THE SPATIAL OCCURRENCE OF FORMAL POLITICAL REPRESENTATION AND THREATENED SPECIES

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ABSTRACT

INTRODUCTION

2.1 Biodiversity crisis

The present day has been defined as within the Anthropocene Epoch, representing a sixth "mass extinction" induced by humans (Lewis and Maslin 2015). Even under extremely conservative assumptions, this century's average rate of vertebrate species loss is up to 100 times higher than the background rate (Ceballos et al. 2015). This loss of the world's biodiversity is due to human-led modifications to the environment. Over-exploitation and agriculture have the greatest impact on biodiversity on a global scale (Maxwell et al. 2016), with the proportion of threats remaining roughly consistent among IPBES regions (W. W. F. 2020).

2.2 Australia's biodiversity crisis

Heightened impact from invasive species and system modifications make Australia's threat profile significantly different when compared to the global aggregate (Kearney et al. 2019). Australia's concoction of threats has led to the rate of species going extinct being the highest in the world with the decline of many endangered species continuing to occur across the continent (Simmonds et al. 2020). In the past decade, three Australian species have gone extinct that were predictable and likely preventable (Woinarski et al. 2017).

2.3 Constraints on abating the biodiversity crisis

Unlike other places, to save Australian threatened species we need active management. This means funding, coordination, effort. In the Australian context, Legge et al. 2018 concluded the five major constraints on improved monitoring, which can roughly be translated into improved management of biodiversity are methodological challenges, cross institutional blockages, within-institutional impediments, policy/legislative deficiencies, and funding shortfalls. Four of these problems represent a significant opportunity for leadership. These significant challenges facing conservation of biodiversity could either be completely or partially improved by institutional changes. These challenges have been explored and explained by scientists over decades, with myriad analyses alerting policy makers, and recommending the necessary reforms. However, the implementation of institutional or system reform at the scale needed has not occurred. As such, a critical step in addressing the species extinction crisis is approaching it as a political and social problem.

2.4 The big gap

Australia has low population density, existing megadiversity, political stability, affluence, and large areas remaining some of the last pressure-free zones in the world (Venter et al. 2016). Australia has domestic and global obligations and responsibilities (CBD, EPBC) to abate to biodiversity loss. Despite these motivations, advantages, obligations, and policy attempts to provide better protection Ward et al. 2019), our biodiversity continues to decline.

No one has explored the spatial occurence between threatened biodiversity and formal representation. Here, we explore this co-occurrence using federally listed threatened species and electoral divisions. Our aim is to showcase potential for Australian elected members to assume responsibility for their local threatened biodiversity that can begin to remove the constraints identified by Legge et al. 2018. We exhibit the mismatch between electorates and threatened species and identify the regions where elected members will need to advocate harder.

METHODS

3.1 Australian threatened species

We used public grids of Species of National Environmental Significance (SNES), listed by the Australian Department of the Environment and Energys Threatened Species Scientific Committee and Minister under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (C. of Australia 2021) (retrieved 1st July 2021). There were 1,961 threatened species listed at the time of analysis (C. of Australia 2021). We used species or species habitat is likely to occur within area distributions as this is the more definitive (than may occur) and represents the area of occupancy (AOO) (Gaston and Fuller 2009).

3.2 Australian federal electorate and terrestrial boundary data

Australia is currently divided into 151 single-member federal electorates for elections to the House of Representatives. The electorates cover the continent of Australia, the island of Tasmania, numerous smaller islands, and marine areas in the North East with Norfolk Island and Jervis Bay Territory being exempt [TODO: What's the deal with Norfolk, it's in the GIS data?] (P. of Australia 2018). The electorate boundaries are drawn on human population distribution within the States and Territories of the Commonwealth. The range of electors across electoral

divisions is 69,332 to 124,507, with a median of 109,430. Federal electoral boundaries and their demographic classification are maintained and released by the Australian Electoral Commission Comission 2019. Australian land boundary spatial data was acquired from the Australian Statistical Geography Standard (ASGS) Edition 3 of Statistics 2021 [TODO: did I actually use this?].

3.3 Co-occurrence comparison of federal electorates and threatened species

We examined the spatial occurrence of Australian federal electorates and threatened species. As electorates in North East Australia comprise marine regions, we have included non-terrestrial threatened species. Threatened species distribution data was generalised to contain unique instances of species at the scientific name level, dissolving circumstances of subpopulations. Some species (43) do not intersect with any electorates and therefore have been excluded from the general analysis sections and are included when specified. Spatial analysis was conducted in R (Team 2021), using the sf (Pebesma 2018) and tidyverse (Wickham et al. 2019) packages. To calculate species per electorate and electorate coverage, species distributions were spatially joined to electorate boundaries. Species and electorate occurrences were spatially intersected to calculate the range proportion of each species in each electorate.

RESULTS

4.1 The distribution of electorates does not match threatened species

Our analysis examines the spatial occurrence of Australian federal electoral boundaries and threatened species listed under the EPBC Act 1999. The largest electorate is Durack (1,629,886 km^2, WA), which is over 50,000 times the size of the smallest, the inner metropolitan electorate of Grayndler (32 km^2, NSW). The median size of electorate is 362 km^2. Threatened species within electorates range from 29 to 387 with a median of 95. Durack (WA) is the largest electorate and contains the most threatened species, at 387 (Figure 1). The electorate of Adelaide contains the least with 29 threatened species and is the 31st smallest. As the size of electorate increases, the number of threatened species does too (Figure 1). The rural electorate of Lingiari (NT) has the lowest concentration of threatened species per km^2 (0.0001), while the inner metropolitan electorate of Sydney contains the highest concentation (2.9326 threatened species per km^2) [ref supp table]. Electorates of provincial (23) and rural (38) demographic classification represent 40% of the 151 electorates. There are 1,738 species that intersect with rural electorates, 577 with

provincial, 485 with outer metro, 453 with inner metro. Rural electorates intersect with 89% of federally listed threatened species. [TODO: how do electoral boundaries match up with species boundaries]

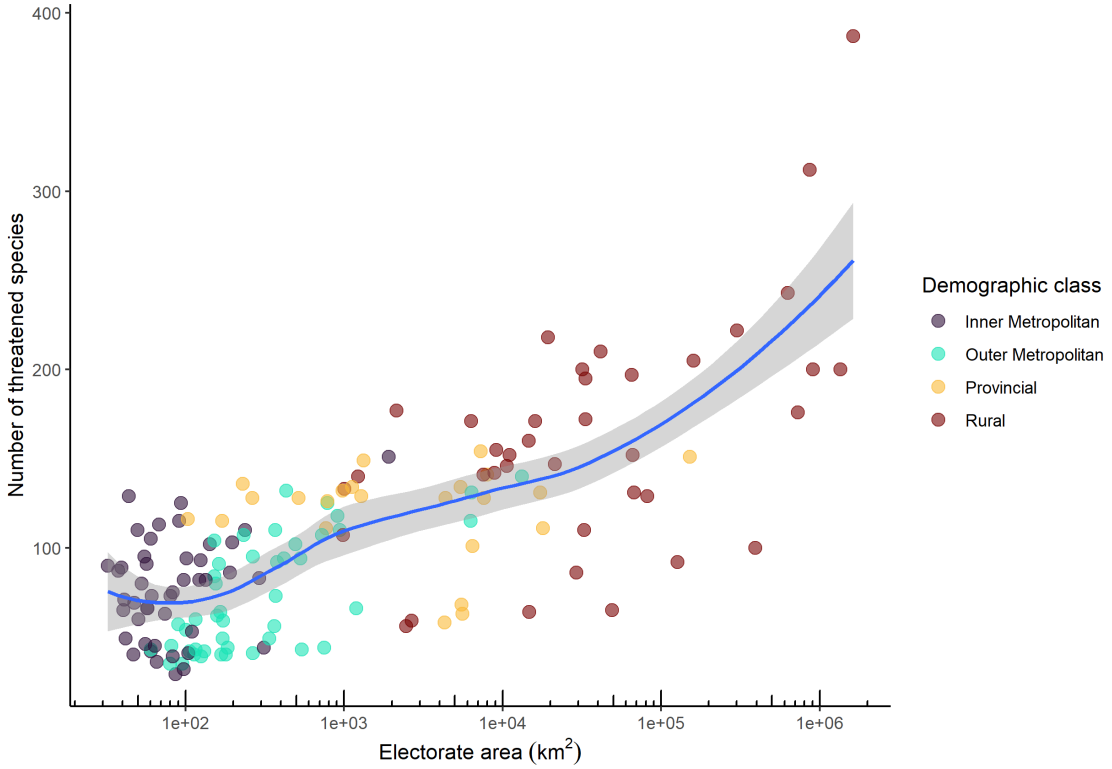

Figure 1: Scatter plot comparing the size of the 151 Australian federal electorates along a log scale and the number of threatened species within. Demographic classification of electorates are shown in colour. Smoothed line was modeled using locally estimated scatterplot smoothing (LOESS)

4.2 Most threatened species are represented by a single electorate/endemic?

A total of 863 (44%) of the 1961 threatened species listed on the EPBC Act reside in a single electorate (Figure 2). Our analysis found 2% of species on the list do not intersect with the boundaries of federal electorates. These species have not been included in the following analysis. The median of how many electorates are covered in each species's range is 2, with a third quartile of 4 (Figure 2). Of the species with a range that covers five or more electorates, 23% are migratory. Two strongly migratory species cover all 151 electorates, the Pacific Swift and the White-bellied Sea Eagle. [TODO: is there a relationship between threatened status and electorate coverage of species]

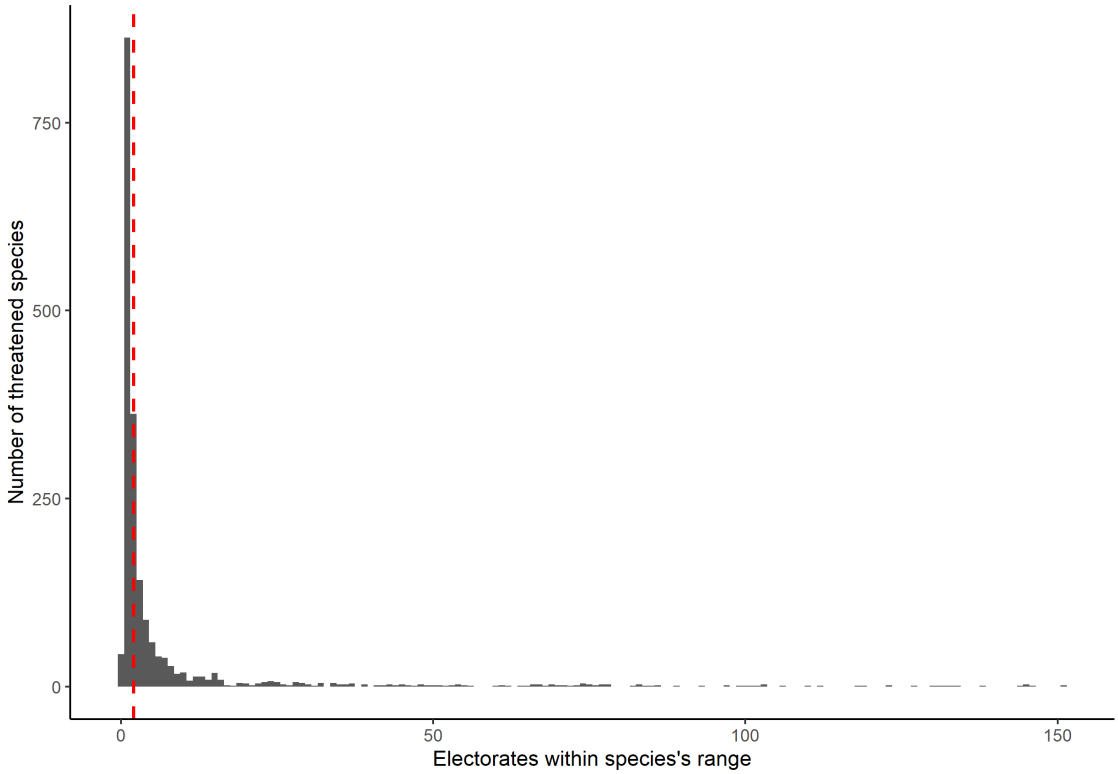

Figure 2: Histogram displaying the number of electorates in a species range and their threatened status. The red dashed line represents the median.

Endemic species were found in 44 electorates (Figure 3). The electorate of Bean contains one endemic species and is the only of inner metropolitan classification. Rural electorates make up 72% of electorates with endemic species. Species which have greater than eighty percent of their range within an electorate were found in 60. Bean contains the 12th highest number of species with 80% of their range within, more than 22 others which are rural. Bean and Pearce contain 26 and 17 threatened species with greater than eighty percent of their range within. [TODO: Maybe need to assign each species to the electorate that has most of it's range?]

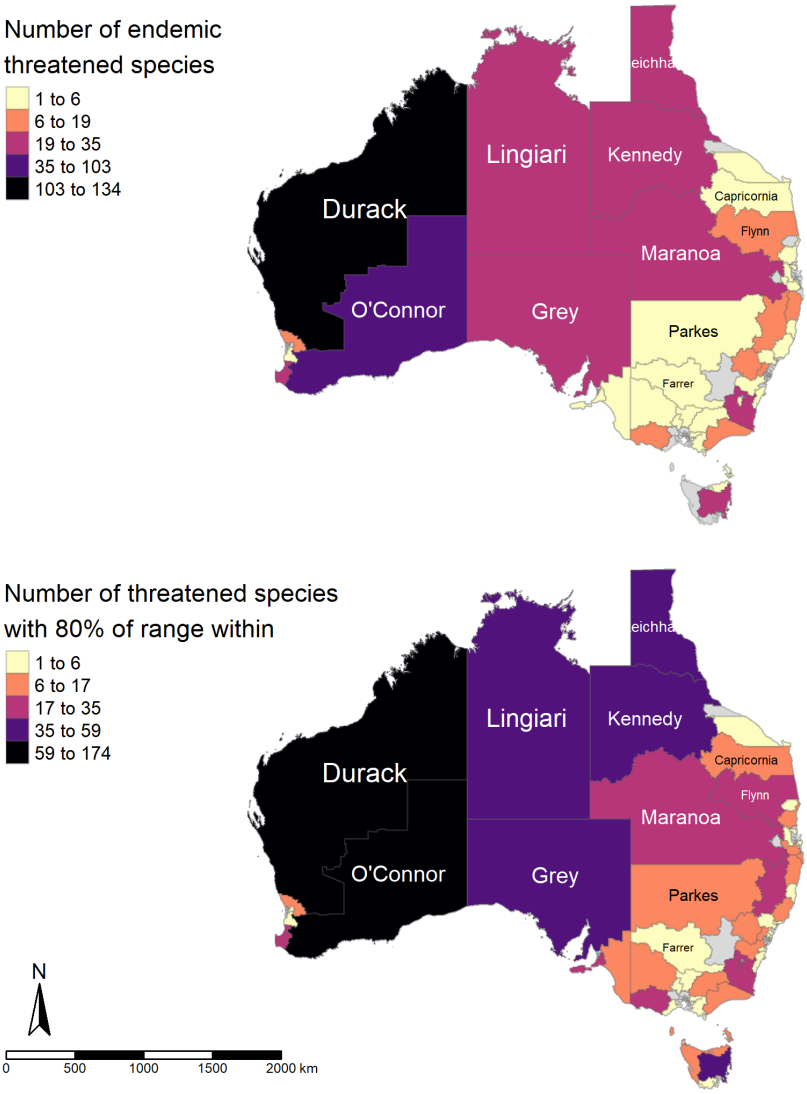

Figure 3: Chloropleth maps displaying A) number of endemic threatened species and B) number of threatened species with at least 80% of their range within continental Australian federal electoral boundaries. External territories (Lord Howe Island, Christmas Island etc) are not included in this map.

DISCUSSION

Examining the spatial occurence of Australian threatened species and formal representation is important. Important because members of parliament are tasked with maintaining and advocating for their region. Biodiversity loss is occuring in every electorate of Australia so therefore a nonpartisan issue. Currently members advocate for car parks, sport fields, yet not their local threatened species. This is potentially a game changer as these members of parliament are responsible for deploying both resources and legislative change. Yet the power of members also

includes ideational and instrumental means.

5.1 Electorates are not drawn on threatened species population, but what they stand for could be an immense mechanism for changing our trajectory

Federal electoral boundaries are drawn on human population distribution within Australia with quotas for states and territories. To meet this, the Australian Electoral Comission draws electorates that are vastly different in size, as the Australian population does not distribute evenly across the continent and islands.

Every Australian electorate contains at least 29 threatened species.

The disparity can primarily be explained by federal electoral boundaries being drawn on the population distribution of humans and the varied occurrence of threatened species. Despite this, the area difference of inner metropolitan electorates compared to the larger rural electorates is not equivalent to threatened species proportion. For example, the electorate of Sydney (NSW) has the highest concentration of threatened species, whilst Lingiari (NT) has the lowest. Lingiari is 30,000 times the size of Sydney yet contains less than double the number of threatened species. Australian urban areas are known to support substantially more threatened species than non-urban areas (Ives et al. 2016; Soanes et al. 2020). Another possible explanation is urban electorates are closer together and therefore share the same species. Another contributing factor is that rural areas may house more species that are undiscovered when compared to built-up urban areas. These explanations need further investigation.

[TODO: what if I drew greater Sydney/median/mean size of electorate as an electorate then tested for how many species it has?]

5.2 Two distinct groupings of species eletorate coverage

Electorates with endemic species require a different approach compared to strongly migratory When approaching the conservation of species through the formal representation paradigm, species that are endemic to a electorate require a different approach compared to migratory or multi-electorate species. What are the benefits of each of these paradigms?

This constitutes 28 species of birds, five mammals, four sub-antarctic plants, three fishes, two reptiles, and the Lorde Howe Island Phasmid. To have no representation from a federally elected member, a species must not be likely to occur on the Australian continent or external territories.

In the case of plants, these are residing on the federally unrepresented site of Macquarie Island. The two reptiles live near East Timor and a rock islet near Tasmania. For the Lorde Howe Island Phasmid, it resides on the remnants of a volcano, Balls pyramid.

This represents a multifacted opportunity for elected members to take responsibility for threatened species and to change our trajectory. Species can only persist Referencing threatened species with their local members enables constituents to better exercise their accountability (e.g. communication) and authorisiation power (e.g. voting). This could manifest in metrics and ideas that garner cross-party support such as threatened species emblems for electorates.

Species can only persist if the legislation and resources expenditure benefit them, through management, threat abatement, etc. Having elected representative acting as species champions has teh potential to have vast impacts. Leaders should be working with local and state counterparts of the Australian politicial system.

Addressing this democracy deficit and pushing advocacy for threatened species onto local constituents and members has the potential to have drastic implications for changing our trajectory.

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SUPPORTING INFORMATION

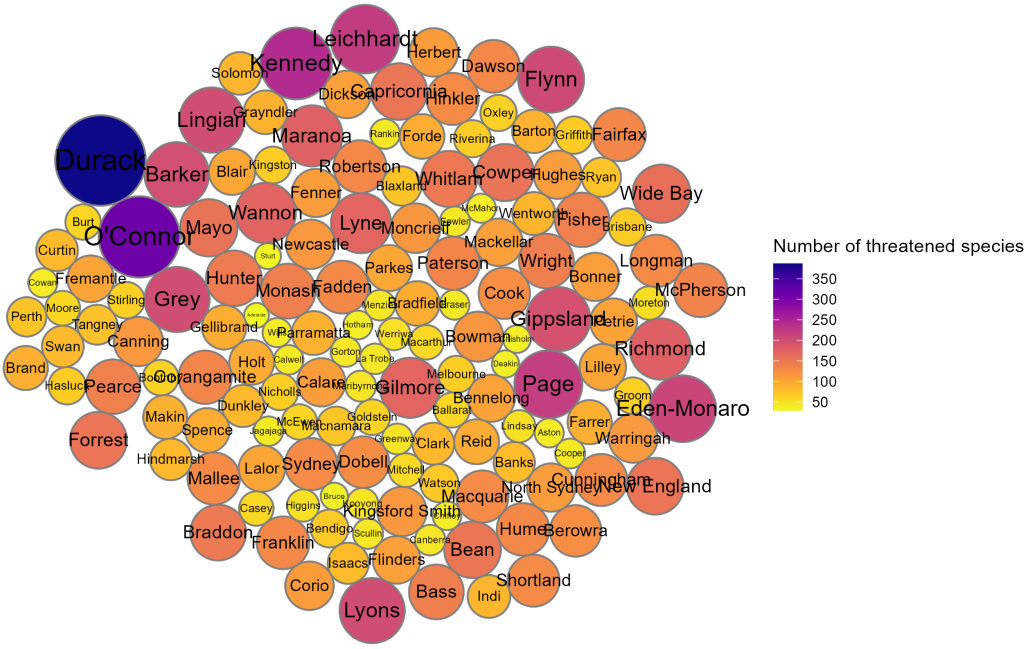

Figure 4: Dorling cartogram of threatened species occurrence within the 151 Australian federal electoral divisions. Size of circles and colour correspond to the number of threatened species within electorates. Positioning of circles roughly represent the geographic location of electorates.

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DATA

Federal electoral boundaries spatial data is available via eechidna or augov SNES data is publicly available via DPEE. Federal terrestrial boundaries is available at the ABS wesbite. The scripts used in this analysis are available on GitHub/Figshare. This should be readily reproducible for other countries and is a focus of the scripts.