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PRELIMINARY STUDY OF POTENTIAL IMPACT OF NOISE ON THE FORTY-SPOTTED PARDALOTE *PARDALOTUS QUADRAGINTUS*

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PRELIMINARY STUDY OF POTENTIAL IMPACT OF NOISE ON THE FORTY-SPOTTED PARDALOTE *Pardalotus quadragintus*

Report to Kingborough Council by S. Bryant

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Cover image: Shaun Bromfield recording birds at Pybus Hill (pic S Bryant)

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SUMMARY OF FINDINGS

Surveys were conducted on the Forty-spotted Pardalote and other woodland bird species prior to, during and post gravel extraction from the Pybus Hill quarry, Bruny Island in August 2012. A total of 104 surveys at 19 sites with 34.8 hours of survey were undertaken to determine whether quarry operation had any impact on bird species presence or behaviour.

Preliminary findings were that Forty-spotted Pardalote and other woodland bird species persisted in the immediate vicinity of the Pybus Hill quarry pre, during and post the period of gravel extraction. The detection rate of Forty-spotted Pardalote and other woodland bird species increased over time during the survey period, including during the period of gravel extraction. No change in gross behaviours were detected in Forty-spotted Pardalote or woodland bird diversity as a result of gravel crushing and operation of the Pybus Hill Quarry and that this is most probably due to the fact that none of the bird species had commenced courtship or breeding at the time of quarry operation. Findings may have been different had quarry operations been undertaken during the breeding period and therefore a precautionary approach is still warranted.

The noise generated from the quarry was partly moderated due to the shape of the quarry face and the constancy of noise during processing and this may have resulted in some habituation to noise by birds in the nearby vicinity. More sophisticated measuring techniques are required to determine whether finer scale changes in physiological condition of individual birds (heart rate, stress levels etc) or the species more generally were being caused by noise generated at the quarry. More statistical analysis is needed to qualify this finding further and this will be undertaken in the future.

RECOMMENDATIONS

- As a precautionary approach timing and operational guidelines of the Pybus Hill Quarry should remain unchanged until such time as more defined information on the breeding activity of the Forty-spotted Pardalote is obtained from the research by A. Edworthy.

- In extreme circumstances only, an extension of operation of the Pybus Hill Quarry could be considered to include extraction activity up to the 15th August - provided a Forty-spotted Pardalote survey has determined that breeding activity has not commenced.

1.0 IMPACT OF NOISE ON WILDLIFE

The study of acoustic ecology can help determine the health of marine and terrestrial habitats. Krause (1993) suggested that every creature has its own aural niche and specific place in a habitat based on the relative frequency, amplitude, timbre and duration of the sound it produces. Krause argued that in natural areas, disturbance to this soundscape could be detrimental to the future of the individual, populations or even entire species.

Determining the effect of noise on wildlife is complicated because responses vary between species and even between individuals of a single population and can vary on either a short, medium or long-term basis. These variable responses are dependent on the characteristics of the noise and its duration, the life history stage of the species, habitat type, season, activity at the time of exposure, sex and age of the individual, level of previous exposure, and whether other physical stresses such as drought are occurring around the time of exposure (Busnel & John 1978). Some animals have adapted to extremely noisy environments, for example rodents in factories, ships, subways and birds on airfields, roadsides, etc., and individuals are able to persist in these environs through a learning process and habituation. It is also well known that sudden or loud noise, in combination with close proximity visual stimulation, will disturb most animal species, including man, and produce a startled or panic reaction.

Songbirds rely on acoustic cues to drive many of their behaviours and typically produce a wide repertoire of calls. These can range from daily contact or social calling, calling to attract a mate or for courtship, nurturing calls to alarm calls warning of potential threats. Any changes to a bird's ability to relay calls not only potentially changes the way it functions in its environment but also heightens the level of risk to which it is exposed. Impacts can range from increased energetic costs of singing, temporary disruption to feeding or flight, to permanent displacement from an area or lengthy interruption to behaviours such as courtship or feeding of young, leading to loss of productivity or even death of offspring (Brumm 2004).

A small number of studies have investigated the potential impact of road noise on Australian bird species. Paris and Schneider (2008) found that traffic noise along roadsides reduced the distance over which acoustic signals could be detected in the grey shrike-thrush *Colluricincia harmonica* causing birds to sing at higher frequencies. Traffic noise made it more difficult for birds to establish and maintain territories, attract mates and maintain pair bonds, and possibly lead to reduced breeding success in noisy roadside habitats. Potvin *et al.* (2011) have shown that urban silvereyes *Zosterops lateralis* call more slowly, at a higher pitch and use different notes compared to rural birds due to the impact of noise. Research is showing that noise can affect a bird's physiology and behaviour in very subtle ways, and if over time it becomes a chronic stress, noise can be injurious to its energy budget, reproductive success and long-term survival. With improved techniques, behaviours such as song duration, pitch or frequency, heart rate, rate of wing beat etc. can now be monitored as indicators of change in response to noise.

To-date no data has been collected on the potential impact of noise or disturbances on the forty-spotted pardalote *Pardalotus quadragintus*.

1.1 AIM OF THE ASSESSMENT

The Kingborough Council operates the Pybus Hill Quarry on Bruny Island to extract gravel for road maintenance and other works. The quarry is immediately surrounded by woodland which supports a breeding colony of the threatened forty-spotted pardalote *Pardalotus quadragintus* and is located within the vicinity of other breeding colonies and foraging habitat for this bird species. Due to limited gravel stocks the Kingborough Council sought to operate the quarry in August 2012 at a time which coincided with the onset of the breeding season of the forty-spotted pardalote.

The aim of this assessment was to determine whether operation of the Pybus Hill quarry, in particular the crushing of rock, affected the forty-spotted pardalote *Pardalotus quadragintus* in terms of colony occupancy or behaviour.

1.2 PROJECT BRIEF

- Consult with DPIPWE specialists on the information required on the species and the use of acoustic measuring equipment;
- Undertake a preliminary survey prior to the commencement of rock crushing to determine the extent forty-spotted pardalote in suitable habitat up to 2 km of the quarry;
- Monitor the species behaviour during crushing events. If a significant level of impact is noted, such as extreme behaviours like broad-scale nest desertion, notify the Council so that cessation of rock crushing occurs pending further advice from DPIPWE;
- Record the level of noise produced during rock crushing activities, along with some recording of background or baselines noise levels;
- Provide a report to Kingborough Council and lodge data on the Natural Values Atlas.

1.3 SPECIES INFORMATION AND STATUS

The forty-spotted pardalote *Pardalotus quadragintus* is endemic to Tasmania and restricted to a few offshore islands, headlands and peninsulas along the east coast. They are a lowland temperate woodland species and occur in a range of open grassy forest communities. During the breeding season adults are territorial and relatively sedentary and form permanent colonies around their critical habitat tree, white gum *Eucalyptus viminalis* (Fig 1).

Birds feed on invertebrates and glean lerp and manna from the foliage, spending most of their time foraging high in the white gum canopy. Forty-spotted pardalote breed annually from August to December and have an average clutch size of 4 to 5 eggs. They nest in hollows, mainly in live or dead eucalypts, fallen limbs, fence posts or occasionally holes in the ground. More detailed information on their ecology is provided by Brown (1986), Bulman *et al.* (1986) and Higgins and Peter (2002).

The species conservation status is:

- Endangered *Environment Protection and Biodiversity Conservation Act 1999*
- Endangered *Threatened Species Protection Act 1995*
- Endangered IUCN Red List under criteria B1ab(ii, iii, iv); B2ab(ii, iii, iv)

The most recent population estimate is a total of 1,500 ± 300 birds contained in six sites: Flinders Island, Maria Island, Bruny Island, Tinderbox, Howden and Coningham (Bryant 2010; Bryant *et al.* 2012). The national recovery plan outlines a range of actions for the species' long-term recovery (Threatened Species Section 2006); which have been more recently reviewed and expanded (Threatened Species Section 2012).

Fig 1 Forty-spotted pardalote *Pardalotus quadragintus*[photo by Elaine McDonald].

1.4 BRUNY ISLAND AND PYBUS HILL

In 2010, Bruny Island was estimated to have 450 ± 90 birds, or about one third of the total population of the species (Bryant 2010). Birds were distributed across the island in about 80 colonies on a range of tenures but mostly private land. Three pardalote breeding colonies occur within a two kilometre radius of the Pybus Hill quarry on south Bruny Island (Fig 2).

These are the Mt Bounty Colony along Wooreddy Road (no 60), the Pybus Hill colony (no 61) immediately surrounding the quarry site, and a small colony along the main road near the Thornbury property (no 76). A small amount of foraging habitat also occurs along the road side immediately in front of the quarry reserve.

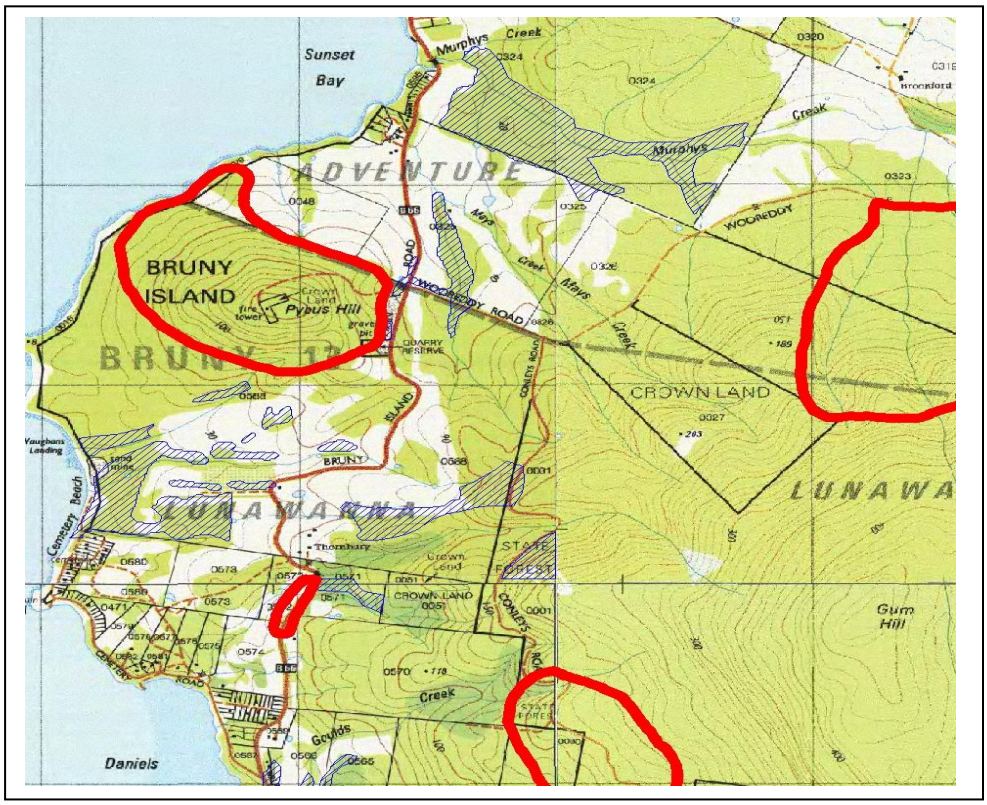


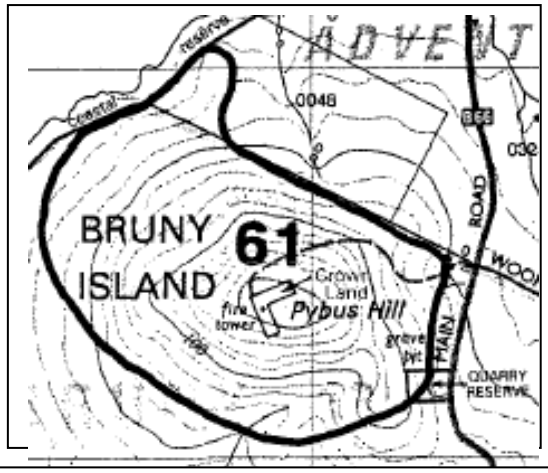
Figure 2 Forty-spotted pardalote colonies within 2km of the Pybus Hill quarry.

PYBUS HILL

The Pybus Hill Colony (No 61) was first identified by Brown (1986) and his original colony map and habitat description are shown in Figure 3.

In 1986 the Pybus Hill colony was estimated to contain approximately 32 birds (Brown 1986). In 1993 – 1995 the estimate was 68 birds with few changes being observed in habitat extent or condition (Bryant 2010). During a survey in 2009 – 2010 no forty-spotted pardalote were detected on the Pybus Hill colony over three repeat visits. Despite some deterioration in habitat quality being noted, it was suspected that the species still persisted in the area and Bryant (2010) stated:

> "Repeat surveys of Pybus Hill (colony 61) failed to locate any forty-spotted pardalotes, however, sufficient white gum exists to hold several pairs of birds. Recent road works and dieback of mature white gum in the upper portion of this colony may have caused the displacement of birds to the lower slopes. It is likely that Pybus Hill retains a very small population of birds thinly scattered across the colony which may be detected with repeat visits."



No. 61. Name: Pybus Hill
Location: NW South Bruny Is. Grid Reference: 189014
Area of Colony: 75ha
Estimated No. of Birds: 32
Percentage of E. viminalis: 25%
Other Eucalypts: E. obliqua, E. globulus, E. pulchella, E. ovata
Land Use: Cattle grazing Tenure: Freehold 2 titles
Evidence of Fire: Fire 8-10 years
Soil Type: Dolerite Direction of Slope: NES&W

General Description:
This is an isolated hill, rising to 150m, on the east coast of South Bruny Island approximately 3km south of Alonnah. Whilst parts of the lower slopes have been cleared to the north and south, the majority of the hill remains intact apart from a small cleared area around a fire tower on top of the hill.

The rock type appears to be dolerite and timber includes the following:- E. viminalis, E. tenuiramis, E. ovata, E. obliqua, E. pulchella and E. globulus.

E. viminalis at average 25% and E. tenuiramis at 50% are dominant around the woodland although other species are locally common in parts. The area has not been burned within the past 8-10 years and grazing does not appear to have greatly affected the undergrowth. Blackwood is a common understorey species to 5m with saggs and bracken lower down. This is particularly applicable to the northern slope.

40-spotted Pardalotes habitat was best on the north and west slopes where E. viminalis was most dense but birds were found around much of the hill. The population was estimated at 30+ birds, possibly up to 40 and as such constitutes one of the best colonies in South Bruny.

Figure 3 Original map and description of the Forty-spotted Pardalote colony on Pybus Hill by Brown (1986).

2.0 METHODOLOGY

SURVEY DESIGN

Survey known sites at varying distances from the quarry:
- On and around Pybus Hill (Colony 61)
- In suitable habitat including Colony 60 and Colony 76 up to 2 km from the quarry
- At a control site (Colony 66 Saintys Creek), 7.34 km from the quarry

Survey for the species using:
- Monitoring sites
- 2 hectare searches
- Transects

Undertake monitoring for the species:
- Prior to quarry operation
- During quarry operation
- Post quarry operation

Record information on:
- Forty-spotted pardalote detection rate and gross behaviours
- Other woodland bird species activity

SURVEY SITES

Data was collected using GPS map datum WGS 84 (Garmin) – 50m search radius from midpoint. Tables 1, 2, 3 identify the location of survey sites and the number of repeat visits.

Table 1 Fixed monitoring sites.

Site	Location (pardalote colony no)	Easting	Northing	Distance to quarry face	No of Visits
M1	Pybus Hill low track (no 61)	0518963	5201815	0.55 km	8
M2	Pybus Hill med track(no 61)	0518919	5201668	0.52 km	8
M3	Pybus Hill hilltop (no 61)	0519067	5201562	0.34 km	8
M4	Saintys Creek [control, no 66)]	0519939	5194111	7.36 km	8
M5	Pybus Hill quarry face (no 61)	0519325	5201393	0.09 km	10
M6	Woodland edge of quarry	0519396	5201207	0.25 km	9
M7	Thornbury Roadside (no 76)	0519079	5200051	1.53 km	8
M8	Wooreddy Road (No 60)	0520637	5201811	1.25 km	8

Table 2 Fixed transects surrounding the Pybus Hill quarry.

No	**Location**	**Easting Start**	**Northing Start**	**Easting End**	**Northing End**	**No of Visits**
T1	Pybus gate to fire tower	0519524	5201678	0518980	5201598	5
T2	Pybus quarry roadside	0519554	5201210	0519532	5201665	3
T3	Site M1 slope to gate	0518894	5201672	0519524	5201678	4
T4	Fenceline above quarry face	0519325	5201393	0519397	5201576	2

Table 3 Two hectare search sites.

Site	Location	Easting	Northing	Distance to quarry face	No of Visits
S2	2 ha search around M2 site	0518741	5201560	0.52 km	3
S3	2 ha search around M3 site	0519113	5201465	0.34 km	4
S4	2 ha search around M4 site	0519855	5194110	7.36 km	3
S5	2 ha search around M5 site	0519193	5201441	0.09 km	4
S6	2 ha search around M6 site	0519396	5201207	0.25 km	4
S7	2 ha search around M7 site	0519166	5200130	1.53 km	2
S8	2 ha search around M8 site	0520544	5201829	1.25 km	3

Figure 4 shows the location of all the survey sites (control site at Saintys Creek inset), and Figures 5,6,7 and 8 show a range of habitat at the monitoring sites.

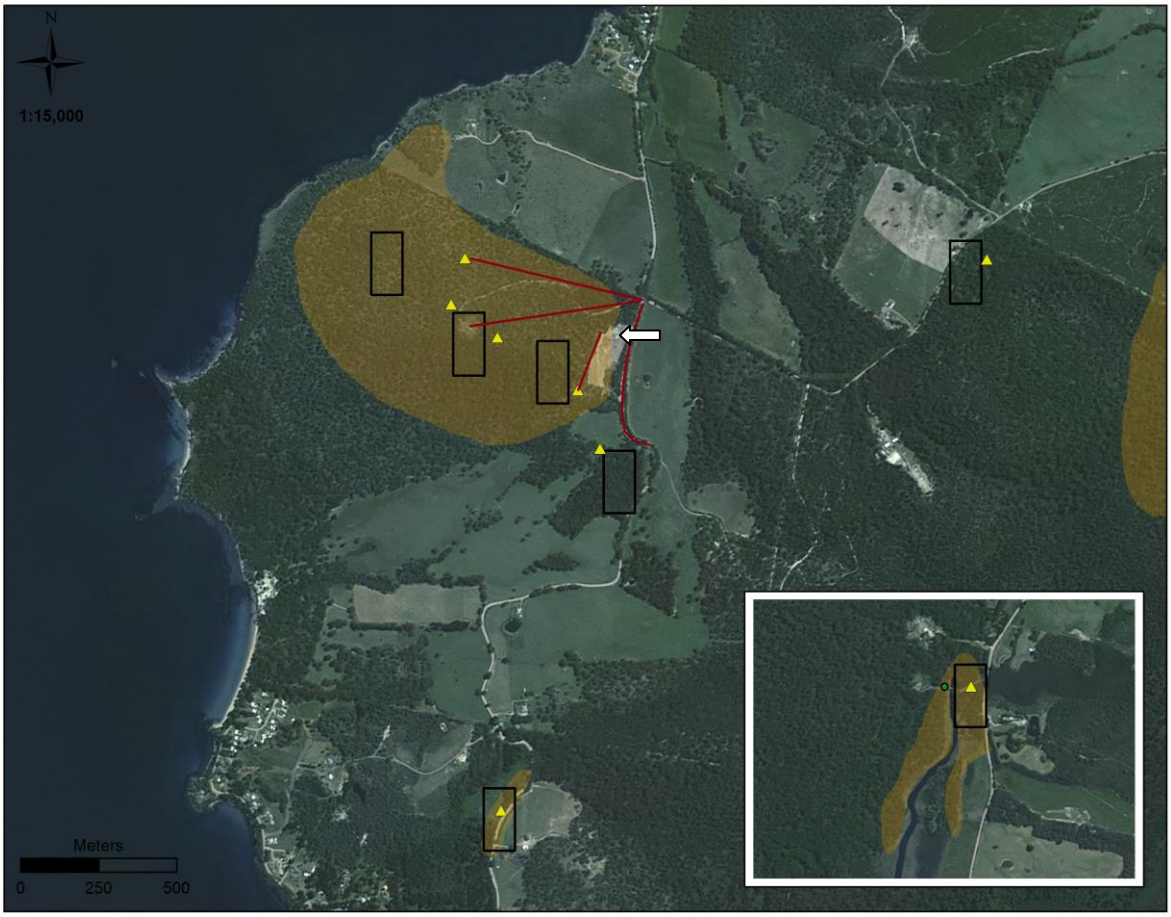


Fig.4 Location of all the survey sites around Pybus Hill quarry and at control sites.

Symbols: Fixed Monitoring Site 2 ha Search Transect Quarry site

Insert: Fixed monitoring site at Saintys Creek, Cloudy Bay (control site)

Fig 5 Monitoring Site M 6 adjacent to quarry.

Fig 6 Monitoring site M5 above quarry.

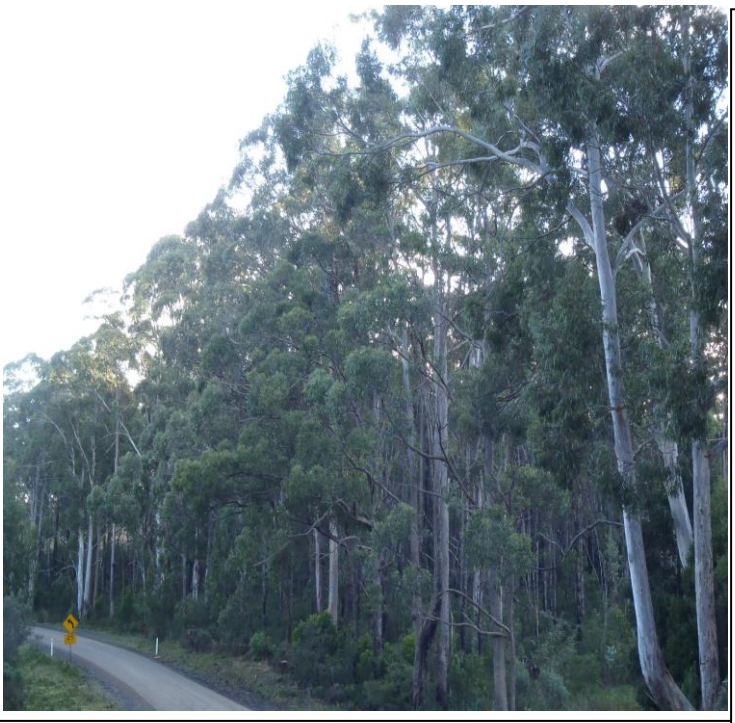


Fig 7 Monitoring M7 Thornbury Roadside.

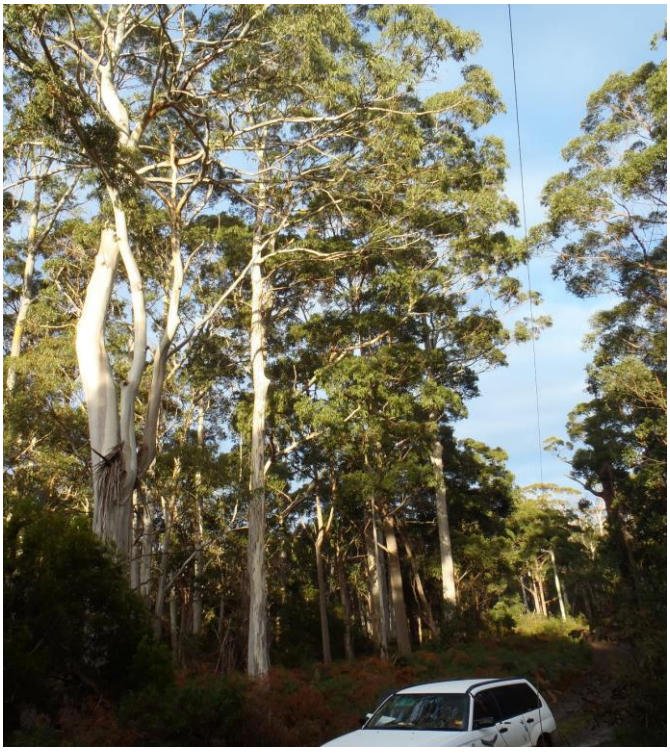


Fig 8 Control site M4 at Saintys Creek.

3.0 RESULTS

Survey Effort

A total of 104 surveys at 19 sites with 34.8 hours of survey were undertaken during this project (Table 4) from the period 1 to 29 August 2012. Most survey effort focused on repeat visits at the monitoring sites, however, there was good replication across all survey methods and during pre-operation, operation and post-operation of the quarry (Table 4).

Table 4 Summary of survey effort for pre, during and post quarry operation.

	Monitoring Sites	**2ha Search Sites**	**Transects**	**Total**
No of Sites	8	7	4	19 sites
No of Surveys	67 surveys	23 surveys	14 surveys	104 surveys
Total Survey time	22.4 hrs	7.7 hrs	4.7 hrs	34.8 hrs
Pre Quarry	24	11	4	39
Quarry operation	35	5	6	46
Post Quarry	8	7	4	19

Forty-spotted Pardalote Detection Rate

The Forty-spotted Pardalote occurs in low numbers in this area and can be difficult to detect by sight or call especially if weather conditions are poor. The sites selected for survey were centred around *Eucalyptus viminalis* and the likelihood of detection increased with repeat site visits. Forty-spotted pardalote were detected at:

Monitoring Sites: 7 of 8 monitoring sites and 25 of 67 surveys

2ha Searches: 4 of 7 search sites and 7 of 23 surveys

Transects: 3 of 4 transects and 4 of 14 surveys

Table 5 shows that forty-spotted pardalote were generally very low in numbers on Pybus Hill compared to the more distant sites which makes it difficult to determine changes in abundance or detection rate.

Table 5 Detection of Forty-spotted Pardalotes during repeat visits to monitoring sites.

Site	Location	Detection / Total Visits	Quarry Operating Yes / No	Pre Quarry	During Operation	Post Quarry
M1	Pybus Hill low	2 / 8	4 / 3	1 / 3	0 / 4	1 / 1
M2	Pybus Hill med	1 / 8	4 / 3	0 / 3	1 / 4	0 / 0
M3	Pybus Hill hilltop	0 / 8	4 / 4	0 / 3	0 / 4	0 / 1
M4	Saintys Creek	2 / 8	4 / 4	1 / 3	0 / 4	1 / 1
M5	Pybus Hill quarry	1 / 10	6 / 4	0 / 3	0 / 6	1 / 1
M6	Woodland edge	6 / 9	5 / 4	1 / 3	4 / 5	1 / 1
M7	Thornbury Roadside	8 / 8	4 / 4	3 / 3	4 / 4	1 / 1
M8	Wooreddy Road	5 / 8	4 / 4	0 / 3	4 / 4	1 / 1

Table 6: Detection rate and survey effort for Forty-spotted Pardalote near Pybus Quarry.

Survey Technique	**No of Sites Detected**	**Total Surveys Detected**	**Survey Effort**
Monitoring Sites	7 of 8 (87.5%)	25 of 65 (38.5%)	21.66
2 ha searches	4 of 7 (57.1%)	7 of 23 (30.4%)	7.66
Fixed Transects	3 of 4 (75.0%)	4 of 14 (28.6%)	4.66
3 survey techniques	**14 of 19 sites**	**36 of 102 (35.3%) surveys**	**33.98 hours**

To better determine potential changes due to noise, the results from all 19 survey sites were grouped into one of three categories according to their proximity to the gravel quarry.

- Around Quarry: 0 - 350 metres from quarry operations [M5, M6, S5, S6, T2, T4]
- Adjacent to Quarry: 350 – 1.0 km from quarry operations [M1, M2, M3, S2, S3, T1, T3]
- Away from Quarry: > 1.0 km from quarry operations [M4, M7, M8, S4, S7, S8]

Table 7 Change in detection rate of Forty-spotted Pardalote and other woodland bird species over the survey period.

Quarry Activity	Around 40 spots detected	Adjacent 40 spots detected	Away 40 spots detected	Around Mean Species Diversity	Adjacent Mean Species Diversity	Away Mean Species Diversity
Pre Quarry Works	3 / 12 (25%)	2 / 17 (11.8%)	5 / 12 (41.7%)	8.08± S.D	4.64± S.D	7.00± S.D
During operation	6/16 (37.5%)	1 / 16 (6.3%)	8 / 14 (57.1%	7.68± S.D	7.75± S.D	9.78± S.D
Post Quarry	4/4 (100%)	1 / 7 (14.3%)	5/6 (83.3%)	10.5± S.D	7.85± S.D	13.33± S.D

Distance from Quarry, Around 0 – 350m, Adjacent 350m – 1,0km, Away > 1.0km

4.0 DISCUSSION

Preliminary findings from this work are that Forty-spotted Pardalote and other woodland bird species persisted in the immediate vicinity of the Pybus Hill quarry during the period of gravel extraction. The detection rate of Forty-spotted Pardalote and other woodland bird species increased over time during the survey period, in spite of gravel crushing. No change in gross behaviours were detected in Forty-spotted Pardalote or woodland bird diversity as a result of gravel crushing and operation of the Pybus Hill Quarry and that this is most probably due to the fact that none of the bird species present had commenced courtship or breeding at the time of quarry operation.

Forty-spotted pardalote had not yet commenced breeding at the time of the survey and so were not exhibiting behaviours such as breeding calls, courtship, nest inspection or nest attendance during this time. Other forms of behaviour suggesting disturbance such as flight – fright, low detection rate, alarm calls, interruption to foraging, etc, were not detected in Forty-spotted Pardalote or other small woodland bird species around or in the near vicinity of the quarry. Forty-spotted Pardalote occur in such low density on Pybus Hill that it was not possible to detect meaningful changes in abundance or detection level during this survey. This finding confirms previous survey work that failed to detect the species after several repeat visits to Pybus Hill and concluded it persists in low density. It is not immediately apparent as to why this low density occurs on Pybus Hill given the amount of suitable habitat and overall patch size. While it could potentially be related to quarry activity, the regular occurrence of birds within close proximity to the quarry on Smith's woodland, presumably subject to similar conditions and habitat pressures, suggests a range of other factors may be occuring.

Findings suggest that over time as the pardalote approached breeding it was more easily detected irrespective of the activity of the quarry and that post quarry operation Forty-spotted Pardalote and other woodland birds were more easily detected by sight and call due to increased behavioural activity. This trend was observed irrespective of distance from the quarry face. This finding would suggest that operation of the quarry at the time of survey did not have a lasting detrimental effect on the pardalote species but again this must be qualified against the naturally low number of birds in this immediate area. More sophisticate statistical analysis will be undertaken on the data in the future to improve the power of analysis to investigate variation between sites and over time.

Continuous noise at low to medium levels can lead to habituation in birds and this may well have been the case by the birds on Pybus Hill in the non-breeding season. During the survey period it was noted that often traffic noise in the immediate vicinity of the quarry generated high noise levels and that it may be reasonable to conclude that many individual woodland birds have become habituated to sharp bursts of noise as well as continuous noise at this location. More sophisticated measuring techniques however are needed to determine physiological responses by birds to noise i.e. change in song tone and duration, change in heart beat or flight response etc as reported in other studies.

A separate acoustic report was produced by Bill Wilson from DPIPWE which provides information on the levels of sound 'dB' produced from quarry operations. This report may provide additional information on the level of sound produced and its relative impact on the hearing abilities of humans and other animal species.

5.0 REFERENCES

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APPENDIX A

DETECTION METHODOLOGY

To survey for the presence of the Forty-spotted Pardalote, the surveyor needs to be highly familiar with the species (including calls). Walk slowly throughout areas of suitable White Gum habitat listening for calls and actively scanning all White Gum canopies for any sign of pardalote movement. If movement is detected then the species needs to be positively identified using binoculars. New methods using repeated site visits and stationary point counts are currently being trialled (M. Webb, Threatened Species Section); multiple surveys are likely to be required to be confident that the species is absent from an area, particularly where birds occur at low densities.

Threatened Species Section (2012). Listing Statement for *Pardalotus quadragintus* (Forty-spotted Pardalote). Department of Primary Industries, Parks, Water and Environment, Tasmania.

APPENDIX B DATA SHEET

Monitoring Sites: **1** – Pybus low track **2** - Pybus mid track **3** – Pybus hilltop **4** – Saintys Creek **5** - Quarry face **6** Smith's woodland **7**- Road Thornbury **8** - Wooreddy Road

Date:	**Site Number:**	**Time Start:**
Weather: **clear cloudy overcast dry drizzle rain still breezy windy** **Quarry in Use**: **Yes excavator rock crushing No**		
Observations	**10 mins**	**10 mins**
Quarry Noise	loud medium low nil	loud medium low nil
40SP Calling		
40SP Seen		
Total No 40SP		
Flying		
Foraging		
Chasing		
Flocking		
Alarm behaviour		
Breeding behaviour Nest inspection Nest occupied Other		
Other Bird Species		
Notes		
Observer:		**Time End:**

APPENDIX C RESULTS

Data has been supplied to DPIPWE and entered on the NCA.

Monitoring Sites

Date	Site	St. Time	Min	Obs	Easting	Northing	Weather	Quarry	Heard	Saw	Total	Tot Bird Species	Notes	
1/08/2012	M1	10.25 am	20	2	518894	5201672	O, S, D	Pre	1	0	1	5	2 bursts of contact calls	low track
5/08/2012	M1	3.35 pm	20	1	518894	5201672	O, Dz, B	Pre	0	0	0	0	bleak conditions -	low track
6/08/2012	M1	1.12 pm	20	1	518894	5201672	O, B	Pre	0	0	0	2		
7/08/2012	M1	3.12 pm	20	1	518894	5201672	O, D, S	Yes	0	0	0	2	good conditions	nil noise
8/08/2012	M1	12.42 pm	20	1	518894	5201672	O, D, B	Yes	0	0	0	10		nil noise
13/08/2012	M1	11.40 am	20	1	518894	5201672	C, D, S	Yes	0	0	0	12	excellent conditions	nil noise
14/08/2012	M1	11.09 am	20	1	518894	5201672	C, D, B	Yes	0	0	0	5	good conditions	nil noise
29/08/2012	M1	12.44 pm	20	1	518894	5201672	O, D, B	Post	0	1	1	7	foraging on vims	post quarry
			140											
1/08/2012	M2	10.05 am	20	2	518919	5201668	O, S, D	Pre	0	0	0	9	Good survey conditions	mid track
5/08/2012	M2	3.10 pm	20	1	518919	5201668	O, Dz, B	Pre	0	0	0	0	poor conditions -	mid track
6/08/2012	M2	12.39 pm	20	1	518919	5201668	O, W	Pre	0	0	0	2	poor conditions	mid track
7/08/2012	M2	2.42 pm	20	1	518919	5201668	CD, D, S	Yes	1	0	1	8	good conditions	low noise
8/08/2012	M2	12.17 pm	20	1	518919	5201668	CD, D, B	Yes	0	0	0	6	good conditions	nil noise
13/08/2012	M2	11.14 am	20	1	518919	5201668	C, D, S	Yes	0	0	0	11	excellent conditions	nil noise
14/08/2012	M2	10.41 am	20	1	518919	5201668	C, D, B	Yes	0	0	0	6	good conditions	nil noise
29/08/2012	M2	11.35 am	20	1	518919	5201668	O, B, D	Post	0	0	0	5	good conditions	mid track
			140											
1/08/2012	M3	10.55 am	20	2	519067	5201562	O, S, D	Pre	0	0	0	8	good vims behind	hilltop

													firetower	
5/08/2012	M3	1.00 pm	20	1	519067	5201562	O, D, S	Pre	0	0	0	8	good conditions	hilltop
6/08/2012	M3	12.08 pm	20	1	519067	5201562	O, DZ, W	Pre	0	0	0	2	overcast	hilltop
7/08/2012	M3	11.15 am	20	1	519067	5201562	D, S, C	Yes	0	0	0	11	good conditions	low noise
8/08/2012	M3	11.52 am	20	1	519067	5201562	CD, D, B	Yes	0	0	0	7	good conditions	low noise
13/08/2012	M3	10.48 am	20	1	519067	5201562	C, D, S	Yes	0	0	0	13	excellent conditions	low noise
14/08/2012	M3	10.13 am	20	1	519067	5201562	C, D, B	Yes	0	0	0	7	good conditions	low noise
29/08/2012	M3	10.45 am	20	1	519067	5201562	C, D, B	Post	0	0	0	10	good conditions	hilltop
			160											
5/08/2012	M4	9.15 am	20	1	519939	5194111	C, S	Pre	0	0	0	13	Saintys Nest site	Saintys
5/08/2012	M4	5.00 pm	20	1	519939	5194111	O, D, S	Pre	3	0	3	10	Calling opposite nest site in gully	Saintys
6/08/2012	M4	7.45 am	20	1	519939	5194111	R, W, O	Pre	0	0	0	3	stormy weather, no activity near nest	Saintys
7/08/2012	M4	7.50 am	20	1	519939	5194111	S, C, D	Yes	0	0	0	12	no nest activity	nil noise
8/08/2012	M4	10.42 am	20	1	519939	5194111	O, B	Yes	0	0	0	2	little activity	nil noise
13/08/2012	M4	2.34 pm	20	1	519939	5194111	C, D, B	Yes	0	0	0	0	no activity	nil noise
14/08/2012	M4	2.07 pm	20	1	519939	5194111	O, D, B	Yes	0	0	0	9	no activity	nil noise
29/08/2012	M4	9.02 am	20	1	519939	5194111	O, D, B	Post	2	2	2	14	breeding calls, chasing near nest site	Saintys
			160											
1/08/2012	M5	11.45 am	20	2	519325	5201393	O, S, D	Pre	0	0	0	9	lot of road noise above quarry	quarry
5/08/2012	M5	11.50 am	20	1	519325	5201393	C, D, B	Pre	0	0	0	4	good conditions	quarry
6/08/2012	M5	11.05 am	20	1	519325	5201393	O, B	Pre	0	0	0	3	good conditions	quarry
6/08/2012	M5	2.50 pm	20	1	519325	5201393	D, C, W	Yes	0	0	0	7	started quarry activity	medium noise
7/08/2012	M5	09.32 am	20	1	519325	5201393	O, D, S	Yes	0	0	0	10	first survey, crushing underway	low-med noise
7/08/2012	M5	10.03 am	20	1	519325	5201393	O, D, S	Yes	0	0	0	7	second survey, crushing underway	medium noise
8/08/2012	M5	1.53 pm	20	1	519325	5201393	O, D, S	Yes	0	0	0	4	excavator at top of quarry face	med - loud noise
13/08/2012	M5	1.13 pm	20	1	519325	5201393	C,D,B	Yes	0	0	0	7	good conditions	medium noise

14/08/2012	M5	12.44 pm	20	1	519325	5201393	C,D,B	Yes-LB	0	0	0	6	excavator lunch break	nil noise
29/08/2012	M5	1.48 pm	20	1	519325	5201393	O, D, B	Post	1	2	3	11	breeding call	post quarry
			200											
1/08/2012	M6	2.00 pm	20	2	519396	5201207	O, S, R	Pre	0	0	0	14	diverse woodland bird site	Keiths
5/08/2012	M6	10.40 am	20	1	519396	5201207	CD, D, B	Pre	2	3	3	13	Three birds making contact calls	Keiths
6/08/2012	M6	10.30 am	20	1	519396	5201207	O,B, D	Pre	0	0	0	3	little activity	Keiths
6/08/2012	M6	3.25 pm	20	1	519396	5201207	D, W, O	Yes	0	0	0	5	other bird species active	low noise
7/08/2012	M6	8.45 am	20	1	519396	5201207	C, S	Yes	0	2	3	14	flying between vim	medium noise
8/08/2012	M6	2.22 pm	20	1	519396	5201207	O,D,B	Yes	2	2	2	11	contact calls, foraging, flying	medium noise
13/08/2012	M6	12.43 pm	20	1	519396	5201207	C, D, B	Yes-LB	0	1	1	12	quarry lunch break	nil noise
14/08/2012	M6	12.16 pm	20	1	519396	5201207	C, D, B	Yes	2	2	2	10	flying, foraging	medium noise
29/08/2012	M6	1.18 pm	20	1	519396	5201207	O, D, B	Post	0	2	2	13	foraging in vims	post quarry
			180											
1/08/2012	M7	12.50 pm	20	2	519182	5200223	O, R	Pre	2	2	2	5	birds foraging, contact calls	2km
5/08/2012	M7	4.15 pm	20	1	519182	5200223	C, D, B	Pre	1	4	5	12	Car noise loud	2km
6/08/2012	M7	9.45 am	20	1	519182	5200223	O, R, W	Pre	0	2	2	5	40spots flying & foraging	2km
7/08/2012	M7	3.53 pm	20	1	519182	5200223	O,D,S	Yes	3	3	3	8	making contact calls	nil noise
8/08/2012	M7	2.52 pm	20	1	519182	5200223	CD, D, S	Yes	2	2	2	10	contact calls, birds foraging	nil noise
13/08/2012	M7	1.45 pm	20	1	519182	5200223	C, D, B	Yes	2	2	2	12	contact calls	nil noise
14/08/2012	M7	1.17 pm	20	1	519182	5200223	C, O, D, B	Yes-LB	1	0	1	14	contact calls, quarry lunch break	nil noise
29/08/2012	M7	9.47 am	20	1	519182	5200223	O, D, B	Post	2	2	2	12	contact calls	2 km
			160											
1/08/2012	M8	1.20 pm	20	2	520637	5201811	O, R,	Pre	0	0	0	3	poor conditions	wooreddy
5/08/2012	M8	2.20 pm	20	1	520637	5201811	O, D, S	Pre	0	0	0	9	Calm after big storm	wooreddy
6/08/2012	M8	9.06 am	20	1	520637	5201811	O, R,	Pre	0	0	0	3	poor conditions	wooreddy
7/08/2012	M8	1.37 pm	20	1	520637	5201811	CD, D, S	Yes	1	3	3	10	contact calls, flying, foraging	med noise

8/08/2012	M8	1.17 pm	20	1	520637	5201811	C, D, B	Yes-LB	2	2	2	9	contact calls, foraging, quarry lunch break	nil noise
13/08/2012	M8	12.11 pm	20	1	520637	5201811	C, D, S	Yes	2	1	2	17	contact calls, flying, foraging	low noise
14/08/2012	M8	11.42 am	20	1	520637	5201811	C, D, B	Yes	2	0	2	17	contact calls	nil noise
29/08/2012	M8	10.14 am	20	1	520637	5201811	C, D, B	Post	1	0	1	12	breeding call	post quarry
			160											

Two hectare Search Sites

Date	Site	St. Time	Min	Obs	Easting	Northing	Weather	Quarry	Heard	Saw	Total	Other Sp	Notes	
6/08/2012	S2	12.39 pm	20	1	518741	5201560	O, W	Pre	0	0	0	4	deteriorating conditions	med track
7/08/2012	S2	2.40 pm	20	1	518741	5201560	S, D, O	Yes	0	0	0	5	good conditions	low noise
29/08/2012	S2	12.00 pm	20	1	518741	5201560	O, D, B	Post	0	0	0	9	good conditions	med track
1/08/2012	S3	11.05 am	20	2	519113	5201465	O, S	Pre	0	0	0	7	good conditions, no birds	Hilltop
5/08/2012	S3	1.20 pm	20	1	519113	5201465	O, D, S	Pre	0	0	0	8	no birds	Hilltop
6/08/2012	S3	12.08 pm	20	1	519113	5201465	O, DZ, W	Pre	0	0	0	4	no birds	Hilltop
29/08/2012	S3	11.10 am	20	1	519113	5201465	C, B, D	Post	0	0	0	12	no birds	Hilltop
5/08/2012	S4	10.05 am	20	1	519855	5194110	C, S	Pre	0	0	0	13	no birds detected	Saintys
6/08/2012	S4	4.44 pm	20	1	519855	5194110	D, O, B	Yes	0	0	0	6	no activity near nest	nil noise
29/08/2012	S4	9.03 am	20	1	519855	5194110	O, B, D	Post	1	0	1	12	breeding call	Saintys
5/08/2012	S5	12.10 pm	20	1	519193	5201441	C, D, B	Pre	0	0	0	5	sea eagle flushed	Quarry
6/08/2012	S5	11.05 am	20	1	519193	5201441	O, B	Pre	0	0	0	4	no birds	Quarry
7/08/2012	S5	9.35 am	20	1	519193	5201441	O, S, D	Yes	0	0	0	1	no activity	med noise
29/08/2012	S5	2.30 pm	20	1	519193	5201441	C, S, D	Post	4	1	4	7	contact, breeding calls, foraging	quarry
5/08/2012	S6	11.20 am	20	1	519396	5201207	CD, D, B	Pre	1	0	1	13	1 bird contact calls	Keiths
6/08/2012	S6	10.30 am	20	1	519396	5201207	O, B, D	Pre	0	0	0	4	no activity	Keiths
7/08/2012	S6	8.45 am	20	1	519396	5201207	S, C, D	Yes	0	2	2	14	foraging in vim	med noise
29/08/2012	S6	1.38 pm	20	1	519396	5201207	S, C, D	Post	2	1	3	11	contact, breeding call, foraging	Keiths
6/08/2012	S7	9.45 am	20	1	519166	5200130	O, R, W	Pre	0	2	2	4	2 birds foraging	2km site

29/08/2012	S7	9.45 am	20	1	519166	5200130	O, B, D	Post	0	1	1	15	foraging in vim	2km site
6/08/2012	S8	8.30am	20	1	520544	5201829	OB, DZ	Pre	0	0	0	4	poor conditions	Wooreddy
7/08/2012	S8	1.37 pm	20	1	520544	5201829	D, S, C	Yes	0	0	0	11	good conditions	low noise
29/08/2012	S8	3.15 pm	20	1	520544	5201829	DZ, O, S	Post	0	0	0	15	good conditions	Wooreddy

Transects

Date	Tran	St. Time	Min	Obs	East S	North S	East End	North End	Weather	Quarry	Heard	Saw	Total	Other Sp	Notes
1/08/2012	T1	09.20 am	20	2	519524	5201678	518980	5201598	O, S, C	Pre	0	0	0	5	good conditions, gate to tower
5/08/2012	T1	12.00 pm	20	1	519524	5201678	518980	5201598	O, D, S	Pre	0	0	0	6	gate to tower
7/08/2012	T1	10.40 am	20	1	519524	5201678	518980	5201598	C, D, S	Yes	0	0	0	7	loud to low noise
7/08/2012	T1	11.40 am	20	1	519524	5201678	518980	5201598	S, C, D	Yes	0	0	0	10	loud to low noise
29/08/2012	T1	11.10 am	20	1	519524	5201678	518980	5201598	O, D, B	Post	0	0	0	7	gate to tower
6/08/2012	T2	3.55 pm	20	1	519554	5201210	519532	5201665	W, D, O	Yes	0	0	0	5	swarms of grey fantails forgaing
7/08/2012	T2	1.10 pm	20	1	519554	5201210	519532	5201665	S, C, D	Yes LB	2	2	2	6	contact calls, foraging, lunch break
29/08/2012	T2	1.15 pm	20	1	519554	5201210	519532	5201665	S, O, D	Post	2	1	3	16	contact calls, foraging,
5/08/2012	T3	3.55 pm	20	1	518894	5201672	519524	5201678	O, Dz, B	Pre	0	0	0	2	Bleak conditions, M1 to gate
6/08/2012	T3	1.12 pm	20	1	518894	5201672	519524	5201678	O, B	Pre	1	0	1	4	contact calls
7/08/2012	T3	3.14 pm	20	1	518894	5201672	519524	5201678	B, O, D	Yes	0	0	0	4	high - low noise
29/08/2012	T3	12.40 pm	20	1	518894	5201672	519524	5201678	O, S, D	Post	0	0	0	5	M1 to gate
29/08/2012	T4	2.37 pm	20	1	519325	5201393	519397	5201576	O, D, B	Post	2	2	2	18	contact calls, foraging, chasing
7/08/2012	T4	10.05 am	20	1	519325	5201393	519397	5201576	S, O, D	Yes	0	0	0	4	difficult to hear bird calls, loud noise
			280												