

**Annual Review of Bycatch in Southern Bluefin Tuna and Related Tuna Longline
Fisheries in the New Zealand 200 n. mile Exclusive Economic Zone**

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by**

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1. Introduction

Southern bluefin tuna and related tuna species such as bigeye tuna caught in commercial fisheries (Japanese and domestic) in New Zealand waters are taken mainly on longlines. A small percentage of these species caught by domestic owned and operated vessels are taken by trolling and handlines. Albacore tuna have not been targeted by Japanese longliners since 1991-92, but for the domestic fleet, about 21% of reported albacore catches were from longlines (Murray *et al.* 1997).

Japanese vessels fishing in New Zealand waters under foreign licences or charter arrangements have generally used a kuralon mainline of about 3000 hooks per set. Domestic owned and operated vessels use monofilament mainline and because of different vessel sizes and operating capacities the numbers of hooks set on these domestic longlines may vary between 300 and 2700 hooks.

Japanese vessels have operated mainly during March to June in waters around southern New Zealand, targeting southern bluefin tuna. During July to August these vessels have moved north and targeted southern bluefin and bigeye tunas north of about 38° S. Domestic owned and operated vessels operate throughout the year, targeting albacore during January to March in waters to the north of New Zealand, then move south to target southern bluefin and bigeye tunas north of about 38° S; some domestic effort has been recorded from southern New Zealand waters, generally by the larger domestic vessels. Since 1991-92, most vessels fishing in New Zealand waters have voluntarily undertaken to set lines at night (Baird 1997).

Associated or dependent or protected nonfish species such as seabirds and marine mammals have been recorded as bycatch to tuna longline fishing operations in New Zealand waters. Since 1987-88, 1145 seabirds have been observed caught on tuna longlines set by Japanese and domestic fleets. Most of the recorded captures from Japanese foreign licensed and chartered longlines have been made during the setting operation; between 1990-91 and 1996-97, when the life status of observed captured seabirds has been recorded, about 96% of seabirds observed caught on these longlines were landed dead. Seabirds observed caught on domestic longlines are generally caught on the haul and subsequently less (22%) are landed dead; the survival rate of seabirds released alive is unknown.

Marine mammals such as New Zealand fur seals and dolphins have also been caught on tuna longlines set in southern waters. Usually these animals are released alive. Non-target fish species such as sharks are caught in large numbers as bycatch on tuna longlines.

2. Review of SBT Fisheries in the New Zealand EEZ

Historically most longline effort in New Zealand waters has been conducted by the foreign licensed Japanese fleet. However, effort by this fleet has declined sharply, especially since 1991–92, and there has been no fishing by this fleet since 1994–95. Japanese vessels operating under charter agreements have fished in New Zealand waters since 1989; this effort has been consistent, with 5 vessels returning in recent years, except in 1995–96, when no Japanese vessels were present.

Effort by domestic owned and operated vessels has increased greatly since 1990–91. This fishery continues to be dynamic. In 1997, vessel numbers declined, reportedly because of economic constraints. About 44 domestic vessels fished for southern bluefin and related tunas in 1997, compared with about 55 in the previous year; this equated to a drop in effort from about 2.1 million to 1.8 million hooks set. Five charter vessels operated in 1997 and fishing effort by these vessels was similar to that in 1994–95, at about 1.2 million hooks.

Since the early 1990s, foreign licensed and chartered Japanese vessels have predominantly targeted southern bluefin tuna in waters off the west and south coasts of the South Island between March and June. In the 1996–97 season vessels returned to fish off the east coast of the South Island, an area not fished since the mid 1990s; catches were reported as good. During July to August, these vessels generally move to north of 38° S to target southern bluefin tuna and bigeye tuna.

New Zealand domestic catches of southern bluefin tuna before the advent of longlining were largely restricted to the months June to August. These months account for over 90% of the landings, with the rest being caught mainly in March to May. The catch of southern bluefin tuna by the domestic owned and operated vessels has continued to drop since 1994–95 when the quota of 420 tonnes for the charter and New Zealand domestic vessels combined was reached. In 1996–97 these vessels caught about 330 tonnes.

3. Fisheries Monitoring

Biological information has been collected by New Zealand Ministry of Fisheries Scientific Observer Programme since 1987. Scientific observers record the catch of all fish and nonfish species during tuna longline operations. Samples are collected for genetic reference material to distinguish southern bluefin from northern bluefin tuna. Genetic samples are also collected from swordfish for a Japanese research project to delineate stock structure. Yellowfin tuna and albacore tuna scales are collected for an ageing project in Taiwan. Observers also facilitate the recovery of tags from a CSIRO (Australia) tagging programme and a SPC (New Caledonia) programme. A full description of the data collection activities of the Ministry of Fisheries Scientific Observer Programme is given in Baird (1995).

Observer coverage has mainly been during April to July, with coverage peaking in June for the foreign-licensed fleet and in May for the chartered fleet. Because the

domestic owned and operated longline fleet fishes throughout the year, there has been observer coverage in most months, but the main period is April to June.

Observer coverage for 1990-91 to 1996-97 is given in Table 1. Coverage has been consistently low for the foreign fleet, except when the total effort was very low. The chartered fleet coverage has been greater than 30% for effort greater than 1.2 million hooks. In 1997, the highest number of observed hooks was recorded for the chartered fleet, with most from the April to June quarter.

Observer coverage of the domestic fleet has been minimal. There was an increase in observer coverage in 1994-95 as the total effort increased, but the percentage of observed hooks was only about 7%. Most observed hooks are recorded for the months April to June. In 1996-97 there was an increase in the number of domestic hooks observed (12% coverage) despite a drop in total effort.

4. Shark and Other Non-target Fish Bycatch

The main non-target fish species observed caught on tuna longlines, and a description of the data and methods used to obtain the bycatch rates, are given in Appendix 1. This work is preliminary; a project undertaken by NIWA and funded by the Ministry of Fisheries on non-target fish bycatch on tuna longlines in New Zealand waters is currently underway.

Shark species caught incidentally include blue, porbeagle, mako, and school sharks and deepwater dogfish. Effort data and numbers of these species by fleet, fishing year, and latitude band are given in Tables 2 & 3. Similarly, bycatch rates for the most commonly caught non-target fish species are given in Tables 4-7.

Blue sharks, Ray's bream, and southern bluefin tuna are the predominant species in waters south of 38° S. Blue sharks, albacore tuna, and porbeagle accounted for most of the catch in waters north of 38° S. The catch rates for blue sharks observed caught on Japanese (foreign licensed and charter) longlines are highest north of 38° S and lowest south of 43°. However, a different trend is seen in the domestic catch rates for blue sharks; catch rates are similar in the northern and southern latitude bands in 1994-95 and highest south of 38° S in subsequent years. The highest catch rates of porbeagle and mako sharks were from waters north of 38° S. Both deepwater dogfish and school sharks were more prevalent in waters south of 38° S. A description of the status of landing and processing of sharks as well as percentage frequency in the catch statistics is given in Anon. (1997).

For the Japanese vessels, bycatch of other non-target fish species such as Ray's bream and dealfish was higher south of 38° S, whereas other species such as oilfish, moonfish, swordfish, and lancetfish showed higher catch rates north of 38° S.

Observed bycatch rates of non-target fish species caught on domestic longlines show a similar trend to those from the Japanese vessels, though catch rates of Ray's bream and dealfish were higher on domestic longlines.

5. Marine Mammal and Marine Reptile Bycatch

New Zealand fur seals (*Arctocephalus forsteri*), common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*) are the main marine mammal species observed caught on tuna longlines during 1990–91 to 1996–97. Before this period 3 turtles, 2 dolphins, and an orca were observed caught and released alive. Three whales have also become tangled in tuna longlines.

New Zealand fur seals have been recorded caught in southern waters on tuna longlines since 1988–89, though there were no recorded captures for the 1990–91 and 1991–92 fishing years. A total of 168 fur seals have been observed caught and of these 144 were released alive and 9 were landed dead; the landing status for the remaining 15 fur seals is unknown.

6. Seabird Bycatch

Data from observed incidental captures of seabirds during tuna longline fishing operations in New Zealand waters from 1990–91 to 1996–97 are given in Tables 8–10. Data have been stratified by fleet, fishing year, and area. The northern area refers to those waters which include Areas 1, 2, and 5 and the southern area refers to Areas 3 and 4 shown in Figure 1. Appendix 2 describes the data and method used to calculate the mean number of seabirds caught and the associated standard error.

The mean bycatch rate for seabirds caught in the northern area has varied greatly for each fleet. Highest bycatch rates for this area were recorded in 1996–97; for domestic vessels, 82 seabirds were observed caught and the mean bycatch rate was 1.10 per 1000 hooks (s.e. = 0.19), and for the charter Japanese vessels, 178 seabirds were observed caught and the mean bycatch rate was 1.40 per 1000 hooks (s.e. = 0.31). Seabird bycatch in 1996–97 was characterised by multiple captures by some vessels, especially those operating off the East Cape of the North Island and the east coast of the South Island. Bycatch rates for the southern area in 1996–97 for charter vessels were similar to those in previous years, at about 0.16 per 1000 hooks (s.e. = 0.05). The large seabird captures made off the South Island east coast were counterbalanced by low observed captures off the south and west coast of the South Island. Few seabirds were observed caught in the southern area by domestic owned and operated vessels; this may be a result of the area fished (off the south and west coasts of the South Island). Domestic vessels operating in southern waters are generally larger than those which operate up north and set a similar number of hooks to the Japanese vessels.

Petrel species are more likely to be caught in northern waters, whereas albatrosses predominate in the incidental captures observed in southern waters. Between 1988–89 and 1996–97, a total of 699 seabirds were returned for verification of identification, and these seabirds represent 14 albatross taxa and 8 petrel taxa (Table 11).

7. Mitigation Measures to minimise bycatch

Measures to minimise seabird bycatch are used by longliners fishing in the New Zealand 200 n. mile EEZ. These include voluntary nightsetting, deployment of a tori line during setting, and use of bait-throwing machines by charter vessels.

The use of tori lines and/or nightsetting was required for Japanese longliners in New Zealand waters in 1992. In September 1993, the Fisheries (Commercial Fishing) Regulations 1986 Amendment No. 15 came into effect to standardise requirements for all tuna longliners. This requires all tuna longliners to deploy tori lines at all times, as a minimum standard, and the tori line design of the Convention for the Conservation of Antarctic Marine Living Resources was adopted.

Research underway for the development of mitigation methods to minimise seabird bycatch includes the development and trialling of underwater setting devices. A description of the mitigation methods used and under investigation is given in the New Zealand paper tabled at ERSWG3 titled "Update on mitigation measures for New Zealand tuna fisheries".

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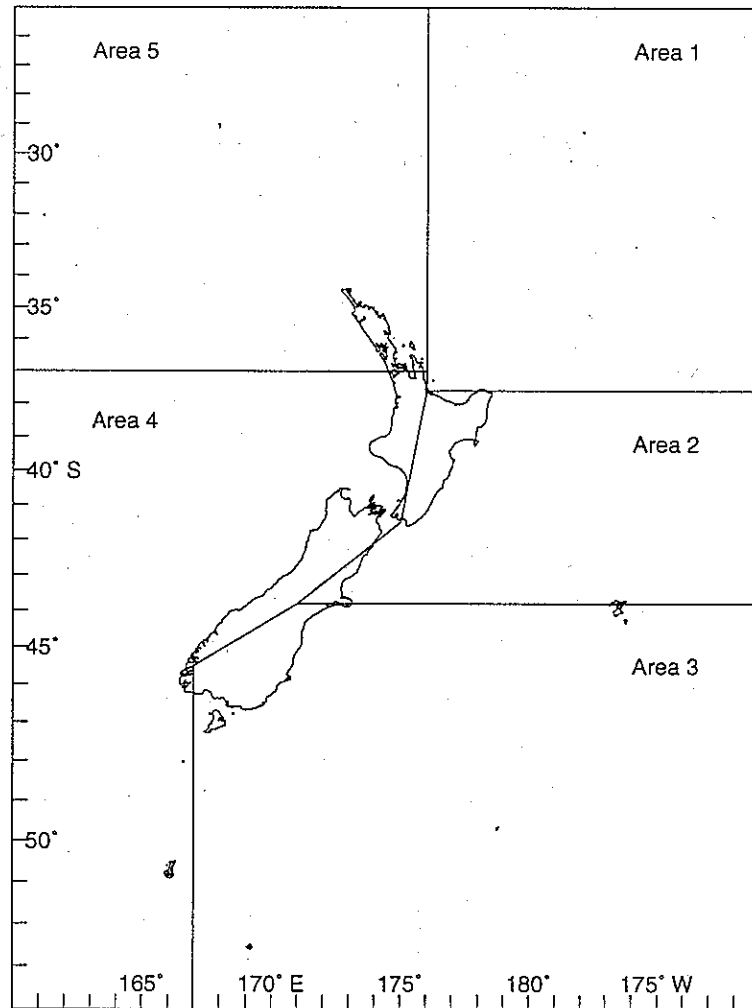


Figure 1: Areas used in seabird bycatch assessment

Table 1: Seasonal fishing and observed effort by foreign licensed and chartered Japanese and domestic owned and operated tuna longline vessels in New Zealand waters, 1990-91 to 1996-97.

Fishing year	Quarter	Foreign licensed Japanese vessels		Chartered Japanese vessels		Domestic vessels	
		Total hooks set	% observed hooks	Total hooks set	% observed hooks	Total hooks set	% observed hooks
1990-91	Oct-Dec	0	-	0	-	0	-
	Jan-Mar	839184	0.0	43020	0.0	7400	0.0
	Apr-Jun	7966113	0.9	737304	5.8	2640	0.0
	Jul-Sep	3262460	5.1	281170	56.6	3030	0.0
		12067757	2.0	1061494	19.0	13070	0.0
1991-92	Oct-Dec	0	0.0	0	-	58135	0.0
	Jan-Mar	120962	0.0	87300	0.0	83733	0.0
	Apr-Jun	5006979	9.3	1172903	0.0	119360	5.4
	Jul-Sep	1891247	2.9	320680	0.0	43770	29.9
		7019188	7.4	1580883	0.0	304998	6.4
1992-93	Oct-Dec	0	-	0	-	13820	0.0
	Jan-Mar	191171	0.0	71760	0.0	160530	0.0
	Apr-Jun	2584861	18.0	1157489	35.9	468581	0.0
	Jul-Sep	311834	54.2	316566	18.0	199152	0.0
		3087866	20.5	1545815	30.6	842083	0.0
1993-94	Oct-Dec	0	-	0	-	127460	0.0
	Jan-Mar	0	-	22980	100.0	456480	0.0
	Apr-Jun	129570	98.4	814435	72.3	647195	0.0
	Jul-Sep	0	-	0	-	196905	1.2
		129570	98.4	837415	73.0	1428040	0.2
1994-95	Oct-Dec	0	-	0	-	141870	11.2
	Jan-Mar	0	-	0	-	775588	4.0
	Apr-Jun	211599	98.8	1046921	41.7	991225	8.8
	Jul-Sep	0	-	177192	75.3	255160	7.3
		211599	98.8	1224113	46.6	2163843	7.1
1995-96	Oct-Dec	0	-	0	-	341070	0.8
	Jan-Mar	0	-	0	-	665317	3.2
	Apr-Jun	0	-	0	-	980956	13.4
	Jul-Sep	0	-	0	-	116210	6.1
		0	-	0	-	2103553	7.7
1996-97	Oct-Dec	0	-	0	-	167084	0.0
	Jan-Mar	0	-	103740	31.6	688949	7.5
	Apr-Jun	0	-	1045585	66.2	791938	20.9
	Jul-Sep	0	-	74040	100.0	169805	0.0
		0	-	1223365	65.3	1817776	11.9

Table 2: Numbers of the main shark species* incidentally caught during observed Japanese foreign licensed and chartered tuna longline operations in New Zealand waters, 1990-91 to 1996-97

Fishing year	Total no. hooks	No. observed hooks	% observed hooks	No. BWS	No. POS	No. MAK	No. POS/MAK	No. DWD	No. SCH
North of 38 S									
1990-91	5021091	353146	7.0	2091	164	320	484	0	3
1991-92	3924629	243646	6.2	2314	378	274	652	0	9
1992-93	768411	317035	41.3	10170	1237	177	1414	0	20
1993-94	77748	77892	100.2	3428	274	61	335	0	4
1994-95	45187	29207	64.6	3344	205	11	216	0	0
1995-96									
1996-97	132940	124120	93.4	5815	301	146	447	0	6
Between 38 S and 43 S									
1990-91	549934	85998	15.6	317	11	17	28	0	6
1991-92	796976	22789	2.9	162	33	1	34	0	2
1992-93	646121	198035	30.6	3850	215	18	233	76	60
1993-94	33900	31200	92.0	3216	37	9	46	5	96
1994-95	318136	184205	57.9	1252	113	17	130	154	81
1995-96									
1996-97	160455	130720	81.5	3958	36	12	48	123	63
South of 43 S									
1990-91	7558226	0	0.0	0	0	0	0	0	0
1991-92	3878466	252414	6.5	154	94	61	155	125	61
1992-93	3219149	590952	18.4	1701	705	25	730	376	80
1993-94	855337	630054	73.7	2516	514	45	559	129	188
1994-95	1072389	566361	52.8	843	675	110	785	466	310
1995-96									
1996-97	929970	544283	58.5	6437	1152	53	1205	201	204

*See Appendix 1.

Table 3: Numbers of the main shark species* incidentally caught during observed domestic owned and operated tuna longline operations in New Zealand waters, 1994-95 to 1996-97

Fishing year	Total no. hooks	No. observed hooks	% observed hooks	No. BWS	No. POS	No. MAK	No. POS/MAK	No. DWD	No. SCH
North of 38 S									
1994-95	1298643	65750	5.1	425	55	65	120	3	11
1995-96	1426364	61062	4.3	572	239	135	374	0	0
1996-97	1332214	76801	5.8	308	87	113	200	0	4
Between 38 S and 43 S									
1994-95*	646760	1840	0.3	5	0	0	0	1	0
1995-96	365390	51409	14.1	2508	205	17	222	2	103
1996-97	294045	62600	21.3	1465	27	8	35	29	23
South of 43 S									
1994-95	218440	85390	39.1	301	37	1	38	32	15
1995-96	311799	50482	16.2	1595	104	4	108	44	10
1996-97	191517	77560	40.5	1157	33	6	39	65	64

*See Appendix 1.

Table 4: Mean catch rates and standard errors for shark species* caught incidentally during observed Japanese foreign licensed and chartered tuna longline operations in New Zealand waters, 1990-91 to 1996-97

Fishing year	Total no. hooks	% observed hooks	No. observed sets	BWS		POS		MAK		POS/MAK		DWD		SCH
				Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	
North of 38 S														
1990-91	5021091	7.0	122	6.009	1.178	0.461	0.061	0.907	0.087	1.357	0.091	0	0.008	0.004
1991-92	3924629	6.2	83	9.607	1.913	1.382	0.2	1.1	0.117	2.667	0.19	0	0.036	0.011
1992-93	768411	41.3	114	32.311	2.927	3.944	0.274	0.536	0.067	4.509	0.275	0	0.0638	0.016
1993-94	77748	100.2	27	42.576	11.535	3.523	0.886	0.781	0.128	4.269	0.888	0	0.0566	0.038
1994-95	45187	64.6	13	113.76	11.842	7.105	1.026	0.38	0.116	7.556	1.108	0	0	0
1995-96														
1996-97	132940	93.4	43	47.243	4.823	2.483	0.301	1.185	0.108	3.669	0.325	0	0.047	0.018
Between 38 S and 43 S														
1990-91	549934	15.6	28	3.662	0.623	0.127	0.042	0.198	0.042	0.323	0.052	0	0.069	0.029
1991-92	796976	2.9	8	7.01	1.882	1.426	0.449	0.044	0.041	1.485	0.466	0	0.092	0.056
1992-93	646121	30.6	66	21.878	5.414	1.188	0.231	0.092	0.024	1.296	0.231	0.399	0.308	0.058
1993-94	33900	92.0	11	106.744	35.865	1.151	0.829	0.28	0.094	1.431	0.873	0.152	2.797	2.333
1994-95	318136	57.9	57	6.863	0.706	0.61	0.075	0.093	0.026	0.702	0.082	0.828	0.438	0.067
1995-96														
1996-97	160455	81.5	44	31.344	9.034	0.281	0.048	0.093	0.027	0.374	0.055	0.923	0.481	0.066
South of 43 S														
1990-91	7558226	0.0	0											
1991-92	3878466	6.5	85	0.602	0.097	0.369	0.083	0.243	0.039	0.608	0.082	0.487	0.241	0.055
1992-93	3219149	18.4	193	2.932	0.274	1.207	0.119	0.043	0.018	1.248	0.123	0.645	0.136	0.017
1993-94	855337	73.7	205	4.104	0.279	0.797	0.081	0.069	0.011	0.867	0.082	0.195	0.298	0.045
1994-95	1072389	52.8	182	1.557	0.175	1.23	0.131	0.196	0.037	1.425	0.132	0.832	0.548	0.078
1995-96														
1996-97	929970	58.5	183	12.148	1.341	2.18	0.225	0.098	0.017	2.263	0.209	0.361	0.373	0.053

* See Appendix I.

Table 5: Mean catch rates and standard errors for other non-target fish species* caught incidentally during observed Japanese foreign licensed and chartered tuna longline operations in New Zealand waters, 1990-91 to 1996-97

Fishing year	Total no. hooks	% observed hooks	No. observed sets	RBM		DEA		OFH		MOO		SWO		LAT
				Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	
North of 38 S														
1990-91	5021091	7.0	122	0.118	0.032	0	2.217	0.276	1.134	0.1481	0.774	0.068	0.296	0.064
1991-92	3924629	6.2	83	0.09	0.021	0	3.642	0.352	1.102	0.084	1.359	0.119	0.194	0.038
1992-93	768411	41.3	114	0.301	0.24	0	2.048	0.165	1.047	0.088	0.648	0.062	0.799	0.102
1993-94	77748	100.2	27	0.04	0.029	0	1.512	0.489	4.723	1.195	1.002	0.116	0.818	0.258
1994-95	45187	64.6	13	0	0	0	2.033	0.383	3.046	0.944	0.387	0.127	0.898	0.342
1995-96														
1996-97	132940	93.4	43	1.114	0.453	0.008	3.436	0.387	0.574	0.115	2.92	0.547	0.048	0.021
Between 38 S and 43 S														
1990-91	549934	15.6	28	1.269	0.242	0.082	0.082	0.03	0.577	0.121	0.355	0.68	0	
1991-92	796976	2.9	8	0.354	0.135	0.041	0.129	0.085	0.303	0.201	0.128	0.082	0	
1992-93	646121	30.6	66	2.231	0.291	0.213	0.213	0.161	0.378	0.079	0.087	0.022	0.011	0.007
1993-94	33900	92.0	11	7.116	3.435	0.097	0.923	0.792	0.271	0.198	0.093	0.062	0	
1994-95	318136	57.9	57	2.495	0.23	1.01	0.01	0.007	0.145	0.033	0	0.005	0.005	
1995-96														
1996-97	160455	81.5	44	2.264	0.428	0.685	0.146	0.142	0.259	0.051	0.032	0.015	0	
South of 43 S														
1990-91	7558226	0.0												
1991-92	3878466	6.5	85	2.412	0.2	0.862	0.165	0.044	0.002	0.007	0	0.004	0.011	0.006
1992-93	3219149	18.4	193	2.23	0.132	0.229	0	0.046	0.046	0.01	0.005	0.004	0.002	0.002
1993-94	855337	73.7	205	13.808	1.296	0.606	0.003	0.003	0.05	0.008	0.003	0.002	0.003	0.002
1994-95	1072389	52.8	182	5.657	0.421	2.157	0.014	0.008	0.063	0.011	0	0.002	0.002	0.002
1995-96														
1996-97	929970	58.5	183	6.767	0.611	4.236	0.069	0.021	0.256	0.031	0.034	0.008	0	

* See Appendix I.

Table 6: Mean catch rates and standard errors for shark species caught incidentally during observed domestic owned and operated tuna longline operations in New Zealand waters, 1994-95 to 1996-97

Fishing year	Total no. hooks	% observed hooks	No. observed sets	BWS		POS		MAK		POS/MAK		DWD		SCH	
				Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error
North of 38 S															
1994-95	1298643	5.1	50	6.501	1.744	0.979	0.51	1.028	0.202	2.076	0.568	0.039	0.022	0.182	0.094
1995-96	1426364	4.3	63	9.888	1.568	3.618	0.843	2.119	0.322	5.758	0.93	0		0	
1996-97	1332214	5.8	96	3.837	0.429	1.034	0.175	1.425	0.166	2.479	0.291	0		0.048	0.023
Between 38 S and 43 S															
1994-95*	646760	0.3													
1995-96	365390	14.1	44	51.36	4.698	3.937	0.634	0.327	0.135	4.302	0.697	0.036	0.025	2.752	1.488
1996-97	294045	21.3	28	21.689	2.714	0.637	0.216	0.113	0.038	0.749	0.213	0.413	0.112	0.341	0.11
South of 43 S															
1994-95	218440	39.1	37	3.83	0.702	0.431	0.119	0.009	0.009	0.429	0.12	0.346	0.105	0.174	0.066
1995-96	311799	16.2	40	34.509	7.423	2.039	0.332	0.097	0.05	2.149	0.342	0.83	0.24	0.213	0.066
1996-97	191517	40.5	30	14.881	1.855	0.423	0.921	0.075	0.027	0.498	0.098	0.853	0.206	0.804	0.21

* See Appendix 1.

Table 7: Mean catch rates and standard errors for other non-target fish species* caught incidentally during observed domestic owned and operated tuna longline operations in New Zealand waters, 1994-95 to 1996-97

Fishing year	Total no. hooks	% observed hooks	No. observed sets	RBM		DEA		OFH		MOO		SWO		LAT	
				Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error	Mean no. fish per 1000 hooks	Standard error
North of 38 S															
1994-95	1298643	5.1	50	0.232	0.122	0.024	0.016	0.31	0.096	2.522	0.467	0.384	0.087	5.768	0.777
1995-96	1426364	4.3	63	0.25	0.062	0	0.263	0.918	0.263	0.823	0.155	0.645	0.126	4.093	0.533
1996-97	1332214	5.8	96	0.176	0.048	0.009	0.009	0.942	0.164	1.325	0.221	1.732	0.295	8.369	0.94
Between 38 S and 43 S															
1994-95*	646760	0.3													
1995-96	365390	14.1	44	4.291	0.681	1.061	0.204	0.157	0.098	1.469	0.283	0.246	0.074	0.102	0.05
1996-97	294045	21.3	28	3.805	0.71	0.972	0.23	0.077	0.075	0.361	0.074	0.479	0.208	1.689	0.954
South of 43 S															
1994-95	218440	39.1	37	8.392	0.743	1.62	0.534	0		0.166	0.049	0			
1995-96	311799	16.2	40	16.499	2.83	1.247	0.4	0.307	0.09	0.307	0.09	0		0.018	0.018
1996-97	191517	40.5	30	7.515	1.052	6.172	1.511	0.254	0.077	0.254	0.077	0.064	0.036	0	0

* See Appendix 1.

Table 8: Seabird bycatch rates calculated from observer data for foreign licensed Japanese vessels operating in New Zealand waters, 1990-91 to 1994-95

Fishing year	Total no. hooks*	% hooks observed	No. birds observed caught	Seabirds per 1000 hooks	Standard error
Northern area†					
1990-91	4863181	4.9	16	0.069	0.021
1991-92	3594884	6.8	7	0.029	0.017
1992-93	691335	50.7	82	0.233	0.037
1993-94	52440	100.3	33	0.625	0.177
1994-95	2100	100.0	0	-	-
1995-96	0	-	-	-	-
1996-97	0	-	-	-	-
Southern area					
1990-91	7059486	.0	-	-	-
1991-92	3409134	8.1	3	0.012	0.008
1992-93	2393891	11.8	57	0.197	0.067
1993-94	77130	97.1	3	0.035	0.027
1994-95	209499	98.8	2	0.010	0.006
1995-96	0	-	-	-	-
1996-97	0	-	-	-	-

* The total number of hooks do not include 162900 hooks set during the years 1990-91 to 1992-93 which have invalid longitude values; most of these hooks were set in the northern area.

† See Figure 1.

Table 9: Seabird bycatch rates calculated from observer data for chartered Japanese vessels operating in New Zealand waters, 1990-91 to 1996-97

Fishing year	Total no. hooks	% hooks observed	No. birds observed caught	Seabirds per 1000 hooks	Standard error
Northern area*					
1990-91	234730	49.2	21	0.183	0.007
1991-92	329855	0.0	-	-	-
1992-93	132396	0.0	-	-	-
1993-94	38868	100.0	0	-	-
1994-95	43087	62.9	1	0.034	0.030
1995-96	0	-	-	-	-
1996-97	135820	93.5	178	1.402	0.312
Southern area					
1990-91	826764	10.4	1	0.013	0.013
1991-92	1251028	0.0	-	-	-
1992-93	1413779	33.4	71	0.152	0.084
1993-94	798547	71.7	68	0.127	0.032
1994-95	1181026	46.0	87	0.163	0.043
1995-96	0	-	-	-	-
1996-97	1087545	61.8	104	0.162	0.049

* See Figure 1.

Table 10: Seabird bycatch rates calculated from observer data for domestic owned and operated vessels operating in New Zealand waters, 1990-91 to 1996-97

Fishing year	Total no. hooks*	% hooks observed	No. birds observed caught	Seabirds per 1000 hooks	Standard error
Northern area†					
1990-91	5730	0.0	-	-	-
1991-92	279988	7.0	3	0.133	0.094
1992-93	788713	0.0	-	-	-
1993-94	1256075	0.0	-	-	-
1994-95	1334483	4.9	8	0.128	0.057
1995-96	1531056	4.2	23	0.400	0.091
1996-97	1453929	5.5	82	1.104	0.198
Southern area					
1990-91	7340	0.0	-	-	-
1991-92	22660	0.0	-	-	-
1992-93	52370	0.0	-	-	-
1993-94	152665	1.6	0	0.000	
1994-95	789530	11.0	14	0.159	0.058
1995-96	508117	19.4	9	0.085	0.032
1996-97	342547	40.0	4	0.034	0.020

* The total number of hooks do not include 148160 hooks set during the years 1991-92 to 1996-97 which have invalid longitude values; most of these hooks were set in the northern area.

† See Figure 1.

Table 11: Numbers of seabirds landed dead and returned for identification (699 birds in total), by species and area*, for the foreign licensed Japanese, chartered Japanese, and domestic owned and operated fleets, for 1988-89 to 1996-97

Seabird species	No. birds returned for identification								% total
	Foreign Japanese vessels		Chartered Japanese vessels		Domestic N.Z. vessels		Southern	Northern	
	Northern	Southern	Northern	Southern	Northern	Southern			
Albatross species									
N.Z. white-capped albatross	1	5	6	89	1				15
N.Z. black-browed albatross	16	6	47	8	1				11
Antipodes I. wandering albatross	7		33	20					9
Southern Buller's albatross		17		33					3
Auckland I. wandering albatross	10		15	5					2
Southern black-browed albatross	11		17	1	1				4
Wandering albatross	3	2		7					2
Salvin's albatross	3		9						2
Southern royal albatross		3		6					1
Grey-headed albatross	1								1
Northern royal albatross			1	1					<1
Snowy wandering albatross			1	1					<1
Chatham Is wandering albatross			1						<1
Light-mantled sooty albatross				39					6
Petrel species									
Grey petrel	118	1	56	10	4				27
White-chinned petrel		2		47					7
Black petrel					4				1
Westland petrel		1							<1
Flesh footed shearwater					6				1
Sooty shearwater				3					<1
Northern giant petrel			5	1					1
Southern giant petrel	2								<1
Total of all seabird species	172	42	191	271	17				100

* See Figure 1.

Appendix 1:

Shark and other non-target fish bycatch data

Observer data collected by the Ministry of Fisheries Scientific Observer Programme were extracted from the NIWA administered tuna longline database in April 1998. Data were then stratified by fleet according to three latitude bands: north of 38° S, between 38° and 43° S, and south of 43° S which provided a reasonably even distribution of observer coverage. Data for the domestic effort prior to 1994–95 were not used because of the small amount of observed effort. Data for the domestic effort in latitude band 38° S to 43° S in 1994–95 were few and were added into the latitude band greater than 43° S.

Total effort data were extracted from the Ministry of Fisheries Tuna Longline Catch Effort Return (TLCER) database in May 1998. The total number of hooks set may underestimate the total effort because fishers may fail to fill in the appropriate catch forms. The domestic vessel data are supplemented by data from the Ministry of Fisheries Catch Effort Landing Return (CELR) database extracted in May 1998 for one vessel which was observed in several years and returned either TLCER or CELR forms; this achieved a more representative coverage of this effort. Where observed effort was recorded for a vessel, but there was no equivalent effort on the TLCER or CELR databases this observed effort was added to the total effort for the appropriate stratification. Comparison of the hook data from the commercial records and from the observed records for the same trip yielded discrepancies in the numbers of hooks per set. This resulted in slightly higher number of hooks observed than recorded as set in some strata.

Where the observed set had been abandoned or where there was no catch record, the data were deleted from the data sets used for the estimation of bycatch rates. Data from one observer showed consistent under reporting and therefore these data were also deleted from the data set.

Concerns about the ability of the observers to distinguish between certain fish species resulted in groupings of fish species. For this reason, mako and porbeagle sharks are dealt with separately as well as combined. Before 1993 some observers recorded only mako sharks and others only porbeagles. Table A below gives the scientific names of the main non-target fish species caught during observed tuna longline operations. Where species are grouped the common name is in bold.

Catch rates (per 1000 hooks) were calculated for the main non-target fish bycatch species on a set by set basis. The resulting catch rates were then stratified by fleet (foreign licensed and chartered Japanese sets were grouped together) and latitude band for each fishing year. These were then run through a bootstrap resampling procedure (Efron & Tibshirani 1993) to provide a mean catch rate and standard error for each stratum.

Appendix 1—continued

Table A: Non-target fish species as recorded by Ministry of Fisheries observers

Species abbreviation	Common names	Scientific names
BWS	Blue shark	<i>Prionace glauca</i>
POS	Porbeagle shark	<i>Lamna nasus</i>
MAK	Mako shark	<i>Isurus oxyrinchus</i>
DWD	Deepwater dogfish	Squaliformes
	Seal shark	<i>Dalatias licha</i>
	Deep sea dogfish	<i>Centroscymnus</i> spp.
	Leafscale gulper shark	<i>Centrophorus squamosus</i>
	Owston's dogfish	<i>Centroscymnus owstoni</i>
	Baxter's dogfish	<i>Etmopterus baxteri</i>
	Lucifer dogfish	<i>Etmopterus lucifer</i>
	Largespine velvet dogfish	<i>Centroscymnus macracanthus</i>
	Velvet dogfish	<i>Zameus squamulosus</i>
SCH	School shark	<i>Galeorhinus galeus</i>
RBM	Ray's bream	<i>Brama brama</i>
DEA	Dealfish	
	Dealfish	<i>Trachipterus jacksonensis</i> & <i>T. trachipterus</i>
	Scalloped dealfish	<i>Zu elongatus</i>
	Ribbonfish	<i>Agrostichthys parkeri</i>
	Oarfish	<i>Regalecus glesne</i>
OFH	Oilfish	<i>Ruvettus pretiosus</i>
MOO	Moonfish	<i>Lampris guttatus</i>
SWO	Broadbill swordfish	<i>Xiphias gladius</i>
LAT	Lancetfish	<i>Alepisaurus ferox</i> & <i>A. brevirostris</i>

Appendix 2:

Seabird bycatch data

Observer data collected by the Ministry of Fisheries Scientific Observer Programme were extracted from the NIWA administered tuna longline database in April 1998. Data were then stratified by fleet according to the areas used in Murray *et al.* (1993). To provide a large enough sample size for a meaningful assessment, the data for each fleet were pooled across areas for each fishing year. Thus, the "northern area" which equates to Areas 1, 2, & 5 (*see* Figure 1) and encompasses waters north of 37° S off the west coast of New Zealand and waters north of 44° S off the east coast and the "southern area" which equates to Areas 3 & 4 and is south of the above latitudes.

Total effort data were extracted from the Ministry of Fisheries Tuna Longline Catch Effort Return (TLCER) database in May 1998. The total number of hooks set may underestimate the total effort because fishers may fail to fill in the appropriate catch forms. The domestic vessel data are supplemented by data from the Ministry of Fisheries Catch Effort Landing Return (CELR) database extracted in May 1998 for one vessel which was observed in several years and returned either TLCER or CELR forms; this achieved a more representative coverage of this effort. Where observed effort was recorded for a vessel, but there was no equivalent effort on the TLCER or CELR databases this observed effort was added to the total effort for the appropriate stratification. Comparison of the hook data from the commercial records and from the observed records for the same trip yielded discrepancies in the numbers of hooks per set. This resulted in slightly higher number of hooks observed than recorded as set in some strata.

For the foreign licensed data there are 162900 hooks in the total hooks data set for 1990–91 to 1992–93 from the TLCERs for which there are invalid longitude values. Until these are validated they are treated as null for the seabird analysis. Similarly for the domestic data during 1991–92 to 1996–97 there are 148160 hooks with invalid longitude values. The latitude values of these hooks show that most were set in the northern area.

Where the observed set had been abandoned or where there was no catch record, the data were deleted from the data sets used for the estimation of bycatch rates. Data from one observer showed consistent under reporting and therefore these data were also deleted from the data set. However, 6 seabirds were recorded from the 5 trips this observer completed and these birds were all recorded as dead and returned for identification. Therefore, these birds are included in the count of different seabird species recorded caught.

To estimate the mean number of seabirds caught per 1000 hooks, the catch rates per set were grouped by fleet and area for each fishing year and then run through a bootstrap resampling procedure (Efron & Tibshirani 1993) to provide a mean catch rate and standard error for each stratum.

