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T. Murray

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T. Murray

NIWA
Private Bag 14901
Wellington

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EXECUTIVE SUMMARY

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This report reviews information derived from catch and effort logsheets collected by the New Zealand Ministry of Fisheries and longline catch and effort data compiled by the Secretariat of the Pacific Community, Noumea, New Caledonia. These data are used to describe the distribution of Pacific bluefin (*Thunnus orientalis*) in comparison with southern bluefin tuna (*T. maccoyii*), both within the New Zealand EEZ and more broadly in the western and central Pacific Ocean. Pacific bluefin tuna, recognized as a distinct taxon from southern bluefin tuna, but previously regarded as a subspecies of bluefin tuna (*T. thynnus*), have been recognized as a minor component of tuna longline catches in the southwestern Pacific Ocean since the 1960s. These regular, but small catches of Pacific bluefin tuna (all by longline), began increasing dramatically with the expansion of the domestic longline fishery in New Zealand waters but apparently not elsewhere in the southwestern Pacific. Part of the reason for increasing catches of Pacific bluefin, stems from the increased ability of fishers to correctly distinguish between Pacific and southern bluefin tunas, and the decision by the Ministry of Fisheries that the two species be separated for quota monitoring purposes.

Reported catches of Pacific bluefin tuna increased exponentially from 1991 to 2002 to nearly 60 t (total landings). Catches have subsequently declined (40 t in 2003 and 54 t in 2004) due to fewer boats longlining and low market prices for all bluefin tuna species generally. Most of the catches within New Zealand waters are from FMA 1 and FMA 2, although catches are made throughout the EEZ. Although catches of Pacific bluefin tuna have been reported in all months, above average catch rates (higher than 1.07 fish per 1000 hooks) of Pacific bluefin tuna occur from April to July.

Cumulative frequency distributions of Pacific bluefin tuna catches indicate that Pacific bluefin range from the North Pacific probably as far south as 48.3° S (99.9% of all catches in the EEZ), although identity has only been confirmed genetically in Pacific bluefin caught as far south as 46.6° S. In contrast, southern bluefin appear not to be caught in New Zealand waters further north than 31.1° S.

1. INTRODUCTION

Globally, three species of bluefin tuna are recognised: Atlantic bluefin tuna (*Thunnus thynnus* Linnaeus, 1758), Pacific bluefin tuna (*Thunnus orientalis* Temminck & Schlegel, 1844) and southern bluefin tuna (*Thunnus maccoyii* Castelnau, 1872). Two of these species (Pacific and southern bluefin tunas) are now routinely recognised in the commercial catches in the western and central Pacific Ocean. Until recently, confusion over taxonomy and identification of the bluefin tuna species in the western and central Pacific Ocean resulted in the belief that Pacific bluefin tuna was largely restricted to the North Pacific Ocean. Genetic and morphological work by Smith et al. (2001), however, resulted in the discrimination between Pacific and southern bluefin tuna in commercial longline catches from New Zealand waters.

Pacific bluefin tuna supports a number of important surface, longline and recreational fisheries principally in the North Pacific Ocean. Over the most recent 10 year period for which data are available (1990–1999), catches have averaged 16 228 t per year (Anon 2002). Most of the Pacific bluefin catch (over 85% on average) is taken in the waters of the northwestern Pacific Ocean, primarily in surface fisheries for juveniles.

Significant catches of Pacific bluefin tuna are also taken by tuna longline in the western and central Pacific Ocean as far south as New Zealand and Australia. This paper reviews information on the distribution, identification, catches, and the southern limits of Pacific bluefin tuna in the southwest Pacific Ocean.

2. DISTRIBUTION

Kitagawa et al. (2000) described Pacific bluefin as "one of the most important fishery resources in the neritic [continental shelf waters] region of Japan" and detailed the distribution of immature bluefin as mainly around Japan and the East China Sea. As juveniles, Pacific bluefin undertake extensive trans-Pacific migrations. Bayliff et al. (1991) described age-0 fish tagged in the western Pacific being recaptured in the eastern, central, and western Pacific and age-1 and age-2 fish tagged in the eastern Pacific being recaptured in the eastern and western Pacific Ocean. Citing reports from the Fisheries Agency of Japan, Bayliff et al. (1991) further noted that small numbers of juvenile Pacific bluefin have also been caught by pole-and-line boats in the waters north of Papua New Guinea, and in the vicinity of the Solomon Islands and the Republic of the Marshall Islands.

Juvenile movement can be extensive and is well determined from long-term tagging studies, but the movements and distribution of adult Pacific bluefin have generally been inferred from longline catches. Shingu et al. (1974) showed the size composition of Pacific bluefin caught by Japanese longline vessels in 1966–67 in the Pacific Ocean west of 160° W. They demonstrated that at that time Pacific bluefin were caught throughout the western Pacific Ocean south of 20° N, and inferred "that the seasonal change in hook rates for the southwest Pacific Ocean showed the spawning migration of adult bluefin to the North Pacific, indicating substantial mixing in the whole western Pacific".

Tomlinson (1996) used Japanese longline data from 1952 to 1986 to describe the movement of large Pacific bluefin. He inferred extensive movements in the North Pacific of about 700 km per month, with large Pacific bluefin concentrating on or near the spawning grounds in April to June, and then moving north and east to reach the central Pacific Ocean and beyond by December–January. While focusing his analysis on the east-west movements of Pacific bluefin in the North Pacific Ocean, Tomlinson (1996) clearly showed regular (and frequently large) catches of Pacific bluefin tuna in the waters of Pacific Islands Forum Fisheries Agency (FFA)[1] member states in most months. Catches were particularly widespread through the FFA region during April–September from 1973 onwards with some of the highest catches in the Pacific Ocean in the Australia–New Zealand region (30° to 40° S) in July to September (Tomlinson 1996, figures 1–12). Pacific bluefin data held at the Secretariat of the Pacific Community, Noumea, New Caledonia (SPC) indicates that longline catches in this region have averaged 35% of the Pacific bluefin tuna catches (range 5% to 75% in number) from the waters of the western and central Pacific Ocean since 1962. Preliminary results reported by Yano (see http://swfsc.ucsd.edu/tunaconf.html) indicate that while most large Pacific bluefin either moved south or stayed near the spawning grounds, one fish moved from southern Japan to cross the equator within 44 days.

The occurrence of Pacific bluefin tuna in the waters of FFA members is of particular interest since this species will be subject to the conservation and management measures of the newly established Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Central and Western Pacific, done at Honolulu, 5 September 2000 (entered into force 19 June 2004). Any such measures would be initiated on the basis of scientific information considered by Commission members resident in or fishing in the waters beyond the FFA region (i.e., the WCPFC Commission's Northern Committee).

Spawning takes place between Japan and the Philippines in April, May, and June, spreading to the waters off southern Honshu in July and to the Sea of Japan in August (Bayliff et al. 1991). A single stock for Pacific bluefin tuna is hypothesised based on morphometrics, tagging, distribution by size, and because no other area has been found where eggs and larvae of Pacific bluefin tuna occur (Shingu et al. 1974). Bayliff (1993) was more definite: "spawning of Pacific northern bluefin tuna...takes place only in the western Pacific Ocean".

Within New Zealand waters, above average catch rates (over 1.07 fish per 1000 hooks) occur in fisheries management areas FMA 1 and FMA 2, although there are few data for FMA 3, FMA 4, and FMA 8 where they have been frequently reported in catches. While Pacific bluefin CPUE is usually highest off the east coasts of the North and South Island, the fish are found throughout the New Zealand EEZ. Above average CPUE for Pacific bluefin tends to be during April to July in New Zealand waters, although catches have been reported in all months.

3. DISTINGUISHING BETWEEN PACIFIC AND SOUTHERN BLUEFIN TUNAS

Although Pacific bluefin tuna have long been recognised by Japanese longline fishers as occurring as far south as 40° S off New Zealand and 46° S off eastern Australia (Shingu et al. 1974), identification of these early catches may have been confused in southern waters with catches of southern bluefin tuna. Doubt about fishers ability to distinguish between southern and Pacific bluefin tunas in longline catches was first raised when Smith et al. (1994) were able to confirm only two of 17 large bluefin identified by Japanese fishers as Pacific bluefin tuna using genetic markers. Based on this research, and to ensure New Zealand stayed within its catch limit obligations under the Convention for the Conservation of Southern Bluefin Tuna (CCSBT), New Zealand domestic catches of bluefin tuna throughout most of the 1990s, regardless of species reported, were attributed to southern bluefin tuna for quota monitoring purposes.

[1] The Forum Fisheries Agency is composed of 17 western and central Pacific Ocean states and territories including: 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. The combined EEZs of FFA members cover an ocean area of more than 27 million km^2 and include much of the North and South Pacific Ocean west of 150° W and south of 20° N.

Genetic markers distinguishing between Pacific and southern bluefin tunas were first identified by Japanese researchers (Chow & Inoue 1993, Chow & Kishino 1995) and Ward et al. (1995) were able to genetically discriminate between Pacific and southern bluefin tuna caught in Australian waters. More recently, Chow et al. (2003) have extended the discrimination to larval bluefin species, including Pacific bluefin larvae, using genetic markers.

Morphological characteristics have also been shown to be useful for discriminating between Pacific and southern bluefin tunas, although most of these are features that cannot be observed without dissection. The only external feature noted by Collette (1999) as useful for separating southern bluefin from Atlantic and Pacific bluefin tunas was caudal keel colour (yellow in southern but dark in both Atlantic and Pacific bluefin tunas). He did note that Atlantic and Pacific bluefin tuna could be separated by gill raker counts and by the "shape of the dorsal wall of the body cavity in large specimens", but did not describe the differences in this character. The discovery of an additional morphological character (possibly the same as that used by Collette (1999)) by Japanese fishers and by Ministry of Fisheries observers has resulted in New Zealand fishers reliably distinguishing between species. This character is a pronounced bulge of creamy white fleshy tissue suspended from the dorso-anterior wall of the body cavity beginning immediately posterior to the pharynx. This character, termed a "chicken breast" by New Zealand fishers because of its resemblance to poached chicken breast, is prominent in Pacific bluefin and absent or greatly reduced in southern bluefin tuna. The nature and purpose of this character is unknown.

Identifications of Pacific and southern bluefin tunas by observers since 1996 using the presence or absence of the "chicken breast" (described by Smith et al. 2001) now appear to be very accurate (with only 3.5% of all bluefin erroneously identified when visual identifications were tested genetically). Following the Smith et al. (2001) study and a series of species identification workshops to teach fishers, fish processing staff, and fisheries compliance officers how to distinguish between bluefin tuna species in commercial catches, the Ministry of Fisheries changed its reporting requirements. Beginning in June 2001 fishers were allowed to report Pacific bluefin separately from southern bluefin tuna in their catch. To ensure compliance, tissue samples continue to be collected so as to confirm fish identified as Pacific bluefin when required.

As Smith et al. (2001) reported, observers can distinguish between bluefin species caught in the EEZ when they are landed and processed, but visual identifications before processing can be problematic. Observers describe Pacific bluefin as more slender or elongate than southern bluefin, suggesting that Pacific bluefin should be of lower weight than southern bluefin tuna of equal length. Analysis of observer data where observer species identification is regarded as accurate (since 1996), however, does not support this and indicates that the length:weight relationships of southern and Pacific bluefin tuna are not significantly different (see Table 1). This may in part be due to the small sample size for Pacific bluefin. Observer data does show that Pacific bluefin in New Zealand waters are usually larger than southern bluefin (maximum sizes of 260 c.f. 210 cm fork length) and that although there is considerable overlap in the size distributions (Figure 1), 95% of southern bluefin and 25% of Pacific bluefin tuna are smaller than 180 cm fork length.

4. THE SOUTHERN LIMIT OF PACIFIC BLUEFIN TUNA IN THE WESTERN PACIFIC

The latitudinal distribution of Pacific and southern bluefin tunas in the New Zealand EEZ has been analysed for the period when Japanese longliners operated under foreign licence (using catch and effort logbook data supplied to the Ministry of Fisheries). This fleet was chosen because Japanese fishers were better able than domestic fishers to distinguish between southern and Pacific bluefin tunas, and because the area of operation of this fleet had a wide latitudinal spread (chartered Japanese vessels were not included because their fishing was spatially restricted). In addition, because quota restrictions during most of the years this fleet fished in the EEZ was not limiting (years up to 1989), there was likely to have been little motivation to misreport their catch. This period was also chosen because by the 1980s, indeed probably much earlier, Japanese fishers had had several decades of fishing for both southern and Pacific bluefin tuna in the region and were generally regarded as able to distinguish between these species despite their similar appearance.

The cumulative frequency distributions of Pacific and southern bluefin tuna catch as a function of latitude is shown in Figure 2. Although the most southerly record for Pacific and most northerly record for southern bluefin represents the putative geographical extent of each species, the cumulative distributions show clearly where the probability of a catch of either species becomes highly unlikely. From Figure 2, 99.9% of all Pacific bluefin are caught in waters north of 48.3° S and 99.9% of all southern bluefin are caught in waters south of 31.1° S. Samples collected by observers from as far south as 46.6° S have been genetically confirmed as Pacific bluefin.

Catch and effort data provided by the SPC which composites longline catches by the fleets of Japan, Korea, and Taiwan for 1962 to 2002 were also used to examine the broader geographical distribution of the bluefin tuna complex in the western and central Pacific Ocean. The cumulative catches by these longline fleets by 5° of latitude is summarised in Figure 3. The Pacific bluefin tuna longline catch corresponding to the area of the WCPFC Northern Committee area (20° N) is also shown in Figure 3, indicating that an appreciable quantity of Pacific bluefin tuna occurs in longline catches in the waters south of 20° N (about 25% of the catch in weight from waters west of 150° W), mostly within the EEZs of FFA member states.

5. PACIFIC BLUEFIN TUNA CATCHES IN THE NEW ZEALAND EEZ

The New Zealand Ministry of Fisheries has recognised Pacific bluefin tuna as a regular but relatively small component of the tuna longline fishery operating in the EEZ since the start of foreign licensed longlining in 1980. However, the generally small catches (usually 1 to 15 t) attracted little more than scientific interest before the start of the domestic longline fishery in the early 1990s. The domestic longline fishery began with a single vessel in 1989, increasing exponentially to over 130 vessels in 2001 (Murray et al. 2002). This fleet of mostly small to medium sized longliners (50 GRT or less) largely targets bigeye tuna in waters north of 40° S, although catches of Pacific bluefin have steadily risen through the 1990s. The exponential increase in landings (ln(TOR landing) = 0.41•Year–812.54, r = 0.90) can be clearly seen in Figure 4, especially after 1996 when fishers became increasingly aware of the differences between Pacific and southern bluefin tunas. Catches in 2002 were nearly 60 t. However, low prices for Pacific and southern bluefin tunas subsequently have seen fewer longliners fishing, and the Pacific bluefin tuna catch declined to 40 t in 2003 and 54 t in 2004. On 1 October 2004, Pacific bluefin tuna were introduced into the Quota Management System and the Total Allowable Commercial Catch within New Zealand fisheries waters was set at 116 t out of a Total Allowable Catch of 120 t.

A summary of the historical catch of Pacific bluefin tuna by fleet, fishing year (1 October to 30 September), and fisheries management area is given in Table 2. This summary is based on groomed catch and effort logbook data and uses the nominal catches to depict the differences between fleets and areas over the history of this fishery. It is clear that, aside from 1981–82 to 1983–84, Pacific bluefin tuna catches by the foreign licensed Japanese fleet were small. These catch levels are at least partly attributable to declining foreign longline fishing effort, especially effort targeting bigeye tuna within the EEZ. The increase in domestic catches corresponds to the landings trend discussed above. However, for both fleets it is clear that most Pacific bluefin tuna catches are from fisheries management areas FMA 1 and FMA 2. These waters correspond to the main area for targeting bigeye tuna, although southern bluefin tuna are also caught in these areas seasonally in appreciable quantities. The extent of Pacific bluefin tuna distribution within the EEZ can be seen in plots of the position of all longline sets since 1980 catching Pacific bluefin tuna (Figure 5).

6. ACKNOWLEDGEMENTS

SPC do not normally provide data on Pacific bluefin tuna separated from records they hold for southern bluefin tuna, an acknowledgement of the difficulty of separating these species, particularly in catches by vessels from Korea and Taiwan. I acknowledge with thanks the provision of bluefin tuna data by species and absolve them from any responsibility as to the inferences drawn in this paper. The manuscript benefited from the critical review by Dr Peter Smith of the National Institute of Water & Atmospheric Research for which the author extends his appreciation. Thanks are also due to Neville Smith and Shelton Harley of the Ministry of Fisheries for comments on the manuscript. Special thanks are due to the observers whose diligence at sea can always be counted on and is always appreciated. This paper would not have been possible without the data they collected.

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Table 1: Length weight regression parameters for southern and Pacific bluefin tunas based on longline observer data from the New Zealand EEZ since 1996 (dependant variable is ln(whole weight, kg); the predictor is ln(fork length, cm.

Parameter	Southern bluefin tuna	Pacific bluefin tuna
Intercept (b_0)	-11.12	-9.88
+ 95% confidence interval of b_0	-11.07	-8.38
- 95% confidence interval of b_0	-11.17	-11.38
Slope (b_1)	3.05	2.81
+ 95% confidence interval of b_1	3.06	3.09
- 95% confidence interval of b_1	3.04	2.52
No. of fish measured	15 208	48
R^2	0.96	0.89

Table 2: Summary of Pacific bluefin tuna nominal catches (whole weight, t) from the New Zealand EEZ by fleet, management area and fishing year.

Fleet	Fish Yr	FMA 1	FMA 2	FMA 3	FMA 4	FMA 5	FMA 6	FMA 7	FMA 8	FMA 9	FMA 10	ET	Unknown	Total
NZ domestic & charter	1988–89					0.1								0.1
	1989–90	0.1	0.9					0.2						1.2
	1990–91	1.1	0.2											1.3
	1991–92	0.3	0.9							0.3				1.5
	1992–93	2.2	0.6					0.2						2.9
	1993–94	1.1	0.5							0.2				1.8
	1994–95	1.4	0.5			0.0								1.9
	1995–96	1.5	6.5					0.1						8.1
	1996–97	8.4	3.7					0.1					0.3	12.6
	1997–98	12.1	6.3			1.0		0.7		2.4		0.4		22.8
	1998–99	11.2	5.2			0.6		0.6	0.3	2.5		0.1	0.2	20.8
	1999–00	5.2	24.2	0.1				0.2	0.1	2.2	0.3	0.1	0.3	32.7
	2000–01	13.1	24.7			0.1		0.3		5.3	0.4	1.0		44.8
	Total	57.8	74.1	0.1		1.8		2.3	0.5	12.9	0.7	1.6	0.8	152.5
Foreign licensed (Japan)	1979–80	0.1	0.4	0.3			0.7					0.2		1.8
	1980–81		0.5	4.1	0.2		0.4				0.1			5.3
	1981–82	21.2	80.8	2.1			0.3			2.3	3.0	0.1	0.4	110.2
	1982–83	16.2	32.3	14.0	6.1					0.8	0.6	0.3	0.1	70.3
	1983–84	14.0	30.6	0.6						0.6	1.2			47.1
	1984–85	2.2	2.3	0.3			0.3			0.7	0.2	1.0		7.0
	1985–86	1.9	2.6	0.3		0.4				0.4	0.1	0.3		5.9
	1986–87	4.0	3.1	0.2		0.8	0.2			0.2	2.1	0.4		10.9
	1987–88	5.8	6.1			1.0				0.3	0.3			13.6
	1988–89	1.2	13.2	0.2						0.4	0.1			15.1
	1989–90	1.9	11.8	0.1						0.1	0.7	0.4	0.1	15.1
	1990–91	3.0	10.5	0.5		0.3					0.2	0.0		14.6
	1991–92	2.5	4.7			0.4				1.5				9.0
	1992–93	0.4	1.7											2.0
	1994–95		0.1											0.1
	Total	74.4	200.7	22.7	6.3	3.0	1.9			7.2	8.6	2.7	0.6	328.1

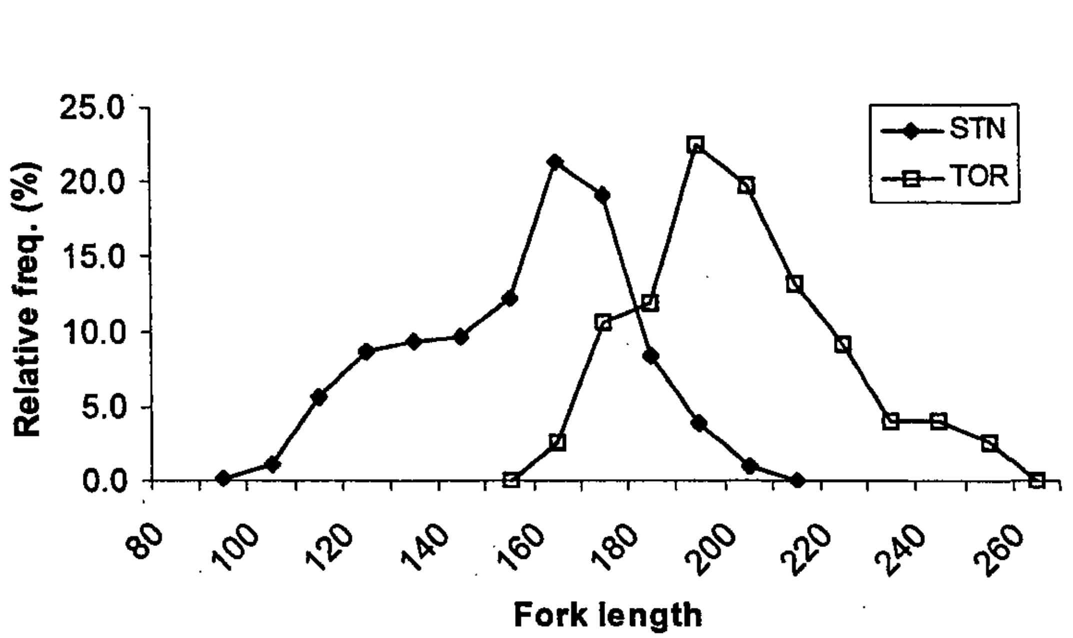

Figure 1: Relative size frequency distributions for southern bluefin tuna (STN), n = 16 698 fish, and Pacific bluefin tuna (TOR), n = 76 fish, based on longline observer data from the New Zealand EEZ since 1996. Each point represents a 10 cm size class.

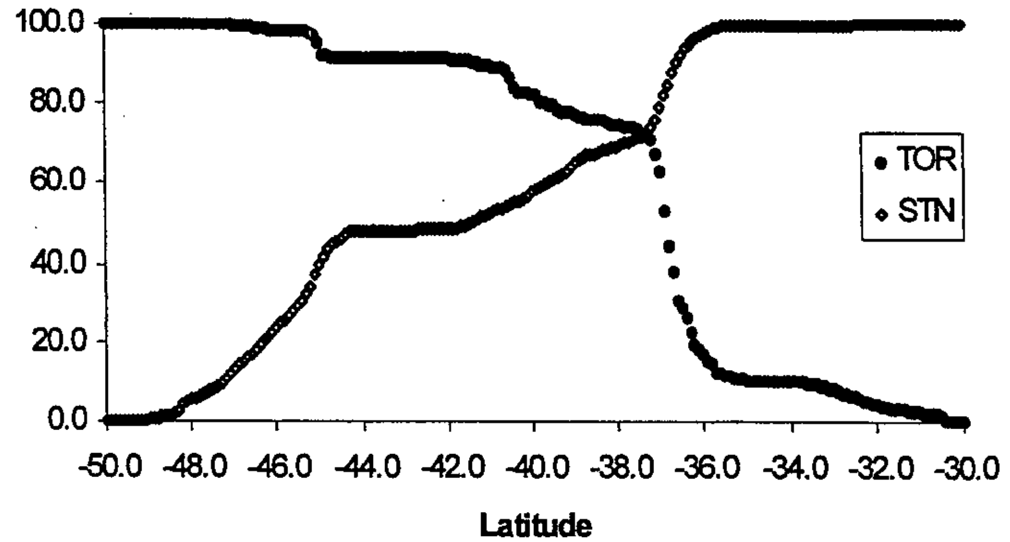

Figure 2: Cumulative frequency distributions of the Japanese foreign licensed longline catch in weight of Pacific (TOR, solid circles) and southern bluefin (STN, open diamonds) by latitude in the New Zealand EEZ and adjacent high seas area for the period 1980 to 1995.

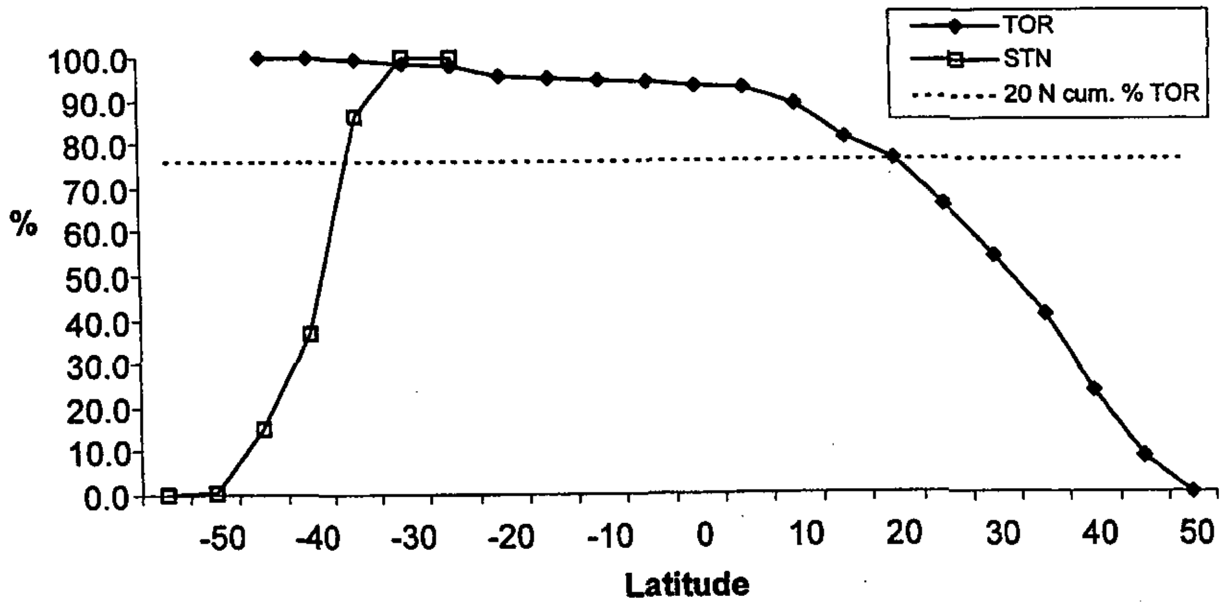

Figure 3: Cumulative frequency distributions of the combined longline catch in weight of Pacific (TOR) and southern bluefin (STN) tunas by latitude (negative = south latitudes; positive = north latitudes) in the WCPFC area, 1962 to 2002.

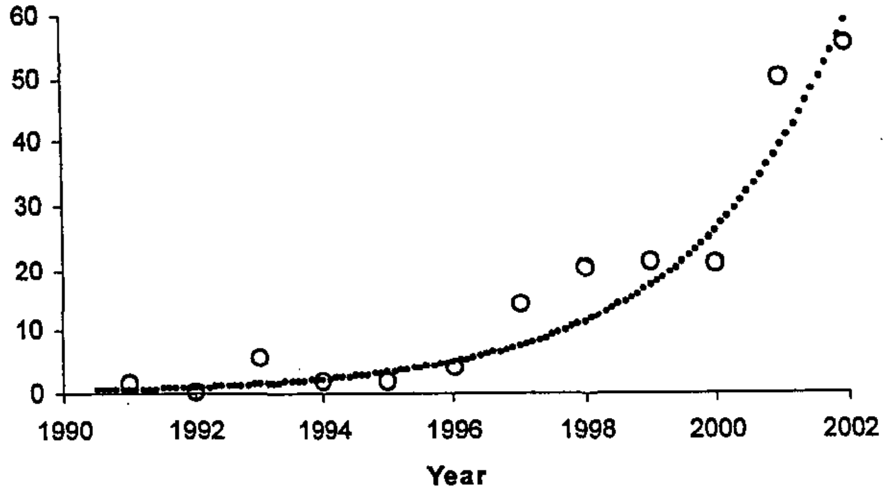

Figure 4: Trend in Pacific bluefin tuna landings (whole weight, t) by New Zealand tuna longline vessels fishing in the EEZ since 1991.

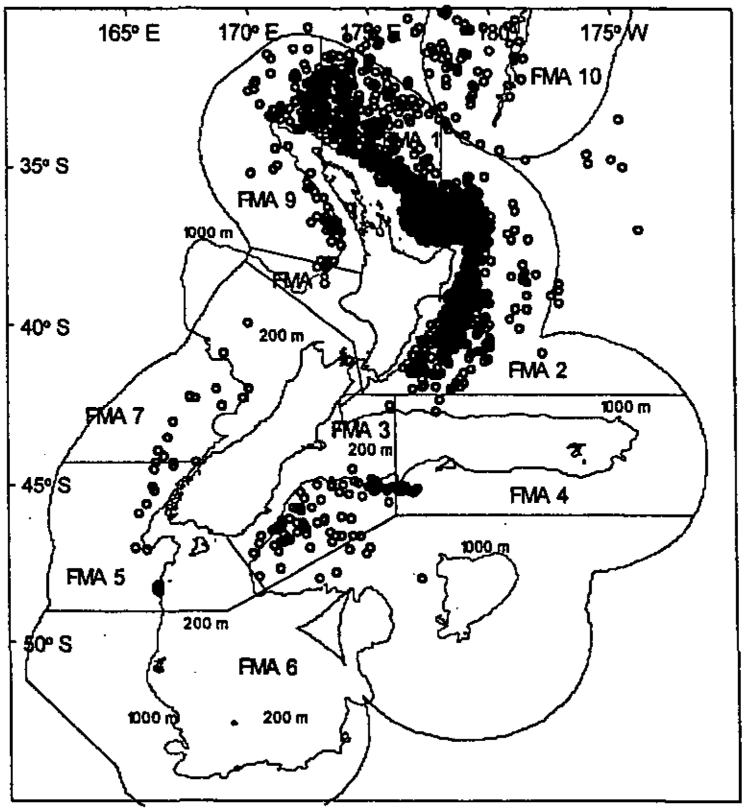

Figure 5: Longline set positions catching Pacific bluefin tuna (open circles) in the New Zealand EEZ and adjacent high seas areas since 1980.