

Assessment of Impact to Terrestrial Fauna
of
Proposed 21 Pedestrian Light Poles
at
Lagoon Park, Manly



by
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1 Introduction

1.1 Background

This terrestrial ecological report was commissioned by Northern Beaches Council to assist in Council's assessment of the environmental impact of a proposal for new lighting of the existing path through Lagoon Park, Manly. The proposed lighting is to improve public safety and assist night-time navigation along the 600m pathway through Lagoon Park. The path is heavily used during the day and at night by bike riders, joggers, walkers and dog walkers and provides east-west access through the park and the path will link to adjoining pathways.

This report describes the findings of a nocturnal fauna survey of Lagoon Park and assesses the ecological impact of the proposed 21 RoadGrace type mains powered light poles on terrestrial fauna.

There was a previous report dated March 2017 that assessed the impact of a proposal for two different lighting options; 14 solar powered poles or 24 solar powered bollard style lights.

1.2 The Study Site

The Study Site is Lagoon Park at Manly which is within the Northern Beaches local government area. Lagoon Park has an area of 3 hectares, consisting of both Community Land and Crown Land, which is managed as one area by Northern Beaches Council. The park is managed in accordance with an approved Plan of Management (Manly Council, 2001). The park boundaries are Manly Lagoon to the north, Pittwater Road to the west, Queenscliff Bridge (Bridge Road) to the east and an urban area of Manly to the south. The image on the cover of this report is an aerial photograph showing the site and its context in the locality. The Site boundary is shown in red and the path shown in magenta in Map 1 and on the aerial photo on the report cover. Map 1 and photographs 1 and 2 show recreational and habitat features of the site.

Lagoon Park is a long and narrow public area mostly containing scattered trees in a mown exotic lawn, there is a children's playground, swings, exercise equipment, rubbish bins tables and benches, a BBQ, buildings (a works shed, an electricity transformer and public toilets), car parks and estuarine vegetation on the northern side adjacent to Manly Lagoon.

A shared cycleway and pedestrian pathway provides east to the west access through the park. The asphalt path is approximately 1.8m wide with sweeping curves and a short fork at the eastern end. There is a car parking area at either end of the pathway and the pathway connects to other paths. This public reserve is frequented by walkers, cyclists and used as an off leash dog exercise area. Dogs are permitted off leash in all areas of the park except for within 10 metres of the playground, picnic and BBQ facilities.

The topography of the site is flat and low lying with average ground levels 1-2m AHD, some of the northern edge of the park occasionally floods.

The geographic co-ordinates of the centre of the site are -33.785°S and 151.284°E.

1.3 Vegetation on the Site

The vegetation at Lagoon Park comprises mature trees along the edges and a central woodland. The tree species in the central and southern part of the park are mostly *Araucaria heterophylla* and *Banksia integrifolia* with occasional *Eucalyptus robusta*, *Cupaniopsis anacardioides* and *Agonis flexuosa* with a mown exotic grass ground cover. The lagoon edge is vegetated with *Casuarina glauca* trees and the mangrove *Avicennia marina* with a reed bed of sedges and rushes dominated by *Phragmites australis* and native couch. These habitats can be seen in Photographs 1 and 2.

The original vegetation at the Site would have been Estuarine Swamp Oak Forest and Estuarine Reedland on the banks of the lagoon. The dominant trees would naturally be *Eucalyptus robusta*, *Banksia integrifolia*, *Melaleuca quinquinervia*, *Avicennia marina* and *Casuarina glauca*.

Parts of the surrounding area are still mapped as these communities (SydneyMetroArea_V2, OEH 2013). Both these vegetation types are components of the Endangered Ecological Community, Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions listed under the BC Act 2016. The vegetation at the site no longer has sufficient characteristic plants or vegetative structure to be classified as this community and is best described as an exotic mown grassland with scattered and clumped native trees with a native riparian reed bed on the northern side.

1.4 Disturbance History

The site has a long history of disturbance and human occupation since European settlement. The impacts on Lagoon Park have been land filling of the lagoon, removal of trees and vegetation, addition of soil nutrients, changed hydrology, changed water quality, planting of exotic species, invasion of weeds. These disturbances have resulted in a loss of ecological value and resilience. The eastern section of the Park was temporarily established as a garbage tip in the 1920's and by the 1930's, there has been residential development along Eurobin Street and Cameron Ave, which define the Park's southern boundary.

1.5 Ecological Values in the Locality

The dominant habitat feature of the locality is the adjacent Manly Lagoon which, is a brackish lagoon that is open to the sea at Queenscliff Beach. The land uses in the catchment of the lagoon includes Manly Dam, the urban areas of Manly Vale, Allambie and Brookvale, golf courses, Warringah Mall retail area, playing fields, roads and some light industrial use. The headwater of the catchment is remnant bushland.

Manly Lagoon is an estuarine environment that is used by aquatic and estuarine fauna including invertebrates (such a prawn breeding habitat), fish (including important breeding habitat and juveniles) and wading and migratory birds. West of Lagoon Park are areas of medium quality habitat that are Manly Golf Course and playing fields and further west is a large area of bushland that is Manly Dam Reserve and Garigal National Park. Due to the close proximity of the site to the estuarine lagoon, the sea, and the vegetation that occurs on this site, this area has particularly high ecological habitat potential. This type of habitat is rare in NSW but there are several examples on the Northern Beaches with Narrabeen Lakes being the largest example.

The locality has a long history of development and the natural environment has been extensively changed since European settlement. Adjacent to the southern part of the park are residential properties which provide habitat to native fauna including birds (noisy minors, magpies, frogmouths, owls), possums, rats, long-nosed bandicoots and domestic animals such as cats and dogs.

The bushland in the locality has been degraded by clearing for development, stormwater run-off, dumping, planting of garden species, weed invasion and human access. This site has been extensively filled, reducing the amount of swamp and the surface area of the lagoon. Manly Lagoon is exposed to numerous pollution sources and in 2004 did not meet national aquatic ecosystem guideline levels for water quality (WSC 2004).



Photograph 1: The pathway and surrounding vegetation in the eastern section of Lagoon Park.



Photograph 2: East end of Lagoon Park looking west showing the estuarine beach that is used extensively for off leash dog walking.

1.6 Avoidance and Minimisation of Impact

The initial lighting layout and design (Apex Lighting Feb 2018) showed all lights (except the easternmost light) located along the southern side of the pathway with the light fitting angled to the north. This would have resulted in the artificial light being projected to the north for all the lights resulting in a large area of the light spill over the water surface at the eastern end of the Lagoon, which may have had an impact on

aquatic invertebrates and fish in the Lagoon as well as wading birds that use the shallow part of the lagoon in this area. To avoid the light spill onto the Lagoon it was recommended that the easternmost 6 lights be flipped to the northern side of the pathway and be oriented towards the south. Light 1 was already oriented this way. The change would only impact the playground and no dwellings would be impacted.

Council has adopted this recommended changed the light pole positions and subsequent orientation of the 5 lights in the current proposal and this is shown in the current plans (Apex Lighting dated 6/4/18). This change in the lighting design will avoid and/or minimise the potential impact of light on the high ecological value riparian and estuarine habitat.

1.7 The Proposed Lighting

The proposal is to install 21 light poles along the curving pathway through Lagoon Park to improve safety and pedestrian navigation. The shared pedestrian and cycleway path runs east-west for a length of approximately 600m from the carparks on Cameron Avenue in the east to the Pittwater Road carpark in the west.

Proposed lighting specification is:

- 21 x Type: RoadGrace light poles BRP711 LED40NW 36W PSDD I DWP3
- Maximum brightness is 8000 lumens (lm) LED bulbs
- Adjustable spigot to change the angle of the light (proposed 10° tilt)
- 6m pole height

The proposed lighting design is compliant with, the Australian Standards for Lighting of Roads and Public Spaces AS 1158.3.1.2005 Part 3.1 Pedestrian Lighting (P3 and P4) and with level 1 controls for environmentally sensitive areas as defined by Australian Standard AS 4282-1997 Obtrusive Effects of Outdoor Lighting with regards to the adjacent houses.

The western 15 light poles will be located on the southern side of the path and will be orientated to the north. The 6 easternmost light poles will be located on the northern side of the path and will be orientated to the south to reduce the light spill onto the lagoon. The estimated artificial illuminance across the park due to the proposed lights are shown on the map by Apex Lighting (6/4/18).

1.8 Assumptions and Limitations

- This report is a terrestrial fauna report and does not include an assessment of aquatic species, the aquatic environment, terrestrial plants, or heritage values. The report does include semi aquatic and wading birds that use the lagoon for feeding and resting.
- The fauna survey was limited to the survey period. The potential use of the area by other species at other times is assessed and discussed in respect to the suitability of the habitat and historical records.
- The close proximity of the site to adjacent residential areas and the high level of public use of the site, limited the survey methods that could be used at this location. Trapping, motion detecting cameras owl calling, and hair tubes could not be used on this site.
- It can never be proven that additional fauna species have not, do not or will not use the site as habitat. The conclusions drawn in this report are a result of surveys, observation and experience.
- This report should be read in its entirety and no part should be taken out of context.

2 Methods

2.1 Desk-top Assessment

2.1.1 Literature Search and Review

Relevant information was obtained from literature, scientific journals, online ecological databases, online high-resolution aerial photo libraries, historical aerial photo libraries and the Internet and incorporated into appropriate sections of this report.

There is a Plan of Management for Lagoon Park (2001 Northern Beaches (Manly) Council) that includes a landscape master plan. The water body of Manly Lagoon has had extensive environmental studies and has an Intergrated Catchment Management Strategy (WSC 2004). These reports describe the water quality and characteristics of the catchment. Most of the reports on the lagoon are in connection with a pollution event and as a consequence are about the benthic invertebrate fauna the fish and the chemistry of the lagoon. An extensive reference list occurs in this document, including a large number of water quality reports and invertebrate studies. A Manly Dam Catchment Bibliography, was completed in 2002 by Ken Higgs.

The ecology of the locality of the site is described in 3 reports; an Exotic Vegetation Management Strategy for Manly Lagoon (Skelton, N., 1996) which includes a survey of the non-aquatic flora and fauna in some parts of the Manly Lagoon habitat, a frog diversity study for the Manly Lagoon Catchment (Etz, S et al 2002) and a report titled Fauna and Fauna of Manly Councils Bushland Reserves (Skelton, N., P. Wong and E. Donner in 2004).

2.1.2 Aerial Photos and Vegetation Maps

Aerial images and vegetation maps were assessed to determine local context, wildlife corridors, features on the site, historic changes to vegetation and disturbance, and for planning fieldwork.

2.1.3 Historic Fauna Records Search

Historic fauna records (BioNet, EPBC Protected Matters database, Birdlife Australia Atlas, Atlas of living Australia) were queried to ascertain past native species found at the site. The data were then combined with local knowledge and the habitat conditions on the site to compile a list of animal species for specific targeting during the fieldwork and to be considered in the assessment. Historic fauna records have been incorporated into Table 2 and Threatened species records are also incorporated into Table 1.

2.2 Field Survey Methods

2.2.1 Fauna Survey Methods

The fauna field surveys were conducted by experienced ecologists over nine (9) nights and two (2) days between 08/08/2016 – 26/08/2016 and between the 22nd of March, 24th March and 28th March 2018.

During the survey period the weather was mostly fine and calm, the exception was the two days 8th and the 22nd of August 2016 and the 24th March 2018 when there had been rain earlier in the day and moderate wind. The maximum daily temperature during the survey period was between 15°C and 27°C and the minimum temperatures were between 10°C and 13°C. There was almost a full moon during the nocturnal field surveys on the 24th March and 28th March 2018.

The field survey involved the following procedures:

- Initial familiarisation with the site and its extent;
- Assessment of the physical characteristics of the site;
- Assessment of the habitats on the site;
- Identification of fauna through sightings and calls;

- Search for scats, remains, nests, dreys, bones, feathers, fur, diggings, scratches, tracks, owl white-wash and food sources;
- Examination of trees for scratchings, sap-feeding notches and hollows;
- Recording and identification of ultrasonic bat calls;
- Spotlighting to search for nocturnal species;
- Detailed searches for targeted threatened species are listed in Table 1;
- Photography of ecological features on the site.

2.2.3 Targeted Threatened Species Search

Table 1: Targeted Threatened Fauna Species

Common Name	Genus and Species	BC Act status	EPBC Act status	Records within 5km
Reptiles				
Rosenberg's Goanna	<i>Varanus rosenbergi</i>	V,P		25
Birds				
Black Bittern	<i>Ixobrychus flavicollis</i>	V,P		1
Beach Stone-curlew	<i>Esacus magnirostris</i>	E4A,P		2
Bush Stone-curlew	<i>Burhinus grallarius</i>	E1,P		8
Curlew Sandpiper	<i>Calidris ferruginea</i>	E1,P	CE,C,J,K	2
Dusky Woodswallow	<i>Artamus cyanopterus cyanopterus</i>	V,P		5
Eastern Curlew	<i>Numenius madagascariensis</i>	P	CE,C,J,K	2
Eastern Osprey	<i>Pandion cristatus</i>	V,P,3		3
Eastern Reef Egret	<i>Egretta sacra</i>	P	C	6
Flesh-footed Shearwater	<i>Ardenna carneipes</i>	V,P	J,K	2
Fork-tailed Swift	<i>Apus pacificus</i>	P	C,J,K	1
Glossy Black-Cockatoo	<i>Calyptrorhynchus lathamii</i>	V,P,2		14
Great Knot	<i>Calidris tenuirostris</i>	V,P	CE,C,J,K	4
Greater Sand-plover	<i>Charadrius leschenaultii</i>	V,P	V,C,J,K	1
Grey Plover	<i>Pluvialis squatarola</i>	P	C,J,K	4
Grey-tailed Tattler	<i>Tringa brevipes</i>	P	C,J,K	4
Latham's Snipe	<i>Gallinago hardwickii</i>	P	C,J,K	1

Common Name	Genus and Species	BC Act status	EPBC Act status	Records within 5km
Lesser Sand-plover	<i>Charadrius mongolus</i>	V,P	E,C,J,K	1
Little Eagle	<i>Hieraaetus morphnoides</i>	V,P		3
Little Lorikeet	<i>Glossopsitta pusilla</i>	V,P		2
Little Tern	<i>Sternula albifrons</i>	E1,P	C,J,K	2
Marsh Sandpiper	<i>Tringa stagnatilis</i>	P	C,J,K	1
Masked Owl	<i>Tyto novaehollandiae</i>	V,P,3		2
Pacific Golden Plover	<i>Pluvialis fulva</i>	P	C,J,K	3
Pied Oystercatcher	<i>Haematopus longirostris</i>	E1,P		5
Powerful Owl	<i>Ninox strenua</i>	V,P,3		119
Red Knot	<i>Calidris canutus</i>	P	C,J,K	1
Red-necked Stint	<i>Calidris ruficollis</i>	P	C,J,K	10
Regent Honeyeater	<i>Anthochaera phrygia</i>	E4A,P	CE	2
Ruddy Turnstone	<i>Arenaria interpres</i>	P	C,J,K	6
Ruff	<i>Philomachus pugnax</i>	P	C,J,K	2
Sanderling	<i>Calidris alba</i>	V,P	C,J,K	7
Sooty Oystercatcher	<i>Haematopus fuliginosus</i>	V,P		16
Sooty Tern	<i>Onychoprion fuscata</i>	V,P		2
Square-tailed Kite	<i>Lophoictinia isura</i>	V,P,3		1
Superb Fruit-Dove	<i>Ptilinopus superbus</i>	V,P		2
Swift Parrot	<i>Lathamus discolor</i>	E1,P,3	CE	4
Varied Sittella	<i>Daphoenositta chrysoptera</i>	V,P		2
Wandering Tattler	<i>Tringa incana</i>	P	J	6
Wedge-tailed Shearwater	<i>Ardenna pacificus</i>	P	J	9
Whimbrel	<i>Numenius phaeopus</i>	P	C,J,K	2
White Tern	<i>Gygis alba</i>	V,P		1
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	P	C	13
White-throated Needletail	<i>Hirundapus caudacutus</i>	P	C,J,K	6
White-winged Black Tern	<i>Chlidonias leucopterus</i>	P	C,J,K	1
Wompoo Fruit-Dove	<i>Ptilinopus magnificus</i>	V,P		1

Common Name	Genus and Species	BC Act status	EPBC Act status	Records within 5km
Mammals				
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	V,P		47
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	V,P		1
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	V,P		297
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V,P	V	72
Koala	<i>Phascolarctos cinereus</i>	V,P	V	3
Little Bentwing-bat	<i>Miniopterus australis</i>	V,P		7
Southern Myotis	<i>Myotis macropus</i>	V,P		8
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	V,P	E	3

BioNet Atlas of NSW Wildlife, Report generated on 23/03/18

Key for BC Act Status

Status	Status	Status Notes
P	Protected Animal	Fauna not listed in Schedule 11 of the NPW Act 1974.
V	Vulnerable	Schedule 2, BC Act 2016, Likely to become endangered unless the circumstances & factors threatening its survival or evolutionary development cease to operate.
E1	Endangered	Schedule 1, part 1, BC Act 2016, Likely to become extinct in nature in NSW unless the circumstances and factors threatening its survival or evolutionary stop, in immediate danger of extinction
E2	Endangered Population	Schedule 1, part 2, BC Act 2016 Population where, numbers have been reduced to such a critical level, or its habitat has been so drastically reduced, that it is in immediate danger of extinction
E4	Extinct	Schedule 1, part 4, BC Act 2016, Species that have not been located in nature during the preceding 50 years despite searching of known and likely habitats
3	Category 3 sensitive species	Species are classed as of medium sensitivity, and provision of precise locations would subject the species to medium risk from threats such as collection/deliberate damage.

Key for EPBC Act Status

Code	Description	Definition under the EPBC Act 1999, and Migratory Birds agreement.
C	CAMBA	China-Australia Migratory Bird Agreement: Refers to species listed in the Bilateral Agreement between the Government of Australia and the Government of The People's Republic of China for the protection of Migratory Birds and their Environment (Subdivision A of Division 1 of Part 5, Commonwealth EPBC Act 1999.)
E	Endangered	Refers to a native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria (Subdivision A of Division 2 of Part 13, Commonwealth EPBC Act 1999).
J	JAMBA	Japan-Australia Migratory Bird Agreement: Refers to species listed in the Bilateral Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (Subdivision A of Division 1 of Part 5, Commonwealth EPBC Act 1999).
K	ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement: Refers to species listed in the Bilateral Agreement between the Government of Australia and the Government of the Republic of Korea for the protection of the Migratory Birds and their Environment (Subdivision A of Division 1 of Part 5, Commonwealth EPBC Act 1999.)

Code	Description	Definition under the EPBC Act 1999, and Migratory Birds agreement.
V	Vulnerable	Refers to a native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria (Subdivision A of Division 1 of Part 13, Commonwealth EPBC Act 1999).
X	Extinct	Refers to a native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died (Subdivision A of Division 1 of Part 13, Commonwealth EPBC Act 1999).

2.3 Qualifications and Experience of the Field Ecologist and Authors

The main author and the principal field ecologist was Nick Skelton. Shari May and Anika Skelton assisted with the field surveys. Shari and Sophia Mueller Sewell assisted with the writing and were responsible for database searches and literature research.

Nicholas Skelton's formal qualifications include a Bachelor of Science with Honours (B. Sc. (Hons) USyd) and a Masters in Applied Science (M. App. Sc. in Vegetation Management UNSW). Nick has been an environmental scientist for more than 20 years, including a university lecturer, research ecologist and consultant ecologist. His work is focused on the Sydney bioregion and he has published many papers in independently reviewed journals on the ecology of Sydney. He has expert knowledge of the local soils, the climate of this area and the local indigenous plants and animals as a result of over 900 ecological surveys. Nick is a member of the relevant professional organisations including a practising member of the Ecological Consultants Association of NSW, Ecological Society of Australia, Royal Zoological Society and Birds Australia. He is licensed by OEH and NSW Department of Primary Industries to carry out surveys on threatened plants and animals and he is a qualified Biodiversity Assessor under the BC Act 2016. Further details can be found at www.ecology.net.au. Sophia Mueller Sewell and Shari May's qualifications include and Bachelor of Science (B. Sc. (Environmental Biology)).

2.4 Relevant Ecological Legislation

All native terrestrial fauna are protected by the National Parks and Wildlife Act 1974, Threatened species have additional protection provided by the NSW Biodiversity Conservation Act 2016 and the Federal, Environment Protection and Biodiversity Conservation Act 1999. This report records exotic and native terrestrial fauna and assess the impact of the proposal on native terrestrial fauna with an emphasis on Threatened species.

The Biodiversity Conservation Act 2016 and the Environment Protection and Biodiversity Conservation Act 1999 list the threatened flora and fauna species, populations and ecological communities that are threatened in NSW. These Acts also describes key threatening processes, critical habitat and recovery plans. This report determines the Threatened species that have suitable habitat at the site and targeted surveys were carried out and the likely impacts of the proposal are assessed. As well as threatened species the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) also protects other 'matter of National Environmental Significance (NES)', Matters of national environmental significance identified in the Act are: world heritage properties, national heritage places, RAMSAR wetlands, nationally threatened species and ecological communities, migratory species protected under international agreements, Commonwealth marine environment, Great Barrier Reef Marine Park, nuclear actions and water resources in relation to coal seam gas and large coal mining developments. This report assesses the relevant parts of these ecological legislation.

3 Results

3.1 Wildlife Corridors

Wildlife corridors form important connections between remnant patches of bushland. They allow exchange of genetic material (pollen, seeds, spores, animals etc.) between areas of habitat in the landscape and

between fragmented remnants. Wildlife corridors allow cross breeding and repopulation of isolated areas where local extinctions may have temporarily occurred. The site is not an important part of a wildlife corridor but is linked to a large area of bushland to the west via the riparian corridor along the Lagoon and creek lines. The connectivity elements of the habitat are trees along the foreshore and adjacent to the urban areas which will not be impacted by the light spill.

3.2 Fauna Habitat within the Site

The fauna habitat features on the site are;

A mown exotic lawn with scattered trees with some in clumps, with no shrub canopy that provides low value foraging habitat for Long-nosed Bandicoots.

Planted and remnant native trees around the boundary of the site and a woodland in the centre of the site provide habitat to arboreal fauna with flowering *Banksia integrifolia* and *Eucalyptus robusta* which are valuable foraging and nectar sources for flying-foxes, possums and birds. The numerous *Casuarina glauca* and Norfolk Island Pine trees have low foraging habitat value. All the trees provide roosts for several species of diurnal and nocturnal birds. No hollow bearing trees were found on the site. There are hollow like structures in the properties to the south and on the northern side of the lagoon, which would be suitable nest/roosts for possums, rats and some species of microbat.

The only mid canopy vegetation is a few shrubs in the north-west and north-east corners adjacent to the lagoon which provide a small amount of habitat and shelter for small birds and possums. The Plan of Management (Manly Council 2001) proposes additional shrub habitat patches.

The reed beds and beach along the northern edge of the site and scattered mangroves are foraging habitat for estuarine birds and the native Water Rat. The native Water Rat is likely to be nesting in the drains.

The park is an off-leash dog exercise area. Although it is a requirement to pick up dog faeces, there are many dog faeces found in the park particularly in the areas adjacent to the houses. The smell of predators is known to deter ground dwelling mammals.

The site does not contain any caves, sandstone floaters or exposed sandstone bedrock, however, the low bridges at Pittwater Rd is known to be a roost for microbats in the summer. The wall in shed/amenities building at the eastern end on the site is currently being used by a rat. The bridge at the north-eastern corner has rats living in the light fittings under the deck.

The site is likely to be used as part of large home range by highly mobile native fauna species including owls, frogmouths, Currawongs Kookaburras, Pelicans as well as exotic species such as foxes and cats.

3.3 Historic Records of Fauna and Habitat at or near the Site

Several threatened species are known to occur within the locality and there are records of the Threatened Powerful Owl adjacent to the site.

The site is not mapped as an important site for migratory or wetland birds, it is not a Federally listed (OEH) Ramsar site and is not mapped as an Important Bird Area (IBA) by Birdlife Australia. A list of Threatened Species that could potentially occur on the site is Table 1.

BioNet Threatened Species Search

There are 2,409 records from 89 different threatened fauna species recorded within 5km of the site. Some of these records are aquatic or marine species. Since this survey only includes terrestrial fauna species, aquatic and plant species have not been included in Table 1. Species that do not have suitable habitat on the site or that are not local native species are not listed. The high number of records is indicative of the high habitat value of the environmental conditions within the locality and the area's importance to the conservation of native flora and fauna.

Atlas of Living Australia

A search of the Atlas of Living Australia Database contained 2 records. The Eastern Great Egret (*Ardea modesta*) from June 2015 and the Masked Lapwing (*Vanellus miles*) from September 2013. Fauna recorded on the site are listed in Table 2.

Migratory and Wetland Birds search

A search of the CAMBA and JAMBA databases found that the site was not known to be an important site for migratory bird species. Recent bird atlas records could not be accessed due to the website being under maintenance.

Northern Beaches Council Data

Northern Beaches Council bird data from between 2006 and 2011 shows a total of 29 records bird species at the site and nearby Hinkler Park. The birds found include several migratory species such as the Great Egret (*Ardea alba*) and the Little Egret (*Egretta garzetta*) in June 2006, several wading birds such as the Gallinago sp and the Spoon Bill (*Platalea regia*) and the Threatened Black Bittern (*Ixobrychus flavicollis*) from July 2011. Fauna recorded on the site or the adjacent Hinckler Park are listed in Table 2.

3.4 Fauna Species Recorded during Survey

Twenty-four species (fifty-eight records) were found during two the surveying periods (18-26th August 2016 and 22nd -28th March 2018. Eighty-one records of 47 different species of fauna have been recorded previously at the study site or on adjacent land. The majority of the fauna species that have been recorded were diurnal birds including several species listed as migratory or marine under the EPBC Act. The most abundant species recorded during the nocturnal survey was the Threatened Grey-headed Flying-fox that regularly forages in the banksia and Eucalypt trees.

Off leash dogs were observed using the site during every survey visit and were more common during the day time.

The list of threatened and non-threatened fauna species found during the field survey or that were recorded at the site are listed in Table 2.



Photograph 3: Native Water Rat footprints in the wet sand at the beach a Lagoon Park

3.5 Threatened Fauna Species recorded on or near the site

Four NSW listed threatened species have been recorded on or adjacent to the site. The Grey-headed Flying-fox (*Pteropus poliocephalus*), Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) were observed and detected on the site during the survey and the Powerful Owl (*Ninox strenua* Bionet), and

the Black Bittern (*Ixobrychus flavicollis*, Warringah Council) were from previous records.

There are reliable records of microbats roosting under the Pittwater Road bridge and it is possible that there is another roost in the small old building near the Bridge Road bridge. No evidence was found during the surveys of the roosts being used. It is likely that these roosts are for the summertime only. The most likely bats using the roosts is the Southern Myotis (*Myotis macropus*), which often roosts under bridges or the Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) which was detected on the site during the survey. There is a known Eastern Bentwing roost in the drains under Warringah Mall and another bat roost at the Gun Emplacement at North Head. Bats from these roosts could forage at the site, most likely during the summer months.

The threatened Grey-headed Flying-fox (*Pteropus poliocephalus*) were the most common nocturnal animal found during the field surveys. Several individuals were found on every nocturnal site visit. A dead Grey-headed Flying-fox (*Pteropus poliocephalus*) was found in one of the trees on the site during the survey (in 2016), which had been tagged as part of a flying-fox monitoring survey. The appropriate authorities were informed of the tag colours.

The list of threatened and non-threatened fauna species found during the field survey or that were recorded at the site are listed in Table 2. An assessment of the likelihood of occurrence of the threatened fauna that have suitable habitat on the site is Table 3.



Map 1, Study Site

Lagoon Park

Features and Habitats

Nocturnal Fauna Survey

Table 2: Fauna Found During Survey or Historically Recorded Near the Site

Nocturnal Fauna Survey Manly Lagoon Park, GIS Environmental Consultants, 2016

Ground Dwelling Mammals

Common Name	Species	Date	Type/Source	Notes
Back Rat	<i>Rattus rattus</i>	12-Aug-16	Observed	Under the Queenscliff bridge
Back Rat	<i>Rattus rattus</i>	Every Survey Visit (2016)	Scats, Nest	In shed/toilet Block
Black Rat	<i>Rattus rattus</i>	24-Mar-18	Observed	Climbing tree
Domestic Dog	<i>Canis lupus familiaris</i>	Every Survey Visit (2016)	Observed, Several	Off leash in whole of park, abundant scats especially on southern edge adjacent to houses
Long-nosed Bandicoot	<i>Perameles nasuta</i>	2014	BioNet	
Long-nosed Bandicoot	<i>Perameles nasuta</i>	2016	BioNet	
Long-nosed Bandicoot	<i>Perameles nasuta</i>	8-Aug-16	Diggings	Along southern edge adjacent to houses
Long-nosed Bandicoot	<i>Perameles nasuta</i>	9-Aug-16	Diggings	Along southern edge adjacent to houses
Long-nosed Bandicoot	<i>Perameles nasuta</i>	12-Aug-16	Diggings	Along southern edge adjacent to houses
Long-nosed Bandicoot	<i>Perameles nasuta</i>	16-Aug-16	Diggings	Along southern edge adjacent to houses
Long-nosed Bandicoot	<i>Perameles nasuta</i>	25-Aug-16	Diggings	Along southern edge adjacent to houses
Long-nosed Bandicoot	<i>Perameles nasuta</i>	23-Mar-18	Diggings	Day time, overcast
Water Rat	<i>Hydromys chrysogaster</i>	8-Aug-16	Tracks	Tracks in wet sand along lagoon edge on beach
Water Rat	<i>Hydromys chrysogaster</i>	9-Aug-16	Tracks	Tracks in wet sand along lagoon edge on beach
Water Rat	<i>Hydromys chrysogaster</i>	18-Aug-16	Tracks	Tracks in wet sand along lagoon edge on beach
Water Rat	<i>Hydromys chrysogaster</i>	25-Aug-16	Tracks	Tracks in wet sand along lagoon edge on beach

Arboreal Mammals

Common Name	Species	Date	Type/Source	Notes
Brush-tailed Possum	<i>Trichosurus vulpecula</i>	9/8/16	Observed	Southern side adjacent to houses
Ring-tailed possum	<i>Pseudocheirus peregrinus</i>	28/3/18	Observed	
Ring-tailed possum	<i>Pseudocheirus peregrinus</i>	24/3/18	Observed	
Ring-tailed possum	<i>Pseudocheirus peregrinus</i>	16/8/16	Dead carcus and a live one	Near Playground
Ring-tailed possum	<i>Pseudocheirus peregrinus</i>	8/8/16	Observed	Near Playground

Nocturnal Birds

Common Name	Species	Date	Type/Source	Notes
Powerful Owl	<i>Ninox strenua</i>	2013	BioNet	Vulnerable, BC Act. Recorded on north side of Lagoon and elsewhere in catchment.
Tawny Frogmouth	<i>Podargus strigoides</i>	28/3/18	Observed	

Flying-foxes

Common Name	Species	Date	Type/Source	Notes
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Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	ry Survey Visit (2016 and 2(Observed, between 4 and 12 a night hanging in a tree	Vulnerable, BC Act and EPBC Act , Mainly (6-20) individuals seen each night mostly feeding in the Banksia trees that were in flowers and a dead tagged one	
Black Flying-fox	<i>Pteropus alecto</i>	16-Aug-16	Observed	Only one of this species seen this night
Black Flying-fox	<i>Pteropus alecto</i>	18-Aug-16	Observed	

Microbats

Common Name	Species	Date	Type/Source	Notes
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	11-Aug-16	Ultrasonic Bat Detector	Vulnerable BC Act , 5 recordings, 43-46Mhz small downward tail on uneven call
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	12-Aug-16	Ultrasonic Bat Detector	Vulnerable BC Act , 2 recordings, 43-46Mhz small downward tail on uneven call

Diurnal Birds

Common Name	Species	Date	Type/Source	Notes
Australian Magpie	<i>Cracticus tibicen</i>	23-Mar-18	Observed	Day time, overcast
Australian Magpie	<i>Cracticus tibicen</i>	11-Aug-16	Observed	Asleep
Azure Kingfisher	<i>Alcedo azurea</i>	20-Jul-11	Warringah Council Record	Hinkler Park and north side of Lagoon
Black Bittern	<i>Ixobrychus flavicollis</i>	20-Jul-11	Warringah Council Record	Vulnerable BC Act , Hinkler Park and north side of Lagoon
Buff banded Rail	<i>Gallirallus philippensis</i>	25-Aug-16	Observed night time feeding	
Buff banded Rail	<i>Gallirallus philippensis</i>	1-Jul-11	Warringah Council Record	Hinkler Park and north side of Lagoon
Cattle Egret	<i>Ardea ibis</i>	20-Jul-11	Warringah Council Record	Migratory EPBC Act , Hinkler Park and north side of Lagoon
Chestnut Teal	<i>Anas castanea</i>	1-Jul-11	Warringah Council Record	Hinkler Park and north side of Lagoon
Crested Pigeon	<i>Ocyphaps lophotes</i>	23-Mar-18	Observed	Day time, overcast
Crested Pigeon	<i>Ocyphaps lophotes</i>	18-Aug-16	Observed	Asleep perched in tree
Darter	<i>Anhinga melanogaster</i>	1-Jul-11	Warringah Council Record	Hinkler Park and north side of Lagoon
Domestic Duck	<i>Anas sp.</i>	1-Jul-11	Warringah Council Record	Hinkler Park and north side of Lagoon
Dusky Moorhen	<i>Gallinula tenebrosa</i>	28-Mar-18	Warringah Council Record	Hinkler Park and north side of Lagoon
Dusky Moorhen	<i>Gallinula tenebrosa</i>	1-Jul-11	Warringah Council Record	Hinkler Park and north side of Lagoon
Eastern Rosella	<i>Platycercus eximius</i>	16-Aug-16	Warringah Council Record	Hinkler Park and north side of Lagoon
Great Cormorant	<i>Phalacrocorax carbo</i>	1-Jul-11	Observed asleep perched in tree	
Great Egret	<i>Ardea alba</i>	11-Aug-16	Warringah Council Record	Hinkler Park and north side of Lagoon
Great Egret	<i>Ardea alba</i>	20-Jul-11	Observed	Migratory EPBC Act
Great Egret	<i>Ardea alba</i>	20-Jun-06	Warringah Council Record	Migratory EPBC Act , Hinkler Park and north side of Lagoon
Grey Teal	<i>Anas gracilis</i>	1-Jul-11	Sean Granger	Migratory EPBC Act , Located near Queenscliff Bridge, shallow water / sandflats
Kookaburra	<i>Dacelo novaeguineae</i>	11-Aug-16	Warringah Council Record	Hinkler Park and north side of Lagoon
Kookaburra	<i>Dacelo novaeguineae</i>	11-Aug-16	Observed	Asleep perched in a tree
Little-black Cormorant	<i>Phalacrocorax sulcirostris</i>	23-Mar-18	Observed	Day time
Little-black Cormorant	<i>Phalacrocorax sulcirostris</i>	1-Jul-11	Observed	Day time, overcast
Little Egret	<i>Egretta garzetta</i>	21-Jun-06	Warringah Council Record	Hinkler Park and north side of Lagoon
Little-pied Cormorant	<i>Phalacrocorax melanoleucos</i>	11-Aug-16	Sean Granger	Migratory EPBC Act , Located near Queenscliff Bridge, shallow water / sandflats
			Observed	Fishing in lagoon and coming ashore

Little-pied Cormorant	<i>Phalacrocorax melanoleucos</i>	1-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Masked Lap-wing (plover)	<i>Venellus miles</i>	23-Mar-18	Observed	Day time, overcast
Masked Lap-wing (plover)	<i>Venellus miles</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Masked Lap-wing (plover)	<i>Venellus miles</i>	28-Mar-18	Observed	On sand bank in lagoon
Masked Lap-wing (plover)	<i>Venellus miles</i>	24-Mar-18	Observed	Along edge of Lagoon
Nankeen Night Heron	<i>Nycticorax caledonicus</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Noisey Minor	<i>Manorina melanocephala</i>	23-Mar-18	Observed	Day time, overcast
Noisey Minor	<i>Manorina melanocephala</i>	11-Aug-16	Observed	Day time
Pacific Black Duck	<i>Anas superciliosa</i>	28-Mar-18	Observed	Observed edge of Lagoon
Pacific Black Duck	<i>Anas superciliosa</i>	24-Mar-18	Observed	Observed edge of Lagoon
Pacific Black Duck	<i>Anas superciliosa</i>	Every Survey Visit (2016)	Observed, several on the Lagoon	
Pacific Black Duck	<i>Anas superciliosa</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Pelican	<i>Pelecanus conspicillatus</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Pied Cormorant	<i>Phalacrocorax varius</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Pied Curawong	<i>Strepera graculina</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Pied Curawong	<i>Strepera graculina</i>	12-Aug-16	Observed	Asleep perched in a tree
Pied Curawong	<i>Strepera graculina</i>	11-Aug-16	Observed	Day time
Pied Curawong	<i>Strepera graculina</i>	8-Aug-16	Observed	Asleep perched in a tree
Purple Swamphen	<i>Porphyrio porphyrio</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Rainbow Lorikeet	<i>Trichoglossus moluccanus</i>	28-Mar-18	Heard calls	
Rainbow Lorikeet	<i>Trichoglossus moluccanus</i>	23-Mar-18	Observed	Day time, overcast
Rainbow Lorikeet	<i>Trichoglossus moluccanus</i>	11-Aug-16	Observed	Day time
Rainbow Lorikeet	<i>Trichoglossus moluccanus</i>	8-Aug-16	Heard calls	Heard night time
Red Wattle-bird	<i>Anthochaera carunculata</i>	11-Aug-16	Observed	Day time
Rock Dove	<i>Columba livia</i>	11-Aug-16	Observed	Day time
Royal Spoonbill	<i>Platalea relia</i>	19-Jun-06	Sean Granger	Located near Queenscliff Bridge, shallow water / sandflats
Silver Gull	<i>Larus novaehollandiae</i>	11-Aug-16	Observed day time	On beach
Silver Gull	<i>Larus novaehollandiae</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Snipe - Latham's?	<i>Gallinago sp.</i>	1-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Spoon-bill	<i>Platalea regia</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Strawnecked Ibis	<i>Threskiornis spinicollis</i>	23-Mar-18	Observed	Day time, overcast
Striated Heron	<i>Butorides striatus</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Striated Heron	<i>Butorides striatus</i>	22-Jun-06	Sean Granger	Located near Queenscliff Bridge, shallow water / sandflats
White (Sacred) Ibis	<i>Threskiornis molucca</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
White-faced Heron	<i>Egretta (Ardea) novaehollandiae</i>	28-Mar-18	Observed	Observed fishing in Lagoon
White-faced Heron	<i>Egretta (Ardea) novaehollandiae</i>	24-Mar-18	Observed	Observed fishing in Lagoon
White-faced Heron	<i>Egretta (Ardea) novaehollandiae</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon
Willy Wagtail	<i>Rhipidura leucophrys</i>	1-Dec-14	BioNet	
Wood Duck	<i>Chenonetta jubata</i>	20-Jul-11	Warringham Council Record	Hinkler Park and north side of Lagoon

Table 3: Habitat Suitability Assessment for Threatened Fauna Species

Common Name	Scientific Name	Habitat Preference	Likely Occurrence
Beach Stone-curlew	<i>Esacus magnirostris</i>	Found exclusively along the coast on beaches, islands, reefs and estuaries. They forage in the intertidal zone of beaches and estuaries, on islands, flats, banks and spits of sand, mud, gravel or rock, and among mangroves. They breed above the littoral zone, at the backs of beaches, or on sandbanks and islands, among low vegetation of grass, scattered shrubs or low trees; also among open mangroves. (OEH 2009)	Medium. Suitable foraging habitat occurs on the site. No suitable nesting habitat occurs on the site. Was not found or heard during site survey. Nearest record a few km south of the site at Reef Beach (Sydney Harbour National Park). No further assessment required.
Black Bittern	<i>Ixobrychus flavicollis</i>	Inhabits estuarine vegetation especially casuarina glauca trees overhanging brackish water and preys on fish and invertebrates.	High. Suitable foraging and nesting or roosting habitat occurs on site. No evidence found during survey. Site may be a part of a large foraging home range but is unlikely to be large enough to sustain a home territory. One record within 10x10km of the site. No further assessment required.
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of She-oak occur. Feeds almost exclusively on the seeds of several species of She-oak (Casuarina and Allocasuarina species), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites.	Low. No suitable nesting habitat on site. The species of casuarina is not an optimal food species. No tree hollows on site and limited feeding habitat. Not found during survey. Site may be a part of a large home range. 21 records within 10x10km of the site. No further assessment required.
Powerful Owl	<i>Ninox strenua</i>	The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. It requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. It roosts by day in dense vegetation. The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old.	High. No suitable nesting habitat on site, due to lack of tree hollows. Low suitability roosting habitat on site due to lack of dense vegetation and fresh water pools. No evidence such as white-wash or pellets found during survey. Site likely to be part of a large home range and provides some foraging habitat. 119 records within 10x10km of the site. One record from 2013 in the adjacent urban environment north of the site. Further assessment in the form of a 5-part test required. See section 8.3

Sooty Oystercatcher	<i>Haematopus fuliginosus</i>	Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries. Forages on exposed rock or coral at low tide for foods such as limpets and mussels. Breeds in spring and summer, almost exclusively on offshore islands, and occasionally on isolated promontories. The nest is a shallow scrape on the ground, or small mounds of pebbles, shells or seaweed when nesting among rocks.(OEH 2017)	Medium. Medium suitability foraging habitat. No suitable nesting habitat. No impact to habitat due to proposal. 16 Records within 10x10km of the site. Nearest record in 1.2km north-east. No further assessment required.
Swift Parrot	<i>Lathamus discolor</i>	In NSW, mostly occurs on the coast and south west slopes. Migrates to the Australian south-east mainland between March and October. Occur in areas where eucalypt are flowering profusely or where there are abundant lerp infestations.	Low. No suitable breeding habitat or food trees on site. No loss of habitat due to proposal. Not found during survey. Site may be a part of a large home range. 4 records within 10x10km of the site. No further assessment required.
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	The White-bellied Sea-Eagle is found in coastal habitats (especially those close to the sea-shore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. The habitats occupied by the Sea-Eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes and the sea). Breeding has been recorded on the coast, at inland sites, and on offshore islands. The White-bellied Sea-Eagle generally forages over large expanses of open water.	Low. No suitable breeding habitat on site. Not found during survey. Could be part of a large home range. 15 records within 10x10km of the site. No further assessment required.
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Populations disperse within about 300 km range of maternity caves. Breeding or roosting colonies can number from 100 to 150,000 individuals. Hunt in forested areas, catching moths and other flying insects above the tree tops.	High. Not suitable breeding or roosting habitat within site but roosting habitat likely immediately adjacent. The site is suitable foraging habitat. Site may be a part of a large foraging home range. An Eastern Bentwing-bat ultrasonic call was regularly detected onsite. The recording was compared to the "Bat calls of NSW" (Department of Environment and Conservation). The call was at a frequency of 42-46 and had irregular spacing. 60 records within 10x10km of the site. Records from north head and known roosting site at Warringah Mall. Further assessment in the form of a 5-part test required. See section 8.3

Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Can travel up to 50 km from the camp to forage; commuting distances are more often <20 km. Feed on the nectar and pollen of native trees, in particular <i>Eucalyptus</i> , <i>Melaleuca</i> and <i>Banksia</i> , and fruits of rainforest trees and vines.	High. Known roosting sites nearby at Balgowlah, but no roosting habitat within the site. Several individuals were found each survey night. Dead Flying Fox found during the survey. Site is likely to be used as part of a large home range. 72 records within 10x10km of the site. Further assessment in the form of a 5-part test required. See section 8.3
Little Bentwing-bat	<i>Miniopterus australis</i>	Occur in moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.	Low. Not detected during the field survey. Not suitable breeding or roosting habitat within site but roosting habitat likely immediately adjacent. The site is suitable foraging habitat. Site may be a part of a large foraging home range. 3 records within 10x10km of the site. No further assessment required.
Southern Myotis	<i>Myotis macropus</i>	Generally roost in groups of 10 - 15 close to water in caves, mine-shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface.	Medium. Not detected during the field survey. Suitable roosting habitat under Pittwater Rd bridge east of the site. The site is suitable foraging habitat. Site may be a part of a large foraging home range. 11 records within 10x10km of the site. No further assessment required.

4 Discussion

4.1 Area Affected by the Proposed Artificial Light

The predicted illuminance, due to the proposed lighting, throughout Lagoon Park is shown on the attached figure (Apex Lighting, Map dated 6/4/18). The map shows the amount of light that lands on the ground measured in Lux. It does not take into account the blocking (shading) of light due to the branches of the trees around the park.

The surrounding urban environment and the street lighting along Pittwater Road, Bridge Street and Cameron Ave already emit artificial light spill into the ends of Lagoon Park.

The proposed lighting is brightest directly under the poles where the illumination is 10 Lux as shown by a thick black line, the lowest illumination that is shown on the figure is 0.1 Lux as shown by a thin black line.

Due to the angle of the light fittings, light is not thrown equally in all directions from each the light pole.

The area lit with a illuminance of between 10 and 2 lux is mostly exotic mown lawn with scattered trees which has low habitat value.

The higher value vegetated habitat along the banks of the lagoon in the central and eastern parts of the park will be affected by a illuminance of between 2 and 0.2 (Apex Lighting, Map dated 6/4/18).

The dense vegetation along the northern edge of the central parts of the park will shade a large amount of the light that would otherwise shine on the riparian habitat and the lagoon.

The following table from America provides a guide to illumination levels, however, the stated moon light levels may be higher in Australia due to the clearer skies in the southern hemisphere and differences in latitude.

Table 1.1. Illumination from common sources.

<i>Source</i>	<i>Illumination (lux)</i>
Full sunlight	103,000
Partly sunny	50,000
Operating table	18,000
Cloudy day	1,000–10,000
Bright office	400–600
Most homes	100–300
Lighted parking lot	10
Full moon under clear conditions	0.1–0.3
Quarter moon	0.01–0.03
Clear starry sky	0.001
Overcast night sky	0.00003–0.0001

4.2 Increased Use of the Park

The lighting of the path is likely to increase the pedestrian use the park and also the amount of dogs being walked. The existing peak night-time use of the park is mostly restricted to the few hours after dusk. The proposal may extend the peak use time later into the night. The current use of the pathway in the few hours after dusk is already high and any additional intensity of use in this time period is unlikely to lead to any additional deterrent for wildlife. Only the extension of the period of use is likely to change.

The smell and sight of a carnivore such as a dog is known to deter fauna from using an area, which will currently be deterring nocturnal ground dwelling animals such as the Long-nosed Bandicoot and the Water Rat. The individuals that already occur on the site are likely to be habituated to the smell of dogs as the part of the site where they are most commonly found is in the areas most heavily used by dogs.

4.3 Other Potential Changes to Habitat

During the field survey it was noted that there were people feeding the wildlife in the reserve, bread and meat. It is also likely that the BBQ will attract scavenging fauna. These food resources are mostly on the open parts of the site where ground dwelling and normally arboreal animals may be at higher risk of predation. It is not clear if the proposal would increase or decrease this behaviour.

4.4 Scientific Studies on Impacts of Artificial Lighting to Fauna

There is deficiency of research data on the impacts of artificial lighting on fauna and very little information on impacts to native Australian fauna. There was an international conference in 2004 on the subject, unfortunately, it was mostly speculation on what the impact could be and the conference set directions for further research rather than provided research findings. The conference on the impacts of artificial lighting resulted in a book compiling the conference papers and a summary paper by T Longcore and C Rich on the topic (*Ecological Consequences of Artificial Night Lighting* 2006). The review paper concluded that;

“The more subtle influences of artificial night lighting on the behaviour and community ecology of species are less well recognized, and constitute a new focus for research in ecology and a pressing conservation challenge” (Longcore. T and Rich. C 2004)

Similarly, an Australian study on the effects of light on biodiversity by J. Newport et, al. (2014) “found a significant gap in knowledge of the impact of these pollutants on Australian fauna”

The study by Newport et, al. (2014) concluded that:

“Light and noise pollution have the potential to affect physiology, behaviour and reproduction of a range of animal taxa (e.g. turtles, penguins, moths and other invertebrates). Types of effects include changes in foraging and reproductive behaviours, reduction in animal fitness, increased risk of predation and reduced reproductive success. These could have flow-on consequences at the population and ecosystem levels”

Changes in light conditions can also interfere with predator-prey relationships. (Longcore and Rich 2004). Some reports have indicated that artificial lighting can affect the breeding patterns in fauna by causing changes in circadian clocks (Longcore and Rich 2004). Due to the increased risk of predation, some fauna such as frogs will become less selective in choosing mates which could lead to a deterioration in survival rates, artificial lighting has also been known to effect the choice of nest sites in some birds (Longcore and Rich 2004).

A study by Santos C.D et al (2010) found that “nocturnal predators may improve their visual skills due to illumination, or feed on concentrations of insects attracted by artificial lights” however “Some diurnal animals like passerines and falcons are also known to extend their daily activity into the night under artificially improved light conditions. The repercussions of these behavioural changes in ecological systems are largely unknown. Estuaries and coastal wetlands are among habitats most exposed to artificial illumination” (Santos, C.D et al 2010).

Longcore and Rich (2004) have also concluded that “Although it may seem beneficial for diurnal species to be able to forage longer under artificial lights, any gains from increased activity time can be offset by increased predation risk”. “Small rodents forage less at high illumination level”.

Foxes (*Vulpes vulpes*) were found in one study to walk on or near illuminated waterside areas rather than unlit ones. The levels of light used in this study to come to that conclusion is not known.

There is inadequate research data to draw conclusions regarding the likely impacts that the proposed type and illuminance of artificial light proposed may have on the terrestrial fauna species that occur at this site.

Based on the literature the impact of the proposed artificial lighting to terrestrial fauna and the value of their habitat, is mostly unknown but likely to be very low and will reduce further with distance from the path and due to shading by vegetation.

4.5 Assessment of Impacts to Fauna Groups

Ground Dwelling Mammals

Ground dwelling mammals tend to forage near cover such as shrubs, that provide cover from predators such as cats, foxes, owls and frogmouths. This may account for the low numbers of ground dwelling mammals recorded on this site, which lacks a dense shrub cover. The proposed lights are most intense in the open areas of the site (10-2 lux) and emit lower illuminance (2-0.1lux) in the higher habitat value areas more vegetation cover.

Although there is currently little scientific evidence it is possible that ground dwelling mammals avoid areas that have artificial lighting and may be deterred by increased pedestrian and dog presence including the smell of dogs. Avoidance behaviour may affect foraging efficiency resulting in less food being consumed and an overall weight loss and reduced reproductive success. There may also higher risk of predation from large owls, cats, dogs or foxes in lit areas as these predators rely on some light being present. Nocturnal foraging mammals are also adapted to levels of light and bright lighting could lead to temporary blindness, temporarily increasing predation risk. Ground-dwelling mammals at the site are unlikely to forage directly underneath the lights, due to the lack of shrub cover in this area and increased predation risk.

The impact of these factors on the ground dwelling animals on this site such as the native Water Rat, rats and bandicoots is difficult to determine with any certainty. The fauna that were found on this site appear to be already habituated to living with the sight of pedestrians, the smell of dogs and at least some artificial lighting as they were found mostly in the parts of the site where dogs, people and artificial were most prevalent which is adjacent to the urban area and the beach. These individuals are not likely to be further deterred by the proposed path lighting.

There may be other species that are already absent from the site due to these deterrents. The proposed lighting is not likely to have an impact on these species as the lack of shrub vegetation cover is likely to a stronger deterrent than the light spill from the lights.

The illuminance of the light hitting the higher value vegetated parts of the site, where ground dwelling mammals are likely to forage, is low and will be reduced further due to the vegetation cover.

Due to existing light spill from surrounding urban areas, the lack of dense shrub cover and the existing high pedestrian and dog use in vicinity of the site, and the low illuminance of the light spill into the high value habitat areas it is considered that the proposed lights are not likely to have a significant impact on ground dwelling mammals.

Arboreal Mammals

There were few possums found in the park, this may be due to the better foraging resources available in the adjacent urban area and the distance between tree canopies. The possums at the site are likely to be already accustomed to the presence of dogs and people and the light spill from the surrounding urban area.

The dead Ring-tailed Possum found was killed by a car, this threat will not be increased by the proposal. According to the diagram by Apex Lighting (Feb 2018) the light spill will not affect most of the trees adjacent to the residential properties, which are where arboreal mammals are most likely to forage.

The additional lighting of the path is unlikely to significantly affect the arboreal mammal habitat that currently occurs at the site.

Nocturnal Birds

Because of the lack of shrub layer and ground cover the prey items that occur at the park are limited to larger mammals such as possums and flying animals such as flying foxes, which are only food for the larger Powerful Owl. Other smaller owls such as the Barking Owl and Sooty Owl, night jays and frogmouths are less likely to forage at this site due to the poor habitat value for their prey species and more likely to use the more urban parts of their home range.

Powerful Owls are very territorial and the predator pressure they apply is more likely to be limited by territory and the availability of nesting and roosting sites rather than catchability of prey.

A Tawny Frogmouth was observed flying through site during the survey and there are anecdotal reports of frogmouths roosting at the park. Frogmouths have a large home range that would include the park and the surrounding urban area. Frogmouths feed on insects, snails, slugs, small reptiles and small mammals (such as mice). The lawn area that will be impacted by the light spill is low value foraging habitat for Frogmouths as their prey are concentrated in areas with bark and leaf litter. This will not change as a result of the proposal.

There is no clear relevant evidence in the literature regarding the impact of artificial lighting on nocturnal birds. The presence of additional artificial light is likely to slightly increase the predation efficiency of owls, however the increase in light, pedestrians and dogs may also deter their prey.

Nocturnal estuarine birds that forage using visual or partially visual means have been found to increase their foraging behaviour activities in areas that are artificially illuminated. The foraging efficiency will unlikely change as a result of the proposal as there will be little to no light spill over the lagoon water surface. Some potential negative impacts to estuarine birds being drawn to well-lit urban areas include an increased risk of disturbance, being attracted to polluted areas and predation. Increased dog use is likely to be the largest impact to wading birds.

Diurnal Birds

There are adequate roosting and resting areas for diurnal species that are away from the direct light spread. This is due to the light being filtered by vegetation. Increased dog use may disturb some ground resting birds such as ducks.

It is considered that the proposed lighting of the pathways is unlikely to have a significant impact on diurnal birds.

Flying-foxes

Flying-foxes were the most abundant animal found during the survey. They were mostly found in flowering banksia trees and did not seem to show any preference for trees that were darker. Flying-foxes occur abundantly in the urban environment, even where there is substantial lighting. Flying foxes are not known to be deterred by dogs.

The foraging efficiency or predation of fruit bats such as the Grey-headed Flying-fox is unlikely to be impacted. It is unlikely that the increase in the light will significantly impact the Flying-foxes using the site.

Microbats

Fast flying insectivorous bats such as the Eastern Bentwing-bat have been found to prefer foraging under artificial lighting presumably due to an increased abundance of insect prey in brighter areas (Australian Bat Society 2004). Slow flying bats have been recorded as avoiding areas that are artificially lit (Australian Bat Society 2004). This Site already has substantial light spill and the microbat species that have been found on the site are faster flying species.

4.6 Manly LEP 2013 Assessment of Clause 6.5 (3) and (4) relating to Terrestrial Biodiversity

Manly LEP 2013 'Terrestrial Biodiversity Map' shows the subject property is located within an area identified as of 'Terrestrial Biodiversity'.

Therefore, Clause 6.5 of MLEP 2013 applies to this proposal and the objectives of the clause and in particular, points (3) and (4) must be considered concerning this proposal.

Clause 6.5 (3) Assessment

- a) *Whether the development is likely to have:*

- i. Any adverse impact on the **condition, ecological value and significance** of the fauna and flora on the land?

Response: The 10-5 lux illuminance light spill will occur along the path and adjacent areas that are mown lawn. The higher value habitat (areas of native vegetation and the banks of the Lagoon) will be impacted by lower illuminance light (2-0.1 lux). The lights and the subsequent increased dog and pedestrian use may deter some native fauna from the site. The predation risk for small ground dwelling mammals that forage in lit areas may be increased. The foraging efficiency of insectivorous fauna such as microbats which can feed on the insects attracted to the lights, will be improved. Due to the already existing high pedestrian and dog use of the park and the light spill from the adjacent urban area the installation on new lights in the park is unlikely to have a significance adverse impact on the condition ecological value and significance of the fauna on the land.

Any adverse **impact on the importance of the vegetation** on the land to the habitat and survival of native fauna?

Response: The proposal will not have any adverse impact on the importance of the vegetation at the site to the habitat and survival of native fauna.

- ii. Any potential to **fragment, disturb or diminish** the biodiversity structure, function and composition of the land?

Response: There will be no disturbance to the vegetation structure and condition at the site. The habitat function may be altered due to the artificial lighting. Some fauna may be deterred from using the site due to the increased pedestrian and dog use however as the site already has a high pedestrian and dog use it is likely that the impact will not be significant.

- iii. Any adverse impact on the habitat elements providing **connectivity** on the land?

Response: The proposal will not change the access for fauna species to and from the site. The path proposed to be lit runs through the centre of the lagoon park. The connectivity elements of the habitat are mostly the trees along the foreshore and adjacent to the urban areas, which run parallel to the proposed path lighting are and will not be impacted by the light spill.

- b) Are there appropriate measures proposed to **avoid, minimise or mitigate** the impacts of the development?

Response: Recommendations to avoid and minimise ecological impact were given to Council, these were adopted and proposal was changed. The six easternmost lights along the path have been moved to the northern side of the path and will be orientated to the south. This will avoid/reduce the area of the lagoon that will be impacted by the light spill. This report makes recommendations for appropriate measures to avoid, minimise or mitigate the impacts of the proposal. See the *Ameliorative Conditions and Management Recommendations* sections of this report for further information.

Clause 6.5 (4) Assessment

- a) Is the development designed, sited and will be managed to **avoid** any significant adverse environmental impact? OR

Response: The light will only be installed along the pathways where pedestrian use is already quite high and the habitat value is low. After recommendations were made the location of the six easternmost lights along the path was moved to the northern side of the path and orientated to the south. This will avoid/reduce the area of the lagoon that will be impacted by the light spill.

- b) If the impact cannot be reasonably avoided by adopting feasible alternatives—is the development designed, sited and will be managed to minimise that impact? OR

Response: The proposal is designed and sited to reduce significant adverse impacts by having minimal changes to the existing disturbed area. The recommendations and ameliorative conditions in this report provide measures to manage and mitigate impacts.

c) *If that impact cannot be minimised—will the development be managed to mitigate that impact?*

Response: N/A

4.7 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) would only become relevant if it was considered that an impact on a 'matter of National Environmental Significance (NES)' were likely, thus providing a trigger for referral of the proposal to the Department of the Environment and Water Resources.

A Protected Matters search was conducted within a 10km radius of the site and the results are attached as Appendix A. A Protected Matters search is a broad scale assessment that includes World Heritage Properties, National Heritage Places, Wetlands of International Importance, Great Barrier Reef Marine Park, Commonwealth Marine Areas, Listed Threatened Ecological communities, Listed Threatened Species, Listed Migratory Species nuclear actions and water resources in relation to coal seam gas and large coal mining developments. The only relevant categories are Threatened species, Threatened Ecological Communities and Migratory species.

The report lists the following ecologically relevant items:

- 10 Threatened Ecological Community
- 86 Threatened species
- 68 Migratory Species

Most of the migratory and aquatic bird species, as well as the fish, sharks and marine mammals are not assessed in this report. This report addresses terrestrial species, which are likely to have potential habitat on the site.

The proposal is unlikely to have an important impact on any ecological matter of National Environmental Significance.

5 Conclusions

The area to be affected by the artificial light spill is shown on the illuminance map. The highest intensity of illuminance (lux) is directly under each light and is a lux of approximately 10 (Apex Lighting Feb 2018). The area affected by 10 lux is approximately 120m² (0.25ha in total, 8.3% of the site). To avoid and minimise the potential impact the six easternmost lights along the path have been moved to the northern side of the path and will be orientated to the south. As a result there will be little light spill onto the water surface of the lagoon.

The lighting of the path is likely to increase the pedestrian and dog use of the park. The number of the human and dog walking will most likely remain concentrated in the early evening, however, the duration of pedestrians and dogs visiting the site is likely to extend later into the night.

There is currently little scientific evidence regarding the impact of artificial light on native fauna or the fauna species that occur on this site. It is possible that native animals may avoid areas that have artificial lighting and may be deterred by pedestrian and dog presence including the smell of dogs. Avoidance behaviour may affect foraging efficiency resulting in less food being consumed and an overall weight loss and reduced reproductive success. There may also be a higher risk of predation from cats, dogs or foxes in lit areas as these predators rely on some light being present. The impact of these factors on the animals currently living on this site is difficult to quantify with any certainty. Some general comments and

recommendations can be made. The fauna are found on this site appear to be already habituated to living with the sight of pedestrians and dogs, the smell of dogs and at least some artificial lighting as they were mostly found in the parts of the site adjacent to the urban area and the beach, where dogs, people and artificial were most prevalent. Any animals that have a strong aversion to artificial light are not likely to currently occur in the park due the existing light sources.

The nocturnal birds and microbats that occur on this site may be assisted by the proposed additional lighting. The diurnal birds that sleep in the park and the numerous flying-foxes that use the park are not likely change their behaviour due to the proposed lighting.

Based on the knowledge available and the environment at the site the impact of the proposed artificial lighting to terrestrial fauna that occur at the site and the value of their habitat, is likely to be very low and will reduce further with distance from the path and due to shading by vegetation.

The proposed type of path lighting as shown on the attached map is not likely to have an important additional impact to the conservation of any terrestrial fauna species that occurs on the site or that are likely to occur on the site.

6 Ameliorative Recommendations

- This report assumes that the six easternmost light poles will be on the northern side of the path and will be orientated to the south and, as a result, there will be little to no light spill onto the Lagoon.
- The habitat value of the park could be enhanced by widening the riparian vegetation along the lagoon edge and providing clumps of low dense vegetation to provide shelter for ground dwelling fauna and enhance the east - west wildlife corridor.
- Trees that have nectar such as *Eucalyptus robusta*, *Banksia integrifolia*, *Melaleuca quinquinervia*, should be preferentially planted.
- Feeding of wildlife should be discouraged as it may cause health problems and hardship when food is not available.
- Rat baiting should occur only within buildings to avoid killing non target native small mammals and birds.

These recommended actions are likely to have a larger positive effect than any negative effect caused by the installation of the artificial lighting.

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8 Appendix A. Assessments of Significance (5-Part Tests)

8.1 Assessment of Significance for the Grey-headed Flying-fox (*Pteropus poliocephalus*)

Background

The Grey-headed Flying-fox is listed as a Vulnerable species on Schedule 2 of the NSW *Threatened Species Conservation Act 1995* and as a Vulnerable species under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*.

Grey-headed Flying-foxes are generally found within 200km of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia.

This species occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps (Eby, 1995). Urban gardens and cultivated fruit crops also provide habitat for this species. Roosting camps are generally located within 20km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.

Grey-headed Flying-foxes forage on the nectar and pollen of native trees, in particular *Eucalyptus*, *Melaleuca* and *Banksia* (Eby, 2000), and fruits of rainforest trees and vines (OEH, 2001).

Threats to this species include: destruction of habitat by clearing for urban development and agriculture, particularly critical winter foraging habitat in the coastal forests of north east NSW; loss of foraging habitat increases the severity of food shortages leading to starvation of animals, spontaneous abortion and high infant mortality; disturbance at roosting sites, particularly during the last few weeks of pregnancy when females can spontaneously abort; unregulated shooting; electrocution on power lines; competition and hybridization with the Black Flying-fox *Pteropus Alecto* (OEH, 2001).

- a) In the case of a **Threatened Species**, whether the action proposed is likely to have an **adverse effect** on the **lifecycle** of the species such that a **viable local population** of the species is likely to be placed at **risk of extinction**.

Response:

The home range of this population is likely to include all of the Manly and further into Mosman and Warringah. It is unlikely that the proposal would have a significantly adverse impact on the lifecycle of these species considering that there was no roosting colony on the site and it is unlikely that the light will affect the breeding for this species. The light spill will cover the central part of the park only and the majority of the Grey-headed Flying-fox foraging habitat will not be effected. Many Grey-headed Flying-foxes were found foraging on the site in areas adjacent to the urban environment where there is already of light spill and it is likely that an increase light will not deter the Flying-foxes from using the site.

- b) In the case of an **Endangered Ecological Community** or **Critically Endangered Ecological Community**, whether the action proposed:
- i) is likely to have an adverse effect on the extent of the Ecological Community such that its local occurrence is likely to be placed at risk of extinction, or
 - ii) is likely to substantially and adversely modify the composition of the Ecological Community such that its local occurrence is likely to be placed at risk of extinction.

Response:

The Grey-headed Flying-fox is not listed as an Endangered Ecological Community or a Critically Endangered Ecological Community; therefore this question is not applicable.

- c) In relation to the **habitat** of a **Threatened Species**, **Population** or **Ecological Community**:
- i) the **extent** to which habitat is likely to be **removed** or **modified** as a result of the action proposed, and

- ii) whether an area of **habitat** is likely to become **fragmented** or **isolated** from other areas of habitat as a result of the proposed action, and
- iii) the **importance** of the habitat to be removed, modified, fragmented or isolated to the **long-term survival** of the species, population or ecological community in the **locality**.

Response:

(i) No habitat will be removed for this proposal. A small area of low value habitat will be directly affected by the light spill. The majority of the Grey-headed Flying-fox habitat on the site will not be affected by the light spill.

(ii) The Proposal would not result in further fragmentation or isolation of habitat from other areas of habitat for this species. Grey-headed Flying-foxes are a highly mobile species.

(iii) There will be no habitat removed for this proposal. The amount of Grey-headed Flying-fox habitat to be impacted by the lights is very small and it is likely the flying-foxes will still be able to use the site as they do now. Many Grey-headed Flying-foxes were found foraging on the site in areas adjacent to the urban environment where there is already light spill and it is likely that an increase in light will not deter the Flying-foxes from using the site. There is also a lot of similar habitat east of the site.

- d) *Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),*

Response:

There is no declared Area of Outstanding Biodiversity Value on or adjacent to the site. The proposal will not directly or indirectly impact any declared Area of Outstanding Biodiversity Value.

- e) *Whether the action proposed constitutes or is part of a **key threatening process** or is likely to increase the impact of, a key threatening process.*

Response:

Key threatening processes of relevance to this species concerning this proposal are:

- **Destruction of habitat by clearing.** No habitat will be cleared for this proposal.
- **Loss of foraging habitat.** No foraging habitat will be lost for this proposal. The foraging efficiency of Grey-headed Flying-foxes at the site is unlikely to be impacted by the lights.
- **Disturbance of roosting habitat (particularly during winter or breeding).** There were no roosting flying-foxes observed at the site. Grey-headed Flying foxes were observed foraging on the site at night. Any potential roosting habitat at the site is unlikely to be disturbed as the lights will only impact during night-time hours.

Conclusions of impacts on Grey-headed Flying Fox:

The proposal is unlikely to have a significant adverse effect on the local populations of the Grey-headed Flying-fox.

No roosting or breeding colonies were found at the site

The light spill will cover the central part of the park only and the majority of the Grey-headed Flying-fox foraging habitat will not be affected. Many Grey-headed Flying-foxes were found foraging on the site in areas adjacent to the urban environment where there is already light spill and it is likely that an increase in light will not deter the Flying-foxes from using the site.

This conclusion is dependent on the limitations and assumptions described in this report.

8.2 Assessment of Significance (5-Part Test) for Powerful Owl (*Ninox strenua*)

Background

The Powerful Owl is the largest of the owl species in Australasia and it grows up to 65cm in length, with a wingspan up to 140cm and can weigh up to 1.45 kilograms. The upper parts of the body are dark grey-brown barred with white and pale brown. The barring is finer on the crown and coarser on the wings and tail. The facemask is incomplete, dark grey-brown with white streaks. The throat and underparts are cream or pale buff and barred with grey-brown chevron-shaped markings. The eyes are orange-yellow, the bill bone is grey, a grading to black at the tip. The toes are creamy yellow and claws are dark grey (Schodde and Tidemann, 1986).

The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered records on the western slopes and plains, suggesting occupancy prior to land clearing (OEH, 2014).

The Powerful Owl inhabits a range of vegetation types, from woodland to open sclerophyll forest to tall open wet forest and rainforest. This species requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. Breeding and hunting occur in open or closed sclerophyll forest or woodlands and occasionally hunting occurs in open habitats. It roosts by day in dense vegetation. The main prey items are medium sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider (OEH, 2014).

Estimated minimum population size in NSW is 2000 pairs (Debus 1994a, Kavanagh 1997) or at least 10,000 individuals. There have been 121 records of Powerful Owl within a 5km radius of the site. This site provides foraging habitat. No owl species were observed during the field survey and there are no suitable nesting hollows at the site.

- a) *In the case of a Threatened Species, whether the action proposed is likely to have an **adverse effect** on the **lifecycle** of the species such that a **viable local population** of the species is likely to be placed at **risk of extinction**.*

Response:

There is likely to be a local viable population. There are many records of Powerful Owls in the locality and there are areas of vegetation within the locality that are suitable roosting and nesting habitat.

The site and the locality are potential roosting and hunting habitat for the Powerful Owl. The foraging habitat on the site is likely to be a small part of a larger home range and there is a low likelihood that the proposed lighting will interrupt the lifecycle or result in the local extinction of this species. There is no evidence of the Powerful Owl nesting on the site and the hollows onsite are not suitable for the Powerful Owl.

The increased lighting may increase the hunting efficiency of the Powerful Owl as they can more easily see the prey that forage under the light spill. Some of the Powerful Owl's prey may be deterred by the light or the presence of dogs at the park which will reduce the amount of prey available. It is likely that most of the small mammals at the park are accustomed to the presence of dogs and artificial light from the urban areas and will not be discouraged from using the park.

The proposed lighting of the path will not affect the nesting or roosting of the Powerful Owls in the locality. The lighting may improve the hunting efficiency of the Powerful Owls at the site. Therefore, it is unlikely that the proposed lighting will have a significant adverse effects on the lifecycle of the Powerful Owl such that the viable population will be put at risk of extinction.

- b) *In the case of an Endangered Ecological Community or Critically Endangered Ecological Community, whether the action proposed:*
- i) *is likely to have an adverse effect on the extent of the Ecological Community such that its local occurrence is likely to be placed at risk of extinction, or*
 - ii) *is likely to substantially and adversely modify the composition of the Ecological Community such that its local occurrence is likely to be placed at risk of extinction.*

Response:

The Powerful Owl is not listed as an Endangered Ecological Community or a Critically Endangered Ecological Community; therefore, this question is not applicable.

- c) *In relation to the **habitat** of a Threatened Species, Population or Ecological Community:*
- i) *the extent to which habitat is likely to be **removed** or **modified** as a result of the action proposed, and*
 - ii) *whether an area of habitat is likely to become **fragmented** or **isolated** from other areas of habitat as a result of the proposed action, and*
 - iii) *the **importance** of the habitat to be removed, modified, fragmented or isolated to the **long-term survival** of the species, population or ecological community in the **locality**.*

Response:

(i) No Powerful Owl habitat will be removed as a result of the proposal. The proposed lighting will modify some foraging habitat for the Powerful Owl. The majority of the trees where Powerful Owls are likely to sit will not be impacted by the light spill.

(ii) The proposal will not further fragment and isolate Powerful Owl habitat on this or adjacent properties. Powerful Owls are highly mobile and are unlikely to be deterred by the lights and the presence of dogs and people.

(iii) The site does contain foraging habitat for this species, however, there was no evidence of the species using the site for nesting and breeding. Powerful Owls have been recorded within 100 of the site on the northern side of the lagoon. No Powerful Owl habitat will be removed as a result of the proposal. The proposed lighting will modify some foraging habitat for the Powerful Owl. The majority of the trees where Powerful Owls are likely to sit will not be impacted by the light spill.. There are other areas of potential Powerful Owl foraging habitat in the vicinity of the site,

- d) *Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),*

Response:

There is no declared Area of Outstanding Biodiversity Value on or adjacent to the site. The proposal will not directly or indirectly impact any declared Area of Outstanding Biodiversity Value.

- e) *Whether the action proposed constitutes or is part of a **key threatening process** or is likely to increase the impact of, a key threatening process.*

Response:

The Recovery Plan for large forest owl's states:

Threatening processes

For all three species of large forest owl, threats are listed in perceived order of severity (greatest to least) in NSW.

7.1.1 Habitat clearing and fragmentation

Forest clearing and fragmentation for agriculture, pine plantations, mining, major infrastructure and urban developments permanently remove foraging and breeding habitat, affecting all age classes of owls. Forest clearing is widespread but concentrated in the coastal lowlands and foothills on flatter terrain and on the western slopes. Small (less than 200 ha) forest fragments that are more than 1 km from large areas of forest are not used by Powerful and Sooty Owls, but may provide marginal habitat for non-breeding Masked Owls (Kavanagh 1997, Kavanagh and Stanton 2002). Clearing for agriculture in the mid-west of NSW and the demise of open forest and woodland on the coast are the major threats past and present for the Masked Owl.

The likely ability of the owls to disperse over tens of kilometres through a mosaic of forested and cleared land suggests that there are unlikely to be any barriers to gene flow within NSW. Owl populations are unlikely to have declined or been fragmented to the point where their genetic integrity is threatened. However, loss of habitat may have caused permanent regional declines and local extinctions (Debus 1994, Debus and Chafer 1994, Debus and Rose 1994). The situation has probably stabilised for the Sooty Owl, which now occurs mostly in wet escarpment forests on rugged terrain, or on public land where no further deforestation is taking place.

7.1.2 Logging

Intensive logging of wood-production forests has the potential for removing nest sites and roost sites for owls, and den sites for prey species, unless these trees can be identified and protected. Intensive logging and other silvicultural practices such as timber stand improvement, change the age structure of the forest by removing many of the older, hollow-bearing trees resulting in the development of much younger stands containing as few as 10% of the original number of hollow trees (Gibbons and Lindenmayer 1997).

Less relevant threats listed are: Fire, Grazing, Predation, Human hazards, Pest control, Disease and Drought.

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Response:

- **Loss of foraging habitat.** No habitat will be removed as a result of this proposal. The lighting of the pathway may improve the hunting efficiency of the owls at the site
- **Loss of hollow-bearing trees.** No hollows were found on the site and no trees will be removed for this proposal.
- **Disturbance of roosting habitat (particularly during winter or breeding).** The site contains potential suitable roosting habitat for this species, however, no evidence of Powerful Owls roosting or nesting on the site was found during the site survey. The lights will be on during night-time hours and therefore are unlikely to affect any roosting owls.

Therefore, the proposal is unlikely to increase in the impact of a key threatening process to any significant extent.

Conclusions of impacts on the Powerful Owl:

Based on the current proposal described in this report, and taking into consideration the assumptions and limitations described in this report, the proposal is unlikely to have a significant impact on this species.

8.3 Assessment of Significance (5-Part Test) for Microbats

Background

Eastern Bentwing-bat (*Miniopterus shreibersii oceanensis*) The Eastern Bentwing-bat is listed as vulnerable under Schedule 1 of the BC Act. This species occupies a range of forested environments, including wet and dry sclerophyll forests, along the coastal portion of eastern Australia and through the Northern Territory and Kimberley area (Churchill 1998).

This species has a fast, level flight exhibiting swift shallow dives (Dwyer 1995). It forages from just above the tree canopy, to many times the canopy height in forested areas, and will utilise open areas where it is known to forage at lower levels. Moths appear to be the main dietary component (Churchill 1998). This highly mobile species is capable of large regional movements in relation to seasonal differences in reproductive behavior and winter hibernation (Gilmore & Parnaby 1994). It is reliant on large nursery caves for the rearing of its young, which occurs between October and February (Churchill 1998), with substantial

numbers of bats (up to 150,000 individuals) occupying a common nursery cave during the breeding season. They often return to the same nursery site on an annual basis. The Eastern Bentwing-bat primarily roosts in caves, although it has also been recorded in mines, culverts, storm water channels and buildings (Churchill 1998), and occasionally tree-hollows. It occupies a number of roosts within specific territorial ranges usually within 300 km of the maternity cave (Churchill 1998), and may travel large distances between roost sites (Dwyer 1995).

The Eastern Bentwing-bat is threatened by a number of processes including loss of foraging habitat, damage to or disturbance of roosting caves (particularly during winter or breeding), application of pesticides in or adjacent to foraging areas, and predation by feral cats and foxes (OEH 2012b).

Potential foraging and poor quality roosting habitat for this species exists in the site.

Eastern Freetail-bat (*Mormopterus norfolkensis*) The Eastern Freetail-bat is listed as vulnerable in NSW under Schedule 1 of the BC Act and nationally under the EPBC Act. This species is found along the east coast from south Queensland to southern NSW. The following information has been sourced from the OEH Threatened Species Profile for Little Bentwing-bats (OEH 2012b): Eastern freetail-bats occur in dry sclerophyll forest, woodland, swamp forest and mangrove forests east of the Great Dividing Range. This species roost mainly in tree hollows but will also roost under bark or in man-made structures. Eastern Freetail-bats are usually solitary but have been recorded roosting communally, and are probably insectivorous.

Threats to the Eastern Freetail-bats included loss of hollow-bearing trees, loss of foraging habitat and the application of pesticides in or adjacent to foraging areas.

Potential foraging and roosting habitat for this species occurs in the study area.

Little Bentwing-bat (*Miniopterus australis*) The Little Bentwing-bat is listed as vulnerable in NSW under Schedule 1 of the BC Act and nationally under the EPBC Act. This species is found along the east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. The following information has been sourced from the OEH Threatened Species Profile for Little Bentwing-bats (OEH 2012b): Little Bentwing-bats inhabit moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and Banksia scrub. They are generally found in well-timbered areas. They roost in caves, tunnels, tree hollows, abandoned mines, storm water drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. They often share roosting sites with the Common (Eastern) Bentwing-bat and, in winter, the two species may form mixed clusters. Little is known of the breeding biology of this species. Maternity colonies form in spring but only five nursery sites/maternity colonies are known in Australia. In NSW, the largest of these maternity colonies is in close association with a large maternity colony of Common Bentwing-bats (*Miniopterus schreibersii*) and it appears that the Little Bentwing-bat is dependent on the larger colony to provide the high temperatures needed to rear its young. Males and juveniles disperse in summer.

Threats to Little Bentwing-bats include predation from foxes and feral cats, particularly around maternity caves, winter roosts and roosts within culverts, tunnels and under bridges. This species is also threatened by disturbance of colonies, especially in nursery or hibernating caves, destruction of caves that provide seasonal or potential roosting sites, changes to habitat, especially surrounding maternity/nursery caves and winter roosts and the use of pesticides.

Potential foraging and roosting habitat for this species occurs in the study area.

- a) *In the case of a Threatened Species, whether the action proposed is likely to have an **adverse effect** on the **lifecycle** of the species such that a **viable local population** of the species is likely to be placed at **risk of extinction**.*

Response:

There is likely to be a local viable population. The Eastern Bentwing-bat was detected on the site on two occasions during the survey. There are areas of vegetation within the locality that provide suitable roosting and nesting habitat including the nearby Pittwater Road Bridge and there are records of threatened microbats in the locality.

The microbats using the site for foraging are likely to be fast flying bats which have been known to be attracted to lights and take advantage of the surplus of insects attracted to the light (Australian Bat Society). The low illumination lighting along the pathways will unlikely deter any microbats from using the site

The lighting will not impact any roosting or breeding habitat for microbats and may improve the foraging efficiency for some bats.

The proposed lighting of the pathway is unlikely to have an adverse effect on the lifecycle of any microbats such that the viable local population is likely to be places at risk of extinction.

b) *In the case of an Endangered Ecological Community or Critically Endangered Ecological Community, whether the action proposed:*

- iii) *is likely to have an adverse effect on the extent of the Ecological Community such that its local occurrence is likely to be placed at risk of extinction, or*
- iv) *is likely to substantially and adversely modify the composition of the Ecological Community such that its local occurrence is likely to be placed at risk of extinction.*

Response:

Micro-bats are not listed as an Endangered Ecological Community or a Critically Endangered Ecological Community; therefore, this question is not applicable.

c) *In relation to the **habitat** of a Threatened Species, Population or Ecological Community:*

- iv) *the extent to which habitat is likely to be **removed** or **modified** as a result of the action proposed, and*
- v) *whether an area of habitat is likely to become **fragmented** or **isolated** from other areas of habitat as a result of the proposed action, and*
- vi) *the **importance** of the habitat to be removed, modified, fragmented or isolated to the **long-term survival** of the species, population or ecological community in the **locality**.*

Response:

(i) No microbat habitat will be removed as a result of the proposal. The proposal will modify some foraging habitat for microbats.

(ii) The proposal would not result in further fragmentation or isolation of habitat from other areas of habitat for these species as there is a larger area of potential microbat foraging and roosting habitat south of the site.

(iii) No suitable hollow-bearing trees, caves, or storm water channels were recorded within the subject site. As the lights will be on during the night it is unlikely that they will affect any roosting microbats. The proposal may improve the foraging habitat for microbats by increasing the abundance of insects around the lights.

d) *Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),*

Response:

There is no declared Area of Outstanding Biodiversity Value on or adjacent to the site. The proposal will not directly or indirectly impact any declared Area of Outstanding Biodiversity Value.

e) *Whether the action proposed constitutes or is part of a **key threatening process** or is likely to result in the operation of, or increase the impact of, a key threatening process.*

Response:

Key threatening processes of relevance to these micro-bat species concerning this proposal are:

- **Loss of foraging habitat.** The proposal will not remove any habitat for microbats. The lighting may improve the foraging efficiency of the microbats at the site.
- **Loss of hollow-bearing trees.** No hollow bearing tree were found on the site. The proposal will not remove any trees.
- **Disturbance of roosting habitat (particularly during winter or breeding).** This site may contain some potential roosting habitat for microbats and there is roosting habitat nearby. The lighting of the path will be during night time hours only and will not disturb any roosting bats.

Therefore, the proposal is unlikely to increase the impact of a key threatening process to any significant extent.

Conclusions of impacts on Micro-bats:

The proposal described in this report is unlikely to have a significant impact on these species. The lighting will not impact any roosting or breeding habitat for microbats and may improve the foraging efficiency for some bats. This conclusion needs to be read in conjunction with the limitations and assumptions section of this report.

9 Appendix B: EPBC Act 1999 Protected Matters Report