ERSWG16: Status of Seabird Distribution data used in the 2025 SEFRA

BirdLife International and ACAP

Canberra, Australia, March 3rd-6th, 2026

Executive Summary

The 2025 CCSBT SEFRA distribution maps represent a major advancement in identifying the spatio-temporal "hotspots" where seabirds are most vulnerable to longline fishing. By integrating high-precision tracking data, weighting by colony size and phenological data (average timing of breeding and migration), and disaggregating information to a monthly resolution, these models move beyond static range maps to provide a temporally dynamic understanding of bird density across the Southern Hemisphere. The power of this approach lies in its ability to weight distributions by colony size, ensuring that the influence of major populations is better reflected and that conservation efforts can be directed toward areas with the highest potential areas of seabird bycatch in CCSBT fisheries.

However, these results must be interpreted with caution, as the models use minimum known distribution information and thus likely results in biased estimates of total risk. To adopt a robust precautionary approach, it is recommended that enhanced bycatch mitigation measures be implemented over broader geographic regions. While these efforts should be centered on identified high-risk hotspots—such as the Tasman Sea, the south-eastern Indian Ocean, and the south-eastern Atlantic—they must extend further to account for the wider dispersal of juveniles and immatures and distributions of un-tracked colonies.

The following factors affecting seabird distribution data used in the SEFRA necessitate a precautionary interpretation of the model findings:

- **Exclusion of Non-Adult Life Stages:** The current density maps represent adult birds only, which is a major limitation because juveniles and pre-breeders (immatures) account for 47% to 81% of total population numbers.
- **Underestimation of Exposure:** Using only adult distributions underestimates exposure to longline fishing effort by up to 18% to 42%[i], as juveniles often disperse more widely and into more northerly latitudes where fishing effort is more concentrated.
- **Potentially Biased Diagnostic Assumptions:** The SEFRA model compares estimated deaths (which may include sub-adults) against relative mortality calculated using only the adult population size.
- **Data Gaps and Outdated Censuses:** Several globally significant breeding populations have not been surveyed in over 10 years, and tracking data are still missing for several

major colonies, providing results that cannot be used (e.g. for giant petrels), or requiring the model to rely on secondary sources or homogeneous range maps to fill the gaps.

- **Assumption of Constant Catchability:** The models assume that catchability is constant across space and within a genus, meaning any regional or age-specific increases in vulnerability to fishing gear are not currently captured.
- **Assumption of static population size:** The models assume a static population size, but we know many of the populations are in decline. In this scenario comparison among years in SEFRA outputs that appear to indicate a reduction in catchability is misleading as this can be driven by the lower number of birds available to catch.

Due to the uncertainties outlined above, high risk areas identified using current SEFRA input data likely fail to capture the full extent of seabird interactions with the fishery. Thus, additional management measures (improved bycatch mitigation) to reduce bycatch over broader areas based on, and centered on, those areas of known high risk are required.

SEFRA Seabird Distribution Methods

For the 2025 CCSBT Spatially Explicit Fisheries Risk Assessment (SEFRA), distribution maps were updated for 16 albatross and petrel taxa, including great albatrosses, mollymawks, sooty albatrosses, and medium petrels. The methodology used to generate these distribution maps relied on integrating diverse tracking datasets with demographic weighting to create representative population-level density maps. Primary data were requested from individual owners via BirdLife International's Seabird Tracking Database (STDB) and provided directly by the New Zealand Department of Conservation (DOC). There were three types of electronic tracking data to estimate the at-sea density of seabirds:

- GPS (Global Positioning System): These data provide high-precision locations and were preferred whenever available.
- PTT (Platform Terminal Transmitters): These were also a preferred data source for tracking the wide-ranging foraging distributions of albatrosses and petrels.
- GLS (Global Location Sensing): Also referred to as geolocation data, GLS record ambient light levels from which location information are calculated, but at a lower precision to other biologgers. As such, GLS was used as a secondary source when GPS and PTT data were unavailable or when the sample sizes for those devices were too small—specifically, if they included fewer than five individuals or had representativeness lower than 70%.

For the species distribution modelling process, each individual track was interpolated regularly in time to ensure equally spaced points. This is necessary to prevent different tag types from biasing the results because the different tags report data at different intervals [i]. That is, to ensure that individual birds with high-frequency reporting did not disproportionately influence the distribution model, each track was interpolated regularly in time to obtain points that were equally spaced. These values were then standardised (divided by the mean to ensure that the characteristics of a few individual birds did not dominate the final model). This created a weighted count per day per track for specific grid cells and months and was aggregated and the final models were fitted to

tracking data at a 1-degree cell resolution. Predictions were initially made at a 1-degree resolution before being aggregated to the 5-degree resolution required for the final SEFRA model to overlay with fishing effort data.

The relative densities were weighted by mean colony size (average number of breeding pairs) to ensure the maps better reflected the influence of larger populations. To address significant geographic gaps where primary tracking data were missing for major breeding colonies, the models were augmented with two secondary data types:

- Spatial Predictions: Quarterly spatial count predictions from Carneiro et al. (2020) [i] were used to "plug" gaps for six taxa, including Gibson's, Grey-headed, Light-mantled sooty, Sooty, Atlantic yellow-nosed, and Black-browed albatrosses.
- Range Maps: The density maps were combined with BirdLife International range maps to account for any colonies that had no empirical tracking data at all.

Gaps and Limitations of Seabird Distribution Data

The distribution data includes several caveats and data gaps for the 16 seabird taxa assessed in the 2025 SEFRA, ranging from life-stage biases to significant geographic and temporal gaps in tracking data.

1. Major Life-History Gap: Adult-Only Focus

The primary limitation of the distribution mapping is that it represents adult birds only. The 2025 distribution maps do not include juveniles or pre-breeders (immatures). This is a significant gap because non-breeding stages can account for 47%–81% of total population numbers[i]. Juveniles and pre-breeders often disperse more widely and into more northerly, less productive waters than adults. For species like the Wandering albatross, juveniles favour lower latitudes where they are far more likely to encounter longline vessels. The modelling suggests that using only adult distributions can underestimate exposure to longline fishing effort by up to 18%–42% [i].

2. Geographic and Colony-Level Data Gaps

Tracking data were not available for every major breeding colony, requiring gaps to be filled with secondary sources. Specifically, tracking data were missing for major colonies of six taxa: Gibson's, Grey-headed, Light-mantled Sooty, Sooty and Black-browed albatrosses, as well as Atlantic yellow-nosed albatross (Table 1). To address these gaps, models were augmented with quarterly spatial predictions from Carneiro et al. (2020) [i], which were rescaled based on the most recent colony size estimates. However, Carneiro et al's maps often represent combined life stages (including juveniles), whereas the rest of the SEFRA distribution data are adult-only, potentially creating inconsistencies in distribution resolution.

The accuracy of the distribution maps relies on weighting tracking data by colony size, yet demographic data are often outdated. ACAP reports that many globally significant breeding populations haven't been censused in over 10 years, and some species, such as the Light-mantled sooty albatross, are notoriously difficult to survey accurately. Further, populations in the distribution models are assumed to be static, when many are declining.

A major diagnostic issue is that observed captures sometimes occur in 5-degree cells where the model predicts zero bird density. This indicates inconsistencies between assumed distributions and actual bird presence, likely caused by misidentification of species or the capture of untracked pre-breeders, and may fail to capture the full spatial extent of bird presence. To account for colonies with zero tracking data and captures reported in 'zero-density zones, the SEFRA relies on BirdLife International range maps, which are used to represent the remainder of the population (i.e., after the proportion of the population where breeding pairs from colonies that have tracking data are accounted for). In the 2025 SEFRA, there were 418 individual birds recorded in 'zero-density' zones. By using the composite maps that included the range maps, this number was reduced to 72 individuals in exploratory model runs, and then 6 individuals in the final dataset (9,815 captures). While helpful for filling gaps, these range maps assume a homogeneous distribution within the species range, failing to account for the heterogeneous "hotspots" identified by empirical tracking.

3. Temporal and Species-Specific Data Gaps

Many species have significant gaps in their temporal coverage, meaning data are missing for several months of the year (Table 1). Some major colonies are represented by a very small number of tracks. For example, the Tristan da Cunha colony for Sooty albatross is based on only three tracks (Table 1).

TABLE 1: SUMMARIES OF THE TOTAL NUMBER OF TRACKS USED TO CREATE THE DENSITY LAYER BY SPECIES, AND SPECIFIC GEOGRAPHIC AND TEMPORAL GAPS IDENTIFIED. THE TOTAL NUMBER OF TRACKS USED FOR THESE 16 TAXA WAS 4,281, WHICH PROVIDED ENOUGH POWER FOR THE SPATIAL MODELS TO EXPLAIN 67% TO 91% OF THE DEVIANCE IN BIRD DENSITY:

Species	Tracks Used in Density Layers	Geographic/Colony Gaps	Temporal Gaps
Gibson's albatross (*Diomedea antipodensis gibsoni*)	41	Missing primary tracking for Disappointment Island (augmented with secondary data).	No data available for October–December; limited data in January and September.
Wandering albatross (*Diomedea exulans*)	1,770	Limited primary data for the Macquarie (only 7 birds) and Marion Island colonies.	Macquarie: coverage only Dec–Mar; Marion Island: coverage only Jan–Sep.
Southern royal albatross (*Diomedea epomophora*)	66	Tracking data were largely limited to the South Pacific region.	Good monthly coverage but lacks circumpolar spatial breadth in adult tracks.
Atlantic yellow-nosed albatross	135	Missing data for the main colony (Tristan da Cunha) and Middle & Stoltenhoff.	No tracking data available from June to September for any colonies.

(*Thalassarche chlororhynchos*)			
Black-browed albatross (*Thalassarche melanophris*)	2,168	Tracking data were sparse for the Islas Diego Ramirez colony.	A northward truncation of tracking in the South Indian Ocean was observed.
Campbell black-browed albatross (*Thalassarche impavida*)	78	Single-colony focus (Campbell Island); missing Western Australia and Chile.	Coverage spans all months, but long-range tracks were not adequately modelled.
Shy albatross (*Thalassarche cauta*)	171	Known foraging areas in the Indian Ocean and off South Africa are missing.	Gaps exist because those regional data are juvenile-only and excluded from this model.
Grey-headed albatross (*Thalassarche chrysostoma*)	782	Missing data for Prince Edward Island (PEI), Crozet, and Kerguelen.	Notable gaps in predicted distribution in the South Indian Ocean (Mar–May).
Southern Buller's albatross (*Thalassarche bulleri bulleri*)	56	Data missing for portions of the year for both Snares and Solander colonies.	Snares: missing Dec–Mar; Solander: missing Sep–Feb.
Northern Buller's albatross (*Thalassarche bulleri platei*)	81	Missing primary tracking data for the Rangitatahi/Sisters colony.	Model unable to fully shift birds to the South American coast by August.
Sooty albatross (*Phoebetria fusca*)	321*	Missing data for PEI and Tristan da Cunha (augmented with secondary maps).	PEI: only 2 tracks (Jul/Sep); Tristan: only 3 tracks (missing Jan–Oct).
Light-mantled sooty albatross (*Phoebetria palpebrata*)	166	Missing data for PEI, Kerguelen, Macquarie, and Auckland Islands.	Tracks were sparse for the Marion Island colony during September and October.
Grey petrel (*Procellaria cinerea)*	134	Missing tracks for PEI & Marion, Crozet, and Kerguelen.	NZ populations were previously erroneously weighted as 6.9% rather than 70%.
Black petrel (*Procellaria parkinsoni*)	163	Concerns regarding the precision of GLS data in Central America and the Caribbean.	Species predicted at low densities around NZ in July when they should be absent.
Westland petrel (*Procellaria westlandica*)	333	Single-colony focus (Punakaiki).	Predicted high densities in NZ waters Jan–Mar although most birds migrate.
White-chinned petrel (*Procellaria aequinoctialis*)	392	Missing Campbell and Disappointment colonies; South Georgia (Islas Georgias del Sur)** dominates.	Tracking identifies the Benguela upwelling zone only between February and September.

* The number 321 represents the total count of tracks used to create the adult density layers for the sooty albatross across all its breeding sites, including Marion (193 tracks), Gough (75 tracks), and Crozet (50 tracks). These tracks provided a robust baseline for the species' overall movement, but the 3 tracks for Tristan da Cunha represented a critical weakness that had to be corrected using secondary modelling sources.

** A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Islas Malvinas), South Georgia and the South Sandwich Islands (Islas Georgias del Sur y Islas Sandwich del Sur) and the surrounding maritime areas.

Conclusion:

Interpreting the outputs of the 2025 SEFRA must be done with a clear understanding of the uncertainties, limitations, and gaps in the available tracking data and the composite distribution maps. The updated distribution mapping for the 2025 SEFRA employed a refined framework to ensure that larger colonies had a proportional influence on the final species-level maps. However, the SEFRA methodology assumes that tracking data from specific sites combined with the BirdLife range maps accurately represents the distribution of the global population, which may not always be the case. Further, because the current SEFRA model focuses on adult birds, the tracking data included only adults or individuals where the life stage was unknown. While the 2025 seabird distribution updates included significantly more data than previous versions, reducing instances where missing colonies accounted for a large percentage of breeding pairs, tracking data were not available for all major breeding colonies. These caveats must be taken into account when addressing seabird bycatch in CCSBT fisheries.

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[i] Carneiro, A.P., Pearmain, E.J., Oppel, S., Clay, T.A., Phillips, R.A., Bonnet-Lebrun, A.S., Wanless, R.M., Abraham, E., Richard, Y., Rice, J. and Handley, J., 2020. A framework for mapping the distribution of seabirds by integrating tracking, demography and phenology. Journal of Applied Ecology, 57(3), pp.514-525.