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SEABIRD BYCATCH RATES IN WCPFC LONGLINE FISHERIES

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ABSTRACT

- Conservation and Management Measure 2007-04 tasks the Scientific Committee with estimating seabird mortality in WCPFC fisheries (CMM-2007-04 Paragraph 9).
- This paper reviews the most recent rates of seabird bycatch reported for fisheries within the WCPFC
- There are significant gaps in the available seabird bycatch data:
  - There are limited data on seabird bycatch rates from the Japanese and Korean distant water fleets operating north of 20°N and south of 30°S in the Pacific Ocean, areas where seabird bycatch is known to be a significant problem.
  - In general, seabird bycatch rates are believed to be lower in tropical longline fisheries, but data remain very limited, and fishing effort in this region is high.
- Currently, the observer coverage within the WCPFC longline fisheries is very low (covering less than 1% of effort). Combined with the non-random distribution of observer effort throughout the area, this leads to severe restrictions in the ability to make estimates of overall seabird bycatch. An improvement in the level and spread of observer coverage would greatly enhance ability of WCPFC to estimate the seabird mortality in its fisheries, and to effectively reduce seabird bycatch.
- Models combining fishing effort data, available bycatch rates and seabird distributions have been used to determine overall seabird bycatch within ICCAT longline fisheries (Klaer *et al*. 2008). A similar approach may be appropriate for WCPFC.

1. INTRODUCTION

The seabird species most vulnerable to bycatch are albatrosses and larger petrels. Eighteen of the 22 species of albatross are threatened with extinction (BirdLife International 2008). It is recognised that, for most species, the key threat comes from incidental mortality associated with fisheries. The seven species of petrel (*Procellaria* species and *Macronectes* species) listed under the Agreement on the Conservation of Albatrosses and Petrels (ACAP), face similar threats. These species are extremely wide-ranging and their distributions overlap considerably with the Western Central Pacific Fisheries Commission (WCPFC) Convention Area (BirdLife International 2007). Analysis of albatross distribution within WCPFC waters and their overlap with longline fisheries (BirdLife International 2007, ACAP 2008) identifies that highest overlap with albatross distribution occurs in waters south of 30°S and north of around 20°N.

Tracking data is lacking for most of the smaller petrel and shearwater species that inhabit the Pacific. Nonetheless, many of these species are potentially vulnerable to longline bycatch. A review found that 16 species of albatross and 60 species of petrel potentially overlapped WCPFC longline fisheries. This included species with IUCN classification of Critically Endangered (6), Endangered (7), Vulnerable (26) and Near Threatened (7) for both

albatrosses and petrels. The remainder were classified by the IUCN as Least Concern. (Waugh 2006).

Recognising that seabird bycatch occurs in WCPFC longline fisheries, and that this may be having an impact on seabird populations, CMM-2007-04 tasks the WCPFC Scientific Committee with estimating the levels of seabird bycatch occurring. This paper reviews the available data on current seabird bycatch rates for pelagic longline fisheries operating within WCPFC waters.

2. METHODS

A review was undertaken of available published and unpublished literature on seabird and fishery interactions to obtain a comprehensive list of bycatch figures from fisheries within WCPFC fisheries. In many cases historical data going back to the 1980s is available, see BirdLife International (2006) for a review. The data presented here was chosen to reflect the current known bycatch rates in WCPFC fisheries.

3. RESULTS

3.1 Observer programs in WCPFC longline fisheries

The existing observer programmes covering pelagic longline fleets fishing within WCPFC waters are comprehensively reviewed in Lawson (2006). Although many of the Contracting or Cooperating Non-Contracting Members (CCMs) that fish within WCPFC waters have observer programmes, the level of observer coverage is generally very low (Table 1). From 1994 to 2003, the average percentage of longline hooks observed throughout the Convention Area was 0.77%. This scale of sampling is not sufficient for complete spatial and temporal coverage and gives extremely low confidence in the resulting seabird bycatch rates (Lawson 2006).

Table 1. Observer coverage within WCPFC (information from Lawson 2006, Mackenzie and Fletcher 2005 and Clemens 2006).

Observer programme	**Coverage**
Pacific Islands Countries and Territories (PICTs)	• Observers are deployed opportunistically, except in Papua New Guinea where 5% of trips have observers.
Australia	• Fisheries are stratified by season and geographic area, observers are placed randomly across these strata. • Overall, target coverage is to be increased from 5.1 to 8.5%. • Specific fisheries may be targeted with higher observer coverage; 100% to monitor southern bluefin tuna in closed areas, 25% of hooks set off North Queensland in 2006 for a study on wire leaders.
New Zealand	• Observer coverage is stratified by target species, geographic area and season. • Objectives for observer deployment are to cover 10% of the catch of tunas, which is largely achieved by concentrated deployment on the few large Japanese Joint-Venture vessels. This sampling strategy does not cover the majority of fishing effort and leaves large seasonal and area gaps in the knowledge of fishing activity and bycatch. Very low coverage has been achieved on small (less than 28m) domestic operated vessels, which represent the majority of the fishing effort, leading to a lack of representativeness in the data. • There are relatively few data from small vessels. From 1998 to 2004, the average observer coverage on pelagic longliners was 1.4% for vessels <28m and 56% for vessels >28m (Mackenzie and Fletcher 2005).
Korea	• In 2005, one trip in WCPFC area was observed. A target coverage rate has not been established.

Chinese Taipei	• In 2005, 5% of vessels had an observer on board at some point. Coverage of total effort is far lower (0.9% of all hooks between 2002 and 2006, Huang *et al*. 2008). • Observers covered six trips in the Pacific Ocean during 2005.
USA (Hawaii)	• Hawaiian 'shallow-set' swordfish longline fisheries require 100% observer coverage. • Hawaiian 'deep-set' tuna longline fisheries maintain at least 20% observer coverage.

3.2 Available seabird bycatch data

Data on the most recently available bycatch rates are summarised in Table 2, and discussed below by region (**North Pacific, South Pacific** and **Tropical Pacific**).

3.2.1 NORTH PACIFIC

Hawaii

Some of the most comprehensive observer coverage, and therefore seabird bycatch data, comes from the Hawaiian pelagic longline fisheries. Vessels targeting swordfish, 'shallow set', are required to have 100% observer coverage while those targeting tuna, 'deep set', have somewhere between 20-30% observer coverage (see Case Study below). Following the adoption of mandatory mitigation measures, seabird bycatch rates have declined from approximately 2,300 albatrosses per year in the late 1990s to less than 200 in 2005 (Clemens 2006).

US west coast

The fleet of pelagic longline vessels based primarily in California fish outside the WCPFC Convention Area for much of the year but a small proportion of their effort is directed at WCPFC waters. These vessels can have relatively high bycatch rates (0.29 birds per 1,000 hooks, NMFS).

Asian distant water fleet

Historical bycatch rates for vessels fishing in Hawaiian waters have been used to model seabird bycatch in the Asian distant water fleets operating in the North Pacific (Crowder and Myers 2001). This study estimated that the Japanese fleet was likely to catch 14,540 birds per year (7,200 Laysan Albatross, *Phoebastria immutabilis*, and 7,340 Black-footed Albatross, *P. nigripes*) and the Chinese Taipei fleet was estimated to catch 2,945 birds per year (1,630 Laysan Albatross, and 1,315 Black-footed Albatross). These estimates cover both the WCPFC and IATTC areas. However, satellite tracking data indicates that over 90% of Laysan and 50% Black-footed Albatross distribution is within the WCPFC Convention Area (ACAP 2008).

Huang *et al*. (2008) estimate similar bycatch rates as those used by Crowder and Myers (2001) for the North Pacific. However, a lower level of fishing effort results in a lower overall estimated bycatch of approximately 1,685 birds per year for the Chinese Taipei fleet in the North Pacific.

The major seabird bycatch data gaps in the North Pacific are those for the Japanese and Korean distant water fleets.

Table 2. Recent seabird bycatch data from WCPFC pelagic longline fisheries.
Key: Tu – Tuna, Sw – Swordfish, Bf – Billfish, SBT – Southern bluefin tuna

Region	Country	Fleet	Target	Year	Effort 1,000 hooks/yr	BPUE Birds/1,000 hooks	Total bycatch	Albatross	Petrel	Shearwater	Source
North Pacific	U.S.	Hawaii'Surface'	Sw	2005	1,725	0.04	69	69			1.
	U.S.	Hawaii'Deep'	Tu	2005	31,250	0.004	125	125			1.
	U.S.	West coast	Sw	2001-03		0.29					2.
	Chinese Taipei	Distant	Tu	2002-06	10,400	0.10-0.22	1,685				3.
	Japan	Distant	Tu	1994-98	OFP data	0.0-0.5	14,540	14,540			4.
Tropics	Chinese Taipei	Distant	Tu	2002-06	24,000	0.005-0.011	168				3.
	New Caledonia	Inshore				1 petrel in 9 months					
	French Polynesia					0					
	Federated States of Micronesia		Tu	1993-94		0.001					5.
	Australia	Cocos + Christmas		1999-2003	3	0					6.
	Western Pacific		Tu			0					7
South Pacific	Australia	ETBF<30°S	Tu, Bf	2002	4,012	0.145	583	95+		237	8.
	Australia	ETBF>30°S	Tu, Bf	2004	3,500		950			583	9.
	Australia	ETBF	Tu, Bf	2007		<0.05	<100				10.
	New Zealand	Vessels <28m	Tu	2004	5,007 sets		1,627				11.
	New Zealand	Foreign >28m	Tu	2003-05	1,818	0.015	28	13	3	0	12.
	New Zealand	Domestic >28m	Tu	2003-05	9.337	0.016	152	72	16	0	12.
	Japan	Distant	SBT	2000-05	14,284	0.04-0.19	842				13 & 14.
	Chinese Taipei	Distant	Tu	2002-06	24,000	0.037-0.053	1,080				3.

Source: **1**, Clemens (2006), **2**, NMFS. **3**, Huang *et al*. 2008, **4**, Crowder and Myers (2001), **5**, Heberer (1994), **6**, DAFF (2003), **7**, Bailey *et al.* (1996), **8**, Baker *et al.* (2007), **9**, Baker and Wise (2005), **10**, B. Baker pers comm. **11**, Mackenzie and Fletcher (2005), **12**, Baird and Smith (2007), **13**, CCSBT (2008), **14**, Kiyota and Takeuchi (2004).

Case Study: The Hawaii Pelagic Longline Observer Programme

Following a period of shore sampling and bycatch monitoring through logbooks, it was decided that bycatch in the Hawaiian pelagic longline fleet of non-target species was unacceptably high and observers were required to monitor the situation at-sea. In 1994, the mandatory acceptance of an observer was written into the licence requirements. Initially, the focus of the observer programme was turtle bycatch with the introduction of seabird bycatch monitoring in 2000. Interactions with marine mammals are also monitored in line with the Marine Mammal Protection Act. Observer data has led to better estimates of the interactions between longline fishing and species considered to be at risk.

The Pacific Islands Regional Office in Honolulu is responsible for monitoring vessel activity and deploying observers on the 164 vessels licensed to fish. They aim for 100% coverage on all Hawaiian-based longline trips targeting swordfish (*Xiphias gladius*) and 20% coverage on deep-set longline trips targeting bigeye tuna (*Thunnus obesus*). The responsibilities of observers are described in the NOAA Hawaii Longline Observer Program Field Manual, (http://ias.pifsc.noaa.gov/lds/docs/currentobservermanual.pdf).

Observers collect data regarding the vessel's fishing gear characteristics and operation (including the time, position, depth, environmental conditions, seabird assemblage and mitigation measures during setting). While hauling, the observer is expected to observe every hook recording the species composition of the catch, interactions with protected species, and biological (life history) data. Observers are required to measure (or at least estimate) the length of every third fish caught regardless of whether it is a target or non-target species. Data recording forms used within this fishery can be found on the NOAA website (http://ias.pifsc.noaa.gov/lds/lods_forms.html).

3.2.2 SOUTH PACIFIC

Japan

Available seabird bycatch data for Japan are those reported to the Commission for the Conservation of Southern Bluefin Tuna from the Japanese Real Time Monitoring Programme (Kiyota and Takeuchi 2004). Effort data indicate that the Japanese fleet targeting Southern Bluefin Tuna (SBT), *Thunnus maccoyii*, set an average of approximately 14 million hooks per year within WCPFC waters between 2000-2005. Applying the stratified bycatch rates from Kiyota and Takeuchi 2004, gives an approximation of 842 birds caught per year within WCPFC waters.

Chinese Taipei

Huang *et al.* 2008 present data collected between 2002 and 2006, stratified seasonally (by quarters) and spatially (5*5 degree squares) and extrapolate to give an estimate of overall seabird bycatch of approximately 1,080 seabirds are caught per year in Chinese Taipei longline fisheries below 25ºS. This is an appropriate approach to use but due to the low observer coverage and non-random distribution of observer effort in the South Pacific, the data must be considered as only preliminary.

The rates of seabird bycatch are lower in the South Pacific compared to those reported in the North Pacific. However, the extent of observed effort is very limited and does not cover areas of potentially high seabird bycatch, such as the Tasman Sea.

Australia
Of the several longline fisheries within Australian waters, the highest seabird bycatch rates have been recorded in the Eastern Tuna and Billfish Fishery (ETBF), particularly south of 30°S. Until recently, bycatch rates in this fishery were high: Baker *et al.* (2007) estimate a bycatch rate of 0.28 birds per 1,000 hooks when fishing south of 30°S. Baker and Wise (2004) reported that bycatch of flesh-footed shearwaters, *Puffinus carneipes*, was also high in waters north of 30°S, where the average CPUE was 0.145 birds per 1,000 hooks in 2002. It was predicted that this level of bycatch would result in a significant decline in the local population of this species.

However, in recent years the estimated incidental catch of seabirds in the ETBF has been reduced dramatically from an estimated 2,000 birds in 2002 to less than 100 birds in 2005 due to implementation of effective mitigation strategies. Seabird bycatch rates are at or below the level of 0.05 seabirds/1,000 hooks, which is the established performance indicator under the Australian Threat Abatement Plan. This reduction has been achieved as a result of the uptake of mitigation measures combined with changes in economic circumstances. The combination of reduced effort, a shift in fishing effort to the north where vessels interact with far fewer seabirds, and the trialling and uptake of innovative mitigation measures has resulted in a dramatic reduction in the incidental catch of seabirds.

New Zealand
Despite the relatively good observer coverage within some New Zealand fisheries, others have little if any coverage. Two sources have been used to give as complete an overview as possible of New Zealand pelagic longline fisheries. Baird and Smith (2007) gives bycatch rates and species composition for large (>28m in length) domestic and foreign licensed vessels. Although responsible for much of the longline effort around New Zealand, small vessels (<28m in length) have very low observer coverage. Mackenzie and Fletcher (2005) stratified observer data in terms of vessel size, season and area to refine the total bycatch figures, their estimates of small vessel bycatch are used here.

Foreign vessels (>28m) licensed to fish within New Zealand waters carry a high level of observer coverage. These vessels report catching 28 seabirds per year at a rate of 0.015 birds per 1,000 hooks. The domestic fleet (>28m) is far larger but has relatively low observer coverage (5.8% between 2003 and 2005). The bycatch rate reported in this fishery is comparable with that of the foreign fleet but the higher effort results in an estimated bycatch of 152 birds per year. Although observer coverage is very low, small vessels (less than 28m in length) appear to be responsible for the majority of seabird bycatch in New Zealand waters (accounting for approximately 1,627 birds per year).

Recent incidents of high albatross bycatch (50 albatrosses, mostly Antipodean albatrosses, *Diomedea antipodensis*, from a single vessel fishing for swordfish near the Kermedec Islands in November 2006 and 12 Chatham albatrosses, *Thalassarche eremita*, caught by a single bottom longline ling vessel in September 2007) have prompted the New Zealand government to strengthen regulations on seabird bycatch mitigation. However observer coverage in these fisheries remains sporadic and at an inadequate level to accurately estimate seabird bycatch.

In the South Pacific, representative data is lacking from small vessels fishing around New Zealand and the Asian distant water fleet.

3.2.3 TROPICAL LONGLINE FISHERIES
In general, seabird bycatch rates in tropical longline fisheries are believed to be lower than those found in high latitudes. The species of seabird most commonly associated with longline bycatch, albatrosses and large petrels, are infrequently encountered over tropical waters in the West Pacific. However, several species of shearwater and smaller petrel are found in the tropical latitudes of the Pacific, and are considered likely to be susceptible to bycatch. To

date, data available indicate low seabird bycatch rates, but that seabird bycatch does occur. A review by Watling (2002) indicated that data were insufficient to form a view on the risk of seabird bycatch in the tropical Pacific Ocean. Given the large longline effort in the region, even low bycatch rates could have the potential to have an impact on seabird populations. Data on which to make such assessments remain very limited and increased observer data would improve understanding.

Chinese Taipei
Huang *et al.* (2008) report low, but not zero, rates of seabird bycatch over the central Pacific.

New Caledonia
Observations in the inshore fishery around New Caledonia recorded bycatch of one bird, a petrel, over a nine-month period.

French Polynesia
Despite fishing in areas of potentially high seabird abundance, down to 32°S, and high observer coverage (five out of six boats with observers), no seabird bycatch was recorded.

Micronesia
Heberer (1994) reports one bird caught on 700,000 hooks observed.

Indonesia
There is a very large artisanal fleet of small vessels (404,600 boats) fishing out of Indonesia. These small vessels operate mainly in the Malacca Strait, Java Sea and Bali Strait and evidence from interviews and questionnaires indicate these fisheries do not catch seabirds. There is also a fleet of larger vessels targeting tuna and billfish in the region. Effort data from these vessels is not available in WCPFC databases and it is not known how far south these vessels fish. Baird (2001) considered that the larger vessels do catch seabirds but there are no data to confirm this.

Seabird bycatch data are lacking for other fleets of longline, pole and line and troll fisheries within the WCPFC area (summarised in WCPFC 2007a). These vessels primarily target tropical waters where seabird bycatch rates are thought to be low but data is lacking. The impact of these vessels is unknown.

4. DISCUSSION

4.1 Observer coverage

Under Conservation and Management Measure 2007-04, (WCPFC 2007b) States are required to *"annually provide to the Commission, in part 1 of their annual reports, all available information on interactions with seabirds, including bycatches and details of species, to enable the Scientific Committee to estimate seabird mortality in all fisheries to which the WCPF Convention applies"*(Article 9).

The WCPFC covers a vast area and range of latitudes. The distribution and abundance of seabird species and fishing effort vary greatly, geographically and seasonally, within this area. Where seabird bycatch has been thoroughly investigated, there are clear spatial and temporal differences in bycatch rates within relatively small areas. An accurate estimate of seabird mortality in WCPFC fisheries will currently be severely limited by low levels of observer data. Sufficient observer coverage is a particular challenge for the accurate monitoring of the highly variable bycatch events that are typical of vulnerable non-target species of seabirds, marine mammals and sea turtles. When CPUE is low, as in seabird and turtle bycatch, high observer coverage (up to 100%) is required to accurately quantify these rates (Lawson 2006). Rare species are likely to have low bycatch rates per unit effort, yet this catch rate may be

significant in population terms. Levels above 20% observer coverage are likely to be required to give confidence in estimated seabird bycatch rates.

Information from independent fisheries observers is widely recognised as the only reliable source of seabird bycatch data. The existing observer programmes of States with pelagic longline fleets fishing within WCPFC waters generally have a very low level of observer coverage. At present, the available information may be useful in determining the areas and seasonsin which seabird bycatch is occurring, but due to the low sampling percentages, we have little confidence that meaningful catch estimates for seabirds can be generated from these data.

4.2 Data gaps

Clear data gaps exist for the Japanese and Korean distant water fleets that operate in international waters, particularly in high latitudes where albatross bycatch occurs. An understanding of seabird bycatch issues in tropical waters also remains very limited. There are indications, mostly anecdotal, that seabird bycatch is minimal, however, more information regarding interactions between seabirds and tropical longline, troll and pole-and-line fisheries is needed.

4.3 Estimating seabird mortality in WCPFC fisheries

As with other large fishery management zones, the WCPFC contains a wide range of different pelagic longline fisheries. There is reasonably good seabird bycatch data for some of these fisheries and very little, if any, for others. A modelling approach, as taken by Crowder and Myers (2001) in the North Pacific or Klaer *et al*. (2008) in the Atlantic, provides an opportunity to amalgamate the available bycatch rate data, fishing effort data and information of seabird distributions to estimate overall seabird bycatch. These models allow the use of 'best guess' estimates in data deficient areas if there is data from comparable adjacent areas. This approach may be applicable to areas of known high seabird bycatch (north of 20°N and south of 30°S) where there is a history of collecting seabird bycatch data. However, in tropical regions there is very little data to work with and priority should be given to collecting baseline data on interactions between seabirds and longline fisheries in tropical waters.

5. CONCLUSION

• Currently, the observer coverage within the WCPFC (less than 1% of all effort) is very low. Combined with the non-random distribution of observer effort throughout the area, this is likely to lead to biases in our understanding of seabird bycatch rates and areas or species most affected. An improvement in the level and spread of observer coverage would greatly enhance the management of the fisheries. Based on the findings of Lawson (2006), a target of obtaining 20% observer coverage throughout the WCPFC fleet would greatly improve the confidence in bycatch data for rare species, such as seabirds and turtles.

• Models combining fishing effort data, available bycatch rates and seabird distributions have been used to determine overall bycatch rates within ICCAT waters (Klaer *et al*. 2008) and the North Pacific (Crowther and Myers 2001). A similar approach may be appropriate for WCPFC waters.

• Available data indicate that where seabird distributions and fishing effort overlap, seabird bycatch is occurring.

• A number of shearwater and petrel species are distributed over the tropical waters of the Pacific. Elsewhere in the world (e.g. Baker and Wise 2005), shearwaters are known to be vulnerable to bycatch in pelagic longline fisheries. Further investigation into the threat tropical longline fisheries pose to seabirds is needed.

• Risk Assessment methods such as those used by Kirby and Hobday (2006) and Waugh (2008) can be used to determine which areas and which species are likely to be affected by high incidental catch rates, thereby allowing a targeting of monitoring and mitigation efforts.

REFERENCES

ACAP (2008) *Albatross and petrel distribution within the WCPFC area*. Agreement for the Conservation of Albatrosses and Petrels (ACAP). Paper prepared for 4th meeting of the WCPFC Ecosystem and Bycatch Specialist Working Group Port Moresby, August 2008

Bailey, K., Williams, P.G. and Itano, D. (1996) *By-catch and discards in western Pacific tuna fisheries: a review of SPC data holdings and literature*. South Pacific Commission Oceanic Fisheries Programme Technical Report No. 34.

Baird, S. J. and Smith, M. H. (2007) *Incidental capture of seabird species in commercial fisheries in New Zealand waters, 2003-2004 and 2004-2005*. New Zealand Aquatic Environment and Biodiversity Report 2007, 108 p.

Baird, S.J. (2001) Report on the International Fishers' Forum on solving the incidental capture of seabirds in longline fisheries. Auckland, New Zealand, 6-9 November 2000 pp. 76.

Baker, G.B., Double, M.C., Gales, R., Tuck, G.N., Abbott, C.L., Ryan, P.G., Petersen, S.L., Robertson, C.J.R. and Alderman, R. (2007) A global assessment of the impact of fisheries-related mortality of shy and white-capped albatrosses: conservation implications. *Biological Conservation*

Baker, G.B. and Wise, B.S. (2005) The impact of pelagic longline fishing on the flesh-footed shearwater *Puffinus carneipes* in Eastern Australia. *Biological Conservation*, **126**, 306-316.

BirdLife International (2006) *Summary of seabird bycatch rates recorded in the Western and Central Pacific*. Paper submitted to the Second Session of the WCPFC Ecosystem and Bycatch SWG Manila, 10th August 2006

BirdLife International (2007) *Distribution of albatrosses and petrels in the WCPFC Convention Area and overlap with WCPFC longline fishing effort*. Scientific Committee third regular session, 13-24 August 2007, Honolulu, USA. WCPFC-SC3-EB SWG/IP-17

BirdLife International (2008) www.birdlife.org/datazone/species

CCSBT (2008) www.ccsbt.org/docs/data.html

Clemens, A. (2006) *Annual Report on Seabird Interactions and Mitigation Efforts in the Hawaii Longline Fishery for 2005*. NOAA Administrative Report AR-PIRO-05-06

Crowther, L.B. and Myers, R.A. (2001) *A comprehensive study of the ecological impacts of the worldwide pelagic longline industry*. First annual report of the Pew Charitable Trusts. 146pp.

Department of Agriculture, Fisheries and Food (2003) *Seabird interactions with longline fisheries in the Australian Fishing Zone: Assessment report for the National Plan of Action for reducing the incidental catch of seabirds in longline fisheries*.

Heberer, C.F. 1994. *Report on the catch of target and bycatch species taken by the longline vessels licensed to operate in the waters of the FSM, 1993-1994*. Summary report on observer data collection. Pohnpei, Federated States of Micronesia: Micronesian Maritime Authority.

Huang, H-W, Chang, K-Y and Tai, J-P (2008) *Preliminary estimation of seabird bycatch of Taiwanese longline fisheries in the Pacific Ocean.* IATTC 9th Stock Assessment Review Meeting, La Jolla USA, 12-16 May 2008

Kiyota, M. and Takeuchi, Y. (2004) *Estimation of incidental take of seabirds in the Japanese southern bluefin tuna longline fishery in 2001-2002*. Paper presented at the CCSBT meeting of the Ecologically Related Species Working Group, 2004. CCSBT-ERS/0402/Info 02.

Kirby, D.S. and Hobday A. (2007). *Ecological risk assessment for the effects of fishing in the western and central Pacific Ocean: productivity-susceptibility analysis.* WCPFC-SC3-EB SWG-WP-1

Klaer, N.L., Black, A.D. and Howgate, E. (2008) *Preliminary estimates of total seabird bycatch by ICCAT fisheries in recent years*. ICCAT SCRS 2008 031

Lawson, T. (2006) *Scientific aspects of observer programmes for tuna fisheries in the western and central Pacific Ocean*. WCPFC-SC2-2006-ST WP-1

MacKenzie, D.I, and Fletcher, D. (2005) *Characterization of seabird captures in NZ fisheries. Report to Ministry of Fisheries for Project ENV2004-04. April 2006*. Unpublished Report to the Ministry of Fisheries, Wellington.

Watling D. (2002). *Interactions between seabird and Pacific Islands' fisheries, particularly the tuna fisheries*. SPC, Noumea. Draft Final Contract Report.

Waugh, S.M., Filippi, D., Walker, N. and Kirby D.S. (2008). *Preliminary results of an Ecological Risk Assessment for New Zealand fisheries interactions with seabirds and marine mammals*. WCPFC-SC4-EB-WP4.

WCPFC (2007a) *The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean*. Scientific Committee Third Regular Session, 13-24 August 2007, Honolulu.

WCPFC (2007b) *Conservation and management measure to mitigate the impact of fishing for highly migratory fish stocks on seabirds*. Conservation and Management Measure 2007-04.