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Analysis of albatross and petrel distribution within the IATTC area: results from the Global *Procellariiform* Tracking Database

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ABSTRACT

This paper presents an analysis of the distribution of albatrosses and petrels within the IATTC area, using data from the Global *Procellariiform* Tracking Database. The results indicate the importance of the IATTC area for Waved Albatross. In addition, while at a global level the IATTC area has a lower degree of overlap with breeding albatross distribution compared to other RFMOs, the results emphasise the importance of the IATTC area for albatrosses foraging during non-breeding periods. This includes non-breeding Black-footed Albatross in the North Pacific; a range of albatross species from New Zealand, which migrate across the South Pacific to take advantage of rich foraging opportunities in the Humboldt Current; and Black-browed Albatross which breed in Chile. The IATTC area is also highly important for the breeding distribution of the small population of Laysan Albatross on Isla de Guadalupe, Mexico, and for the non-breeding distribution of Northern Royal Albatross from Taiaroa Head, New Zealand. Tracking data are not yet available for the non-breeding distribution of Buller's or Salvin's Albatross, but data from other sources suggests the particular importance of the IATTC area for these species, and also for Laysan Albatross. The albatross tracking data indicate a high degree of overlap with the 5x5 degree grid squares within which there was longline fishing effort in the period 1997-2004.

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Albatross and petrel tracking data presented in this report are from the Global *Procellariiform* Tracking Database. Data holders of those data analysed in this paper are listed below. Initial results from analysis of the database have been published in *Tracking Ocean Wanderers* (BirdLife International, 2004b). This report was prepared by Dr Cleo Small, BirdLife International Global Seabird Programme (cleo.small@rspb.org.uk) and Frances Taylor (softfrog@lantic.net), who bear responsibility for the accuracy of information presented here, not the data holders. The presentation of material in this report does not imply any expression of opinion on the part of BirdLife International concerning the legal status of any country, territory or area

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1. INTRODUCTION

Albatrosses, petrels and shearwaters that forage by diving are some of the most vulnerable species to bycatch in fisheries (Wooller *et al*, 1992; Brothers *et al*, 1999). Nineteen of the world's 21 albatross species are now globally threatened with extinction (IUCN 2004, BirdLife International 2004a), and incidental catch in fisheries, especially longline fisheries, is recognised as one of the principal threats to many of these species (Robertson & Gales 1998).

At its 73rd meeting, the IATTC adopted Resolution C-05-01, requesting an assessment of the impact of incidental catch of seabirds in IATTC fisheries, when feasible and appropriate, and that this assessment should include an identification of the geographic areas in which seabird interactions may be occurring. This paper presents analysis of data from the Global *Procellariiform* Tracking Database, a database that has been established through a unique collaboration between scientists from around the world, coordinated by BirdLife International. The paper explores the spatial distribution of albatrosses and petrels in the East Pacific, and the overlap IATTC longline fishing effort.

2. METHODS

2.1 Albatross and petrel remote tracking data

Over 90% of existing albatross and petrel tracking data have been submitted to the Global *Procellariiform* Tracking Database, representing 19 of the 21 species of albatross, both species of giant-petrel, White-chinned Petrel, Westland Petrel and Short-tailed Shearwater (**Table 1**). The contributors of the data presented in this paper are listed on page (ii) of this report. **Appendix 1** lists species names used in the text.

The satellite tracking (PTT) data were processed using standardised methods agreed among data-holders. Data points were first validated using a filter based on McConnell *et al.* (1992), which calculates a bird's velocity between each pair of satellite uplinks. Where the velocity was over the maximum velocity *vMax* (*vMax* set at 100km.hr-1 for all species) and an alternative latitude and longitude was provided, the filter substituted the alternative point. In an iterative process, the filter then removed the point with the highest velocity over *vMax*, although a point was not removed if it had location class 1, 2, or 3 because these locations have an accuracy of up to 1km (Argos, 1989, 1996). The velocities for the 4 points adjacent to the removed point were then recalculated and the process repeated, until no low quality point had a velocity above *vMax* (BirdLife, 2004b).

In order to convert the PTT tracking data into density distributions, the assumption was made that birds travelled at constant speed and in a straight line between each pair of uplinks. The path of the bird was then resampled at hourly intervals. If the interval between two uplinks was more than 24 hours, no resampling was conducted between these points. Bird tracks were grouped into datasets that represented unique combinations of species/colony/breeding status/breeding stage/sex, as far as data availability allowed. Kernels were derived from these datasets using the kernel function in ArcGIS 8.2, with a smoothing (*h*) parameter of 1 degree grid square and a grid size of 0.1 degree. A smoothing factor of 1 degree was selected on the basis that this was likely to be the smallest practical unit for management on the high seas. Data points were not separated into ‘commuting’ or ‘foraging’ points. It is thus recognised that not all areas used by the albatrosses and petrels will be areas of foraging, although these still represent areas where there is potential interaction with fisheries.

Data holders submitted Geolocator (GLS) data to the database in a processed form, since the variety of geolocators available made it unrealistic to develop a standardised validation routine for GLS data. GLS data did not require resampling since the locations are available from tracked birds at approximately 12-hour intervals. Kernel density distribution maps were generated as above, but with a smoothing parameter *h* of 2 degrees, which was the nominal resolution of the GLS data, and a cell size of 0.5 degrees.

The foraging ranges and distributions of albatrosses vary depending on stage of the breeding season, sex and colony. For each species, overall breeding distribution was calculated by weighting each dataset by the number of individuals at sea for that particular combination of colony/breeding stage/sex. Density distributions for each species were standardised to allow addition across species to create multi-species maps. Population sizes of albatross species vary greatly: there are over 500,000 annual breeding pairs of Black-browed and Laysan Albatross, whereas three albatross species have less than 1000 annual breeding pairs (Table 1). For this reason, the multi-species maps were calculated with all species weighted equally, to avoid domination of the maps by the few species with large populations. The density distributions are represented on maps by the 50, 75 and 95% utility distributions (UDs), indicating the areas within which birds spend 50, 75 and 95% of their at-sea time. For full further details on methods for data validation and derivation of density distributions, see Tracking Ocean Wanderers (BirdLife, 2004b).

Tracking data are not available for all colonies of all species, and fewer data exist for non-breeding distribution compared to distribution during the breeding season (Table 1). Care must be taken when interpreting kernel distributions where data is missing from some colonies (Table 1, and indicated on maps), and where sample sizes are small. Ideally, analysis would be based on at least 10-15 tracks for each breeding stage, and preferably each sex, before results would be considered to approach reliability, though the effect of sample size varies between species (BirdLife 2004b). Distribution of albatrosses and petrels has also been identified as varying between years, though analysis suggests that while differences do exist, they are not as substantial as other factors, such as breeding stage (Weimerskirch et al, 1993; Prince et al, 1998; Weimerskirch, 2004; Phillips et al, 2004).

2.2 Overlap with IATTC area and IATTC longline fishing effort

The IATTC area used for analysis in this paper is that defined under the Antigua Convention, extending to 50°N and 50°S, bounded to the west by 150°W. For each albatross and petrel species, calculations were made of the % at-sea time spent within the IATTC area for breeding adult birds during the breeding season, and (where data were available) for adults and juveniles during the non-breeding season. The albatross distributions were also overlain with a map of the distribution of longline fishing effort within the IATTC area from 1997-2004 (IATTC, 2006), and calculations were made of the % at-sea time spent within the 5x5 degree grid squares in which longline fishing effort took place.

3. RESULTS

The combined global breeding distribution of 23 species of albatross and petrel is shown in **Figure 1**, which highlights the global concentration of albatrosses and petrels in the Southwest Atlantic Ocean, Southwest Indian Ocean and Southwest Pacific Ocean, as well as the distribution of albatrosses in the North Pacific and around the Galapagos Islands. The degree of overlap between the distribution of albatrosses and petrels and the IATTC area are summarized in **Table 2**, which also indicates overlap with the distribution of IATTC longline fishing effort (1997 - 2004).

For the Pacific, the Global *Procellariiform* Tracking Database includes breeding distribution data for 13 of the 15 albatross species which breed in the region, as well as data for Westland Petrel and Short-tailed Shearwater. At a global level, the IATTC area overlaps with a low proportion of breeding albatross distribution compared to other tuna RFMOs (BirdLife, 2004b). However, the results emphasise the importance of the IATTC area Waved Albatross, whose breeding distribution is entirely within the East Pacific (**Figure 2**). The breeding distributions of four other species also overlapped with the IATTC area (Black-footed, Black-browed, Grey-headed and Laysan Albatross) although the overlap was lower, ranging from 1-6% of breeding distribution at a species level. Nevertheless, these overlaps were highly important at a colony level for Laysan Albatross from Isla de Guadalupe (95% breeding distribution within IATTC area), and Black-browed Albatross from Chile (19% breeding distribution within IATTC area) (**Figures 3-6**)..

The results also emphasise the particular importance of the IATTC area for non-breeding distributions of albatrosses and petrels, including Black-footed Albatross in the North Pacific (**Figure 8**), Black-browed Albatross from Chile (**Figure 9**), and a range of species from New Zealand which migrate across the Pacific to the South American coast to take advantage of the rich foraging opportunities in the Humboldt Current (**Figures 10-12**). No tracking data were available for the non-breeding distribution of Salvin's, Buller's, and Southern Royal Albatross, or for Westland or White-chinned Petrel, though other observation data indicate that they are present in the IATTC area (see Section 4.2 below).

With the exception of the albatrosses distributed in the far south of the IATTC area, there was a high degree of overlap between albatross distribution within the IATTC area, and the 5x5 grid squares in which IATTC longline fishing effort was conducted between 1997-2004 (Table 2).

4. DISCUSSION

4.1 Data limitations

The Global Procellariiform Tracking Database includes over 90% of existing tracking data for albatross and petrel species. However, key data gaps remain for some species and sites.
No breeding distribution data were available for Pacific-breeding populations of Short-tailed Albatross, Salvin's Albatross and White-chinned Petrel, although, given the location of their breeding sites in the far west of the Pacific, their breeding distributions are unlikely to overlap with the IATTC area.

For Laysan and Black-footed Albatross it also must be noted that no remote tracking data were available from some of the main breeding sites such as Midway Atoll and Laysan Island, which account for over 90% and 70% of the breeding populations, respectively. However, remote tracking data were from the nearby from Tern Island (French Frigate Shoals).

Fewer tracking data exist for bird distribution during the non-breeding season, in part due to practical difficulties in collecting such data. In order to improve knowledge of overlap between albatross and petrel distribution and IATTC fisheries, key data gaps to fill are data on the non-breeding distribution of Salvin's Albatross and Buller's Albatross in the Southeast Atlantic (both adults and juveniles), and further data on the non-breeding distribution of all three North Pacific albatross species (Laysan, Black-footed and Short-tailed Albatross). Other data gaps include the non-breeding distribution of Waved Albatross, Southern Royal Albatross, White-chinned Petrel and also Chatham Island populations of Buller's Albatross.

Seabird-at-sea observations are also an important source of seabird distribution data within the IATTC area. In contrast to tracking data, at-sea data lack information on the origin and status (breeder, migrant, non-breeder) of the birds observed. However, they can provide key data, particularly for species for which tracking data are lacking, and furthermore there is a real need to investigate the feasibility of combining tracking and at-sea datasets (BirdLife, 2004b).

4.2 Northeast Pacific

For Laysan Albatross, the breeding distribution of Laysan Albatross tracked from Isla de Guadalupe, Mexico, was concentrated almost entirely within the IATTC area (95% breeding distribution), mostly north of 25°N (**Figure 3**), though this population represents <1% of the total breeding population of Laysan Albatross. Data held in the Global Procellariiform Tracking Database indicate that Laysan Albatross tracked from Hawaii during the breeding season had no overlap with the IATTC area. Similarly, Laysan Albatross tracked from the Aleutian Islands during the non-breeding season had no overlap with the IATTC area (**Figures 3** & **7**). There are reasons to believe, however, that these may be underestimates. Firstly, care must be taken in interpreting the non-breeding tracking data for Laysan Albatross presented here, since they were collected by placing tracking devices on birds caught while at sea. As such the data are likely to be biased towards the locations in which the birds were tagged, and should not be considered representative of the species as a whole. In addition, tracking data from 1998 and 1999, which are not currently held in the Global Procellariiform Tracking Database, identified Laysan Albatross from Tern Island foraging as far east as 125°W during the breeding season (mostly concentrated north of 40°N) (Fernandez *et al*, 2001). In 1999, a year when Laysan Albatross experienced high nest failure, foraging areas were further south than in 1998. Birds tracked following breeding failure used the IATTC area extensively, foraging as far east as 130°W, and concentrated between 20-40°N. Other data sources also suggest that Laysan Albatross are distributed in the Northeast Pacific, albeit in lower abundance that Black-footed Albatross (Shuntov, 1974, cited in Fernandez 2001; Harrison, 1990; Cousins & Cooper, 2000; Tickell, 2000; Shaffer, in prep.). Further remote tracking of non-breeding Laysan Albatross (adult and juvenile) would be of great value.

For Black-footed Albatross, tracking data support observations of the general more easterly distribution of Black-footed Albatross compared to Laysan Albatross (Shuntov, 1974, cited in

Fernandez *et al* 2001; Harrison, 1990; Tickell, 2000), bringing it into greater overlap with the IATTC area, particularly during the non-breeding season, when 36% of Black-footed Albatross distribution overlapped with the IATTC area (**Figures 4** & **8**). As above, some care must be taken when interpreting the non-breeding tracking data for Black-footed since they were collected by placing tracking devices on birds caught while at sea, though the fact that the birds tagged in the Aleutian Islands then moved into the IATTC area and used it extensively, supports the argument that birds are choosing to forage there.

No overlap was found between the IATTC area and the non-breeding tracking data for Short-tailed Albatross, although other data sources document Short-tailed Albatross records in the East Pacific, as far south as 35°N (McDermond & Morgan, 1993; Cousins *et al* 2000).

Further evidence of the overlap between albatross distribution and pelagic longline fishing effort in the Northeast Pacific comes from US observer data from the California longline fishery that targets swordfish and occasionally tuna. High rates of seabird bycatch (0.29 birds/1000 hooks) have been recorded in the IATTC area (25-40°N) (Petersen *et al*, 2003), and both Laysan and Black-footed Albatross were caught east of 150°W, though bycatch rates for Black-footed Albatross were 15 times those for Laysan Albatross. Seabird bycatch rates reported from pelagic fisheries in Hawaii suggest that fewer seabirds are caught by vessels targeting tuna, compared to those targeting swordfish (0.013 and 0.758 birds per thousand hooks respectively, Cousins *et al*, 2000). However, given the spatial and temporal clustering of albatross distribution, great caution must be taken in making inferences from such comparisons of bycatch rates, since mortality rates depend on numerous factors, not least seabird abundance, and rates are only reliably comparable if vessels are fishing concurrently in the same areas (Gilman *et al*, 2005).

4.3 Southeast Pacific

The highest degree of overlap between the IATTC area and albatrosses and petrels in the Southeast Pacific was for the distribution of Waved Albatross. Tracking data during the breeding season (April-December) reveal that foraging was focused in the Peruvian upwelling area between the Galapagos Islands and the coast of Peru (**Figure 2**) (Anderson *et al*, 1998; Anderson *et al*, 2003). No tracking data are currently available on the distribution of Waved Albatross during the non-breeding season (December-April), or the distribution of juveniles (age at first breeding is 5 years). However, few observations of Waved Albatross have been made outside the Peruvian Upwelling area (Tickell, 2000), and observational data from other sources indicate the highest aggregations of Waved Albatross on the Peruvian continental shelf occur during the non-breeding season (Goya & Cardenas, 2003), suggesting that the IATTC area is highly important for Waved Albatross during all life-cycle stages.

The distributions of the two other albatross species that breed in the Southeast Pacific have a low level of overlap with the IATTC area at a species level (1 and 4% global breeding distribution of Grey-headed and Black-browed Albatross, respectively), but this is significant for Black-browed Albatross at a colony level. Chilean Black-browed Albatross foraged along the edge of the continental shelf, spending 19% of their time within the IATTC area during the breeding season (October until March) (**Figure 5**). This overlap increased to 65% during the non-breeding season (**Figure 9**), when their range extended northwards to 25°S. This brought them into a high degree of overlap with areas of IATTC longline fishing effort during the non-breeding season (but not during the breeding season). Grey-headed Albatross forages for squid in areas near the pelagic front during the breeding season, and their distribution had little overlap with IATTC fisheries (**Figure 6**), or with Chilean demersal longline fisheries for toothfish and hake, which also operate in the region (Moreno, 2003). No tracking data were available for the non-breeding distribution of Grey-headed Albatross from Chile.

The southeast IATTC area is also a particularly important destination for non-breeding albatrosses from New Zealand, which migrate across the Pacific to forage in highly productive waters off the west coast of South America. Tracking data were only available for the non-breeding distribution of Chatham, Antipodean and Northern Royal Albatross, but the data indicate that overlap with the IATTC area is extensive. The IATTC area overlapped with over 50% of the non-breeding distribution of Chatham Albatross, Antipodes Albatross from the Antipodes Is, and Northern Royal Albatross from Taiaroa Head (note however that Taiaroa Head represents <1% of the global Northern Royal Albatross population). The migration of all three species across the Pacific was concentrated at or below 40°S, after which Chatham Albatross moved north along the Humboldt Current into Peruvian coastal waters, consolidating in a wintering area north of 20°S, in areas which also overlapped with IATTC longline fishing effort (**Figure 10**). Birds then returned to their breeding colony following a more northerly route (Robertson *et al*, 2000). In contrast, tracking data from Antipodean and Northern Royal Albatross are remained largely south of 40°S (**Figures 11** & **12**), generally foraging south of IATTC longline fishing areas.

While non-breeding tracking data are not yet available for the distribution of Buller's, Salvin's and Southern Royal Albatross, observations from other sources indicate that they are commonly observed off the South American coast (Jehl,1973; Stahl *et al*, 1998; Robertson *et al*, 2003; Spear *et al*, 2003; Goya & Cardenas, 2003). In surveys conducted by 15 research vessels, almost all albatrosses were observed within 400km (c.200nm) from shore, most within 200km (c.100 nm) (Spear *et al*, 2003), with Salvin's Albatross having a somewhat similar distribution to Chatham Albatross, being abundant between 10-40°S, and Buller's Albatross are distributed slightly further south, being most abundant below 30-40°S (Jehl, 1973; Stahl *et al*, 1998, Spear *et al*, 2003). Spear *et al* (2003) estimated that up to 75% of the breeding population of Chatham and Salvin's Albatross may have been present on the South American coast during the non-breeding season. All were most often recorded while the birds were 'attending fishing vessels'. All species would be expected to be present in the Southeast Pacific in some number year-round, although peak abundances of Chatham and Salvin's albatross have been recorded in April – September, with Buller's most abundant in Sept-December (Stahl *et al*, 1998, Spear *et al*, 2003).

These observations indicate likely spatial overlap between IATTC fisheries and the distribution of these albatross species. While seabird bycatch data have been collected from Chilean industrial and artisanal demersal longline fisheries for Patagonian toothfish and hake (Moreno, 2003), no data are yet available for Chilean swordfish fisheries, or for other tuna and swordfish fisheries in the region. In Peru, Jahnke et al (2001) estimated that Peru's artisanal longline fleet, which principally target Common Dolphin Fish (*Coryphaena hippurus*) and sharks, though with some tunas, was catching 2370-5610 albatrosses per year. The study was based on interviews with fishermen, 90% of whom reported that birds were hooked when setting gear, with rates of 1 to 2 birds per 1000 hooks. Awkerman *et al* (in press) have recorded a decline in adult survival of

Waved Albatross over the period 1999-2005, and a decline in the breeding population since 1994, and leg-band recovery and interviews with fishermen have revealed mortality of Waved Albatross within Peruvian artisanal fisheries, although it is not yet clear how much is intentional take. Unlike other albatrosses, the reputation of the Waved Albatross is that is not a ship-follower (Anderson & Cruz, 1998), suggesting that bycatch in industrial longline fisheries may be low. However, no observer data on seabird bycatch rates from industrial longline fisheries are yet available, and Waved Albatross distribution has a high (91%) overlap with 5x5 grid squares in which IATTC longline fishing effort took place (1997-2004).

Summary

The IATTC area is highly important for the foraging areas of Waved Albatross, and for the non-breeding distribution of Black-footed Albatross, New Zealand albatross species, which migrate across the South Pacific to the rich foraging grounds in the Humboldt Current, as well as for Black-browed Albatross which breed in Chile. The IATTC area is also highly important for the non-breeding distribution of Northern Royal Albatross breeding at Taiaroa Head, and for the small population of Laysan Albatross which breed on Isla de Guadalupe, Mexico. Tracking data for Laysan Albatross which are not currently held by the Global Procellariiform Tracking Database indicate that Laysan Albatross also use the IATTC area during both the breeding and non-breeding periods.

Within the IATTC area, the overlap between albatross distribution and IATTC longline fishing effort is high for all species, with the exception of that in the far south of the IATTC area, indicating areas of potential seabird interaction. The results also indicate that the majority of the albatross species are distributed across the Pacific, spanning both WCPFC and IATTC Convention Areas, indicating that there may be benefits of coordination between the two Commissions in terms of information-sharing in relation to effectively assessing seabird distribution and seabird bycatch issues within the Pacific.

Key data gaps remain in remote-tracking data of albatrosses and petrels, which, if filled, would improve knowledge of areas of risk of seabird bycatch within the IATTC area, particularly tracking data for the non-breeding distribution of Salvin’s and Buller’s Albatross in the Southeast Atlantic, and further data on the non-breeding distribution of all three North Pacific albatross species (Laysan, Black-footed and Short-tailed Albatross) in the North Pacific. Seabird-at-sea observations are also an important source of seabird distribution data within the IATTC area, and greater integration of these two datasets would be of value.

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Appendix 1. Key to species names used in the text

Common	**Scientific**	**Status**[1]
Antipodean Albatross[2]	*Diomedea antipodensis*	Vulnerable
Black-browed Albatross	*Thalassarche melanophrys*	Endangered
Black-footed Albatross	*Phoebastria nigripes*	Endangered
Buller's Albatross	*Thalassarche bulleri*	Vulnerable
Campbell Albatross	*Thalassarche impavida*	Vulnerable
Chatham Albatross	*Thalassarche eremita*	Critically Endangered
Grey-headed Albatross	*Thalassarche chrysostoma*	Vulnerable
Laysan Albatross	*Phoebastria immutabilis*	Vulnerable
Light-mantled Albatross	*Phoebetria palpebrata*	Near Threatened
Northern Royal Albatross	*Diomedea sanfordi*	Endangered
Short-tailed Albatross	*Phoebastria albatrus*	Vulnerable
Shy Albatross	*Thalassarche cauta*	Near Threatened
Southern Royal Albatross	*Diomedea epomophora*	Vulnerable
Sooty Albatross	*Phoebetria fusca*	Endangered
Wandering Albatross	*Diomedea exulans*	Vulnerable
Waved Albatross	*Phoebastria irrorata*	Vulnerable
Westland Petrel	*Procellaria westlandica*	Vulnerable
Short-tailed Shearwater	*Puffinus tenuirostris*	Least Concern

1 Source IUCN 2004, BirdLife International 2004b.
2 Including Gibson's Albatross *D. (antipodensis) gibsoni.*

Table 1. Remote tracking data of species of albatross and petrel held in the Global *Procellariiform* Tracking Database. * = new data added since the publication of *Tracking Ocean Wanderers*.

Species	Site	Annual Breeding Pairs	Global popn (%)	Datasets submitted to the Global *Procellariiform* Tracking Database (Number of tracks) Blank cells indicate no tracking data.
Amsterdam	Ile Amsterdam	17	100%	Breeding (15 tracks)
Antipodean	Antipodes Is	5,148	41%	Non-breeding (failed/migratory/resident)(13 tracks)
	Campbell Island	6	0%	
Antipodean (Gibson's)	Auckland Is	7,319	59%	Breeding (3 tracks) and non-breeding (2 tracks)
Atlantic Yellow-nosed	Gough Island	7,500	23%	
	Tristan da Cunha Is	25,750	77%	
Black-browed	Antipodes Is	115	0%	
	Campbell Island	16	0%	
	Chile	122,870	20%	Breeding (165 tracks)
	Falkland Is (Malvinas)	380,000	62%	Breeding (198 tracks), and failed migratory track (1), plus non-breeding geolocator data
	Heard & McDonald Is	729	0%	
	Iles Crozet	880	0%	
	Iles Kerguelen	4,270	1%	Breeding (26 tracks)
	Macquarie Island	182	0%	Breeding (7 tracks)
	Snares Is	1	0%	
	South Georgia*	100,332	16%	Breeding (365 tracks), and failed migratory (3 tracks) plus non-breeding geolocator data
Black-footed	Hawaiian Islands	62,575	97%	Breeding (74 tracks)
	Izu Shoto	914	1%	
	Ogasawara Gunto	1,103	2%	
	Senkaku Retto	25	0%	
	Tagged at sea			Non-breeding (18 tracks)
Buller's	Chatham Is	18,150	58%	
	Three Kings	20	0%	
	Snares Is	8,465	27%	Breeding (180 tracks), failed (24 adult tracks, 73 juvenile tracks, all during breeding season)
	Solander Is	4,800	15%	Breeding (49 tracks), failed (137 tracks, during breeding season)
Campbell	Campbell Island*	26,000	100%	Breeding (10 tracks)
Chatham	Chatham Is	4,000	100%	Breeding (16 tracks), failed and non-breeding resident and migratory (17 tracks), also juveniles (2 tracks)
Grey-headed	Campbell Island	6,400	6%	Breeding (5 tracks)
	Chile	16,408	15%	Breeding (67 tracks), and failed migratory track (1)
	Iles Crozet	5,940	6%	
	Iles Kerguelen	7,905	7%	
	Macquarie Island	84	0%	Breeding (9 tracks)
	Prince Edward Is	7,717	7%	Breeding (6 tracks)
	South Georgia*	61,582	58%	Breeding (299 tracks) and failed migratory (4 tracks) plus non-breeding geolocator data
Indian Yellow-nosed	Ile Amsterdam	25,000	70%	Breeding (34 tracks)
	Ile St. Paul	12	0%	
	Iles Crozet	4,430	12%	
	Iles Kerguelen	50	0%	
	Prince Edward Is	6,000	17%	
Laysan	Hawaiian Islands	554,318	100%	Breeding (76 tracks, from Tern Is)
	Izu Shoto	1	0%	
	Mexico	350	0%	Breeding (60 tracks)
	Ogasawara Gunto	30	0%	
	Tagged at sea			Non-breeding (10 tracks)

Table 1 continued.

Species	Site	Annual Breeding Pairs	Global popn (%)	Datasets submitted to the Global *Procellariiform* Tracking Database (Number of tracks) Blank cells indicate no tracking data.
Light-mantled	Antipodes Is	169	1%	
	Auckland Is	5,000	23%	
	Campbell Island	1,600	7%	
	Heard & McDonald Is	350	2%	
	Iles Crozet	2,421	11%	
	Iles Kerguelen	4,000	18%	
	Macquarie Island	2,000	9%	Breeding (10 tracks)
	Prince Edward Is	241	1%	
	South Georgia*	6,250	28%	Breeding (42 tracks)
Northern Royal	Chatham Is	2,060	99%	Breeding (28 tracks), failed/migratory, non-breeding (15 tracks)
	Taiaroa Head	18	1%	Breeding (3 tracks), failed and non-breeding resident and migratory (2 tracks) and juveniles (14 tracks)
Salvin’s	Bounty Is	76,352	99%	
	Iles Crozet	4	0%	
	Snares Is	587	1%	
Short-tailed	Izu Shoto	220	95%	Non-breeding (7 tracks)
	Hawaiian Islands	1	0%	
	Senkaku Retto	11	5%	
Shy	Antipodes Is	18	0%	
	Auckland Is	72,233	85%	
	Chatham Is	1	0%	
	Tasmania	12,250	14%	Breeding (64 tracks), failed/migratory (5 tracks) and juveniles (3 tracks)
Sooty	Gough Island	5,000	38%	
	Ile Amsterdam	350	3%	
	Ile St. Paul	20	0%	
	Iles Crozet	2,248	17%	Breeding (26 tracks)
	Iles Kerguelen	4	0%	
	Prince Edward Is	2,755	21%	
	Tristan da Cunha Is	2,747	21%	
Southern Royal	Auckland Is	72	1%	
	Campbell Island	7,800	99%	Breeding (7 tracks)
Tristan	Gough Island	798	100%	Breeding (128 tracks)
	Tristan da Cunha Is	3	0%	
Wandering	Iles Crozet	2,062	26%	Breeding (204 tracks) & migratory track (1)
	Iles Kerguelen	1,094	14%	Breeding (11 tracks)
	Macquarie Island	10	0%	
	Prince Edward Is	2,707	34%	Breeding (20 tracks), failed/migratory, non-breeding (3 tracks)
	South Georgia	2,001	25%	Breeding (207 tracks) and failed migratory (4 tracks)
	Unknown			Non-breeding, migratory (5 tracks)
Northern Giant-petrel	Antipodes Is	300	3%	
	Auckland Is	100	1%	
	Campbell Island	240	2%	
	Chatham Is	2,150	19%	
	Iles Crozet	1,060	9%	
	Iles Kerguelen	1,400	12%	
	Macquarie Island	1,110	10%	
	Prince Edward Is	540	5%	
	South Georgia	4,310	38%	Breeding (18 tracks)

Table 1 continued.

Species	Site	Annual Breeding Pairs	Global popn (%)	Datasets submitted to the Global *Procellariiform* Tracking Database (Number of tracks) Blank cells indicate no tracking data.
Southern Giant-petrel	Antarctic Continent	290	1%	
	Antarctic Peninsula	6,500	21%	
	Argentina*	1,350	4%	Breeding (16 tracks)
	Chile	290	1%	
	Falkland Is(Malvinas)	3,100	10%	
	Gough Island	50	0%	
	Heard & McDonald Is	4,400	14%	
	Iles Crozet	1,060	3%	
	Iles Kerguelen	4	0%	
	Macquarie Island	2,300	7%	
	Prince Edward Is	1,790	6%	
	South Georgia	4,650	15%	Breeding (11 tracks)
	South Orkney Is	3,400	11%	
	South Sandwich Is	1,550	5%	
White-chinned Petrel	Antipodes Is	50,000	?%	
	Auckland Is	50,000	?%	
	Campbell Island	?	?%	
	Iles Crozet	50,000	?%	Breeding (16 tracks)
	Iles Kerguelen	200,000	?%	
	Falkland Is(Malvinas)	?	?%	
	Macquarie Island	?	?%	
	Prince Edward Is	?	?%	
	South Georgia*	2,000,000	?%	Breeding (23 tracks)
Westland Petrel	Punakaiki	2,000	100%	Breeding (20 tracks)
Short-tailed Shearwater	SE Australia (French, Montague.)	?	?%	Breeding (3 tracks), and single post-breeding track

Table 2. Overlap between the distribution of breeding and non-breeding albatrosses and petrels and the IATTC area (% at-sea distribution), derived from tracking data from the Global *Procellariiform* Tracking Database, and % distribution within the 5x5 grid squares in which there was IATTC pelagic longline fishing effort 1997-2004. Overlaps are given for each breeding site, though overlap with global population of each species is also shown where there were sufficient data.

Species	Site	Global popn (%)	Overlap with IATTC area (%)	Overlap with IATTC longline fishing effort (%)
BREEDING SEASON				
Antipodean (Gibson's) Albatross	Auckland Islands	59	0	0
Black-browed Albatross	Global population	100	**4**	0
	Chile	20	**19**	0
	Macquarie Island	<1	0	0
Black-footed Albatross	Hawaiian Islands*	97	**6**	**4**
Buller's Albatross	Snares Islands	27	0	0
	Solander Islands	15	**3**	**2**
Campbell Albatross	Campbell Island	100	0	0
Chatham Albatross	Chatham Islands	100	0	0
Grey-headed Albatross	Global population	100	**1**	0
	Campbell Island	6	0	0
	Chile	15	**3**	0
	Macquarie Island	<1	0	0
Light-mantled Albatross	Macquarie Island	9	0	0
Laysan Albatross	Isla de Guadalupe	<1	**95**	**91**
	Hawaiian Islands*	100	0	0
Northern Royal Albatross	Chatham Islands	99	0	0
	Taiaroa Head	1	0	0
Southern Royal Albatross	Campbell Island	99	0	0
Shy Albatross	Tasmania	14	0	0
Sooty Albatross	Iles Crozet	17	0	0
Waved Albatross	Isla Española	100	**100**	**93**
Westland Petrel	Punakaiki	100	0	0
COMBINED breeding distribution of 23 species			**5**	**5**
NON-BREEDING SEASON				
Antipodean Albatross	Antipodes Islands	41	**60**	**12**
Antipodean (Gibson's) Albatross	Auckland Islands	59	0	0
Black-browed Albatross	Chile	20	**65**	**44**
Black-footed Albatross	Tagged offshore Alaska & California	-	**36**	**35**
Chatham Albatross	Chatham Islands	100	**54**	**42**
Laysan Albatross	Tagged Alaska	-	0	0
Northern Royal Albatross	Chatham Islands	99	**3**	0
	Taiaroa Head	1	**56**	**1**
Short-tailed Albatross	Izu Shoto, Japan	95	0	0
Shy Albatross	Tasmania	14	0	0
Wandering Albatross	Global population	100	**4**	**2**

* Data from Hawaii are from Tern Island. Tracking data are not available from Midway Atoll or Laysan Is, which represent 70% and >90% of the Black-footed and Laysan Albatross populations, respectively.

Figure 1. Combined breeding distribution map for the 23 species of albatross, giant-petrel, petrel and shearwater for which there are breeding data in the Global *Procellariiform* Tracking Database. Each species has been given equal weighting. The Utilisation Distributions (UDs) show the estimated area of 50%, 75% and 95% of the combined breeding distribution.

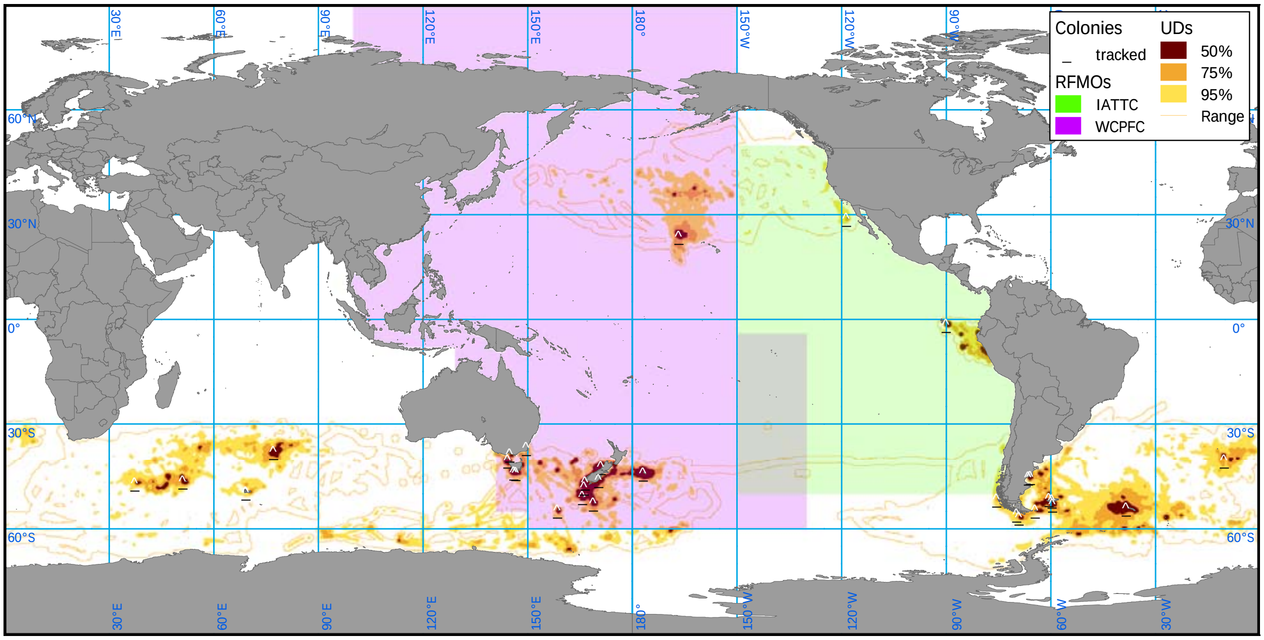

Figure 2. Distribution of Waved Albatrosses during the breeding season tracked from Isla Espanola (>99% population), and overlap with IATTC area, and IATTC longline fishing effort 1997-2004 (hooks set per 5° grid square).

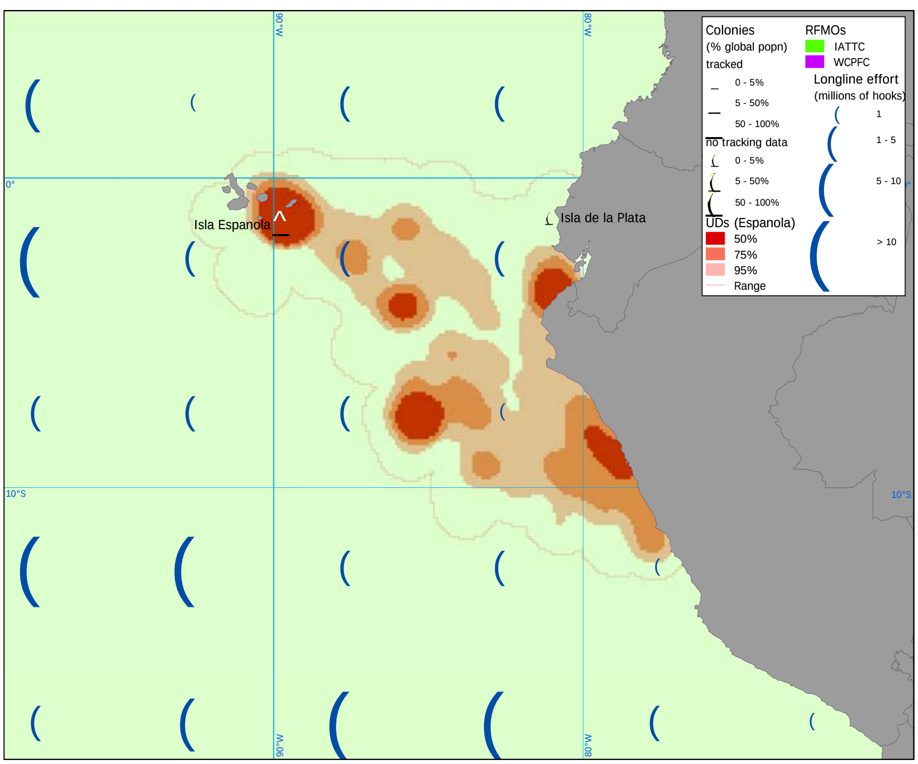

Figure 3. Breeding distribution of Laysan Albatrosses tracked from Tern Island in Hawaii, and Isla de Guadalupe in Mexico, and overlap with the IATTC area and IATTC longline effort from 1997-2004 (hooks set per 5° grid square). Tern Island and Isla de Guadalupe each represent <1% of the global Laysan Albatross population. No tracking data are available from Midway Atoll or Laysan Island in Hawaii, which together represent over 90% of the global Laysan Albatross population.

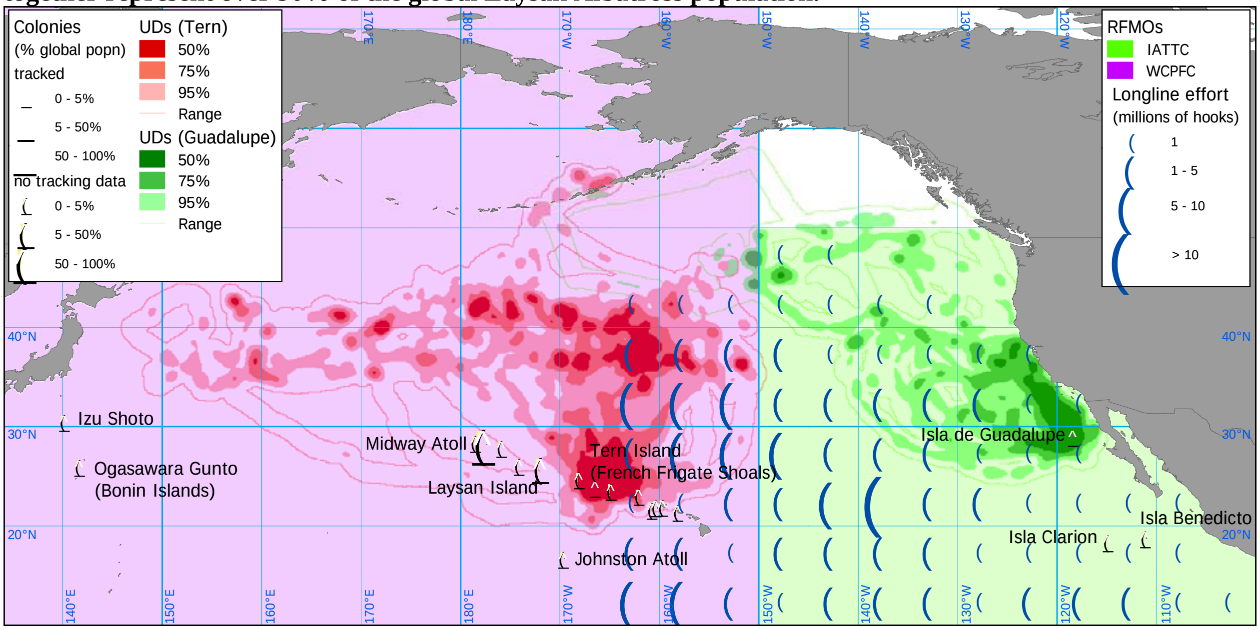

Figure 4. Breeding distribution of Black-footed Albatross tracked from Tern Island, Hawaii, and overlap with the IATTC area and IATTC longline fishing effort 1997-2004 (hooks set per 5° grid square).

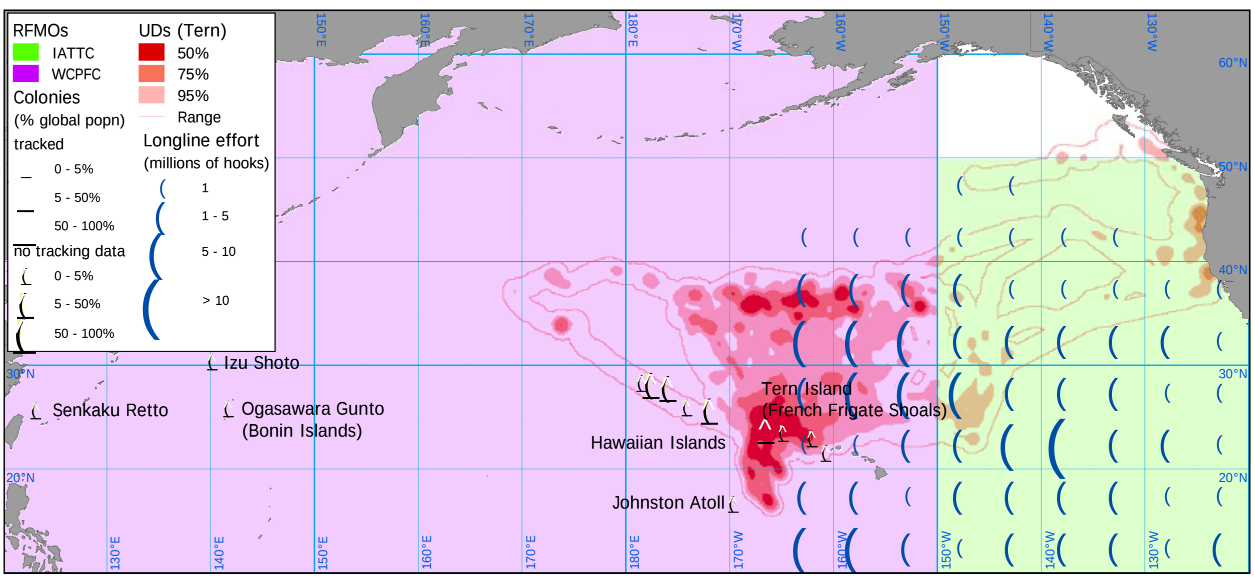

Figure 5. Breeding distribution of Black-browed Albatrosses tracked from three Chilean islands, together representing 20% of the global Black-browed Albatross population, and overlap with the IATTC area and IATTC longline effort from 1997-2004 (hooks set per 5° grid square).

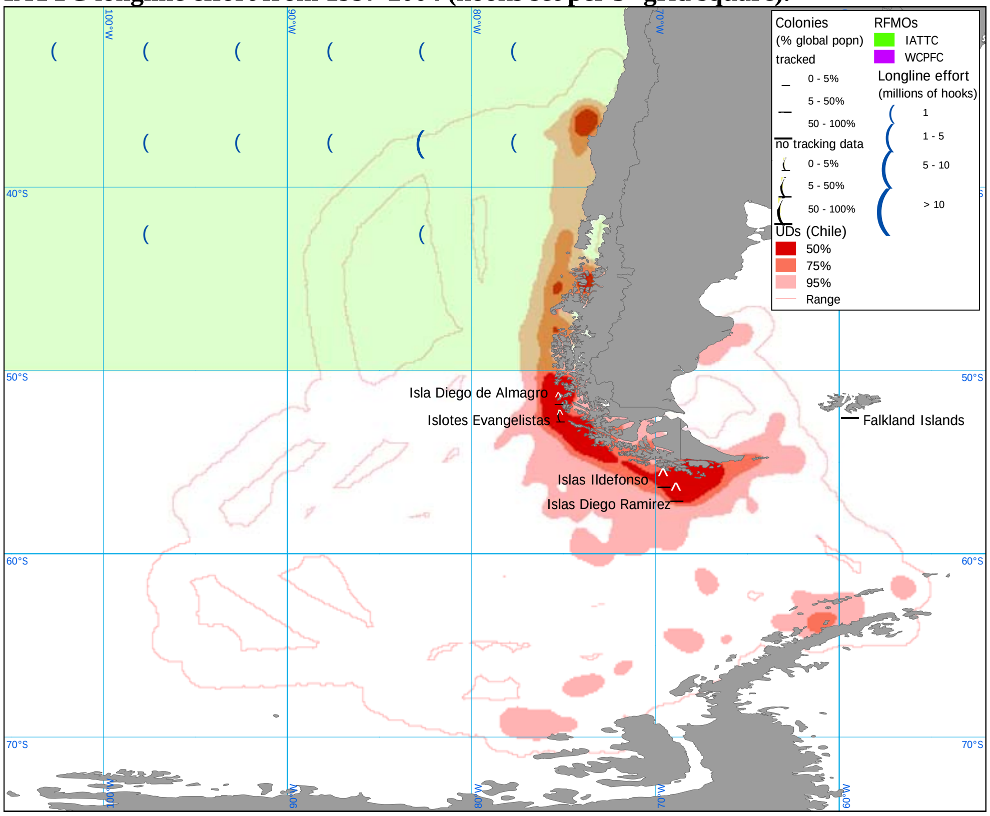

Figure 6. Breeding distribution of Grey-headed Albatross tracked from two Chilean islands, together representing 15% of the global Grey-headed Albatross population, and overlap with the IATTC area and IATTC longline effort from 1997-2004 (hooks set per 5° grid square).

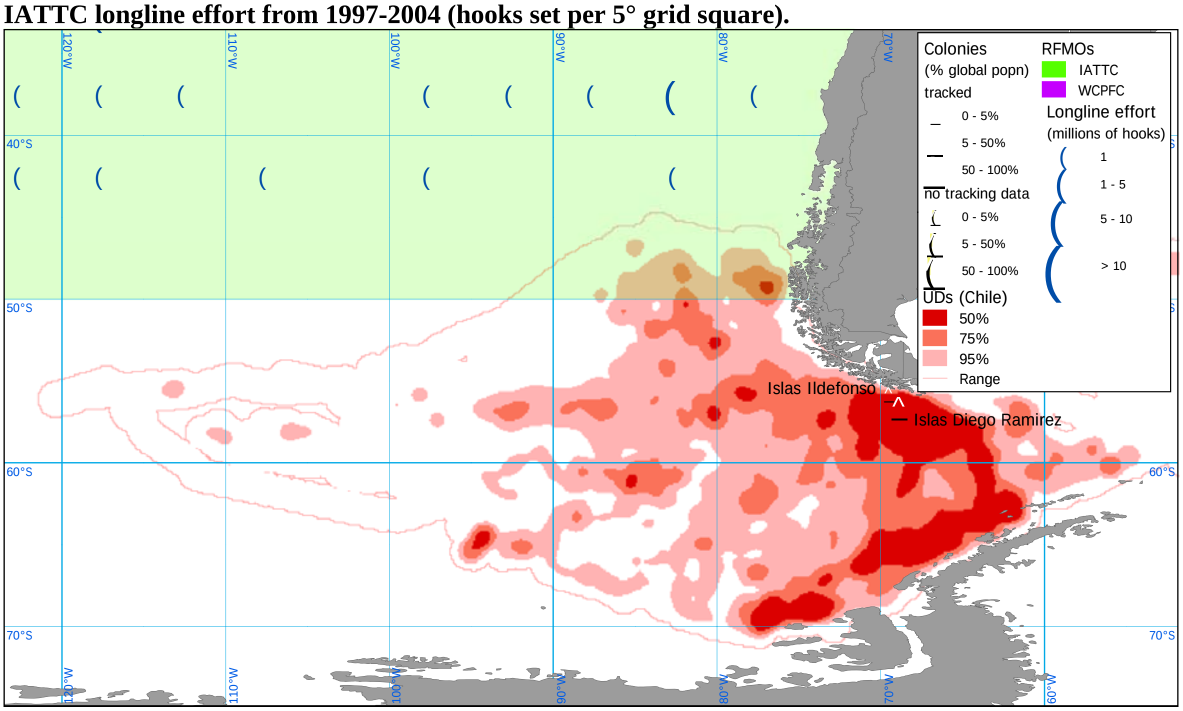

Figure 7. Distribution of 10 non-breeding Laysan Albatrosses tracked after capture in the Aleutian Islands (deployment locations shown with white stars), indicating no overlap with IATTC area.

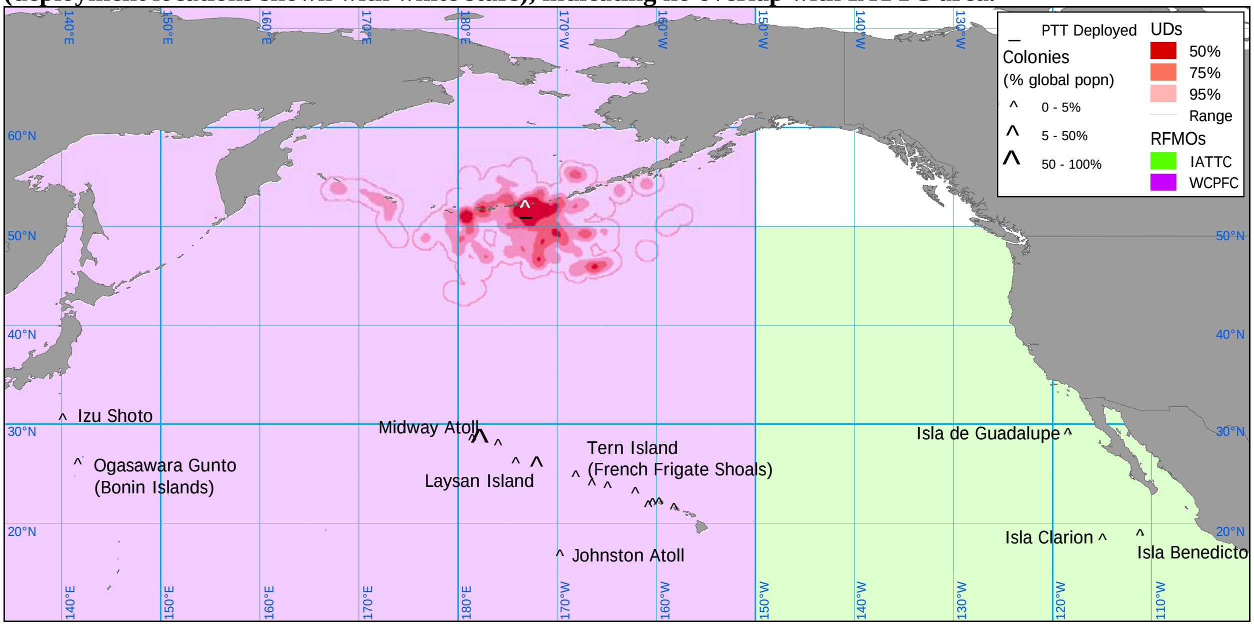

Figure 8. Distribution of Black-footed Albatrosses during the non-breeding season tracked after capture at-sea, and overlap with the IATTC area and IATTC longline effort from 1997-2004 (hooks set per 5° grid square). Birds tagged off the coast of California (6 birds, Hyrenbach & Dotson, 2003) remained east of 130°W while birds tracked from the Aleutian Islands (10 birds, data contributed by Rob Suryan) ranged across much of the northern IATTC area (deployment locations shown with white stars).

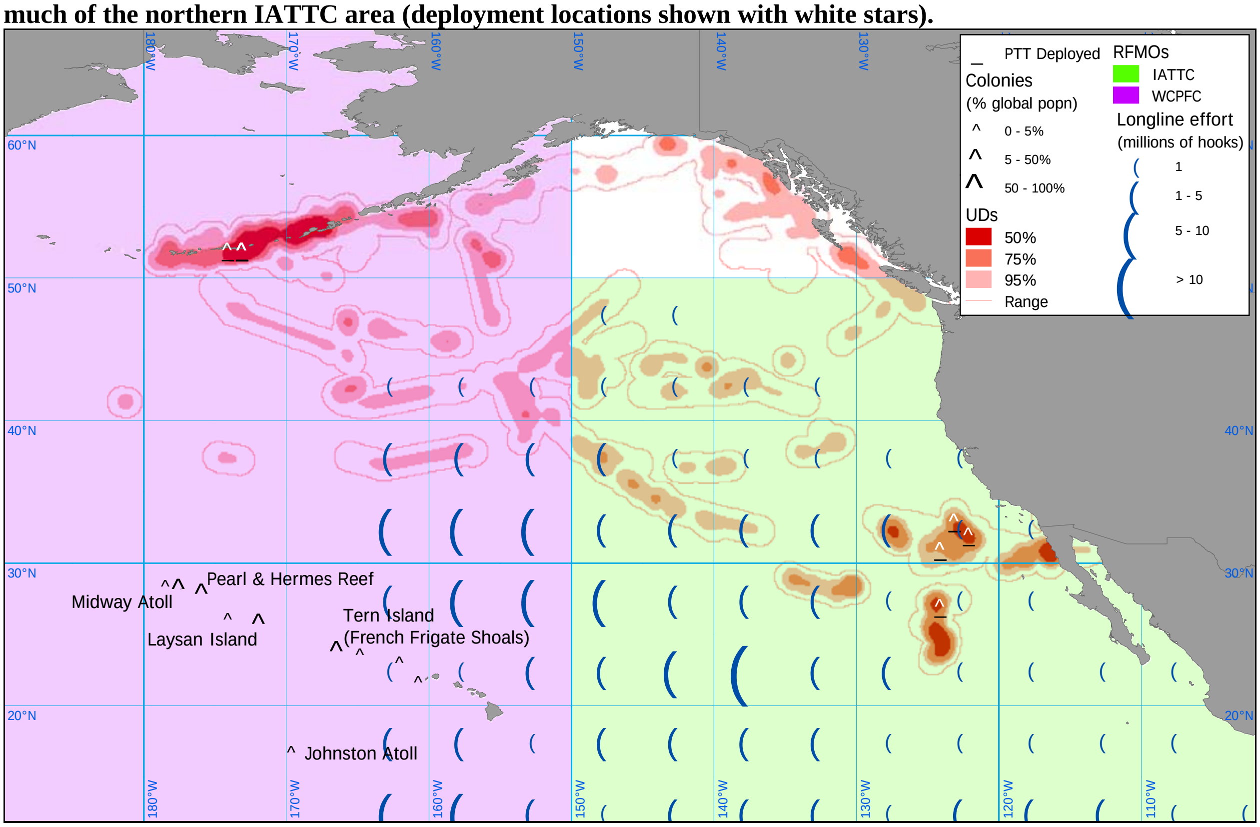

Figure 9. Distribution of Black-browed Albatrosses during the non-breeding season, tracked from Islas Diego Ramirez, Chile, using geolocators, and overlap with the IATTC area and IATTC longline effort from 1997-2004 (hooks set per 5° grid square).

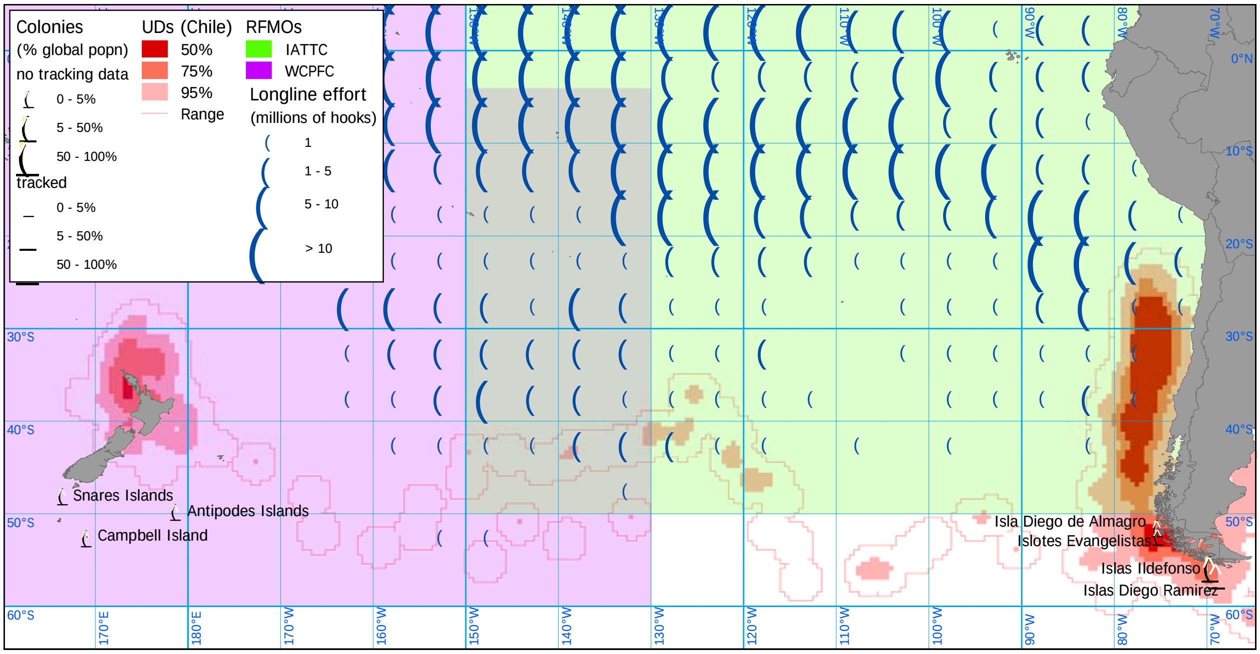

Figure 10. Distribution of Chatham Albatrosses during the non-breeding season, tracked from the only population, and overlap with IATTC area and with IATTC longline effort from 1997-2004 (hooks set per 5° grid square).

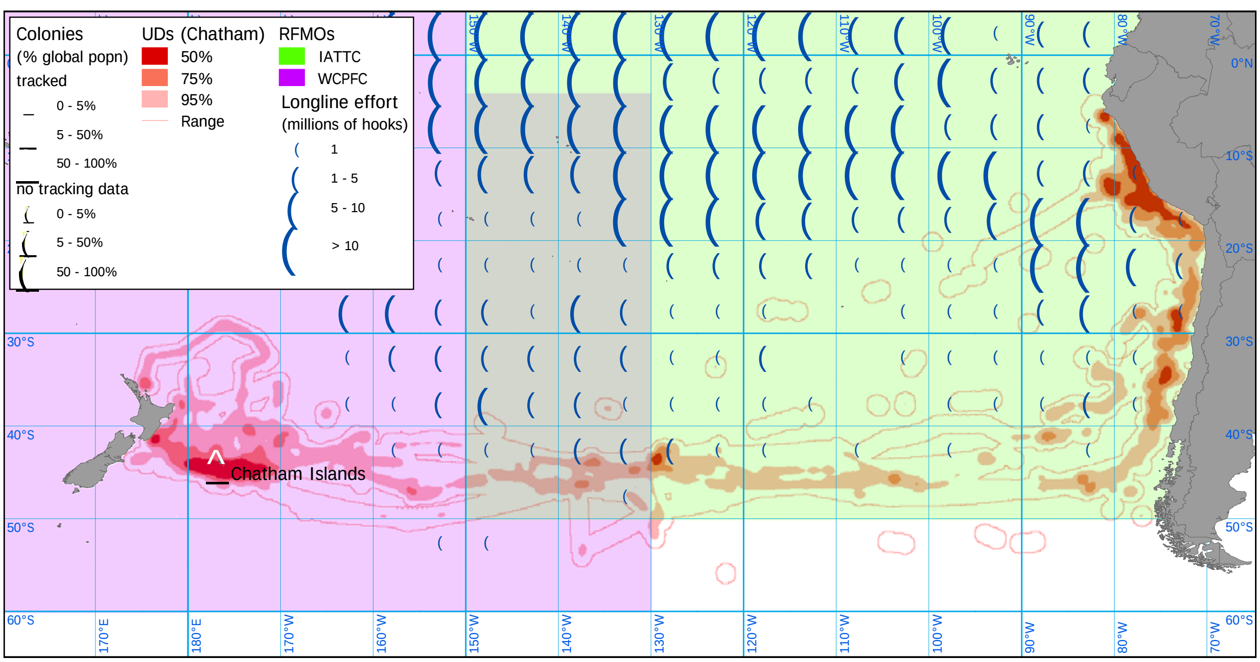

Figure 11. Distribution of non-breeding Antipodean (including Gibson's) Albatrosses tracked from the Auckland and Antipodes Islands, and overlap with the IATTC area and with IATTC longline effort from 1997-2004 (hooks set per 5° grid square).

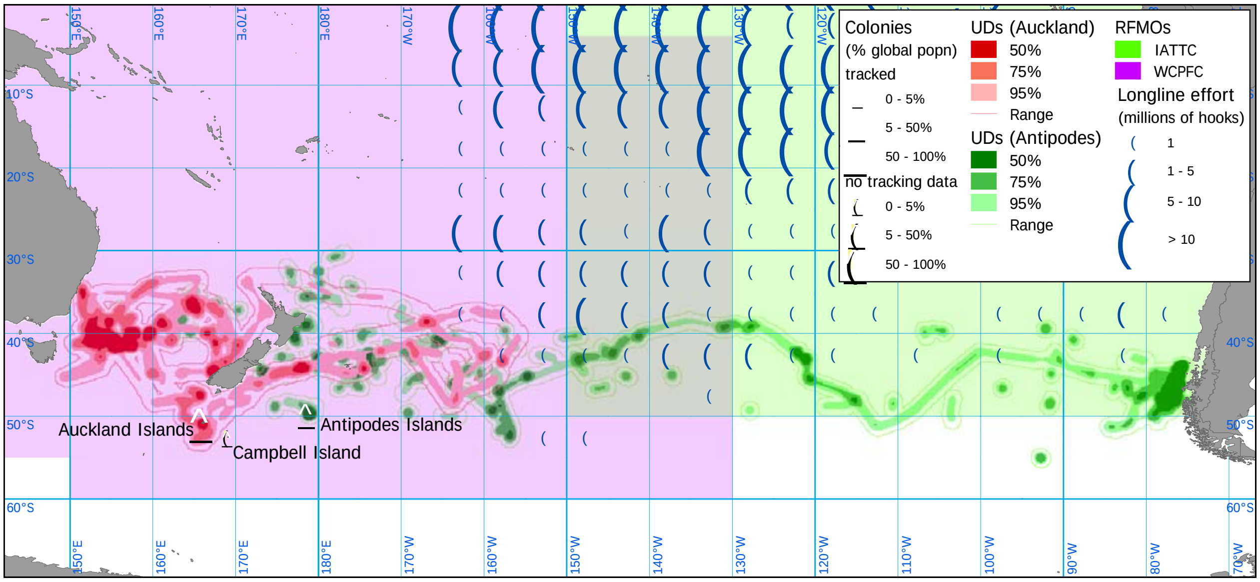

Figure 12. Distribution of non-breeding Northern Royal Albatrosses tracked from both populations (Chatham Islands=99% global population, Taiaroa Head<1% global population), and overlap with the IATTC area and IATTC longline effort from 1997-2004 (hooks set per 5° grid square).