

Managing pelagic longline-albatross interactions in the North Pacific Ocean

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Abstract

The short-tailed (*Phoebastria albatrus*), black-footed (*P. nigripes*) and Laysan albatrosses (*P. immutabilis*), all native to the North Pacific, interact with demersal and pelagic longline vessels and may on occasion be caught by a baited hook and drown. This problem has been studied in detail for 105-115 pelagic longline vessels home-ported in Hawaii, which take between 1,000-2,000 each of both black-footed and Laysan albatrosses each year. No takes of short-tailed albatrosses have been reported for the Hawaii longline fishery, but between 1993 and 1997, a total of five birds have been incidentally caught in the Alaska longline fisheries. The black-footed and Laysan albatrosses are most vulnerable to longline fishing for broadbill swordfish (*Xiphias gladius*), where longlines are set near the surface providing ample opportunity for albatrosses to intercept baited hooks. Studies of the rarer black-footed albatross population revealed fishery induced mortality to be a chronic rather than catastrophic source of mortality. Some simple mitigation methods implemented in the fishery should reduce the incidental catch of albatross by an order of magnitude and eventually lead to negligible take levels. However, the Hawaii-based longline vessels targeting swordfish represents only a small fraction of pelagic longline effort in the North Pacific and albatrosses will continue to be taken by Japanese, Taiwanese and Korean longliners operating in the same vicinity. These Asian vessels fish primarily for tuna (*Thunnus* spp.) and are likely to have much lower albatross take rates than the Hawaii-based fleet, but collectively these 3,000+ vessels still represent a significant threat to North Pacific albatrosses. Although several multilateral fishery bodies and agreements identify cost-effective methods to significantly reduce the incidental catch of seabirds in longline fisheries, very few international or national fishery management organizations require longline fishermen to employ these mitigation measures. There is a need to strengthen international efforts to reduce seabird mortality on longlines, and effective monitoring of albatross populations to gauge the success of mitigation measures.

1.0 Introduction

In this paper, we have prepared maps showing the crude distribution of three North Pacific albatross species and pelagic longline fishing activity, in order to understand where interactions could occur between these seabirds and various longline fleets in the North Pacific Ocean. We also describe the pelagic longline fishing techniques used by different fishing nations, and review the actions by several international agencies and fishery bodies to reduce seabird mortality in the North and Central Pacific longline fisheries. Lastly, we review the international agreements and initiatives that can or could address seabird mortality in North and Central Pacific longline fisheries.

2.0 At-sea distributions and foraging behaviors of the North Pacific albatrosses

Maps showing the breeding locations, plus crude approximations of the range and regions most frequented by the three North Pacific albatross species (Figure 1) were generated using information gathered from several studies (Rice and Kenyon 1962, Sanger 1972, Robbins and Rice 1974, Sanger 1974, Hasegawa and DeGange 1982, McDermond and Morgan 1993, Sherburne 1993, Anderson and Fernandez 1998). Our objective was to show the regions where the species were known to converge and then to compare these findings with the distribution of pelagic longline fishing activity.

To date, only Anderson and Fernandez (1998) have completed satellite telemetry studies of breeding Laysan and black-footed albatrosses. No known telemetry studies have been completed for short-tailed albatrosses. Without the aid of telemetry studies, information on albatross distribution can be estimated from a variety of sources including: 1) sighting records; 2) fishery observer programs; 3) breeding sites; 4) at-sea behavior and feeding ecology; and 5) empirically from the location of oceanographic fronts in the North Pacific. A large volume of literature has been published on the population biology of Laysan and black-footed albatrosses, however, only recent work primarily by H. Hasegawa (Toho University) supplies population information for the short-tailed albatross.

The short-tailed, black-footed and Laysan albatrosses range over the entire North Pacific Ocean, however, there are regions where albatrosses are more commonly observed (Figure 1). These regions are associated with breeding colonies and highly productive waters of the Bering Sea and Gulf of Alaska, as well as the waters in the region of the North Pacific Transition Zone (NPTZ) and along the west coast of North America. The NPTZ (Figure 2) is a broad, weak, eastward flowing surface current composed of a series of fronts situated between the Subtropical Gyre to the south and the Sub arctic Gyre to the north (Roden 1980).

Differences in distribution at sea for the three North Pacific albatross species might be explained, in part, by variations in foraging behaviors and preferred prey. Even though there are biases associated with sighting records, such that the majority of sightings are from land-based or fishery derived sources, it is reasonable to assume that the seabirds are migrating to regions of high productivity to forage regardless of their preferred food. Unfortunately, these same areas of high productivity also attract longline fishing operations (Seki *et al.* 1999).

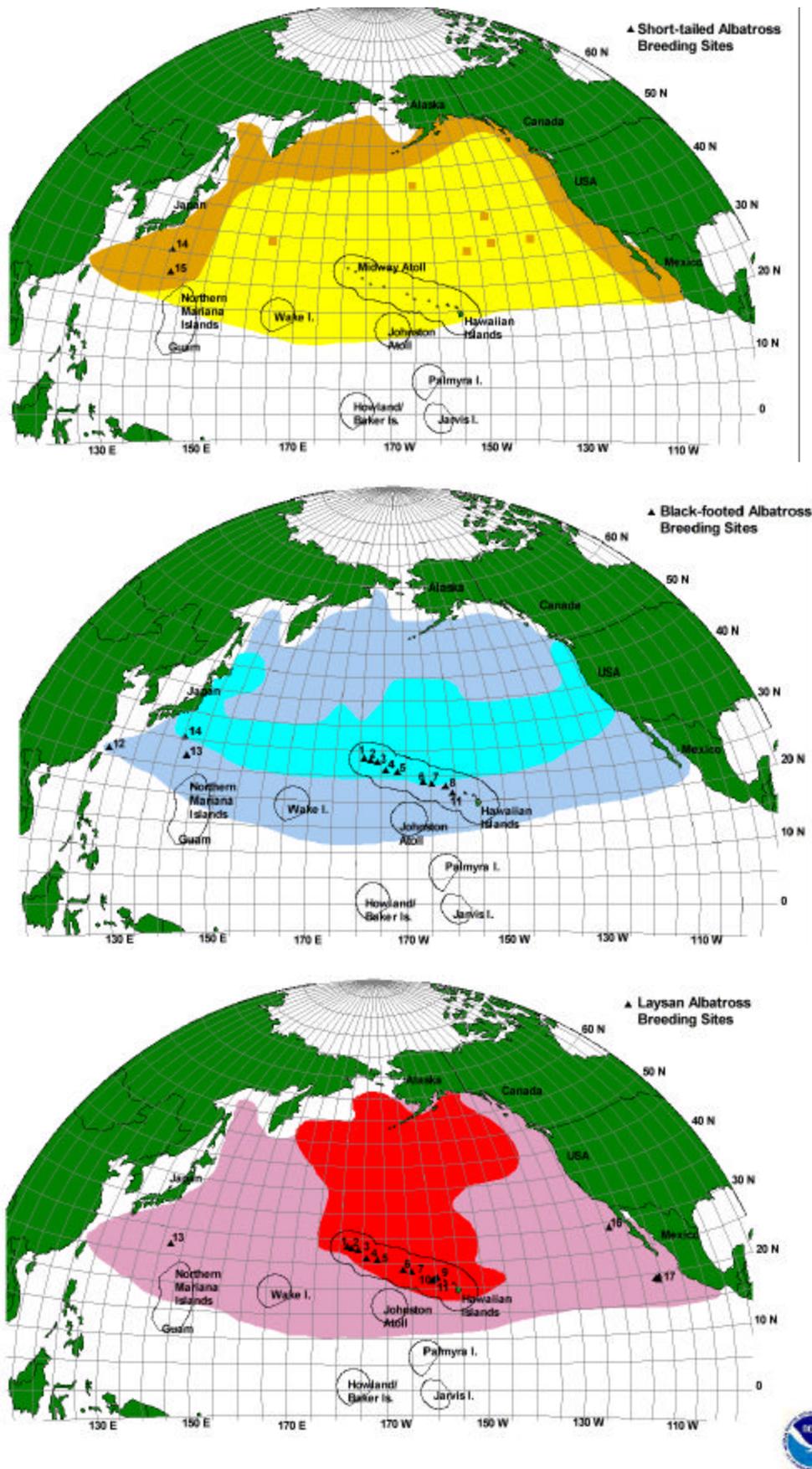


Figure 1.

Figure 1. Breeding sites plus crude approximations of the range and regions most frequented by short-tailed, black-footed and Laysan albatrosses in the North and Central Pacific. The entire North Pacific Ocean is the range for all three species, and darker areas indicate regions where sightings have been most prevalent. Short-tailed albatrosses breed only in the Western Pacific and are known to visit the NWHI with one or two birds routinely visiting Midway Atoll (top figure). The majority of short-tailed albatross sightings occur along the coastlines of Asia, Japan, Russia, the Aleutian Islands, the Gulf of Alaska and the west coast of North America. A few sightings recorded at sea occur in the NPTZ. Black-footed albatross breed on the Northwestern Hawaiian Islands (NWHI) and in the Western Pacific (center figure). The majority of black-footed sightings at sea occur in the NPTZ and along the west coast of North America and the east coast of Japan. Black-footed albatrosses are known to forage in the Bering Sea and the Gulf of Alaska, but the results of Anderson and Fernandez (1998) satellite tagging study suggests that this species prefer to forage off the west coast of North America while the Laysan albatross migrate north to Alaska. The Laysan albatross also breed on the NWHI and Bonin Island in the Western Pacific, however, the species has established two colonies in the Eastern Pacific on islands off of the Mexican coast (bottom figure). Breeding sites: (1) Kure Atoll; (2) Midway Atoll; (3) Pearl and Hermes Reef; (4) Lisianski Island; (5) Laysan Island; (6) French Frigate Shoals; (7) Necker Island; (8) Nihoa Island; (9) Kauai Island; (10) Niihau Island; (11) Kaula Island; (12) Senkaku Islands (Kita-Kojima); (13) Bonin Island (Chichijima); (14) Izu Island (Torishima); (15) Minami-Kojima Island; (16) Guadelupe Island; (17) Mexican Island.

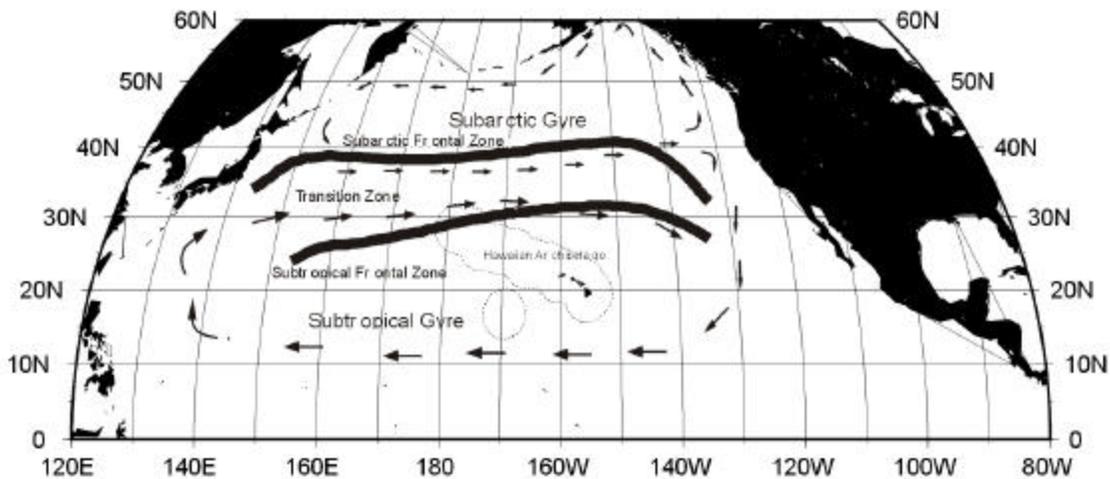


Figure 2. The North Pacific transition zone (NPTZ) is the region between the subarctic and subtropical frontal zones. Dashed lines (---) show the U.S. Exclusive Economic Zones (EEZ) around the Hawaiian Archipelago and Johnston Atoll (figure was adapted from Roden 1991 by D. Foley of Hawaii Coastwatch).

3.0 Pelagic longline fisheries of the North Pacific

Seabirds are vulnerable in the North Pacific to demersal longline fishing off the coast of Alaska and Bering Sea, and the pelagic longline fisheries further south in the North and Central Pacific, especially between 20° and 40° N. latitude (Figures 3 and 4). Pelagic longline fishing in the Pacific went through a period of great expansion in the latter half of the 20th Century, initially from Japan as it rebuilt its economy after WW II, and then later by Taiwan and Korea¹. The total Japanese fleet had peaked by the mid-1960s, and was comprised of coastal, offshore and distant water vessels. The Taiwanese longline fleet peaked in the late 1980s, and like the Japanese fleet has distant water and offshore components. The Korean fleet is much smaller, with the fleet size peaking in the mid-1970s. Other Asian fleets that have contributed to the overall increase in pelagic longline fishing in the North Pacific are the Chinese, Philippine and Indonesian, while the revitalization and expansion of the Hawaii longline fishery also added further to the total number of Pacific longline vessels and volume of hooks deployed.

On average about 570 million longline hooks are deployed each year in the Pacific² but only a fraction of these represent a threat to North Pacific albatrosses. Albatross bycatch appears to be a function of the density of birds in the vicinity of the fishing vessels and the type of longline fishing, particularly where shallow sets are made, with slow sink rates of baited hooks deployed at the same time birds are feeding most actively. This combination of factors tends to be a characteristic of swordfish-directed fishing rather than longline fishing focused on tuna (Table 1). For this reason, our paper focuses on swordfish pelagic longline fisheries in the North Pacific and attempts to assess their threat potential to albatrosses in the absence of any hard numbers relating to take levels other than for the Hawaii pelagic longline fishery.

Table 1. Incidental catches of albatrosses in the Hawaii pelagic longline fishery by set type based on NMFS observer records from 1994-1998.

Targeted Fish During Set	Observed Bird Catch	Number of Observed Sets	Bird Catch/Set
Swordfish	370	488	0.758
Mixed (Swordfish and Tuna)	472	946	0.499
Tuna	16	1,250	0.013

¹Information on Asian longline fleet sizes on an annual basis was compiled from Lawson (1999a)

²Data on number of longline hooks deployed in the Pacific Ocean from the public domain database on Secretariat of the Pacific Community's Oceanic Fishery Program web-page.

3.1 Hawaii and other U.S. longline swordfish catch

The revitalization of the Hawaii longline fishery was due to the development of local and export markets for fresh tuna to the mainland and Japan, and the discovery of swordfish stocks around Hawaii (Boggs and Ito 1997, Dalzell 1997). Participation in the Hawaii longline fishery increased from 37 vessels in 1987, to 75 and then doubled again to 156 vessels in 1991. Further entry to the fishery was halted by a moratorium in 1991, later formalized as a limited entry program with a cap of 164 vessels. Landings increased rapidly and by 1991, had reached 8,165 mt, of which 3,992 mt was swordfish. The newer vessels in the fishery were characterized by a greater reliance on sophisticated electronic gear for navigation and finding fish. These newer vessels also tended to be larger in size. The majority of vessels operating in the Hawaii longline fishery range between 56 to 74 ft (17-22 m) in length, with the larger vessels fishing to the northeast of the Hawaiian Islands and targeting a mixture of swordfish (*Xiphias gladius*) and bigeye tuna (*Thunnus obesus*). The revitalized fleet also adopted more modern longline gear, using continuous nylon monofilament main lines stored on spools, with snap on monofilament gear. Monofilament longline gear is more flexible in configuration and can be used to target various depths more easily than traditional tar-coated rope longlines. Both daytime and nighttime fishing are practiced using the same monofilament system. Depth of a longline set irrespective of mainline material is principally a function of the length of mainline between adjacent floats and the number of hooks between floats (HBF). In targeting deep dwelling bigeye tuna, 12-25 HBF are deployed with lots of sag to reach as deep as 400 m. Only four to six HBF are deployed when targeting swordfish and the line is kept relatively taut so that it stays within the first 30-90 m of the water column. Nighttime fishing employs luminescent light sticks to attract swordfish and their prey to the baited hooks. Longlines deployed for swordfish are baited with large squid (*Illex* spp). Tuna-targeting longlines tend to be set during the day and use saury (*Cololabis saira*) as bait. Saury bait tends to sink faster than squid, which often has pockets of air trapped within the mantle. Currently, the Hawaii fishery represents about 2.7% of the longline hooks deployed in the entire Pacific each year.

The Hawaii-based fishery is monitored through a number of different instruments. Among the federal permit obligations is a mandatory National Marine Fisheries Service (NMFS) log book detailing the catch and characteristics of each longline set. NMFS also deploys observers, primarily to record protected species interactions on the Hawaii longline vessels, with coverage ranging between four and five percent annually. The observer data on albatross catch is used to generate fleet wide estimates of the annual take (Table 2). U.S. longline vessels also must carry a vessel monitoring system (VMS) so that closed areas around the Hawaii islands, and more latterly on the high seas are monitored. Lastly about 30% of the longline fleet are boarded for inspection by the U.S. Coast Guard (USCG) each year as part of routine fishery patrols.

A smaller fleet of U.S. longliners also fishes for swordfish from ports in southern California, with fleet size ranging from 15-30 m vessels. The California fleet is augmented annually by Hawaii-based vessels that fish from California during mid-winter, and fish progressively to the west, until it becomes

more practical to be based in Hawaii. Hawaii longline vessels operating from California complete log books, but do not carry observers.

Table 2. Estimated annual total incidental catches of albatrosses in the Hawaii longline fishery based on catches recorded by NMFS observers on monitored fishing trips. Values in parentheses are 95% confidence bounds.

Year	Black-footed Albatross			Laysan Albatross		
	Observed Catch	Estimated Total Catch	(95% CI)	Observed Catch	Estimated Total Catch	(95% CI)
1994	126	1,994	(1,508-2,578)	73	1,828	(933-2,984)
1995	105	1,979	(1,439-2,497)	107	1,457	(767-2,308)
1996	59	1,568	(1,158-1,976)	31	1,047	(569-1,610)
1997	107	1,653	(1,243-2,101)	66	1,150	(599-1,875)
1998	46	1,963	(1,479-2,470)	56	1,479	(822-2,336)

Source: NMFS, Southwest Fisheries Science Center, Honolulu Laboratory, unpubl. data.

3.2 Japanese swordfish fisheries

Japanese longline fisheries are classified into three categories, namely coastal, offshore and distant vessels (Takahashi and Yokawa 1999). The sizes of the boats range 10-20 gt, 20-120 gt and 120-500 gt respectively. The annual catch of swordfish by offshore and distant water longlines has been stable at around 11,000 mt. In the North Pacific the catch reached to over 9,000 mt in 1985 and 1987, then decreased to 4,800 mt during 1988 and 1991, and since 1992, has fluctuated between 6,000 and 8,000 mt. The catch of coastal longliners, also in the North Pacific fluctuated between 600 and 1,000 mt in the 1980s, but increased to 1,300 mt since 1993.

The Japanese North Pacific catch amounts to about 55% of the total swordfish catch of all vessels active in the North Pacific (Takahashi and Yokawa 1999; Table 3). There is a directed longline fishery for swordfish in the coastal and offshore waters of Japan which takes about 40% of the total Japanese swordfish catch, and 60% North Pacific catch. Swordfish directed longline fishing uses only 3-4 branch lines and mackerel as bait. The branch lines used for directed fishing are shorter than those used for tuna, and fishing is conducted at night. Monofilament line has been introduced to Japanese longliners in favor of the tar-coated kuralon, but this type of gear is not commonly used in the North Pacific swordfish directed fishery. Since the mid-1970s, Japanese tuna longliners have been fishing deeper to target bigeye tunas. Uozumi and Okamoto (1997) monitored the depth of Japanese longline sets with time depth recorders. They found that the deepest hook depths with 5, 7, 9, 11, 13 and 15

HBF were 90, 120, 150, 180, 210 and 240 m, respectively. Suzuki and Kume (1982) consider conventional (i.e., shallow) and deep longlining to be those with four to six HBF and ten or more HBF. Hampton *et al.* (1998) summarized data on Asian longline fleets over time to develop standardized indices of fishing effort. In the North Pacific, between 150° E. and 150° W. longitude and 0-40° N. latitude, nearly 40% of longliners were using four to six HBF and fished at relative shallow depths prior to 1981. After 1981, the Japanese fleets on average fished deeper tending to use 10-11 and 12-15 HBF to the mid-1980s, with a steadily increasing proportion of sets using 16-20 hooks, until the 1990s, when this was the commonest gear configuration.

3.3 Taiwanese swordfish fisheries

Swordfish catches are an incidental catch of distant water tuna longline fishery and the offshore tuna longline fishery in Taiwan (Sun *et al.* 1999). Taiwan also has a small coastal harpoon fishery for swordfish. The offshore tuna longline fishery catches the majority of the swordfish, ranging from 53 to 91% by number with an average of 87%. Most of this catch (75-97%, mean = 88%) comes from fishing in the North Pacific (Table 3). The distant water longline fishery comprise vessels > 100 gt, usually 150-250 gt, and has been operating in the Pacific Ocean since 1963. The main fishing ground for this fishery varies considerably throughout the central and southwest Pacific Ocean where albacore tuna (*T. alalunga*) and sometimes bigeye tuna are the target species and swordfish a bycatch. Few swordfish are caught by this fishery in the Northern Pacific due to its southern Pacific focus. Like the Japanese longline vessels, Taiwanese longliners have traditionally used mainly tar-covered kuralon, however newer vessels are equipped with monofilament.

The offshore fishery longline fleet consists of two classes of vessels of < 100 gt. The first group comprises vessels of 20-50 gt, home ported in Tung-Kang and Kaushiung, which make short trips of seven to ten days landing their catch to their home port. The second group is composed of larger vessels of 50-70 gt based in fishing ports of the western Pacific islands countries. Both types of vessel target primarily yellowfin (*T. albacares*) and bigeye tunas for the Japanese sashimi market, taking swordfish as a bycatch. These fleets, however, fish predominantly in the North Pacific. Most of these vessels use monofilament main lines and branch lines. In the North Pacific (150° E. to 180° and 0° to 40° N.) between 1981 and 1996, nearly 60% of the Taiwanese vessels fished very deep using more than 20 HBF, and a further 21% using 16-20 HBF (Hampton *et al.* 1998). The total North Pacific catch of swordfish by Taiwanese longline vessels currently amounts to about 1,100 mt annually.

3.4 Korean longline fishery

The Korean longline fleet comprises about 150 vessels of about 370 gt which fish primarily in the tropical Pacific for bigeye and yellowfin tunas for the Japanese frozen sashimi market (Lee *et al.* 1997). As with the Taiwanese fleets, the small volume of swordfish caught by this fleet is taken as bycatch. The Korean fleet operates almost exclusively in the equatorial belt between 10° N. and 10° S., and as such may not interact with North Pacific albatrosses. Further, like the Japanese vessels, there has been a shift in longline gear deployment from shallow sets to deep sets. Prior to 1981, Korean vessels used predominantly four to six HBF on their longlines. From 1981 onwards, an increasing

proportion of vessels switched to deeper sets using more hooks, such that by 1996, 47% of vessels employed 10-11 HBF. Like the Japanese and other Asian fleets the longlines tend to be constructed predominantly from tar-covered Kuralon.

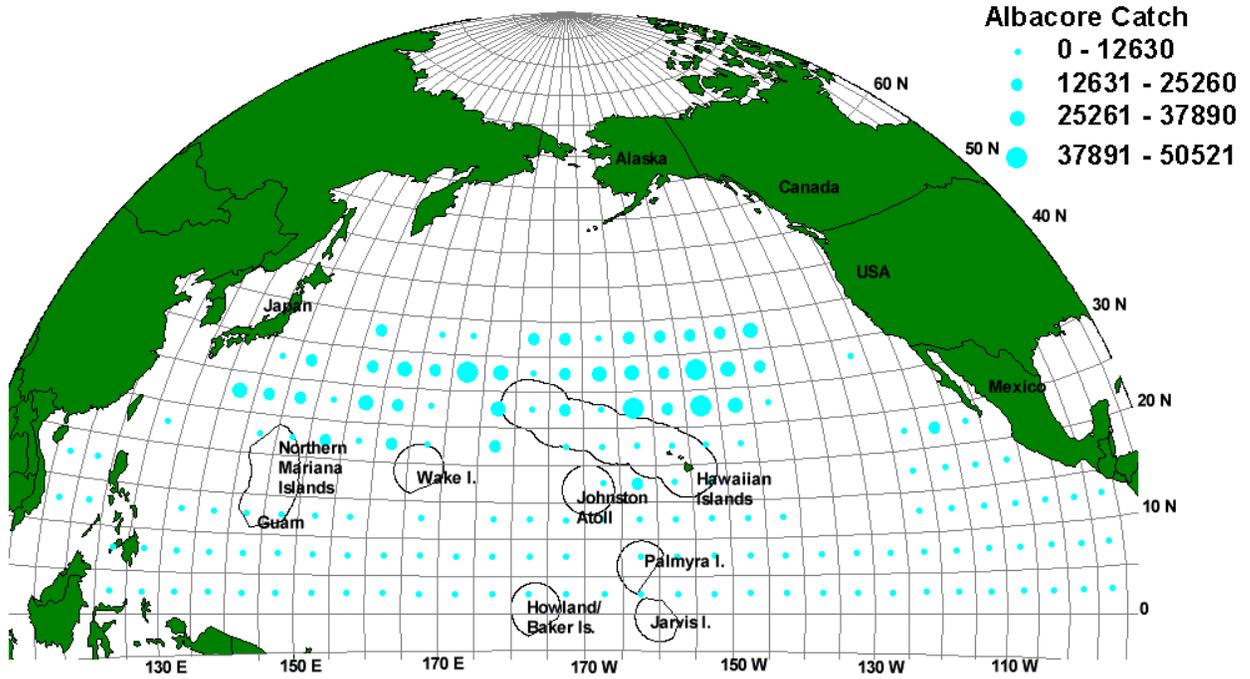
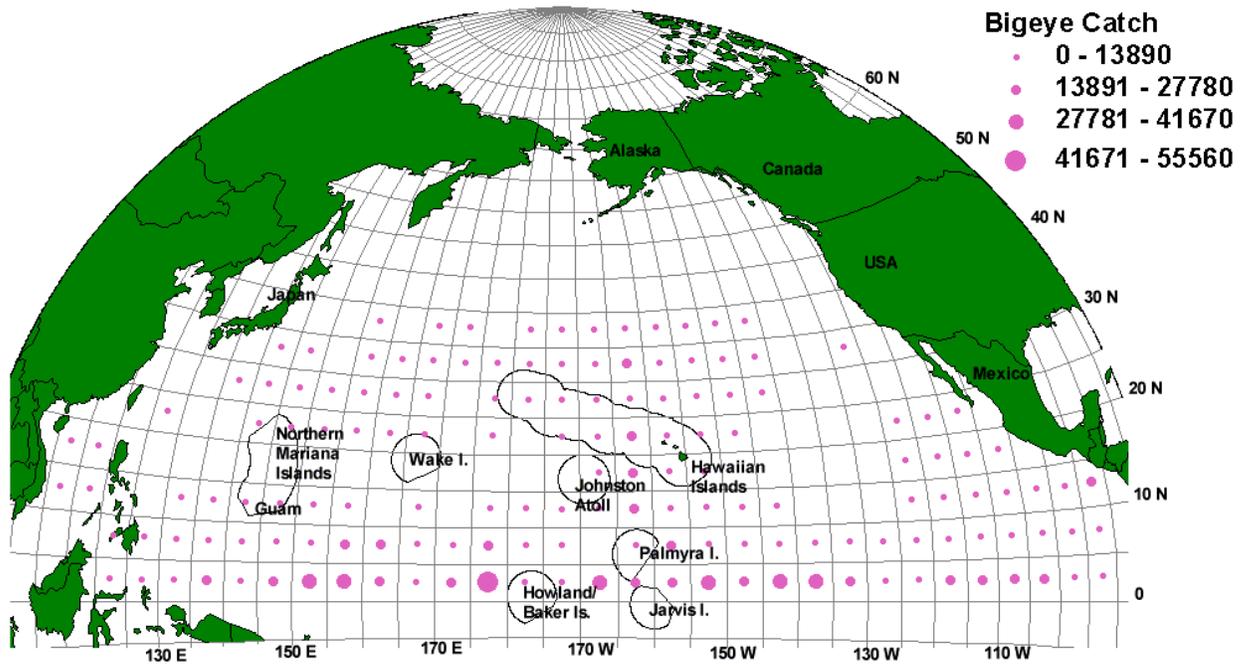


Figure 3. Pelagic longline fishing catch (in metric tons) for bigeye and albacore tuna in the North and Central Pacific Ocean for 1997. Sources: NMFS, Southwest Fisheries Science Center, Honolulu Laboratory and Secretariat of the Pacific Community's Oceanic Fishery Program web-page.

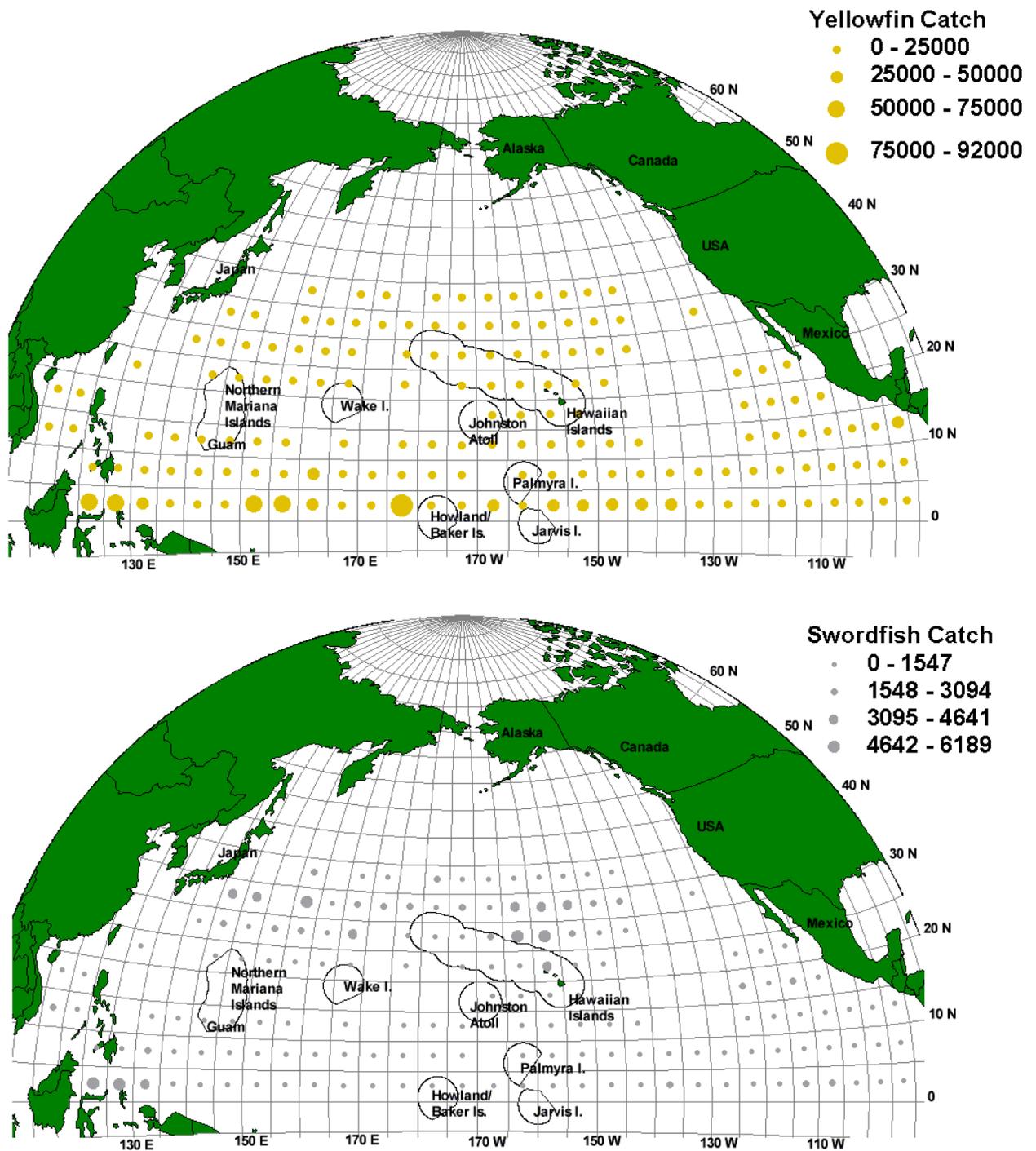


Figure 4. Pelagic longline fishing catch (in metric tons) for yellowfin tuna and swordfish in the North and Central Pacific Ocean for 1997. Sources: NMFS, Southwest Fisheries Science Center, Honolulu Laboratory and Secretariat of the Pacific Community's Oceanic Fishery Program web-page.

However, according to Moon *et al.* (1999) there has been an increasing trend towards using monofilament leaders on the branch lines. In 1990, only nine percent of vessels were using monofilament leaders, but by 1995, this had risen to 93%. Branch lines with monofilament leaders appear to be much more effective at catching bigeye and yellowfin tunas than wire leader equipped branch lines. Korean longliners land about 270 mt of swordfish annually, mainly from equatorial latitudes either side of the equator.

3.5 Other Asian fleets

Relative newcomers to longline fishing are the Chinese, Philippine and Indonesian longliners (Lawson 1999b). Fishing companies in China have based several fleets in ports of Palau, the Federated States of Micronesia and Marshall Islands under bilateral access arrangements. The Chinese longline fleet operating in central Micronesia numbered as high as 456 vessels in 1994, but has been greatly reduced since then to less than 75 vessels operating from Pohnpei and Palau. These vessels use monofilament main lines as well as branch lines, but fishing where they do in Micronesia, they are too far south to be of any real threat to North Pacific albatrosses. The same applies to Philippine and Indonesian longliners that tend to operate within their Exclusive Economic Zones and sufficiently far south to present no threat to North Pacific albatrosses.

Table 3. Annual North Pacific pelagic longline catches of swordfish, albacore, bigeye and yellowfin tunas.

Year	Swordfish Catch	Albacore Catch	Bigeye Tuna Catch	Yellowfin Tuna
1990	12,203	9,999	65,503	46,629
1991	13,225	12,386	56,529	43,022
1992	14,560	13,401	62,609	46,187
1993	16,055	18,525	57,822	44,103
1994	12,582	18,589	54,875	38,731
1995	11,199	24,156	49,723	46,741
1996	10,889	24,776	37,972	38,247
1997	11,118	18,271	42,986	37,821
Average	12,729	17,516	53,502	42,685

Source: The public domain database on Secretariat of the Pacific Community's Oceanic Fishery Program web-page.

4.0 Multilateral agencies, fishery bodies and international agreements

There are numerous regional and international fishery bodies that manage fishing in the North and Central Pacific ocean that have the authority to address the problem of incidental mortality of

seabirds in longline fisheries (Table 4). There are also several multilateral agreements and initiatives that address or could address seabird mortality on longlines in this region (Table 5).

A review of international and regional activities reveals that three multilateral agencies and fishery bodies, United Nations Food and Agriculture Organization (FAO), the World Conservation Union (IUCN) and the International Pacific Halibut Commission (IPHC), have taken steps to specifically address the problem of seabird mortality in Northern Hemisphere longline fisheries (Table 4). Only FAO has taken substantive steps with the endorsement of a non-binding International Plan of Action (IPOA) for Reducing the Incidental catch of seabirds in longline fisheries in July 1999. However, no actions have been taken to coordinate policies, research, monitoring or enforcement by national-level fishery managers, and the majority of North and Central Pacific longline vessels continue to operate without employment of seabird deterrent measures.

Table 4. Actions by Multilateral Agencies and Fishery Bodies to Reduce Seabird Mortality in North and Central Pacific Longline Fisheries.

Name of Multilateral Agency or Fishery Body	Member States, Territories, and Organizations	Area of Interest, Advisory or Regulatory	Actions to Reduce Seabird Mortality in Longline Fisheries
United Nations Food and Agriculture Organization (FAO)	175 Member Nations	All Oceans Advisory body	a) The non-binding FAO Code of Conduct for Responsible Fisheries, Article 7.6.9, promotes the minimization of catch of both non-target fish and non-fish species. b) The non-binding FAO International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries was endorsed by the 23 rd session of the Committee on Fisheries, adopted by the FAO Council and FAO Conference in 1999. The voluntary plan calls on all States to implement the plan, which provides guidance for the development of national plans of action (FAO Fisheries Department 1998, FAO 1999).
Asia-Pacific Fishery Commission (APFIC)	20 nations ³	Asia Pacific Region Advisory body	APFIC, an FAO regional fishery body, has not taken actions to address seabird mortality in longline fisheries (FAO 1997b).
Group of Temperate	Argentina, Australia, Brazil,	Southern Hemisphere	The Valdivia Group's Biodiversity working group has an Ad Hoc working group on albatross which is developing

³ Australia, Bangladesh, Cambodia, China, France, India, Indonesia, Japan, Korea, Malaysia, Myanmar, Nepal, New Zealand, Pakistan, Philippines, Sri Lanka, Thailand, United Kingdom, USA and Vietnam.

Southern Hemisphere Countries on Environment (Valdivia Group)	Chile, New Zealand, South Africa, and Uruguay	(marine and terrestrial) Advisory body	a framework for regional collaboration to conserve all Southern Hemisphere albatross species. The Ad Hoc working group has developed a document that outlines proposed elements of a cooperative instrument to restore and maintain albatross populations, which is hoped to eventually result in a regional instrument (Ad Hoc Working Group on Albatross 1999, Bomford 1999).
South Pacific Forum Fisheries Agency (FFA)	Australia, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Solomon Islands, Tonga, Tuvalu, Vanuatu, and Samoa	EEZs of the 16 listed Member Nations, located in the South Pacific Advisory body	FFA does not address seabird mortality in longline fisheries. Through its role in facilitating the establishment of access arrangements, drafting and reviewing fisheries legislation, coordinating regional surveillance, and collecting and disseminating data, FFA is in a position to effectively address seabird mortality of longline fisheries occurring in the EEZs of its member nations (Alexander <i>et al.</i> 1997).
International Union for the Conservation of Nature (World Conservation Union or IUCN)	76 member nations, 111 member government agencies, 732 member non-governmental organizations, and 36 affiliates.	Global Advisory body	a) IUCN's advisory resolution CGR1, adopted in 1996, entitled, "Incidental Mortality of Seabirds in Longline Fisheries," calls upon States to adopt the goal of reducing seabird bycatch in longline fisheries to insignificant levels, and immediately implement seabird bycatch reduction measures by longline fisheries. b) IUCN has criteria for the identification of threatened species, and has categorized the black-footed albatross as Vulnerable, the Laysan albatross "lower-risk—least concern," and the short-tailed albatross as Vulnerable (IUCN 1996).
Inter-American Tropical Tuna Commission (IATTC)	Costa Rica, France, Japan, Nicaragua, Panama, USA, Vanuatu, and Venezuela	Eastern Pacific Ocean (FAO Area 87) Regulatory body	IATTC does not address seabird mortality in longline fisheries. The Convention of the IATTC may be flexible enough to provide the Commission with the ability to address seabird impacts by longline fisheries (Brothers <i>et al.</i> 1998, Sakagawa 1999).

Pacific Island Roundtable for Nature Conservation	All 26 SPREP member countries and territories ⁴	Pacific Islands region Advisory body	The Roundtable does not address seabird mortality in longline fisheries. However, the goals of the action strategy for Nature Conservation in the Pacific islands region 1999-2002, are broad enough to allow the roundtable to address this problem (Pacific Island Roundtable for Nature Conservation 1999, South Pacific Regional Environment Programme 1999).
International Pacific Halibut Commission (IPHC)	USA and Canada	Territorial waters off the west coasts of Canada and the USA	The IPHC introduced legislation to ensure that seabird mortality levels remain low (International Pacific Halibut Commission 1998). (FAO Areas 18, 61, and 67)
Secretariat of the Pacific Community (SPC)	SPC has 26 member countries and territories of which 22 are in Melanesia, Micronesia, and Polynesia	Between 25° N. - 45° S. latitude, and 125° E – 120° W. longitude Advisory body	SPC does not collect observer north of 25°N latitude, where seabirds are known to interact with longline vessels. SPC does not address seabird mortality in longline fisheries (Bailey <i>et al.</i> 1996, Alexander <i>et al.</i> 1997).
North Pacific Interim Scientific Committee for Tuna and Tuna-Like Species (ISC)	No information	North Pacific Ocean Advisory body	ISC does not address seabird mortality in longline fisheries (http://www.nmfs.gov/oneagree.html).
Organization for Economic Cooperation and Development	29 Member countries ⁵	Global Advisory body	OECD does not address seabird mortality in longline fisheries. OECD has an ad hoc expert group on fisheries studying the economics of fisheries management, with a sub-group of Iceland, Canada, Australia, and the USA, formed in 1994, to examine bycatch issues (Haward <i>et</i>

4 Plus, World Heritage Center of UNESCO, Foundation for Peoples of the South Pacific International, IUCN, New Zealand Ministry of Foreign Affairs and Trade, The Nature Conservancy Asia/Pacific Region office, University of the South Pacific, and World Wide Fund for Nature.

5 Japan, Australia, New Zealand, Finland, Mexico, the Czech Republic, Hungary, Poland, and Korea, USA, Canada, and European countries

(OECD)

al. 1998).

North Pacific Marine Science Organization (PICES)	Canada, China, Japan, Republic of Korea, Russian Federation, and USA	Northern North Pacific Ocean Advisory body	PICES does not address seabird mortality in longline fisheries (http://pices.ios.bc.ca).
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While there has been some progress with international agreements and initiatives to address seabird mortality in North and Central Pacific longline fisheries, only the Convention on the Conservation of Migratory Species (CMS) currently can obligate a contracting party to execute a legally binding agreement to address seabird mortality in longline fisheries (Table 5). The CMS Secretariat could, therefore, develop a legally binding, multilateral, range state agreement for the three North Pacific species of albatrosses that interact with longline fisheries.

The other multilateral agreements and initiatives listed in Table 5 do not contain enforceable regulations that, when violated, result in sanctions on a contracting party or fishing vessel. As is the case with most “soft law” international conventions, contracting parties are obligated to act in accordance with Convention guidelines, and international politics or fear of losing credibility influences some nations to meet Convention guidelines. Nonetheless, there may be additional legally binding conventions, as the United Nations Implementing Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks (UNIA) will be legally binding once it comes into effect. The Agreement obligates signatory States to 1) consider the effects of fishing on associated and dependent species, 2) provides guidance on applying the precautionary approach, 3) defines how coastal states and distant water fishing nations will cooperate to conserve and manage tuna and other fish stocks, and 4) requires regional fisheries bodies to develop management strategies along with enforcement and monitoring control and surveillance systems to ensure compliance with fisheries regulations for highly migratory species. The Agreement to Promote Compliance with International Conservation and Management Measures by Vessels Fishing the High Seas could also be used to legally enforce other international agreements once it comes into effect. The Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Central and Western Pacific Region (MHLIC), however, would have to be amended after it comes into effect to address seabird mortality on longlines.

Table 5. International Agreements and Initiatives that Address Seabird Mortality in North and Central Pacific Longline Fisheries

Name of Agreement or Initiative	Contracting Parties or Adopters	Area of Coverage, and Legally Binding or Advisory	How agreement or Initiative Addresses Seabird Mortality in North and Central Pacific Longline Fisheries
Kyoto Declaration and Kyoto Plan of Action	95 nations that met at the International Conference on the Sustainable Contribution of Fisheries to Food Security	Global Advisory	The Kyoto Declaration states policies towards better fisheries management. The Kyoto Plan of Action lists areas requiring urgent attention (Haward <i>et al.</i> 1998).
Rome Consensus on World Fisheries	FAO's 175 Member Nations	Global Advisory	The Rome Consensus urges governments and international organizations to minimize wasteful fishing practices (http://www.fao.org).
United Nations Implementing Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks (High Seas Agreement or UNIA)	The Agreement will come into effect once ratified by 30 nations	Global Legally binding (once comes into effect)	Several articles in the Agreement include measures to conserve associated or dependent non-target species including seabirds, providing a strong vehicle to direct international action to address the problem of seabird mortality in commercial fisheries (Haward <i>et al.</i> 1998).
Convention on Biological Diversity (CBD)	174 nations and the European Community	Global Advisory	The Convention obligates contracting parties to conserve biodiversity, including marine biodiversity, and parties are to cooperate to implement the treaty outside of national boundaries. The CBD has not been used to address seabird mortality in longline fisheries (http://www.biodiv.org).

Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention of CMS)	55 nations	Global Advisory and legally binding	CMS requires range states to execute formal multilateral agreements and less formal Memoranda of Understanding to manage taking of species listed in the appendices of the Convention. Draft agreements are currently being developed to protect 16 albatross species (Bergin 1997; Brothers <i>et al.</i> 1998; CMS 1998; Haward <i>et al.</i> 1998; Cooper, in press).
United Nations Convention on the Law of the Sea (UNCLOS)	132 nations	Global Legally binding	The treaty has a provision that deals with bycatch within national jurisdiction. This provision directs coastal states to maintain or restore sustainable populations of associated or dependent species. The Convention does not contain enforceable regulations. Countries that do not want to comply with restrictions imposed by an agreement can refuse to do so or withdraw from the Convention. Furthermore, if a home nation enters into an agreement that might restrict fishing, fishing vessels from that nation can adopt a flag of another nation that has not signed the agreement (Alexander <i>et al.</i> 1997, Haward <i>et al.</i> 1998).
Rio Earth Summit Agenda 21	Adopted by participants of the 1992 United Nations Conference on Environment and Development	Global Advisory	Agenda 21 promotes the development and use of selective fishing gears and practices to minimize bycatch of non-target species (Haward <i>et al.</i> 1998).
Cancun Declaration	Adopted by the participants of the 1992 Cancun Conference on Responsible Fishing	Global Advisory	The Declaration calls for coastal states to promote the use of selective fishing gears and practices to minimize waste of catch of target species and bycatch of non-target species (Haward <i>et al.</i> 1998).

Agreement to Promote Compliance with International Conservation and Management Measures by Vessels Fishing the High Seas	Agreement will come into effect when ratified by 25 states	Global Legally binding (once comes into effect)	Contracting Parties are obligated to ensure fishing vessels flying their flags do not violate international management measures (Haward <i>et al.</i> 1998).
Migratory Bird Treaty Act (MBTA)	Bilateral agreements between the USA and Canada, Mexico, Japan, and the former Soviet Union	Land and seas of the signatory nations Legally binding	The MBTA is the USA's domestic enabling legislation to implement bilateral treaties between the USA and Canada, Mexico, Japan, and the former Soviet Union to protect and conserve migratory birds. There is controversy within the USA concerning to what degree the MBTA restricts the take of migratory birds, including seabirds.
Multilateral High Level Conference to develop a Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Central and Western Pacific Region (MHLC)	Under negotiation by 28 nations	Central and Western Pacific Legally binding (once comes into effect)	The current April 2000 draft Convention does not contain specific language to take steps to minimize seabird mortality in longline fisheries (Western Pacific Regional Fishery Management Council 2000).
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	125 nations	Global Legally binding	CITES protects endangered species from over-exploitation by controlling trade in live or dead animals and animal parts through a system of permits. The short-tailed albatross is listed in Appendix I of the Convention, which prohibits international trade in wild specimens of this species. CITES does not address the incidental mortality of seabirds in longline fisheries (Alexander <i>et al.</i> 1997, Haward <i>et al.</i> 1998).

5.0 Discussion

Pelagic longline fishing fleets may pose a serious threat to North Pacific albatrosses, but combinations of different factors are required before that threat is realized. When monofilament longlines

are set shallow, with floatation aided by light sticks and bait, in proximity to a large population of albatrosses, then, without mitigation measures, bird takes are likely to be extensive. Fortunately we know how extensive this is for the Alaska and Hawaii U.S. longline vessels through observer programs. Without observer data we may only guess at the impact of the other fishing fleets. Empirically, there may be fewer birds killed per boat due to fishing locations and method of fishing, but due to sheer fleet size the mortality may still be significant. Clearly, similar observer information with gear descriptions and seabird interaction rates is urgently required for other longline fleets to achieve a more balanced picture of fishery induced mortality.

We made some crude calculations on the potential numbers of albatrosses killed in the North and Central Pacific pelagic longline fisheries, based on the ratio of swordfish and seabirds caught in the Hawaii pelagic longline fishery. Recent analysis of the Hawaii-based longline bird catches suggest that fisheries operating close to breeding colonies have higher bird catch rates (Kleiber 1998ab, Laurs *et al.* 1999). The Hawaii-based longline fishery fishes near the NWHI breeding colonies in the U.S. EEZ 50 nautical miles the shore, as well as on the high seas. We used data generated from mixed sets, where vessels target a mix of swordfish and tuna, as this is thought to best approximate the fishing technique for swordfish used by other longline in the North Pacific. We only used swordfish catch data for Japanese (9,360 mt) and Taiwanese (1,100 mt) fleets, since they comprise most of the other pelagic longline effort in the North Pacific. We also used the average catch rate of Laysan and black-footed albatrosses (0.43 and 0.57 birds caught/mt fish caught with swordfish gear). Based on these assumptions we estimate that pelagic longline vessels targeting swordfish, other than the Hawaiian longline fishery, annually catch a total of 10,500 albatrosses. We applied similar methods to North Pacific pelagic longline vessels targeting tuna (using 0.24 and 0.31 birds caught/mt fish caught with tuna gear in the Hawaii longline fishery for Laysan and black-footed albatrosses and the averages in Table 3) and found the estimated annual catch of albatrosses was about 21,000. Clearly, these figures are speculative and should not be cited as anything other than a rough guess using the data most readily to hand.

However, until we have good direct observational material on the temporal and spatial distributions of albatross takes for pelagic longline fleets in the North Pacific other than the Hawaii longline fishery then the only avenue left will be to generate empirical estimates such as this. Moreover, having the numbers of birds taken will not solve the albatross bycatch problem, but if numbers are available the process of managing the problem at the regional level can be addressed through national policy and/or international fora and agreements. Pelagic longline operations are not equal when managers attempt to estimate seabird mortality resulting from incidental catch. Differences in gear configurations used to target swordfish or tunas result in different seabird catch rates. There is a need to collect gear descriptions, as well as seabird catch rates (in bird catch/hook) for each fishery in the North and Central Pacific Ocean. There is also a need to conduct satellite tag studies of all three North Pacific albatross species, especially for the endangered short-tailed albatross. Juvenile birds are more susceptible to being caught on longline gear (Brothers 1991, Boggs in press), and satellite telemetry studies would show the distributions of these birds with respect to current longline fishing effort. Fishing effort and seabird catch data may be achievable through the existing Interim Scientific Committee for the Management of Tunas and Tuna-like Species in the North Pacific, or the fledgling management commission being developed by the Central and Western Pacific by a series of ministerial-level meetings

known as the Multi-Lateral High Level Conference.

To address seabird mortality in the North and Central Pacific longline fisheries, only the CMS currently can obligate a contracting party to execute a legally binding agreement. Once the United Nations Implementing Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks (High Seas Agreement or UNIA) becomes effective, then this agreement would also be legally binding to contracting parties. Without a coordinated effort, the efforts of agencies like the Western Pacific Regional Management Council to reduce albatross mortality on pelagic longline vessels will be less effective. However, efforts must be made, even if the efforts are restricted to a sub-national level, to provide support toward solving the problem.

Therefore, there is a need for regional, centralized coordination of research and management activities by regional and national-level fishery bodies to coordinate management of longline fisheries for the North and Central Pacific. Several multilateral agencies and fishery bodies could assume the task of regionally coordinating the management of albatross and longline interactions, but there is a need for improved coordination amongst these organizations. The geographical coverage of the agencies and bodies are patchwork in nature, meaning that no single organization covers the entire range of the North Pacific albatrosses. For instance, organizations that could collect and distribute data on incidental seabird catch, such as SPC, FFA, and IATTC, likely have different structures for their data collection and dissemination. A first step that a regional coordinating body could perform could be to make these data collection and distribution processes consistent, as accurate region-wide scientific data helps achieve effective management.

Through collaboration via a centralized coordinating body, each nation could tailor seabird deterrent measures to the context of their pelagic longline fisheries to maximize a reduction in seabird mortality on longlines as there is a need for fishery-specific adaptation of seabird mitigation measures. Because longline fishermen are likely the most qualified to develop seabird mitigation tools, and because it would potentially allow fishermen to develop a sense of ownership and support for the required implementation these tools. A centralized coordination body could encourage and support national efforts to allow longline fishermen develop and test current or new seabird deterrent methods. Longline fishermen will be much more likely to employ seabird measures that are economically and operationally suitable to their fishery, regardless of whether these measures are legally mandated or voluntary. Thus, it behooves fisheries managers to directly involve and make allies of the longline industry in the process to develop and require seabird mitigation measures (Brothers et. al. 1998, Croxall 1998).

There is also a need for managers to develop outreach programs to inform North Pacific pelagic longline fishermen concerning the economic benefits they can derive from avoiding seabirds, to develop and augment a seabird conservation ethic amongst fishermen. A centralized coordinating body could also assist the development of national-level outreach and capacity building workshops providing fishery managers the opportunity to learn from industry's experiences with mandatory seabird deterrent measures and the development of new innovative seabird avoidance methods. Thus, through these national-level outreach and capacity building efforts, a centralized coordinating body can disseminate the results of ongoing research and development, results of efforts to monitor the effectiveness of mitigation

measures, and conduct outreach to instruct how measures can be effectively used.

It is not our intention to vilify longline fishing or longline fleets that target swordfish or a mixture of swordfish and tunas, but simply to address the management of the interaction problem associated with seabirds and pelagic longlines in the North Pacific. The global demands for high quality-high value longline caught fish, especially swordfish, is unlikely to diminish and the problems associated with the incidental catch of seabirds by pelagic longline vessels are manageable. Studies have shown that several different technical and operational methods are extremely effective in reducing albatross mortality by longline gear (FAO 1999, Boggs in press, Grabowsky-Kaaialii in prep.) and indeed the interaction problems in the North and Central Pacific are mild compared with demersal longliners in Alaska and pelagic longlining in the South Pacific and Southern Ocean, where the species and sheer number of birds involved are much greater. We have an opportunity for developed and less developed countries to collaborate via an integrated management approach to more equitably share the costs to protect seabirds from being incidental caught on pelagic longline gear. This could be achieved by making use of international conventions and agreements to protect seabirds, to induce States that are not parties to these conventions and agreements to comply with their provisions. This will require outreach and capacity building efforts to develop a sense of ownership and perhaps even a conservation ethic by the longline industry for using seabird avoidance measures.

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