, Palyoora, Plains Mouse	Mammals			VU
Pseudomys fieldi	Shark Bay Mouse, Djoongari, Alice Springs Mouse	Mammals			VU
Pseudomys novaehollandiae	New Holland Mouse, Pookila	Mammals			VU
Pseudomys pilligaensis	Pilliga Mouse, Poolkoo	Mammals			VU
Pteropus poliocephalus	Grey-headed Flying-fox	Mammals	I		VU
Rhinolophus robertsi	Large-eared Horseshoe Bat, Greater Large-eared Horseshoe Bat	Mammals	I		VU
Rhinonicteris aurantia (Pilbara form)	Pilbara Leaf-nosed Bat	Mammals	I		VU
Saccolaimus saccolaimus nudicluniatus	Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat	Mammals	I		VU
Setonix brachyurus	Quokka	Mammals		I	VU
Sminthopsis butleri	Butler's Dunnart	Mammals			VU
Sminthopsis douglasi	Julia Creek Dunnart	Mammals			VU
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum	Mammals			VU
Xeromys myoides	Water Mouse, False Water Rat, Yirrkoo	Mammals			VU
Zyzomys maini	Arnhem Rock-rat, Arnhem Land Rock-rat, Kodjperr	Mammals			VU

* Species of fish, turtles/tortoises, sea-snakes and whales are excluded. We have been conservative in not including small mammals as taxa that can be adequately monitored via camera trapping.

** Some species of herpetofauna may be able to be monitored using camera traps, however these require targeted methods (Welbourne *et al.* 2020).