Behavioral responses of satellite tracked Blainville's beaked whales (*Mesoplodon densirostris*) to mid-frequency active sonar

Trevor W. Joyce [1,2], John W. Durban [2], Diane E. Claridge [3], Charlotte A. Dunn [3], Leigh S. Hickmott [4], Holly Fearnbach [5], Karin Dolan [6], David Moretti [6]

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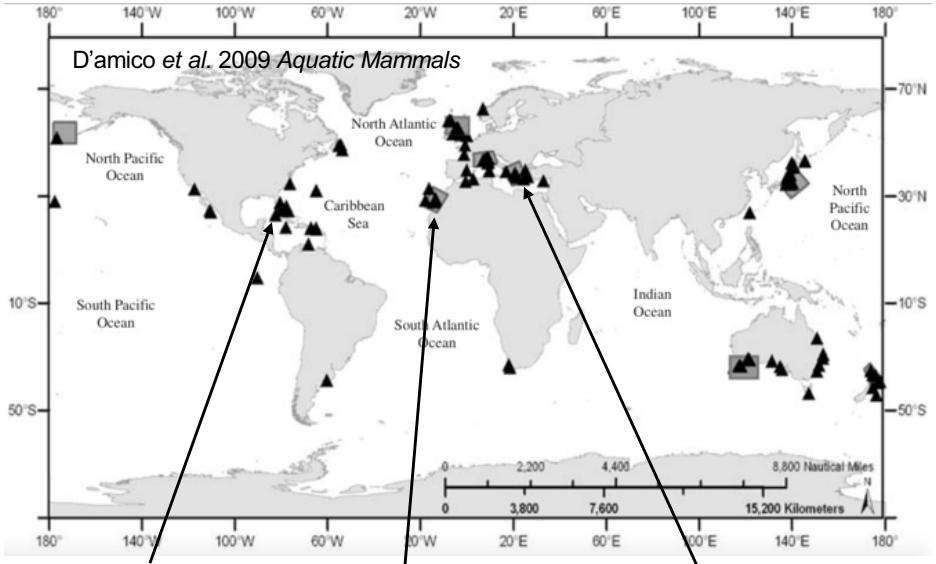
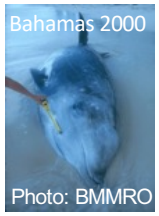
6. Naval Undersea Warfare Center, Newport, U.S.A.

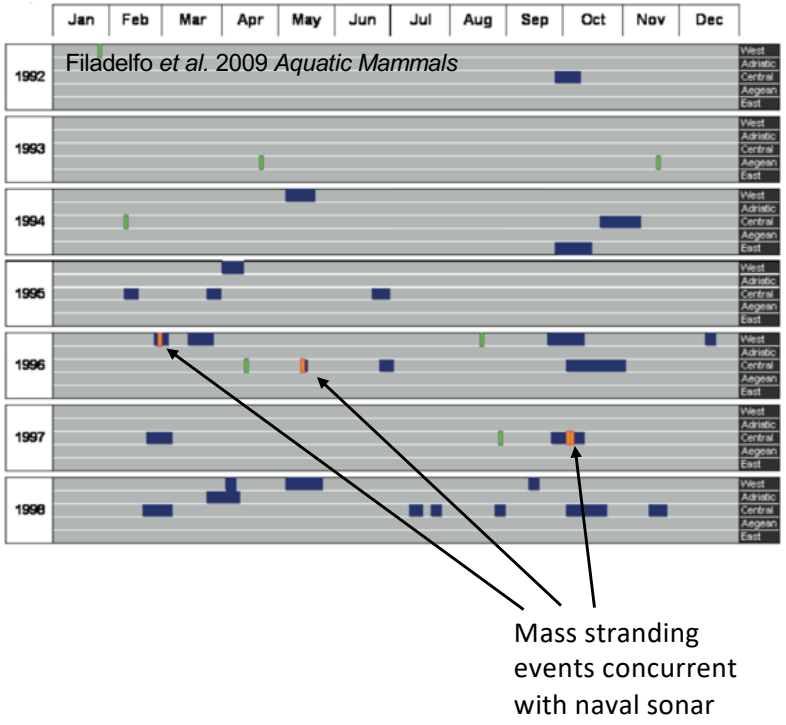
Background: Mass Stranding Events and Naval Exercises

Co-occurrence in Space





Co-occurrence in Time

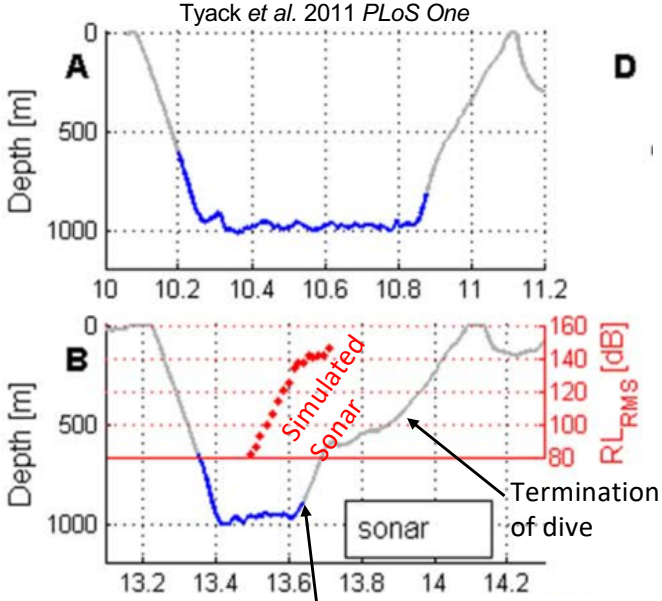


Illlustrations: Uko Gorter

Background: Disruption of Foraging and Movement

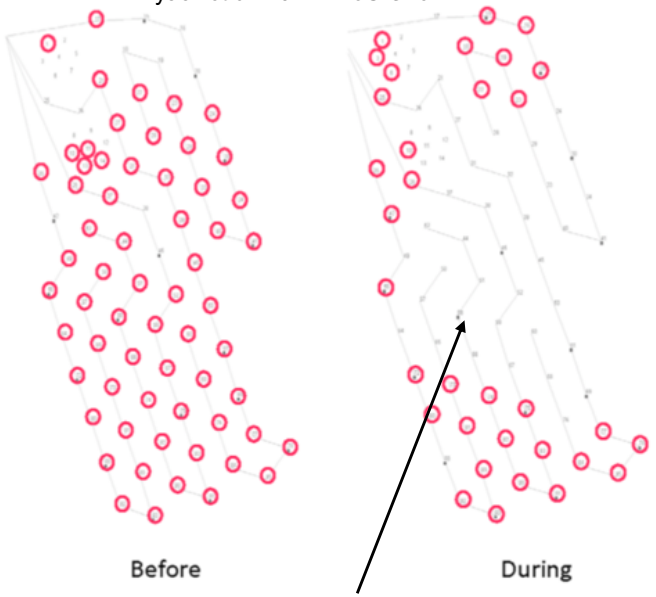
Disruption of Foraging Behavior

Tyack *et al.* 2011 *PLoS One*



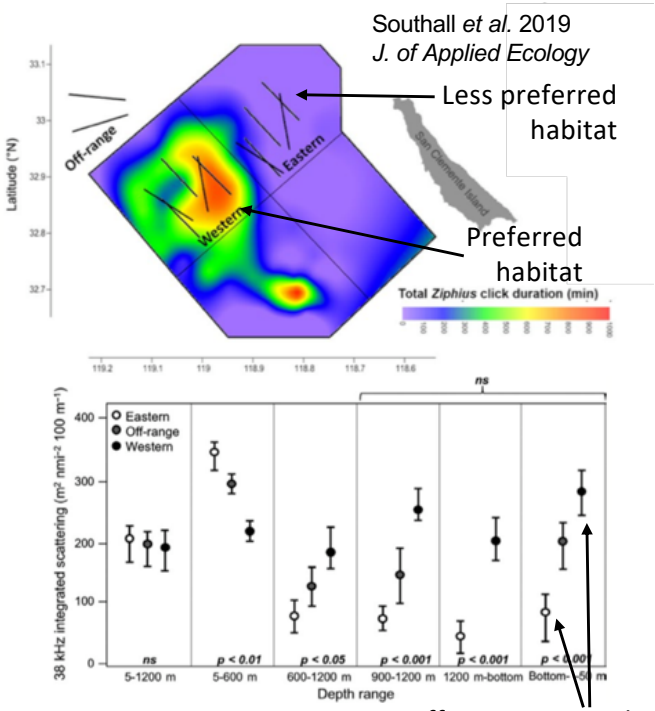
Disruption of Distribution Patterns

Tyack *et al.* 2011 *PLoS One*

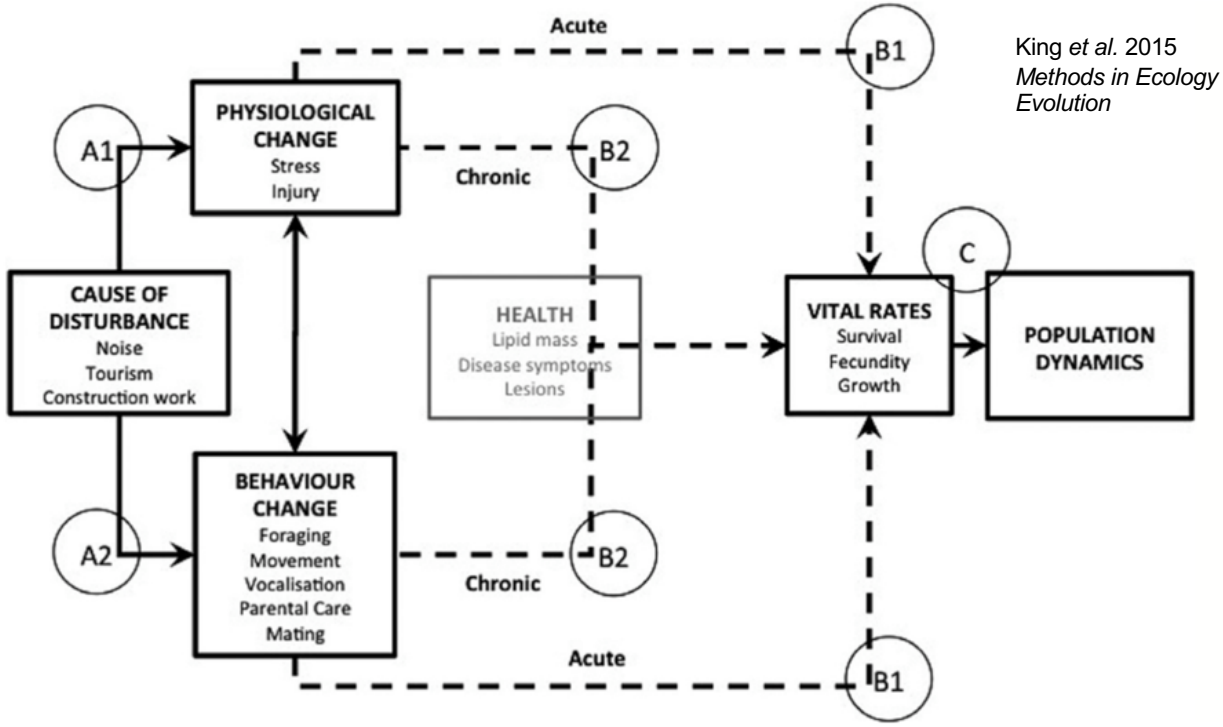


Potential Energetic Consequences

Southall *et al.* 2019
J. of Applied Ecology



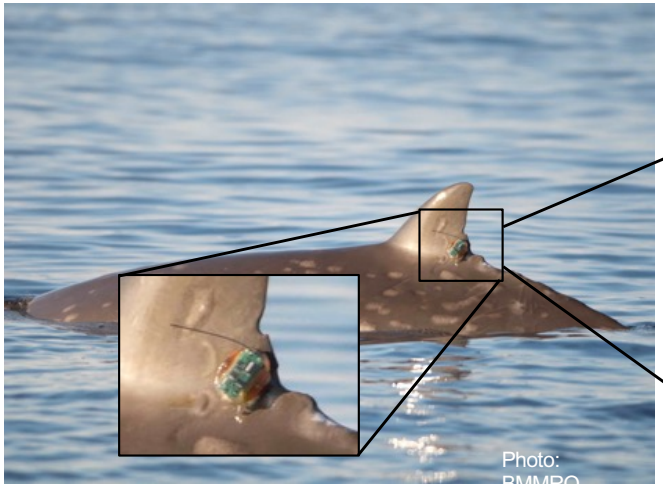
Background: Population Consequences of Acoustic Disturbance (PCAD)



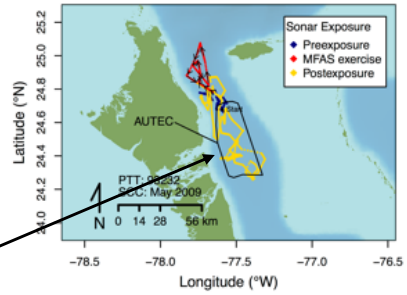
King *et al.* 2015
Methods in Ecology and Evolution

Methods: LIMPET Satellite Transmitter Tags

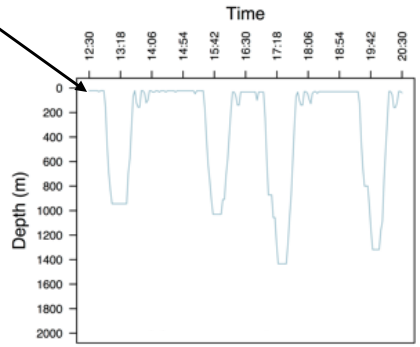
LIMPET Satellite Transmitter Tags



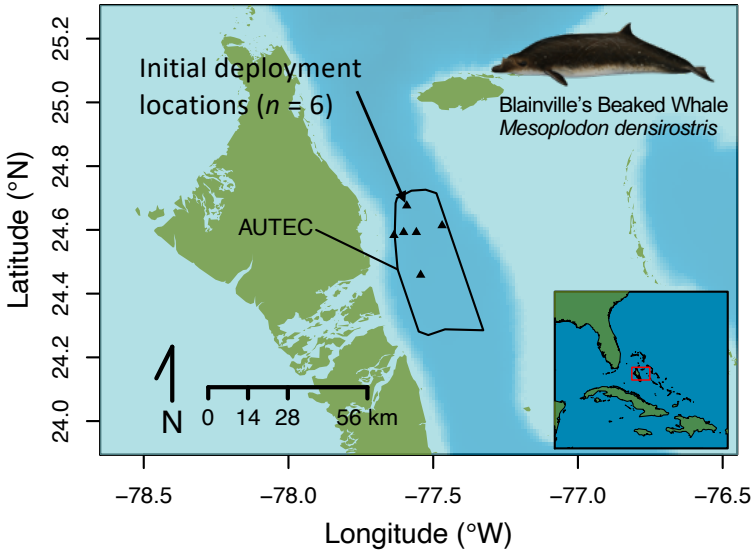
Spatial Movements



Dive Behavior



Deployments at AUTEC prior to anti-submarine warfare exercises (2009 – 2015)

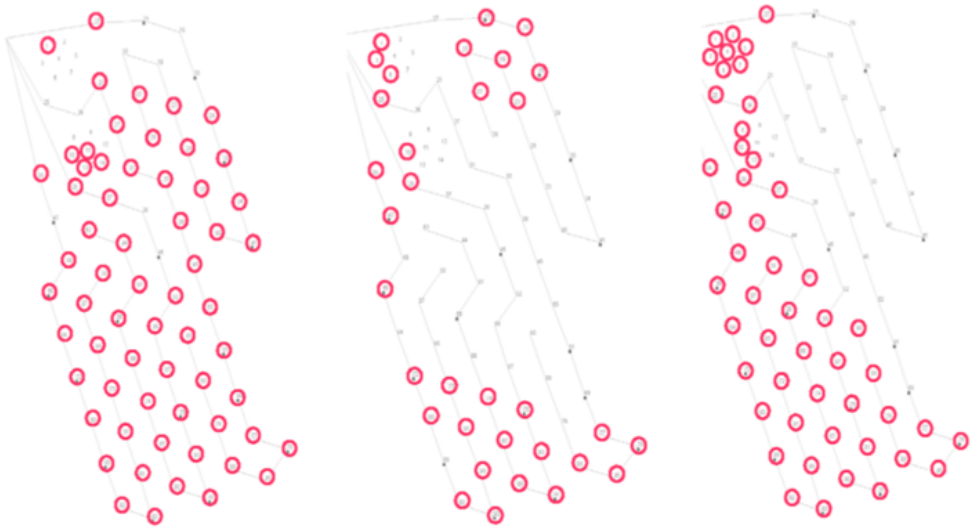


Illustrations: Uko Gorter

Objective: Bridge spatial and temporal scales of previously documented responses

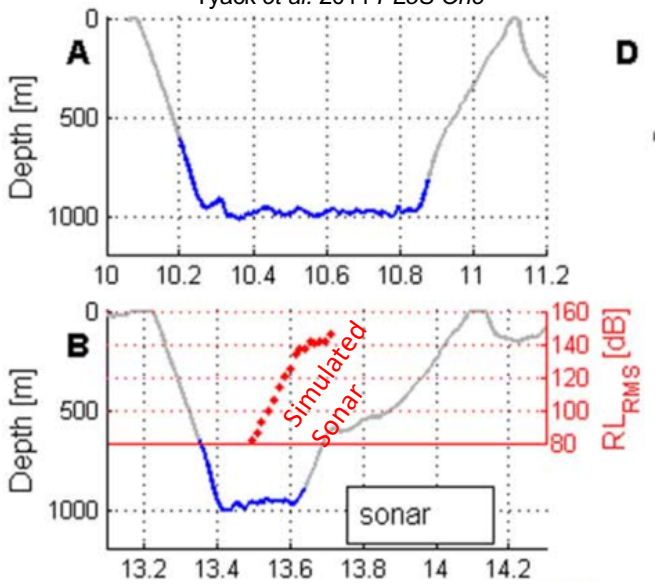
Population-level Displacement Response

Tyack *et al.* 2011 *PLoS One*



Individual-level Foraging Interruption Response

Tyack *et al.* 2011 *PLoS One*



Medium-endurance
LIMPET satellite tags

Objective: Bridge spatial and temporal scales of previously documented responses

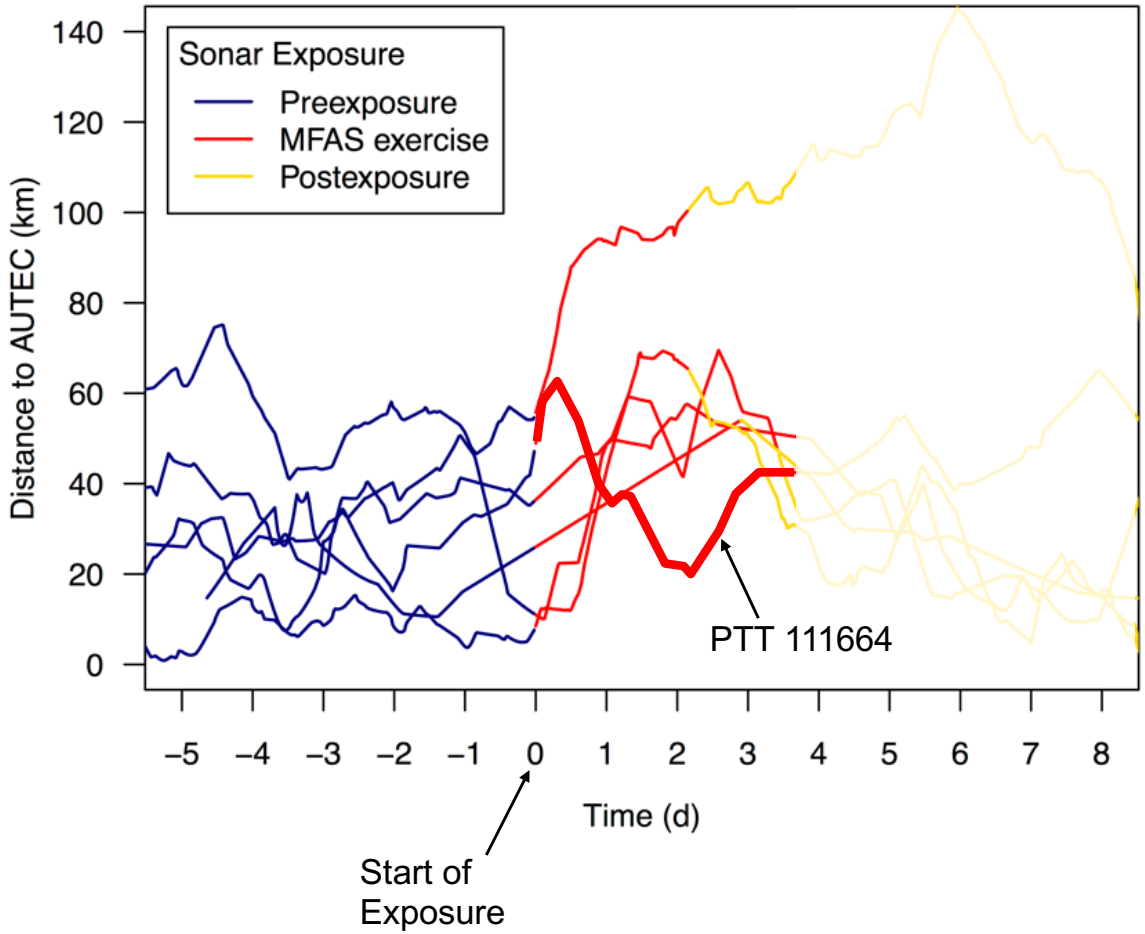
1) Whether, where, and how far were individuals displaced?

2) How did received levels change over displacement?

3) Did deep dive cycles continue to occupy the same proportion of time budgets?

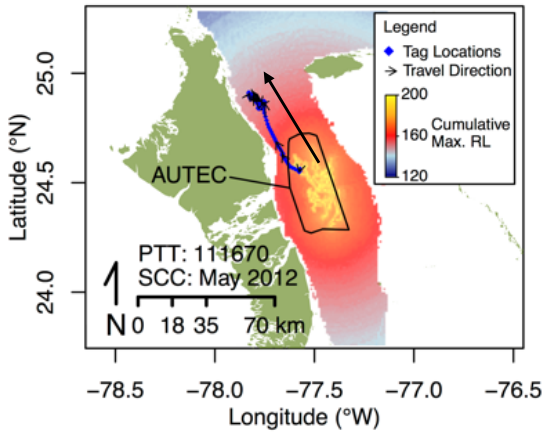
4) How soon did displaced animals return?

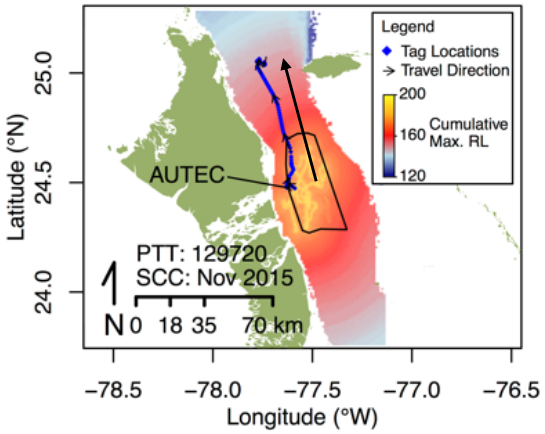
Results: 1) Whether and how far were individuals displaced?

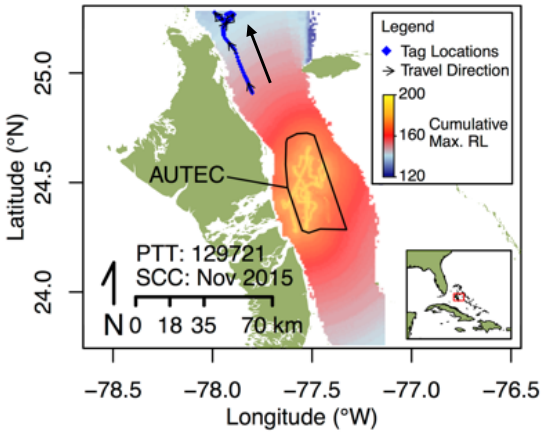


Joyce *et al.* In Press
Marine Mammal Science

Results: 1) Where were individuals displaced?







Joyce *et al.* In Press
Marine Mammal Science

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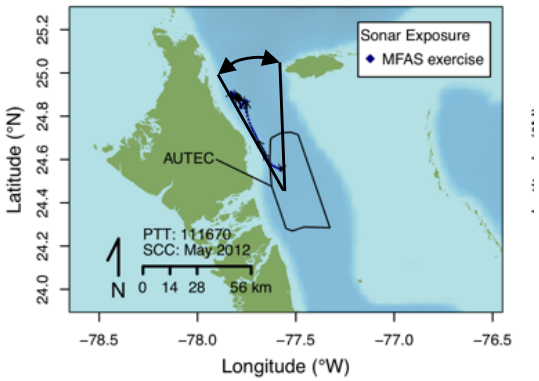

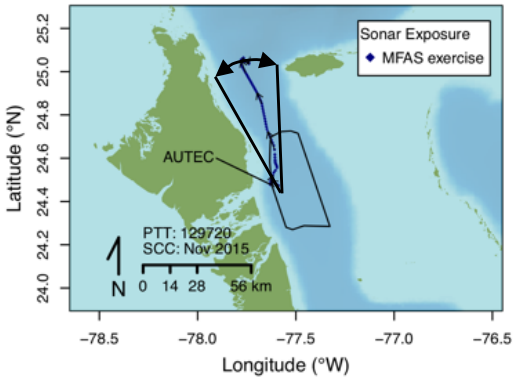

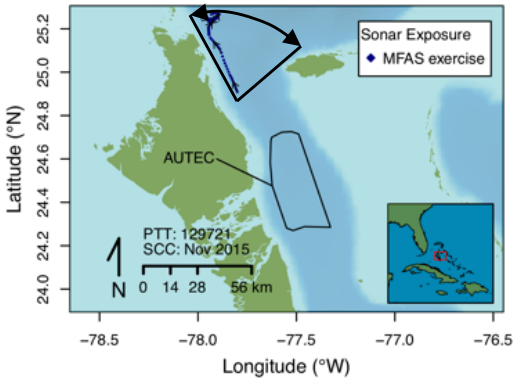

Joyce *et al.* In Press
Marine Mammal Science

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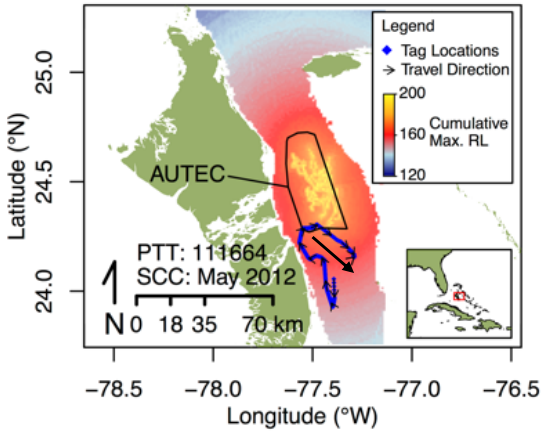
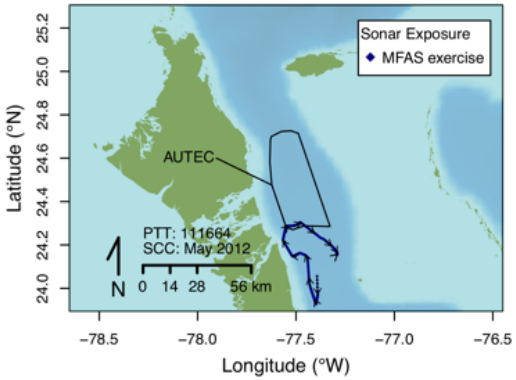
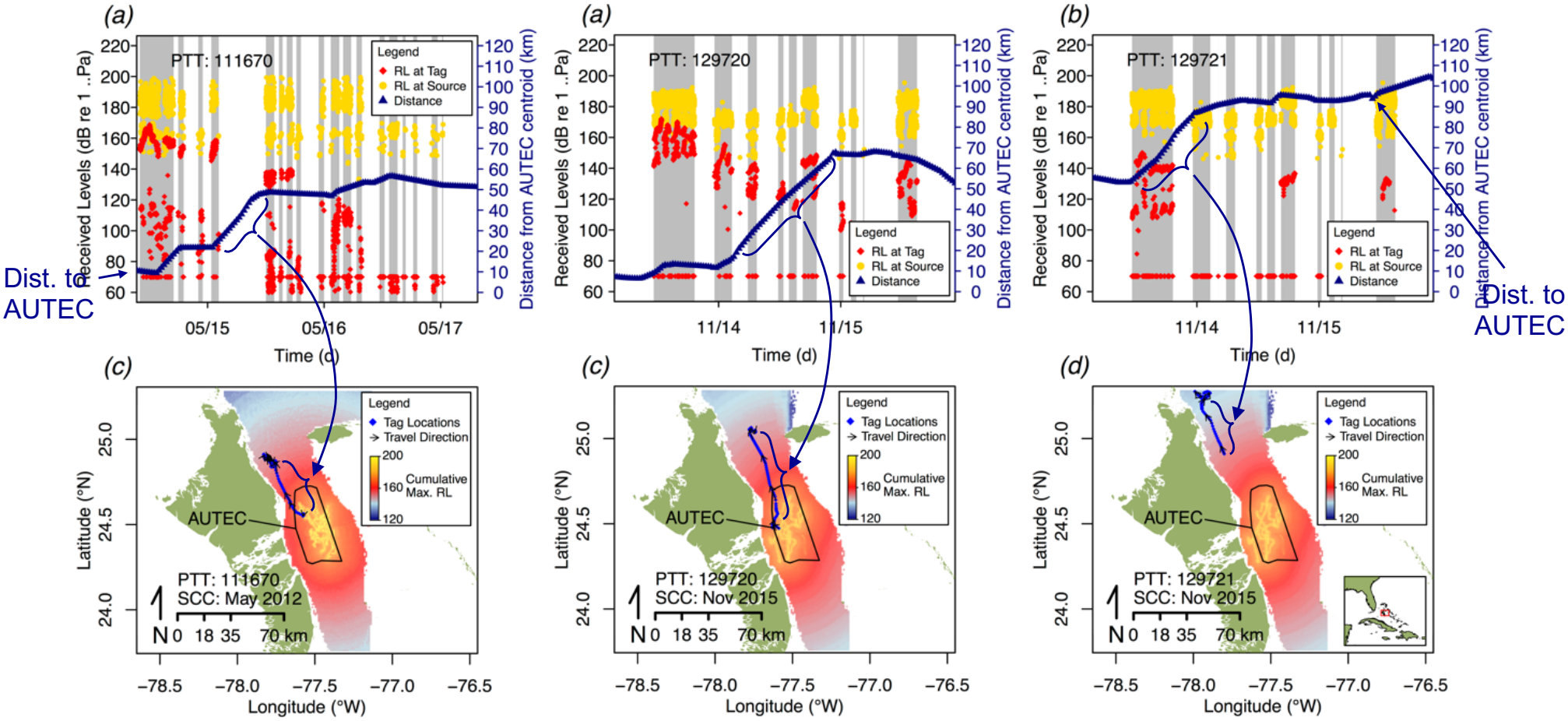




Joyce *et al.* In Press
Marine Mammal Science

Results: 2) How did received levels change over displacement?

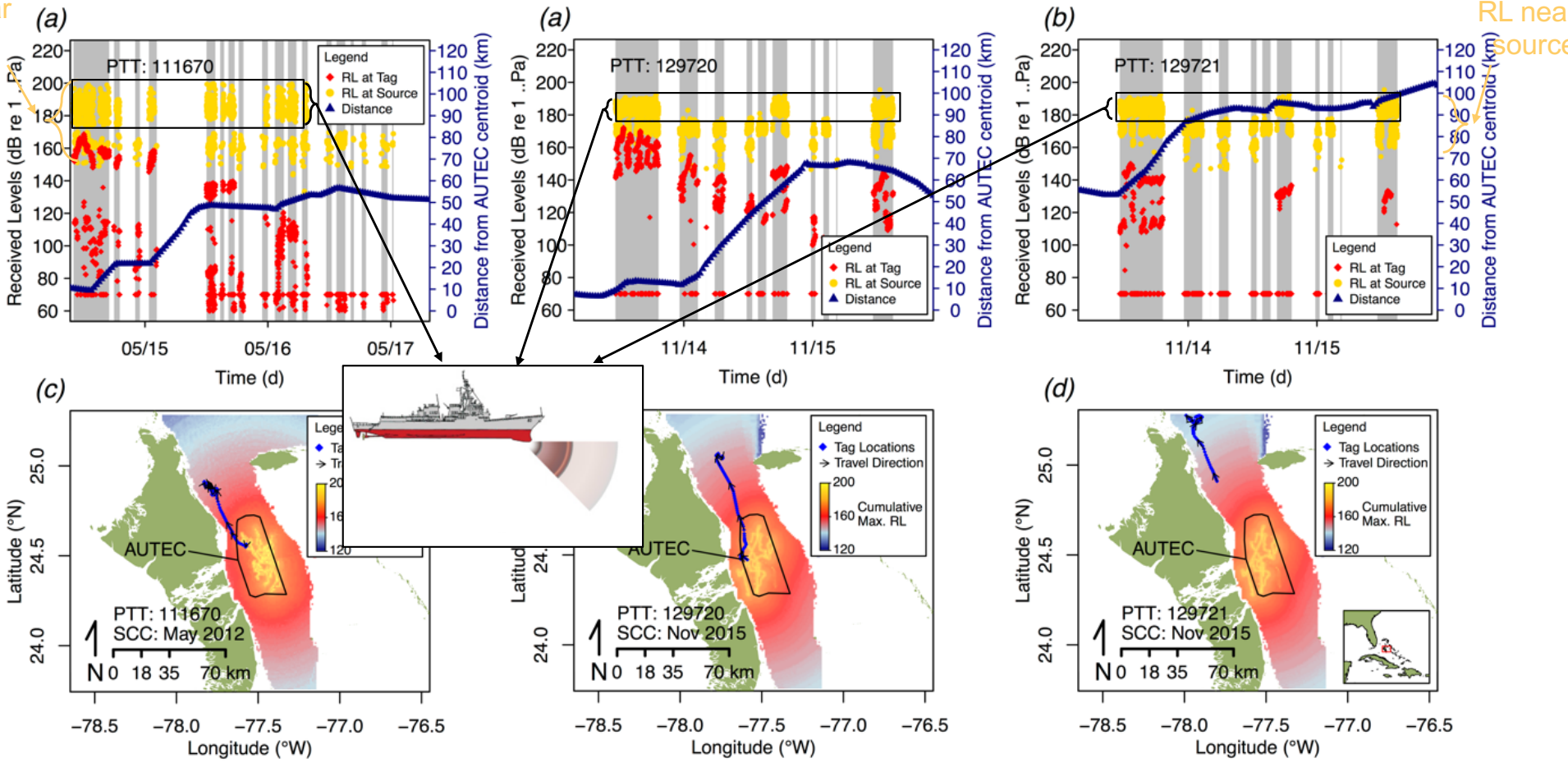


Joyce *et al.* In Press
Marine Mammal Science

Results: 2) How did received levels change over displacement?

RL near source

RL near source



Joyce *et al.* In Press
Marine Mammal Science

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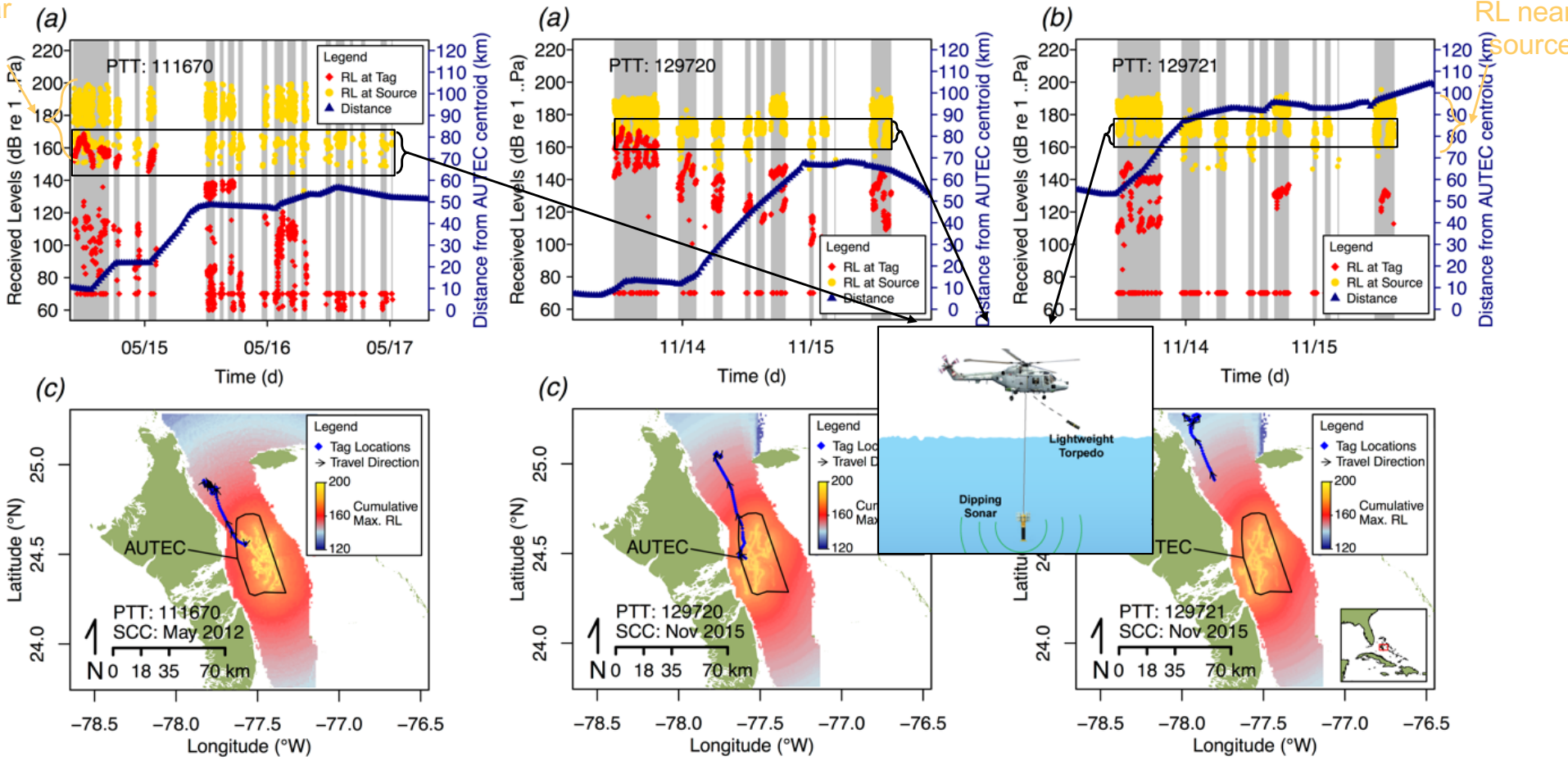
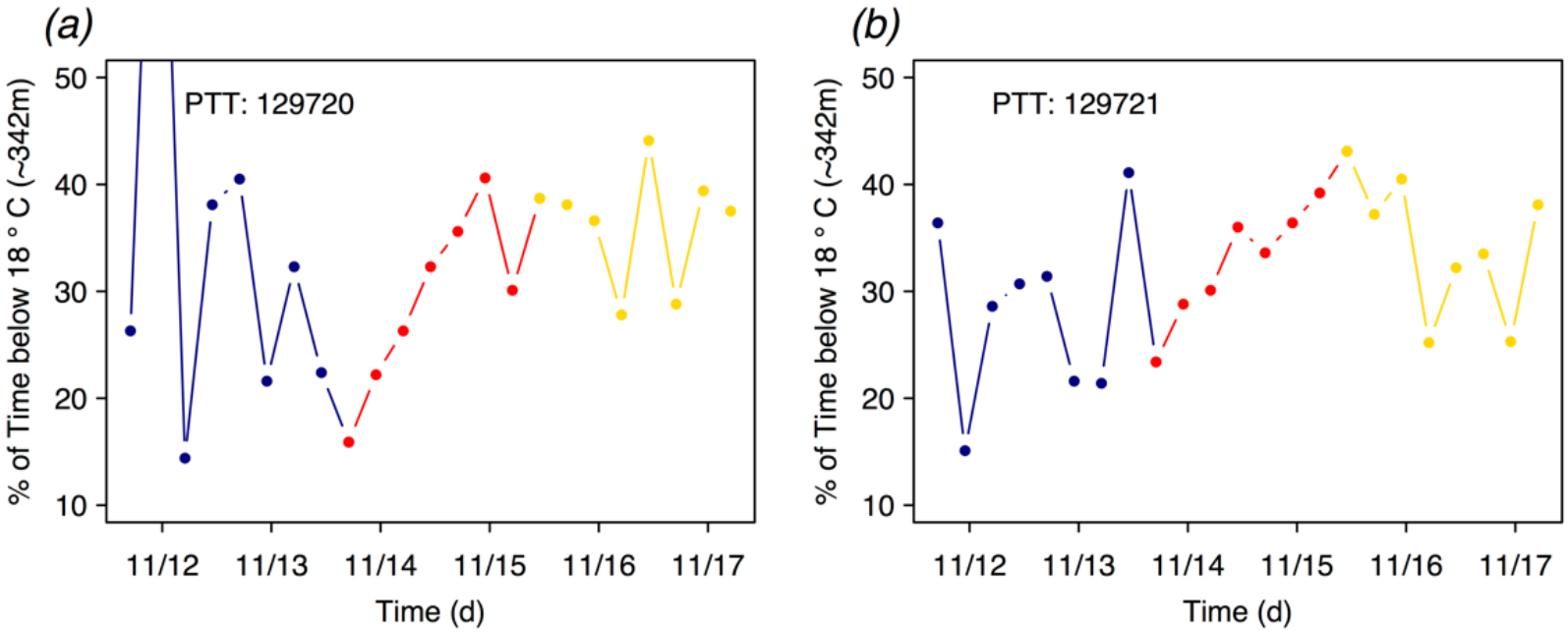


Joyce *et al.* In Press
Marine Mammal Science

Results: 3) Did deep dives continue to occupy the same proportion of time budgets?



Joyce *et al.* In Press
Marine Mammal Science

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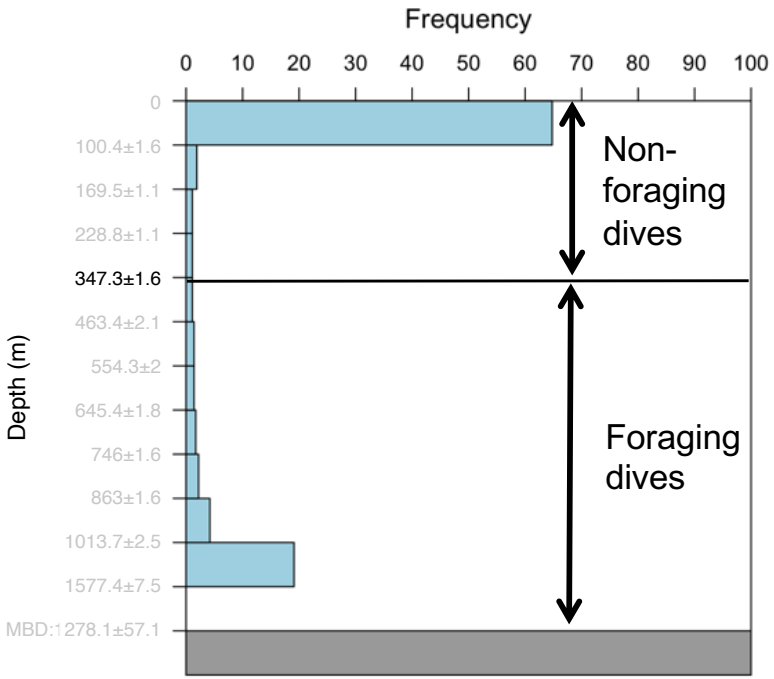

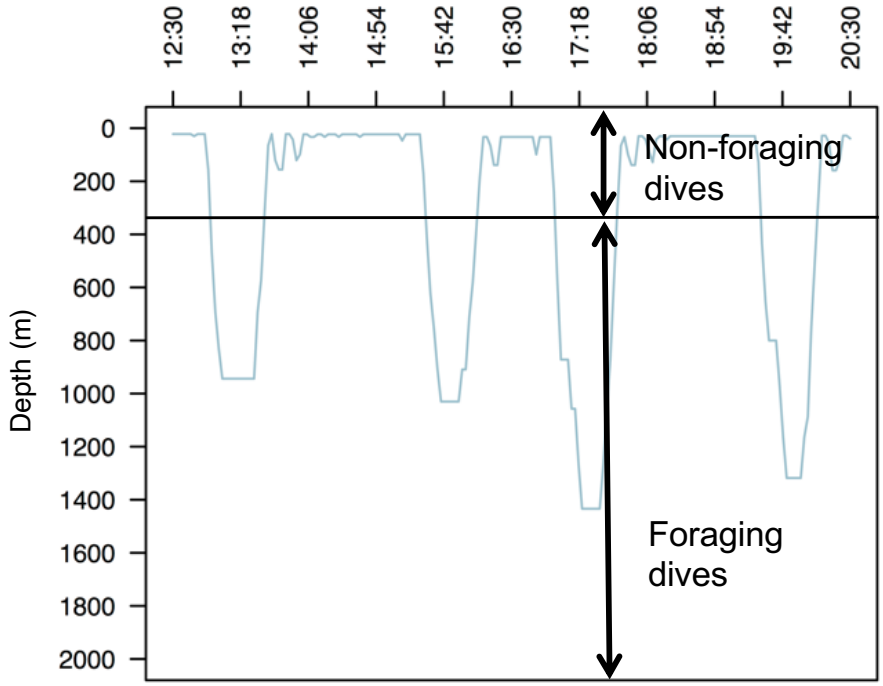

Joyce *et al.* 2016
Marine Mammal Science

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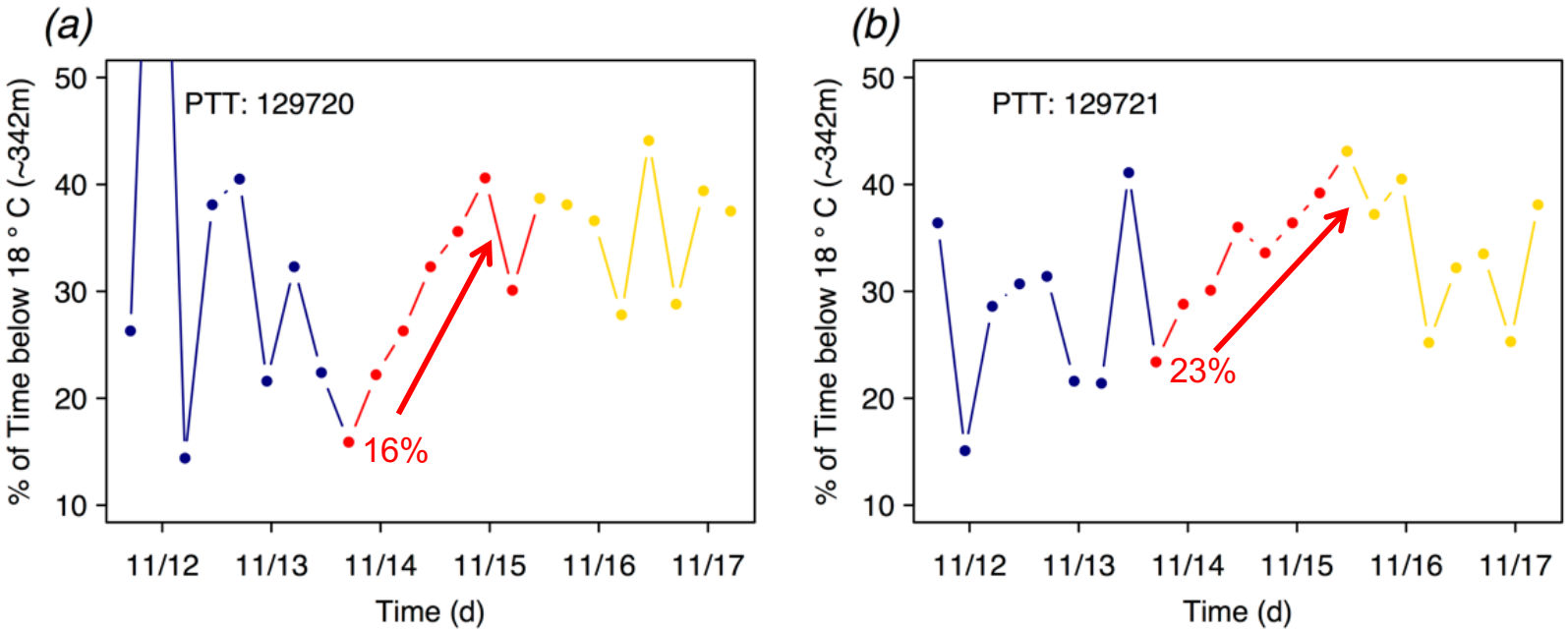

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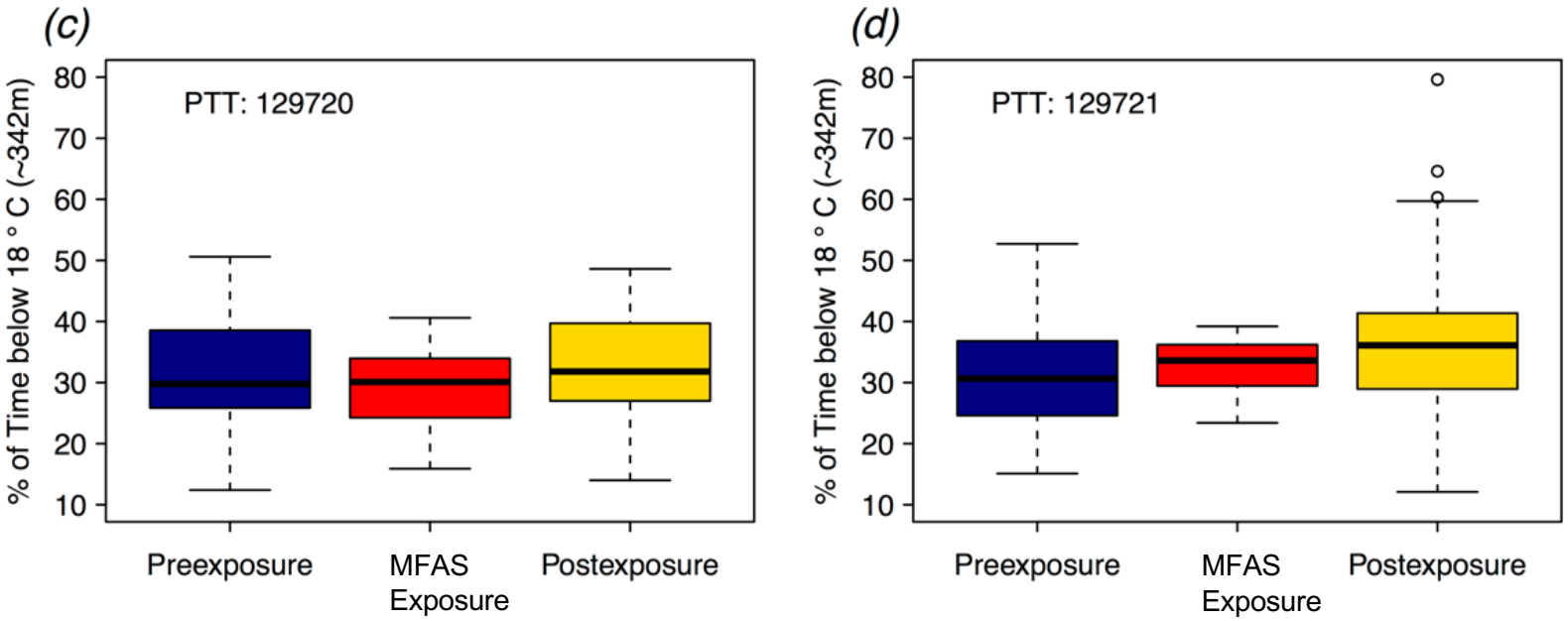

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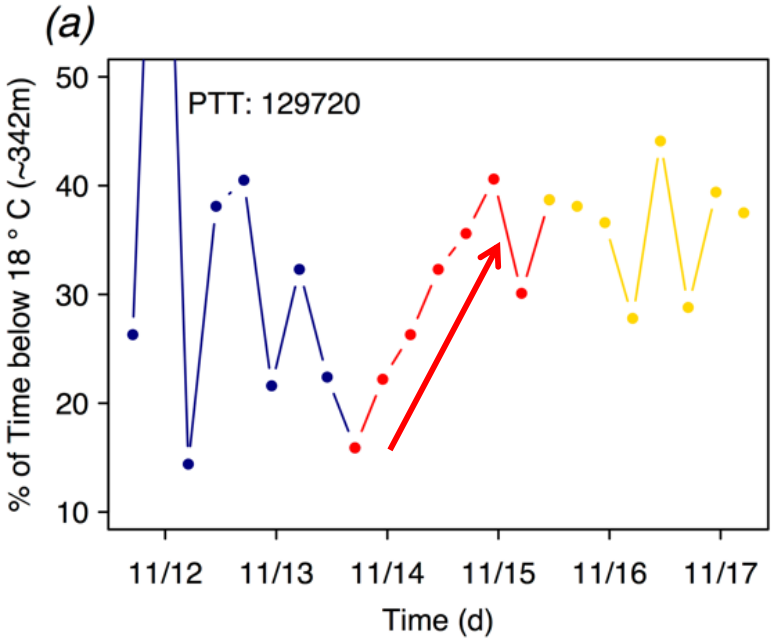
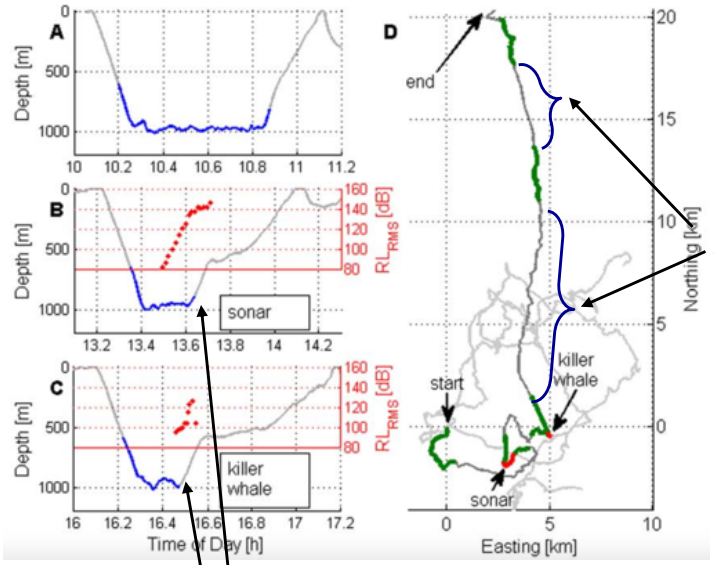


Tyack *et al.* 2011 *PLoS One*



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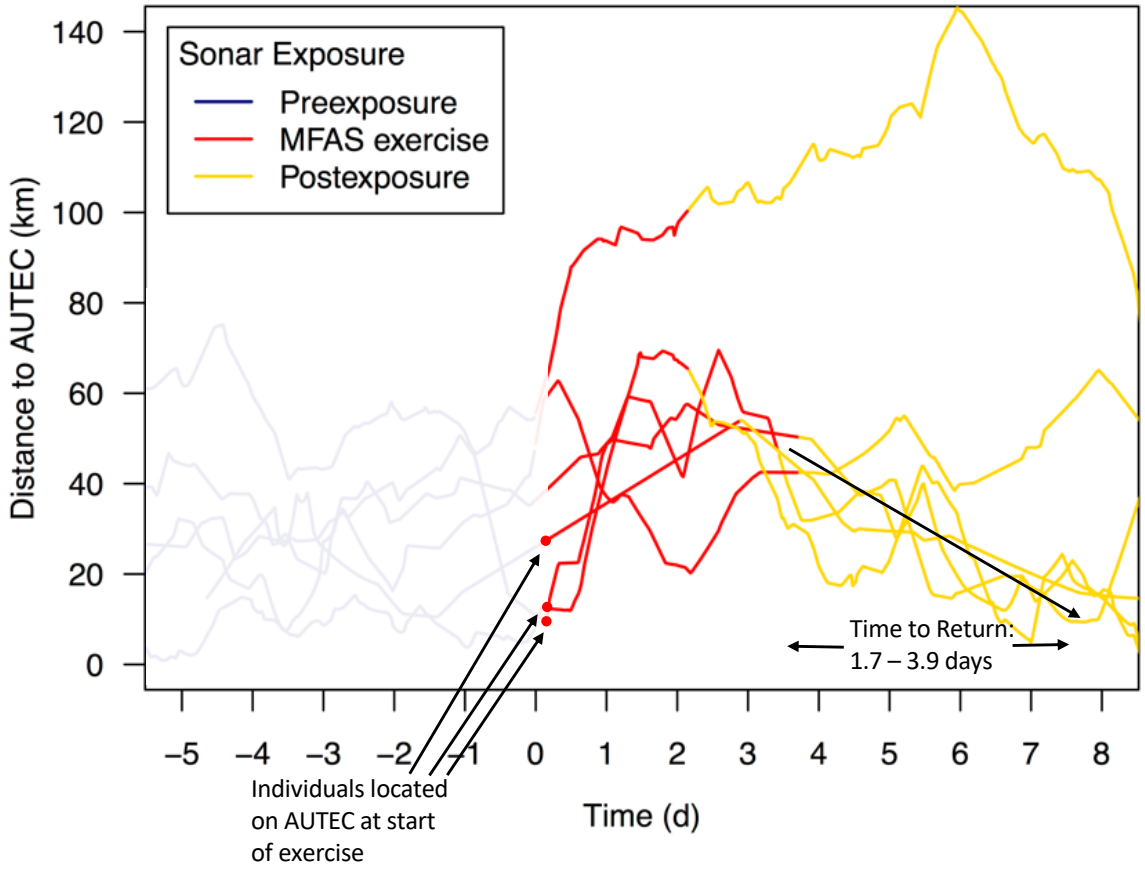
Results: 4) How soon did displaced animals return?



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Conclusions

Observed behavioral patterns were consistent with previous responses

Information added by satellite tags:

- Confirmation of displacement response
- Displacements extended beyond geographic area covered by passive acoustic array
- Magnitude of changes in RL
- Continuation of deep foraging dives during exposure
    - Transient reductions during initial flight

Future Directions

- Energetic consequences of displacement and foraging interruption responses
    - Comparison of AUTEC and displacement areas using AUV bioacoustic sampling

Acknowledgments: Many thanks!

Field Collaborators:

- Robert Pitman, Olivia Patterson, Aaron Banks, Marie Guilpin, Kendria Ferguson, Eric Lewallen and Edward Adderley
- Captains and Crews of the *R/V Walton Smith* and *M/V Slumber Venture*

Funders:

- Office of Naval Research
- U.S. Navy's Living Marine Resources Program
- Strategic Environmental Research and Development Program
- National Science Foundation Graduate Research Fellowship Program
- National Research Council Post-doctoral Associateship Program