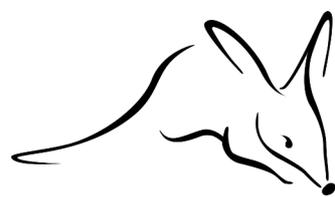


North Head
Ecohealth Report 2021



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Summary

Australian Wildlife Conservancy (AWC) has implemented an Ecological Health Monitoring Program (Ecohealth) to measure the changes in the status and trend of conservation assets, and threats to those assets, across North Head Sanctuary (North Head). Metrics from the program are reported in annual Ecohealth Reports and summarised in the annual Scorecards. This is the Ecohealth Report for 2021. Values of metrics derived in this report were based on data collected during surveys carried out between 2017 and 2021. The complete set of metrics and their values are summarised in the accompanying Ecohealth Scorecard.

At North Head, 14 surveys are conducted on a schedule of 1-3 years to report on 23 biodiversity and 5 threat indicators. In implementing the Ecohealth program in 2021, AWC conducted 2,660 live trap nights, 404 nest box inspections, 30 bird surveys, 30 spotlighting surveys, 30 acoustic trap nights, 84 vegetation surveys and 616 camera trap nights. These surveys detected 18 native mammal species, 45 bird species and 159 flora species.

AWC has reintroduced three small native mammals to North Head: the Bush Rat (*Rattus fuscipes*), Eastern Pygmy-possum (*Cercartetus nanus*) and Brown Antechinus (*Antechinus stuartii*). Of these, Bush Rats have become one of the most common and widespread native mammals on the headland. Bush Rat population size remained stable in 2021, and this reintroduced native species now appears to have a competitive advantage over the invasive black rat.

Abundance of the Eastern Pygmy-possum increased in 2021, continuing a trend since 2018. Occupancy and total captures of the Brown Antechinus also increased in 2021. These results suggest successful breeding and recruitment by these two reintroduced species, but findings may be compounded by post-fire effects. Successful establishment of reintroduced species is important for the ecological health of North Head, with reintroduced species helping to restore key ecological processes (e.g., predator-prey interactions, pollination).

North Head is home to an Endangered population of Long-nosed Bandicoots (*Perameles nasuta*). In 2021, the Bandicoot population was estimated at 248 individuals; the highest population estimate since surveys began. This peak is likely related to above average rainfall received in 2020 combined with post-fire resource supplementation.

Surveys were conducted for several surveillance species in 2021. Average species richness per site was higher in 2021 compared to the previous survey in 2019 for both diurnal birds and microbats. In contrast, the average number of plant species detected per site decreased. These findings are largely considered the result of post-fire responses.

No feral predators (cats, *Felis catus*; and foxes, *Vulpes vulpes*) were detected in 2021. While these species have never been abundant on the headland, a few detections are usually recorded each year. The lack of detections in 2021 likely reflects incursion prevention measures including camera monitoring, baiting, trapping, and cohesive management by AWC and Sydney Harbour Federation Trust (SHFT) in partnership with the National Parks and Wildlife Service.

Both abundance and occupancy of invasive black rats remains low across the headland. This is likely a consequence of previous black rat removal efforts (between 2014-2016) and the re-establishment of the native Bush Rat on the headland.

In October 2020, a prescribed fire lit in the adjacent National Park escaped containment lines and burnt ~23% of the headland (including ~22% of the SHFT/AWC project area). With the exception of plant species richness, there have been no measurable negative impacts from the fire for most metrics. Post-fire rainfall and active intervention in the form of resource supplementation may have ameliorated fire impacts.

Most conservation assets are tracking well at North Head, either remaining stable or increasing relative to results from previous years. Plant richness has declined post-fire at burnt sites, but it is expected that richness will recover with time. Future monitoring will allow effects of management interventions (e.g., species reintroductions, prescribed burns, vehicle access restrictions) and unplanned events (e.g., wildfire) on ecological health indicators to be more fully understood, along with other drivers of spatial and temporal change (e.g., weather patterns).

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Introduction

Australian Wildlife Conservancy (AWC) currently owns, manages, or works in partnerships across 31 properties in Australia, covering almost 6.5 million hectares, to implement our mission: *the effective conservation of Australian wildlife and their habitats*. AWC relies on information provided by an integrated program of monitoring and research to measure progress in meeting its mission and to improve conservation outcomes.

AWC's Ecohealth Monitoring Program has been designed to measure and report on the status and trends of species, ecological processes and threats on each of these properties (Kanowski et al. 2018). Data from the monitoring program are used to address the following broad questions relevant to our mission:

- 'are species persisting on a property?'
- 'are habitats being maintained?'
- 'are threats below ecologically-significant thresholds?'

For threatened and iconic species, including reintroduced species, AWC's monitoring program aims to obtain more detailed information related to their conservation management; for example, data on survival, recruitment, condition, distribution and/or population size.

The structure of the Ecohealth Program is as follows. AWC's Monitoring and Evaluation framework provides guidance on the development of the Ecohealth Monitoring Plans for each property managed by AWC: these plans describe the conservation values and assets of each property, the threats to these assets, and the monitoring program that will be used to track their status and trend, and to evaluate outcomes. Annual survey plans and schedules are developed to implement these plans. The outcomes of these surveys are presented in annual Ecohealth Reports and summary Ecohealth Scorecards.

This document is one of a series of annual Ecohealth Reports for North Head Sanctuary (referred to here as North Head). The companion Ecohealth Scorecard presents the indicators and their metrics in a summary format.

North Head Sanctuary

North Head is a site of high ecological value within the Sydney Basin (Figure 1). North Head is within the traditional lands of the Gayamaygal people. It protects the majority of the remaining Eastern Suburbs Banksia Scrub vegetation community (listed as Endangered nationally, Critically Endangered in NSW; Figure 2), and a population of Long-nosed Bandicoots (*Perameles nasuta*; listed as Endangered in NSW). However, North Head has also suffered biodiversity losses on a scale similar to many other parts of Australia, including the local extinction of a number of species, especially mammals vulnerable to introduced predators.

Since 2009, under contract with the Sydney Harbour Federation Trust (SHFT), AWC has run an integrated set of projects that aim to prevent further loss of biodiversity at North Head, restore animal assemblages and their associated ecological processes, and monitor key conservation assets and threats. AWC is contracted to manage 74 ha of land in the middle of the headland for which SHFT is responsible (30% of total headland area; Figure 2). However, since Ecohealth indicators extend across the headland, surveys associated with the Ecohealth Program are not restricted to this 74 ha area (i.e., surrounding areas managed by NSW National Parks and Wildlife Service, NPWS, are included, by agreement with NPWS). Including the entire headland area in surveys allows Ecohealth indicators to be monitored and managed holistically.

North Head supports 196 species of native vertebrates, including 18 mammals, 148 birds, and 23 reptiles and 7 amphibians (Appendix 1). The Grey-headed Flying-fox (*Pteropus poliocephalus*) and the Large-eared Pied-bat (*Chalinolobus dwyeri*) are the only nationally threatened species known to occur on the headland. Another 18 vertebrate species or populations listed as threatened under NSW legislation are known to occur or are likely to occur on the sanctuary, including 1 amphibian, 10 birds and 7 mammals.

There are no extant large mammals on North Head. Of the small to medium-sized mammals historically present, five species persist: Water Rat (*Hydromys chrysogaster*), Long-nosed Bandicoot, Short-beaked Echidna (*Tachyglossus aculeatus*), Common Ringtail Possum (*Pseudocheirus peregrinus*) and Common Brushtail Possum (*Trichosurus vulpecula*). Small to medium-sized mammals are particularly susceptible to

predation by introduced predators and habitat degradation (Radford et al. 2018) and at least five species – Eastern Pygmy-possum (*Cercartetus nanus*), Brown Antechinus (*Antechinus stuartii*), Bush Rat (*Rattus fuscipes*), Eastern Quoll (*Dasyurus viverrinus*) and Rufous Bettong (*Aepyprymnus rufescens*) – have become locally extinct from the North Head area since European settlement. Two bird species (Diamond Firetail, *Stagonopleura guttata*; and Eastern Ground Parrot, *Pezoporus wallicus*), two frogs (Giant Burrowing Frog, *Heleioporus australiacus*; and Wallum Froglet, *Crinia tinnula*), and one reptile (Broad-headed Snake, *Hoplocephalus bungaroides*) are also locally extinct.

Between 2014 and 2019 AWC reintroduced three locally extinct small mammal species to North Head: Eastern Pygmy-possum, Brown Antechinus and Bush Rat.

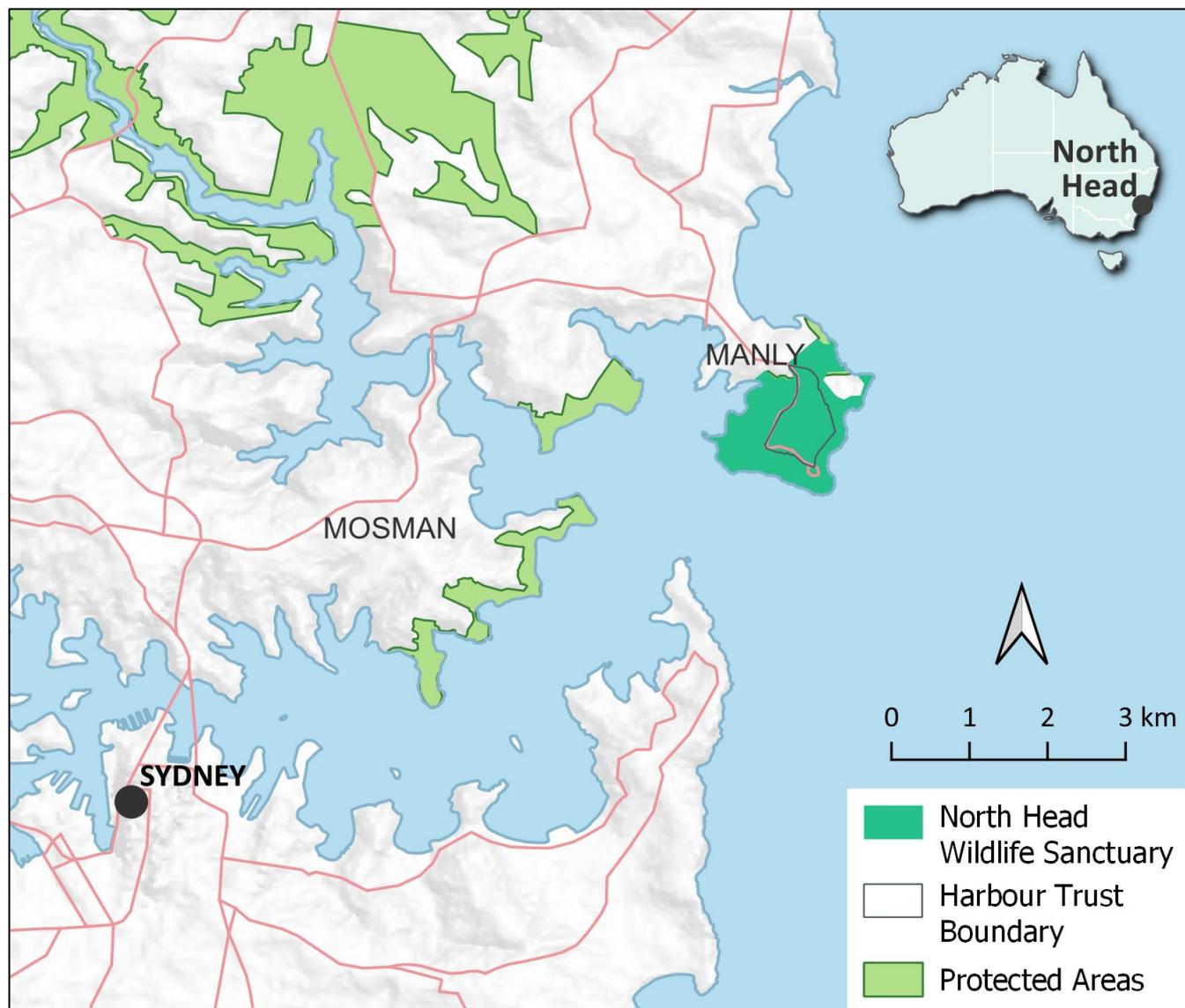


Figure 1. Location and regional context of North Head.

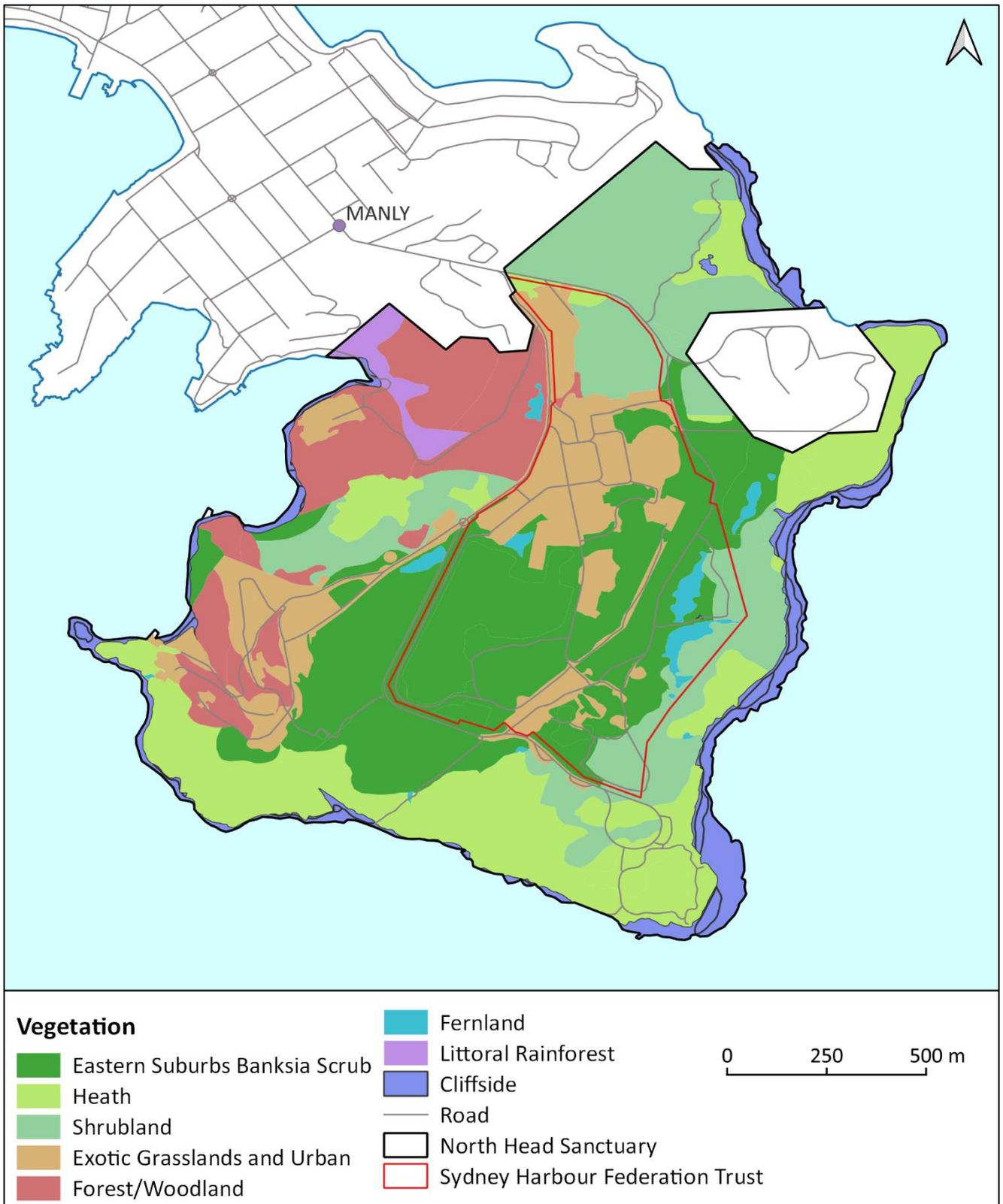


Figure 2. Extent and distribution of broad vegetation types of North Head. Note the map extends across all tenures on the headland. AWC’s contract with the Sydney Harbour Federation Trust concerns 74 ha of land managed by the Harbour Trust in the middle of the headland (area encompassed by red line).

Climate and weather summary

The climate in the Sydney region typically consists of warm summers and mild, cooler winters. Annual average rainfall is ~1,279 mm (Figure 3), distributed across the year, but with summer/autumn generally being wetter than spring (Figure 4). Rainfall in 2021 was 1,390 mm, slightly above average, primarily due to large totals received in March (Figure 4). Mean maximum temperatures range between 26°C in summer and 17°C in winter. With a mean temperature of 27°C in January and a mean low of 18°C in July, 2021 was hotter than average.

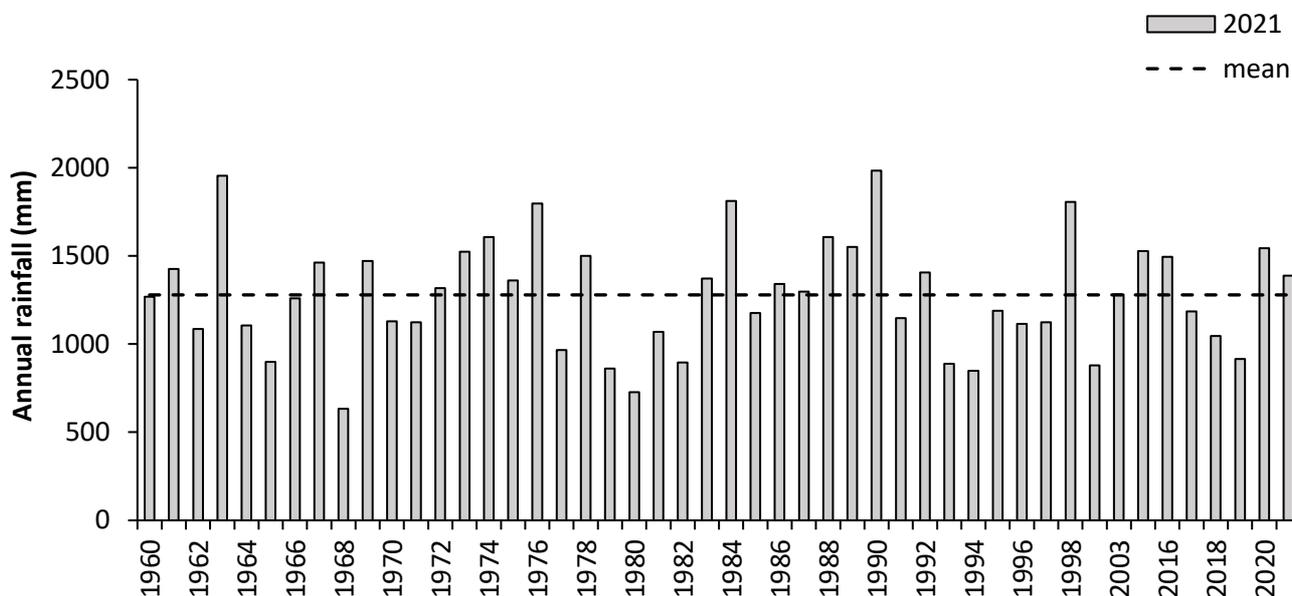


Figure 3. Annual rainfall, Sydney: compared with mean values. Data for Sydney Botanical Gardens (station number: 066006; Bureau of Meteorology, Climate Data Online). Dashed line = average annual rainfall 1960 – 2021.

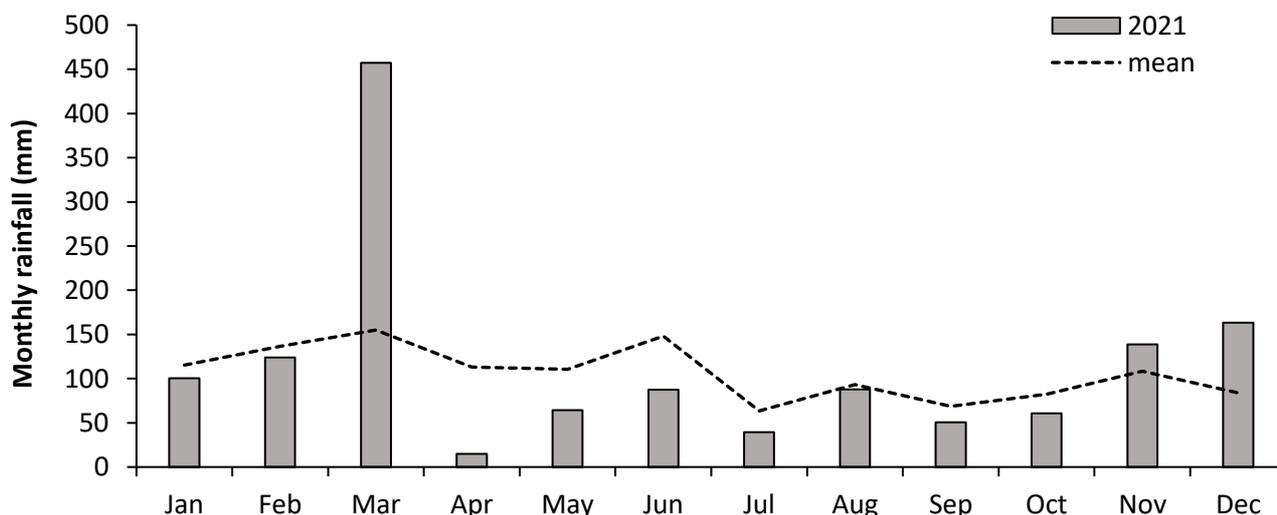


Figure 4. Monthly rainfall, Sydney: 2021 compared with mean values. Data for Sydney Botanical Gardens (station number: 066006; Bureau of Meteorology, Climate Data Online). Dashed line = average monthly rainfall 1960-2021.

Recent fire history

Fire is a major driver of the structure and composition of Australian ecosystems, and hence wildlife habitat. Fire is an essential regenerative tool for the Eastern Suburbs Banksia Scrub (ESBS) and a fire interval of between 8 to 15 years is required to promote optimal regeneration and species richness for the dominant

plant species within this community. Prior to 2020, control burns were last conducted on part of the headland in 2018.

In October 2020, a National Parks and Wildlife Service prescribed burn was conducted along an 8 ha perimeter of the sewerage treatment plant. The fire escaped containment lines and burnt a large proportion of the vegetation on the headland. Much of the canopy was also scorched due to the high intensity of the burn. Only a small portion of 2020 burn areas experienced a cooler, understory burn (see Results section). The fire consumed much of the Bush Rat, Eastern Pygmy-possum and Brown Antechinus reintroduction area and adjacent ESBS, including areas where a range of species were well established and had been captured at high rates. In response to the fire, AWC developed a range of post fire-management strategies designed to maximise survival of persisting wildlife in both the short and long-term. These included the provision of supplementary shelters, nest boxes, food, and water.

Methods

Monitoring and evaluation framework

North Head's Ecohealth Monitoring Program has been designed to measure and report on the status and trends of selected biodiversity and threat indicators using metrics derived from data collected through a series of purpose-designed surveys. Where possible, the annual status and trends will be evaluated against performance criteria relevant to each species, guild or assemblage.

Key threatened and iconic vertebrates

The Ecohealth program is focused on species of high conservation value, including threatened and 'iconic' species (e.g., regional endemics, species with high public profile and other species of conservation importance because of the role they play in an ecosystem, etc). Where relevant, reintroduced species are also in this category.

Monitoring programs for reintroduced species in the establishment phase (i.e., within 5-10 years of establishment) are typically set out in a *Translocation Proposal*, along with success criteria to evaluate outcomes around survival, recruitment, population size, etc.

AWC will develop *Population Management Plans* to underpin management of long-established populations of reintroduced species, to ensure early detection of any serious issues that arise, and to trigger timely responses. These plans will specify a monitoring and evaluation program (e.g., Berry et al. 2021).

AWC will aim to develop *Conservation Plans* for the remaining key (extant) threatened and iconic species, with similar objectives to Population Management Plans. These plans will specify metrics to monitor outcomes for target species against nominated performance criteria.

Vertebrate assemblages and surveillance species

AWC's mission involves the conservation of all wildlife, not only threatened or reintroduced species. For this reason, AWC's monitoring program extends to surveillance monitoring of faunal assemblages (mammals, birds, reptiles, frogs). The monitoring program aims to address questions relevant to the conservation of assemblages.

At the most basic level, the program seeks to establish whether all species that are known to occur on the property are persisting on the property (i.e., 'are all species present?').

With increasing information, the monitoring program can address more detailed questions relating to conservation of assemblages, such as 'have species maintained their distributions or abundance?' However, the boom/bust conditions of most Australian environments can lead to large variations in the numbers of individuals in a population and the habitats or sites occupied by a species – these variations may not necessarily be informative in relation to the conservation of a species at a property over the long term.

AWC is currently working on developing an evaluation framework for surveillance monitoring of faunal assemblages. At present, we will continue to present data on a range of metrics relating to indicator species and guilds.

Indicators and metrics

On North Head, 23 biodiversity (species, guilds, and assemblages) indicators have been selected for monitoring (Table 1). Nineteen of these indicators are reported on in 2021, including nine related to threatened and iconic species (of which, three are reintroduced species), and the remainder to surveillance monitoring of faunal assemblages.

Threat metrics are selected to monitor the status and trends of weeds, introduced predators and herbivores and fire regimes. Five threat indicators have been selected for monitoring (Table 2). All five of these threat metrics are reported on in 2021.

Table 1. Biodiversity indicators and metrics for North Head.

Reintroduced vertebrates

Indicator	Survey name/methods	Metric	Performance criteria
Brown Antechinus (<i>Antechinus stuartii</i>)	Standard Trapping Survey	Occupancy	Increase in distribution
		Breeding	Evidence of breeding
		Genetic diversity	Maintained/increased genetic diversity relative to founders
Eastern Pygmy-possum (<i>Cercartetus nanus</i>)	Pygmy-possum Nest Box Survey	Abundance	Increase in abundance
		Occupancy	Stable or increasing occupancy
		Breeding	Evidence of breeding
		Genetic diversity	Maintained/increased genetic diversity relative to founders
Bush Rat (<i>Rattus fuscipes</i>)	Standard Trapping Survey	Population estimate	Stable or increasing population estimate
		Genetic diversity	Maintained/increased genetic diversity relative to founders

Key threatened and iconic vertebrates

Indicator	Survey name	Survey method	Metric/s
Mammals			
Long-nosed Bandicoot (<i>Perameles nasuta</i>)	Bandicoot Cage Trap Survey	Cage trapping	Population estimate
Frogs			
Red-crowned Toadlet (<i>Pseudophryne australis</i>)	Frog Survey	Active listening, call playback, spotlighting	Occupancy

Vertebrate assemblages and surveillance species

Indicator	Survey name	Survey method	Metric/s
Mammals			
Assemblage richness	Standard Trapping Survey, Pygmy-possum Nest Box Survey, Bandicoot Cage Trap Survey, Feral Predator Camera Survey, Nocturnal Survey, Bat Survey	All mammal survey methods	Number of species
Ground-dwelling mammals			
Short-beaked Echidna (<i>Tachyglossus aculeatus</i>)	Feral Predator Camera Survey	Camera trapping	Occupancy
Arboreal mammals			
Common Ringtail Possum (<i>Pseudocheirus peregrinus</i>)	Nocturnal Survey	Spotlighting	Abundance, occupancy

Indicator	Survey name	Survey method	Metric/s
Common Brushtail Possum (<i>Trichosurus vulpecula</i>)	Nocturnal Survey	Spotlighting	Abundance, occupancy
Bats			
Assemblage richness	Bat Survey	Acoustic Detectors	Number of species
Bat guild	Bat Survey	Acoustic detectors	Occupancy, richness (per site)
Reptiles			
Assemblage richness	Reptile Survey	Funnel and camera trapping	Number of species
Small-medium reptile guild	Reptile Survey	Funnel and camera trapping	Occupancy
Birds			
Assemblage richness	Standard Bird Survey, Nocturnal Survey	Transects, spotlighting transects, active listening	Number of species
Diurnal bird guild	Standard Bird Survey	Transects	Richness (per site)
Nocturnal bird guild	Nocturnal Survey	Spotlighting and Active Listening	Occupancy
Powerful Owl (<i>Ninox strenua</i>)	Nocturnal Survey	Spotlighting transects	Presence/absence
Barking Owl (<i>Ninox connivens</i>)	Nocturnal Survey	Spotlighting transects	Presence/absence
Frogs			
Assemblage richness	Frog Survey	Active listening, spotlighting	Number of species

Key threatened and iconic plants

Indicator	Survey name	Survey method	Metric/s
Threatened plants			
<i>Eucalyptus camfieldii</i>	Camfieldii Monitoring and Recruitment Survey	Quadrat assessment	Abundance Recruitment

Vegetation indicators and surveillance species

Indicator	Survey name	Survey method	Metric/s
Community structure			
Plant assemblage richness	Vegetation Survey	Quadrat	Number of species, richness
Eastern Suburbs Banksia Scrub	Banksia Scrub Mapping	Satellite imagery and fire history	Percentage senescent (identified in historical surveys), percentage long unburnt (greater than 15 years)
Ecological processes			
Pollination	Pollination Survey	Seed set count	Proportion of successful seed set

Table 2. Threat indicators and metrics for North Head in 2021.

Indicator	Survey name/methods	Metric/s	Performance criteria
Feral predators			

Indicator	Survey name/methods	Metric/s	Performance criteria
Cat (<i>Felis catus</i>)	Feral Predator Camera Survey	Activity	Identify cat incursion; threshold is >0 cats
Fox (<i>Vulpes vulpes</i>)	Feral Predator Camera Survey	Activity	Identify fox incursion; threshold is >0 foxes
Pest animals			
Black rat (<i>Rattus rattus</i>)	Standard Trapping Survey	Abundance, occupancy	Monitor abundance; ongoing treatment
Fire			
Inappropriate fire regime	Fire Scar Analysis	Area burnt by prescribed fire (ha) Area burnt by wildfire (ha)	Monitor area burnt by vegetation type; Targets TDB
Vehicle strike			
Long-nosed Bandicoot (<i>Perameles nasuta</i>) road mortality	Vehicle Strike Incidence Reports	Individuals killed	Monitor and document vehicle strikes; ongoing community education

Survey types and history

To report on the Biodiversity and Threat Indicators, our survey teams conduct a variety of surveys repeated on a schedule of 1-3 years, as required to obtain timely information on each indicator. These include:

For threatened and iconic species, including reintroduced species, a range of targeted surveys including:

- Standard Trapping Survey
- Pygmy-possum Nest Box Survey
- Bandicoot Cage Trap Survey
- Frog Survey
- Banksia Scrub Mapping
- *Eucalyptus camfieldii* Monitoring and Recruitment Survey

For monitoring of assemblages, surveillance species and ecological processes, these include:

- Feral Predator Camera Survey
- Nocturnal Survey
- Bat Survey
- Standard Bird Survey
- Reptile Survey
- Frog Survey
- Vegetation Survey
- Pollination Survey

To monitor threats, a range of surveys are used, including:

- Feral Predator Camera Survey
- Standard Trapping Survey
- Fire Scar Analysis
- Vehicle Strike Incident Reports

Eleven ecological surveys were conducted at North Head in 2021. Below is a list of surveys reported upon in this Ecohealth Report (Table 3). The methodology is described and results of these surveys and computations are reported on in this document.

Table 3. Survey history and effort for Ecohealth surveys on North Head presented in this report.

Survey name	Effort (2021)	Description/comment	Previous surveys
Standard Trapping Survey	1,190 trap nights	20 sites surveyed with 5 Elliott traps and 5 cage traps for 3 nights. Repeated biannually. Replicate nights reduced during one survey in 2021	2020 – 1,200 trap nights 2019 – 1,200 trap nights 2018 – 1,200 trap nights 2017, 2019, 2020 – 1,200 trap nights each
Pygmy-possum Nest Box Survey	404 box surveys	101 nest boxes each checked four times annually	2020 – 252 box surveys 2019 – 378 box surveys 2018 – 252 box surveys
Bandicoot Cage Trap Survey	1,470 trap nights	49 transects with 6 cage traps each for 5 nights. Repeated annually	2020 – 1,176 trap nights 2018 – 1,470 trap nights 2006, 8, 10, 12, 14, 16 – 1,410 trap nights
Frog Survey	0	Three sites surveyed for one night. Last survey 2020	2020 – 3 surveys 2018 – 6 surveys
Banksia Scrub Mapping	Ongoing	Percentage of burnt and unburnt ESBS analysed following prescribed burns and wildfires	Mapping commenced in year 2019
<i>Eucalyptus camfieldii</i> Monitoring and Recruitment Survey	49 surveys	Health status surveys of 41 individual trees Eight recruitment plot surveys conducted surrounding known specimens	
Feral Predator Camera Survey	616 camera trap nights	Eight sites, one camera/site, four surveys per year. Survey one; 14 nights, survey two and three; 20 nights, survey four; 23 nights.	2020 – 640 camera trap nights 2019 – 640 camera trap nights 2018 – 640 camera trap nights
Nocturnal Survey	10 surveys	10 sites, three replicates	2019 – 20 surveys
Bat Survey	20 surveys	Ten sites. One acoustic detector/site for three nights, repeated twice	2019 – 20 surveys
Standard Bird Survey	10 surveys	Ten sites, three replicates	2019 – 10 surveys
Vegetation Survey	35 surveys	35 vegetation monitoring sites	2018 – 35 surveys
Pollination Survey	114 surveys	38 trees, three branches per tree. 22 trees used in previous monitoring years were burnt in the 2020 fire, so were unable to be surveyed	2019 – 180 surveys 2017 – 180 surveys
Fire Scar Analysis	Ongoing	Total area (ha) and proportion (%) of vegetation types burnt each year by prescribed burns and wildfire	Analysis commenced in 2018
Vehicle Strike Incident Reporting	Ongoing	Incident reporting process includes a mortality register maintained by AWC and NPWS.	AWC incident reporting commenced in 2017

Survey design and methods

Standard Trapping Survey

The Standard Trapping Survey was conducted at 20 survey sites across North Head, stratified by vegetation type (each broad vegetation type has a minimum of two survey sites; Figure 5). The survey entails live trapping of small-medium mammals (Bush Rat, Brushtail Possum, Brown Antechinus, Long-nosed Bandicoot and introduced black rat, *Rattus rattus*). Surveys are conducted biannually.

Surveys were conducted over three consecutive nights. Trapping sites comprised: 10 traps (5 x Elliott traps, 5 x cage traps) placed in pairs along a 100-m transect (~25 m intervals), with paired traps at least 10 m apart. Traps were lined with insulating material (e.g., leaf litter, coconut fibre) and baited with a mixture of peanut butter, oats and honey. Transects were separated by a distance of at least 100 m.

Captured Brushtail Possums and black rats were marked with an indelible marker-pen to temporarily identify recaptures within the same sampling period. Bush Rats, Brown Antechinus and Long-nosed Bandicoot had a microchip inserted under the skin to enable individual identification.

The Standard Trapping Survey was conducted in May and December 2021. In December 2021 survey effort was reduced: one trapping site had to be closed due to high covid activity at the traps.

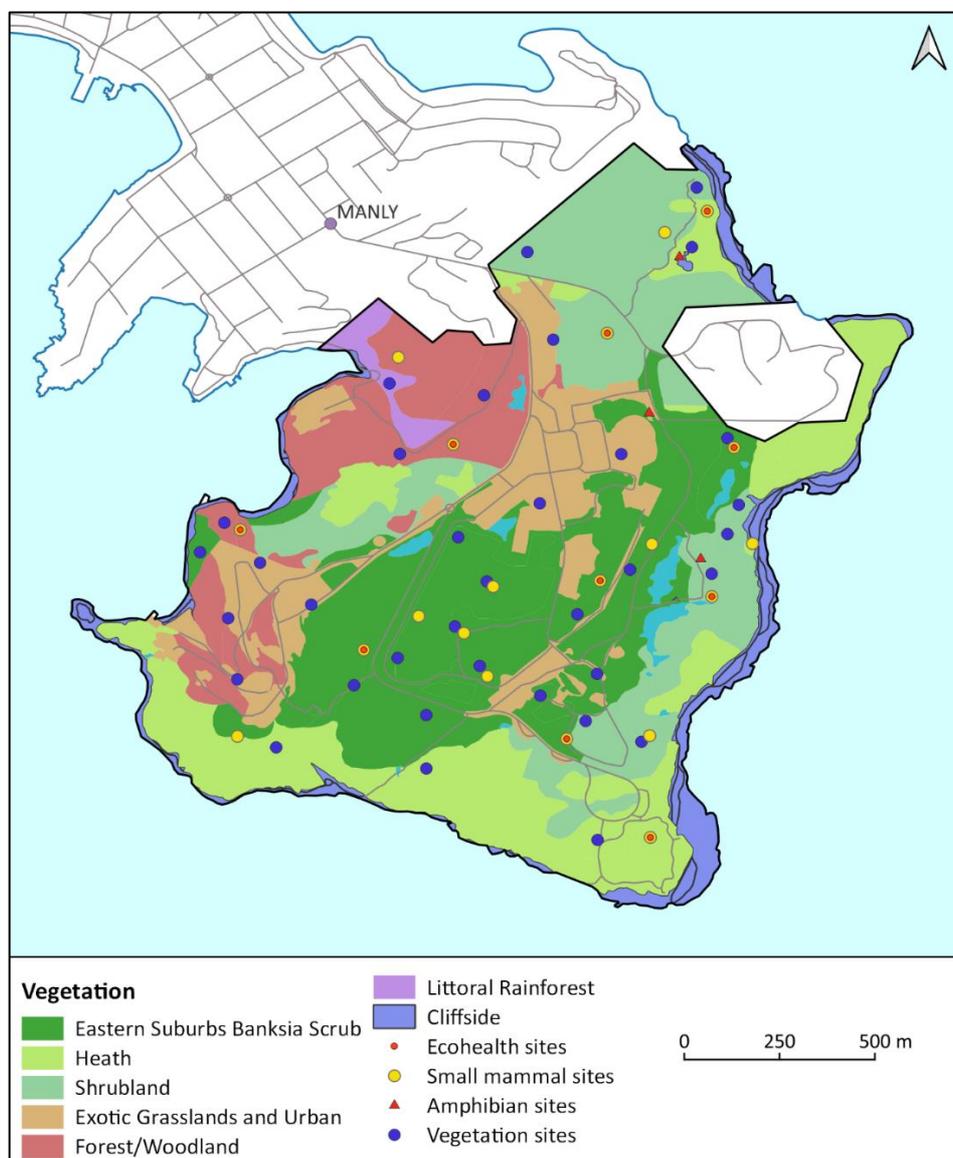


Figure 5. Location of all Ecohealth survey sites at North Head. Surveys include 35 vegetation sites (Vegetation Survey), 20 small-medium mammal sites (Standard Trapping Survey), 10 sites where birds, bats, arboreal mammals and reptiles are monitored (Standard Bird Survey, Reptile Survey, Bat Survey, Nocturnal Survey) and 3 amphibian survey sites (Frog Survey).

Pygmy-possum Nest Box Survey

In 2017, 63 nest boxes were installed across North Head for monitoring small mammals (primarily the hollow-dependent reintroduced Eastern Pygmy-possum). Nest box locations were stratified by vegetation type, with each broad vegetation type having a minimum of two nest boxes. After an escaped hazard reduction burn in 2020, an additional 38 nest boxes were deployed throughout the burnt areas of the headland, providing replacement habitat for animals inhabiting these areas. All new nest boxes were also stratified by vegetation type. Consequently, the total number of nest boxes monitored for Eastern Pygmy-possums in 2021 was 101. Four rounds of nest box surveys were conducted: two coinciding with the Standard Trapping Survey in March and December, and two in March and August.

Bandicoot Cage Trap Survey

To survey Long-nosed Bandicoot, AWC worked with NPWS to conduct live-trapping on 49 transects across North Head (Figure 6). Surveys were conducted over five consecutive nights. Transects were ~180 m in length and stratified by vegetation type. Six wire cage traps were placed along each transect at 20 m intervals. Each cage was baited with universal bait (oats, peanut butter and honey), replenished daily.

The Bandicoot Cage Trap Survey was conducted in May 2021.

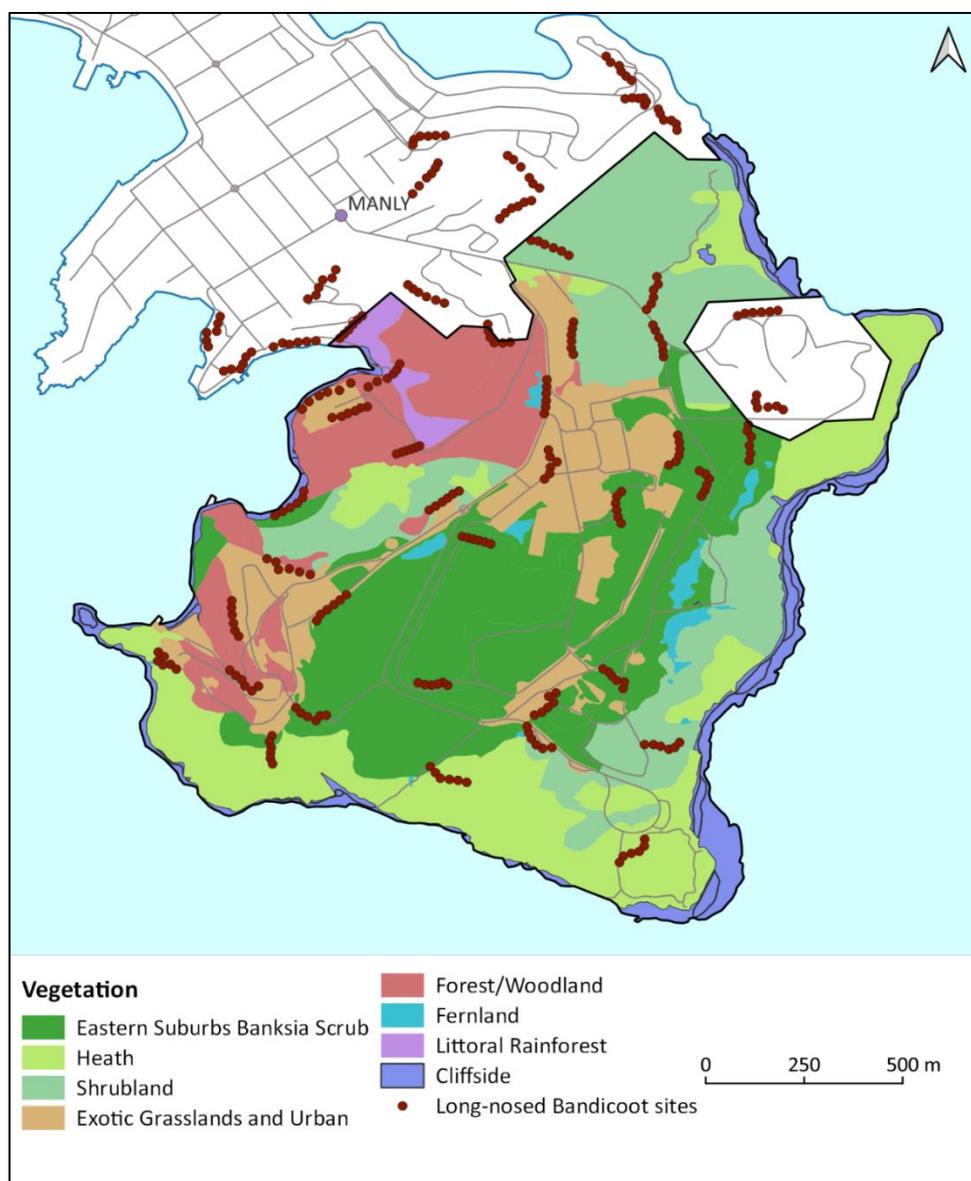


Figure 6. Location of the Long-nosed Bandicoot transects. 49 transects are deployed across the headland during the May biennial survey conducted by both AWC and NPWS, as the survey extends across SHFT and NPWS tenures.

Frog Survey

Frog Surveys are conducted at North Head every two years and were not conducted in 2021.

Previously, Frog Surveys were undertaken at three ephemeral wetlands: Hanging Swamp, Quarry, and Frog Pond (Figure 5). Surveys were conducted on warm nights in March and December following rain events. Frogs were surveyed using a combination of targeted listening, call-playback and spotlight surveys within the ephemeral wetlands. At each wetland, one observer listened for frog calls for a five-minute period. Then, calls for the Red-crowned Toadlet (*Pseudophryne australis*) were broadcast for one minute with responses recorded on the datasheet. Active searches were then conducted by spotlight for a 10-minute period. Searches were conducted along the margins of waterbodies.

Banksia Scrub Mapping

Previous research conducted by the Sanctuary Foundation at North Head has shown that fire has a positive impact on Eastern Suburbs Banksia Scrub, with burnt plots having greater plant cover, more native species, greater diversity and fewer weeds than long unburnt plots (Lambert and Lambert 2015). In addition, many mammals such as the Long-nosed Bandicoot exhibit a preference for patchy habitat, with open areas for foraging and dense scrub for nesting, single age senescent vegetation does not provide this habitat (Chambers and Dickman 2008, Scott et al. 1999). If a prescribed burn is conducted or a wildfire occurs the percentage of burnt ESBS habitat is mapped. The proportion of long unburnt and senescent ESBS is then calculated.

Eucalyptus camfieldii Monitoring and Recruitment Survey

The threatened plant *Eucalyptus camfieldii* was surveyed at known occurrence sites on the headland. A historical data base of 84 recorded locations of *E. camfieldii* was compiled from threatened species monitoring conducted by Nick Skelton and opportunistic observation by the North Head Sanctuary Foundation. While the locations of the trees had been recorded there was no current data on their status and no robust monitoring of tree health, age and recruitment.

At each of the 84 locations a survey was conducted, and the status of the tree was confirmed as alive or dead. Where a living tree was observed, measurement of height, circumference, signs of herbivory, dieback and crown density were taken to assess the health of the individual.

To measure recruitment of *E. camfieldii* a subset of eight 'alive' trees was chosen. At each tree a 20 x 20 m quadrat was established around the base, and any *E. camfieldii* occurring within these quadrats was assessed and classified by age class with measurements of height of plant and distance from main tree taken.

The *Eucalyptus camfieldii* Monitoring and Recruitment Survey was conducted in September 2021.

Nocturnal Survey

Surveys for nocturnal birds and Common Ringtail Possum were conducted on two consecutive nights at 10 Ecohealth monitoring sites, stratified by vegetation (Figure 5). Active listening was conducted by a single observer at the point for 10 minutes. Pre-recorded calls of two threatened indicator species, the Barking Owl (*Ninox connivens*) and Powerful Owl (*Ninox strenua*) were then broadcast for a total of 10 minutes (1 minute of calls followed by 1 minute listening, repeated five times) using a megaphone. Spotlight surveys consisted of a 10-minute search by one observer along a 400 m transect, running along a pathway or road, closest to the grid point, within the same vegetation class. Spotlight surveys were conducted after the call playbacks to allow additional time to detect a return call.

The Nocturnal Survey was conducted in September 2021.

Bat Survey

Surveys for bats were conducted during summer and spring using acoustic detectors (Song Meter SM4BAT FS) at 10 Ecohealth monitoring sites, stratified by vegetation (Figure 5). Acoustic detectors were placed in a suitable tree within appropriate flyways. Song Meter microphones were securely placed (using an occy strap if needed) at ~1.5-1.8 m above ground level, leaving the sound meter box at the base of the tree. Song meters were left in-situ for three consecutive nights. Acoustic detectors (Song Meter SM4BAT FS) were set up with

default audio settings; solar calculation method is set to “sunset/sunrise”; and location set to Manly coordinates (33.8060°S, 151.2948°E).

Identification of recorded bat species was undertaken by a suitably qualified expert (Dr Brad Law, NSW Department of Primary Industry and Environment (DPIE)) using an automated procedure based on a bat-call library that has been developed for the Sydney area by DPIE.

Standard Bird Survey

Surveys for diurnal birds were conducted in spring using a point count and active-search method, for a 20-minute period within a 2-ha plot at each of 10 Ecohealth monitoring sites, stratified by vegetation (Figure 5). Surveys commenced with a 10-minute point count, where bird calls and/or sightings were recorded within a 50 m distance band. A further 10 minutes was then spent searching the 2 ha area for additional birds. Repeat surveys were conducted at each site on three consecutive mornings, beginning at sunrise (i.e., a total of 3 x 20-minute surveys at each of the 10 sites). Where possible, different observers were used on each repeat survey of each site.

Vegetation Survey

Vegetation surveys were conducted at 35 sites, stratified by seven broad vegetation types (Figure 5). At each site a 20 x 20 m plot was sampled for floristic composition. Plots were sampled as four 5 x 5 m subdivisions. Within each subdivision, data was collected on species of trees above waist height. A 1 x 1 m plot was randomly placed in each subdivision, in which detailed floristic surveys were conducted (i.e., identification of all plant species and estimates of species abundance, mean height, and cover).

The Vegetation Survey was conducted in October 2021.

Pollination Survey

Preliminary monitoring conducted in 2017 was used to establish a baseline for pollination rates on the headland prior to the reintroduction of small mammals. Subsequent biennial surveys were used to examine efficacy of small mammals on successful pollination and follicle production.

Four target species in the *Banksia* genus (*B. marginata*, *B. aemula*, *B. ericifolia* and *B. integrifolia*) were used to examine pollination rates of the critically endangered ESBS. Surveys were conducted at 10 sites within the ESBS Community (Figure 7).

During each biennial survey, at the beginning of the flowering season (May/June) six individual trees with unopened inflorescences were chosen (n = 60) at each of the 10 sites and their locations recorded. Three branches per tree were selected that had at least three unopened inflorescences (n = 180). Each branch was labelled using flagging tape/electrical tape (e.g., B1, B2, B3), and individual inflorescences were labelled using a different colour flagging (e.g., B1-I1, B1-I2). In September, each inflorescence was examined from the sample branches and seed set was counted for every inflorescence.

Not all sites were able to be sampled in 2021 as the 2020 escaped hazard reduction burn encompassed 6 of the 10 sites, most of the trees within these burnt sites were killed (see burn scar: Figure 7), where trees were only charred they were still used for the survey.

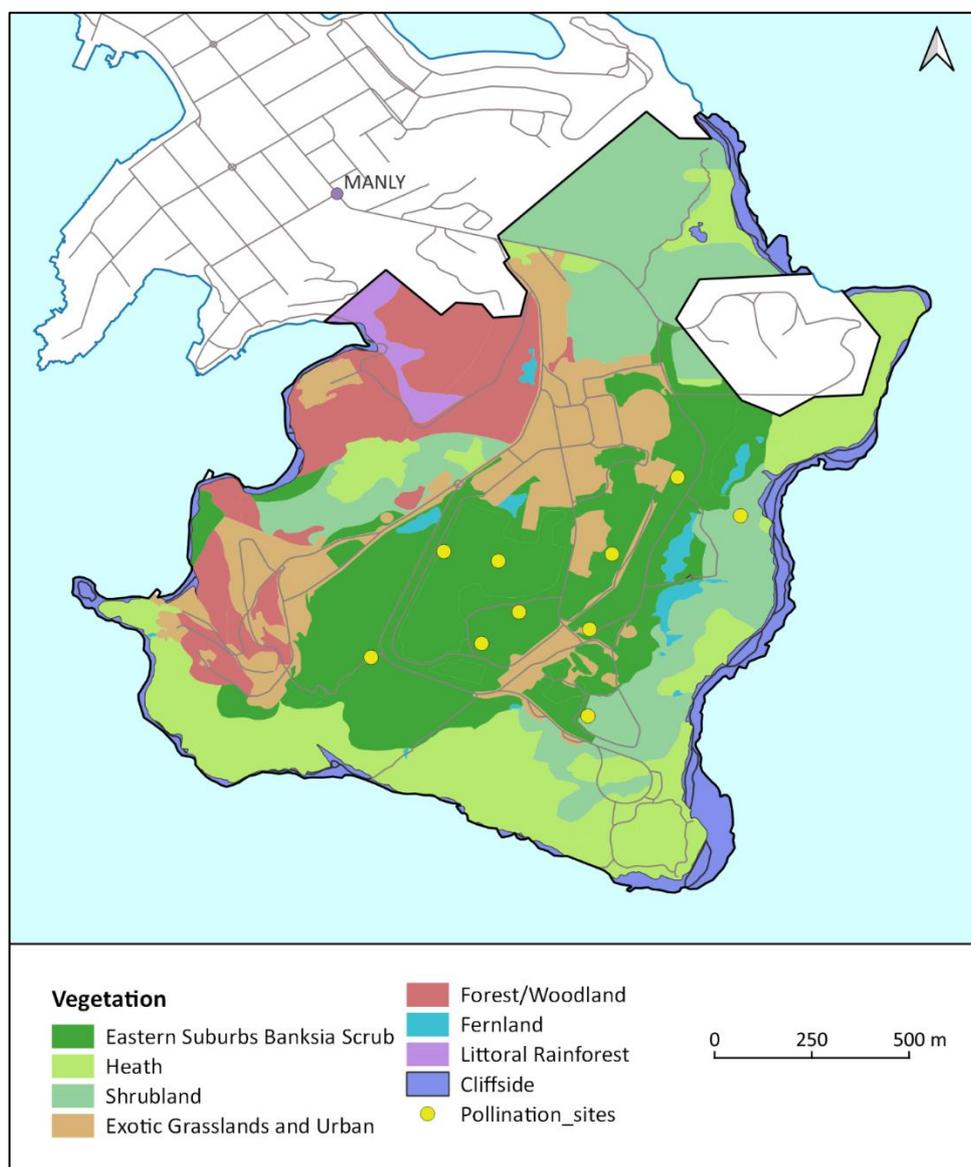


Figure 7. Location of pollination survey sites on North Head.

Feral Predator Camera Survey

To monitor feral predators (foxes and cats), one unbaited camera was deployed at eight separate locations concurrently across North Head. Cameras were placed on the road/track network to target areas known to be frequented by foxes and cats. Surveys were undertaken in March, June, September, and December. Camera traps deployed to detect feral predator incursions were also used to detect Short-beaked Echidnas.

Cameras were attached to a tree using a python lock, situated horizontal and ~50 cm above ground and left in-situ for 20 days. Reconyx camera settings for photo images were as follows: sensitivity: high; number images: 3 images per trigger; time between triggers: Rapidfire, no lag between triggers.

Fire scar analysis

As part of a headland wide Fire Management Plan sections of the headland have been designated for prescribed burns. Whether these burns are conducted is dependent on variables such as temperature and rainfall. If a prescribed burn is conducted or a wildfire occurs, satellite images are utilised in ArcMap and the fire scar is traced to estimate the total hectares burnt. The proportion of the headland and each vegetation type burnt is then calculated for the year.

Vehicle strike incident reporting

Throughout the year, an incident report process is initiated when animal mortality or injury is reported to SHFT/AWC by stakeholders or members of the public. AWC completes a SHFT Incident Report Form, detailing

location, cause of death (e.g., vehicle collision) and photos, where possible. Data from this incident reporting pertaining to Long-nosed Bandicoots is input into a Mortality Register maintained by AWC and NPWS. This Mortality Register is the source of data for the vehicle strike Ecohealth Metric.

Analysis methods

Most Ecohealth metrics are common across the indicator species for North Head. Unless noted otherwise, the metrics are calculated as set out in Table 4.

Table 4. Metrics and associated calculations for North Head.

Indicator	Metric	Survey data sources	Description	Analysis summary/calculation
Assemblage richness	Number of species	All surveys and incidental records	A measure of intactness for the whole sanctuary	The number of species detected on the sanctuary within the last 2-5 years is compared to the number of species listed as 'confirmed', 'very likely' or 'likely' on the sanctuary species list.
Bush Rat, Long-nosed Bandicoot	Population estimate	Standard Trapping Survey, Bandicoot Cage Trap Survey	Estimate of total number of individuals in the population based upon live trapping	<p>Mark-recapture was used to estimate total population size of Bush Rat and Long-nosed Bandicoot based on trapping surveys. This approach is used when counting all individuals in a population is not practical. In mark-recapture analyses, a portion of the population is captured and marked, prior to release. During subsequent sampling event(s), another portion is captured, and the number of previously marked animals is counted. Assuming the number of previously marked animals is proportional to the total number of marked animals in the population, the total population size is calculated (Banks and Price 2018).</p> <p>For Long-nosed Bandicoot: population estimate was calculated by the University of Sydney using the closed population estimation program, CAPTURE (within MARK; Banks and Price 2018).</p> <p>For Bush Rat: population estimate was calculated from each survey using a closed population CMR Schnabel model.</p>
Eastern Pygmy-possum, black rat	Abundance	Standard Trapping Survey, Pygmy-possum Nest Box Survey	Number of detections per 100 trap/survey nights	<p>Per 100 trap nights:</p> <p>For Eastern Pygmy-possum: Total abundance across four survey rounds (low capture rates preclude calculation of average abundance per survey): (Total no. individuals recorded across the year (excluding recaptures)/ total number of trap nights per year) x 100</p> <p>For black rat: Calculate the average over all survey sites of: (No. individuals recorded at survey site/</p>

Indicator	Metric	Survey data sources	Description	Analysis summary/calculation
				total number of trap night at survey site) x 100
Powerful Owl, Barking Owl	Presence/absence	Nocturnal Survey	A measure of presence or absence across the whole headland	A simple measure of whether the species was detected (1) or not (0). Owls occupy territory larger than the headland, do not expect more than one breeding pair to be present, therefore other metrics not applicable
Various species and guilds	Occupancy	Standard Trapping Survey, Bat Survey, Frog Survey	A measure of distribution; the proportion of sites where the species was recorded using a particular technique	For individual species: (number of sites at which the species was recorded across all surveys/ number of sites surveyed) x 100 For guilds: (number of sites at which any species within the relevant guild was recorded/ number of sites surveyed) x 100
Eastern Pygmy-possum, Brushtail Possum, Ringtail Possum, nocturnal bird guild, Echidna	Average occupancy	Pygmy-possum Nestbox Survey, Nocturnal Survey, Feral Predator Camera Survey	A measure of distribution; the average number of sites where the species was recorded using a particular technique	For Eastern Pygmy-possum and Echidna: Calculate the average over all surveys of: (number of sites at which the species was recorded/number of sites surveyed) x 100 For Brushtail and Ringtail Possum: Calculate the average over all survey nights of: (number of sites at which the species was recorded/number of sites surveyed) x 100 Average occupancy used due to variable survey effort (number of sites and/or replicate nights) across years
Various	Richness	Bat Survey, Nocturnal Survey, Standard Bird Survey, Frog Survey, Vegetation Survey	A measure of diversity; average number of species per site	Average number of species recorded at each site
Eastern Suburbs Banksia Scrub	% Senescent % Long unburnt	Banksia Scrub Mapping	A measure of Banksia Scrub condition	The percentage of total senescent ESBS and long unburnt was estimated from historical fire maps and remote sensing imagery. Historical data collected on the headland identified areas of senescent ESBS (Skelton et al. 2003) while fire maps allow areas to be identified that are long unburnt, prescribed burns and wildfire are subtracted from these totals.
Pollination	% Successful seed set	Pollination Survey	A measure of pollination rates of Banksia species	Pollination rate is calculated as the percent of Banksia inflorescences that have successful seed set:

Indicator	Metric	Survey data sources	Description	Analysis summary/calculation
				(number of Banksia inflorescences with seed set/total number of monitored Banksia inflorescences) x 100
Feral predators – foxes and cats, Brushtail Possum, Ringtail Possum	Activity	Feral Predator Camera Survey, Nocturnal Survey	A measure of activity across all sites	Feral predators: Cameras at eight sites provided data on activity (number of triggers per monitoring period) of foxes and cats (averages not appropriate due to low detection rates). A 30-minute interval was applied to triggers at a given camera to filter out multiple triggers from a single fox or cat. For Brushtail and Ringtail Possum: Calculate the average over all survey sites of: (No. detections of that species recorded at survey site/ total number of survey nights) x 100
Fire Scar Mapping	Prescribed fire (ha) Wildfire (ha)	Satellite and historical data	The area burnt in prescribed burns and wildfire	Satellite images are used to calculate the total hectares burnt during prescribed burns and wildfires. Using ArcGIS the outline of the burn is traced then the area calculated.

Results

Reintroduced species

Brown Antechinus

In 2021, Brown Antechinus occupancy was 15%. This metric has rapidly increased from previous years: occupancy was 5% in 2017 and 2018 and zero in 2019 and 2020 (Figure 8). This sudden increase in occupancy may be related to changes in habitat and food availability after the 2020 fire. Prior to the fire it was thought that the Brown Antechinus may have been occupying an area of cliffside habitat that was inaccessible for trapping. Much of this habitat burnt in 2020, potentially forcing Brown Antechinus to use other areas of the headland where trapping is conducted. Post-fire reduction in food resources may have also made the species more trappable.

Nine Brown Antechinus (five new, four recaptures) were detected in 2021. This detection rate is significantly higher than all previous years whereby only one Brown Antechinus was detected each year between 2017-2019 and none captured in 2020. Of the captured Brown Antechinus there was a significant male sex bias (four male, one female) in May and female sex bias in December (all animals captured were pregnant females). This is a reflection of the breeding cycle of the Brown Antechinus. Breeding occurs in late winter where males become more active and travel larger distances to find mates. After this two-week intensive mating period all males die, leaving only pregnant females in the population.

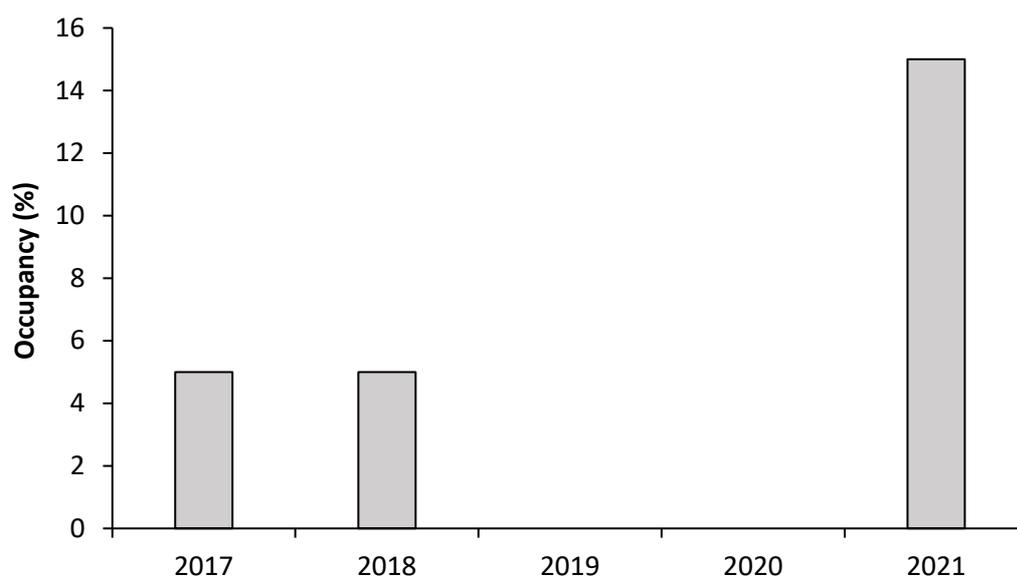


Figure 8. Brown Antechinus occupancy (%) from Standard Trapping Surveys 2017-2021.

Eastern Pygmy-possum

In 2021, abundance of the Eastern Pygmy-possum was 4.7 individuals per 100 nest box surveys (Table 5). This result continues to increase gradually.

In 2021, 19 individual Eastern Pygmy-possums (new captures only, excluding recaptures) were detected. This number is slightly higher than that obtained in 2020 ($n = 17$) and 2019 ($n = 16$), and substantially more than the 2018 result ($n = 5$). Eastern Pygmy-possum captures fluctuated throughout 2021. The first and second round of surveys in March and May saw the highest number of captures ($n = 7$ per survey). Sex of captured individuals was consistently female biased except for the final survey in December when all animals captured ($n = 4$) were male.

In 2021, individual Eastern Pygmy-possums were captured in 16 out of 101 nest boxes, with a mean occupancy per survey of 4.7% (± 0.8 ; Table 5). This metric has remained relatively stable in recent years. However, the location of occupied nest boxes showed some variation in 2021 compared to previous years, with some boxes being occupied for the first time in 2021 (Figure 9). This may reflect an avoidance of areas severely burnt in the 2020 fire.

Table 5. Eastern Pygmy-possum abundance (number of individuals/100 trap nights) and average occupancy (% \pm SE) per survey from Pygmy Possum Nest Box Surveys throughout 2018–2021.

Abundance				Average occupancy (%)			
2018	2019	2020	2021	2018	2019	2020	2021
2.0	4.2	4.5	4.7	3.2 (± 1.1)	5.8 (± 2.4)	4.2 (± 0.5)	4.7 (± 0.8)

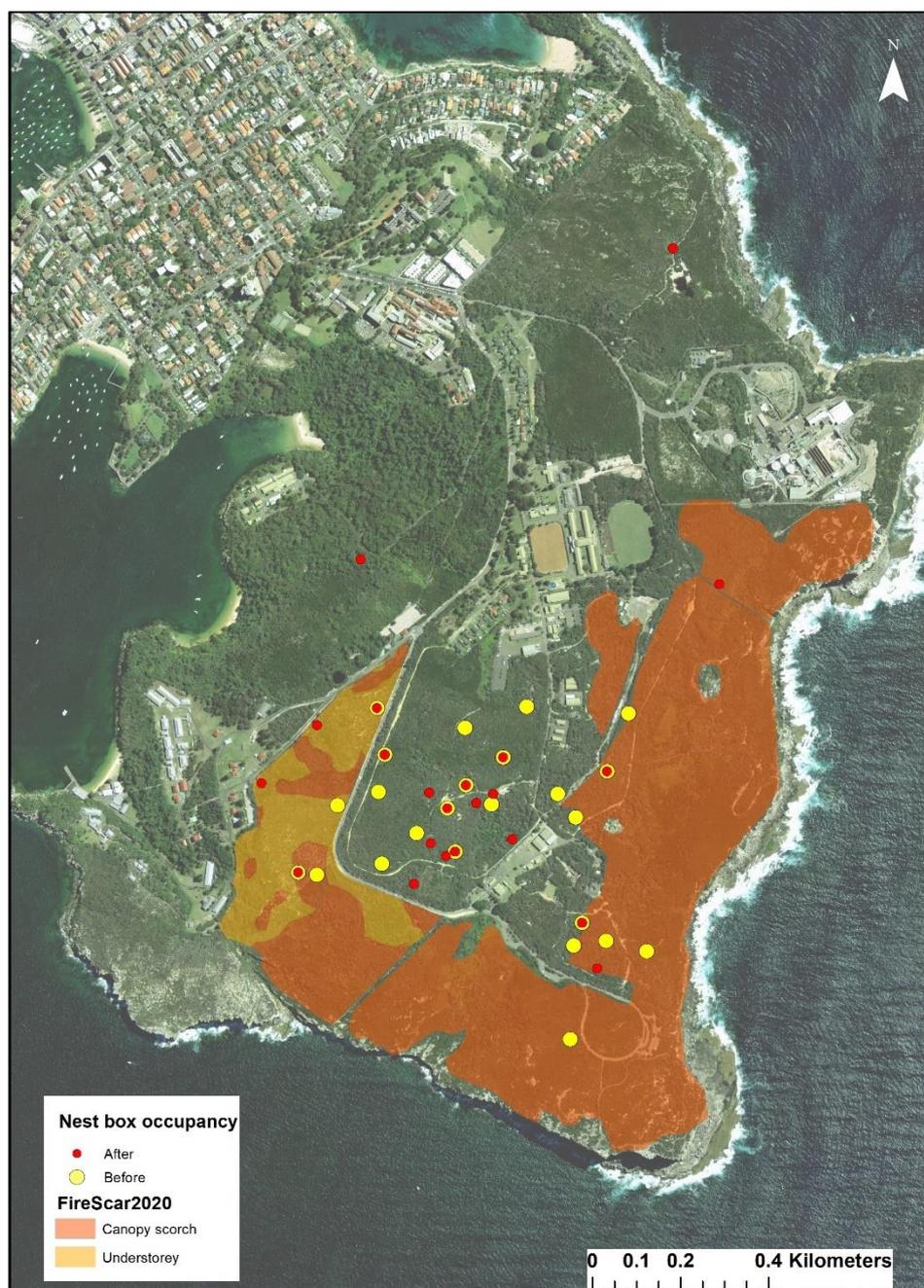


Figure 9. Eastern Pygmy-possum nest box occupancy before (June 2018-September 2020) and after (November 2020-December 2021) fire.

Bush Rat

In 2021, 181 individual Bush Rats were captured across two surveys. Mark-recapture analysis produced a population estimate of 144 in May and 106 in December (Figure 10). This metric has remained relatively consistent since 2018, with higher captures in May than December for all years except 2018.

Sex distribution was relatively even with 93 males and 87 females (number of individuals excluding recaptures) captured in 2021 (note: the sex of one captured individual was not recorded).

Bush Rats were detected at all 20 survey sites. This metric has also remained stable since 2018, demonstrating the ongoing persistence of the Bush Rat population across the whole headland.

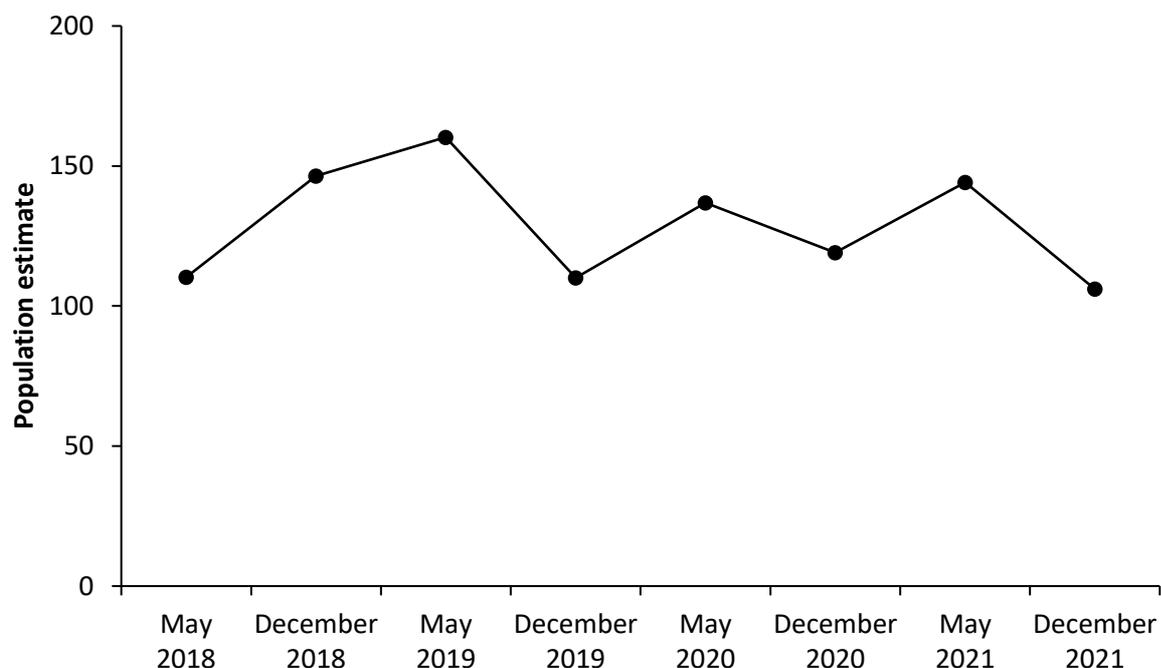


Figure 10. Bush Rat population estimates from Standard Trapping Surveys conducted during 2018-2021. *Populations estimates are derived from mark recapture analysis.*

Key threatened and iconic vertebrates

Long-nosed Bandicoot

In 2021, 150 (85 females, 63 males, 2 not recorded) Long-nosed Bandicoots were trapped a total of 277 times across 47 transects. Results from population modelling (CAPTURE) estimate that the total population size at North Head is 248 (± 20.50) individuals (Figure 11). This is the highest estimate since monitoring began in 2004 and continues an upward trend in population size since 2010 (Figure 11). The sex ratio has remained female-biased since 2016.

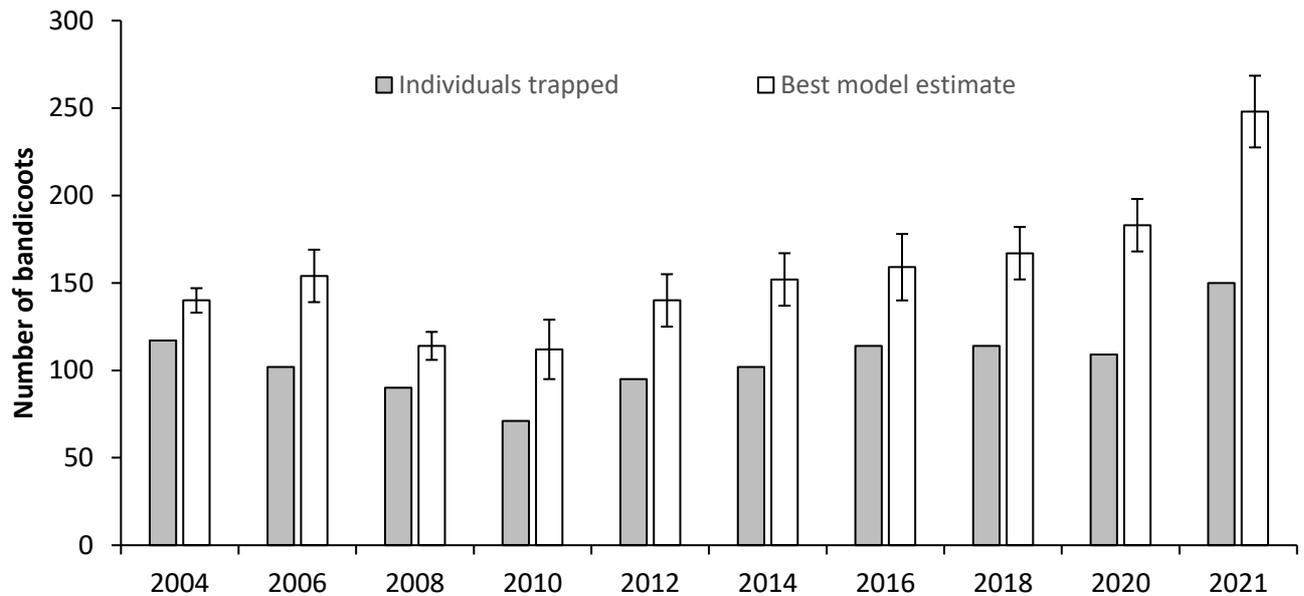


Figure 11. Comparison of the number of individual Long-nosed Bandicoots trapped and the population estimate (\pm SE) since surveys began in 2004. Population estimates are derived from mark recapture estimates in CAPTURE.

Red-crowned Toadlet

Surveys for the threatened Red-crowned Toadlet were not conducted in 2021. During 2020 surveys this species was not identified, despite being recorded at 33% of sites in 2018. This may be due to prior detection occurring during the early autumn survey, which was not conducted in 2020. However, the 2020 survey was conducted after the wildfire burnt across part of North Head. Frogs may have been negatively affected by this event (e.g., due to reduced water availability and/or water toxicity: Dahm et al. 2015). Future surveys will help to confirm the status of this species at North Head.

Vertebrate assemblages and surveillance species

Mammal assemblage

From the 18 species known to occur 17 mammal species were detected at North Head between 2019 - 2021. The only species not detected was the Rakali (*Hydromys chrysogaster*) which was last detected in 2018.

Short-beaked Echidna

Camera trapping detected Echidnas at 16% (average per survey) of monitoring sites set up to detect predators in 2021. This is lower than 2018 and 2019 where Echidnas were detected at 20% of sites but substantially higher than 2020 (6%; Figure 12). The low detection in 2020 is likely linked to the escaped hazard reduction burn that burnt a large proportion of the headland.

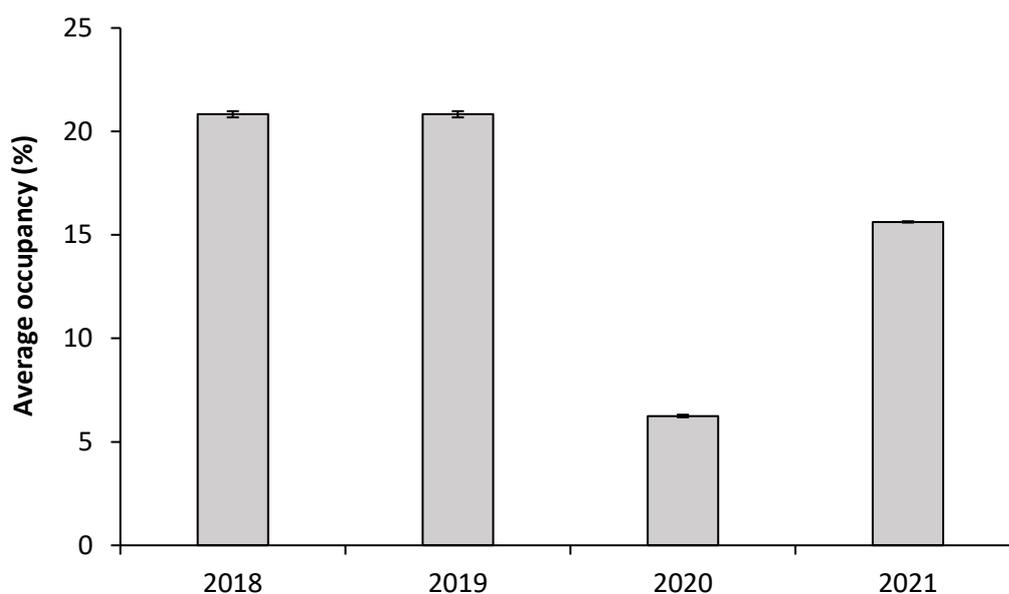


Figure 12. Short-beaked Echidna average occupancy (\pm SE) from camera trap surveys throughout 2018-2021.

Common Ringtail Possum

The activity and average occupancy for the Common Ringtail Possum has remained stable between 2019 and 2021 (Table 6). Ringtail Possum activity is three times higher than the Brushtail Possum indicating that it is the most abundant arboreal mammal on the headland.

Table 6. Brushtail and Ringtail Possum activity (number of sightings/100 spotlighting nights; \pm SE) and average nightly occupancy (%) at North Head.

Species	Activity		Average occupancy (%)	
	2019	2021	2019	2021
Common Brushtail Possum	35 (\pm 18)	47 (\pm 13)	25 (\pm 13)	33 (\pm 7)
Common Ringtail Possum	145 (\pm 31)	147 (\pm 43)	65 (\pm 10)	70 (\pm 9)

Common Brushtail Possum

Both activity and average occupancy for the Common Brushtail Possum have remained relatively stable between 2019 and 2021 (Table 6). This indicates that the headland continues to provide suitable habitat for this species despite a large area being burnt in 2020.

Bats

Nine species of microbat were identified during 2021 (Table 7) with three new species detected; the Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*) and the Southern Myotis (*Myotis macropus*), both listed as vulnerable in NSW, and Ride's Free-tailed bat (*Ozimops ridei*). In addition to these new detections the total record of bat activity was 8,086 calls detected, this is nearly double that of 2019 when 4,404 calls were detected. This increased level of activity and detection of new species is likely due to post fire effects whereby microbats are drawn to the increase of insects resulting from the flush of new growth (Broken-Brow et al. 2020).

Overall, there was an increase in the average number of species detected at each site between 2019 and 2021 (Figure 13). All species detected in 2019 were detected again in 2021.

Table 7. Species of microbats detected at North Head during 2021.

Scientific name	Common name	Status NSW	Detection
<i>Austronomus australis</i>	White-striped Freetail Bat		
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Vulnerable	

<i>Chalinolobus gouldii</i>	Gould's Wattled Bat		
<i>Miniopterus australis</i>	Little Bent-winged Bat	Vulnerable	
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	Vulnerable	
<i>Myotis macropus</i>	Southern Myotis	Vulnerable	New record
<i>Ozimops ridei</i>	Ride's Free-tailed bat		New record
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat	Vulnerable	New record
<i>Vespadelus vulturnus</i>	Little Forest Bat		

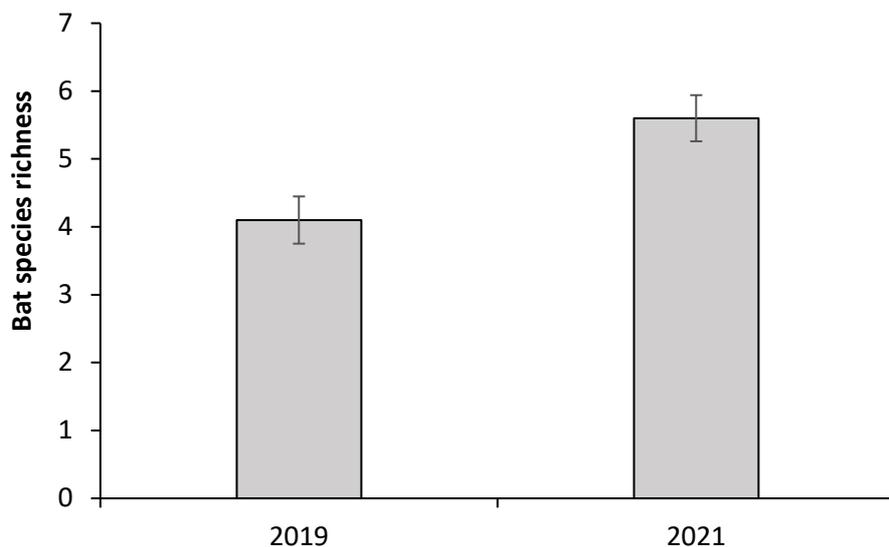


Figure 13. Bat species richness (average number of species per site \pm SE) across survey sites.

Bird assemblage

Of 160 bird species recorded as confirmed, very likely or likely to occur at North Head 54 species were detected between 2019 – 2021 in AWC surveys. A number of the species not detected are seasonal or irregular visitors so the lack of detection may be due to the timing of the survey rather than the absence of the species. In addition, survey sites do not encompass the beaches or shoreline so species that nest or forage in this habitat may have been missed.

Diurnal bird guild

Forty-two species of diurnal birds were recorded 892 times during 2021 surveys at North Head (Appendix 2). Average richness per site was higher in 2021 compared to 2019 (Figure 14).

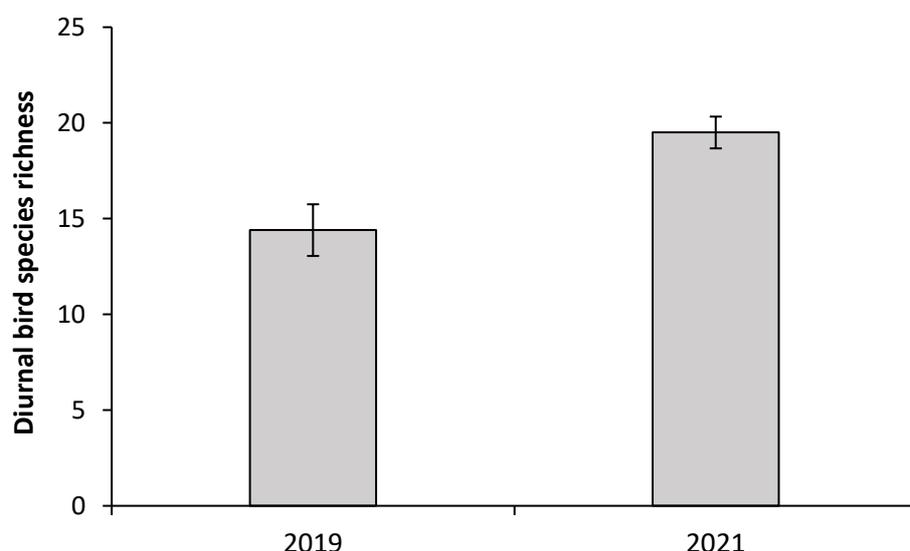


Figure 14. Diurnal bird guild richness (average number of species per site \pm SE) across survey sites.

The Sulphur-crested Cockatoo (*Cacatua galerita*), Rainbow Lorikeet (*Trichoglossus moluccanus*), New Holland Honeyeater (*Phylidonyris novaehollandiae*), Little Wattlebird (*Anthochaera chrysoptera*), Pied Currawong (*Strepera graculina*) and Eastern Whipbird (*Psophodes olivaceus*) were the most frequently detected species (listed in order of frequency) comprising 55% of total records.

Of the species detected in 2021, six were new records; the Australian Wood Duck (*Chenonetta jubata*), Little Corella (*Cacatua sanguinea*), Pied Cormorant (*Phalacrocorax varius*), Satin Flycatcher (*Myiagra cyanoleuca*), Scarlet Honeyeater (*Myzomela sanguinolenta*) and Silver Gull (*Chroicocephalus novaehollandiae*) were not detected in 2019 surveys. Of the species detected in 2019 surveys, six species; the Crimson Rosella (*Platycercus elegans*), Eastern Rosella (*Platycercus eximius*), Eastern Spinebill (*Acanthorhynchus tenuirostris*), Australian Golden Whistler (*Pachycephala pectoralis*), Grey Goshawk (*Accipiter novaehollandiae*), Satin Bowerbird (*Ptilonorhynchus violaceus*) were not detected in 2021 surveys.

None of the diurnal birds recorded in 2021 were threatened species.

Nocturnal bird guild

Three nocturnal bird species were detected in 2021 at North Head. This is a reduction in species richness compared to 2019 (Table 8).

Targeted call playback elicited one response from a Powerful Owl, which is listed as vulnerable in NSW. Other nocturnal bird species detected included Southern Boobook (*Ninox boobook*) and Tawny Frogmouth (*Podargus strigoides*). Of these the Southern Boobook was the most common, detected at 4/10 sites. The Eastern Barn Owl (*Tyto javanica*) and threatened Barking Owl were detected in 2019 but not detected in 2021.

Average occupancy of nocturnal bird species has declined slightly since 2019 (Table 8).

Table 8. Nocturnal bird guild total richness and occupancy (\pm SE; average per survey night).

Total richness		Average occupancy (%)	
2019	2021	2019	2021
5	3	30 (\pm 11)	20 (\pm 7)

Powerful Owl

The Powerful Owl was detected on the headland in 2021 (and also in 2019). There is an abundance of suitable prey species for Powerful Owl at North Head (e.g., Common Ringtail Possum, Bush Rat, rabbits, *Oryctolagus cuniculus*; and nesting bird species). The continued detection of this species indicates that the headland is

within the territory of a resident pair of Powerful Owls that likely utilise the headland for nesting and/or hunting.

Barking Owl

The Barking Owl was not detected in 2021 surveys despite being detected in 2019. Wide-ranging species can be difficult to detect as they may be utilising other habitat within their territory at the time of survey. Long-term data is needed to establish a trend and rationale for the absence of this species during the survey period.

Amphibian guild

No amphibian surveys were conducted in 2021. Seven species of frog are known to occur at North Head. All seven species have been recorded in the last 3 years. Five of these (total richness = 5) were identified during the 2020 surveys; Common Eastern Froglet (*Crinia signifera*), Striped Marsh Frog (*Limnodynastes peronii*), Eastern Dwarf Tree Frog (*Litoria fallax*), Freycinet's Frog (*Litoria freycineti*) and Peron's Tree Frog (*Litoria peronii*). This is two fewer species than detected in 2018 surveys, when the Spotted Grass Frog (*Limnodynastes tasmaniensis*) and threatened Red-crowned Toadlet were also recorded. However, survey effort was lower in 2020 (sites surveyed once) than 2018 (sites surveyed twice), which may influence these results.

Of the 3 survey sites, the Quarry has the highest richness. This highlights the importance of maintaining this habitat, as it is the only permanent water body at North Head, even during drought.

Key threatened and iconic plants

Eucalyptus camfieldii

Surveys conducted in 2021 revealed that 41 *E. camfieldii* trees remain alive on the headland. Historical records indicated that 84 trees were persisting at North Head, however monitoring revealed that the majority have since died. Of the 43 that have died, only a handful have known causes, one from an unsuccessful translocation (replanted during a fence construction), one from possum herbivory and two presumed to have perished during the 2020 wildfire. Future management interventions could include exclusion fencing for seedlings/saplings and possum guards to reduce herbivory, protection from hazard reduction burns and implementation of an evaluation process to be conducted prior to any translocations.

For 41 trees identified as alive in 2021 the following health metrics were obtained; average height 564 cm (\pm 118), average DBH 18 cm (\pm 1.5), average crown density 29% (\pm 3.9) and average dieback 46% (\pm 5.1). These trees will be used as the future baseline for monitoring the persistence of the species on the headland.

Of the eight trees monitored for recruitment, 25% had seedling/sapling growth within the plots. Of the seedlings/saplings found to be growing the average height was 15.6 cm (\pm 11.1) and average distance from parent tree was 82 cm (\pm 54.5).

Vegetation indicators and surveillance species

Plant assemblage

Of the 214 plant species known to occur (confirmed) at North Head, 181 have been recorded since 2018.

Average species of flora per site shows a decline since 2018 (Figure 15). The decline in species richness is likely due to the extensive fire in 2020 that burnt 78.2 ha (37%) of North Head. A range of vegetation types were consumed by the fires, with almost 50% of the ESBS on the headland now extensively burnt. In addition to the area of ESBS, 87% of the fernland habitat was burned on the headland (see section on Fire below). When comparing species richness at sites that were burnt and those that were not, species richness remained the same at unburnt sites but decreased substantially at burnt sites (Figure 16). Much of the headland is still in varying stages of post-fire recovery and at some sites regeneration is very slow, leading to a reduction in species detection.

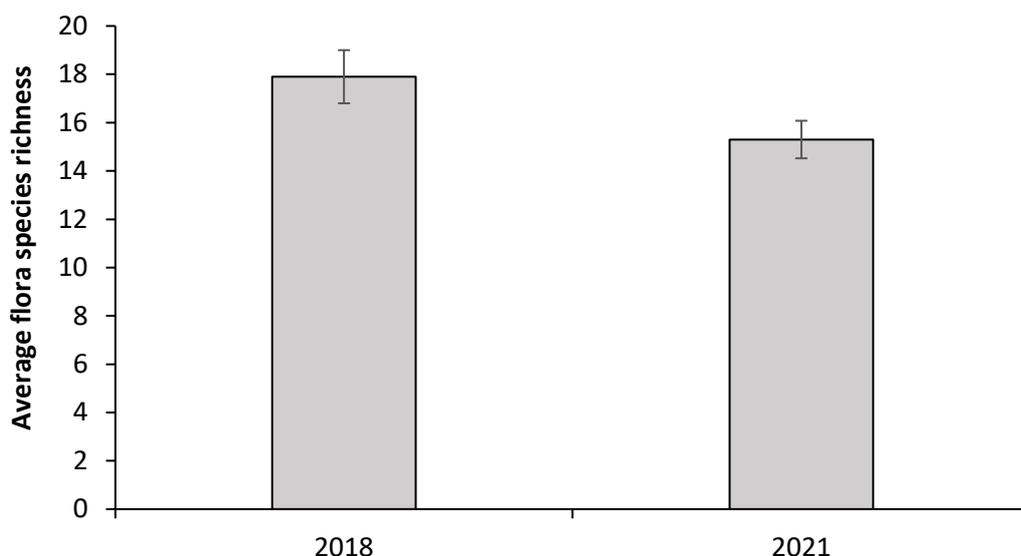


Figure 15. Average flora species richness (number of species per site ±SE) across survey sites.

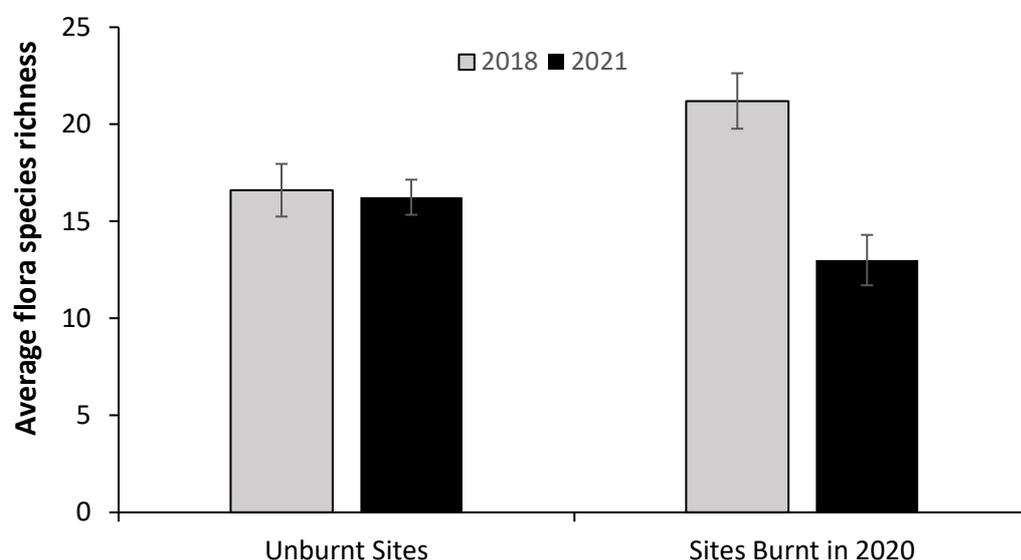


Figure 16. Average flora species richness (number of species per site) (±SE) at burnt and unburnt sites.

Eastern Suburbs Banksia Scrub

During 2020, nearly 50% of all ESBS on North Head was burnt. Although this reduction in available habitat is likely detrimental to the fauna on the headland in the short- to medium-term, in the longer term, the large extent of fire may be positive for the health of the ESBS, given that much of the ecosystem had been long-unburnt and become senescent. Since 2019 there has been a reduction in the proportion of ESBS classified as senescent (from 70% to 21%) and long unburnt (from 79% to 47%; Table 9). There were no prescribed burns in 2021.

Table 9. Proportion of Eastern Suburbs Banksia Scrub Community at North Head that is senescent and long unburnt. Estimates are obtained from ArcMap vegetation layers and fire scar boundaries.

Year	Percentage of senescent ESBS (%)	Percentage long unburnt ESBS (%)
2019	70	79
2020	21	47
2021	21	47

Pollination

Pollination surveys conducted in 2021 revealed that 34% of Banksia cones had seed set. Seed set since 2017 revealed a slight upward trend between 2017 and 2019 but declined in 2021 (Figure 17). This decline may be due to stress placed on the Banksia from the extensive fire in 2020. While all extensively burnt sites were removed from the analysis, many trees within the fringe sites had some degree of damage, in addition a number of sites had to be moved which may have impacted the results.

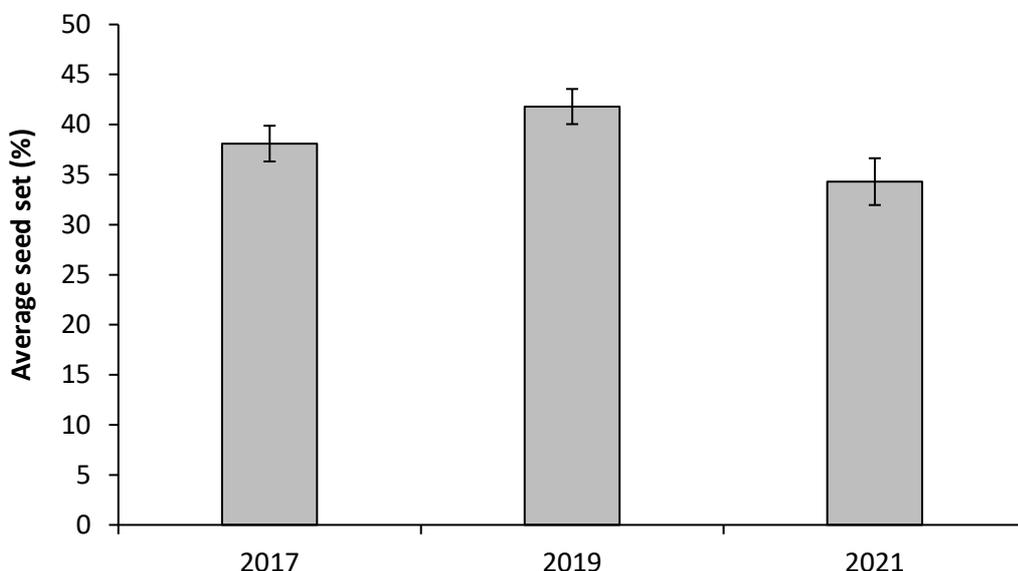


Figure 17. Average seed set of Banksia trees (\pm SE) across survey sites.

Threat indicators

Feral predators

Feral predator monitoring surveys conducted in 2021 did not detect any cat activity. Cat incursions have seen a decreasing trend which can be seen through decreasing number of detections between 2016 and 2020 (Figure 18). There have been no cats captured on predator cameras since 2018. This may be due to an increased effort from AWC and NPWS in educating the public on the importance of keeping cats inside and the enforcement of a zero-pet policy on the headland.

In 2021, there was a decrease in fox incursions with zero detections in any of the four Predator Camera Surveys.

The low level of fox activity on the headland is likely due to a range of incursion preventative measures, including camera monitoring, baiting, trapping, and cohesive management and monitoring by AWC and SHFT in partnership with NPWS.

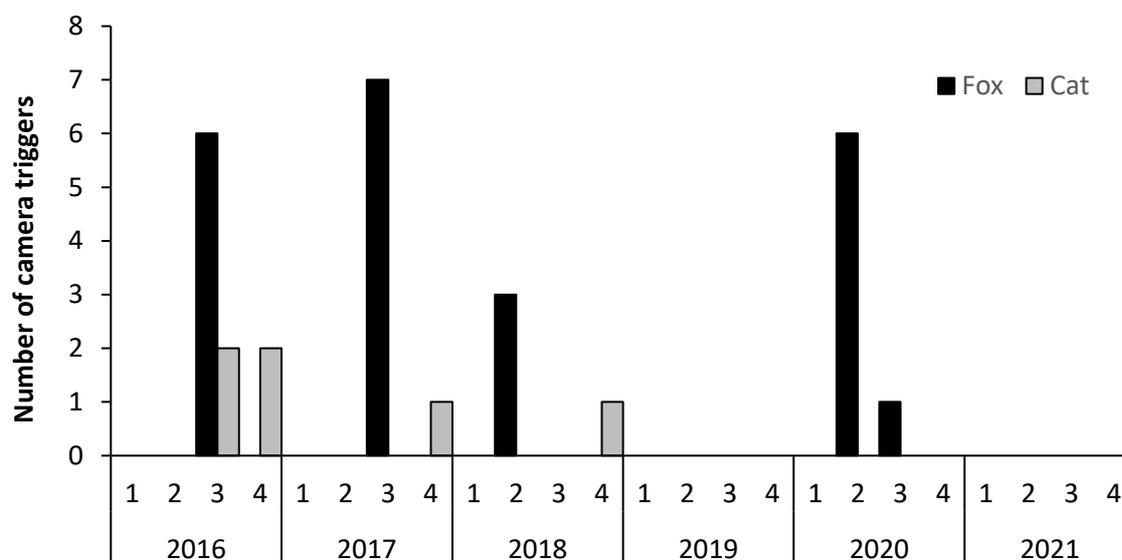


Figure 18. Number of feral predator (fox and cat) camera triggers from 2016-2021. Data are shown for each survey round (n = 4) each year. Survey rounds are carried out at the same time each year; 1 = March/April, 2 = June/July, 3 = September/October and 4 = December.

Black rat

Black rats are invasive rodents that are highly successful colonisers. Black rats act as vectors for a range of diseases and ectoparasites. They can also negatively impact native fauna through both predation and competition (Banks and Hughes 2012). North Head has an established population of black rats that is likely to limit recruitment and access to resources for native fauna. An intensive removal program in parts of the headland has been undertaken to enhance the establishment of a Bush Rat population at North Head.

In 2021, monitoring of black rats was conducted through biannual trapping surveys associated with monitoring the reintroduced small mammal and bandicoot populations. Black rats were captured at 55% of trapping sites, with an abundance estimate (i.e., total number of individuals captured per 100 trap nights) of 3 (Table 10). The abundance estimate was stable between 2020 and 2021 but substantially lower than previous years. Occupancy was slightly higher than 2020 but substantially lower than previous years.

Table 10. Black rat abundance (\pm SE; total individuals per site/100 trap nights) and site occupancy (%) between 2018-2021.

Abundance				Occupancy (%)			
2018	2019	2020	2021	2018	2019	2020	2021
17.2 (\pm 2.8)	16.3 (\pm 2.4)	4.3 (\pm 1.4)	3 (\pm 0.8)	90	100	50	55

The decline in black rat numbers is likely a consequence of previous black rat removal efforts (between 2014 – 2016) and the continued re-establishment of the native Bush Rat on the headland. The significant decline between 2019 and 2020 may be a delayed effect as the Bush Rats reach higher numbers on the headland. Bush Rats accounted for 90% of all rodent captures in 2021, compared to 10% for the black rat (Figure 19).

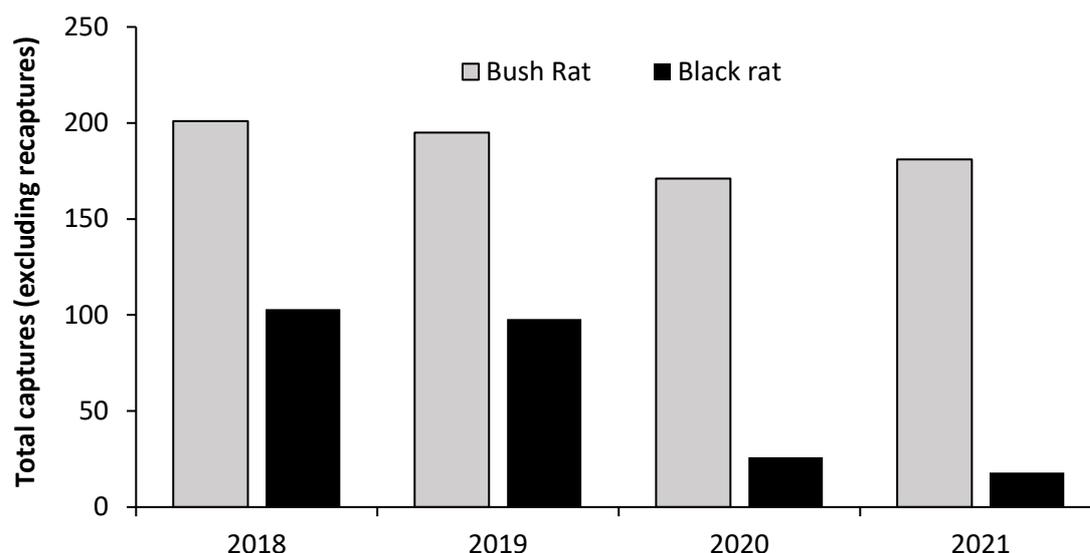


Figure 19. Capture rates of Bush Rats and black rats during May and November surveys from 2018-2021.

Fire

There were no prescribed burns or wildfires on North Head in 2021 (Table 11). In 2020, approximately 56.9 ha of habitat was burnt in the escaped fire, 16 ha of which is managed for SHFT by AWC. Together with the 21.3 ha burnt in the September prescribed burns (2.1 ha of which is managed by AWC; Table 12), 24% of SHFT land and 78.2 ha (37%) of North Head has been burnt within the last 12 months. During the October fire, much of the canopy was scorched due to the high intensity of the burn.

A range of vegetation types were consumed by both the escaped and prescribed burns, with almost 50% of the ESBS on the headland now extensively burnt (Table 12). In addition to the area of ESBS, 87% of the fernland habitat was burned on the headland. This vegetation type is highly sensitive to disturbance and a preferred habitat of many of the ground dwelling mammals.

Table 11. Total area (ha) burnt during prescribed burns and wildfire since 2018.

Prescribed burns (ha)				Wildfire (ha)			
2018	2019	2020	2021	2018	2019	2020	2021
13.9	0	21.3	0	0	0	57	0

Table 12. Total area (ha) of vegetation types on North Head, including proportion burnt in 2020 September prescribed burns and October escaped burn. Note: some areas not classified as vegetation (e.g., tracks) were also impacted by fire but are not shown here.

Vegetation types	Area (ha)	Area burnt (ha)	Area burnt (%)
Eastern Suburbs Banksia Scrub	68.7	31.3	46
Exotic Grassland and Urban	36	0.5	1
Fernland	3.1	2.7	87
Heath	51.9	26.7	51
Shrubland	50.4	16.2	32
Total	210.1	78.2	37

Vehicle strike

A total of 6 Long-nosed Bandicoot vehicle strike mortalities were reported and logged in 2021. Mortalities were reported from locations across both NPWS and SHFT tenure (i.e., across the entire headland). February

and September saw the highest number of vehicle strike mortalities ($n = 2$ for each) which may be due to increased headland visitation during summer months and utilisation of green spaces during the start of COVID19 lockdown. The remainder of mortalities ($n = 2$) occurred in April and August.

Vehicle strike mortalities have been decreasing (Figure 20) likely due to scheduled park closures and increased signage.

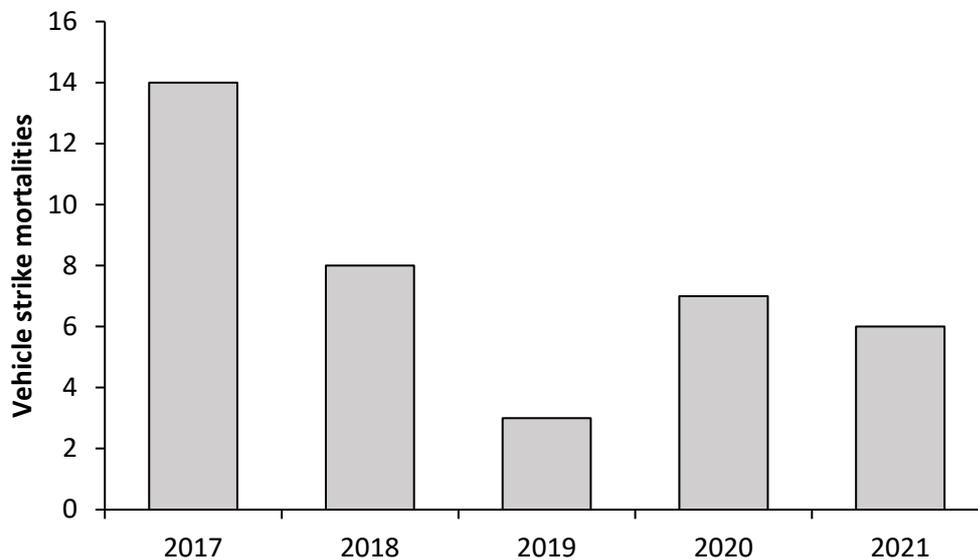


Figure 20. Long-nosed Bandicoot vehicle strike mortalities from 2017-2021.

Discussion

Fire and associated impacts

North Head is an area of high biodiversity value in Sydney, being an 'island' of relatively intact natural vegetation surrounded by urbanisation. It contains the majority of the remaining Critically Endangered Eastern Suburb Banksia Scrub community and supports a vast array of native species. Fire is an important component of the ecology of the headland, with patchy, lower intensity burns working to maintain vegetation diversity in heathland and the banksia scrub community. In contrast, wide-scale high intensity burns can homogenise vegetation, damage vegetation types less adapted to fire (Broken-Brow et al. 2020; Department of Environment and Climate Change 2009), reduce habitat suitability and key resources for some species (potentially resulting in increased competition for resources), and increase risk of predation by both native and feral predators (Hradsky et al. 2017).

In October 2020, a prescribed fire escaped containment lines and burnt ~23% of the headland (including ~22% of the SHFT/AWC project area). Most of the fire scar was subjected to high intensity fire resulting in complete vegetation removal. This has dramatically altered vegetation structure across the headland and reduced the area of available habitat for species dependent on older vegetation successional stages. Despite these fire-induced changes, few negative impacts on faunal assemblage at North Head have been recorded. Plant species richness has declined post-fire, with monitoring plots in burnt areas having fewer species compared to pre-fire data. It is not yet known whether this reflects loss of species from the headland or slow post-fire recovery, but the latter is most likely.

Metrics for some species of high conservation value, such as the Long-nosed Bandicoot and Brown Antechinus, have improved in the post-fire environment. There are multiple plausible explanations for this finding, and the lack of negative fire impacts more generally. First, species at North Head (including previously locally extinct species now reintroduced) are likely adapted for survival in post-fire environments given the relatively short optimal burn interval (8-15 years) for ESBS vegetation. Second, above-average rainfall in 2021 may have ameliorated post-fire impacts via increased resource provision (e.g., invertebrates). Third, AWC's active intervention may also have ameliorated post-fire impacts. Immediately following the fire AWC began a number of activities to minimise the fire's impact, including deployment of artificial habitat (e.g., nest boxes,

habitat pods, Bandicoot bungalows) and provision of supplementary food and water. AWC has also worked to ensure that feral species (e.g., black rats, cats, foxes) have not become established in the post-fire environment. Finally, the fire may have caused shifts in resource availability and animal behaviour that have resulted in higher capture rates (see below).

Reintroduced mammals

Since their reintroduction, Bush Rats have become one of the most common native mammal species on the headland. Capture rates remained high in 2021 and Bush Rats continued to be detected at all survey sites. Importantly, establishment of a Bush Rat population at North Head now appears to be delaying/preventing the invasive black rat from becoming numerically dominant. Eastern Pygmy-possums increased in number and spread further across the headland in 2021, but as with previous years, detections remain low. The number of detections of the Brown Antechinus was considerably larger in 2021 compared with earlier years. In the years following reintroduction this species was not captured more than once per year until 2021. This sudden increase in detection may be related to changes in habitat and food availability after the 2020 fire. Reduction in habitat availability may have forced Brown Antechinus into areas of the headland they did not previously occupy and reduction in food resources may have made the species more trappable. Through the reintroduction of Bush Rats, Eastern Pygmy-possums and Brown Antechinus, AWC has increased the overall native mammal richness on the headland from five to eight species. Prior to this reintroduction program, no native mammals smaller than ~700 g persisted at North Head. Given low detection rates for both Eastern Pygmy-possum and Brown Antechinus, additional translocations are required to supplement the existing populations and ensure the establishment of these species on the headland. Supplementations of both species are planned in 2022.

Long-nosed Bandicoot

The Long-nosed Bandicoot population estimate has gradually increased with each survey since 2010 with 2021 being the highest population estimate since monitoring began. This is a positive outcome as it was predicted that this threatened species may be negatively impacted by the fire. After the fire, AWC deployed a number of management interventions to assist wildlife which may have buffered Long-nosed Bandicoots from the full impact of the fire and even supported post-fire breeding. However, 2020/21 also had above average rainfall, preceded by years of drought (Figure 3). This increase in available water in the months following the fire could have led to an increase in plant growth and invertebrates, potentially offsetting some post-fire impacts (Hope 2012; Driessen et al. 2021). Longer-term data is needed to determine if this is a one-off peak or an ongoing trend. Despite this positive result, total population size is still relatively small, making the population vulnerable to inbreeding and other stochastic processes. Ongoing monitoring and management are required.

Assemblages

All species assemblages for North Head have now been surveyed across at least two years. Over this period, 78 of 185 species have been detected. Only one undetected species was a mammal (Rakali) and the rest were birds. While many species of birds remained undetected this is likely due to their residency status and the timing of the survey. Outcomes varied in 2021: diurnal birds and microbats exhibited an increase in species richness while richness of nocturnal birds and flora decreased. Decline in plant richness is clearly related to the 2020 fire, with fewer species detected at burnt sites. More data is needed to assess trends through time and normal variability for other assemblages. However, species detected on the headland to date are in line with expectations.

Feral pests

Feral cats and foxes are generally not resident on the headland, which enables high species diversity and persistence of threatened species in the project area. However, incursions do occur occasionally. AWC deploys cameras to monitor for incursions and collates records relating to incidental sightings. When an incursion is suspected, NPWS initiates a baiting/trapping program to remove the pest animal.

No cats or foxes were detected in 2021. This is a positive outcome as it was expected that there would be a surge in feral predator incursions following the 2020 fire. Previous research conducted in areas subjected to prescribed burns has shown a five-fold increase in feral cat and fox activity and a doubling in the consumption

of medium-sized prey (Hradsky et al. 2017). The low feral predator activity is likely due to incursion prevention measures, including baiting, trapping, and integrated management and monitoring by AWC and SHFT in partnership with NPWS. To ensure the ongoing persistence of native fauna at North Head, continued monitoring and removal of feral predators is required. This will be of even greater importance in the coming years as North Head continues to recover from the escaped fire. Keeping cats and foxes off the headland will enhance the ability of native fauna to recolonise burnt areas where they are otherwise more vulnerable to predation.

Numbers of black rats have not recovered since initial control efforts and reintroduction of the Bush Rat. Following intensive reintroduction efforts, the native Bush Rat is now likely an established species and therefore has a competitive advantage over the black rat which is unable to infiltrate areas of prime habitat where the Bush Rat is now resident (Stokes et al. 2009). Ongoing monitoring of black rats into the future is required to ensure that this invasive species does not become the dominant rodent across the headland again.

Acknowledgments

Thanks to the Sydney Harbour Federation Trust (SHFT) for its support for the continued partnership at North Head.

AWC acknowledges the Gayamaygal people as the Traditional Custodians of the country on which North Head resides. We also acknowledge their continuing connection to land, culture and community. We pay our respects to Gayamaygal Elders past present and emerging.

AWC's Ecohealth Program is only possible because of the generosity of AWC's supporters.

For their assistance in conducting Ecohealth surveys at North Head in 2021, we particularly thank Aiden Wright, Holly Nelson, Mareshell Wauchope and Angela Rana.

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Appendices

Appendix 1. All vertebrate fauna occurring at North Head (confirmed, very likely or likely)

Order	Family	Species	Scientific name
Amphibians			
Anura	Hylidae	Eastern Dwarf Tree Frog	<i>Litoria fallax</i>
Anura	Hylidae	Freycinet's Frog	<i>Litoria freycineti</i>
Anura	Hylidae	Peron's Tree Frog	<i>Litoria peronii</i>
Anura	Limnodynastidae	Brown-striped Frog	<i>Limnodynastes peronii</i>
Anura	Limnodynastidae	Spotted Grass Frog	<i>Limnodynastes tasmaniensis</i>
Anura	Myobatrachidae	Common Eastern Froglet	<i>Crinia signifera</i>
Anura	Myobatrachidae	Red-crowned Toadlet	<i>Pseudophryne australis</i>
Birds			
Accipitriformes	Accipitridae	Brown Goshawk	<i>Accipiter fasciatus</i>
Accipitriformes	Accipitridae	Grey Goshawk	<i>Accipiter novaehollandiae</i>
Accipitriformes	Accipitridae	Black-shouldered Kite	<i>Elanus axillaris</i>
Accipitriformes	Accipitridae	White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>
Accipitriformes	Accipitridae	Whistling Kite	<i>Haliastur sphenurus</i>
Accipitriformes	Accipitridae	Little Eagle	<i>Hieraaetus morphnoides</i>
Anseriformes	Anatidae	Chestnut Teal	<i>Anas castanea</i>
Anseriformes	Anatidae	Pacific Black Duck	<i>Anas superciliosa</i>
Anseriformes	Anatidae	Australian Wood Duck	<i>Chenonetta jubata</i>
Apodiformes	Apodidae	Fork-tailed Swift	<i>Apus pacificus</i>
Apodiformes	Apodidae	White-throated Needletail	<i>Hirundapus caudacutus</i>
Caprimulgiformes	Podargidae	Tawny Frogmouth	<i>Podargus strigoides</i>
Charadriiformes	Charadriidae	Masked Lapwing	<i>Vanellus miles</i>
Charadriiformes	Laridae	Common Noddy	<i>Anous stolidus</i>
Charadriiformes	Laridae	Grey Noddy	<i>Anous albivitta</i>
Charadriiformes	Laridae	Silver Gull	<i>Chroicocephalus novaehollandiae</i>
Charadriiformes	Laridae	Caspian Tern	<i>Hydroprogne caspia</i>
Charadriiformes	Laridae	White Tern	<i>Gygis alba</i>
Charadriiformes	Laridae	Sooty Tern	<i>Onychoprion fuscatus</i>
Charadriiformes	Laridae	Common Tern	<i>Sterna hirundo</i>
Charadriiformes	Laridae	White-fronted Tern	<i>Sterna striata</i>
Charadriiformes	Laridae	Greater Crested Tern	<i>Thalasseus bergii</i>
Charadriiformes	Stercorariidae	Long-tailed Jaeger	<i>Stercorarius longicaudus</i>
Charadriiformes	Stercorariidae	Parasitic Jaeger	<i>Stercorarius parasiticus</i>
Charadriiformes	Stercorariidae	Pomarine Jaeger	<i>Stercorarius pomarinus</i>
Charadriiformes	Turnicidae	Painted Buttonquail	<i>Turnix varius</i>
Columbiformes	Columbidae	White-headed Pigeon	<i>Columba leucomela</i>

Order	Family	Species	Scientific name
Columbiformes	Columbidae	Rock Dove	<i>Columba livia</i>
Columbiformes	Columbidae	Bar-shouldered Dove	<i>Geopelia humeralis</i>
Columbiformes	Columbidae	Peaceful Dove	<i>Geopelia placida</i>
Columbiformes	Columbidae	Brown Cuckoo-Dove	<i>Macropygia phasianella</i>
Columbiformes	Columbidae	Crested Pigeon	<i>Ocyphaps lophotes</i>
Columbiformes	Columbidae	Spotted Dove	<i>Spilopelia chinensis</i>
Coraciiformes	Alcedinidae	Laughing Kookaburra	<i>Dacelo novaeguineae</i>
Coraciiformes	Alcedinidae	Sacred Kingfisher	<i>Todiramphus sanctus</i>
Coraciiformes	Coraciidae	Oriental Dollarbird	<i>Eurystomus orientalis</i>
Cuculiformes	Cuculidae	Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>
Cuculiformes	Cuculidae	Pallid Cuckoo	<i>Cacomantis pallidus</i>
Cuculiformes	Cuculidae	Pheasant Coucal	<i>Centropus phasianinus</i>
Cuculiformes	Cuculidae	Horsfield's Bronze Cuckoo	<i>Chrysococcyx basalus</i>
Cuculiformes	Cuculidae	Shining Bronze Cuckoo	<i>Chrysococcyx lucidus</i>
Cuculiformes	Cuculidae	Pacific Koel	<i>Eudynamis orientalis</i>
Cuculiformes	Cuculidae	Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>
Falconiformes	Falconidae	Nankeen Kestrel	<i>Falco cenchroides</i>
Falconiformes	Falconidae	Australian Hobby	<i>Falco longipennis</i>
Falconiformes	Falconidae	Peregrine Falcon	<i>Falco peregrinus</i>
Galliformes	Megapodiidae	Australian Brushturkey	<i>Alectura lathami</i>
Galliformes	Phasianidae	Brown Quail	<i>Coturnix ypsilophora</i>
Gruiformes	Rallidae	Buff-banded Rail	<i>Gallirallus philippensis</i>
Gruiformes	Rallidae	Lewin's Rail	<i>Lewinia pectoralis</i>
Passeriformes	Acanthizidae	Yellow Thornbill	<i>Acanthiza nana</i>
Passeriformes	Acanthizidae	Brown Thornbill	<i>Acanthiza pusilla</i>
Passeriformes	Acanthizidae	Chestnut-rumped Heathwren	<i>Calamanthus pyrrhopygius</i>
Passeriformes	Acanthizidae	Brown Gerygone	<i>Gerygone mouki</i>
Passeriformes	Acanthizidae	Rockwarbler	<i>Origma solitaria</i>
Passeriformes	Acanthizidae	White-browed Scrubwren	<i>Sericornis frontalis</i>
Passeriformes	Artamidae	Pied Butcherbird	<i>Cracticus nigrogularis</i>
Passeriformes	Artamidae	Grey Butcherbird	<i>Cracticus torquatus</i>
Passeriformes	Artamidae	Australian Magpie	<i>Gymnorhina tibicen</i>
Passeriformes	Artamidae	Pied Currawong	<i>Strepera graculina</i>
Passeriformes	Campephagidae	Black-faced Cuckooshrike	<i>Coracina novaehollandiae</i>
Passeriformes	Cisticolidae	Golden-headed Cisticola	<i>Cisticola exilis</i>
Passeriformes	Climacteridae	White-throated Treecreeper	<i>Cormobates leucophaea</i>
Passeriformes	Corvidae	Australian Raven	<i>Corvus coronoides</i>
Passeriformes	Dicaeidae	Mistletoebird	<i>Dicaeum hirundinaceum</i>
Passeriformes	Dicruridae	Spangled Drongo	<i>Dicrurus bracteatus</i>
Passeriformes	Estrildidae	Red-browed Finch	<i>Neochmia temporalis</i>

Order	Family	Species	Scientific name
Passeriformes	Estrildidae	Double-barred Finch	<i>Taeniopygia bichenovii</i>
Passeriformes	Hirundinidae	Welcome Swallow	<i>Hirundo neoxena</i>
Passeriformes	Hirundinidae	Fairy Martin	<i>Petrochelidon ariel</i>
Passeriformes	Maluridae	Superb Fairywren	<i>Malurus cyaneus</i>
Passeriformes	Maluridae	Variiegated Fairywren	<i>Malurus lamberti</i>
Passeriformes	Meliphagidae	Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>
Passeriformes	Meliphagidae	Red Wattlebird	<i>Anthochaera carunculata</i>
Passeriformes	Meliphagidae	Little Wattlebird	<i>Anthochaera chrysoptera</i>
Passeriformes	Meliphagidae	Yellow-faced Honeyeater	<i>Caligavis chrysops</i>
Passeriformes	Meliphagidae	Noisy Miner	<i>Manorina melanocephala</i>
Passeriformes	Meliphagidae	Lewin's Honeyeater	<i>Meliphaga lewinii</i>
Passeriformes	Meliphagidae	Scarlet Honeyeater	<i>Myzomela sanguinolenta</i>
Passeriformes	Meliphagidae	White-eared Honeyeater	<i>Nesoptilotis leucotis</i>
Passeriformes	Meliphagidae	Noisy Friarbird	<i>Philemon corniculatus</i>
Passeriformes	Meliphagidae	White-cheeked Honeyeater	<i>Phylidonyris niger</i>
Passeriformes	Meliphagidae	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>
Passeriformes	Monarchidae	Magpie-lark	<i>Grallina cyanoleuca</i>
Passeriformes	Monarchidae	Black-faced Monarch	<i>Monarcha melanopsis</i>
Passeriformes	Monarchidae	Satin Flycatcher	<i>Myiagra cyanoleuca</i>
Passeriformes	Monarchidae	Leaden Flycatcher	<i>Myiagra rubecula</i>
Passeriformes	Oriolidae	Australasian Figbird	<i>Sphecotheres vieillotii</i>
Passeriformes	Pachycephalidae	Grey Shrikethrush	<i>Colluricincla harmonica</i>
Passeriformes	Pachycephalidae	Australian Golden Whistler	<i>Pachycephala pectoralis</i>
Passeriformes	Pachycephalidae	Rufous Whistler	<i>Pachycephala rufiventris</i>
Passeriformes	Pardalotidae	Spotted Pardalote	<i>Pardalotus punctatus</i>
Passeriformes	Pardalotidae	Striated Pardalote	<i>Pardalotus striatus</i>
Passeriformes	Passeridae	House sparrow	<i>Passer domesticus</i>
Passeriformes	Petroicidae	Eastern Yellow Robin	<i>Eopsaltria australis</i>
Passeriformes	Petroicidae	Rose Robin	<i>Petroica rosea</i>
Passeriformes	Psophodidae	Eastern Whipbird	<i>Psophodes olivaceus</i>
Passeriformes	Ptilonorhynchidae	Satin Bowerbird	<i>Ptilonorhynchus violaceus</i>
Passeriformes	Pycnonotidae	Red-whiskered bulbul	<i>Pycnonotus jocosus</i>
Passeriformes	Rhipiduridae	Grey Fantail	<i>Rhipidura albiscapa</i>
Passeriformes	Rhipiduridae	Willie Wagtail	<i>Rhipidura leucophrys</i>
Passeriformes	Sturnidae	Common Myna	<i>Acridotheres tristis</i>
Passeriformes	Sturnidae	Common starling	<i>Sturnus vulgaris</i>
Passeriformes	Zosteropidae	Silveryeye	<i>Zosterops lateralis</i>
Pelecaniformes	Ardeidae	White-necked Heron	<i>Ardea pacifica</i>
Pelecaniformes	Ardeidae	White-faced Heron	<i>Egretta novaehollandiae</i>
Pelecaniformes	Pelecanidae	Australian Pelican	<i>Pelecanus conspicillatus</i>

Order	Family	Species	Scientific name
Pelecaniformes	Threskiornithidae	Australian White Ibis	<i>Threskiornis molucca</i>
Phaethontiformes	Phaethontidae	Red-tailed Tropicbird	<i>Phaethon rubricauda</i>
Procellariiformes	Diomedeidae	Wandering Albatross	<i>Diomedea exulans</i>
Procellariiformes	Diomedeidae	Indian Yellow-nosed Albatross	<i>Thalassarche carteri</i>
Procellariiformes	Diomedeidae	Shy Albatross	<i>Thalassarche cauta</i>
Procellariiformes	Diomedeidae	Black-browed Albatross	<i>Thalassarche melanophris</i>
Procellariiformes	Procellariidae	Buller's Shearwater	<i>Ardenna bulleri</i>
Procellariiformes	Procellariidae	Flesh-footed Shearwater	<i>Ardenna carneipes</i>
Procellariiformes	Procellariidae	Sooty Shearwater	<i>Ardenna grisea</i>
Procellariiformes	Procellariidae	Wedge-tailed Shearwater	<i>Ardenna pacifica</i>
Procellariiformes	Procellariidae	Short-tailed Shearwater	<i>Ardenna tenuirostris</i>
Procellariiformes	Procellariidae	Streaked Shearwater	<i>Calonectris leucomelas</i>
Procellariiformes	Procellariidae	Cape Petrel	<i>Daption capense</i>
Procellariiformes	Procellariidae	Southern Fulmar	<i>Fulmarus glacialoides</i>
Procellariiformes	Procellariidae	Southern Giant Petrel	<i>Macronectes giganteus</i>
Procellariiformes	Procellariidae	Northern Giant Petrel	<i>Macronectes halli</i>
Procellariiformes	Procellariidae	Fairy Prion	<i>Pachyptila turtur</i>
Procellariiformes	Procellariidae	Common Diving Petrel	<i>Pelecanoides urinatrix</i>
Procellariiformes	Procellariidae	Westland Petrel	<i>Procellaria westlandica</i>
Procellariiformes	Procellariidae	White-necked Petrel	<i>Pterodroma cervicalis</i>
Procellariiformes	Procellariidae	White-headed Petrel	<i>Pterodroma lessonii</i>
Procellariiformes	Procellariidae	Great-winged Petrel	<i>Pterodroma macroptera</i>
Procellariiformes	Procellariidae	Black-winged Petrel	<i>Pterodroma nigripennis</i>
Procellariiformes	Procellariidae	Little Shearwater	<i>Puffinus assimilis</i>
Procellariiformes	Procellariidae	Fluttering Shearwater	<i>Puffinus gavia</i>
Procellariiformes	Procellariidae	Hutton's Shearwater	<i>Puffinus huttoni</i>
Psittaciformes	Cacatuidae	Sulphur-crested Cockatoo	<i>Cacatua galerita</i>
Psittaciformes	Cacatuidae	Little Corella	<i>Cacatua sanguinea</i>
Psittaciformes	Cacatuidae	Yellow-tailed Black Cockatoo	<i>Calyptorhynchus funereus</i>
Psittaciformes	Cacatuidae	Galah	<i>Eolophus roseicapilla</i>
Psittaciformes	Psittaculidae	Australian King Parrot	<i>Alisterus scapularis</i>
Psittaciformes	Psittaculidae	Crimson Rosella	<i>Platycercus elegans</i>
Psittaciformes	Psittaculidae	Eastern Rosella	<i>Platycercus eximius</i>
Psittaciformes	Psittaculidae	Scaly-breasted Lorikeet	<i>Trichoglossus chlorolepidotus</i>
Psittaciformes	Psittaculidae	Rainbow Lorikeet	<i>Trichoglossus moluccanus</i>
Sphenisciformes	Spheniscidae	Little Penguin	<i>Eudyptula minor</i>
Strigiformes	Strigidae	Southern Boobook	<i>Ninox boobook</i>
Strigiformes	Strigidae	Southern Barking Owl	<i>Ninox connivens connivens</i>
Strigiformes	Strigidae	Powerful Owl	<i>Ninox strenua</i>
Strigiformes	Tytonidae	Eastern Barn Owl	<i>Tyto javanica</i>

Order	Family	Species	Scientific name
Suliformes	Anhingidae	Australasian Darter	<i>Anhinga novaehollandiae</i>
Suliformes	Phalacrocoracidae	Little Pied Cormorant	<i>Microcarbo melanoleucos</i>
Suliformes	Phalacrocoracidae	Great Cormorant	<i>Phalacrocorax carbo</i>
Suliformes	Phalacrocoracidae	Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>
Suliformes	Phalacrocoracidae	Pied Cormorant	<i>Phalacrocorax varius</i>
Suliformes	Sulidae	Australasian Gannet	<i>Morus serrator</i>
Suliformes	Sulidae	Brown Booby	<i>Sula leucogaster</i>
Mammals			
Carnivora	Canidae	Domestic dog	<i>Canis lupus familiaris</i>
Carnivora	Canidae	Fox	<i>Vulpes vulpes</i>
Chiroptera	Miniopteridae	Little Bent-winged bat	<i>Miniopterus australis</i>
Chiroptera	Miniopteridae	Large Bent-winged Bat	<i>Miniopterus orianae oceanensis</i>
Chiroptera	Molossidae	White-striped Freetail Bat	<i>Austronomus australis</i>
Chiroptera	Molossidae	Ride's Free-tailed Bat	<i>Ozimops ridei</i>
Chiroptera	Pteropodidae	Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>
Chiroptera	Vespertilionidae	Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>
Chiroptera	Vespertilionidae	Gould's Wattled Bat	<i>Chalinolobus gouldii</i>
Chiroptera	Vespertilionidae	Little Forest Bat	<i>Vespadelus vulturnus</i>
Chiroptera	Emballonuridae	Yellow-bellied Sheath-tail Bat	<i>Saccolaimus flaviventris</i>
Chiroptera	Vespertilionidae	Southern Myotis	<i>Myotis macropus</i>
Dasyuromorphia	Dasyuridae	Brown Antechinus	<i>Antechinus stuartii</i>
Diprotodontia	Burramyidae	Eastern Pygmy Possum	<i>Cercartetus nanus</i>
Diprotodontia	Phalangeridae	Common Brushtail Possum	<i>Trichosurus vulpecula</i>
Diprotodontia	Pseudocheiridae	Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>
Carnivora	Felidae	Cat	<i>Felis catus</i>
Lagomorpha	Leporidae	Rabbit	<i>Oryctolagus cuniculus</i>
Monotremata	Tachyglossidae	Short-beaked Echidna	<i>Tachyglossus aculeatus</i>
Peramelomorpha	Peramelidae	Long-nosed Bandicoot	<i>Perameles nasuta</i>
Rodentia	Muridae	Water-rat, Rakali	<i>Hydromys chrysogaster</i>
Rodentia	Muridae	Bush Rat, Mootit	<i>Rattus fuscipes</i>
Rodentia	Muridae	Black rat	<i>Rattus rattus</i>
Reptiles			
Squamata	Agamidae	Eastern Water Dragon	<i>Intelligama lesueurii</i>
Squamata	Boidae	Carpet Python, Diamond Python	<i>Morelia spilota</i>
Squamata	Colubridae	Green Tree Snake	<i>Dendrelaphis punctulatus</i>
Squamata	Diplodactylidae	Lesueur's Velvet Gecko	<i>Amalosia lesueurii</i>
Squamata	Elapidae	Golden-crowned Snake	<i>Cacophis squamulosus</i>
Squamata	Elapidae	Eastern Small-eyed Snake	<i>Cryptophis nigrescens</i>
Squamata	Elapidae	Yellow-faced Whipsnake	<i>Demansia psammophis</i>
Squamata	Elapidae	Black-bellied Swamp Snake	<i>Hemiaspis signata</i>

Order	Family	Species	Scientific name
Squamata	Elapidae	Eastern Brown Snake	<i>Pseudonaja textilis</i>
Squamata	Pygopodidae	Burton's Snake-lizard	<i>Lialis burtonis</i>
Squamata	Pygopodidae	Common Scaly-foot	<i>Pygopus lepidopodus</i>
Squamata	Scincidae	Red-throated Skink	<i>Acritoscincus platynota</i>
Squamata	Scincidae	Elegant Snake-eyed Skink	<i>Cryptoblepharus pulcher</i>
Squamata	Scincidae	Robust Ctenotus	<i>Ctenotus robustus</i>
Squamata	Scincidae	Copper-tailed Skink	<i>Ctenotus taeniolatus</i>
Squamata	Scincidae	Cunningham's Skink	<i>Egernia cunninghami</i>
Squamata	Scincidae	Eastern Water Skink	<i>Eulamprus quoyii</i>
Squamata	Scincidae	Dark-flecked Garden Sunskink	<i>Lampropholis delicata</i>
Squamata	Scincidae	Pale-flecked Garden Sunskink	<i>Lampropholis guichenoti</i>
Squamata	Scincidae	White's Skink	<i>Liopholis whitii</i>
Squamata	Scincidae	Three-toed Skink	<i>Saiphos equalis</i>
Squamata	Scincidae	Weasel Skink	<i>Saproscincus mustelinus</i>
Squamata	Scincidae	Eastern Blue-tongued Lizard	<i>Tiliqua scincoides</i>

Appendix 2. All diurnal bird species recorded in 2021 surveys at North Head

Species	Scientific name
Australian Brush Turkey	<i>Alectura lathamii</i>
Australian Magpie	<i>Gymnorhina tibicen</i>
Australian Raven	<i>Corvus coronoides</i>
Australian Wood Duck	<i>Chenonetta jubata</i>
Bar-shouldered Dove	<i>Geopelia humeralis</i>
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>
Brown Gerygone	<i>Gerygone mouki</i>
Brown Quail	<i>Synoicus ypsilophora</i>
Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>
Eastern Koel	<i>Eudynamis orientalis</i>
Eastern Whipbird	<i>Psophodes olivaceus</i>
Eastern Yellow Robin	<i>Eopsaltria australis</i>
Grey Butcherbird	<i>Cracticus torquatus</i>
Grey Fantail	<i>Rhipidura albiscapa</i>
Laughing Kookaburra	<i>Dacelo novaeguineae</i>
Little Corella	<i>Cacatua sanguinea</i>
Little Wattlebird	<i>Anthochaera chrysoptera</i>
Masked Lapwing	<i>Vanellus miles</i>
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>
Noisy Miner	<i>Manorina melanocephala</i>
Pacific Black Duck	<i>Anas superciliosa</i>
Peregrine Falcon	<i>Falco peregrinus</i>
Pied Cormorant	<i>Phalacrocorax varius</i>
Pied Currawong	<i>Strepera graculina</i>
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>
Red Wattlebird	<i>Anthochaera carunculata</i>
Red-browed Finch	<i>Neochmia temporalis</i>
Red-whiskered Bulbul	<i>Pycnonotus cafer</i>
Satin Flycatcher	<i>Myiagra cyanoleuca</i>
Scarlet Honeyeater	<i>Myzomela sanguinolenta</i>
Silver Gull	<i>Chroicocephalus novaehollandiae</i>
Silvereye	<i>Zosterops lateralis</i>
Spangled Drongo	<i>Dicrurus bracteatus</i>
Spotted Dove	<i>Spilopelia chinensis</i>
Spotted Pardalote	<i>Pardalotus punctatus</i>
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>
Superb Fairy-Wren	<i>Malurus cyaneus</i>
Variiegated Fairy-Wren	<i>Malurus lamberti</i>
Welcome Swallow	<i>Hirundo neoxena</i>
White-browed Scrubwren	<i>Sericornis frontalis</i>
White-cheeked Honeyeater	<i>Phylidonyris niger</i>
Yellow-tailed Black Cockatoo	<i>Zanda funereus</i>

Appendix 3. All flora species recorded in 2021 at North Head

Family	Species	Scientific name	Status (NSW and North Head)
Apiaceae	Flannel Flower	<i>Actinotus helianthi</i>	
Apiaceae	Lesser Flannel Flower	<i>Actinotus minor</i>	
Apiaceae	Wooly Xanthosia	<i>Xanthosia pilosa</i>	
Apiaceae	Frangipani	<i>Plumeria sp.</i>	
Araceae	Swiss cheese plant	<i>Monstera deliciosa</i>	Weed
Arecaceae	Cabbage-tree palm	<i>Livistona australis</i>	
Asparagaceae	Asparagus weed	<i>Asparagus officinalis</i>	Weed
Asparagaceae	Climbing asparagus fern	<i>Asparagus scandens</i>	Weed
Asparagaceae	Asparagus fern, broom asparagus	<i>Asparagus virgatus</i>	Weed
Asparagaceae	Glory of the snow	<i>Chionodoxa forbesii</i>	Weed
Asparagaceae	Black thistle	<i>Cirsium vulgare</i>	Weed
Asparagaceae	Daisy-bush	<i>Olearia tomentosa</i>	
Asparagaceae	Bindyi	<i>Soliva sessilis</i>	Weed
Asparagaceae	Dandelion	<i>Taraxacum officinale</i>	Weed
Asparagaceae	Coltsfoot	<i>Tussilago farfara</i>	Weed
Caesalpiniaceae		<i>Cassia coluteoides</i>	Weed
Campanulaceae		<i>Wahlenbergia gracilis</i>	
Casuarinaceae	Scrub She-oak	<i>Allocasuarina distyla</i>	
Casuarinaceae	Swamp She-oak	<i>Casuarina glauca</i>	
Commelinaceae	Creeping Christian	<i>Commelina cyanea</i>	
Compositae	Scotch thistle	<i>Onopordum acanthium</i>	Weed
Cupressaceae	Oyster Bay pine	<i>Callitris rhomboidea</i>	
Cupressaceae	Old Man's Beard	<i>Caustis flexuosa</i>	
Cupressaceae	Caustis	<i>Caustis pentandra</i>	
Cupressaceae		<i>Chorizandra cymbaria</i>	Locally significant
Cupressaceae	Button Grass	<i>Eleocharis sphacelata</i>	Locally significant
Cupressaceae	Cut Grass	<i>Gahnia sieberiana</i>	
Cupressaceae	Variable Sword Edge	<i>Lepidosperma laterale</i>	
Cupressaceae	Bracken Fern	<i>Pteridium esculentum</i>	
Cupressaceae		<i>Hibbertia fasciculata</i>	
Cupressaceae	Guinea Flower	<i>Hibbertia linearis</i>	
Cupressaceae	Golden Guinea Flower	<i>Hibbertia scandens</i>	
Cupressaceae		<i>Hibbertia serpyllifolia</i>	
Elaeocarpaceae	Blueberry Ash	<i>Elaeocarpus reticulatus</i>	
Epacridaceae	Cranberry Heath	<i>Astroloma humifusum</i>	Locally significant
Epacridaceae	Fuchsia Heath	<i>Epacris longiflora</i>	
Epacridaceae	Bearded Heath	<i>Leucopogon ericoides</i>	

Family	Species	Scientific name	Status (NSW and North Head)
Epacridaceae	Small-leaved White Beard	<i>Leucopogon microphyllus</i> var. <i>microphyllus</i>	
Epacridaceae	Tree Broom-heath	<i>Monotoca elliptica</i>	
Epacridaceae	Prickly Broom-heath	<i>Monotoca scoparia</i>	
Epacridaceae	Pink five-corners, Long-leaf Five-corners	<i>Styphelia triflora</i>	
Epacridaceae	Snow Wreath	<i>Woolisia pungens</i>	
Epacridaceae		<i>Ricinocarpos pinifolius</i>	
Epacridaceae	Sydney Golden Wattle	<i>Acacia longifolia</i>	
Epacridaceae		<i>Acacia sophorae</i>	
Epacridaceae	Sweet Scented Wattle	<i>Acacia suaveolens</i>	
Epacridaceae	Sunshine Wattle	<i>Acacia terminalis</i> var. <i>terminalis</i>	Endangered
Epacridaceae	Bossiaea	<i>Bossiaea ensata</i>	
Epacridaceae	Bossiaea	<i>Bossiaea heterophylla</i>	
Epacridaceae	Parrot-pea	<i>Dillwynia floribunda</i> var. <i>floribunda/teretifolia</i>	
Epacridaceae	Eggs and Bacon	<i>Dillwynia retorta</i>	
Epacridaceae	Weed	<i>Dipogon lignosus</i>	
Epacridaceae	FALSE Sarsaparilla	<i>Hardenbergia violacea</i>	
Epacridaceae	Dusky Coral-pea	<i>Kennedia rubicunda</i>	
Epacridaceae		<i>Pultenaea</i> sp.	
Gleicheniaceae	Pouched Coral Fern	<i>Gleichenia dicarpa</i>	
Gleicheniaceae	Coral Fern	<i>Gleichenia microphylla</i>	
Goodeniaceae	Blue Dampiera	<i>Dampiera stricta</i>	
Goodeniaceae	Star-haired Goodenia	<i>Goodenia stelligera</i>	Locally significant
Haemodoraceae		<i>Haemodorum planifolium</i>	
Iridaceae	Leafy Purple Flag	<i>Patersonia glabrata</i>	
Iridaceae	Silky Purple Flag	<i>Patersonia sericea</i>	
Iridaceae	Hairy Devil's Twine	<i>Cassytha pubescens</i>	
Lindsaeaceae	Screw Fern	<i>Lindsaea linearis</i>	
Lomandraceae	Needle Mat-rush	<i>Lomandra cylindrica</i>	Locally significant
Lomandraceae	Spiny-headed Mat-rush	<i>Lomandra longifolia</i>	
Luzuriagaceae	Wombat Berry	<i>Eustrephus latifolius</i>	
Luzuriagaceae	Rusty Petals	<i>Lasiopetalum ferrugineum</i> var. <i>ferrugineum</i>	
Luzuriagaceae		<i>Lasiopetalum rufum</i>	
Luzuriagaceae	Wrinkled Kerrawang	<i>Rulingia hermannifolia</i>	Locally significant
Luzuriagaceae	Snake Vine	<i>Stephania japonica</i> var. <i>discolor</i>	
Myrtaceae	Lily Pilly	<i>Acmena smithii</i>	
Myrtaceae	Smooth-barked Apple	<i>Angophora costata</i>	
Myrtaceae	Dwarf Apple	<i>Angophora hispida</i>	

Family	Species	Scientific name	Status (NSW and North Head)
Myrtaceae	Heath Myrtle	<i>Baeckea imbricata</i>	
Myrtaceae	Crimson Bottlebrush	<i>Callistemon citrinus</i>	
Myrtaceae	Common Fringe Myrtle	<i>Calytrix tetragona</i>	
Myrtaceae	Bloodwood	<i>Corymbia gummifera</i>	
Myrtaceae	Darwinia	<i>Darwinia fascicularis subsp. fascicularis</i>	
Myrtaceae	Bangalay	<i>Eucalyptus botryoides</i>	
Myrtaceae	Heart Leaved Stringy Bark	<i>Eucalyptus camfieldii</i>	Vulnerable
Myrtaceae	Rosy Heath Myrtle	<i>Euryomyrtus ramosissima</i>	Locally significant
Myrtaceae	Tick Bush	<i>Kunzea ambigua</i>	
Myrtaceae	Pink Kunzea	<i>Kunzea capitata</i>	
Myrtaceae	Lemon Scented Tea Tree	<i>Leptospermum polygalifolium subsp. polygalifolium</i>	
Myrtaceae	Paperbark Tea Tree	<i>Leptospermum trinervium</i>	
Myrtaceae	Ball Honey Myrtle	<i>Melaleuca nodosa</i>	
Myrtaceae	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>	
Myrtaceae		<i>Syzygium australe</i>	
Myrtaceae		<i>Syzygium oleosum</i>	
Ochnaceae	Ochna, Mickey Mouse plant	<i>Ochna serrulata</i>	Weed
Oxalidaceae	Yellow oxalis	<i>Oxalis corniculata</i>	Weed
Phormiaceae	Blue Flax Lily	<i>Dianella caerulea var. caerulea/producta</i>	
Phyllanthaceae	Breynia	<i>Breynia oblongifolia</i>	
Phyllanthaceae	Cheese Tree	<i>Glochidion ferdinandi</i>	
Picrodendraceae	Bush Pea	<i>Micrantheum ericoides</i>	
Picrodendraceae	Rough-fruit Pittosporum	<i>Pittosporum revolutum</i>	
Picrodendraceae	Sweet Pittosporum	<i>Pittosporum undulatum</i>	
Picrodendraceae	Oat Speargrass	<i>Anisopogon avenaceus</i>	
Picrodendraceae	Common Couch	<i>Cynodon dactylon</i>	
Picrodendraceae	Wiry Panic	<i>Entolasia stricta</i>	
Picrodendraceae		<i>Eragrostis brownii</i>	
Picrodendraceae	African love grass	<i>Eragrostis curvula</i>	Weed
Picrodendraceae	Blady Grass	<i>Imperata cylindrica var. major</i>	
Picrodendraceae	Spreading Panic Grass	<i>Paspalidium distans</i>	
Picrodendraceae		<i>Paspalum sp.</i>	Weed
Picrodendraceae	Kangaroo Grass	<i>Themeda australis</i>	
Podocarpaceae	Dwarf plum pine, Spiny-leaf podocarp	<i>Podocarpus spinulosus</i>	
Primulaceae	Scarlet pimpernel	<i>Anagallis arvensis</i>	Weed

Family	Species	Scientific name	Status (NSW and North Head)
Primulaceae		<i>Anagallis arvensis</i> var. <i>purpurea</i>	Weed
Proteaceae	Wallum Banksia	<i>Banksia aemula</i>	
Proteaceae	Heath Leaved Banksia	<i>Banksia ericifolia</i> var. <i>ericifolia</i>	
Proteaceae	Coastal Banksia	<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>	
Proteaceae	Silver Banksia	<i>Banksia marginata</i>	
Proteaceae	Banksia	<i>Banksia oblongifolia</i>	
Proteaceae	Old Man Banksia	<i>Banksia serrata</i>	
Proteaceae	Smoke Bush	<i>Conospermum longifolium</i> subsp. <i>Longifolium</i>	
Proteaceae	Grey Spider Flower	<i>Grevillea buxifolia</i> subsp. <i>buxifolia</i>	
Proteaceae	Red Spider Flower	<i>Grevillea speciosa</i>	Locally significant
Proteaceae	Broad-leaved Hakea	<i>Hakea dactyloides</i>	
Proteaceae	Hakea	<i>Hakea gibbosa</i>	
Proteaceae	Willow-leaved hakea	<i>Hakea salicifolia</i> subsp. <i>salicifolia</i>	
Proteaceae	Dagger Hakea	<i>Hakea teretifolia</i>	
Proteaceae	Drumsticks	<i>Isopogon anethifolius</i> / <i>Isopogon anethifolium</i>	
Proteaceae	Mountain Devil	<i>Lambertia formosa</i>	
Proteaceae	Hairy Geebung	<i>Persoonia hirsuta</i>	Endangered
Proteaceae	Lance-leaved Geebung	<i>Persoonia lanceolata</i>	
Proteaceae	Smooth Geebung	<i>Persoonia levis</i>	
Proteaceae	Conesticks	<i>Petrophile pulchella</i>	
Proteaceae	Creeping buttercup	<i>Ranunculus repens</i>	Weed
Restionaceae	Spreading-Rope Rush	<i>Empodisma minus</i>	
Restionaceae	Cord Rush	<i>Restio dimorphus</i> / <i>Chordifex dimorphus</i>	Locally significant
Restionaceae	Tassel Rush	<i>Restio fastigiatus</i>	
Restionaceae	Crowea	<i>Crowea saligna</i>	Locally significant
Restionaceae	Cascade of Stars Wax Flower	<i>Philothea buxifolia</i>	
Restionaceae		<i>Philothea salsolifolia</i>	
Smilacaceae	Native Sarsaparilla	<i>Smilax glycyphylla</i>	
Solanaceae	Black-berry nightshade	<i>Solanum nigrum</i>	Weed
Verbenaceae	Lantana	<i>Lantana camara</i>	Weed
Verbenaceae		<i>Verbena</i> sp.	
Vitaceae	Native Grape	<i>Cissus hypoglauca</i>	
Xanthorrhoeoideae	Broad-leaved Grass Tree	<i>Xanthorrhoea arborea</i>	
Xanthorrhoeoideae	Forest Grass Tree	<i>Xanthorrhoea media</i>	
Zingiberaceae	Ginger lily	<i>Hedychium gardnerianum</i>	Weed

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