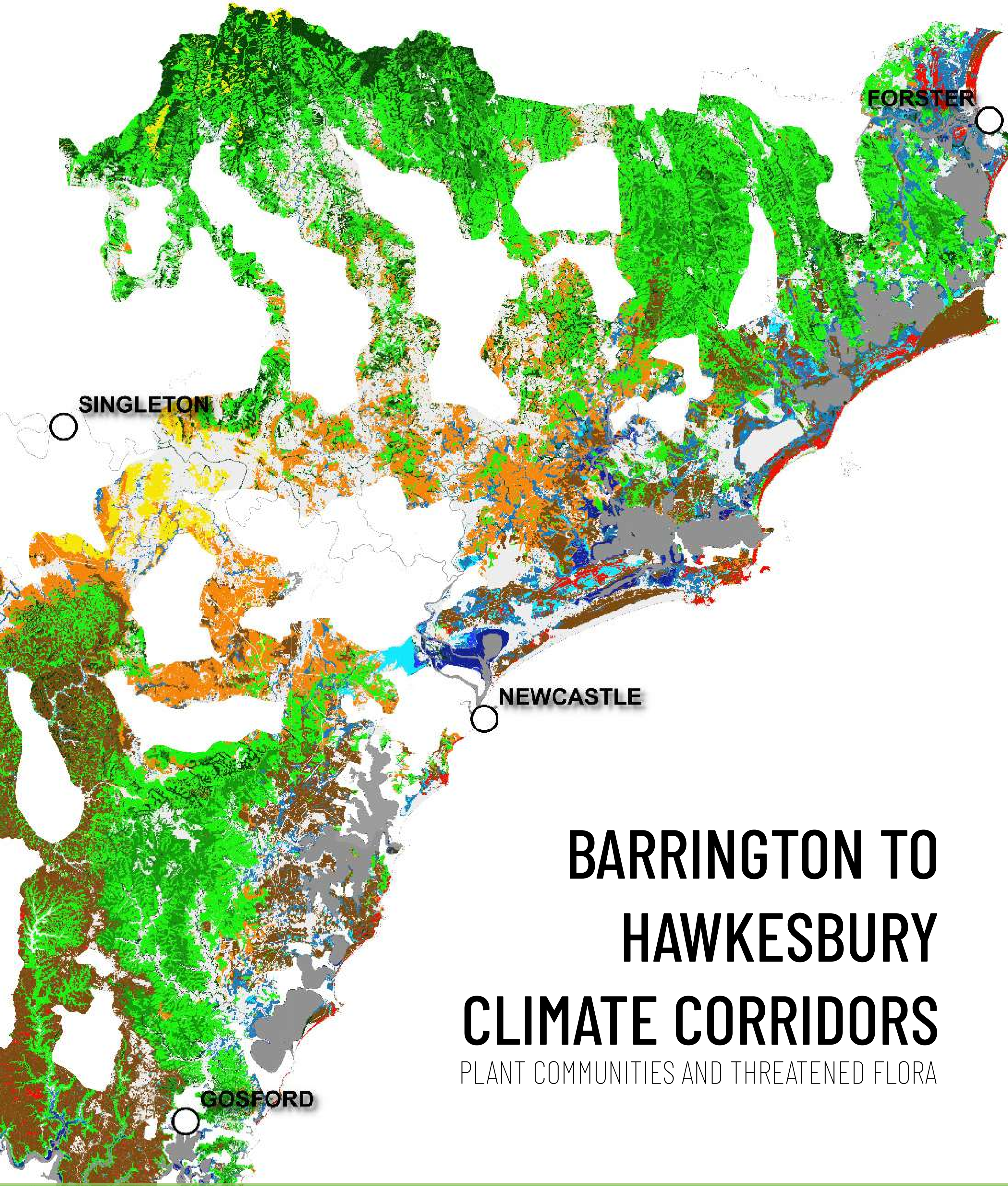

BARRINGTON TO HAWKESBURY CLIMATE CORRIDORS

PLANT COMMUNITIES AND THREATENED FLORA

CONNECTING REGIONAL CLIMATE CHANGE REFUGIA FOR NATIVE SPECIES' PERSISTENCE IN A WARMING WORLD

BARRINGTON TO HAWKESBURY CLIMATE CORRIDORS ALLIANCE 2022

Lead Author: Paul Winn
Contributors: Jo Lynch, William Degeer, Nicola Bowskill

The founding organisations of the Barrington to Hawkesbury Climate Corridors Alliance include:

The Community Environment Network (CEN) was formed in 1997 as an over-arching body to support individuals and groups in Lake Macquarie, Wyong and Gosford who are working for the environment.

EcoNetwork Port Stephens founded in March 1993 is a not-for-profit and 100% volunteer-run organisation dedicated to the interest of all who treasure and want to preserve the natural beauty and biodiversity of the Port Stephens estuary, peninsulas and rural hinterland.

The Hunter Bird Observers Club (HBOC) formed in 1976, and is the largest club in the Hunter Region that caters specifically for those with an interest in bird life in its natural habitat.

The Hunter Community Environment Centre (HCEC) was established in 2004 to encourage and facilitate environmental and social justice advocacy and education in the Hunter region.

The National Parks Association NSW – Hunter branch has been active in the region for 65 years with early community meetings held in Newcastle to protect Barrington Tops and Myall Lakes contributing to the formation of the state wide association seeking to protect, connect and restore the integrity and diversity of natural systems in NSW and beyond, through national parks, marine sanctuaries and other means.

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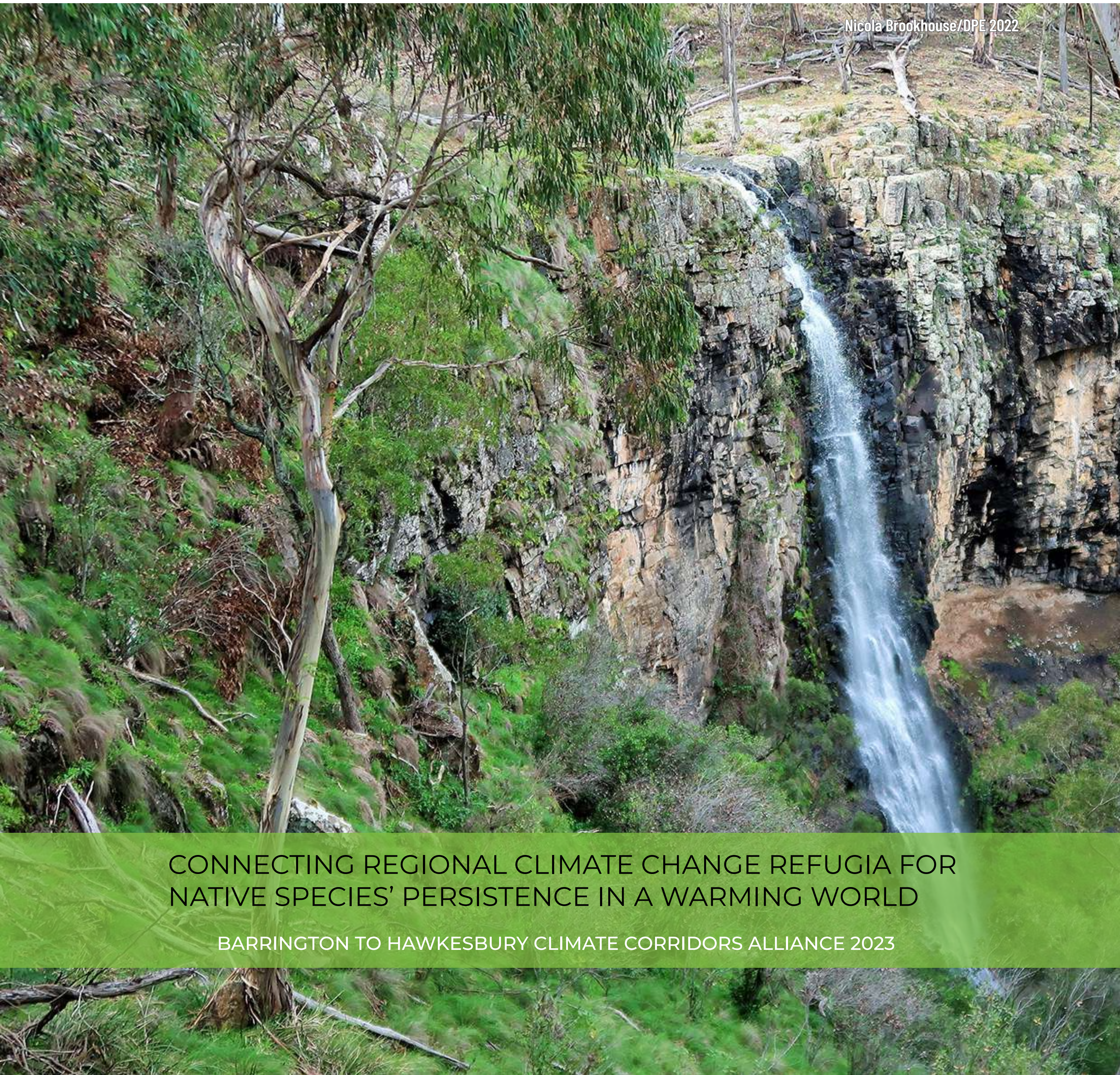
BARRINGTON TO HAWKESBURY CLIMATE CORRIDORS

PLANT COMMUNITIES AND THREATENED FLORA


Nicola Brookhouse/DPE 2022

CONNECTING REGIONAL CLIMATE CHANGE REFUGIA FOR NATIVE SPECIES' PERSISTENCE IN A WARMING WORLD

BARRINGTON TO HAWKESBURY CLIMATE CORRIDORS ALLIANCE 2023

Foreword

Imagine you were able to step into a time machine. Set the dial to 17,000 years before present (BP) at the height of the last ice age. For your destination, punch in Burraga Swamp near Barrington Tops. Make sure you bring a few extra jumpers. Open the door and what would you see?

Spread before you would be a treeless grassland, a landscape adapted to a climate that is colder and drier than today's. We know this from the pollen record preserved in the sediments at the bottom of the swamp.

Shut the door, and set the dial to 6,000 years BP. Grassland has now been replaced by a fully developed cool temperate rainforest, dominated by beech trees (Nothofagus) and tree ferns (Dicksonia). The climate is similar to today's, but slightly warmer and wetter.

But where did all the trees, lush understorey and forest fauna come from? They didn't just spontaneously appear by magic. Go back to 17,000 years BP, then move progressively forward at intervals of 2,000 years to observe the incremental changes.

You'll notice that there were small pockets of rainforest vegetation in gullies at lower elevations. These occurred in positions that were protected from heavy frosts and where the soil was moister. As the climate warmed and became wetter, the patches gradually became larger, and progressively migrated upslope until they eventually coalesced and replaced the ice-age grasslands.

The rainforest pockets acted as 'refugia' that allowed a whole collection of species to persist in a landscape that on the whole was unfavourable for their survival. As the climate improved, the species were able to gradually spread to wherever conditions were favourable. Were the climate to deteriorate, they could potentially retreat to suitable refugia and thereby survive to another epoch. But species can retreat to refugia only if there are niches available that provide the necessary conditions, otherwise their fate is extinction.

By this process, climate change has been an important process throughout geological history in driving the evolution, diversity and geographical distribution of plants, animals and all other life forms.

So in that sense climate change is nothing new. But what is new and unprecedented today is the rate of human-induced climate change and the level of human disturbance to the natural landscape. This includes human settlement, agriculture, forestry, land clearing, altered fire

regimes, invasive species and fragmentation of habitat. These changes are occurring faster than the natural ability of species to adapt through evolution, or to migrate in step with changes in the distribution of climatic zones.

Human disturbance of the landscape throws up all manner of impediments and barriers to the movement of species and habitats, greatly reducing their resilience to climate change. Species can become 'trapped' in locations with unsuitable conditions, driving populations down to unviable levels, and eventually causing local extinctions. This is particularly so for plants which, unlike fauna, cannot uproot themselves and walk, swim or fly somewhere else.

Plant dispersal operates over the scale of thousands or tens of thousands of years. It varies greatly from species to species. Some can easily disperse over great distances with the aid of wind, sea currents or passing animals. But others can spread just a few metres with each generation. Many species are dependant upon other species, and are thereby obliged to travel as a passenger or companion.

Over the past 60 years or so we have built up an impressive but far from complete network of national parks, nature reserves and other 'protected areas'. These aim to conserve a diverse sample of our natural areas and their supporting ecological processes in the long term. But in establishing the network, we have not taken into account the rate or consequences of human-induced climate change, nor the extent of landscape disruption occurring between protected areas. It has become increasingly clear that we need to provide for suitable climate refugia, and for the ability of species to move across the landscape to reach refugia.

This report presents a strategic approach to securing the protection of native vegetation on private and public lands to complement the protected area network. It aims to promote a landscape between Barrington Tops and the Hawkesbury River that is better adapted to a range of possible climate futures.

Ian Donovan
President Hunter Branch
National Parks Association of NSW

I acknowledge that I live on Awabakal land, that sovereignty was never ceded and pay my respects to Elders past, present and emerging.

Symplocos baeuerlenii, Greg Tasney 2021

We recommend

1. An immediate moratorium on further land clearing within identified Climate Change Corridors.

2. A specific strategy be included in both the Hunter Regional Plan 2041 and the Central Coast Regional Plan 2041 for the protection of Climate Corridors through an integrated suite of mechanisms (including development controls, major infrastructure planning, voluntary land acquisition and private land conservation).

3. The regional strategy described above be supported by detailed zoning and development guidelines under local environmental plans and development control plans administered by local councils, and also by investment programs implemented by Local Land Services.

4. Environmental Planning Instruments (EPI), including State Environmental Planning Policies (SEPP) and Local Environment Plans (LEP) be amended to conserve Climate Corridors from further development.

5. The Biodiversity Offset Scheme be radically amended to provide adequate stewardship payments to encourage landholders to protect, manage, and restore native vegetation within Climate Corridors under Voluntary Conservation Agreements or other secure conservation measures.

6. Targeted voluntary private land acquisition of large core areas of high quality habitat and essential corridors for restoration, particularly the large areas of moist forests in southern Mid-coast, and moist and dry landscapes across the Hunter River Valley through Cessnock, Singleton, and Dungog LGAs.

7. State Forests be transferred to National Park reserves as Regional Parks or other appropriate reserve category and managed by Local Communities for conservation and recreation.

Kunzea Rupestris, Jamie Plaza, 2022, ©

Caladenia concolor, Cathy Powers 2015

Contents


Eucalyptus Glaucina, Harry Rose, 2019 ©

Introduction

Barrington to Hawkesbury is a NSW coastal region covering almost 1.18 million ha (1,180 km2) between Barrington Tops in the north and Hawkesbury River in the south taking in the LGAs of Central Coast, Lake Macquarie, Cessnock, Newcastle, Port Stephens, Dungog, the former Great Lake Council area of Mid Coast LGA, and parts of Singleton LGA. The area straddles the southern-most end of the North Coast Bioregion - Parts Mummel Escarpment, Barrington, Upper Hunter, Karuah Manning Sub Bioregions, and the northern-most end of the Sydney Basin Bioregion - Wyong, and Part Pittwater, Yengo, Hunter Sub Bioregions (See Map 1).

The region supports 255 Plant Community Types (PCT) within 11 Vegetation Formations (See Map 3). National Park reserves in the Region total about 240,000 ha (21.3%), State Forests almost 120,000 ha (11%), and other Public Lands a further 44,400 ha (4%) (See Map 2). Native vegetation covers about 780,000 ha or about 66 percent of the region, about 44 percent is mapped as Key Fauna Habitats[1] (342,300 ha), and 34 percent (265,000 ha) is made up of nine Ecological Communities of Nationally Environmental Significance - five Endangered and four Critically Endangered (See Table 1 and Map 5).

Central to the region is the Hunter River Valley which represents the major break in the Great Dividing Range providing a link between coastal and inland NSW species. The region also incorporates an overlap between tropical and temperate zones known as the MacPherson–Macleay Overlap[2] where the limits of many species are found.[3]

The area is of great ecological significance supporting four features of high international conservation value:

- **Myall Lakes – Ramsar Convention on Wetlands,**
- **Hunter Estuary - Ramsar Convention on Wetlands,**
- **Part Greater Blue Mountains World Heritage Area and**
- **Part Barrington Tops World Heritage Area [4]**

1 DPE, Upper North East and Lower North East Fauna Key Habitats. https://datasets.seed.nsw.gov.au/dataset/fauna-key-habitats-for-north-east-nswe01b8
2 Burbidge NT (1960) Phytogeography of the Australian Region. Australian Journal of Botany 8(2), 75–211.
3 Australian Government, 2018. Bioregional Assessment Hunter subregion. https://www.bioregionalassessments.gov.au/assessments/11-context-statement-hunter-subregion/1121-physical-geography
4 ibid

The present protected area network was not designed to accommodate climate change and the biodiversity values it currently protects will not all survive under different climatic conditions.[1] As the distribution of most species, populations and communities is determined by climate, most will be adversely affected by the inevitable changes we will see to the climate with populations necessarily having to move across the landscape to remain within their climactic envelope.[2]

Wildlife corridors facilitate this movement between patches of habitats and increase native species richness and abundance.[3] Wildlife corridors influence dispersal behaviour, migration rates, ecological community composition,[4] have substantial effects on the genetics of populations, and provide long-term conservation benefits that extend beyond targeted species to entire ecological communities irrespective of dispersal abilities or population sizes.[5]

The Barrington to Hawkesbury Climate Corridor Alliance[6] recommends urgent conservation measures to limit the significant loss of biodiversity projected for the region due to climate change.[7]

The recommendations first set out in the report Barrington to Hawkesbury Climate Corridors: Connecting regional climate change refugia for native species' persistence in a warming world published in December 2022 are based on the climate corridors identified in 2007 by the then NSW Department of Environment and Climate Change for the Northeast and Nandewar IBRA Bioregions.[8] These climate corridors identify landscape-scale wildlife migration pathways of optimum habitat which

1 NSW Scientific Committee (2000) Anthropogenic Climate Change - key threatening process listing

Threatened Species Conservation Act. https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=20025

2 NSW Scientific Committee (2000) Anthropogenic Climate Change - key threatening process listing

Threatened Species Conservation Act. https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=20025

3 See for example Beier, P., and R. F. Noss 1998. Do habitat corridors provide connectivity? Conservation Biology 12:1241–1252; Brudvig, L. A., E. I. Damschen, J. J. Tewksbury, N. M. Haddad, and D. J. Levey 2009. Landscape connectivity promotes plant biodiversity spillover into non-target habitats. Proceedings of the National Academy of Sciences of the United States of America 106:9328–9332; Gilbert-Norton, L., R. Wilson, J. R. Stevens, and K. H. Beard 2010. A meta-analytic review of corridor effectiveness. Conservation Biology 24:660–668; Haddad, N. M. 1999. Corridor use predicted from behaviors at habitat boundaries. American Naturalist 153:215–227;

4 Harrison, R. L. 1992. Toward a theory of inter-refuge corridor design. Conservation Biology 6:293–295; Lindenmayer, D. B., and H. A. Nix 1993. Ecological principles for the design of wildlife corridors. Conservation Biology 7:627–630; Andreassen, H. P., S. Halle, and R. A. Ims 1996. Optimal width of movement corridors for root voles: not too narrow and not too wide. Journal of Applied Ecology 33:63–70; Damschen, E. I., L. A. Brudvig, N. M. Haddad, D. J. Levey, J. L. Orrock, and J. J. Tewksbury 2008. The movement ecology and dynamics of plant communities in fragmented landscapes. Proceedings of the National Academy of Sciences of the United States of America 105:19078–19083.

5 Christie, M.R. and Knowles, L.L. (2015), Habitat corridors facilitate genetic resilience irrespective of species dispersal abilities or population sizes. Evol Appl, 8: 454-463. https://doi.org/10.1111/eva.12255

6 NSW National Parks Association (Hunter Branch); Community Environment Network; EcoNetork Port Stephens; Hunter Bird Observers Club; Hunter Community Environment Centre.

7 See https://www.hcec.org.au/climate-corridors

8 Dept of Environment and Climate Change (2007), Wildlife Corridors for Climate Change – Landscape Selection Process, Key altitudinal, Latitudinal and Coastal Corridors, An internal report, DECC, N.S.W

represent a strategic approach to securing the protection of native vegetation on private and public lands that complement and connect National Parks and Conservation Reserves to ensure the NSW National Parks Estate is prepared for a range of potential climate futures.

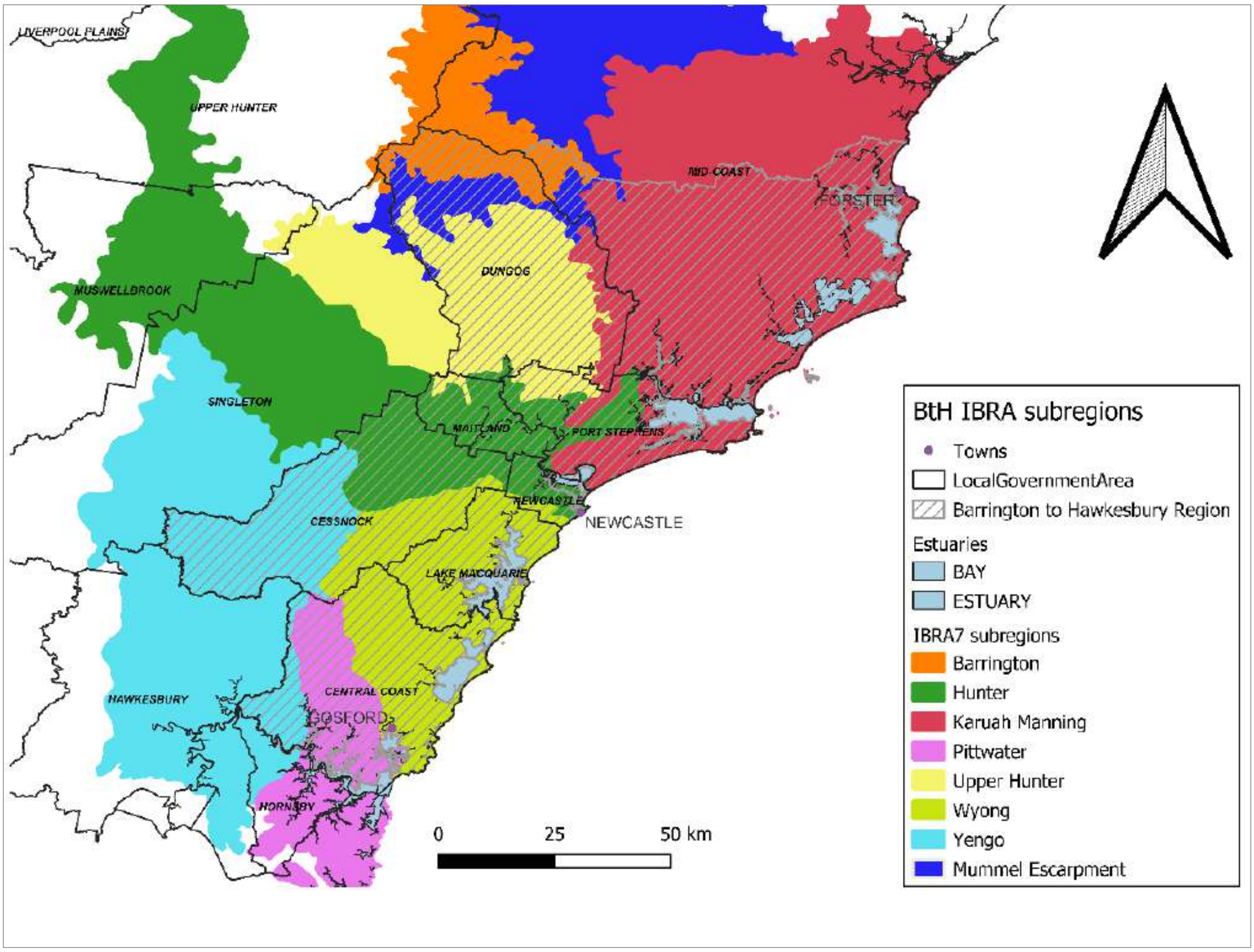
In our first report we set out climate change refugia for Threatened fauna species identified by Beaumont et al (2019)[1] and confirmed by Bradstock et al (2021)[2] as critical climate change refugia essential for the survival of species to 2070. This report sets out modelled climate impacts to NSW Threatened flora and identifies climate refugia for plant communities and Threatened flora that the Barrington to Hawkesbury Climate Corridors would protect from further destruction and fragmentation by agriculture, forestry, and development.

1 Beaumont, L. J., Baumgartner, J. B., Esperón-Rodríguez, M, & Nipperess, D. (2019). Identifying climate refugia for key species in New South Wales - Final report from the BioNode of the NSW Adaptation Hub, Macquarie University, Sydney, Australia. https://www.climatechange.environment.nsw.gov.au/sites/default/files/2021-06/Identifying%20climate%20refugia%20for%20key%20species%20in%20NSW.PDF

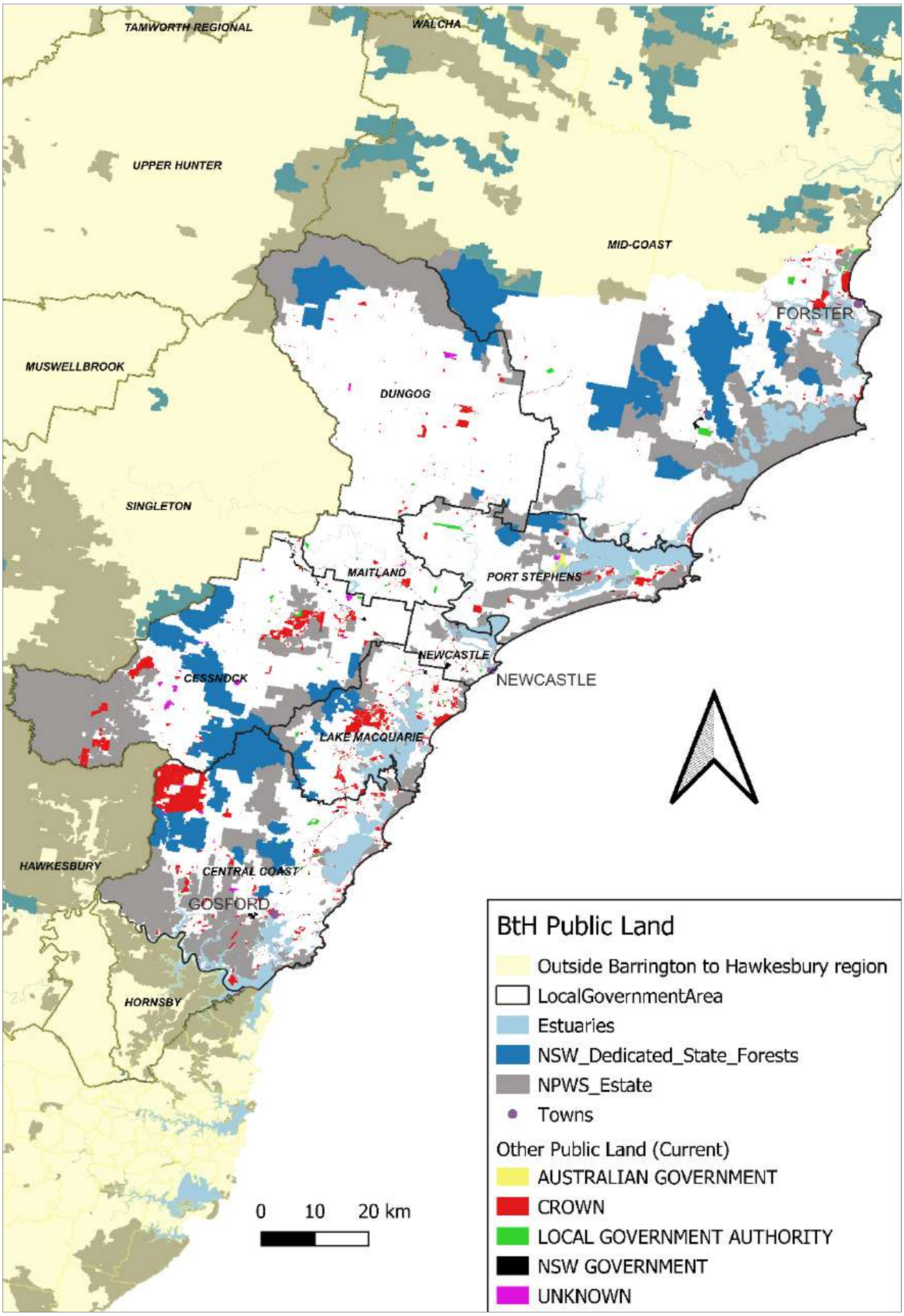
2 Bradstock, R., Bedward, M., Price., O (2021). Risks to the NSW Coastal Integrated Forestry Operations Approvals Posed by the 2019/2020 Fire Season and Beyond: A Report to the New South Wales Natural Resources Commission. https://www.nrc.nsw.gov.au/Coastal%20IFOA%20-%20Final%20report%20-%20Fire%20regimes%20-%20UoW.pdf?downloadable=1

Eucalyptus Glaucina, Harry Rose, 2018 ©

The Barrington to Hawkesbury region

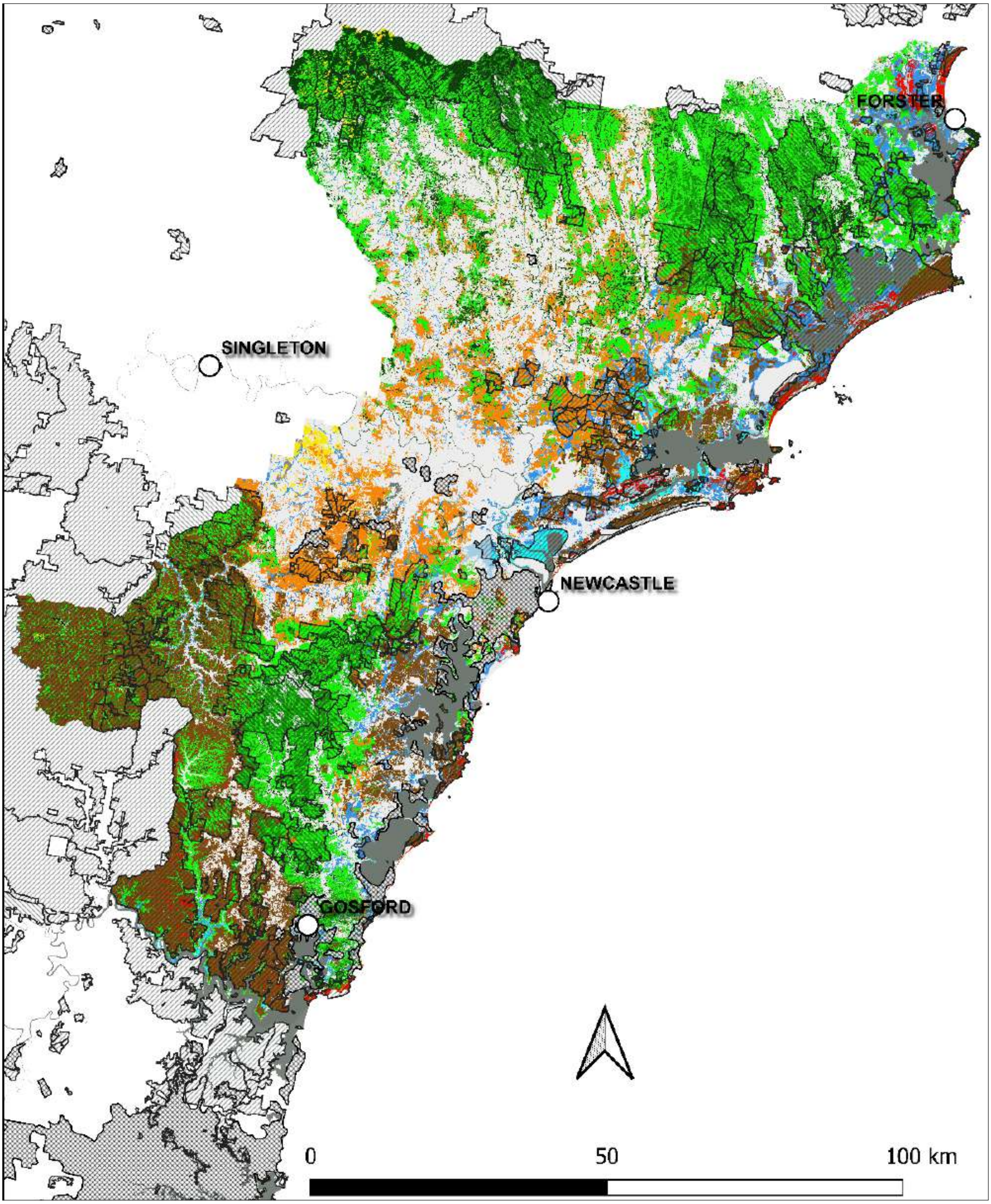


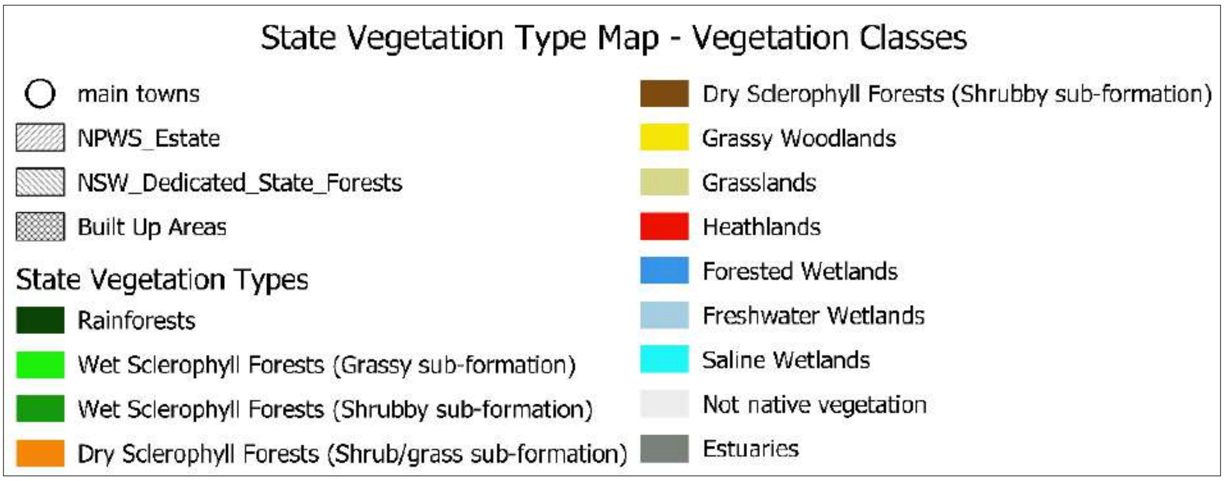
Map 1: Interim Bio regionalisation of Australia sub-bioregions between Barrington and Hawkesbury.



Map 2: BTH public land. Tenure layers: State Government of NSW and Department of Planning and Environment https://datasets.seed.nsw.gov.au/dataset/

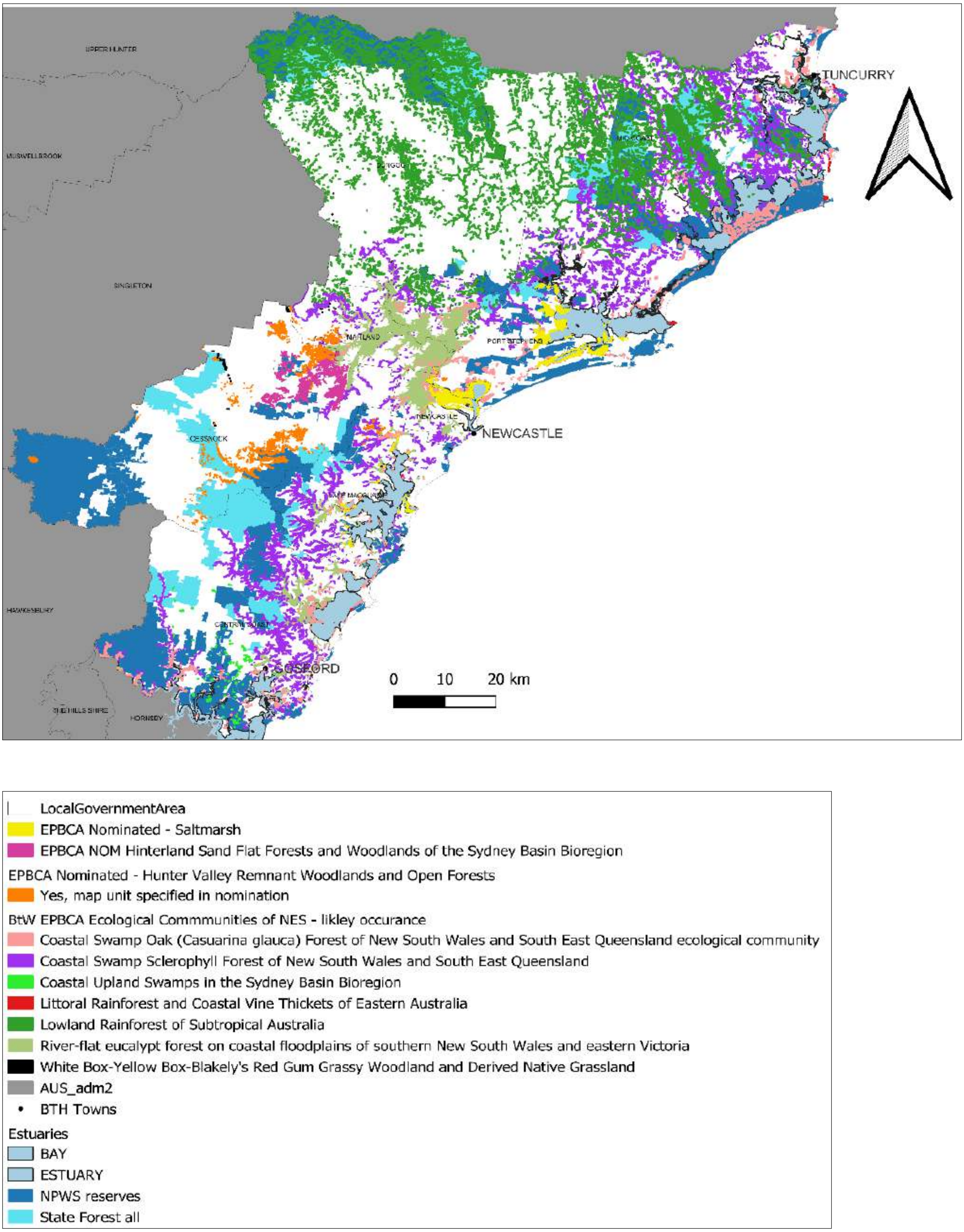
Plant Communities within Barrington to Hawkesbury





Map 3. State Vegetation Types (Formations) of the Barrington to Hawkesbury Region (copyright NSW Department of Planning and Environment- https://datasets.seed.nsw.gov.au/dataset/nsw-state-vegetation-type-map*)*

Grevillea Guthrieana, Geoff Derrin, 2022,



Map 4: BTH Ecological Communities of National Environmental Significance. Datasets: Australia - Ecological Communities of National Environmental Significance (Public Grids), 6/11/22. Commonwealth of Australia (2016). https://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7B184A3793-2526-48F4-A268-5406A2BE85BC%7D

Table 1: BTH Ecological Communities of National Environmental Significance.

ECOLOGICAL COMMUNITY	EPBC	Area (ha)
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	360
Lowland Rainforest of Subtropical Australia	Critically Endangered	95,816
River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria	Critically Endangered	72,835
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	364
Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland	Endangered	69,886
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland	Endangered	14,206
Coastal Upland Swamps in the Sydney Basin Bioregion	Endangered	984
Hunter Valley Remnant Woodlands and Open Forest	Nomination	6,704
Hinterland Sand Flat Forests and Woodlands of the Sydney Basin Bioregion	Nomination	4,235
TOTAL		**265,391**

The region supports;

- **7 Endangered Ecological Communities of National Environmental Significance (four Critically Endangered) and a further three ECNES nominations,**
- **9 Endangered Populations,**
- **106 Threatened terrestrial animals; 61 birds, 30 mammals, nine frogs, five reptiles, and one insect.**
- **116 Threatened terrestrial plants (See Appendix 3 and 4).**


Leucopogon Fletcheri, Murray Fagg, 2014 ©

Sophora tomentosa, Tatters (Flickr) 2009

Climate Refugia

Threats to the natural environment are being exacerbated by ever increasing greenhouse gas (GHG) concentrations. In 2021, GHG emissions increased 6.4 percent to a new record, eclipsing the pre-pandemic peak as global economic activity resumed.[1]

The combined global land and ocean temperature has increased at an average rate of 0.08 degrees Celsius (C) per decade since 1880, but since 1981, the rate of increase has more than doubled to 0.18 °C per decade.[2]

Areas of suitable habitat within generally unfavourable landscapes are referred to as 'refugia'. Refugia represent areas that biodiversity can persist in, or retreat to, until the surrounding landscapes becomes favourable to expand.[3]

> *"The persistence of species throughout the climatic disruptions of the late Quaternary was likely facilitated by the persistence of remnant populations within refugia.[4]"*

1 P. Bhanumati, Mark de Haan, James William Tebrake, 2022. Greenhouse Emissions Rise to Record, Erasing Drop During Pandemic. The latest data from the IMF's Climate Change Indicators Dashboard provides a worrying picture. June 30, 2022. International Monetary Fund. https://www.imf.org/en/Blogs/Articles/2022/06/30/greenhouse-emissions-rise-to-record-erasing-drop-during-pandemic

2 See https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature#:~:text=According%20to%20NOAA's%202021%20Annual,0.18%20%C2%B0C)%20per%20decade.

3 Keppel G, Van Niel KP, Wardell-Johnson GW *et al*. (2012) Refugia: identifying and understanding safe havens for biodiversity under climate change. *Global Ecology and Biogeography*, **21**, 393–404.; Keppel, G. and Wardell-Johnson, G.W. (2012), Refugia: keys to climate change management. Glob Change Biol, 18: 2389-2391.

4 Correa-Metrio, Alexander, et al.(2022) "Detrended Correspondence Analysis: A Useful Tool to Quantify Ecological Changes from Fossil Data Sets." *Boletín de La Sociedad Geológica Mexicana*, vol. 66, no. 1, 2014, pp. 135–43. *JSTOR*, http://www.jstor.org/stable/24921266. Accessed 8 Oct. 2022

However, contemporary climate change is a much more significant problem than in the past due to the speed of the change coupled with the pre-existing threats to native species from modification of land and waters by human settlements, pastoralism, agriculture, logging, invasive pests and weeds, inappropriate fire regimes, land clearing and resulting fragmentation of natural vegetation.[1] These threats erode native species resilience to climate change by disrupting species movements and natural ecological processes, and drive populations down to unviable levels.

The major threats impairing natural resilience to climate change are:

- **Land clearing and resulting loss and fragmentation of core habitats and migration corridors;**
- **Unsustainable extractive land use activities, primarily livestock grazing and logging;**
- **Changed hydrology and extraction of water;**
- **Invasive weeds and animal pests;**
- **Inappropriate fire regimes (intensities, frequencies and timings).[2]**

Bushfires and floods are rapidly becoming more frequent and extreme, exotic species invasions are increasing as native ecosystems come under stress, and potential shifts in human populations will likely result in the conversion of additional natural areas to agriculture and settlements.

Beaumont et al (2019)[3] provides the results of habitat suitability modelling for 81 landscape-managed species[4] and 238 site-managed species[5] of southeast Australia, under a "business as usual" greenhouse gas emissions scenario (RCP 8.5).

The Geographic Information System (GIS) datasets present future habitat suitability for native species under four different configurations of potential trends in temperature and rainfall set out in Table 2 below

1 Taylor M. & Figgis P. (eds) (2007) Protected Areas: Buffering nature against climate change. Proceedings of a WWF and IUCN World Commission on Protected Areas symposium, 18-19 June 2007, Canberra. WWF Australia, Sydney.

2 ibid

3 Beaumont, L. J., Baumgartner, J. B., Esperón-Rodríguez, M, & Nipperess, D. (2019). Identifying climate refugia for key species in New South Wales - Final report from the BioNode of the NSW Adaptation Hub, Macquarie University, Sydney, Australia. https://www.climatechange.environment.nsw.gov.au/sites/default/files/2021-06/Identifying%20climate%20refugia%20for%20key%20species%20in%20NSW.PDF

4 9 Endangered and 72 Vulnerable terrestrial vertebrate fauna

5 34 vertebrates and 204 plants -13 Critically Endangered, 125 Endangered, and 100 Vulnerable species

Table 2. Global climate models used by Beaumont et al (2019) and the futures they predict.

Climate Future	Global Climate Model	Represents a future that is:
Warmer/Wetter	MIROC3.2 (medres)	Warmer and wetter than present, particulartly in NE NSW, althrough alpine regions are proejected to become dryer
Hotter/Wetter	CCCMA CGM3 t (T47)	Warmer than MIROC, and wetter across most of the State, although areas in NW and SE NSW may be slightly dryer
Hotter/Little Change in Precipitation	ECHAMS/MPI-OM	Has the greatest increase in temperature of the four scenarios. Precipitation trends vary across the State (slightly wetter in NE and coastal regions, slightly dryer elsewhere)
Warmer/Dryer	CSIRO-Mk 3.0	Warmer than present, and the dryest of the four models

Differences in the projected area of suitable habitat for each species under these four climate change scenarios represent the uncertainty of future temperatures and rainfall patterns predicted by a number of global and regional climate models. Future rainfall patterns are particularly uncertain.

Beaumont et al (2019) utilised habitat suitability modelling to assess the relationship between species' occurrence patterns and environmental characteristics to estimate which regions were likely to retain conditions broadly suitable for the species across the range of plausible future climate scenarios to 2070. They do not indicate the probability that a target species will successfully colonise an area, but rather identify areas likely to serve as refugia throughout the century. Viable populations of target species must, of course, be allowed to persist in the region and be able to migrate to the newly suitable habitat.

An area may be classified by the habitat suitability model (HSM) as suitable, yet the target species may be absent because of dispersal limitations or biotic factors or a variable important for the species may have been excluded from the model, leading to predictions that indicate suitability of the considered environmental factors.[1] Also, the HSM may underestimate the potential environmental and geographic ranges of species that have suffered substantial habitat loss.[2]

It must be also be remembered that models provide only a limited representation of reality. In order to develop a comprehensive understanding of species' responses to climate change, the output of HSMs should be used in conjunction with other information about the biology and ecology of species.[3]

1 Beaumont, L. J., Baumgartner, J. B., Esperón-Rodríguez, M, & Nipperess, D. (2019). Identifying climate refugia for key species in New South Wales - Final report from the BioNode of the NSW Adaptation Hub, Macquarie University, Sydney, Australia.

2 ibid

3 ibid

These authors tell us that:

- **For a given species, populations in regions projected to become climatically unsuitable under all four climate scenarios are at substantial risk from climate change.**
- **Protection of climate refugia for multiple species offer a means of prioritising conservation efforts.**
- **Unless reversed, current stresses, including habitat loss and degradation, may erode the capacity of some key refugial regions to maintain viable populations.**
- **Adequate resource be provided to fully assess the vulnerability to climate change of threatened species in the North Coast, Hunter and Greater Sydney regions (as well as the Shoalhaven), as habitat suitability models indicate that threatened species in these regions face substantial threat from climate change.**

Beaumont et al (2019) concludes that under the worst case climate scenario 45 percent of fauna and 72 percent of flora species are likely to have little to no suitable habitat or areas for translocation by 2070.[1] These authors suggest the east coast region of NSW will be heavily impacted with several important refugia for threatened species projected to be located close to heavily urbanized regions. The report identifies key regions for threatened species as likely to occur around the Sydney Basin and in the north-east coast, as well as the South Eastern Highlands.

Climate refugia accommodating the majority of local flora are likely to play a critical role in the long-term endurance of plant communities in the face of climate change. The quality of habitat is thought to relate to its resilience to the additional stress of climate change (Field et al. 2014; Zomer et al. 2008), thus ensuring the management of refugia in areas of good condition is likely to yield more favourable outcomes.[2]

1 Beaumont et al. (2019). Op cit.

2 ibid

Threatened Flora between Barrington and Hawkesbury

> *While our analysis of the data specific to the Barrington to Hawkesbury region presented by Beaumont et al (2019) reveals that suitable habitat for fauna species will be severely degraded by the effects of climate change, flora species will suffer far greater extinctions and range contractions.*

For the Barrington to Hawkesbury region, the NSW BioNet wildlife atlas lists 122 Threatened flora species recorded since 2000. Of these species, Beaumont et al (2019) models habitat for 28, 12 of which (43%) will have no suitable habitat in the region by 2070 under a worst case climate scenario (See Appendix 1 and summary below)

Overall, Beaumont et al (2019) identifies suitable habitat for 204 Threatened NSW plant species, 74 of which had suitable habitat modelled within the Barrington to Hawkesbury region in 2000. Of these 74 species, 64 (86%) suffer significant range contractions by 2070, with 38 (51%) having no suitable habitat, a further 27 species (11 with recorded sightings since 2000) experience significant range contractions, and 10 species (4 with recorded sightings since 2000) experience range expansions under a worst case climate scenario.

Melaleuca Biconvexa, Eyeweed, 2012, ©

Summary of predicted habitat suitability for Threatened Flora by 2070 due to Climate Change

Overlap (consensus) of all 4 climate futures (See Appendix 1 for maps of modelled refugia)

1. Predicted regional extinctions – Recorded sightings since 2000 (R)with no suitable habitat predicted in the region by 2070

1. *Allocasuarina defungens (Dwarf Heath Cassuarina) R*
2. *Asperula asthenese (Trailing Woodruff) R*
3. *Cryptostylis hunbteriana (Leafless Tongue Orchid) R*
4. *Coastesi paniculata (Axe Breaker) R*
5. *Eucalyptus glaucina (Slaty Red Gum) R*
6. *Grevillia guthereana R*
7. *Grevillea parviflora subsp. Supplicans R*
8. *Kunzea rupestris (Rocky Kunzea) R*
9. *Leucopogon fletcheri subsp. Fletcheri R*
10. *Melaleuca biconvexa (Biconvex Paperbark) R*
11. *Persoonia hirsuta (Hairy Geebung) R*
12. *Tylophora woolsii R*
13. *Zerira involucrate R*

Allocasuarina Defungens, Nick Lambert,2022 ©

2. No suitable habitat predicted by 2070 – no sightings but modelled habitat in 2000 with no suitable habitat predicted by 2070

1. *Acacia courtii (Northern Brother Wattle)*
2. *Acronychia littoralis*
3. *Allocasuarina simulans*
4. *Archidendron henersonii (White Lace Flower)*
5. *Caesalpinia bonduc (Fever Nut)*
6. *Caladena concolor (Crimson Spider Orchid)*
7. *Darwinia penduncularis*
8. *Exacris purpurascens (Port Jackson Heath)*
9. *Eucalyptus sp. Cattai*
10. *Eucalyptus langleti (Green Malee Ash)*
11. *Eucalyptus sturissiana (Ettreema Malee)*
12. *Hibbertia puberula*
13. *Hibbertia stricta subsp. Furcaluta*
14. *Irenepharsus typherus (Illawarra Irene)*
15. *Leucopogon exolasius (Woronoa Beard Heath)*
16. *Lindernia alsinoides (Noahs False Chickweed)*
17. *Persicaria elatior (Tall Knotweed)*
18. *Phaius australis (Lesser Swamp Orchid)*
19. *Pimelea spicata (Spike's Rice Flower)*
20. *Pterostylis cobarensis (Greenhood Orchid)*
21. *Senecio spathulatus (Coastal Groundsel)*
22. *Symplococ Beauerlenii (Small Leafed Hazelwood)*
23. *Triplarina nowraensis (Nowra Heath Myrtle)*
24. *Xylosome terrae-reginae*


Triplarina nowraensis (Nowra Heath Myrtle) , Don Wood ©


Phaius australis, Peter Woodard 2010

3. Range contractions predicted by 2070 – Recorded sightings since 2000 (R)with no suitable habitat predicted in the region by 2070

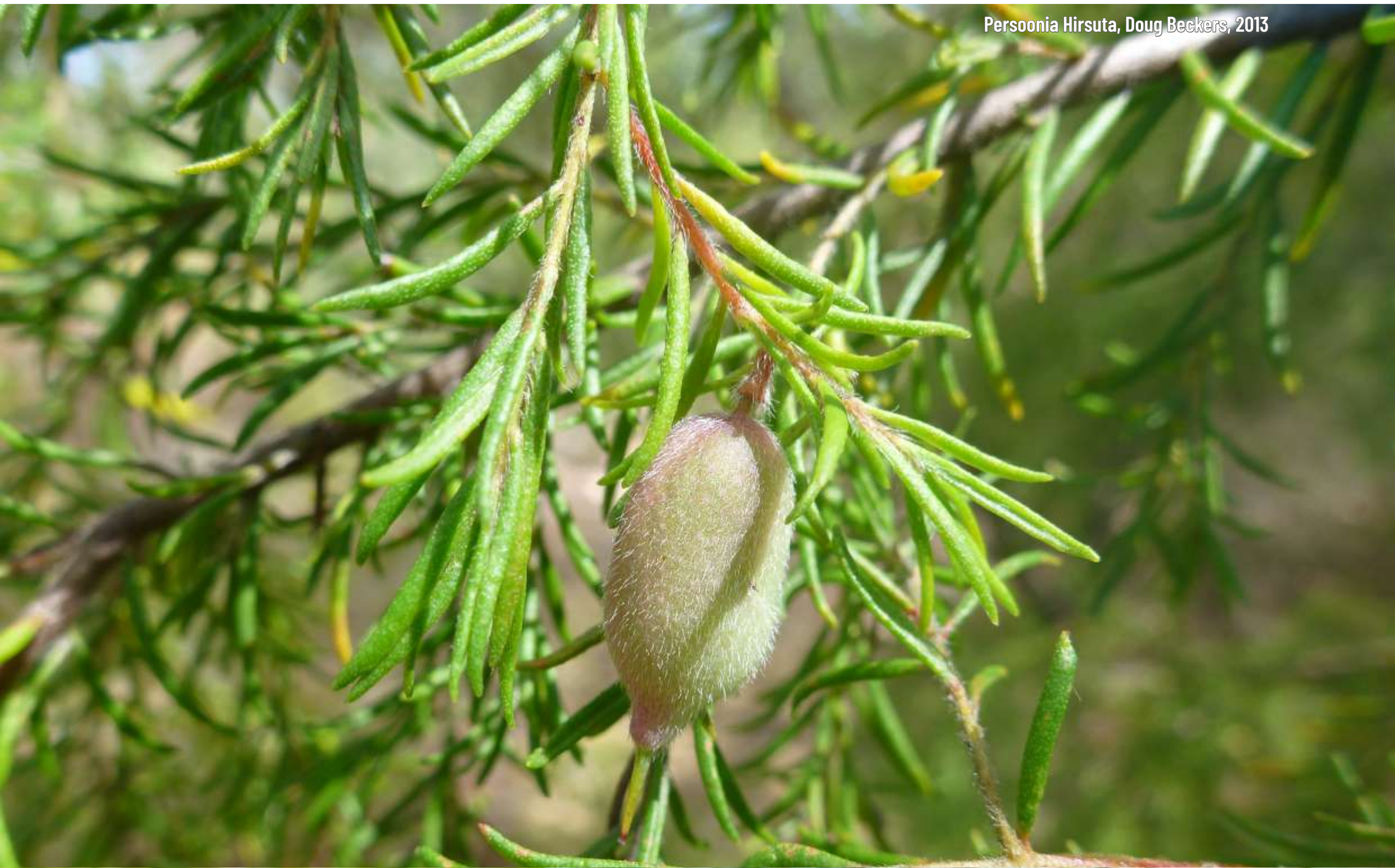
1. *Acacia pubescens*
2. *Acacia terminalis (Sunshine Wattle) R*
3. *Astrotrichia crassifolia R*
4. *Callocephalon fimbriatum*
5. *Chthonicola sagittata*
6. *Darwinia biflora*
7. *Diurius praecox (Rough Doubletail) R*
8. *Eleocharis tetraqueta*
9. *Eucalyptus camfieldii (Camfiel's Stringy Bark)R*
10. *Eucalyptus largeana (Craven Gray Box) R*
11. *Genoplesium baueri (Bauer's Midge Orchid)*
12. *Grevillea hilliana (White Silky Oak)*
13. *Hibbertia sp backstown*
14. *Lasiopetalum joyce R*
15. *Malaleuca deanei (Deans Paperbark) R*
16. *Melichris hirsuitus*
17. *Micromtus blakelyi R*
18. *Myriophyllum implicatum*
19. *Olearia cordata R*
20. *Persoonia mollis subsp. Maxima*
21. *Phyllanthus microcladus*
22. *Pultenea maritima (Coastal Headland Pea)*
23. *Senna acclinis (Rainforest Cassia) R*
24. *Syzigium paniculatum (Magenta Lilly Pilly) R*
25. *Tinospora tinosporoides (Arrow Head Vine)*
26. *Uromytrus australis (Peach Myrtle)*
27. *Wilsonia backhousei*

Syzigium paniculatum (Magenta Lilly Pilly) ©

4. Range expansions predicted by 2070 – Recorded sightings since 2000 (R)with no suitable habitat predicted in the region by 2070

1. *Acacia gordonii*
2. *Angophora exul (Dwarf Apple)*
3. *Caesalpinia bonduc (Fever Nut)*
4. *Chamaesyce psammogeton (Sand spurge) R*
5. *Diurius arenaria (Sand Doubletail) R*
6. *Grevillea caleyi (Claey's Grevillia)*
7. *Pimelea curviflora R*
8. *Quassia sp. Mooney Creek*
9. *Sophora tomentose (Necklace Pod)*
10. *Tetratheca glandulosa (Glandular Pink Bell) R*


Acacia gordonii, Tony Rodd 2007



Persoonia Hirsuta, Doug Beckers, 2013

Tetratheca juncea, Gavin Ayre 2013

Northern Brother-Wattle, Thomas Mesaglio, ©

Barrington to Hawkesbury Climate Corridors

The 2 most frequently recommended biodiversity climate adaptation strategies are to expand protected areas and by conserving or restoring corridors or connected areas.[1] As climatic conditions change in the coming decades, the persistence of many populations of native species will depend on their ability to colonize newly suitable habitat. However, areas that facilitate this dispersal must be identified and protected from land uses that block such movement.[2]

Large-scale corridors that span climatic gradients can enhance the capacity of species to shift to new, more climatically favourable areas, allowing species to respond to shifting climates through natural dispersal rather than requiring active intervention. Regional scale corridors are particularly important to connect habitat refugia that may be critical to species' survival. Corridors can promote the movement of individuals between different populations, increasing gene flow and reducing genetic bottlenecks and drift associated with isolated populations, increasing the resilience of species to adapt to climate change.

Even small changes in climate may mean that species must travel considerable distances over land to stay within their preferred climatic "envelope". Corridors must, therefore, be large enough to support entire populations as they move – landscape corridors with high quality core habitat spanning large areas.

Ecological restoration plays an essential role in corridor conservation, in terms of restoring native vegetation, design of overpasses and underpasses across highways and canals, removal of aquatic barriers, and rehabilitation of mined areas.

1 Beier, Paul. (2012). Conceptualizing and Designing Corridors for Climate Change. Ecological Restoration. 30. 312-319. 10.3368/er.30.4.312.

2 Carroll, C, Parks, SA, Dobrowski, SZ, Roberts, DR (2018) Climatic, topographic, and anthropogenic factors determine connectivity between current and future climate analogs in North America. *Glob Change Biol*. 2018; 24: 5318– 5331. https://doi.org/10.1111/gcb.14373

Key directions for enhancing natural resilience have been reported as:

- **Identify and protect climate refugia**
- **Conserve large-scale migration corridors**
- **Maintain viable populations to enable adaptation**
- **Reduce threatening processes at the landscape scale**
- **Conserve natural processes and connectivity at the landscape scale and**
- **Special interventions to avert extinctions.**[1]

Within the Barrington to Hawkesbury region, existing National Parks and the transfer of State Forests to the National Park Estate would accommodate many of the threatened species' suitable habitat in 2070 modelled by Beaumont et al (2019). However, to allow for populations to move as climate patterns shift, these areas must be functionally connected with large landscape scale corridors.

Five regional Coastal Climate Corridors were identified in 2007 by the then Department of Environment and Climate Change (See Map 11). From north to south, these include:

1. **Lower Manning to Wallingat**
2. **Wallingat to Karuah**
3. **Karuah to Hunter**
4. **Newcastle, and**
5. **Lake Macquarie to Gosford.**

Twelve Dry Climate Corridors (See Map 12) were also identified including from north to south:

1. **Barrington Tops,**
2. **Barrington Tops to Paterson,**
3. **Barrington to Muswellbrook,**
4. **Karuah to Port Stephens,**
5. **Pokolbin to Karuah,**
6. **Belford to Karuah,**
7. **Werakata,**
8. **Pokolbin,**
9. **Jilliby to Yango,**
10. **Jilliby to Brisbane Waters**

Five Moist Climate Corridors (See Map 13) were additionally identified from north to south:

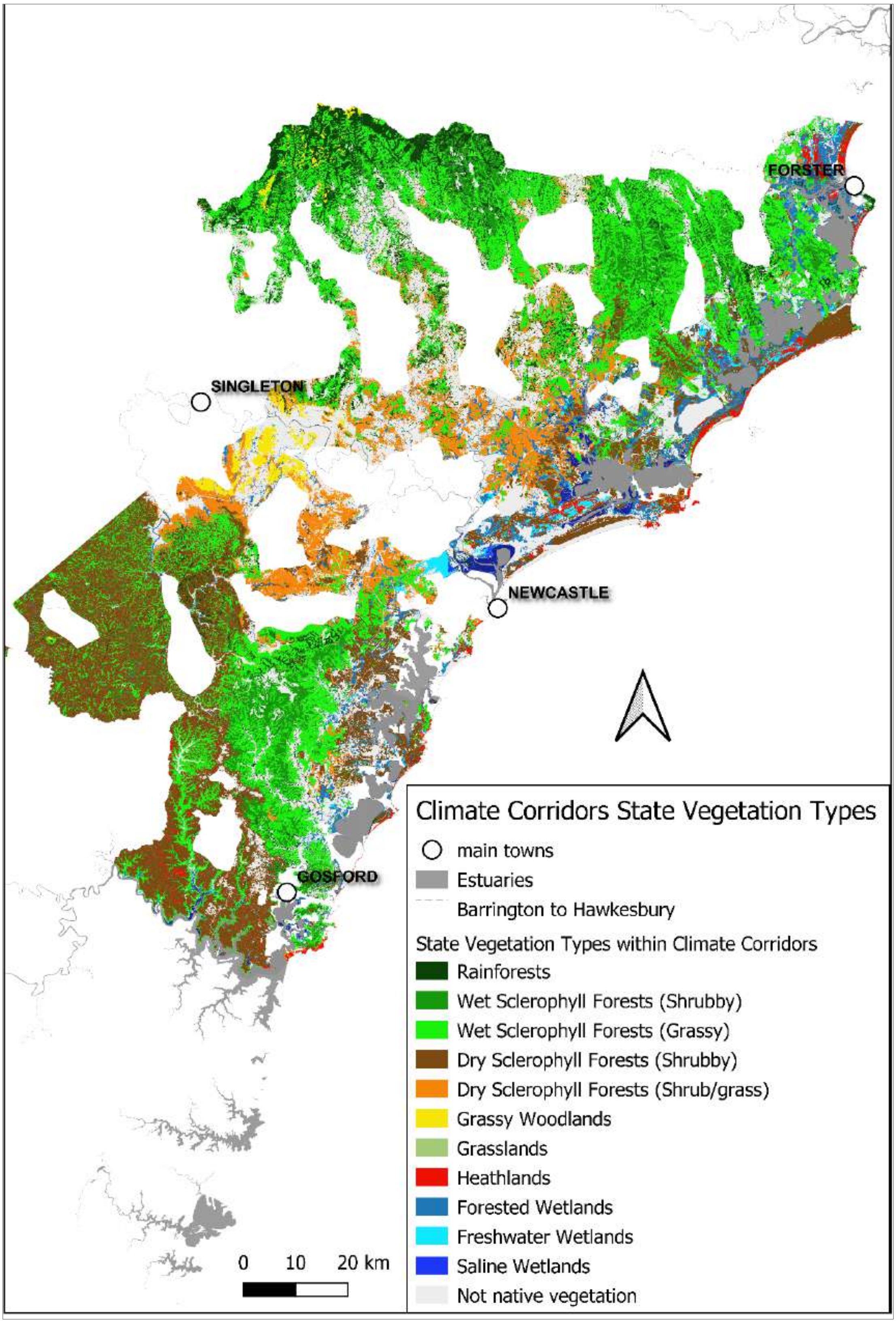
1. **Mid North Coast Escarpment to Barrington**
2. **Barrington to Myall**
3. **Great Lakes To Barrington**
4. **Paterson to West Barrington**
5. **West Coastal Ranges to the Escarpment.**

In total, these Climate Corridors total 1,012,000 ha. Corridors that extend outside the region that provide vital linkages across the Hunter Valley are recommended for protection. These include the Moist West Coastal Ranges to Escarpment and Paterson to West Barrington Climate Corridors, and the Dry Pokolbin and Pokolbin to Karuah Climate Corridors.

While restoring native vegetation, installing overpasses and underpasses across highways, removal of aquatic barriers, and rehabilitation of mined areas will all play an essential role in the functionality of these corridors, conserving native vegetation within these corridors and protecting it from further degradation must begin now.

1 Taylor M. & Figgis P. (eds) (2007) Protected Areas: Buffering nature against climate change. Proceedings of a WWF and IUCN World Commission on Protected Areas symposium, 18-19 June 2007, Canberra. WWF Australia, Sydney.

Plant Communities within Barrington to Hawkesbury Climate Corridors



Map 5. State Vegetation Types within Barrington To Hawkesbury Climate Corridors

Table 3. State Vegetation Types (Classes and forms) within the Barrington to Hawkesbury Climate Corridors

Vegetation Formations and Classes	Area (ha)	Area (ha)
Rainforests		**81,437**
Cool Temperate Rainforests	1,753	
Dry Rainforests	34,351	
Littoral Rainforests	849	
Northern Warm Temperate Rainforests	23,765	
Subtropical Rainforests	20,719	
Wet Sclerophyll Forests (Grassy sub-formation)		**231,566**
Northern Hinterland Wet Sclerophyll Forests	226,971	
Northern Tableland Wet Sclerophyll Forests	4,596	
Wet Sclerophyll Forests (Shrubby sub-formation)		**84,057**
North Coast Wet Sclerophyll Forests	74,974	
Northern Escarpment Wet Sclerophyll Forests	3,302	
South Coast Wet Sclerophyll Forests	5,728	
Southern Escarpment Wet Sclerophyll Forests	53	
Dry Sclerophyll Forests (Shrub/grass sub-formation)		**85,666**
Central Gorge Dry Sclerophyll Forests	921	
Hunter-Macleay Dry Sclerophyll Forests	84,612	
Northern Gorge Dry Sclerophyll Forests	65	
North-west Slopes Dry Sclerophyll Woodlands	68	
Dry Sclerophyll Forests (Shrubby sub-formation)		**193,258**
Coastal Dune Dry Sclerophyll Forests	21,910	
Northern Escarpment Dry Sclerophyll Forests	4	
South Coast Sands Dry Sclerophyll Forests	36	
South East Dry Sclerophyll Forests	2,111	
Sydney Coastal Dry Sclerophyll Forests	59,784	
Sydney Hinterland Dry Sclerophyll Forests	105,390	
Sydney Montane Dry Sclerophyll Forests	193	
Sydney Sand Flats Dry Sclerophyll Forests	3,692	
Western Slopes Dry Sclerophyll Forests	137	
Grasslands		**425**
Maritime Grasslands	418	
Temperate Montane Grasslands	6	
Grassy Woodlands		**13,532**
Coastal Valley Grassy Woodlands	10,962	
New England Grassy Woodlands	1,952	
Subalpine Woodlands	605	
Tableland Clay Grassy Woodlands	9	
Western Slopes Grassy Woodlands	4	
Heathlands		**11,246**
Coastal Headland Heaths	2,123	
Northern Montane Heaths	14	
Sydney Coastal Heaths	1,215	
Sydney Montane Heaths	3	
Wallum Sand Heaths	7,891	
Forested Wetlands		**52,173**
Coastal Floodplain Wetlands	30,547	
Coastal Swamp Forests	19,876	
Eastern Riverine Forests	1,749	
Freshwater Wetlands		**10,739**
Coastal Freshwater Lagoons	5,724	
Coastal Heath Swamps	5,003	
Montane Bogs and Fens	11	
Montane Lakes	2	
Saline Wetlands		**7,957**
Mangrove Swamps	5,806	
Saltmarshes	2,150	
Not native vegetation		**240,803**
Not native vegetation	240,803	
Vegetation Total	**772,057**	**772,057**
Climate Corridors total	**1,012,859**	**1,012,859**

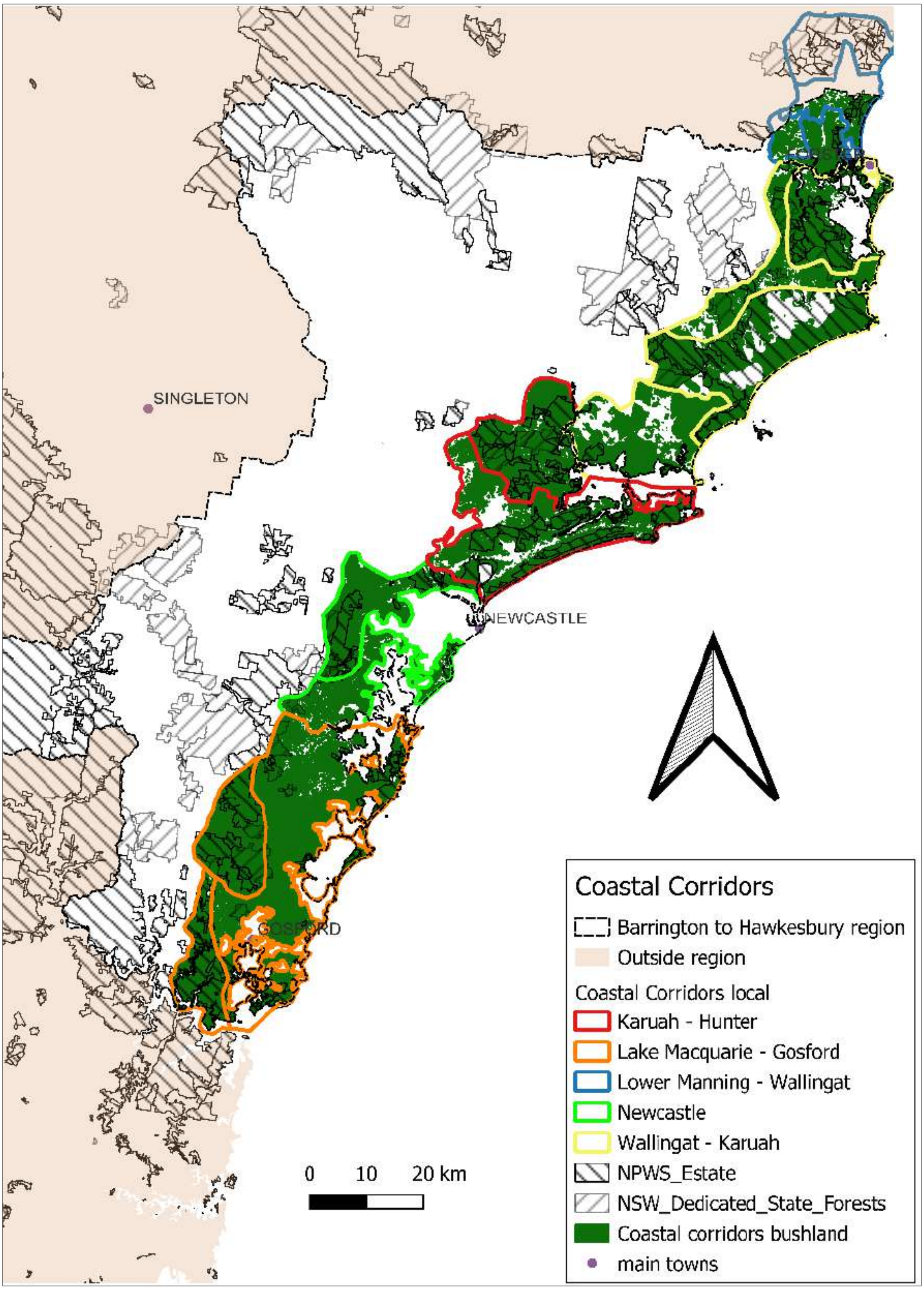
Coastal Climate Corridors

The Coastal Climate Corridors total almost 380,000 ha, and includes 260,000 ha of native vegetation, and 134,000 ha of key fauna habitats.

Much of this habitat is on private land, which must be protected from further fragmentation if we are to salvage some of our biodiversity from the grips of climate change.

Table 4: Details of Coastal Climate Corridors between Barrington and Hawkesbury

Corridor name	Feature	Reference sp. 1	Reference sp.2	HCV	Key habitats (ha)	Vegetation (ha)	Area (ha)
Karuah - Hunter	Reserve buffer	Koala	Green and Golden Bell Frog	high	16,017	23,993	28,643
Wallingat - Karuah	Linkage across Floodplain	Koala	Green and Golden Bell Frog	high	12,042	21,409	35,282
Wallingat - Karuah	Linkage across Floodplain	Koala	Grey-headed Flying Fox	high	5,871	15,330	22,172
Wallingat - Karuah	Reserve buffer	Koala	Eastern Chestnut Mouse	high	23,882	43,405	47,762
Newcastle	Protect and enhance	Squirrel Glider	Grey-headed Flying Fox		6,270	15,101	22,347
Newcastle	Linkage across Floodplain	Squirrel Glider	Grey-headed Flying Fox		4,858	12,578	19,692
Lake Macquarie - Gosford	Reserve buffer	Koala		high	14,191	16,523	19,776
Lake Macquarie - Gosford	Reserve buffer	Squirrel Glider	Koala	high	8,830	11,700	15,008
Karuah - Hunter	Linkage across Floodplain	Koala	Squirrel Glider	high	14,681	36,225	55,668
Wallingat - Karuah	Reserve buffer	Koala	Grey-headed Flying Fox	high	9,471	20,876	27,138
Lake Macquarie - Gosford	Valley floor linkage	Squirrel Glider	Wallum Froglet	high	17,483	44,021	84,658
TOTALS					**133,596**	**261,161**	**378,147**



Map 6: Proposed protected Barrington to Hawkesbury Coastal Climate Corridor[1]

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1 Dept of Environment and Climate Change (2007), Wildlife Corridors for Climate Change – Landscape Selection Process, Key altitudinal, Latitudinal and Coastal Corridors, An internal report, DECC, N.S.W. Datasets: State Government of NSW and Department of Planning and Environment (2010a). Climate Change Corridors (Coastal Habitat) for North East NSW. https://datasets.seed.nsw.gov.au/dataset/climate-change-corridors-coastal-habitat-for-north-east-nsw

While there are relatively large areas of extant vegetation in the Coastal corridors, the percentage of Key Habitat and Old Growth is relatively low overall. The area of Key Habitat is a subset, in many cases a small subset, of the existing vegetation. Likewise, the area of old growth is a very small percentage of extant vegetation, in many cases less than 5% of the area.

Priorities for particular corridor features should focus on improving the marginal areas, for example joining of stepping stone remnants and enhancing existing lower-quality vegetation stands. The protection of existing High Conservation Value (HCV) vegetation can include improving reserve buffers, and providing links from the coast to the hinterland as well as between coastal habitats.

Coastal wetlands are a major habitat of importance on the region's coast. Many species flora restricted to coastal environments and the wetlands of the region. Over the long term, these important areas can provide stronghold populations for coastal flora. Projects which restore natural drainage and allow for the wetland systems to exist without pressure from agriculture and urban development will enhance the viability of wetlands of the region.

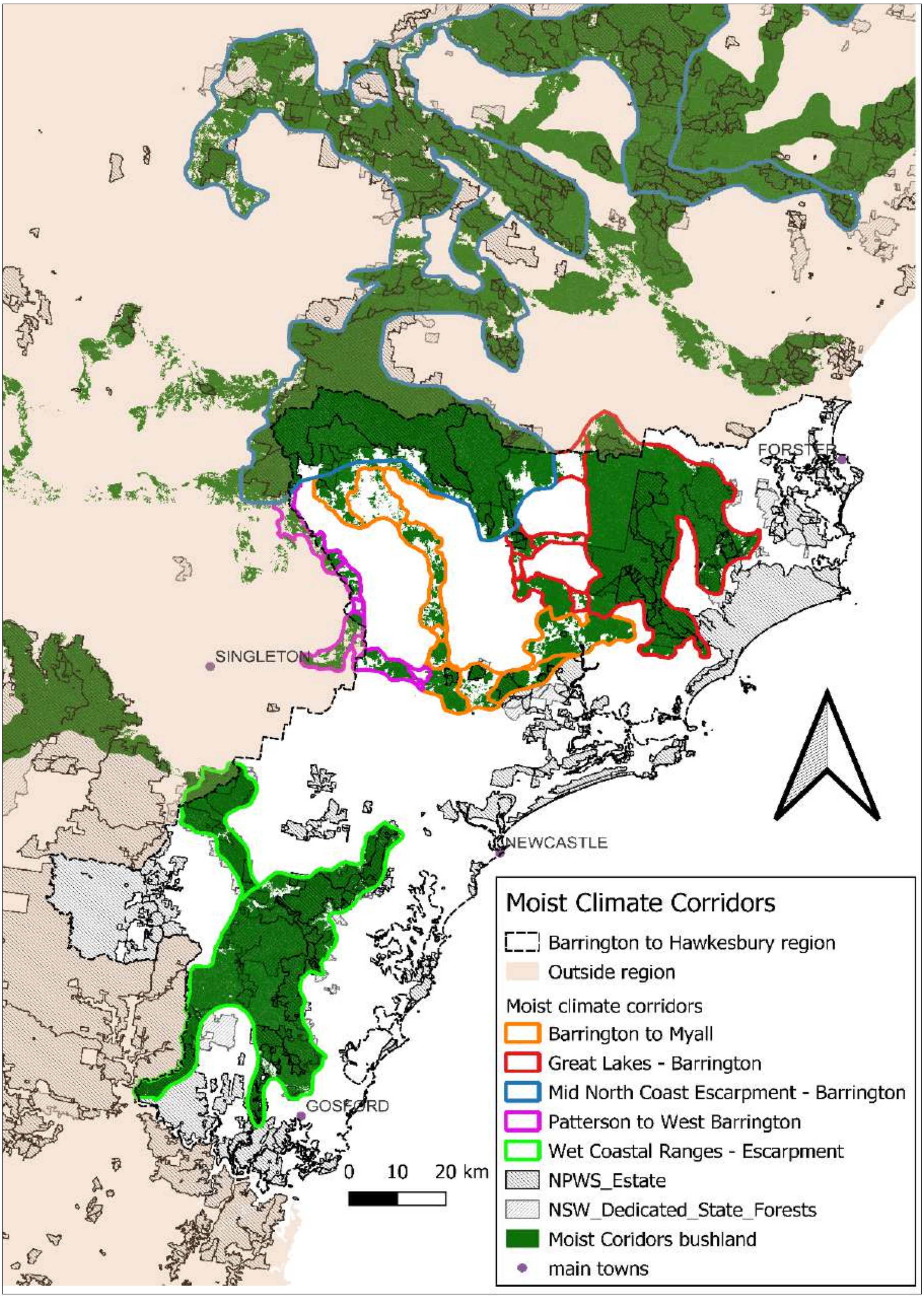
Moist Climate Corridors

The Moist Climate Corridors total about 1.4 million ha, including over 1 million ha of native vegetation, 470,000 ha of key fauna habitats, 260,000 ha of old growth forest, and over 200,000 ha of rainforest. However, about 80 percent of the 817,000 ha Mid North Coast Escarpment to Barrington Corridor is outside the region.

Table 5: Details of Moist Climate Corridors between Barrington and Hawkesbury

Corridore name	Reference sp.1	Reference sp.2	Voluntary Conservation Agreement	HCV	Key habitat (ha)	Vegetation (ha)	Rainforest (ha)	Old growth (ha)	Corridor area (ha)
Barrington to Myall	Grey-headed Flying Fox	Sooty Owl	priority		7,772	36,040	3,091	3,649	64,321
Great Lakes - Barrington	Stuttering Frog	Sooty Owl	priority	high	54,923	121,080	6,398	18,619	116,288
Mid North Coast Escarpment - Barrington	Giant Barred Frog	Sooty Owl	priority	high	330,593	737,888	196,903	235,111	817,410
Patterson to West Barrington	Koala	Grey-headed Flying Fox			365	12,390	1,130	1,802	21,916
Wet Coastal Ranges - Escarpment	Yellow-bellied Glider	Sooty Owl	priority	high	75,918	105,584	673	-	121,775
TOTALS					**469,571**	**1,012,982**	**208,195**	**259,181**	**1,141,711**

The Moist corridors link major moist habitats such as high altitudinal rainforest and wet sclerophyll and moist eastern foothills forests. The moist habitat assemblage corridors network links contiguous areas of forest across altitudinal gradients and latitudinal gradients. Reference species are predominantly rainforest and high altitudinal species considered quite vulnerable to the impacts of climate change



Map 7: Proposed protected Barrington to Hawkesbury Moist Climate Corridor[1]

1 State Government of NSW and Department of Planning and Environment (2010b). Climate Change Corridors (Moist Habitat) for North East NSW. https://datasets.seed.nsw.gov.au/dataset/climate-change-corridors-moist-habitat-for-north-east-nsw

There is an absence of moist corridor connection across the Hunter Valley due to the drier environments occurring there and the fact that the Hunter Valley is a natural dry barrier for many moist habitat species. The corridors designating HCV Linkages highlight the areas where populations of moist assemblage species will be present in the corridor based on the presence of areas of key habitat.

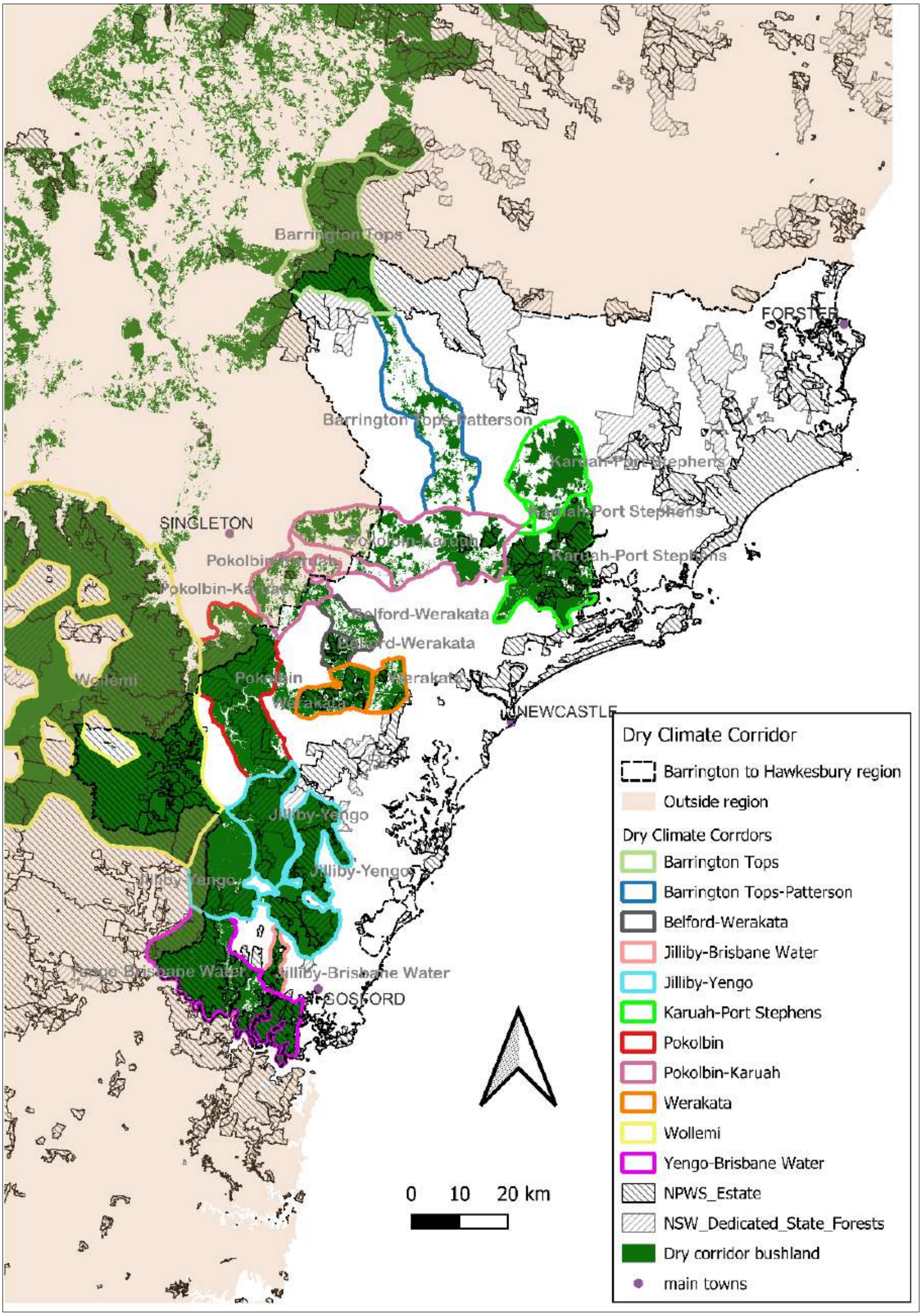
Dry Climate Corridors

There is a strong network of corridors and associated key habitats for dry habitat assemblages across the Hunter Valley in locations where moist habitat assemblages are absent. The Hunter Valley has historically represented a 'dry' barrier to many moist habitat fauna species. HCV Linkages highlight the areas where good populations of dry assemblage species should be already utilising the corridor based on the presence of areas of key habitat.[1]

Table 6: Details of Dry Climate Corridors between Barrington and Hawkesbury

Corridor name	Feature	Reference sp. 1	Reference sp. 2	HCV	Vegetation (ha)	Key habitats (ha)	Old growth (ha)	Coridor area (ha)
Barrington Tops	Reserve Buffer	Broad-toothed Rat		HCV	39,898	30,110	9,017	41,677
Barrington Tops-Patterson	Stepping Stone Remnants	Squirrel Glider	Grey-headed Flying-fox		10,296	893	443	36,758
Belford-Werakata	Valley Floor Linkages	Woodland Birds	Squirrel Glider		2,709	662	-	7,395
Belford-Werakata	Reserve Buffer	Woodland Birds	Squirrel Glider		3,024	2,678	-	4,172
Jilliby-Brisbane Water	Reserve Buffers and Linkages	Red-crowned Toadlet		HCV	3,871	2,823	-	4,272
Jilliby-Yengo	Protect and Enhance Existing	Koala	Giant Burrowing Frog	HCV	23,098	14,247	-	24,604
Jilliby-Yengo	Reserve Buffers and Linkages	Koala	Giant Burrowing Frog	HCV	26,786	22,406	-	29,847
Jilliby-Yengo	Valley Floor Linkages	Koala	Giant Burrowing Frog	HCV	18,160	15,682	-	20,383
Karuah-Port Stephens	Reserve Buffers and Linkages	Coastal Emu	Koala	HCV	27,194	17,684	2,915	34,190
Karuah-Port Stephens	Valley Floor Linkages	Coastal Emu	Koala	HCV	14,109	886	1,254	25,394
Karuah-Port Stephens	Linkage across Floodplain	Coastal Emu	Koala	HCV	167	11	10	1,110
Pokolbin	Valley Floor Linkages	Woodland Birds	Brush-tailed Rock Wallaby	HCV	38,382	16,479	-	44,883
Pokolbin-Karuah	Valley Floor Linkages	Woodland Birds	Brush-tailed Phascogale		21,750	4,755	3,164	49,571
Pokolbin-Karuah	Linkage across Floodplain	Woodland Birds	Brush-tailed Phascogale		269	3	-	7,417
Pokolbin-Karuah	Valley Floor Linkages	Woodland Birds	Brush-tailed Phascogale		6,430	2,707	-	18,234
Werakata	Reserve Buffers and Linkages	Woodland Birds	Swift Parrot	HCV	9,490	6,315	-	11,529
Werakata	Valley Floor Linkages	Woodland Birds	Swift Parrot	HCV	4,239	1,690	-	7,018
Yengo-Brisbane Water	Reserve Buffers and Linkages	Red-crowned Toadlet		HCV	40,730	24,595	-	44,334
Totals					**229,444**	**129,316**	**16,803**	**324,255**

1 The Department of Environment and Climate Change (2007) FAUNA CORRIDORS FOR CLIMATE CHANGE Landscape Selection Process Key Altitudinal, Latitudinal and Coastal Corridors for response to Climate Change Hunter Central Rivers Catchment Management Authority (HCRCMA).



Map 8: Proposed protected Barrington to Hawkesbury Dry Climate Corridor1

1 State Government of NSW and Department of Planning and Environment (2010). Climate Change Corridors (Dry Habitat) for North East NSW. https://datasets.seed.nsw.gov.au/dataset/climate-change-corridors-dry-habitat-for-north-east-nswf5a7e

The Dry Climate Corridors total almost 320,000 ha, including 230,000 ha of native vegetation, 130,000 ha of key fauna habitats, and 17,000 ha of old growth forest.

The cleared floodplains of the region represent major barriers to dispersal for many species. It is recognised that considerable resources would be required to complete these links however their importance should not be ignored. The higher productivity, access and permanent water of the major river systems will make these areas a high priority for conservation activities to address climate change.

These have been refugia in past droughts and should be a high priority for future conservation efforts. Projected increased salinity in these areas may mean land becomes available for conservation as farming becomes unviable.[1]

Grevillea Guthrieana, Geoff Derrin, 2022

1 ibid


Cryptostylis Hunteriana, Eyeweed, 2009

Conclusion and recommendations

We recommend:

1. An immediate moratorium on further land clearing within identified Climate Change Corridors.
2. A specific strategy be included in both the Hunter Regional Plan 2041 and the Central Coast Regional Plan 2041 for the protection of Climate Corridors through an integrated suite of mechanisms (including development controls, major infrastructure planning, voluntary land acquisition and private land conservation).
3. The regional strategy described above be supported by detailed zoning and development guidelines under local environmental plans and development control plans administered by local councils, and also by investment programs implemented by Local Land Services.
4. Environmental Planning Instruments (EPI), including State Environmental Planning Policies (SEPP) and Local Environment Plans (LEP) be amended to conserve Climate Corridors from further development.
5. The Biodiversity Offset Scheme be radically amended to provide adequate stewardship payments to encourage landholders to protect, manage, and restore native vegetation within Climate Corridors under Voluntary Conservation Agreements or other secure conservation measures.
6. Targeted voluntary private land acquisition of large core areas of high quality habitat and essential corridors for restoration, particularly the large areas of moist forests in southern Mid-coast, and moist and dry landscapes across the Hunter River Valley through Cessnock, Singleton, and Dungog LGAs.
7. State Forests be transferred to National Park reserves as Regional Parks or other appropriate reserve category and managed by Local Communities for conservation and recreation

The internationally significant Barrington to Hawkesbury region is centred on the Hunter Valley which represents the major break in the Great Dividing Range providing a link between coastal and inland NSW and represents an important overlap between tropical and temperate zones, as such the limits of many species are found here.

The region supports at least 122 Threatened flora species, which have been recorded since 2000. Of these species Beaumont et al (2019) models habitat in the region for 28, 12 of which (43%) will have no suitable habitat in the region by 2070 under a worst case climate scenario.

Overall, Beaumont et al (2019) identifies suitable habitat for 204 Threatened NSW plant species, 74 of which had suitable habitat modelled within the Barrington to Hawkesbury region in 2000. Of these 74 Barrington to Hawkesbury species, 64 (86%) suffer significant range contractions by 2070, with 38 (51%) having no suitable, a further 27 species (11 with recorded sightings since 2000) experience significant range contractions, and 10 species (4 with recorded sightings since 2000) experience range expansions under a worst case climate scenario.

The pace of the changing climate is intensifying existing threats to native species and is likely to become the greatest threat to native species in the coming decades.

Five Coastal Climate Corridors, twelve Dry Climate Corridors, and five Moist Climate Corridors identified in 2007 by NSW Government are recommended for protection from further regional bushland loss and degradation. With a total area of 1,013,000 hectares, the corridors would protect 772,000 hectares of native vegetation.

This will require the transfer of State Forests to secure conservation tenure as Regional Parks under the National Parks and Wildlife Act and appropriate Local Environment Plan Zoning and the provision of stewardship payments and targeted acquisition for private bushland conservation.

These large-scale functioning corridors span climatic gradients and enhance the capacity of populations to shift to new climate refugia, allowing species to respond to shifting climates and extreme events through natural dispersal rather than requiring active intervention. If we are to provide the greatest chance for native species to survive the ravages of climate change, these connected habitats must be protected from further fragmentation and degradation. If we wish to minimise native species' extinction, climate refugia and identified Climate Corridors must be legally protected.

The five described Coastal Climate Corridors will improve reserve buffers, and provide links from the coast to the hinterland as well as between coastal habitats. These Coastal Climate Corridors encompass critical habitats for half of the native fauna species projected to decline in the region to 2070, and will assist in the migration of these and other species to newly suitable habitats as the climate changes. Key faunal species of these Climate Corridors include the Koala, Squirrel Glider, and Brush-tailed Phascogale with important populations in the coastal forests throughout this area, however much of the habitat is fragmented. Reconnection and restoration of these forests must be a priority for future works.

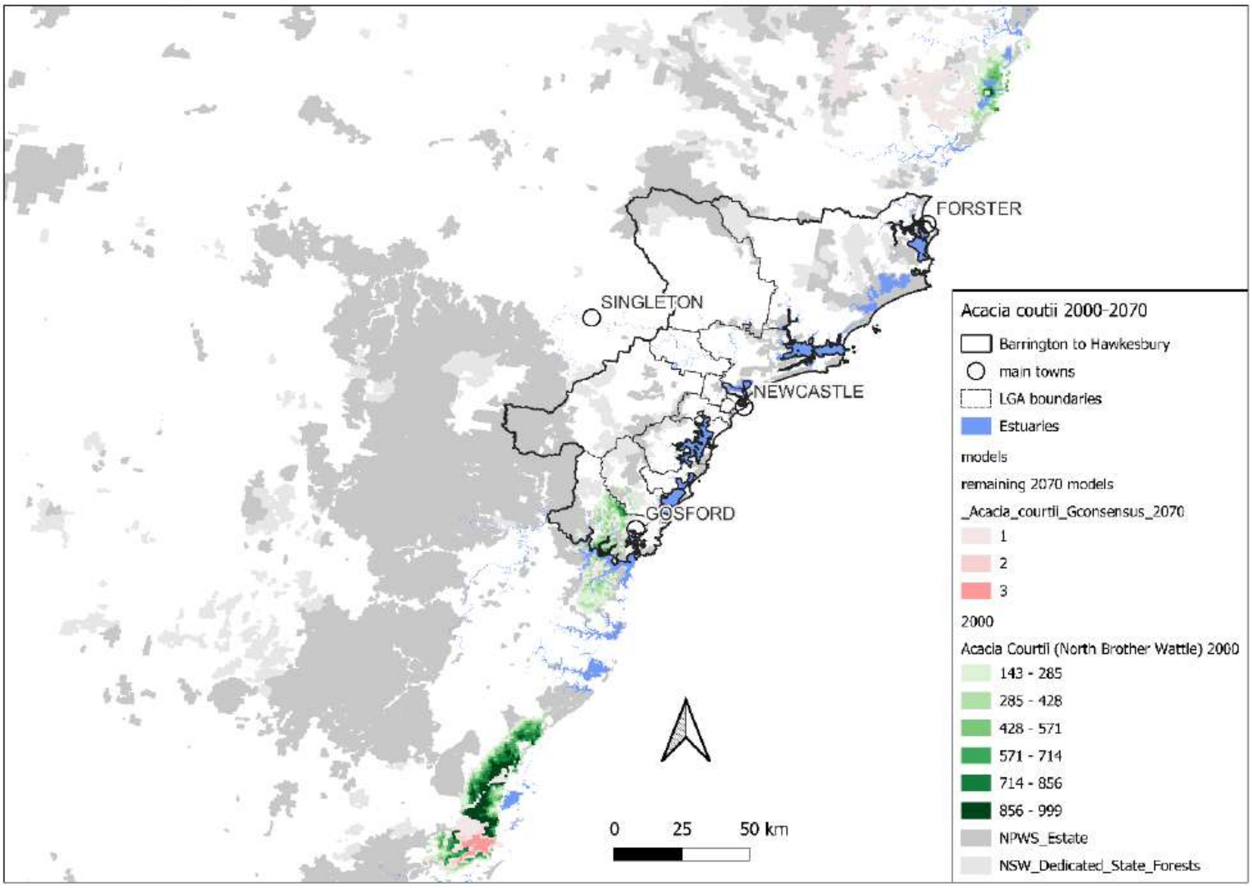
The five Moist Climate Corridors link high altitudinal rainforest and wet sclerophyll and moist eastern foothills forests and link contiguous areas of forest across altitudinal and latitudinal gradients. However, they do not connect across the Hunter Valley representing a barrier for many moist habitat species. Reference species are predominantly rainforest and high altitudinal species considered highly vulnerable to the impacts of climate change. These Moist Climate Corridors encompass critical habitat for almost 60 percent of the species projected to decline to 2070 in the region.

There is a strong network of twelve Dry Climate Corridors and associated key habitats for dry habitat assemblages across the Hunter Valley in locations where moist habitat assemblages are absent. These Dry Climate Corridors encompass projected critical habitat for 40 percent of the species projected to decline by 2070.

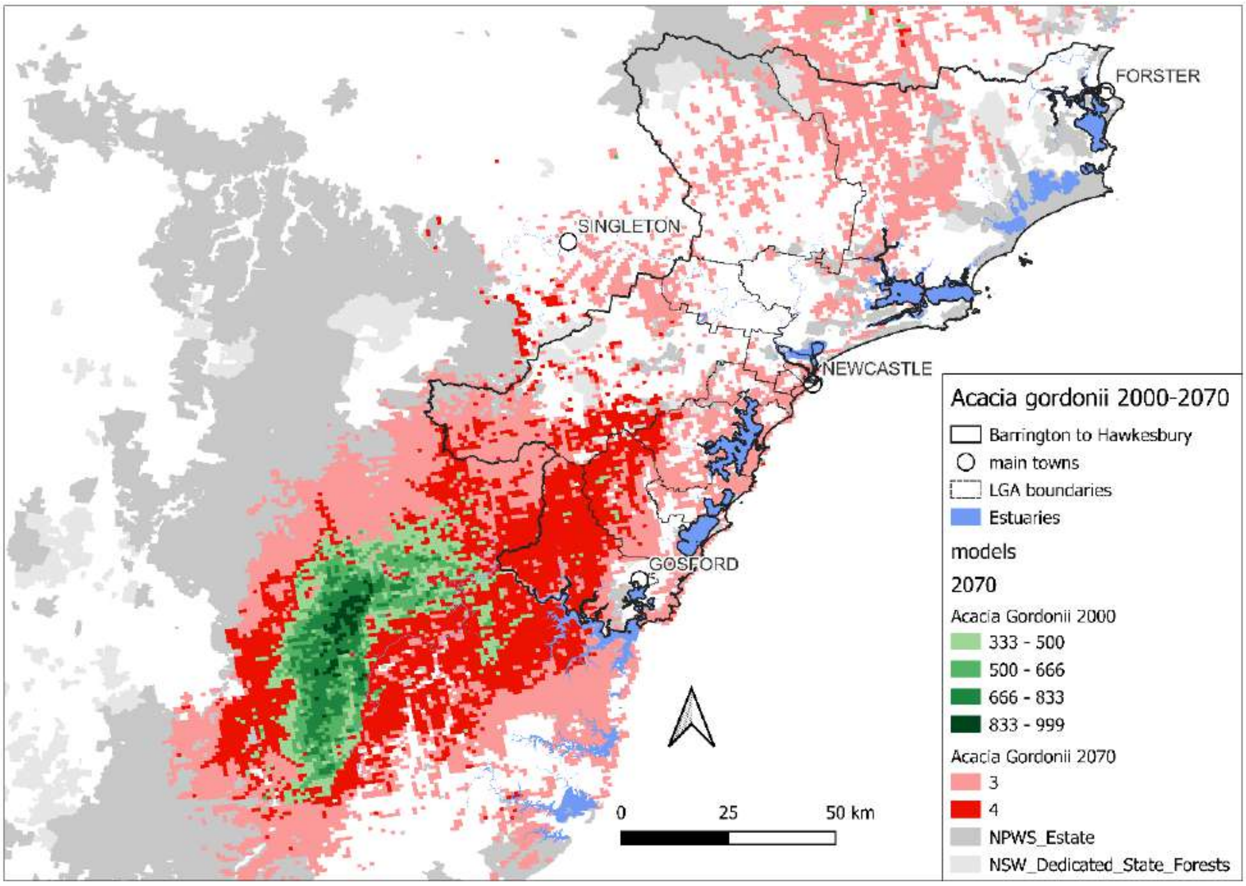
Rapidly reducing greenhouse gas emissions will be necessary to avert the worst extinction predictions. However, despite positive commitments from some countries, annual global greenhouse gas emissions continue to rise, with 2021 seeing a 6.4 percent increase, a new record.

Further fragmentation and degradation of existing habitat in State Forest and on private land must be reined in if we are to salvage some of our biodiversity from the grips of climate change.

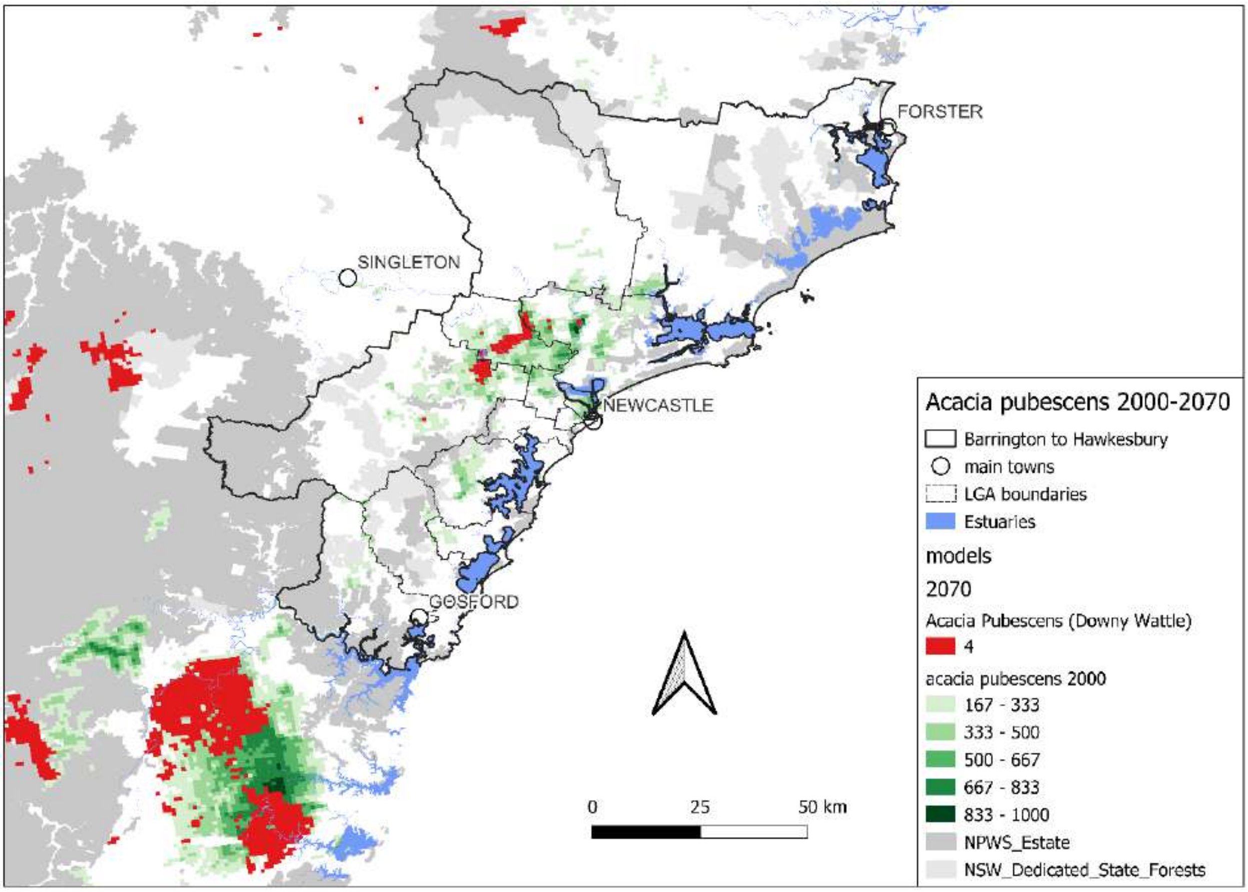
Appendix 1: Flora Species modelled by Beaumont et al (2019) for the Barrington to Hawkesbury Region



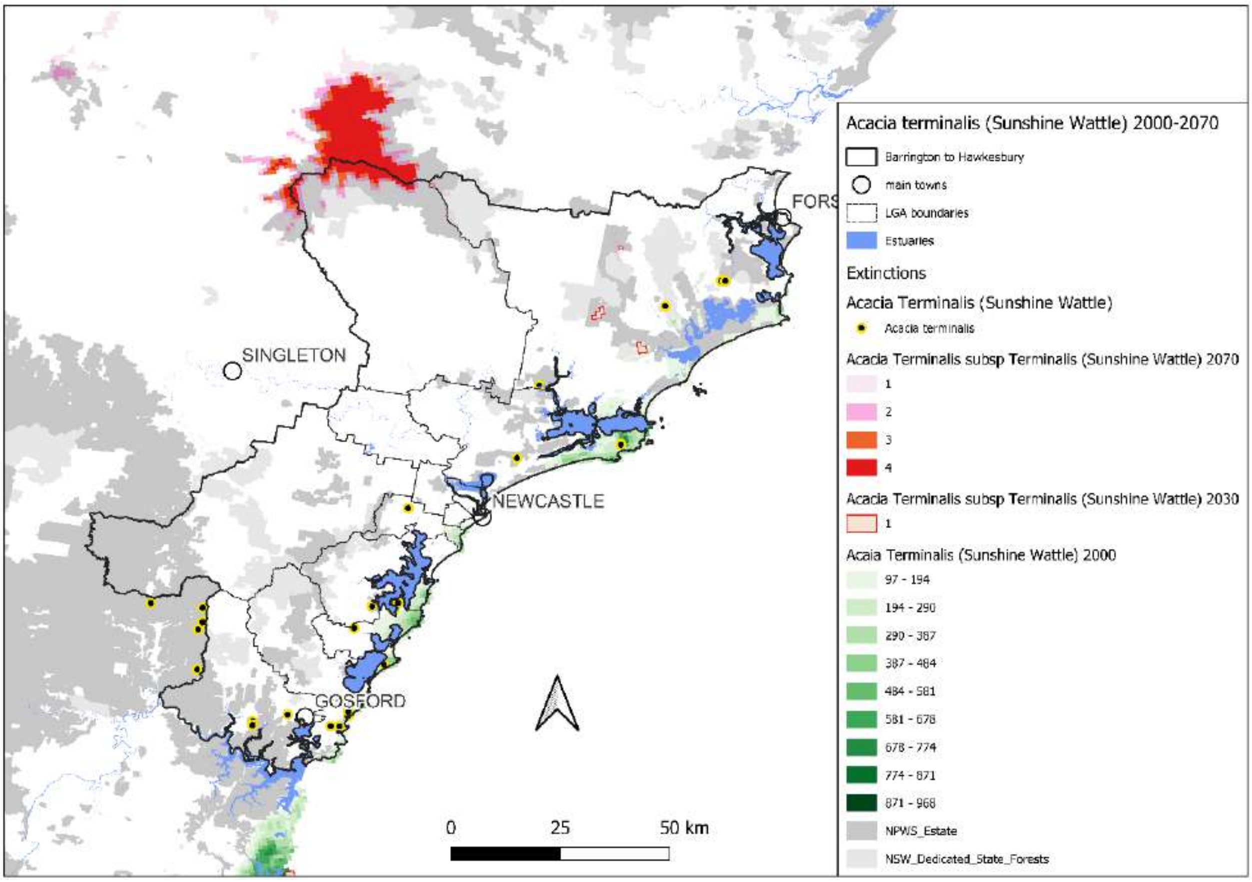
Map 1. Acacia courtii (Northern Brother Wattle) 2000–2070. No habitat remaining under all 4 climate futures.



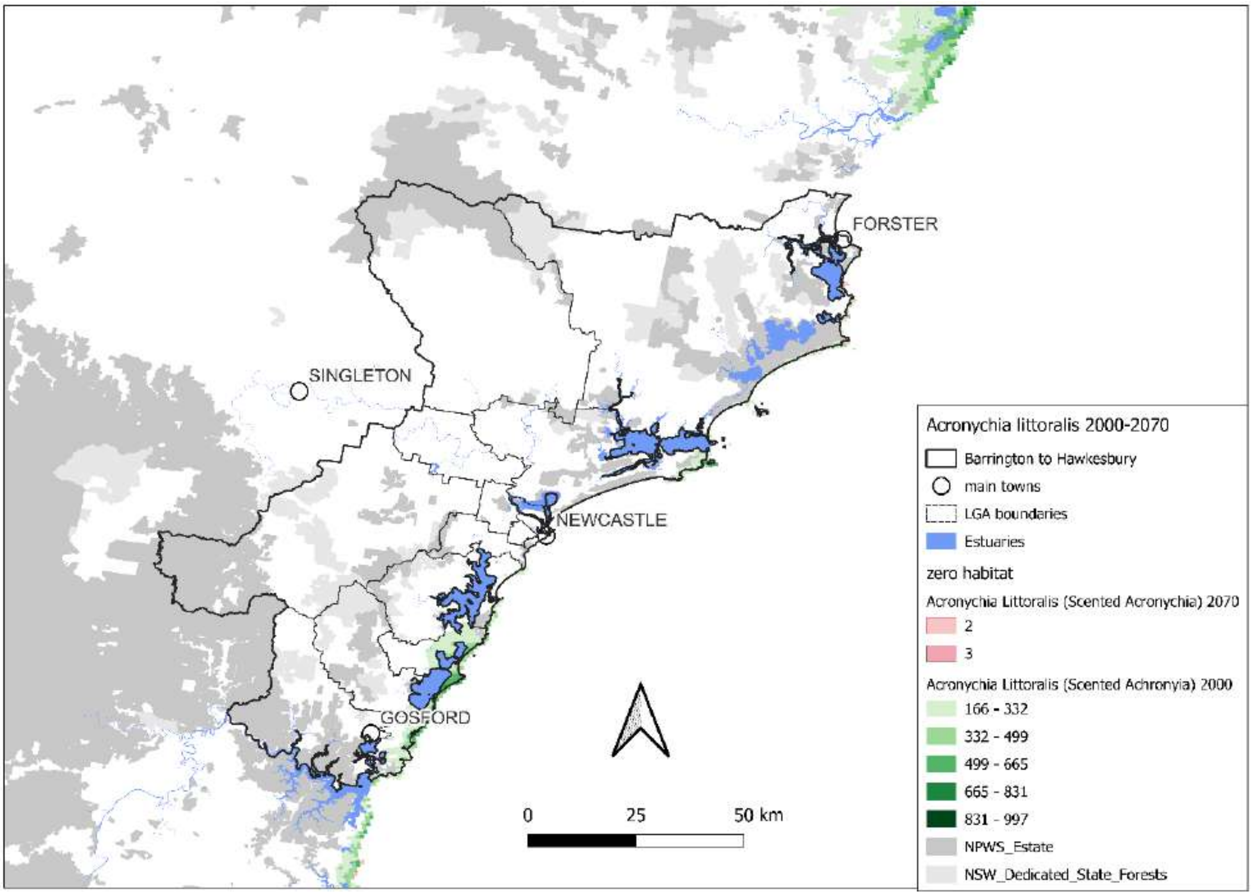
Map 2. Acacia gordonii 2000 – 2070. Significant range expansion under all 4 climate futures.



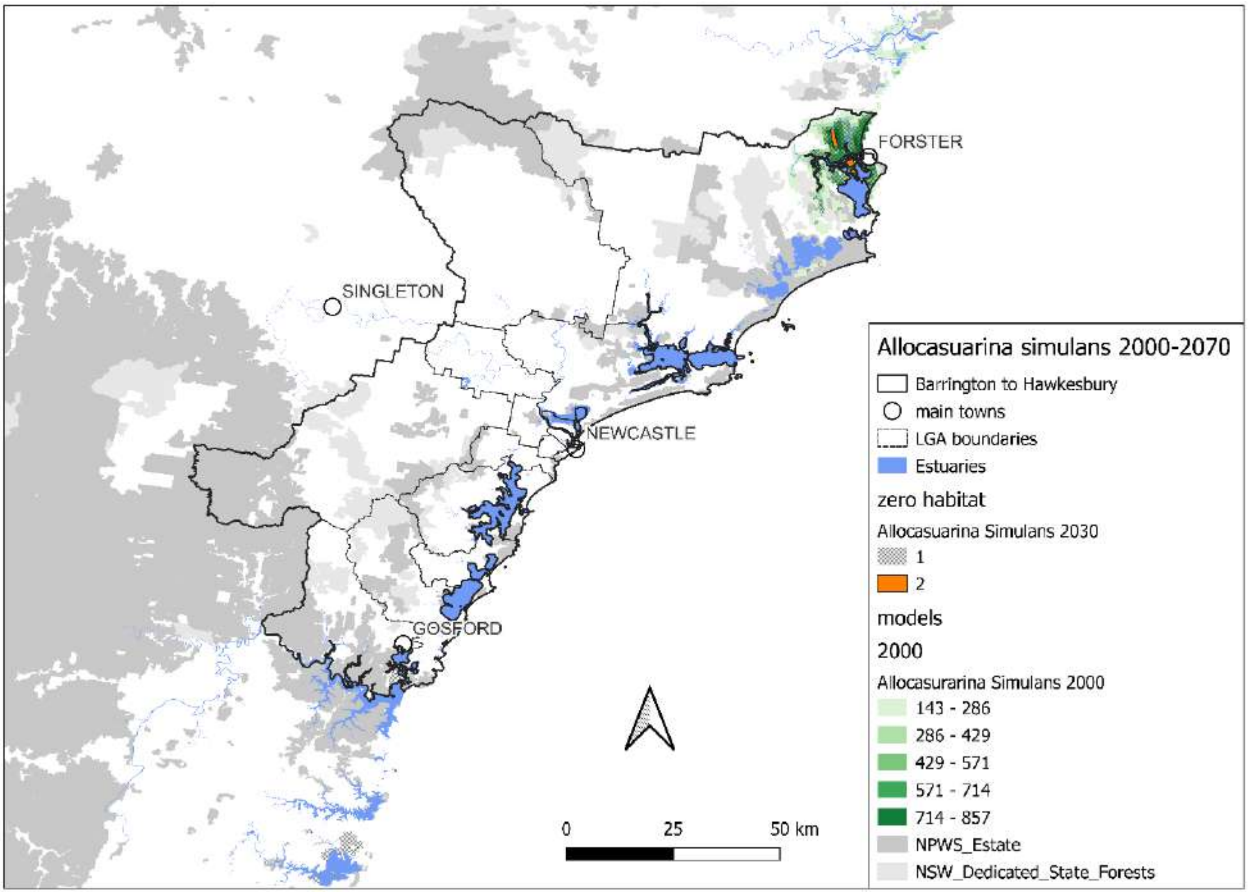
Map 3. Acacia pubescens 2000 – 2070. Range contractions by 2070 under all 4 climate futures.



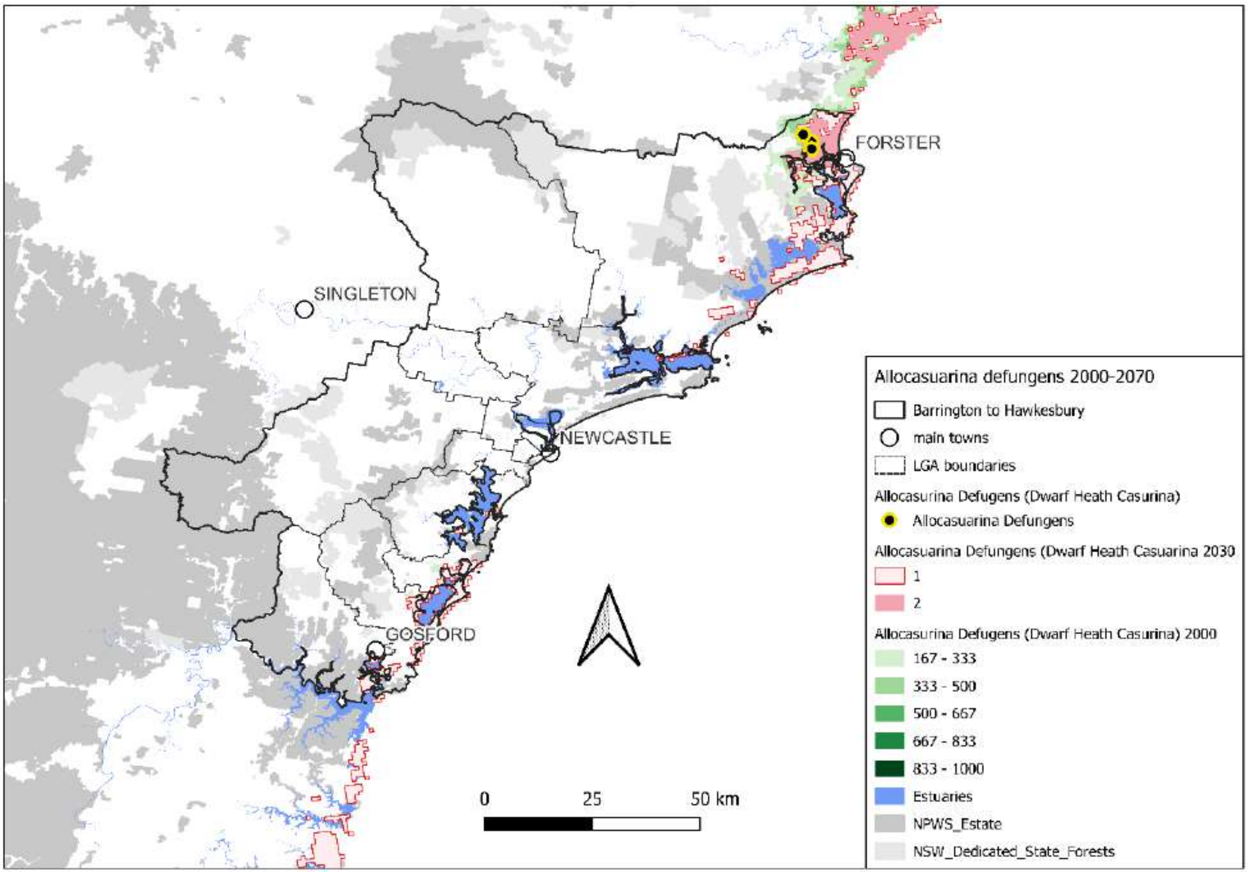
Map 4. Acacia terminalis (Sunshine Wattle) 2000 -2070. Sightings since 2000. Contractions under all climate futures.



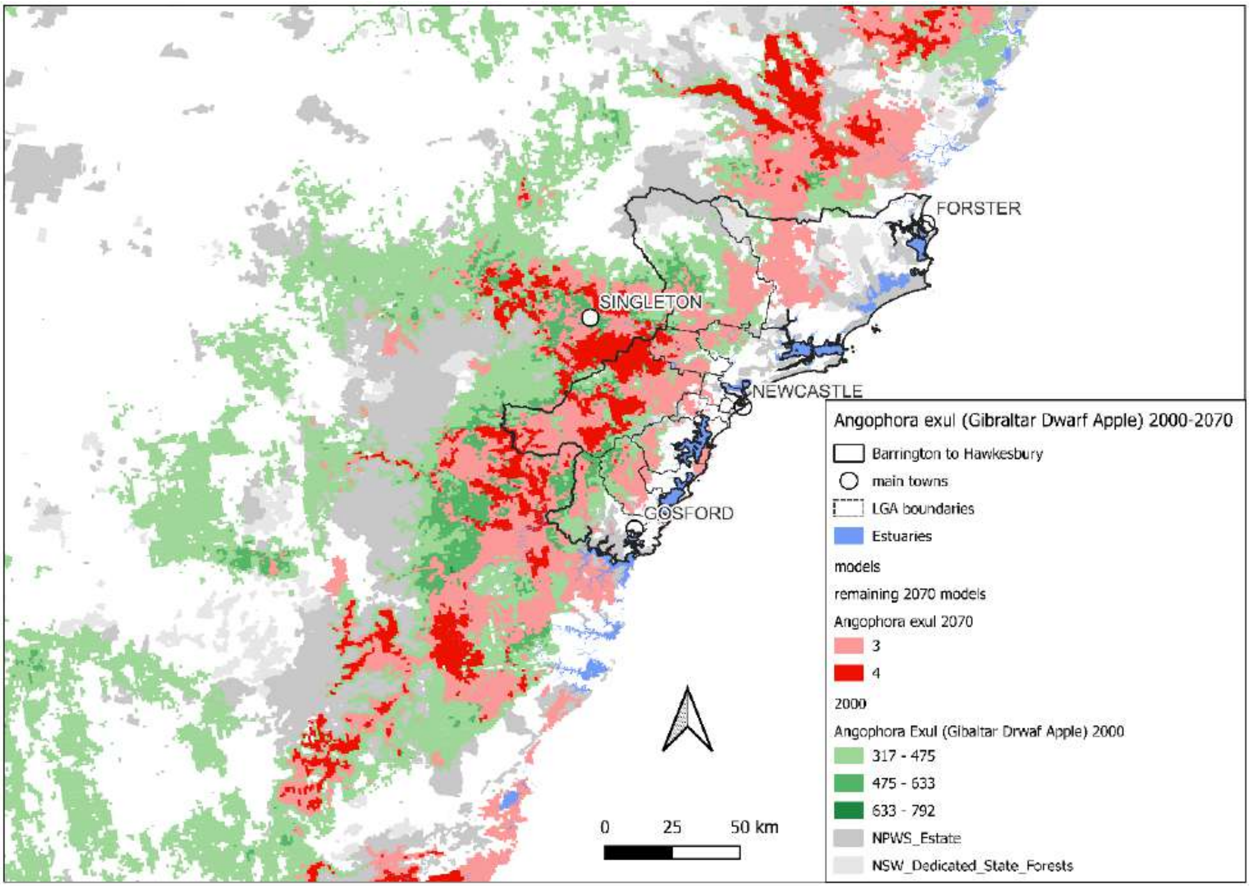
Map 5. Acronychia littoralis 2000 -2070. No habitat under all 4 climate futures.



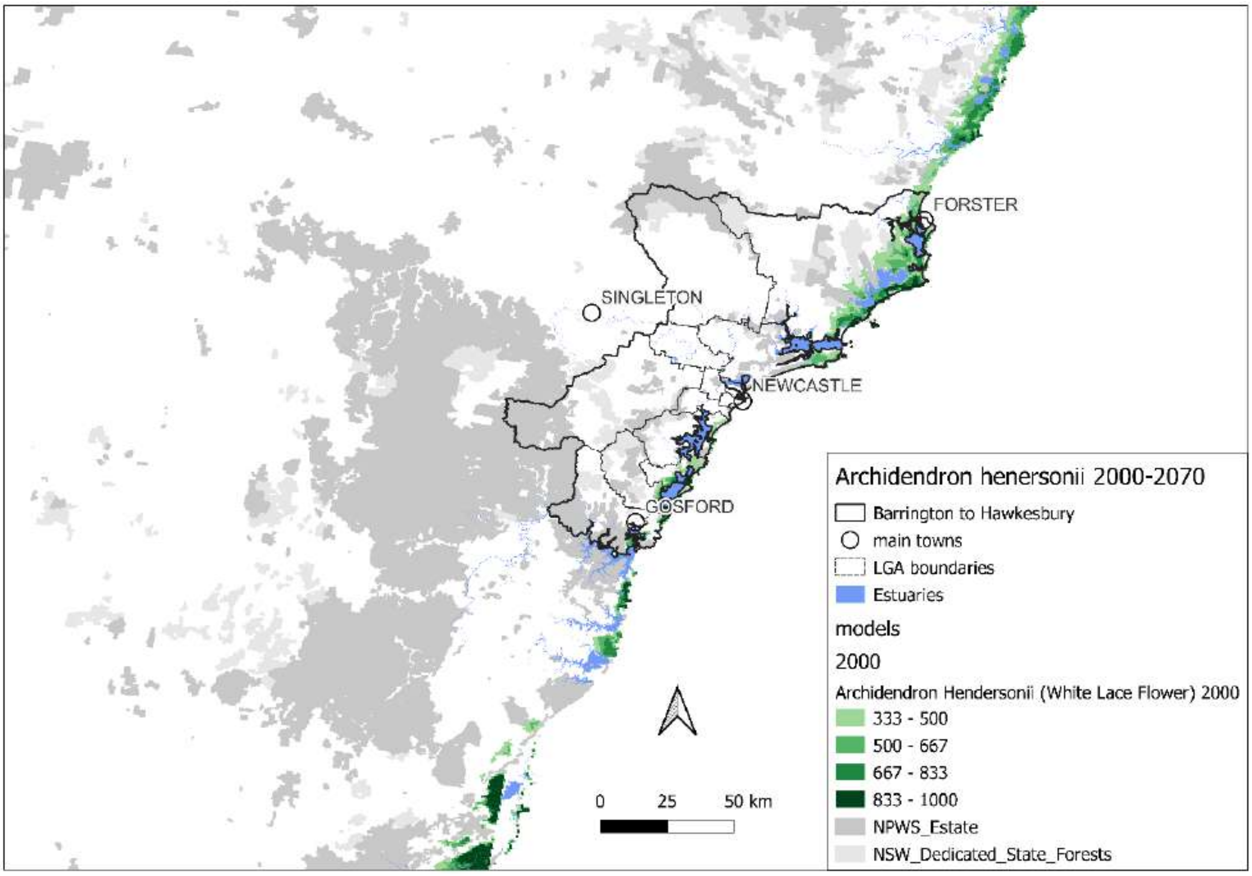
Map 6. Allocasuarina simulans 2000 –2070. No habitat under all 4 climate futures.



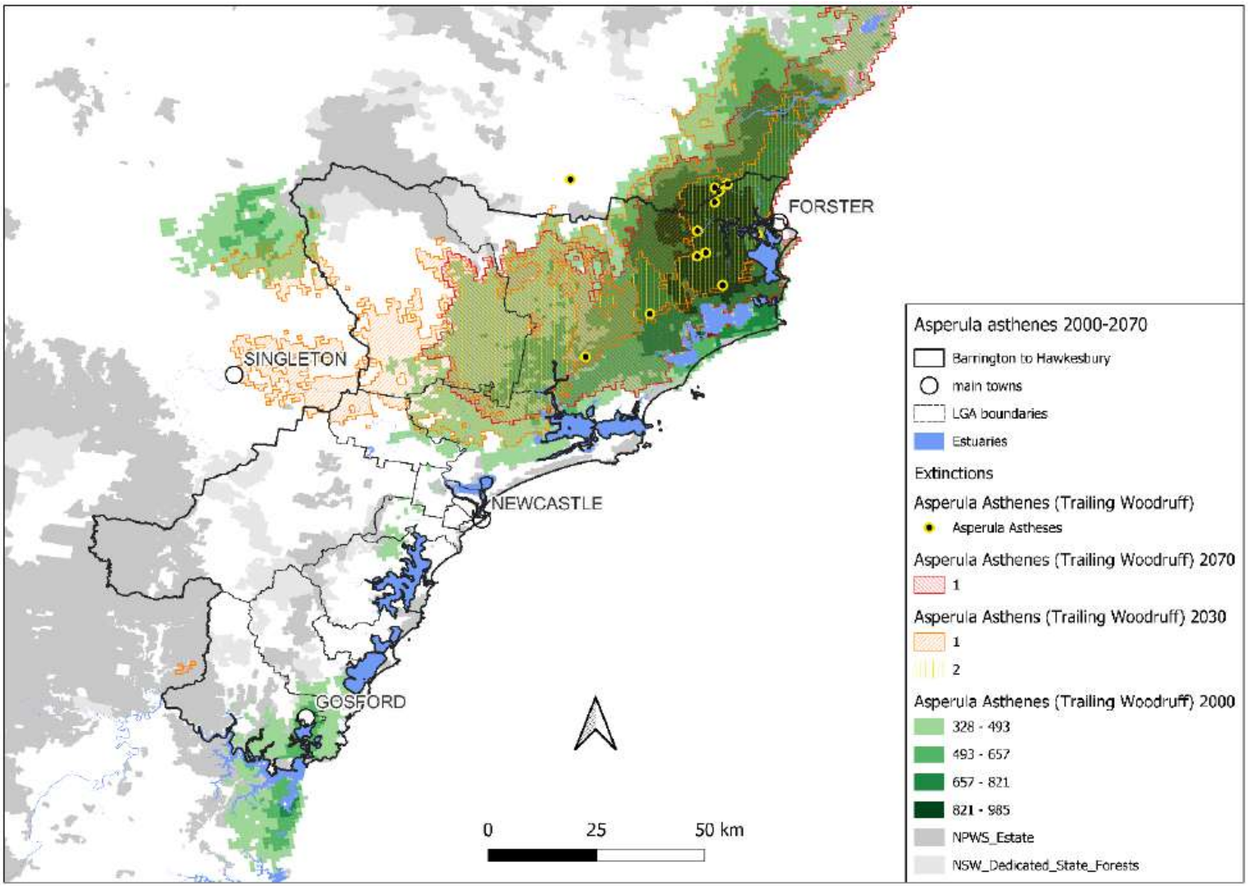
Map 7. Allocasuarina defungens 2000–2070. Sightings since 2000. Regional extinction under all 4 climate futures.



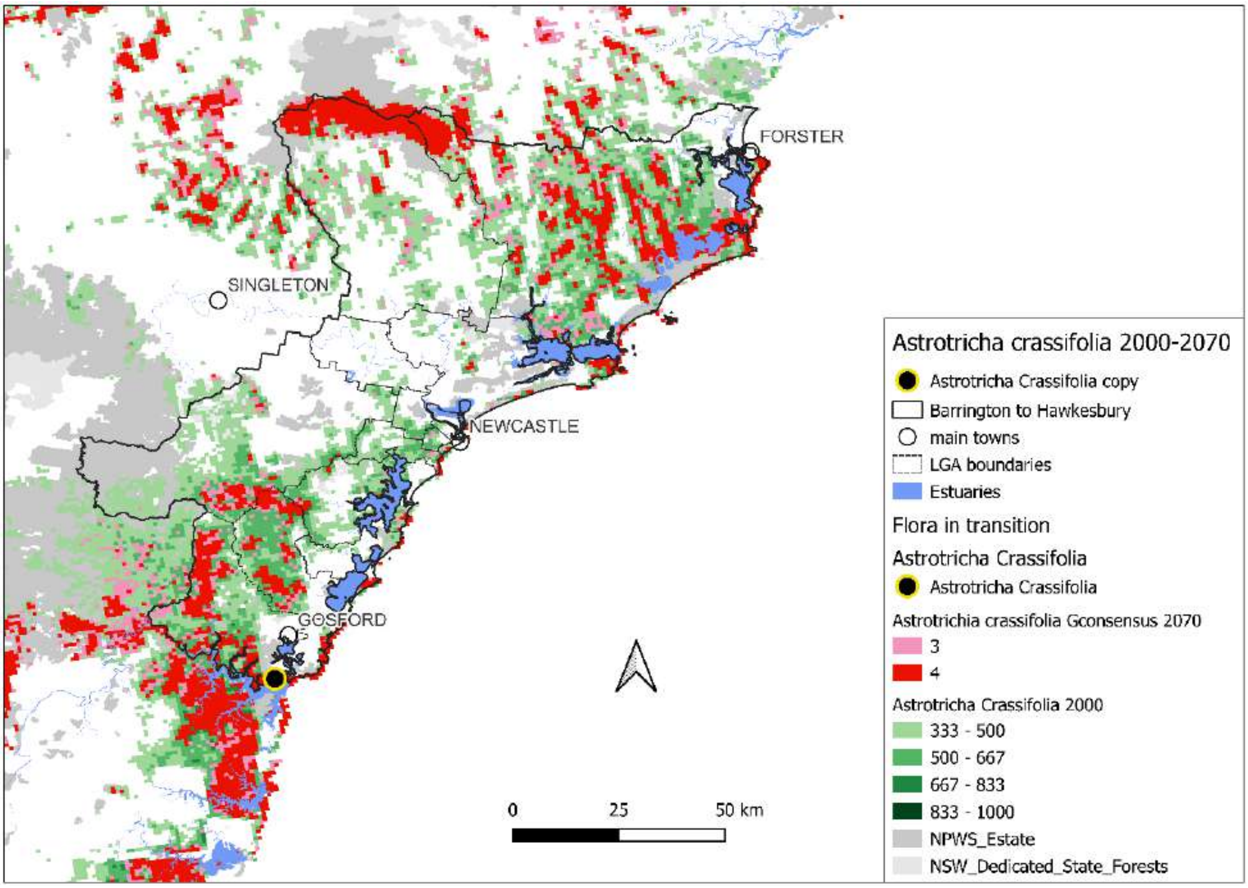
Map 8. Angophora exul (Dwarf Apple) 2000 –2070. Range contraction under all 4 climate futures.



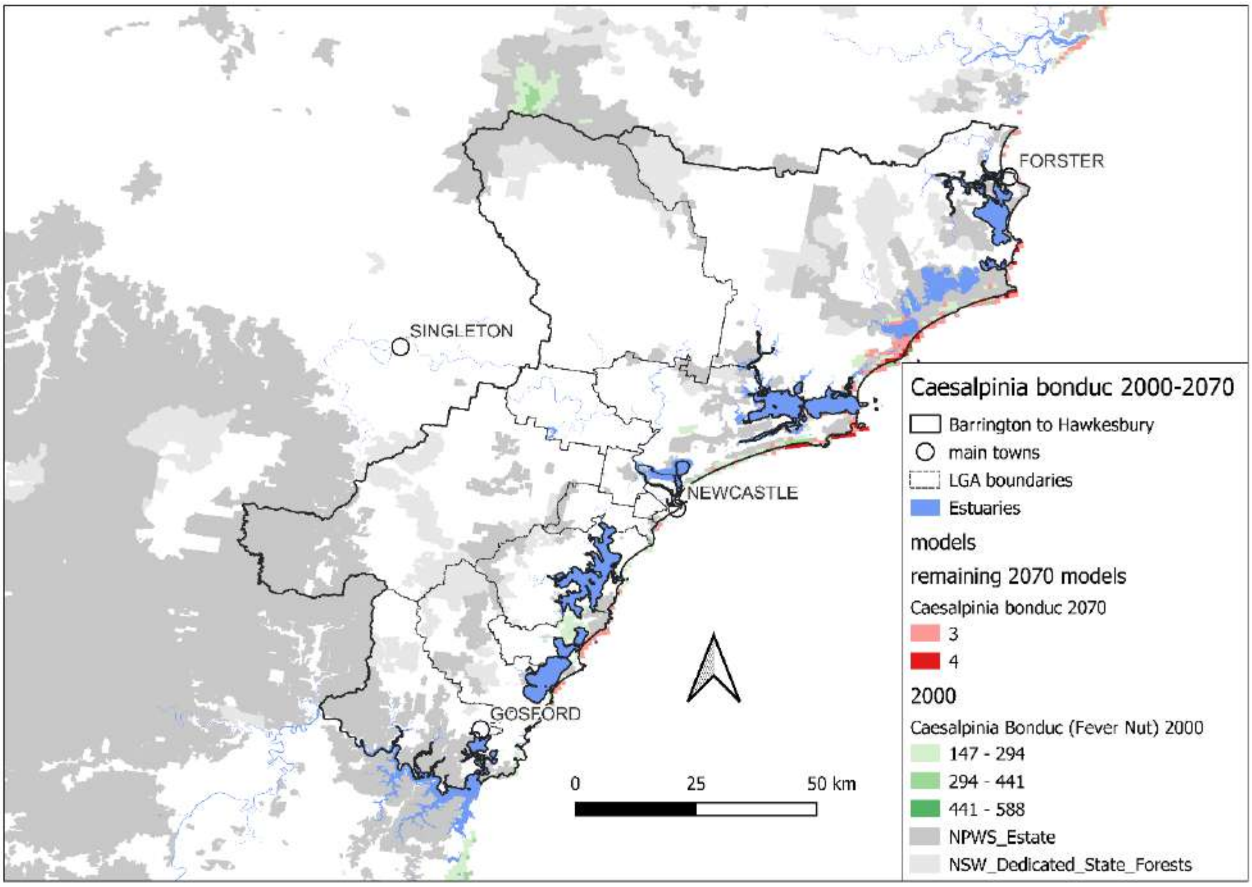
Map 9. Archidendron henersonii (White Lace Flower) 2000 –2070. No habitat by 2070 under all 4 climate futures.



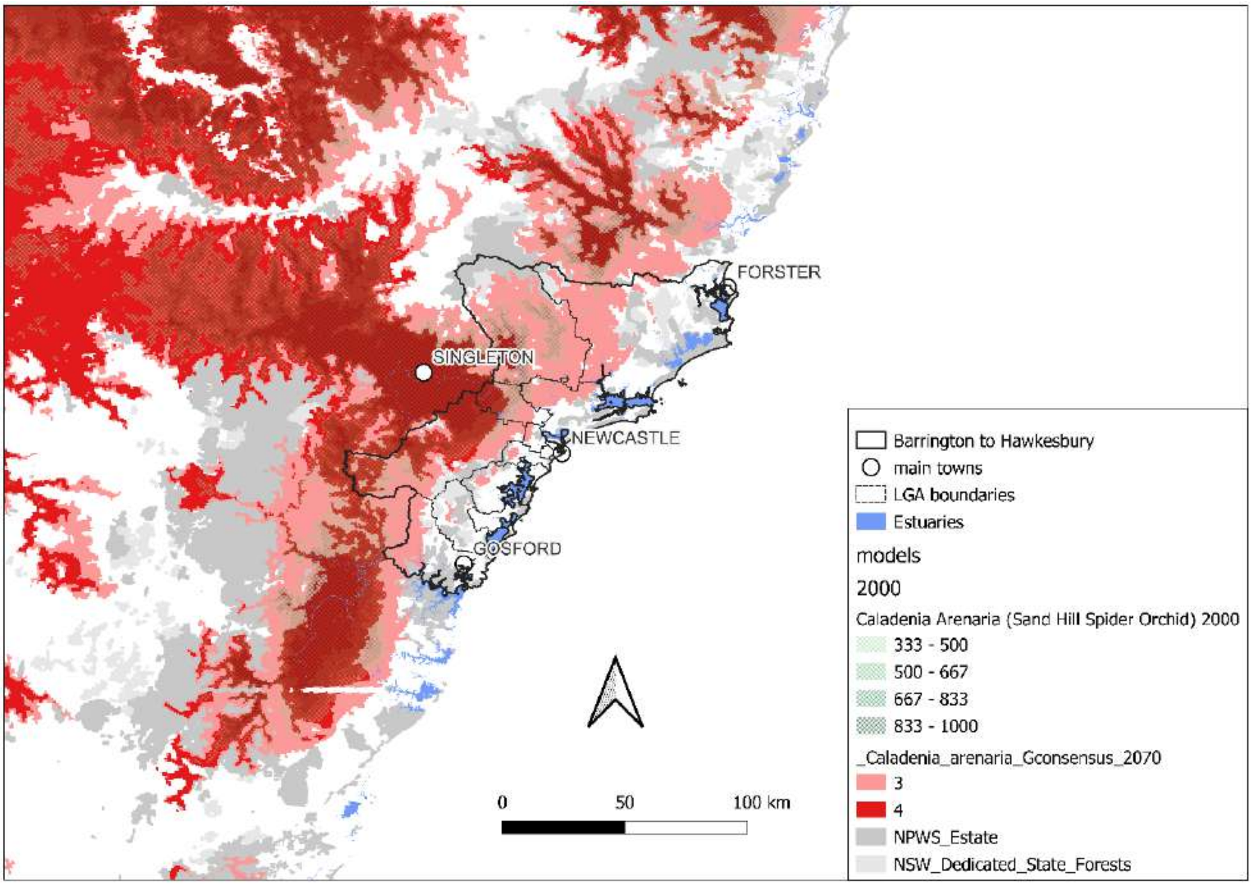
Map 10. Asperula asthenes (Trailing Woodruff) 2000-2070. Sighted since 2000. Regional extinction by 2070 under all 4 climate futures.



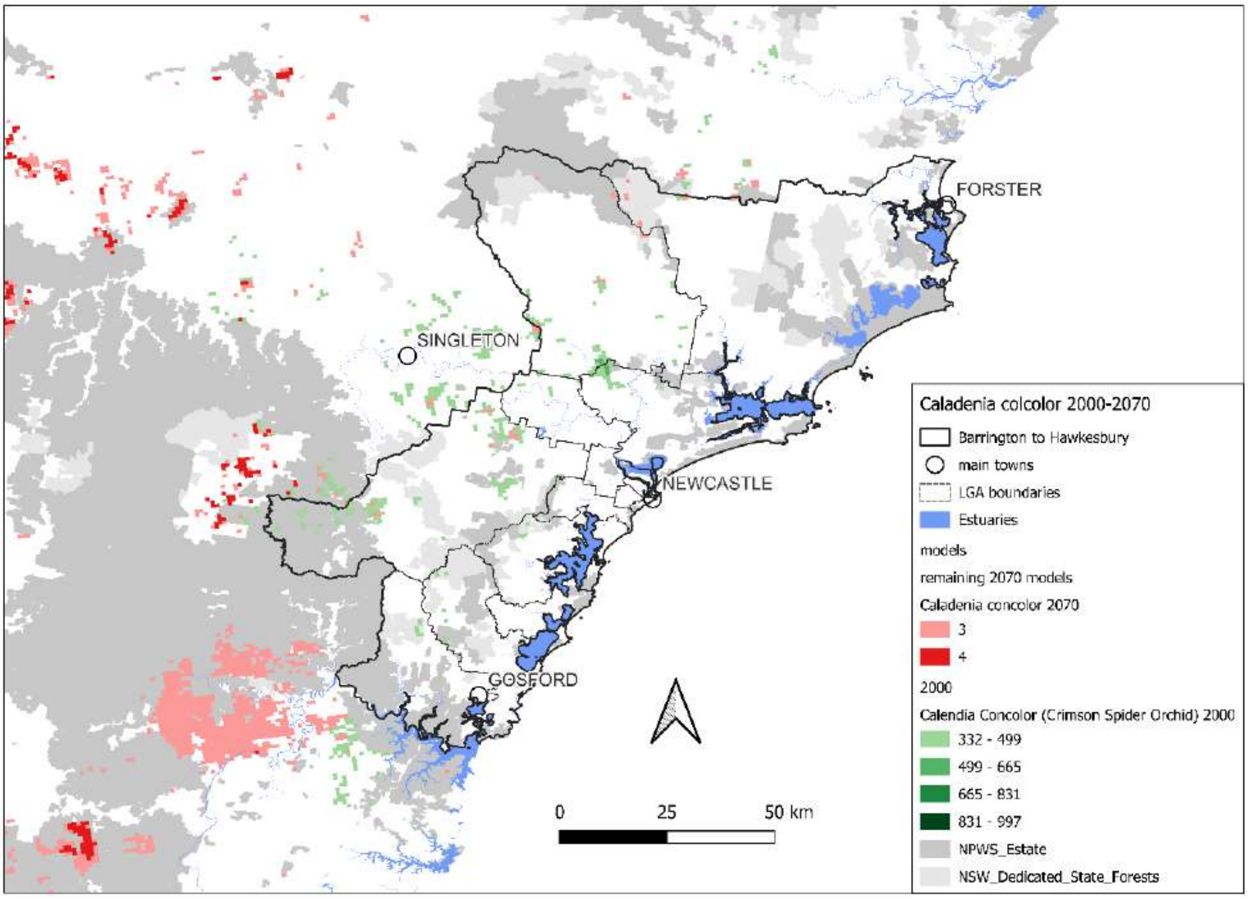
Map 11. Astrotrichia crassifolia 2000 – 2070. Sighting since 2000. Range contraction by 2070 under all 4 climate futures.



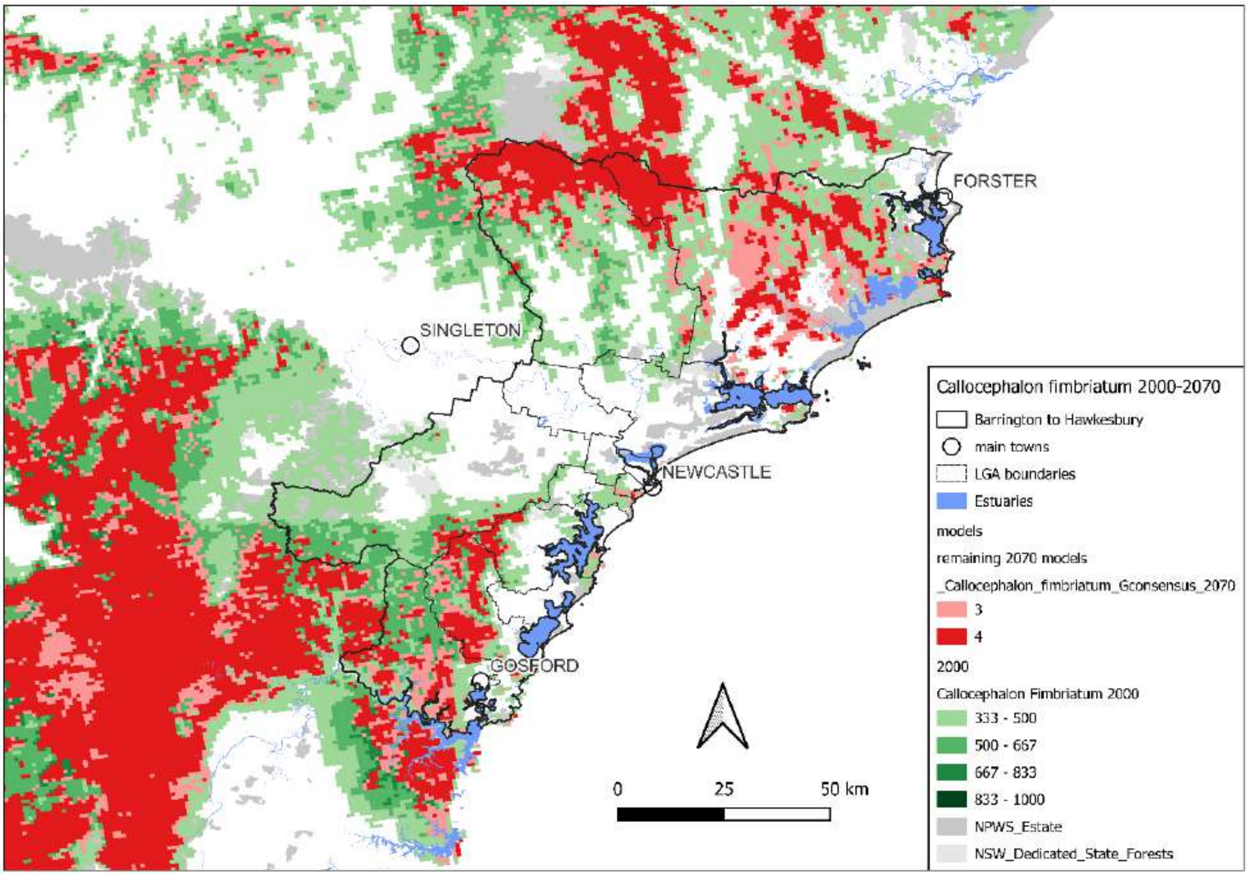
Map 12. Caesalpinia bonduc (Fever Nut) 2000 – 2070. No habitat by 2070 under all 4 climate futures.



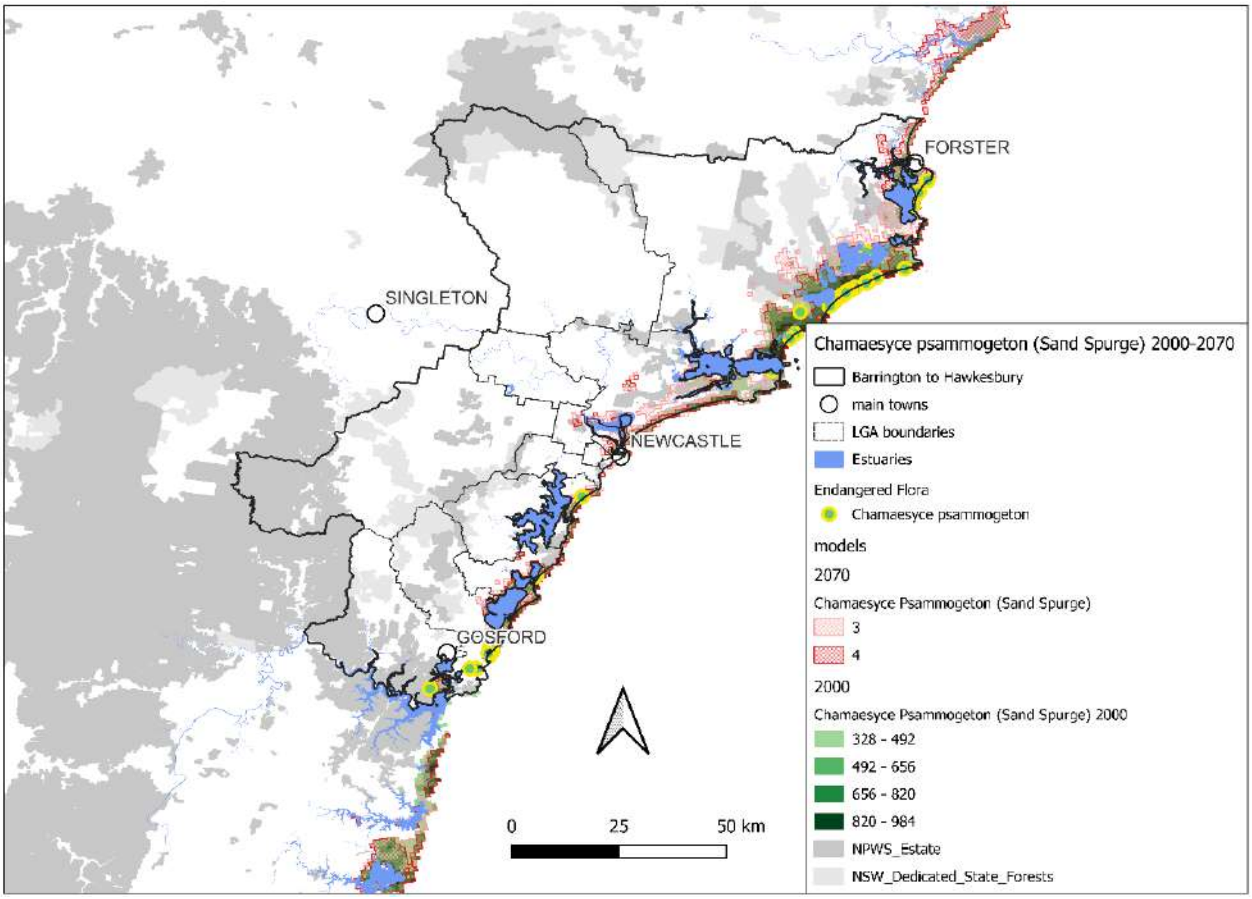
Map 13. Calendia arenaria (Sand Hill Spider Orchid) 2000-2070. Range expansion in BTH by 2070 under all 4 climate futures.



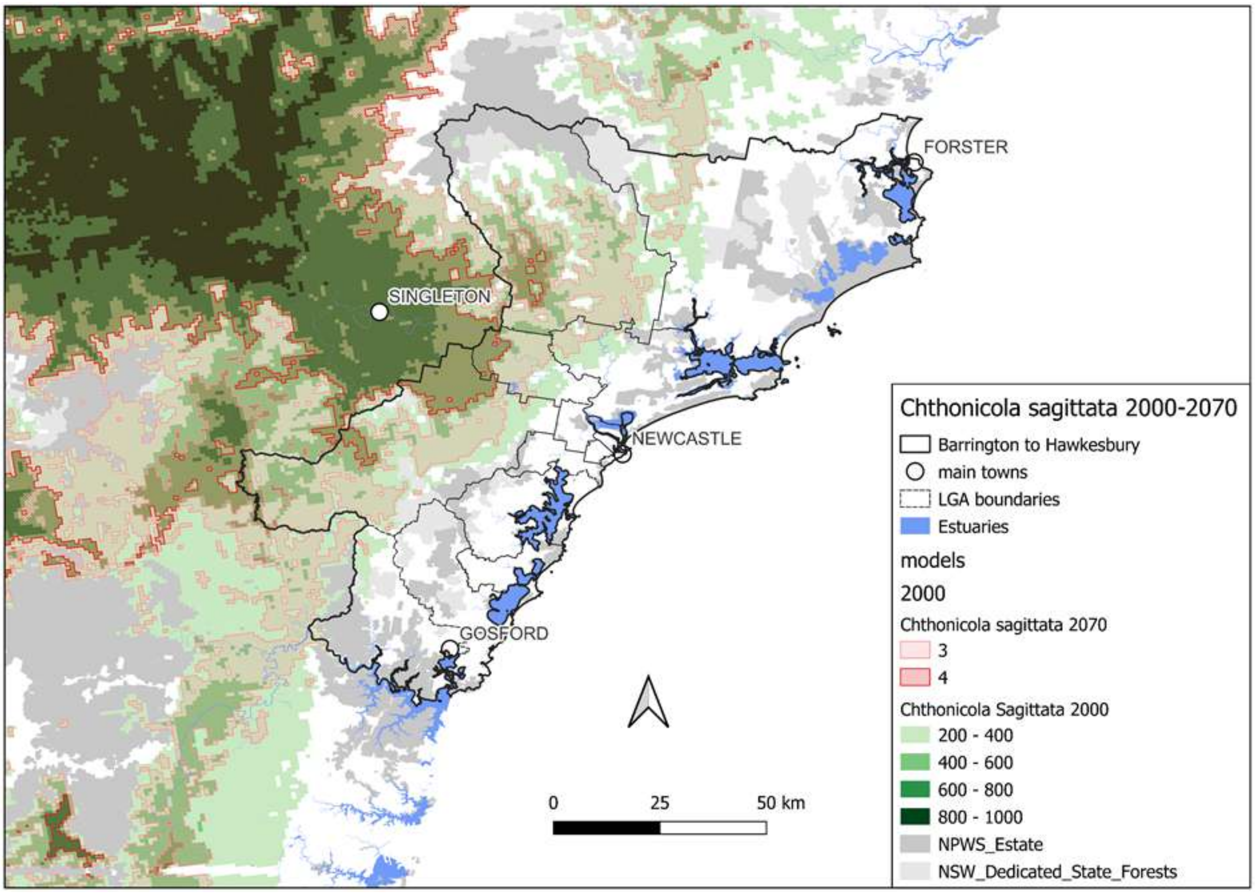
Map 14. Caladena concolor 2000-2070 (Crimson Spider Orchid). No habitat by 2070 under all 4 climate futures.



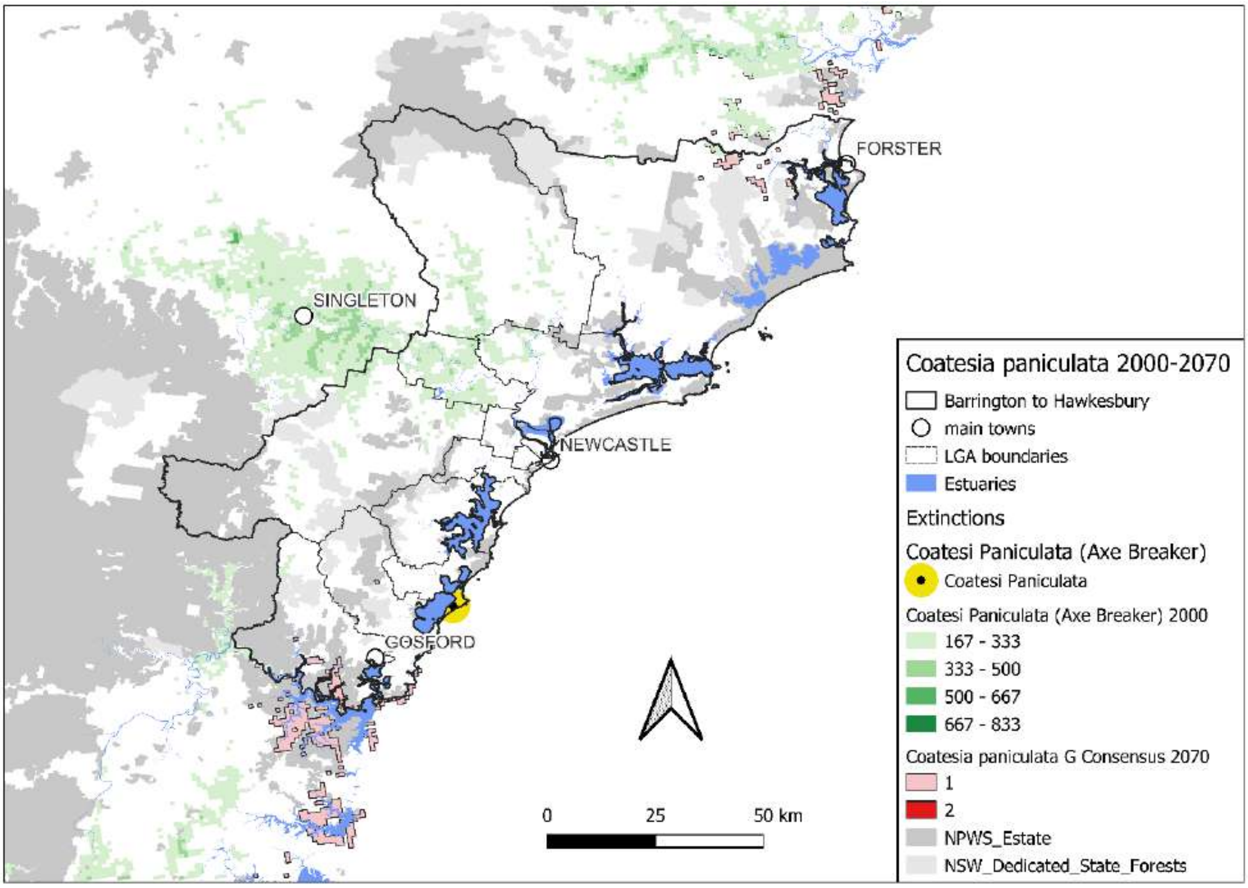
Map 15. Callocephalon fimbriatum 2000 – 2070. Range contraction by 2070 under all 4 climate futures.



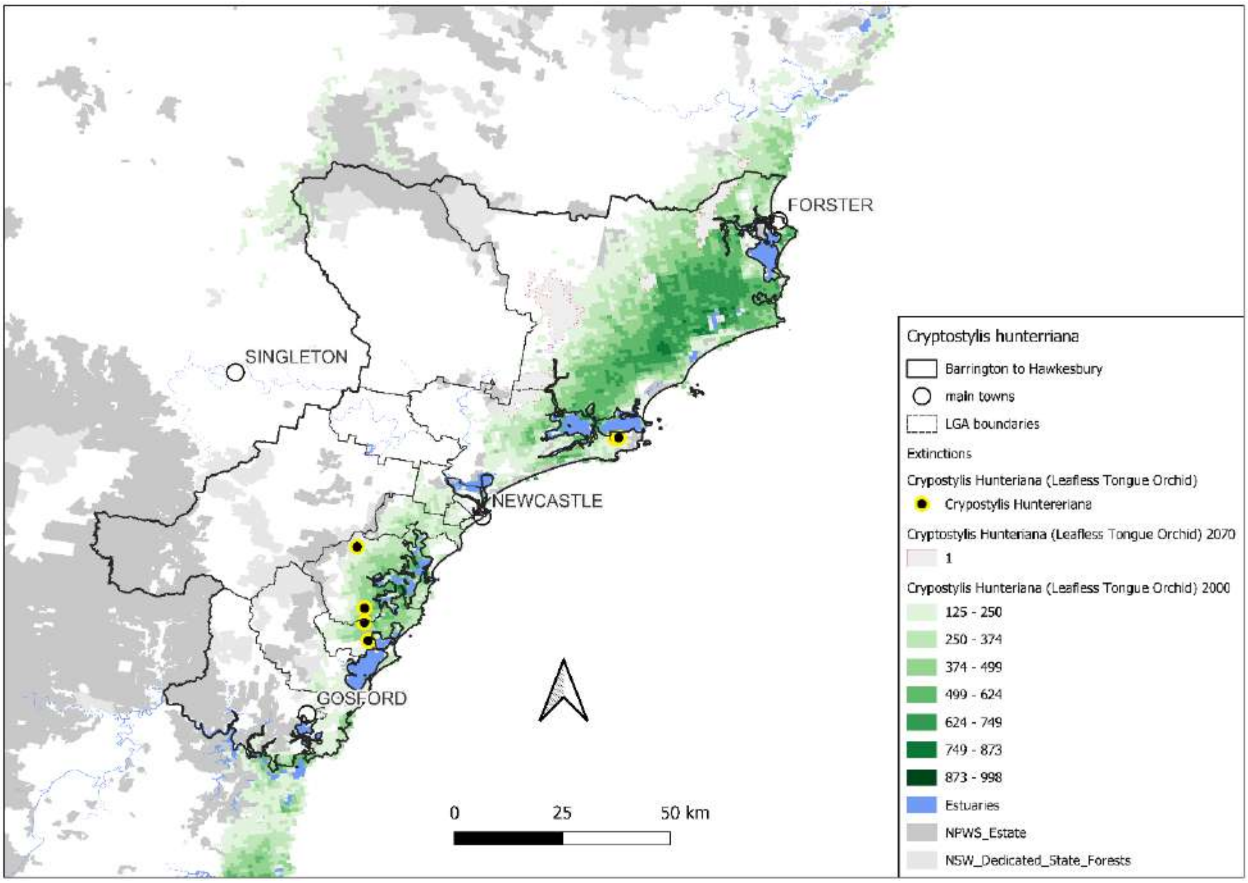
Map 16. Chamaesyce psammogeton (Sand spurge) 2000 – 2070. Recorded sightings since 2000. Slight range expansion by 2070 under all 4 possible climate futures.



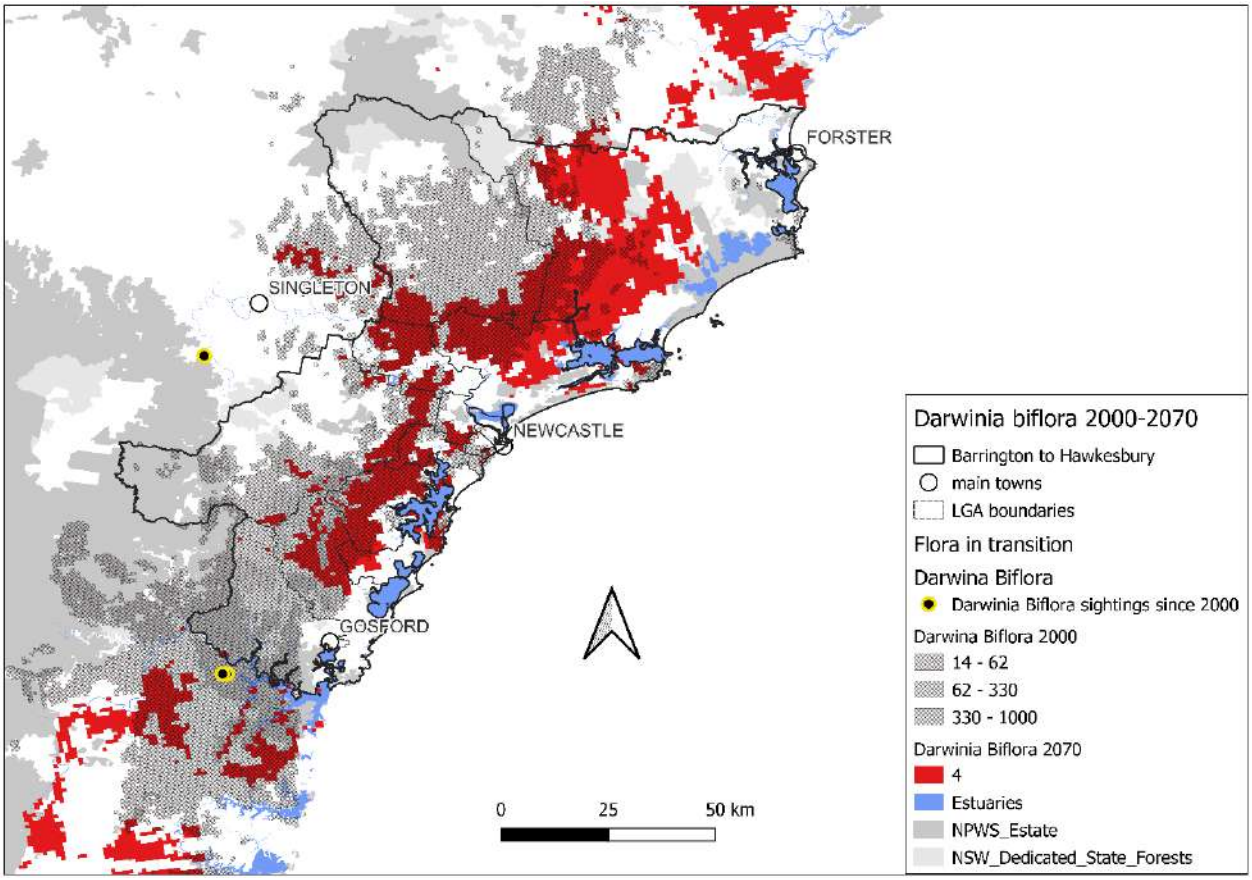
Map 17. Chthonicola sagittata 2000 – 2070. Range contraction by 2070 under all 4 possible climate futures.



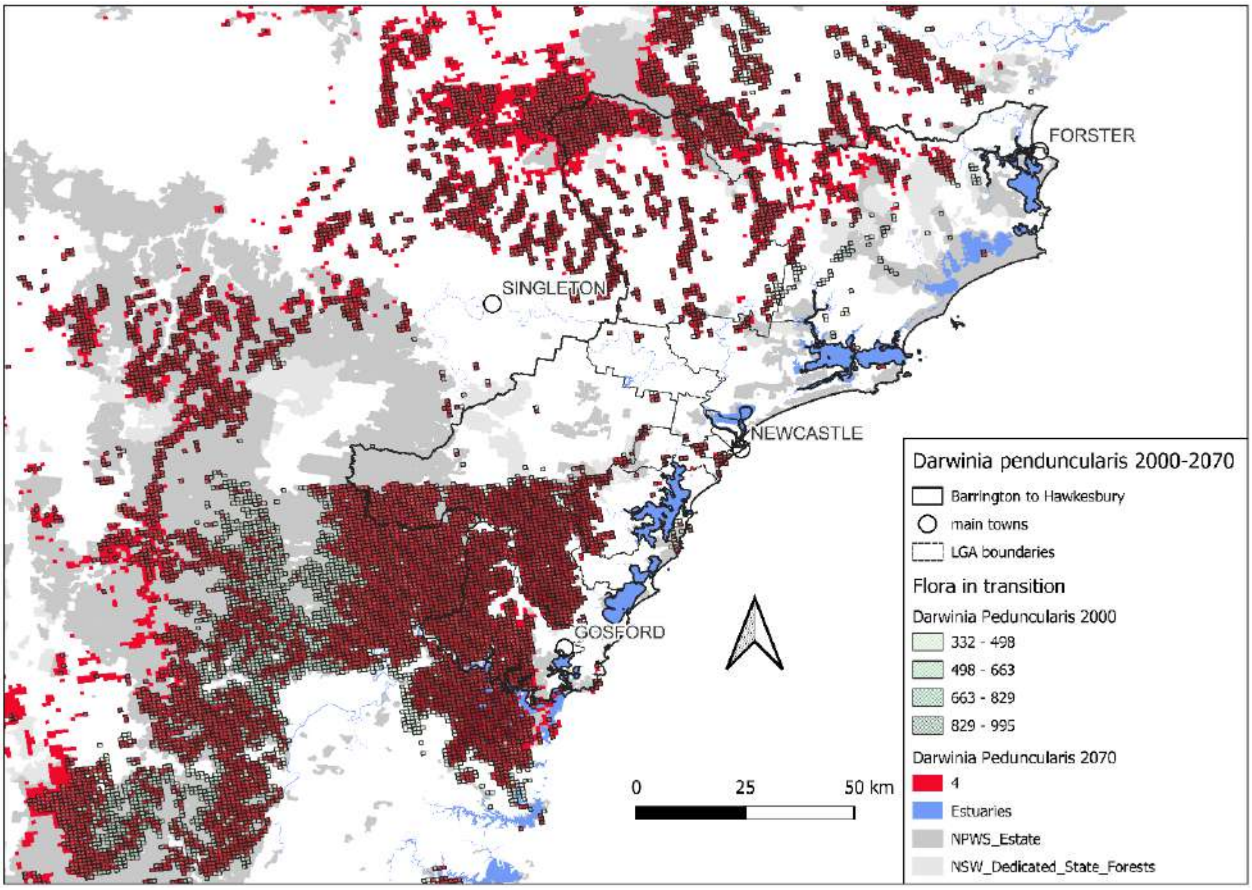
Map 18. Coatesia paniculata 2000-2070. Sighed since 2000. Regionally extinct by 2070 under all 4 climate futures.



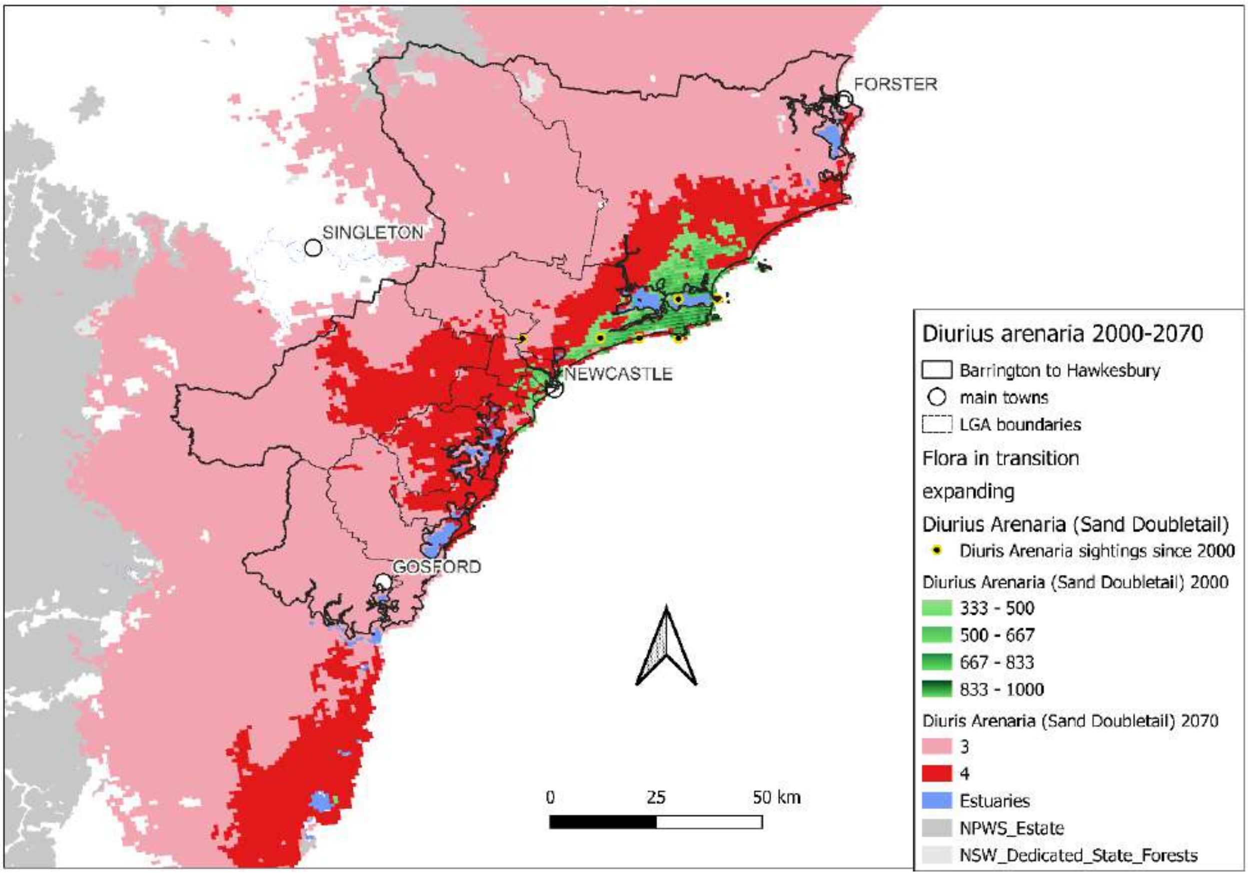
Map 19. Cryptostylis hunteriana (Leafless Tongue Orchid) 2000-2070. Sighed since 2000. Regional extinction by 2070 under all 4 climate futures.



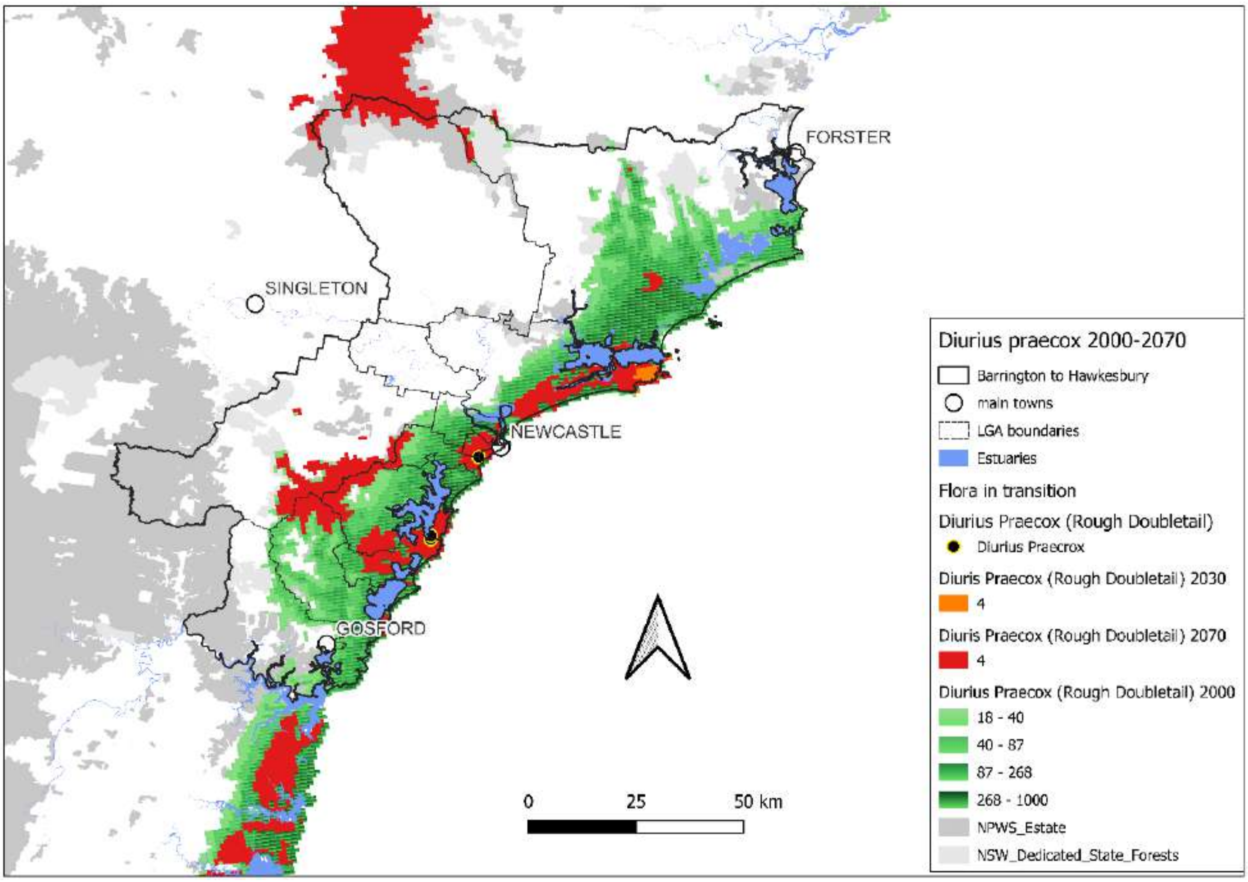
Map 20. Darwinia biflora 2000-2070. Sighed since 2000. Range contraction by 2070 under all 4 climate futures.



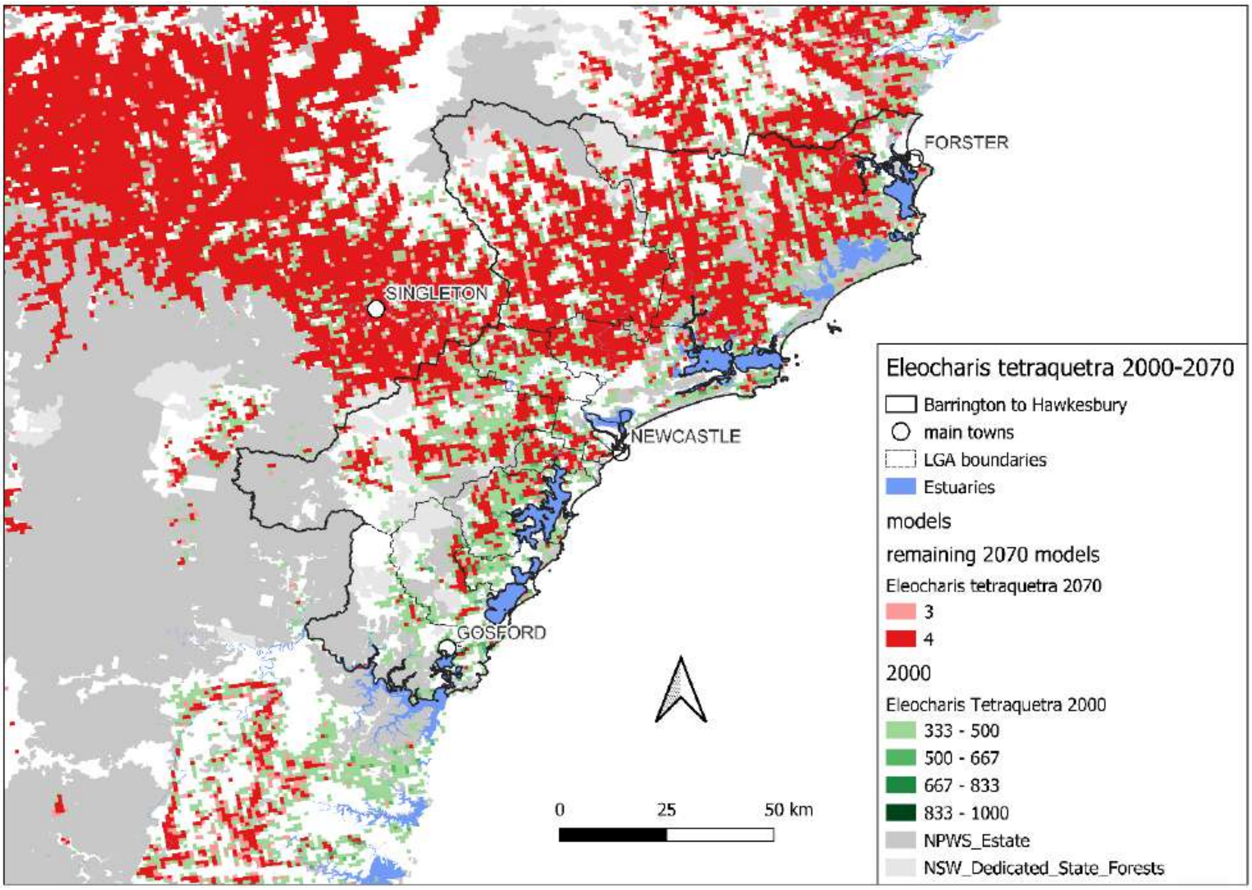
Map 21. Darwinia penduncularis 2000-2070. Slight range contraction by 2070 under all 4 climate futures.



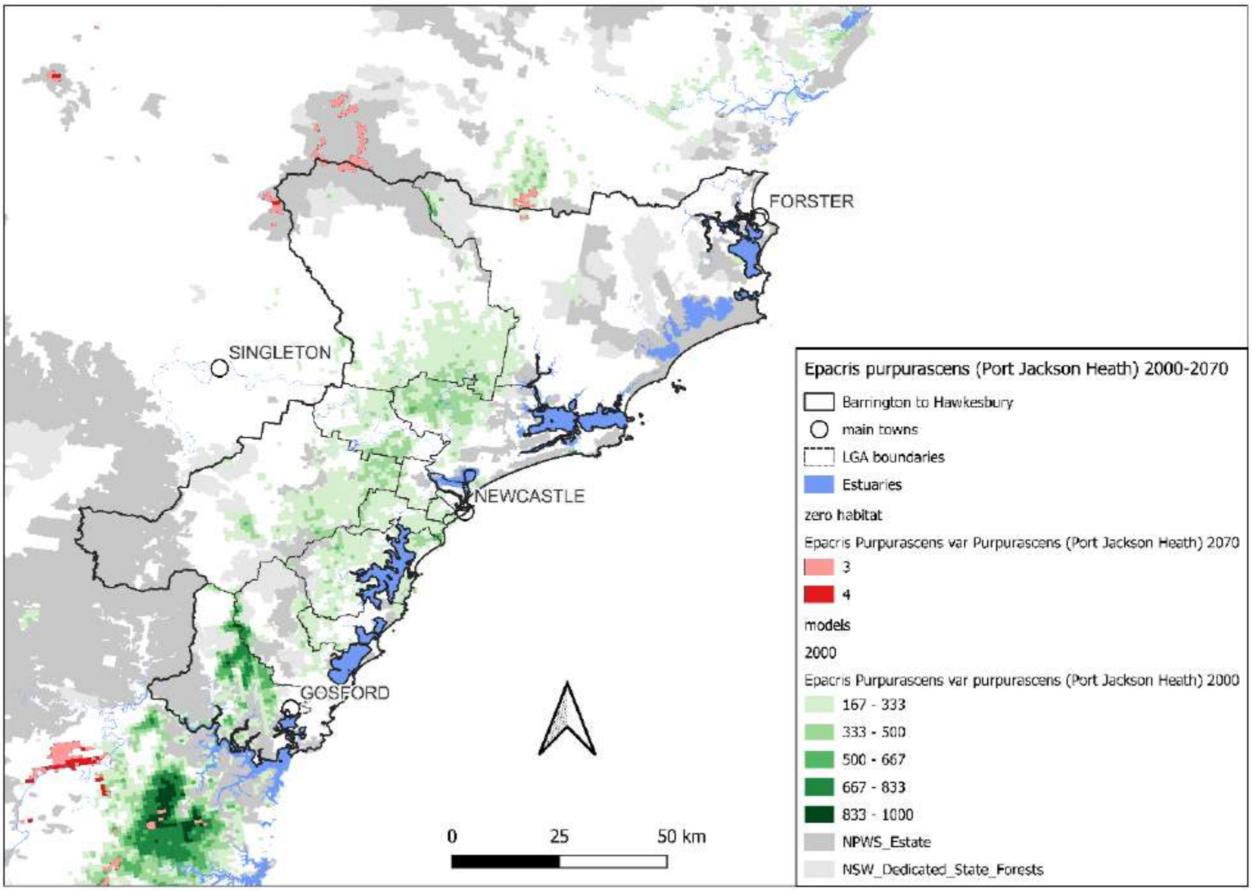
Map 22. Diurius arenaria (Sand Doubletail) 2000-2070. Sighted since 2000. Range expansion by 2070 under all 4 climate futures.



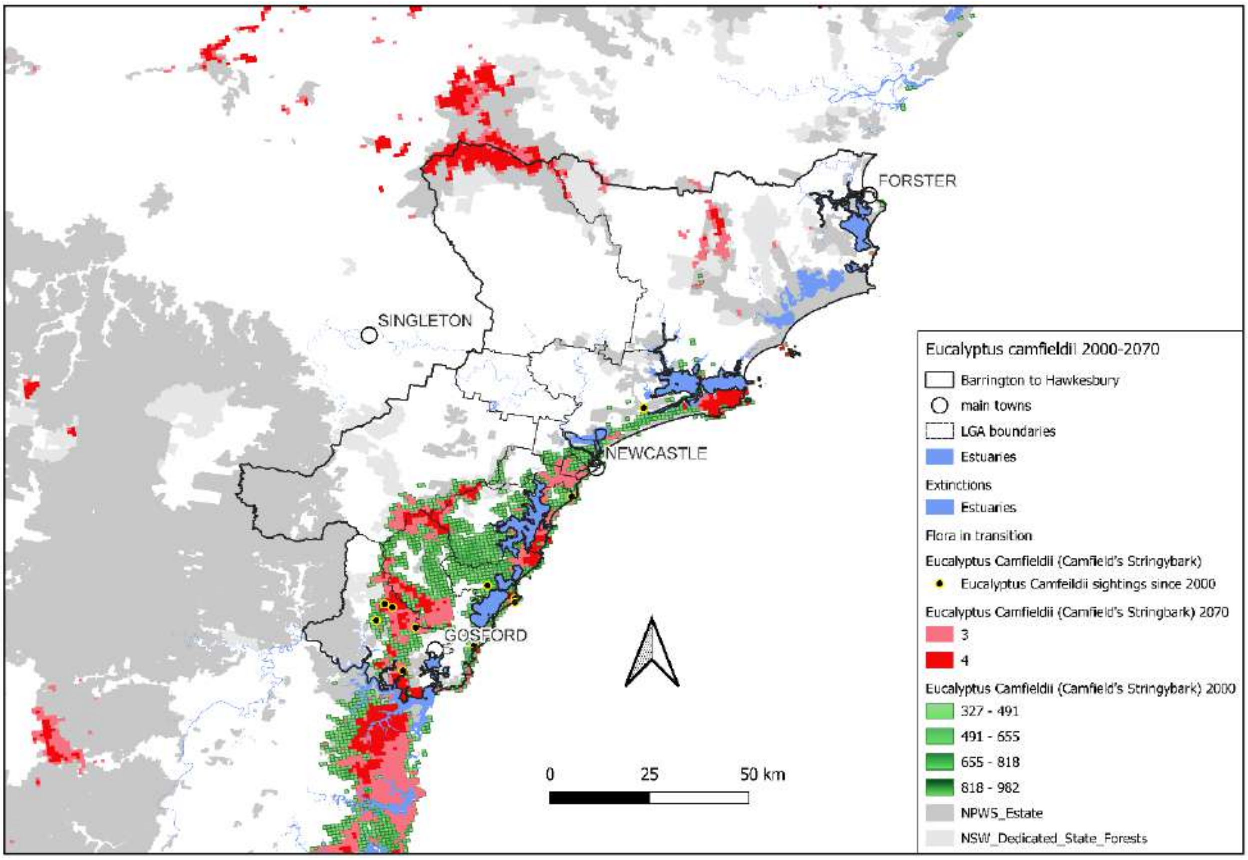
Map 23. Diurius praecox (Rough Doubletail) 2000-2070. Sighted since 2000. Range contraction by 2070 under all 4 climate futures.



Map 24. Eleocharis tetraqueta 2000-2070. Range contraction by 2070 under all 4 climate futures.



Map 25. Exacris purpurascens (Port Jackson Heath) 2000-2070. No habitat by 2070 under all 4 climate futures.



Map 26. Eucalyptus camfieldii (Camfiel's Stringy Bark) 2000-2070. Sighted since 2000. Range contractions by 2070 under all 4 climate futures

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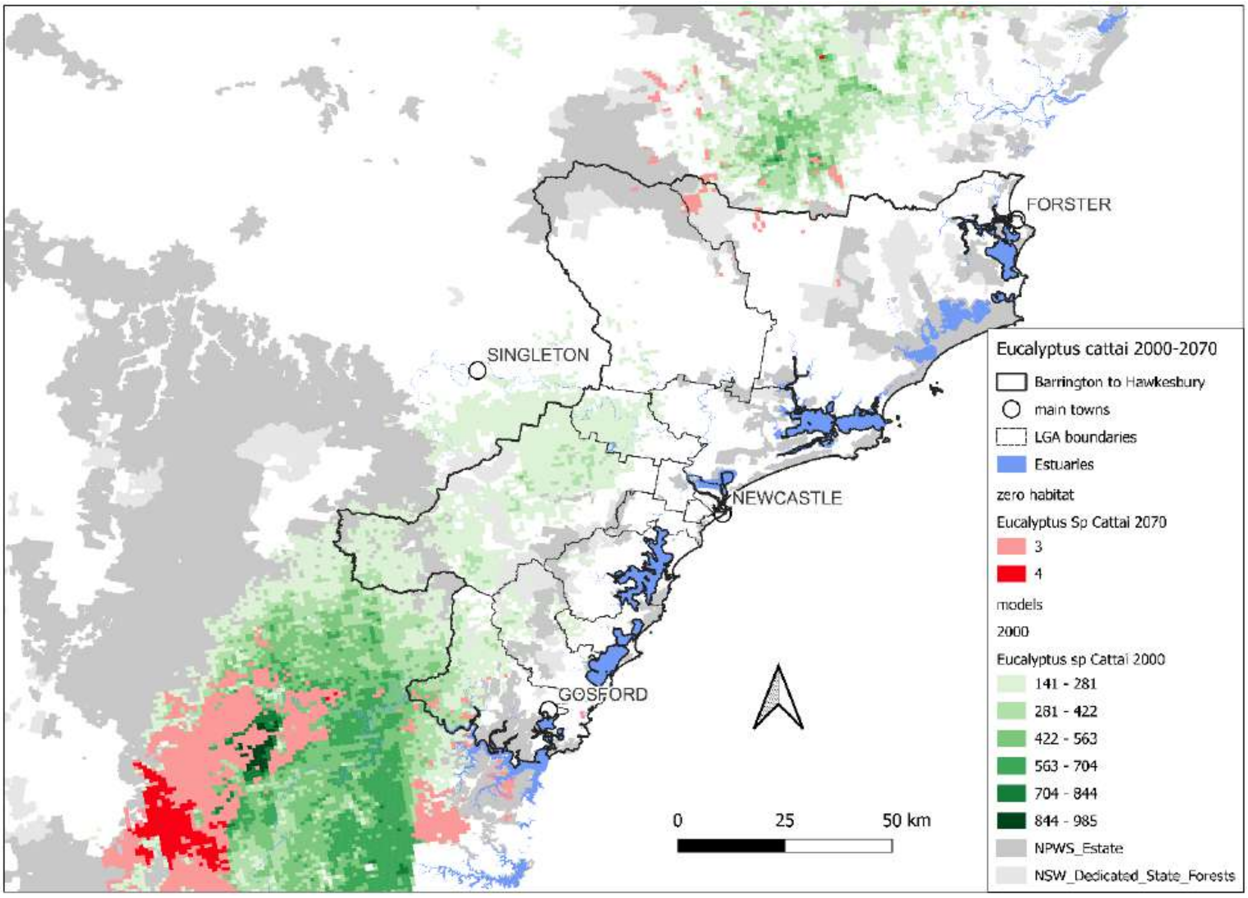
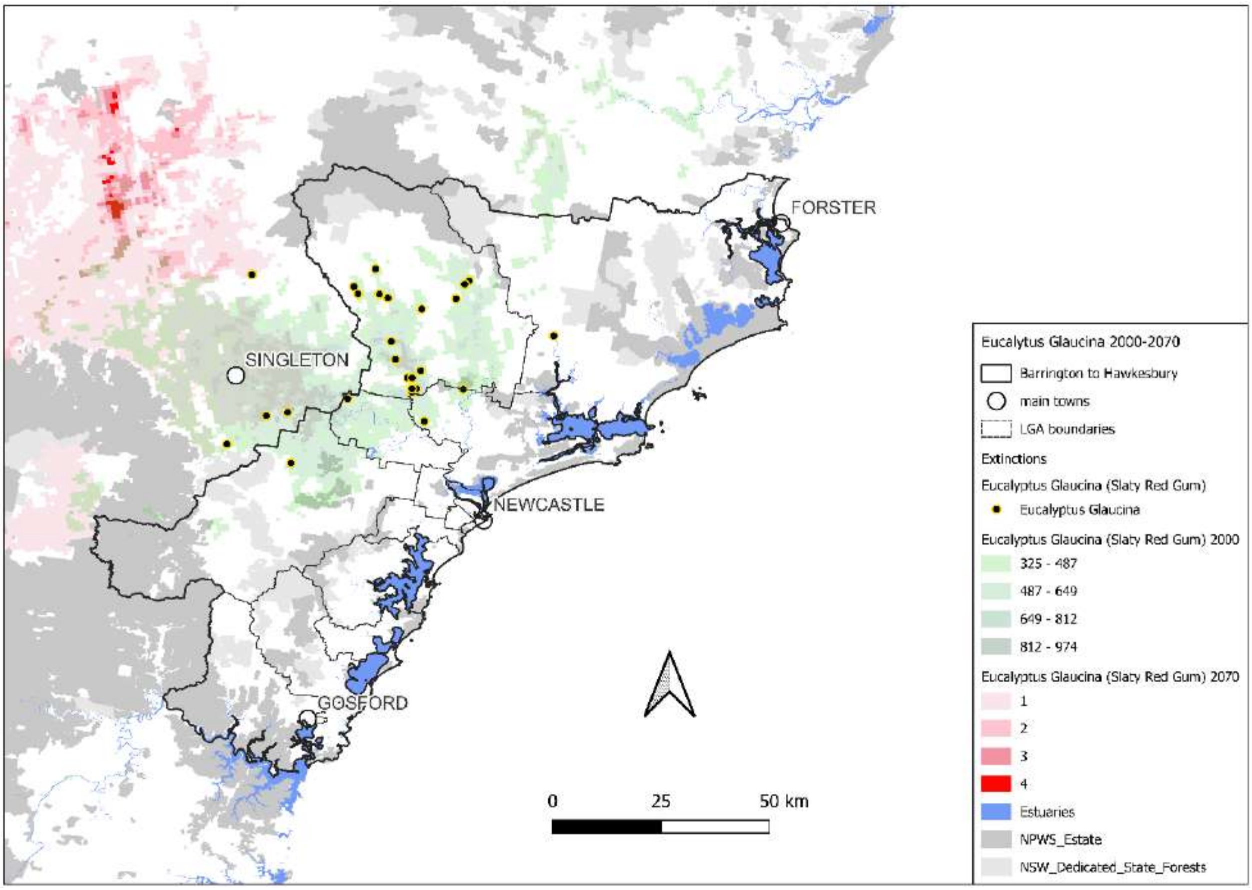
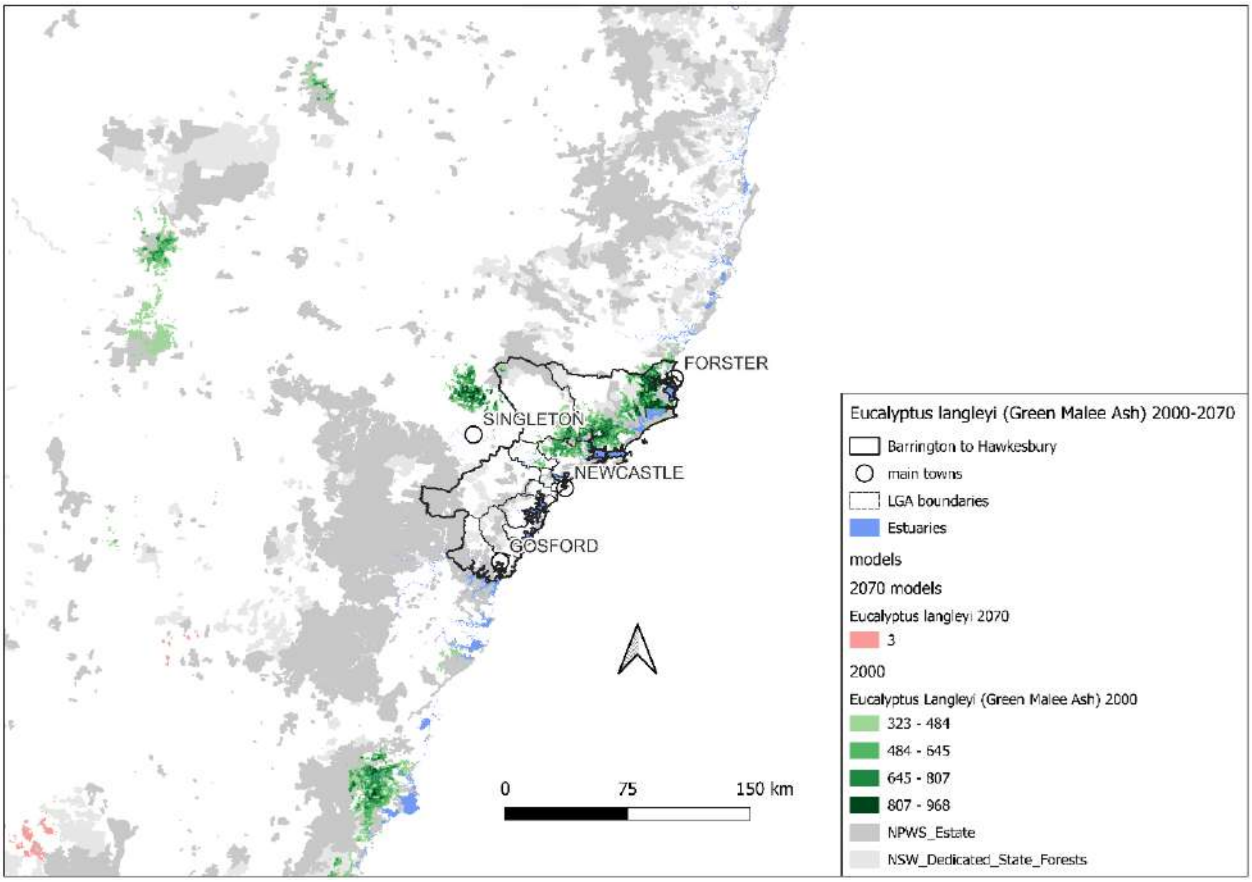


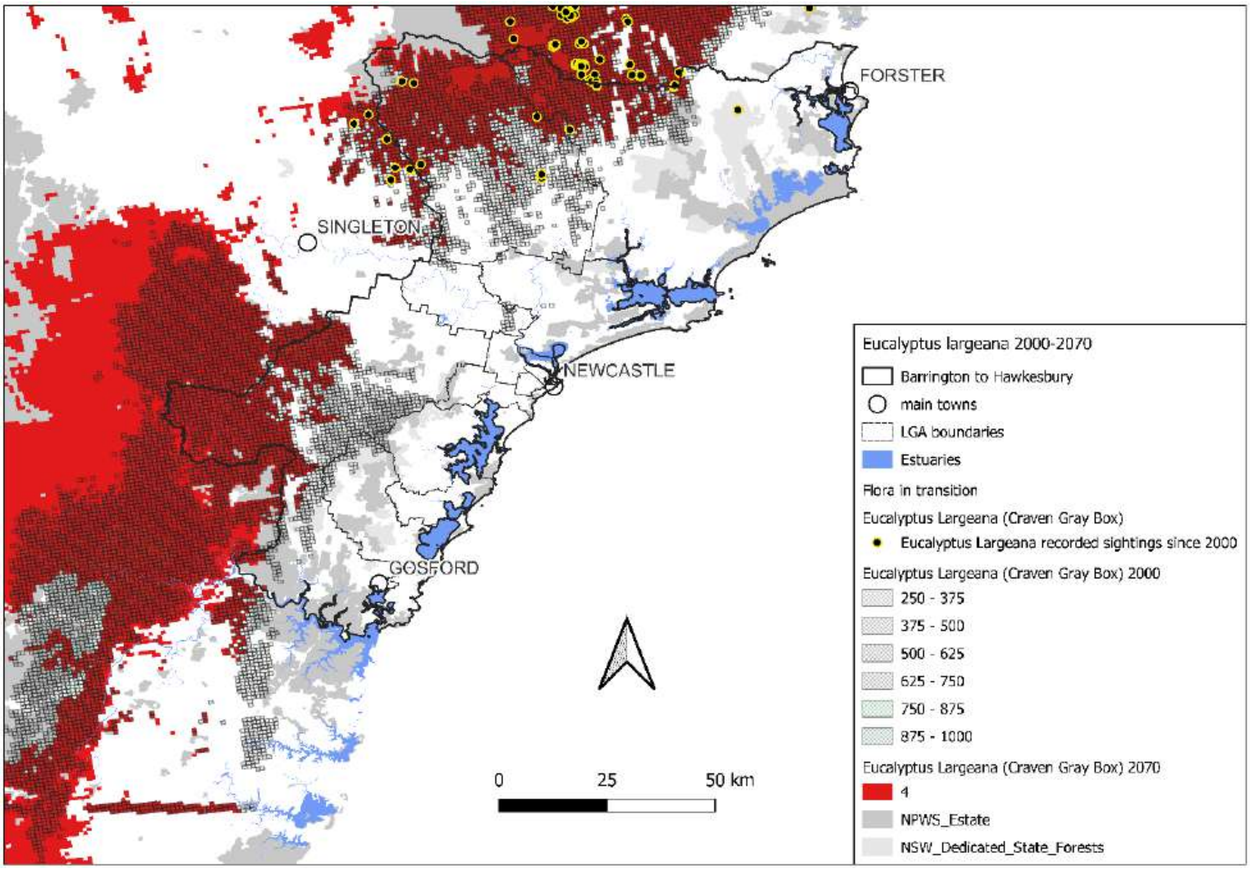
Map 27. Eucalyptus sp. cattai 2000-2070. No habitat by 2070 under all 4 climate futures.



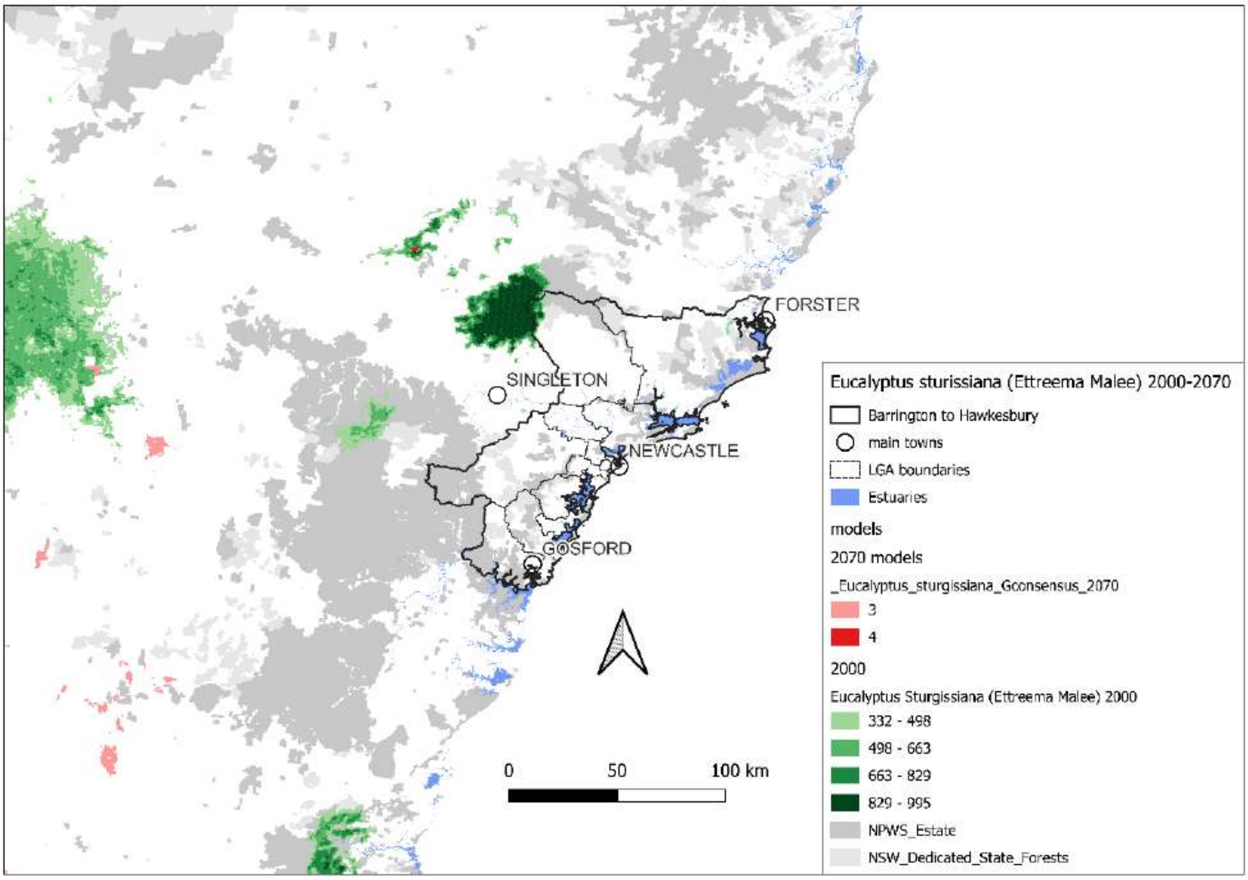
Map 28. Eucalyptus glaucina (Slaty Red Gum) 2000-2070. Sighted since 2000. Regional extinction by 2070 under all 4 climate futures.



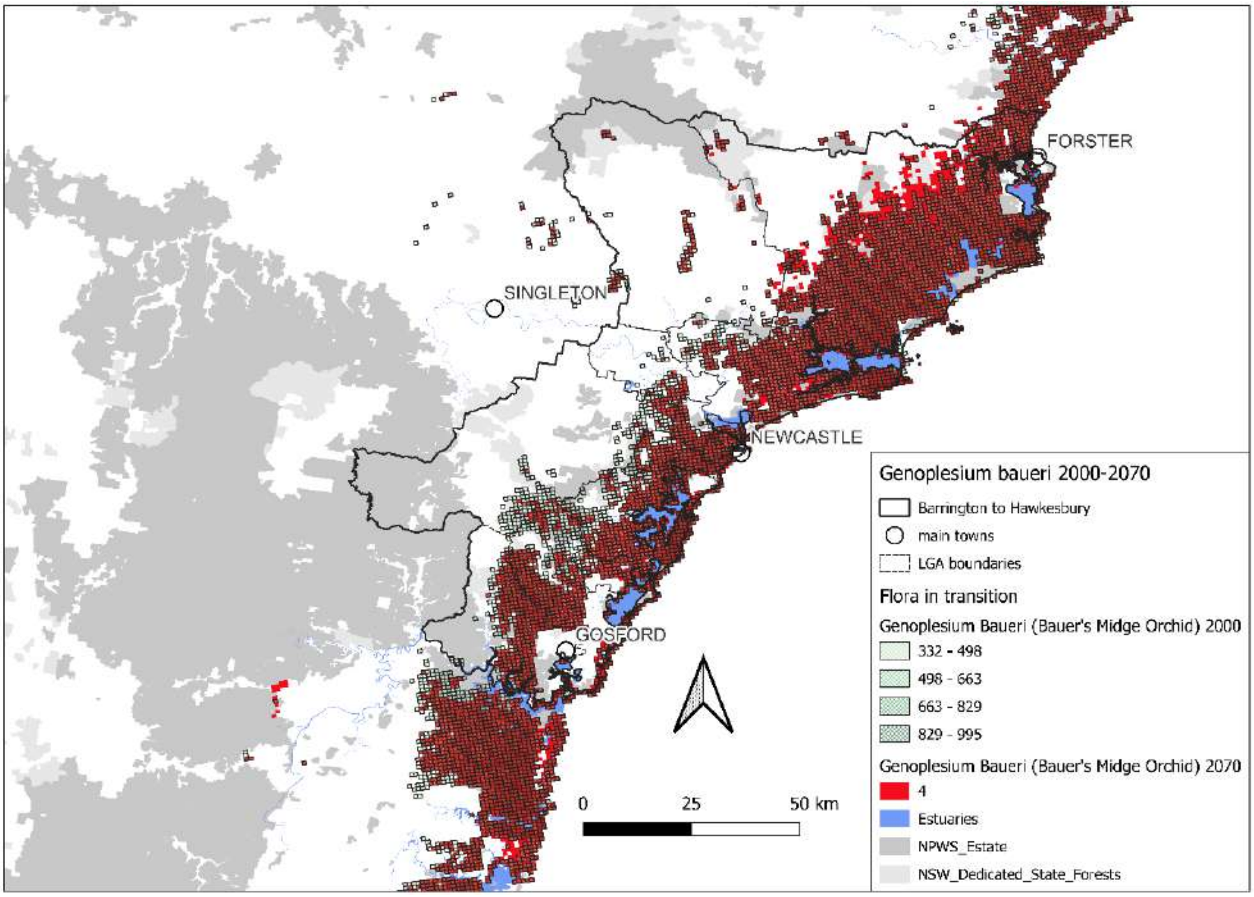
Map 29. Eucalyptus langleti (Green Malee Ash) 2000-2070. No habitat by 2070 under all 4 climate futures.



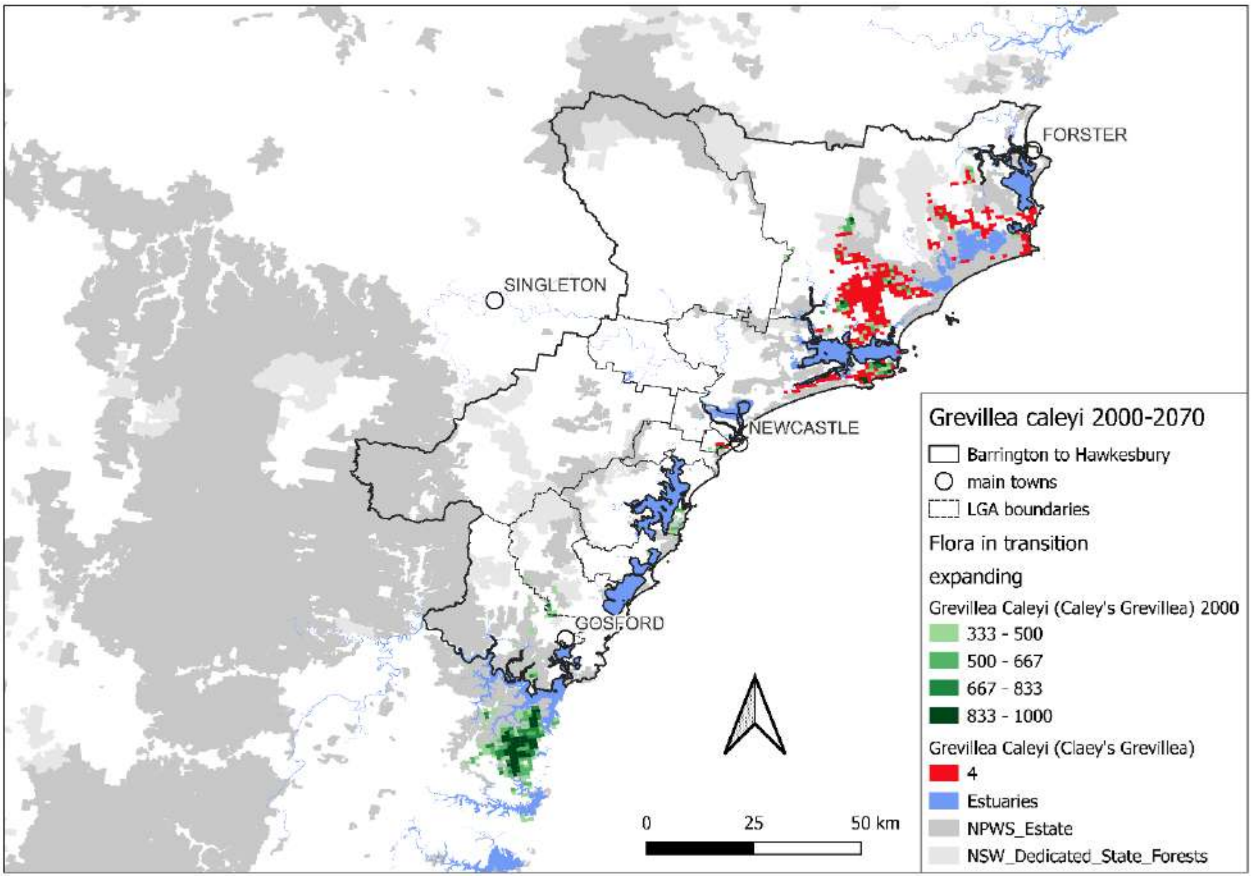
Map 30. Eucalyptus largeana (Craven Gray Box) 2000-2070. Sighted since 2000. Range contractions by 2070 under all 4 climate futures.



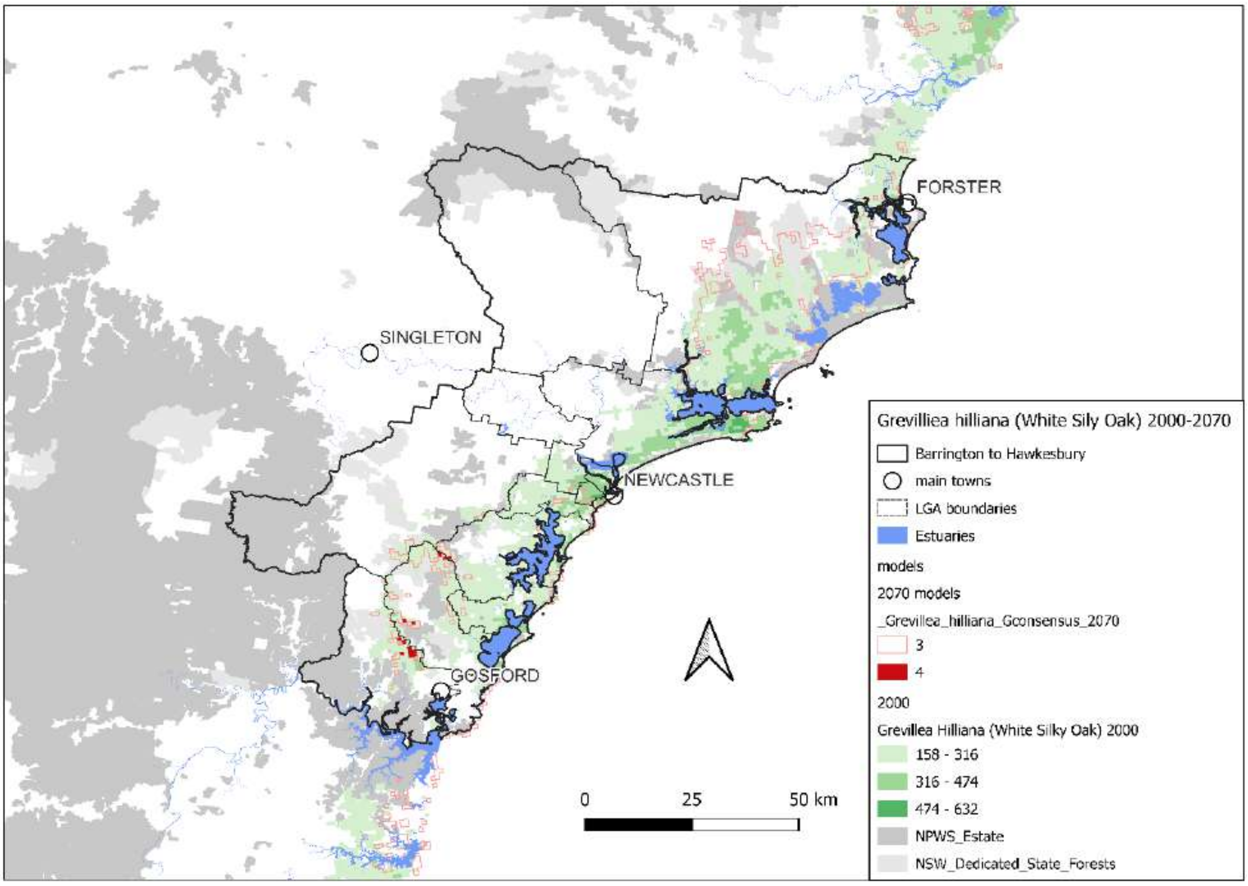
Map 31. Eucalyptus sturissiana (Ettreema Malee) 2000-2070. No habitat by 2070 under all 4 climate futures.



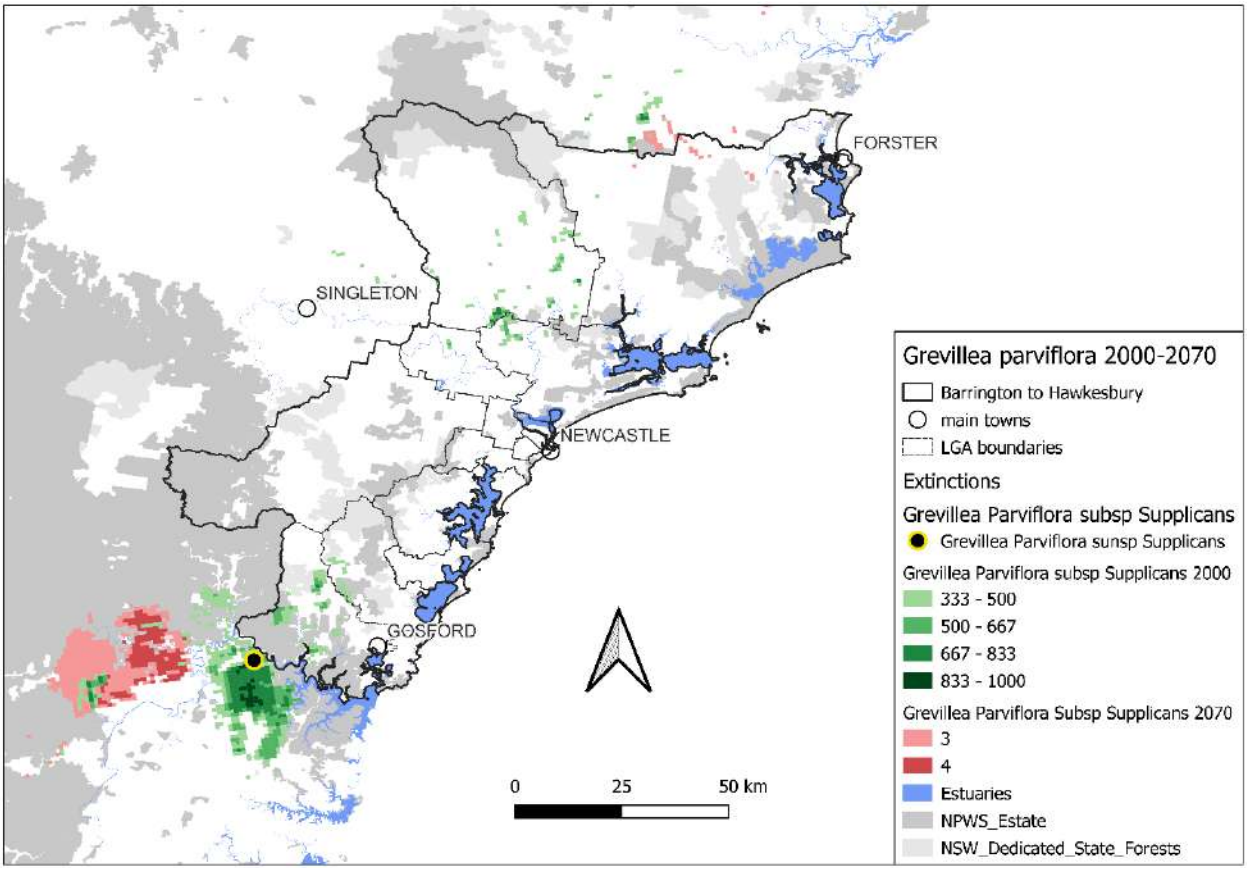
Map 32. Genoplesium baueri (Bauer's Midge Orchid) 2000-2070. Range contractions by 2070 under all 4 climate futures.



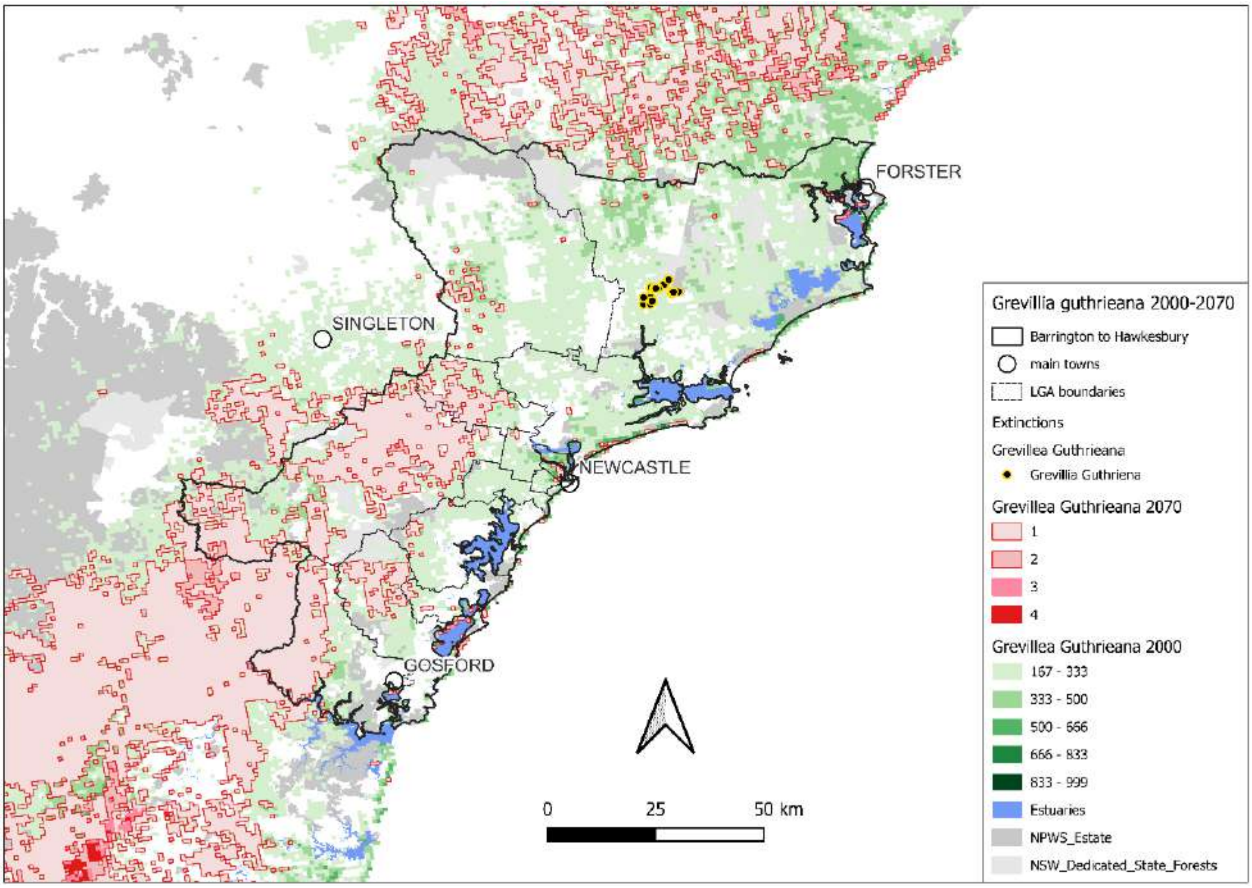
Map 33. Grevillea caleyi (Claey's Grevillia) 2000-2070. Range expansion by 2070 under all 4 climate futures.



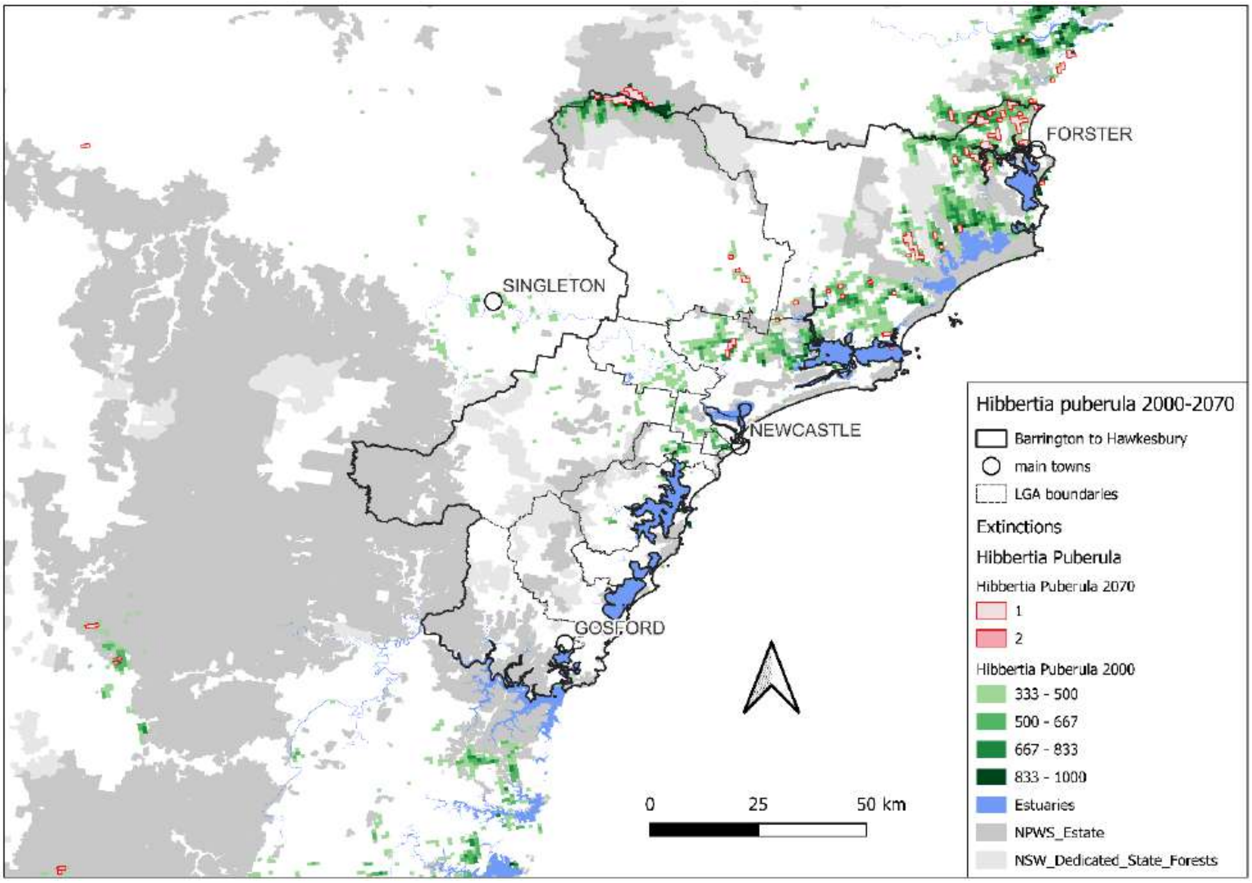
Map 34. Grevillea hilliana (White Silky Oak) 2000-2070. Range contraction by 2070 under all 4 climate futures.



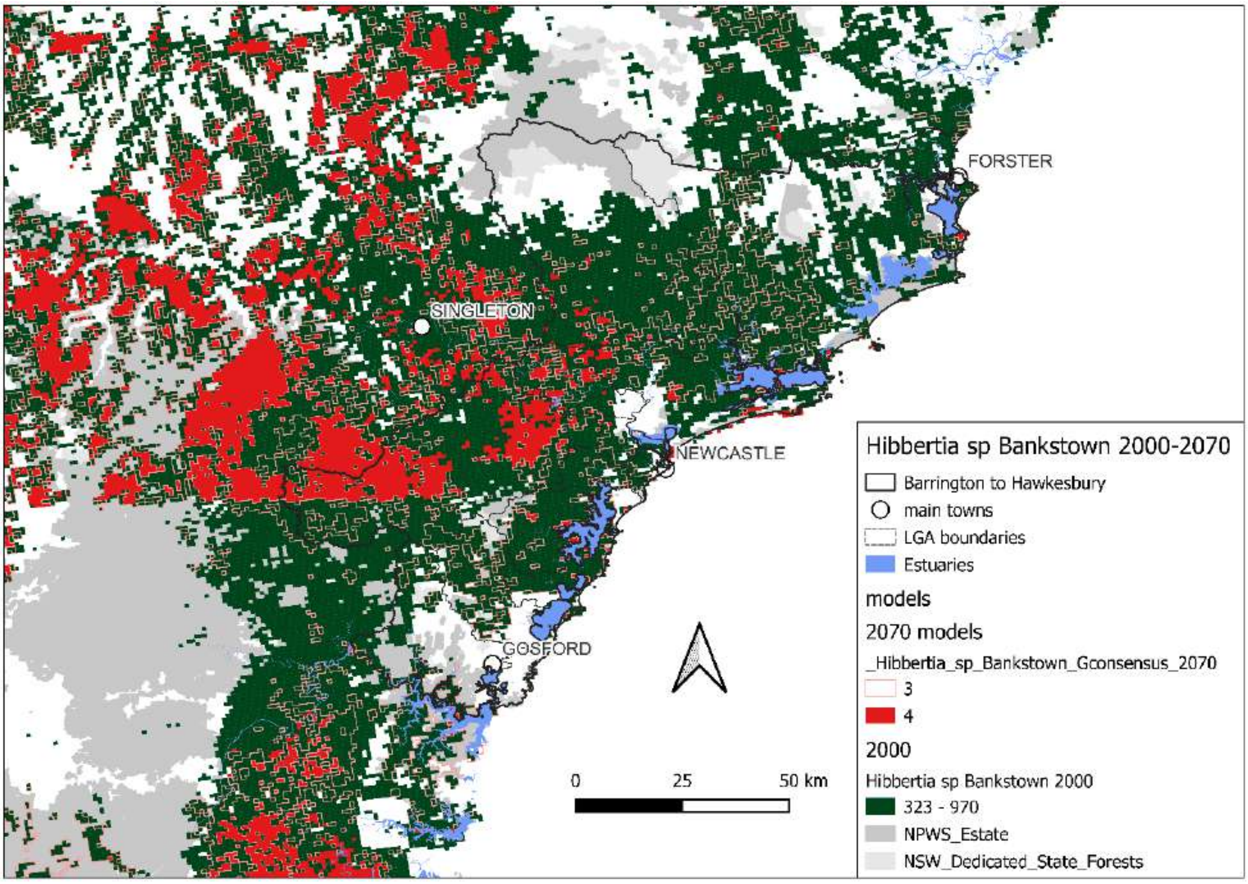
Map 35. Grevillea parviflora subsp. supplicans 2000-2070. Sighted since 2000. Regional extinction by 2070 under all 4 climate futures.



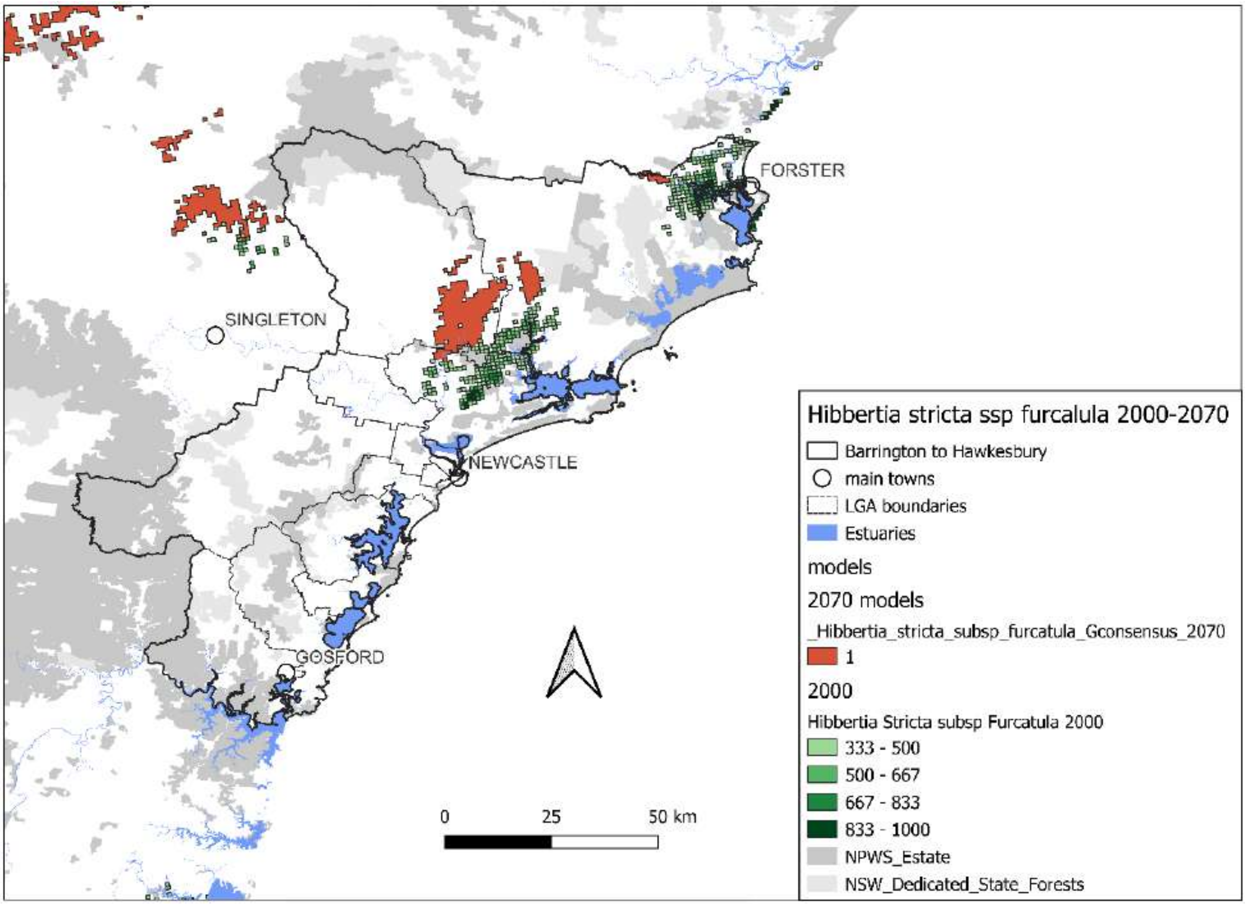
Map 36. Grevillea guthrieana 2000-2070. Sighted since 2000. Regional extinction by 2070 under all 4 climate futures.



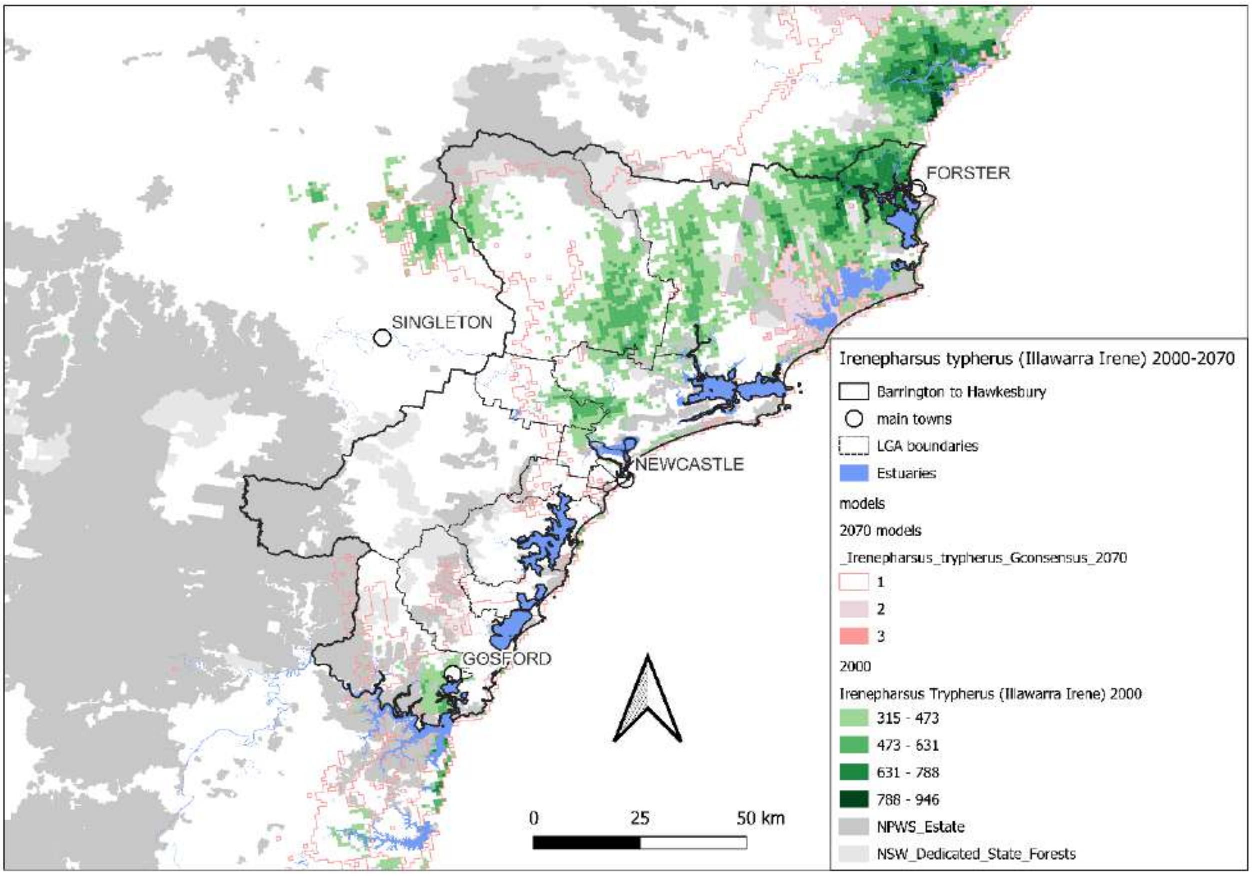
Map 37. Hibbertia puberula 2000-2070. No habitat by 2070 under all 4 climate futures.



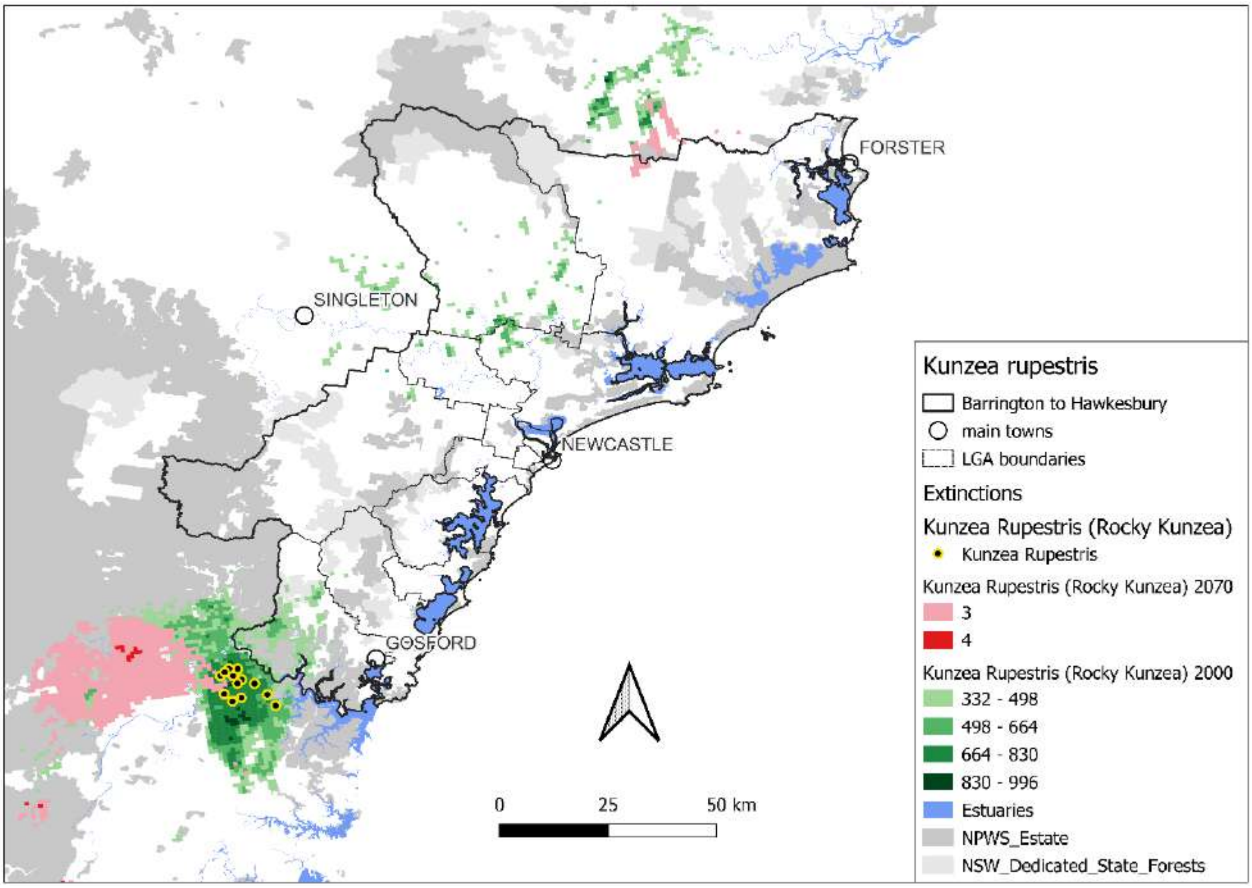
Map 38. Hibbertia sp backstown 2000-2070. Range contractions by 2070 under all 4 climate futures.



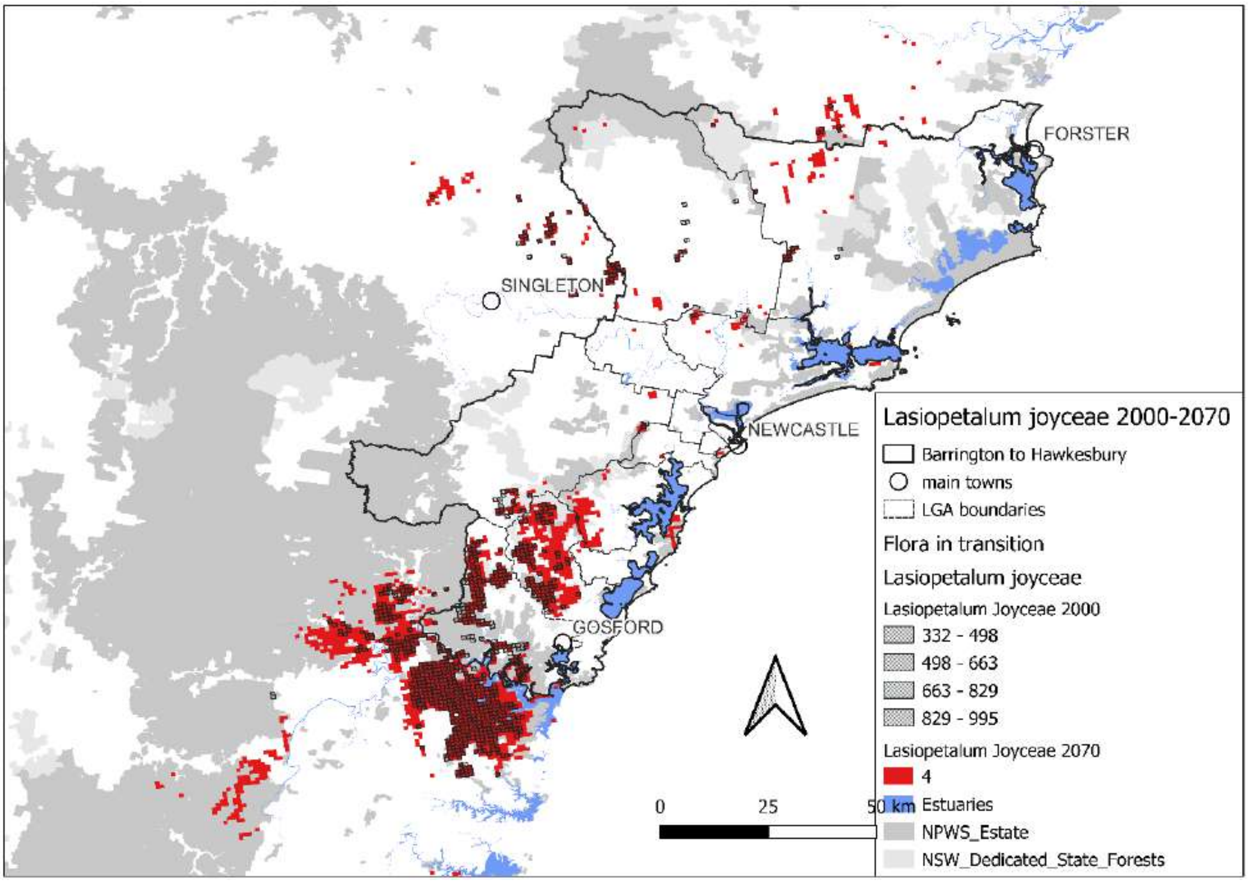
Map 39. Hibbertia stricta subsp. Furcaluta 2000-2070. No habitat by 2070 under all 4 climate futures.



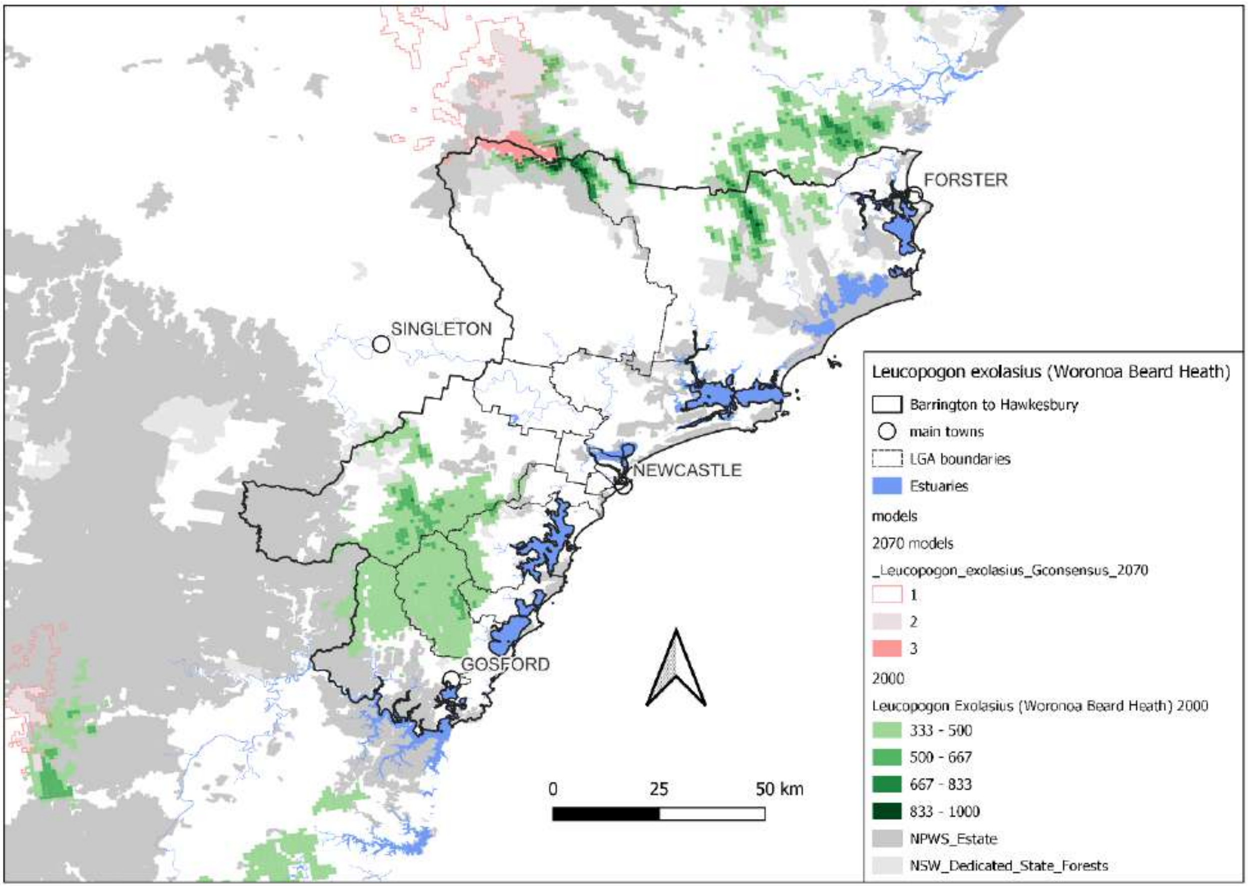
Map 40. Irenepharsus typherus (Illawarra Irene) 2000-2070. No habitat by 2070 under all 4 climate futures.



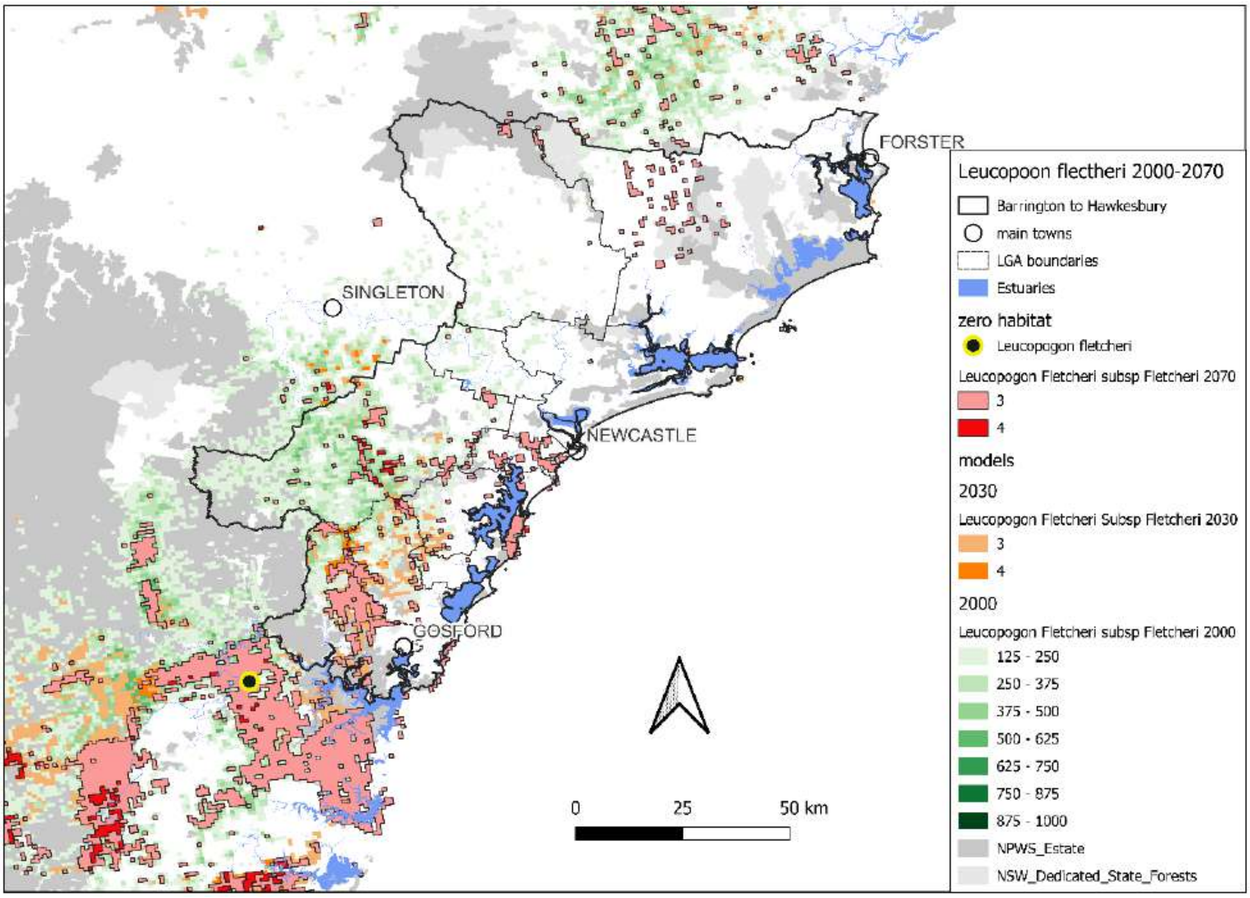
Map 41. Kunzea rupestris (Rocky Kunzea) 2000-2070. Sighted since 2000. Regional extinction by 2070 all 4 climate futures.



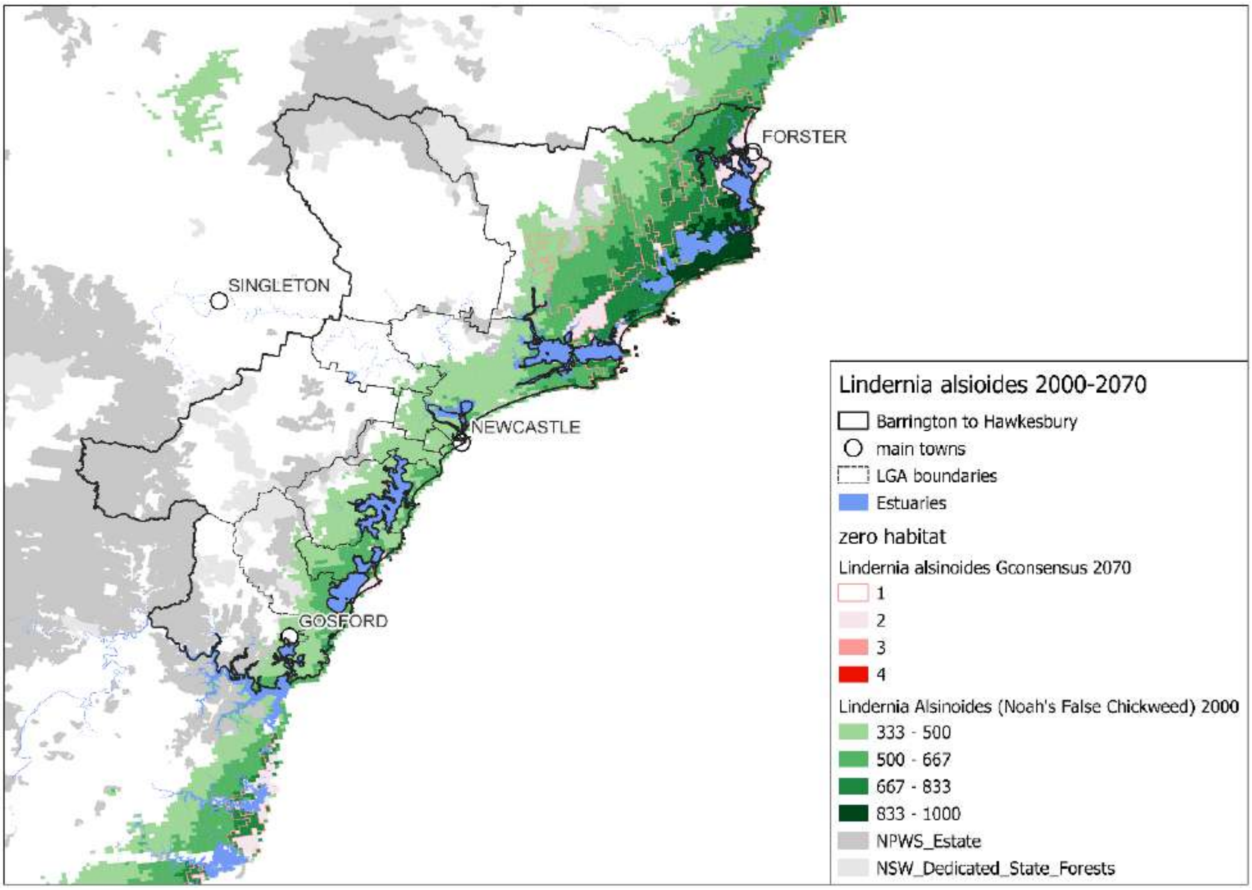
Map 42. Lasiopetalum joyce 2000-2070. Sighted since 2000. Range contraction by 2070 under all 4 climate futures.



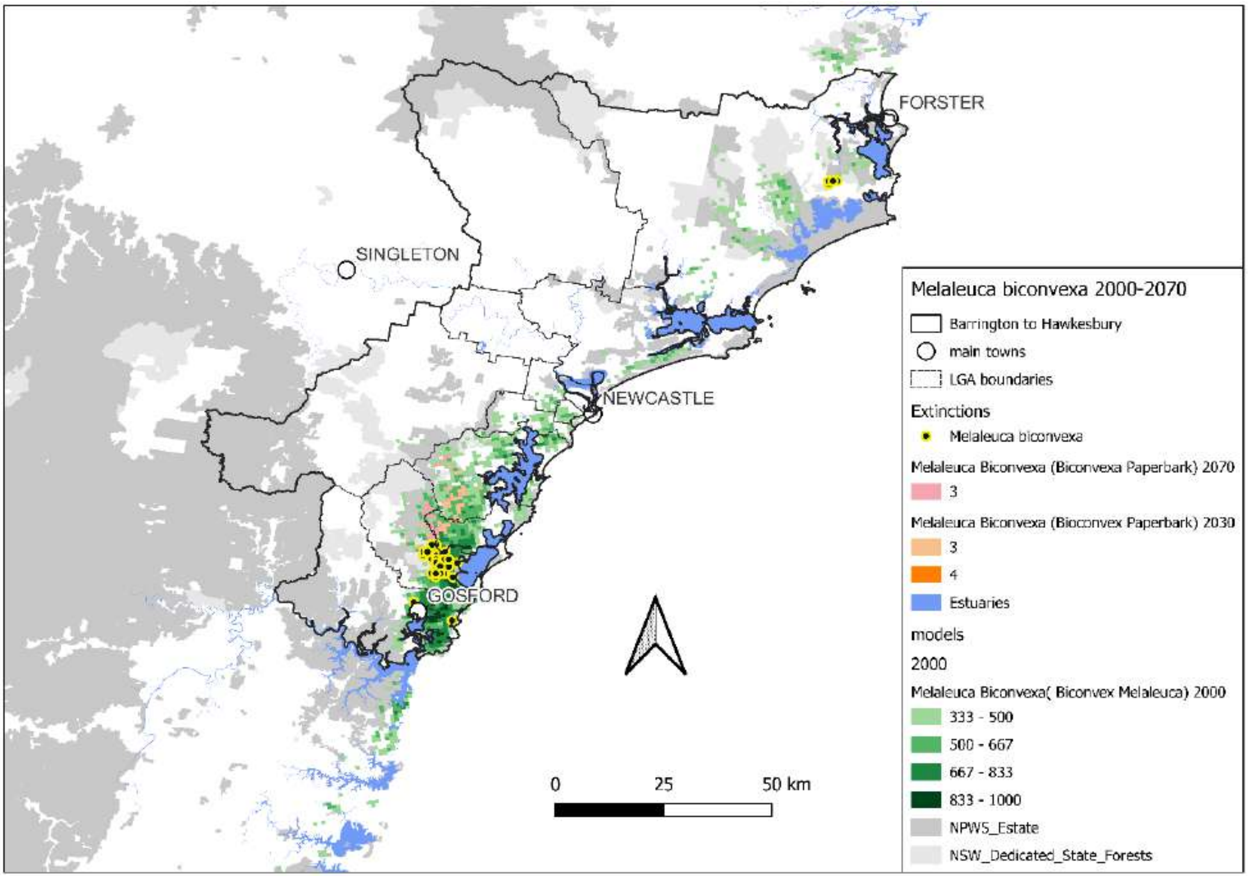
Map 43. Leucopogon exolasius (Woronoa Beard Heath) 2000-2070. No habitat by 2070 all 4 climate futures.



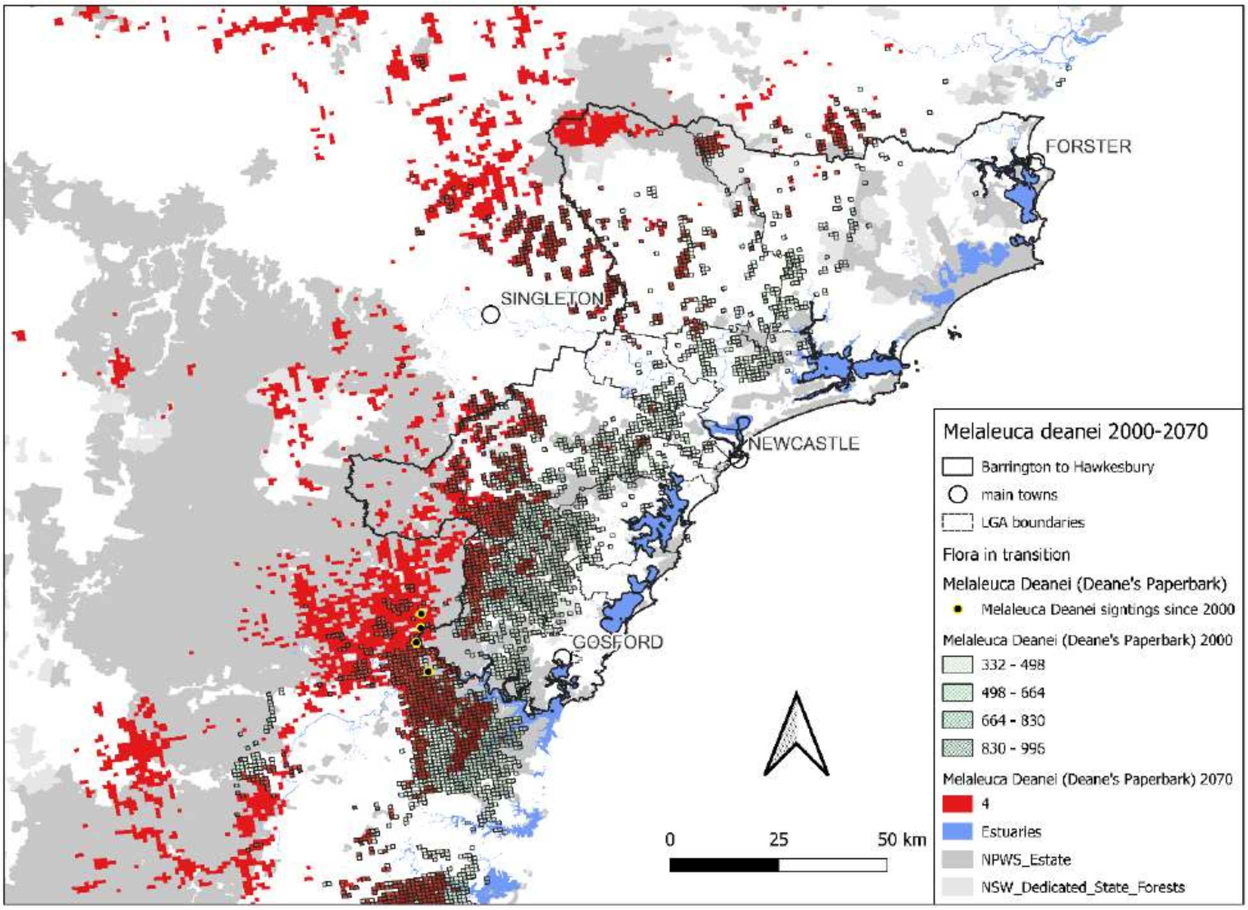
Map 44. Leucopogon fletcheri subsp. Fletcheri 2000-2070. Sighted since 2000. Regional extinction by 2070 all 4 climate futures.



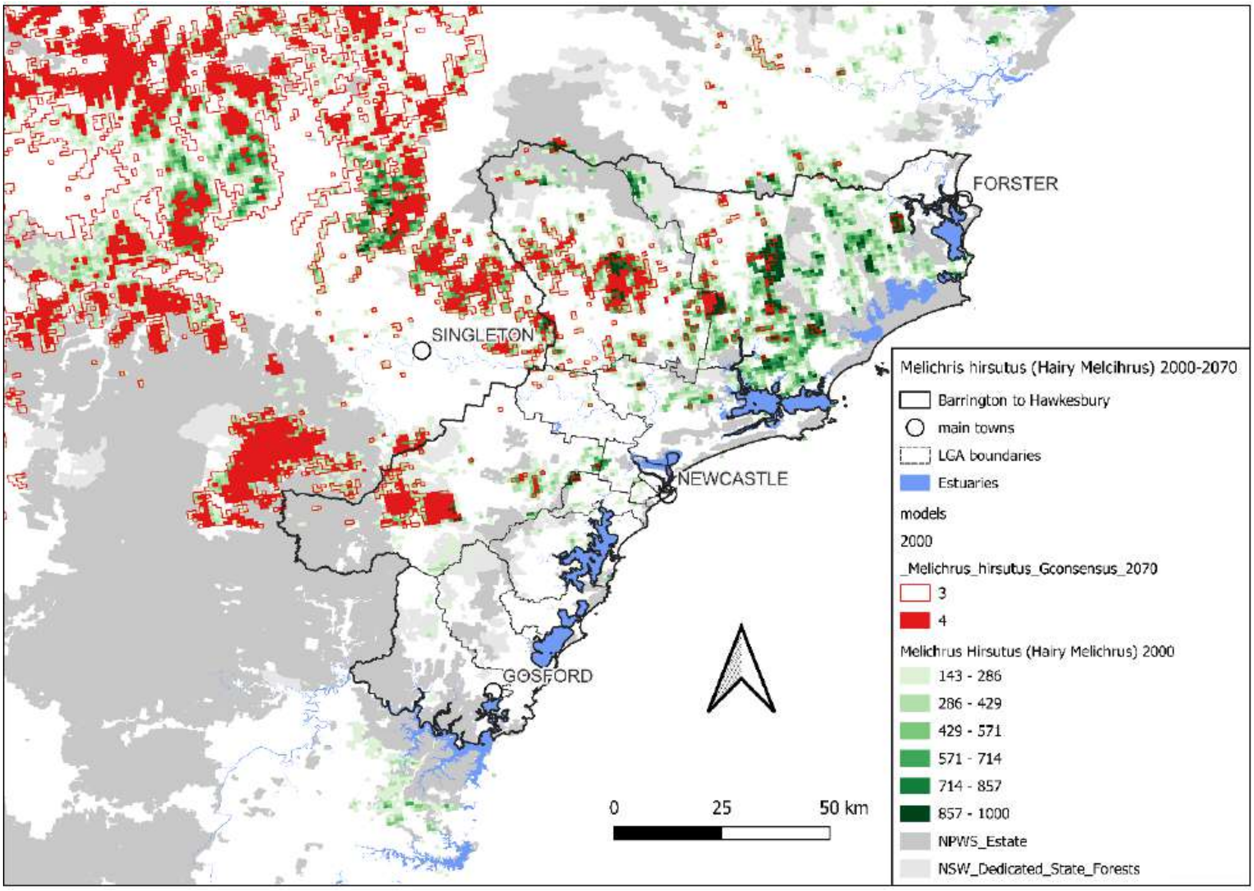
Map 45. Lindernia alsinoides (Noahs False Chickweed) 2000-2070. No habitat by 2070 under all 4 climate futures.



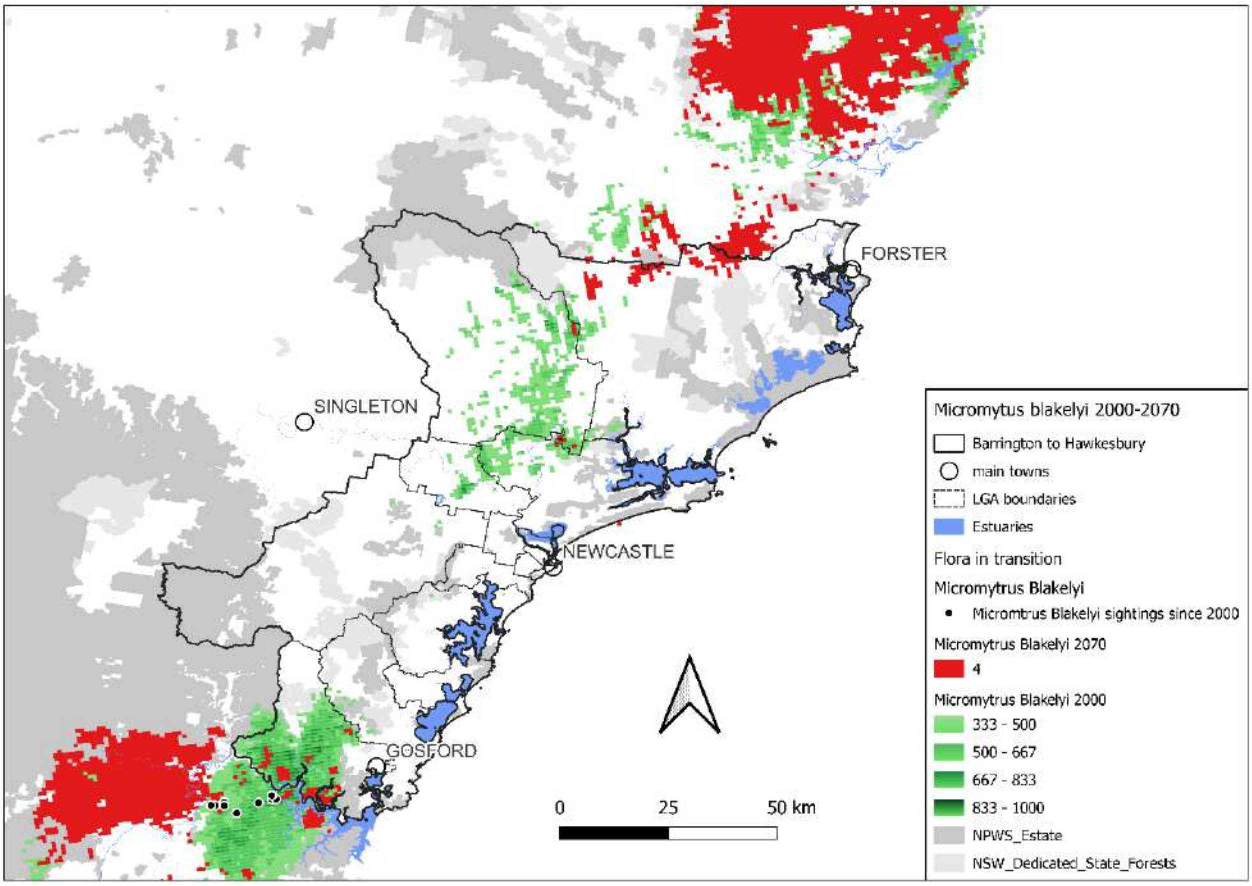
Map 46. Melaleuca biconvexa 2000-2070. Sighted since 2000. Regional extinction by 2070 under all 4 climate futures.



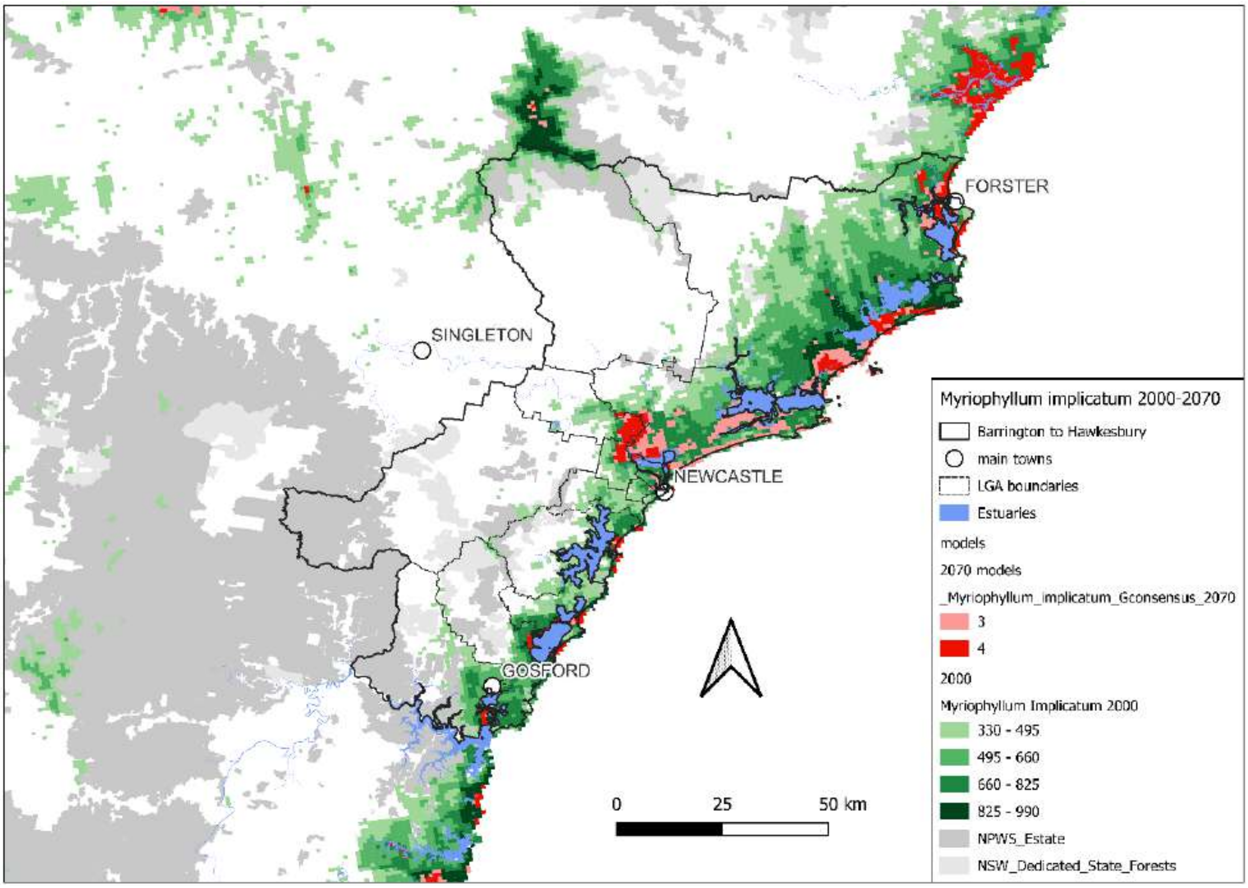
Map 47. Malaleuca deanei (Deans Paperbark) 2000-2070. Sighted since 2000. Range contractions under all 4 climate futures.



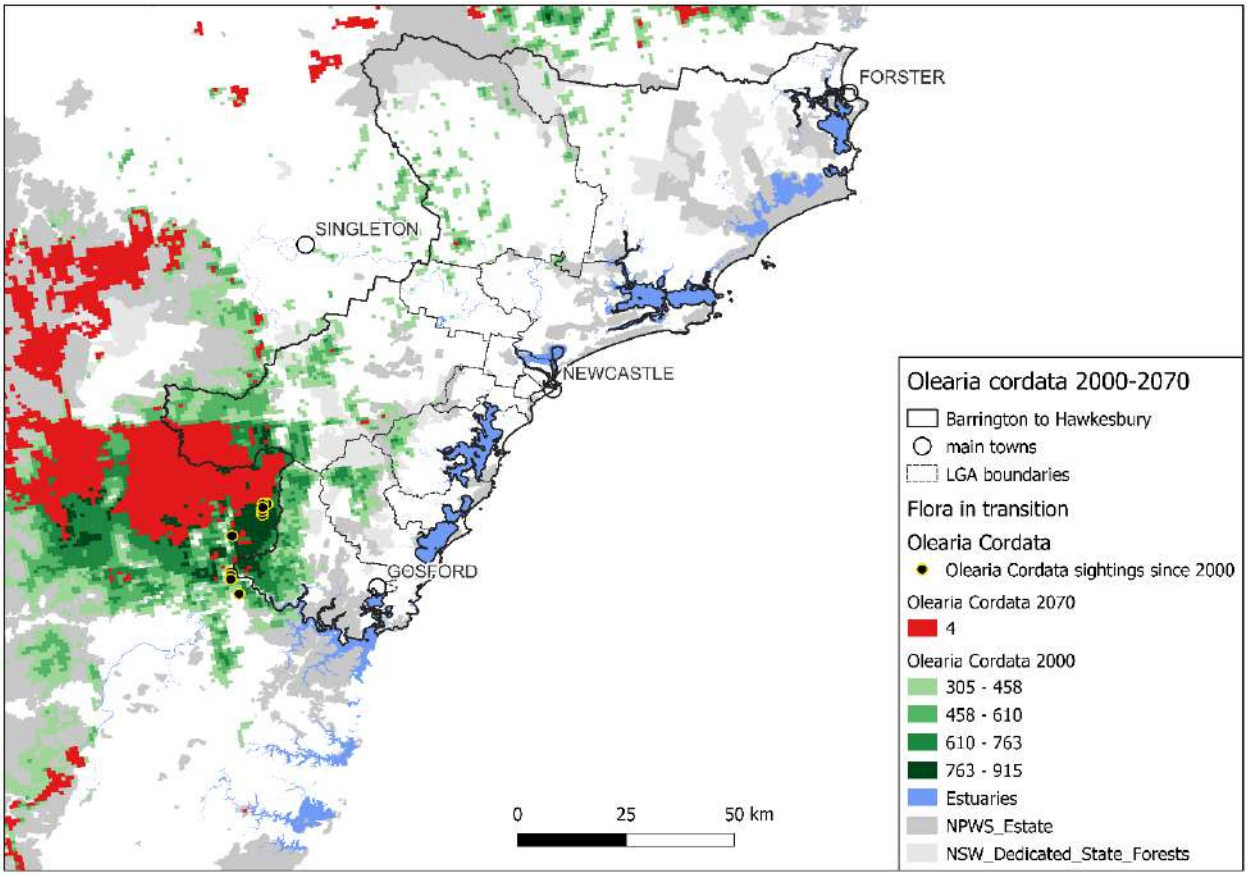
Map 48. Melichris hirsuitus 2000-2070. Range contractions by 2070 under all 4 climate futures.



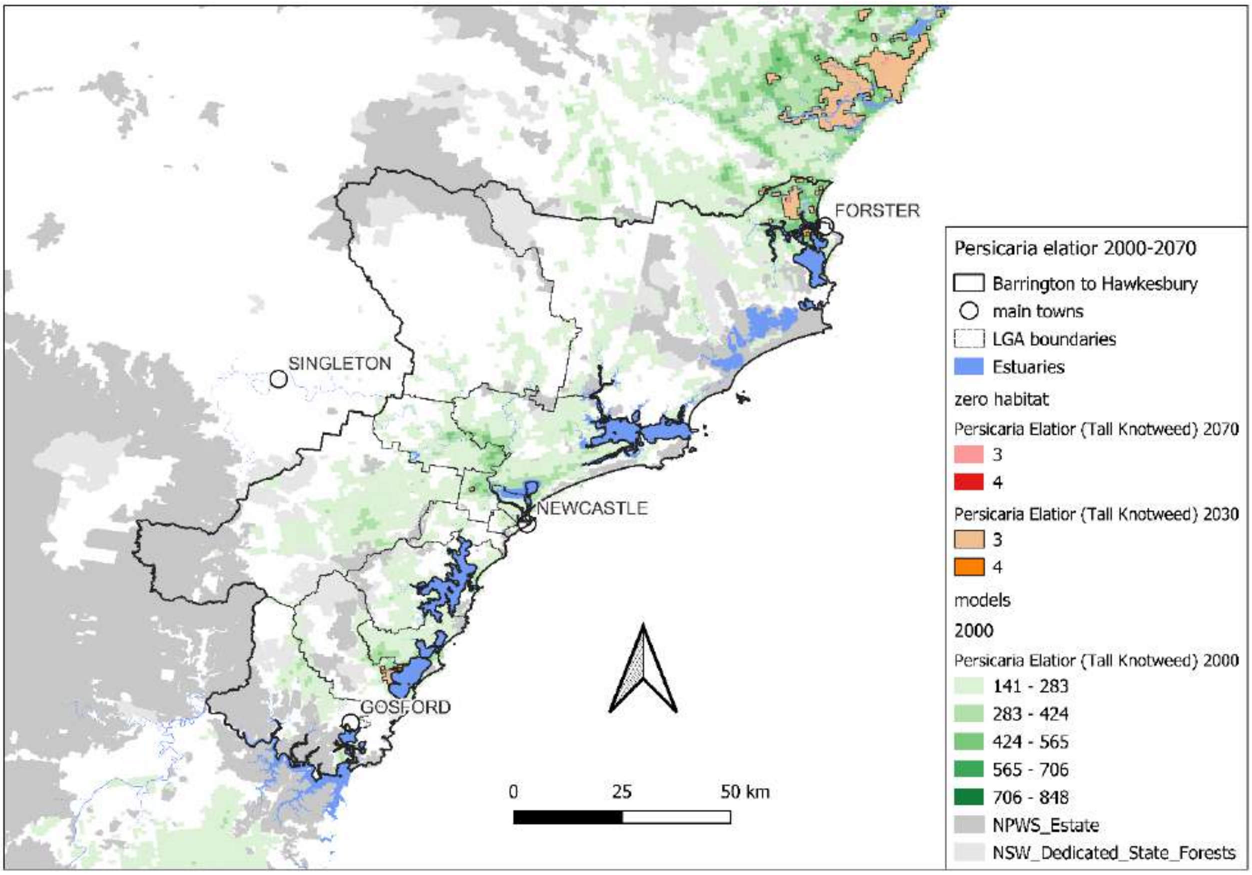
Map 49. Micromtus blakelyi 2000-2070. Sighted since 2000. Range contractions by 2070 under all 4 climate futures.



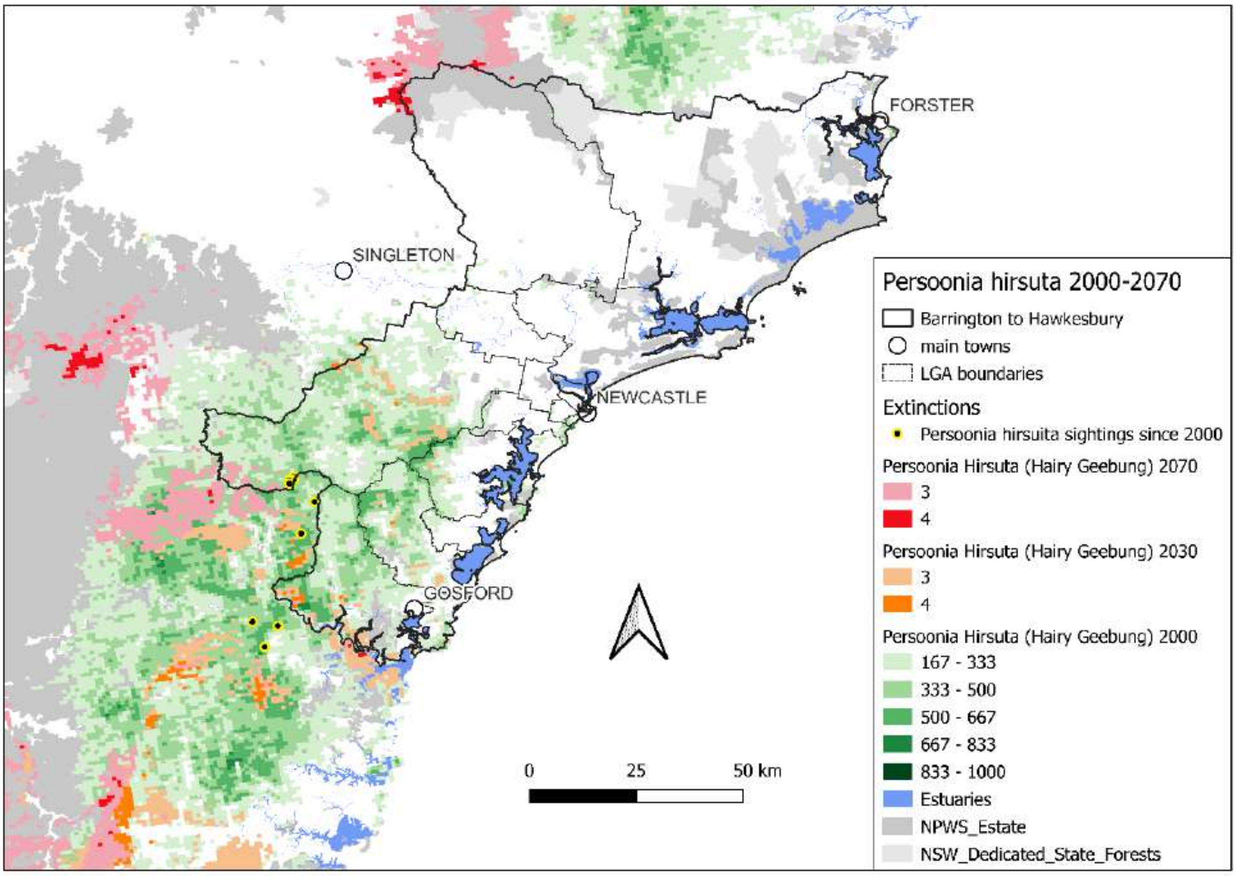
Map 50. Myriophyllum implicatum 2000-2070. Range contractions by 2070 under all 4 climate futures.



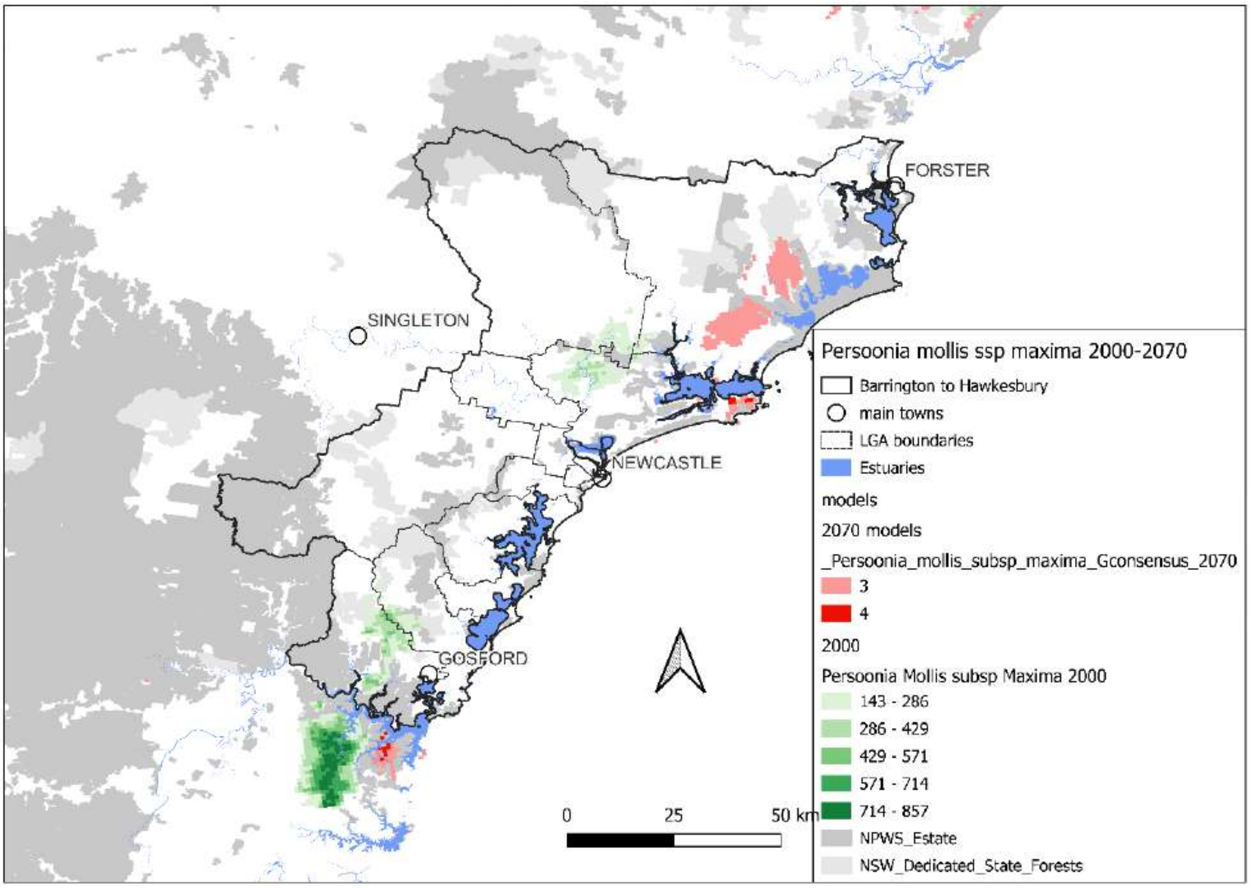
Map 51. Olearia cordata 2000-2070. Sighted since 2000. Range contractions by 2070 under all 4 climate futures.



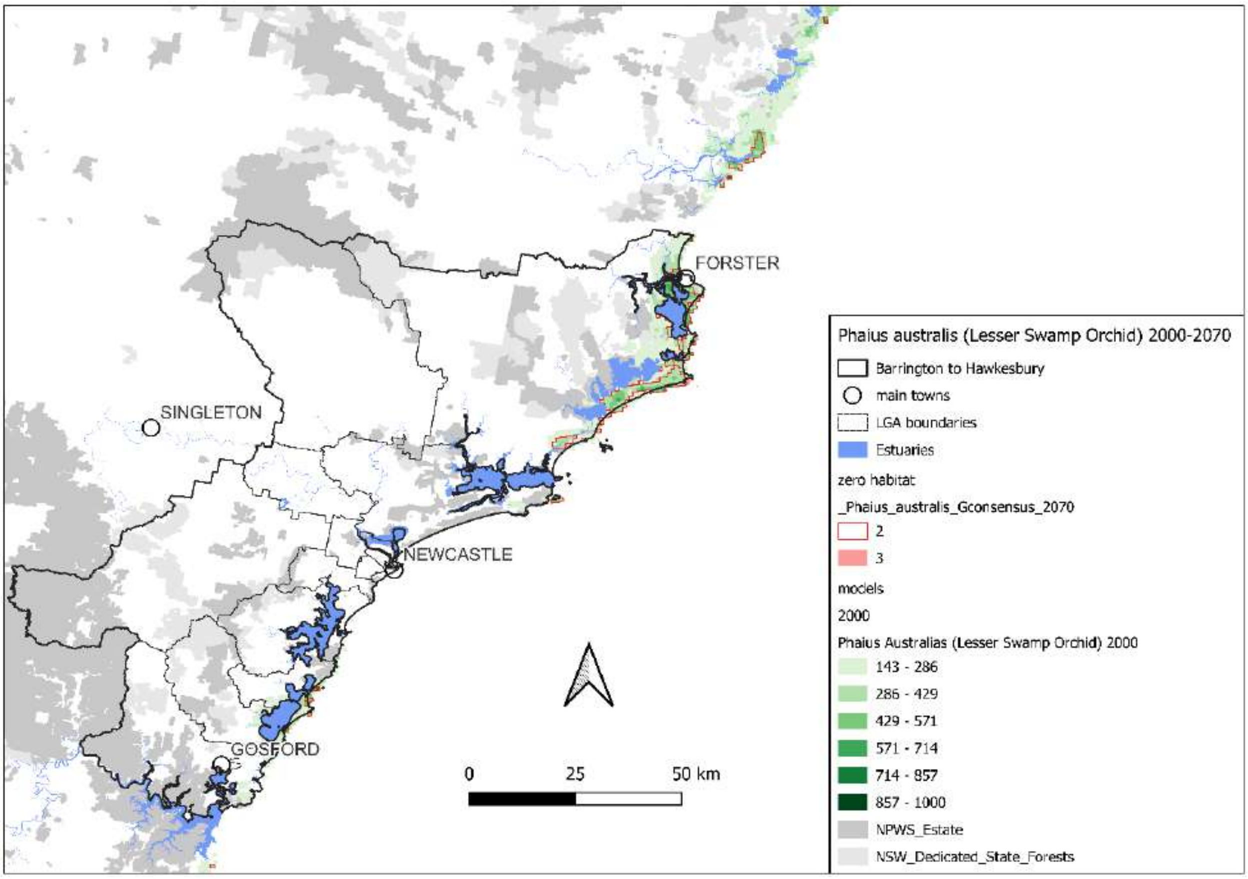
Map 52. Persicaria elatior (Tall Knotweed) 2000-2070. No habitat by 2070 under all 4 climate futures.



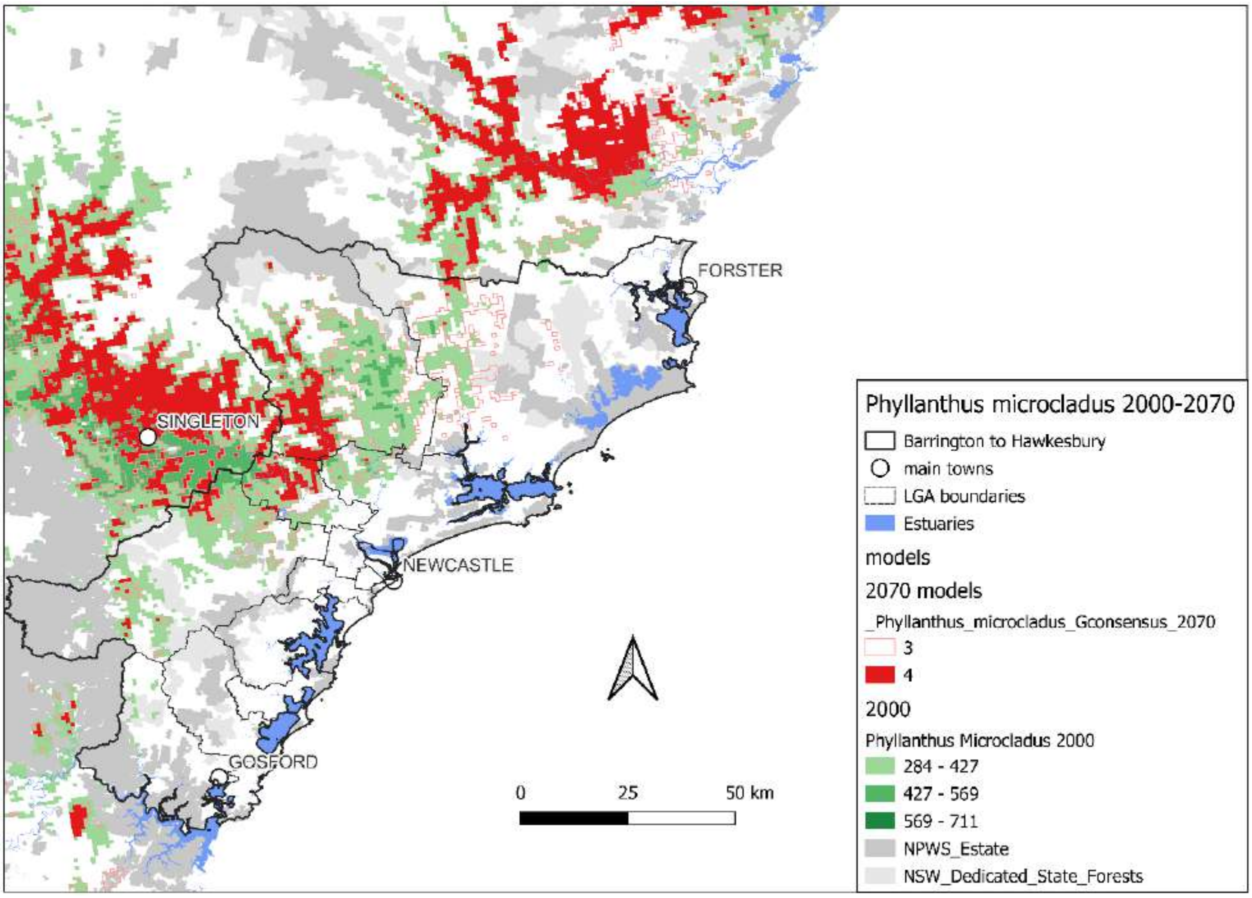
Map 53. Persoonia hirsuta (Hairy geebung) 2000-2070. Sighted since 2000. Regional extinction by 2070 under all 4 climate futures.



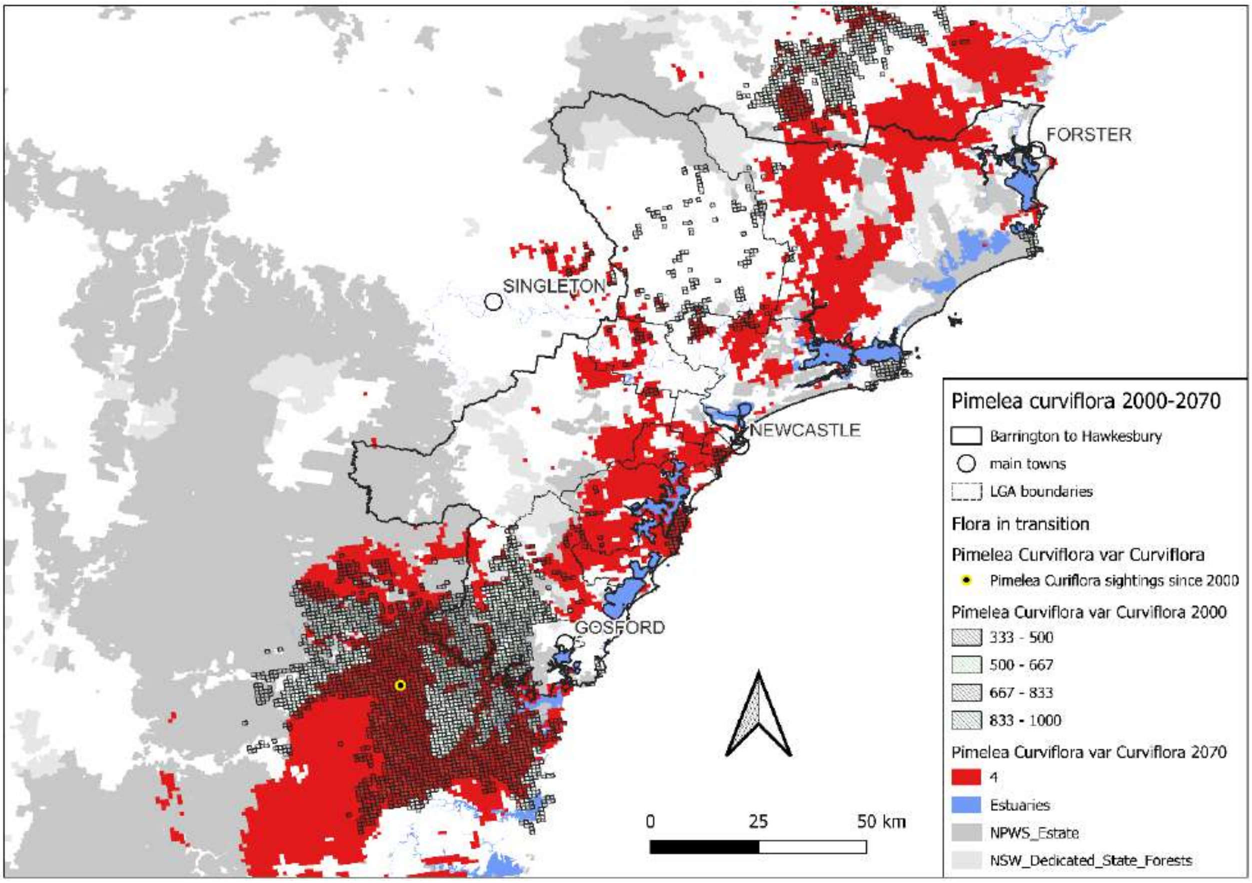
Map 54. Persoonia mollis subsp. maxima 2000-2070. Range contractions by 2070 under all 4 climate futures.



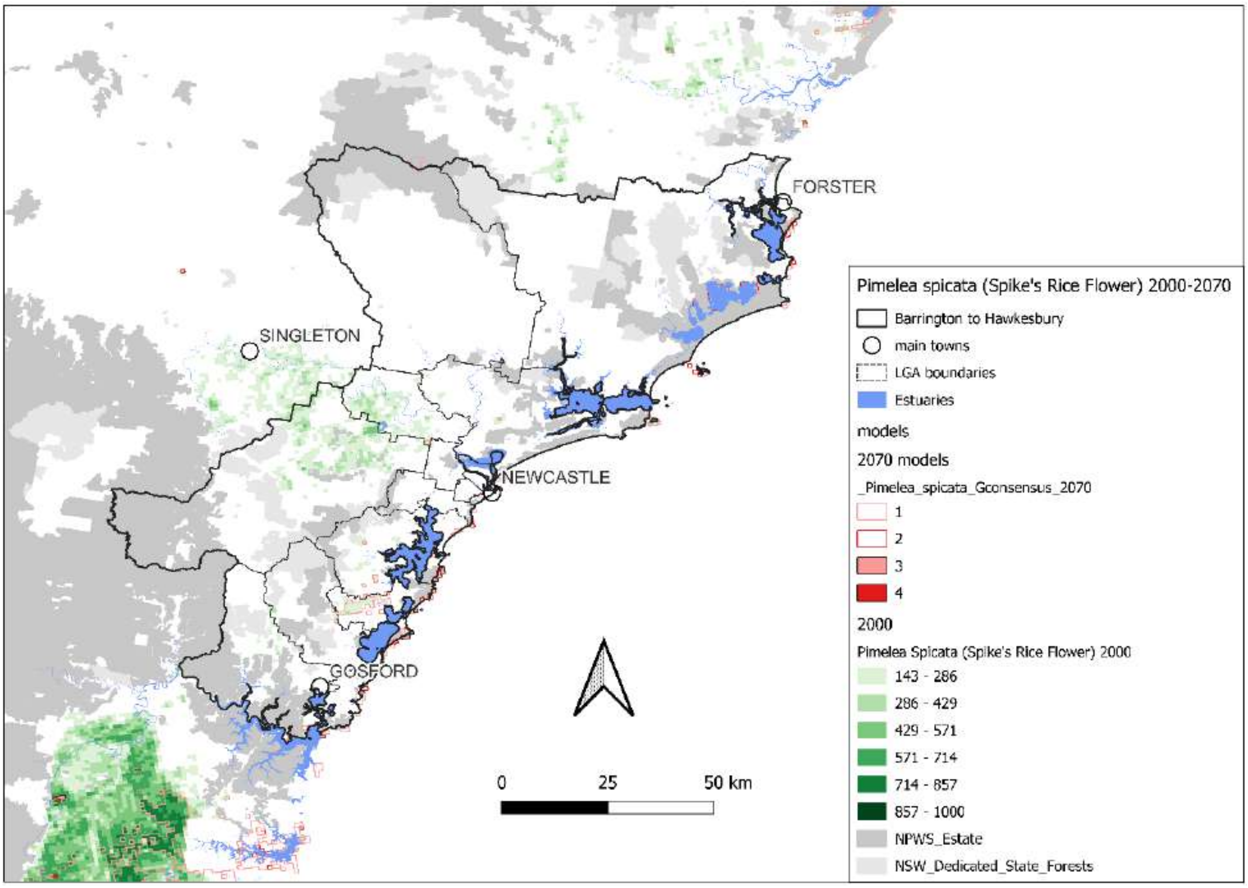
Map 55. Phaius australis (Lesser Swamp Orchid) 2000-2070. No habitat by 2070 under all 4 climate futures.



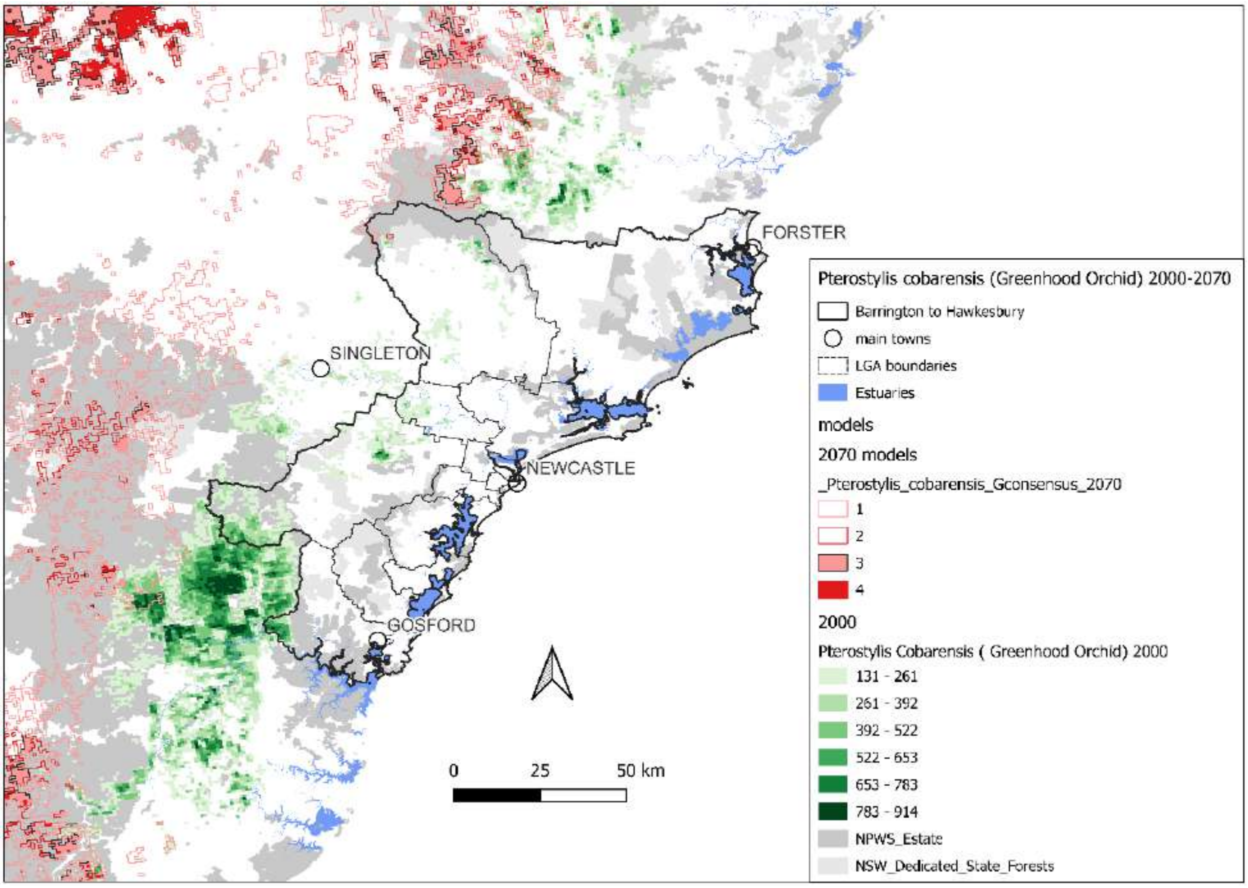
Map 56. Phyllanthus microcladus 2000-2070. Range contractions by 2070 under all 4 climate futures.



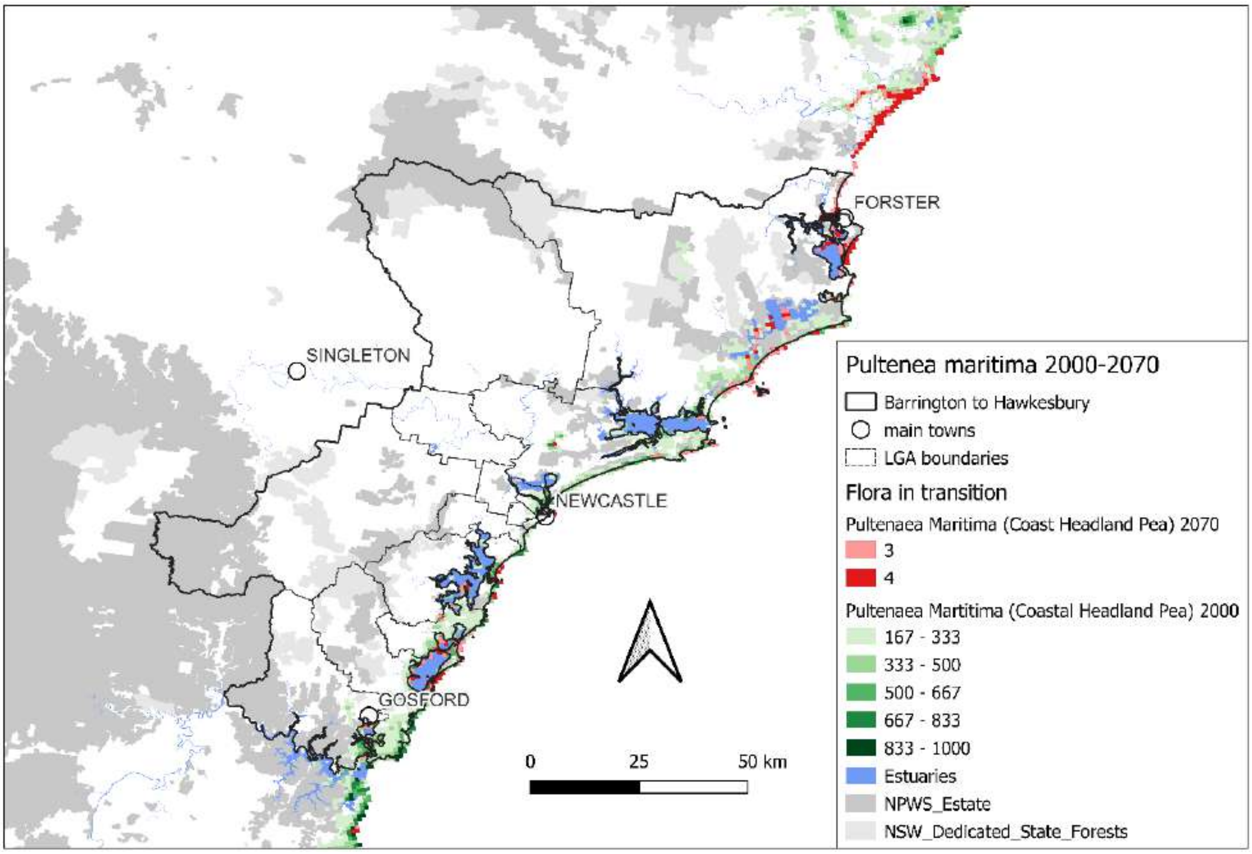
Map 57. Pimelea curviflora 2000-2070. Sighted since 2000. Range expansion by 2070 under all 4 climate futures.



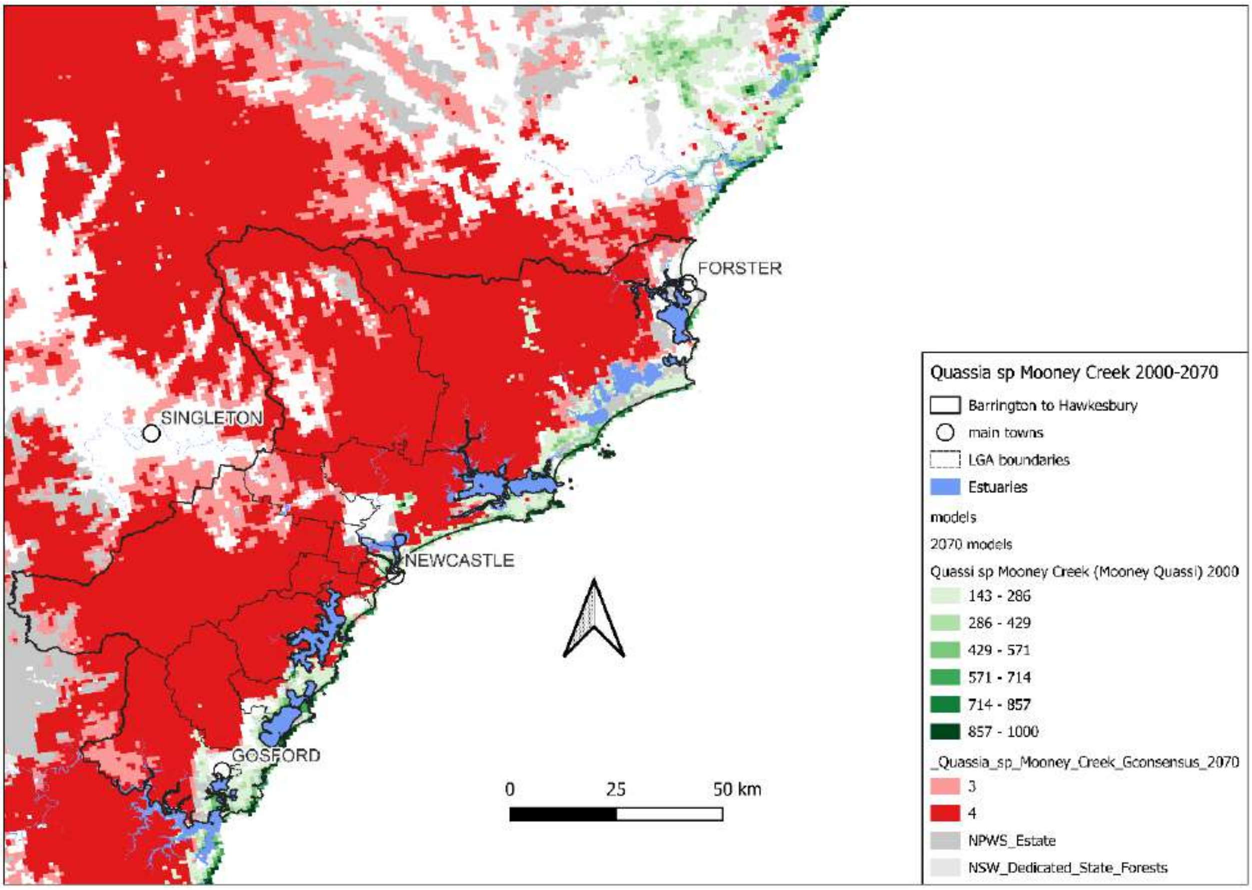
Map 58. Pimelea spicata (Spike's Rice Flower) 2000-2070. No habitat by 2070 under all 4 climate futures.



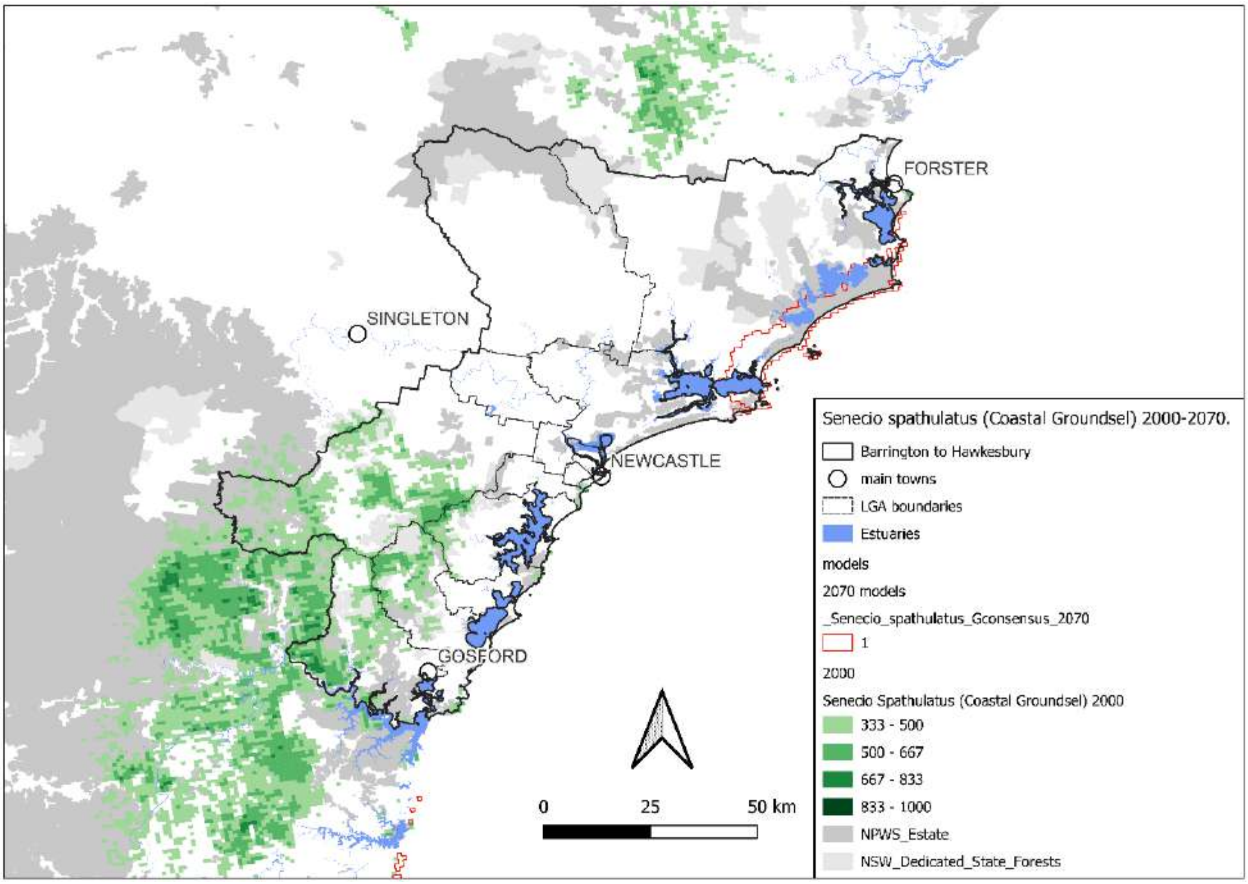
Map 59. Pterostylis cobarensis (Greenhood Orchid) 2000-2070. No habitat by 2070 under all 4 climate futures



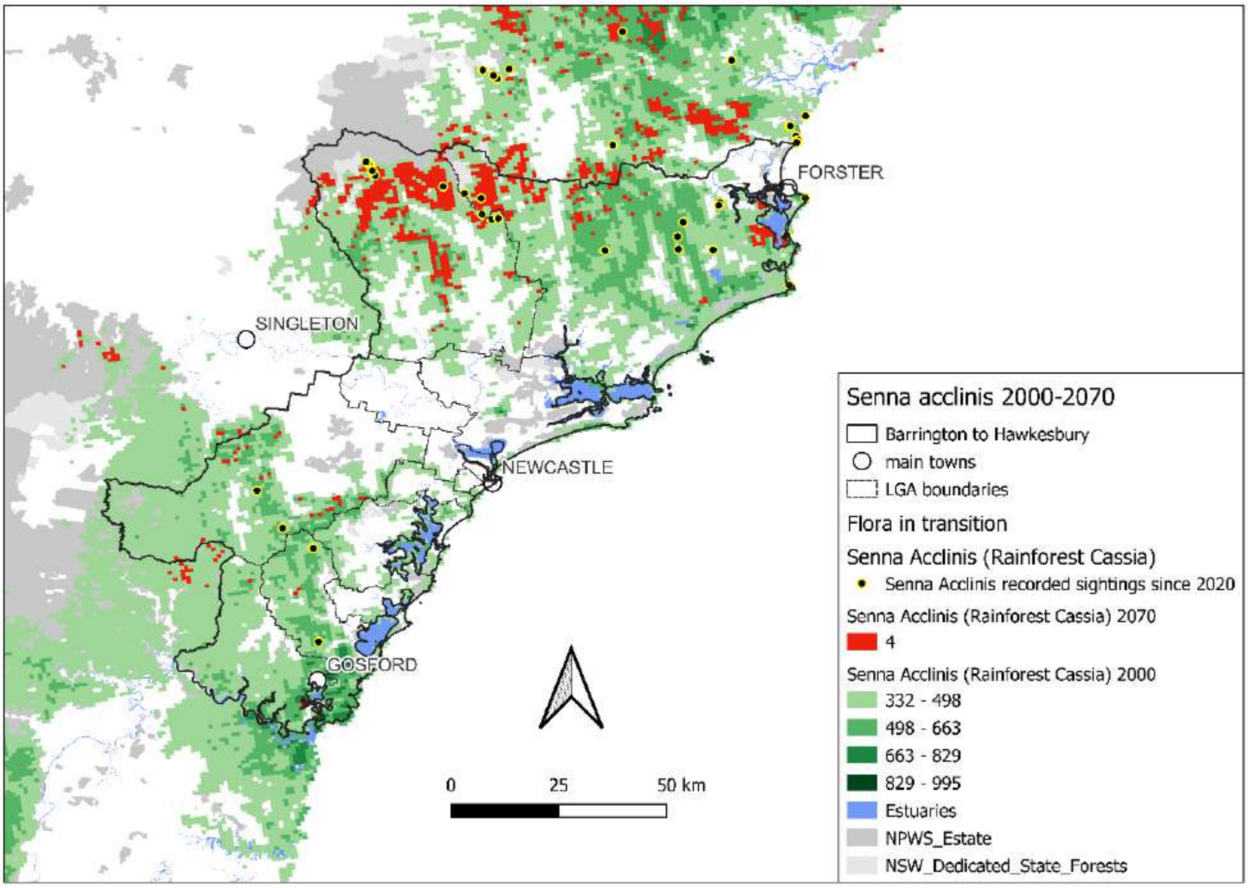
Map 60. Pultenea maritima (Coastal Headland Pea) 2000–2070. Range contractions under all 4 climate futures.



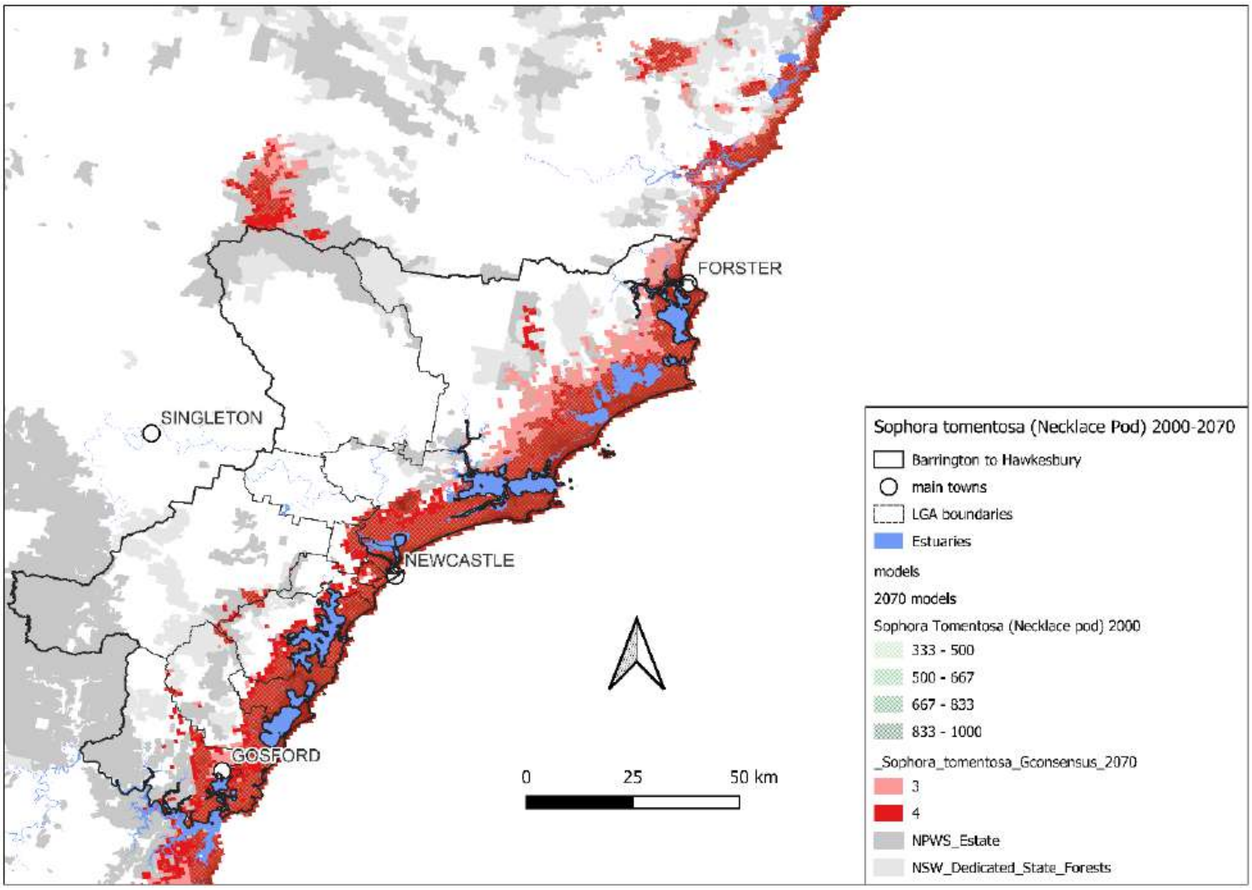
Map 61. Quassia sp. Mooney Creek 2000–2070. Significant range expansions under all 4 climate futures.



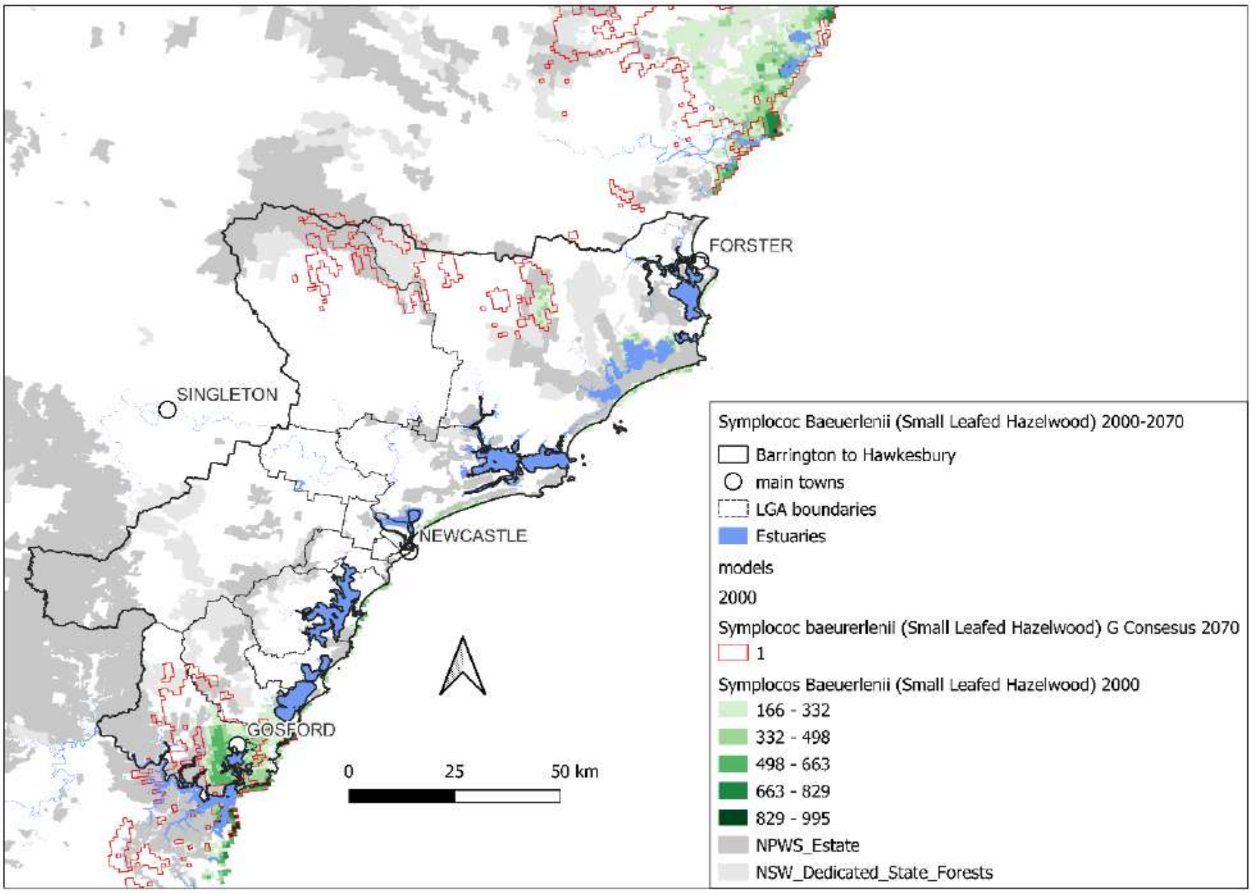
Map 62. Senecio spathulatus (Coastal Groundsel) 2000-2070. No habitat by 2070 under all 4 climate futures.



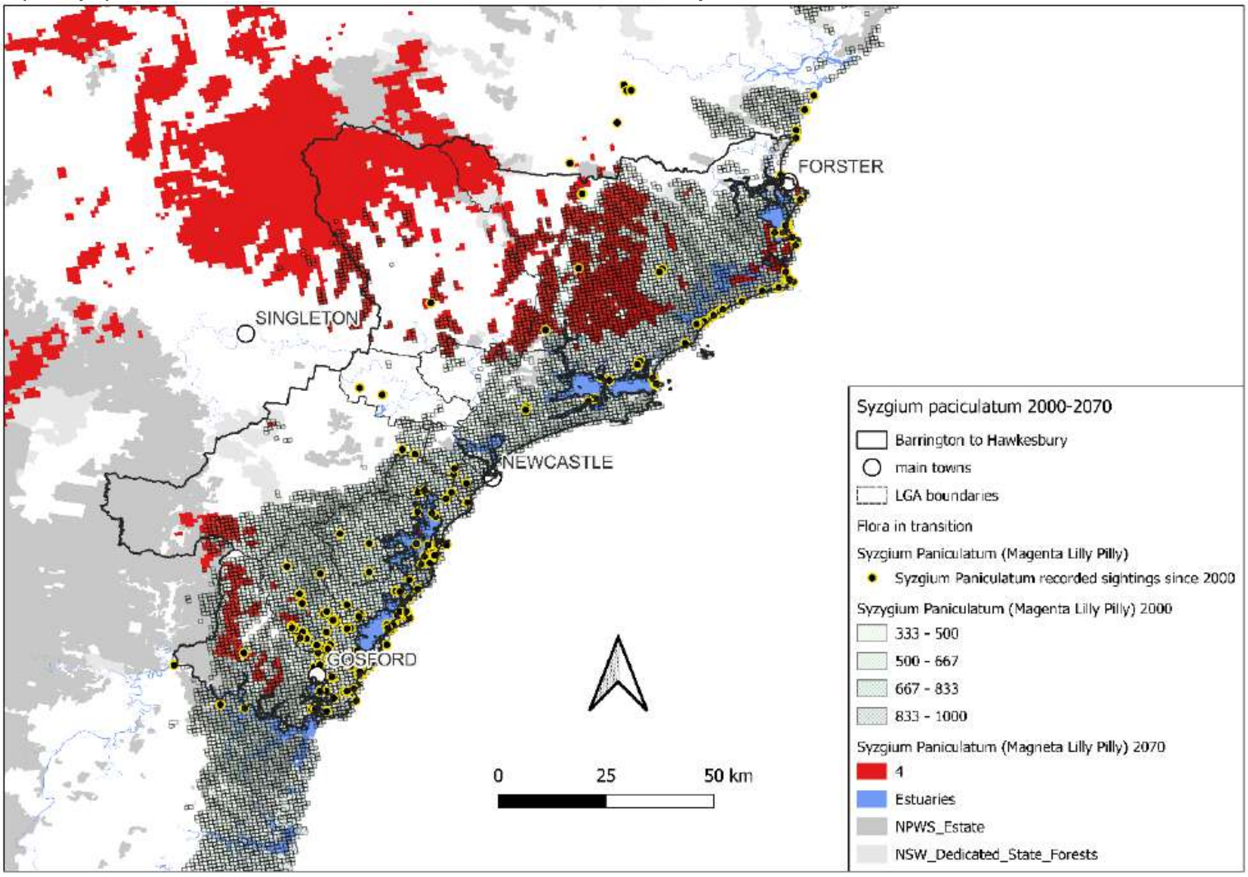
Map 63. Senna acclinis (Rainforest Cassia) 2000-2070. Sighted since 2000. Range contraction by 2070 under all 4 climate futures.



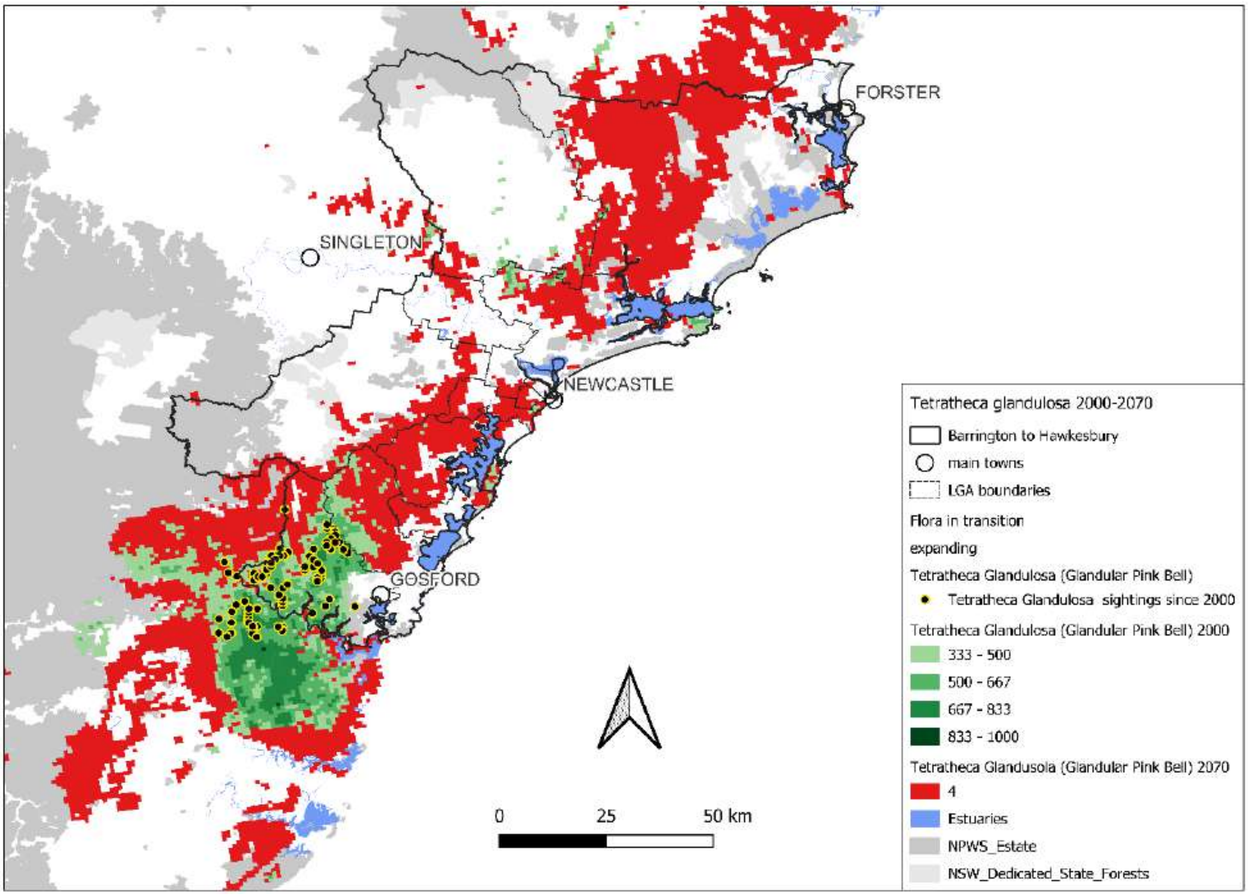
Map 64. Sophora tomentose (Necklace Pod) 2000-2070. Range expansion by 2070 under all 4 climate futures.



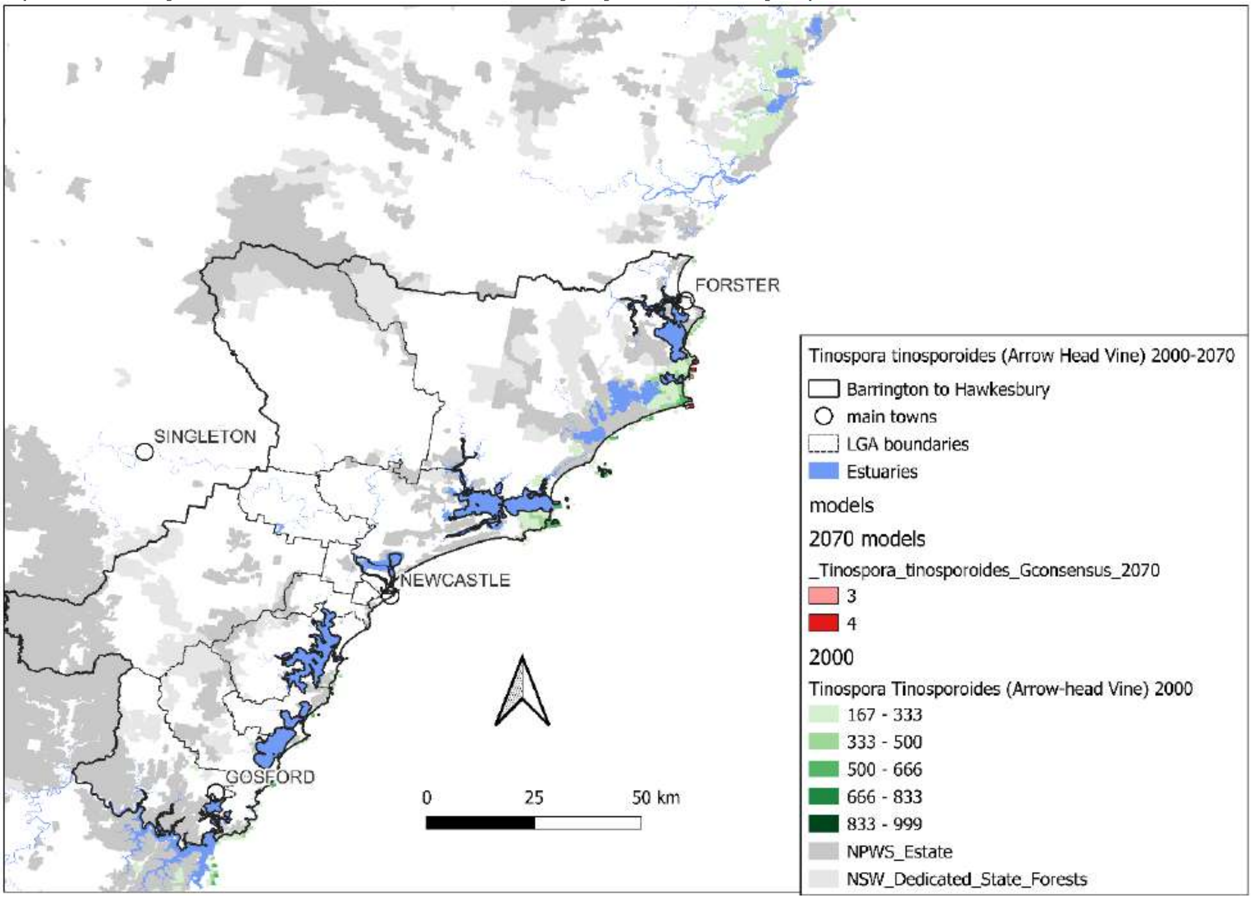
Map 65. Symplococ Beauerlenii (Small Leafed Hazelwood) 2000-2070. No habitat by 2070 under all 4 climate futures.



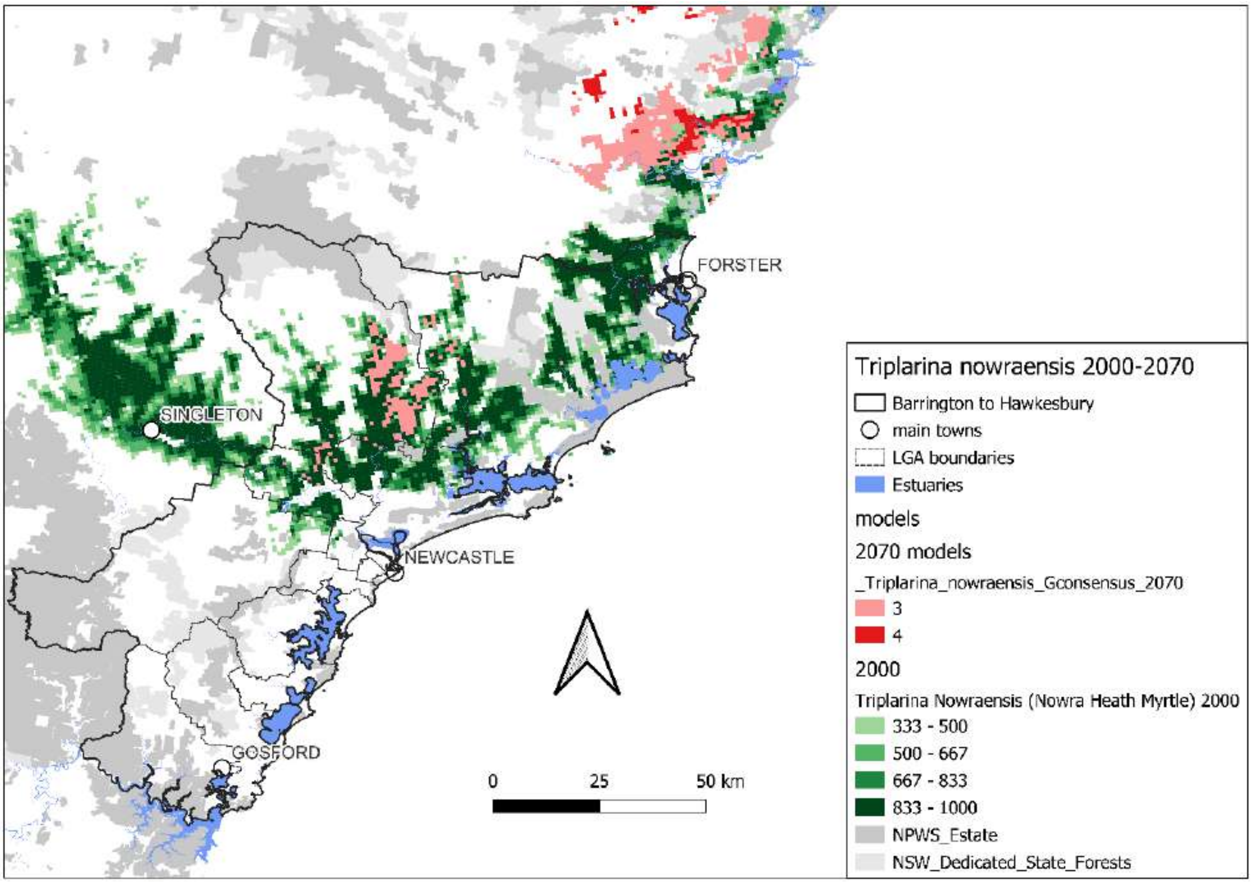
Map 66. Syzigium paniculatum (Magenta Lilly Pilly) 2000-2070. Sighted since 2000. Range contraction by 2070 under all 4 climate futures.



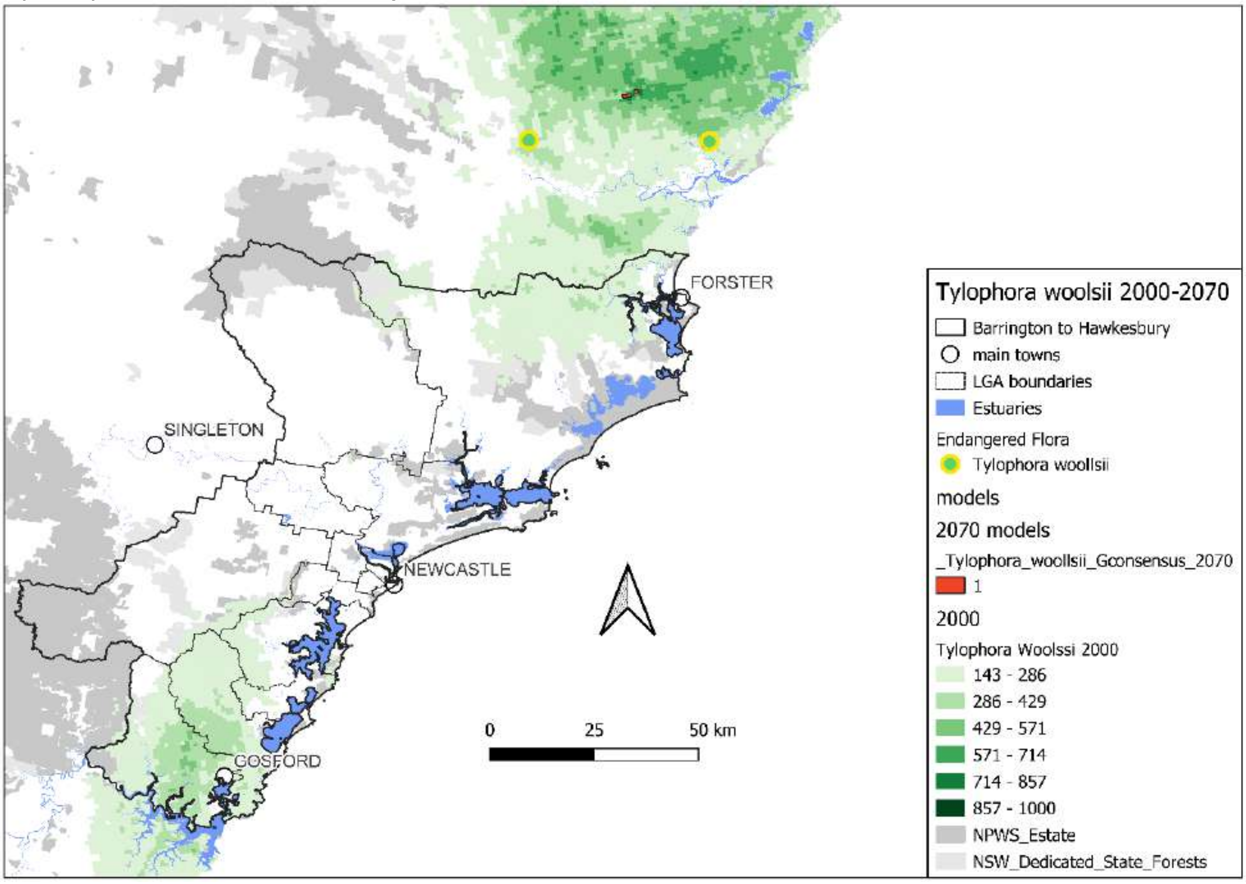
Map 67. Tetratheca glandulosa (Glandular Pink Bell) 2000–2070. Sightings since 2000. Range expansions under all 4 climate futures.



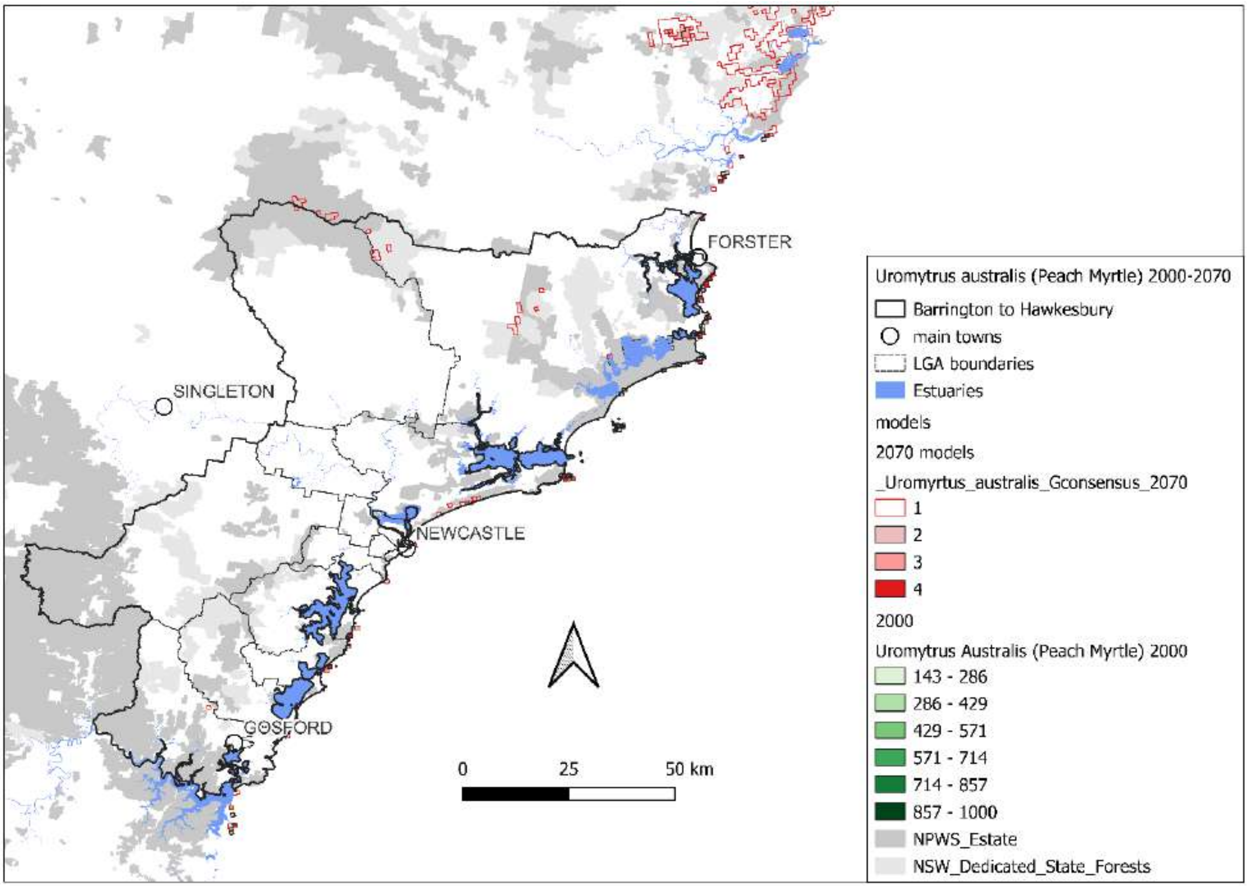
Map 68. Tinospora tinosporoides (Arrow Head Vine) 2000–2070. Range contraction under all 4 climate futures.



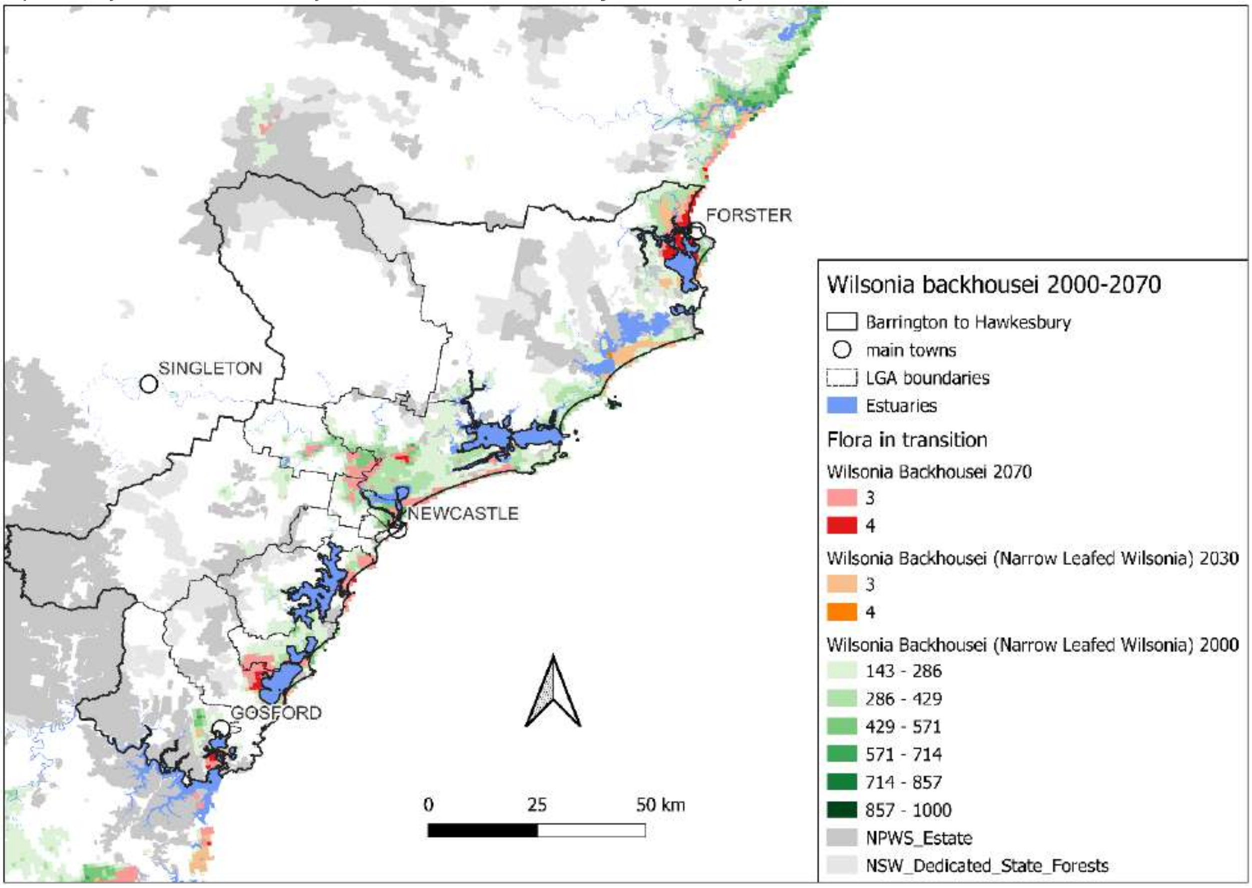
Map 69. Triplarina nowraensis (Nowra Heath Myrtle) 2000-2070. No habitat under all 4 climate futures.



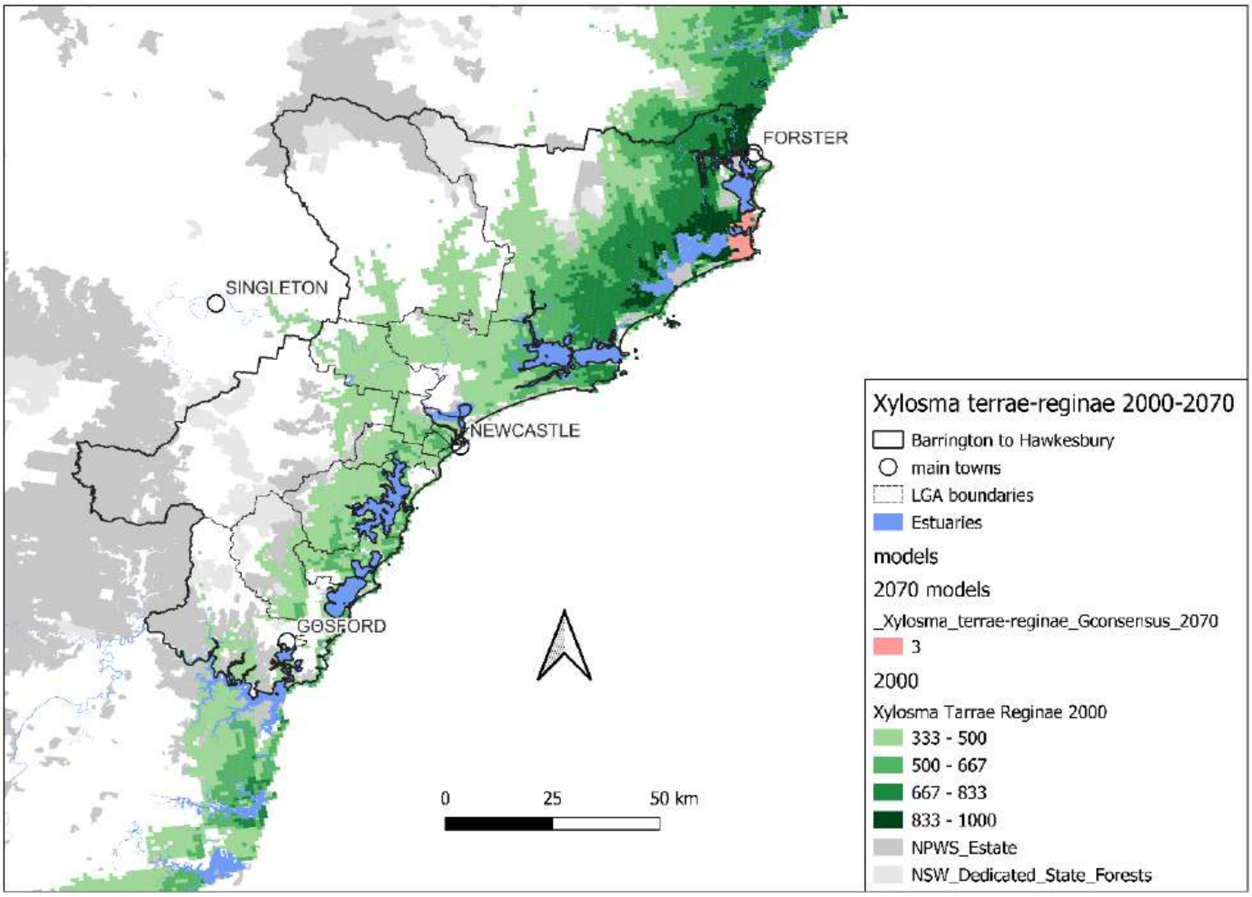
Map 70. Tylophora woolsii 2000-2070. Sighted since 2000. Regional extinction by 2070 under all 4 climate futures.



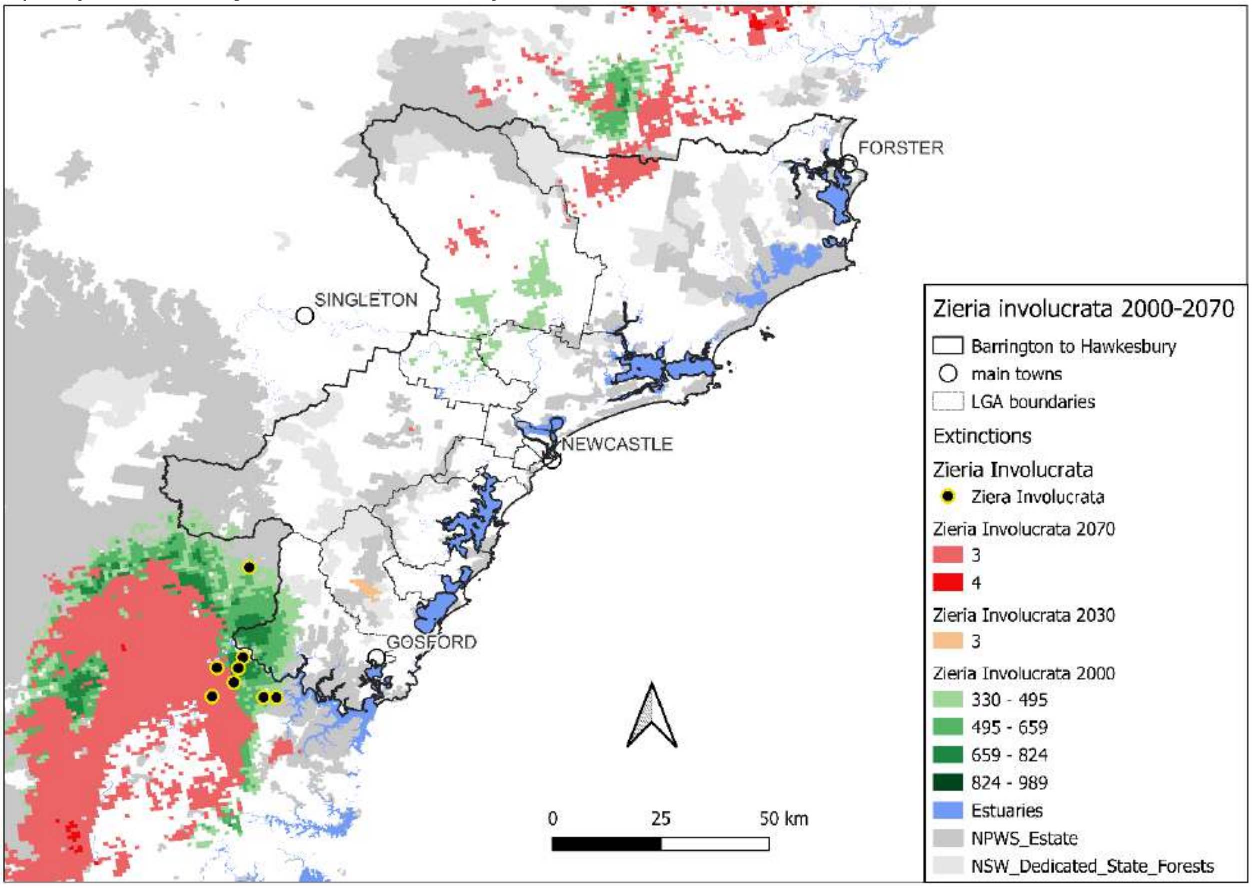
Map 71. Uromytrus australis (Peach Myrtle) 2000-2070 2000-2070. Range contraction by 2070 under all 4 climate futures.



Map 72. Wilsonia backhousei 2000–2070. Range contractions under all 4 climate futures.



Map 73. Xylosome terrae-reginae 2000-2070. No habitat by 2070 under all 4 climate futures.



Map 74. Zerira involucrate 2000-2070. Sightings since 2000. Regional extinction by 2070 under all 4 climate futures.

Appendix 2. Plant Community Types within the Barrington to Hawkesbury Climate Corridors

State Vegetation Class and Plant Community Types	Sum of Hectares	Number of Plant Communities
Rainforests	**83,331**	**39**
Central Coast Gallery Rainforest	776	
Central Eastern Ranges Riparian Dry Rainforest	15	
Greater Sydney Enriched Grey Myrtle Dry Rainforest	52	
Hunter Coast Lowland Grey Myrtle Wet Forest	4,925	
Hunter Valley Whalebone Dry Rainforest	3,042	
Hunter-Peel Ranges Dry Rainforest	7	
Illawarra Escarpment Warm Temperate Rainforest	3	
Lower Hunter Tuckeroo Riparian Rainforest	1,080	
Lower North Grey Myrtle Riparian Dry Rainforest	163	
Lower North Hinterland Riparian Dry Rainforest	2,492	
Lower North Sands Littoral Rainforest	173	
Lower North Waterhousea Riparian Rainforest	10,466	
Lower North Waterhousea-Water Gum Rainforest	6,200	
Lower North Wet Gully Palm Rainforest	6,449	
Mid North Headland Brush Box Littoral Rainforest	5	
Mount Warrawolong Screeslope Rainforest	11	
Mount Yengo Subtropical Dry Rainforest	4	
Myall-Wallis Lakes Littoral Rainforest	520	
Northern Escarpment Antarctic Beech Rainforest	1,453	
Northern Escarpment Coachwood-Beech Rainforest	410	
Northern Escarpment Dry Rainforest	1	
Northern Escarpment Sassafras Rainforest	217	
Northern Escarpment Sassafras-Booyong-Corkwood Rainforest	5,683	
Northern Escarpment Sassafras-Prickly Ash Rainforest	7,957	
Northern Escarpment Shatterwood Dry Rainforest	145	
Northern Hinterland Baloghia-Booyong Subtropical Rainforest	382	
Northern Hinterland Baloghia-Dendrocnide Subtropical Rainforest	18,565	
Northern Hinterland Shatterwood Dry Rainforest	5,940	
Northern Lowland Subtropical Rainforest	176	
Northern Sands Tuckeroo-Banksia Forest	148	
Northwest Sydney Sandstone Grey Myrtle Dry Rainforest	3,894	

Sydney Basin Warm Temperate Rainforest	102	
Sydney Coast Tuckeroo Littoral Rainforest	150	
Sydney Coastal Foreshores Gully Rainforest	3	
Sydney Coastal Lilly Pilly-Palm Gallery Rainforest	331	
Sydney Hinterland Grey Myrtle Riparian Forest	50	
Sydney Sandstone Coachwood-Grey Myrtle Rainforest	1,338	
Tomaree Headland Littoral Rainforest	0	
Western Sydney Complex Dry Rainforest	1	
Wet Sclerophyll Forests (Shrubby sub-formation)	**82,737**	**20**
Central Coast Dolerite Hills Wet Forest	114	
Far South Hinterland Stringybark Sheltered Forest	3,188	
Hunter Coast Ranges Turpentine Wet Forest	28,268	
Lower North Choricarpia Wet Forest	664	
Lower North Escarpment Blue Gum Wet Forest	1,260	
Lower North Foothills Turpentine-Flooded Gum Wet Forest	5,554	
Lower North Ranges Riparian Turpentine Forest	7,482	
Lower North Turpentine-Tallowwood-Grey Gum Forest	938	
Mid North Escarpment Blue Gum Moist Forest	682	
Mount Warrawolong Basalt Wet Forest	53	
Northern Brush Box Subtropical Wet Forest	2	
Northern Escarpment Brush Box-Tallowwood-Maple Wet Forest	8,692	
Northern Escarpment Corkwood-Brush Box Wet Forest	462	
Northern Escarpment Layered Blackbutt Fern Forest	457	
Northern Escarpment New England Blackbutt-Tallowwood Wet Forest	1,241	
Northern Hinterland Brush Box-Quince Wet Forest	589	
Northern Hinterland Tallowwood-Brush Box Wet Forest	17,926	
Northern Lowland Viney Wet Forest	1,333	
Northern Turpentine-Brush Box Wet Forest	3,275	
Sydney Enriched Sandstone Moist Forest	556	
Wet Sclerophyll Forests (Grassy sub-formation)	**230,696**	**32**
Central Coast Escarpment Moist Forest	2,308	
Craven Grey Box Grassy Forest	322	
Hunter Coast Lowland Spotted Gum Moist Forest	7,855	
Hunter Escarpment Enriched Moist Forest	124	
Hunter Range Blue Gum Gully Forest	973	
Hunter Range Colluvial Apple-Gum Forest	8,883	
Hunter Range Sheltered Grey Gum Forest	4,583	
Hunter Range Turpentine-Grey Myrtle Gully Forest	3,371	
Hunter Valley Hills Wet Vine Forest	2,487	
Lower Hunter Screeslope Wet Forest	7	

Lower North Escarpment Blue Gum Grassy Forest	8,218	
Lower North Escarpment Red Gum Grassy Forest	4,233	
Lower North Ranges Turpentine Moist Forest	36,391	
Lower North Sheltered Valley Red Gum Forest	2	
Lower North Spotted Gum-Mahogany-Ironbark Sheltered Forest	61,778	
Lower North White Mahogany-Spotted Gum Moist Forest	31,887	
Northern Blackbutt-Turpentine Shrub Forest	631	
Northern Bloodwood-Ironbark Moist Grassy Forest	30	
Northern Escarpment Messmate Cool Wet Forest	402	
Northern Escarpment Messmate Moist Grassy Forest	3,974	
Northern Foothills Blackbutt Grassy Forest	18,689	
Northern Gorges Diverse Grassy Forest	492	
Northern Hinterland Blackbutt-Forest Oak Wet Forest	170	
Northern Hinterland Grey Gum-Mahogany Grassy Forest	447	
Northern Hinterland Grey Gum-Turpentine Mesic Forest	525	
Northern Hinterland Tallowwood-Forest Oak Grassy Forest	4,870	
Northern Hinterland White Mahogany Moist Grassy Forest	13,883	
Sydney Basin Creekflat Blue Gum-Apple Forest	889	
Sydney Coastal Shale-Sandstone Forest	11	
Sydney Turpentine Ironbark Forest	2	
Watagan Range Turpentine-Mahogany Grassy Forest	12,192	
West Mount Royal Slopes Grassy Forest	66	
Dry Sclerophyll Forests (Shrub/grass sub-formation)	**97,288**	**17**
Central Hunter Ironbark Grassy Woodland	484	
Hunter Coast Foothills Apple-Ironbark Grassy Forest	5,101	
Hunter Coast Foothills Spotted Gum-Ironbark Grassy Forest	43,608	
Hunter Coast Lowland Flats Damp Forest	4,485	
Hunter Coast Lowland Spotted Gum Dry Forest	1,015	
Hunter Coast Sandy Creekflat Low Paperbark Scrub	4,789	
Hunter Coast White Mahogany Low Forest	547	
Hunter Escarpment Footslopes Ironbark Forest	326	
Hunter Escarpment Grey Box Forest	332	
Lower Hunter Clay Heath	10	
Lower Hunter Lowland Ironbark-Paperbark Forest	2,522	
Lower Hunter Spotted Gum Scrubby Transition Forest	2,252	
Lower Hunter Spotted Gum-Ironbark Forest	5,774	
Lower North Coastal Hills Red Gum Grassy Forest	49	
Lower North Foothills Ironbark-Box-Gum Grassy Forest	25,897	
Lower North Serpentinite Red Gum Woodland	3	
Northern Gorges Red Gum-Stringybark Forest	95	

Dry Sclerophyll Forests (Shrubby sub-formation)	**188,205**	**41**
Blue Mountains Peppermint Shrub Forest	397	
Coastal Sands Apple-Blackbutt Forest	19,033	
Coastal Sands Bloodwood Low Forest	641	
Coastal Sands Littoral Scrub-Forest	581	
Cockle Creek Sandflat Scribbly Gum Forest	26	
Far South Coastal Ranges Silvertop Ash Forest	1,579	
Hunter Coast Foothills Apple Forest	9,047	
Hunter Coast Lowland Apple-Bloodwood Forest	15,531	
Hunter Coast Lowland Scribbly Gum Forest	10,899	
Hunter Range Grey Gum-Stringybark Forest	3,022	
Hunter Range Ironbark Forest	31,500	
Hunter Range Peppermint Moist Gully Forest	0	
Hunter Range Rockplate Scrub	3	
Hunter Range Yellow Bloodwood Forest	549	
Kanangra Peaks Silvertop Ash Forest	2	
Kurri Sand Heathy Woodland	1,521	
Kurri Sand-Clay Woodland	2,165	
Lower Hunter Yellow Bloodwood Forest	1,296	
Lower North Escarpment Rocky Shrub Woodland	4	
Lower North Sand Swale Banksia Woodland	191	
Lower North Sandplain Heathy Forest	2,406	
Northern Sydney Scribbly Gum Woodland	4,959	
Pearl Beach Sand Forest	28	
Quorrobolong Sand Flats Forest	2,478	
Shoalhaven Escarpment Peppermint-Silvertop Ash Forest	193	
South Coast Sands Bangalay Littoral Forest	47	
Southeast Foothills Woollybutt Dry Shrub Forest	384	
Southeast Hinterland Silvertop Ash-Stringybark Forest	214	
Sydney Coastal Enriched Sandstone Forest	242	
Sydney Coastal Sandstone Bloodwood Shrub Forest	23,683	
Sydney Coastal Sandstone Foreshores Forest	2	
Sydney Coastal Sandstone Gully Forest	220	
Sydney Coastal Sandstone Riparian Forest	1,186	
Sydney Hinterland Grey Gum Transition Forest	0	
Sydney Hinterland Peppermint-Apple Forest	13,687	
Sydney Hinterland Turpentine Sheltered Forest	1,950	
Sydney Hinterland Turpentine-Apple Gully Forest	13,374	
Sydney Hinterland Yellow Bloodwood Woodland	25,028	
Umina Coastal Sand Woodland	68	
Watagan Escarpment Rocky Shrub Forest	70	

Western Hunter Rockplate Micromyrtus Heath	0	
Forested Wetlands	**58,572**	**41**
Central Coast Flats Mesic Swamp Forest	660	
Central Hunter Swamp Oak Riparian Forest	111	
Coastal Creekflat Layered Grass-Sedge Swamp Forest	4,665	
Coastal Creekline Dry Shrubby Swamp Forest	438	
Coastal Floodplain Swamp Paperbark Scrub	300	
Coastal Sand Swamp Mahogany Dry Forest	387	
Coastal Sands Swamp Mahogany Rush Forest	1,567	
Coastal Valleys Swamp Oak Riparian Forest	2,915	
Estuarine Sea Rush Swamp Oak Forest	2,600	
Estuarine Swamp Oak Twig-rush Forest	5,026	
Estuarine Swamp Oak-Mangrove Forest	242	
Far North Mesophyll Paperbark Swamp Forest	23	
Hunter Coast Lake Flats Apple Forest	770	
Hunter Coast Paperbark-Swamp Mahogany Forest	1,295	
Hunter Coast Sandplain Sedge Paperbark Wetland	12	
Hunter Coast Swamp Oak Rainforest	16	
Hunter Estuarine Melaleuca nodosa Scrub	397	
Hunter Range Creekflat Apple-Red Gum Forest	1,400	
Hunter River Oak Mesic Forest	77	
Lower North Creekflat Mahogany Swamp Forest	2,994	
Lower North Hinterland River Oak Forest	1,530	
Lower North Riverflat Eucalypt-Paperbark Forest	10,606	
Northern Creekflat Eucalypt-Paperbark Mesic Swamp Forest	3,743	
Northern Estuarine Paperbark Sedge Forest	1,823	
Northern Floodplain Paperbark Fern Swamp Forest	4	
Northern Hinterland Grassy River Oak Forest	38	
Northern Hinterland River Oak Sheltered Forest	2	
Northern Lowland Orange Gum Dry Swamp Forest	21	
Northern Melaleuca quinquenervia Swamp Forest	6,100	
Northern Paperbark-Swamp Mahogany Saw-sedge Forest	4,681	
Northern Sands Paperbark Sedge Low Forest	108	
Northern Sands Swamp Mahogany Shrubby Rush Forest	91	
Northern Swamp Mahogany-Bottlebrush Swamp Forest	1,835	
Northern Swamp Oak-Paperbark Forest	203	
Southern Estuarine Swamp Paperbark Creekflat Scrub	280	
Sydney Coastal Sandstone Riparian Scrub	192	
Sydney Creekflat Swamp Mahogany-Paperbark Forest	41	
Sydney Hinterland Red Gum Riverflat Forest	745	
Tomago Drooping Red Gum Swamp Woodland	348	

Wyong Paperbark-Woollybutt Swamp Forest	283	
Yengo Creekflat Sedgeland	4	
Freshwater Wetlands	**11,732**	**30**
Blue Mountains Swamp Heath	1	
Coast Sands Baumea articulata Sedgeland	2,100	
Coast Sands Cladium Sedgeland	4	
Coast Sands Lepironia Sedgeland	244	
Coastal Floodplain Phragmites Reedland	1,464	
Coastal Sand Couch Wetland	1	
Coastal Sydney Sand Saw-sedge Wet Shrubland	45	
Estuarine Reedland	212	
Foredune Swale Marsh	2	
Hunter Coast Grasstree Graminoid Swamp Scrub	34	
Lower North Sands Swamp Scrub	1,770	
Lower North Sands Wallum Bottlebrush Swamp Heath	342	
New England Tableland Carex Fens	3	
Northern Lower Floodplain Eleocharis Wetland	921	
Northern Lowland Clay Wet Heath	1,383	
Northern Sand Swale Paperbark Sedge Shrubland	60	
Northern Sandplain Saw-sedge-Fern Swamp Heath	120	
Northern Sandplain Wet Heath	865	
Northern Sands Baloskion-Baumea Wetland	302	
Northern Sands Baumea-Eleocharis Sedgeland	15	
Northern Sands Chorizandra Sedgeland	71	
Northern Sands Prickly Tea-tree Wet Shrubland	2	
Southern Lower Floodplain Freshwater Wetland	1,318	
Sydney Coastal Sand Swamp Scrub	49	
Sydney Coastal Sandstone Creekline Swamp Heath	0	
Sydney Coastal Upland Swamp Heath	394	
Sydney Sandstone Button Grass Sedgeland	2	
Tableland Semi-permanent Shallow Wetlands	2	
Western New England Wet Tea-tree Scrub	5	
Grasslands	**464**	**3**
Central Headland Grassland	33	
Northern Headland Grassland	1	
Spinifex Strandline Grassland	430	
Grassy Woodlands	**5,646**	**9**
Barrington-Point Lookout Montane Grassy Forest	605	
Central Hunter Ironbark-Spotted Gum Forest	2,377	

Cumberland Moist Shale Woodland	5	
Cumberland Shale-Sandstone Ironbark Forest	4	
Hunter Range Basalt Peaks Red Gum-Velvet Wattle Forest	77	
Liverpool Range Box-Silvertop Stringybark Forest	1,268	
Lower Hunter Red Gum-Paperbark Riverflat Forest	840	
Northern Hinterland Valleys Red Gum Grassy Forest	470	
Heathlands	**11,519**	**16**
Bellinger Escarpment Rockplate Mallee Heath	12	
Blue Mountains Rocky Mallee Heath	3	
Bouddi Headland Wallum Heath	301	
Coastal Foredune Wattle Scrub	1,606	
Coastal Headland Clay Heath	73	
Colo Plateau Dwarf Apple Heath-Woodland	719	
Hunter Coast Headland Clay Heath	112	
Lower North Coast Headland Clay Heath	473	
Lower North Sandplain Wallum Heath	4,350	
Mid North Swamp Oak Headland Scrub	3	
Northern Sandplain Damp Wallum Heath	3,283	
Northern Sydney Heath-Mallee	8	
Northern Sydney Sandstone Rockplate Shrubland	424	
Southern Sandplain Heath	69	
Sydney Hinterland Dwarf Apple Low Woodland	85	
Tomaree Headland Rocky Scrub	0	
Saline Wetlands	**8,242**	**7**
Coastal Headland Sea Spray Grassland	0	
Estuarine Club Rush-Arrowgrass Wetland	80	
Grey Mangrove-River Mangrove Forest	6,011	
Paspalum vaginatum-Samphire Saltmarsh	182	
Prickly Couch-Sea Rush Saltmarsh	8	
Samphire Saltmarsh	1,431	
Sporobolus virginicus Saltmarsh	530	
Unattributed	**1**	
Unattributed	1	
Not native vegetation	**401,065**	
Not native vegetation	401,065	
Total Native Vegetatetation	**778,432**	
Grand Total	**1,179,497**	**164**

Appendix 3. Threatened Flora of the Barrington to Hawkesbury Region

Family	Genus species	Common name	BCA	EPBCA
Fabaceae (Mimosoideae)	Acacia pendula	Acacia pendula population in the	E2	
Myrtaceae	Darwinia fascicularis subsp. oligantha	Darwinia fascicularis subsp. oligantha population in the Baulkham Hills and	E2	
Myrtaceae	Eucalyptus camaldulensis	Eucalyptus camaldulensis population in the Hunter catchment	E2	
Myrtaceae	Eucalyptus oblonga	Eucalyptus oblonga population at Bateau Bay, Forresters Beach and Tumbi Umbi in the Wyong local	E2	
Myrtaceae	Eucalyptus parramattensis subsp. parramattensis	Eucalyptus parramattensis C. Hall. subsp. parramattensis in Wyong and Lake Macquarie local government	E2	
Myrtaceae	Eucalyptus seeana	Eucalyptus seeana population in the Greater Taree local government area	E2	
Orchidaceae	Cymbidium canaliculatum	Cymbidium canaliculatum population in the Hunter Catchment	E2,P,2	
Orchidaceae	Diuris tricolor	Pine Donkey Orchid population in the Muswellbrook local government area	E2,V,P,2	
Apocynaceae	Cynanchum elegans	White-flowered Wax Plant	E1	E
Apocynaceae	Marsdenia longiloba	Slender Marsdenia	E1	V
Apocynaceae	Parsonsia dorrigoensis	Milky Silkpod	V	E
Apocynaceae	Tylophora woollsii	Cryptic Forest Twiner	E1	E
Araliaceae	Astrotricha crassifolia	Thick-leaf Star-hair	V	V
Asteraceae	Olearia cordata		V	V
Asteraceae	Ozothamnus tesselatus		V	V
Asteraceae	Picris evae	Hawkweed	V	V
Asteraceae	Rutidosis heterogama	Heath Wrinklewort	V	V
Asteraceae	Senecio spathulatus	Coast Groundsel	E1	
Campanulaceae	Isotoma fluviatilis subsp. fluviatilis			X
Casuarinaceae	Allocasuarina defungens	Dwarf Heath Casuarina	E1	E
Casuarinaceae	Allocasuarina simulans	Nabiac Casuarina	V	V
Casuarinaceae	Allocasuarina thalassoscopica			E
Convolvulaceae	Wilsonia backhousei	Narrow-leafed Wilsonia	V	
Dilleniaceae	Hibbertia procumbens	Spreading Guinea Flower	E1	
Dilleniaceae	Hibbertia puberula		E1	
Dilleniaceae	Hibbertia spanantha	Julian's Hibbertia	E4A,2	CE
Dilleniaceae	Hibbertia superans		E1	
Elaeocarpaceae	Tetratheca glandulosa		V	
Elaeocarpaceae	Tetratheca juncea	Black-eyed Susan	V	V
Ericaceae	Epacris purpurascens var. purpurascens		V	
Ericaceae	Leucopogon fletcheri subsp. fletcheri		E1	
Euphorbiaceae	Amperea xiphoclada var. pedicellata		E4	X
Euphorbiaceae	Chamaesyce psammogeton	Sand Spurge	E1	
Fabaceae (Caesalpinioideae	Senna acclinis	Rainforest Cassia	E1	
Fabaceae (Faboideae)	Dillwynia tenuifolia		V	
Fabaceae (Faboideae)	Pultenaea maritima	Coast Headland Pea	V	
Fabaceae (Faboideae)	Swainsona sericea	Silky Swainson-pea	V	
Fabaceae (Mimosoideae)	Acacia bynoeana	Bynoe's Wattle	E1	V
Fabaceae (Mimosoideae)	Acacia pubescens	Downy Wattle	V	V
Fabaceae (Faboideae)	Dillwynia tenuifolia	Dillwynia tenuifolia Sieber ex D.C. in the Baulkham Hills local government area	E2,V	
Goodeniaceae	Velleia perfoliata		V	V
Grammitidaceae	Grammitis stenophylla	Narrow-leaf Finger Fern	E1,3	
Haloragaceae	Haloragis exalata subsp. exalata	Square Raspwort	V	V
Juncaginaceae	Maundia triglochinoides		V	
Lamiaceae	Prostanthera askania	Tranquility Mintbush	E1	E
Lamiaceae	Prostanthera cineolifera	Singleton Mint Bush	V	V
Lamiaceae	Prostanthera densa	Villous Mint-bush	V	V
Lamiaceae	Prostanthera junonis	Somersby Mintbush	E1	E
Linderniaceae	Lindernia alsinoides	Noah's False Chickweed	E1	
Lindsaeaceae	Lindsaea fraseri	Fraser's Screw Fern	E1,3	
Malvaceae	Commersonia prostrata	Dwarf Kerrawang	E1	E
Malvaceae	Lasiopetalum joyceae		V	V

Myrtaceae	Angophora inopina	Charmhaven Apple	V	V
Myrtaceae	Callistemon linearifolius	Netted Bottle Brush	V,3	
Myrtaceae	Darwinia biflora		V	V
Myrtaceae	Darwinia glaucophylla		V	
Myrtaceae	Darwinia peduncularis		V	
Myrtaceae	Eucalyptus camfieldii	Camfield's Stringybark	V	V
Myrtaceae	Eucalyptus castrensis	Singleton Mallee	E1	
Myrtaceae	Eucalyptus fracta	Broken Back Ironbark	V	
Myrtaceae	Eucalyptus glaucina	Slaty Red Gum	V	V
Myrtaceae	Eucalyptus largeana	Craven Grey Box	E1	E
Myrtaceae	Eucalyptus parramattensis subsp. decadens		V	V
Myrtaceae	Eucalyptus pumila	Pokolbin Mallee	V	V
Myrtaceae	Eucalyptus sp. Howes Swamp Creek		E1	E
Myrtaceae	Kunzea rupestris		V	V
Myrtaceae	Melaleuca biconvexa	Biconvex Paperbark	V	V
Myrtaceae	Melaleuca deanei	Deane's Paperbark	V	V
Myrtaceae	Melaleuca groveana	Grove's Paperbark	V	
Myrtaceae	Micromyrtus blakelyi		V	V
Myrtaceae	Rhodamnia rubescens	Scrub Turpentine	E4A	CE
Myrtaceae	Rhodomyrtus psidioides	Native Guava	E4A	CE
Myrtaceae	Syzygium paniculatum	Magenta Lilly Pilly	E1	V
Orchidaceae	Caladenia tessellata	Thick Lip Spider Orchid	E1,P,2	V
Orchidaceae	Chiloglottis platyptera	Barrington Tops Ant Orchid	V,P,2	
Orchidaceae	Corunastylis sp. Charmhaven (NSW896673)		E4A,P,2	CE
Orchidaceae	Corybas dowlingii	Red Helmet Orchid	E1,P,2	
Orchidaceae	Cryptostylis hunteriana	Leafless Tongue Orchid	V,P,2	V
Orchidaceae	Dendrobium melaleucaphilum	Spider orchid	E1,P,2	
Orchidaceae	Diuris arenaria	Sand Doubletail	E1,P,2	
Orchidaceae	Diuris bracteata		E1,P,2	X
Orchidaceae	Diuris flavescens	Pale Yellow Doubletail	E4A,P,2	CE
Orchidaceae	Diuris pedunculata	Small Snake Orchid	E1,P,2	E
Orchidaceae	Diuris praecox	Rough Doubletail	V,P,2	V
Orchidaceae	Diuris tricolor	Pine Donkey Orchid	V,P,2	
Orchidaceae	Diuris venosa	Veined Doubletail	V,P,2	V
Orchidaceae	Genoplesium insigne	Variable Midge Orchid	E4A,P,2	CE
Orchidaceae	Genoplesium littorale	Tuncurry Midge Orchid	E4A,P,2	CE
Orchidaceae	Prasophyllum petilum	Tarengo Leek Orchid	E1,P,2	E
Orchidaceae	Pterostylis chaetophora		V,P,2	
Orchidaceae	Pterostylis elegans	Elegant Greenhood	V,P,2	
Orchidaceae	Pterostylis gibbosa	Illawarra Greenhood	E1,P,2	E
Orchidaceae	Pterostylis riparia		V,P,2	V
Orchidaceae	Rhizanthella slateri	Eastern Australian Underground Orchid	V,P,2	E
Orchidaceae	Rhizanthella slateri	Rhizanthella slateri (Rupp) M.A. Clem. & Cribb in the Great Lakes LGA	E2,V,P,2	E
Orchidaceae	Thelymitra adorata	Wyong Sun Orchid	E4A,P,2	CE

Orobanchaceae	Euphrasia arguta		E4A	CE
Orobanchaceae	Euphrasia ciliolata	Polblue Eyebright	V	
Poaceae	Ancistrachne maidenii		V	
Polygonaceae	Muehlenbeckia sp. Mt Norman	Scrambling Lignum	V	
Polygonaceae	Persicaria elatior	Tall Knotweed	V	V
Proteaceae	Grevillea guthrieana	Guthrie's Grevillea	E1	E
Proteaceae	Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V
Proteaceae	Grevillea parviflora subsp. supplicans		E1	
Proteaceae	Grevillea shiressii		V	V
Proteaceae	Hakea archaeoides	Big Nellie Hakea	V,3	V
Proteaceae	Macadamia integrifolia	Macadamia Nut		V
Proteaceae	Macadamia tetraphylla	Rough-shelled Bush Nut	V	V
Proteaceae	Persoonia hirsuta	Hairy Geebung	E1,P,3	E
Proteaceae	Persoonia pauciflora	North Rothbury Persoonia	E4A,P,3	CE
Restionaceae	Baloskion longipes	Dense Cord-rush	V	V
Rhamnaceae	Pomaderris brunnea	Brown Pomaderris	E1	V
Rhamnaceae	Pomaderris queenslandica	Scant Pomaderris	E1	
Rhamnaceae	Spyridium burragorang	Spyridium burragorang in the Cessnock LGA	E2	
Rubiaceae	Asperula asthenes	Trailing Woodruff	V	V
Rutaceae	Asterolasia elegans		E1	E
Rutaceae	Leionema lamprophyllum subsp. fractum		E4A	
Rutaceae	Zieria involucrata		E1	V
Rutaceae	Zieria lasiocaulis	Willi Willi Zieria	E1	E
Santalaceae	Thesium australe	Austral Toadflax	V	V
Solanaceae	Solanum sulphureum	Manning Yellow Solanum	E1	E
Thymelaeaceae	Pimelea curviflora var. curviflora		V	V
Winteraceae	Tasmannia glaucifolia	Fragrant Pepperbush	V	V
Winteraceae	Tasmannia purpurascens	Broad-leaved Pepperbush	V	
Zannichelliaceae	Zannichellia palustris		E1	

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