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Monitoring in the Australian Rangelands: Where we've come from and where we should be headed.

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Abstract

The need for a widespread national ecosystem monitoring program for Australian rangelands is often identified (Eyre et al, 2011; Smyth and James, 2004; Watson and Novelly, 2004). Such a program is necessary to inform on the magnitude and direction of change in biodiversity and productivity of these vast and environmentally and economically important lands. This recognition is most often framed negatively – that we don't know enough about our biodiversity, that we are not collecting biodiversity data and do not have monitoring programs in place to effectively inform on these issues. Whilst in a holistic sense this is indeed true it is important to acknowledge that a great deal of excellent rangeland monitoring work has occurred in Australia over many decades to inform on these issues. The success of WARMS (Watson et al, 2007), ACRIS (Bastin et al, 2009) and TERN Ausplots (Guerin et al, 2017) are some examples, but there are others. None of these programs get close to realising our ideal monitoring network, but they have achieved parts of that vision well. They form a basis from which we can incrementally improve our sampling. This paper investigates what the essential components to an holistic rangeland monitoring should include, which of these components already exist and what, as a community, we need to advocate for in the future. There are many reasons to be optimistic about this continuing journey.

Introduction:

At 81% of the Australian continent, rangelands are a major land use, with widely varying, variable rainfall, temperature, evapotranspiration and seasonality. Despite being widespread, Australia's rangeland ecosystems are relatively poorly studied and understood and have significant information gaps (Morton et al, 2011; Sparrow et al, 2014). Sparse information and few widespread surveillance monitoring programs reporting biodiversity makes detecting and reporting on change extremely difficult (Bastin et al, 2008; Eyre et al, 2011). There is a critical need for this kind of information to assist the sparse population that manages these lands to make informed decisions on management actions.

Rangeland information needs

Land managers in the Australian rangelands have a huge responsibility to effectively maintain and manage these environments to enable sustainable production whilst maintaining their unique biodiversity assets. Often competing priorities complicate decision making and robust surveillance monitoring programs are essential to provide information to assist making complex management decisions. Finding an appropriate balance between these land uses based on objective information is crucial to our economy and pivotal to appropriate management. The more consistent and objective our monitoring data are, the better and more effective our management decisions will be and the more sustainable our Rangelands will become. Whist we do not currently have a system that provides for this ideal, we do not need to create this system from nothing. In Australia, we have a long history of pastoral

and biodiversity monitoring programs (Usually conducted at the state level) that will assist and become parts of a more holistic monitoring program. It is worth briefly reviewing this previous work.

Previous rangelands monitoring

Much of our current understanding of ecosystem condition and dynamics in rangelands (Bastin *et al*, 2008; NLWRA, 2001) is derived from pastoral monitoring programs (Foulkes *et al.* 2014) which are regionally based and often production focussed, assessing species palatable to domestic grazing animals. These limitations mean data are often not comparable nor compatible with activities such as determining national benchmarks, acknowledged as a major shortfall of existing monitoring programs (Watson *et al.* 2007). Each of these state programs collect useful and valuable data. However, by using different methods they make consistent analyses across state borders difficult or impossible. Increasingly analyses are conducted continentally (Paul et al, 2016; Herrick et al, 2010) or globally (Bastin et al 2017), spurred by technological advances in the acquisitions and processing of satellite imagery (Pettorelli et al, 2014; Yoccoz et al, 2001). This requires consistent or at least compatible datasets that enable datasets to be analysed together.

Australia has a few programs that are starting to address this at a national scale. ACRIS resulted from a report (NLWRA, 2001) with the aim of increasingly reporting at the national scale on Rangelands. Later a biodiversity assessment component was added and a great deal of work was put into getting dataset from each of the states into forms that could be analysed together (Bastin *et al*, 2008) although the report acknowledges that the ability to report consistently nationally was hampered by gaps and incompatible data. Unfortunately, this program was underfunded from its inception and subsequent funding has not been forthcoming.

The Ausplots program, whilst also being underfunded, began in 2010 as part of the TERN program supported by the NCRIS research infrastructure program. This program added several novel aspects to the ACRIS legacy. Ausplots collaboratively arrived at a standardised method (White et al, 2012) for use across the country, and employed methods that were more objective than those used previously, with novel photopoint techniques allowing computer analysis for environmental parameters. Ausplots also focused on taking a range of vegetation and soil samples that are managed for subsequent analysis including re-identification in response to taxonomic change. Whilst this ongoing program has made some significant headway it still falls far short of ideal. The program is currently collecting and managing data and samples from 550 plots across the continent, a great start, but inadequate for our 7.6 million square kilometres of country. Funding has been announced for the next decade and planning has commenced for the next phase of the project to collect more plots to address this issue, and incorporate re-visits to previously established plots. For financial reasons, the program only currently collects information on vegetation and soils. Fauna information (vertebrate and invertebrate) is not collected although protocols to do that have been developed (O'Neill et al, 2017), and some fauna survey will hopefully be added in the near future.

Pastoral monitoring needs and Biodiversity monitoring needs are different but complimentary

Many states have, or have had effective pastoral monitoring programs to assess the "condition" of pastoral land, primarily with the aim of preventing long term irreversible degradation. These programs have been carried out by state based agencies, usually using state based protocols. Staff employed to implement these programs are often in different sections and possess different skill sets to those employed by the same governments to collect biodiversity monitoring data. Often these two types of programs are implemented on different time periods. Pastoral programs often utilise a combination of remote sensing and field based observations to make assessments of condition (Department of Environment and Natural Resources, 2017). The jurisdictional nature of these programs results in areas occurring in similar environments, that function in a similar way ecologically, and on occasion occurring quite near each other (across state boundaries) being assessed in markedly different manners with different recommendations and outputs. Often these programs focus on assessing ground cover and its persistence as a surrogate measure of environmental condition (Bastin et al, 2014), with areas with greater ground cover, and ground cover persistence being less susceptible to erosion and other deleterious environmental processes. Additionally, historically, there has been a dichotomy between Environmental monitoring and Pastoral monitoring programs – often supporting vastly different methods

and rigor in programs supported by the same government. Environmental monitoring has been historically less well supported by agencies, with less of a legislative requirement. Most states have, or have had state based biological survey programs (e.g. Smyth et al 2009, McKenzie et al, 2009), but often without rigorous location (decimeter accuracy required to accurately re-locate plots during revisits) information and no intent for re-visits, this information is primarily utilised for inventory studies and informing on the distribution and abundance of species. Given that many of the needs of pastoral monitoring and biodiversity monitoring are similar and our increasingly continental (and indeed global) outlook on these issues …

…Is there something that we can do to address this?

Absolutely! We need to design monitoring programs that fulfil the needs of both pastoral monitoring programs and biodiversity monitoring programs, funded by both agencies and collecting information relevant to both needs, although the location of plots for each purpose is likely to be different. For any type of environmental survey one of the most significant costs is the equipment and staff time to get to the survey location. By working together, we minimise that wasted time. It is likely that the program will need to collect a little more information on each site than each would need independently, but that is outweighed by the increased efficiencies. More plots would be able to be established and monitored than with both programs working in isolation.

What is needed?

Most importantly we need to assess what is needed by each program. Both environmental monitoring programs and pastoral monitoring programs need good quality information on the types of plants occurring where, and how much of them occur, how is the environment changing, and what is the cause of that change? Pastoral monitoring programs are generally interested in this information only for species that are impacted by grazing, but need to accurately know how much occurs (usually relative or absolute measures of biomass) as this will help determine appropriate carrying capacities. Environmental monitoring requires information on which plant species occur in a plot along with abundance, structural and functional information for all species. Additionally, both programs require some basic soil information

Our new system needs to incorporate all scales of monitoring.

Current thinking defines three major types/ scales of monitoring – and these are essential for accurate and effective management of our rangelands.

Landscape Monitoring

An effective monitoring system will incorporate landscape monitoring which provides information at regional to continental scale and is characterised by data across our whole continent, most commonly provided by a range of remote sensing analysis techniques and often incorporating GIS and modelling products. This type of information now (with recent technological advances) provides us with widespread information that is calibrated to environmental change surrogates that are manifest in reflectance changes from the earth. This provides spatial context to our management decisions – which areas need most attention and why? This now also enables a reasonably high temporal resolution with some information available daily or weekly.

Surveillance Monitoring

Surveillance monitoring is widespread, consistent monitoring across the continent. It will provide us with information on what environmental change is occurring where, and the magnitude and direction of that change. Being consistent and widespread across the continent enables us to be aware of environmental change that is not evident from satellite imagery, and also to quantify the amount of change that is happening in an ecosystem. Surveillance monitoring information is also important for validating the remotely sensed products provided by landscape monitoring.

Targeted Monitoring

Lastly, we need good quality quantitative process information. This is provided by targeted monitoring programs that are designed for this purpose (Lindenmayer and Likens, 2010). Typically, they are questions driven with methods specifically designed to address that issue in that ecosystems and understand the cause or drivers of change in that environment. It is not possible for this type of information to be consistent given that particular environments have differing drivers and pressures. This type of monitoring can identify and quantify the cause of changes identified in surveillance monitoring. A wholistic monitoring program for Australian rangelands will incorporate aspects of all three types of monitoring.

Where to from here?

To progress this, we are obligated to build on what already exists. The state based monitoring programs, ACRIS and TERN Ausplots have all made useful advances in monitoring in Australia and we need to capitalise on this previous work and the learnings that we have from them. The glass is actually half full... there is a long way to go, but already a great start has been made. We need to learn from our previous mistakes, and prevent them from happening again, and use and learn from that experience to determine the most appropriate way forward.

We should aspire to a system that monitors all taxa, and work together to develop a system that encompasses this, but not be too critical of ourselves when our system is sub-optimal due to resourcing constraints. We should do what we can do well and provide a basis for adding extra components when support is available, and work together to obtain that support.

For too long we have argued between ourselves about who's monitoring is more valuable and should be supported. We do this at our peril and surely need to change our focus. All types of monitoring are essential – we need to embrace this, understand where our own monitoring sits in a holistic system and what value it provides and better articulate that. Most importantly we need to work together to advocate for increased resourcing for environmental monitoring generally – we're all under-funded! We need our advocates and champions to support this and provide leadership as monitoring benefits greatly from having champions (Lindenmayer and Likens, 2010).

We need to embrace the open data agenda, providing our data freely, easily and openly, with appropriate safeguards for threatened species (Lindenmayer and Scheele, 2017; Lowe et al, 2017). Until we are open and transparent with our data we will be accused of having something to hide. The vast majority of this type of data has been funded from public funding and the public deserves to have access to the data in which they have invested.

Where possible we need to collect objective data where we measure and calculate rather than infer and guestimate from expert opinion. That expert opinion is particularly valuable when determining where and what to monitor, our data collection needs to be as objective as possible to ensure repeatability and ensure that change we detect is as much as is possible is real than an artefact of how we have sampled. By obtaining data objectively we also increase its utility and compatibility with other similar data and greatly increase the probability for reuse. To do this we must document our methods well and obtain information on their accuracy. Where possible we need to future proof our data by collecting samples for subsequent use, addressing taxonomic change, and embracing new techniques.

Summary

Australia has huge areas of rangelands and good quality objective information is needed to effectively manage these lands sustainably. We have a long history of rangeland management, with many successful jurisdictional programs, which, along with national initiatives such as ACRIS and TERN Ausplots provide much useful information for this purpose. Regardless, much more information is needed to effectively manage these lands. We need to work together (Pastoral and environmental monitoring programs) to use our sparse resources for maximum benefit. A unified system is needed that integrates components of landscape, surveillance and targeted monitoring to understand Where change is occurring, how much change there is, and what is the cause of that change. Most importantly we, as a community, need to stop arguing amongst ourselves as to who's monitoring is better, and start engaging in public debate to highlight the critical underfunding of all forms of environmental monitoring. Future generations will need this information to effectively manage our environmental legacy. We have a long way to go, but we've made a great start and we know what we need to do to achieve this aim.

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