

# Vocal behavior of short-finned pilot whales pre, during and post exposure to playbacks of mid frequency active sonar and killer whale calls

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# Introduction

In order to quantify effects there is a need for more data on behavioural responses

The potential effects of military sonar have posed many questions

Much focus has been in relation to extreme visible events such as stranding or avoidance



All photos  
courtesy of  
BMMRO

# Introduction

Beaked whales can show a silencing response with respect to sound exposure



Social odontocetes may not be able to show this silencing response as the cost may be too high.



# Aim

The aim of this study was to look at more subtle vocal responses to noise exposure by assessing vocal rates and call types of short-finned pilot whales with respect to playbacks of MFA sonar and killer whale calls

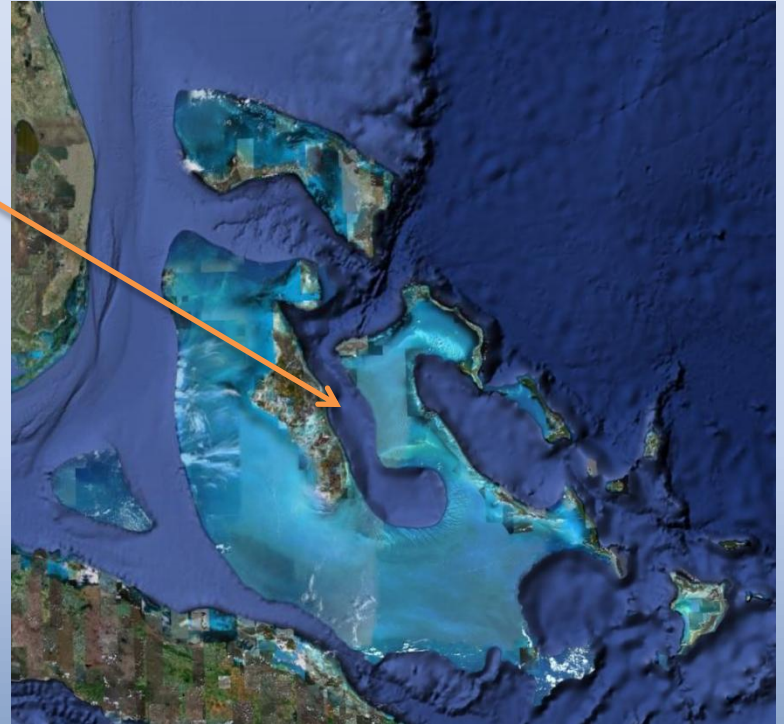


# Data Collection

Tongue of the Ocean, Andros  
Bahamas

August-September 2007 and  
August to October 2008

Dtags on 4 individual pilot  
whales in 2007



# Data Collection

The sound source was designed to broadcast at 2-5 kHz to match MFA frequencies



The MFA sounds were selected from actual waveforms from military sonars

The orca sounds were wild killer whale calls, attenuated due to the frequency restriction of the sound source

# Data Collection

Over 30 hours of Dtag data from 4 individuals

2 individuals were exposed to playbacks

2 individuals collected baseline data

Date	Experiment	Total on animal time
17th August 2007	Playback	12:58:56
17th August 2007	Playback	3:12:56
16th September 2007	Baseline	16:50:54
17th September 2007	Baseline	1:16:33

# Data Collection

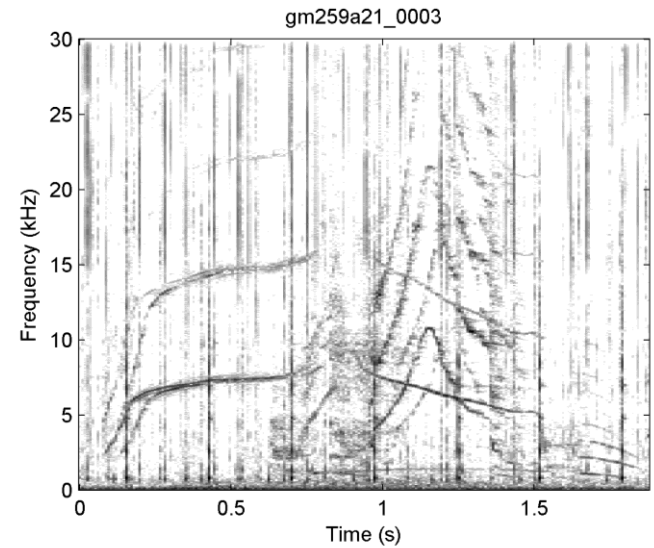
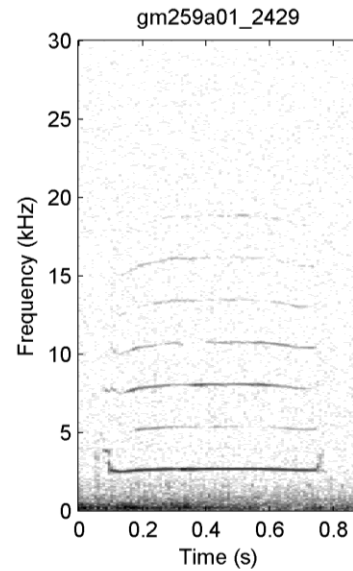
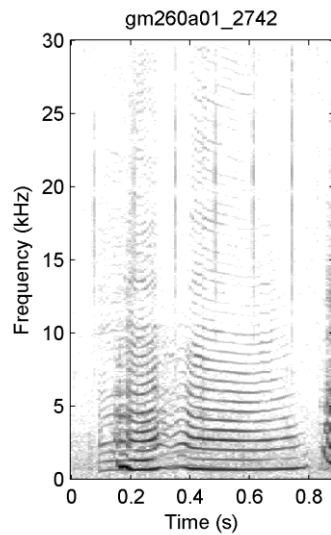
## Playback stimuli

Sound Source	Start SL (dB re 1 $\mu$ Pa at 1 m)	End SL (dB re 1 $\mu$ Pa at 1 m)	Total playback time (minutes)	Comments
MFA sonar sound	150	165	4	Mitigation started: whales sighted within 1000m
MFA sonar sound	165	212	14	Restarted 50 minutes after first attempt ceased
Orca Stimulus	132	192	23	Orca stimulus started 30 minutes after end of second MFA sonar sound



# Data Analysis

All audible sounds were digitized (n = 3,202)



# Data Analysis

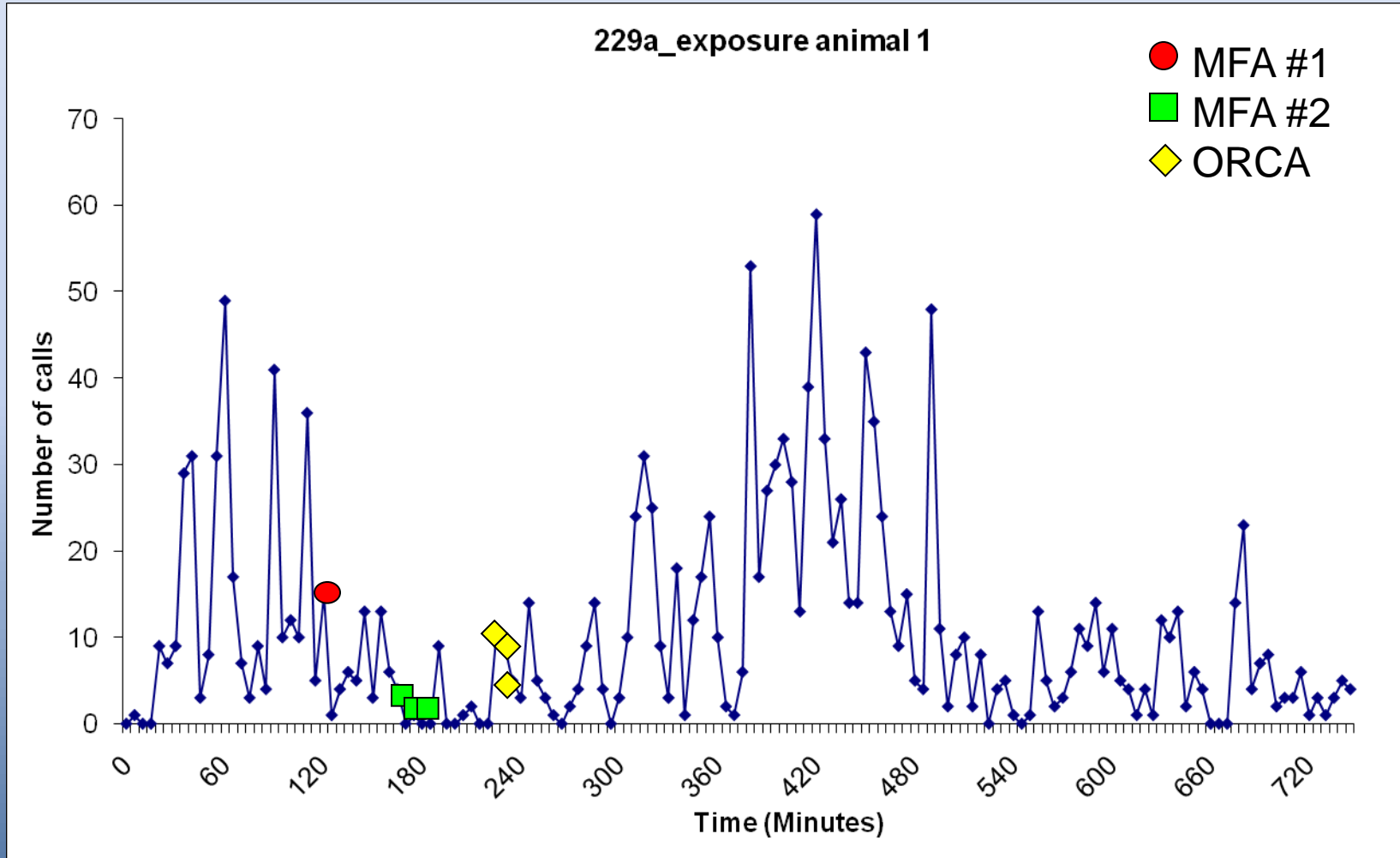
Periods were determined as pre during and post playback

Call rates per minute were calculated for randomly selected start times within each period, for both exposure animals

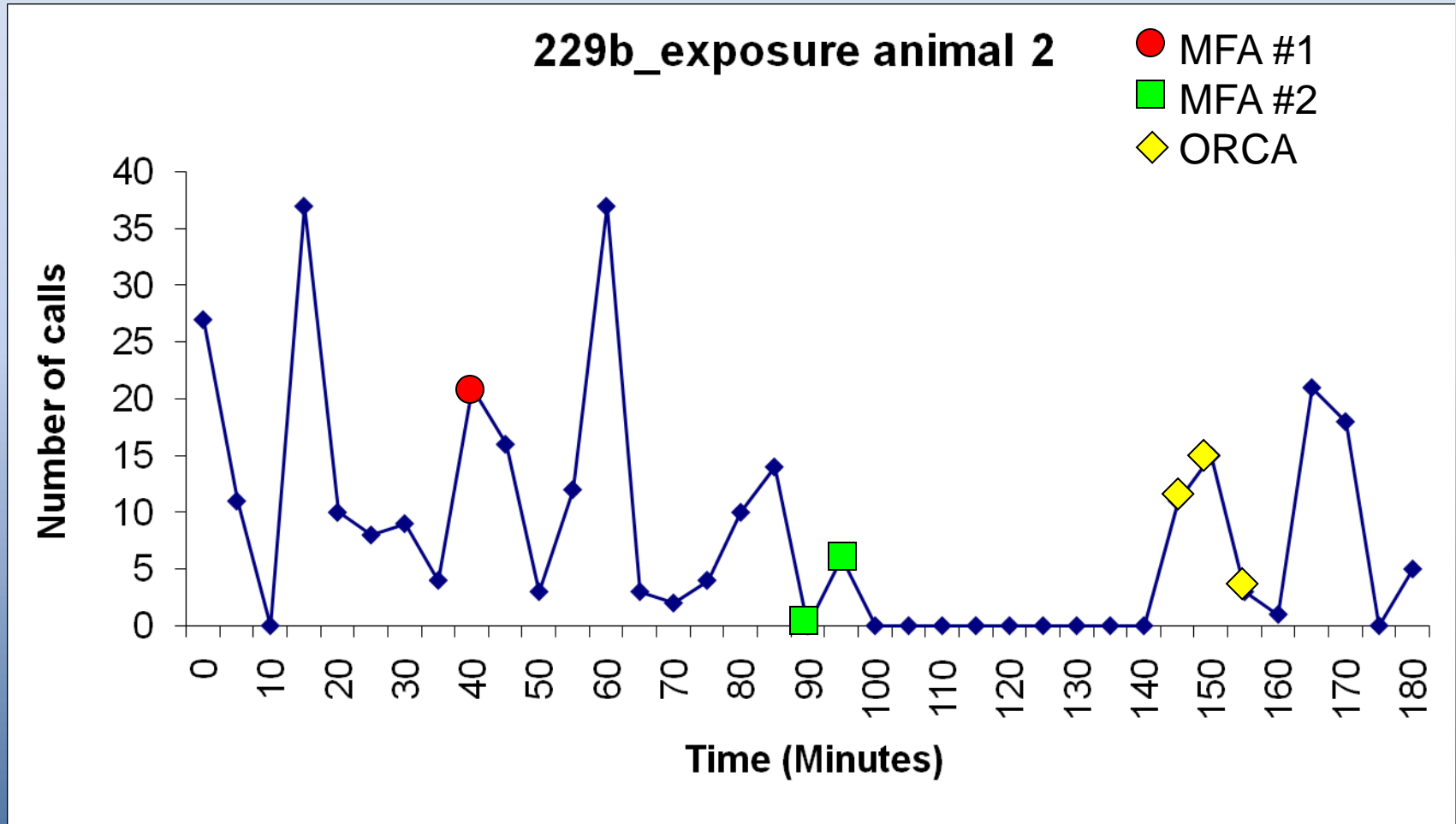
Call rates per minute were calculated for randomly selected start times for the baseline animals

Calls for all animals were categorised, by 3 independent observers

# Results – Call Rates



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# Results – Call Rates

Call rates were significantly different between periods for each exposure animal, Kruskal-Wallis test,  $p < 0.001$  ( $n = 70$  ( $n = 10$  for each animal and each event))

Post-hoc tests show that both animals had higher call rates during pre exposure and the first MFA exposure (Mann-Whitney test  $p < 0.05$ ) compared to the second MFA exposure and the killer whale calls.

# Results – Call Rates

For the two baseline animals there was also a significant difference ( $p=0.002$ ,  $n=210$ ) in call rates per minute.

Call rates with respect to behaviour must also be considered



# Results – Call categories

In total 169 call type categories were assigned. This amounted to 54% of all the calls

Significantly higher rates of certain categorised, stereotyped calls were also evident during pre exposure and the first MFA exposure (Kruskal-Wallis  $p < 0.05$ ).

# Conclusions

There appears to have been a drop in call rates after the second sonar signal for both whales and a possible silencing response for the closest whale

But.... For the first whales, call rates were equally low at other times during the acoustic record



# Conclusions

There is a drop in call rate, immediately after the killer whale calls for both animals

But...after this immediate drop there then seems to be a fluctuation in rates.

# Conclusions

Considerations:

All signals were played one after the other possibly creating a cumulative effect

There were significant differences in call rates in the baseline animals

There is pseudoreplication in the data due to small samples sizes especially during playback 1

Consideration to received levels at the animal and behaviour must be incorporated into a more robust statistical framework.

# Further work

Consideration to received levels at the animal and behaviour must be incorporated into a more robust statistical framework.

Analysis of the changes in rates of the baseline animals and finer scale behavioural data need to be considered.

# Acknowledgements

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