SCIENTIFIC COMMITTEE
FIFTH REGULAR SESSION

10-21 August 2009
Port Vila, Vanuatu

Spatial risk indicators for seabird interactions with longline fisheries in the western and central Pacific

WCPFC-SC5-2009/EB-WP-06

David Seán Kirby[1], Susan Waugh[2], Dominique Filippi[3]

[1]Oceanic Fisheries Programme, Secretariat for the Pacific Community,
BP D5, 98848 Nouméa Cédex, New Caledonia
[2]BirdLife Global Seabird Programme, 84 Ghuznee Street, Wellington, New Zealand
[3]Sextant Technology, 116 Wilton Road, Wellington, New Zealand

Abstract

In this paper we assess the risk of interactions between longline fisheries and seabirds in the Western and Central Pacific Fisheries Commission (WCPFC) Convention Area. Efforts to reduce fishing-induced mortality are especially important for Procellariiform seabirds, particularly albatrosses and gadfly petrels, which are at particularly high risk of species extinction. We use a spatially explicit *Productivity-Susceptibility Analysis* (PSA) to determine (a) the probability of seabird-fisheries interactions occurring, by comparison of fishing effort and species range distributions, and (b) the risk of adverse effects of fishing-induced mortality on populations of seabirds. We also identify areas of high seabird diversity as well as areas with the potential for fisheries interactions if fishing effort were to increase in those areas. On the basis of the analysis we make recommendations for future research and for future refinement of management measures.

Introduction

In this paper we assess the risk of interactions between longline fisheries and seabirds in the Western and Central Pacific Fisheries Commission (WCPFC) Convention Area. We further develop and apply methods discussed by Kirby and Hobday (2006) and examined in more detail for seabirds by Waugh et al (2008) for a suite of seabird species known to be vulnerable to capture in longline fisheries. We use a spatially explicit version of a *Productivity-Susceptibility Analysis* (PSA) to determine the probability of seabird-fisheries interactions and the potential for adverse effects of fisheries mortality on populations of seabirds. We step through the development of the *Susceptibility* axis, mapping the results at each stage back onto a 5×5 degree grid across the entire Convention Area, thereby incorporating multiple perspectives on 'risk', i.e. to particular species, from particular flags and in particular areas. This allows the monitoring and management implications by species/flag/area to be easily understood.

'Risk' in this analysis refers to the probability of adverse effects on seabirds as a result of fishing mortality. We relate this, firstly, to the probability that a species is subject to fishing-induced mortality, under the general assumption that this risk is proportional to the overlap between distributions of fishing effort and of the seabird species concerned. This overlap index is used to define the *Susceptibility* score.

Additional indicators are then developed for the number of species and the number of individuals potentially affected by fishing-induced mortality in any particular area. This allows consideration of 'biodiversity hotspots' as well as areas where the potential for fisheries interactions with seabirds of any species is highest.

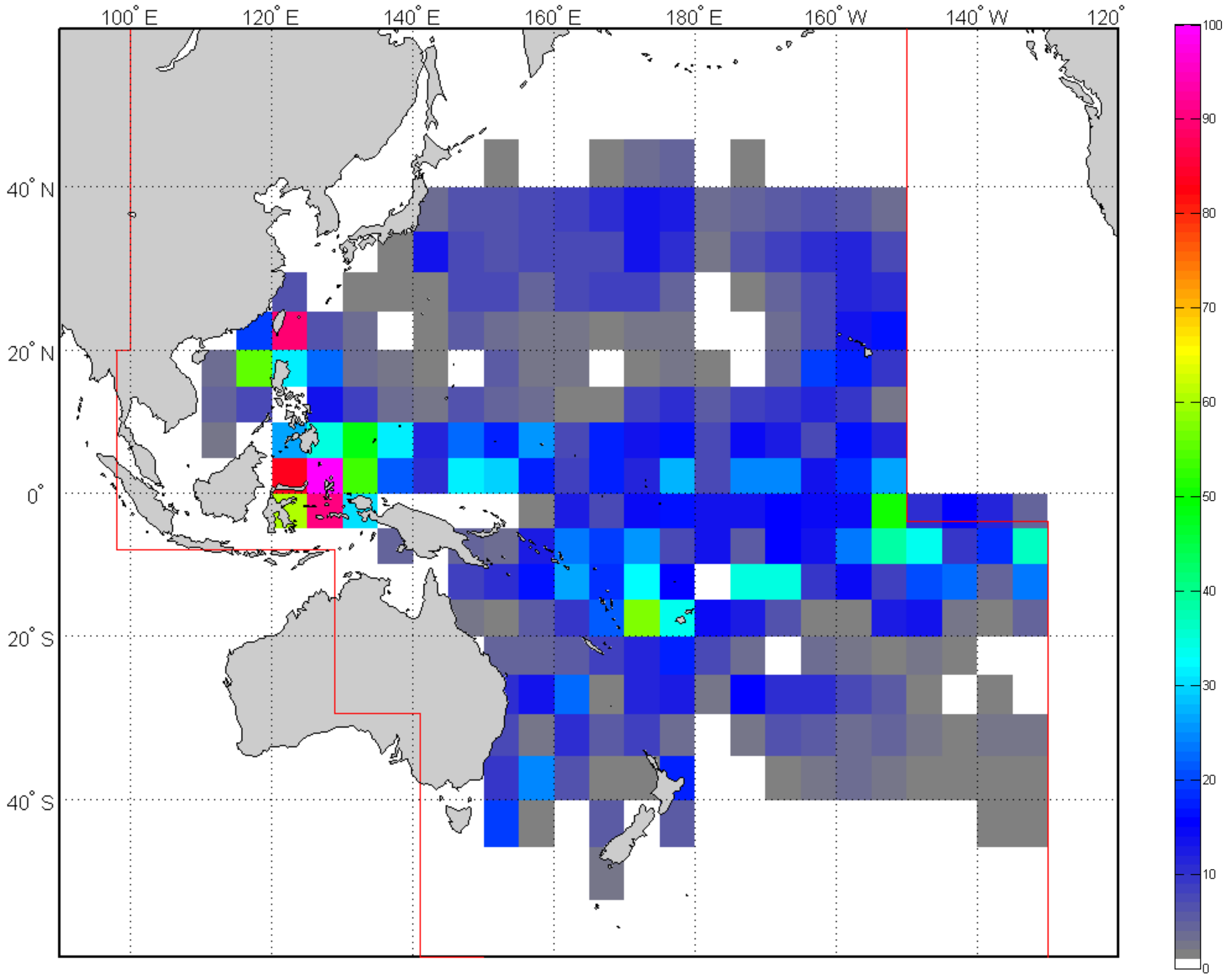
Finally, we determine areas where fisheries pose the most risk of population-level effects. To assess the risk of population-level effects we carry out an analysis including a measure of the population growth rate for each species and re-define 'risk' as the anticipated consequences at a population level of the probable fishing-induced mortality incurred. This therefore includes the *Productivity* axis of the PSA in addition to the *Susceptibility* as derived from the spatial overlap.

Methods

Longline fishing effort and its distribution

Longline fishing effort data for vessels targeting tunas and swordfish was extracted from SPC databases. These data were number of hooks stratified by flag state per 5 degree square per month for the period 2002 to 2007. We plotted fishing effort density, within 5-degree squares of latitude and longitude, as thousands of hooks per square km and summed the fishing effort within each square across the 6 years of data (Fig. 1). We did not attempt to account for monthly, seasonal or inter-annual variability in the distribution of effort, as bird distribution data were not available to describe corresponding changes in range.

Figure 1. Fishing effort density for WCPFC longline fisheries by 5-degree square (2002-2007) (thousand hooks/km^2)



Study species and their distributions

We examined the range of seabird species occurring in the WCPFC Convention Area, whose families or genera are known to be captured in longline fishing. In order to reduce the scope of the study to a manageable size, we excluded 192 other seabird species outside the order Procellariiformes, despite information to suggest that some level of incidental mortality may also occur for some of these species (Gales et al. 1999. Waugh et al. 2008, Huang et al. 2008). We excluded several species of diving petrel and storm petrel due to lack of detailed data on their population ecology, as well as expert opinion that indicated lower likelihood of fisheries interactions with this group. We also excluded species for which there was no information about their distribution at sea. We therefore analysed data for a group of 74 species, which included albatrosses, petrels, and shearwaters occurring in both tropical and temperate oceanic systems. See Table 1 for the species list, including biological attributes used to calculate *Productivity* (see below).

Of the 74 species included, 23 have previously been recorded captured in western Pacific longline fisheries by fisheries observers during the entire history of the national and regional observer programmes contributing to the SPC database (mostly mid-1990s onwards; Table 1). This list is the best available data but is nonetheless unlikely to be comprehensive for two main reasons: firstly not all species included in this analysis would have been recorded by fisheries observers even if they had been caught, because of the difficulties in correctly identifying hooked seabirds, and especially those that have been soaking underwater for several hours. The observer data therefore include a large number of "unidentified seabirds", around 1/3 of the total records held by SPC. Secondly, the representativeness of the observer data is compromised by the low overall coverage of Pacific longline fleets by scientific observers, which is <1% for all fleets combined. The fact that in many parts of the region seabird bycatch is a statistically rare event implies that a much higher percentage of observer coverage is needed in order to reliably estimate catches, by comparison to target or bycatch fish species (Lawson 2006).

The range data available were limited to average annual distributions for all species. We mapped species distributions on a global scale (i.e. including outside the WCPFC Convention Area) assuming that 100% of the population of the species was distributed within the BirdLife Range Map (Appendix 1 for species examples). We estimated the proportion of the global population that is within the WCPFC Convention Area based on the proportion of a species' total range within this zone.

We then defined areas within the global range of a species where a higher proportion of birds from each species could be found relative to the surrounding area (Hotspots; See Appendix 1 for species level details), using either:

a. Remote-tracking data layers, with 50, 75, 90, 95% utility distribution for 12 species (see BirdLife 2005 for methods in determining kernel distributions of birds on the basis of these data for 16 species), for breeding and non-breeding ranges. In order to represent average annual probability distributions we attributed 40% of each population to the breeding season range, and 60% to the non-breeding range[1] each comprised of up to three kernel layers; or

b. Species foraging radius approach – for 18 species where remote-tracking data were unavailable, colony locations and average foraging radius of the birds were used based on published estimates of foraging activity. We estimated the density of birds from individual populations within the WCPFC Convention Area, attributing 50% of the individual populations to these zones, defined by the radius of the average foraging trip from a colony.

c. Where data on concentrations of foraging activity were not available, we only used the BirdLife Range Maps to describe the species ranges, with an even distribution of the species attributed to its range within the Convention Area.

---

[1] Weightings based on previous work in ICCAT fisheries: 70% of species population is presumed to be breeding adults, occupying the breeding range during 6 months of the year, as do 10% of the non-breeding adult population, therefore on average 40% of total population occupies the breeding range during the year; 20% of the population is attributed to the juvenile stage, which occupies the non-breeding range throughout the year, and is joined by the breeding and non-breeding adults during half of the year.

Productivity-Susceptibility Analyses (PSAs)

We used the maps of longline fishing effort in the WCPFC Convention Area and those of species distributions to calculate risk scores based on (a) *Susceptibility* indicators, calculated as the product of fishing effort and normalised species distributions (i.e. proportion of a species' range) (Eq. 1):

$$susceptibility(species, flag) = \int_{pacific} normal\_bird\_density(species) \times effort\_density(flag)$$

and (b) a *Productivity* indicator, defined as the maximum reproductive rate.

In previous PSA analyses, *Productivity* estimates have been generated using a collection of variables that determine reproductive output, standardised and averaged in order to provide a scale-free indicator that approximates the intrinsic rate of population increase. This methodology was developed to deal with information across a wide range of taxon groups, including fish, turtles, mammals and seabirds, where population parameters that are not directly measureable are unknown.

For this study, where all study species are within a single taxonomic order, we were able to use a more harmonious set of life-history parameters to approximate $R_{\max}$, the maximum rate of increase of a population with no resource limitation, predation or competition (Sibly & Hone 2003). Niel & Lebreton (2005) demonstrated that for birds there is a constant relationship between generation length and population growth rate. They established that maximum annual growth rate $\lambda_{\max}$ can be estimated for long-lived species using estimates of age at first reproduction (α) and adult annual survival (s).

We solved for $\lambda_{\max}$, to derive the index of *Productivity*, based on the relationship between this parameter and age at first breeding and annual adult survival, (Eq. 2):

$$\lambda_{\max} = \exp\left[\left(\alpha + \frac{s}{\lambda_{\max} - s}\right)^{-1}\right]$$

$R_{\max}$ was calculated from $\lambda_{\max}$ thus: $R_{\max} = \lambda_{\max} - 1$

We estimated α and s values for each species based on parameter values found in the scientific literature. Where more than one value was available for a species, the value from the study likely to provide the most robust estimation of $R_{\max}$ was used, i.e.. that with the largest sample size, or a longer-term study. Where severe colony-based threats (i.e. from factors other than fishing mortality) were apparent, which are likely to result in depressed *s* values, we excluded these values from the study. For species where data were absent, we substituted a value from a closely-related species. $R_{\max}$ values were normalized, with a maximum value set at 1.

Overall risks of adverse effects on seabird populations are then calculated by combining both *Productivity* and *Susceptibility* indicators (Eq. 3).

$$risk = (Productivity^2 + Susceptibility^2)^{1/2}$$

We normalized outputs of the overall PSA, combining both *Susceptibility* and *Productivity* indicators, so that values fell between 0 and 1. After the PSA outputs had been generated, we re-created maps without the results for Fiji petrel as the extremely high values generated for this species made interpretation of mapping outputs difficult. Values plotted were square-root transformed to normalize the distribution of the data. Five levels were attributed to the outputs based on the actual frequency distribution of the PSA scores, in order to ease interpretation. Negligible levels of risk (0 – 0.001): white; Low (0.001 – 0,2): royal blue; Low to Medium (0.2 – 0.4): pale blue; Medium (0.4 – 0.6): green; Medium to High (0.6 – 0.8): orange; High (0.8 – 1.0): pink. Risk scores by 5×5 degree area were calculated as (Eq. 4):

$$Risk(area) = \sum_{all\_species} \sum_{all\_flags} Risk(species, flag)$$

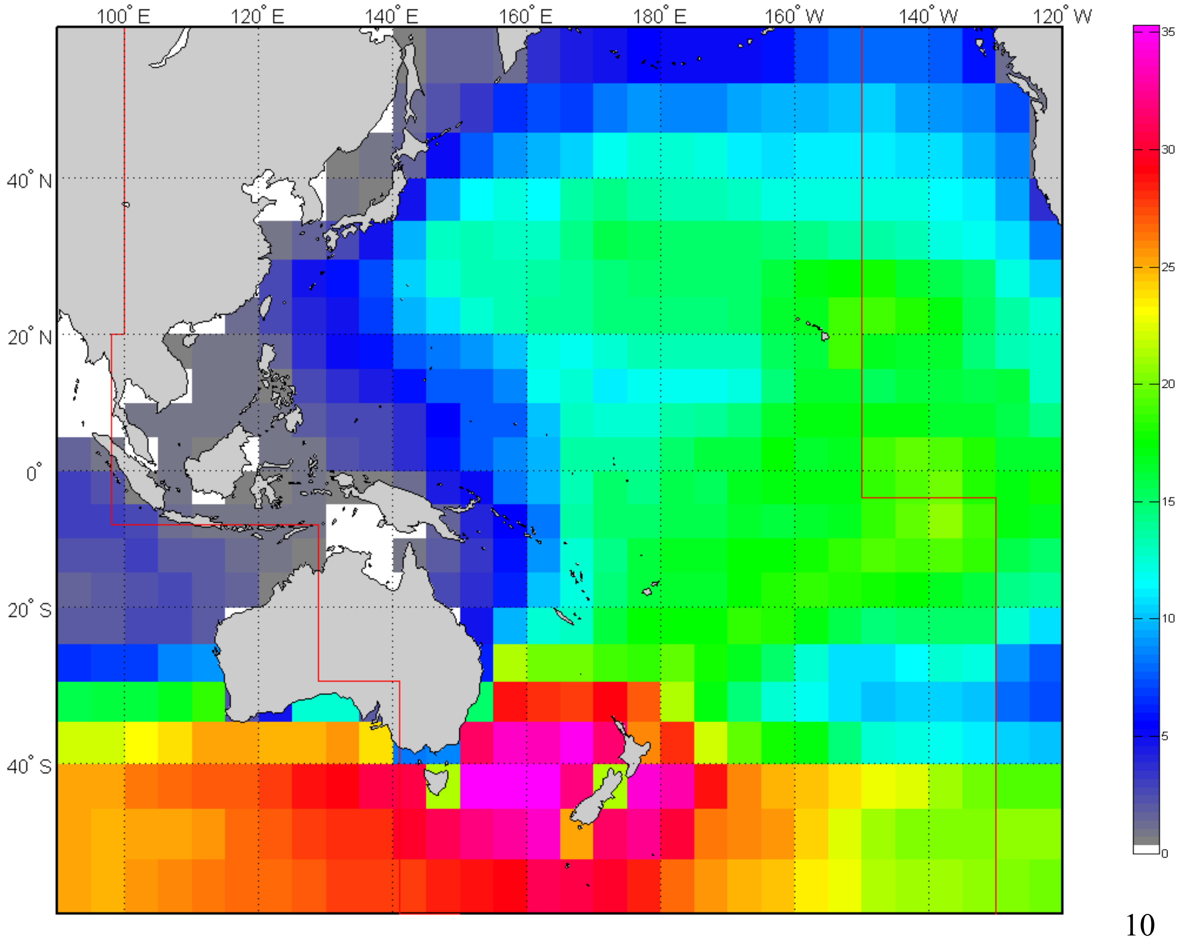
Results

Risk indicators for seabird-fisheries interactions based on spatial overlap

The maps for risk indicators for seabird-fisheries interactions based on spatial overlap can be seen in Figs. 2, 3 & 4. We have included Figs. 2 & 3 for information in their own right, while Fig. 4 is also used as the *Susceptibility* indicator in the subsequent *Productivity-Susceptibility Analysis* (PSA).

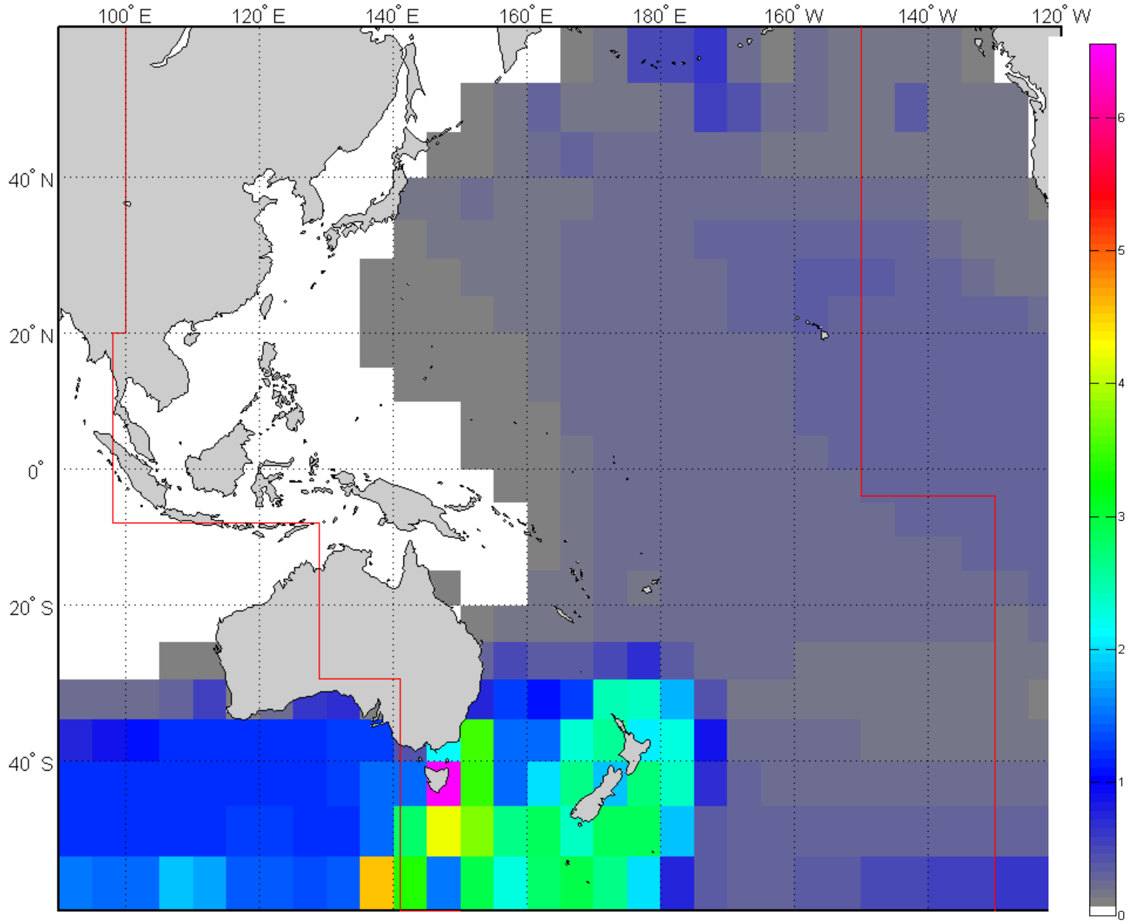
In Fig. 2 we can see which areas are frequented by more/less species of seabird. This tells us what areas might be considered 'biodiversity hotspots' for seabirds and which other areas are frequented by only one or two species. This information is useful as it illustrates, for example, the extent to which scientific observers must be trained in identifying numbers of different species depending on the area in which they are working. The results show that highest seabird diversity occurs in the Tasman Sea, temperate areas north, south, west and east of the Tasman Sea, and in an arc spreading north-east to the central Pacific and back to the north-west Pacific.

Figure 2. Plot of seabird diversity (number of species per 5×5 degree area) for 74 species of albatross and petrel found in the WCPFC Convention Area



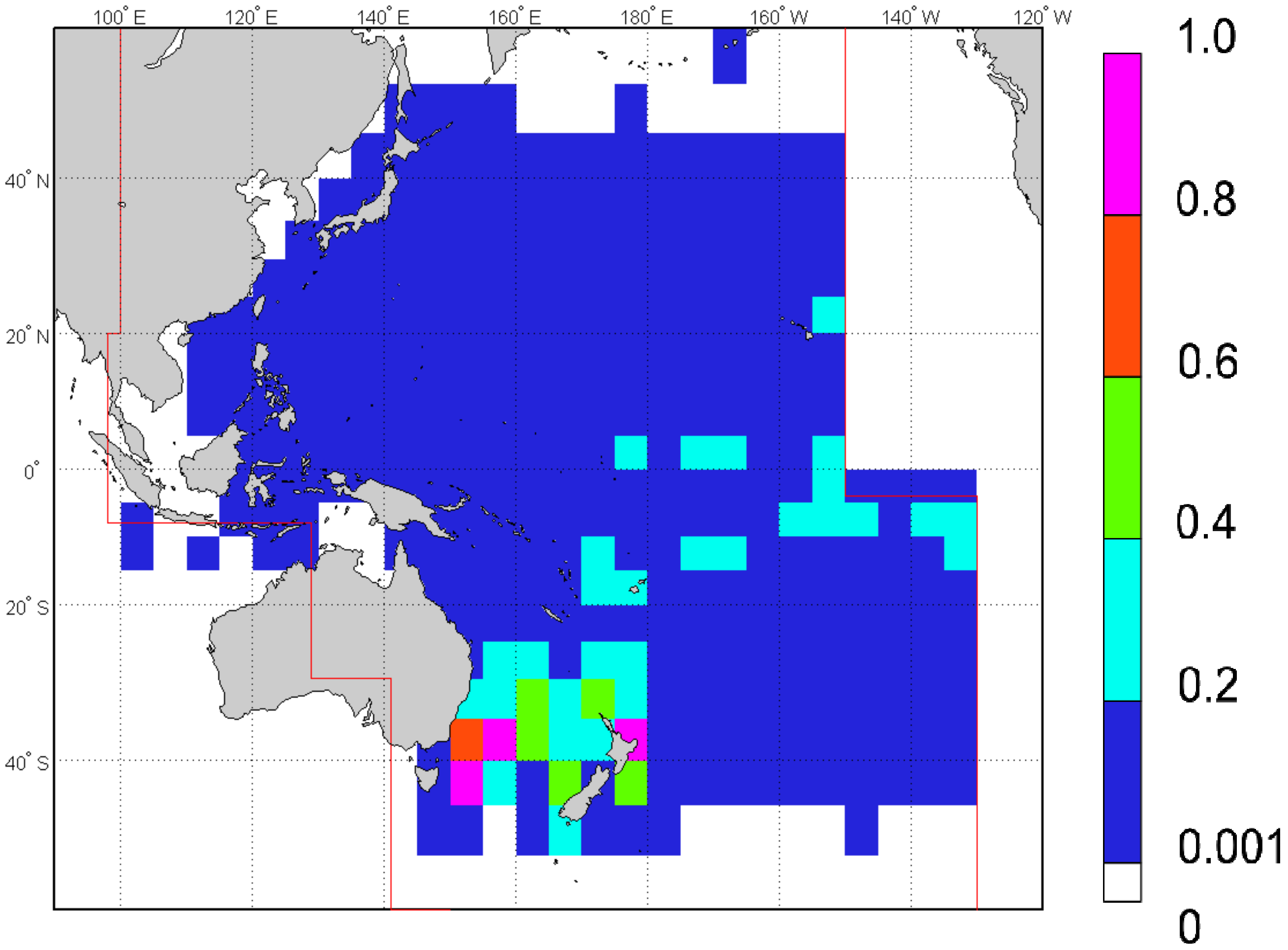
In Fig. 3. we have scaled the number of species present (Fig. 2) by their respective population sizes to give the expected numbers of seabirds in each area. The results show that waters around New Zealand and west into the Tasman Sea and Southern Ocean have the highest absolute numbers of seabirds. While this is an intermediate step, as it is the combined presence of fishing effort and seabirds that results in risk of capture, it does suggest areas where use of mitigation measures would be necessary in order to minimize the number of seabird interactions if these areas are actually fished now or in the future.

Figure 3. Plot of seabird numbers (individuals per 5×5 degree area) for 74 species of albatross and petrel found in the WCPFC Convention Area (birds/km^2)



In Fig. 4. we have combined the estimate of absolute number of seabirds (Fig. 3) with fishing effort (Fig. 1), in order to plot where fishing-induced mortality of seabirds is most likely to have been occurring over the study period (2002–2007). These values are used as the *Susceptibility* index in the PSA described below. The results show the highest risk of seabird interactions to be in the Tasman Sea and east of New Zealand, but the risk landscape extends again through an arc into the central tropical Pacific and back to the north-east Pacific. There are also some localized 5×5 areas within this arc and north of 20ºS where higher than average interactions are expected. These areas are certainly worthy of increased monitoring and possible application of mitigation measures.

Figure 4. Zones of greatest likelihood of capture of seabirds, based on distributions of fishing effort (Fig. 1) and seabird numbers (Fig. 3). Highest risk areas: pink; Medium to high: orange; Medium: green; Medium to low: pale blue; Low: dark blue; Negligible: white



Productivity-Susceptibility Analyses (PSAs) for risk of species-level effects

We calculated Productivity-Susceptibility (PSA) scores for all species included in the analysis (Fig. 5). Values expressed in maps and in tables are generated on the basis of the distance from the origin of this plot.

Species were spread along the *Productivity* axis in relation to their R_{max} value, a measure of their ability to rebuild populations. The grouping of species along this axis that is apparent in Fig. 5. indicates where species-specific values were lacking, and substitute values were used for several species from the same genus. Values ranged from near to 0.9 for species that are common and rapidly-breeding (e.g. Bulwers' petrel, Cape petrel) to close to 0.05 for the slowest-breeding species (e.g. some long-lived and biennially-breeding albatrosses). The R_{max} values used for this study are in Table 1.

The results of the PSA, combining Fig. 4 as the *Susceptibility* indicator on the *y*-axis with values of R_{max} as the *Productivity* indicator on the *x*-axis, are shown in Fig. 5. We have tabulated the outputs of the PSAs to examine them in more detail in relation to the likely effect of combined fishing effort (i.e. aggregated across areas and flags) for each species (Table 2), and the proportion of risk at a species level attributed to each flag (see outputs for each species in Table 3). We have then mapped the PSA results back to the 5×5 grid across the WCPFC Convention Area (Fig. 6). Thus the outputs are defined in relation to three questions, discussed in more detail below:

Q1. Which species are most at risk of adverse effects from WCPFC longline fishing?

Q2. In which areas is there greatest risk of adverse effects on seabird species?

Q3. Which flags are posing the greatest risk of adverse effects on seabird species?

Which species are most at risk of adverse effects from WCPFC longline fishing?

The top ranked (most at risk) ten species includes six gadfly petrels[2], one shearwater, and three albatross species. The petrel and shearwater species concerned occur in tropical waters, while the albatrosses are mainly temperate in distribution.

The next highest risk species (ranked 11–25) include a range of petrels and albatrosses from tropical and temperate regions. Twenty three of the top 25 species are listed as threatened with extinction, including two species listed as *Critically Endangered* and two as *Endangered*. Three species had extremely small population sizes of a few dozen individuals each.

The medium risk species (ranked 26–50) contains nine albatrosses species, all of which are threatened with extinction, including 4 which are classified as *Endangered* or *Critically Endangered*. Of the remaining 16 petrel species, six are threatened with extinction including four *Endangered* species.

The lowest ranked species included 10 species for which there is no overlap in the WCPFC Convention Area with the fishing effort used in the analysis (2002–2007), or where these birds ranges abuts, but does not enter the WCPFC Convention Area. These species include three *Critically Endangered* and one *Endangered* species. They are listed at the bottom of Table 2.

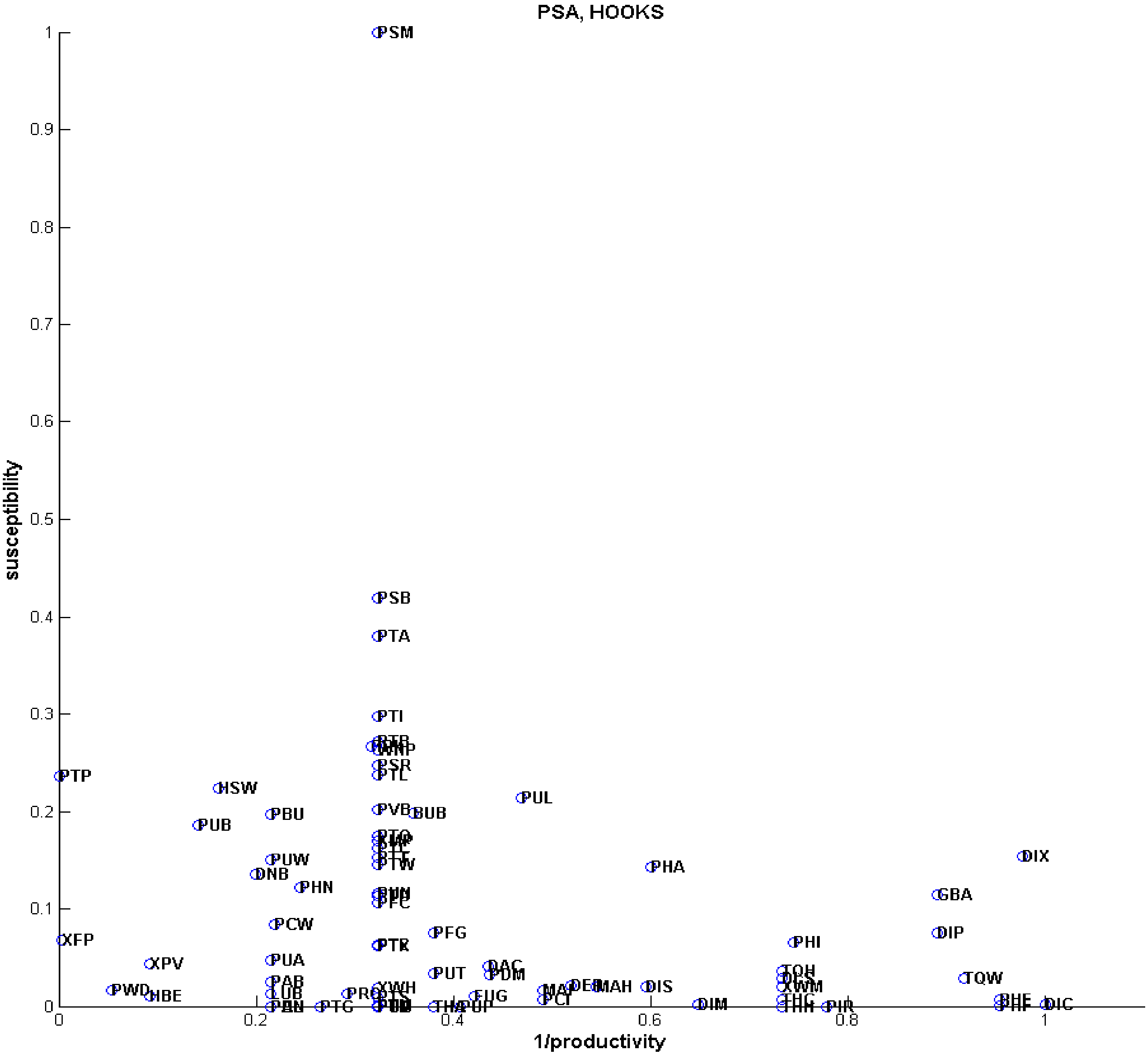
The analysis shows that species likely to be at risk from fishing include many species which are poorly known. Species likely to be exposed to high levels of risk include some with small population sizes, and with severe conservation threat status, from a range of tropical and temperate environments.

Some of the Pterodroma and Pseudobulweria species may not in fact be susceptible to fishing mortality, due to their small size; however, very small storm petrels are occasionally caught in longlining operations in temperate and sub-Antarctic regions (Waugh et al. 2008). Therefore without specific information that allows us to eliminate the possibility of fisheries effects, we must consider that there is some likelihood of catch for these species.

---

[2] Petrels from the genuses *Pterodroma* and *Pseudobulweria*

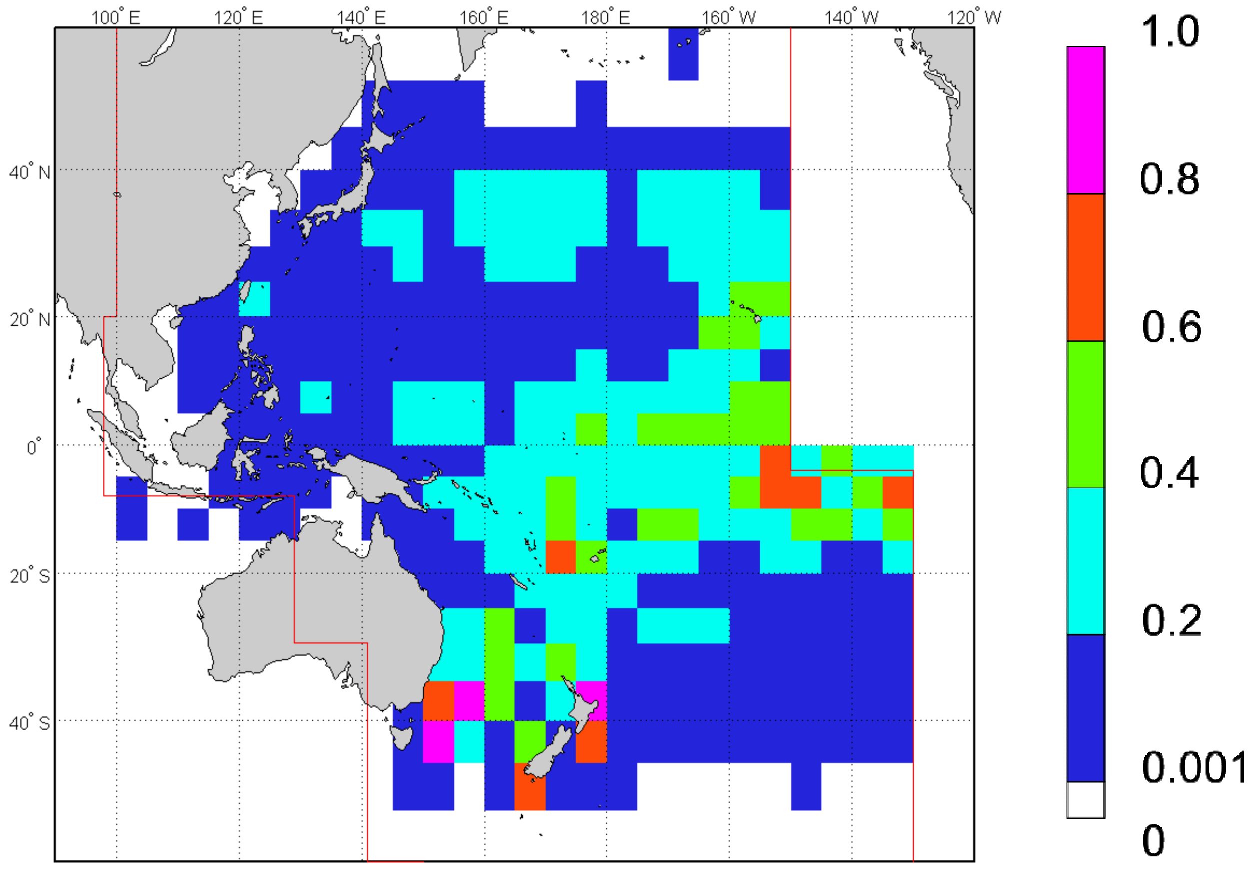
Figure 5. PSA outputs for 74 species of albatross and petrel included in the analyses. ***Susceptibility*****: degree of overlap of species with fishing effort;** ***Productivity*****: maximum population growth rate for each species**



In which areas is there most risk of adverse effects on seabird species?

The areas with highest likelihood of species-level population effects occur in the Tasman Sea, east of New Zealand, around Fiji and at the equator at 165 °W (Fig. 6, pink areas[3]). Moderate-to-high risk levels (red) occur in an arc from Australasia, through the Vanuatu-Fiji area, finishing in the east of the WCPFC Convention Area in French Polynesia. Medium risk areas (green) are most prevalent through the central Pacific to around 20 °S, but with areas in temperate regions around Hawaii, and eastern and southern New Zealand. Lowest levels of risk occur in the south-eastern and north western parts of the Convention Area, including waters north of Australia and Papua New Guinea.

Figure 6. Areas of likely species-level effects of fishing in the WCPFC Convention Area. Highest risk areas - pink, Medium-high - orange; Medium – green; Medium-low – pale blue; Low – dark blue; Negligible risk – White.



---

[3] Note that the highest risk area was the 5-degree square around the island of Gau, Fiji. This was removed from the plots as its extremely high risk score made it difficult to interpret results for other areas.

Which flags are posing the most risk of adverse effects on seabird species?

Nine flags contribute over 90% of the combined risk to seabirds in the WCPFC (Fig. 7). Of these, only 5 contribute over 50% of the total risk. These are, in descending order: Japan (20%), Fiji (17%), Chinese Taipei (14%), Republic of Korea (12%), and New Zealand (12%). Other flags contribute less than 5% of the total risk each. This outcome is due to the distribution of fishing effort in relation to the highest risk species, which contains many tropical petrels, and several species which have low productivity.

Similarly, when we examined what was the ranking of flag states in relation to effects on individual species, we found that the probability of adverse effects was not evenly spread among flags. The five flags with the highest likelihood of population effects on species, in descending order, were Japan, Chinese Taipei, Vanuatu, China, Republic of Korea, and Australia. The PSA scores for each flag by species is set out in Table 3, as are the contributions of each flag to the risk score for each species.

Figure 7. Sum of PSA scores for all species in the analysis, attributed to flag

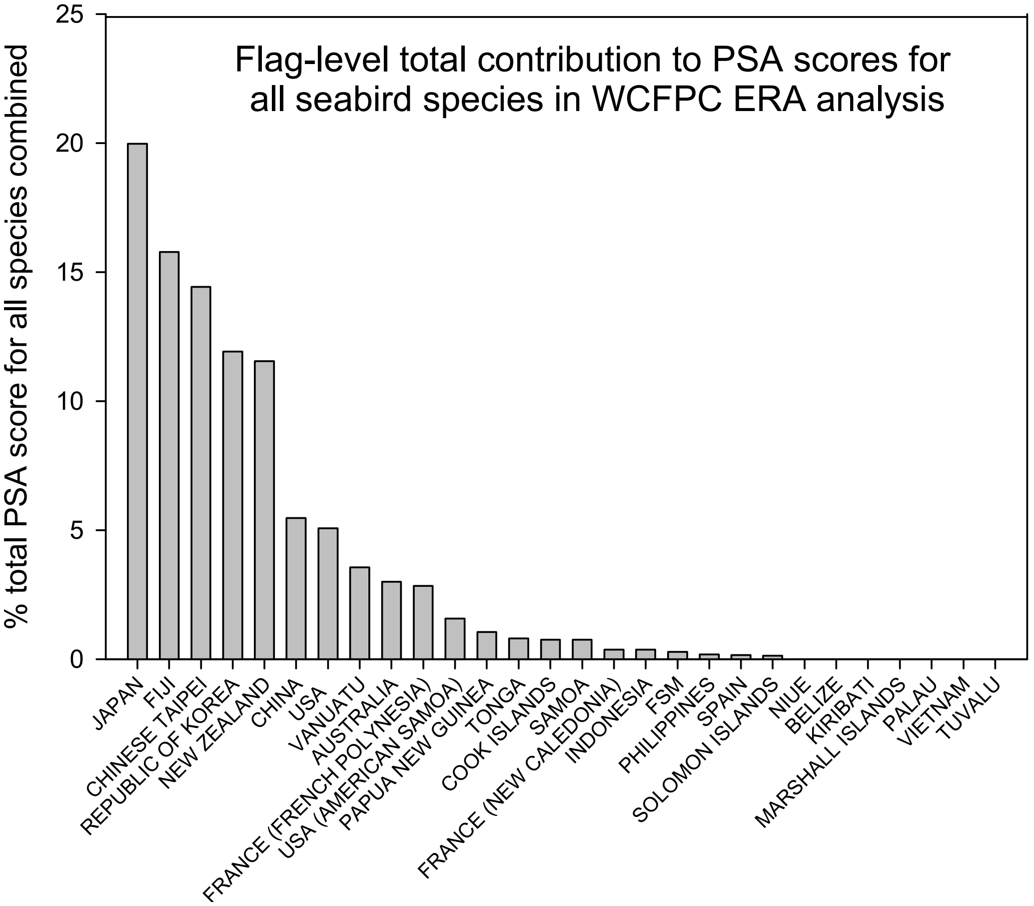
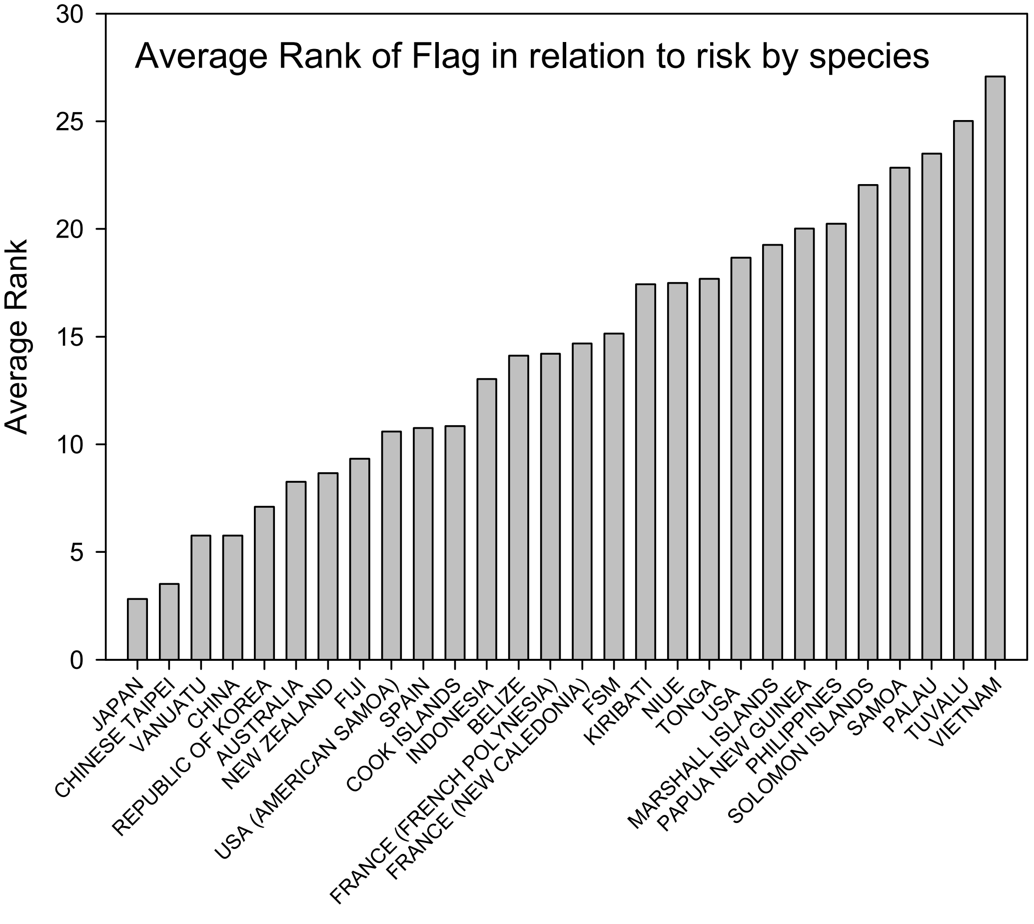


Figure 8. Average rank of flags in relation to risk by species. Flags with highest average ranks (smaller number) are most likely to have adverse effects on viability of a number of seabird species



Discussion

The WCPFC Convention Area is host to a range of seabird species, including a number of threatened species. Minimizing seabird interactions in terms of total mortality is an objective of the WCPFC Convention and WCPFC Conservation and Management Measure CMM2007-04, as is the aim of alleviating pressure on fragile populations.

A key finding of the study is that the risk of seabird popoulation effects is spread over a far greater extent than previously acknowledged, and potentially effects a wider range of species, some of which are highly vulnerable to extinction. Efforts to reduce fishing-induced mortality are especially important for Procellariiform seabirds, particularly albatrosses and gadfly petrels, which are at particularly high risk of species extinction. Albatrosses are the most threatened group of birds in the world with 19 out of 22 species threatened with extinction (BirdLife International 2008). Of the 74 seabird species examined in the study, 41 (55%) are threatened with extinction (IUCN 2009).

The two highest ranked petrels are little-known species in the risk assessment were Fiji petrel and Beck's petrel, which have recently been rediscovered after a period when they were thought to be extinct. They are both listed as *Critically Endangered* and are estimated to have extremely small global population sizes, at fewer than 50 and 300 individuals, respectively (BirdLife 2008). Fishing-induced mortality for these species would be of great concern with regard to their global population status.

Wandering albatrosses (ranked 2nd) have been shown to suffer population effects of fishing mortality (Weimerskirch et al. 1997, Tuck et al. 2001.). Recent incidental mortality of 51 Antipodean albatrosses (ranked 5th) in one swordfish fishing trip shows that this species is highly susceptible to capture in surface longline fisheries (New Zealand Ministry of Fisheries 2006).

The findings of this study do not contradict previous information, that suggested that highest risk area occurs south of 30ºS and north of 23ºN. Instead, they identify a finer-scaled landscape of risk, in a relative sense, across both tropical and temperate environments. A high probability of capturing seabirds, as well as an associated risk of population effects, may still exist outside the medium- to high-risk zones identified here, but may be more localized or affecting single species (e.g. Laysan or short-tailed albatrosses) in a way that this analysis is not designed to detect.

This study has identified areas of seabird biodiversity, areas of higher potential for and probability of fishing-induced seabird mortality, species at risk of population-level effects of fishing-induced mortality, areas where this risk is highest summed across species, the contribution of individual flag states to the risk of species-level effects, and the contribution of individual species to total risk posed by flag.

Areas in which fishing is most likely to result in captures of considerable numbers of seabirds were identified in the Tasman Sea and surrounding ocean, and east of New Zealand. These known bycatch areas have rich assemblages of both albatrosses and petrels (see Fig. 2), many of which are threatened with extinction.

One short coming of this type of analysis is that risk to particular species is not examined in great detail, even if additional information is actually available. Future analyses would be strengthened by examining well documented case studies for species of particular conservation concern. This could lead to the upgrading of risk classifications for particular areas based on additional risk already established for these species.

The PSA approach used here allowed us to use all available information about species for the WCPFC Convention Area, and include different data types describing the species ranges. In this study, the scarcity of independently derived information on seabird catch from the WCFPC fisheries precluded using actual bycatch information in the study; such data have been used elsewhere, either semi-quantitatively (Klaer & Black 2008), or to define species catchability (New Zealand Ministry of Fisheries, unpublished report).

The key assumption that risk is proportional to spatial overlap of species with fishing effort is logical enough for species that are known to attempt to take baited hooks if they are available. There may be some inter-species variation in this tendency, in addition to temporal and spatial variability in this tendency for any particular species, but this is very difficult to quantify and the data necessary to do so are not presently available.

It will be useful, as more observer data becomes available in WCPFC fisheries, to include indices of catchability for different species. In other contexts (e.g. ICCAT), expert opinion has been used to assign a catchability coefficient to susceptiblity scores. In the current analysis, after prior exclusion of some species known not to take baited hooks, catchability is treated as equal among all species, with *Susceptibility* described only by the degree of spatial overlap with longline effort. It is therefore possible that some species have been attributed medium-to-high risk scores when little or no risk is occurring. Small petrels, particularly from the Gadfly petrel family have only rarely been reported in fishing bycatch. However, the number of these species occurring within the WCPFC, from small and fragile populations, makes it nonetheless imperative to examine possible risk, even if observer data are lacking to verify whether this risk is realized.

Although it would be interesting to carry out fine-scaled analysis of the relative ranking of species along the *Productivity* axis this is not possible at this stage, due to the large number of substitutions employed in the analysis: ca. 50% of survival or age-at-first breeding scores were from substitute species. Thus, while it is useful to regard the *Productivity* score as an index of relative productivity among all the species, the score should only really be regarded as being *high*, *medium* or *low*.

Conclusions

The areas defined as high and medium risk need particular monitoring and mitigation measures in order to reduce incidental mortality of seabirds. Firstly, there are areas where large numbers of seabirds are likely to be captured – running in an axis from Australasia to Hawaii, with a few isolated outlying areas (Fig. 4). Secondly, there are areas where population effects of incidental mortality are likely to be disproportionately large compared to the absolute number of bycatch events occurring (Fig. 6). These include temperate areas but also many tropical areas such as those around Fiji, Vanuatu and the central to eastern tropical Pacific. The analysis has demonstrated a far broader area where species may be adversely affected by fishing mortality than previously thought, in particular in tropical waters where bycatch of species is rare and has therefore been considered to be insignificant in terms of population effects (see Watling 2002).

The disaggregation of risk posed to individual species by individual flag states has demonstrated that the likely effects of fishing are not spread evenly between the different flags. We hope that this analysis helps fisheries managers from the flag states posing the highest risk in justifying the need for better monitoring and management of their fleets. If effective mitigation measures are already in place on these fleets then the risk rankings given here will of course change. We therefore hope that better monitoring of those fishing fleets most likely to have adverse effects on seabird species will be carried out and that the results of such monitoring will be shared with the WCPFC Scientific

Committee, so that all flag states can come to understand their relative success in minimizing the risk of adverse effects of longline fisheries on seabirds.

There is a need to consider whether the current seabird measure (CMM2007-04) should be applied in areas than are not currently covered and to a wider range of vessels. For example, some tropical areas that are currently outside the zone of application of the CMM are shown as high risk by these analyses. Vessels <24m length fishing north of 23ºN, which includes some higher risk areas, are currently exempt from the requirements of the CMM, despite the lack of evidence for vessel-size-related differences in catch rates.

The current analysis provides a useful overview and broad scale representation of the relative risk that longline fishing poses to seabirds in the Convention Area, given the constraints of variable data quality. Experience from similar analyses in other international and national fisheries shows that more complex models are likely to result in relatively minor adjustment of risk rankings by area, species or flag, providing diminishing returns in terms of understanding fisheries impacts on seabirds. In specific cases, where high risk classification is accompanied by availability of high quality data sets on population ecology, age-structured population modeling can be used to examine scenarios for minimizing risk of adverse population effects. However, these opportunities will be limited in number because they are time consuming and costly to pursue.

We would therefore recommend that the results presented form a basis for future decision making in terms of defining areas where longline fisheries pose a risk of adverse effects on seabird populations.

The process of determining such areas should be iterative, in that new seabird and fisheries data will become available through time, and these can be incorporated into subsequent analyses. This should be seen as a natural evolution of the best available science, rather than invalidating the logic of the current analysis, with management able to become less precautionary and more evidence-based as the quality of datasets and sophistication of analyses both improve. For now, however, a precautionary approach is justified by the limited observational data. More detailed information about species propensity to be caught on longline sets, along with refinement to our knowledge of fishery specific catch rates and species distributions will greatly build on our knowledge of where risk of seabird mortality is most acute across the WCPFC area.

Future work

Noting the discussion above, we recommend that in future analyses of the likelihood and effects of seabird interactions in WCPFC longline fisheries:

a) Additional data on seabird distributions should be incorporate as they become available over the next 2–3 years, e.g. by 2010 over 1000 seabird colony records will be available for the Australasia region via new BirdLife International databases.

b) The potential effect of spatio-temporal variability on the results should be analyzed as it is possible that seasonal and interannual variability in fishing effort distribution may result in different risk rankings to those presented here.

c) Estimate any differences in catchability among seabird species, using observer data from areas where several species overlap with longline fisheries at the same time, as this may significantly influence the outcome of the analyses. Behavioural aspects, such as whether seabirds are foraging in or migrating through particular areas, should also be examined and incorporated in future risk assessments.

d) Carry out analyses in relation to fishing targeting strategies, as it is possible that, for example, 1000 hooks of swordfish fishing effort poses a different risk of seabird capture compared to 1000 hooks of albacore effort, depending on the time of fishing, gear configuration etc. Data on fishing gear configuration (e.g. hooks per basket, float line length), on deployment of mitigation methods and on actual catch of seabirds will of course be required to examine this aspect.

e) Examine whether the outcomes, by comparison with global seabird assessments, adequately deal with risk to particular species, via case-studies on seabird species of established conservation concern.

Recommendations

On the basis this analyses we recommend that the WCPFC:

1. Define areas of risk throughout the Convention Area, on a graded scale from lowest to highest risk, at the level of 5 degree squares rather than latitudinal bands, based on the analysis of species-level effects of seabird-fisheries overlaps (Fig. 6) as well as those areas that have the highest potential interaction rates (Figs. 3 & 4). These areas should be revised as new information becomes available for analysis.

2. Develop more detailed data collection at the operational level, particularly for fisheries operating in medium to high risk areas, in relation to gear configuration, use of mitigation measures and catch of seabirds. These data need to be provided across the Convention Area and made available to the Scientific Committee for analysis and review.

3. Continue to develop spatially stratified analyses of fisheries interactions with bycatch species in the WCPFC Convention Area, particularly threatened species, building on the approach developed and results obtained in this study.

4. Consider revising its mitigation requirements in the future in light of risk areas identified by this type of analysis; improved data on seabird distribution and on catchability will improve the analyses, giving managers confidence in the results..

Acknowledgements:

We are grateful to the following organizations for supporting the study: Western and Central Pacific Fisheries Commission; Secretariat for the Pacific Community; BirdLife International. We are particularly grateful to the many contributors of data which assisted the study, in particular: British Antarctic Survey, Javier Arata, Christopher Robertson, David Nicholls, Dave Anderson, Jill Awkerman, David Hyrenbach, David Nicholls, Amanda Freeman David Nicholls, Christopher Robertson, Peter Ryan, Deon Nel, Graham Robertson, Henri Weimerskirch, Jean-Claude Stahl, Paul Sagar, Kath Walker, Michelle Hester, Nic Huin, Nic Klomp, Mark Schultz, Rachael Alderman, Richard Cuthbert, Rosemary Gales, Ross Wanless, Samantha Petersen, Scott Shaffer, Michelle Antals, Michelle Kappes, Susan Waugh and Akira Suzuki. We thank the BirdLife International staff who assisted in the preparation of species distributional layers: Ian May; Mark Balman; Ben Lascelles; Phil Taylor; Cleo Small and Steve Cranwell; the staff at SPC, Tim Lawson and Peter Williams, who assisted with data extracts for the study; Frances Taylor for technical advice, and to Richard Phillips and Nathan Walker for commentary on the methods.

References

BirdLife International (2008) http://www.birdlife.org/datazone/index.html. Sourced 15 November 2008.

BirdLife International (2004) 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 International, Cambridge, UK.

Gales R, Brothers N, Reid T, Pemberton D, Baker GB (1999) Longline seabird mortality in Australia – Progress & Policy_International Ornithological Congress 22, Durban.

Hobday AJ, Smith A, Webb H, Daley R, Wayte S, Bulman C, Dowdney J, Williams A, Sporcic M, Dambacher J, Fuller M, Walker T (2006) Ecological Risk Assessment for the Effects of Fishing: Methodology. Report R04/1072 for the Australian Fisheries Management Authority, Canberra

Huang HW, Chang KY, Tai JP (2008) Overview of the interaction between seabird and Taiwanese longline fisheries in the Pacific Ocean. Working Paper EB-WP5. 4th Regular Session of the WCPFC Scientific Committee, Honolulu

IUCN 2009. www.iucnredlist.org sourced 1 June 2009.

Kirby DS, Hobday A (2007) Ecological risk assessment for the effects of fishing in the Western and Central Pacific Ocean: Productivity-Susceptibility Analysis. Working Paper EB-WP1, 3rd Regular Session of the WCPFC Scientific Committee, Honolulu

Klaer NL, Black A, Howgate E (2008) Preliminary estimates of total seabird bycatch by ICCAT fisheries in recent years. ICCAT-SCRSS 2008 031.

Lawson T (2006) Scientific aspects of observer programmes for tuna fisheries in the western and central Pacific ocean. Working Paper ST-WP-1. 2nd Regular Session of the WCPFC Scientific Committee, Manila

New Zealand Ministry of Fisheries, unpublished report (2009) Ecological Risk Assessment for Seabirds in New Zealand fisheries. Primary components of Ecological Risk Assessment methodology – calculating vulnerability and productivity for species. Report presented to the Aquatic Environment Working Group. 23 July 2009.

New Zealand Ministry of Fisheries (2006) Minister proposes emergency action in swordfish fishery. Press Release from the New Zealand Ministry of Fisheries. 28 November 2006. www.fish.govt.nz. Accessed 21/07/09

Niel C, Lebreton JD (2005) Using demographic invariants to detect overharvested bird populations from incomplete data. *Conservation Biology* 19:826–835

Sibly RM, Hone J (2003) Population growth rate and its determinants: an overview. Pp 11 – 40. In Sibly, R.M., Hone, J. and Clutton-Brock. (eds). *Wildlife Population Growth Rates.* Cambridge University Press, Cambridge. Pp 11 – 40

Tuck GN, Polacheck T, Croxall JP, Weimerskirch H (2001) Modelling the impact of fishery by-catches on albatross populations. Journal of Applied Ecology 38: 1182–1196

Waugh S, Filippi D, Walker NA, Kirby DS (2008) Updated preliminary results of an ecological risk assessment for seabirds and marine mammals with risk of fisheries interactions. Report to the Scientific Committee for CCAMLR, WG-FSA-08/51.

Waugh SM, Mackenzie DI, Fletcher D (2008) Seabird bycatch in New Zealand trawl and longline fisheries 1998 – 2004. Papers and Proceedings of the Royal Society of Tasmania 142:45 – 66

Weimerskirch H, Brothers N, Jouventin P (1997) Population dynamics of wandering albatross *Diomedea exulans* and Amsterdam albatross *D. amsterdamensis* in the Indian Ocean and their relationships with long-line fisheries: Conservation implications. *Biological Conservation* 79: 257–270

Table 1. Estimated *Productivity* (R_{max}) values, derived from Age-at-maturity and Annual Adult Survival rates, for 75 species of albatrosses and petrels found in the WCPFC Convention Area and which are vulnerable to capture on longline fisheries. Scientific name follows BirdLife International taxonomy (www.birdlife.org). 'Code' is generally FAO Code but may include other national standard codes. Whether as species has been observed captured in the region is noted (Y: yes), as is threat status for species as defined by the International Union for the Conservation Nature (IUCN; www.iucnredlist.org). World population (number of individuals) estimated by BirdLife International. Where a population size range was provided, we have taken the mid-point of that range to use in analyses). Species are listed in alphabetical order of their scientific name.

Code	BLI Scientific name	BLI Common name	Rmax	Age-at-maturity average	Survival average	Threat status	Global population	BLI tracking data	Recorded bycatch
BUB	*Bulweria bulwerii*	Bulwer's Petrel	0.898	5	94.7	LC	750000		
DAC	*Daption capense*	Cape Petrel	0.827	6	94	LC	2000000		
GBA	*Diomedea antipodensis*	Antipodean Albatross	0.564	7	97	VU	25000	Y	
DIP	*Diomedea epomophora*	Southern Royal Albatross	0.056	7	97	VU	28750	Y	Y
DIX	*Diomedea exulans*	Wandering Albatross	0.053	9	96	VU	26000	Y	Y
DIS	*Diomedea sanfordi*	Northern Royal Albatross	0.071	7	94.6	EN	17000	Y	
FUG	*Fulmarus glacialoides*	Southern Fulmar	0.084	5	95.5	LC	4000000		
HBE	*Halobaena caerulea*	Blue Petrel	0.127	5.4	84	LC	3000000		
LUB	*Lugensa brevirostris*	Kerguelen Petrel	0.107	5.5	90	LC	1000000		
MAI	*Macronectes giganteus*	Southern Giant-petrel	0.078	7	93	LC	97000		Y
MAH	*Macronectes halli*	Northern Giant-petrel	0.074	7.5	93	LC	19000		Y
PAB	*Pachyptila belcheri*	Thin-billed Prion	0.107	6.7	84	LC	7000000		
PWD	*Pachyptila desolata*	Antarctic Prion	0.136	5	84	LC	50000000		
XFP	*Pachyptila turtur*	Fairy Prion	0.149	4.5	84	LC	5000000		
XPV	*Pachyptila vittata*	Broad-billed Prion	0.128	5.4	84	LC	15000000		
PAN	*Pagodroma nivea*	Snow Petrel	0.107	5.5	90	LC	4000000		
PHA	*Phoebastria albatrus*	Short-tailed Albatross	0.071	6.7666667	95	VU	2350		
PHI	*Phoebastria immutabilis*	Laysan Albatross	0.063	8	95	VU	1200000	Y	Y
PIR	*Phoebastria irrorata*	Waved Albatross	0.061	8.3	95	CR	35000	Y	
PHN	*Phoebastria nigripes*	Black-footed Albatross	0.103	4	95	EN	120000	Y	Y

Code	BLI Scientific name	BLI Common name	Rmax	Age-at-maturity average	Survival average	Threat status	Global population	BLI tracking data	Recorded bycatch
PHF	*Phoebetria fusca*	Sooty Albatross	0.054	7	97.3	EN	42000		
PHE	*Phoebetria palpebrata*	Light-mantled Albatross	0.054	7	97.3	NT	58000		Y
PRO	*Procellaria aequinoctialis*	White-chinned Petrel	0.097	6.5	89	VU	7000000		
PCI	*Procellaria cinerea*	Grey Petrel	0.079	7	93	NT	400000		Y
PRK	*Procellaria parkinsoni*	Parkinson's Petrel	0.094	7	88	VU	10000	Y	Y
PCW	*Procellaria westlandica*	Westland Petrel	0.106	6	88	VU	20000	Y	Y
PSB	*Pseudobulweria becki*	Beck's Petrel	0.094	5.5	93	CR	149.5		
PSM	*Pseudobulweria macgillivrayi*	Fiji Petrel	0.094	5.5	93	CR	25.5		
PSR	*Pseudobulweria rostrata*	Tahiti Petrel	0.094	5.5	93	NT	20000		
PTA	*Pterodroma alba*	Phoenix Petrel	0.094	5.5	93	EN	30000		
PTT	*Pterodroma atrata*	Henderson Petrel	0.094	5.5	93	EN	74999.5		
PTX	*Pterodroma axillaris*	Chatham Petrel	0.094	5.5	93	EN	500		
PTB	*Pterodroma brevipes*	Collared Petrel	0.094	5.5	93	NT	5500		
WNP	*Pterodroma cervicalis*	White-necked Petrel	0.094	5.5	93	VU	100000		
PTC	*Pterodroma cookii*	Cook's Petrel	0.094	5.5	93	VU	1258000		
PTD	*Pterodroma defilippiana*	De Filippi's Petrel	0.094	5.5	93	VU	14999.5		
PTE	*Pterodroma externa*	Juan Fernandez Petrel	0.094	5.5	93	VU	3000000		
XMP	*Pterodroma inexpectata*	Mottled Petrel	0.094	5.5	93	NT	1500000		
XWH	*Pterodroma lessonii*	White-headed Petrel	0.094	5.5	93	LC	600000		
PTL	*Pterodroma leucoptera*	Gould's Petrel	0.094	5.5	93	VU	12000		
PTO	*Pterodroma longirostris*	Stejneger's Petrel	0.094	5.5	93	VU	400000		
PDM	*Pterodroma macroptera*	Great-winged Petrel	0.083	6.5	93	LC	150000		Y
PTM	*Pterodroma magentae*	Magenta Petrel	0.094	5.5	93	CR	135		
PTS	*Pterodroma mollis*	Soft-plumaged Petrel	0.094	5.5	93	LC	5000000		
PVB	*Pterodroma neglecta*	Kermadec Petrel	0.094	5.5	93	LC	175000		
PTG	*Pterodroma phaeopygia*	Galapagos Petrel	0.1	5	93	CR	14999.5		

Code	BLI Scientific name	BLI Common name	Rmax	Age-at-maturity average	Survival average	Threat status	Global population	BLI tracking data	Recorded bycatch
PTP	*Pterodroma pycrofti*	Pycroft's Petrel	0.087	5.5	72	VU	6500		
PTW	*Pterodroma sandwichensis*	Hawaiian Petrel	0.094	5.5	93	VU	12800		
PTI	*Pterodroma solandri*	Providence Petrel	0.094	5.5	93	VU	100000		
PTU	*Pterodroma ultima*	Murphy's Petrel	0.094	5.5	93	NT	900000		
PUA	*Puffinus assimilis*	Little Shearwater	0.107	5.5	90	LC	900000		
PUU	*Puffinus auricularis*	Townsend's Shearwater	0.107	5.5	90	CR	624.5		
PBU	*Puffinus bulleri*	Buller's Shearwater	0.107	5.5	90	VU	2500000		
PFC	*Puffinus carneipes*	Flesh-footed Shearwater	0.094	5.5	93	LC	650000		Y
PUC	*Puffinus creatopus*	Pink-footed Shearwater	0.094	5.5	93	VU	40000		
PFG	*Puffinus griseus*	Sooty Shearwater	0.088	6	93	NT	20000000	Y	Y
PUN	*Puffinus heinrothi*	Heinroth's Shearwater	0.094	5.5	93	VU	624.5		
HSW	*Puffinus huttoni*	Hutton's Shearwater	0.115	5	90	EN	325000		
PUL	*Puffinus lherminieri*	Audubon's Shearwater	0.08	8	90	LC	500000		
PUW	*Puffinus newelli*	Newell's Shearwater	0.107	5.5	90	EN	35800		
PUB	*Puffinus pacificus*	Wedge-tailed Shearwater	0.118	4	93	LC	5200000		Y
PUP	*Puffinus puffinus*	Manx Shearwater	0.085	6	93.5	LC	1150000		
PUT	*Puffinus tenuirostris*	Short-tailed Shearwater	0.088	6	93	LC	23000000		Y
DNB	*Thalassarche bulleri*	Buller's Albatross	0.109	5	91.3	NT	64000	Y	Y
TQH	*Thalassarche carteri*	Indian Yellow-nosed Albatross	0.063	9	93.5	EN	65000		Y
THC	*Thalassarche cauta*	Shy Albatross	0.063	9	93.5	NT	26000	Y	
THH	*Thalassarche chlororhynchos*	Atlantic Yellow-nosed Albatross	0.063	9	93.5	EN	69100		Y
DIC	*Thalassarche chrysostoma*	Grey-headed Albatross	0.052	10	95.3	VU	250000	Y	Y
DER	*Thalassarche eremita*	Chatham Albatross	0.076	7	93.5	CR	11000	Y	Y
TQW	*Thalassarche impavida*	Campbell Albatross	0.055	10	94.5	VU	49000	Y	
DIM	*Thalassarche melanophrys*	Black-browed Albatross	0.068	9	92	EN	1200000	Y	Y

Code	BLI Scientific name	BLI Common name	Rmax	Age-at-maturity average	Survival average	Threat status	Global population	BLI tracking data	Recorded bycatch
DLS	*Thalassarche salvini*	Salvin's Albatross	0.063	9	93.5	VU	62000		Y
XWM	*Thalassarche steadi*	White-capped Albatross	0.063	9	93.5	NT	299999.5		Y
THA	*Thalassoica antarctica*	Antarctic Petrel	0.087	6	93	LC	15000000		

Table 2. Species rankings in relation to PSA score. Species are listed in descending order of PSA score, and are listed with their common and scientific name and IUCN threat status, and with the mid-point of the estimated population size in numbers of individuals. The listed species are split into four groups: Highest risk (red) for the top 10 species, High Risk for those ranked 11- 25, (orange) Medium Risk (yellow) for those ranked 26-50, and Lowest Risk (green) for those ranked 51-74. The lowest ranked species (indicated "-") are 10 species which had ranges which did not overlap with WCPFC fishing effort in the current analysis.

BLI Scientific name	BLI Common name	Species	IUCN Threat status	Estimated Population mid point (individuals)	Rank in this analysis
Pseudobulweria macgillivrayi	Fiji Petrel	PSM	CR	25	1
Diomedea exulans	Wandering Albatross	DIX	VU	26000	2
Pseudobulweria becki	Beck's Petrel	PSB	CR	150	3
Pterodroma alba	Phoenix Petrel	PTA	EN	30000	4
Diomedea antipodensis	Antipodean Albatross	GBA	VU	25000	5
Puffinus lherminieri	Audubon's Shearwater	PUL	LC	500000	6
Pterodroma solandri	Providence Petrel	PTI	VU	100000	7
Pterodroma brevipes	Collared Petrel	PTB	NT	5500	8
Phoebastria albatrus	Short-tailed Albatross	PHA	VU	2350	9
Pterodroma cervicalis	White-necked Petrel	WNP	VU	100000	10
Procellaria parkinsoni	Parkinson's Petrel	PRK	VU	10000	11
Pseudobulweria rostrata	Tahiti Petrel	PSR	NT	20000	12
Pterodroma leucoptera	Gould's Petrel	PTL	VU	12000	13
Bulweria bulwerii	Bulwer's Petrel	BUB	LC	750000	14
Diomedea epomophora	Southern Royal Albatross	DIP	VU	28750	15
Pterodroma neglecta	Kermadec Petrel	PVB	LC	175000	16
Pterodroma longirostris	Stejneger's Petrel	PTO	VU	400000	17
Pterodroma inexpectata	Mottled Petrel	XMP	NT	1500000	18
Pterodroma cookii	Cook's Petrel	PTC	VU	1258000	19
Pterodroma atrata	Henderson Petrel	PTT	EN	75000	20
Phoebastria immutabilis	Laysan Albatross	PHI	VU	1200000	21
Pterodroma sandwichensis	Hawaiian Petrel	PTW	VU	12800	22
Puffinus bulleri	Buller's Shearwater	PBU	VU	2500000	23
Puffinus heinrothi	Heinroth's Shearwater	PUN	VU	625	24
Pterodroma ultima	Murphy's Petrel	PTU	NT	900000	25
Puffinus huttoni	Hutton's Shearwater	HSW	EN	325000	26
Puffinus carneipes	Flesh-footed Shearwater	PFC	LC	650000	27
Puffinus newelli	Newell's Shearwater	PUW	EN	35800	28
Phoebastria nigripes	Black-footed Albatross	PHN	EN	120000	29
Puffinus griseus	Sooty Shearwater	PFG	NT	20000000	30
Thalassarche bulleri	Buller's Albatross	DNB	NT	64000	31
Thalassarche carteri	Indian Yellow-nosed Albatross	TQH	EN	65000	32
Puffinus pacificus	Wedge-tailed Shearwater	PUB	LC	5200000	33
Thalassarche impavida	Campbell Albatross	TQW	VU	49000	34
Thalassarche salvini	Salvin's Albatross	DLS	VU	62000	35
Pterodroma externa	Juan Fernandez Petrel	PTE	VU	3000000	36
Pterodroma axillaris	Chatham Petrel	PTX	EN	500	37
Procellaria westlandica	Westland Petrel	PCW	VU	20000	38

BLI Scientific name	BLI Common name	Species	IUCN Threat status	Estimated Population mid point (individuals)	Rank in this analysis
Daption capense	Cape Petrel	DAC	LC	2000000	39
Thalassarche steadi	White-capped Albatross	XWM	NT	300000	40
Pterodroma macroptera	Great-winged Petrel	PDM	LC	150000	41
Puffinus tenuirostris	Short-tailed Shearwater	PUT	LC	23000000	42
Diomedea sanfordi	Northern Royal Albatross	DIS	EN	17000	43
Thalassarche eremita	Chatham Albatross	DER	CR	11000	44
Macronectes halli	Northern Giant-petrel	MAH	LC	19000	45
Puffinus assimilis	Little Shearwater	PUA	LC	900000	46
Macronectes giganteus	Southern Giant-petrel	MAI	LC	97000	47
Phoebetria palpebrata	Light-mantled Albatross	PHE	NT	58000	48
Pterodroma lessonii	White-headed Petrel	XWH	LC	600000	49
Pachyptila belcheri	Thin-billed Prion	PAB	LC	7000000	50
Thalassarche cauta	Shy Albatross	THC	NT	26000	51
Fulmarus glacialoides	Southern Fulmar	FUG	LC	4000000	52
Pachyptila vittata	Broad-billed Prion	XPV	LC	15000000	53
Procellaria aequinoctialis	White-chinned Petrel	PRO	VU	7000000	54
Procellaria cinerea	Grey Petrel	PCI	NT	400000	55
Pterodroma mollis	Soft-plumaged Petrel	PTS	LC	5000000	56
Lugensa brevirostris	Kerguelen Petrel	LUB	LC	1000000	57
Thalassarche chrysostoma	Grey-headed Albatross	DIC	VU	250000	58
Halobaena caerulea	Blue Petrel	HBE	LC	3000000	59
Pachyptila desolata	Antarctic Prion	PWD	LC	50000000	60
Thalassarche melanophrys	Black-browed Albatross	DIM	EN	1200000	61
Pterodroma magentae	Magenta Petrel	PTM	CR	135	62
Pachyptila turtur	Fairy Prion	XFP	LC	5000000	63
Phoebetria fusca	Sooty Albatross	PHF	EN	42000	64
Pterodroma defilippiana	De Filippi's Petrel	PTD	VU	15000	-
Pterodroma pycrofti	Pycroft's Petrel	PTP	VU	6500	-
Puffinus creatopus	Pink-footed Shearwater	PUC	VU	40000	-
Pagodroma nivea	Snow Petrel	PAN	LC	4000000	-
Puffinus puffinus	Manx Shearwater	PUP	LC	1150000	-
Thalassoica antarctica	Antarctic Petrel	THA	LC	15000000	-
Thalassarche chlororhynchos	Atlantic Yellow-nosed Albatross	THH	EN	69100	-
Phoebastria irrorata	Waved Albatross	PIR	CR	35000	-
Pterodroma phaeopygia	Galapagos Petrel	PTG	CR	15000	-
Puffinus auricularis	Townsend's Shearwater	PUU	CR	625	-

Table 3. Species level information on risk posed to species in the Ecological Risk Assessment, assigned to the flag state of vessels which fish in regions overlapping the distribution of the species. Flags are listed in descending order of their contribution to risk for the species, with flags contributing the first 90% of risk for each species listed. The overall rank of the species in the PSA is indicated as "rank of species in analysis". Those ranked with smaller numbers had highest overall risk levels. Species are listed by alphabetical order in relation to their scientific name.

Scientific name	Common Name	Flag	Flag contribution to species risk	Rank of species in analysis
Bulweria bulwerii	Bulwer's Petrel	CHINESE TAIPEI	31%	14
Bulweria bulwerii	Bulwer's Petrel	REPUBLIC OF KOREA	16%	14
Bulweria bulwerii	Bulwer's Petrel	JAPAN	14%	14
Bulweria bulwerii	Bulwer's Petrel	INDONESIA	12%	14
Bulweria bulwerii	Bulwer's Petrel	CHINA	7%	14
Bulweria bulwerii	Bulwer's Petrel	USA	5%	14
Bulweria bulwerii	Bulwer's Petrel	PHILIPPINES	5%	14
Daption capense	Cape Petrel	CHINESE TAIPEI	21%	39
Daption capense	Cape Petrel	JAPAN	13%	39
Daption capense	Cape Petrel	FRENCH POLYNESIA	11%	39
Daption capense	Cape Petrel	FIJI	10%	39
Daption capense	Cape Petrel	VANUATU	8%	39
Daption capense	Cape Petrel	NEW ZEALAND	7%	39
Daption capense	Cape Petrel	AMERICAN SAMOA	6%	39
Daption capense	Cape Petrel	AUSTRALIA	6%	39
Daption capense	Cape Petrel	CHINA	4%	39
Daption capense	Cape Petrel	REPUBLIC OF KOREA	4%	39
Diomedea antipodensis	Antipodean Albatross	JAPAN	56%	5
Diomedea antipodensis	Antipodean Albatross	NEW ZEALAND	25%	5
Diomedea antipodensis	Antipodean Albatross	CHINESE TAIPEI	9%	5
Diomedea epomophora	Southern Royal Albatross	NEW ZEALAND	99%	15
Diomedea exulans	Wandering Albatross	JAPAN	76%	2
Diomedea exulans	Wandering Albatross	AUSTRALIA	15%	2
Diomedea sanfordi	Northern Royal Albatross	NEW ZEALAND	97%	43
Halobaena caerulea	Blue Petrel	JAPAN	49%	59
Halobaena caerulea	Blue Petrel	NEW ZEALAND	40%	59
Halobaena caerulea	Blue Petrel	CHINESE TAIPEI	6%	59
Lugensa brevirostris	Kerguelen Petrel	JAPAN	54%	57
Lugensa brevirostris	Kerguelen Petrel	NEW ZEALAND	35%	57
Lugensa brevirostris	Kerguelen Petrel	CHINESE TAIPEI	6%	57
Macronectes giganteus	Southern Giant-petrel	JAPAN	37%	47
Macronectes giganteus	Southern Giant-petrel	NEW ZEALAND	24%	47
Macronectes giganteus	Southern Giant-petrel	AUSTRALIA	18%	47
Macronectes giganteus	Southern Giant-petrel	CHINESE TAIPEI	13%	47

Scientific name	Common Name	Flag	Flag contribution to species risk	Rank of species in analysis
Macronectes halli	Northern Giant-petrel	JAPAN	37%	45
Macronectes halli	Northern Giant-petrel	NEW ZEALAND	23%	45
Macronectes halli	Northern Giant-petrel	AUSTRALIA	20%	45
Macronectes halli	Northern Giant-petrel	CHINESE TAIPEI	13%	45
Pachyptila belcheri	Thin-billed Prion	JAPAN	44%	50
Pachyptila belcheri	Thin-billed Prion	NEW ZEALAND	26%	50
Pachyptila belcheri	Thin-billed Prion	AUSTRALIA	20%	50
Pachyptila desolata	Antarctic Prion	JAPAN	43%	60
Pachyptila desolata	Antarctic Prion	NEW ZEALAND	31%	60
Pachyptila desolata	Antarctic Prion	AUSTRALIA	15%	60
Pachyptila turtur	Fairy Prion	JAPAN	37%	63
Pachyptila turtur	Fairy Prion	NEW ZEALAND	23%	63
Pachyptila turtur	Fairy Prion	AUSTRALIA	21%	63
Pachyptila turtur	Fairy Prion	CHINESE TAIPEI	12%	63
Pachyptila vittata	Broad-billed Prion	NEW ZEALAND	83%	53
Pachyptila vittata	Broad-billed Prion	JAPAN	6%	53
Pachyptila vittata	Broad-billed Prion	CHINESE TAIPEI	5%	53
Phoebastria albatrus	Short-tailed Albatross	CHINESE TAIPEI	46%	9
Phoebastria albatrus	Short-tailed Albatross	JAPAN	32%	9
Phoebastria albatrus	Short-tailed Albatross	USA	15%	9
Phoebastria immutabilis	Laysan Albatross	USA	35%	21
Phoebastria immutabilis	Laysan Albatross	JAPAN	31%	21
Phoebastria immutabilis	Laysan Albatross	CHINESE TAIPEI	21%	21
Phoebastria immutabilis	Laysan Albatross	VANUATU	11%	21
Phoebastria nigripes	Black-footed Albatross	USA	31%	29
Phoebastria nigripes	Black-footed Albatross	CHINESE TAIPEI	26%	29
Phoebastria nigripes	Black-footed Albatross	JAPAN	25%	29
Phoebastria nigripes	Black-footed Albatross	VANUATU	15%	29
Phoebetria fusca	Sooty Albatross	AUSTRALIA	100%	64
Phoebetria palpebrata	Light-mantled Albatross	NEW ZEALAND	48%	48
Phoebetria palpebrata	Light-mantled Albatross	JAPAN	42%	48
Phoebetria palpebrata	Light-mantled Albatross	CHINESE TAIPEI	5%	48
Procellaria aequinoctialis	White-chinned Petrel	JAPAN	45%	54
Procellaria aequinoctialis	White-chinned Petrel	NEW ZEALAND	29%	54
Procellaria aequinoctialis	White-chinned Petrel	CHINESE TAIPEI	11%	54
Procellaria aequinoctialis	White-chinned Petrel	AUSTRALIA	7%	54
Procellaria cinerea	Grey Petrel	NEW ZEALAND	69%	55
Procellaria cinerea	Grey Petrel	JAPAN	25%	55
Procellaria parkinsoni	Parkinson's Petrel	NEW ZEALAND	79%	11
Procellaria parkinsoni	Parkinson's Petrel	JAPAN	6%	11
Procellaria parkinsoni	Parkinson's Petrel	FRENCH POLYNESIA	5%	11
Procellaria parkinsoni	Parkinson's Petrel	CHINESE TAIPEI	4%	11

Scientific name	Common Name	Flag	Flag contribution to species risk	Rank of species in analysis
Procellaria westlandica	Westland Petrel	NEW ZEALAND	97%	38
Pseudobulweria becki	Beck's Petrel	REPUBLIC OF KOREA	24%	3
Pseudobulweria becki	Beck's Petrel	CHINESE TAIPEI	19%	3
Pseudobulweria becki	Beck's Petrel	FIJI	11%	3
Pseudobulweria becki	Beck's Petrel	CHINA	11%	3
Pseudobulweria becki	Beck's Petrel	JAPAN	11%	3
Pseudobulweria becki	Beck's Petrel	FRENCH POLYNESIA	5%	3
Pseudobulweria becki	Beck's Petrel	VANUATU	4%	3
Pseudobulweria becki	Beck's Petrel	AMERICAN SAMOA	3%	3
Pseudobulweria becki	Beck's Petrel	AUSTRALIA	2%	3
Pseudobulweria macgillivrayi	Fiji Petrel	FIJI	96%	1
Pseudobulweria rostrata	Tahiti Petrel	CHINESE TAIPEI	23%	12
Pseudobulweria rostrata	Tahiti Petrel	REPUBLIC OF KOREA	20%	12
Pseudobulweria rostrata	Tahiti Petrel	JAPAN	12%	12
Pseudobulweria rostrata	Tahiti Petrel	FIJI	11%	12
Pseudobulweria rostrata	Tahiti Petrel	CHINA	10%	12
Pseudobulweria rostrata	Tahiti Petrel	FRENCH POLYNESIA	5%	12
Pseudobulweria rostrata	Tahiti Petrel	VANUATU	4%	12
Pseudobulweria rostrata	Tahiti Petrel	AMERICAN SAMOA	3%	12
Pseudobulweria rostrata	Tahiti Petrel	AUSTRALIA	2%	12
Pterodroma alba	Phoenix Petrel	REPUBLIC OF KOREA	26%	4
Pterodroma alba	Phoenix Petrel	CHINESE TAIPEI	18%	4
Pterodroma alba	Phoenix Petrel	CHINA	13%	4
Pterodroma alba	Phoenix Petrel	FIJI	9%	4
Pterodroma alba	Phoenix Petrel	FRENCH POLYNESIA	9%	4
Pterodroma alba	Phoenix Petrel	AMERICAN SAMOA	6%	4
Pterodroma alba	Phoenix Petrel	JAPAN	5%	4
Pterodroma alba	Phoenix Petrel	VANUATU	3%	4
Pterodroma alba	Phoenix Petrel	SAMOA	3%	4
Pterodroma atrata	Henderson Petrel	REPUBLIC OF KOREA	33%	20
Pterodroma atrata	Henderson Petrel	CHINESE TAIPEI	22%	20
Pterodroma atrata	Henderson Petrel	FRENCH POLYNESIA	22%	20
Pterodroma atrata	Henderson Petrel	JAPAN	14%	20
Pterodroma axillaris	Chatham Petrel	NEW ZEALAND	99%	37

Scientific name	Common Name	Flag	Flag contribution to species risk	Rank of species in analysis
Pterodroma brevipes	Collared Petrel	REPUBLIC OF KOREA	28%	**8**
Pterodroma brevipes	Collared Petrel	CHINESE TAIPEI	17%	**8**
Pterodroma brevipes	Collared Petrel	FIJI	14%	**8**
Pterodroma brevipes	Collared Petrel	CHINA	11%	**8**
Pterodroma brevipes	Collared Petrel	FRENCH POLYNESIA	7%	**8**
Pterodroma brevipes	Collared Petrel	JAPAN	6%	**8**
Pterodroma brevipes	Collared Petrel	AMERICAN SAMOA	5%	**8**
Pterodroma brevipes	Collared Petrel	VANUATU	4%	**8**
Pterodroma cervicalis	White-necked Petrel	REPUBLIC OF KOREA	21%	**10**
Pterodroma cervicalis	White-necked Petrel	JAPAN	18%	**10**
Pterodroma cervicalis	White-necked Petrel	CHINESE TAIPEI	18%	**10**
Pterodroma cervicalis	White-necked Petrel	CHINA	10%	**10**
Pterodroma cervicalis	White-necked Petrel	FIJI	8%	**10**
Pterodroma cervicalis	White-necked Petrel	USA	7%	**10**
Pterodroma cervicalis	White-necked Petrel	VANUATU	4%	**10**
Pterodroma cervicalis	White-necked Petrel	FRENCH POLYNESIA	4%	**10**
Pterodroma cookii	Cook's Petrel	REPUBLIC OF KOREA	22%	**19**
Pterodroma cookii	Cook's Petrel	CHINESE TAIPEI	19%	**19**
Pterodroma cookii	Cook's Petrel	JAPAN	16%	**19**
Pterodroma cookii	Cook's Petrel	USA	10%	**19**
Pterodroma cookii	Cook's Petrel	CHINA	9%	**19**
Pterodroma cookii	Cook's Petrel	FRENCH POLYNESIA	6%	**19**
Pterodroma cookii	Cook's Petrel	VANUATU	5%	**19**
Pterodroma cookii	Cook's Petrel	AMERICAN SAMOA	4%	**19**
Pterodroma externa	Juan Fernandez Petrel	USA	35%	**36**
Pterodroma externa	Juan Fernandez Petrel	REPUBLIC OF KOREA	25%	**36**
Pterodroma externa	Juan Fernandez Petrel	JAPAN	17%	**36**
Pterodroma externa	Juan Fernandez Petrel	CHINESE TAIPEI	13%	**36**
Pterodroma externa	Juan Fernandez Petrel	CHINA	7%	36

Scientific name	Common Name	Flag	Flag contribution to species risk	Rank of species in analysis
Pterodroma inexpectata	Mottled Petrel	REPUBLIC OF KOREA	20%	18
Pterodroma inexpectata	Mottled Petrel	CHINESE TAIPEI	18%	18
Pterodroma inexpectata	Mottled Petrel	JAPAN	15%	18
Pterodroma inexpectata	Mottled Petrel	CHINA	9%	18
Pterodroma inexpectata	Mottled Petrel	FIJI	8%	18
Pterodroma inexpectata	Mottled Petrel	USA	7%	18
Pterodroma inexpectata	Mottled Petrel	VANUATU	6%	18
Pterodroma inexpectata	Mottled Petrel	FRENCH POLYNESIA	4%	18
Pterodroma inexpectata	Mottled Petrel	AMERICAN SAMOA	3%	18
Pterodroma lessonii	White-headed Petrel	JAPAN	39%	49
Pterodroma lessonii	White-headed Petrel	NEW ZEALAND	29%	49
Pterodroma lessonii	White-headed Petrel	AUSTRALIA	14%	49
Pterodroma lessonii	White-headed Petrel	CHINESE TAIPEI	11%	49
Pterodroma leucoptera	Gould's Petrel	CHINESE TAIPEI	18%	13
Pterodroma leucoptera	Gould's Petrel	REPUBLIC OF KOREA	14%	13
Pterodroma leucoptera	Gould's Petrel	FIJI	13%	13
Pterodroma leucoptera	Gould's Petrel	JAPAN	12%	13
Pterodroma leucoptera	Gould's Petrel	CHINA	12%	13
Pterodroma leucoptera	Gould's Petrel	FRENCH POLYNESIA	8%	13
Pterodroma leucoptera	Gould's Petrel	AMERICAN SAMOA	6%	13
Pterodroma leucoptera	Gould's Petrel	VANUATU	4%	13
Pterodroma leucoptera	Gould's Petrel	AUSTRALIA	4%	13
Pterodroma leucoptera	Gould's Petrel	SAMOA	3%	13
Pterodroma longirostris	Stejneger's Petrel	REPUBLIC OF KOREA	28%	17
Pterodroma longirostris	Stejneger's Petrel	JAPAN	26%	17
Pterodroma longirostris	Stejneger's Petrel	CHINESE TAIPEI	22%	17
Pterodroma longirostris	Stejneger's Petrel	CHINA	12%	17
Pterodroma longirostris	Stejneger's Petrel	USA	7%	17
Pterodroma macroptera	Great-winged Petrel	JAPAN	34%	41
Pterodroma macroptera	Great-winged Petrel	NEW ZEALAND	22%	41
Pterodroma macroptera	Great-winged Petrel	CHINESE TAIPEI	18%	41
Pterodroma macroptera	Great-winged Petrel	AUSTRALIA	14%	41
Pterodroma macroptera	Great-winged Petrel	VANUATU	9%	41

Scientific name	Common Name	Flag	Flag contribution to species risk	Rank of species in analysis
Pterodroma magentae	Magenta Petrel	INDONESIA	35%	**62**
Pterodroma magentae	Magenta Petrel	SPAIN	29%	**62**
Pterodroma magentae	Magenta Petrel	NEW ZEALAND	13%	**62**
Pterodroma magentae	Magenta Petrel	VANUATU	10%	**62**
Pterodroma magentae	Magenta Petrel	CHINESE TAIPEI	9%	**62**
Pterodroma mollis	Soft-plumaged Petrel	NEW ZEALAND	58%	56
Pterodroma mollis	Soft-plumaged Petrel	JAPAN	37%	56
Pterodroma neglecta	Kermadec Petrel	CHINESE TAIPEI	20%	16
Pterodroma neglecta	Kermadec Petrel	REPUBLIC OF KOREA	20%	16
Pterodroma neglecta	Kermadec Petrel	JAPAN	18%	16
Pterodroma neglecta	Kermadec Petrel	CHINA	9%	16
Pterodroma neglecta	Kermadec Petrel	FIJI	8%	16
Pterodroma neglecta	Kermadec Petrel	USA	6%	16
Pterodroma neglecta	Kermadec Petrel	VANUATU	4%	16
Pterodroma neglecta	Kermadec Petrel	FRANCE (FRENCH POLYNESIA)	4%	16
Pterodroma neglecta	Kermadec Petrel	USA (AMERICAN SAMOA)	2%	16
Pterodroma sandwichensis	Hawaiian Petrel	USA	56%	22
Pterodroma sandwichensis	Hawaiian Petrel	REPUBLIC OF KOREA	18%	22
Pterodroma sandwichensis	Hawaiian Petrel	JAPAN	13%	22
Pterodroma sandwichensis	Hawaiian Petrel	CHINA	6%	22
Pterodroma solandri	Providence Petrel	JAPAN	23%	7
Pterodroma solandri	Providence Petrel	REPUBLIC OF KOREA	21%	7
Pterodroma solandri	Providence Petrel	CHINESE TAIPEI	15%	7
Pterodroma solandri	Providence Petrel	FIJI	11%	7
Pterodroma solandri	Providence Petrel	USA	10%	7
Pterodroma solandri	Providence Petrel	CHINA	6%	7
Pterodroma solandri	Providence Petrel	VANUATU	5%	7

Scientific name	Common Name	Flag	Flag contribution to species risk	Rank of species in analysis
Pterodroma ultima	Murphy's Petrel	CHINESE TAIPEI	25%	25
Pterodroma ultima	Murphy's Petrel	REPUBLIC OF KOREA	24%	25
Pterodroma ultima	Murphy's Petrel	CHINA	14%	25
Pterodroma ultima	Murphy's Petrel	FRANCE (FRENCH POLYNESIA)	10%	25
Pterodroma ultima	Murphy's Petrel	JAPAN	7%	25
Pterodroma ultima	Murphy's Petrel	USA (AMERICAN SAMOA)	6%	25
Pterodroma ultima	Murphy's Petrel	VANUATU	5%	25
Puffinus assimilis	Little Shearwater	CHINESE TAIPEI	31%	46
Puffinus assimilis	Little Shearwater	JAPAN	24%	46
Puffinus assimilis	Little Shearwater	NEW ZEALAND	15%	46
Puffinus assimilis	Little Shearwater	VANUATU	15%	46
Puffinus assimilis	Little Shearwater	AUSTRALIA	9%	46
Puffinus bulleri	Buller's Shearwater	REPUBLIC OF KOREA	21%	23
Puffinus bulleri	Buller's Shearwater	CHINESE TAIPEI	18%	23
Puffinus bulleri	Buller's Shearwater	JAPAN	17%	23
Puffinus bulleri	Buller's Shearwater	CHINA	9%	23
Puffinus bulleri	Buller's Shearwater	FIJI	9%	23
Puffinus bulleri	Buller's Shearwater	USA	7%	23
Puffinus bulleri	Buller's Shearwater	VANUATU	5%	23
Puffinus bulleri	Buller's Shearwater	USA (AMERICAN SAMOA)	3%	23
Puffinus bulleri	Buller's Shearwater	NEW ZEALAND	2%	23
Puffinus carneipes	Flesh-footed Shearwater	JAPAN	28%	27
Puffinus carneipes	Flesh-footed Shearwater	CHINESE TAIPEI	18%	27
Puffinus carneipes	Flesh-footed Shearwater	FIJI	13%	27
Puffinus carneipes	Flesh-footed Shearwater	REPUBLIC OF KOREA	11%	27
Puffinus carneipes	Flesh-footed Shearwater	CHINA	7%	27
Puffinus carneipes	Flesh-footed Shearwater	USA	7%	27
Puffinus carneipes	Flesh-footed Shearwater	VANUATU	6%	27
Puffinus carneipes	Flesh-footed Shearwater	AUSTRALIA	3%	27

Scientific name	Common Name	Flag	Flag contribution to species risk	Rank of species in analysis
Puffinus griseus	Sooty Shearwater	REPUBLIC OF KOREA	19%	30
Puffinus griseus	Sooty Shearwater	CHINESE TAIPEI	19%	30
Puffinus griseus	Sooty Shearwater	JAPAN	17%	30
Puffinus griseus	Sooty Shearwater	CHINA	9%	30
Puffinus griseus	Sooty Shearwater	FIJI	8%	30
Puffinus griseus	Sooty Shearwater	USA	7%	30
Puffinus griseus	Sooty Shearwater	VANUATU	6%	30
Puffinus griseus	Sooty Shearwater	FRANCE (FRENCH POLYNESIA)	4%	30
Puffinus griseus	Sooty Shearwater	USA (AMERICAN SAMOA)	3%	30
Puffinus heinrothi	Heinroth's Shearwater	PAPUA NEW GUINEA	63%	24
Puffinus heinrothi	Heinroth's Shearwater	JAPAN	25%	24
Puffinus heinrothi	Heinroth's Shearwater	CHINESE TAIPEI	6%	24
Puffinus huttoni	Hutton's Shearwater	JAPAN	35%	26
Puffinus huttoni	Hutton's Shearwater	AUSTRALIA	30%	26
Puffinus huttoni	Hutton's Shearwater	NEW ZEALAND	25%	26
Puffinus huttoni	Hutton's Shearwater	CHINESE TAIPEI	7%	26
Puffinus lherminieri	Audubon's Shearwater	CHINESE TAIPEI	25%	6
Puffinus lherminieri	Audubon's Shearwater	REPUBLIC OF KOREA	25%	6
Puffinus lherminieri	Audubon's Shearwater	JAPAN	12%	6
Puffinus lherminieri	Audubon's Shearwater	CHINA	11%	6
Puffinus lherminieri	Audubon's Shearwater	FIJI	9%	6
Puffinus lherminieri	Audubon's Shearwater	FRANCE (FRENCH POLYNESIA)	5%	6
Puffinus lherminieri	Audubon's Shearwater	VANUATU	3%	6
Puffinus lherminieri	Audubon's Shearwater	USA (AMERICAN SAMOA)	3%	6
Puffinus newelli	Newell's Shearwater	USA	40%	28
Puffinus newelli	Newell's Shearwater	REPUBLIC OF KOREA	31%	28
Puffinus newelli	Newell's Shearwater	JAPAN	13%	28
Puffinus newelli	Newell's Shearwater	CHINESE TAIPEI	9%	28

Scientific name	Common Name	Flag	Flag contribution to species risk	Rank of species in analysis
Puffinus pacificus	Wedge-tailed Shearwater	CHINESE TAIPEI	29%	33
Puffinus pacificus	Wedge-tailed Shearwater	REPUBLIC OF KOREA	17%	33
Puffinus pacificus	Wedge-tailed Shearwater	JAPAN	16%	33
Puffinus pacificus	Wedge-tailed Shearwater	CHINA	8%	33
Puffinus pacificus	Wedge-tailed Shearwater	FIJI	7%	33
Puffinus pacificus	Wedge-tailed Shearwater	USA	5%	33
Puffinus pacificus	Wedge-tailed Shearwater	VANUATU	3%	33
Puffinus pacificus	Wedge-tailed Shearwater	FRANCE (FRENCH POLYNESIA)	3%	33
Puffinus pacificus	Wedge-tailed Shearwater	USA (AMERICAN SAMOA)	2%	33
Puffinus pacificus	Wedge-tailed Shearwater	AUSTRALIA	2%	33
Puffinus tenuirostris	Short-tailed Shearwater	JAPAN	67%	42
Puffinus tenuirostris	Short-tailed Shearwater	AUSTRALIA	11%	42
Puffinus tenuirostris	Short-tailed Shearwater	CHINESE TAIPEI	6%	42
Puffinus tenuirostris	Short-tailed Shearwater	REPUBLIC OF KOREA	5%	42
Puffinus tenuirostris	Short-tailed Shearwater	CHINA	2%	42
Thalassarche bulleri	Buller's Albatross	NEW ZEALAND	51%	31
Thalassarche bulleri	Buller's Albatross	JAPAN	48%	52
Thalassarche bulleri	Buller's Albatross	JAPAN	46%	31
Thalassarche bulleri	Buller's Albatross	NEW ZEALAND	31%	52
Thalassarche bulleri	Buller's Albatross	AUSTRALIA	10%	52
Thalassarche bulleri	Buller's Albatross	CHINESE TAIPEI	8%	52
Thalassarche carteri	Indian Yellow-nosed Albatross	JAPAN	47%	32
Thalassarche carteri	Indian Yellow-nosed Albatross	AUSTRALIA	17%	32
Thalassarche carteri	Indian Yellow-nosed Albatross	NEW ZEALAND	17%	32
Thalassarche carteri	Indian Yellow-nosed Albatross	CHINESE TAIPEI	12%	32
Thalassarche cauta	Shy Albatross	JAPAN	50%	51
Thalassarche cauta	Shy Albatross	AUSTRALIA	42%	51

Scientific name	Common Name	Flag	Flag contribution to species risk	Rank of species in analysis
Thalassarche chrysostoma	Grey-headed Albatross	CHINESE TAIPEI	32%	58
Thalassarche chrysostoma	Grey-headed Albatross	JAPAN	24%	58
Thalassarche chrysostoma	Grey-headed Albatross	VANUATU	20%	58
Thalassarche chrysostoma	Grey-headed Albatross	NEW ZEALAND	17%	58
Thalassarche eremita	Chatham Albatross	NEW ZEALAND	66%	44
Thalassarche eremita	Chatham Albatross	CHINESE TAIPEI	10%	44
Thalassarche eremita	Chatham Albatross	VANUATU	5%	44
Thalassarche eremita	Chatham Albatross	JAPAN	4%	44
Thalassarche eremita	Chatham Albatross	FIJI	3%	44
Thalassarche impavida	Campbell Albatross	NEW ZEALAND	68%	34
Thalassarche impavida	Campbell Albatross	JAPAN	20%	34
Thalassarche impavida	Campbell Albatross	CHINESE TAIPEI	5%	34
Thalassarche melanophrys	Black-browed Albatross	JAPAN	27%	61
Thalassarche melanophrys	Black-browed Albatross	CHINESE TAIPEI	25%	61
Thalassarche melanophrys	Black-browed Albatross	NEW ZEALAND	17%	61
Thalassarche melanophrys	Black-browed Albatross	AUSTRALIA	13%	61
Thalassarche melanophrys	Black-browed Albatross	VANUATU	13%	61
Thalassarche salvini	Salvin's Albatross	JAPAN	40%	35
Thalassarche salvini	Salvin's Albatross	NEW ZEALAND	28%	35
Thalassarche salvini	Salvin's Albatross	CHINESE TAIPEI	15%	35
Thalassarche salvini	Salvin's Albatross	VANUATU	9%	35
Thalassarche steadi	White-capped Albatross	JAPAN	38%	40
Thalassarche steadi	White-capped Albatross	NEW ZEALAND	25%	40
Thalassarche steadi	White-capped Albatross	AUSTRALIA	17%	40
Thalassarche steadi	White-capped Albatross	CHINESE TAIPEI	13%	40