Department of Conservation
Te Papa Atawhai

File Ref: DOC-7692068

Date: 11 July 2024
To: Paul Jansen, IC, HPAI response
From: Mike Ogle, Technical adviser, Marine Species Team

Subject: Time for a southern elephant seal to travel from Antarctica to New Zealand in relation to HPAI

1 Purpose

To answer your emailed question: "*How long does it take for a sea elephant to swim from Ross Sea to a Subantarctic island and from there to NZ?*"

2 Conclusion

2.1 Travel time

Average travel time for a southern elephant seal (SES) from the Ross Sea, via Macquarie Island, to Nugget Point (southern South Island) would be just over 6 weeks (43.2 days, 95% CI 40.4 to 46.5 days). This should be considered a minimum estimate, other factors would significantly increase this; there are important caveats noted below.

2.2 Caveats

- None of the ARGOS tracks of southern elephant seals followed the hypothetical route. Instead, they mostly radiate out from Macquarie Island, generally heading either south or north before returning to Macquarie Island. Therefore, transport of HPAI by elephant seal from Antarctica to New Zealand, would more likely need to be transmitted from a southern elephant seal that had been in Antarctica, which then passed HPAI to another SES at Macquarie Island and this SES travelled north to New Zealand.
- Seasonality is important as fewer SES visit NZ in winter. Depending on time of year there could be a delay of months from contracting HPAI on Macquarie Island before travelling to NZ.
- Feeding bouts will delay travel. When calculating travel speed very few feeding bouts were included. So, again, the average travel time above would increase significantly if these were to occur.

3 Method

3.1 Hypothetical path travelled.

A location 200km east off the east coast of Oates Land in the Ross Sea was arbitrarily chosen as the start point of travel for a southern elephant seal; and travelling from there to Macquarie Island (2129km) and then on to Nugget Point, southern South Island, New Zealand (1179km), a total distance of 3308km (Figure 1). Macquarie Island was chosen as it has a large SES population

3.2 Data source

The locations downloaded for the previous file note (DOC-7679413) did not have an identifier for individual animals (or tracking device). However, another repository (with the same location points) was found to include device id as a variable. This data (IMOS 2024) was sourced from Australia's Integrated Marine Observing System (IMOS) – IMOS is enabled by the National Collaborative Research Infrastructure strategy (NCRIS). It is operated by a consortium of institutions as an unincorporated joint venture, with the University of Tasmania as Lead Agent.

3.3 Filtering & Tracks

Only location points with good quality (quality index>=0) were used. Tracks were created from these filtered points based on device id and arranged by date. The resulting tracks were further filtered with the removal of tracks that did not extend over more than 4° latitude (this removed short tracks and tracks that had no significant north or south travel).

3.4 Average travelling speed

Average speed could have been calculated from distance and time between each ARGOS fix along a track. However, this would have given an estimate that did not allow for the meandering nature of SES tracks when applied to two far distant points (as the question posed requires); and would include resting and area-restricted searching (Owen *et al* 2016). To overcome this, speeds were calculated from two distant points along parts of relatively straight track (mean length between distant points approximately 1000km) in multiple locations. These straight-line segments (n=49) were drawn over tracks using only good quality points as start and finish points (Figure 3 and Figure 4). Segments were only drawn where they would not vary from the underlying track by more than 200km and not include significant feeding bouts. To calculate speed, length of segment (Vincenty (ellipsoid) great circle distance[1]) was divided by the time taken from each segments start point to finish point. Of the 49 travelling speeds, two were considered outliers (Figure 2) and were not included in the final data. From this the mean travelling speed was estimated to be 3.2 km/h (95% CI 3.0 - 3.4, t = 28.445, df = 46, p-value < 2.2e-16).

3.5 Travel time required

With the route and average travelling speed described above, total time for travel from Ross Sea to Nugget Point (via Macquarie Island) would be 43.2 days (95% CI 40.4 to 46.5 days); breakdown see Table 1.

Table 1: Travel distance and time required

Location	Distance (km)	Mean days required	Upper 95% CI	Lower 95% CI
Ross Sea to Macquarie Island	2129	27.8	30	26
Macquarie Island to Nugget Point	1179	15.4	16.6	14.4
Total	3308	**43.2**	46.5	40.4

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References

IMOS. 2024, Satellite tracking of pinnipeds - Delayed mode, https://portal.aodn.org.au/search?uuid=06b09398-d3d0-47dc-a54a-a745319fbece , accessed 2/7/2024.

Owen et al 2016. A week in the life of a pygmy blue whale: migratory dive depth overlaps with large vessel drafts. Animal Biotelemetry (2016) 4:17. DOI 10.1186/s40317-016-0109-4

R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

[1] Function 'distVincentyEllipsoid' in package *geosphere* version 1.5-18, R Core Team (2022).

Figure 1: Hypothetical route for southern elephant seal.

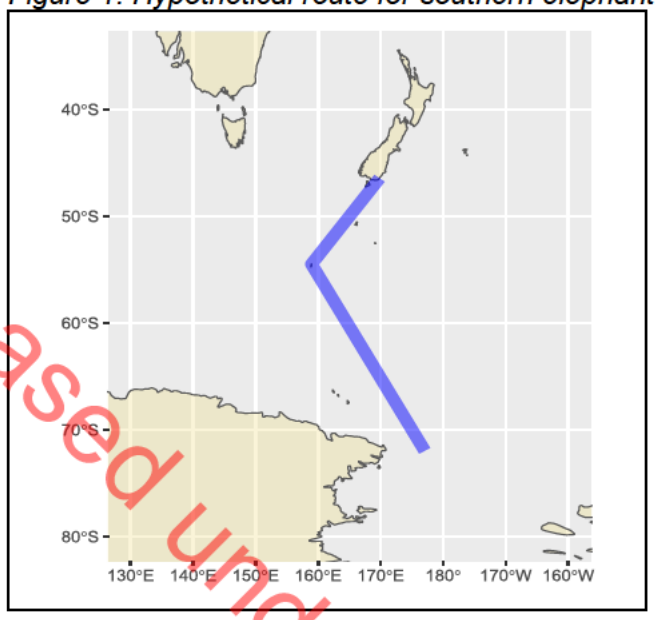
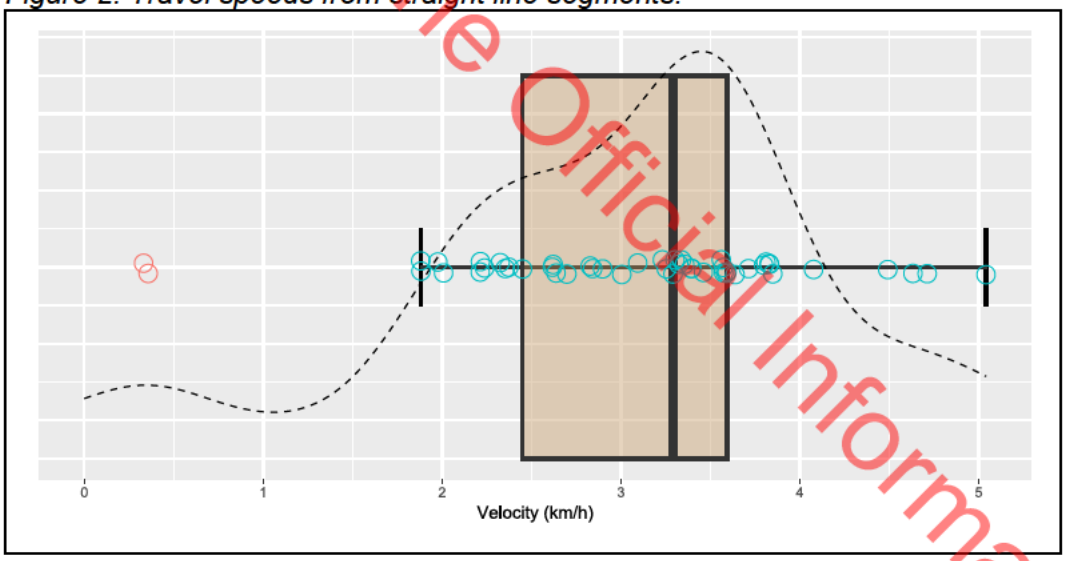
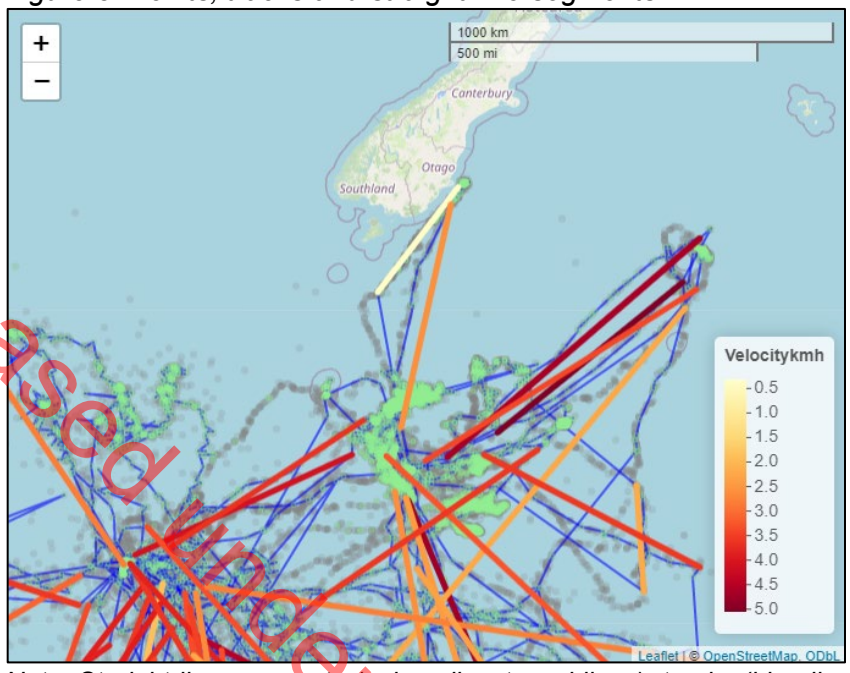


Figure 2: Travel speeds from straight line segments.



Note, shows box plot for straight line segments speeds (outliers red points), individual straight line segments speeds (blue points), density (dashed line).

Figure 3: Points, tracks and straight-line segments.



Note: Straight line segments (pale yellow to red lines), tracks (blue lines), good quality points (light green), low quality points (grey). Only partial area of all data is shown to illustrate method.

Figure 4: Individual tracks and straight-line segments used for average travelling speed