Biodiversity Management Plan

for

113 Orchard Street, Warriewood

16th December 2024

GIS Environmental Consultants

45 Austin Ave, North Curl Curl 2099
Ph: (02) 9939 5129, Mobile: 0419 438 672
ecology@ecology.net.au, www.ecology.net.au

Document Information

Prepared for:	Tony McLain
Prepared by:	Nicholas Skelton, B. Sc. (Hons), M. App. Sc. (Ecology and Vegetation Management) Olivia Zurek, B. Environmental Science, Cert III. Conservation and Ecosystem Management
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Nicholas Skelton, B.Sc. (Hons), M. App. Sc.

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GIS Environmental Consultants

ABN: 66011504339
45 Austin Ave,
North Curl Curl, NSW 2099
Phone: (02) 9939 5129
Mobile: 0419 438 672
Email: ecology@ecology.net.au
Web: www.ecology.net.au

1 Table of Contents

1. Introduction

The native vegetation on the property 113 Orchard Street, Warriewood has high conservation value as it contains Central Coast Escarpment Moist Forest (PCT 3230) and Coastal Enriched sandstone Forest (PCT 3592) that are in good condition and the site is suitable habitat for a wide variety of native flora and fauna including Threatened species.
Due to the ecological sensitivity of the property Council has identified that a Biodiversity Management Plan is required to be part of the Development Application that has been lodged for replacement of the house, bushfire hazard reduction, construction of horse arena stables and paddocks, wastewater disposal system and associated works. This plan will become part of the approval and will require works for 5 years and for the life of the development.

This Biodiversity Management Plan (BMP) describes the:

- Existing ecological (biodiversity) values on the property that are required to be retained as specified by the DA approval Conditions on Consent
- Impact avoidance and minimisation actions that are required to be carried out during construction to protect (mitigate impact on) the native bushland habitat that is required to be retained from accidental construction impact (including nest box installation, fauna rescue, temporary construction site fencing and clean water diversion, permanent marker bollard installation etc.),
- Thinning of vegetation in Zone B (Map 2) to establish a bushfire fuel reduced Asset Protection Zone (APZ) in accordance with the approved fire report and approved arborist report,
- Bushland management during construction and for a period of a minimum of 5 years to maintain and improve the habitat value and make the native ecological community on the property more resilient requiring less maintenance Zones A and B and fuel reduced only in Zone B Map 2,
- Requirements for the ongoing long-term ecological maintenance of the biodiversity values of the property to maintain biodiversity values,
- Supervision and monitoring of the impact avoidance, thinning, bushland management works, and providing guidance on appropriate actions for any unexpected environmental or ecological.
- Certifying as needed.

1.1 Background

This Biodiversity Management Plan is a requirement of the Development Application for the demolition and construction of a dwelling and new horse arena, stables, paddocks and associated works. The approved DA will have conditions of consent that require that the actions described in this plan are carried out. Various pieces of legislation also require the conservation and management of bushland on private land, including the Biosecurity Act 2015, which requires the removal of weeds, the National Parks and Wildlife Act 1974, and the Biodiversity Conservation Act 2016, which protect Threatened species, native species and ecological communities and the Council LEP and DCP.

1.2 These Works Are Separate to the Formal Biodiversity Offset

- The works specified in this plan are not formal Biodiversity Offsets for the impact of the proposal as required by the Biodiversity Conservation Act and as calculated by the BAM and offset by the BOS to offset the impact of the development (DA) by retirement of biodiversity credits. The Biodiversity Offsets for the direct impacts on native vegetation are calculated in the Biodiversity Development Assessment Report (GIS Environmental Consultants, November 2024)

1.3 Land to Which this Biodiversity Management Plan Applies

Map 2 shows the location and extent (0.46ha) of the Biodiversity Management Area, consisting of Zone A and Zone B where the works described in this plan are to be carried out. The areas of biodiversity habitat required to be retained are Zone A (Environment Protection and Management Area, 4,000 sqm) and some trees and ground cover in Zone B (APZ Managed Habitat 585 sqm) shown on Map 2. The Arborist report may separately protect some additional trees.

1.4 Bushfire Fuel Reduction Asset Protection Zone Requirements

The Bushfire Assessment report that was submitted with the DA application and became part of the approval, shows the extent and location of the APZ and the requirements for fuel reduction. The report in turn refers to a guideline by the Rural Fire Service. These documents specify the fuel hazard reduction that must be undertaken. The majority of the APZ area described in the Bushfire Assessment report will be managed as horse paddocks, landscaping or become hard surfaces such as buildings, paths driveways etc. Hence, the only remaining area of native vegetation that will need to be managed as an APZ is Zone B, shown in dark blue on Map 2. Compliance with the requirements of the fire report at the time of issue of the occupation certificate and in perpetuity will need to be checked.

1.5 Objective of this Biodiversity Management Plan

This Biodiversity Management Plan prescribes methods and a timeline for the effective management of the biodiversity values on this property, specifically:

- Protection during construction of biodiversity values to be retained (as specified in the Conditions of Consent), including the habitat and biodiversity in all of Zone A and some trees and ground cover in Zone B;
- Careful management of the existing habitat in accordance with Conditions of Consent to establish the bushfire fuel levels in the Asset Protection Zone (APZ) in accordance with the approved fire report in Zone B by qualified bushland managers;
- Restoration and regeneration of already disturbed habitat;
- Active management of habitat for 5 years and then ongoing management for the life of the development; and
- Monitoring to determine if quantifiable goals are being met and allow prescription of appropriate adaptive management where goals are not being achieved or there has been unexpected environmental events.

There will be additional tree protection during construction that is specified in the approved arborist report also available on Councils web site.

Existing Biodiversity values on this property include the existing native plants and animals, habitat for flora and fauna including vegetation structure and floristics, natural rock features, clean water (low nutrients and sediment), stormwater volumes etc.

The objectives will be achieved by:

- Baseline monitoring
- Installing nest boxes, Zone A
- Avoiding unintentional impact during to construction by installing temporary construction protection fencing, Boundary of Zone C Construction Area
- Rescuing and relocating fauna in trees to be removed, Zones B and C
- Establishing and maintaining the required fuel reduction Asset Protection Zone (APZ) for bushfire protection in the Zone B

- Management of weeds using bush regeneration techniques, Zones A, B and C
- Preventing introduction of weed propagules and pathogens by implementing hygiene protocols
- Reducing stormwater pollution by diverting clean stormwater around the construction area, horse areas and the sewage wastewater dewatering areas
- Preventing erosion by maintaining a ground cover
- Installing permanent bollards and signage on the boundary of the APZ

1.6 Duration of this Biodiversity Management Plan

This plan is for a minimum of 5 years, after which, the owner of the land still has obligations under the NPWS Act the Biosecurity Act and the Biodiversity Conservation Act to conserve and maintain the biodiversity values and a requirement to maintain the bushfire APZ.

1.7 Physical Features on the Site

1.7.1 Topography

The site is a lower slope with lowest part of the property is the southeastern boundary at 18.98 AHD and the highest is the western boundary at 43.47 AHD.
The slope of the whole site is steep and approximately 21° (23%) ranging from 20-30° with an aspect to the south-east.
The slope of the site is a constraint that has flow on effects for civil engineering, bushfire protection, wastewater, stormwater, and indirect ecological impacts.
Topographical features of the site locality are shown on the map in Figure 3.1 of the BDAR.

1.7.2 Hydrology

This site is approximately 150 metres northeast of Mullet Creek which feeds into South Creek and Narrabeen Lagoon. The site is also approximately 400 metres south of Fern Creek which feeds into Narrabeen Creek and South Creek. There is wetland habitat to the south and south-east of the site including the protected Warriewood Wetlands area.
The aspect of the site is south-east.
No springs or swamps were evident on the site during inspection or are evident from the type of vegetation on the site. No ground water dependent ecosystems occur on this site.
The proximity to all types of Hydrology features is shown on the map in Figure 3.1 of the BDAR.

1.7.3 Geology and Soils

The soil type is Watagan Soil Landscape, a thin colluvial soil, and it is on Hawkesbury Sandstone geology.

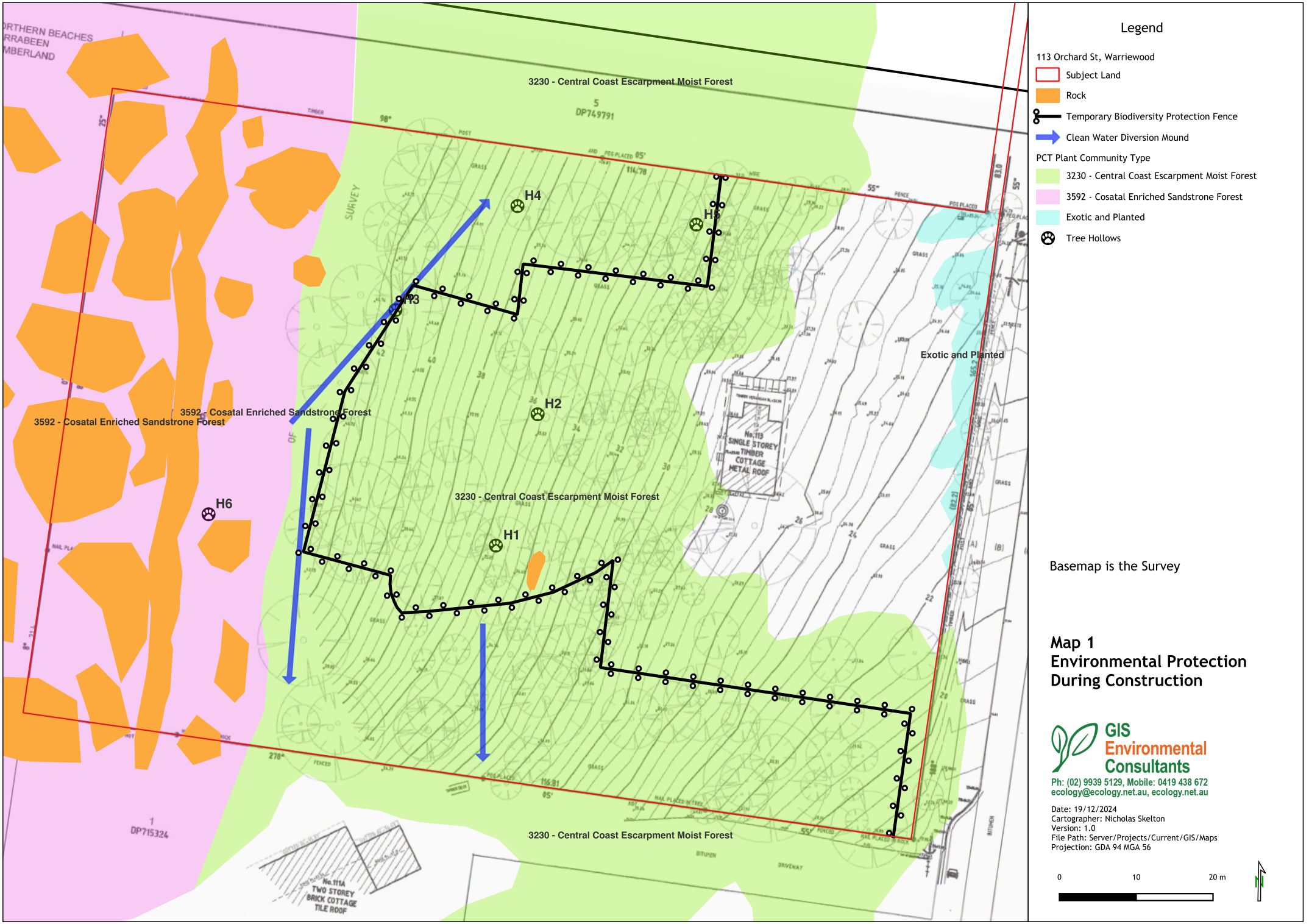
1.7.4 Fire History

The site shows signs of not being burnt in at least 20 years. Fire history records from NPWS were checked and they do not show any fires on this site.

1.7.5 Disturbance History

Historic disturbance on this property is of 3 types:

1. There is no evidence of disturbance in the western end of the property that is mapped as the Environment Protection Area (Zone A) on Map 2.
2. The central part of the site has had moderate disturbance by slashing of the shrub layer for bushfire protection.
3. The lower part of the site where the existing house, exotic mown lawn, planted exotic and native trees and driveway is highly disturbed and has been nearly totally cleared of native vegetation.



Legend

113 Orchard St, Warriewood

- Subject Land
- Rock
- Temporary Biodiversity Protection Fence
- Clean Water Diversion Mound

PCT Plant Community Type

- 3230 - Central Coast Escarpment Moist Forest
- 3592 - Cosatal Enriched Sandstrone Forest
- Exotic and Planted
- Tree Hollows

Basemap is the Survey

Map 1
Environmental Protection During Construction

GIS Environmental Consultants
Ph: (02) 9939 5129, Mobile: 0419 438 672
ecology@ecology.net.au, ecology.net.au

Date: 19/12/2024
Cartographer: Nicholas Skelton
Version: 1.0
File Path: Server/Projects/Current/GIS/Maps
Projection: GDA 94 MGA 56

0 10 20 m

Photo Page 1 – Site Features

Photo 1. General site view, southwestern side looking east

Photo 2. General site view, northeastern side looking southeast

Photo 3. Western side of site, looking west. Sandstone boulders

Photo 4. Large fallen log on site

Photo 5. Sugar Glider in tree hollow (PP2, Photo 1)

Photo 6. Sugar Glider on tree observed entering hollo

4 Biodiversity Values on the Site

A more detailed description of the ecological values at the site is given in the report titled 'Biodiversity Development Assessment Report for the Demolition and Construction of a Dwelling, New Horse Arena, Stables, Paddocks and Associated Works at 113 Orchard Street, Warriewood' by GIS Environmental Consultants (25th November 2024) which can be found on the development application part of Councils web site.

4.1 Vegetation Communities on the Site

The vegetation on the site meets the definition of Central Coast Escarpment Moist Forest (PCT 3230) and Coastal Enriched Sandstone Forest (PCT 3592). There are no Threatened Ecological Communities on this site.

4.1.1 Coastal Enriched Sandstone Forest PCT 3592 Description

A tall to very tall shrubby sclerophyll open forest found on slightly enriched Hawkesbury Sandstone soils on sheltered slopes and occasionally crests on the Sydney coastal sandstone plateaus. The tree canopy very frequently includes a high cover of *Angophora costata* commonly in combination with *Corymbia gummifera* and *Eucalyptus piperita*, with *Eucalyptus pilularis* occasionally locally abundant. A taller mid-stratum is characterised by very frequent however sparse cover of *Pittosporum undulatum* and *Allocasuarina littoralis* or *Allocasuarina torulosa*. A mid-dense lower shrub layer is comprised of dry sclerophyll species that commonly include *Leptospermum trinervium*, *Persoonia levis*, *Lomatia silaifolia*, *Acacia ulicifolia* and *Dodonaea triquetra*, with *Banksia serrata* and *Banksia spinulosa* recorded occasionally. The ground layer is typically a sparse cover of graminoids that almost always includes *Dianella caerulea* and *Lomandra longifolia* with the grass *Entolasia stricta* and fern *Pteridium esculentum*, with frequent occurrences of climbers such as *Smilax australis*. This PCT is primarily distributed at elevations of less than 200 metres asl downslope of shale soils on the north shore of Sydney and Sutherland and on the Narrabeen sandstone escarpment along the Pittwater Peninsular. It grades into a heathy forest PCT 3595 on rocky Hawkesbury Sandstone gullies or moist shrub and fern forest PCT 3176 with increased shelter in deeper gullies.

4.1.2 Central Coast Escarpment Moist Forest (PCT 3230)

A tall to very tall sclerophyll open forest with a sparse mixed mesophyll and sclerophyll mid-stratum and a ground layer of ferns and grasses. This PCT occurs on Narrabeen sandstone slopes and escarpments of the lower Hawkesbury, Pittwater, Brisbane Waters and Watagan Ranges, Central Coast region. The tree canopy is variable in composition and no set of eucalypt species is consistently recorded with a high cover. *Angophora floribunda* and *Syncarpia glomulifera* are common, however maybe a member of the upper canopy or as a small tree, sometimes both. There are a range of canopy species that also have high cover, however each occur no more than occasionally or rarely across the distribution of the PCT. These include *Eucalyptus pilularis*, *Eucalyptus piperita*, *Eucalyptus saligna* or *Eucalyptus deanei*, *Eucalyptus paniculata*, *Angophora costata*, *Eucalyptus umbra* or *Eucalyptus punctata*. A layer of small trees is almost always present and dominated by *Allocasuarina torulosa*, with a lower shrub layer very frequently including *Persoonia linearis*, commonly *Breynia oblongifolia*, occasionally with *Platysace lanceolatus*, *Myrsine variabilis* and *Synoum glandulosum* subsp. *glandulosum*. Occasionally there is a sparse cover of Livistona australis, typically with no more than one or two individuals. The ground layer is characterised by a high cover of ferns with *Pteridium esculentum* almost always present, commonly with a higher cover of *Calochlaena dubia* and occasionally *Blechnum cartilagineum*. Small mesic climbers are both diverse and very frequent including *Eustrephus latifolius*. Grasses also comprise a high proportion of the cover, very frequently including *Imperata cylindrica* and *Entolasia stricta*, commonly with *Microlaena stipoides*. Graminoids almost always include *Dianella caerulea* and very frequently *Lomandra longifolia*. This PCT is primarily found at low elevation Narrabeen escarpments and hills, commonly on lower slopes above the flooded Hawkesbury and Pittwater valleys. It occurs typically on sheltered to intermediate easterly aspects or rarely on crests of the main range east of Gosford and in the Watagan Range, both identified as residual Hawkesbury Sandstone, however this may only be a thin layer above the Narrabeen stratum. A geological outlier occurs on a volcanic dyke at West Head in Kuring-Gai National Park. On Narrabeen shales in the Central Coast-Pittwater districts it is replaced by moist forest PCT 3234 on sheltered aspects or dry grassy forest PCT 3437 on drier aspects.

4.2 Plant Species (Floristics)

The native and exotic plant species that occur on the site and adjacent lands are listed in Appendix A. The list also contains the relative abundance of the species from the 20x20m plot that was in the development footprint and the Central Coast Escarpment Moist Forest (PCT 3230).

4.2.1.1 Floristics in Vegetation Zone A - Central Coast Escarpment Moist Forest

63 species of native plant and 10 species of non native plant occur on the property.

Table 4.1. Plant Species List

with summaries of Status, Floristics (Composition) and Cover (Structure, Relative Abundar

113 Orchard St, Warriewood

6 November 2024

Botanist, Nicholas Skelton, GIS Environmental Consultants

GIS Environmental Consultants
Ph: (02) 9939 5129, Mobile: 0419 438 672
ecology@ecology.net.au, ecology.net.au

Table 4.1a. Ecological Status (legal, conservation) Species Summary

Number of Plant Species in each Plot, summariseed by legal status and conservation importance

	BC Act Threatened	Native to NSW (non Threatened)	Planted Non Native	Weed Other	Weed Regional Syd Priority	Weed State Priority	Total
VZ1 Plot 1		46	1	8			55
Additonal Outside Plots		6	0	1	1		8
Total	0	52	1	9	1	0	63

Table 4.1b. Native Plant Species Composition (Species Richness, Floristics) Summary

Native Species Richness in each Vegetation Zone, inside and outside plots, summarised by Growth Form

	Fern (EG)	Grass & Grass Like (GG)	Forb (FG)	Shrub (SG)	Tree (TG)	Other (OG)	Total
VZ1 Plot 1	2	4	17	2	11	10	46
Additonal Outside Plots	2	0	2	0	2	2	8
Total	4	4	19	2	13	12	54

Table 4.1c. Native Vegetation Structure Summary (Projected Foliage Cover)

Projected Native Foliage Cover % in each Vegetation Zone, in plots, summarised by Growth Form

	Fern (EG)	Grass & Grass Like (GG)	Forb (FG)	Shrub (SG)	Tree (TG)	Other (OG)
VZ1 Plot 1	0.15	3.9	4.6	0.5	90.2	1.5

Table 4.1d. Non-Native (Weeds, Exotics) Composition (Species Richness, Floristics) Summary

Weed Species Richness in each Vegetation Zone, inside and outside plots, summarised by Growth Form

	Fern (EG)	Grass & Grass Like (GG)	Forb (FG)	Shrub (SG)	Tree (TG)	Other (OG)	Total
VZ1 Plot 1		2	3	3			8
Additonal Outside Plots			1		1		2
Total	0	2	4	3	1	0	10

4.3 Vegetative Structure

The tree canopy is a forest dominated by *Syncarpia glomulifera (*Turpentine Tree), followed by *Eucalyptus piperita* (Sydney Peppermint). The shrub canopy is currently very sparse and reflects the history of thinning for bushfire protection of the existing house. The ground cover is sparce and is dominated by herbs.

4.3.1.1 Structure in Vegetation Zone A - Central Coast Escarpment Moist Forest

The tree canopy in VZ1 is all native and has a cover of 90.2%. The shrub canopy is almost non-existent with only 0.5% native cover, and the ground cover is 8.65% native, with mostly herbs and some grasses.

4.4 Existing Weeds

A total of 11 weed species were recorded on the site, including *Bidens pilosa*, *Briza maxima*, *Conzya bonariensis*, *Lilium formosanum*, *Ochan serrulata*, *Setaria palmifolia*, *Salanum mauritianum*, *Taraxacum officinale*, *Senna pendula* and *Argentina adenophora*.

A list of the weeds on the survey plots and in the vicinity of the site is provided in Table 4.1e within Appendix A.

5 Fauna Habitat

The site contains good quality habitat for many species. Below is a table summarising fauna that have been previously recorded on the site.

Table 5.5 Summary of Fauna that have been Recorded on the site

Common Name	Scientific Name	Evidence
Birds		
Australian Brush-turkey	*Alectura lathami*	O,C
Australian Magpie	*Cracticus tibicen*	O
Laughing Kookaburra	*Dacelo novaeguineae*	O
Noisy Miner	*Manorina melanocephala*	O
Pied Currawong	*Strepera graculina*	O
Rainbow Lorikeet	*Trichoglossus moluccanus*	O
Sulphur-crested Cockatoo	*Cacatua galerita*	O
Mammals		
Common Brushtail Possum	*Trichosurus vulpecula*	A
Common Ringtail Possum	*Pseudocheirus peregrinus*	A
Dog	*Canis lupus familiaris*	O
European Rabbit	*Oryctolagus cuniculus*	P, T
Swamp Wallaby	*Wallabia bicolor*	O
Sugar Glider	*Petaurus breviceps*	O, S, Q
Reptiles		
Diamond Python	*Morelia spilota*	A
Water Dragon	*Intellagama lesueurii*	A

Fauna in **bold** indicates a Threatened Species.

Key

*Introduced species, +Listed as Threatened Species under the NSW Biodiversity Conservation Act 2016, ?Species presence uncertain

Observation Types: Observed (O), Heard call (W), Scat (P), Nest/roost (E), Tracks or scratchings (T), Burrow (B), Crushed Cones (G), Hair (H), Feathers or skin (F), Dead (K), Camera (Q), In scat (X), Bone or teeth or shell (Y), In raptor/owl pellet (Z), Ultrasonic bat detector (U), Anecdotal (A)

Legend

113 Orchard St, Warriewood

- Subject Land
- Rock
- Permanent Bollards marking BM Area
- Clean Water Diversion Mound

Biodiversity Management Areas

- Zone A Environment Protection and Management 4000 sqm
- Zone B APZ Managed Habitat 585 sqm

Basemap is the Site Plan rev N

Map 2
Ecological Maintainence

GIS Environmental Consultants
Ph: (02) 9939 5129, Mobile: 0419 438 672
ecology@ecology.net.au, ecology.net.au

Date: 16/12/2024
Cartographer: Nicholas Skelton
Version: 1.0
File Path: Server/Projects/Current/GIS/Maps
Projection: GDA 94 MGA 56

0 10 20 m

Photo Page 2 - Tree Hollows

Photo 1. Sugar glider hollow

Photo 2. Hollow bearing tree

Photo 3. Hollow bearing tree

Photo 4. Hollow bearing tree

8 Ecological Works

The ecological works required for this Biodiversity Management Plan (BMP) are divided into 3 stages and the Biodiversity Management Area (BMA) is divided into 3 zones.

The 3 Zones are:

- **Zone A - Environment Protection and Management, of good quality bushland using Assisted Regeneration**
  Dark green area on Map 2 – 4,000sqm. Zone A contains undisturbed Central Coast Escarpment Moist Forest (PCT 3230) and Coastal Enriched Sandstone Forest (PCT 3592). This zone is to have:
    - protection fencing during construction,
    - installation of nest boxes,
    - installation of Environment Protection Fencing during construction,
    - installation of bollards and signage to mark the outer boundary of the APZ, and
    - weeds managed every 6 months for a minimum of 5 years.

- **Zone B - APZ Managed Habitat, Weed Control**
  Dark blue = area on Map 2 – 585sqm. Zone B is Central Coast Escarpment Moist Forest (PCT 3230). This zone is to have:

    - protection fencing during construction,
    - fauna rescue during tree removal,
    - tree thinning in to establish to meet APZ standards,
    - installation of Environment Protection Fencing during construction, and
    - weeds managed every 6 months for a minimum of 5 years.

- **Zone C - Earthworks and Construction Area**

    - fauna rescue during tree removal,
    - installation of Environment Protection Fencing during construction, and
    - weed control every 6 months

The 3 stages are:

- **Stage 1 – At issue of the Construction Certificate** and after payment of offsets. Baseline monitoring, installation of nest boxes, fauna rescue, tree thinning, and tree removal in construction area.

- **Stage 2 – During Construction and Prior to Occupation Certificate**, including prior to Construction Certificate and during construction. This stage includes all tasks and details that would otherwise be detailed in a Construction Environment Management Plan (CEMP) and can be used for the same purpose.

- **Stage 3 - Ongoing maintenance** for the remaining part of the 5 years.

This document addresses each of the stages in turn and the management actions for each zone are described within each stage. A GANNT chart is provided in Appendix C which outlines the timing of each management action. Estimated costs for each management action are provided in Appendix D.

9 Quantifiable Goals and Key Performance Indicators

The following Key Performance Indicators (KPI's) are to be met at each annual monitoring period over the 5-year duration of this Biodiversity Management Plan. If these levels are not achieved, then more effort is required until these quantifiable goals are achieved.

KPI's, where possible, should use the SMART criteria, i.e. they should be Specific, Measurable, Achievable, Relevant and Time-bound.

- There is to be no harm to native vegetation to be retained.
- There are to be no weeds in the tree or shrub vegetation layers.
- Weed removal is to achieve <5% weed projected foliage cover at all times.
- Bushfire fuel hazard reduction requirements are to be met within the APZ.
- The soil surface is not to be left bare.
- No fertiliser, pesticides or insecticide are to be used.
- Only works consistent with this BMP are permitted within Zone A.
- No environmental weeds are to be planted in the property.
- Installation of temporary during-construction fencing and signage, with maintenance ensuring that no damage occurs. The fencing is to keep out machinery, domestic animals and people other than those performing ecological works described in this BMP.
- Installation of metal bollards and signage at the end of construction.
- No rubbish to be left behind.
- Annual monitoring reports are to be completed and provided to Council on request.

10 Restoration Management Actions

10.1 Monitoring

The monitoring of European Rabbits, weed control, fences, erosion, pests, disease, ecological works, Key Performance Indicators/Quantifiable Goals and Benchmarks are to be carried out by the Project Ecologist, who is to be **independent** of the Bush Regeneration Contractor.
The Project Ecologist is to assist the owner/developer in managing the Bush Regeneration contractor and to monitor the site to provide proof of meeting the DA conditions and to certify where necessary. Whether the quantifiable goals Performance Criteria and Benchmarks are being met will need to be assessed by an appropriately qualified Project Ecologist (Environmental Scientist, B. Sc.) with at least 10 years of experience in the ecology of the area. Monitoring of the site must be undertaken:

- Baseline survey before issue of Construction Certificate;
- Every 6 months during construction;
- Before Issue of Occupation Certificates as well as;
- Every 12 months for the 5-year life of this BMP.

Monitoring photos for each of the five (5) monitoring points must be taken at standing height from each compass directions (N, E, S, W). The location of photo monitoring points is shown using a camera symbol on Map 3. The table below contains the co-ordinates of each photo monitoring point:

Photo Monitoring Point	Easting	Northing
P1	341001	6270926
P2	340983	6270920
P3	340973	6270895
P4	340976	6270872
P5	340994	6270857

There will be ongoing monitoring by a qualified Project Ecologist, who will be independent of the bush regeneration contractor, to ensure the ongoing quantifiable goals and key performance indicators are being met. The Project Ecologist will be responsible for monitoring in relation to:

- Ongoing quantifiable goals and performance targets;
- Indicators that assess change in threatened species abundance, occupancy, or habitat
- Photo points, see Map 3;
- Review of the management plan and activities;
- Condition and abundance of logs, hollows, and nest boxes;
- Evidence of disease;
- Changes in vegetation integrity;
- Potential threats to the ecological community;
- Recommended remedial actions; and
- Documentation of the findings in report

10.2 Maintenance Weed Management

Follow up weeding will involve hand weeding and selective application of herbicide to weeds that emerge after the primary weed removal. Recognised bush regeneration methods should be used that are appropriate for each weed species.
Weeds on all parts of the property are to be prevented from flowering. It is important that weeds and weed propagules do not spread to nearby bushland, causing a fire hazard, health issues and aesthetic problems.

10.3 Vegetation Remediation Techniques to be used on this Site

Due to the high level of native species richness and cover on this site, the ecosystem has a high

resilience and capacity to self-repair. Accordingly, assisting the natural regeneration of bushland with minimal intervention is the recommended technique on this site. Natural regeneration involves improving ecological conditions and promoting opportunities for recruitment of native species. The specific tools that are most applicable to this site have been selected and in some cased adapted for unique conditions on this site. It is recommended that planting does not occur on this site.

10.4 Weed Removal

Weeds are to be controlled by using bush regeneration techniques.

Hand Removal

Areas with native species in the groundcover layer should be weeded by hand to avoid killing any of the existing native plants.

Cut and Paint, Scrape and Paint

Cut and paint or Scrape and Paint is the preferred method for shrub weeds on this site.

Spraying

The preferred type of weed removal is by hand. The site currently contains a very low number of weeds, and it is unlikely that spraying will be necessary.

In the event that a large plume of weeds establishes on the site and herbicide is proposed to be used, it is to be applied to weeds with a hand spray bottle or wipe.

Slashing, Mowing and Broad scale use of Herbicide

Due to the high level of native species richness and cover on this site, slashing, mowing, and broad scale use of herbicide is not to be used on the site.

General

The use of any herbicide on the site is to be recorded. It is important that dye is added to herbicide if any herbicide is used on this site as it is a residential site.

All weeds are to be removed by suitably qualified bush regenerators using the most appropriate technique for each species.

All weed material is to be completely removed off-site, as piles of weeded material can be a target for arson, can prevent germination of native species underneath and in some cases cause re-seeding or re-infestation.

A detailed description of various bush regeneration methods is provided in Appendix E.

10.5 Adaptive Management for Uncertain Biodiversity Impacts

The climate on this site is dominated by the seasons and droughts. During cold or dry times, the ground cover vegetation on the site is sparse and many species are resting as dormant seeds, bulbs or other structures. At times when the weather is not cold and there has been good rain, the ground cover is dense, and grasses are abundant.

To adapt to these changes an adaptive approach is needed to be taken for the weed control where more effort is used in the wetter and warmer times. To allow for this, it is recommended that the contract for the bush regenerators be over a long period to allow some flexibility with the timing of site visits. To control this flexibility, it is essential that there is a Project Ecologist that is regularly liaising with the bush regeneration contractor and plant supply nursery. There is no flexibility with the quantifiable goals, the duration, the number or type of plants to be planted or the fencing.

Other unpredictable circumstances may also occur such as Rabbits, dumping and fire that may need adaptation of Risks Associated with this Biodiversity Management Plan.

10.6 Risk assessment

- Spreading of weeds by machinery and clothing
- Native plants being harmed due to poorly educated workers
- Planted plants dying due to lack of water
- Plants being eaten by rabbits
- Infection by *Phytophthora cinnamomi* or Myrtle Rust

The recommended actions required to reduce risks are discussed in this BMP.

10.7 Required Qualifications for Bush Regenerators

The ecological works are only to be undertaken by qualified bush regeneration persons with a minimum TAFE Certificate III in Conservation and Ecosystem Management (CEM) qualification and supervised by a worker with minimum TAFE Certificate III in CEM, at least 2 years of full-time equivalent experience in the Sydney region and be accredited by the Australian Association of Bush Regenerators (AABR).

The Project Ecologist can assist with the management of the Bush Regeneration Contract as they will be monitoring the site. The Bush Regenerator must be totally independent of the Project Ecologist. For more information on bush regeneration contract management see 'Bush Regeneration, a practical guide to contract management' by Peter Davies and Peter Dixon (2003). Additional resources in relation to managing contracts can also be found at: https://www.aabr.org.au/learn/professional-practice/managing-contracts/
For a list of bush regeneration companies, see the Australian Association of Bush Regenerators (AABR) website: https://www.aabr.org.au/do/business-directory/wpbdm-category/aabr-accredited-bush-regenerators/
A list of suitable local Bush Regenerators is provided in Appendix F.

10.8 Required Qualifications for the Project Ecologist

The Project Ecologist is responsible for assisting the owner and the builder with protecting the biodiversity values on the site during construction, assisting the builder avoiding fines, monitoring the ecological improvement of the site, providing advice and certifying at the end of construction that the works have been carried out in accordance with the ecological conditions of consent.

A Project Ecologist is to be appointed for the duration of the 5 years prior to the issue of the Construction Certificate. The Project Ecologist is responsible for the supervision of the remediation works and during construction ecological works, ecological monitoring, reporting and certification. The Project Ecologist must have the minimum qualifications of a relevant bachelor's degree or a TAFE Diploma in Conservation and Ecosystem Management (CEM) and 5 years professional work experience in ecology within the Sydney region and must be familiar with Bushland Regeneration practices. The Project Ecologist must be independent of the Bush Regeneration contractor.

The Project Ecologist is to provide advice on:

- Protection of biodiversity values
- Pre-clearance fauna rescue
- The bush regeneration contractor
- The procuring of suitable plant material from a bush regeneration nursery, if applicable
- Weed control
- Mulching in appropriate locations if applicable
- Interactions between residence and wildlife. e.g., brush turkeys, ticks and snakes
- Licencing to do with Threatened species if applicable
- Tree removal/trimming
- Feral animals e.g. Foxes, Cats, Ducks, Common Mynas and Rats
- Installation of nest boxes
- Timing of the works
- Identifying adaptive management triggers and measures to allow for modification for: unusual weather, bushfire, and other unexpected changes

10.9 Licences that may be Required

- An AQF3 Chemical Accreditation is required for anyone who will be using herbicide.
- Chainsaw Licence for anyone operating a chainsaw.

10.10 General Restrictions

- There is to be no damage to any native trees or native vegetation or disturbance to the natural soil surface within the Environment Protection Area (Zone A).
- There is to be no vehicles or machinery entering the Environment Protection Area (Zone A).
- There is to be no depositing of fill, spoil or stockpiling of materials in the Environment Protection Area (Zone A).
- Only works consistent with this BMP are permitted within the Environment Protection Area (Zone A).
- No access is allowed into Environment Protection Area (Zone A) during construction, unless for the purpose of carrying out works permitted by this BMP.

- This BMP must be included in any tender documents for construction including a clear description of the responsibilities of the builder and the project manager/owner.
- No sediment or waste produced during construction is to enter the Environment Protection Area (Zone A).
- All equipment and clothing are to be cleaned or sterilised with bleach before entering the site to prevent the spread of weeds and Phytophthora.
- There is to be no bushfire hazard reduction within the Environment Protection Area (Zone A).
- Dogs, Cats, Horses and other companion or domestic animals are not to enter the Environment Protection Area (Zone A).
- No removal of logs or firewood within the Environment Protection Area (Zone A).
- No fertiliser, pesticides or insecticide are to be used.

Legend

113 Orchard St, Warriewood

- Subject Land
- Rock
- Permanent Bollards marking BM Area
- Clean Water Diversion Mound

Biodiversity Management Areas

- Zone A Environment Protection and Management 4015 sqm
- Zone B APZ Managed Habitat 585 sqm
- Monitoring Points

Map 3
Environmental Monitoring

GIS Environmental Consultants
Ph: (02) 9939 5129, Mobile: 0419 438 672
ecology@ecology.net.au, ecology.net.au

Date: 16/12/2024
Cartographer: Nicholas Skelton
Version: 1.0
File Path: Server/Projects/Current/GIS/Maps
Projection: GDA 94 MGA 56

0 10 20 m

12 Stage 1 – At Issue of Construction Certificate

This stage will involve the installation and maintenance of temporary Environment Protection Fencing and Tree Protection Fencing, creation of Clean Water Diversion Mounds and installation of permanent metal bollards. The management techniques are of 3 kinds; general techniques across the entire site, general techniques across all the zones and techniques specific to only 1 or 2 of the zones.

12.1 Engagement of Bushland Regenerator and Project Ecologist

Evidence of the engagement of a Bushland Regeneration Contractor and Project Ecologist must be provided to Council prior to the issue of the Construction Certificate. Details about engaging a Bushland Regeneration Contractor and Project Ecologist are described in sections 10.8 and 10.9 of this report.

12.2 Baseline Monitoring – Zones A and B

Baseline monitoring, including baseline Photo Points, is to be done by the Project Ecologist prior to any works on the site and a report will be submitted to Council prior to issue of the Construction Certificate. Monitoring details are provided in section 10.1 of this report.

12.3 Primary Weed Removal – All Zones

Primary weed removal is to occur prior to the issue of the Construction Certificate. Details about general weed control for this site are described in section 10.8 and 10.9 of this report.

12.4 Nest Boxes – Zone A

A minimum of 2 Microbat and 2 small mammal nest boxes are to be installed on the site. The nest boxes are to be installed prior the removal of any removal of trees and habitat to ensure that this habitat is available for fauna before they are displaced. It is recommended that the nest boxes are ordered 3 weeks prior to installation to allow for time for them to be shipped and assembled.
The nest boxes are to be installed in Zone A by a qualified Ecologist, bush regenerator or tree climber who is experienced in nest box installation.
Nest boxes are to be monitored for use by feral bees or pest bird species during monitoring surveys.
If any trees removed contain hollows, each hollow removed is to be replaced by 2 next boxes or artificial hollows which are to be placed in Zone A. Section 13.2.3 of this report addresses this in detail.
A general guideline for nest boxes and artificial hollows by the Biodiversity Conservation Trust (August 2020) is attached in Appendix G.

12.5 Ecological Site Induction

An Ecological Site Induction by the Project Ecologist must be included as part of the induction of all workers and visitors to the site. A confirmation of induction is to be signed by every worker and visitor. The Ecological Site Induction is to include:

- A summary of this Bushland Management Plan;
- Information on the important ecological features on the site, e.g. hollows and Swift Parrot feed trees;
- What to do if native fauna is found on the site;
- Hygiene protocols to prevent the introduction of weeds and pathogens; and
- Vegetation and tree clearance protocols.

12.6 Tree Protection Measures

Tree Protection Fencing and other tree protection measures will be installed as per the details described in the Arborist report. This is the responsibility of the builder and arborist.

12.7 Temporary Environment Protection Fence – All Zones

The proposal requires that during construction, there is to be a temporary 1.8m panel Environment Protection Fence in the location shown on Map 1 to prevent accidental damage to trees and native vegetation. The fence must have A4 size water-proof signage every 10 metres describing the prohibition of access (except for surveying, APZ management, ecological conservation and monitoring works). The signage is to have the following text written on it:

NO ACCESS
Biodiversity Management Area
This area is to be managed in accordance with the Bushland Management Plan (BMP) by GIS Environmental Consultants (December 2024).
The Arborist may enter this area only for the trimming and removal of trees to establish the APZ. Other than this, only Bushland Regenerators and the Project Ecologist may enter this area and only for the purpose of carrying out the ecological works described in the BMP.
Fertiliser, insecticides or pesticides are NOT to be used in this area.
NO vehicles or machinery are to enter this area.
NO sediment or waste can enter this area.
NO stockpiling.
NO dumping.
NO rubbish or litter.
NO dogs, cats, horse or other domestic animals are to enter this area.
REMEMBER to sterilise ALL equipment and footwear prior to entering.

The fencing and signage should be installed by the bushland regenerator and assisted by the builder. The fencing and signage must be installed prior to any earthworks.

12.8 Clean Water Diversion Mounds

The clean water diversion mounds are to be dug by hand by the bush regeneration contractor in the locations shown on Maps 1, 2 and 3. These will be shallow swale and hump deep drainage lines that will divert the clean surface water around the earthworks, horse paddocks, stables and the on-site sewage disposal area. The goal of the of these diversion mounds is to prevent clean water entering these areas and adding to the dirty water volume which would lead to nutrients and sediment leaving the site. Nutrients and sediment from the horse manure and sediment from the construction site going into the downstream protected and ecologically important Warriewood Wetlands. The clean water diversion mounds are to be 20cm deep and 20cm wide. They are to be maintained throughout the life of this plan. They are to be made by the Bushland Regenerator.

12.9 Sediment Control

- The Soil Conservation Act discourages the removal (pr pruning more than 25% of the original canopy) of vegetation including trees on slopes greater than 18 degrees may not be removed, except in accordance with conditions identified in a Geotechnical Engineer Assessment Report undertaken for that purpose.
- Landowners have a duty of care in the appropriate management of soil erosion and landslip risks when clearing trees and vegetation. Landowners who clear trees and vegetation under a DA approval or for bushfire protection are not exempt from liability. It is the responsibility of landowners to seek expert advice in relation to these matters. The requirements below have been recommended to assist landowners in the management of vegetation on their land operating in accordance with these conditions does not absolve the landowner from their responsibility for landslip and erosion issues. To manage soil erosion and landslip risks on land with a slope greater than 18º:
    - there is to be no disturbance of the soil,
    - vegetation must not be removed below the soil surface
    - all topsoil must remain on the soil surface,
    - retain a protective ground cover on the soil surface, and
    - the use of graders, ploughs, bulldozers (or other types of heavy machinery that are designed to break the soil surface such as excavators) to establish or maintain an APZ is not permitted.

- The Blue Book (Landcom) standards for sediment control are to be used to prevent sedimentation of the stormwater flowing from the construction site into the downslope Warriewood Wetlands.
- No sediment is to enter the stormwater system.

12.10 Monitoring During Construction – All Zones

Monitoring is to occur every 6 months during construction and is the responsibility of the Project Ecologist. Monitoring details are provided in section 10.1 of this report.

12.11 Establishment of the Asset Protection Zone (APZ)

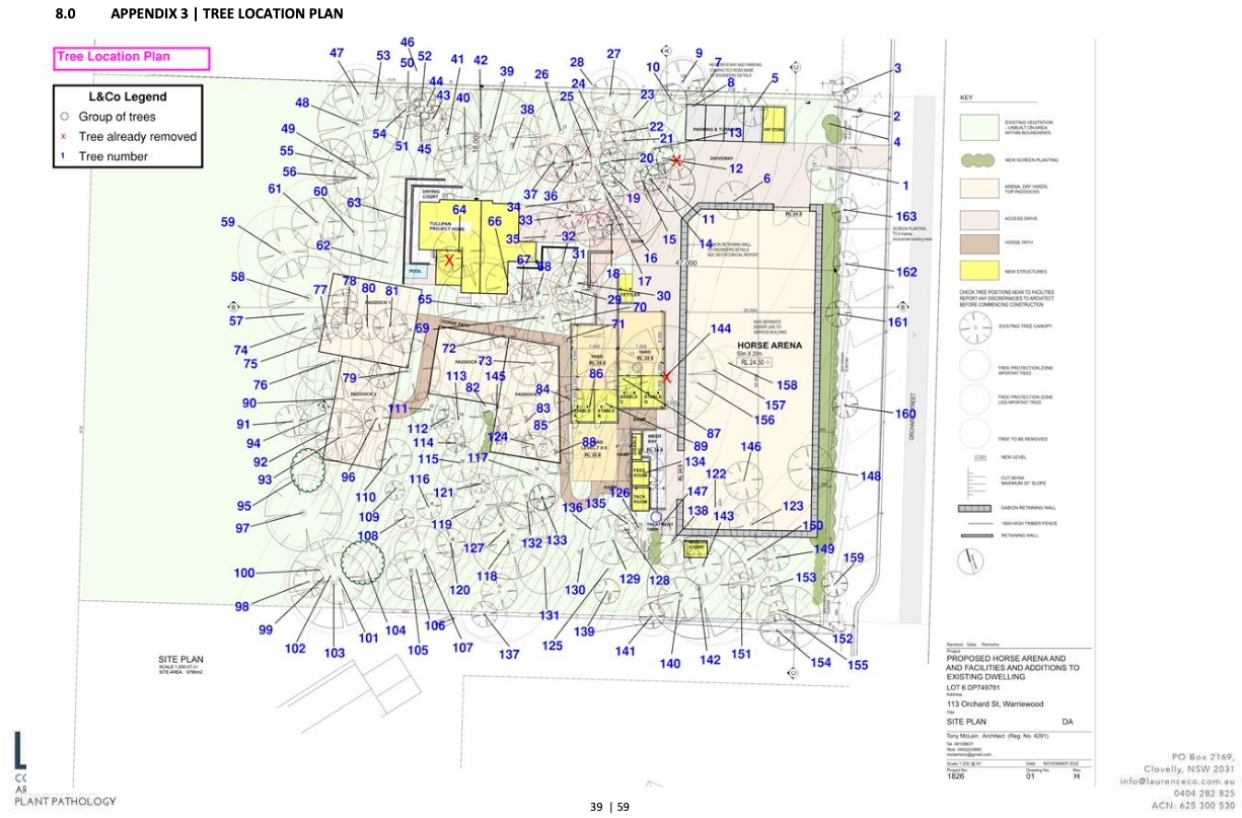
The Asset Protection Zone is to be established only in Zone B.
The APZ/IPA may be able to be achieved by the following actions adapted from Standards for Asset Protection Zones (NSW Rural Fire Service) for establishing and maintaining an APZ:

- The conservation management and establishment of the fuel reduced bushland habitat in Zone B involves both selective fuel reduction (tree and shrub removal, thinning and pruning) and the retention of vegetation, soil and some leaf litter.
- All weeds and exotics are to be removed first, then there can be removal of dead material, and then thinning of native vegetation if necessary to meet the fuel load requirements.
- Ground fuels such as fallen leaves, twigs (less than 6 mm in diameter) and bark should be reduced on a regular basis. This flash fuel burns quickly and increases the intensity of a fire.
- Fine fuels can be removed by hand.
- Logs or hollows are not flash fuel and are to be retained.
- The leaf litter fuel reduction is not carried out to an extent that exposes bare earth which would lead to soil erosion and/or weed invasion.
- An effective way to permanently reduce fuel loads is to use a 20% cover of large 0.5 – 1m diameter flat shaped rocks placed on the ground surface in the APZ. Rocks provide permanent fuel reduction, are low maintenance and are good habitat. Some of the rocks can be retained from the construction. Rocks and quantities must be supervised by the Project Ecologist. There is to be no fine material deposited. If a weathered look is desired then the application of a mixture of ochre, yogurt and topsoil will rapidly accelerate aging.
- Trees to be removed within the APZ are to be marked onsite by the Arborist in consultation with the Project Ecologist and the Bushfire consultant. All other trees within the APZ will be retained.
- Tree trunks to be retained are to be selected by the Arborist in consultation with the Project Ecologist and the Bushfire consultant prior to tree removal.
- Native shrubs can be retained as clumps or islands up to 20% of the area.
- Flammable shrubs are not to be located under trees or within 10m of any exposed windows or
- doors.

There is to be no storage of flammable materials or planting of plants under the building.
The removal of fine fuels, weeds and thinning of shrubs is to be undertaken by a qualified Bush Regeneration Contractor.
When choosing trees for removal to establish the APZ, trees with high habitat value should be avoided where possible, including:

- Avoid removal of **hollow-bearing trees** identified on Map 1. This includes trees T24, T41, T60, T65 and T113. Additionally, trees that are likely to contain hollows (trees described in the Arborist Report as containing cavities) include trees T6, T19, T22, T23, T25, T39, T49, T61, T62, T65, T69, T87, T95, T96, T101, T116, T150 and T156. If any hollows are removed, these are to replaced with 2 artificial hollows or nest boxes.
- This site is mapped on the Swift Parrot Important Habitat map. The Swift Parrot is a Threatened bird that is also at risk of potential Serious and Irreversible Impacts. It breeds in Tasmania and migrates to mainland Australia during the winter months to forage for food. One of the key threats contributing to the Swift Parrot's rapid decline is the reduction of food resources available in mainland Australia due to development. Important feed trees for the Threatened Swift Parrot found on this site include ***Eucalyptus robusta*** **(Swamp Mahogany) and** ***Corymbia gummifera*** **(Red Bloodwood)**. It is important that these species are NOT removed unless necessary.
- Large Eucalypt trees provide high habitat value and are not flash fuel, and should be retained where possible.

Tree numbering is consistent with the Tree Location Plan below extracted from the Arboricultural Impact Assessment and Tree Protection Specification by Laurence and Co Consultancy, Arboriculture and Plant Pathology:



An Ecologist or licensed wildlife handler must be present during removal of any trees, including during APZ establishment.

12.12 Fauna Rescue during Tree and Vegetation Removal – Entire Site

A qualified ecologist should be present on-site prior to and during vegetation removal activities to ensure works are in line with industry best-practice techniques and to ensure steps are taken to minimise harm to protected and threated fauna. These steps include:

- The vegetation to be cleared should be surveyed by the ecologist immediately prior to clearing works to identify the presence of any fauna.
- The ecologist should have a cage ready to hold and transport any injured wildlife to WIRES or a local veterinary practice, blankets or hessian sacks to assist in capture, heavy-duty gloves to prevent scratches and bites, and a warm water bottle to provide warmth to any captured fauna if need be.
- Each tree containing fauna or hollows should be carefully shaken by suitable construction machinery prior to felling or sectionally dismantled by chainsaw (depending on method of felling). If fauna appear at this point, it should be allowed to relocate of its own accord or captured in the case of injury.
- Each tree felled should be inspected for hollows. Any hollows identified will be thoroughly checked for residing fauna.
- After a tree is felled, if fauna appear, attempt to capture with a blanket or sack and place in cage. Otherwise retreat and allow fauna to relocate on its own accord.
- Assess condition of captured fauna and relocate if healthy. If fauna is injured or appear distressed, cover cage with a blanket, inform WIRES and/or local veterinary practice and transport as soon as practicable. Keep injured wildlife warm and in quiet environment to lower stress levels.

- If any fauna species, or a nest or roost are located during clearing, then works should cease until safe relocation can be advised.
- If Microbats appear, capture and place in hessian sack to be relocated in dark environment safe from predators and release after dusk that evening.
  Should fauna approach the work site, cease clearing works until fauna relocate. Avoid making loud noises to encourage relocation.
- Landowners have a duty of care to avoid cruelty and harm to native, introduced or domestic animals when clearing trees and vegetation. Landowners who clear trees and vegetation are not exempt from prosecution under the *National Parks and Wildlife Act 1974* for harm to protected fauna, or for deliberate cruelty to animals under the *Prevention of Cruelty to Animals Act 1979*. A DA approval does not absolve the landowner from their responsibility for avoiding harm to protected fauna or deliberate cruelty to animals. Note: 'protected fauna' is as defined in the *National Parks and Wildlife Act 1974*. If you witness any displaced, orphaned or injured wildlife you should contact the Office of Environment and Heritage, or licensed fauna rehabilitation group for assistance. Visit the Office of Environment and Heritage for further advice and the full list of licensed providers.

12.13 Hollow-bearing Tree Removal and Hollow Management

Any removal of a hollow-bearing tree from the site should be done in accordance with the following best practice guidelines:

- Hollow bearing trees to be removed should be sectionally dismantled and soft felled.
- Where tree hollows cannot be retained due to the proposed works, artificial hollows are to be provided using existing tree limbs, supplemented by other materials as necessary. These artificial hollows should be located away from construction activity in areas likely to provide habitat for arboreal mammals and installed prior to any works commencing.
- Additional artificial hollows or nest boxes should be provided in compensation at a rate of two artificial hollows for every natural tree hollow removed. On this site, that would require the installation of two artificial hollows of similar size to the one being removed. Artificial hollows or nest boxes are to be installed in Zone A only.
- The design, construction, and installation of artificial hollows should be carried out in accordance with best practice protocols.
- Artificial tree hollows are to be installed prior to any clearing commencing under the supervision of a suitably experienced ecologist.
- Hollow-bearing trees on this site are identified on Maps 1 and 2. This includes trees T24, T41, T60, T65 and T113. Additionally, trees that are likely to contain hollows (trees described in the Arborist Report as containing cavities) include trees T6, T19, T22, T23, T25, T39, T49, T61, T62, T65, T69, T87, T95, T96, T101, T116, T150 and T156.

Tree numbering is consistent with the Tree Location Plan below extracted from the Arboricultural Impact Assessment and Tree Protection Specification by Laurence and Co Consultancy, Arboriculture and Plant Pathology.
A general guideline for nest boxes and artificial hollows by the Biodiversity Conservation Trust (August 2020) is attached in Appendix G.

12.14 Sediment Control

- The Soil Conservation Act discourages the removal of vegetation including trees on slopes greater than 18 degrees may not be removed (or pruned more than 25% of the original canopy) except in accordance with conditions identified in a Geotechnical Engineer Assessment Report undertaken for that purpose.
- Landowners have a duty of care in the appropriate management of soil erosion and landslip risks when clearing trees and vegetation. Landowners who clear trees and vegetation under a DA approval or for bushfire protection are not exempt from liability. It is the responsibility of landowners to seek expert advice in relation to these matters. The requirements below have been recommended to assist landowners in the management of vegetation on their land operating in accordance with these conditions does not absolve the landowner from their responsibility for landslip and erosion issues. To manage soil erosion and landslip risks on land with a slope greater than 18º:

  - there is to be no disturbance of the soil,
  - vegetation must not be removed below the soil surface
  - all topsoil must remain on the soil surface,
  - retain a protective ground cover on the soil surface, and
  - the use of graders, ploughs, bulldozers (or other types of heavy machinery that are designed to break the soil surface such as excavators) to establish or maintain an APZ is not permitted.
- The Blue Book (Landcom) standards for sediment control are to be used to prevent sedimentation of the stormwater flowing from the construction site into the downslope Warriewood Wetlands.
- Landowners have a duty of care to avoid cruelty and harm to native, introduced or domestic animals when clearing trees and vegetation. Landowners who clear trees and vegetation are not exempt from prosecution under the *National Parks and Wildlife Act 1974* for harm to protected fauna, or for deliberate cruelty to animals under the *Prevention of Cruelty to Animals Act 1979*. A DA approval does not absolve the landowner from their responsibility for avoiding harm to protected fauna or deliberate cruelty to animals. Note: 'protected fauna' is as defined in the *National Parks and Wildlife Act 1974*. If you witness any displaced, orphaned or injured wildlife you should contact the Office of Environment and Heritage, or licensed fauna rehabilitation group for assistance. Visit the Office of Environment and Heritage for further advice and the full list of licensed providers.

12.15 Secondary Weed Control – All Zones

Secondary weed control will occur 6 months after primary weed control.

12.16 Maintenance Weed Control – All Zones

Maintenance weed control will occur every 6 months throughout construction with the first session 6 months after secondary weed control.

13 Stage 2 – Prior to Occupation Certificate

13.1 Permanent Bollards – Zone A

Once all construction works have been completed, the temporary Environment Protection Fencing on Map 1 is to be replaced by 45mm galvanised metal bollards with a minimum height of 500mm with an endcap spaced every 5m as shown on Map 2. The bollards will protect the good quality native vegetation within this site from encroachment, removal of logs and trampling of habitat. The bollards are to have 2 litres of concrete at the base or if in rock there is to be a hole drilled and a reinforcing rod cemented into the rock and pole. Every second bollard is to have an A5 size metal sign with the following text:

Environment Protection Area
This area is to be managed in accordance with the Bushland Management Plan (BMP) by GIS Environmental Consultants (December 2024).
Fertiliser, insecticides or pesticides are NOT to be used in this area.
Native vegetation in this area must NOT be harmed in any way.
NO vehicles or machinery are to enter this area.
NO Bushfire Hazard Reduction.
NO removal of rocks, logs or firewood.
NO rubbish or litter.
NO dogs, cats, horse or other domestic animals are to enter this area.

Figure 1 Example of a Bollard delineating a Conservation Area

The bollards must be installed prior to the issue of the Occupation Certificate.

13.2 Monitoring – All Zones

Monitoring is to occur after construction and after the installation of permanent bollards. Monitoring is the responsibility of the Project Ecologist who will submit a report to Council prior to the issue of the Occupation Certificate. Monitoring details are provided in section 10.1 of this report.

14 Stage 3 - Ecological Maintenance for the remaining part of the 5 years

This section is for the ongoing ecological maintenance for a period of at least 5 years after the issue of the construction certificate.

The measures for post construction impact to threatened species mitigation.

- Weed control
- Monitoring
- Adaptive management triggers and measures to allow for modification for, unusual weather, bushfire, and other unexpected changes - See Section 10.6 of this report.

14.1 Continuation of Maintenance Weed Control – All Zones

Maintenance weed control is to continue every 6 months after construction has ceased until 5 years from the issue of the Construction Certificate.

14.2 Annual Monitoring – All Zones

Once construction has finished, monitoring by the Project Ecologist is to continue on an annual basis. Monitoring details are provided in section 10.1 of this report.

14.3 Maintenance of the Asset Protection Zone (Zone B)

The Asset Protection Zone is to management as a bushfire fuel reduced area in perpetuity of the development. The Asset Protection Zone is to be managed at least annually (in September).
The APZ/IPA may be able to be achieved by the following actions adapted from Standards for Asset Protection Zones (NSW Rural Fire Service) for establishing and maintaining an APZ:

- The conservation management and establishment of the fuel reduced bushland habitat in Zone B involves both selective fuel reduction (tree and shrub removal, thinning and pruning) and the retention of vegetation, soil and some leaf litter.
- All weeds and exotics are to be removed first then there can be removal of dead material then thinning of native vegetation if necessary to meet the fuel load requirements.
- Ground fuels such as fallen leaves, twigs (less than 6 mm in diameter) and bark should be reduced on a regular basis. This flash fuel burns quickly and increases the intensity of a fire.
- Fine fuels can be removed by hand.
- Logs or hollows are not flash fuel and are to be retained.
- The leaf litter fuel reduction is not be carried out to an extent that exposes bare earth which would lead to soil erosion and/or weed invasion.
- Native shrubs can be retained as clumps or islands up to 20% of the area.
- Flammable shrubs are not to be located under trees or within 10m of any exposed windows or doors.
- Zone A around the dwelling is to be fuel free by using a pebble mulch with timber edging to prevent the pebbles from spilling into the adjacent bushland.

There is to be no storage of flammable materials or planting of plants under the building.
The removal of fine fuels, weeds and thinning of shrubs is to be undertaken by a qualified Bush Regeneration Contractor.

14.4 Description of Exclusion Areas for Domestic Animals

There are no exclusion areas on this property for domestic animals. Pet cats or dogs on the property are to be kept indoors at night. It is recommended that any domestic cats or dogs are kept indoors most of the time, as they pose a predatory threat to the native fauna that may occur on the site.

Table 4.1. Plant Species List

with summaries of Status, Floristics (Composition) and Cover (Structure, Relative Abundan

113 Orchard St, Warriewood

6 November 2024

Botanist, Nicholas Skelton, GIS Environmental Consultants

GIS Environmental Consultants
Ph: (02) 9939 5129, Mobile: 0419 438 672
ecology@ecology.net.au, ecology.net.au

Table 4.1a. Ecological Status (legal, conservation) Species Summary

Number of Plant Species in each Plot, summariseed by legal status and conservation importance

	BC Act Threatened	Native to NSW (non Threatened)	Planted Non Native	Weed Other	Weed Regional Syd Priority	Weed State Priority	Total
VZ1 Plot 1		46	1	8			55
Additonal Outside Plots		6	0	1	1		8
Total	0	52	1	9	1	0	63

Table 4.1b. Native Plant Species Composition (Species Richness, Floristics) Summary

Native Species Richness in each Vegetation Zone, inside and outside plots, summarised by Growth Form

	Fern (EG)	Grass & Grass Like (GG)	Forb (FG)	Shrub (SG)	Tree (TG)	Other (OG)	Total
VZ1 Plot 1	2	4	17	2	11	10	46
Additonal Outside Plots	2	0	2	0	2	2	8
Total	4	4	19	2	13	12	54

Table 4.1c. Native Vegetation Structure Summary (Projected Foliage Cover)

Projected Native Foliage Cover % in each Vegetation Zone, in plots, summarised by Growth Form

	Fern (EG)	Grass & Grass Like (GG)	Forb (FG)	Shrub (SG)	Tree (TG)	Other (OG)
VZ1 Plot 1	0.15	3.9	4.6	0.5	90.2	1.5

Table 4.1d. Non-Native (Weeds, Exotics) Composition (Species Richness, Floristics) Summary

Weed Species Richness in each Vegetation Zone, inside and outside plots, summarised by Growth Form

	Fern (EG)	Grass & Grass Like (GG)	Forb (FG)	Shrub (SG)	Tree (TG)	Other (OG)	Total
VZ1 Plot 1		2	3	3			8
Additonal Outside Plots			1		1		2
Total	0	2	4	3	1	0	10

Table 4.1e. Plant Species List

Part of Site	% PFC	Genus and Species	Family	Common Name	Growth Form	Status
Plot 1 VZ1	0.1	Adiantum aethiopicum	ADIANTACEAE	Maidenhair Fern	Fern	Native to NSW
Plot 1 VZ1	2	Allocasuarina torulosa	CASUARINACEAE	Forest She-oak	Tree	Native to NSW
Plot 1 VZ1	6	Angophora bakeri	MYRTACEAE	Rough-barked Angophora	Tree	Native to NSW
Plot 1 VZ1	4	Angophora costata	MYRTACEAE	Smooth-barked Apple	Tree	Native to NSW
Plot 1 VZ1	0.05	Banksia integrifolia subsp. integrifolia	PROTEACEAE	Coastal Banksia	Tree	Native to NSW
Plot 1 VZ1	0.2	Billardiera scandens	PITTOSPORACEAE	Apple Berry, Dumplings	Vine	Native to NSW
Plot 1 VZ1	0.3	Breynia oblongifolia	EUPHORBIACEAE	Breynia	Shrub	Native to NSW
Plot 1 VZ1	0.2	Cayratia clematidea	VITACEAE	Slender Grape	Vine	Native to NSW
Plot 1 VZ1	1	Corymbia gummifera	MYRTACEAE	Bloodwood	Tree	Native to NSW
Plot 1 VZ1	0.3	Dianella caerulea var. producta	PHORMIACEAE	Blue Flax Lily (Taller)	Herb	Native to NSW
Plot 1 VZ1	0.05	Dipodium punctatum	ORCHIDACEAE	Hyacinth Orchid	Herb	Native to NSW
Plot 1 VZ1	0.2	Dodonaea triquetra	SAPINDACEAE	Hop Bush	Shrub	Native to NSW
Plot 1 VZ1	0.1	Entolasia stricta	POACEAE	Wiry Panic	Grass	Native to NSW
Plot 1 VZ1	7	Eucalyptus botryoides	MYRTACEAE	Bangalay	Tree	Native to NSW
Plot 1 VZ1	28	Eucalyptus piperita	MYRTACEAE	Sydney Peppermint	Tree	Native to NSW
Plot 1 VZ1	0.1	Eustrephus latifolius	LUZURIAGACEAE	Wombat Berry	Vine	Native to NSW
Plot 1 VZ1	0.1	Geitonoplesium cymosum	LUZURIAGACEAE	Scrambling Lily	Vine	Native to NSW
Plot 1 VZ1	0.05	Glochidion ferdinandi var. ferdinandi	EUPHORBIACEAE	Cheese Tree	Tree	Native to NSW
Plot 1 VZ1	0.1	Glycine tabacina	FABACEAE	Love Creeper	Vine	Native to NSW
Plot 1 VZ1	0.1	Hibbertia scandens	DILLENIACEAE	Golden Guinea Flower	Vine	Native to NSW
Plot 1 VZ1	2	Hydrocotyle peduncularis	APIACEAE		Herb	Native to NSW
Plot 1 VZ1	3	Imperata cylindrica	POACEAE	Blady Grass	Grass	Native to NSW

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Plot 1 VZ1	1	Corymbia gummifera	MYRTACEAE	Bloodwood	Tree	Native to NSW
Plot 1 VZ1	0.2	Kennedia rubicunda	FABACEAE	Dusky Coral-pea	Vine	Native to NSW
Plot 1 VZ1	0.1	Lomandra gracilis	LOMANDRACEAE	Mat-rush	Herb	Native to NSW
Plot 1 VZ1	0.5	Lomandra longifolia	LOMANDRACEAE	Spiny-headed Mat-rush	Herb	Native to NSW
Plot 1 VZ1	0.05	Micrantheum hexandrum	EUPHORBIACEAE	Micrantheum	Herb	Native to NSW
Plot 1 VZ1	0.05	Olearia tomentosa	ASTERACEAE	Daisy-bush	Herb	Native to NSW
Plot 1 VZ1	0.3	Oplismenus aemulus	POACEAE	Basket Grass	Grass	Native to NSW
Plot 1 VZ1	0.1	Ozothamnus diosmifolius	ASTERACEAE		Herb	Native to NSW
Plot 1 VZ1	0.05	Pandorea pandorana	BIGNONIACEAE	Wonga Wonga Vine	Vine	Native to NSW
Plot 1 VZ1	0.1	Pomax umbellata	RUBIACEAE	Pomax	Herb	Native to NSW
Plot 1 VZ1	0.05	Poranthera microphylla	EUPHORBIACEAE		Herb	Native to NSW
Plot 1 VZ1	0.05	Pratia purpurascens	LOBELIACEAE	White Root	Herb	Native to NSW
Plot 1 VZ1	0.05	Pseuderanthemum variabile	ACANTHACEAE	Pastel Flower	Herb	Native to NSW
Plot 1 VZ1	0.05	Pteridium esculentum	DENNSTAEDTIACEAE	Bracken	Fern	Native to NSW
Plot 1 VZ1	0.05	Rapanea howittiana	MYRSINACEAE	Brush Muttonwood	Tree	Native to NSW
Plot 1 VZ1	0.7	Schelhammera undulata	UVULARIACEAE	Lilac Lily	Herb	Native to NSW
Plot 1 VZ1	0.05	Sigesbeckia orientalis	ASTERACEAE		Herb	Native to NSW
Plot 1 VZ1	0.4	Stephania japonica var. discolor	VITACEAE	Slender Grape	Vine	Native to NSW
Plot 1 VZ1	42	Syncarpia glomulifera	MYRTACEAE	Turpentine	Tree	Native to NSW
Plot 1 VZ1	0.5	Themeda triandra	POACEAE	Kangaroo Grass	Grass	Native to NSW
Plot 1 VZ1	0.05	Thysanotus tuberosus	ANTHERICACEAE		Herb	Native to NSW
Plot 1 VZ1	0.4	Viola hederacea	VIOLACEAE	Native Violet	Herb	Native to NSW
Plot 1 VZ1	0.05	Xanthosia tridentata	APIACEAE	Rock Xanthosia	Herb	Native to NSW
Plot 1 VZ1	0.05	Cordyline australis	LILIACEAE	New Zealand Cordyline	Tree	Native to NSW
Plot 1 VZ1	0.05	Livistona australis	ARECACEAE	Cabbage Tree Palm	Palm	Native to NSW
Plot 1 VZ1	0.05	Synoum glandulosum	MELIACEAE	Scentless Rosewood	Tree	Native to NSW
Plot 1 VZ1		Bidens pilosa	ASTERACEAE	Cobbler's Pegs, Pitchforks	Herb	Weed
Plot 1 VZ1		Briza maxima	POACEAE	Quaking Grass	Grass	Weed
Plot 1 VZ1		Conyza bonariensis	ASTERACEAE	Fleabane	Shrub	Weed
Plot 1 VZ1		Lilium formosanum	LILIACEAE	Formosan Lily	Herb	Weed
Plot 1 VZ1		Ochna serrulata	OCHNACEAE	Ochna, Mickey Mouse Plant	Shrub	Weed
Plot 1 VZ1		Setaria palmifolia	POACEAE	Palm Grass	Grass	Weed
Plot 1 VZ1		Solanum mauritianum	SOLANACEAE	Wild Tabacco Tree	Shrub	Weed
Plot 1 VZ1		Taraxacum officinale	ASTERACEAE	Dandelion	Herb	Weed
Rest of Site		Asplenium australasicum	ASPLENIACEAE	Birds Nest Fern	Fern	Native to NSW
Rest of Site		Calochlaena dubia	DICKSONIACEAE	Soft Bracken	Fern	Native to NSW
Rest of Site		Parsonsia straminea	APOCYNACEAE	Monkey Rope	Vine	Native to NSW
Rest of Site		Stellaria flaccida	CARYOPHYLLACEAE		Herb	Native to NSW
Rest of Site		Xanthorrhoea australis	XANTHORRHOEACEAE	Grass Tree	Grass Tree	Native to NSW
Rest of Site		Eucalyptus umbra	MYRTACEAE	Bastard Mahogany	Tree	Native to NSW
Rest of Site		Senna coluteoides var. glabrata	FABACEAE	Senna	Tree	Weed
Rest of Site		Ageratina adenophora	ASTERACEAE	Crofton Weed	Herb	Weed W3

Swift Parrot - profile

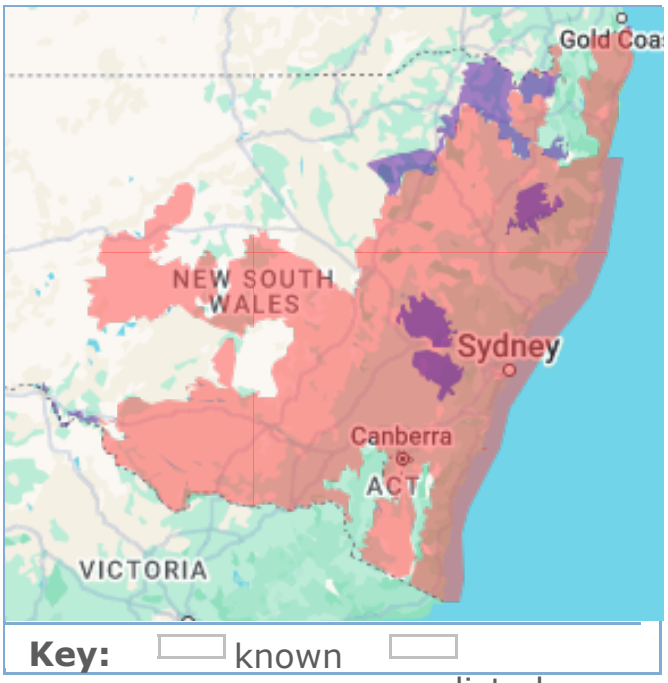
Scientific name: *Lathamus discolor*

Conservation status in NSW: **Endangered**

Commonwealth status: **Critically Endangered**

Gazetted date: 24 Mar 2000
Profile last updated: 23 Sep 2022

Indicative distribution



The areas shown in pink and/purple are the sub-regions where the species or community is known or predicted to occur. They may not occur thoughout the sub-region but may be restricted to certain areas. (**click here** to see geographic restrictions). The information presented in this map is only indicative and may contain errors and omissions.

Description

The Swift Parrot is small parrot about 25 cm long. It is bright green with red around the bill, throat and forehead. The red on its throat is edged with yellow. Its crown is blue-purple. There are bright red patches under the wings. One of most distinctive features from a distance is its long (12 cm), thin tail, which is dark red. This distinguishes it from the similar lorikeets, with which it often flies and feeds. Can also be recognised by its flute-like chirruping or metallic "kik-kik-kik" call.

Distribution

Breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW mostly occurs on the coast and south west slopes.

You can help map Distribution and Habitat
Each year the Swift Parrot Recovery Team relies on the involvement of volunteers to identify areas the birds are visiting and what resources they are using. This information directly helps the recovery effort for this species. Surveys are conducted twice a year and aim to cover the migratory winter range of this species. Mainland surveys are held over one weekend in May and a weekend in August every year. Hearing of observations of Swift Parrots outside of the count weekends are also greatly appreciated.

All information helps and the Recovery Team is also very interested to receive sighting information of these birds outside the survey dates. Surveys are run in combination with the Regent Honeyeater survey effort, another Endangered migratory woodland bird.

Contact BirdLife Australia on 03 9347 0757 or freecall 1800 665 766 to find out more about participating in the mainland Swift Parrot surveys.

Habitat and ecology

- Migrates to the Australian south-east mainland between February and October.
- On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations.
- Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Forest Red Gum *E. tereticornis*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*.
- Commonly used lerp infested trees include Inland Grey Box *E. microcarpa*, Grey Box *E. moluccana*, Blackbutt *E. pilularis*, and Yellow Box *E. melliodora*.

Yellow Box *E. melliodora*.

- Return to some foraging sites on a cyclic basis depending on food availability.
- Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum *Eucalyptus globulus*.

Regional distribution and habitat

Click on a region below to view detailed distribution, habitat and vegetation information.

- **Brigalow Belt South**
- **Cobar Peneplain**
- **Murray Darling Depression**
- **Nandewar**
- **New England Tablelands**
- **NSW North Coast**
- **NSW South Western Slopes**
- **Ocean**
- **Riverina**
- **South East Corner**
- **South Eastern Highlands**
- **South Eastern Queensland**
- **Sydney Basin**

Threats

- Habitat loss and fragmentation from forest harvesting, residential/industrial development, agricultural clearing,

senscence and dieback.

- Changes in spatial and temporal distribution of habitat due to climate change.
- Reduced food availability due to drought conditions.
- Competition from introduced bees and large, aggressive honeyeaters for food resources.
- Collisions with human made structures resulting in death or injury.
- Psittacine Beak and Feather Disease vulnerability.
- Weed invasion impacting on habitat regeneration and health.
- High fire frequency impacting on food resource availability.
- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners.
- Predation by cats.
- Illegal capture and trade of wild birds for aviculture

Recovery strategies

A targeted strategy for managing this species has been developed under the Saving Our Species program; click **here** for details. For more information on the Saving Our Species program click **here**

Activities to assist this species

- Reduce collisions in areas where Swift Parrots are foraging by closing window blinds or letting windows get dirty. Alternatively hang wind chimes, mobiles etc in front of windows. Hang strips of fabric across wire mesh fences.
- Retain stands of winter-flowering feed-trees, particularly large mature individuals.
- Revegetate with winter-flowering tree species where appropriate.
- Participate in biannual surveys to locate the winter foraging areas for this species

for this species.

Information sources

- Higgins, P.J. (ed.) (1999) Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird.
- Kennedy, S. (2001) Swift Parrots. Results of winter surveys on mainland Australia 1995-2000.
- Kennedy, S.J. and Overs, A.E. (2001) Foraging Ecology and Habitat Use of the Swift Parrot on the South-Western Slopes of New South Wales. Corella 25:68-74.
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- Saunders, D.L. and Heinsohn, R. (2008) Winter habitat use by the endangered, migratory Swift Parrot (*Lathamus discolor*) in New South Wales. Emu 108: 81-89
- Saunders, D.L., Brereton, R., Tzaros, C., Holdsworth, M. and Price, R. (2007) Conservation of the Swift Parrot *Lathamus discolor* management lessons for a threatened migratory species. Pacific Conservation Biology 13 (2): 111-119
- Swift Parrot Recovery Team (2001) Swift Parrot Recovery Plan. Department of Primary Industries, Water and Environment, Hobart.

Appendix E - GANTT Timeline of Ecological (Bush Regeneration) Works

113 Orchard Street, Warriewood

GIS Environmental Consultants

Task No	Task	Responsibility	Stage 1 At Issue of Construction Certificate													Stage 2 Prior to Occupation Certificate		Stage 3 Ongoing ecological Maintenance Works					
			To be achieved prior to the issue of the DA Construction Certificate													After Construction, Prior to issue of the Occupation Certificate		For a minimum of 5 years from the issue of the Construction Certificate					
	week (wk) / month (mth) / year (yr)		1wk	2wks	3wks	4wks	5wks	3mths	6mths	9mths	12mths	15mths	18mths	21mths	24mths	After Construction		6mths	1 yr	1.5 yrs	2 yrs	2.5 yrs	3 yrs
1	Engage Project Ecologist	Owner																					
2	Write brief to engage bush regeneration business based on this BMP	Project Ecologist																					
3	Engage Bush Regeneration Contractor	Owner with Project Ecologists Assistance																					
4	Order nest boxes	Project Ecologist																					
5	Meeting onsite with Bush Regeneration Contractor and Project Ecologist to discuss timetable, works, mark out the location of the temporary environment protection fence and the clean water diversion mounds, and take baseline monitoring photos	Bush Regeneration Contractor/Project Ecologist																					
6	Ecological monitoring	Project Ecologist																					
7	Install nesting boxes in Zone 1	Project Ecologist																					
8	Primary Weed Control achieving <20% weed cover	Bush Regeneration Contractor																					
9	Certification for Construction Certificate and Certification for Occupation Certificate	Project Ecologist																					
10	Erect temporary Environment Protection Fence, including signage, and any Tree Protection Measures	Bush Regenerator Contractor, Arborist and Builder																					
11	Fauna Rescue During Tree and Vegetation Removal	Project Ecologist																					

Task No	Task	Responsibility	Stage 1 At Issue of Construction Certificate To be achieved prior to the issue of the DA Construction Certificate	Stage 2 Prior to Occupation Certificate After Construction, Prior to issue of the Occupation Certificate	Stage 3 Ongoing ecological Maintenance Works For a minimum of 5 years from the issue of the Construction Certificate
12	**Establishment of sediment control measures**	Builder			
13	**Creation of Clean Water Diversion Mounds**	Bush Regeneration Constractor and Builder			
14	**Ecological Site Induction**	Project Ecologist			
15	**APZ Establishment**	Bush Regenerator Contractor, Arborist and Project Ecologist			
16	**Fauna Rescue During Tree and Vegetation Removal**	Project Ecologist			
17	**Additional Installation of Nest Boxes if required**	Project Ecologist			
18	**Secondary Weed Control**	Bush Regeneration Contractor			
19	**Maintenance Weed Control**	Bush Regeneration Contractor			
20	**Maintenance of APZ**	Bush Regeneration Contractor			
21	**Bollards and Signage for Environment Protection Area**	Builder			

Appendix D. Estimated Costing

Stage and Task	Estimate Cost
Prior to Construction Certificate	
Initial (Primary) Weed Removal	
Primary Weed removal, within Zones 1 and 2, <20% weed cover	$1,200
Site Ecologist	
Baseline monitoring, advise and certification for Construction Certificate	$1,600
4x Nest boxes, including purchase and installation	$1,400
Other	
Temporary Environment Protection Fence (approx. 160m @$15/m)	$2,400
Signage – 8x $40 each	$320
Tree Protection Fencing	Cost by Builder
Clean Water Diversion Mounds	$1,200
During Construction	
Secondary Weed and Maintenance Weed Control during Construction	
Secondary Weed Control, <10% weed cover	$900
Maintenance Weed Control, maintain at <10% weed cover	$1,200/6mths
Site Ecologist	
Ecological Site Induction	$400
Fauna rescue during tree and vegetation removal	$300/hr
Monitoring every 6 months	$600/6mths
Monitoring, report and certification for Occupation Certificate	$1,600
Potential additional 4x nest boxes if hollows are removed	$1,400
Other	
Metal bollards after construction, prior to Occupation Certificate	Cost by Builder
Establishment of the APZ	$9,000
Ongoing Maintenance for 5 years	
Maintenance Weed/Exotic Control	$900/6mths
Maintenance APZ Management	$1,200/12mths
Annual Monitoring	$600/yr

- These prices are only estimates. This costing must be verified by competitive quoting.
- A contingency of 15% should be allocated for any error in costing but also to cover unexpected events.
- An inflation rate of 10%/yr has been applied to all labour rates for maintenance purposes.
- Assume working rates may vary in the field due to site conditions or approaches taken by the teams during execution of works.

Prices are only indicative. Quotes from qualified bush regenerators and plant propagation nurseries can be obtained from contractors listed on this web site: https://www.aabr.org.au/do/business-directory/

20 Appendix E - Weed Control Methods

Personal Protection Equipment: hat, gloves, long sleeves/pants, boots, sunscreen and insect repellent and additional when using herbicide safety glasses, respirator. Always wash hands after use.

Modified from Garden Escapees & Other Weeds of Bushland & Reserves
3rd Edition 2015 mid North Coast Weeds Co-ordinating Committee.

1. Hand pull/dig (using knife/trowel)

- rake back leaf litter.
- cut down alongside plant.
- grasp stem or leaves at ground level and pull firmly while loosening soil from roots with knife/trowel.
- shake excess soil from roots and bag for removal or place plant on rock/log to die.
- replace leaf litter. e.g. Inkweed, Thistle.

2. Crown cut (using knife)

- only the underground growing heart of the plant needs to be removed.
- rake back leaf litter.
- grasp plant at ground level, gathering stems together, insert knife and cut in a circular motion to remove crown.
- replace disturbed soil/leaf litter and gently pat down. e.g. Ground Asparagus.

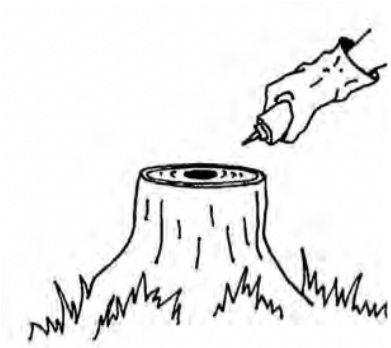
3. Skirting (using secateurs and herbicide)

- as low as possible, depending on access, gather and cut all vines around tree.
- apply herbicide IMMEDIATELY (within 10 seconds of cutting) to ground cut stems first, then aerial stems.
- check for reshooting within 6 weeks, retreating where necessary.
  e.g. Morning Glory, Moth Vine, Ivy.
  Note: NOT suitable for vines with aerial tubers e.g. Madiera Vine.

4. Stem scrape (using knife and herbicide)

- working close to ground, scrape along the stem of the plant for about 15-30 cm to expose vascular tissue.
- apply herbicide to exposed vascular tissue IMMEDIATELY (within 10 seconds of scraping).
- take care not to ringbark entire stem.
- leave plant insitu until completely dead, and re-treat if necessary.
  e.g. Madiera Vine, Ochna, Senna, Morning Glory.

5. Cut and Paint (using saw and herbicide)



- the plant should not have aerial tubers.
- appropriate on woody weeds up to 10cm basal stem diameter.
- cut stem horizontally close to ground, below any branching stems or side shoots.
- apply herbicide to cambium layer IMMEDIATELY within 10 seconds of making cut.
  e.g. Bitou Bush, Lantana, Privet.

PPE: hat, gloves, safety glasses, long sleeves/ pants, boots sunscreen and insect repellent.

6. Foliar spraying (Knapsacks and pressure sprayers)

- the use of herbicide diluted with water at a specific rate.
- most suited for use on certain shrubs, grasses and dense vines.
- foliage should be sprayed to the point of runoff (until every leaf is wet but not dripping).
- do not make up more dilute than required for the job and do not store diluted herbicide as it may breakdown and become inactive.
- always use fresh clean water for mixing not ground or dam water as herbicide may breakdown and become inactive.

Illustration: Taken from Noxious and Environmental Weed Control Handbook - NSWDPI

Various spraying/control regimes and herbicide information is available for use on particular weeds. The NSW Department of Primary Industries has developed a Management guide application for smart devices entitled “NSW Weed Wise” that is available online free of charge. Contact the Noxious Weeds Officer at your local Council or visit http://weeds.dpi.nsw.gov.au/ for further details.

Appendix H – Local Bush Regeneration Companies

A full list of Bush Regenerators accredited by the Australian Association of Bush Regeneration is available at https://www.aabr.org.au/do/business-directory/wpbdm-category/aabr-accredited-bush-regenerators/

Terra Australis Regeneration
Erick Vallis
Lot 2, 9 Orlando Road, Cromer, NSW, 2099
Ph: 02 9971 9312
Fax: 02 9971 9312
Mob: 0416 317 555
Email: terra_australis@iprimus.com.au

Waratah Eco Works
5 Corniche Rd, Church Point NSW, 2105
Mob (Mick): 0402 030 187
Ph: 02 9979 3313
Email: dixonj@wew.net.au

Apunga
Central Coast
Contact name: Mark Settner
Website: Apunga.com.au
Ph: 0423221549
Email: info@apunga.com.au

Australian Areas Management and Repair
213 Garden St, Warriewood NSW 2102
Contact Name: Steve McRae
Mob: 0410594363
Ph: 9999 4363
Email: steve@aamrenvironmental.com.au

BARRC – Bushland & Rainforest Regeneration
PO Box 993, Wahroonga, NSW, 2076
Contact name: Scott Meier
Mob: 0427 736 595
Ph: 02 9652 1419
Fax: 02 9652 1419
Email: barrcltd@hotmail.com
Lower North Coast: PO Box 148, Pacific Palms, NSW, 2428

Australian Bushland Restoration P/L
90 Parr Prd, Narraweena NSW 2099
Contact name: David Harris
Mob: 0417 626 462
Ph: 02 99823827
Fax: 02 99821727
Email: austbushrest@optusnet.com.au
david@bushregen.com.au

NSW GOVERNMENT | Biodiversity Conservation Trust

Biodiversity Conservation Trust

Guideline for Artificial Hollows

For private land conservation agreements | August 2020

Contents

Glossary

Term	Definition
Accredited assessor	In individual accredited to apply the Biodiversity Assessment Method under the NSW Biodiversity Offset Scheme and assess impacts on biodiversity at development sites and biodiversity stewardship sites.
Artificial Hollow	A hollow structure that aims to mimic a natural tree hollow. This may be an artificially constructed nest box, salvaged fallen hollow or habitat augmentation approaches such as chainsaw hollows, that have been found to be used as refuge or breeding habitat for hollow-dependent fauna.
Biodiversity Assessment Method (BAM)	The BAM is a scientific document that outlines how an accredited person assesses impacts on biodiversity at development sites and stewardship sites.
BCT	Biodiversity Conservation Trust
Biodiversity Stewardship Agreement (BSA)	An agreement for landholders wishing to generate and sell biodiversity credits under the Biodiversity Offsets Scheme. They provide permanent conservation and funded management of the biodiversity values on the land.
Conservation Agreement (CA)	An agreement relating to land for the purpose of conserving or studying the biodiversity of the land. May or may not have funding to undertake management actions. Includes all conservation agreements administered by the BCT.
Conservation area	An area of land to which a private land conservation agreement applies.
GPS	Global Positioning System
Hollow	Cavities formed in the trunk or branches of a living or dead tree.
Management plan	Refers to the management plan included in the conservation or biodiversity stewardship agreement. This plan identifies the management actions required to be undertaken in the conservation area.

Plant Community Type (PCT)	The master community-level classification of approximately 1,500 NSW vegetation types in the NSW Government's BioNet Vegetation Classification. Used in NSW's planning and assessment tools and vegetation mapping programs.
Wildlife Refuge Agreement (WRA)	An agreement between the BCT and the landholder to protect and manage wildlife habitat on an area of land.

Objective

Natural tree hollows (or cavities) provide essential shelter and breeding opportunities for a range of fauna species including mammals, birds, reptiles and frogs. Many of these species are threatened. The protection of habitat trees is often a priority for private land conservation, however in many modified landscapes old trees no longer exist. Allowing for the natural development of hollows in modified landscapes can be a slow process. Installing artificial hollows in the form of nest boxes, salvaged fallen hollows, stag relocation or more recently, chainsaw hollows, has been a method employed to provide additional habitat for species that depend on hollows for nesting or roosting. The utilisation of these structures by target species and their durability over time largely depends on construction materials, design specifications and the method of installation (Goldingay et al. 2018).

In some circumstances, and if implemented appropriately, providing habitat for hollow-dependent fauna through artificial hollows may be used to achieve biodiversity conservation goals such as supporting threatened species. However, the installation of artificial hollows is considered an interim solution while natural hollows form, and landholders installing artificial hollows must make a long-term commitment to monitor their use and undertake maintenance as required.

The NSW Biodiversity Conservation Trust (BCT) works in partnership with landholders to establish private land conservation agreements to conserve and manage high-value biodiversity on private land. These guidelines have been developed for landholders with private land conservation agreements to help determine whether installation of artificial hollows as a management action will achieve conservation objectives and if so, identify the most appropriate artificial hollow type for the target species and site conditions.

The guidelines aim to provide greater consistency in identifying fauna species for which this management action is appropriate, outline artificial hollow specifications for different species, and identify circumstances where funding of artificial hollows is supported by the BCT.

Introduction

The NSW Biodiversity Conservation Trust (BCT) partners with landholders to conserve and manage biodiversity on private land by establishing conservation and biodiversity stewardship agreements. Biodiversity values in conservation areas and stewardship sites are maintained, enhanced or restored through a range of management actions.

In NSW, at least 46 mammals, 81 birds, 31 reptiles and 16 frogs depend upon the availability of natural hollows for shelter and breeding (see Appendix 1 for examples). However, threats including past and current land uses have contributed to the ongoing loss of hollow-bearing trees. The loss of hollow bearing trees is listed as a key threatening process for NSW wildlife. Natural hollows take a long time to form. As trees experience damage over time, larger, older 'habitat trees' tend to have more hollows per tree, and a greater range of different sized hollows (Whitford 2002, Goldingay 2011). Large hollows are particularly rare and occur mostly in trees over 220 years old (Gibbons and Lindenmayer 2000).

When the availability of natural hollows is limited, the addition of artificial hollows[1] has been identified as a management action to provide supplementary habitat for a range of different hollow-dependent species, such as bats, birds and marsupials (see examples in Appendix 1). It should be noted however, that scientific evidence indicates some hollow dependent species do not, or rarely use artificial hollows (examples in Appendix 1). In conservation areas lacking or under-resourced in natural hollows, the BCT supports the installation of artificial hollows if the site is deemed suitable for the specific target hollow-dependent species, and there is evidence that the target species uses artificial hollows. Artificial hollows may include suitably constructed nest boxes, salvaged fallen hollows or, where suitable, the creation of hollows within existing trees.

This guideline aims to help landholders determine whether the addition of artificial hollows might be appropriate as a management action to improve biodiversity within their site. Information in this guideline is based on current research and knowledge of species use of artificial hollows in specific ecosystems. This guideline outlines principles and circumstances for when the addition of artificial hollows may be appropriate, and provides landholders with optimal design specifications, minimum construction standards and installation techniques for artificial hollows targeting native fauna.

Acknowledging that each site presents unique circumstances, these guidelines should be used as a framework that can be tailored to a variety of situations and target species. Regular monitoring, as part of a long-term adaptive management strategy will be used to evaluate the conservation outcomes from installing artificial hollows, and their cost-effectiveness. This information will be essential to help guide decision-making and inform adaptive management.

[1] *The term 'artificial hollow' is defined in the Glossary for the purpose of this guideline.*

Figure 1 Nest box designed for parrot species (Source: SMEC Australia with permission from Transport for NSW)

Are artificial hollows appropriate for a conservation area?

The first step to determine whether the installation of artificial hollows may help achieve biodiversity conservation outcomes, is to identify the hollow-dependent species that occur, or potentially occur on the site. In addition to published reports, field surveys and database searches (e.g. NSW BioNet, Atlas of Living Australia), anecdotal records can be used to inform what hollow-dependent species are present on a site. For all biodiversity stewardship agreements (BSAs) and for some conservation agreements (CAs), field surveys will be required to inform this. For landholders with a conservation agreement, BCT staff can help you identify potential species. For BSAs, hollow-dependent species would be identified by BAM Accredited Assessors.

It is important to note that artificial hollows are not a suitable substitute for natural hollows for all hollow-dependent species. The BCT will generally support the installation of artificial hollows where evidence indicates use by the target species. A list of hollow-dependent threatened species in NSW and evidence for artificial hollow use is provided in Appendix 1.

If you have a conservation agreement and have identified one or more hollow-dependent species potentially occurring on the site, the decision tree in Figure 2 can be used to determine if artificial hollows are an appropriate management action for your site. For BSAs, the decision tree in Figure 3 can be used to guide whether the installation of artificial hollows may be an appropriate management action, and whether the installation of artificial hollows may generate biodiversity credits for the target species. BCT staff or (for BSAs) a BAM accredited assessor can help you work through the decision trees.

Decision making tree for conservation agreements and wildlife refuge agreements

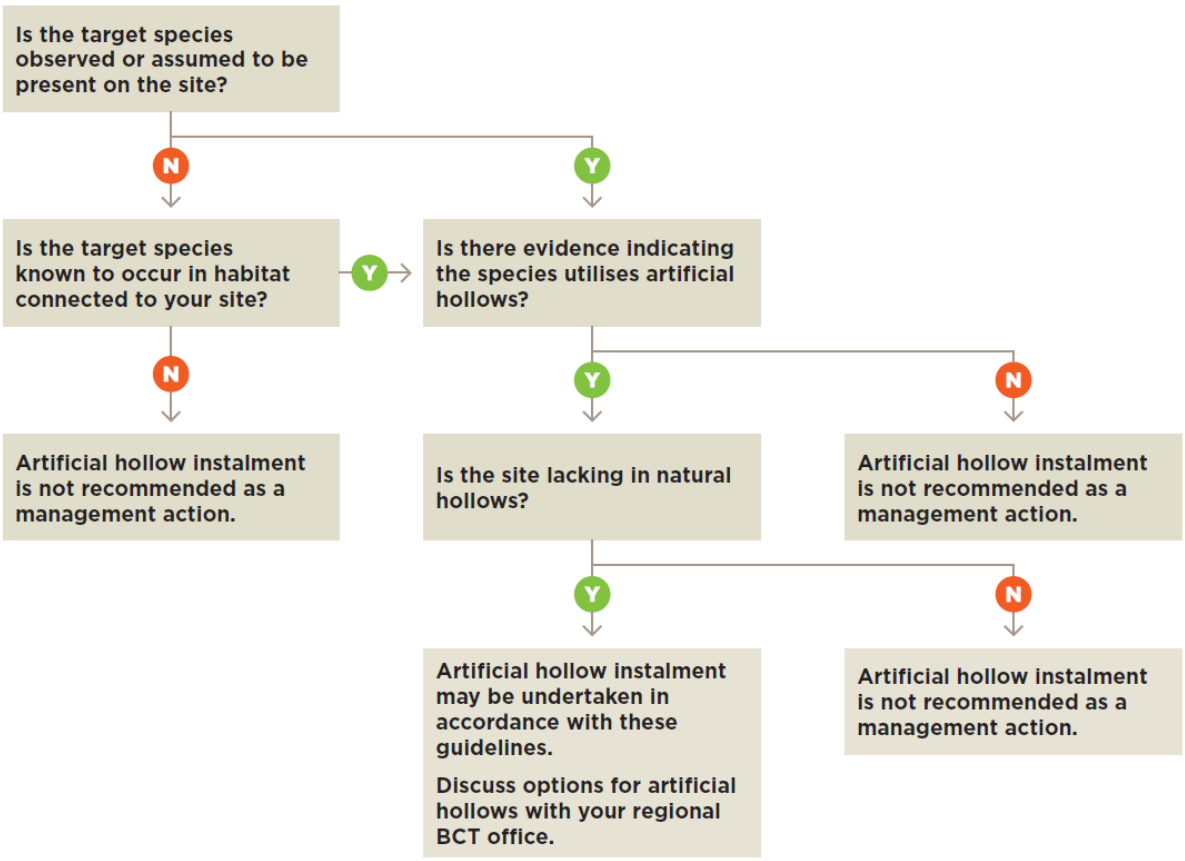


Figure 2 Decision making tree for conservation agreements and wildlife refuge agreements

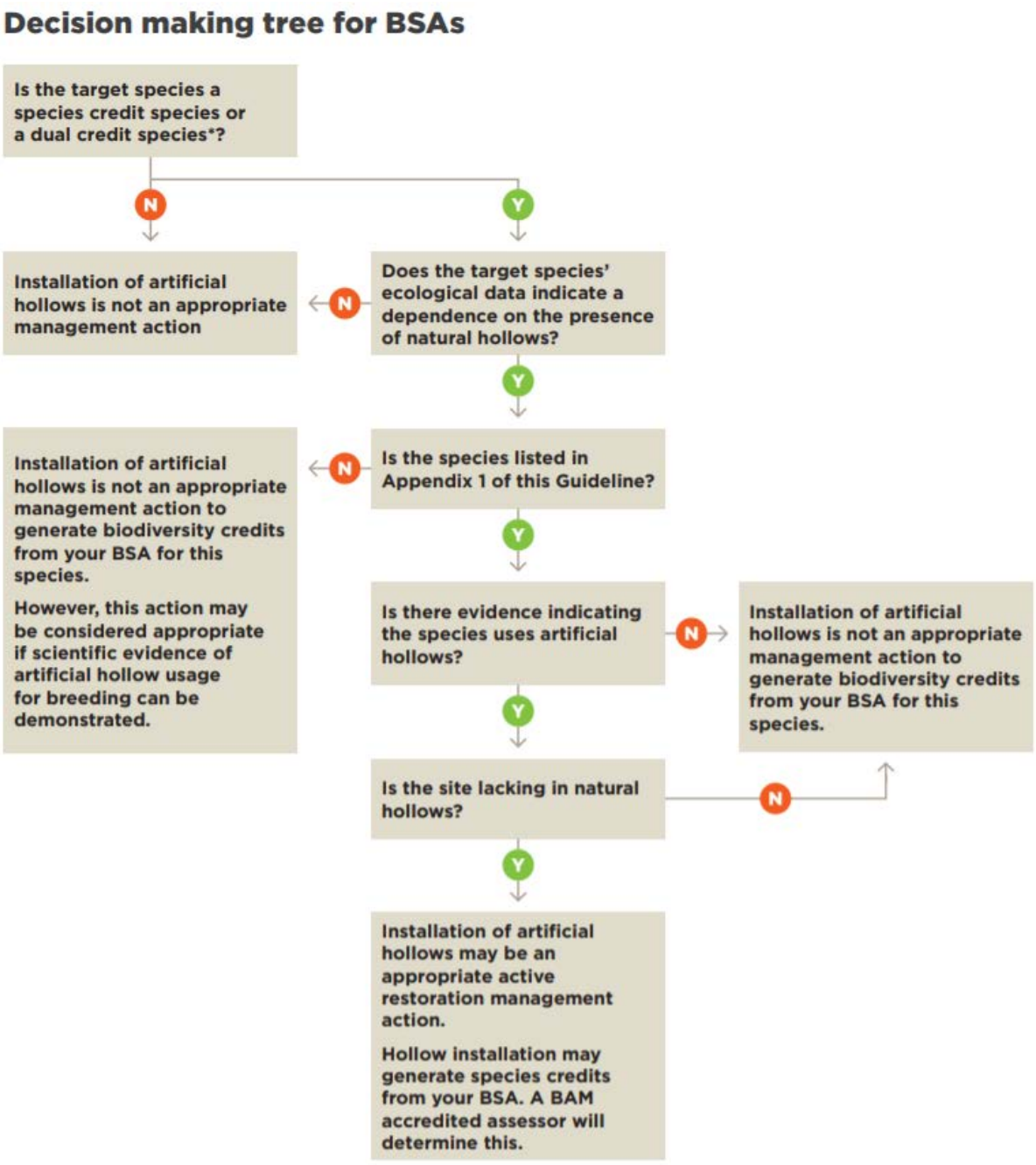


Figure 3 Decision making tree for BSAs (Refer to the Biodiversity Assessment Method (OEH 2017))*

Principles of installing artificial hollows

The installation of artificial hollows to support hollow-dependent species in private land conservation agreements should be guided by the following principles:

1. The installation of artificial hollows contributes to a broader, longer term strategy of supporting the development of natural hollows at the site. Artificial hollows are to be maintained or replaced until sufficient natural hollows develop.

2. Artificial hollows should only be installed if it is appropriate for the site[2].

3. Artificial hollows should only be installed in trees that do not have existing functional hollows.

4. Artificial hollows should only be installed where a target species has been identified as potentially inhabiting the vegetation at the site and when there is evidence to suggest the target species will utilise artificial hollows for breeding or shelter.

5. The design of artificial hollows should be based on specifications for the target species in these guidelines, unless BCT is provided with scientifically rigorous justification as to why another specification should be used.

6. The number of artificial hollows installed in a designated area will be determined by the BCT based on an onsite assessment and guided by the large tree benchmark for the Vegetation Class on the site[3].

7. The placement of artificial hollows, including spacing and degree of clustering, should be guided by knowledge of the target species.

8. Optimise positive outcomes through careful planning, clear objectives, measurable targets, appropriate artificial hollow design and installation, and positioning in a suitable location.

9. Ongoing monitoring[4] should be used to determine if conservation objectives have been achieved and to guide adaptive management.

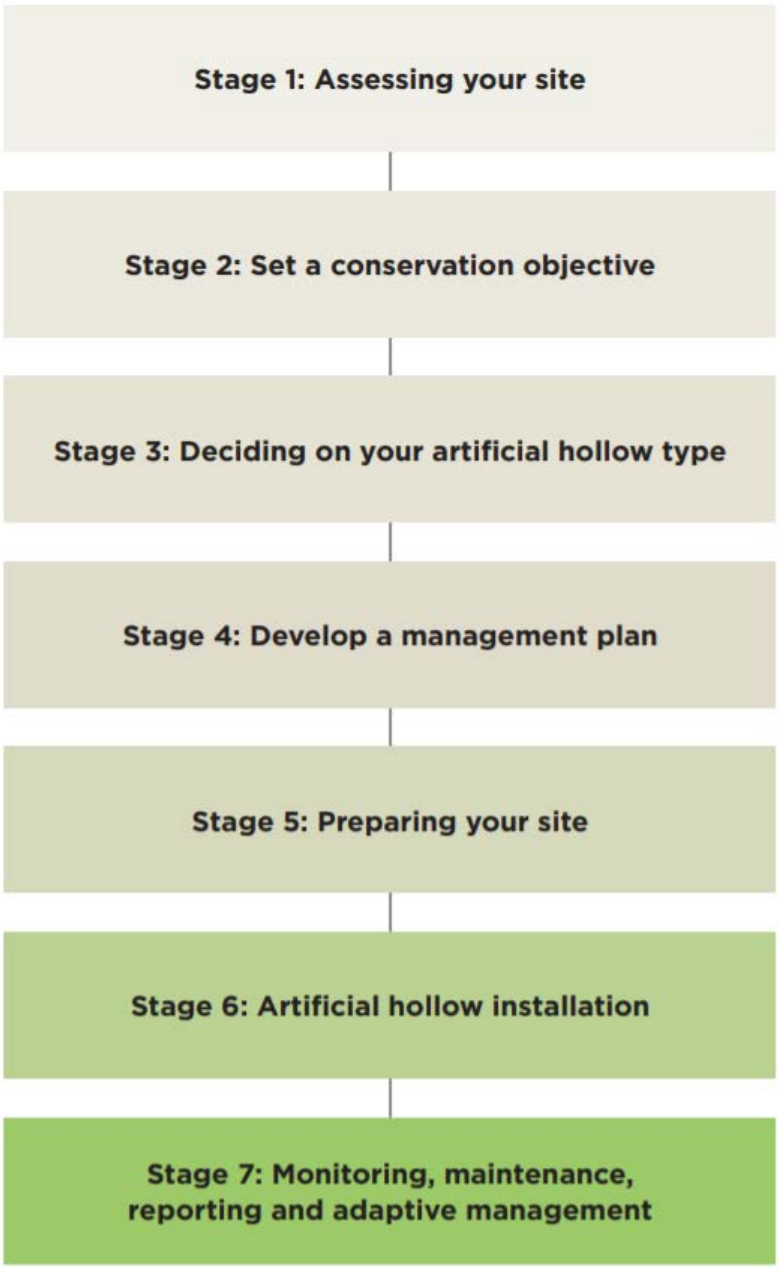
[2] *Refer to the artificial hollow framework*

[3] *Or an appropriate benchmark determined by BCT staff, consultant ecologist or BAM accredited assessor.*

[4] *Refer to the artificial hollow framework - Stage 7 – Monitoring, maintenance, reporting and adaptive management*

BCT artificial hollow framework

This section provides an overarching framework for the stages of planning and implementing artificial hollows as a management action for a private land conservation agreement. This framework can be applied once it has been determined by using the decision trees in Figure 2 or Figure 3 that artificial hollows are suitable for your site. BCT staff or a BAM accredited assessor can support you in working through this framework and if required, link you with professionals in artificial hollow planning, building and installation. More detailed information about each stage is provided in the following sections.



Stage 1 – Assessing your site

An initial site assessment will assist in determining whether your conservation area is suitable for the installation of artificial hollows to provide habitat for hollow-dependent fauna. This involves:

- Assessing past disturbance history
- Determining the Vegetation Class and Plant Community Types (PCTs) on your site
- Considering your site in the context of the surrounding landscape
- Estimating the number of natural hollows currently present on your site

Table 1 provides more detail on why this site information is important to inform specific management actions for artificial hollows on your site. These factors are key considerations to ensure the conservation objectives can be met.

See the Literature Cited and Further Reading section for other resources that may assist in assessing your site.

Table 1 Assessing site context

Action	Explanation
Past disturbance	Biodiversity assessment reports, historical aerial photographs and vegetation mapping can be used to understand the past disturbance of a site. If selective logging or vegetation thinning has occurred, it is likely that the number of large trees (with associated hollows) are absent or in low numbers.
Determine the Vegetation Class and PCTs on your site (BCT officer or BAM accredited assessor)	Large tree benchmarks for the Vegetation Class can help determine the number of artificial hollows that should be installed[5]. PCT's can also be used by a BCT officer or BAM accredited assessor to help determine the target species for the site. PCT's and their condition may also be used to delineate management zones, whereby the area designated for artificial hollows can be identified as a management zone and documented in your management plan.
Determine locality context	What kind of landscape bounds the property? For example, is there connecting vegetation, busy roads, water bodies or neighbouring fences with barbed wire immediately adjacent to the site? This information will help identify areas that may or may not be suitable for installing artificial hollows. Consider target species movement through the landscape, availability and location of habitat

[5] A more appropriate hollow benchmark may be determined by BCT staff, a consultant ecologist or an accredited assessor, and/or if your target species is known to utilise clusters of hollows. BCT staff can assist identify whether this is the case.

Action	Explanation
	resources, and potential dangers such cleared land exposing target species to predators.
Estimating natural hollow density	An estimate of the density of natural hollows present on a site will be determined through large tree counts across vegetation classes or PCTs during the site assessment. This measure recognises the importance of services provided by large trees (including natural hollows) and minimises variability in hollow counts by site assessors. An average large tree density will be calculated for each PCT. For BSA sites, a BAM accredited assessor will collect large tree data when undertaking BAM vegetation plots to determine the PCTs at a site. If there are a high number of existing natural hollows within the site or adjacent to the site, the installation of artificial hollows may not be an appropriate management action considering cost effectiveness.

Stage 2 – Set a conservation objective

Each conservation area may have multiple conservation objectives that will be used to identify appropriate management actions to maintain or improve biodiversity. As a landholder you will have to determine if providing habitat for hollow-dependent species that occur on or near your site, is one of the conservation goals you aim to achieve.

Artificial hollow installation contributes to a broader longer-term conservation objective of supporting the restoration of natural hollows over time.

The decision about what conservation objective to set should be based on the purpose of your agreement, an understanding of the current habitat available for target hollow-dependent species on the site, consideration of cost versus benefit, the ability to manage current threats (such as pest species), and the capacity for the management actions to support the restoration of natural hollows over time.

For a small grant your objective may be to:

- Provide habitat for a range of different hollow-dependent species on a site that is lacking in natural hollows
- Improve habitat connectivity for highly mobile hollow-dependent species populations
- Aid the detection of hollow-dependent species believed to inhabit the site.

For a conservation agreement your objective may be to:

- Provide habitat (nesting or roosting) for a target threatened species known to occupy your site or connecting habitat
- Provide breeding habitat in the absence of natural hollows for a hollow-dependent threatened bird species known to forage in the vegetation type of your site
- Provide habitat for a highly mobile threatened species known to utilise the vegetation type of your site but not recorded specifically at the site.
- Provide habitat for the hollow-dependent prey of a target threatened species e.g. installing nest boxes for possums or gliders that are a food resource for Powerful Owls.

BCT staff in consultation with relevant experts such as fauna habitat specialists can assist landholders in determining if habitat enhancement through artificial hollows is appropriate to achieve your objective.

For a BSA site your objective may be to:

- Provide breeding habitat for a threatened species known to inhabit your site (habitat enhancement) and generate species credits

A BAM accredited assessor can help you determine if habitat enhancement through artificial hollows is appropriate to achieve your objective and determine conditions under which species credits may be generated.

Stage 3 – Determining the artificial hollow type

The type of artificial hollow selected should be appropriate for the target species and budget. As determined in Stage 2, the installation of artificial hollows is likely to be in response to one of two scenarios:

1. Providing additional habitat for hollow-dependent fauna in areas where natural tree hollows are lacking – artificial hollows of different sizes will be installed to target a range of hollow-bearing species likely to utilise the site.
2. Encouraging the presence or reintroduction of one or more target threatened species – only artificial hollows specifically designed to suit the target threatened species will be installed.

For BSAs, credits are only issued in line with the BAM (OEH 2017). Scenario 1 will not be used to generate credits.

Specifications for artificial hollows aim to mimic dimensions of natural hollows that the target species is known to occupy. Specifications typically include the size and shape of entrance hole, internal cavity size, placement height on the tree, orientation, and material type.

Consider the costs associated with building or buying artificial hollows and installing them, along with the number of artificial hollows proposed for your site. Monitoring and maintenance requirements including possible replacement should also be factored into the consideration of costs.

Types of artificial hollows

Table summarises the main types of artificial hollows that are considered appropriate. Further details about each type is provided in Appendix 2.

Table 2 Summary of artificial hollow types available for installation

Type	Description	Effectiveness	Cost	Risk
Manufactured	Installation of pre-fabricated 'nest boxes' built to standard specifications dependent on the target species.	Low – High (dependent upon targeted species, design specifications and material quality).	Moderate	Nest boxes not of suitable quality for target species; provide short term habitat only if not maintained; High maintenance if poorly made with an attachment that does not allow for tree growth.

Type	Description	Effectiveness	Cost	Risk
Salvaged	Hollows are cut from felled hollow-bearing (habitat) trees, capped if necessary, and attached to non-habitat trees.	Moderate (evidence for several species).	Low - Moderate	Hollows inappropriately sourced.
Chainsaw / drilled	Hollows cut into standing trees or existing hollows modified to improve access.	Moderate (evidence for several species).	High in short-term. Low in long-term	Requires technical training and certification to install; tree health potentially compromised; entrance plates falling off or entrance closed by tree growth

Stage 4 – Develop a management plan

Information collected in Stages 1-3 will help determine suitable management actions. Development of the management plan will involve planning and prioritising management actions and setting realistic targets within clear timeframes to reach conservation objectives. BCT staff, ecological consultants, or (for BSAs), BAM accredited assessors can assist landholders in this process.

The management plan should include:

- the number and type of artificial hollows required for each management zone,
- the location of suitable trees for installation (closer proximity to water and food resources may increase occupation and subsequent breeding success),
- installation technique and who would install the artificial hollows (refer to Stage 6),
- measures to protect the artificial hollows from fire,
- monitoring and reporting requirements for your site (refer to Stage 7 and Appendix 3),
- relevant triggers for the repair and replacement of artificial hollows, including managing unwanted occupants (refer to Stage 7), and
- costs associated with management actions including construction, installation, monitoring and maintenance.

Spacing / Density

It is recommended that multiple artificial hollows be provided to reduce hollow competition and allow individuals to occupy alternative hollows within their home range. For example, a single glider will utilise numerous hollows and a single phascogale up to 40 hollows across its large home range). To

prevent overcrowding and maximise coverage, artificial hollows targeting the same species should be adequately spaced. Spacing between hollows targeting different species is less important.

Each conservation area may be occupied or visited by a suite of hollow-dependent species, each of which have preferences regarding hollow dimensions, location and density. Density of hollows is not well researched for many species and may be regionally variable for species that occur across parts of NSW. Optimal density and spacing for target species within a conservation area should be discussed with BCT staff, an ecologist or a BAM accredited assessor.

Input from appropriately qualified professionals

Landholders must seek the advice of the BCT or an ecologist with expertise in the ecological requirements of the target species to determine the appropriate artificial hollow type, specifications and installation location. Landholders are also encouraged to seek advice from suitably qualified experts or contractors. These will be determined based on the target species and site condition.

For chainsaw hollows it is important to first consult with an ecologist with understanding of the roosting behaviour of the target species, to determine the appropriate hollow specifications. A qualified professional such as an arborist will then be required to determine if the tree can support this type of hollow and create it.

Protecting artificial hollows from fire

Bushfires pose a significant risk to fauna occupying artificial hollows. Management actions such as raking leaf litter (e.g. leaves, twigs and bark) away from the base of the tree can reduce the risk of the tree being destroyed by fire.

Stage 5 – Preparing your site

Preparation of your site is important for the successful installation of artificial hollows. Before beginning installation, you should:

- Obtain and prepare artificial hollows including the attachment of a unique identification number for monitoring. Identification can be in the form of a number printed on the bottom of a nest box/salvaged hollow, a tag attached directly to the trunk of the tree or another durable method.
- Review your management plan to confirm requirements for specific management zones.
- Assess the safety risks of the chosen method of installation.
- Employ the services of a qualified professional if required.

Stage 6 – Artificial hollow installation

When installing artificial hollows, safety should always be considered. It is a potentially hazardous activity with a significant chance of injury from risks such as, but not limited to, working at heights, lifting heavy items and using tools.

Artificial hollow installation technique and location will be dependent on the hollow type and site conditions. See Appendix 2 for more information about the installation technique and location for each type of artificial hollow.

After determining a suitable location for hollow installation, orient the hollow in a suitable direction to protect it from prevailing weather and extreme temperatures. In hotter regions, for example, nest boxes may become too hot for target species to inhabit if they are not in a shaded position during the hottest part of the day.

When determining the height of the artificial hollow, consider the requirements for monitoring and the optimal height for the target species, including placement to avoid attack by predators. For example, if cats are present in the area, wrapping a metal sheet around the base of the tree will prevent them from accessing the artificial hollow. Recommended hollow heights for a range of species are provided in Appendix 2, Table 5.

Stage 7 – Monitoring, maintenance, reporting and adaptive management

The success of an artificial hollow installation program is uncertain. Even with best practice implementation, artificial hollows can deteriorate and thus need maintenance or replacement, non-target exotic species such as European honeybees can take up residence, and other factors may prevent use by the target species', warranting relocation of the artificial hollow elsewhere. Occupancy by target species is often low (Lindenmayer et al, 2017). Ongoing monitoring is essential to determine how effective the installation of artificial hollows has been in supporting the target species, and to build our general understanding of the circumstances under which investing in artificial hollows may be worthwhile.

Monitoring

The responsibility of monitoring and reporting on the installation of artificial hollows is shared between the landholder and BCT staff.

A monitoring form such as that provided in Appendix 3 must be completed by the landholder following the installation of artificial hollows to provide baseline information. This includes for each artificial hollow, a unique identifier, the location of the tree (using a GPS), the type of hollow and the date of installation. A georeferenced photo of each artificial hollow should be taken and stored for comparison over the monitoring period and to assist the landholder and BCT staff locate the hollow in subsequent years. Photographs are also encouraged as part of the monitoring program and can be provided to the BCT for assistance with identifying species and reporting.

Annual inspections of each hollow should then record on the monitoring form any observations of species activity around the hollows, the condition of each hollow and tree, and any maintenance of

the hollow required and/or performed (Appendix 3). Any clear occupancy by non-target species should be included. Outside the formal monitoring period, opportunistic sightings of non-target species occupying nest boxes should be reported to the BCT.

Damage to hollows should be repaired as soon as is practicable.

As a guide, if there is no evidence of the target species using the artificial hollow over three years, it should be relocated elsewhere within the conservation area. Monitoring of chainsaw hollows should also involve observations of tree health, and changes to the hollow entrance.

If occupancy monitoring is required, this should be done in consultation with BCT staff or an ecologist to minimise disturbance to hollow occupants and aid species identification. Factors including the best time of day and year to monitor should be considered, depending on the behaviour of the target species. For example, monitoring is often performed at dawn or dusk. Care should be taken during nesting season to avoid disturbing incubation. Hinged lids on nest boxes can be used for inspections if access to the box is available. Cameras mounted on a pole can be used where access is limited, or the lid of the hollow cannot be removed (e.g. chainsaw hollows).

Maintenance

When condition of the artificial hollow deteriorates to a level that makes it unsuitable for the target species, maintenance is required (Table 3). Some minor damage may be possible to repair while the artificial hollow is in position, but the safest practice for any major repairs is to remove the hollow from the tree to undertake maintenance at ground level. Record any required maintenance or maintenance undertaken in the monitoring form (Appendix 3).

Table 3 Condition of artificial hollows

Condition	Description	Action
Good	No damage or minimal damage that does not affect the function of the hollow.	None
Moderate	Minor damage, but the hollow still provides suitable habitat for the target species. Examples: lid slightly loose, sides warping due to moisture	Undertake minor repairs if not occupied. Continue to monitor
Poor	Major damage to artificial hollow making it no longer suitable for occupation by the target species Examples: Tree attachment failing, missing lid	Repair or replace

Figure 4 Nest boxes in good (left), moderate (middle – peeling lid) and poor (right – fallen from tree, no lid and honeycomb present) condition (Source: SMEC Australia with permission from Transport for NSW)

Nest boxes may require replacing if they become occupied by European honeybees. While bees may move out of nest boxes after a period of time, native wildlife may refuse to use a box previously occupied by bees.

Figure 5 Repair of minor damage to a nest box (Source: SMEC Australia with permission from Transport for NSW)

Reporting

Artificial hollows that are funded by the BCT will have reporting requirements to track the progress and success of management actions. Monitoring must be consistent with the BCT Ecological Monitoring Module and include, at a minimum:

- Inspection dates
- Condition of artificial hollows
- Any evidence of occupancy including species identification where possible
- Details of maintenance and management undertaken.

Monitoring information provided by the landholder (e.g. species observations, hollow and tree condition, and the details of any maintenance required or performed), should be included in the report.

During each monitoring period, BCT staff or an ecologist will also assess the success of the artificial hollow installation against the specific conservation objectives identified in Stage 2.

Frequently Asked Questions

Will the BCT fund the installation of artificial hollows?

The BCT would only fund the procurement and installation of artificial hollows in accordance with these guidelines i.e. in situations where i) natural hollow densities are considered a limiting factor for target native species to utilise the area (i.e. if hollow densities are below benchmark levels for the Vegetation Class), and ii) where there is evidence indicating successful use of artificial hollows by the specific target species. For conservation agreements, BCT ecologists will assess the appropriateness of including management actions that involve the use of artificial hollows during the site assessment. For biodiversity stewardship agreements, the BAM accredited assessor will determine if artificial hollows are an appropriate active restoration management action and, if relevant, the conditions under which species credits may be generated.

There are a number of pathways through which landholders can seek support from the BCT for implementing conservation management actions in their conservation area: fixed price offers, conservation tenders, co-investment partnerships and conservation partners grants. Whether funding is available to undertake artificial hollow installation and management in accordance with this guideline will be dependent on the specific suite of management actions or activities that are identified for each individual mechanism. If funding is available, landholders must cost these management actions as accurately as possible

Why are tree hollows important?

Many species of wildlife depend on tree hollows for shelter, nesting and breeding. They provide protection from the weather and potential predators.

What are artificial hollows used for?

Artificial hollows are used to supplement natural tree hollows when they are absent or low in number. Specifically designed artificial hollows can also be used to monitor and detect the presence of particular species.

What animals use tree hollows?

In NSW, terrestrial vertebrate species that are reliant on tree hollows for shelter and nests include at least 46 mammals, 81 birds, 31 reptiles and 16 frogs (Gibbons and Lindenmayer 1997, Gibbons and Lindenmayer 2002). Appendix 1 lists threatened species that use tree hollows.

How often do I need to check the artificial hollows?

External condition of nest boxes and salvaged hollows should be checked at least once every 6-12 months to ensure they are still in suitable condition and not damaging the tree. Internal occupants should be inspected less often, as determined by the management plan specific to the site, and, if

applicable for a BSA, the specific reporting requirements for generating species credits. Disturbance should be minimised to prevent occupants from vacating the artificial hollow.

Does the nest box need to be cleaned?

Occupants of the nest boxes will generally maintain the contents of the artificial hollow and it is not necessary to remove any material found inside. Disturbance, including removal of nesting material, may result in the animal abandoning the hollow.

What happens if pests are in the artificial hollows?

Sometimes non-target native species or unwanted pest species take over artificial hollows, making them unavailable for use by the target species. Pests may include the European Honeybee (*Apis mellifera*), Common Myna (*Acridotheres tristis*) and Common Starling (*Sturnus vulgaris*).

Unwanted pest species should be documented and managed. This may include removing and relocating the relevant nest box or participating in a pest management program run by local council or Local Land Services. There is some evidence to suggest that European Honeybees may relocate from artificial hollows over time and should not be removed, however this is not always the case. Some native wildlife will not occupy a nest box that has been previously inhabited by bees, and the nest box may require replacing. BCT staff or an ecologist can assist in determining suitable management responses. Reporting unwanted occupants to the BCT provides useful information on the effectiveness of artificial hollows for target species and supports adaptive management.

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Appendix 1: List of hollow-dependent threatened species in NSW[6] and evidence[7] of artificial hollow use

Table 4 List of hollow-dependent threatened species in NSW and evidence of artificial hollow use. (Status: VU = Vulnerable, EN = Endangered)

Scientific Name	Common Name	Status	Evidence of species using artificial hollows	Evidence of species not using artificial hollows
Birds				
Cacatua leadbeateri	Major Mitchell's Cockatoo	VU	Hurley and Stark 2015 (Victorian sub-species) Macak 2020	No evidence found
Callocephalon fimbriatum	Gang-gang Cockatoo	VU	No evidence found	No evidence found
Calyptorhynchus lathami	Glossy Black-cockatoo	VU	Goldingay and Stevens 2009 (Kangaroo Island sub-species in Berris et al. 2018)	No evidence found
Calyptorhynchus banksii	Red-tailed Black-cockatoo	VU	Goldingay and Stevens 2009	No evidence found

[6] From the NSW Scientific Committee Final Determination for the Loss of Hollow-bearing trees as a Key Threatening Process Listing, last updated December 2019.
[7] Based on a review of scientific literature of Australian studies. Not all sources may have been identified through the review of available databases.

Scientific Name	Common Name	Status	Evidence of species using artificial hollows	Evidence of species not using artificial hollows
Climacteris picumnus	Brown Treecreeper (eastern subsp.)	VU	No evidence found Note: SoS* lists 'nest box installation' as a Recovery Strategy action	Negligible count (2 of 324 boxes), Lindemayer et al. 2017
Cyclopsitta diophthalma coxeni	Double-eyed Fig-parrot	EN	No evidence found	No evidence found
Glossopsitta porphyrocephala	Purple-crowned Lorikeet	VU	The Purple-crowned Lorikeet *Glossopsitta porphyrocephala* roosts and possibly nests in artificial cavities (Hicks 1997; Hutchinson 1998)	Nest-boxes or artificial hollows maybe worth trialling, although the preference of wild lorikeets for knotholes in the living bark of trunks and limbs, with apparently precise microclimate and other characteristics of the nest-chamber, may mean that boxes are reluctantly accepted or are less successful (perhaps related to hygiene issues) (Courtney and Debus 2006)
Neophema pulchella	Turquoise Parrot	VU	Goldingay and Stevens 2009 (moderate use)	No evidence found
Neophema splendida	Scarlet-chested Parrot	VU	No evidence found	No evidence found
Nettapus coromandelianus	Cotton Pygmy-Goose	EN	No evidence found	No evidence found
Ninox connivens	Barking Owl	VU	No evidence found Note: NSW draft Recovery Plan supports investigation of the need for and efficacy of hollow supplementation.	No evidence found
Ninox strenua	Powerful Owl	VU	McNabb and Greenwood 2011	No evidence found

Scientific Name	Common Name	Status	Evidence of species using artificial hollows	Evidence of species not using artificial hollows
Polytelis anthopeplus monarchoides	Regent Parrot (eastern subsp.)	EN	No evidence found	No evidence found
Polytelis swainsonii	Superb Parrot	VU	Ongoing studies with chainsaw hollows	Negligible count (1 out of 324 boxes), Lindemayer et al. 2017
Tyto novaehollandiae	Masked Owl	VU	Thomson 2006 (juvenile only)	No evidence found
Tyto tenebricosa	Sooty Owl	VU	No evidence found Note: Approved NSW Recovery Plan states “The potential for artificial hollows (nest-boxes) to fast-track habitat development for owls should be investigated.”	No evidence found
Mammals				
Cercartetus concinnus	Western Pygmy-possum	EN	No evidence found Note: OEH SoS* draft action plan lists nest box installation as a recovery action.	No evidence found
Cercartetus nanus	Eastern Pygmy-possum	VU	Beyer and Goldingay 2006 Rueegger at al. 2012 Law et al. 2013 Goldingay and Keohan 2018	No evidence found
Chalinolobus nigrogriseus	Hoary Wattled Bat	VU	No evidence found	No evidence found

Scientific Name	Common Name	Status	Evidence of species using artificial hollows	Evidence of species not using artificial hollows
Chalinolobus picatus	Little Pied Bat	VU	No evidence found	No evidence found
Dasyurus maculatus	Spotted-tailed Quoll	VU	No evidence found	No evidence found
Falsistrellus tasmaniensis	Eastern False Pipistrelle	VU	Goldingay and Stevens 2009 (possible use)	No evidence found
Mormopterus beccarii	Beccari's Freetail-bat	VU	No evidence found	No evidence found
Mormopterus norfolkensis	Eastern Freetail-bat	VU	Rueegger et al. 2020	No evidence found
Mormopterus " sp 6"	Hairy-nosed Freetail bat	EN	No evidence found	No evidence found
Myotis macropus (formerly *M. adversus*)	Southern Myotis (formerly Large-footed Myotis)	VU	Unpublished evidence of use of artificial habitat in culverts	No evidence found
Nyctophilus bifax	Eastern Long-eared Bat	VU	No evidence found	Rueegger et al. 2019
Nyctophilus timoriensis	Greater Long-eared Bat	VU	No evidence found	Rueegger et al. 2019 It appears that most roost sites are used just for a single day and large distances are travelled at night, with consecutive roost sites generally within four km (Lumsden et al. 2008).
Petaurus australis	Yellow-bellied Glider	VU	Goldingay et al. 2020a	Goldingay unpublished data

Scientific Name	Common Name	Status	Evidence of species using artificial hollows	Evidence of species not using artificial hollows
Petaurus norfolcensis	Squirrel Glider	VU	Beyer and Goldingay 2006 Sandpiper Ecological 2016 Goldingay et al. 2020a	No evidence found
Phascogale tapoatafa	Brush-tailed Phascogale	VU	Beyer and Goldingay 2006 Sandpiper Ecological 2016 Scida and Gration 2018 Goldingay et al. 2020b	No evidence found
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	VU	Rueegger et al. 2020	No evidence found
Scoteanax rueppellii	Greater Broad-nosed Bat	VU	No evidence found	No evidence found
Vespadelus baverstocki	Inland Forest Bat	VU	No evidence found	No evidence found
Reptiles				
Hoplocephalus bungaroides	Broad-headed Snake	EN	No evidence found	No evidence found
Hoplocephalus bitorquatus	Pale-headed Snake	VU	No evidence found Note: SoS* notes a critical action for this species: “erect suitably designed nest-boxes microbat/glider style) in locations lacking tree hollows (e.g. young stands), and in areas in or close to known riparian habitat, to provide shelter for the species. Ensure that nest boxes are monitored regularly to	No evidence found

Scientific Name	Common Name	Status	Evidence of species using artificial hollows	Evidence of species not using artificial hollows
			evaluate their uptake and effectiveness.”	
Hoplocephalus stephensii	Stephens' Banded Snake	VU	No evidence found	No evidence found
Amphibians				
Litoria littlejohni	Littlejohn's Tree Frog	VU	No evidence found	No evidence found
Litoria piperata	Peppered Frog	VU	No evidence found	No evidence found
Litoria subglandulosa	Glandular Frog	VU	No evidence found	No evidence found

* NSW Government Saving Our Species program (https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/saving-our-species-program)

Appendix 2: Types of artificial hollows

Manufactured nest boxes

Over previous decades the nest box has been the standard approach to provide artificial hollows to target species in both natural and controlled habitats (e.g. aviaries and wildlife enclosures). They vary widely in both design and construction, with associated differences in suitability and longevity. The standards provided below seek to maximise both for target species within a conservation area.

Design

A standard nest box design typically includes a hinged, sloping lid, a suitably sized entrance hole, interior dimensions specific to targeted fauna and an incised ladder to allow for easy exit (e.g. Figure 6). Small holes (5-7 millimetres) are to be drilled into the bottom corners of the box for drainage.

In particularly exposed sites, artificial nest boxes painted white, with an affixed painted plywood sleeve, can prevent boxes from overheating and increase the likelihood of occupation. The sleeve can be affixed approximately 20mm away from the nest box wall and 40mm from the roof, overhanging the walls by 30-40mm, and with a gap between its top and sides to let hot air to escape (Rhind and Ellis unpublished data)

Dimensions relevant for native species are provided in Table 5. Note that entrance size is the main determinant of species use. Other hollow dimensions (length, breadth and width) need to be no smaller than the minimum specifications provided, so the box is large enough to contain individuals or groups. Other design specifications for target species may be suitable. If design specifications differ to those provided in Table 5 you should consult with BCT prior to artificial hollow construction.

Note that the species to be targeted within any conservation area should be those identified as appropriate according to these guidelines. Consultation with the BCT to determine target species is essential prior to nest box construction or purchase. Some relevant references are provided in the bibliography at the end of this guideline.

Figure 6 Glider box with rear (tree-facing) entry (Source: www.nestingboxes.com.au)

Table 5 Nest box specifications for target fauna species

Species / Guild	Dimensions (length x breadth x height)	Diameter of entrance	Depth below entrance	Height above ground	Placement	Source
Feathertail Glider	15x15x45 cm	25 mm	100-200 mm	2 metres	Vertical	Goldingay et al. 2007
Yellow-bellied Glider	25x30x55 cm	70-80 mm	400 mm	6-8 metres	Vertical	Franks and Franks 2011; Goldingay (pers. comm*)
Sugar / Squirrel Glider	14x15x60 cm	35-45 mm, rear entry (e.g. Figure 6)	N/A	3-6 metres	Vertical	Goldingay et al. 2015; Goldingay (pers. comm)
Brush-tailed Phascogale	15x20x40 cm	35 mm	300 mm	3-6 metres	Vertical	Franks and Franks 2011; Goldingay (pers. comm)
	20x20x27 cm	50 mm with internal partition	0 mm	4-8 metres	Vertical	Scida and Gration 2018

Species / Guild	Dimensions (length x breadth x height)	Diameter of entrance	Depth below entrance	Height above ground	Placement	Source
Insectivorous bats	10x20x45 cm	10 mm slit	Entrance at bottom	3 metres	Clear flight path (i.e. no vegetation blocking entrance)	Franks and Franks 2011
Glossy Black Cockatoo	30x40x1500 cm	200 mm	1200 mm	8-10 metres	Vertical	Franks and Franks 2011
	Volume >0.03 m^3	>120 mm	Entrance on front/towards top	>6 metres	Vertical	Goldingay and Stevens 2009
Little Lorikeet	15x15x50 cm	55 mm	350 mm	3-5 metres	45 degrees	Franks and Franks 2011
Pardalote	12x50x12 cm	30 mm tube	80 mm	5 metres	Horizontal	Franks and Franks 2011

Species / Guild	Dimensions (length x breadth x height)	Diameter of entrance	Depth below entrance	Height above ground	Placement	Source
Owlet – nightjar	15x15x15 cm	70 mm	300 mm	5 metres	Vertical	Franks and Franks 2011
	Volume >0.03 m^3	>50 mm	Entrance on front/towards top	Various	Vertical	Goldingay and Stevens 2009
Eastern Pygmy-possum	17x17x25 cm	15 mm slot		1.5-2 metres		Bladon, Dickman and Hume 2002
	13x10x10 cm	25-45 mm	60 mm	1 metre	Vertical	Rueegger, Goldingay and Brookes 2012
	30-40 cm hollow log	30 mm	-	-	Vertical	Law et al. 2013

Construction Materials

High quality materials are imperative to ensuring a maximum lifespan for nest boxes. Many commercially-made nest boxes last little more than a decade. The minimum requirement is marine grade plywood of greater than 18 mm thickness. However, hardwood is recommended as long as it can be sourced sustainably (i.e. not felled for nest box purposes or taken from where it is providing valuable ground habitat elsewhere). ‘Log hollows’ can be created using an intact log such as those designed for small gliders in Figure 7.

Figure 7 Log hollows carved from solid logs (Source: Steve Griffiths)

Installation

To prevent nest boxes dislodging from host trees (particularly thick-barked species) and to allow for future tree growth, installation should utilise the *Habisure*™ system or similar (see Figure 8). If the nest box or salvaged hollow is not suitable for this hanging system (e.g. heavy and dangerous to install), high quality stainless steel fixings can be used to attach the artificial hollow to the tree (e.g. Figure 9). Consider monitoring the security of the attachment over time and any impacts on tree health. Boxes should be installed with a north to north-easterly aspect to maximise exposure to winter sunlight and minimise exposure on summer afternoons.

Each box should be sequentially labelled prior to installation for ease of identification and reference during monitoring, and GPS coordinates recorded (as per Stage 7 of the artificial hollows framework).

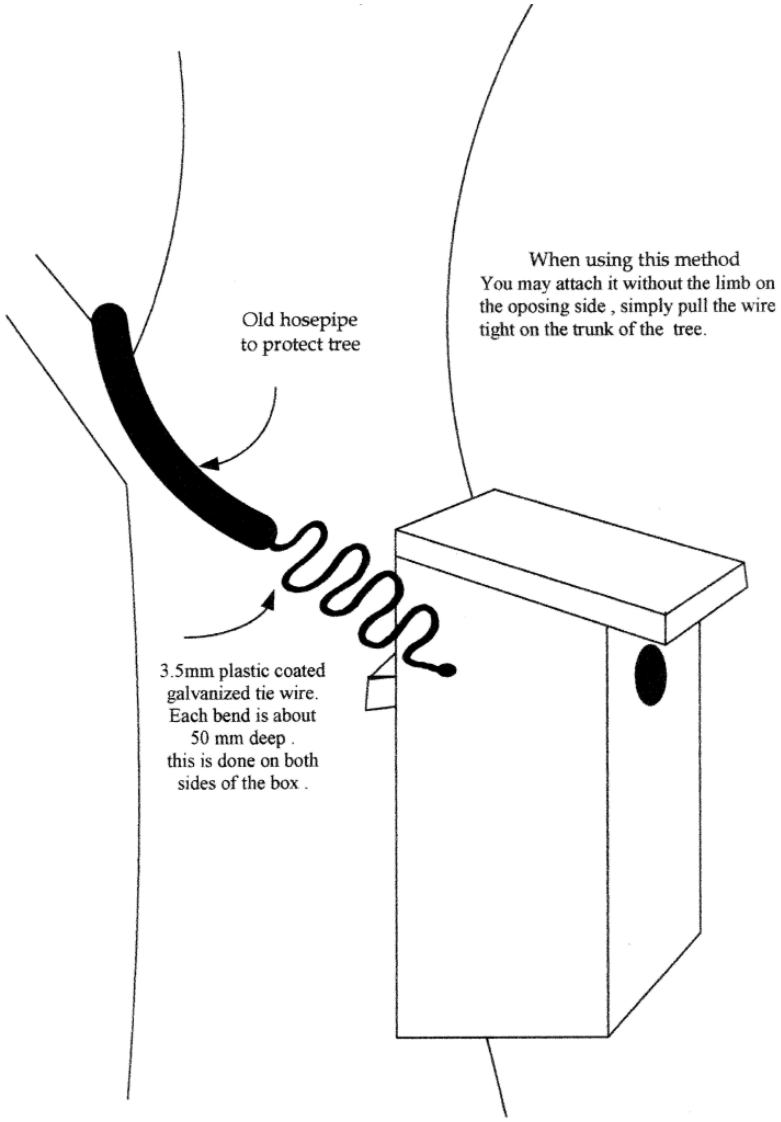

Figure 8 Installation using the Habisure™ System (Source: Hollow Log Homes www.hollowloghomes.com)

Figure 9 Installation of carved hollow logs using stainless steel fixings (Source: Steve Griffiths)

Salvaged nest boxes

Felled timber with naturally formed hollows provide a ready-made alternative to standard nest boxes. As natural hollows, they are more likely to produce favourable conditions for target species and provide a better 'feel' when installed in the host tree compared to manufactured nest boxes.

Design

Ideally, a salvaged hollow will include a pre-formed entrance and can be cut above and below the hollow to provide a natural lid and base. However, many natural hollows would simply provide the 'shell' and require a cap to be installed at either end, and an entrance hole to be created (Figure 10). Salvaged hollows can also be combined with a constructed hollow (Figures 11 and 12). Any requirements to modify the salvaged hollows should incorporate design specifications for target species provided in Appendix 2, Table 5.

Figure 10 These salvaged hollows would need to be capped (Source: www.instructables.com)

Figure 11 Example of a salvaged hollow combined with a constructed hollow (Source: James Brazill Boast)

Figure 12 Salvaged hollows used to supplement constructed hollows (Source: James Brazill Boast)

Construction Materials

It is imperative that hollows salvaged for this process are sustainably sourced. In this regard, no hollow (standing or fallen) should be collected from elsewhere in the conservation area for this purpose. An example of a sustainably sourced hollow would be from a construction site, where the hollows would otherwise be destroyed following tree-felling, or those salvaged from sustainable forestry practices.

As per manufactured nest boxes, salvaged hollows should be hardwood of an appropriate thickness (>18 mm). Any capping requirements should use marine grade plywood as a minimum and be sealed with waterproofing to reduce warping and splitting.

Installation

It is recommended that a suspension mechanism similar to the *Habisure*™ system be incorporated into the salvaged hollow design (Figure 8). Specifications regarding height and aspect should be as per manufactured nest boxes and tailored for target species listed In Appendix 2.

For larger hollows, a more elaborate attachment mechanism involving galvanised strapping or cables/turnbuckles would be necessary, however the BCT would only recommend such installations in exceptional circumstances. Central Coast Council's *Guideline for the Relocation of Large Tree Hollows* provides some interesting examples and can be viewed at http://www.cwcewa.com.au/s/Guideline-for-Relocation-of-Large-Tree-Hollows.pdf

Chainsaw hollows

As an alternative way to mimic natural hollows, recent techniques to create hollows within existing trees have been developed. Studies have found that 'chainsaw hollows' cut directly into live trees

regulate temperature more effectively than nest boxes, log hollows or salvaged hollows (Griffiths et al. 2018), and high utilisation of the hollows by local native species have been recorded. These hollows are also more likely to provide long-term habitat with potentially lower maintenance requirements compared to standard nest boxes or salvaged hollows.

Design

Given the nature of the practice, chainsaw hollows are most appropriate for targeting small to medium sized species including microbats, gliders, and small parrots (e.g. lorikeets, rosellas). An ecologist with understanding of the roosting behaviour of the target species, should provide input regarding specific hollow specifications. Design of the hollow may differ between practitioners (generally arborists), however they fundamentally require the removal of a section of a healthy, mature tree, with either the entrance left open (for parrots) or a small section re-attached (the 'entrance' plate or 'face' plate) to leave a small entrance for gliders or microbats (Figure 13). There is little information on the longevity or durability of entrance plates, so this should be monitored. Consider using hard wood for the entrance plate, as green wood from the cut tree can shrink over time.

Construction Materials

As the hollows are carved directly into the tree, no construction materials are necessary. It is however recommended that trees be selected that allow for created hollows to meet spatial requirements for targeted species (Appendix 2) whilst not risking the health or structural integrity of the tree.

Installation

To prevent tree failures and for safety considerations, chainsaw hollows are only to be created by adequately qualified arborists (AQF Level 5 or equivalent) and only mature trees >40cm trunk diameter are suitable. An initial tree health assessment should be conducted by the arborist in any case). Chainsaw hollows may therefore involve higher upfront costs for qualified assistance compared to nest boxes, however ongoing costs outside of monitoring are likely to be lower than nest boxes.

Interested landholders should contact the BCT for further details.

Figure 13 Glider hollow creation within a living Sugar Gum (Eucalyptus cladocalyx) (Source: Griffiths et al. 2018)

Appendix 3: Sample monitoring form

The form on the following page provides an example of a suitable form for recording data from a monitoring period. A description of the details required are provided in the table below.

Entry	Required details
Identifier	Unique identifier (e.g. number) for each artificial hollow or tree.
Target species	Target species or group the hollow is designed for.
Location	Use a GPS to record: Zone, Easting and Northing OR Latitude and Longitude.
Installation date	Date artificial hollow was installed.
Species observations	Record observations of any species using the box, or evidence that the artificial hollow is being used for breeding or shelter. Record any evidence of occupancy by non-target species.
Photo IDs	For any photos taken of the hollow, record a unique file name for the photo
Artificial hollow condition	Condition of artificial hollow at the time of inspection (refer to 'Maintenance' in Stage 7).
Tree Health	Condition of the tree in which the artificial hollow occurs. Consider indicators such as foliage cover, disturbance and damage.
Maintenance and/or management	The status of any maintenance required to the artificial hollow e.g. type of maintenance required, date repaired and the nature of the repair. Record any actions performed to manage target species or the outcomes of previous actions.

Site: _____ Observers(s): _____ Inspection date:_____

Identifier	Target species	Location	Installation date	Species observations	Photo IDs	Artificial hollow Condition	Tree Health	Maintenance and/or management
Unique number of hollow	Target species/group	Easting/northing OR Latitude/longitude		e.g. Signs of occupation or breeding by target species, occupation by non-target species (e.g. bees)		Good/Moderate/Poor	Good/Moderate/Poor	Maintenance actions for artificial hollow Actions to manage non target species and outcomes (if applicable)