Atlantic Behavioral Response Study (BRS)

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Overview

Effects of military sonar is an important and active science/policy topic

Increasingly complex BRS - realistic sources, exposure context

Need to apply and adapt proven methods to:

- Evaluate multiple spatial and temporal scales

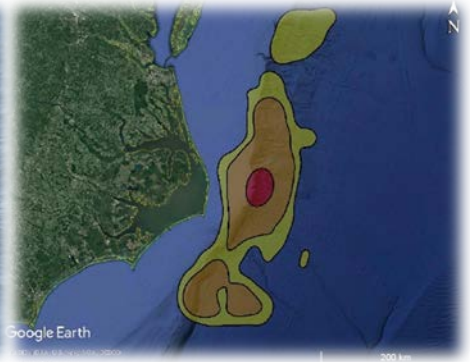
- Build sample size in high-priority species

Study Site:
Cape Hatteras, NC (USA)

Navy mid-frequency active sonar (MFAS) used occasionally, but not an active sonar range

High density of high-priority Cuvier's beaked whales & short-finned pilot whales

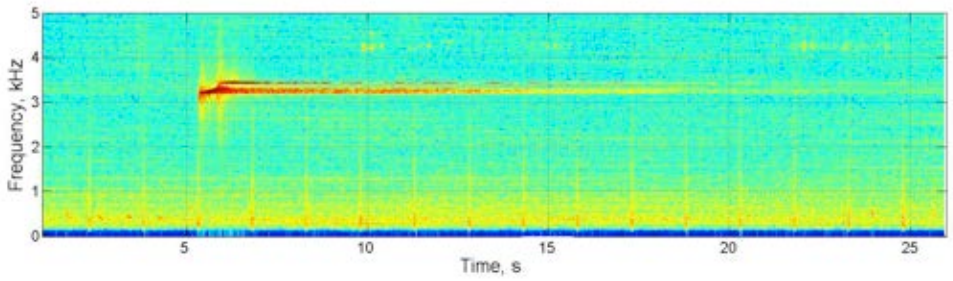
Extensive baseline tag data from pre-BRS efforts (2014-16) and current study (ongoing)



Overall Study Objectives

Directly measure behavior of Cuvier's beaked whales and short-finned pilot whales on multiple spatial and temporal scales before, during, and after known exposures to Navy MFAS signals.

Quantify probability of specific responses (*avoidance, foraging, social*) relative to key exposure variables (*received level, spatial proximity, animal behavioral state*).



Experimental Design

Baseline data: many individuals; multiple animals in groups

Strategic *multi-scale* tag integration

- Archival, high-resolution acoustic and movement tags (DTAGs): hours

- Satellite-linked position and moderate-resolution dive data tags (SPLASH): weeks

Re-sights of satellite-linked tags, photo ID: group composition, additional tags

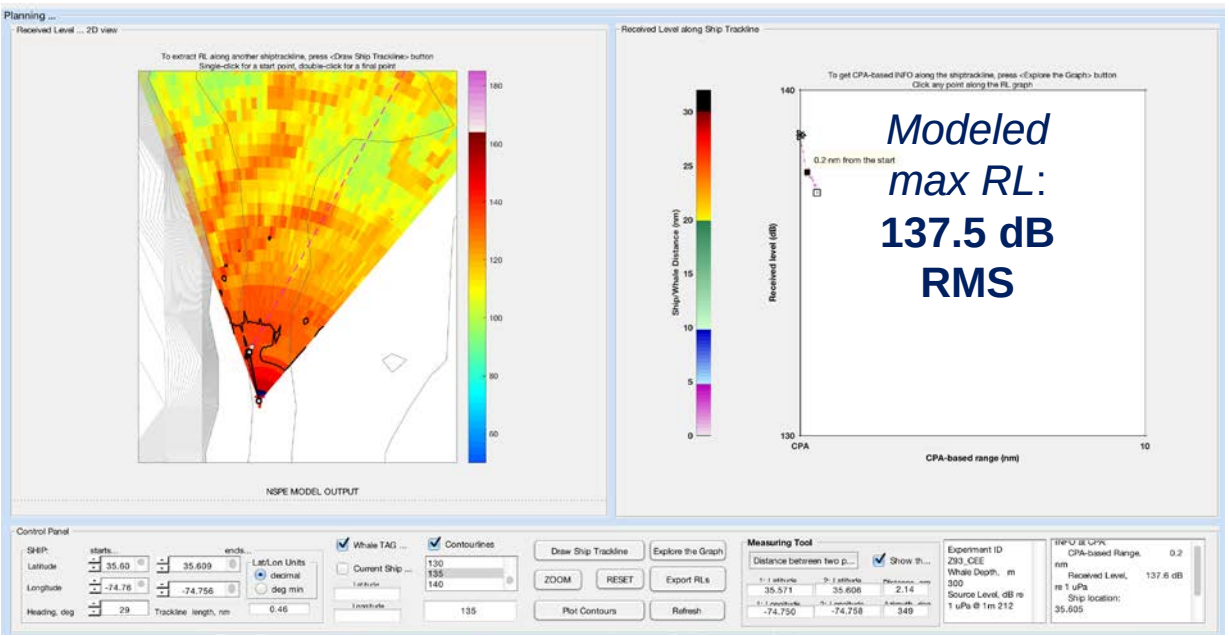
Experimental Design

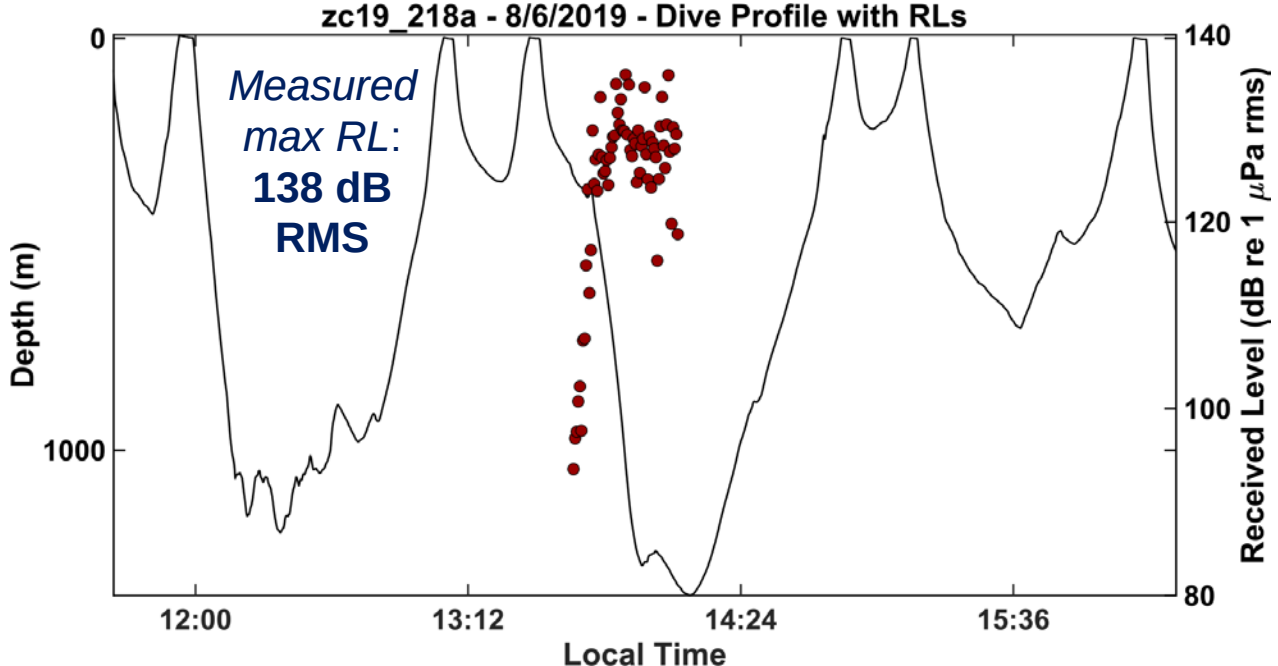
Before-during-after paradigm - controlled exposure experiments (CEEs)

Controlled source range-orientation using *in situ* modeled received levels (RL)

Exposure RLs measured directly (DTAGs; HARPs) (Schick* talk – this session @15:30)

*also see: Schick et al, 2019 ESOMM-2018 special issue





Methods – Field Priorities

Species priorities:

1) Cuvier's beaked whale

2) Short-finned pilot whale

MFAS source types/priorities:

1) Operational ship-based Navy 53C - tactical MFAS

2) Experimental source - simulated Navy MFAS

Results – Tag Deployments and CEEs (to date)

2017-19 spring and summer month-long field seasons (six total)

Species	SPLASH tag deployments	DTAG deployments
Cuvier's beaked whale	**41**	**3**
Short-finned pilot whale	**31**	**10**

MFAS Source Type	Total CEEs	Tagged/exposed beaked whales	Tagged/exposed pilot whales
Operational Navy 53C	**3**	**10**	**17**
Experimental (simulated)	**8**	**34**	**25**
Silent Control	**2**	**10**	**12**

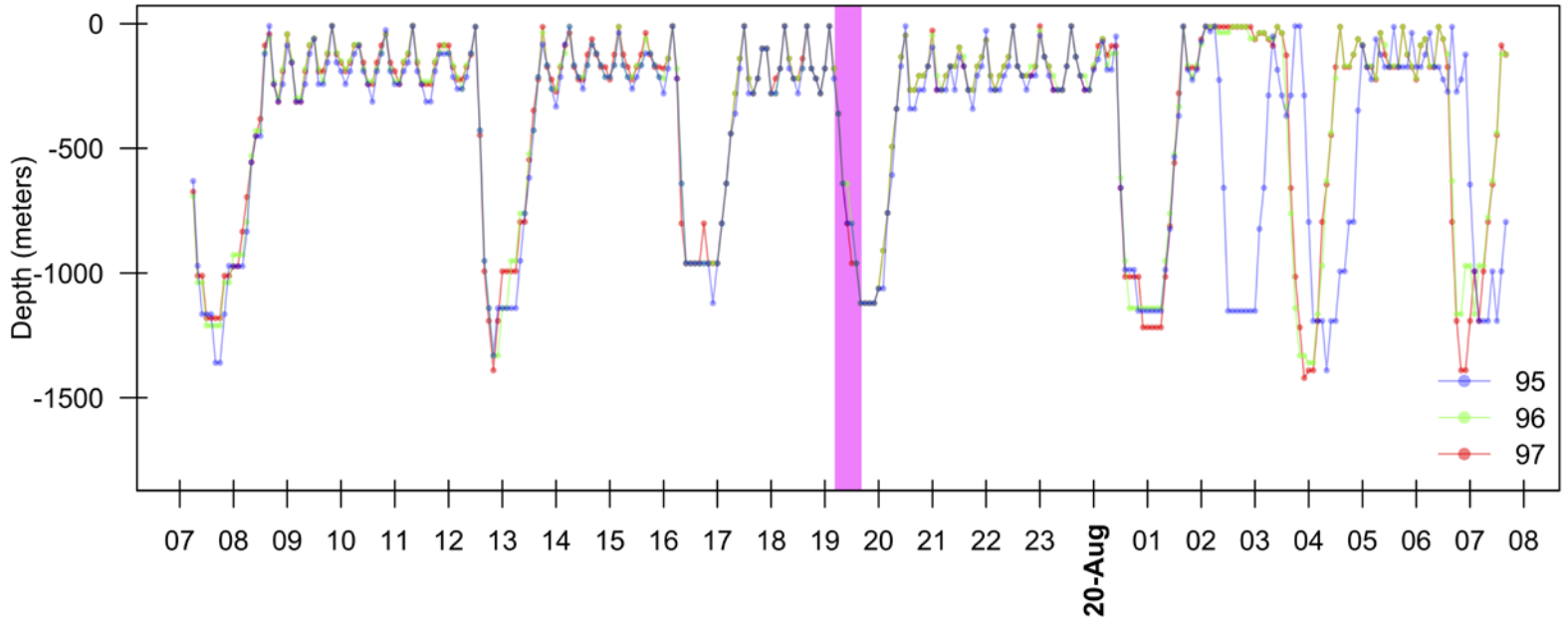
Results – Baseline Data (selected)

> 50,000 hours of multi-scale movement and dive data

Baseline pilot whale steroid hormone levels (Wisse talk – Mon 12:00)

New insights into heterogeneity in beaked whale diving (Quick talk - Wed 15:25)

Beaked whale diving synchrony (Cioffi talk - Wed 13:45)



Results – Avoidance Response Analysis

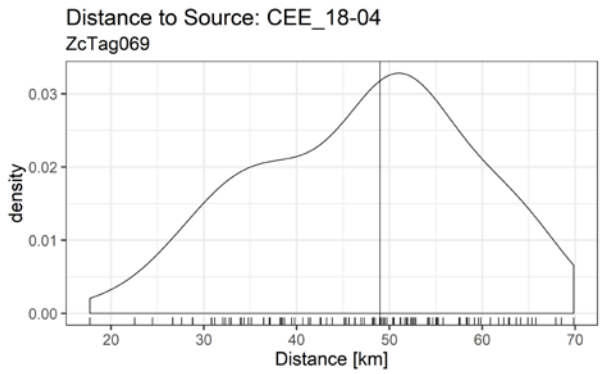
Real Navy MFAS CEE (*USS NITZE*) with satellite-tagged beaked whale (Zc69)

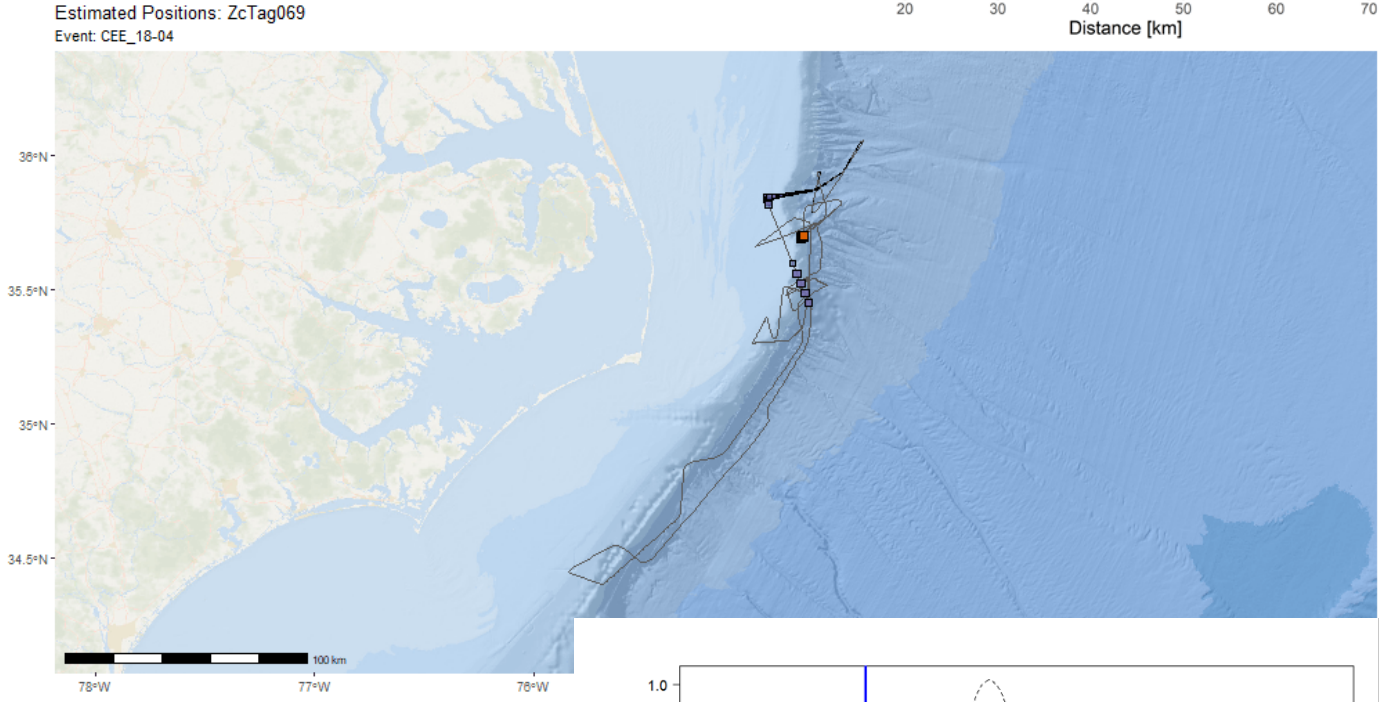
~ 48 km range at start CEE

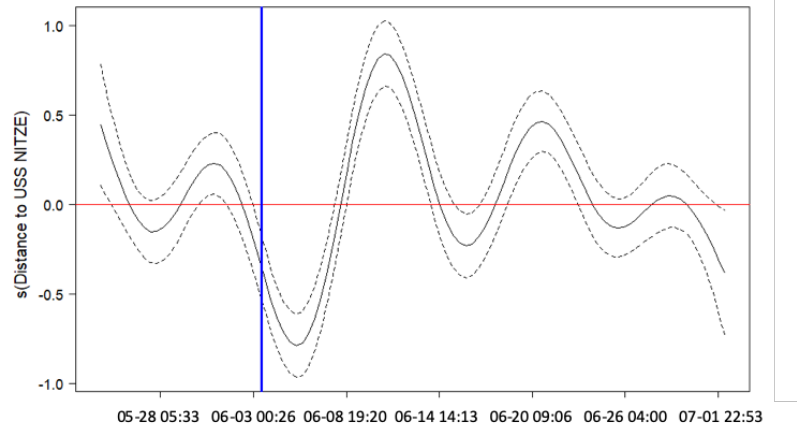
~125 dB RMS RL (modeled at depth)

Horizontal avoidance analysis: Multi-stage modeling approach with many filtered track imputations to evaluate time-varying response

Evaluation: Zc69 moving away from NITZE just prior to CEE but continued movement away from frequented area suggests strong horizontal avoidance response







Hanks, et al. (2015). The Annals of Applied Statistics 9: 145–65.

Results – Social Response?

Simulated MFAS CEE with sat-tagged beaked whale (Zc89)

~ 5 km range at start CEE

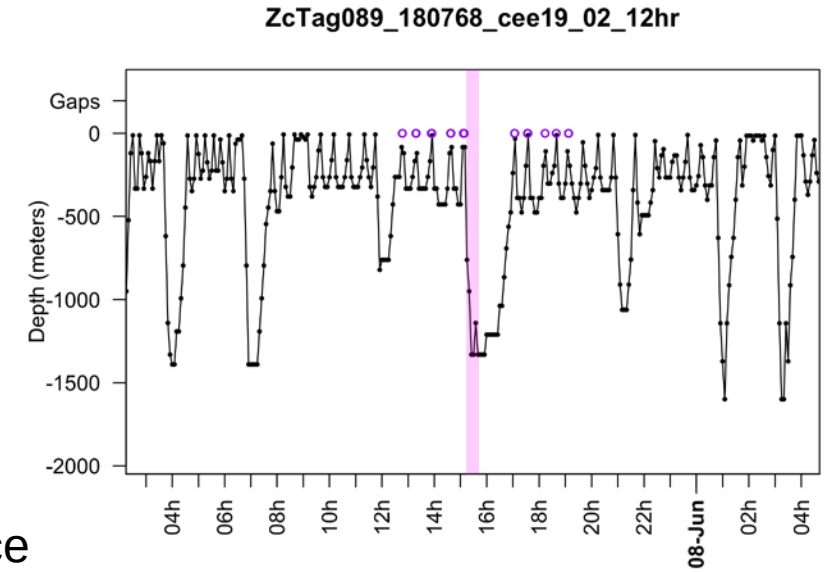
~140 dB RMS RL (modeled)

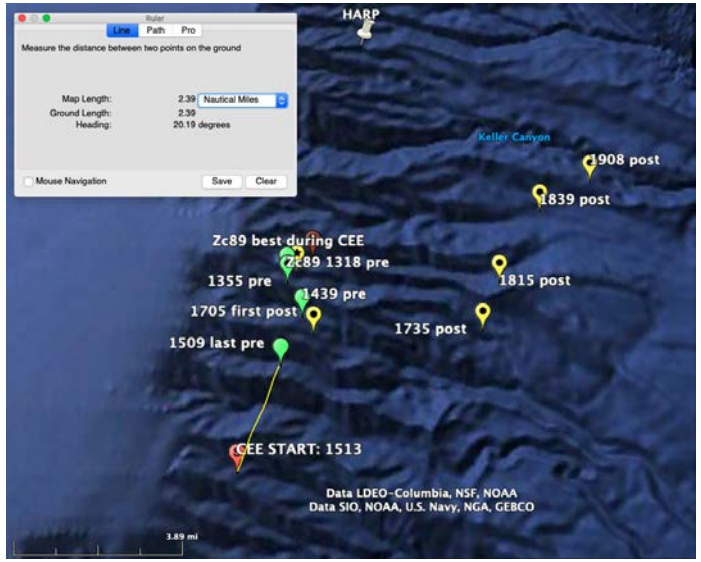
Tag and Focal Follow Data:

Deep dive of ~2h with shallow ascent

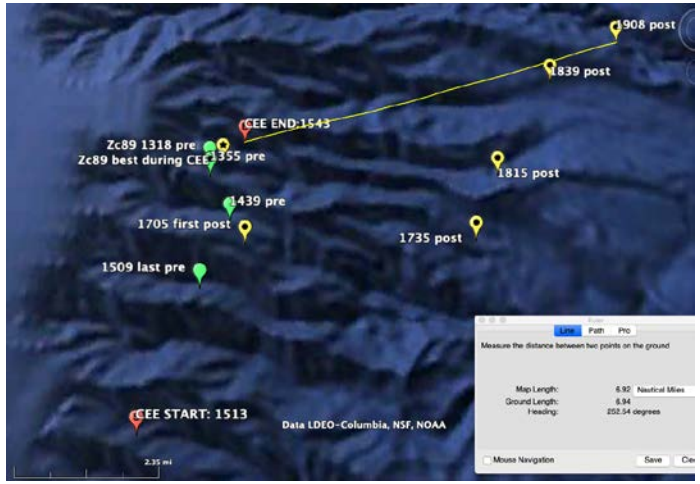
Directed movement away from CEE source

Zc89 in group of 4 before CEE; alone after





START CEE location to last focal posit
(Zc89 in group of 4)



POST CEE – 4th focal posit post-exposure
(first visual; Zc89 alone)

Evaluation:

Possible/likely change in diving/foraging

Sustained directed avoidance

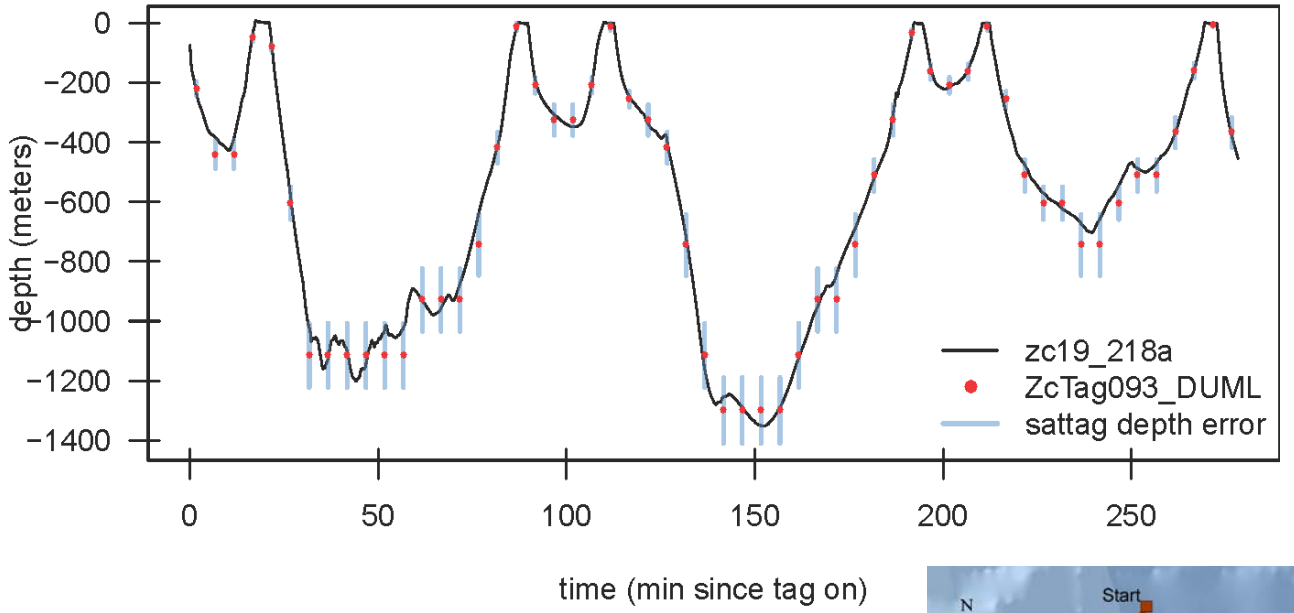
Novel observations of possible social group disruption (Zcs 95, 96, 97)

Results – Multi-scale response measurements

Simulated MFAS CEE with satellite-tagged beaked whale (Zc93) AND DTAG (Zc19_218a)

~ 5 km range at start CEE

137.5 dB RMS max (modeled);
138 dB (measured)

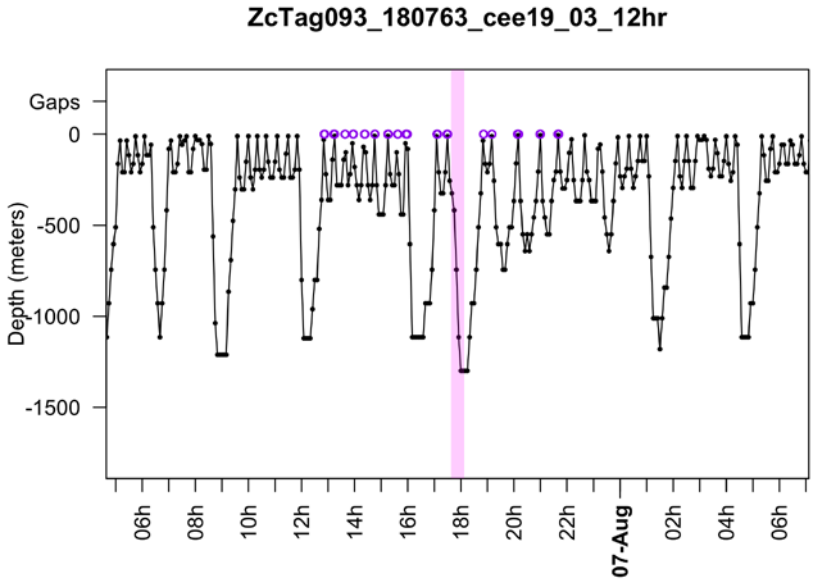


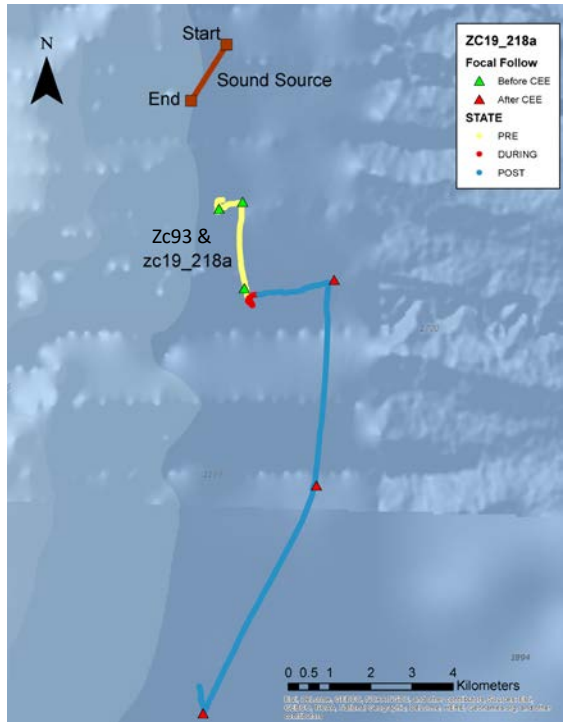
Observations from Tag, Focal Follow:

Very good agreement in dive depths in DTAG and 5-min time series SPLASH tag

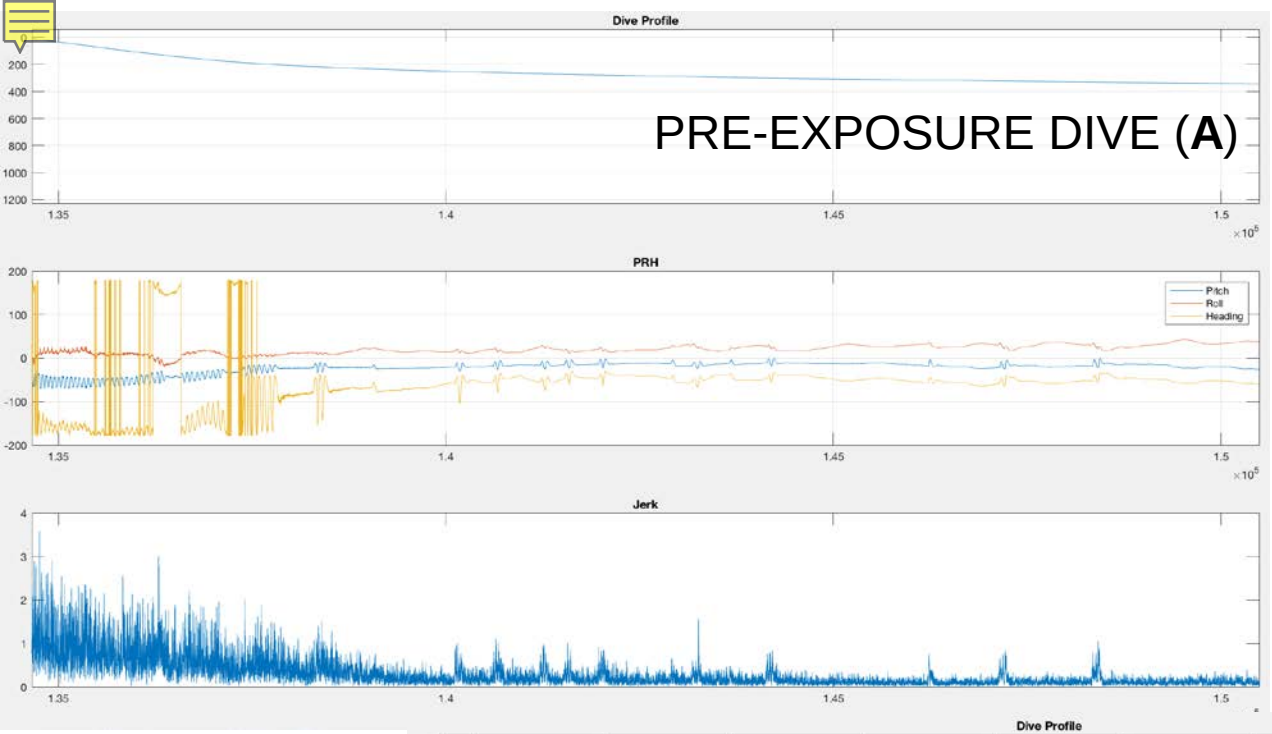
Possible shallow dive becomes deep dive at exposure onset

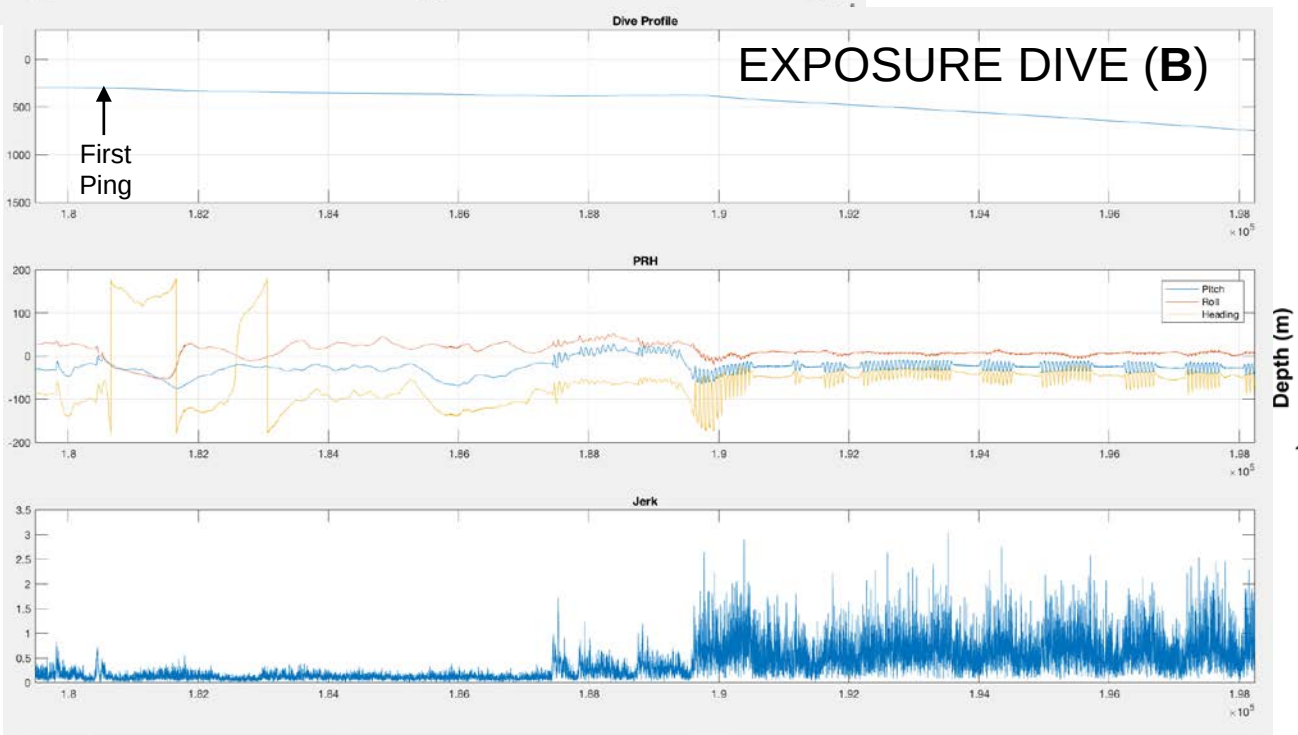
Sustained, directed avoidance for hours AFTER CEE; ~10 kts into ~ 5 kt current

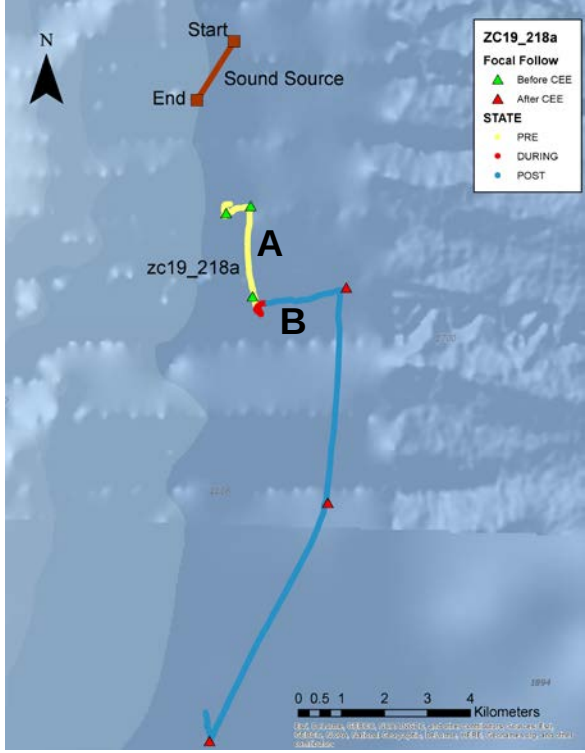


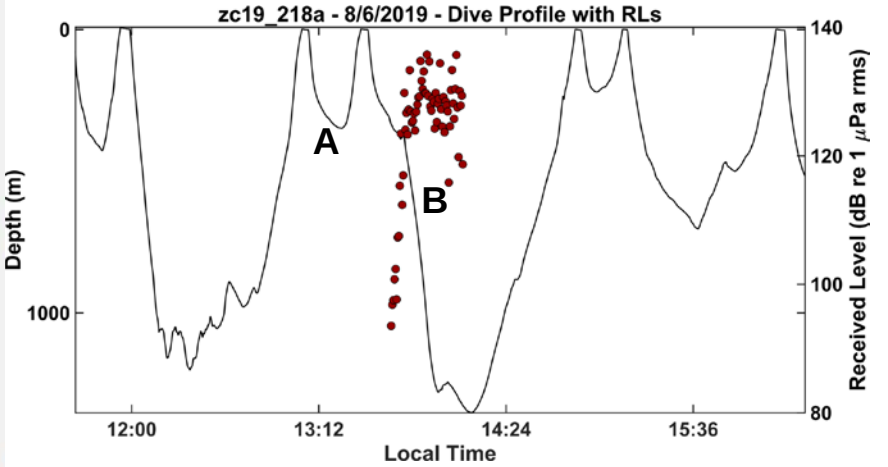


Zc19_218a fine-scale response









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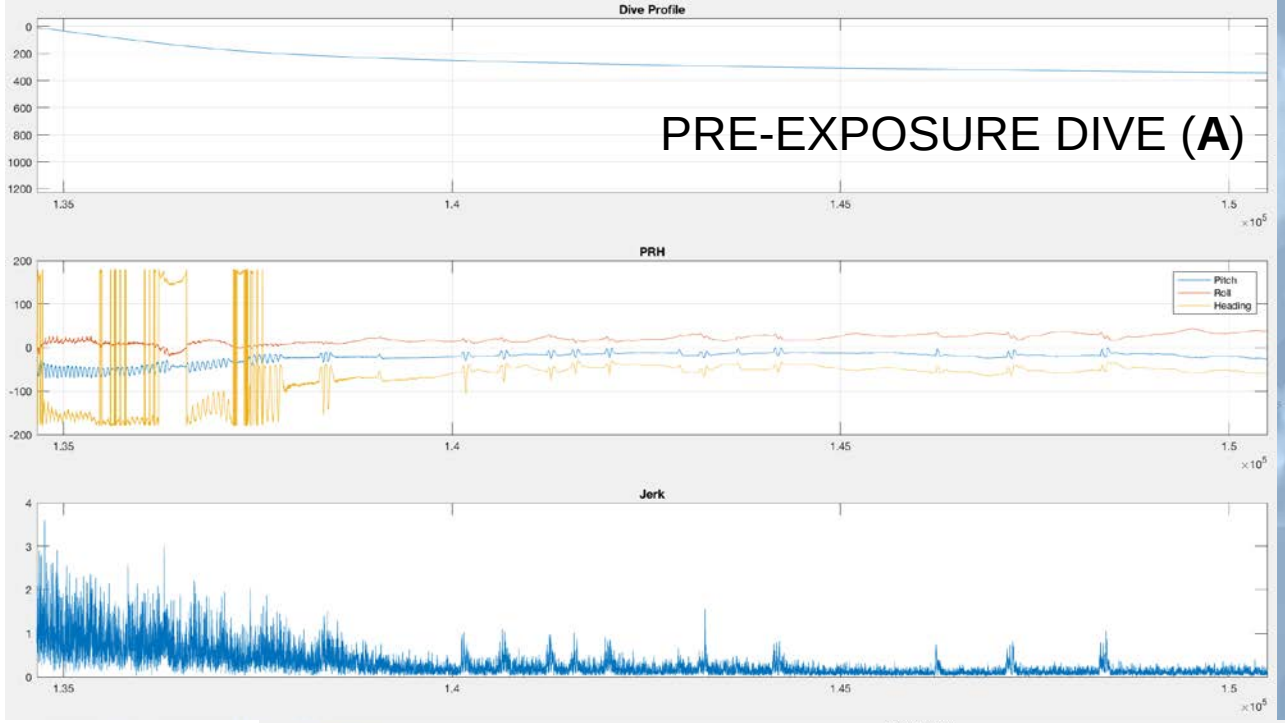
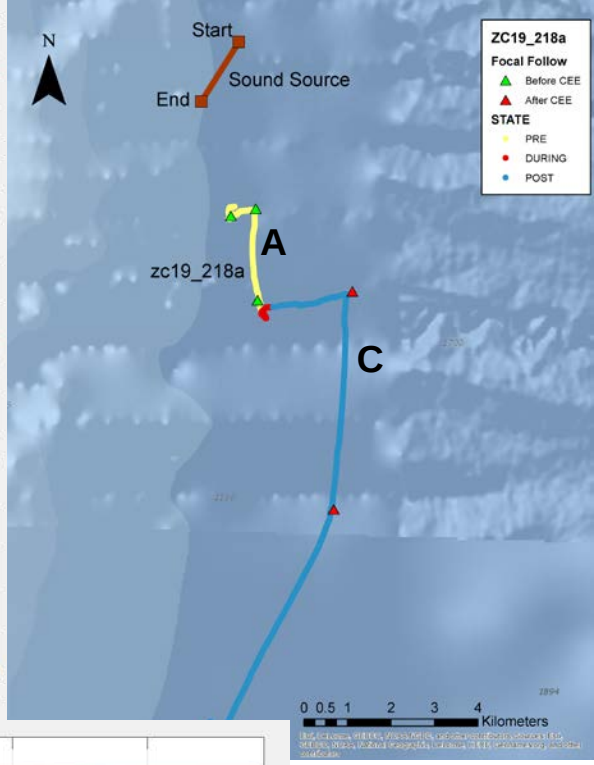


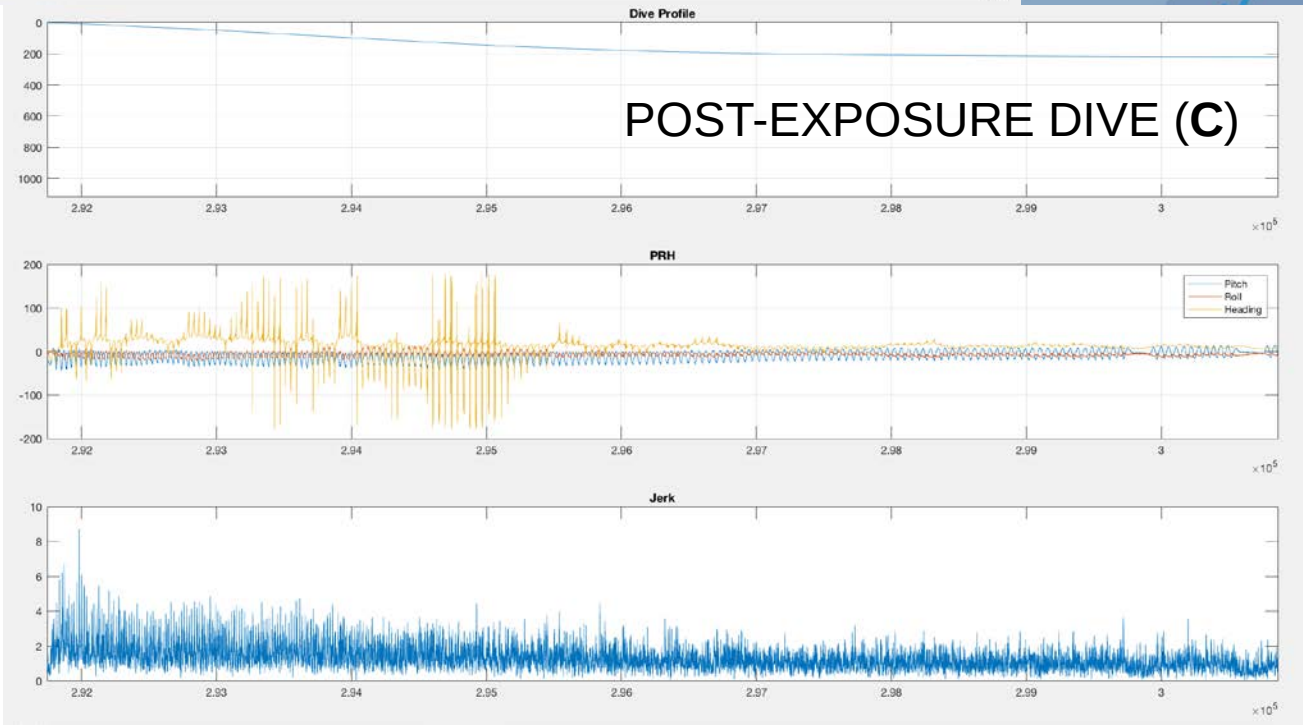


Fine-scale DTAG Zc19_218a and Zc93 Evaluation:

Change in orientation at start of MFAS exposure

Likely change in diving/foraging

Sustained, directed, >10 kt avoidance – extremely energetic response



Conclusions and Next Steps

Very successful field effort:

- Many multi-scale tag deployments on both species (n=85); extensive baseline data
- CEEs (n=12; 86 animal –exposure ‘events’) at various ranges and controlled RLs

Responses in some (not all) cases often strong but generally short-term, including:

- Avoidance of CEE location (often strongest after exposure)
- Changes in diving/foraging behavior (shallow ascent, extended dive duration)
- First indications of potential disruption of social groups

Top priority for subsequent field effort is to replicate simulated MFAS CEEs with more operational Navy vessel CEEs at exposure RLs in the 130-140 dB range

Acknowledgements

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The 7th Effects of Sound in the Ocean on Marine Mammals (ESOMM-2020) will be held on 3-6 November 2020 in Beaufort, North Carolina, USA

ESOMM-2020 will continue to build on the tradition of presentations and discussions of research, monitoring, new field and analytical methods of measuring and understanding how noise from different sound sources may affect marine mammals, as well as most effectively managing these issues.

Brandon Southall, Doug Nowacek, Andy Read (ESOMM-2020 Co-Chairs)