

Interim Lake Macquarie

Large Forest Owl



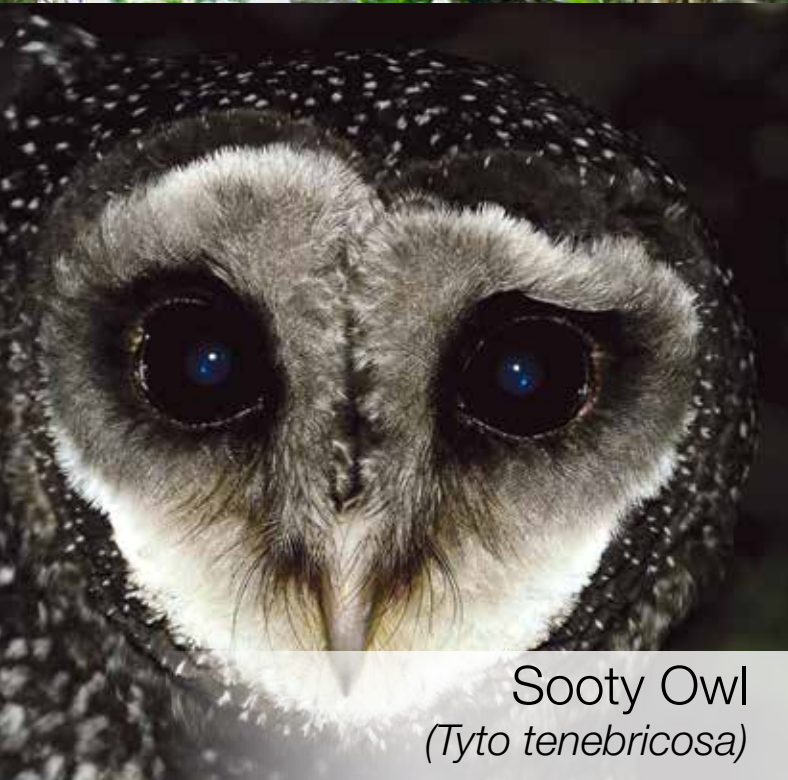
Planning and Management
Guidelines 2014



Powerful Owl
(*Ninox strenua*)



Masked Owl
(*Tyto novaehollandiae*)



Sooty Owl
(*Tyto tenebricosa*)



Barking Owl
(*Ninox connivens*)

Lake Macquarie City Council October 2014

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Sooty Owl (Michael Todd)



Executive summary

The Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*) and Barking Owl (*Ninox connivens*) are listed as threatened (Vulnerable) species in the *NSW Threatened Species Conservation Act 1995* (TSC Act). All species continue to be threatened by clearing of forest and woodland for agriculture, urban development, major infrastructure, mining, pine plantations and intensive harvesting practices for wood production in native forests (Kavanagh, 2002). In particular, these species are susceptible to the felling of old growth forest and woodland as they and their prey are dependent on large hollow bearing trees (Kavanagh, 2002). As top order predators these species have also been recognised for their conservation significance as important 'management indicators' to the health of the broader ecosystem (Forest Fauna Surveys, 1999; Milledge et al., 1991; Kavanagh, 1991).

These large forest owls (Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*) and Barking Owl (*Ninox connivens*)) have all been recorded within the Lake Macquarie Local Government Area (LGA), with Lake Macquarie City Council (LMCC) appearing to be a "hot spot" for conservation of the Masked Owl (*Tyto novaehollandiae*) (Kavanagh, pers. com, 2014). Lake Macquarie is one of the fastest growing urban regions in NSW. This growth is placing significant development pressure on remaining ecosystems, including those that comprise the habitat of large forest owls. It is estimated that up to 5,238 ha or 13% of potential large forest owl habitat within the LGA is likely to be subject to development pressure to 2030.

There is limited scientific understanding of the biology of large forest owls within the Lake Macquarie LGA, particularly with regard to the number of breeding pairs, their home range extent and their significance to the broader population. There is also limited understanding of how urban development affects the biology of large forest

owls within the LGA. For example it is relatively unknown to what extent large forest owls can tolerate habitat loss within proximity to nest and roost sites and to what extent impact can occur without causing a 'significant' impact to the local population (i.e. where 'significance' refers to that defined under Section 5A of the *Environmental Planning & Assessment Act 1979 - EP&A Act*).

These Guidelines aim to support future land use planning and management by providing guidance on species-specific features and planning requirements. The Guidelines also aim to improve certainty for developers and planning staff during assessment of urban land use proposals and in future conservation planning for the species. The Guidelines integrate with strategic land use planning, and include a review of the consequences of projected land use change, and future conservation planning requirements for the species. In the long term this guideline may be used to work toward a landscape-scale conservation planning framework to assist in ensuring that all four species of large forest owls are retained across their existing distribution within the Lake Macquarie LGA.

Key objectives of these Guidelines are to (1) summarise relevant knowledge of the species within the Lake Macquarie LGA to inform planning and management; (2) to provide interim guidelines for land use planning and management activities within the Lake Macquarie LGA; and (3) to identify scientific research priorities for the LGA.

The Guidelines are interim in nature because of the limited current knowledge of large forest owls within the Lake Macquarie LGA, and should be updated following significant advances in knowledge on the species and / or following new planning or large forest owl management information.



1. Background

The Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*) and Barking Owl (*Ninox connivens*) are listed as threatened (Vulnerable) species on the *NSW Threatened Species Conservation Act* (TSC Act). While these threatened large forest owls have been recorded within the LGA, the number of breeding pairs, and their associated home range within the LGA is not known.

This lack of data was identified as an increasing issue during assessment of rezoning and development applications by Council staff, particularly when attempting to quantify the significance of impact to local populations (i.e. as required under Section 5A of the *Environmental Planning & Assessment Act*).

In 2012 and 2013 Lake Macquarie City Council (LMCC) engaged Mr John Young to complete targeted surveys for large forest owls during the known breeding period of April to September (LMCC, 2014a). John Young has over 40 years experience with the breeding biology of Australian owls, working on similar wildlife projects, and has also been engaged by Local, State and Federal Governments for wildlife assessments. The study prioritised areas identified for future residential and employment land investigations by the Lower Hunter Regional Strategy (LHRS), the Newcastle – Lake Macquarie Western Corridor Strategy (NLMWCS), the Lake Macquarie Local Environmental Plan 2014b (LM LEP) and Lake Macquarie Lifestyle 2030 Strategy. Subsequent stages of survey within the LGA may become possible subject to future funding. The study included a number of recommendations including that:

- Data on large forest owls (e.g. records and habitat of conservation priority) continue to be collected, particularly in areas identified for future development early in the planning process; and
- Council work with owl experts to develop a large forest owl Conservation Management Plan (CMP), a biodiversity CMP and/or bio certification of the new LEPs for the LGA (LMCC, 2014a).

In 2014, Lake Macquarie City Council convened a scientific workshop to review the scientific knowledge of the species and current environmental impact assessment practices. This was informed by a number of reports including the:

- *Lake Macquarie Large Forest Owl Study - North West City Sector* (LMCC 2014a);
- *Distribution of Large Forest Owls in the City of Lake Macquarie* (Forest Fauna Surveys, 1999);
- *Recovery Plan for Large Forest Owls* (DEC, 2006); and
- *Draft Recovery Plan for the Barking Owl* (*Ninox connivens*) (NSW NPWS, 2003).

The Guidelines are based on the scientific workshop outcomes (Appendix 1) and consultation with a range of stakeholders.

2. Aims and objectives

The Guidelines aim to establish a landscape-scale conservation framework complemented by site-based measures to assist in ensuring that all four species of large forest owls remain viable across their existing distribution within the Lake Macquarie LGA. It summarises current knowledge of large forest owls within the Lake Macquarie LGA and reviews the implications of this understanding for land use planning and management. The document should be used as a reference for strategic planning and project development assessment within the Lake Macquarie LGA.

Key objectives of the Guideline are to:

- (1) Summarise relevant knowledge of the species within the Lake Macquarie LGA to inform planning and management;
- (2) Provide interim guidance for land use planning and management activities within the Lake Macquarie LGA; and
- (3) Identify scientific research priorities for the LGA.



Powerful Owllet (Kristen Hardy)

Large old growth hollows are required for nesting and roosting.



3. Biology and ecology

An understanding of biological and ecological characteristics is important for informing future planning and management actions. The NSW Recovery Plan (NSW DEC 2006) and draft Recovery Plan (NSW NPWS, 2003) provide a review of biological and ecological characteristics of these species from a statewide

perspective. A local review of large forest owl habitat characteristics has also been completed by Forest Fauna Surveys (1999) and LMCC (2014a). Key habitat characteristics are summarised in Table 1 and mapped national distributions are provided in Map 1. Appendix 2 provides photo examples of nest trees.

MAP 1

National distribution of large forest owls



Powerful Owl distribution



Masked Owl distribution



Sooty Owl distribution



Barking Owl distribution



Masked Owls (Michael Todd)

Table 1:
Key characteristics of large forest owls habitat within the Lake Macquarie LGA

Large Forest Owl	Summary of Key Habitat Characteristics
Powerful Owl	<p>Habitat – Powerful Owl breeding and roosting sites, and also preferred foraging, have been associated with more enclosed forest along creek and gully lines. Foraging also extends into dry and regrowth forest.*</p> <p>Nest & Roost Trees - Nest sites are within hollows of large, old growth, trees. Roost sites tend to be primarily beneath dense foliage within dense forest along creeklines or swamps or side gullies on steep slopes. Within the LMLGA nest trees have included Smooth Barked Apple (<i>Angophora costata</i>) and Sydney Peppermint (<i>Eucalyptus piperita</i>) trees that have hollows west and south-west facing. Hollows have been approximately 15–20 metres high in the tree, of approx. 30–50cm internal diameter and approx. 1–5+ metres deep (see Appendix 2). Nest trees have also tended to be within 100 metres of creeklines.</p> <p>Diet - The Powerful Owl hunts for prey that almost exclusively lives in trees and mostly takes prey which is 50-100% of its own body weight particularly the common ringtail possum in coastal forest, and the greater glider in escarpment forest (Kavanagh, 2002; NSW DEC, 2006).</p>
Masked Owl	<p>Habitat – Primarily open forest and woodland with a sparse understorey or ground cover, or the ecotone between closed forest and open forest or woodland.*</p> <p>Nest & Roost Sites – Nest sites are within hollows and tend to consist of one or two large, old growth, nest trees with an additional 2 to 6 large, old growth, breeding roost trees within relatively close proximity (i.e. within approximately 500 metres of each other). Within the LMLGA nest trees have included Spotted Gum (<i>Corymbia maculata</i>), Smooth Barked Apple (<i>Angophora costata</i>) and Blue Gum (<i>Eucalyptus saligna</i>) trees that have hollows that are vertical, south-east and north-east facing. Hollows have been approx. 12–20 metres high in the tree, of approx. 35–50cm internal diameter and approx. 1–5+ metres deep (see Appendix 2). Nest trees within the LM LGA also tend to be within 100 metres of creeklines, although on occasion have been identified higher in the catchment at great distances from the creekline.</p> <p>Diet - The Masked Owl takes smaller prey, which is 3-20% of its body weight (Kavanagh 2002). Primarily small or medium sized ground fauna, particularly native rodents, supplemented with a few arboreal mammals and birds.</p>
Sooty Owl	<p>Habitat - Sooty Owls have been recorded from wetter sites within gullies and creeklines with dense forest.*</p> <p>Nest & Roost Trees - Within the LMLGA nest trees have included Blue Gum (<i>Eucalyptus saligna</i>) and Smooth Barked Apple (<i>Angophora costata</i>) trees that have south-west and north-east facing hollows. Hollows have been approx. 12 metres high in the tree, of approx. 35–50cm internal diameter and approx. 1–3+ metres deep in a main branch close to the trunk. Nest trees also tend to be within 100 metres of creeklines.</p> <p>Diet – The Sooty Owl tends to be a generalist predator foraging on arboreal and small terrestrial fauna occurring in its more specialised habitat. It particularly favours the common ringtail, but also takes large numbers of sugar gliders and bush rat (NSW DEC, 2006).</p>
Barking Owl	<p>Habitat - No nest sites have been identified for the Barking Owl within the LM LGA and observational records are rare. Surveys within the LGA may however be missing Barking Owls as they are difficult to detect particularly in the vicinity of barking dogs (Kavanagh, pers com. Scientific workshop, 2014).</p> <p>Barking Owls tend to inhabit open woodlands and forest edge habitats where forests adjoin farmlands, effectively creating an open farmland-woodland mosaic. Use of forest interior habitats is less common; in particular the use of extensive areas of moist forest habitat is uncommon with drier woodlands being the most frequented habitat.</p> <p>Nest & Roost Trees – Nesting and roosting tends to occur near watercourses or wetlands in dense foliage including rainforests, <i>Casuarina</i>, <i>Allocasuarina</i>, <i>Angophora</i>, <i>Melaleuca</i> and <i>Eucalypt</i> species particularly red gum species. They typically breed in hollows of large eucalypts or paperbarks.</p> <p>Diet - They forage on a wide range of prey including small and large birds, rabbits, other small ground mammals, arboreal mammals, bats and insects.</p>

Sources: NSW DEC (2006), Forest Fauna Surveys (1999), Kavanagh (2003), SWIFFT(2009), LMCC (2014a) and ngh Environmental (2012).

* Note: Riparian vegetation was flagged at the scientific workshop as being of particular significance as it tends to provide higher quality large forest owl foraging habitat and preferred roosting and nesting habitat for the majority of large forest owl species.



Powerful Owl (Mary Maloney)

Large forest owls are top order predators feeding on large prey species.

Large forest owls have been recognised for their conservation significance as important ‘management indicators’ or ‘target species’ (Forest Fauna Surveys, 1999; Milledge et al., 1991; Kavanagh, 1991). As they are species at the top of the food chain, requiring large territories, their breeding within an area often indicates the health and viability of the broader ecosystem.

The owls tend to live as monogamous, sedentary life-long pairs in large permanent home ranges for approximately 10 to 15 years. Age at first breeding is expected to be approximately one to two years and continues annually, predominantly at the same nest site, with one to two chicks (Kavanagh, 2002 and 2004; NSW NPWS, 2003).

Maps 2 and 3 show the location of existing known records and nest sites within the Lake Macquarie LGA, these include:

- ‘Potential’ nest sites are sites where the nest tree has yet to be located but large forest owl breeding behaviour has been recorded in the last 5 years (e.g. regular observations of large forest owl calls on dusk / dawn and /or sightings of fledglings during the known breeding period);

- ‘Tree no longer present’ nest sites, these are historic nest trees that have either collapsed and / or been impacted by development.



Powerful Owl (Chris Charles)

Owls forage predominantly within 2km of nest sites particularly within riparian habitat.



Masked Owls (Michael Todd)



Masked Owl – Michael Todd



Masked Owl – Michael Todd



Masked Owlet – Michael Todd

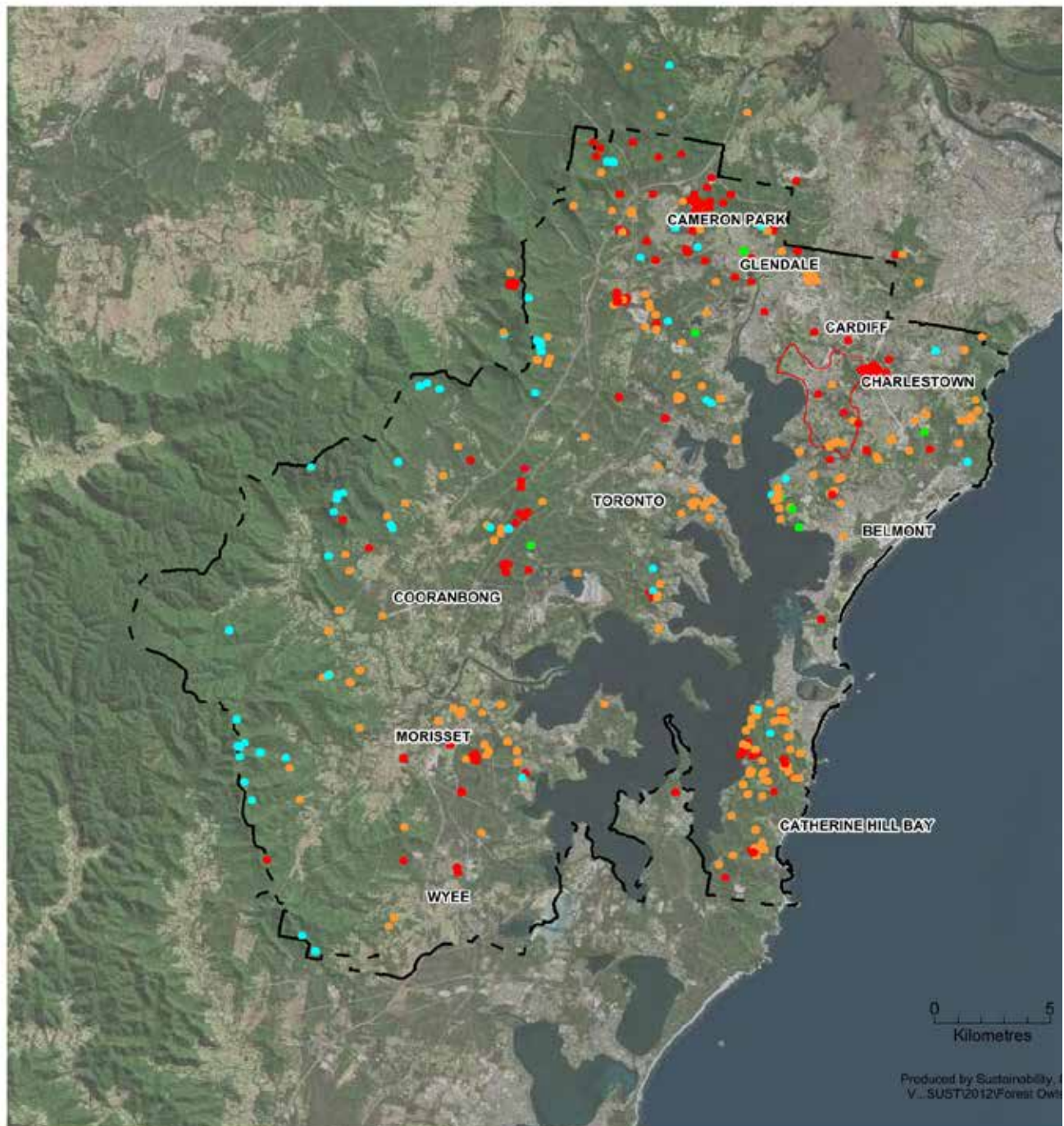
Owls tend to nest in permanent locations that are crucial for breeding.


NSW DEC (2006) estimated the minimum population sizes for NSW at approximately 1,500 pairs for the Masked Owl (*Tyto novaehollandiae*) and 2,000 pairs for the Powerful Owl (*Ninox strenua*) and Sooty Owl (*Tyto tenebricosa*) (NSW DEC 2006). It is unknown how many pairs of Barking Owl (*Ninox connivens*) occur within the state (NSW NPWS, 2003). The number of breeding pairs within the Lake Macquarie LGA is difficult to determine, as adequate systematic survey has not yet been completed. Survey and associated records of large forest owls within the Lake Macquarie LGA tend to occur predominantly where development and/or rezoning applications have occurred. Forest Fauna Surveys (1999) completed some preliminary systematic survey for the Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*) and Masked Owl (*Tyto novaehollandiae*). While this survey improved an understanding of the distribution of owls across the LGA, considerable additional survey effort would be required to confidently determine the number, distribution and home range of breeding pairs within the LGA.

Potential large forest owl habitat is provided in Map 4, based on woodland, forest and rainforest habitat categories developed by Forest Fauna Surveys (2014) and vegetation mapping provided by Bell, Driscoll and LMCC (2014) (Appendix 3). While an estimate of potential habitat is provided, it is not certain that the four large forest owl species occur over the full area of habitat identified as suitable, or that they occur at a consistent density.






MAP 2

Distribution of large forest owl records within the Lake Macquarie LGA



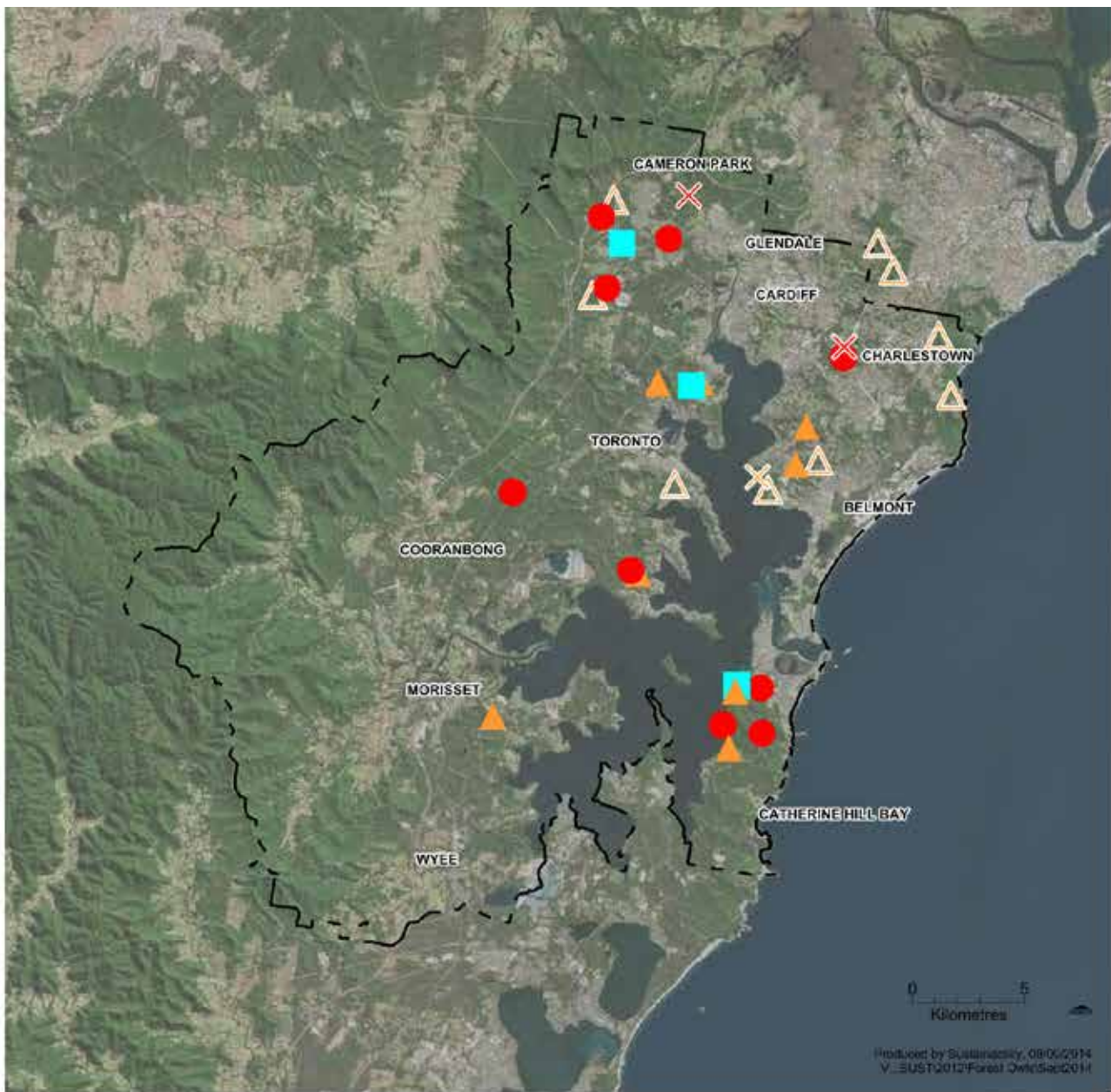
 Lake Macquarie City boundary

Owl records (LMCC fauna database, 15/03/2014)

-  Powerful Owl
-  Masked Owl
-  Sooty Owl
-  Barking Owl
-  Masked Owl radio-tracked in 1994 (multiple records)

Map 3

Distribution of large forest owl nest site records within the Lake Macquarie LGA



— Lake Macquarie City boundary

Nest site records (LMCC fauna database, 15/03/2014)

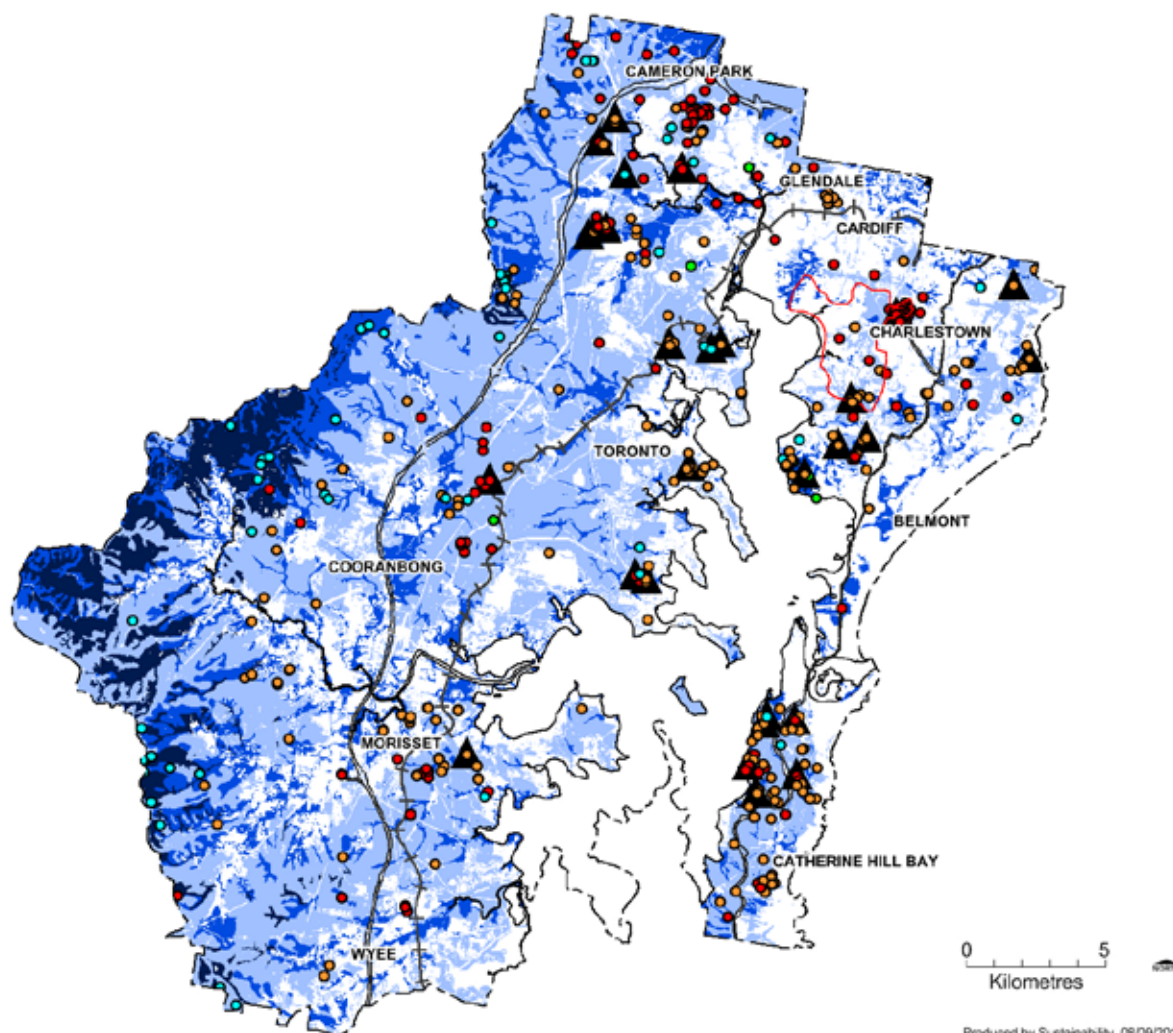
- | | |
|---|---|
| ▲ Powerful Owl: active nest | ● Masked Owl: active nest |
| △ Powerful Owl: potential nest site * | ✕ Masked Owl: tree no longer present ** |
| ✕ Powerful Owl: tree no longer present ** | ■ Sooty Owl: active nest |

* 'Potential' refers to a site where the nest tree has yet to be located but large forest owl breeding behaviour has been recorded in the last 5 years.

** 'Tree no longer present' refers to a historic nest tree that has either collapsed and/or been impacted by development.

Map 4

Potential large forest owl habitat categories



Produced by Sustainability, 08/09/2014
V..SUST/2012/Forest Owls/Sept2014

Owl records

Source: LMCC fauna database, 15/03/2014

- Powerful Owl
- Sooty Owl
- Barking Owl
- Masked Owl
- Masked Owl radio-tracked in 1994 (multiple records)
- ▲ Nest tree *

- Lake Macquarie City boundary
- Highway
- + + + Railway

Potential Large Forest Owl habitat categories **

- Rainforest
- Forest
- Woodland

* Includes active and potential nest sites as per Map 3.

** 'Potential Large Forest Owl habitat' provides a very broad prediction of potential owl habitat that may be used by some and/or all four species and is based on woodland, forest and rainforest habitat categories of Forest Fauna Surveys (2014). An unknown proportion of potential habitat may be unsuitable for some species as there is still a very limited understanding as to the extent that differing species will encroach within differing habitat / vegetation types and/or to what degree they can tolerate territory overlap.

4. Legislative and planning context

Relevant strategic land use planning documents taken into account in reviewing potential future impacts on large forest owls include the:

- Lower Hunter Regional Strategy (LHRS) (NSW Department of Planning 2006) and Newcastle – Lake Macquarie Western Corridor Planning Strategy (NLMWCPS) (NSW Planning 2010);
- Lower Hunter Regional Conservation Plan (LHRCP) (DECCW 2009);
- Lake Macquarie City Lifestyle 2030 Strategy (Lake Macquarie City Council 2013), Lake Macquarie Local Environmental Plan 2014b (LEP);
- NSW Recovery Plan for Large Forest Owls Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*), Masked Owl (*Tyto novaehollandiae*) (NSW DEC 2006) and draft Recovery Plan for the Barking Owl (*Ninox connivens*) Draft Recovery Plan) (NSW NPWS, 2003)

- NSW Threatened Species Priorities Action Statement (PAS) (NSW DECC, 2007) including priority actions that have now been identified for the Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*) and Barking Owl (*Ninox connivens*).

The LHRS (NSW DoP, 2006), NLMWCPS (NSW Planning 2010) and Lake Macquarie Lifestyle 2030 Strategy (LMCC 2013) identify proposed urban, employment and conservation land within the Lake Macquarie LGA. The Lake Macquarie LEP (2014b) also includes large parcels of vegetated land zoned for development and development investigation. Map 5 indicates future urban development and land use in the Lake Macquarie LGA to 2030. Table 2 provides information on the proportion of potential owl habitat within reserves, conservation land and affected by potential future urban development.

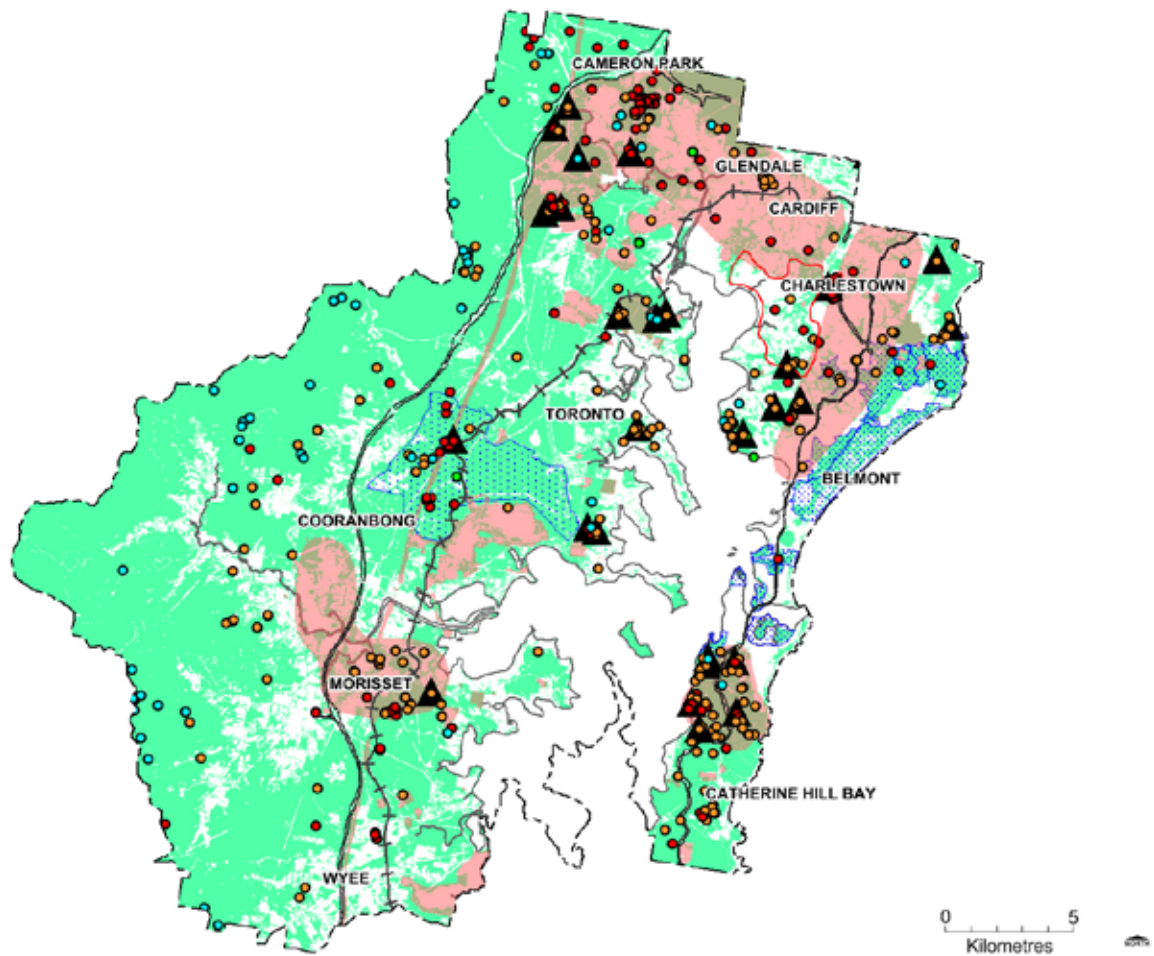
Table 2

Potential large forest owl habitat within the Lake Macquarie LGA and conservation status

Land category / status	Potential habitat (ha)*	Proportion of potential habitat within LGA (%)	No. of confirmed Nests	Potential Nests
Lake Macquarie LGA	41,065	100	20	7
Potential future urban development land to 2030	5,238	13	9	1
National Park and Nature Reserves (E1)	7,303	18	1	2
State Forest	5,037	12	0	0
Conservation zoned land (E2)	17,552	43	9	3
Proposed Lake Macquarie Coastal Wetlands Park	680	2	0	0
Proposed Awaba Conservation Area	2,020	5	1	0
Council owned bushland	1,821	4	3	1
Within 100m of creeklines	21,261	52	12	4
Within 100m of creeklines and marked for potential urban development.	2,126	5	5	0

Map 5

Indicative future urban development and land use in Lake Macquarie LGA to 2030



Produced by Sustainability, 09/09/2014
V...SUST/2012/Forest Owls/Sept2014

Owl records

Source: LMCC fauna database, 15/03/2014

- Powerful Owl
- Masked Owl
- Sooty Owl
- Barking Owl
- Masked Owl radio-tracked in 1994 (multiple records)
- ▲ Nest tree *

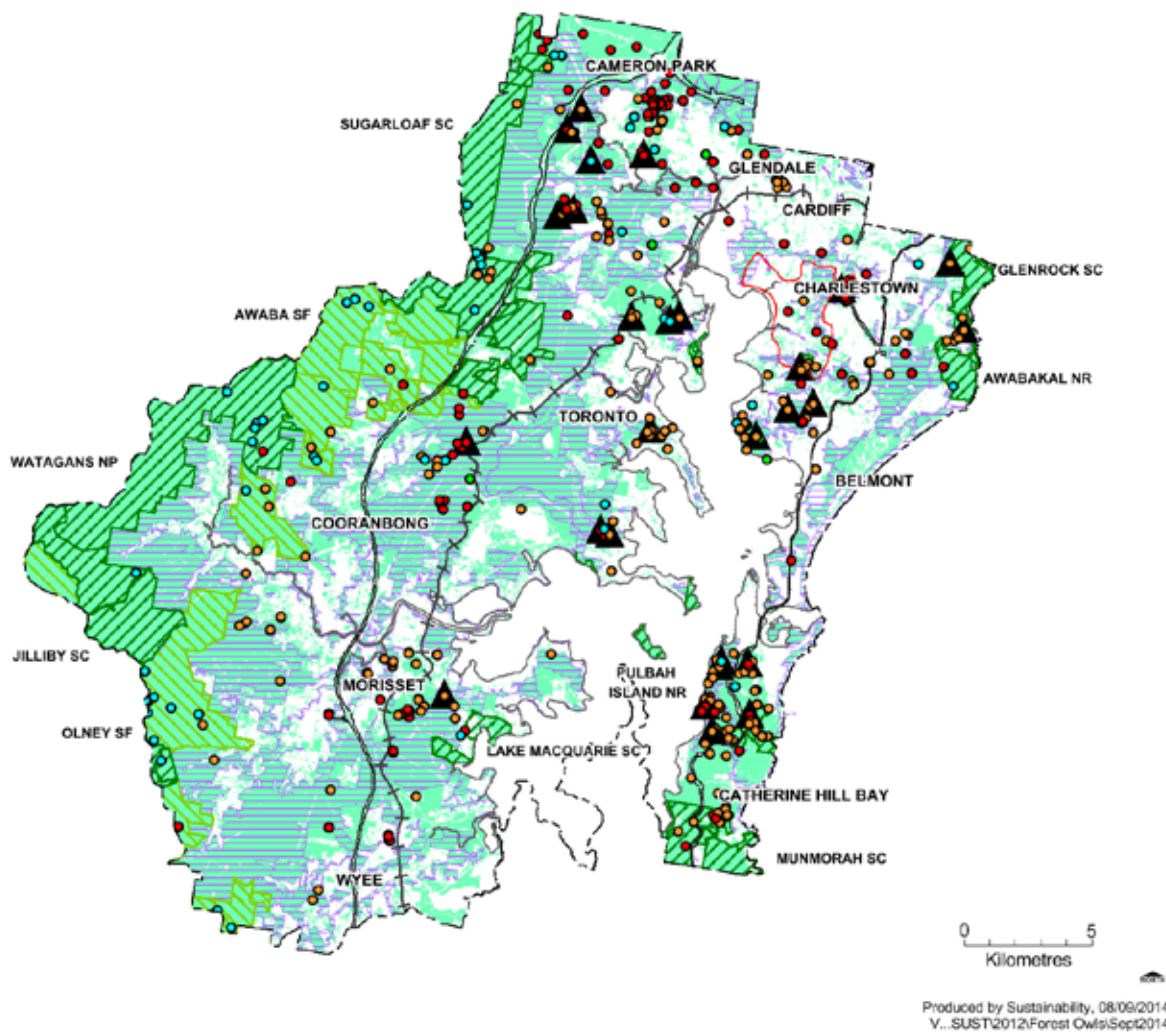
- Lake Macquarie City boundary
- Proposed Awaba Conservation Area
- Proposed Coastal Wetland Park
- Potential Large Forest Owl habitat
- Predicted future urban development & infrastructure to 2030 **
- Highway
- Railway

* Includes active and potential nest trees as per Map 3.

** Source: NSW DoP (2006 & 2010), LMCC (2013 & 2014b)

Map 6

Conservation security of large forest owl habitat within the Lake Macquarie LGA



Owl records

Source: LMCC fauna database, 15/03/2014

- Powerful Owl
- Masked Owl
- Sooty Owl
- Barking Owl
- Masked Owl radio-tracked in 1994 (multiple records)
- ▲ Nest tree *

- Lake Macquarie City boundary
- State Forest
- National Park - E1
- Conservation-zoned land - E2
- Potential Large Forest Owl habitat **
- Highway
- Railway

* Includes active and potential nest sites as per Map 3.

** Includes all potential large forest owl habitat categories as per Map 4.



The Lower Hunter Regional Conservation Plan (LHRCP) (NSW DECC, 2009) sets out a 25-year program to support conservation efforts in the Lower Hunter Valley. The LHRCP identifies west Lake Macquarie as the next highest priority for additional conservation areas with important wildlife linkages, diverse vegetation and large forest owl habitat. The LHRCP also provides guidance on assessing biodiversity gains and losses, as well as implementation mechanisms that can be used for management of conservation land.

The LEP 2014b identifies existing land use within the LGA, including the location of National Parks and Conservation zoned land (Map 6). Habitat within National Parks is considered relatively secure as National Parks are owned and managed primarily for conservation purposes. While land zoned E2 Environmental Conservation affords some protection it is generally considered of lower conservation security than land zoned E1 National Parks and Nature Reserves (i.e. as E2 parcels are often privately owned, not managed for conservation and have been subject to state significant development, rezoning and other urban development proposals in the past). The conservation security of large forest owls within the LGA is considered relatively low with only one known confirmed nest site identified as occurring within a National Park (Map 6). Nine confirmed and three potential nest sites have been identified on E2 Conservation zoned land (Map 6 and Table 2).

The Lake Macquarie Lifestyle 2030 Strategy (LMCC 2013) provides future land use planning direction and includes, amongst other, proposed future conservation reserves. The Lake Macquarie Lifestyle 2030 Strategy includes proposal for the Awaba Conservation Area to be added to the reserve system. While a comprehensive large forest owl survey of this area has yet to be undertaken it is likely to incorporate at least one additional Masked Owl nest site (Todd, 2006)(Map 6).

Strategic conservation objectives and management actions for maintaining viable populations of large forest owls across their distribution are provided in the:

- NSW Recovery Plan for the Large Forest Owls: Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*), Masked Owl (*Tyto novaehollandiae*) (DECC, 2006);
- Draft NSW Recovery Plan: Recovery Plan for the Barking Owl (*Ninox connivens*) (NSW NPWS 2003); and
- NSW Threatened Species Priorities Action Statement (PAS) (NSW DECC, 2007) including priority actions that have now been identified for the Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*) and Barking Owl (*Ninox connivens*).



Barking Owl (John Young)

The distribution of barking owls within the LGA is not well known.



Masked Owl (John Young)

A number of the recovery and priority actions, if implemented, would assist in the conservation of large forest owl habitat in the Lake Macquarie LGA, these include to:

- Implement a regional monitoring program;
- Prepare and disseminate environmental impact assessment guidelines to assist consent and determining authorities and environmental consultants to assess and mitigate the impacts of developments on the large forest owls and their habitat (Action 4.1); and
- Monitor and report on the effectiveness of concurrence and licence conditions that have previously been applied to reduce the impacts of developments on the ... large forest owl species or their habitat (Action 4.2).

While implementation of recovery and priority actions would assist Council in managing large forest owls

within the LGA, the Office of Environment and Heritage (OEH) has not generally pursued recovery actions due to subsequent shifts in approach to conservation in NSW. Conservation approaches have tended to shift from being species focused to being landscape/ ecosystem focused on the general basis that conservation approaches at the landscape /ecosystem level would be applicable to a number of threatened species utilising similar landscapes/ ecosystems. While a landscape and/or ecosystem level approach to conservation is of merit, there is still value in pursuing some of the species-specific actions identified in the Recovery Plans and Priority Action Statements. Recovery and priority actions of particular value include those that are aimed at providing guidance on environmental impact issues that cannot be reliably predicted at the landscape/ecosystem level (e.g. such as the number, location and impact tolerance levels of large forest owl nest and roost sites).



Masked Owl (Michael Todd)

Additional breeding roost trees are also usually required within close proximity to the nest tree.

5. Information gaps

Key information gaps identified during the scientific workshop pertained to questions on what:

- Constitutes a '*local population*' and a '*significant impact*' for the purposes of Section 5A of the EP&A Act?
- Extent can large forest owls tolerate impacts particularly within proximity to nest and roosting resources, preferred foraging habitat along riparian corridors, connectivity corridors and old growth forest fragments?
- Is the amount, location and type of high priority conservation habitat that would facilitate retention of all four species across their current distribution within the LGA (e.g. the amount and location of old growth forest, nest sites, riparian corridors and/or home range extent)?
- Management practices assist in avoiding and mitigating impacts to large forest owls? and
- Future scientific research needs to be prioritised?

Particular effort was made at the scientific workshop to identify ways to better use existing knowledge of large forest owls in planning and management, as well as to help guide and prioritise future research. Outcomes of the workshop are included in Appendix 1.



Powerful Owl (Michael Todd)

Owls forage on a wide variety of prey species.



6. Planning and management issues

This section identifies important issues for strategic conservation and development planning, and describes how large forest owl conservation requirements can be integrated into planning and development processes. It draws on the scientific knowledge of the species and seeks to integrate conservation planning issues with development planning requirements.

Approximately 5,238 ha (i.e. 13%) of potential habitat within Lake Macquarie LGA is likely to be subject to development pressure to 2030. This is based on the extent of development foreshadowed in the relevant planning documents for the Lake Macquarie LGA and the Lower Hunter Region, including the Lake Macquarie Lifestyle 2030 Strategy and the LHRS. Map 5 shows potential long term land use impacts on potential owl habitat within the LGA. Given the proposed location of future urban development, large forest owl conservation planning and management issues are expected to arise.

Matters of importance for strategic planning and land management are discussed below including conservation issues, data and information issues, determining significant impacts arising from development, use of biodiversity offsets, strategic planning objectives, and implementation mechanisms.

6.1 Conservation issues

Currently only one confirmed nest site is known to occur within a National Park (Map 6). While nine confirmed and three potential nest sites have been identified on E2 Conservation zoned land (Table 2), E2 land is often not managed for conservation and has been subject to state significant development, rezoning and other urban development proposals in the past.

A conservation planning framework would aid Council, landowners and other stakeholders in working toward a conservation reserve system that facilitates the retention of large forest owls across their existing distribution in the long term. Such a framework would also aid in identifying

areas of lesser habitat value within the LGA where some loss may be acceptable.

Development of a conservation planning framework would include:

- Improving knowledge on the number of local breeding pairs within the LGA, the location of nest sites and associated habitat of conservation priority;
- Identifying high conservation priority areas and reasonable locations for conservation reserves that would facilitate retention of existing large forest owl distributions within the LGA in the long term; and
- Working with land owners and managers to develop a reasonable approach to long term management.

While at this stage there is limited knowledge of where large forest owl conservation priority areas should be located, it may be possible to provide guidance to identify conservation areas in the future. Sections 7 and 8 of these Guidelines provide interim guidance on measures to address conservation issues.

6.2 Impact Assessment

Determining the significance of impacts in development assessment is important for the purpose of meeting requirements under the EP&A Act and TSC Act. Specific matters important for determining significant impact include:

- Understanding the number of local breeding pairs within the LGA, the location of nest sites and associated habitat of conservation priority and their importance to the local population;
- Identifying the quantity of habitat required for foraging (i.e. prey type and abundance) for large forest owls; and
- Identifying the extent that large forest owls can tolerate habitat loss and disturbance particularly within proximity to nest and roost sites and associated buffers, riparian corridors, connectivity corridors and old growth forest fragments.



Currently, there is no reasonable knowledge of the number of large forest owl breeding pairs within the Lake Macquarie and or how significant these pairs may be to the local, regional and state population. There is also limited understanding of the extent that large forest owls can tolerate habitat loss in relation to urban development. Given these limitations, the significance of a proposed impact is difficult to reliably determine. It is however possible to provide interim guidance for assessing the significance of impact.

Sections 7 and 8 of this Guideline provide interim guidance for impact assessments.



Masked owls often forage on ground fauna and are vulnerable to vehicular strikes.

6.3 Data and information issues

Appropriate information for decision-making is important and requires consistent survey methods. The Lake Macquarie Flora and Fauna Survey Guidelines (LMCC 2013b) refer to survey requirements for large forest owls (Appendix 4).

The Guideline provides further information to support the application of the Lake Macquarie Flora and Fauna Survey Guidelines (LMCC, 2013b).

6.4 Biodiversity offset requirements

Biodiversity offsets are measures used to compensate for the loss of biodiversity values when impacts cannot be avoided or otherwise mitigated. Offsets which increase security of remaining large forest owl habitat and appropriate management, have merit in supporting the persistence of the species. It is useful to provide some guidance about offset requirements within Lake Macquarie LGA particularly to assist in strategic retention of a connected network of viable large forest owl habitat across the LGA.

There are a number of offset methodologies available, but none specifically refer to large forest owls, and in practice most offsets are negotiated. The NSW Biobanking Assessment Methodology is applied extensively as a benchmark for determining offset ratios. However, this methodology does not adequately address large forest owl habitat particularly as:

- There are no specific survey requirements for large forest owls under the Biobanking Assessment Methodology, as these species are treated as ecosystem credit species and do not require assessment of significant large forest owl habitat features such as nest and roost sites;
- Impact to significant large forest owl habitat (e.g. nest trees, breeding roost trees and old growth forest) is offset using ecosystem credits that do not need to guarantee that they have similar and/or improved large forest owl habitat attributes (i.e. it is possible that a nest site and / or significant old growth forest could be removed and offset with disturbed and regenerating forest); and
- Native vegetation corridors are able to be substantially reduced in width and in some instances severed using the methodology, which affects owl prey species and associated owl foraging habitat.



Given this, it is recommended that the Office of Environment and Heritage review the Biobanking credit calculator for large forest owls to

- Assess their suitability to be treated as species credits and if so determine the appropriate survey methods to be used;
 - Re-assess the species credits that can be achieved by certain management actions;
 - Re-assess survey requirements to ensure that significant large forest owl habitat (i.e. such as old growth forest, nest and roost sites and associated buffers and riparian areas) are surveyed; and
 - Ensure that significant habitat features (i.e. particularly large forest owl nest and roost sites and associated buffers) are red flagged (i.e. prohibited unless exceptional circumstances are demonstrated to the Minister).
- o Not depleted but subject to continuing and significant threatening processes which may reduce its extent;
- All remaining occurrences of rare, endangered and vulnerable forest ecosystems should be reserved or protected by other means as far as is practicable. A rare ecosystem is one where its geographic distribution involves a total range of generally less than 10,000ha, a total area of generally less than 1,000 hectares in the region, or patch sizes of generally less than 100 hectares, where such patches do not aggregate to significant areas;
 - Where old growth forest is rare or depleted (generally less than 10% of the extant distribution) within a forest ecosystem, all viable examples should be protected, wherever possible. For other vegetation communities, 60% of the old growth forest would be protected; and
 - To “... maintain viable populations of native forest species throughout their natural ranges”. This is to be achieved partly by ensuring that reserves are “... large enough to sustain the viability, quality and integrity of populations”.

6.5 Strategic planning objectives

Strategic planning objectives are helpful in clarifying and guiding strategic conservation planning within the LGA.

The Lower Hunter Regional Conservation Plan (Department of Environment and Climate Change 2009) applies the agreed national and state JANIS (Commonwealth of Australia 1997) targets for forested environments, old growth forest and fauna species to the Lower Hunter, these include:

- A general principle of 15% reservation of the pre-1750 distribution of each forest ecosystem;
- Where forest ecosystems are recognised as vulnerable, then at least 60% of their remaining extent should be reserved. A vulnerable forest ecosystem is one which is:
 - o Approaching a reduction in areal extent of 70% within a bioregional context and which remains subject to threatening processes; or

Sections 7 and 8 of these Guidelines provide guidance on how this could be applied.

6.6 Implementation mechanisms

Mechanisms for planning implementation include recovery plans, legal conservation / planning agreements, development assessment requirements, dedication / acquisition of conservation reserves, biodiversity offset agreements and management frameworks (including monitoring). The planning and management section of these Guidelines provides guidance on when it may be appropriate to use the differing mechanisms.

7. Planning and management guidelines

7.1 Objectives

Objectives for planning and managing large forest owl habitat within Lake Macquarie LGA include to:

- Maintain viable local populations of all four species of large forest owls across their existing distribution within the Lake Macquarie LGA (i.e. including retention of all confirmed nest sites within the Lake Macquarie LGA and sufficient adjoining foraging habitat to maintain their viability in the long term);
- Apply consistent field survey methods across the LGA;
- Improve their conservation status within the LGA by prioritising the following conservation priority habitat for protection in reserves:
 - Confirmed nest sites (i.e. confirmed nest and breeding roost trees) and sustainable home range extant habitat around such sites;
 - Riparian habitat;
 - Corridor connectivity along riparian corridors and between major habitat fragments; and
 - Old growth forest;
- Identify important large forest owl habitat where no clearing is acceptable.

7.2 Guidelines

Guidelines for planning issues and management actions identified earlier in the document are outlined in Tables 3 and 4. The Guidelines provide supplementary information to the Flora and Fauna Guidelines and are to be considered in strategic planning, conservation planning and development proposals.

Strategic Planning Proposals

The guidelines apply to strategic planning proposals as outlined in Item 3 of Table 3. Where the guidelines apply strategic planning proposals will need to address the following Items in Table 3:

- Include an assessment in accordance with Item 1;
- Aim to protect and enhance conservation priority habitat identified in Item 2;
- Avoid triggering a significant impact at any future development application stage by considering the requirements of Item 4;
- Assess cumulative impacts to large forest owl habitat in accordance with Items 3 and 4; and
- Ensure any proposed offset is consistent with Item 5.

Development Applications

The guidelines apply to development applications as outlined in Item 3 of Table 3. Where the guidelines apply, development applications will need to address the following Items in Table 3 and Table 4:

- Include an assessment in accordance with Item 1 in Table 3;
- Aim to protect and enhance conservation priority habitat identified in Item 2 of Table 3. As a minimum this is to include avoiding triggering a significant impact by addressing requirements of Item 4 in Table 3;
- Assess cumulative impacts to large forest owl habitat in accordance with Item 4 in Table 3;
- Ensure any proposed offset is consistent with Item 5 in Table 3; and
- Ensure any land use and/or management is consistent with Table 4.

Note: These Guidelines are interim in nature and are intended to be applied until further scientific research into the species (i.e. identified in Section 8) is available.

Table 3

Planning guidelines for large forest owls

Item	Planning Issue	Guideline
1	Survey guidelines, analysis and reporting	<p>Field surveys should be undertaken in accordance with large forest owl survey requirements of the Lake Macquarie Flora and Fauna Survey Guidelines (LMCC, 2013b) (Appendix 4).</p> <p>Where a nest and/or breeding roost tree is confirmed an assessment of conservation priority habitat on site is to be provided. As a minimum the assessment should include a plan that clearly shows the proposed rezoning and/ or development footprint in relation to:</p> <ul style="list-style-type: none"> - Confirmed nest and / or breeding roost trees identified on the subject site; - Nest and / or breeding roost tree vegetation buffers (i.e. 100m and 50m respectively) that occur on the subject site; - Riparian habitat and connectivity corridors on the subject site; and - Old growth forest on the subject site. <p>A desktop assessment of home range extent habitat may also be required for larger planning proposals and/or development applications particularly where large forest owl habitat within 2km of confirmed nest sites is below 500ha. Such desktop assessments are to include a plan that clearly identifies habitat fragments / native vegetation within 2km of the confirmed nest site and the area of such fragments.</p> <p><i>Note: The location of large forest owl nest site records should be provided to Council digitally with an accuracy of preferably 1 metre but not made publicly available. While making nest site records publicly available may help to promote awareness of the sites significance and need for protection, there are disadvantages in that it may lead to increased visitation, disturbance and vandalism of the sites. Nest sites and breeding roost sites should only be made publicly available at a scale of 1:250,000 and GPS coordinates only provided to the landowner, or consultants acting on behalf of the landowner, on request and in conjunction with a confidentiality agreement.</i></p>
2	Conservation Priority Habitat & Conservation Planning	<p>Conservation priority habitat currently protected in conservation reserves is not adequate either to protect viable local populations of large forest owls or to conserve large forest owls across their local geographic range. Additional conservation reserves in public ownership or with legal security are required. Areas to be prioritised for conservation reserve investigations include:</p> <p>Confirmed nest and breeding roost trees:</p> <ul style="list-style-type: none"> - All confirmed nest and breeding roost trees are to be retained with minimum 100m and 50m vegetation buffers respectively; and - Corridors of native vegetation, are to be retained between confirmed nest trees, breeding roost trees and riparian corridors. Corridors should be assessed on a site-by-site basis and would preferably be of 100m width. <p>Home range extent habitat:</p> <ul style="list-style-type: none"> - A minimum of 500ha of suitable foraging habitat within a radius of 2km of detected confirmed nest sites is to be prioritised for conservation (see Map 7). - Retained habitat (native vegetation) should be in no more than 3 to 4 large patches as fragmentation can affect quality of foraging habitat (i.e. the number of prey). <p>Riparian habitat:</p> <ul style="list-style-type: none"> - Riparian habitat provides core prey habitat. Riparian habitat also provides preferred roosting and nesting habitat for the majority of large forest owl species. Minimum 25m, 50m, 75m, 100m, 150m and 200m vegetation buffers on both sides of all 1st, 2nd, 3rd, 4th, 5th and 6th order streams within the LGA should be prioritised for conservation across the Lake Macquarie LGA and particularly within 2kms of confirmed nest and breeding roosts (see Map 7). <p>Connectivity corridors:</p> <ul style="list-style-type: none"> - While large forest owls are highly mobile, native vegetation connectivity across the LGA is of particular importance to prey species. Corridors of native vegetation across the LGA to be prioritised for conservation are: <ul style="list-style-type: none"> - Riparian corridors (i.e. vegetation connectivity along creeklines and drainage channels); - Between catchments via ridgelines (i.e. within state forests each 500ha block of forest is connected by undisturbed corridors of 40m width between second-order and 80m width between third-order streams to link neighbouring catchments (NSW DEC, 2006). Similar corridors and associated corridor widths are appropriate for application across the Lake Macquarie LGA); and - Between large habitat patches. Measures to link prey habitat (e.g. glide poles and fauna over/ under passes) should also be used where unavoidable impacts are likely to significantly fragment prey species habitat; and <p>Old growth forest fragments:</p> <ul style="list-style-type: none"> - Old growth forest refers to those areas that have >10 habitat trees per ha with a range of hollow sizes including those greater than 10cm in diameter. Additionally, any forest supporting >3 trees with >80cm diameter at breast height (DBH) per ha. <p>All old growth forest should be prioritised for conservation in accordance with JANIS targets. JANIS targets require that “where old growth forest is rare or depleted (i.e. less than 10% of the extent distribution) within a forest ecosystem, all viable examples should be protected, wherever possible. For other vegetation communities, 60% of old growth would be protected” (NSW DECC, 2009). This criteria should be used as a guide for onsite assessment.</p> <p><i>Note: It is acknowledged that, at the time of adoption of this guideline, the distribution of ‘rare or depleted’ old growth forest within the LGA was unknown. In the absence of this information Councils Biodiversity Planning Policy and Guidelines assessment requirements for ‘Habitat trees’ should be used (LMCC 2012).</i></p>

<p>3 Strategic Planning Proposals and Development Applications</p>	<p>Strategic Planning Proposals and Development Applications should aim to protect and enhance conservation priority habitat. As a minimum, this is to include avoiding triggering a significant impact under Section 5A of the Environmental Planning & Assessment Act (EP&A) Act at the development application stage.</p> <p><i>Note: Single dwelling applications and / or development applications that propose to remove < 1ha of large forest owl habitat on land zoned Residential, Business and / or Industrial, will not be subject to this guideline. Where applications are staged and or lodged incrementally, cumulative amounts of proposed clearing will be assessed as contributing to this 1ha clearing trigger.</i></p> <p><i>Note: Planning proposals seeking to rezone >1ha of large forest owl habitat within 2km of a confirmed nest tree*, will need to consider the cumulative impacts of the proposed land uses on large forest owl habitat. Where the total area of large forest owl habitat within a 2 km radius of a confirmed nest tree (including the land proposed to be rezoned) is <500ha, adequate justification will need to be provided for loss of any further habitat. In the east of the LGA, the amount of habitat remaining around confirmed nest sites* (i.e. that has not been zoned for urban development), is generally reaching and / or already below the minimum 500ha habitat retention threshold. Urban rezoning proposals within these areas, particularly of habitat within land zoned E2 and RU6 under LMLEP2014b, will need to ensure that the viability of nest sites are maintained, and it is expected that development will be limited. In the west of the LGA habitat remaining around confirmed nest sites* is often above the minimum 500 ha vegetation retention threshold, which may afford some flexibility when assessing future planning proposals.</i></p>
<p>4 Determining the significance of development impacts</p> <p><i>Note: Assessing whether a significant impact may occur affects whether a species impact statement (SIS) is required.</i></p>	<p>For the purposes of assessing development applications under Section 5A of the EP&A Act, a significant impact on large forest owls includes an impact which:</p> <ul style="list-style-type: none"> - Encroaches within 100m of confirmed nest trees; - Encroaches within 50m of confirmed breeding roost trees; - Severs vegetation connectivity between a confirmed nest and/or breeding roost tree and adjoining large forest owl habitat; and - Affects connectivity corridors such that prey species are significantly impacted. <p>For the purposes of assessing cumulative impact of development applications under Section 5A of the EP&A Act, a significant impact on large forest owls includes an impact which proposes to remove >1ha of large forest owl habitat on land zoned Environmental Protection, Rural, Recreation and/ or Special Purpose; or >5ha of large forest owl habitat on land zoned Residential/ Industrial and/ or Business, within 2km of a confirmed nest site where:</p> <ul style="list-style-type: none"> - Home range extent habitat within this area has already been reduced to less than 500ha; and - A strategic area wide assessment and a strategic area based plan has yet to be undertaken / prepared. <i>Note: Where loss of large forest owl habitat cannot be avoided on site a strategic area wide assessment may be undertaken and an area based plan prepared which includes suitable provisions of biodiversity offsets to compensate for the loss of foraging habitat.</i>
<p>5 Offsetting</p>	<p>The following habitat features should not to be cleared and cannot be offset:</p> <ul style="list-style-type: none"> - Confirmed nest trees and breeding roost trees and their respective 100 and 50m vegetation buffers; - Potential habitat within 2km of a confirmed nest trees (i.e. that is below the minimum 500ha habitat retention threshold and/or identified as a riparian habitat) (see Maps 7); and - Connectivity corridors. <p>The above features should however be prioritised when seeking offsets for impacts to less significant large forest owl habitat.</p> <p>Offsets should be secured via legal conservation/planning agreements, development assessment and management frameworks (including monitoring).</p>

**Note: While breeding at a confirmed nest site may cease temporarily (i.e. when one of the breeding pair are impacted / killed), the nest site (i.e. the old growth nest and breeding roost trees, associated buffers and adjoining habitat) often become re-used by future pairs. In this regard, historic nest sites should generally be managed and maintained as per confirmed nest sites.*

Table 4

Management guidelines for large forest owls

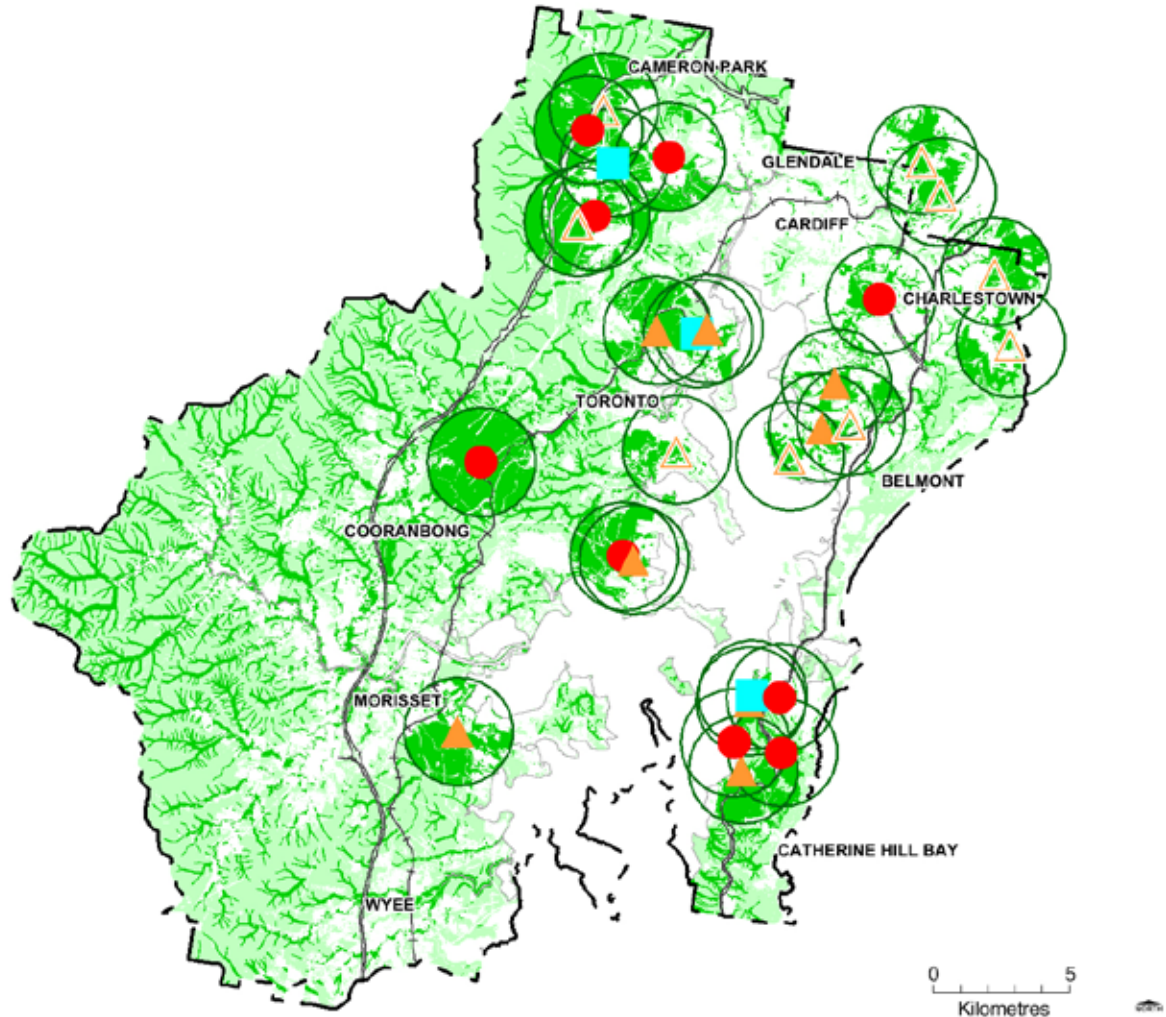
Bushfire	Asset protection zone management such as slashing and fire trails are to be excluded from conservation priority habitat such as nest and roost trees and buffers, riparian habitat and corridors. Nest and roost tree buffer areas should also be excluded and protected from hazard reduction burns. Hazard reduction burns in areas outside of nest tree buffers would also preferably be conducted outside of the large forest owl primary breeding period of March to October.
Services	Service easements should be located outside of nest and roost tree buffer areas. Public authorities should also be notified where nest and breeding roost sites occur on land that they manage.
Grazing and slashing	Grazing, slashing, roads and trails are to be excluded from nest and roost tree buffers, riparian habitat, corridors and/or conservation priority areas.
Roads and trails	
Lighting	Lighting should be directed away from and not interfere with nest and breeding roost trees.
Nest boxes and other mitigation measures	<p><u>Large Forest Owls</u></p> <p>There is currently little evidence to support the use of large forest owl nest boxes and they are not considered an appropriate mitigation tool for impact to large forest owl nest and breeding roost trees. There may be merit however in providing nest boxes as a temporary supplementary measure to compensate for impacts to general roost sites, particularly juvenile roost sites. If installed nest boxes should be:</p> <ul style="list-style-type: none"> - Installed high in emergent trees (i.e. +20metres and/or in the top 20% of the canopy), on major tree limbs and face toward bushland; and - Made of marine ply or equivalent and follow an accredited design (e.g. Thompson, 2006); - Actively managed and/ or removed on completion of the mitigation period. <p>An example of an appropriately designed and installed large forest owl nest box is provided in Figure 1.</p> <p><u>Prey Species</u></p> <p>Nest boxes are of merit for assisting in mitigating justified and unavoidable impacts to large forest owl prey species habitat.</p> <p>Consideration of glide poles and fauna over/underpasses should also be used where unavoidable impacts are likely to significantly fragmented prey species habitat.</p>
Monitoring Development Approvals	<p>Monitoring is an important tool in better understanding how large forest owls respond to development impacts. Development approvals that involve clearing up to the minimum boundary of a nest tree buffer will also require:</p> <ul style="list-style-type: none"> - Monitoring before, during and following construction; - Monitoring results to be submitted annually to Council; - Monitoring results to be publicly published; and - Monitoring to be completed by an owl expert or as otherwise agreed with Council.



Figure 1 - An example of an appropriately designed and installed large forest owl nest box

Map 7

Priority conservation habitat



Produced by Sustainability, 16/09/2014
V...SUST2012/Forest Owls/Sept2014

Nest sites (LMCC fauna database, 15/03/2014)

- Powerful Owl: active nest
- Powerful Owl: potential nest site
- Masked Owl: active nest
- Sooty Owl: active nest

2 km radius from nest trees

Note: Habitat within 2 km of nest trees should be maintained above the minimum 500 ha habitat retention threshold.

- Lake Macquarie City boundary
- Large Forest Owl habitat of conservation priority
- Potential Large Forest Owl habitat



8. Scientific research priorities

The scientific workshop reviewed the priorities for scientific research to support effective planning and management of large forest owls within the Lake Macquarie LGA. Reference to recovery and priority actions identified in the following were considered as part of this process:

- NSW Recovery Plan for the Large Forest Owls: Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*), Masked Owl (*Tyto novaehollandiae*) (DECC, 2006);
- Draft NSW Recovery Plan: Recovery Plan for the Barking Owl (*Ninox connivens*) (NSW NPWS 2003); and
- NSW Threatened Species Priorities Action Statement (PAS) (NSW DECC, 2007) including priority actions that have now been identified for the Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*) and Barking Owl (*Ninox connivens*).

Scientific research priorities identified during the scientific workshop included:

- Investigate how large forest owls respond to development impacts and proposed interim guidance identified during the workshop;
- Improve mapping of large forest owl habitat across the LGA particularly of nest and breeding roost trees and old growth forest;
- Identify the number, location and home range of local breeding pairs within the LGA;
- Identify high conservation priority areas;

- Develop survey methodology to calculate impact to owl habitat (i.e. for ecologist to follow during impact assessment similar to state forests); and
- Amend the Biobanking Assessment Methodology to more appropriately consider large forest owl habitat and offsetting requirements

Recommendations on how these research priorities may be implemented in the longer term have been provided in Appendix 5. Any research project initiated in the future would be subject to Council's financial review and approvals process.



Sooty Owl (Ashley Banwell)

Owls have differing hollow size and shape preferences for roosting and nesting.

9. Conclusions

These Interim Planning and Management Guidelines outline current knowledge of the biology and ecology of large forest owls within the Lake Macquarie LGA and are intended to inform decision-making in relation to the species within the LGA. These Guidelines identify requirements for the conservation of the species in the long term, and aim to provide improved certainty for development within the LGA.

Large forest owl habitat within the Lake Macquarie LGA is expected to be subject to significant future development pressure. These Guidelines outline the possible scale of these impacts and conservation measures that are available based on current knowledge of the species and known potential development.

Given the limited current knowledge of the species, these Guidelines are interim in nature and should be reviewed:

- When scientific information becomes available that can improve on current management and planning advice;
- When future planning and development scenarios change; and/or
- If conservation status of the species changes.



Masked Owl (Michael Todd)



Glossary

Conservation Priority Habitat: Confirmed nest and breeding roost trees and associated 100m and 50m vegetation buffers respectively; minimum home range extent habitat; riparian habitat, connectivity corridors and old growth forest.

Connectivity corridors: Native vegetation linkages across the LGA that are to be prioritised for conservation (i.e. along riparian corridors, between large habitat fragments and that link catchments via ridgelines).

Home range extent habitat: Large forest owl foraging habitat within 2km of confirmed nest trees. Note: Minimum Home Range Extent Habitat refers to a minimum of 500ha of large forest owl habitat being retained within 2km of nest sites to maintain the nests viability in the long term.

Local population: A breeding pair of large forest owls that is local to the Lake Macquarie LGA (i.e. that resides and/or regularly uses habitat within the Lake Macquarie LGA).

Nest site: Confirmed nest trees and breeding roost trees.

Old growth forest: refers to those areas that have >10 habitat trees per ha with a range of hollow sizes including those greater than 10cm in diameter. Additionally, any forest supporting >3 trees with >80cm diameter at breast height (DBH) per ha.

Potential Large Forest Owl Habitat (within Lake Macquarie LGA): All woodland, forest and rainforest habitat categories in Forest Fauna Surveys (2014). Note: 'Potential habitat' provides a very broad prediction of potential owl habitat that may be used by some and/or all four species. An unknown proportion of potential habitat may be unsuitable for some species as there is still a very limited understanding as to the extent that differing species will encroach within differing habitat / vegetation types and/or to what degree they can tolerate territory overlap.

Risk of extinction: the likelihood that the local population will become extinct either in the short-term or in the long-term as a result of direct or indirect impacts on the viability of that population (NSW DECC, 2007).

Riparian Corridor : Vegetation connectivity along creeklines and drainage channels.

Riparian Habitat : Vegetation within 25m , 50m, 75m, 100m, 150m and 200m of the centreline of the first, second, third, fourth, fifth and sixth order streams respectively.

Viable: the capacity to successfully complete each stage of the life cycle under normal conditions (NSW DECC, 2007).

Viable Population: Large forest owl(s) occurring on a site and forming all or part of a local population are assumed to be viable in the absence of adequate scientific information that shows this not to be the case.



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Barking Owl (Brendan Smith)

Appendix 1

Report on scientific workshop

Scientific workshop outcomes - Large Forest Owls

Background to the workshop

The Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*) and Barking Owl (*Ninox connivens*) are listed as threatened (Vulnerable) species on the NSW TSC Act. While these threatened large forest owls have been recorded within the LGA the number of known and active breeding pairs, and their associated home range within the LGA is relatively limited. This lack of data was identified as an increasing issue during assessment of development applications and in strategic planning of the LGA.

In 2012 and 2013 Lake Macquarie Council engaged Mr John Young to complete targeted surveys for large forest owls between the owls known breeding period of April to September (LMCC, 2013). The study was prioritised on areas identified for future residential and employment land investigations by the Lower Hunter Regional Strategy (LHRS), the Newcastle – Lake Macquarie Western Corridor Strategy (NLMWCS) and the Lake Macquarie Local Environmental Plan 2014b (LM LEP), with the view that subsequent stages of survey within the LGA may become possible subject to future funding. Council staff also completed a review of other known records within the LGA.

In 2014 Lake Macquarie City Council convened a scientific workshop to review the scientific knowledge of the species and current environmental impact assessment practices, and to reach agreement on the most effective steps to improve planning and management for the species. The workshop was held on Wednesday 9 April 2014 at Lake Macquarie City Council offices. The workshop was attended by representative scientific specialists with relevant knowledge of taxonomy, field biology, planning and management, and representatives of both state and local government. Those attending the workshop were:

Dr Rod Kavanagh	Niche Environment and Heritage
John Young	John Young Wildlife Enterprises
Dr David Bain	Birds Australia
Michael Murray	Forest Fauna Surveys
Lucas Grenadier	NSW Office of Environment and Heritage

Sarah Warner	LMCC
Symon Walpole	LMCC
Robbie Economos	LMCC
Martin Fallding	LMCC
Mandy McDonald	LMCC

Workshop outcomes are presented below. Key issues to be followed up to facilitate future planning and management for the species are outlined and proposed actions are suggested where appropriate.

Impact Assessment

Proposed impacts often require assessment of whether a local population of threatened species is likely to be significantly impacted such that it is no longer viable (i.e. as required under Section 5A of the Environmental Planning and Assessment Act (EP&A Act)). To address this requirement there needs to be both an understanding of what the 'local population' is and also how the 'local population' responds to impacts proposed.

Determining what constitutes a local population

Without a better understanding of the biology of large forest owls within the Lake Macquarie LGA it is difficult to determine the distribution and density of the 'local population' that occurs within the Lake Macquarie area as required under Section 5A of the EP&A Act.

The following definitions were discussed:

- Distributions for each species as defined in the Recovery Plan for Large Forest Owls, Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*) and Sooty Owl (*Tyto tenebricosa*) ((NSW DEC, 2006) and Draft Recovery Plan for the Barking Owl (*Ninox connivens*);
- 'Local population: the population that occurs in the study area. The assessment of the local population may be extended to include individuals beyond the study area if it can be clearly demonstrated that contiguous or interconnecting parts of the population continue beyond the study area, according to the following definitions.... The local population of resident fauna species comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas

(contiguous or otherwise) that are known or likely to utilise habitats in the study area...Where study area means the subject site and any additional areas which are likely to be affected by the proposal either directly or indirectly. The study area should be extended as far as necessary to take all potential impacts into account' (NSW DECC 2007);

- 'Local - pertaining to or characterized by place or position in space; spatial...pertaining to a city, town, or small district rather than an entire state or country' (Dictionary.com, 2014).

While there is evidence that owls are genetically related across the state and interstate it was acknowledged that the definition of 'local population' for the purpose of Section 5A of the EP&A Act would need to be in this legislative and planning context. Given this there was general consensus that, for large forest owls detected within the LM LGA, a local population should be defined as:

a breeding pair of large forest owls that are likely to use habitat in the study area and that are local to the Lake Macquarie LGA (i.e. that reside predominantly within the Lake Macquarie LGA).

Determining significance of impact to local populations

Without a better understanding of how local populations of large forest owls respond to impacts, particularly urban development impacts, it is difficult to determine if a proposal is likely to significantly affect a local population.

The NSW state forest Threatened Species Conservation Act (TSC Act) licences issued under the Forestry and National Park Estate Act (F&NPE Act) provide requirements for managing state forest impacts to large forest owl habitat. State forest impacts differ to those of urban development in that they tend to be less permanent in nature (i.e. areas tend to be temporarily cleared and then left to regenerate). Impacts such as noise, lighting and road traffic all tend to be greater for urban development than in state forests. While impacts differ between state forest and urban development the state forest licence framework could provide a useful tool in developing impact assessment criteria for urban development. The following large forest owl habitat categories provided below are based on the state forest licence framework.

Nest / roost trees

State forest TSC Act licence agreements require protection of nest and roost sites (NSW DECC, 2006). This requirement was also considered relevant to urban development impacts where there was general consensus that to avoid significant impact, as defined under Section 5A of the EP&A Act, nest and breeding roost trees would need to be retained.

It was also noted that nest and roost sites should be retained as an important resource within the LGA regardless of whether large forest owls temporarily vacate the site for a number of years.

Nest /roost tree buffers

State forest TSC Act licence agreements require vegetation protection buffers to nest and roost sites of 50m and 30m respectively (NSW DECC, 2006). This requirement was considered relevant to urban development, however buffers widths were considered to warrant an increase due to the increased permanency and severity of urban development impacts. Buffer widths previously applied within the LGA were discussed this included:

- 100m buffer widths to nest and roost sites identified in the North Lakes residential subdivision. Owls were monitored at this site for 5 years however were found to stop using the site relatively shortly after development of the site commenced (HWR, 2009);
- 50m buffer widths applied to nest and roost sites in the Stage 14 Wallarah residential subdivision (HCCJRPP, 2010). Owls were monitored and found to persist at the site three years after development commenced. Development is still being constructed in the immediate proximity of the site so it still unknown if the owls will continue to persist post construction. Development at Wallarah is however subject to a number of development controls that require substantial tree retention on individual lots, within conservation areas and along drainage lines. These controls and the level of tree retention on the site was a major consideration in determining buffer widths at Stage 14. As this level of development control and tree retention is not typical of development within the LGA it was not considered appropriate to apply this width as the LGA standard when determining significance of impact under Section 5A.



Masked Owl (Michael Todd)

In the absence of more information on the tolerance levels of large forest owl nest and roost trees to urban development impacts, particularly for new estates that result in substantial clearing and loss of habitat, it was considered the interim guideline should require a:

- Minimum 100m vegetation buffer to all nest trees;
- Minimum 50m vegetation buffer to all breeding roost trees;
- Minimum 100m wide vegetation connectivity corridor between all nest trees and breeding roost trees; and
- Vegetation connectivity between nest / roost trees and riparian corridors.

It was considered that to avoid significant impact, as defined under Section 5A of the EP&A Act, to nest and breeding roost trees that the above buffer widths and vegetation would need to be retained. It was also noted that these buffers and vegetation should be retained as an important resource within the LGA regardless of whether large forest owls temporarily vacate the site for a number of years.

Home range extent

State forest TSC Act licence agreements require a proportion of habitat to be retained within proximity to nest and roost trees to assist in avoiding significant impact to the local populations home range extent. For state forests in southeastern NSW a minimum 300 ha of habitat is required to be retained within a 2km radius of powerful owl and masked owl detection sites and also for the sooty owl in southeastern NSW (NSW DECC, 2006). This requirement was also considered relevant to urban development however, the amount of habitat required to be retained within a 2km radius of nest sites was considered to warrant an increase due to the increased permanency and severity of urban development impacts.

In the absence of more information on the tolerance levels of large forest owls to home range habitat loss to urban development impacts it was considered the interim guideline should prioritise habitat within 2km of nest sites for conservation. In instances where impact is demonstrated to be unavoidable clearing should not exceed a minimum 500ha vegetation retention threshold. Subsequent to the workshop it was also noted that Lyon (et al, 2002) identified '500ha as likely to be smaller than the likely home range of large forest owls but that (this) should provide cores of good habitat from which the owls can range as they need'. Within the state forest context

the 500ha was considered a compromise between what was known about owl home ranges and what was thought to be bureaucratically possible to achieve in the forest management context. In an urban context, such as LMCC, the 500 ha is even more of a challenge given the permanency of impacts. This is why the 500 ha figure was considered a minimum habitat retention threshold. While it recognises that, in some locations (e.g. some old leafy suburbs like Beecroft) that Powerful Owls will forage more widely than just within these 500 ha core areas, that similar information for the Sooty and Masked is very scant, and non-existent for the Barking Owl (Kavanagh, pers. com, 2014) .

In assessments of significance, as defined under Section 5A of the EP&A Act, it was identified that impact to large forest owl habitat within 2km of nest trees should maintain the minimum 500ha habitat retention threshold. It was also noted that retained habitat should preferably be in no more than 3 to 4 patches as fragmentation can affect quality of foraging habitat (i.e. the number of prey).

Riparian Habitat

State forest TSC Act licence agreements recognise riparian habitat as being the higher quality habitat for large forest owls particularly for prey species. Vegetation buffers to riparian corridors are required at widths of 10m, 20m, 30m and 50m either side for 1st, 2nd, 3rd and 4th order streams respectively (NSW DECC, 2006). This requirement was considered relevant to urban development however buffer widths were considered to warrant an increase due to the increased permanency and severity of urban development impacts.

In the absence of more information on the tolerance of large forest owls and their prey to urban development impacts (i.e. particularly to primary habitat along riparian areas) it was considered the interim guideline should:

- Prioritise for conservation large forest owl habitat 25m, 50m, 75m and 100m either side of all 1st, 2nd, 3rd and 4th order streams within the LGA (Smith et al, 2002). Subsequent to the workshop it was also recommended that habitat 150m and 200m either side of 5th and 6th order streams also be prioritised for conservation (i.e. also recommended by Smith et al, (2002)), noting that there are a limited number of these stream orders within the LGA .

The above buffer widths and vegetation need to be prioritised for conservation across the Lake Macquarie LGA and particularly within 2km of nest and breeding roosts.

Connectivity corridors

While large forest owls are highly mobile, vegetation connectivity across the LGA is of particular importance to prey species. State forest TSC Act licence agreements require connectivity corridors along riparian areas as well between large habitat fragments in adjoining catchments. These requirements are also relevant to other areas of the Lake Macquarie LGA, particularly those planned for urban development. In this regard it was considered that vegetation linkages across the LGA should be prioritised for conservation particularly:

- along riparian corridors (i.e. using previously identified buffers widths);
- between catchments via ridgelines (i.e. In state forests each 500ha block of forest is connected by undisturbed corridors of 40m width between second-order and 80m width between third-order streams to link neighbouring catchments (NSW DECC, 2006). Similar corridors and associated corridor widths were considered appropriate to apply across the Lake Macquarie LGA); and
- between large habitat patches. Preliminary identification of large habitat fragment linkages has been completed by Forest Fauna Surveys (1999). This work should be further reviewed and a connected network of large forest owl habitat mapped for the LGA. Glide poles and fauna over/under passes were also considered of merit where unavoidable impacts are likely to significantly fragmented prey species habitat.

Old growth forest fragments

Old growth forest provide an important hollow bearing tree resource for large forest owl nesting, roosting and prey. State forest TSC Act licence agreements require that all areas designated as old growth forest be excluded from logging and that up to 10 hollow bearing trees be retained per 2 ha (NSW DECC, 2006). JANIS targets also require that where old growth forest is rare or depleted (i.e. less than 10% of the extent distribution), that all viable examples be protected and that for other ecosystem types 60% of old growth should be protected (NSW DECC, 2009).

In the absence of a definition for old growth forest it was considered that the interim guideline should include old growth as:

- areas of habitat that have a minimum of 10 fist size hollows (i.e. hollows with an opening diameter of approximately 10cm)/ per ha; or
- habitat with >10 habitat trees per ha with a range of hollow sizes including small to large and very large hollows. Additionally, any forest supporting >3 trees with >80cm DBH per ha.

It was also considered that the interim guideline should require retention of all such old growth forest in accordance with JANIS targets (i.e. to avoid significant impact to large forest owl priority foraging and nesting/roosting habitat).

In the longer term more accurate mapping of old growth forest across the LGA is considered warranted and proposed alternatives have been provided below in the section on future scientific research priorities for the LGA.

Acceptable Loss

The concept of acceptable loss was discussed particularly what would be considered an acceptable loss of habitat within the LGA without significantly impacting large forest owls.

It was considered that habitat identified during the previous discussion for 'Impact Assessment' could be used as the interim basis for what would and would not be considered acceptable loss within the LGA.

Conservation Priority Areas

It was recommended that Council work with landowners within the LGA to identify, protect and manage a network of well-connected high quality large forest owl habitat across the LGA. As an initial step, an active conservation priority map layer could be developed by mapping key habitat features identified during the previous discussion on 'Impact Assessment'. The active map layer could be updated when additional information (e.g. additional nest sites) are identified.

JANIS criteria were discussed. JANIS criteria are a set of biodiversity targets for forested environments agreed to by Australian states and territories and the Australian Government (Commonwealth of Australia 1997). JANIS targets relevant to large forest owl habitat within the Lake Macquarie LGA included to:

- "... maintain viable populations of native forest species throughout their natural ranges". This is to be achieved partly by ensuring that reserves are "... large enough to sustain the viability, quality and integrity of populations".
- Retain all old growth forest where it's rare or depleted (generally less than 10% of the extent distribution) retain all. For other vegetation communities retain 60%; and
- Reserve 15% of the pre-1750 distribution of each forest ecosystem.
- Retain all remaining occurrences of rare, endangered and vulnerable (approaching 70% reduction in area) forest ecosystems; and
- Retain at least 60% of other vulnerable communities.

It was recommended that these JANIS targets also be used to develop the conservation priority map layer for the LGA.

Offsetting

It was noted that the NSW Biobanking Assessment Methodology may not adequately assess the species particularly as:

- Survey requirements for large forest owls under the Biobanking methodology are based on calculating ecosystem credits and do not require detailed survey for significant large forest owl habitat features such as nest and roost sites; and
- Impact to significant large forest owl habitat (e.g. nest trees, roost trees and old growth forest) is offset using ecosystem credits that do not need to guarantee that they have similar and/or improved large forest owl habitat attributes (i.e. it is possible that a nest site and

/ or significant old growth forest could be removed and offset with disturbed and regenerating forest).

It was recommended that a request be made to the Office of the Environment and Heritage to amend the Biobanking credit calculator such that:

- Targeted survey for significant large forest owl habitat is required (e.g. targeted survey for nest and breeding roost trees be required within the species known breeding period);
- Large forest owls are removed from ecosystem credit calculations and new species specific credit calculations formulated;
- Identified large forest owl nest and breeding roost trees and associated buffers be red flagged; and
- Offsetting impacts to large forest owl nest and breeding roost trees, and respective 100m and 50 m buffers, be 'red flagged' under the methodology.

Local offsetting principles were also discussed. Generally, it was not considered appropriate to impact and offset habitat features identified during the previous discussion for '*Impact Assessment*'. Habitat features identified during the discussion on '*Impact Assessment*' should however be prioritised when seeking offsets for impacts to less significant vegetation.

Survey Effort

Large forest owl survey requirements are included in the Lake Macquarie Flora and Fauna Survey Guidelines (LMCC, 2013b). Some additional guidance may also be warranted with regard to the assessment of matters previously discussed for '*Impact Assessment*'.

The sensitivity of large forest owl nest site records was discussed. There is advantage in making these records publicly available as it helps to promote awareness of their significance and need for protection against direct and indirect impacts. There was some concern that making the records publicly available may lead to increased traffic and vandalism of the sites.

It was recommended that nest sites only be made publicly available at a scale of 1:250000 and GPS coordinates only provided to the landowner or consultants acting on behalf of the landowner on request and in conjunction with a confidentiality agreement.

Management

Maintenance Activities

It was recommended that APZs, slashing, grazing and roads / trails be excluded from nest and roost tree buffers, riparian buffers, corridors and/or conservation priority areas. It was also recommended that effort be made to locate service easements outside of these areas and that public authorities be notified where nest and breeding roost sites occur on land that they manage.

Nest and roost tree buffer areas should be excluded and protected from hazard reduction burns. Hazard reduction burns in areas outside of nest tree buffers would also preferably be conducted outside of the large forest owl primary breeding period of March to October.

Lighting should also be directed away, from nest and breeding roost trees.

Mitigation measures

There is little evidence to support the use of large forest owl nest boxes and given this, they are not considered an appropriate mitigation tool for impact to large forest owl nest and roost trees.

Nest boxes were however considered of merit for assisting in mitigating unavoidable impacts to large forest owl prey species habitat. Consideration of glide poles and fauna overpasses was also considered of merit where unavoidable impacts are likely to significantly fragmented prey species habitat.

Monitoring

Monitoring is an important tool in better understanding how large forest owls respond to development impacts. It was recommended that development approvals that involve clearing up to the minimum boundary of a nest tree buffer also require:

- monitoring before, during and following construction;
- monitoring results to be submitted annually to Council; and
- monitoring results be publicly published preferably in a recognised conservation journal.

Future Scientific Research Priorities

Discussions throughout the workshop highlighted a number of deficiencies in the understanding of large forest owls within the Lake Macquarie LGA, particularly with regard to their distribution and density as well as their ability to respond to development impacts. Key areas of future research that were recommended during discussions have been summarised in Appendix 4.



Sooty Owl (Michael Todd)

Appendix 2

Examples of Large Forest Owl Nest Trees

Example of Masked Owl Nest Tree



Example of Powerful Owl Nest Tree



Example of Sooty Owl Nest Tree





Appendix 3

Broad habitat types and vegetation communities of potential large forest owl habitat categories

Owl habitat type	Broad Habitat Type / Category	Vegetation Community Map Unit (Bell and Driscoll, 2014)
Rainforest	Rainforest	1, 1a, 1g, 3e, 46c
	Littoral Rainforest	4
Forest	Wet Sclerophyll Forest	5, 6, 6a, 9a, 9e, 9i, 12, 12a, 12b, 12c, 12d, 15k, 39
	Riparian Forest	5a, 5b, 5e, 5h, 11a, 42c, 114
	Spotted Gum Forest (+/- Ironbark)	12a, 12b, 12c, 12d, 15, 15d, 15h, 15l, 15m, 15n, 17o
	Swamp Mahogany Forest	33c, 37, 37a, 37e, 37f, 37g, 37j, 42, 43
	Forest Red Gum Forest	37d, 38, 38a, 38c, 43f
	Swamp Oak / Melaleuca Forest	40, 40d, 42a,, 43a, 100a, 108b, 110a, 110b
Woodland	Dry Sclerophyll Forest / Woodland	9, 9b, 9d, 9f, 9h, 9l, 11, 21a, 21d, 21f, 21g, 22, 22e, 26h, 33d, 111a, 111c, 112, 119,123.
	Dry Sclerophyll Forest / Woodland with Banksia understorey	15i, 25a, 30, 30a, 30b, 30e, 30f, 30h, 30i, 30j, 31, 31?, 31j, 31k, 33, 33a, 122

Source: Forest Fauna Surveys (2014)



Appendix 4

Large forest owl survey requirements extracted from the LMCC flora and fauna survey guideline (LMCC, 2013)

Table 3
Recommended minimum survey effort for fauna group

Fauna Group	Survey Technique	Survey Period (refer to species specific information for targeted surveys)	Minimum Survey <100 h
Birds			
Nocturnal birds	Quiet listening on a ridge near suitable habitat	Late February to mid August depending on species	Refer to Appendix 8.7
	Formal census (call playback)	Best undertaken outside breeding season (October to January depending on species) or if no response to two consecutive nights of quiet listening during breeding season.	One point census/km ² repeated minimum of 3 visits on non-consecutive nights Note: Alternative methods to playback particularly during breeding season (refer Appendix 8.7 and 8.6)
	Pellet / roost / nest tree searches	Best in breeding season as pellets decompose	Searches of potential roost / nest trees.
	Stagwatch potential roost / nest trees	Best undertaken in breeding season	Observing potential roost hollows for 30 mins - prior to sunset and 60 mins following sunset 3-4 nights and / or mornings, or more if owls are recorded in order to identify nest/roost sites

Nocturnal Birds

Nocturnal birds are often detected only when they vocalise for territory proclamation or social contact (NPWS, 1997). Two techniques are utilised to record the occurrence of nocturnal birds, formal census and opportunistic recordings. Procedures for surveys for owls from an owl expert (John Young) are provided in Appendix 8.7. Whilst John Young does not advocate broadcast of playback recordings, it is a useful survey technique to rapidly assess presence of nocturnal birds and is described below.

Where habitat is present for large forest owls, targeted surveys should be conducted during the preferred breeding season which will vary depending on the species of Owl. Suitable roost and nest site should be stag watched. If owls are detected additional survey will be required to identify roost and nest locations.

Where Owls are detected within the periods specified below, or potential roost / nest trees are present within the study area, Council will require accurate coordinates, identification, and inspection, of potential roost and nest locations.

Critical times for the detection of nest and roost trees (breeding season) include:

Sooty Owls	April to August
Barking Owl	June to September
Powerful Owl	March to August
Masked Owl	February to July (J. Young Pers. Comm. 2 April 2012).

Playback calls should not be used during the breeding season unless quiet listening after dusk and before dawn (refer to Appendix 8.7) for 2 consecutive nights has yielded no records.



The dates and timing of the records and surveys for forest owls are critical and should be documented. For example, calls close to dusk and dawn during the breeding season would indicate close proximity to breeding and roosting sites (J. Young Pers. Comm. 2 April 2012).

Formal Census

The recommended methodology follows that described by York *et al.*, (1991); Kavanagh and Peake, (1993); NPWS and State Forests of NSW (1994) and Debus (1995).

Where fauna surveys are undertaken on land >50 ha in area, nocturnal bird formal census plots should be separated by a minimum distance of 1 km. This minimises the potential for re-sampling of the same birds.

Following dusk, or when arriving at a new survey plot, a quiet listening period of 15 minutes is undertaken, followed by broadcast of recorded calls of threatened species likely to occur. Such species should include the large forest owls, masked owl, sooty owl, powerful owl and barking owl. Other nocturnal bird species include bush stone-curlew, Australasian bittern and black bittern in areas of suitable habitat. Each species call is broadcast for 5 min, followed by 1-2 min of stationary spotlighting after each species broadcast. Following the final broadcast, a quiet listening period of 5 min for audible response and then a foot spotlight search of the area for a further 10 min

should be carried out. Specific details are described in Kavanagh and Peake, (1993); NPWS and State Forests, (1994) and Debus (1995).

Good quality digital recordings of nocturnal birds can be obtained from David Stewart, Nature Sound, Mullumbimby. State Forests of NSW also retail CD recordings of nocturnal birds and animals.

Recommended minimum power rating of broadcasting equipment is 8-10 watts so that calls can be audible for a distance of 600-1,000 m. A loud hailer or suitable speaker connected to an i-pod or portable CD player is sufficient. No census should be undertaken on very windy or rainy periods (York *et al.*, 1991; Kavanagh and Peake, 1993). Consideration should also be given to minimising undertaking playback calls in proximity to residential areas, or during nesting periods of owls.

Opportunistic Observations

Calls of nocturnal birds are often heard whilst undertaking other nocturnal activities, such as spotlight searches. Consultants should be aware of the range of vocalisations of all nocturnal species occurring in the City of Lake Macquarie. Broadcasting of nocturnal bird calls can also elicit vocalism from arboreal mammals. These should be identified and noted in the report (NPWS 1998).

Table 8.2 - 1

Lake Macquarie Fauna Survey Guideline Minimum Requirements and the Level of Survey Undertaken

Fauna Group	Survey Technique	Survey Period	Survey Effort per Vegetation Type	Effort Undertaken and Comments
Birds				
Diurnal birds	Formal census	Summer and winter	1 ha plot for 20 minutes	Forest habitats - A total of 12, 30 minute surveys were undertaken across three days totalling six person hours of survey <u>Disturbed Land</u> – Sampled opportunistically
Nocturnal birds	Formal census	Summer and winter	One point census per square kilometre	Forest habitats - Spotlighting transects were undertaken on two nights, totalling seven person hours of survey - four call playback sessions were also undertaken over two nights (once at each of four sites) <u>Disturbed Land</u> – Sampled opportunistically

8.7.3

FOREST OWL SURVEYS:

Procedure for Surveys from Owl expert John Young

Masked, Powerful and Sooty Owls chiefly breed during the months of late April to mid July. The most effective results for identifying these four species is **from late February through to mid May**. For Barking Owls the breeding season is **from June to September**. This is the time for the most effective results in detecting the Barking Owl.

With the onset of breeding season pairs are usually found within close proximity to the nest site, especially during the first half hour after dark and last half hour before dawn. Surveys undertaken at other times are unlikely to identify the owls even when they are present.

Following is the recommended approach to identifying the presence of these species of owls.

Step One. Assess habitat for the likely location or area in which a pair of owls may be present. Locate position on highest vantage point possible in order to hear and survey a large area, i.e. tree, elevated ridge. Attempting to locate these birds by their call from the bed of a gully is extremely difficult as sound does not travel as far, and noises deflected off tree trunks. It makes it difficult to accurately determine direction of owl's call.

Step Two Take up vantage position no later than 20 minutes before dusk and for at least one half hour into total darkness. Between late February and mid May is the most important time of the year for Masked, Powerful and Sooty Owls as these species will be close to their breeding territories. For Barking Owls the most important time is from June to August. The first calls of the evening, especially just on dusk, will usually indicate a breeding territory because the owls have had no time to move. If a call is recorded, it is a good idea to repeat this

method a further 1-2 evenings for cross reference. The researcher should take care to remain quiet during this period, excessive noise can affect the success of surveys for these birds.

Step Three If no call is detected during this period, refer to the playback method of Kavanagh and Peake (1993), NPWS and State Forests (1994) and Debus (1995). In some instances a pair of owls will not respond to broadcast of pre-recorded calls. All 4 species of threatened owls are more than capable of approaching quietly and not indicating their presence.

Step Four One of the most successful techniques for identifying the presence of large forest owls is to squeak by mouth, like a distressed bird or rat. This will frequently lure the owls out into the open as they rapidly approach seeking the invisible meal. If you cannot squeak by mouth, then a piece of polystyrene rubbed on glass will give a similar effect.

Step Five At day break or just before dawn is generally the best time of all for sitting quietly in the owl's territory. As it is getting light, all four species will often farewell the night by calling as they go to their day time roosts. This frequently gives away a home site, or in the case of the Powerful Owl, the day time roost location.

Sampling effort

Debus (1995) notes that sampling effort may require repeated sampling over time to determine the presence of threatened large forest owls. The recommended number of visits to determine the presence or absence of threatened large forest owls, with 90% confidence is 7 for Powerful Owl, 8 for Sooty and 9 for Masked Owl (Debus, 1995).

8.8 APPENDIX

Suitable times for clearing and disturbance to avoid loss of threatened species – key life cycle periods for Threatened fauna

Forest Owls	Large or connecting areas of forest with areas of large hollow bearing trees for nesting and depending on the species, a supply of arboreal and terrestrial mammals as a food source	Mainly breed in the Autumn/ Winter period although the Masked Owl can breed any time of the year and the Barking Owl breeds Winter/ Spring	Protect known nesting and roosting trees with a 100m buffer zone Avoid vegetation removal during the breeding season so as to retain the prey supply for feeding the chicks Protect riparian vegetation with an adequate buffer zone for breeding of prey species
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Appendix 5

Further research priorities and implementation

Future Scientific Research Priority	Potential method	Potential Responsibility*	Research priority (high, medium or low)*
Investigate how large forest owls respond to development impacts and proposed interim guidance identified during the workshop.	Continue to monitor and make publicly available results required by development consent conditions (e.g. at Wallarah).	Landowner / developer and LMCC staff	High
To improve mapping of large forest habitat across the LGA.	<p>Design an independent survey to derive the quality of data needed for proper habitat assessment and modelling, this may include</p> <ul style="list-style-type: none"> - Mapping of emergent trees at sample points across the LGA by identifying larger crowns from LiDAR/ aerial photos; and/or - Completing a rapid point assessment across the LGA that records habitat hollow size/number, crown diameter and DBH along set transects. Sample points across the LGA could be similar to those used by Bell, Driscoll and LMCC (2014) for the vegetation-mapping project; and/or - Mapping age of clearing across the LGA from historic aerial photographs; and/or - Completing a literature review of previous flora and fauna studies that included habitat tree assessments (e.g. that were completed for development applications and rezonings) to get a better understanding of the local definition of old growth; and/or - Designing an independent survey to derive the quality of data needed for proper assessment and modelling. 	LMCC staff and/or collaboration with Universities, Birds Australia or consultant.	Medium
To improve mapping of nest and breeding roost sites across the LGA and associated home range extent.	Seek funding to complete a systematic survey of large forest owls, particularly of nest sites within the LM LGA.	LMCC staff	Medium
	Continue ecological investigations currently being completed for the Birds Australia Powerful Owl Project (i.e. that could be potentially expanded to cater for other species).	Potentially Birds Australia with support from LMCC staff (e.g. community engagement staff)	High
	Ensure ecological assessments for planning proposals and development applications are consistent with the LMCC Flora Fauna Survey Guideline (2013).	Landowners and LMCC staff	High



Future Scientific Research Priority	Potential method	Potential Responsibility*	Research priority (high, medium or low)*
<p>Improve conservation priority area mapping and management.</p>	<p>Update the Interim Conservation Priority Map layer as new information becomes available.</p> <p>Complete a review on the priority map layer such that it meets the following JANIS targets:</p> <ul style="list-style-type: none"> - A general principle of 15% reservation of the pre-1750 distribution of each forest ecosystem; - Where forest ecosystems are recognised as vulnerable, then at least 60% of their remaining extent should be reserved. A vulnerable forest ecosystem is one which is: <ul style="list-style-type: none"> o Approaching a reduction in areal extent of 70% within a bioregional context and which remains subject to threatening processes; or o Not depleted but subject to continuing and significant threatening processes which may reduce its extent; - All remaining occurrences of rare, endangered and vulnerable forest ecosystems should be reserved or protected by other means as far as is practicable. A rare ecosystem is one where its geographic distribution involves a total range of generally less than 10,000ha, a total area of generally less than 1000 hectares in the region or patch sizes of generally less than 100 hectares, where such patches do not aggregate to significant areas; - Where old growth forest is rare or depleted (generally less than 10% of the extant distribution) within a forest ecosystem, all viable examples should be protected, wherever possible. For other vegetation communities, 60% of the old growth forest would be protected; and - To "... maintain viable populations of native forest species throughout their natural ranges". This is to be achieved partly by ensuring that reserves are "... large enough to sustain the viability, quality and integrity of populations". 	<p>LMCC staff</p>	<p>High</p>

Future Scientific Research Priority	Potential method	Potential Responsibility*	Research priority (high, medium or low)*
<p>Develop survey methodology to calculate impact to owl habitat (i.e. for ecologist to follow during impact assessment similar to state forests).</p>	<p>Update the LMCC Flora and Fauna Assessment Guidelines to reflect interim guidance provided in the discussion on 'Impact Assessment'. It is also important that Council staff work with OEH to review the Biobanking methodology and how it is applied to these species.</p>	<p>LMCC Staff</p>	<p>High</p>
<p>Amend the Biobanking Assessment Methodology</p>	<p>It is recommended that a request be made to the Office of the Environment and Heritage to amend the Biobanking credit calculator such that:</p> <ul style="list-style-type: none"> - Targeted survey for significant large forest owl habitat is required (e.g. targeted survey for nest and breeding roost trees be required within the species known breeding period); - Large forest owls are removed from ecosystem credit calculations and new species specific credit calculations formulated; and - Proposed impact to significant large forest owl habitat features is 'red flagged' (i.e. particularly to large forest owl nest and breeding roost trees, respective 100m and 50m buffers, the vegetation connection between the nest tree and the breeding roost and the vegetation connection between the nest/breeding roost tree and riparian habitat). 	<p>LMCC Staff and OEH</p>	<p>High</p>

*Responsibility and Research Priority allocated subsequent to the workshop.



Powerful Owlets (Kristen Hardy)