Australian Marine Mammal Centre Grants Program
Final Report

- **Project No**. – 2011/05
- **Title** - 'An empirical assessment of whale alarms and avoidance, or not, by migrating humpback whales'
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- **Co-Investigators** Dr Dave Slip, Maryrose Gulesserian
- **Organisation** – Macquarie University

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1. Project Summary

Cetacean entanglements in fishing gear costs governments, fishermen and stakeholders millions of dollars a year, and often results in serious injury or death of the entangled animal. Substantial effort has been directed toward attempts to use acoustic deterrents to reduce or eliminate incidental capture of dolphins, but there is little evidence of the effectiveness of such methods for resolving fishery conflicts with large whales. As the east Australian humpback whale population continues to increase, interactions with fishing gear will increase. We tested the effectiveness of low-frequency whale alarms in deterring humpback whales from approaching a potential source of entanglement (a mooring, functionally equivalent to a lobster pot mooring)

Humpback whales on their northern migration were tracked from Cape Solander in Botany Bay National Park, Sydney (34˚01'S, 151˚14'E). 1 June 2012 to 9 August 2012 and 28 June to 4 August 2013. Whales were tracked by a Research Assistant using a Sokkia SET4A theodolite, connected to a laptop computer . Whale paths were plotted by in real time. Observations were made from dawn to dusk on weekdays to minimise the impact of recreational boaters on weekends.

In 2012 an off the shelf commercial whale alarm (Fumunda F3, 3kHz Whale Pinger® (135 db (+/- 5 db), 5 seconds emission interval and 400m/s emission duration) was moored at a depth of 5m in a water depth of 55m, 1.5km from the coast and in the path most heavily used by whales during the northern migration The alarm was switched on/off manually and changeovers occurred during the field season but on dates not reported to the team tracking the whales from shore (i.e. their observation were blind to the status of the alarm). In 2013, we custom built an alarm that produced one of three tones (*Fumunda* as above, the *Cato* tone: an upswept tone 2.0 to 2.1 kHZ,

duration 1.5 sec and repeated every 8 sec and a control (*alarm off*)) for 11 hours/day during daylight hours with each tone presented in a random sequence. Again the observers were blind as to which tone was emitted on any given day.

In 2012, of 137 pods tracked, 82 passed within 500m of the alarm, 51 when it was on and 31 when it was off. In 2012 there was no discernible response to the alarm, pods did not differ in directionality or surfacing behaviour whether the alarm was on or off and a number of pods passed directly over the alarm while it was operational. This suggests that the alarms as currently configured are unlikely to effectively deter humpback whales from approaching nets or other potential hazards, at least during their northerly migration phase.

In 2013, 107 tracks were recorded over 33 observation days with 29 tracks on days when the Fumunda tone was played, 26 when the Cato tone was played and 43 when the alarm was off. Analysis is still progressing but as can be seen in the attached figures, again there was no convincing deviation from track regardless of which tone was playing.

2. The Outcomes and Objectives – Key Findings

Project Objectives:

- 1. Contribute to the development of effective whale alarms.

This was the first real life situation test of the commercially available 3khz alarms in the path of migrating whales in the southern hemisphere. We both assessed the whale responses to the alarms and also recorded in situ measurements of the acoustic propagation of the whale alarm tones in a grid formation at 15m and 5m depth using a hydrophone deployed from a boat drifting with wind and current in a systematic fashion. One consequence of this latter study is that in 2013 we trialled the new tonal sound after extensive consultation with Prof Doug Cato, using again a double blind study. The Cato alarm used a tonal upsweep (see specifications below). The Cato alarm was based on a sound broadcast previously to Humpback whales and known to elicit a response (see Dunlop et al 2013)

Tone specifications- 2013 whale alarm study

1. **No tone (control)**

2. **Future Oceans F3 whale alarm**
   Frequency: 3kHz
   Emission duration (pulse duration): 400m/s
   Emission interval: every 5 seconds

3. **Doug Cato tone**
   Frequency: swept frequency from 2 to 2.1 kHz
   Emission duration (pulse duration): 1.5s
   Emission interval: every 8 seconds

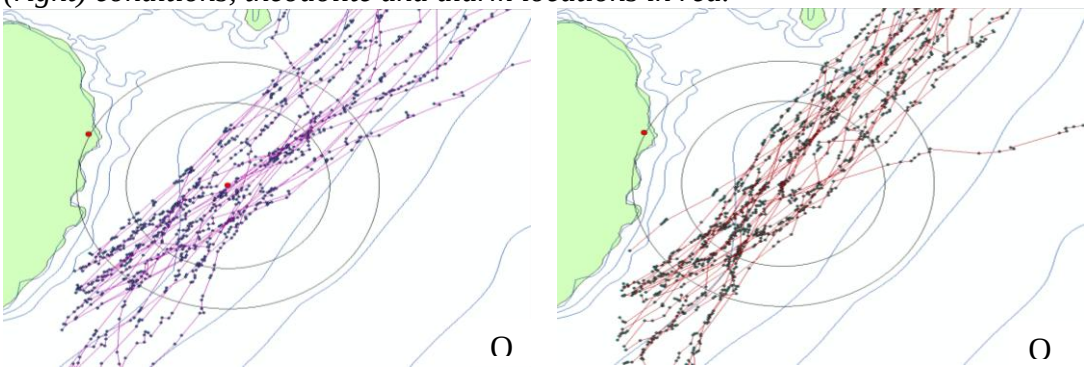
- 2. Test the efficacy of whale alarms as an effective means of alerting migrating humpback whales.

We used a double blind study to test the responses of humpback whales on their northern migration to commercially available alarms and the latter came up wanting.

For 2012:

All tracks were imported into ESRI® ArcMap™ 10.00 and only tracks that had a surfacing within 500m of the alarm were used. Tracks were divided into three stages: approaching the alarm, in the near vicinity of the alarm and having passed the alarm. To allocate surfaces into these groups two circles were created, one at 1,500 from the alarm and one at 1000 meters from the alarm. Surfaces that occurred between the two arcs before passing the alarm were the approaching group and those that fell between the two arcs having passed the alarm were the passed group. Whales that surfaced within 500 meters of the alarm were the near vicinity group. All statistical analyses were performed using SPSS 20.0 for Windows statistical package (SPSS Inc. 2007). Mixed linear models were created with whale as the subject effect and response variables course, course change, time between surfacing and speed. Tracks were filtered for speeds >30km/hr and converted to knots. For all statistical analyses, the null hypothesis was rejected if $p < 0.05$.

Fig 1 2012. All tracks that passed within 500m of the alarm in OFF (left) and ON (right) conditions, theodolite and alarm locations in red.



Using a mixed linear model with course (from north) as the response variable there was no significant interaction between alarm status and vicinity to the alarm ($F_{2,528}$=.501, $p > 0.05$). With change in course there was no sig. interaction between course change and alarm status ($F_{1,702}$=.224, $p > 0.05$) nor course change and vicinity to alarm ($F_{2,702}$=.063, $p > 0.05$). Using time from last surface, alarm status was not sig. different ($F_{1,702}$=.094, $p > 0.05$). Alarm status was significantly different with speed as the response variable ($F_{1,528}$ =16.148, $p < 0.05$), but no sig. interaction between alarm status and vicinity to the alarm ($F_{2,528}$=1.550, $p > 0.05$).

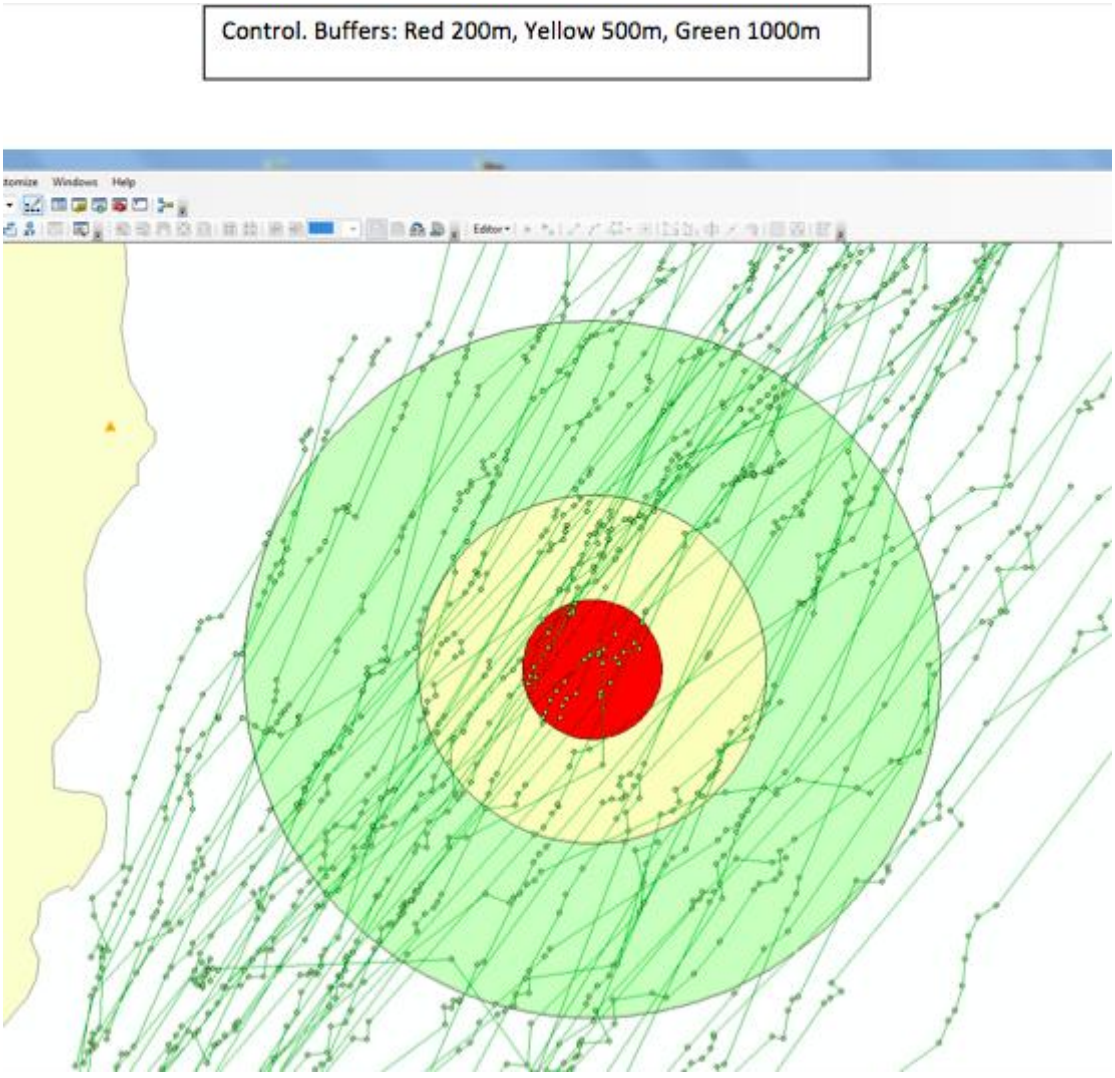
In sum, there was no discernible alteration in directionality or behavioural responses to the alarms, in fact several whales swam directly over the alarm mooring while it was operational (Fig 1). If there had been trailing lines attached and surface floats (e.g as in lobster pots) then this could have resulted in entanglements. This suggests that the alarms are unlikely to effectively deter humpback whales from approaching potential hazards, at least during their northerly migration.

The 2012 results have been submitted to Endangered Species Research:

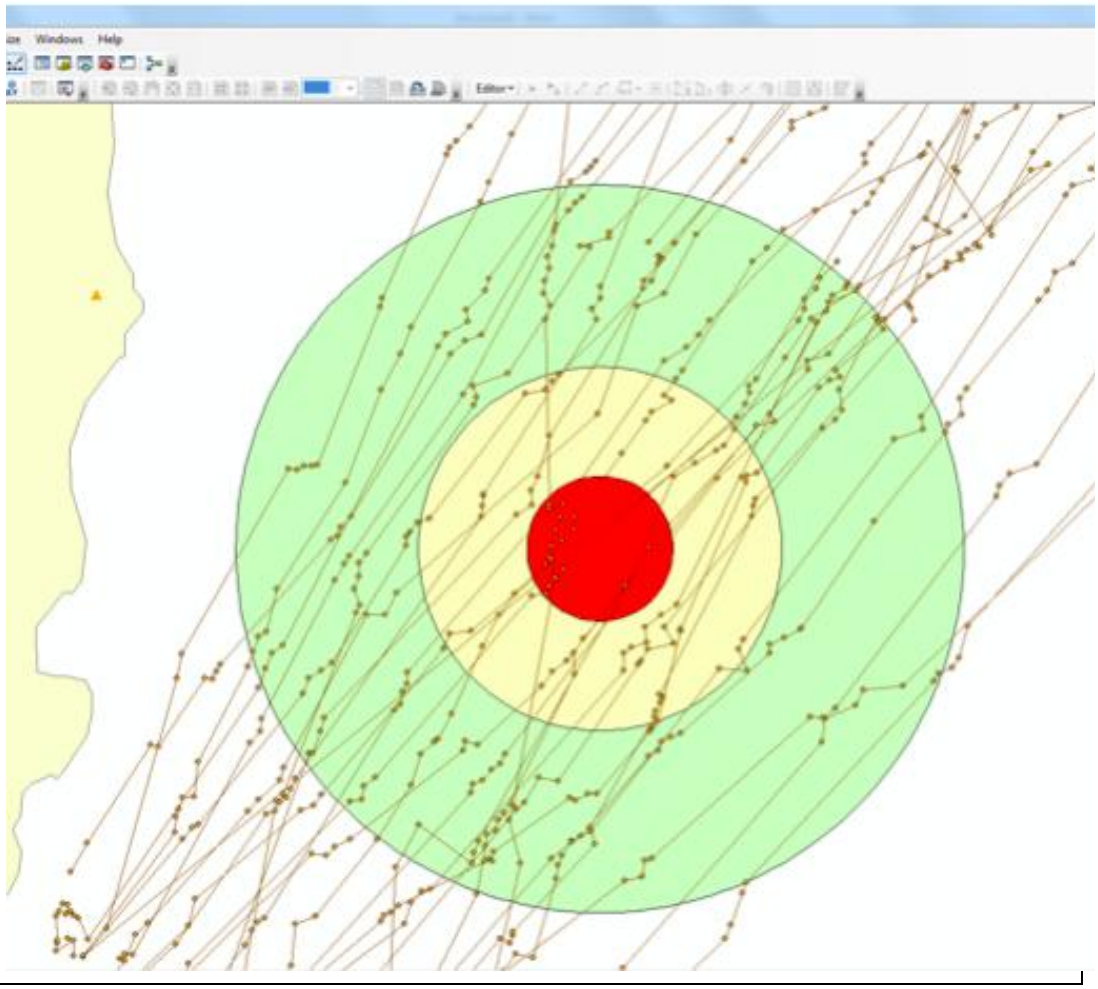
Harcourt R, Pirotta V, Heller G, Peddemors V, Slip D. (submitted) Whale alarms fail to deter migrating humpback whales: an empirical test. Endangered Species Research. submitted 4 March 2014.

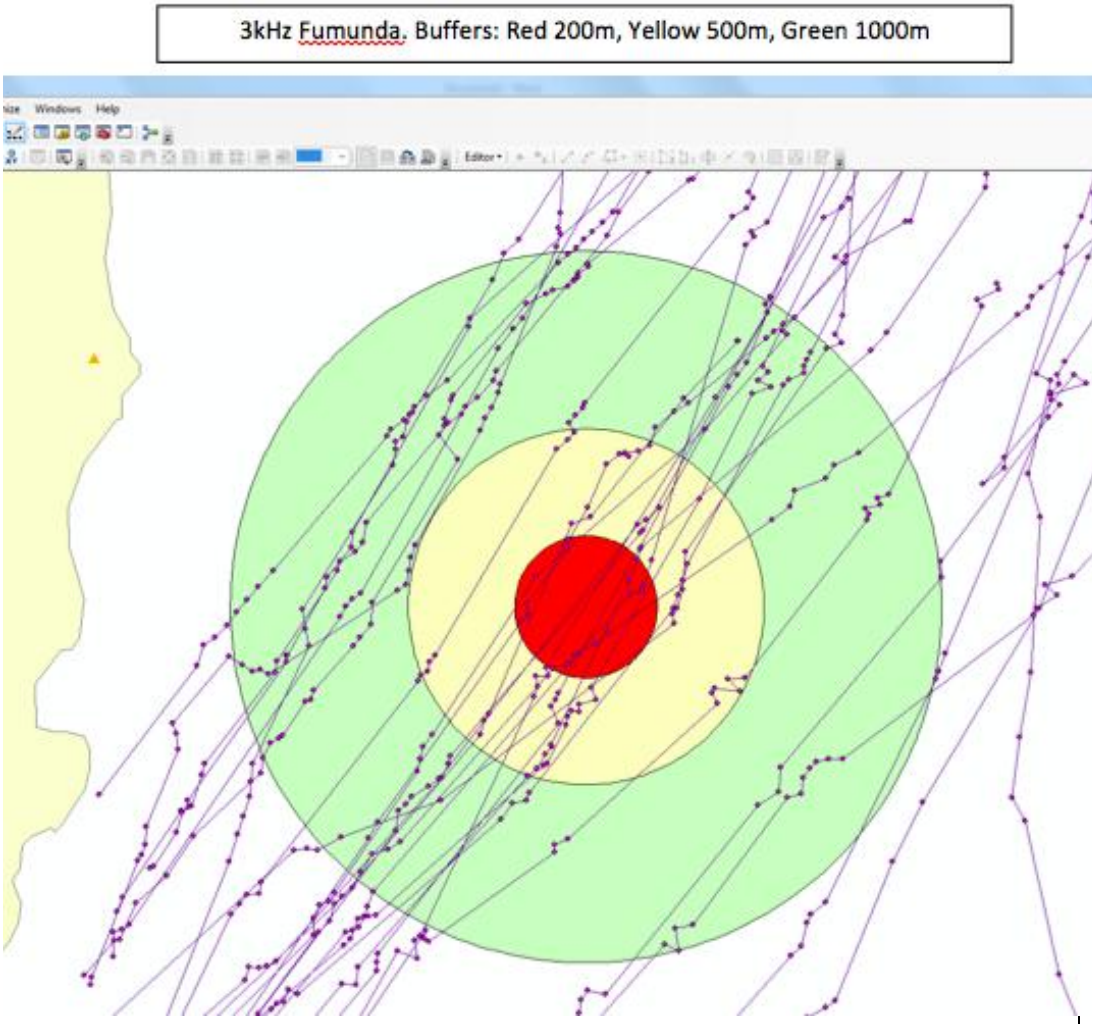
For 2013 the data analysis is underway. A visual representation is provided below. The audible range for the experimental apparatus was significantly further than the commercial alarm providing a more robust trial. No obvious differences in tracks have been detected yet.

Fig 2 2013.



2-2.1kHz swept Cato tone. Buffers: Red 200m, Yellow 500m, Green 1000m





- 3. If proven successful, develop mitigation measures for implementing alarms on all fishing gear and shark nets to ensure the reduction of reported cetacean entanglements.

Dunlop, R. A., Noad, M. J., Cato, D. H., Kniest, E., Miller, P. J., Smith, J. N., & Stokes, M. D. (2013). Multivariate analysis of behavioural response experiments in humpback whales (Megaptera novaeangliae). ***The Journal of experimental biology*****,** ***216*****(5), 759-770.**

3. Implications for Management

What are the key recommendations for management based on the findings.

The key recommendation for management from this study is that commercial alarms as currently configured are NOT effective deterrents at least of migrating humpback whales and when deployed as single units. We cannot comment on their use in multiple arrays eg along the length of fishing nets.

4. Other Benefits

How has this project advanced the field of research? (e.g. scientific discoveries, new methodologies)
Yes- this research has identified lack of efficacy of a unit being sold in large quantities to the fishing industry. The in situ work with real whales has advanced our understanding of the use of these alarms and led to further testing of a new experimental tonal system – which also appears at first pass to be at least not a major deterrent.

5. Problems Encountered (if any)

Describe any major problems encountered during the Activity and how they were addressed.
In 2012 we had problems with a remote switch and so the study design was not as originally planned. In 2013 we built a custom unit that switched on a random cycle between the three tones- this unit was far more effective and we are very confident would be an ideal unit for trials in other studies. There were problems with the initial contractor but the second contractor built an excellent seaworthy unit that performed faultlessly.

6. Communication

How will results be communicated to management
Results have been communicated directly to the NSW Office of Environment Marine Fauna Advisory Committee and to the Shark Meshing Program Team at NSW Fisheries.
Stakeholder engagement feedback (plain English for feedback to stakeholders)
NPWS and NSW Fisheries are our main stakeholders and the results have been communicated to the main parties in each of these organisations. Both groups were actively involved in the refined alarm study in 2013.
Students supported (if any)
V. Pirotta, now enrolled in a Masters by Research
PhD Theses and dissertations (if any)
MRES arising from this work now in progress
Publications (other than theses and dissertations)
Planned publications
Harcourt R, Pirotta V, Heller G, Peddemors V, Slip D. (submitted) Whale alarms fail to deter migrating humpback whales: an empirical test. Endangered Species Research. submitted 4 March 2014. We also plan to submit this to the IWC as a special report. A larger publication on this and earlier work is also in prep.
Presentations
Pirotta V, Harcourt R., Slip D, Peddemors V Ross G. An empirical assessment of whale alarms and avoidance or not, by migrating humpback whales. AMSA Gold Coast July 2013

Pirotta V, Gulesserian M, Slip D, Ross G, Peddemors V, Heller G, Harcourt R. 2013. Boats, Drills and Alarms: Humpback whale responses to an ever noisier world. Speed Talk. Society for Marine Mammalogy Biennial Conference, Dunedin NZ, 6-13 Dec 2013

7. Project Outputs

A list of the actual outputs of the research including milestones, progress reports and data products such as models etc.	Proposed date of completion	Actual date of completion
Progress Report 1	31 Aug 2012	13 Sep 2012
Final report 1	19 Jan 2014	11 March 2014