VALIDATION OF THE USE OF ANTS AS BIOINDICATORS OF THE IMPACT OF SEISMIC OPERATIONS IN THE COOPER BASIN

A. J. McArthur
Honorary Research Associate
South Australian Museum
Adelaide

SUMMARY

A report (Watts et al 2002) concluded that ant activity was not reduced by seismic operations in the Cooper Basin. The main environmental effect appeared to be visual, while changes in ant activity resulted from changed foraging patterns. A fourth trapping of ants in 2003 confirms the conclusions in the report. The two studies spanned a three year period and found that ant activity immediately after construction of the seismic line was higher on the line than off it and three years after had returned to normal. Over this period, total ant activity was never reduced. As ants are accepted as good bioindicators, it is deduced that disturbance by linear seismic operations is statistically insignificant.

INTRODUCTION

A seismic survey programme was recorded 40 kilometres to the north west of Moomba in the South Australian sector of the Cooper Basin, during the winter of 2000. The impact was measured by studying ant activity. Ants were selected as indicators because they make up a large proportion of the biomass of the area. They were sampled from eight sites located on two seismic lines immediately prior to line preparation in 2000, immediately after data recording and again in 2001, one year after the operations. Details of this year long study are contained in *The Impact Of Seismic Lines On Ant Communities In The Cooper Basin And Potential Use As Bioindicators Of Ecological Recovery Rates*, presented to PIRSA in 2002. Briefly the results were:

> "No significant difference ($p > 0.05$) was detected between the ants on the proposed route and those off the route. When resampled two months 'after' the construction of the line, significant changes were detected. Both the average number of species per trap and average number of individuals per trap were significantly more ($p < 0.05$) on the line than off the line. When the line was resampled in the same locations one year later the average number of ants per trap had increased significantly both on the seismic line and in adjacent regions. There was a decrease in average numbers caught on the seismic line compared with off the line but the difference was not statistically significant ($p > 0.05$). From this it would appear that after a year the ant usage of the area had returned to normal, albeit with an overall large increase in number of ants captured."

In 2003, Rob Langley of PIRSA sampled ants for the fourth time at the same sites which provided data confirming the conclusions of the 2002 report. This additional data has enabled the observation of interactions between different ant genera following the seismic operations and provides strong support for the use of ants to measure environmental disturbance.

METHOD

Thirty five pitfall traps were set at 3m spacing, in a grid of seven rows (6 rows off the line and 1 row on the line) as shown in Fig. 1 and repeated at 4 sites on dunes and at 4 on swales. Traps were 18 mm diameter, 200 mm long, filled with 70% alcohol and exposed for 14 days. Site identification, habitat, and periods of exposure of traps are shown in the Appendix.

Fig. 1. Layout of pitfall traps, spaced 3 m, in relation to a seismic line near Moomba.

	1	2	3	4	5
	6	7	8	9	10
	11	12	13	14	15
Seismic line	16	17	18	19	20
	21	22	23	24	25
	26	27	28	29	30
	31	32	33	34	35

RESULTS

The ants sampled in 2003 were delivered to the South Australian Museum where they were identified and counted. The numbers of ants sampled are shown in Table 1. Other invertebrates collected are preserved in the South Australian Museum and are available for future study.

Table 1. Numbers and genera of ants collected in pitfall traps near Moomba over three years.

Ant taxa	Before	After operations			
	Jun 00	Aug 00	Aug 01	Jul 03	Total
Anillomyrma spp	1	3	1	0	5
Anochetus spp	0	1	0	1	2
Camponotus spp	30	51	37	53	171
Cardiocondyla spp	0	0	1	0	1
Cerapachys spp	0	0	6	0	6
Doleromyrma spp	15	22	0	1	38
Iridomyrmex virideanus	14	16	123	109	262
Iridomyrmex spp	536	620	928	675	2759
Machomyrma spp	0	0	4	0	4
Melophorous spp	42	34	79	11	166
Meranoplus spp	10	9	22	29	70
Monomorium spp	431	353	4487	424	5695
Paratrechina sp	0	0	0	1	1
Pheidole spp	1646	1419	2899	1205	7169
Rhytidoponera sp1	149	34	36	33	252
Rhytidoponera sp2	289	120	128	181	718
Solenopsis spp	3	2	6	0	11
Sphinctomyrmex spp	3	0	0	0	3
Tapinoma spp	3	5	58	0	66
Tetramorium spp	125	89	160	94	468
Total ants	3297	2778	8975	2817	17867

DISCUSSION

The data from the four trappings has been analysed and is presented as graphs which indicate ant activity on and off the seismic line at 8 different sites identified as A to H. Each row consisted of 5 traps as shown in Fig. 1. Activity of all ants and of the most common ant taxa is shown in the following graphs.

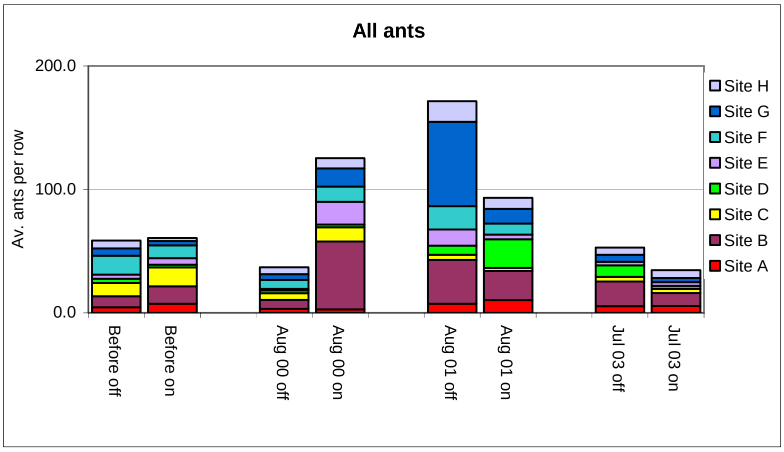
"Av. ants per row" data for the graphs was derived thus:

"off" line: (sum of ants from 6 rows of traps off the line)/6;

"on" line: the sum of ants from one row on the line.

The influence of seismic operations on the total number of ants sampled

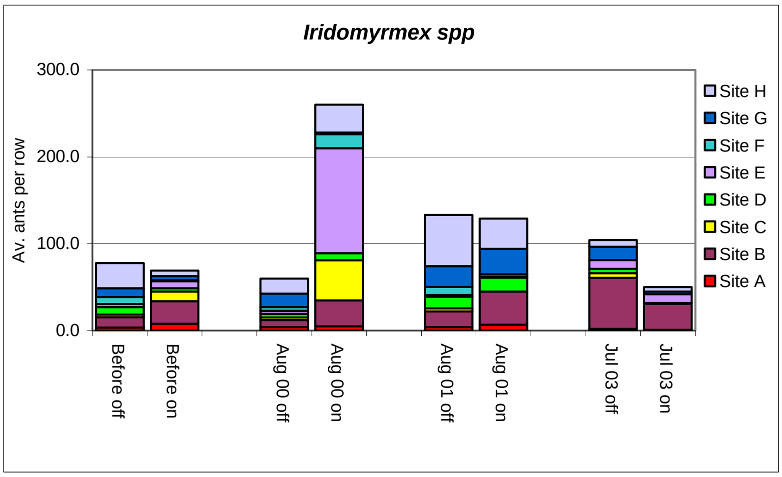
It is known that ants are attracted to disturbed ground, presumably because new resources including seeds are made available.



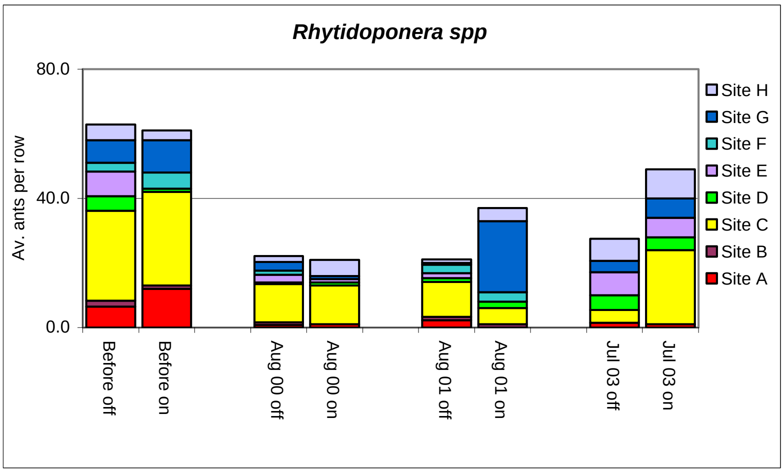
The graph for all ants shows that the activity of all ant genera on and off the line prior to the operations was practically equal. However activity on the seismic line was boosted immediately after the operations, maintained at a higher level the following year, particularly in the vicinity of the line and after another two years had returned to near normal.

The influence of seismic operations on ant genera

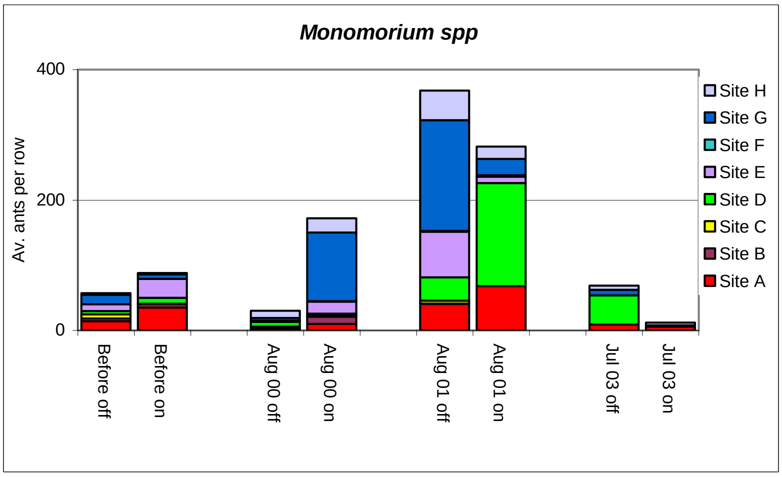
Changes in activity of ants of the most populous genera are shown in the following graphs. Greenslade, 1985 proposed a structure for the hierarchy of an ant community in which he described *Iridiomyrmex* species as dominant while other genera were ranked as sub-ordinant, opportunist etc. He described as dominant those which are "aggressive, broadly adapted and influence the occurrence of other species".

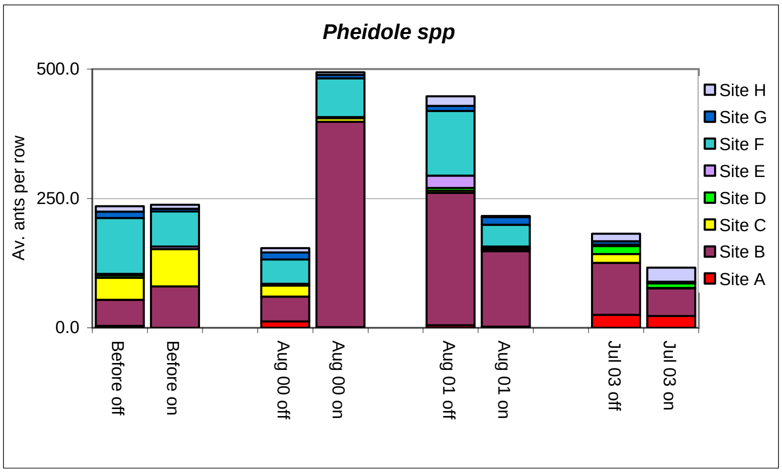


The small *Iridomyrmex* species are the dominant one here and with their advanced command and communication capabilities would exploit the recently created resource as shown in the graph above by their increased activity on the line.

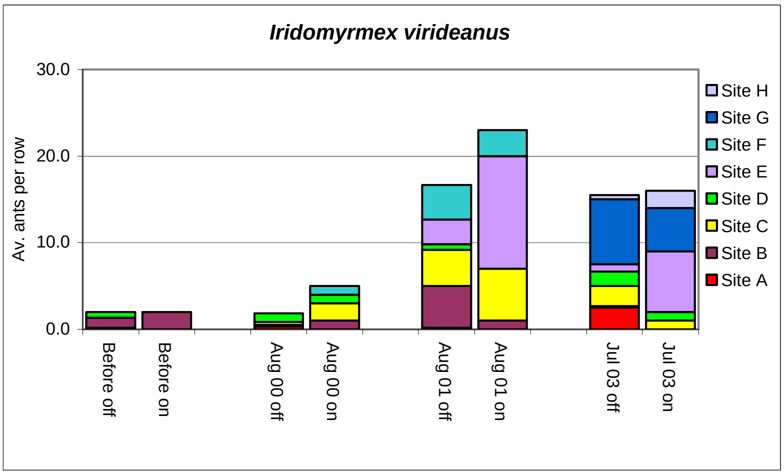


The decline in *Rhytidoponer*a activity after seismic operations corresponds with the rise in *Iridomyrmex* spp activity. *Rhytidoponera* are large primitive ants and would have been repelled by the large numbers of small, swift, advanced *Iridomyrmex.* By 2003, *Iridomyrmex* activity had dropped to near year 2000 numbers while *Rhytidoponera spp* have risen to near year 2000 numbers.

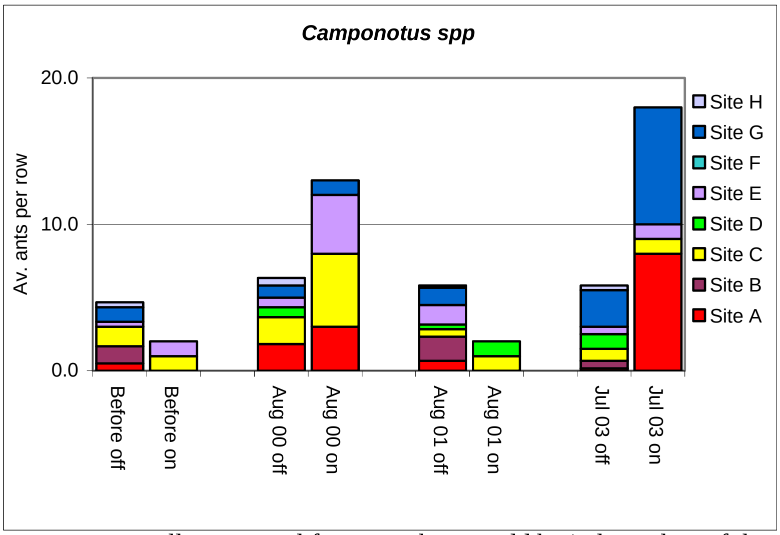




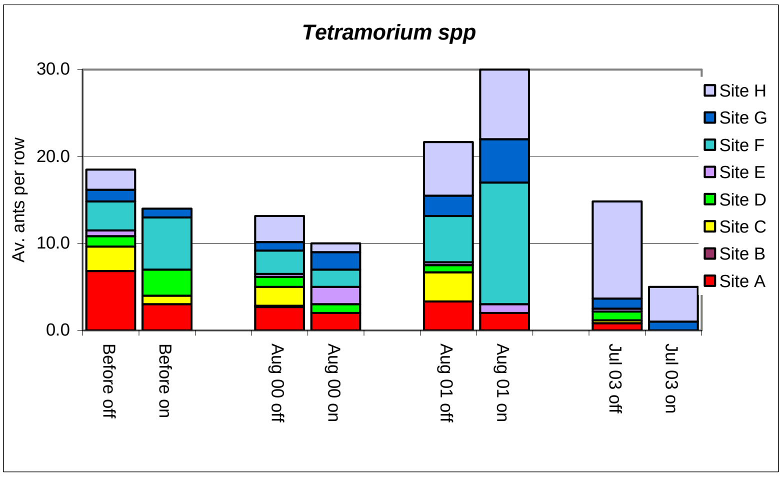
Monomorium and *Pheidole* species are both seed gatherers and would have been attracted to the line and its vicinity in search of seed in 2000 and 2001. By 2003 their activities had returned to near year 2000 levels.



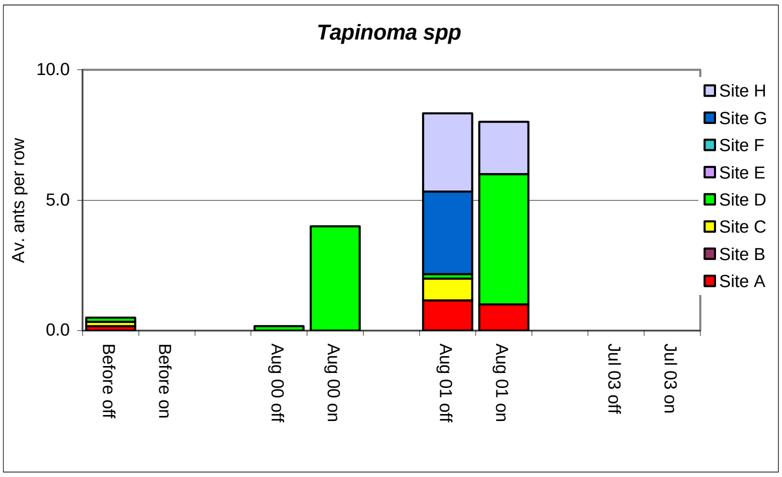
Iridomyrmex virideanus, known as the meat ant is a diurnal forager and is known to forage over 150m from its nest. From the above graph it can be seen that its activity increased substantially after seismic operations and appears to be declining.



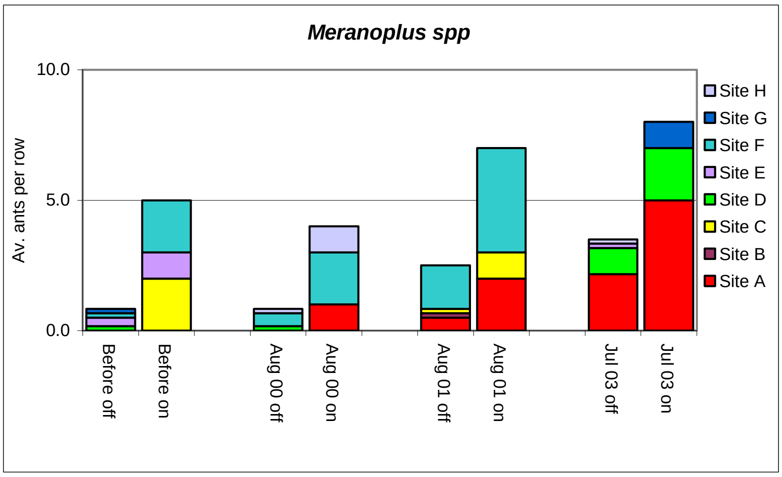
As *Camponotus* spp are genarally nocturnal foragers, they would be independent of the dominant *Iridomyrmex* which are diurnal. It is outside the scope of this paper to speculate on the increase in activity in July 2003.



Tetramorium spp. Here the numbers are small and changes in activity are statistically insignificant.



Tapinoma spp. Numbers are too small to be statistically significant



Meranoplus spp. Of all ants encountered in the study, *Meranoplus* are the most heavily armed and can probably defend themselves against the more aggressive ants. They are general scavengers and may prey on some of the small Iridomyrmex, Monomorium and Pheidole. Although their numbers are low, there activity in year 2003 continues to be above that of year 2000.

CONCLUSION

Seismic operations have not reduced ant activity in the study area and as ants make up a large part of the biomas it follows that the impact of seismic operations on the ecology of the area is unlikely to be significant. Ant activity after 3 years had returned to near normal supporting the conclusion of the 2002 report that

> *The study found that construction of seismic lines is slightly positive in terms of the local ant fauna although the effect detected is small, and unlikely to be of much biological significance. The main environmental effect of seismic line construction appears to be visual—biologically it simply represents a slight reorganisation of local vegetation patterns and hence animal foraging patterns. Seismic lines appear to have an initial short-term impact on ant microdistributions (ants were attracted to the line, an effect that dissipated after a year).*

At the level of ant genera, changes in the hierarchal structure of the ant community can be seen from the graphs above. There was no significant reduction in activity of ant genera over the three year period. The graph for “all ants” and those of genera above supports the finding in the 2002 report that

> *Measurement of the ecological impact of linear disturbances can be obtained by simply counting the total number of ants per trap and comparing the numbers on and off the line. This finding eliminates the need for costly ant identification, greatly simplifying any monitoring procedure.*

RECOMMENDATION

Because the study was confined to long linear disturbances associated with seismic operations, it is recommended that a study of well sites be undertaken to test the appropriateness of ants as bioindicators of environmental impact resulting from wider scale disturbance.

REFERENCE

Greenslade, P.J.M., 1985. Preliminary observations on ants (Hymenoptera : Formicidae) of forests and woodlands in the Alligator Rivers region, N. T. *Proc.Ecol. Soc. Aust.* **13**:153-160.

Watts, C.H.,McArthur, A.J., Oakey, H. and Verbyla, A. 2002. The impact of seismic lines on ant communities in the Cooper Basin and potential use as bioindicators of ecological recovery rates. htpp://www.pir.sa.gov.au/pages/petrol/environment/research_projects/ants_report

APPENDIX

Table 2. Site identification, habitat, and periods of exposure of traps.

Site	Habitat	Before	After		
		23/5-6/6/00	15/8-29/8/00	14/8-28/8/01	26/6-10/7/03
A	Swale	23/5-6/6/00	15/8-29/8/00	14/8-28/8/01	26/6-10/7/03
B	Swale	23/5-6/6/00	15/8-29/8/00	14/8-28/8/01	26/6-10/7/03
C	Dune	23/5-6/6/00	15/8-29/8/00	14/8-28/8/01	26/6-10/7/03
D	Dune	23/5-6/6/00	15/8-29/8/00	14/8-28/8/01	26/6-10/7/03
E	Swale	23/5-6/6/00	15/8-29/8/00	14/8-28/8/01	26/6-10/7/03
F	Swale	23/5-6/6/00	15/8-29/8/00	14/8-28/8/01	26/6-10/7/03
G	Dune	23/5-6/6/00	15/8-29/8/00	14/8-28/8/01	26/6-10/7/03
H	Dune	23/5-6/6/00	15/8-29/8/00	14/8-28/8/01	26/6-10/7/03