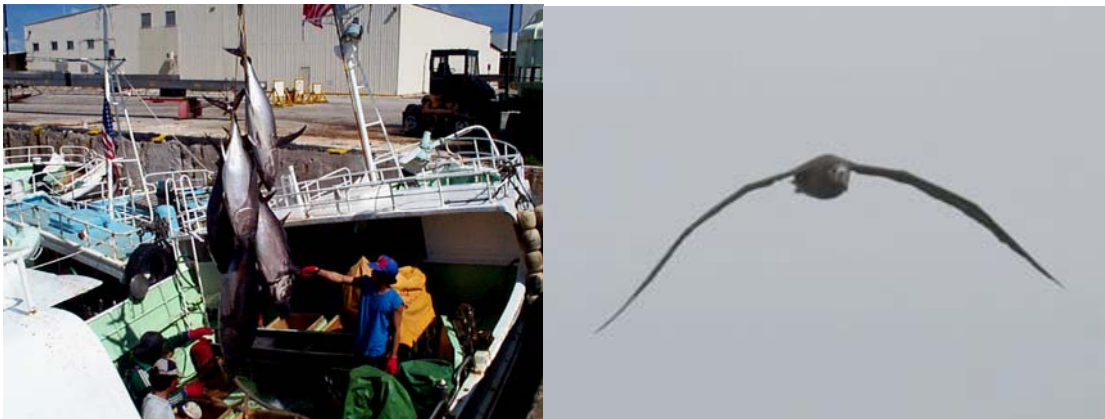

Incidental Capture of Seabirds in Pelagic Longline Fisheries of the Tropical and Subtropical Pacific Islands Region and

Draft Pacific Islands Regional Plan of Action for Reducing the Incidental Catch of Seabirds in Pelagic Longline Fisheries

September 2006



Prepared for the
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SUMMARY

Available information indicates that seabird interactions with longline vessels operating in tropical and subtropical areas of the western and central Pacific Ocean (WCPO) are very rare, except in the Hawaii-based longline fisheries. A large amount of observer data have been collected from tropical and subtropical Pacific pelagic longline fisheries (15.7 million pelagic longline hooks in 8,786 sets observed from 1995-2005). However, the observer coverage rate has been extremely low (0.8% of total effort from 1995-2005). The observer data that have been collected have not been as evenly distributed amongst flag States, areas and seasons as would be desired, which is critical for assessing whether or not seabird bycatch is problematic. This is because abundance of seabird species and seabird species complexes in different areas of the tropical Pacific may exhibit high inter-annual and seasonal variability. However, available observer data are distributed across seasons and cover many of the areas within the WCPO, particularly in the EEZs of Forum Fisheries Agency Members, thus accounting for some of the potential inter-annual variability in seabird actions that might occur at these fishing grounds. Improvements could be made to observer data collection protocols to optimize the accuracy in quantifying rare captures events of seabirds and other species groups of special interest (sea turtles and marine mammals).

In the absence of sufficient direct information on seabird interactions from observer data, indirect information can be used to attempt to estimate the degree of seabird interactions. This indirect information has been obtained from (i) fishermen interviews, (ii) comparing the distributions of seabird species known to be vulnerable to capture in longline fisheries in other regions to the distribution of longline effort in the tropical and subtropical WCPO, and (iii) identifying tropical and subtropical Pacific seabird species that may be susceptible to longline capture based on the characteristics of seabird species that are captured in temperate zone longline fisheries. These studies have revealed that longline fishermen have very rarely observed seabirds being captured when longline fishing at grounds in the tropical and subtropical Pacific, and that there are several species of seabirds present in this region that may be vulnerable to capture in longline fisheries, several of which are Threatened. However, there is large uncertainty in these results that can only be resolved through direct observations of the fisheries.

To comply with the Western and Central Pacific Fisheries Commission Resolution 2005-01 on the *Incidental Catch of Seabirds*, and the Food and Agriculture Organization of the United Nation's *International Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries*, FFA Members (excluding Australia and New Zealand, which have already conducted assessments and determined that their longline fisheries have problematic seabird interactions and adopted National Plans of Action, and Tokelau, which currently has no longline activity) are encouraged to conduct assessments of their longline fisheries to determine if a seabird bycatch problem exists. National fishery management authorities are encouraged to achieve adequate levels of observer coverage to detect and reliably estimate levels of incidental seabird capture. This includes adequate spatial and temporal coverage of fishing effort, as it is likely that seabird interactions will be highly variable temporally and spatially. It may require several years for assessments to be conducted in individual fisheries because of the potential of the high temporal and spatial variability in seabird bycatch rates, and because interactions with any threatened populations of seabirds may be particularly rare events. Due to the rarity of seabird capture events even in fisheries with relatively high seabird interaction rates, there is a need for onboard observers dedicated to observing interactions with species groups of special interest, including seabirds, to provide accurate bycatch data. Observers should obtain annual training in standardized methods to count seabird abundance during setting and seabird species identification.

If analysis of observer data for an FFA Member's pelagic longline fishery reveals problematic seabird interactions, then the Country is encouraged to adopt and implement a *Pacific Islands Regional Plan of Action for Reducing the Incidental Catch of Seabirds in Pelagic Longline Fisheries*. Here we

present a Draft *Pacific Islands Regional Plan of Action – Seabirds* for consideration by FFA Members in the case where a longline fishery is determined to have problematic seabird interactions (problematic in that the fishery is causing population-level effects, is capturing individuals of a threatened seabird population, or has seabird bycatch levels and rates that could be substantially reduced through the employment of seabird avoidance methods). A review of seabird bycatch avoidance methods and initiatives by Regional Fishery Management Organizations and other organizations to manage seabird bycatch in longline fisheries is conducted to identify suitable seabird avoidance measures for the *Pacific Islands Regional Plan of Action – Seabirds*. This assessment considers the operational and economic effects from instituting alternative seabird avoidance methods. FFA Members with pelagic longline fisheries with problematic seabird interactions may opt to develop their own National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries. The benefit of developing a National Plan of Action-Seabirds tailored to their individual fisheries is that solutions to fisheries bycatch problems, including seabird bycatch, may be fishery-specific.

1. INTRODUCTION

Mortality in longline fisheries is a critical global threat to albatrosses and large petrels (Brothers *et al.* 1999; Gilman 2001; Gilman *et al.*, 2005). Because seabirds are highly migratory species, which frequently move in and between national jurisdictions and interact with longline vessels on the high seas, international collaboration is necessary to effectively address this problem in fisheries with seabird bycatch problems. Primarily while fishing gear is being set, seabirds are hooked or entangled, dragged underwater, and drown as the gear sinks. The species of seabirds most frequently caught by longliners are albatrosses and petrels in the Southern Ocean; Arctic fulmar (*Fulmarus glacialis*) (a type of petrel) in North Atlantic fisheries; and albatrosses, gulls, and fulmars in North Pacific fisheries (Brothers *et al.* 1999). The health of populations of albatrosses and large petrels are most at risk from this threat.

While data on seabird bycatch from the world's longline fisheries are scarce, including for longline fisheries operating in the tropical and subtropical Pacific, available information indicates that seabird interactions with longline vessels operating in tropical and subtropical areas of the western and central Pacific Ocean (WCPO) are very rare except in the Hawaii-based longline fisheries (Watling, 2002). This is because there is low abundance in the tropical and subtropical Pacific, excluding Hawaii, of the species of seabirds known to be vulnerable to capture in longline gear (Watling, 2002). This is consistent with results of a literature review conducted by Brothers *et al.* (1999), who found only one record (Heberer, 1994) of a seabird being caught in the tropical Pacific Islands region out of 700,000 observed hooks on 51 fishing trips by the Federated States of Micronesia-based longline tuna fishery from 1993-1994. Dai *et al.* (2006) report that an observer on a Chinese longline bigeye tuna vessel operating in the tropical eastern Pacific Ocean (between 3 - 17 deg. S latitude, 96 - 146 deg. W longitude) from July – November 2003 interacted with six seabirds (shearwater spp., storm petrels and blue-footed boobies) during the observation of 304,390 hooks.¹ The western portion of the vessel's fishing grounds was within the EEZ around French Polynesia, while the majority of the effort was on the high seas east of the EEZ around French Polynesia (Dai *et al.*, 2006). Australia's *Threat Abatement Plan for the Incidental Catch (or Bycatch) of Seabirds During Oceanic Longline Fishing Operations* requires the employment of 'serious' seabird avoidance methods by longline vessels operating South of 25 deg. S. latitude, based on evidence that seabird bycatch in Australian longline fisheries is problematic in areas South of this boundary (Environment Australia, 1998).

The aim of this report is to assist Forum Fisheries Agency Members in complying with the Western and Central Pacific Fisheries Commission (WCPFC) 2005 resolution on the incidental catch

¹ It is likely only the shearwater was caught in the longline gear, while the booby likely alighted on the vessel to rest and the storm petrel might have collided with the vessel.

of seabird, and the United Nations Food and Agriculture Organization's *International Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries*. The United Nations Food and Agriculture Organization's *International Plan of Action - Seabirds* encourages States to voluntarily implement the plan starting by conducting an assessment of longline fisheries to determine if a seabird bycatch problem exists. If a problem exists, States are then encouraged to develop a National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (FAO, 1999). The WCPFC, at their Second Session in December 2005, adopted Resolution 2005-01, Resolution on the Incidental Catch of Seabirds (Western and Central Pacific Fisheries Commission, 2005). The resolution calls on all Commission Members, Cooperating Non-Members, and participating Territories to implement the FAO International Plan of Action on seabirds and provide the Commission with available information to allow for an estimate of seabird mortality in all fisheries that fall under the WCPF Convention. The resolution further states that at its annual meeting in 2006 the Commission shall consider measures to mitigate the incidental catch of seabirds.

We assess available information on the degree of seabird bycatch in longline fisheries operating in the western central Pacific Ocean and evaluate the state of data collection programs to provide information on seabird bycatch in Forum Fisheries Agency Member Countries and territory pelagic longline fisheries operating in the tropical and subtropical Pacific.² We also review the state of knowledge of seabird bycatch avoidance in pelagic and demersal longline fisheries and review initiatives of Regional Fishery Management Organizations to address seabird bycatch. We discuss the effects of instituting measures to reduce seabird bycatch in the WCPO, including the need, operational and economic effects, and consideration of effects on other species groups of special interest of alternative seabird avoidance methods. Finally, we discuss next steps for Forum Fisheries Agency Members to implement the WCPFC seabird resolution and United Nations Food and Agriculture Organization's Plan of Action on seabird bycatch.

This assessment includes longline fisheries of Countries and territories operating in the tropical and subtropical Pacific Islands region, excluding Hawaii. The assessment covers the domestic and foreign licensed locally-based longline fisheries and foreign licensed distant water longline fisheries operating in the EEZs and on the high seas in between these EEZ areas of the following 21 tropical and subtropical Pacific Island Countries and territories: American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna (Fig. 1). This includes all FFA Member Countries and territories except for Australia and New Zealand. Pelagic longline fisheries set about 582 million hooks in 2003 in the area between 30 deg. S. and 20 deg. N. latitudes (Secretariat of the Pacific Community Oceanic Fisheries Programme public domain data). Australia, New Zealand, and Hawaii, USA – based longline fisheries were excluded from the study because the issue is well documented for these countries, and each of these nations has developed a National Plan of Action – Seabirds (New Zealand Department of Conservation and Ministry of Fisheries, 2000; U.S. National Marine Fisheries Service, 2001; Commonwealth of Australia, 2003).

² The 16 FFA Member Countries and one Territory are Australia, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, and Vanuatu.



Fig. 1. The 21 Pacific Island Countries and territories of the western and central Pacific, identified with a black circle below their name, which are included in this assessment of seabird bycatch in pelagic longline fisheries.

2. QUANTITATIVE INFORMATION ON SEABIRD BYCATCH IN LONGLINE FISHERIES OPERATING IN THE WESTERN AND CENTRAL PACIFIC

2.1. SPC/OFP Longline Observer Dataset

Most observer data held by the Secretariat of the Pacific Community (SPC) Oceanic Fisheries Programme (OFP) have been collected through the national programmes of SPC member countries and territories, and some of the national observers have been funded by the OFP. Since the early 1980's, the OFP has funded occasional observer coverage of pelagic longline trips in the SPC Region. Fig. 2 shows the number of observed pelagic longline trips in the tropical and subtropical Pacific conducted by national observer programs of Pacific Island Countries and territories and the SPC observer program from 1990-2005 (a) excluding observed trips by New Zealand, Australia and Hawaii national observer programs, and (b) excluding observed domestic trips by the Australian national observer program. Observer coverage of the entire WCPO pelagic longline fisheries has been extremely low (< 0.1%) from 1990-2004 (Molony, 2005), and was only slightly higher with 0.8% observer coverage (total of 15,700,978 hooks observed in 8,786 sets) of a total of 1,870,705,211 hooks set from 1995-2005 by pelagic longline vessels based in the Countries and territories of the tropical and subtropical Pacific Islands (SPC unpublished data provided by Emmanuel Schneider, 16 August 2006, Secretariat of the Pacific Community). OFP conducted a

South Pacific Regional Tuna Resource Assessment and Monitoring Project from 1995 to 2000. The project funded four full time and number of national observers. The project's observers observed 130 longline trips in every fleet operating in the SPC Region excluding the Australia-based longline fleet, in addition to observing 60 trips by purse seine and pole-and-line vessels. The project employed a full-time Observer and Port Sampler. In 2000 SPC created a Fishery Monitor Supervisor post. This position was complimented by a new Fishery Monitoring Supervisor post in 2000 and an Observer and Port Sampler Trainer in 2002 to work with the Forum Fisheries Agency to provide training, management support, and assistance with data quality control for national observer programmes. Since the end of this project in 2000 SPC has focused on supporting national observer programmes (personal communication, Deirdre Brogan, Secretariat of the Pacific Community, 30 August 2006).

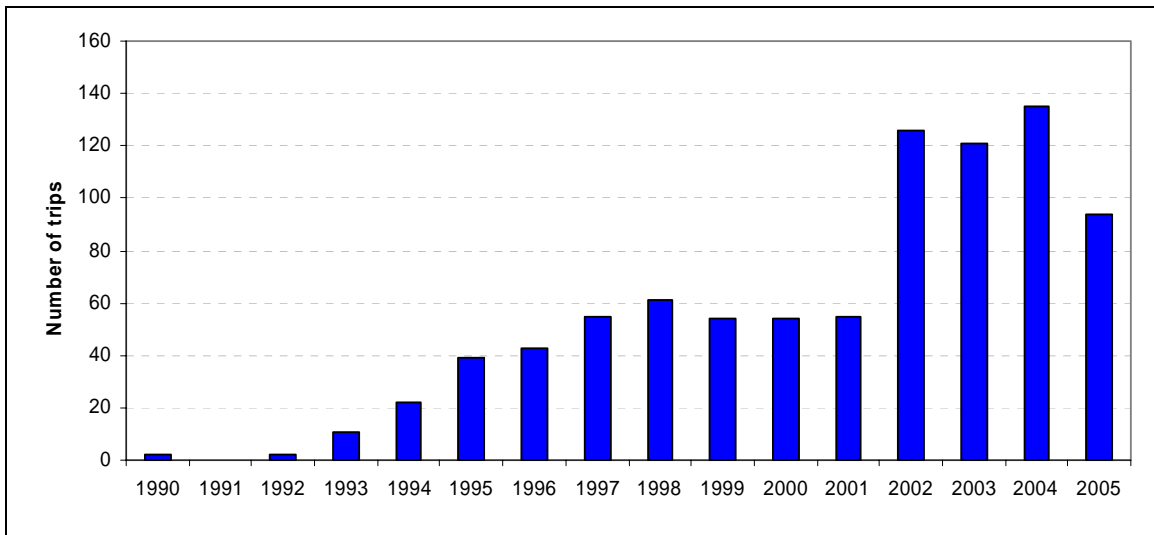


Fig. 2a. Observer coverage by national observer programs of Pacific Island Countries and territories and the SPC observer program of pelagic longline trips made in the tropical and subtropical western and central Pacific Ocean, excluding observer program coverage from New Zealand, Australia, and Hawaii, data for 2005 are preliminary, 1990-2005 (SPC unpublished data provided by Deirdre Brogan, 30 August 2006, Secretariat of the Pacific Community).

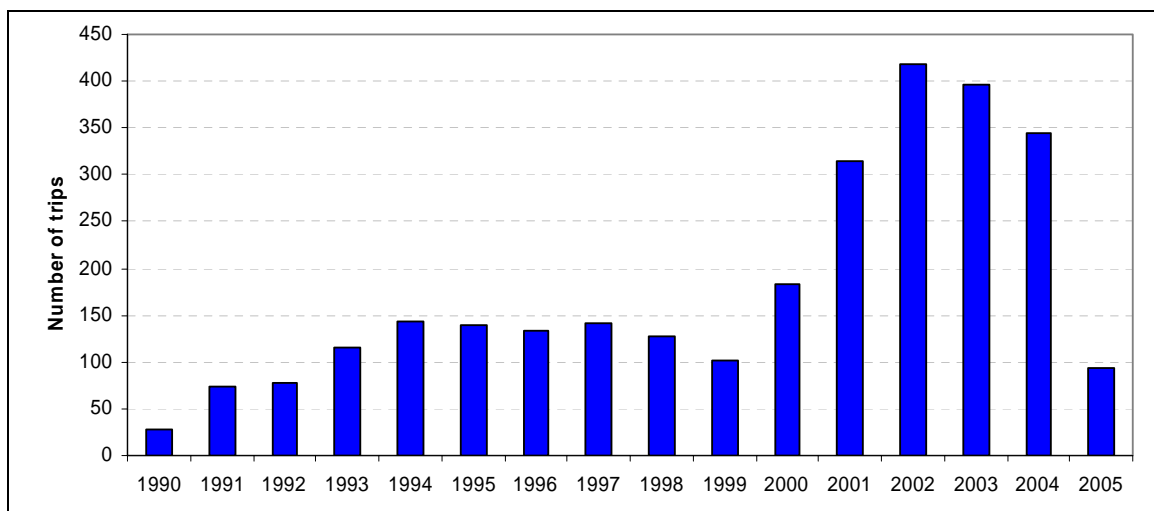


Fig. 2b. Observer coverage by national observer programs of Pacific Island Countries and territories, New Zealand and Hawaii, and the SPC observer program of pelagic longline trips

made in the tropical and subtropical western and central Pacific Ocean, excluding observer program coverage from Australia's domestic fishery, data for 2005 are preliminary, 1990-2005 (SPC unpublished data provided by Deirdre Brogan, 30 August 2006, Secretariat of the Pacific Community).

Molony (2005) analyzed the SPC observer dataset³ for pelagic longline seabird bycatch in the WCPFC region for (i) tropical shallow-setting vessels with < 10 hooks in a basket fishing in the area between 15 degrees N – 10 degrees S, (ii) tropical deep-setting vessels with \geq 10 hooks in a basket fishing in the area between 15 degrees N – 10 degrees S; and (iii) temperate longline albacore fisheries fishing in the area between 10-31 degrees S. Between 1990 and 2004, the SPC observer dataset contains 39 observer records of birds being captured by longline vessels, primarily from observed trips made by high seas industrial longline fisheries, between 15 degrees N and 31 degrees S in the WCPO in 25 sets (Fig. 3). Eight of these were caught in shallow-setting tropical longline fisheries, 31 were caught in the temperate longline albacore fisheries and no seabirds were recorded caught in deep-setting tropical longline fisheries (Molony, 2005). Of these 39 recorded bird captures, 28 were caught within the Australia EEZ (Fig. 3). From 1995 - 2004, of a total of 6, 846 observed sets between 15 degrees N and 31 degrees S in the WCPO, a total of 12 seabirds were recorded as being captured (1.8 birds per 1000 sets) (Molony, 2005). When extrapolating the observer records to all pelagic longlining effort during this period between 15 degrees N and 31 degrees S, there were 1,593 (+/- 8,714 95% CI) seabirds caught per year between 1990 – 2004 (Molony, 2005). The large error interval around the point estimate is due to the very small sample size. Eight of these were caught in a single set in 1991 in longline albacore vessel fishing in the Australian EEZ North of 31 degrees S. No information is available on the species of seabirds that were captured. Thirty seven of these records listed the species as "unidentified" and two records identified the birds as 'albatross' (Molony, 2005). Of the 39 records of captured seabirds, 28 were recorded as being dead at the time of gear retrieval, three were alive and no information was recorded on the condition of the remaining eight (Molony, 2005).

Table 1 summarizes the results of additional analysis of the SPC data holdings from 1995-2005 for seabird bycatch rates of pelagic longline fisheries operating in the tropical and subtropical Pacific Islands region, broken down into the same three categories employed by Molony (2005). Of the 28 observed seabird captures during this period, 15 were caught within the Australia EEZ (12 off the Australian continent, 3 in the EEZ adjacent to Norfolk Island), 6 were caught on the high seas, two each were in the Indonesian and Federated States of Micronesia EEZs, and one each was in the French Polynesia, Marshall Islands and New Zealand EEZs.⁴

³ The SPC observer dataset for longline fisheries is comprised of data from the SPC observer programme, the national programmes of Pacific Island Countries and Territories (PICTs) and data from Australia, New Zealand and Hawaii (Deirdre Brogan, Secretariat of the Pacific Community, personal communication, 30 August 2006).

⁴ As of 14 August 2006 a data request is being processed by the Secretariat of the Pacific Community (SPC) to provide seabird bycatch rates in tropical and subtropical Pacific Island region pelagic longline fisheries stratified by country and territory of vessel registration. At the time of making this information request, SPC is required to obtain authorization from the national management authorities to make these data public. However, the Scientific Committee of the Western and Central Pacific Fisheries Commission recommended to the Commission at its August 2006 meeting that catch data stratified by country should be placed in the public domain (personal communication, Tim Lawson, SPC, 25 August 2006). This new policy may become operational if it is adopted by the Commission at its next regular session in December 2006. Available observer data coverage of the Cook Islands-based longline fishery have no records of seabird captures, however information on the proportion of effort that has been observed and observer data collection protocols are not readily available (Cook Islands Government, 2006).

Table 1. Seabird bycatch rates in pelagic longline fisheries of the tropical and subtropical Pacific Islands region, 1995-2005 (SPC unpublished data provided by Emmanuel Schneider, 16 August 2006, Secretariat of the Pacific Community).

Fishery Category	Number of observed hooks (sets)	Number of observed seabirds captured	Seabird bycatch rate (number per 1000 hooks)
Tropical shallow-setting (< 10 hooks per basket) pelagic longline fisheries operating between 15 deg. N latitude and 10 deg. S latitude	500,590 (572)	9	0.018
Tropical deep-setting (\leq 10 hooks per basket) pelagic longline tuna fisheries operating between 15 deg. N latitude and 10 deg. S latitude	212,543 (378)	1	0.0047
Pelagic longline albacore fisheries operating between 15 - 31 deg. S latitude	5,245,494 (2,269)	18	0.0034

In 2002 observer programs supplying data to SPC initiated recording the incidence of seabirds diving on baited hooks in addition to recording seabird captures. In time these data may contribute to improving the understanding of seabird species distribution, abundance and behavior by geographical area and season (personal communication, Deirdre Brogan, Secretariat of the Pacific Community, 30 August 2006).

One of the scientific objectives of longline observer programs of Pacific Island Countries and territories that are SPC-members is to collect data on interactions with seabirds and other species groups of special interest (sea turtles and marine mammals) (Lawson, 2006). The form used by these observer programs of SPC-member Pacific Island Countries and territories asks the observers to record all landings, and observers are advised to watch the entire gear hauling operation on the smaller offshore vessels (personal communication, Deirdre Brogan, SPC Fishery Monitoring Supervisor, 17 August 2006). Observers on distant water longliners collect data on caught fish during the first two of every three sets (Lawson, 2006), and thus observers on these large high seas longliners may not observe seabird captures for a third of the fishing effort.

As is the case with most fishery observer programs, it is likely that observers on pelagic longline vessels in the tropical and subtropical Pacific do not see all seabird captures during observed hauls, which would require the observer to be at the hauling station observing each branch line as it is retrieved, due to time constraints from performing their primary duties of measuring fish on deck (e.g., crew may drop branch lines containing caught birds or gaff the bird off the hook and not bring the bird on deck, Gales et al., 1998).

Observer data collection supported by the Secretariat of the Pacific Community, Forum Fisheries Agency and Republic of Korea are not stratified by time period, geographical area or flag (Lawson, 2006). Thus, seabird bycatch rates determined from analysis of the Secretariat of the Pacific Community dataset may not be representative for the region. The estimated seabird catch rates may be underestimates or overestimates due to the low observer coverage rate and non-evenly-distributed observer coverage.

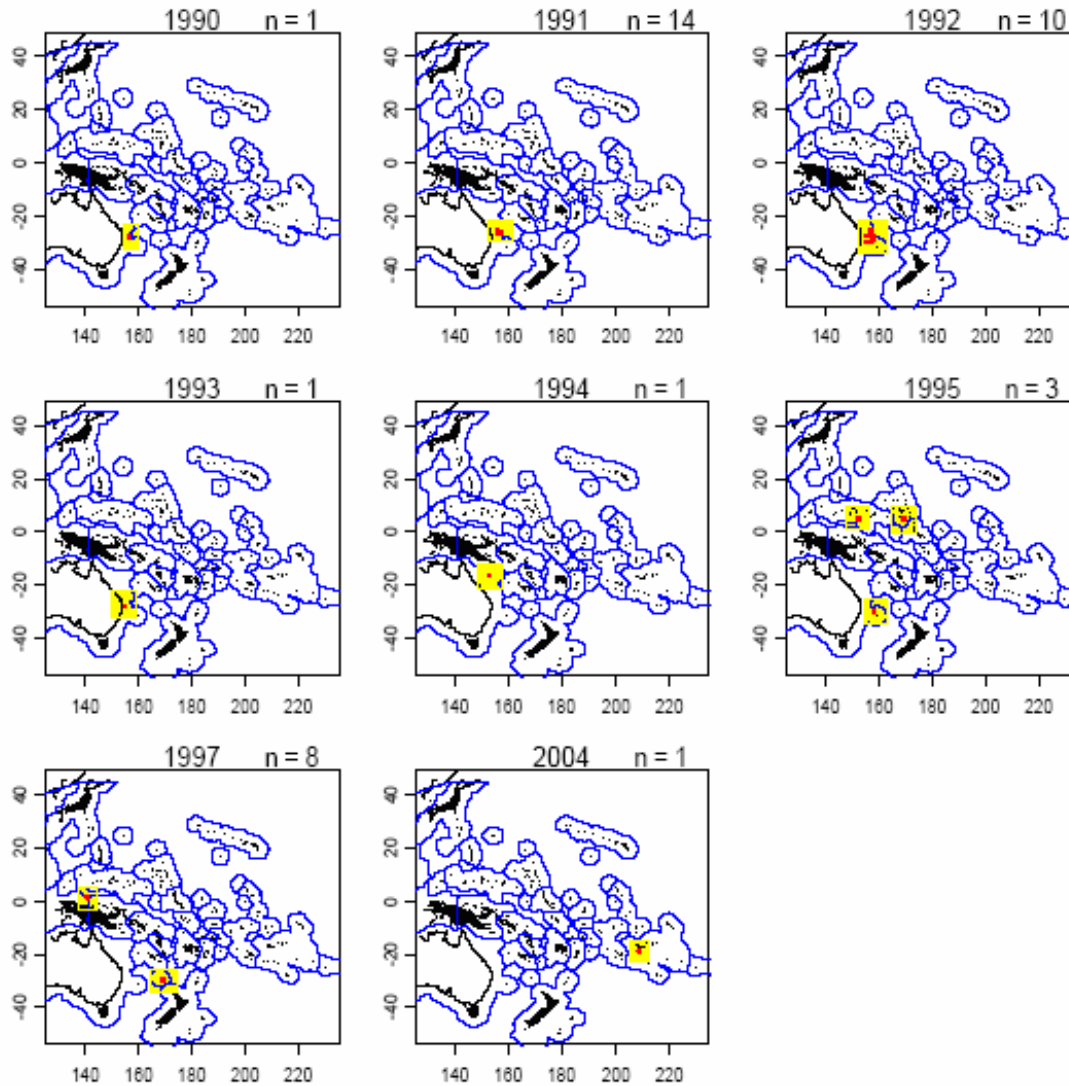


Fig. 3. Location of the 39 observed seabird captures (identified with a red dot with adjacent area highlighted yellow) recorded by Secretariat of the Pacific Community observers between 1990-2004 in pelagic longline fisheries operating between 15 deg. N and 31 deg. S latitude (Molony, 2005).

Molony (2005) did not assess seabird bycatch levels and rates for longline fisheries operating North of 15 deg. N and South of 31 deg. S due to limited data for the areas held by the Secretariat of the Pacific Community. Molony (2005) also reviewed the Secretariat of the Pacific Community logsheets for 1978-2004 and decided not to use these data for the seabird bycatch analysis because the capture of non-commercial species is rarely recorded on logsheets: there are only 22 records of seabird captures in > 1.6 million pelagic longline sets covered in the dataset.

2.2. National Observer Programs and Pelagic Longline Fisheries of the Pacific Islands Region

Table 2 provides a summary of the national observer program coverage of pelagic longline fisheries in the tropical and subtropical Pacific Islands region, and identifies which countries/territories have pelagic longline fisheries based there and operating in their EEZ. There were over 5,000 pelagic longline vessels operating in the Western and Central Pacific Fisheries Convention Area in 2005

catching a total of 242,059 mt (30% of which was albacore), which was 10-12% of the total catch in this area (Williams and Reid, 2006). Over the past 5 years the Pacific-Islands domestic albacore fisheries have grown from taking 32% of the total south Pacific albacore longline catch in 1998 to accounting for over 53% in 2005, while foreign distant water (large freezer vessels that undertake long trips over several months and operate over large areas) and foreign offshore (smaller vessels that are domestically based out of Pacific Island ports that target bigeye and yellowfin for the fresh sashimi market and have ice or chill capacity) fleets have been reduced in size in the WCPO (Williams and Reid, 2006).

Table 2. Status and trends of national observer program coverage of pelagic longline fisheries operating in the tropical and subtropical Pacific Islands region by locally-based domestic and foreign vessels operating in EEZ and high seas waters, and distant water vessels operating in EEZ areas and on the high seas.

Country or territory	Pelagic longline activity	Pelagic longline observer coverage
American Samoa (USA)	In 2002 there were 70 domestic locally-based longline vessels, which caught 7,754 mt. There were no foreign licensed vessels fishing in the EEZ around American Samoa in 2002. Source: Secretariat of the Pacific Community (2003).	Observer coverage began in 2005. The U.S. National Marine Fisheries Service plans to raise observer coverage to 20%. Source: Secretariat of the Pacific Community (2003).
Chinese Taipei (Taiwan)	The distant-water longline fleet operating in the Western and Central Pacific Fisheries Convention Area increased by 76% from 2000–2003, from 78 in 2000 to 137 vessels in 2003, but has stabilized at 133 vessels in 2005. In 2004 there were 1,060 active offshore vessels based out of ports in the WCPO. Sources: Chinese-Taipei Government (2005); Williams and Reid (2006).	In 2001 the Chinese Taipei Fisheries Administration initiated an experimental observer program. Two observers were deployed on Chinese Taipei vessels in the Pacific Ocean each year from 2002 - 2004. In 2005 observers from the Chinese Taipei Longline Observer Programme observed six pelagic longline trips in the Pacific Ocean, and observed four trips in 2004. It is not clear if these trips were conducted in the tropical and subtropical Pacific Islands region. Observers are required to photograph and record the species of all caught seabirds, record the number and condition of caught seabirds and collect the bill of dead seabirds. Sources: Chinese-Taipei Government (2005); Lawson (2006).
China	There has been recent expansion of Chinese distant-water longliners targeting albacore on the high seas of the South Pacific and targeting bigeye and yellowfin tuna in the eastern areas of the tropical Western and central Pacific Fisheries Convention Area. Source: Williams and Reid (2006).	No information is available on a national observer program for China's longline vessels.
Cook Islands	There are currently between 22 and 33 domestic Cook Islands-based longline vessels active in the Western and Central Pacific Fisheries Commission Convention Area. There was one domestic Cook Islands-based longline vessel active in the WCPFC Convention Area in 2000, 4 in 2001, 17 in 2002, 51 in 2003, 40 in 2004, and 27 in 2005. In	In 2002, the Cook Islands Ministry of Marine Resources appointed an Observer Coordinator and initiated an observer training program. The government has identified a target of 20% observer coverage of the longline fisheries. Recent coverage has been about 5%. All observers are based in Rarotonga and, consequently, coverage is likely to be biased to the southern area of the EEZ. In 2004, SPC and

	<p>2005 the domestic vessels set a total of 7,491,200 hooks. Over 67% of the total catch of 3,430 mt in 2005 was albacore tuna. Almost all of the fishing effort is at grounds within the Cook Islands EEZ. Pelagic longline vessels from American Samoa, Samoa and Taiwan fish in the Cook Islands EEZ. In 2002 there were 9 foreign licensed vessels that fished in the Cook Islands EEZ, which caught 83 mt.</p> <p>Sources: Secretariat of the Pacific Community (2003); Cook Islands Government (2006); Lawson (2006).</p>	<p>FFA-supported observers observed four trips. Cook Islands Government support has been allocated for observer and port sampling programs in 2006.</p> <p>Sources: Secretariat of the Pacific Community (2003); Cook Islands Government (2006); Lawson (2006).</p>
<p>Federated States of Micronesia</p>	<p>In 2005 there were 20 domestic locally-based longline vessels, which primarily fished in the Republic of the Marshall Islands EEZ, setting 17,887,500 hooks and catching 334 mt (based on logsheet data, believed to be an underestimate by the FSM Government). In 2005 there were 138 foreign licensed vessels that fished in the FSM EEZ (104 from Japan, 31 from Taiwan, 2 from Belize, and 1 from the Philippines), which caught 3,747 mt.</p> <p>Sources: Secretariat of the Pacific Community (2003); Federated States of Micronesia Government (2006).</p>	<p>The FSM National Oceanic Resource Management Authority established an observer program in 1979, which in 2005 had 7 trained observers. Observer coverage of longline effort has been < 1%. In 2004, SPC and FFA-supported observers observed six trips. The access agreement with Japan allows FSM observers to observe a total of six longline trips per year. Observer coverage of distant water Taiwanese and Japanese-flagged longline vessels licensed to fish in the FSM EEZ is difficult for placement of FSM observers because these vessels are based out of Guam.</p> <p>Sources: Secretariat of the Pacific Community (2003); Federated States of Micronesia Government (2006); Lawson (2006)</p>
<p>Fiji</p>	<p>In 2002 there were 119 domestic locally-based longline vessels, which caught 10,974 mt, and there were 15 foreign licensed vessels that fished in the Fiji EEZ, which caught 79 mt.</p> <p>Source: Secretariat of the Pacific Community (2003).</p>	<p>The Fiji Department of Fisheries of the Ministry of Fisheries and Forests manages an observer program with about 11 observers. In 2002 this agency established an Observer Coordinator position. Observer coverage has been < 1%. In 2004, SPC and FFA-supported observers observed 11 trips.</p> <p>Sources: Secretariat of the Pacific Community (2003); Lawson (2006).</p>
<p>French Polynesia (France)</p>	<p>There were 72 active pelagic longline offshore vessels in 2005, and 75 active vessels in 2004. Of the 72 active 2005 vessels, 26 were freezer longliners, 40 were smaller vessels that preserve their fish with ice, and 6 use a combination of ice and freezers to preserve their catch. In 2005 the vessels set a total of 21,454,126 hooks. Over 47% of the total catch of 5,082 mt in 2005 was albacore tuna. Authorization for foreign fishing in the French Polynesian EEZ was discontinued in 2001. There were no active coastal pelagic longline skipjack 'bonitier' vessels in 2005 or 2006.</p>	<p>The Service de la Pêche established an observer program in 2002 with a Monitoring Supervisor/Liaison Officer and three observers. There has been 3-5% observer coverage of pelagic longline trips. In 2004, SPC and FFA-supported observers observed 20 trips.</p> <p>Sources: Secretariat of the Pacific Community (2003); Lawson (2006); Ponsonnet (2006).</p>

	<p>Sources: Secretariat of the Pacific Community (2003); Lawson (2006); Ponsonnet (2006).</p>	
Guam (USA)	<p>There are no locally based domestic or foreign licensed pelagic longline vessels and no distant water foreign licensed longline vessels fishing in the EEZ around Guam. One Guam-based pelagic longline vessel is expected to initiate fishing in 2006.</p> <p>Source: Personal communication, Manuel Duenas, Guam Fishermen's Cooperative Association, 1 July 2006.</p>	NA
Indonesia	<p>Indonesian catches contribute about 17% of total tuna catches for the Western and Central Pacific Fisheries Convention Area.</p> <p>Source: MRAG Americas (2003).</p>	<p>There is no national observer program for longline vessels. The Indonesian Directorate General for Capture Fisheries reports data on annual catch estimates, licensing and export data. The reported statistics are highly aggregated, such that a large proportion of estimated catch is not identified by gear type, catch information for two or more species are aggregated under the category 'tuna', and there is limited information accompanying data to explain the sampling protocols that were used. No information is available on the location of catch and effort.</p> <p>Source: MRAG Americas (2003).</p>
Japan	<p>In 2004 there were a total of 1,447 longline vessels operating in the Western and Central Pacific Fisheries Convention Area, which set 118 million hooks. 484 of these vessels were large distant water longliners.</p> <p>Source: Uosaki et al. (2005).</p>	<p>No information was available on national observer coverage in Japan's 2005 national tuna fisheries report to the WCPFC.</p> <p>Source: Uosaki et al. (2005).</p>
Kiribati	<p>In 2002 there were no domestic locally-based longline vessels. There were 89 foreign licensed vessels that fished in the Kiribati EEZ in 2002, which caught 2,144 mt.</p> <p>Source: Secretariat of the Pacific Community (2003).</p>	<p>The Republic of Kiribati Fisheries Division of the Ministry of Natural Resources Development manages an observer program with 20 observers and in 2002 established an Observer Coordinator post. Observer coverage is < 1%.</p> <p>Source: Secretariat of the Pacific Community (2003).</p>
Korea	<p>In 2004 there were a total of 190 longline tuna vessels active in the Western and Central Pacific Fisheries Convention Area, catching a total of 183,490 mt.</p> <p>Source: Moon et al. (2005).</p>	<p>In 2002 the Ministry of Maritime Affairs and Fisheries created an observer program for distant water longline vessels. There was one observed pelagic longline trip in 2005 and zero in 2004 in the Western and Central Pacific Fisheries Convention Area. Observers from the Republic of Korea Longline Observer Programme are expected to collect information on interactions with seabirds and other species groups of special interest. There is no target observer coverage rate.</p> <p>Sources: Moon et al. (2005); Lawson (2006).</p>

Marshall Islands	<p>In 2005 92 foreign licensed locally-based vessels (44 from China, 25 from Japan, 6 from Federated States of Micronesia, 5 from Taiwan, 2 from Korea, and 10 from 'other' countries) caught 3,768 mt of which 43% was bigeye tuna. In 2005 there were no active domestic locally-based longline vessels; there was one active domestic locally-based longline vessel in 2004, which set 38,300 hooks and caught 8 mt.</p> <p>Sources: Secretariat of the Pacific Community (2003); Lawson (2006); Muller (2006).</p>	<p>In 2002 the Marshall Islands Marine Resources Authority established a National Observer and Port Sampling Coordinator. There are 9 observers in the national observer program, who observed 26 longline trips in 2005. In 2004, SPC and FFA-supported observers observed 23 trips.</p> <p>Sources: Secretariat of the Pacific Community (2003); Lawson (2006); Muller (2006).</p>
Nauru	<p>In 2005 there were no locally-based foreign licensed pelagic longline vessels or foreign licensed distant water vessels fishing in the Nauru EEZ. Two domestic locally-based pelagic longline vessels owned by the Nauru Fisheries and Marine Resources Authority, which caught < 1 mt in 2005.</p> <p>Sources: Secretariat of the Pacific Community (2003); Nauru Fisheries and Marine Resources Authority (2006).</p>	<p>Nauru does not have a national observer program.</p> <p>Source: Secretariat of the Pacific Community (2003).</p>
New Caledonia (France)	<p>In 2005 there were 27 domestic locally-based longline vessels licensed to fish in the EEZ adjacent to New Caledonia, of which 23 were active and set 5 million hooks and caught 2,473 mt (1,590 mt of which was albacore). Since 2001 no foreign licensed longline vessels have been permitted to fish in the EEZ adjacent to New Caledonia. In 2002 there were 25 domestic locally-based pelagic longline vessels, which caught a total of 1,936 mt (primarily albacore tuna). These vessels fish exclusively in the New Caledonia EEZ. There is no licensed foreign fishing in the EEZ around New Caledonia.</p> <p>Sources: Secretariat of the Pacific Community (2003); New Caledonia Government (2006); Lawson (2006).</p>	<p>From 2000-2005 national observers observed 39 longline trips of 286 sets and 520,615 hooks. Observers reported no observations of interactions with seabirds, sea turtles and marine mammals. The New Caledonia Service de la Marine Marchande et des Pêches Maritimes hired a Monitoring Supervisor/Liaison Officer and one observer in 2002. These staff are based at the Secretariat of the Pacific Community, and SPC manages observer placement and data processing. About 5% of longline trips have been observed. In 2004, SPC and FFA-supported observers observed 12 trips.</p> <p>Sources: Secretariat of the Pacific Community (2003); New Caledonia Government (2006); Lawson (2006).</p>
Niue	<p>In 2005 there were 13 foreign licensed locally-based longline vessels that were authorized to fish in the Niue EEZ under a charter agreement. These 13 vessels set 2,631,500 hooks and caught 123 mt of which 55 mt was albacore. No foreign licensed distant water longline vessels operated in the Niue EEZ in 2005.</p>	<p>The Niue Fisheries Division of the Ministry of Agriculture, Forestry and Fisheries is planning to establish an observer program to place observers on the new joint venture locally-based longline vessels.</p> <p>Sources: Secretariat of the Pacific Community (2003); Tafatu (2006).</p>

	Sources: Secretariat of the Pacific Community (2003); Tafatu (2006).	
Northern Mariana Islands (USA)	There are no locally-based domestic or foreign licensed pelagic longline vessels or foreign licensed distant water longline vessels fishing in the EEZ around the Northern Mariana Islands. Source: Secretariat of the Pacific Community (2003).	NA
Palau	A locally-based pelagic longline fleet is comprised of foreign licensed vessels from Taiwan, China and Belize. Japanese distant water longline vessels operate in the Palau EEZ. In 2005 there were 115 foreign licensed locally-based vessels (107 from Taiwan, 6 from Belize, and 2 from China) and there were 12 foreign licensed distant water vessels from Japan. Sources: Secretariat of the Pacific Community (2003); Lawson (2006); Sisor (2006).	The Palau government is establishing a national fisheries observer program. In 2006 SPC and FFA conducted an observer training course in Palau and 12 participants from Palau received observer certification. In 2004, SPC and FFA-supported observers observed five trips. Sources: Secretariat of the Pacific Community (2003); Lawson (2006); Sisor (2006).
Papua New Guinea	In 2006 there were 18 active domestic locally-based longline tuna vessels and 9 active domestic locally-based longline shark vessels. In the previous two years there were 39 active longline tuna vessels and 9 active longline shark vessels. Since 1995 foreign licensed vessels are not permitted to fish in the PNG EEZ. In 2004 the 39 longline tuna vessels set 9,318,800 hooks and caught 4,810 mt in the Western and Central Pacific Fisheries Convention Area. In 2004 the 9 longline shark vessels caught a total of 1,474 mt. Sources: Secretariat of the Pacific Community (2003); Kumoru and Koren (2006).	The PNG National Fisheries Authority observer program is the largest in the Pacific Islands region with about 100 observers located at 10 seaports around the country. Observer coverage of the two domestic longline fisheries has been about 5%. In 2005 PNG observers observed 9 longline tuna trips and 15 longline shark trips. In 2004, SPC and FFA-supported observers observed 11 longline trips. The Papua New Guinea Government's 2006 national tuna fisheries report to the Scientific Committee of the WCPFC does not report bycatch of seabirds, sea turtles or marine mammals in the longline fisheries. Sources: Secretariat of the Pacific Community (2003); Kumoru and Koren (2006); Lawson (2006).
Philippines	In 2004 there were about 14 domestic longline tuna vessels and 25 distant water longline vessels, which operate in the Pacific, Indian and Atlantic Oceans. The Philippines catch comprise about 13% of total tuna catches in the Western and Central Pacific Fisheries Convention Area. Sources: MRAG Americas (2003); Barut and Garvilles (2005).	There is no national observer program. Catch effort data are reported, but coverage is low and only disaggregated by broad fishing area and catch and effort are not classified by gear type. There is low confidence in the reliability of some data reported by the Philippines Bureau of Agricultural Statistics. Source: MRAG Americas (2003).
Samoa	In 2002 there were 80 domestic locally-based longline vessels, which caught 4,901 mt. There were no foreign licensed vessels that fished in the	There is no observer coverage of the domestic longline fishery. Source: Secretariat of the Pacific Community

	Samoa EEZ in 2002.	(2003).
	Source: Secretariat of the Pacific Community (2003).	
Solomon Islands	In 2002 there were 25 domestic locally-based longline vessels, which caught 856 mt, and there were 46 foreign licensed vessels that fished in the Solomon Islands EEZ, which caught 839 mt. Source: Secretariat of the Pacific Community (2003).	The Solomon Islands Fisheries Division of the Ministry of Fisheries and Marine Resources operates an observer program with about 12 observers, an Observer Coordinator and Assistant Observer Coordinator. In 2004, SPC and FFA-supported observers observed 21 trips. Observer coverage has been at about 20% for the domestic fleet but there has been no coverage of foreign vessels. Sources: Secretariat of the Pacific Community (2003); Lawson (2006).
Spain	In 2004 eight Spanish pelagic longline shallow-setting longline swordfish vessels began to fish in the WCPO. These eight vessels set just over 1 million hooks in 2004. Five of these vessels were based out of Indonesia. Source: Instituto Espanol de Oceanografia.	No observer data are available from the Spanish longline swordfish vessels that fished in the WCPO in 2004. Source: Instituto Espanol de Oceanografia.
Tokelau	In 2002 there were no locally-based domestic or foreign licensed pelagic longline vessels or foreign licensed distant water vessels fishing in the Tokelau EEZ. Source: Secretariat of the Pacific Community (2003).	NA
Tonga	In 2005 there were 15 domestic locally-based longline vessels, which caught 552 mt. There were no foreign licensed vessels that fished in the Tonga EEZ in 2005. Sources: Secretariat of the Pacific Community (2003); Tonga Government (2006).	There is no observer coverage of locally-based longline vessels. In 2004, SPC and FFA-supported observers observed 11 trips. Sources: Secretariat of the Pacific Community (2003); Lawson (2006); Tonga Government (2006).
Tuvalu	There are no locally-based domestic or foreign longline vessels. In 2005 there were 51 foreign licensed distant water pelagic longline vessels (42 from Korea, 8 from Taiwan, and 1 from Fiji). All 51 of these vessels actively fished in the Tuvalu EEZ in 2005 and caught 980 mt. Sources: Secretariat of the Pacific Community (2003); Tupau (2006).	There is no national observer program and there is negligible observer coverage of foreign licensed longline vessels. In 2004 SPC and FFA held an observer training course in Tuvalu and 17 participants passed the course. No national observers have been placed on longline vessels due to a lack of funding. The Tuvalu Fisheries Department is seeking financial support to establish a national fisheries observer program. Sources: Secretariat of the Pacific Community (2003); Tupau (2006).
Vanuatu	In 2005 there were 55 Vanuatu-based distant water and offshore longline	Vanuatu does not have a national fisheries observer program.

vessels of which 11 were authorized to fish in the Vanuatu EEZ. In 2002 there were 13 domestic locally-based longline vessels, which caught 354 mt, and there were 72 foreign licensed locally-based vessels (Fiji and Taiwan-flagged) that fished in the Vanuatu EEZ, which caught 2,303 mt.

Source: Secretariat of the Pacific Community (2003); Vanuatu Government (2006).

Sources: Secretariat of the Pacific Community (2003); Vanuatu Government (2006); Williams and Reid (2006).

Wallis and Futuna (France)

There are no locally-based domestic or foreign licensed pelagic longline vessels or foreign licensed distant water vessels fishing in the EEZ around Wallis and Futuna.

NA

Source: Secretariat of the Pacific Community (2003)

Observer coverage in the region's high seas pelagic longline fisheries may increase in the future due to provisions of the Western and Central Pacific Fisheries Convention. Article 28 of the Convention calls for the Commission to operate a regional observer program and requires flag states to ensure that their vessels, except those that operate exclusively in waters under national jurisdiction, are prepared to accept an observer from the Commission's regional observer program. Flag state permission is required for Commission observers to continue their duties if the observed vessel enters the EEZ of the flag state. Vessels that fish exclusively in the national waters of the flag state are not required to carry Commission observers (Secretariat of the Pacific Community, 2003).

3. INDIRECT INFORMATION ON THREAT TO SEABIRDS FROM INTERACTIONS WITH LONGLINE FISHERIES OF THE WESTERN AND CENTRAL PACIFIC

3.1. Distributions of Albatrosses and Large Petrels to Determine Overlap with Fishing Grounds

In the absence of data from direct observations of seabird bycatch levels and rates in longline fisheries, information on temporal and spatial overlap between the distributions of seabird species known to be vulnerable to capture in longline fisheries and the location of longline fishing grounds can provide an indication of the existence of a bird bycatch problem in individual fisheries. Small (2006) presents information from remote tracking data (from satellite tracking devices attached to the back of birds, geolocators attached to birds' legs and Global Positioning System devices) on the distribution of albatrosses and petrels in the Western and Central Pacific Fisheries Convention Area, and compares this to the spatial distribution of pelagic longline fishing effort in the Western and Central Pacific Fisheries Convention Area for the period 2000-2003 using data from the Secretariat of the Pacific Community Oceanic Fisheries Programme public domain dataset. The study did not include information on the distribution of shearwater species identified by Watling (2002) as potentially vulnerable to longline bycatch in the tropical and subtropical Pacific Islands region. Small (2006) explains that remote tracking data are not available for shearwaters and some petrels believed to be vulnerable to capture in longline gear. Small (2006) found that albatross distribution is concentrated outside the tropical and subtropical Pacific Islands region, being concentrated North of 20 deg. N. latitude and South of 30 deg. S. latitude, and that these seabirds are found both on the high seas and in EEZs. Waugh (2006) conducts a similar study, reviewing the distributions of albatross and petrel species within the Western and Central Pacific Fisheries Convention Area from

data on at-sea observations, banding recoveries and satellite telemetry, finding that 16 albatross species and 60 petrel species occur in the WCPFC area.

3.2. Fisher Interviews

Interviews with longline fishers can provide an indication of the extent of seabird interactions (e.g., Jahncke et al., 2001). Biases inherent in social surveys such as these include limitations of recall, inclusion of socially or politically desirable responses, or simply a cultural bias against perceived management intrusion within the fishing society. Given the political nature of the seabird bycatch issue, information received from interviewing fishers is likely subject to uni-directional bias. Also, fishers may not be able to accurately identify seabird species. Having expressed the large limitations of information on bycatch collected from interviews with longline fishers, information from interviews can provide very useful insights into the longline industry practices and attitudes towards seabird bycatch.

Watling (2002) interviewed sixteen longline captains, vessel owners and researchers with experience of longline fishing operations in Tonga, Fiji, Cook Island, French Polynesia, New Caledonia, Papua New Guinea, and Samoa, to obtain information on the occurrence of seabird interactions. Responses were consistent that seabird interactions in these fisheries are extremely rare events, and two respondents recalled catching three or fewer seabirds in their lifetime experience longline fishing in the tropical Pacific Islands region (Watling, 2002). A captain of a Fiji-based longline vessel reported that seabirds are often present and remove bait from hooks and forage on discarded bait and offal, but never observed a seabird being captured (Watling, 2002).

3.3. Identifying Tropical and Subtropical Pacific Seabird Species that May be Susceptible to Longline Capture Based on Observations of these Species Being Captured in Temperate Zone Longline Fisheries

Based on available information, seabird species that may be vulnerable to capture in pelagic longline fisheries operating in the tropical and subtropical Pacific Islands region include the: Wedge-tailed Shearwater (*Puffinus pacificus*), Sooty Shearwater (*P. griseus*) Short-tailed Shearwaters (*P. tenuirostris*), Flesh-footed Shearwater (*P. carneipes*), Pink-footed Shearwater (*P. creatopus*), Christmas Shearwater (*P. nativitatis*), Newell's Shearwater (*P. newelli*), Heinroth's Shearwater (*P. heinrothi*), Juan Fernandez Petrel (*Pterodroma externa*), and Murphy's Petrel (*Pterodroma ultima*) (Watling, 2002).

This species list is based primarily on observations of the species of seabirds that are commonly captured in longline fisheries outside of the tropical and subtropical Pacific Islands region. However, observations of a seabird species bycatch levels in a longline fishery in one area may not necessarily be an accurate predictor of the existence or lack of problematic bycatch of this species in other regions. There is a need for onboard observer data across seasons and different parts of ranges of seabirds thought to be vulnerable to capture in longline fisheries in tropical and subtropical Pacific Island longline fisheries, because it is possible that a seabird species may have different foraging strategies when breeding vs. not breeding, or whilst migrating vs. non migrating. Observer coverage of Pacific Island longline fisheries is needed to directly determine which seabird species, if any, are caught in tropical and subtropical Pacific longline fisheries.

The Hawaii-based longline tuna and swordfish fisheries catch seabirds primarily at fishing grounds North of the Hawaii Islands and predominantly catch black-footed (*Phoebastria nigripes*) and Laysan (*P. immutabilis*) albatrosses, which range throughout the North Pacific primarily North of 20 degrees N. latitude; observer data show that the capture of other seabird species in the Hawaii-based longline fisheries are extremely rare events (Gilman et al., 2005). Based on their ranges, is not likely that Laysan or Black-footed albatrosses are caught in tropical and subtropical Pacific longline fisheries other than the Hawaii-based fleet. Watling (2002) reviews seabird bycatch data from Australia and New Zealand to determine if the ranges of the species and species groups known to be caught in these nation's longline fisheries overlap with tropical and subtropical Pacific longline fishing grounds, and concludes that, of the four species groups (petrels, shearwaters, boobies and skuas) that are potentially vulnerable to capture in longline fisheries in the tropical Pacific, only four

seabirds of the 32 that are caught in the New Zealand and Australia fisheries are found in the tropical Pacific. These four species are the Wedge-tailed Shearwater, a common breeding resident, Sooty and Short-tailed Shearwaters, which are common annual migrants through the Pacific Islands region, and the Flesh-footed Shearwater, which is an uncommon annual migrant (Watling, 2002). It is not known if the three shearwater species that are annual migrants forage in the tropical Pacific, or if they simply migrate across the region to and from the Southern and Northern Pacific (Watling, 2002). Watling (2002) also concluded that the species known to be caught in Australia and New Zealand-based pelagic longline fisheries are > 500 g in weight, corresponding to relatively large sized seabirds. Based on this observation, Watling (2002) identifies seven additional seabird species (Pink-footed Shearwater, Christmas Shearwater, Newell's Shearwater, Heinroth's Shearwater, Hawaiian Petrel, Juan Fernandez Petrel, and Murphy's Petrel) that occur in the tropical Pacific that may be vulnerable to capture in pelagic longline fisheries, these being the seabirds that are > 500 g excluding those whose range overlaps with the Australia and New Zealand longline fleets and have not been observed to be caught in these fisheries. Six of these seven seabird species are classified as threatened by IUCN's Red List (Watling, 2002). The Hawaiian Petrel, which breeds in the Hawaiian Islands and migrates to the Southern Hemisphere where it overlaps with fishing grounds of the Australian pelagic longline fleet, has not been observed to interact with the Australia-based longline vessels (Environment Australia, 1998). This demonstrates that a seabird species' weight is not the only factor to consider to determine its vulnerability to capture in longline fisheries. A species' behavior is a more important attribute to consider, as certain species exhibit no inclination to interact with fishing vessels.

4. REVIEW OF SEABIRD BYCATCH AVOIDANCE METHODS – BENEFITS FROM A REGIONAL SINK RATE PERFORMANCE STANDARD

A review of methods designed to reduce seabird bycatch in pelagic longline fisheries reveals that there are numerous methods that, when employed to prescription, can reduce seabird bycatch to negligible levels (Gilman et al. 2005). A review of most seabird avoidance methods in use in pelagic and demersal longline fisheries can be found in Brothers et al. (1999) and Gilman et al. (2005). Over the past 15 years, national governments, regional organizations and longline industries have developed and tested seabird avoidance methods in longline fisheries, which can be divided into six categories of methods to (Brothers 1995; Brothers et al. 1999; Gilman et al., 2005):

- (1) Alter fishing practices to avoid peak areas and periods of bird foraging (e.g., night setting, area and seasonal closures);
- (2) Reduce the detection of baited hooks by birds (e.g., blue-dyed bait, shielded lights);
- (3) Limit bird access to baited hooks (e.g., side-setting, underwater setting devices, thawed bait, addition of more weight closer to hooks, bait-casting machines);
- (4) Deter birds from taking baited hooks (e.g., bird-scaring line with streamers, acoustic deterrents, water cannon, towed buoy);
- (5) Reduce the attractiveness of baited hooks to birds (e.g., artificial lures, artificial smell); and
- (6) Reduce injury to hooked birds (e.g., improved bird handling).

Establishment of a regional or international performance standard for longline hook sink rate, and prescribing gear weighting designs that meet this standard that are achievable by all longline fisheries, will contribute to resolving the problem of low vessel use of seabird avoidance methods (Gilman et al. 2005). Line weighting is an effective seabird avoidance method, which, when used in combination with other seabird avoidance methods such as night setting and side setting, can nearly eliminate seabird capture (Gilman et al. 2005; Brothers and Gilman, 2006). Prescribed gear weighting designs can facilitate high compliance because compliance is easily assessed by fishery management authorities through dockside inspections, and it is unlikely that crew will change the gear configuration at sea due to the time it would take to do so. Furthermore, in some demersal

longline fisheries, fishers do not alter gear from the way it is provided by gear manufacturers, who would build the gear according to the international prescription. While standardized line weighting and hook sink rate alone would not adequately minimize seabird interactions in all fisheries, a regional or international standard would be an important step forward, especially for fleets that currently do not employ any seabird bycatch reduction methods, including illegal, unregulated and unreported fisheries.

5. INITIATIVES OF REGIONAL FISHERY MANAGEMENT ORGANIZATIONS

Gilman (2001), Small (2005) and Western and Central Pacific Fisheries Commission (2006) review actions taken by international organizations and Regional Fishery Management Organizations to address seabird bycatch problems in longline fisheries. Table 3 provides an updated review, and where information is available, evaluates the effectiveness and problems with specific initiatives. Of the Regional Fishery Management Organizations, only the Commission for the Conservation of Antarctic Marine Living Resources and Commission for the Conservation of Southern Bluefin Tuna require the employment of seabird avoidance methods.

Table 3. Actions by regional fishery management organizations and other international organizations to address seabird bycatch in longline fisheries.

RFMO	Initiatives to Address Seabird Bycatch in Longline Fisheries	Evaluation of Efficacy and Any Problems with Initiatives
Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)	<p>The CCAMLR area of application approximates the waters south of the Antarctic Convergence. CCAMLR first adopted mitigation measures in 1991 to reduce seabird bycatch (measure 29/X).</p> <p>CCAMLR's current seabird bycatch measures for longline fisheries are specified in Conservation Measure 25-02, and apply to Contracting Party longline fisheries when fishing in the Convention area (CCAMLR, 2005). Regulations include requirements for tori (bird scaring) lines, line weighting, a ban on the disposal of offal during setting or hauling gear, a requirement for night setting and restrictions on deck-lighting. CCAMLR has also established seabird bycatch limits in exploratory fisheries and has delayed the opening of fishing seasons until the end of the breeding season of most albatrosses and petrels (CCAMLR, 2004, 2005; Western and Central Pacific Fisheries Commission, 2006).</p> <p>There is 100% coverage of longline fishing vessels by independent observers (of different nationality than the vessel's flag State). In December 2000 Vessel Monitoring Systems became compulsory to all CCAMLR Member fisheries within the Convention area except krill fisheries (Conservation Measure 149/XVII). CCAMLR has a catch documentation program for Patagonian toothfish in an effort to combat illegal, unreported, and unregulated fishing.</p>	<p>Seabird bycatch levels have been reduced by 99% from 1997 levels, prior to the institution of seabird conservation measures, to 2003 levels (a reduction from 6,589 to 15 seabirds captured) (Small, 2005). Due to industry attitudes towards the prescribed seabird avoidance methods, In the absence of the current 100% observer coverage, it is unlikely that the 99% reduction in seabird bycatch levels would be maintained, thus calling into question the suitability of use of the prescribed mitigation measures in other fisheries lacking high observer coverage. It is unclear if CCAMLR measures taken to combat illegal, unregulated, and unreported 'pirate' fisheries have been effective in reducing seabird bycatch levels in these illegal fisheries (Small, 2005).</p>
Inter-American Tropical Tuna Commission (IATTC)	<p>IATTC manages tuna and tuna-like stocks in the East Pacific. IATTC has not required the employment of seabird avoidance measures in Member longline fisheries. Observer coverage is not required on longline vessels. IATTC Resolution C-05-01 on the incidental mortality of seabirds, recommends implementation of the FAO International Plan of</p>	<p>There is insufficient information to assess the degree of seabird bycatch problems in Member longline fisheries IATTC does not require the employment of seabird avoidance measures by longline vessels. IATTC could improve efforts to</p>

	<p>Action – Seabirds, the collection of information on seabird interactions, including bycatch in fisheries under the purview of IATTC, and for the Working Group on Stock Assessment to assess the impact of seabird bycatch in tuna fisheries operating in the eastern Pacific (Inter-American Tropical Tuna Commission, 2005).</p> <p>To combat illegal fishing activity, IATTC manages a 'positive list' of legal longline vessels and has a bigeye trade documentation scheme.</p>	<p>combat illegal fishing activities by establishing a port and at-sea inspection program, expanding the documentation scheme to record catch levels and not just trade, and requiring member vessels to use VMS.</p>
<p>Commission for the Conservation of Southern Bluefin Tuna (CCSBT)</p>	<p>CCSBT manages Southern bluefin tuna stocks, a species that is most abundant between 30 - 50° South. Australia, Japan, Korea, New Zealand and Taiwan are CCSBT Members and the Philippines is a cooperating non-member. Since 1995, under the auspices of CCSBT, Members have required the employment of bird scaring lines (also called a tori line, a device consisting of a line with suspended streamers, deployed from a pole astern during line setting to deter birds from taking baited hooks) in their longline fisheries when at grounds South of 30 deg. S. latitude (Western and Central Pacific Fisheries Commission, 2006). In 1995, CCSBT also adopted recommendations on data collection and education for bycatch in the Southern bluefin tuna fishery, including seabirds (Gilman, 2001). In 2001 CCSBT adopted a target of 10% observer coverage of Member's longline fisheries, Members are not required to collect information on seabird bycatch and are not required to share observer data with CCSBT.</p> <p>CCSBT institutes two programs to contribute to address illegal, unregulated, and unreported illegal fisheries: (i) CCSBT manages a list of authorized vessels, expanded in October 2004 to include vessels of all sizes, and (ii) has a trade documentation scheme.</p>	<p>Insufficient information is available to assess compliance with or the efficacy of the requirement for tori line use on seabird bycatch. CCSBT has insufficient data collection on seabird bycatch. The requirement for use of tori lines is likely insufficient as requiring tori lines likely results in low compliance when there is insufficient surveillance because tori lines are relatively impractical (Gilman et al., 2005). CCSBT efforts to combat illegal, unregulated and unreported illegal fisheries are likely ineffective and could be improved, by instituting a VMS program, a port and at-sea inspection scheme, and catch documentation program that records total catch (Small, 2005).</p>
<p>World Conservation Union (IUCN)</p>	<p>IUCN Resolution 1.15, adopted in 1996, entitled <i>Incidental Mortality of Seabirds in Longline Fisheries</i>, calls upon States to adopt the goal of reducing seabird bycatch within longline fisheries to insignificant levels for affected species, and immediately implement seabird bycatch reduction measures by longline fisheries (IUCN, 1996). IUCN Resolution 2.66, <i>Pirate Fishing and Seabird Mortality from Longlining in the Southern Ocean and Adjacent Waters</i>, adopted in 2000, calls upon States and regional fishery bodies to combat illegal, unreported, and unregulated pirate fishing for Patagonian toothfish (<i>Dissostichus eleginoides</i>); to reduce the mortality of seabirds in longline fisheries in the Southern Ocean; to comply with the FAO International Plan of Action on seabird bycatch; and to support development of an Agreement for Southern Hemisphere Albatrosses and Petrels (IUCN, 2000a). IUCN Recommendation 2.75, <i>Southern Hemisphere Albatross and Petrel Conservation</i>, adopted at the Second World Conservation Congress of IUCN, calls upon States and regional fishery bodies to take action to conserve Southern Hemisphere albatrosses and petrels,</p>	<p>These IUCN resolutions and recommendation are advisory and not legally binding.</p>

identify threats to these seabirds, participate in meetings to adopt an Agreement for the Conservation of Southern Hemisphere Albatrosses and Petrels, implement CCAMLR conservation measures, and implement the FAO International Plan of Action on seabird bycatch (IUCN, 2000b). Resolution 1.16, *Fisheries By-catch*, and Recommendation 19.61, *By-catch of Non-target Species*, also call on States and fishery bodies to address the problem of seabird bycatch in longline fisheries.

United Nations
Food and
Agriculture
Organization
(FAO)

The FAO *International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries* (IPOA—Seabirds). The IPOA—Seabirds calls on all States to implement the plan starting by conducting an assessment of longline fisheries to determine if a seabird bycatch problem exists. If a problem exists, States are then encouraged to develop a National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (FAO, 1999).

The IPOA—Seabirds is voluntary and not legally binding.

International
Pacific Halibut
Commission
(IPHC)

The U.S. and Canada are the two member nations of IPHC. IPHC manages demersal longline halibut fisheries in Convention waters, which are the territorial waters off the west coasts of Canada and the USA, including the southern and western coasts of Alaska (IPHC, 1998). IPHC prepared, *A Feasibility Study That Investigates Options for Monitoring Bycatch of the Short-tailed Albatross in the Pacific Halibut Fishery off Alaska*, and recommends implementation of a combination of monitoring approaches (IPHC, 2000).

No seabird avoidance strategies are required, but both Canada and the U.S. have prescribed seabird avoidance measures in longline fisheries operating in the IPHC area. IPHC has no regulatory authority regarding seabird bycatch, but coordinates with the two member nations and conducts research to address the problem.

Indian Ocean
Tuna Commission
(IOTC)

IOTC manages tuna and billfish stocks in the Indian Ocean. IOTC adopted a resolution on Reducing Incidental Bycatch of Seabirds in Longline Fisheries in 2006 (Indian Ocean Tuna Commission, 2006). There is no requirement for an onboard observer program in Member longline fisheries, and few Members supply observer data to the Commission (Small, 2005). IOTC has taken several measures to combat illegal, unregulated, and unreported fishing: (i) IOTC manages a list of authorized vessels, (ii) requires Member port states to conduct port inspections of non-Member vessels, (iii) exchanges information on illegal fishing vessels, and (iv) has a trade documentation program for bigeye tuna.

There is insufficient information to assess the degree of seabird bycatch problems in Member longline fisheries. No seabird avoidance strategies are required.

The IOTC seabird resolution has several technical problems, including exempting all longline swordfish vessels using the Lindgren-Pitman monofilament main line and main line spool style of longline gear from complying with recommended seabird avoidance measures, the selection of 30 deg. S latitude as the Northern limit for employment of recommended seabird avoidance measures (Australia has recognized that problematic seabird bycatch levels occur further North to 25 deg. S latitude (Environment Australia, 1998)), and the selection of tori lines as the recommended seabird avoidance measure when other strategies to reduce seabird bycatch have been demonstrated to be more effective as well as promote a higher degree of industry compliance, which is critical when resources for surveillance are minimal (Gilman et

		<p>al., 2005). These problems may be corrected through future amendments to the resolution (personal communication, Alejandro Anganuzzi, Executive Secretary, IOTC, 2 August 2006).</p> <p>Measures to combat illegal fisheries could be improved by instituting a catch documentation program that records total catch, requiring the use of VMS by Member vessels, require port inspections by Member vessels, and conduct at-sea inspections (Small, 2005).</p>
<p>Western and Central Pacific Fisheries Commission (WCPFC)</p>	<p>The Convention area covers the western and central Pacific and manages migratory fish stocks as defined under Annex I of the United Nations Law of the Sea to include tunas, billfish, cetaceans and sharks. WCPFC adopted a resolution on the <i>Incidental Catch of Seabirds</i> (Resolution 2005-01) in December 2005, calling for Members, Cooperating Non-Members, and Participating Territories to implement the FAO International Plan of Action – Seabirds, report to the WCPFC on their implementation of the FAO plan, provide the WCPFC with available information on seabird interactions to enable an estimate of total seabird mortality in fisheries to which the Western and Central Pacific Fisheries Convention applies, and the WCPFC will consider measures to reduce seabird bycatch at its 2006 annual meeting (Western and Central Pacific Fisheries Commission, 2005). WCPFC does not require Members to assess seabird bycatch levels in their fisheries or to employ seabird avoidance measures.</p>	<p>No seabird avoidance strategies are required, and no measures have been instituted to combat illegal fishing. The Convention text includes several provisions for the adoption of measures to address these problems. WCPFC came into force very recently (in 2004) and has made substantial progress in this short time towards highlighting priority fisheries bycatch problems, including seabird bycatch.</p>
<p>International Commission for the Conservation of Atlantic Tunas (ICCAT)</p>	<p>ICCAT manages tuna and billfish fisheries in the Atlantic. In 2002, ICCAT adopted a resolution on reducing incidental mortality of seabirds (Resolution 02-14). This resolution encourages ICCAT Members to collect data on seabird interactions, urges members to implement FAO's NPOA-Seabirds, and resolves that the Scientific Committee will report to the Commission on the impact of incidental mortality on seabirds 'when feasible and appropriate' (International Commission for the Conservation of Atlantic Tunas, 2002). ICCAT encourages, and does not require, Members to establish onboard observer programs.</p> <p>ICCAT has taken several measures to combat illegal fishing activity: (i) ICCAT manages a list of authorized and illegal vessels; (ii) manages trade documentation schemes for bluefin, swordfish and bigeye; and (iii) requires Members to document imports and landings and provide this information to the Commission. Also, Member vessels > 24 m long must use VMS but the VZMS data are not required to be shared with ICCAT.</p>	<p>There is insufficient information to assess the degree of seabird bycatch problems in Member longline fisheries. No seabird avoidance strategies are required. Data collection on seabird bycatch is voluntary and not standardized.</p> <p>Measures to combat illegal fisheries could be improved by instituting a catch documentation program that records total catch, requiring the use of VMS by all Member vessels, require port inspections by Member vessels, and conduct at-sea inspections (Small, 2005).</p>
<p>Agreement on the Conservation of Albatrosses and</p>	<p>ACAP entered into force in 2004. It identified fishery interactions as a key threat facing these seabird species, and recommended that collaboration with</p>	

Petrels (ACAP)	regional fishery management organizations be pursued to reduce seabird bycatch in fisheries.	
Council of the Central Eastern Pacific Tuna Fishing Agreement (CEPTFA)	The Convention has yet to enter into force, only three of the requisite five ratifications have been made by the USA, Costa Rica and Panama.	The Regional Fishery Management Organization has yet to be established.
South East Atlantic Fisheries Organization (SEAFO)	SEAFO is a Regional Fishery Management Organization that manages the Southeast Atlantic high seas area.	The Regional Fishery Management Organization was formed very recently in 2004. No seabird avoidance strategies are required.
Permanent Commission of the South Pacific (CPPS) or the Galapagos Agreement	CCPS is an advisory body acting as an interim Secretariat until the Galapagos Agreement comes into effect. There will be four Member Countries of Chile, Peru, Ecuador and Colombia. CCPS manages high seas fish stocks of the Southeast Pacific.	The Regional Fishery Management Organization has yet to be established. No seabird avoidance strategies are required.
South West Indian Ocean Fisheries Commission (SWIOFC)	SWIOFC is a proposed Regional Fishery Management Organization that would manage non-tuna stocks in the Western Indian Ocean. An agreed Convention text has yet to be developed.	The Regional Fishery Management Organization has yet to be established. There is insufficient information to assess the degree of seabird bycatch problems in Member longline fisheries. No seabird avoidance strategies are required.

6. ADDRESSING SEABIRD BYCATCH PROBLEMS IN THE WESTERN CENTRAL PACIFIC

6.1. Next Steps for FFA Members to Implement the WCPFC Resolution on Seabird Bycatch in Longline Fisheries and FAO International Plan of Action - Seabirds

There is little empirical information available to assess the degree and conservation threat of seabird bycatch in longline fisheries of the tropical and subtropical Pacific Islands region. While available information indicates that seabird bycatch rates are relatively low, it is possible that highly threatened seabird populations may be affected (Watling, 2002), and that individual fisheries in the region could have problematic seabird bycatch levels and rates. Existing observer data are insufficient to support a conclusion with any certainty that no pelagic longline fisheries operating in the tropical Pacific Islands region have problematic seabird bycatch, problematic in that this mortality source could be contributing to existing or cause future seabird population declines. To eliminate uncertainty in determining if seabird bycatch poses a serious problem in Pacific Island longline fisheries, data specifically on seabird interactions need to be collected by independent onboard observers in all fisheries.

Countries and territories with longline fisheries operating in their EEZ or on the high seas that are located at the Northern, Southern and Eastern extremes of the region (Northern Mariana Islands, USA; Marshall Islands; New Caledonia, France; Fiji; Tonga; Cook Islands; and French Polynesia) (Fig. 1) are potentially the highest priority locations for augmenting observer coverage to record seabird interactions.

6.1.1. Increase Onboard Observer Coverage and Define Data Collection Protocol to Ensure Consistent Collection of Seabird Interaction Events.

There is a need for adequate observer coverage in all longline fisheries of the tropical Pacific Islands region. Observer coverage rates in the tropical Pacific Islands region are relatively low (Molony, 2005). This results in very large error intervals around point estimates of total seabird captures and capture rates from considerable

'raising' of the data to extrapolate to all fleets operating in the area. A large sample size ($N > 1000$) is needed to accurately characterize rare events such as seabird captures in tropical and subtropical Pacific longline fisheries (personal communication, September 2006, Don Kobayashi, U.S. National Marine Fisheries Service, Pacific Islands Fisheries Science Center). Also, observer coverage rates are not evenly distributed among flag States, areas and seasons. In order to accurately assess the existence of any seabird bycatch problem in an individual longline fishery, long-term observer coverage is needed because abundance of seabird species and seabird species complexes in different areas of the tropical Pacific may exhibit high inter annual and seasonal variability relative to higher latitudes, possibly due to the spatial and temporal variability in distribution of wind strength. Furthermore, if a fishery is interacting with an endangered seabird population with a small population size, the capture of a very small number of individuals from this population could be problematic (cause or contribute to population declines). In fisheries that do have infrequent bycatch of endangered populations of seabirds, or have sporadic high seabird bycatch rates of species that breed outside the region (when wind conditions are suitable for seabird foraging), a high rate of observer coverage over a long time period is likely needed to accurately characterize these rare events. Adequate onboard observer coverage rates and adequate temporal and spatial observer coverage provides information on the level and trends in seabird mortality and allows fishery management authorities to determine if regulatory requirements and performance standards are being met.

Observer data collection protocols could be improved to optimize the accuracy of information collected on the number of seabirds being brought to the vessel during gear retrieval. Current observer programs were not specifically designed to collect information on seabird bycatch or bycatch of other species groups of special interest (sea turtles, marine mammals, sharks) (Molony, 2005). Because seabird interactions are extremely rare events, and because it is a documented practice for crew to conceal captured seabirds from observers not continuously viewing the line hauling process (Gales et al. 1998), onboard observers would need to observe every hook as it is being hauled to the vessel from a position at the bulwark adjacent to the vessel hauling position for optimal accuracy of estimates of bird capture levels and rates (Gilman et al., 2005). And there is a need to account for the loss of caught birds before the haul to produce accurate estimate of total seabird capture levels and rates (Brothers 1991; Gales et al. 1998; Gilman et al. 2003; Gilman et al., 2005, In Press b).

6.1.2. Develop Observer Capacity for Seabird Species Identification: Secretariat of the Pacific Community and national observer program data collection protocols could improve information on seabird interactions in pelagic longline fisheries by developing the capacity of onboard observer to identify and record the species of seabirds that interact with the fishing gear.

6.1.3. Modify Observer Data Collection Protocol to Record Seabird Abundance during Setting for Fisheries with Problematic Seabird Bycatch: For fisheries in the region that are determined from an assessment of observer data to have substantial seabird bycatch problems, observer program data collection protocols should be expanded to record abundance of problematic seabird species during setting in order to facilitate determining seabird capture rates normalized for seabird abundance (Gilman et al., 2003, 2005). Observer data collection protocols could be standardized to collect information on seabird abundance during setting and hauling. For instance, Gilman et al. (2003, In Press b) counted and recorded the number of each seabird species present within a 500 m by 500 m square area (within 250 m of port and starboard of the center of the vessel stern and within 500 m behind the vessel) astern of the vessel every 15 minutes during the set. Observer programs could define a similar area around the vessel and frequency of counts to provide consistency in measurements of mean seabird abundance during sets and hauls. A smaller area around the vessel will need to be defined for seabird abundance observations during sets or hauls that occur at night.

Normalizing seabird interaction rates for bird abundance is an analysis approach consistent with the accepted understanding of animal abundance and the capture process (e.g., Ricker 1958; Seber 1973) derived from an early study on rats (Leslie and Davis 1939). Of all the factors that likely

affect the level of bird interactions with longline gear per unit of effort, including weather conditions, seabird species complex, and differences in gear and fishing practices, seabird abundance may be one of the most important. Gilman et al. (2003) demonstrated a highly significant linear correlation between albatross abundance and seabird interaction rates, confirming the hypothesis that seabird interaction rates should be normalized for seabird abundance. However, few studies report seabird bycatch rates normalized for seabird abundance.

To help explain the benefit of normalizing seabird interaction rates for bird abundance, consider the scenario where one vessel has an average of 15 seabirds attempting to obtain bait from hooks, while a second vessel has 150 seabirds attempting to steal baits, and both vessels are employing the same seabird avoidance method(s) and fishing methods and gear while fishing at the same fishing grounds. Based on the results from Gilman et al. (2003), we expect about 10 times more seabird captures per unit effort (e.g., per 1000 hooks) by the second vessel than by the first, assuming all other potentially important factors (weather conditions, seabird species complex, different type of gear, different bait, etc.) that significantly effect bird capture rates are the same for the two vessels. If we did not normalize the capture rates from the two vessels by bird abundance, a comparison of the reported capture rates (presented as captures per 1000 hooks) would imply that the capture rate for the first vessel was 10 times lower than that of the second vessel when in fact they were both employing seabird avoidance methods of the same efficacy. Therefore, normalizing capture rates for bird abundance is important to allow for more accurate comparisons between seabird interaction rates reported from multiple vessels and fleets. It is also possible to test the influence of other variables besides bird abundance. For instance, Brothers et al. (1999) and Chereil et al. (1996) have shown how environmental variables influence seabird bycatch rates.

6.2. Need to Consider Commercial Viability of Bycatch Avoidance Methods

There are operational and economic effects from instituting alternative seabird avoidance methods. Given the state of management frameworks of the majority of the worlds' longline fisheries, there is a need to focus on the commercial viability of bycatch reduction methods in order to catalyze changes in fishing methods and gear and regulatory measures that will abate longline bycatch (Gilman et al., 2005). To resolve the global problem of seabird mortality in longline fisheries, there is a need to identify and institute the broad use of methods that not only have the capacity to minimize seabird capture, but which are also practical and convenient and provide crew with incentives to employ them consistently and effectively. It is critical to account for economic and social values of longline fisheries to achieve changes that abate bycatch (FAO, 2004).

As the loss of bait to seabirds and concomitant reduction in catch of fish can be significant, the use of seabird avoidance measures is expected to be cost saving for longline fisheries. However, most longline fleets do not employ effective seabird avoidance methods despite the availability of effective methods that also increase fishing efficiency (Brothers et al., 1999a; FAO, 2003). Reasons for this may be (i) low industry awareness of the availability, effectiveness, and practicability of these seabird avoidance methods; (ii) few national fishery management authorities manage interactions between seabirds and longline vessels or require employment of effective seabird avoidance methods (Brothers et al., 1999; BirdLife International, 2003; FAO, 2003; Gilman and Freifeld, 2003); and (iii) lack of a sufficiently strong economic incentive for industry to change long-standing fishing practices. Recognizing this context of global longline fisheries, maximizing industry's sense of ownership for using effective seabird avoidance measures and providing industry with incentives for voluntary compliance are needed. The longline industry responds best to economic incentives and disincentives (Gilman et al., 2005). Seabird mitigation methods that increase fishing efficiency and have operational benefits have the best chance of being accepted by industry. Eco-labeling and certification programs can also provide industry with strong market-based and social incentives to meet criteria to be certified as a sustainable fishery, including the employment of effective bycatch reduction methods, but requires adequate marketing of the label to make it economically viable for industry to participate. Additionally, if regulations requiring the use of seabird avoidance methods are effectively enforced and carry sufficient economic consequences for noncompliance, broad industry compliance can be achieved.

Gilman et al. (2003, In Press b) provide a model for designing fisheries bycatch research experiments to collect information to reveal each treatment's economic viability, practicality, and enforceability. Analyzing differences in alternative seabird avoidance methods' effect on bait retention, hook setting rates, and target fish catch-per-unit-of-effort; operational benefits and costs; time and money to adopt and employ; and enforceability is of high interest to industry, fishery management authorities, and other stakeholders (Gilman et al., 2005).

6.3. Fishery-Specific Solutions to Bycatch

Solutions to fisheries bycatch problems, including seabird bycatch, may be fishery-specific (Gilman et al., 2005). Different seabird avoidance methods may be appropriate for different longline fisheries due to differences in the diving abilities of seabird species that interact with each fishery, vessel designs, fishing gear, and fishing methods (Brothers et al. 1999). There are many factors that influence the degree of seabird entanglements and hookings in an individual longline fishery and for a specific vessel. Fishing practices (e.g., automated versus manual line hauling, method of gear deployment, season and time of day when setting, use of deck lighting at night, offal discharge practices, fishing grounds, condition of bait when setting, and proper use of mitigation measures), type and configuration of fishing gear (e.g., placement and amount of weight and concomitant baited hook sink rate, length of branch lines, size of hooks, use of light sticks, use of seabird avoidance methods), weather conditions when setting, and the complex of seabird species present influence the number of seabirds a specific vessel and fishery will catch (Brothers 1991; Brothers 1995; Environment Australia 1998; Brothers et al. 1999; Gilman et al., 2005). Therefore, broad assessments in individual fisheries must precede advocacy for uptake of specific seabird avoidance methods.

For instance, while an underwater setting chute has been shown to be very effective at avoiding seabird interactions in the Hawaii pelagic longline tuna fleet (Gilman et al., 2003), trials of the chute in the Australian pelagic longline fishery have not been as promising, likely due to the seabird species complex that interacts with the fishing vessels and their bait scavenging abilities and behavioral interactions, the weighting design of the fishing gear, and the use of live bait (Brothers et al., 2000). The deep-diving Flesh-footed Shearwater (*Puffinus carneipes*), currently one of the two most often caught species in Australian waters, can reach baits to a depth of 20 m, getting caught on baited hooks and bringing baited hooks to the surface to make them available to larger albatrosses, petrels, and skua species, if these other species are present. Luckily deep-diving seabirds infrequently interact with the Hawaii longline fleet. In the Australian fishery, the chute may not be effective without being combined with additional mitigation measures and alterations to existing gear and fishing techniques in Australian waters where this seabird assemblage is seasonally present. For instance, when compared to the Hawaii longline tuna fishery, which uses 45 to 80 g swivels within 20 to 90 cm from the hook, the Australian longline tuna fleet, which places 20 to 38 g weights (if any) 3 to 4 fathoms from the hook, will have a slower hook sink rate than the Hawaii fishery, making baited hooks available to diving seabirds longer than if the weights were placed closer to the hooks. Also, in the Australian fishery, the effect of using live bait on seabird capture is as yet unclear (the majority of the fleet uses a high proportion of live bait), but is believed to increase seabird access to baited hooks.

6.4. Marine Protected Areas, Area and Seasonal Closures

Area and seasonal closures are management tools that can complement employment of other strategies to reduce bycatch (Gilman, 2002; Gilman et al, 2005, 2006). Closed areas can have substantial adverse economic effects on industry, but remain an available tool to fishery managers if alternative effective methods are not available. It may also be a more desirable option than a closed fishery. Currently information of sufficient detail is lacking for the tropical and subtropical Pacific Islands region to determine if area or seasonal closures would be effective to address any seabird bycatch problems in pelagic longline fisheries. If in the future this information does become available and temporal or spatial closures are identified as an effective strategy to complement

seabird avoidance in pelagic longline fisheries, several factors require consideration to ensure that the closed areas do not exacerbate bycatch problems.

For instance, resource use restrictions of a marine protected area may displace effort to adjacent and potentially more sensitive and valuable areas, especially if an effective management regime does not exist for these other areas (Gilman, 2002). And instituting a closure for one longline fleet may result in increased effort by another nation's longline fleet with fewer controls to manage bycatch. For instance, during a four-year closure of the Hawaii longline swordfish fishery due to concerns over bycatch of sea turtles, swordfish supply to the U.S. marketplace traditionally met by the Hawaii fleet was replaced by imports from foreign longline fleets, including from Mexico, Panama, Costa Rica, and South Africa, which have substantially higher ratios of sea turtle captures to unit weight of swordfish catch and less stringent or no measures to manage seabird bycatch (Bartram and Kaneko, 2004; Sarmiento, 2004).

Establishing protected areas containing seabird nesting colonies and adjacent waters within a nation's Exclusive Economic Zone is potentially an expedient method to reduce interactions between seabirds and longline fisheries. However, establishing high seas marine protected areas to restrict longline fishing in seabird foraging areas and migration routes, which would require extensive and dynamic boundaries defined in part by the location of large-scale oceanographic features and short-lived hydrographic features such as eddies and fronts, and would require extensive buffers (Hyrenbach et al., 2000), may not be a viable short-term solution (Thiel and Gilman 2001). This is due in part to the extensive time anticipated to resolve legal complications with international treaties, to achieve international consensus and political will, and to acquire requisite extensive resources for surveillance and enforcement to implement high-seas marine protected areas (Thiel and Gilman 2001). Furthermore, design of a high seas protected area to address interactions between albatrosses and longline fisheries would need to account for albatrosses' complex foraging strategies, involving segregation by gender and age classes (Hyrenbach et al. 2000).

International bodies have created marine protected areas on the high seas: The International Whaling Commission declared the Indian and Southern Oceans as no-take sanctuaries for whales, covering 30 percent of the world's oceans mostly on the high seas. Conventions governing international shipping have designated large areas of the ocean that include high seas as Special Areas where stringent restrictions apply regarding discharges from ships. Furthermore, under the United Nations Convention on the Law of the Sea, the International Seabed Authority could protect areas from minerals extraction beyond national jurisdiction where there is a risk of harm to the marine environment (Kelleher 1999). Recent developments within the framework of the United Nations Convention on the Law of the Sea and associated conventions may make it possible in the future to restrict fisheries activities on the high seas that are shown to undermine marine conservation (Kelleher 1999).

6.5. Considering Effects on Other Bycatch Species Groups

In addition to seabird bycatch, interactions between longline fisheries and sea turtles, sharks and cetaceans are also problematic (Gilman et al., 2005, 2006, In Press a). When prescribing methods to reduce seabird bycatch, it is important to identify any conflicts as well as mutual benefits of bycatch of these other species groups of special interest. For instance, when designing gear to improve the baited hook sink rate to avoid seabird interactions, the gear design needs to consider effects on any change in the depth of various components of the gear, which can affect the catch rate of sea turtles and sharks (Rey and Munoz-Chapuli, 1991; Williams, 1997; Gilman et al. 2006, In Press a).

7. REGIONAL PLAN OF ACTION - SEABIRDS

To comply with the WCPFC Resolution 2005-01 on the *Incidental Catch of Seabirds*, and the Food and Agriculture Organization of the United Nation's *International Plan of Action for Reducing the Incidental Catch of Seabirds in Pelagic Longline Fisheries*, FFA Members (excluding Australia and

New Zealand, which have already conducted assessments and determined that their longline fisheries have problematic seabird interactions and adopted National Plans of Action, and Tokelau, which currently has no longline activity) are encouraged to conduct assessments of their longline fisheries to determine if a seabird bycatch problem exists. National fishery management authorities are encouraged to achieve adequate levels of observer coverage to detect and reliably estimate levels of incidental seabird capture. This includes adequate spatial and temporal coverage of fishing effort, as it is likely that seabird interactions will be highly variable temporally and spatially. It may require several years for assessments to be conducted in individual fisheries because seabird bycatch rates are potentially temporally and spatially highly variable, and because interactions with any threatened populations of seabirds may be particularly rare events. Due to the rarity of seabird capture events even in fisheries with relatively high seabird interaction rates, there is a need for onboard observers dedicated to observing interactions with species groups of special interest, including seabirds, to provide accurate bycatch data. Observers should obtain annual training in standardized methods to count seabird abundance during setting and seabird species identification.

If an assessment of an FFA Member's pelagic longline fishery reveals problematic seabird interactions, then the FFA Member Country is encouraged to adopt and implement a *Pacific Islands Regional Plan of Action for Reducing the Incidental Catch of Seabirds in Pelagic Longline Fisheries*. Appendix I presents a Draft *Pacific Islands Regional Plan of Action – Seabirds* for consideration for adoption by FFA Members in the case where a longline fishery is determined to have problematic seabird interactions. Results of the review of seabird bycatch avoidance methods and initiatives by Regional Fishery Management Organizations and other organizations to manage seabird bycatch in longline fisheries assisted in identifying suitable seabird avoidance measures for the *Pacific Islands Regional Plan of Action – Seabirds*. The selection of suitable seabird avoidance methods considered the operational and economic effects from instituting alternative seabird avoidance methods. FFA Members with pelagic longline fisheries with problematic seabird interactions may decide to develop their own National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries. The benefit of developing a National Plan of Action-Seabirds tailored to their individual fisheries is that solutions to fisheries bycatch problems, including seabird bycatch, may be fishery-specific, as described previously (Gilman et al., 2005).

For pelagic longline fisheries where seabird capture rates and levels are problematic but relatively moderate and are temporally and spatially variable and unpredictable, such that seabird captures are an acute problem, occurring in pulses and not chronically, the Draft *Pacific Islands Regional Plan of Action – Seabirds* recommends the adoption of a prescribed branch line weighting design, which is a seabird mitigation measure that has minimal imposition on industry while providing a reasonable degree of protection for seabirds. For these fisheries, a line weighting design of a minimum of 45 g of weight within 0.5 m of the hook is prescribed to achieve a baited hook sink rate performance standard of 1 m s^{-1} over at least the first 5 m. This is the sink rate of baited hooks in the Hawaii-based longline fleet, which uses Lindgren Pitman monofilament line and spool style gear with a minimum of a 45 g swivel located at 0.5 m from the hook (Brothers and Gilman, 2006).

For pelagic longline fisheries where seabird capture rates and levels are problematic and relatively high, as is expected to occur for longline fisheries operating at grounds south of 30 deg. S latitude, where seabird bycatch is known to be problematic, the *Pacific Islands Regional Plan of Action – Seabirds* recommends that, in addition to complying with the branch line weighting design, vessels in these fisheries be required to employ one of three additional measures of side setting, night setting, or bird-scaring line to further protect baited hooks from seabirds. Experiments have demonstrated that these three seabird avoidance methods can significantly reduce seabird capture rates. Specifications for side setting and night setting are defined in U.S. National Marine Fisheries Service (2005) and are suitable for adoption for the *Pacific Islands Regional Plan of Action - Seabirds*. The CCAMLR or CCSBT tori line design and deployment guidelines are suitable for adoption.

8. ACKNOWLEDGEMENTS

Nigel Brothers, Marine Ecology and Technology Consultant, provided insightful comments on drafts of this report. Emmanuel Schneiter, Tim Lawson and Deirdre Brogan, Secretariat of the Pacific Community, conducted several data queries of the SPC observer database and technical input.

9. REFERENCES

- Bartram P, Kaneko J. 2004. *Catch to Bycatch Ratios: Comparing Hawaii's Pelagic Longline Fisheries with Others*. Prepared for the Pacific Fishery Research Program and Joint Institute for Marine and Atmospheric Research, University of Hawaii, Manoa, Honolulu, Hawaii, USA. 44 pp.
- Barut, N., E. Garvilles. 2005. *Philippines Fishery Report*. National Fisheries Research and Development Institute, Bureau of Fisheries and Aquatic Resources, Philippines. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, Noumea, New Caledonia, 8-19 August 2005.
- BirdLife International. 2003. *FAO's Positive Efforts to Cut Seabird Deaths Undermined by 14 'longline laggards.'* BirdLife International, Cambridge, UK. 3 pp.
- Brothers, N.P. 1991. Albatross mortality and associated bait loss in the Japanese longline fishery in the southern ocean. *Biological Conservation* 55, 255-268.
- Brothers, N.P. 1995. *Catching Fish Not Birds: A Guide to Improving Your Longline Fishing Efficiency*. Australian Longline Version. Australia Parks and Wildlife Service, Hobart, Australia. 32 pp.
- Brothers, N.P., Cooper, J., and Lokkeborg, S. 1999. *The Incidental Catch of Seabirds by Longline Fisheries: Worldwide Review and Technical Guidelines for Mitigation*. FAO Fisheries Circular No. 937. Food and Agriculture Organization of the United Nations, Rome.
- Brothers, N., Chaffey, D., Reid, T. 2000. AFMA Research Fund--Final Report. Performance Assessment and Performance Improvement of Two Underwater Line Setting Devices for Avoidance of Seabird Interactions in Pelagic Longline Fisheries. ARF Project R2000/0469. Australian Fisheries Management Authority and Environment Australia, Canberra.
- Brothers, N., E. Gilman. 2006. *Technical Assistance for Hawaii Pelagic Longline Vessels to Change Deck Design and Fishing Practices to Side Set*. Hawaii Longline Association, U.S. NOAA Fisheries Pacific Islands Fisheries Science Center and Pacific Islands Regional Office, and Western Pacific Regional Fishery Management Council: Honolulu, Hawaii.
- CCAMLR. 2004. *CCAMLR's Work on the Elimination of Seabird Mortality Associated with Fishing*. CCAMLR Secretariat, Hobart, Australia.
- CCAMLR. 2005. *CCAMLR Conservation Measure 25-02. Minimisation of the Incidental Mortality of Seabirds in the Course of Longline Fishing or Longline Fishing Research in the Convention Area*. CCAMLR Secretariat, Hobart, Australia.
- Cherel, Y., Weimerskirch, H. Duhamel, G. 1996. Interactions between longline vessels and seabirds in Kerguelen waters and a method to reduce seabird mortality. *Biological Conservation* 75, 63-70.
- Chinese-Taipei Government. 2005. *Tuna Fisheries Status Report of Chinese Taipei in the Western and Central Pacific Region*. Deep-Sea Fisheries Research and Development Center, Fisheries Administration. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 8-19 August, 2005, Noumea, New Caledonia.
- Commonwealth of Australia. 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*. Australia Department of Agriculture, Fisheries and Forestry, Canberra, Australia. 164 pp.
- Cook Islands Government. 2006. *National Tuna Fishery Report*. WCPFC-SC2-2006. Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August 2006, Manila, Philippines. 5 pp.
- Dai, X., Xu, L., Song, L. 2006. *Observation of Sea Bird Bycatch in the Chinese Longline Fishery in the IATTC Waters*. IATTC Document SAR-7-05e. Prepared for the Inter-American Tropical

- Tuna Commission Working Group to Review Stock Assessments 7th Meeting, 15-19 May 2006. La Jolla, California, USA. 3 pp.
- Environment Australia. 1998. *Threat Abatement Plan for the Incidental Catch (or Bycatch) of Seabirds During Oceanic Longline Fishing Operations*. Canberra, Australia.
- FAO. 1999. *International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries*. United Nations Food and Agriculture Organization: Rome, Italy. 10 pp.
- FAO. 2003. Implementation of the NPOA-Seabirds. Committee on Fisheries Progress Report from 24th Session on Implementation of the International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries. United Nations Food and Agriculture Organization Committee on Fisheries, Rome, 3 pp.
- FAO. 2004. *Technical Consultation on Sea Turtles Conservation and Fisheries, Bangkok, Thailand, 29 November – 2 December 2004. Sea Turtle Conservation Concerns and Fisheries Management Challenges and Options*. Food and Agriculture Organization of the United Nations, Rome. 23 pp.
- Federated States of Micronesia Government. 2006. *National Tuna Fishery Report. Federated States of Micronesia*. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August, 2006, Manila, Philippines.
- Gales, R., Brothers, N., Reid, T. 1998. Seabird mortality in the Japanese tuna longline fishery around Australia, 1988-1995. *Biological Conservation* 86, 37-56.
- Gilman, E. 2001. Integrated management approach to address incidental mortality of seabirds in longline fisheries. *Aquatic Conservation* 11, 391-414.
- Gilman, E. 2002. Guidelines for coastal and marine site-planning and examples of planning and management intervention tools. *Ocean and Coastal Management* 45(6-7), 377-404.
- Gilman, E., Freifeld, H. 2003. Seabird mortality in north Pacific longline fisheries. *Endangered Species Update* 20, 35-46.
- Gilman, E., C. Boggs, and N. Brothers. 2003. Performance assessment of an underwater setting chute to mitigate seabird bycatch in the Hawaii pelagic longline tuna fishery. *Ocean and Coastal Management* 46(11-12), 985-1010.
- Gilman, E., N. Brothers, D. Kobayashi. 2005. Principles and approaches to abate seabird bycatch in longline fisheries. *Fish and Fisheries* 6(1): 35-49.
- Gilman, E., E. Zollett, S. Beverly, H. Nakano, D. Shiode, K. Davis, P. Dalzell, I. Kinan. 2006. Reducing sea turtle bycatch in pelagic longline gear. *Fish and Fisheries* 7(1): 2-23.
- Gilman, E., N. Brothers, G. McPherson, P. Dalzell. In Press a. Review of cetacean interactions with longline gear. *Journal of Cetacean Research and Management*.
- Gilman E., Brothers N., Kobayashi D. 2006 In Press b. Comparison of the efficacy of three seabird bycatch avoidance methods in Hawaii pelagic longline fisheries. *Fisheries Science* 73(1).
- 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*. Micronesian Maritime Authority, Pohnpei, Federated States of Micronesia.
- Hyrenbach, K.D., Forney, K.A., Dayton, P.K. 2000. Marine protected areas and ocean basin management. *Aquatic Conservation: Marine and Freshwater Ecosystems* 10, 437-458.
- Indian Ocean Tuna Commission. 2006. *Resolution 06/04 on Reducing Incidental Bycatch of Seabirds in Longline Fisheries*. IOTC Executive Secretary, Victoria, Seychelles.
- Instituto Espanol de Oceanografia. 2005. *Fisheries Report of EU-Spain for the Year 2004. Research Program on Tuna and Tuna-like Species, Coruna, Spain*. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, Noumea, New Caledonia, 8-19 August 2005. 3 pp.
- Inter-American Tropical Tuna Commission. 2005. *Resolution on Incidental Mortality of Seabirds*. IATTC Resolution C-05-01.
- International Commission for the Conservation of Atlantic Tunas. 2002. *Resolution by ICCAT on Incidental Mortality of Seabirds*. Resolution 02-14. Madrid, Spain. 1 pp.

- IPHC. 1998. *The Pacific Halibut: Biology, Fishery, and Management*. Technical Report No. 40. International Pacific Halibut Commission: Seattle, WA, USA, 68pp.
- IPHC. 2000. *A Feasibility Study that Investigates Options for Monitoring Bycatch of the Short-tailed Albatross in the Pacific Halibut Fishery off Alaska*. Prepared for the U.S. National Marine Fisheries Service. International Pacific Halibut Commission: Seattle, WA, USA. 30pp.
- IUCN. 1996. *Incidental Mortality of Seabirds in Longline Fisheries, Resolution CGR1.69*. Adopted at the First World Conservation Congress, Montreal, Canada, October 14-23, 1996. World Conservation Congress, International Union for the Conservation of Nature (IUCN): Gland, Switzerland.
- IUCN. 2000a. *Pirate Fishing and Seabird Mortality from Longlining in the Southern Ocean and Adjacent Waters, Resolution CGR2.66*. Adopted at the Second World Conservation Congress, Amman, Jordan, 4-11 October 2000. World Conservation Congress, International Union for the Conservation of Nature (IUCN): Gland, Switzerland.
- IUCN. 2000b. *Southern Hemisphere Albatross and Petrel Conservation, Recommendation CGR2.75*. Adopted at the Second World Conservation Congress, Amman, Jordan, 4-11 October 2000. World Conservation Congress, International Union for the Conservation of Nature (IUCN): Gland, Switzerland.
- Jahncke, J., E. Goya, and A. Guillen. 2001. Seabird by-catch in small-scale longline fisheries in Northern Peru. *Waterbirds* 24(1): 137-141.
- Kelleher, G. 1999. Guidelines for Marine Protected Areas. IUCN World Commission on Protected Areas: Gland, Switzerland. 107 pp.
- Kumoru, L., L. Koren. 2006. *Tuna Fisheries Report – Papua New Guinea*. Papua New Guinea National Fisheries Authority, Port Moresby, Papua New Guinea. WCPFC-SC2-2006. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August 2006, Manila, Philippines. 25 pp.
- Lawson, T. 2006. Scientific Aspects of Observer Programmes for Tuna Fisheries in the Western and Central Pacific Ocean. Secretariat of the Pacific Community, Oceanic Fisheries Programme. WCPFC-SC2-2006/ST WP-1. Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August 2006, Manila, Philippines. 28 pp.
- Leslie, P.H., Davis, D. 1939. An attempt to determine the absolute number of rats on a given area. *Journal of Animal Ecology* 8, 94-113.
- MRAG Americas. 2003. *Review of Data Standards for the Western and Central Pacific Region*. Interim Advice to the Preparatory Conference for the Western and Central Pacific Fisheries Commission (WCPFC). Prepared for the Preparatory Conference for the Western and Central Pacific Fisheries Commission. Tampa, Florida, USA. 51 pp.
- Molony, B. 2005. *Estimates of the Mortality of Non-Target Species with an Initial Focus on Seabirds, Turtles and Sharks*. Prepared for the 1st Meeting of the Scientific Committee of the Western and Central Pacific Fisheries Commission, Noumea, New Caledonia, 8-19 August 2005. WCPFC-SC1, EB WP-1. Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia. 85 pp.
- Moon, D-Y., K. Soon-Song, J-R. Koh. 2005. *Korean Tuna Fisheries in the Western and Central Pacific Ocean*. National Fisheries Research and Development Institute, Busan, Korea. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, Noumea, New Caledonia, 8-19 August 2005.
- Muller, B. 2006. *Marshall Islands Tuna Fisheries*. Marshall Islands Marine Resources Authority, Republic of the Marshall Islands. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August, 2006, Manila, Philippines.
- Nauru Fisheries and Marine Resources Authority. 2006. *National Tuna Fishery Report – Nauru*. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August 2006, Manila, Philippines.
- New Caledonia Government. 2006. *Annual Report – Part 1. New Caledonia*. Government of New Caledonia, Noumea, New Caledonia. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August 2006, Manila, Philippines. 6 pp.

- New Zealand Department of Conservation and Ministry of Fisheries. 2000. Seabird interactions with fisheries in the New Zealand Exclusive Economic Zone: A review and National Plan of Action – Draft. Wellington, New Zealand. 106 pp.
- Ponsonnet, C. 2006. *Tuna Fisheries in French Polynesia in 2005*. Fisheries Department, Tahiti, French Polynesia. WCPFC-SC2-2006. Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August 2006, Manila, Philippines. 11 pp.
- Rey, J.C., Munoz-Chapuli, R. 1991. Relation between hook depth and fish efficiency in surface longline gear. *Fishery Bulletin* 89(4): 729-732.
- Ricker, W. 1958. *Handbook of Computations for Biological Statistics of Fish Populations*. Bulletin No. 119. Fisheries Research Board of Canada, Ottawa, Canada.
- Sarmiento, C. 2004. *Assessing Market Transfer Effects Generated by Court Rulings in the Hawai'i Longline Fishery*. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii, USA.
- Seber, G. 1973. *The Estimation of Animal Abundance and Related Parameters*. Hafner Press, New York.
- Secretariat of the Pacific Community. 2003. *Capacity of Pacific Island Countries and Territories to Meet the Likely Data Requirements of the Western and Central Pacific Fisheries Commission*. Prepared for Working Group II of the Fifth Session of the WCPFC Preparatory Conference, 29 September – 3 October 2003, Rarotonga, Cook Islands Secretariat of the Pacific Community, Oceanic Fisheries Programme, Noumea, New Caledonia. 42 pp.
- Sisior, K. 2006. *Tuna Fisheries in the Waters of the Republic of Palau*. Bureau of marine Resource, Oceanic Fisheries Management Section, Palau. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August 2006, Manila, Philippines. 10 pp.
- Small, C. 2005. *Regional Fisheries Management Organisations: Their Duties and Performance in Reducing Bycatch of Albatrosses and other Species*. BirdLife International, Cambridge, UK. 101 pp.
- Small, C. 2006. Distribution of Albatrosses and Petrels in the WCPFC Convention Area and Overlap with WCPFC Longline Fishing Effort. BirdLife International, Cambridge, UK. 17 pp.
- Tafatu, J. 2006. *Country Fisheries Report – Niue*. Department of Agriculture, Forestry and Fisheries, Niue. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August, 2006, Manila, Philippines.
- Thiel, H., Gilman E. 2001. Protection for seabirds on the high seas. In Proceedings: Marine Protected Areas on the High Seas, Scientific Requirements and Legal Aspects. Expert Workshop, International Academy of Nature Conservation, Isle of Vilm, Germany, 27 February to 4 March 2001, Thiel, H. (ed). Federal Agency of Nature Conservation: Hamburg, Germany.
- Tonga Government. 2006. *National Tuna Fishery Report, Tonga*. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August 2006, Manila, Philippines.
- Tupau, F. 2006. *Tuvalu National Tuna Fisheries Report*. Fisheries Department, Ministry of Natural Resources, Funafuti, Tuvalu. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August 2006, Manila, Philippines.
- Uosaki, K., H. Okamoto, Y. Nishikawa. 2005. *National Tuna Fisheries Report of Japan as of 2005*. National Research Institute of Far Seas Fisheries, Shimizu, Japan. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, Noumea, New Caledonia, 8-19 August 2005.
- U.S. National Marine Fisheries Service. 2001. *Final United States National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration: Silver Spring, MD, USA.
- U.S. National Marine Fisheries Service. 2005. Fisheries Off West Coast States and in the Western Pacific; Pelagic Fisheries; Additional Measures to Reduce the Incidental Catch of Seabirds in the Hawaii Pelagic Longline Fishery. Federal Register 70(242): 75075-75080.

- Vanuatu Government. 2006. *National Tuna Fishery Report, Vanuatu*. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August 2006, Manila, Philippines.
- Watling, D. 2002. Interactions Between Seabirds and Pacific Island's Fisheries, Particularly the Tuna Fisheries. Prepared for the Secretariat of the Pacific Community, Noumea, New Caledonia. 37 pp.
- Waugh, S. 2006. Towards a Seabird Mortality Risk Assessment: Distribution of Seabirds in the WCPFC Convention Area and Potential Overlap with Fisheries. Prepared for the Scientific Committee Second Regular Session, 7-18 August 2006, Manila, Philippines. New Zealand Ministry of Fisheries, Wellington, New Zealand. 10 pp.
- Western and Central Pacific Fisheries Commission. 2005. Resolution on the Incidental Catch of Seabirds. Resolution 2005-01. Adopted at the Second Session of the Western and Central Pacific Fisheries Commission, Pohnpei, FSM, 12-16 December 2005. 1 pp.
- Western and Central Pacific Fisheries Commission. 2006. *Information on Seabird Mitigation Measures of other RFMOs*. WCPFC-SC2-2006/GN IP-3. Western and Central Pacific Fisheries Commission, Pohnpei, Federated States of Micronesia. 11 pp.
- Williams, P.G. 1997. *Shark and Related Species Catch in Tuna Fisheries of the Tropical Western and Central Pacific Ocean*. Prepared for the Food and Agricultural Organisation of the United Nations for the 23-27 April 1998 meeting of the Technical Working Group on Sharks. Noumea, New Caledonia: South Pacific Commission, 22 pp.
- Williams, P., C. Reid. 2006. Overview of Tuna Fisheries in the Western and Central Pacific Ocean, Including Economic Conditions – 2005. Prepared for the Western and Central Pacific Fisheries Commission Scientific Committee Second Regular Session, 7-18 August 2006, Manila, Philippines. Secretariat of the Pacific Community and Pacific Islands Forum Fisheries Agency, Noumea, New Caledonia, and Honiara, Solomon Islands. 42 pp.

Appendix 1

Draft Pacific Islands Regional Plan of Action for Reducing the Incidental Catch of Seabirds in Pelagic Longline Fisheries

1. Introduction and Purpose

The United Nations Food and Agriculture Organization's *International Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries* (International Plan of Action – Seabirds) encourages States to voluntarily implement the plan starting by conducting an assessment of longline fisheries to determine if a seabird bycatch problem exists. If a problem exists, States are then encouraged to develop a National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (FAO, 1999). The International Plan of Action – Seabirds provides guidance for the contents of national plans, stating that they may contain provisions for assessments to determine the extent and nature of a State's incidental mortality of seabirds in longline fisheries, prescribe appropriate longline fishery-specific mitigation measures, contain plans for research and development, prescribe outreach and education activities, and provide guidance for data collection programs. The Western and Central Pacific Fisheries Commission (WCPFC) adopted a resolution on the *Incidental Catch of Seabirds* (Resolution 2005-01) in December 2005. This resolution calls for Members, Cooperating Non-Members, and Participating Territories to implement the FAO International Plan of Action – Seabirds, report to the WCPFC on their implementation of the FAO plan, provide the WCPFC with available information on seabird interactions to enable an estimate of total seabird mortality in fisheries to which the Western and Central Pacific Fisheries Convention applies, and the WCPFC will consider measures to reduce seabird bycatch at its 2006 annual meeting (Western and Central Pacific Fisheries Commission, 2005).

There is a dearth of information on seabird interactions in domestic and foreign licensed longline fisheries based out of Pacific Islands Forum Fisheries Agency (FFA) Member Countries and territory and foreign licensed distant water longline fisheries operating in the EEZs adjacent to FFA Member Countries and territory in the tropical and subtropical Pacific, excluding Australia and New Zealand (Watling, 2002; Gilman, 2006). Therefore, as a first step, FFA Members are encouraged to conduct assessments of their longline fisheries to determine if seabird bycatch problems exist. FFA Members who determine that their pelagic longline fisheries have problematic seabird bycatch are then encouraged to adopt and implement this *Pacific Islands Regional Plan of Action for Reducing the Incidental Catch of Seabirds in Pelagic Longline Fisheries* (*Pacific Islands Regional Plan of Action - Seabirds*), which provides two tiers of prescribed seabird avoidance methods depending on the scale and patterns of seabird interactions.

Prescribed seabird avoidance methods were selected based on an assessment of the operational and economic effects from their employment. FFA Members with pelagic longline fisheries with problematic seabird interactions may decide to develop their own National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries. The benefit of developing a National Plan of Action-Seabirds tailored to their individual fisheries is that solutions to fisheries bycatch problems, including seabird bycatch, may be fishery-specific, as described previously (Gilman et al., 2005).

2. Assessing Seabird Bycatch Levels and Rates in Individual Longline Fisheries and Observer Defined Duties

Through consultation with SPC, FFA and WCPFC, national fishery management authorities are encouraged to achieve adequate levels of observer coverage to detect and reliably estimate levels of incidental seabird capture. This includes adequate spatial and temporal coverage of fishing effort, as it is likely that seabird interactions will be highly variable by area and season. It may require

several years for assessments to be conducted in individual fisheries because seabird bycatch rates are potentially temporally and spatially highly variable, and because interactions with any threatened populations of seabirds may be particularly rare events. Due to the rarity of seabird capture events even in fisheries with relatively high seabird interaction rates, onboard observers should be dedicated to observing seabird interactions, as observers need to watch the hauling of every branch line being retrieved from a position at the bulwark at the hauling station as their primary duty in order to obtain an accurate count of seabird captures. Observers should obtain annual training in standardized methods to count seabird abundance during setting and seabird species identification.

In general, where information is available to determine the population level effects from seabird interactions in an individual fishery, a fishery has a seabird bycatch problem if mortality levels are contributing to or likely to contribute in the future to a population decline, or otherwise if bycatch levels and rates could be substantially reduced through the employment of seabird avoidance methods. Although this *Pacific Islands Regional Plan of Action - Seabirds* does not include quantitative criteria for determining what constitutes a seabird bycatch problem for individual longline fisheries, national fishery management authorities, in consultation with SPC, FFA and WCPFC, should make a determination that is consistent with applicable national law and international guidance.

3. Seabird Avoidance Measures

For pelagic longline fisheries where seabird capture rates and levels are problematic but relatively moderate and are temporally and spatially variable and unpredictable, such that seabird captures are an acute problem, occurring in pulses and not chronically, the Draft *Pacific Islands Regional Plan of Action – Seabirds* recommends the adoption of a prescribed branch line weighting design, which is a seabird mitigation measure that has minimal imposition on industry while providing a reasonable degree of protection for seabirds. For these fisheries, a line weighting design of a minimum of 45 g of weight within 0.5 m of the hook is prescribed to achieve a baited hook sink rate performance standard of 1 m s^{-1} over at least the first 5 m.⁵

For pelagic longline fisheries where seabird capture rates and levels are problematic and relatively high, as is expected to occur for longline fisheries operating at grounds south of 30 deg. S latitude, where seabird bycatch is known to be problematic, the *Pacific Islands Regional Plan of Action – Seabirds* recommends that, in addition to complying with the branch line weighting design, vessels in these fisheries be required to employ one of three additional measures of side setting, night setting, or bird-scaring line to further protect baited hooks from seabirds. Experiments have demonstrated that these three seabird avoidance methods can significantly reduce seabird capture rates. Specifications for side setting and night setting are defined in U.S. National Marine Fisheries Service (2005) and are suitable for adoption for the *Pacific Islands Regional Plan of Action - Seabirds*. The CCAMLR or CCSBT tori line design and deployment guidelines are suitable for adoption.

4. Timeline for Implementation

FFA Members are encouraged to achieve adequate levels of observer coverage as soon as possible that enable adequate spatial and temporal coverage of fishing activities to detect and reliably estimate levels of incidental seabird capture.

⁵ Based on the sink rate over the first 5 m of the baited hooks used by the Hawaii-based longline tuna fleet using Lindgren Pitman monofilament line and spool 'American-style' longline gear with a minimum of a 45 g swivel located within 0.5 m of the hook (Brothers and Gilman, 2006). There are crew safety issues with branch line weighting, but there are methods to manage this safety risk.

Upon determining that a pelagic longline fishery has problematic seabird interactions (is causing population-level effects, is capturing individuals of a threatened seabird population, or has seabird bycatch levels and rates that could be substantially reduced through the employment of seabird avoidance methods), the FFA Member is encouraged to immediately adopt and implement this Pacific Islands Regional Plan of Action – Seabirds, or otherwise adopt and implement their own National Plan of Action – Seabirds tailored to their individual fisheries.

5. Streamer Line Design Specifications

The following guidelines for the design of a bird-scaring streamer line, adapted from CCAMLR (2005), are to be complied with for vessels that select this seabird avoidance method:

- a. Vessels are encouraged to optimize the aerial extent and ensure that it protects baited hooks as far astern of the vessel as possible, even in crosswinds and especially in conditions of strong wind.
- b. The streamer line shall be attached to the vessel such that it is suspended from a point a minimum of 7 m above the water at the stern on the windward side of the point where baited hooks enters the water (Fig. 1).
- c. The streamer line shall be a minimum of 150 m in length, providing 80 – 100 m of aerial coverage). If additional tension is required to maintain the aerial portion of the bird line such that in crosswinds the aerial extent of the streamer line is over the hookline, then increase drag by increasing the length of the line that is dragged in the water behind the aerial portion of the bird line. Towing an object at the seaward end of the bird line is not a recommended method to increase line tension because experience reveals that this tends to result in the bird line tangling with the gear, which can result in breaking the main line or bird line.
- d. Branched streamers, each comprising two strands of a minimum of 3 mm diameter brightly colored plastic tubing (plastic tubing should be of a type that is manufactured to be protected from ultraviolet radiation) or cord, shall be attached no more than 5 m apart. The first streamer line is attached 5 m astern and every 5 m thereafter along the aerial extent of the line. Streamer length shall range between minimums of 6.5 m from the stern to 1 m for the seaward end. When a streamer line is fully deployed, the branched streamers should reach the sea surface in the absence of wind and swell. Swivels or a similar device should be placed in the streamer line in such a way as to prevent streamers being twisted around the streamer line. Each branched streamer may also have a swivel or other device at its attachment point to the streamer line to prevent fouling of individual streamers.
- e. Vessels are encouraged to deploy a second streamer line such that two streamer lines are towed from the point of attachment on each side of the location where baited hooks are entering the water. The leeward streamer line should be of similar specifications (in order to avoid entanglement the leeward streamer line may need to be shorter) and deployed from the leeward side of the hookline.

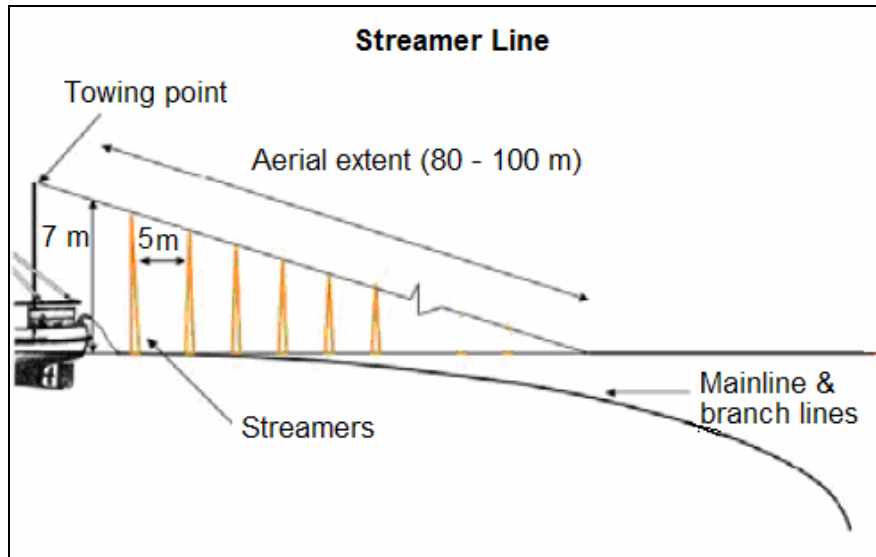


Fig. 1. Schematic of streamer line design (adapted from CCAMLR, 2005).

6. Side Setting Specifications

Side setting means setting longline gear from the side of the vessel rather than the conventional position at the stern (Gilman et al., 2005; Yokota and Kiyota, 2006). Crew set baited hooks close to the side of the vessel hull where seabirds, such as albatrosses, don't pursue them. Ideally, by the time the stern passes, the hook has sunk beyond the reach of seabirds. Vessels opting to side set will (adapted from U.S. National Marine Fisheries Service (2005)):

- a. Set all gear from a position on the port or starboard side as far forward as possible but a minimum of 2 m from the stern corner (Fig. 2). Side setting from the port side is more convenient than from the starboard side if hauling is conducted from the starboard side. This is because a fixed position main line shooter will not interfere with line hauling at the conventional starboard position when port side setting, it is a more natural throwing motion for right-handed crew to set from the port side, and main line shooters have motors on their left side, making it more convenient to clip branch lines to the main line when port side setting. A vessel's layout may make it impossible to set from the port side, or it may be possible to set further forward from the starboard side. Setting from the starboard side can reduce birds' ability to take advantage of wind direction to access baited hooks. When setting from the starboard side, if possible, use a main line shooter motor and mounting plate that accommodate right side mounting.
- b. Throw baited hooks as far forward and as close to the hull as possible.
- c. Clip branch lines to the mainline the moment that the line shooter passes the baited hook. This minimizes tension in the branch line, and keeps the baited hook from being pulled towards the surface where birds can reach it.

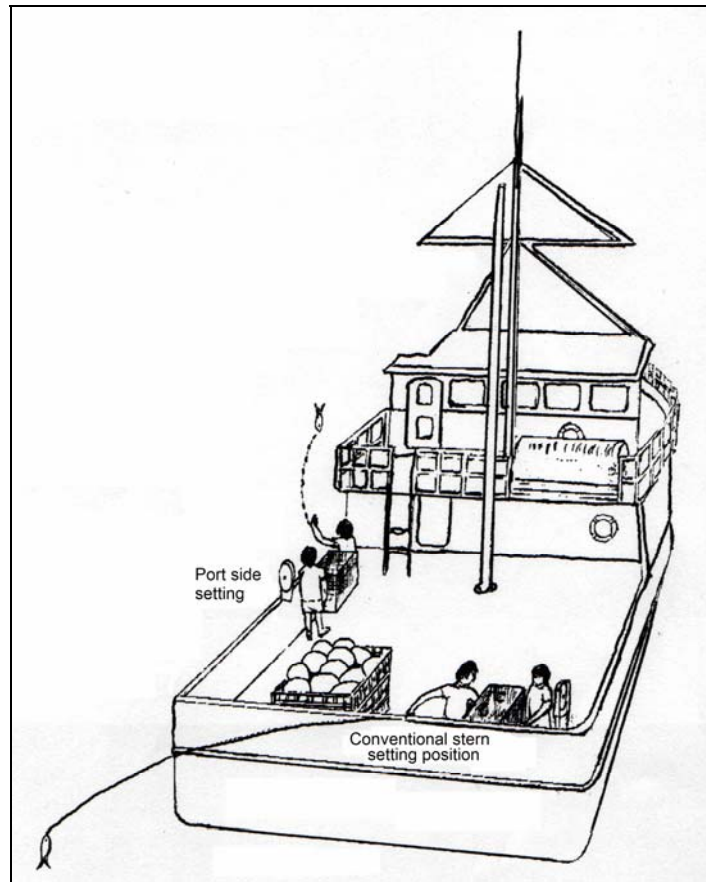


Fig. 2. Conventional stern setting position and port side setting position (Gilman et al., In Press).

8. Night Setting Specifications

Vessels opting to night set will begin the deployment of all gear at least 1 hour after local sunset and complete the deployment no later than local sunrise, using only the minimum vessel lights to conform with navigation rules and best safety practices (adapted from U.S. National Marine Fisheries Service (2005)). This method of bait protection, when combined with adequate line weighting and another bait protection method such as side setting, can be the only solution to prevent high seabird mortalities at areas where proficient diving species of seabirds are present.

9. References

- Brothers, N., E. Gilman. 2006. *Technical Assistance for Hawaii Pelagic Longline Vessels to Change Deck Design and Fishing Practices to Side Set*. Hawaii Longline Association, U.S. NOAA Fisheries Pacific Islands Fisheries Science Center and Pacific Islands Regional Office, and Western Pacific Regional Fishery Management Council: Honolulu, Hawaii.
- CCAMLR. 2005. CCAMLR Conservation Measure 25-02. Minimisation of the Incidental Mortality of Seabirds in the Course of Longline Fishing or Longline Fishing Research in the Convention Area. CCAMLR Secretariat, Hobart, Australia.
- FAO. 1999. *International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries*. United Nations Food and Agriculture Organization: Rome, Italy. 10 pp.

- Gilman E., Brothers N., Kobayashi D. In Press. Comparison of the efficacy of three seabird bycatch avoidance methods in Hawaii pelagic longline fisheries. *Fisheries Science* 73(1).
- Gilman, E.L. 2006. *Incidental Capture of Seabirds in Pelagic Longline Fisheries of the Tropical and Subtropical Pacific Islands Region and Pacific Islands Regional Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries*. Prepared for the Pacific Islands Forum Fisheries Agency, Honiara, Solomon Islands.
- Gilman, E., N. Brothers, D. Kobayashi. 2005. Principles and approaches to abate seabird bycatch in longline fisheries. *Fish and Fisheries* 6(1): 35-49.
- Yokota, K., M. Kiyota. 2006. *Preliminary Report of Side-Setting Experiments in a Large Sized Longline Vessel*. National Research Institute of Far Seas Fisheries, Shimizu, Japan. Prepared for the Scientific Committee of the Western and Central Pacific Fisheries Commission, 7-18 August, 2006, Manila, Philippines.
- U.S. National Marine Fisheries Service. 2005. Fisheries Off West Coast States and in the Western Pacific; Pelagic Fisheries; Additional Measures to Reduce the Incidental Catch of Seabirds in the Hawaii Pelagic Longline Fishery. *Federal Register* 70(242): 75075-75080.
- Watling, D. 2002. Interactions Between Seabirds and Pacific Island's Fisheries, Particularly the Tuna Fisheries. Prepared for the Secretariat of the Pacific Community, Noumea, New Caledonia. 37 pp.
- Western and Central Pacific Fisheries Commission. 2005. Resolution on the Incidental Catch of Seabirds. Resolution 2005-01. Adopted at the Second Session of the Western and Central Pacific Fisheries Commission, Pohnpei, FSM, 12-16 December 2005. 1 pp.