

Where did the whales go?

Movement ecology and habitat use of New Zealand southern right whales Tohorā

Xuelei Zhang^{1*}, Emma L. Carroll¹, Rochelle Constantine¹ & Virginia Andrews-Goff²
¹ University of Auckland ² Australian Antarctic Division
Email: xzha420@aucklanduni.ac.nz

New Zealand Tohorā use the subantarctic Maungahuka Auckland Islands for calving and socializing^{1,2}, where there is potential spatial overlap with human activities. Ensuring the population's long-term recovery requires better understanding of spatial and temporal habitat use in relation to Marine Protected Areas (MPAs): Marine Mammal Sanctuaries (MMS), IUCN Important Marine Mammal Areas (IMMAs).

SATELLITE TELEMETRY DATA

- High spatial and temporal resolution
- Suitable for tracking marine species that conduct long-distance seasonal migration
- All Tohorā were tagged in subantarctic Maungahuka Auckland Islands (Figure 1) with SPOT372A Argos satellite tags

Number of whales tagged	
Year	n
2020	6
2021	11
2022	8
Total	25

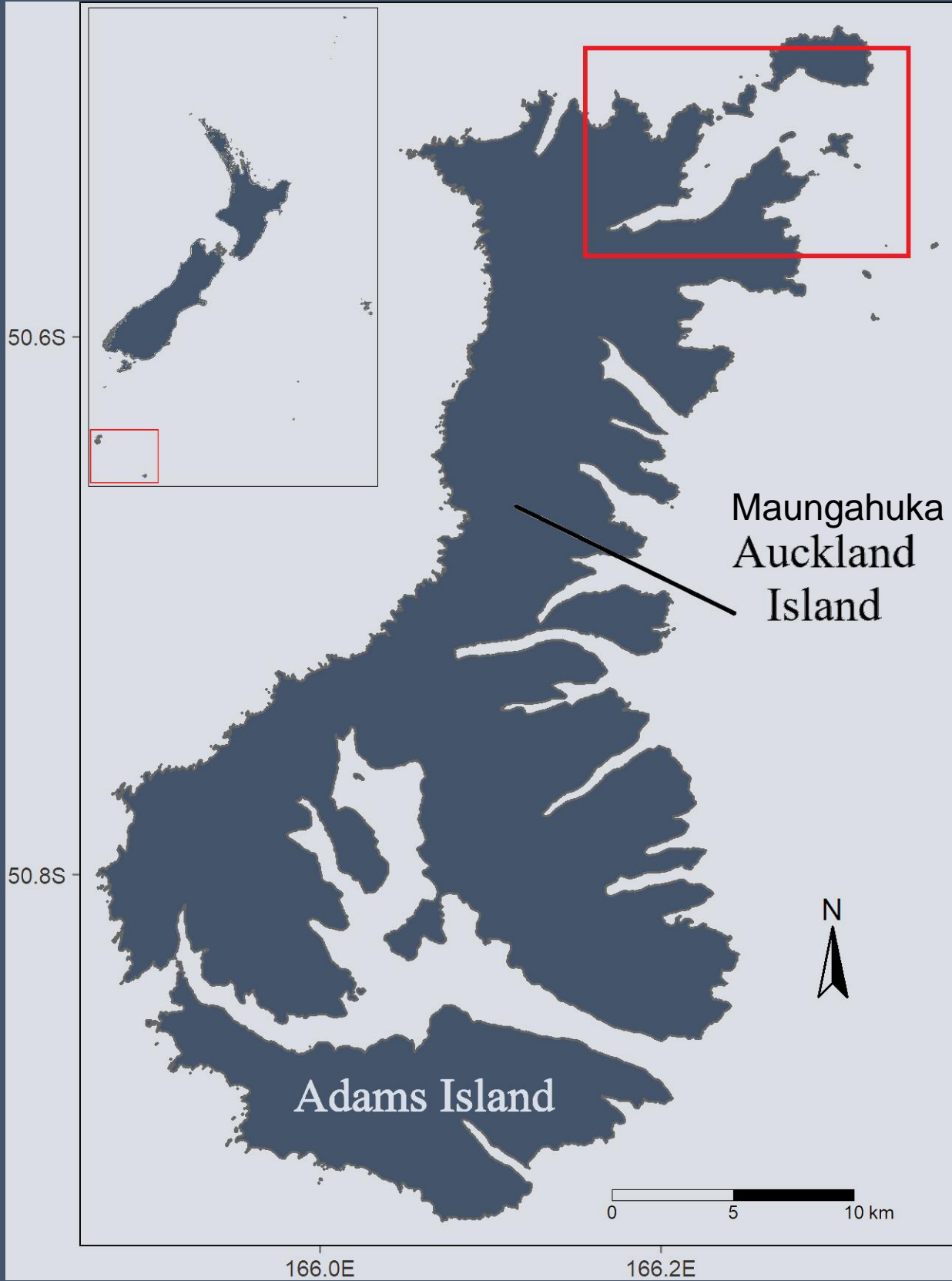


Figure 1: Map of Maungahuka Auckland Islands; red box indicates Port Ross, where the whales were tagged

STATE SPACE MODEL

- The raw locations of whales were filtered using a continuous-time state-space model³.
- A random walk movement model was applied to the QC'd data to investigate the relationship between movement, speed, and direction of tagged whales³ within the New Zealand Exclusive Economic Zone.
- Modelled data was categorized into two behavioural states: transit and area restricted search, which infers socializing or feeding behaviour.

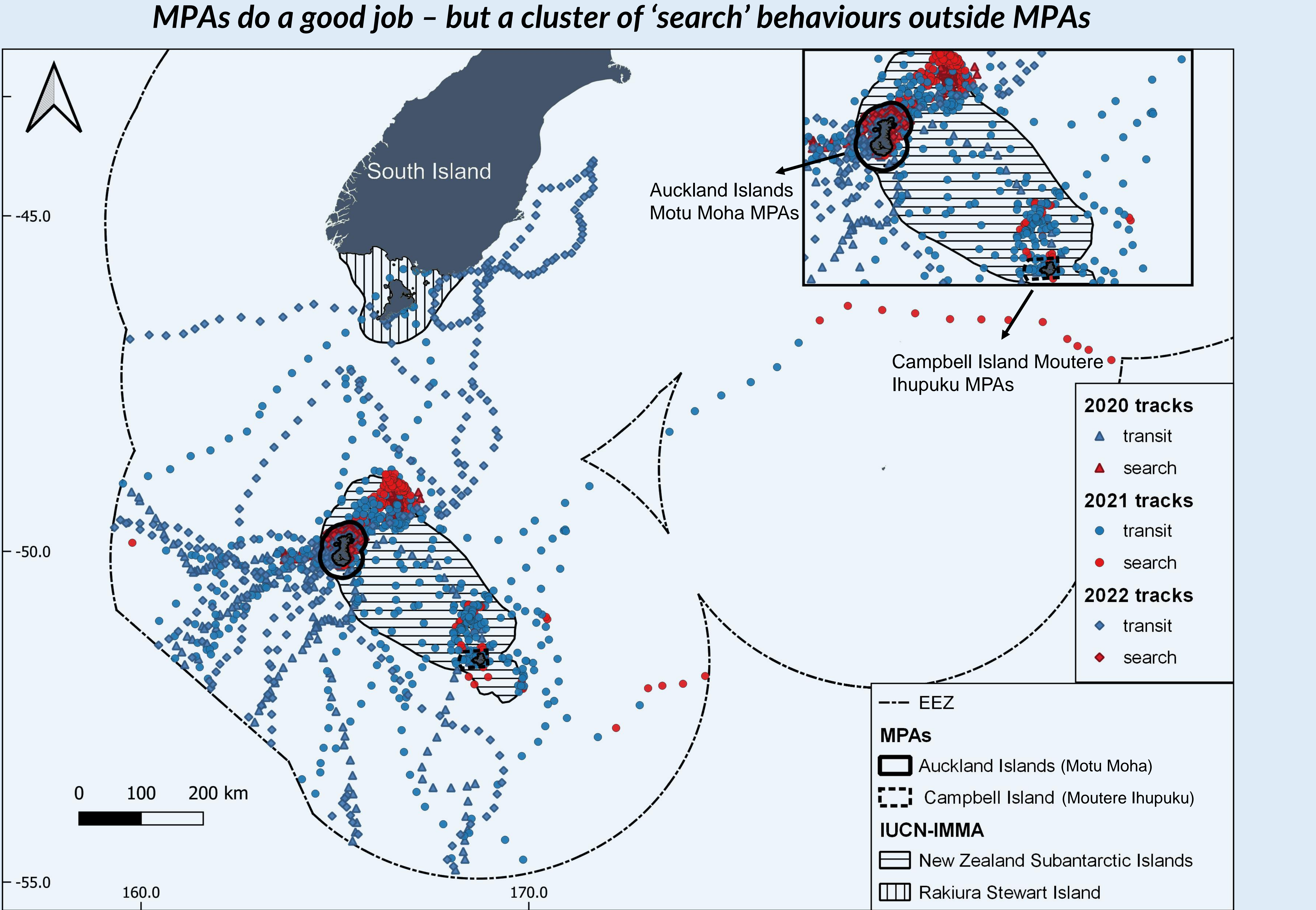


Figure 2. Behavioural states within New Zealand Exclusive Economic Zone: Red = area restricted search (e.g., foraging and socializing); Blue = inferred transit in relation to Marine Protected Areas and IUCN Important Marine Mammal Areas. Inset map shows close up of Motu Moha Auckland Islands and Moutere Ihupuku Campbell Island MPAs.

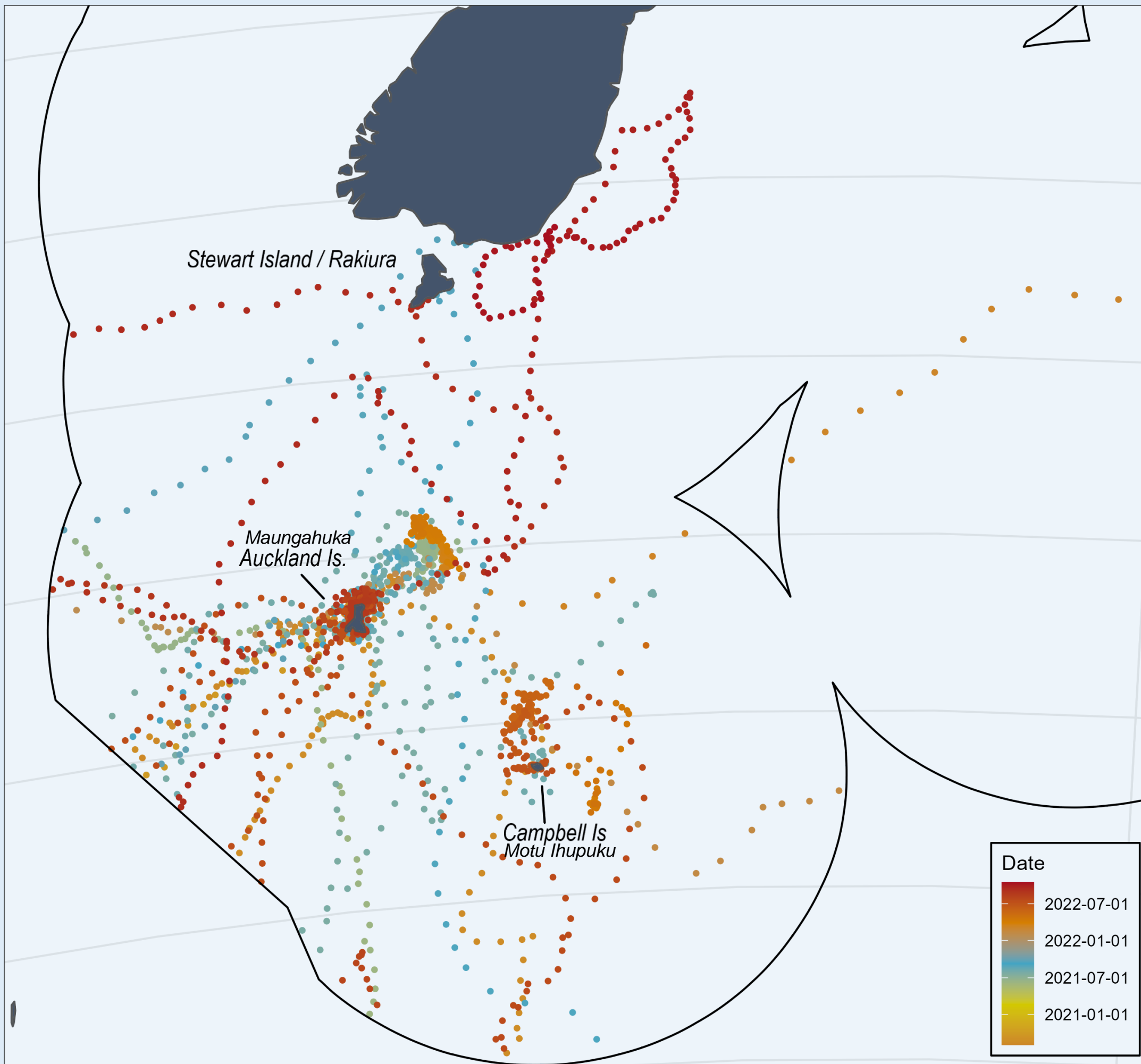


Figure 3. Temporal movement of the 25 satellite tagged Tohorā in Aotearoa New Zealand waters

Discussion and future work

- Most of the whale's search behaviours were within the MPAs.
- Most migration behaviours (transit) are not within the MPAs.
- We also identify an area northeast of the Maungahuka Auckland Islands where the whale's show search behaviours, but which is outside the MPA boundary, leaving them unprotected by current conservation measures (Fig. 2).
- Tohorā moved in several different directions when they left the Auckland Islands to conduct summer foraging (Fig. 3).
- Future work will provide a more detailed description on the movement patterns of Tohorā, including time spent within and outside MPAs in southern New Zealand and overlap with human activities (e.g., fishing, shipping)
- We will also investigate the connection between behavioural modes and environmental variables.

References:
1: Carroll et al., 2013 Ecological Applications
DOI: 10.1890/12-1657.1
2: Torres et al., 2017 Polar Biology
DOI: 10.1007/s00300-016-1926-x
3: Jonsen et al., 2020 Movement Ecology
DOI: 10.1186/s40462-020-00217-7

Acknowledgements: We thank the Kaitiaki Roopū o Murihiku for discussions around and support of this project. Fieldwork was conducted under Marine Mammal Protection Act Permit 84845-MAR, Marine Reserve Act Permit 87513-MAR and University of Auckland (UOA) Animal Ethics approved protocols 002072 and AEC23880 to ELC. Funding from Royal Society Te Apārangi Rutherford Discovery Fellowship, Live Ocean, Lou and Iris Fisher Charitable Trust, Joyce Fisher Charitable Trust, Brian Sheth/Sangreal Foundation, UOA Science Faculty Research Development Fund, International Whaling Commission - Southern Ocean Research Partnership, Antarctic and Southern Ocean Coalition, New Zealand Department of Conservation Te Papa Atawhai (DOC) and the Cawthron Institute. Thanks to field team: S. Childerhouse, E. Stuck, R. Cole, L. Riekkola, C. Meyer, B. Morris, A. Spyksma, I. Skipworth, R. Robinson, Captain Steve Kafka and crew of the Eovohe, Captain Rodney Russ and the crew of the Strannik. Thanks to Australian Antarctic Division, British Antarctic Survey, Antarctic New Zealand, Strannik Ocean Voyages, Spindrift Images, Bluff Yacht Club, DOC Southland and US National Oceanographic and Atmospheric Administration for logistic and in-kind support.