Fine scale overlap of Gibson's Albatross and pelagic longline fishing effort

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Summary

Gibson's Albatross (*Diomedea antipodensis gibsoni*) is a declining species of high conservation concern that is highly vulnerable to bycatch in commercial fisheries, as highlighted by the collaborative Spatially Explicit Fisheries Risk Assessment in Agenda Item 5.1.3. This report provides insights of four years (2019, 2022-24) of GPS/PTT satellite tracking of 82 Gibson albatross, comprising both of adult and juvenile cohorts, and spatiotemporal overlap with pelagic longline fishing effort, as inferred from Automated Identification System (AIS) data. Our findings indicate that the range of tracked birds was largely consistent across years, covering the eastern and central Tasman Sea, the Great Australian Bight, and waters off the east coast of Aotearoa New Zealand. Adults tended to predominately utilise the Tasman Sea and the Great Australian Bight, while juveniles dispersed widely into both the Tasman Sea and Pacific Ocean east of Aotearoa New Zealand. Assessments of overlap of tracked Gibson's Albatross with pelagic longline fishing effort determined that areas of highest bird-vessel overlap occurred in CCSBT and WCPFC, primarily in the central Tasman Sea and North-East of Aotearoa New Zealand. Areas beyond national jurisdiction had higher occurrences of overlap than EEZs, with the majority of overlap occurring between in areas beyond national jurisdiction in latitudes between 30°S and 20°S. Future work will include evaluating sex differences in overlap and identifying differences and trends in overlap among flag states. However, even without these additional fine-scale analyses, the work presented here provides insights into areas where Gibson's Albatross are at high risk from bycatch in pelagic longline fisheries and where increased bycatch mitigation efforts would reduce risk to Gibson's Albatross.

Background

Gibson's Albatross (*Diomedea antipodensis gibsoni*) is classified as 'Nationally Critical' under the Aotearoa New Zealand Threat Classification System and as 'Endangered' on the IUCN Red List, and is thus recognised as a species of high conservation concern (Birdlife International, 2018; Robertson et al., 2021). This species breeds exclusively on Maukahuka | Auckland Islands, in the Subantarctic of Aotearoa New Zealand, with 92% of the population breeding on Adams Island, 7% on Disappointment Island, and 1% scattered on Auckland Island. The at-sea distribution of Gibson's Albatross extends throughout the Tasman Sea and along the continental shelf of southeastern Australia, the Great Australian Bight, and eastern Aotearoa New Zealand (Walker & Elliot, 2006; Elliot et al. 2020).

The Gibson's Albatross has experienced a 5.7% per year decline in the adult population since a sudden population crash in 2005 (Francis et al., 2015; Elliot et al., 2020). Since then, population recovery has been very slow to limited with the current population estimated at ~5400 breeding pairs. This number comprises less than half of the estimated breeding pairs pre-population crash (Rexer-Huber et al., 2020, Walker et al. 2023). Fishing-related mortality from bycatch in commercial fisheries is a key threat to Gibson's albatross, mainly from pelagic longline fisheries, particularly in areas beyond Aotearoa New Zealand's jurisdiction (Francis et al., 2015).

As a result, since December 2019, The New Zealand Department of Conservation – Te Papa Atawhai (DOC) and Ministry for Primary Industries (MPI) have been undertaking a multi-year tracking project, deploying satellite transmitting devices on Gibson's Albatross across various age classes and breeding states. This tracking project is aimed to provide insights into the species' distribution and provide a detailed understanding of spatiotemporal overlap with pelagic longline fishing effort throughout its range.

Methods

Tracking devices

A total of 82 Gibson's albatross over four years (2019, 2022-24) were fitted with GPS/PTT satellite transmitters to their back feathers using water-proof tape. Full details of the fieldwork, technical details of transmitting devices, and attachment methods are reported by Rexer-Huber et al. (2020), Parker et al. (2022) and Walker et al. (2023). These devices provide location data for as long as they are attached to the birds (mean = 184 days).

Tracking data

Following deployment, data were compiled and cleaned to evaluate bird location data. Location data was cleaned as following: 1) PTT-derived locations with an Argos quality of A, B and Z were discarded (Douglass et al., 2012), 2) Argos-generated error ellipse variable of >10km error radius were eliminated, and 3) a speed filter was applied removing flight speeds greater than 50 m/s as sustained flight at this speed was deemed unrealistic (Merkel et al., 2016; Bose & Debski, 2020). In the circumstance that both a GPS fix and PTT-derived location were available, GPS fixes with a consistent fix interval (6 hours) were chosen and the PTT-derived location was discarded. If the fix interval was >6 hours and a PTT-derived location was available, then this was chosen. Following this cleaning process, 53,918 albatross locations were retained and used as the final data set.

To generate insights into the relative occurrence of Gibson's albatross within geopolitical areas, we first quantified bird occurrence, which was calculated by dividing the number of bird hours spent in an area by the total number of bird hours in that particular year. Relative occurrence was then allocated into various jurisdictions: 1) Exclusive Economic Zones (EEZs) and Areas Beyond National Jurisdiction (ABNJ), as well as per Regional Fisheries Management Organisations (RFMOs) (including EEZs), including the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), the Western and Central Pacific Fisheries Commission (WCPFC), the Inter-American Tropical Tuna Commission (IATTC), and the Indian Ocean Tuna Commission (IOTC). The WCPFC region was calculated separately (eastern and western WCPFC), determined by east or west of the 180° meridian line. As some RFMOs overlap, the total sum of the relative occurrence exceeded 100%.

Point-based fishing effort overlap estimation

To quantify spatiotemporal overlap of fishing effort for each bird location, we identified vessels within a 100 km radius albatross locations, acquiring vessel information (fishing effort, gear type, and flag state) from Global Fishing Watch (GFW) at a 0.01° x 0.01° daily resolution (Kroodsma et al., 2018). For the spatiotemporal overlap analyses, we first interpolated albatross tracks at 1 hr intervals. Total spatiotemporal overlap between a fishing vessel and bird location was then calculated by the total fishing effort value for that location, divided by 24 and then multiplied by the mean bird hour for that location. Overlap of fishing effort with bird location was then separated into 5° latitudinal bands, to identify the total percentage overlap within separate latitudinal regions. And presented as percentage overlap.

Results

At-sea distribution

The at-sea distribution of Gibson's Albatross is shown in Fig. 1a-4a, with birds ranging from 22°S to 65°S into Antarctic waters, as well as extending across to south-western Australia 106°E and east of Rēkohu | Wharekauri | Chatham Islands at 140°W. The general distribution of Gibson's Albatross throughout the years shows consistent utilisation of the central and eastern Tasman Sea. Small portions of the adult population are seen to extend off the Chatham Rise and continental shelf of southern Australia, with adult males in particular observed dispersing into the Southern Ocean and to south-western Australia. Adult Gibson's Albatross spent 50% of their time within the Aotearoa New Zealand EEZ, 30% in Areas Beyond National Jurisdiction (ABNJ), and the remaining 20% in the EEZs of other countries such as Australia, Fiji, and Tonga (Fig. 1d-4d). Adult Gibson's Albatross distribution largely fell within the Convention Areas of CCSBT and WCPFC, with some use of the Convention Area of IOTC.

Similarly to adults, juveniles dispersed widely into the Tasman Sea, southern Australia, and off the east coast of Aotearoa New Zealand. Juvenile distribution, however, extended further east and north compared to the adults, spending almost 50% of their time in ABNJ (Fig. 3d). Juveniles occurred in the Aotearoa New Zealand EEZ the most, followed by the Australian EEZ and, to some extent, dispersed into other EEZs of countries in the Pacific Ocean. As juvenile Gibson's Albatross dispersed further than adults, they occurred in several RFMO Convention Areas, primarily in CCSBT and Western WCPFC followed by Eastern WCPFC, IOTC, and IATTC.

Spatiotemporal overlap with pelagic longline fishing effort

Spatiotemporal overlap of Gibson's Albatross with pelagic longline fishing effort varied over space and time. The majority of pelagic longline fishing overlap occurred in the central Tasman Sea, and North-East of Aotearoa New Zealand (Fig. 1a-4a). Bird-vessel overlap occurred predominantly in ABNJ, just outside the Australian EEZ and North-East of the Aotearoa New Zealand EEZ. While overlap was highest in ABNJ, there was overlap off the east coast of Australia as well as small amounts of overlap around the coast of Aotearoa New Zealand. The overlap hotspot within the central Tasman Sea appeared consistent across years.

The probability of spatiotemporal overlap between Gibson's Albatross and pelagic longline effort showed an inverse relationship with latitude. The further North birds occurred, the more likely they were to overlap in space and time with fishing effort. Specifically, the probability of overlap was the highest between 30°S and 25°S, followed by 25°S and 20°S (Fig. 1e-4e). Overlap between 30°S and 25°S was consistently the highest for adults across all years, while juveniles had equally high overlap further north between 25°S and 20°S. While Gibson's Albatross disperse into four RFMO regions, total overlap hours was highest where birds were observed to occur the most, i.e., in the CCSBT and WCPFC Convention Areas.

Next steps

Future work will include the completion of the 2024 tracking year with a possibility of continuing another year of tracking in 2025. Further fine scale analyses will be completed, specifically identifying sex differences and identifying relative overlap with different flag states.

While further analyses will be undertaken, new data are unlikely to deviate from the results presented here. The data presented here already provides clear insights into the consistent use of the central Tasman Sea by Gibson's Albatross. We illustrate that this area is where most spatiotemporal overlap with pelagic longline fishing is occurring, and thus where bycatch risk to Gibson's Albatross is likely the highest. Given these insights and the high risk status assigned to Gibson's Albatross as per the collaborative Spatially Explicit Fisheries Risk Assessment in Agenda Item 5.1.3, increased bycatch mitigation efforts here, particularly in latitudes between 30°S and 25°S, appear warranted to reverse the severe decline observed at the colony. Additionally, as we only analyse overlap, not direct risk, increased observer coverage, either direct or through electronic monitoring would provide further insights into how the identified overlap translates into bycatch risk.

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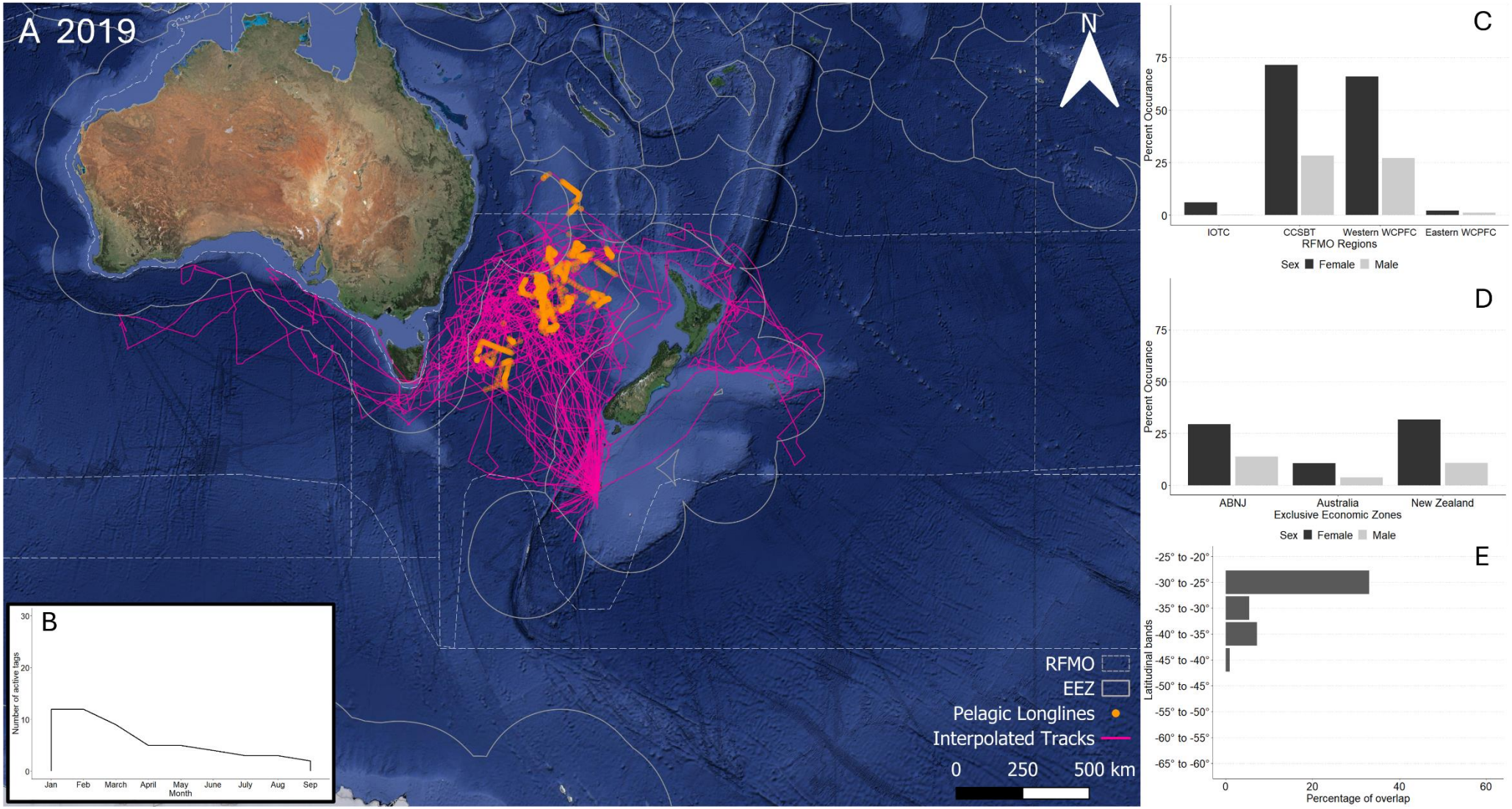

Figure 1: A) Overlap of Gibson's albatross tracks (n = 10 adult females, n = 2 adult males) and pelagic longlines fishing effort during 2019. B) Transmission duration of satellite trackers deployed on Gibson's albatross in 2019. C) Relative occurrence of Gibson's albatross per RFMO. D) Relative occurrence of Gibson's albatross per EEZ. E) Percentage of albatross locations overlapping with longline fishing effort per 5° latitudinal bands in 2019.

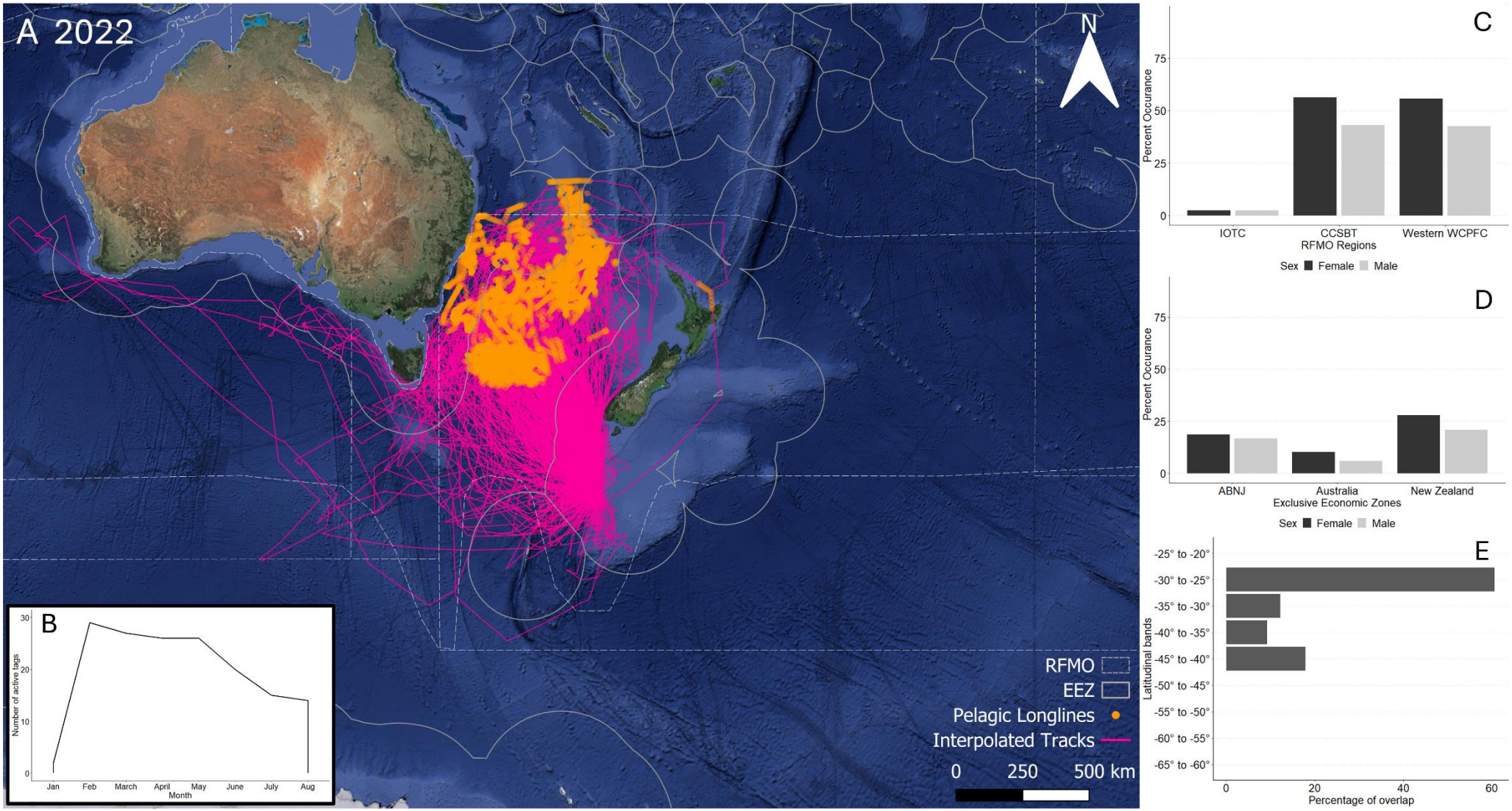

Figure 2: A) Overlap of Gibson's albatross tracks (n = 15 adult females, n = 13 adult males) and pelagic longlines fishing effort during 2022. B) Transmission duration of satellite trackers deployed on Gibson's albatross in 2022. C) Relative occurrence of Gibson's albatross per RFMO. D) Relative occurrence of Gibson's albatross per EEZ. E) Percentage of albatross locations overlapping with longline fishing effort per 5° latitudinal bands in 2022.

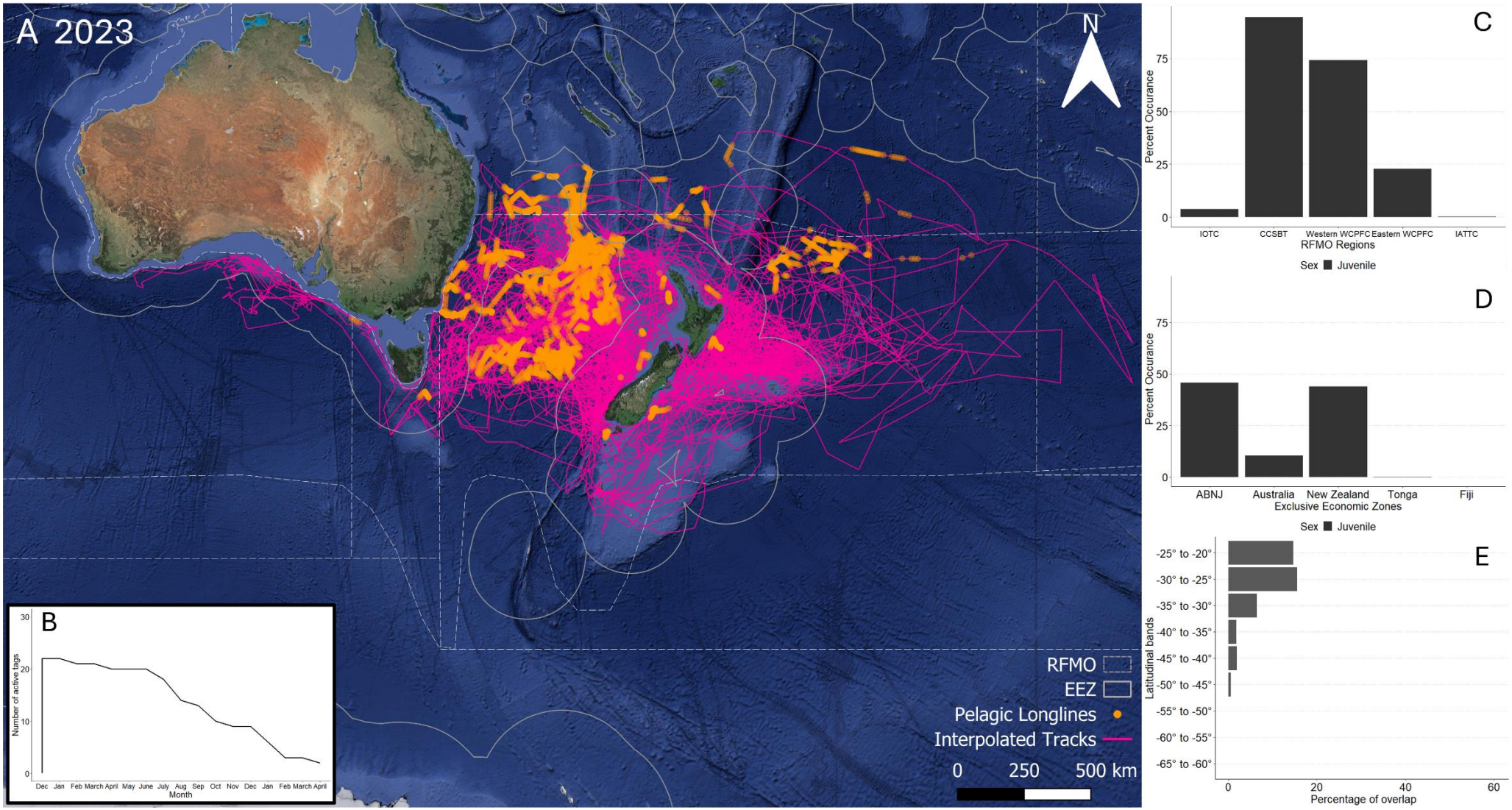

Figure 3: A) Overlap of Gibson's albatross tracks (n =22 juveniles) and pelagic longlines fishing effort during 2023. B) Transmission duration of satellite trackers deployed on Gibson's albatross in 2023. C) Relative occurrence of Gibson's albatross per RFMO. D) Relative occurrence of Gibson's albatross per EEZ. Note: Values <0.01 are not visible due to axis scaling. E) Percentage of albatross locations overlapping with longline fishing effort per 5° latitudinal bands in 2023.

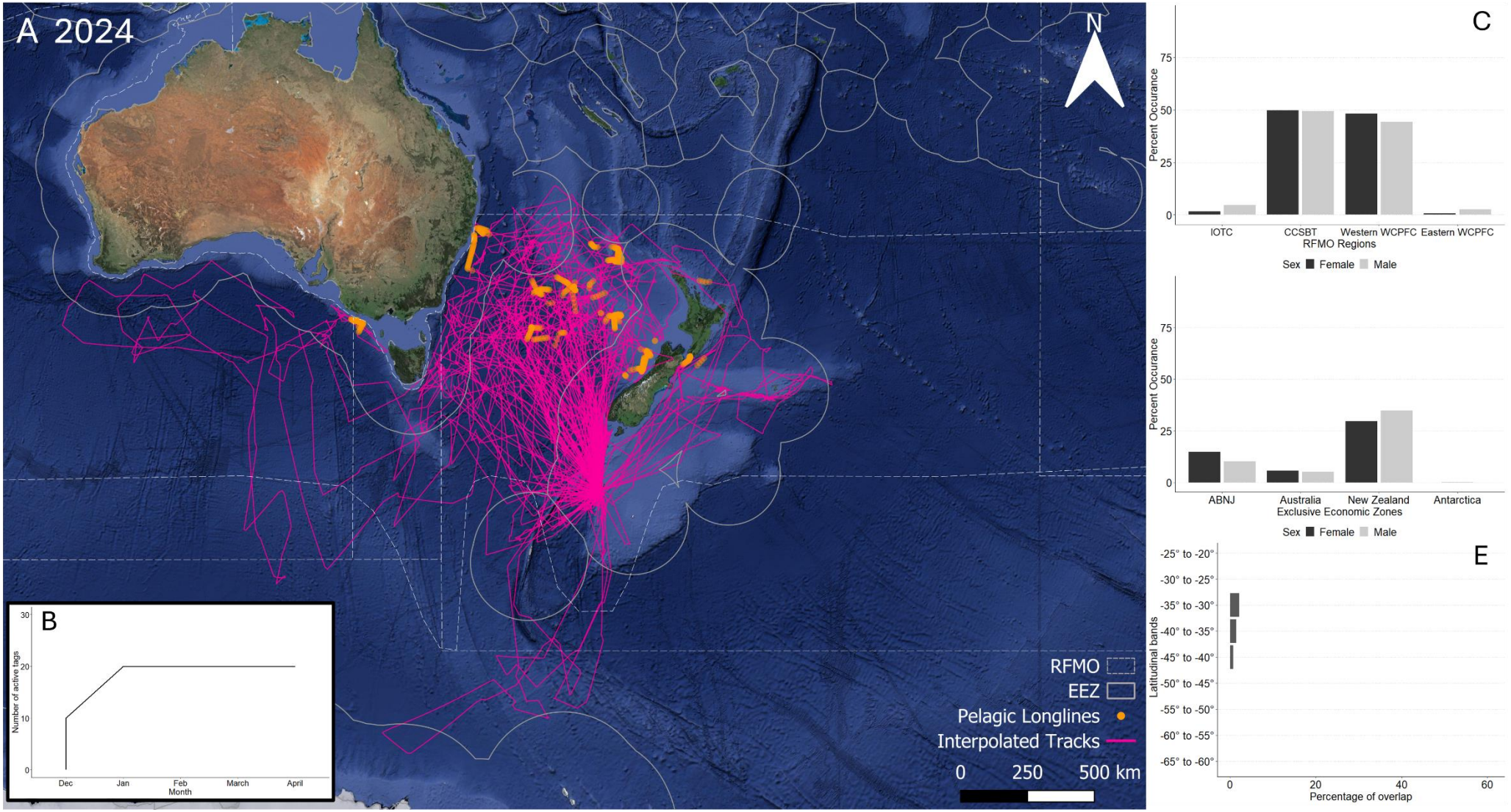

Figure 4: A) Overlap of Gibson's albatross tracks (n = 10 adult females, n = 10 adult males) and pelagic longlines fishing effort during 2024. B) Transmission duration of satellite trackers deployed on Gibson's albatross in 2024. C) Relative occurrence of Gibson's albatross per RFMO. D) Relative occurrence of Gibson's albatross per EEZ. Note: Values <0.01 are not visible due to axis scaling. E) Percentage of albatross locations overlapping with longline fishing effort per 5° latitudinal bands in 2024.

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