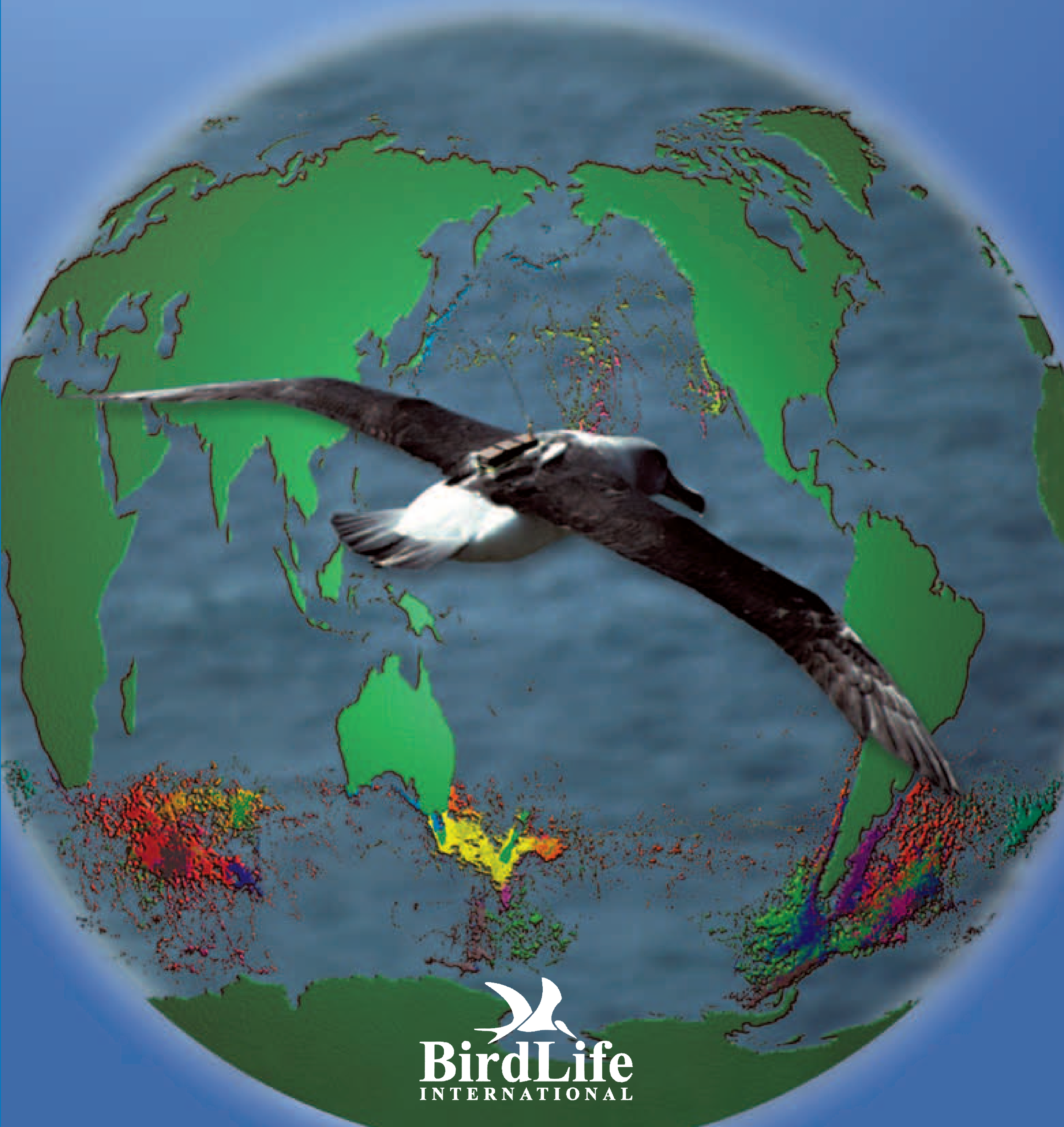
TRACKING OCEAN WANDERERS

The global distribution of albatrosses and petrels

Results from the Global Procellariiform Tracking Workshop,
1–5 September, 2003, Gordon's Bay, South Africa



BirdLife
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What is BirdLife International?

BirdLife International is a Partnership of non-governmental conservation organisations with a special focus on birds. The BirdLife Partnership works together on shared priorities, policies and programmes of conservation action, exchanging skills, achievements and information, and so growing in ability, authority and influence.

What is the purpose of BirdLife International? – Mission Statement

The BirdLife International Partnership strives to conserve birds, their habitats and global biodiversity, working with people towards sustainability in the use of natural resources.

Where is BirdLife International heading? – Vision Statement

Birds are beautiful, inspirational and international. Birds are excellent flagships and vital environmental indicators. By focusing on birds, and the sites and habitats on which they depend, the BirdLife International Partnership is working to improve the quality of life for birds, for other wildlife (biodiversity) and for people.

Aims

Birdlife's long-term aims are to:

- Prevent the extinction of any bird species
- Maintain and where possible improve the conservation status of all bird species
- Conserve and where appropriate improve and enlarge sites and habitats important for birds
- Help, through birds, to conserve biodiversity and to improve the quality of people's lives
- Integrate bird conservation into sustaining people's livelihoods.

Guiding principles

BirdLife International works with all like-minded organisations, national and local governments, decision-makers, land-owners and managers, in pursuing bird and biodiversity conservation.

The global work of the BirdLife Partnership is funded entirely by voluntary donations. To find out more about how you could support this work, please contact the BirdLife International Secretariat, Wellbrook Court, Girton Road, Cambridge CB3 0NA, United Kingdom.

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The BirdLife Global Seabird Programme

Seabirds are often highly migratory. They travel widely across oceans and between different territorial waters, and spend considerable time in high seas areas, where no national jurisdiction exists, making it essential to address seabird conservation at a range of scales: national, regional and global.

Consequently in 1997, BirdLife International established a BirdLife Global Seabird Conservation Programme. This programme, international in its nature and scope, operates through a developing alliance of regional task groups, supplemented by close links to BirdLife Partners based in, or closely linked to, each region.

The main focus of the programme, exemplified by BirdLife's 'Save the Albatross' campaign, is the seabird mortality caused by bycatch in longline and other fisheries. It is the most critical conservation problem facing many species of seabirds. BirdLife works across a range of levels: working with fishers to encourage the use of onboard mitigation measures to reduce seabird mortality, and lobbying governments and international organisations to develop and implement appropriate regulatory frameworks and international agreements.

The Partnership played a key role in drafting the Agreement on the Conservation of Albatrosses and Petrels (ACAP, drafted under the guidelines of the Convention on Migratory Species), and has worked closely with the Food and Agriculture Organization of the United Nations' International Plan of Action for Seabirds (IPOA–Seabirds), including direct involvement in the drafting of National Plans of Action for Chile, Brazil, New Zealand and the Falkland Islands (Malvinas).

The strength of the programme lies in international collaboration between BirdLife Partners, scientists, industry and governments. We urge everyone to be involved in future initiatives. Please feel free to contact us.

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Results from the Global Procellariiform Tracking Workshop, 1–5 September, 2003, Gordon's Bay, South Africa

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EXECUTIVE SUMMARY

BACKGROUND AND INTRODUCTION

Seabirds belonging to the order Procellariiformes (albatrosses and petrels) are amongst the most pelagic of seabirds and occur in all of the world's oceans. They are, therefore, excellent potential indicators of the state of marine ecosystems, especially high seas.

The status and trends of albatross breeding populations are well documented and, with 19 of 21 species now globally threatened and the remainder Near Threatened (BirdLife International 2004a); albatrosses have become the bird family most threatened with extinction. Many petrel species are also globally threatened. Although albatross and petrel species face many threats at their breeding sites, the main problems they encounter currently relate to the marine environment, particularly involving interactions with fisheries, notably the many thousands of birds killed annually by longline fishing.

Many of the solutions to these problems require accurate knowledge of the distributions of albatrosses and petrels throughout their annual and life cycles. Such data are also invaluable for understanding many aspects of the ecology and demography of these species and their role in the functioning of marine systems—including their potential susceptibility to changes in these.

In terms of remote-tracking to reveal their at-sea distribution (a key to understanding how they function in marine ecosystems), albatrosses (and giant-petrels) are the most studied of all marine species. Given the substantial potential of these data for conservation applications, including for marine analogues of terrestrial Important Bird Areas (IBAs), pioneered by BirdLife since the 1980s, BirdLife convened an evaluation workshop to explore the data and concepts with the main dataholders. This report presents the results of the workshop.

AIMS

The main strategic aims of the workshop were:

1. To assess how at-sea distribution data from remote-tracking studies of seabirds can contribute to:
   i. the development of criteria for defining Important Bird Areas (IBAs) in the marine environment;
   ii. current initiatives for the establishment of high seas Marine Protected Areas (MPAs) especially by IUCN.
2. To scope the extent to which these data can be used to quantify overlap between marine areas used by albatrosses and the location of fishing effort, especially longline:
   i. to identify areas of higher risk, especially for the development of appropriate mitigation measures for the fisheries involved;
   ii. to identify the Regional Fishery Management Organisations (RFMOs) with prime responsibility for the management of fisheries with significant risk of incidental bycatch of globally threatened non-target species, especially albatrosses and petrels.
3. To establish a Geographic Information System database to maintain detailed information on remote-recorded range and distribution of seabirds, as an international conservation tool.

RESULTS

Data and methods

- Over 90% of all extant albatross and petrel tracking data was submitted to the workshop, representing 16 species of albatross, both species of giant-petrel and White-chinned Petrel. A GIS database was developed to facilitate analysis, visualisation and interpretation of these data.
- Standard analytical procedures were developed and applied to the satellite tracking (PTT) data from raw data records submitted by dataholders.
- Consistent procedures were developed for the presentation of geolocator tracking (GLS) data—the main source of information for distributions in non-breeding seasons.
- Appropriate analytical procedures were agreed for transforming location data into density distributions, a crucial step in the visualisation, analysis and interpretation of multiple data sets.
- Protocols for data access and use, acknowledging the need to make available information to the international conservation community while safeguarding the proprietary rights of the individual data contributors and data users, were agreed.

Analysis and case-histories

The data available allowed the demonstration of a variety of properties relating to albatross and petrel ecology and distribution, including:

- The nature and variation in range and distribution, for breeding birds, in relation to stage of breeding season, gender (sex) and year (i.e. interannual variation).
- Differences in range and distribution of breeding birds from different colonies within the same population (island group).
- Similarities and differences in range and distribution of breeding birds from different populations of the same species, using data for the two species (wandering albatross, black-browed albatross) with the most comprehensive data, which provide compelling evidence of the insights that can be generated by applying common and consistent approaches to data from a variety of studies and sites.
- Regional syntheses for providing clear indications of the potential (and challenges) for using data across a range of albatross and petrel species to identify areas of key habitat common to different species.
- Similarities and differences in range and distribution of breeding and non-breeding birds at the same time of year.
- The spectacular journeys and far-distant destinations (comprising migratory routes, staging areas and wintering ranges) of some species of albatross and petrel during the non-breeding season.

These represent very significant achievements, some indicating interesting aspects and avenues for future research, others identifying potential biases and concerns relating to analysis and interpretation of data, yet others revealing key gaps in our knowledge. Nevertheless, all indicate the potential of such data to address important questions relating to albatross and petrel ecology and conservation.

Strategic aims and applications

Definition of Important Bird Areas (IBAs) and contribution to high seas Marine Protected Areas

- Tracking data for albatrosses and petrels will make a key contribution to attempts to identify areas of critical habitat for marine organisms and hotspots of biodiversity in coastal and pelagic marine ecosystems.
- Characterising density distributions and combining (weighting) these with estimates of source population size, will be fundamental approaches for marine taxa.
- The extent to which existing definitions of IBAs, developed for terrestrial species and systems, can be extended to marine contexts requires considerable further investigation for which the albatross and petrel data are uniquely suited; however, approaches which combine data from different groups of marine animals (e.g. fish, seabirds, marine mammals) are likely to be essential in longer-term approaches to issues of marine habitat conservation.
- The albatross and petrel data represent a uniquely coherent and comprehensive data set, covering large areas of marine habitat, and are therefore especially suitable for further investigation, perhaps particularly in high seas contexts.

Interactions with fisheries and fishery management organisations

- Examples of overlap between albatross distribution (both breeding and on migration) and fishing effort illustrate the considerable importance and potential of approaches to match data on the distribution (and abundance) of albatrosses and petrels with data on fishing effort, particularly for longline fisheries.
- Difficulties in obtaining data for appropriate scales and times, even for the better documented fisheries, may constrain what can be achieved, especially in terms of analysis seeking to estimate bycatch rates and/or their impact on source populations of albatrosses.
- Nevertheless, even existing data are adequate to provide broad characterisation of the location (and timing) of potential interactions between albatross species and different longline fisheries; this is a high priority task.
- These data are used to provide a preliminary identification of the responsibilities of RFMOs for environmentally sensitive management of albatrosses and their habitat based on overlap of ranges and jurisdictions. For the Southern Hemisphere this provides very clear indications of the critical role of, in preliminary priority order, Commission for the Conservation of Southern Bluefin Tuna (CCSBT), Western and Central Pacific Fisheries Commission (WCPFC), Indian Ocean Tuna Commission (IOTC), International Commission for the Conservation of Atlantic Tunas (ICCAT) and Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).
- A similar initial review, in relation to Exclusive Economic Zones (EEZs), is also provided.
- Combined with data on overlap with fishing operations, these will enable preliminary identification of the times, places and fisheries where adverse interactions are most likely and, thereby, allow the identification of mitigation measures appropriate to the circumstances.

Maintaining the database as an international conservation tool

Participants agreed to maintain the tracking database, assembled for the purposes of this workshop, beyond the meeting and production of its report.

- The database should be maintained and reconstituted by re-submission of data on the basis of the agreed policy on data access and use.
- A policy and practice for data access and use (based on principles developed for the Census of Marine Life Ocean Biogeographic Information Service (OBIS) – SEAMAP Programme) was agreed.
- BirdLife International offered, at least as an interim measure, to house and manage the database at its Secretariat headquarters in Cambridge, UK.
- The offer was accepted in principle. However the need to maintain and augment the data, to facilitate interactive and collaborative use, to link the albatross and petrel and tracking data to other, analogous, data sets and to the latest information on the physical and biological marine environment was recognised. Possibilities for linking, or possibly migrating, the Procellariiform Tracking Database from BirdLife to an organisation or institution specialising in the management and analysis of data on marine systems and biogeography should be investigated.

FUTURE WORK

Existing data

- All data submitted to the workshop should be re-submitted to the new database, managed by BirdLife, and subject to the agreed data access and use procedures.
- Other extant data, especially for Antipodean and Waved Albatrosses, and Westland Petrel *Procellaria westlandica*, should be requested from relevant dataholders and data owners.
- New data should be requested as it becomes available.

New data

Priorities are:

- For breeding birds, more data (and in most cases from more individuals) are needed for some stages of the breeding cycle (particularly incubation), for sexed birds and for sufficient years to assess the consistency of basic distribution patterns, for additional populations (island groups) and from more colonies within populations.
- For most species, data on the distribution of adults when not breeding.
- For almost every species, data on the distribution of immatures and early life-history stages.

Methods

- Evaluation of the potential biases of using the different types (and where appropriate different duty cycling) of existing data (e.g. PTT, GLS) in different kinds of analysis and on the use of appropriate spatial statistics to create density distributions from the different kinds of tracking data.

Environment

- Need to facilitate easy access to appropriate data sets on the physical and biological environment at appropriate scales, including detailed bathymetry, sea surface temperature, marine productivity, sea-ice etc.

Links to other tracking/sighting data on pelagic marine taxa

- Facilitate links to analogous sets of data on other petrels, penguins, marine mammals, sea turtles and migratory fish.
- Encourage and support links with initiatives like the Marine Mammal Tracking Database and programmes like the Census of Marine Life's Tagging Of Pacific Pelagics which are trying to assemble similar data on a collaborative basis.
- Investigate the feasibility and utility of combining remote tracking and survey data sets. Prime candidate areas for pilot studies to do this with seabird data would include the north-east Pacific, tropical east Pacific, south-west Atlantic and parts of the Indian Ocean.

Links to data from fisheries

Compare and analyse the distribution data for albatrosses/petrels and fishing effort to:

- Identify times and places where potential exists for adverse interactions between fisheries and albatrosses/petrels. This would enable:
  - i. Specification of mitigation measures appropriate to these circumstances;
  - ii. Approaches to RFMOs with appropriate jurisdictions, singly or in combination, to seek to develop the necessary regulations to apply the mitigation measures.
- Estimate bycatch rates of albatrosses/petrels for appropriate areas and at appropriate scales and for extrapolation to areas where bycatch data from fisheries are currently lacking.
- Assist modelling of seabird-fishery interactions with implications for fisheries (taking financial losses through bycatch into account in cost-benefit analyses) and for seabird populations.

IBAs and Marine Protected Areas

- Identify and relate areas of core habitat to population estimates and threatened status to evaluate in detail the implications of different criteria for helping define marine IBAs.
- Develop this approach further by choosing suitable systems/areas in which to link to remote-tracking data on other seabirds (especially penguins) and to at-sea survey data. This is especially relevant for coastal and shelf systems (i.e. within EEZs).
- Develop this further relative to Marine Protected Areas in conjunction with data on other marine taxa (e.g. marine mammals, sea turtles) and on resource use (e.g. fisheries, hydrocarbons). This is relevant both to EEZs and to high seas.

Agreement on the Conservation of Albatrosses and Petrels (ACAP)

- The applications envisaged of the albatross and petrel tracking database are highly relevant to the conservation aims of ACAP. The database is likely to be a key tool for furthering the work of ACAP.

RESUMEN EJECUTIVO

ANTECEDENTES E INTRODUCCIÓN

Las aves pertenecientes al orden Procellariiformes (albatros y petreles) se encuentran entre las más pelágicas de las aves marinas y están presentes en todos los mares del mundo. Potencialmente son, por lo tanto, unos excelentes indicadores del estado de los ecosistemas marinos, sobre todo en alta mar.

Existe buena información sobre el estado y la tendencia de las poblaciones reproductoras de albatros. 19 de las 21 especies de albatros se encuentran amenazadas en la actualidad y el resto están en situación de casi amenaza ('Near Threatened') (BirdLife International 2004a). Por ello, la familia Diomedeidae se ha convertido en la familia de aves con mayor riesgo de extinción. Muchas especies de petreles y pardelas se encuentran también globalmente amenazadas. Aunque las especies de albatros y petreles sufren muchas amenazas en sus lugares de cría, sus problemas más importantes tienen lugar en el medio marino, sobre todo los que se derivan de las interacciones con pesquerías, especialmente los cientos de miles de aves que mueren cada año como consecuencia de la pesca de palangre.

Muchas de las soluciones a estos problemas requieren un conocimiento adecuado de las distribuciones de los albatros y los petreles a lo largo de sus ciclos anuales y vitales. Esa información resulta muy valiosa también para poder comprender muchos aspectos de la ecología y la demografía de dichas especies, así como su papel en el funcionamiento de los ecosistemas – incluida su susceptibilidad a los cambios potenciales en los ecosistemas.

En el aspecto del seguimiento a distancia para revelar cómo se distribuyen en el mar (un elemento clave para comprender cuál es su función dentro de los ecosistemas marinos), los albatros (y los petreles gigantes) se encuentran entre las especies marinas mejor estudiadas. Dado el potencial de estos datos para los objetivos de conservación, que se extiende al equivalente marino de las Áreas Importantes para las Aves (IBA), impulsadas por BirdLife International desde la década de los años 1980, BirdLife organizó un taller de evaluación para explorar los datos y los conceptos emanados con los principales proveedores de esos datos. Este informe presenta los resultados del taller

OBJETIVOS

Los principales objetivos estratégicos del taller fueron:

1. Evaluar de qué forma los datos de distribución en el mar obtenidos mediante seguimiento a distancia pueden contribuir a:
   i. la elaboración de criterios para definir Áreas Importantes para las Aves (IBAs) en el medio marino;
   ii. iniciativas actualmente ya en marcha de cara a establecer Áreas Marinas Protegidas en alta mar (MPAs) especialmente por parte de la UICN.
2. Analizar hasta qué punto esos datos pueden ser útiles para cuantificar el grado de coincidencia entre las áreas marinas que utilizan los albatros y la localización del esfuerzo pesquero, especialmente de palangre:
   i. para identificar las áreas de mayor riesgo, especialmente de cara a desarrollar medidas correctoras adecuadas para las pesquerías en cuestión;
   ii. para identificar las Organizaciones Regionales de Pesca (RFMOs) que tienen la responsabilidad principal en la gestión de las pesquerías con riesgo significativo de capturas accidentales de especies no objetivo mundialmente amenazadas, especialmente albatros y petreles.
3. Crear una base de datos de Sistemas de Información Geográfica (GIS) para almacenar información detallada sobre los movimientos y la distribución de las aves marinas obtenida a través del seguimiento a distancia, como una herramienta de conservación internacional.

RESULTADOS

Datos y métodos

- Se aportaron al taller más del 90% de todos los datos existentes de seguimiento de albatros y petreles, representativos de16 especies de albatros, las dos especies de petreles gigantes y Pardela Gorgiblanca Se desarrolló una base de datos GIS para facilitar el análisis, la visualización y la interpretación de los datos.
- Se desarrollaron procedimientos analíticos estándar, y se aplicaron los mismos a los datos de seguimiento por satélite (PTT) a partir de los datos en bruto aportados por los participantes.
- Se elaboraron procedimientos coherentes para la presentación de los datos de seguimiento por geolocalizador (GLS) – la principal fuente de información para la distribución de aves fuera de las temporadas de cría.
- Se convinieron unos procedimientos analíticos adecuados para transformar los datos de localizaciones en densidades de distribución, un paso esencial de cara a la visualización, análisis e interpretación de múltiples series de datos.
- Se acordaron protocolos para el uso y acceso a los datos, teniendo en cuenta la necesidad de facilitar información a la comunidad conservacionista internacional mientras al mismo tiempo se tienen que salvaguardar los derechos de propiedad de los titulares que aportaron los datos y de los usuarios de los mismos.

Análisis y casos ilustrativos

Los datos disponibles hicieron posible la demostración de varias propiedades relativas a la ecología y la distribución de los albatros y petreles, incluyendo:

- La naturaleza y la variación en el área y en la distribución, para las aves reproductoras, en relación con la fase de la temporada de cría, con el género (sexo) y el año (es decir, variación interanual).
- Diferencias en el área y en la distribución de las aves reproductoras pertenecientes a distintas colonias dentro de una misma población (grupo de islas).

- Semejanzas y diferencias en el área y en la distribución de aves reproductoras pertenecientes a distintas poblaciones de una misma especie, utilizando los datos de las dos especies con mayor información disponible (albatros viajero y albatros ojeroso), lo cual ha aportado pruebas ilustrativas de los resultados que pueden obtenerse si se aplican los mismos enfoques coherentes a datos obtenidos en distintos estudios y procedentes de distintos lugares.
- Síntesis regionales para aportar indicaciones claras del potencial (y los retos) de usar datos sobre diversas especies de albatros y petreles para identificar áreas comunes de hábitat esencial para las distintas especies.
- Semejanzas y diferencias en el área y la distribución de aves reproductoras y no reproductoras en la misma época del año.
- Los impresionantes viajes y los destinos lejanos (incluyendo las rutas migratorias, las áreas de reposo y las áreas de invernada) de algunas especies de albatros y petreles fuera de la época de reproducción.

Estos resultados representan unos avances muy importantes: algunos son indicativos de aspectos interesantes y abren nuevas líneas de investigación, otros identifican posibles sesgos y preocupaciones relativas al análisis y a la interpretación de los datos, e incluso otros revelan lagunas importantes en nuestro conocimiento. No obstante, todos indican el potencial de esos datos para hacer frente a las cuestiones importantes en la ecología y la conservación de albatros y petreles.

Objetivos y aplicaciones estratégicas

Definición de Áreas Importantes para las Aves (IBA) y contribución a las Áreas Marinas Protegidas en alta mar

- Los datos de seguimiento de albatros y petreles van a suponer una contribución esencial a los esfuerzos para identificar áreas de hábitat primordial para los organismos marinos y los núcleos de biodiversidad en los ecosistemas marinos costeros y pelágicos.
- Algunos de los enfoques fundamentales para los taxones marinos consistirán en caracterizar las distribuciones de densidades y combinar (sopesar) éstas con las estimas de tamaño de la población de origen.
- El grado con el que las actuales definiciones de IBA, desarrolladas para las especies y los ecosistemas terrestres, puedan extenderse al contexto marino requerirá de mucha investigación futura, para la cual los albatros y petreles están perfectamente situados; no obstante, es muy probable que los enfoques que combinan datos relativos a distintas clases de animales (p.ej., peces, aves marinas, mamíferos marinos) se conviertan en esenciales para la conservación a largo plazo de los hábitats marinos.
- La información relativa a los albatros y petreles representa una serie de datos amplia, única y coherente que se extiende sobre grandes áreas de hábitat marino; resulta por tanto especialmente adecuada para la investigación futura, posiblemente de modo especial para el contexto de alta mar.

Interacciones con pesquerías y organizaciones de gestión pesquera

- Los ejemplos de coincidencia entre la distribución de albatros (tanto en época de cría como fuera de ella) y el esfuerzo pesquero demuestran la gran importancia y el potencial de relacionar datos sobre la distribución (y abundancia) de albatros y petreles con los datos sobre esfuerzo de pesca, especialmente en el caso de las pesquerías de palangre.
- Los resultados pueden verse afectados por las dificultades en obtener datos en escalas y tiempo adecuados, especialmente por lo que respecta a los análisis tendentes a estimar la proporción de capturas accidentales y/o al impacto de éstas sobre las poblaciones de origen de los albatros.
- No obstante, los datos actualmente disponibles resultan apropiados, incluso, para caracterizar burdamente la localización (y la temporalidad) de las interacciones potenciales entre las especies de albatros y las distintas pesquerías de palangre; esta es una actuación altamente prioritaria.

  Estos datos sirven para realizar una identificación preliminar de las responsabilidades de los Organismos Regionales de Pesca (RFMOs) de cara a una gestión ambientalmente sensible de los albatros y su hábitat basada en la superposición de las áreas y las jurisdicciones. En el hemisferio Sur, esto aporta indicaciones muy claras del papel fundamental de los siguientes ORP, situados por orden preliminar de prioridad: Comisión para la conservación del atún de aleta azul (CCSBT), Comisión pesquera del Pacífico occidental y central, (WCPFC), Comisión del atún del Océano Índico (IOTC), Comisión internacional para la conservación del atún atlántico (ICCAT), y Comisión para la conservación de los recursos vivos marinos antárticos (CCAMLR). (N*ota: siglas en inglés*).
- Se elabora de forma preliminar también una revisión similar para las Zonas Económicas Exclusivas (EEZ).
- Combinada con los datos de superposición con la actividad pesquera, esta información permitirá identificar de forma preliminar las épocas, los lugares y las pesquerías en las que las interacciones perjudiciales son más probables y, por lo tanto, permitirá identificar medidas correctoras apropiadas a las circunstancias.

Mantener la base de datos como una herramienta de conservación internacional

Los participantes acordaron mantener una base de datos de seguimiento a distancia, reunida con motivo de este taller, más allá de la reunión y la elaboración de este informe.

- Dicha base de datos debería mantenerse y restaurarse mediante el envío de nuevo de los datos siguiendo los acuerdos alcanzados referentes al acceso y al uso de los datos.
- Se acordaron unos criterios y unas instrucciones para el acceso y el uso de los datos (basados en los principios desarrollados para el Programa *Census of Marine Life Ocean Biogeographic Information Service* (OBIS) – SEAMAP).
- BirdLife International ofreció albergar y gestionar, por lo menos como medida provisional, dicha base de datos en las oficinas centrales de su Secretariado en Cambridge, Reino Unido.
- La oferta se aceptó en principio. Sin embargo, se reconoció la necesidad de mantener y aumentar los datos, de facilitar un uso interactivo y compartido de los mismos, y de vincular los datos de seguimiento de albatros y petreles con otras series de datos análogas y con la última información disponible sobre los elementos físicos y biológicos del medio marino. Deberían investigarse las posibilidades de vincular, o

incluso de migrar, la Base de Datos de Seguimiento de Procellariiformes de BirdLife a otra organización o institución especializada en la gestión y el análisis de datos sobre sistemas y biogeografía marinos.

ORIENTACIONES DE CARA AL FUTURO

Datos existentes

- Todos los datos presentados en el taller deberían volver a enviarse a la nueva base de datos, gestionada por BirdLife, y deberían de someterse a los procedimientos acordados sobre acceso y uso de los datos.
- Deberían de solicitarse, de sus correspondientes depositarios o dueños, otros datos que se conoce que existen, particularmente para el Albatros de las Antípodas, para el Albatros de Galápagos, y para la Pardela de Westland (*Procellaria westlandica*).
- Deberían solicitarse nuevos datos a medida que estén disponibles.

Nuevos datos

Las prioridades son:

- Entre las aves reproductoras, se necesitan más datos (y en muchos casos sobre más ejemplares) para algunas fases del ciclo reproductor (especialmente la incubación), para aves de sexo conocido y para un número de años suficiente que permita evaluar la coherencia de los patrones básicos de distribución, para otras poblaciones (grupos de islas) y para más colonias dentro de las poblaciones.
- Para la mayoría de especies, datos sobre la distribución de los adultos cuando no se están reproduciendo.
- Para casi todas las especies, datos sobre la distribución de inmaduros y de las primeras fase de su ciclo vital.

Métodos

- Evaluar los posibles sesgos derivados de utilizar distintos tipos (y en su caso distintos ciclos de tareas) de datos existentes (p.ej. PTT, GLS) en distintos tipos de análisis y del uso de la adecuada estadística espacial para generar densidades de distribución a partir de los distintos tipos de datos de seguimiento.

Medio

- Facilitar de modo prioritario un acceso fácil a las series de datos adecuadas sobre el medio físico y biológico, en una escala adecuada, incluyendo batimetría detallada, temperatura de la superficie del agua, productividad marina, hielo en el mar, etc.

Vínculos con otros datos de seguimiento/avistamiento sobre otros taxones pelágicos

- Facilitar vínculos con otras series de datos análogas sobre otros petreles, pingüinos, mamíferos marinos, tortugas marinas y peces migratorios.
- Fomentar y apoyar los vínculos con iniciativas como la Base de Datos de Seguimiento de Mamíferos Marinos y programas como el Censo de Marcaje de la Vida Marina del Pacífico Pelágico que buscan reunir datos similares sobre la base de la colaboración.
- Indagar sobre la versatilidad y la utilidad de combinar series de datos de seguimiento a distancia y de censos. Las áreas ideales como candidatas para estudios piloto de este tipo con datos sobre aves marinas son el Pacífico NE, el Pacífico E tropical, el Atlántico SO y partes del océano Índico.

Vínculos con datos sobre pesquerías

Comparar y analizar los datos de distribución de albatros/petreles y de esfuerzo de pesca para:

- Identificar épocas y lugares con potencial para dar lugar a interacciones nocivas entre las pesquerías y los albatros/petreles. Eso permitiría:
  i. Especificar las medidas correctoras apropiadas para esas circunstancias;
  ii. Contactos con las ORP con jurisdicción, de forma individual o combinada, de cara a intentar desarrollar la regulación necesaria para que se apliquen las medidas correctoras.
- Estimar la proporción de capturas accidentales de albatros/petreles en determinadas áreas y en la escala apropiada y extrapolarla a las áreas en las que no se dispone de datos de capturas accidentales en sus pesquerías.
- Ayudar a modelizar las interacciones aves marinas-pesquerías con implicaciones para las pesquerías (teniendo en cuenta las pérdidas financieras causadas por las capturas accidentales en los análisis coste-beneficio) y para las poblaciones de aves marinas.

IBA y Áreas Marinas Protegidas

- Identificar y relacionar las áreas de hábitat primordial con las estimas de población y el grado de amenaza, de cara a evaluar con detalle las implicaciones de los distintos
  criterios, con el fin de ayudar a definir las IBA marinas.
- Desarrollar aún más ese enfoque a través de la selección de sistemas/áreas adecuados con el objetivo de vincularlos con los datos de seguimiento a distancia de otras aves marinas (especialmente pingüinos) y de censos en el mar. Esto es especialmente importante para los sistemas costeros y de plataforma continental (p.ej. dentro de las ZEE).
- Desarrollar aún más este enfoque en relación con las Áreas Marinas Protegidas de forma combinada con los datos de otros taxones marinos (p.ej. mamíferos marinos, tortugas marinas) y con el uso de los recursos (p.ej. pesquerías, hidrocarburos). Esto es importante tanto para las ZEE como para alta mar.

Acuerdo para la conservación de albatros y petreles

- Las aplicaciones futuras previstas para las base de datos de seguimiento de albatros y petreles son altamente relevantes para los objetivos de conservacion de la ACAP. Es probable que la base de datos acabe siendo una herramienta clave para los futuros trabajos de la ACAP.

1 INTRODUCTION

Seabirds belonging to the order Procellariiformes (albatrosses and petrels) are amongst the most pelagic of seabirds and occur in all of the world's oceans. They are, therefore, excellent potential indicators of the state of high seas marine ecosystems, increasingly recognised as amongst the least known, yet most imperilled, of marine systems and habitats.

The status and trends of albatross and petrel breeding populations are reasonably well documented. These data contributed to the recognition that albatrosses, with 19 of 21 species now globally threatened and the remainder Near Threatened (BirdLife International 2004a; see Table 1.1), have become the bird family most threatened with extinction.

However the crux of their problem derives from their relationship with the marine environment, particularly involving interactions with fisheries, notably the hundreds of thousands of birds killed annually by longline fishing.

In terms of remote-tracking to reveal their at-sea distribution (a key to understanding how they function in marine ecosystems), albatrosses (and giant-petrels) are the most studied of all marine species.

Such data are potentially invaluable contributions to current BirdLife International initiatives, seeking to complement their pioneering work in the 1980s in defining terrestrial Important Bird Area networks (priority sites for land based conservation) with the first steps towards similar approaches for marine habitats. Until now attempts to characterise the at-sea distribution of threatened seabird species (e.g. Figure 1.1) have been derived from distribution maps in field guides and regional handbooks.

Against this background, BirdLife International, with generous support from the Wallace Research Foundation, invited all holders of remote-tracking data for albatrosses

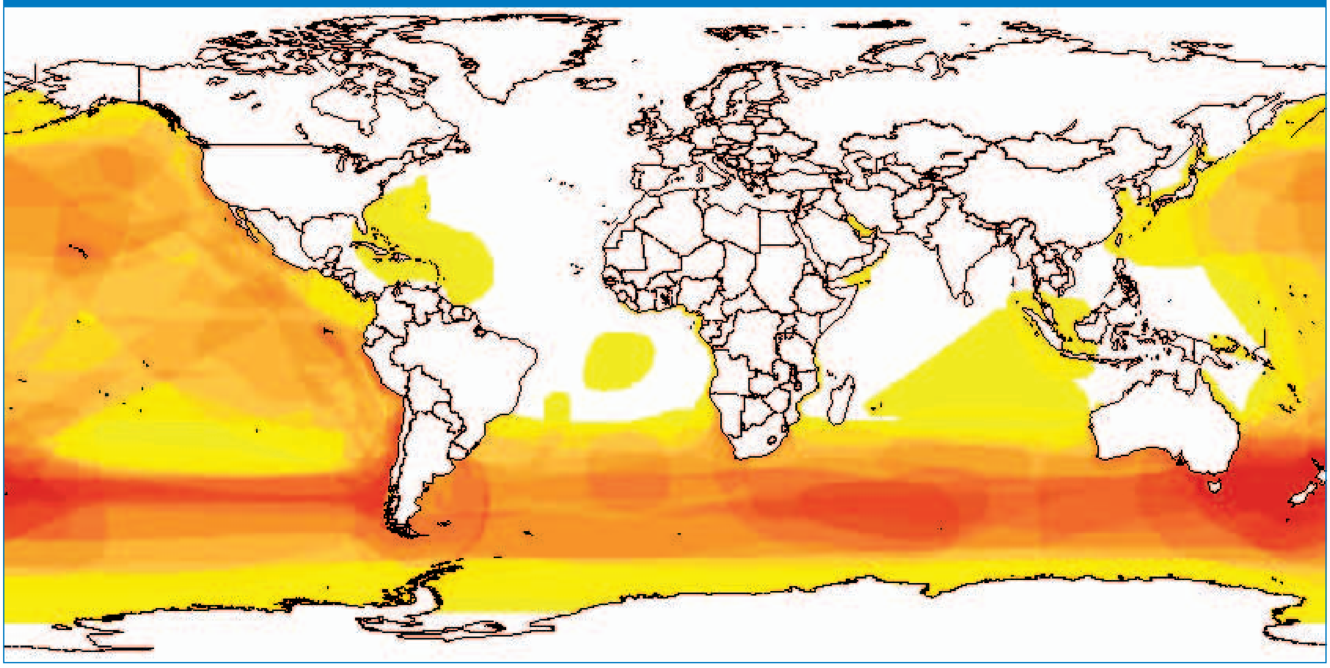
Table 1.1. Global conservation status of all albatross and selected petrel species, according to BirdLife International (2004a).

Common name	Scientific name	Status
Amsterdam Albatross	*Diomedea amsterdamensis*	CR
Antipodean Albatross[1]	*Diomedea antipodensis*	VU
Black-browed Albatross	*Thalassarche melanophrys*	EN
Black-footed Albatross	*Phoebastria nigripes*	EN
Buller's Albatross	*Thalassarche bulleri*	VU
Campbell Albatross	*Thalassarche impavida*	VU
Chatham Albatross	*Thalassarche eremita*	CR
Grey-headed Albatross	*Thalassarche chrysostoma*	VU
Laysan Albatross	*Phoebastria immutabilis*	VU
Light-mantled Albatross	*Phoebetria palpebrata*	NT
Northern Royal Albatross	*Diomedea sanfordi*	EN
Southern Royal Albatross	*Diomedea epomophora*	VU
Salvin's Albatross	*Thalassarche salvini*	VU
Short-tailed Albatross	*Phoebastria albatrus*	VU
Shy Albatross	*Thalassarche cauta*	NT
Sooty Albatross	*Phoebetria fusca*	EN
Tristan Albatross	*Diomedea dabbenena*	EN
Wandering Albatross	*Diomedea exulans*	VU
Waved Albatross	*Phoebastria irrorata*	VU
Atlantic Yellow-nosed Albatross	*Thalassarche chlororhynchos*	EN
Indian Yellow-nosed Albatross	*Thalassarche carteri*	EN
Northern Giant-petrel	*Macronectes halli*	NT
Southern Giant-petrel	*Macronectes giganteus*	VU
White-chinned Petrel	*Procellaria aequinoctialis*	VU

[1] Including Gibson's Albatross *D. (antipodensis) gibsoni*

CR Critically Endangered; EN Endangered; VU Vulnerable; NT Near Threatened

Figure 1.1. Distribution of threatened seabirds of the world (after BirdLife International 2004b).



and petrels to a Global Procellariiform Tracking Workshop. This was held at Gordon's Bay, South Africa from 1–5 September 2003. It was co-convened by Dr Deon Nel (BirdLife Seabird Programme) and Prof John Croxall (British Antarctic Survey and Chairman of RSPB, the BirdLife Partner in the UK). The technical coordinator was Frances Taylor (BirdLife Seabird Programme) supported by Janet Silk (British Antarctic Survey) and Samantha Petersen (BirdLife South Africa). The workshop was attended by 28 scientists from 8 countries (listed in full at Annex 1).

Aims

The main strategic aims of the workshop were:

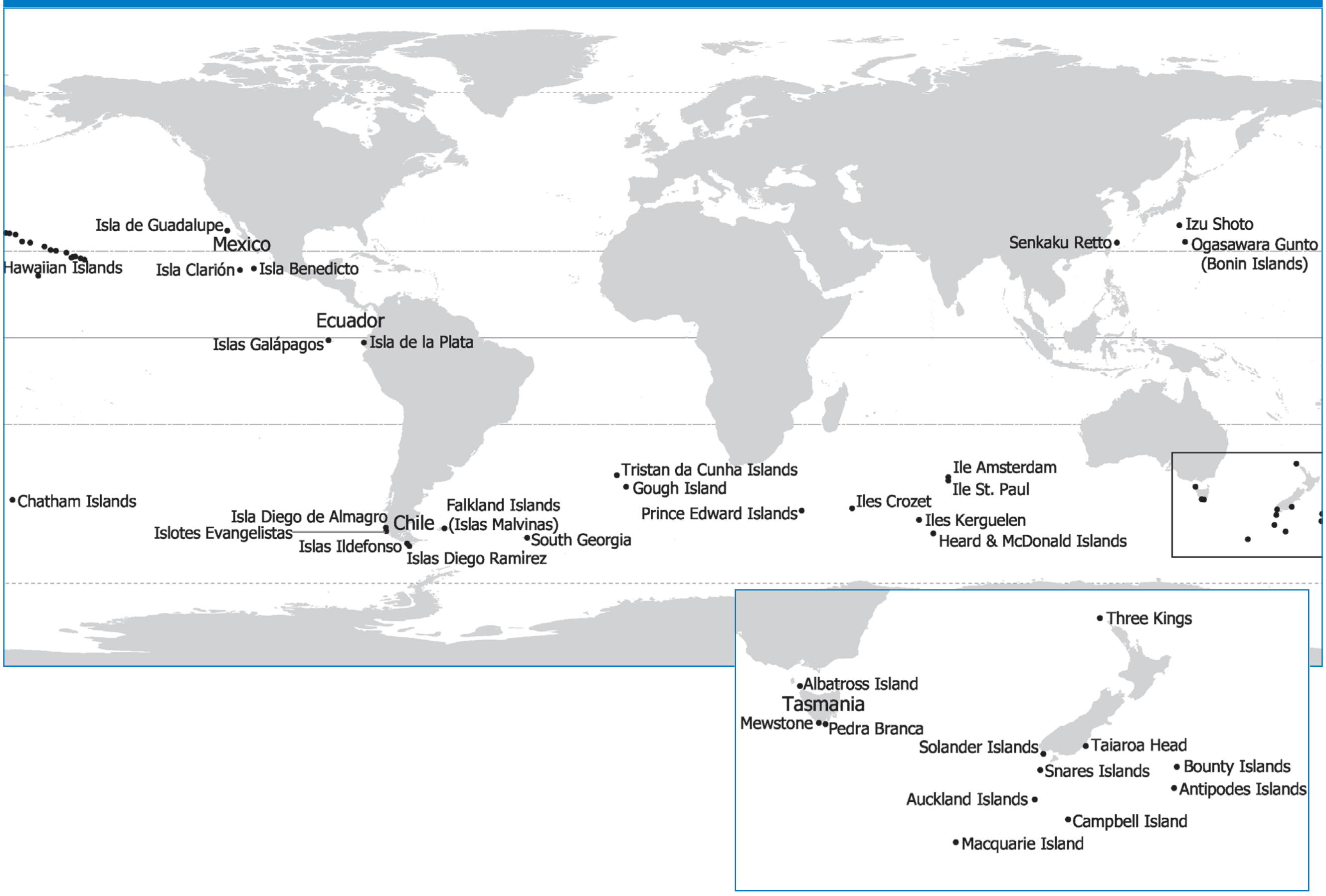
1. To assess how at-sea distribution data from remote-tracking studies of seabirds can contribute to:
   i. the development of criteria for defining Important Bird Areas (IBAs) in the marine environment;
   ii. current initiatives for the establishment of high seas Marine Protected Areas (especially by IUCN).

2. To scope the extent to which these data can be used to quantify overlap between marine areas used by albatrosses and the location of fishing effort, especially longline:
   i. to identify areas of higher risk, especially for the development of appropriate mitigation measures for the fisheries involved;
   ii. to identify the Regional Fishery Management Organisations (RFMOs) with prime responsibility for the management of fisheries with significant risk of incidental bycatch of albatrosses (and petrels).

3. To establish a Geographic Information System (GIS) database to maintain detailed information on remote-recorded range and distribution of seabirds, as an international conservation tool.

John Croxall, Frances Taylor and Deon Nel

Figure 1.2. Location of main breeding sites of albatrosses.



2 METHODS

2.1 TRACKING METHODS

Currently there are two methods employed for tracking albatrosses and petrels, satellite or platform terminal transmitters (PTT) and geolocators (GLS). Both have advantages and disadvantages: the former providing more accurate and numerous fixes at greater cost and shorter battery life, while the latter are cheaper and lighter with a potentially much longer deployment period, but require retrieval of the device and more complex data processing.

Both types of data were submitted. PTT data were primarily provided for birds tracked during the breeding season. PTT data submitted to the database were in unvalidated form to ensure that standard validation routines were used during processing. The GLS data consisted primarily of dispersal and over-wintering tracks. GLS data were submitted in post-processed form as the processing is extremely time-consuming. Although this meant that processing and validation were non-standard, contributors submitted details of the methods they used, and these were entered as metadata. In the event, all submitted GLS data had been subjected to almost identical post-processing routines.

2.2 METHODS FOR ANALYSING PTT DATA

2.2.1 Standardisation and validation of data

PTT Tracking data were submitted in a variety of formats, which were standardised to the format given in Table 2.1.

Separation of deployments and trips was usually done by the data contributors. A 'deployment' refers to the period between attaching a PTT device to an individual and the removal of the device from the individual, or the cessation of uplinks from the device indicating battery failure or loss of the device. A 'trip' refers to the period between an individual leaving the colony—either identified by the data contributor, or where this information was not provided, by examining the distance from the central point of the colony—and the subsequent return to the colony. As many birds will roost at sea in close proximity to the colony, intervals of less than 12 hours were not considered to be separate trips. In the few cases where deployments were not separated by the contributor, the return of the bird to the general area of the colony and a gap of more than 24 hours between successive uplinks were assumed to indicate the start of a new deployment. The individual was identified as the main statistical unit, with data separated on a biological basis where that information was available (see Table 2.1). An attempt was made to differentiate between individuals foraging from a breeding colony and those that had dispersed as part of non-breeding migration.

In order to ensure standard validation, PTT data contributors were asked to submit unvalidated datasets. Each dataset was then passed through a filter which coded points according to their location quality and the velocity of the bird. An iterative forward/backward averaging filter, based on that used by McConnell *et al.* (1992) for validating Southern Elephant Seal *Mirounga leonina* tracking data, was applied to calculate the bird's velocity at each uplink (Figure 2.1). If this velocity was over the maximum velocity v_{max}, and the alternative lat/long was provided, the filter substituted the alternative point. Once all the velocities were calculated the filter removed the point with the maximum velocity over v_{max}. However, if the Advanced Research Global Observation Satellite (Argos) location quality was provided, a point was not removed if it had location class 1, 2 or 3, because these locations have an accuracy of up to 1 km (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 over v_{max}. No assumptions were made about points on land and these were therefore not discarded if they passed the filter's criteria. The validation/filtering methodology was explicitly documented within the dataset's metadata and excluded points were coded with the reason for exclusion, so that alternative filtering criteria can be used in the future.

v_{max} was set at 100 km.hr^{-1} for all species. This resulted in an overall 2.4% of points being rejected. For species whose maximum velocity is likely to be over 100 km.hr^{-1}, such as the Wandering, Northern Royal, Black-browed and Grey-headed Albatrosses, the percentage of points rejected was 1.8%, 2.7%, 1.2% and 4.3% respectively. For species such as the giant-petrels, whose maximum velocity is likely to be lower, the rejection rates were 1.9% and 0.4% for Southern and Northern Giant-petrels respectively.

Figure 2.1. Method used to calculate the average velocity of the bird at a particular point.

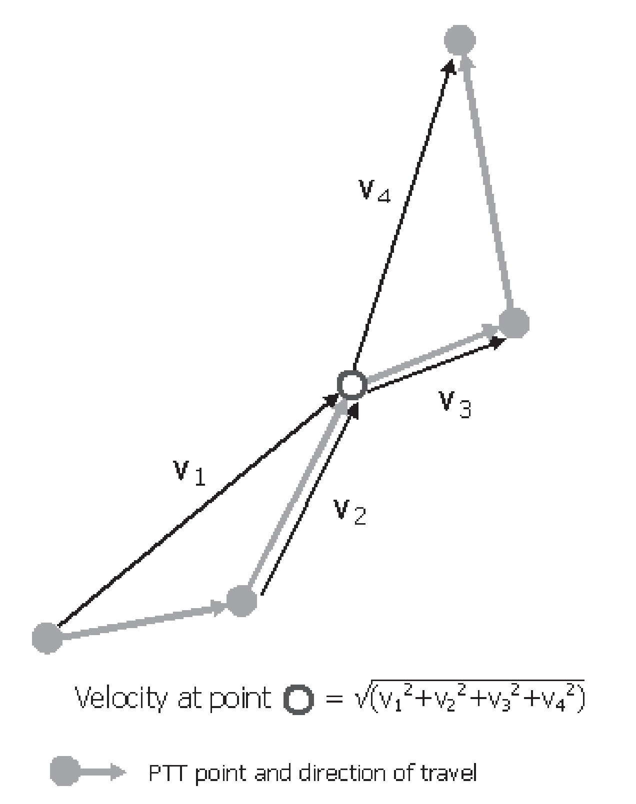


Table 2.1. Format of the standardised PTT tracking data.

Name	Type	Length	Description
Species	string	3	links to Species table
Site	string	3	links to Site table
Colony	string	3	links to Colony table, which in turn has links to Site
TrackID	string	10	unique track identifier, usually device ID + trip number, depending on what was provided
PointID	integer		sequential number to identify uplinks within a trip
DeviceID	string	10	unique PTT identifier
DeviceType	string	20	PTT type, usually blank
DutyCycle	string	15	if blank, assume continuous
RepRate	string	5	repetition rate, usually blank
TripID	integer		Sequential number to identify trips within a deployment. A trip is defined as time at sea lasting more than 12 hours, and ends upon the bird's return to the colony, as defined by the data contributor (see Location).
TripStart	datetime		used for validation
TripEnd	datetime		used for validation
BirdID	string	10	ring number or other label to uniquely identify an individual
Age	string	1	A: adult, J: subadult / juvenile / prebreeder, U: unknown
Sex	string	1	M: male, F: female, U: unknown
Status	String	1	R: resident, M: migratory – assigned by examining track. If bird moved off from colony in a consistent direction then defined as migratory.
BreedStatus	string	1	B: breeder; N: non-breeder; U: unknown
BreedStage	string	2	PE: pre-egg EB: early breeding (includes incubation and brood stages) IN: incubation CK: chick (includes brood, guard and post-guard stages) BG: brood guard (includes brood and guard stages, also referred to as 'small chick') BD: brood stage (also referred to as 'early chick') GD: guard stage PG: post-guard stage (also referred to as 'large chick') FM: failed breeder / migration after breeding UN: unknown
Latitude	float	8.4	
Longitude	float	8.4	
AltLat	float	8.4	alternative latitude provided by Argos
AltLon	float	8.4	alternative longitude provided by Argos
DateGMT	date		
TimeGMT	time		
DateLocal	date		
TimeLocal	time		
TimeZone	string	6	
Quality	string	1	Argos location quality code (0-3, A, B, Z) (Argos 1989, 1996)
<u>Code</u>	integer		-9: invalidated by user 9: validated by user -1: invalid as average velocity over v_{max} 1: valid as velocity under v_{max} -2: invalid as low quality 2: valid as high quality (Argos location code = 1, 2 or 3) 3: alternate point invalid as average velocity over v_{max} 3: alternate point valid as velocity under v_{max} 4: alternate point valid as high quality (Argos location code = 1, 2 or 3) 0: not validated
Location	string	1	C: colony, S: at sea – provided by data contributor, else calculated using a set radius from the colony. Used to demarcate trips
Comments	memo		
Contributor	memo		
Reference	memo		
<u>VelFilt</u>	float	8.4	average velocity calculated by the velocity filter
<u>Elapsed</u>	float	8.4	time in hours elapsed since the previous uplink
<u>Distance</u>	float	8.4	great circle distance in km from the previous uplink
<u>Velocity</u>	float	8.4	velocity in $km.hr^{-1}$ from previous to current uplink
<u>ColDist</u>	float	8.4	great circle distance in km from the colony
<u>Sunrise</u>	string	20	time of sunrise(s) at current latitude/longitude and date
<u>Sunset</u>	string	20	time of sunset(s) at current latitude/longitude and date
<u>DayNight</u>	string	1	D: daytime uplink, N: night-time uplink

italics: unique identifier for each uplink   <u>underline</u>: calculated fields   **bold**: mandatory fields required from data holder

2.2.2 Deriving density distribution maps

In order to identify areas which are highly utilised by albatrosses and petrels, some indication of density needs to be derived from the PTT tracking data. However the sampling regime of these data is dependent on several factors: the speed at which the bird is travelling, its latitude (Georges *et al.* 1997), and the performance of the device itself. In order to provide a more regular sampling regime it was assumed that a bird flew in a straight line at constant velocity between two successive uplinks, where these uplinks were less than 24 hours apart. The path of the bird was then resampled at hourly intervals, any remaining time being added to the first segment of the next path between successive uplinks. If the interval between uplinks was more than 24 hours, no assumptions were made about the bird's behaviour and these paths were not resampled. In this way devices with long duty cycles were also catered for as no assumptions were made about the bird's location during 'OFF' cycles. The resampling method also ensured that each trip was weighted by its duration when calculating density distributions. The process produced locations for the individual at hourly intervals, and thus density distribution maps derived from these locations were indicative of time spent ('bird hours') in a particular area.

Albatrosses and petrels are central place foragers when breeding, so in any density distribution map the uplinks around the colony could potentially outweigh any more distant foraging area. If the commuting points to and from foraging areas are removed, this high density around the colony should be reduced. However this requires making assumptions about the bird's activity based solely on the tracking data. In addition, commuting birds could still be at risk from fisheries interactions if they encounter a fishing vessel and stop to forage. To assess the effect of excluding commuting data, foraging points for Wandering Albatrosses were assumed to be those resampled points occurring between sunrise and sunset where the velocity was less than 20 km/hr. By excluding all other points, a density distribution of foraging locations was produced. This did not noticeably reduce the density around the colony, and there was little difference in areas of importance (Figure 2.2). Therefore foraging and commuting points were not separated out in the final maps. It is thus recognised that not all 'hot spots' identified by the kernel analysis will be foraging areas, but they still represent areas of risk.

Kernel density estimators have been successfully used in several tracking studies to quantify habitat use and identify home ranges (e.g. Wood *et al.* 2000). The single most important step when using these estimators is the selection of the smoothing (or *h*) parameter. This can greatly influence the home range size and can also highlight or smooth over areas of high density (Annex 3), so it is necessary to explicitly report the methods used to ensure transparency and objectivity. Care needs to be taken when comparing different datasets, but current experience and practice is encouraging (e.g. Matthiopoulos 2003).

As this study does not attempt to estimate range sizes, aiming instead to identify core areas of utilisation for conservation manage-ment, the selection of *h* was done by identifying the smallest practical unit of management on the high seas. For present purposes the workshop participants agreed this to be a 1 degree grid square. Although the use of 1 degree as a smoothing parameter means the shape of the kernel will vary with changes in latitude, it was agreed that the effects of this would be small in relation to the scales at which the data would be presented, and that this latitude-related distortion is widely understood.

Kernel density distribution maps were derived using the kernel function in ArcGIS 8.2. The grid size was set at one-tenth of the value of *h* i.e. 0.1 of a degree. If sample sizes were sufficiently large, separate kernel density distribution maps were produced for birds of different ages (juvenile, adult), breeding status, sex and breeding stage.

2.2.3 Combining density grids (weighting)

The density grids derived by kernel analysis of the resampled PTT locations for each part of the population were adjusted to reflect an index of 'seabird at sea hours' as follows: the kernel density estimate of each cell was divided by the number of resampled PTT locations for the dataset, and then weighted by the number of individuals at sea for that particular colony and breeding status/stage (e.g. Figure

Figure 2.2. Kernel density distribution contours of breeding Wandering Albatrosses tracked from Iles Crozet, showing density contours using all locations (A) and foraging locations only (B).

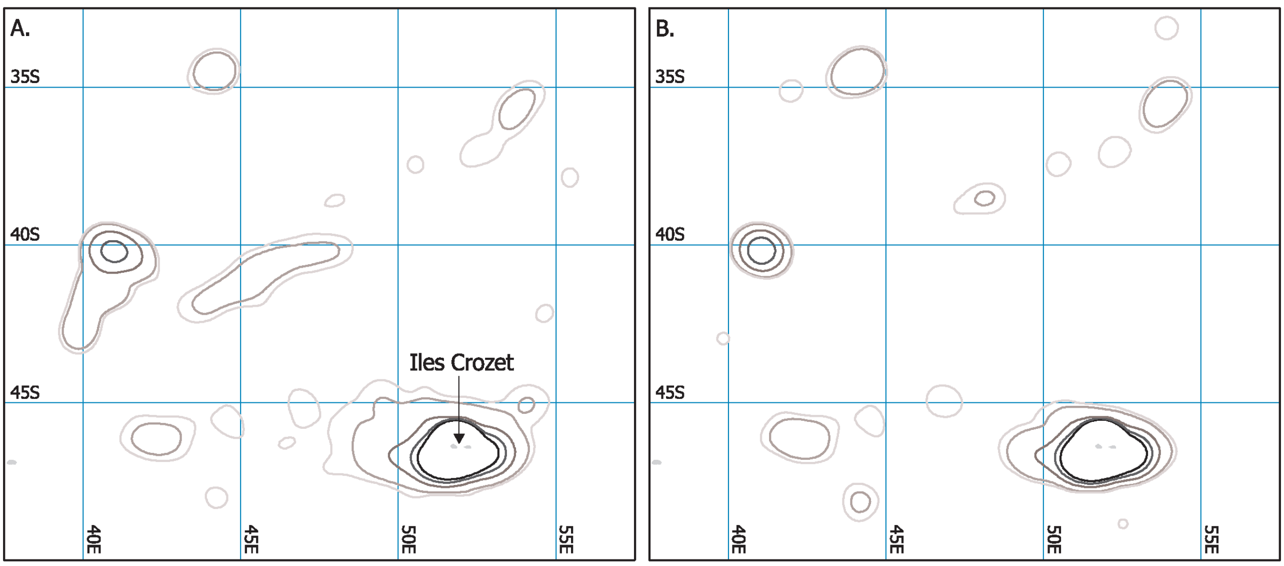
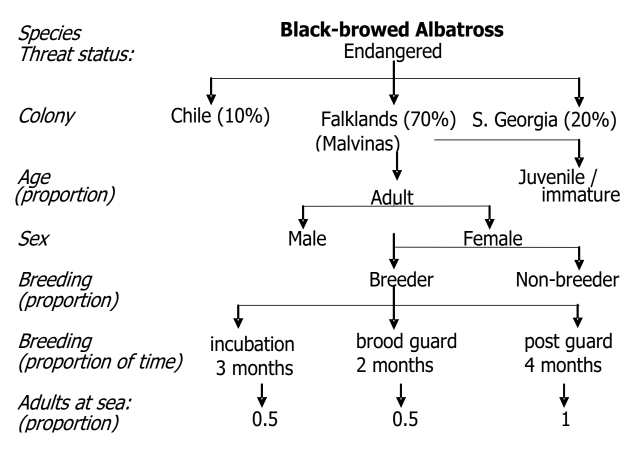


Figure 2.3. Example of how the species density distribution map for Black-browed Albatross *Thalassarche melanophrys* was compiled.



2.3). These grids were then summed to provide a density grid for the colony. However, because there are many more tracking data available for adult breeding birds than for non-breeding or juveniles/subadults, separate maps were produced for these categories. Species maps were generated by combining colony grids weighted according to colony size. Colony sizes, expressed as the number of breeding pairs, were drawn from several sources (Gales 1998, Tickell 2000, Arata *et al.* 2003, Lawton *et al.* 2003, Robertson, G. *et al.* 2003c, BirdLife International 2004b, Patterson *et al.* in press), which variously reported the number of breeding pairs, nests, eggs, chicks or fledglings censused at the colony. In each case the latest available census figure has been used to weight the colony, regardless of the census method used. The density distributions are represented on the maps by Utilisation Distributions (UDs), which provide probability contours indicating the relative time that birds spend in particular areas. For example, birds will spend 50% of their time within a 50% UD contour.

Frances Taylor

2.3 EFFECT OF SAMPLE SIZE ON KERNEL ANALYSIS

The sample sizes of the datasets submitted to the Global Procellariiform Tracking Workshop varied widely (see Annex 7), and some indication is needed of the reliability of utilisation distributions produced from small samples, particularly as most of the non-breeding data fell into this category. Two datasets with different characteristics were therefore examined in more detail. (1) Wandering Albatrosses breeding on Iles Crozet radiated out from the colony in a relatively uniform manner (Figure 2.4), with foraging hotspots identified in several locations at varying distances and directions from the colony. This dataset is very large, consisting of 205 tracks, and so the UDs produced from the full dataset should reliably reflect the actual foraging distribution of breeding birds from this colony. Although individuals were not identified in the dataset, it was assumed for the purposes of this exercise that each track was obtained from a unique individual. (2) Buller's Albatrosses breeding on the Snares Islands showed a more skewed distribution, with hotspots concentrated along the shelf-break of New Zealand's South Island, eastern Tasmania, and two discrete areas in the Tasman Sea (Figure 2.5). The dataset consists of 37 tracked individuals.

A series of random samples of increasing size (10 replicates of each) were extracted from each of the two datasets, and the areas of the resultant UDs plotted against sample size (Figures 2.6 and 2.7) (see also Annex 3). The areas of the UDs from the full datasets were plotted as the last point. The curves appeared to approach this asymptote with increasing sample size. The higher probability UDs approached the asymptote faster: in the case of the Crozet dataset a sample size of over 60 tracks produced no major increase in area for the 50% UD; whereas the 50% UD from the Snares dataset appears to plateau with a sample size of only four individuals. The area of the 75% UD reaches a plateau after 140 and 12 tracks for the Crozet and Snares datasets respectively. Conversely the 95% UD does not appear to have reached a maximum value even with the full dataset in the case of the Crozet tracks.

Figure 2.4. Utilisation distributions (UDs), range and resampled locations from PTT tracks for breeding Wandering Albatrosses from Iles Crozet. A UD provides a probability contour indicating the relative amount of time birds spend in a particular area i.e. they will spend 50% of their time within the 50% UD contour. The dotted line represents the range, or the 100% UD contour.

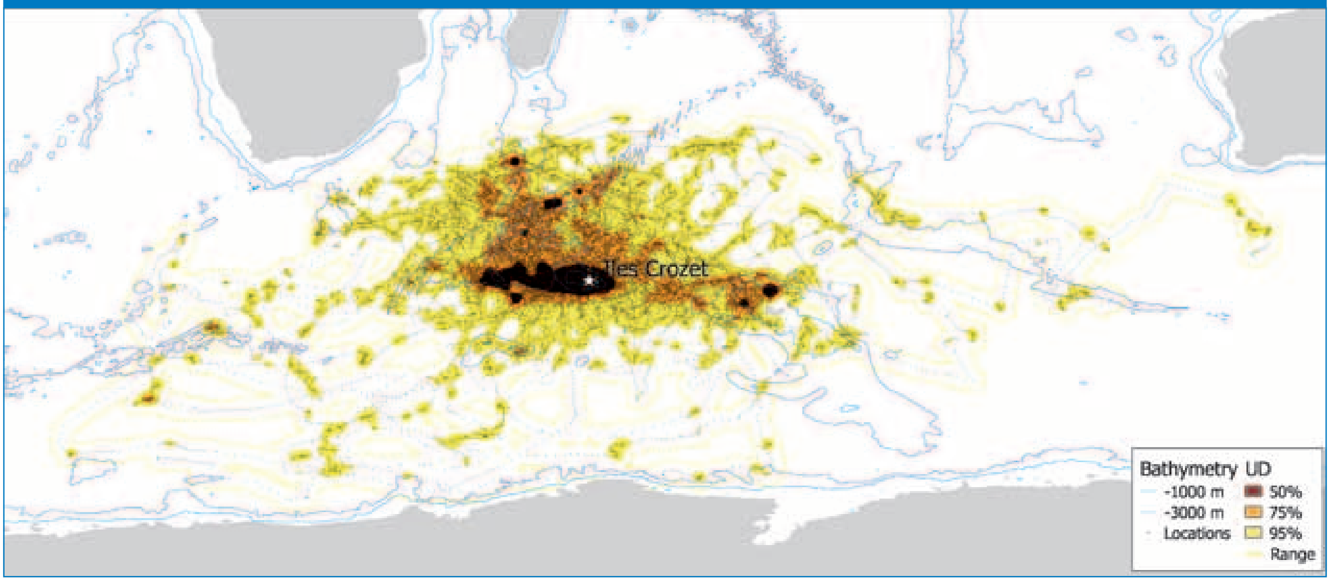
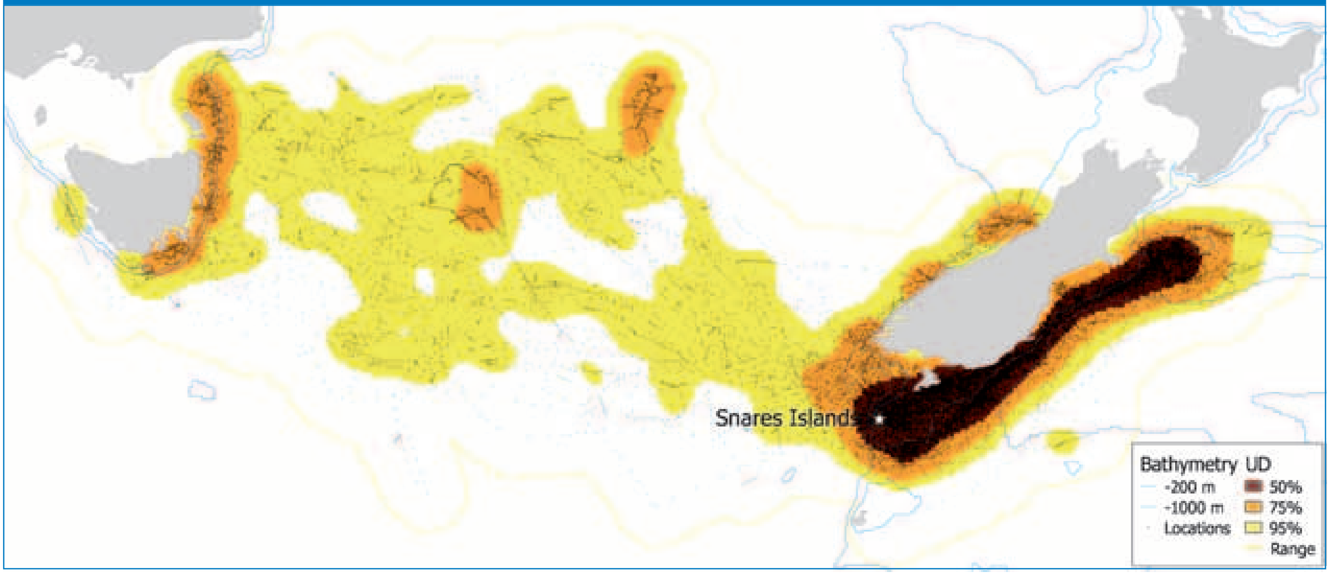


Figure 2.5. Utilisation distributions (UDs), range and resampled locations from PTT tracks for breeding Buller's Albatrosses from Snares Islands.



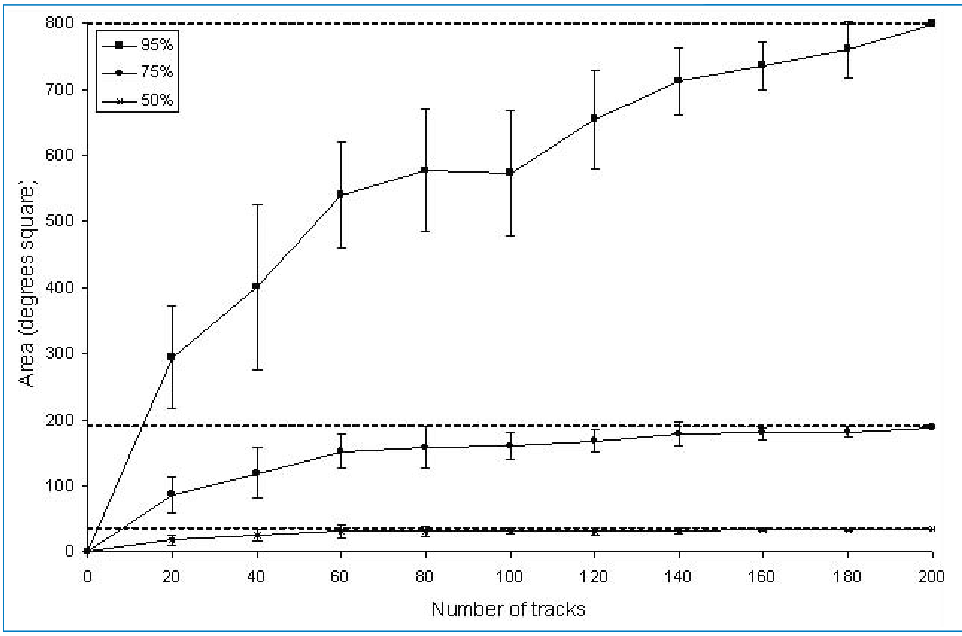


Figure 2.6. Mean UD areas (50%, 75% and 95%) and standard deviations in relation to sample size (number of tracks selected randomly from the dataset) for breeding Wandering Albatrosses tracked from Iles Crozet.

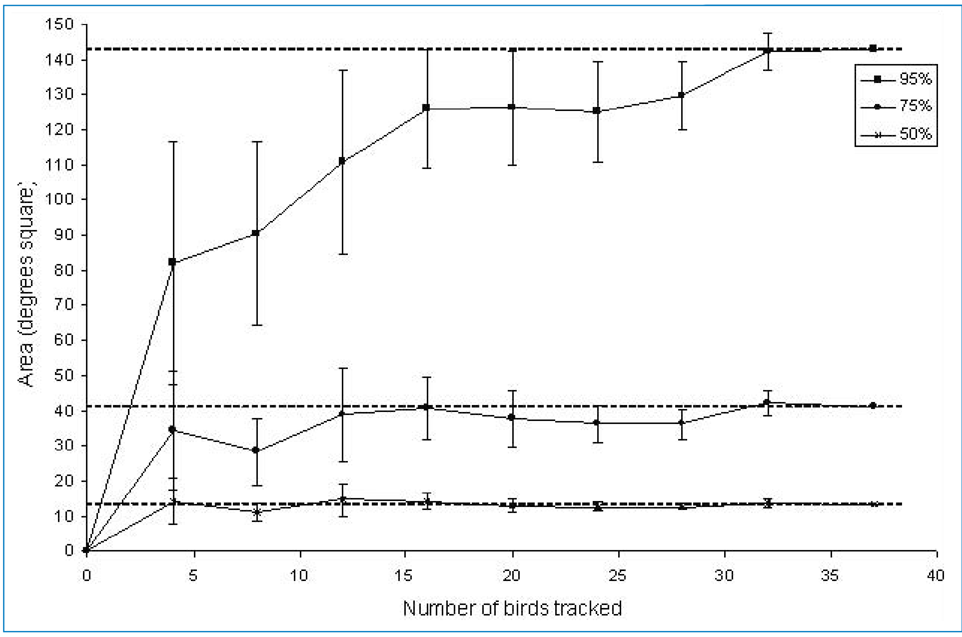


Figure 2.7. Mean UD areas (50%, 75% and 95%) and standard deviations in relation to sample size (number of individuals selected randomly from the dataset) for breeding Buller's Albatrosses tracked from Snares Islands.

Figure 2.8. Utilisation distributions (UDs) and range for breeding Buller's Albatrosses from Snares Islands. Each map was produced from the PTT tracks of four individuals selected at random from the complete dataset.

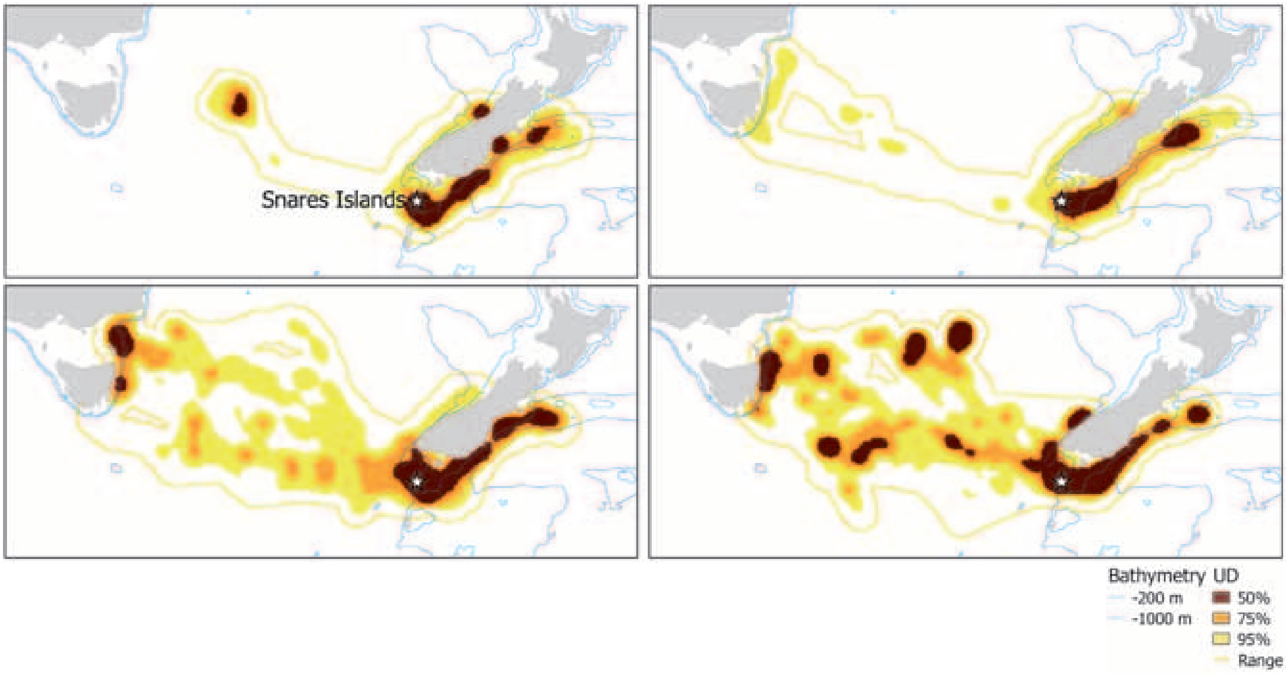
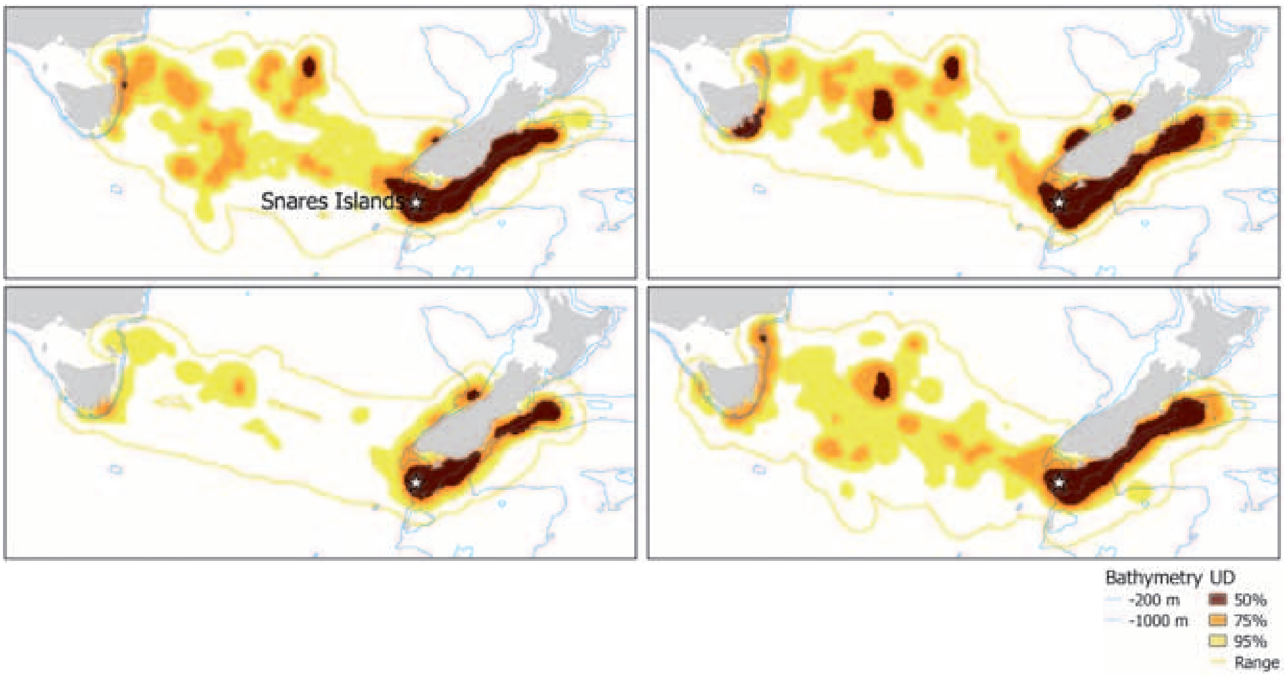


Figure 2.9. Utilisation distributions (UDs) and range for breeding Buller's Albatrosses from Snares Islands. Each map was produced from the PTT tracks of 12 individuals selected at random from the complete dataset.



The area of the 50% UD requires fewer tracks to reach a stable maximum value, which is encouraging for the purpose of identifying marine Important Bird Areas as these will be located in areas of high-intensity use. However care is needed as the locations of these hotspots are not necessarily the same for each random sample: in Figure 2.8 four samples of the Buller's dataset are shown, using four tracks drawn at random from the complete dataset. Even though the total area of the 50% UD is similar to that of the complete dataset, different regions are highlighted and some apparent hotspots are missed completely. At sample sizes this small, the foraging behaviour of a single individual on a single trip can produce hotspots in regions not frequented by any other individuals in the dataset. If the random sample is increased to 12 the influence of a single individual is reduced and hotspots are found in similar areas to the complete dataset (Figure 2.9), although some are still missed. The possibility of missing hotspots should be borne in mind when interpreting maps irrespective of the sample size.

Frances Taylor, Aleks Terauds and David Nicholls

2.4 METHODS FOR ANALYSING GLS DATA

Geolocation (Global Location Sensing or GLS-logging) is an alternative to satellite-telemetry for determining animal location. GLS loggers record light levels and use the timing of local noon and midnight to estimate longitude, and day length to estimate latitude. Although not as accurate as satellite tags, their small size and longevity mean that they are ideally suited to long-term deployment, and are therefore highly effective for migration studies.

The GLS technique provides 2 locations per day (at local midday and midnight) except for a variable period around the equinox when it is impossible to estimate latitude. The accuracy of the technique varies but given the type of device, processing technique and study-species it is reasonable to assume, based on data collected between 30°S and 60°S, an average error of around 186 km for GLS datasets submitted to the workshop (Phillips *et al*. 2004a).

2.4.1 Standardisation of GLS data

A variety of GLS loggers are available, differing in both design and recording interval. Techniques for converting light levels to location estimates also vary (e.g. threshold methods compared with curve-fitting), as do approaches to subsequent post-processing to remove unrealistic locations. The latter is a particularly time-consuming part of the analysis. For these reasons it was deemed unrealistic to develop a standardised validation routine for the GLS component of the workshop tracking data.

Data contributors were therefore asked to submit post-processed GLS locations and provide brief metadata on the conversion methods and validation rules that had been applied. In fact, there was little difference in the proportion of points eliminated in each of the four GLS datasets submitted to the workshop (6.9%, 15.2%, 5.9% and 6.9% of locations excluded during June and July and 21.0%, 22.8%, 24.5% and 29.6% of locations excluded in August).

The GLS tracking data were standardised according to the format indicated in Table 2.2.

In order to separate breeding from non-breeding season data, if individual-specific data were not provided, the breeding season for a particular population was defined as the time from the mean copulation date to mean fledging date. All locations falling outside this date range were assigned a status of N (non-breeder) and a stage of NB (non-breeding).

2.4.2 Density distribution maps

As GLS locations are available from tracked birds at approximately 12-hour intervals and invalid locations are eliminated more or less randomly, there is no requirement to resample the data. For a variable period around the equinoxes, however, it is impossible to obtain location estimates and consequently sample sizes were consistently smaller during March and September and, to a lesser extent, during April and August. Histograms presented alongside each distribution map indicate the sample size (bird days) per month, highlighting the under-representation of ranges during certain periods.

The analysis of submitted GLS data was restricted to the non-breeding period as (better quality) satellite-tracking data were available for breeding birds for all species and sites concerned. Kernel density distribution maps were generated in ArcMap 8.1 using a smoothing factor of 2 degrees (the nominal resolution of the GLS data) and a cell size of 0.5 degrees (see PTT methods section for further details).

Janet Silk

Table 2.2. Format of the standardised GLS tracking data.

Name	Type	Length	Description
Species	string	3	links to Species table
Site	string	3	links to Site table
Colony	string	3	links to Colony table, which in turn has linksto Site
TrackID	string	10	unique track identifier, usually device ID + trip number, depending on what was provided
PointID	integer		sequential number to identify uplinks within a trip
DeviceID	string	10	GLS identifier
DeviceType	string	20	GLS device type
TripID	integer		sequential number to identify trips or stages within a deployment
BirdID	string	10	ring number or other label to uniquely identify an individual
Age	string	1	A: adult, J: subadult / juvenile / prebreeder, U: unknown
Sex	string	1	M: male, F: female, U: unknown
Status	string	1	B: breeder; N: non-breeder; U: unknown
Stage	string	2	PE: pre-egg IN: incubation CK: chick (includes brood, guard and post-guard stages) FM: failed breeder / migration after breeding UN: unknown
Latitude	float	8.4	
Longitude	float	8.4	
DateGMT	date		
TimeGMT	time		
Code	integer		-9: invalidated by user 9: validated by user
Comments	memo		
Contributor	memo		
Reference	memo		

2.5 METHOD FOR ANALYSING MIGRATION ROUTES

Migration locations were distinguished from resident locations based on consistent movement in an easterly or westerly direction at high velocities (>20 km/h). Resident locations only were used to calculate kernel density distributions maps of wintering areas.

An indication of the variation in the routes taken from one wintering area to the next was obtained by calculating the average latitude ± 1 SD of all migration points within 10 degree longitudinal bands (Figure 2.10).

Frances Taylor and Janet Silk

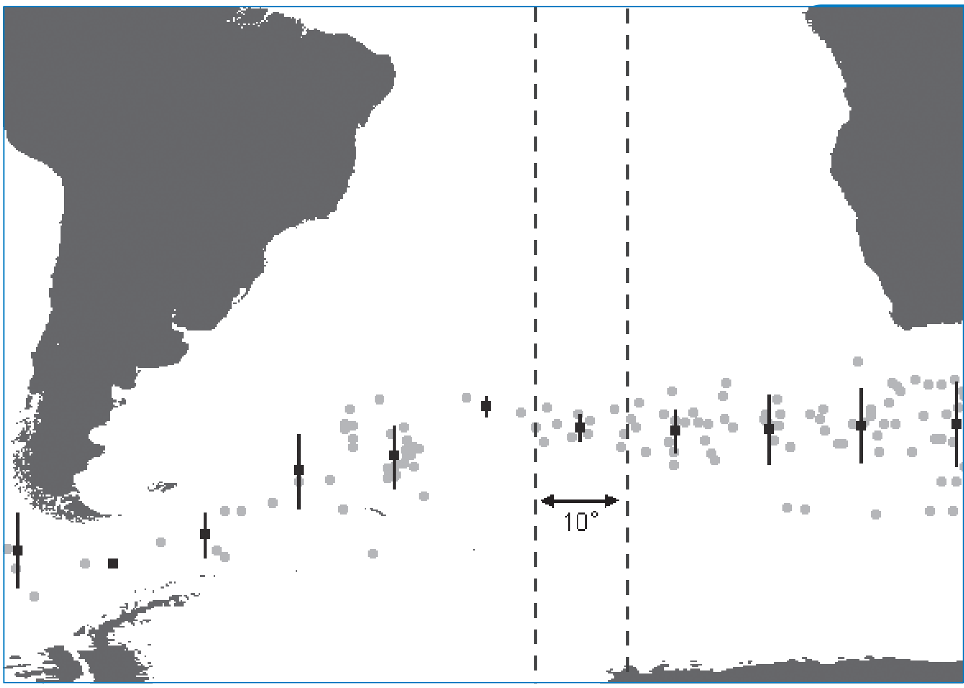


Figure 2.10. Example of a migration route. The grey points are the migration locations. The black squares and vertical bars indicate the mean latitude ± 1 SD within each 10° band.

3 RESULTS

Data were provided for 16 species of albatross, both species of giant-petrel and White-chinned Petrel; these are listed at Annex 2. A bibliography of published studies involving remote tracking of albatrosses, giant-petrels and *Procellaria* petrels is provided at Annex 4.

Figure 3.1 provides a map of locations from which PTT or GLS tracking data were obtained for the workshop.

The data submitted are summarised, for PTT and GLS tracking locations, in Figures 3.2 and 3.3.

The results of analysis undertaken during and after the workshop are divided into five main sections. These involve examples of:

1. Variation in foraging range and distribution of breeding birds in relation to: a. stage of breeding cycle; b. sex; c. year; d. colony.
2. Breeding season ranges for species where data are available from several different geographical (island group) populations.
3. Ranges and distributions of birds which are not breeding: a) whether adults or immatures during the breeding season; b) adults on migration and in staging and/or "wintering" areas.
4. Summaries of range and distribution data available for all species for different regions (comprising Southwest Atlantic and southern South America, Indian Ocean, Australasia and North Pacific).
5. Overlap between albatross ranges and distributions and the jurisdictions of fishery management organisations and of longline fishing effort.

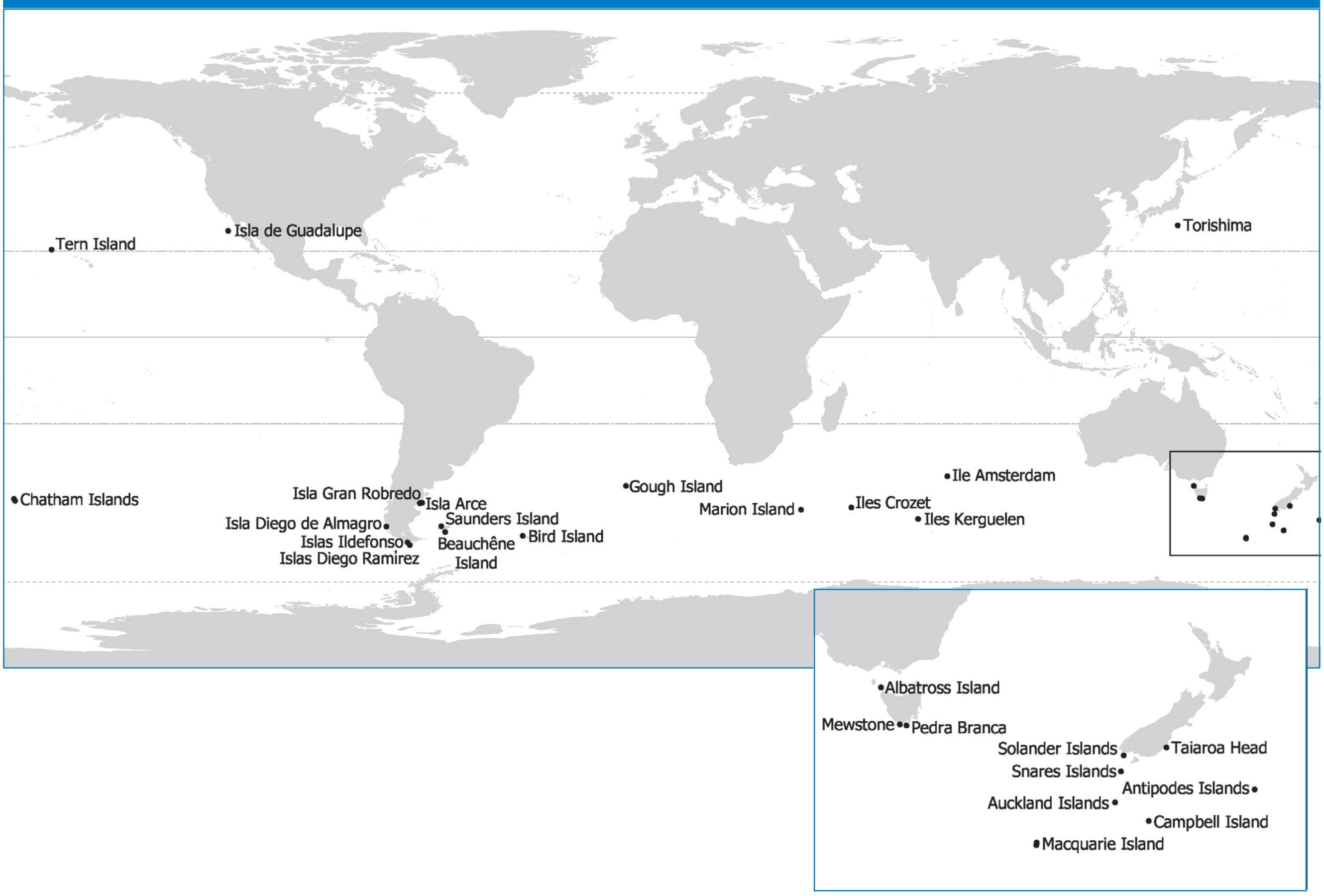
3.1 DISTRIBUTION OF BREEDING BIRDS

3.1.1 Distribution of breeding birds in relation to stage of breeding cycle

Wandering Albatross *Diomedea exulans* – Iles Crozet

The distribution at sea of foraging Wandering Albatrosses from Possession Island (Crozet Islands) differed greatly according to the stages of the breeding season (Figure 3.4). During incubation Wandering Albatrosses forage for foraging trips lasting on average 10 days, ranging from 2 to 22 days. They forage at long distances (up to 3,600 km) from Possession Island, from Antarctic waters along the Antarctic continent to sub-tropical waters, mainly using long looping movements stopping regularly en route for brief periods. At this time birds are foraging mainly over oceanic waters, visiting the Crozet shelf only during the week or so preceding hatching, i.e. during the longer trips over oceanic waters. They can also visit shelf areas around Kerguelen, or the seamounts located between the Crozet and Prince Edward Islands. As soon as the chick hatches,

Figure 3.1. Locations for which PTT or GLS tracking data were provided for the workshop.



the foraging strategy completely changes. They make short foraging trips lasting 1–5 days (average 2 days) and forage mainly over the Crozet shelf, the shelf break and the neighbouring oceanic waters. They mostly concentrate on the shelf break, in sectors that are colony-specific. For Possession Island these sectors are mostly concentrated on the south-eastern shelf edge, at a distance of 20–50 km from the colonies. As soon as the chick is left alone on the

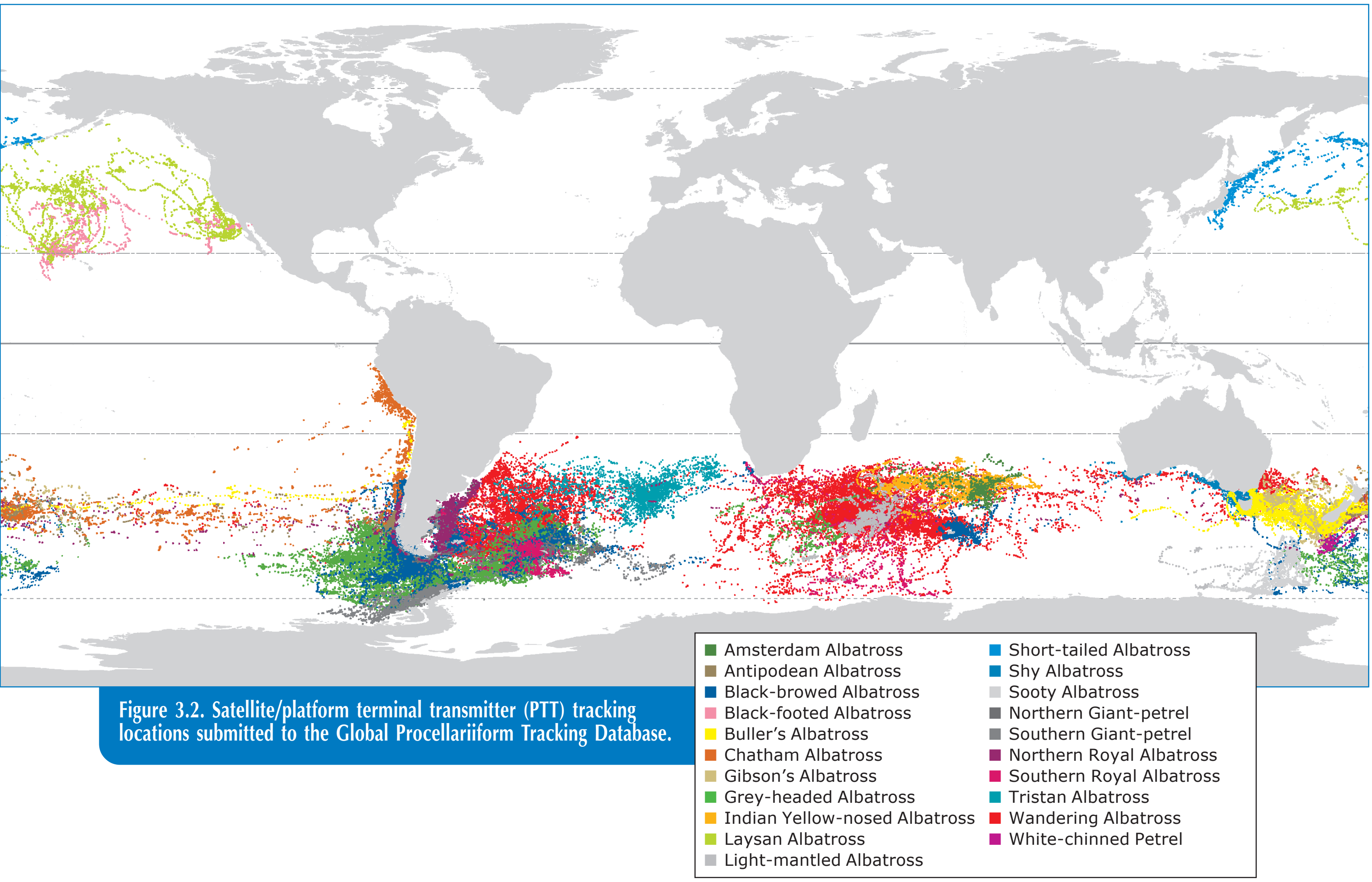


Figure 3.2. Satellite/platform terminal transmitter (PTT) tracking locations submitted to the Global Procellariiform Tracking Database.

Figure 3.3. Geolocator (GLS) tracking locations submitted to the Global Procellariiform Tracking Database.

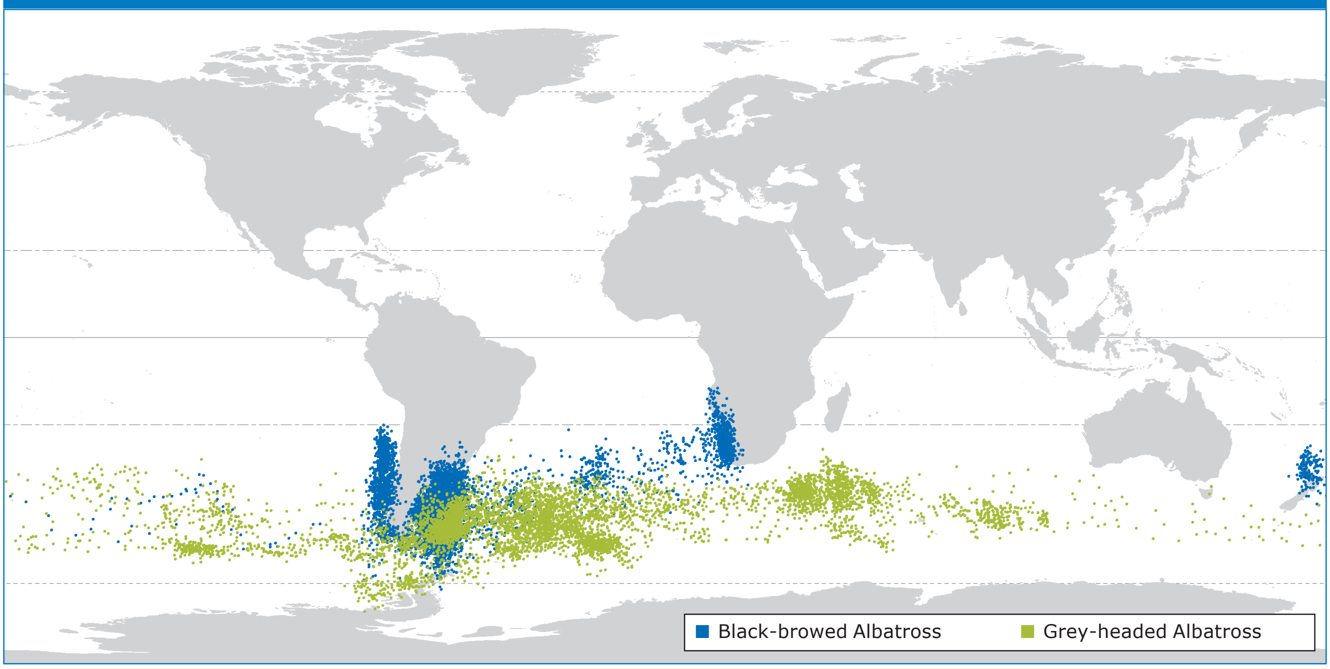
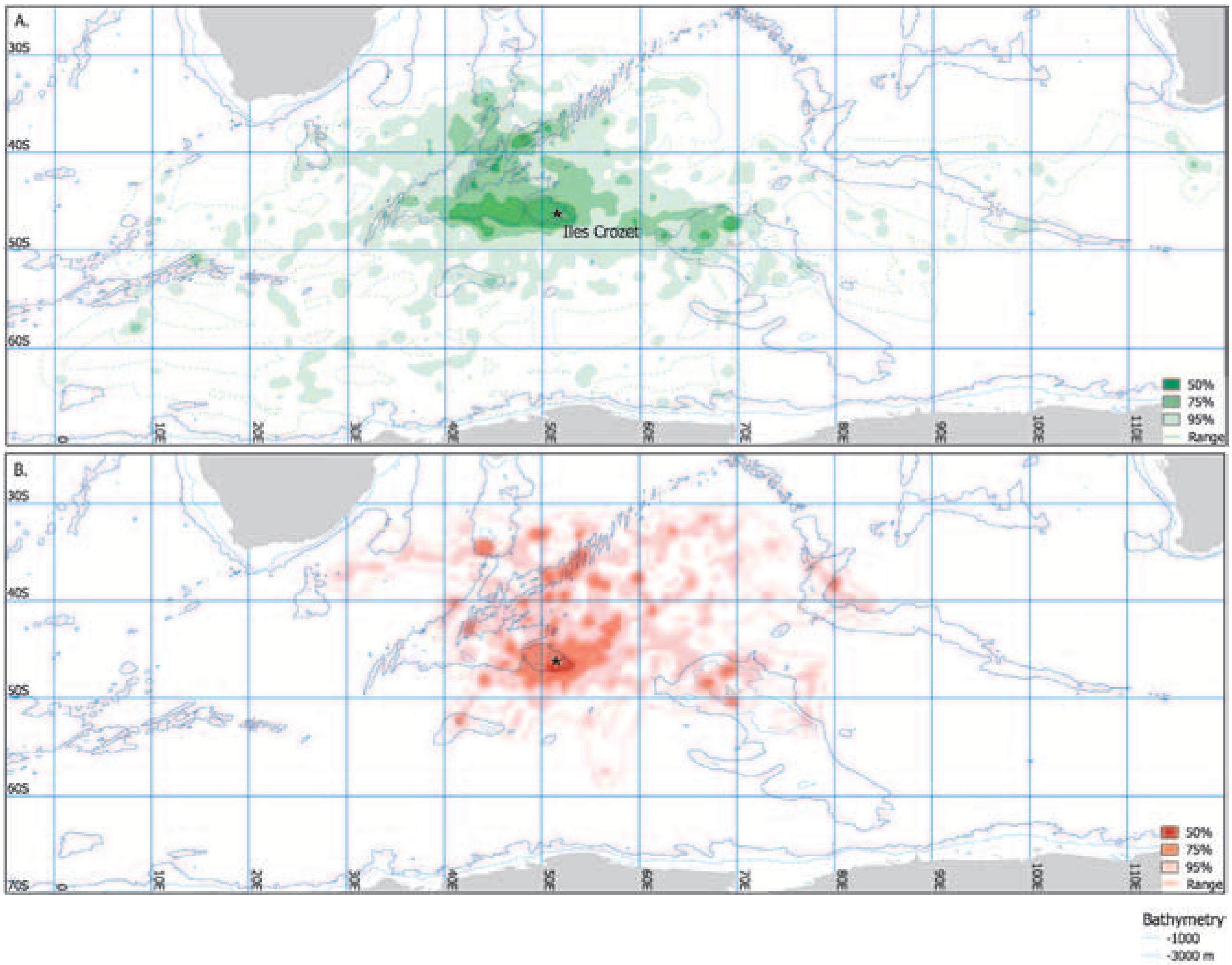


Figure 3.4. Utilisation distribution maps for breeding Wandering Albatrosses tracked from Iles Crozet at different stages in the breeding cycle. A. incubating birds (n=38,011 hrs); B. chick rearing (n=10,859 hrs). (Unable to determine number of individuals of each category from dataset, so sample sizes are given in number of hours tracked.)



nest, birds use a two-fold strategy, whereby they alternate long foraging trips in oceanic waters (similar to those of the incubation period) with a succession of short trips to the shelf edge and neighbouring oceanic waters (similar to the brooding period trips). Oceanic trips are mainly done to the north of the Crozet Islands, i.e. birds no longer go south to Antarctic waters.

These important changes in foraging habitats and duration of trips observed at Crozet at different stages of the breeding season (see also Figures 3.13 and 3.14) have been found at other breeding sites, e.g. South Georgia, Marion Island and also Kerguelen Island.

Henri Weimerskirch

Tristan Albatross *Diomedea dabbenena* – Gough

The utilisation distribution maps for the Tristan Albatross reveal substantial differences between the three major stages of the breeding cycle. During incubation most foraging is concentrated around Gough Island from 20°W to 0° of longitude and between 35–50°S, although some individuals also made trips to western areas of the South Atlantic moving as far as 50°W (Figure 3.5A). Foraging trips during incubation averaged 10 days (range 6–22 days) and with an average foraging range of 940 km. During the brood/guard stage foraging trips averaged 2 days (range 0.5–4 days) and are centred on Gough (Figure 3.5B), with an average range of 380 km. The sudden change from trips of long duration during incubation to short trips in the brood/guard stage is expected, as breeding adults are constrained to frequently feed small chicks at this time (Weimerskirch *et al.* 1993, Prince *et al.* 1998). During the post-guard stage the foraging distribution of breeding adults ranges across the South Atlantic from 50°W to 10°E and between latitudes 30–45°S. Trips during the post-guard stage averaged 5 days in duration (range 1 to 21 days) and varied greatly in range, with the maximum distance of trips varying from 110 to 3,500 km. The distribution of foraging locations indicates no clear pattern in relation to bathymetric features with most foraging locations concentrated over pelagic waters (>3,000 m depth) and within the sub-tropical zone and sub-tropical convergence zones. The distribution of the Tristan Albatross mainly between 30–45°S suggests that the species is at considerable risk from longline mortality as most pelagic fishing effort in the South Atlantic occurs within these latitudes (Tuck *et al.* 2003). However, variation between different stages of the breeding cycle and spatial variation in pelagic fishing effort over the year means that numbers of

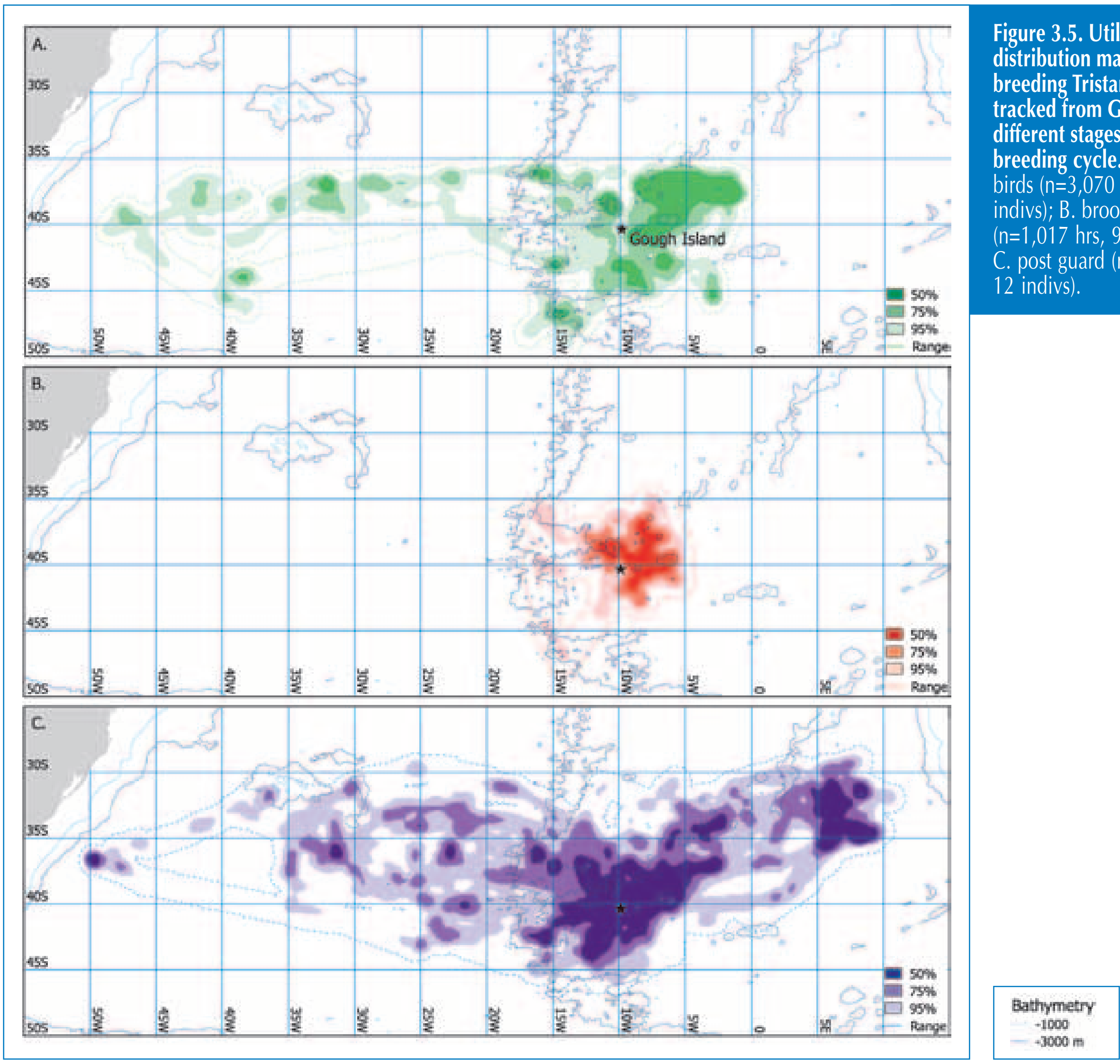


Figure 3.5. Utilisation distribution maps for breeding Tristan Albatrosses tracked from Gough Island at different stages during the breeding cycle. A. incubating birds (n=3,070 hrs, 17 indivs); B. brood-guard (n=1,017 hrs, 9 indivs); C. post guard (n=7,364 hrs, 12 indivs).

birds at risk from longline mortality is likely to vary greatly over the course of the year (Cuthbert *et al.* 2004).

Richard Cuthbert

Black-browed Albatross *Thalassarche melanophrys* – Falkland Islands (Malvinas)

During the incubation period birds from Saunders Island foraged almost exclusively on the Patagonian Shelf to the north of the Falkland Islands (Malvinas) and up to 41ºS (Figure 3.6C). Within this huge potential foraging area, the sites of most intense foraging, as represented by areas of higher density, were located in relatively discrete areas. Three such areas were located along the shelf break: one was between 49º and 50ºS, another around 48ºS and the third was between 45º and 46ºS. Another area of high density was located east and north-east of Peninsula Valdez between 41º and 43ºS. Two further areas were located close inshore to two fishing ports, Rawson and Camerones. Towards the end of the incubation period, birds reduced their foraging trips both in terms of duration and distance travelled and mostly stayed close to the north coast of the islands.

During the chick rearing period, the foraging area was much smaller and confined to the Falkland Islands (Malvinas) Inner Conservation Zone, apart from small areas on the shelf break between 46º and 48ºS (Figure 3.6F). The major area of foraging activity was situated close to the north west coast of the islands from the Jason Islands to the northern entrance of Falkland Sound. Another area of high activity was situated close to the shelf break to the north east of the islands at around 50ºS. As in the incubation period, almost all foraging was to the north of the islands.

During the incubation period birds from Beauchêne Island use the largest foraging area of all, with birds ranging from 41º to 56ºS (Figure 3.6B). Most of the area used was over the Patagonian Shelf, the only exception being the area of high activity inside the Southern Area of Cooperation (SAC) box (of concern, should this area open for oil exploration as planned). In the southern part of their distribution, areas of high foraging activity were situated on the shelf break south-west of the islands, east and west of Staten Island and south of Cape Horn. In the northern part areas of high activity were similar to those used by birds from Saunders Island during incubation. These are along the shelf break between 46º and 48ºS, on the Patagonian Shelf west of Peninsula Valdez between 41º and 43ºS and around the same two fishing ports. As at Saunders Island, birds reduced foraging distance towards the end of the incubation period and concentrated close to the islands, but in this case along the southern coasts.

During the chick rearing period birds from Beauchêne Island also had a restricted foraging range, being almost a mirror image of the one used by birds from Saunders Island at the same period (Figure 3.6E). Most activity was concentrated along the south coast of the islands, mainly west of Beaver Island, at the southern entrance of Falkland Sound, around Sea Lion Island and around Beauchêne Island itself. Areas of lower activity also existed along the shelf break, south-west of the islands, in the SAC box and on the Burdwood Bank.

Overall, these data clearly show the difference between a very restricted foraging range during chick-rearing (Figure 3.6D) and an incubation period range (Figure 3.6A) which is orders of magnitude larger, even though smaller favoured foraging areas can be identified.

This confinement to shelf waters and to the shelf break is in accordance with other studies at Kerguelen Island (Weimerskirch *et al.* 1997c) and South Georgia (Prince *et al.* 1998), but differs from some birds studied at Campbell Island (Waugh *et al.* 1999) which foraged over deeper waters.

Nic Huin

Black-browed Albatross *Thalassarche melanophrys* – Chile

Black-browed Albatross foraging distribution in Chile is known for all breeding stages only at the Diego Ramirez Islands (Figure 3.7). Although marked differences in the extension (both in time and distance) of the foraging trips between stages were found, breeding Black-browed Albatrosses from Diego Ramirez used mainly the continental shelf and slope of central (north to 35ºS) and southern Chile, with sporadic trips into deeper oceanic waters to the west of Chile, to the Antarctic Polar Frontal Zone and the Antarctic Peninsula. During incubation, albatrosses foraged along the Chilean coast, from 35–57ºS, concentrating their effort mostly off the Arauco Gulf (37ºS), Chiloé Island (43ºS) and southern Chile (52–57ºS). Trip duration and range were significantly reduced during brooding, when birds foraged mainly around the southern tip of the Chilean continental shelf, although a few birds prospected in Antarctic Polar Frontal Zone

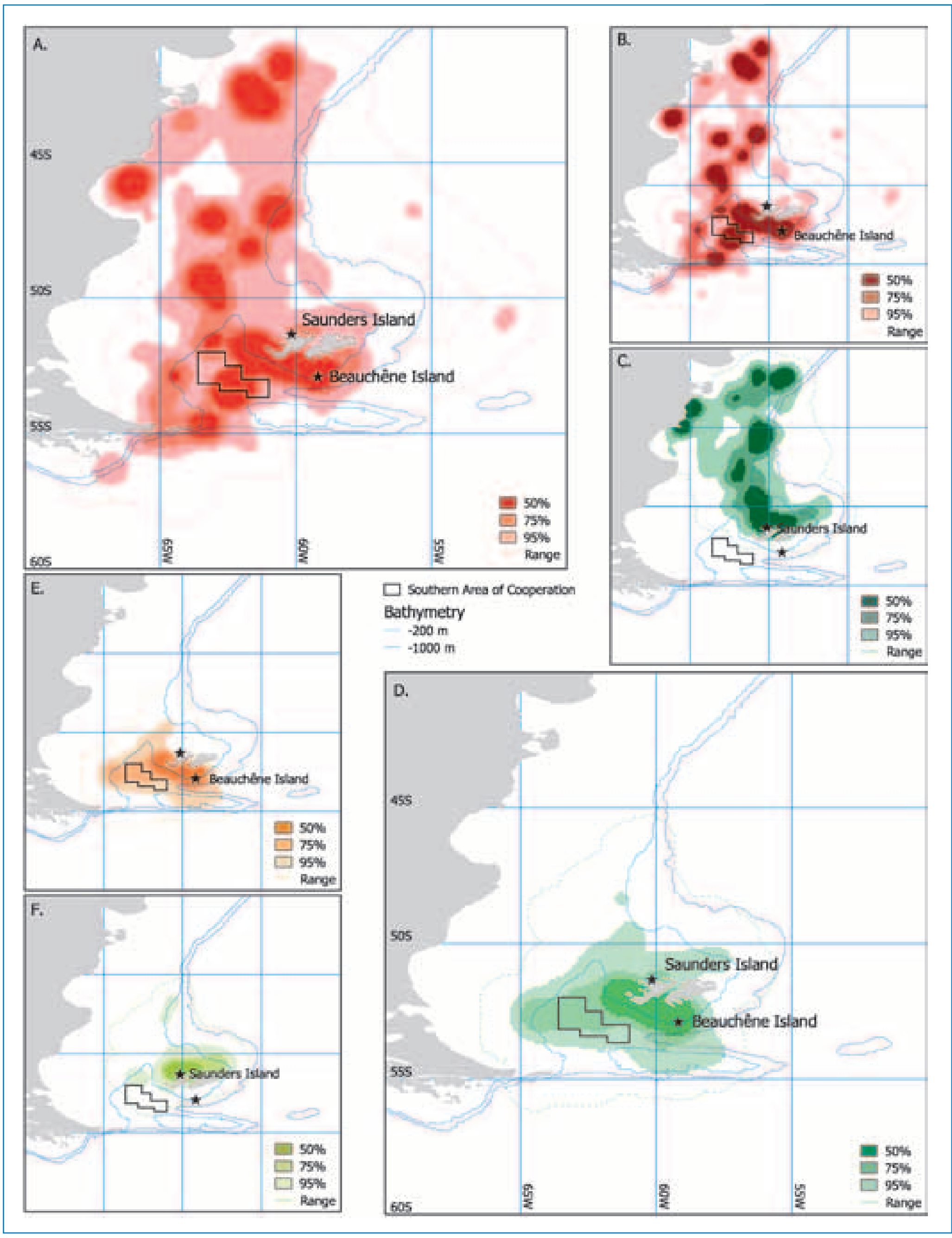


Figure 3.6. Utilisation distribution maps for breeding Black-browed Albatrosses tracked from the Falkland Islands (Malvinas) at different stages in the breeding cycle. A. incubating birds from the Beauchêne and Saunders colonies, weighted by colony size (n=5,412 hrs, n=11 indivs); B. incubating birds from Beauchêne (n=2,653 hrs, 4 indivs); C. incubating birds from Saunders (n=2,759 hrs, 7 indivs); D. post guard birds from the Beauchêne and Saunders colonies, weighted by colony size (n=7,984 hrs, n=12 indivs); E. post guard birds from Beauchêne (n=3,397 hrs, 4 indivs); F. post guard birds from Saunders (n=4,587 hrs, 8 indivs).

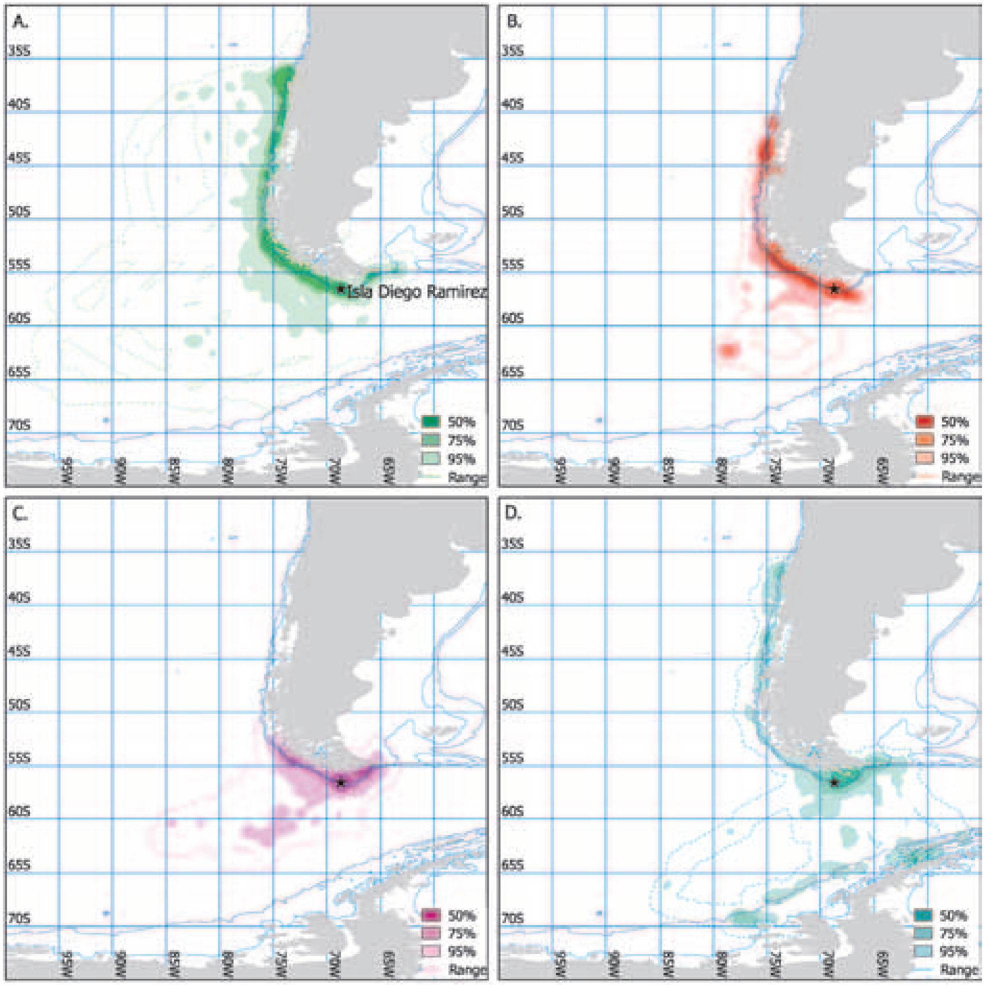


Figure 3.7. Utilisation distribution maps for breeding Black-browed Albatrosses tracked from Isla Diego Ramirez at different stages in the breeding cycle. A. incubating birds (n=10,103 hrs); B. early breeding (incubation/ brooding) (n=1,642 hrs); C. brooding (n=5,367 hrs); D. post guard (n=6,083 hrs). (Unable to determine number of individuals of each category from dataset, so sample sizes are only given in number of hours tracked).

waters. Main foraging areas were located over the continental shelf and slope south to 55ºS. During chick-rearing, albatrosses mixed two strategies, short trips over the surrounding waters in southern Chile (similar to distribution during brooding), representing up to 90% of total trips, with long trips to central Chile (similar to those made during incubation) and Antarctic waters, mainly along the continental shelf and slope of the western Antarctic Peninsula. Despite the difference in trip characteristics between breeding stages, Black-browed Albatrosses tracked from Diego Ramirez foraged mainly over Chilean territorial waters, especially inside the EEZ waters during breeding, with very occasional forays into Argentine Patagonian Shelf waters.

During incubation, birds tracked from Isla Ildefonso show a similar distribution to Diego Ramirez, with concentrations occurring off the Arauco Gulf, Los Chonos Archipelago (45ºS) and southern Chile (50–57ºS). This result is similar to that between Falkland Island (Malvinas) colonies during incubation.

There is a strong interaction between breeding albatrosses and fishing vessels, which produce food through offal discards and cause mortality by incidental capture (Arata and Xavier 2003, Moreno *et al*. 2003). Thus, it seems likely that fishing boats could affect the normal distribution patterns of Black-browed Albatrosses in southern Chile and reduce inter-colony competition by food, allowing greater than normal levels of foraging range overlap.

Javier Arata and Graham Robertson

3.1.2 Distribution of breeding birds in relation to sex

Northern and Southern Giant-petrels *Macronectes halli* and *M. giganteus* – South Georgia

Giant-petrels are the largest birds of the family Procellariidae, weighing about 4–5 kg and with a wingspan of 150–210 cm. Both sibling species, the Northern *Macronectes halli* and the Southern *M. giganteus,* show a noticeable sexual size dimorphism in which males are between 16 and 35% heavier and have disproportionately larger bills than females (González-Solís 2004). The two species are the dominant scavengers of the Southern Ocean; males and females of both species rely mainly on penguin and pinniped carrion, but complement this diet by taking live seabirds, scavenging on food waste and feeding on marine prey such as crustaceans, cephalopods and fish (Hunter 1985).

There is much evidence, from various sources, that both species of giant-petrels are among the more remarkable examples of sexual segregation in feeding habits in birds. Direct observation of feeding habits, diet analysis and stable isotope heavy metal studies, all suggest clear segregation in the trophic habits of males and females in both species (Hunter 1983, Becker *et al*. 2002, González-Solís *et al*. 2002b, González-Solís and Croxall 2005). Such sexual differences in the type of prey consumed imply a fundamental decision to direct the searching effort to particular habitats.

This is well demonstrated in the areas exploited by each sex during the incubation period. In both species most males engaged in short trips close to the breeding grounds whereas most females foraged in pelagic waters further away from

South Georgia (Figures 3.8 and 3.9). Satellite tracking of southern giant-petrels breeding in Patagonia and at Palmer Station (Antarctica) also suggest a similar segregation in foraging areas between males and females (Quintana and Dell'Arciprete 2002, Patterson and Fraser 2003). At South Georgia, males of the Northern species seem more restricted to shorelines than the more pelagic Southern species, which accords well with the greater specialisation of

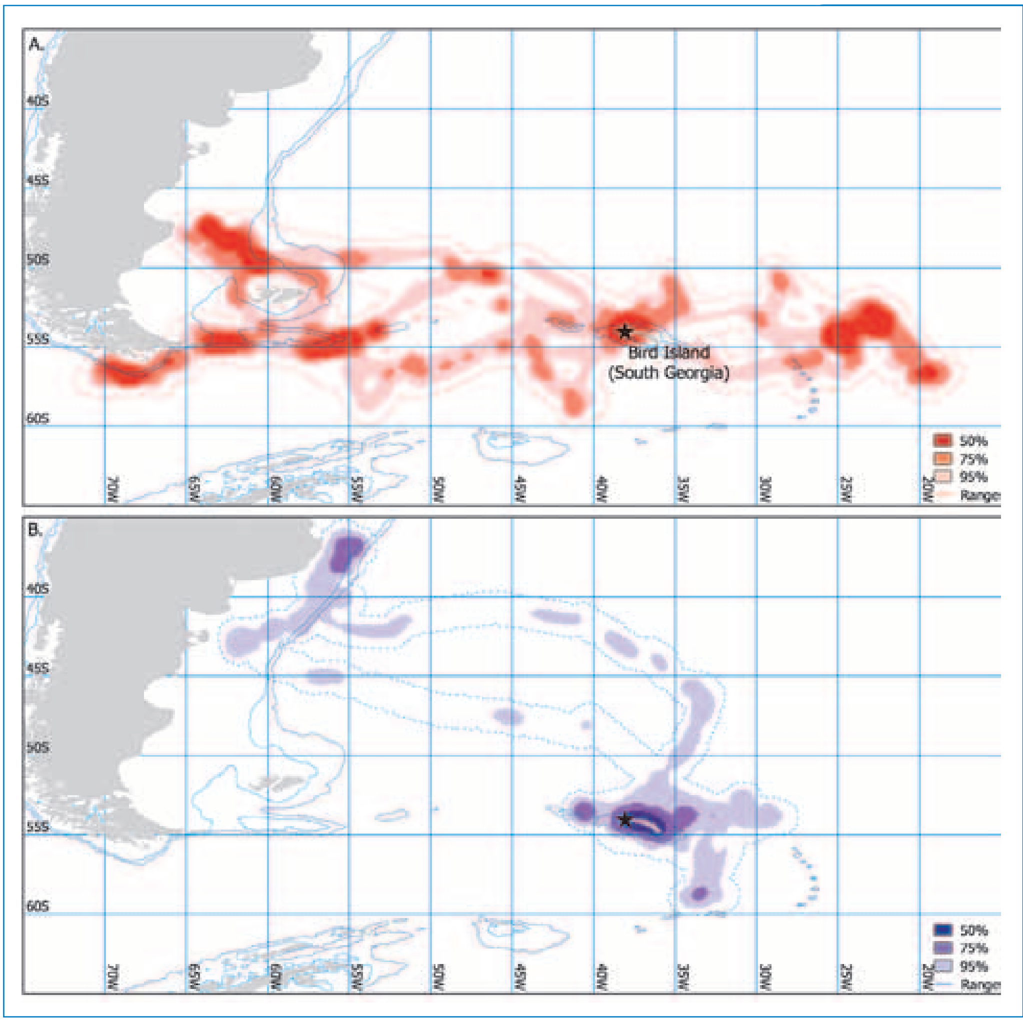


Figure 3.8. Utilisation distribution maps for incubating male and female Northern Giant-petrels, tracked from Bird Island, South Georgia. A. incubating females (n=2,048 hrs, 9 individuals); B. incubating males (n=1,873 hrs, 9 individuals).

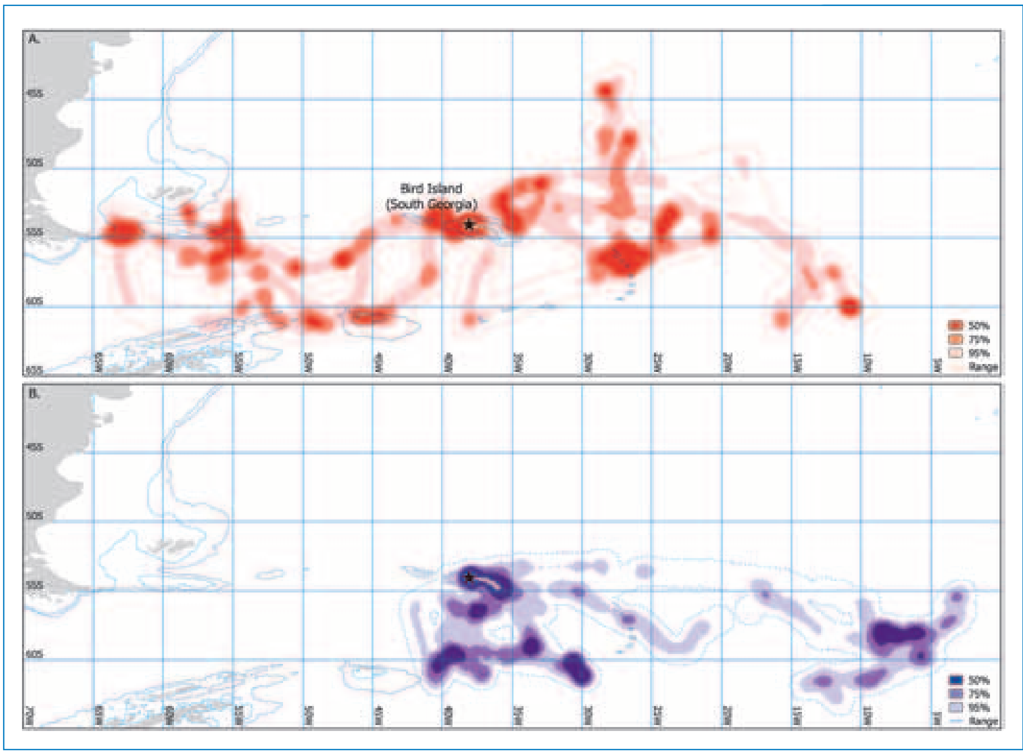


Figure 3.9. Utilisation distribution maps for incubating male and female Southern Giant-petrels, tracked from Bird Island, South Georgia. A. incubating females (n=1,973 hrs, 5 individuals); B. incubating males (n=1,379 hrs, 6 individuals).

the former species in exploiting fur seal carcasses. This difference is also supported by the data from activity recorders deployed together with some satellite PTT's, which registered longer dry periods (out of contact with salt water) for Northern Giant-petrel males. (González-Solís *et al*. 2002a). Overall, sexual segregation in the foraging areas was reflected in a number of trip features: males showed lower median trip duration, daily distance covered, flight speed, maximum foraging range and activity range than females (González-Solís *et al*. 2000a, González-Solís *et al*. 2000b).

Pelagic areas exploited by males and females also differed in their directionality with respect to the breeding site. Females of both species showed similar foraging areas, exploiting pelagic waters east and west of South Georgia, but Southern Giant-petrel females showed a more pronounced tendency to forage towards eastern waters and Northern females towards the Patagonian Shelf. Similarly, Southern Giant-petrel males also foraged mainly towards east and south of South Georgia and the unique long trip performed by a Northern Giant-petrel male was north of the Patagonian Shelf. These differences may partly be shaped by the intraspecific competition among the different colonies of the two species. Whereas there are no Northern Giant-petrel colonies at the Patagonian Shelf, Southern Giant-petrels breeding at South Georgia and intending to forage towards South America may compete with the substantial breeding population there.

Jacob Gonzalez-Solis

Wandering Albatross *Diomedea exulans* – South Georgia
Although results from the first satellite-tracking study hinted at potential latitudinal segregation (Prince *et al.* 1992), these maps suggest there is little difference in the overall distribution of male and female Wandering Albatrosses from South Georgia during breeding. However, as with Wandering Albatrosses at Crozet (Weimerskirch *et al.* 1993), this masks some rather subtle distinctions depending on breeding stage. Detailed examination of these data and more recent GPS tracks suggests that females have a slight tendency to forage in more northerly waters, particularly during incubation. However, a rigorous statistical comparison has not been

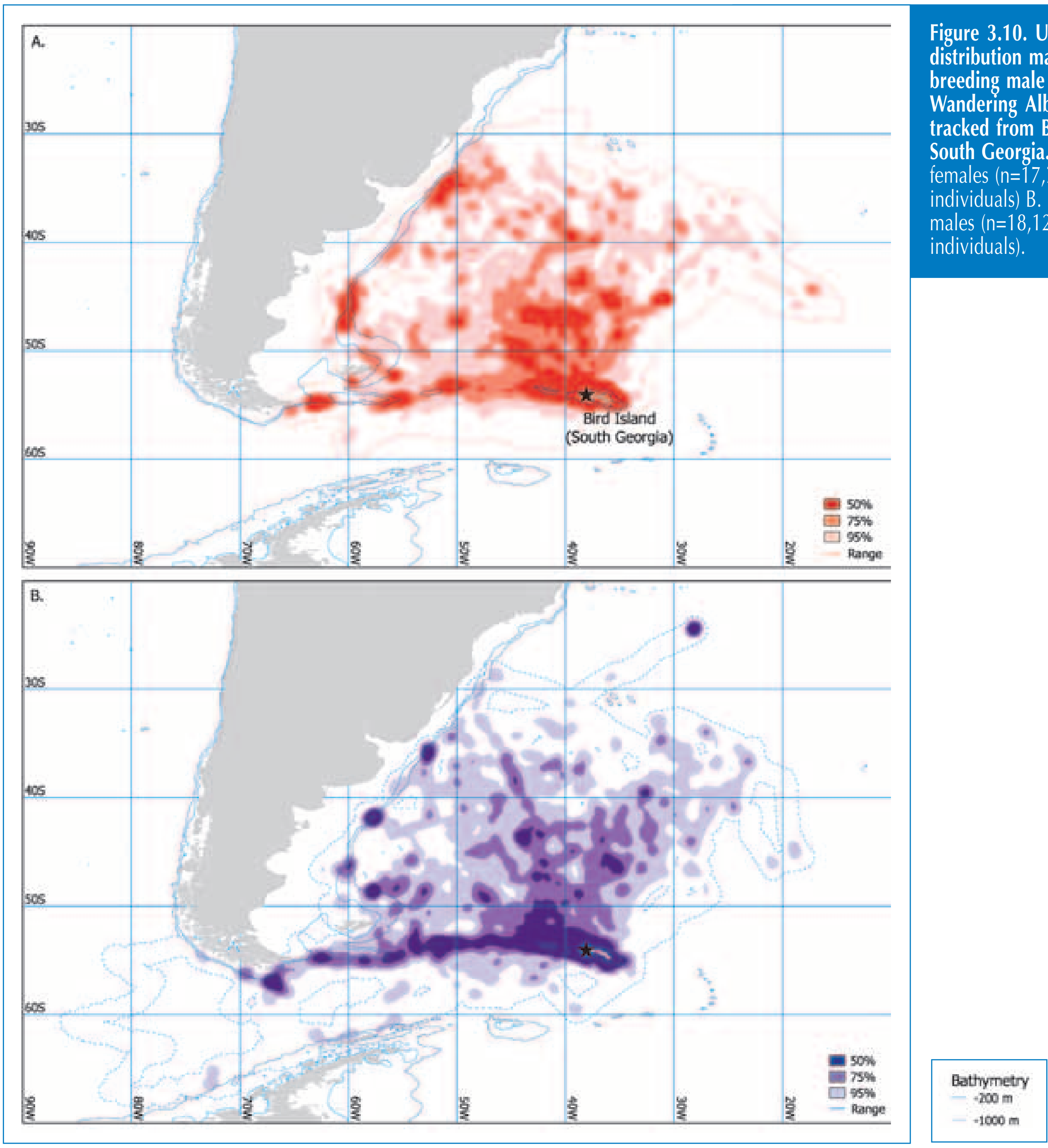


Figure 3.10. Utilisation distribution maps for breeding male and female Wandering Albatrosses, tracked from Bird Island, South Georgia. A. breeding females (n=17,772 hrs, 58 individuals) B. breeding males (n=18,123 hrs, 64 individuals).

undertaken. It is worth noting, for example, that the most recent GPS data indicates that during incubation, females also travel through the Drake Passage as far as 78°W (c.f. Figure 3.10). This emphasises that conclusions concerning sexual segregation based on small samples sizes must be viewed with considerable caution.

During brood-guard, differences are more clear-cut. Occasionally, both males and females (cf. Prince *et al.* 1998) have been recorded travelling to Falkland Islands (Malvinas)/Burdwood Bank waters (Croxall *et al.* 1999). Otherwise, males feed predominantly on the local South Georgia shelf and shelf-slope. By comparison, females utilise these habitats to a lesser extent, instead feeding routinely in oceanic waters from 51°–56°S. This is corroborated by dietary analyses: during brooding, males consume large amounts of Patagonian Toothfish *Dissostichus eleginoides* presumably obtained as discards from long-line fishing vessels, whereas females feed on a much greater diversity of fish and squid

Richard Phillips and John Croxall

Buller's Albatross *Thalassarche bulleri* – Snares

Among breeders from the Snares Islands, foraging distributions of males and females tended to be largely segregated during most of the breeding cycle as a result of differences in foraging time allocation between long and short trips, in foraging destinations and range during long trips, and in habitat utilisation with respect to water depth (Stahl and Sagar 2000b).

During the pre-egg stage (Figure 3.11A, B), foraging trips of both males and females were either to the Tasman Sea (long trips) or within 180 km of the Snares (short trips). Males then spend much more time at the nest than females, and allocated 69% of foraging time to short trips, with sites of most intensive foraging located over the shelf and slope south and east of the Snares. Females overlapped with males in that area, but in contrast to males, allocated 99% of foraging time to long trips, with sites of most intensive utilisation located over oceanic waters in the southern and central part of the Tasman Sea.

During the incubation period (Figure 3.11C, D), long trips accounted for over 98% of foraging time in both sexes, and sexual segregation at that time stemmed primarily from

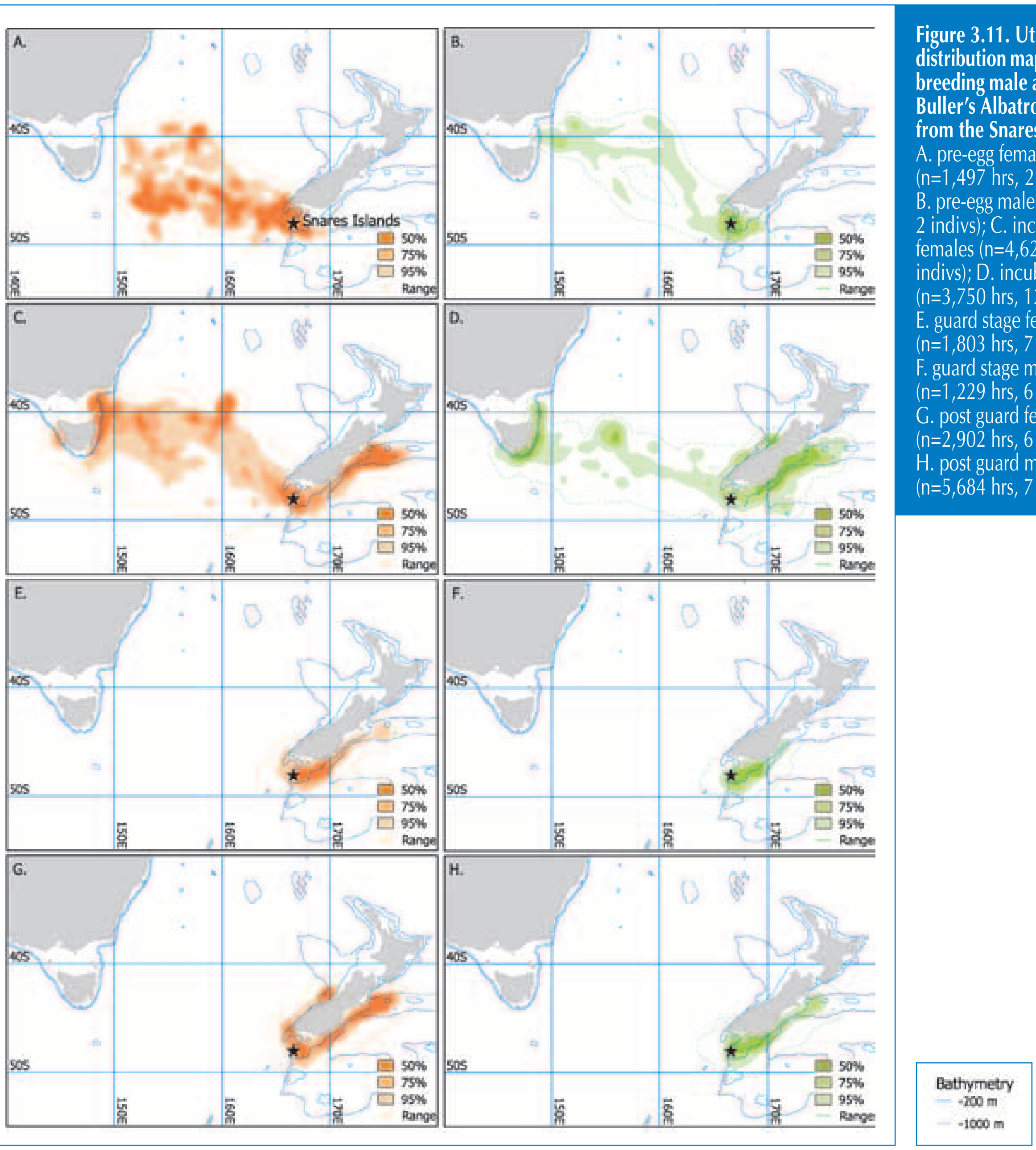


Figure 3.11. Utilisation distribution maps for breeding male and female Buller's Albatrosses tracked from the Snares Islands.
A. pre-egg females (n=1,497 hrs, 2 indivs); B. pre-egg males (n=1,128 hrs, 2 indivs); C. incubating females (n=4,622 hrs, 15 indivs); D. incubating males (n=3,750 hrs, 12 indivs); E. guard stage females (n=1,803 hrs, 7 indivs); F. guard stage males (n=1,229 hrs, 6 indivs); G. post guard females (n=2,902 hrs, 6 indivs); H. post guard males (n=5,684 hrs, 7 indivs).

a greater utilisation by males of foraging areas off the South Island east coast (52 vs. 29% of foraging time) and west coast (9 vs 0%), and a greater utilisation by females of foraging areas in the Tasman Sea (69 vs. 38%). Off the South Island east coast, females tended to forage at greater distances from the Snares than males (Stahl and Sagar 2000b), with their area of most intensive use located further north-east (western part of Chatham Rise) than that of males. Areas of intensive use were also segregated in the Tasman Sea, where males foraged primarily over shelf and slope areas south-east of Tasmania, and females primarily over oceanic waters around 40ºS and the eastern approaches to Bass Strait.

Foraging distributions of males and females overlapped most extensively during the brood guard stage (Figure 3.11E, F), when both allocated most foraging time to short trips (86 and 82% respectively). At that time, areas of most intensive use were located east and north-east of the Snares in both sexes, with females tending to forage over deeper waters than males (Stahl and Sagar 2000b).

During the early part of the post guard stage (up to mid-June), both sexes switched to a dual strategy of short trips and long trips to the South Island east coast (Figure 3.11G, H). At that time, the distributions of males and females again overlapped east and north-east of the Snares, but females made much more extensive use of distant foraging areas east of the South Island (Otago and western part of the Chatham Rise) as a result of greater time allocation to long trips compared to males (89 vs. 56%). Sexual segregation was most pronounced after mid-June, when males switched to a foraging regime of solely short trips (shelf and slope areas east and north east of the Snares), while females retained a foraging regime of mostly long trips (83% of foraging time) combined with a shift to the South Island west coast during both long trips (area of most intensive use off Westland) and short trips (Fiordland).

Jean-Claude Stahl and Paul Sagar

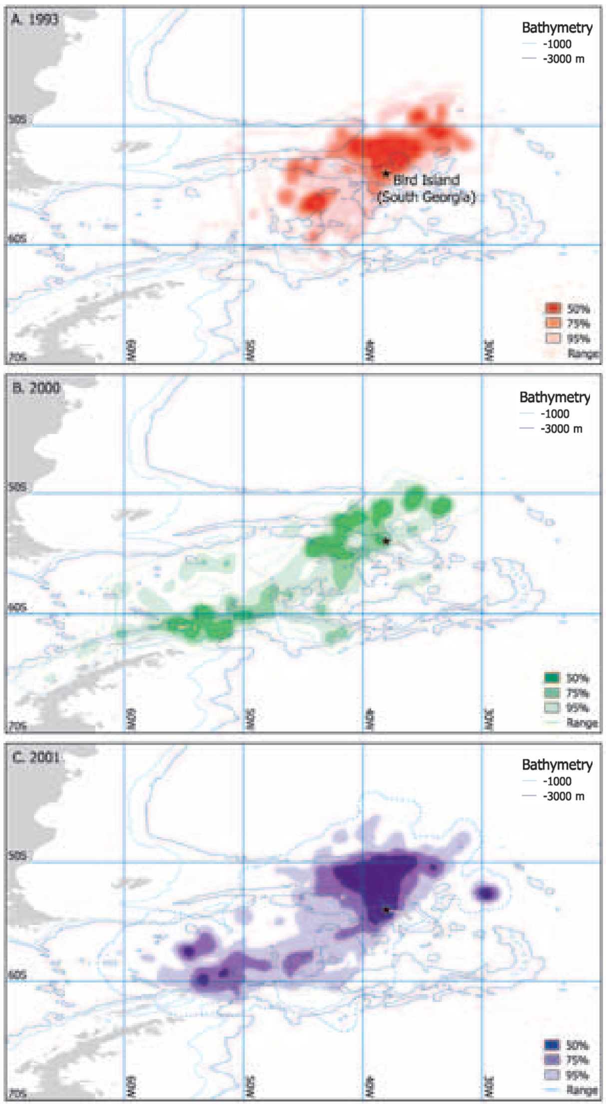
3.1.3 Distribution of breeding birds in relation to year

Grey-headed Albatross *Thalassarche chrysostoma* – South Georgia

Despite extensive overlap between years in 60–70% of the overall range and in several presumably key areas, there was also a considerable degree of inter-annual variability in foraging site selection of Grey-headed Albatrosses during chick-rearing (Figure 3.12). Thus, the maximum range was much smaller (with less reliance on Antarctic waters), and the use of shelf and shelf-break areas far more restricted in 1993, compared with the other two years. Nonetheless, core feeding areas in Antarctic Polar Frontal Zone (APFZ), which follows a roughly east-west axis to the north of South Georgia, were used in every season. This is presumably because birds travelling to this region can to an extent predict the likely location of prey aggregations (notably those of the ommastrephid squid, *Martialia hyadesi*) associated with mesoscale oceanographic features such as eddies (Rodhouse *et al.* 1996, Xavier *et al.* 2003).

In every year, foraging birds also dispersed widely into oceanic waters (the Scotia Sea) to the south of South Georgia. Core sites here appeared to be much less predictable, and for example only in 1993 was there an apparent concentration centred around 56ºS 45ºW. This was not associated with any discernable bathymetric or hydrographic feature (Prince *et al.* 1998, Wood *et al.* 2000), and its absence in succeeding seasons suggests it may have resulted from some ephemeral or transient set of oceanographic conditions.

Figure 3.12. Utilisation distribution maps for breeding Grey-headed Albatrosses tracked from Bird Island, South Georgia during the first quarter (mid-January to March – post-guard stage) in different years. A. 1993 (n=4,261 hrs, 9 indivs); B. 2000 (n=2,395 hrs, 8 indivs); C. 2001 (n=9,315 hrs, 10 indivs).



One striking difference among the three years was in the relative use of shelf and shelf-break waters. In 1993, relatively few birds travelled to the shelf to the north-west of South Georgia or to the South Orkney Islands, which led Prince *et al.* (1998) to conclude that Grey-headed Albatrosses feed only to a limited extent in neritic waters. By contrast, the more recent tracking data (particularly from 2000) illustrate that breeders can make extensive use of shelf waters around the South Orkneys, South Shetlands and as far south as Adelaide Island in the Antarctic Peninsula region, where krill *Euphausia superba* are the dominant prey items (Xavier *et al.* 2003). Remotely-sensed Sea Surface Temperature data indicate that conditions near South Georgia were unusually warm in March 2000, which was associated with poor overall breeding performance in Grey-headed Albatrosses (Xavier *et al.* 2003). This might suggest that foraging as far away as the Antarctic Peninsula is exceptional, were it not that one of only four birds tracked during late February to early March 2003 also switched to these alternative feeding grounds after experiencing poor feeding success near the APFZ (Catry *et al.* in press b).

Although these utilisation distributions provide a clear illustration of differences in foraging site selection of Grey-headed Albatrosses tracked at the same stage of the season in different years, this variation is much less extensive than that associated with breeding stage (incubation versus brooding versus post-brood chick-rearing) at the same site (Phillips *et al.* 2004b).

Richard Phillips and John Croxall

Wandering Albatross *Diomedea exulans* – Crozet

No critical study has been carried out to investigate whether significant differences exist between years in the foraging zones of Crozet's Wandering Albatrosses. The data would need careful analysis, taking into account not just the stage of tracking period (as in Figures 3.13 and 3.14), but also the sex and the colony whence tracking was carried out. Preliminary examination suggest that if differences exist, they are probably not important. When foraging over

Figure 3.13. Utilisation distribution maps for breeding Wandering Albatrosses tracked from Iles Crozet during different years. A–C. 1990, first (n=1,901 hrs), second (n=4,753 hrs) and third (n=2,795 hrs) quarters; D–F. 1992, first (n=1,649 hrs), second (n=1,836 hrs) and third (n=795 hrs) quarters. The first quarter is January to March (incubation), the second is April to June (early chick rearing) and the third is July to August (late chick rearing). (Unable to determine number of individuals for each period from dataset, so sample sizes are only given in number of hours tracked.)

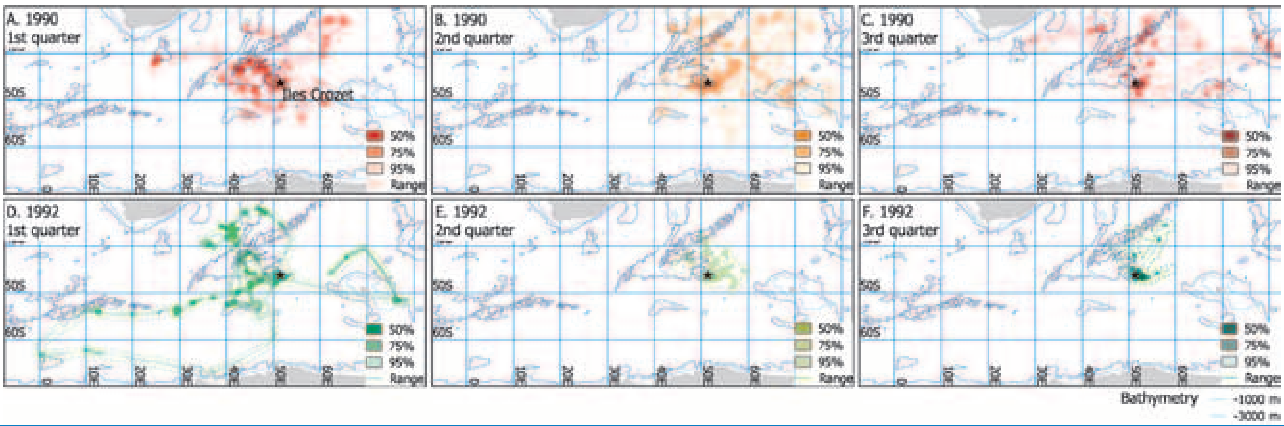


Figure 3.14. Utilisation distribution maps for breeding Wandering Albatrosses tracked from Iles Crozet during different years. A and B. 1998, first (n=7,193 hrs) and second (n=670 hrs) quarters; C and D. 1999, first (n=11,804 hrs) and second (n=1,107 hrs) quarters; E and F. 2000, first (n=2,882 hrs) and second (n=403 hrs) quarters. The first quarter is January to March (incubation) and the second is April to June (early chick rearing). (Unable to determine number of individuals for each period from dataset, so sample sizes are only given in number of hours tracked.)

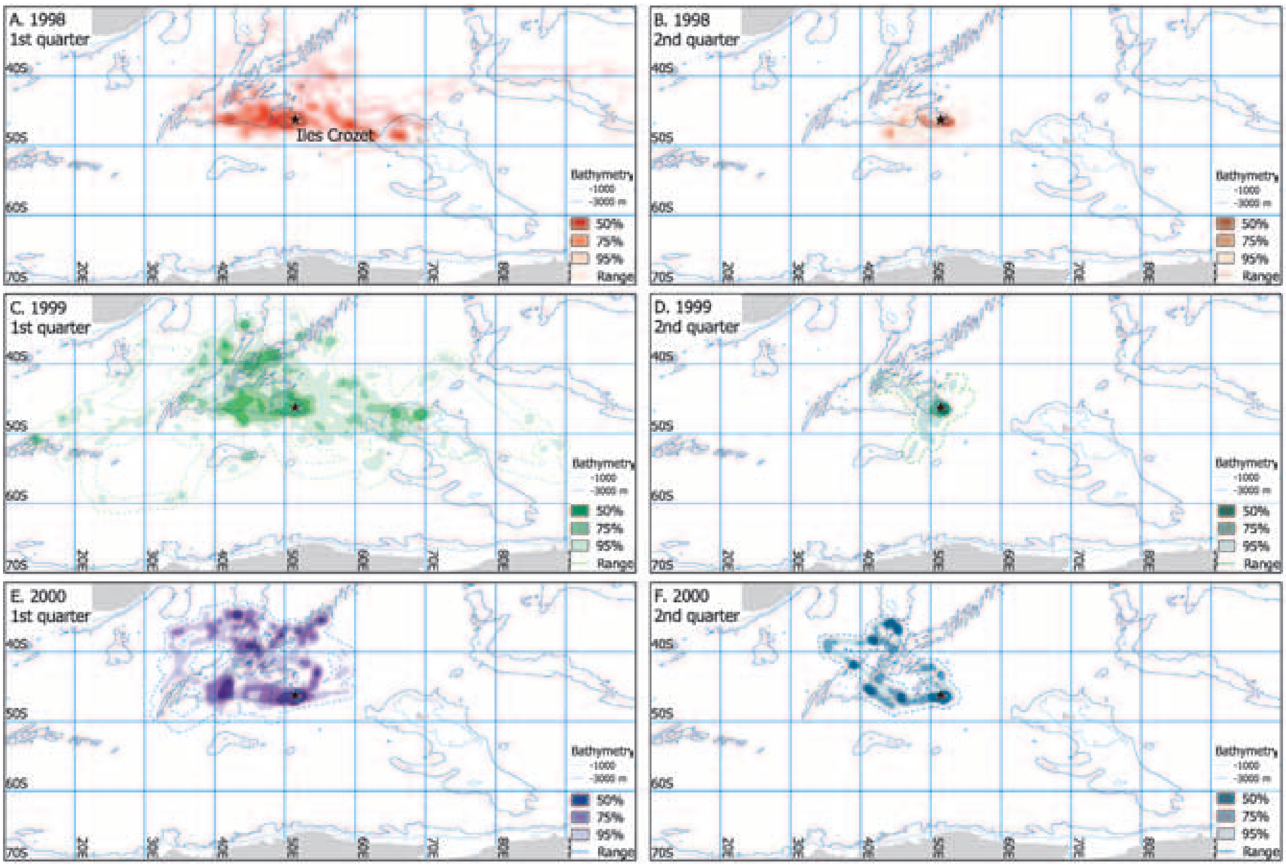
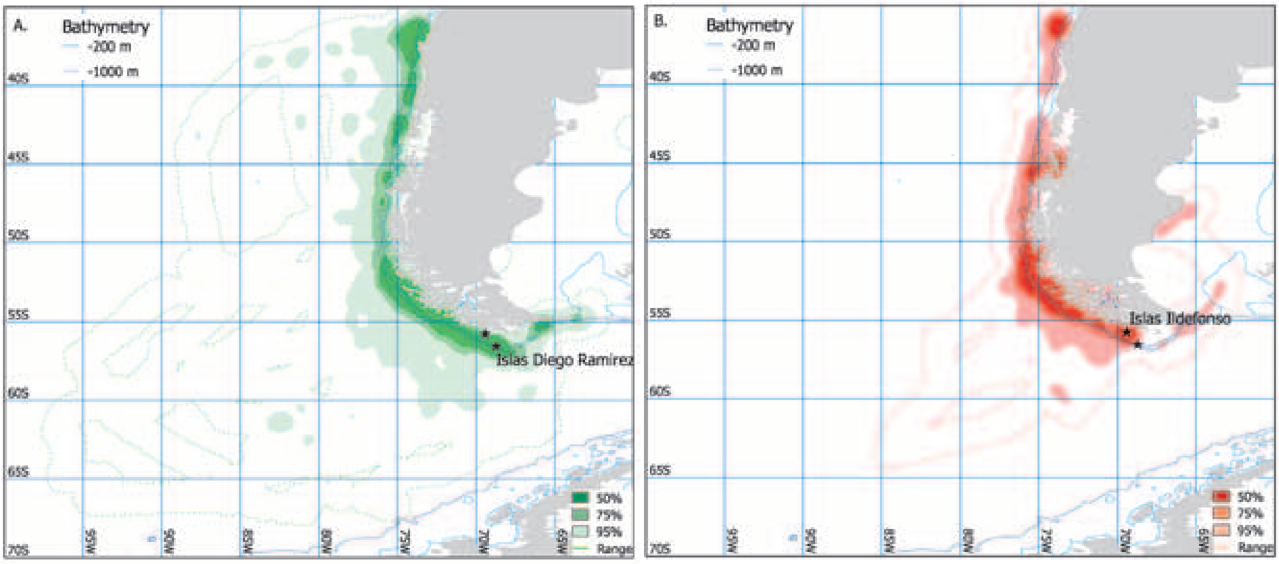


Figure 3.15. Utilisation distribution maps for incubating Black-browed Albatrosses tracked from Islas Diego Ramirez (A) (n=10,103 hrs) and Islas Ildefonso (B) (n=5,015 hrs). (Unable to determine number of individuals of each category from dataset, so sample sizes are only given in number of hours tracked.)



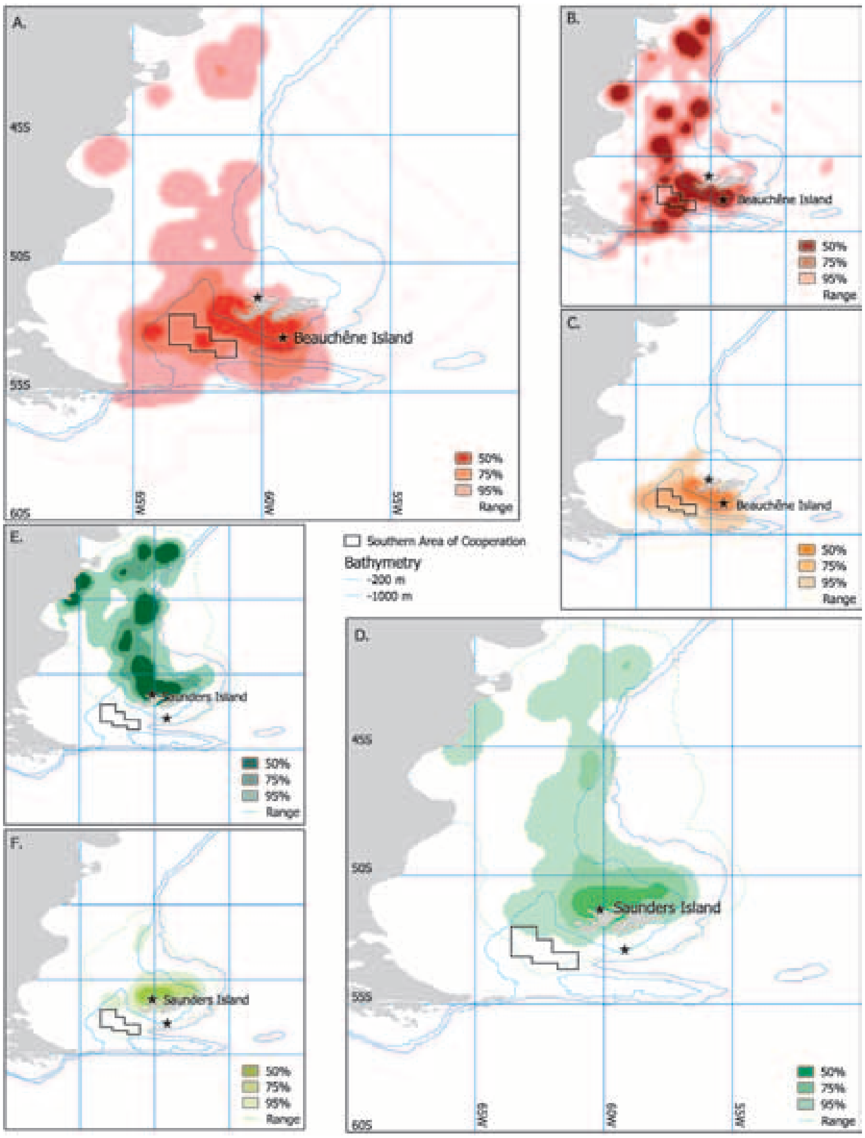


Figure 3.16. Utilisation distribution maps for breeding Black-browed Albatrosses tracked from different colonies at the Falkland Islands (Malvinas). A. all breeding birds from the Beauchêne colony (n=6,050 hrs, 8 indivs); B. incubating birds from Beauchêne (n=2,653 hrs, 4 indivs); C. post guard birds from Beauchêne (n=3,397 hrs, 4 indivs); D. all breeding birds from the Saunders colony (n=7,346 hrs, 15 indivs); E. incubating birds from Saunders (n=2,759 hrs, 7 indivs); F. post guard birds from Saunders (n=4,587 hrs, 8 indivs).

oceanic waters the movement of birds is influenced in a large extent by wind conditions, and thus changes in wind conditions might influence zones of foraging. The presence of fisheries might also influence foraging zones, especially for short trips to the shelf edges, or long trips to other continental shelves. For example it has been shown that in the late 1980s and early 1990s no Wandering Albatrosses from Crozet spent time on the northern and eastern edge of the Kerguelen shelf, but later Crozet birds started to exploit this area, at the same time that a fishery developed there.

Henri Weimerskirch

3.1.4 Distribution of breeding birds in relation to colony

Black-browed Albatross *Thalassarche melanophrys* – Chile and Falkland Islands (Malvinas)

During the incubation period birds tracked from neighbouring colonies in Chile (Figure 3.15 – Diego Ramirez and Ildefonso) and the Falkland Islands (Malvinas) (Figure 3.16B, Saunders and Beauchêne) show broadly overlapping foraging areas.

However, during the chick-rearing period, breeding adults from the Saunders and Beauchêne Islands (Falkland Islands/Malvinas) showing virtually mutually exclusive foraging areas (Figure 3.16C,F). Thus birds from Saunders Island stayed to the north of the main islands and birds from Beauchêne stayed to the south (Huin 2002). This suggests that partitioning of foraging areas is favoured when birds are restricted to relatively small areas.

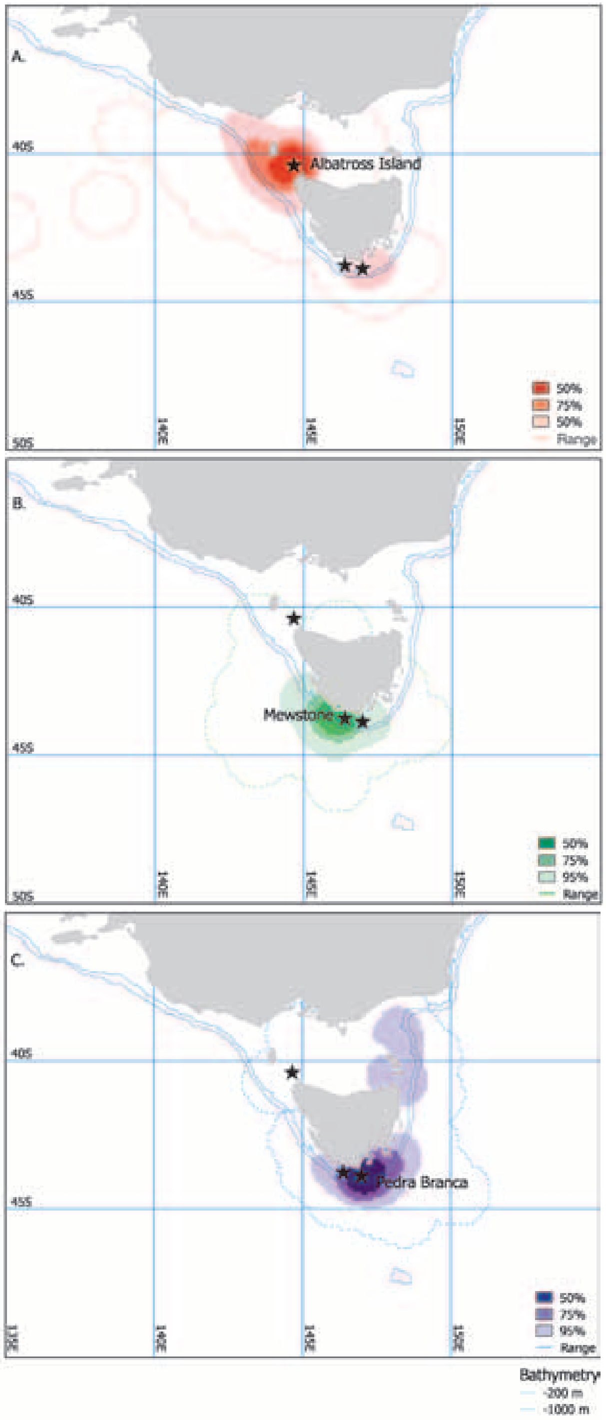
Nic Huin, Javier Arata and Graham Robertson

Shy Albatross *Thalassarche cauta* – Tasmania

Shy Albatrosses breed only on three localities around Tasmania, south of continental Australia. All colonies are within 100 km of the Tasmanian mainland with one (Albatross Island 40°23'S, 144°39'E – ~5,000 pairs) located in western Bass Strait and the other two (Pedra Branca 43°52'S 146°58' – 200 breeding pairs and Mewstone 43°45'S 146°23'E – 7,000 breeding pairs) located to the south of Tasmania. Shy Albatrosses breed annually with eggs laid in September and chicks typically fledging in April.

Breeding birds were satellite tracked from Albatross Island (n=12), Pedra Branca (n=4) and Mewstone (n=2) colonies during incubation and early chick rearing (Figure 3.17). These birds foraged in relatively local waters, either over the continental shelf or shelf break and never crossed into oceanic pelagic waters. The highest density of foraging locations of birds from Albatross Island occurred 74 km west of the island during incubation with a foraging area of some 28,000 km^2 over the Australian continental shelf. There was little overlap between the foraging areas of birds from this colony and the other two southern colonies. This foraging area decreased during early chick rearing with the highest density occurring just 9 km to the west of Albatross Island, although there was still considerable overlap in foraging areas during incubation and early chick rearing. Breeding birds from Pedra Branca foraged over a relatively small area (9,500 km^2) to the east or southeast towards the continental shelf (Brothers *et al.* 1998, Hedd *et al.* 2001). Mewstone breeding birds also primarily foraged in local waters over the southern shelf and shelf break and there was considerable overlap in areas used by birds from this colony and the Pedra Branca colony.

Figure 3.17. Utilisation distribution maps for incubating Shy Albatrosses, tracked from Albatross Island (A) (n=10,751 hrs), Mewstone (B) (n=2,521 hrs) and Pedra Branca (C) (n=2,906 hrs). (Unable to determine number of individuals of each category from dataset, so sample sizes are only given in number of hours tracked.)



The progression of foraging trips were similar to that observed with other albatross species, with trip duration and distance longest during incubation and shortening progressively as hatching approached, with further reductions during the early chick rearing period. In general breeding adult Shy Albatrosses are relatively sedentary, travelling slowly and feeding over the continental shelf within 200 km of their breeding colonies. Most foraging trips occurred in waters of less than 200 m in depth with occasional trips into deeper waters associated with the shelf edge. (Brothers *et al.* 1998, Hedd *et al.* 2001)

Aleks Terauds and Rosemary Gales

3.2 SYNTHESIS OF DISTRIBUTION OF BREEDING BIRDS FROM DIFFERENT POPULATIONS OF SELECTED SPECIES

Black-browed Albatross *Thalassarche melanophrys*
The utilisation distribution map (Figure 3.18) illustrates the largely mutually-exclusive foraging ranges of breeding Black-browed Albatrosses from different populations. This was particularly apparent for the South Atlantic/South American region, where data coverage represented all populations and most breeding stages. Although birds from both South Georgia and Chile foraged in many cases at very large distances from nest sites (hence the greater overall ranges), there was little or no spatial overlap between the two populations, or with birds from the Falkland Islands (Malvinas). The same applies in the New Zealand sector where satellite-tracking of the closely-related Campbell Albatross *Thalassarche impavida* (Waugh *et al.* 1999) indicates only marginal overlap with Black-browed Albatrosses tracked from Macquarie Island, despite their relative geographical proximity.

Although not indicated on these maps, the distribution of Black-browed Albatrosses during winter, as determined through GLS tracking (BAS unpublished data: see also Section 3.3.3, Figs. 3.27, 3.28 and 3.29), also shows that most foraging areas are exclusive to birds from a particular island group. However, there is rather more overlap than during the breeding season, with, for example, movements to the Chilean shelf by Black-browed Albatrosses from the Falkland Islands (Malvinas), and to northern New Zealand waters by birds from Diego Ramirez.

In terms of habitat preferences, more than half the breeding birds tracked from each site visited shelf or shelf-break waters, in many cases relatively close to their colony. Indeed, Black-browed Albatrosses from the Falkland Islands (Malvinas) were confined almost exclusively to the Patagonian Shelf, either very close to breeding sites or in several discrete areas to the north, including one inshore area close to Argentinean fishing ports (Huin 2002 and see Section 3.1.1). Similarly, birds tracked from Kerguelen mostly travelled to the northern and eastern Kerguelen shelf and to the north-east of Heard Island (Weimerskirch *et al.* 1997c). By comparison, although many Black-browed Albatrosses from South Georgia also foraged in shelf and shelf-slope areas (around and to the north-west of South Georgia, and at the South Orkney and South Shetland Islands), many others visited Antarctic Polar Frontal Zone (APFZ) waters to the north, and deep, oceanic waters to the south (Prince *et al.* 1998). Similarly, although Campbell Albatrosses spent more than 50% of the time in adjacent

Figure 3.18. Overlap of utilisation distributions for breeding Black-browed Albatrosses tracked from five different populations. Chile (Isla Diego de Almagro, Islas Ildefonso: incubation, Islas Diego Ramirez: incubation, brood and post guard) (n=30,863 hrs); Falkland Islands/Malvinas Beauchêne and Saunders Islands: incubation and post guard) (n=13,396 hrs); South Georgia (Bird Island: incubation and chick rearing) (n=7,718 hrs); Iles Kerguelen (incubation and chick rearing) (n=7,678 hrs); Macquarie Island (incubation and brood guard) (n=3,956 hrs). Where possible, density distributions were weighted by the proportion of time spent in each breeding stage and the proportion of breeders at sea during the breeding stage, as well as by the colony size. (Unable to determine number of individuals from all datasets, so sample sizes are only given in number of hours tracked.)

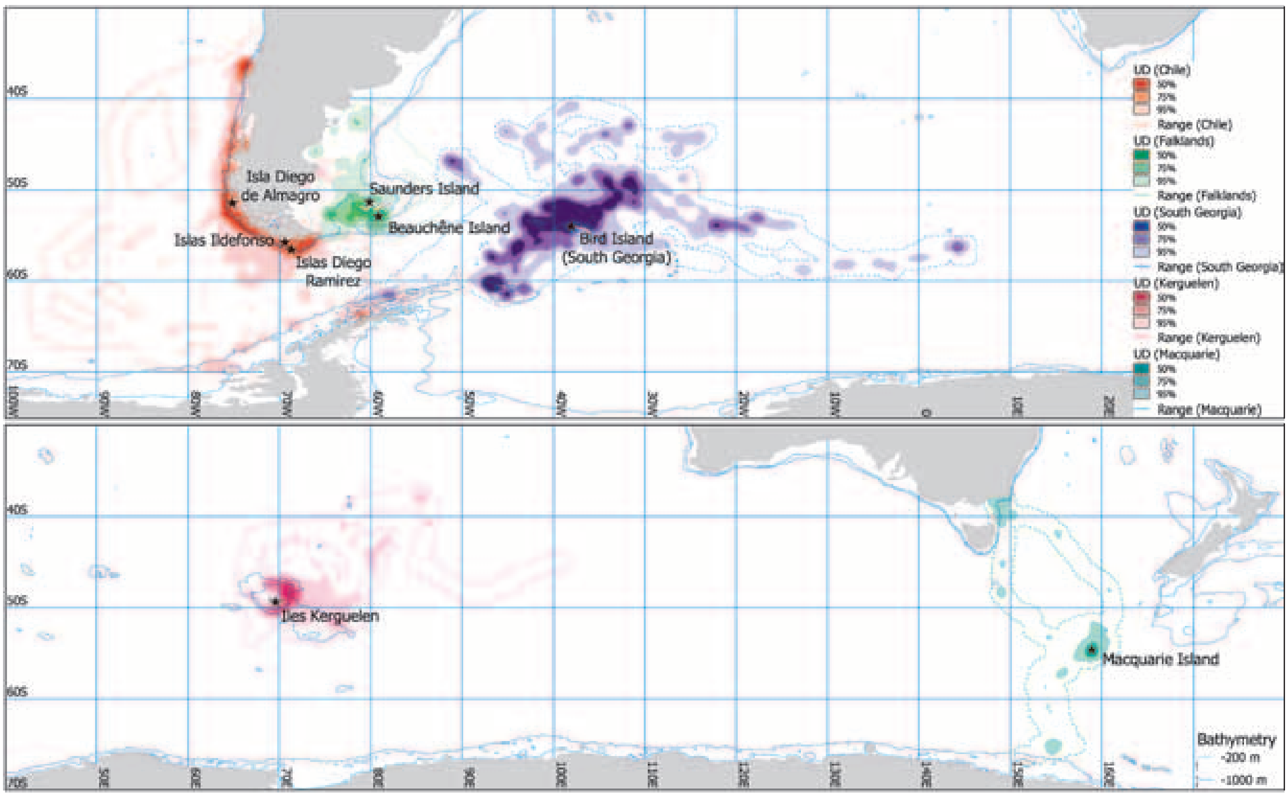
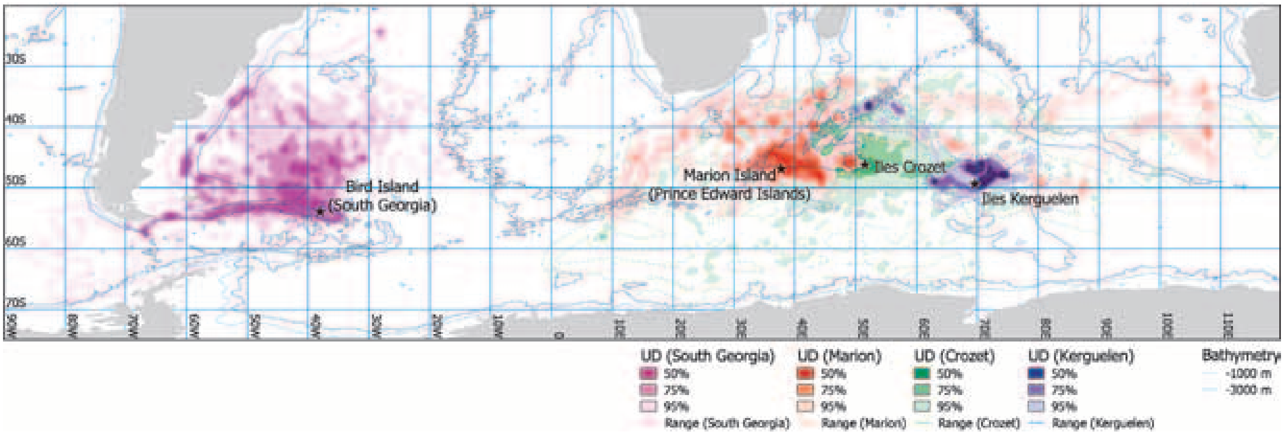


Figure 3.19. Overlap of utilisation distributions for breeding Wandering Albatrosses tracked from four different populations. Prince Edward Islands (Marion Island: incubation, brood guard and post guard) (n=8,142 hrs); Iles Kerguelen: chick rearing (n=1,742 hrs); Iles Crozet: incubation and chick rearing (n=48,870 hrs); South Georgia (Bird Island: incubation and chick rearing) (n=37,712 hrs). Where possible, density distributions were weighted by the proportion of time spent in each breeding stage and the proportion of breeders at sea during the breeding stage. (Unable to determine number of individuals from all datasets, so sample sizes are only given in number of hours tracked.)



shelf areas, some travelled as far as inshore waters on the west coast of South Island, New Zealand, or to the APFZ at a considerable distance south of the colony (Waugh *et al.* 1999). This shows an interesting parallel with the situation at Macquarie Island, where birds foraged in nearby shelf waters as well as far to the north at the eastern end of the Bass Strait. However, unusually for this species, foraging also took place at the ice edge, far south of the colony.

Not surprisingly, given they exploit of a variety of foraging areas and habitats, Black-browed Albatross have a varied diet (depending on the site, generally fish, krill or squid when feeding in shelf and shelf-break areas, and squid when feeding at frontal zones or in deeper oceanic water; Prince *et al.* 1998, Waugh *et al.* 1999, Cherel *et al.* 2000, Arata and Xavier 2003). The inevitable overlap with commercial fishing interests in shelf waters has had marked effects on population trajectories, initially resulting in increases at some sites where discarded fish and offal constituted an important supplementary food resource, but latterly (and more typically), major declines as the effects of incidental mortality in trawl and long-line fisheries resulted in reduced adult and juvenile survival rates (Croxall *et al.* 1998, Huin 2002, Reid and Sullivan 2004).

Richard Phillips, Javier Arata, Rosemary Gales, Nic Huin, Graham Robertson, Aleks Terauds and Henri Weimerskirch

Wandering Albatross *Diomedea exulans*
Wandering Albatrosses have been tracked from all their breeding sites (South Georgia, Marion, Crozet and Kerguelen) (Figure 3.19), with the exception of Macquarie Island where the population is extremely small. Wandering Albatrosses are wide-ranging species, and the foraging area covered by breeding populations is huge. As a consequence, there is an extensive overlap between populations in the Indian Ocean due to the relative proximity of the groups of islands (Prince Edwards, Crozet and Kerguelen) that constitute the stronghold of the species. South Georgia (and Macquarie) are considerably more distant. The zones of overlap between populations in the Indian Ocean are mainly the seamounts between Crozet and Marion Island, and the eastern edge of the Kerguelen shelf, the Crozet population overlapping with the Marion and Kerguelen populations. Thus if competition takes place, it is especially relevant to the Crozet birds whose range is encompassed both by Marion and Kerguelen birds.

The foraging habitat preferences of each population are strikingly similar, and probably explain why diet is also similar. The water masses exploited by the species are basically sub-Antarctic and subtropical waters, although they can regularly reach Antarctic as well as tropical waters. Wandering Albatrosses are basically wide-ranging oceanic foragers, but during long foraging trips, they can also reach distant shelf areas. For example South Georgia birds reach the Patagonian Shelf edge and Crozet birds reach the Kerguelen shelf area. However it is notable that Wandering Albatrosses spend a very substantial proportion of their time foraging over neritic waters, especially during the short trips of the chick-rearing period, in the immediate proximity of the breeding grounds. This has important implications for conservation, especially the potential susceptibility of the species, considered as oceanic, to the development of fisheries around the breeding grounds, for example for Patagonian Toothfish.

The propensity of Wandering Albatrosses to have an extended foraging range over a wide variety of water masses may increase the potential contact with many different fisheries, pelagic as well as shelf fisheries, tropical as well as sub-Antarctic fisheries. The similarity in habitats exploited and the overlap between populations probably explains the similar population trajectories of the three populations of the Indian Ocean. The decline of the populations in the early 1970s has been linked to the development of sub-tropical tuna fisheries in the Indian Ocean, and recovery to the reduction in the fishing effort there. Being based in a different ocean, with different fisheries, it is not surprising that the South Georgia population has a contrasting trajectory, one of continuing decline since the 1970s (e.g. Tuck *et al.* 2001).

Given the good coverage of breeding Wandering Albatrosses in the Indian Ocean, future tracking research should focus on the non-breeding part of the population. A small number of non-breeding adult birds have been tracked with geolocators from Crozet, and some juveniles have been tracked for two years from Crozet. Both studies show that birds forage extensively outside the range of breeding birds, showing the importance of tracking the non-breeding part of the population (more than 50% of the entire population during a season) to understand the dynamics of the populations of these species. Similar tracking from other sites, particularly involving more individuals of adult non-breeding birds or immatures, is highly desirable.

Henri Weimerskirch, John Croxall and Deon Nel

3.3 DISTRIBUTION OF NON-BREEDING BIRDS

3.3.1 Adults and immatures during the breeding season

Buller's Albatross *Thalassarche bulleri* – New Zealand
In Buller's Albatrosses, about 45% of birds associated with colonies are successful breeders, 20% are unsuccessful breeders, 25% are immature prebreeders, and 10% are non-breeding adults (Sagar and Stahl unpubl. data). Thus a third (and up to half when including failed breeders) of birds foraging from those colonies are non-breeders, a figure comparable to that reported for other albatrosses (e.g. Woodward 1972, Weimerskirch 1982, Anderson *et al.* 2002). Foraging patterns of such birds are virtually unknown, although likely to differ from those of breeders because of different constraints of coming ashore. With the aim of modelling interactions between this albatross and New Zealand fisheries (Broekhuizen *et al.* 2003), we tracked breeders and non-breeders from Snares and Solander Islands colonies via the Argos system. We here summarise the patterns recorded among Snares Islands birds (based on Stahl and Sagar 2000b and unpubl. data) to illustrate how breeding status can affect the distribution and hence contact with fishing fleets of birds foraging from the same central place.

Based on tracking data from 32 birds (16M, 16F), the foraging distribution of Snares Island breeders extends from Tasmania to the Chatham Rise east of the South Island of New Zealand, and from the southern edge of the Snares shelf (49°S) north to about 40–43°S (Figure 3.20). Overall, their sites of most intensive foraging are located around the Snares and southern New Zealand (short trips), off the South Island east and west coasts, and in the western Tasman Sea (long trips), although utilisation of those areas changes greatly throughout the breeding season. Thus, breeders of both sexes undertake primarily long trips during the incubation period (mostly Tasman Sea and South Island east coast) and early post guard (mostly South Island east coast), and primarily short trips within 450 km from the Snares during the brood guard. After mid-June (late post guard), males switch to solely short trips, whereas females retain a foraging regime of mostly long trips but switch to the South Island west coast. A similar sexual difference is recorded during the pre-egg stage, when males undertake mostly short trips, females mostly long trips to the Tasman Sea.

Tracked non-breeding adults (1M, 2F) foraged within the range of breeders, and their two sites of most intensive foraging (vicinity of Snares, South Island west coast) also coincided with foraging hotspots of breeders. Unlike breeders, they never foraged in the Tasman Sea (as recorded in failed breeders from Solander Island, Stahl and Sagar 2000a and unpubl. data) or off the South Island east coast (probably an artefact of small sample size, as Solander Island birds did forage there). When controlling for the stage of the breeding cycle (stages delineated by mean dates), non-breeding adults tended to forage closer to the Snares than breeders as a result of greater time allocation to short trips. This was most pronounced during the incubation period, when two failed breeders initiated solely short trips and barely overlapped with breeders, and also recorded during the early post guard, when short trips accounted for 61% of foraging time in a remating female compared to 23% in breeders. After mid-June, however, this female switched to a foraging pattern identical to that of breeding females (long trips to the South Island west coast).

Seven immature prebreeders (4M 3F) made a greater use of Tasmanian waters than breeding adults, and foraged farther offshore south-west of Tasmania and east of the South Island. This overall pattern is, however, a composite of distinct foraging patterns recorded among those birds, which we interpret as reflecting the sequence of foraging patterns during pre-breeding years. Thus, the two youngest birds tracked (aged 6–7 years, 1st–2nd season ashore) dispersed to Tasmanian waters shortly after instrumentation in May (post guard, main colony attendance period of those age classes) and foraged there until at least early August (about two weeks from the onset of fledging). This, and records of subadults off Victoria in February (Stahl *et al.* 1998), suggest that the youngest prebreeders make occasional (possibly single) visits to the Snares from a staging area in Southeast Australian waters.

Older pre-breeders (aged 8–9 years) were tracked during consecutive roundtrips from the Snares. Two of those (1M, 1F, 1st–2nd season ashore) initiated mostly long trips throughout the incubation period (Tasman Sea, shared with breeders) and brood guard (South Island east coast, beyond the main foraging area of breeders). Two others (males associated with a nest site, 2nd–3rd season ashore) initiated mostly short trips throughout the breeding season, thus foraging closer to the Snares than breeders during the incubation period and early post guard, but largely overlapping with breeders during the brood guard and late post guard. The remaining bird (female, 1st season ashore) initiated solely short trips during the incubation period, but switched to mostly long trips (South Island east and west coasts) during the brood guard, thus foraging closer to and farther from the Snares than breeders respectively. A similar pattern was recorded among two experienced non-breeding females from the Solander Island (Sagar and Stahl unpubl. data).

On present evidence, breeders and non-breeders commute to the same rather than distinct foraging areas, but use those areas in different sequence and proportion, and as a result tend to be segregated at sea at most times. Use of those foraging areas also seems to differ fundamentally between inexperienced prebreeders, which tend to forage over distant areas at all times, and experienced non-breeders (prebreeders and adults, including failed breeders), which tend to forage in the vicinity of colonies during all (males) or part (females) of the breeding season. These and some of the recorded segregation patterns are probably applicable to other procellariiforms, as consistent with the age- and experience-related progression in colony attendance (e.g. Fisher and Fisher 1969, Pickering 1989) and concentrations of non-breeders around colonies (Anderson *et al.* 1998) documented in other species. Only the pattern recorded during the late post guard may be specific to Buller's Albatross, as associated with a late switch in the foraging regimes of breeders not yet documented in other species.

Jean-Claude Stahl and Paul Sagar

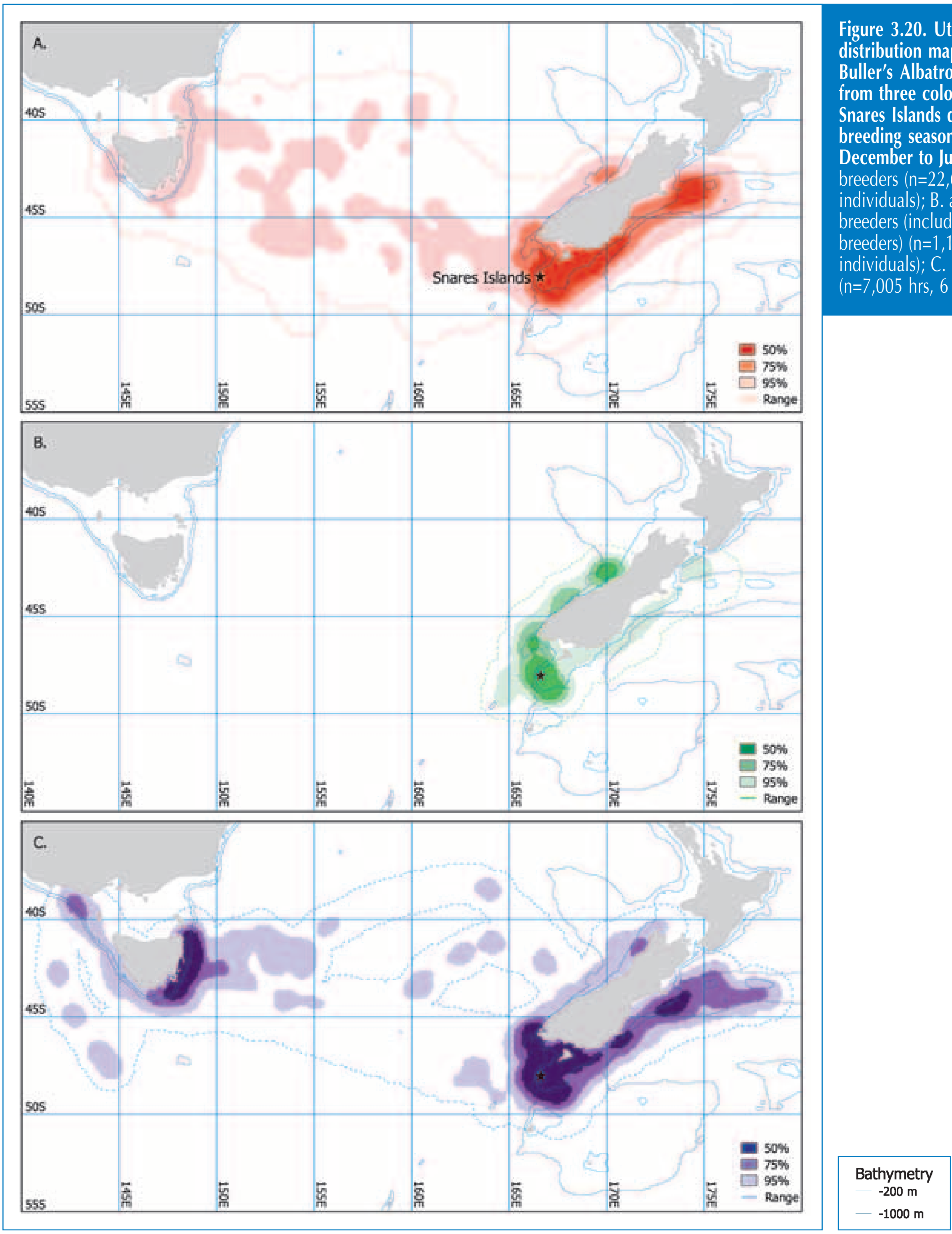


Figure 3.20. Utilisation distribution maps for Buller's Albatrosses tracked from three colonies at the Snares Islands during the breeding season (mid-December to July). A. adult breeders (n=22,615 hrs, 57 individuals); B. adult non-breeders (including failed breeders) (n=1,192 hrs, 3 individuals); C. immatures (n=7,005 hrs, 6 individuals).

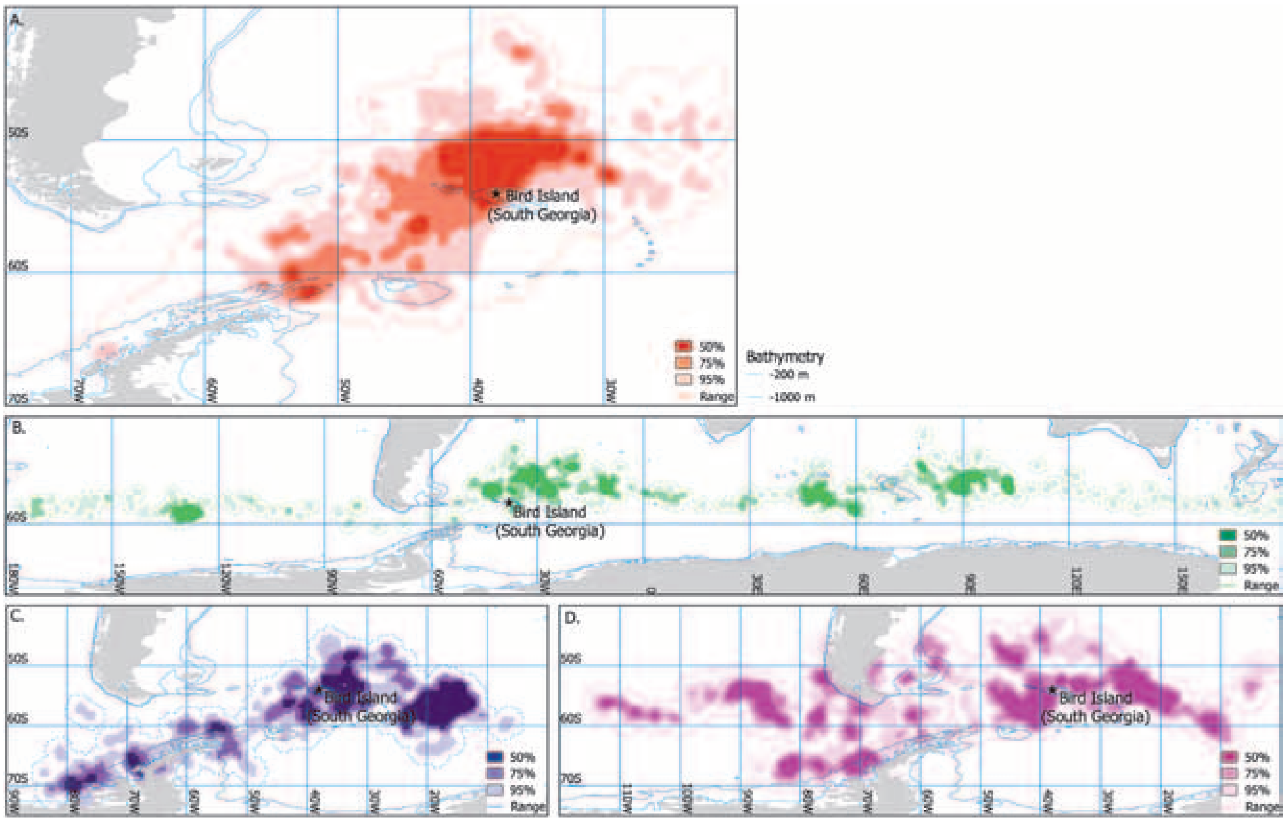
Grey-headed Albatross *Thalassarche chrysostoma* – South Georgia

The utilisation distribution maps in Figure 3.21 compare the foraging ranges of three groups of Grey-headed Albatross from Bird Island, South Georgia during the austral summer: (1) breeding birds (late incubation to late chick-rearing); (2) non-breeding adult birds (i.e. birds of known breeding status between breeding attempts); and (3) failed breeders (nests failed in late incubation). All data for birds in groups 2 and 3 were collected using GLS loggers and locations are therefore subject to greater errors (mean error ± 186 km; Phillips *et al.* 2004a) compared with the satellite tracking data obtained for breeding birds.

During December to April, breeding Grey-headed Albatrosses (Figure 3.21A) foraged extensively in the Antarctic Polar Frontal Zone (APFZ), at widely dispersed sites in oceanic waters to the south-west of South Georgia, and over shelf waters around the South Orkney Islands and the northern tip of the Antarctic Peninsula (for more details see Section 3.1.3).

Non-breeding Grey-headed Albatrosses from South Georgia have a circumpolar winter distribution (see non-breeding season maps in Section 3.3.3). During October and

Figure 3.21. Utilisation distribution maps for breeding and non-breeding Grey-headed Albatrosses tracked from Bird Island at South Georgia. A. breeding birds (n=25,217 hrs, 40 indivs) tracked using PTT's from December to June; B. non-breeding birds (n=6 indivs) tracked using geolocators during October and November; C. non-breeding birds (n=6 indivs) tracked using geolocators during February and March; D. failed breeders (n=5 indivs) tracked using geolocators from January to April.



November (corresponding to the incubation period for breeding birds) they were still widely distributed in the Southern Ocean (Figure 3.21B), with obvious concentrations in the South Atlantic, to the south of the Prince Edward Islands, along the Indian-Antarctic Ridge and on the Pacific-Antarctic Ridge. By February and March (Figure 3.21C) all birds had moved to between 5°W to 85°W, much closer to the breeding colony at 38°W and in areas more or less corresponding to those used by breeding birds.

Failed breeders tracked during January to April (corresponding to the chick-rearing period) showed a similar distribution to the non-breeding birds, but were dispersed more widely in the south-east Pacific and around the Falkland Islands (Malvinas) and the coast of southern Chile (Figure 3.21D).

These maps show clearly that during the main summer breeding period there is a great deal of overlap in the distribution of birds of different status from the same colony. However, non-breeding and failed birds, which are not constrained by the requirement to return frequently to the colony to feed their chicks, are able to extend their range further into the deep oceanic waters to the east of the South Sandwich Islands and westwards into the Bellingshausen Sea.

Janet Silk, Richard Phillips and John Croxall

Chatham Albatross *Thalassarche eremita* – Chatham Islands

The annually breeding Chatham Albatross, (one of the larger *Thalassarche* mollymawks) is restricted to one breeding site with difficult access at The Pyramid (Chatham Islands). Total research time ashore has been limited to about 110 days over 30 years, mainly concentrated at the end of hatching in early December. Before tracking, little was known of its distribution, with confirmed records away from New Zealand (from Peru) not being recorded until 1987.

In February 1997, a breeding male (with large chick) was tracked for 111 days until the battery expired. In October 1997 a breeding pair was tracked for about 300 days (until battery expiration) using transmitting regimes that provided positions every 1.5 to 2.5 days. In December 1998, ten birds (3 breeding pairs, 1 failed breeding pair and 2 adolescent pre-breeders) were tracked using an intermittent rolling transmission cycle that covered all parts of the day during the 8-day cycle.

Both observations ashore and the satellite tracking demonstrated that incubating and chick rearing parents have short incubation and guarding stints of about 2–4 days with a range of 0.5 to 8 days and their at sea locations were concentrated within a radius of 260 km (maximum 450 km) of the breeding colony when on eggs, increasing to 360 km (maximum 600 km) when feeding chicks, especially as the chicks increased in age. This range was all within 12–18 hours direct flying from the colony and enabled some non-incubating mates to return to the nest nightly.

There was no obvious sexual difference in either incubation/guarding nest site behaviour or at sea distribution, at any time of the breeding season.

At sea locations (Figure 3.22A) were concentrated along continental slope features (1,000 m to 3,000 m), most especially on the southern and eastern edge of the Chatham

Rise, which features extensive cold-water upwellings. Notwithstanding the kernel map, there were few records close to the Chatham Islands and within the 200 m isobath. Some individuals demonstrated repeated visits to similar locations.

Failed breeders, after losing an egg or young chick, generally retain a regular association with the nest site until late December, before migration. Following failure, the movements at sea became more widespread, both eastwards and westwards. Flights tended to be longer and included a wider range of pelagic areas away from the continental shelf and slope.

The two 4 and 5 year old adolescents had a relatively short tracking life. Neither adolescent foraging range overlapped to any significant extent with the breeding or failed breeding birds. The more northerly distribution pattern suggested a wider ranging exploratory regime in more temperate waters, with a minimum of attachment to the breeding colony.

Christopher Robertson and David Nicholls

Northern Royal Albatross *Diomedea sanfordi* – Chatham Islands and Taiaroa

The biennially breeding Northern Royal Albatross breeds primarily on 3 small islets in the Chatham Islands, and a small mainland colony at Taiaroa Head on the South Island of New Zealand. The Little Sister Islet at the northern extremity of the Chatham Islands and Taiaroa Head were the breeding locations studied.

Various tracking experiments were undertaken from November 1993 to November 1998 mainly designed to test different transmission regimes over extended periods. Tracking periods ranged from 5 days to 564 days over 20 deployments covering most parts of breeding, migration, and wintering, over the two-year biennial cycle. Most of the long distance deployments used transmitters with duty cycles of up to 6 days between transmissions.

As with the Chatham Albatross, both observations ashore and the satellite tracking demonstrated that incubating and chick rearing parents have short incubation and guarding stints of about 2–4 days and their at sea locations were concentrated primarily within a radius of 300 km of the breeding colony when on eggs and guarding the chick. The range then increases as the chick advances in age. This range was all within 12–18 hours direct flying from the colony. Some non-incubating mates returned to the nest nightly. Most locations are confined to the shelf edge, break and slope over bathymetry from 1,000–2,000 m, but the kernel map probably overemphasises use of shallower areas over

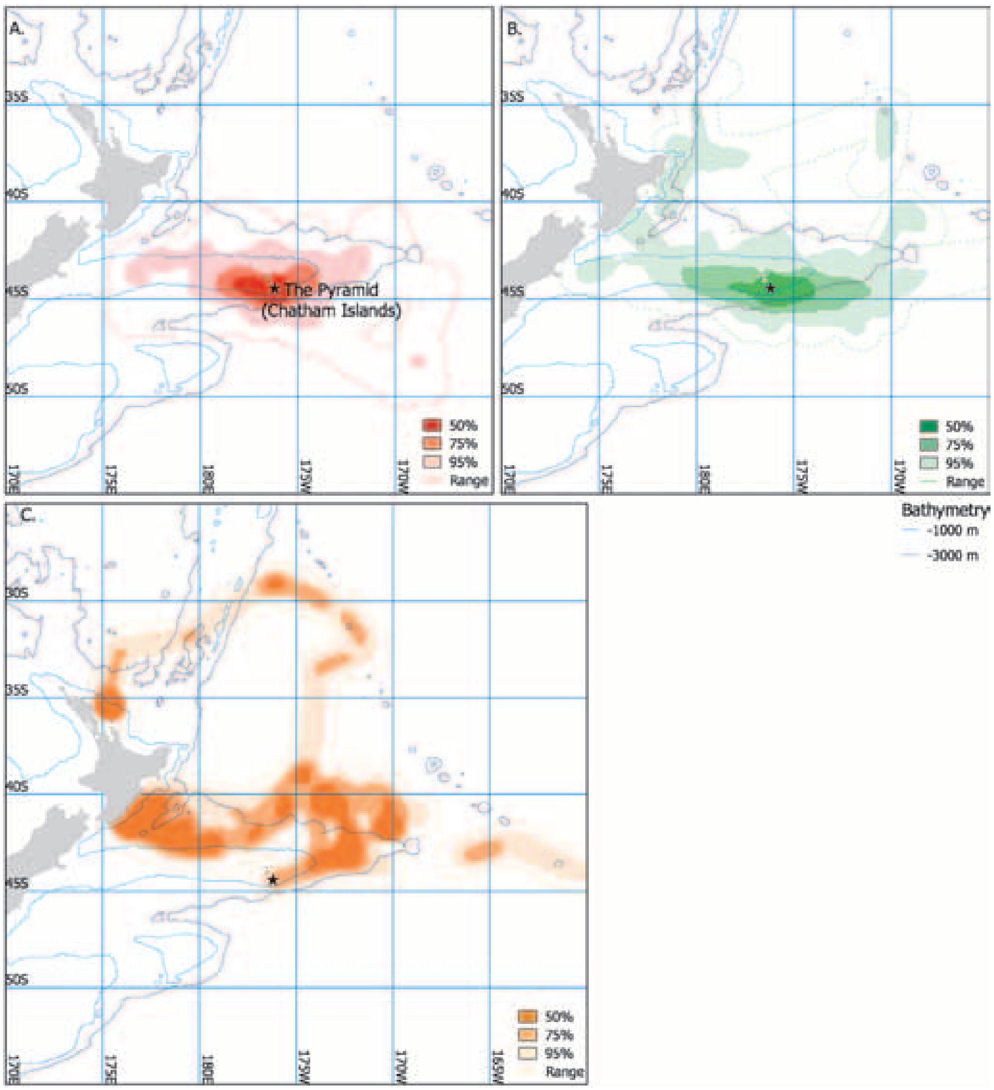
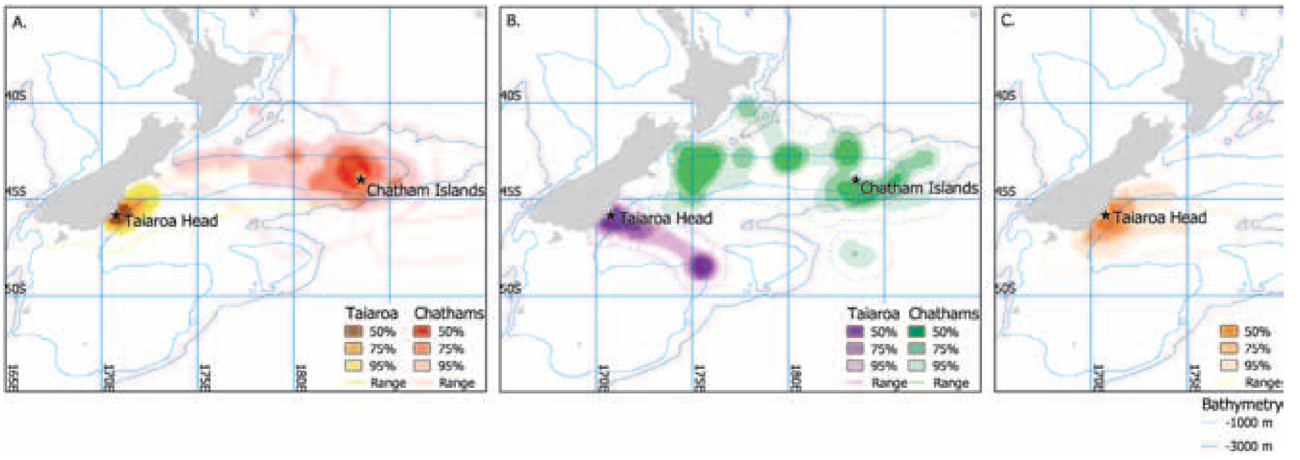


Figure 3.22. Utilisation distribution maps for breeding and non-breeding Chatham Albatrosses tracked from the Chatham Islands during the breeding season. A. breeding birds tracked during the breeding season (Oct–Mar) (n=8,136 hrs, 10 indivs); B. resident failed breeders, tracked from Nov–Feb i.e. during the breeding season (n=7,745 hrs, 6 indivs); C. adolescent pre-breeders tracked from Nov–Dec i.e. during the breeding season (n=1,626 hrs, 2 indivs).

Figure 3.23. Utilisation distribution maps for breeding and non-breeding Northern Royal Albatrosses tracked from the Chatham Islands and Taiaroa Head during the breeding season. A. breeding birds tracked during the breeding season (Nov–Sep) (Taiaroa: n=6,370 hrs, 3 indivs; Chathams: n=6,370 hrs, 13 indivs); B. resident failed breeders, tracked from the Chathams from Feb–Jul (Taiaroa: n=98 hrs, 1 indiv; Chathams: n=341 hrs, 1 indiv); C. adolescent pre-breeders tracked from Taiaroa Head from Feb–Apr (n=883 hrs, 2 indivs).



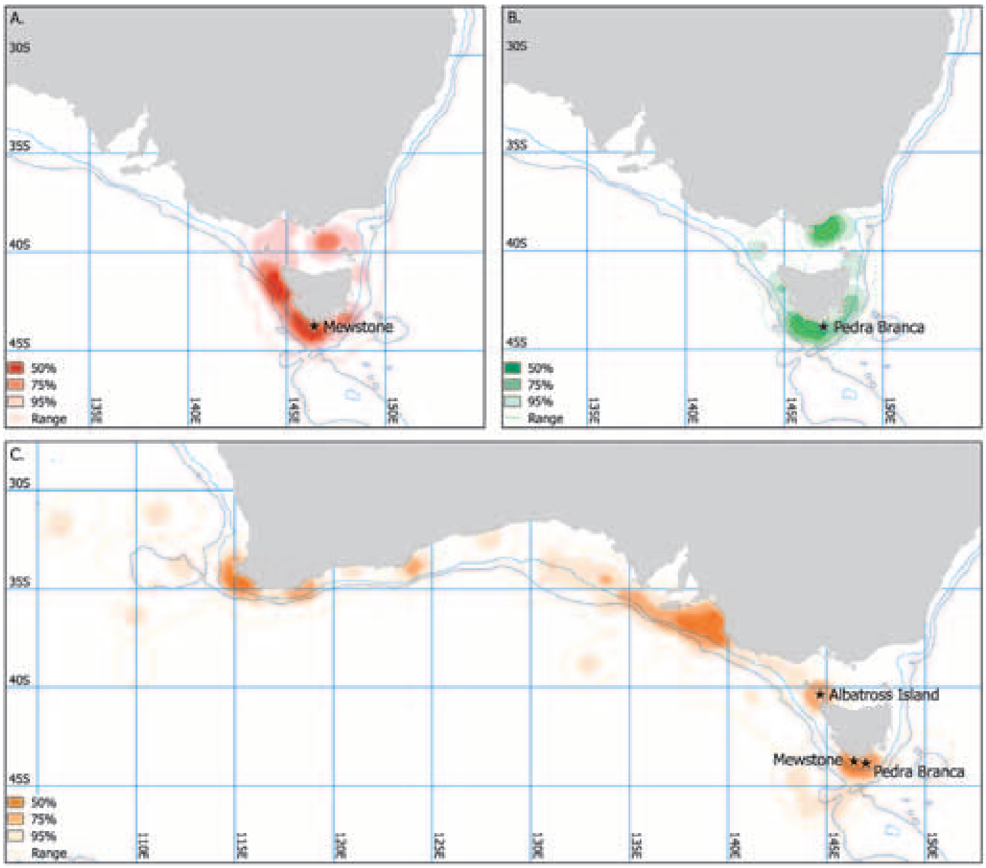


Figure 3.24. Utilisation distribution maps for adult and juvenile non-breeding Shy Albatrosses tracked from Tasmania. A. post-breeding adults tracked from Mewstone from Apr–May (n=913 hrs, 3 indivs); B. post-breeding adults tracked from Pedra Branca from Apr–Aug (n=212 hrs, 2 indivs); C. post-fledging juveniles tracked from Albatross Island, Mewstone and Pedra Branca from Mar–Jul (n=2,587 hrs, 3 indivs).

the Chatham Rise, which were possibly commuting positions.

One female tracked in 1993 and again in 1998 demonstrated a strong affinity for visiting the same locations five years apart.

There was no obvious sexual difference in either incubation/guarding nest site behaviour or at sea distribution, at any time of the breeding season.

Christopher Robertson and David Nicholls

3.3.2 Adults and immatures during the non-breeding season

Shy Albatross *Thalassarche cauta* – Tasmania

After breeding, adults ranged more widely than breeding birds with considerable larger foraging areas. Post breeding adults from Albatross Island travelled up to 750 km from the colony with individuals travelling north and crossing Bass Strait and south along the west coast of Tasmania (Brothers *et al.* 1998). Post-breeding adults from Pedra

Branca and the Mewstone also showed a similar range with the distances travelled increasing in the months following chick fledging. Post breeding adults from the southern colonies generally remained within 200 km of their respective colonies for the first two week following chick fledging then increased their range to utilise waters all around Tasmania, concentrating around known 'hot spots' of production off the south east coast of continental Australia and the west coast of Tasmania. Although these birds travelled thousands of kilometres during June and July, no birds were ever recorded in oceanic waters and all foraging was concentrated in shallow waters on the shelf or at the shelf edge. As the breeding season approached through August, breeders tended to return waters closer to their respective breeding colonies. Successful parents from Albatross Island spent just nine weeks at-sea off the southeast Australia before returning to the breeding colony and foraging in localised waters. Consistent travelling speeds, foraging trip durations and foraging locations across years suggest relatively stable prey availability and/or accessibility for adult Shy Albatrosses.

One fledgling from each breeding colony was tracked during 1996, with tracks obtained for the first 60–80 days at sea. All chicks moved westwards immediately after fledging and over the first three months foraged almost exclusively in southern Australian continental shelf waters. Dispersal from the colonies was rapid with all chicks moving at least 500 km from the colony within six days of fledging. Chicks from Albatross Island and Pedra Branca travelled relatively quickly to the eastern side of the Great Australian Bight where they remained foraging for six weeks. The chick from the Mewstone travelled further west before concentrating its activity off the southwest coast of Western Australia some three weeks after fledging. During this time the fledgling covered 4,113 km and flew an average of 206 km each day. Although foraging was concentrated around the shelf and shelf edge, all fledglings undertook long looping flights into more oceanic waters at some stage during the tracking period.

Aleks Terauds and Rosemary Gales

3.3.3 Migration routes and wintering areas

Chatham Albatross *Thalassarche eremita* – Chatham Islands
Upon migratory departure eastwards from the breeding location, birds took from 11–30 days to cross the south Pacific and reach the coast of South America. Four females averaged 14.5 days and 4 males 24.5 days. This may have been a consequence of weather systems becalming birds for a period during migration. Such an explanation must be

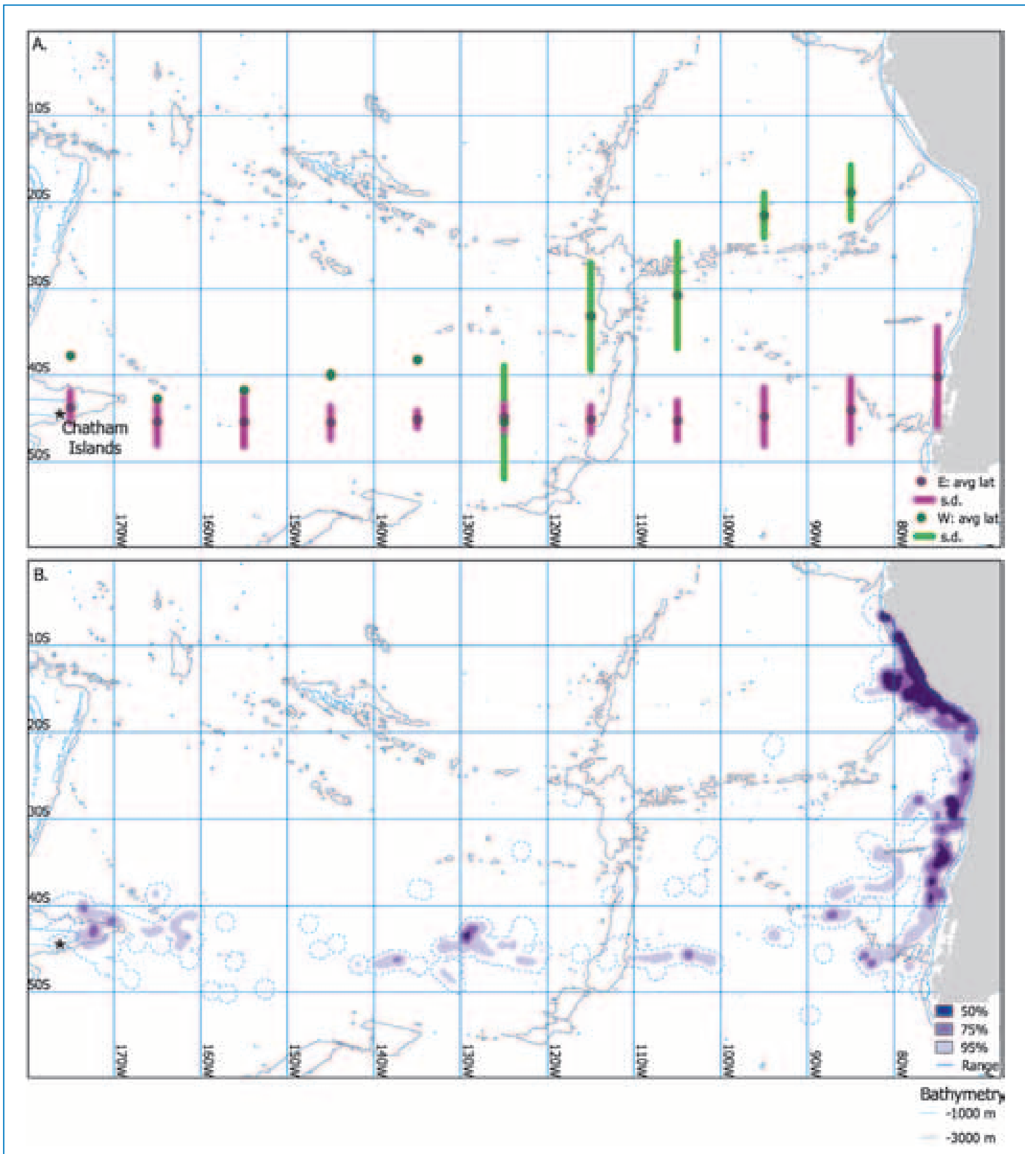
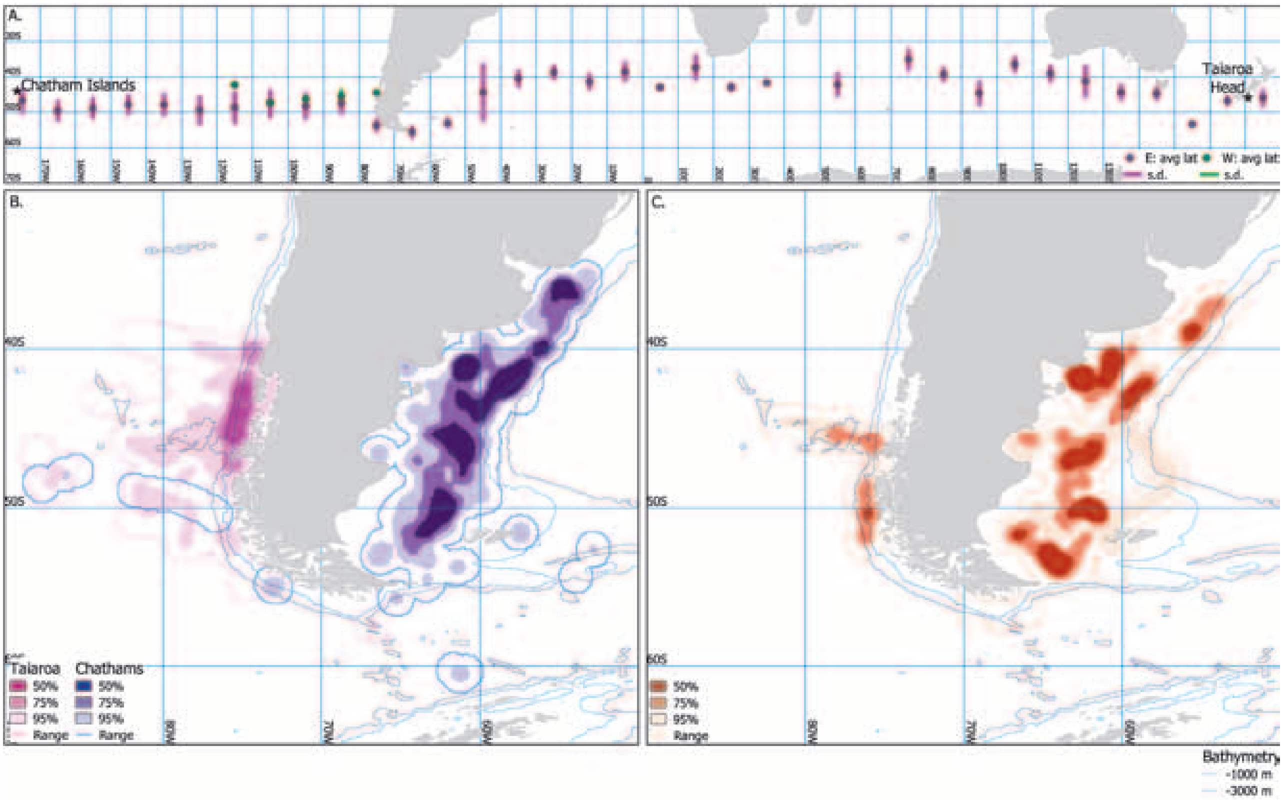


Figure 3.25. Utilisation distribution and migration route maps for dispersing Chatham Albatrosses tracked from the Chatham Islands. A. easterly and westerly migration routes of failed and post-breeders tracked from Jan–Aug (east: n=1,359 locations, 10 indivs; west: n=80 locations, 4 indivs all of whom were tracked migrating east). (Only locations where the bird was consistently moving > 20 km/hr in an east-west direction were used.) B. foraging areas of dispersing failed and post-breeders tracked from Jan–Aug (n=10,235 hrs, 9 indivs). (Transit locations used to generate map A. were excluded.)

Figure 3.26. Utilisation distribution and migration route maps for dispersing Northern Royal Albatrosses tracked from the Chatham Islands and Taiaroa Head. A. easterly and westerly migration routes of failed breeders and adolescents tracked from the Chathams and Taiaroa Head from Jan–Nov (east: n=822 locations, 7 indivs; west: n=78 locations, 1 indiv). (Only locations where the bird was consistently moving > 20 km/hr in an east-west direction were used.); B. foraging areas of dispersing failed breeders tracked from the Chathams and Taiaroa Head from Jan–Oct (Taiaroa: n=3.422 hrs, 1 indiv; Chathams: n=2.094 hrs, 4 indivs); C. foraging areas of dispersing adolescents tracked from Taiaroa Head from Mar–Nov (n=1.193 hrs, 2 indivs). (Transit locations used to generate map A. were excluded from maps B. and C.)



considered, as the areas of concentration in the central Pacific do not seem to relate bathymetrically to any other potential foraging sites throughout the year. Migration was direct once started, with any backtracking confined to the starting area. Mean outward migration rates ranged from 350–650 km per day, with a maximum of 900 km.

Failed breeders followed by successful breeders arrive in a broad band along the South American coast (between 30°S and 50°S) from late January to early April and then progress rapidly north as far as 5°S before consolidating in the wintering area off the coast of Peru, north of 20°S. They are transiting the northward moving Humboldt and Peruvian Currents in a narrow band along the steep continental shelf slope between isobaths 500–5000 m. Concentrations were found at upwellings from 6°S–10°S, and the landward end of the Nazca Oceanic Ridge at 15°S. These are parts of one of the most productive marine habitats in the world. Variations between years, that may be related to changes in La Nina weather patterns, saw a greater use of the upper shelf areas in one year.

Homeward migration data are few but, apart from some backtracking in one individual at the start, seemed to be direct, as with the outward pattern. At least one bird travelled to the Chathams in 21 days at a mean rate of 530 km per day. The more northerly return route suggests a downwind migration pattern round the central Pacific high-pressure system.

Some 90% of the sedentary wintering time of 3–4 months is spent within the EEZ's of Peru and Chile.

Christopher Robertson and David Nicholls

Northern Royal Albatross *Diomedea sanfordi* – Chathams and Taiaroa

Migration tracking experiments were confined to failed breeders and adolescents who could be expected to return to the breeding colony. Two individuals from the Chathams marked as failed breeders, were tracked round the world, failed breeding a second time and were two thirds of the way home the second time when the batteries failed. Both demonstrated a remarkable synchrony of travel, visiting similar areas to within 3 days of a calendar year later. All satellite-tracked birds completed their migrations in a downwind easterly progression without backtracking. Significant distances of up to 1800 km were travelled in 24 hours with regular movement patterns of 10 degrees of longitude at 40°S to 50°S.

Outward migration averaged 7–10 days from New Zealand breeding colonies to wintering areas in South America. Homeward migration averaged 20–30 days. However, it was noted that females tended to leave wintering grounds later than males and return home more rapidly. Egg yolk deposition is known to commence about 42 days before egg laying which is when they are approximately two thirds of the migration distance towards the breeding colony.

One Taiaroa failed breeder wintered on the Chilean coast of South America, including a mid-winter excursion of some 2,000 km westward back into the south Pacific. However, it returned to Chile and then migrated home downwind (without stopping at the Patagonian Shelf) via the Atlantic and Indian Ocean.

The main wintering area was on the Patagonian Shelf, where after some possible northward exploration on arrival, there was a steady progression from the south to the northern end of the range throughout the year with departure thence on migration being from the northern end of the range. Individuals tracked to the wintering area more than once showed little variation to the pattern in successive years.

Testing of a type of geolocation and activity logger since the satellite tracking, indicates that while on migration only 40% of the time is spent flying with 90% of flights being less than 4 hours in duration. During wintering periods in Chile and Argentina only 20% of the time is spent flying. The downwind use of the strong westerly wind belt especially for the rapid homeward migration close to the equinoxial gales is used to cover extensive ocean areas between prime shelf feeding locations.

The subsequent geolocation data experiment has also recorded that, with a similar mix of failed breeders and adolescents from Taiaroa, one migrated round the world wintering in Argentina, two migrated to Chile and returned via the Pacific, and two did not migrate at all from New Zealand waters during the winter. Notable variations in breeding behaviour at Taiaroa were also noted at the same time, suggesting substantial variation in normal food patterns related to El Niño conditions round South America.

Christopher Robertson and David Nicholls

Black-browed Albatross *Thalassarche melanophrys* – South Georgia, Falkland Islands (Malvinas) and Chile

After breeding, Black-browed Albatrosses from South Georgia migrate directly several thousand km to South African waters, spending the first half of the winter in the highly productive Benguela Current region, where they are frequently found in association with fishing vessels (Prince *et al.* 1998, Figure 3.27). By late July, birds start to return towards South Georgia, in most cases stopping en route for several weeks in oceanic waters in the central South Atlantic, and arriving at the colony in early October.

In contrast, most Black-browed Albatrosses from the Falkland Islands (Malvinas) winter on the Patagonian shelf, in much closer proximity to breeding colonies (Figure 3.28). There is an intriguing gender-difference in distribution; males are restricted to the Patagonian Shelf and deeper water to the east and south whereas females disperse more widely, utilising the Patagonian Shelf, a much greater area of oceanic water in the central South Atlantic, and the narrow Chilean shelf from 28°– 46° S (Figure 3.28). The 27 birds followed in this study included six breeding pairs, and there was no evidence of a link in distribution of pair members at sea at any point during the winter period.

Black-browed Albatrosses from Diego Ramirez make more extensive use of the Chilean shelf and deeper waters offshore, with some migrating to the Patagonian Shelf and others travelling over 8000 km to spend the non-breeding season around northern New Zealand (Figure 3.29). This overlap in distribution of non-breeding Black-browed Albatrosses from the Chilean and Falkland Islands (Malvinas) populations in shelf areas on both the eastern and western seaboard of South America contrasts with the largely mutually-exclusive foraging ranges observed during the chick-rearing period (Sections 3.1.1 and 3.1.4, Figs 3.6, 3.15 and 3.16).

Richard Phillips, Javier Arata, John Croxall, Nic Huin, Graham Robertson and Janet Silk

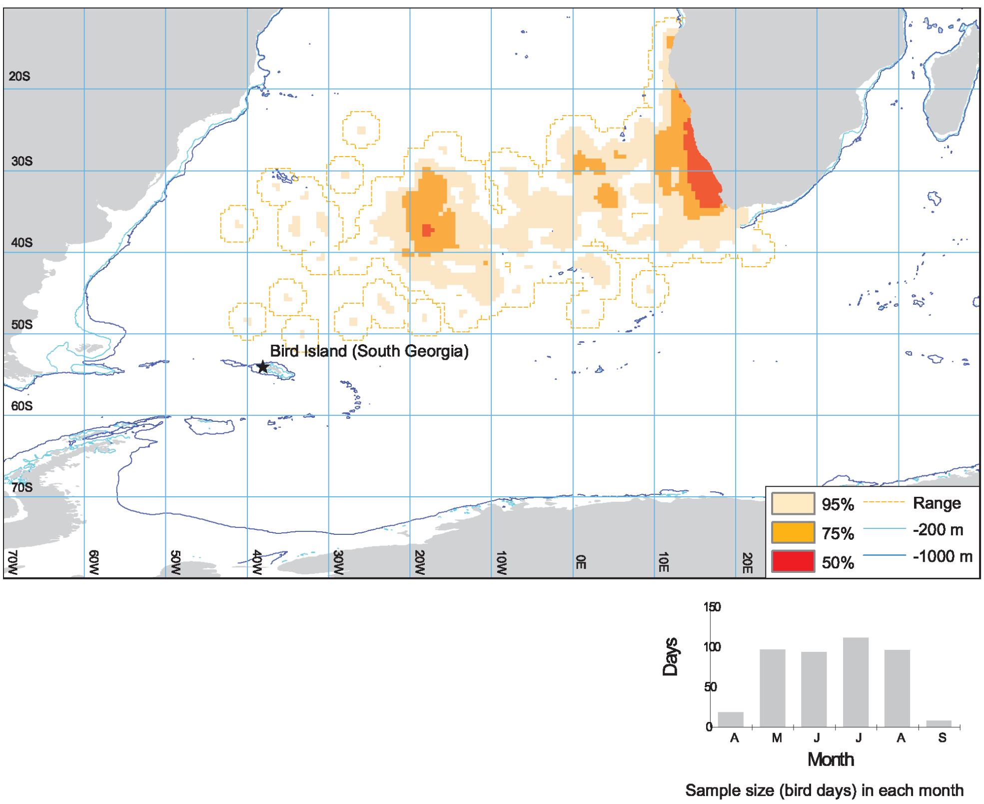
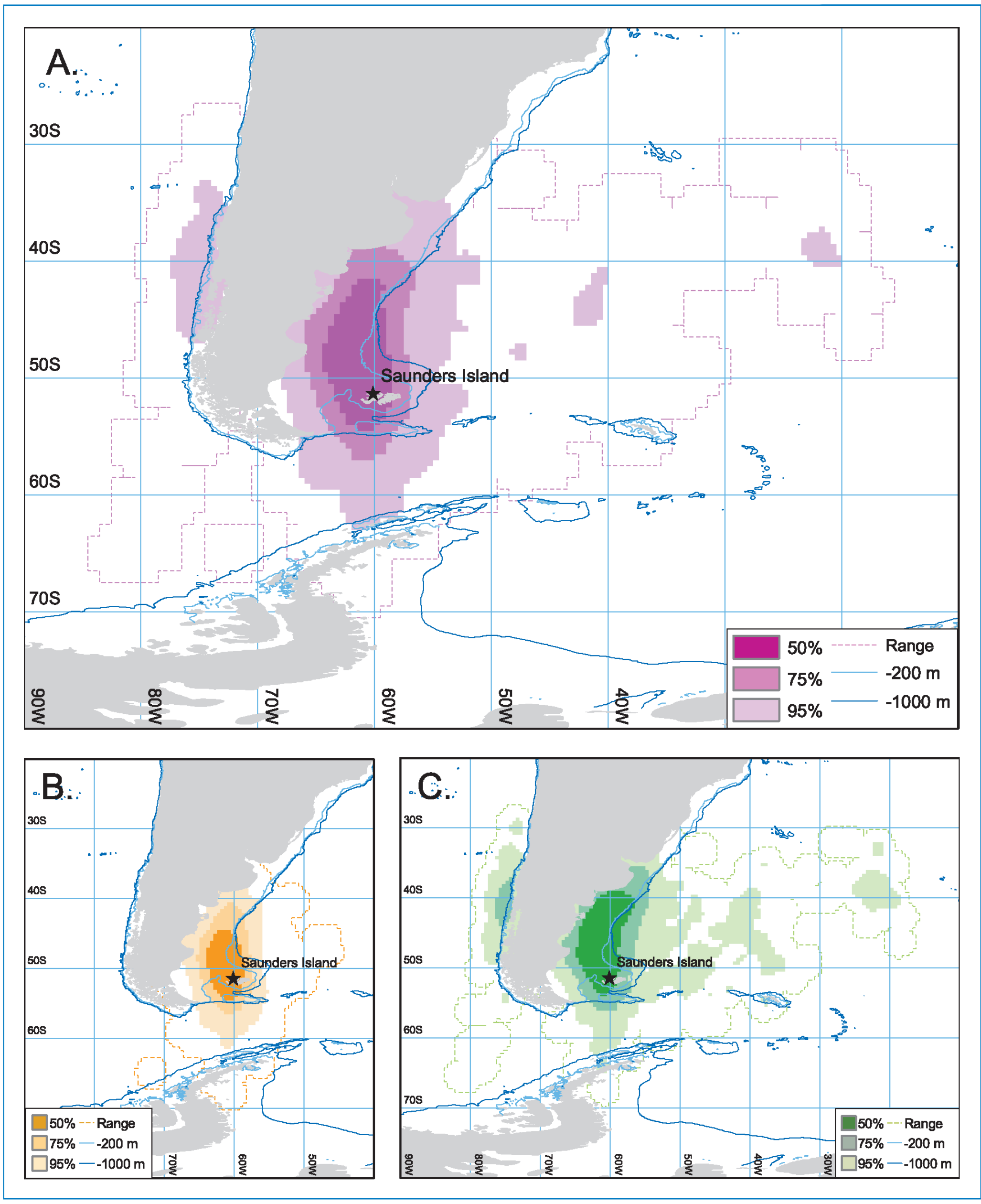


Figure 3.27. Utilisation distribution maps for Black-browed Albatrosses tracked from Bird Island, South Georgia during the non-breeding season (n=4 indivs).



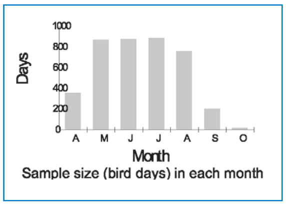
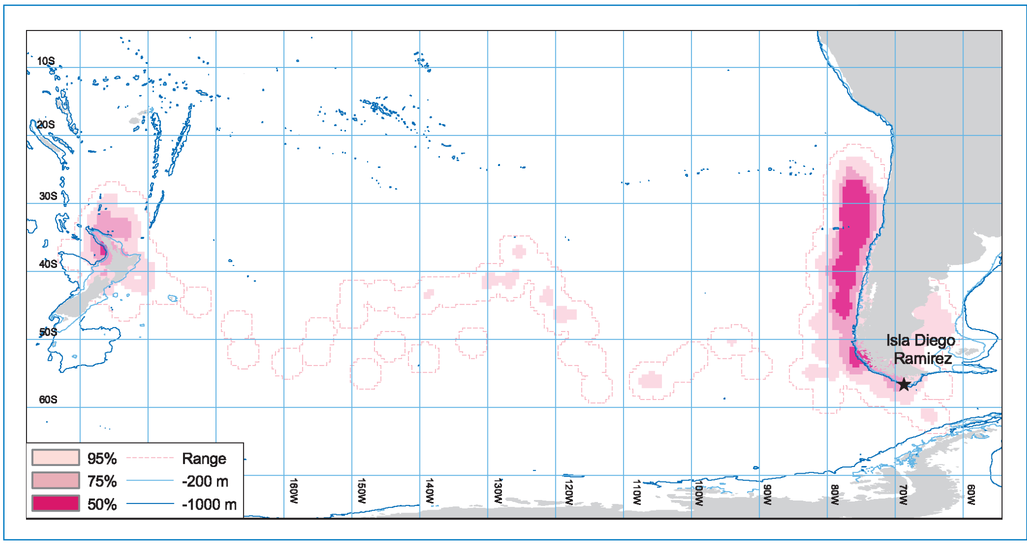


Figure 3.28. Utilisation distribution maps for Black-browed Albatrosses tracked from Saunders Island (Falklands Islands/Malvinas) during the non-breeding season. A. all birds (n=27 indivs); B. males only (n=16 indivs); C. females only (n=11 indivs).



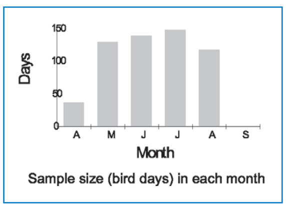


Figure 3.29. Utilisation distribution maps for Black-browed Albatrosses tracked from Diego Ramirez, Chile during the non-breeding season (n=5 indivs).

Grey-headed Albatross *Thalassarche chrysostoma* – South Georgia

During the 18-month non-breeding period, Grey-headed Albatrosses have a circumpolar distribution mainly between 30°S and 60°S (Figure 3.30). Outside their foraging range in the south-west Atlantic while breeding (see Figure 3.12), they spent most time in core areas on the Patagonian Shelf and southern Indian Ocean (two areas in the west and one in the east), and tended to be more widely dispersed whilst in the Pacific Ocean. Although only the staging area in the south-west Indian Ocean (Figure 3.30) coincides with one of the primary tuna longline fishing grounds (Tuck *et al.* 2003), their migration routes traverse most of the key tuna fishing areas south of 30°S as well as others exploited for Patagonian Toothfish. Adequate protection of non-breeding Grey-headed Albatrosses would therefore require mitigation measures to be adopted in virtually all longline fisheries south of 30°S.

Richard Phillips, Janet Silk and John Croxall

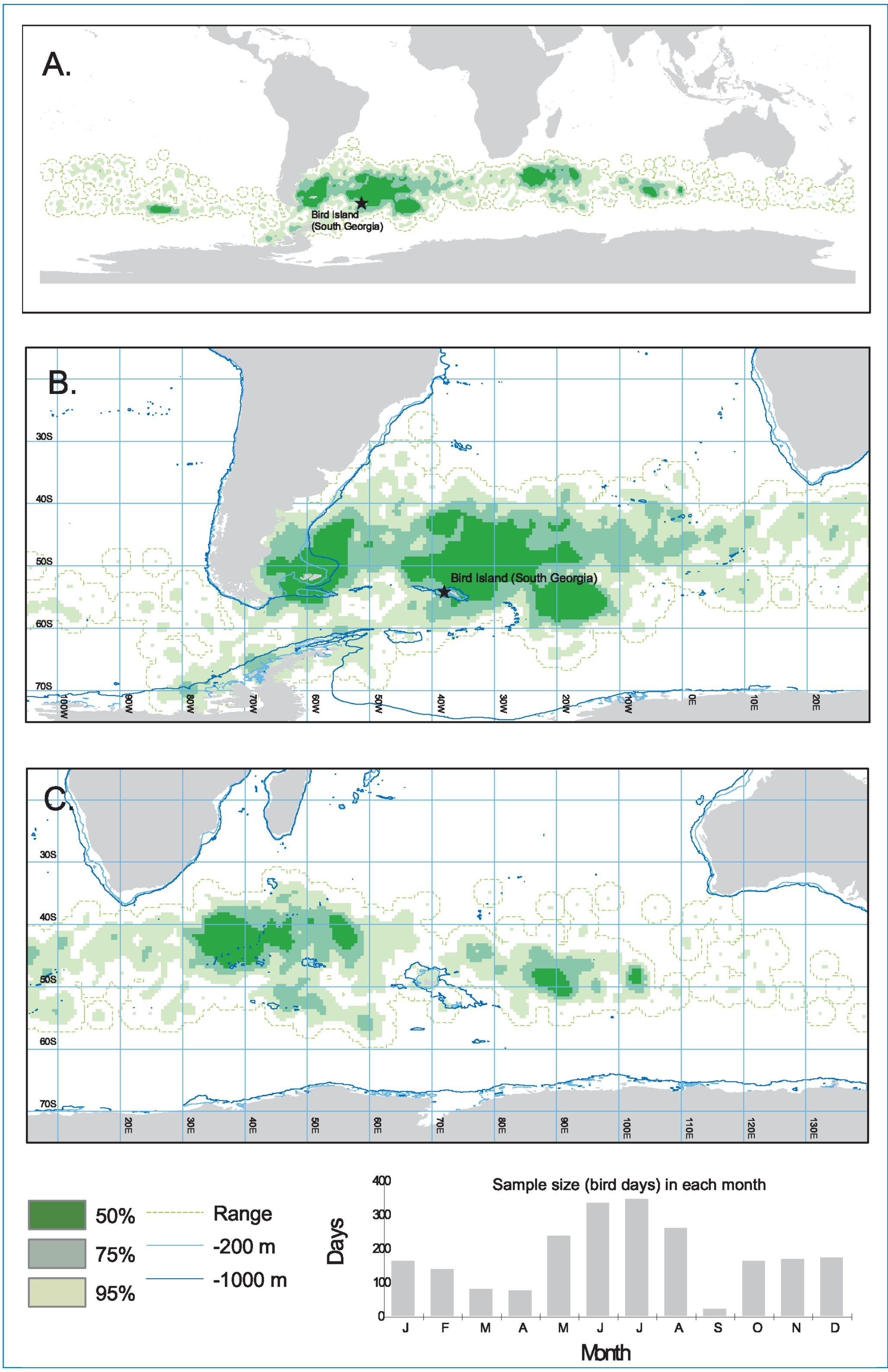


Figure 3.30. Utilisation distribution maps for Grey-headed Albatrosses (a biennial breeder) tracked from Bird Island, South Georgia in the 18 months between breeding attempts (n=6 indivs). A. Overall distribution; B. South Atlantic; C. Southern Indian Ocean.

4 REGIONAL SUMMARIES

4.1 SOUTH-WEST ATLANTIC AND SOUTHERN SOUTH AMERICA

4.1.1 Breeding

Composite distribution maps for the south-west Atlantic and South American sector illustrate very effectively the location of core areas of overlap in foraging ranges of the target albatrosses and petrels breeding in the region. Considering the maximum extent of foraging ranges (Figures 4.1A and 4.1B), breeding birds obviously travel over a vast area. Nevertheless, the 95% utilisation distributions (Figure 4.1C), illustrate that much of this habitat (particularly waters >1000m deep) is exploited only by single species. This is particularly apparent in the south-east Pacific, where the inclusion of chick-rearing tracks from the large Black-browed Albatross and small Southern Giant-petrel colonies in Chile (see Tables 4.1– 4.2) is unlikely to change the picture.

In terms of identifying key areas for the greatest number and diversity of threatened seabirds, all composite maps highlight more or less the same core regions, even though each was derived using different criteria. Interestingly, comparatively few sites appear to be important for multiple species (Figure 4.1D), perhaps reflecting the diversity of feeding strategies and high level of niche specialisation in albatrosses and petrels. However, here the lack of tracking data from populations of Southern Giant-petrels breeding in the Falkland Islands (Malvinas) and in the southern Scotia Sea (see Table 4.2) is unfortunate, as their inclusion would no

Table 4.1. PTT datasets included in the summary of breeding birds in the South-west Atlantic and South American region.

Site	Colony	Breeding stage	Year(s)	No. of hours	No. of indivs	No. of tracks	Contributor(s)
Black-browed Albatross							
Chile	Isla Diego de Almagro	incubation	2001	2,654	?	13	Graham Robertson
	Islas Diego Ramirez	incubation	1997–2001	10,103	?	62	Graham Robertson (97), Javier Arata (99–02)
		brood	1999–2001	5,367	?	32	
		early breeding	1997–1999	1,642	?	9	
		post guard	2001–2002	6,083	12	23	
	Islas Ildefonso	incubation	2001	5,014	?	26	Graham Robertson
Falkland Islands (Malvinas)	Beauchêne Island	incubation	2000	2,653	4	11	Nic Huin
		post guard	2000	3,397	4	48	
	Saunders Island	incubation	1998	2,759	7	22	
		post guard	1999	4,587	6	117	
South Georgia	Bird Island	incubation	1996	2,402	10	10	British Antarctic Survey
		chick	1993–1994	5,316	12	74	
			Total	**51,977**	**?**	**447**	
Grey-headed Albatross							
Chile	Islas Diego Ramirez	incubation	1997–2001	12,663	?	37	Graham Robertson (97), Javier Arata (99–02)
		brood	2000–2002	5,250	18	18	
		post guard	2001–2002	3,803	11	11	
	Islas Ildefonso	incubation	2001	572	1	1	Graham Robertson
South Georgia	Bird Island	incubation	1993–1995	953	4	5	British Antarctic Survey
		chick	1991–2001	24,264	35	239	
			Total	**47,505**	**?**	**311**	
Tristan Albatross							
Gough Island		incubation	2001	3,070	17	21	Richard Cuthbert
		brood guard	2001	1,017	9	28	
		post guard	2001	7,364	12	79	
			Total	**11,451**	**38**	**128**	
Wandering Albatross							
South Georgia	Bird Island	incubation	1991–2000	7,440	42	52	British Antarctic Survey
		chick	1990–2002	30,272	89	155	
			Total	**37,712**	**115**	**207**	
Northern Giant-petrel							
South Georgia	Bird Island	incubation	1998	3,921	18	18	British Antarctic Survey
			Total	**3,921**	**18**	**18**	
Southern Giant-petrel							
Argentina	Isla Arce	brood	2001–2002	4,014	5	5	Flavio Quintana
	Isla Gran Robredo	incubation	1999–2000	2,692	2	2	
		brood	2000	1,582	2	2	
South Georgia	Bird Island	incubation	1998–1999	3,352	11	11	British Antarctic Survey
			Total	**11,640**	**20**	**20**	
White-chinned Petrel							
South Georgia	Bird Island	incubation	1996–1997	1,074	4	4	British Antarctic Survey
		chick	1998	2,240	6	19	
			Total	**3,314**	**9**	**23**	

Figure 4.1. Regional summary of breeding albatrosses, giant-petrels and petrels in the South-west Atlantic and South American region.

A. Combined utilisation distribution map for 7 species of breeding albatross, giant-petrel and petrel tracked in the region of the South American continent. (See Table 4.1 for the list of species and datasets included). Each species has been given equal weighting.

B. Combined utilisation distribution map for the above 7 species of breeding albatross, giant-petrel and petrel, where each species has been weighted according to their IUCN threat status: Black-browed Albatross (E); Grey-headed Albatross (V); Northern Giant-petrel (NT); Southern Giant-petrel (V); Tristan Albatross (E); Wandering Albatross (V); White-chinned Petrel (V). The weights used were: NT (Near Threatened) = 1; V (Vulnerable) = 2; E (Endangered) = 3; CE (Critically Endangered) = 4.

C. Species density distribution map including the above 7 species. Only the range included in the 95% utilisation distribution of each species was used to calculate the number of species in each area.

D. Species density distribution map including the above 7 species. Only the range included in the 50% utilisation distribution of each species was used to calculate the number of species in each area.

E. Locations of colonies from which breeding birds were tracked.

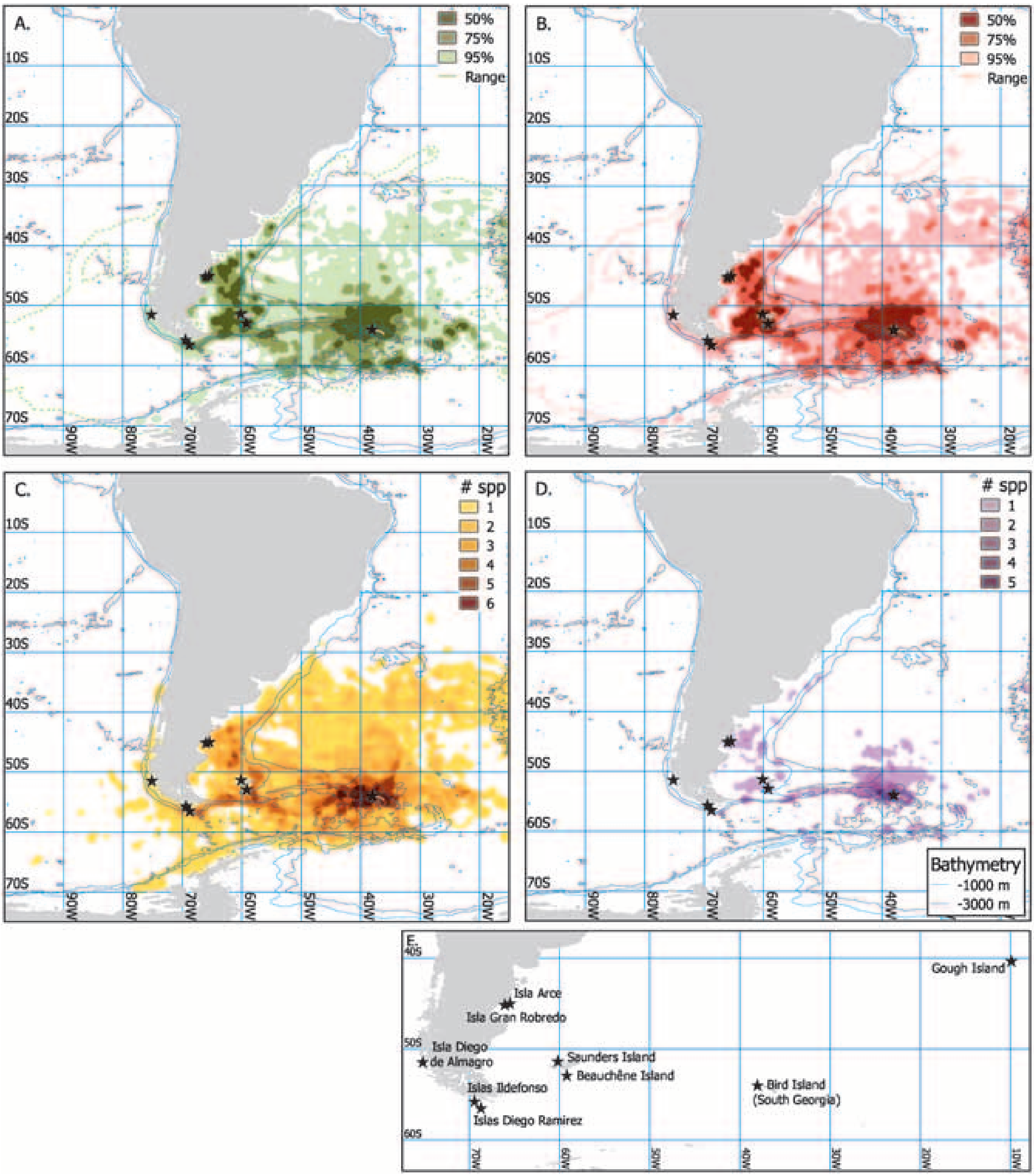


Table 4.2. Gap analysis of breeding PTT tracking data for the South-west Atlantic and South American region.

				PTT tracking data			
Species	Site	Annual no. breeding pairs	% regional population	No. of hours	No. of individuals	No. of tracks	% tracking data (in hours)
Atlantic Yellow-nosed Albatross	Gough Island	7,500	23%				
	Tristan da Cunha Islands	25,750	77%				
Black-browed Albatross	Chile	122,870	16%	30,863	?	165	59%
	Falkland Islands (Malvinas)	548,584	71%	13,396	18	198	26%
	South Georgia	100,332	13%	7,718	21	84	15%
Grey-headed Albatross	Chile	16,408	21%	22,288	?	67	47%
	South Georgia	61,582	79%	25,217	36	244	53%
Light-mantled Albatross	South Georgia	6,250	100%				
Sooty Albatross	Gough Island	5,000	65%				
	Tristan da Cunha Islands	2,747	35%				
Tristan Albatross	Gough Island	798	100%	11,451	38	128	100%
	Tristan da Cunha Islands	3	0%				0%
Wandering Albatross	South Georgia	2,001	100%	37,712	115	207	100%
Northern Giant-petrel	South Georgia	4,310	100%	3,921	18	18	100%
Southern Giant-petrel	Antarctic Continent	290	1%				0%
	Argentina	1,350	6%	8,288	9	9	71%
	Chile	290	1%				0%
	Falkland Islands (Malvinas)	3,100	15%				0%
	Gough Island	50	0%				0%
	Palmer Station	6,500	31%				0%
	South Georgia	4,650	22%	3,352	11	11	29%
	South Orkney Islands	3,400	16%				0%
	South Sandwich Islands	1,550	7%				0%
White-chinned Petrel	Falkland Islands (Malvinas)	2,500	0%				0%
	South Georgia	2,000,000	100%	3,314	9	23	100%

doubt change the emphasis, resulting in more cores highlighted on the Patagonian Shelf and along the Scotia Arc.

The combined 50% utilisation distributions may help pinpoint the core sites (Figure 4.1D). Close to the huge seabird colonies at South Georgia, these are: (a) the shelf that surrounds the archipelago and extends westwards to Shag Rocks, exploited by most locally-breeding procellariiforms; (b) the somewhat deeper waters (1000–3000 m) between Shag Rocks and the Burdwood Bank along the North Scotia Ridge, utilised particularly by Wandering Albatrosses; (c) the Antarctic Polar Frontal Zone, which runs in an east-west axis to the north of South Georgia and (d) several areas of deep, sub-Antarctic waters at around c. 45–48°S, which are favoured feeding grounds of Black-browed, Grey-headed and Wandering Albatrosses.

Figure 4.1D also highlights the importance of several discrete patches of shelf habitat south of 55 ºS along the Scotia Arc, extending from the Antarctic Peninsula to the South Sandwich Islands. Of these, the more westerly areas tend to be exploited by albatrosses and the most north-easterly by both giant-petrel species from South Georgia. The addition of tracking data from Southern Giant-petrels from other sites would presumably further emphasise the importance of these shelf areas.

On the Patagonian Shelf there are clearly many hotspots located around the Falkland Islands (Malvinas), to the south-east at the Burdwood Bank, and to the east and north-east of Peninsula Valdez (see Sections 3.1.1 and 3.1.5). Despite being relatively inshore, several sites near to Peninsula Valdez are key areas not just for Black-browed Albatrosses from the Falkland Islands (Malvinas) and Southern Giant-petrels from Argentina, but also for White-chinned Petrels and female Northern Giant-petrels commuting during incubation from as far away as South Georgia. Similarly, other important sites on the shelf break relate to foraging White-chinned Petrels and Wandering Albatrosses from South Georgia.

Although not particularly apparent from Figure 4.1D, the small Chilean shelf is of considerable importance to local Black-browed Albatrosses. Finally, in the central South Atlantic, there are apparently several core areas on the mid-Atlantic Ridge utilised by Tristan Albatrosses. Coverage in this region, however, is rather poor, with no data available for the other three local target species; Southern Giant-petrel, Atlantic Yellow-nosed and Sooty Albatrosses (Table 4.2).

Although coverage was generally good, it should be noted that data were missing entirely for three species (Light-mantled, Sooty and Atlantic Yellow-nosed Albatrosses), for most breeding populations of Southern Giant-petrel, and for chick-rearing birds at several sites (Tables 4.1–4.2). The inclusion of additional information from these taxa would undoubtedly result in some changes of emphasis, and should therefore be a target for future research. However, many of the core areas highlighted here are dependent on bathymetry, or associated with relatively constant hydrodynamic or oceanographic features such as tidal or oceanic frontal systems where prey aggregations are to an extent predictable. As such, it is unlikely that these would alter a great deal from year to year, and there are clearly a number of candidate sites for marine IBA status. It is also important to note that tracking data from non-breeding birds indicates the existence of further areas on the Patagonian Shelf and on the west coast of South America that may be critical for species when wintering (see Section 4.1.2).

Richard Phillips, Javier Arata, Richard Cuthbert, Nic Huin, Flavio Quintana and Graham Robertson

4.1.2 Non-breeding (includes migrating failed breeders, post-breeders and non-breeders)

Maps of combined utilisation by 5 species of non-breeding albatrosses show two major areas of intensive use by those species, one extending along the Humboldt Current (7–50ºS) and from there westwards into the southeast Pacific (40–50ºS), the other over the Patagonian Shelf south of 35ºS (Figure 4.2). More localised patches of intensive use are also found around South Georgia and over oceanic waters to the north and north-west (38–48ºS). Similar patterns are obtained when weighting species equally or according to IUCN threat status.

Figure 4.2. Regional summary of non-breeding albatrosses in the South-west Atlantic and South American region.

A. Combined utilisation distribution map for 5 species of non-breeding albatross tracked in the region of the South American continent. (See Table 4.3 for the list of species and datasets included). Each species has been given equal weighting.

B. Combined utilisation distribution map for the above 5 species of non-breeding albatross, where each species has been weighted according to their IUCN threat status: Antipodean Albatross (V); Buller's Albatross (V); Chatham Albatross (CE); Northern Royal Albatross (E); Wandering Albatross (V). The weights used were: NT (Near Threatened) = 1; V (Vulnerable) = 2; E (Endangered) = 3; CE (Critically Endangered) = 4.

C. Species density distribution map including the above 5 species. Only the range included in the 95% utilisation distribution of each species was used to calculate the number of species in each area.

D. Species density distribution map including the above 5 species. Only the range included in the 50% utilisation distribution of each species was used to calculate the number of species in each area.

E. Locations of colonies from which non-breeding birds were tracked.

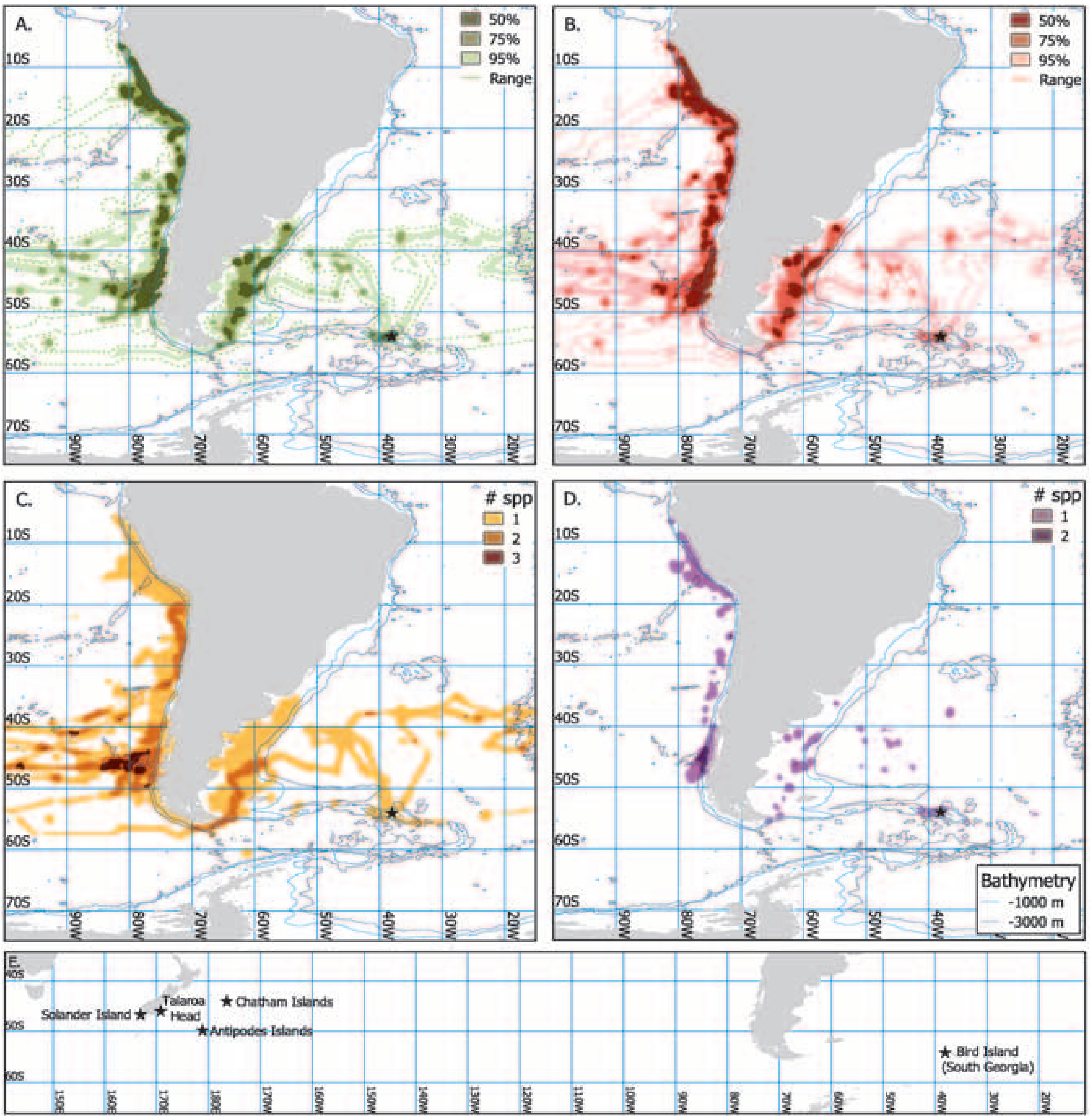


Table 4.3. PTT tracking datasets included in the summary of migratory non-breeding birds in the South-west Atlantic and South American region.

Site	Colony	Status	Year(s)	No. of hours	No. of indivs	No. of tracks	Contributor(s)
Antipodean Albatross							
Antipodes Islands		failed/migration	1996	1,009	1	1	David Nicholls
		non-breeding	1996	243	1	1	
			Total	**1,252**	**2**	**2**	
Buller's Albatross							
Solander Islands	North-West Headland	failed/migration	1997	982	2	2	Jean-Claude Stahl, Paul Sagar
			Total	**982**	**2**	**2**	
Chatham Albatross							
Chatham Islands	The Pyramid	failed/migration	1997–1999	11,149	8	8	Christopher Robertson, David Nicholls
		non-breeding	1998	570	1	1	
			Total	**11,719**	**9**	**9**	
Northern Royal Albatross							
Chatham Islands		failed/migration	1996–1998	2,225	4	6	Christopher Robertson, David Nicholls
New Zealand	Taiaroa Head	failed/migration	1998	3,671	1	1	
		non-breeding	1998	1,481	2	2	
			Total	**7,377**	**7**	**9**	
Wandering Albatross							
South Georgia	Bird Island	failed/migration	1992–1998	3,617	4	4	British Antarctic Survey
			Total	**3,617**	**4**	**4**	

Over the Humboldt Current and its south-western approaches, species density obtained from 95% utilisation distributions is highest in the south (40–50ºS, up to 3 species; mostly Antipodean, Northern Royal and Chatham Albatrosses), intermediate in the central region (20–40ºS, up to 2 species; mostly Chatham and Buller's Albatrosses), and low in the north (7–20ºS, Chatham Albatross only). All areas north of 40ºS are dominated by a single species when using 50% utilisation distributions, although this may merely reflect the limited number of Buller's Albatross locations, all of which were within 32–41ºS during the eastward migration (southeast Pacific) and 20–32ºS over the wintering area (Humboldt Current; Stahl and Sagar 2000a). Inclusion of Salvin's Albatross (abundant and widely distributed between 10–40ºS (Spear *et al.* 2003)) and Black-browed Albatross (abundant south of 40ºS during the non-breeding season (Jehl 1973)) would have presumably increased species density in all areas, but probably without altering the pattern of south to north decrease in species density.

Over the Patagonian Shelf and in the southwest Atlantic, areas of extensive use are mostly dominated by one species (Northern Royal and Wandering Albatross respectively); overlap between the 95% utilisation distributions of the two species over the southern Patagonian Shelf reflects the track of a Wandering Albatross commuting over that area. The distribution of Northern Royal Albatrosses over the Patagonian Shelf, however, largely overlaps that of non-breeding Black-browed Albatrosses from the Falkland Islands (Malvinas) (Grémillet *et al.* 2000), not included in the analysis.

Jean-Claude Stahl, Paul Sagar, John Croxall, David Nicholls and Christopher Robertson

4.2 INDIAN OCEAN

4.2.1 Breeding

The combined utilisation distribution maps for all the species of albatrosses and petrels tracked in the Indian Ocean (Figure 4.3) show that the overall range covers the entire western part of the south Indian Ocean. The eastern part is almost unexploited, not even by albatrosses from Kerguelen and Amsterdam that have the potential range to go much further east than they actually do.

The 95% utilisation distribution shows that it is mainly the sub-tropical and sub-Antarctic waters that are exploited. The Antarctic waters are not regularly visited by albatrosses, only White-chinned Petrels foraging there in summer. The 50% utilisation distribution shows that birds mainly concentrate in the vicinity of the breeding grounds, but also in some sectors such as the seamounts between the Prince Edwards and Crozet islands, or the sub-tropical front areas north of Crozet. Weighting each species according to its conservation status leads to the same conclusions.

In terms of the species distribution maps, the Crozet sector appears as a hotspot but this is due to the fact that the most species have been tracked from this site. Hotspots for multi-site origin are the Tropical Convergence Zone north of Crozet where birds from different species come from Crozet, but also Amsterdam Island, Marion Island and the seamount zone between Marion and Crozet.

In terms of hotspots for populations and species in the Indian Ocean, several sectors can be identified. First the vicinity of islands, that generally encompass the large shelf and shelf-edge waters around the islands, is the major zone of concentration of species and individuals. However this is not only due to the presence of the shelves, since around Amsterdam and Marion Island the shelf extent is very limited, but also to the proximity of islands. However, some species are specialised in exploiting shelf edges, such as Black-browed Albatrosses throughout the breeding season, or Wandering Albatrosses and White-chinned Petrels during short trips in the chick-rearing period. The effect of the proximity of islands is partly due to the bias arising from the tracking of central place foragers whose density decreases with the distance from the breeding island. Other hotspots, not influenced by the close vicinity of islands, are apparent: seamounts, such as those between Marion and Crozet are possible areas of enhanced production, but also could be recent areas of illegal fishing for Patagonian Toothfish. A last hotspot, well known for its enhanced production, is the zone of the Subtropical Convergence north of Marion and Crozet where, in addition

Figure 4.3. Regional summary of breeding albatrosses and petrels in the southern Indian Ocean.

A. Combined utilisation distribution map for 7 species of breeding albatross and petrel tracked in the southern Indian Ocean. (See Table 4.4 for the list of species and datasets included). Each species has been given equal weighting.

B. Combined utilisation distribution map for the above 7 species of albatross and petrel, where each species has been weighted according to their IUCN threat status: Amsterdam Albatross (CE); Black-browed Albatross (E); Grey-headed Albatross (V); Sooty Albatross (E); Wandering Albatross (V); Indian Yellow-nosed Albatross (E); White-chinned Petrel (V). The weights used were: V (Vulnerable) = 2; E (Endangered) = 3; CE (Critically Endangered) = 4.

C. Species density distribution map including the above 7 species. Only the range included in the 95% utilisation distribution of each species was used to calculate the number of species in each area.

D. Species density distribution map including the above 7 species. Only the range included in the 50% utilisation distribution of each species was used to calculate the number of species in each area.

E. Locations of colonies from which breeding birds were tracked.

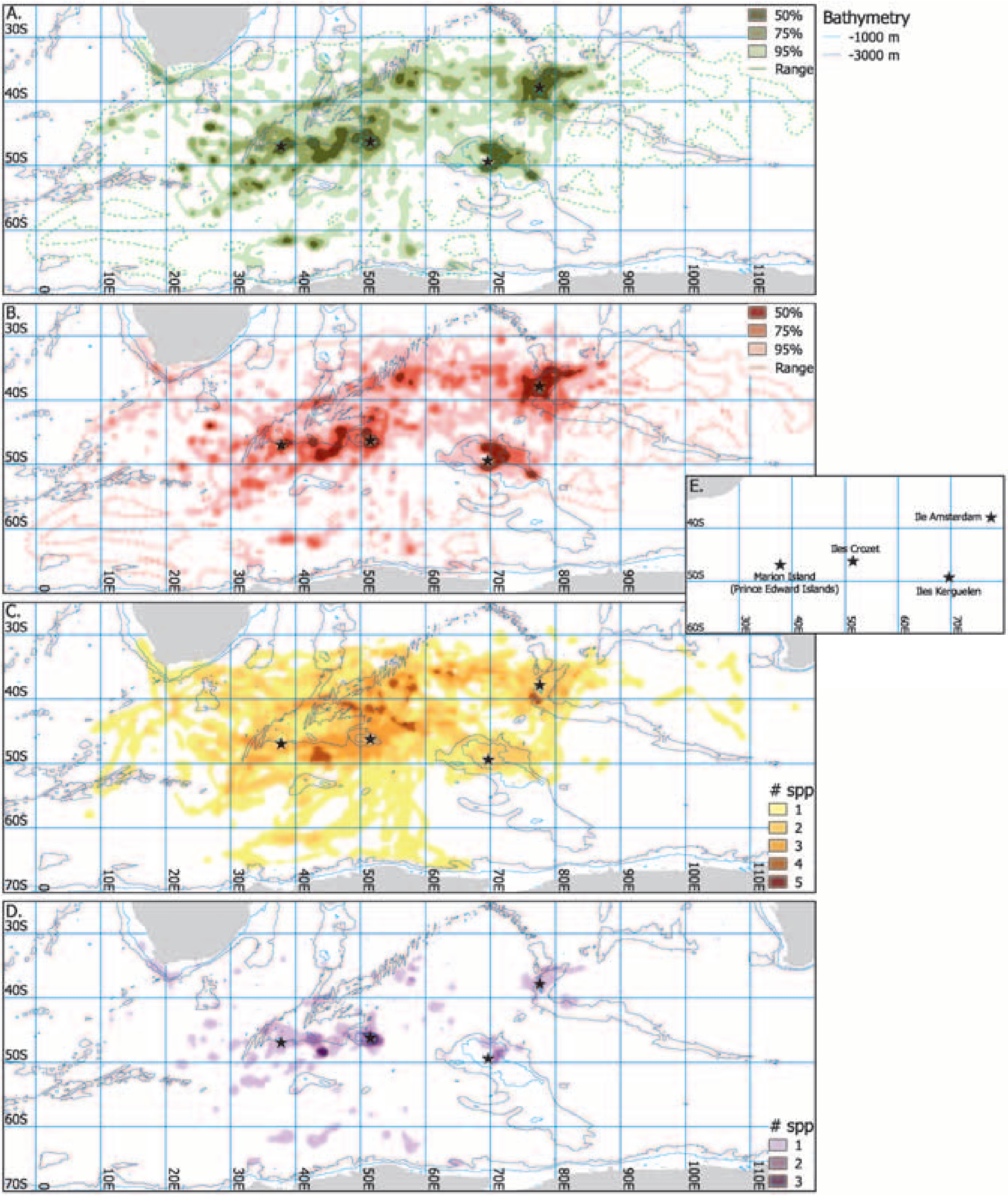


Table 4.4. PTT tracking datasets included in the regional summary of breeding birds in the Indian Ocean.

Site	Colony	Breeding stage	Year(s)	No. of hours	No. of indivs	No. of tracks	Contributor(s)
Amsterdam Albatross							
Ile Amsterdam		incubation	1996–2000	5,160	?	15	Henri Weimerskirch
			Total	**5,160**	**?**	**15**	
Black-browed Albatross							
Iles Kerguelen		incubation	1999	1,782	8	8	Henri Weimerskirch
		chick	1994–1995	5,896	?	18	
			Total	**7,678**	**?**	**26**	
Grey-headed Albatross							
Prince Edward Islands	Marion Island	incubation	1997	1,343	4	4	Deon Nel
		chick	1998	551	2	2	
			Total	**1,894**	**?**	**6**	
Sooty Albatross							
Iles Crozet		early breeding	1992–1995	8,194	?	26	Henri Weimerskirch
			Total	**8,194**	**?**	**26**	
Wandering Albatross							
Iles Crozet		incubation	1989–2001	38,011	?	157	Henri Weimerskirch
		chick	1990–1999	10,859	?	47	
Iles Kerguelen		chick	1998–1999	1,742	?	11	
Prince Edward Islands	Marion Island	incubation	1998	1,751	4	4	Deon Nel
		brood guard	1997	2,481	8	8	
		post guard	1997	3,910	8	8	
			Total	**58,754**	**?**	**235**	
Indian Yellow-nosed Albatross							
Ile Amsterdam		incubation	2000	4,229	?	9	Henri Weimerskirch
		chick	1995–2001	6,297	?	25	
			Total	**10,526**	**?**	**34**	
White-chinned Petrel							
Iles Crozet		incubation	1996	2,350	?	9	Henri Weimerskirch
		chick	1997	2,255	7	7	
			Total	**4,605**	**?**	**16**	

Table 4.5. Gap analysis of breeding PTT tracking data for the southern Indian Ocean.

Species	Site	Annual no. breeding pairs	% regional population	PTT tracking data: No. of hours	No. of individuals	No. of tracks	% tracking data (in hours)
Amsterdam Albatross	Ile Amsterdam	17	100%	5,160	?	15	100%
Black-browed Albatross	Iles Crozet	880	17%				0%
	Iles Kerguelen	4,270	83%	7,678	?	26	100%
Grey-headed Albatross	Iles Crozet	5,940	28%				0%
	Iles Kerguelen	7,905	37%				0%
	Prince Edward Islands	7,717	36%	1,894	?	6	100%
Indian Yellow-nosed Albatross	Ile Amsterdam	25,000	70%	10,526	?	34	100%
	Iles Crozet	4,430	12%				0%
	Iles Kerguelen	50	0%				0%
	Prince Edward Islands	6,000	17%				0%
Light-mantled Albatross	Iles Crozet	2,421	36%				
	Iles Kerguelen	4,000	60%				
	Prince Edward Islands	241	4%				
Salvin's Albatross	Iles Crozet	4	100%				
Sooty Albatross	Ile Amsterdam	350	7%				0%
	Iles Crozet	2,248	42%	8,194	?	26	100%
	Iles Kerguelen	4	0%				0%
	Prince Edward Islands	2,755	51%				0%
Wandering Albatross	Iles Crozet	2,062	35%	48,870	?	204	83%
	Iles Kerguelen	1,094	19%	1,742	?	11	3%
	Prince Edward Islands	2,707	46%	8,142	17	20	14%
Northern Giant-petrel	Iles Crozet	1,060	35%				
	Iles Kerguelen	1,400	47%				
	Prince Edward Islands	540	18%				
Southern Giant-petrel	Iles Crozet	1,060	37%				
	Iles Kerguelen	4	0%				
	Prince Edward Islands	1,790	63%				
White-chinned Petrel	Iles Crozet	50,000	?%	4,605	?	16	100%
	Iles Kerguelen	200,000	?%				0%
	Prince Edward Islands	?	?%				0%

to the convergence, a succession of semi-permanent eddies occur as a result of the retroflection of the Agulhas Current meeting the Southern Ocean wind-driven westerly current.

Although the number of species studied in the zone is relatively high, it must be noted that one species, the Wandering Albatross is over-represented in terms of the number of individuals tracked (three sites (Marion, Crozet and Kerguelen) and over 11 seasons for some sites (e.g. Crozet)). Otherwise, no species has been tracked at more than one site. It will be of great interest to see whether different populations of other species forage in the same sectors, for example Grey-headed Albatrosses from Crozet and Kerguelen, or Yellow-nosed Albatrosses from Prince Edward or Crozet. Every species of resident albatross has been tracked at least from one site in the Indian Ocean, but some species only in limited numbers, such as the two *Phoebetria* species from Crozet. On the other hand, giant-petrels have not been tracked in the Indian Ocean, and this is a future requirement, in view of the relatively small size of the populations, and relatively high susceptibility to longline fisheries in the sector. The species most threatened locally by toothfish longline fisheries, White-chinned Petrels and Grey Petrels, should be a major focus for future tracking studies. Only White-chinned Petrels have been tracked at the Crozet Islands showing that, while breeding, they are in contact with fisheries off South Africa, with subtropical oceanic fisheries, as well as neritic fisheries for toothfish. The tracking of White-chinned and Grey Petrels from Kerguelen would be important since it is around this island that a major legal longline fishery, killing substantial numbers of both species, is still operating.

Henri Weimerskirch and Deon Nel

4.3 AUSTRALASIA

4.3.1 Breeding

Maps of combined utilisation by 9 species of breeding albatrosses highlight the importance of the vicinity of breeding grounds as major foraging areas for breeding birds in this region (Figure 4.4). Thus areas of intensive use

Figure 4.4. Regional summary of breeding albatrosses around New Zealand and Australia.

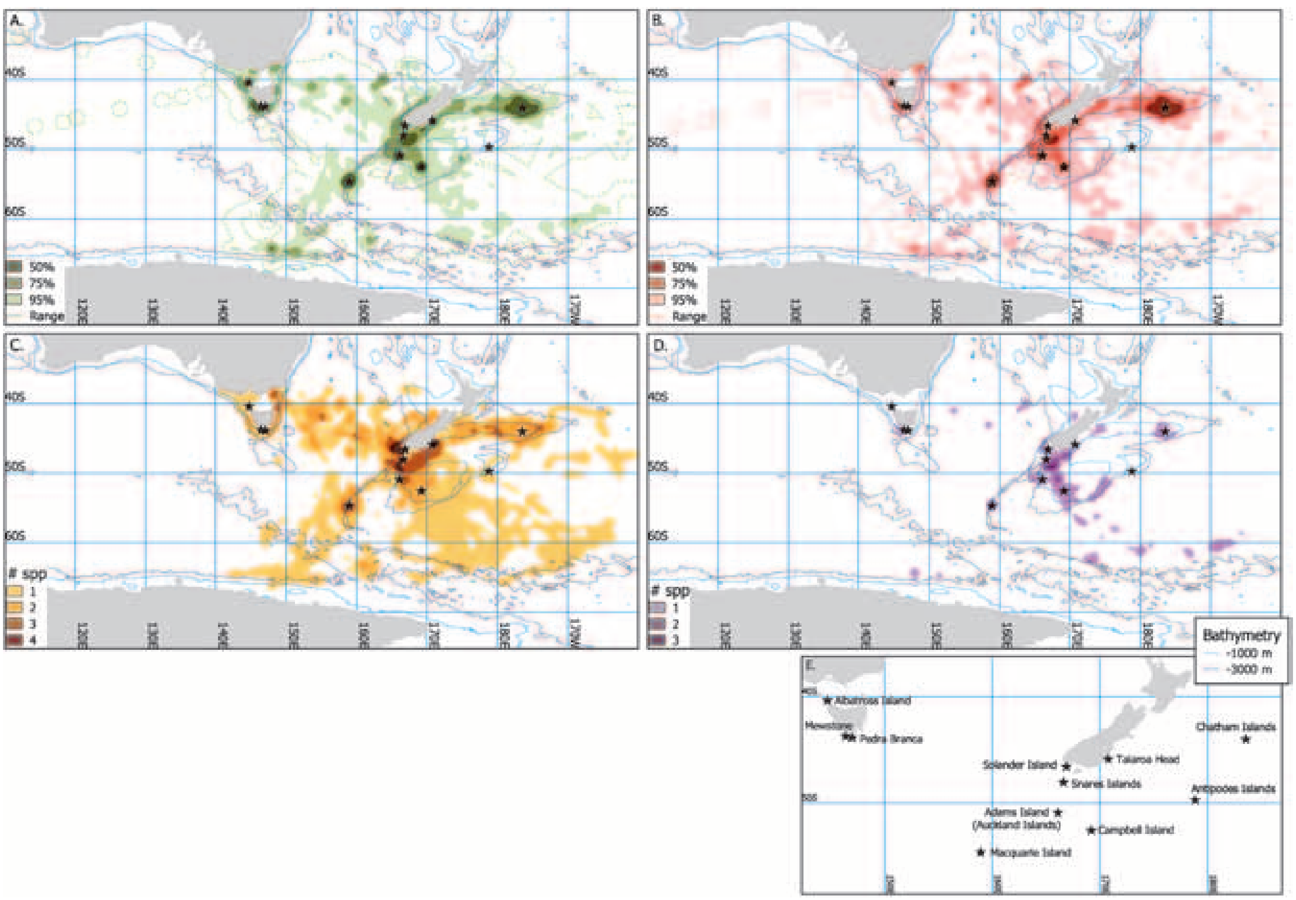
A. Combined utilisation distribution map for 9 species of breeding albatross tracked in the region of New Zealand and the Australian continent. (See Table 4.6 for the list of species and datasets included). Each species has been given equal weighting.

B. Combined utilisation distribution map for the above 9 species of breeding albatross, where each species has been weighted according to their IUCN threat status: Antipodean (Gibson's) Albatross (V); Black-browed Albatross (E); Buller's Albatross (V); Chatham Albatross (CE); Grey-headed Albatross (V); Light-mantled Albatross (NT); Northern Royal Albatross (E); Southern Royal Albatross (V); Shy Albatross (NT). The weights used were: NT (Near Threatened) = 1; V (Vulnerable) = 2; E (Endangered) = 3; CE (Critically Endangered) = 4.

C. Species density distribution map including the above 9 species. Only the range included in the 95% utilisation distribution of each species was used to calculate the number of species in each area.

D. Species density distribution map including the above 9 species. Only the range included in the 50% utilisation distribution of each species was used to calculate the number of species in each area.

E. Locations of colonies from which breeding birds were tracked.



surround the breeding localities of most of the tracked birds, including Albatross Island, Mewstone and Pedra Branca off Tasmania (Shy Albatross), Macquarie (Black-browed, Grey-headed and Light-mantled Albatrosses), Campbell (Southern Royal, Grey-headed Albatrosses), Auckland (Antipodean (Gibson's) Albatross), Snares (Buller's Albatross) and Chatham Islands (Northern Royal and Chatham Albatrosses) in the New Zealand region (Brothers *et al.* 1998, Robertson and Nichols 2000, Stahl and Sagar 2000a and b, Hedd *et al.* 2001, Nichols *et al.* 2002, Waugh *et al.* 2002, Robertson, C. *et al.* 2003b, R. Gales unpublished data). Beyond those foraging zones, areas of most intensive use are located over shelf and slope areas around the South Island of New Zealand (Antipodean (Gibson's), Northern Royal, Southern Royal, and Buller's Albatrosses) and over the Chatham Rise (Northern Royal and Chatham Albatrosses). Over oceanic waters, areas of most intensive use are located over subtropical waters of the Tasman Sea between 40–46ºS (Antipodean (Gibson's) and Buller's Albatrosses), over the

Table 4.6. PTT tracking datasets included in the summary of breeding birds in the Australasian region.

Site	Colony	Breeding stage	Year(s)	No. of hours	No. of indivs	No. of tracks	Contributor(s)
Antipodean (Gibson's) Albatross							
Auckland Islands	Adams Island	incubation	1994	1,345	2	2	David Nicholls
		guard	1994	366	1	1	
			Total	**1,711**	**3**	**3**	
Black-browed Albatross							
Macquarie Island		incubation	1999–2001	3,525	6	6	Alex Terauds, Rosemary Gales
		brood guard	2000	431	1	1	
			Total	**3,956**	**6**	**7**	
Buller's Albatross							
Solander Islands	North-West Headland	incubation	1997	2,711	6	11	Jean-Claude Stahl, Paul Sagar
		guard	1997	971	3	18	
		post guard	1997	3,796	5	20	
Snares Islands	Mollymawk Bay	pre-egg	2001–2002	1,575	2	16	
		incubation	1995–2002	5,575	18	22	
		guard	1996	1,859	5	29	
		post guard	1996	6,004	6	31	
	Punui Bay	pre-egg	2001–2002	1,050	2	16	
		incubation	1999–2002	1,768	5	8	
		guard	1999	420	4	11	
		post guard	1999	2,042	4	9	
	Razorback	incubation	1999	1,029	4	4	
		guard	1999	753	4	25	
		post guard	1999	540	3	4	
	Unknown	incubation	1995	1,448	5	5	Henri Weimerskirch
			Total	**31,541**	**47**	**229**	
Chatham Albatross							
Chatham Islands	The Pyramid	chick	1997–1999	8,136	9	16	Christopher Robertson, David Nicholls
			Total	**8,136**	**9**	**16**	
Grey-headed Albatross							
Campbell Island		chick	1997	1,271	5	5	Henri Weimerskirch
Macquarie Island		incubation	1999–2001	2,777	5	6	Alex Terauds, Rosemary Gales
		brood guard	1999–2000	1,236	3	3	
			Total	**5,284**	**13**	**14**	
Light-mantled Albatross							
Macquarie Island	Bauer Bay	incubation	2002–2003	1,224	3	3	Rosemary Gales
		brood guard	2002–2003	493	2	2	
	Hurd Point	incubation	2002–2003	1,207	3	3	
		brood guard	2002–2003	738	2	2	
			Total	**3,662**	**7**	**10**	
Northern Royal Albatross							
Chatham Islands		early breeding	1994–1996	6,370	13	28	Christopher Robertson, David Nicholls
New Zealand	Taiaroa Head	early breeding	1993–1998	885	3	3	
			Total	**7,255**	**16**	**31**	
Southern Royal Albatross							
Campbell Island	Campbell Island	incubation	1999	2,973	7	7	Henri Weimerskirch
			Total	**2,973**	**7**	**7**	
Shy Albatross							
Tasmania	Albatross Island	incubation	1993–1996	10,751	?	41	Rosemary Gales
		brood guard	1997	1,371	2	2	
		post guard	1994–1995	4,094	?	15	
	Mewstone	incubation	1997–1998	2,521	2	2	
	Pedra Branca	incubation	1997	2,906	4	4	
			Total	**21,643**	**?**	**64**	

Table 4.7. Gap analysis of breeding PTT tracking data for the Australasian region.

				PTT tracking data			
Species	Site	Annual no. breeding pairs	% regional population	No. of hours	No. of individuals	No. of tracks	% tracking data (in hours)
Antipodean Albatross	Antipodes Islands	5,148	100%				
	Campbell Island	6	0%				
Antipodean (Gibson's) Albatross	Auckland Islands	7,319	100%	1,711	3	3	100%
Black-browed Albatross	Antipodes Islands	115	37%				0%
	Campbell Island	16	5%				0%
	Macquarie Island	182	58%	3,956	6	7	100%
	Snares Islands	1	0%				0%
Buller's Albatross	Chatham Islands	18,150	58%				0%
	Three Kings	20	0%				0%
	Snares Islands	8,465	27%	24,063	37	180	76%
	Solander Islands	4,800	15%	7,478	10	49	24%
Campbell Albatross	Campbell Island	26,000	100%				
Chatham Albatross	Chatham Islands	4,000	100%	8,136	9	16	100%
Grey-headed Albatross	Campbell Island	6,400	99%	1,271	5	5	24%
	Macquarie Island	84	1%	4,013	6	9	76%
Light-mantled Albatross	Antipodes Islands	169	2%				0%
	Auckland Islands	5,000	57%				0%
	Campbell Island	1,600	18%				0%
	Macquarie Island	2,000	23%	3,662	7	10	100%
Northern Royal Albatross	Chatham Islands	2,060	99%	6,370	13	28	88%
	Taiaroa Head	18	1%	885	3	3	12%
Salvin's Albatross	Bounty Islands	76,352	99%				
	Snares Islands	587	1%				
Shy Albatross	Antipodes Islands	18	0%				0%
	Auckland Islands	72,233	85%				0%
	Chatham Islands	1	0%				0%
	Tasmania	12,250	14%	21,643	?	64	100%
Southern Royal Albatross	Auckland Islands	72	1%				0%
	Campbell Island	7,800	99%	2,973	7	7	100%
Wandering Albatross	Macquarie Island	10	100%				
Northern Giant-petrel	Antipodes Islands	300	8%				
	Auckland Islands	100	3%				
	Campbell Island	240	6%				
	Chatham Islands	2,150	55%				
	Macquarie Island	1,110	28%				
Southern Giant-petrel	Macquarie Island	2,300	100%				
White-chinned Petrel	Antipodes Islands	50,000	?%				
	Auckland Islands	50,000	?%				
	Campbell Island	?	?%				
	Macquarie Island	?	?%				

Polar Frontal Zone and Antarctic waters (60–67ºS) from 145ºE to 165ºW (Grey-headed and Light-mantled Albatrosses), and sub-Antarctic and Antarctic waters southwest of Macquarie (Light-mantled Albatross) and south-east of Campbell (Grey-headed Albatross). Similar patterns are obtained when weighting species equally or according to IUCN threat status.

Species density obtained from 95% utilisation distributions was highest south and south-east of New Zealand (up to four species, see above), over the central Chatham Rise, around Macquarie and in the western Tasman Sea west to Bass Strait (up to three species). Species overlaps of 50% utilisation contours were mostly confined south and south-east of New Zealand (up to three species), and around Campbell and Macquarie (up to two species).

Jean-Claude Stahl, Paul Sagar, Rosemary Gales, David Nicholls, Christopher Robertson, Alex Terauds and Henri Weimerskirch

4.3.2 Non-breeding (includes non-breeding adults and immatures, and migrating and resident failed and post-breeders)

Maps of combined utilisation by non-breeders of 7 albatross species (Figure 4.5) reveal a more diffuse distribution pattern than that of breeding birds, albeit partly derived from foraging locations of central-foraging birds (colony attending prebreeders, adult non-breeders and failed breeders). Areas of most intensive use also tended to be more concentrated over shelf and slope areas than in breeders (except in the western Tasman Sea), and located in more northerly waters, although both possibly reflecting differences in species composition among foraging locations obtained for breeders and non-breeders.

Off Australia, areas of most extensive use are located over shelf and slope areas south of Australia from Cape Leeuwin to Bass Strait (migrating Wandering, Northern Royal and Shy Albatrosses, over-wintering Shy Albatrosses), all around Tasmania (Wandering, Antipodean (Gibson's), Shy and Buller's Albatrosses), and from there north-eastwards along the Victoria and New South Wales coast north to about 34ºS (well documented over-wintering area of Wandering and Antipodean (Gibson's) Albatrosses) (Nichols *et al.* 1996, Brothers *et al.* 1998, Stahl and Sagar 2000a and b, Hedd *et al.* 2001). Around New Zealand, areas of most extensive use are located over shelf and slope areas from 40ºS off the South Island south to 50ºS south of the Snares (Antipodean (Gibson's), Northern Royal and Buller's Albatrosses), over the central and eastern parts of the Chatham Rise (Antipodean, Northern Royal, Chatham Albatrosses), and around the Antipodes Islands (Antipodean Albatross) (Stahl and Sagar 2000a and b, Nichols *et al.* 2002, Robertson, C. *et al.* 2003b). Over oceanic waters, the area most extensively used is located in the western Tasman Sea between 36–43ºS (Antipodean (Gibson's), Buller's Albatrosses). More confined areas of intensive use are located over the Challenger Plateau and Lord Howe Rise west of New Zealand (Antipodean (Gibson's) Albatross), and over oceanic waters east and north-east of the Chathams (Wandering, Antipodean). Similar patterns are obtained when weighting species equally or according to IUCN threat status (Nichols *et al.* 1995, Stahl and Sagar 2000a and b).

Species density obtained from 95% utilisation distributions was highest over the Chatham Rise (up to 4–5 species), around Tasmania and east of the South Island of New Zealand (up to three species), and over oceanic waters in the western and central Tasman Sea and east of the Chatham Islands (up to three species). Species overlaps of 50% utilisation contours were confined to the eastern part of the Chatham Rise (up to three species), western Tasman Sea, and shelf and slope areas east of Tasmania and New South Wales and south-east of Kangaroo Island (up to two species).

Jean-Claude Stahl, Paul Sagar, David Nicholls, Aleks Terauds and Rosemary Gales.

Figure 4.5. Regional summary of non-breeding albatrosses around New Zealand and Australia.

A. Combined utilisation distribution map for 7 species of non-breeding albatross tracked in the region of New Zealand and the Australian continent. (See Table 4.8 for the list of species and datasets included). Each species has been given equal weighting.

B. Combined utilisation distribution map for the above 7 species of breeding albatross, where each species has been weighted according to their IUCN threat status: Antipodean Albatross (V); Antipodean (Gibson's) Albatross (V); Buller's Albatross (V); Chatham Albatross (CE); Northern Royal Albatross (E); Shy Albatross (NT); Wandering Albatross (V). The weights used were: NT (Near Threatened) = 1; V (Vulnerable) = 2; E (Endangered) = 3; CE (Critically Endangered) = 4.

C. Species density distribution map including the above 7 species. Only the range included in the 95% utilisation distribution of each species was used to calculate the number of species in each area.

D. Species density distribution map including the above 7 species. Only the range included in the 50% utilisation distribution of each species was used to calculate the number of species in each area.

E. Locations of colonies from which non-breeding birds were originated (Marion and Crozet Islands, the sites of origin of the Wandering Albatrosses, are not shown).

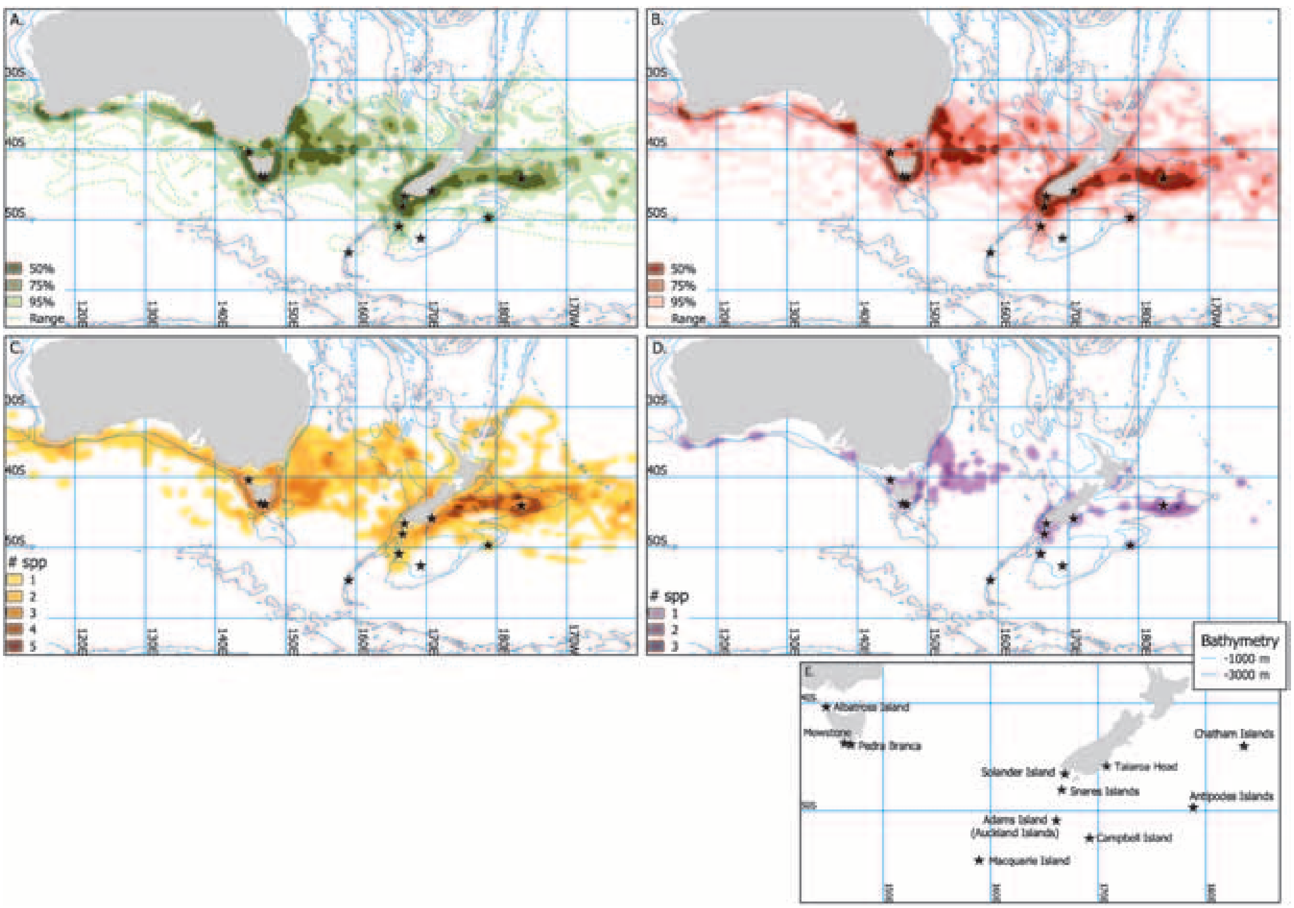


Table 4.8. PTT tracking datasets included in the summary of non-breeding birds in the Australasian region.

Site	Colony	Age	Status	Year(s)	No. of hours	No. of indivs	No. of tracks	Contributor(s)
Antipodean Albatross								
Antipodes Islands		adult	failed/migration	1996	1,009	1	1	David Nicholls
		adult	non-breeding	1996–1997	814	2	12	
				Total	**1,823**	**3**	**13**	
Antipodean (Gibson's) Albatross								
Auckland Islands	Adams Island	adult	non-breeding	1995	2,382	2	2	David Nicholls
Unknown		adult	non-breeding	1994	1,693	1	1	
				Total	**4,075**	**3**	**3**	
Buller's Albatross								
Solander Islands	North-West Headland	adult	failed/migration	1997	1,060	1	8	Jean-Claude Stahl, Paul Sagar
		unknown	non-breeding	2002	8,375	8	129	
Snares Islands	Mollymawk Bay	immature	non-breeding	2000–2001	1,310	2	11	
	Punui Bay	adult	failed/migration	2002	388	2	12	
		adult	non-breeding	2001	804	1	12	
		immature	non-breeding	2000–2001	5,695	4	62	
				Total	**17,632**	**18**	**234**	
Chatham Albatross								
Chatham Islands	The Pyramid	adult	failed/migration	1997–1999	18,894	9	17	Christopher Robertson, David Nicholls
		immature	non-breeding	1998	1,626	2	2	
				Total	**20,520**	**11**	**19**	
Northern Royal Albatross								
Chatham Islands		adult	failed/migration	1996–1998	2,566	4	15	Christopher Robertson, David Nicholls
New Zealand	Taiaroa Head	adult	failed/migration	1998	3,769	1	2	
		immature	non-breeding	1998	2,364	2	14	
				Total	**8,699**	**7**	**31**	
Shy Albatross								
Tasmania	Albatross Island	immature	non-breeding	1996	2,587	3	3	Rosemary Gales
	Mewstone	adult	failed/migration	2002	913	3	3	
	Pedra Branca	adult	failed/migration	2002	212	2	2	
				Total	**3,712**	**8**	**8**	
Wandering Albatross								
Indian Ocean		adult	non-breeding	1992	2,161	1	1	David Nicholls
Tasmania		adult	non-breeding	1993–1995	5,459	4	4	
				Total	**7,620**	**5**	**5**	

4.4 NORTH PACIFIC

4.4.1 Breeding and non-breeding (including post-breeders)

Three species of *Phoebastria* albatrosses breed on islands spanning the sub-tropical North Pacific Ocean: Laysan (*P. immutabilis*), Black-footed (*P. nigripes*), and Short-tailed (*P. albatrus*) Albatrosses (see Table 4.10). Ship-based observations, fisheries bycatch and satellite tracking studies reveal that Laysan, Black-footed, and Short-tailed Albatrosses are widely distributed in the North Pacific, ranging from the sub-Arctic waters of the Bering Sea (60–65°N), to tropical waters in the south (15–20°N) (Hasegawa and DeGange 1982, McDermond and Morgan 1993). In contrast to its two congeners, however, the Short-tailed Albatross primarily occurs in continental shelf and slope waters (McDermond and Morgan 1993, USFWS unpubl. data) and is much less densely distributed, owing to its small population size.

While there is much less information on the oceanic habitats and overall ecology of the Short-tailed Albatross, all three species are attracted to fishing vessels and forage in regions that overlap with commercial fisheries. Thus, interactions with fishing vessels can be a significant cause of mortality (e.g. Stehn *et al*. 2001). Of particular concern are interactions involving Short-tailed Albatrosses because their populations are at critically low numbers compared to the other two species and their breeding range is restricted to two colonies. Furthermore, recent censuses and demographic models suggest that Black-footed Albatross populations may be at risk due to impacts of longline fishing (Lewison and Crowder 2003). If albatross populations are affected by detrimental anthropogenic activities at sea, then studies addressing the habitat use and the marine distributions of albatrosses are essential to implement the necessary policy changes.

The data summarised in the figures below were collected by multiple studies from various breeding sites in the North Pacific. The majority of the tracking effort for Laysan and Black-footed Albatrosses originates from the Northwest Hawaiian Islands, primarily Tern Island. Following research conducted in 1998 (Fernández *et al.* 2001, Hyrenbach *et al.* 2002), researchers from TOPP (Tagging of Pacific Pelagics; see Annex 5) conducted a total of 54 deployments on Laysan and Black-footed Albatrosses in 2002–2004. This study differed from earlier work in that: (1) both satellite transmitters and light-based geolocation loggers were deployed simultaneously on some individuals (n=28); and (2) birds were studied during the incubation and brooding periods from mid-November to mid-February. In the 2002–2003 breeding season (shown in Figure 4.6), both albatross species made excursions to the North Pacific transition zone (between 30–40°N). Foraging trips ranged from 10–32 days

Table 4.9. PTT tracking datasets included in the summary of breeding and non-breeding birds in the North Pacific.

Site	Colony	Breeding stage/ Status	Year(s)	No. of hours	No. of indivs	No. of tracks	Contributor(s)
Black-footed Albatross							
Hawaiian Islands	Tern Island	incubation	2002–2003	1,517	6	6	Scott Shaffer
		brood	2003	354	4	7	
		early breeding	2003	818	4	4	
Unknown		failed/migration	1997–1999	1,846	6	8	David Hyrenbach
			Total	**4,535**	**20**	**25**	
Laysan Albatross							
Hawaiian Islands	Tern Island	incubation	2002–2003	3,582	8	8	Scott Shaffer
		brood	2003	242	4	7	
		early breeding	2003	650	2	2	
Mexico	Isla de Guadalupe	early breeding	2003	3,792	20	20	
			Total	**8,266**	**34**	**37**	
Short-tailed Albatross							
Izu Shoto	Torishima	failed/migration	2002–2003	2,616	7	7	Rob Suryan
			Total	**2,616**	**7**	**7**	

Table 4.10. Gap analysis of breeding PTT tracking data for the North Pacific.

				PTT tracking data			
Species	Site	Annual no. breeding pairs	% regional population	No. of hours	No. of individuals	No. of tracks	% tracking data (in hours)
Black-footed Albatross	Hawaiian Islands	62,575	97%	2,689	14	17	100%
	Izu Shoto	914	1%				0%
	Ogasawara Gunto	1,103	2%				0%
	Senkaku Retto	25	0%				0%
Laysan Albatross	Hawaiian Islands	554,318	100%	4,474	14	17	54%
	Izu Shoto	1	0%				0%
	Mexico	350	0%	3,792	20	20	46%
	Ogasawara Gunto	30	0%				0%
Short-tailed Albatross	Hawaiian Islands	1	0%				
	Izu Shoto	220	95%				
	Senkaku Retto	11	5%				
Waved Albatross	Isla de la Plata	10	0%				
	Islas Galápagos	18,200	100%				

during the incubation stage to 1–3 days during the brooding stage. Given the time constraints of the brooding stage, most albatrosses remained close to their colony and below the transition zone. The TOPP research team also deployed satellite transmitters and light-based geolocation loggers on Laysan Albatrosses at Guadalupe Island, Baja California, Mexico. This is very small colony (~350 pairs), and was recently established (within last 50 years). Furthermore, almost nothing was known about the foraging ecology of birds from this island. In the 2002–2003 breeding season, 24 Laysan Albatrosses were studied during the incubation, brooding, and early rearing stages from late January to late March. The deployments were identical to those made on Tern Island in the same season. However, the data show that there is little overlap in the spatial distribution of the birds breeding at Guadalupe Island and in Hawaii. Albatrosses from Guadalupe Island remained primarily in the California Current region south of 45°N, with some birds venturing within 10 km of the coastline, though one bird travelled north to the Aleutian Islands (Henry unpubl.). Inter-annual differences (Tern Island only) and gender-based segregation have not yet been examined. In addition to determining the foraging movements of albatrosses at Tern and Guadalupe Islands, TOPP researchers also compared and validated the use of geolocation loggers (GLS) against conventional satellite telemetry by conducting dual deployments of the tags on each albatross.

Satellite tracking of Short-tailed Albatrosses (n=30 individuals) has occurred during May to November and in all cases the transmittered birds were not actively breeding or returning to a breeding colony. Most transmitters (n=26) were deployed on birds (sub-adult and adult) just prior to their post-breeding dispersal from the colony at Torishima, Japan. Another four individuals were captured at-sea in the Aleutian Islands, Alaska, during the non-breeding season. Upon leaving Torishima, all birds flew to the east coast of Japan into the Kuroshio Current region. From there, further migration seemed to follow two general patterns. Birds flew east, offshore of the continental shelf then directly north, arriving at the Aleutian Islands within two to four weeks. The second pattern was for albatrosses to remain in the Kuroshio and Oyashio Current regions off Japan and southern Kurile Islands, Russia, for nearly three months. However, in early September they travelled north and east along the Kurile Islands and southern Kamchatka Peninsula (Russia) and into the Aleutian Islands and Bering Sea. Once at the Aleutian Islands and Bering Sea, the birds usually began travelling east or north, often remaining over the continental shelf and slope and within passes between islands, but occasionally moving farther offshore. One Short-tailed Albatross was tracked to the California Current region of North America.

In addition to colony-based studies, Black-footed Albatrosses have been tracked during their post-breeding dispersal (July–September) off California. A pilot project during 1997–99 established the feasibility of tagging this species at-sea and provided valuable insights into the movements and habitats of post-breeding birds. In spite of the small sample size (1 male / 5 females), this study revealed that non-breeding birds range over large distances (100s–1,000s km) and inhabit the same oceanographic 'transition zones' where swordfish *Xiphias* spp. and albacore *Thunnus alalunga* are taken in the northeast Pacific Ocean (Hyrenbach and Dotson 2003). These preliminary results suggest that post-breeding albatrosses are particularly susceptible to U.S. and foreign pelagic longline fleets.

Scott Shaffer, Dan Costa, Rob Suryan, and David Hyrenbach

Figure 4.6. Regional summary of breeding and non-breeding albatrosses in the North Pacific.

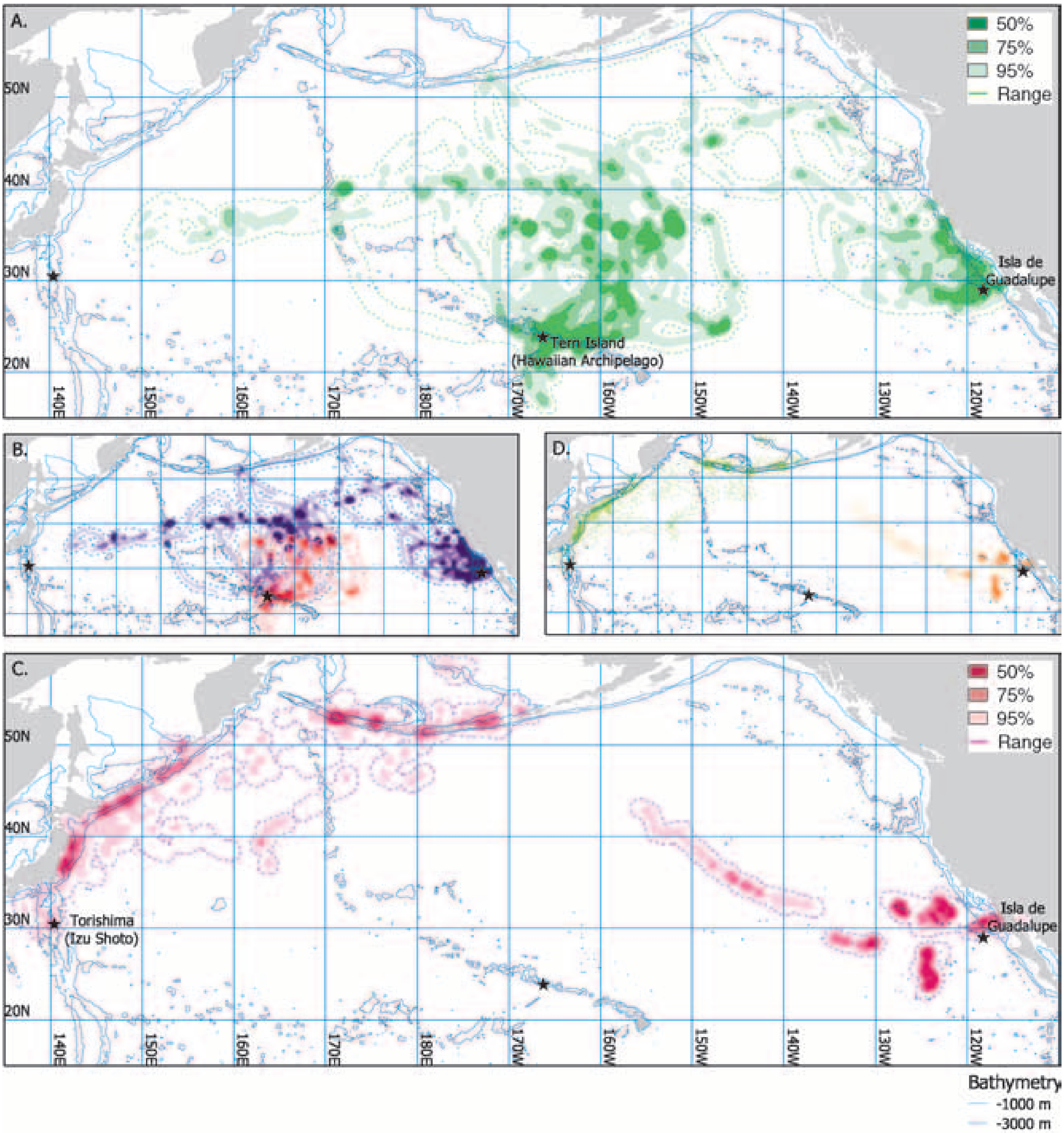
A. Combined breeding utilisation distribution map for two species of albatross tracked in the North Pacific. (See Table 4.9 for the list of breeding species and datasets included.) Colonies were given equal weight.

B. Shows the separate distributions of the two species, with Laysans in blue and Black-footed in red.

C. Combined non-breeding utilisation distribution map for two species of albatross tracked in the North Pacific. (See Table 4.9 for the list of non-breeding species and datasets included.)

D. Shows the separate distributions of the two species, with Short-tailed in green and Black-footed in orange.

For the combined maps species were given equal weights.



5 DISCUSSION

This section reports discussion on topics relating to the strategic aims of the workshop, that is: contribution to definition of critical marine habitats; links to data on fishing effort and fishery management responsibilities; and the potential establishment of the GIS database as an international conservation tool.

5.1 MARINE IMPORTANT BIRD AREAS (IBAS)

Existing global IBA criteria could be adapted and applied in the marine environment to identify IBAs for albatrosses and giant-petrels. Existing global IBA criteria of probable relevance to the marine environment are:

A1 Globally-threatened species
Criterion: The site regularly holds significant numbers of a globally threatened species or other species of global conservation concern.

A3 Biome-restricted assemblages
Criterion: The site is known or thought to hold a significant component of a group of species whose distributions are largely or wholly confined to one biome.

A4 Congregations
Criteria: Site known or thought to hold on a regular basis:
i. 1% of the global population of a congregatory seabird species
ii. ≥ 20,000 waterbirds or ≥ 10,000 pairs of seabird of one or more species
iii. to exceed thresholds for migratory species at bottleneck sites.

BirdLife's European Partnership had previously suggested four possible types of marine IBA:
1. Seaward extensions to breeding colonies, where the seaward boundary would, as far as possible, be species-specific based on average foraging range.
2. Non-breeding concentrations in shallow coastal waters—for divers, grebes, sea ducks etc.
3. Migration bottlenecks through or around which large numbers pass regularly, such as straits, headlands etc.
4. Open ocean sites for pelagic species.

Of these, 1–3 at least can be accommodated within the existing criteria without any difficulty.

At the workshop discussion of the first of these suggested that seaward extensions from breeding colonies of 200 nautical miles, the limit of EEZs, would protect the breeding populations of a significant number, perhaps two-thirds, of albatross species and also other, non-breeding but centre-place foraging birds, as well as those species which migrate to staging areas or wintering destinations within the EEZs of other countries when not breeding. Species for which this approach is unlikely to be adequate when breeding include those with long incubation stints, which forage beyond continental shelves and shelf breaks.

Inclusion of the whole EEZ of at least some countries, particularly the larger ones, as 'marine IBAs' is unrealistic and a narrower focus will be needed to identify core areas in which more stringent levels of protection would apply. Also, innovative management strategies, such as seeking to close or limit fisheries during periods when birds are present, in order to minimise interaction, should be investigated. Where data allow, the actual distribution of the birds should be used, rather than, say, an arbitrary circle drawn around an island.

It was agreed that future work was needed to assess for each species what proportion of time they spend within EEZs and to conduct sensitivity analyses to explore the consequences of using different radii around colonies. These analyses will also take into account the conservation status of the species concerned; the consequences will be explored of seeking to capture a greater proportion—say 80%—of the density grid within IBAs for species classified as Critical, as opposed to 50%, which might be the default for Vulnerable and Near Threatened species. This study also needs to take account of the fact that some species behave differently in different parts of their range.

It was recognised that open oceanic [type 4] sites, beyond EEZs, would need to be identified for concentrations of some species. The predictability and persistence of such areas is likely to vary from reasonably high to fairly low, depending, at least in part, upon the oceanographic feature(s)—bathymetry, gyres etc.—responsible for the concentration, but further work is needed to clarify this.

Data availability was recognised to be a limiting factor in being able to identify potential IBAs. This is particularly true for adults in their non-breeding phase and juveniles; identifying sites for these will be more difficult.

Overall, for albatrosses, IBAs are likely to be of three types:
1. Congregations of breeders around islands.
2. Congregations of breeders in oceanic areas.
3. Congregations of non-breeders.

It was suggested that there is little effective difference between the second and fourth type of marine IBA proposed by the European Partnership; they are merely two ends of a continuum. The underlying distinction between inshore and offshore waters may be of less importance outside the European sphere.

The existing global IBA category A4ii, designed to capture seabird breeding colonies, could readily be adapted for application to non-breeding concentrations, by simply using the 20,000 individuals threshold used for waterbirds.

The possibility of adapting IBA category A3 for biome-restricted assemblages to the marine environment was debated, using a map of oceanographic provinces as a point of departure. Although of limited use for albatrosses, it was felt that this approach might have application for smaller seabirds, at least some of which are confined to one or a limited number of such provinces. Advice was needed from relevant experts. It was pointed out that some species are more likely to be found along the boundaries of such provinces, rather than within the provinces themselves. Shipboard observations of seabirds at sea would be a particularly useful source of data for this analysis.

Overall, it was concluded that if marine IBAs could be identified for albatrosses, it ought to be possible to identify sites for other seabirds.

Since the workshop one significant development has been the commencement of a four-year project to identify marine IBAs for seabirds in Spain, to be executed by the Sociedad Española de Ornitología (SEO), the BirdLife Partner in Spain, in conjunction with Sociedade Portuguesa para o Estudo das Aves (SPEA), the BirdLife partner in Portugal, with funding from the European Union and the Spanish Ministry of the Environment. This project seeks to create maps of distribution at sea and use of space in the marine environment for those seabird species listed in Annex 1 of the European Union's Birds Directive with populations in Spain. The work will involve satellite tracking of Cory's Shearwater *Calonectris diomedea*, and Audouin's Gull *Larus audouinii*, radio tracking of Bulwer's Petrel *Bulweria bulwerii*, Little Shearwater *Puffinus assimilis,* Madeiran Storm-petrel *Oceanodroma castro* and European Shag *Phalacrocorax aristotelis desmarestii*, analysis and mapping of seabird ringing recoveries in Spain, surveys of coastal waters around gull and tern breeding colonies in the Ebro delta and Albufera de Valencia, collection and analysis of data from observers on board fishing vessels and of a database of beached seabirds. The oceanographic (physical and biotic as well as anthropic) factors influencing the distribution patterns of seabirds at sea are to be identified and mapped. These findings will then be integrated and used to develop further the criteria for the selection of marine IBAs.

Lincoln Fishpool

5.2 INTERACTIONS WITH FISHERIES AND FISHERY MANAGEMENT ORGANISATIONS

5.2.1 Relationships between distribution of albatrosses and petrels and fishing effort

Albatross and petrel bycatch

Many species of albatross and petrel are incidentally caught on the hooks of pelagic and demersal longline fishing vessels operating in both the Northern and Southern Hemispheres. Attracted to offal discharge or thousands of baited hooks, the birds can become hooked or entangled and drown. The expansion of commercial longline operations has been coincident with the recorded decline of several populations of seabird. Longline fishing has been implicated in this decline.

The major pelagic commercial distant-water longline fleets have traditionally been those of Japan, Taiwan and Korea. The distant-water vessels of Japan targeting tunas and billfish began expanding their range in the 1950s. During the 1960s longline effort spread southward from the tropical regions of the Pacific. This expansion was hastened by the development of vessels with deep freezers and the discovery of the rich southern bluefin tuna stock. The Taiwanese fleet moved into southern waters in the 1970s and is currently the largest and most extensive fleet operating in the Southern Ocean. More recently, effort from the local pelagic longline fleets of Australia, New Zealand, South Africa and South America has increased within their Exclusive Economic Zones. Japanese-style pelagic longline fisheries tend to set around 3,000 hooks per shot on main lines that may be 100 km or more in length. In southern waters they typically target albacore, swordfish and southern bluefin tuna to 45°S.

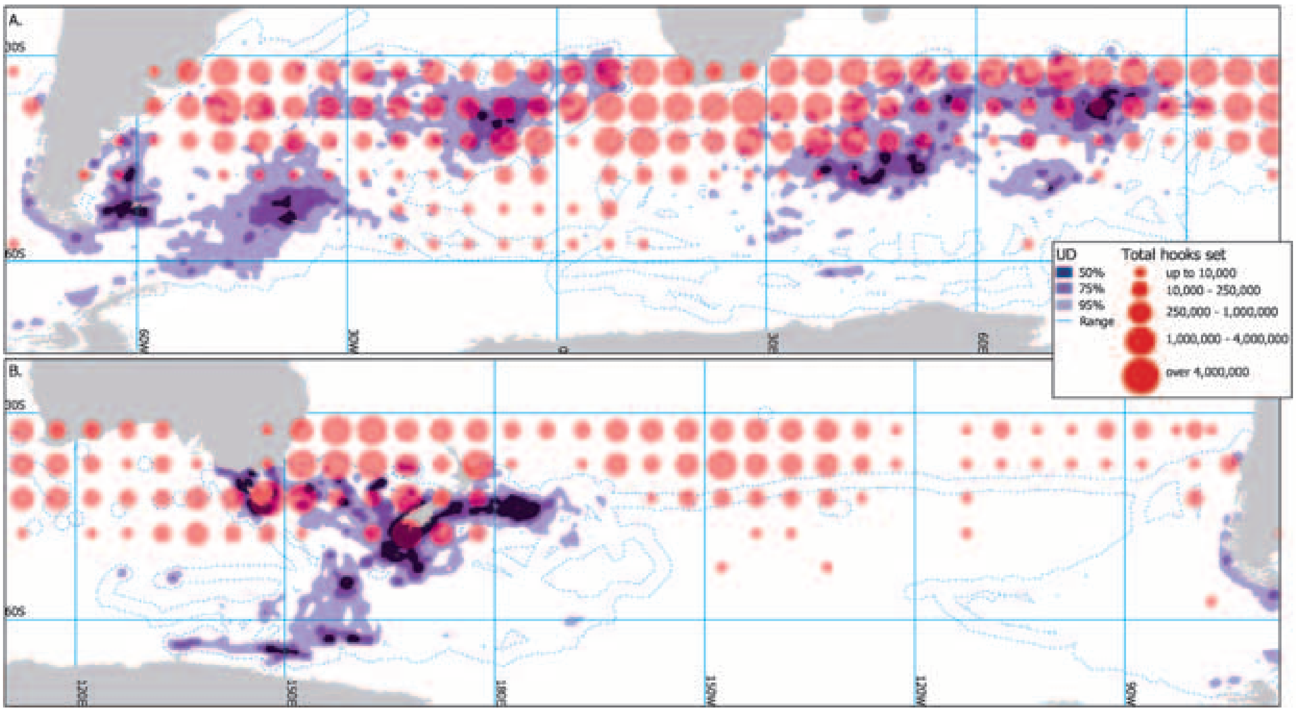
The demersal, or bottom-set, longline fleets of the Southern Ocean did not begin to expand until the 1980s. These vessels target species that include Patagonian toothfish, hake and ling. Demersal vessels can set more than one line in a day and a single set can have 20,000 hooks. As the target species are demersal, and not as dispersed as the tunas, the lines are generally shorter than a pelagic line (around 15 km). The main demersal longline nations operating in the Southern Ocean are Chile and Argentina (with large industrial and artisanal fleets), New Zealand and those operating under the jurisdiction of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). Pelagic longline vessels that target the mobile and dispersed tuna species on the high seas pose a serious threat due to the highly migratory nature of albatrosses and petrels. On the other hand, demersal longliners, which target more sedentary species on continental shelf or slope regions, place breeding birds and fledglings at risk.

In addition to those vessels regulated by Regional Fisheries Management Organisations (RFMOs), recent high prices and restrictive quotas for tunas and toothfish have led to the rapid expansion of Illegal Unregulated or Unreported (IUU) longline fishing. The substantial effort of these vessels and subsequent impact on target and incidentally caught species is difficult to quantify. However, as these vessels are unlikely to be employing bycatch mitigation measures at all, or at the same level as regulated vessels, the impact on seabirds may be substantial.

Figures 5.1 to 5.3 show the distribution of reported pelagic fishing effort for all nations combined averaged across years 1990 to 1998 south of 30°S, overlain with the utilisation distributions of breeding albatrosses. These data do not include any IUU data or scaled-up estimates of effort records that are not reported to RFMOs. The figures show strong concentrations of effort off southern Africa, the east and west coasts of Australia and New Zealand and off the coast of Uruguay. Not shown are demersal fisheries with concentrations off Chile, the Patagonian Shelf, New Zealand and many sub-Antarctic islands. It is important to note that these spatial distributions have changed since the beginning of the fisheries, and as shown in Figure 5.3, change over time and space even within a year. This has implications for assessing historical and current impacts on bird populations. Figures 5.8 to 5.13 show overlaps between estimated albatross and petrel foraging distributions and areas of jurisdiction for various RFMOs. These figures and Tables 5.3 to 5.5 clearly highlight the critical role that RFMOs have in the conservation of oceanic seabirds through appropriate management of their fisheries.

Clearly the overlap in spatial and temporal distributions between fishing effort and seabird foraging distributions is critical in terms of our ability to assess and mitigate interactions. Determining overlaps can assist the identification of hot spots of interaction, facilitate bycatch rate analyses and guide monitoring and mitigation policies. However, fisheries, and even individual vessels, will differ in their overall impact on seabirds. This is because they differ in their application of mitigation measures (e.g. bird scaring devices, line weighting) and operational procedures (e.g. time of set, season/area of fishing, offal discharge). In addition, seabirds vary in their desire and ability to attack and

Figure 5.1. Overlap between the reported annual fishing effort from pelagic longline fleets operating south of 30°S averaged across years 1990–1998 (by 5° grid square) and the combined utilisation distribution of 13 species of breeding albatrosses obtained from satellite tracking data. Effort data are only that reported to the IOTC, ICCAT, SPC, IATTC, CCSBT and domestic New Zealand, Australian and South African fishery agencies (from Tuck *et al.* 2003). Satellite tracking data are from 1989 to 2003. A. South Atlantic and Southwest Indian Ocean; B. South Pacific.
Regional Fisheries Bodies: Commission for the Conservation of Southern Bluefin Tuna (CCSBT); Indian Ocean Tuna Commission (IOTC); Inter-American Tropical Tuna Commission (IATTC); International Commission for the Conservation of Atlantic Tunas (ICCAT); Secretariat of the Pacific Community (SPC).



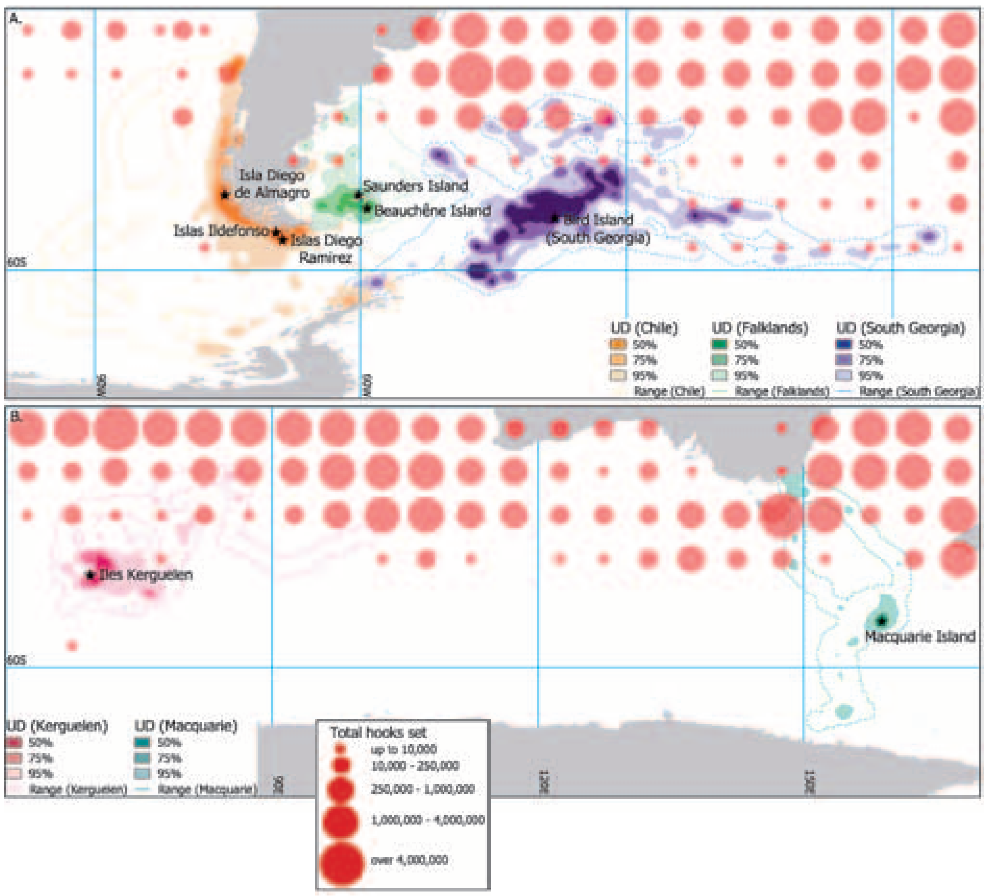
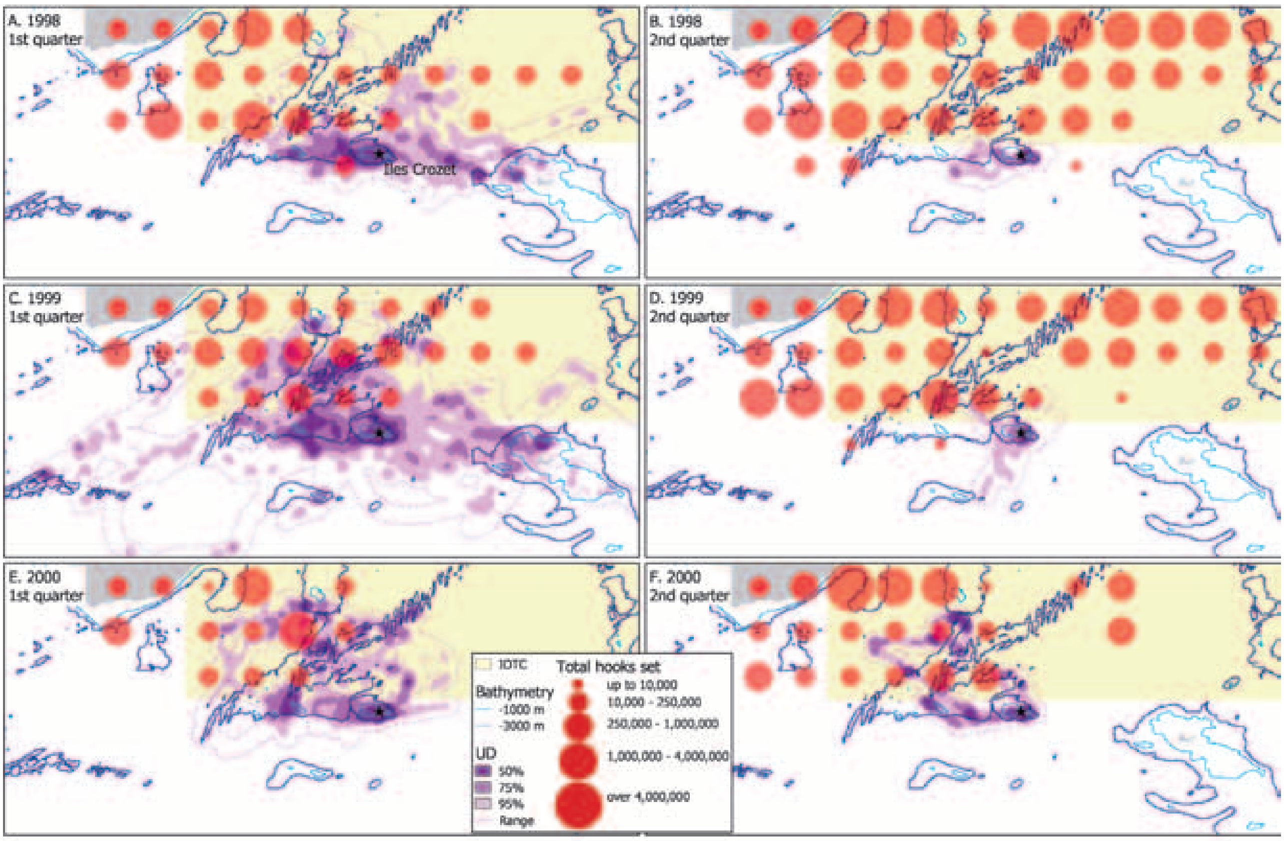


Figure 5.2. Overlap between the reported annual fishing effort from pelagic longline fleets operating south of 30°S averaged across years 1990–1998 (by 5° grid square) and the utilisation distributions of breeding Black-browed Albatrosses from 5 populations obtained from satellite tracking data. Effort data are only those reported to the IOTC, ICCAT, SPC, IATTC, CCSBT and domestic New Zealand, Australian and South African fishery agencies (from Tuck *et al.* 2003). Satellite tracking data are from 1992 to 2002. A. Chilean, Falkland Islands (Malvinas) and South Georgia populations; B. Kerguelen and Macquarie populations.
Regional Fisheries Bodies: Commission for the Conservation of Southern Bluefin Tuna (CCSBT); Indian Ocean Tuna Commission (IOTC); Inter-American Tropical Tuna Commission (IATTC); International Commission for the Conservation of Atlantic Tunas (ICCAT); Secretariat of the Pacific Community (SPC).

Figure 5.3. Overlap between the total quarterly Japanese, Korean and Taiwanese longline fishing effort reported to the Indian Ocean Tuna Commission (IOTC) (by 5° grid square) and the corresponding utilisation distributions of breeding Wandering Albatrosses tracked from Iles Crozet during the first and second quarters of 1998, 1999 and 2000. Together the above fishing fleets represent 98%, 92% and 90% of the total fishing effort reported to the IOTC during 1998, 1999 and 2000 respectively. (The first quarter is January to March (incubation) and the second is April to June (early chick-rearing).)



capture baited hooks. This all suggests that studies of the overlap of distributions, the continuation (or in many cases, the establishment) of reliable and transparent monitoring systems and the development and implementation of adequate mitigation regimes are vital.

Fishing data

There is a strong need to be able to access appropriate fishery data in order to carry out studies of interactions with seabird populations. These data need to be easily accessed, easily interpreted, well-maintained and as comprehensive as possible. However, a public database of fishing effort and related data will need to overcome several issues, not least of which is the potential commercial sensitivity of the data itself. Some of these data issues are listed below:

- *Access arrangements:* RFMOs vary in their willingness to provide data. However, most are willing to provide data to individuals or research organisations for relevant research purposes, as long as the RFMO can maintain some degree of control over use (who is using it, what for, what does the product look like). Obtaining data (specifically effort data) for general public use will require mutual agreement between the data provider and end user. In some circumstances, requests from users may need to go directly to data managers at RFMOs for consideration on a case-by-case basis.
- *Use:* There are many areas where users may unwittingly misuse the provided fishing data (e.g. using incomplete fishing effort data, assuming interactions where none exist). Appropriate caveats agreed by the data provider will need to be attached.
- *Delays in obtaining up-to-date data:* Wherever possible, data provided should be the most current available. Clear dates should be attached to the data.
- *Spatial and temporal scales:* Historical and current data should be provided, however in many cases the spatio-temporal scales will be determined by the data-provider. For example, in many cases shot-by-shot data would be ideal for analyses, however fishery agencies may legally only be able to provide data on a much broader scale (e.g. spatial resolution by Fishery Management Area and an annual temporal resolution).
- *Gaps:* There are many fisheries for which we have limited or no knowledge of effort (magnitude, where, when) or bycatch. The best available data should be provided in these cases, with appropriate literature references and contacts.

In addition to fishing effort data, operational and management procedures should be made available within the database (or website). Such information should include any RFMO conservation measure requirements (e.g. mandatory night setting, use of tori lines), notes on observer programs and monitoring, bycatch information (if it exists), and key contacts within the RFMO.

Geoff Tuck

5.2.2 Relationships between distribution of albatrosses and petrels and the Statistical Areas of the Food and Agriculture Organisation of the United Nations (FAO)

Much fisheries information, including catch and effort data for many fisheries which have potential for bycatch of albatrosses and petrels, is still provided only at the scale of FAO Statistical Areas (Figure 5.4) and subdivisions of these. While any analysis and comparison with seabird data at these scales is likely to be too coarse to be of much use in management contexts, nevertheless it may represent the lowest common denominator for some data compilations and comparisons, at least for the time being.

To indicate the scale and nature of potential comparisons with albatross and petrel range data, we provide simple depictions, using breeding phase data only (Figure 5.5), tabulated in Table 5.1 and summarised on a species-specific basis in Figure 5.6.

The basic comparisons by area (Figure 5.5, Table 5.1) emphasise the importance of five main regions: (a) north Pacific (FAO areas 77, 67 and 61 in order of priority); (b)

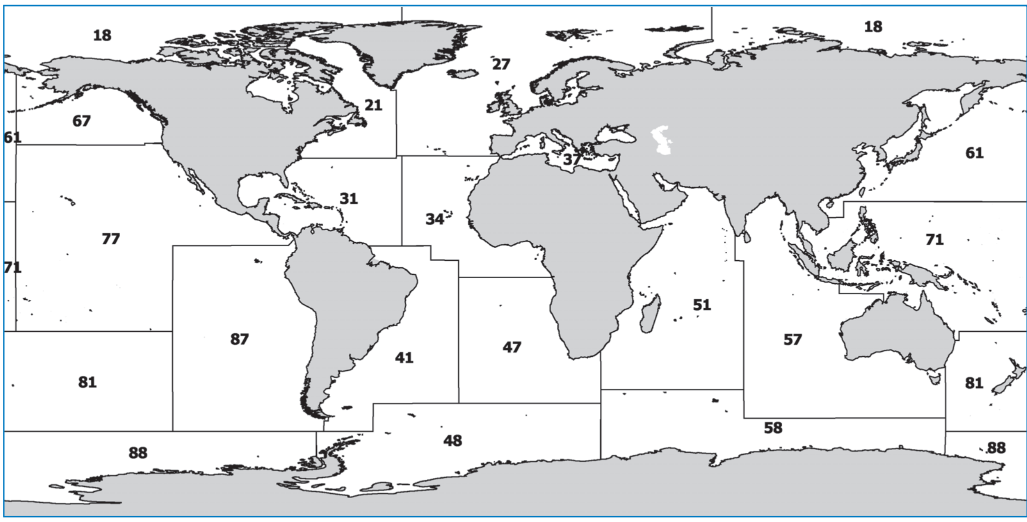


Figure 5.4. Map of the Food and Agriculture Organisation of the United Nation's (FAO) Statistical Areas.

Figure 5.5. Global utilisation distributions (UD's) of breeding albatrosses in relation to the FAO Statistical Areas. A UD provides a probability contour indicating the relative amount of time birds spend in a particular area i.e. they will spend 50% of their time within the 50% UD. The dotted line represents the entire range, or 100% UD. This composite was created by calculating the utilisation distributions for each species and combining them giving each species equal weighting. UD's for each species were derived from density distribution maps obtained by satellite tracking of breeding birds of the following 16 species from these locations: Amsterdam Albatross (Amsterdam Island), Antipodean (Gibson's) Albatross (Auckland Islands), Black-browed Albatross (Isla Diego de Almagro, Islas Ildefonso, Islas Diego Ramirez, Falkland Islands (Malvinas), South Georgia and Iles Kerguelen), Black-footed Albatross (Tern Island), Buller's Albatross (Solander Island and Snares Islands), Chatham Albatross (Chatham Islands), Grey-headed Albatross (Islas Ildefonso, Islas Diego Ramirez, South Georgia, Marion Island, Campbell Island and Macquarie Island), Light-mantled Albatross (Macquarie Island), Laysan Albatross (Tern Island and Isla de Guadalupe), Northern Royal Albatross (Chatham Islands and Taiaroa Head), Southern Royal Albatross (Campbell Island), Shy Albatross (Albatross Island, Mewstone and Pedra Branca), Sooty Albatross (Iles Crozet), Tristan Albatross (Gough Island), Wandering Albatross (South Georgia, Marion Island, Iles Crozet and Iles Kerguelen) and Indian Yellow-nosed Albatross (Amsterdam Island).

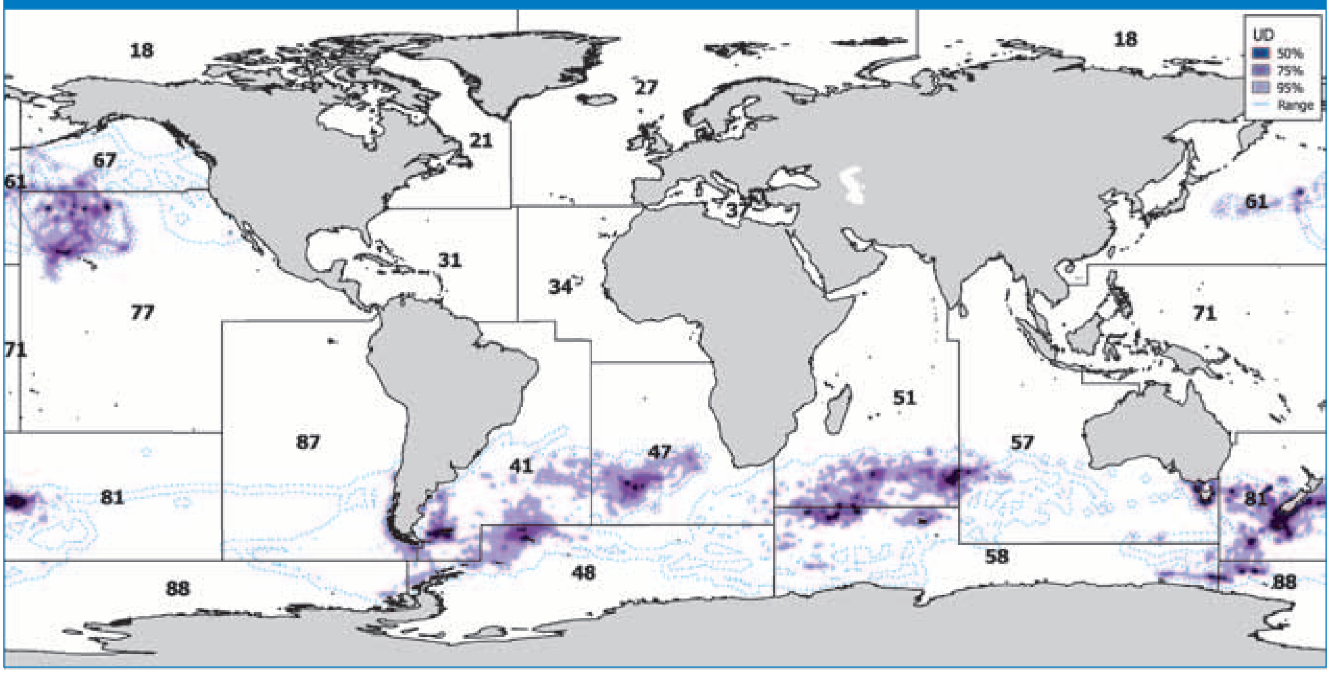


Figure 5.6. Percentage time at sea spent in different FAO Statistical Areas while breeding for 11 species of albatross. Only those species for which a large proportion (over 70%) of the global population is represented by satellite tracking data are shown.

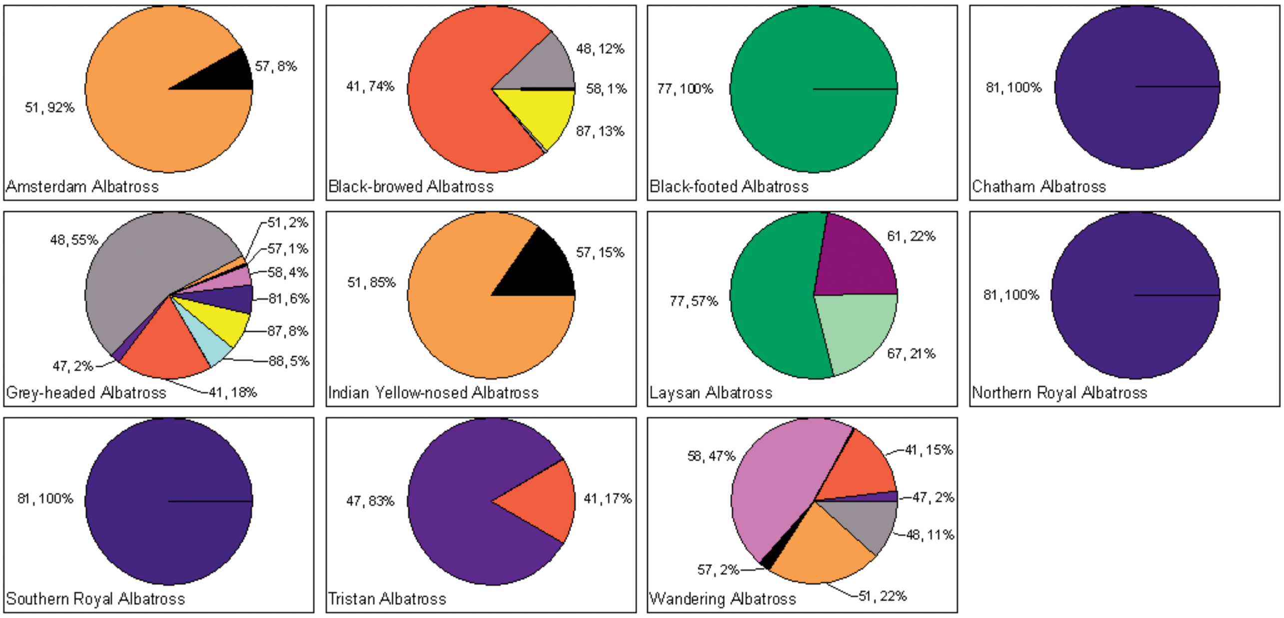


Table 5.1. Percentage time at sea spent in selected FAO Statistical Areas while breeding for 16 species of albatross, two species of giant-petrel and one petrel species for which satellite tracking data were submitted to the workshop.

Species	Threat status[1]	% global popn tracked[2]	Sites tracked[3]	FAO Area 41	47	48	51	57	58	61	67	77	81	87	88
Albatrosses															
Amsterdam	CE	100	all > 1%				92	8							
Antipodean	V	59	–										100		
Black-browed	E	100	all > 1%	74		12			1					13	
Black-footed	E	97	all > 5%									100			
Buller's	V	42	–					3					96	1	
Chatham	CE	100	all > 1%										100		
Grey-headed	V	87	–	18	2	55	2	1	4				6	8	5
Indian Yellow-nosed	E	70	–				85	15							
Laysan	V	100	all > 1%							22	21	57			
Light-mantled	NT	9	–						14				56		30
Northern Royal	E	100	all > 1%										100		
Shy	NT	15	–					100							
Sooty	E	17	–			1	35	1	62				1		
Southern Royal	V	99	all > 1%										100		
Tristan	E	100	all > 1%	17	83										
Wandering	V	100	all > 1%	15	2	11	22	2	47						
Giant-petrels and Petrels															
Northern Giant-petrel	NT	38	–	34		63								3	
Southern Giant-petrel	V	20	–	32		68									
White-chinned Petrel	V	?	?	34		63	1		2						

[1] NT: Neat Threatened, V: Vulnerable, E: Endangered, CE: Critically Endangered (BirdLife International 2004a)
[2] The percentage of the global population tracked was calculated by summing the proportion of the global annual number of breeding pairs at each site for which tracking data was contributed.
[3] Indicates whether tracking data was submitted for all sites containing over 1% or 5% of the global annual number of breeding pairs.

Table 5.2. Comparison of the importance of FAO Areas to the breeding albatrosses for which satellite tracking data was submitted to the workshop.

FAO Area	41	47	48	51	57	58	61	67	77	81	87	88
No. of albatross species tracked within FAO Area during breeding (out of 16 total)	4	3	4	6	9	7	1	2	2	10	4	4
% time spent in RFMO by tracked breeding birds:												
– species given equal weight	8	6	5	15	7	8	1	1	10	35	1	2
– species weighted by threat status	8	7	4	20	4	8	1	1	11	34	1	1
Rank of importance of FAO Area to satellite tracked breeding albatrosses, taking the number of species and time spent in the FAO Area into account	5	7	8	2	6	4	10	11	3	1	12	9
No. of albatross species caught in long-line fisheries within FAO Area (out of 21 total)[1]	8	7	7	7	17	8	3	3	4	15	10	4
No. of albatross species caught in trawl fisheries within FAO Area (out of 21 total)[1]	3	6	2	0	8	2	0	2	0	10	0	1

[1] From Robertson, C. *et al.* 2003a.

the cold temperate South Atlantic (areas 41 and 47); (c) central Indian Ocean (area 51); (d) Australasia – west Pacific (areas 57 and 81); and (e) Antarctica (areas 48, 58 and 88).

At a species level, Figure 5.6 indicates the potential difference between species with existing tracked breeding ranges essentially confined to single FAO areas (e.g. Black-footed Albatross in area 77, Chatham, Northern Royal and Southern Royal Albatrosses in area 81) and those whose breeding ranges overlap with many FAO areas (e.g. Grey-headed and Wandering Albatrosses).

All of these data emphasise, in terms of trying to compare seabird and fisheries data, the artificiality of the FAO boundaries, at least as far as pelagic seabirds are concerned. For most purposes, therefore, comparisons at finer scales will be essential and are likely, in terms of influencing management, to be targeted more effectively in relation to the areas of jurisdiction of regional fishery bodies.

John Croxall and Frances Taylor

5.2.3 Relationships between distribution of albatrosses and petrels and areas of jurisdiction of Regional Fisheries Management Organisations (RFMOs)

Duty of RFMOs

In the 1990s, developments in the international legal framework governing the oceans established the duty of States to cooperate within Regional Fisheries Management Organisations (RFMOs), recognising that many marine species are highly mobile and can only be conserved through collaboration between States (FAO 1995, Lugten 1999, United Nations 1995). Of particular relevance to the conservation of albatrosses, the new legal framework also established the duty of RFMOs to conserve not only target fish stocks, but also all non-target species affected by fishing (Small in review).

Overlap between RFMO areas and albatross distribution

Of the 18 RFMOs in existence (FAO 2004), the areas of twelve coincide with the known distributions of albatrosses. In addition, the Galapagos Agreement, not yet in force, plans to establish a new RFMO in the Southeast Pacific, and the Permanent Commission for the South Pacific (CPPS) (an advisory body) is acting as Secretariat in the interim period. The areas of these 13 RFMOs are illustrated in Figure 5.7. Overlap with the global distribution of breeding albatrosses is shown in Figure 5.8 (all species with equal weights) and Figure 5.9 (species weighted by threat status), and overlap with respect to regions is shown in Figure 5.10. Table 5.3 summarises the distribution of breeding albatrosses in relation to RFMO areas.

The results indicate that breeding albatrosses spend most time in the areas managed by (1) Commission for the Conservation of Southern Bluefin Tuna (CCSBT), (2) Western and Central Pacific Fisheries Commission (WCPFC), (3) Indian Ocean Tuna Commission (IOTC), (4) International Commission for the Conservation of Atlantic Tunas (ICCAT) and (5) Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) (Table 5.4). All five of these RFMOs have longline fisheries operating within their areas, and each is also particularly important for individual albatross species (Figure 5.11).

CCSBT was the highest ranked RFMO in terms of % albatross time, with an area that coincides with the ranges of 14 of the 16 albatross species for which breeding data were available. This includes approximately 70% of the total distribution of breeding albatrosses, almost 100% of the breeding ranges of both Critically Endangered albatross species

Table 5.3. Percentage time at sea spent in selected RFMOs while breeding for 16 species of albatross, two species of giant-petrel and one petrel species for which satellite tracking data was submitted to the workshop. (Note: the percentages do not total to 100% as several RFMO boundaries overlap.)

Species	Threat status[1]	% global popn tracked[2]	Sites tracked[3]	RFMO[4] CCAMLR	CCSBT	CPPS	IATTC	IATTC new	ICCAT	IOTC	IPHC	WCPFC	CEPTFA	NPAFC	PSC	SEAFO	SWIOFC
Albatrosses																	
Amsterdam	CE	100	all > 1%		100					100							93
Antipodean	V	59	–		98							98					
Black-browed	E	100	all > 1%	12	16	12	1	3	79								
Black-footed	E	97	all > 5%				6	6				94		37			
Buller's	V	42	–		90	1		1		3		87					
Chatham	CE	100	all > 1%		99							99					
Grey-headed	V	87	–	67	24	8		1	64	2		6				2	2
Indian Yellow-nosed	E	70	–		100					100							86
Laysan	V	100	all > 1%				1	2			27	98	1	73			
Light-mantled	NT	9	–	44	1							55					
Northern Royal	E	100	all > 1%		98							98					
Shy	NT	15	–		83					83		1					
Sooty	E	17	–	68	88					31		1					31
Southern Royal	V	99	all > 1%		96							99					
Tristan	E	100	all > 1%		99				100							83	
Wandering	V	100	all > 1%	61	84				26	22						2	20
Giant-petrels and Petrels																	
Northern Giant-petrel	NT	38	–	60	20	3			92								
Southern Giant-petrel	V	20	–	64	20				84								
White-chinned Petrel	V	?	?	65	28				93	1							1

[1] –: not threatened, NT: Neat Threatened, V: Vulnerable, E: Endangered, CE: Critically Endangered (BirdLife International 2004a)
[2] The percentage of the global population tracked was calculated by summing the proportion of the global annual number of breeding pairs at each site for which tracking data was contributed.
[3] Indicates whether tracking data was submitted for all sites containing over 1% or 5% of the global annual number of breeding pairs.
[4] CCAMLR – Commission for the Conservation of Antarctic Marine Living Resources, CEPTFA – Council of the Eastern Pacific Tuna Fishing Agreement, CCSBT – Commission for the Conservation of Southern Bluefin Tuna, CPPS – Permanent Commission for the South Pacific: area proposed under the Galapagos Agreement, IATTC – Inter-American Tropical Tuna Commission, IATTC new – Area that will be managed by IATTC if the Antigua Agreement comes into force, ICCAT – International Commission for the Conservation of Atlantic Tuna, IOTC – Indian Ocean Tuna Commission, IPHC – International Pacific Halibut Commission, NPAFC – North Pacific Anadromous Fish Commission, PSC – Pacific Salmon Commission, SEAFO – South East Atlantic Fisheries Organisation, SWIOFC – South West Indian Ocean Fisheries Commission, WCPFC – Western and Central Pacific Fisheries Convention.

Figure 5.7. Areas of jurisdiction of selected RFMOs. CCAMLR – Commission for the Conservation of Antarctic Marine Living Resources, CEPTFA – Council of the Eastern Pacific Tuna Fishing Agreement, CCSBT – Commission for the Conservation of Southern Bluefin Tuna, CPPS – Permanent Commission for the South Pacific: area proposed under the Galapagos Agreement, IATTC – Inter-American Tropical Tuna Commission, ICCAT – International Commission for the Conservation of Atlantic Tuna, IOTC – Indian Ocean Tuna Commission, IPHC – International Pacific Halibut Commission, NPAFC – North Pacific Anadromous Fish Commission, PSC – Pacific Salmon Commission, SEAFO – South East Atlantic Fisheries Organisation, SWIOFC – South West Indian Ocean Fisheries Commission, WCPFC – Western and Central Pacific Fisheries Convention.

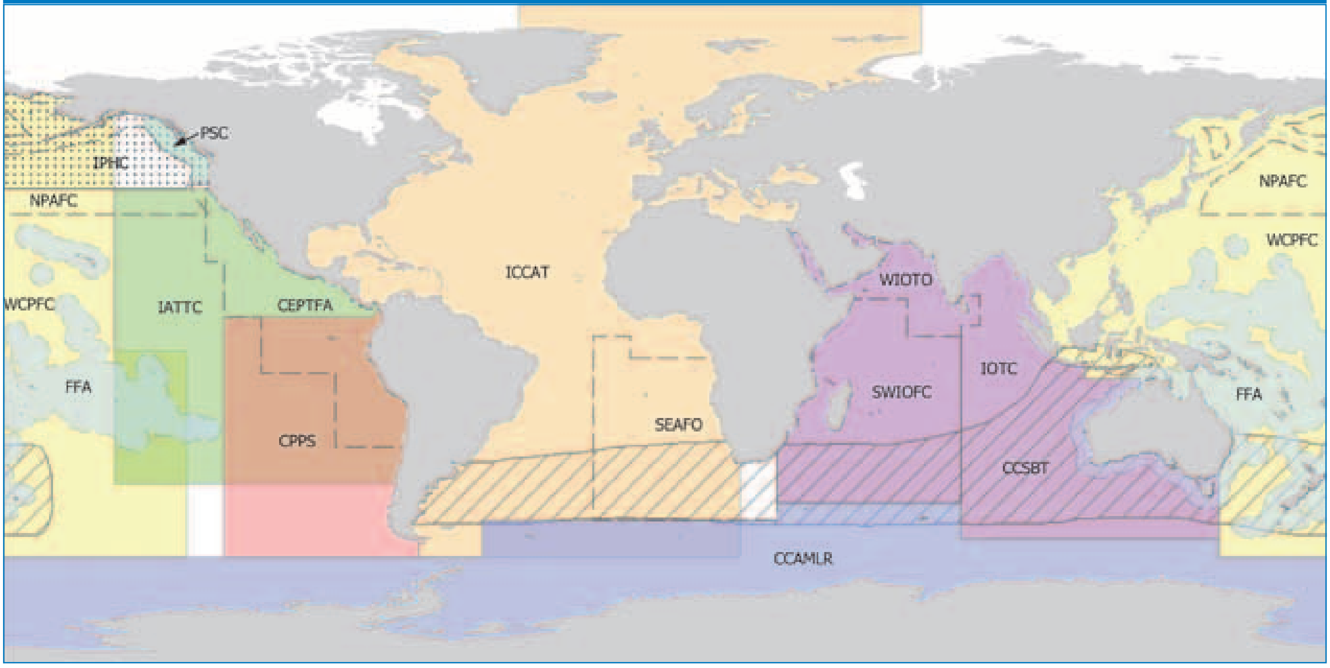


Figure 5.8. Global utilisation distributions (UDs) of breeding albatrosses in relation to the areas of competence of selected RFMOs. A UD provides a probability contour indicating the relative amount of time birds spend in a particular area i.e. they will spend 50% of their time within the 50% UD. The dotted line represents the entire range, or 100% UD. This composite was created by calculating the utilisation distributions for each species and combining them giving each species equal weighting. UD's for each species were derived from density distribution maps obtained by satellite tracking of breeding birds of the following 16 species from these locations: Amsterdam Albatross (Amsterdam Island), Antipodean (Gibson's) Albatross (Auckland Islands), Black-browed Albatross (Isla Diego de Almagro, Islas Ildefonso, Islas Diego Ramirez, Falkland Islands (Malvinas), South Georgia and Iles Kerguelen), Black-footed Albatross (Tern Island), Buller's Albatross (Solander Island and Snares Islands), Chatham Albatross (Chatham Islands), Grey-headed Albatross (Islas Ildefonso, Islas Diego Ramirez, South Georgia, Marion Island, Campbell Island and Macquarie Island), Light-mantled Albatross (Macquarie Island), Laysan Albatross (Tern Island and Isla de Guadalupe), Northern Royal Albatross (Chatham Islands and Taiaroa Head), Southern Royal Albatross (Campbell Island), Shy Albatross (Albatross Island, Mewstone and Pedra Branca), Sooty Albatross (Iles Crozet), Tristan Albatross (Gough Island), Wandering Albatross (South Georgia, Marion Island, Iles Crozet and Iles Kerguelen) and Indian Yellow-nosed Albatross (Amsterdam Island). For explanation of RFMO acronyms see Fig. 5.7.

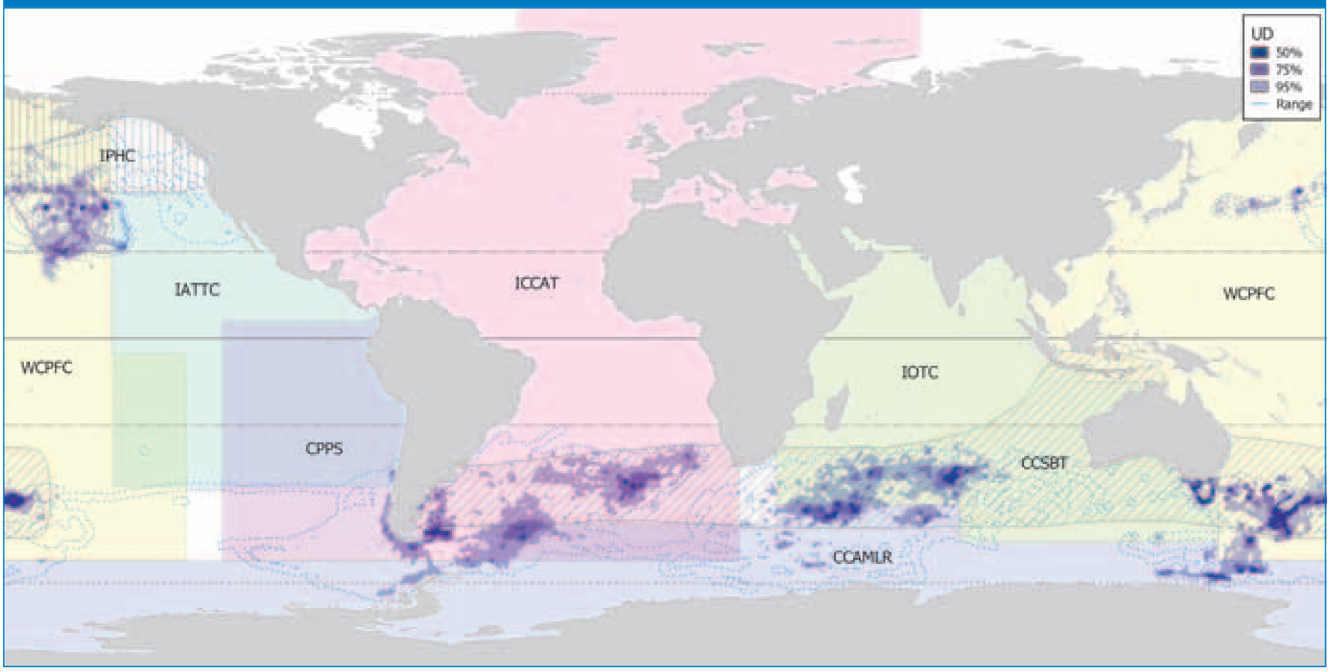


Figure 5.9. Global utilisation distributions (UD's) of breeding albatrosses weighted by threat status, in relation to the areas of competence of selected RFMOs. A UD provides a probability contour indicating the relative amount of time birds spend in a particular area i.e. they will spend 50% of their time within the 50% UD. The dotted line represents the entire range, or 100% UD. This composite was created by calculating the utilisation distributions for each species and combining them by weighting each species according to its IUCN threat status. The weights used were: NT (Neat Threatened) = 1; V (Vulnerable) = 2; E (Endangered) = 3; CE (Critically Endangered) = 4. The threat status of each species is given below. UD's for each species were derived from density distribution maps obtained by satellite tracking of breeding birds of the following 16 species from these locations: Amsterdam Albatross: CE (Amsterdam Island), Antipodean (Gibson's) Albatross: V (Auckland Islands), Black-browed Albatross: E (Isla Diego de Almagro, Islas Ildefonso, Islas Diego Ramirez, Falkland Islands (Malvinas), South Georgia and Iles Kerguelen), Black-footed Albatross: E (Tern Island), Buller's Albatross: V (Solander Island and Snares Islands), Chatham Albatross: CE (Chatham Islands), Grey-headed Albatross: V (Islas Ildefonso, Islas Diego Ramirez, South Georgia, Marion Island, Campbell Island and Macquarie Island), Light-mantled Albatross: NT (Macquarie Island), Laysan Albatross: V (Tern Island and Isla de Guadalupe), Northern Royal Albatross: E (Chatham Islands and Taiaroa Head), Southern Royal Albatross: V (Campbell Island), Shy Albatross: NT (Albatross Island, Mewstone and Pedra Branca), Sooty Albatross: E (Iles Crozet), Tristan Albatross: E (Gough Island), Wandering Albatross: V (South Georgia, Marion Island, Iles Crozet and Iles Kerguelen) and Indian Yellow-nosed Albatross: E (Amsterdam Island). For explanation of RFMO acronyms see Fig. 5.7.

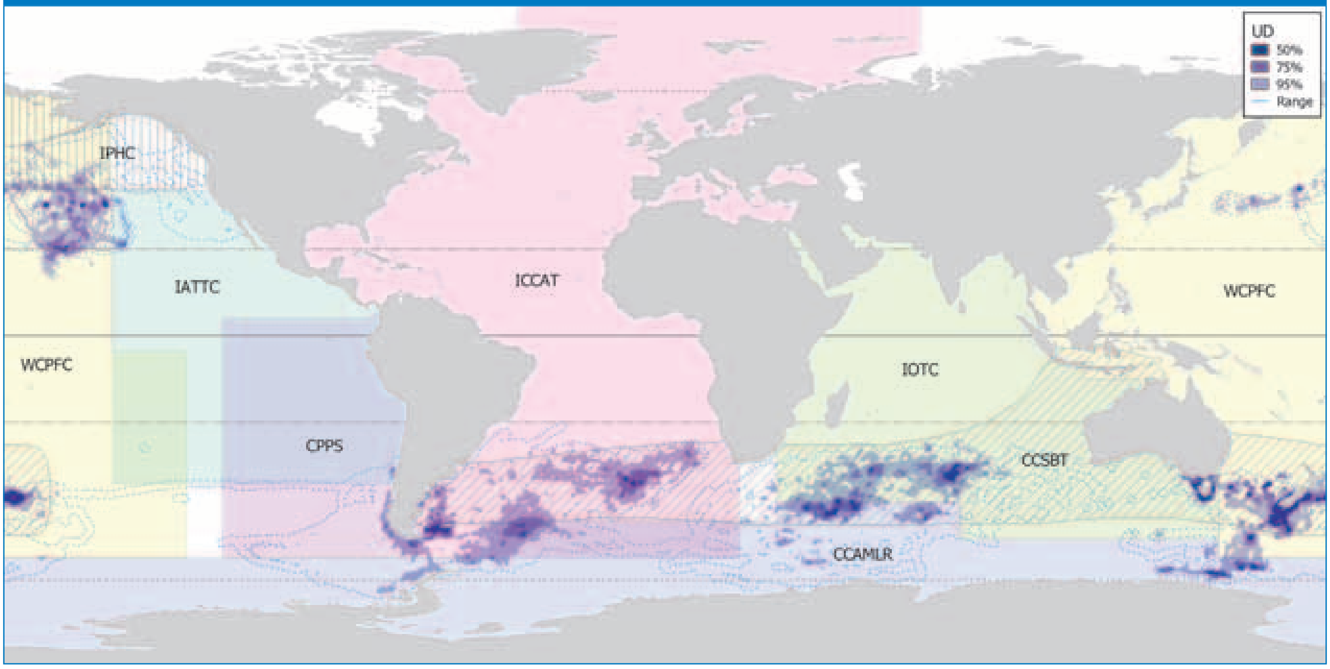


Table 5.4. Comparison of the importance of selected RFMOs to the breeding albatrosses for which satellite tracking data was submitted to the workshop. For explanation of RFMO acronyms see Table 5.3.

	CCAMLR	CCSBT	CPPS	IATTC	IATTC new	ICCAT	IOTC	IPHC	WCPFC	CEPTFA	NPAFC	PSC	SEAFO	SWIOFC
RFMO Area (millions of km^2)	83	73	37	62	75	137	69	14	129	18	20	1.6	23	27
No. of albatross species tracked within RFMO during breeding (out of 16 total)	8	14	4	5	7	4	9	2	12	1	2	1	4	6
% time spent in RFMO by tracked breeding birds:														
– species given equal weight	16	67	1	1	1	17	21	2	46	0	7	0	5	14
– species weighted by threat status	14	72	1	1	1	18	23	1	45	0	6	0	6	19
Rank of importance of RFMO to satellite tracked breeding albatrosses, taking the number of species and time spent in the RFMO into account	5	1	10	12	11	4	3	9	2	13	7	14	8	6

and 90% or more of the ranges of at least 4 of the 6 Endangered albatross species for which tracking data are available.

The WCPFC was the second highest RFMO in terms of albatross distribution, containing more than 45% of breeding albatross time. Highest concentrations of albatross distribution occur offshore from southeast Australia, and around New Zealand (Figure 5.12), and the WCPFC area includes 79% of the breeding distribution of New Zealand and Australian albatrosses (Table 5.5). Non-breeding data are also available for this region, and indicate that some of the WCPFC's breeding albatrosses migrate into areas managed by IOTC and the Inter-American Tropical Tunas Commission (IATTC) during non-breeding (Figure 5.13).

The WCPFC area is also highly important for the three species of albatrosses breeding in the northern hemisphere (Figure 5.10), including almost 100% of the breeding ranges of the Laysan and Black-footed Albatrosses in the North Pacific. (No breeding distribution data were available for the Short-tailed Albatross, but distribution is likely to be highly, if not entirely, concentrated within the WCPFC area.)

IOTC, ICCAT, and CCAMLR follow in terms of proportion of albatross distribution, each including 16–21 % of albatross distribution, and each being particularly important for specific albatross species: the southern part of the Indian Ocean, managed by IOTC, is crucial for the Critically Endangered Amsterdam Albatross and the

Endangered Indian Yellow-nosed Albatross, while the South Atlantic, managed by ICCAT, is crucial for the Endangered Tristan, Black-browed, and Atlantic Yellow-nosed Albatrosses. CCAMLR's area is particularly important for Wandering and Grey-headed Albatrosses.

The East Pacific Ocean, managed by IATTC and the RFMO established by the Galapagos Agreement, once it comes into force (the Secretariat is being managed by the Permanent Commssion of the South Pacific (CPPS) in the interim period), contains a low proportion of the breeding

Figure 5.10. Regional maps of global utilisation distributions (UD's) of breeding albatrosses in relation to the areas of competence of selected RFMOs. Important breeding sites for albatrosses in each region are shown. A. North Pacific; B. Australasia; C. Southern Atlantic and Indian Oceans. These composites were created by calculating the utilisation distributions for each species and combining them with equal weighting of each species. For explanation of RFMO acronyms see Fig. 5.7.

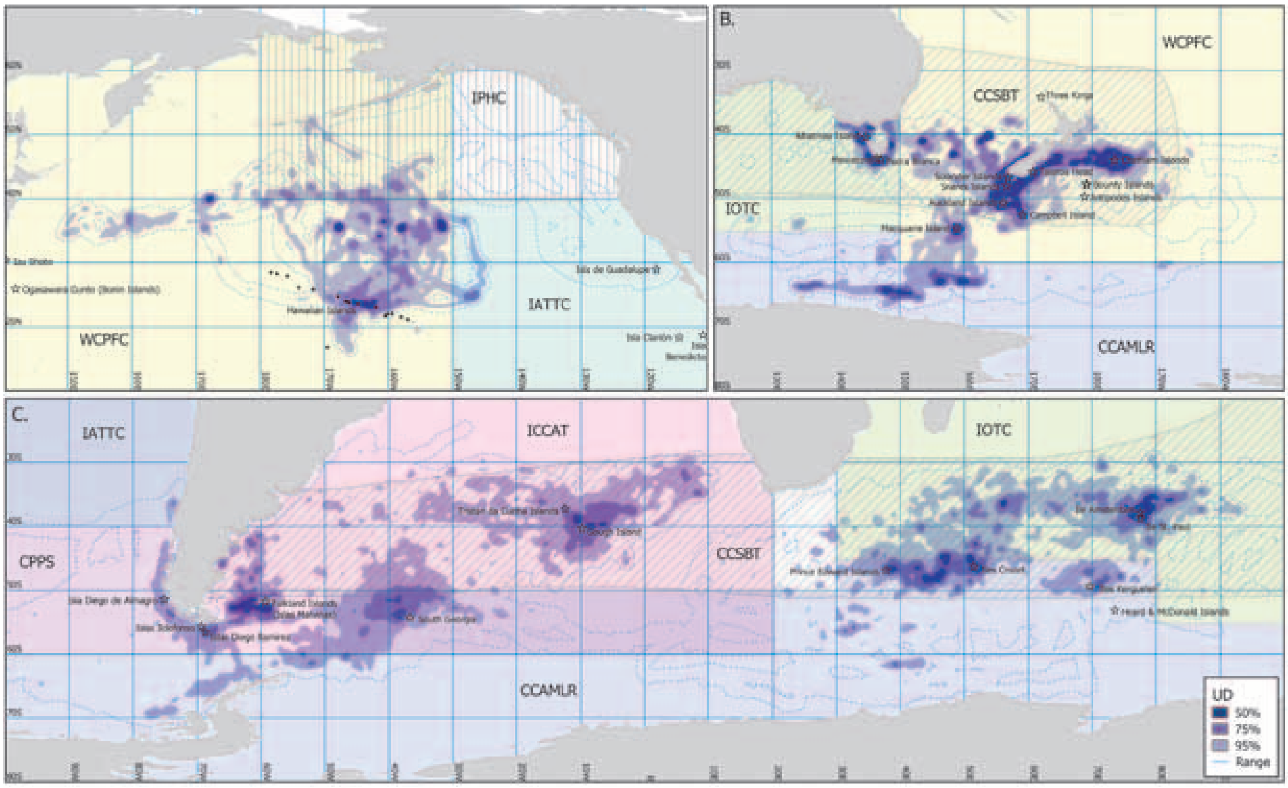


Figure 5.11. Percentage time at sea spent in selected RFMOs while breeding for 11 species of albatross. Only those species for which a large proportion (over 70%) of the global population is represented by satellite tracking data are shown. (Note: the percentages do not total to 100% as several RFMO boundaries overlap.) For explanation of RFMO acronyms see Fig. 5.7.

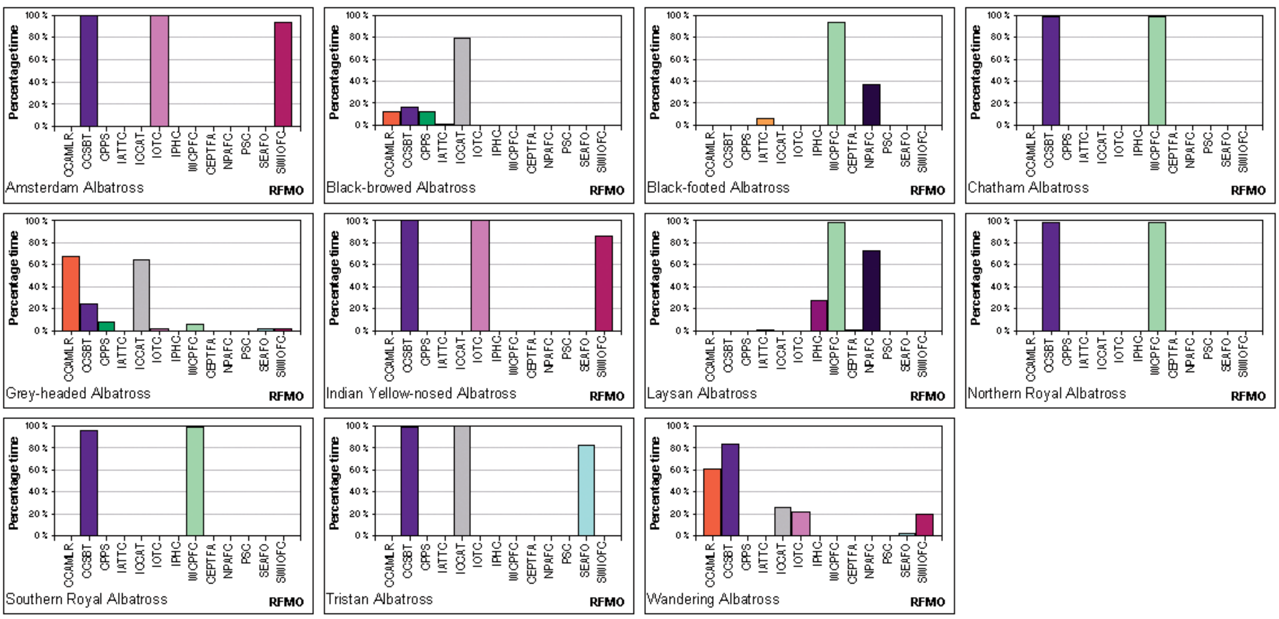
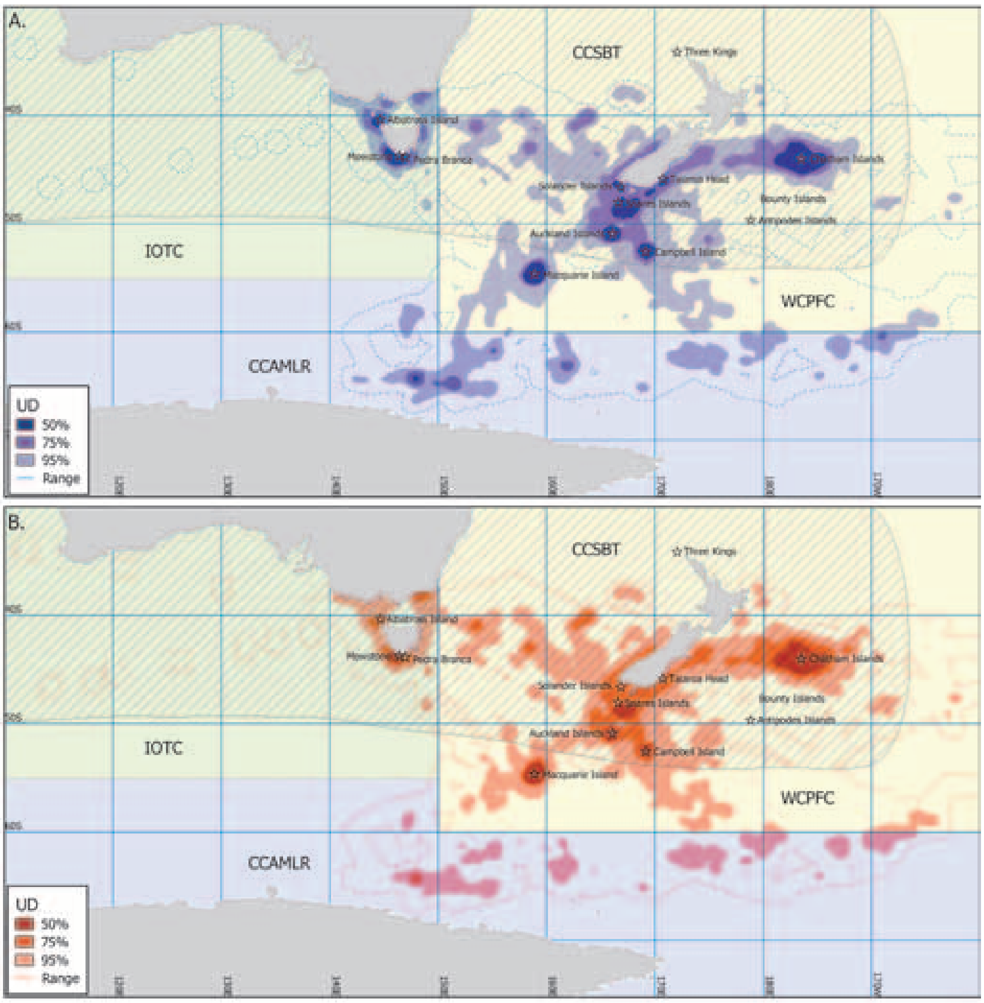


Figure 5.12. Global utilisation distributions (UD's) of breeding albatrosses from New Zealand and Australia in relation to the areas of competence of selected RFMOs. For explanation of RFMO acronyms see Fig. 5.7. A UD provides a probability contour indicating the relative amount of time birds spend in a particular area i.e. they will spend 50% of their time within the 50% UD. The dotted line represents the entire range, or 100% UD. Important breeding sites for albatrosses in the region are shown. The composite in A. was created by calculating the utilisation distributions for each species and combining them with equal weighting of each species. The composite in B. was created by calculating the utilisation distributions for each species and combining them by weighting according to IUCN threat status. The weights used were: NT (Neat Threatened) = 1; V (Vulnerable) = 2; E (Endangered) = 3; CE (Critically Endangered) = 4. The threat status of each species is given after the species name below.

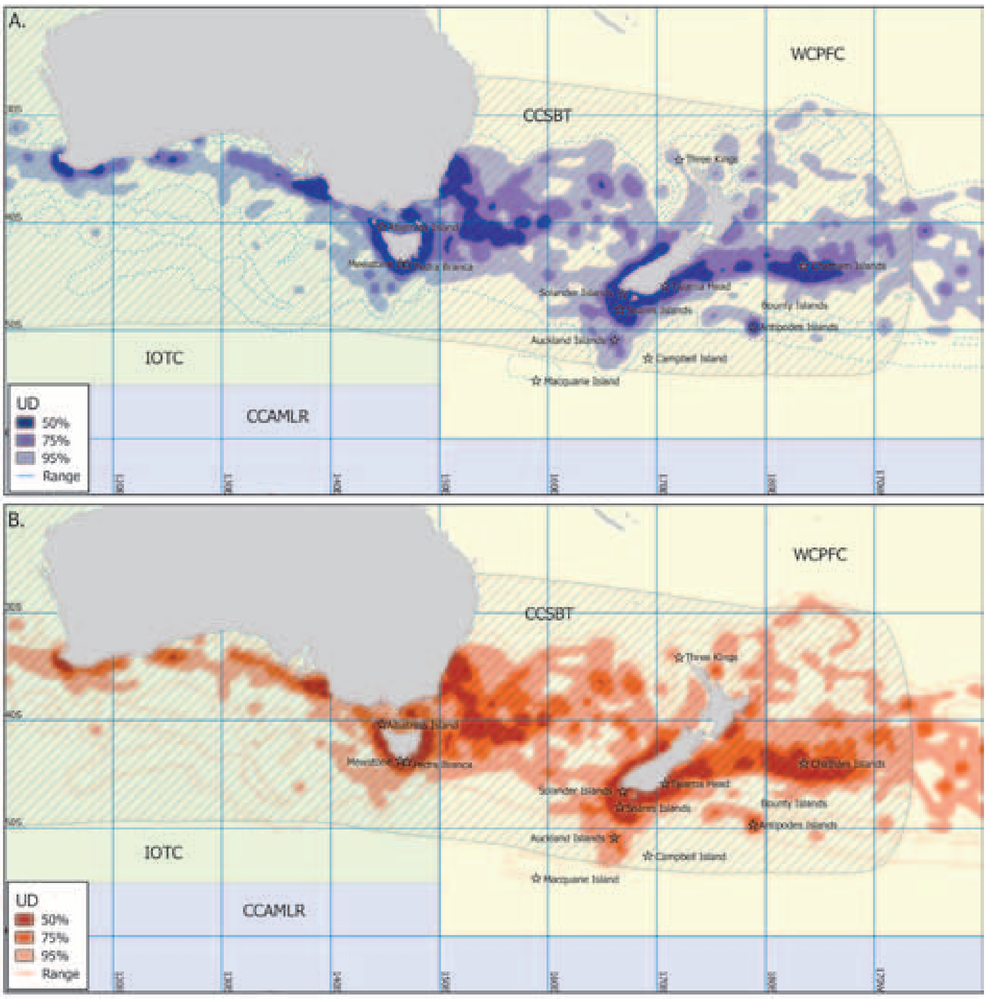


UD's for each species were derived from density distribution maps obtained by satellite tracking breeding birds of the following 9 species from the locations given: Antipodean (Gibson's) Albatross: V (Auckland Islands), Black-browed Albatross: E (Macquarie Island), Buller's Albatross: V (Solander Island and the Snares Islands), Chatham Albatross: CE (Chatham Islands), Grey-headed Albatross: V (Macquarie and Campbell Islands), Light-mantled Albatross: NT (Macquarie Island), Northern Royal Albatross: E (Chatham Islands and Taiaroa Head), Southern Royal Albatross: V (Campbell Island) and Shy Albatross: NT (Albatross Island, Mewstone and Pedra Branca).

Table 5.5. Comparison of the importance of selected RFMOs to the New Zealand and Australian albatrosses (breeding and non-breeding) for which satellite tracking data was submitted to the workshop. For explanation of RFMO acronyms see Table. 5.3.

	CCAMLR	CCSBT	CPPS	IATTC	IATTC new	ICCAT	IOTC	IPHC	WCPFC	CEPTFA	NPAFC	PSC	SEAFO	SWIOFC
RFMO Area (millions of km^2)	83	73	37	62	75	137	69	14	129	18	20	1.6	23	27
No. of albatross species tracked within RFMO:														
– breeding (out of 9 total)	2	5	1	1	1	0	3	0	5	0	0	0	0	0
– non-breeding (out of 6)	2	4	3	2	3	1	3	0	4	2	0	0	1	1
% time spent in RFMO by tracked birds:														
– breeding														
– species given equal weight	7	70	0	0	0	0	10	0	79	0	0	0	0	0
– species weighted by threat status	4	74	0	0	0	0	5	0	87	0	0	0	0	0
– non-breeding														
– species given equal weight	0	70	18	7	20	5	24	0	44	6	0	0	0	2
– species weighted by threat status	0	63	25	12	27	7	15	0	46	9	0	0	0	2
Rank of importance of RFMO to satellite tracked albatrosses, taking the number of species and time spent in the RFMO into account:														
– breeding	4	2	6	7	5	8	3	8	1	8	8	8	8	8
– non-breeding	10	1	5	6	4	8	3	12	2	7	12	12	11	9

Figure 5.13. Global utilisation distributions (UD's) of non-breeding albatrosses from New Zealand and Australia in relation to the areas of competence of selected RFMOs. For explanation of RFMO acronyms see Fig. 5.7. A UD provides a probability contour indicating the relative amount of time birds spend in a particular area i.e. they will spend 50% of their time within the 50% UD. The dotted line represents the entire range, or 100% UD. Important breeding sites for albatrosses in the region are shown. The composite in A. was created by calculating the utilisation distributions for each species and combining them giving each species equal weighting. The composite in B. was created by calculating the utilisation distributions for each species and combining them by weighting according to IUCN threat status. The weights used were: NT (Neat Threatened) = 1; V (Vulnerable) = 2; E (Endangered) = 3; CE (Critically Endangered) = 4. The threat status of each species is given after the species name below.



UD's for each species were derived from density distribution maps obtained by satellite tracking non-breeders and failed breeders of the following 7 species from the locations given: Antipodean Albatross: V (Antipodes Islands), Antipodean (Gibson's) Albatross: V (Auckland Islands), Buller's Albatross: V (Solander Island and the Snares Islands), Chatham Albatross: CE (Chatham Islands), Northern Royal Albatross: E (Chatham Islands and Taiaroa Head), Shy Albatross: NT (Albatross Island, Mewstone and Pedra Branca) and Wandering Albatross: V (Indian Ocean and Tasman Sea).

distribution of albatrosses, though this would be increased if breeding distribution data from Waved Albatrosses were included in the dataset. However, the Southeast Pacific, particularly the coastal shelf offshore from Peru and Chile is significantly more important when the ranges of non-breeding albatrosses are considered. If IATTC's new Antigua Convention comes into force, IATTC's area will expand by 10º latitude north and south. The new IATTC convention area, and the area managed by CPPS/Galapagos Agreement would then each encompass approximately 20% of the non-breeding distribution of Australian and New Zealand albatrosses

The areas of the non-tuna RFMOs in the Southeast Atlantic and Southwest Indian Ocean also overlap with albatross distributions. South-East Atlantic Fisheries Commission (SEAFO) and South-West Indian Ocean Fisheries Commission (SWIOFC) are still in the process of development—in particular, SWIOFC's convention has not yet been drafted, and the area that it will manage is still under discussion. However, the area currently proposed for SWIOFC includes 14% of breeding albatross distribution, which increases to 19% of distribution if weighted by threat status. The areas that will be managed by SEAFO and SWIOFC are particularly important in relation to the Critically Endangered Amsterdam Albatross, and the Endangered Tristan and Indian Yellow-nosed Albatrosses, respectively. The indications are that they will be principally responsible for trawl fisheries and artisanal fisheries (since tuna longlines in their areas will be managed by ICCAT and IOTC, respectively). However, incidental mortality is known to be widespread in trawl fisheries (Bartle 1991, Sullivan *et al.* 2003). Management by SEAFO and especially SWIOFC will therefore be important in relation to albatross conservation.

Implications for albatross conservation

CCAMLR is the only RFMO to have undertaken comprehensive measures to reduce albatross mortality: CCSBT requires its vessels to use streamers lines and WCPFC is not yet fully active, but ICCAT and IOTC have neither assessed albatross mortality within their fisheries, nor established any mitigation measures. The new WCPFC Convention includes a commitment to minimising impact of fisheries on non-target species, to developing a regional observer program within its fisheries and to monitoring the status of such species. These commitments present a unique opportunity to ensure that WCPFC undertakes effective mitigation of albatross bycatch.

Cleo Small and John Croxall

5.2.4 Relationships between distribution of albatrosses and petrels and Exclusive Economic Zones (EEZs)

Several albatross species are at risk from interactions with longline fisheries because of their vast foraging ranges, particularly during non-breeding phase. These ranges often occur over high seas areas, where fisheries regulation is difficult to implement. Although the RFMOs discussed above perform some of this regulation, currently it is mainly within territorial waters and Exclusive Economic Zones (EEZs) that it is practical to enforce measures to ensure the conservation of threatened albatrosses and petrels. It is thus essential to examine the amount of time spent in these regions by different species during different phases of their life cycle, so that countries can be made aware of the importance of their national waters to albatross survival. For the purposes of this study, the EEZ area (usually claimed from 24–200 nm) includes the 12 nm territorial waters and 24 nm contiguous zones (Figure 5.14).

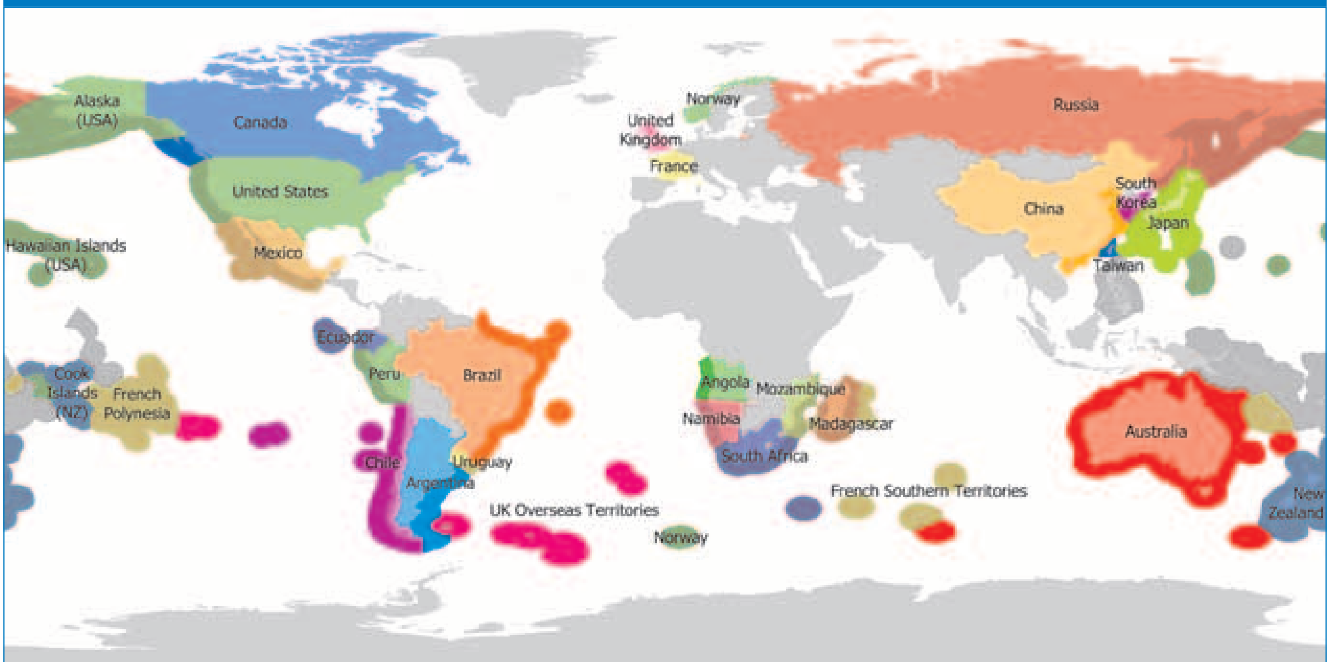
From Table 5.6 and Figure 5.15 it is clear that some species of albatross rely more heavily on EEZ areas during breeding than others. Thus Laysan Albatrosses spend 84% of their time during breeding on the high seas. Other species particularly at risk outside EEZs include Black-footed (66%), Grey-headed (56%), Tristan (56%), Indian Yellow-nosed (49%) and Wandering (45%) Albatrosses. Of these, the Black-footed, Indian Yellow-nosed and Tristan Albatrosses are listed as Endangered by the IUCN, whereas the rest are Vulnerable. Of the 11 species for which tracking data were submitted for a large proportion of the global population, all spent some time during the breeding season on the high seas, although in some cases this was as low as 1 or 2%. This amount of time is expected increase substantially for non-breeders, when birds are no longer restricted to breeding colonies found within the EEZs. Unfortunately insufficient data was submitted to the workshop to perform a similar analysis for non-breeders.

An examination of the regional distribution of breeding albatrosses (Figure 5.16) shows the importance of particular countries for the different species. The Critically Endangered Chatham, Endangered Northern Royal and Vulnerable Southern Royal Albatrosses are confined almost exclusively to the New Zealand EEZ during breeding, spending at most 2% of their time outside this area. The Critically Endangered Amsterdam Albatross spends 79% of its time within the area of France's Southern Territories EEZ, being restricted to breeding on French Ile Amsterdam. Similarly the Indian Yellow-nosed Albatross, which breeds only in the French Southern Territories and South African Prince Edward Islands, spends 51% of its time in French waters. Other countries of importance to particular species include the United Kingdom (Black-browed (51%), Grey-headed (33%) and Tristan (44%) Albatrosses) and United States (Black-footed (34%) and Laysan (15%) Albatrosses).

For three species in particular, Black-browed, Grey-headed and Wandering Albatross, international co-operation is vital to ensure their survival. These species have wide breeding and foraging ranges and are found over most of the Southern Ocean. Differing levels of protection by the countries whose EEZs they frequent will place them at risk during different phases of their annual and life cycle.

Due to the number of endemic species found breeding on its surrounding islands, New Zealand ranks as the most

Figure 5.14. Main countries with EEZs overlapping albatross distribution (the EEZs include territorial and contiguous waters).



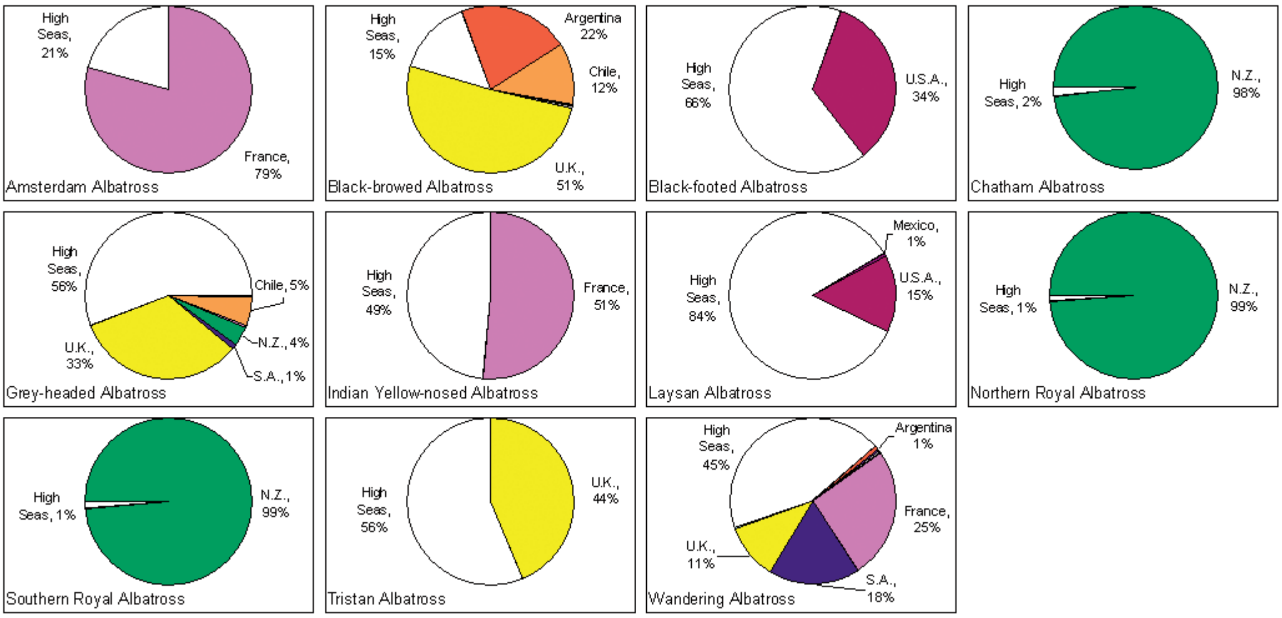
The geographical designations employed do not imply the expression of any opinion whatsoever on the part of BirdLife International concerning the legal status of any country, territory or area, or concerning the delimitation of its frontiers or boundaries. At the time of going to press it was noted that the EEZ surrounding South Georgia does not extend as far west as indicated in the map. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning the sovereignty over the Falkland Islands (Malvinas).

Table 5.6. Percentage time at sea spent in EEZs as opposed to the high seas while breeding for 16 species of albatross, two species of giant-petrel and one petrel species for which satellite tracking data was submitted to the workshop. (The EEZ area includes territorial and contiguous waters.)

Species	Threat status[1]	% global popn tracked[2]	Sites tracked[3]	Argentina	Australia	Brazil	Chile	Canada	France	Mexico	Norway	New Zealand	South Africa	United Kingdom	Uruguay	USA	High seas
Albatrosses																	
Amsterdam	CE	100	all > 1%						79								21
Antipodean	V	59	–		2							59					39
Black-browed	E	100	all > 1%	22			12							51			15
Black-footed	E	97	all > 5%													34	66
Buller's	V	42	–		4							79					17
Chatham	CE	100	all > 1%									98					2
Grey-headed	V	87	–				5					4	1	33			56
Indian Yellow-nosed	E	70	–						51								49
Laysan	V	100	all > 1%							1						15	84
Light-mantled	NT	9	–		50												50
Northern Royal	E	100	all > 1%									99					1
Shy	NT	15	–		83												17
Sooty	E	17	–						40				3				56
Southern Royal	V	99	all > 1%									99					1
Tristan	E	100	all > 1%											44			56
Wandering	V	100	all > 1%	1					25				18	11			45
Giant-petrels and Petrels																	
Northern Giant-petrel	NT	38	–	14			3							59			24
Southern Giant-petrel	V	20	–	21										39			41
White-chinned Petrel	V	?	?	16					1					53			30

[1] NT: Neat Threatened, V: Vulnerable, E: Endangered, CE: Critically Endangered (BirdLife International 2004a)
[2] The percentage of the global population tracked was calculated by adding the proportion of the global annual number of breeding pairs at each site for which tracking data was contributed.
[3] Indicates whether tracking data was submitted for all sites containing over 1% or 5% of the global annual number of breeding pairs.

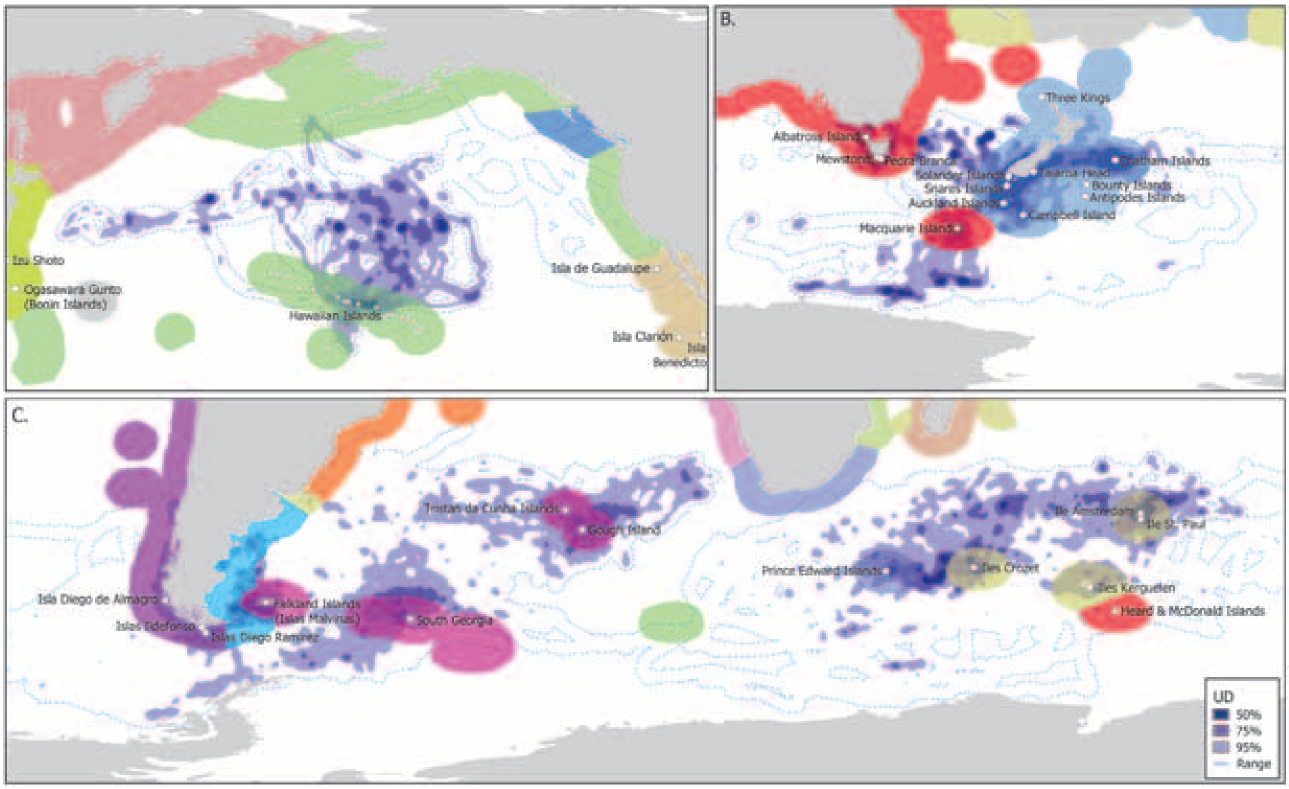
Figure 5.15. Percentage time at sea spent in EEZs as opposed to the high seas while breeding for 11 species of albatross. Only those species for which a large proportion (over 70%) of the global population is represented by satellite tracking data are shown.



important country for the conservation of breeding albatrosses, with seven species spending 29% of their time during breeding within its EEZ (Table 5.7). France, Australia, the United Kingdom and the USA follow in order of importance. The Agreement on the Conservation of Albatrosses and Petrels (ACAP), which seeks to conserve albatrosses and petrels in the southern hemisphere by coordinating international activity to mitigate known threats to their populations, entered into force on the 1 February 2004. Of the nations listed above with EEZs in the southern ocean, all have signed ACAP but France has yet to ratify the agreement. The USA has developed a National Plan of Action to deal with bycatch issues.

The importance of several countries for breeding albatrosses has been under-estimated because some datasets were not submitted to the workshop. The addition of tracking data for Waved Albatrosses, for example, will highlight Ecuador and Peru's primary responsibilities for the protection of this species (Anderson *et al.* 2003), while the distribution of Short-tailed Albatrosses overlaps the EEZs of China, Japan, Russia, South Korea and Taiwan. The non-breeding distribution of albatrosses also needs to

Figure 5.16. Regional maps of global utilisation distributions (UD's) of breeding albatrosses in relation to EEZs. Important breeding sites for albatrosses in each region are shown. A. North Pacific; B. Australasia; C. Southern Atlantic and Indian Oceans. These composites were created by calculating the utilisation distributions for each species and combining them giving each species equal weighting.



The geographical designations employed do not imply the expression of any opinion whatsoever on the part of BirdLife International concerning the legal status of any country, territory or area, or concerning the delimitation of its frontiers or boundaries. At the time of going to press it was noted that the EEZ surrounding South Georgia does not extend as far west as indicated in the map. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning the sovereignty over the Falkland Islands (Malvinas).

be examined. Several of the New Zealand albatrosses are known to frequent the coastal shelf off South America (Nicholls *et al.* 2002, Spear *et al.* 2003), making Argentina, Chile, Peru and Uruguay crucial for their conservation.

Frances Taylor

5.3 ESTABLISHMENT, MAINTENANCE AND USE OF A GIS TRACKING DATABASE

The workshop participants acknowledged the importance and uniqueness of the integrated perspective of global Procellariiform distributions achieved at this workshop, and agreed to maintain the tracking database assembled for the Important Bird Area (IBA) delineation exercise beyond this meeting. However, participation in this exercise does not imply the contribution of the tracking data into a permanent database, nor does it give BirdLife International the permission to use the contributed data indefinitely. The data sets used in this workshop will not be automatically incorporated into a permanent database at the end of this exercise. Instead, the workshop participants will be given the opportunity to re-submit their data sets into a permanent repository, on the basis of agreed-upon terms of use to be ratified at a later date. Alternatively, users may choose to withdraw their data from the tracking database once the IBA exercise has been completed.

Many important issues concerning data ownership and the longevity of this database will be determined in future discussions. Nonetheless, the participants decided to proceed with the establishment of the Procellariiform tracking database at this time, acknowledging the need to

Table 5.7. Comparison of the importance of overlapping EEZs to the breeding albatrosses for which satellite tracking data was submitted to the workshop. (The EEZ area includes territorial and contiguous waters.)

	Argentina	Australia	Brazil	Chile	Canada	France	Mexico	Norway	New Zealand	South Africa	United Kingdom	Uruguay	USA	High seas
No. of albatross species tracked within EEZ during breeding (out of 16 total)	3	9	2	3	1	7	1	2	7	3	4	2	2	16
% time spent in EEZ by tracked breeding birds:														
– species given equal weight	1	9	0	1	0	12	0	0	27	1	9	0	3	36
– species weighted by threat status	2	4	0	1	0	16	0	0	29	1	9	0	3	34
Rank of importance of EEZ to satellite tracked breeding albatrosses, taking the no. of species and time spent in the EEZ into account	6	3	10	8	13	2	9	12	1	7	4	11	5	

balance the broad availability of this information to the conservation community with the proprietary rights of the individual data contributors. The workshop participants felt enough safeguards were currently in place to mitigate the perceived threat of unauthorised use of the contributed data.

Overall Strategy: The Procellariiform tracking database seeks to:

- *Attract Data Providers with Tools:* The development and integration of analytical tools (e.g., data filtering, quality control, analysis, and visualisation) will be essential to attract additional data providers. Access to these tools and services will serve as an incentive for data holders to contribute to the database. Every effort will be made to acknowledge contributions to the system by the data holders, through the creation of data provider pages (Annex 6.1), and data set summaries (Annex 6.2).
- *Enhance Meta-data Collection:* The establishment of reporting criteria for ancillary data (e.g., tag specifications, sampling regime, methodology, data filtering) will enhance the retroactive compilation of standardised meta-data from past studies, and the collection of complete ancillary measurements for future research. Meta-data standards are particularly important for discriminating between different versions of the same datasets (e.g., raw locations versus tracks cleaned with a "speed filter"), and for providing an accurate description of the data archived in the system.
- *Integrate Tracking Data with Other Relevant Datasets:* This database will add value to the tracking data by integrating these observations with other relevant information such as 1) **seabird distribution information** including colony size and location, at-sea surveys, and bycatch distributions; 2) **threats** from interactions with fisheries, fishing effort, and shipping lanes; 3) **environmental data** such as bathymetry, oceanographic variables (e.g., sea surface temperature, chlorophyll concentration, sea-level height), and wind speed and direction; 4) **management information** for EEZs, RFMOs, IBAs; and 5) **ecological data** such as distributions of prey, fishery target species, and other threatened taxa (e.g., turtles, sharks, cetaceans). In essence, these disparate data layers will enhance the broad applicability and the value of the Procellariiform tracking database by placing the tracking data in a broader context. This integration may take several forms, ranging from visual overlays to statistical summaries of the raw data, and will require the collaboration with other existing initiatives. In particular, the workshop participants highlighted the need to coordinate with the Tagging of Pacific Pelagics (TOPP) and the Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) projects to avoid "reinventing the wheel".
- *Promote Collaboration:* It is our hope that the creation of this database will enhance collaborations between investigators, by promoting the exchange of perspectives, ideas, and analytical techniques. The complete meta-data documentation, including annotated lists of published references, tools (e.g., software) linked with specific datasets, and contact information for each data contributor, will help open these channels of communication. Moreover, this developing "information commons" will nurture a sense of community, essential to forge firm collaborations.

Data Contribution: The Procellariiform tracking database will only be an effective conservation tool if providers contribute their data in a complete and prompt manner.

- *Rapid Integration:* The sooner new tracking data are contributed to the database, the better. Ideally, we would hope that providers would contribute their data within five years of their collection.
- *Completeness:* Data providers are urged to contribute both the raw data and any updated filtered versions.
- *Documentation:* All contributions will include complete and standardised meta-data documentation of data collection, filtering, and processing procedures.

Data Sharing: Data sharing protocols will ensure the broad utility of the system, while protecting the proprietary rights of the data providers.

- *Management of Data Sets:* Data providers will be able to restrict user access to specific products (e.g., raw data, kernel plots) on any or all of their datasets by using a password protected data provider profile page (Annex 6.1). Public access may be restricted (1) to avoid the misinterpretation of data that are scarce or of poor quality (e.g., small sample sizes, large location errors); and (2) to protect the exclusive rights of providers to new or unpublished data. Database users will be notified of the restricted status of the data, and will be urged to contact the original data provider to gain access to this information.
- *Display:* The display of various data sets and products (e.g., maps, tabular summaries) should enhance the utility of the system to the broader community, while ensuring that the proprietary rights of data contributors are protected. Because users with different needs and computer skills will interact with this system, we advocate a flexible approach, whereby a central database will take on a variety of distinct appearances. To facilitate diverse searching and browsing options, the database system will provide species-specific pages, summaries of individual data sets including meta-data, a search engine interface, and a mapping tool interface.

  A species coverage page will display a tabular summary of the data holdings, including the species names, taxonomic information, and the number of datasets and records for a given species (example at http://seamap.env.duke.edu/species). This page will give users the ability to rapidly determine whether the database holds the information they seek. It will also provide links to species-specific page listings for all individual datasets, including relevant observations and summary pages describing each individual data set in the system (Annex 6.2).
- *Searching:* Users will have the ability to search the database for available data using individual species names (e.g., common name, Integrated Taxonomic Information System name / code), provenance (e.g., colony of origin), jurisdictions (e.g., Exclusive Economic Zones, Regional Fishery Management Council), status (e.g., breeding or non-breeding), specific geographic areas (e.g., latitude / longitude), and appropriate temporal windows (e.g., monthly and quarterly time periods were considered). These queries will yield information about the number of records and datasets that include observations of the species in question, and will provide links to web pages devoted to individual species and specific data sets.

- *Mapping:* We envision two types of basic data displays: (1) a static picture of all the locations (e.g., unfiltered, 1×1 degree resolution) included within the meta-data posted for each individual data set (Annex 6.2), and (2) a dynamic picture of filtered low resolution (1×1 degree) locations interactively defined by the user (example at http://obis.env.duke.edu/map/main/viewer.pmap). Because the raw tracking data can be publicly available, the decimal location information will be rounded off to the nearest degree of latitude and longitude to decrease the spatial resolution of the observations. Users will be able to interactively modify these maps by querying the system for individual species names (i.e., based on the query search capability listed above). Additionally, these observations may be superimposed on other environmental (e.g., bathymetry, SST, chlorophyll, etc.) and management (e.g., EEZs, RFMOs) data layers.
- *Tools:* Data providers will be able to use publicly available filtering / analysis tools on their own datasets. However, **all data users** will have to seek the authorisation from the original provider(s), before they can use these tools on other datasets.

System Longevity: The long-term viability of the Procellariiform tracking database is critical to enhance its conservation applicability. Because the maintenance of the system will incur costs, it is important to develop tools for automating the addition of new datasets or appending older versions of an original dataset. This approach should keep the costs of maintaining the database to a minimum. Overall, workshop participants did not favour a "use for fee" system; rather it was suggested that the database be publicly available for free. Therefore, in order to maintain the database, workshop participants agreed that support from an NGO was preferable to a government agency due to concerns of trust, capacity, and longevity. **BirdLife International** is an ideal candidate for this task due to its vital interest in the conservation of all bird life. Furthermore, the workshop participants agreed that **BirdLife International**'s experience working with management / conservation agencies worldwide, provided an essential bridge between researchers and resource managers.

Terms of Use

While these terms of use are in principle broadly applicable, the workshop participants acknowledge that other types of data (e.g., fisheries effort and bycatch, at-sea surveys) may be subject to more / less stringent proprietary / confidentiality controls.

By using any Procellariiform tracking dataset, **ALL** users agree to the following terms and conditions:

1. Not to use data contained herein in any publication, product, or commercial application **without prior written consent** from the original data provider(s). While initial inquiries may be conducted by electronic mail, users and providers will formalise their collaboration agreements using standardised electronic "terms of use" forms (e.g., terms.pdf) that will be archived by the database manager(s) (Annex 6.3).
2. Once consent has been obtained, users shall adhere to the following conditions:
   - The original data provider(s) must be given **co-authorship** of any product including "recent" data (i.e., gathered during the previous 10 years) unless the original data provider declines authorship. Ultimately, inclusion as an author is decided by the data provider(s) and not the data user(s).
   - Authorship will be **optional** for products involving "historical" data gathered more than 10 years in the past. In this case, authorship decisions will be at the discretion of the user(s) and not the original data provider(s).
   - After approval of use is obtained, authors agree to **cite** and / or acknowledge both the original data provider(s) and the Procellariiform Tracking dataset appropriately in all publications or products (e.g., web pages, models, and presentations). For publication in peer-reviewed journals, editors have suggested that the database version and the date the system was accessed be included in the citation. The version of the specific database, as described in the meta-data, will be essential to determine the level of data filtering and processing.
3. No data user shall hold any tracking device manufacturer (e.g., Lotek, Microwave Telemetry) or location processing service (e.g., Argos Inc.), the Procellariiform tracking database, or the original data provider(s) liable for errors in the data. While every effort has been made to ensure the integrity and quality of the database, BirdLife International (or whomever ultimately maintains this database) cannot guarantee the accuracy of the datasets contained herein.

David Hyrenbach, Daniel Costa, John Croxall, Richard Cuthbert, Lincoln Fishpool, William Fraser, Rosemary Gales, Nic Huin, Deon Nel, David Nicholls, Donna Patterson, Richard Phillips, David Pinaud, Flavio Quintana, Christopher Robertson, Graham Robertson, Peter Ryan, Scott Shaffer, Janet Silk, Jean-Claude Stahl, Robert Suryan, Frances Taylor, Aleks Terauds, Geoff Tuch, Henri Weinerskirch, Barbara Weinecke

5.4 GAP ANALYSIS

Inspection of the data in Annex 7 allows a very rough assessment of the main and priority gaps in remote-tracking data for albatrosses and giant-petrels. For breeding birds this assessment (based only on PTT data) is summarised in Table 5.8 and Figure 5.17. Absence of data is relatively straightforward to assess. Under-representation of data was assessed rather simplistically against a minimum expectation that tracking hours should exceed 10% of the number of breeding individuals at a site and that the number of individuals tracked (or inferred to be tracked from the number of tracks available) should exceed 0.1% of the number of breeding individuals at that site.

This preliminary overview does not take account the distribution of tracking sites within the populations concerned. In general, only one or two colonies, often from only one island of an archipelago, have been the sites for collection of remote-tracking data. There are, however, some notable exceptions to this, particularly for Black-browed and Grey-headed Albatross in Chile, for Shy Albatross in Tasmania and Black-browed Albatross in the Falkland Islands (Malvinas).

For birds other than those of breeding status tracked while breeding, the gaps are so extensive (Figure 5.18) that it is easier to indicate what information we have (Table 5.9).

John Croxall and Frances Taylor

Table 5.8. Data requirements to complete or augment existing remote-tracking data for breeding albatrosses and petrels. This assessment relates to main breeding sites (>5% of global breeding population). Values in parentheses are proportion (%) of global breeding population.

Species	Data lacking	Data enhancement needed
Amsterdam Albatross	–	–
Antipodean (including Gibson's) Albatross	Antipodes Is (41)	Auckland Is (59)[1]
Atlantic Yellow-nosed Albatross	All (Gough (23)/Tristan (77))	
Black-browed Albatross	–	Falkland Is (Malvinas) (62), South Georgia (16)[2]
Black-footed Albatross	–	Hawaiian 15 (97)[2]
Buller's Albatross	Chatham Is (95)	
Campbell Albatross	–	Campbell I (100)[3]
Chatham Albatross	–	–
Grey-headed Albatross	Crozet (6), Kerguelen (7)	South Georgia (58), Prince Edward Is (7)
Indian Yellow-nosed Albatross	Crozet (12), Prince Edward Is (17)	
Laysan Albatross		Hawaiian Is (100)[2]
Light-mantled Albatross	All sites except Macquarie (9)[1], particularly Auckland (23), Campbell (7), Crozet (11), Kerguelen (18), South Georgia (28)[1]	–
Northern Royal Albatross	–	–
Salvin's Albatross	All (Bounty Is (99))	–
Short-tailed Albatross	All (Izu (95), Senkaku (5))[2]	?
Shy Albatross	Auckland Is (85)	–
Southern Royal Albatross	–	Campbell I (99)
Tristan Albatross	–	–
Wandering Albatross	–	–
Waved Albatross	–	Galapagos[3]
Northern Giant-petrel	All sites except South Georgia, particularly Chathams (19), Kerguelen (12), Macquarie (10)	–
Southern Giant-petrel	All sites except South Georgia, particularly Falkland Islands (Malvinas) (10), Heard (14), South Orkneys (11)	–
White-chinned Petrel	All sites except South Georgia, Crozet, particularly Antipodes, Auckland, Kerguelen	South Georgia, Crozet
Spectacled Petrel	All	–
Blue Petrel	All	–
Parkinson's Petrel	All	–
Grey Petrel	All	–

[1] Data in process of publication; [2] Additional data known, or believed, to be available; [3] Data published.

Table 5.9 Summary of tracking data available from main breeding sites (sites with >5% total global population) for (a) Adult non-breeders and (b) Sub-adults and juveniles.

A. Adult non-breeders	Data available	during breeding season	out of breeding season
Antipodean (including Gibson's) Albatross	both main sites		3 birds each site
Black-browed Albatross	GLS data from all three sites PTT data from two of three sites	 1 bird	36 birds 2 birds
Black-footed Albatross	only main site	6 birds	
Buller's Albatross	two of three sites	1 and 3 bird(s)	
Chatham Albatross	only main site	6 birds	5 birds
Grey-headed Albatross	GLS data from one of six sites PTT data from two of six sites	17 birds 1 bird each site	6 birds
Northern Royal Albatross	both main and subsidiary site	4 and 1 bird(s)	
Short-tailed Albatross	only main site	2 birds	5 birds
Shy Albatross	one of two main sites	5 birds	
Wandering Albatross	three of four main sites and at sea	1, 3 and 4 bird(s)	
B. Sub-adult/juveniles	**Data available**	**during breeding season**	**out of breeding season**
Buller's Albatross	one of three sites	6 birds	
Chatham Albatross	only main site	2 birds	
Northern Royal Albatross	subsidiary site	2 birds	
Shy Albatross	one of two main sites		3 birds

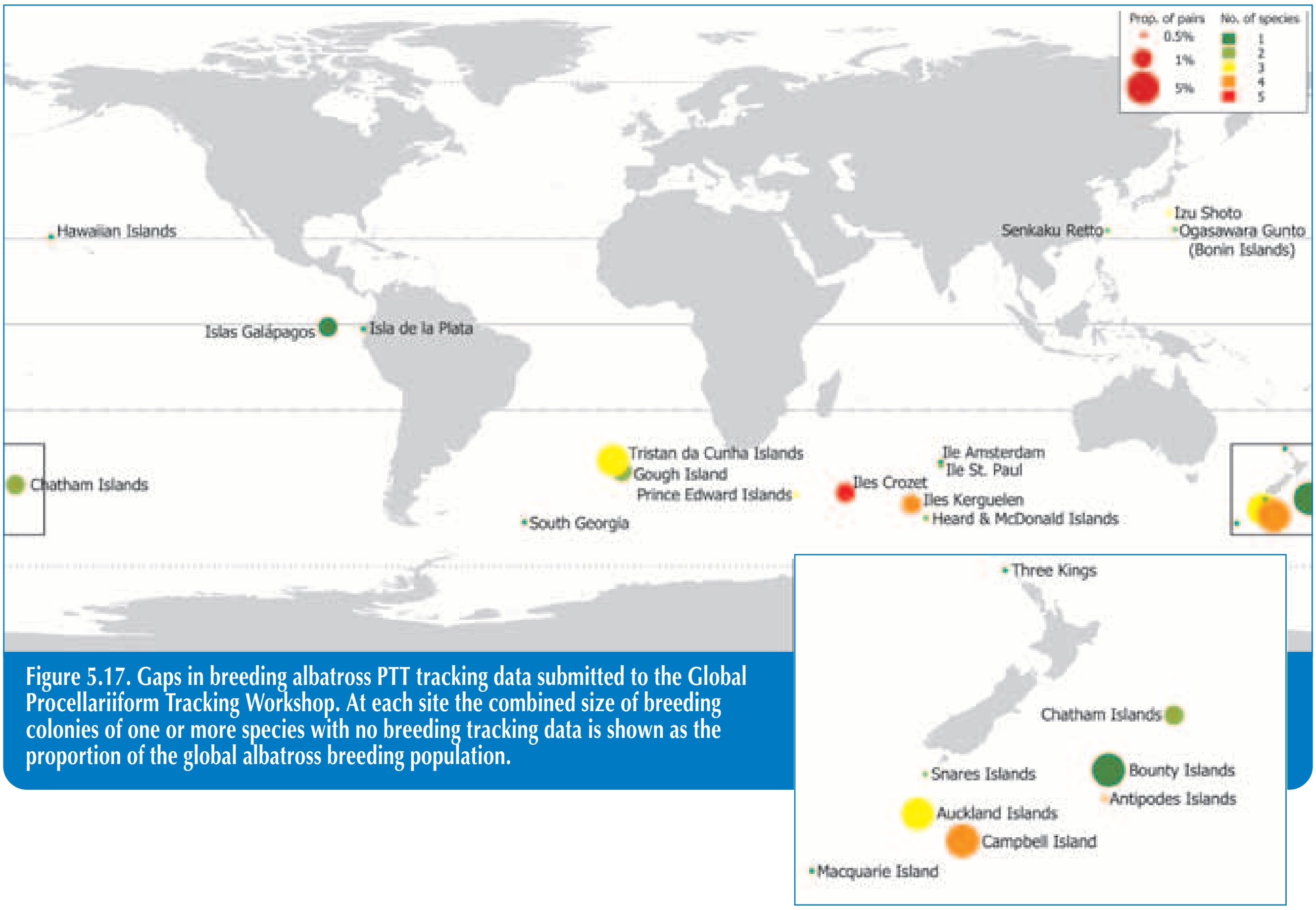


Figure 5.17. Gaps in breeding albatross PTT tracking data submitted to the Global Procellariiform Tracking Workshop. At each site the combined size of breeding colonies of one or more species with no breeding tracking data is shown as the proportion of the global albatross breeding population.

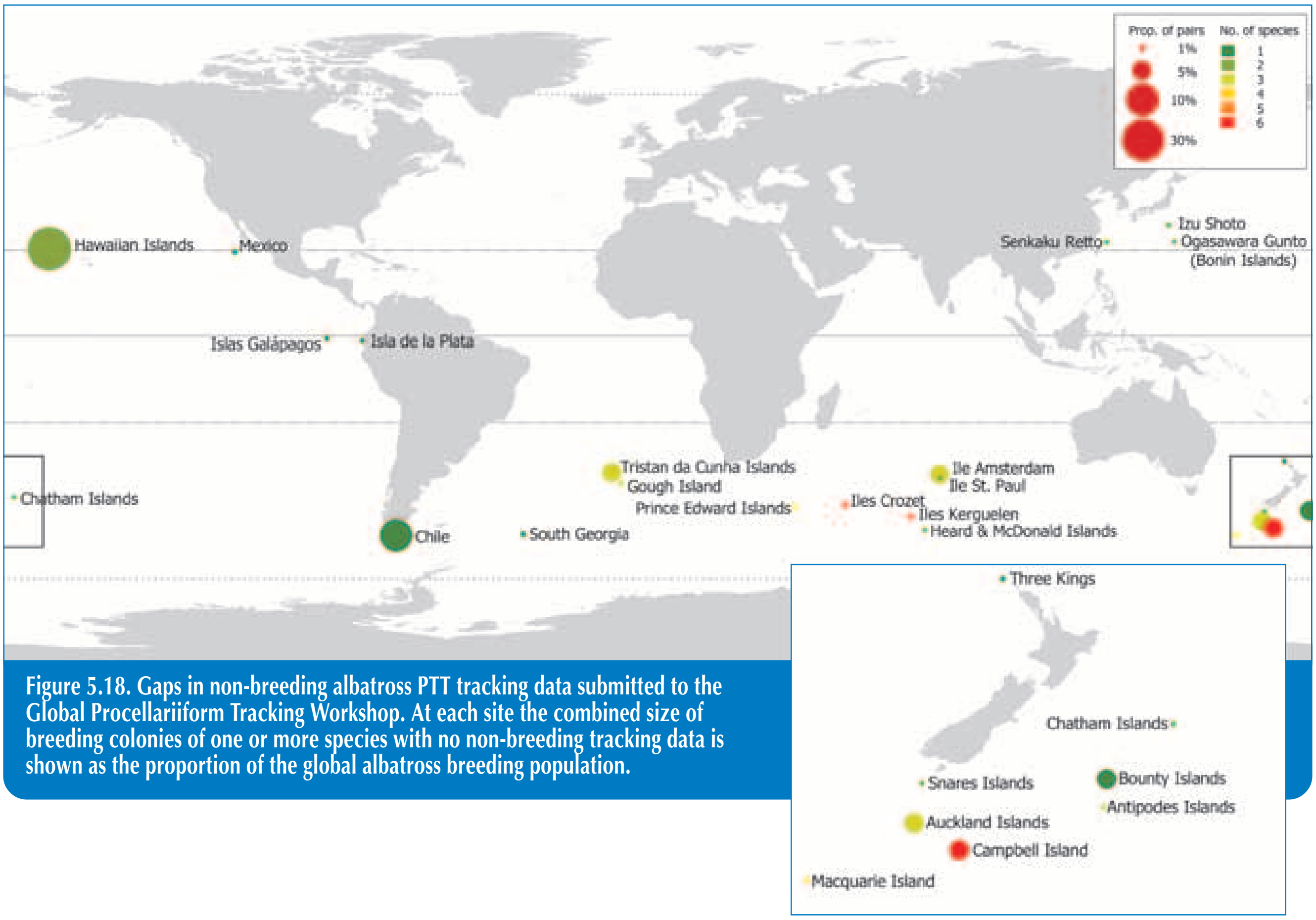


Figure 5.18. Gaps in non-breeding albatross PTT tracking data submitted to the Global Procellariiform Tracking Workshop. At each site the combined size of breeding colonies of one or more species with no non-breeding tracking data is shown as the proportion of the global albatross breeding population.

6 CONCLUSIONS AND FUTURE WORK

In addition to evaluating progress in respect of the original strategic aims, this section also attempts to summarise the achievements of the workshop and to indicate some of the future steps necessary to develop its potential.

This recognises that the workshop, and the work undertaken subsequently, was undoubtedly a landmark in the collaborative use of remote-recording data on the ranges and distributions of seabirds. Nevertheless, this initiative is still only a start in the evolution of what we hope will become a valuable tool for collaboration and cooperation. We hope it will help advance scientific understanding of the principles underlying the use of marine habitats by albatrosses and petrels and also the application of this knowledge to address priority conservation and management issues in marine systems—especially on the high seas.

6.1 COLLABORATION AND SYNTHESIS

This workshop could not have happened without the commitment of individual scientists and organisational dataholders to contribute their data—in most cases containing material unpublished and/or unexploited to a greater or lesser extent—to address goals of common concern and interest.

This trust and commitment allowed a number of important achievements to be realised.

Data

- Over 90% of all extant albatross and petrel tracking data was submitted to the workshop, representing 18 of the 23 candidate species of albatross and giant-petrel, plus White-chinned Petrel.

Methods

- Standard analytical procedures could be developed and applied to the satellite tracking (PTT) data because dataholders were prepared to submit the raw data records.
- Consistent procedures could be developed for the presentation of geolocator tracking data—the main source of information for distributions in non-breeding seasons.
- Agreement could be reached, for the purposes of the present exercise, on appropriate analytical procedures to transform location data to density distributions, a crucial step in the visualisation, analysis and interpretation of data sets in combination.

Preliminary results

- Indication of the nature and variation in range and distribution, for breeding birds, in relation to stage of breeding season, gender (sex) and year (i.e. interannual variation).
- Indication of differences in range and distribution of breeding birds from different colonies within the same population (island group).
- Indications of both similarities and differences in range and distribution of breeding birds from different populations of the same species. These syntheses at the species level, particularly for the two species (Wandering Albatross, Black-browed Albatross) with the most comprehensive data, provide compelling evidence of the insights that can be generated by applying common and consistent approaches to data from a variety of studies and sites.
- Regional syntheses providing preliminary indications of the potential (and challenges) for using data across a range of albatross and petrel species to identify areas of key habitat common to different species.
- Illustration of both similarities and differences in range and distribution of breeding and non-breeding birds at the same time of year.
- Illustration of the spectacular journeys and far-distant destinations (comprising migratory routes, staging areas and wintering ranges) of some species of albatross and petrel during the non-breeding season.

All the foregoing represent very significant achievements, some indicating interesting aspects and avenues for future research, others identifying potential biases and concerns relating to analysis and interpretation of data, yet others revealing key gaps in our knowledge, nevertheless all indicating the potential of such data to address important questions relating to albatross and petrel ecology and conservation.

6.2 STRATEGIC AIMS AND APPLICATIONS

6.2.1 Definition of Important Bird Areas (IBAs) and contribution to high seas Marine Protected Areas

Despite the many difficulties identified and foreseen, there was unanimous recognition that tracking data for albatrosses and petrels will be essential contributors to attempts to identify areas of critical habitat from marine organisms and hotspots of biodiversity in coastal and pelagic marine ecosystems.

The approaches developed in relation to characterising density distributions and to combining (weighting) these with estimates of source population size, while requiring further refinement, are likely to be fundamental elements that will come to be standard practice for these and other migratory pelagic marine taxa.

The extent to which existing definitions of IBAs, developed for terrestrial species and systems, can be extended to marine contexts requires considerable further investigation (including as specified in Section 5.1), for which the albatross and petrel data are uniquely suited.

Valuable though the IBA concept has been, concerns were raised that the levels of knowledge of distribution and abundance of marine taxa (especially threatened species) and the ways in which marine habitat protection has been developed so far, favour approaches which combine data from different groups of marine animals (e.g. fish, seabirds, marine mammals).

Nevertheless, as the albatross and petrel data represent a uniquely coherent and comprehensive data set, covering large areas of marine habitat, they are especially suitable for further investigation, perhaps particularly in high seas contexts.

6.2.2 Interactions with fisheries and fishery management organisations

The great potential to match data on the distribution (and abundance) of albatrosses and petrels with data on fishing effort, particularly for longline fisheries, is evident and has been stressed in several publications seeking to address the potential impact of longline fisheries on albatrosses (see Section 5.2). Several examples of overlap between albatross distribution (both breeding and on migration) and fishing effort are provided in Section 5.2 to illustrate the considerable importance of such approaches.

However, as noted, for many purposes the difficulties in obtaining data for appropriate scales and times, even for the better documented fisheries, may constrain what can be achieved, especially in terms of analysis seeking to estimate bycatch rates and/or their impact on source populations of albatrosses.

Nevertheless, combining fishing effort and albatross distribution data may provide the only effective way to address these issues. The data are certainly adequate to provide broad characterisation of the location (and timing) of potential interactions between albatross species and different longline fisheries; this is a high priority task.

The albatross distribution data are, despite the gaps and deficiencies in terms of providing a consistent global overview, very useful for enabling a preliminary identification of the responsibilities of Regional Fisheries Management Organisations (RFMOs) for environmentally sensitive management of albatrosses and their habitat based on overlap of ranges and jurisdictions.

For the Southern Hemisphere this provides very clear indications of the critical role of, in preliminary priority order, CCSBT, WCPFC, IOTC, ICCAT and CCAMLR (see Table 5.3).

These results offer considerable opportunity as a factual basis for approaching particular RFMOs in respect of their obligations to address issues of seabird bycatch, especially of albatrosses and petrels.

Combined with data on overlap with fishing operations, they also provide scope to identify the times, places and fisheries where adverse interactions are most likely and, thereby, allow the identification of mitigation measures appropriate to the circumstances.

6.2.3 Establish and maintain a Geographical Information System (GIS) database as an international conservation tool

Participants agreed to maintain the tracking database, assembled for the purposes of this workshop, beyond the meeting and production of its report.

They agreed that the database should be reconstituted by re-submission of data once an appropriate policy on data access and use, safeguarding a proprietary rights of individuals and organisations (whether as dataholders, data providers or data owners), had been agreed.

Both the policy and practice for data access and use (based on principles developed for the Census of Marine Life Ocean Biogeographic Information Service (OBIS) – SEAMAP Programme) was developed during the workshop (see Section 5.3).

On the assumption that the GIS database used during the workshop would be required to be maintained for future use, BirdLife International offered, at least as an interim measure, to house and manage the database at its Secretariat headquarters in Cambridge, UK.

This offer was appreciated and accepted in principle. However it was recognised that:

a) this entailed considerable work, simply to maintain the database;
b) if/when the database was augmented with new data and used as a collaborative tool, this would create considerable additional work in respect of managing data, data access and data use;
c) there would be increasing needs to link the albatross and petrel and tracking data to other, analogous, data sets and to the latest information on the physical and biological marine environment. It would likely require very rapid and effective links with other international databases. This may be facilitated by linking, or possibly migrating, the Procellariiform Tracking Database from BirdLife to an organisation or institution specialising in the management and analysis of data on marine systems and biogeography.

6.3 FUTURE WORK

6.3.1 Database enhancement

Supplementary data needs

The ability to generate realistic habitat use maps for albatrosses and petrels still requires substantial amounts of data.

1. At the species level, no data were submitted for Waved Albatross, Salvin's Albatross and Atlantic Yellow-nosed Albatross. However published breeding season data are available for the first two of these (Anderson *et al.* 1998, Fernández *et al.* 2001). Tracking work is in progress for Atlantic Yellow-nosed Albatross.

   Incorporating range data for Campbell Albatross (see Annex 10 – Errata) would emphasise the importance of the area of the Campbell Plateau south of New Zealand. The inclusion of data for Waved

Figure 6.1. Range of Waved Albatrosses tracked from Islas Galápagos (Fernández *et al.* 2001).

Albatross (Figure 6.1) would considerably emphasise the importance of the Humboldt Current habitat offshore of Ecuador and Peru and portray migration routes to and from albatross concentrations at sea around the Galapagos Islands.
2. For the other species, even for breeding birds, more data (and in most cases from more individuals) are needed for some stages of the breeding cycle (particularly incubation), for sexed birds and for sufficient years to assess the consistency of basic distribution patterns. Particularly, however, data are needed for additional populations (island groups) and from more colonies within populations.
3. For most species data are urgently needed on the distribution of adults when not breeding.
4. For almost every species data are lacking on the distribution of immatures and totally absent for early life-history stages (and the subsequent at-sea phase lasting the next 3–5 years).

It could be argued that without data for all breeding cycle and life-history stages we cannot depict albatross and petrel ranges sufficiently accurately for management and conservation purposes. Nevertheless, for many applications, if the adult breeding and non-breeding distributions and core areas could be characterised this would, until adequate empirical data become available, likely provide adequate safeguards for juveniles and immatures. Completing the picture for adult birds is, therefore, potentially more important than diverting much resource into studying juveniles and immatures.

Analysis and methods
More work is desirable to evaluate the potential biases of using the different types (and where appropriate different duty cycling) of existing data (e.g. PTT, GLS) in different kinds of analysis and particularly on the appropriate use of spatial statistics to create density distributions from the different kinds of tracking data.

Environmental data
There is a priority need to facilitate easy access to appropriate data sets on the physical and biological environment at appropriate scales, including detailed bathymetry, sea surface temperature, marine productivity, sea-ice etc.

6.3.2 Links to other tracking data

There is a need to facilitate links to analogous sets of data on other petrels (some data are becoming available for shearwaters and fulmars), penguins (extensive data exist from the temperate and sub-Antarctic species), marine mammals (many data sets for phocid and otariid seals and increasingly for cetaceans), sea turtles (data now available for most species) and migratory fish (some data for tuna and tuna-like species becoming available).

There is a need to encourage and support initiatives like the Marine Mammal Tracking Database (Annex 8) and programmes like Tagging Of Pacific Pelagics (Annex 5) which are trying to assemble similar data on a collaborative basis.

6.3.3 Links to seabird-at-sea survey data

Existing data are much more extensive than remote-tracking data and often deal with very large numbers of sightings. However the lack of knowledge of the origin and status (breeder, migrant, non-breeder) of the birds observed reduces their utility for some purposes. Also, for deriving density-distribution maps, essential for relating to environmental features and examining relationships of interest, most data were not collected by consistent standard methods valid for producing quantitative outputs. Therefore high quality survey data tend to be rather restricted in space and time.

Nevertheless there is a real need to investigate the feasibility and utility of combining remote tracking and survey data sets. Prime candidate areas for pilot studies to do this would include the north-east Pacific, tropical east Pacific, south-west Atlantic and parts of the Indian Ocean. These are all sites where substantial quantitative at-sea surveys have taken place in areas commonly frequented by remote-tracked albatrosses.

6.3.4 Links to data from fisheries

The highest priority investigations, involving comparing the distribution data for albatrosses and petrels and fishing effort would include:
1. Identification of times and places where potential exists for adverse interactions between fisheries and albatrosses/petrels. This would enable:
   i. Specification of mitigation measures appropriate to these circumstances;
   ii. Approaches to RFMOs, singly or in combination, with appropriate jurisdictions, to seek to develop the necessary regulations to apply the mitigation measures.
2. Estimation of bycatch rates of albatrosses/petrels for appropriate areas and at appropriate scales and for extrapolation to areas where bycatch data from fisheries are currently lacking.
3. Assistance for modelling seabird-fishery interactions with implications for fisheries (taking financial losses through bycatch into account in cost-benefit analyses) and for seabird populations.

6.3.5 IBAs and Marine Protected Areas

A priority need is to relate areas of core habitat (at different levels of definition) to population estimates and threatened status in order to evaluate in detail the implications of different criteria for helping define marine IBAs (from the perspective of albatrosses and petrels). Additional, related, suggestions are made in Section 5.1.

There is also a need to develop this approach further by choosing suitable systems/areas in which to link to remote-tracking data on other seabirds (especially penguins) and to at-sea survey data. This is especially relevant for coastal and shelf systems (i.e. within EEZs).

In the context of Marine Protected Areas, it is important to develop this further in conjunction with data on other marine taxa (e.g. marine mammals, sea turtles) and on resource use (e.g. fisheries, hydrocarbons). This is relevant both to EEZs and to high seas.

6.3.6 Relationship with the Agreement for the Conservation of Albatrosses and Petrels

As indicated in Annex 9 the applications envisaged of these albatross and petrel data, particularly as set out above, have substantial relevance to the work of ACAP.

BirdLife International will continue to assist the development of products of relevance. It will also try to facilitate coordination on these initiatives and products through its partners, particularly in countries which are members of ACAP.

6.3.7 Long term database management

As indicated earlier (Section 6.2.3) there is a need to consider the long term future of the database, particularly in terms of maximising its usefulness as a resource, both to scientific research and international conservation.

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ANNEXES

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[1] Unable to attend workshop – represented by Aleks Terauds
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[3] Unable to attend workshop – represented by David Pinaud

ANNEX 2 LIST OF DATA SUBMITTED

Table 1. Breeding PTT datasets submitted to the Global Procellariiform Tracking Workshop.

Site	Colony	Breeding stage	Year(s)	Contributor(s)	Main reference(s)
Wandering Albatross (*Diomedea exulans*)					
Iles Crozet		incubation	1989–2001	a	Jouventin and Weimerskirch 1990,
		chick	1990–1999		Waugh and Weimerskirch 2003, Weimerskirch 1998
Iles Kerguelen		chick	1998–1999	a	Jouventin and Weimerskirch 1990, Waugh and Weimerskirch 2003, Weimerskirch 1998
Prince Edward Islands	Marion Island	incubation	1998	k	Nel *et al.* 2002
		brood guard	1997		
		post guard	1997		
South Georgia	Bird Island	incubation	1991–2000	e	Croxall and Prince 1996, Prince *et al.* 1998
		chick	1990–2002		
Tristan Albatross (*Diomedea dabbenena*)					
Gough Island		incubation	2001	n	Cuthbert *et al.* 2004
		brood guard	2001		
		post guard	2001		
Antipodean (Gibson's) Albatross (*Diomedea antipodensis gibsoni*)					
Auckland Islands	Adams Island	incubation	1994	j	Walker *et al.* 1995
		unknown	1994		
Amsterdam Albatross (*Diomedea amsterdamensis*)					
Ile Amsterdam		incubation	1996–2000	a	Waugh and Weimerskirch 2003
Southern Royal Albatross (*Diomedea epomophora*)					
Campbell Island	Campbell Island	incubation	1999	a	Waugh and Weimerskirch 2003
Northern Royal Albatross (*Diomedea sanfordi*)					
Chatham Islands		early breeding	1994–1996	m	Robertson C. and Nicholls 2000
New Zealand	Taiaroa Head	early breeding	1993–1998	m	Robertson C. and Nicholls 2000
Black-footed Albatross (*Phoebastria nigripes*)					
Hawaiian Islands	Tern Island	incubation	2002–2003	f	N
		brood	2003		
		early breeding	2003		
Laysan Albatross (*Phoebastria immutabilis*)					
Hawaiian Islands	Tern Island	incubation	2002–2003	f	N
		brood	2003		
		early breeding	2003		
Mexico	Isla de Guadalupe	early breeding	2003	l	N
Shy Albatross (*Thalassarche cauta*)					
Tasmania	Albatross Island	incubation	1993–1996	d	Brothers *et al.* 1998, Hedd *et al.* 2001, M
		brood guard	1997		
		post guard	1994–1995		
	Mewstone	incubation	1997–1998		
	Pedra Branca	incubation	1997		
Chatham Albatross (*Thalassarche eremita*)					
Chatham Islands	The Pyramid	chick	1997–1999	h, i	Robertson C. *et al.* 2000a
Buller's Albatross (*Thalassarche bulleri*)					
Solander Islands	North-West Headland	incubation	1997	g	Broekhuizen *et al.* 2003, Sagar and Weimerskirch 1996, Stahl and Sagar 2000a
		guard	1997		
		post guard	1997		
Snares Islands	Mollymawk Bay	pre-egg	2001–2002	g	Broekhuizen *et al.* 2003, Sagar and Weimerskirch 1996, Stahl and Sagar 2000b
		incubation	1995–2002		
		guard	1996		
		post guard	1996		
	Punui Bay	pre-egg	2001–2002		
		incubation	1999–2002		
		guard	1999		
		post guard	1999		
	Razorback	incubation	1999		
		guard	1999		
		post guard	1999		
	Unknown	incubation	1995	a	Sagar and Weimerskirch 1996
Black-browed Albatross (*Thalassarche melanophrys*)					
Chile	Isla Diego de Almagro	incubation	2001	b	F
	Islas Diego Ramirez	incubation	1997–2001		
		brood	1999–2001		
		early breeding	1997–1999		
		post guard	2001–2002		
	Islas Ildefonso	incubation	2001		
Falkland Islands (Malvinas)	Beauchêne Island	incubation	2000	c	Huin 2002
		post guard	2000		
	Saunders Island	incubation	1998		
		post guard	1999		
Iles Kerguelen		incubation	1999	a	Weimerskirch 1998
		chick	1994–1995		
Macquarie Island		incubation	1999–2001	d	Terauds *et al.* in prep
		brood guard	2000		
South Georgia	Bird Island	incubation	1996	e	A
		chick	1993–1994		Prince *et al.* 1998

Table 1 ... continued. Breeding PTT datasets submitted to the Global Procellariiform Tracking Workshop.

Site	Colony	Breeding stage	Year(s)	Contributor(s)	Main reference(s)
Grey-headed Albatross (*Thalassarche chrysostoma*)					
Campbell Island		chick	1997	a	Waugh *et al.* 1999
Chile	Islas Diego Ramirez	incubation	1997–2001	b	F
		brood	2000–2002		
		post guard	2001–2002		
	Islas Ildefonso	incubation	2001		
Macquarie Island		incubation	1999–2001	d	Terauds *et al.* in prep
		brood guard	1999–2000		
Prince Edward Islands	Marion Island	incubation	1997	k	Nel *et al.* 2000, Nel *et al.* 2001
		chick	1998		
South Georgia	Bird Island	incubation	1993–1995	e	A
		chick	1991–2001		Prince *et al.* 1998
Indian Yellow-nosed Albatross (*Thalassarche carteri*)					
Ile Amsterdam		incubation	2000	a	Weimerskirch 1998, G
		chick	1995–2001		
Sooty Albatross (*Phoebetria fusca*)					
Iles Crozet		early breeding	1992–1995	a	Weimerskirch 1998
Light-mantled Albatross (*Phoebetria palpebrata*)					
Macquarie Island	Bauer Bay	incubation	2002–2003	d	M
		brood guard	2002–2003		
	Hurd Point	incubation	2002–2003		
		brood guard	2002–2003		
Southern Giant-petrel (*Macronectes giganteus*)					
Argentina	Isla Arce	brood	2001–2002	o	J
	Isla Gran Robredo	incubation	1999–2000		Quintana and Dell'Arciprete 2002
		brood	2000		
Antarctic Peninsula	Palmer Station	incubation	1999–2003	p[1]	I
		early breeding	1999–2003		
		brood	2001		
		brood guard	1999–2003		
		chick	1999–2003		
		guard	1999–2002		
		post guard	2003		
South Georgia	Bird Island	incubation	1998–1999	x	González-Solís *et al.* 2000a
Northern Giant-petrel (*Macronectes halli*)					
South Georgia	Bird Island	incubation	1998	x	A
White-chinned Petrel (*Procellaria aequinoctialis*)					
Iles Crozet		incubation	1996	a	Weimerskirch *et al.* 1999
		chick	1997		
South Georgia	Bird Island	incubation	1996–1997	e	Berrow *et al.* 2000
		chick	1998		

[1] Data withdrawn after workshop

Table 2. Non-breeding PTT datasets (including failed breeders, non-breeding adults and juveniles/sub-adults/immatures) submitted to the Global Procellariiform Tracking Workshop.

Site	Colony	Age	Status	Year(s)	Contributor(s)	Main Reference(s)
Wandering Albatross (*Diomedea exulans*)						
Iles Crozet		adult	non-breeding	1992	t	Nicholls *et al.* 1995
Indian Ocean		adult	non-breeding	1992	t	Nicholls *et al.* 1995
Prince Edward Islands	Marion Island	adult	failed/migration	1997	k	Nel *et al.* 2002
		adult	non-breeding	1992	t	Nicholls *et al.* 1995
South Georgia	Bird Island	adult	failed/migration	1992–1998	e	Croxall and Prince 1996, Prince *et al.* 1998
Tasmania		adult	non-breeding	1993–1995	t	Nicholls *et al.* 1995
Antipodean Albatross (*Diomedea antipodensis*)						
Antipodes Islands		adult	failed/migration	1996	j, q	Nicholls *et al.* 1996, Nicholls *et al.* 2000
		adult	non-breeding	1996–1997		
Antipodean (Gibson's) Albatross (*Diomedea gibsoni*)						
Auckland Islands	Adams Island	adult	non-breeding	1995	j	Nicholls *et al.* 2000
Unknown		adult	non-breeding	1994		
Northern Royal Albatross (*Diomedea sanfordi*)						
Chatham Islands		adult	failed/migration	1996–1998	m	Robertson C. and Nicholls 2000
New Zealand	Taiaroa Head	adult	failed/migration	1998	m	Robertson C. and Nicholls 2000
		immature	non-breeding	1998		
Short-tailed Albatross (*Phoebastria albatrus*)						
Izu Shoto	Torishima	adult	failed/migration	2002–2003	s	unpubl.
Black-footed Albatross (*Phoebastria nigripes*)						
Unknown		adult	failed/migration	1997–1999	r	Hyrenbach and Dotson 2001, Hyrenbach and Dotson 2003
Shy Albatross (*Thalassarche cauta*)						
Tasmania	Albatross Island	immature	non-breeding	1996	d	Brothers *et al.* 1998, Hedd *et al.* 2001, M
	Mewstone	adult	failed/migration	2002		
	Pedra Branca	adult	failed/migration	2002		

Table 2 ... continued. Non-breeding PTT datasets (including failed breeders, non-breeding adults and juveniles/sub-adults/immatures) submitted to the Global Procellariiform Tracking Workshop.

Site	Colony	Age	Status	Year(s)	Contributor(s)	Main Reference(s)
Chatham Albatross (*Thalassarche eremita*)						
Chatham Islands	The Pyramid	adult	failed/migration	1997–1999	h, i	Robertson C. *et al.* 2000a
		immature	non-breeding	1998		
Buller's Albatross (*Thalassarche bulleri*)						
Solander Islands	North-West Headland	adult	failed/migration	1997	g	Broekhuizen *et al.* 2003, Sagar and Weimerskirch 1996, Stahl and Sagar 2000a
		unknown	non-breeding	2002		
Snares Islands	Mollymawk Bay	immature	non-breeding	2000–2001	g	Broekhuizen *et al.* 2003, Sagar and Weimerskirch 1996, Stahl and Sagar 2000b
	Punui Bay	adult	failed/migration	2002		
		adult	non-breeding	2001		
		immature	non-breeding	2000–2001		
Black-browed Albatross (*Thalassarche melanophrys*)						
Falkland Islands (Malvinas)	Beauchêne Island	adult	failed/migration	2000	c	Huin 2002
South Georgia	Bird Island	adult	failed/migration	1992–1993	e	Prince *et al.* 1998
Grey-headed Albatross (*Thalassarche chrysostoma*)						
Chile	Islas Diego Ramirez	adult	failed/migration	1999	b	F
South Georgia						
	Bird Island	adult	failed/migration	1996	e	Prince *et al.* 1998
Southern Giant-petrel (*Macronectes giganteus*)						
Antarctic Peninsula	Palmer Station	adult	non-breeding	2001–2002	p[1]	I

1 Data withdrawn after workshop

Table 3. Breeding and non-breeding GLS datasets submitted to the Global Procellariiform Tracking Workshop.

Site	Colony	Status	Year(s)	Contributor(s)	Main reference(s)
Black-browed Albatross (*Thalassarche melanophrys*)					
Chile	Islas Diego Ramirez	non-breeding	2001	u	A
Falkland Islands (Malvinas)	Saunders Island	non-breeding	1999–2000	v	A
South Georgia	Bird Island	non-breeding	2002	w	A
Grey-headed Albatross (*Thalassarche chrysostoma*)					
South Georgia	Bird Island	non-breeding	1999–2000	w	A

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ANNEX 3 ALBATROSS TRACKING AND UTILISATION DISTRIBUTIONS FROM KERNELS

Introduction

The exploration of kernelling Royal Albatross data arose because there were strong differences on methods of analysis and the presentation of the results of satellite tracking. The Workshop faces similar challenges. Our satellite telemetry methodology differed between the various individuals within the single species. The differences were intentional at the time, but it requires careful analysis if we are to achieve valid comparisons and summaries. These complications are directly relevant to procedures combining datasets.

Definitions

The kernel is the shape placed over each observation. The process of summing the kernels creates a measure of abundance, either as a density, or the probability of occurrence across the range.

Utilisation distribution is the grid or contour map of the occurrence.

Home range is the area used by an animal in its normal daily activities. Home range for an albatross that has migrated to the other side of the world is arguably a contradiction, so we used range.

Methods

The homogenous data set is of a single northern royal albatross (abandoned breeding, migrated via the Pacific Ocean to the Patagonian Shelf; bird was present from March to 30 June, totalling 558 selected Argos locations; transmission regime: on-period 25 hours, off-period 23 hours, i.e. exactly two days. The kernels, utilisations distributions and maps were prepared in Animal Movements Extension 2.0 in ESRI ArcView 3.2.).

Results

Smoothing produces different forms of the Utilisation Distributions. The user must decide the form depending on their hypothesis. There is no single choice, and no one other than the user can decide. Different kinds of subsets of the data do affect the range and Utilisation Distributions. These differences may be deeply hidden in the data. We tested the sample size and its effects on the area of the range. Small samples underestimated the range, but indicated a measure of by how much the range might be underestimated. It cannot of course show the places where an underestimate might be occurring.

Subsets

With subsets, such as day versus night, or, night, dawn, day, dusk, accuracy of locations and speed, the area of the ranges was close to the range area expected for the sample size. However for transmission regime, or, for seasonal time periods of the time spent on the Patagonian Shelf namely, early, middle and late, the range areas emphatically did not match the range for the complete data set.

Conclusions

Choosing the smoothing is subjective. The activity at hot spots is speculative. Concentrations may only in a limited sense indicate risk. Combining results and comparing maps from different datasets, other than at the most superficial levels, needs care but the exploration described here provides methods to ensure valid use.

David Nicholls, Christopher Robertson and Beat Naef-Daenzer

ANNEX 4 LIST OF PUBLISHED TRACKING STUDIES OF ALBATROSSES AND PETRELS

Species	Colony	Incubation	Chick-rearing	Adult non-breeding
Wandering Albatross (*Diomedea exulans*)	South Georgia	A	Arnould *et al.* 1996, Croxall and Prince 1996, Nicholls *et al.* 2002, Prince *et al.* 1992, 1998, 1999, Xavier *et al.* 2003, 2004	Prince *et al.* 1998, A
	Prince Edward	Nel *et al.* 2002	Nel *et al.* 2002	
	Crozet	Weimerskirch *et al.* 1993, 1994, 1997a, 1997b, Weimerskirch 1998	Weimerskirch *et al.* 1993, 1994, 1997a, 1997b, Weimerskirch 1998, Shaffer *et al.* 2003	Nicholls *et al.* 1995, Weimerskirch and Wilson 2000
	Macquarie	B	B	
	At sea			Nicholls *et al.* 1995, Murray *et al.* 2002, 2003a
Tristan Albatross (*Diomedea dabbenena*)	Gough	Cuthbert *et al.* 2004	Cuthbert *et al.* 2004	C
Antipodean Albatross (*Diomedea antipodensis*)	Antipodes	Nicholls *et al.* 2002 N	Nicholls *et al.* 2002	Murray *et al.* 2003b, Nicholls *et al.* 1996, 2000
	Campbell			
Antipodean (Gibson's) Albatross (*Diomedea antipodensis gibsoni*)	Auckland	Walker *et al.* 1995 N	Walker *et al.* 1995	Murray *et al.* 2002, 2003b, Nicholls *et al.* 2000
Amsterdam Albatross (*Diomedea amsterdamensis*)	Amsterdam and St. Paul	Waugh and Weimerskirch 2003		
Southern Royal Albatross (*Diomedea epomophora*)	Campbell Auckland	Troup *et al.* 2000, Waugh *et al.* 2002		
Northern Royal Albatross (*Diomedea sanfordi*)	Chatham	Nicholls *et al.* 1994, 2002, Robertson C. and Nicholls 2000	Nicholls *et al.* 1994, 2002, Robertson C. and Nicholls 2000	Nicholls *et al.* 1994, 2002, Robertson C. and Nicholls 2000
	Taiaroa Head	Robertson C. and Nicholls 2000	Robertson C. and Nicholls 2000	Robertson C. and Nicholls 2000
Waved Albatross (*Phoebastria irrorata*)	Galapagos	Anderson *et al.* 1998, 2003	Anderson *et al.* 2003	
Short-tailed Albatross (*Phoebastria albatrus*)	Izu (Torishima) Senkaku	E	E	E
Black-footed Albatross (*Phoebastria nigripes*)	Midway and North-western Hawaii Izu (Torishima) Bonin, Japan Senkaku	O	Fernández *et al.* 2001, Hyrenbach *et al.* 2002	
Laysan Albatross (*Phoebastria immutabilis*)	Midway and North-western Hawaii	O	Fernández *et al.* 2001, Hyrenbach *et al.* 2002	
	Bonin, Japan			
	Mexico (Guadalupe)	O	O	
Shy Albatross (*Thalassarche cauta*)	Tasmania (Albatross, Mewstone, Pedra Branca)	Brothers *et al.* 1998, Gales *et al.* 2000, Hedd *et al.* 2001	Brothers *et al.* 1998, Gales *et al.* 2000, Hedd *et al.* 2001	Brothers *et al.* 1998, Gales *et al.* 2000
White-capped Albatross (*Thalassarche steadi*)	Auckland Antipodes			
Salvin's Albatross (*Thalassarche salvini*)	Bounty Snares			
Chatham Albatross (*Thalassarche eremita*)	Chatham	Nicholls and Robertson C. 2000, Robertson C. *et al.* 2000a	Nicholls and Robertson C. 2000, Robertson C. *et al.* 2000a	Nicholls and Robertson C. 2000, Robertson C. *et al.* 2000a
Buller's Albatross (*Diomedea bulleri*)	Snares	Sagar and Weimerskirch 1996, Stahl and Sagar 2000b	Stahl and Sagar 2000b	
	Solander	Stahl and Sagar 2000a	Stahl and Sagar 2000a	Stahl and Sagar 2000a
	Chatham			
Black-browed Albatross (*Thalassarche melanophrys*)	Falkland Islands (Malvinas)	Grémillet *et al.* 2000, Huin 2002	Huin 2002	Grémillet *et al.* 2000
	South Georgia	Phillips *et al.* 2003, 2004b	Bevan *et al.* 1995, Phillips *et al.* 2003, 2004b, Prince *et al.* 1998, 1999, Veit and Prince 1997, Wood *et al.* 2000	Prince *et al.* 1998 A
	Chile (Diego Ramirez)	Robertson C. *et al.* 2000b, F	Robertson C. *et al.* 2000b, F	
	Crozet		Weimerskirch 1998	
	Kerguelen	Pinaud and Weimerskirch 2002	Cherel and Weimerskirch 1995, Pinaud and Weimerskirch 2002, Waugh and Weimerskirch 1998, Weimerskirch *et al.* 1997c	
	Heard			
	Macquarie	B	B	
	Antipodes			

Species	Colony	Incubation	Chick-rearing	Adult non-breeding
Campbell Albatross (*Thalassarche impavida*)	Campbell		Waugh and Weimerskirch 1998, Waugh *et al.* 1999	
Grey-headed Albatross (*Thalassarche chrysostoma*)	South Georgia	Phillips *et al.* 2004b	Bevan *et al.* 1995, Catry *et al.* in press a and b, Phillips *et al.* 2004b, Prince *et al.* 1998, 1999, Rodhouse *et al.* 1996, Veit and Prince 1997, Wood *et al.* 2000, Xavier *et al.* 2003	A
	Chile (Diego Ramirez)	Robertson C. *et al.* 2000b	Robertson C. *et al.* 2000b	
	Prince Edward	Nel *et al.* 2000, 2001	Nel *et al.* 2000, 2001	
	Crozet			
	Kerguelen			
	Campbell		Waugh *et al.* 1999	
	Macquarie	B	B	
Indian Yellow-nosed Albatross (*Thalassarche carteri*)	Prince Edward			
	Crozet			
	Amsterdam and St. Paul		Weimerskirch 1998, G	
	Kerguelen			
Atlantic Yellow-nosed Albatross (*Thalassarche chlororhynchos*)	Gough	C	C	C
	Tristan da Cunha			
Sooty Albatross (*Phoebetria fusca*)	Gough	C	C	C
	Tristan da Cunha			
	Prince Edward		H	
	Crozet	Weimerskirch 1998	Weimerskirch 1998	
	Kerguelen			
	Amsterdam and St Paul			
Light-mantled Albatross (*Phoebetria palpebrata*)	South Georgia		Phillips *et al.* in press	A
	Prince Edward			
	Crozet	Weimerskirch 1998		
	Kerguelen			
	Heard			
	Macquarie	Weimerskirch and Robertson G. 1994		
	Auckland			
	Campbell			
	Antipodes			
Southern Giant-petrel (*Macronectes giganteus*)	Chile			
	Argentina	Quintana and Dell'Arciprete 2002, J	Quintana and Dell'Arciprete 2002, J	
	Falkland Islands (Malvinas)			
	South Georgia	González-Solís *et al.* 2000a, 2000b	González-Solís *et al.* 2000a, 2000b	
	South Orkney and S. Shetland			
	Antarctic Peninsula	Patterson and Fraser 2000, I	Patterson and Fraser 2000, I	I
	Gough			
	Prince Edward			
	Crozet			
	Kerguelen			
	Heard			
	Macquarie			
Northern Giant-petrel (*Macronectes halli*)	South Georgia	González-Solís *et al.* 2000a, 2000b	González-Solís *et al.* 2000a, 2000b	
	Prince Edward Islands			
	Crozet			
	Kerguelen			
	Macquarie			
	Auckland			
	Campbell			
	Antipodes			
	Chatham			
	Stewart			
Northern Fulmar (*Fulmarus glacialis*)	Greenland			Falk and Møller 1995
	Bjørnøya		Weimerskirch *et al.* 2001	
White-chinned Petrel (*Procellaria aequinoctialis*)	Falkland Islands (Malvinas)			
	South Georgia	Berrow *et al.* 2000, Weimerskirch *et al.* 1999	Berrow *et al.* 2000	Berrow *et al.* 2000, A
	Prince Edward			
	Crozet	Weimerskirch *et al.* 1999	Catard *et al.* 2000	
	Kerguelen			
	Auckland			
	Campbell			
	Antipodes			

Species	Colony	Incubation	Chick-rearing	Adult non-breeding
Spectacled Petrel (*Procellaria conspicillata*)	Inaccessible			
Black Petrel (*Procellaria parkinsoni*)	Little and Great Barrier Islands	K	K	
Westland Petrel (*Procellaria westlandica*)	New Zealand (Punakaiki)	L	Freeman *et al.* 1997, 2001, L	
Grey Petrel (*Procellaria cinerea*)				
Cory's Shearwater (*Calonectris diomedea*)	Crete Salvages	 Mougin and Jouanin 1997		Ristow *et al.* 2000
Pink-footed Shearwater (*Puffinus creatopus*)	Chile (Mocha)	Guicking *et al.* 2001		
Great Shearwater (*Puffinus gravis*)				
Sooty Shearwater (*Puffinus griseus*)	Snares		Weimerskirch and Shaffer 2003	
Short-tailed Shearwater (*Puffinus tenuirostris*)	SE Australia (Montague, NSW; French, Vic.)		Klomp and Schultz 1998, 2000	Nicholls *et al.* 1998

Unpublished data and studies in progress

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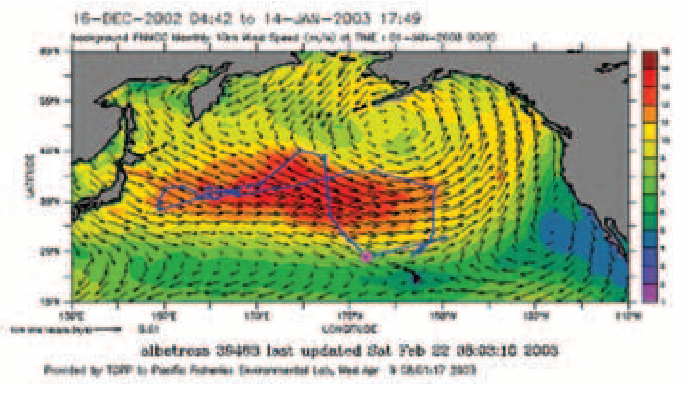
ANNEX 5 TAGGING OF PACIFIC PELAGICS (TOPP)

Programme overview

Tagging of Pacific Pelagics (TOPP) is a large multidisciplinary research program that combines the efforts of fish, shark, squid, and marine bird, mammal, and reptile biologists with the oceanographic community to study how the physical processes of the oceans affect species distributions, abundances, and movement patterns (Block *et al.* 2003). A central objective of TOPP is to devise better predictive tools to model ecosystem dynamics of the North Pacific Ocean and possibly other oceans in the future. TOPP also aims to increase public awareness of ocean life by developing outreach programs to educate students, teachers, and the general public about the lives of organisms that most people rarely see in a lifetime.

To study pelagic predators, TOPP investigators are using the animals as ocean explorers to obtain an "organism eye" view of the pelagic realm. Thus, animals are equipped with state of the art microprocessor-based data collection devices (see Table 1 for details on seabirds) to sense and record a variety of parameters of the ocean environment (e.g. temperature, conductivity, and light) in which they inhabit. Data are either transmitted via the Advanced Research Global Observation Satellite (Argos) uplink or animals are recaptured at a later date for device recovery and data retrieval. In addition, TOPP investigators are using a variety of remote sensing tools (e.g. AVHRR, SeaWifs, QuickScat) that are combined with data collected on the animals to obtain a clearer picture of the physical and biological processes that influence where pelagic organisms find food. In essence, this information will provide a much greater resolution of the "hotspots" that cause marine predators to aggregate in specific oceanic regions.

A final element of the TOPP program is to develop a suite of analytical tools that can be used to quantify, qualify, visualise, and archive data in a more integrative and dynamic way. One tool already under development is a Live Access Server (LAS), which is a database that contains information collected on the animals as well as environmental data collected via remote sensing. When visualised together (Figure 1), a clearer view of the physical features that influence where animals travel can be obtained. For example, Figure 1 shows the movement pattern of a Laysan Albatross tracked with satellite telemetry from Tern Island, Northwest Hawaiian Islands. The track is overlaid on top of the average wind vectors and barometric pressure for the time period in which the animal was tracked. We believe that the LAS is a tool that will provide researchers, environmental managers and policy makers with the information necessary to regulate, manage, and conserve pelagic ecosystems of the North Pacific Ocean.



The role of seabirds in the TOPP Program

Pelagic seabirds are major marine predators that search for food over both meso- and broad-scale ocean habitats (Hyrenbach *et al.* 2002, Fritz *et al.* 2003). The physical forcing of water aggregates their prey, so it is conceivable that seabirds seek out particular oceanographic features to find food. Seabirds also form an integral part of the TOPP program because many species overlap spatially, temporally, and trophically with other TOPP organisms. Therefore, it is possible to investigate the interactions between seabirds and other TOPP organisms by tracking multiple species at the same time. Another and perhaps more compelling reason why the TOPP program is studying seabirds is that they operate over very large spatial scales within a minimum amount of time because they can fly rapidly over the sea surface (400-500 km day^{-1} in albatrosses). ***Thus, seabirds can sample the marine environment quickly, so their response to changes in oceanographic features occurs over short temporal scales compared to most other TOPP organisms.***

TOPP is also studying seabirds because many species forage in locations that overlap with areas heavily used by human activities. For example, Laysan and Black-footed Albatrosses forage in areas that are prime fishing grounds for the longline fishing fleets. Thus birds are exposed to risks of entanglement with hooks or nets. The information gained by studying seabirds directly or indirectly affected by interactions with humans follows one of the main directives of TOPP's parent program, the Census of Marine Life (CoML), which is a large international organisation interested in conserving marine life.

Currently, there are four seabird species being studied in the TOPP program. This includes Laysan and Black-footed Albatrosses tracked from Tern Island, Northwest Hawaiian Islands, and Laysan Albatrosses from Guadalupe Island, Mexico. Investigators are also conducting preliminary studies on Sooty Shearwaters (*Puffinus griseus*) at Snares Island, New Zealand and Pink-footed Shearwaters (*P. creatopus*) at the Juan Fernandez Islands, Chile. Although the shearwaters breed in the southern hemisphere, they are known to migrate into the North Pacific in between breeding seasons. At this time, it is believed that the birds remain in the North Pacific for several months. Therefore, TOPP investigators are testing the use of archival geolocation tags to track the migratory flight patterns of the shearwaters during the non-breeding periods.

Scott Shaffer and Dan Costa

Table 1. Electronic tags deployed on seabirds in TOPP.

Tag	Cost	Location Quality	Duration of use	Size (grams)	Species
Argos PTT	$2,500	0.1–60 km	30-40 d	15–30	Albatrosses
GPS	$1,500	3–10 m	30+ d	60	Albatrosses
Archival	$1,000	~ 185 km	2 yrs	6	Albatrosses and Shearwaters

ANNEX 6 EXAMPLES OF DATA ACCESS AND TERMS OF USE WEB PAGES

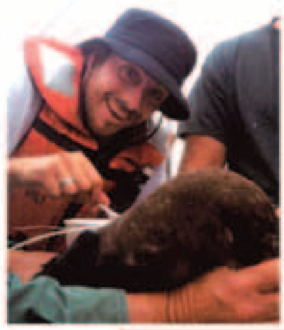
6.1 Example of data provider profile page

Logout

Profile

Dr. David Hyrenbach

Title	Research Scientist
Organisation	Duke University Marine Laboratory acronym: DUML
Address (line 1)	135 Duke Marine Lab Road
Address (line 2)	
City	Beaufort
State	NC
Zip	28516
Country	USA
Phone	+1 (252) 504-7576
Fax	+1 (252) 504-7648
Email	khyrenba@duke.edu
URL	http://moray.ml.duke.edu//david_hyrenbach.shtml
Comments	



Edit My Profile

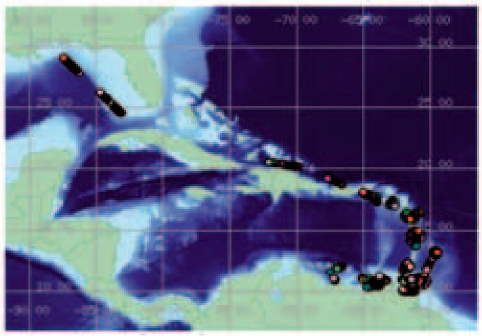
Datasets

ID	Title	Taxonomy	Metadata	Published	Owner	Actions
7	Duke Marine Lab Albatross Tagging	X	X	X	David Hyrenbach	

+ Add New Dataset (PROVIDES LINKS TO DATA SUBMISSION / META-DATA CREATION TOOLS)

6.2 Example of data set documentation page

Title	Duke Marine Lab Albatross Tagging
ID	7
# of Records	657
Date, Begin	1997-Jul-10
Date, End	1999-Sep-20
Latitude, Min	23.30
Latitude, Max	43.37
Longitude, Min	-156.27
Longitude, Max	-113.24



larger image (ZOOM IN)
interactive map (LINK TO MAPPING TOOLS)

View Species Recorded
(LINK TO SPECIES-SPECIFIC PAGE)

View Metadata (LINK TO DATA SET META-DATA PAGE)

Download data as text (comma-separated values *.csv) (OPTION TO DOWNLOAD THE DATA)

Data Source
David Hyrenbach, at Duke University Marine Lab (LINK TO DATA PROVIDER(S) PAGE(S))

Abstract
Argos satellite tracking of post-breeding Black-footed Albatrosses during their dispersal at-sea off southern California. A total of 4 female and 1 male birds in adult (age 3) plumage, but of unknown provenance / and reproductive status, were tracked during summer (July–September).

Purpose
This objective of this pilot study was to assess the feasibility of capturing and tagging albatrosses at-sea from an oceanographic vessel. These data were used to assess the susceptibility of the satellite-tracked birds to the Japanese Eastern Pacific Ocean (EPO) pelagic longline fishery, by quantifying the temporal and spatial overlap of the telemetry tracks and fishing effort. Additionally, differences in nocturnal / diurnal activity patterns (ranging patterns, movement rates) were used to investigate the influence of diel and lunar cycles on albatross foraging behaviour.

Contacts (PROVIDES ADDITIONAL CONTACT INFORMATION AND A LOG OF DATASET MODIFICATIONS)

Name	Role	Date modified
Hyrenbach, David	Data Collector	–
Hyrenbach, David	Data Provider	–

6.3 Example of electronic "terms of use" form

1) Contact Information

a) Main Data Set Contact (Provider 1):

Title
Name
Organisation
Address
City
State
Zip
Country
Phone
Fax
Email

b) Data User:

Title
Name
Organisation
Address
City
State
Zip
Country
Phone
Fax
Email

Names of additional data provider(s):

Provider 2:
Provider 3:
Provider 4:
Provider 5:
Provider 6:

2) Agreement

a) Terms of Use

By using any Procellariiform tracking dataset, users agree to the following terms and conditions:

1) Not to use data contained herein in any publication, product, or commercial application without prior written **consent** from the original data provider(s). While initial inquiries may be conducted by electronic mail, users and providers will formalise their agreement using standardised electronic "terms of use" archived by the database manager(s). This form will document the type of data, the duration, and the anticipated products involved in the collaboration.
2) Once consent has been obtained, users shall adhere to the following conditions:
   - The original data provider(s) must be given **co-authorship** of any product including "recent" data, gathered during the previous 10 years, unless the original data provider declines authorship. Ultimately, inclusion as an author is decided by the data provider(s).
   - Authorship will be **optional** for products involving "historical" data gathered more than 10 years in the past, in which case, authorship decisions will be at the discretion of the user(s).
   - To **cite** both the original data provider(s) and the Procellariiform Tracking dataset appropriately after approval of use is obtained. More specifically, journal editors have suggested that the version of the database and the date the system was accessed be included in the citation. Additionally, the version of the specific database, as described in the meta-data, will be essential to determine the level of data filtering and processing.
3) No data user shall hold Argos Inc., the Procellariiform tracking database or the original data provider(s) **liable** for errors in the data. While every effort has been made to ensure the integrity and quality of the database, **BirdLife International** (or whomever maintains the database) cannot guarantee the accuracy of the datasets contained herein.

b) Comments:

- Main Data Set Contact (Provider 1):

- Data User:

3) Request Statement

a) Data Specifications: Please mark all applicable fields

Date Set Number / Title:

Geographic Scope: Range of latitude: Range of longitude:

Temporal Scope: Start date (YYMMDD): End date (YYMMDD):

Location Types: All available ☐ Geo-location ☐ GPS ☐ Argos ☐

Genders: All birds ☐ Known only ☐ Males only ☐ Females only ☐

Comments:

b) Data Use: Please mark all applicable fields

Professional Use:

Scientific Presentation ☐

Publication: Popular journal ☐ Technical report ☐ Book ☐ Peer-reviewed journal ☐

Grant proposal ☐

Other use:

Material be posted on the internet: None ☐ Figures ☐ Tables ☐ Text ☐

Time limit: Start date (YYMMDD): End date (YYMMDD):

Co-authorship Provider 2: Yes (compulsory) ☐ Yes (optional) ☐ No ☐

Co-authorship Provider 3: Yes (compulsory) ☐ Yes (optional) ☐ No ☐

Co-authorship Provider 4: Yes (compulsory) ☐ Yes (optional) ☐ No ☐

Co-authorship Provider 5: Yes (compulsory) ☐ Yes (optional) ☐ No ☐

Co-authorship Provider 6: Yes (compulsory) ☐ Yes (optional) ☐ No ☐

c) Approval:

We agree with the terms of use outlined above. We understand that this agreement facilitates the one-time use of the data as described above, and that it precludes the dissemination of any additional analyses or derived products, without further consensual agreement. That is, any use beyond the scope outlined in this document will be stipulated in additional data use agreements.

We hereby agree to abide by the terms of use described in this form.

Data Contact (Name, Date) ______________________ [Review before final submit]

Date User (Name, Date) ______________________ [Review before final submit]

Database Manager (Date Filed) ______________________ User Password ______________________

ANNEX 7 GAP ANALYSIS

Table 1. Summary of breeding and non-breeding PTT tracking data obtained, in relation to size of colony[1].

	All sites							Sites containing over 1% of global population							Sites containing over 5% of global population						
Species	No. Sites	Tracked	% Sites	5 Popn	No. hours	No. indivs	No. tracks	No. Sites	Tracked	% Sites	5 Popn	No. hours	No. indivs	No. tracks	No. Sites	Tracked	% Sites	5 Popn	No. hours	No. indivs	No. tracks
Breeding																					
Amsterdam Albatross	1	1	100%	100%	5,160	?	15	1	1	100%	100%	5,160	?	15	1	1	100%	100%	5,160	?	15
Antipodean Albatross	2							1							1						
Antipodean (Gibson's) Albatross	1	1	100%	100%	1,711	3	3	1	1	100%	100%	1,711	3	3	1	1	100%	100%	1,711	3	3
Atlantic Yellow-nosed Albatross	2							2							2						
Black-browed Albatross	10	5	50%	100%	63,611	>45	480	3	3	100%	99%	51,977	>39	447	3	3	100%	99%	51,977	>39	447
Black-footed Albatross	4	1	25%	97%	2,689	14	17	3	1	33%	97%	2,689	14	17	1	1	100%	97%	2,689	14	17
Buller's Albatross	4	2	50%	42%	31,541	47	229	3	2	67%	42%	31,541	47	229	3	2	67%	42%	31,541	47	229
Campbell Albatross	1							1							1						
Chatham Albatross	1	1	100%	100%	8,136	9	16	1	1	100%	100%	8,136	9	16	1	1	100%	100%	8,136	9	16
Grey-headed Albatross	7	5	71%	87%	54,683	>47	331	6	4	67%	87%	50,670	>41	322	6	4	67%	87%	50,670	>41	322
Indian Yellow-nosed Albatross	5	1	20%	70%	10,526	?	34	3	1	33%	70%	10,526	?	34	3	1	33%	70%	10,526	?	34
Laysan Albatross	4	2	50%	100%	8,266	34	37	1	1	100%	100%	8,266	14	17	1	1	100%	100%	8,266	14	17
Light-mantled Albatross	9	1	11%	9%	3,662	7	10	8	1	13%	9%	3,662	7	10	6	1	17%	9%	3,662	7	10
Northern Royal Albatross	2	2	100%	100%	7,255	16	31	1	1	100%	99%	6,370	13	28	1	1	100%	99%	6,370	13	28
Salvin's Albatross	3							1							1						
Short-tailed Albatross	3							2							2						
Shy Albatross	4	1	25%	14%	21,643	?	64	2	1	50%	14%	21,643	?	64	2	1	50%	14%	21,643	?	64
Sooty Albatross	7	1	14%	17%	8,194	?	26	5	1	20%	17%	8,194	?	26	4	1	25%	17%	8,194	?	26
Southern Royal Albatross	2	1	50%	99%	2,973	7	7	1	1	100%	99%	2,973	7	7	1	1	100%	99%	2,973	7	7
Tristan Albatross	2	1	50%	100%	11,451	38	128	1	1	100%	100%	11,451	38	128	1	1	100%	100%	11,451	38	128
Wandering Albatross	5	4	80%	100%	96,466	>132	442	4	4	100%	100%	96,466	>132	442	4	4	100%	100%	96,466	>132	442
Waved Albatross	2							1							1						
Northern Giant-petrel	9	1	11%	38%	3,921	18	18	8	1	13%	38%	3,921	18	18	5	1	20%	38%	3,921	18	18
Southern Giant-petrel	14	2	14%	20%	11,640	20	20	10	2	20%	20%	11,640	20	20	8	1	13%	15%	3,352	11	11
White-chinned Petrel	9	2	22%	?%	7,919	>9	39	?	2	?%	?%	7,919	>9	39	?	1	?%	?%	3,314	9	23
Non-breeding																					
Amsterdam Albatross	1							1							1						
Antipodean Albatross	2	1	50%	100%	1,823	3	13	1	1	100%	100%	1,823	3	13	1	1	100%	100%	1,823	3	13
Antipodean (Gibson's) Albatross	1	1	100%	100%	4,075	3	3	1	1	100%	100%	4,075	3	3	1	1	100%	100%	4,075	3	3
Atlantic Yellow-nosed Albatross	2							2							2						
Black-browed Albatross	10	2	20%	83%	2,661	3	3	3	2	67%	83%	2,661	3	3	3	2	67%	83%	2,661	3	3
Black-footed Albatross	4	1	25%	97%	1,846	6	8	3	1	33%	97%	1,846	6	8	1	1	100%	97%	1,846	6	8
Buller's Albatross	4	2	50%	42%	17,632	18	234	3	2	67%	42%	17,632	18	234	3	2	67%	42%	17,632	18	234
Campbell Albatross	1							1							1						
Chatham Albatross	1	1	100%	100%	20,520	11	19	1	1	100%	100%	20,520	11	19	1	1	100%	100%	20,520	11	19
Grey-headed Albatross	7	2	29%	74%	596	2	2	6	2	33%	74%	596	2	2	6	2	33%	74%	596	2	2
Indian Yellow-nosed Albatross	5							3							3						
Laysan Albatross	4							1							1						
Light-mantled Albatross	9							8							6						
Northern Royal Albatross	2	2	100%	100%	8,699	7	31	1	1	100%	99%	2,566	4	15	1	1	100%	99%	2,566	4	15
Salvin's Albatross	3							1							1						
Short-tailed Albatross	3	1	33%	91%	2,616	7	7	2	1	50%	91%	2,616	7	7	2	1	50%	91%	2,616	7	7
Shy Albatross	4	1	25%	14%	3,712	?	8	2	1	50%	14%	3,712	?	8	2	1	50%	14%	3,712	?	8
Sooty Albatross	7							5							4						
Southern Royal Albatross	2							1							1						
Tristan Albatross	2							1							1						
Wandering Albatross	5	3	60%	86%	9,196	8	8	4	3	75%	86%	9,196	8	8	4	3	75%	86%	9,196	8	8
Waved Albatross	2							1							1						
Northern Giant-petrel	9							8							5						
Southern Giant-petrel	14							10							8						
White-chinned Petrel	9							?							?						

[1] Colony sizes from Arata *et al.* (2003), BirdLife International (2004b), Gales (1998), Lawton *et al.* (2003), Patterson *et al.* (in press), Robertson C. *et al.* (2003b) and Tickell (2000).

Table 2. Breeding PTT tracking data obtained from the various colonies[1].

				PTT tracking data			
Species	Site	Annual no. breeding pairs	% global population	No. of hours	No. of individuals	No. of tracks	% tracking data (in hours)
Amsterdam Albatross	Ile Amsterdam	17	100%	5,160		15	100%
Antipodean Albatross	Antipodes Islands	5,148	100%				
	Campbell Island	6	0%				
Antipodean (Gibson's) Albatross	Auckland Islands	7,319	100%	1,711	3	3	100%
Atlantic Yellow-nosed Albatross	Gough Island	7,500	23%				
	Tristan da Cunha Islands	25,750	77%				
Black-browed Albatross	Antipodes Islands	115	0%				0%
	Campbell Island	16	0%				0%
	Chile	122,870	18%	30,863		165	49%
	Falkland Islands (Malvinas)	380,000	62%	13,396	18	198	21%
	Heard and McDonald Islands	729	0%				0%
	Iles Crozet	880	0%				0%
	Iles Kerguelen	4,270	1%	7,678		26	12%
	Macquarie Island	182	0%	3,956	6	7	6%
	Snares Islands	1	0%				0%
	South Georgia	100,332	16%	7,718	21	84	12%
Black-footed Albatross	Hawaiian Islands	62,575	97%	2,689	14	17	100%
	Izu Shoto	914	1%				0%
	Ogasawara Gunto (Bonin Islands)	1,103	2%				0%
	Senkaku Retto	25	0%				0%
Buller's Albatross	Chatham Islands	18,150	58%				0%
	Three Kings	20	0%				0%
	Snares Islands	8,465	27%	24,063	37	180	76%
	Solander Islands	4,800	15%	7,478	10	49	24%
Campbell Albatross	Campbell Island	26,000	100%				
Chatham Albatross	Chatham Islands	4,000	100%	8,136	9	16	100%
Grey-headed Albatross	Campbell Island	6,400	6%	1,271	5	5	2%
	Chile	16,408	15%	22,288		67	41%
	Iles Crozet	5,940	6%				0%
	Iles Kerguelen	7,905	7%				0%
	Macquarie Island	84	0%	4,013	6	9	7%
	Prince Edward Islands	7,717	7%	1,894		6	3%
	South Georgia	61,582	58%	25,217	36	244	46%
Indian Yellow-nosed Albatross	Ile Amsterdam	25,000	70%	10,526		34	100%
	Ile St. Paul	12	0%				0%
	Iles Crozet	4,430	12%				0%
	Iles Kerguelen	50	0%				0%
	Prince Edward Islands	6,000	17%				0%
Laysan Albatross	Hawaiian Islands	554,318	100%	4,474	14	17	54%
	Izu Shoto	1	0%				0%
	Mexico	350	0%	3,792	20	20	46%
	Ogasawara Gunto (Bonin Islands)	30	0%				0%
Light-mantled Albatross	Antipodes Islands	169	1%				0%
	Auckland Islands	5,000	23%				0%
	Campbell Island	1,600	7%				0%
	Heard and McDonald Islands	350	2%				0%
	Iles Crozet	2,421	11%				0%
	Iles Kerguelen	4,000	18%				0%
	Macquarie Island	2,000	9%	3,662	7	10	100%
	Prince Edward Islands	241	1%				0%
	South Georgia	6,250	28%				0%
Northern Royal Albatross	Chatham Islands	2,060	99%	6,370	13	28	88%
	Taiaroa Head	18	1%	885	3	3	12%
Salvin's Albatross	Bounty Islands	76,352	99%				
	Iles Crozet	4	0%				
	Snares Islands	587	1%				
Short-tailed Albatross	Hawaiian Islands	1	0%				
	Izu Shoto	220	95%				
	Senkaku Retto	11	5%				
Shy Albatross	Antipodes Islands	18	0%				0%
	Auckland Islands	72,233	85%				0%
	Chatham Islands	1	0%				0%
	Tasmania	12,250	14%	21,643		64	100%
Sooty Albatross	Gough Island	5,000	38%				0%
	Ile Amsterdam	350	3%				0%
	Ile St. Paul	20	0%				0%
	Iles Crozet	2,248	17%	8,194		26	100%
	Iles Kerguelen	4	0%				0%
	Prince Edward Islands	2,755	21%				0%
	Tristan da Cunha Islands	2,747	21%				0%

Table 2 ... continued. Breeding PTT tracking data obtained from the various colonies[1].

Species	Site	Annual no. breeding pairs	% global population	PTT tracking data: No. of hours	No. of individuals	No. of tracks	% tracking data (in hours)
Southern Royal Albatross	Auckland Islands	72	1%				0%
	Campbell Island	7,800	99%	2,973	7	7	100%
Tristan Albatross	Gough Island	798	100%	11,451	38	128	100%
	Tristan da Cunha Islands	3	0%				0%
Wandering Albatross	Iles Crozet	2,062	26%	48,870		204	51%
	Iles Kerguelen	1,094	14%	1,742		11	2%
	Macquarie Island	10	0%				0%
	Prince Edward Islands	2,707	34%	8,142	17	20	8%
	South Georgia	2,001	25%	37,712	115	207	39%
Waved Albatross	Isla de la Plata	10	0%				
	Islas Galápagos	18,200	100%				
Northern Giant-petrel	Antipodes Islands	300	3%				0%
	Auckland Islands	100	1%				0%
	Campbell Island	240	2%				0%
	Chatham Islands	2,150	19%				0%
	Iles Crozet	1,060	9%				0%
	Iles Kerguelen	1,400	12%				0%
	Macquarie Island	1,110	10%				0%
	Prince Edward Islands	540	5%				0%
	South Georgia	4,310	38%	3,921	18	18	100%
Southern Giant-petrel	Antarctic Continent	290	1%				0%
	Antarctic Peninsula	6,500	21%				0%
	Argentina	1,350	4%	8,288	9	9	71%
	Chile	290	1%				0%
	Falkland Islands (Malvinas)	3,100	10%				0%
	Gough Island	50	0%				0%
	Heard and McDonald Islands	4,400	14%				0%
	Iles Crozet	1,060	3%				0%
	Iles Kerguelen	4	0%				0%
	Macquarie Island	2,300	7%				0%
	Prince Edward Islands	1,790	6%				0%
	South Georgia	4,650	15%	3,352	11	11	29%
	South Orkney Islands	3,400	11%				0%
	South Sandwich Islands	1,550	5%				0%
White-chinned Petrel	Antipodes Islands	50,000	?%				0%
	Auckland Islands	50,000	?%				0%
	Campbell Island	?	?%				0%
	Iles Crozet	50,000	?%	4,605		16	58%
	Iles Kerguelen	200,000	?%				0%
	Falkland Islands (Malvinas)	?	?%				0%
	Macquarie Island	?	?%				0%
	Prince Edward Islands	?	?%				0%
	South Georgia	2,000,000	?%	3,314	9	23	42%

[1] Colony sizes from Arata *et al.* (2003), BirdLife International (2004b), Gales (1998), Lawton *et al.* (2003), Patterson *et al.* (in press), Robertson C. *et al.* (2003b) and Tickell (2000).

Table 3. Non-breeding PTT tracking data obtained from the various colonies[1].

Species	Site	Annual no. breeding pairs	% global population	PTT tracking data: No. of hours	No. of individuals	No. of tracks	% tracking data (in hours)
Amsterdam Albatross	Ile Amsterdam	17	100%				
Antipodean Albatross	Antipodes Islands	5,148	100%	1,823	3	13	100%
	Campbell Island	6	0%				0%
Antipodean (Gibson's) Albatross	Auckland Islands	7,319	100%	4,075	3	3	100%
Atlantic Yellow-nosed Albatross	Gough Island	7,500	23%				
	Tristan da Cunha Islands	25,750	77%				
Black-browed Albatross	Antipodes Islands	115	0%				0%
	Campbell Island	16	0%				0%
	Chile	122,870	18%				0%
	Falkland Islands (Malvinas)	380,000	62%	689	1	1	26%
	Heard and McDonald Islands	729	0%				0%
	Iles Crozet	880	0%				0%
	Iles Kerguelen	4,270	1%				0%
	Macquarie Island	182	0%				0%
	Snares Islands	1	0%				0%
	South Georgia	100,332	16%	1,972	2	2	74%
Black-footed Albatross	Hawaiian Islands	62,575	97%	1,846	6	8	100%
	Izu Shoto	914	1%				0%
	Ogasawara Gunto (Bonin Islands)	1,103	2%				0%
	Senkaku Retto	25	0%				0%

Table 3 ... continued. Non-breeding PTT tracking data obtained from the various colonies[1].

Species	Site	Annual no. breeding pairs	% global population	PTT tracking data: No. of hours	No. of individuals	No. of tracks	% tracking data (in hours)
Buller's Albatross	Chatham Islands	18,150	58%				0%
	Three Kings	20	0%				0%
	Snares Islands	8,465	27%	8,197	9	97	46%
	Solander Islands	4,800	15%	9,435	9	137	54%
Campbell Albatross	Campbell Island	26,000	100%				
Chatham Albatross	Chatham Islands	4,000	100%	20,520	11	19	100%
Grey-headed Albatross	Campbell Island	6,400	6%				0%
	Chile	16,408	15%	165	1	1	28%
	Iles Crozet	5,940	6%				0%
	Iles Kerguelen	7,905	7%				0%
	Macquarie Island	84	0%				0%
	Prince Edward Islands	7,717	7%				0%
	South Georgia	61,582	58%	431	1	1	72%
Indian Yellow-nosed Albatross	Ile Amsterdam	25,000	70%				
	Ile St. Paul	12	0%				
	Iles Crozet	4,430	12%				
	Iles Kerguelen	50	0%				
	Prince Edward Islands	6,000	17%				
Laysan Albatross	Hawaiian Islands	554,318	100%				
	Izu Shoto	1	0%				
	Mexico	350	0%				
	Ogasawara Gunto (Bonin Islands)	30	0%				
Light-mantled Albatross	Antipodes Islands	169	1%				
	Auckland Islands	5,000	23%				
	Campbell Island	1,600	7%				
	Heard and McDonald Islands	350	2%				
	Iles Crozet	2,421	11%				
	Iles Kerguelen	4,000	18%				
	Macquarie Island	2,000	9%				
	Prince Edward Islands	241	1%				
	South Georgia	6,250	28%				
Northern Royal Albatross	Chatham Islands	2,060	99%	2,566	4	15	29%
	Taiaroa Head	18	1%	6,133	3	15	71%
Salvin's Albatross	Bounty Islands	76,352	99%				
	Iles Crozet	4	0%				
	Snares Islands	587	1%				
Short-tailed Albatross	Hawaiian Islands	1	0%				0%
	Izu Shoto	220	95%	2,616	7	7	100%
	Senkaku Retto	11	5%				0%
Shy Albatross	Antipodes Islands	18	0%				0%
	Auckland Islands	72,233	85%				0%
	Chatham Islands	1	0%				0%
	Tasmania	12,250	14%	3,712	8	8	100%
Sooty Albatross	Gough Island	5,000	38%				
	Ile Amsterdam	350	3%				
	Ile St. Paul	20	0%				
	Iles Crozet	2,248	17%				
	Iles Kerguelen	4	0%				
	Prince Edward Islands	2,755	21%				
	Tristan da Cunha Islands	2,747	21%				
Southern Royal Albatross	Auckland Islands	72	1%				
	Campbell Island	7,800	99%				
Tristan Albatross	Gough Island	798	100%				
	Tristan da Cunha Islands	3	0%				
Wandering Albatross	Iles Crozet	2,062	26%	2,418	1	1	26%
	Iles Kerguelen	1,094	14%				0%
	Macquarie Island	10	0%				0%
	Prince Edward Islands	2,707	34%	3,161	3	3	34%
	South Georgia	2,001	25%	3,617	4	4	39%
Waved Albatross	Ecuador	10	0%				
	Islas Galápagos	18,200	100%				
Northern Giant-petrel	Antipodes Islands	300	3%				
	Auckland Islands	100	1%				
	Campbell Island	240	2%				
	Chatham Islands	2,150	19%				
	Iles Crozet	1,060	9%				
	Iles Kerguelen	1,400	12%				
	Macquarie Island	1,110	10%				
	Prince Edward Islands	540	5%				
	South Georgia	4,310	38%				

Table 3 ... continued. Non-breeding PTT tracking data obtained from the various colonies[1].

Species	Site	Annual no. breeding pairs	% global population	PTT tracking data: No. of hours	No. of individuals	No. of tracks	% tracking data (in hours)
Southern Giant-petrel	Antarctic Continent	290	1%				
	Antarctic Peninsula	6,500	21%				
	Argentina	1,350	4%				
	Chile	290	1%				
	Falkland Islands (Malvinas)	3,100	10%				
	Gough Island	50	0%				
	Heard and McDonald Islands	4,400	14%				
	Iles Crozet	1,060	3%				
	Iles Kerguelen	4	0%				
	Macquarie Island	2,300	7%				
	Prince Edward Islands	1,790	6%				
	South Georgia	4,650	15%				
	South Orkney Islands	3,400	11%				
	South Sandwich Islands	1,550	5%				
White-chinned Petrel	Antipodes Islands	50,000	?%				
	Auckland Islands	50,000	?%				
	Campbell Island	?	?%				
	Iles Crozet	50,000	?%				
	Iles Kerguelen	200,000	?%				
	Falkland Islands (Malvinas)	2,500	?%				
	Macquarie Island	?	?%				
	Prince Edward Islands	?	?%				
	South Georgia	2,000,000	?%				

[1] Colony sizes from Arata *et al.* (2003), BirdLife International (2004b), Gales (1998), Lawton *et al.* (2003), Patterson *et al.* (in press), Robertson C. *et al.* (2003b) and Tickell (2000).

ANNEX 8 MARINE MAMMAL TRACKING DATABASE

Project Title: A Database For The Study Of Marine Mammal Behaviour: A Tool To Define Their Critical Habitat And Behaviour

Principal Investigators: Drs. Daniel P. Costa and Scott A. Shaffer

Background

In recent years, the US Navy has come under pressure to evaluate the effects of its fleet activities on marine organisms, particularly marine mammals. Consequently, the Office of Naval Research created a program called Effects of Sound on the Marine Environment (ESME) to evaluate and model the influence of sound propagation on marine mammal species. As part of this effort, it was important to survey the scientific literature to collate information from all studies that focused on diving behaviour and/or tracking of free-ranging marine mammals. The data compiled from this survey were placed into a database that was used to model the impact and response of marine mammals to various sound fields.

Our long-term goal was to compile a comprehensive database that could be used alone or in combination with other disciplines (*e.g.,* oceanography, fisheries science, etc.) to develop predictive models for defining the critical habitat of marine mammals. The first goal was to compile a bibliography of all published research on diving behaviour and movement patterns of marine mammals. The second goal was to create a database, which incorporated all data from the publications. The third goal was to identify and catalogue where available, unpublished data with respect to species, investigator, data type, and their potential availability. The fourth goal was to host a workshop with all major investigators from the international community to discuss the possibility of creating a common data-reporting scheme for diving behaviour and movement patterns of marine mammals.

Our search for published papers, reports, book chapters, and books totalled to 448 references (413 references on diving behaviour and 35 on movement patterns). The bibliography contained references dating back to the 1960s to Nov 2002. The data from all available publications were extracted and entered into a Microsoft Access 2000 database. The specific diving behaviours of marine mammals included such parameters as the diving depth, duration, surface time, and diving frequency. We also incorporated the metadata that included details about the animals studied such as species, age, sex, reproductive season, and number of individuals tracked, etc. Lastly, the database included parameters about the locations of animals (e.g., hemisphere, major ocean basins, oceanic zones) and the type of equipment used to monitor diving and movement patterns. The database has 1,815 entries (i.e. single animals) comprised of 24 pinniped and 16 cetacean species, plus the dugong and sea otter. The majority of species are from high latitudes (67%), and the greatest representation is from pinnipeds (1,560 entries), of which, Antarctic fur seals (288 entries), Weddell seals (258 entries), and harbour seals (247 entries) comprise the majority of entries. For cetaceans, there are only 241 entries of which, the majority are from harbour porpoises (42 entries) and white whales (49 entries).

In December 2001, we held a workshop that focused on the feasibility, development, and implementation of a common approach to archive diving and tracking data of marine mammals. This included discussions focused on specific issues such as data formats, standards, metadata, and the potential for a central or common access archive. The workshop was a similar effort to that of the Procellariiform Tracking workshop and it included a total of 45 researchers from five countries including the U.S., Canada, Scotland, Australia, and Japan. Among all the participants, there was **unanimous** support for standardising the way data are reported in publications. Everyone felt this would make it easier to compare data collected by various groups. Concerning the creation of a central data archive, participants of the workshop were **unanimously** supportive but it was suggested that a *Metadata archive* be created initially. This Metadata archive would only contain information about 1) the instruments used, 2) the animals studied (e.g. age, mass, number, sex), 3) the synthesised published data, and 4) the complete contact information of the primary investigator. Thus, no proprietary data would be included. However, it was agreed that the creation of this type of an archive would be extremely useful and that it would expedite the exchange of information among different labs. In terms of creating a data repository for raw or unpublished data, there was **unanimous but conditional** support among the participants. This was largely attributed to three main factors: 1) proprietary control of raw unpublished data, 2) concern over the ability to maintain the data archive from a logistical and financial standpoint, and 3) data access and security. Lastly, our workshop received international notoriety by being featured in the journal *Nature* (volume 415, page 4, 2002).

Currently, there are similar efforts underway to accomplish what we originally set out to do. For example, the OBIS-SeaMAP program has developed a database that is a repository for similar types of data that we compiled. In the near future, we will port our database over the SeaMAP program. Lastly, we plan to submit a review paper this year that outlines the results of our work and offers directions for future studies. This database was funded by a grant from the Office of Naval Research (N00014-00-1-0880) to D.P. Costa.

Dan Costa and Scott Shaffer

ANNEX 9 SEABIRD TRACKING AND DISTRIBUTION: POTENTIAL CONTRIBUTIONS TO THE AGREEMENT ON THE CONSERVATION OF ALBATROSSES AND PETRELS (ACAP)

ACAP was designed to address the multitude of threats currently facing albatrosses and petrel populations, both on land and at sea. Therefore amongst its high level objectives, arising from the overall obligation to achieve and maintain a favourable conservation status for albatrosses and petrels, are mitigation of adverse influences, both at breeding colonies (e.g. elimination and control of non-native injurious taxa) and in marine habitats (e.g. incidental mortality). Both these aims require the development and use of effective conservation measures (another objective of ACAP).

In respect of marine habitats, ACAP's conservation objectives include:

- Conservation (and restoration) of habitats.
- Sustainability of marine living resources on which albatrosses and petrels depend.
- Avoidance of pollution.
- Development of management plans for the most important foraging and migratory habitats.
- Conservation of marine areas critical to survival of albatrosses/petrels with unfavourable conservation status.

The last two of these clearly require identification and delimitation of critical habitats, making the present BirdLife International initiative of considerable potential importance to the success of ACAP.

The tasks and responsibilities of the ACAP Advisory Committee—the group charged with the ACAP Action Plan—include, amongst a very extensive list of topics:

- Identifying known and suspected threats and best practice mitigation.
- Defining foraging ranges and migration routes.
- Assessing distribution and effort of interacting fisheries.
- Provision of data on albatross/petrel interactions with fisheries.

These four tasks lie at the heart of addressing threats to albatrosses and petrels in the marine environment.

The work being undertaken within the BirdLife Seabird Programme—and particularly in this project—is obviously highly relevant to these aims. The seabird tracking database is likely to be a key tool for furthering the work of ACAP.

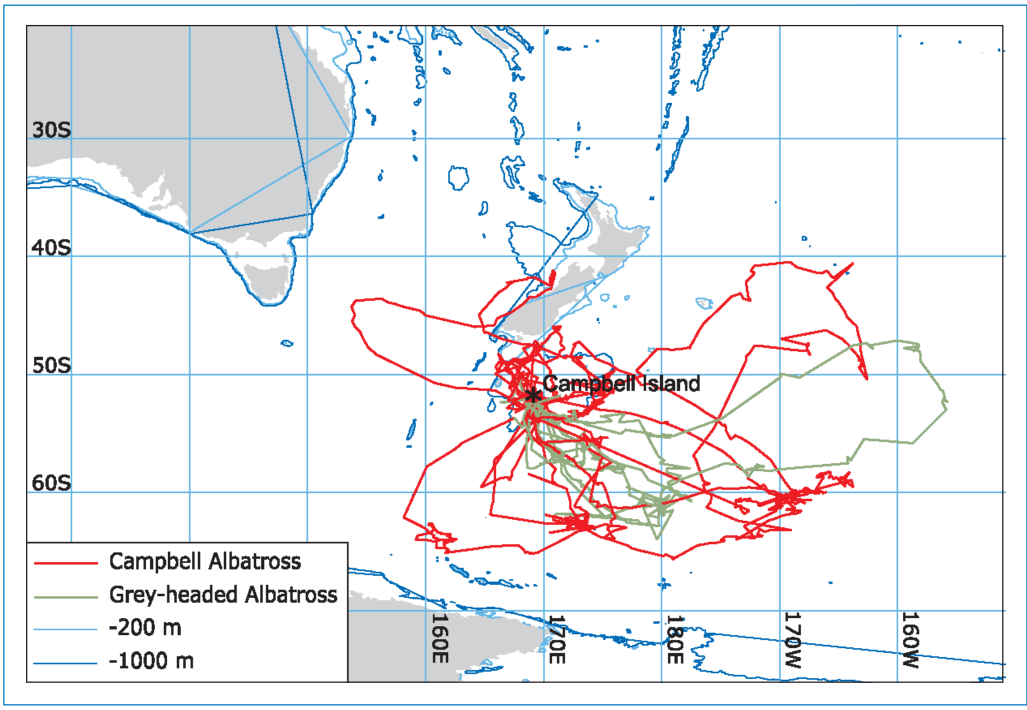
John Croxall

ANNEX 10 ERRATUM: CAMPBELL ALBATROSS *THALASSARCHE IMPAVIDA*

At the last stage before final proof, the editors were notified that of the 14 tracks from Campbell Island submitted to the database as Grey-headed Albatross *Thalassarche chrysostoma*, ten were of Campbell Albatross.

The main database has now been updated to reflect this. Data tables in this report have also been updated to indicate the true number of Grey-headed Albatross tracks submitted to the workshop. However time constraints prevented updating fully the following tables and figures: Figure 4.4, Figure 5.1, Figure 5.5, Figure 5.6, Table 5.1, Table 5.2, Figure 5.8, Figure 5.9, Figure 5.10, Table 5.3, Table 5.4, Figure 5.11, Figure 5.12, Figure 5.13, Table 5.5, Table 5.6, Figure 5.12, Figure 5.16, Table 5.7.

The effect on maps of Grey-headed Albatross distribution of these mis-classifications is, however, very small. A map showing the distribution of the tracks from Campbell Island (Grey-headed Albatross *Thalassarche chrysostoma* and Campbell Albatross *Thalassarche impavida*) is provided below.



Campbell and Grey-headed Albatrosses tracked from Campbell Island (Waugh *et al.* 1999).

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TRACKING OCEAN WANDERERS

The global distribution of albatrosses and petrels

Results from the Global Procellariiform Tracking Workshop, 1–5 September, 2003, Gordon's Bay, South Africa

Effective reduction of the threat to albatrosses and petrels requires accurate knowledge of their distribution throughout their life-cycle stages and annual migrations. Such data are invaluable in identifying important sea areas for foraging and migration, and in assessing the potential susceptibility of birds to mortality from interaction with fishing vessels. These birds also provide an indication of other changes in marine systems, such as climate change.

This report presents the results of a pioneering initiative, led by BirdLife International, in which scientists from around the world have collaborated to assemble and analyse a global database that includes over 90% of the world's remote-tracking data of albatrosses and petrels.

These data:

- make a unique contribution to defining key areas and critical habitats for albatrosses;
- identify national (e.g. within Exclusive Economic Zones) and international (e.g. through Regional Fisheries Management Organisations) responsibilities for the conservation of albatrosses and petrels;
- will be used to assess overlap and interaction between albatrosses and petrels and commercial fisheries, especially longline fisheries in which bycatch is the major threat to most albatross populations.

The data, and the results presented in this report, will be a key tool for the conservation of albatrosses and petrels. In particular:

- they will be of immense assistance in developing and prioritising the work of the international Agreement on the Conservation of Albatrosses and Petrels, designed to protect albatross and petrel habitats at land and at sea;
- they will facilitate the development of area and fishery-specific measures to reduce and eliminate the killing of seabirds in commercial fishing operations.

BirdLife will seek to stimulate development of, and links to, similar databases for other pelagic marine animals, especially other seabirds, marine mammals, turtles and migratory fish.

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