

Ben Fairfax
Bluestone Property Solutions P/L
Suite 1, Level 6
71 Macquarie St
Sydney NSW 2000

Ref: 11SUTECO-36

17 February 2012

Dear Ben,

ECOLOGICAL SURVEYS AT CRONULLA SHARKS REDEVELOPMENT SITE

We have conducted surveys for birds, frogs and micro-chiropteran bats during November 2011 to February 2012 to better understand the impacts that could be associated with redevelopment of the Cronulla Sharks redevelopment site.

Ecologists involved in the survey and analysis were:

- Lucas McKinnon
 - Bachelor of Environmental Science (Honours), University of Wollongong
 - BioBanking Accredited Assessor (No. 0076), *Threatened Species Conservation Act 1995*, TAFE NSW and DECCW
- Dr Rodney Armistead
 - PhD in Conservation Biology from Murdoch University, Perth Western Australia. 2008
 - Bachelor of Advanced Science (Honours), Deakin University, Geelong. 2001
- Peter Knock
 - Bachelor of Applied Science, University of Canberra, 1990
 - Associate Diploma of Environmental Control, Mitchell College of advanced Education 1988

Methods

The survey site, referred to in this letter as the Cronulla Sharks complex (CSC), is located along Captain Cook Drive, Cronulla (Figures 1 and 2). Bird, frog and bat surveys were conducted in accordance with the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft* (DEC 2004), and *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna Amphibians* (DECC 2009). The methods used in the survey are explained in more detail below.

Bird surveys

Visual and call recognition surveys were conducted for birds present within CSC using an 'area search method'. This method involved spending twenty minutes at a particular location or habitat type searching for birds. Surveys were undertaken at the Solander Park playing field, among the mangroves, at the training ground adjacent to Toyota Park and bitumen car park. Mudflat surveys were conducted from the observation platform located at the end of the Woollooware Bay board walk. Survey locations are shown in Figure 3.

All birds observed or heard calling were recorded and identified to species' level using Geering *et al.* (2008) and Day and Simpson (2010).

Green and Golden Bell Frogs

Green and Golden Bell Frog (*Litoria aurea*) (GGBF) surveys were conducted at four locations within CSC and one adjacent locality (Figure 3). Surveys were conducted over three separate nights (Table 3). Each survey was conducted within a week of at least 5 mm of rainfall being recorded (Table 4). Call back surveys were conducted by playing recorded calls of breeding male GGBF's through a loud hailer. Each survey involved playing calls for at least five minutes followed by ten minutes listening for reply calls.

Active daytime searches were conducted in conjunction with each bird survey. The spotlight surveys were conducted in conjunction with the night time call back surveys (Table 1 and 2).

Micro-chiropteran Bat Surveys

Micro-chiropteran surveys were undertaken at four locations (Figure 3). Bat ultra-sonic calls were recorded using SD2 recording devices. Surveys at each site were conducted over at least one hour and for a maximum of twelve hours. Bat calls were analysed by Peter Knock using the program AnalookW (Version 3.7w 31 December 2009, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay *et al.* 2004); and south-east Queensland and north-east New South Wales (Reinhold *et al.* 2001) and the accompanying reference library of over 200 calls from north-eastern NSW. (<http://www.forest.nsw.gov.au/research/bats/default.asp>).

Results and discussion

Fauna habitats

The habitat types present within the survey site include open grasslands (playing fields), bitumen car park (often with large ephemeral puddles), an estuarine channel, mangroves, intertidal mudflats and emergent oyster beds wooded with wooded posts and floating platforms (Figure 2). The mangrove, mudflats and emergent oyster bed wooden posts provide important foraging and roosting habitat for migratory waders and shorebirds (NSW Scientific Committee 1998; Stuart 2004). The mudflats that are exposed at low tide were extensive and provided excellent foraging habitat for several migratory waders and shore birds. However, at high tide the mudflats become completely covered by water forcing the waders to leave the site to roost elsewhere until the next low tide.

At high tide and dusk Little Terns (*Sterna albifrons*) and Silver Gulls (*Chroicocephalus novaehollandiae*) were observed in large numbers roosting on the wooded posts in oyster beds within the bay. These structures have been identified as important roost habitats for migratory and shore birds (Herbert 2007).

Mangroves provide excellent roosting and nesting habitat for a range of bird species and for some micro-bat species (Herbert 2004; DEC 2004). However, during the present survey, only the Australian White Ibis (*Threskiornis molucca*), Australian Raven (*Corvus coronoides*), Pied Currawong (*Strepera graculina*), Willy-Wag Tails (*Rhipidura leucophrys*) and Superb Fairy Wrens (*Malurus cyaneus*) were recorded using the mangrove. None of the bird species recorded using the mangroves appeared to be roosting or nesting. No nests or accumulations of faeces were observed at any location within the mangroves to suggest the site is used otherwise. Furthermore, no threatened or migratory bird species were observed roosting in the mangrove within the study area at high tide or at night.

Australian White Ibis and Australian Raven were observed leaving the mudflats at dusk and flying east. Both species were observed leaving in groups of five, suggesting that these species roost for night elsewhere. This suggests birds roost elsewhere, away from CSC. Several possible locations that are known to provide shore birds and waders with roosting habitat include the TSC Act listed Taren Point Shorebird Endangered Ecological Community (TPS EEC) and the Towra Point RAMSAR listed wetland (Scientific Committee 2011). Each site

offers habitat to up to twenty species of migratory birds, including several that were recorded during the present survey. This includes the Eastern Curlew (*Numenius madagascariensis*), Bar-tailed Godwit (*Limosa lapponica*) and Whimbrel (*N. phaeopus*).

Results of fauna surveys

Migratory Birds

A total of 38 birds were recorded during the surveys (Table 5, 6 and 7). The majority of the species were recorded among the open grassy and bitumen areas present at the site.

Six bird species listed as migratory under the *Environmental Biodiversity Protection Act* (1999) were recorded (Table 4). All of the migratory birds were recorded on the Woollooware Bay mudflats at low tide.

One bird species is listed as threatened under the *Threatened Species Conservation Act*. The Sooty Oystercatcher (*Haematopus fuliginosus*) was recorded roosting on a barge among the oyster beds (Table 6).

Frog surveys

No frogs of any species, including the target threatened species (the Green and Golden Bell Frog), were recorded during the surveys. The night time spotlight and day time searches revealed that all of the fresh or brackish waterways searched were populated by the Plague Minnow (*Gambusia holbrooki*). This species of fish has been shown to have a significant impact on GGBF population, and is listed as a Key Threatening Process. It may have been a major contributing factor to some localised extinctions (DEC 2005). Plague minnows prey upon the tadpoles of the GGBF.

Micro-chiropteran bat surveys

Five species of micro-chiropteran bats were recorded over the two survey efforts (Table 7).

However, there is some uncertainty about three species identified due to weak or distant calls. This includes the TSC Act listed Large-footed Myotis (*M. macropus*), Greater Long-eared Bat (*N. timoriensis*) and Eastern Long-eared Bat (*N. bifax*). The distant or low frequency calls suggest that these species may have been foraging away from the study site. This may be especially true for the Greater and Long-eared Bats that typically inhabit forest and coastal scrub which does not occur on the survey site. The Large-footed Myotis may have been foraging over Woollooware Bay and may roost in the hollows present within the mangroves.

Conclusion and recommendations

The site provides suitable habitat for a variety of bird species. However, no migratory birds or threatened bird species were observed using the mangroves, grassy playing fields or the car park. Only the tidal mudflats in Woollooware Bay offered suitable foraging habitat to the migratory birds recorded in the region. In addition, the wooded poles within the offshore oyster beds provide up to 100 Little Terns and Silver Gulls with roosting habitat. Therefore, the site does not appear to be an important roosting location for migratory or threatened birds and the development is unlikely to have a direct impact upon the habitat used by the migratory or threatened birds.

However, one threatened species of micro-chiropteran, the Large-footed Myotis, may nest within the mangroves and forage over Woollooware Bay. Additional survey could be performed to confirm presence or absence of this species. If recorded, there may be specific management strategies that could be implemented to prevent adverse impacts e.g. habitat offsets.

Other conclusions and recommendations from ELA's 2011 report are supported by this investigation.



Figure 1. Location of Cronulla Sharks Complex, the subject site.

SUITE 4, 2-4 MERTON ST SUTHERLAND NSW 2232 | PO BOX 12 SUTHERLAND NSW 1499 T | 02 8536 8600 F | 02 9542 5622

ARMIDALE | CANBERRA | COFFS HARBOUR | DARWIN | GOSFORD | MUDGE | NAROOMA | NEWCASTLE
 PERTH | ST GEORGES BASIN | SUTHERLAND | SYDNEY | WOLLONGONG



Figure 2. Location of study regions within the subject site.



Figure 3. Location of bird, Green and Golden Bell Frog and Anabat surveys.



Figure 4. Habitat types present within the study site.

Table 1. Dates, tides times and ecologist who undertook the survey each migratory bird survey.

| DATE | TIDE | | TIME | ECOLOGIST |
|----------|----------|------|--------------|----------------|
| 24/11/11 | Low | 0.2m | 1405 - 1515 | Rod Armistead |
| 24/11/11 | High | 1.9m | 0900 – 1100 | Rod Armistead |
| 2/12/11 | EBB Tide | 1.4m | 0700 – 08300 | Rod Armistead |
| 8/12/11 | Low | 0.5m | 1300 – 1515 | Lucas McKinnon |
| 9/12/11 | High | 1.7m | 830 – 1000 | Rod Armistead |
| 22/12/11 | Low | 0.3m | 1130 – 1245 | Rod Armistead |
| 22/12/11 | High | 1.3m | 1815 - 1930 | Rod Armistead |
| 6/01/12 | Low | 0.6m | 1220 – 1400 | Rod Armistead |
| 6/01/12 | High | 1.6m | 1700 – 2000 | Rod Armistead |
| 18/01/12 | Low | 0.5m | 1105 - 1230 | Rod Armistead |
| 18/01/12 | High | 1.2m | 1845 – 2000 | Rod Armistead |
| 30/01/12 | Low | 0.6m | 1915 – 2015 | Rod Armistead |
| 30/01/12 | High | 1.3m | 1315 - 1430 | Rod Armistead |
| 13/02/12 | Low | 0.4m | 1300 – 1400 | Rod Armistead |
| 13/02/12 | High | 1.5m | 1845 - 2000 | Rod Armistead |

Table 2. Dates, times and ecologist who undertook the call back and active searches for Green and Golden Bell Frog

| DATE | SURVEY LOCATION | TIME | ECOLOGIST |
|----------|-----------------------------------|----------------|---------------|
| 18/02/12 | Solander Playing Field | 2000 – 2015hrs | Rod Armistead |
| 18/02/12 | Channel | 2020 – 2035hrs | Rod Armistead |
| 18/02/12 | Golf Course Channel | 2037 – 2055hr | Rod Armistead |
| 30/02/12 | Solander Playing Field | 1955 – 2010 | Rod Armistead |
| 30/02/12 | Channel | 2030 – 2043hrs | Rod Armistead |
| 30/02/12 | Golf Course Channel | 2045 – 2100 | Rod Armistead |
| 30/02/12 | Elouera Road Wetlands Wetlands | 1930 - 1950 | Rod Armistead |
| 13/02/12 | Solander Playing Field | 1950 – 2010 | Rod Armistead |
| 13/02/12 | Channel | 2030 – 2043hrs | Rod Armistead |
| 13/02/12 | Golf Course Channel | 2050 – 2100 | Rod Armistead |
| 13/02/12 | Elouera Road Wetlands Wetlands | 1930 – 1945 | Rod Armistead |

Table 3. Sydney rainfall records prior to Green and Golden Bell Frog survey

| SURVEY DATE | DAYS OF RAINFALL PROIR TO SURVEY | DAILY RAINFALL (MM) | CUMULATIVE TOTAL PROIR TO EAC H SURVEY (MM) |
|-------------|----------------------------------|---------------------|---|
| 18/01/12 | Sunday 15/01/12 | 29.0 | 53.6 |
| | Monday 16/01/12 | 18.6 | |
| | Tuesday 17/01/12 | 6.0 | |
| 30/01/12 | Thursday 26/01/12 | 29.6 | 31.8 |
| | Friday 28/01/12 | 2.0 | |
| | Saturday 29/01/12 | 0.2 | |
| 12/01/12 | Friday 11/02/12 | 3.8 | 7.8 |
| | Saturday 12/02/12 | 2.2 | |
| | Sunday 12/02/12 | 1.8 | |

Source - <http://weather.farmonline.com.au/station.jsp>

Table 4. Dates and times for Anabat surveys.

| DATE | TIME | SURVEY LOCATION | HABITAT TYPE | CALL ANALYSIS |
|----------|-------------|---|---------------------------------|---------------|
| 05/01/12 | 1800 - 0600 | Western Carpark | Mangrove | Peter Knock |
| 05/01/12 | 1800 - 0600 | Solander Playing Field | Mangrove | Peter Knock |
| 05/01/12 | 1800 - 0600 | Mangrove near viewing platform | Mangrove | Peter Knock |
| 13/02/12 | 1930 - 2050 | Solander Playing Field | Grassy playing field | Peter Knock |
| 13/02/12 | 1935 - 2055 | Small wetland near Solander Playing Field | Grass playing field and wetland | Peter Knock |
| 13/02/12 | 1945 – 2100 | Western Carpark | Bitumen car park | Peter Knock |
| 13/02/12 | 2000 - 2100 | Mangrove near viewing platform | Mangrove | Peter Knock |

Table 4. Listed migratory bird species recorded during the surveys and the habitat type each species was observed in.

| FAMILY | GENUS | SPECIES | COMMON NAME | OPEN AREAS | MANGROVES | MUDFLATS | MAXIMUM NUMBERS | REGULARITY OF OBSERVATION |
|------------------|-------------------|-------------------------|-----------------------------------|------------|-----------|----------|-----------------|---------------------------|
| Ardeidae | <i>Ardea</i> | <i>alba</i> | Great Egret | | | Ob | 1 | Once/infrequent |
| Laridae | <i>Sterna</i> | <i>albifrons</i> | Little Tern ^{1, 2} | | | Ob | 100+ | Often |
| Recurvirostridae | <i>Himantopus</i> | <i>himantopus</i> | Black-winged Stilt | | | Ob | 2 | Once/infrequent |
| Scolopacidae | <i>Limosa</i> | <i>lapponica</i> | Bar-tailed Godwit ^{1, 2} | | | Ob | 30 | All surveys |
| Scolopacidae | <i>Numenius</i> | <i>madagascariensis</i> | Eastern Curlew ^{1, 2} | | | Ob | 25 | All surveys |
| Scolopacidae | <i>Numenius</i> | <i>phaeopus</i> | Whimbrel ^{1, 2} | | | Ob | 18 | All surveys |

¹ - Listed under the CAMBA Agreement² – Listed under the JAMBA Agreement

Table 5. Threatened species recorded and habitat type

| FAMILY | GENUS | SPECIES | COMMON NAME | HABITAT TYPE | MAXIMUM NUMBERS | REGULARITY OF OBSERVATION |
|----------|-------------------|--------------------|---------------------|---|-----------------|---------------------------|
| Ardeidae | <i>Haematopus</i> | <i>fuliginosus</i> | Soot Oyster Catcher | On barge among oyster beds in Woollooware Bay | 1 | Once/infrequent |

Table 6. Other bird species recorded during the surveys and the habitat type each species was observed in.

| FAMILY | GENUS | SPECIES | COMMON NAME | OPEN AREAS | MANGROVES | MUDFLATS |
|--------------|-------------------|------------------------|---------------------|------------|-----------|----------|
| Acanthizidae | <i>Acanthiza</i> | <i>pusilla</i> | Brown Thorn-bill | Ob/H | | |
| | | | Mangrove (Striated) | | | |
| Ardeidae | <i>Ardeola</i> | <i>Straitus</i> | Bittern | | | Ob |
| Ardeidae | <i>Egretta</i> | <i>novaehollandiae</i> | White-Faced Heron | | Ob | Ob |
| Artamidae | <i>Gymnorhina</i> | <i>tibicen</i> | Australian Magpie | Ob/H | | |
| Artamidae | <i>Strepera</i> | <i>graculina</i> | Pied Currawong | Ob/H | Ob/H | |
| Cacatuidae | <i>Cacatua</i> | <i>sanguinea</i> | Little Corella | Ob/H | | |
| | | | Sulphur-crested | | | |
| Cacatuidae | <i>Cacatua</i> | <i>galerita</i> | Cockatoo | Ob/H | | |

| FAMILY | GENUS | SPECIES | COMMON NAME | OPEN AREAS | MANGROVES | MUDFLATS |
|-------------------|------------------------|------------------------|-----------------------|------------|-----------|----------|
| | | | Black-faced Cuckoo | | | |
| Campephagidae | <i>Coracina</i> | <i>novaehollandiae</i> | Shrike | Ob | | |
| Charadriidae | <i>Vanellus</i> | <i>miles</i> | Masked Lapwing | Ob | Ob | |
| Columbidae | <i>Ocyphaps</i> | <i>lophotes</i> | Crested Pigeons | Ob | | |
| Columbidae | <i>Streptopelia</i> | <i>chinensis</i> | Spotted Turtle Dove | Ob/H | | |
| Corvidae | <i>Corvus</i> | <i>coronoides</i> | Australian Raven | Ob/H | | Ob/H |
| Corvidae | <i>Corvus</i> | <i>mellori</i> | Little Raven | Ob | | |
| Dicruridae | <i>Grallina</i> | <i>cyanoleuca</i> | Magpie Lark | Ob | Ob | |
| Dicruridae | <i>Rhipidura</i> | <i>leucophrys</i> | Willy Wagtail | Ob/H | Ob/H | |
| Hirundinidae | <i>Petrochelidon</i> | <i>ariel</i> | Fairy Martin | | Ob | |
| Hirundinidae | <i>Hirundo</i> | <i>neoxena</i> | Welcome Swallow | Ob | Ob | Ob |
| Laridae | <i>Chroicocephalus</i> | <i>novaehollandiae</i> | Silver Gulls | | | Ob |
| Maluridae | <i>Malurus</i> | <i>cyaneus</i> | Superb Fairy Wren | Ob/H | Ob | |
| Meliphagidae | <i>Manorina</i> | <i>melanocephala</i> | Noisy Miner | Ob/H | | |
| Pardalotidae | <i>Pardalotus</i> | <i>punctatus</i> | Spotted Pardalote | H | | |
| Pelecaniformis | <i>Pelecanus</i> | <i>conspicillatus</i> | Pelican | | | Ob |
| Phalacrocoracidae | <i>Phalacrocorax</i> | <i>varius</i> | Pied Cormorant | | | Ob |
| Phalacrocoracidae | <i>Anthochaera</i> | <i>carunculata</i> | Red Wattle Bird | Ob/H | | |
| Psittacidae | <i>Trichoglossus</i> | <i>haematodus</i> | Rainbow Lorikeets | Ob/H | | |
| Psittacidae | <i>Psephotus</i> | <i>haematonotus</i> | Red-rumped Parrots | Ob/H | Ob | |
| Pycnonotidae | <i>Pycnonotus</i> | <i>jocosus</i> | Red Whiskered Bulbul | Ob/H | | |
| Sturnidae | <i>Acridotheres</i> | <i>tristis</i> | Indian Myna | Ob/H | | |
| Sturnidae | <i>Sturnus</i> | <i>vulgaris*</i> | Starling | Ob/H | | |
| Threskiornithidae | <i>Threskiomis</i> | <i>molucca</i> | Australian White Ibis | Ob | Ob | Ob |
| Threskiornithidae | <i>Platalea</i> | <i>regia</i> | Royal Spoonbill | | | Ob |
| Turdidae | <i>Turdus</i> | <i>merula</i> | Blackbird | H | | |
| Zosteropidae | <i>Zosterops</i> | <i>lateralis</i> | Silvereye | Ob/H | | |

Table 7. Microchipetrian bat results

| NIGHT | LABEL | COMMON NAME | LOCATION | CONSERVATION STATUS | CERTAINTY OF SPECIES |
|------------|--------------------------------|----------------------|----------------------|--|-----------------------------|
| 5/01/2012 | <i>Chalinolobus gouldii</i> | Gould's Wattle Bat | Mangrove | | Moderate |
| 5/01/2012 | <i>Chalinolobus morio</i> | Chocolate Wattle Bat | Mangrove | | High |
| 5/01/2012 | <i>Mormopterus sp2</i> | Free-tail Bat | Mangrove | | Low – weak or distant calls |
| 5/01/2012 | <i>Myotis / Nyctophilus sp</i> | Large Footed Myotis | Mangrove | <i>M. macropus</i> , <i>N. timoriensis</i> and <i>N. bifax</i> are listed as Vulnerable under the TSC Act. <i>N. timoriensis</i> is also listed as Vulnerable under the EPBC Act. | Low – weak or distant calls |
| 13/02/2012 | <i>Chalinolobus gouldii</i> | Gould's Wattle Bat | Grassy Playing Field | | High |
| 13/02/2012 | <i>Vespadelus vulturnus</i> | Little Forest bat | Grassy Playing Field | | High |

References

- Geering, A., Agnew, L., and Harding, S. (2008). *Shorebirds of Australia*. CSIRO Publishing.
- Day, N., and Simpson, K. (2010). *Field Guide to the Birds of Australia*. 8th Edition. Penguin Books.
- Department of Environment and Conservation NSE (DEC) (2005). *Bat Roosts*. Information Sheet
- Department of Environment and Conservation NSE (DEC) (2005). *Green and Golden Bell Frog Litoria aurea (Lesson 1829) Recovery Plan*.
- Herbert, C. (2007). *Distribution, Abundance and Status of Birds in the Hunter Estuary*. A report for Newcastle City Council
- Lloyd, A.M., Law, B.S., and Goldingay, R. (2006) Bat activity on riparian zones and upper slopes in Australian timber production forests and the effectiveness of riparian buffers. *Biological Conservation* 129, 207-220.
- McKenzie, N. L., Stuart, A. N., and Bullen, R. D. (2002). Foraging ecology and organisation of a desert bat fauna. *Australian Journal of Zoology* 50, 529-548.
- Mills, D. J., Norton, T. W., Parnaby, H. E., Cunningham, R. B., and Nix, H. A. (1996). Designing surveys for microchiropteran bats in complex forest landscapes - a pilot study from south-east Australia. *Special issue: Conservation of biological diversity in temperate and boreal forest ecosystems* 85, 149-161.
- Law, B. S., Anderson, J., and Chidel, M. (1999). Bat communities in a fragmented forest landscape on the south-west slopes of New South Wales, Australia. *Biological Conservation* 88, 333-345.
- NSW Scientific Committee (1998). *Final Determination: The shorebird community occurring on the relict tidal delta sands at Taren Point – endangered ecological community listing*.
- Parnaby, H. (1992). An interim guide to identification of insectivorous bats of south-eastern Australia. *Technical Reports of the Australian Museum Number 8*.
- Pennay, M., Law, B., and Rhinhold, L. (2004). *Bat calls of New South Wales: Region based guide to echolocation calls of Microchiropteran bats*. NSW Department of Environment and Conservation, Hurstville.
- Pizzy, G., and Knight, F. (2007). *The field guide to the Birds of Australia*. HarperCollins Publishers. Sydney, NSW.

Appendix A: Anabat call analysis information

Anabat Results – Shark Park, 3 Anabat nights. 5 January 2012

Anabat 1 and 2 failed to record any bat echolocation calls with both devices failing after initial startup presumably due to low battery power. Therefore Anabat 4 was the only device to record any usable data. The following analysis is on Anabat 4 recordings only.

Bat calls were analysed using the program AnalookW (Version 3.7w 31 December 2009, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW (<http://www.forest.nsw.gov.au/research/bats/default.asp>).

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

1. Recordings containing less than three pulses were not analysed (Law et al. 1999).
2. Only search phase calls were analysed (McKenzie et al. 2002).
3. Four categories of confidence in species identification were used (Mills et al. 1996):
 - a. definite – identity not in doubt
 - b. probable – low probability of confusion with species of similar calls
 - c. possible – medium to high probability of confusion with species with similar calls; and
 - d. unidentifiable – calls made by bats which cannot be identified to even a species group.
4. *Nyctophilus* spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al. 2004).

| Night | Label | Number | Definite | Probable | Possible |
|------------------------|---------------------------------------|--------|----------|----------|----------|
| 1/5/2012 | <i>Chalinolobus gouldii</i> | 9 | 5 | 1 | 3 |
| 1/5/2012 | <i>Chalinolobus morio</i> | 10 | 2 | 3 | 5 |
| 1/5/2012 | <i>Mormopterus</i> sp2 | 2 | 2 | 0 | 0 |
| 1/5/2012 | <i>Myotis</i> / <i>Nyctophilus</i> sp | 4 | 4 | 0 | 0 |
| 1/5/2012 | low | 61 | | | |
| 1/5/2012 | short | 6 | | | |
| 1/5/2012 | Junk | 334 | | | |
| | | | | | |
| Total calls Identified | | 25 | | | |
| Total sequences | | 426 | | | |
| % Id'ed | | 5.8685 | | | |

A total of **426** call sequences were recorded within the study area; Shark Park from one Anabat device. Of these, **25 (6%)** of the sequences could be identified confidently to species or genus level (see table above). The calls of **3 species** were identified with 4 calls attributed to the *Myotis* / *Nyctophilus* split. These species groups are very similar in call profile and when calls are fragmented due to excessive wind they are difficult to distinguish. Of all the calls identified the only possible NSW TSC listed species was of Large footed *Myotis* (*Myotis macropus*) and should be considered likely to occur.

As stated above call profiles were only available from the Anabat 4 device however from these call sequences there were a large percentage of non-bat calls (junk) and low quality calls. It appears that the weather conditions on the night of the 5 January was quite poor with excessive wind and possible rain interspersed throughout the evening and this is attributed to this high junk and low call attribution. The 'low' call attributed data however are still able to be attributed to bat activity which therefore be considered moderate bat activity on a generally poor weather night.

Anabat Results – Shark Park, 3 Anabat nights 13 February 2012.

Anabat 1 (Carpark) and Anabat 2 (Playing field 1) recorded no discernable bat echolocation calls (table1). Anabat 3 (Playing field 2) recorded two common species only Little forest bat (*Vespadelus vulturnus*) and Gould's wattled bat (*Chalinolobus gouldii*). Overall there was very low microbat activity at the site on the 13 February 2012.

Bat calls were analysed using the program AnalookW (Version 3.7w 31 December 2009, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW (<http://www.forest.nsw.gov.au/research/bats/default.asp>).

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

1. Recordings containing less than three pulses were not analysed (Law et al. 1999).
2. Only search phase calls were analysed (McKenzie et al. 2002).
3. Four categories of confidence in species identification were used (Mills et al. 1996):
 - a. definite – identity not in doubt
 - b. probable – low probability of confusion with species of similar calls
 - c. possible – medium to high probability of confusion with species with similar calls; and
 - d. unidentifiable – calls made by bats which cannot be identified to even a species group.
4. *Nyctophilus* spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al. 2004).

| Anabat | Night | Label | Number | Definite | Probable | Possible |
|------------------|------------|-----------------------------|--------|----------|----------|----------|
| Carpark | 13/02/2012 | Junk | 19 | | | |
| Carpark | 13/02/2012 | low | 1 | | | |
| Playing field 01 | 13/02/2012 | Junk | 19 | | | |
| Playing Field 2 | 13/02/2012 | <i>Chalinolobus gouldii</i> | 1 | 1 | 0 | 0 |
| Playing Field 2 | 13/02/2012 | <i>Vespadelus vulturnus</i> | 14 | 2 | 10 | 2 |
| Playing Field 2 | 13/02/2012 | low | 4 | | | |
| Playing Field 2 | 13/02/2012 | short | 2 | | | |
| Playing Field 2 | 13/02/2012 | Junk | 22 | | | |