Corella, 2019, 43: 1-7

The distribution of a flute-like dialect in territorial songs of the Superb Lyrebird *Menura novaehollandiae* in the New South Wales North Coast and New England Tableland Bioregions

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Received: 16 February 2018
Accepted: 25 July 2018

On-site recordings were made and field data obtained on the territorial songs of the Superb Lyrebird *Menura novaehollandiae* at 100+ sites in forests of the New South Wales North Coast and New England Tableland Bioregions during winter from 2009-2014. Songs were categorized as either 'flute-like' or not flute-like, and the two song types are compared. Maps are presented that define the geographical extent of the flute-like dialect. The study demonstrates that the flute-like song extends over a wider area than previously thought, but the exact place of origin remains unknown. Some interesting discontinuities in the distribution of this song dialect are discussed.

INTRODUCTION

The vocal repertoire of the Superb Lyrebird *Menura novaehollandiae* includes mimicry (mostly of other birds such as the Laughing Kookaburra *Dacelo novaeguineae*, Pied Currawong *Strepera graculina,* and Crimson Rosella *Platycercus elegans*), species-specific territorial song (typically 6-10 sec. duration) and invitation-display calls. Usually mimicry of the calls, songs, wing beats, and beak snaps of other bird species makes up 70-80% of Superb Lyrebird vocalisations, with the remainder consisting of territorial song and other signals (Robinson and Curtis 1996; Higgins *et al*. 2001). Lyrebird vocal mimicry is culturally transmitted from adult males to young birds rather than learned directly from mimicked models (Robinson and Curtis 1996). Territorial songs and mimicry repertoires are regionally distinct and typically change little over time (Higgins *et al*. 2001). Thus Powys (2006) found in a longitudinal study that geographically-distinct territorial songs were shared by all individuals in an area and changed little over a thirty-year period.

Lyrebird songs are loud and can be heard by humans from one kilometre or more away (Frith 1969; Reilly 1988; Powys 1995; Robinson and Curtis 1996). Most singing occurs during the winter breeding season (June and July) when males sing for up to 50% of daylight hours in bouts lasting 30 minutes or longer. The Superb Lyrebird's species-specific invitation-display calls include a very loud 'blick' call, as well as softer clicking, whirring, twanging, scissors-grinding, thudding, and huffing sounds (Powys 1995, 2008). These complex sounds occur over the entire range of the species, although with regional variation. They are sometimes mistaken for anthropogenic sounds, but are not mimicry. No known recording exists of a lyrebird *in the wild* mimicking mechanical or other anthropogenic sounds, although there are recordings of captive birds delivering such mimicry (Higgins *et al*. 2001; Taylor 2014).

The current study builds on the only suggested example of Superb Lyrebird imitation of a man-made sound in *territorial song* (Robinson 1975; Reilly 1988; Smith 1988; Rankin *et al*. 1999). Powys *et al*. (2013) investigated the cultural history of a Superb Lyrebird chick that was purportedly raised in captivity in the 1920s in Australia's New England Tablelands. The bird allegedly mimicked the sounds of the household's flute player, learning two tunes and an ascending scale, and when released back into the wild it is claimed that its flute-like songs and timbre spread throughout the local lyrebird population. Powys *et al*.'s (2013) research uncovered substantial primary source data, including archival and contemporaneous interviews, but was unable to confirm the veracity of the story. Thus, the flute-like song dialect's origins remain uncertain.

The sonogram in Figure 1 shows clear differences between flute-like and non-flute-like lyrebird songs in three localities. In contrast to the typically steep frequency sweeps in non-flute-like territorial songs (Fig. 1c) in our study area and in other areas of the species' range, flute-like songs are characterized by a morphology of short, discrete notes that resemble the timbre of a flute, recorder, or other similar aerophone. Individual notes of minimal frequency variation are delivered in groups of 3-5 ascending notes (Fig. 1b). In addition to the main theme, a flute-like song often begins with introductory notes (Fig. 1a and 1c). Songs at some sites attain a high degree of complexity by means of what appears in a sonogram as overlapping, ascending 'scales'. To our knowledge, no recordings outside our study area have captured such flute-like elements in the Superb Lyrebird's vocalisations.

The aim of the present study was to determine the geographical extent of flute-like songs, concentrating on a population of Superb Lyrebirds in the northeast of New South Wales (NSW).

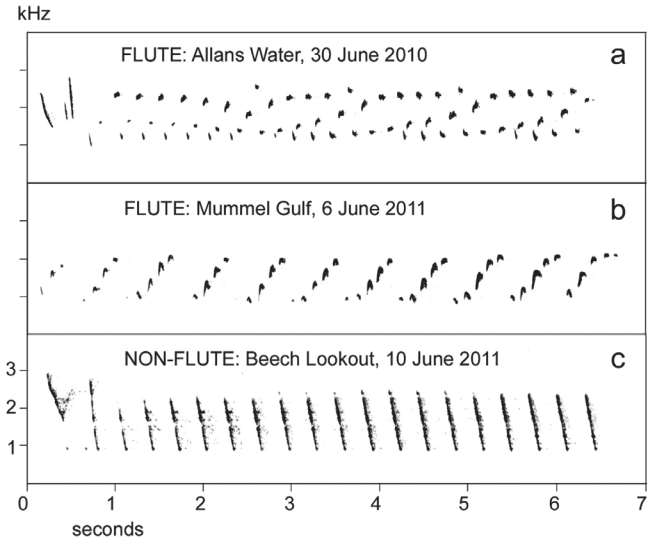

Figure 1. *A sonogram comparing three Superb Lyrebird territorial songs: a) Allans Water (site 7/subsite A11): 30 23 19.4, 152 27 09.1, 1391m, 30 June 2010 (flute); b) Enfield State Forest Road, Mummel Gulf NP (site 47): 31 20 45.7, 151 52 15.4, 1080m, 6 June 2011 (flute); and c) Beech LO, Cunnawarra NP (site 26), 30 31 06.5, 152 21 16.2, 1388m, 10 June 2011 (non-flute).*

METHODS

Study area

Fieldwork was conducted from 2009 to 2014. Most recording sites were within the NSW North Coast Bioregion, the remainder being in the New England Tableland Bioregion. Both bioregions encompass the steep slopes and gorges of the Great Escarpment and are characterized by a cool, temperate climate with no dry season. Vegetation in the study area included both *Eucalyptus* forest and rainforest, with an open forest floor that lyrebirds require for feeding. Rainforest types included cool-temperate with Antarctic Beech *Nothofagus moorei*, sub-tropical, warm-temperate, and dry. *Eucalyptus* forest types included wet and dry sclerophyll, sub-alpine, tall forests with a rainforest understorey, and woodland (Cooper and McAllan 1999).

General survey methods

The sampling protocol was designed to obtain a comprehensive coverage of song in every suitable habitat (access permitting) from the putative site of introduction to the edge of that contiguous habitat and beyond. Superb Lyrebirds are common throughout these dense forests despite the loss of nearby habitat associated with human settlement, logging and clearing of native forests, fires, agriculture, and predation. Recording sites were generally more than one kilometre apart (due to the carrying power of the lyrebird's voice), but in areas with a high density of singing birds, subsites were defined. Some remote sites had to be excluded from the survey because access was too difficult. Locations where lyrebirds were detected were documented using a hand-held GPS unit. Nine field-survey trips were undertaken, the first with two observers/recordists, the others with one observer/recordist.

The northernmost survey site was at Cloud's Creek State Forest (site 1) and the southernmost at Woko National Park (NP) (site 85), and the survey extended from Sheba Dam between Nundle and Hanging Rock in the west (site 124) to the Never Never Picnic Area in Dorrigo NP in the east (site 10). Sound recordings were made at elevations between 192 (site 12) and 1557m (site 16) above sea level.

Choice of recording sites was also influenced by interviews with, and recordings obtained from, the first sound recordists to document flute-like song. These localities (and specific sites when known) were visited to determine whether flute-like song producing lyrebirds were still present. Maps were created from Google terrain maps and satellite images in Google Earth. GPS coordinates were entered as location markers in Google Earth. Screen shots were processed using layers in Photoshop Elements.

Sound recording of lyrebird vocalisations

Birds were observed and recorded singing in all weathers. Recordings with Olympus LS-10 Linear PCM Field Recorders and Sennheiser ME66 and ME67 shotgun microphones covered with windshields were made opportunistically daily throughout daylight hours on each field trip. Sites initially visited during heavy rain were revisited to be certain that inclement weather had not inhibited birds from singing (Reilly 1988). All sites, but especially those where no songs were heard or recorded, were assessed for evidence of suitable lyrebird habitat, including lyrebird-raked ground.

After approximately five minutes (min) and once several territorial songs had been recorded, the recordist would either elect to continue recording or move to another individual/site. Recordings varied in length. At sites not yielding flute-like elements, we tried to record song minimally for 30 min (and up to 86 min, with a mean duration of 43 min) or to return to the site on another trip. Recordings were annotated with GPS coordinates, altitude, date, time, place, and observational notes, including behaviour and habitat. Archival recordings from six sources were collected, analysed, and incorporated into our data base; we had made no recordings at these sites prior to 2009.

RESULTS

Occurrence of flute-like song elements

In documenting how far flute-like songs extend geographically, sites close together have been combined as single symbols on the main map in Figure 2 to provide an overall visual summary of our findings. The 85 productive recording sites (1-85) are summarised in Appendix 1; 37 of these were categorised as flute-like and 48 as non-flute-like. At another 30 sites not documented here, no lyrebirds were observed or recorded, although some of the sites contained what appeared to be suitable habitat. Flute-like elements were documented at elevations from 418 (site 37) to 1557m (site 16) above sea level.

Figure 3 shows a detailed map of the area surveyed at Allans Water (sites 6-7 in Appendix 1). It includes the Jones' homestead ruins (subsite A1), alleged site of the 'original flute bird', and the site of the Manns' homestead (subsite A2) where Martha Manns lived in the 1930s. It was Manns who later recounted the story

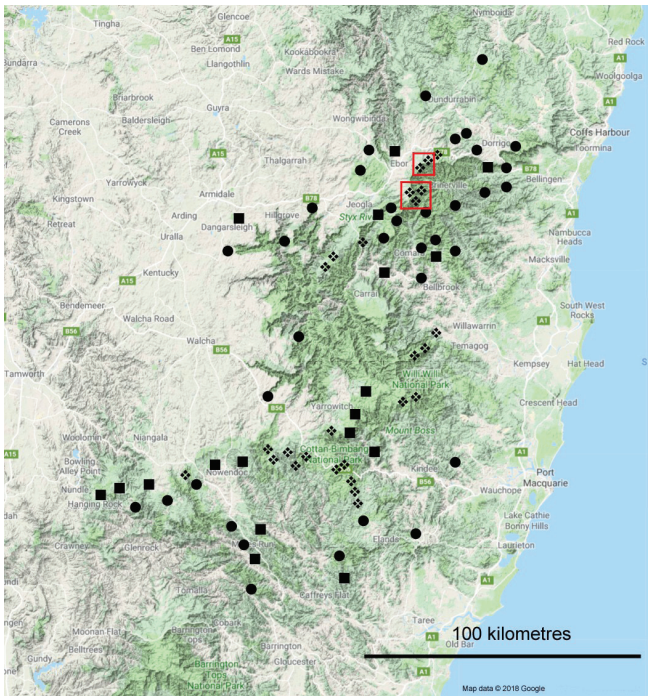

Figure 2. *The bioregions of NSW North Coast and New England Tableland showing Superb Lyrebird field sites: ❖ = flute; ● = non-flute; ■ = no songs heard/recorded. The top (more northerly) red box indicates Allans Water, the site of the 'original bird', which is detailed in Figure 3. The bottom (more southerly) red box indicates sites in and near New England NP and is detailed in Figure 4.*

of a flute player and a captive bird (Powys *et al*. 2013). Sixteen recording subsites in this area yielded lyrebird territorial songs with flute-like elements (Appendix 2); only hints of non-flute-like elements were heard or recorded at Allans Water. All the songs here achieved a high degree of complexity resembling that in the sonogram in Figure 1a. Allans Water songs with flute-like elements were longer and more complex than the flute-like songs in other areas.

However, the presence/absence of flute-like elements could not be predicted by distance from the ruins of the homestead where the 'original bird' was purportedly released at Allans Water. Radiating out from this site, our survey catalogued no flute-like elements in territorial songs to the north, east, or west. Flute-like songs were documented at Knodingbul Rd (site 56) in Doyles River State Forest (SF) (which, at 129.5 km away, was the site farthest to the south of the homestead ruins) and at Myall Creek campsite, Nowendoc SF (site 63) (the farthest to the south west). The farthest site surveyed from the homestead ruins was Woko NP (site 85), a non-flute-like site (172.5 km distant).

Another highly productive recording area was the New England NP at sites at and near Banksia Point Lookout and along Robinsons Knob Trail (Fig. 4 and Appendix 3). Fourteen recording sites here yielded lyrebird territorial songs containing flute-like elements at twelve locations (sites B1-B8 and R1-R2), and all these songs had a moderate degree of complexity. However, just to the south and almost within hearing distance of sites B1-B8 is a group of non-flute-like lyrebirds at sites R3-

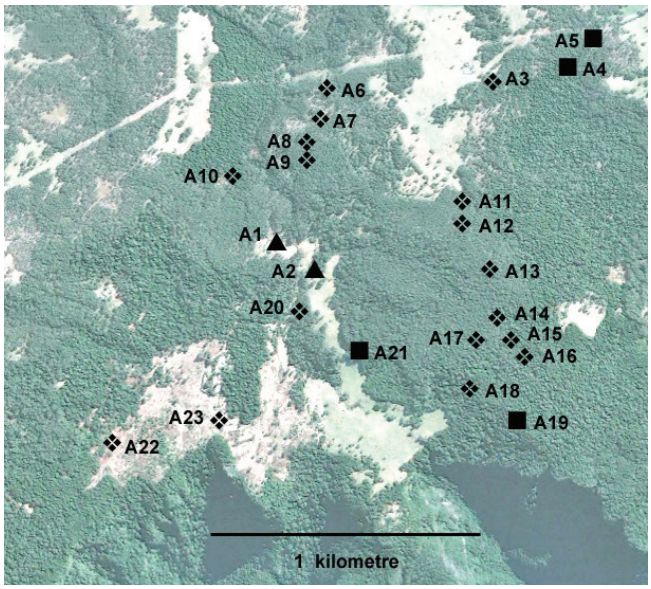

Figure 3. *The area of Allans Water near Ebor showing Superb Lyrebird field sites: ❖ = flute; ▲ = homestead sites; ■ = no songs heard/recorded.*

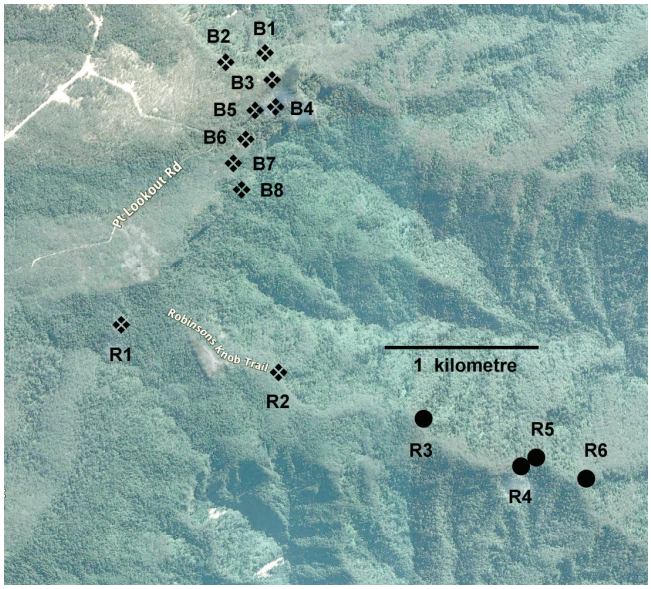

Figure 4. *Sites in New England NP at and nearby Banksia Point Lookout (B), and along Robinsons Knob Trail (R) showing Superb Lyrebird field sites: ❖ = flute; ● = nonflute.*

R6, but flute-like song populations occur again farther south in the ranges west of Kempsey, indicating that flute-like song distribution is not continuous even in contiguous habitat.

Some individuals delivered both flute-like and non-flute-like territorial songs. Also at site 35, several individuals delivered mimicry but no species-specific territorial songs. Revisits to this site on subsequent trips yielded similar results in recordings totalling 103 min of song. At the 17 other sites visited multiple times (shown in Appendix 1), song types were also consistent and had not changed over the years.

Song structure will be investigated more fully in a future paper, but preliminary evidence suggests that the flute-like elements at Fenwicks Rd in Cottan-Bimbang (site 44) and Mummel Gulf NPs (sites 46-48) are simpler and more consistent with the sonogram in Figure 1b than that in Figure 1a. However, both simple and more complex flute-like songs were recorded from the southerly 'flutists' at site 56 (Knodingbul Rd). Conceivably, a lyrebird's age might affect song complexity, with younger males giving simpler songs, which might explain how some areas surveyed had both simple and more complex songs (Taylor *et al*. unpubl. data).

DISCUSSION

This study has extended the previously known boundaries of the flute-like lyrebird song dialect. Initial recordists of the flute-like song focussed on Allans Water (sites 6 and 7) and Point Lookout in New England NP (site 16), which are approximately 15 km apart (Powys *et al*. 2013). However, in 1991 Ederic Slater recorded flute-like songs at Carrai (near our sites 38 or 39, approximately 65 km south of the Allans Water sites) and somewhere in, or near, Mt. Boss (possibly near our site 40, Hastings Forest Way, Willi Willi NP), which is ~85 km south of the Allans Water sites (Rankin *et al*. 1999). Slater argued that flute songs would not have 'travelled' that distance within the suggested time frame from the 1920s (the time of the alleged existence of the original flute-mimicking lyrebird at Allans Water) to 1991, although two other lyrebird experts (Sydney Curtis and Norman Robinson) believed that if there were no major habitat break, it could be possible (see Powys *et al*. 2013). In 1983, Glenn Holmes recorded the flute-like dialect occurring 'at least as far south as the Oxley Highway' (see Rankin *et al*. 1999), extending its distribution to ~120 km south of Allans Water. The present study verified Holmes' suggestion and extended the boundary another 10 km to the south (including sites 46-48, 54-56, and 82-83).

Researchers who have investigated the lyrebird's flute-like songs disagree on whether, were the 'flute lyrebird' story true, a new song could, or would be likely to, spread the extraordinary distance of 130 km in a relatively short time (from, say, 1920 to 1983). Breeding adult males and females are sedentary throughout their range, and both occupy territories. As a primarily cursorial bird, a lyrebird mainly walks and runs within its territory rather than flies. Male territories are all-purpose, maintained throughout the year and actively defended against conspecific intruders, and the maximum recorded lifetime movement of a lyrebird is only *c.* 10 km (Higgins *et al*. 2001). Given this, are lyrebirds capable of the magnitude of cultural transmission and change implied by the 'release of a captive bird' scenario?

For a new song to spread by vocal learning, presumably contiguous habitat would be required. Satellite imagery viewed on Google Earth suggests that sufficient contiguous forest habitat links all the lyrebird populations that we surveyed. Both flute-like and non-flute-like singing lyrebirds inhabit this contiguous forest area, but on the other hand flute-like songs were not found beyond any significant habitat gaps. For instance, a gap south of Knodingbul Road separates our main study area from Barrington Tops NP, where flute-like songs do not occur (Taylor *et al*. unpubl. data).

We noted that flute-like songs seemed not to carry as far as non-flute-like songs. This was confirmed by comparing the waveform peaks of territorial songs with the relative loudness of the mimicked call of the Grey Shrike-thrush *Collurincincla harmonica* from the recorded song of the same lyrebird. Non-flute-like territorial songs were louder than mimicry, whilst flute-like songs were similar to, or less loud than, mimicry (Taylor *et al*. unpubl. data). This could have implications for the relative abilities of co-occurring flute-like and non-flute-like males to attract females, although the argument is complicated by the fact that some males sing both song types.

Also of some relevance to the spread of the flute-like dialect in a relatively short time is what has happened to the vocal repertoire of the Superb Lyrebirds introduced to Tasmania from Victoria between 1934 and 1949 (Higgins *et al*. 2001). After more than 60 years of separation, 'dramatic differences' between the vocalisations of the mainland and Tasmanian lyrebirds were noted (Jordan 2007). The Tasmanian lyrebirds had begun to mimic endemic Tasmanian bird species, while continuing to produce the mimicked calls of mainland Eastern Whipbirds *Psophodes olivaceus* and Pilotbirds *Pycnoptilus floccosus*. Whipbird mimicry declined in accuracy over the years and was, by the 1980s, barely recognizable, but a more recent survey has found a range of 'whip' calls from strong to weak, as might be expected after long isolation from the original model (Jordan 2007). Whilst flute-like songs are territorial songs and may not be mimicry, the Tasmanian introduction does indicate strikingly that Superb Lyrebirds have the capacity for vocal learning from original models and not just from other lyrebirds, and the ability to retain, albeit possibly in a decaying form, the mimicked vocalizations of models to which they have long ceased to be exposed. These demonstrated vocal learning abilities perhaps make the spread of a flute-like song dialect in a relatively short time more plausible.

Three unanswered questions that seem to challenge the credibility of the flute story are: Why did the flute-like song fail to spread the 20-30 km from Allans Water to contiguous sites around Dorrigo, yet spread over 100 km to the south? Why does the distribution suddenly shift from flute-like to non-flute-like singers south of Allans Water in New England NP when flute populations occur again in the ranges west of Kempsey? Why do some males sing both flute-like and non-flute-like songs? There remain many unanswered and interesting questions about the flute-like song dialect of Superb Lyrebirds, irrespective of whether we regard the story of the original flute-mimicking lyrebird as plausible or unlikely.

CONCLUSION

The distribution map (Fig. 2) that we produced is consistent with the potential origin and cultural transmission of a flute-like song, either from the site of putative introduction or from some other contiguous site within the study area. From ground surveys and by studying Google Earth views of the terrain, we concluded that there is enough forest habitat remaining even in 2018 to connect populations of flute-like singing lyrebirds continuously from Allans Water to Knodingbul Road 130 km to the south. However, whilst habitat was continuous, flute-like songs were not geographically continuous, being separated by zones containing non-flute-like singing lyrebirds. The origins of these flute-like territorial songs remain unknown, and we still cannot discount the flute lyrebird story.

ACKNOWLEDGEMENTS

We thank all property owners who allowed us to conduct fieldwork on their land. We are grateful to the archival recordings from this area by Sydney Curtis, Neville Fenton, Phillip and Jane Ulman, Martha Manns, Enid Rayner and Ederic Slater. We also thank two anonymous peer reviewers and the editor of *Corella* for their valuable assistance in guiding the production of this paper. Hollis Taylor's research for this paper was supported in part by a 2013 Research Development Grant from the University of Technology Sydney (Faculty of Arts and Social Sciences).

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Appendix 1

Productive Superb Lyrebird recording sites (flute-like and non-flute-like). Sites 1-65 are from N to S; sites 66-85 re-start the N to S layout. In this and subsequent tables, the letter in column 6 denotes the observer (C=Carol, H=Hollis) and the number the trip number.

Site	Location	Flute	GPS South, East	Alt	Fieldtrip
1	Clouds Creek SF	no	30 08 53.3, 152 35 23.6	782	H2
2	Mt Hyland NR	no	30 11 17.2, 152 25 48.6	1255	C3
3	Deer Vale E of NR	no	30 19 11.8, 152 37 19.5	782	H5
4	Deer Vale NR	no	30 19 22.9, 152 35 37.9	921	C3/H5
5	Tree Fern Vale	no	30 19 51.0, 152 34 09.4	1084	C3/H5
6	Allans Water forest, NENP	YES	30 23 19.4, 152 27 09.1	1391	C4/H7/H8
7	Allans Water homestead	YES	30 23 36.6, 152 26 42.0	1330	C3
8	Native Dog RA/Guy Fawkes River NP	no	30 23 14.7, 152 16 05.8	1255	H2
9	Cathedral Rock NP walking track	no	30 25 49.3, 152 15 03.7	1481	C3
10	Never Never picnic area, Dorrigo NP	no	30 21 28.1, 152 47 29.2	748	H2
11	Waterfall Way, Newell Falls RA, Bellinger	no	30 24 07.6, 152 44 49.2	389	C3
12	Orama (Upper Thora), Diehappy SF	no	30 26 32.3, 152 42 00.3	192	C3
13	Scotchman SF, E boundary, Baalijin NR	no	30 28 13.0, 152 41 47.0	413	C4
14	Lyrebird Firetrail, Baalijin NR	no	30 28 37.1, 152 39 55.5	647	C4
15	Killiecrankie Mt	no	30 32 29.6, 152 32 29.5	883	C4
16	Pt Lookout, NENP (top of escarpment)	YES	30 29 19.4, 152 24 30.1	1557	H2/H7/H8
17	Banksia Point LO, NENP	YES	30 29 33.0, 152 24 23.6	1446	H2/C4/H5/H7/H8
18	Lyrebird Track S of Banksia Pt LO, NENP	YES	30 29 44.6, 152 24 22.9	1352	C4
19	Wrights LO, near Pt Lookout	YES	30 30 19.2, 152 23 50.9	1322	C4
20	Snowy Range 1, Wrights LO	YES	30 30 29.0, 152 24 33.3	1252	C4
21	Snowy Range 2, Wrights LO	no	30 30 39.1, 152 25 13.4	1155	C4
22	Snowy Range 3-5, Wrights LO	no	30 30 47.9, 152 25 46.4	1028	C4
23	Snowy Range 6 (S of Grasstree Ridge)	no	30 31 48.8, 152 26 55.4	882	C4
24	Snowy Range 7 (5.5km SE of Wrights LO)	no	30 31 53.2, 152 26 59.5	827	C4
25	Cunnawarra Trail, Cunnawarra & NE NPs	no	30 31 48.3, 152 21 37.1	1310	C3
26	Beech LO, Cunnawarra NP	no	30 31 06.5, 152 21 16.2	1388	C3/H5/H7
27	Forest Way/Softwood Rd, Cunnawarra NP	no	30 31 23.5, 152 20 18.1	1260	C3/H7

Appendix 1 (continued)

Site	Location	Flute	GPS South, East	Alt	Fieldtrip
27	Forest Way/Softwood Rd, Cunnawarra NP	no	30 31 23.5, 152 20 18.1	1260	C3/H7
28	Edgars LO, Oxley Wild Rivers NP	no	30 31 57.7, 152 01 34.3	1018	H2
29	Wollomombi Falls, Oxley Wild Rivers NP	no	30 32 04.3, 152 01 58.4	952	H2/H5
30	Dangars Gorge LO, Oxley Wild Rivers NP	no	30 40 28.2, 151 43 29.8	977	H2/C3
31	Long Point, Oxley Wild Rivers NP	no	30 39 58.9, 151 56 00.9	1041	C3
32	Georges Ck, Cunnawarra NP	YES	30 39 32.7, 152 12 17.7	776	C3
33	Raspberry Mtn, Cedar Rd, Styx River SF	YES	30 42 40.0, 152 06 06.3	910	C3
34	Raffertys Ck, Styx River SF	YES	30 43 56.5, 152 04 08.2	934	C3
35	O'Sullivans Gap, Pee Dee NR	no	30 47 06.4, 152 26 06.5	245	H5/H7
36	Budd's Mare/Riverside Trail	no	30 58 32.0, 151 58 24.6	937	H7
37	Mt Mystery Timber Reserve	YES	30 56 53.4, 152 24 18.1	418	C3/C4
38	Carrai Rd, Hogsback/McCoys, Carrai SF	YES	30 59 35.4, 152 21 09.4	907	C3
39	Kookaburra Forest Camp, Carrai SF	YES	31 01 27.2, 152 20 13.8	960	C3
40	Hastings Forest Way, Willi Willi NP	YES	31 09 38.8, 152 22 46.2	1012	CH1
41	Plateau Beech, 1.5 km from camp, Werrikimbe NP	YES	no signal		CH1
42	Plateau Beech camp, Werrikimbe NP	YES	31 10 48.2, 152 19 35.4	1055	CH1
43	No 1 Tower LO (Five Ways Hill), Bellangry SF	no	31 17 09.9, 152 32 08.3	661	CH1
44	Fenwicks Rd, Cottan-Bimbang NP	YES	31 16 32.6, 152 04 34.1	1029	CH1
45	Tia Falls, Oxley Wild Rivers NP	no	31 09 23.2, 151 51 29.8	1053	CH1
46	Mummel Gulf NP West	YES	31 19 07.1, 151 47 20.2	1286	C6
47	Mummel Gulf NP, New Country Swamp camp	YES	31 19 51.3, 151 51 59.9	1144	C4
48	Mummel Gulf NP, Enfield Forest Rd	YES	31 21 04.6, 151 52 09.2	1091	C4/H7/H8
49	Myrtle Scrub Scenic Dr NW end, Cottan-Bimbang NP	YES	31 20 57.0, 152 00 52.9	1154	H5/H8
50	Myrtle Scrub Scenic Drive SE end, Mt Seaview	YES	31 23 22.1, 152 03 33.6	909	H5
51	N Oxley Hwy, SE end Myrtle Scr Sc Dr, Mt Seaview	YES	31 23 20.5, 152 03 36.4	920	H5
52	Stockyard Ck	YES	31 24 13.3, 152 07 28.6	739	CH1/H8
53	Stockyard Ck Rd junction	YES	31 24 45.5, 152 08 03.0	916	CH1/H7/H8
54	Knodingbul Rd #1, Cottan-Bimbang NP	YES	31 28 06.5, 152 09 15.7	632	CH1/H8
55	Knodingbul Rd #2 + 3, Cottan-Bimbang NP	YES	31 28 50.4, 152 09 26.9	861	CH1/H8
56	Knodingbul Road #4 + 5, Doyles River SF	YES	31 29 32.3, 152 09 39.3	856	CH1
57	Knodingbul Rd/Blue Knob Rd junction, Bulga	no	31 34 41.4, 152 10 47.9	773	CH1
58	Boorganna NR	no	31 36 49.3, 152 24 39.5	690	C3
59	Dingo Tops camp, Tapin Tops NP, Dingo SF	no	31 39 58.0, 152 08 34.8	867	CH1
60	Pigeon Top, Giro SF	no	31 38 04.8, 151 46 52.4	828	C6
61	Jacky Barkers Road, Giro SF	no	31 33 22.0, 151 34 57.3	911	C6
62	Roller Road, Nowendoc SF	no	31 26 01.6, 151 34 57.3	1162	C6
63	Myall Ck campsite, Nowendoc SF	YES	31 25 43.5, 151 33 27.2	914	C6
64	Tuggolo Ck, Tuggolo SF	no	31 29 40.0, 151 29 47.0	1220	C6
65	Tomalla NR	no	31 31 53.6, 151 21 41.4	1132	C6
66	Allans Water/Rim of World	YES	30 23 54.1, 152 26 30.4	1358	C9
67	Allans Water/priv res JL	YES	30 23 49.0, 152 27 10.9	1207	C9
68	Allans Water/priv res LT/Rim	YES	30 23 57.8, 152 26 13.6	1351	C9
69	Majors Point	YES	30 25 13.2, 152 25 34.5	1513	C9
70	Majors Point escarpment	YES	30 25 13.5, 152 25 38.0	1503	C9
71	Majors Point escarpment	YES	30 25 21.6, 152 25 31.6	1504	C9
72	Johnsens Rd nr Dorrigo	no	30 20 20.0, 152 37 13.9	986	C9
73	Johnsens Rd nr Dorrigo	no	30 20 20.0, 152 37 00.9	868	C9
74	Thumb Creek SF/nr Blue Knob	no	30 41 58.4, 152 33 45.2	621	C9
75	Thumb Ck/Sheet-o-bark Rd	no	30 41 26.9, 152 33 07.9	717	C9
76	Thumb Ck/nr Kilprotay Rd	no	30 40 46.8, 152 33 10.5	723	C9
77	Nulla 5 Day SF/PostmansTrl	no	30 40 51.4, 152 26 29.3	594	C9
78	Nulla Ck Rd, nr Nulla Nulla	no	30 39 11.5, 152 28 30.1	194	C9
79	Lower Creek SF/ Petroi Rd	no	30 40 50.2, 152 14 53.9	417	C9
80	Lower Creek SF/ Petroi Rd	no	30 40 01.8, 152 15 30.1	652	C9
81	Lower Ck SF/ Petroi Rd ridge	no	30 39 42.9, 152 15 41.6	766	C9
82	Mummel Gulf/Daisy Patch Rd	YES	31 22 02.4, 151 55 54.8	1046	C9
83	Mummel Gulf/Daisy Patch Rd	YES	31 22 11.2, 151 55 53.0	1022	C9
84	Carsons PLO, southeast	no	31 40 45.9, 151 49 55.3	756	C9
85	Woko NP/Cliff Track	no	31 47 45.2, 151 47 52.4	317	C9

Appendix 2

Allans Water field sites used in this study (NA designates no song heard or recorded).

Subsite	Location	Flute	GPS South, East	Alt	Fieldtrip
A1	Jones' homestead ruins/priv res JU	NA	30 23 26.1, 152 26 37.8	1278	C4/H7/H8/C9
A2	Manns' homestead approx site	NA	30 23 27.5, 152 26 42 4	1301	H7
A3	New Eng NP nr gate/priv res CL	YES	30 22 56.4, 152 27 13.9	1344	H8
A4	Redman Rd	NA	30 22 54.4, 152 27 27.0	1272	C9
A5	Redman Rd, clearing beside ford	NA	30 22 48.7, 152 27 31.6	1331	C9
A6	Near access road	YES	30 23 09.4, 152 26 40.6	1329	H7
A7	Near access road	YES	30 23 11.3, 152 26 41.4	1320	H7
A8	Near access road/ravine	YES	30 23 04.7, 152 26 42.4	1342	H7
A9	Near access road/fence	YES	30 22 58.7, 152 26 43.2	1314	H7
A10	Private res DE backyard	YES	30 23 14.5, 152 26 26.8	1322	H8
A11	Forest Site 1	YES	30 23 19.4, 152 27 09.1	1391	C4
A12	Forest Site 2	YES	30 23 22.6, 152 27 09.1	1415	C4
A13	Forest Site 3	YES	30 23 30.1, 152 27 13.3	1415	C4
A14	Forest Site 4	YES	30 23 38.3, 152 27 14.6	1426	C4
A15	Forest Site 5	YES	30 23 40.5, 152 27 17.2	1434	C4
A16	Forest Site 7	YES	30 23 44.1, 152 27 19.4	1421	C4
A17	Forest Site 6	YES	30 23 41.3, 152 27 11.8	1432	C4
A18	Lyrebird Hill/priv res JL	YES	30 23 49.0, 152 27 10.9	1207	H8/C9
A19	Farthest pt walked to escarpment	NA	30 23 53.0, 152 27 18.0	1390	C4
A20	Near Jones' homestead site	YES	30 23 36.6, 152 26 42.0	1330	C3
A21	Near tank, Jones'/Manns' sites	?	30 23 42.9, 152 26 52.5	1357	C4
A22	Rim of the World, gully	YES	30 23 57.8, 152 26 13.6	1351	C9
A23	Rim of the World, escarpment	YES	30 23 54.1, 152 26 30.4	1358	C9

Appendix 3

Banksia Point LO and Robinsons Knob Trail field recording sites.

Subsite	Location	Flute	GPS South, East	Alt	Fieldtrip
B1	Eagles Nest Lookout	YES	30 29 13.0, 152 24 27.8	1350	C4
B2	Berarngutta Picnic Area	YES	30 29 15.7, 152 24 18.1	1545	H7/H8
B3	Point Lookout	YES	30 29 19.4, 152 24 30.1	1557	H2/H7
B4	Weeping Rock	YES	30 29 25.6, 152 24 30.2	1463	C4
B5	Platypus Valley Lookout	YES	30 29 26.0, 152 24 26.0	1532	H5/H7/H8
B6	Banksia Point Lookout	YES	30 29 33.0, 152 24 23.6	1478	H2/H5/H7/H8
B7	B Pt LO/Tree Fern Valley	YES	30 29 38.3, 152 24 20.6	1464	C4
B8	Lyrebird Track	YES	30 29 44.6, 152 24 22.9	1352	C4
R1	Wrights Lookout	YES	30 30 19.2, 152 23 50.9	1322	C4
R2	Snowy Range 1	YES	30 30 29.0, 152 24 33.3	1252	C4
R3	Snowy Range 2	no	30 30 39.1, 152 25 13.4	1155	C4
R4	Snowy Range 4	no	30 30 49.4, 152 25 43.4	984	C4
R5	Snowy Range 3	no	30 30 47.9, 152 25 46.4	1028	C4
R6	Snowy Range 5	no	30 30 53.2, 152 26 02.1	956	C4