8 Mitigation Measures

8.1 AVOID AND MINIMISE

Although the initial pipeline route attempted to avoid large patches of vegetation and minimise creek crossings, it would still have impacted on approximately 17.45 ha of EEC. Sydney Water and ELA undertook site inspections to realign routes wherever possible so that the impact due to the Proposal is reduced to only 2.1 ha of EEC.

As detailed design progresses, pipeline alignments may continue to be refined. The following ongoing considerations will assist in minimising potential impacts on riparian and aquatic habitats:

- Where pipelines run parallel to drainage lines, alignments have been placed outside the ‗top of bank'. This approach reduces creek crossings, prevent changes in erosion processes during high flows and allow for potential re-establishment of riparian vegetation
- Where pipelines cross a drainage line, preference of construction technique (whilst subject to technical constraints) will be given to existing infrastructure, e.g., utilise road crossings and/or bridges
- Farm dams and coastal freshwater lagoons have been avoided where technically feasible
- Water pipeline alignments should use existing and/or proposed road alignments so that construction impacts are shared and/or minimised through geographic consolidation
- Wastewater pipeline alignments have been adjusted and/or realigned in response to the results of the flora, fauna and ecological assessment.

Pipeline alignments in the remainder of the Concept Approval area (i.e., outside the Project Approval area) will be refined in accordance with the above measures. Where practical, this will include:

- placing pipelines on final alignments that results in the least impact to native vegetation and to avoid significant hollow-bearing trees
- refining infrastructure design to avoid native vegetation (e.g. at reservoir locations)
- using construction methods that avoid and/or minimise impacts (e.g. under-boring instead of open trenching)

8.2 CONSTRUCTION MANAGEMENT MEASURES

Vegetation clearing must be undertaken for the proposed works to occur. However, Sydney Water will mitigate the impacts of disturbance by adopting risk minimising practices for pre-clearing and clearing activities onsite.

Potential management measures to minimise impacts to flora and fauna, include:

8.2.1 Risk minimising practices

- Limiting the extent of the direct pipeline construction impact to a maximum width of 10 m through native vegetation
- Trenching and re-emplacement of earthen materials
- Underboring, in cases where impacts could potentially be significant (e.g. Direct Impact Area 2)
- Washing down all equipment at an appropriate depot prior to commencement of native vegetation removal (to minimise weed or pathogen spread)

- Appropriate soil stockpiling, locating construction facilities and vehicle turning areas in already cleared lands where practical, removal of noxious weeds and decreasing barriers for movement of native fauna where possible
- Temporary diversion or partial bunding of minor streams during trenching to allow for connectivity of flows and fish passage

8.2.2 Pre-clearing practices

- Protecting and physically delineating areas of native vegetation that are not to be removed
- Protection of hollow-bearing trees (HBTs) where practical
- Where impacts to HBTs cannot be avoided, keep an inventory of those trees to be removed and implement suitable mitigation measures (eg. placement of the cut tree and any other fauna habitat elements in suitable adjacent habitat)
- A Pre-start Clearing Inspection is completed by an ecologist of the proposed disturbance area to identify the presence of fauna
- Pre Start Clearing Inspections also identify biological resources within the disturbance area including habitat resources (hollows, stag trees and coarse woody debris) and the availability of endemic seed

8.2.3 Active clearing practices

- Environmental and noxious weeds are controlled within the disturbance area prior to clearing
- Seed collection is undertaken
- The identified habitat trees are inspected prior to felling
- If no fauna is observed, a bulldozer is used to rip the root zone around the base of the tree
- The dozer slowly pushes the tree to allow it to fall under its own weight, thereby minimising damage during felling
- A trained wildlife handler is onsite to inspect the tree and to attend to any animals which may be injured or require assistance
- The toppled trees are left on the ground overnight to allow any other unidentified animals to relocate
- The trees are reinspected in the morning prior to being relocated to the rehabilitation areas for habitat augmentation.

8.3 REHABILITATION

Rehabilitation of all construction sites and disturbed surfaces is a central part of the construction process. All construction sites and locations will be appropriately stabilised and/or rehabilitated post-construction. The following areas will take priority in terms of rehabilitation:

- The direct impact locations identified and detailed in this Section
- Riparian corridors where native vegetation communities are directly impacted.

8.4 OPERATIONAL IMPACTS AND MITIGATION MEASURES

Operation of the Proposal presents very minimal potential for direct impacts on terrestrial flora and fauna. The aspects of operation with potential to impact terrestrial flora and fauna include:

- routine maintenance and repairs of pipelines, which involves access to maintenance structures
- routine maintenance and repairs to reservoirs
- wastewater overflows and leakage from maintenance structures and wastewater pipelines.

Potential impacts associated with routine maintenance are likely to be very minor and may involve some disturbance of vegetation by workers and equipment, and some excavation to gain access to underground components and pipelines. Such work will be subject to Sydney Water's existing environmental procedures for maintenance works. If required, future repairs to sites and pipelines may be subject to further environmental assessment by Sydney Water.

Wastewater overflows and leakages from the wastewater system have the potential to impact on native vegetation and fauna habitats. Environmental protection licence compliance and meeting water quality and public health guidelines will ensure that potential impacts in this regard are minimised and not significant.

8.5 OFFSET

Offsets can be a practical mitigation response to situations where there are significant environmental impacts that cannot be avoided. In such situations the offset should be consistent with the *DECCW Interim policy on assessing and offsetting biodiversity impacts of Part 3A developments* (DECCW 2010c), or should be undertaken in accordance with any requirements of a Biocertification Order.

In terms of the Proposal, offsets are not considered to be necessary for the following reasons:

- The Proposal will not have a significant impact on riparian or conservation corridors identified in the West Dapto masterplan
- The Proposal will not have a significant impact on threatened species, migratory species or endangered ecological communities listed under the TSC Act or the EPBC Act
- A statutory offset framework (such as Biocertification and Special Infrastructure Contributions) has not been established to manage offset actions from numerous Development Applications for subdivision and infrastructure.
- Further reductions in impact are likely to occur as detailed design is undertaken in the Concept Area.
- Existing environmental conditions will be maintained by adoption of the construction management and rehabilitation measures proposed
- The potential impacts of vegetation removal and habitat loss associated with water pipeline construction, can generally be considered as shared impacts of infrastructure corridors
- Reservoir construction direct impact areas have been conservatively estimated and will likely be substantially reduced during detailed design

- The potential direct impacts of wastewater pipeline construction (including impacts on riparian environments) will not be noticeable due to the native vegetation and/or habitat areas immediately adjoining the identified direct impacts areas and the construction management and rehabilitation measures proposed.

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9 Conclusions

This report has considered the impacts to flora, fauna and aquatic habitats resulting from the construction of water and wastewater infrastructure in the West Dapto Urban Release Area and the Adjacent Growth Areas.

With regard to the entire Proposal (Concept Plan Area and Project Application Area), a maximum of 3.4 hectares of native vegetation is proposed to be cleared. Of this, approximately 2.10 hectares is EEC. However this amount is likely to be reduced as detailed route planning for future Project Approval applications is undertaken. These amounts do not represent a significant impact to the EECs or to species that utilise them as habitat. Impacts to sensitive riparian and aquatic habitats are largely avoided through the use of boring. Minor impacts can be expected where trenching is undertaken in dry watercourses and drainage lines. However, these will be temporary and will not impact on habitat for any threatened species.

In the Project Application area, only 1.28 ha of native vegetation is to be cleared. Of this, 0.96 ha is EEC. Again, this does not have a significant impact on the EEC or the threatened or migratory species that may use them.

As there are no significant impacts to threatened species, populations or ecological communities, and there is no existing framework requiring offsets, an offset for the 1.28 ha being cleared in the Project Application area is not necessary for this Proposal.

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Appendix 1: Ecologist CVs

eco logical AUSTRALIA

CURRICULUM VITAE

Lucas McKinnon

SENIOR ECOLOGIST

QUALIFICATIONS

- Bachelor of Environmental Science (Honours), University of Wollongong
  Thesis topic: *Validation and Field Assessment of Endangered Ecological Communities on Community Lands within the Wollongong LGA*
- BioBanking Accredited Assessor (No. 0076), *Threatened Species Conservation Act 1995*, TAFE NSW and DECCW
- Aboriginal Cultural Awareness Training, TAFE NSW
- Forest Soil and Water Protection, TAFE NSW

Lucas is an Environmental Scientist / Ecologist with 8 years' post graduate experience working in both the private and public sectors. After completing an honours thesis studying endangered ecological communities (EECs) in the Wollongong LGA, he went onto to further studies in vegetation at the University of Wollongong and with the Australian Museum. In 2005, he began work in native vegetation policy with the former NSW Department of Natural Resources, working on the implementation of the *Native Vegetation Regulation 2005*, and with the co-ordination of threatened species policy, and went on to work in biodiversity conservation policy at the former NSW Department of Environment and Climate, Change (DECC). Whilst with DECC, Lucas also worked with the on-ground regulation of native forestry on private land on the north coast of NSW.

Lucas has worked with property scale vegetation planning with qualifications in the assessment of broadscale clearing and farmscale private native forestry under the *Native Vegetation Act, 2003*, and is an accredited BioBanking Assessor under the *Threatened Species Conservation Act, 1995*, qualified to undertake and prepare surveys and assessments for the NSW Biodiversity Banking and Offset Scheme.

Lucas has highly developed skills in research, policy development and project management, and these skills are complemented by his field skills with flora and fauna survey. Since starting ELA in October 2009, he has worked as a Project Manager and Field Ecologist on a variety of small and large scale projects, including vegetation mapping, impact assessment, biodiversity offset strategies, flora and fauna monitoring, Biobanking approvals and targeted threatened species surveys.

RELEVANT PROJECT EXPERIENCE

- *Yallah-Marshall Mount Ecological Sensitivity Analysis:* Lead Ecologist for **ecological sensitivity analysis** of the Yallah – Marshall Mount area of Wollongong LGA, including vegetation map validation and targeted threatened species survey. New records identified of the threatened climber, *Cynanchum elegans*
- *Cannes Reserve Species Impact Statement:* **Project Manager** for SIS in Pittwater LGA at site with Grey-headed Flying Fox, and the EECs Littoral Rainforest and Pittwater Spotted Gum Forest
- *West Dapto and Adjacent Growth Areas:* Lead Ecologist for Part 3A **flora, fauna and ecological assessment** of West Dapto Urban Release Area and Adjacent Growth Areas, including the Yallah and Marshall Mount area
- *Bronlow Hill:* Biobanking Assessor for 60ha Cumberland Plain Woodland **Biobank site**
- *Tharbogang BOS:* Project Manager and Lead Ecologist for **Biodiversity Offset Strategy** for landfill and quarry, Griffith LGA
- *Spring Farm:* Project Manager and Lead Ecologist for Elderslie Banksia Scrub Forest **Species Impact Statement**
- *ARTC:* Project Manager and Lead Ecologist for **Purple Copper Butterfly habitat assessment**
- *Pine Dale Coal Mine:* Project Manager and Lead Ecologist for **vegetation mapping** project and **Purple Copper Butterfly** survey
- *Werris Creek Coal Mine:* Project Manager and Lead Ecologist for **monitoring program** of offset lands including collection of baseline data for flora and fauna
- *West Pymble:* Lead ecologist for **peer review and field validation** of threatened ecological communities, Blue Gum High Forest and Sydney Turpentine Ironbark Forest
- *Marsden Park; Eastern Creek; Camden:* Ecologist for **flora assessment** of potential threatened ecological community, Cumberland Plain Woodlands and Derived Native Grasslands, including additional threatened

species survey for *Grevillea juniperina* and Cumberland Plain Snail

- *Werris Creek Coal mine*: Project Manager and Lead Ecologist for **flora and fauna assessment** of Part 3A development proposal for Life of Mine Extension Project in Box-Gum Woodland Critically Endangered Ecological Community (CEEC) on the Liverpool Plains, NSW.
- *Thornton Park TOD*: Lead Ecologist for **flora, fauna and riparian assessment** of proposed 1200 lot Transit Oriented Development (TOD) at North Penrith.
- *Grasmere*: Lead Ecologist for **flora, fauna and riparian assessment** of proposed 30 lot sub-division of rural land containing Cumberland Plain Woodland (CEEC), at Grasmere, Camden LGA, south west of Sydney.
- *Yellow Rock*: Project Manager for **Management Plan** of Deerubbin Local Aboriginal Land Council lands at Yellow Rock, Blue Mountains LGA.
- *Molongolo*: **vegetation survey** – determination of the presence and extent of EPBC Box-Gum Woodland CEEC on the outskirts in Molongolo growth area of Canberra.
- *Tralee Station:* **Invertebrate survey** for the threatened Golden Sun Moth (*Synemon plana*) near Queanbeyan.
- *Metropolitan Colliery:* **vegetation survey and monitoring** for Metropolitan Colliery, west of Helensburgh in Sydney Catchment Area lands
- *Warringah Council:* **Impact Assessment** of infrastructure development adjacent to a sandstone community at Belrose, northern Sydney.
- *Penrith Lakes Development Corporation:* **preliminary ecological advice** on future development adjacent to the Nepean River.
- *Integral Energy*: **Impact assessment** for the proposed re-establishment of access tracks to infrastructure managed by Integral Energy off Mount Ousley Road and Appin Road
- *NSW Natural Resource Commission:* **strategic input and background research** for review of White Cypress Pine forestry in NSW.
- *NSW Natural Resources Commission:* **strategic input and review** into a review of River Red Gum forestry practices.
- *Private Native Forestry (PNF):* **operational administration** of regulatory activities under the *Native Vegetation Act 2003* and PNF Code of Practice (NSW Dept. of Environment, Climate Change & Water).
- *EEC Recovery Project:* **development and implementation** of identification package for endangered ecological communities (EECs), including simple I.D. Guidelines and Indicative EEC Mapping Series for coastal floodplain EECs (NSW Dept. of Environment and Climate Change).
- *Native Vegetation Act 2003*, **Implementation Committee Secretariat** (NSW Dept. of Natural Resources).

CURRICULUM VITAE

Ian Dixon

AQUATIC ECOLOGIST

QUALIFICATIONS

- Master of Tropical Environmental Management : The Relationship Between Terrestrial, Aquatic and Riparian Attributes – 2006
- Graduate Diploma of Tropical Environmental Management – 2001
- Bachelor of Landscape Architecture: Regeneration strategy for the Snowy River - 1999

Ian is an aquatic ecologist with eight years of experience in riparian ecology and river health assessment. Prior to joining Eco Logical Australia in 2010, Ian was a Research Fellow at the Tropical Rivers and Coastal Knowledge research hub through Charles Darwin University, where he was involved in trialling river health assessment techniques in the wet/dry tropics of northern Australia. Ian has a depth of experience in developing assessment protocols and investigating the interactions between catchment activity and riparian health.

Ian has a wide range of skills in aquatic assessment. He is very experienced in assessing aquatic biota, riparian health, catchment disturbance, hydrological change, water quality and bank stability. He is highly proficient at surveying/sampling riverine biota e.g. macroinvertebrate sampling using AUSRIVAS procedures, fish surveys using electrofishing techniques, and riparian floristic surveys. His experience includes roles such as study design, field method development and implementation, habitat assessment, stakeholder engagement, data analysis, milestone reporting and budget tracking. In addition, he has trained staff, park rangers, land managers, indigenous owners, community interest groups and volunteers to assist in field studies and data analysis.

RELEVANT PROJECT EXPERIENCE

- Royal Far West Development, Ecological Impact Assessment (Urbis)
- Grays Point Sewer, Review of Environmental Factors (ITS, Sydney Water)
- De Freitas Wetland Restoration, Review of Environmental Factors (Fairfield City Council)
- South West Rail Link Riparian Corridor Assessment, Aquatic and Riparian Assessment (Transport Construction Authority)
- Groundwater Dependent Ecosystems at Tallawarra: Risk Assessment (TRUenergy)
- Upper Georges River Strategic Plan of Management (Campbelltown City Council)
- Schofields Precinct Riparian and Aquatic Assessment (NSW Department of Planning)
- West Horsley Aquatic Habitat Assessment (Sydney Water)
- Dunoon Dam Aquatic Flora and Fauna Assessment (Rous Water)
- Tillegra Dam Ramsar Wetland Impact Assessment (Hunter Water Corporation)
- Options paper for the conservation of the Murray Cod, Murrumbidgee River (ACTEW Corporation)
- Brookvale Creek Ecological Assessment (Warringah Council)
- Impact assessment of lead shot to riparian and stream communities (Illawarra Gun Club)
- Bottom-up and top-down control of riverine food webs (Tropical Rivers and Coastal Knowledge - Commonwealth Environmental Research Facility)
- The Health of the Aquatic Environment in the Darwin Harbour Region (N.T. Department of Natural Resources, Environment and The Arts)
- Riparian Assessment for Northern Gulf Rivers (Australian Rivers Institute)
- Riparian condition in the Gilbert River and Walsh River catchments (Australian Centre for Tropical Freshwater Research)
- Riparian condition in the Ord River catchment (W.A. Department of Conservation)
- Riparian condition in the Darwin Harbour catchment (N.T. Department of NRETAS)

CURRICULUM VITAE

Anna Foley

BOTANIST

QUALIFICATIONS

- Bachelor of Science (Honours) in Geography (Freshwater Ecology), University of Melbourne, Parkville VIC. (Thesis discussing effect of environmental flows on aquatic and riparian vegetation)
- Bachelor of Science, University of Melbourne, Parkville VIC. (Majoring in Botany and Ecology)

Anna joined ELA in February 2010. She brings with her extensive field work experience which has equipped her with strong plant identification skills of both native and exotic flora. She is confident in devising and implementing field botany methods and vegetation mapping techniques. Anna also has extensive experience in producing flora assessments and vegetation management plans with a solid understanding of vegetation management policy.

Anna's university and work background has provided her with frequent opportunities to liaise with government departments, environmental agencies and landholders. She has devised a range of strategies and programs at a strategic level including ecological advice for urban growth area precinct structure plans, bioregional action planning, and complex native vegetation offset management strategies for large State infrastructure projects.

She has built a strong work ethic and show strengths in effective communication, time management, teamwork capabilities and has a determined interest in pursuing a career in environmental management.

RELEVANT PROJECT EXPERIENCE

- Review of Environmental Factors, including assessment of Cumberland Plain Woodland listed under the TSC Act and EPBC Act, in South West Growth Centres for Sydney Water.
- Impact assessment of Box-Gum grassy woodland in northern Victoria and northern NSW, protected by Commonwealth, NSW and Victorian legislation.
- Saltmarsh extent and condition mapping of Tuggerah Lakes, Wyong Shire, NSW.
- Macroinvertebrate sampling, identification and SIGNAL2 analysis, Wollondilly Shire, NSW.
- Vegetation monitoring in closed catchments above Woronora Dam, NSW.
- Surveys for a suite of NSW threatened flora including *Dillwynia tenuifolia*, *Persoonia nutans* (Nodding Geebung), *Micromyrtis minutiflora*, *Grevillea juniperina* subsp. *juniperina* (Juniper-leaved Grevillea), *Diuris pedunculata* (Small Snake Orchid) and *Pimelea spicata* (Spiked Rice-flower).
- Targeted survey for threatened fauna including nationally threatened *Delma impar* (Striped Legless Lizard), Golden Sun Moth (*Synemon plana*) and *Litoria raniformis* (Southern Bell Frog) and state-listed Cumberland Plain Land Snail (*Meridolum corneovirens*) and Eastern Pygmy Possum (*Cercartetus nanus*).
- Landscape-scale biodiversity planning for the Strzelecki Ranges bioregion, Victoria.
- Determination of the presence and extent of EPBC Act-listed Natural Temperate Grassland of the Victorian Volcanic Plain, Melton West to Bacchus Marsh, Victoria.
- GIS vegetation mapping, and native vegetation precinct plans of ecological vegetation classes in urban growth areas, south-east Melbourne.
- Targeted surveys and conservation management plans for a suite of Victorian threatened flora including nationally threatened *Dianella amoena* (Matted Flax-lily), *Pimelea spinescens* subsp. *spinescens* (Spiny Rice-flower) and *Rutidosis leptorrhynchoides* (Button Wrinklewort).
- Field validation of ecological values between Burrumbeet and Stawell, western Victoria.
- A range of Net Gain assessments under 'Victoria's Native Vegetation Management – A Framework for Action', as well as vegetation management plans and complex offset strategies for both private and government clients.

CURRICULUM VITAE

Andrew Whitford

ECOLOGIST

QUALIFICATIONS

- Master of Applied Science (Environmental Science), University of Sydney.
- Diploma of Conservation and Land Management, Ryde TAFE.
- Bachelor of Arts (Communications), Emerson College, Boston.

- NSW Occupational Health and Safety White Card – CGI00742512SEQ2
- Rail Safety Induction Certificate – 0010065492
- DECCW Scientific Licence – SL100243
- Senior First Aid Certificate

Andrew is an ecologist with experience in environmental remediation. He brings considerable fieldwork experience as he has spent the last 4 years supervising and undertaking bushland remediation with The National Trust of Australia (NSW) Ltd and one year with Eco Logical Australia. In this role he has written management plans, planned and executed vegetation mapping, undertaken threatened species translocation, and undertaken impact remediation and repair.

Andrew's University and TAFE training and time with ELA have given him great experience in field skills such as native and exotic plant identification, fauna identification, GIS mapping, sediment control options, and degraded site management. In this time he has also worked on numerous complex reports including Plans of Management, Vegetation Management Plans, Weed Management Plans, Construction Environment Management Plans, 7-part tests and EPBC Significance Assessments. He has developed an understanding of NSW and Commonwealth legislation as well as liaising with clients and stakeholders. Andrew has worked on numerous projects in a variety of locations throughout the Sydney Basin and NSW.

RELEVANT PROJECT EXPERIENCE

- Fauna Monitoring at Warringah for *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat)
- Flora and Fauna Assessment and Biophysical Constraints and Opportunities Report at Helensburgh
- Flora Assessment and Vegetation Removal Supervision for works associated with the Southern Sydney Freight Line in south-western Sydney
- Flora and Fauna Assessment at Lake Illawarra for Tallawarra Lands Conservation Plan
- Plan of Management for Malabar Headland, Randwick including threatened species and EEC management
- Rural Waterways Riparian Assessment for Hills Shire Council
- Targeted Flora searches at Yallah adjacent to Lake Illawarra
- Weed Mapping and Vegetation Management Plan for Defense lands at Kapooka, Bandiana, and Wagga Wagga

CURRICULUM VITAE

Elizabeth Norris

SENIOR ECOLOGIST

QUALIFICATIONS

- Bachelor of Science, Macquarie University, Sydney. Biology/Ecology and Palaeontology major, 1983.
- Post Certificate in Electron Microscopy, Sydney Technical College, Transmission and Scanning Microscopy, 1986.
- Master of Science, Macquarie University, Sydney. Thesis entitled: *'A study of the soil and vegetation patterns within part of the Pilliga Forests, and an evaluation of the impact of European settlement on the vegetation'*, 1997.

Liz has 20 years botanical and ecological research in the New South Wales: Sydney Basin, Coastal New South Wales, Hunter Valley, North and South Western Slopes and Plains, often to remote areas. She has a Bachelor of Science, a post graduate certificate in electron microscopy and a Master of Science (Thesis) "*A study of the soil and vegetation patterns within part of the Pilliga Forests, and an evaluation of the impact of European settlement on the vegetation*".

Liz is a senior botanist/ecologist at Eco Logical Australia (permanent part time). During this time, she has been involved in a large number of systematic floristic surveys, targeted flora surveys, vegetation monitoring, the development of strategic conservation plans, other ecological assessments and an ecological expert to the NSW Land and Environment Court. She has been an employee at the National Herbarium, Royal Botanical Gardens from 1982 – 2009 and has undertaken a range of duties including various research projects and curation of the herbarium collection. Liz has extensive experience as a field botanist, has written species descriptions for the Flora of NSW, and provided technical advice at flora workshops.

RELEVANT PROJECT EXPERIENCE

Ecological Constraints / Impact Assessment

- Ingleside Biodiversity Strategy
- Pre-clearing Assessment for APZ dvelopment
- Calderwood Urban Development Ecological Survey
- South Cecil Hills Ecological Constraints Analysis
- Crudine Ridge Wind Farm Ecological Assessment (Wind Prospect)
- Ecological Impact Assessments – various (Integral Energy)
- Biobanking Pilot Assessments (DECC)
- El Caballo Blanco and Gledswood Rezoning Ecological and Bushfire Assessment (Landcom)
- Ballanagamang Biobanking Assessment (Ecotrades)
- Blacktown Olympic Park Site Expansion Flora and Fauna Impact Assessment (Blacktown City Council)
- Marsden Park Industrial Precinct Ecological Assessment & EPBC Surveys (APP)
- Alex Avenue Ecological Assessment (Landcom)
- Area 20 Ecological Assessment (GCC)
- Shoalhaven LGA Rural Residential property Flora survey
- Vegetation survey and targeted orchid survey for SEPP 5 development in Wyong LGA.
- Vegetation surveys for Integral Energy and the NSW Road & Traffic Authority and other authorities
- Raymond Terrace and Medowie Wastewater Transportation System, Hunter Water.
- Flora survey and assessment for proposed water pipeline - fennel Bay to Toronto, Hunter Water.
- Flora survey and report including assessment under EPBC and TSC Acts, Kiama LGA.

Targeted threatened species survey

- Targeted orchid survey, Buckingbong State Forest
- Various targeted flora surveys, Cumberland Plain
- Targeted flora surveys, Maroota State Conservation Area (DECCW)

- Hawkesbury City Council's Council and Crown Reserves Vegetation survey

Vegetation Survey and Mapping

- Vegetation Survey for South-east Corner Biometric Benchmark Project
- Systematic Vegetation Surveys, Upper Hunter Regional Environmental Management Strategy
- Marra Marra NP and Muogomarra NR NPWS flora surveys
- Wetland Vegetation Surveys for LiDAR, Lowbidgee and Gwydir wetlands (DECC)
- Vegetation Survey, Durness Station, Tea Gardens, Great Lakes LGA
- Vegetation Survey, Camerons Gorge Nature Reserve, DECCW
- Vegetation Survey, Maroota State Conservation Area, DECCW
- Wingecarribee LGA Flora survey and targeted threatened species survey
- Baulkham Hills Shire Natural Assets Mapping
- Hawkesbury City Council's Council and Crown Reserves Vegetation survey

Ecological Monitoring

- Systematic surveys of long term monitoring plots within Upland Swamps, Newnes Plateau
- Metropolitan Colliery Vegetation Monitoring Program

Ecological Reviews

- EPBC Conservation Advice (DEWHA)
- Review of Threatened Species Nominations (DECCW)

Other

- Vegetation Condition Assessment, South West Slopes, DEWHA
- EPBC Referral - Cumberland Plain Woodland, Wivenhoe

CURRICULUM VITAE

Michael Ward

BOTANIST

QUALIFICATIONS

- Master of Environmental Management, University of New England (currently under completion)
- Bachelor of Science (Sustainable Resource Management), University of Newcastle
- Diploma in Conservation and Land Management, TOCAL
- Certificate IV in Assessment and Workplace Training, ETC Training
- Certificate II in Bushland Regeneration, TAFE NSW

Michael has ten years experience in ecological consulting and bushland management, focused mainly in the Central Coast and Hunter regions of NSW. During this time, Michael has developed strong identification skills of both native and naturalised flora, as well as considerable expertise in ecological restoration.

Michael has undertaken floristic surveys, Biobank assessments, vegetation monitoring and targeted surveys for threatened flora and noxious weeds species. He has also developed vegetation community and environmental weed mapping, ecological restoration plans and Biobanking Site Management Plans.

As a qualified trainer, Michael has developed and delivered a range of accredited and informal training packages covering topics including plant identification, environmental weed control techniques and biodiversity monitoring. Michael also has considerable experience coordinating and supervising on-ground restoration works.

RELEVANT PROJECT EXPERIENCE

- Tuggerah Lakes Saltmarsh Mapping
- 'Mates of the Lakes' Tuggerah Lakes Saltmarsh Rehabilitation Plan
- Dead Mangrove Creek EIS
- Werrington Creek Rehabilitation Project
- CEN Threatened Flora Training
- Hunter Water Corp Tree Planting for Carbon Offset
- Narrabri Rehabilitation Strategy
- Vales Point VMP - update to EEC Mapping
- Lake Macquarie Community Biodiversity Monitoring
- Lake Macquarie Wetlands Climate Change Assessment
- Warnervale Heath Wrinklewort Reserve Easement Ecology Advice
- Warnervale, Heath Wrinklewort Daisy Reserve Survey Work
- Darkinjung Land Council Biobank Agreement Assessment
- Halekulani Preliminary Ecological Constraints Analysis
- Ourimbah Campus Nursing Building VMP
- Wyee LES
- Durness Vegetation Mapping
- Minimbah Road Environment Assessment
- Puddledock Environmental Assessment
- Whitebridge Biobanking Assessment
- Cessnock Biobanking Assessment

Appendix 2: Threatened Species Likelihood of Occurrence

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
PLANTS						
Acacia baueri subsp. *aspera*		1	V	—	Associated with heath and dry eucalypt forest and woodland on sandy soils (Smith and Smith 1995).	No – most recently recorded in 1969
Acacia bynoeana	Bynoe's Wattle	1	E	V	The species is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra (NPWS 1999). It is found in heath and dry sclerophyll forest, typically on a sand or sandy clay substrate, often with ironstone gravels (NPWS 1999). The species seems to prefer open and sometimes slightly disturbed sites (NPWS 1999). Characteristic overstorey species include: *Corymbia gummifera*, *Eucalyptus haemastoma*, *E. gummifera, E. parramattensis*, *E. sclerophylla*, *Banksia serrata* and *Angophora bakeri*. Shrubs often associated with the species include *B. spinulosa*, *B. serrata, A. oxycedrus*, *A. myrtifolia* and *Kunzea* spp. (NPWS 1999). It flowers from September to March and fruits mature in November.	No – no heathy vegetation or gravel soils
Arthropteris palisotii	Lesser Creeping Fern	1	E	—	Rhizomatous rainforest fern growing on tree trunks (RBG 2011).	Unlikely – may be extinct in NSW

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Boronia deanei	Deane's Boronia	8	V	V	There are scattered populations of Deane's Boronia between the far south-east of NSW and the Blue Mountains (including the upper Kangaroo River near Carrington Falls, the Endrick River near Nerriga and Nalbaugh Plateau), mainly in conservation reserves. Grows in wet heath, often at the margins of open forest adjoining swamps or along streams (DEC 2005).	No – no wet heath habitat
Caladenia tessellata	Thick-lipped Spider-orchid	0	E	V	Occurs in grassy sclerophyll woodland, often growing in well-structured clay loams or sandy soils south from Swansea (DEC 2005). Usually in sheltered moist places, in areas of increased sunlight. It flowers from September to November (DEC 2005).	Unlikely – no records in local area
Chorizema parviflorum	Chorizema parviflorum population in the Wollongong LGA	24	EP	—	Found in heathy country and scattered on sandstone. This endangered population has been recorded from between Austinmer and Albion Park in the local government areas of Wollongong and Shellharbour. All known sites (excluding the site at Austinmer where it occurs on a coastal headland) occupy woodland or forest dominated by Forest Red Gum (*Eucalyptus tereticornis*) and/or Woollybutt (*E. longifolia*). Flowering period is August to January, with seeds maturing from November. The species is difficult to locate when not in flower, as it is often tangled amongst (and partially concealed by) a grassy understorey (DEC 2005).	Potential – Forest Red Gum woodland present
Cryptostylis hunteriana	Leafless Tongue-orchid	0	V	V	It is known from a range of vegetation communities including swamp-heath and woodland (DEC 2005). The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); where it appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*) (DEC 2005). Bell (2001) has identified Coastal Plains Scribbly Gum Woodland and Coastal Plains Smoothed-barked Apple Woodland as potential habitat on the Central Coast. Flowers between November and February, although may not flower regularly (DEC 2005, Bell 2001).	Unlikely – no previous records in local area,

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Cynanchum elegans	White-flowered Wax Plant	0	E	E	*Cynanchum elegans* is a clonal climber or twiner with a variable form, and flowers between August and May, peaking in November (DEC 2005). It occurs in dry rainforest gullies, scrub and scree slopes, and prefers the mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities (NPWS 2002). The species has also been found in littoral rainforest; *Leptospermum laevigatum – Banksia integrifolia* subsp *integrifolia* coastal scrub; *Eucalyptus tereticornis* aligned open forest/ woodland; *E. maculata* aligned open forest/woodland; and *Melaleuca armillaris* scrub to open scrub (NPWS 2002)..	Known within Field Assessment Area
Daphnandra sp. C Illawarra EPBC Act as *Daphnandra johnsonii*	Illawarra Socketwood	40	E	E	Occupies the rocky hillslopes and gully slopes of the Illawarra escarpment and coastal lowlands, occasionally extending onto the upper escarpment slopes. Associated soils are loams and clay loams (DEC 2005; DEWR 2005).	Known – previous records close to Study areain Calderwood Valley
Grevillea parviflora subsp. *parviflora*	Small Flower Grevillea	4	V	V	Occurs on sandy clay loam soils, often with lateritic ironstone gravels (DEC 2005). Soils are mostly derived from Tertiary sands or alluvium and from the Mittagong Formation with alternating bands of shale and fine-grained sandstones. Soil landscapes include Lucas Heights and Berkshire Park (DEC 2005). Often occurs in open, slightly disturbed sites such as along tracks. Flowering has been recorded from July to December as well as April-May (DEC 2005).	Unlikely – absence of gravel soils within Field Assessment Area
Grevillea rivularis	Carrington Falls Grevillea	22	E	E	Restricted to the riparian zone of the Kangaroo River in the Carrington Falls area near Robertson on the NSW Central Tablelands. Preferred habitat is moist sandy alluvium on sandstone in dense riparian heath or open wet heath, adjacent to eucalypt woodland/forest (DEWR 2008).	None – restricted to Carrington Falls, no previous records below escarpment
Haloragis exalata subsp. *exalata* var. *laevis*	Square Raspwort	5	V	V	Square Raspwort appears to require protected and shaded damp situations in riparian habitats (DEC 2005).	Unlikely – no records in proximity to Field Assessment Area

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Irenepharsus trypherus	Illawarra Irene	22	E	E	Occupies steep slopes and cliff lines at the ecotone of sclerophyll forest and rainforest (DEC 2005).	Potential – one record adjacent to Study areain Calderwood Valley
Lespedeza juncea subsp. *sericea*	*Lespedeza juncea* subsp. *sericea* population in Wollongong LGA	1	EP	—	This endangered population occurs south of Dapto in the Wollongong LGA. Known from just one roadside population of approximately 200 plants. Located in a small strip of open forest dominated by *Eucalyptus tereticornis* (Forest Red Gum), *E. longifolia* (Woollybutt), and *Melaleuca decora* (White Feather Honeymyrtle), on Budgong Sandstone. Prefers full sun to light shade. Flowers between February and March (DEC 2005).	Known to occur within Field Assessment Area
Leucopogon exolasius	Woronora Beardheath	1	V	V	Associated with Sydney Sandstone Gully Forest on rocky hillsides and creek banks (NPWS 1997).	No – absence of associated vegetation type
Melaleuca biconvexa	Biconvex Paperbark	0	V	V	Biconvex Paperbark generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. Flowering occurs over just 3-4 weeks in September and October (DEC 2005).	Unlikely – absence of records within local area
Persoonia glaucescens	Mittagong Geebung	1	E	V	Species‘ range is contracting, and the north-eastern limit at Couridjah (Thirlmere Lakes) or Buxton southern limit is thought to now be Berrima, & the western limit at High Range. The Mittagong Geebung grows in woodland to dry sclerophyll forest on clayey and gravely laterite. The preferred topography is ridge-tops, plateaux and upper slopes. Aspect does not appear to be a significant factor (DEC 2005).	Unlikely – no records below the Escarpment

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Pimelea spicata	Pimelea spicata	34	E	E	Occurs on undulating topography on substrates derived from Wianamatta Shale in areas of Cumberland Plain Woodland Vegetation Community. Recorded from open woodlands and grasslands dominated by *Eucalyptus moluccana*, *E. crebra, E. tereticornis, Bursaria spinosa* and *Themeda triandra* , and in the Illawarra occurs on clay soils on coastal headland in *Themeda triandra* grassland with low native shrubs present (DSEWPAC 2011b). .	Unlikely – all records occur east of Lake Illawarra on coastal headlands, Study arealies west of Lake Illawarra
Pomaderris walshii	Carrington Falls Pomaderris	9	CE	—	Currently only known from the upper Kangaroo River and its tributaries (above Carrington Falls), south-east of Robertson NSW. Habitat preference is riparian shrubland dominated by *Callicoma serratifolia*, *Ceratopetalum apetalum, Grevillea rivularis* and open grassy forest dominated by *Eucalyptus fastigata* (RBG 2011).	None – all records occur along upper Kangaroo River.
Pterostylis gibbosa	Illawarra Greenhood	16	E	E	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage (DEC 2005).	Known within Field Assessment Area
Pterostylis pulchella	Pretty Greenhood	2	V	V	Grows on escarpments close to waterfalls and on moist, sheltered ridges; chiefly from Blue Mountains to Fitzroy Falls (RBG 2011).	No – most recent record in 1954
Pterostylis saxicola	Sydney Plains Greenhood	0	E	E	Currently known from only five locations: Georges River NP (Yeramba Lagoon), Ingleburn, Holsworthy, Peter Meadows Creek, St Marys Towers (Douglas Park). Most commonly found on shallow soil in depressions on sandstone rock shelves above cliffs. Vegetation upslope are either shale/sandstone transition or shale communities (DECCW 2011).	No – absence of sandstone rock shelves, and Study areadoes not include any of 5 known locations
Pultenaea aristata		28	V	V	Uncommon species known from the Woronora Plateau from Helensburgh to Mt Kiera. Occurs on exposed sandstone soils in both moist and dry sclerophyll woodland or heath, often associated with upland swamp vegetation (DEWHA 2008b). .	No – Study area does not include Woronora Plateau

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Solanum celatum		272	E	—	Grows in rainforest clearings, or in wet sclerophyll forests, and responds well to fire/disturbance. Restricted to an area from Wollongong to just south of Nowra, and west to Bungonia. Majority of records are prior to 1960 and the majority of populations are likely to have been lost to clearing (DEC 2005).	Potential – recorded in Calderwood Valley in 2007
Thelymitra sp. Kangaloon (D.L. Jones 18108)	Kangaloon Sun Orchid	N/A	—	CE	Four populations are known on the NSW Southern Tablelands near Moss Vale/Kangaloon/Fitzroy Falls, in sedgeland swamps over grey silty clay loam soils (DSEWPAC 2011b).	No – absence of sedgland swamps, and Study areadoes not include any of 4 known populations
Thesium australe	Austral Toadflax	0	V	V	Austral Toad-flax has a wide ecological tolerance. However, it is largely confined to grasslands, grassy woodlands or sub-alpine grassy heathlands (DEC 2005).	Unlikely – no previous records in locality
Zieria granulata	Hill Zieria	121	E	E	Restricted to the Illawarra region, primarily occupying the coastal lowlands between Oak Flats and Toolijooa, in the Shellharbour and Kiama LGAs. The typical habitat is dry ridge tops and rocky outcrops on shallow volcanic soils, usually on Bumbo Latite. Less frequently found on the moist slopes of the Illawarra escarpment and in low-lying areas on Quaternary sediments. Associated vegetation includes Bracelet Honey-myrtle *Melaleuca armillaris* scrub, Forest Red Gum *Eucalyptus tereticornis* woodland and rainforest margins, although the species has been recorded from a number of other vegetation types (DEC 2005).	Potential – Study areaincludes moist slopes of Illawarra escarpment and foothills, one record (1978) in Albion Park near Field Assessment Area
AMPHIBIANS						

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Heleioporus australiacus	Giant Burrowing Frog	15	V	V	Forages in woodlands, wet heath, dry and wet sclerophyll forest (Ehmann 1997). Associated with semi-permanent to ephemeral sand or rock based streams (Ehmann 1997), where the soil is soft and sandy so that burrows can be constructed.	No – all records outside the Study area(i.e. above the)escarpment
Litoria aurea	Green and Golden Bell Frog	431	E	V	This species has been observed utilising a variety of natural and man-made waterbodies (Pyke & White 1996) such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands and billabongs, stormwater detention basins, farm dams, bunded areas, drains, ditches and any other structure capable of storing water (DEC 2005). Fast flowing streams are not utilised for breeding purposes by this species (Mahony 1999). Preferable habitat for this species includes attributes such as shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading (DEC 2005). Large permanent swamps and ponds exhibiting well-established fringing vegetation (especially bulrushes–*Typha* sp. and spikerushes–*Eleocharis* sp.) adjacent to open grassland areas for foraging are preferable (Ehmann 1997; Robinson 1993). Ponds that are typically inhabited tend to be free from predatory fish such as Mosquito Fish (*Gambusia holbrooki*) (DEC 2005).	Unlikely – known populations east of Lake Illawarra
Litoria littlejohni	Littlejohn‘s Tree Frog, Heath Frog	124	V	V	This species breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heathy forests and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground (DEC 2005).	No – absence of heathy forest or woodland.
Mixophyes balbus	Stuttering Frog	11	E	V	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor (DEC 2005).	No – known records to the south of Calderwood Valley.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Pseudophryne australis	Red-crowned Toadlet	24	V	—	Red-crowned Toadlets are found in steep escarpment areas and plateaus, as well as low undulating ranges with benched sandstone outcroppings in the Sydney Basin (DEC 2005). Within these geological formations, this species mainly occupies the upper parts of ridges, usually being restricted to within about 100 metres of the ridgetop (DEC 2005). Associated with open forest to coastal heath (Ehmann 1997). Utilises small ephemeral drainage lines (‗feeder-creeks'),&upland swamps (Ehmann 1997).	No – all previous records occur west of the escarpment
REPTILES						
Hoplocephalus bungaroides	Broad-headed Snake	1	E	V	Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments in summer (DEC 2005).	No – absence of exposed cliff edges, only record occurs west of escarpment
Varanus rosenbergi	Heath Monitor	4	V	—	Associated with Sydney sandstone woodland and heath land. Rocks, hollow logs and burrows are utilised for shelter (DECC 2007). Terrestrial termitaria are required for reproduction (King and Green 1999).	No – absence of heathy vegetation, all records west of escarpment
FISH						
Macquaria australasica	Macquarie Perch	0	V	E	Within the Hawkesbury-Nepean and Shoalhaven catchments, the eastern form of the species prefers clear water and deep rocky holes with lots of shelter from aquatic vegetation, debris, rocks and overhanging banks. Previous records occur within the Nepean, Cataract, Avon & Cordeaux Dams, however these streams all feed the Nepean River, and no records are present within streams that run east of the escarpment in the Illawarra (DSEWPAC 2011b). .	No – there is no suitable habitat within the Field Assessment Area

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Prototroctes maraena	Australian Grayling	0	V	V	Historically, this species occurred in coastal streams from the Grose River southwards through NSW, Vic. and Tas. On mainland Australia, this species has been recorded from rivers flowing east and south of the main dividing ranges. This species spends only part of its lifecycle in freshwater, mainly inhabiting clear, gravel-bottomed streams with alternating pools and riffles, and granite outcrops but has also been found in muddy-bottomed, heavily silted habitat. Grayling migrate between freshwater streams and the ocean and as such it is generally accepted to be a diadromous (migratory between fresh and salt waters) species (DSEWPAC 2011b).	No – there are no previous records north of Nowra for this species
MAMMALS (EXCLUDING BATS)						
Cercartetus nanus	Eastern Pygmy-possum	4	V	—	Found in wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath (Menkhorst & Knight 2004). Pygmy-Possums feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit (Turner & Ward 1995). The presence of *Banksia* spp. and *Leptospermum* spp. are an important habitat feature (DEC 2005). Small tree hollows are favoured as day nesting sites, but nests have also been found under bark, in old birds nests and in the branch forks of tea-trees (Turner & Ward 1995).	Unlikely – all records occur west of escarpment

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Dasyurus maculatus	Spotted-tailed Quoll (SE Mainland Population)	34	V	E	The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests (Mansergh 1984; DEC 2005), more frequently recorded near the ecotones of closed and open forest. This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in (DEC 2005). Maternal den sites are logs with cryptic entrances, rock outcrops,burrows & tree hollows (DSEWPAC 2011b).	Unlikely – absence of large areas of relatively intact vegetation within Field Assessment Area, more suitable habitat occurs at Illawarra escarpment, and west on plateau and in catchment areas.
Dasyurus viverrinus	Eastern Quoll	1	E	V	Associated with a variety of habitats, including dry sclerophyll forest, shrub, heath land, riparian forests and agricultural areas. Requires features such as hollow logs and rock piles for shelter (NPWS 1999b).	No – most recent record was in 1956, presumed extinct on the Australian mainland
Isoodon obesulus obesulus	Southern Brown Bandicoot	5	E	E	This species is associated with heath, coastal scrub, heathy forests (Menkhorst & Knight 2004), shrubland and woodland on well drained soils. This species is thought to display a preference for newly regenerating heathland and other areas prone to fire (Menkhorst & Seebeck 1990).	Unlikely – all records west of escarpment, absence of heathy vegetation in Field Assessment Area.
Petaurus norfolcensis	Squirrel Glider	3	V	—	Associated with dry hardwood forest and woodlands (Menkhorst et al. 1988; Quin 1995). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al. 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quin 1995).	Unlikely – sparse previous records, all west of escarpment

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Petrogale penicillata	Brush-tailed Rock-wallaby	1	E	V	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (Strahan 1995).	No – lack of suitable habitat, closest known population in Nowra
Phascolarctos cinereus	Koala	63	V	—	Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70% (Reed et al. 1990), with acceptable Eucalypt food trees.	Unlikely – all records occur west of escarpment
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland)	9	V	V	Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature (DEC 2005).	Unlikely – all records occur west of escarpment in Budderoo NP
Pseudomys fumeus	Smoky Mouse	0	CE	E	Recent NSW records are concentrated in the Alps and far south coast hinterland. Habitat ranges from coastal heath to dry ridgeline forest, sub-alpine heath and wetter gullies. Ground cover such as grass tussocks, dense low vegetation, rocks and logs provide required shelter sites (DECCW 2011).	Unlikely – no previous records in locality
Pseudomys novaehollandiae	New Holland Mouse	N/A	—	V	Recorded as disjunct populations from Queensland to Tasmania,. Habitat include heathland, open woodland with heathy understorey, and vegetated sand dunes, and the home range varies from 0.44 ha to 1.4 ha. This nocturnal species is social and usually shares a burrow with other individuals (DEWHA 2010). Relatively little is known about habitat preferences, and many vegetation types appear to provide habitat, but soil conditions do need to be suitable for burrowing and growth of hypogeal fungi is likely to be a key diet component (DSE 2003).	Unlikely – absence of heathy vegetation within Field Assessment Area

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
BATS						
Chalinolobus dwyeri	Large-eared Pied Bat	2	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 1998, DEC 2005). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill 1998, DEC 2005).	Potential – foraging habitat
Falsistrellus tasmaniensis	Eastern False Pipistrelle	3	V	—	Prefers moist habitats with trees taller than 20m (DEC 2005). Roosts in tree hollows but has also been found roosting in buildings or under loose bark (DEC 2005).	Known
Miniopterus australis	Little Bent-wing Bat	0	V	-	Cave-dwelling bats that have rarely been recorded in tree hollows. Will forage in well-timbered areas including rainforest, vine-thicket, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests (Churchill 2008).	Known
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	33	V	—	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). It forages above and below the tree canopy on small insects (AMBS 1995, Dwyer 1995, Dwyer 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (DEC 2005, Dwyer 1995).	Known
Mormopterus norfolkensis	Eastern Freetail Bat	4	V	—	Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (DEC 2005, Allison & Hoye 1998). Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (DEC 2005, Allison & Hoye 1998).	Known

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Myotis macropus	Large-footed Myotis	5	V	—	Rarely recorded more than 100 km inland, this species forages over streams and pools and utilises a range of habitats from small creeks to large lakes and mangrove lined estuaries. Generally roosts close to waterbodies in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage (DEC 2005).	Known
Pteropus poliocephalus	Grey-headed Flying-Fox	54	V	V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998, Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998).	Known
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	1	V	—	Found in almost all habitats, from wet and dry sclerophyll forest, open woodland (Churchill 1998). Roosts in tree hollows; may also use caves; has also been recorded in a tree hollow in a paddock and in abandoned sugar glider nests (Churchill 1998, DEC 2005). The Yellow-bellied Sheathtail-bat is dependent on suitable hollow-bearing trees to provide roost sites (DEC 2005). .	Known
Scoteanax rueppellii	Greater Broad-nosed Bat	4	V	—	Associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill, 1998), tending to be more frequently located in more productive forests (Hoye & Richards 1998). Within denser vegetation types use is made of natural and man made openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 1998).	Known
DIURNAL BIRDS						
Anthochaera phrygia EPBC Act Migratory list as *Xanthomyza phrygia*	Regent Honeyeater	1	E	E, M: JAMBA	Inhabits temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts (such as Red Ironbark *E. fibrosa*, White Box *E. albens* and Yellow Box *E. melliodora*) and mistletoes, and riparian forests of River Oak (*Casuarina cunninghamiana*) (Garnett 1993) and Swamp Mahogany (*Eucalyptus robusta*) in coastal areas (NPWS 1999c).	Unlikely – only one record in local area occurs east of Lake Illawarra, while Study arealies west of Lake Illawarra.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Botaurus poiciloptilus	Australasian Bittern	6	V	—	Occurs in south-east and south-west Australia, including Tasmania. Prefers densely vegetated freshwater wetlands, and occurs rarely in estuarine habitats (DSEWPAC 2011b).	No – absence of estuarine or wetland habitat
Burhinus grallarius	Bush Stone-curlew	1	E	—	Associated with dry open woodland with grassy areas, dune scrubs, in savanna areas, the fringes of mangroves, golf courses and open forest / farmland (DEC 2005; Marchant & Higgins 1993). Forages in areas with fallen timber, leaf litter, little undergrowth and where the grass is short and patchy (Marchant & Higgins 1993). Species likely requires large tracts of habitat to support breeding, in which there is a preference for relatively undisturbed habitat.	Unlikely – Last recorded from the Nowra/Bomaderry area in November 1937. A lone bird was recovered from Shoalhaven Heads in 1998 and later released on Comerong Island (Chafer .
Callocephalon fimbriatum	Gang-gang Cockatoo	128	V	—	Inhabits dense, tall, wet forests of mountains and gullies, alpine woodlands in summer (Morcombe 2004). In winter they occur at lower altitudes in drier more open forests and woodlands, particularly box-ironbark assemblages (Shields & Chrome 1992). They sometimes inhabit woodland, farms and suburbs in autumn/winter (Simpson & Day 2004).	Unlikely – all previous records occur west of escarpment
Calyptorhynchus lathami	Glossy Black-Cockatoo	12	V	—	Associated with a variety of woodlands and drier forests containing *Allocasuarina* species (a key food source), usually reflecting the poor nutrient status of underlying soils (DECCW 2011, DEC 2005). Intact drier forest types with less rugged landscapes are preferred (DEC 2005). Nests in large trees with large hollows (DEC 2005).	Unlikely – small areas containing *Allocasuarina* spp. provide foraging habitat within the Field Assessment Area.
Coracina lineata	Barred Cuckoo-shrike	1	V	—	It is associated with subtropical, dry and littoral rainforests and is restricted to below 500m elevation (DEC 2005).	Unlikely – one record in local area at Mount Keira

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Daphoenositta chrysoptera	Varied Sittella	2	V	—	Varied Sitellas are endemic and widespread in mainland Australia. Varied Sitellas are found in eucalypt woodlands and forests throughout their range. They prefer rough-barked trees like stringybarks and ironbarks or mature trees with hollows or dead branches (Birds in Backyards 2011)	Unlikely – both local records occur west of escarpment
Dasyornis brachypterus	Eastern Bristlebird	13	E	E	Distribution ranges from Conondale Ranges in SE Qld, along NSW coast to NE Victoria. In NSW disjunct populations occur in the north-east, south-east and Illawarra. Habitat is characterised by dense, low vegetation including heath and open woodland with a heathy understorey and in northern NSW occurs in open forest with tussocky grass understorey: fire interval is key in habitat preference, as birds prefer habitat with long fire intervals and are known to disappear post-fire (NPWS 1999d).	No – absence of heathy vegetation within Field Assessment Area, all local records occur west of escarpment near Budderoo NP
Ephippiorhynchus asiaticus	Black-necked Stork	3	E	—	Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains (Marchant & Higgins 1993). Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant & Higgins 1993; DEC 2005).	No – absence of wetland or estuarine habitat
Epthianura albifrons	White-fronted Chat	2	V	—	Inhabits most of southern Australia, mostly in temperate to arid climates & very rarely in the sub-tropics. Occupies foothills and lowlands below 1000m asl. In NSW, prefers damp open habitats including saltmarsh & wetlands along the central & south coast, & near waterways west of Divide (DECCW 2011).	No – absence of saltmarsh and wetland habitat

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Glossopsitta pusilla	Little Lorikeet	1	V	—	In NSW, Little Lorikeets are distributed in forests and woodlands from the coast across the Divide, reaching west as far as Albury, Parkes, Dubbo and Narrabri. Occur in dry, open eucalypt forests and woodlands. Recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. Primarily feed on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands *Eucalyptus albens* (White Box) and *E. melliodora* (Yellow Box) are particularly important food sources for pollen and nectar respectively (DECCW 2011).	Unlikely – only one local record, which occurs west of escarpment
Grantiella picta	Painted Honeyeater	1	V	—	A nomadic species that typically inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests with abundant mistletoe (DEC 2005). It is a specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias, preferring *Amyema* sp. mistletoe (DEC 2005).	Unlikely – absence of typical habitat, only one local record from 1991,
Gygis alba	White Tern	2	V	—	Subtropical and tropical seas; usually far from land, except in breeding season where it forages over lagoons and reefs around islands (Morcombe 2004).	No – absence of marine habitat within Field Assessment Area
Haematopus fuliginosus	Sooty Oystercatcher	13	V	—	Intertidal rocky and coral reefs, mostly on ocean shores, breeds mostly on offshore islands, occasionally frequents sandspits and tidal mudflats (Marchant and Higgins 1993).	No – absence of marine habitat, mudflats and sandspits in Field Assessment Area; all local records occur east of Lake Illawarra.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Haematopus longirostris	Pied Oystercatcher	21	V	—	Undisturbed sandy beaches, sandspits and sandbars, tidal mudflats and estuaries, coastal islands (Marchant and Higgins 1993).	No – absence of beach or estuarine habitat in Field Assessment Area;.
Irediparra gallinacea	Comb-crested Jacana	2	V	—	Freshwater wetlands, such as lagoons, billabongs, swamps, lakes and reservoirs, generally with abundant floating aquatic vegetation (Marchant and Higgins 1993).	Unlikely – all local records on coast at Minnamurra/Killalea.
Ixobrychus flavicollis	Black Bittern	13	V	—	Occurs in both terrestrial and estuarine wetlands generally in areas of permanent water and dense vegetation (DEC 2005). In areas with permanent water it may occur in flooded grassland, forest, woodland, rainforest and mangroves (DEC 2005)	Unlikely – absence of estuarine wetlands within Field Assessment Area.
Lathamus discolor	Swift Parrot	30	E	E	Breeds in Tasmania between September and January. Migrates to mainland in autumn, where it forages on profuse flowering eucalypts (Blakers et al. 1984, Schodde and Tidemann 1986). Hence, in this region, autumn and winter flowering eucalypts are important for this species. Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*) (DEC 2005).	Potential – *E. tereticornis* is a winter-flowering species, however all previous record occur east of Lake Illawarra,
Lophoictinia isura	Square-tailed Kite	4	V	—	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. Appears to occupy large hunting ranges of more than 100 km^2(DEC 2005). Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs (DEC 2005).	Unlikely –all previous records occur east of Lake Illawarra.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Neophema pulchella	Turquoise Parrot	9	V	—	Inhabits steep rocky ridges and gullies, rolling hills, valleys and river flats and the plains of the Great Dividing Range (Marchant & Higgins 1993). Lives at the periphery of eucalypt woodland adjoining clearings, timbered ridges, and creeks within farmland (DEC 2005). Spends much of the time on the ground in the shade, foraging on seed and grasses (DEC 2005).	Unlikely – all local records occur west of escarpment with exception of one record in a reserve at Windang (Lake Illawarra)
Oxyura australis	Blue-billed Duck	3	V	—	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation (DEC 2005). The species is completely aquatic, swimming low in the water along the edge of dense cover (DEC 2005). It will fly if disturbed, but prefers to dive if approached (DEC 2005). Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and over-wintering lakes with some long-distance dispersal to breed during spring and early summer (DEC 2005). Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes (DEC 2005).	No – absence of deep permanent wetlands in Field Assessment Area; local records occur only at Killalea Lagoon in 1985-1986
Pachycephala olivacea	Olive Whistler	5	V	—	Inhabits wet forest on the ranges of the east coast, mostly above 500m asl. NSW distribution is disjunct from beech forest around Barrington Tops & MacPherson Ranges in north, and wet forests from Illawarra south to Vic, including Snowy Mtns and Brindabella Range. Nest in low forks of shrubs, breeding between September and January (DEC 2005).	Unlikely – all local records occur west of the escarpment
Petroica boodang	Scarlet Robin	7	V	—	In NSW, occurs from the coast to the inland slopes, with some dispersing to open habitat of lower valleys and plains after breeding in July-January (DEC 2005). In habits dry open eucalypt forest and woodland with a sparse shrub layer. Occasionally occurs in mallee, wet forest, wetlands or tea-tree swamps (DEC 2005).	Unlikely – all local records occur west of escarpment in catchment of Lake Avon.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Petroica phoenicea	Flame Robin	1	V	—	Endemic to SE Australia, and ranges from south-east Qld to south-east SA, including Tasmania. In NSW, birds breed from spring to late summer in upland tall moist eucalypt forests and woodlands, often on ridges and slopes, preferring clearings or areas with an open understorey dominated by native grass. Birds migrate to drier, more open forests, woodlands or grasslands in winter (DEC 2005).	Unlikely – sole local record (1992) occurs west of escarpment.
Petroica rodinogaster	Pink Robin	3	V	—	Found in Tasmania, upland east Victoria, and far south-east NSW. Inhabits rainforest and tall, open eucalypt forest, particularly in densely vegetated gullies. On the mainland, the species disperses north and west and into more open habitats in winter (DEC 2005).	Unlikely – Study areamay provide winter foraging habitat; previously recorded near Study areain July 1996.
Pezoporus wallicus wallicus	Ground Parrot (eastern subspecies)	3	V	—	Predominantly restricted to coastal heath and sedgelands that provide a high density of cover and food foraging resources (Blakers et al. 1984; Simpson & Day 2004).	No – absence of heath & sedgelands in Field Assessment Area.
Polytelis anthopeplus monarchoides	Regent Parrot (eastern subspecies)	1	E	V	Distribution is confined to the semi-arid interior of south-eastern Australian mainland, and in NSW inhabits the south-west of the state. Prefers riparian or littoral *Eucalyptus camaldulensis* forest or woodland, and adjacent *Eucalyptus largiflorens* woodlands (DEC 2005; DSEWPAC 2011b).	No – absence of preferred habitat; sole local record at Mount Keira in 1990.
Polytelis swainsonii	Superb Parrot	1	V	V	Found throughout eastern inland NSW, in Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. On the south-west slopes, nest trees can be in open Box-Gum Woodland or isolated paddock trees. Species known to be used are Blakely‘s Red Gum, Yellow Box, Apple Box and Red Box. May forage up to 10 km from nesting sites, primarily in grassy box woodland (DEC 2005).	No – absence of preferred tree species in Field Assessment Area; one local record (1984) at Primbee, east of Lake Illawarra.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Ptilinopus magnificus	Wompoo Fruit-Dove	1	V	—	Associated with large, undisturbed patches of tall tropical or subtropical rainforest, at all altitudes, preferably with a diversity of fruit (Higgins and Davies 1996; DEC 2005). Occasionally located in patches of monsoon rainforest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest (Higgins and Davies 1996; DEC 2005).	No – sole local record was in 1920 at Mount Keira.
Ptilinopus regina	Rose-crowned Fruit-Dove	1	V	—	Tall tropical and subtropical, evergreen or semi-deciduous rainforests, especially with a dense growth of vines on trees (Higgins and Davies 1996). Also located in closed wet sclerophyll forest, gallery forests or sclerophyll woodlands with abundant fruiting trees, near or next to rainforest (DEC 2005). Is thought to prefer large areas of vegetation, but has been located in patches and occasionally in parks and gardens with fruiting trees (Higgins and Davies 1996).	Unlikely – no tropical or subtropical rainforest within the Field Assessment Area; sole local record (1996) at Mount Keira.
Ptilinopus superbus	Superb Fruit-Dove	3	V	—	Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms (DEC 2005). It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees (*ibid.*). Part of the population is migratory or nomadic (*ibid.*). At least some of the population, particularly young birds, moves south through Sydney, especially in autumn (*ibid.*). Breeding takes place from September to January (*ibid.*). Will feed in adjacent mangroves or eucalypt forests (Blakers et al. 1984).	Unlikely – most recent record was in 1992 at Mount Keira.
Puffinus assimilis	Little Shearwater	1	V	—	Seabird of the sub-tropics, known to feel on continental shelf and breed on subtropical and Antarctic islands. Recorded in NSW along the coast & in breeding colonies on Lord Howe Island (NPWS 1999e).	No – absence of marine or shoreline habitat within Field Assessment Area.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Sterna fuscata	Sooty Tern	2	V	—	Forages offshore, usually only observed onshore in breeding season or when storms force them to shelter (DEC 2005)	No – absence of marine or shoreline habitat within Field Assessment Area.
Stictonetta naevosa	Freckled Duck	9	V	—	Associated with a variety of plankton-rich wetlands, such as heavily vegetated, large open lakes and their shores, creeks, farm dams, sewerage ponds and floodwaters (DEC 2005).	Unlikely – Study area includes creeks and farm dams, though only previously recorded in Lake Illawarra..
NOCTURNAL BIRDS						
Ninox connivens	Barking Owl	3	V	—	Associated with a variety of habitats such as savannah woodland, open eucalypt forests, wetland and riverine forest. The habitat is typically dominated by Eucalypts (often Red Gum species), however often dominated by *Melaleuca* species in the tropics (DEC 2005). It usually roosts in dense foliage in large trees such as River She-oak (*Allocasuarina cunninghamiana*), other *Casuarina* and *Allocasuarina*, eucalypts, *Angophora*, *Acacia* and rainforest species from streamside gallery forests (NPWS 2003). It usually nests near watercourses or wetlands (NPWS 2003) in large tree hollows with entrances averaging 2-29 metres above ground, depending on the forest or woodland structure and the canopy height (Debus 1997).	Unlikely – only one record below the escarpment with low accuracy

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Ninox strenua	Powerful Owl	21	V	—	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes (Debus & Chafer 1994). Large trees with hollows at least 0.5m deep are required for shelter and breeding.	Unlikely– Study area includes small areas of forest; however local records occur on, or west of, escarpment.
Tyto novaehollandiae	Masked Owl	5	V	—	Associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland (DEC 2005) and especially the ecotone between wet and dry forest, and non forest habitat. Known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh & Peake 1993).	Unlikely – Study areaincludes forest margins; however, the last record east of the escarpment was in 1969.
Tyto tenebricosa	Sooty Owl	21	V	—	Sooty Owls are associated with tall wet old growth forest on fertile soil with a dense understorey and emergent tall *Eucalyptus* species (DEC 2005, Debus 1994). Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes in caves. The Sooty Owl is typically associated with an abundant and diverse supply of prey items and a selection of large tree hollows (Debus 1994, Garnett 1993, Hyem 1979).	Unlikely – absence of wet old growth forest within the Field Assessment Area; no records have been made east of escarpment
MIGRATORY SPECIES						
Apus pacificus	Fork-tailed Swift	N/A	—	M: CAMBA, JAMBA, ROKAMBA	Aerial species, recorded over open country, from semi-deserts to coasts, sometimes forests and cities (DSEWPAC 2011b).	Unlikely – flyover habitat only

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Ardea alba	Great Egret	N/A	—	M: CAMBA, JAMBA	The Great Egret is common and widespread in Australia (McKilligan 2005). It forages in a wide range of wet and dry habitats including permanent and ephemeral freshwaters, wet pasture and estuarine mangroves and mudflats (McKilligan 2005).	Known
Ardea ibis	Cattle Egret	N/A	—	M: CAMBA, JAMBA	Cattle Egrets forage on pasture, marsh, grassy road verges, rain puddles and croplands, but not usually in the open water of streams or lakes and they avoid marine environments (McKilligan 2005). Some individuals stay close to the natal heronry from one nesting season to the next, but the majority leave the district in autumn and return the next spring. Cattle Egrets are likely to spend the winter dispersed along the coastal plain and only a small number have been recovered west of the Great Dividing Range (McKilligan 2005).	Known
Arenaria interpres	Ruddy Turnstone	N/A	—	M: Bonn, CAMBA JAMBA, ROKAMBA	Widespread along Australian coastlines from September to April, outside of breeding season. Shows strong preference for rocky shores or beaches, with large deposits of seaweed wrack (DSEWPAC 2011b).	No – absence of shoreline habitat within Field Assessment Area.
Calidris acuminata	Sharp-tailed Sandpiper	N/A	-—	M: Bonn, CAMBA, JAMBA, ROKAMBA	It prefers the grassy edges of shallow inland freshwater wetlands. It is also found around sewerage treatment ponds, flooded grasslands, mudflats, mangroves, rocky shores and beaches (Birds in Backyards 2011).	No – absence of wetlands, mudflats, shoreline etc. within Field Assessment Area.
Calidris alba	Sanderling	15	V	M: Bonn, CAMBA, JAMBA, ROKAMBA	Summer non-breeding migrant (Sept – May). Found in coastal areas on beaches, near reefs & inlets, along tidal mudflats, bare open coastal lagoons, and rarely in near-coastal wetlands (DEC 2005).	No – absence of shoreline habitat within Field Assessment Area.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Calidris canutus	Red Knot	N/A	—	M: Bonn, CAMBA, JAMBA, ROKAMBA	Migratory species that breeding in the Arctic. Migration patterns are complex, however birds generally start arriving in south-east Australia in September and may stay until early April (DSEWPAC 2011b). Gather in large flocks on the coast in sandy estuaries with tidal mudflats (Birds in Backyards 2010).	No – absence of estuarine habitat within Field Assessment Area.
Calidris ferruginea	Curlew Sandpiper	N/A	—	M: Bonn, CAMBA, JAMBA, ROKAMBA	Intertidal mudflats of estuaries, lagoons, mangrove channels; around lakes, dams, floodwaters, flooded saltbush surrounds of inland lakes (Morcombe 2004).	No – absence of estuarine and large bodies of freshwater within Field Assessment Area.
Calidris ruficollis	Red-necked Stint	N/A	—	M: Bonn, CAMBA, JAMBA, ROKAMBA	They are mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. Occasionally they have been recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs or shoals. They also occur in saltworks and sewage farms; saltmarsh; ephemeral or permanent shallow wetlands near the coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats (DSWEPAC 2011)	Unlikely – absence of shoreline or estuarine habitat; species is likely to prefer Lake Illawarra within local area.
Calidris tenuirostris	Great Knot	N/A	V	M: Bonn, CAMBA, JAMBA, ROKAMBA	Migratory bird that inhabits Australia from late August to April, with a few birds wintering over in Australia. Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons (DEC 2005).	No – absence of estuarine habitat within Field Assessment Area.
Charadrius bicinctus	Double-banded Plover	N/A	—	M: Bonn	Found on littoral, estuarine and fresh or saline terrestrial wetlands and also saltmarsh, grasslands and pasture. It occurs on muddy, sandy, shingled or sometimes rocky beaches, bays and inlets, harbours and margins of fresh or saline terrestrial wetlands such as lakes, lagoons and swamps, shallow estuaries and rivers. Mostly occurs in Australia between December and August. Breeds only in NZ (DSEWPAC 2011b).	No – species may utilise pasture, however is likely to prefer estuarine environment of Lake Illawarra.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Charadrius leschenaultii	Greater Sand-plover	7	V	M: Bonn, CAMBA, JAMBA, ROKAMBA	In NSW, common in Northern Rivers region, and occasional visitors further south to Shoalhaven district. Almost entirely restricted to coastal habitat (estuarine or littoral), including bays, beaches, inshore reefs, mudflats, sandbanks, rock platforms, lagoons, occasionally on saltmarsh and brackish swamps, and rarely on freshwater wetlands and pasture. Breeding does not occur within Australia (DSEWPAC 2011b).	Unlikely – species may utilise pasture, however is likely to prefer estuarine environment of Lake Illawarra (no records west of the Lake).
Charadrius mongolus	Lesser Sand-plover	2	V	M: Bonn, CAMBA, JAMBA, ROKAMBA	In NSW, distributed along the east coast and occasionally inland. Key sites include Hunter River estuary, Tuggerah Lakes, Clarence River estuary, Richmond River estuary, Shoalhaven River estuary, and Botany Bay. Tidal mudflats and sandflats in sheltered locations, and occasionally ocean beaches, saltmarsh, rock platforms & outcrops, mangroves and saltworks (DSEWPAC 2011b).	No – absence of estuarine habitat within Field Assessment Area; no records east of Lake Illawarra.
Diomedea exulans	Wandering Albatross	13	E	V, M: Bonn, JAMBA	Marine forager in Australian Waters within Southern Ocean. Breeds on Australian territories Macquarie and Heard Island, and other sub-Antarctic island groups. Non-breeding birds are usually found between 30^{o} and 50^{o} S (DSEWPAC 2011b).	No – absence of marine habitat within Field Assessment Area; no records east of Lake Illawarra.
Gallinago hardwickii	Latham‘s Snipe	N/A	—	M: Bonn, CAMBA, JAMBA, ROKAMBA	A variety of permanent and ephemeral wetlands, preferring open fresh water wetlands with nearby cover (Higgins and Davies 1996). Occupies a variety of vegetation around wetlands (Higgins and Davies 1996) including wetland grasses and open wooded swamps (Simpson and Day 2004).	Unlikely – absence of good wetland habitat within Field Assessment Area.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Haliaeetus leucogaster	White-bellied Sea-Eagle	N/A	—	M: CAMBA	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas (Marchant & Higgins 1996, Simpson & Day 2004). Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away (Marchant & Higgins 1996).	Unlikely – flyover habitat only
Heteroscelus brevipes EPBC Act, CAMBA & ROKAMBA as *Tringa brevipes.*	Grey-tailed Tattler	N/A	—	M: Bonn, CAMBA, JAMBA, ROKAMBA	In NSW, occurs along the coast from Queensland to Tilba Lake (south coast), concentrated on central coast. Usually seen in small flocks on sheltered coasts with reefs and rock platforms or with intertidal mudflats (DSEWPAC 2011b).	No – absence of shoreline or intertidal habitat within Field Assessment Area; no records east of Lake Illawarra.
Hirundapus caudacutus	White-throated Needletail	N/A	—	M: CAMBA	Forages aerially over a variety of habitats usually over coastal and mountain areas, most likely with a preference for wooded areas (Marchant & Higgins 1999, Simpson & Day 2004). Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather (Marchant & Higgins 1999).	Potential – Study area includes small wooded areas providing marginal foraging habitat.
Limicola falcinellus	Broad-billed Sandpiper	3	V	M: Bonn, CAMBA, JAMBA, ROKAMBA	Regular visitor to NSW between Ballina and Shoalhaven Heads. Preferred habitat is estuarine sandflats and mudflats, and occasionally inhabit saltmarshes, freshwater lagoons, saltworks, sewage farms, reefs, rock platforms, and coastal creeks, swamps and lakes with mud- or sandflats (DSEWPAC 2011b).	No – absence of estuarine habitat within Field Assessment Area; no records east of Lake Illawarra.
Limosa lapponica	Bar-tailed Godwit	N/A	—	M: Bonn, CAMBA, JAMBA, ROKAMBA	Occurs in all Australian coastal areas. In NSW, the Hunter estuary is a site of international important. Bar-tailed Godwits prefer intertidal sand- and mudflats, beaches, sandbars, estuaries, inlets, harbours, coastal lagoons and bays. Breeding occurs in northern hemisphere summer (DSEWPAC 2011b).	No – absence of marine or estuarine habitat within Field Assessment Area.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Limosa limosa	Black-tailed Godwit	2	V	M: Bonn, CAMBA, JAMBA, ROKAMBA	Prefers coastal regions, with scattered inland records. Usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats (DSEWPAC 2011b).	No – absence of shoreline or estuarine habitat within Field Assessment Area; no records east of Lake Illawarra.
Macronectes giganteus	Southern Giant Petrel	3	E	E M: Bonn.	Ocean-going bird that scavenges off-shore. Birds winter over off the coast of Australia, and off the south-east coast are mostly recorded between June & December. Breeding occurs mainly on Antarctic and sub-Antarctic islands during August-September (DSEWPAC 2011b).	No – absence of marine habitat in Field Assessment Area; no records east of Lake Illawarra.
Merops ornatus	Rainbow Bee-eater	N/A	—	M: JAMBA	Resident in coastal and subcoastal northern Australia; regular breeding migrant in southern Australia, arriving September to October, departing February to March, some occasionally present April to May (Pizzey and Knight 1997). Occurs in open country, chiefly at suitable breeding places in areas of sandy or loamy soil: sand-ridges, riverbanks, road-cuttings, sand-pits, occasionally coastal cliffs (*ibid*). Nest is a chamber a the end of a burrow, up to 1.6 m long, tunnelled in flat or sloping ground, sandy back or cutting (*ibid*).	Known.
Monarcha melanopsis	Black-faced Monarch	N/A	—	M: Bonn	Rainforest and eucalypt forests, feeding in tangled understorey (Blakers et al. 1984). May also be found in coastal scrub or damp gullies, and during migration, more open woodland habitats. Breeding migrant that arrives in coastal south-eastern Australia in September and returns north in March (Birds in Backyards 2011).	Potential – small areas of breeding habitat (eucalypt forest) are present within Field Assessment Area.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Myiagra cyanoleuca	Satin Flycatcher	N/A	—	M: Bonn	Associated with eucalypt forests, often near wetlands or watercourses but absent from rainforests (DSEWPAC 2011b, Blakers et al. 1984); occurs in open forests, often at height (Simpson & Day 2004). Breed above 600m asl during Nov-Jan, and migrate north for winter (DSEWPAC 2011b).	Unlikely – Locations in the Study areainclude Lake Heights
Neophema chrysogaster	Orange-bellied Parrot	0	CE	CE, M: JAMBA	Breeds in south-west Tasmania, and winters over on the mainland in south-east SA and southern Victoria. Occasional records from NSW, most recently at Shellharbour and Sydney in 2003. Typical winter habitat is saltmarsh and strandline/foredune vegetation communities either on coastlines or coastal lagoons. Spits and islands are favoured but they will turn up anywhere within these coastal regions (DEC 2005).	Unlikely – no previous records in local area
Numenius madagascariensis	Eastern Curlew	N/A	—	M: Bonn, CAMBA, JAMBA, ROKAMBA	Primarily coastal distribution, prefers sheltered areas including estuaries, mudflats and soft sandy beaches (DSEWPAC 2011b).	No – absence of estuaries, beaches and mudflats within Field Assessment Area.
Numenius minutes	Little Curlew	N/A	—	M: Bonn, CAMBA , JAMBA, ROKAMBA	Little Curlews may gather in large flocks on coastal and inland grasslands and black soil plains in northern Australia, near swamps and flooded areas. They also feed on playing fields, paddocks and urban lawns (Birds in Backyards 2011).	No – species generally distributed in northern Australia
Numenius phaeopus	Whimbrel	N/A	—	M: Bonn, CAMBA, JAMBA, ROKAMBA	Whimbrel is often found on the intertidal mudflats of sheltered coasts. It is also found in harbours, lagoons, estuaries and river deltas, often those with mangroves, but also open, unvegetated mudflats. It is occasionally found on sandy or rocky beaches, on coral or rocky islets, or on intertidal reefs and platforms. It has been infrequently recorded using saline or brackish lakes near coastal areas. It also used saltflats with saltmarsh, or saline grasslands with standing water left after high spring-tides, and in similar habitats in sewage farms and saltfields (DSEWPAC 2011b).	No – absence of lakes, estuarine or shoreline habitat within Field Assessment Area.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Pandion haliaetus	Osprey	1	V	M: Bonn	Inhabit coastal areas, particularly river mouths, lagoons, lakes, islands, reefs and rocky shorelines. In NSW, breeding occurs from July to September and nests are high up in stags, usually within 1 km of the sea (DEC 2005).	No – absence of lakes, estuarine or shoreline habitat within Field Assessment Area.
Pluvialis fulva	Pacific Golden Plover	N/A	—	M: Bonn, CAMBA, JAMBA, ROKAMBA	Primarily a coastal species, usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Non-breeding summer migrant (DEC 2005).	No – absence of estuarine or intertidal habitat within Field Assessment Area.
Pterodroma leucoptera leucoptera	Gould's Petrel	1	V	E M: JAMBA	The Australian subspecies breeds only on two islands near the mouth of Port Stephens (NSW) between November and March. The subspecies distribution at sea is poorly known, but is recorded off south-east Australia in the Tasman Sea (esp. off Tasmania) between December and April (DSEWPAC 2011b).	No – absence of marine habitat within Field Assessment Area.
Puffinus carneipes EPBC Act as *Ardenna carneipes*	Flesh-footed Shearwater	2	V	M: JAMBA, ROKAMBA,	Visitor to the waters of the continental shelf off southern Australia. Breeds August-May on islands off the coast of south-west WA, Smith Island (off Eyre Peninsula SA), and Lord Howe Island. Migrates to northern hemisphere for rest of the year (DSEWPAC 2011b).	No – absence of marine habitat within Field Assessment Area.
Rhipidura rufifrons	Rufous Fantail	N/A	—	M: Bonn	The Rufous Fantail is a summer breeding migrant to southeastern Australia (Morcombe 2004). The Rufous Fantail is found in rainforest, dense wet eucalypt and monsoon forests, paperbark and mangrove swamps and riverside vegetation (Morcombe 2004). Open country may be used by the Rufous Fantail during migration (Morcombe 2004).	Potential- wet eucalypt forest, and small pockets of rainforest present on escarpment within Field Assessment Area.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Rostratula benghalensis s. lat. EPBC Act as *Rostratula australis*	Painted Snipe	1	E1	M: CAMBA	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber (DEC 2005). Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds (*ibid.*). Breeding is often in response to local conditions; generally occurs from September to December (DEC 2005). Roosts during the day in dense vegetation (OEH 2011)c. Forages nocturnally on mud-flats and in shallow water (DEC 2005). Feeds on worms, molluscs, insects and some plant-matter (*ibid.*).	Unlikely – only recorded once on shore of Lake Illawarra in 1970, and not since.
Sterna albifrons	Little Tern	289	E	M: Bonn, CAMBA, JAMBA, ROKAMBA	In NSW, birds arrive in September-November, more commonly north of Sydney. Breeds along the coast in spring-summer, and departs in May. Coastal waters, bays, inlets, saline or brackish lakes and rivers. Nest in small colonies in low dunes or beaches just above high tide mark near estuaries or coastal lakes (DEC 2005).	Unlikely – absence of shoreline or estuarine habitat within Field Assessment Area.
Thalassarche melanophris	Black-browed Albatross	1	V	V M. Bonn.	Marine species that inhabits Antarctic, subantarctic and temperate waters (and occasionally the tropics). Largely confined to Antarctic and subantarctic islands & surrounding waters during breeding season (September-April). Migrate north along cold-water currents north to continental shelf of Australia, occasionally entering coastal & inshore waters (DSEWPAC 2011b).	Unlikely – no marine habitat. One record in 1977 and none since.
Thinornis rubricollis	Hooded Plover	2	CE	M	In south-eastern Australia this species uses long stretches of sandy shore, backed by tussock and creeper-covered dunes with nearby inland lakes (DEC 2005). Preferred habitat is beaches with a wide wash zone with seaweed mounds for feeding (Murlis 1989).	No – absence of beach habitat. Only recorded in 1986 & 1988.
Tringa stagnatilis	Marsh Sandpiper	N/A	—	M: Bonn, CAMBA, JAMBA, ROKAMBA	Coastal species. Inhabits permanent or ephemeral wetlands of varying degrees of salinity, commonly inland (DEC 2005). Breeds Eastern Europe to Eastern Siberia (*ibid*).	No – absence of wetland habitat within Field Assessment Area.

Scientific Name	Common Name	Number of records	TSC	EPBC	Habitat Associations	Likelihood Occurrence
Xenus cinereus	Terek Sandpiper	5	V	M: Bonn, CAMBA, JAMBA, ROKAMBA	Rare migrant to NSW coast, more common in northern Australia. Key sites include Richmond River estuary and Hunter River estuary (latter is internationally important for species conservation). Usually recorded on tidal mudflats, estuaries, lagoons and creeks, preferably near mangroves (DEC 2005).	No – absence of estuarine habitat and mangrove-lined creeks within Field Assessment Area.

Disclaimer: Data extracted from the NPWS Atlas of NSW Wildlife (OEH 2011a) and DSEWPAC (2011a) EPBC Act Protected Matters Report are only indicative and cannot be considered a comprehensive inventory.

Additional records from the current ELA study have been included in this table. N/A denotes where a species is listed only under the EPBC Act and previous records do not appear on searches for threatened species on the Atlas of NSW Wildlife (OEH 2011a).

Listed Marine species and Listed Migratory aquatic marine species have been excluded given the lack of marine habitat within the impact area.

CE = Critically Endangered; E = Endangered; EP = Endangered Population; V = Vulnerable; M = Migratory
Bonn = Bonn Convention for the Conservation of Migratory Species of Wild Animals; CAMBA = China-Australia Migratory Bird Agreement; JAMBA = Japan-Australia Migratory Bird Agreement; ROKAMBA = Republic of Korea-Australia Migratory Bird Agreement

Appendix 3: Flora Inventory

Appendix 4: Fauna Inventory

Class	Family	*Genus*	*Species*	Common name		ELA 2011	ELA2011b	ELA2009a	ELA2009b
Amphibia	Hylidae	*Litoria*	*caerulea*	Green Tree Frog	Native	x			x
Amphibia	Hylidae	*Litoria*	*revelata*	Revealed Frog	Native			x	
Amphibia	Hylidae	*Litoria*	*rubella*	Desert Tree Frog	Native				x
Amphibia	Myobatrachidae	*Crinia*	*signifera*	Common Eastern Froglet	Native	x		x	x
Amphibia	Myobatrachidae	*Limnodynastes*	*tasmaniensis*	Spotted Marsh Frog	Native				x
Amphibia	Myobatrachidae	*Limnodynastes*	*salmini*	Salmon-striped Frog	Native				x
					Total	**2**	**0**	**2**	**5**
Aves	Acanthizidae	*Acanthiza*	*chrysorrhoa*	Yellow-rumped Thornbill	Native				
Aves	Acanthizidae	*Acanthiza*	*lineata*	Striated Thornbill	Native				
Aves	Acanthizidae	*Acanthiza*	*nana*	Yellow Thornbill	Native				
Aves	Acanthizidae	*Acanthiza*	*pusilla*	Brown Thornbill	Native				
Aves	Acanthizidae	*Gerygone*	*albogularis*	White-throated Gerygone	Native				
Aves	Acanthizidae	*Gerygone*	*mouki*	Brown Gerygone	Native				
Aves	Acanthizidae	*Smicrornis*	*brevirostris*	Weebill	native			x	
Aves	Accipitridae	*Accipiter*	*novaehollandiae*	Grey Goshawk	Native				
Aves	Accipitridae	*Accipter*	*cirrocephalus*	Collared Sparrowhawk	Native				
Aves	Accipitridae	*Accipter*	*fasciatus*	Brown Goshawk	Native				
Aves	Accipitridae	*Aquila*	*audax*	Wedge-tailed Eagle	Native	x			
Aves	Accipitridae	*Aviceda*	*subcristata*	Pacific Baza	Native	x			x
Aves	Accipitridae	*Circus*	*approximans*	Swamp Harrier	Native				
Aves	Accipitridae	*Circus*	*assimilis*	Spotted Harrier	Native				
Aves	Accipitridae	*Elanus*	*axillaris*	Black-shouldered Kite	Native			x	x
Aves	Accipitridae	*Haliaeetus*	*leucogaster*	White-bellied Sea eagle	Native				
Aves	Accipitridae	*Haliastur*	*sphenurus*	Whistling Kite	Native				
Aves	Accipitridae	*Hieraaetus*	*morphnoides*	Little Eagle	Native				
Aves	Accipitridae	*Milvus*	*migrans*	Black Kite	Native				
Aves	Accipitridae	*Pandion*	*cristatus*	Osprey	Native				
Aves	Acrocephalidae	*Acrocephalus*	*australia*	Australian Reed-Warbler	Native			x	
Aves	Alaudidae	*Alauda*	*arvensis*	Eurasian Skylark	Exotic				
Aves	Alaudidae	*Cincloramphus*	*mathewsi*	Rufous Songlark	Native				
Aves	Alaudidae	*Cinclorhemphus*	*cruralis*	Brown Songlark	Native				
Aves	Alcedinidae	*Alcedo*	*azurea*	Azure Kingfisher	Native	x			x
Aves	Alcedinidae	*Todiramphus*	*sanctus*	Sacred Kingfisher	Native				
Aves	Anatidae	*Anas*	*gracilis*	Grey Teal	Native				
Aves	Anatidae	*Anas*	*castanea*	Chestnut Teal	Native				
Aves	Anatidae	*Anas*	*platyrhynchos*	Northern Mallard	Native				
Aves	Anatidae	*Anas*	*rhynchotis*	Australasian Shoveler	Native				
Aves	Anatidae	*Anas*	*superciliosa*	Pacific Black Duck	Native	x		x	
Aves	Anatidae	*Aythya*	*australis*	Hardhead	Native				
Aves	Anatidae	*Biziura*	*lobata*	Musk Duck	Native				
Aves	Anatidae	*Chenonetta*	*jubata*	Australian Wood Duck	Native	x			x
Aves	Anatidae	*Cygnus*	*atratus*	Black Swan	Native				
Aves	Anatidae	*Dendrocygna*	*eytoni*	Plumed Whistling-Duck	Native			x	x
Aves	Anatidae	*Malacorhynchus*	*mernbranaceus*	Pink-eared Duck	Native				
Aves	**Anatidae**	***Stictonetta***	***naevosa***	**Freckled Duck**	**Native**				
Aves	Anatidae	*Tadorna*	*tadornoides*	Australian Shelduck	Native				

Class	Family	*Genus*	*Species*	Common name		ELA 2011	ELA2011b	ELA2009a	ELA2009b
Aves	Apodidae	*Dacelo*	*novaeguineae*	Laughing Kookaburra	native				x
Aves	Apodidae	*Hirundapus*	*caudacutus*	White-throated Needletail	Native				
Aves	Ardeidae	*Ardea*	*alba*	Great Egret	Native	x			
Aves	Ardeidae	*Ardea*	*cinerea*	Grey Heron	Native				
Aves	Ardeidae	*Ardea*	*ibis*	Cattle Egret	Native	x		x	
Aves	Ardeidae	*Ardea*	*pacifica*	White-necked Heron	Native			x	x
Aves	Ardeidae	*Egretta*	*garzetta*	Little Egret	Native				
Aves	Ardeidae	*Egretta*	*novaehollandiae*	White-faced Heron	Native	x		x	x
Aves	Ardeidae	*Ixobrychus*	*flavicollis*	Black Bittern	Native				
Aves	Ardeidae	*Nycticorax*	*caledonicus*	Nankeen Night-Heron	Native				
Aves	Artamidae	*Artamus*	*cyanopterus*	Dusky Woodswallow	Native			x	
Aves	Artamidae	*Cracticus*	*nigrogularis*	Pied Butcherbird	Native				x
Aves	Artamidae	*Cracticus*	*torquatus*	Grey Butcherbird	Native	x		x	
Aves	Artamidae	*Gymnorhina*	*tibicen*	Australian Magpie	Native	x		x	x
Aves	Artamidae	*Strepera*	*graculina*	Pied Currawong	Native	x		x	
Aves	Burhinidae	*Numenius*	*madagascariensis*	Eastern Curlew	Native				
Aves	Cacatuidae	*Cacatua*	*galerita*	Sulphur-crested Cockatoo	Native			x	x
Aves	Cacatuidae	*Cacatua*	*sanguinea*	Little Corella	Native	x		x	
Aves	Cacatuidae	*Cacatua*	*tenuirostris*	Long-billed Corella	Native				
Aves	Cacatuidae	*Calyptorhynchus*	*funereus*	Yellow-tailed Black-Cockatoo	Native	x			
Aves	Cacatuidae	*Eolophus*	*roseicapillus*	Galah	Native	x		x	
Aves	Campephagidae	*Coracina*	*novaehollandiae*	Black-faced Cuckoo-shrike	Native	x		x	x
Aves	Campephagidae	*Coracina*	*papuensis*	White-bellied Cuckoo-shrike	Native				
Aves	Campephagidae	*Lalage*	*sueurii*	White-winged Triller	Native				
Aves	Charadriidae	*Charadrius*	*bicinctus*	Double-banded Plover	Native				
Aves	Charadriidae	*Charadrius*	*mongolus*	Lesser Sand Plover	Native				
Aves	Charadriidae	*Charadrius r*	*ruficapillus*	Red-capped Plover	Native				
Aves	Charadriidae	*Elseyornis*	*melanops*	Black-fronted Dotterel	Native				
Aves	Charadriidae	*Erythrogonys*	*cinctus*	Red-kneed Dotterel	Native				
Aves	Charadriidae	*Eudynamys*	*orientalis*	Eastern Koel	Native				
Aves	Charadriidae	*Himantopus*	*himantopus*	Black-winged Stilt	Native				
Aves	Charadriidae	*Pluvialis*	*fulva*	Pacific Golden Plover	Native				
Aves	Charadriidae	*Pluvialis*	*squatarola*	Grey Plover	Native				
Aves	Charadriidae	*Vanellus*	*miles*	Masked Lapwing	Native	x		x	
Aves	Cincosomatidae	*Psophodes*	*leucogaster*	Eastern Whipbird	Native	x		x	
Aves	Climacteridae	*Cormobates*	*leucophaea*	White-throated Treecreeper	native			x	x
Aves	Columbidae	*Columba*	*livia*	Rock Dove	Exotic				x
Aves	Columbidae	*Geopelia*	*humeralis*	Bar-shouldered Dove	Native				
Aves	Columbidae	*Geopelia*	*striata*	Peaceful Dove	Native	x		x	x
Aves	Columbidae	*Lopholaimus*	*antarcticus*	Topknot Pigeon	Native				
Aves	Columbidae	*Macropygia*	*amboinensis*	Brown Cuckoo-Dove	Native				
Aves	Columbidae	*Ocyphaps*	*lophotes*	Crested Pigeon	Native				x
Aves	Columbidae	*Phaps*	*chalcoptera*	Common Bronzewing	Native			x	
Aves	Columbidae	*Streptopelia*	*chinensis*	Spotted Turtledove	Exotic				
Aves	Coraciidae	*Eurystomus*	*orientalis*	Dollarbird	Native				
Aves	Corvidae	*Corvus*	*mellori*	Little Raven	Native				
Aves	Corvidae	*Corvus*	*coronoides*	Australian Raven	Native	x		x	x
Aves	Corvidae	*Corvus*	*orru*	Torresian Crow	Native			x	
Aves	Cuculidae	*Cacomantis*	*pallidus*	Pallid Cuckoo	Native				
Aves	Cuculidae	*Cacomantis*	*flabelliformis*	Fan-tailed Cuckoo	Native				
Aves	Cuculidae	*Cacomantis*	*variolosus*	Brush Cuckoo	Native				
Aves	Cuculidae	*Chalcites*	*basalis*	Horsfield‘s Bronze-Cuckoo	Native				

Class	Family	*Genus*	*Species*	Common name		ELA 2011	ELA2011b	ELA2009a	ELA2009b
Aves	Cuculidae	*Chalcites*	*lucidus*	Shining Bronze-Cuckoo	Native				
Aves	Cuculidae	*Scythrops novaehollandiae*	*novaehollandiae*	Channel-billed Cuckoo	Native				
Aves	Dicaeidae	*Dicaeum*	*hirundinaceum*	Mistletoebird	Native				x
Aves	Dicruridae	*Dicrurus*	*bracteatus*	Spangled Drongo	Native				
Aves	Dicruridae	*Grallina*	*cyanoleuca*	Magpie-lark	Native	x		x	x
Aves	Dicruridae	*Monarcha*	*melanopsis*	Black-faced Monarch	Native				
Aves	Dicruridae	*Myiagra*	*inquieta*	Restless Flycatcher	Native				
Aves	Dicruridae	*Myiagra*	*rubecula*	Leaden Flycatcher	Native				
Aves	Dicruridae	*Rhipidura*	*albiscapa*	Grey Fantail	Native	x		x	x
Aves	Dicruridae	*Rhipidura*	*leucophrys*	Willie Wagtail	Native	x		x	
Aves	Dicruridae	*Rhipidura*	*rufifrons*	Rufous Fantail	Native				
Aves	Estrildidae	*Lonchura*	*castaneothorax*	Chestnut-breasted Manikin	Native				
Aves	Estrildidae	*Neochmia*	*temporalis*	Red-browed Finch	Native	x			
Aves	Estrildidae	*Taeniopygia*	*bichenovii*	Double-barred Finch	Native				
Aves	Estrildidae	*Taeniopygia*	*guttata*	Zebra Finch	Exotic				
Aves	Falconidae	*Falco*	*berigoga*	Brown Falcon	Native	x			x
Aves	Falconidae	*Falco*	*peregrinus*	Peregrine Falcon	Native				
Aves	Falconidae	*Falco*	*cenchroides*	Nankeen Kestrel	Native				
Aves	Falconidae	*Falco*	*longipennis*	Australian Hobby	Native				
Aves	Falconidae	*Fulica*	*atra*	Eurasian Coot	Native	x		x	
Aves	Fringillidae	*Carduelis*	*carduelis*	European Goldfinch	Exotic				
Aves	Haematopodidae	*Haematopus*	*fuliginosus*	Sooty Oystercatcher	Native				
Aves	Haematopodidae	*Haematopus*	*longirostris*	Pied Oystercatcher	Native				
Aves	Halcyonidae	*Dacelo*	*novaeguineae*	Laughing Kookaburra	Native	x		x	
Aves	Hirundinidae	*Hirundo*	*neoxena*	Welcome Swallow	Native			x	
Aves	Hirundinidae	*Petrochelidon*	*ariel*	Fairy Martin	Native				
Aves	Hirundinidae	*Petrochelidon*	*nigricans*	Tree Martin	Native				
Aves	Laridae	*Chlidonias*	*hybrias*	Whiskered Tern	Native				
Aves	Laridae	*Chroicocephalus*	*novaehollandiae*	Silver Gull	Native				
Aves	Laridae	*Hydroprogne*	*caspia*	Caspian Tern	Native				
Aves	Laridae	*Larus*	*dominicanus*	Kelp Gull	Native				
Aves	Laridae	*Thalasseus*	*bergii*	Crested Tern	Native				
Aves	Maluridae	*Malurus*	*cyaneus*	Superb Fairy-wren	Native	x		x	x
Aves	Maluridae	*Malurus*	*lamberti*	Variegated Wren	Native				
Aves	Maluridae	*Stipiturus*	*malachurus*	Southern Emu-wren	Native				
Aves	Meliphagidae	*Acanthorhynchus*	*tenuirostris*	Eastern Spinebill	Native				
Aves	Meliphagidae	*Acnthochaera*	*chrysoptera*	Little Wattlebird	Native	x			
Aves	Meliphagidae	*Acnthochaera*	*tenuirostris*	Eastern Spinebill	Native	x			
Aves	Meliphagidae	*Anthochaera*	*chrysoptera*	Little Wattlebird	Native				
Aves	Meliphagidae	*Epthianura albifrons*	*albifrons*	White-fronted Chat	Native				
Aves	Meliphagidae	*Lichenostomus*	*chrysops*	Yellow-faced Honeyeater	Native			x	
Aves	Meliphagidae	*Lichenostomus*	*fuscus*	Fuscous Honeyeater	Native				
Aves	Meliphagidae	*Lichenostomus*	*penicillatus*	White-plumed Honeyeater	Native				x
Aves	Meliphagidae	*Manorina*	*melanocephala*	Noisy Miner	Native	x		x	
Aves	Meliphagidae	*Meliphaga*	*lewinii*	Lewins honeyeater	Native			x	
Aves	Meliphagidae	*Melithreptus*	*lunatus*	White-naped Honeyeater	Native				
Aves	Meliphagidae	*Myzomela*	*sanguinolenta*	Scarlet Honeyeater	Native				
Aves	Meliphagidae	*Philemon*	*corniculatus*	Noisy Friarbird	Native	x		x	
Aves	Meliphagidae	*Phylidonyris*	*novaehollandiae*	New Holland Honeyeater	Native				
Aves	Menuridae	*Menura*	*novaehollandiae*	Superb Lyrebird	Native	x			x
Aves	Motacillidae	*Anthus*	*australis*	Australian (Richard's) Pitpit	Native				
Aves	Oriolidae	*Oriolus*	*sagittatus*	Olive-backed Oriole	Native				

Class	Family	*Genus*	*Species*	Common name		ELA 2011	ELA2011b	ELA2009a	ELA2009b
Aves	Pachycephalidae	*Colluricincla*	*harmonica*	Grey Shrike-thrush	Native			x	
Aves	Pachycephalidae	*Pachycephala*	*pectoralis*	Golden Whistler	Native				
Aves	Pachycephalidae	*Pachycephala*	*rufiventris*	Rufous Whistler	Native				
Aves	Pardalotidae	*Pardalotus*	*punctatus*	Spotted Pardalote	Native	x		x	
Aves	Pardalotidae	*Pardalotus*	*striatus*	Striated Pardalote	Native				x
Aves	Pardalotidae	*Sericornis*	*frontalis*	White-browed Scrubwren	Native			x	x
Aves	Passeridae	*Passer*	*domesticus*	House Sparrow	Exotic				x
Aves	Passeriformes	*Aplonis*	*metallica*	Metallic Starling	Exotic			x	
Aves	Pelecanidae	*Pelecanus*	*conspicillatus*	Australian Pelican	Native				
Aves	Petroicidae	*Eopsaltria*	*australis*	Eastern Yellow Robin	Native	x		x	x
Aves	Petroicidae	*Petroica*	*rosea*	Rose Robin	Native				
Aves	Phalacrocoracidae	*Anhinga*	*novaehollandiae*	Australasian Darter	Native				
Aves	Phalacrocoracidae	*Anthochaera*	*carunculata*	Red Wattlebird	Native			x	
Aves	Phalacrocoracidae	*Microcarbo*	*melanoleucos*	Little Pied Cormorant	Native				
Aves	Phalacrocoracidae	*Phalacrocorax*	*sulcirostris*	Little Black Cormorant	Native				
Aves	Phalacrocoracidae	*Phalacrocorax*	*carbo*	Great Cormorant	Native				
Aves	Phalacrocoracidae	*Phalacrocorax*	*varius*	Pied Cormorant	Native				
Aves	Podargidae	*Podargus*	*strigoides*	Tawny Frogmouth	Native				
Aves	Podicipedidae	*Podiceps*	*cristatus*	Great-crested Grebe	Native				
Aves	Podicipedidae	*Poliocephalus*	*poliocephalus*	Hoary-headed Grebe	Native				
Aves	Podicipedidae	*Tachybaptus*	*novaehollandiae*	Australasian Grebe	Native	x			
Aves	Psittacidae	*Platycercus*	*adscitus eximius*	Eastern Rosella	Native	x		x	x
Aves	Psittacidae	*Platycercus*	*elegans*	Crimson Rosella	Native	x			x
Aves	Psittacidae	*Psephotus*	*haematonotus*	Red-rumped Parrot	Native				
Aves	Psittacidae	*Trichoglossus*	*haematodus*	Rainbow Lorikeet	Native	x		x	
Aves	Ptilonorhynchidae	*Ptilonorhynchus*	*violaceus*	Satin Bowerbird	Native				
Aves	Pycnonotidae	*Pycnonotus*	*jocosus*	Red-whiskered Bulbul	Exotic	x			x
Aves	Rallidae	*Butorides*	*striatus*	Striated Heron	Native				
Aves	Rallidae	*Gallinula*	*tenebrosa*	Dusky Moorhen	Native	x			
Aves	Rallidae	*Gallirallus*	*philippensis*	Buff-banded Rail	Native				
Aves	Rallidae	*Porana*	*tabuensis*	Spotless Crake	Native				
Aves	Rallidae	*Porphyrio*	*porphyrio*	Purple Swamphen	Native	x		x	x
Aves	Rallidae	*Porzana*	*fluminea*	Australian Spotted Crake	Native				
Aves	Rallidae	*Porzana*	*pusilla*	Baillon‘s Crake	Native				
Aves	Recurvirostridae	*Recurvirostra*	*novaehollandiae*	Red-necked Avocet	Native				
Aves	Rostratulidae	*Rostratula*	*australis*	Australian Painted Snipe	Native				
Aves	Scolopacidae	*Actitis*	*hypoleucos*	Common Sandpiper	Native				
Aves	Scolopacidae	*Arenaria*	*interpres*	Ruddy Turnstone	Native				
Aves	Scolopacidae	*Calidris*	*acuminata*	Sharp-tailed Sandpiper	Native				
Aves	Scolopacidae	*Calidris*	*ferruginea*	Curlew Sandpiper	Native				
Aves	Scolopacidae	*Calidris*	*ruficollis*	Red-necked Stint	Native				
Aves	Scolopacidae	*Gallinago*	*hardwickii*	Latham's Snipe	Native				
Aves	Scolopacidae	*Limosa*	*lapponica*	Bar-tailed Godwit	Native				
Aves	Scolopacidae	*Limosa*	*limosa*	Black-tailed Godwit	Native				
Aves	Scolopacidae	*Tringa*	*nebularia*	Common Greenshank	Native				
Aves	Scolopacidae	*Tringa*	*stagnatilis*	Marsh Sandpiper	Native				
Aves	Strigidae	*Ninox*	*novaeseelandiae*	Southern Boobook	Native			x	
Aves	Sturnidae	*Acridotheres*	*tristis*	Common Myna	Exotic	x		x	x
Aves	Sturnidae	*Sturnus*	*vulgaris**	European Starling	Exotic				
Aves	Sturnidae	*Turdus*	*merula **	Common Blackbird	Exotic				
Aves	Sylvidae	*Cisticola*	*exilis*	Golden-headed Cisticola	Native				
Aves	Sylvidae	*Megalurus*	*gramineus*	Little Grassbird	Native				

Class	Family	*Genus*	*Species*	Common name		ELA 2011	ELA2011b	ELA2009a	ELA2009b
Aves	Sylvidae	*Megalurus*	*timoriensis*	Tawny Grassbird	Native				
Aves	Threskiornithidae	*Platalea*	*flavipes*	Yellow-billed Spoonbill	Native				
Aves	Threskiornithidae	*Platalea*	*regia*	Royal Spoonbill	Native				
Aves	Threskiornithidae	*Plegadis*	*facinellus*	Glossy Ibis	Native				
Aves	Threskiornithidae	*Threskiomis*	*molucca*	Australian White Ibis	Native	x			
Aves	Threskiornithidae	*Threskiomis*	*spinicollis*	Straw-necked Ibis	Native	x			
Aves	Turnicidae	*Coturnix*	*pectoralis*	Stubble Quail	Native				
Aves	Turnicidae	*Coturnix*	*ypsilophora*	Brown Quail	Native				
Aves	Turnicidae	*Excalfactoria*	*chinensis*	King Quail	Native				
Aves	Tytonidae	*Tyto*	*alba*	Barn Owl	Native				
Aves	Zosteropidae	*Zosterops*	*lateralis*	Silvereye	Native	x			
					Total	**45**	**0**	**45**	**33**
Fish	Anguillidae	*Anguilla*	*reinhardtii*	Longfin Eel	Native			x	x
					Total	**0**	**0**	**1**	**1**
Mammalia	Bovidae	*Bos*	*taurus*	European Cow	Exotic	x			x
Mammalia	Bovidae	*Capra*	*hircus*	Goat	Exotic	x			
Mammalia	Canidae	*Vulpes*	*vulpes*	European Fox	Exotic	x		x	
Mammalia	Cervidae	*Cervus*	*timoriensis*	Rusa	Exotic	x			
Mammalia	Cervidae	*Dama*	*dama*	Fellow Deer	Exotic			x	x
Mammalia	Equidae	*Equus*	*asinus*	Donkey	Exotic	x			
Mammalia	Equidae	*Equus*	*ferus subsp. caballus*	Horse	Exotic	x			x
Mammalia	Felinae	*Felis*	*catus*	Feral Cat	Exotic	x			
Mammalia	Leporidae	*Oryctolagus*	*cuniculus* *	European Rabbit	Exotic			x	
Mammalia	Phalangeridae	*Trichosurus*	*vulpecula*	Common Brushtail Possum	Native			x	
Mammalia	Vombatida	*Vombatus*	*ursinus*	Hairy-nosed Wombat	Native	x			
					Total	**8**	**0**	**4**	**3**
Mammalia (Chiroptera)	**Miniopteridae**	***Miniopterus***	***australis***	**Little Bentwing Bat**	**Native**	**x**	**x**		**x**
Mammalia (Chiroptera)	**Miniopteridae**	***Miniopterus***	***schreibersii oceanensis***	**Eastern Bentwing Bat**	**Native**	**x**		**x**	
Mammalia (Chiroptera)	**Molossidae**	***Mormopterus***	***norfolkensis***	**East-coast Freetail Bat**	**Native**	**x**	**x**	**x**	
Mammalia (Chiroptera)	Molossidae	*Mormopterus*	*species 2*	Mormopterus species 2	Native	x	x	x	
Mammalia (Chiroptera)	Vespertilionidae	*Austronomus*	*australis*	White-striped Freetail Bat	Native	x	x	x	
Mammalia (Chiroptera)	Vespertilionidae	*Chalinolobus*	*gouldii*	Gould's Wattled Bat	Native	x	x	x	x
Mammalia (Chiroptera)	Vespertilionidae	*Chalinolobus*	*morio*	Chocolate Wattled Bat	Native	x	x	x	x
Mammalia (Chiroptera)	**Vespertilionidae**	***Falsistrellus***	***tasmaniensis***	**Eastern False Pipstrelle**	**Native**	**x**			**x**
Mammalia (Chiroptera)	**Vespertilionidae**	***Myotis***	***macropus***	**Large-footed Myotis**	**Native**	**x**	**x**		
Mammalia (Chiroptera)	Vespertilionidae	*Nyctophilus*	*sp.*	Long-eared Bat	Native	x			x
Mammalia (Chiroptera)	Vespertilionidae	*Rhinolophus*	*megaphyllus*	Eastern horseshoe Bat	Native	x			x
Mammalia (Chiroptera)	**Vespertilionidae**	***Saccolaimus***	***flaviventrus***	**Yellow-bellied Sheath-tail Bat**	**Native**	**x**			**x**
Mammalia (Chiroptera)	**Vespertilionidae**	***Scoteanax***	***reuppellii***	**Greater Broad-nosed Bat**	**Native**	**x**			**x**
Mammalia (Chiroptera)	Vespertilionidae	*Scotorepens*	*orion*	Eastern Broad-nosed Bat	Native		x		
Mammalia (Chiroptera)	Vespertilionidae	*Vespadelus*	*darlingtoni*	Large Forest Bat	Native	x	x	x	
Mammalia (Chiroptera)	Vespertilionidae	*Vespadelus*	*vulturnus*	Little Forest Bat	Native	x	x	x	
					Total	**15**	**10**	**8**	**8**
Reptilia	Cheluidae	*Chelodina*	*longicolli*	Eastern Snake-necked Turtle	Native				x
Reptilia	Elapidae	*Pseudechis*	*guttatus*	Blue-bellied Black Snake	Native	x			
Reptilia	Gekkonidae	*Gehyra*	*variegata*	Common Dtella	Native				x
Reptilia	Pygopodidae	*Delma*	*plebeia*	Basalt Snake-lizard	Native				x
Reptilia	Pygopodidae	*Lialis*	*burtonis*	Burton‘s Snake-lizard	Native				x
Reptilia	Scincidae	*Carlia*	*tetradactyla*	Southern Rainbow Skink	Native				x
Reptilia	Scincidae	*Cryptoblepharus*	*pulcher*	Elegant Snake-eyed Skink	Native				x
Reptilia	Scincidae	*Ctenotus robustus*	*robustus*	Eastern Striped Skink	Native				x
Reptilia	Scincidae	*Lampropholis*	*delicata*	Dark-flecked Garden Sun Skink	Native	x		x	x

Class	Family	*Genus*	*Species*	Common name		ELA 2011	ELA2011b	ELA2009a	ELA2009b
Reptilia	Scincidae	*Menetia*	*greyii*	Dwarf Skink	Native				x
					Total	**2**	**0**	**1**	**9**
					Grand total	**77**	**15**	**66**	**64**

Appendix 5: Anabat Analysis

Bat calls were analysed using the program AnalookW (Version 3.3q 03 October 2006, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al 2004); and south-east Queensland and north-east New South Wales (Reinhold et al 2001) and the accompanying reference library of over 200 calls from north-eastern NSW (http://www.forest.nsw.gov.au/research/bats/default.asp).

Bat calls are analysed using species-specific parameters of the call profile such as call shape, characteristic frequency, initial slope and time between calls (Reinhold et al 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et al 2006) were followed:

1. Recordings containing less than three pulses were not analysed (Law et al 1999).

2. Only search phase calls were analysed (McKenzie et al 2002).

3. Four categories of confidence in species identification were used (Mills et al 1996):

a. definite – identity not in doubt

b. probable – low probability of confusion with species of similar calls

c. possible – medium to high probability of confusion with species with similar calls; and

d. unknown – calls made by bats which cannot be identified to even a species group.

4. *Nyctophilus* spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al 2004).

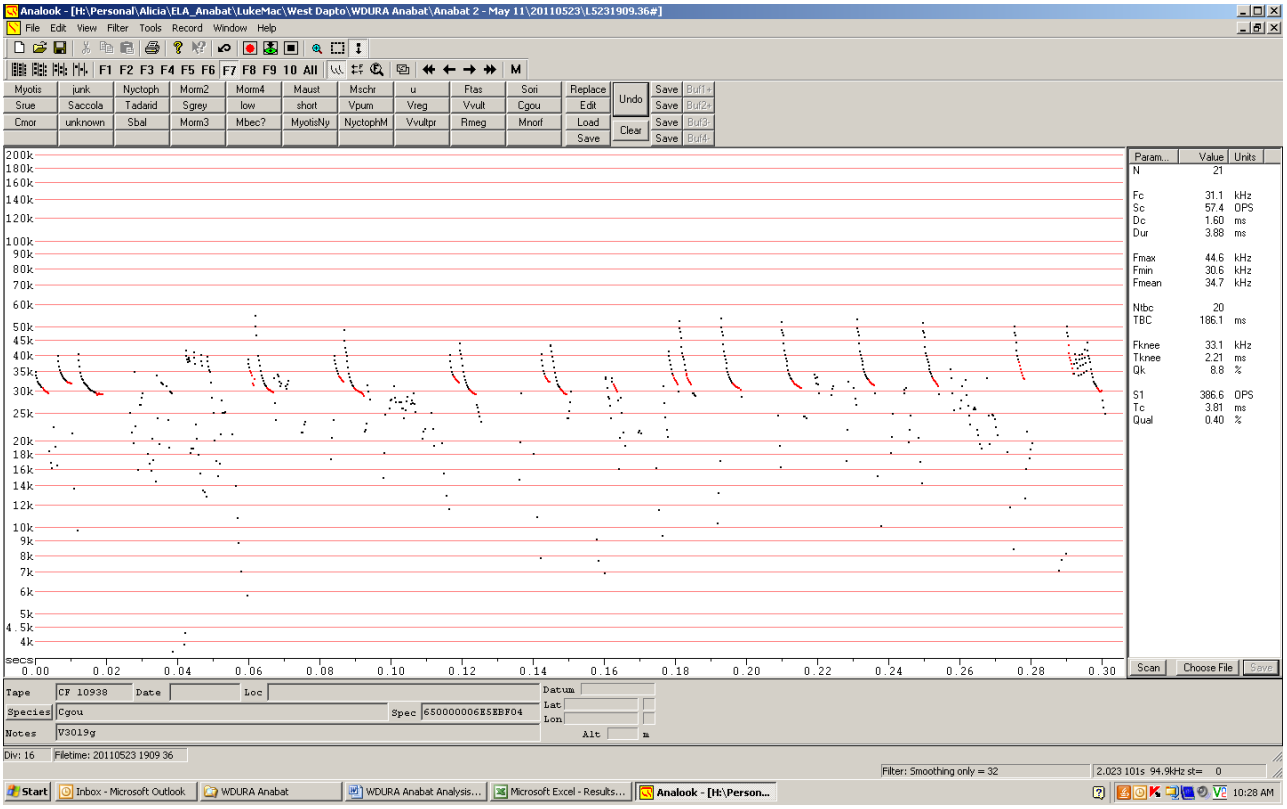

Table 22: Call profile of *Chalinolobus gouldii* recorded at 19:09h on 23 May 2011, West Dapto Ag School, Huntley Rd, West Dapto, NSW

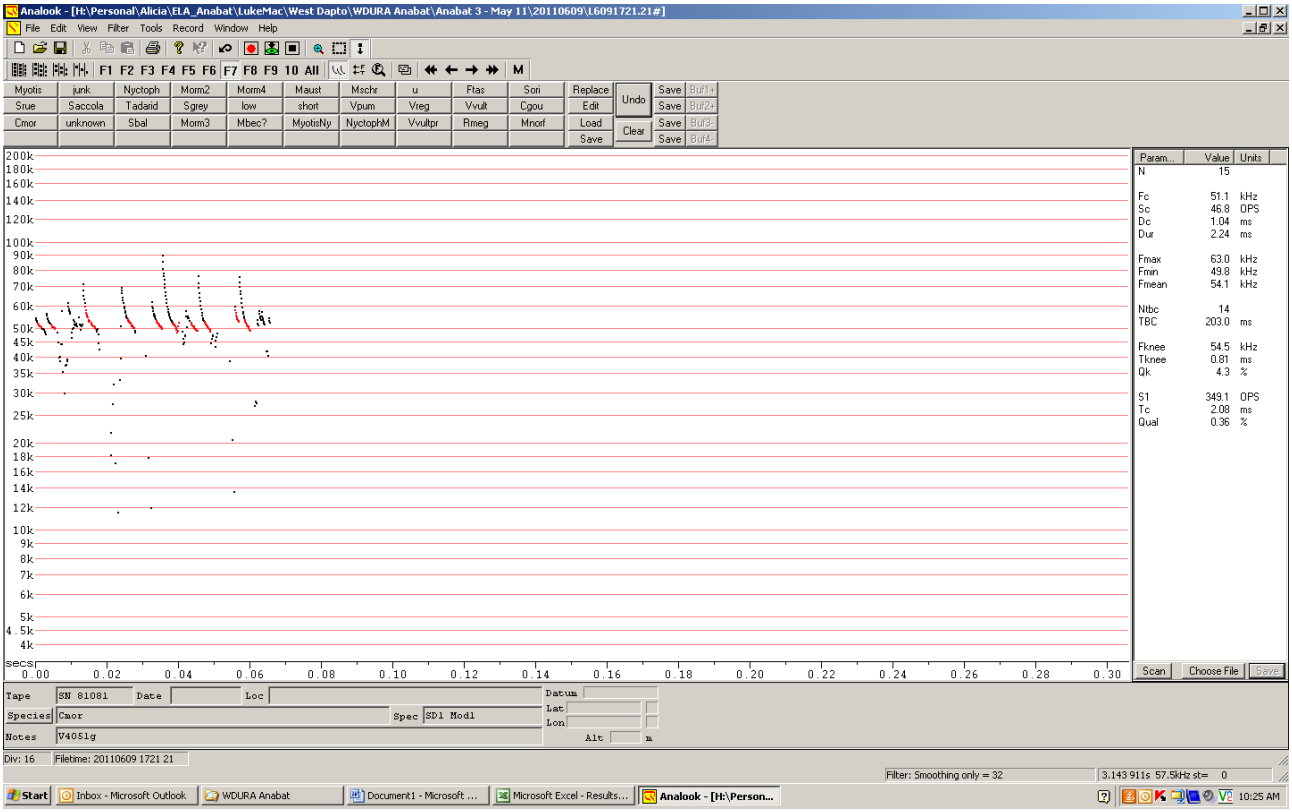

Table 23: Call profile of *Chalinolobus morio* recorded at 17:21h on 9 June 2011, Marshall Mount Rd, Yallah, NSW

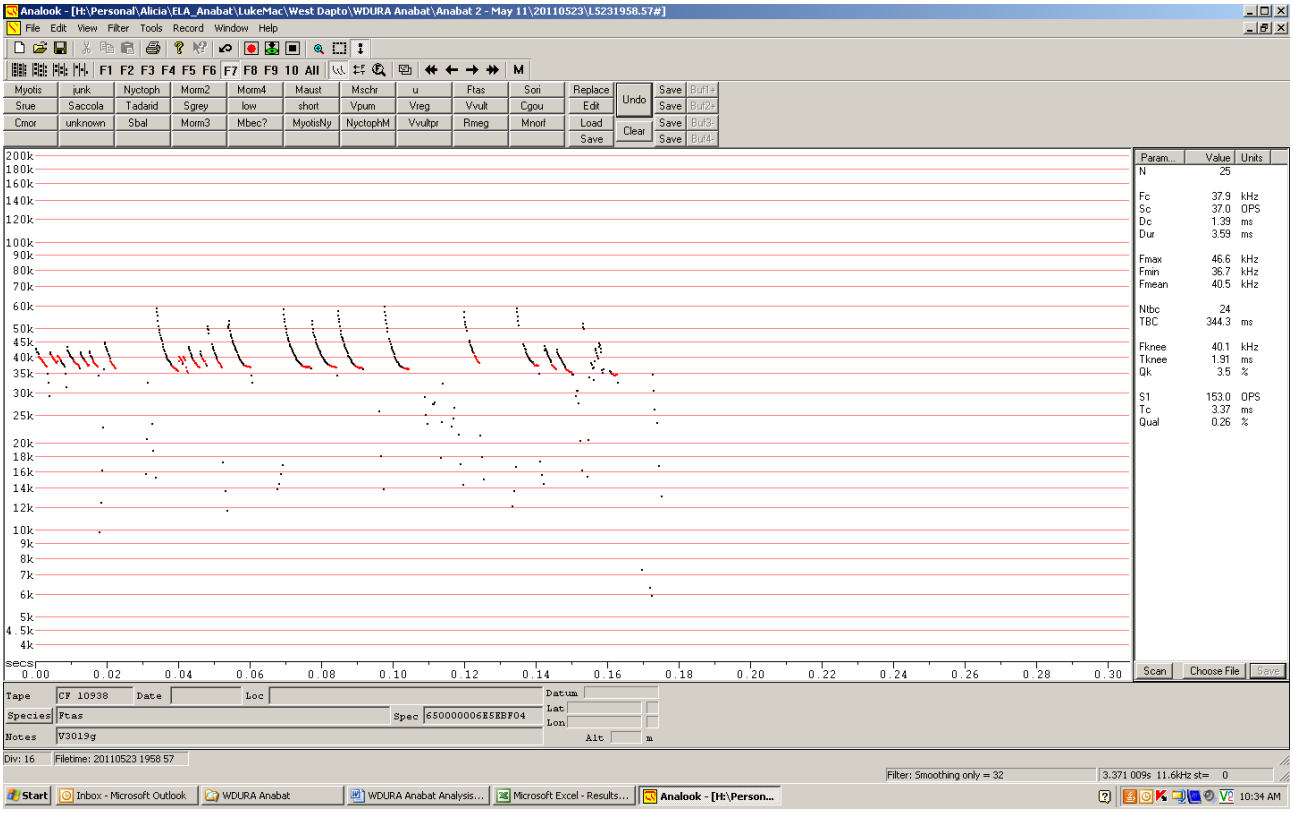

Table 24: Call profile of the threatened *Falsistrellus tasmaniensis* (Vulnerable, TSC Act) recorded at 19:58h on 23 May 2011, West Dapto Ag School, Huntley Rd, West Dapto, NSW

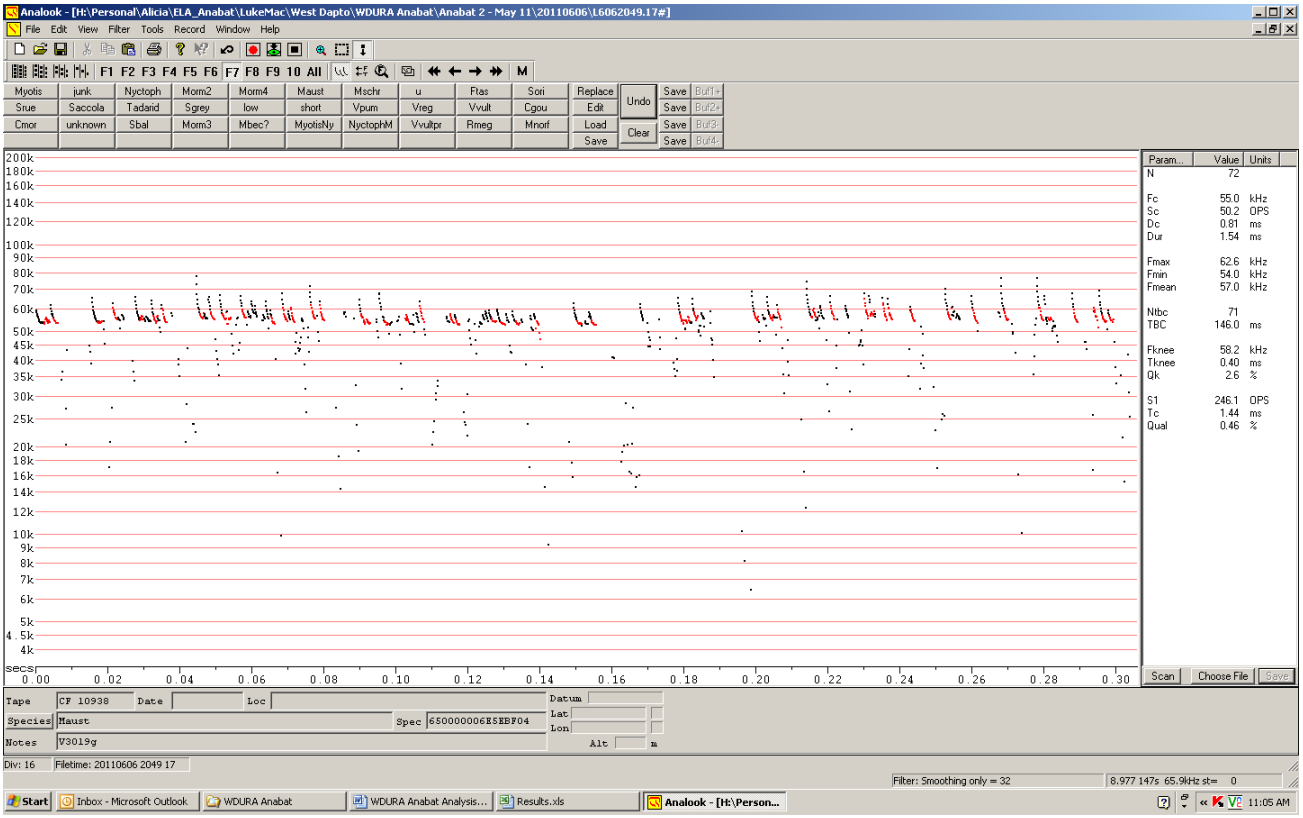

Table 25: Call profile of the threatened *Miniopterus australis* (Vulnerable, TSC Act), recorded at 20:49h on 6 June 2011, Bong Bong Rd, Horsley, NSW

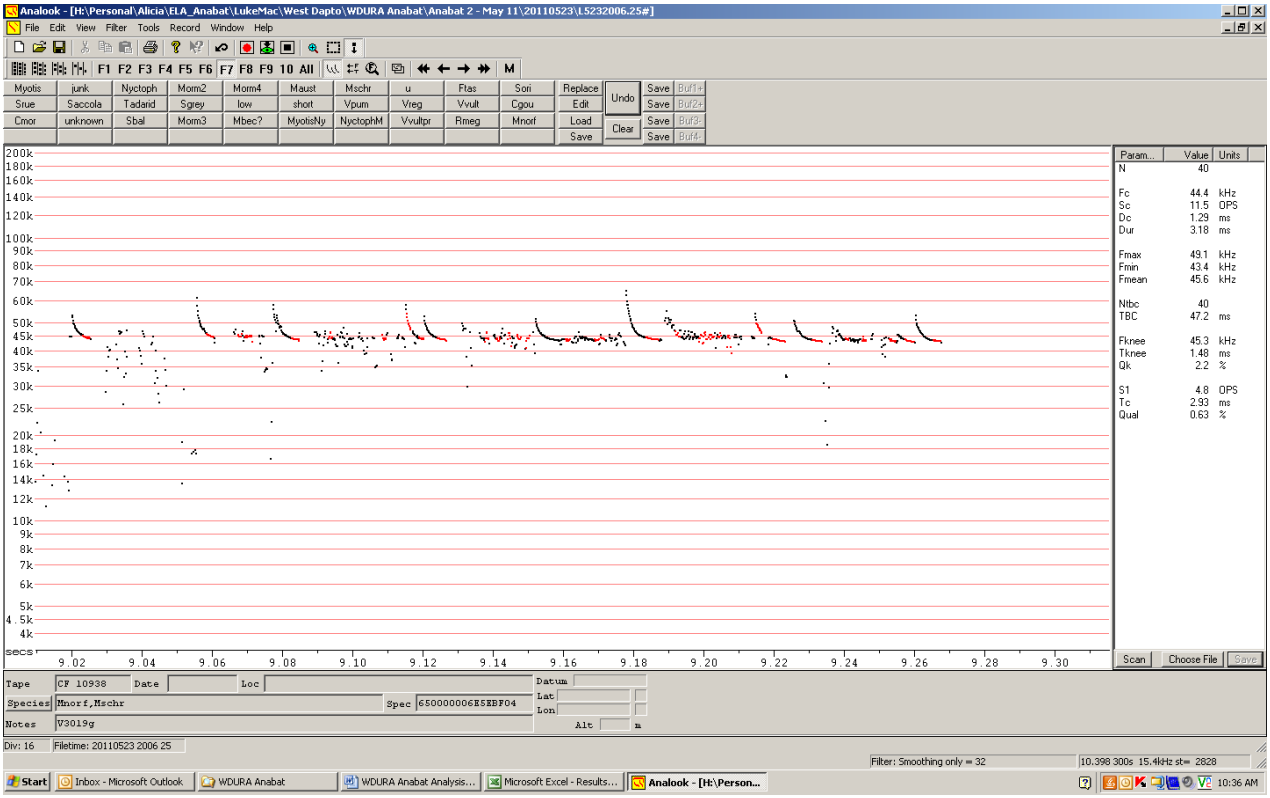

Table 26: Call profile of the threatened *Miniopterus schreibersii oceanensis* (Vulnerable, TSC Act), recorded at 20:06h on 23 May 2011, West Dapto Ag School, Huntley Rd, West Dapto, NSW

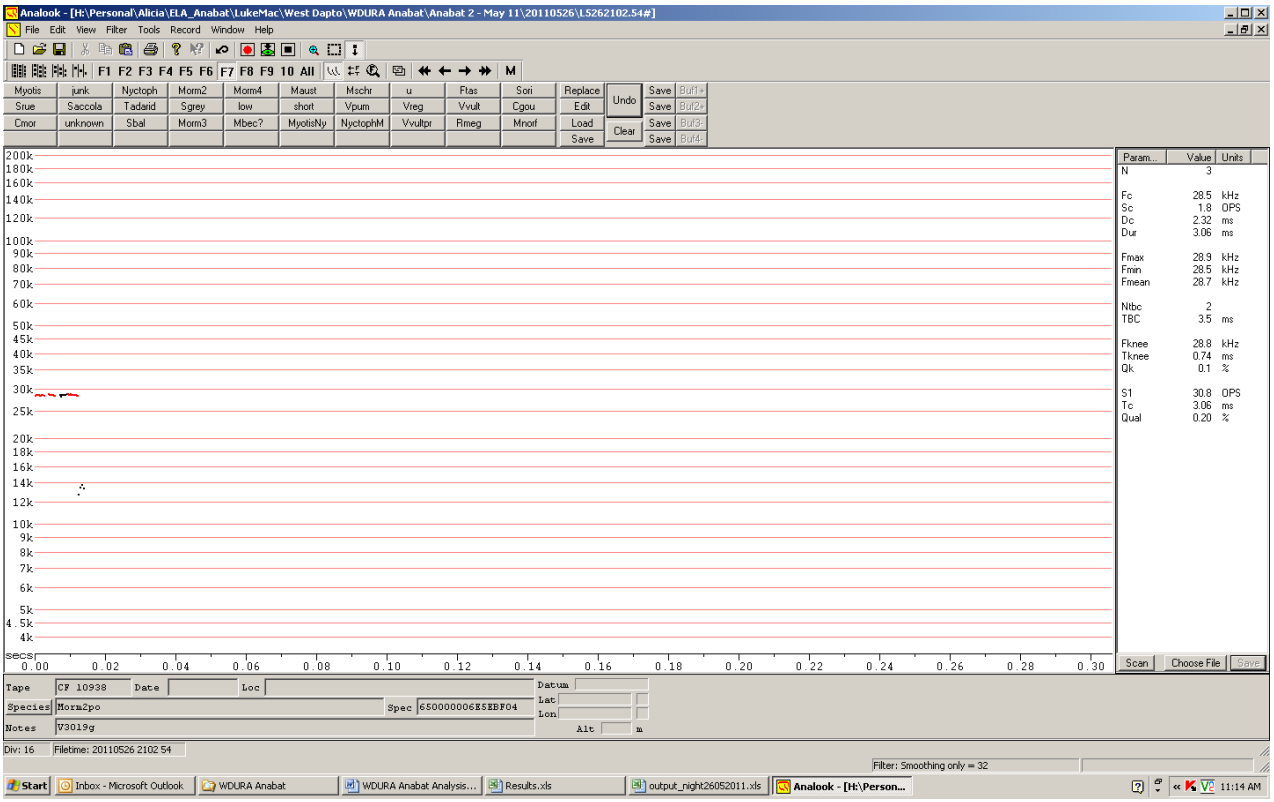

Table 27: Possible call profile of *Mormopterus species 2* recorded at 21:02h on 26 May 2011, Calderwood Rd and Marshall Mount Rd, Calderwood, NSW

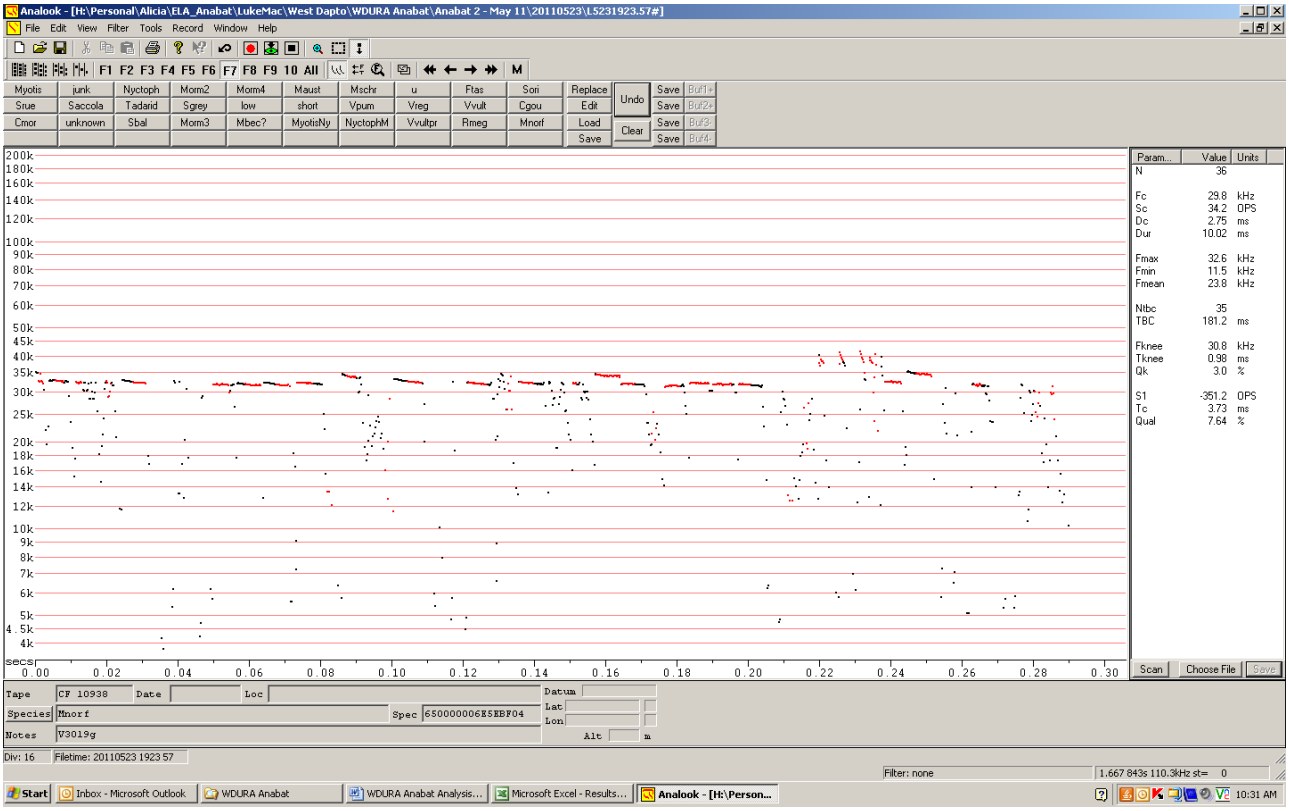

Table 28: Call profile of the threatened *Mormopterus norfolkensis* recorded at 19:23h on 23 May 2011, West Dapto Ag School, Huntley Rd, West Dapto, NSW

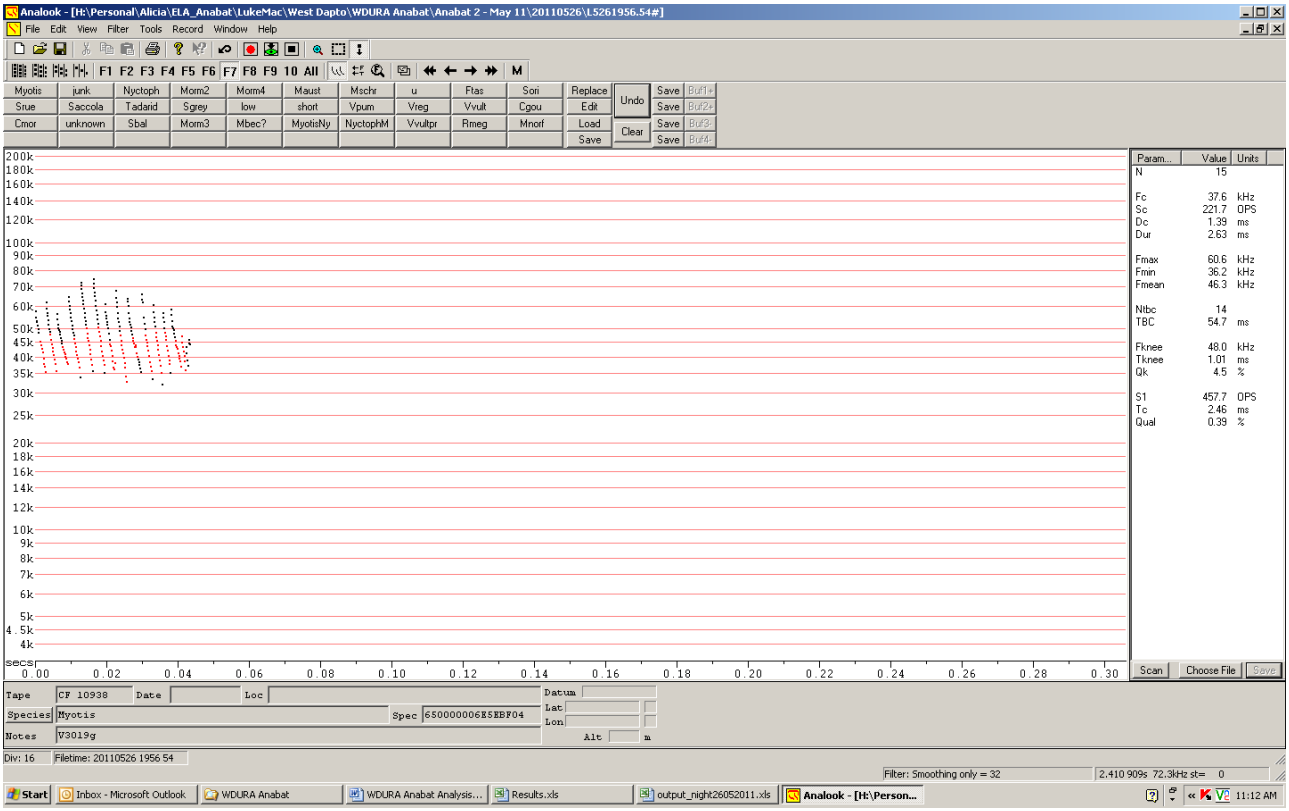

Table 29: Call profile of the threatened *Myotis macropus* recorded at 19:56h on 26 May 2011, Calderwood Rd and Marshall Mount Rd, Calderwood, NSW

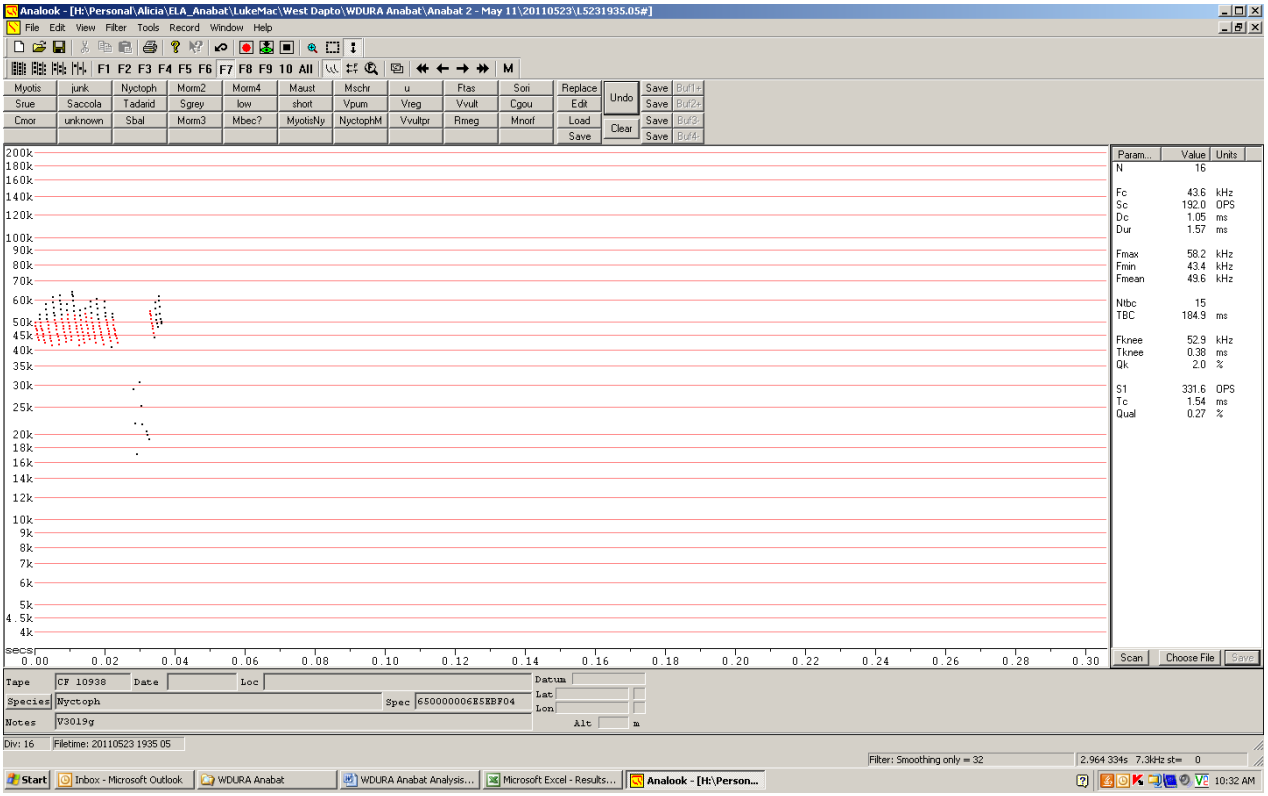

Table 30: Call profile of *Nyctophilus sp.* recorded at 19:35h on 23 May 2011, West Dapto Ag School, Huntley Rd, West Dapto, NSW

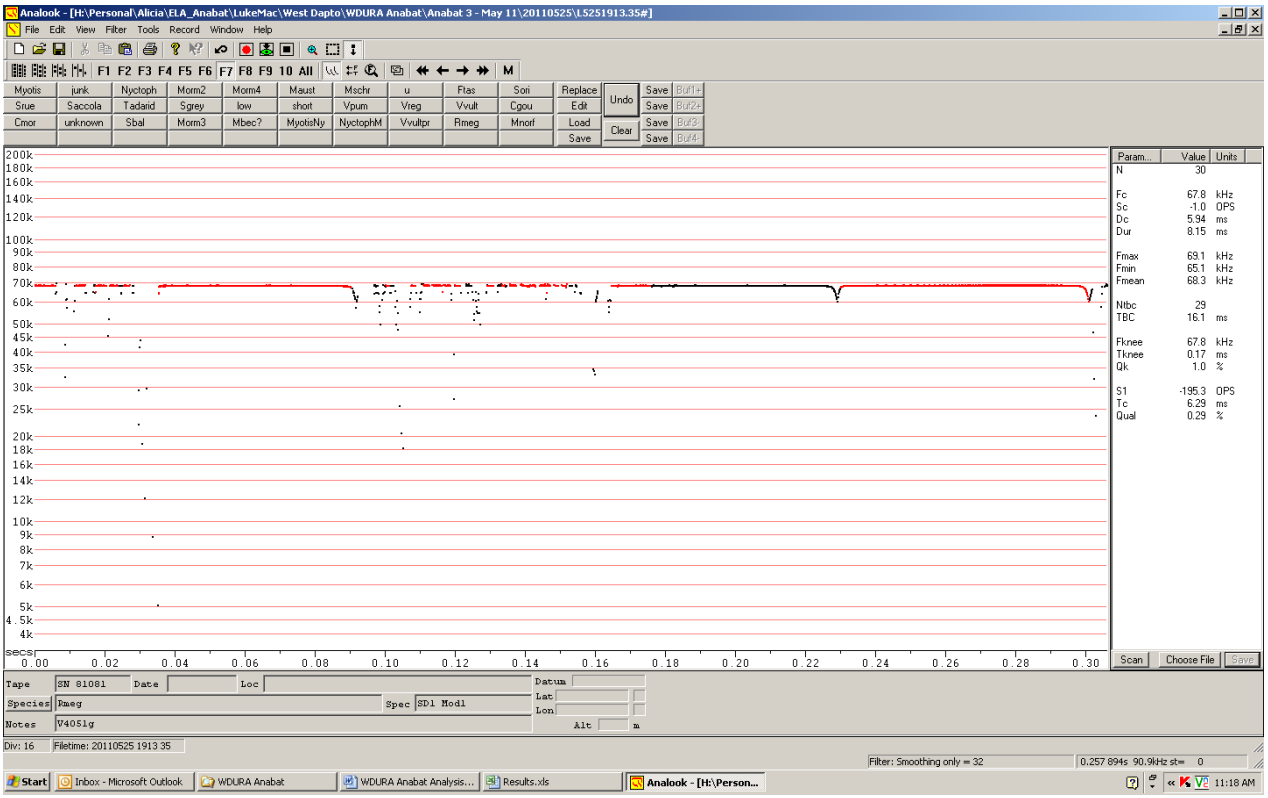

Table 31: Call profile of *Rhinolophus megaphyllus* recorded at 19:13h on 25 May 2011, Calderwood Road (West), Calderwood, NSW

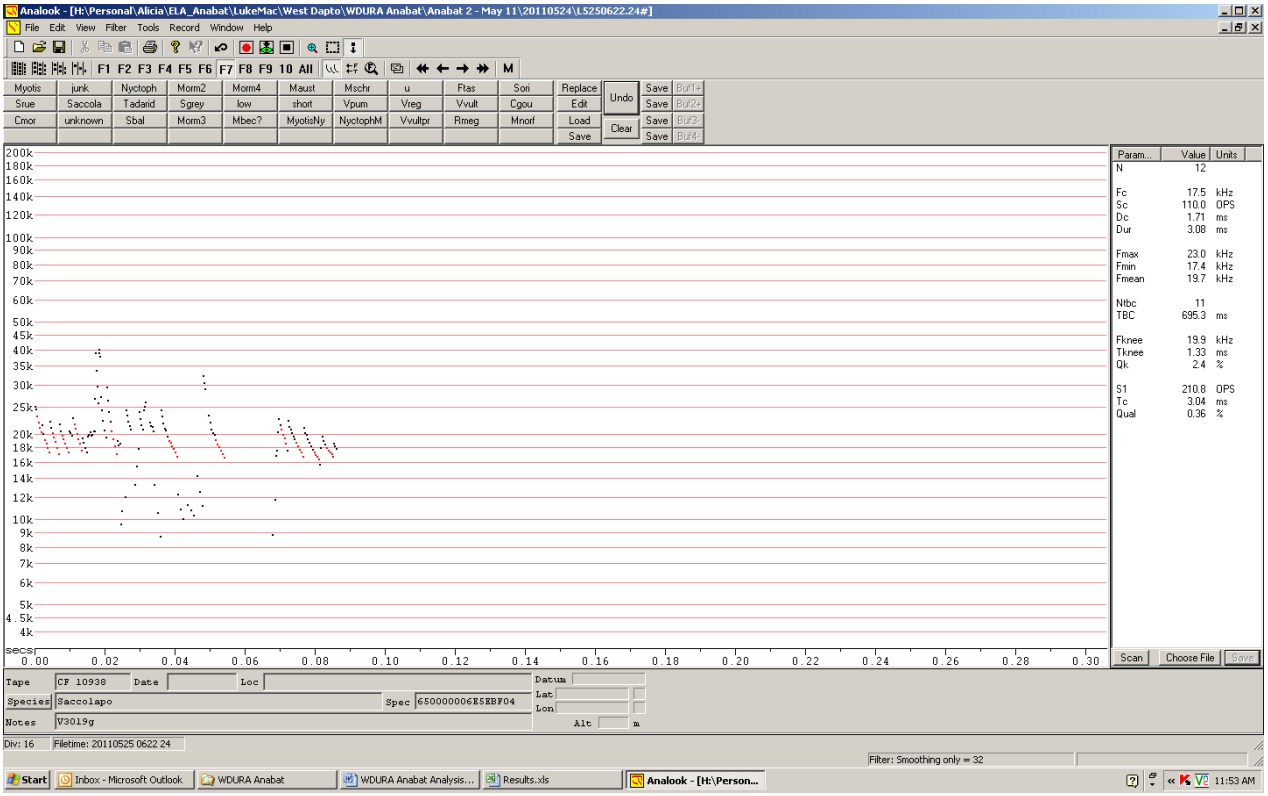

Table 32: Possible call profile of the threatened *Saccolaimus flaviventrus* (Vulnerable, TSC Act), recorded at 06:22h on 25 May 2011, West Dapto Ag School, Huntley Rd, West Dapto, NSW

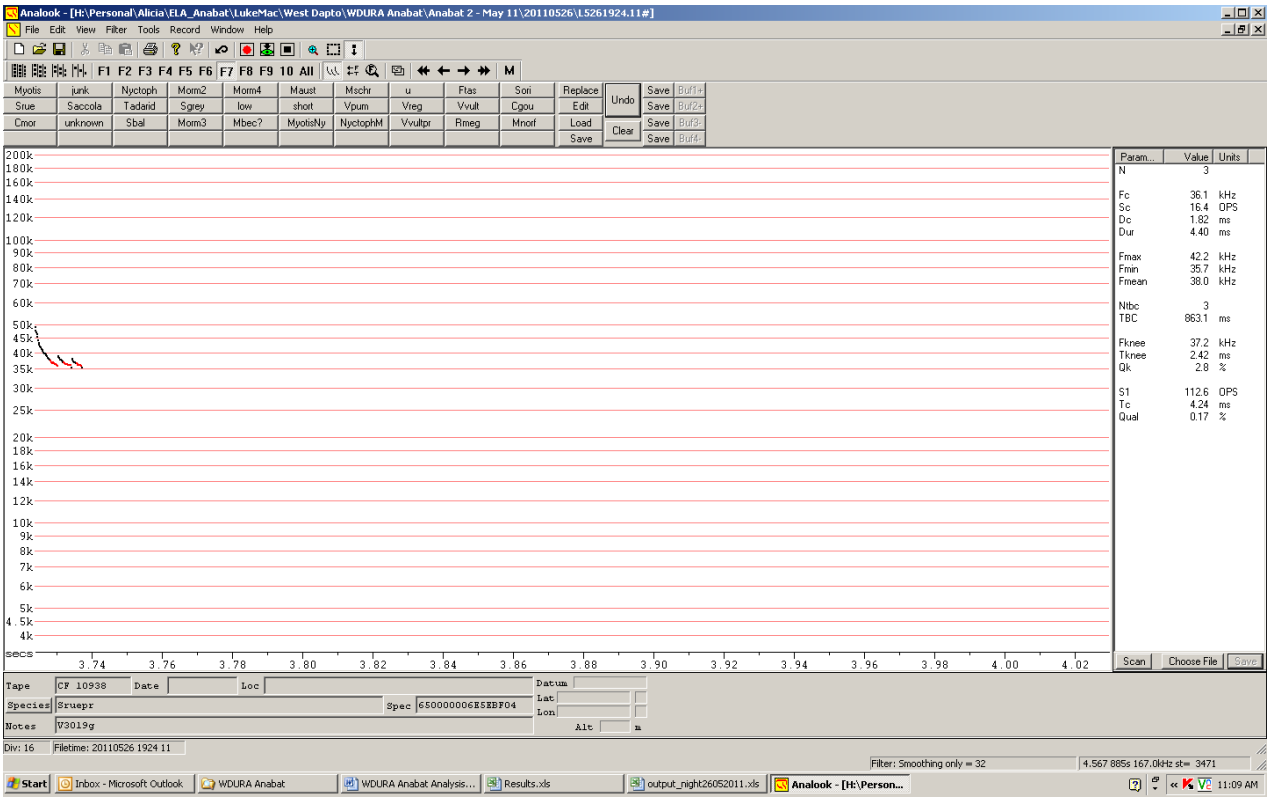

Table 33: Possible call profile of the threatened *Scoteanax reuppellii* (Vulnerable, TSC Act), recorded at 19:24h on 26 May 2011, Calderwood Rd and Marshall Mount Rd, Calderwood, NSW

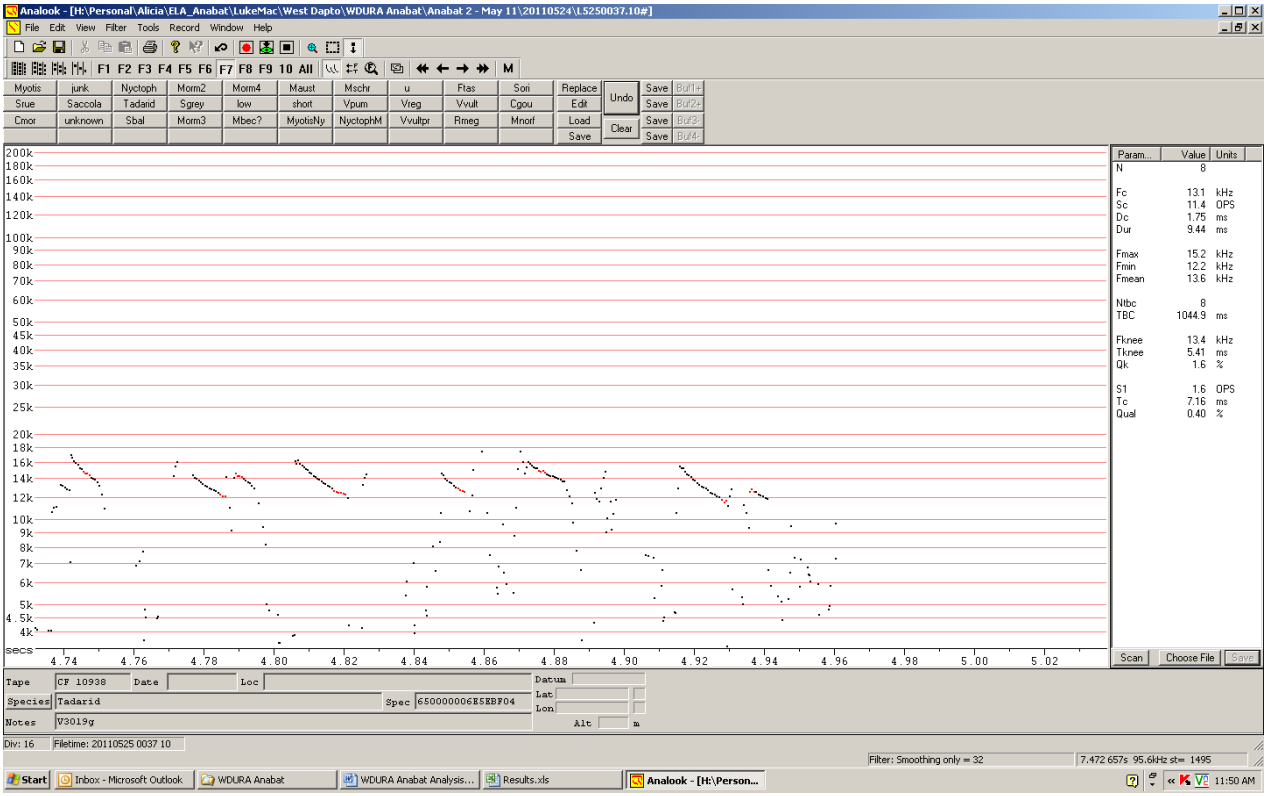

Table 34: Call profile of *Tadarida australis* recorded at 00:37h on 25 May 2011, West Dapto Ag School, Huntley Rd, West Dapto, NSW

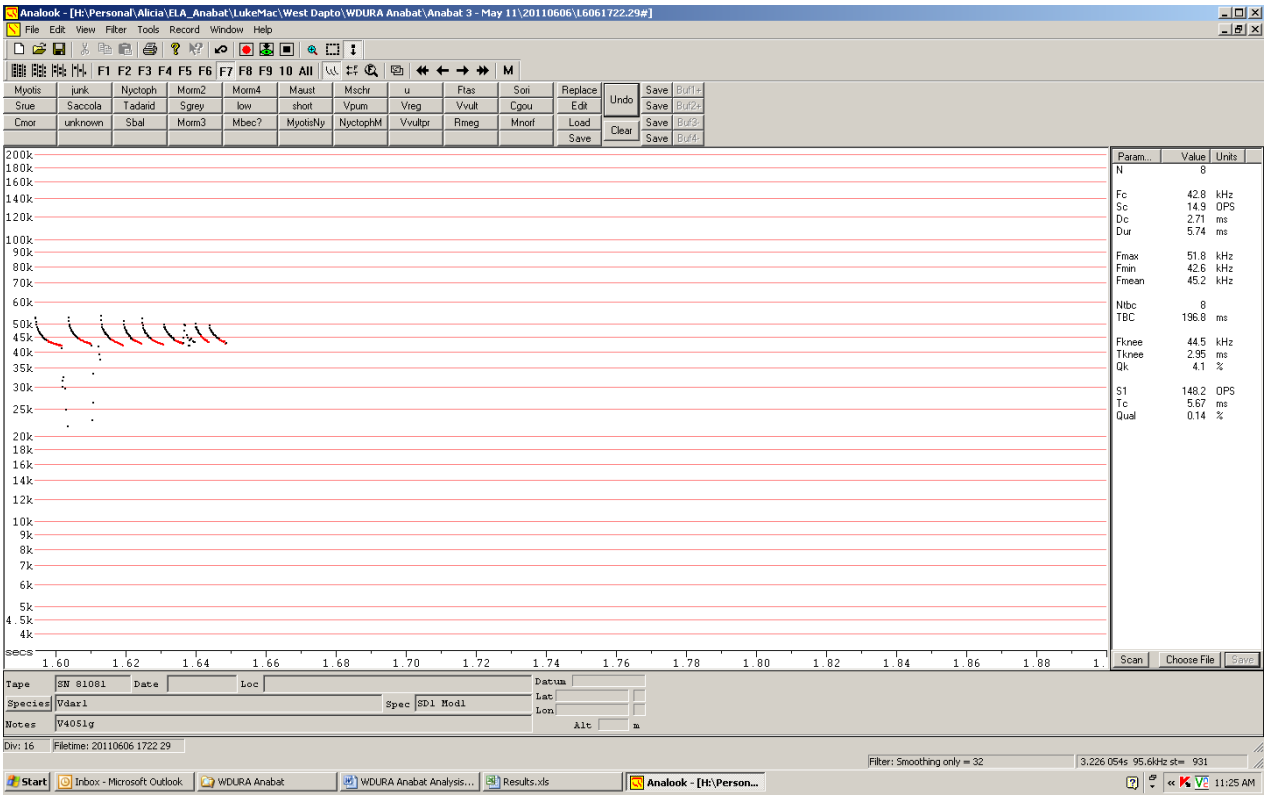

Table 35: Call profile of *Vespadelus darlingtoni* recorded at 17:22h on 6 June 2011, Sheafes Rd (riparian), Kembla Grange, NSW

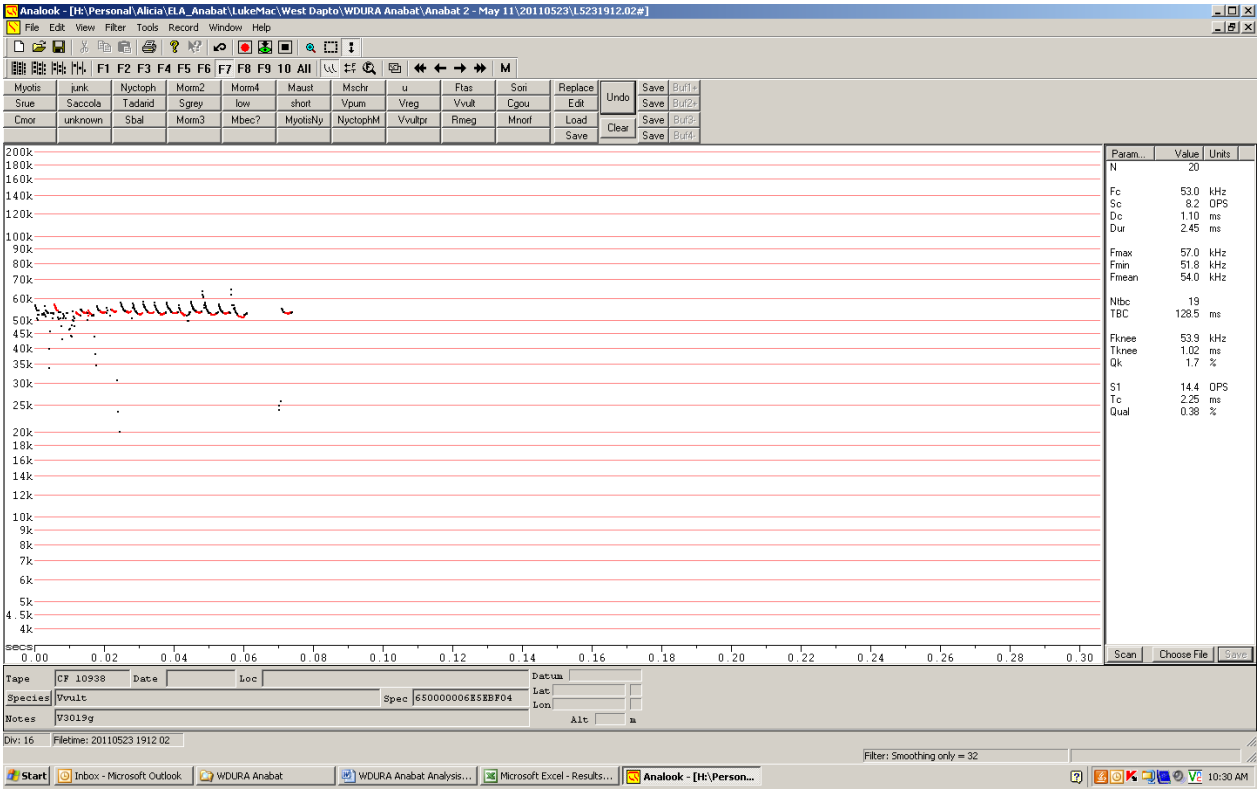

Table 36: Call profile of *Vespadelus vulturnus* recorded at 19:12h on 23 May 2011, West Dapto Ag School, Huntley Rd, West Dapto, NSW

Appendix 6: Riparian Field Proformas

Rapid Assessment of Riparian Condition (DEWHA 2009)

	Largely unmodified (5)	**Slightly modified (4)**	**Moderately modified (3)**	**Substantially modified (2)**	**Severely modified (1)**
SPATIAL INTEGRITY	No or little evidence of broadscale loss of native vegetation	Width reduced by up to 1/3 and/or some breaks in continuity	About 50% of the native vegetation remains, either in strips or patches	Only small patches of well-separated native vegetation remain	Little or no remaining native vegetation
NATIVENESS	Vegetation predominantly native, few weeds and no ‗high threat' species	Exotic species present but not dominating any strata, ‗high threat' species rare	One or more strata dominated by exotic species, ‗high threat' species present	Most strata dominated by exotic species, ‗high threat' species abundant	Few native species remaining, cover dominated by exotic species
STRUCTURAL INTEGRITY	Number of strata and cover within each similar to reference	Cover within one stratum up to 50% lower or higher than reference	One stratum missing or extra, cover within remaining strata 50% lower or higher than reference	More than one stratum completely altered from reference (lost or <10% remaining)	Structure completely altered from reference (e.g. grassland shrubland, forest pasture)
AGE STRUCTURE	Dominant strata with reference level of cover and at least three age classes present (juveniles, sub-adults and adults)	Reduced cover (75-50%) of dominant strata, and/or only two age classes present	Reduced cover (75-50%) of dominant strata, and only one age class present	Reduced cover (<50%) of dominant strata, and only one age class present	Dominant strata mostly absent
DEBRIS	Quantities and cover similar to reference	Some evidence of unnatural loss of debris (e.g. through collection of firewood, trampling of leaf litter by stock)	Quantities and/or cover 50% higher or lower than reference	Very small quantities of debris present	Debris mostly absent or completely dominating the sites, with little or no living vegetation

Eco Logical Australia: Rapid Assessment of Stream Condition

Site No: **Project: West Dapto Pipes**
RCMS category: **Date:**
Waypoint: **Photos:**

Hydrology

Type		**Channel Modification**	
Vegetated swamp/floodplain		Heavily modified (Concrete channel)	1
Open water wetland		channel)	2
Billabong		straightened)	3
Small drainage line		straightened)	4
Braided channel		Unmodified	5
Creek			
River		**Fish Habitat Classification**	Class 1
Estuary		(Fairfull & Witheridge 2003)	Class 2
Other			Class 3
			Class 4

Physical Form

Bank Slope	Ave	**Erosion**	**% of**
<30	5	Gully	
30-70	4	Slump	
>70 or undercut	3	Sheet	
Channel incised	2	Undercut	

Water Quality and Aquatic Habitat

Connectivity		**Velocity**	
Major high flow barrier (e.g. large dam)	1	Stagnant	1
Numerous low flow barriers without fish passage (farm dams and weirs)	2	Slow (<0.1 m/s)	2
		Medium (0.1-0.3 m/s)	3
One low flow barrier (e.g. farm dam or weir)	3	Fast (0.3-0.7 m/s)	4
Minor barrier/s with fish passage during all flows	4	Very fast (>0.7 m/s)	5
No barriers	5		

Habitat	**%**	**Aquatic Vegetation Richness (native & weed)**	
Riffle		Absent	1
Run		1 species	2
Pool		2 species	3
		3 species	4
Turbidity		4+ species	5
Very turbid	1		
Turbid	2	**Native Aquatic Vegetation**	
Moderate	3	Absent	1
Clear	4	Rare	2
Very clear	5	Occasional	3
		Common	4
Wetted Width	**m**	Abundant	5
Min-max			
Average		**Native Aquatic Vegetation Species**	
Depth			
<10 cm			
10-20 cm			
20-30 cm			
10-100 cm		**Instream Woody Debris**	
>100 cm		Absent	1
		Rare (e.g. 1 log/50 m)	2
Dominant instream substrate mix		Occasional	3
Sub-dominant instream substrate mix		Common	4
(e.g. rocks, cobble, gravel, sand, clay, slit)		Abundant (e.g. 5 logs/50 m)	5

Fish habitat classification (Fairfull & Witheridge 2003)

Classification	Characteristics of Waterway Type
Class 1 Major fish habitat	Major permanently or intermittently flowing waterway (e.g. river or major creek), habitat of a threatened fish species.
Class 2 Moderate fish habitat	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.
Class 3 Minimal fish habitat	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.
Class 4 Unlikely fish habitat	Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).

Appendix 7: Assessments of Significance

TSC Act – Impact Assessments for threatened species

The following threatened species impact assessments have been prepared for all species that are ~~k~~known" to occur at the Project Site and species that would potentially suffer some impact from the proposal. Survey effort between 2004 and 2010 was considered sufficient to identify if ~~p~~otential" or ~~li~~kely" species actually occurred. The survey effort at the Project Site is compliant with *'Threatened Biodiversity Survey and Assessment Guidelines'* (DEC 2004) for all species. Survey effort is actually more comprehensive for all flora and fauna groups than the suggested survey effort (See **Section 5**, **Table 8** and **Table 9**).

Impact assessment on these species and ecological communities is consistent with the Part 3A, EP&A Act, *Draft Guidelines for Threatened Species Assessment'* (DEC and DPI 2005) and Matters of National Environmental Significance – Significant Impact Guidelines 1.1' (DEWHA 2009).

No threatened flora listed under the TSC Act or EPBC Act have been recorded in the study area, although targeted searches have been undertaken at the appropriate survey periods.

Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion – Endangered Ecological Community.

The Illawarra Lowlands Grassy Woodland (ILGW) is a vegetation community that occupies the Illawarra coastal plain and escarpment foothills. The characteristic species within the canopy this community include Forest Red Gum *Eucalyptus tereticornis*, Thin-leaved Stringybark *E. eugenioides*, Woolybutt *E. longifolia*, Coast Grey Box *E. bosistoana* and the White Feather Honey-myrtle *Melaleuca decora*. The understorey is generally dominated by grasses and shrubs including Acacia mearnsii and *Dodonaea viscosa*. This community is threatened by degradation, fragmentation, heavy grazing and soil compaction, rural and urban residential development.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Illawarra Lowlands Grassy Woodland is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

In a worst case scenario, the Proposal will incur an impact of 2.1 to ILGW. The proposed clearing represents a very minor proportion of the total extent of ILGW in the local area and the potential habitat for this ECC. As discussed in **Section 7**, this 2.1 ha of clearing is not absolute, but is subject to further refinement in the Concept Plan area and much of the calculated impact in the PA will not take place, will be revegetated or will impact on highly degraded remnants. Therefore, the proposed clearing does not threaten the viability of this community in the local area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

This is not a threatened species or population.

How is the proposal likely to affect habitat connectivity?

Given the highly modified nature pasture and vegetation patches along the present construction corridor, it is unlikely that the proposed works will significantly add to the pre-existing levels of fragmentation present within the region. Considering the presence of woodland patches and the highly mobile nature of the species, it is unlikely that the proposal will significantly contribute or reduce the existing levels of habitat connectivity. In addition, the project will only temporarily impact on an already highly modified landscape.

How is the proposal likely to affect critical habitat?

Critical habitat has not been declared for this endangered ecological community.

Conclusions

Whilst the impact of the Proposal will potentially remove approximately 2.1 ha of ILGW in various condition states, this impact is not considered to be significant when the following is taken into account:

- the small amount of ILGW clearing considered for Project Approval (0.96 ha)
- the proposed clearing in the southern part of the site is not final, and further reductions in this footprint will be considered during future planning exercises
- Significant remnants of this community have been avoided through forward planning, in particular at Direct Impact Areas 2, where no clearing is to take place as a product of this Project given the area is a known threatened species habitat and maintains a high proportion of hollow bearing trees
- the incremental nature of the clearing coupled with the rehabilitation of the final landform providing an intermediary habitat resource for fauna movement and dispersal of floral genetic resources

Swift Parrot (*Anthochaera phrygia*) – Endangered and migratory

Swift Parrots are winter migrants to the south-eastern Australia mainland (March – October) from Tasmania. While on the mainland they feed on winter-flowering eucalypts, such as *Eucalyptus tereticornis* (DEC 2005). Swift Parrots when on the mainland occupy areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark E. *sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Inland Grey Box E*. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis*. This species breeds from September to January in Tasmania, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum Eucalyptus globules (DECCW 2010b). The Swift Parrot is a highly mobile species able to utilise a variety of nectar sources over large areas (DECCW 2010b).

NSW EP&A Act assessment

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Swift parrot is a highly mobile species that occupy a range of woodland habitats. Swift Parrots, will migrate often over vast distances to forage among patches of flowering eucalypt trees. This species is known to forage among *Eucalyptus tereticornis,* which are common in the region. Other eucalyptus species known to be visited by Swift Parrots when flowering include, Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark E. *sideroxylon*, and White Box *E. albens*.

Given the high mobility of the species and the extent of intact woodlands in the adjoining areas, it is unlikely that the proposal will negatively impact upon the life cycle of this species. The surrounding area contains patches of woodland that provide foraging and roosting habitat for this species that will remain unaffected by the proposed works. This species breeds in Tasmania from September to January, therefore these works will not directly impact on the reproductive success this species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

This project will result in the removal of approximately 3.4ha of potential foraging habitat across the PA and CA areas for this species. In addition, the project will only a short term impact with revegetation occurring soon after. It is also noted that this vegetation clearance will be incremental, thus maintaining a majority of this foraging habitat at any point in time. In addition, the entire construction corridor will be rehabilitated using local providence species following the completion of the works associated with the project.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

No, Swift Parrots have a wide distribution across eastern Australia from Tasmania, South Australia, Victoria through to the south-east of Queensland.

How is the proposal likely to affect current disturbance regimes?

The majority of the Study areaand adjoining lands are currently used to provide pasture for grazing and pasture improvement and/or cropping. The project will result in the loss of approximately 3.4 ha of remnant native vegetation across the Proposal Area. However, given the highly modified nature vegetation along the

present construction corridor, it is unlikely that the proposed works will significantly add to the existing levels of fragmentation of vegetation or fauna habitat.

How is the proposal likely to affect habitat connectivity?

Given the highly modified nature pasture and vegetation patches along the present construction corridor, it is unlikely that the proposed works will significantly add to the pre-existing levels of fragmentation present within the region. Considering the presence of woodland patches and the highly mobile nature of the species, it is unlikely that the proposal will will significantly contribute or reduce the existing levels of habitat connectivity. In addition, the project will only temporarily impact on an already highly modified landscape.

How is the proposal likely to affect critical habitat?

No critical habitat has been declared for this species.

Conclusion

Whilst the impact of the project will encroach on ~~k~~known" habitat for Swift Parrot, the impact is not considered to be significant due to:

- The highly mobile nature of the species
- Breeding activities occur in Tasmania
- The amount and connectivity of the remaining remnant habitat available in the adjoining area will still support a viable population

EPBC Act assessment

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population

There is no known population of this species in Wollongong or the locality.

- reduce the area of occupancy of the species

Swift Parrot is only known from one record on the eastern side of Lake Illawarra, it is considered a vagrant in the area and as such the area of occupancy for this species will not be impacted upon by the proposal.

- fragment an existing population into two or more populations

No. There is no known population of this species in Wollongong or the locality.

- adversely affect habitat critical to the survival of a species

No critical habitat has been declared for this species.

- disrupt the breeding cycle of a population

There is no known population of this species in Wollongong or the locality.

- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Swift Parrot is only known from one record on the eastern side of Lake Illawarra, any proposed vegetation removal in the study area will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

No. The proposal will not exacerbate any invasive species becoming established.

- introduce disease that may cause the species to decline, or

The proposal will not introcudce disease to the study area.

- interfere with the recovery of the species.

Swift Parrot is not common to the Illawarra is only known from a vagrant record to the east of Lake Illawarra. The proposal will not interfere with the recorvery of this species, whose main potential for recovery is the presence of hollows of mature River Red Gum trees for breeding.

The following criteria appy to migratory species under the EPBC Act and have been addressed above.

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

Conclusion

The proposal is unlikely to constitute a significant impact on Swift Parrot, given that:

- It is only known in the Illawarra from vagrant records to the east of Lake Illawarra
- No breeding habitat will be impacted upon by the proposal, the main threat to the recory of this species

Powerful Owl (Ninox strenua) – vulnerable

The Powerful Owl (*Ninox strenua*) is listed as a vulnerable species under Schedule 2 of the TSC Act. It is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria and occurs at low densities. In NSW it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered, mostly historical records on the western slopes and plains.

Powerful Owls occur primarily in densely vegetated gullies of open and tall open forest, but they are also found in a wider range of habitats, including forests and woodlands within the metropolitan regions of cities. However, optimal habitat requires large tracts of forest or woodland habitat, including a tall shrub layer and abundant hollows supporting high densities of arboreal marsupial prey species.

This species roosts in dense mid-canopy trees (such as Turpentines, She-oaks and rainforest trees), or tall shrubs in sheltered gullies, typically on wide creek flats and at the heads of minor drainage lines. Nesting occurs in large hollows (greater than 45 cm wide and greater than 100 cm deep) in eucalypts in unlogged, unburnt gullies and lower slopes within 100 m of streams or minor drainage lines. Nest trees are typically emergent, and are often the largest and oldest in a stand. Powerful Owls are faithful to traditional nesting hollows but can also use other hollows within the nesting gully.

Pairs of birds occupy large home ranges (300-1500 ha), utilising various portions of this area at different times, depending on the local abundance of arboreal mammals as a food source. Powerful Owls prey particularly on the Greater Glider and Ringtail Possum although the relative importance of prey items appears to vary regionally, with other prey such as Sugar Gliders, Brushtail Possums, Grey-headed Flying-foxes, insects and birds also used.

This species is threatened by a number of processes including loss and fragmentation of suitable forest and woodland habitat from land clearing for residential and agricultural development, which also affects the populations of arboreal prey species. Other threats include loss of hollow-bearing trees suitable for nesting, disturbance around nest sites (particularly during pre-laying, laying and downy chick stages), high frequency hazard reduction burning (affecting prey availability), secondary poisoning, road kills, and predation of fledglings by foxes, dogs and cats.

The Powerful Owl was not recorded during the surveys, but there are records for the species within 10 km of the study area. While there is potential for the species to occur on the site, the species could potentially be present in the in Concept Area foraging, rather than utilising it as a roosting or breeding habitat.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Factors likely to have an adverse effect on the life cycle of the Powerful Owl would include a substantial loss and/or fragmentation of foraging habitat, loss of suitable nesting and roosting habitat, disturbance around nest sites (particularly during pre-laying, laying and downy chick stages), high frequency hazard reduction burning (affecting prey availability), secondary poisoning, road kills, and predation of fledglings by foxes, dogs and cats.

The proposed development will result in the potential incremental removal of up to 3.4 ha of native vegetation refer to **Section 7**). Impacted vegetation does not represent potential nesting and roosting habitat as Powerful Owl use large hollows (greater than 45 cm wide and greater than 100 cm deep) in eucalypts in unlogged, unburnt gullies and lower slopes within 100 m of streams or minor drainage lines. The loss of potential foraging habitat is expected to be minimal when considering the large undisturbed areas of potential habitat available in the surrounding landscape, including lands in the formal reserve system (throughout the National Parks and Sydney Catchment Authority estate along the Illawarra Escarpment). These areas would contain higher densities of prey species and mature hollow bearing trees, which evidenced by almost all records within 10km of the site being above the escarp (one record exists in the urban area Wollongong from 2002, which is only accurate to 10,000m). Thus, it is unlikely that the loss of vegetation will significantly disrupt the life cycle of the species such that a viable local population is placed at risk of extinction.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposed development will result in the potential incremental removal of up to 3.4 ha of native vegetation (refer to **Section 7**). As discussed above, the vegetation removal at the site does not constitute important nesting, roosting or foraging habitat as the species has almost exclusively been recorded above the escarpment and has never been recorded in the Concept Area. Therefore, the amount of habitat lost due to the proposed development is not likely to represent a significant loss to the species.

The vegetation clearance will occur as a number of discrete and incremental events, across a 10 m corridor over an area of approximately 250 ha. The proposal will not result in the fragmentation or isolation of foraging, sheltering or breeding habitat for Powerful Owl.

How is the proposal likely to affect habitat connectivity?

As discussed above, the vegetation removal at the site does not constitute important nesting, roosting or foraging habitat as the species has almost exclusively been recorded above the escarpment and has never been recorded in the Concept Area. The modification of the small amount of habitat is not likely to affect the long-term survival of the highly mobile Powerful Owl in the locality.

How is the proposal likely to affect critical habitat?

No critical habitat of this species has been identified for the Powerful Owl.

Conclusions

The proposed development is unlikely to impose a significant effect on the Powerful Owl given that:

- the Powerful Owl is not known to utilise the Concept Area with any frequency
- is more frequently recorded above the escarpment
- the proposed works would only remove a very small area of potential foraging habitat within the study area and locality
- the proposed works would not isolate an area of known habitat from currently interconnecting areas of potential habitat for this wide ranging species.

On the basis of the above considerations, it is likely that the proposed development will not result in a significant effect on the survival of the Powerful Owl. Consequently, a Species Impact Statement is not required for the proposed development with respect to this species.

Barking owl (Ninox connivens) – vulnerable

The Barking Owl is found throughout Australia except for the central arid regions and Tasmania. It is quite common in parts of northern Australia, but is generally considered uncommon in southern Australia. It has declined across much of its distribution across NSW and now occurs only sparsely. It is most frequently recorded on the western slopes and plains. It is rarely recorded in the far west or in coastal and escarpment forests. This species inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses. Denser vegetation is used occasionally for roosting. During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as Acacia and Casuarina species, or the dense clumps of canopy leaves in large Eucalypts. Territories range from 30 to 200 hectares and birds are present all year. Three eggs are laid in nests in hollows of large, old eucalypts including river red gum (*Eucalyptus camaldulensis*), white box (*Eucalyptus albens*), red box (*Eucalyptus polyanthemos*) and Blakely‘s red gum (*Eucalyptus blakelyi*) (DECC 2008k).

This species is known from the area from one vagrant record in 1988, which is accurate to 10,000m, and only three records are known from within 10km of the site (each <1996). Potential foraging habitat is present at the site for this species, however, suitable nesting habitat in the form of large hollow-bearing trees is not present within the study area. In addition this species is more commonly known to nest in River Red Gum, White Box, Red Box and Blakely‘s Red Gum, none of which are known from the Wollongong LGA.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The barking owl has the potential to forage across the site, however, no potential nesting habitat is present. A small area of potential foraging habitat for this species would be removed due to the proposal, though given the rarity of the records for this species in the locality (i.e. 10km of the Concept Area), there will no adverse effect on the life cycle of this species such that a viable local population of the species would placed at risk of extinction.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposed development will result in the potential incremental removal of up to 3.4 ha of native vegetation (refer to **Section 7**). As discussed above, the vegetation removal at the site does not constitute important nesting, roosting or foraging habitat as this species is not considered to be common or resident to

the locality. Therefore it is unlikely that the proposed habitat removal would be considered to comprise of an important area of habitat for this highly mobile species within the locality.

How is the proposal likely to affect habitat connectivity?

The vegetation clearance will occur as a number of discrete and incremental events, across a 10 m corridor over an area of approximately 160 ha. The proposal will not result in the fragmentation or isolation of foraging, sheltering or breeding habitat for Barking Owl.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Barking Owl occurs across mainland Australia from Cape York along the east coast to Port Augusta, as well as in the south-west corner of W.A. and the Pilbara. It is not at the limit of its known distribution.

How is the proposal likely to affect critical habitat?

No critical habitat has been declared for this species.

Conclusion

However, the proposed removal is unlikely to have a significant impact on this species such that it would put a local population of the species at risk of extinction or substantially isolate any areas of potential habitat as:

- This species is only known from the locality from three historic records (<1996) highly unlikely to be present in the Concept Area or utilise it for foraging, roosting or nesting
- No potential nesting habitat would be impacted
- This species is highly mobile and can forage widely
- The proposal would not isolate habitat for this species
- Potential habitat for this species would remain within the study area, directly adjacent to the site and is present throughout the locality.

Grey-headed Flying Fox (Pteropus poloiocephalus)

The Grey-headed Flying-fox is listed as a vulnerable threatened species under the EPBC Act.

This species inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998, Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998).

Grey-headed Flying Fox is known from the locality with a permanent camp located at Farmborough Heights, in the Wollongong LGA approximately 2kms north of the Project Site. The vegetation within the study area provides potential roosting habitat for this species though it does not commonly forage below the escarpment in Wollongong, as evidenced by the low number of records on the floodplain from the Atlas of NSW Wildlife.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Grey-headed Flying Fox (GHFF) owl has the potential to forage across the site, however, no potential nesting habitat is present, with the nearest camp located at Farmborough Heights, approximately 2 km north of the Project Site. A small area of potential foraging habitat for this species would be removed due to the proposal, though given the rarity of the records for this species in the locality (i.e. 10km of the Concept Area), there will no adverse effect on the life cycle of this species such that a viable local population of the species would placed at risk of extinction.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposed development will result in the potential incremental removal of up to 3.4 ha of native vegetation (refer to **Section 7**). As discussed above, the vegetation removal at the site does not constitute important nesting, roosting or foraging habitat as this species is not considered to commonly forage across the floodplain. Therefore it is unlikely that the proposed habitat removal would be considered to comprise of an important area of habitat for this highly mobile species within the locality.

How is the proposal likely to affect habitat connectivity?

The vegetation clearance will occur as a number of discrete and incremental events, across a 10 m corridor over an area of approximately 160 ha. The proposal will not result in the fragmentation or isolation of foraging, sheltering or breeding habitat for GHFF.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

GHFF occurs across mainland Australia from Cape York along the east coast to Port Augusta, as well as in the south-west corner of W.A. and the Pilbara. It is not at the limit of its known distribution.

How is the proposal likely to affect critical habitat?

No critical habitat has been declared for this species.

Conclusion

The proposed vegetation removal is unlikely to have a significant impact on this species such that it would put a local population of the species at risk of extinction or substantially isolate any areas of potential habitat as:

- This species is only known from the locality from disparate records, mostly outside of the Project Site and is unlikely to utilise the Concept Area for foraging or roosting or nesting
- No potential nesting habitat would be impacted, the nearest GHFF camp is found approximately 3km to the north at Farmborough Heights
- This species is highly mobile and can forage widely
- The proposal would not isolate habitat for this species
- Potential habitat for this species would remain within the study area, directly adjacent to the site and is present throughout the locality.

Microchiropteran Bats

Eastern False Pipistrelle (Falsistrellus tasmaniensis) – Vulnerable

The Eastern False Pipistrelle is found on the South-east coast and ranges of Australia, from Southern Queensland to Victoria and Tasmania. It generally roosts in Eucalypts hollows but has also been found under loose bark on trees, urban environments, in buildings. However, it does have a preference for moist habitats and hollow bearing trees taller than 20m. The Eastern False Pipistrelle forages above or just below the tree canopy for beetles, moths, weevils and other flying insects (DECCW 2010). This species has been recorded to move up to 12km from roost to foraging area (Van Dyck and Strahan 2008).

Eastern Bent-wing-bat (Miniopterus schreibersii oceanensis) – Vulnerable

The Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) is listed as a vulnerable species under Schedule 2 of the TSC Act. This species occupies a range of forested environments (including wet and dry sclerophyll forests), along the coastal portion of eastern Australia, and through the Northern Territory and Kimberley area (subject to subdivision of this species).

This species forages just above the tree canopy in forested areas as well utilise open areas where it is known to forage at lower levels. Moths appear to be the main dietary component. This highly mobile species is capable of large regional movements in relation to seasonal differences in reproductive behaviour and winter hibernation. Though individuals often use numerous roosts, it congregates in large numbers at a small number of nursery caves to breed and hibernate. Although roosting primarily occurs in caves, it has also been recorded in mines, culverts, stormwater channels, buildings, and occasionally tree-hollows. This species occupies a number of roosts within specific territorial ranges usually within 300 km of the maternity cave, and may travel large distances between roost sites.

Eastern Free-tail Bat (Mormopterus norfolkensis) – Vulnerable

The Eastern Free-tail Bat occupies dry sclerophyll forest and woodland east of the Great Dividing Range. This species roosts in tree hollows, beneath bark or in man-made structures such as drains and buildings (DECC 2008o).

Little Bent-wing-bat (Miniopterus australis) - Vulnerable

The Little Bent-wing Bat (Miniopterus australis is a small insectivorous bat that is listed as vulnerable under Schedule 2 of the TSC Act. This species occurs in a range of habitats including lowland, rainforest, vine thicket dense coastal forest wet and dry sclerophyll forest, paper bark swamps and urban areas.

During the summer breeding season this species in gathers in large numbers at one of the five Australian maternal caves. However, during throughout the remainder of the year this species forms small isolated colonies. This species roosts in a variety of habitats including caves, tunnels, hollows in trees, abandoned mines, stormwater drains, culverts, beneath bridges and often buildings.

This species is vulnerable to habitat disturbance, pesticides, predation from feral cats and foxes.

Southern or Large-footed Myotis (Myotis adversus) – Vulnerable

The Southern or Large-footed Myotis (*Myotis adversus*) is listed as a vulnerable species under Schedule 2 of the TSC Act. This species occupies a range of coastal and sub-coastal environments from the Kimberly in the forested environments (including wet and dry sclerophyll forests), along the coastal portion of eastern Australia, and through the Northern Territory and Kimberley area (subject to subdivision of this species).

Yellow-bellied Sheath-tail Bat (Saccolaimus flaviventris) – Vulnerable

The Yellow-bellied sheathtail-bat roosts singly or in groups of up to six, in tree hollows and buildings. In treeless areas they are known to utilise mammal burrows. They forage in most habitats throughout their very wide range, including areas with and without trees and appear to defend an aerial territory DECC (2010).

Greater Broad-nosed Bat (Scoteanax rueppellii) – Vulnerable

The Greater Broad-nosed Bat is a large powerful bat with a broad head and square muzzle. It occurs through eastern Australian from Victoria in the south to the Atherton Tableland in Queensland. This species is generally found in gullies and along river systems that drain through the Great Dividing Range

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Factors likely to have an adverse effect on the life cycle of a viable population of seven micro-bat species includes disturbance to roosting and breeding sites; loss of hollow bearing trees, declines in foraging habitat, application of pesticides, predation from introduced foxes and cats.

The Project intends to remove a total of 3.4 ha of woodland, scattered trees and other vegetation from the PA and CA, across a proposed footprint of ~160ha (Study area~800ha). However, the loss of hollow bearing trees across will reduce the number of nest location across the site.

All of these species have widespread distributions across eastern and northern Australia, they are all highly mobile, and for example the individual of the Eastern False Pipistrelle have been recorded moving 12km from roosts to foraging sites. In addition, during the summer months the Little Bent-wing Bat will migrate away from its typical foraging sites to maternal caves to breed.

In addition, there are considerable areas of potential habitat that will not be disturbed by the proposal that will provide potential habitat to these species. Therefore, the clearing at the Concept Site is unlikely represents

a small fraction of the habitat available to these species in the local area and is therefore unlikely to impact significantly on the long-term survival of each species

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Given, the proportionally small area of potential habitat to be removed, the remaining habitat within the Study areaand in adjacent areas as well as the highly mobile of each species, it is unlikely that the proposed works will reduce the viability of the local population and increase the risk of extinction.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

No, Little Bent Wing Bat occurs along the east coast from Newcastle to Cape York, the Eastern Bentwing Bat and the Large-footed Myotis occur along the east and north areas of Australia, including Kimberly, Yellow-bellied Sheath-tailed Bat occurs across the Australian continent. Greater Broad-nosed Bat occurs from the Atherton Tablelands, QLD, to the north-eastern Victorian Alps. Eastern False Pipistrelle occurs along the east coast from south-east QLD to south-eastern SA.

How is the proposal likely to affect current disturbance regimes?

The majority of the Study areaand adjoining lands are currently used to provide pasture for grazing and pasture improvement and/or cropping. The project will result in the loss of approximately 3.4ha of remnant native vegetation across the Field Assessment Area, of 160ha footprint. However, given the highly modified nature vegetation along the present construction corridor, it is unlikely that the proposed works will significantly add to the existing levels of fragmentation of vegetation or fauna habitat.

How is the proposal likely to affect habitat connectivity?

Given the highly modified nature pasture and vegetation patches along the present construction corridor, it is unlikely that the proposed works will significantly add to the pre-existing levels of fragmentation present within the region. Considering the presence of woodland patches and the highly mobile nature of the species, it is unlikely that the proposal will significantly contribute or reduce the existing levels of habitat connectivity. In addition, the project will only temporarily impact on an already highly modified landscape.

How is the proposal likely to affect critical habitat?

Critical habitat cannot be declared for vulnerable species.

Conclusions

The Proposal will result in the removal of a small amount of potential foraging, roosting, and breeding habitat for Eastern Bent-wing Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat, Little Bent Winged Bat, Eastern Free-tail Bat and Yellow-bellied Sheath-tailed Bat. However, the proposed removal is unlikely to have a significant impact on these species such that it will put a local population at risk of extinction or substantially isolate any areas of potential habitat as:

The proposed works in the Concept area will constitute a minor disturbance to an area of foraging habitat within the locality.

Larger areas of suitable foraging habitat are present within the surrounding landscape.

The works are unlikely to isolate or fragment any currently connecting areas of habitat in terms of use by these highly mobile species.

The works are unlikely to impact potential foraging and roosting habitat will be conserved with the Project Site and adjacent to the Project Site.

The clearance area is very small proportionally to that available habitat remaining in the local area.

Great Egret (*Ardea alba*) and Cattle Egret (*Ardea ibis*) – Migratory

The Great Egret and the Cattle Egret have a widespread distribution across Australia with breeding populations found all over the country with the exception of the driest regions of the interior. They inhabit a wide range of wetland habitats, usually foraging in stock paddocks, pasture, croplands, mudflats, shallow freshwater and estuarine wetlands.

The Cattle Egret is a highly mobile species that enables it to migrate to more optimal foraging and breeding habitats if required to do so. The Great Egret has a diverse diet, which includes fish, macroinvertebrates, frogs, lizards, snakes and small birds and mammals (DEWHA, online).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The proposed works are unlikely to have a significant impact any mudflats, major drainage lines, waterways or associated aquatic and riparian vegetation that represents important habitat for the Great Egret. Therefore, the proposed works are unlikely to significant impact on habitat for this species. In addition, the impact will only be short term, and there will be little impact on the ability of this species to recolonise the region once the project is complete. In addition, the entire construction corridor will be rehabilitated using local providence species following the completion of the works associated with the project.

- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species

The Study areafor this project is approximately 800ha, across a highly modified landscape that is currently resident to various invasive species that may be harmful to migratory species, specifically the European Red Fox (*Vulpes vulpes*). Considering the resident nature of this species the Project is unlikely to exacerbate this impact of this species on migratory species.

- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species

The proposed works will not significant impact any mudflats, major drainage lines, waterways or associated aquatic and riparian vegetation that represents important breeding and foraging habitat for the Great Egret or Cattle Egret. Therefore, it is unlikely that the proposed works should not disrupt the lifecycle of the Great Egret or Cattle Egret.

Conclusion

The proposal is unlikely to constitute a significant impact on Great Egret given that:

- The proposed works will constitute a minor disturbance to an area of foraging habitat for the species in the local region
- The proposed works will not disturb any major waterways or associated vegetation
- There are large areas of suitable foraging and breeding habitat present within the surrounding landscape
- Due to the highly mobile nature of the species and its ability to use a variety of habitats it is unlikely to become isolated or fragmented from currently connected areas of habitat

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