

# Dive Behavior of Humpback Whales off Northern California and Behavioral Response to Ships



Angela Szesciorka  
SAC Meeting  
August 2015

# Collaboration Efforts

- Moss Landing Marine Laboratories
- Subcontract with Cascadia
- ONR Funded



# Animal Behavior







# Humpback Whales

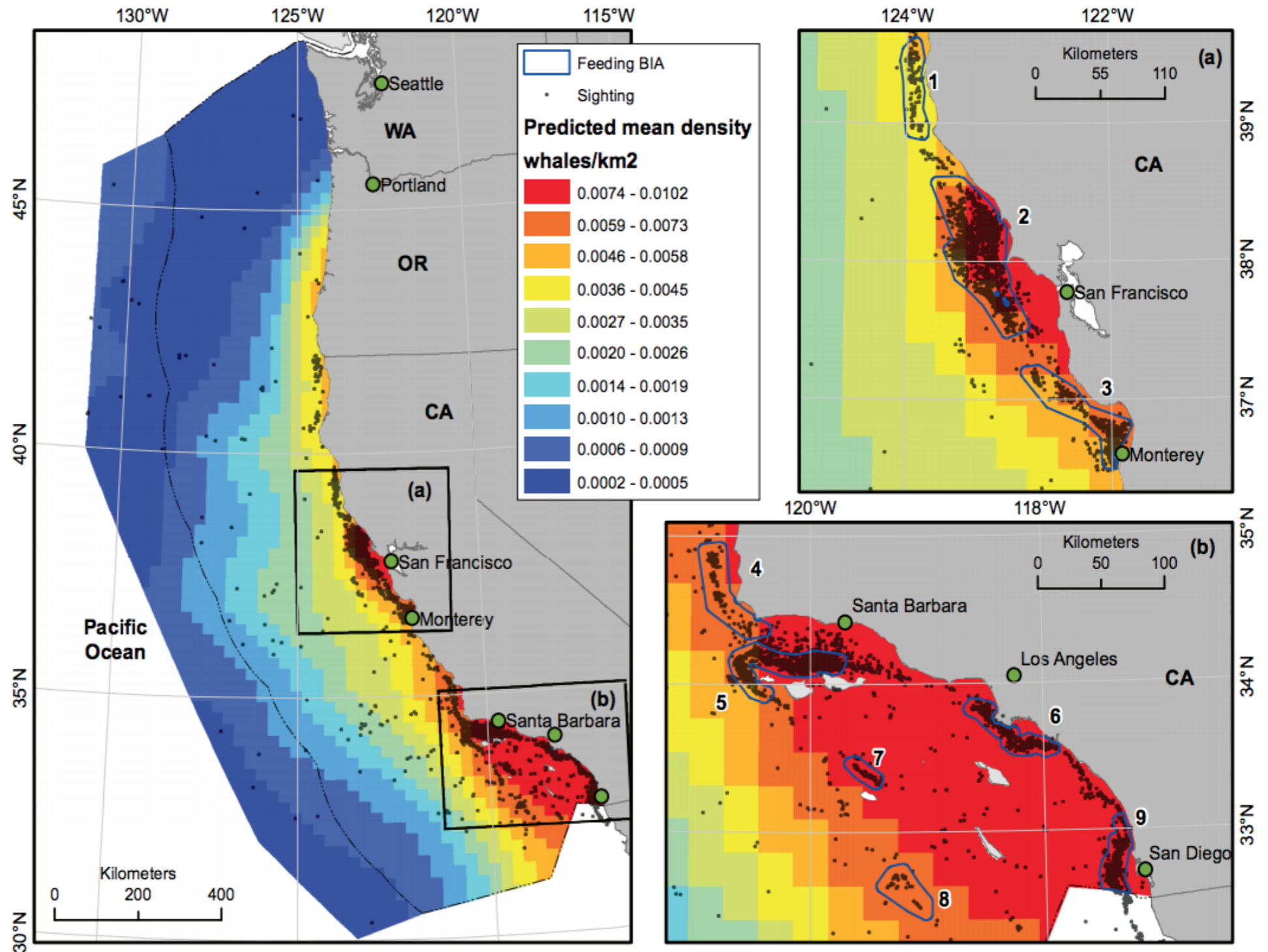
## Eastern North Pacific Stock





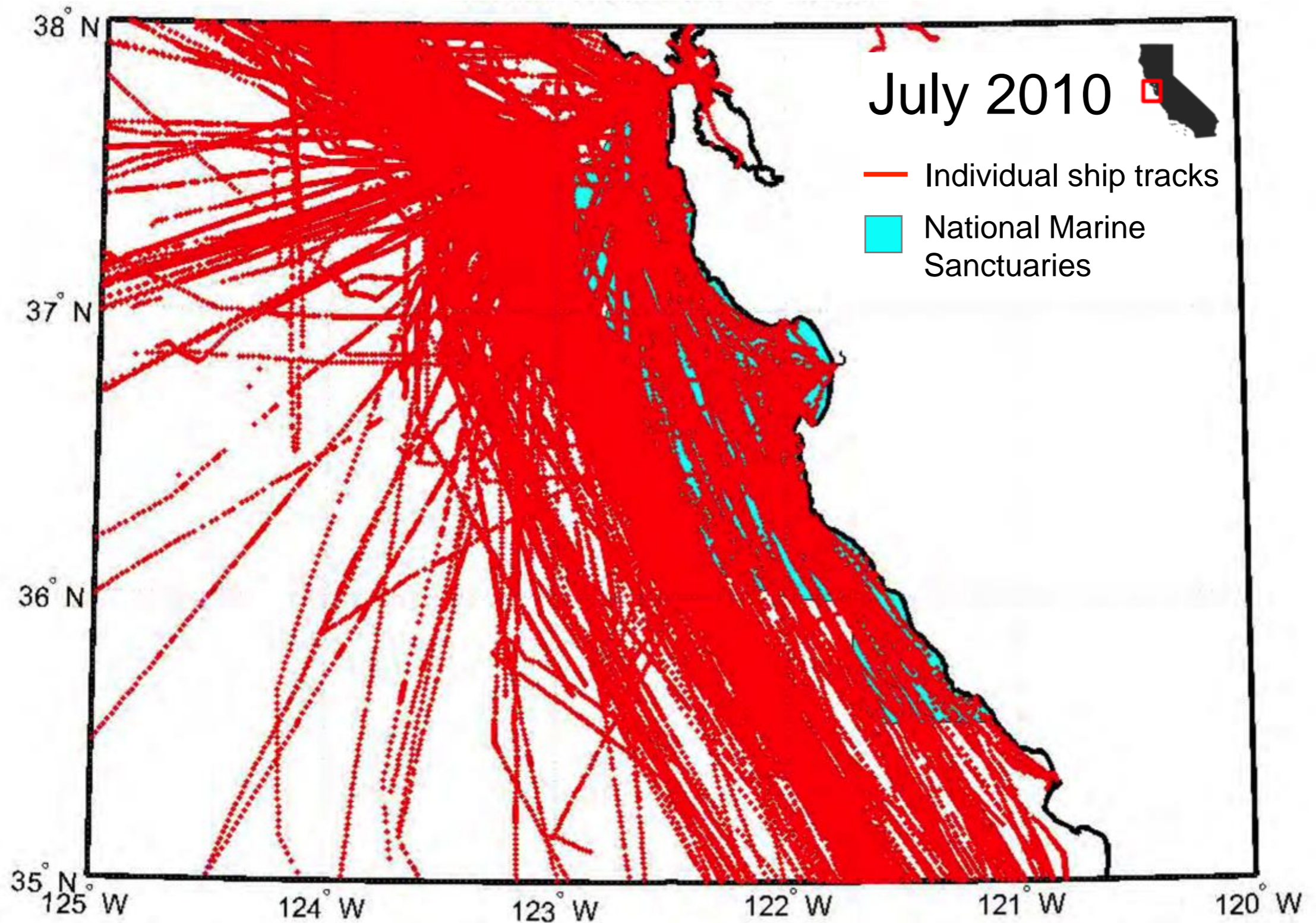
# Humpback Whales

## Eastern North Pacific Stock



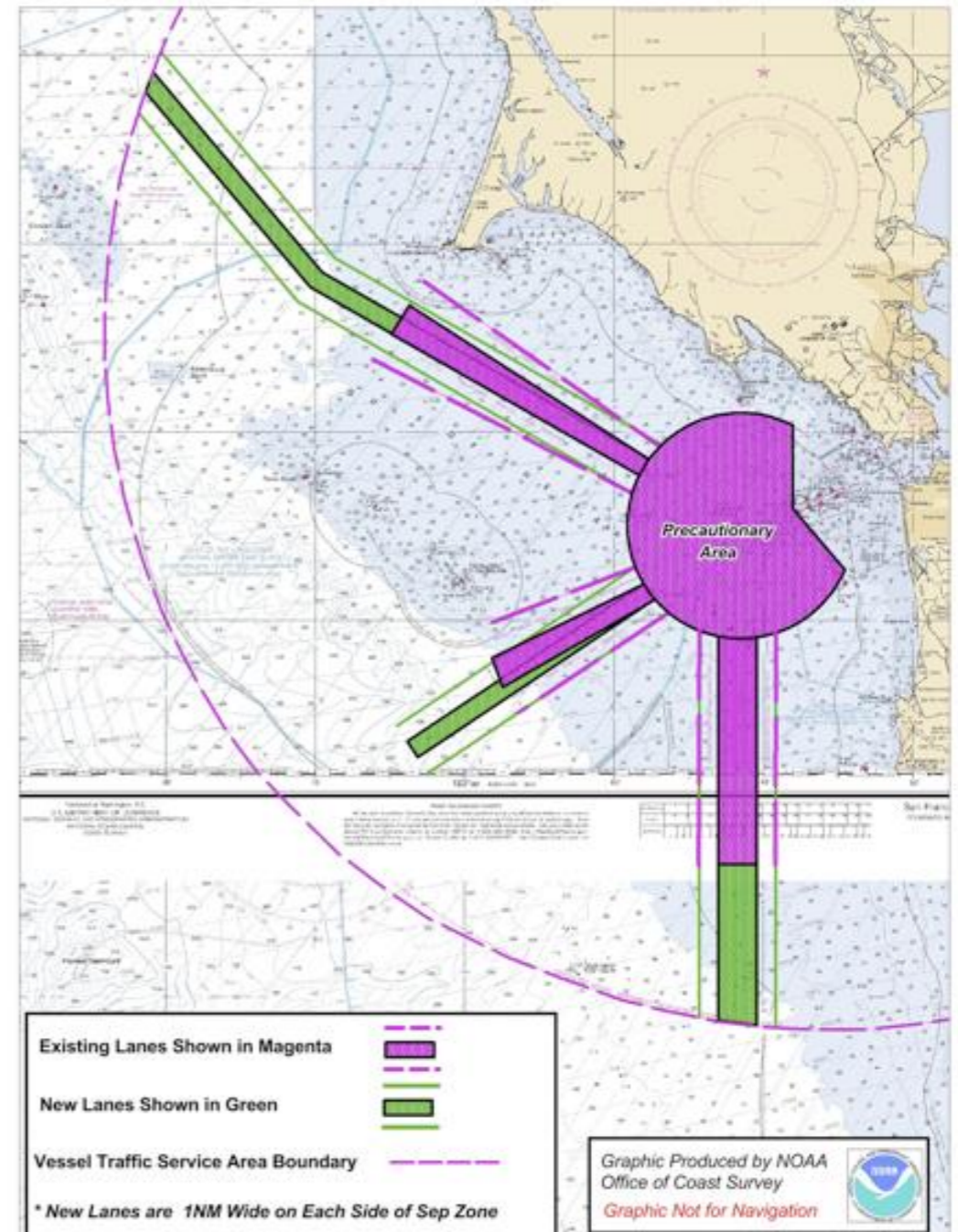
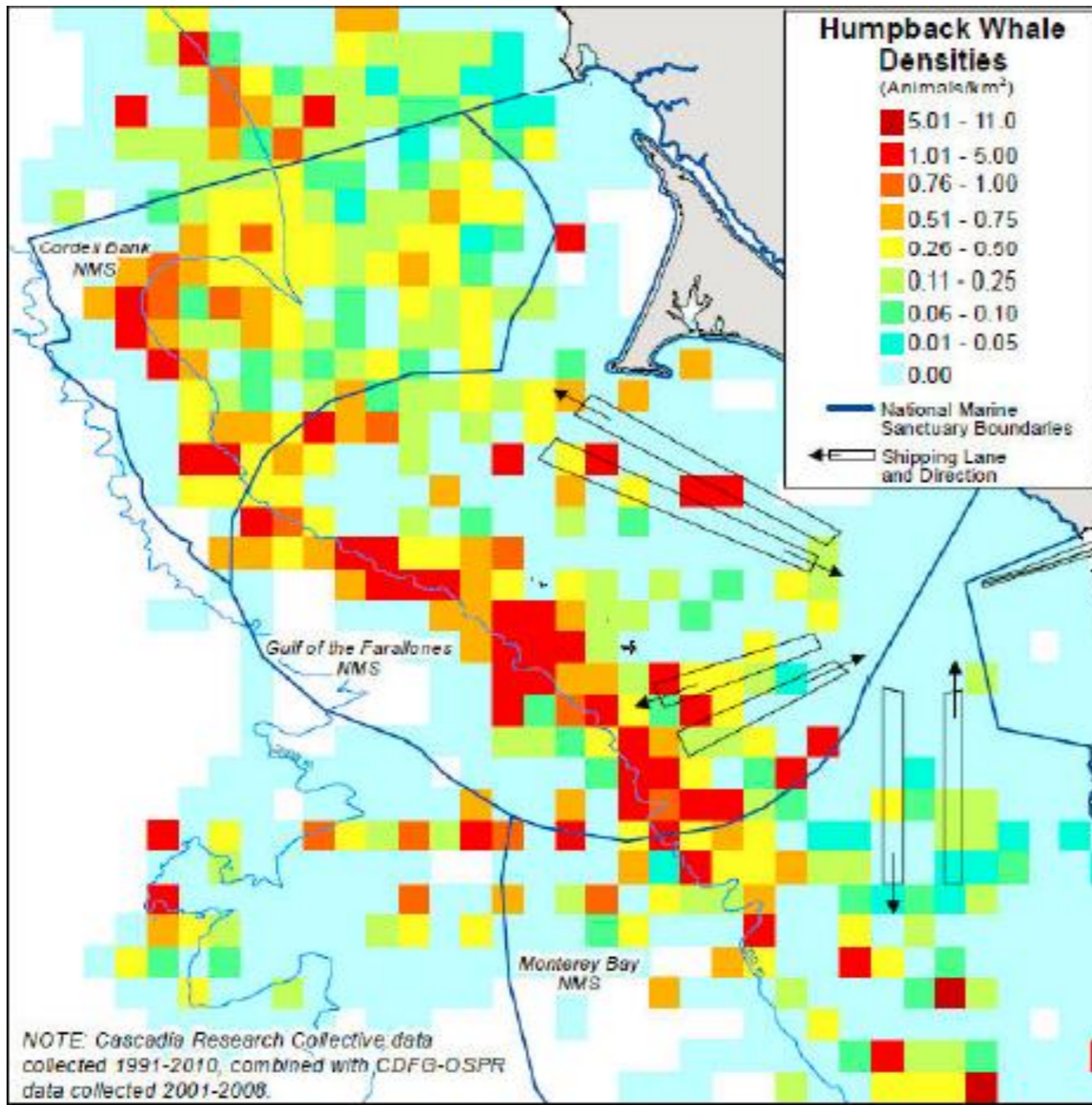


# Ship Traffic





# Ship Strike Risk



Keiper et al. 2011







# Behavioral Response





# Goals

- Examine differences between nearshore and offshore dive behavior
- Investigate the context of close encounters with ships and behavior response to encounters



# Tagging



Alex Olson/Cascadia Research



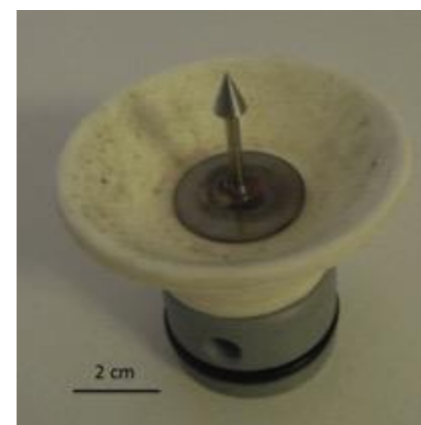
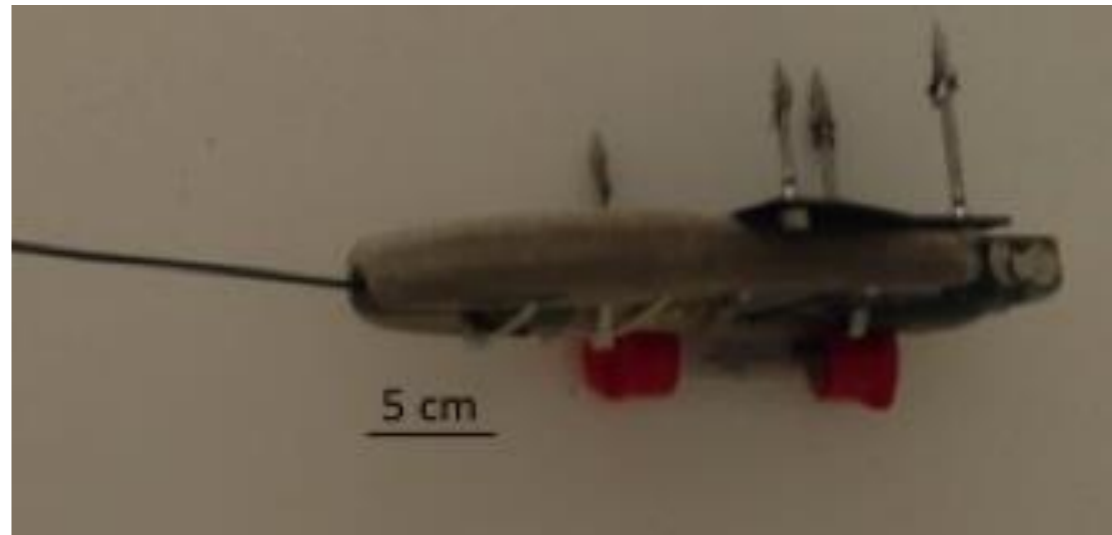
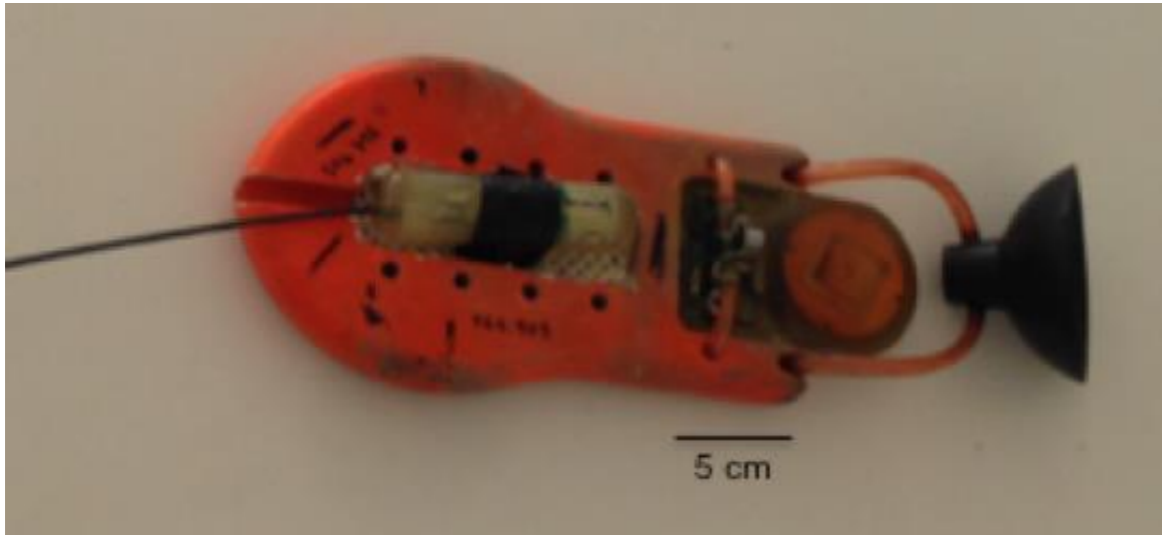
Angela Szesciorka, Cascadia Research



John Calambokidis, Cascadia Research



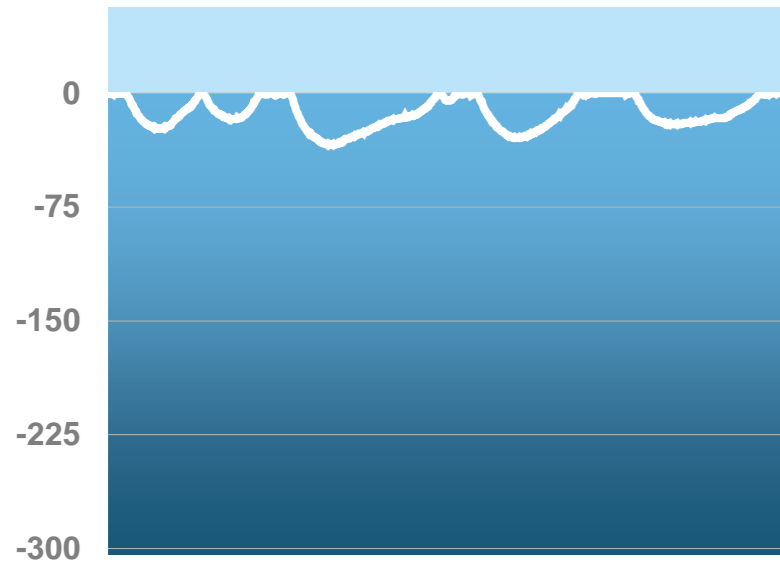
# Tag Design



All photos: Angela Szesciorka, Cascadia Research

# Dive Classification

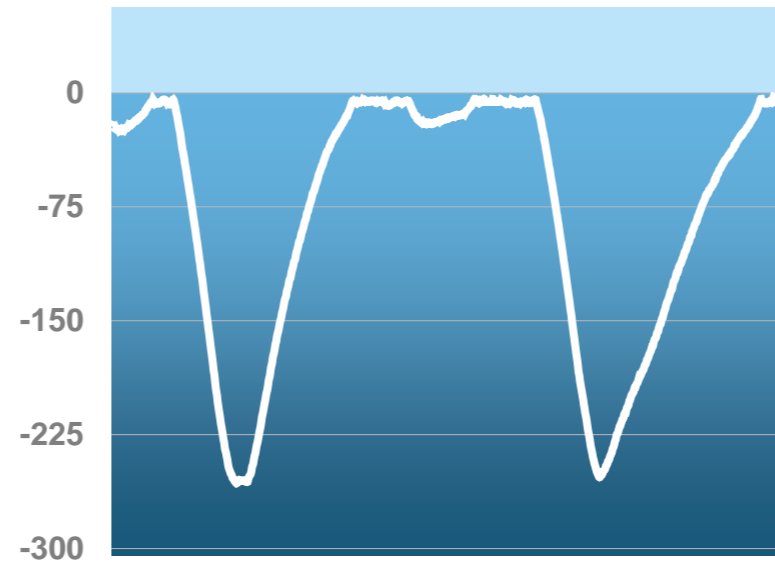
## Surface dive



Time (s)

10-50 m

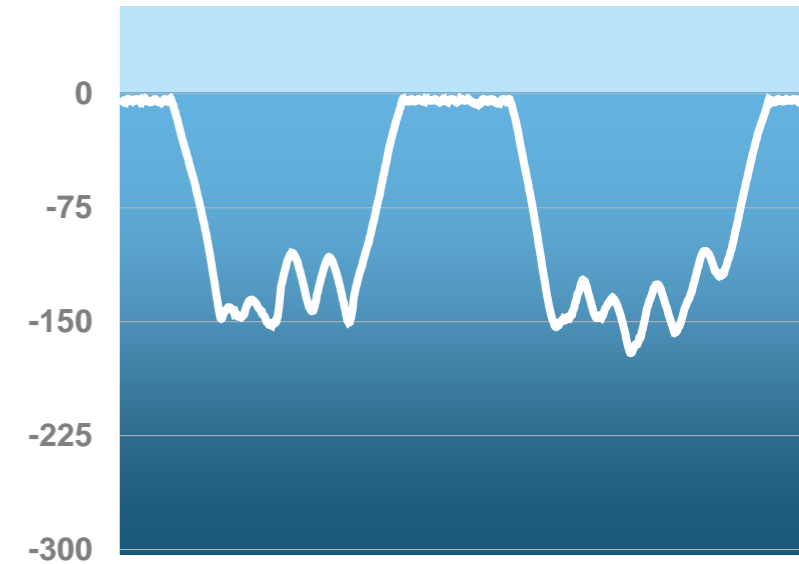
## Exploratory dive



Time (s)

> 50 m  
no foraging

## Foraging dive

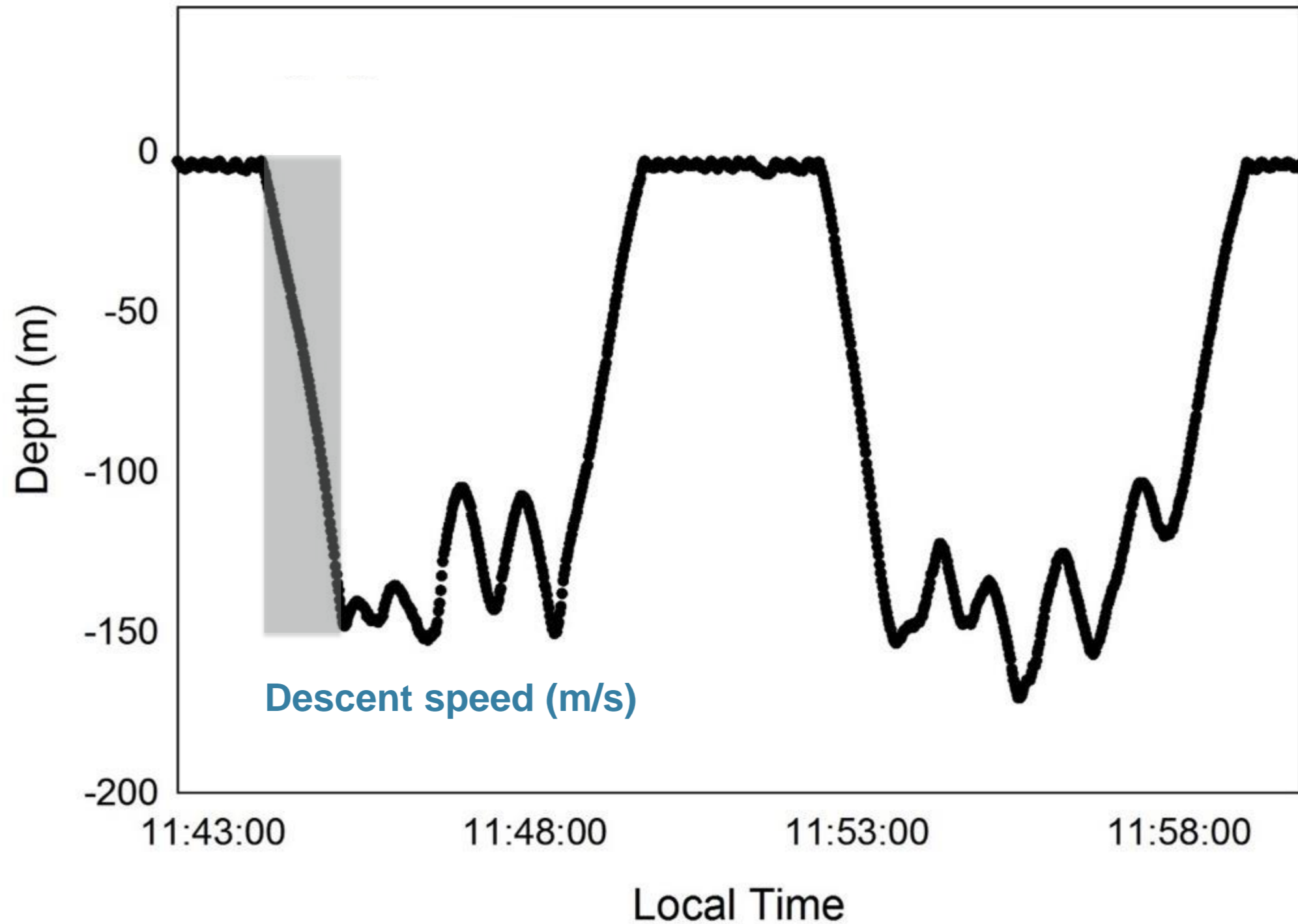


Time (s)

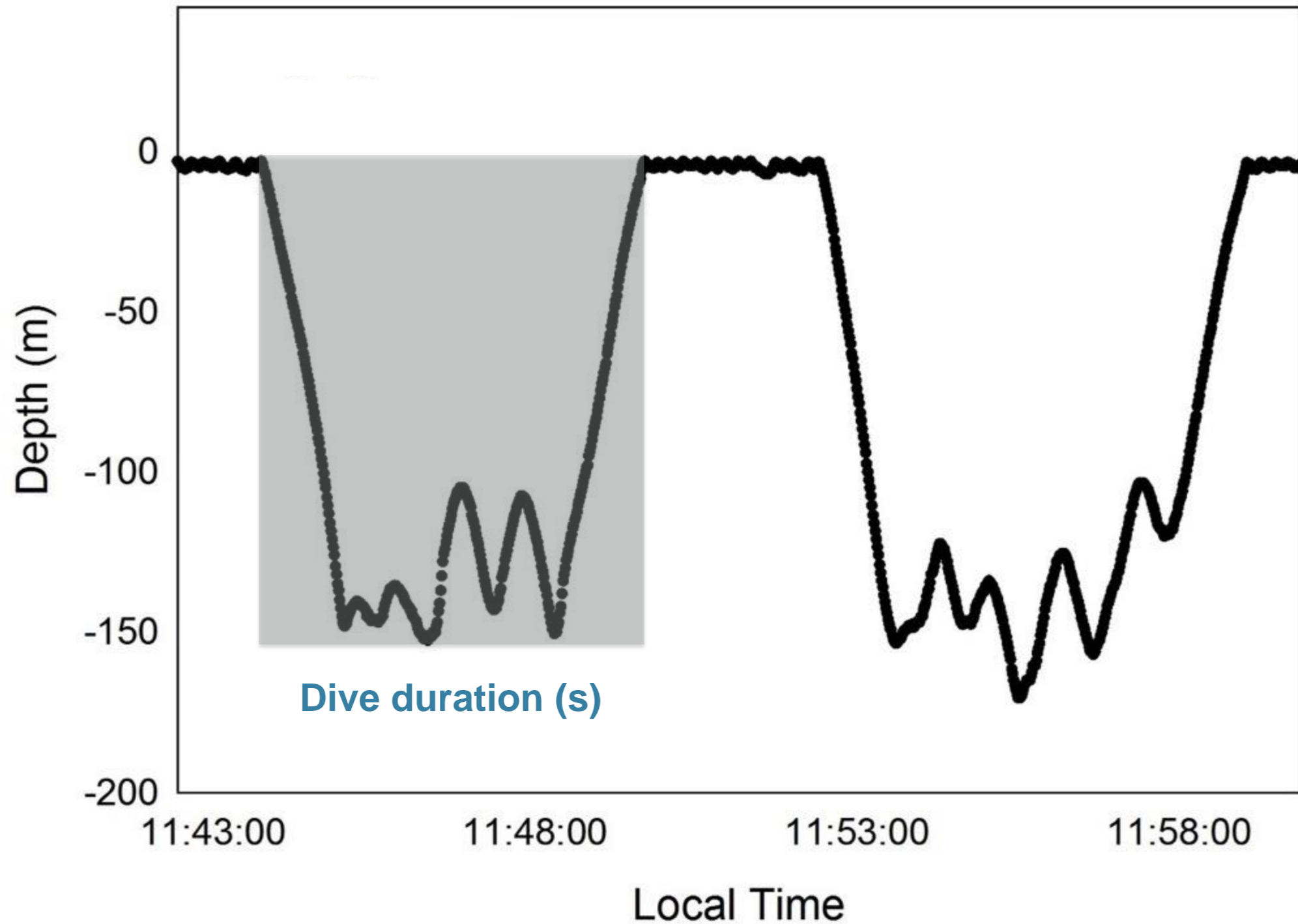
> 50 m  
forage lunges



# Dive Parameterization

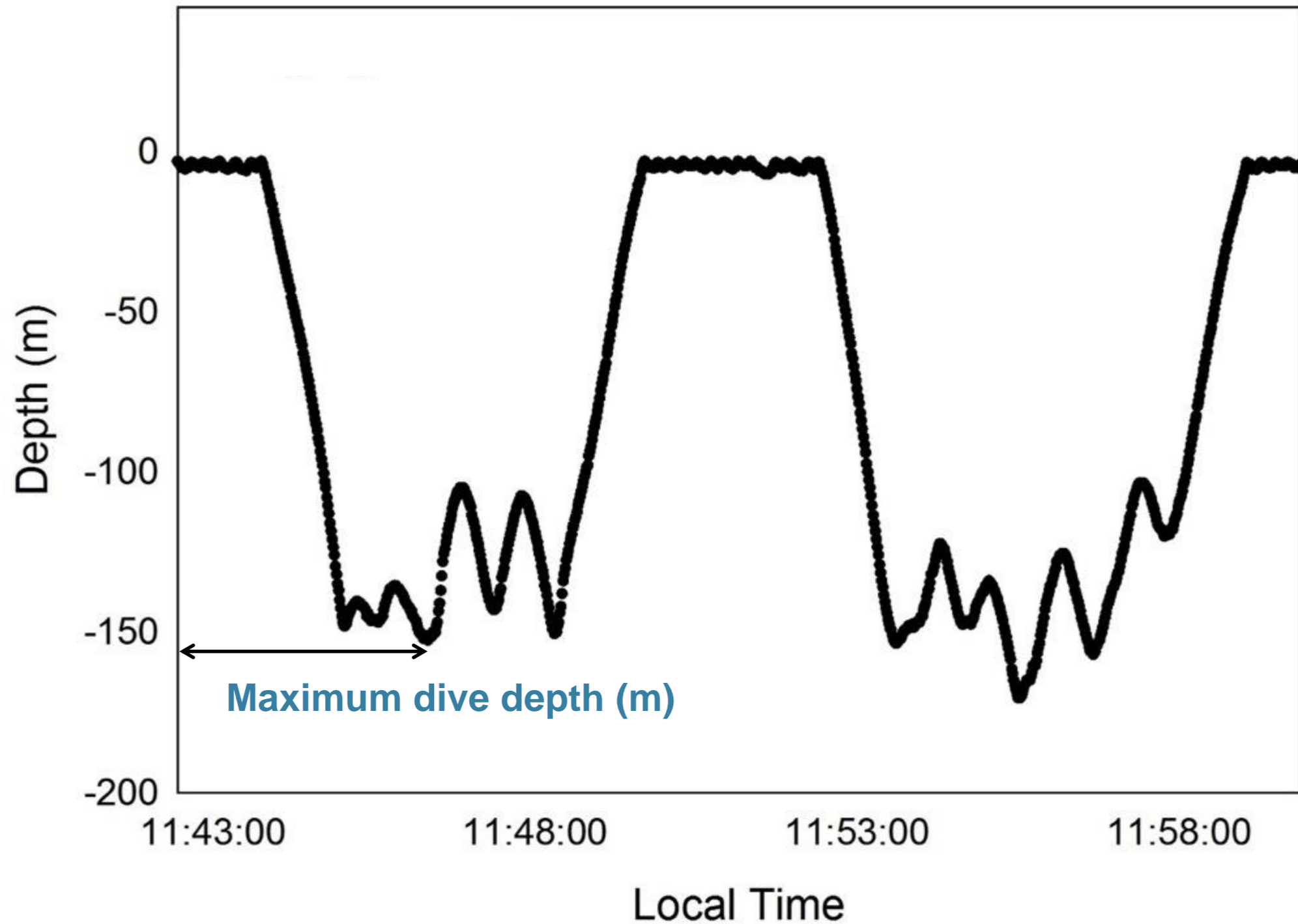


# Dive Parameterization

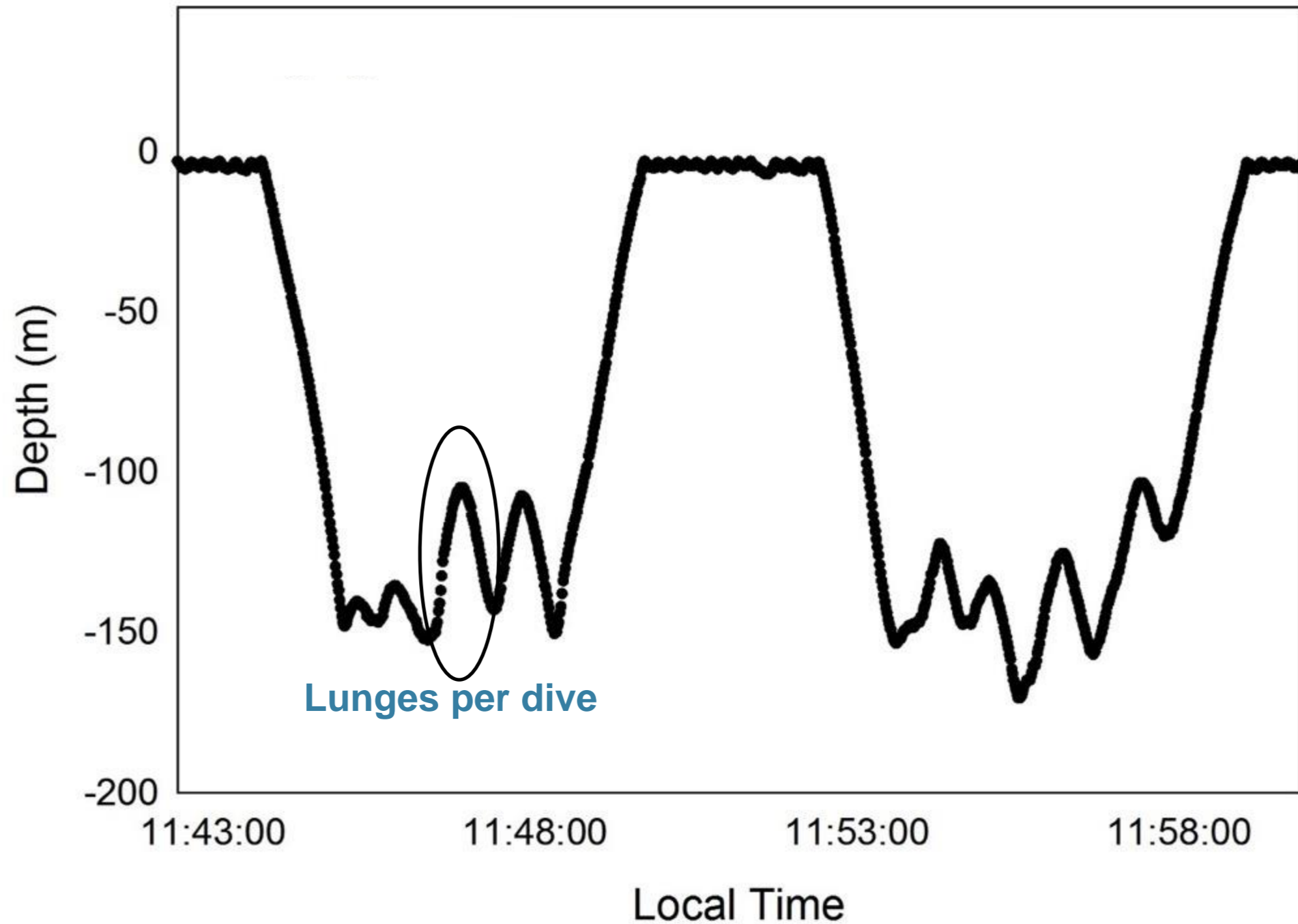




# Dive Parameterization

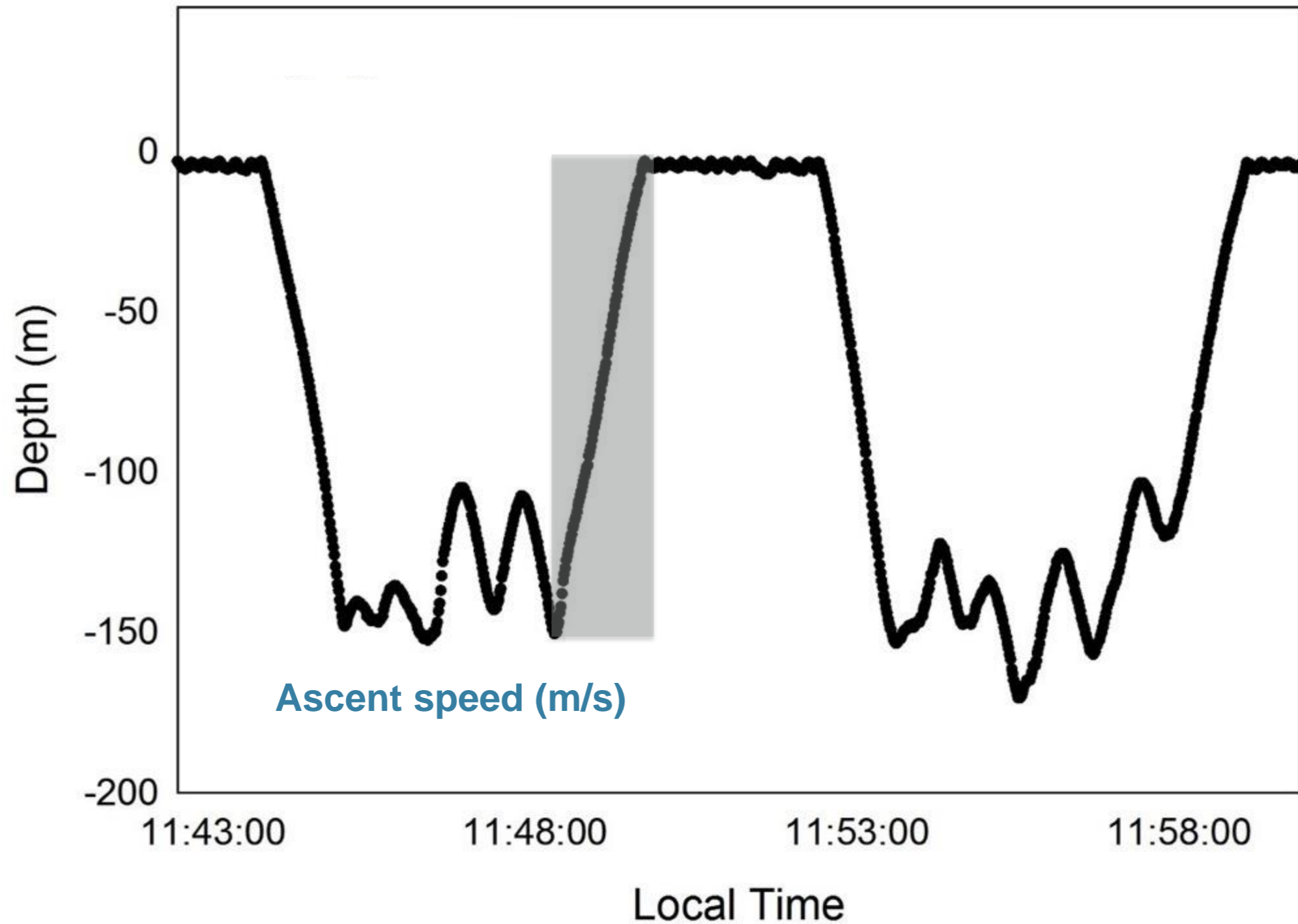


# Dive Parameterization

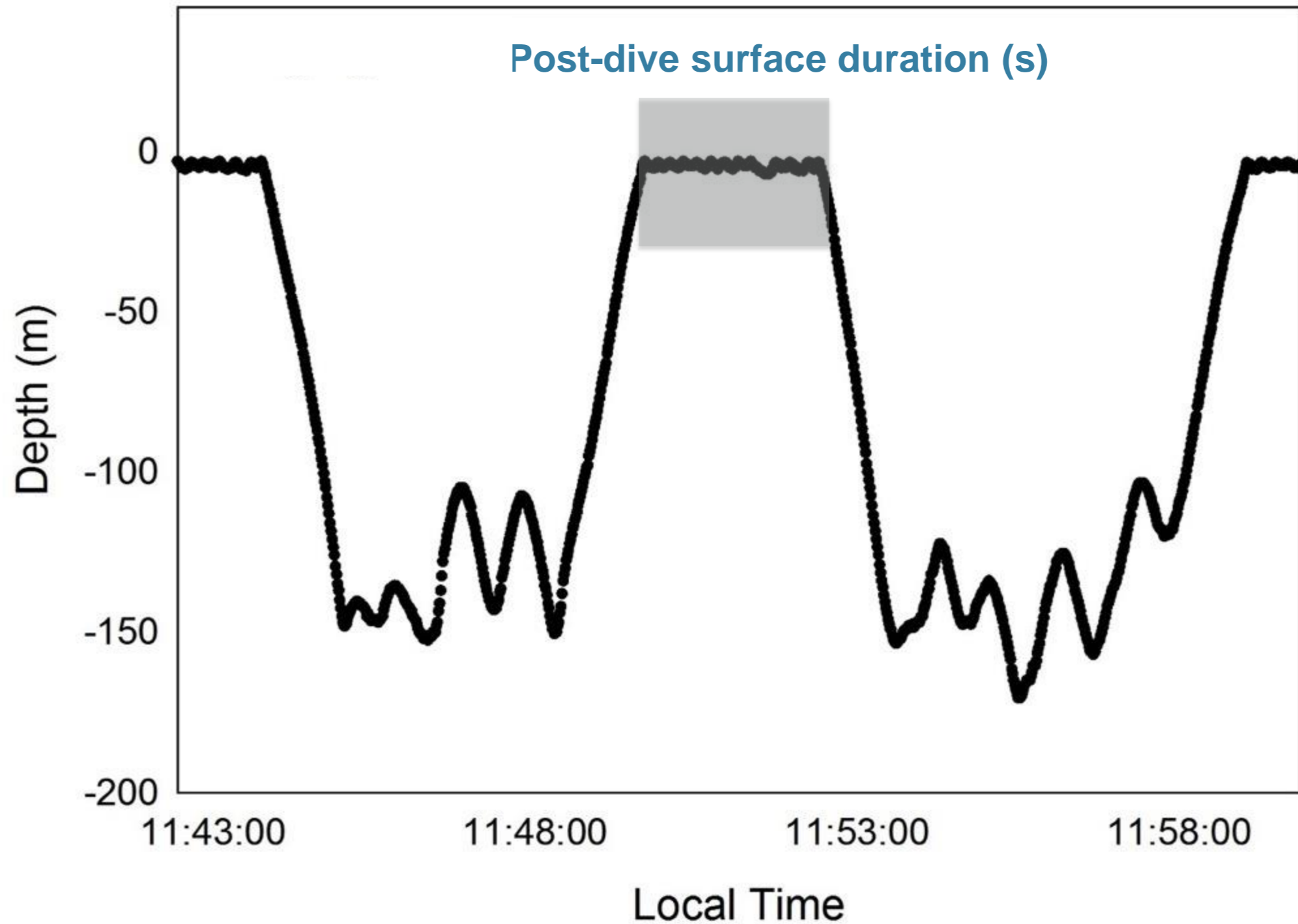




# Dive Parameterization

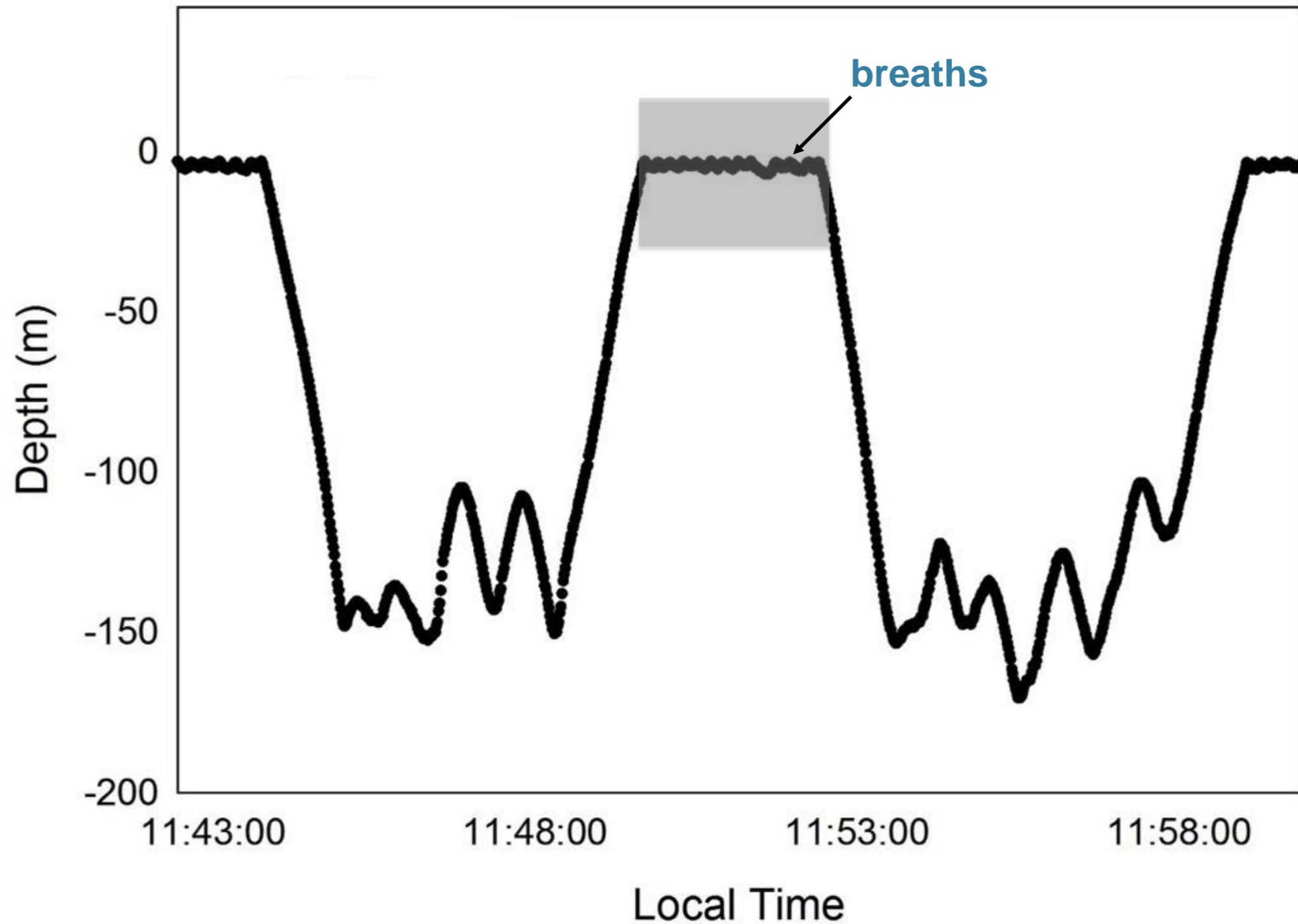


# Dive Parameterization

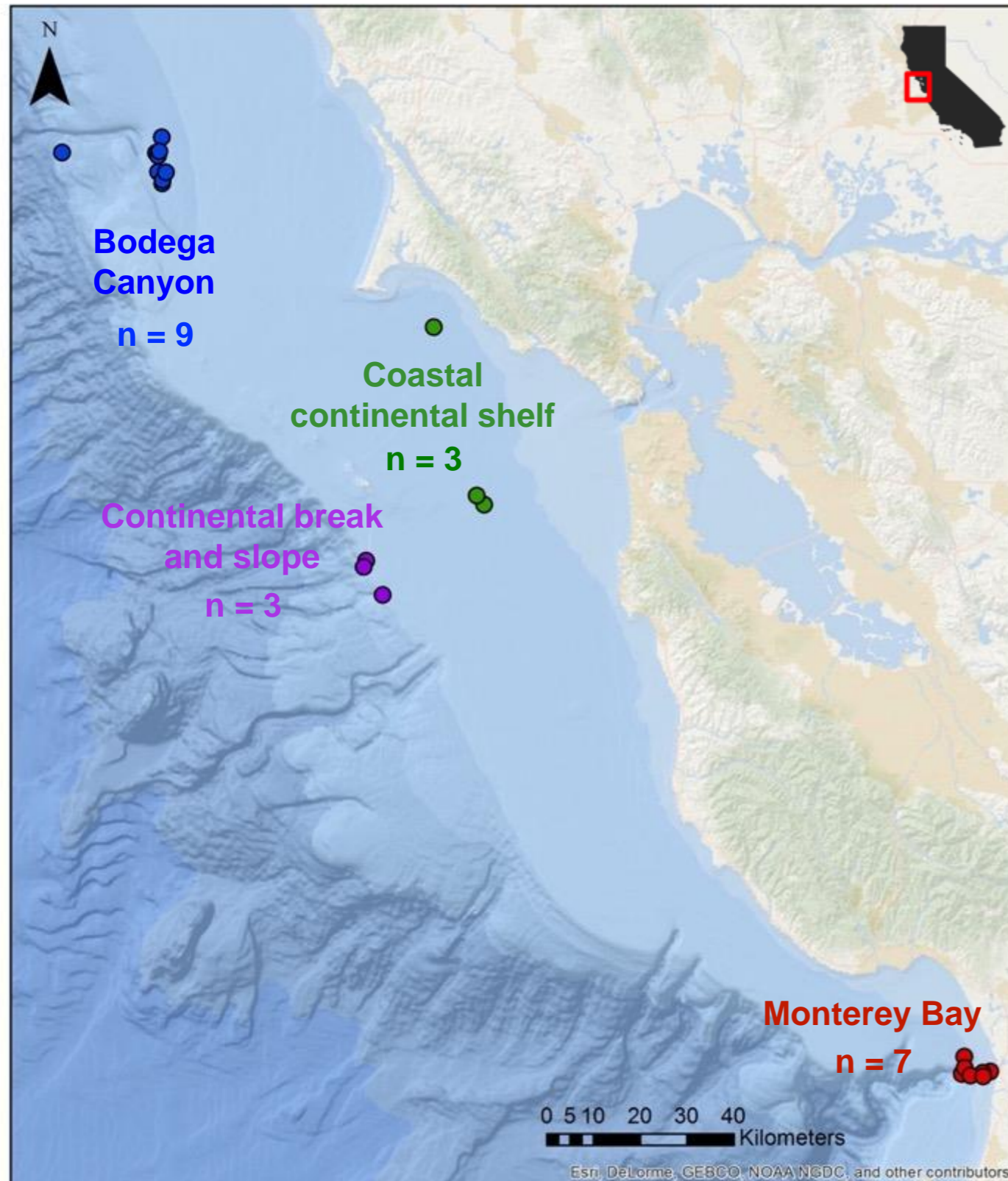




# Dive Parameterization



# Tagging Efforts



203 hours dive data

- **142** hours daytime
- **61** hours nighttime

1,900 dives

- **1,278** surface dives
- **141** exploratory dives
- **481** foraging dives

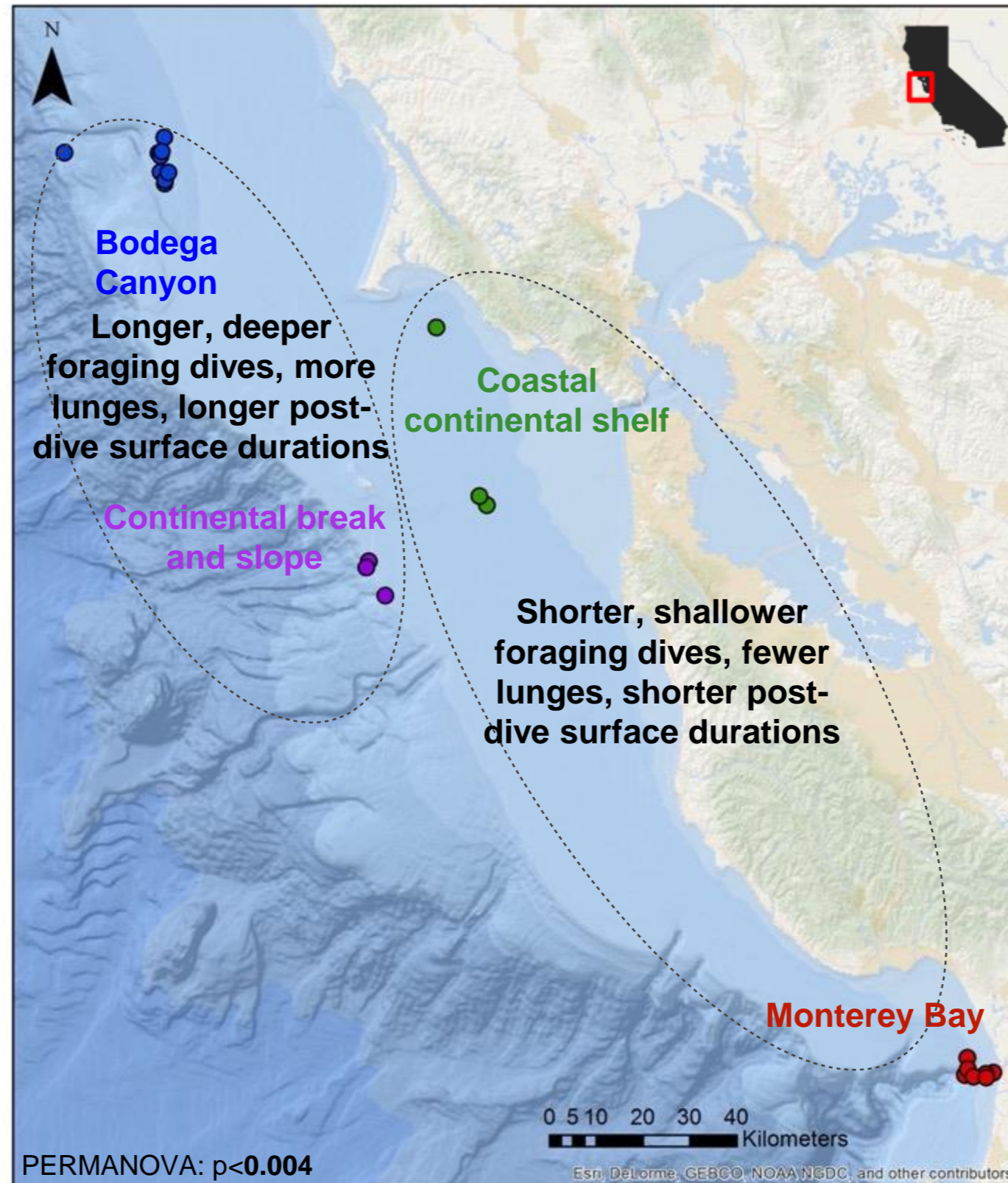
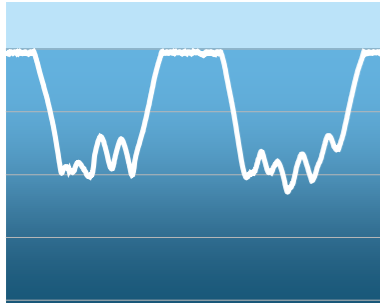




# Regional differences in dive behavior

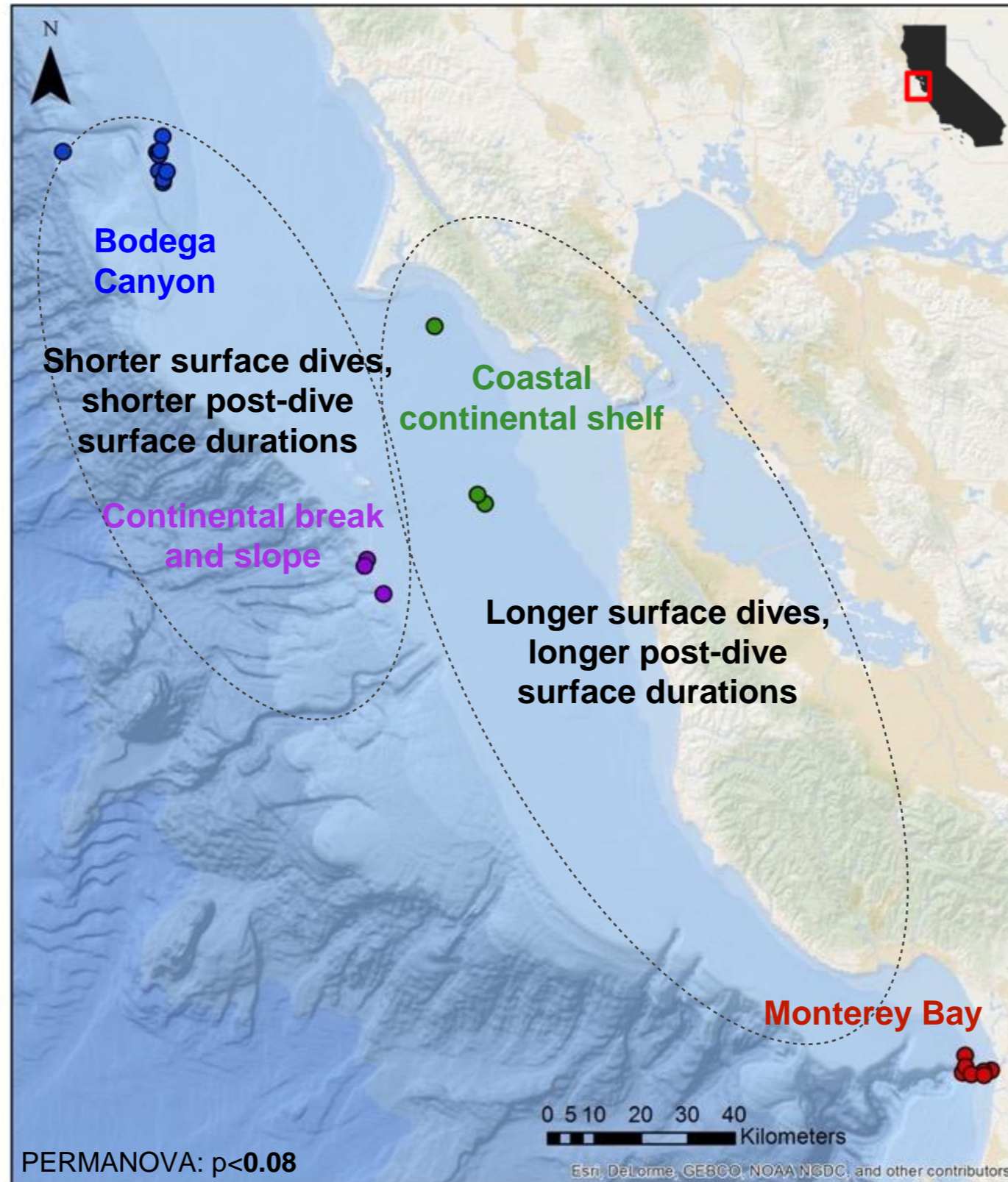
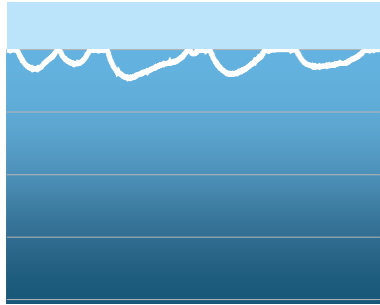
- Regional dive differences
  - Nested PERMANOVA
  - SIMPER analysis
  - Variance partitioning

# Regional Differences: Foraging Dives





# Regional Differences: Surface Dives

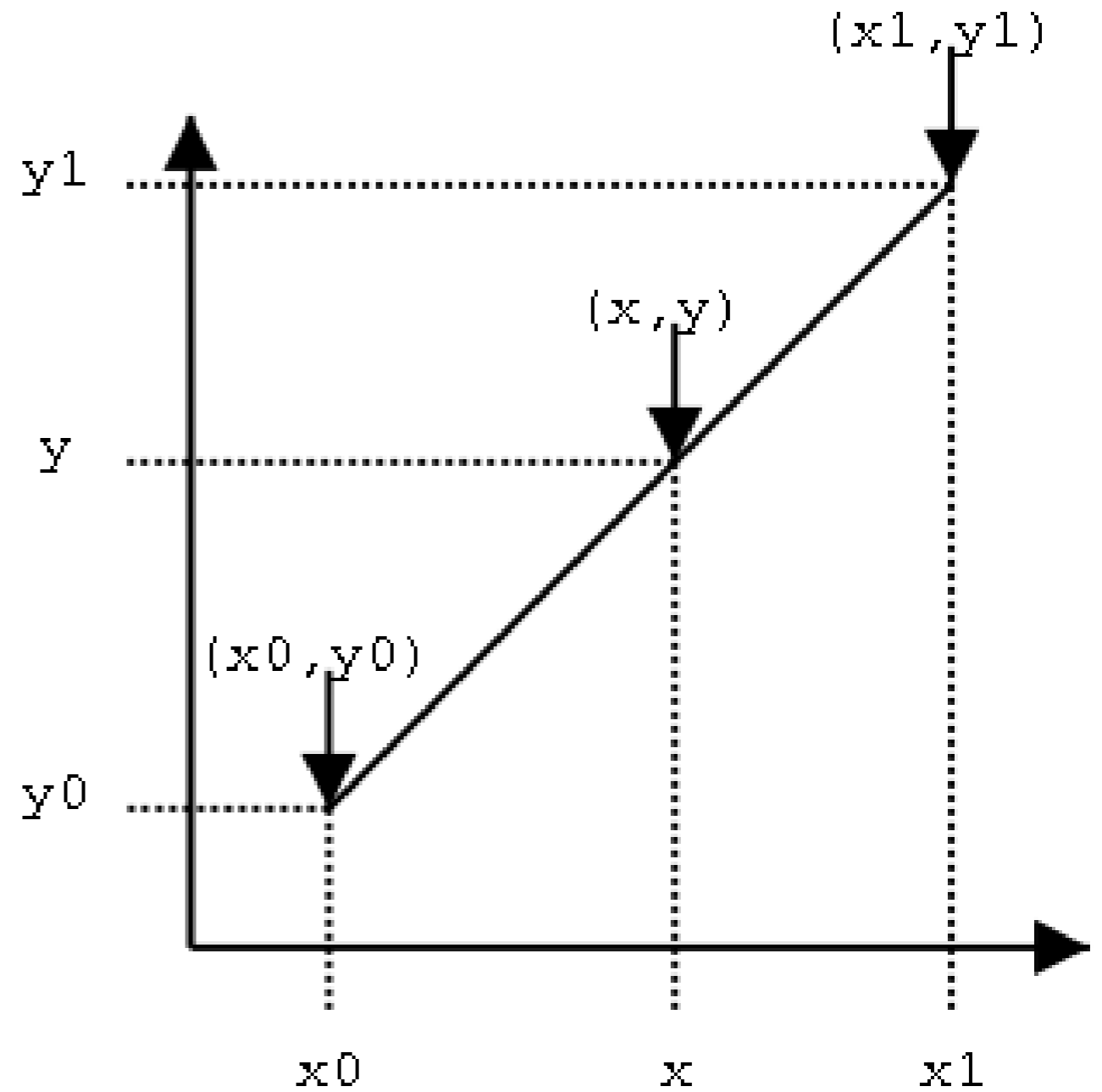


# Behavioral Response to Ships

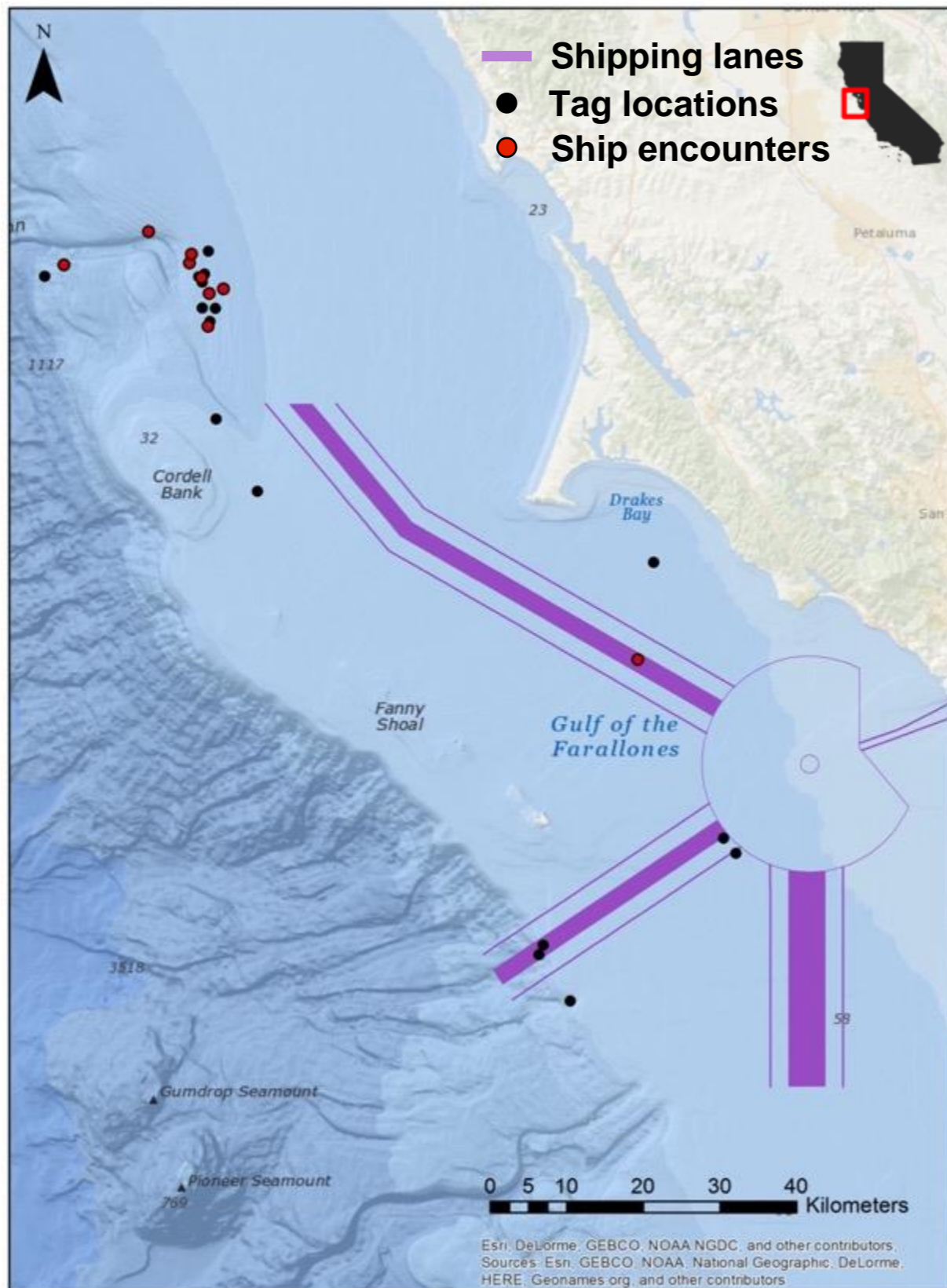




# GPS Interpolation



# Close Encounters



**9** encounters

**7** ships / **6** whales

**6-19** min / **26** m



# Individual Whale Analyses

- Dive behavior versus ship distance
  - Principal component analysis (PCA) scores
- Randomized intervention analysis (RIA)
  - Before versus after encounter



# Case Study: 20130902-2 and Hanjin Argentina

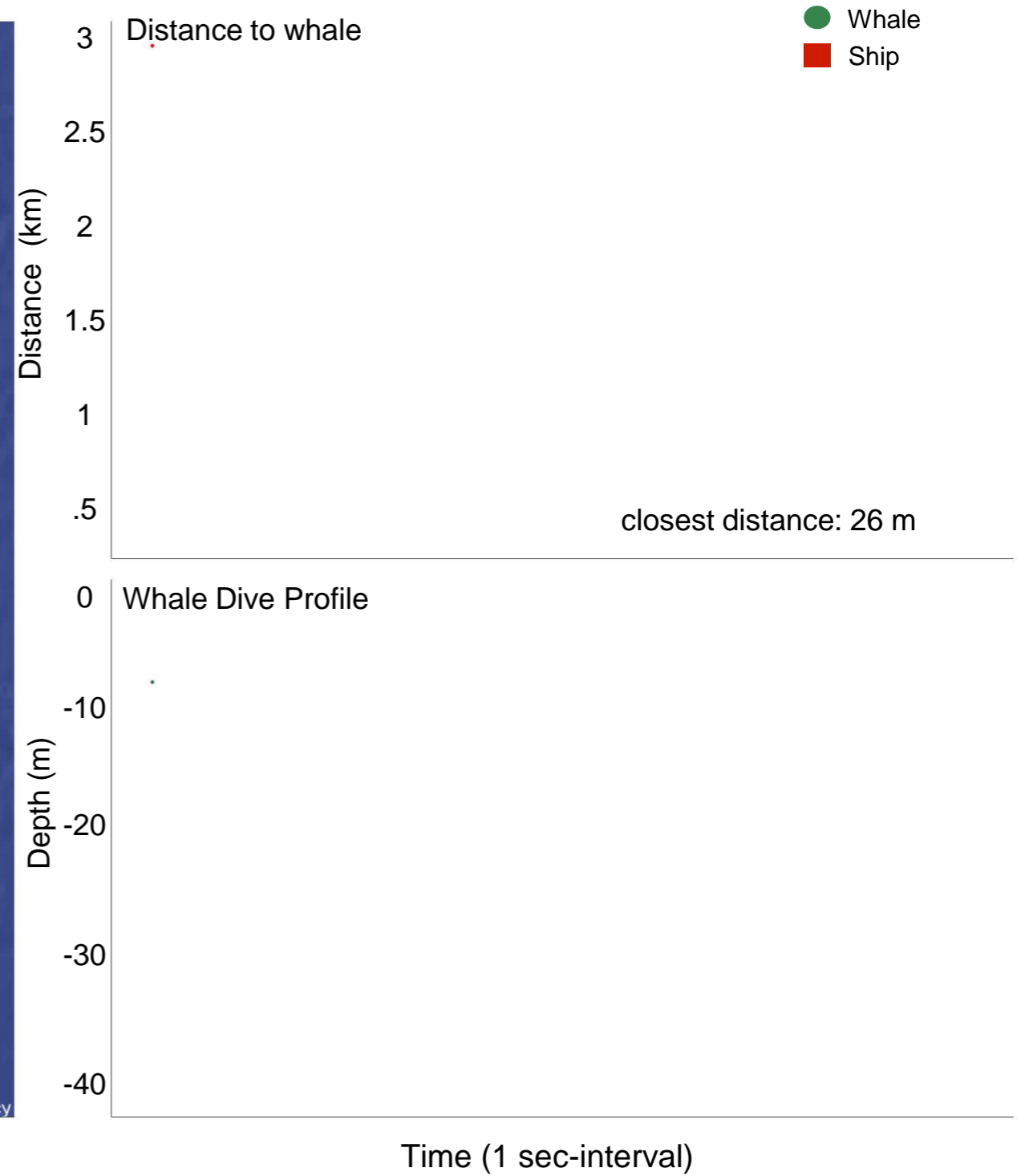
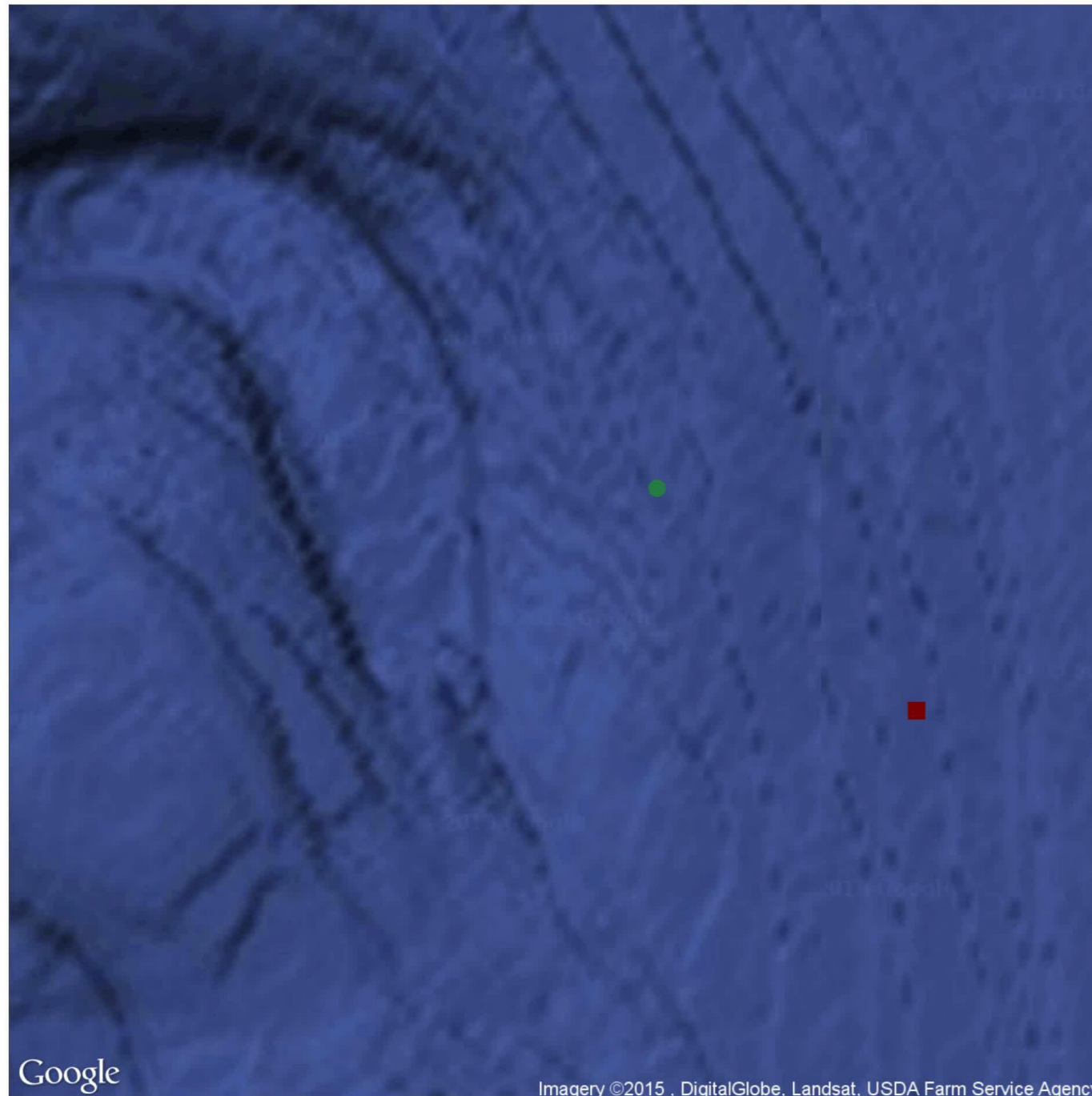


**26 m encounter**  
**13 minutes**





# Case Study: 20130902-2 and Hanjin Argentina



# Case Study: 20130902-3 and SS Maui



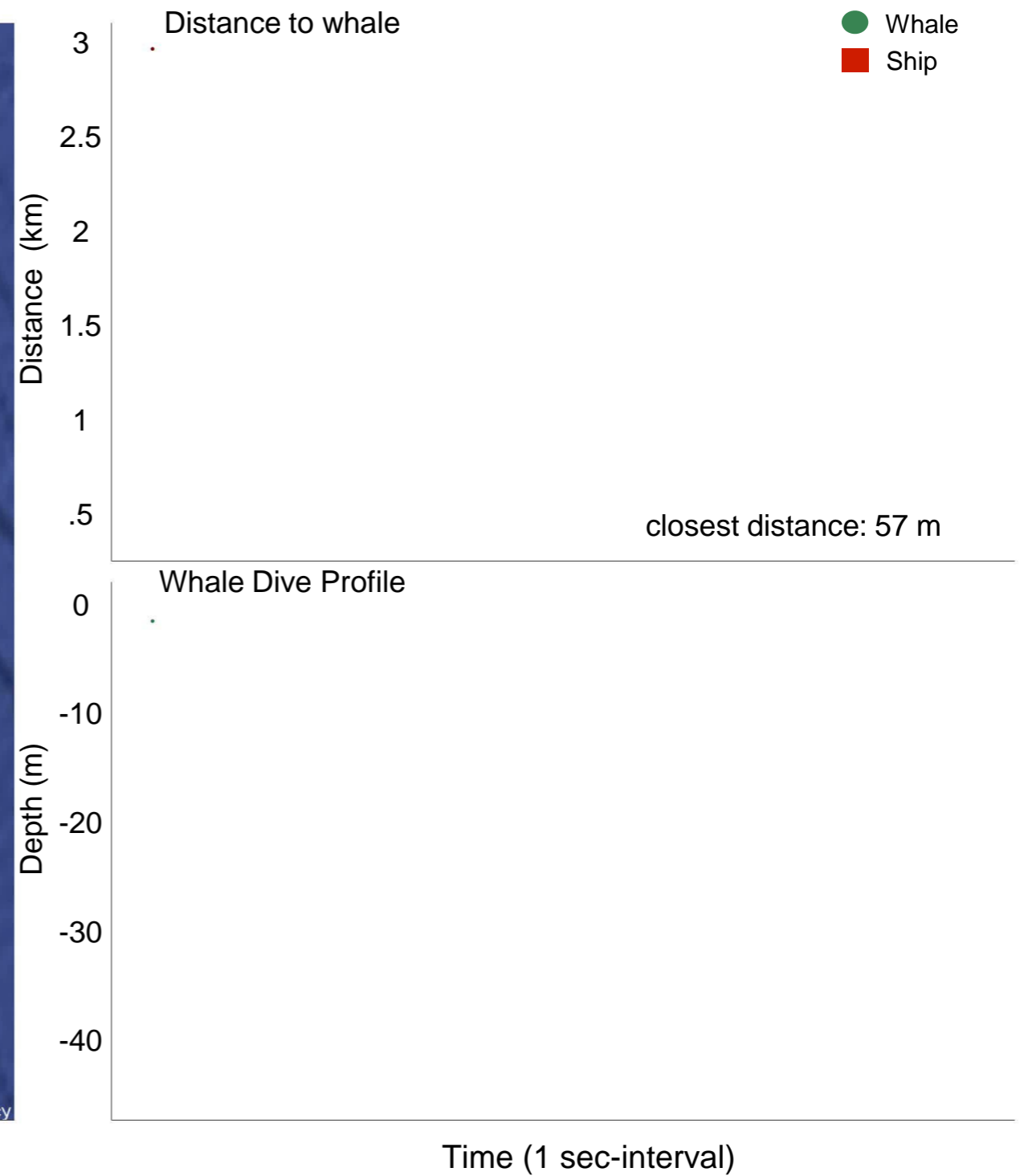
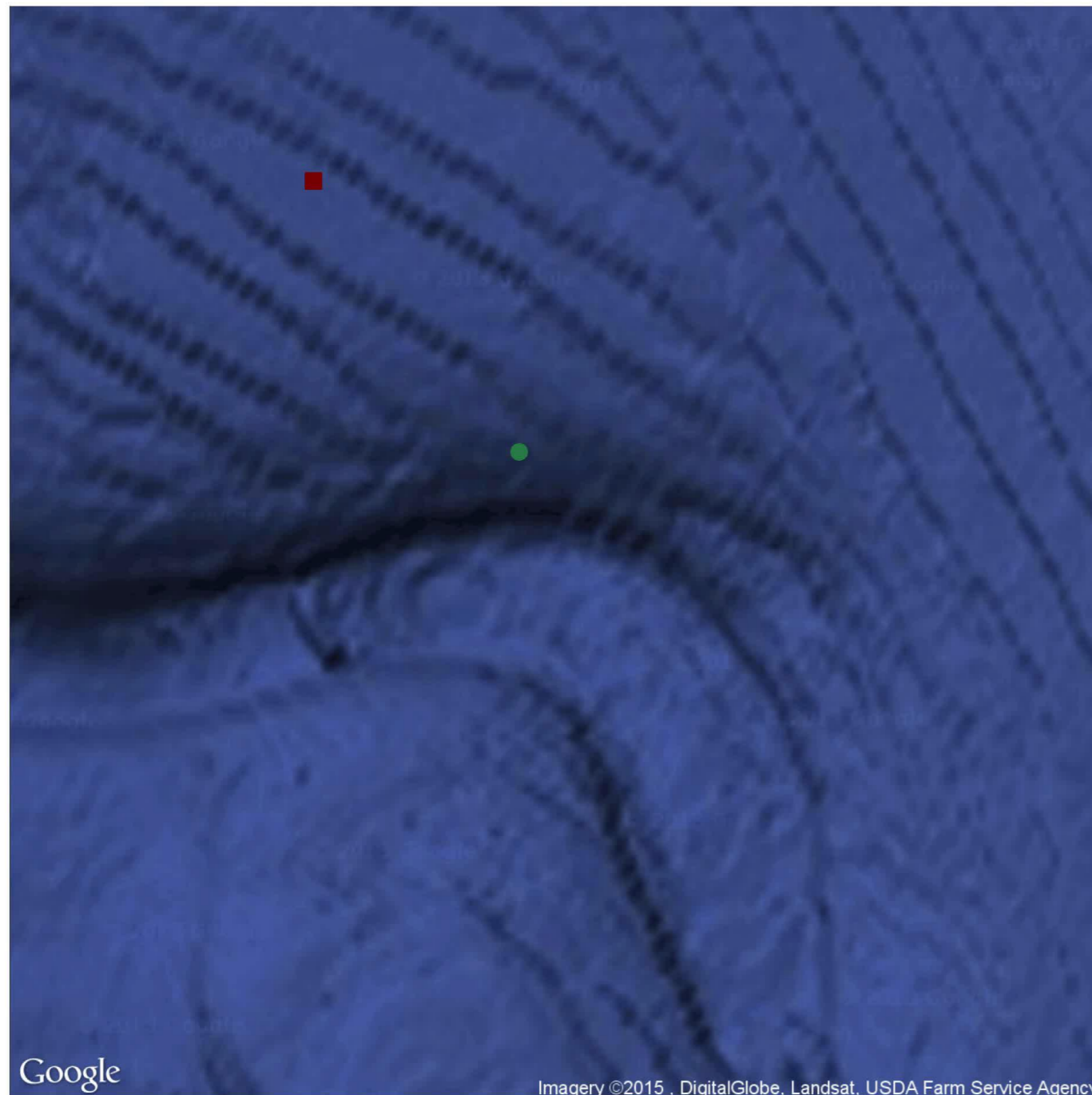
Injured

**157** m encounter  
**17** minutes





# Case Study: 20130902-3 and SS Maui



# Behavioral Response

After encounters:

↑ Descent speed

↓ Ascent speed

↑ Respiration

Indicative of:

- **Evasive action**
- **Increased stress**





# Behavioral Response

- Context-dependent
- Response detection
- Natural variability



Behavioral response detection < 700 m

# Encounters

- 6 out of 15 whales (40%)
- 9 encounters in 3.5 days
- 5 out of 9 encounters (56%)
  - One juvenile whale (n=2)
  - One injured whale (n=3)

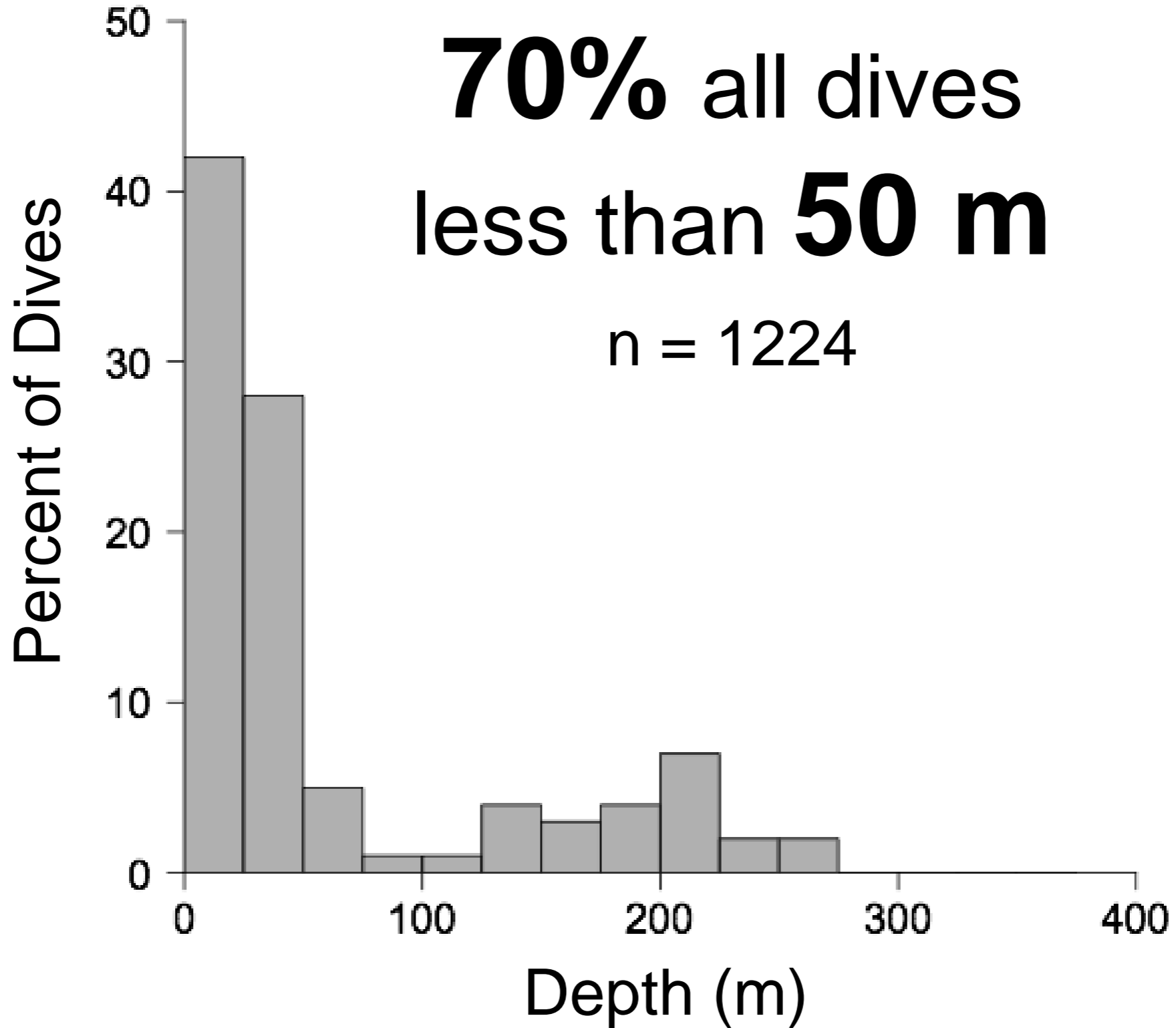




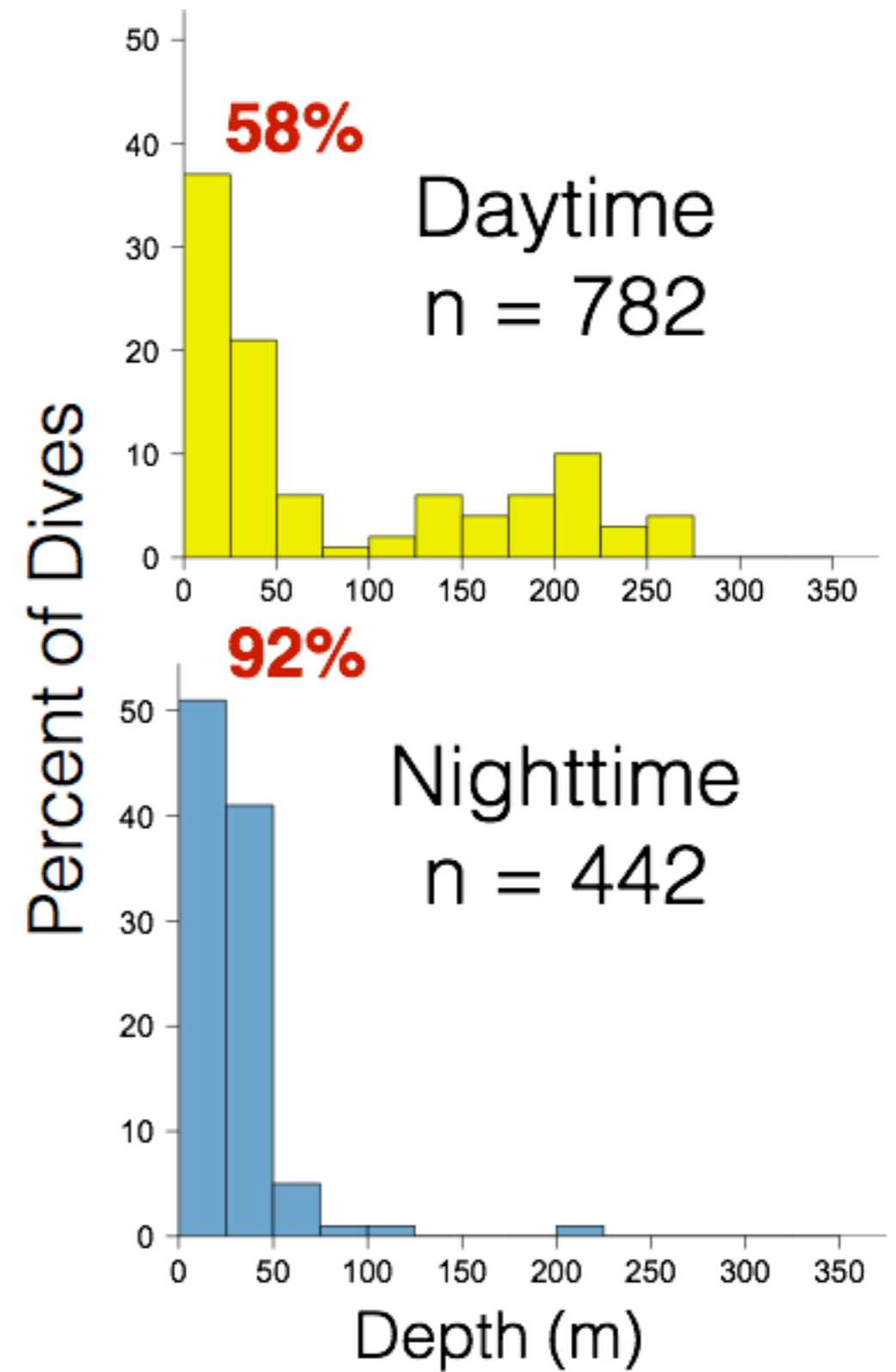
# Risk Factors

**70%** all dives  
less than **50 m**

n = 1224

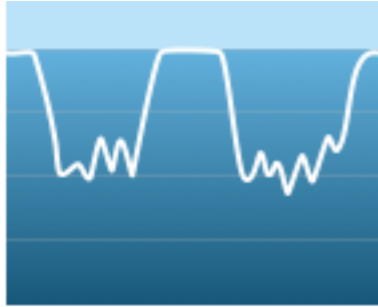


# Diel Habitat Use





# Prey Distribution



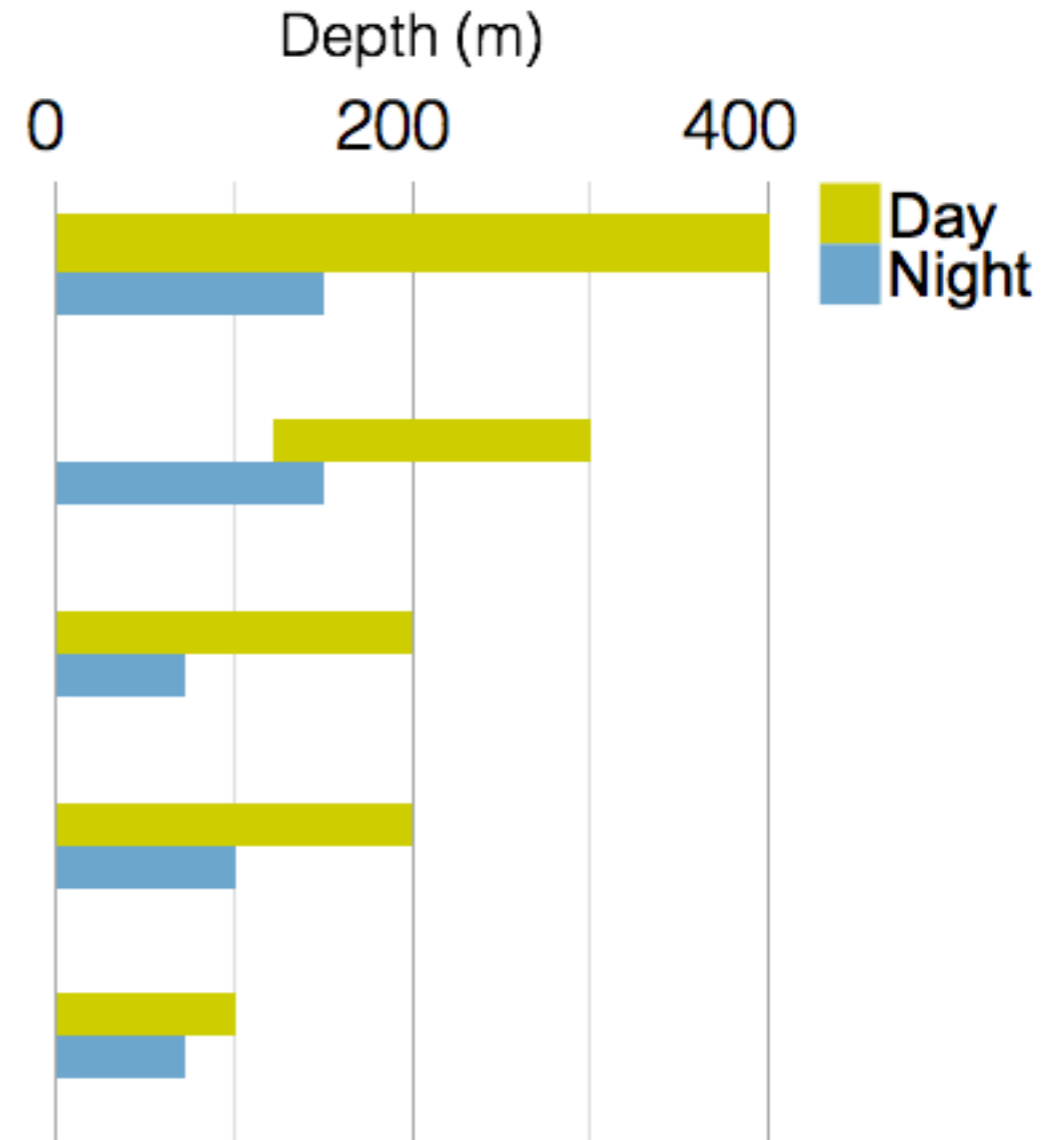
Euphausiid (*Euphausia pacifica*)

Euphausiid (*Thysanoessa spinifera*)

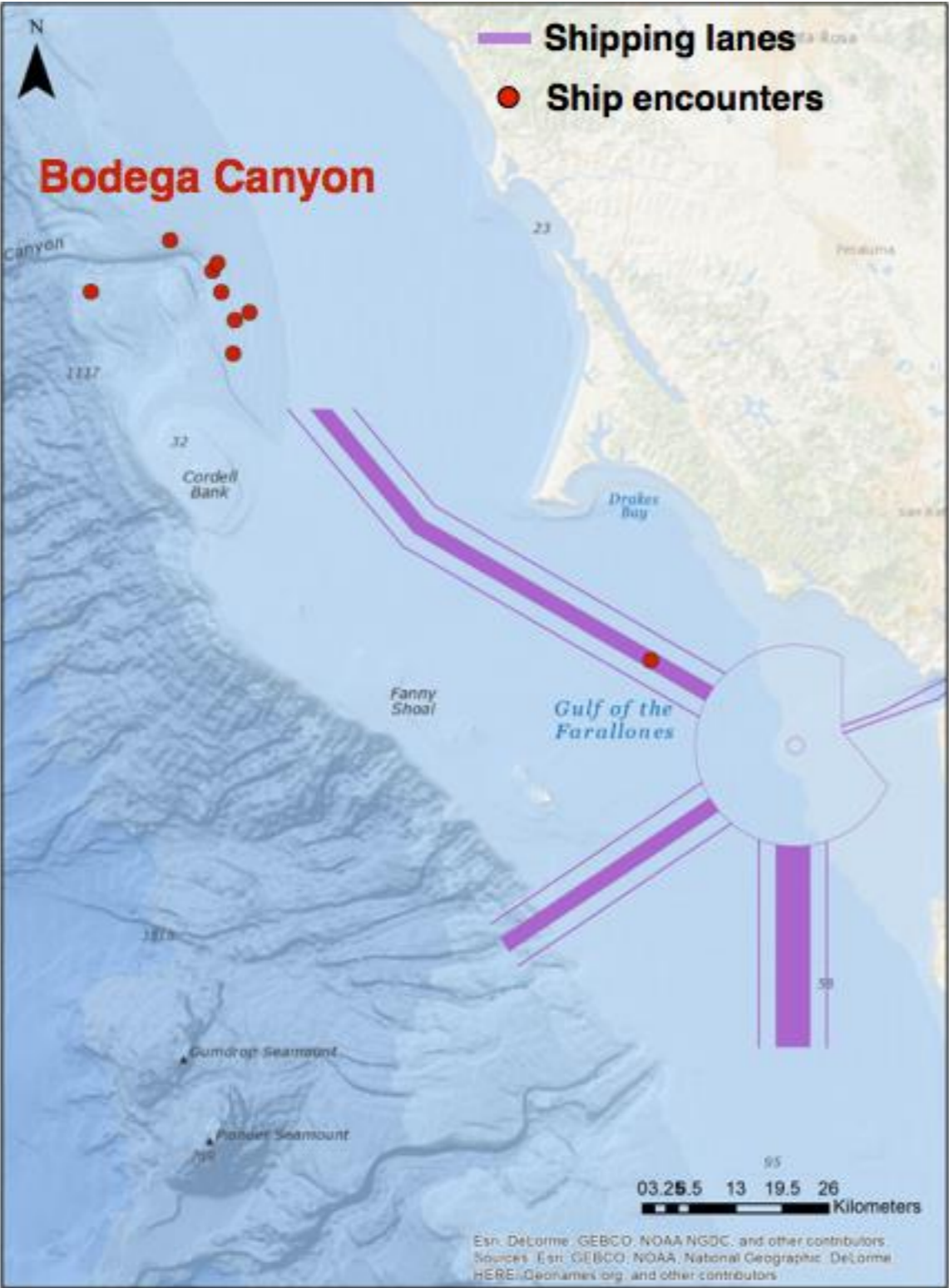
Northern Anchovy (*Engraulis mordax*)

Pacific Herring (*Clupea pallasii*)

Pacific Sardine (*Sardinops sagax*)



# Risk Factors

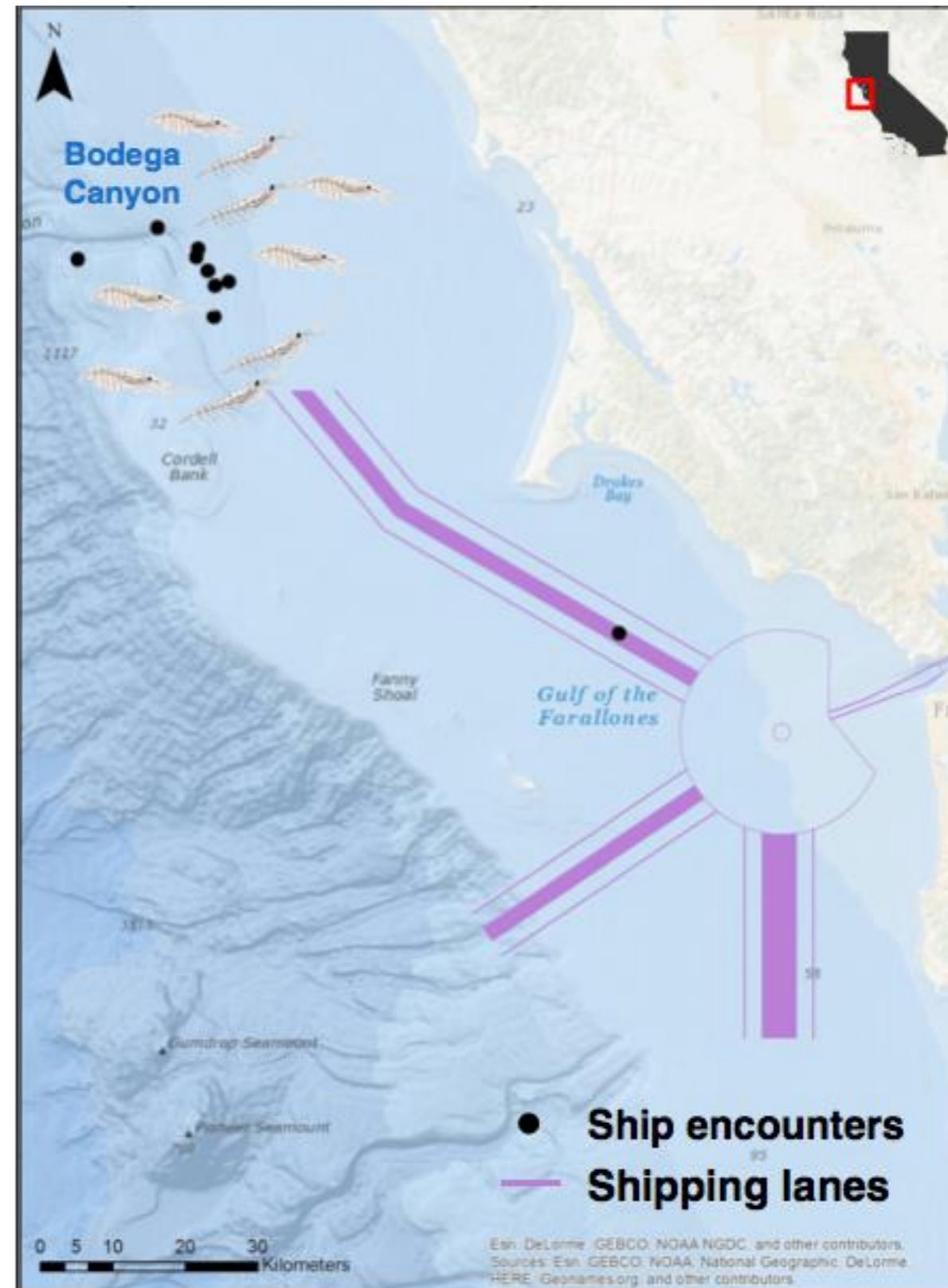




# Combined Drivers of Dive Behavior

## Bodega Canyon Dive Behavior

- Proportionately more surface dives than whales in other regions
- Longest post-dive surface durations after foraging dives



# Fitness Implications of Disruption

- Sub-lethal effects of chronic encounters
- Must acquire energy for entire year
- Disruption may affect fitness
- Individual to population level effects





# Next Steps

- More tag deployments
- Sound playback experiments
- Fine-scale kinematic movements
- Hormone/stress levels
- Publish!

# Acknowledgements

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Mike Graham

## Unofficial Committee

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Alison Stimpert

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Bill Burgess  
Mason Cole  
Kris Machado  
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Wildlife Computers

## Logistics/Data

John Berge  
Erica Burton  
Michael Carver  
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Ken Israel  
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Chris Miller  
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Murray Stein  
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Larry Young  
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## Programming/Stats

Miche Capone  
Stacy DeRuiter  
Matt Edwards  
Stephanie Flora  
Karin Forney  
Scott Hamilton  
Elliott Hazen  
Megan McKenna

## Thesis Prep/Support

Cheryl Barnes  
Emily Donham  
Catherine Drake  
Ryan Fields  
Scotty Gabara  
Stephen Loiacono  
Birgitte McDonald  
Gabi Navas  
Stephanie Schneider  
Peter Stiteler  
Library Staff  
MLML Faculty/Staff  
Sanctuary Cruises

## Field Assistance

Johanna Anderson  
David Cade  
Miche Capone  
Casey Clark  
Lindsay Cooper  
Dharma Donham  
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Alex Olson  
Dan Powers  
Bobby San Miguel  
Vertebrate Ecology  
Lab





# Questions? Recommendations?

