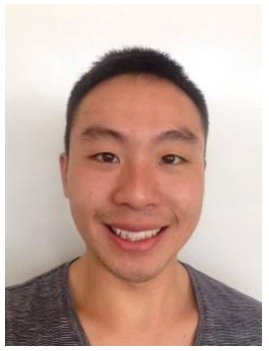
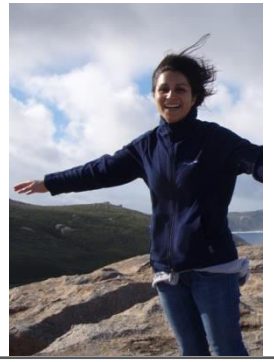
Acoustic monitoring finding new populations of the endangered blue whale

Tracey Rogers, Gary Truong, Joy Tripovich, Naysa Balcazar





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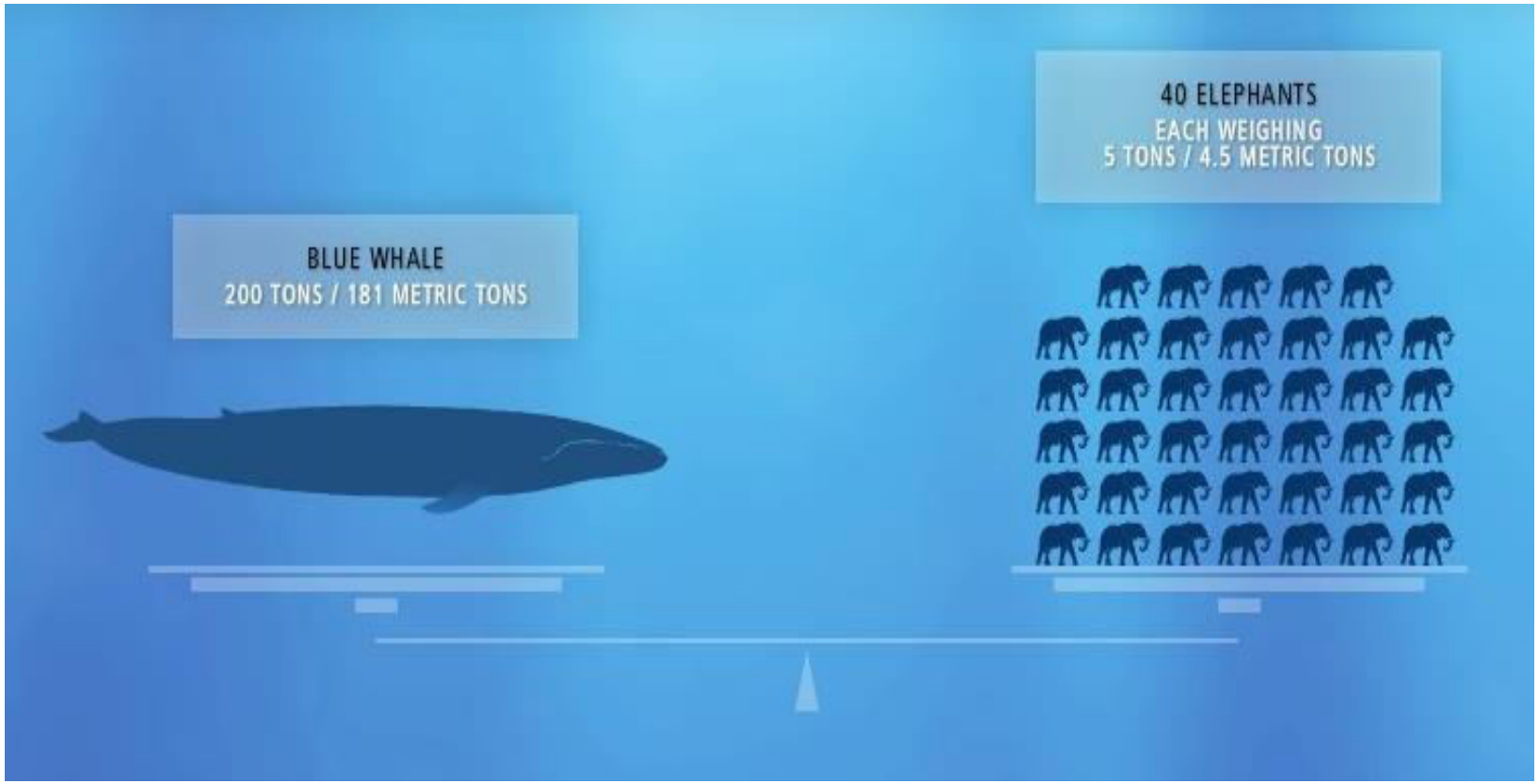
Blue whale (*Balaenoptera musculus*)

Largest baleen whale

Critically endangered

Migrate away from feeding grounds to breed



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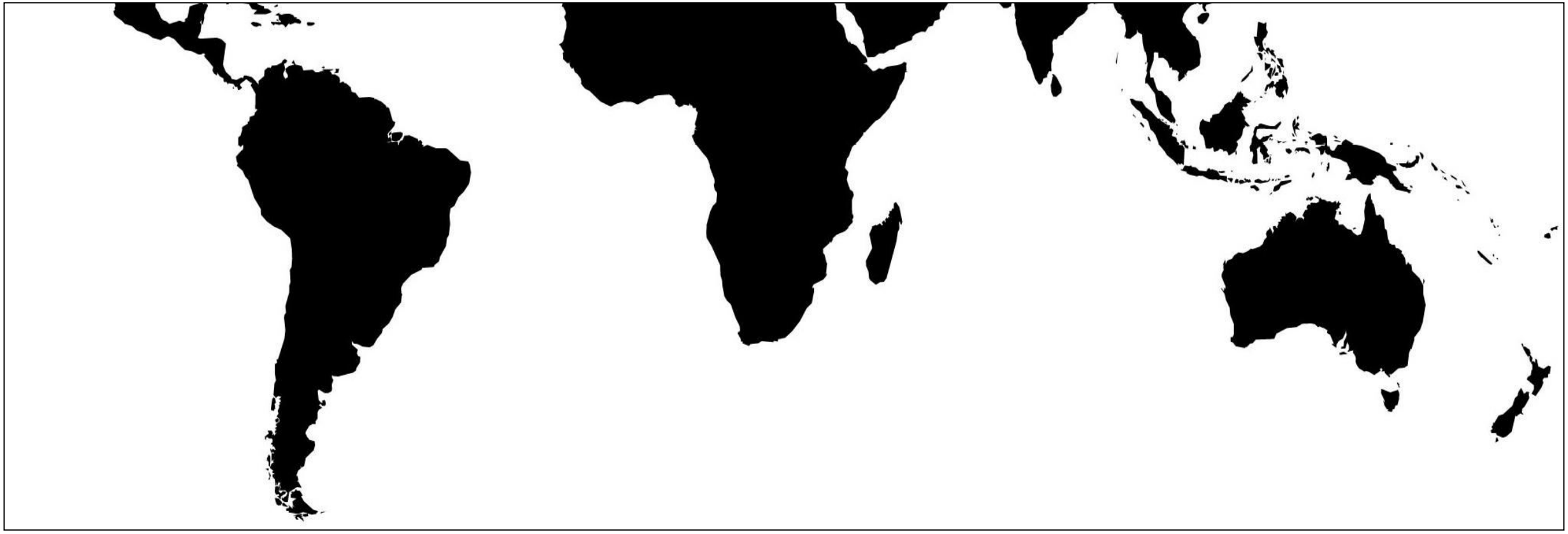
Blue whales of the Southern Hemisphere



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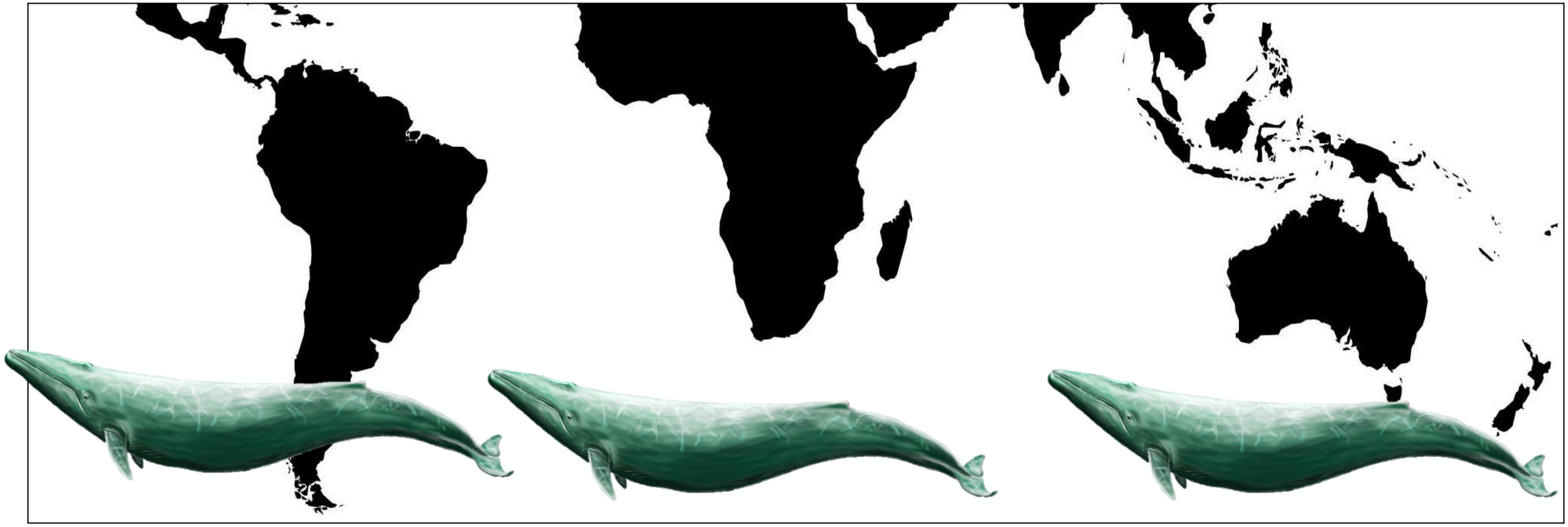
Blue whales of the Southern Hemisphere



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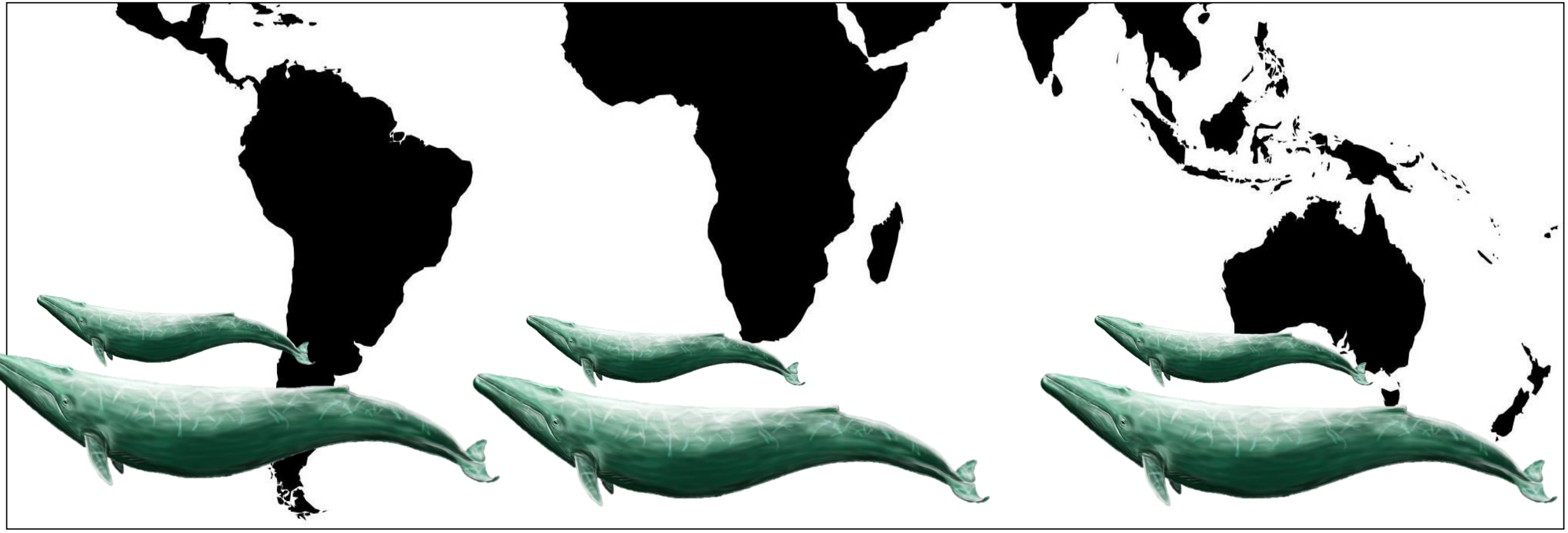

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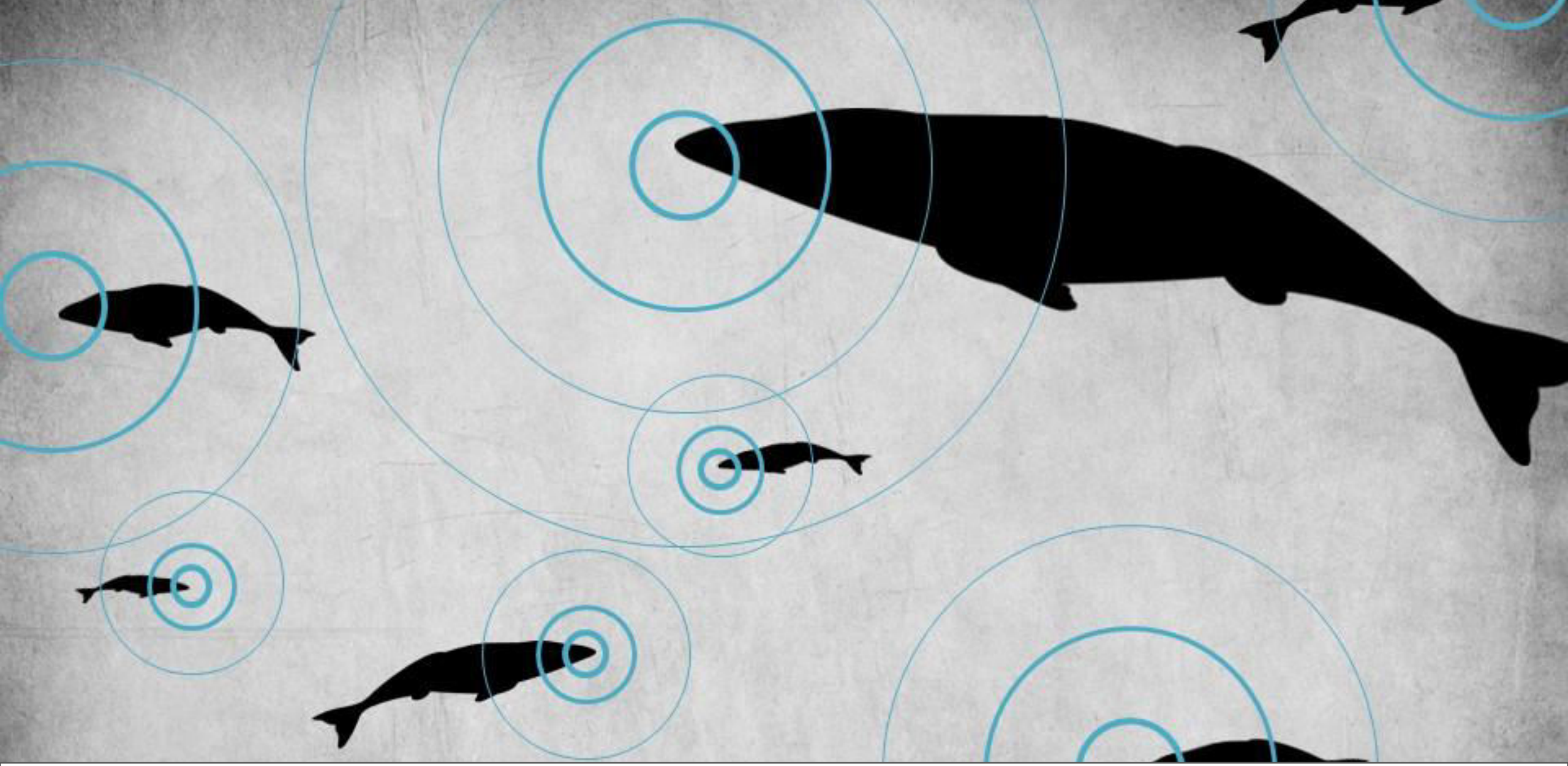

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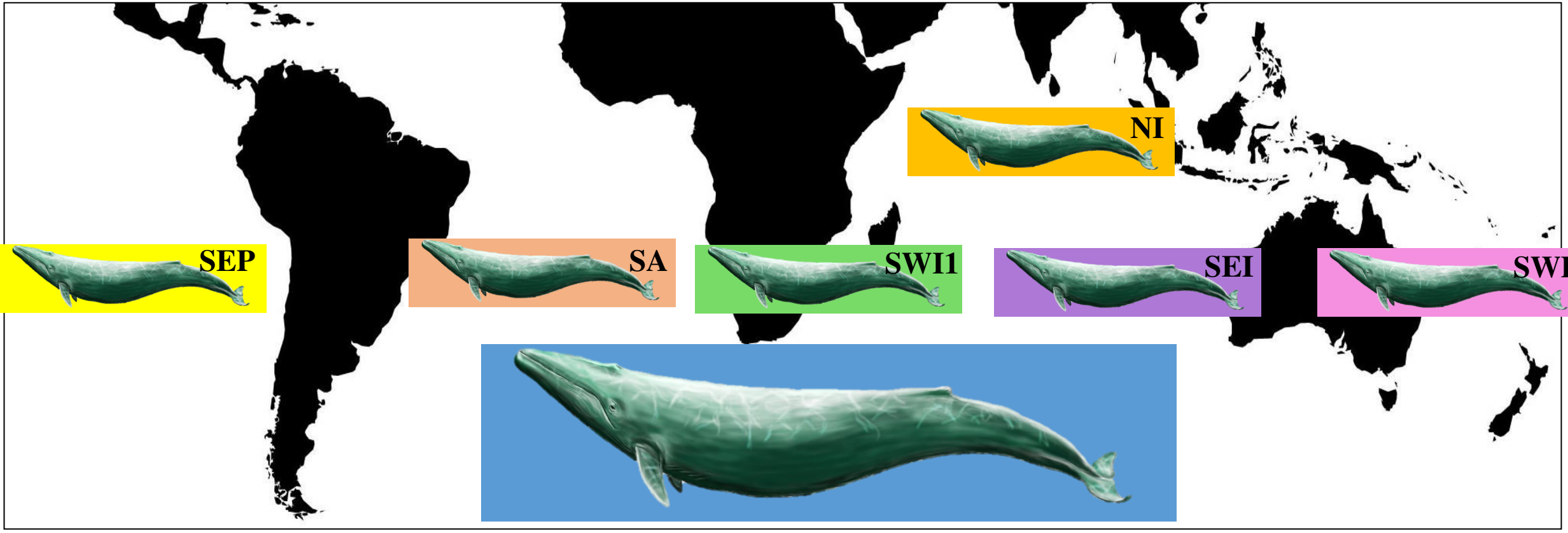
Blue whales of the Southern Hemisphere



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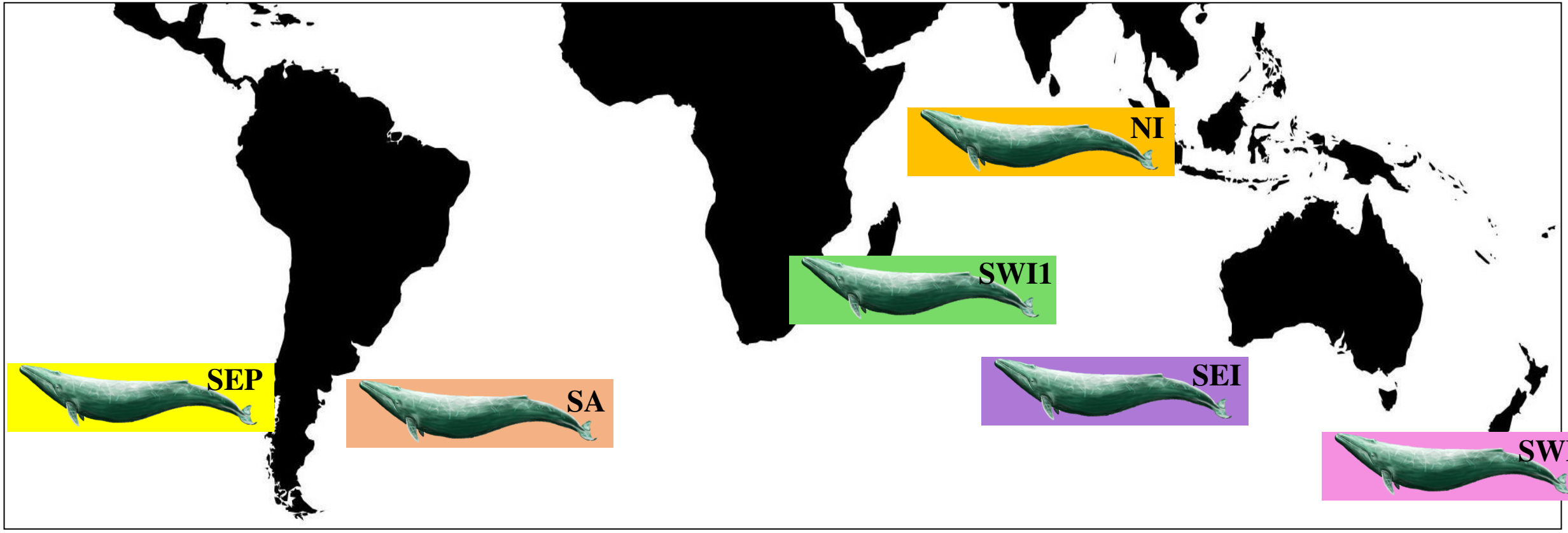

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Datasets

Holger KLINK

David MELLINGER

Sharon NIEUKIRK

Robert P. DZIAK

CTBTO
PREPARATORY COMMISSION

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

IMOS
Integrated Marine Observing System

SCRIPPS INSTITUTION OF OCEANOGRAPHY
UC San Diego

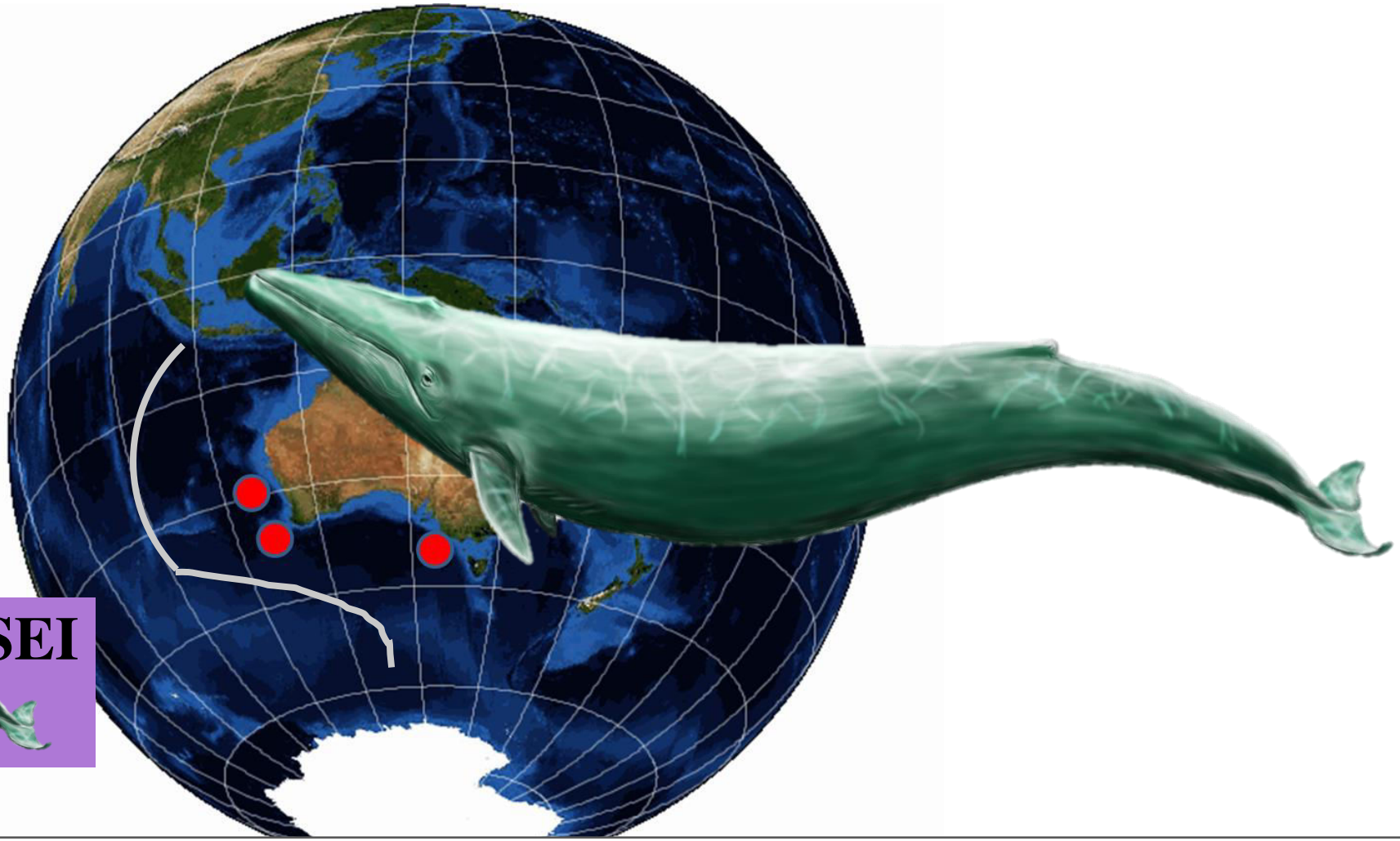
CORNELL UNIVERSITY FOUNDED A.D. 1865
Cornell University

OSU
Oregon State UNIVERSITY

Tripovich, et al. Rogers 2015. Temporal segregation of the Australian and Antarctic blue whale call types (*Balaenoptera musculus* spp.). J. Mammalogy, 96(3), 603-610.

Antarctic blue whales are off the West coast of Australia

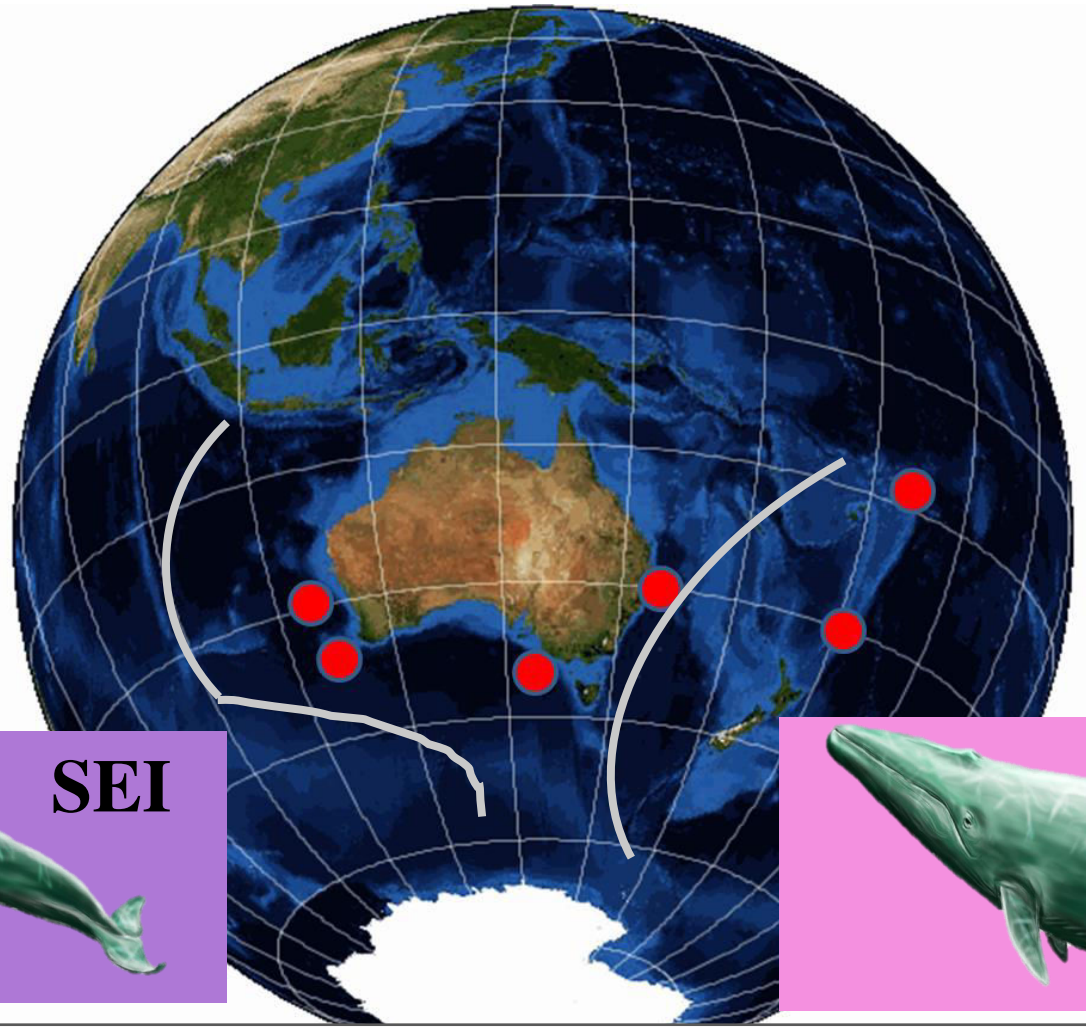
SEI pygmy blue whales
Antarctic blue whales
together at same time

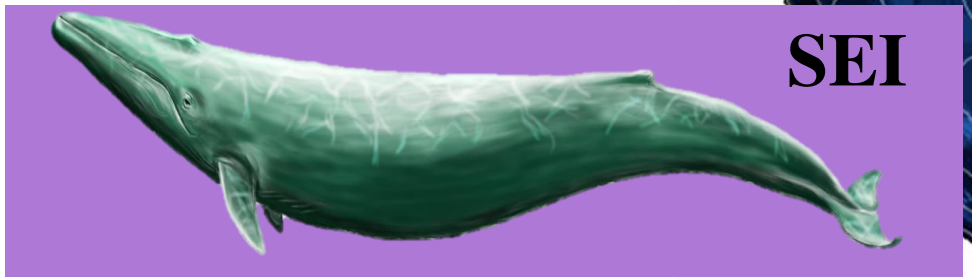


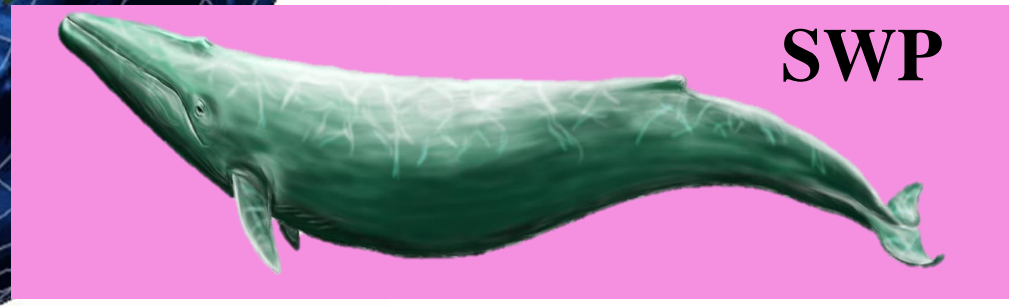
Balcazar, et al. Rogers, 2015. Calls reveal population structure of blue whales across the southeast Indian Ocean and the southwest Pacific Ocean. J. Mammalogy, *96*(6), 1184-1193.

SWP pygmy blue whales (NZ-type call) are also off Australia and north Lau Basin

The SEI & SWP are discrete populations







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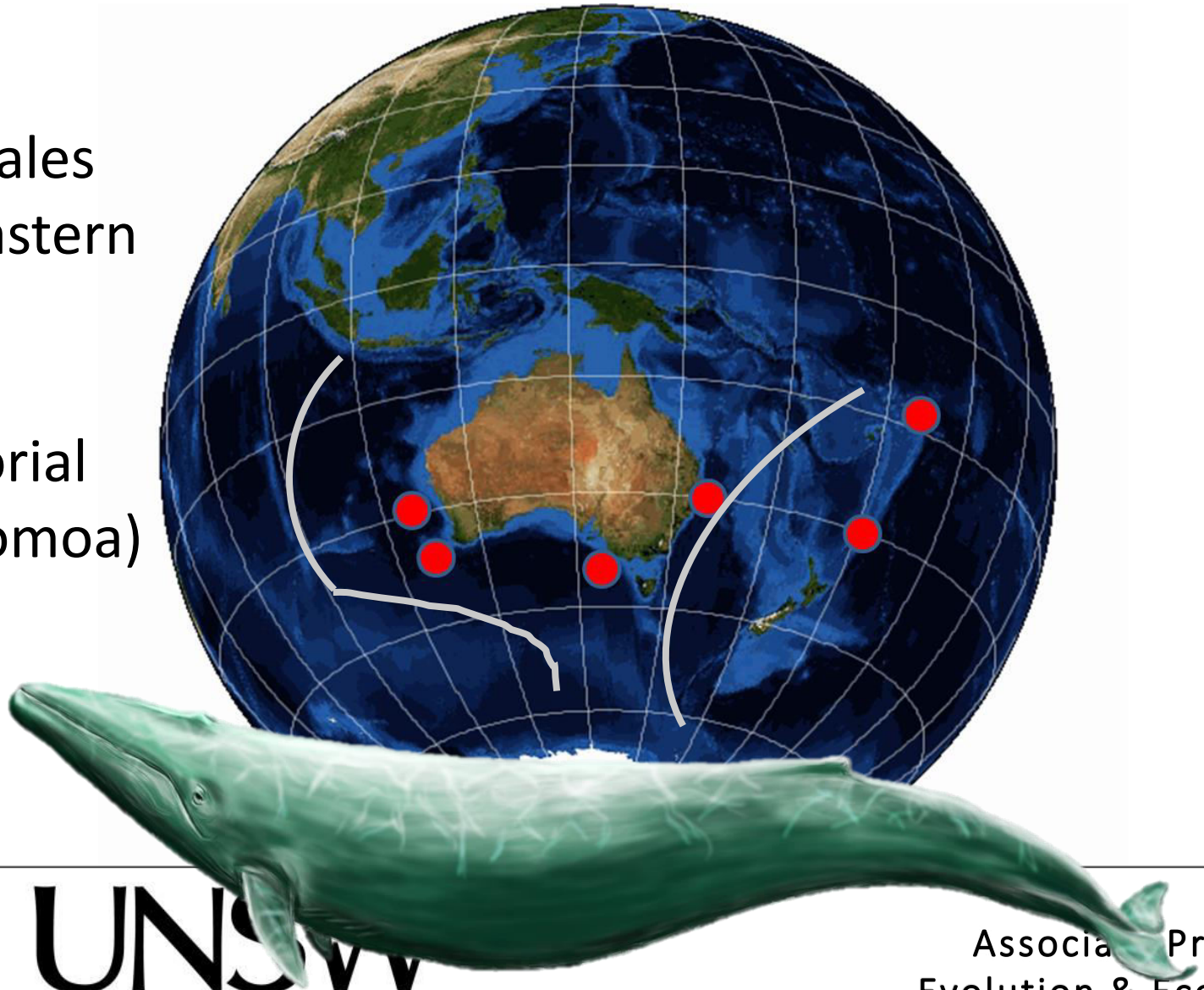
Balcazar, et al. Rogers 2017. Using calls as an indicator for Antarctic blue whale occurrence and distribution across the southwest Pacific and southeast Indian Oceans. Marine Mammal Science, 33(1), 172-186.

Antarctic blue whales off the coast of Eastern Australia

North into equatorial Eastern Pacific (Somoa)



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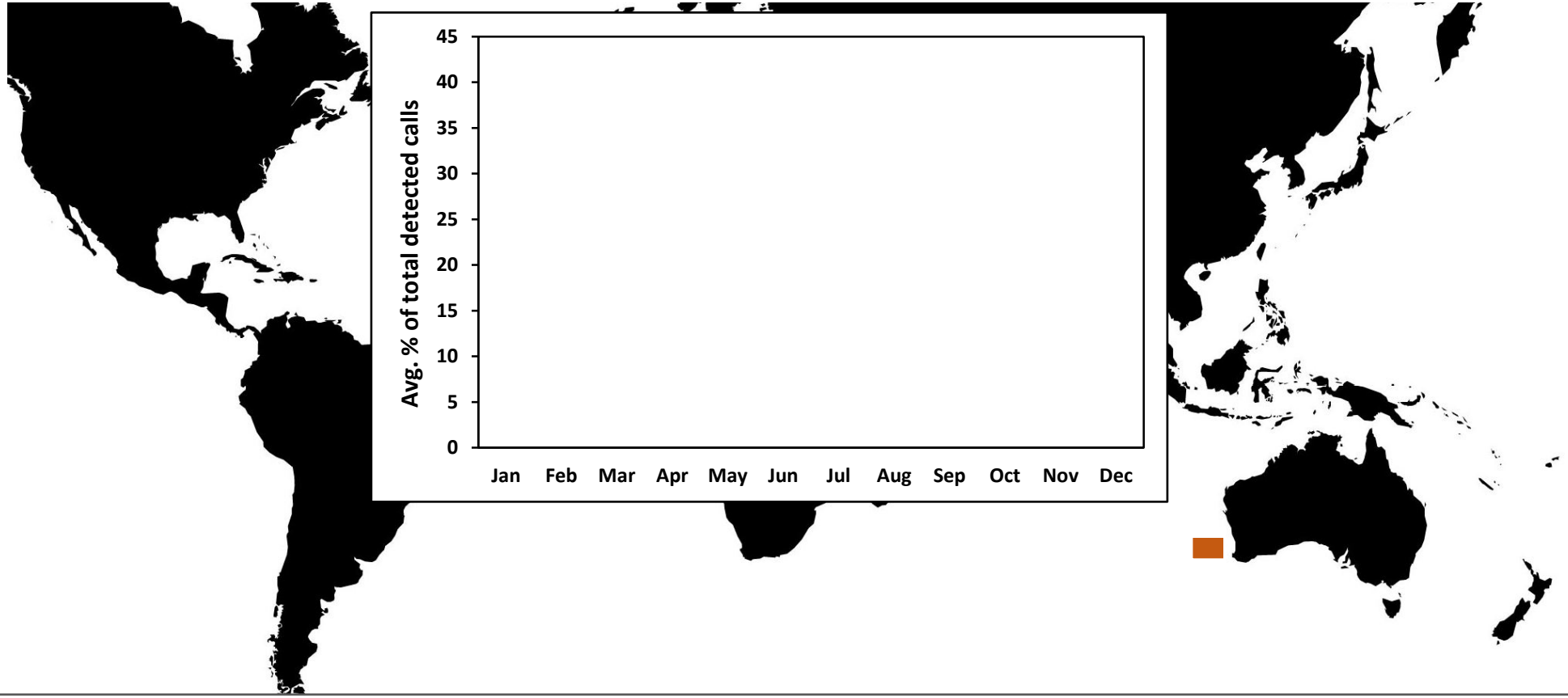
Seasonal variation



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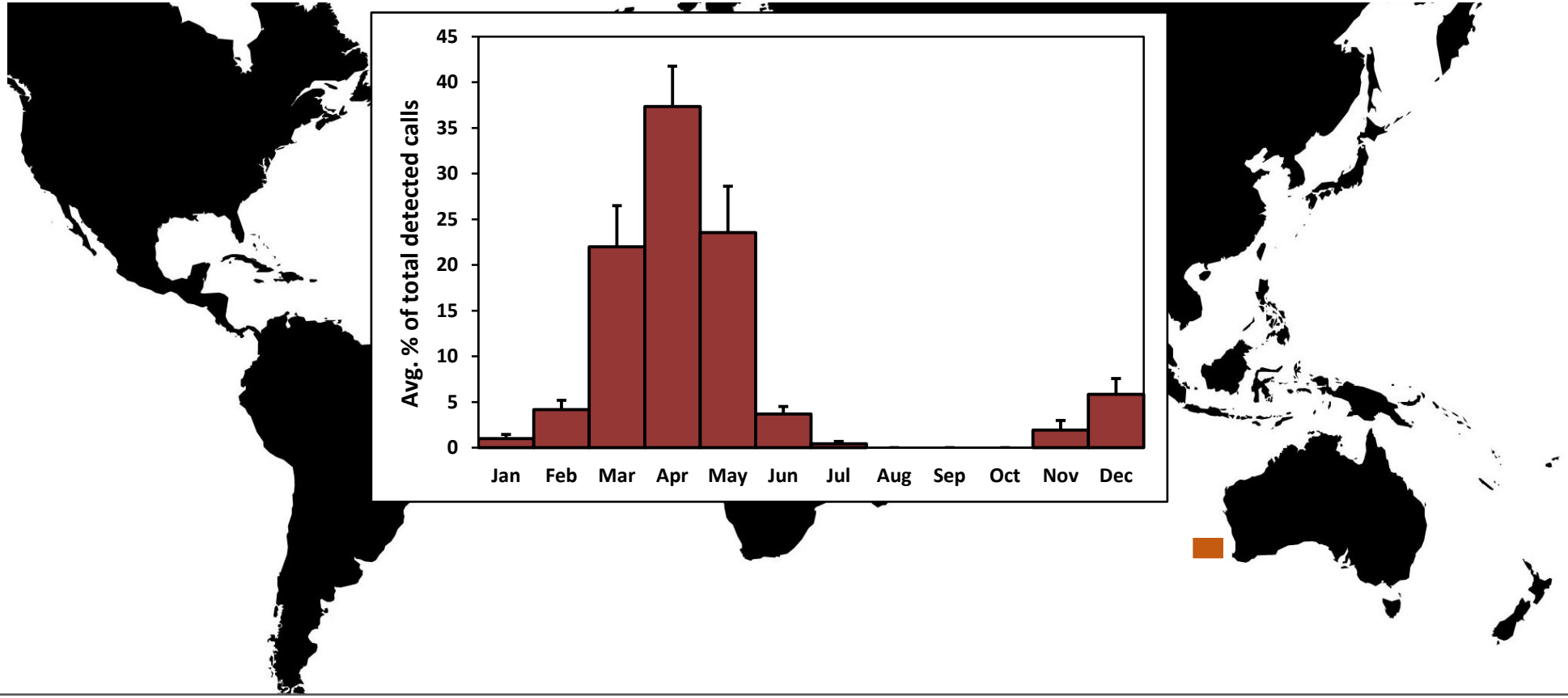
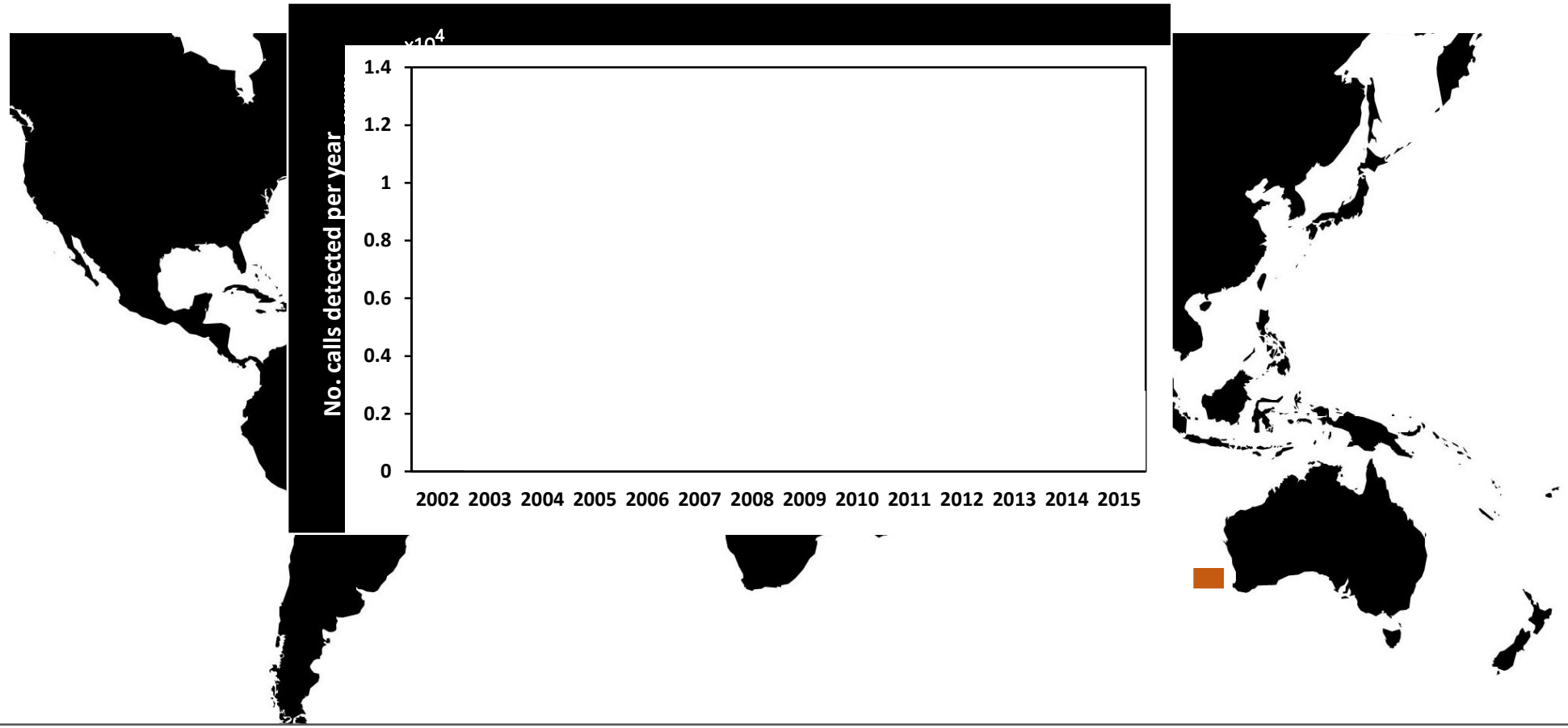
Seasonal variation



Interannual variation



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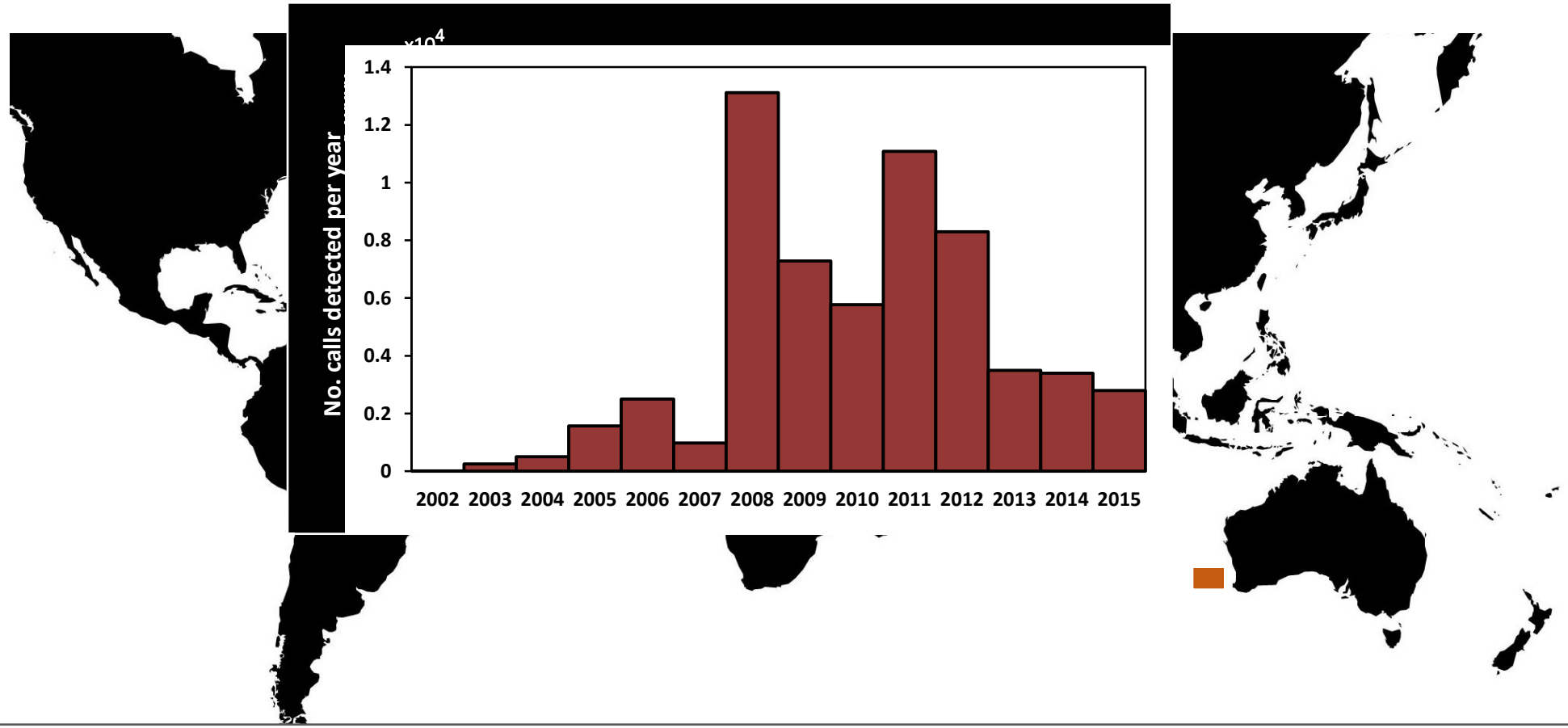

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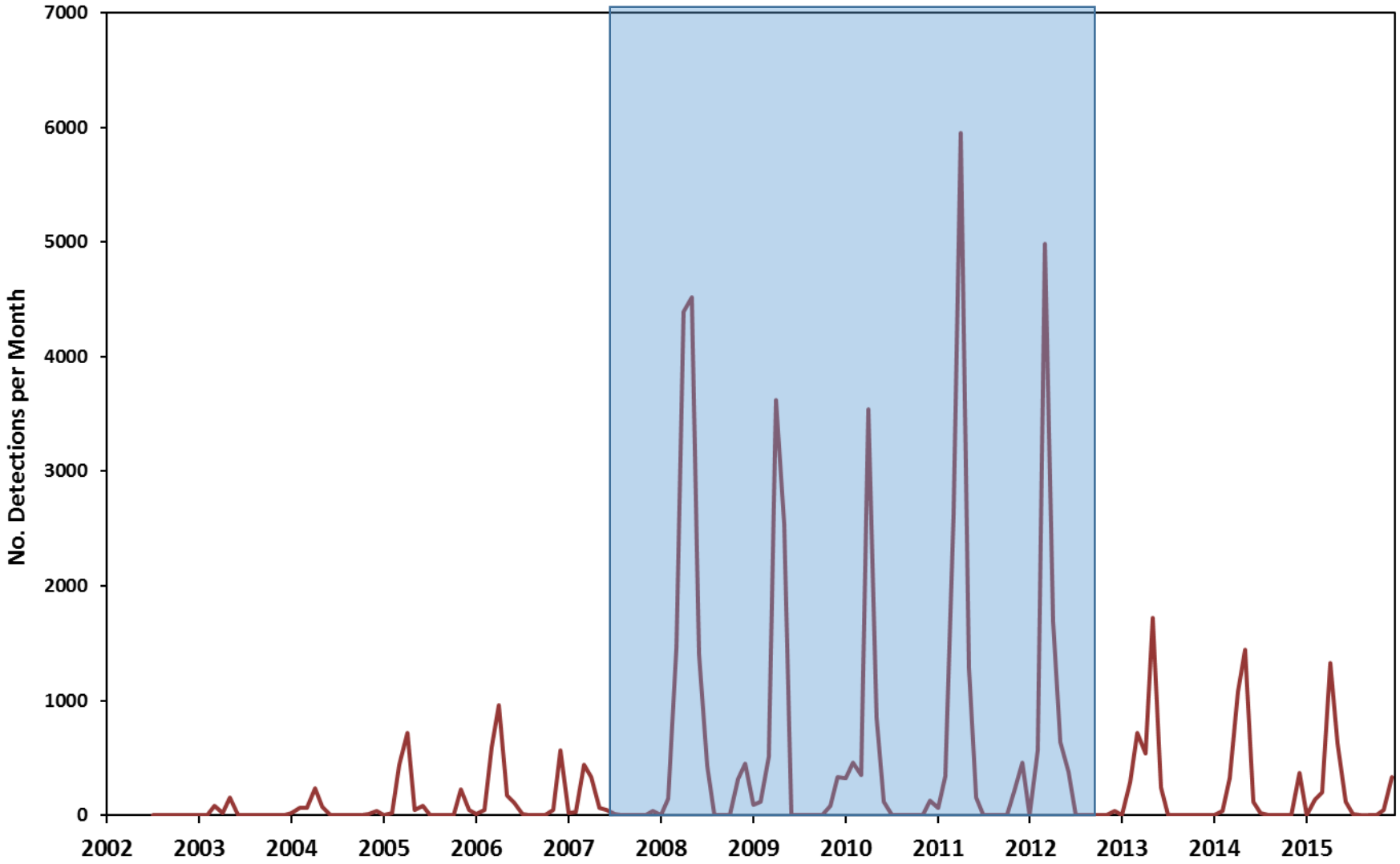
Monthly Time Series of Detections



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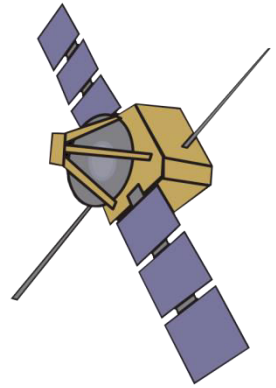
Environmental Variables



Satellite derived environmental variables

- Sea Surface Temperature (SST)
- Sea Surface Height (SSH)
- Chlorophyll at Hydrophone (Chla.HP)
- Chlorophyll at Bonnie Upwelling (Chla.Feed)
- Southern Oscillation Index (SOI)

Model selection using Time Series analysis

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Evolution & Ecology Research Centre

Model Selection

SST

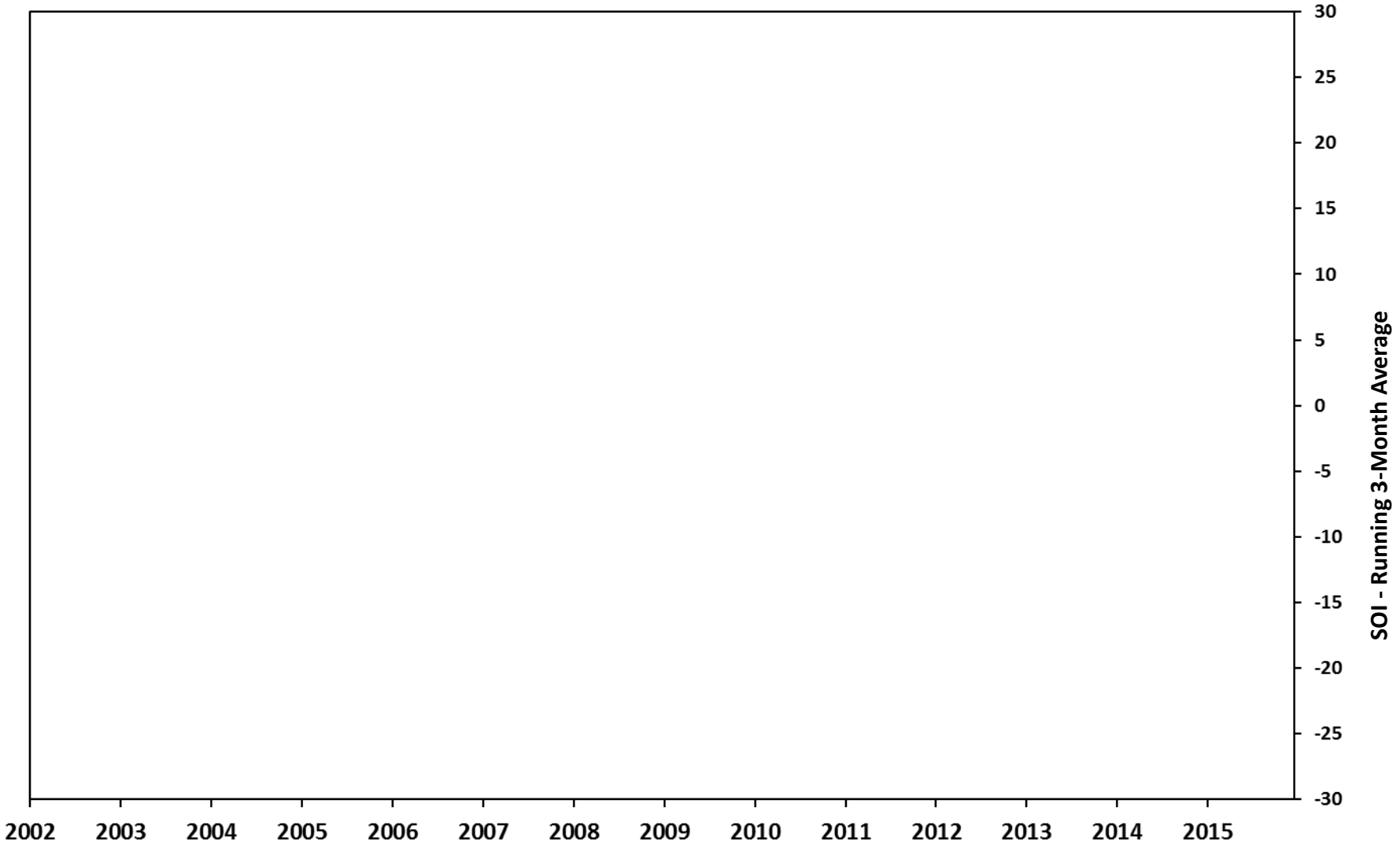
SSH ↑

Chla @ Hydrophone ↓

Chla @ Feed ↑

SOI ↑

EL Niño Southern Oscillation (ENSO)



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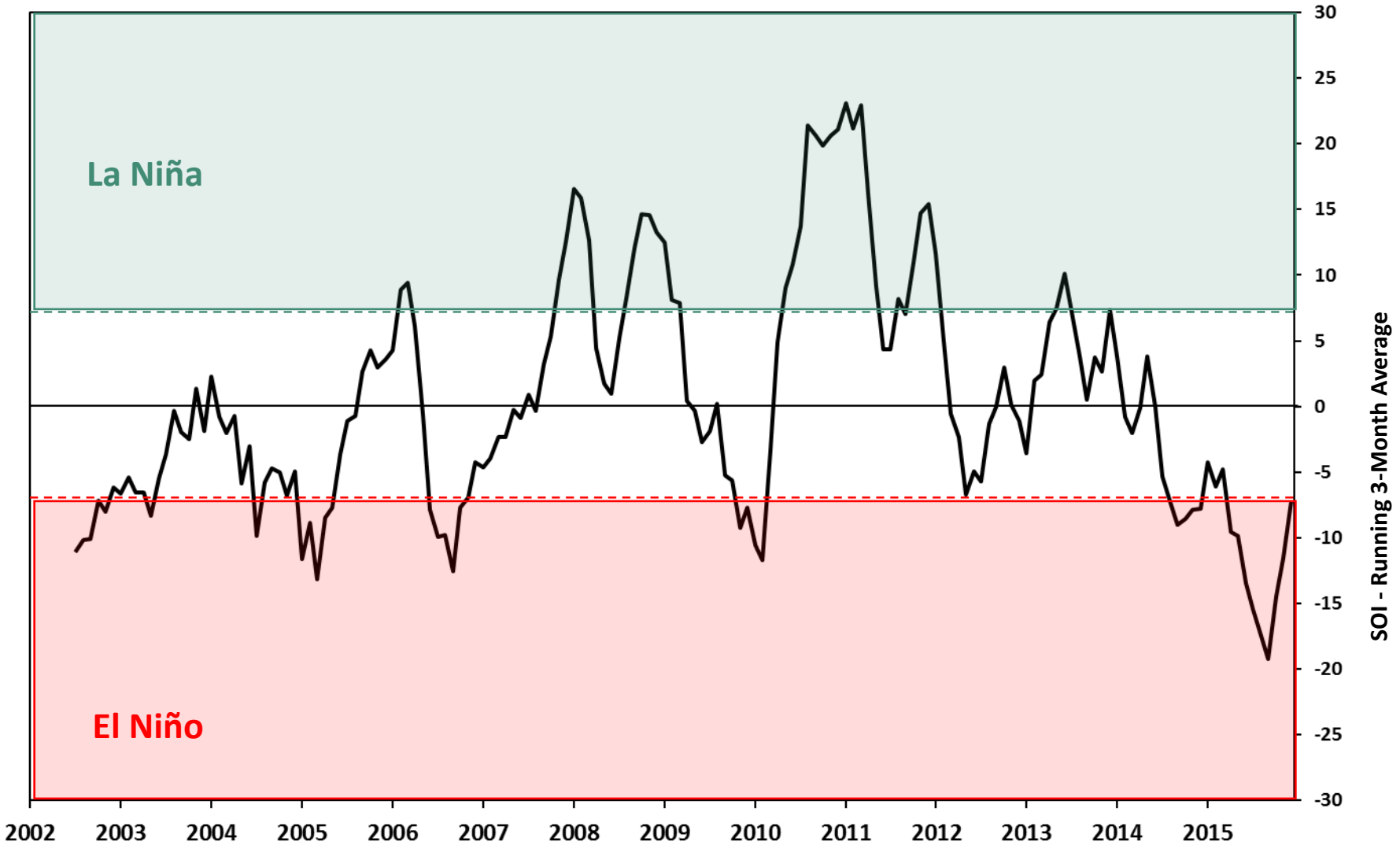

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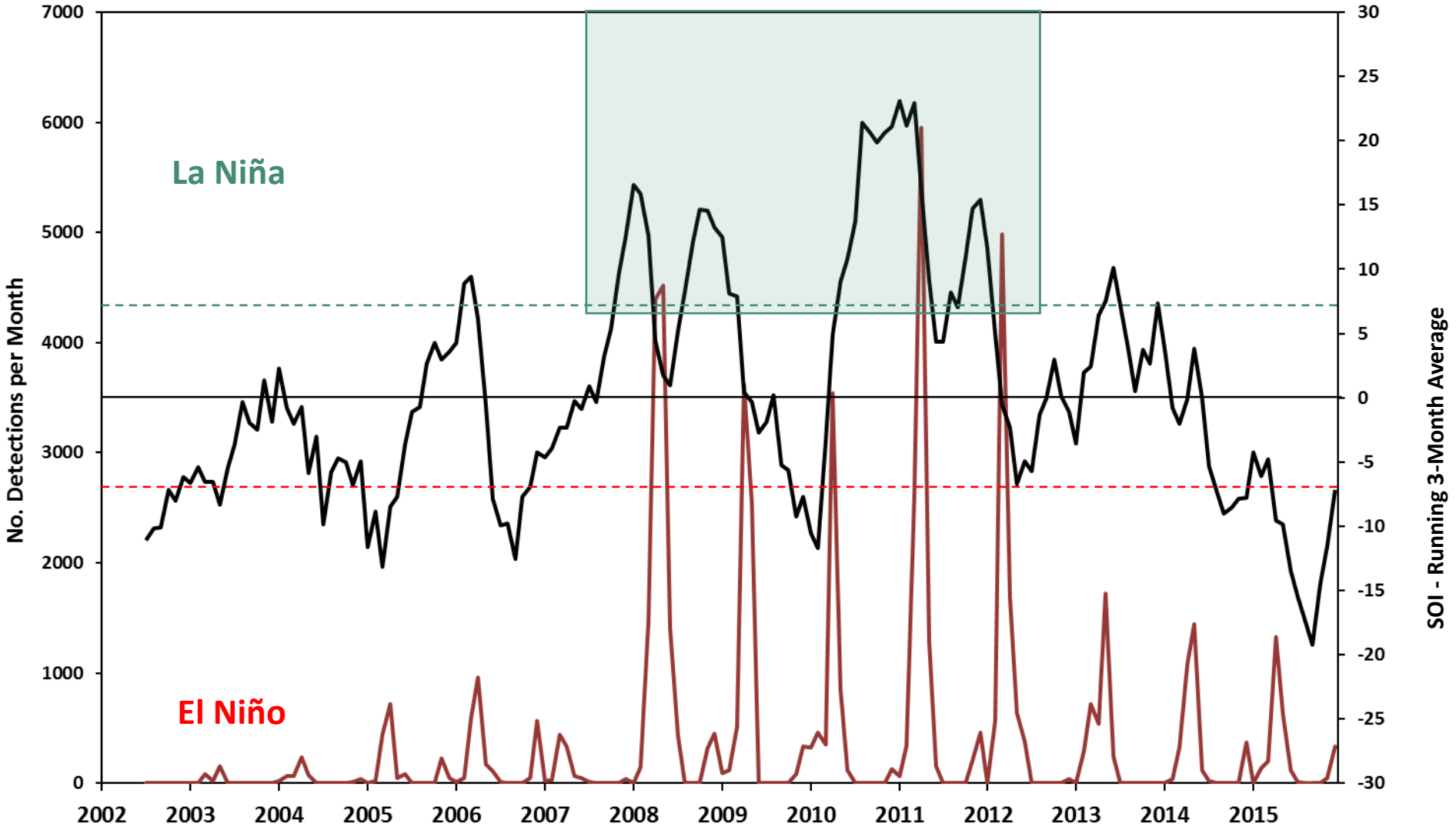
EL Niño Southern Oscillation



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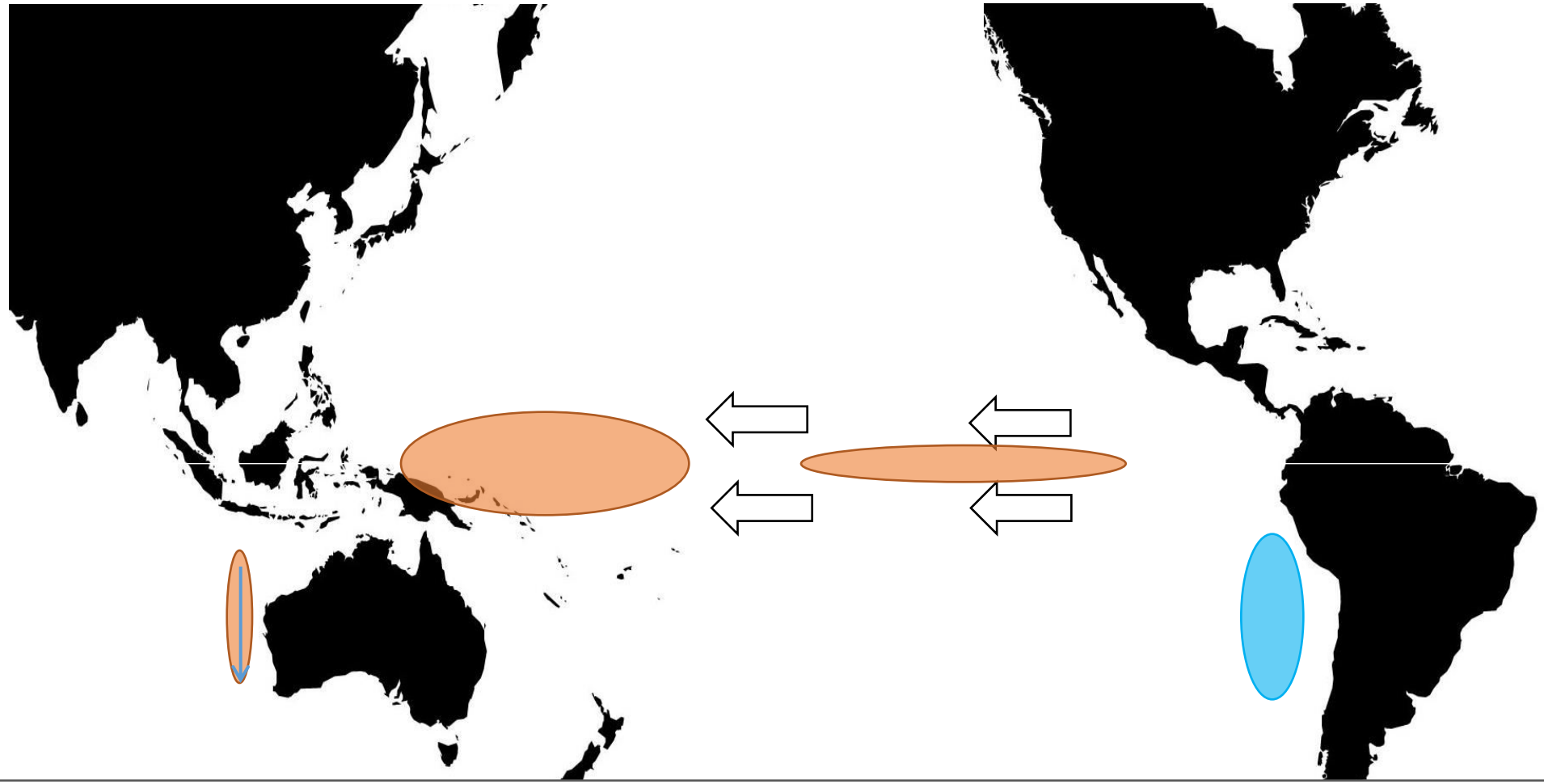
ENSO - Normal Conditions



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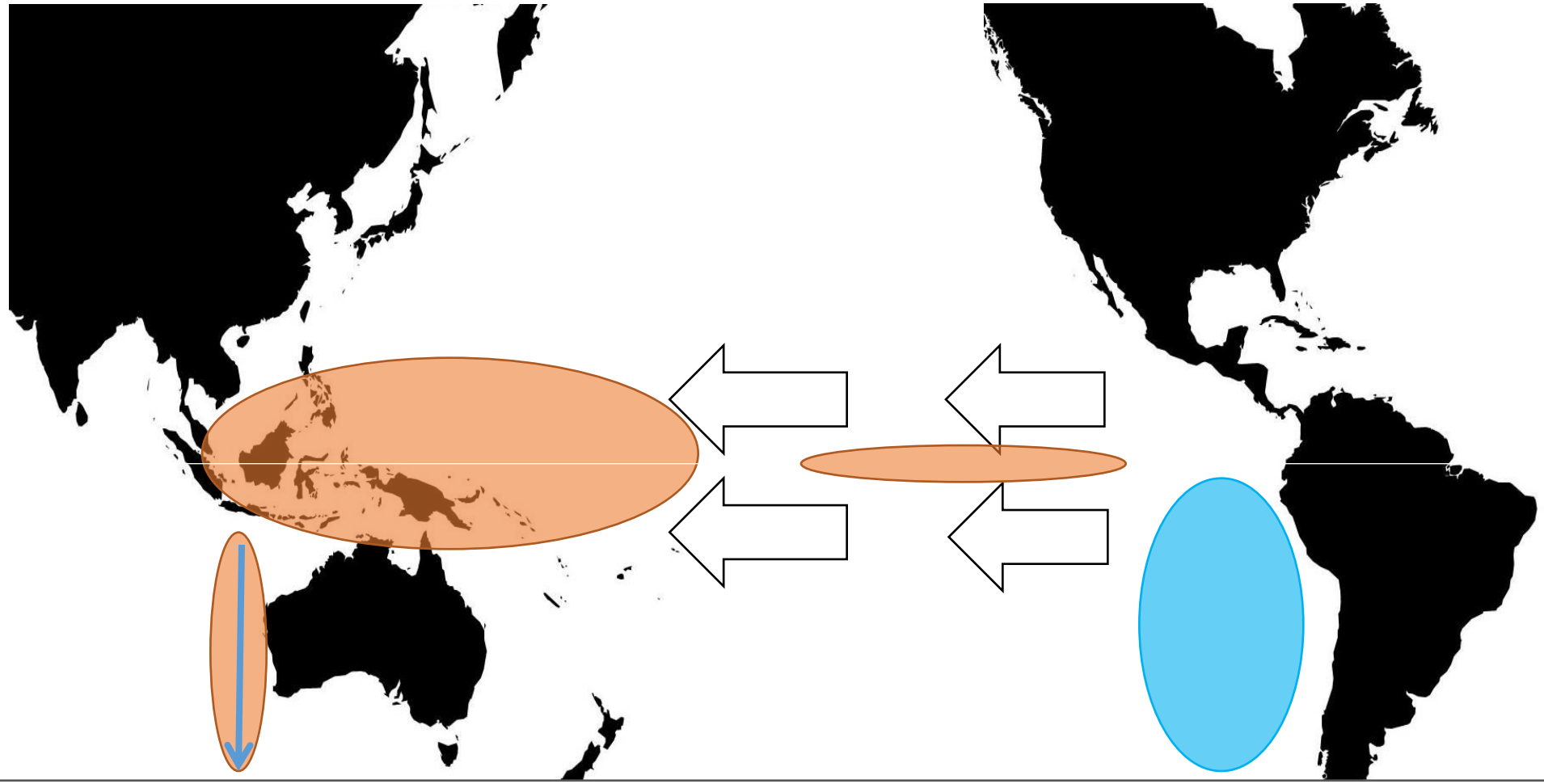
ENSO - La Niña conditions



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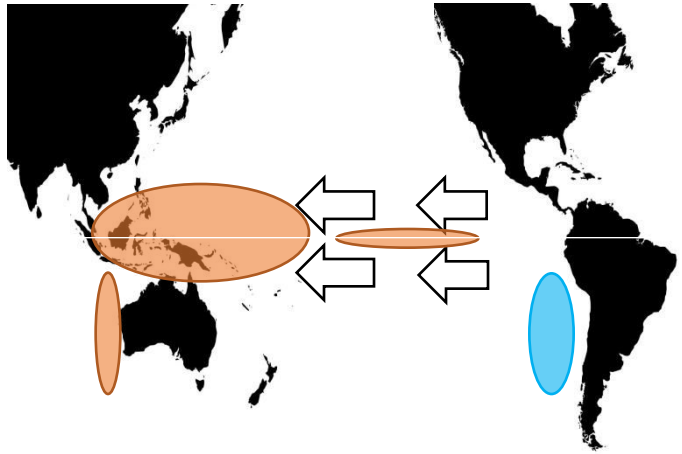
Why are there more calls during La Niña?

Strengthening of the Leeuwin current

Good conditions for krill and zooplankton to grow

Whales feed on increased krill abundance and are in good condition



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Take home message

CTBTO data provided the long term data that identified:

New populations of blue whales that we did not know were there.

ENSO cycle influences the migratory behaviour of blue whales.

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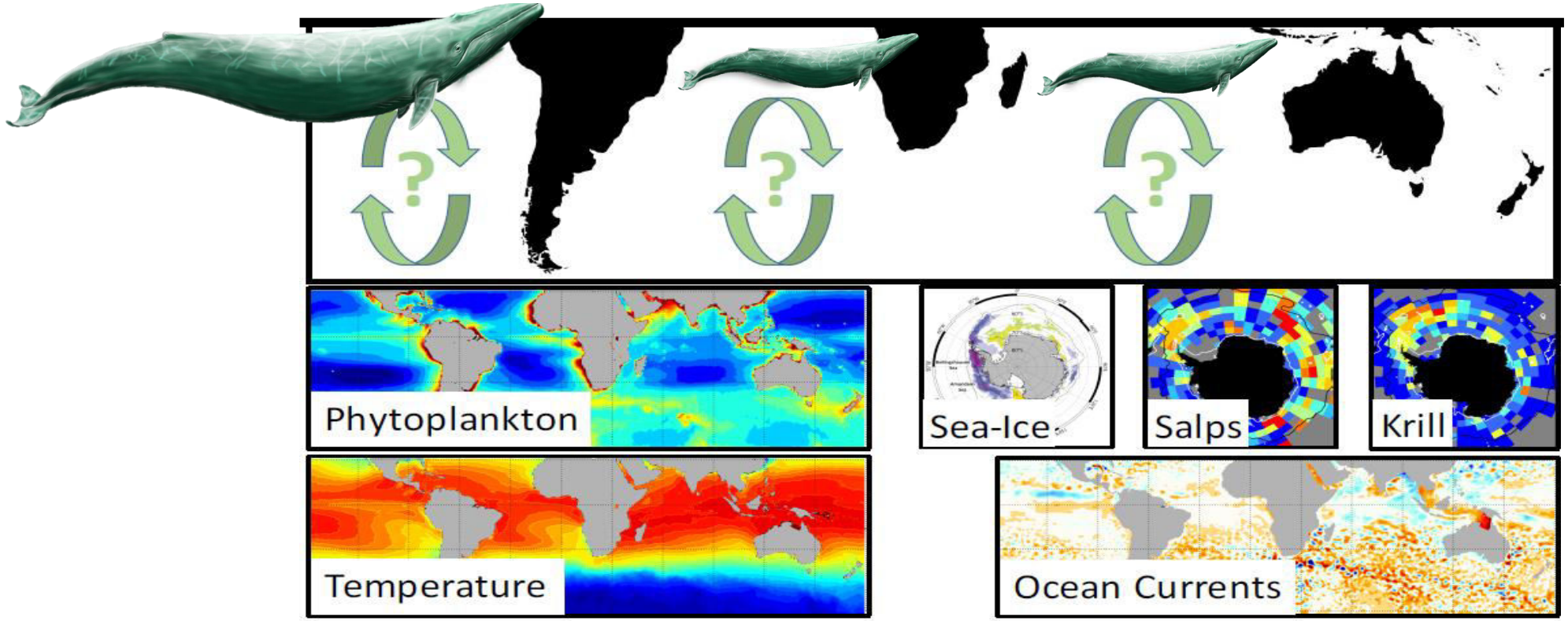
Take home message

CTBTO hydroacoustic monitoring data provides calibrated long-term data of biological importance. Needed to tease apart how warming of Southern Hemisphere oceans is impacting the ecosystem.



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Thank you for listening

Acknowledgments

The CTBTO preparatory commission for providing the data used in this study

Disclaimer

The commission is not responsible for the views presented here

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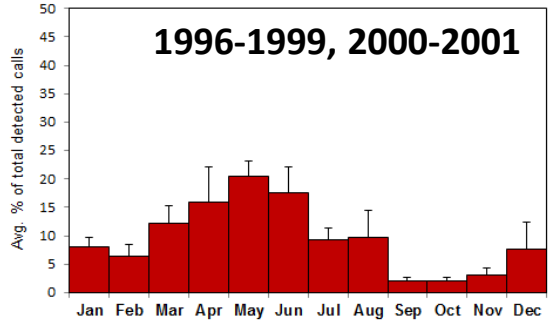
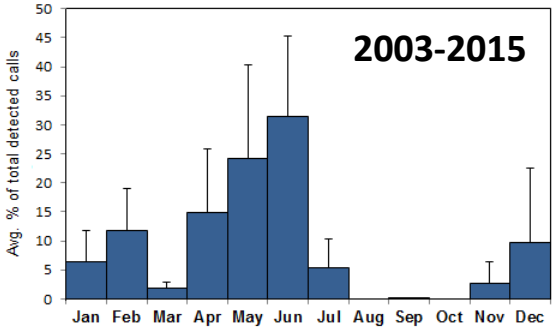
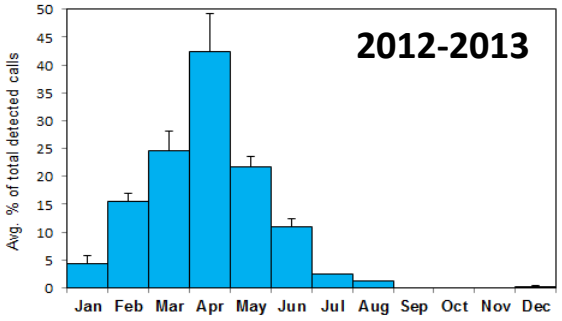
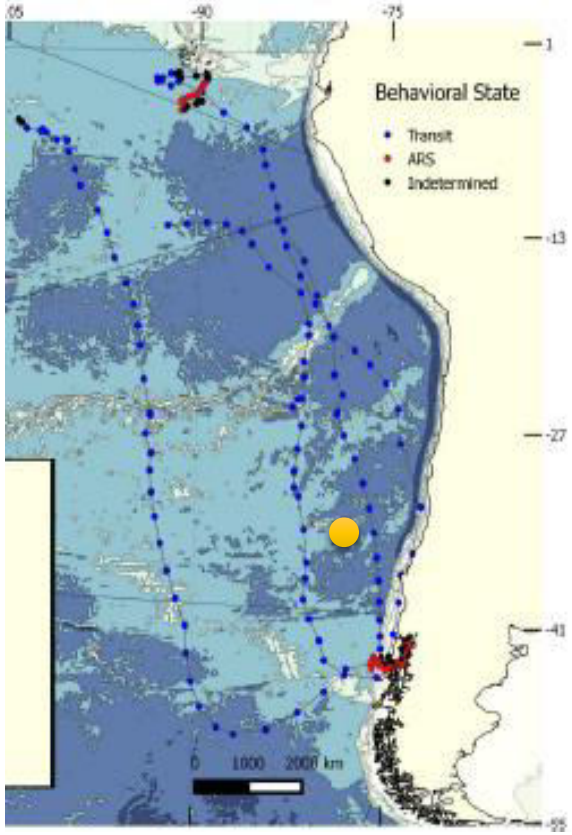
ETP

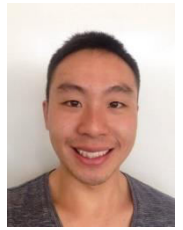




CER

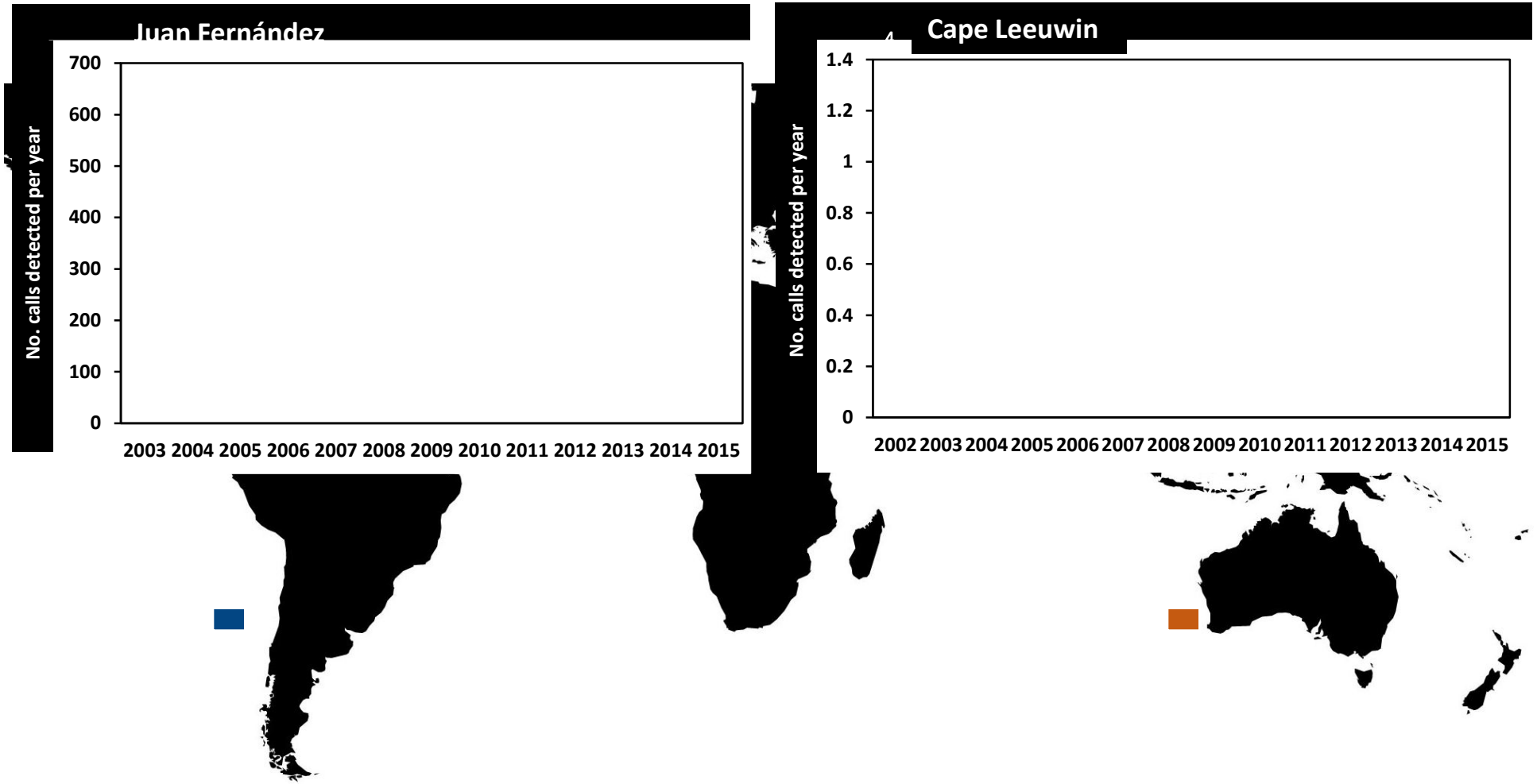






Modified from Buchan *et al.* 2015

Interannual variation



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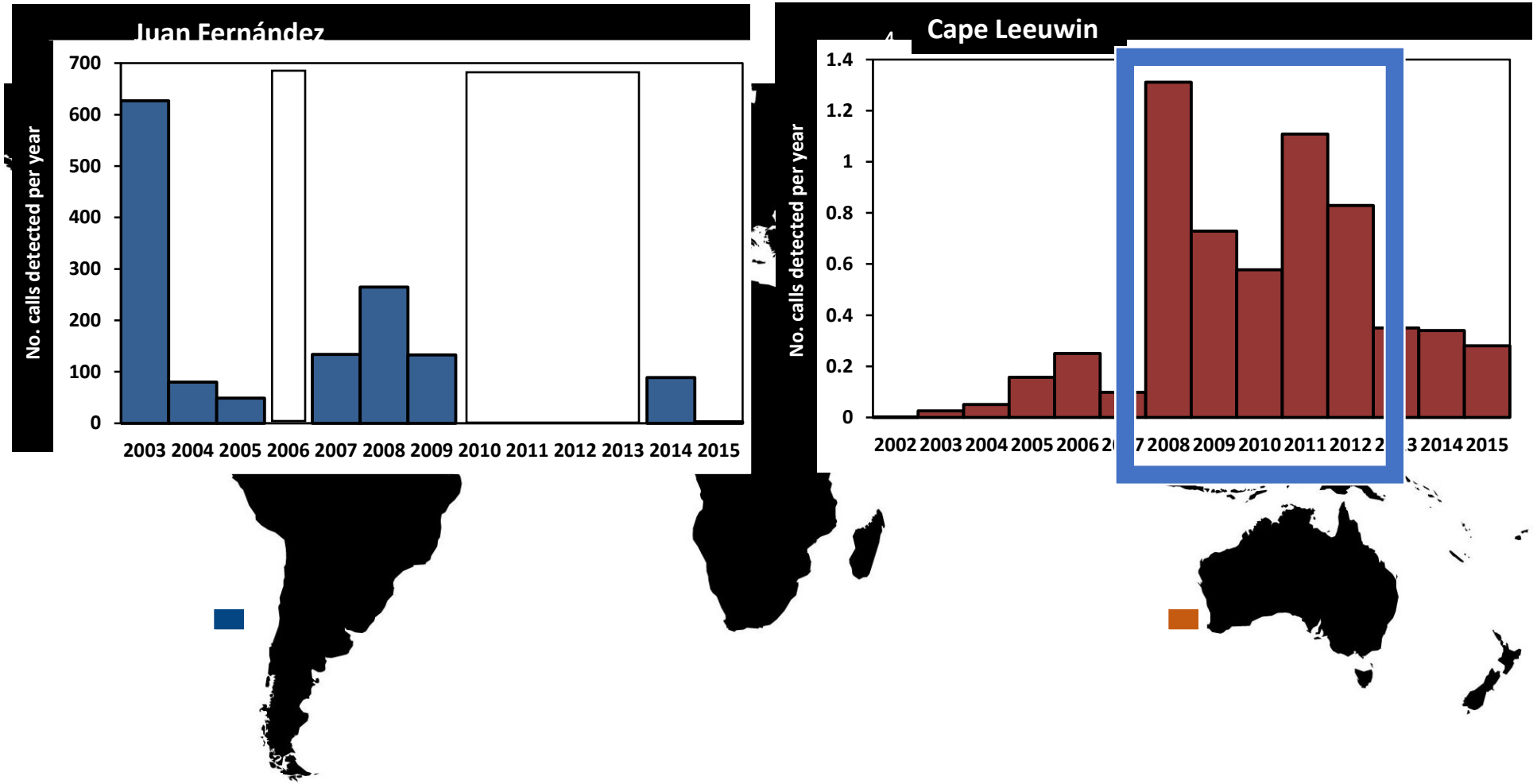
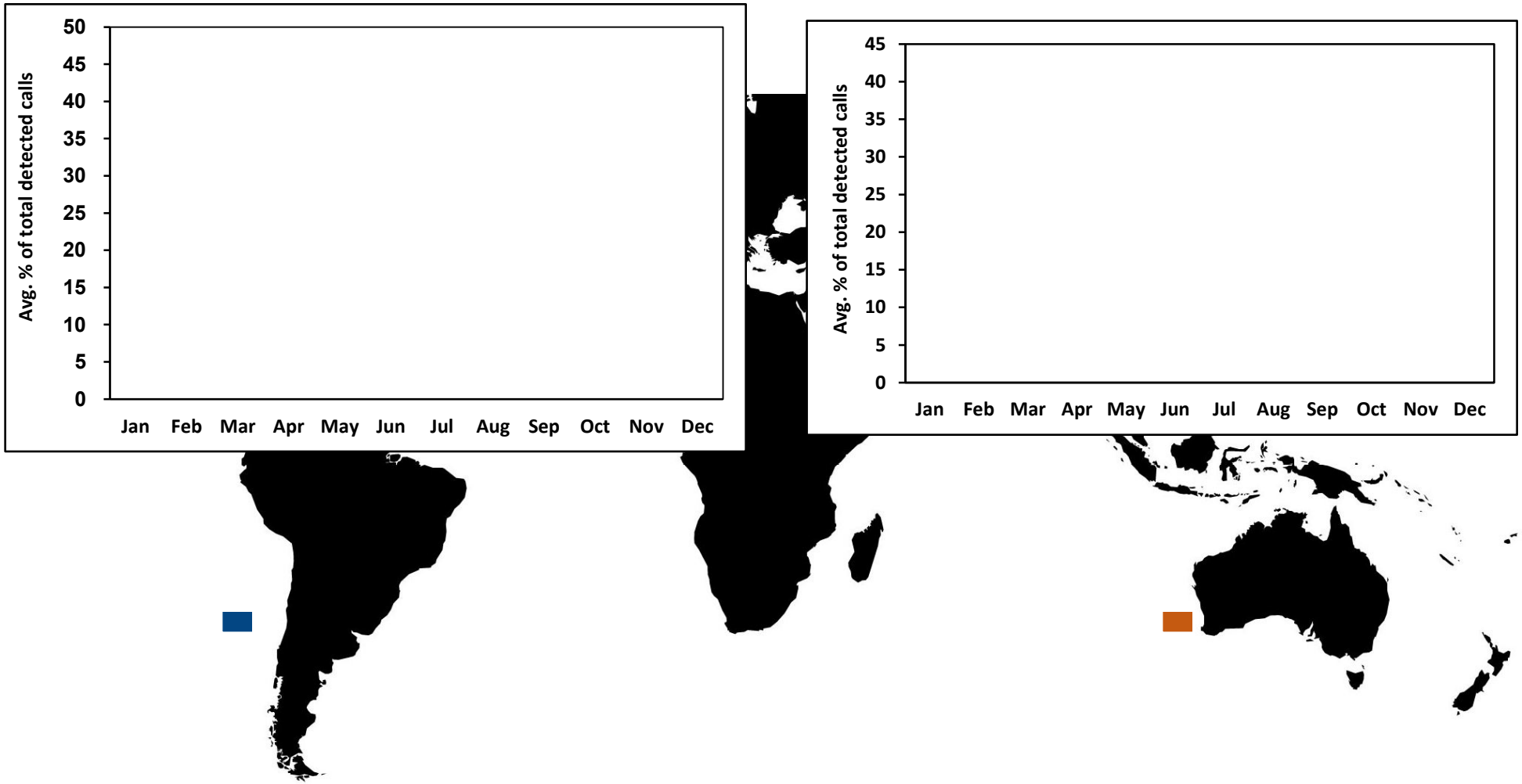
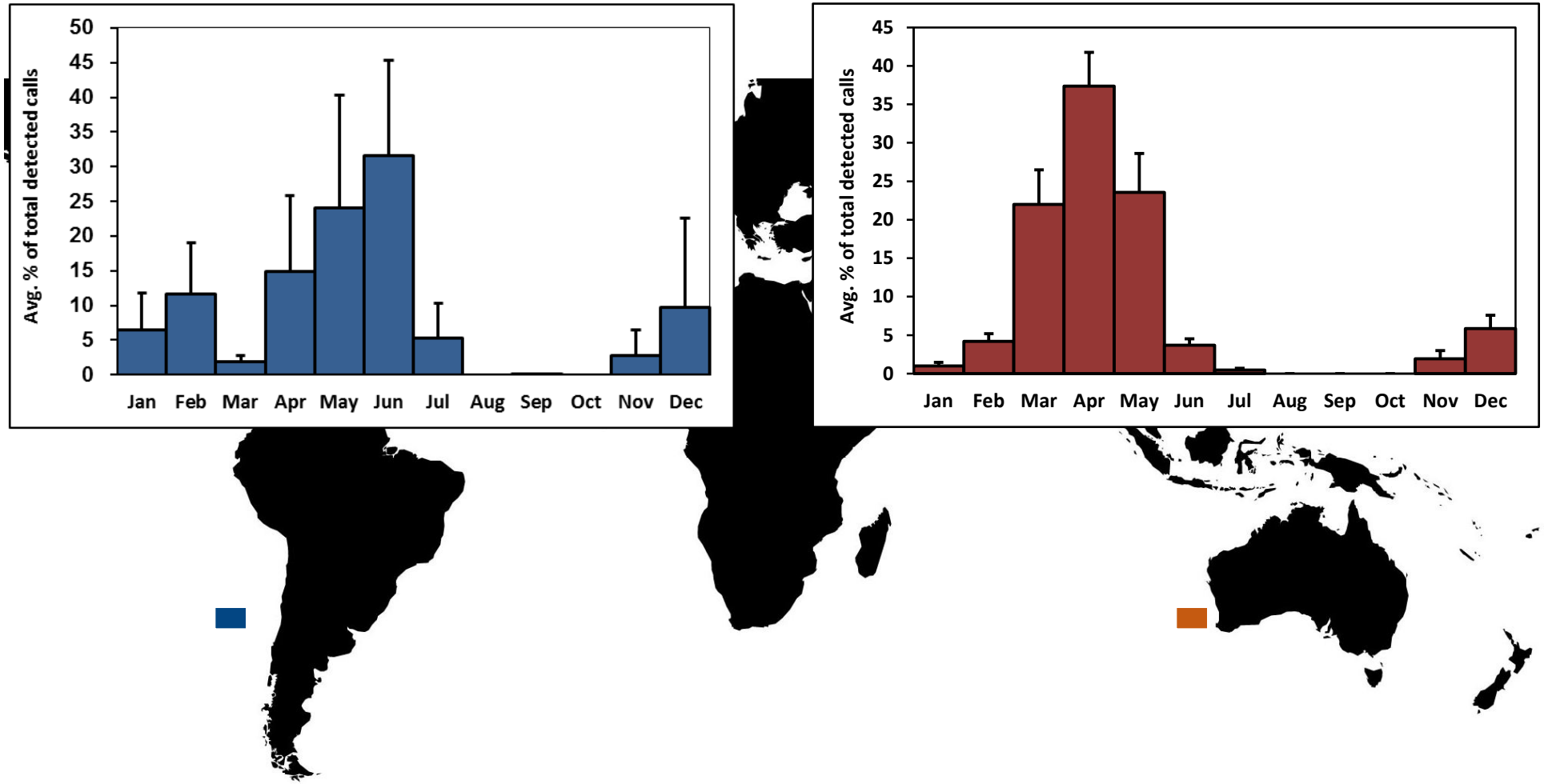


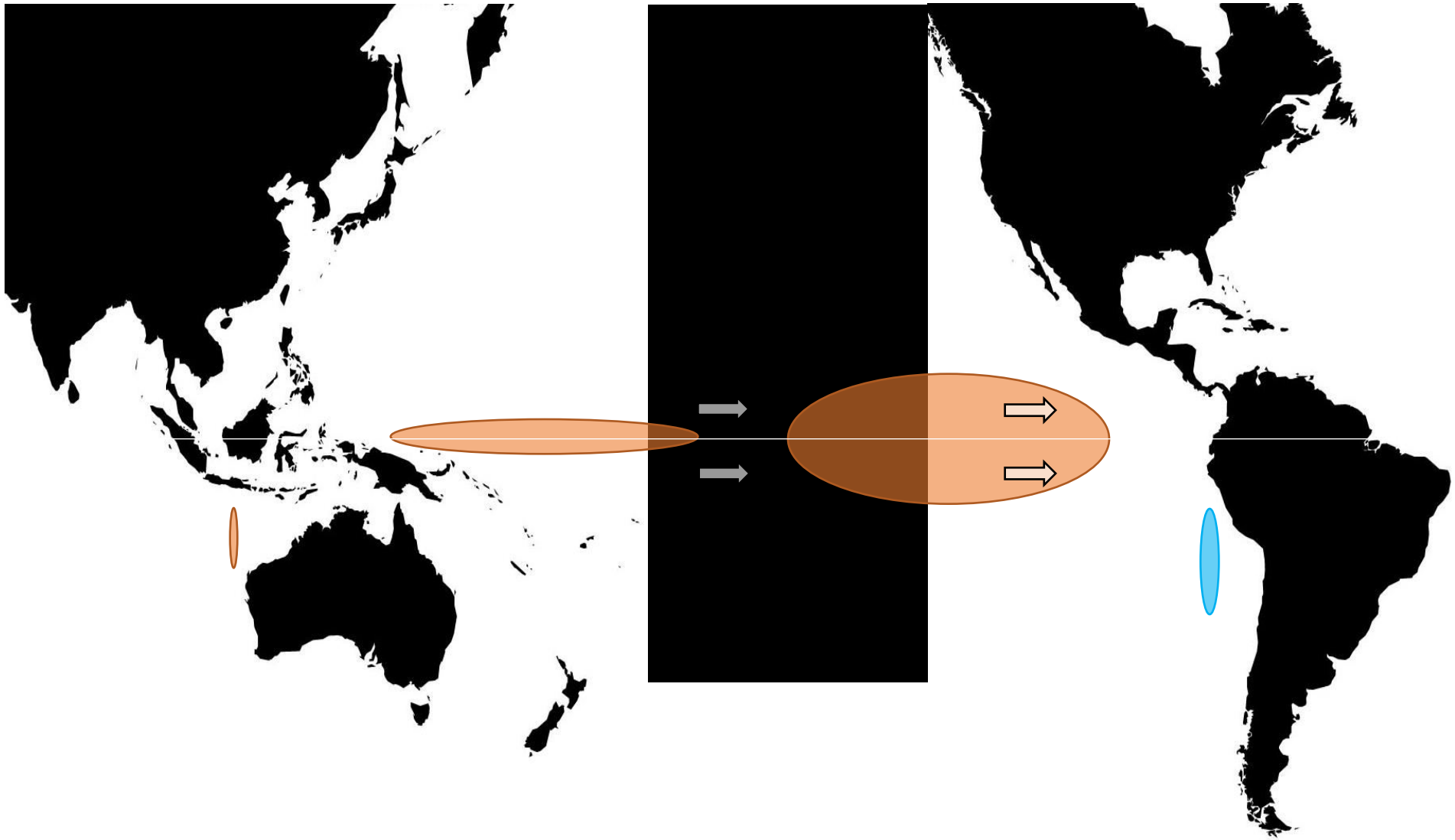
Seasonal variation



Seasonal variation



El Niño

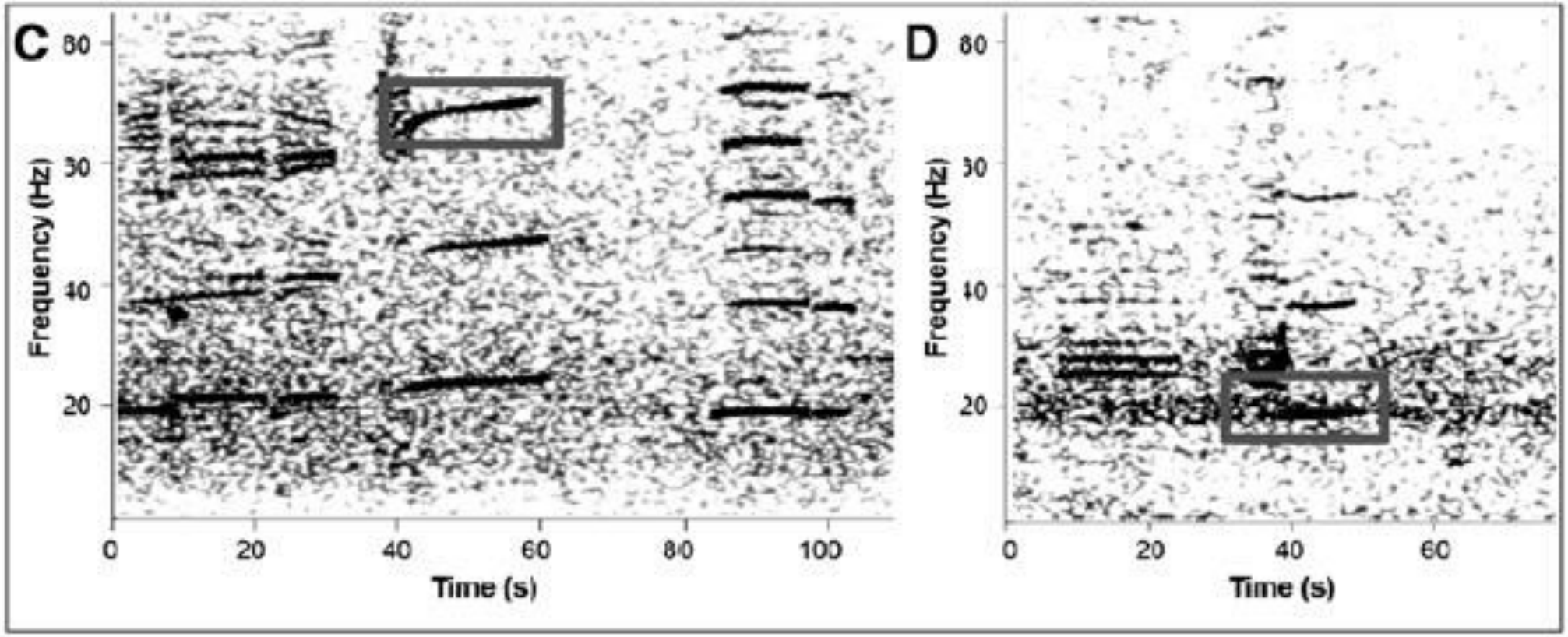


Detector performance

- Ishmael (V.1.80)
- Automated energy ratio method
- targeted the high-intensity band of the first part of the calls, between 19 and 21 Hz
- Triggered a detection when energy in this band was higher than a 0.2 threshold between 12 and 30 seconds
- bandwidth account shift ~0.14–0.16 Hz / year
- Positive detections were checked manually Raven Pro 1.4
- Missed detections & False detection for each year.

System

- 3 autonomous hydrophones, moored to the seafloor, suspended at ~1000 m.
- Record continuous ocean sound
- Sampling rate 250 Hz
- Relatively flat response (± 1 dB)
- Upper frequency limit 120 Hz
- Part of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization.



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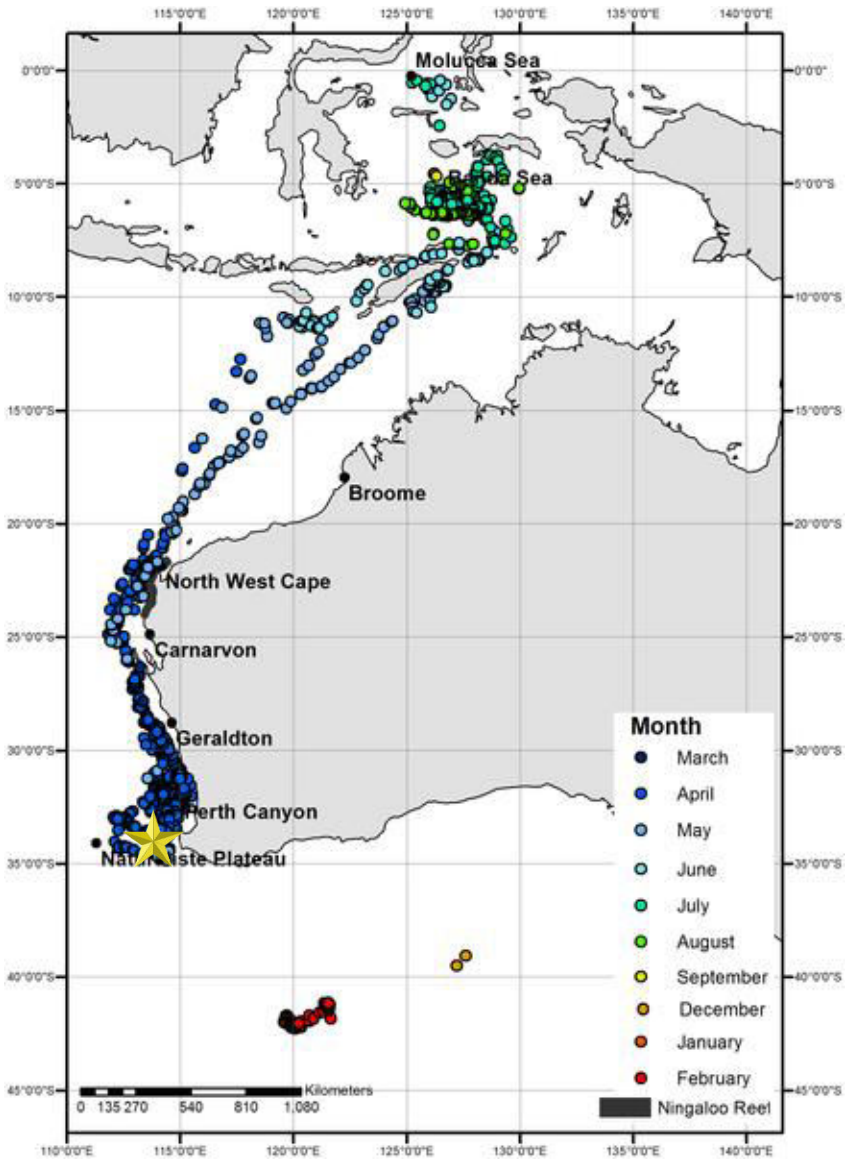

Double MC, Andrews-Goff V, Jenner KCS, Jenner MN, Laverick SM, et al. (2014) Migratory Movements of Pygmy Blue Whales (Balaenoptera musculus brevicauda) between Australia and Indonesia as Revealed by Satellite Telemetry. PLOS ONE 9(4): e93578. https://doi.org/10.1371/journal.pone.0093578
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0093578

How does ENSO work?

ENSO operates over the Pacific ocean

Results from variations in ocean temperatures in the Equatorial Pacific

Linked to extreme events such as flooding and drought

Associate Professor Tracey Rogers
Evolution & Ecology Research Centre

Model Selection

SST

SSH

Chla @ Hydrophone

Chla @ Feed

SOI