2017-2018

# Predicted climate change effects on 10 culturally significant species in the Minyumai Indigenous Protected Area

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## Contents

# Overview of predicted climate change for the NSW North Coast region

Minyumai IPA lies between Tabbimoble Nature Reserve and Bundjalung National Park in northern NSW, just south of the Evans River and Evans Head (Figure 1).

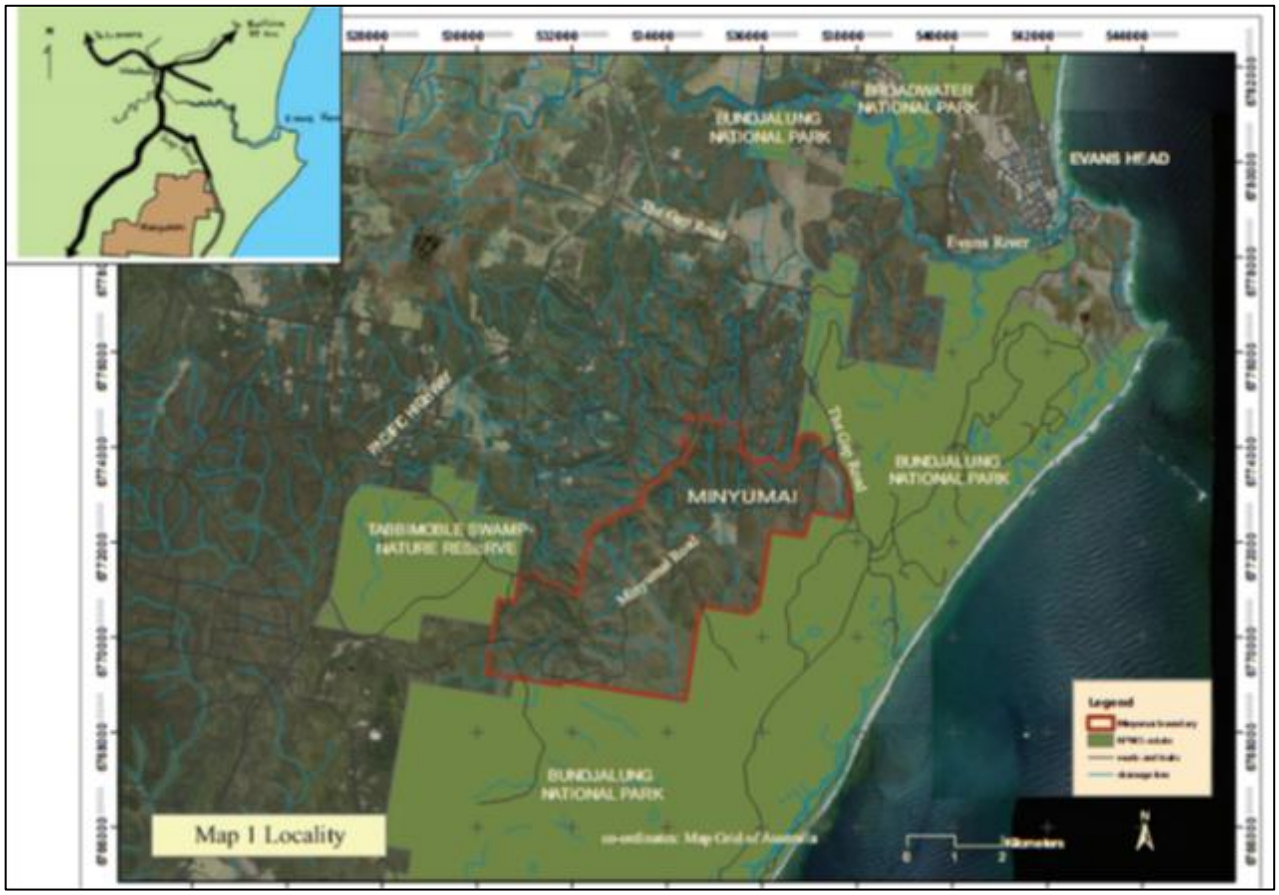


Figure 1: Map of the Minyumai Indigenous Protected Area, Northern NSW.

The summarised information below on predicted climate changes in northern NSW is from the NSW Government OEH Adapt NSW North Coast Climate Change Snapshot (2014) accessed from: http://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Climate-projections-for-your-region/North-Coast-Climate-Change-Downloads. Projections are based on simulations from a suite of 12 climate models.

| Projected **temperature** changes | |
|---|---|
| Maximum temperatures are projected to increase in the near future by 0.4 – 1.0°C | Maximum temperatures are projected to increase in the far future by 1.5 – 2.4°C |
| Minimum temperatures are projected to increase in the near future by 0.5 – 1.0°C | Minimum temperatures are projected to increase in the far future by 1.6 – 2.5°C |
| The number of hot days will increase | The number of cold nights will decrease |
| **Projected rainfall changes** | |
| Rainfall is projected to decrease in winter | Rainfall is projected to increase in autumn and spring |
| **Projected Forest Fire Danger Index (FFDI) changes** | |
| Average fire weather is projected to increase in summer and spring | Severe fire weather days are projected to increase in summer and spring |

## Temperature

Based on observations from 1910 to 2011 temperature is projected to increase by 0.4-1.0°C during the period of 2020-2029, and up to 1.5-2.4°C between 2060-2069. An increase in the number of high temperature days (over 35°C) is projected to increase and a reduction of potential frost risk is anticipated. The north coast region is expected to experience an increase in all temperature variables (maximum, mean, and minimum) by 2030 and further increase by 2070 (See Figure 2 below).

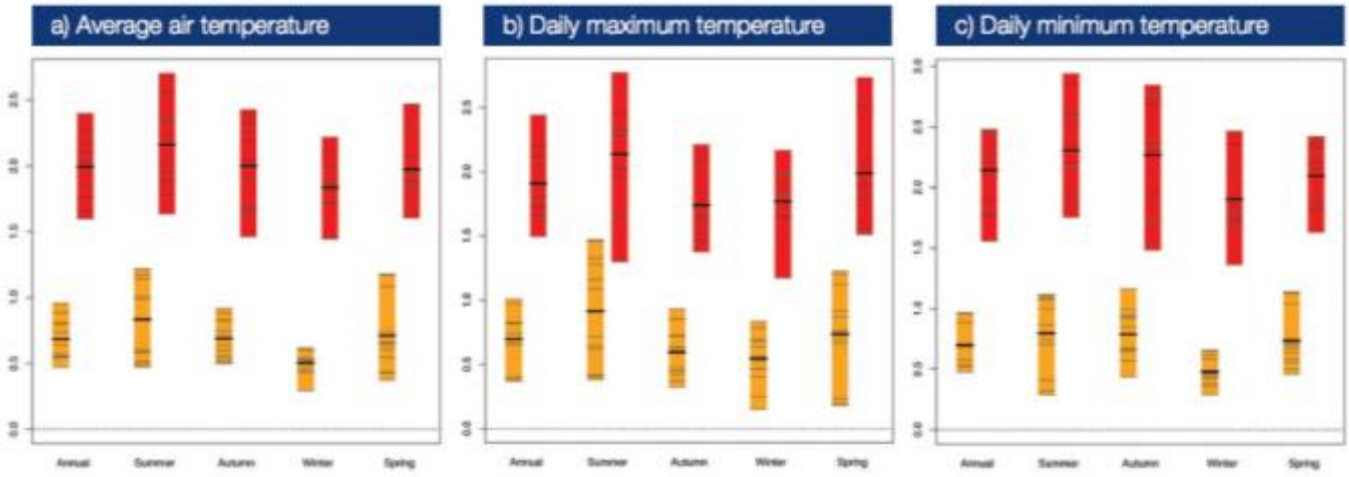


Figure 2: Projected air temperature changes for the North Coast Region by season (2030 yellow, 2070 red): a) average, b) daily maximum, and c) daily minimum. Source: NSW OEH 2014

## Hot Days (above 35°C)

Currently the North Coast region experiences an average of 9 hot days per year (Figure 3). Inland areas (Casino, Richmond Valley) are projected to be most affected and could see 15-20 hot days per year by 2030, and 40 hot days by 2070. The region on average is projected to see an increase of 0-5 days by 2030, and 3-12 days by 2070.

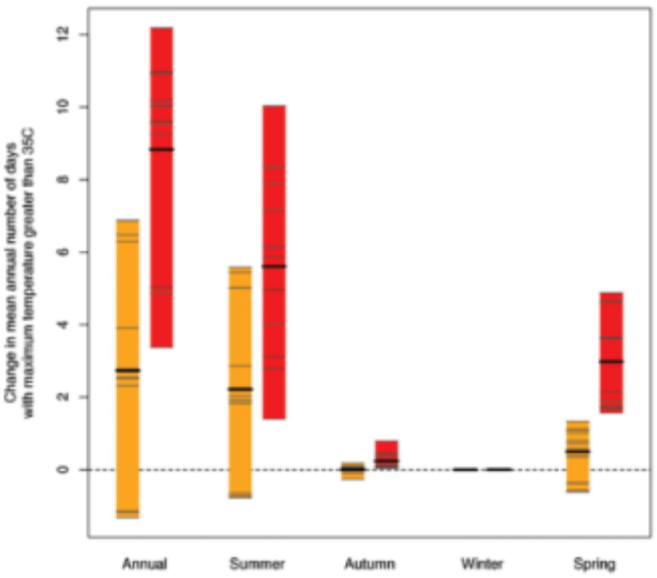


Figure 3: Projected Changes in the number of hot days (above 35°C) for the North Coast Region annually and by season (2030 yellow, 2070 red). Source: NSW OEH 2014

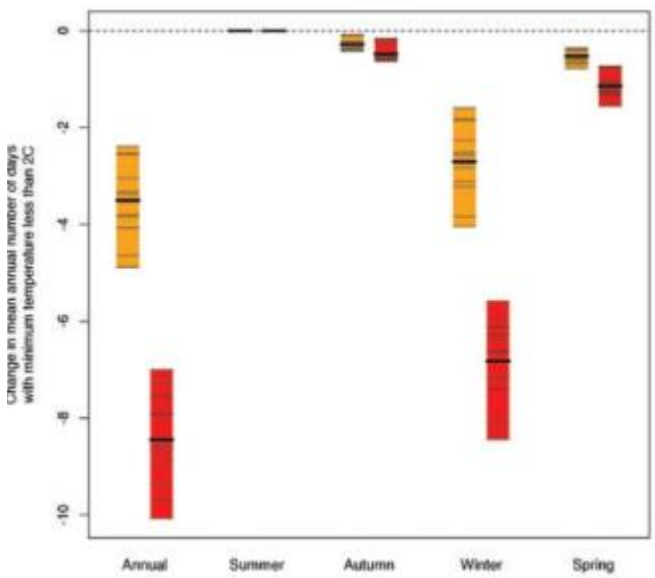


Figure 4: Projected Changes in the number of cold nights (below 2°C) for the North Coast Region annually and by season (2030 yellow, 2070 red). Source: NSW OEH 2014

## Cold Nights (below 2°C)

The North Coast region is expected to see an average decrease in cold nights across the region of 2-5 nights by 2030, and 7-10 nights by 2070 (Figure 4). The greatest decrease in cold nights is expected along the mountain region that could see 10-20 fewer cold nights by 2030, and over 30 by 2070.

## Rainfall

Currently, rainfall varies significantly across the region although there is generally less away from the coast. Rain is seasonal with higher levels of precipitation in summer (see Figure 5). The region has, in the past, experienced substantial rainfall variability with periods of dry and wet conditions (see Figure 6). This included a period of below average rainfall in the early 2000s, followed by two of the wettest years on record in 2010-2011.

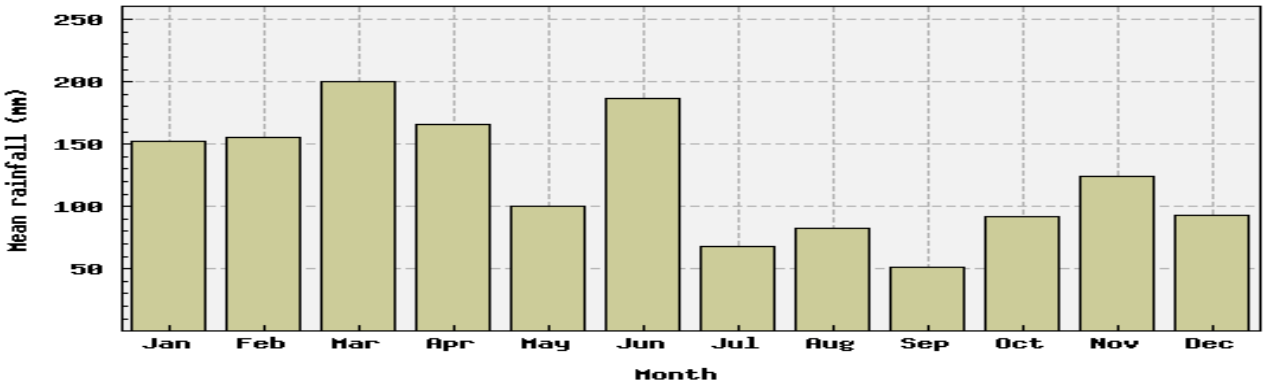


Figure 5: Average monthly rainfall at Evans Head Bombing Range (near Minyumai). Data Source: Bureau of Meteorology; Years 1998-2018.


Figure 6: Total Annual Rainfall at Evans Head Bombing Range (near Minyumai) for 1998-2016. Data Source: Bureau of Meteorology. Dotted line is fitted linear trend showing marginal increase in total annual rainfall over this period.

The climate change models predict more variation in future rainfall. The majority of models (7 out of 12) suggested that autumn and spring rainfall will increase by about 8% and 3% respectively by 2030, and by 15% and 5% by 2070. They also suggest that winter rainfall will decrease in the Minyumai area by about 5% by 2030 (Figure 7).

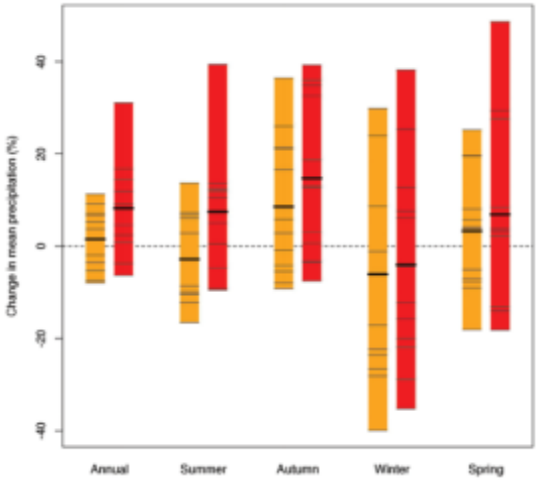


Figure 7: Projected Changes in average annual rainfall for the North Coast region, annually and by season (2030 yellow, 2070 red). Source: NSW OEH 2014

## Forest Fire Danger Index (FFDI)

The Forest Fire Danger Index (FFDI) is used in NSW to quantify fire weather. The FFDI combines observations of temperature, humidity and wind speed with an estimate of the fuel load. In northern NSW, there are only three locations where FFDI can be conducted: Lismore, Casino and Coffs Harbour. According to the NSW OEH Climate Change Snapshot (2014), currently, the FFDI is lowest in Coffs Harbour (3.3) and highest in Casino (6.4). The highest average FFDI occurs in Spring and the lowest is in Autumn.

Fire weather is severe when the FFDI is above 50 while FFDI below 12 suggests low to moderate fire weather. Severe fire days are currently estimated to occur 2 days per year at Casino, but are rare at Lismore and Coffs Harbour.

There is little projected change in FFDI for the NSW North Coast region. It is expected that the fire danger will be slightly higher in spring, summer and winter and actually lower in Autumn. But this translates to little change in the high fire danger days, which are predicted to only slightly increase by not even a full day more by 2070 and only in Spring (see Figure 8 and 9 below).

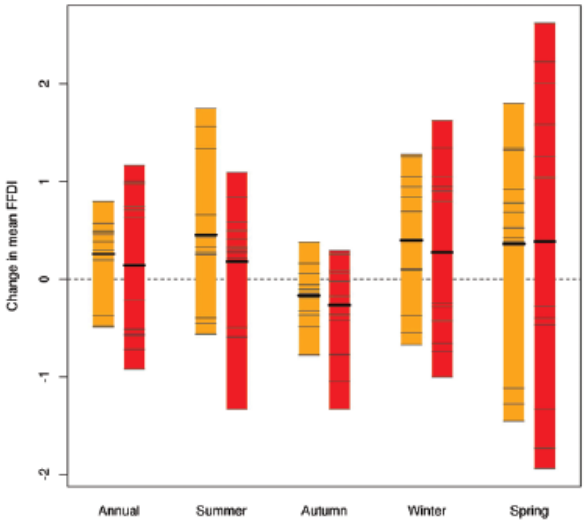


Figure 8: Projected Changes in the average daily FFDI for the North Coast region, annually and by season (2030 yellow, 2070 red). Source: NSW OEH 2014

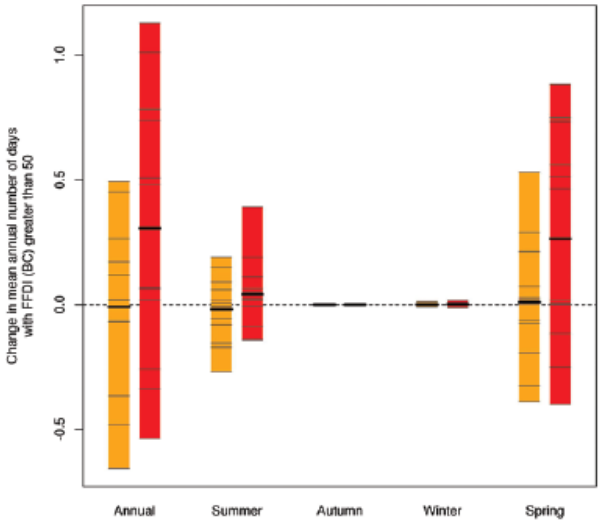


Figure 9: Projected Changes in the average annual number of days with FFDI greater than 50 for the North Coast region, annually and by season (2030 yellow, 2070 red). Source: NSW OEH 2014

# Methods used to predict climate change impacts on Minyumai culturally significant species

## Identification of Minyumai culturally significant species

Culturally significant species and events that indicate different seasons across the greater Bandjalang estate were identified by the Minyumai Rangers (in consultation with Elders) at the start of the project. This knowledge was used to develop the Minyumai Seasonal calendar (Figure 10). This calendar was then used to identify species that could be monitored or assessed by the Minyumai Rangers at the Minyumai IPA to determine the likelihood of climate change impacts.

Minyumai Doobai (women) Rangers developing the Bandjalang seasonal calendar, March 2017.

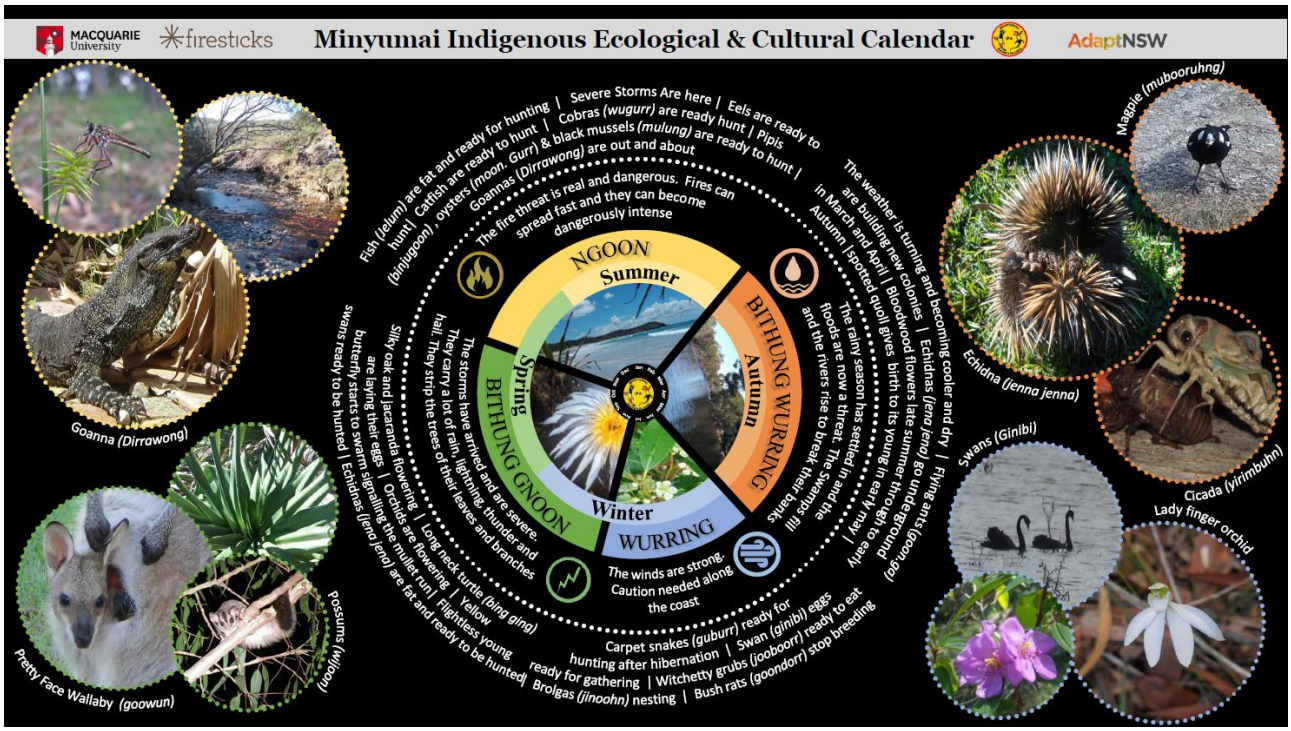


Figure 10: Minyumai Seasonal Calendar

From the calendar, the species in Table 1 were identified (largely from Elders videos/sources) as having visible responses to changing weather. In Table 1 we also note which species could be monitored in the Minyumai IPA and were of interest by the Rangers.

| Season | Species | Behaviour | Monitoring potential? |
|---|---|---|---|
| Ngoon (Spring-Summer) | Fish, Eel, Catfish | Ready for hunting | Not in IPA |
| | Oysters, Mussels | Ready for hunting | Not in IPA |
| | Dirrawong (Goanna) | Visible and mobile | Yes |
| Bithung Wurring (Autumn) | Flying ants | Build colonies | Not of interest |
| | Echidna | Go underground | Not often seen at IPA |
| | Bloodwood tree | Flowering | |
| | Quoll | Giving birth | Not found on IPA |
| Wurring (start of Winter) | Carpet snake | Hibernate, ready for hunting | Not often seen at IPA |
| | Swan eggs | Ready for gathering | Not found on IPA |
| | Witchetty grubs | Ready to eat | |
| | Brolga | nesting | Not found on IPA |
| | Bush rats | Stop breeding | Not often seen at IPA |
| Bithung Ngoon (Winter – spring) | Silky oak | Flowering | Not found on IPA |
| | Jacaranda | Flowering | Not found on IPA |
| | Long necked turtles | Laying eggs | Not found on IPA |
| | Orchids | Flowering | Tricky to monitor as not common on IPA |
| | Yellow butterfly | Swarming – indicates mullet run | Not found on IPA |
| | Young swan | Ready to be hunted | Not found on IPA |
| | Echidna | Ready for hunting | Not often seen at IPA |

Table 1: Species mentioned in Minyumai Seasonal Calendar

From this list further discussion with the Rangers took place about which species could be monitored in the IPA. The following criteria were used to workshop species for potential climate change monitoring:

1. Traditional significance either as totems, bush food or other useful plants
2. Species that are of contemporary interest to the Rangers, and
3. Species that are visible and can be monitored

Table 2 below outlines the species chosen by the Rangers and their associated cultural values (both traditional and contemporary).

| Bandjalang name | Common English name | Scientific name | Traditional values | Contemporary values |
|---|---|---|---|---|
| Goowun [1] | Red-necked Wallaby | *Macropus rufogriseus* | Eaten, skin? | Common at Minyumai; human connection |
| Wayilany [2] | Glossy-black Cockatoo | *Calyptorhynchus lathami ssp. lathami* | Totem | Threatened species; occurs at Minyumai |
| Dirrawong [1] | Lace Monitor | *Varanus varius* | Totem | Common at Minyumai |
| | Phascogale | *Phascogale tapoatafa spp.* | Eaten? | Threatened species; occurs at Minyumai |

[1] From Minyumai Seasonal Calendar
[2] From interactive Bundjalung-Yugambeh Dictionary http://bundjalung.dalang.com.au/language/dictionary

| | | | | |
|---|---|---|---|---|
| | | *tapoatafa* | | |
| Mandarahm [1,2] | Native Raspberry | *Rubus moluccanus var. trilobus* | Edible fruit | Occurs at Minyumai |
| | Lomandra | *Lomandra longifolia* | Used in weaving dilly bags and mats | Occurs at Minyumai and planted to deter Cane Toads |
| Juybam? [2] | Waterlily | *Nymphaea giganteus* | Edible parts – yam, stem, seeds? | Occurs at Minyumai |
| | Beach Pineapple | *Pandanus tectorius* | Edible nuts; used in weaving? | Occurs at Chinamen's Beach |
| | Large-leaf Geebung | *Persoonia cornifolia* | Edible fruit | Occurs at Minyumai |
| | Native Lasiandra | *Melastoma affine* | Edible fruit | Occurs at Minyumai |

Table 2: Species chosen for monitoring ffects of climate change at Minyumai

## Methods used to predict Climate change impact on species

To investigate potential climate change impacts on the above mentioned 10 species, we looked at evidence from:

1. Traditional and local Knowledge
2. The Atlas of Living Australia Spatial Portal
3. The NSW Bionode Climate Change modelling website

### 1. Traditional and Local Knowledge

Traditional Bandjalang knowledge of species and their habitats, behaviours and other ecological knowledge has been severely affected by colonisation and language loss. The Minyumai Rangers are working to re-learn their traditional language and knowledge and have been listening to old recordings as part of this project. As a result, knowledge of culturally important species is being rebuilt in the region. This project is contributing to the opportunity to do this and combine new knowledge with old knowledge that is available.

| Bandjalang name | Common English name | Scientific name | Traditional and Local knowledge about effects of climate |
|---|---|---|---|
| Goowun | Red-necked Wallaby | *Macropus rufogriseus* | Seen around the Minyumai IPA office throughout the year whereas previously left over winter |
| Wayilany | Glossy-black Cockatoo | *Calyptorhynchus lathami ssp. lathami* | Not known |
| Dirrawong | Lace Monitor | *Varanus varius* | Seen around the Minyumai IPA office throughout the year whereas previously hibernated over winter |
| | Phascogale | *Phascogale tapoatafa spp. tapoatafa* | Not known |
| Mandarahm | Native Raspberry | *Rubus moluccanus var. trilobus* | Not known |
| | Lomandra | *Lomandra longifolia* | Not known |
| Juybam? | Waterlily | *Nymphaea giganteus* | Not known |
| | Beach | *Pandanus tectorius* | Not known |

| | | | |
|---|---|---|---|
| | Pineapple | | |
| | Large-leaf Geebung | *Persoonia cornifolia* | Not known |
| | Native Lasiandra | *Melastoma affine* | Not known |

Table 3: Traditional and local knowledge of select culturally significant species at Minyumai IPA

## 2. The Atlas of Living Australia Spatial Portal

To assess whether current species habitat would be suitable under future climate scenarios, we used the ALA online spatial analysis tool (https://spatial.ala.org.au/). We can use this tool to:

a. Assess current species distribution and look where the Minyumai IPA sits – is it already at the edge of the species range? And potentially therefore at risk? Or is located in the middle of the current species distribution, and therefore less likely to be at risk unless it is a mountain top species or other factors may affect its distribution eg food source?

b. Using the ALA Spatial Portal we can also plot the current known species locations against future climate variables and see whether the site is still expected to sit within the species range and known climate preferences. There are many future climate variables we can chose. In this study we chose to investigate the annual rainfall (using BioClim_Bio12 data) versus Mean annual Temperature (using BioClim_Bio01 data). For more information (ie metadata) on these data and models see https://spatial.ala.org.au. These model variables are made readily available through the Spatial Portal in the ALA through the "Predict" function (see screen shot below) which uses MaxEnt to model species distribution against selected climate variables.

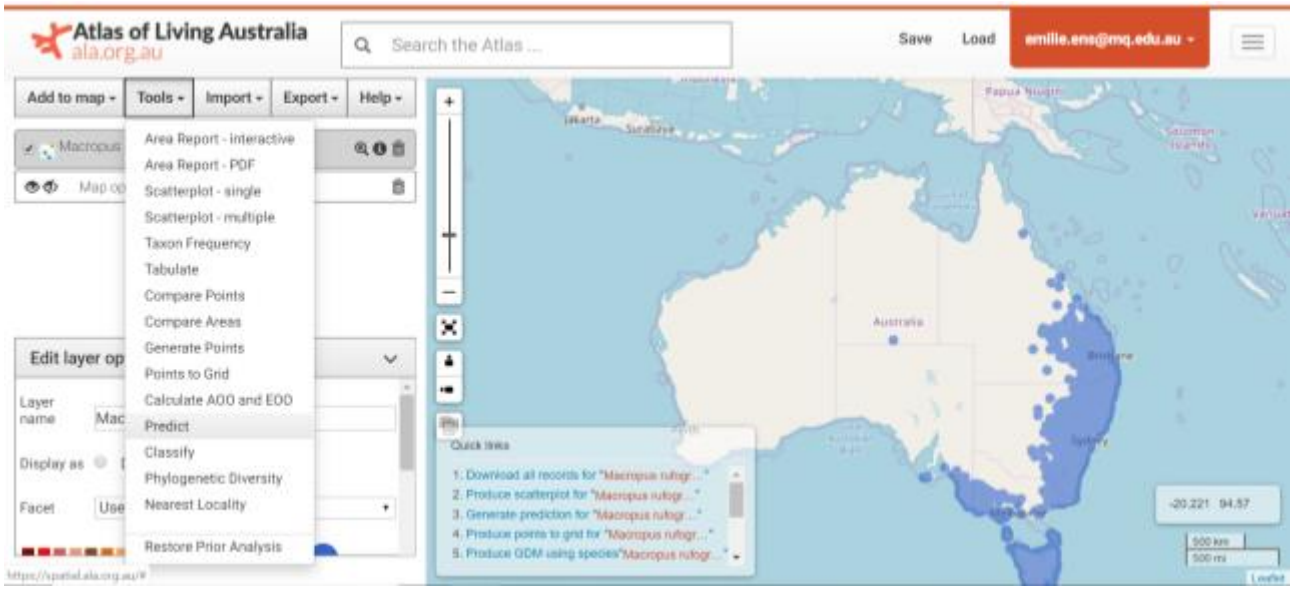


Figure 11: Atlas of Living Australia Spatial Portal

## 3. NSW OEH – Macquarie University BioNode Climate Change website

We can also use Macquarie University's BioNode website to investigate potential climate change effects on Minyumai Culturally Significant species. See https://www.mq.edu.au/research/research-centres-groups-and-facilities/secure-planet/centres/biodiversity-node/Webtools

Of particular relevance to this work were the Threatened Species and Climate Refugia Tools. To ascertain the predicted impact of climate change on our species of interest we simply searched for the species in the tool search bar and searched for relevant information.

# Results of potential Climate Change impacts on Minyumai Culturally Significant Species

We present a mixed methods approach to presenting the results of the climate change impact investigations for each species.

## FAUNA

*Macropus rufogriseus* – Red-necked Wallaby

The Minyumai Rangers have noticed this species hanging around their office for longer over "winter" than they noticed in the past. They suggested that the warmer winters were resulting in a shorter "hibernation" period for this species.

The Red-necked Wallaby is commonly seen in the Minyumai Indigenous Protected Area (MIPA), northern NSW and across south eastern Australia from Mackay to Adelaide as well as Tasmania (see Figure 12).

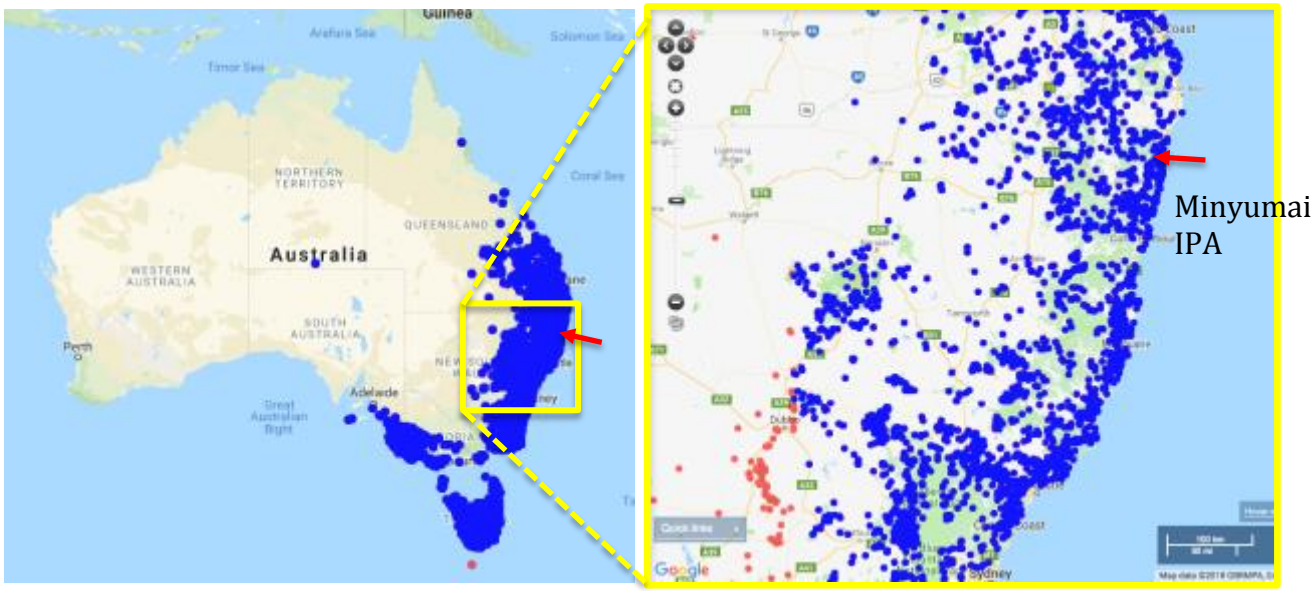


Figure 12: Map of the known distribution of Red-necked Wallaby in Australia (left) and across the NSW North Coast (right), as reported in ALA from 48,345 occurrences. The red arrow shows location of Minyumai IPA.

Because the Minyumai IPA is in the middle of the current distribution of the Red-necked Wallaby, some may predict that expected climate change is not likely to affect this species. However, if we look at the current environmental data associated with the current known locations of this species (images below), we can see that the Minyumai IPA lies in the warmer and wetter portion of the climate niche for this species (see black outline in scatterplot below right). A 2°C increase in temperature and about 70-100mm increase (up to 10% increase) in annual rainfall at Minyumai could push this species to the edge of its known limits (white arrow in Figure 13).

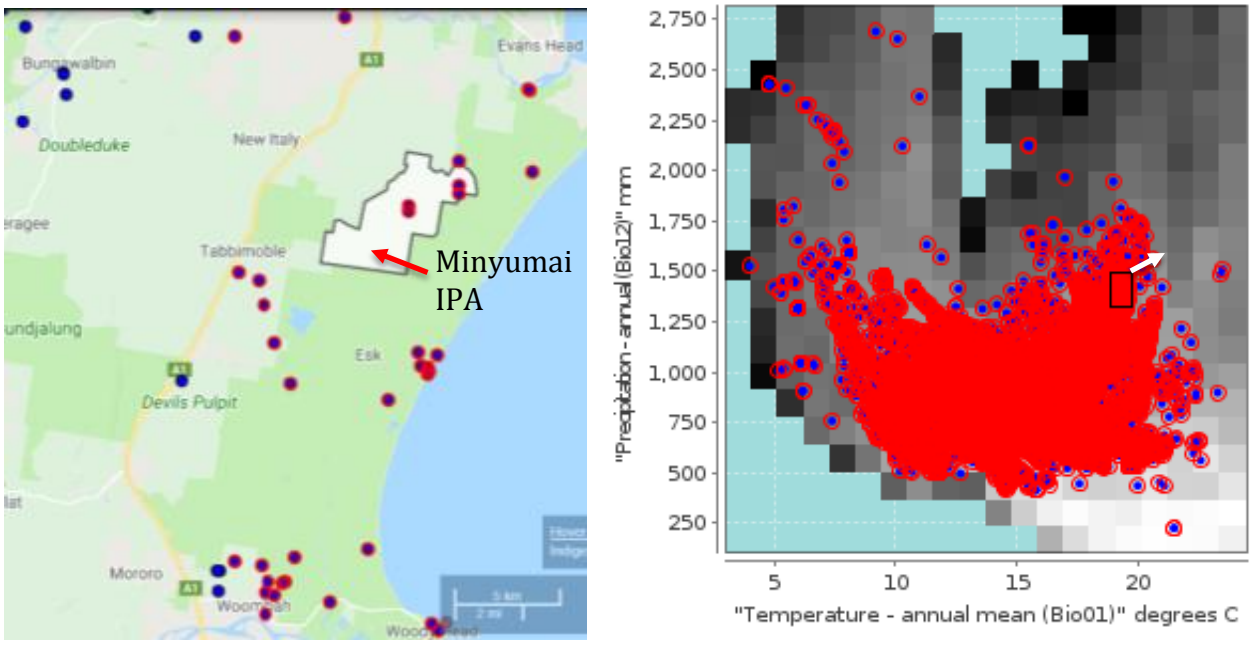


Figure 13: ALA records of the Red-necked Wallaby in and around the Minyumai IPA (left). Records highlighted in red are those with environmental variables occurring in the black box space in the scatterplot to right. White arrow in right diagram shows extent of environmental variable shift taking this species to the edge of its current limit.

In addition, the increase in extreme heat days predicted for the Nth NSW coast over summer (2-6 days more) and spring (1-3 days more) may affect this species' health and reproductive capacity.

The BioNode tools did not provide any data for this species.

*Calyptorhynchus lathami* ssp*. lathami* – Glossy Black Cockatoo

The Glossy Black Cockatoo is listed as Vulnerable in NSW https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10140.

Dave Milledge (Landmark Consulting, Ecologist) recorded this species in April 2013 in the Minyumai IPA. It was feeding on Casuarina nuts along one of the fire trails. It is rarely seen in the IPA and Rangers are trying to encourage it by looking after the Casuarina and planting more.

The maps below show that the Glossy Black Cockatoo (subspecies *lathami*) has been observed across the south eastern coast of Australia but mainly around Brisbane and NE Victoria (Figure 11). It has only been recorded 939 times and not very often in NSW.

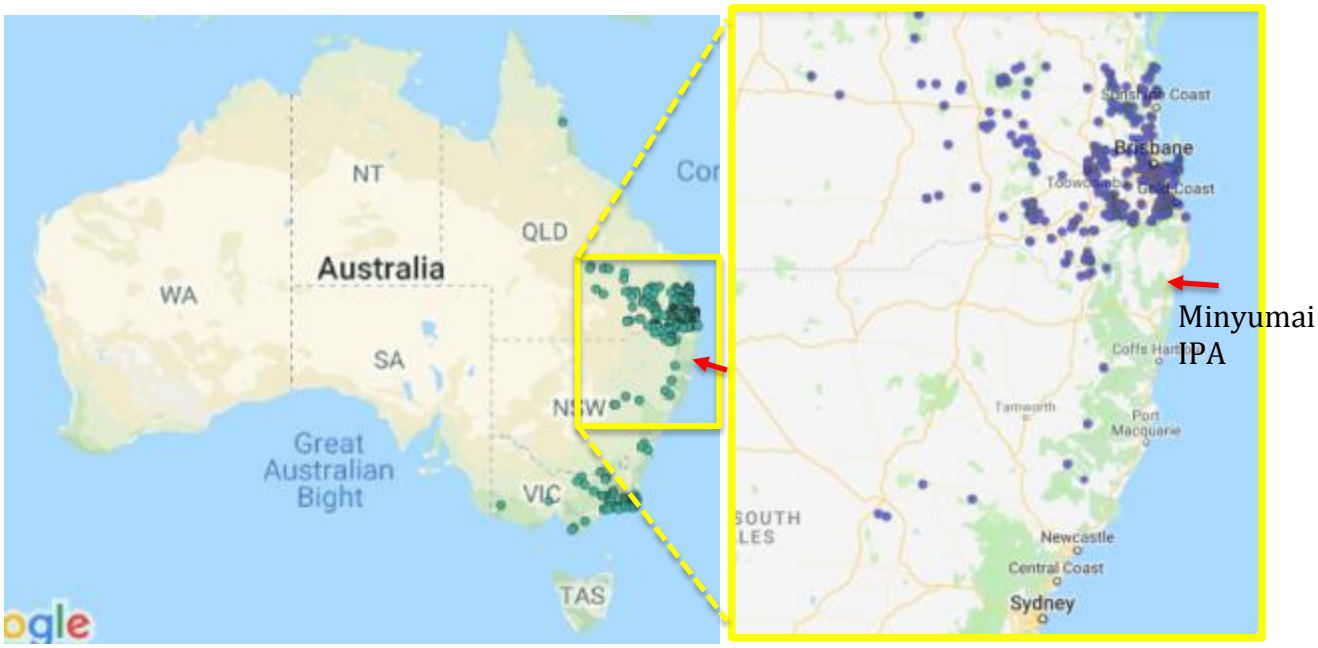


Figure 14: Distribution of the Glossy Black Cockatoo (subspecies *lathami*): Australia wide (left) and North Coast region (right) as reported in the ALA (939 occurrences).

When we look at the current climate envelope for this subspecies based on annual rainfall and annual mean (Figure 15b) for the best matched location (in Fig 15b: black square, Fig 15a red dots) we can see that this is the upper limit of this species preferred annual mean temperature and getting towards the high end of its preferred annual rainfall. If we consider these parameters alone, the predicted 2°C increase in temperature and about 70-100mm increase (up to 10% increase) in annual rainfall at Minyumai could push this species to the beyond its known preferred climate (white arrow in Figure 15b).

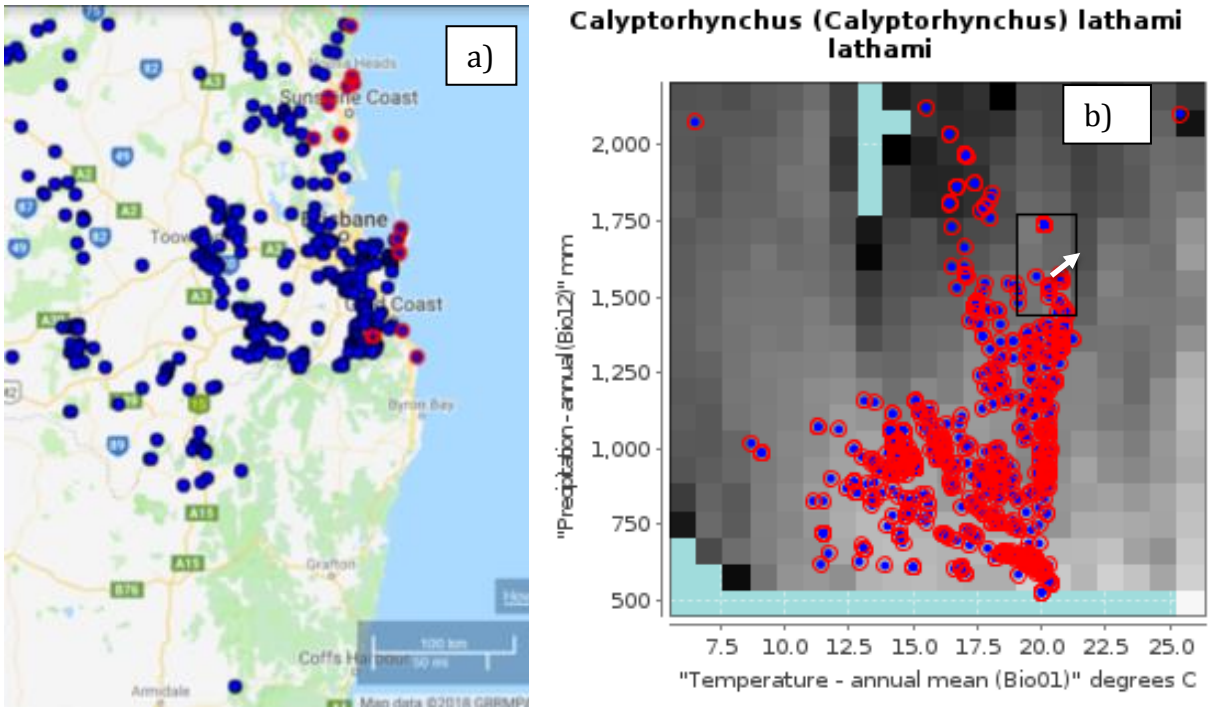


Figure 15: a) records of Glossy Black Cockatoo near Minyumai IPA (blue dots) and red highlighted dots showing similar climate to Minyumai IPA. b) The annual rainfall and annual mean temperature data for each Glossy Black Cockatoo record showing region where Minyumai climate sits in black square and predicted climate change in white arrow.

The BioNode Climate Refugia tool suggests that the northern half of the Minyumai IPA may become a significant regional refuge for this species in the future. When looking at the consensus approach to the 4 models presented through the tool, 2 of the 4 models show the IPA as a significant regional refuge (Figure 16, 17).

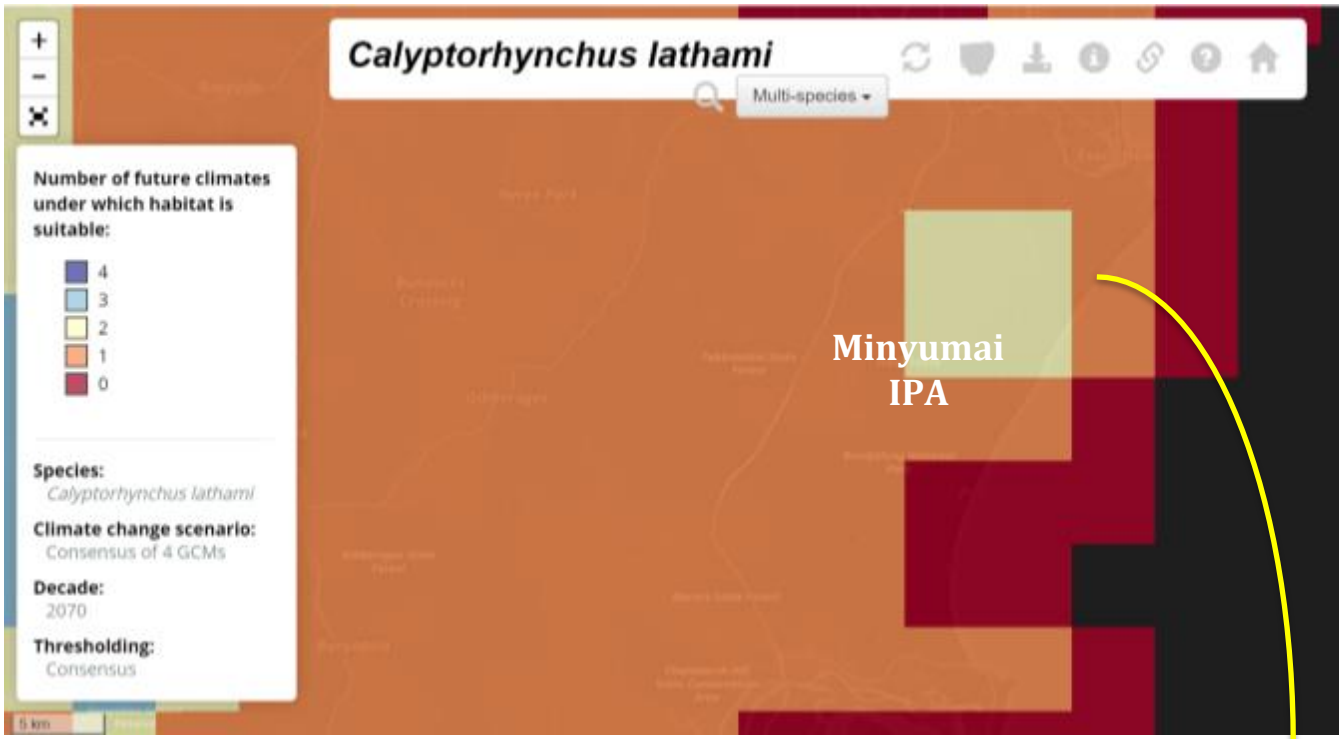


Figure 16: Consensus of 4 BioNode Climate Refugia models for future climate refugia for the Glossy-black Cockatoo near the Minyumai IPA

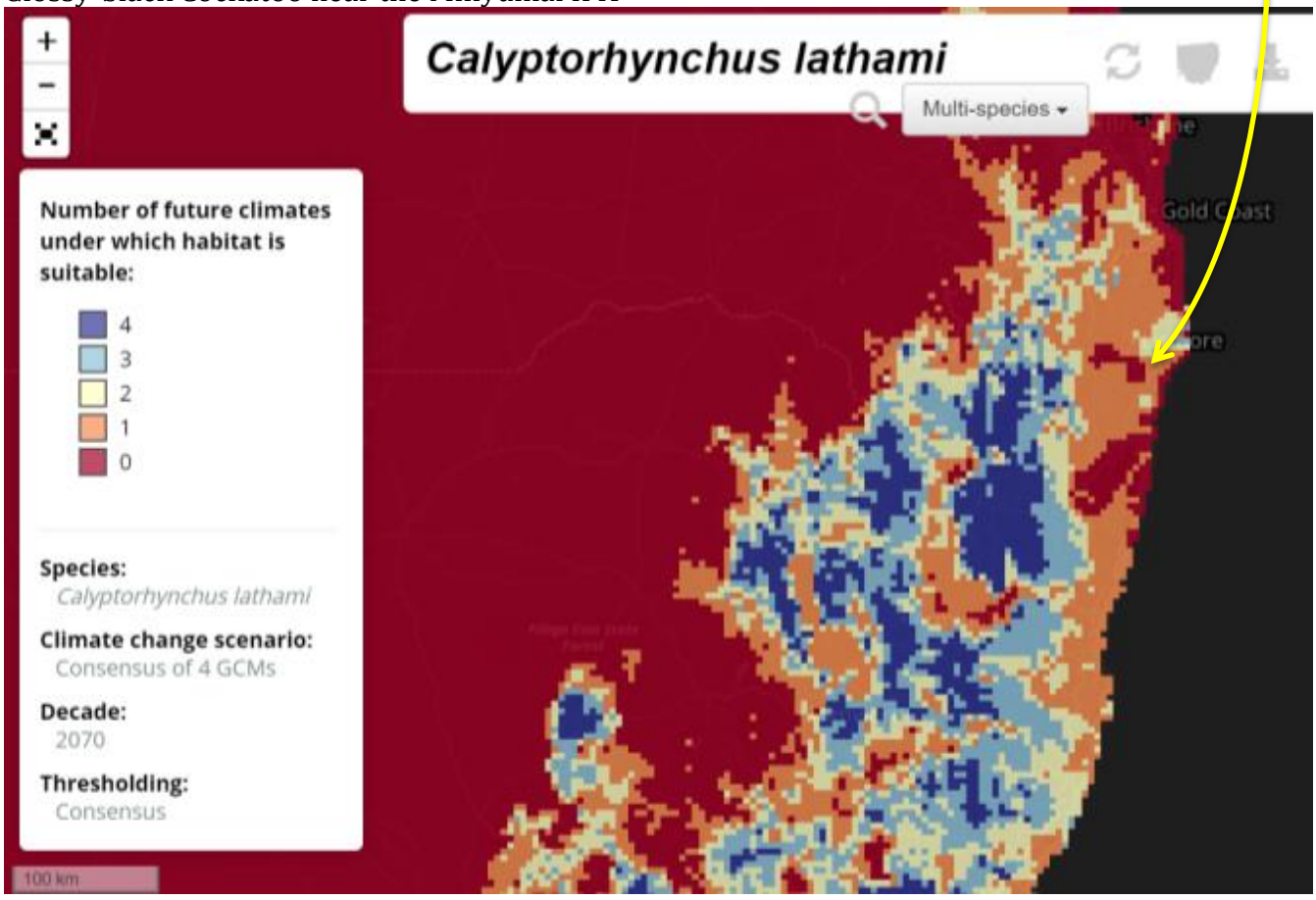


Figure 17: Consensus of 4 BioNode Climate Refugia models for future climate refugia for the Glossy-black Cockatoo along the NSW North Coast

*Varanus varius* – Dirrawong/Lace Monitor

The Dirrawong is a significant totem for the Bandjalang people. It is frequently seen in the Minyumai IPA. Similar to the Red-necked Wallaby, the Minyumai Rangers have seen the Dirrawong hang around their office much later into the Winter than they previously did. Some years they said the Goanna's don't seem to hibernate at all.

The Dirrawong has a widespread distribution along the Australian east coast and south towards Adelaide (Figure 18).

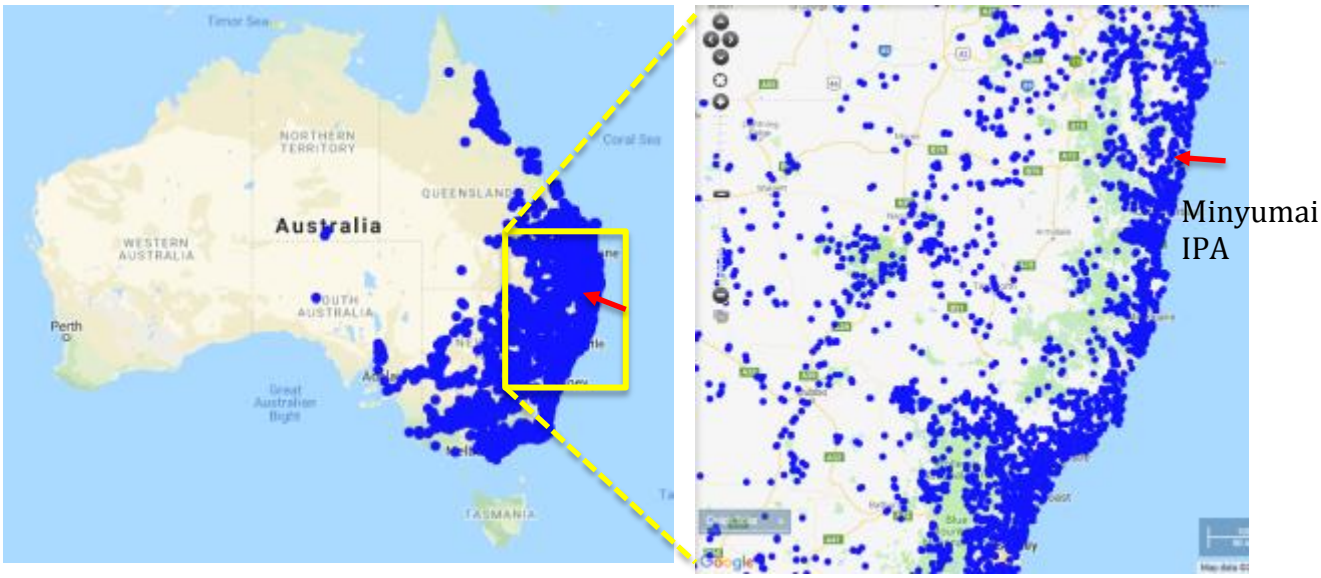


Figure 18: Dirrawong distribution across Australia (left) and the NSW North Coast region (as reported in the ALA from 10,311 occurrences)

The climate niche of this species (Figure 19b) shows that the records near Minyumai (in the black square in Fig 19b) are close to the bulk of where this species lives although it is known to tolerate much higher annual rainfall and average annual temperature.

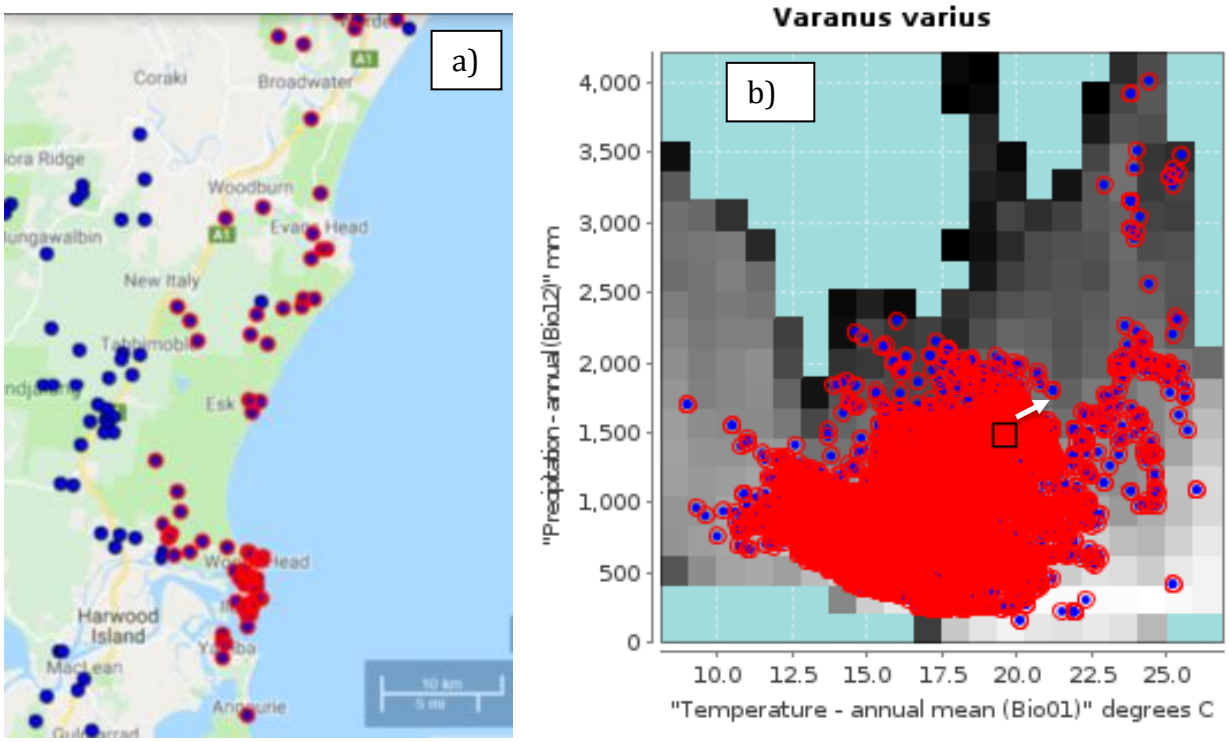


Figure 19: a) records of Dirrawong near Minyumai IPA (blue dots) and red highlighted dots showing similar climate to Minyumai IPA. b) The annual rainfall and annual mean temperature data for each Dirrawong record showing the region where Minyumai climate sits in the black square and predicted climate change in white arrow.

The Dirrawong (Varanus varius) does not show up in any of the BioNode Tools.

### *Phascogale tapoatafa* spp. *tapoatafa* – Brush-Tailed Phascogale

Recent fauna surveys detected populations of the Brush -Tailed Phascogale at Minyumai IPA. A mother and babies was also found in a set of draws in a gazebo near the Rangers office! The brush-tailed Phascogale is listed as vulnerable in NSW. Follow this web link to find out more about this species: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10613.

The main threats according to the NSW Government are:

- Loss and fragmentation of habitat
- Loss of hollow-bearing trees
- Predation by foxes and cats, and
- Competition for nesting hollows with the introduced honeybee

Recent research has suggested that *Phascogale tapoatafa* has three sub-species across Australia – in northern Australia (ssp. *kimberleyensis*), south east Australia (ssp. *tapoatafa*) and south western Australia (ssp. *wambenger*) which reflects some of the disjunct distribution (and mis-identifications) in the distribution map below to the left. For more information on these sub species follow this link: http://dx.doi.org/10.11646/zootaxa.4055.1.1

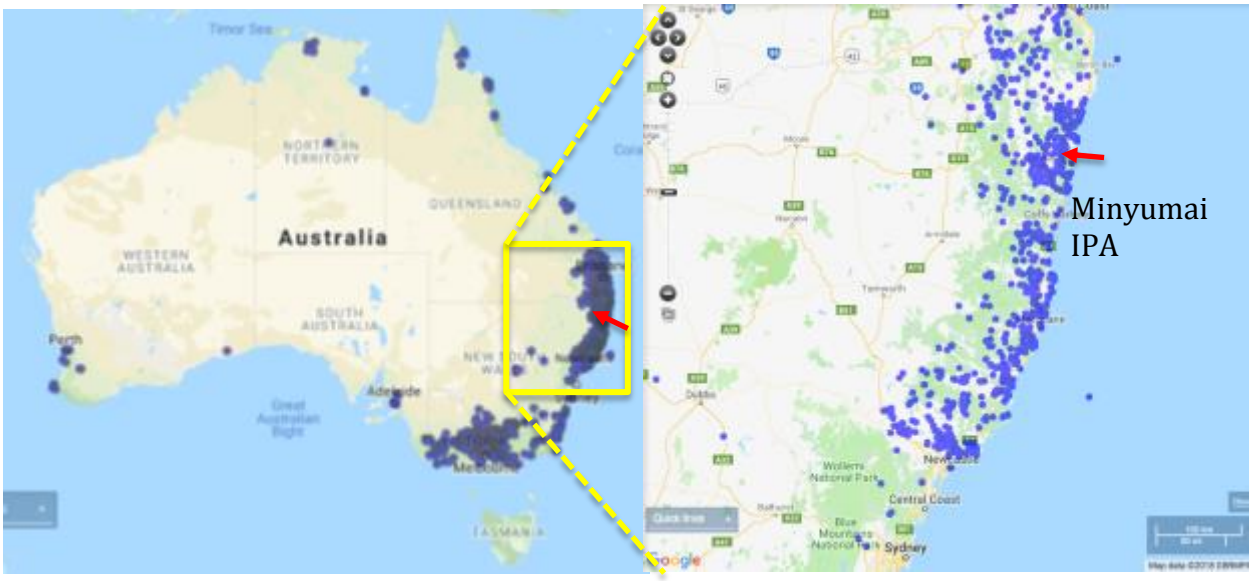


Figure 20: Maps above show the distribution of *Phascogale tapoatafa* across Australia (left) and northern NSW (right) (data from the ALA - 4773 occurrences).

The distribution map for the brush-tailed phascogale in northern NSW above suggests it is commonly found, however it is listed as Vulnerable in NSW. Figure 21 shows the annual records for this species in the SE Qld bioregion, which is where the Minyumai IPA lies. It shows that some individuals have been recorded in most years, especially since the 1990s when sometimes at least 10 have been recorded. Although we note that 10 individuals is not many for such a large region which is under constant threat from development and invasive species.

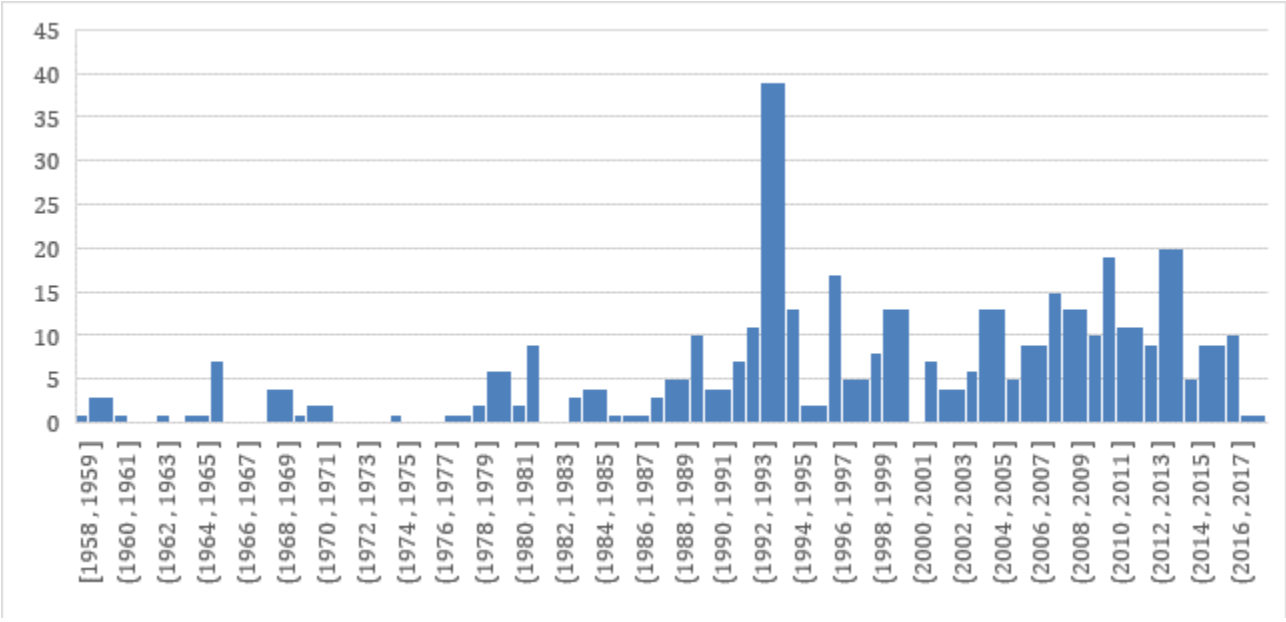


Figure 21: Number of records for the Brush-tailed Phascogale in the SE Qld bioregion since 1958 (data from ALA).

If we look at the climate envelope for this species in terms of annual rainfall and average temperature (Figure 22b) we can see that the Minyumai IPA again lies at the warmer and wetter end of its preferred habitat, although it is known to exist outside of this preferred range. However the predicted temperature and rainfall (white arrow) suggests that if this species survives here it will be at its outer limits of climate preference.

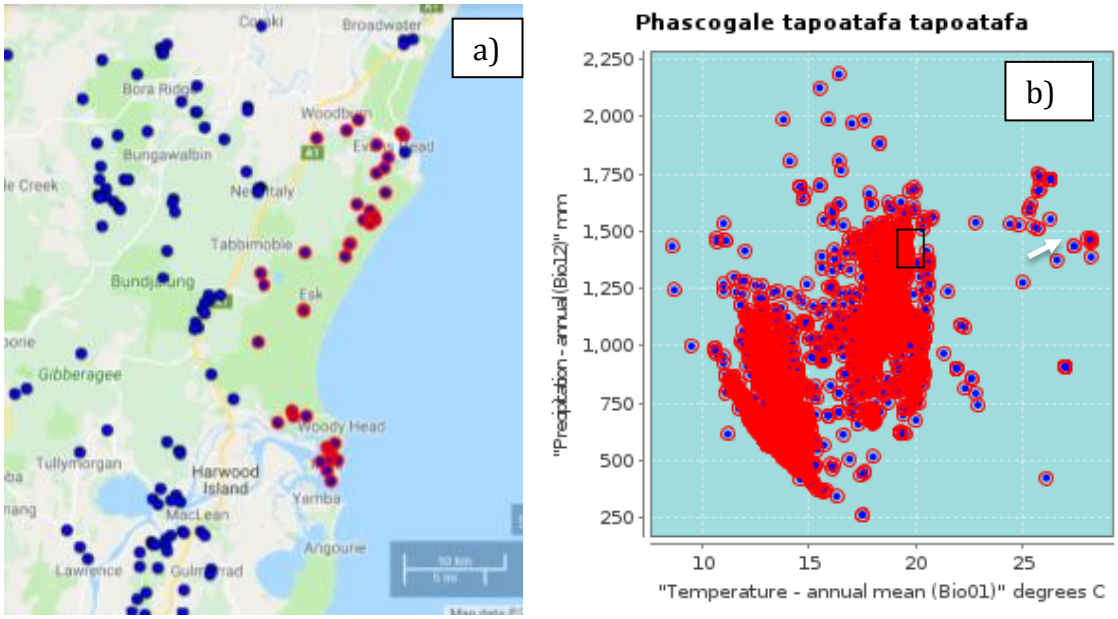


Figure 22: a) records of the Phascogale near Minyumai IPA (blue dots) and red highlighted dots showing similar climate to Minyumai IPA. b) The annual rainfall and annual mean temperature data for each Phascogale record showing the region where Minyumai climate sits in the black square and predicted climate change in white arrow.

The BioNode Climate Refugia Tool suggests that Minyumai IPA is likely to be a good refuge for this species in the future with 3 out of 4 models suggesting suitable habitat (Figure 23).

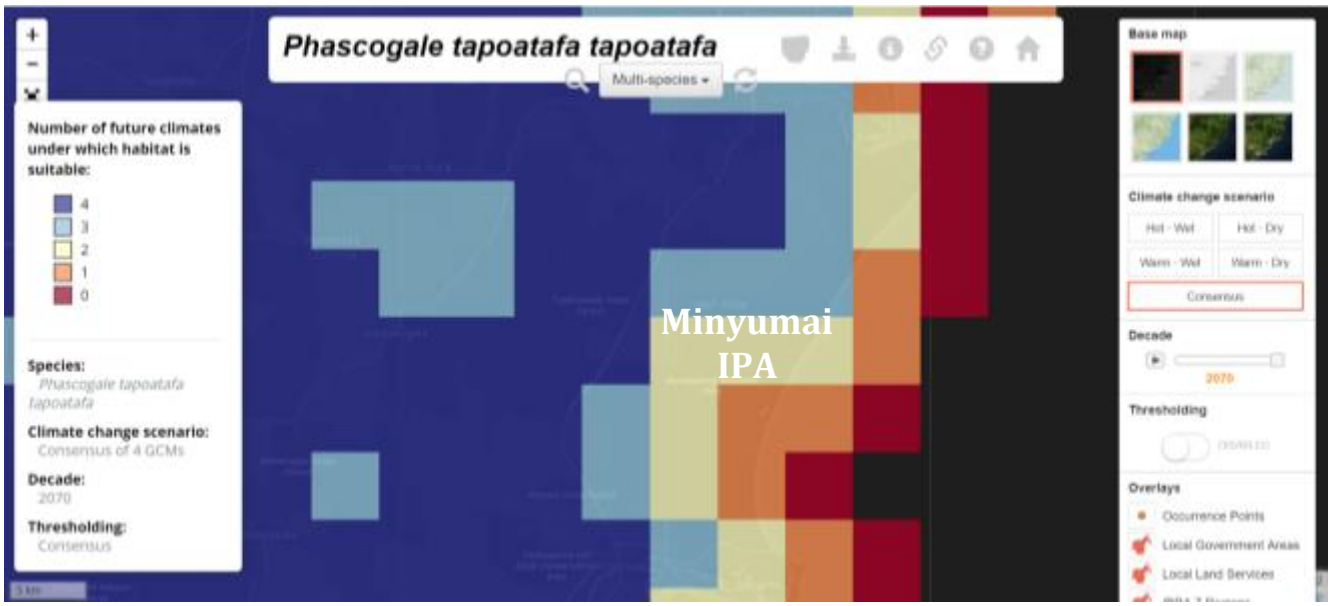


Figure 23: NSW BioNode Climate Refugia consensus results (of 4 models) that shows best refugia for the Brush-Tailed Phascogale near the Minyumai IPA.

## FLORA

*Rubus moluccanus* var. *trilobus* – Native Raspberry


Mundaruhm (Native Raspberry) is a favoured fruit of the Minyumai Rangers. They have not noticed much change to its fruit production or plant health in recent years.

It is widely distributed along the temperate and into the tropical zones of the Australian east coast (Figure 24a).

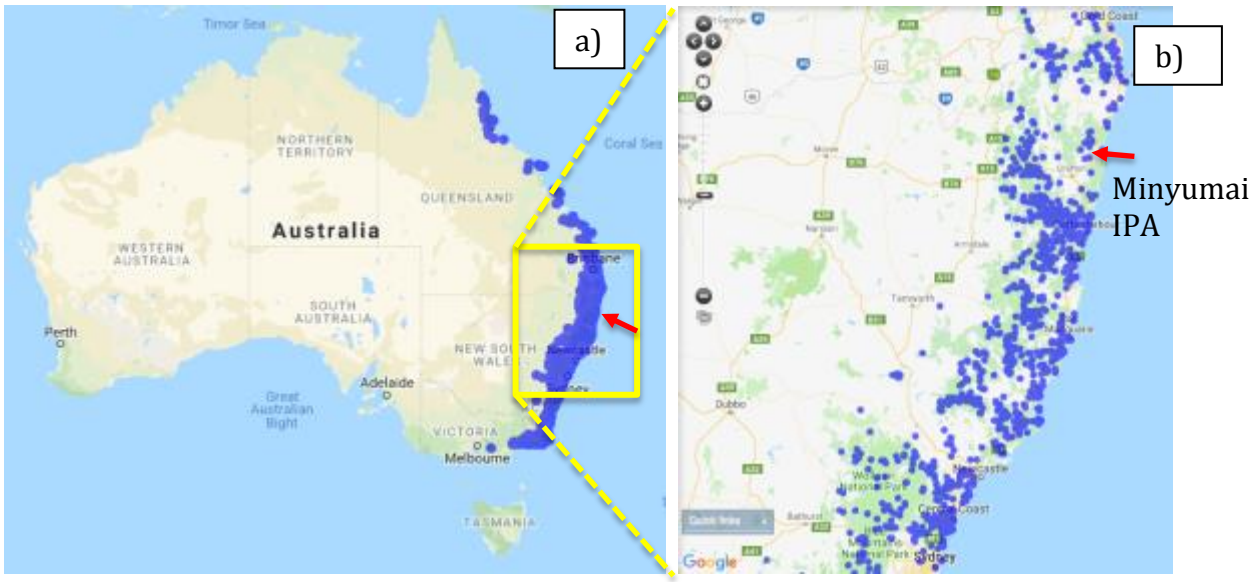


Figure 24: a.) Distribution of the Native Raspberry in Australia; and b) the North Coast region as reported in the ALA from 2795 occurrences.

Again, looking at the climate envelope for this species (Figure 25b), the predicted climate shift of 2°C increase in temperature and about 70-100mm increase (up to 10% increase) in annual rainfall at Minyumai could also push this species into the warmer and wetter region of its distribution.

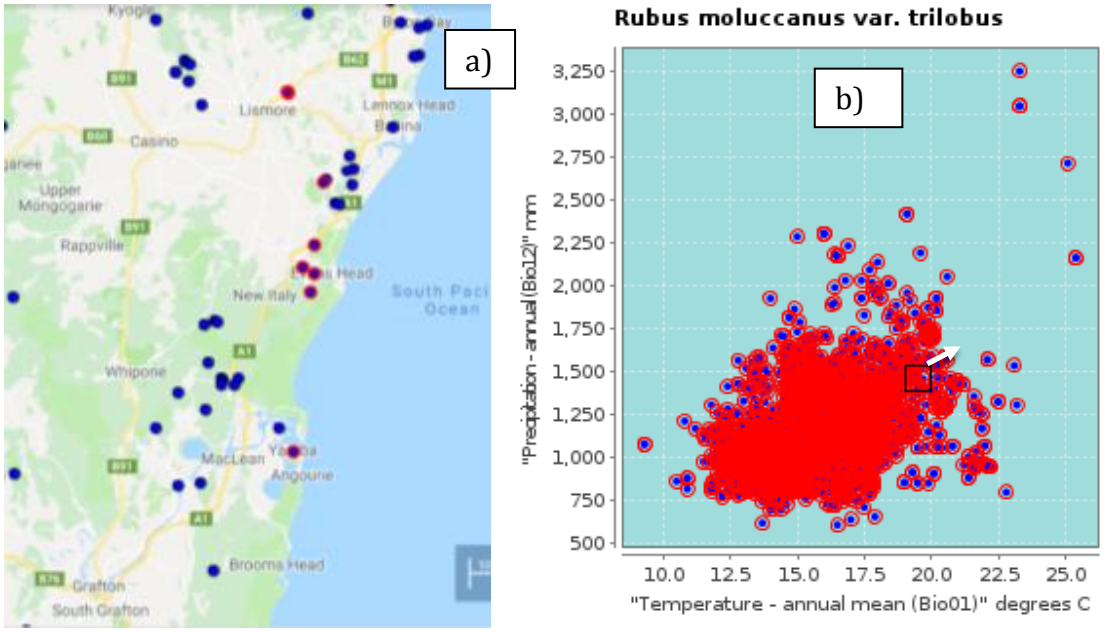


Figure 25: a) records of the Native Raspberry near Minyumai IPA (blue dots) and red highlighted dots showing similar climate to Minyumai IPA. b) The annual rainfall and annual mean temperature data for each Raspberry record showing the region where Minyumai climate sits in the black square and predicted climate change in white arrow.

There is no information for this species in the MQ BioNode Tools.

### *Lomandra longifolia* – Spiny-Headed Mat Rush

Lomandra is a well-known useful plant of Aboriginal people. It was and still is widely used for weaving bags and mats. It is also a bush food: the seeds can be roasted and ground into a flour and the ends of leaves chewed for sugary sustenance. The Minyumai Rangers have not noticed any change in the seeding or growth of this widely dispersed plant in the Minyumai IPA.

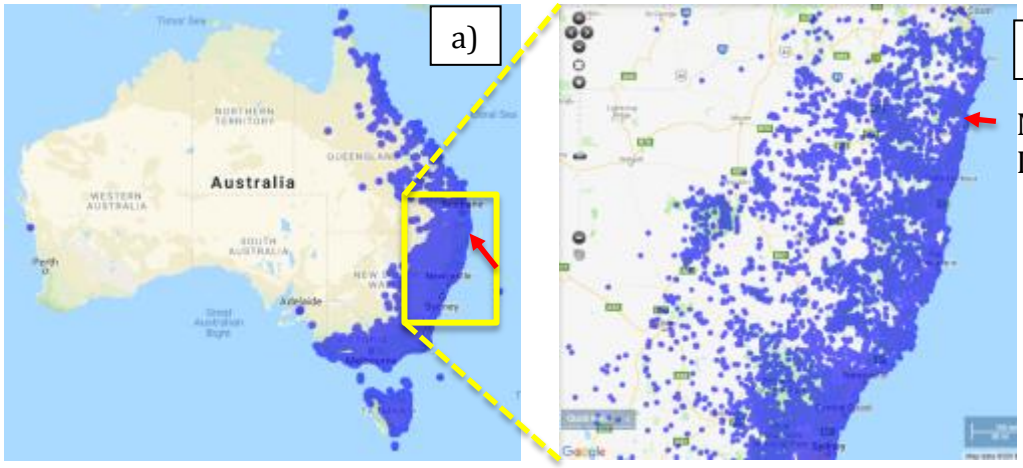


Figure 26: a) Distribution of Lomandra longifolia Australia wide; and b) in the North Coast region as reported in the ALA (from 52,900 occurrences).

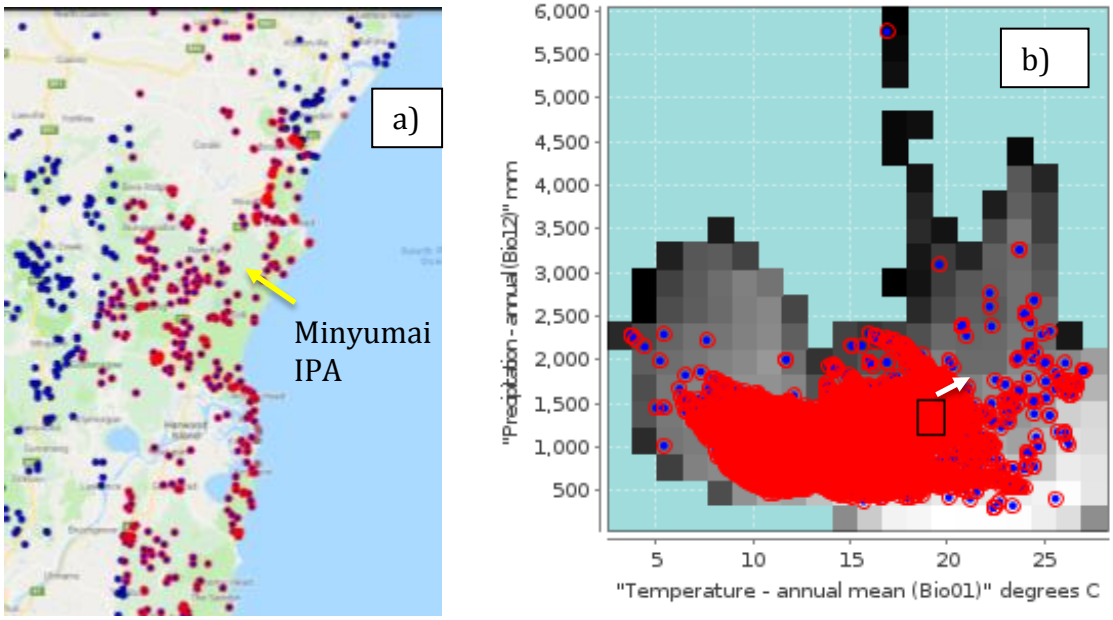


Figure 27: a) records of the Lomandra near Minyumai IPA (blue dots) and red highlighted dots showing similar climate to Minyumai IPA. b) The annual rainfall and annual mean temperature data for each Lomandra record showing the region where Minyumai climate sits in the black square and predicted climate change in white arrow.

There is no information for this species in the MQ BioNode Tools.

### *Nymphaea gigantea* – Water Lily

Water lilies are useful bush food plants. The “yams”, stem and seeds are typically edible.

The Water lily has not been commonly recorded in northern NSW (Figure 28). It would be worth checking the identification of the populations at Minyumai. Minyumai is at the cooler limit of this species’ current distribution (Figure 29). The predicted temperature and rainfall increases may benefit this species in the IPA.

There is no information for this species in the MQ BioNode Tools.

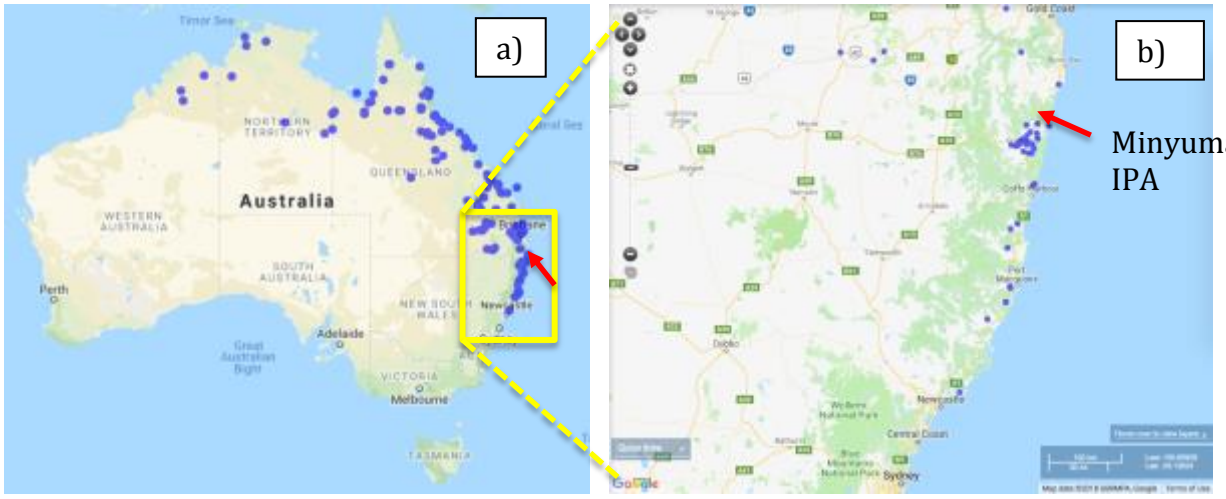


Figure 28: a) The distribution of *Nymphaea gigantea* in Australia; and b) the North Coast region as reported in the ALA (from 295 occurrences.

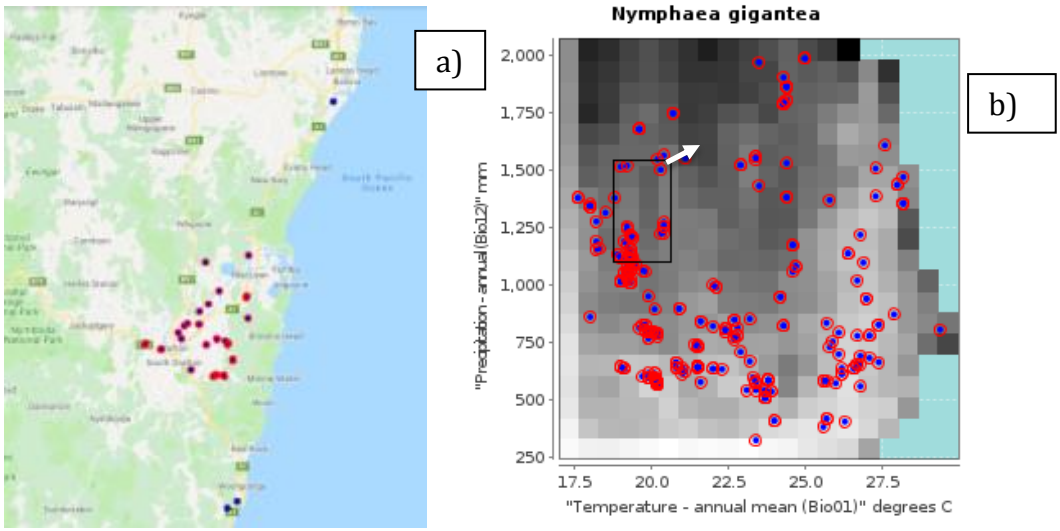


Figure 29: a) records of *Nymphaea gigantea* near Minyumai IPA (blue dots) and red highlighted dots showing similar climate to Minyumai IPA. b) The annual rainfall and annual mean temperature data for each *Nymphaea gigantea* record showing the region where Minyumai climate sits in the black square and predicted climate change in white arrow.

### *Pandanus tectorius* – Beach Pineapple

The beach pineapple has edible nuts and the leaves are likely to have been used in weaving mats and baskets.

It is common along the east coast of Australia above Port Macquarie (Figure 30) and although it does not occur within the Minyumai IPA, it is common in coastal areas of the Bandjalang estate. Predicted climate shifts may benefit this species as within the Bandjalang area it is near is southern-most and cooler/drier distribution (Figure 31b).

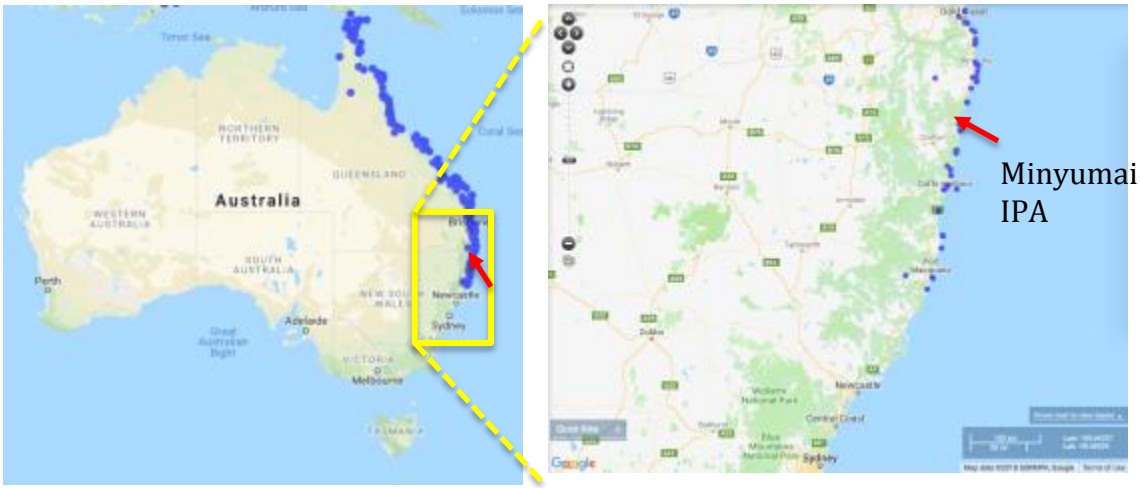


Figure 30: Distribution of the beach pineapple in Australia wide (left) and the NSW North Coast region (right) as reported by the ALA (from 621 occurrences).

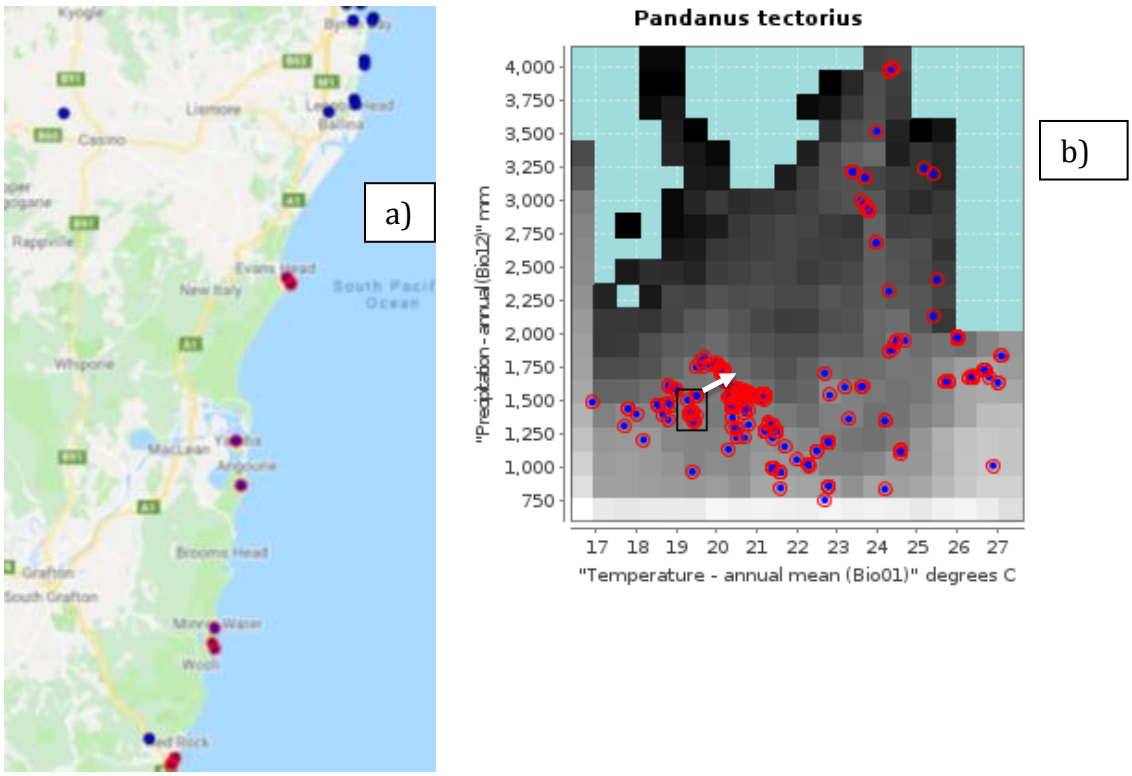


Figure 31 a) records of Beach Pineapple near Minyumai IPA (blue dots) and red highlighted dots showing similar climate to Minyumai IPA. b) The annual rainfall and annual mean temperature data for each Beach Pineapple record showing the region where Minyumai climate sits in the black square and predicted climate change in white arrow.

There is no information for this species in the MQ BioNode Tools.

The large-leaved geebung is commonly found in central eastern Australia along the coast and tablelands (Figure 32). It is also commonly seen at Minyumai. It has edible fruits when they are yellow-brown.

The climate envelope for this species (Figure 33) shows that in the Minyumai area, it is at its warmer and wetter distribution. With predicted warmer and wetter conditions, this species may be pushed to its limits.

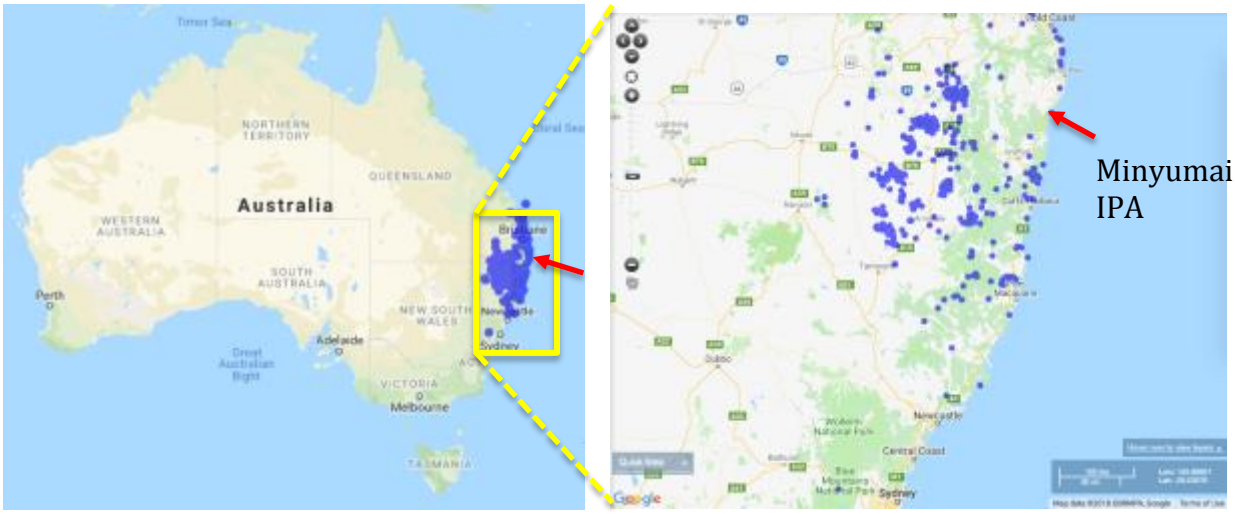


Figure 32: Distribution of the large-leaved geebung Australia wide (left) and in the NSW North Coast region (right) as reported by ALA from 1288 occurrences.

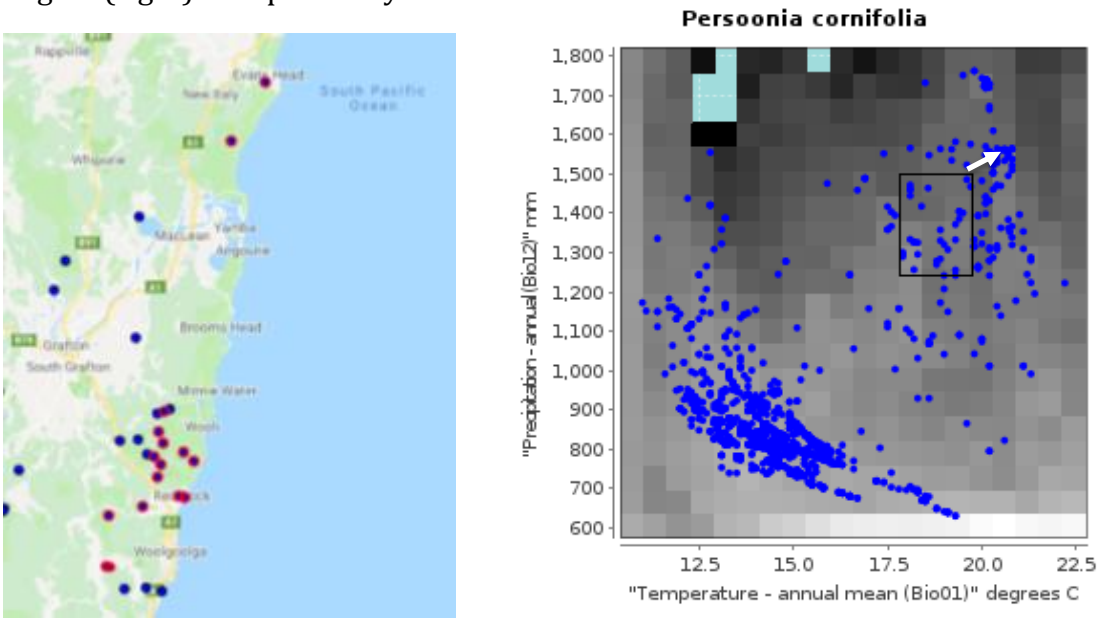


Figure 33 a) left: records of the large-leaved geebung near Minyumai IPA (blue dots) and red highlighted dots showing similar climate to Minyumai IPA. b) The annual rainfall and annual mean temperature data for each large-leaved geebung record showing the region where Minyumai climate sits in the black square and predicted climate change in white arrow.

There is no information for this species in the MQ BioNode Tools.

Native Lassiandra has edible purple fruits and occurs across northern Australia and down to Sydney on the east coast (Figure 34) including the Bandjalang estate. According to its current climate envelope (Figure 35), Minyumai sits at the cooler/drier end of its distribution. Expected increases in temperature and rainfall could benefit this species around Minyumai.

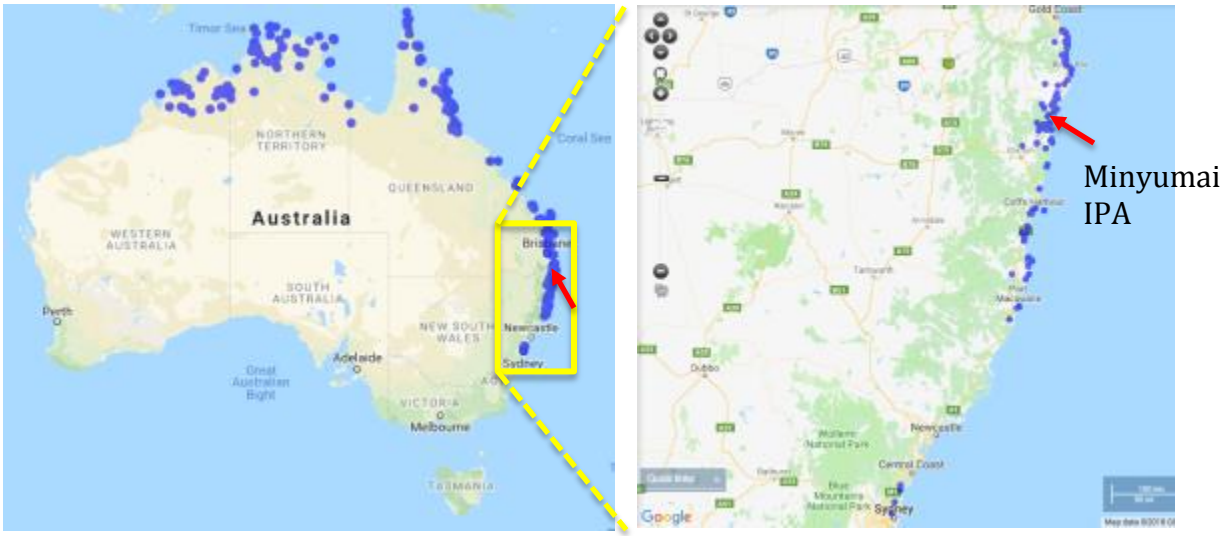


Figure 34: Distribution of the Native Lassiandra Australia wide (left) and in the NSW North Coast region (right) as reported by ALA from 424 occurrences.

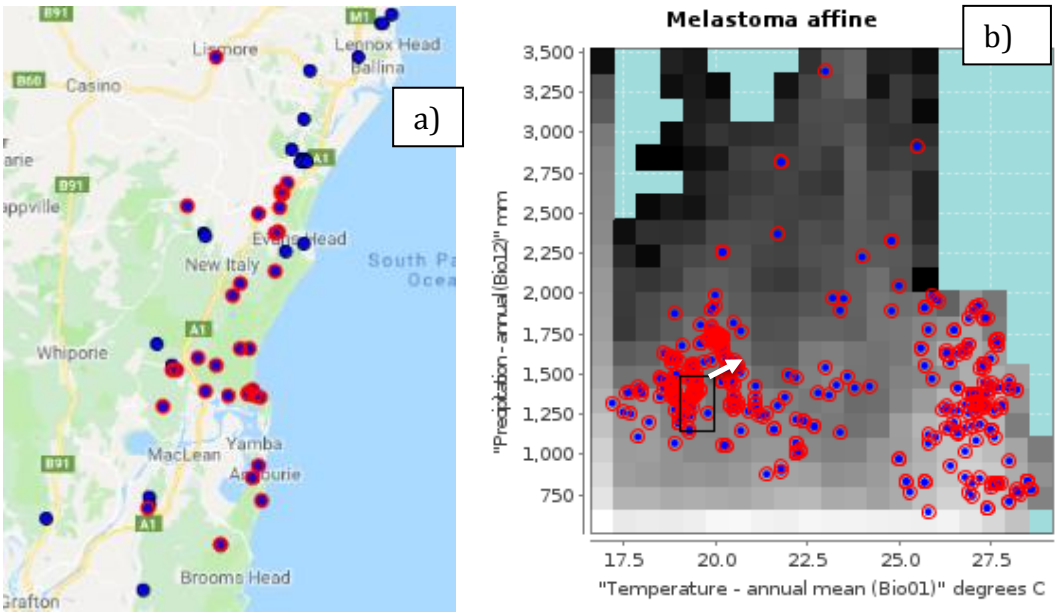


Figure 36 a) records of Native Lassiandra near Minyumai IPA (blue dots) and red highlighted dots showing similar climate to Minyumai IPA. b) The annual rainfall and annual mean temperature data for each Native Lassiandra record showing the region where Minyumai climate sits in the black square and predicted climate change in white arrow.

There is no information for this species in the MQ BioNode Tools.

# Discussion

The Minyumai IPA is located between Tabbimoble Nature Reserve and Bundjalung National Park on the NSW north coast (Figure 1) and lies within the SE Queensland Bioregion.

Based on the NSW Government OEH Adapt NSW North Coast Climate Change Snapshot (2014), the predicted climate change for this area is expected to include:

- slightly higher annual rainfall with more variability in summer and spring
- more extreme heat (>35 °C) days
- fewer cold nights (<2°C)

Ten culturally important fauna (4) and flora (6) species were studied as part of this project. Indigenous knowledge suggests that the behaviour of some fauna species is changing due to warmer winters, namely the Red-necked Wallaby and Lace Monitor, which are not hibernating for as long as they were known to. The Rangers are keen to pay more attention to observed seasonal and inter-annual changes in plants and animals following this project (see videos).

In terms of predicted climate distribution shifts, using species location data from the ALA, most of the selected species are widely distributed along the east coast of Australia. Minyumai tends to lie in the middle of the current distributions, suggesting that a climate change buffer exists for these species at Minyumai IPA. There are however 3 species worth noting.

For two species, *Phascogale tapoatafa* (Brush-Tailed Phascogale) and *Persoonia cornifolia* (Large-Leaf Geebung), Minyumai IPA is nearing the northern extent of current distributions. Plots of the rainfall vs temperature data for the known locations of these species shows that the Minyumai climate is on the edge of their current climate preferences. Warmer, wetter conditions may make Minyumai less favourable for them. This is of particular concern for the Phascogale as it is listed as vulnerable in NSW and endangered in Victoria. The Persoonia is locally common around Minyumai; however, its restricted habitat to Nth NSW/ SE Qld warrant attention when considering climate change adaptation options. It is also a favoured bush fruit plant that is also likely to be a source of food for birds.

The final species that is of ongoing concern at the Minyumai IPA is the Glossy-black Cockatoo. It is also listed as vulnerable in NSW with a dissected distribution due to land clearing. Although the NSW Scientific Committee do not suggest climate change is a concern for this species, the ALA generated rainfall vs temperature graphs and OEH-MQ BioNode Climate Refugia Tool both suggest that habitat may become less suitable for this species in Nth NSW. Although we note that the BioNode Climate refugia tool predicts that the Minyumai IPA may become a significant regional refuge for this species.

For these 5 culturally significant species of concern for Minyumai (Behaviour changes for Red-necked Wallaby, Lace Monitor; and potential distribution change for Phascogale, Persoonia and Glossy-Black Cockatoo) it will be important for the Minyumai Rangers to monitor these species and potentially discuss breeding strategies for the fauna and regeneration strategies for plants and food plants of species of concern. Notably, the Rangers are already planting Casuarina to encourage Glossy-Black Cockatoo habitation.