Entanglement of migrating whales down under: the search for an effective mitigation strategy.

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Are alarms effective?

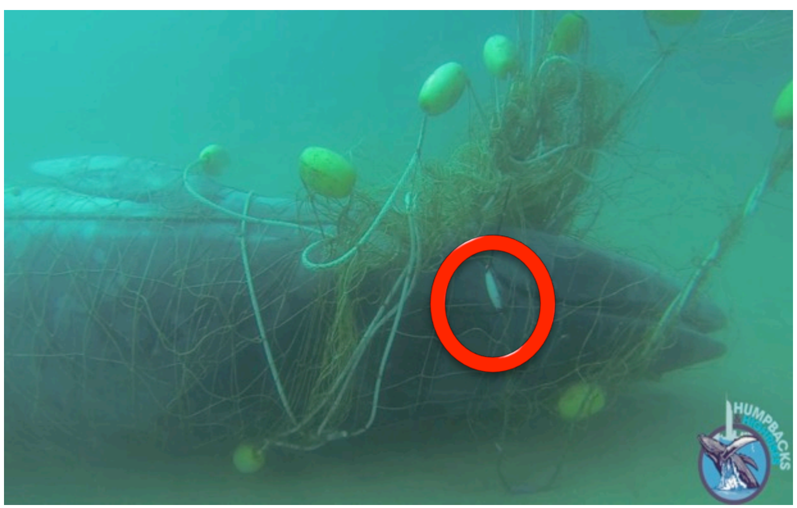
Empirical testing of alarms

)

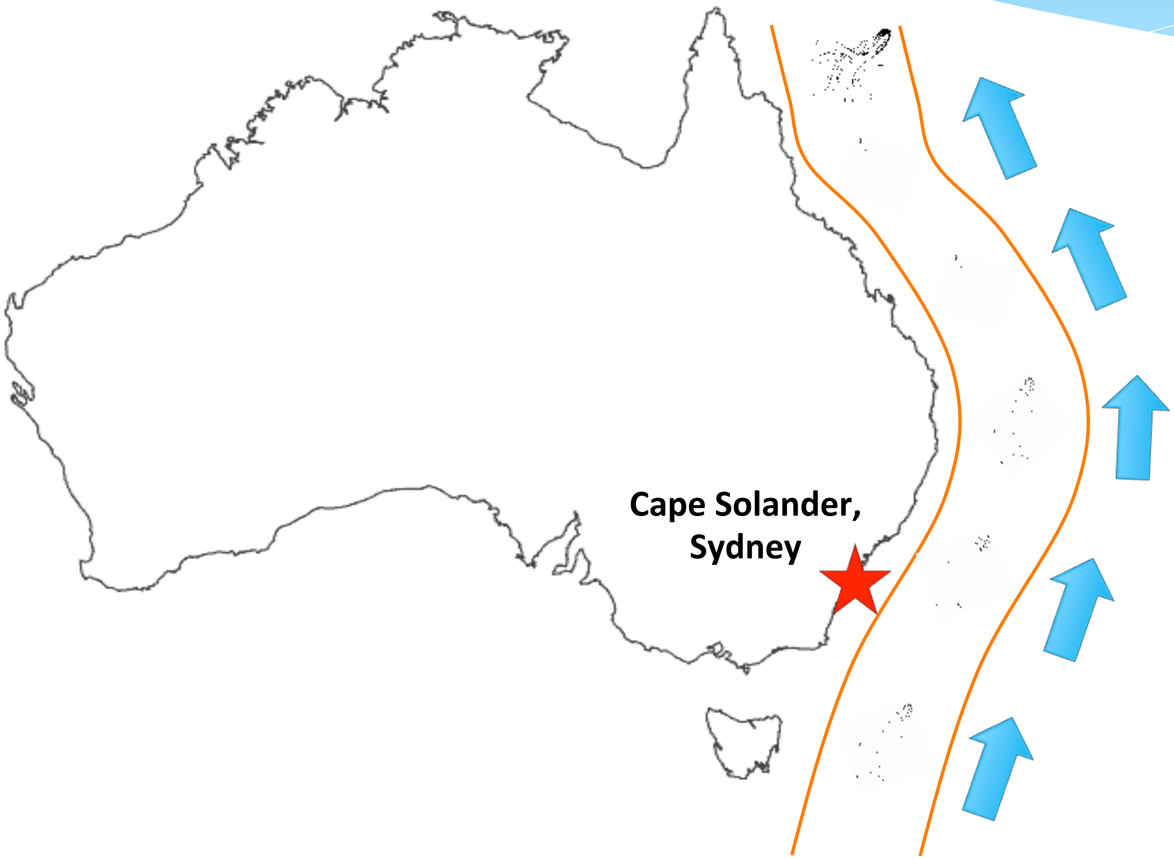
1) **Investigate the effectiveness of the commercially available 3 kHz Fumunda F3™ whale alarm on humpback whale movements.**

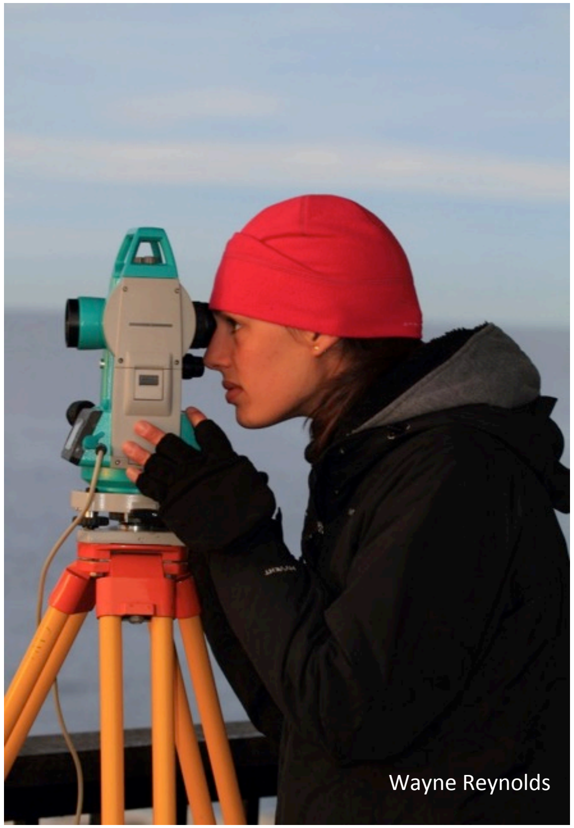
2) **Investigate the effectiveness of a louder Future Oceans F3™ whale alarm tone**

3) **Investigate the effectiveness of a 2-2.1kHz swept tone**



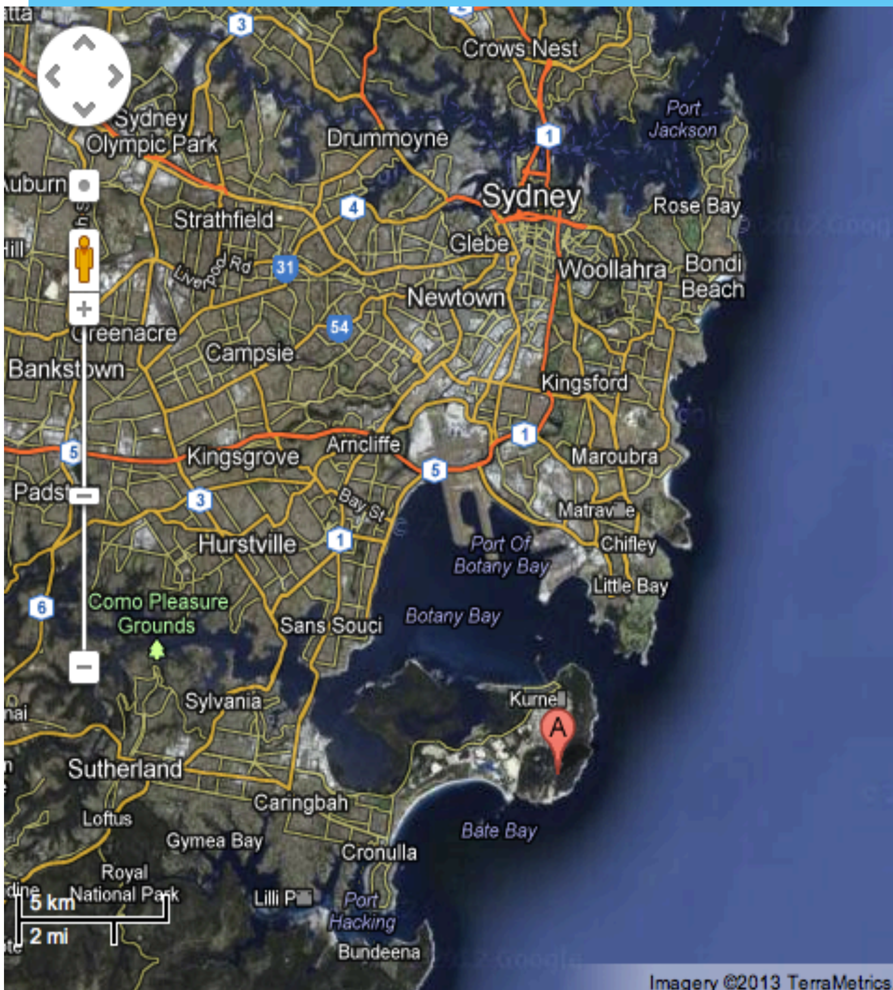
Methods

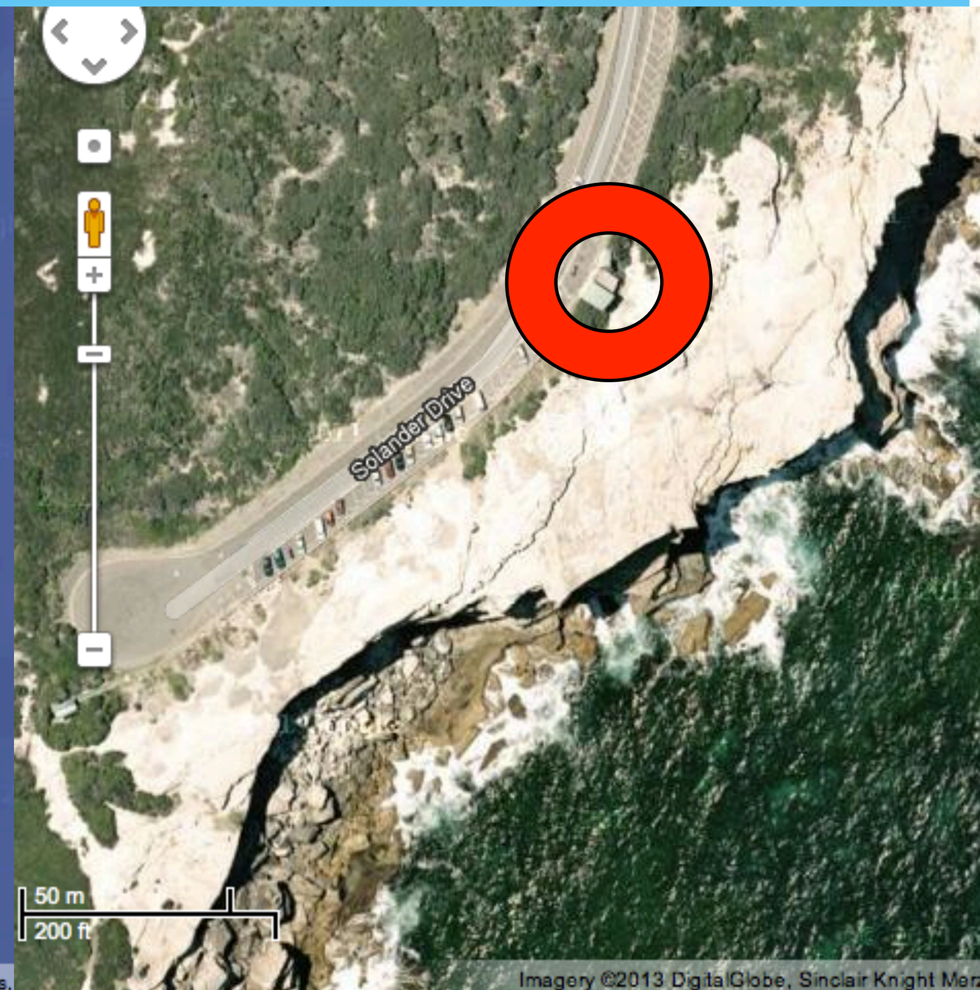




- **Focal follows- Record spatial information, behaviour and direction**
- **15 minute sample scan for vessels**

Study Site: Cape Solander, Kamay Botany Bay National Park, Sydney, Australia





Aims 2012

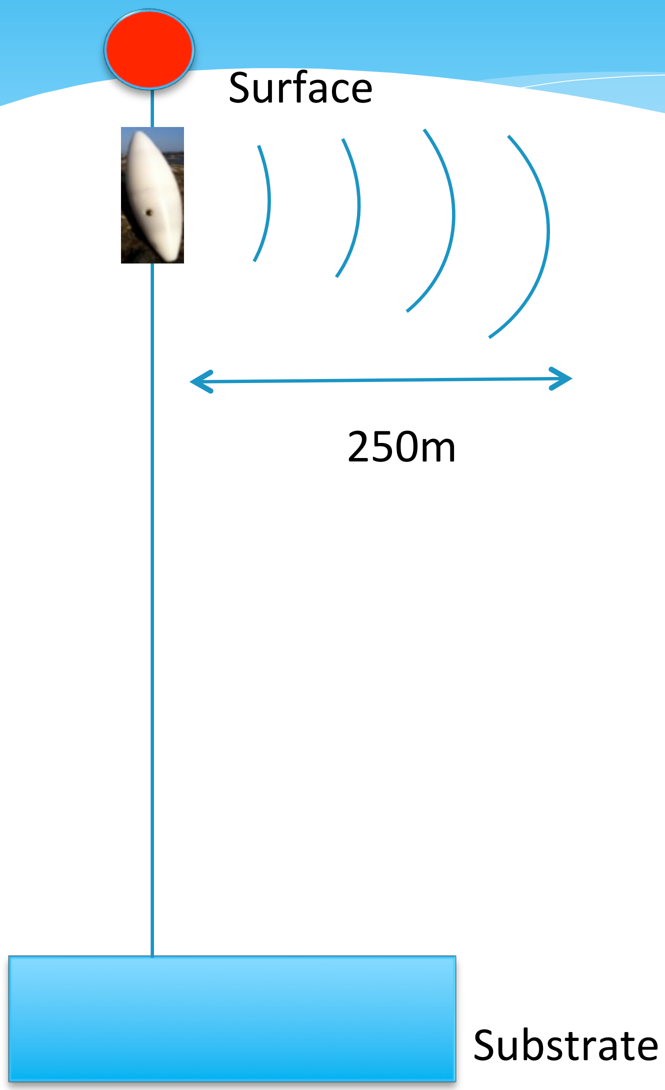
Investigate the effectiveness of the commercially available 3 kHz Fumunda F3™ whale alarm on humpback whale movements.

Whale alarm mooring - subsurface float

Range Detectability

- Two recordings locations:
- *In situ* Cape Solander
- Cronulla Fisheries Wharf, Gunnamatta Bay
- HTI 554036 hydrophone - M-Audio Micro Track 24/96 Digital Recorder.
- Source level from 1 meter of the alarm
- Floated over the site on a 2km by 2km grid

Range Detectability

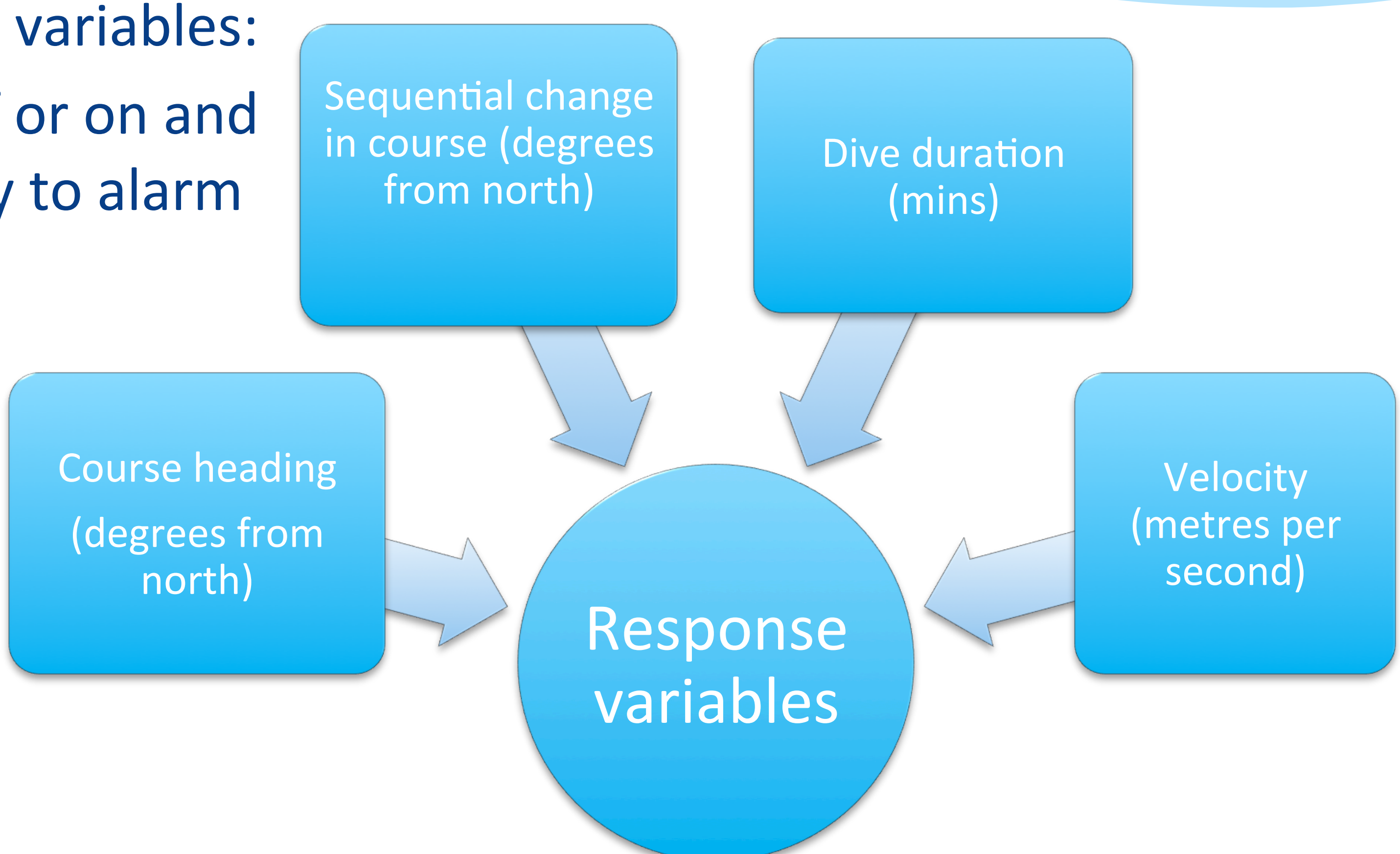


- Whale alarm detectable at 250 meters

Generalised Linear Mixed Model

- Whale as a subject effect
- Source variables:

alarm off or on and proximity to alarm

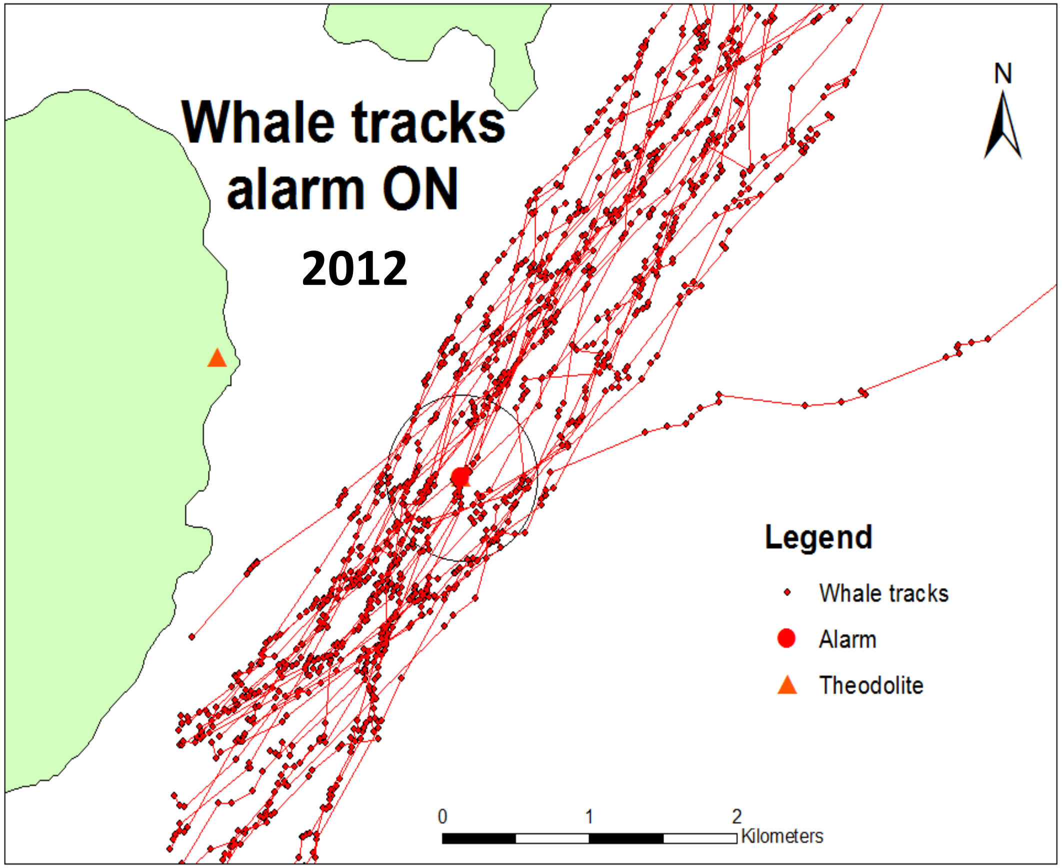


2012: Commercial Alarm (Harcourt *et al.* 2014)

2012

n= 137
Total surface time (min) **no difference** (P=0.094; F= 7.709)
Dive duration (min) **no difference** (P= 0.760; F= 0.094)
Blow rate (per min) **no difference** (P= 0.216; T=2.056) *Within 500m OFF v ON

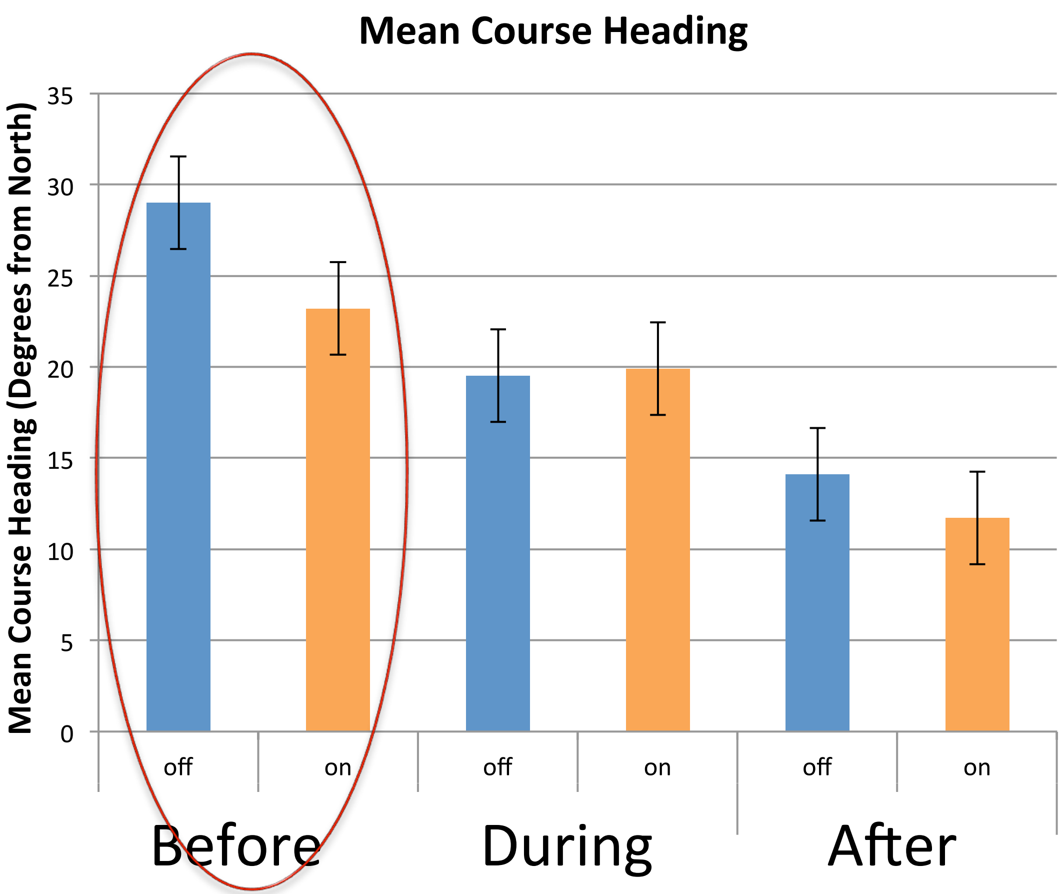
Range detectability: **500m** via in situ measurements



Output level specified by the manufacturer is **135 dB** re 1 µPa.
Erbe et al (2011) found on average, levels were less (**98 ± 7 up to 118 ± 3 dB** re 1 $\mu Pa^2/Hz$ @ 1 m for the fundamentals of three F3 whale alarms tested).

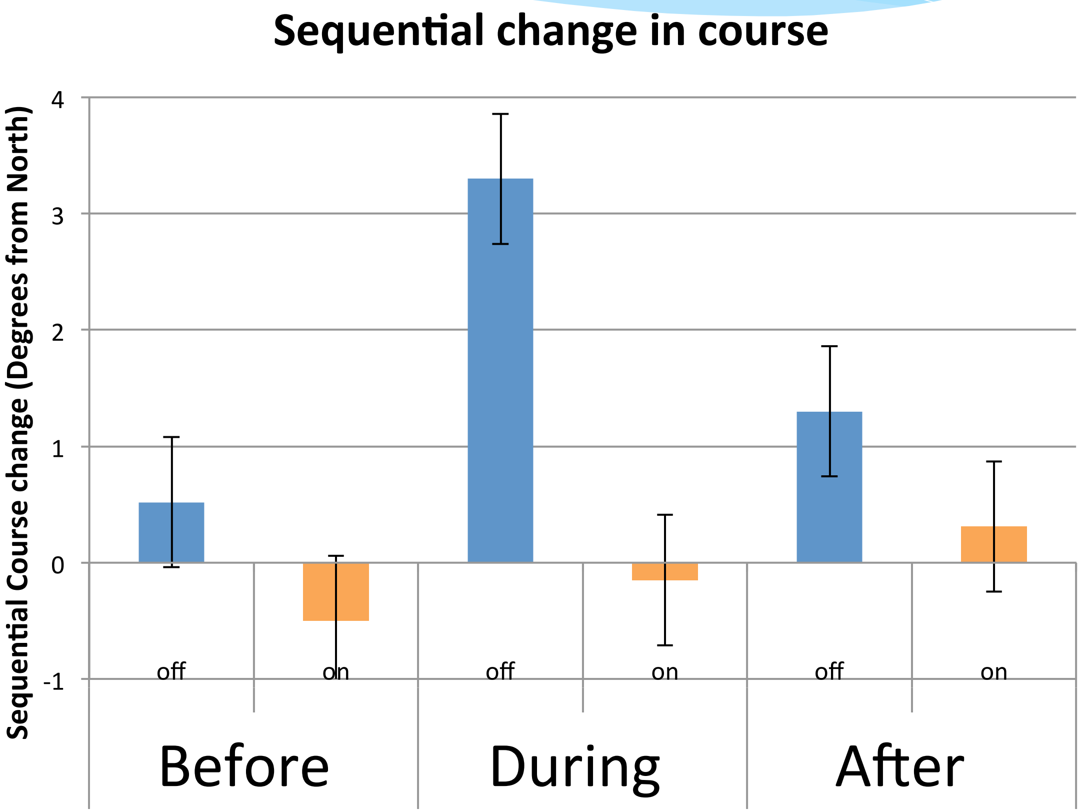
Course heading

- The direction that whales were heading changed with location ($F_{2,702}$=7.709, p < 0.05)
- But there was no effect of the alarm ($F_{1,702}$ =0.961p > 0.05) or any interaction of alarm and location ($F_{2,702}$=.501, p > 0.05).
- This suggests the changes were due to something other than the alarm such as the coastline



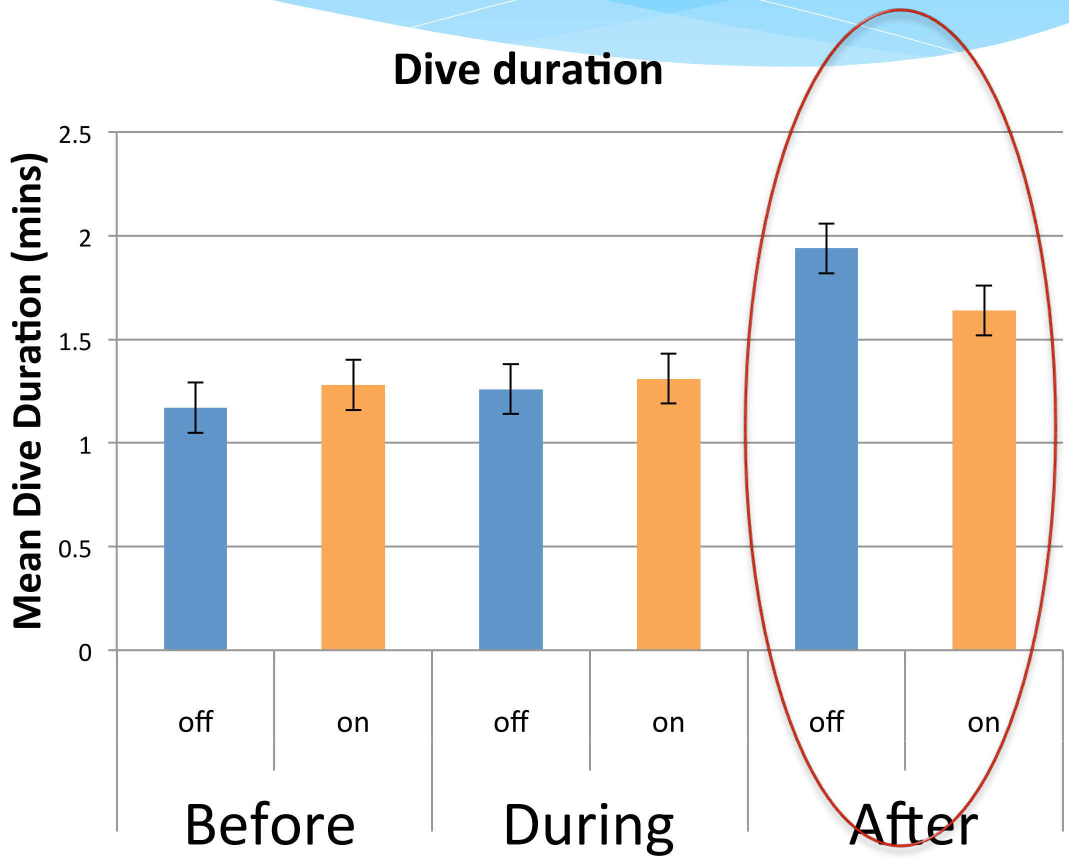
Sequential change in course

- Whales did not make directional changes in response to the alarm $F_{1,702}$=.224, $p > 0.05$, or in response to their location with respect to the alarm $F_{2,702}$=.063, $p > 0.05$



Dive duration

- Dive duration did not vary with alarm on and off, $F_{1,702}$=.094, $p > 0.05$
- Dive duration differed among the three areas $F_{2,702}$= 4.633, $p < 0.05$ but this difference was not due to the alarm
- Whales dived for longer in the area after they had passed the alarm which may be a topological effect



Alarms (Harcourt *et al.* 2014)

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ENDANGERED SPECIES RESEARCH
Endang Species Res

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FREE ACCESS

A whale alarm fails to deter migrating humpback whales: an empirical test

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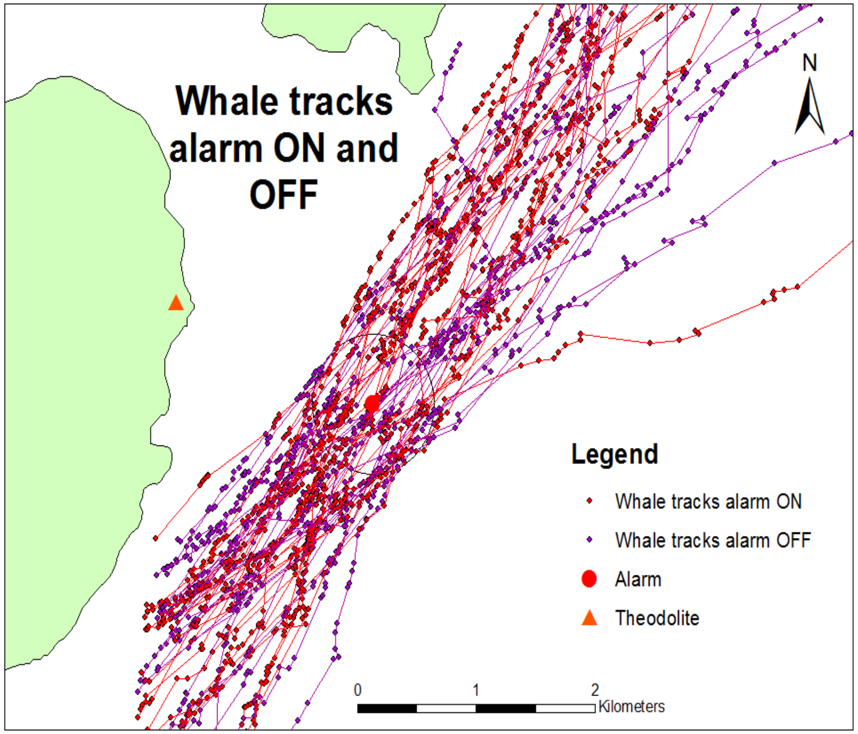
Why no apparent effect?

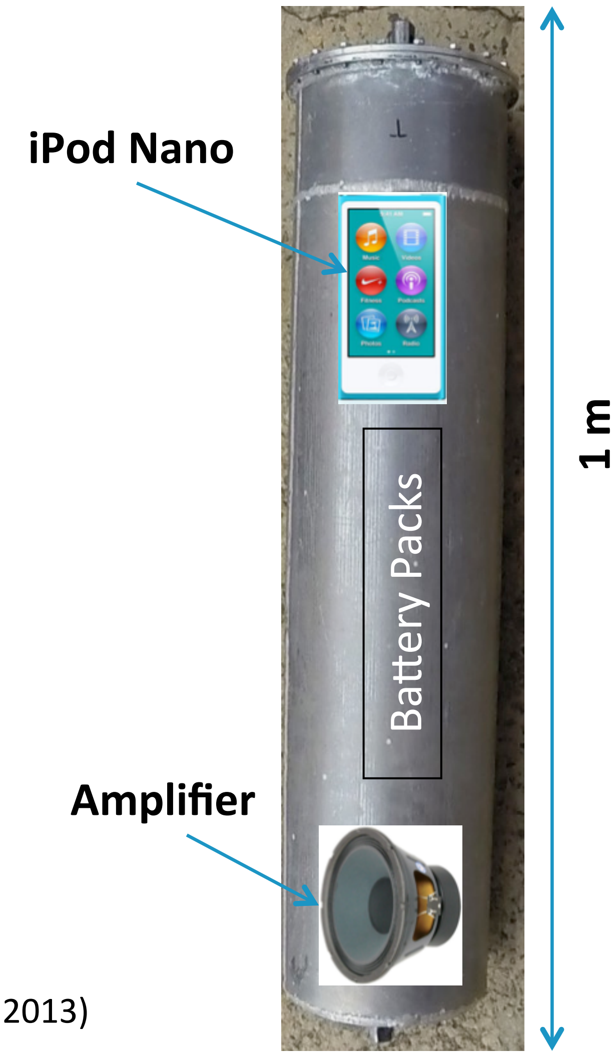
- Ambient noise (Effects on sound propagation?)
- Alarm power (battery level)
- Whales cannot hear or are indifferent to the tone



Experiment 2: Whale alarm on steroids

Alarm played for 11 hours / day :

1. T1: Future Oceans F3™ Tone
2. T2: Cato tone (Dunlop. et al 2013)
3. C: Control ‘no tone’



Acoustic characterisation of tones

Future Oceans
3kHz

Emission duration:
400m/s

(135 dB re 1 µPa Future Oceans)

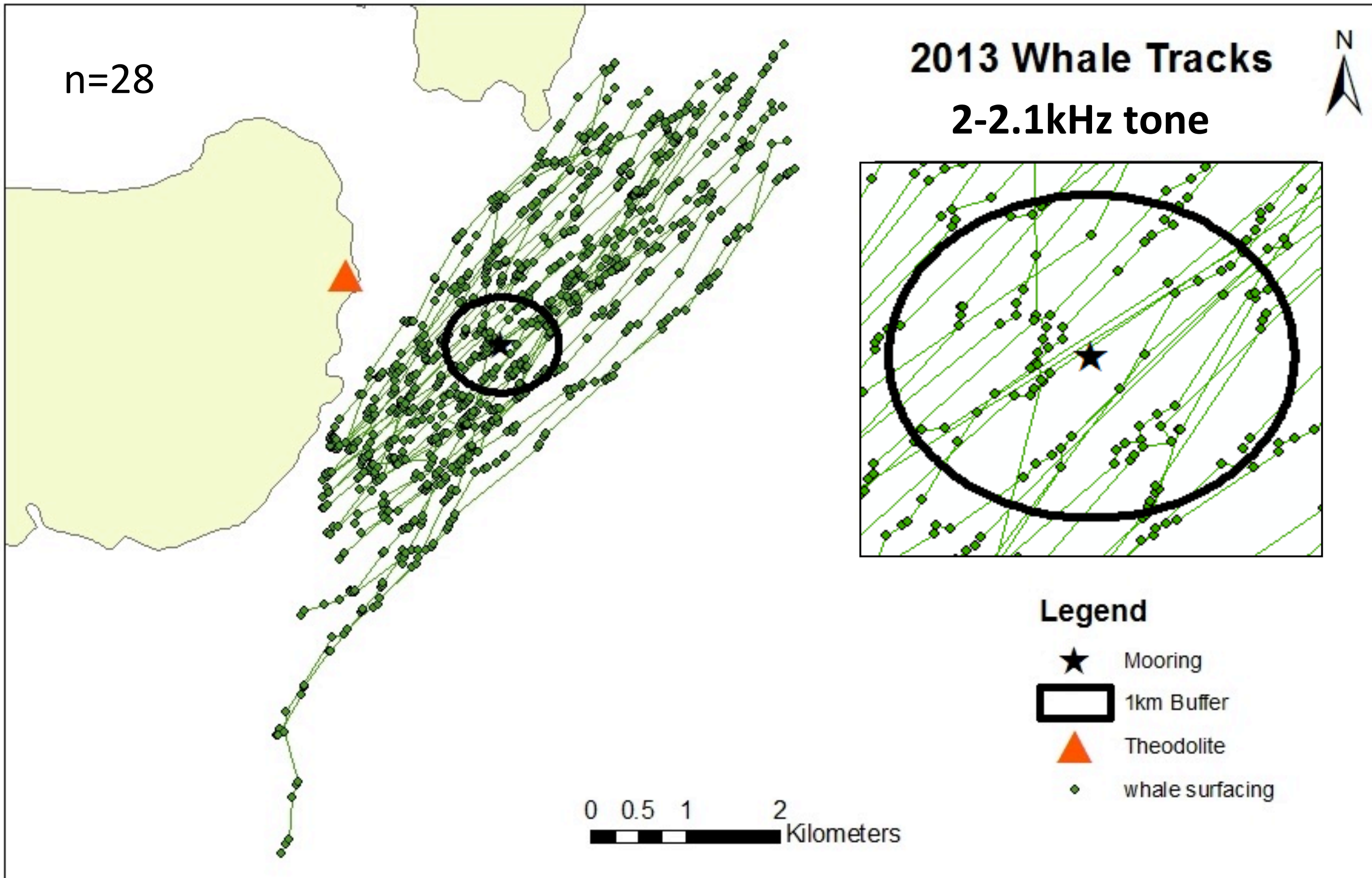
Cato tone
2-2.1kHz

Emission duration:
1.5sec

(148 to 153 dB re 1 µPa Dunlop et al. 2013)

2013: Tone comparison

Range detectability: **1000m** via in situ measurements



All surfacing's beyond 4km excluded

2013: Tone comparison

2013

n=108

Dive duration (min)

no difference

(2kHz: P= 0.073; F= -1.793)

(3kHz: P= 0.371; F= -0.894)

Speed (m/sec)

no difference

(2kHz: P= 0.298; T= -1.044)

(3kHz: P= 0.618; F= -0.498)

Course from north (degrees)

no difference

(2kHz: P= 0.449; T= -0.76)

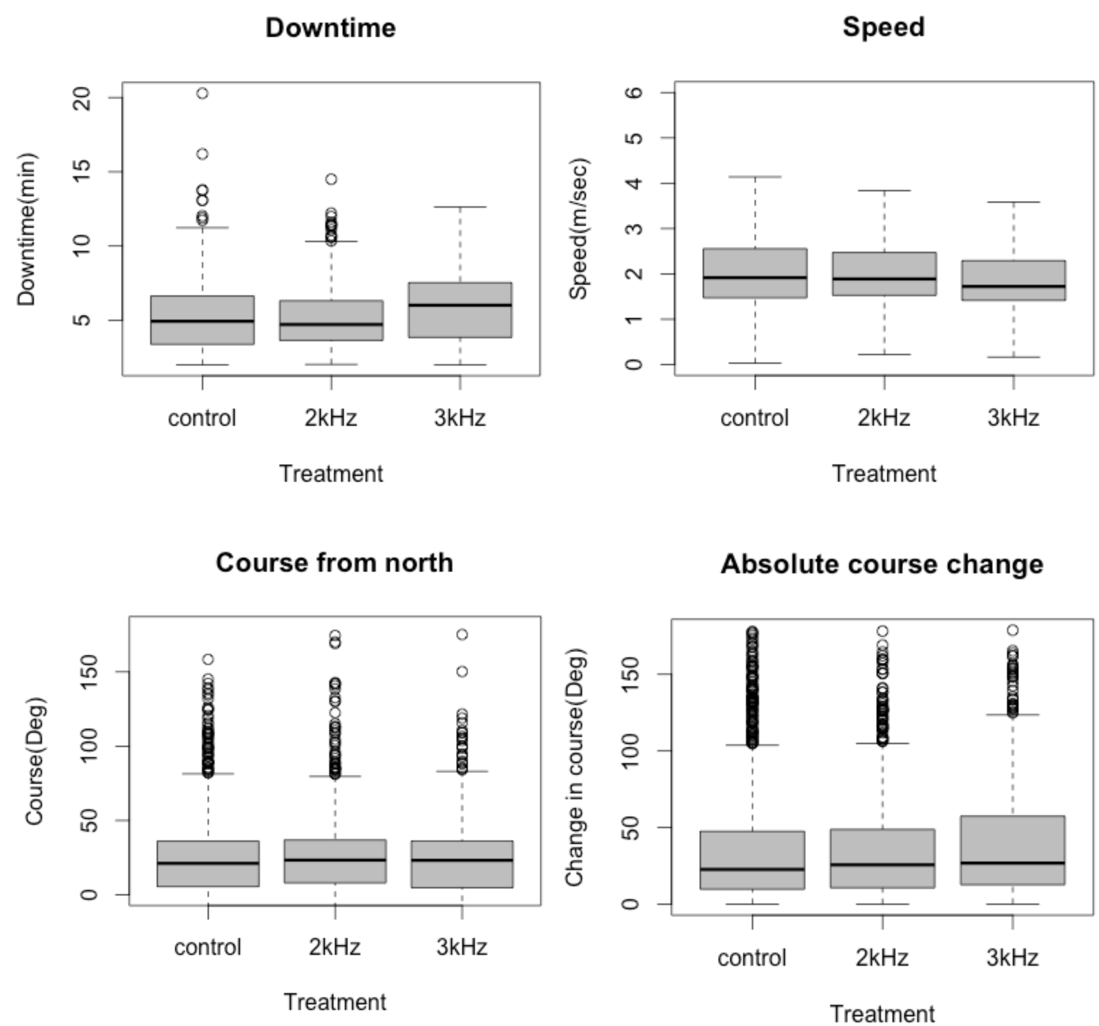
(3kHz: P= 0.652; F= -0.452)

Absolute course change (degrees)

no difference

(2kHz: P= 0.061; T= -1.90)

(3kHz: P= 0.185; F= -1.33)



Alarms 2

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ENDANGERED SPECIES RESEARCH
Endang Species Res

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Migrating humpback whales show no detectable response to whale alarms off Sydney, Australia

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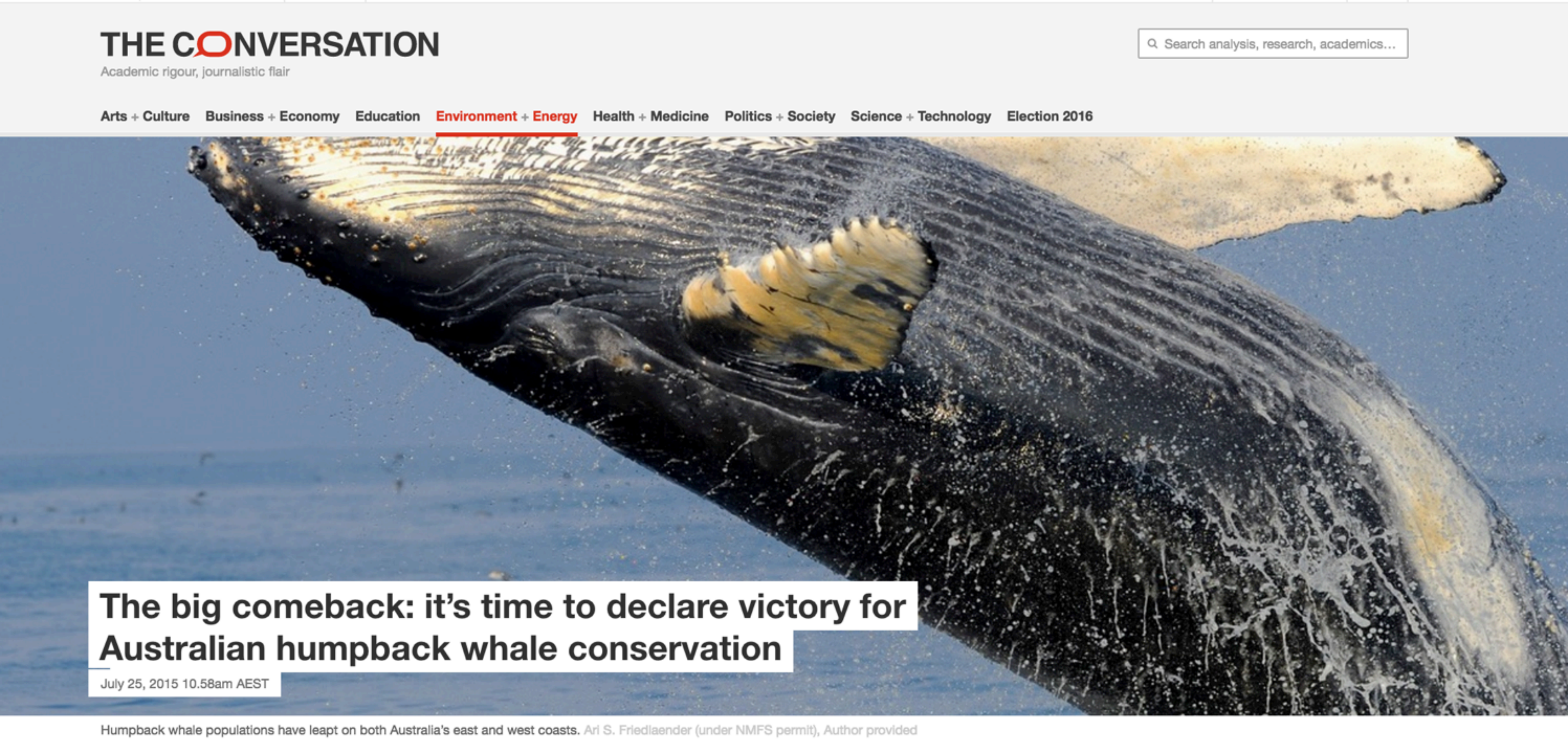
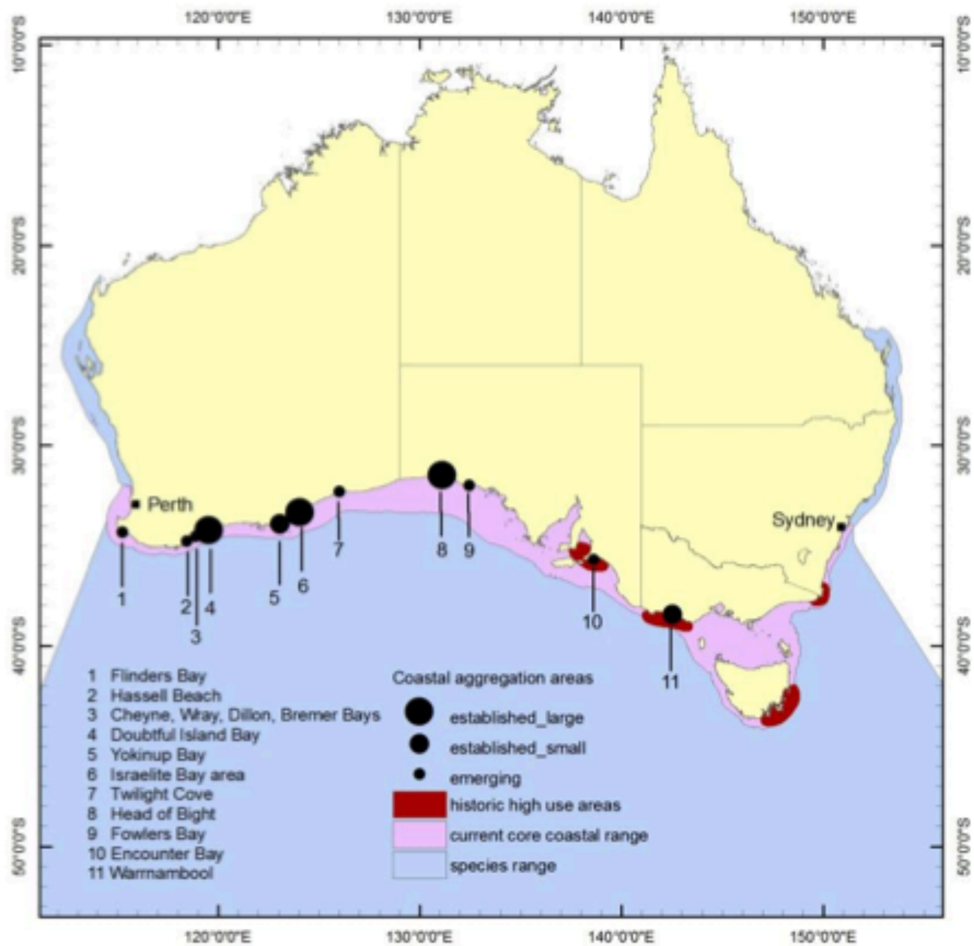
The need for alternative approaches

Is entanglement a conservation issue?



YES
Southern right whales (*Vulnerable*)



Map of species range, core coastal range, and coastal aggregation areas of Southern Right Whales

Oz southern right whales are different stocks: SE Australia particularly vulnerable (Ne ~50)

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SCIENTIFIC REPORTS

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Cultural traditions across a migratory network shape the genetic structure of southern right whales around Australia and New Zealand

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Fidelity to migratory destinations is an important driver of connectivity in marine and avian species. Here we assess the role of maternally directed learning of migratory habitats, or migratory culture, on the population structure of the endangered Australian and New Zealand southern right whale. Using DNA profiles, comprising mitochondrial DNA (mtDNA) haplotypes (500 bp), microsatellite genotypes (17 loci) and sex from 128 individually-identified whales, we find significant differentiation among winter calving grounds based on both mtDNA haplotype ($F_{ST} = 0.048$, $\Phi_{ST} = 0.109$, $p < 0.01$) and microsatellite allele frequencies ($F_{ST} = 0.008$, $p < 0.01$), consistent with long-term fidelity to calving areas. However, most genetic comparisons of calving grounds and migratory corridors were not significant, supporting the idea that whales from different calving grounds mix in migratory corridors. Furthermore, we find a significant relationship between $\delta^{13}C$ stable isotope profiles of 66 Australian southern right whales, a proxy for feeding ground location, and both mtDNA haplotypes and kinship inferred from microsatellite-based estimators of relatedness. This indicates migratory culture may influence genetic structure on feeding grounds. This fidelity to migratory destinations is

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Population structure and individual movement of southern right whales around New Zealand and Australia

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South east Oz including pots…..

J. CETACEAN RES. MANAGE. 10(1):1–8, 2008 1

Southern right whale (*Eubalaena australis*) mortalities and human interactions in Australia, 1950-2006

Catherine Kemper*, Douglas Coughran+, Robert Warneke#, Rebecca Pirzl++, Mandy Watson^, Rosemary Gales** and Susan Gibbs*

Contact e-mail: Kemper.Cath@saugov.sa.gov.au

ABSTRACT

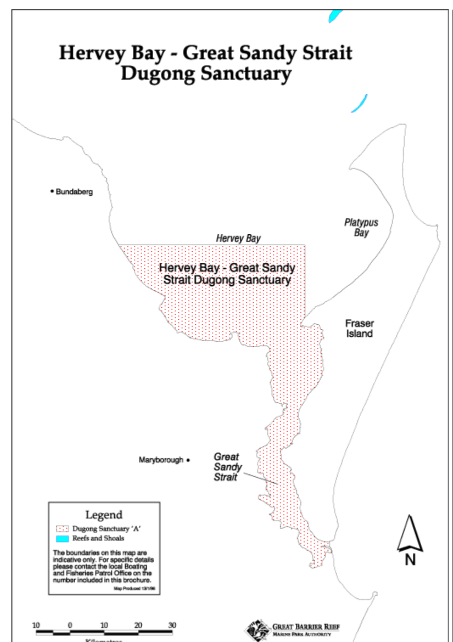
A total of 44 records of southern right wha
museums, wildlife agencies and researche
recorded in all months except January and 6
of the continent where southern right whale
carcasses (with no evidence of human intera
non-fatal vessel collisions *n*=3, non-fatal sl
anthropogenic incidents has increased 4-fol
whereas the opposite was the case for event
crab) were associated with several entangle
and death. As a proportion of the total recor
South Africa (16%) or the North Atlantic (3

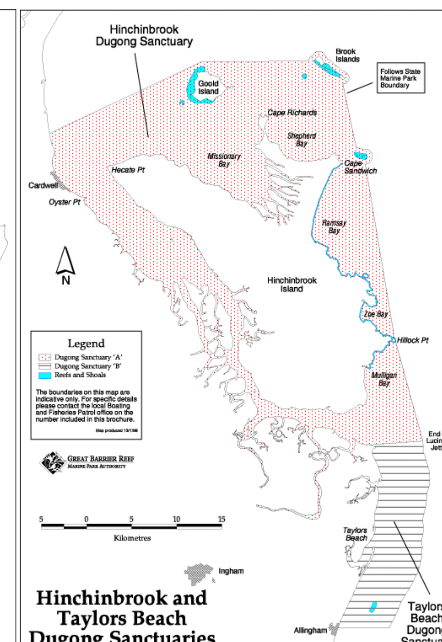
KEYWORDS: SOUTHERN RIGHT WHA

Fig. 3. Southern right whale entangled in crab pots and lines near Point Lowly, Spencer Gulf, South Australia in August 2002. Note the healthy body condition suggesting recent entanglement.

Spatial closures/ fisheries modifications approach

* Review the spatial location and intensity of TEPS entanglement in Australia
* Identify hotspots of risk for endangered and migratory species
* Spatial closures proven effective for Dugong in northern Australia

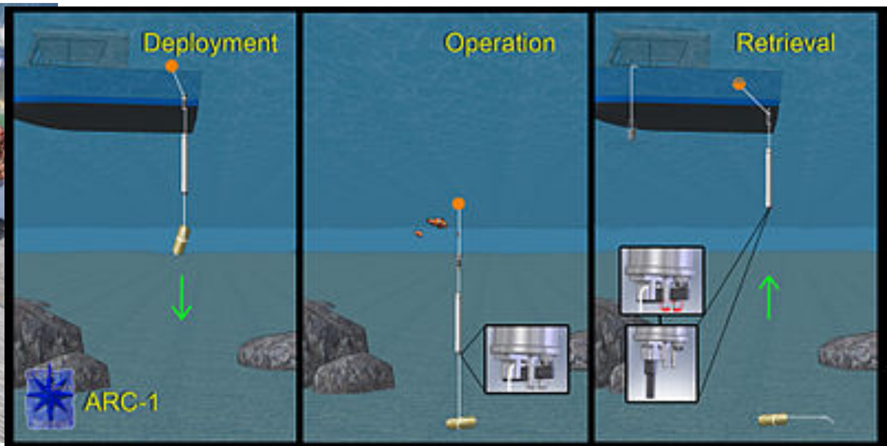




Spatial closures/ fisheries modifications approach

* Develop a risk mitigation strategy using a cost-benefit analysis (TEPS vs Fishery)
* Extensive experience of acoustic releases for Australia's animal tracking program (IMOS Animal Tracking)
* Implement for high risk areas? (see Liggins & Wesley 1330) needs further C/B



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* Acoustic Releases: Integrated Marine Observing System

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- Cape Solander NPWS volunteers
- Wayne Reynolds

IMOS Integrated Marine Observing System