Glossy Black-cockatoo

***Calyptorhynchus lathami* (Temminck, 1807)**

Other common names Glossy Cockatoo, Casuarina Cockatoo, Leach's Black Cockatoo, Leach's Red-tailed Cockatoo, Latham's Cockatoo

Conservation status

The Glossy Black-cockatoo is listed as a **Vulnerable Species** on Schedule 2 of the New South Wales *Threatened Species Conservation Act, 1995* (TSC Act).

Description (summarised from Crome & Shields 1992)

Length
480mm
Wing
350mm
Tail
215mm
Bill
46mm
Tarsus
25mm
Weight
425g

The adult male Glossy Black-cockatoo has mainly dull black plumage that may be tinged brownish. Two bright red panels are visible on the tail. The bill, eye ring and legs are dark grey. Flight is buoyant with shallow, effortless wing-beats. Individuals often fly at considerable height when travelling between feeding areas.

The female is similar in appearance to the male except for irregular yellow patches around the neck, head and orange-red tail panels. Immature birds are similar to the female with more yellow below and on wings and a paler bill.

Individuals differ from the Red-tailed Black-cockatoo due to their inconspicuous crest and distinctive calls that are soft, wavering and plaintive, disyllabic*kaa-er* and a harsh alarm screech.

Glossy Black-cockatoo - male and female

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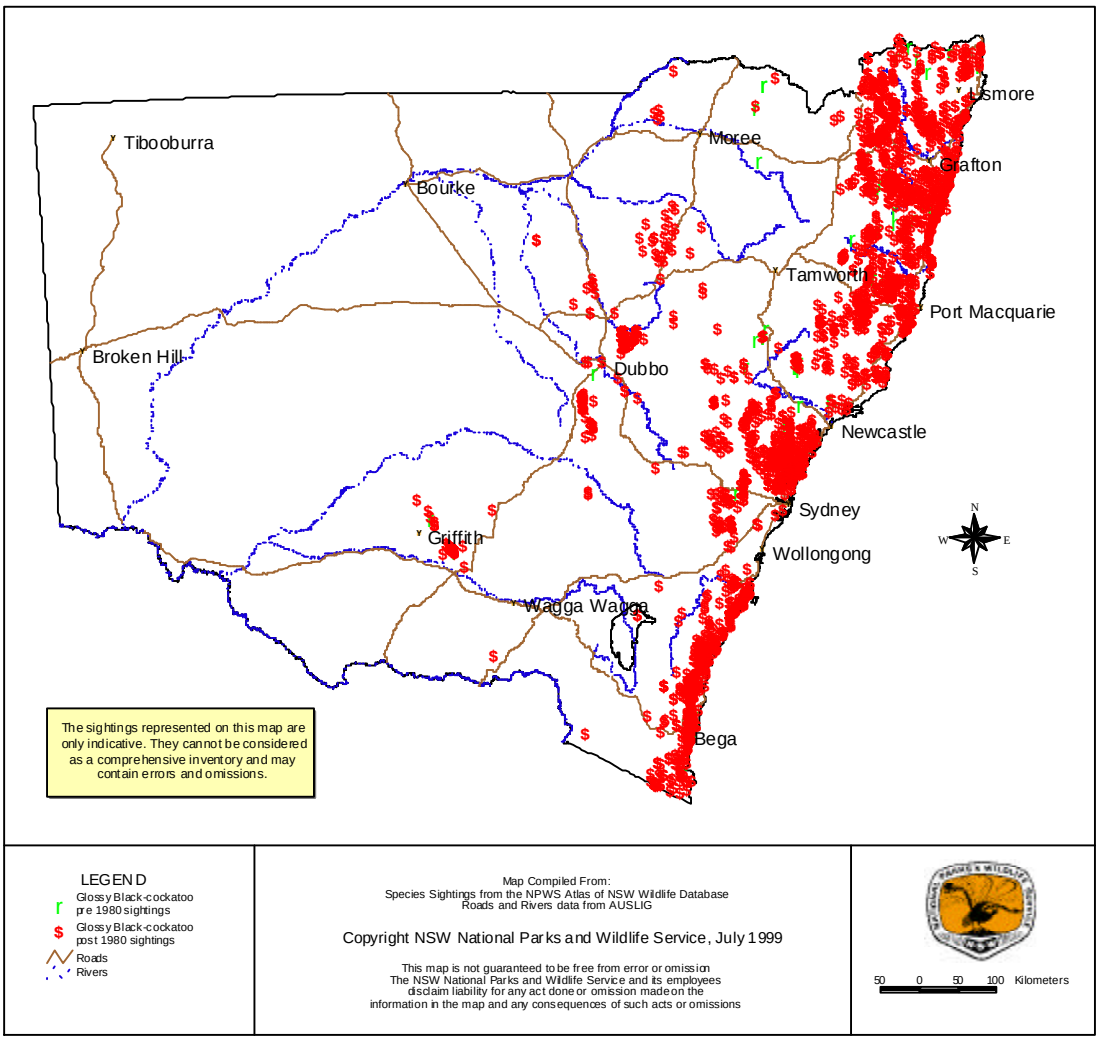

NPWS records of the Glossy Black-cockatoo in NSW

Distribution

The Glossy Black-cockatoo is sparsely distributed along the east coast and immediate inland districts from western Victoria to Rockhampton in Queensland (Crome & Sheilds 1992). In NSW, the species is found as far west as Cobar and Griffith in isolated mountain ranges (Pizzey 1991). Isolated populations of the species inhabit King Island in Bass Strait and Kangaroo Island off the coast of South Australia (Schodde *et al.* 1993).

The inland distribution of the species is restricted by the occurrence of the various casuarina species (Ayers *et al.* 1996).

Recorded occurrences in conservation reserves

Various conservation reserves throughout eastern and central NSW (NPWS 1999).

Habitat

The Glossy Black-cockatoo characteristically inhabits forests on sites with low soil-nutrient status, reflecting the distribution of **key** *Allocasuarina* spp. (Tanton 1994). The drier forest types with intact and less rugged landscapes are preferred by the species (NPWS 1994).

Ecology

The Glossy Black-cockatoo is probably the most specialised member of its family feeding exclusively on seeds extracted from the wooden cones of casuarinas (she-oaks). The bill is used to remove the tough outer hull while the cone is rotated in the left foot. The exposed seeds are then stripped away and eaten. The art of opening a casuarina cone is apparently learned behaviour, as immature birds frequently seem to have trouble manipulating the cones into the correct position (Crome & Shields 1992).

Adults only breed during the autumn and winter. During the 29 days of incubation the female is dependent on the male for food as she usually remains on the nest in a large tree hollow, lined with chips and dust (Crome & Shields 1992). Only one young bird is raised per season and a juvenile may associate with its parents for an indefinite period after fledging at approximately 60 days.

The species is gregarious, usually recorded in family parties of seldom more than 10. Locally nomadic, small flocks roam in search of feeding areas and roost communally.

Threats (summarised from Crome & Shields 1992; NPWS in prep.)

- Natural and other hazards may fragment habitat
- Loss of habitat through clearing and associated activities, including intensive logging, burning and grazing
- Logging of nest trees within the proximity of food resources
- Inappropriate fire regimes reducing its range by removing nesting and feeding resources

Management (summarised from Crome & Shields 1992; NPWS in prep.)

- Protection and maintenance of known or potential habitat
- Replanting areas with casuarina trees and promotion of their growth and development in areas from which they have been eliminated
- Alteration of prescribed burning and grazing regimes to ensure the enhancement and maintenance of the vegetation within known or potential habitat

Recovery plans

A recovery plan has not been prepared for this species.

References

Ayers D., Nash S. and Baggett K. 1996. Threatened Species of Western NSW. NPWS, Hurstville.

Crome F. and Shields J. 1992. Parrots and Pigeons of Australia. Angus and Robertson, Sydney.

NPWS 1994. Fauna of north-east NSW forests. North East Forests Biodiversity Study Report No. 3. NPWS, Hurstville.

NPWS (in prep.). Threatened Species Management Manual. Forest Conservation Unit. NPWS, Hurstville.

NPWS 1999. Atlas of NSW Wildlife. NPWS, Hurstville.

Pizzey G. 1991. A Field Guide to the Birds of Australia. Revised Edition. Angus and Robertson, Sydney.

Schodde R., Mason I. and Wood J. 1993. Geographic differentiation in the Glossy Black-Cockatoo and its history. *Emu* 93: 156-66

Tanton M.T. 1994. Fauna impact statement. Proposed forestry operations in the Eden Management Area. Environmental Impact Statement. Volume B, Appendix 1. State Forest of NSW, Sydney.

For further information contact

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Web site www.npws.nsw.gov.au

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Threatened Species Information

Greater Broad-nosed Bat

Scoteanax rueppellii

Conservation Status

The Greater Broad-nosed Bat is listed as a **Vulnerable Species** under the NSW *Threatened Species Conservation Act 1995* (TSC Act).

Description

The Greater Broad-nosed Bat is a large bat dark reddish brown in colour with slightly paler belly. It has a long forearm and ears that are slender and triangular. Distinguished from other broad-nosed bats by its size and from the Eastern falsistrelle (*Falsistrellus tasmaniensis*) by its two, not four, upper incisor teeth (Churchill 1998).

Distribution

From the Atherton Tablelands in north Queensland along the coastal regions to southern NSW (Churchill, 1998).

Habitat

Inhabits a variety of habitats from woodland through moist and dry eucalypt forest to rainforest. However, it does not occur at altitudes above 500 m (Strahan 1995).

Ecology

Females congregate in colonies prior to birth and a single young is born in January. Males are excluded from the colony during the birth and rearing of young (Churchill 1998).

The Greater Broad-nosed Bat feeds on slow-flying prey such as large moths and a variety of beetles, including ground beetles, chafers and leaf beetles (Churchill 1998 and Strahan 1995).

References

Churchill, S. (1998) **Australian Bats** New Holland Publishers, Sydney

Strahan, R. (ed) (1995) **Mammals of Australia** Australian Museum**,** Reed New Holland, Sydney, Revised Edition

RECOVERY OUTLINE

Ground Parrot (eastern)

1	Family	Psittacidae
2	Scientific name	*Pezoporus wallicus wallicus* (Kerr, 1792)
3	Common name	Ground Parrot (eastern)
4	Conservation status	Vulnerable: C2a

5 Reasons for listing

The small population of this subspecies is probably declining and is severely fragmented, with no sub-population exceeding 1,000 mature individuals (Vulnerable: C2a).

	Estimate	*Reliability*
Extent of occurrence	*60,000 km²*	*medium*
trend	*stable*	*medium*
Area of occupancy	*500 km²*	*low*
trend	*decreasing*	*low*
No. of breeding birds	*4,000*	*low*
trend	*decreasing*	*medium*
No. of sub-populations	*6*	*medium*
Largest sub-population	*1,500*	*low*
Generation time	*5 years*	*low*

6 Infraspecific taxa

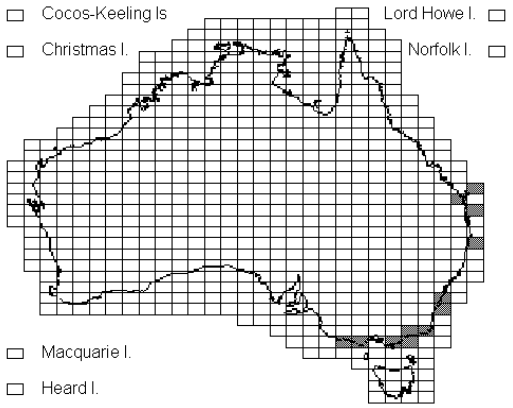
P. w. flaviventris (south-western Western Australia) is Endangered. *P. w. leachi* (Tasmania, including Bass Strait Is) is Least Concern. Taxonomy follows Schodde and Mason (1997).

7 Past range and abundance

Patchy distribution through coastal eastern Australia from Wide Bay and Fraser I., Qld, to Adelaide Plain, S. A. (Higgins, 1999).

8 Present range and abundance

Current major population centres: Queensland: Fraser I. and adjacent coastline south to Noosa; New South Wales: Broadwater to Red Rock on far north coast, Myall Lakes and seven sites between Barren Grounds Nature Reserve and Nadgee Nature Reserve; Vic.: Mallacoota to L. Tyres, Wilsons Prom., Carlisle R. in Otway Ra. and Long Swamp, Discovery Bay (McFarland, 1991a, Baker, 1997, Higgins, 1999 NSW NPWS, 2000). The presence of vagrant birds at least 200 km from the nearest known sub-population suggest that there is probably some movement between sub-populations. However, there are major breaks in distribution in central Victoria, central New South Wales and south-east Queensland. No longer found in South Australia, (Higgins, 1999) and there are also no recent records from the Otway Ra. (R. Loyn) where there has been an on-going decline in abundance (Higgins, 1999).



9 Ecology

The eastern subspecies of Ground Parrot lives in low heathland and sedgeland (Meredith, 1984, Meredith *et al.*, 1984, McFarland, 1989). Nests are made on the ground, beneath dense vegetation, the clutch size averaging 3-4 (McFarland, 1991b). Predation by native and introduced predators occurs, but is not thought to be biologically significant (McFarland, 1989). Seeds are eaten from a wide range of herbs, graminoids and heath, the diet generally reflecting the range of available plants, but excludes seeds that need processing to remove woody husks (McFarland, 1991c). Heathland becomes unsuitable immediately after fire (Meredith *et al.*, 1984, McFarland, 1993), in some cases, for a further four years (Jordan, 1987, Baker and Whelan, 1994), but suitability may decline if left unburnt for more than 15 years (McFarland, 1989). In sedgeland and graminoid heathlands, Ground Parrots persist for many more years after fire (Meredith *et al.*, 1984, Baker and Whelan, 1994). A mosaic of burning that allows movement between patches of different post-fire recovery is likely to be important to ensure rapid recolonisation of recently burnt areas.

10 Threats

An imposed fire regime is required to maintain the integrity of habitat with a mosaic of fire ages being used to ensure (1) refugia in time of fire, (2) rapid re-colonisation of habitat that has recovered after fire, and (3) recovery of habitat that has become unsuitable through being unburnt for too long. (Meredith, 1983, McFarland, 1993). Maintenance of a fire mosaic requires an annual allocation of management resources

and sustained political will, both of which are proving difficult to maintain in many reserves.

11 Information required

11.1 Develop captive breeding techniques.

11.2 Determine prevalence of disease in wild population.

12 Recovery objectives

12.1 Ensure persistence of all sub-populations

12.2 Re-establish subspecies in South Australia.

13 Actions completed or under way

13.1 Conservation reserves have been gazetted specifically for the parrot.

13.2 Ecological studies have been undertaken in the three eastern states.

13.3 A Recovery Plan has been prepared for the Ground Parrot in New South Wales.

14 Management actions required

14.1 Map known and potential habitat.

14.2 Conduct surveys and initiate monitoring.

14.3 Controlled mosaic burning at appropriate intervals in all remaining habitat, where appropriate in a manner that also suits other heath-dependent species such as the Eastern Bristlebird *Dasyornis brachypterus.*

14.4 Establish a population in captivity in S. A., with the aim of re-introduction into S. A. This would also allow development of techniques that are suitable for the western subspecies and the Night Parrot.

14.5 Investigate links between conservation of Fleurieu Peninsula subspecies of Southern Emu-wren *Stipiturus malachurus intermedius* and re-establishment of Ground Parrot in S. A.

14.6 Re-establish a wild sub-population in S. A.

15 Organisations responsible for conservation

New South Wales National Parks and Wildlife Service, Queensland Parks and Wildlife Service, South Australian Department of Environment and Heritage, Tasmanian Parks and Wildlife Service, Victorian Department of Natural Resources and Environment.

16 Other organisations involved

Birds Australia, Parks Victoria, Adelaide Zoo, fire management authorities, private land-holders.

17 Staff and financial resources required for recovery to be carried out

Staff resources required 2001-2005 *0.3* *Curator* [1]

Financial resources required 2001-2005

Action	*Conservation agencies*	*Other funding sources*	*Total*
Fire management [1]	$50,000	$0	$50,000
Map habitat	$56,000	$0	$56,000
Conduct surveys and initiate monitoring	$69,000	$0	$69,000
Determine disease prevalence	$2,000	$0	$2,000
Develop captive breeding techniques and establish captive population [2]	$30,000	$50,000	$80,000
Investigate links with Southern Emu-wren	$2,500	$0	$2,500
Re-establish subspecies in South Australia	$20,000	$50,000	$70,000
Total	$229,500	$100,000	**$329,500**

1 Costs additional to those needed for routine fire management of habitat.
2 Cost shared among Night Parrot and western and eastern subspecies of Ground Parrot.

18 Bibliography

Baker, J. 1997. *Ground Parrot Recovery Plan 1997-2002.* N. S. W. National Parks and Wildlife Service, Sydney.

Baker, J. and Whelan, R. 1994. Ground Parrots and fire at Barren Grounds, New South Wales: a long term study and an assessment of management implications. *Emu* 94:300-304.

Higgins, P. J. (ed.) 1999. *Handbook of Australian, New Zealand and Antarctic Birds. Vol. 4. Parrots to Dollarbird.* Oxford University Press, Melbourne.

Jordan, R. 1987. The Ground Parrot in Barren Grounds Nature Reserve. *RAOU Rep.* 27:19-23.

McFarland, D. C. 1989. The Ground Parrot *Pezoporus wallicus wallicus* (Kerr) in Queensland: Habitat, Biology and Conservation. Department of Environment and Conservation, Queensland.

McFarland, D. C. 1991a. The biology of the Ground Parrot, *Pezoporus wallicus*, in Queensland. III. Distribution and abundance. *Wildl. Res.* 18:199-213.

McFarland, D. C. 1991b. The biology of the Ground Parrot, *Pezoporus wallicus*, in Queensland. II. Spacing, calling and breeding behaviour. *Wildl. Res.* 18:185-197.

McFarland, D. C. 1991c. The biology of the Ground Parrot, *Pezoporus wallicus*, in Queensland. I. Microhabitat use, activity, cycle and diet. *Wildl. Res.* 18:169-184.

McFarland, D. C. 1993. Fire and bird conservation. Pp. 41-44 in *Birds and their Habitats: Status and Conservation in Queensland.* C. P. Catterall, P. V. Driscoll, K. Hulsman, D. Muir and A. Taplin (eds). Queensland Ornithological Society, Brisbane.

Meredith, C. W. 1984. The Ground Parrot *Pezoporus wallicus* Kerr. RAOU Conservation Statement No. 1. RAOU, Melbourne.

Meredith, C. W., Gilmore, A. M. and Isles, A. C. 1984. The Ground Parrot in south-eastern Australia: a fire adapted species? *Aust. J. Ecol.* 9:367-380.

NSW NPWS 2000. Draft Recovery Plan for the Ground Parrot *Pezoporus wallicus.* New South Wales National Parks and Wildlife Service, Hurstville.

Schodde, R. and Mason, I. J. 1997. Aves (Columbidae to Coraciidae). *Zoological Catalogue of Australia. Vol. 37.2.* W. W. K. Houston and A. Wells (eds). CSIRO Publishing, Melbourne.

Comments received from

Jack Baker, Richard Loyn, David McFarland, Peter Menkhorst, Anthony Overs.

Threatened Species Information

Large-footed Myotis

Myotis adversus

Conservation Status

The Large-footed Myotis is listed as a **Vulnerable Species** under the NSW *Threatened Species Conservation Act 1995* (TSC Act).

Description

The Large-footed Myotis is dark grey to reddish brown in colour with long ears and a long, straight and slender tragus. The Large-footed Myotis can be distinguished from other Australian bats by its disproportionately large feet (>8mm long) (Churchill 1998).

Distribution

The Large-footed Myotis is primarily a coastal species occurring from the Kimberley to Victoria and South Australia. They rarely occur further than 100 m inland except along major rivers such as, the Murray and Fitzroy Rivers (Churchill 1998).

Habitat

The Large-footed Myotis roosts in colonies in caves, mines, tunnels, bridges and buildings and sometimes in dense foliage in the tropical part of its range. Males of the species roost alone when they are not breeding (Strahan 1995).

Ecology

Reproduction in the Large-footed Myotis varies depending on latitude. In NSW and Victoria one young is usually born in November or December whereas two young are born in south-eastern Queensland, one in early October and the other in late January. In northern Queensland three successive births occur in a year as a tropical pattern of breeding is adopted (Strahan 1995).

The Large-footed Myotis forage over water feeding on flying insects, aquatic insects and small fish and may forage individually or in groups. Fish are captured by raking their claws across the surface (Churchill 1998; Menkhorst and Knight 2001).

References

Churchill, S. (1998) **Australian Bats** New Holland Publishers, Sydney

Menkhorst, P. and Knight, F. (2001) **A Field Guide to the Mammals of Australia** Oxford University Press, South Melbourne, Australia

Strahan, R. (ed) (1995) **Mammals of Australia** Australian Museum**,** Reed New Holland, Sydney, Revised Edition

Threatened Species Information

Long-nosed Potoroo

Potorous tridactylus

Conservation Status

The Long-nosed Potoroo is listed as a **Vulnerable Species** under the NSW *Threatened Species Conservation Act 1995* (TSC Act), and as a **Vulnerable Species** under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

Description

The Long-nosed Potoroo is brown-grey in colour with a rufous tinge on its flanks and pale grey underparts (Menkhorst and Knight 2001). Their tail is sparsely furred often with a white tip at the end of the blackish tail (DPIWE 2003). The hind foot has only two pads and the ears are short, rounded and dark grey on the outer surface. The rhinarium and adjacent muzzle are naked (Menkhorst and Knight 2001).

Distribution

The Long-nosed Potoroo occurs in eastern and northern Tasmania and patchily from coastal south-western Victoria to south-eastern Queensland. It inhabits moderately dry grassy woodland to wet dense scrub (Menkhorst and Knight 2001, DPIWE 2003).

Habitat

The Long-nosed Potoroo generally inhabits areas where rainfall is greater than 760 mm in coastal heath and dry and wet sclerophyll forests. The Long-nosed Potoroo requires habitat that has thick ground cover and prefers areas where the soil is light and sandy (Strahan 1995).

Ecology

The Long-nosed Potoroo is generally a solitary, nocturnal animal that feeds on underground fungi, tubers, soil arthropods, some seeds, fruits and green vegetation (Menkhorst and Knight 2001). It builds a rough squat of vegetation beneath dense cover and creates a series of track 'runways' through the vegetation (DPIWE 2003).

The Long-nosed Potoroo does not have a set breeding season and breeds throughout the year with up to two single young being raised per year (Menkhorst and Knight 2001).

References

Department of Primary Industries, Water and Environment (DPIWE) (2003) **Long-nosed Potoroo** (online) Tasmania Parks and Wildlife, http://www.dpiwe.tas.gov.au/inter.nsf/WebPages/BHAN-53825L?open

Menkhorst, P. and Knight, F. (2001) **A Field Guide to the Mammals of Australia** Oxford University Press, South Melbourne, Australia

TAXON SUMMARY

Masked Owl (southern Australia)

1	Family	Tytonidae
2	Scientific name	*Tyto novaehollandiae novaehollandiae* (Stephens, 1826)
3	Common name	Masked Owl (southern Australia)
4	Conservation status	Near Threatened: a

5 Reasons for listing

The area occupied by this subspecies is thought to have declined by at least half, particularly in the semi-arid zone (Near Threatened: a).

	Estimate	*Reliability*
Extent of occurrence	*4,000,000 km²*	*high*
trend	*stable*	*medium*
Area of occupancy	*35,000 km²*	*low*
trend	*stable*	*medium*
No. of breeding birds	*7,000*	*low*
trend	*stable*	*medium*
No. of sub-populations	*2*	*medium*
Largest sub-population	*6,500*	*low*
Generation time	*5 years*	*low*

6 Infraspecific taxa

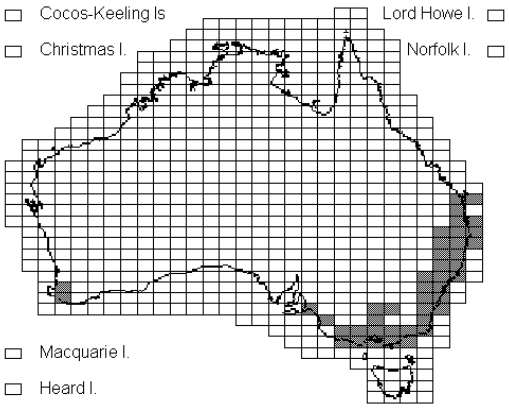
T. n. castanops (Tasmania, introduced to Lord Howe I.) and *T. n. melvillensis* (Tiwi Is, N. T.) are Endangered, *T. n. kimberli* (northern mainland Australia, including north-east Queensland; after Debus, 1993, Higgins, 1999) is Near Threatened. There are four other subspecies in New Guinea and nearby islands. The species 'global status is Least Concern.

7 Past range and abundance

Sparsely distributed through subcoastal mainland Australia from Fraser I, Qld, to Carnarvon, W. A., including Nullarbor Plain. Also occurs inland of Great Dividing Ra. (Schodde and Mason, 1980, Higgins, 1999). Generally found in sub-coastal habitats, but also inland along watercourses (Schodde and Mason, 1980, Debus, 1993). Fossil evidence of wider inland distribution during wetter climates (Rich *et al.*, 1978).

8 Present range and abundance

Numbers reduced in inland New South Wales, South Australia, and on the Nullarbor Plain (Schodde and Mason, 1980, Smith *et al.*, 1995, Higgins, 1999). In Western Australia, restricted to south-west (Johnson and Storr, 1998). Recently located at only 5 of 100 sites surveyed in southern forests, all records from the southern coastal strip between Margaret R. and Manjimup (R. Kavanagh), but also recorded further north, including woodland areas, such as Dryandra (A. A. Burbidge). In Victoria, population estimated at 300-400 pairs, mostly in East Gippsland (Peake *et al.*, 1993). New South Wales: 1,500-2,000 pairs in north-east (Higgins, 1999); 190 pairs in 3,200 km² of State Forests and protected area in south-east (Kavanagh, 1997).



9 Ecology

The southern subspecies of Masked Owl occupies a home range of 5-10 km² within a diverse range of wooded habitats that provide large hollow-bearing trees for roosting and nesting and nearby open areas for foraging (Kavanagh and Murray, 1996, Higgins, 1999). This can include forests, remnants within agricultural land or almost treeless inland plains (Schodde and Mason, 1980, Peake *et al.*, 1993, Debus and Rose, 1994, Higgins, 1999). Nests and roost sites are usually in hollows of large trees, often in riparian forest. Clutch size is usually 3-4 (Schodde and Mason, 1980, Kavanagh, 1996). Masked Owls also roost, and less commonly nest, in caves (Debus, 1993, Peake *et al.*, 1993, Debus and Rose, 1994). Prey are principally terrestrial mammals, including rodents and marsupials (Debus, 1993, Kavanagh, 1996), although possums, gliders, bats, birds, lizards and rabbits may be taken opportunistically (Schodde and Mason, 1980, Hollands 1991, Debus, 1993, Debus and Rose, 1994, Kavanagh, 1996, Higgins, 1999).

10 Threats

Clearance for agriculture has certainly affected abundance in many parts of the species 'range, particularly Western Australia and South Australia (Higgins, 1999), and is the principal reason for listing the subspecies. The reason for the low density of Masked Owls, however, is unknown. Although food does not appear to be limiting on the east coast (Kavanagh, 1996), the apparent decline in arid

Australia may be linked to that of mammals of between 50 and 200 g (Burbidge and McKenzie, 1989). However, Masked Owls may never have been common in dry areas (Debus, 1993). Within forests on the east coast, the availability of nest trees could be declining (Peake *et al.*, 1993, Kavanagh, 1996), but the scarcity of Masked Owls from logged forest in New South Wales (Kavanagh and Bamkin, 1995, Kavanagh *et al.*, 1995) is more likely to be because the vigorous regrowth after logging makes the habitat less suitable for foraging (Kavanagh *et al.*, 1995).

11 Recommended actions

11.1 Undertake follow-up surveys in New South Wales forests to determine trends in abundance and further baseline surveys in forests of south-western Western Australia and south-east Queensland.

11.2 Undertake further modelling work in Victoria to assess habitat requirements and predict distribution.

11.3 Maintain a diverse mosaic of fire ages within forest habitats to keep patches of understorey open.

12 Bibliography

Burbidge, A. A. and McKenzie, N. L. 1989. Patterns in the modern decline of Western Australia ŝ vertebrate fauna: Causes and conservation implications. *Biol. Conserv.* 50:143-198.

Debus, S. J. S. 1993. The mainland Masked Owl *Tyto novaehollandiae*: a review. *Aust. Bird Watcher* 15:168-191.

Debus, S. J. S. and Rose, A. B. 1994. The Masked Owl *Tyto novaehollandiae* in New South Wales. *Aust. Birds* 28 (Suppl.):S40-S64.

Higgins, P. J. (ed.) 1999. *Handbook of Australian, New Zealand and Antarctic Birds. Vol. 4. Parrots to Dollarbird.* Oxford University Press, Melbourne.

Hollands, D. 1991. *Birds of the Night.* A. H. and A. W. Reed, Sydney.

Johnstone, R. E. and Storr, G. M. 1998. *Handbook of Western Australian Birds. Vol. 1. Non-passerines (Emu to Dollarbird).* W. A. Museum, Perth.

Kavanagh, R. P. 1996. The breeding biology and diet of the Masked Owl *Tyto novaehollandiae* near Eden, New South Wales. *Emu* 96:158-165.

Kavanagh, R. P. 1997. Ecology and Management of Large Forest Owls in South-Eastern Australia. PhD thesis, University of Sydney, Sydney.

Kavanagh, R. P. and Bamkin, K. L. 1995. Distribution of nocturnal forest birds and mammals in relation to the logging mosaic in south-eastern New South Wales. *Biol. Conserv.* 71:41-53.

Kavanagh, R. P. and Murray, M. 1996. Home range, habitat and behaviour of the Masked Owl *Tyto novaehollandiae* near Newcastle, New South Wales. *Emu* 96:250-257

Kavanagh, R. P., Debus, S. J. S., Tweedie, T. and Webster, R. 1995. Distribution of nocturnal forest birds and mammals in north-eastern New South Wales: relationships with environmental variables and management history. *Wildl. Res.* 22:359-377.

Peake, P., Conole, L. E., Debus, S. J. S., McIntyre, A. and Bramwell, M. 1993. The Masked Owl *Tyto novaehollandiae* in Victoria. *Aust. Bird Watcher* 15:125-136.

Rich, P. V., McEvey, A. R. and Walkley, R. 1978. A probable Masked Owl *Tyto novaehollandiae* from Pleistocene deposits of Cooper Creek, South Australia. *Emu* 78:88-90.

Schodde, R. and Mason, I. J. 1980. *Nocturnal Birds of Australia.* Lansdowne, Melbourne.

Smith, P. J., Smith, J. E , Pressey, R. L. and. Whish, G. L. 1995. Birds of Particular Conservation Concern in the Western Division of New South Wales: Distributions, Habitats and Threats. *National Parks and Wildlife Service Occasional Paper* 20. New South Wales National Parks and Wildlife Service, Hurstville.

Comments received from

Andrew Burbidge, Stephen Debus, Rod Kavanagh, Richard Loyn, Penny Olsen.

Melaleuca biconvexa (a small tree) - vulnerable species listing

NSW Scientific Committee - final determination

The Scientific Committee, established under the Threatened Species Conservation Act, has made a Final Determination to list the small tree, *Melaleuca biconvexa* Byrnes as a vulnerable species on Schedule 2 of the Act. Listing of vulnerable species is provided by Part 2 of the Act.

The Scientific Committee has found that:

1. *Melaleuca biconvexa* Byrnes is a shrub to small tree with papery bark growing in damp places. A detailed description is provided in Harden, G. 1991. Flora of New South Wales Volume 2 UNSW Press, Sydney. p. 175.

2. *Melaleuca biconvexa* occurs as disjunct populations in coastal New South Wales from Jervis Bay to Port Macquarie, but the main concentration of records is in the Gosford/Wyong area. The distribution of the disjunct southern population in the Jervis Bay area has been recently described by Mills, K. 1993 - "The Natural Vegetation of the Jervis Bay Region of New South Wales", the National Estates Grant Scheme report.

3. Within the Gosford/Wyong area most populations occur on private land or on road reserves. The species may occur in dense stands forming a narrow strip adjacent to watercourses, in association with other Melaleuca species or as an understorey species in wet forest. Multiple stems may arise from single rootstocks so that an estimate of population size is not possible from visual inspection of stands.

4. Populations are threatened by land clearing, filling, excavation for construction of floodwater detention basins and alteration to water tables.

5. In view of 3 and 4 above the Scientific Committee is of the opinion that *Melaleuca biconvexa* is likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate, and is therefore eligible for listing as a vulnerable species.

Proposed gazettal date: 18/9/98
Exhibition Period: 18/9/98 to 23/10/98

TAXON SUMMARY

Powerful Owl

1	Family	Strigidae
2	Scientific name	*Ninox strenua* (Gould, 1838)
3	Common name	Powerful Owl
4	Conservation status	Least Concern

5 Reasons for listing

Any decline in the range or density of this species has been less than 50% (so not Near Threatened: a or c), and the population size exceeds 3,000 (so not d). Although there are probably only 7,000 mature individuals, numbers are unlikely to be decreasing significantly (so not Vulnerable: C2b).

	Estimate	*Reliability*
Extent of occurrence	*450,000 km²*	*high*
trend	*stable*	*high*
Area of occupancy	*50,000 km²*	*low*
trend	*stable*	*medium*
No. of breeding birds	*7,000*	*medium*
trend	*stable*	*medium*
No. of sub-populations	*1*	*medium*
Generation time	*10 years*	*low*

6 Infraspecific taxa

None described.

7 Past range and abundance

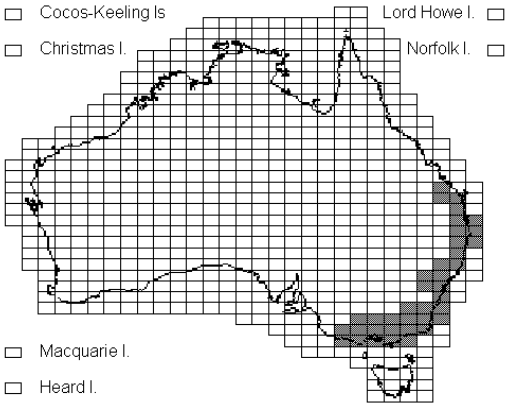
Eastern Australia, from south-western Victoria to at least Eungella, and possibly Bowen, Qld (Schodde and Mason, 1980, Pavey 1993, Eyre and Schulz, 1996). Mostly on the coastal side of the Great Dividing Range and adjacent inland slopes (Schodde and Mason, 1980, Higgins, 1999). Exceptional records further inland are probably non-breeding birds (NSW NPWS, 1998), but indicate an ability of the species to move long distances. Otherwise, breeding throughout range.

8 Present range and abundance

Although extensive areas of range now unsuitable, no contraction of range evident and species occupies suburban Brisbane, Sydney and Melbourne (Pavey, 1993, 1995, Silveira, 1997). Population estimates: Victoria, fewer than 500 pairs (C. Silveira); New South Wales, 1,000-1,500 pairs in north-east (Higgins, 1999), and 125 pairs in 3,200 km² of State Forest and National Park in south-east (Kavanagh, 1997).

9 Ecology

Powerful Owls are sedentary within home ranges of about 1,000 ha within open eucalypt, casuarina or *Callitris* pine forest and woodlands, though they often roost in denser vegetation, including rainforest or exotic pine plantations (Chafer, 1992, Kavanagh, 1997, Higgins, 1999). Nests, in which two eggs are laid, are in tree hollows, usually within or below the foliage in large living eucalypts that area at least 50 cm (and more commonly over 150 cm) in diameter, with ages estimated to be from 150 to over 500 years (McNabb, 1996). The principal prey are medium-sized mammals, particularly possums and gliders, but birds, flying-foxes, rats and insects are also taken (Higgins, 1999). Most prey are hollow-dwelling, and require a shrub layer (McNabb, 1996), and owls are most common in areas that have more large old trees and more hollows than available on average (Soderquist *et al.*, in press). Hunting may be concentrated in one part of a pair's home range for several years, apparently causing local declines in prey density (Kavanagh, 1988).



10 Threats

Although the population size and area occupied by Powerful Owls have declined as a result of widespread clearance for agriculture and pastoralism (Debus and Chafer, 1994, Webster *et al.*, 1999a), over half the habitat remains intact, with population densities probably little different from the pre-European times. Similarly, although intensive forestry practices remove old-growth forest, and owl densities in remaining forest may eventually be affected by a reduction in the availability of suitable nest hollows and den sites for prey (Kavanagh *et al.*, 1995, Gibbons and Lindenmayer, 1997, Webster *et al.*, 1999a), studies in New South Wales suggest Powerful Owls can persist in logging mosaics, by nesting in un-logged patches and hunting in logged areas. There was no difference in frequency of owl detection between heavily logged, lightly logged and un-logged forest (Kavanagh *et al.*,

1995, Kavanagh, 1997). Intense wildfire can result in local loss but, if suitable habitat remains nearby, Powerful Owls may return to forage in 20 year-old regrowth (Kavanagh, 1997). Poisoning, disturbance and predation by foxes on fledglings may cause nest failure and some deaths (NSW NPWS, 1998, Higgins, 1999, Webster *et al.*, 1999b), but are unlikely to be significant causes of increased mortality. Thus, at present, no threat or decline justifies a threatened classification for the species. For the smaller regional populations within each state, a status of Near Threatened or Vulnerable can more easily be justified. Modelling suggests there is a low probability of extinction in Victoria, but as the results are sensitive to changes in the probability of survival of adult birds, there is a need to improve the ability to identify individuals (McCarthy *et al.*, 1999).

11 Recommended actions

11.1 Develop techniques for identifying individual adult owls, possibly by computer analysis of calls.

11.2 Conserve adequate areas of suitable nesting habitat by gazettal of conservation reserves, and through native forest management plans, conservation agreements, clearance controls and development mitigation strategies.

11.3 Develop and implement appropriate forestry practices, particularly with regard to preservation of suitable nesting trees, and protection of riparian vegetation.

11.4 Develop appropriate wildfire management strategies on public and private land.

11.5 Enhance community awareness of Powerful Owls, their environmental significance and their conservation requirements.

12 Bibliography

Chafer, C. J. 1992. Observations of the Powerful Owl *Ninox strenua* in the Illawarra and Shoalhaven regions of New South Wales. *Aust. Bird Watcher* 14:289-300.

Debus, S. J. S. and Chafer, C. J. 1994. The Powerful Owl *Ninox strenua* in New South Wales. *Aust. Birds* 28 (Suppl.):S21-S38.

Eyre, T. J. and Schulz, M. 1996. Northern range extension of the Powerful Owl *Ninox strenua*. *Aust. Bird Watcher* 16:296-298.

Gibbons, P. and Lindenmayer, D. B. 1997. Conserving Hollow-dependent Fauna in Timber-production Forests. *Environmental Heritage Monograph* no. 3. NSW National Parks and Wildlife Service, Sydney.

Higgins, P. J. (ed.) 1999. *Handbook of Australian, New Zealand and Antarctic Birds. Vol. 4. Parrots to Dollarbird.* Oxford University Press, Melbourne.

Kavanagh, R. P. 1988. The impact of predation by the Powerful Owl, *Ninox strenua*, on a population of the Greater Glider, *Petauroides volans. Aust. J. Ecol.* 13:445-450.

Kavanagh, R. P. 1997. Ecology and Management of Large Forest Owls in South-Eastern Australia. Unpubl. PhD thesis, University of Sydney, Sydney.

Kavanagh, R. P., Debus, S. J. S., Tweedie, T. and Webster, R. 1995. Distribution of nocturnal forest birds and mammals in north-eastern New South Wales: relationships with environmental variables and management history. *Wildl. Res.* 22:359-377.

McCarthy, M. A., Webster, A., Loyn, R. H. and Lowe, K. W. 1999. Uncertainty in assessing the viability of the Powerful Owl *Ninox strenua* in Victoria, Australia. *Pacific Conserv. Biol.* 5:144-154.

McNabb, E. G. 1996. Observations of the biology of Powerful Owl *Ninox strenua* in southern Victoria. *Aust. Bird Watcher* 16:267-295.

NSW NPWS 1998. Large Forest Owls Northern Regional Recovery Plan. NSW National Parks and Wildlife Service, Coffs Harbour.

Pavey, C. R. 1993. Distribution and conservation status of the Powerful Owl in Queensland). Pp. 144-154 in *Australian Raptor Studies.* P. Olsen (ed.). Australasian Raptor Association, RAOU, Melbourne.

Pavey, C. R. 1995. Food of the Powerful Owl *Ninox strenua* in suburban Brisbane, Queensland. *Emu* 95:231-232.

Schodde, R. and Mason, I. J. 1980. *Nocturnal Birds of Australia.* Lansdowne, Melbourne.

Silveira, C. E. 1997. Targeted assessments of key threatened vertebrate fauna in relation to the North-east and Benalla-Mansfield Forest Management Area (NE FMA), Victoria: Powerful Owl *Ninox strenua.* Report to Arthur Rylah Institute, Heidelberg.

Soderquist, T. R., Lowe, K. W., Loyn, R. H. and Price, R. T. in press. Habitat quality of Powerful Owl territories in the box-ironbark forest of Victoria, Australia. *Proceedings of the International Owl Conference, Canberra, 2000.*

Webster, A., Humphries, R., and Lowe, K. 1999a. Powerful Owl *Ninox strenua. Natural Resources and Environment Action Statemen*t 92.

Webster, A., Cooke, R., Jameson, G. and Wallis, R. 1999b. Diet, roosts and breeding of Powerful Owls *Ninox strenua* in a disturbed, urban environment: a case for cannibalism? Or a case of infanticide? *Emu* 99:80-83.

Comments received from

Stephen Debus, Rod Kavanagh, Richard Loyn, Penny Olsen.

Prasophyllum affine

Common name Kinghorn Point Leek Orchid

Conservation status

Prasophyllum affine Lindl. is listed as an **Endangered Species** under Schedule 1 of the of the New South Wales *Threatened Species Conservation Act, 1995*. The species is also listed as an **Endangered Species** on Schedule 1 of the Commonwealth *Endangered Species Protection Act, 1992*.

General description

P. affine is a terrestrial herb that grows to a height of 50cm with a single leaf of the same length. The flowers are strongly scented and maybe green, red, brown or purple. Flowers are apparent from November to December, but may appear earlier due to the effects of fire. A photograph of *P. affine* can be found in Bishop (1996) and an illustration can be found in Bernhardt & Rowe (1993).

Scientific description

The leek orchid *P. affine* (Orchidaceae) is a terrestrial herb to 50cm high with a single, erect leaf (to 50 cm long) which is thin and terete. The inflorescence is usually 40-flowered and moderately dense. The strongly scented thick textured flowers are coloured with tints of green, red, brown and purple. Dorsal sepals ovate to lanceolate, 9-12mm long. Lateral sepals to 12 mm long, leathery, joined or partly free but not diverging, margins incurved. Lateral petals linear to oblong, 8-10mm long, horizontal, apex incurved, acute. Labellum on a thick claw, green to purple-red, lamina, ovate to lanceolate, recurved at 90°, often constricted near the middle, margins entire. Callus plate green to purple, triangular, glistening, occupying most of the recurved part of the labellum. Column wings falcate, c. 3mm long, truncate, red or green; rostellum short and broad (Bernhardt & Rowe 1993).

P. affine is very similar to *P. appendiculatum*, *P. frenchii* and *P. litorale*. These three species can be distinguished from *P. affine* by their callus plate which ceases well before the labellum apex. *P. affine* is also similar to *P. fuscum* which is confined to the Blue Mountains and Hawkesbury Sandstone. *P. fuscum* can be distinguished by its thinner-textured and less crowded flowers (Bishop 1996).

Distribution

The only known surviving population of this species occurs on private land in the Kinghorn Point-Currarong area of south-east NSW (J. Briggs pers. comm.).

Recorded occurrences in conservation reserves

P. affine is not currently known to occur within any conservation reserves (Briggs & Leigh 1996).

Habitat

P. affine grows in coastal heathland on grey-brown silty soils and avoids swampy habitats (Bernhardt & Rowe 1993; Bishop 1996).

Ecology

P. affine flowers from November to December and flowers more freely after fire (Bernhardt & Rowe 1993). Fire stimulation of flowering is common within the genus (Jones 1993). Like other *Prasophyllum* this species has a dormant phase. Plants are dormant during summer and sprout after good autumn rains to produce a slender tubular leaf. The flowering spike emerges from this leaf later. Individual plants maintain themselves by producing a new tuber each year. Most species of *Prasophyllum* seem to reproduce by seed (Jones 1993).

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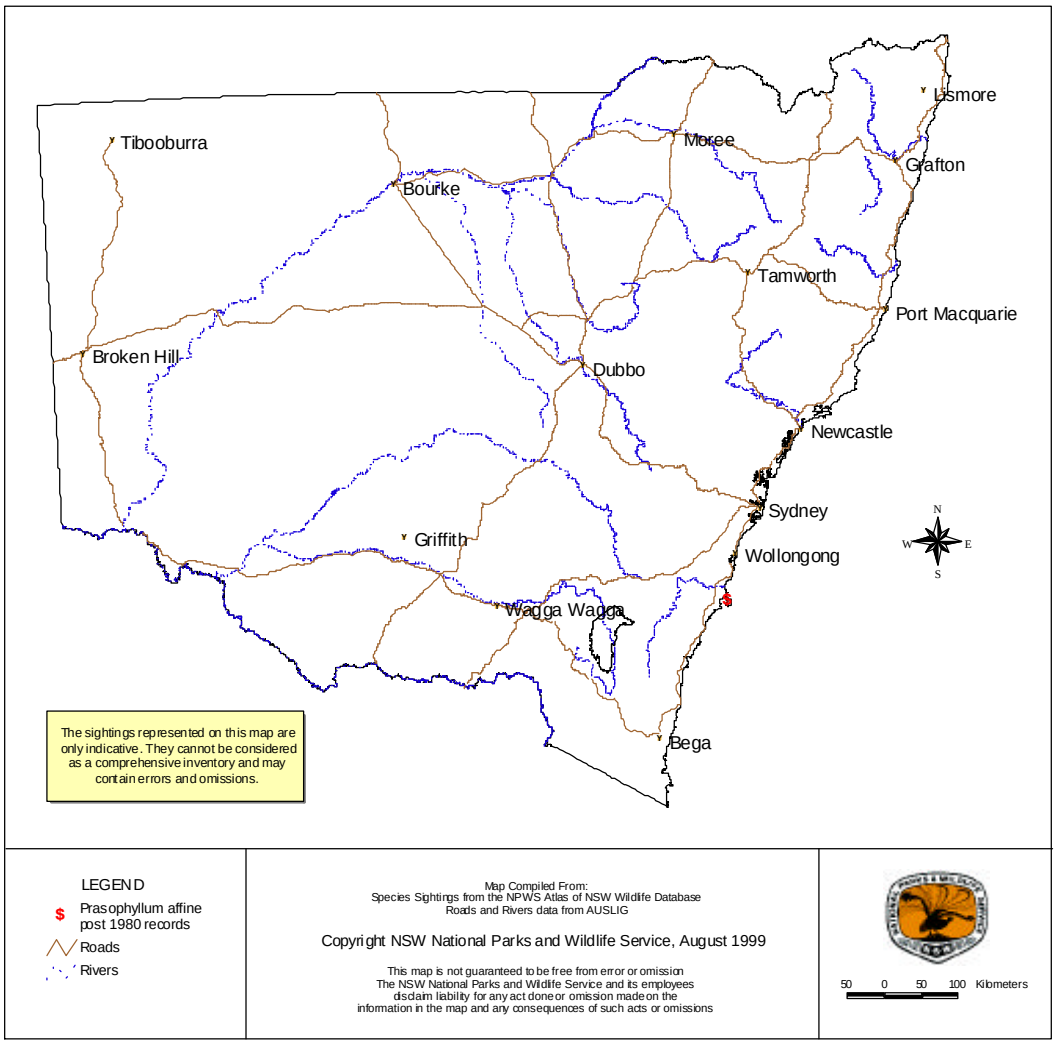

NPWS records *Prasophyllum affine* in NSW

Threats

The only known surviving population of*P. affine* is highly vulnerable to a change in land use. The site is currently subject to low intensity stock grazing. Future potential land uses include rural residential development and higher intensity agricultural production (pasture improvement, etc.).

Management

Negotiations with the landowner and local government are required to ensure the site is adequately protected in the future.

Recovery plans

A recovery plan has not been prepared for *P. affine*.

References

Bernhardt P. and Rowe R.R. 1993. Prasophyllum, in G.J. Harden (Ed.) Flora of New South Wales Volume 4: 155-163. New South Wales University Press, Kensington.

Bishop T. 1996. Field guide to the orchids of New South Wales and Victoria. UNSW Press, Sydney.

Briggs J.D. and Leigh J.H. 1996. Rare or threatened Australian plants. CSIRO Publishing, Australia.

Jones D.L. 1993. Native Orchids of Australia. Reed Books, Australia.

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General enquiries: 43 Bridge St Hurstville NSW 2220 Phone 1300 36 1967 or 02 9585 6333.
Web site www.npws.nsw.gov.au

NSW NATIONAL PARKS AND WILDLIFE SERVICE

Regent Honeyeater

***Xanthomyza phrygia* (Shaw, 1794)**

Other common names None

Conservation status

The Regent Honeyeater is listed as an **Endangered Species** on Schedule 1 of the New South Wales *Threatened Species Conservation Act, 1995* (TSC Act). This species is also listed as an **Endangered Species** on Schedule 1 of the Commonwealth *Endangered Species Protection Act, 1992*.

Description (summarised from Menkhorst 1993)

Length
200-220mm
Wingspan
mm
Tail
mm
Bill
mm
Tarsus
mm
Weight
41-46g

The Regent Honeyeater is a medium-sized honeyeater with black, white and bright yellow plumage. Black plumage is dominate on the head, neck, breast and back are predominately black. The black plumage on the wings is edged with white and the outer feathers are bright yellow.
A distinguishing, large patch of bare, cream-coloured warty skin surrounds each eye.

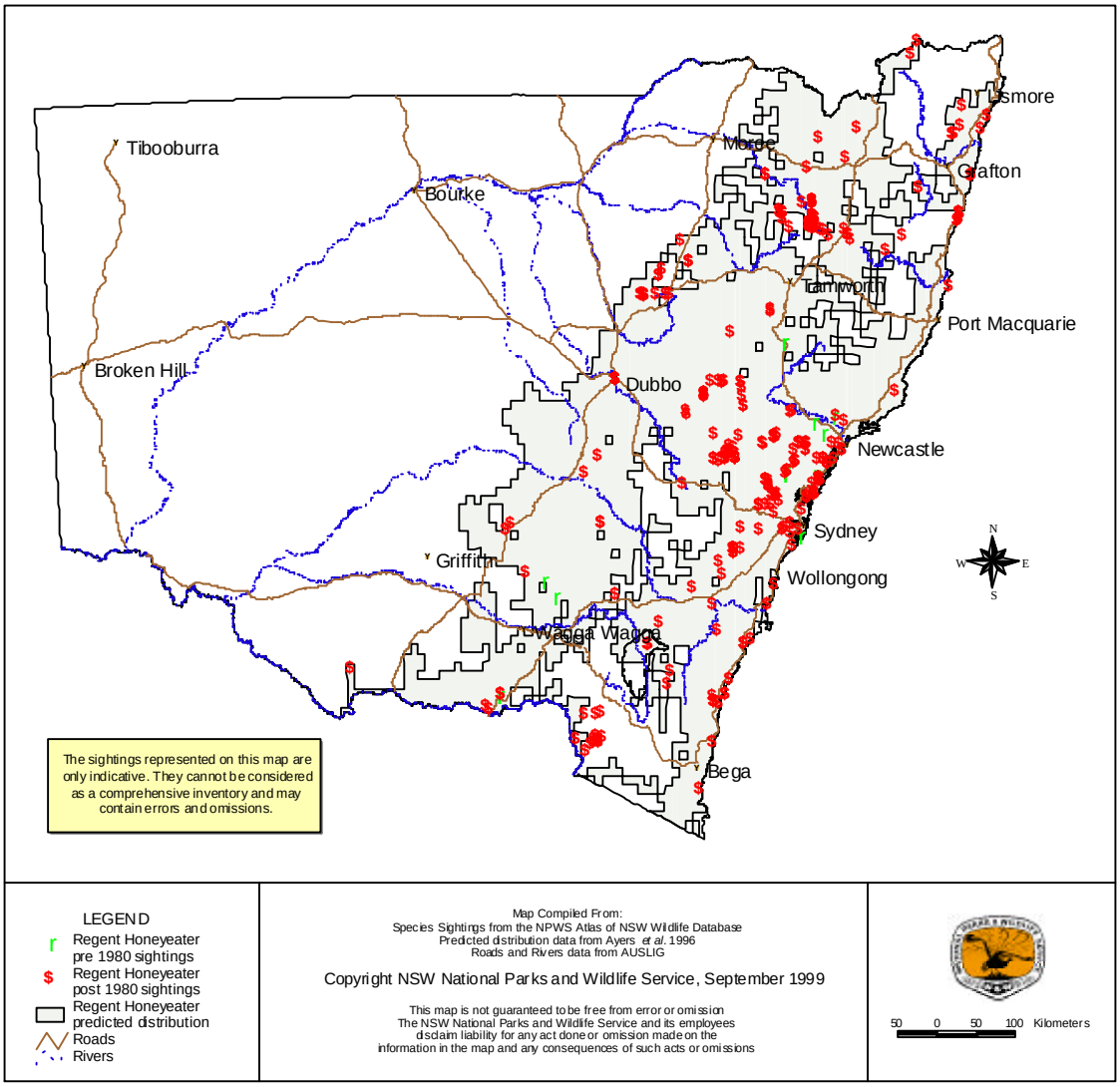
Distribution

Historically this species was distributed from Kangaroo Island in South Australia along the eastern coastline of Victoria and NSW, to Dalby in Queensland and from the coast to the western slopes of the Great Dividing Range as far inland as Narrabri, Parkes and Warrumbungle National Park (Peters 1979). However, the species has declined greatly in numbers and disappeared from some parts of its former range as a result of clearing of large areas for agriculture (Blakers *et al.* 1984).

Though the species is widely dispersed, the range of this once abundant honeyeater has contracted dramatically (UBBS 1996). The species distribution is now extremely patchy, with the population having declined to less than 1500 individuals (NPWS 1997). There are now only a small number of known breeding sites in NSW, the most important of which are: Warrumbungles NP, Pilliga NR, Barraba district, central coast around Gosford, Hunter Valley, and Capertee Valley (UBBS 1996; Ayers*et al.* 1996; NPWS 1997).

Regent Honeyeater

NSW NATIONAL PARKS AND WILDLIFE SERVICE



NPWS records of the Regent Honeyeater in NSW

In 1994, the largest aggregate of birds since the 1900s (approximately 152), was located in the Capertee valley during the 1995 breeding season (Ayers *et al.* 1996).

Recorded occurrences in conservation reserves

Munghorn Gap NR, Pilliga NR, Cocklebay NR, The Charcoal Tank NR, Yengo NP, Warrumbungle NP, Wollemi NP, Scheyville NP, Goulbourn River NP, Broadwater NP, Bundjalung NP, Yuraygir NP, Nattai NP, Brisbane Waters NP, Ingalba NP, Hat Head NP, Royal NP, Seven Mile Beach NP (NPWS 1999).

Habitat

The Regent Honeyeater is a semi-nomadic species which occurs in temperate eucalypt woodlands and open forest in south-eastern Australia (Pizzey 1980). Most records of the species are from box-ironbark eucalypt associations, and wet lowland coastal forests dominated by Swamp Mahogony, Spotted Gum and Riverine Casuarina woodlands (NPWS 1997). Remnant stands of timber, roadside reserves, travelling stock routes and street trees also provide important habitat at certain times (Ayers *et al.* 1996).

Ecology

The Regent Honeyeaters diet comprises of nectar and arthropods. Studies undertaken by Webster &Menkhorst (1992) indicate the main dietary item is nectar taken from 16 species of eucalypt and 2 species of mistletoe. However, the most frequent nectar sources are 3 species of eucalypt; Red Ironbark, White Box and Yellow box (Webster & Menkhorst 1992).

Nests are frequently located in Red Ironbark and Red River Gum but may also be in other eucalypts, mistletoe clumps and casuarinas. During the breeding season which occurs between July and November, 1-3 eggs are laid and incubated for a period of bzzzt days. Fledgling success may be dependant on the abundance of nectar from eucalypt flowers, predation and nests being damaged or blown down (Webster & Menkhorst 1992)

Threats

- Loss of habitat and fragmentation of habitat through clearing for agriculture, fenceposts and firewood, particularly in box-ironbark woodlands
- Slow incremental reduction in tree age classes
- Reduction in large flowering eucalypts in woodlands
- Grazing by domestic stock and rabbits prevents habitat regeneration
- Competition with other honeyeater species
- Tree decline and dieback on rural properties

Management

- Protection and maintenance of known or potential habitat, including the implementation of protection zones around recent records
- Control of feral animals around potential habitat areas, specifically targeting foxes

Recovery plans

A recovery plan has not been prepared for the species.

References

Ayers D., Nash S. and Baggett K. 1996. Threatened Species of Western NSW. NPWS, Hurstville.

Blakers M., Davies S. J. J. F. and Reilly P. N. 1984. The Atlas of Australian Birds. Melbourne University Press, Victoria.

Garnett S. 1992. Threatened and Extinct Birds of Australia. Royal Australian Ornithologists Union and Australian National Parks and Wildlife Service, Canberra.

Urban Bushland Biodiversity Study 1996. Draft Fauna Technical Report. NPWS, Hurstville.

Peters D. E. 1979. Some evidence for a decline in population status of the Regent Honeyeater. *Australian Bird Watcher* 8: 117-123.

NPWS 1997. Draft species recovery plan for the Regent Honeyeater *Xanthomyza phrygia*. NPWS, Hurstville.

NPWS 1999. Atlas of NSW Wildlife. NPWS, Hurstville.

Marchant S. J. S. and Higgins P. J. (Eds) 1993. Handbook of Australian, New Zealand and Antarctic Birds Volume 2: Raptors to Lapwings. Oxford University Press, Melbourne.

Pizzey G. 1980. A field guide to the Birds of Australia. Collins, Sydney.

Webster and Menkhorst 1992.

For further information contact

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NSW NATIONAL PARKS AND WILDLIFE SERVICE

Rhizanthella slateri (an underground orchid) - vulnerable species listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the underground orchid *Rhizanthella slateri* (Rupp) M. A. Clem. and P. J. Cribb as a VULNERABLE SPECIES in Schedule 2 of the Act. Listing of vulnerable species is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. *Rhizanthella slateri* (Rupp) M. A. Clem. and P. J. Cribb (family Orchidaceae) is described in Harden (1993, Flora of New South Wales, Vol 4, page 219, UNSW Press, Kensington) as a 'Terrestrial saprophytic herb with fleshy underground stem to 15 cm long and 15 mm diam., whitish, often branching, with prominent, fleshy, overlapping bracts. Flowering heads maturing below the soil surface or extending 2 cm above the ground, to c. 2 cm diam., the receptacle of up to 18 whitish triangular bracts to 8 mm long; flowers up to 30, tubular, purplish. Dorsel sepal curved, the tip narrowing linear to filiform, the base broad and hooding the column and most of the 2 lateral petals; lateral sepals erect, broad at base but each lateral sepal folding lengthwise into a filiform tip longer than the dorsal sepal and often protruding beyond the length of bracts making the cup. Lateral petals about half the length of the lateral sepals. Labellum claw a short, flexible hinge; labellum lamina cordate, thick, tongue-like with the upper surface covered with fine papillae. Column short and broad with column wings reduced to narrow, papillose 'ears'; anther broad and curving, stigma a thickened pad. Flowers Oct-Nov.'

2. *Rhizanthella slateri* ranges from southeastern Queensland to the south coast of NSW. In NSW, it is currently only known from fewer than 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. At each location, only a few individuals are known. However, *Rhizanthella slateri* is difficult to detect, it is usually located when the soil is disturbed, and there may well be more locations of the species within its known range. The species grows in eucalypt forest but no informative assessment of the likely preferred habitat for the species is available.

3. Habitat disturbance has threatened the survival of the species at some of the known sites. One known site is subject to potential clearing for road construction. The small population size at known locations may make the species threatened by stochastic events.

In view of the above the Scientific Committee is of the opinion that *Rhizanthella slateri* (Rupp) M. A. Clem. and P. J. Cribb is likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Proposed Gazettal date: 06/12/02

Exhibition period: 06/12/02 – 24/01/03

TAXON SUMMARY

Sooty Owl (Australian)

1	Family	Tytonidae
2	Scientific name	*Tyto tenebricosa tenebricosa* (Gould, 1845)
3	Common name	Sooty Owl (Australian)
4	Conservation status	Least Concern

5 Reasons for listing

Most suitable habitat within the historical range of this subspecies is uncleared and surveys have shown that current logging practices do not reduce Sooty Owl density in at least 50% of their range. There are at least two sub-populations, one of which contains more than 1,000 mature individuals (so not Vulnerable: C, even were the population found to be declining).

	Estimate	*Reliability*
Extent of occurrence	*230,000 km²*	*medium*
trend	*stable*	*high*
Area of occupancy	*50,000 km²*	*low*
trend	*stable*	*medium*
No. of breeding birds	*10,000*	*low*
trend	*stable*	*medium*
No. of sub-populations	*2*	*medium*
Largest sub-population	*9,700*	*low*
Generation time	*5 years*	*low*

6 Infraspecific taxa

T. t. arfaki of New Guinea is the only other recognised subspecies. Global status of species is Least Concern.

7 Past range and abundance

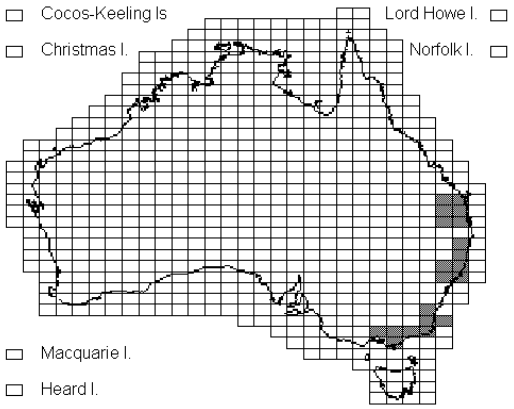
Disjunct distribution through coastal and near-coastal eastern Australia, between Clarke Ra., central Qld, and Kinglake National Park, Dandenong and Strzelecki Ra., Vic. (Schodde and Mason, 1980, Higgins, 1999).

8 Present range and abundance

Although the overall distribution of Sooty Owls is little changed, there have been local declines and extinctions, particularly from Big Scrub area, northern N. S. W. and probably central Gippsland, Vic. In north-east New South Wales, both numbers and area occupied (now ca. 3,000-3,500 pairs) are estimated to be at 80% of pre-European levels (Debus, 1994, Kavanagh *et al.*, 1995, NSW NPWS, 1998). In Victoria, fewer than 800 (and probably 500) individuals (Silveira, 1997, Higgins, 1999). Estimated 175 individuals in 3,200 km² of State Forest and National Park in south-eastern New South Wales (Kavanagh, 1997).

9 Ecology

Sooty Owls live in wet eucalypt forest and rainforest that grows on fertile soils, where there are tall emergent trees. They are most frequently found in tall old-growth forests, with a dense understorey, but may also live in younger forests if there are suitable nesting trees nearby (Higgins, 1999). Suitable habitat is largely confined to gullies and valley slopes (Smith, 1984a, Kavanagh and Jackson, 1997). Optimal habitat contains tall eucalypts with large hollows suitable for nesting and roosting, but also a range of hollows that provide shelter for prey (Milledge and Palmer, 1990). The same nest is used repeatedly, and the owls also roost, and occasionally nest, in caves (Hyem, 1979, Schodde and Mason, 1980, Hollands, 1991). Within forests, Sooty Owls hunt in both open and closed forest, but apparently avoid clearings (Loyn *et al.*, 1986, Lundie-Jenkins, 1993). Their diet is dominated by a range of arboreal and terrestrial mammals, including introduced species in disturbed areas, as well as some birds (Schodde and Mason, 1980, Smith, 1984b, Loyn *et al.*, 1986, Lundie-Jenkins, 1993, Holmes, 1994, Higgins, 1999).



10 Threats

Clearance of habitat for agriculture is likely to have adversely affected Sooty Owls, with some of the remaining habitat fragmented or degraded by logging, burning, dieback and urbanisation (Lundie-Jenkins, 1993, Kavanagh and Peake, 1993, Chafer and Anderson, 1994, Debus, 1994, Kavanagh and Jackson, 1997). In the Victorian Mountain Ash *Eucalyptus regnans* forests, the Sooty Owl is mainly found in forest that has not been logged or burnt for over 150 years (Milledge and Palmer, 1990, Milledge *et al.*, 1991). However, more than 50% of former habitat still remains uncleared and un-fragmented, and in northern New South Wales, the owl's presence is either independent of logging history, or associated with logged sites that have few old, hollow trees.

Recolonisation of 20 year old regrowth has been described (Kavanagh *et al.*, 1995). This apparent discrepancy may be related to differences in either floristic diversity with the Mountain Ash forests studied being less diverse than those studied elsewhere, or in logging practices (Kavanagh *et al.*, 1995). Listing at a State level may be warranted because of low regional numbers.

11 Recommended actions

11.1 Undertake follow-up surveys in N. S. W. forests to determine trends in abundance and baseline surveys in forests of south-east Qld.

12 Bibliography

Chafer, C. J. and Anderson, M. 1994. Sooty Owls in the Hacking R. catchment. *Aust. Birds* 27:77-84.

Debus, S. J. S. 1994. The Sooty Owl *Tyto tenebricosa* in New South Wales. *Aust. Birds* 28 (Suppl.):S4-S19.

Higgins, P. J. (ed.) 1999. *Handbook of Australian, New Zealand and Antarctic Birds. Vol. 4. Parrots to Dollarbird.* Oxford University Press, Melbourne.

Hollands, D. 1991. *Birds of the Night.* A. H. and A. W. Reed, Sydney.

Holmes, G. 1994. Prey of the Sooty Owl in subtropical Queensland. *Sunbird* 24:25-27.

Hyem, E. L. 1979. Observations on owls in the Upper Manning district, N. S. W. *Corella* 3:17-25.

Kavanagh, R. P. 1990. Survey of Powerful and Sooty Owls in south-eastern New South Wales. Final Report to the World Wildlife Fund. Project 120.

Kavanagh, R. P. and Jackson, R. 1997. Home range, movements, habitat and diet of the Sooty Owl *Tyto tenebricosa* near Royal National Park, Sydney. Pp. 2-13 in *Australian Raptor Studies II.* G. Czechura and S. Debus (eds). *Birds Australia Monograph 3.* Birds Australia, Melbourne.

Kavanagh, R. P., Debus, S. J. S., Tweedie, T. and Webster, R. 1995. Distribution of nocturnal forest birds and mammals in north-eastern New South Wales: relationships with environmental variables and management history. *Wildl. Res.* 22:359-377.

Loyn, R. H., Traill, B. J. and Triggs, B. 1986. Prey of Sooty Owls in East Gippsland before and after fire. *Vic. Nat.* 103:147-149.

Lundie-Jenkins, G. 1993. The diet of the Sooty Owl *Tyto tenebricosa* in the Blue Mountains, N. S. W. *Emu* 93:124-127.

Milledge, D. R. and Palmer, C. L. 1990. The Sooty Owl in Mountain Ash Forests in the Victorian Central Highlands. Report to the Department of Conservation and Environment, Melbourne.

Milledge, D. R., Palmer, C. L. and Nelson, J. L. 1991. "Barometers of change": The distribution of large owls and gliders in Mountain Ash forests of the Victorian Central Highlands and their potential as management indicators. Pp. 53-65 in *Conservation of Australia's Forest Fauna*. D. Lunney (ed.). Royal Zoological Society of New South Wales, Sydney.

NSW NPWS 1998. Large Forest Owls Northern Regional Recovery Plan. NSW National Parks and Wildlife Service, Coffs Harbour.

Schodde, R. and Mason, I. J. 1980. *Nocturnal Birds of Australia.* Lansdowne, Melbourne.

Silveira, C. E. 1997. Targeted assessments of key threatened vertebrate fauna in relation to the North-east and Benalla-Mansfield Forest Management Area (NE FMA), Victoria: Powerful Owl *Ninox strenua*. Report to Arthur Rylah Institute, Heidelberg.

Smith, P. 1984a. Forest avifauna near Bega I. Differences between forest types. *Emu* 84:200-210.

Smith, P. 1984b. Prey items of the Sooty Owl and Barn Owl at Bega, New South Wales. *Corella* 8:71-72.

Comments received from

Stephen Debus, Rod Kavanagh, Peter Menkhorst, Penny Olsen.

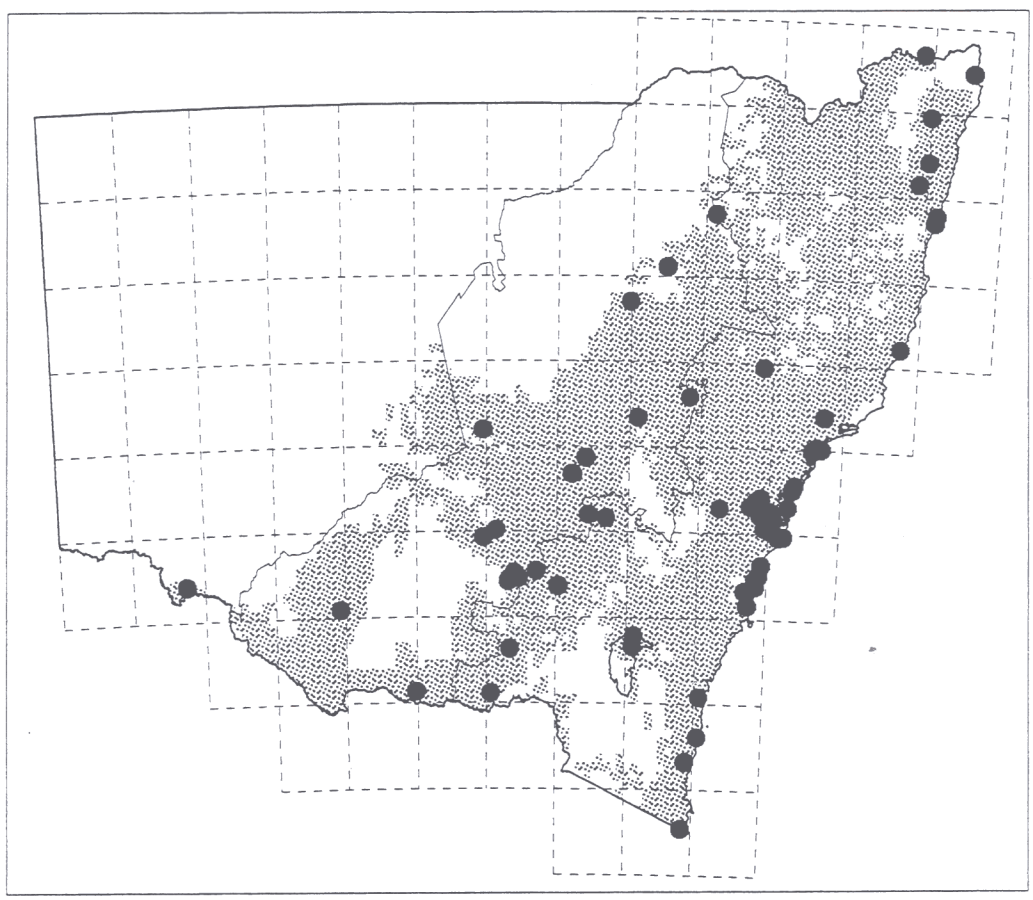
Swift Parrot

Lathamus discolor

Species Code 0309

TSC Act status Vulnerable
National status Vulnerable

Distribution



The Swift Parrot breeds in Tasmania and its nearby islands (including the Furneaux group) and migrates to mainland Australia to feed during winter (Slater *et al.* 1986). On the mainland they inhabit suitable areas between the Mount Lofty Ranges (South Australia) and south-eastern Queensland. Within NSW these parrots are mostly found in the south-east (Sydney-ACT region) but do occur inland as far as Ivanhoe, Griffith and Warialda (Pizzey 1980). Generally regarded as an infrequent visitor to the Western Zone (P. Ewin pers. comm.).

Ecology Swift Parrots migrate to south-eastern mainland Australia in February-April to feed on winter blossoms and return to breed in Tasmania between September and November. On the mainland they occur in a wide variety of habitats, depending on where there are flowering blossoms. Drier sclerophyll forests and woodlands, other timbered countries, plantations, parks, gardens or city streets and occasionally green grasslands are all used by these birds (Pizzey 1980, Simpson and Day 1993). They feed alone and in parties, mostly within the topmost branches of

eucalypt trees, often hanging upside down to reach the blossoms (Reader's Digest 1986). Principal foods are eucalypt nectar and pollen, as well as sugary lerps, although banksia nectar, insects and their larvae (weevils and caterpillars), seeds (e.g. grass), fruits and berries (including cultivated species) and some vegetative matter are also eaten (Pizzey 1980). These parrots only venture onto the ground when drinking and feeding on fallen seeds and flowers (Reader's Digest 1986). Wintering flocks of Swift Parrots are nomadic in response to the availability to blossoms and other food sources. If sufficient food is available they may remain within the same district for about a week, returning to the same tree each night to roost (Pizzey 1980).

Threats

Clearing - of food trees in particular is likely to constitute the major threat to this species within mainland Australia. Removal of significant numbers of such trees from an area are likely to cause these nomadic birds to feed in other districts. However, given the infrequency with which these birds visit the Western Zone of NSW, even this is not likely to be a major threat.

Trapping - some birds may be trapped for the bird trade during the non-breeding season (Garnett 1992).

Sydney Coastal Estuary Swamp Forest Complex in the Sydney Basin Bioregion - endangered ecological community listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Sydney Coastal Estuary Swamp Forest Complex in the Sydney Basin Bioregion as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule 1 of the Act. The listing of Endangered Ecological Communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. The Sydney Coastal Estuary Swamp Forest Complex is the name given to the plant community characterised by the assemblage of species listed in paragraph 3 that is a mosaic of vegetation types occurring on waterlogged estuarine alluvial soils and strongly influenced by periodically poor drainage conditions. All sites are within the Sydney Basin Bioregion.

2. Sydney Coastal Estuary Swamp Forest Complex includes vegetation described as Coastal Swamp Forest Complex (Map unit 27a) in Benson & Howell (1994), and referred to in Adam & Stricker (1993) and Smith & Smith (1997). Sydney Coastal Estuary Swamp Forest Complex is part of the alluvial forest of Chafer (1997).

3. Sydney Coastal Estuary Swamp Forest Complex is characterised by the following assemblage of plant species

- Acacia longifolia;
- Baumea juncea;
- Blechnum camfieldii;
- Blechnum indicum;
- Calochlaena dubia;
- Carex appressa;
- Casuarina glauca;
- Darwinia procera;
- Dodonaea triquetra;
- Eucalyptus botryoides;
- Eucalyptus robusta;
- Gahnia clarkei;
- Gahnia sieberiana;
- Glochidion ferdinandi;
- Hydrocotyle peduncularis;
- Hypolepis muelleri;
- Imperata cylindrica;
- Isachne globosa;
- Livistona australis;
- Melaleuca biconvexa;

- Melaleuca ericifolia;
- Melaleuca linariifolia;
- Melaleuca styphelioides;
- Persicaria strigosa;
- Phragmites australis;
- Pteridium esculentum;
- Triglochin procera;
- Typha orientalis;
- Villarsia exaltata; and
- Viola hederacea.

4. The total species list of the flora and fauna of the community is considerably larger than that given in 3 (above), with many species present in only one or two sites or in very small quantity. In any particular site not all of the assemblage listed above may be present. At any one time, propagules and seeds of some species may only be present in the soil seed bank with no above-ground individuals present. Invertebrate species may be restricted to sediments or canopy trees and shrubs for example. The species composition of the site will be influenced by the size of the site and by its recent disturbance history. The number of species and the above-ground composition of species will change with time since fire, and may also change in response to changes in fire frequency. The community includes animals and invertebrates many of which are poorly known.

5. Sydney Coastal Estuary Swamp Forest Complex is a mosaic ranging from forest to scrub to reedland and includes open-forest with Eucalyptus robusta and Eucalyptus botryoides, woodland with Livistona australis, scrub with Melaleuca species including Melaleuca linariifolia, Melaleuca styphelioides and Melaleuca ericifolia, herbland with waterferns and reedland with Phragmites australis. Casuarina glauca may occur as a component of this community [but pure Casuarina glauca forests are a separate community, as are mangroves and saltmarsh].

6. Sydney Coastal Estuary Swamp Forest Complex occurs on waterlogged estuarine alluvial soils strongly influenced by periodically poor drainage conditions such as soils of the Cockle Bay, Tacoma Swamp and Warriewood Soil Landscapes (Chapman & Murphy 1989, Murphy 1993). It may grade into Sydney Coastal Riverflat Forest which generally occurs on higher land or away from the estuary. It may grade into Casuarina glauca, Juncus saltmarsh and mangrove communities in areas subject to regular tidal inundation. It differs from Sydney Coastal Freshwater Swamp in having a more silty site and higher nutrients, and generally less open standing water.

7. Sydney Coastal Estuary Swamp Forest Complex is or has been known to occur in the local government areas of Lake Macquarie, Wyong, Gosford, Baulkham Hills, Pittwater, Warringah, Liverpool, Rockdale, Sutherland, Wollongong, Shellharbour and Kiama, but may occur elsewhere in the Sydney Basin Bioregion.

8. Sydney Coastal Estuary Swamp Forest Complex has been reported from Swansea, Porters Creek Wetland, Wyong River floodplains, Lisarow wetlands, Erina Creek, Bensville, Middle and Deep Creeks and Narrabeen Lagoon, Dee Why Lagoon, Voyager Point, Leo Smith Reserve Ramsgate, Kurnell,

Bundeena and Mill Creek, Bellambi Lagoon, Fairy Creek, Wollingurry Swamps (Duck Creek), Dunmore Wetlands (Shellharbour) and Minnamurra Wetlands (Kiama) but may occur elsewhere.

9. Disturbed remnants are still considered to form part of the community described under this determination where the natural soil and associated seedbank is partially intact. At some sites changes to hydrology or drainage might be required to assist regeneration.

10. Sydney Coastal Estuary Swamp Forest Complex has been extensively cleared and filled for recreational purposes - playing fields, car parks and roads. Remnants are threatened with waste filling, clearing associated with urban development, urban runoff associated with proximity to urban and agricultural areas, weed invasion including Ludwigia peruviana, Ipomoea cairica and Anredera cordifolia, and by grazing and trampling, including by deer.

11. Small areas of the Sydney Coastal Estuary Swamp Forest Complex has been reported from Cockle Bay Nature Reserve, and Garigal and Royal National Parks.

12. Plant species of conservation significance reported for Sydney Coastal Estuary Swamp Forest Complex include Melaleuca biconvexa and Darwinia procera. As a winter flowering plant Eucalyptus robusta is particularly important to fauna. Animals of conservation significance include Australasian Bittern, Botaurus poiciloptilus and Large Footed Myotis, Myotis adversus.

13. In view of the small size of existing remnants, and the threat of further disturbance and degradation, the Scientific Committee is of the opinion that the Sydney Coastal Estuary Swamp Forest Complex in the Sydney Basin Bioregion is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

References

Adam, P & Stricker, J (1993) Wetlands of the Sydney Region National Estates Grants Programme. Project no 55. Report by Nature Council of NSW.

Benson, D. & Howell, J. (1994) The natural vegetation of the Sydney 1:100 000 map sheet Cunninghamia 3(4): 679-787.

Chafer, C.J. (1997) Biodiversity of Wetlands in the Illawarra Catchments: an inventory. Illawarra Catchment Management Committee, Wollongong.

Chapman, G.A. & Murphy, C.L. (1989) Soil landscapes of the Sydney 1:100 000 sheet. Soil Conservation Service of N.S.W., Sydney.

Murphy, C.L. (1993). Soil landscapes of the Gosford-Lake Macquarie 1:100 000 sheet Report. Dept of Conservation and Land Management, Sydney.

Smith, P. & Smith, J. (1997) Interim report on natural area survey of Warringah's bushland. P & J Smith

Threatened Species Information

White-footed Dunnart

Sminthopsis leucopsis

Conservation Status

The White-footed Dunnart is listed as a **Vulnerable Species** under the NSW *Threatened Species Conservation Act 1995* (TSC Act).

Description

The White-footed Dunnart is small carnivorous marsupial with a finely pointed muzzle that is darker on top and greyish-buff underneath. The underparts of this species are a pale grey and a warmer buff on the side of the head. The tail is thin and slightly bicoloured in the same shade as the rest of the body (Menkhorst and Knight 2001).

Distribution

The White-footed Dunnart is patchily distributed throughout lowland healthy woodland and forest, coastal scrub and coastal dune grassland in south-eastern New South Wales, south Victoria and Tasmania. An isolated population of this species also occurs in upland rainforest in the Paluma area of north-east Queensland (Menkhorst and Knight 2001).

Habitat

The White-footed Dunnart occurs in open understorey and low density vegetation in south-eastern Australia. Dunnarts feed on a wide variety of terrestrial invertebrates commonly found in ridges and in gullies in both logged and unlogged forest. The White-footed Dunnart has the ability to travel long distances to find suitable habitat and often occurs in recently disturbed forest (Strahan 1995).

Ecology

The White-footed Dunnart is a nocturnal species that feeds on arthropods and small skinks and lives in bark nests beneath fallen timber or dense litter. Breeding for this species occurs from August to September with up to ten young born (Strahan 1995; Menkhorst and Knight 2001).

References

Menkhorst, P. and Knight, F. (2001) **A Field Guide to the Mammals of Australia** Oxford University Press, South Melbourne, Australia

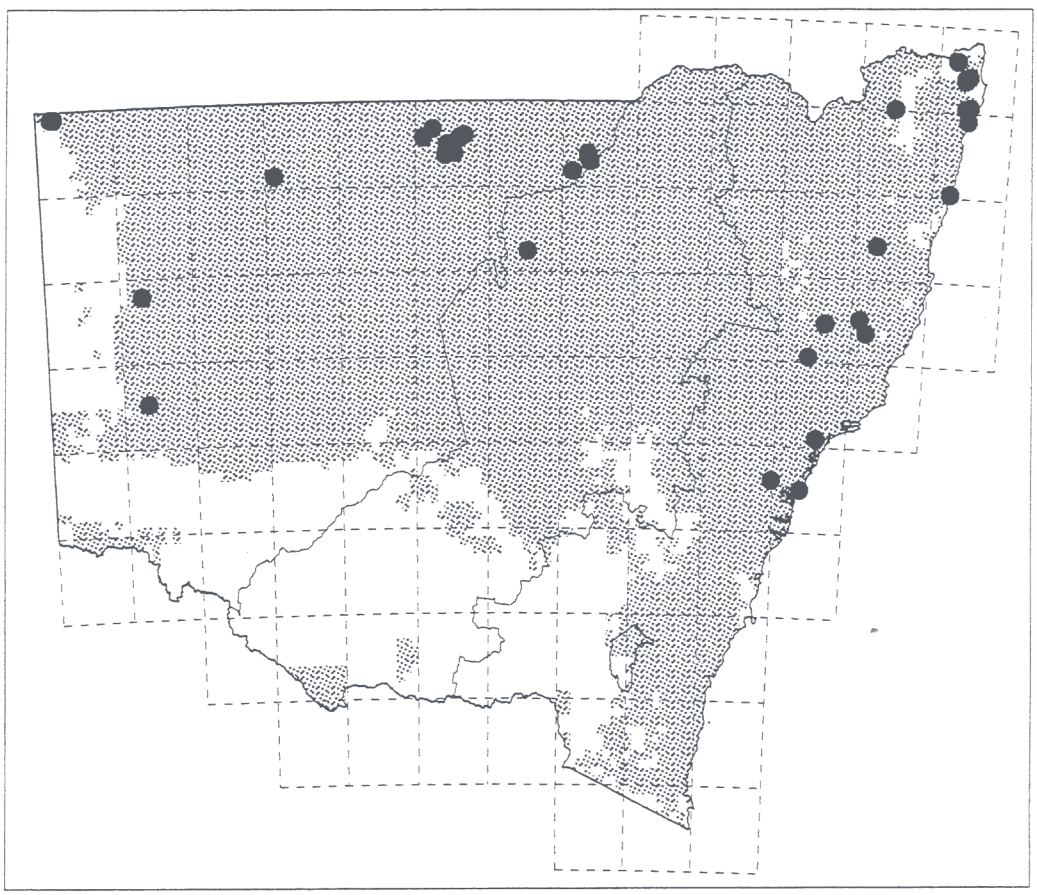
Strahan, R. (ed) (1995) **Mammals of Australia** Australian Museum**,** Reed New Holland, Sydney, Revised Edition

Yellow-bellied Sheathtail-bat

Saccolaimus flaviventris

Species Code 1321 **TSC Act status** Vulnerable

Distribution



Widespread across eastern and northern Australia but rarely recorded because of its high and rapid flying habit (Dickman *et al.* 1993, Richards 1995a). Recently caught around watering points in a variety of semi-arid woodlands east of Enngonia and at several sites between Bourke, Walgett and Collarenebri. Identifications from calls indicate the species may be more common than previously thought. May be a seasonal visitor to Victoria (Richards 1995a).

Ecology Yellow-bellied Sheathtail-bats occur in most wooded habitats. During the day they roost in large tree hollows and sometimes also the abandoned nests of Sugar Gliders (Richards 1995a). At night they forage for airborne insects (largely beetles and moths) above the canopy, although in open woodlands and mallee country they also feed closer to the ground (Hall and Richards 1979, Richards 1995a). In the southern portion of its range it is thought to undergo a winter migration to warmer areas. During this time it has been recorded from a variety of other habitats, and has been

observed resting on the walls of buildings in daylight (Richards 1995a). The population is suspected to be reduced (Lunney *et al.* 1995).

Threats
Clearing - of old trees with hollows eliminates roosting sites.

Grazing - at severe levels may reduce regeneration of roost trees.

Predation - by feral cats at roost sites may have localised impacts.

Annex F

AMG

VINCENTIA SPECIES IMPACT STATEMENT
AMG CO-ORDINATES OF SURVEY LOCATIONS

Survey Site	Residential or Commercial Site	Easting	Northing	Easting	Northing
FLORA					
Vegetation Quadrats					
1	Residential	286035	6117144		
2	Residential	285479	6116723		
3	Residential	285559	6116968		
4	Residential	285889	6116713		
5	Residential	286111	6116225		
6	Residential	286058	6116378		
7	Residential	286242	6116322		
8	Residential	285529	6116609		
9	Residential	285752	6116664		
10	Residential	285727	6116921		
11	Residential	286417	6116186		
12	Residential	286633	6116356		
Orchids					
Transects 10 m apart	Commercial	286307	6115890	286842	6116403
Underground Orchid Transects					
	Residential	285475	6116789	285582	6116772
	Residential	285476	6116783	285582	6116752
	Residential	285617	6116704	285742	6116696
	Residential	285623	6116739	285722	6116736
	Residential	285696	6116601	285785	6116576
	Residential	285704	6116648	285781	6116602
	Residential	286140	6116398	286307	6116292
	Residential	286141	6116413	286309	6116298
	Residential	286470	6116605	286611	6116591
	Commercial	286475	6116626	286590	6116596
***Galium australe* Transects**					
	Residential	285840	6117158	285983	6117235
	Residential	285831	6117167	285974	6117243
	Residential	285525	6116504	285612	6116902
	Residential	285513	6116506	285601	6116904
	Residential	285781	6116342	286487	6116895
	Residential	285789	6116333	286495	6116886
	Commercial	286684	6116466	286651	6116730
	Commercial	286696	6116469	286663	6116732
Hollow-bearing Tree Count					
1	Commercial	286525	6115705	286627	6116759
2	Commercial	286665	6116582	286728	6116636
3	Residential	285709	6116465	285814	6116484
4	Residential	285484	6116638	285576	6116645
5	Residential	285544	6116732	285567	6116847
6	Residential	285532	6116931	285603	6116973
7	Residential	285657	6116812	285670	6116908
8	Residential	285590	6116582	285680	6116664
9	Residential	286111	6116193	286124	6116291
10	Residential	286019	6116264	286038	6116371
11	Residential	286074	6116506	286168	6116546
12	Residential	286182	6116320	286224	6116391
13	Residential	285771	6116609	285850	6116655
14	Residential	285725	6116709	285762	6116799
15	Residential	285767	6116903	285877	6116964

VINCENTIA SPECIES IMPACT STATEMENT
AMG CO-ORDINATES OF SURVEY LOCATIONS

Survey Site		Residential or Commercial Site	Easting	Northing	Easting	Northing
	16	Residential	285896	6116698	285978	6116749
	17	Residential	286255	6116636	286358	6116678
	18	Residential	285915	6117024	285990	6117100
	19	Residential	286051	6117123	286122	6117196
FAUNA						
Trapping						
	A1	Commercial	286820	6115998	286854	6115956
	A2	Commercial	286531	6115889	285498	6115798
	A3	Residential	286522	6116443	286443	6116372
	A4	Residential / Commercial	286425	6116307	286374	6116220
	A5	Residential	286035	6116360	286089	6116250
	A6	Commercial	285596	6116576	285511	6116742
	A7	Residential	285584	6116743	285960	6116688
	A8	Residential	286157	6117123	285996	6117225
	B1	Residential	286019	6116406	286109	6116244
	B2	Residential	285665	6116535	285527	6116798
	B3	Residential	285891	6116789	285992	6116690
	B4	Residential	286176		286066	6117156
	C1	Commercial	286820	6115998	286854	6115956
	C2	Commercial	285542	6115889	286509	6115798
	C3	Residential	286527	6116579	286468	6116489
	C4	Residential	285740	6116405	286051	6116188
	C5	Residential	285663	6116843	285566	6116730
Stagwatching/Spotlighting						
		Residential	286000	6117200		
		Residential	285955	6116394		
		Residential	285986	6116487		
		Residential	286176	6117156		
		Residential	285866	6116555		
		Residential	286414	6116913		
		Residential	-35.0688	150.659		
		Residential	-35.0685	150.659		
		Residential	-35.0722	150.654		
		Residential	-35.0744	150.653		
		Residential	285584	6116743		
		Residential	285500	6116800		
		Residential	286000	6116300		
Targeted surveys for Giant Burrowing Frog						
		Residential	285542	6116559	285635	6116929
		Residential / Commercial	285583	6116277	286461	6116038
		Residential	285635	6116929		
		Residential	285896	6116339	285955	6116394
		Residential	285896	6116339	285986	6115487
		Residential	285955	6116394	286061	6116620
		Residential	285986	6115487	286133	6116668
		Residential	285986	6116487	286061	611620
		Residential	286000	6117200	286310	6117153
		Residential	286061	6116620	286146	6116709
		Residential	286310	6117153	285635	611929

VINCENTIA SPECIES IMPACT STATEMENT
AMG CO-ORDINATES OF SURVEY LOCATIONS

Survey Site	Residential or Commercial Site	Easting	Northing	Easting	Northing
	Residential	286501	6116733	288380	6116822
	Commercial	286760	6116557	286627	6116350
	Residential	286955	6116394	285896	611339
	Residential	288380	6116822		
Birds					
Ground Parrot	Commercial	286425	6115768		
	Commercial	286480	6115700		
	Commercial	286480	6115910		
	Commercial	286480	6115996		
	Commercial	286480	6115700		
	Commercial	286480	6115900		
	Commercial	286500	6115700		
	Commercial	286730	6116150		
	Commercial	286730	6116500		
	Commercial	286740	6116150		
Eastern Bristlebird Transects					
	Residential	285470	6116450	285566	6116994
	Residential	285493	6116602	285503	6116995
	Residential	285500	6116400	285520	6116700
	Residential	285780	6116600	285920	6116420
	Residential	285830	6116473	286036	6116770
	Residential	285930	6116945	286170	6116770
	Residential	285935	6117115	286202	6116851
	Residential / Commercial	286298	6116601	286601	6116399
	Residential	286300	6116150	286600	6116400
	Residential / Commercial	286300	6116344	286601	6116399
	Residential / Commercial	286340	6115900		

Annex G

Bower 2004

FloraSearch

CONFIDENTIAL

POLLINATORS OF THE JERVIS BAY LEEK ORCHID, *Prasophyllum affine,* AT VINCENTIA, NSW – DISTRIBUTION AND MOVEMENTS

Prepared by Dr. C.C. Bower
for Environmental Resources Management Australia
Version 2, 1 May 2004

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SUMMARY

This section summarises the findings of the study in relation to the Project Brief.

Objective 1. *Determine and map the general distribution, abundance and movement patterns of the relevant* Ariphron *sp. and Pepsinae taxa across the subject site and adjacent areas that are likely to be the pollinators of* Prasophyllum affine *that occur on the subject site.*

- *Ariphron* sp. was confirmed as the dominant visitor to *Prasophyllum affine* flowers at the Leisure Centre site, accounting for six of the eleven potential pollinators captured.
- As in 2001, Spider Wasps (Pepsinae) comprised the next most important group of pollinators.
- *Ariphron* sp. was found to be widely but patchily distributed and locally abundant across the subject site. The populations of Pepsinae were too low for conclusions on distribution to be drawn.
- Male *Ariphron* sp. showed a high degree of faithfulness to their home breeding colony when patrolling for females. Home territories were about 15 to 25m long.
- Marked male *Ariphron* sp. were found to move over 200m from their breeding territories to feed on *Prasophyllum affine* in the Leisure Centre colony.

Objective 2. *Determine and map the key breeding / feeding areas and corridors across the subject site and adjacent areas*.

- The study successfully located the major breeding colonies of *Ariphron* sp. across the study site. These were generally in areas of thinned vegetation disturbed by minor vehicle tracks or firetrails with some containing relatively large populations.
- Two small breeding populations were found in undisturbed grassland within the main District Centre *Prasophyllum affine* colony. It is likely other small populations occur in undisturbed habitat on other parts of the site, but these are very difficult to detect.
- *Ariphron* sp. and Pepsinae were only seen feeding on *Prasophyllum affine* flowers. Searches of other flowering plants did not locate any other feeding hosts or feeding areas.
- Habitats suitable for *Ariphron* sp. are grassy woodlands dominated by Scribbly Gum, *Eucalyptus sclerophylla*, and Red Bloodwood, *Corymbia gummifera*.
- Habitats not suitable for *Ariphron* sp. are the wet sedgelands and the main gully. This means that the proposed corridor from the Leisure Centre *Prasophyllum affine* colony to Jervis Bay National Park is dominated by habitats unsuitable for colonisation by, or migration of, the main pollinator of *P. affine* at Vincentia. There appear to be no viable alternatives for this corridor; all potential routes in suitable habitat have been already broken by construction of the Leisure Centre.

Objective 3. *Determine the likely importance of each key feeding and breeding area to the* Prasophyllum affine *population on the subject site*.

- The most important *Ariphron* sp. breeding area for pollination of *Prasophyllum affine* was three breeding colonies located along a minor track running from the vicinity of the main Leisure Centre *P. affine* colony to the powerline 200m to the south west. Marked males from these colonies were found feeding on *P. affine* in the main colony.

- All other *Ariphron* sp. breeding areas appear to be too distant from *P. affine* populations to contribute significantly to pollination under current circumstances. Some of these populations, particularly those on the firetrail north of the Leisure Centre, may ultimately contribute to pollination if corridors equivalent to minor tracks are cut through intervening dense vegetation to the 'residential' *P. affine* population.

Objective 4. *Provide recommendations on the management of pollinator habitat in the context of commercial and residential development to ensure survival of the pollinator species in the area and thereby encourage the ongoing survival of* Prasophyllum affine *on the subject site*.

RECOMMENDATIONS

The three following recommendations constitute a minimum set of requirements to ensure the access of *Prasophyllum affine* at Vincentia to its key local pollinator, *Ariphron* sp., in the medium term.

1. A minimum reservation of one hectare be set aside for the protection of the three breeding colonies of *Ariphron* sp. along the minor track to the south west of the main Leisure Centre *Prasophyllum affine* population. This reservation should be 200 × 50m centred on the minor track. This area could be considered in lieu of some of the proposed corridor in the sedgeland north west of the Leisure Centre *P. affine* population.

2. A corridor of natural habitat be established to connect the 'residential' *Prasophyllum affine* population to Jervis Bay National Park. This corridor should run along the top of the eastern side of the main gully so that it includes grassy woodland habitat suited to the movement of *Ariphron* sp. It should be 15 to 20 m wide and include a minor disturbance track that could be a narrow (one or two slasher widths) unformed walking and / or mountain bike track. This track should be as natural as possible with no concrete, paving, ash, woodchips or the like. Basic erosion control structures would be required, but as little else as possible.

3. A similar corridor to that described in two above be established on the east side of the gully to connect the 'pumping station' *Prasophyllum affine* population to Jervis Bay National Park. Obviously the tracks on the east and west sides could be connected for public recreation.

CONCLUSIONS

1. The redesigned proposal for the Vincentia District Centre as of June 2004 meets the above recommendations.

2. The areas of existing natural habitat proposed to be preserved within the 'Environment Zone' adequately protect the main breeding areas of the key pollinator, *Ariphron* sp., to the south west of the main *Prasophyllum affine* colony. There is also a sufficient area of habitat adjacent to the breeding areas to provide food sources for the pollinator's larval hosts, and for the adult pollinators themselves.

3. The road proposed to traverse the 'Environment Zone' will pass through the main pollinator breeding area and is potentially detrimental. It will likely result in a small reduction in the current breeding area and the loss of part of the wasp population. More importantly, it will potentially interrupt the movement of pollinators along the existing minor track which provides a flyway between the breeding area and the *P. affine* colony. The degree to which the road will inhibit movement of wasps from the south western part of the breeding area to the *P. affine* colony is unknown. There is also potential for mortality of wasps flying low across the road on what is likely to be a heavily used short cut for motor vehicles. These potential detrimental effects will be substantially mitigated by the proposed elevated roadway with under road passages for wildlife, including insects. The design of this structure will maximize light penetration, allow continued growth of vegetation and minimize the potential for impacts between insects and motor vehicles.

4. The proposals to protect the 'residential' and 'pumping station' *Prasophyllum affine* colonies, and to link them with pollinator populations, are considered adequate. The 25m buffer will minimize losses from the orchid populations due to edge disturbance. The corridors have been designed to provide links to pollinator populations that should result in increased pollination of the orchids over time. They also provide links to Jervis Bay National Park that should allow recolonisation of the 'environment zone' by pollinators if population declines occur in the future.

TECHNICAL SUMMARY

This section summarises the main scientific findings of the study.

- This study aimed to determine the critical breeding and feeding sites, and movement patterns, of the main pollinators of the Jervis Bay leek Orchid, *Prasophyllum affine*, on the Stockland Development site at Vincentia, NSW.

- *Ariphron* sp., a species of Flower Wasp (Thynninae), was confirmed as the dominant pollinator of the main Leisure Centre *P. affine* population. As in the preceding 2001 study, several species of Spider Wasps (Pepsinae) also contributed to pollination.

- For unknown reasons flowering in *Prasophyllum affine* was two weeks later in 2003 than in previous years.

- Pollination levels reached higher levels in *Prasophyllum affine* in 2003, 35 percent of open flowers on 20 November, than in 2001, when it peaked at 21 percent. The difference was possibly due to the later flowering, warmer weather and consequent higher levels of pollinator activity, in 2003.

- Pollinators were twice as abundant on Leisure Centre *Prasophyllum affine* population in 2003 as in 2001, but were nevertheless uncommon; only one pollinator was found every 36 minutes of searching or one every 290 plants examined. *Ariphron* sp. carried higher pollinia loads than other pollinators and was relatively four times more abundant than in 2001, suggesting it was responsible for most of the pollination observed.

- Malaise Traps, sweep netting and observation of flowering plants such as Tea Tree, *Leptospermum* spp. were found to be inefficient methods of finding potential pollinators of *Prasophyllum affine* for a mark and recapture study. The most effective method of finding *Ariphron* sp. was by direct observation of patrolling males in breeding areas.

- Breeding colonies of *Ariphron* sp. were located and mapped in the area approximately bounded by Naval College Road, Wool Road, Moona Creek Road and the firetrail running NNW of the Leisure Centre. Some 15 breeding areas were mapped. The majority of breeding colonies were located in lightly disturbed natural grassland beside minor tracks and firetrails. The identity of breeding colonies was confirmed by observation of wingless females being picked up by males prior to mating.

- With one exception, all *Ariphron* sp. breeding colonies were located in open grassy woodland dominated by Scribbly Gum, *Eucalyptus sclerophylla*, and Red Bloodwood, *Corymbia gummifera*. The exception was a small colony in disturbed open sedgeland adjacent to more typical grassland.

- In a mark and recapture study, 187 *Ariphron* sp. males were marked with coloured Tipp-Ex in their breeding areas according to distance from the main Leisure Centre *P. affine* population. Wasps were marked along a minor track running south west of the orchid population and along a similar track below the southern powerline on either side of the junction with the first track. Recaptures of marked males showed they

exhibited a high degree of faithfulness to the breeding area in which they were marked when they were patrolling for females. By contrast males undertook longer distance movements of 200m or more when seeking food.

- It was concluded that three *Ariphron* sp. breeding colonies on the minor track south west of the Leisure Centre *P. affine* population are important sources of pollinators for this population. Other concentrations of *P. affine* in the study area and nearby do not appear to be close enough to, or linked by a suitable flyway to, *Ariphron* sp. breeding colonies, and hence are not well pollinated by this species. On the basis of the results of this study, recommendations are made above that will cater for the pollination of all populations of *P. affine* on the subject site.

INTRODUCTION

This report provides the rationale, methods, results and conclusions of a study of the distribution and movement patterns of the main pollinators of the Jervis Bay Leek Orchid, *Prasophyllum affine*. The study was conducted between 7 and 20 November 2003 at the site of the proposed Stockland commercial and residential development at Vincentia, about 26 km SSE Nowra, NSW. The study followed an earlier one conducted by the author in 2001, which showed that *P. affine* is pollinated primarily by a suite of native wasps in several families. The dominant pollinator at Vincentia was a small undescribed Thynnine or Flower Wasp in the genus *Ariphron*.

The following objectives for the 2003 study were agreed with Environmental Resources Management Australia (ERM):

1. Determine and map the general distribution, abundance and movement patterns of the relevant *Ariphron* spp. and Pepsinae taxa across the subject site and adjacent areas that are likely to be the pollinators of *Prasophyllum affine* that occur on the subject site;

2. Determine and map the key breeding / feeding areas and corridors across the subject site and adjacent areas;

3. Determine the likely importance of each key feeding and breeding area to the *Prasophyllum affine* population on the subject site; and

4. Provide recommendations on the management of pollinator habitat in the context of commercial and residential development to ensure survival of the pollinator species in the area and thereby encourage the ongoing survival of *Prasophyllum affine* on the subject site.

This report addresses objectives 1 to 3. Objective 4 is the subject of a separate report that discusses options for the conservation of the Jervis Bay Leek Orchid at Vincentia.

Background

Detailed background information for this study is contained in Bower (2002), which reports the results of the pollination study on *P. affine* conducted in spring 2001. That report also contains comprehensive literature reviews of the biology of the genus *Prasophyllum* and of the pollinators found in that study. Below is a brief summary of the biology of the Flower Wasps (Thynninae), two species of which were found to be the dominant pollinators of *P. affine* in the Jervis Bay area in 2001 (Bower, 2002) and which were the main subjects of this study.

General Description of Breeding Behaviour of Thynnine Wasps

The wasp family Thynninae is one of the largest and most prominent groups in the Australian insect fauna. The most outstanding feature of the Thynninae is a marked sexual dimorphism, such that males and females are quite dissimilar in all species. Females are wingless, usually much smaller than males and adapted for burrowing underground. By contrast males are winged, strong flyers and do not burrow. The burrowing females parasitise soil dwelling insect larvae, usually those of beetles, by first stinging and paralyzing them, and then laying a

single egg on the outside of the host. The larvae feed on the paralysed grub and, once mature, overwinter in the soil as pupae or adults before emerging in the following season to complete the annual lifecycle.

Mating behaviour in thynnines is unique among the aculeate Hymenoptera. Females rise to the soil surface and call for males via a wind-borne scent (sex pheromone). Depending on the species, females may call from just below the surface of sandy soils, from burrows at the surface, below leaf litter or from vegetation 10 to 30 cm above the ground. Females calling at the soil surface may climb grass stems if they initially fail to attract males. Males seek female pheromone signals by patrolling low over the ground in wide loops, often along regular circuits. These circuits may be relatively small, only 10-15m long or up to 30-40m in larger species (C.C. Bower, personal observations). Flight height varies with species from very low (2-5 cm in *Ariphron* sp.) to 30 or 40 cm in some other species. Generally each species has a characteristic flight height, which may depend on the calling heights of females. Males tend to rest between bouts of patrolling, and at the end of the day, on grass stems or other vegetation in the breeding area. Males can sometimes be observed if flushed from resting perches when walking through a breeding area. The data suggests most Thynnines have persistent local populations, relatively small breeding areas to which individual males remain faithful, and low dispersal rates to new areas.

When a female begins calling it is usual for numbers of males to respond immediately. This is readily observed by the sudden aggregation of males towards a site of pheromone emission. Such sites are characterized by several males flying in tight loops around low vegetation, or zig-zagging in front of a grass tussock or plant stems. Once a male finds a female, he grapples her from above with his legs and immediately flies off with her to a nearby perch where mating takes place. They then fly in copula to a nectar source where the male assists the female to feed. After feeding and copulation are complete the male returns the female to near where he found her and drops her to the ground from a low height. She burrows in immediately and the male resumes patrolling.

Some key breeding activities of Thynnines are readily observable in the field and can be used to delineate their breeding areas. These behaviours are:

- Patrolling by males.
- Pickup of calling females.
- Male resting sites.

METHODS

Monitoring techniques

Several methods were employed to survey the distribution and abundance of *Ariphron* sp. and to define it's breeding and feeding areas. These methods were also suitable for determining the same information for the Pepsinae. The methods and the rationale for them are:

1. *Malaise traps*. These traps are translucent tent-like structures designed to intercept insects on their flight paths. They are particularly suited for hymenoptera and would successfully capture Thynninae and Pepsinae. These traps were used in attempts to locate concentrations of *P. affine* pollinators. A limitation of Malaise Traps is that they

are generally only successful in the taller vegetation types such as woodland, forest and heath. The malaise traps were set up at selected locations early each morning and then checked for captures at regular intervals during the day. The locations of traps and amount of trapping time were recorded.

2. *Sweep netting*. This technique involves sweeping a large diameter insect net back and forth across vegetation whilst slowly walking along a transect. Insects on the vegetation are dislodged and caught in the net. This method is particularly suitable for sampling resting insects, which may include Thynnines resting between patrol flights or when the temperatures are too low for flight. It is also suitable for insects feeding on honeydew secreted by psyllids or leafhoppers and has potential for collecting female thynnines from their calling perches. This activity took place opportunistically between monitoring the malaise traps and conducting the behavioural and feeding observations outlined below. The locations and amount of sweep netting undertaken were recorded.

3. *Feeding observations*. Observations at flowering plants, particularly *Prasophyllum affine, Leptospermum* and *Eucalyptus* species, were conducted to determine the distribution of feeding areas of *Ariphron* sp. and Pepsinae, and the species of plants on which they feed. Searches were conducted as intensive 30 min observations of flowers in particular areas, concentrating on those in reasonably close proximity (within 300m) to the main *P. affine* colony.

4. *Behavioural observations*. Behavioural observations involved systematically examining areas of interest for signs of Thynnine or Pepsine mating or nesting activity. Areas identified as potential breeding grounds were systematically walked and the locations of breeding activity recorded by GPS. Behaviours sought were evidence of calling females, male aggregations, patrolling males or resting males. The search effort was quantified.

Mark, release and recapture

In order to gain data on the movement patterns of *Ariphron* sp. and Pepsinae, individual insects were captured by sweep net and marked on the dorsal center of the thorax with either coloured Tipp-Ex liquid paper or numbered 'Queen Bee Markers' depending on the size of the insect. Only larger insects such as Pepsinae and larger Thynninae were big enough for Queen Bee markers, while *Ariphron* sp. was too small. All marked insects were released where captured with the location of releases being recorded. Considerable efforts were made to recapture marked insects in order to measure movement distances. Distances were measured using a 50m fiberglass tape measure.

Small numbers of insect species of interest were retained to confirm their identity.

Pollination levels in *P. affine*.

Inflorescences of 71 individually numbered *P. affine* plants at the Vincentia main site were monitored on three occasions (13/11, 17/11, 20/11) to determine the levels of pollinator visitation to flowers and pollination rates. Each flower was examined on each inflorescence using a 10× hand lens. For each flower the presence or absence of the pollinarium, and whether the stigma had been pollinated, was recorded. Removal of the pollinarium and

pollination of the stigma both indicate a successful visit by a pollinator. At the same time data was collected on the phenology of flowering in the orchid population. The numbers of unopened buds, open flowers and closed flowers were recorded for each plant.

RESULTS

Evaluation of Pollinator Detection Methods

Malaise Trapping

Four Malaise Traps were deployed on each of the first three days of the study, representing a total of 84 trap hours. The traps were placed across potential insect flight paths in wooded areas where they tended to blend in more with the vegetation than on open sites for which they are not suited.

The results were somewhat disappointing. The traps took about 1.5 hours to set up each day and caught relatively few insects considered potential *P. affine* pollinators; only five Hymenoptera of a suitable size were caught. These included two Thynnine species not known to visit *P. affine* and a Hatchet Wasp (Evaniidae). The traps captured mainly flies (Diptera) of many species, as well as occasional click beetles (Elateridae), domestic bees (*Apis mellifera*), native bees (*Exoneura* sp.) and an ichneumonid wasp. No *Ariphron* sp., the dominant *P. affine* pollinator, were caught in Malaise Traps. The four Thynnine wasps captured, three brownish *Thynnoides* aff. *senilis*, and a smaller all black species, were marked with numbered Queen Bee markers, but were not seen again.

Due to the low yield of potential pollinators and information from the Malaise Traps, it was decided to discontinue malaise trapping after three days and concentrate on other more efficient approaches.

Sweep Netting

Sweep netting was attempted only twice. On 7.11.03, 100 sweeps (two sets of 50) were carried out in the wet sedgeland to the north of the main *P. affine* colony, and on 8.11.03, 500 sweeps (10 sets of 50) were undertaken in the grassland parts of the block between Wool Road and the access road to the Leisure Centre, opposite the main *P. affine* colony. While none of the main pollinators of *P. affine* was captured, two minor pollinators were taken, the small sphecid wasp, *Cerceris* sp. and a small Hatchet Wasp (Evanidae) (Bower, 2002). Otherwise, the catch was mainly flies, beetles, ants, spiders and grasshoppers. As with malaise trapping, sweep netting was not effective for the main pollinators and was abandoned in favour of more efficient methods.

Feeding Observations

At the beginning of the study searches of flowering plants were conducted for feeding individuals of *P. affine* pollinators. The purpose was both to capture wasps for marking for the movement studies and to determine what the important alternative nectar sources were. Many heathland shrub and herb species were in flower, especially various Myrtaceae; *Leptospermum polygalifolium*, *L. trinervium*, *L. juniperinum*, *Melaleuca thymifolia*, *M. squamea* and *Kunzea ambigua*. Of these, by far the most attractive to insects in general was *L.*

polygalifolium (Yellow Tea Tree), which was common and covered in masses of flowers in early November.

All flowering plants, and *L. polygalifolium* in particular, were observed for pollinators whenever moving around the site. On nine occasions in the first three days of the study intensive 30 minute searches of flowering shrubs were conducted in areas to the west and south of the main *P. affine* colony. These searches revealed no *Ariphron* sp., but a wide variety of other nectar-feeding insects including three other species of Thynnine wasps, none of which has been seen on *P. affine*. (Also seen feeding on Yellow Tea Tree flowers was *Lissopimpla excelsa*, the pollinator of *Cryptostylis hunteriana*.)

The observations of flowering shrubs were discontinued when it became clear *Ariphron* sp. or any of the other major pollinators of *P. affine* was not heavily utilizing them.

Behavioural Observations

Direct observation of individual males of *Ariphron* sp., was found to be the most effective and efficient means of determining the distribution and movements of this species. A breeding area of *Ariphron* sp. was located in the late afternoon of 8.11.03 by sighting males patrolling backwards and forwards along a motor vehicle wheel rut below the power line at the western side of the development site. Some eight males were observed patrolling over about a fifteen metre length of the track. Subsequently, other colonies of *Ariphron* sp. were located in similar situations in areas around the known *P. affine* colonies. From day 4 onwards all work was by direct observation of insects.

Determination of Breeding Areas of *Ariphron* sp.

Locations of Patrolling and Resting Males

Locations of patrolling and resting male *Ariphron* sp. are shown on Figure 1. These were found by searching the site on foot for Thynnines displaying these behaviours. Most breeding areas were located through observation of patrolling males. All but two of the breeding areas, those within the main *P. affine* colony, were along firetrails and minor tracks. In most cases males were using motor vehicle wheel ruts as a patrol route and were easy to see against the whitish soil. Only one patrol area, in the main *P. affine* colony, was found in undisturbed vegetation; this was revealed by observation of flying males in the late afternoon when the low sunlight reflected from their wings. Patrolling males in two other breeding areas were utilizing sparsely vegetated disturbance areas beside the main firetrail running between the western pumping station and Moona Creek Road. Figure 2 gives photographs showing typical locations of *Ariphron* sp. breeding colonies along minor unformed access tracks.

Not all firetrails, tracks or disturbance areas were utilized by *Ariphron* sp. All disturbance areas, and tracks between Moona Creek Road and Wool Road were examined in conditions favourable for insect activity, with *Ariphron* sp. being found only where shown on Figure 1. Similarly, two tracks running north of Moona Creek Road were searched and only one small *Ariphron* sp. colony was found (Figure 1). The areas around the two *P. affine* colonies on either side of the main gully were checked in detail without locating any *Ariphron* sp. activity. Random walks in undisturbed sedgeland, grassland and grassy woodland also failed to reveal additional breeding areas. However, given the inconspicuousness of *Ariphron* sp. against dark backgrounds, it is possible some colonies were missed. This last point is emphasized by the

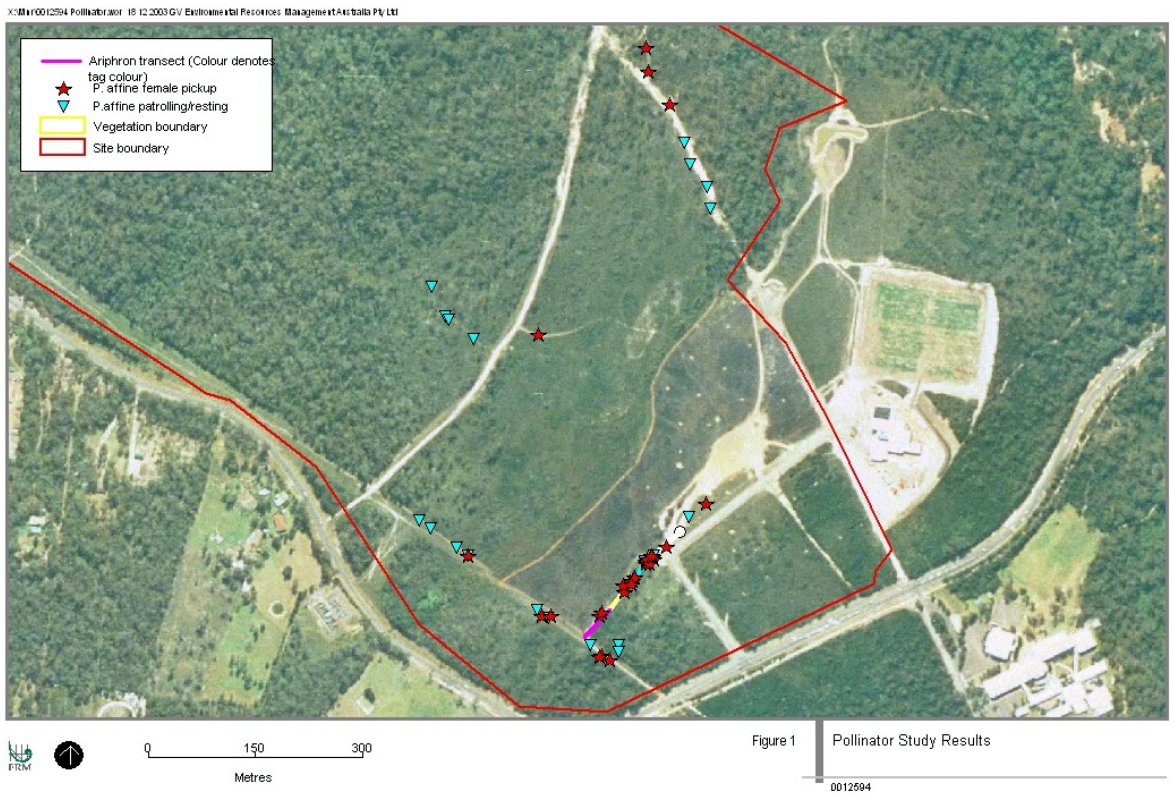

Figure 1. Locations of *Ariphron* sp. Breeding Areas, Stockland Development site, Vincentia, NSW.

fact that breeding activity was not seen in the main *P. affine* colony until late in the study despite much time being spent there throughout. However, these populations are quite small.

Breeding areas of other Thynnine species were found, often in the same areas as *Ariphron* sp. The most common was a large brown species, *Thynnoides* aff. *senilis*, which occurred in four places with *Ariphron* sp. A third, as yet unidentified species, a little larger than *Ariphron* sp., overlapped with *Ariphron* sp. at two sites, one of which also had the *T.* aff. *senilis*. These findings suggest that Thynnines in general may have similar site preferences for breeding.

Locations of Female Pickups

Sixteen examples of female *Ariphron* sp. being picked up by males were observed (Figure 1), as well as ten other aggregations of males searching for females. Such observations confirm the existence of a breeding area. With one exception, all findings of male aggregations and female pickups occurred in areas where male patrolling had been observed. The exception was the observation of a small male aggregation and associated female pickup in an area of the main *P. affine* colony where no patrolling had been seen (Figure 1). Apart from this one case, all female pickups and male aggregations took place in vegetation fringing minor tracks, usually within 20 cm of the bare wheel rut, or between the wheel ruts (Figure 2).

Habitats of Ariphron *sp.*

Habitats for *Ariphron* sp. are mainly Scribbly Gum / Bloodwood woodland (Community 1), Scribbly Gum woodland (Community 7) and to a much lesser extent Sedgeland (Community 8) (Figure 2). *Ariphron* appears to favour grassland or grassy woodland communities, rather than wet sedgeland. The Vincentia vegetation map does not distinguish grassland from sedgeland. The site of the main *P. affine* colony near the Leisure Centre is a secondary grassland rather than sedgeland and probably formerly supported a heathy woodland, which is now regenerating with mainly *Banksia ericifolia*.

Movement Patterns of *Ariphron* sp.

A study of the movement patterns of *Ariphron* sp. was carried out on male wasps in breeding areas to the south west of the main *P. affine* colony.

Marking

Movement patterns were studied by capturing patrolling males in an insect net and marking them with coloured Tipp-Ex liquid paper on the dorsal center of the thorax. Five colours were available; pink, white, blue, cream and grey. The colours were used to represent distances from the main *P. affine* colony (Table 1). The *Ariphron* sp. colonies utilized in this study were those below the western power line between Wool Road and the main gully (power line group), and those on the minor track from the corner of the Leisure Centre road to the power line (Figure 3). The minor track from the power line to the edge of the main *P. affine* colony is just over 200m long and was divided into four sections, each 50m long, and is termed the East / West (E/W) Transect (Figure 1).

Table 1. Numbers of *Ariphron* sp. males marked and distances from the main *P. affine* colony.

Distance to edge of *P. affine* colony (m)	Tipp-Ex colour	No. males marked
0 - 50	White	16
50 – 100	Blue	44
100 – 150	Cream	45
150 – 200	Grey	29
> 200	Pink	53
Total		**187**

Wasps were marked whenever the weather favoured insect activity and males were patrolling. Activity generally occurred when temperatures were above 15°C and light intensity was increasing. Activity was terminated by decreasing light intensities through the arrival of heavy cloud cover or with the approach of sunset, or if temperatures became too high in the middle of the day. Patrolling was most intense when the numbers of females calling was high and tended to decline when female calling stopped, i.e. when all available females had been picked up. There was usually a peak of calling in the morning from about 8 to 8.30 am until 10.30 or so. However, this peak could shift forwards on cooler mornings. On hot days activity often resumed in mid afternoon around 3 pm and continued until around 5 or 5.30 pm. This seemed to coincide with a smaller afternoon peak of female calling.

Figure 2a. Site of *Ariphron* sp. breeding area (left half of picture), 55m from main *Prasophyllum affine* colony on the East / West Transect (blue area).

Figure 2b. *Ariphron* sp. breeding area (foreground to red flag) below southern powerline. Males patrolled in right hand wheel rut.

Figure 2c. ***Ariphron*** **sp. breeding area along abandoned track through thick heath south of Moona Creek Road.**

Figure 2d. ***Ariphron*** **sp. breeding area in open grassland between firetrail and dense heath (to right). Across main gully north of Leisure Centre.**

In addition to *Ariphron* sp. several other species of insects considered potential pollinators of *P. affine* were marked (Table 2). A total of 71 individuals of species other than *Ariphron* sp. were marked with either Queen Bee tags or Tipp-Ex according to their size and location captured.

Table 2. Other wasp species marked.

Wasp species	Family	Location marked	Type of marker	Nos. marked
Thynnoides aff. *senilis*	Thynninae	Western power line	Queen Bee	43
Small black	Thynninae	Western power line	Pink Tipp-Ex	6
Small black	Thynninae	NE side main *P. affine* colony	White Tipp-Ex	2
Small black	Thynninae	East of main *P. affine* colony	White Tipp-Ex	7
Small black	Thynninae	0 - 50 m on E / W transect	White Tipp-Ex	3
Thynnoides sp. (black)	Thynninae	Malaise Trap	Queen Bee	3
Very large yellow spotted	Thynninae	On Yellow Tea Tree	Queen Bee	3
Small Hatchet Wasp	Evanidae	150 – 200 m on E / W transect	Grey Tipp-Ex	4
Total				**71**

Recaptures

A total of 107 marked *Ariphron* sp. were recaptured (Table 3). Most were recaptured in breeding areas while capturing patrolling males to mark new individuals. Eighty six percent of the recaptures were males recaught in the area where they were marked, suggesting a high degree of faithfulness to one breeding colony, probably the one from which they emerged. A further seven wasps were caught within 10m of the sector in which they were marked. These were probably also patrolling their natal breeding colonies, which in some cases overlapped the randomly defined study sector boundaries.

Table 3. Numbers of marked *Ariphron* sp. recaptured according to minimum distances moved from the marking point.

Minimum distance moved (m)	Marker colour					Total
	White	Blue	Cream	Grey	Pink	
0	5	14	17	9	47	**92**
0 – 10	2	2	2	1		**7**
10 – 20						
20 – 30						
30 – 40				1		**1**
40 – 50		1	1			**2**
50 – 100		1	1			**2**
100 – 150				1	1	**2**
150 – 200						
>200				1		**1**
Total	**7**	**18**	**21**	**13**	**48**	**107**

The most interesting recaptures are the eight wasps caught more than 30m from the sector in which they were marked. Six of these wasps were caught along the E / W transect and two in the main District Centre *Prasophyllum affine* colony. The wasps on the E / W transect may

have been using the vehicle track as a convenient pathway and were probably either leaving or returning to their natal breeding colony when caught. There are two likely explanations for males being away from their home breeding area:

1. They may have been visiting other breeding colonies seeking mates
2. They may have been seeking food

Four of these wasps moved relatively long distances:

1. A male marked pink below the power line was captured 140m down the E / W transect.
2. A grey-marked male was observed in the main *P. affine* colony where it appeared to be attracted to a *P. affine* inflorescence. It had moved a minimum of 213m.
3. A blue-marked male with P. affine pollinia on its face was caught while feeding on a *P. affine* inflorescence in the main *P. affine* colony. This wasp had moved a minimum of 94m from the sector on the E / W transect where it was marked.
4. A grey-marked wasp moved over 100m east towards the *P. affine* colony down the E / W transect.

These data suggest male wasps may move well away from their breeding colonies for food, but tend to seek mates mostly, if not exclusively, in their 'home' breeding area.

Other Thynnines and Hatchet Wasps

The other marked Thynnine species (Table 2) showed a similar pattern of faithfulness to their home breeding colony to that of *Ariphron* sp. In fact, all recaptures were within the area of the breeding colony where they were marked. However, the numbers of individuals marked and recaptured were much lower than for *Ariphron* sp. and this probably accounts for the lack of longer distance movement records. Interestingly, two recaptures of marked hatchet wasps were distant by 40m and over 50m from where they were marked suggesting a lack of colonial behaviour in this species.

Pollinators of *Prasophyllum affine* in 2003.

At the beginning of this study (7 Nov.) only two spikes of *Prasophyllum affine* in the main District Centre colony carried open flowers. This had increased to about ten spikes by 9 November, and by the thirteenth many of the 121 inflorescences in the colony had open flowers and pollination had begun.

After a significant number of *Ariphron* sp. had been marked, systematic searches of the main *P. affine* colony were carried out from 15 to 20 November in order to detect any marked wasps feeding there (3.2 above). This also allowed the documentation of insects visiting and pollinating *P. affine*. Searches involved walking the entire area of the *P. affine* population and visiting every plant twice, once on the way from west to east, and once on the return trip. This took 10 to 15 minutes if no pollinators were found and longer if insects were collected and processed. Twenty six such inspections resulted in the collection or observation of 10 insects that had removed pollinia from *P. affine* onto their faces and hence were pollinators (Table 4). The rate of pollinator visitation is quite low, i.e. one pollinator observed for every 2.4 inspections (36 minutes), suggesting pollinators might be a limiting factor in reproduction for *P. affine*.

The dominant pollinator group was the Flower Wasps (Thynninae), as it had been in 2001, comprising seven of the eleven pollinators; six were *Ariphron* sp. and the other was a similar sized, as yet unidentified yellow-spotted species. Five *Ariphron* sp. bore pollinia on their faces and one was carrying a female in copula. The yellow-spotted species also carried a female in copula. The next most prominent group was three species of Spider Wasps (Pepsinae), of which one individual of each species was caught. A single domestic honeybee, *Apis mellifera*, was captured with pollinia on its mouthparts. Honeybees are unlikely to be significant pollinators of *P. affine*; they were numerous in the area on other flowering plants, but were seen rarely on *P. affine*, and only once with pollinia. Honeybees are too large to collect pollinia on the frontal regions of their heads, as do the main pollinators, and it is likely they regularly groom them from their mouthparts onto the floral segments. It was common to see pollinaria attached to the petals or sepals of *P. affine* where they had been groomed from larger insects such as honeybees and the larger Pepsinae. By contrast smaller species such as *Ariphron* sp. appeared unable to remove pollinaria once they were attached, and large aggregations built up on the faces of some individuals.

As well as being more numerous on *P. affine* flowers, *Ariphron* sp. carried higher numbers of pollinaria than the other pollinators with some individuals carrying 11 or 12 (Table 4). This suggests either, or both that *Ariphron* sp. visits more flowers than other pollinators or that it does not groom them off. In either case the high accumulation / retention of pollinaria on *Ariphron* sp. indicates it is an efficient pollinator of *P. affine*. This conclusion is in agreement with that in the 2001 study (Bower, 2002).

Table 4. Pollinators of *Prasophyllum affine*, main colony, Vincentia, November 2003

Pollinator	Date	No. pollinaria by location on face					
		Frons	Clypeus	Antennae	Mouthparts	Eye	Total
Apis mellifera	18.11				3		3
Ariphron sp.	18.11	4		3	4		11
Ariphron sp.	18.11						0
Ariphron sp.	18.11		11				11
Ariphron sp.	20.11	2	9	1			12
Ariphron sp.	20.11						?
Ariphron sp.	20.11						?
Pepsinae 1	15.11		6				6
Pepsinae 2	18.11			5			5
Pepsinae 3	19.11				3		3
Thynninae sp.	19.11	2				1	3

Phenology of *Prasophyllum affine* in 2003.

The progression of flowering and pollination of *Prasophyllum affine* was measured at the Vincentia Leisure Centre colony on three occasions during the study period. On first arrival at the site on 7 November 2003, only two inflorescences carried open flowers, both of which had been in flower for some time, possibly a week or more. However, the majority of the population was well behind these two early plants in their flower development. By November 9, about 10 plants carried open flowers, and by 13 November, when the first formal count was made, just over 40 percent of flowers were open (Figure 3). The data for the first assessment was taken from 71 marked plants, but due to loss of some plants the numbers declined to 66 on the last two assessments (17 and 20 Nov.).

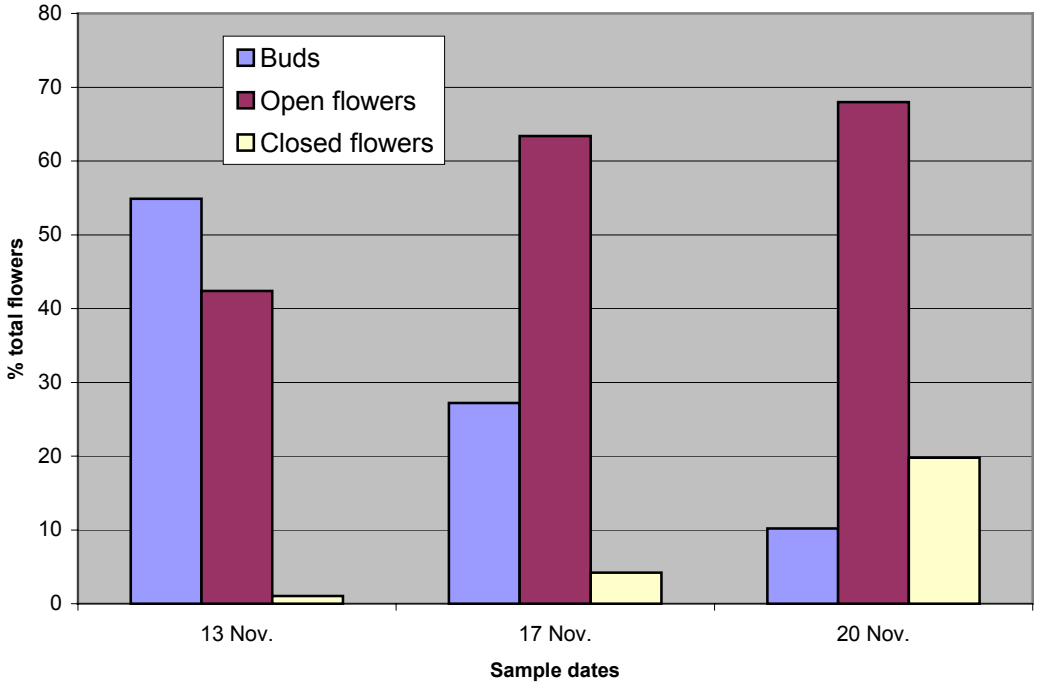

Figure 3. Phenology of *Prasophyllum affine* in the main Vincentia District Centre colony, November 2003.

Flowering of *Prasophyllum affine* was much later in 2003 than in previous years. For example, the proportion of buds versus open flowers was about the same on November 13, 2003 as it was on November 1, 2001 (Bower 2002). During the second week of the study there were high proportions, between 40 and 70 percent, of open flowers on the site (Figure 3) and the numbers of buds declined from 55 to 10 percent, while the numbers of closed (finished) flowers rose from one to 20 percent. Flowering was at its peak during the second week of the study and would have declined over the next week or so.

Pollinia Removal and Pollination

The first pollination assessment of flowers in the Vincentia District Centre *Prasophyllum affine* colony showed there had been very little visitation by insects to flowers prior to November 13. At this time only 0.5 percent of open flowers were pollinated and pollinia had been removed from 5 percent of flowers (Figure 4). However, over the next four days significant pollination occurred, so that by November 17, some 28 percent of flowers had been pollinated and pollinia removed from 34 percent. Pollinator activity continued until November 20, when the levels of pollination and pollinia removal reached 35 and 49 percent, respectively (Figure 4). Also by this time, significant numbers of flowers pollinated earlier in the week had closed, some 20 percent (Figure 1), and seed pods had begun to develop.

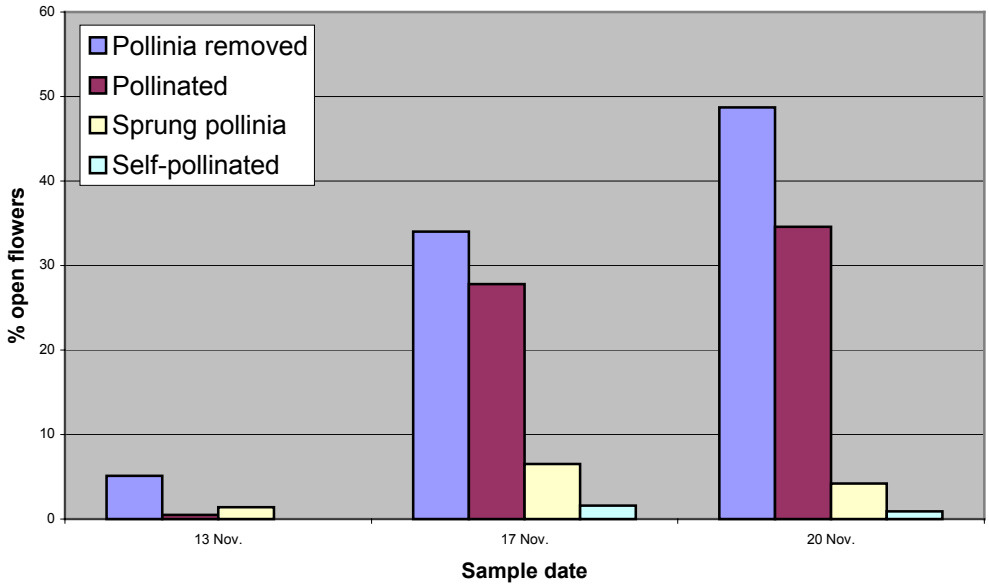

Figure 4. Levels of pollinia removal and pollination of stigmas in open flowers of *Prasophyllum affine* in the main colony at the Vincentia District Centre, November 2003.

A very small proportion of flowers self-pollinated by 'springing' of pollinia from the anthers. This was found in 1.6 and 0.9 percent of flowers at the assessments on 17 and 20 November, respectively (Figure 4). However, self-pollination does not occur in all flowers that fail to place their pollinia on an insect. Springing of pollinia is relatively uncommon, affecting only 6.5 and 4.2 percent of open flowers at the last two assessments with only about a quarter of these eventually self-pollinating. Springing is regarded as an accidental phenomenon, usually occurring in older flowers, and caused by drying of the strap (stipe) that connects the pollinia bundles to the viscidium, which in turn sticks to the pollinator. Drying causes the stipe to bend, thereby pulling the pollinia from the anther sacs. In extreme cases the stipe will move the pollinia through a 180 degree arc depositing them on the stigma and effecting self-pollination.

DISCUSSION

Flower Phenology

For reasons that are not clear, the great majority of the *Prasophyllum affine* population at Vincentia flowered two weeks later in 2003 than in 2001 (Bower, 2002) and other years (J. Briggs, personal communication). The number of plants flowering in 2003 was also about 20 percent higher than in 2001; no plants flowered in 2002, due to extreme drought (J. Briggs, pers. comm.). The late flowering in 2003 is likely to have increased the average temperatures during flowering; certainly the daily maximum temperatures were higher than the 2001 flowering season. This is likely to have been the main reason for the increased pollinator activity and pollination rates in 2003.

Pollination Levels

Pollination levels reached 35 percent of open flowers in 2003, two thirds higher than the maximum in 2001. However, the 2003 study encompassed only about the first half of the flowering period and higher pollination levels may potentially have occurred subsequently. This is unlikely since the weather became cool and wet after 20 November and little further pollination is expected to have occurred. By contrast to the pollination rates, the peak levels of pollinia removal were similar between the two years, about 44 and 49 percent of open flowers in 2001 and 2003, respectively. This suggests the suite of insects involved in pollination in 2003 was relatively more effective at transmitting pollen to new flowers than that in 2001. This contention is explored further below. Despite the higher pollination level in 2003, the rate of pollination in *P. affine* is much lower than for most other *Prasophyllum* species, where levels usually exceed 50 percent and often reach 70 to 80 percent (Coleman, 1933; Jones, 1972; Bernhardt and Burns-Balogh; 1986, Peakall, 1987).

Identity of Pollinators

The 2003 study confirmed the findings of the previous study regarding the dominant pollinator species for *P. affine* at Vincentia. As in 2001, the main pollinators were *Ariphron* sp., a species of Flower Wasp (Thynninae). Less important were a second unidentified thynnine species and three species of Spider Wasps (Pepsinae). A single domestic honeybee was also captured with a pollinarium on its mouthparts, but is not considered to be an important pollinator.

Pollinator Abundance and Efficiency

Pollinators were twice as abundant on *Prasophyllum affine* flowers in 2003, one collected every 36 minutes of searching, than they were in 2001, when one was collected every 74 minutes. This may account for the higher pollination levels in 2003, especially since *Ariphron* sp. was four times more abundant on the flowers than it was in 2001. While many insects are capable of removing pollinaria from flowers, the larger species can groom them from their faces and mouthparts resulting in wastage of pollen. There is no evidence of grooming in *Ariphron* sp., which tends to retain all pollinaria it collects and is therefore a more effective pollinator of *P. affine* than larger species.

Even though pollinators were more abundant in 2003 than in 2001, they were still quite scarce and difficult to find. Despite this relative scarcity, a significant proportion of flowers was pollinated. This no doubt is a result of pollinators visiting multiple flowers on each inflorescence and is confirmed by the multiple pollinaria removed by individuals. Pollinators carrying multiple pollinaria can pollinate a series of flowers on each inflorescence, so that relatively few pollinators can pollinate many flowers. This can also result in relatively high levels of geitonogamous self-pollination within an inflorescence, i.e. pollinators visiting many flowers on an inflorescence are likely to pollinate some flowers with pollen from other flowers on the same plant.

Pollinator Breeding Areas

The 2003 study has identified the key breeding areas of *Ariphron* sp. (Figure 1), the dominant pollinator of *Prasophyllum affine* at Vincentia. This is the first time that breeding areas of a

pollinator have been defined for the purposes of orchid conservation. Overall, *Ariphron* sp. was found to be widespread in open grassy woodlands dominated by Scribbly Gum and Red Bloodwood. However, it was not uniformly distributed. Rather, it was concentrated in patches in disturbance areas along minor tracks. The males of this and two other thynnine species appeared to be breeding more successfully along the track margins than elsewhere. This was evidenced by the fact that most females were observed to be calling or collected by males from either the vegetation between the wheel ruts or within about 20 cm of the trackside. This suggests there is a higher concentration of underground larval hosts for thynnines along tracks, which may be related to easier access to the soil for egg laying by beetles where the normally dense ground cover is broken by the track.

Movements of *Ariphron* sp.

The mark and recapture study showed that *Ariphron* sp. males usually patrol for females in the same area as they were originally marked. This 'breeding territory' is likely to be the breeding colony from which they themselves emerged and is quite small, encompassing linear distances along tracks of only about 15 to 25 metres. However, marked males were found to move up to 200m from their breeding areas to feed on *Prasophyllum affine* nectar in the main District Centre colony. Movements greater than this are likely since only a few longer distance movements were observed in this study and may not be a fully representative sample. The data therefore suggests *Ariphron* sp. may travel relatively long distances, in excess of 200m, in search of food. However, they appear to return to the breeding area after they have fed.

These observations help to resolve a discrepancy in the literature on thynnines. Peakall (1990) and Peakall and Beattie (1996) concluded that the Thynninae have quite small home ranges. By contrast, Alcock (1981) considered the home range might be quite large. However, none of these authors distinguished between mate seeking movements, which are localised, and nectar seeking behaviour, which may involve longer distance movements. It is clear that breeding territories and feeding ranges need to be distinguished in considering the movements of thynnines and the areas needed to support them.

Assessment of the Requirements of *Ariphron* sp.

Following is an assessment of the essential requirements for the survival of *Ariphron* sp.:

- *Viable populations of appropriate soil dwelling beetle larvae as hosts for the wasp's larval stages*. It is clear that the *Ariphron* sp. breeding colonies identified in this study are based on areas where suitable larval hosts occur. It is not known how stable these colonies are and whether they move according to the abundance of the hosts in the soil, which seems likely. It is probable wasps overexploit their hosts in some locations causing colonies to decline, while new colonies are rising elsewhere, as host – parasite theory would predict. It is therefore important to have sufficient area to avoid overexploitation of the host across the whole site with subsequent extinction of the parasite. This could be accommodated by conserving a number of breeding colonies and the area between them to allow for expansion, contraction and movement.

- *Hosts for the adult beetles*. These are most likely to be eucalypt trees upon which the adult beetles feed. Also important are plant roots as food for the beetle larvae. The

host trees should be retained in sufficient numbers and in close proximity to the areas suitable for beetle egg laying and wasp access to the soil.

- *Suitable habitat types*. Habitat that provides the requirements of both the beetle hosts and the *Ariphron* sp. parasite at Vincentia is open grassy woodland dominated by Scribbly Gum and Bloodwood on drier soils, with areas of minor soil disturbance, such as unformed vehicle tracks.

- *Unsuitable habitat types*. Habitat that does not appear to meet these requirements is the wetter sandy sedgeland, and the heavy wet black soils of the gully.

- *Adequate nectar sources for adults*. In addition to larval hosts and appropriate soils, adult *Ariphron* sp. require nectar sources as food. The full range of adult food sources remains unclear. Because *Ariphron* sp. was not found in searches of other flowering plants at Vincentia in 2003 we unfortunately have no information on nectar sources other than *P. affine*. It is highly unlikely that *Ariphron* sp. is solely dependent on *P. affine* for nectar, given that many *Ariphron* sp. breeding colonies are located a long way from any occurrences of *P. affine*. (One possible record of *Ariphron* sp. feeding on *Leptospermum polygalifolium* in 2001 was not confirmed by capture of the specimen). It would be advisable to ensure the availability of as complete a range of local plants as possible, especially ground cover species similar to *P. affine*, that flower in the mid to late spring period. Given the ability, and demonstrated need for, *Ariphron* sp. to move 200m or more to find nectar, a critical habitat requirement is for sufficient area to provide adequate nectar sources.

- *Sufficient area to maintain a viable population in perpetuity*. Any conservation area should ideally ensure the *Ariphron* sp. population does not become extinct due to fluctuations resulting from long term environmental extremes. There are very few estimates of minimum viable areas or population sizes for insects, although there is evidence that 50 ha are needed for some species.

- *Habitat continuity.* The small size of *Ariphron* sp. and its behaviour of flying very close to the ground suggests it is unlikely to fly over obstacles such as walls, or large areas of unsuitable habitat such as car parks, to reach *P. affine*. It will therefore need almost continuous suitable habitat between breeding areas and *P. affine*. However, this needs to be tempered by the fact that wasps from south west of the Leisure Centre *P. affine* site must have crossed 10 to 20 m of bare soil to reach the orchids.

Assessment of Pollinator Sources for *Prasophyllum affine* Colonies at Vincentia.

The results of this study allow an assessment to be made of the key sources of pollinators for each of the four main concentrations of *Prasophyllum affine* at Vincentia.

- *District Centre (Main) colony*. This colony was the main focus of the current study and is the best pollinated of all the extant populations of the Jervis Bay Leek Orchid (Bower, 2002). The main pollinator, *Ariphron* sp., occurs in small numbers within the area of the colony, but the main pollinator sources are large breeding areas beside the minor track running 200m south west from the Leisure Centre access road to the powerline. The source of the Pepsinae visiting *P. affine* is unknown. Pepsinae do not exhibit the colonial behaviour characteristic of the thynnines and may be more

dispersed across the area. However, most species bury their spider prey in the soil and are likely to prefer areas of easier access to the soil such as sites of minor disturbance. They are therefore likely to favour similar areas to the thynnines.

Conservation of pollinators for the District Centre *P. affine* colony will require reservation of the *Ariphron* sp. breeding colonies along the minor track to the south west of the orchids with sufficient area of surrounding habitat to ensure their medium term survival. The resources that should be conserved are outlined above and include viable populations of beetle hosts and their resources (eucalypts), and adult nectar sources. There are three breeding concentrations of *Ariphron* sp. along this track (Figure 1) each contributing pollinators to the *P. affine* colony. It is considered all three should be conserved as a minimum, and the minimum area of surrounding habitat to protect their resources in the medium term should be the 200m length of the track with 25m on either side, an area of one hectare.

The proposal for a corridor linking the District Centre *P. affine* colony to Jervis Bay National Park via the sedgeland to the main gully to the north west is not considered viable because both the sedgeland and the main gully are unsuitable habitats for *Ariphron* sp. and Pepsinae. Consequently, this corridor is highly unlikely to provide a route for recolonisation of the *P. affine* population with pollinators. Any corridor would need to be in grassy woodland habitat. All options for such a corridor have been neutralised by past developments, particularly the Leisure Centre, which effectively breaks the band of grassy woodland that formerly bordered the wet sedgeland to the north east. The lack of a suitable corridor of existing habitat reinforces the need to protect the *Ariphron* sp. breeding colonies as proposed above. The option of creating an artificial grassy woodland habitat in the wet sedgeland area for pollinators, and / or as a more suitable corridor, is considered unlikely to succeed due to site constraints, mainly unsuitable soils and moisture levels.

- *Pumping station colony*. This *Prasophyllum affine* colony occurs beside the main gully on the edge of the sedgeland to the west of the pumping station north west of the Leisure Centre. In 2001, searches failed to find any pollinators, and although not formally measured, pollination levels appeared to be very low. The nearest *Ariphron* sp. population is across the main gully about 120m to the north. While the orchids are within the wasp's known feeding flight range, the intervening tall dense gully vegetation may form an impenetrable barrier to the low flying insect. This *P. affine* population appears to be in marginal habitat both for itself and for pollinators. In addition the works associated with the pumping station may have further isolated it. The only option for improving pollination levels in this group may be to retain a corridor of suitable habitat on the eastern side of the gully to the north. This would need to be on land not owned by Stockland Development.

- *'Residential' colony*. This *Prasophyllum affine* colony is located across the main gully to the west of the pumping station colony in an area of grassy open heathland. No pollinators were found during searches in 2001 and pollination levels appeared low. No sign of *Ariphron* sp. was found within the colony area or nearby in this study. The nearest *Ariphron* sp. population was a small one 140m to the west, with much larger populations 175m to the north. These appear to be a little too far away to contribute significant pollination to this *P. affine* colony. The density of the heathland vegetation between the orchids and the Ariphron sp. colonies may exacerbate this. Pollination

levels may be increased in this colony by providing a slashed corridor NNE along the top edge of the main gully to intersect with the firetrail where the large *Ariphron* sp. colonies occur. This corridor may provide a flyway for wasps to the orchids, but ultimately may become colonized by them.

- *'Oval' colony*. Located to the north of the Leisure Centre oval, this *Prasophyllum affine* colony had no pollinators in searches in 2001 and low pollination levels. This population will not be affected by the proposed development. There do not appear to be any *Ariphron* sp. colonies in close proximity, given the failure to find them on the flowers in 2001 and in one search in 2003. However, the area has not been surveyed thoroughly.

REFERENCES

Alcock, J. (1981). Notes on the reproductive behaviour of some Australian thynnine wasps (Hymenoptera: Tiphiidae). *Journal of the Kansas Entomological Society*, 54: 681-93.

Bernhardt, P., and P. Burns-Balogh (1986). Observations of the floral biology of *Prasophyllum odoratum* (*Orchidaceae, Spiranthoideae*). *Plant Systematics and Evolution*, 153: 65-76.

Coleman, E. (1933). Pollination of orchids: Genus *Prasophyllum*. *The Victorian Naturalist*, 44: 214-21.

Jones, D.L. (1972). The pollination of *Prasophyllum alpinum* R. Br. *The Victorian Naturalist*, 89: 260-3.

Peakall, R. (1987). *Pollination biology and aspects of the population genetics of* Prasophyllum fimbria *H.G. Reichb.* Chapter 4 in *Genetic Systems of Australian Terrestrial Orchids*. Pp. 64-98. Doctoral Thesis, University of Western Australia.

Peakall, R. (1990). Responses of male *Zaspilothynnus trilobatus* Turner wasps to females and the sexually deceptive orchid it pollinates. *Functional Ecology*, 4: 159-67.

Peakall, R., and Beattie, A.J. (1996). Ecological and genetic consequences of pollination by sexual deception in the orchid *Caladenia tentaculata*. *Evolution*, 50: 2207-20.

Annex H

RoTAP

Conservation Rating According to Briggs and Leigh (1996)

Briggs and Leigh (1996) list over 5,000 species, sbuspecies and varieties of plants which have been ranked according to their conservation status. Not all of these species are listed on the schedules of the various commonwealth and state threatened species legislation and consequently these species are extraneous to the statutory assessment process.

Briggs and Leigh (1996) developed a range of codes to rank each species and these are used in a variety of combinations:

- 1 Species only known from one collection;
- 2 Species with a geographic range of less than 100 km in Australia;
- 3 Species with a geographic range of more than 100 km in Australia;
- X Species presumed extinct; no new collections for at least 50 years;
- E Endangered species at risk of diappearing from the wild state if present land use and other causal factors continue to operate;
- V Vulnerable species at risk of long-term disappearance through continued depletion;
- R Rare, but no currently considered to be endangered;
- K Poorly known species that are suspected to be threatened;
- C Known to be represented within a conservation area;
- a At least 1,000 plants are known to occur within a conservation reserve(s);
- i less than 1,000 plants are known to occur within a conservation reserve(s);
- The reserved population size is unkown;
- t The total known populaiton is reserved; and

\+ The species has a natural occurrence oversears.

Annex I

DEC DG Requirements

NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

ABN 30 841 387 271

Neil Hargreaves
Development Manager
Stockland Development Pty Ltd
GPO Box 998
SYDNEY NSW 1041

DOC 03/17572, File 03/09495

17 December 2003

Dear Sir,

RE: DIRECTOR-GENERAL'S REQUIREMENTS FOR A SPECIES IMPACT STATEMENT FOR VINCENTIA MASTERPLAN

Thank you for your letter of 24 November 2003 requesting the Director-General's requirements for a Species Impact Statement (SIS) for the proposal cited above. In addition to the eleven subject threatened species that were identified in the 8-part test report by ERM in November 2003), the Department of Environment and Conservation NSW (DEC) requires that the following additional 18 species and one Endangered Ecological Community (EEC) must be considered in the SIS: Thick-Lip Spider Orchid (*Caladenia tesselata*), Tangled Bedstraw (*Galium australe*), Biconvex Paperbark (*Melaleuca biconvexa*), Underground Orchid (*Rhizanthella slateri*), Sydney Coastal Estuary Swamp Forest Complex Endangered Ecological Community, Long-nosed Potoroo (*Potorous tridactylus*), Southern Brown Bandicoot (*Isoodon obesulus*), White-footed Dunnart (*Sminthopsis leucopus*), Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*), Large-footed Myotis (*Myotis adversus*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Greater Broad-nosed Bat (*Scoteanax rueppellii*), Swift Parrot (*Lathamus discolor*), Turquoise Parrot (*Neophema pulchella*), Regent Honeyeater (*Xanthomyza phrygia*) and Square-tailed Kite (*Lophoictinia isura*).

For your information the purpose of a SIS in the draft master plan and development consent process as it relates to your application is:

- to allow you, as applicant, to identify the issues pertaining to threatened species and provide appropriate amelioration for adverse impacts resulting from the proposal;

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Programs &
Planning Division
Southern Directorate
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Head Office
43 Bridge Street
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- to assist the consent authorities in the assessment of your draft master plan under *State Environmental Planning Policy 71 Coastal Protection* and of your development application under Part 4 under the *Environmental Planning and Assessment Act 1979* (EP&A Act); and
- if the consent authorities decide to give their consent to the application it will be used to assist the Director-General of DEC in deciding whether or not concurrence should be granted. If, however, the Minister (in this case, the Minister for DIPNR) is the consent authority then this information will be used to inform the Minister for the Environment when he is consulted regarding the proposal.

It is essential to note that Section 111(1) of the *Threatened Species Conservation Act 1995* (the TSC Act) requires that the applicant must, in preparing the SIS, comply with the requirements of the Director-General. As any consent granted where the Director-General's requirements are not met may be invalid, the SIS will be assessed as to whether all requirements are complied with.

The following requirements are based on the standards developed for other SISs prepared elsewhere in NSW. As per normal practice, extra requirements have been identified for some of those species so far recorded on the subject site or in close proximity to the site, which include the Eastern Bristlebird, Ground Parrot, *Prasophyllum affine* and *Cryptostylis hunteriana*.

Definitions

The definitions given below are relevant to these requirements:

development has the same meaning as in the *Environmental Planning and Assessment Act 1979.*
activity has the same meaning as in the *Environmental Planning and Assessment Act 1979.*
proposal is the development, activity or action proposed
subject site means the area directly affected by the proposal.
study area is the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly.
locality is the area within a 10 km radius of the subject site.
subject species means those threatened species which are known or considered likely to occur in the study area.

All other definitions are the same as those contained in the TSC Act.

Matters which have been limited or modified

I consider that the following Section 110 matters need not be addressed by your SIS.

- Section 110(2)(e). This section is a replication of Section 110(2)(a).
- Section 110(2)(g). The matters raised in this section of the TSC Act have been clarified by the requirements below.

- All reference to endangered populations. The TSC Act does not currently list any endangered populations that occur in the vicinity of the proposed development.
- All reference to Critical Habitat. There is currently no declared Critical Habitat in the Shoalhaven City Council LGA. There are two final and one preliminary listings of Critical Habitat in NSW.

Matters to be addressed

The TSC Act provides that the SIS must meet all the matters specified in Sections 109 and 110 of the TSC Act with the exception of those matters limited above. The requirements outlined in Sections 109 and 110 (excluding the matters limited above) have been repeated below (italics) along with the specific Director-General's Requirements for your proposal. Previous surveys and assessments may be used to assist in addressing these requirements. All references used throughout the SIS must be cited and listed in a bibliography.

Please note that 20 Key Threatening Processes are now listed in NSW. Of particular relevance to your proposed development are the listed Key Threatening Processes:

1. Predation by the European Red Fox *Vulpes vulpes*;
2. Predation by the Feral Cat *Felis cattus*;
3. Ecological consequences of high frequency fires;
4. Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands;
5. Clearing of native vegetation.
6. Removal of dead wood and dead trees.

For each species likely to be affected by any of the Key Threatening Processes the SIS shall address whether the proposed activity will increase this threat, and shall describe proposed measures to ameliorate such threats.

1 Form of the Species Impact Statement

1.1 A Species Impact Statement must be in writing (Section 109 (1))
1.2 A Species Impact Statement must be signed by the principal author of the statement and by:
(a) the applicant for the licence, or
(b) if the Species Impact Statement is prepared for the purposes of the Environmental Planning and Assessment Act 1979, the applicant for development consent or the proponent of the activity proposed to be carried out (as the case requires) Section 109(2))

2. Contextual information

2.1 Description of proposal, subject site and study area

A Species Impact Statement must include a full description of the action proposed, including its nature, extent, location, timing and layout (Section 110 (1))

A full description of the action includes a description of all associated actions, including, but not restricted to: installation and maintenance of utilities, fire protection zones (including the intended management regimes to be applied to such zones), access and egress routes; and changes in surface water flows. These actions may occur on or off the *subject site*. The type of action proposed shall be detailed, including the timetable for the construction of the proposed development. If a staged development approach is adopted then the timetable shall clearly indicate this. In describing the proposal, the proportion of the *subject site* and the *study area* that will be affected is to be provided, including details of the location of any auxiliary infrastructure and all component parts of the proposal such as (i) roadworks and temporary access routes, (ii) utilities such as electricity, drainage, sewage, gas, (iii) any actions necessary for fire management, (iv) stockpile areas, (v) temporary buildings etc.

The vegetation within the study area that is to be retained is to be fully documented, and shown on the relevant plans and maps. The proposed management regimes for such areas are also to be documented.

2.2 Provision of relevant plans and maps

A plan of the *study area*, including the scale of the plan shall be provided. Colour aerial photograph of the locality (or reproduction of such a photograph) shall be provided. This aerial photograph shall clearly show the subject site and the scale of the photograph.

A topographic map of the site and immediate surrounds at a scale of 1:25000 shall be provided. This map shall detail the location of the proposal and location of works on site.

A map of the locality, showing landscape features including rivers, swamps, wetlands, any locally significant areas for threatened species such as parks and reserves, and areas of high human activity such as townships, regional centres and major roads will also be provided. The location, size and dimensions of study area shall be provided. This map shall represent the area within at least a 3 km radius of the subject site.

This map shall show the location and type of vegetation communities, including a list of dominant species, present within the subject area. This plan is to show the location of any key habitat resources for threatened species (e.g. potential and recorded habitat of *Prasophyllum affine* and the foraging and breeding habitat of its primary pollinators, Eastern Bristlebird and Ground Parrot habitat, stands of Glossy Black Cockatoo feed trees, trees used as nesting sites by the Square-tailed Kite, and stands of trees bearing hollows or trees likely to mature into hollow-bearing trees).

2.3 Land tenure information

Information about the land tenure across the *study area* shall be provided. Any limitations to sampling across the *study area* (e.g. denied access to private land) shall be noted.

Information on current activities on or usage of the *study area* shall be noted.

3 Initial assessment

A general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action (Section 110 (2)(a))

3.1 Identifying subject species

In determining these species (the subject species), consideration shall be given to the habitat types present within the study area, recent records of threatened species in the locality and the known distribution and habitats utilised by threatened species in the region. The location of the subject species recorded during the SIS survey shall be represented on a map of the study area. All available historical records shall also be included. Where the habitat of each subject species within the study area can be clearly delineated, this habitat shall be represented on a map of the study area. Databases such as the DEC Atlas of NSW Wildlife, Australian Museum and Royal Botanic Gardens may be used to assist in compiling the list.

The following threatened species and Endangered Ecological Community (EEC) shall be considered for inclusion in the list of subject species:

FLORA	
Jervis Bay Leek Orchid	*Prasophyllum affine**
Thick Lip Spider Orchid	*Caladenia tessellata*
Leafless Tongue Orchid	*Cryptostylis hunteriana*
Tangled Bedstraw	*Galium australe*
Biconvex Melaleuca	*Melaleuca biconvexa*
Underground Orchid	*Rhizanthella slateri*
EEC	
Sydney Coastal Estuary Swamp Forest Complex	
Fauna	
Southern Brown Bandicoot	*Isoodon obesulus**
Long-nosed Potoroo	*Potorous tridactylus**
White-footed Dunnart	*Sminthopsis leucopsis*
Eastern Chestnut Mouse	*Pseudomys gracilicaudatus*
Large-footed Myotis	*Myotis adversus*
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*
Eastern Freetail-bat	*Mormopterus norfolkensis*

Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*
Greater Broad-nosed Bat	*Scoteanax rueppellii*
Eastern Pygmy-possum	*Cercartetus nanus*
Squirrel Glider	*Petaurus norfolcensis*
Yellow-bellied Glider	*Petaurus australis*
Giant Burrowing Frog	*Heleioporus australiacus*
Glossy Black-Cockatoo	*Calyptorhynchus lathami*
Eastern Bristlebird	*Dasyornis brachypterus**
Ground Parrot	*Pezoporus wallicus*
Swift Parrot	*Lathamus discolor**
Regent Honeyeater	*Xanthomyza phrygia**
Turquoise Parrot	*Neophema pulchella*
Square-tailed Kite	*Lophoictinia isura*
Powerful Owl	*Ninox strenua*
Sooty Owl	*Tyto tenebricosa*
Masked Owl	*Tyto novaehollandiae*

* denotes that the species is listed as threatened under the Commonwealth *Environmental Protection and Biodiversity Conservation Act* 1999 (EPBC Act).

It is recommended that the proponent contact the Department for the Environment and Heritage with regard to consideration of the Commonwealth threatened species listed above. Consideration may also need to be given to species that are not threatened in NSW, but are Commonwealth listed under the EPBC Act (e.g. White-bellied Sea Eagle).

Whilst it is not a specific requirement, it is strongly recommended that, while conducting the flora survey, attention is given to the possible occurrence of the following species listed as Rare under ROTAP (Rare or Threatened Australian Plants, Briggs and Leigh 1996): *Corybas undulatus, Leptospermum epacridoideum, Pultenaea villifera,* and *Platysace stephensonii.* If any of these species are detected on the subject site, it would be appropriate that the SIS consider the impacts of the proposal on these species. This information will be necessary should any of the above species be listed on the Schedules of the TSC Act prior to a decision being made on the application.

3.2 Identifying habitats

In describing the study area, consideration shall be given to the previous land uses and the effect of these land uses on the study area. Relevant historical events may include fire, clearing, logging, slashing, recreational use and agricultural activities.

A description of habitat including such components as the frequency of tree hollows, the presence of wetlands, the density of understorey vegetation, the composition of the ground cover, the soil type and the presence of heath and permanent or ephemeral swamps shall be given. The condition of the habitat within the study area shall be discussed, including the prevalence of introduced species. A description of the habitat requirements of threatened species likely to occur in the study area shall be provided.

In defining the study area, consideration shall be given to possible indirect effects of the proposed action on species/habitats in and surrounding the subject site: for example through altered fire and hydrology regimes, soil erosion or pollution, fencing, habitat fragmentation and disruption of wildlife movement corridors, increased predation by the European Red Fox and Feral Cat, edge effects, altered light and noise regimes, disturbance of roosting areas or other impacts due to increased use of the area by humans, impact of increased levels of domestic and feral predators.

4 Survey

4.1 Requirement to survey

A fauna and flora survey is to be conducted in the study area. Targeted surveys shall be conducted for all subject species determined in accordance with Section 3 above. Previous surveys and assessments may be used to assist in addressing this requirement. However, the efficacy of such previous assessments in meeting this requirement must be described in full.

Flora
Particular attention shall be paid to the timing of flora surveys, as many of the subject species will only be present for a few months each year. The orchid species will only be present above ground for a few months each year and can only be recognised with confidence when flowering.

Fauna
Particular attention shall be paid to the timing and climatic conditions for conducting fauna surveys, as many of the subject species will only be present or detectable for a few months each year or during certain climatic conditions. Additional advice on these matters should be sought from the DEC contact officers detailed below if needed.

Identification of all species is essential. Identification to genus only is not acceptable. Species of taxonomic uncertainty shall be confirmed by a recognised authority such as the Australian Museum or National Herbarium at the Royal Botanic Gardens, Sydney.

4.2 Documentation of survey effort and technique

4.2.1 Description of survey techniques and survey sites

Survey technique(s) shall be described and a reference given, where available, outlining the survey technique employed.

Survey site(s) shall be identified on a clearly keyed map. The size, orientation and dimensions of quadrat or length and separation of transect shall be clearly documented for each type of survey technique undertaken. Full AMG grid references for the survey site(s) shall be provided.

4.2.2 Documenting survey effort and results

DEC survey proformas are to be used by field staff when applying a range of standard fauna survey techniques. Digital copies of these proformas are available by electronic mail. Please contact the nominated contact officer below. These proformas shall used by field staff when undertaking fauna surveys and completed data sheets shall be included as an appendix to the SIS.

The time invested in each survey technique shall be summarised in the SIS, based on completed proformas, e.g. - number of person hours / transect, duration of call playback, number of nights traps set.

It is not sufficient to aggregate all time spent on all survey techniques. Effort must be expressed each time a particular survey technique is applied.

Personnel details including name of surveyor(s) and contact phone number must be included. The person who identified records (e.g., anabat, hair tubes, scat analysis) shall also be identified.

Environmental conditions during the survey shall be noted at the commencement of each survey technique. These conditions must be documented in the SIS. Surveys shall be undertaken during seasons and climatic conditions during which the subject species are most likely to be detected. In the case of *P. affine, Cryptostylis hunteriana, Rhizanthella slateri* and *Galium australe*, surveys must be undertaken whilst the species are known to be in flower at the known locations on the site or at nearby locations, thereby maximising the chances of detecting at least some individuals in a particular season.

An assessment of the efficacy of each survey regime in detecting each species under the intensity utilised by the study is to be provided. The effect of the season and weather at the time of the field survey shall be considered with respect to the adequacy of survey results. An assessment will also be made of the adequacy of the survey and background information used to assess the likely area of use (home range) for each species. Any areas which may act as corridors between the study area and adjacent areas of likely habitat for subject species shall be identified and described.

A full list of all fauna and the threatened flora found during the course of surveys shall be included (such information is indicative of the habitat quality of the site). Completed Atlas of NSW Wildlife cards are to be provided for each threatened species record in any survey conducted for the purposes of the SIS. For confidentiality, these cards are not to be included in the SIS but rather shall accompany the SIS when supplied to the DEC.

4.3 Specific survey requirements

Outlined below are details of the survey methods that are necessary to determine the presence of those threatened species known or likely to be on the site. Any

flora and fauna survey of the proposed site must include the use of these survey methods.

Thick Lip Spider Orchid - *Caladenia tessellata*

There are two historic records close to the proposed development site. Surveys must be conducted for this species when it is most likely to be flowering. Flowering has been recorded from early September until early November. Fortnightly systematic surveys along evenly spaced transects located about 10 m apart in all areas of potential habitat shall be undertaken. *Caladenia* leaves are distinctive and it should be possible to identify the presence of *Caladenia* leaves on the subject site prior to flowering if plants of this genus are present. The genus can be recognised by leaves and fruiting heads following flowering, so it may be possible to survey for the genus post-flowering. However, flowering plants will be needed in order to identify to species level.

Leafless Tongue Orchid - *Cryptostylis hunteriana*

This species can only be satisfactorily surveyed when it is flowering, although it is possible for experts to recognise stems of this species at the bud stage. The exact flowering time is unpredictable and the species can flower anytime between early December and mid March. Searches at about three weekly intervals over this period are, therefore, required. Systematic surveys using evenly spaced transects located about 10 m apart through all areas of heath/shrubland and low woodland with heath/shrubland understorey must be undertaken.

Jervis Bay Leek Orchid - *Prasophyllum affine*

Surveys must be undertaken between late October and late November, once a number of individuals at known sites have commenced flowering. Systematic surveys using evenly spaced transects located about 10 m apart through all areas of heath/shrubland and low woodland with heath/shrubby understorey must be undertaken. A detailed population count is required. The results of the 2003 survey season must be combined with the survey results obtained since 2000 on the subject site. There is now evidence that only a portion of the population flowers each year. It is required that surveys also be conducted in the fringes of adjacent woodland areas, because although the current known distribution is primarily within areas of treeless heath on clay, some individuals have been recorded in sedgeland/woodland interface.

Bower (2002) identified Flower and Spider Wasps as the primary pollinators of *P. affine* at Vincentia. Bower (2002) recommended that an understanding of the resources needed by the pollinators of *P. affine* may help to better define the habitat required to sustain the species in the long term. Bower (2002) noted that the location of the breeding area for the dominant Thynninae Wasp pollinator, *Neozeleboria* sp., should be determined for Vincentia. From many years of survey experience, Bower (2002) found that many *Neozeleboria* species and populations have colonies that are patchily distributed.

Bower (2002) further noted that studies of other *Neozeleboria* spp indicate that they feed on the honeydew produced by psyllids on eucalypt foliage. It is, therefore, important that as much as possible of the existing eucalypt populations be maintained close to the Vincentia site. However, it is clear from the records in the Vincentia study that the Vincentia *Neozeleboria* also feeds on floral nectar. This may include *Leptospermum* blossom as well as *P. affine*, since a *Neozeleboria*-like wasp was seen on *Leptospermum*, but escaped capture and could not be formally identified. Therefore, it would also be of value to ensure that *Leptospermum* species are maintained at the site, possibly supplemented by additional plantings in regeneration areas.

The role of the Spider Wasps as pollinators is not clear from this study. Four different species were collected on *P. affine* flowers, three of which were carrying pollinaria when caught. This suggests the Pepsinae are potentially important pollinators.

The essential requirements of Pepsinae are:

1. Spiders for larval development and female nutrition – A sufficient area of natural habitat to support enough spiders to maintain viable Spider Wasp populations is needed. However, since Pepsinae are non-specific in their prey needs, relatively small areas, of the order of a few tens of hectares, are likely to be sufficient. However, literature on this point has not been accessed.

2. Nectar sources – Nectar requirements are similar to those of the Thynninae.

Bower (2002) considers that all pollinators should be conserved for two reasons:

1. As insurance against loss of one or more over time

2. As insurance against seasonal variations in pollinator abundance

In order to address the recommendations and comments by Bower (2002) the following studies in relation to the identification of pollinator breeding and feeding habitat must be undertaken.

- Identify for all pollinator species those areas of the subject site, and surrounding land if relevant, that are important sources of food for adult and larval stages of the wasps and also those areas that provide important refugia.
- Estimate pollinator population sizes and identify breeding and feeding areas for the wasp populations that are most likely to be pollinating the various *P. affine* populations.
- Assess the minimum area and critical locations of pollinator feeding and breeding habitat that needs to be protected and maintained in order to retain a population of pollinators that will maintain adequate pollination levels of *P. affine* and remain viable in the long term.

- Assess the ability of pollinators to traverse potential infrastructure obstacles such as car parks and buildings, fences, lawns etc.
- Determine whether any off-site areas are important sources of pollinators, either through direct flight to the orchid plants or through recolinisation of pollinator habitat on-site following possible on-site loss of pollinators as a result of adverse conditions or events.
- Identify whether any parts of the proposed development are likely to impede movement of pollinators to *P. affine* populations, or that would impede recolinization from surrounding habitat

Underground Orchid - *Rhizanthella slateri*

There are records of this vulnerable orchid from across the other side of Naval College Road. Survey methodology and appropriate timing for surveys are currently being formulated by the Shoalhaven City Council (SCC) and a recognised underground orchid expert. The consultant should, therefore, contact Dr Sandie Jones, Environmental Planner, Shoalhaven City Council for further information.

Tangled Bedstraw - *Galium australe*

Tangled Bedstraw *Galium australe* was listed as Endangered (Presumed Extinct) until it was relocated in 2002. A population was discovered near Lake Windemere in the Commonwealth Territory at Jervis Bay growing with *Eucalyptus pilularis / E. botryoides* and Turpentine (on slopes with friable loamy soil and abundant ferns in the understorey). The best time for survey seems to be summer - it is impossible to identify without flowers or fruit. This species appears to exhibit a patchy distribution and can be easily overlooked during flora surveys. It may be appropriate to use a transect survey method as required for *P. affine, C. tessellata* and *C. hunteriana.*

Biconvex Melaleuca - *Melaleuca biconvexa*

There are records of this species in close proximity to the proposed development site and it is possible that the species occurs along drainage lines on the site. The species can be surveyed at any time. Should it be located, this would represent the most eastern population in southern NSW. There may, therefore, be a need to undertake a genetic analysis as per earlier work undertaken by DEC to determine the relationship of this population with others in the region.

Sydney Coastal Estuary Swamp Forest Complex Endangered Ecological Community

The subject site has been mapped by ERM as having Woollybutt/Paperbark Forest which has Swamp Mahogany *E. robusta* as one of the component species. Swamp Mahogany is one of the indicator species of the Sydney Coastal Estuary Swamp Forest Complex. The consultant should refer to the definition of the EEC in the NSW Scientific Committee determination, which is available on the DEC Website: www.npws.nsw.gov.au. The extent and quality of the Sydney Coastal Estuary Swamp Forest Complex in the study area are to be mapped and evaluated

in the context of occurrences of this Endangered Ecological Community within a 10 km radius of the study area. The relative extent of the community in the study area and the 10 km radius area and their respective importance for the conservation of the community are to be evaluated.

The defining of the Sydney Coastal Estuary Swamp Forest Complex and the delineation of the boundary of this community is of critical importance. An explicit definition of this community must be given and how, in practice, this definition is used to identify the boundary of the community in the field clearly set out.

Southern Brown Bandicoot

This species is Commonwealth listed and highly threatened in the region and across NSW. If this species is present on site, the impact of the proposed development is likely to be significant. Consequently, it will be essential to protect all known sites.

The occurrence of *I. obesulus* at a site may be indirectly inferred from the presence of distinctive conical-shaped excavations in the soil. These excavations, which represent the forage-diggings of animals, vary in size but typically range from 5-10 cm deep and 3-10 cm wide. Occasionally, forage-diggings may be up to 30-40 cm deep and 15 cm wide. Since similarly-shaped forage-diggings can be left by the common and widely distributed Long-nosed Bandicoot (*Perameles nasuta*), and the uncommon Long-nosed Potoroo (*Potorous tridactylus*), further survey work will be necessary to identify which species is/are present. These species are variously known to occur together.

Live-trapping using wire mesh 'bandicoot' traps (200 mm wide x 170 mm tall x 500 mm long) is the preferred survey method for detecting *I. obesulus* (manufactured by R.E. Walters Pty. Ltd., Sunshine, VIC). This method will allow for unequivocal identification of animals, provided the person undertaking the trapping work is experienced in identifying bandicoots. If this is not the case, then any captured animals should be photographed, measured and have hair-samples taken for later analysis (see below). Subsequent identification of the animal in question can then be made by an appropriate expert.

The type of bait used to lure animals into traps may vary, but is usually based on a mixture of peanut butter and rolled oats. Various additives can be incorporated into this mixture, such as honey, golden syrup, pistachio essence (Keith Harris and Co. Ltd., Thornleigh, New South Wales), or sardines. Where possible, a range of such bait types should be used, alternated between traps with equal effort.

Ideally, live-trapping survey for *I. obesulus* should be carried out during the warmer months, from early September through to late April. Outside of this period trapping should only be conducted during fine weather. Regardless of time of year, periods of inclement weather (ie. heavy rainfall) should be totally avoided.

The number of traps set at a site will vary according to the extent of suitable habitat, the area over which characteristic forage-diggings are present, and the scale of the proposed development or activity. Traps should ideally be arranged in lines or transects through likely habitat types, or as indicated by the presence of forage-diggings. Traps should be spaced between 20 and 50 metres apart. As a general rule a minimum of 10 traps per ha should be set.

Traps should be set for a minimum period of 4-5 consecutive nights. This duration of time is usually sufficient to determine the identity of the animals present at a site. On each day traps should be set at dusk and checked the following morning. Where possible, traps should not be left open during daylight hours, particularly during periods of hot weather. In situations were the same animals are being repeatedly trapped, individual trap stations may need to be closed.

Handling of captured animals should be kept to a minimum, since bandicoots are prone to stress. Adult female animals may lose pouch young upon capture and handling. Any handling that needs to be undertaken should be done on animals restrained within the confines of an opaque bag. Thick cotton, as used in the manufacture of tracksuit pants, is an ideal material for this purpose.

Other survey techniques such as hair-sampling tubes (as per Scotts and Craig 1988) can also be used to detect *I. obesulus*, but these should always be viewed as a secondary option to live-trapping with wire mesh cage traps. If used, hair-sampling tubes should be set with the same attractant baits as indicated above, for a period of at least 7 and up to 10 days. As with live trapping, the spatial configuration and intensity of sampling will vary according to the particular situation. A person specialising in mammalian hair analysis should identify all hair samples collected during survey.

Further specific guidance in relation to survey for *I. obesulus* should be sought from DEC via the contact addresses listed below.

Long-nosed Potoroo

The Long-nosed Potoroo is also Commonwealth listed. Whilst there are a few records in nearby Booderee NP, the adequacy of reservation of the species is unknown. For survey techniques please refer to Southern Brown Bandicoot.

White-footed Dunnart, Eastern Pygmy-possum and Eastern Chestnut Mouse

The true status of the White-footed Dunnart in the Shoalhaven region is poorly known. It is not known whether the species is widespread or localised and hence, the adequacy of reservation in the region is unknown. If the species was found on the subject site, then the consultant should survey off-site to determine the local significance of the population on the subject site. The Eastern Pygmy-possum was recorded on the subject site by ERM in December 2003. Therefore, the consultant must map the preferred habitat on the subject site and also determine the regional status of the species through off-site surveys. The Eastern Chestnut Mouse has been recently recorded in Booderee NP and Bhewerre Peninsula. However, its

status in the region is not known. The species prefers wet and swampy heathlands and to a lesser extent open woodlands. Surveys for all three species must be conducted with pitfall traps wherever possible, or alternatively small "Elliott" traps.

Squirrel Glider

The consultant needs to determine the distribution and abundance of the species on the subject site and its status in the region. Squirrel Gliders may occur across a wide variety of forest and woodland vegetation types. The likelihood of occurrence of animals within a stand of native vegetation will be dependent upon a range of factors. Key features of habitat likely to increase the probability of the species occurring on-site include the presence of large hollow-bearing eucalypt trees and an understorey of flowering shrubs, particularly from the genus *Acacia*. In instances where one or both of these features are present, and the form of development proposed is likely to impact upon them, then either follow-up survey should be conducted or the species should be assumed to be present for the purpose of further assessment.

Live-trapping in trees is the preferred survey method for detecting Squirrel Gliders. Traps should be either large Elliott box traps or wire mesh 'bandicoot' traps (200 mm wide x 170 mm tall x 500 mm long; Figure 2) (manufactured by R.E. Walters Pty. Ltd., Sunshine, VIC).

Live-trapping is a preferred sampling technique as it allows for unequivocal identification of animals. This is particularly important as the Squirrel Glider is very similar in appearance to the smaller Sugar Glider, *P. breviceps*, and both species may occur in the same or similar habitats. The Squirrel Glider may be distinguished from the latter species on the basis of the following characteristics; (i) it is up to twice the size of the Sugar Glider, (ii) its tail is bushier at the base, (iii) its facial markings are typically more distinct, (iv) it has a longer, more pointed face, (v) longer and narrower ears, and (vi) the belly fur is completely white compared to the patchy grey of the sugar glider.

If definite identification cannot be made then any captured animals should be photographed and measured. Subsequent identification of the animal in question can then be made by an appropriate expert.

The type of bait used to lure gliders into traps is usually based on a mixture of peanut butter, honey and rolled oats. A honey and water solution may be sprayed above and below the trap entrance.

Ideally, live-trapping survey for Squirrel Gliders should be carried out during the warmer months, when there is a lower probability of occurrence of flowering eucalypts (Smith 2000).

The number of traps set at a site will vary according to the extent of suitable habitat, the area over which possible den sites are present, and the scale of the proposed clearing or activity. Traps should ideally be positioned horizontally in

low tree branches. Traps must be attached to trees and spaced approximately 50-100 m apart in a transect or grid layout, as the habitat allows.

Traps must be set for a minimum period of 3-4 consecutive nights. This duration of time is usually sufficient to determine whether gliders are present at a site. On each day traps should be set at dusk and checked the following morning. Where possible, traps should not be left open during daylight hours, particularly during periods of hot weather. In situations where the same animals are being repeatedly trapped, individual trap stations may need to be closed.

Other survey techniques such as spotlighting and stagwatching can also be used to detect the Squirrel Glider but are not preferred over live-trapping. These survey techniques require observers with experience in Squirrel Glider identification as the species can be easily confused with Sugar Glider by untrained observers, especially from afar and after dusk. Spotlighting of a given transect should be undertaken on at least three different occasions, on mild nights, generally along established trails or roads. Squirrel Gliders can be difficult to detect using this survey technique, and often the white ventral fur first attracts attention, rather than eyeshine (Menkhorst *et al.* 1988).

Routine stagwatching (standing under hollow-bearing trees at dusk watching animals emerge from hollows) can focus on large hollow-bearing trees within any given stand. It must be carried out simultaneously at all potential trees to be effective.

If the species is present, given the rarity of the species in the region, any proposed development must avoid direct impacts on the species in the first instance, minimise any unavoidable or indirect impacts, and then set up processes which establish long-term conservation of the species on-site.

Yellow-bellied Glider

The distribution and abundance of aggregations of den sites and feed trees must be determined using appropriate nocturnal surveys and mapping methods. Surveys must consist of stag watching, spotlighting, call play-back and habitat assessment. Spotlighting surveys must be done on foot in potential habitats. Call play-back should also focus on potential habitats. At each call play-back site, the call of the Yellow-bellied Glider should be played through a megaphone for 5 minutes, followed by 10 minutes of spotlighting. Feed trees are characterised by 'v'-shaped scars on the trunks and branches where gliders have incised the surface to extract sap. An assessment of potential links between habitat on the site and habitats in the broader landscape surrounding the site must be conducted.

Threatened Microchiropteran Bats

The subject site has an exceptionally diverse micro-bat fauna, with seven species being detected by Gunninah. Therefore, the regional significance of the subject site needs to be determined. All five subject species, Large-footed Myotis, Eastern False Pipistrelle, Eastern Freetail-bat, Yellow-bellied Sheathtail-bat and

Greater Broad-nosed Bat, will be impacted through the loss of roosting sites, and indirectly through urban impacts of light, noise, increased risk of predation by nocturnal raptors and cats. There will also be an incremental loss of urban roost trees. The number and location of roost sites of the five subject bats should be identified. The DEC is happy to discuss the various techniques that would be required to acquire this information.

Giant Burrowing Frog

The rarity and cryptic habits of the Giant Burrowing Frog are problematic for survey design. Surveys for this species need to be targeted at appropriate habitats, seasons, and weather conditions, along with appropriate techniques and effort. The patchy distribution, low numbers and cryptic habitats of this species means that sampling effort, including the area sampled and the number of times sampled, must be high. Detection can be enhanced by sampling in seasons and weather conditions when the species is most conspicuous. The Giant Burrowing Frog calls most frequently between February and April. Overall detection levels of this species (calling, non-calling and larval records) are highest from January through to May. The species appears to be active only at night, mostly after rain storms, and generally under warm or mild conditions. In particular, summer rain storms may be an important trigger for breeding activity.

Major drainage systems, or groups of drainage systems are likely to provide an appropriate base-line stratification. Each of these units then needs to be sampled across the range of broad habitats (landforms, vegetation classes, altitude) in which the species potentially occur. For the Giant Burrowing Frog, sampling may be conducted in a stream section, stationary water body away from streams and in terrestrial habitats away from drainage lines. Where possible, sampling must be conducted in each of these situations in any given area or 'survey site'.

- Advertisement call play-back technique must be conducted at all sample sites on a repeated basis, in conjunction with standard visual censuses under ideal climatic and temporal conditions.

- Spotlight searches must be conducted along streams at night, either during or immediately after rain, during warm or mild conditions, from February to April. A minimum of 500 m should be searched at each stream site. Call play back should be conducted at 100 m intervals, subject to findings of the above trials of this technique. Sites should be sampled on a minimum of three occasions.

- Tadpole sampling should be conducted in all pool habitats along each 500 m stream transect during the day. Tadpole sampling should also be conducted in any stationary water bodies near the stream. A dip net with a long pole is dragged through each pool for a set time, usually 1-2 minutes. Tadpole sampling could be conducted on the same day as each nocturnal frog census. Some sampling could occur later in the year until May. A minimum of three censuses should be conducted at each site.

This species is likely to be impacted by altered hydrology, pollution, and predation by feral and companion animals. The habitat of the Giant Burrowing Frog is likely to be poorly reserved.

Ground Parrot

There have been recent records (as recently as December 2003) of the Ground Parrot on the subject site. Impacts on the species include predation, fire and human disturbance. Call detection is the most appropriate method of survey for Ground Parrots. Flushing of birds in suitable habitat is also an appropriate method but requires a substantial number of people to walk in a line, with about five metres between each person, through the habitat in question. Ground Parrots in high densities call regularly at dawn and dusk, with the call being easily identified, and able to be heard for a distance of about 400 m in ideal conditions. A listening period of sixty minutes should enable the listener to maximise the chances of detecting a Ground Parrot, and determine the number and location of calling birds. For example, in an area of ten hectares, two listening surveys should be conducted, one dawn and one dusk survey, provided that there are still, dry conditions. An area of 50 hectares would require at least four listening surveys, i.e. two dusk and two dawn surveys. For a dawn survey, the listener should begin surveying one hour before sunrise, and for a dusk survey the listener should be present at sunset and begin the survey at about fifteen minutes after sunset for one hour. It is thought that Ground Parrots call less when there is a low density of birds present in a particular area. It should be assumed that the species is present, even if calls are not detected. Surrounding suitable habitat within 2 km must also be surveyed for this species and estimates of the population resident within the area provided. The areas of suitable habitat are to be shown on the previously mentioned map.

Eastern Bristlebird

This Endangered ground-dwelling bird has been recorded on the subject site in recent times and is threatened by further loss and fragmentation of its habitats. The loss of any viable area of individual birds is considered to be a significant impact. Surveys shall be conducted during Spring and Summer as there is little chance of birds responding to calls outside these seasons. Background information on home range sizes and habitat use is available in Baker (1998, 2001). A listening period of 30 minutes beginning at sunrise is required, before conducting a search for the species. A slow search involves walking at 2 km an hour through the study area, or along a transect representative of the study area. On completion of the slow search, call detection using a taped call to elicit a response should be used to attempt to detect the species. The Eastern Bristlebird's distinctive calls can be heard within 100 m. A call playback session consists of playing the taped call for two minutes, followed by a listening period of thirty minutes. It should be noted that the species may respond immediately, i.e. during the tape playing, or may not respond at all. Call playback sessions should be conducted at points along a given transect through the appropriate habitat (Baker 2001). The distance between survey points should be 200 m. The consultant should also give consideration to habitat mapping information that is now available for the Shoalhaven area by contacting one of the DEC contact staff listed below.

Powerful Owl, Masked Owl and Sooty Owl

There are numerous records of the Powerful Owl on the subject site and the surrounding area. The Masked Owl is known to be resident in the northern drainage line of the subject site. There is a record of a Sooty Owl on the subject site. However, it may have been passing through rather than being a resident.

Nocturnal call-playback surveys should focus on detection of key nesting and roosting resources. Surveys to detect likely nesting areas should be undertaken from June-September. Drainage lines should be searched for evidence of 'white-wash' indicating roost sites. Roost sites detected during this period may indicate nearby breeding habitat (large trees with large hollows often close to drainage lines) that should be retained and buffered from disturbance. Searches for pellets must be conducted at any roost or nest tree that is located. These are to be analysed to identify key prey items. This information should be used to identify strategies to protect prey species on the site.

Glossy Black Cockatoo

This iconic parrot is threatened by the loss of mature hollow-bearing trees and viable *Allocasuarina* foraging habitat that has been lost in the fires of late 2001. Presently, much of the foraging habitat in the St George's Basin/Vincentia area is recovering from the fire. Therefore, the subject site may be temporally significant for the Glossy Black Cockatoo.

To determine the regional and temporal significance of the key foraging habitats of the Glossy Black Cockatoo in the St George's Basin/Vincentia area, DEC and the Shoalhaven City Council are considering undertaking a collaborative mapping project in 2004. The consultants should consider undertaking their own mapping or wait until this information becomes available.

Surveys for nesting and roosting habitat should be undertaken in autumn and winter and concentrate on identification and assessment of large hollow-bearing trees.

Swift Parrot

The regional significance of the subject site for the Swift Parrot is unknown. The site may provide suitable winter foraging habitat in Spotted Gum and Swamp Mahogany areas. Diurnal fixed-width transect or point-count surveys between March and October should be conducted across the subject site

Regent Honeyeater

The regional significance of the subject site for the Regent Honeyeater is unknown. There are potential breeding and foraging habitats on the subject site that should be surveyed using diurnal fixed-width transect or point-count surveys and call playback techniques, as the species responds to taped calls during the breeding season. Whilst surveys can be conducted at any time of the year, the optimal time is spring and summer during the breeding season.

Turquoise Parrot

There is a record of the species from the subject site in 2001. The regional status of the species is not known. Diurnal fixed-width transect or point-count surveys are best conducted in the breeding season (Spring-Sumer). If the species is found on the subject site, the consultant needs to determine the regional significance of the subject site.

Square-tailed Kite

There would appear to be a resident bird or pair of birds in the vicinity of the subject site. These individuals may operate over an entire region, so the significance of the subject site is unknown. A diurnal survey must be conducted to determine whether there is key breeding habitat on the site. A search for nesting trees must be undertaken and the home range of the resident bird(s) should be quantified to determine the significance of the subject site.

5 Assessment of likely impacts on threatened species

5.1 Assessment of species likely to be affected

An assessment of which threatened species or population known or likely to be present in the area are likely to be affected by the action (Section 110(2)(c))

This requirement is asking the person preparing the SIS to refine the list of subject species (given the outcome of survey and analysis of likely impacts) in order to identify which threatened species may be affected and the nature of the impact. The remaining requirements in this section need only be addressed for those species that are likely to be affected by the proposal. It is the view of DEC that the proposed development may lead to a significant impact on all of the subject species, should they be present. Therefore, this section must be addressed for all subject species.

5.2 Discussion of local and regional abundance

An estimate for the local and regional abundance of those species (or populations) (Section 110 (2)(d))

5.2.1 Discussion of other known local populations

A discussion of other known populations in the locality shall be provided. The long term security of other habitats shall be examined as part of this discussion. The relative significance of the subject site for the identified threatened species in the locality shall be discussed. For the orchid species in particular, the results of previous surveys for other populations of the species in the region shall be considered. This shall include a summary of sites where unsuccessful searches are known to have been conducted. The importance of the population on the subject site to the overall survival of these orchid species shall be addressed, including

consideration of any likely genetic differences between the Vincentia populations and other known populations.

Particular attention shall be given to considering the indirect impact of the development on habitat and the resident individuals of the species within 2 km of the *subject site*. Specific consideration must be given to the cumulative impact of other proposed developments in the Vincentia area.

5.2.2 Discussion of habitat utilisation

An estimate of the numbers of individuals utilising the area and how these individuals use the area (e.g. residents, transients, adults, juveniles, nesting, foraging) and discussion of the significance of these individuals to the viability of the threatened species in the locality is required.

5.2.3 Description of vegetation

The vegetation present within the study area and the area covered by each vegetation community shall be mapped and described. Include reference to the vegetation classification system used (e.g. Specht). Classification must have regard to both structural and floristic elements.

5.2.2 Discussion of corridors

If movement corridors for threatened species or endangered populations are present within the subject site, the impact of the proposal on these areas shall be discussed.

5.3 Assessment of habitat

A full description of the type, location, size and condition of the habitat (including critical habitat) of those species and populations and details of the distribution and condition of similar habitats in the region (Section 110 (2)(f))

5.3.1 Description of habitat values

Specific habitat features shall be described (e.g. frequency and location of hollow-bearing trees, areas of heath and woodland with heath understorey overlying clay, drainage lines, soaks etc) and the density of understorey vegetation and groundcover.

The condition of the habitat within the study area shall be discussed, including the prevalence of introduced species, species of weeds present and an estimate of the total weed cover as a percentage of each vegetation community, whether trampling or grazing is apparent, effects of erosion, prevalence of rubbish dumping, history of resource extraction or other disturbances and proximity to roads.

Details of the subject site's fire history (e.g. frequency, time since last fire, intensity) and the source of fire history (e.g. observation, local records), shall be provided.

5.4 Discussion of conservation status

For each species or population likely to be affected, details of its local, regional and State-wide conservation status,...[and]... its habitat requirements ... (Section 110(2)(c))

Assessment shall include reference to the threatening processes which are generally accepted by the scientific community as affecting the species or population and are likely to be caused or exacerbated by the proposal. Assessment shall also include reference to any draft Recovery Plans which may be relevant to the proposal. While no Recovery Plans or Threat Abatement Plans for the listed species and community have been approved in accordance with the TSC Act as yet, several draft Recovery Plans have been prepared. Where a plan is relevant to any subject species, consideration shall be given to the information contained in these plans and whether any recommendation is applicable to the proposal. Draft Recovery Plans are available for *P. affine* and the Yellow-bellied Glider. Draft Recovery Plans are currently in preparation for the Southern Brown Bandicoot, Squirrel Glider, Eastern Bristlebird, Ground Parrot and Regent Honeyeater. National Recovery Plans are available for the Regent Honeyeater and Swift Parrot. Once a list of species known or likely to occur in the subject area or locality has been derived, the DEC contact officers listed below shall be contacted to determine whether draft Recovery Plans or management plans are available for any additional listed species.

5.5 Likely impacts

Assessment of impacts shall include the assessment of indirect impacts and those of associated activities, including, but not restricted to: installation and maintenance of utilities, fire protection zones, access and egress routes; and changes in surface water flows. These actions or impacts may occur on or off the subject land.

For all subject species, the SIS shall state the following:

- the location, nature and extent of habitat removal or modification which may result from the proposed action;
- the potential impact of the removal and/or modification of habitat and the likelihood of and extent of loss of food resources and the impact this may have on the subject fauna species;
- any indirect impacts of the proposal such as the fragmentation or isolation of populations, increased distance required for fauna and pollinator movement between habitat patches, changed fire regimes as a result of both deliberate fire management and increased incidence of wildfire, changes in soil or water regimes, disturbance to feeding or nesting/breeding of species as a result of human visitation and associated motor vehicles and increased predation by the European Red Fox and Feral Cat;

- the likely contribution of the proposed action to the threatening processes already acting on populations of those species in the locality. Particular attention shall be given to the potential for increased fox or cat predation on Eastern Bristlebirds and Ground Parrots.

In the case of *P. affine*

- an assessment of the threats (e.g. trampling, increased fire frequency, rubbish dumping, weed invasion, pollution, increased nutrient levels resulting from horticultural activities and dog defacations etc.), to *P. affine* and its habitat which are likely to result from a expected greatly increased concentration of people and dogs in the area;
- the likely effect of identified likely threats on the survival of individual plants and the habitat of *P. affine*;
- in relation to potential impacts on the pollinators of *P. affine* the following issues raised by Bower (2002) must be addressed:
- identify what habitat is critical for the survival of the pollinators;
- the likely consequences of the potential loss or reduction in size of local populations of pollinators of *P. affine* and discuss how the development could be designed to reduce the loss to non-significant levels;
- the extent to which pollinator habitat diversity will be protected and maintained;
- the extent to which likely pollinator refugia will be protected and maintained;
- the extent to which retained *P. affine* habitat and pollinator habitat will remain connected to adjacent pollinator habitat and the likely effectiveness of these connections in allowing recolonisation of the subject site by pollinators if they were lost from the site during a catastrophic event;
- demonstrate that sufficient pollinator habitats are to be retained on the development site to ensure survival of the pollinators

5.5 Description of feasible alternatives

A description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed, having regard to the biophysical, economic and social considerations and the principles of ecologically sustainable development (Section 110(2)(h))

Where a Statement of Environmental Effects, Environmental Impact Statement or Review of Environmental Factors deals with these matters, the SIS may refer to the relevant section of the SEE, EIS or REF.

Feasible alternatives shall also be illustrated as part of the draft master plan.

Options for alternative designs relating to the layout of the Commercial Site and the proposed adjacent Residential Site shall be considered which would minimise encroachment on threatened species habitat and maximise buffer areas between proposed developments and threatened species habitats.

The feasibility of placing the Commercial Site and/or the Residential Site on other sites shall be described. The socio-economic benefits of the development shall be described.

6 Ameliorative measures

6.1 Description of ameliorative measures

A full description and justification of the measures proposed to mitigate any adverse effect of the action on the species and populations and ecological community including a compilation (in a single section of the statement) of those measures (Section 110 (2)(i) and Section 110 (3)(f))

In describing the intended ameliorative measures a clear distinction must be made between recommendations of the consultant preparing the SIS and what the applicant actually intends to implement.

6.1.1 Long term management strategies

Consideration shall be given to developing long term management strategies to protect areas within the study area which are of particular importance for the threatened species likely to be affected. This may include proposals to restore or improve habitat on site where possible. Given the rarity of *P. affine*, it will be particularly important to detail how the species can be satisfactorily managed and maintained in close proximity to a large commercial centre and residential development.

Use of appropriate fencing, screening plantings, open space buffers and use of roads as boundaries to sensitive habitat are among matters that might be considered to ameliorate the impact of the development. Appropriate educational signage is another measure that might be considered in gaining public co-operation in avoiding the impact to habitat critical for the survival of threatened species populations. Advice to prospective purchasers regarding their responsibilities and restrictions on development is also recommended.

6.1.2 Compensatory strategies

Where significant modification of the proposal to minimise impacts on threatened species is not possible then compensatory strategies should be considered. These may include other offsite or local area proposals that contribute to long term conservation of the threatened species.

Where such proposals involve other lands, or where involvement of community groups is envisaged in such proposals, such groups are to be consulted and proposals shall contain evidence of support from these stakeholders and relevant land managers.

Compensatory benefits likely to result from such measures proposed for alternative sites are to be discussed and evaluated along with a discussion of

details of proposed resourcing of such actions and the mechanisms of how they might best occur.

6.1.3 Ongoing monitoring

Any proposed pre-construction monitoring plans or on-going monitoring of the effectiveness of the mitigation measures shall be outlined in detail, including the objectives of the monitoring program, method of monitoring, reporting framework, duration and frequency. Generally, proposed ameliorative strategies which have not been proved effective should be undertaken under experimental design conditions and appropriately monitored.

7 Socio-Economic Factors

The following issues shall be addressed:

7.1 The social and economic benefits and consequences of the proposed development, for both the local and regional community, should be detailed. Discussion of these benefits and consequences should cover factors such as short- and long-term employment arising both directly and indirectly from the development, as well as the significance of increased educational facilities for both the local and regional community. The social and economic costs of the development not proceeding should also be detailed.

8 Additional Information

8.1 Qualifications and experience

A Species Impact Statement must include details of the qualifications and experience in threatened species conservation of the person preparing the statement and of any other person who has conducted research or investigations relied on in preparing the statement (Section 110(4))

8.2 Other approvals required for the development or activity

A list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the species or population or ecological community (Sections 110(2)(j) and 110(3)(g))

In providing a list of other approvals the following shall be included

- Where a consent is required under Part 4 of the *Environmental Planning and Assessment Act 1979*, the name of the consent authority and the timing of the development application shall be included; or
- Where an approval(s) is required under Part 5 of the *Environmental Planning and Assessment Act 1979*, the name of the determining authority(ies), the basis for the approval and when these approvals are proposed to be obtained shall be included.

8.3 Licensing matters relating to the survey

Persons conducting flora and fauna surveys must have appropriate licences or approvals under relevant legislation. The relevant legislation and associated licences and approvals that may be required are listed below:

National Parks and Wildlife Act 1974:

- General Licence (Section 120) to harm or obtain protected fauna (this may include threatened fauna).
- Licence to pick protected native plants (Section 131).

Threatened Species Conservation Act 1995:

- Licence to harm threatened animal species, and/or pick threatened plants and/or damage the habitat of a threatened species (Section 91).

Animal Research Act 1985:

- Animal Research Authority to undertake fauna surveys.

8.4 Section 110 (5) reports

Section 110(5) of the *Threatened Species Conservation Act 1995* has the effect of requiring the DEC to provide information regarding the State-wide conservation status of the subject species as it has available, in order to satisfy ss.110(2)&(3) of the Act. To this end, a number of publications have been produced:

The DEC has produced a set of profiles for a number of threatened species, populations and ecological communities.

- Published profiles relevant to the suggested list of subject species for this development include: Glossy Black Cockatoo, Square-tailed Kite, Ground Parrot, Eastern Bristlebird, Regent Honeyeater, Southern Brown Bandicoot, Long-nosed Potoroo, White-footed Dunnart, Giant Burrowing Frog.
- A set of these profiles, including a folder for their storage can be purchased for $50 from the DEC Information Centre.
- A number of these profiles are also available for downloading from the DEC web page at www.npws.nsw.gov.au.

The DEC Threatened Species Unit, Queanbeyan, is also preparing draft environmental assessment guidelines for threatened species, endangered populations and endangered ecological communities. Available draft guidelines relevant to the suggested list of subject species for this development are Eastern Bristlebird and Southern Brown Bandicoot.

Proponents and consultants should note that the DEC has no further published information available to satisfy s.110(5) of the Act and that purchase or receipt of the above profiles can be taken to have satisfied the requirements of ss.110(2)&(3) in relation to the State-wide conservation status of the species, populations and ecological communities.

Should you require any further information on these requirements please contact Damon Oliver on 6298 9727 for fauna issues or John Briggs on 6298 9714 for flora issues, or fax 02 6299 4281 for either officer.

For general inquiries regarding the requirements please do not hesitate to contact me on (02) 6298 9715.

Yours sincerely

17 DEC 2003

MICHAEL SAXON
Manager, Threatened Species (Southern)
Department of Environment and Conservation
as delegate to the Director-General

References

Baker, J. (1998). Radio-tracking the eastern bristlebird at Jervis Bay. Consultant's report to Environment Australia and NSW NPWS. (Available at DEC Nowra Area Office).

Baker, J. (2001). Population density and home range estimates for the Eastern Bristlebird at Jervis Bay, south-eastern Australia. *Corella* 25(3): 62-67.

Bower, C. C. (2002). Population of the Jervis Bay Leek Orchid, *Prasophyllum affine* Lindley (Orchidaceae). Final report to the Jervis Bay Leek Orchid Recovery Team. Unpublished report, pp 49.

Menkhorst, P.W., Weavers, B.W. and Alexander, J.S.A. (1988). Distribution, Habitat and Conservation Staus of the Squirrel Glider *Petaurus norfolcensis* (Petauridae: Marsupialia) in Victoria. *Aust. Wildl. Res.* **15**, 59-71.

Smith, A. (2000). Study in Progress: Sub-regional Squirrel Glider Study North Wyong Shire. Unpublished report prepared by Austeco Environmental Consultants, Armidale, NSW.

Annex J

Subconsultants

List of subconsultants employed on the project

Name	Organisation
Barbara Triggs	Dead Finish, Genoa, Victoria
Dr Colin Bower	FloraSearch, Orange, NSW
Dr Neil Saintilan	Australian Catholic University, Sydney
Glenn Hoye	Fly-By-Night Bat Surveys Pty. Ltd.
Peter Ekert	Ekerlogic Consulting Services, NSW

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