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New Zealand tuna fisheries, 2001 and 2002

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EXECUTIVE SUMMARY

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The main fisheries for tuna in 2001 and 2002 were the albacore troll fishery, the skipjack tuna purse-seine fishery, the southern bluefin tuna longline fishery, and the bigeye tuna longline fishery. The troll and purse-seine fisheries occur in summer, while the southern bluefin tuna longline fishery operates in winter. The longline fishery targeting bigeye tuna operates primarily in autumn and winter with smaller catches in spring and summer. Fishing effort and catch rates for the tuna and swordfish caught by these fisheries are reviewed.

No trend in standardised CPUE is evident for the surface fisheries for albacore tuna and the nominal (un-standardised) CPUE for tuna and swordfish in the longline fisheries vary with fleet and target species. CPUE models using a quasi-likelihood generalised additive model that standardise for a number of factors and covariates indicate that although relative abundance in the albacore troll fishery may not have changed, the relative abundance of bigeye and southern bluefin tuna has changed in the longline fisheries. In the last two fisheries it was possible to incorporate foreign licensed longline data from 1980 to extend the time series of abundance indices and compare them with the nominal CPUE values. For both the bigeye and southern bluefin tuna fisheries there is evidence of variability in relative abundance over the time series with relative abundance in 2002 lower than in the early 1980s.

In the bigeye tuna longline fishery between 1980 and 2002 for the standardised abundance indices derived here, there are only moderate differences between the estimated coefficients and the nominal CPUE values for bigeye tuna. Nominal and standardised CPUE exhibit similar trends with low relative abundance in 1981–83 compared with 1980, followed by an increase to about 90% (standardised) of the 1980 level during 1984–86. Since 1986 the relative abundance of bigeye tuna indices in the New Zealand EEZ further declined to about 15% of the 1980 level in 1995. The bigeye tuna abundance indices then increased to about 40% (of 1980 value) in 1998, followed by a decline to about 10% thereafter.

The temporal and spatial distribution of the southern bluefin tuna longline fishery has changed to such an extent that the fishery was analysed as three separate fishing areas (east coast north and south of 44° S and the west coast of both islands). The estimated southern bluefin tuna abundance indices for the east coast north of 44° S are similar to, or less than, the nominal CPUE values until 1994. There is a substantial increase in southern bluefin tuna nominal CPUE and abundance indices after 1995. In 1998 to 2002, the estimated abundance index is about 50–70% of the 1980 value in this area (about 50% in 2002). Nominal CPUE has declined faster than the standardised indices since 1999, reaching about 20% of 1980 values by 2002.The estimated abundance indices of southern bluefin tuna for the east coast fishing area south of 44° S for 1997 to 2002 increased to about 40% of the 1980 value, apart from substantial declines in 2000 and 2002. However, only a small proportion of overall effort in the New Zealand southern bluefin tuna fishery has occurred in this region since 1992. For the west coast fishing area there appears to be significant differences between yearly southern bluefin tuna nominal CPUE values and estimated year coefficients. However, there was a sharp reduction in effort after 1993, and this is reflected in the increase in the size of the confidence intervals over that period. The standardised indices suggest a more modest increase in southern bluefin tuna abundance in this region after 1994 than is suggested by the nominal CPUE time series, from about 40% of 1985 abundance before 1994 to about 50% after 1994, although year-to-year variability is also high. Given the likely underestimate in uncertainties, this conclusion remains tentative.

1. INTRODUCTION

New Zealand tuna fisheries are based on stocks that occur largely outside the 200 nautical mile Exclusive Economic Zone (EEZ). In New Zealand waters, tuna are important and valuable fisheries (currently more than $NZ20 million annually). No tuna species are included in the Quota Management System at this time. Southern bluefin tuna (*Thunnus maccoyii*) is managed by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), and is subject to a 420 t competitive national catch limit. Other tuna species of commercial importance to New Zealand are albacore (*T. alalunga*), bigeye (*T. obesus*), skipjack (*Katsuwonus pelamis*), yellowfin (*T. albacares*), and Pacific bluefin (*T. orientalis*) tunas. Although billfish are a regular bycatch on tuna longlines, all except swordfish (*Xiphias gladius*) must be released when caught. Swordfish may not be targeted, but can be landed by domestic fishers as an incidental catch. This species has become increasingly important to the domestic tuna longline fishery and landings in the last few years have rapidly increased.

The southern bluefin tuna fishery in New Zealand began as a handline and troll fishery off the west coast of the South Island from small vessels during winter. These methods are now only occasionally used, and most southern bluefin tuna are caught by longline vessels in autumn and winter. Southern bluefin tuna catches, restricted to a national competitive catch limit of 420 t since 1989, have usually been below this limit with landings averaging 281 t per year over the past 10 years, and a maximum landing of 529 t in 1990 (Murray et al. 2004).

In New Zealand, albacore form the basis of a summer troll fishery, primarily on the west coasts of the North and South Islands, and this accounts for most albacore landings. Albacore are also caught throughout the year by longline (usually 1000–2500 t per year). Annual landings over the past 10 years (1991 to 2000) have averaged 4583 t with a maximum landing of 6526 t in 1998 (Murray et al. 2004).

Bigeye tuna are caught by longline around the northern half of the North Island throughout spring and autumn, with landings averaging 174 t per year over the past 10 years; with a maximum landing of 422 t in 2000 (Murray et al. 2004).

Skipjack tuna are caught in small numbers by trolling, with most of the catch by purse-seine during summer. Skipjack tuna landings have averaged 4583 t per year over the past 10 years, with a maximum landing of 9699 t in 2000 (Murray et al. 2004). Yellowfin tuna, caught in small numbers in the troll fishery, are generally a bycatch of longline sets targeting bigeye tuna in summer.

Landings of yellowfin tuna have averaged 98 t per year over the past 10 years, with a maximum landing of 198 t in 1996 (Murray et al. 2004). Pacific bluefin tuna (*Thunnus orientalis*), only recently recognised (June 2000) as contributing to tuna landings, have averaged 9 t per year over the past 10 years, with a maximum landing of 21 t in 1999 (Murray et al. 2004).

Swordfish are a bycatch of longline sets targeting bigeye and southern bluefin tuna around both the North and South Islands. Swordfish landings have averaged 337 t per year over the past 10 years, but have been increasing with increased longline effort, especially over the last few years, with a maximum landing of 1004 t in 1999 (Murray et al. 2004).

In addition to the tuna target species, several other commercially valuable species, together with commonly caught species (both fish and non-fish) of little or no value, make up the longline bycatch. Catch composition and bycatch estimates were reported by Francis et al. (1999, 2000, 2004) for the tuna longline fishery. The longline bycatch has also focused attention on the potential for impacts on a range of dependent or associated species, particularly those that are rare, have low fecundity, or about which little is known.

Similarly, for purse-seine fishing targeting skipjack tuna in the EEZ, over 60 fish species have been reported as bycatch (Habib et al. 1982). Trolling and other tuna fishing methods do not appear to have an appreciable bycatch.

This report addresses objectives 1A and 1B of Ministry of Fisheries project TUN2001/01:
To produce reports of the New Zealand fisheries for albacore, bigeye, skipjack, southern bluefin, Pacific bluefin and yellowfin tuna and swordfish for the 2001 (1A) and 2002 (1B) calendar years.

2. METHODS

Data used in this report were taken from several sources. Landings data are from the Licensed Fish Receiver Reports (LFRR), and catch, fishing effort, fishing operational data, and vessel information are from the catch and effort logsheet data provided by each fisher to the Ministry of Fisheries on Tuna Longline Catch Effort Returns (TLCER) and Catch Effort Landing Returns (CELR). Grooming of these data and the range checks applied are outlined in the database documentation for *tuna* (Wei 2004). Information on size composition, length and weight, sex ratio, discard and loss rate of fish is from data collected on longline vessels by observers from the Ministry of Fisheries Scientific Observer Programme. Grooming of these data and the range checks applied are outlined in the database documentation for *l_line* (Mackay & Griggs 2001). Murray et al. (1999, 2004) previously noted that CELR data have a sufficiently high percentage of the catch reported in weight rather than number. These data have now been updated to correctly assign the reported numbers to either weight or fish number, increasing the accuracy of the summarising of domestic tuna fisheries. Where fish number was recorded, this was converted to catch in weight using an estimate of the average weight of a fish of a given species caught by a specific gear type, as outlined by Murray et al. (2004).

Additional information used in standardising CPUE included data on moon phase and on the southern oscillation index (SOI) for El Niño and La Niña events and is used as a proxy for basin wide climatic variation known to affect tuna CPUE. Moon phase data were based on the algorithms of Duffet-Smith (1990) and the date and location of each operation from the CELR and TLCER data. Moon phase represents a measure of the fraction of the illuminated lunar disc and hence is a measure of the amount of light at night during longline sets. The SOI data are from the National Ocean and Atmospheric Administration Climate Prediction Center (http://www.cpc.ncep.noaa.gov/data/indices/index.html). The SOI data represent the standardised difference between the standardised monthly sea level pressure anomalies of Tahiti and Darwin.

CPUE was standardised using a Generalised Additive Model (GAM) approach for the albacore troll fishery, and for the bigeye and southern bluefin tuna longline fisheries. Generalised Linear Models (GLMs) are often used to account (standardise) for systematic changes in catchability, fishing power, etc, while estimating trends in abundance (e.g., Punt et al. 2000). GLMs have three main components: a linear predictor describing the systematic component of the data, a member of the exponential class of distributions describing the random component, and a link function relating the linear predictor to the mean of the distribution. GAMs, which are extensions of GLMs allowing the non-linear effects of covariates on the response to be estimated from the data, are also now being used (e.g., Bigelow et al. 1999, Daskalov 1999). In both model types, response variables are assumed independent, i.e., the data arise from a random sampling process. For this report we used a ten-fold cross-validation procedure (to avoid over-fitting) with a main-effects quasi-likelihood Poisson model (dispersion parameter estimated rather than fixed at unity) to standardise catch rates in albacore, bigeye, and southern bluefin tuna. The cross-validation process was combined with stepwise model selection incorporating a variable penalty term for predictor degrees of freedom which enabled selection of a model with optimal (R^2) predictive skill while minimising over-fitting to the data.

3. CHARACTERISTICS OF NEW ZEALAND TUNA FISHERIES

Trolling, purse-seining, and longlining are the main tuna fishing methods used in New Zealand; handline and pole-and-line are occasionally used. In 2001 and 2002, 2 types of vessels fished in New Zealand waters: New Zealand domestic vessels, and Japanese longliners on charter to a New Zealand company (four each year in 2001 and 2002). Foreign licensed tuna fishing ceased operating in the New Zealand EEZ in 1995. Due to confidentiality provisos of the Ministry of Fisheries, fishing effort by Japanese owned and operated longliners chartered by a New Zealand company and that by New Zealand owned and operated vessels are combined in this report.

3.1 Number of vessels fishing for tuna

The number of boats fishing by method in 2001 and 2002 is shown in Table 1. The number of vessels fishing from 1989 to 2000 was reported by Murray et al. (2004). The number of longline vessels in the New Zealand fishery has steadily increased from 1989 with a peak of 152 in 2002. The number of vessels in the troll fishery has remained relatively constant, with an average of 340 vessels in the 10 year period from 1991 to 2000, and this trend is continued in 2001 and 2002. The number of purse-seine vessels has increased. Up to 67 vessels carry out some handlining, but the number of days fished by this method and the amount of tuna caught were relatively small. Vessels fishing by pole and line was highest in 1995 with 15 vessels, but this method is infrequently used and accounts for only a small proportion of the New Zealand tuna catch.

3.2 Fishing effort by method, target, area, FMA, and quarter

3.2.1 Longline fishery

Southern bluefin tuna and bigeye tuna are the most common target species in the New Zealand tuna longline fishery, together accounting for about 90% of all hooks set in 2001 and 2002. The number of hooks set for each target species is shown in Table 2. In 2001, 73% of hooks set were for bigeye tuna and 19% for southern bluefin tuna, and in 2002, 63% of hooks were set for bigeye and 26% for southern bluefin tuna. Albacore was the reported target for 5% of hooks set in 2001 and 8% in 2002, with Pacific bluefin tuna, yellowfin tuna and swordfish accounting for about 2% of hooks set each year.

The start of set positions for all longline sets targeting southern bluefin tuna in 2001 and 2002 are shown in Figure 1 and 2 respectively; Figures 3 and 4 show set positions for these two years where bigeye tuna was the target species. Most longline sets are made off the continental shelf in waters deeper than 1000 m. Most sets targeting southern bluefin tuna are made off the west coast of the South Island in FMA 5 and FMA 7, and off the east coast of the North Island, particularly FMA 2, and sets targeting bigeye tuna occur around the North Island, especially in FMAs 1, 2, and 9.

The number of hooks set by longline vessels targeting southern bluefin tuna, by FMA (Fisheries Management Area) is shown in Table 3. In 2001, 48% of hooks were set in FMA 2, 29% in FMA 5 and 12% in FMA 7, with lesser numbers set in FMAs 3, 1, and 6, and little in the other areas. In 2002, 52% of hooks were set in FMA 2, 22% in FMA 5 and 19% in FMA 7, and lesser numbers in FMAs 1, 3, 9, and 6 and few in the remaining areas. This represents a shift from the largest effort reported in FMA 7 in previous years (Murray et al. 2004) to a greater amount of effort in FMA 2.

Hooks set for bigeye tuna by FMA are shown in Table 4. Effort was concentrated around the North Island with 51% of hooks set in FMA 1, 22% in FMA 2 and 22% in FMA 9 in 2001, and in 2002, 56% were set in FMA 1, 22% in FMA 2 and 16% in FMA 9. Some effort also occurred in FMA 8 and FMA 10 in both years.

Longlining is done all year round in the New Zealand EEZ. Southern bluefin tuna were primarily targeted during the second quarter (94% of hooks set in 2001 and 93% in 2002) (Table 5). Southern bluefin tuna have been subject to a national competitive catch limit (420 t since 1989), so effort in this fishery has been relatively stable. However, there was a large increase in the number of hooks set in FMA 2 in the second quarter of 2002 due to increase in effort by the domestic fishery.

Bigeye tuna are targeted throughout the year, in all quarters, as shown in Table 6. Murray et al. (2004) reported that longline effort targeting bigeye tuna has exponentially increased from 1991 to 2000, with about 5.9 million hooks set for bigeye tuna in 2000. This effort continued to increase, with 7.2 million hooks set for bigeye in 2001, which represents a peak, and 6.7 million hooks were set in 2002. Most of this effort is by domestic owned and operated longliners.

3.2.2 Troll fishery

The troll fishery is a surface fishery operated by New Zealand domestic vessels almost exclusively targeting albacore (98% in 2001 and 99% in 2002) (Table 7). Skipjack is the target species for less than 1% of days trolling, and other species of tunas including southern bluefin, bigeye, and yellowfin, are targeted only occasionally.

The areas fished in 2001 and 2002 are shown in Figure 5 and 6. Most trolling for albacore occurs on the west coast of both islands. Most days were fished in FMAs 7, 8, and 9 (Table 8). In 2001, 51% of days were fished in FMA 7, 14% in FMA 8 and 19% in FMA 9, and in 2002, 62% of days were fished in FMA 7, 17% in FMA 8 and 12% in FMA 9. Some fishing also occurred in FMAs 1, 2, and 5 in both years, and some also occurred in high seas areas.

This fishery typically operates during summer, with most effort in the first quarter and some fishing in the second and fourth quarters (Table 9). In 2001, 81% of days fished were in quarter 1, and 83% of days in 2002.

The amount of troll effort in 2001 and 2002 represents a big increase in effort compared with that reported by Murray et al. (2004) when the average catch was 4583 t for the 10 year period from 1991–2000. Most of the increase occurred in the first quarter in FMAs 7, 8, and 9.

3.2.3 *Purse-seine fishery*

The purse-seine fishery, is a surface fishery operating during the summer months. Almost all purse-seine sets targeted skipjack tuna: 94% in 2001 and 9 % in 2002 (Table 10). Yellowfin tuna, blue mackerel, and pilchard were targeted occasionally.

Purse-seine set positions in 2001 and 2002 are shown in Figure 7 and 8. The purse-seine fishery mostly operates on the continental shelf in FMA 1 off the east coast of the North Island. Number of purse-seine sets by FMA are shown in Table 11, and by quarter in Table 12. Most effort occurred in the first quarter in FMA 1, with some effort in FMAs 2, 8, and 9 and some purse seining was done in high seas areas. The effort has declined compared with the number of sets reported by Murray et al. (2004) in the last 3 years.

3.3 Tuna and swordfish landings

Landings of tunas and swordfish in 2001 and 2002 are shown in Table 13. Data are presented as catch in tonnes in the New Zealand EEZ and high seas areas separately, and compared with Licensed Fish Receiver Reports (LFRR). High seas catch is not reported to licensed fish receivers. Murray et al. (2004) reported landings for 1987–2000.

The largest landings were from the surface fisheries for albacore (troll fishery) and skipjack tuna (purse-seine fishery). Albacore landings have been variable since 1987, and peaked at 6526 t in 1998 (Murray et al. 2004). LFRR landings reported 5353 t in 2001 and 5638 t in 2002. Skipjack landings from LFRR records peaked at 9690 t in 2000 (Murray et al. 2004) and have been lower since then at 3692 t in 2001 and 3344 t in 2002. High seas catches of skipjack tuna have been significant.

Southern bluefin tuna catches have been fairly constant. When the 420 t catch limit is exceeded, the domestic allocation is reduced so that New Zealand catches do not exceed the catch limit on average. Landings of bigeye tuna were low before 1997 (Murray et al. 2004), then increased to a peak of 480 t in 2001, and dropped to 200 t in 2002.

Landings of yellowfin tuna, generally a bycatch species, were low before 1994 and reached the highest level of 198 t in 1996 (Murray et al. 2004), were fairly high in 2001, and low in 2002. The high seas catch of yellowfin was much greater than the New Zealand catch. Landings of Pacific bluefin tuna were low, reaching about 20 t in 2000 (Murray et al. 2004), but increased to 50 t in 2001 and 55 t in 2002. This increase is probably due to the recent ability to distinguish Pacific bluefin tuna from southern bluefin tuna (Smith et al. 2001). Murray et al. (2004) predicted that longline catches of Pacific bluefin tuna would rise because of this.

Swordfish landings increased dramatically in recent years to about 1000 t (Murray et al. 2004). The highest swordfish catch was 1029 t in 2001, and a bit lower in 2002 with 929 t reported by LFRR landings. Targeting of swordfish (along with all other billfish) is prohibited, but the increase in domestic longlining effort has resulted in an increase in swordfish catches and landings.

3.4 Tuna and swordfish catch by area, method, target species, and season

Catch for each species by fishing method, in 2001 and 2002, is presented in Table 14. Tables 15–21 give a breakdown of catch for each species stratified by method, target species and quarter for 2001 and 2002, and Tables 22–28 show the catch by species stratified by method, target species and FMA for these two years. A summary of Tables 22–28 expressed as CPUE is given in Appendix 2, for the main methods and target species.

3.4.1 Albacore

Most albacore were caught by trolling (60%) and longlining (40%) with minor amounts caught by handline and pole-and-line (Table 14).

The troll fishery runs from late summer (quarter 4) to early autumn (quarter 2). Most of the albacore catch was in the first quarter (Table 15), and most of the albacore was caught on the west coast of both islands in FMAs 7, 8, and 9 (Table 22). Some troll catch also occurred in FMA 1 and FMA 2, particularly in 2001. High seas troll catches were a minor component in 2001 and 2002.

In the longline fishery most albacore were caught as bycatch where bigeye tuna or southern bluefin tuna were the target species. These catches occurred throughout the year in 2001 and 2002 around the North Island mainly in FMAs 1, 2, and 9 in the bigeye fishery, and in the second quarter mostly in FMA 2 where southern bluefin was the target species (Tables 15 and 22). Albacore were sometimes targeted by longline, and caught throughout the year, mostly in the second quarter, in FMAs 1, 2, and 9, but in lesser quantities. Albacore were targeted by handline and pole-and-line, and occasionally by purse-seine, but catches were small. There were some high seas captures of albacore, mainly longlining for bigeye tuna (Table 22).

3.4.2 Bigeye tuna

Bigeye tuna were almost exclusively caught by longline with occasional small catches by trolling (Table 14). Bigeye were caught throughout the year with the greatest amount caught in the third quarter in 2001 and 2002 (Table 16). Catches were highest in FMA 1, with smaller catches in FMA 2 and FMA 9, and some in FMA 8 and FMA 10 (Table 23). Some bigeye were also caught by longline when albacore and southern bluefin were the target species, and some bigeye were caught by troll in summer (quarters 1 and 4) mainly when targeting albacore (Table 16), mostly in the northern FMAs. There were some high seas captures longlining for bigeye tuna (Table 23).

3.4.3 Pacific bluefin tuna

Pacific bluefin tuna (previously called northern bluefin tuna) were caught only by longline (Table 14). They were usually caught as bycatch when southern bluefin or bigeye tunas were targeted, mostly in the second and third quarters (Table 17), and mainly in FMAs 1 and 2 (Table 24).

3.4.4 Skipjack tuna

Almost all skipjack tuna were caught by purse-seine with small catches by troll and longline (see Table 14). Most of the skipjack caught by purse-seine were caught in the first quarter, and a significant quantity was caught in the fourth quarter in 2001 (Table 18). Most were caught in FMA 1, with smaller catches in FMAs 2, 8, and 9, and in 2001 in FMA 7 as well. There were significant purse-seine catches of skipjack in high seas areas (Table 25).

Skipjack was the usual target species in the purse-seine fishery, but some were also caught in FMA 1 when blue mackerel were targeted, and in high seas areas when yellowfin tuna were targeted, in 2001. Some skipjack were caught in the first two quarters in the albacore troll fishery in FMAs 1, 2, 7, 8, and 9, and skipjack were occasionally targeted by troll. Small quantities were caught throughout the year in the longline fishery when bigeye, yellowfin, or albacore tunas were targeted (Tables 18 and 25).

3.4.5 Southern bluefin tuna

Southern bluefin tuna were almost exclusively caught by longline, with occasional small catches by troll and handline (see Table 14). Most southern bluefin were caught in the second quarter, with some in quarters 1 and 4 (Table 19). Some southern bluefin tuna were caught by longline when bigeye tuna or albacore were targeted and small quantities were caught in the troll fishery when albacore were targeted. A small amount were caught by handline targeting southern bluefin in 2001, but no handlining targeted or caught southern bluefin tuna in 2002 (Table 19). Most southern bluefin tuna were caught in FMAs 2, 5, and 7 (Table 26), which corresponds to the areas with highest effort.

3.4.6 Yellowfin tuna

Yellowfin tuna were caught by longline and purse-seine and in small quantities by troll (Table 14). Purse-seine catches were made in summer, in the fourth quarter in 2001 and the first quarter of 2002, when targeting skipjack or yellowfin tuna (Table 20). All of this purse-seine activity was in high seas areas (Table 27).

Yellowfin were caught by longline, mostly as bycatch in the bigeye and southern bluefin tuna fisheries, although they were sometimes targeted. Longline captures occurred throughout the year, mostly in summer (Table 20) in FMAs 1, 2, 9, and 10 (Table 27). There was a small troll catch in summer in FMAs 1, 2, and 9.

3.4.7 Swordfish

Swordfish catches were almost entirely by longline, with occasional small troll catches in 2002 but not in 2001 (see Table 14). Swordfish were usually caught as bycatch when tunas, particularly bigeye, were targeted. Although targeting of swordfish is prohibited, it was sometimes recorded as the target species. Swordfish were caught throughout the year, with the highest captures in quarters 1–3 in 2001, and the first quarter in 2002 when targeting bigeye tuna, and in the second quarter targeting southern bluefin tuna (Table 21). Highest catches occurred in FMAs 1, 2, and 9, and some were caught in FMAs 5, 7, 8, and 10 (Table 28).

3.5 Tuna and swordfish catch rates

Tuna and swordfish are highly migratory fish with extensive ranges, so the utility of catch rates as stock status indicators is sometimes questioned. However, even though a specific fishery may exploit only a small portion of a large mobile stock, trends in catch rates can serve as an important regional diagnostic of stock status. This was clearly evident when stock assessment model results were compared with a range of fishery indicators, including fishery-specific trends in catch rate, for southern bluefin tuna in the late 1980s (Caton 1991). In this case optimistic stock assessment results could not be corroborated by reference to catch rate trends and significant quota reductions were instituted from 1989.

In most instances, however, the greatest use of catch rates is as an index of relative abundance, either on its own or as an input to a stock assessment model. Where fishing practices are constant over time unstandardised (or nominal) catch rates are generally used. However, in most instances the introduction of new fishing technology, changes in area or season fished, changes in fishing practice in response to regulatory or economic forces, and climatic shifts affect catch rate as a measure of abundance. Then it is necessary to use information on changes in fishing operations and environmental information to adjust (or standardise) catch rates. If catch rates are not standardised, interpretation of changes in CPUE can be misleading.

We present a series of catch rate trends as catch per unit of fishing effort (CPUE), where the unit of effort is gear-specific and mirrors that used elsewhere for similar tuna fisheries. Nominal CPUE trends are shown for each of the six tuna species and for swordfish caught in the EEZ by the three primary gear types used (purse-seine, troll, and longline). Nominal CPUE is shown by fleet and target for each species caught in the longline fishery since the different fishing practices used, as well as the different areas and seasons fished, can affect CPUE. For three fisheries (albacore troll, bigeye tuna longline, and southern bluefin tuna longline) we present the results of CPUE modelling to standardise catch rates for factors shown to influence CPUE. The results of the standardisation are contrasted with equivalent nominal trends.

3.5.1 Troll fishery

3.5.1.1 Nominal CPUE

The nominal CPUE trend for the albacore troll fishery in New Zealand waters is shown in Figure 9. CPUE is given as the number of albacore caught per day fished by a vessel targeting albacore. There is no discernable trend in CPUE from period 1991 to 2002. Troll catches have been remarkably stable, averaging 62.2 albacore per day fished. CPUE in the New Zealand fishery is similar to that of the high seas USA troll fishery, the only other large troll fishery for albacore in the South Pacific Ocean. Childers & Bartoo (1999) reported CPUE from USA troll vessels that operate more than 1000 n. miles east of New Zealand along the Subtropical Convergence Zone. In this fishery the CPUE is 82.3 fish per day and is much more variable. The peaks and troughs in the CPUE time series for the USA and New Zealand troll fisheries are nearly synchronous, suggesting that relative abundance of juvenile albacore is similar in a given year for the two fishing grounds.

3.5.1.2 Standardised CPUE

The trend in CPUE relative to 1990 was modelled to produce a standardised CPUE series for the albacore troll fishery. For all trolling where albacore is reported as the target species, catch (number of fish) and effort (days fished) data for target and main bycatch species, FMA, date, start times, depth, moonphase, and Southern Oscillation Index (SOI) data were used in the standardisation.

The model selection process is similar to that described by Richardson et al. (2001) and Murray et al. (2004) except that a ten-fold cross-validation procedure has been used with a main-effects quasi-likelihood Poisson model to avoid over-fitting. Residual plots for the albacore CPUE model given here were similar with respect to a lack of trend in residuals to those shown by Richardson et al. (2001) for southern bluefin tuna and references therein.

For the additive models used, covariates were fitted using the local regression scatter plot smoother, loess (Chambers & Hastie 1993), with the default smoothing parameter (½). Predictor variables tested for inclusion were as follows.

1. Factors (categorical)
   - *year*
   - *month* – January to February
   - *FMA – Fishery Management Area*
2. Covariates (continuous)
   - *effort* – number of days fished by trolling
   - *SOI* – NOAA standardised Tahiti-Darwin sea level pressure
   - *bycatch* – catch per unit effort of bycatch species
   - *moonphase* – fraction of illuminated lunar disc
   - *depth* – bathymetric depth

The final model is:

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CPUE ~ year + FMA + lo(SOI) + lo(moonphase)
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where lo( ) is the local regression scatter plot smoother, loess (see Chambers & Hastie 1993). The analysis of deviance table for the final GAM model is given in Appendix 1.

CPUE is defined here as catch per day, but in reality the trolling operation is probably similar in many respects to a longline operation that was discussed in detail by Richardson et al. (2001), who concluded that longline CPUE can be viewed as proportions (of successes), and suggested investigating whether albacore CPUE should be redefined as catch per hook per unit time.

The albacore tuna CPUE model does not incorporate interactions (e.g., spatial-temporal), which may be significant, and could change the conclusions given below. Cross-validation has been used with regression tree models (De'ath & Fabricus 2000, Venables & Ripley 2002) to check the importance of potential interaction terms. Regression trees partition the response (CPUE) into homogeneous groups defined by combinations of the explanatory variables and handle non-additive behaviour (i.e., interactions) quite naturally. If interactions between predictor variables are important, regression trees can show greater predictive skill than additive models. In this case an optimal tree can be used to explore the interacting variables, which may help improve the additive model, or assist interpretation of the results. However, in both tree and additive models, the predictive skill is low ($R^2 < 0.1$) and additional predictors or models are required before there can be confidence in the standardised indices. The dispersion parameter for this model is 68.3, suggesting significant over-dispersion. This provides another indication that alternative models need to be explored.

There is little significant difference between the relative year abundance estimated by the model and nominal CPUE indices, and no clear trend can be discerned (Figure 10).

3.5.2 Longline fishery

3.5.2.1 Nominal CPUE

The nominal CPUEs for tunas and swordfish caught in the longline fishery are shown in Figures 11 to 14 for bigeye tuna, southern bluefin tuna, yellowfin tuna, and swordfish. CPUE is shown by target species for yellowfin tuna and swordfish.

Most of the species caught in the longline fishery, while commercially valuable, are not the primary species fishers seek. These bycatch species are usually a regular component of the catch and their CPUE may be related to abundance. Exceptions to this are species that occur infrequently (e.g., Pacific bluefin tuna), or are caught seasonally and in small quantities (e.g., Yellowfin tuna). For species that are targeted (e.g., bigeye and southern bluefin tuna) or caught in substantial amounts (e.g., swordfish) it is generally assumed that nominal CPUE is related to relative abundance.

Bigeye tuna are targeted by longline, especially by domestic owned and operated vessels, throughout most of the year primarily north of 40° S. Bigeye tuna CPUE is shown in Figure 11. CPUE was at its highest in 1984, at 7.0 fish per 1000 hooks set, steadily declined to a low of 0.9 fish per 1000 hooks in 1995, and showed some increase in the mid to late 1980s. In 2001, the CPUE was 1.4 fish per 1000 hooks and in 2002 was at the lowest ever, at 0.5 fish per 1000 hooks.

Southern bluefin tuna nominal CPUE is shown in Figure 12. After a steady decline through the 1980s and early 1990s to a low of 1.1 fish per 1000 hooks set in 1991, there was a period of increasing CPUE from 1991 to 1995, followed by another decline in 1996 and a further increase. CPUE was 3.2 fish per 1000 hooks in 2001 and 2.1 in 2002. The increasing CPUEs in the early 1990s follow the substantial quota reductions imposed by Australia, Japan, and New Zealand of about 60% and coincides with a period of increased recruitment of juveniles (Anon. 1996). These CPUE values have not been adjusted for changes in fishing practices, but the nominal CPUEs may be one of the few hopeful signs in a global stock regarded by the IUCN as critically endangered (Matsuda et al. 1998).

Yellowfin tuna CPUE by target species and in total is shown in Figure 13. This species is rarely targeted and generally caught as bycatch, particularly in the bigeye tuna longline fishery. Total CPUE most closely follows that of the target species bigeye tuna. The overall average CPUE in 1980–2002 was 2.9 fish per 1000 hooks and there was a significant peak in 1997. Total yellowfin CPUE was 2.1 fish per 1000 hooks in 2001 and 1.2 in 2002. As catch rates of yellowfin tuna are generally low, it is unclear whether CPUE trends represent relative abundance or reflect variable climatic conditions that affect the catch rate of more northern species. It was only in 1996–98 that CPUE approached levels seen in longline fisheries elsewhere in the central and western Pacific Ocean (Lawson 2000).

The CPUE for swordfish by target is shown in Figure 14. Swordfish are commonly caught on tuna longlines set for bigeye and southern bluefin tunas but cannot legally be targeted in the New Zealand EEZ. Some targeting of swordfish is reported, and anecdotal reports suggest that targeting may be more extensive, and it is clear that swordfish landings have been increasing. The rapid rise in swordfish catch has been attributed to an increase in longline sets by the New Zealand domestic fishery and a positive correlation between fishing effort and swordfish CPUE (Murray et al. 2001). Figure 14 shows that swordfish CPUE increased through the 1990s and reached a peak in 1997. There appears to be some decline or plateau in swordfish CPUE since 1998. While the increasing trend in swordfish CPUE could be interpreted as evidence of targeting, the magnitude of CPUE is substantially lower than in swordfish target fisheries elsewhere. This may suggest that some targeting of swordfish is taking place (and possibly with increasing frequency) but that it is not a widespread practice. Ward & Elscot (2000) report swordfish CPUEs of 12–16 per 1000 hooks in the former Hawaiian longline target fishery and 3–10 per 1000 hooks for the Brisbane target fishery. The New Zealand longline fishery has shown an average CPUE from 1980 to2002 of 1.9 fish per 1000 hooks, with a peak of 5.7 in 1997. Total swordfish CPUE was 2.8 fish per 1000 hooks in 2001 and 2.4 in 2002.

3.5.2.2 Standardised CPUE of bigeye and southern bluefin tuna

Catch (number of fish), effort (number of hooks) for target and bycatch species, longline start of set position, date, start and finish times, sea surface temperature, bathymetric depth, Southern Oscillation Index, vessel specifications, and moon phase were used during the standardisation procedure for longline sets where bigeye tuna was reported as the target species. The model selection process used for bigeye tuna CPUE is similar to that described by Richardson et al. (2001) and Murray et al. (2004), except that a ten-fold cross-validation procedure has been used with a main-effects quasi-likelihood Poisson model to avoid over-fitting. Residual plots for the bigeye tuna CPUE model given here were similar (with respect to a lack of trend in residuals) to those shown in Richardson et al. (2001) for southern bluefin tuna.

For the additive models used, covariates were fitted using the local regression scatter plot smoother, loess (Chambers & Hastie 1993) with the default smoothing parameter (½). Predictor variables tested for inclusion were as follows.

1. Factors
   - *year*
   - *month* – February to August
   - *nation* – Foreign (Japanese or charter), domestic (N.Z. owned and operated)
2. Covariates
   - *moonphase* – fraction of illuminated lunar disc
   - *SST*– sea surface temperature measured by vessels
   - *lat* – latitude of longline set start position
   - *long* – longitude of longline set start position
   - *effort* – number of hooks (thousands)
   - *bycatch* – catch per unit effort of bycatch species
   - *SOI* – Southern Oscillation Index
   - *depth* – bathymetric depth

The final model for bigeye tuna CPUE is:

```
CPUE ~ year + month + lo(SOI) + lo(SST) + lo(depth) + lo(lat) +
lo(long) + lo(moonphase)
```

Bycatch, a significant predictor, was positively correlated with bigeye tuna catch rates. Since this suggests that bycatch was not determining catchability in this fishery, this predictor was dropped from the final model. The estimated dispersion parameter for this model is 2.6. The analysis of deviance table for the final GAM model is given in Appendix 1.

Between 1980 and 2002, there are only moderate differences between the estimated coefficients and the nominal CPUE values (Figure 15). Nominal and standardised CPUE exhibit similar trends with low relative abundance in 1981 to 1983 compared with 1980, followed by an increase to about 90% (standardised) of the 1980 level during 1984 to 1986. Since 1986, bigeye tuna indices in the New Zealand EEZ have further declined to about 15% of the 1980 level in 1995. The bigeye tuna abundance indices then increased to about 40% (of 1980) in 1998 followed by a decline to about 10% thereafter.

The bigeye tuna CPUE model does not incorporate interactions (e.g., spatial-temporal), which may be significant, and could change the above conclusions. Cross-validation has also been used with regression tree models to try to check the importance of potential interaction terms. The optimal tree for the analysis presented here has slightly greater predictive power than the equivalent main effects GAM, which suggests that the some interaction effects might improve the model's predictive ability.

The spatio-temporal complexity of the southern bluefin tuna fishery, particularly during the 1990s, motivated the division of the EEZ into three regions (east coast north of 44° S, east coast south of 44° S, and the west coast) for this analysis. In the region on the east coast south of 44° S, the data for 1992 to 1996 were combined since there was very little fishing in that period. All three fishing areas have contracted since the 1980s.

Model selection is as described for the bigeye analysis. Residual plots for the southern bluefin tuna CPUE models given here were similar with respect to a lack of trend in residuals to those shown by Richardson et al. (2001).

For the additive models used, covariates were fitted using the local regression scatter plot smoother, loess (Chambers & Hastie 1993), with the default smoothing parameter (½). Predictor variables used were as follows.

1. Factors
   - *year*
   - *month* – February to August
   - *nation* – Japanese (foreign or charter), domestic (N.Z. owned and operated).
2. Covariates
   - *moonphase* – fraction of illuminated lunar disc
   - *SST* – sea surface temperature measured by vessels
   - *lat* – latitude of longline set start position
   - *long* – longitude of longline set start position
   - *effort* – number of hooks (thousands)
   - *bycatch*– catch per unit effort of bycatch species
   - *SOI* – Southern Oscillation Index
   - *depth* – bathymetric depth

The final area specific models for southern bluefin tuna CPUE are:

East coast north of 44° S:

```
CPUE ~ year + month + lo(lat) + lo(long) + lo(moonphase) + lo(SST) +
nation
```

East coast south of 44° S:

```
CPUE ~ year + month + lo(SOI) + lo(lat) + lo(long) + lo(moonphase) +
lo(SST)
```

West coast:

```
CPUE ~ year + month + lo(SOI) + lo(SST) + lo(lat) + lo(long) +
lo(depth) + lo(moonphase)
```

Dispersion parameters were estimated as 2.8, 1.1, and 2.5 respectively for the three models. Analyses of deviance tables for the final GAM models are given in Appendix 1.

The estimated southern bluefin tuna abundance indices for the east coast north of 44° S are, considering errors in the estimates, similar to or less than the nominal CPUE values until 1994 (Figure 16a). There is a substantial increase in mean southern bluefin tuna CPUE and abundance indices after 1995. In 1998 to 2002, the estimated abundance index is about 50–70% of the 1980 value (about 50% in 2002).

The estimated abundance indices of southern bluefin tuna for the east coast fishing area south of 44° S when 1992 to 1996 are combined (Figure 16b) because there was little effort in this region during that time. Indices for 1997 to 2002 increased to about 40% of the 1980 value, apart from 2000 and 2002 when they were substantially smaller at about 15% of the 1980 value. Only a small proportion of overall effort in the New Zealand southern bluefin tuna fishery has been in this region since 1992, as reflected in the increased uncertainty in standardised indices after that date.

For the west coast fishing area there appear to be significant differences between nominal southern bluefin tuna CPUE values and estimated year coefficients (Figure 16c). However, there was a sharp reduction in effort after 1993, and this is reflected in the increase in the size of the confidence intervals over that period. The standardised indices suggest a more modest increase in southern bluefin tuna abundance in this region after 1994 than is suggested by the nominal CPUE time series, from about 40% of 1985 abundance before 1994 to about 50% after 1994. Given the likely underestimate in uncertainties, this conclusion remains tentative.

The remarks above on exclusion of interactions (for bigeye and southern bluefin tuna) are also relevant here. Regression trees in all three areas produced models with improved predictive skill, suggesting that inclusion of interactions terms could be useful (see additional comments in Richardson et al. (2001)).

4. BIOLOGICAL PARAMETERS OF TUNA AND SWORDFISH

Biological data for albacore, bigeye tuna, southern bluefin tuna, yellowfin tuna, and swordfish are collected by Ministry of Fisheries scientific observers and are taken from the *l_line* database. Data for 2001 were collected from 25 trips, covered 503 sets, and represented 100% of the Japanese charter fleet and 5% of the hooks set by the New Zealand domestic vessels. The 2002 data came from 14 trips and 360 sets, and represented 100% of the Japanese charter fleet and 2% of the hooks set by the New Zealand domestic vessels.

4.1 Size frequency distributions

The length frequency distributions for albacore, bigeye tuna, southern bluefin tuna, yellowfin tuna, and swordfish caught by longline in 2001 and 2002, and the period over which all observer data was collected, from 1987 to 2002 are shown in Figures 17–21.

Albacore caught by longline (Figure 17) ranged from 37 to 133 cm fork length, with a mean of 82.8 cm for 1987–2002. The 2001 distribution shows modes at 74, 84 and 100 cm, which is similar to the 1987–2002 distribution and the mean for 2001 was 79.0 cm. The fish in 2002 appear to be larger, with the first peak at 86 cm and a mean of 87.0 cm, but the sample size is very much smaller (Figure 17). Albacore caught by troll and measured as part of a port sampling programme were smaller than those caught by longline, ranging from 38 to 99 cm with a mean of 63.2 cm (Griggs 2003).

Bigeye tuna caught by longline are shown in Figure 18, and ranged from 74 to 190 cm fork length with a mean of 131.8 cm. The mean in 2001 was 132.5 cm and peaks are seen at 118 cm and 128 cm, which roughly corresponds to the distribution of 1987–2002. Too few fish were caught in 2002 to show any trend in size distribution.

The size composition for southern bluefin tuna caught by longline is shown in Figure 19. The overall mean from 1987 to 2002 was 148.9 cm fork length, and fish ranged in size from 82 to 215 cm. However, some of the larger fish measured are likely to be Pacific rather than southern bluefin tuna, especially in early data. Fish in 2001 and 2002 had a similar range of lengths to that seen in the aggregated sample and a wide range of size classes can be seen in the data. The mean length in 2001 was 140.4 cm and in 2002 it was 145.0 cm.

Yellowfin size distribution is shown in Figure 20. Fish ranged from 58 to 160 cm fork length with a mean of 116.9 cm. The mean in 2001 was 122.9 with a peak at 122 cm. Too few fish were caught in 2002 to comment on the size distribution. Size composition of swordfish is shown in Figure 21. The overall size range from 1987 to2002 was 76– 330 cm lower jaw to fork length with a mean of 177.3 cm. There was a large proportion of small fish in the catch in 2001 with a mean of 166.8 cm and a prominent mode at 125 cm, but the mean of 177.4 cm in 2002 is closer to that of the aggregated sample.

4.2 Length–weight relationships

Length–weight relationships were derived using ordinary least squares regressions of natural log of greenweight on the natural log of fork length. The parameters of these relationships with their standard errors and sample sizes are given in Table 29 for albacore, bigeye tuna, southern bluefin tuna, yellowfin tuna, and swordfish for 2001 and 2002. Length–weight relationships are given separately for males and females and for the sexes combined.

4.3 Sex ratio

The sex ratios observed for albacore, bigeye tuna, southern bluefin tuna, yellowfin tuna, and swordfish for 2001 and 2002 are given in Table 30. These were not determined when sample sizes are too small. Most albacore are not sexed, and bigeye and yellowfin tuna catches were low in 2002. Sex ratios of albacore and bigeye tuna in 2001 and southern bluefin tuna in 2002 are close to a 1:1 ratio, but chi-square tests yield statistically significant differences ($p = 0.05$) from a 1:1 ratio for southern bluefin and yellowfin tuna in 2001. Some of these departures from a 1:1 ratio may be related to sample size.

For southern bluefin tuna caught in the EEZ the departure from 1:1 is a regular feature in each year and may be due to the age composition of the catch. Caton (1991) reported departures from a 1:1 sex ratio in southern bluefin tuna from different fishing grounds, noting that females appear to predominate in catches of juveniles while males (as is the case here) appear to predominate in catches of adults. Murray et al. (2004) reported more males than females in the New Zealand catch, and this is seen again in 2001 and 2002.

In swordfish the sex ratio is significantly different from a 1:1 sex ratio, with females caught about three times as frequently as males in the longline fishery. Chi-square tests show that the sex ratio is not significantly different from a 3:1 ratio (Table 30). Nakamura (1985) also reported a departure from a 1:1 sex ratio in swordfish in other areas, noting that most swordfish over 140 kg are females (equivalent to about 215 cm lower jaw to fork length). In the New Zealand EEZ, females are predominant in the swordfish longline catch that are 125 cm lower jaw to fork length and longer (Murray et al. 1999, 2004).

4.4 Discards

The number and proportion of fish retained, discarded or lost, are summarised in Table 31. Overall discard and loss rates are low.

In 2001, 8662 albacore were retained (97.2%), 127 discarded (1.4%), and 118 lost (1.3%). In 2002, 1384 albacore were retained (97.3%), 25 discarded (1.8%), and 13 lost (0.9%). Most of the discarded albacore were dead: 91% in 2001 and 100% in 2002. Most of these fish were discarded due to damage, mostly caused by sharks. In 2001, 44% of the lost albacore fell off the hook dead, and this was the fate of 15% in 2002, while the rest of the lost fish escaped alive, and 10 fish were released alive in 2001.

In 2001, 372 bigeye were retained (96.4%), 9 were discarded (2.3%), and 5 were lost (1.3%). In 2002, 30 bigeye were retained (90.9%), 1 was discarded (3.0%), and 2 were lost (6.1%). Of the discards, 3 small fish were released alive and 6 dead fish were discarded due to shark damage in 2001, and 1 dead fish was discarded due to shark damage in 2002. In both years, all lost fish escaped alive.

Almost all southern bluefin tuna were retained. In 2001, 3001 fish were retained (98.0%), 11 were discarded (0.4%), and 50 were lost (1.6%). In 2002, 3022 fish were retained (98.5%), 9 were discarded

(0.3%), and 38 were lost (1.2%). Of the 2001 discards, 5 were alive and 6 dead. Of the 5 southern bluefin tuna that were released alive in 2001, 1 was small, and the other 4 were released after the end of the fishing season. All 6 dead fish were discarded due to damage. There were 49 lost fish in 2001 which escaped alive, and it was not known in the remaining 1 was alive or dead. In 2002, 4 dead fish were discarded due to damage, and 4 were released alive after the end of the season, and the fate of 1 fish recorded as discarded was uncertain. Of 38 lost fish, 37 escaped alive and 1 fell off dead.

In 2001, 355 yellowfin were retained (96.2%), 4 were discarded (1.1%), and 10 were lost (2.7%), while in 2002, all 30 yellowfin that were caught were retained. The two dead fish were discarded due to damage and 2 small fish were released alive. Of 10 lost fish, 9 escaped alive.

In 2001, 665 swordfish were retained (81.0%), 139 were discarded (16.9%), and 17 were lost (2.1%). In 2002, 249 swordfish were retained (92.9%), 17 were discarded (6.3%), and 2 were lost (0.7%). Of the discards, 56% of those caught in 2001 were dead and 35% of those caught in 2002 were dead. Most of the lost fish escaped alive, with 5 lost fish that fell off dead in 2001 (29%). Damage affected 20% of the dead fish that were discarded in 2001, and 29% of the dead fish in 2002. Most of the remaining fish that were discarded or released alive in 2001 were small. As seen in Figure 19, there were a lot of small fish in 2001. Most of the swordfish that were released in 2002 were small fish that were tagged before release.

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6. REFERENCES

Anon. (1996). Report of the second meeting of the CCSBT Scientific Committee, Hobart, 26 August – 5 September 1996, 36 p. Commission for the Conservation of Southern Bluefin Tuna, Canberra, Australia.

Bigelow, K.A.; Boggs, C.H.; He, X. (1999). Environmental effects on swordfish and blue shark catch rates in the US North Pacific longline fishery. *Fisheries Oceanography 8*: 178–198.

Caton, A. (1991). Review of aspects of southern bluefin tuna biology, population and fisheries. *I-ATTC Special Report No. 7*: 181–350.

Chambers, J.M.; Hastie, T.J. (1993). Statistical models in S. Chapman and Hall, London.

Childers, J.; Bartoo, N. (1999). Overview of the U.S. South Pacific albacore troll fishery. SCTB12/ WP ALB–3. Tahiti. (Unpublished report held by Secretariat of the Pacific Community, Noumea, New Caledonia).

Daskalov, G. (1999). Relating fish recruitment to stock biomass and physical environment in the Black Sea using generalised additive models. *Fisheries Research 41*: 1–23.

De'ath, G.; Fabricius, K.E. (2000). Classification and regression trees: A powerful yet simple technique for ecological data analysis. *Ecology, 81(11):* 3178–3192.

Duffet-Smith, P. (1990). Astronomy with your PC. Cambridge University Press, Cambridge.

Francis, M.P.; Griggs, L.H.; Baird, S.J.; Murray, T.E.; Dean, H.A. (1999). Fish bycatch in New Zealand tuna longline fisheries. *NIWA Technical Report 55.* 70 p.

Francis, M.P.; Griggs, L.H.; Baird, S.J.; Murray, T.E.; Dean, H.A. (2000). Fish bycatch in New Zealand tuna longline fisheries, 1988–89 to 1997–98. *NIWA Technical Report 76.* 79 p.

Francis, M.P.; Griggs, L.H.; Baird, S.J. (2004). Fish bycatch in New Zealand tuna longline fisheries, 1998–99 to 1999–2000. *New Zealand Fisheries Assessment Report 2004/22.* 62 p.

Griggs, L. (2003). Monitoring the length structure of commercial landings of albacore tuna during the 2002–2003 fishing year. Final Research Report for Ministry of Fisheries Research Project TUN2001/01, Objective 2. 17 p. (Unpublished report held by MFish, Wellington).

Habib, G.; Clement, I.T.; Bailey, K.N.; Carey, C.L.; Swanson, P.M.; Voss, G.J. (1982). Incidental fish species taken in the purse-seine skipjack fishery, 1975–81. *Fisheries Research Division Occasional Publication: Data Series No. 5.* 49 p.

Lawson, T. (2000). Secretariat of the Pacific Community tuna fishery yearbook, 1999. SPC, Noumea, New Caledonia, v + 155 p.

Mackay, K.A.; Griggs, L. (2001). Database documentation: *l_line.* NIWA Fisheries Data Management Database Documentation Series. (Unpublished report held by NIWA library, Wellington). 38 p.

Matsuda, H.; Takenaka, Y.; Yahara, T.; Uozumi, Y. (1998). Extinction risk assessment of declining wild populations: the case of southern bluefin tuna. *Researches on Population Ecology 40*: 271–278.

Murray, T.E.; Richardson, K.; Griggs, L.H. (2004). New Zealand tuna fisheries, 1991 to 2000. *New Zealand Fisheries Assessment Report 2004/59.* 65 p.

Murray, T.; Griggs, L.; Dean, H. (2001). New Zealand domestic tuna fisheries, 1989–90 to 1998–99. Final Research Report for MFish Project TUN1999/01. (Unpublished report held by MFish, Wellington).

Murray, T.; Richardson, K.; Dean, H.; Griggs, L. (1999). New Zealand tuna fisheries with reference to stock status and swordfish bycatch. Final Research Report for MFish Project TUN97/01. v + 126 p. (Unpublished report held by MFish, Wellington).

Nakamura, I. (1985). FAO Species Catalogue. Vol. 5. Billfishes of the world. *FAO Fisheries Synopsis No. 125, Vol. 5*, iv + 65 pp. FAO Rome.

Punt, A.E.; Walker, T.I.; Taylor, B.L.; Pribac, F. (2000). Standardisation of catch and effort in a spatially-structured shark fishery. *Fisheries Research 45*: 129–145.

Richardson, K.M.; Murray, T.E.; Dean, H.A. (2001). Models for southern bluefin tuna in the New Zealand EEZ, 1998–99. *New Zealand Fisheries Assessment Report 2001/18*, 21 p.

Smith, P.J.; Griggs, L.H.; Chow, S. (2001). DNA identification of Pacific bluefin tuna (*Thunnus orientalis*) in the New Zealand fishery. *New Zealand Journal of Marine and Freshwater Research 35*: 843–850.

Venables, W.N.; Ripley, B.D. (2002). Modern applied statistics with S, Fourth Edition. Springer-Verlag, New York.

Ward, P.; Elscot, S. (2000). Broadbill swordfish: status of world fisheries. Bureau of Rural Sciences, Canberra, xiv + 208 p.

Wei, F. (2004). Database Documentation: *tuna*. NIWA Fisheries Data Management Database Documentation Series. (Unpublished report held by NIWA library, Wellington). 25 p.

Table 1: Number of boats fishing for tunas by method in 2001 and 2002.

	No of vessels	
Fishing method	2001	2002
Longline	131	152
Troll	341	325
Purse-seine	13	12
Handline	37	67
Pole and line	4	6

Table 2: Number of hooks set for each target species in the longline fishery in 2001 and 2002.

2001	No of hooks	% of total
Bigeye tuna	7198910	72.6%
Southern bluefin tuna	1886575	19.0%
Albacore	523693	5.3%
Yellowfin tuna	233720	2.4%
Pacific bluefin tuna	52680	0.5%
Swordfish	1850	<0.1%
Other	15680	0.2%
2002	No of hooks	% of total
Bigeye tuna	6767469	63.2%
Southern bluefin tuna	2800642	26.2%
Albacore	878792	8.2%
Pacific bluefin tuna	161810	1.5%
Yellowfin tuna	82000	0.8%
Other	13600	0.1%

Table 3: Number of hooks set by longline vessels targeting southern bluefin tuna in 2001 and 2002, by FMA (ET, high seas areas; unkn., unknown).

Year	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.	Total
2001	44500	904297	128485	0	555621	22900	218352	900	6270	3950	1000	300	1886575
2002	51020	1466699	47768	1500	619415	25861	538733	1600	34596	2400	7450	3600	2800642

Table 4: Number of hooks set by longline vessels targeting bigeye tuna in 2001 and 2002, by FMA (ET, high seas areas; unkn., unknown).

Year	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.	Total
2001	3642159	1607907	0	1300	0	0	13090	54950	1600756	181048	91650	6050	7198910
2002	3760427	1457330	0	1200	0	0	69450	109100	1107136	198931	58415	5480	6767469

Table 5: Number of hooks set by longline vessels targeting southern bluefin tuna in 2001 and 2002 by quarter (Q1=January to March, etc.).

Year	Q1	Q2	Q3	Q4	Total
2001	102 975	1 765 450	1 200	16 950	1 886 575
2002	154 726	2 604 936	2 600	38 380	2 800 642

Table 6: Number of hooks set by longline vessels targeting bigeye tuna in 2001 and 2002 by quarter (Q1=January to March, etc.).

Year	Q1	Q2	Q3	Q4	Total
2001	1 798 055	1 397 529	2 466 515	1 536 811	7 198 910
2002	2 130 183	1 198 321	2 038 275	1 400 690	6 767 469

Table 7: Number of days fishing for each target species in the troll fishery in 2001 and 2002.

2001	No of days	% of total
Albacore	7935	98.4%
Skipjack tuna	65	0.8%
Southern bluefin tuna	2	0.0%
Yellowfin tuna	6	0.1%
Other	53	0.7%

2002	No of days	% of total
Albacore	7796	99.0%
Skipjack tuna	29	0.4%
Bigeye tuna	12	0.2%
Southern bluefin tuna	3	0.0%
Yellowfin tuna	1	0.0%
Other	30	0.4%

Table 8: Number of troll vessel days targeting albacore, by FMA (ET, high seas areas; unkn., unknown).

Year	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.	Total
2001	582	498	6	1	81	0	4074	1144	1519	0	18	12	7935
2002	301	235	10	5	163	0	4795	1353	910	0	3	21	7796

Table 9: Number of troll vessel days targeting albacore, by quarter (Q1=January to March, etc.).

Year	Q1	Q2	Q3	Q4	Total
2001	6465	1236	0	234	7935
2002	6458	997	0	341	7796

Table 10: Number of purse-seine sets for each target species in 2001 and 2002.

2001	No of sets	% of total
Skipjack tuna	312	93.7%
Yellowfin tuna	8	2.4%
Blue mackerel	7	2.1%
Other	6	1.8%

2002	No of sets	% of total
Skipjack tuna	300	96.5%
Blue mackerel	5	1.6%
Yellowfin tuna	1	0.3%
Other	5	1.6%

Table 11: Number of purse-seine sets targeting skipjack tuna by FMA (ET, high seas areas; unkn., unknown).

Year	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.	Total
2001	203	12	0	0	0	0	13	20	19	0	42	3	312
2002	216	9	0	0	0	0	0	14	20	0	38	3	300

Table 12: Number of purse-seine sets targeting skipjack tuna by quarter (Q1=January to March, etc.).

Year	Q1	Q2	Q3	Q4	Total
2001	249	1	0	62	312
2002	299	0	0	1	300

Table 13: Summary of reported commercial catch (t) and catch reported by LFRR landings for 2001 and 2002.

2001	N.Z. catch	High seas	Total reported	LFRR
Albacore	4762.3	23.0	4785.3	5353.0
Bigeye tuna	468.1	8.6	476.8	480.1
Pacific bluefin tuna	45.0	0.9	45.9	49.8
Skipjack tuna	3951.3	969.0	4920.3	3691.5
Southern bluefin tuna	328.8	0.6	329.4	358.5
Yellowfin tuna	132.3	281.9	414.2	137.4
Swordfish	980.6	17.4	998.0	1028.7

2002	N.Z. catch	High seas	Total reported	LFRR
Albacore	4675.4	11.6	4687.0	5637.7
Bigeye tuna	180.2	1.8	182.0	199.9
Pacific bluefin tuna	52.6	0.4	53.0	55.4
Skipjack tuna	3344.4	794.8	4139.2	3343.7
Southern bluefin tuna	426.9	1.9	428.9	450.3
Yellowfin tuna	24.3	241.3	265.6	24.6
Swordfish	856.1	8.8	864.9	928.8

Table 14: Summary of reported commercial catch (t) by fishing method for 2001 and 2002.

2001	Longline	Troll	Handline	Pole & line	Purse-seine	Other	Total
Albacore	1935.8	2848.1	0.6	0.6	0.1	0.2	4785.3
Bigeye tuna	476.6	0.2	0.0	0.0	0.0	0.0	476.8
Pacific bluefin tuna	45.9	0.0	0.0	0.0	0.0	0.0	45.9
Skipjack tuna	9.0	63.9	<0.1	<0.1	4847.1	0.3	4920.3
Southern bluefin tuna	329.3	<0.1	0.1	0.0	0.0	0.0	329.4
Yellowfin tuna	130.3	3.6	0.0	0.0	280.3	0.0	414.2
Swordfish	997.9	0.0	0.0	0.0	0.0	0.2	998.0

2002	Longline	Troll	Handline	Pole & line	Purse-seine	Other	Total
Albacore	1938.6	2747.4	0.8	0.1	0.0	0.0	4687.0
Bigeye tuna	180.8	1.2	0.0	0.0	0.0	0.0	182.0
Pacific bluefin tuna	53.0	0.0	0.0	0.0	0.0	0.0	53.0
Skipjack tuna	11.1	31.0	0.0	<0.1	4097.1	0.0	4139.2
Southern bluefin tuna	428.6	0.3	0.0	0.0	0.0	0.0	428.9
Yellowfin tuna	23.8	0.5	0.0	0.0	241.3	0.0	265.6
Swordfish	862.8	2.1	0.0	0.0	0.0	0.0	864.9

Table 15: Albacore reported commercial catch (t) by method, target species and quarter for 2001 and 2002 (Q1=January to March, etc.).

Year	Method	Target species	Q1	Q2	Q3	Q4	Total
2001	Troll	Albacore	2446.6	355.8	0.0	44.6	2847.0
		Other	1.1	<0.1	0.0	0.0	1.1
	Longline	Bigeye tuna	320.9	479.9	411.9	189.0	1401.6
		Southern bluefin tuna	7.6	284.6	1.3	1.8	295.2
		Albacore	52.4	101.6	23.8	9.3	187.1
		Other	21.7	24.3	2.1	3.9	51.9
	Handline	Albacore	0.2	0.0	0.0	0.4	0.6
	Pole&line	Albacore	0.6	0.0	0.0	0.0	0.6
	Purse-seine	Albacore	0.1	0.0	0.0	0.0	0.1
2002	Troll	Albacore	2345.4	240.7	0.0	161.1	2747.2
		Other	0.2	<0.1	0.0	0.0	0.2
	Longline	Bigeye tuna	289.5	484.5	190.6	73.4	1038.0
		Southern bluefin tuna	21.8	434.3	1.7	0.4	458.3
		Albacore	70.8	281.7	10.2	14.8	377.5
		Other	18.3	45.2	1.2	0.2	64.8
	Handline	Albacore	0.3	0.6	0.0	0.0	0.8
	Pole&line	Albacore	<0.1	0.1	0.0	0.0	0.1

Table 16: Bigeye tuna reported commercial catch (t) by method, target species and quarter for 2001 and 2002 (Q1=January to March, etc.).

Year	Method	Target species	Q1	Q2	Q3	Q4	Total
2001	Longline	Bigeye tuna	59.4	64.9	213.9	104.3	442.6
		Albacore	2.1	4.5	7.4	3.5	17.6
		Southern bluefin tuna	1.0	6.4	0.0	0.3	7.8
		Other	5.3	1.0	0.9	1.4	8.6
	Troll	Albacore	0.1	0.0	0.0	0.1	0.2
2002	Longline	Bigeye tuna	57.3	19.3	58.7	31.6	167.1
		Albacore	3.1	1.7	1.5	0.3	6.5
		Southern bluefin tuna	1.1	4.2	0.0	0.1	5.4
		Other	1.5	0.1	0.1	0.0	1.7
	Troll	Albacore	<0.1	0.0	0.0	1.2	1.2
		Bigeye tuna	<0.1	0.0	0.0	0.0	<0.1

Table 17: Pacific bluefin tuna reported commercial catch (t) by method, target species and quarter for 2001 and 2002 (Q1=January to March, etc.).

Year	Method	Target species	Q1	Q2	Q3	Q4	Total
2001	Longline	Bigeye tuna	5.5	8.0	12.1	2.1	27.6
		Southern bluefin tuna	0.8	13.2	0.0	0.0	14.0
		Albacore	0.6	2.3	0.5	<0.1	3.5
		Pacific bluefin tuna	0.0	0.4	0.2	0.0	0.6
		Other	<0.1	0.2	0.0	0.0	0.2
2002	Longline	Bigeye tuna	7.1	6.5	17.1	3.9	34.5
		Southern bluefin tuna	0.4	8.4	0.0	0.4	9.1
		Albacore	1.9	2.6	0.5	0.2	5.1
		Pacific bluefin tuna	1.7	2.0	0.4	0.0	4.1
		Other	0.1	0.0	0.0	0.0	0.1

Table 18: *Skipjack tuna reported commercial catch (t)* by method, target species and quarter for 2001 and 2002 (Q1=January to March, etc.).

Year	Method	Target species	Q1	Q2	Q3	Q4	Total
2001	Purse-seine	Skipjack	3576.3	20.0	0.0	1185.5	4781.8
		Blue mackerel	0.1	0.0	0.0	47.0	47.1
		Yellowfin tuna	0.0	0.0	0.0	18.1	18.1
	Troll	Albacore	37.5	20.0	0.0	1.0	58.5
		Skipjack	2.8	2.5	0.0	0.0	5.3
		Other	0.1	0.0	0.0	0.0	0.1
	Longline	Bigeye tuna	2.6	2.4	2.0	0.7	7.8
		Yellowfin tuna	0.2	0.3	0.0	0.0	0.5
		Albacore	0.3	0.1	0.1	0.1	0.5
		Other	0.0	0.2	0.0	0.0	0.2
2002	Purse-seine	Skipjack	4078.1	0.0	0.0	9.0	4087.1
		Blue mackerel	8.5	0.0	0.0	1.5	10.0
	Troll	Albacore	13.6	14.9	0.0	0.2	28.7
		Skipjack	1.3	0.9	0.0	0.0	2.2
		Other	<0.1	0.0	0.0	0.0	<0.1
	Longline	Bigeye tuna	0.8	1.4	5.1	2.4	9.7
		Albacore	0.2	0.8	0.1	0.1	1.1
		Other	<0.1	0.2	<0.1	<0.1	0.3

Table 19: Southern bluefin tuna reported commercial catch (t) by method, target species and quarter for 2001 and 2002 (Q1=January to March, etc.).

Year	Method	Target species	Q1	Q2	Q3	Q4	Total
2001	Longline	Southern bluefin tuna	1.6	295.5	0.0	0.2	297.4
		Bigeye tuna	1.4	15.7	3.6	5.0	25.6
		Albacore	0.3	4.2	0.1	0.1	4.8
		Other	0.1	1.4	0.0	0.0	1.5
	Handline	Southern bluefin tuna	0.0	0.1	0.0	0.0	0.1
	Troll	Albacore	0.0	<0.1	0.0	0.0	<0.1
2002	Longline	Southern bluefin tuna	3.6	383.5	0.0	0.3	387.4
		Bigeye tuna	0.4	20.6	2.9	2.6	26.5
		Albacore	0.1	12.2	0.0	0.0	12.4
		Other	0.4	1.9	0.0	0.0	2.3
	Troll	Albacore	0.1	<0.1	0.0	0.0	0.1
		Southern bluefin tuna	0.0	0.2	0.0	0.0	0.2

Table 20: Yellowfin tuna reported commercial catch (t) by method, target species and quarter for 2001 and 2002 (Q1=January to March, etc.).

Year	Method	Target species	Q1	Q2	Q3	Q4	Total
2001	Purse-seine	Skipjack tuna	0	0	0	201.4	201.4
		Yellowfin tuna	0	0	0	78.9	78.9
	Longline	Bigeye tuna	54.8	10.0	5.4	36.8	107.0
		Yellowfin tuna	13.1	0.9	0.0	1.2	15.2
		Albacore	2.5	1.2	0.1	1.2	5.1
		Southern bluefin tuna	0.8	0.5	0.0	0.4	1.7
		Other	0.2	0.9	<0.1	0.2	1.3
	Troll	Albacore	3.1	0.1	0.0	0.1	3.4
		Other	0.3	0.0	0.0	0.0	0.3
2002	Purse-seine	Skipjack tuna	200.5	0.0	0.0	0.0	200.5
		Yellowfin tuna	40.8	0.0	0.0	0.0	40.8
	Longline	Bigeye tuna	13.4	0.7	0.7	5.1	19.9
		Yellowfin tuna	1.3	0.0	0.0	<0.1	1.3
		Southern bluefin tuna	0.3	0.6	0.0	0.0	0.9
		Albacore	0.6	0.1	0.0	0.1	0.8
		Other	0.9	<0.1	0.0	0.0	0.9
	Troll	Albacore	0.2	0.0	0.0	0.1	0.3
		Other	0.1	0.0	0.0	0.0	0.1

Table 21: Swordfish reported commercial catch (t) by method, target species and quarter for 2001 and 2002 (Q1=January to March, etc.).

Year	Method	Target species	Q1	Q2	Q3	Q4	Total
2001	Longline	Bigeye tuna	242.0	218.2	208.9	72.0	741.1
		Southern bluefin tuna	11.7	149.0	0.3	0.6	161.7
		Albacore	18.9	27.7	9.5	2.4	58.4
		Yellowfin tuna	17.1	3.8	0.0	2.0	22.9
		Pacific bluefin tuna	1.4	8.6	0.9	0.0	10.9
		Swordfish	0.3	0.0	0.4	0.0	0.7
		Other	0.0	1.8	0.4	0.0	2.2
2002	Longline	Bigeye tuna	255.3	126.4	129.1	48.4	559.7
		Southern bluefin tuna	8.7	177.5	0.1	0.3	186.6
		Albacore	23.6	51.2	9.9	1.3	86.1
		Pacific bluefin tuna	6.3	11.5	1.8	0.0	19.7
		Yellowfin tuna	9.5	0.0	0.0	0.8	10.3
		Other	0.2	0.0	0.2	0.0	0.4
	Troll	Swordfish	0.0	0.3	0.7	0.1	1.1
		Other	0.9	0.1	0.0	0.0	1.1

Table 22: Albacore reported commercial catch (t) by method, target species and FMA for 2001 and 2002 (ET, high seas areas; unkn., unknown).

Year	Method	Target species	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.	Total
2001	Troll	Albacore	155.8	130.2	1.3	0.5	13.4	0.0	1536.9	431.6	569.5	0.0	3.3	4.6	2847.0
		Other	0.6	<0.1	0.0	0.0	0.0	0.0	0.4	<0.1	<0.1	0.0	0.0	0.0	1.1
	Longline	Bigeye tuna	547.4	365.6	0.0	0.1	0.0	0.0	6.0	19.1	429.7	15.7	16.9	1.1	1401.6
		Southern bluefin tuna	13.1	253.0	<0.1	0.0	13.7	0.0	10.7	0.8	1.7	2.0	0.1	<0.1	295.2
		Albacore	43.5	90.2	0.0	0.0	0.2	0.0	0.0	1.4	49.0	0.0	2.8	0.0	187.1
		Other	18.1	9.2	0.0	0.0	<0.1	0.0	0.0	0.0	23.4	0.1	0.0	0.4	51.2
	Handline	Albacore	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.6
	Pole&line	Albacore	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.6
	Purse-seine	Albacore	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
2002	Troll	Albacore	71.3	36.6	1.4	1.0	40.0	0.0	1685.7	501.9	396.2	0.0	1.4	11.6	2747.2
		Other	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.2
	Longline	Bigeye tuna	355.3	428.6	0.0	0.1	0.0	0.0	14.4	26.0	192.8	9.9	9.3	1.7	1038.0
		Southern bluefin tuna	15.3	412.9	0.0	0.4	3.3	0.0	19.7	0.5	5.9	0.1	0.0	0.2	458.3
		Albacore	32.9	275.5	0.2	0.0	0.0	0.0	7.1	8.3	51.7	<0.1	0.8	1.0	377.5
		Other	2.1	42.4	0.0	0.0	0.0	0.5	1.2	3.2	15.3	0.1	0.0	0.0	64.8
	Handline	Albacore	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.8
	Pole&line	Albacore	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1

Table 23: Bigeye tuna reported commercial catch (t) by method, target species and FMA for 2001 and 2002 (ET, high seas areas; unkn., unknown).

Year	Method	Target species	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.	Total
2001	Longline	Bigeye tuna	238.5	63.8	0.0	0.0	0.0	0.0	0.1	1.6	106.8	23.1	8.5	0.3	442.6
		Albacore	9.2	5.9	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.1	0.0	17.6
		Southern bluefin tuna	0.9	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8
		Other	5.1	1.9	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.1	0.0	0.5	8.6
	Troll	Albacore	0.1	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2
2002	Longline	Bigeye tuna	108.1	20.5	0.0	0.0	0.0	0.0	1.6	2.8	25.7	6.6	1.8	0.1	167.1
		Albacore	2.2	2.5	0.0	0.0	0.0	0.0	0.9	0.5	0.6	0.0	0.0	0.0	6.5
		Southern bluefin tuna	0.4	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	5.4
		Other	0.5	1.0	0.0	0.0	0.0	0.0	<0.1	0.2	0.1	0.0	0.0	0.0	1.8
	Troll	Albacore	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1	1.2	0.0	0.0	0.0	1.2
		Bigeye tuna	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1

Table 24: Pacific bluefin tuna reported commercial catch (t) by method, target species and FMA for 2001 and 2002 (ET, high seas areas; unkn., unknown).

Year	Method	Target species	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.	Total
2001	Longline	Bigeye tuna	10.6	10.4	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.3	0.9	0.0	27.6
		Southern bluefin tuna	0.5	12.8	0.0	0.0	0.1	0.0	0.4	0.0	0.0	0.2	0.0	0.0	14.0
		Albacore	0.4	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	3.5
		Pacific bluefin tuna	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
		Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2
2002	Longline	Bigeye tuna	16.8	12.8	0.0	0.0	0.0	0.0	0.2	0.0	3.8	0.5	0.4	0.0	34.5
		Southern bluefin tuna	0.2	8.2	0.0	0.0	0.2	0.0	0.2	0.0	0.3	0.1	0.0	0.0	9.1
		Albacore	0.8	4.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	5.1
		Pacific bluefin tuna	0.3	2.8	0.0	0.0	0.0	0.0	0.0	0.3	0.7	0.0	0.0	0.0	4.1
		Other	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

Table 25: Skipjack tuna reported commercial catch (t) by method, target species and FMA for 2001 and 2002 (ET, high seas areas; unkn., unknown).

Year	Method	Target species	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.	Total
2001	Purse-seine	Skipjack	2263.0	225.0	0.0	0.0	0.0	0.0	445.7	427.3	418.4	0.0	950.5	52.0	4781.8
		Blue mackerel	47.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.1
		Yellowfin tuna	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.1	0.0	18.1
	Troll	Albacore	4.5	9.9	0.0	0.0	0.1	0.0	6.8	15.9	21.2	0.0	0.1	0.1	58.5
		Skipjack	2.8	0.4	0.0	0.0	0.0	0.0	0.0	0.9	1.2	0.0	0.0	0.0	5.3
		Other	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Longline	Bigeye tuna	3.2	1.2	0.0	0.0	0.0	0.0	<0.1	0.2	2.8	0.1	0.2	0.0	7.8
		Yellowfin tuna	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.5
		Albacore	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.5
		Other	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2002	Purse-seine	Skipjack	2804.9	89.5	0.0	0.0	0.0	0.0	0.0	221.0	165.0	0.0	794.7	12.0	4087.1
		Blue mackerel	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
	Troll	Albacore	1.4	0.8	0.0	0.0	0.2	0.0	11.5	10.0	4.9	0.0	0.0	<0.1	28.7
		Skipjack	0.2	0.0	0.0	0.0	0.0	0.0	0.7	<0.1	1.3	0.0	0.0	0.0	2.2
		Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	<0.1
	Longline	Bigeye tuna	6.7	0.2	0.0	0.0	0.0	0.0	0.0	<0.1	2.0	0.5	0.2	0.0	9.7
		Albacore	0.2	0.1	0.0	0.0	0.0	0.0	0.1	<0.1	0.7	0.0	0.0	0.0	1.1
		Other	0.1	0.1	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.3

Table 26: Southern bluefin tuna reported commercial catch (t) by method, target species and FMA for 2001 and 2002 (ET, high seas areas; unkn., unknown).

Year	Method	Target species	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.	Total
2001	Longline	Southern bluefin tuna	2.3	104.0	12.4	0.0	102.9	2.8	72.1	0.3	0.0	0.3	0.3	0.0	297.4
		Bigeye tuna	10.2	13.9	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.4	0.1	0.0	25.6
		Albacore	0.8	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0	4.8
		Other	0.0	0.7	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
	Handline	Southern bluefin tuna	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Troll	Albacore	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	<0.1
2002	Longline	Southern bluefin tuna	1.8	134.4	0.8	0.1	125.9	0.6	120.6	0.0	0.3	0.0	1.8	1.1	387.4
		Bigeye tuna	5.9	19.2	0.0	0.0	0.0	0.0	0.3	0.0	1.0	0.0	<0.1	0.1	26.5
		Albacore	0.1	11.6	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.4	0.1	0.0	12.4
		Other	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	2.3
	Troll	Albacore	0.0	0.0	0.0	0.0	0.1	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.1
		Southern bluefin tuna	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2

Table 27: Yellowfin tuna reported commercial catch (t) by method, target species and FMA for 2001 and 2002 (ET, high seas areas; unkn., unknown).

Year	Method	Target	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.	Total
2001	Purse-seine	Skipjack tuna	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	201.4	0.0	201.4
		Yellowfin tuna	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78.9	0.0	78.9
	Longline	Bigeye tuna	56.8	31.4	0.0	0.0	0.0	0.0	0.0	<0.1	14.0	3.2	1.6	<0.1	107.0
		Yellowfin tuna	9.6	4.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.4	0.0	0.0	15.2
		Albacore	1.4	2.6	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	5.1
		Southern bluefin tuna	0.4	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
		Other	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.3
	Troll	Albacore	1.0	1.5	0.0	0.0	0.0	0.0	<0.1	0.1	0.8	0.0	0.0	0.0	3.4
		Other	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.3
2002	Purse-seine	Skipjack tuna	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	200.5	0.0	200.5
		Yellowfin tuna	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.8	0.0	40.8
	Longline	Bigeye tuna	8.8	3.2	0.0	0.0	0.0	0.0	0.0	0.3	5.7	1.9	0.0	0.0	19.9
		Yellowfin tuna	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	1.3
		Southern bluefin tuna	0.1	0.3	0.0	0.0	0.0	0.0	<0.1	0.0	0.4	0.0	0.0	0.0	0.9
		Albacore	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.8
		Other	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.9
	Troll	Albacore	0.1	<0.1	0.0	0.0	0.0	0.0	<0.1	<0.1	0.1	0.0	0.0	0.1	0.3
		Other	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1

Table 28: Swordfish reported commercial catch (t) by method, target species and FMA for 2001 and 2002 (ET, high seas areas; unkn., unknown).

Year	Method	Target species	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.	Total
2001	Longline	Bigeye tuna	290.1	266.4	0.0	0.0	0.0	0.0	1.5	3.2	141.3	21.5	16.8	0.4	741.1
		Southern bluefin tuna	4.5	120.0	0.2	0.0	22.7	0.0	10.7	0.1	1.4	2.0	0.1	0.0	161.7
		Albacore	11.4	37.6	0.0	0.0	0.0	0.0	0.0	0.1	8.7	0.0	0.5	0.0	58.4
		Yellowfin tuna	8.1	7.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6	1.2	0.0	0.0	22.9
		Pacific bluefin tuna	2.7	2.6	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0	10.9
		Swordfish	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
		Other	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	<0.1	2.2
2002	Longline	Bigeye tuna	214.4	170.4	0.0	0.0	0.0	0.0	6.1	16.7	118.7	25.7	7.3	0.3	559.7
		Southern bluefin tuna	2.6	137.8	0.0	0.0	6.6	0.0	32.7	0.1	5.6	0.3	0.4	0.5	186.6
		Albacore	16.1	51.0	0.1	0.0	0.0	0.0	4.4	4.7	8.5	0.0	1.0	0.3	86.1
		Pacific bluefin tuna	1.4	9.5	0.0	0.0	0.0	0.0	0.0	1.1	7.7	0.0	<0.1	0.0	19.7
		Yellowfin tuna	4.7	0.9	0.0	0.0	0.0	0.0	0.0	0.4	3.5	0.8	0.0	0.0	10.3
		Other	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.4
	Troll	Swordfish	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
		Other	0.9	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	1.1

Table 29: Length-weight relationships (ln(fork length) vs ln(greenweight)) for longline caught tuna and swordfish, 2001 and 2002 (not determined when n<50); b_0, intercept; b_1, slope; SE, standard error.

Species	Year	Sex	n	b_0	SE_{b0}	b_1	SE_{b1}	R^2
Albacore	2001	male	39					
		female	22					
		all	7053	-10.24	0.05	2.86	0.01	0.91
	2002	male	10					
		female	6					
		all	815	-10.05	0.28	2.80	0.06	0.72
Bigeye tuna	2001	male	96	-10.88	0.56	3.01	0.11	0.88
		female	88	-8.88	0.66	2.60	0.13	0.81
		all	190	-9.91	0.42	2.81	0.09	0.85
	2002	male	3					
		female	2					
		all	11					
Southern bluefin tuna	2001	male	1300	-11.38	0.08	3.11	0.02	0.97
		female	1161	-11.32	0.09	3.09	0.02	0.96
		all	2470	-11.36	0.06	3.10	0.01	0.97
	2002	male	1447	-11.13	0.08	3.05	0.02	0.96
		female	1309	-11.14	0.11	3.06	0.02	0.93
		all	2758	-11.13	0.07	3.05	0.01	0.95
Yellowfin tuna	2001	male	32					
		female	34					
		all	68	-6.88	1.02	2.14	0.21	0.61
	2002	male	1					
		female	0					
		all	4					
Swordfish	2001	male	126	-11.96	0.36	3.13	0.07	0.94
		female	265	-13.23	0.25	3.38	0.05	0.95
		all	449	-12.76	0.19	3.29	0.04	0.95
	2002	male	32					
		female	55	-10.03	0.70	2.79	0.13	0.90
		all	121	-12.25	0.41	3.21	0.08	0.93

Table 30: Sex ratios of longline caught tuna and swordfish, 2001 and 2002 (not determined when n<50).

Species	Year	male	female	n	ratio	1:1 ratio Chi square	1:3 ratio Chi square
Albacore	2001	49	25	74	1.96	3.89	
	2002	12	6	18			
Bigeye tuna	2001	186	175	361	1.06	0.17	
	2002	13	11	24			
Southern bluefin tuna	2001	1602	1387	2989	1.16	7.73	
	2002	1568	1445	3013	1.09	2.51	
Yellowfin tuna	2001	128	205	333	0.62	8.90	
	2002	17	10	27			
Swordfish	2001	174	445	619	0.39	59.32	2.39
	2002	56	142	198	0.39	18.68	0.85

Table 31: Summary of discards in longline caught tuna and swordfish, 2001 and 2002.

Year	Species	Number retained	% retained	released alive	discarded dead	% discarded	escaped alive	fell off dead	% lost
2001	Albacore	8662	97.2	10	117	1.4	64	52	1.3
	Bigeye tuna	372	96.4	3	6	2.3	5	0	1.3
	Southern bluefin tuna	3001	98.0	5	6	0.4	49	0	1.6
	Yellowfin tuna	355	96.2	2	2	1.1	9	1	2.7
	Swordfish	665	81.0	61	75	16.9	12	5	2.1
2002	Albacore	1384	97.3	0	25	1.8	11	2	0.9
	Bigeye tuna	30	90.9	0	1	3.0	2	0	6.1
	Southern bluefin tuna	3022	98.5	5	4	0.3	37	1	1.2
	Yellowfin tuna	30	100.0	0	0	0.0	0	0	0.0
	Swordfish	249	92.9	11	6	6.3	2	0	0.7

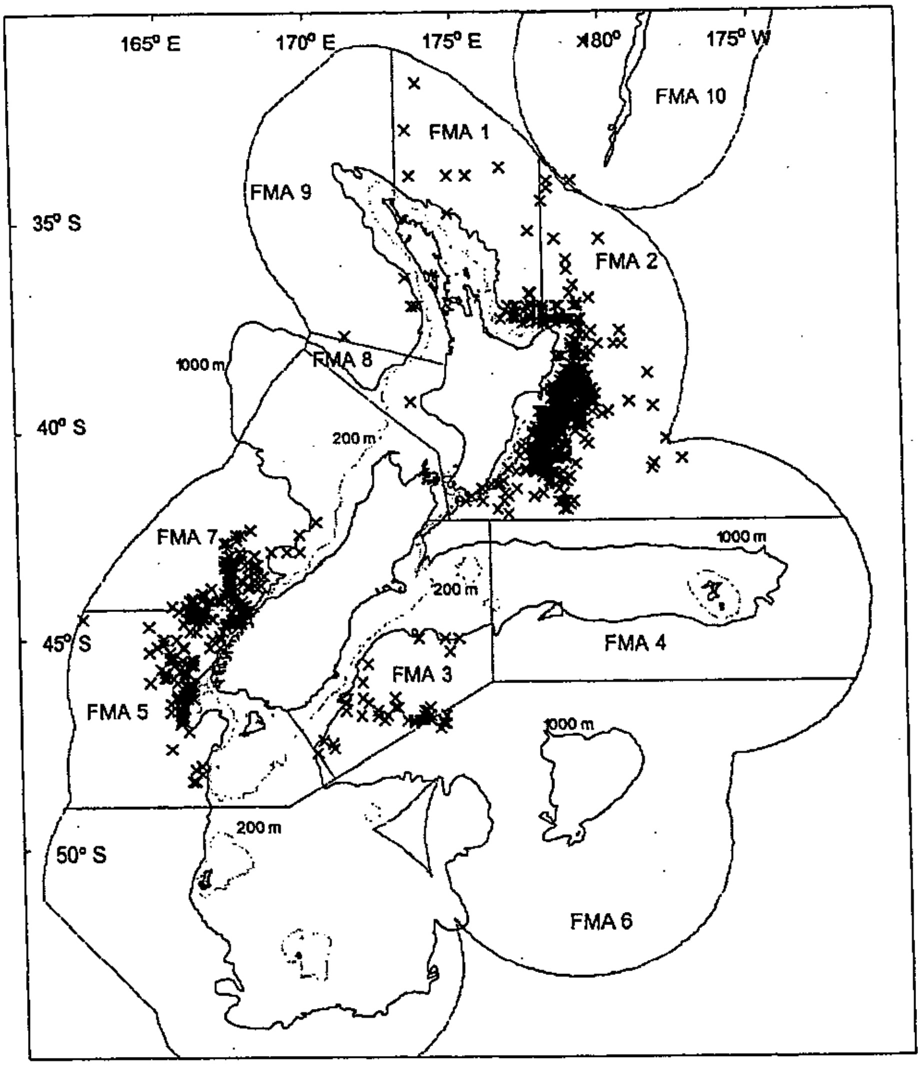


Figure 1: Tuna longline set positions targeting southern bluefin tuna in 2001.

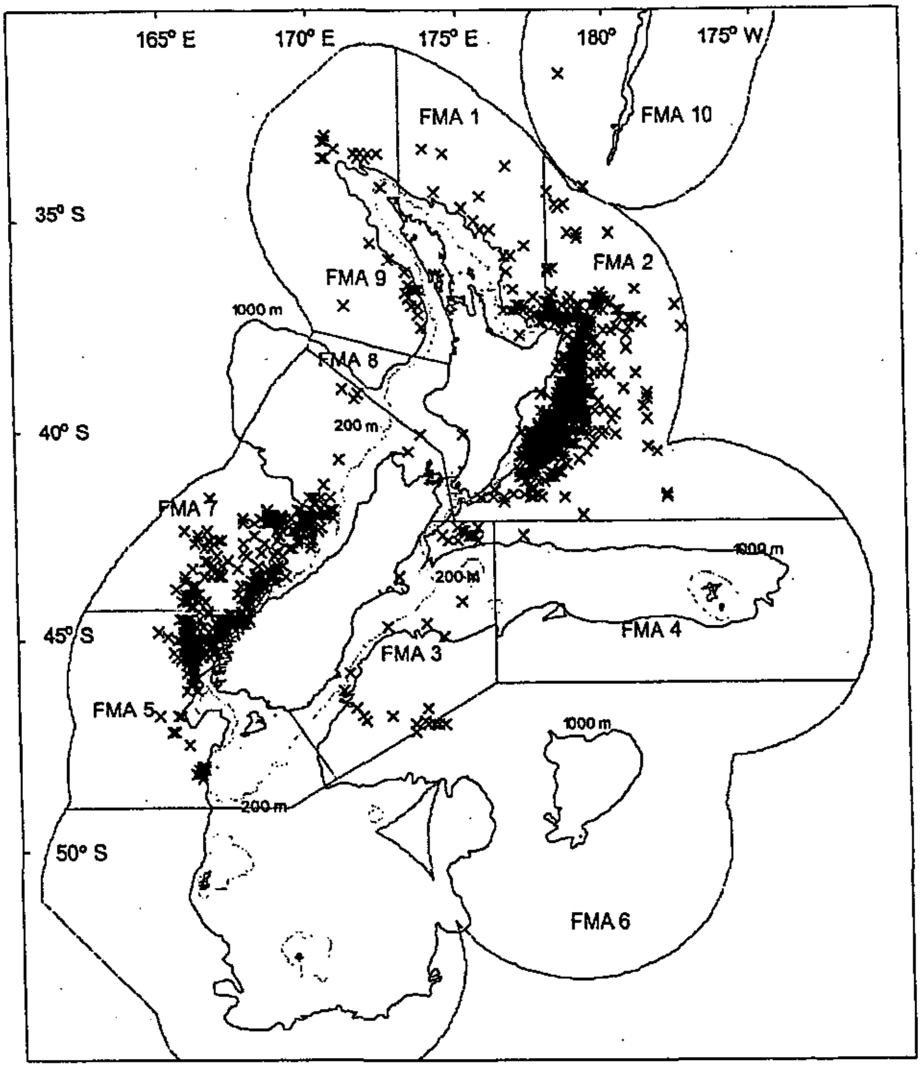


Figure 2: Tuna longline set positions targeting southern bluefin tuna in 2002.

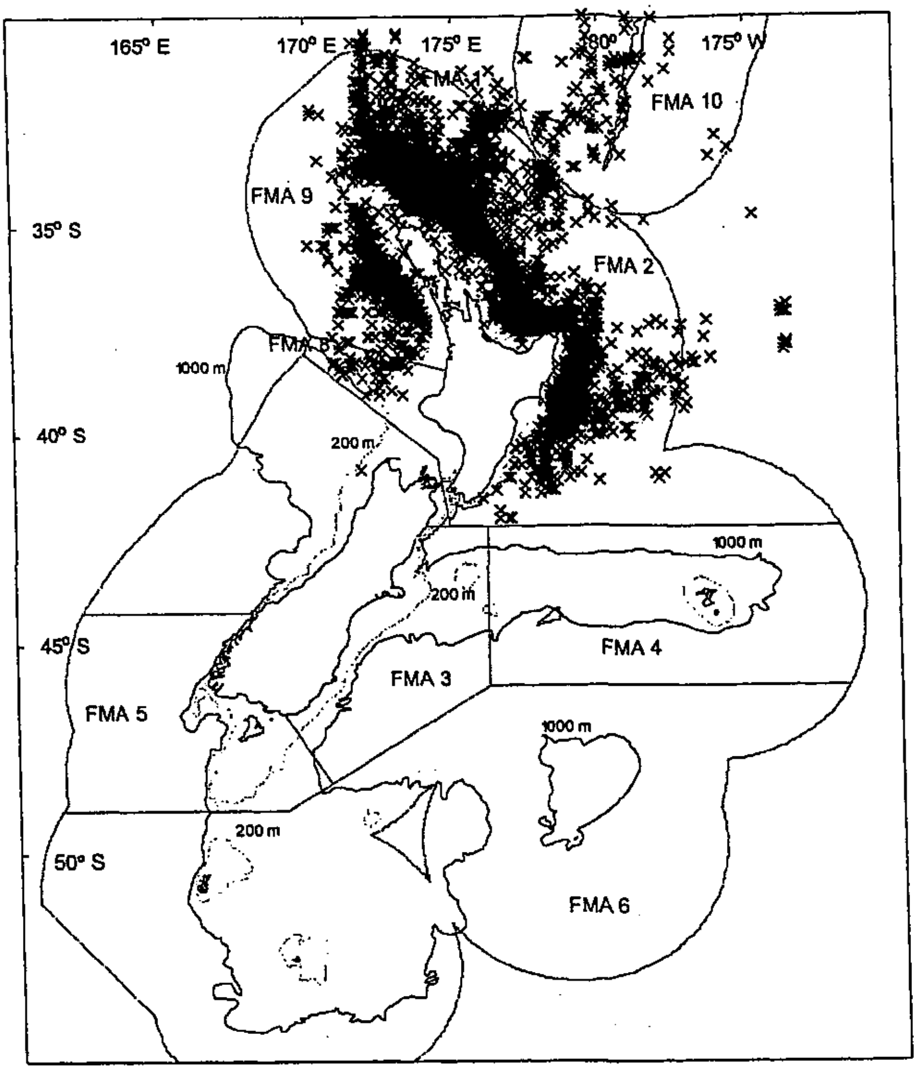


Figure 3: Tuna longline set positions targeting bigeye tuna in 2001.

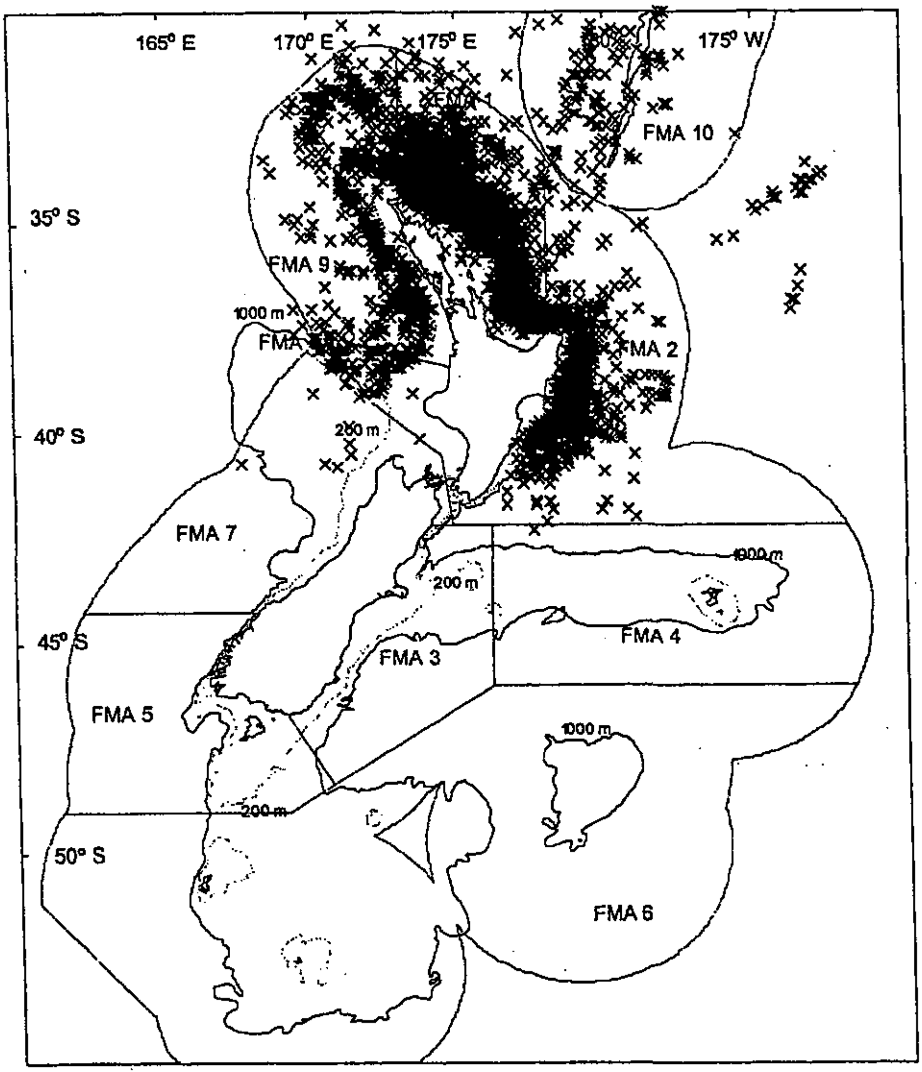


Figure 4: Tuna longline set positions targeting bigeye tuna in 2002.

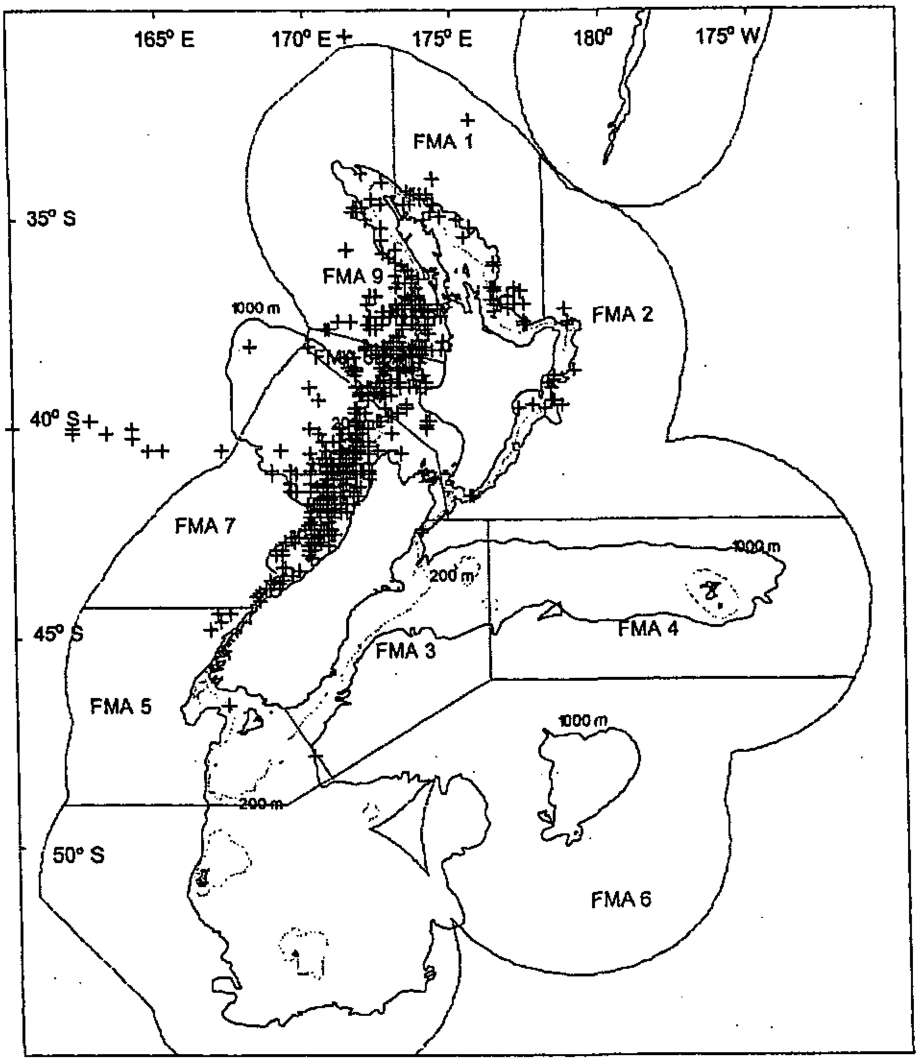


Figure 5: Troll positions targeting albacore in 2001.

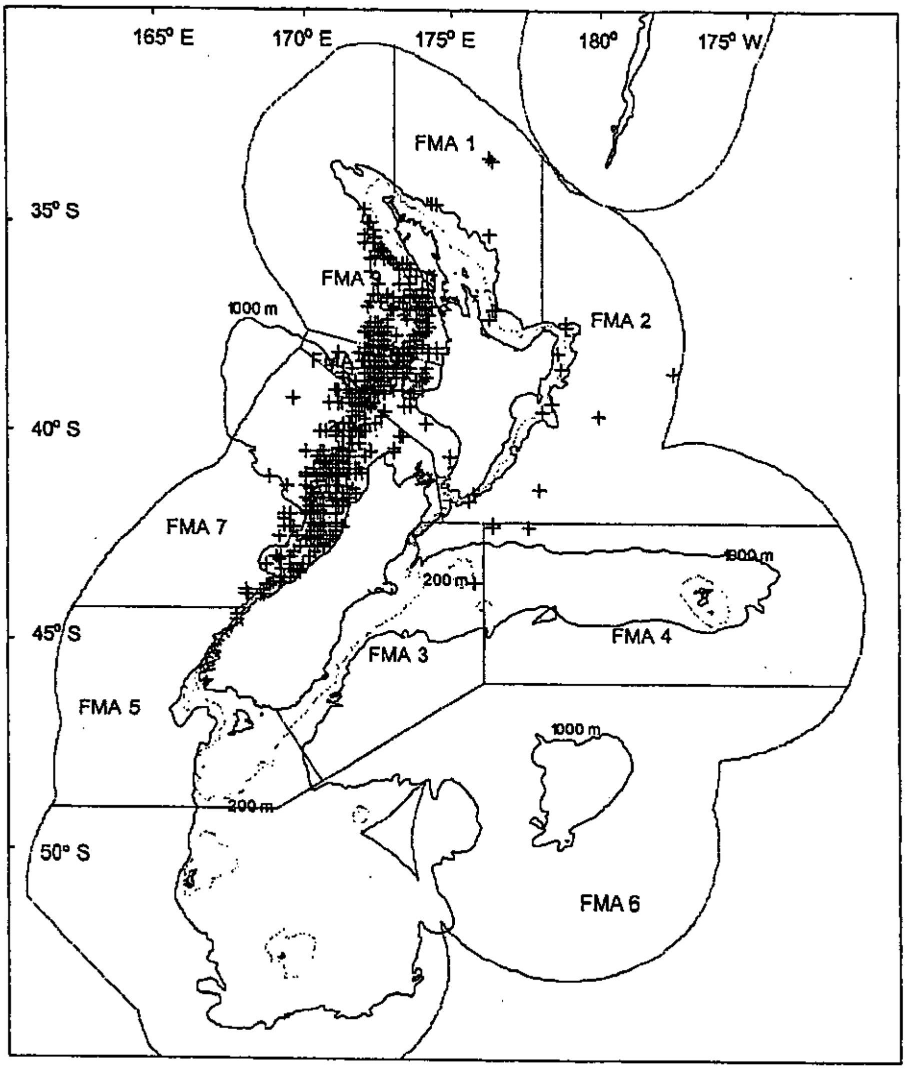


Figure 6: Troll positions targeting albacore in 2002.

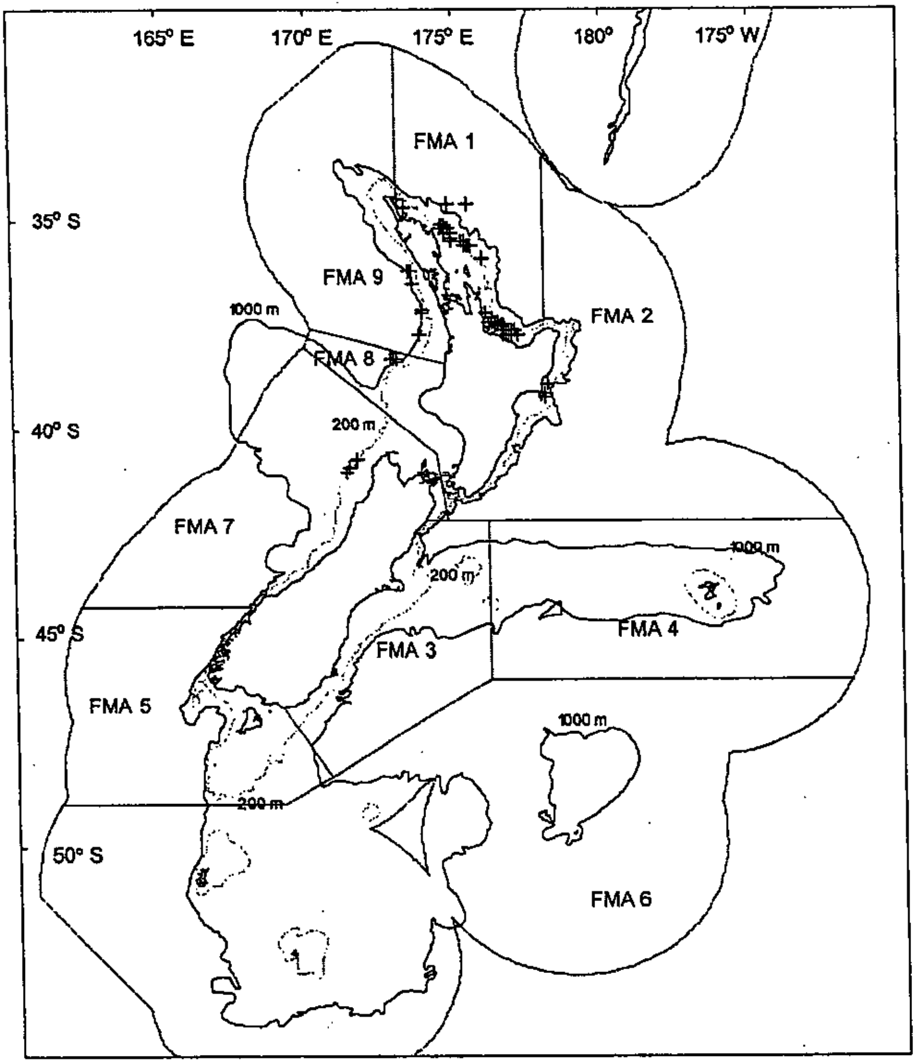


Figure 7: Purse seine set positions targeting skipjack tuna in 2001.

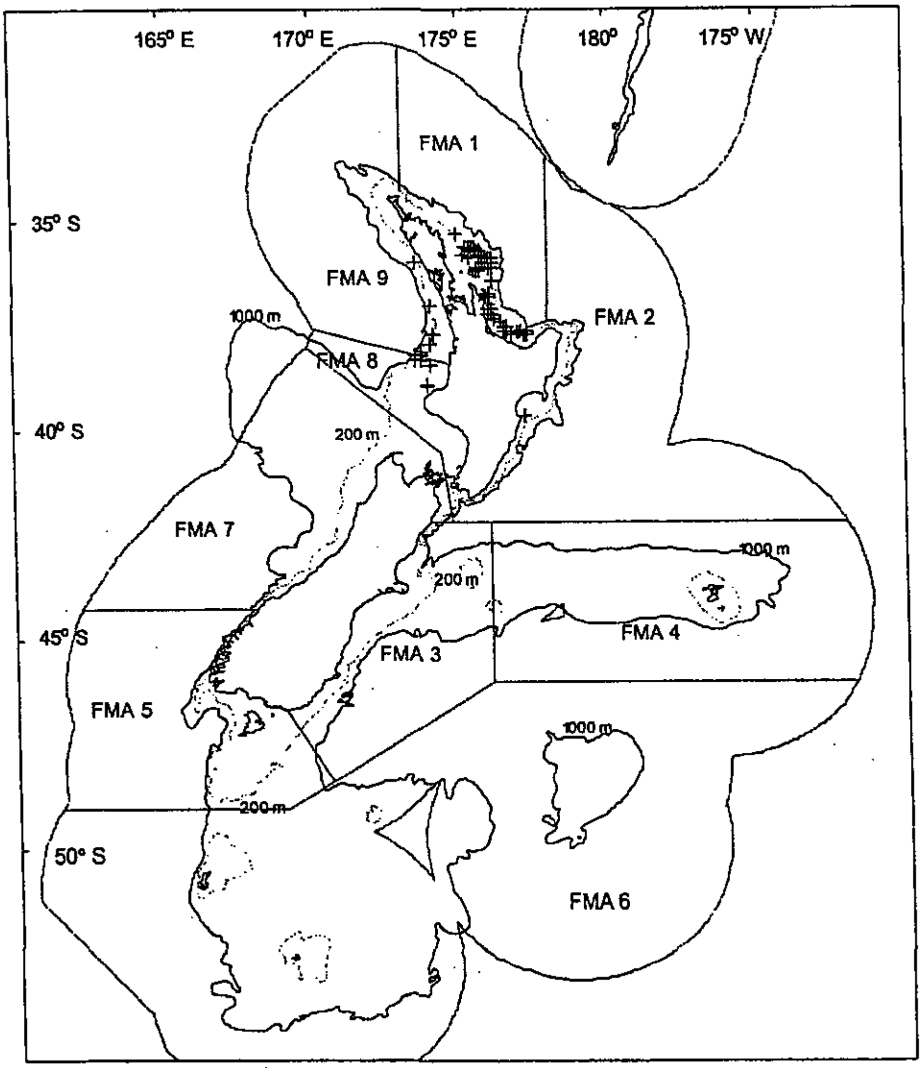


Figure 8: Purse seine set positions targeting skipjack tuna in 2002.

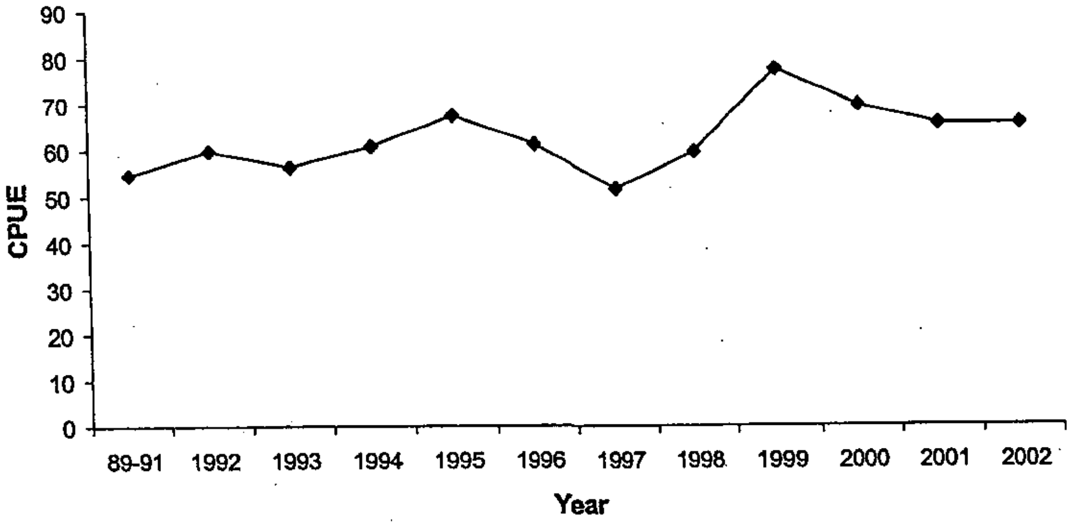


Figure 9: Nominal un-normalised CPUE for albacore in the New Zealand troll fishery.

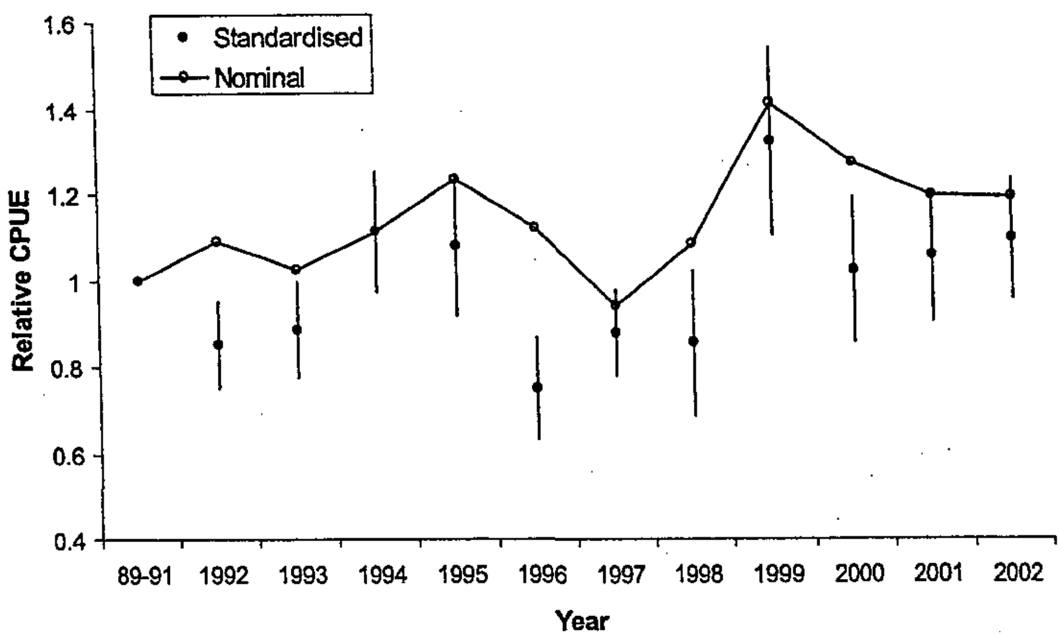


Figure 10: Standardised CPUE for albacore in the New Zealand troll fishery (circles +/- 2σ errors) contrasted with nominal CPUE (solid line). CPUE data are shown relative to the 1989–91 combined value.

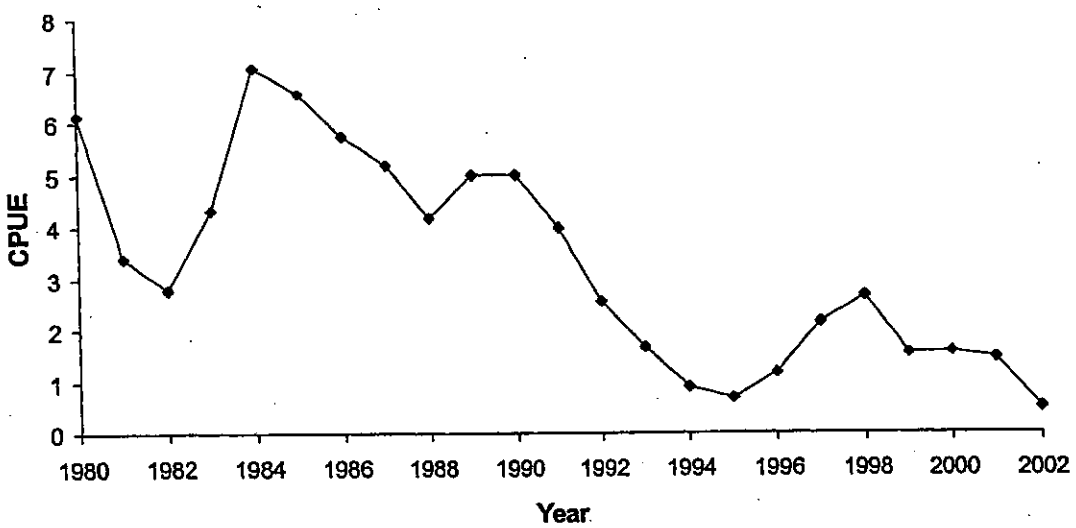


Figure 11: Nominal un-normalised CPUE of bigeye tuna in the New Zealand longline fishery.

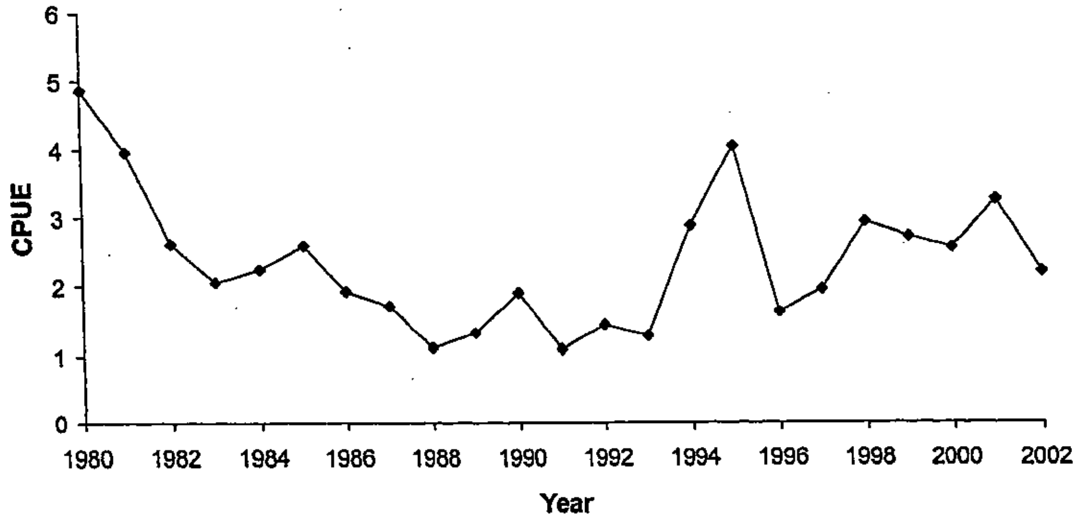


Figure 12: Nominal un-normalised CPUE of southern bluefin tuna in the New Zealand longline fishery.

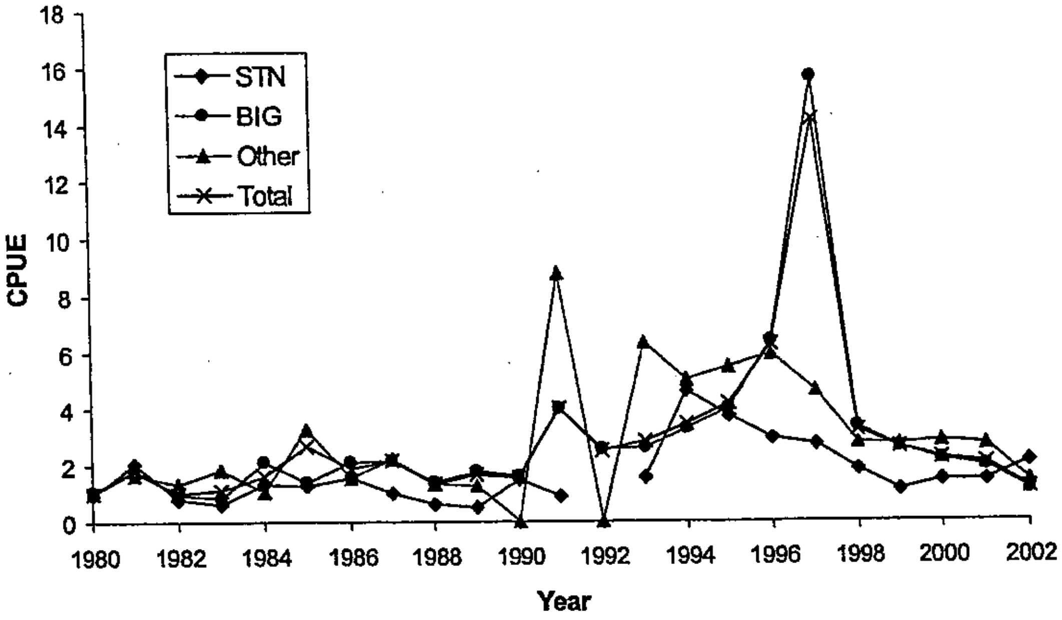


Figure 13: Nominal un-normalised CPUE of yellowfin tuna in the New Zealand longline fishery, by target species.

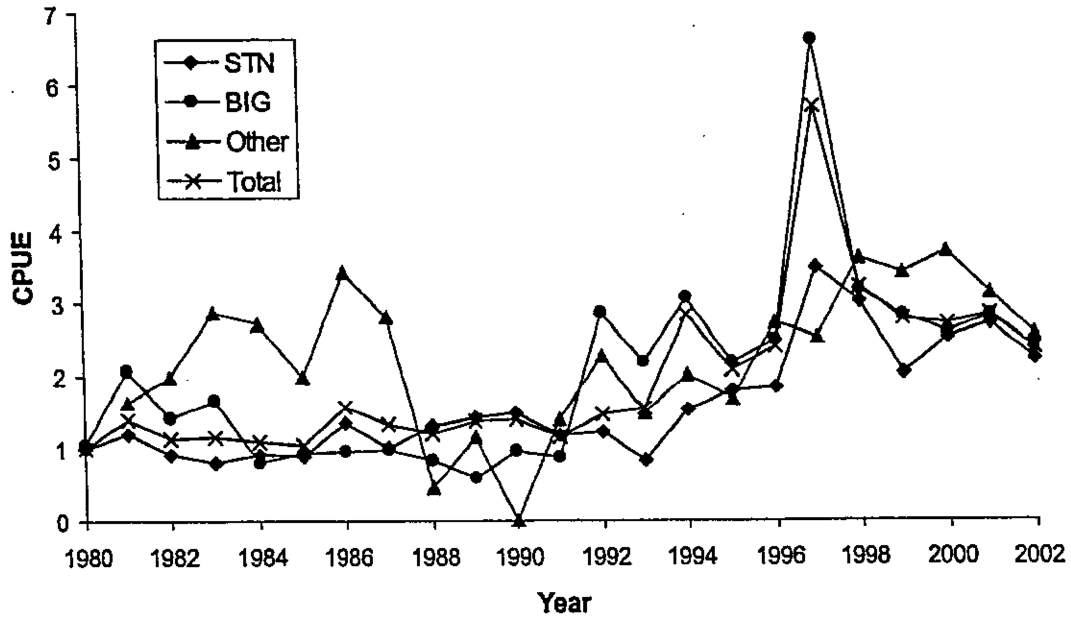


Figure 14: Nominal un-normalised CPUE of swordfish in the New Zealand longline fishery, by target species.

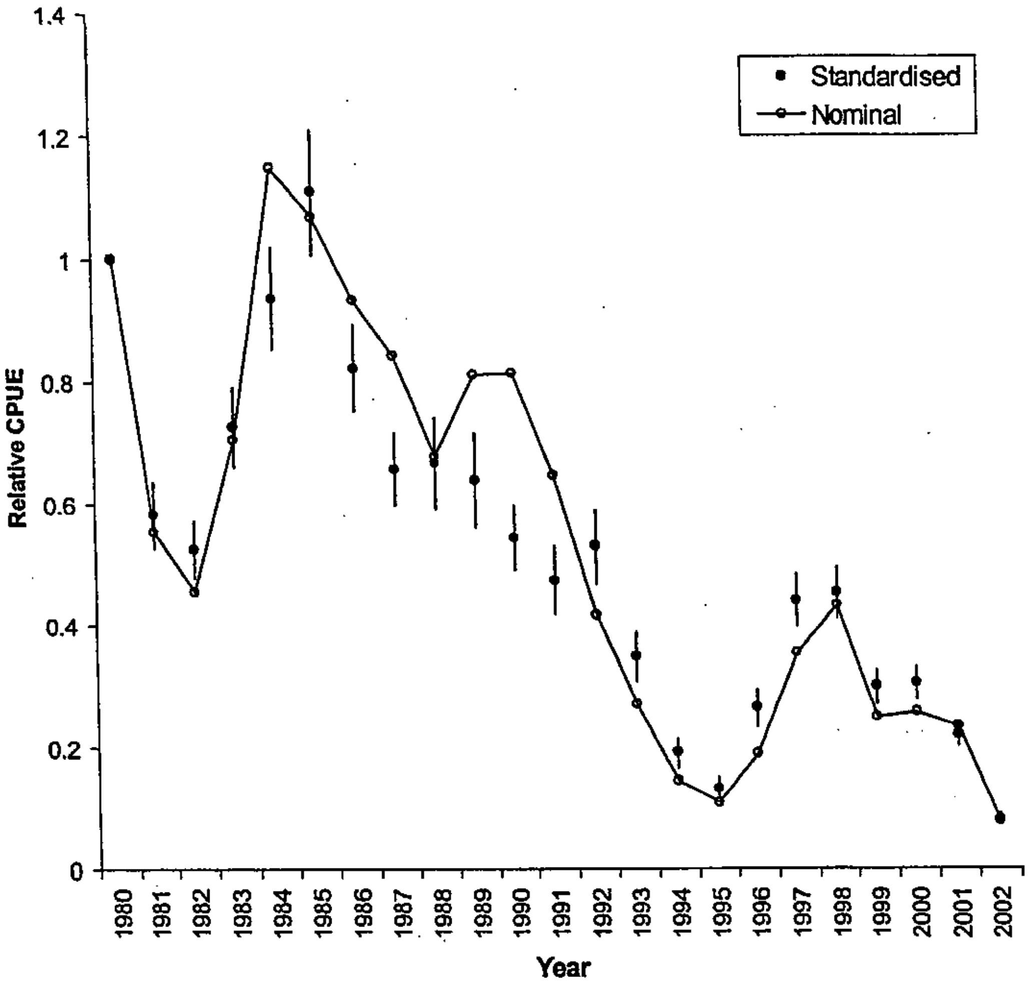


Figure 15: Standardised CPUE for bigeye tuna in the New Zealand longline fishery (+/- 2σ errors) contrasted with nominal CPUE. CPUE values are shown relative to the 1980 CPUE value.

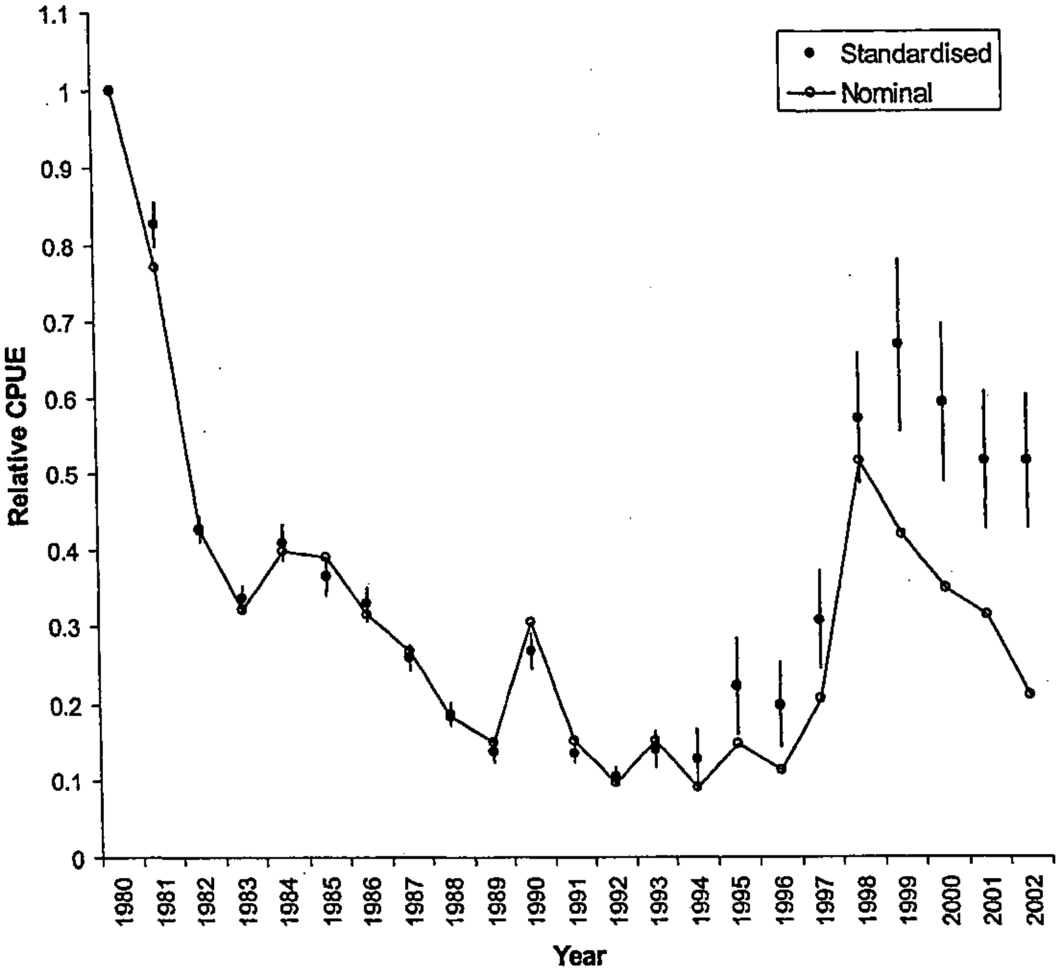


Figure 16a: Standardised CPUE for southern bluefin tuna in the New Zealand longline fishery off the east coast of New Zealand north of 44° S (+/- 2σ errors) contrasted with nominal CPUE. CPUE values are shown relative to the 1980 CPUE value.

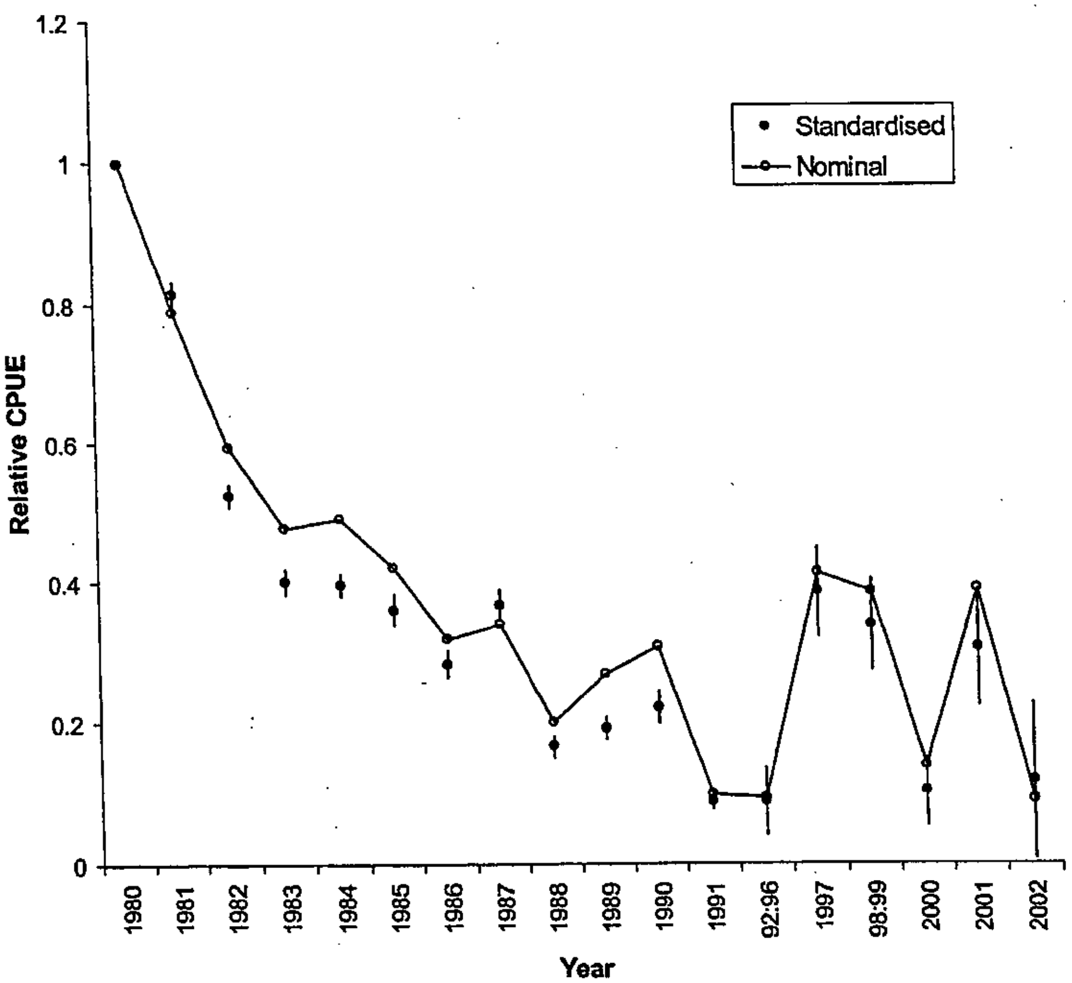


Figure 16b: Standardised CPUE for southern bluefin tuna in the New Zealand longline fishery off the east coast of the South Island south of 44° S (+/- 2σ errors) contrasted with nominal CPUE. CPUE values are shown relative to the 1980 CPUE value.

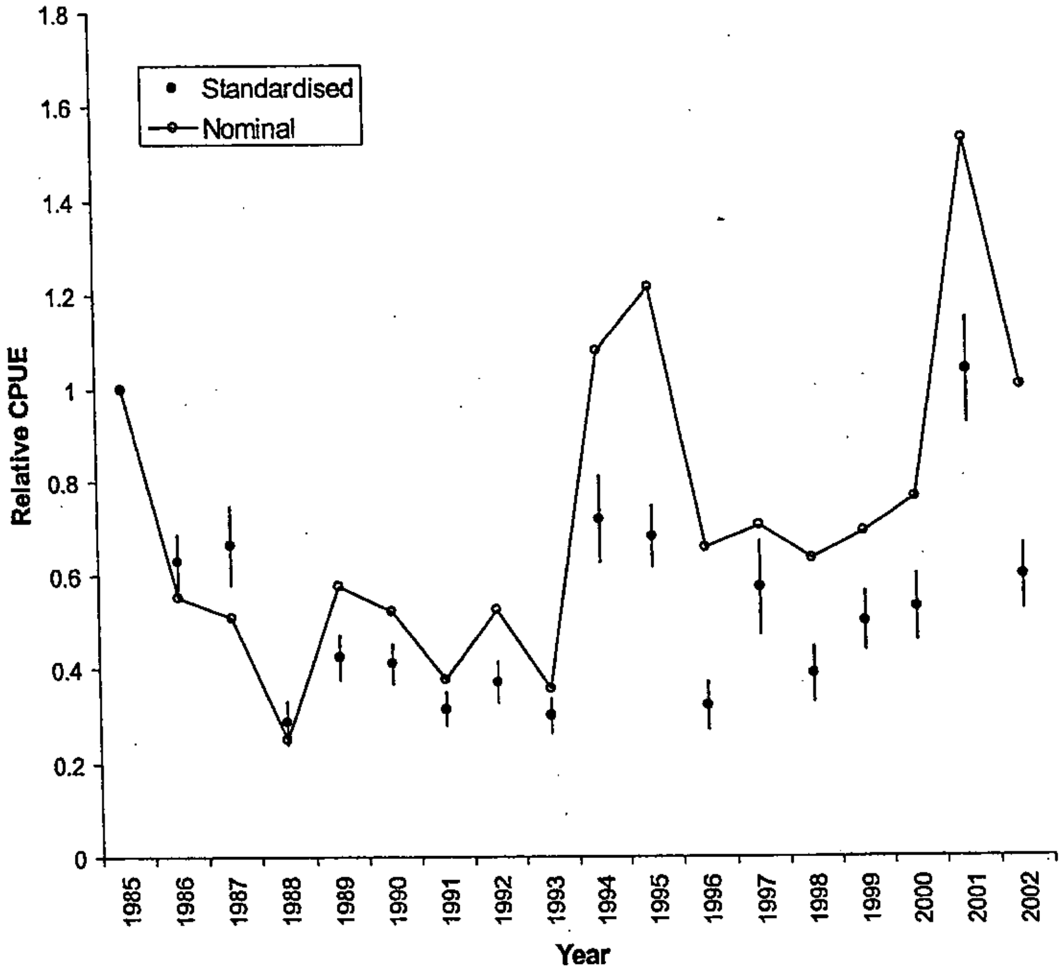
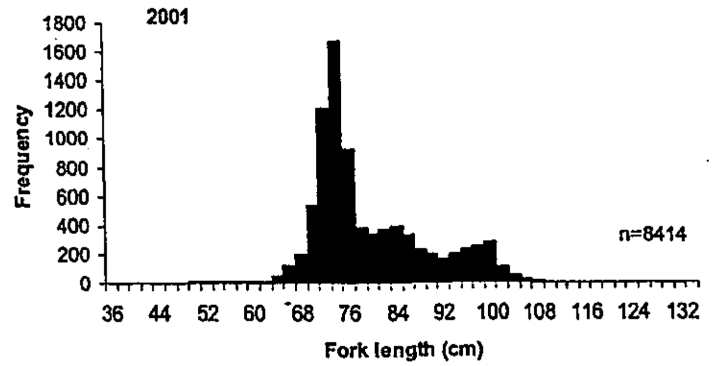
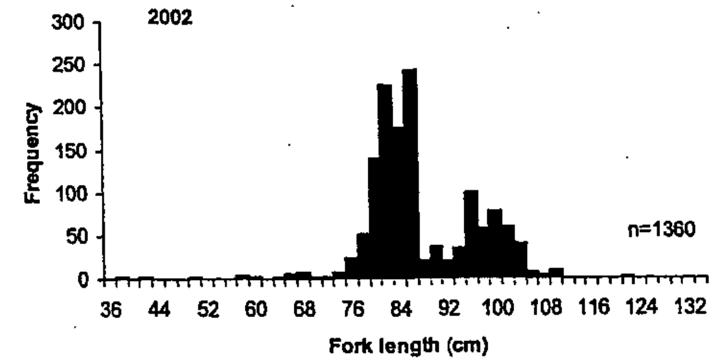


Figure 16c: Standardised CPUE for southern bluefin tuna in the New Zealand longline fishery off the west coast of the South Island (+/- 2σ errors) contrasted with nominal CPUE. CPUE values are shown relative to the 1985 CPUE value.





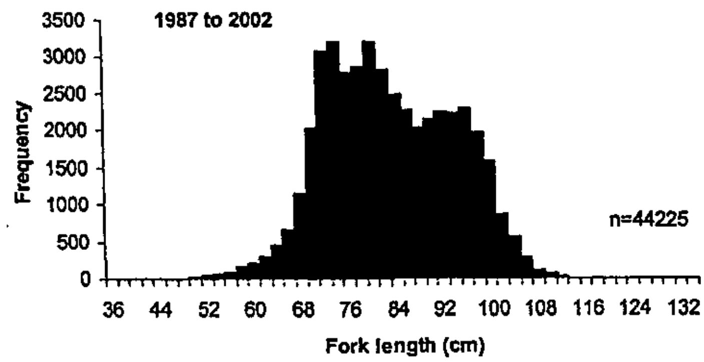
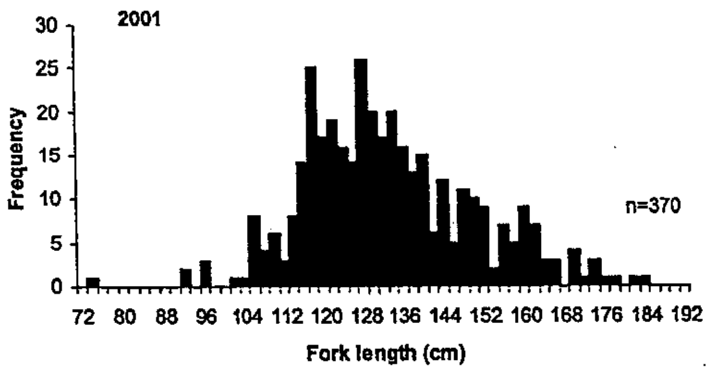
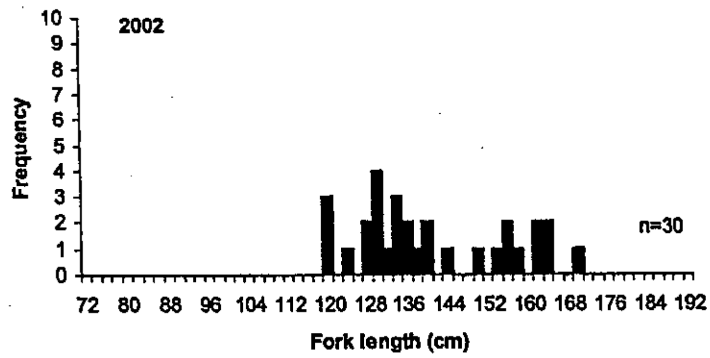


Figure 17: Size frequency distributions for albacore caught by longline, 2001, 2002, and all observer data collected since 1987, for all fleets combined.





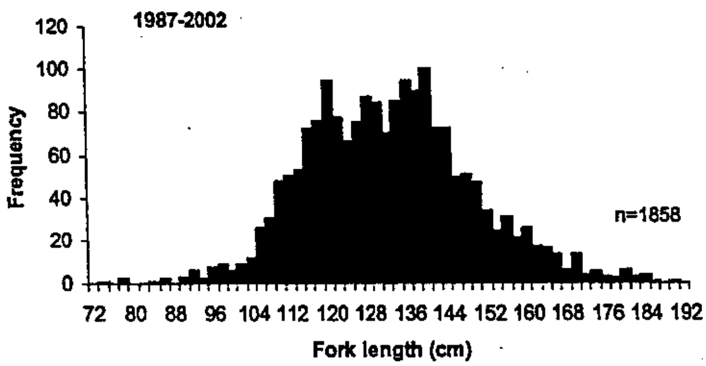


Figure 18: Size frequency distributions for bigeye tuna caught by longline, 2001, 2002, and all observer data collected since 1987, for all fleets combined.

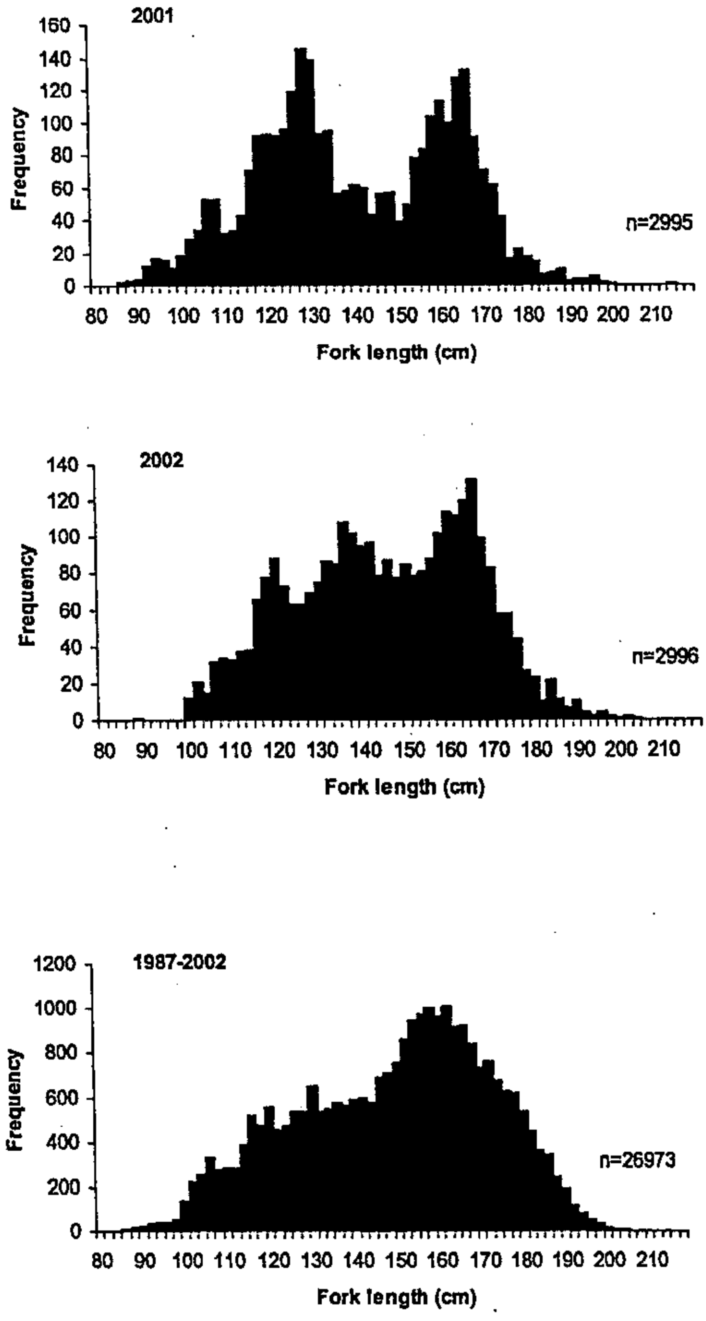


Figure 19: Size frequency distributions for southern bluefin tuna caught by longline, 2001, 2002, and all observer data collected since 1987, for all fleets combined.

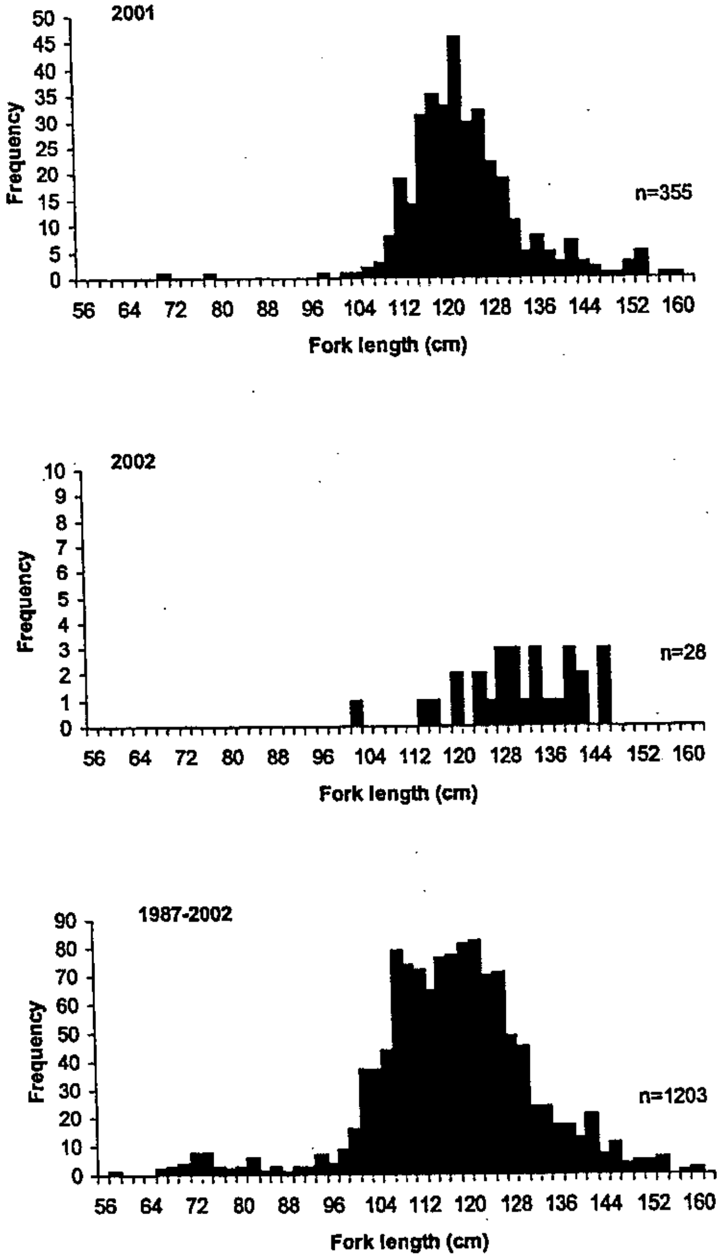


Figure 20: Size frequency distributions for yellowfin tuna caught by longline, 2001, 2002, and all observer data collected since 1987, for all fleets combined.

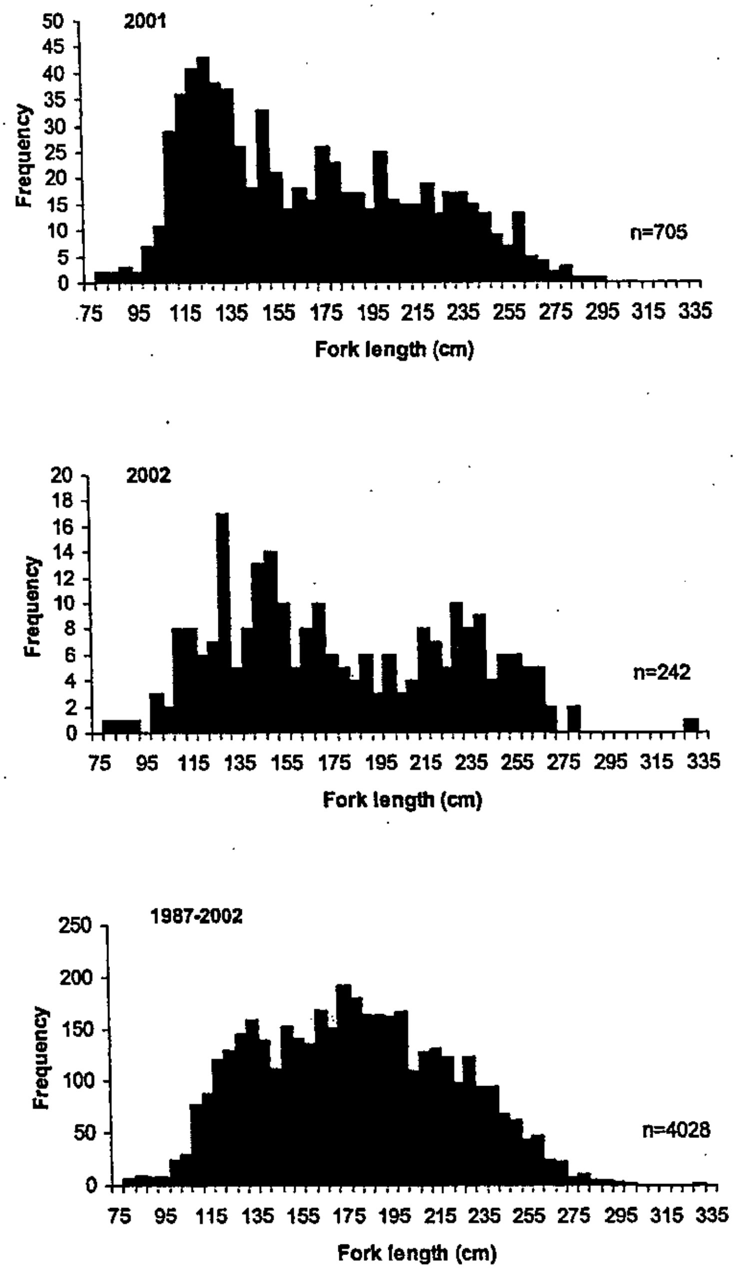


Figure 21: Size frequency distributions for swordfish caught by longline, 2001, 2002, and all observer data collected since 1987, for all fleets combined, where "fork length" refers to lower jaw to fork length.

Appendix 1: Analysis of deviance tables for the final GLM and GAM CPUE models derived for the albacore troll, bigeye tuna longline, and southern bluefin tuna longline fisheries

Albacore troll fishery

Analysis of deviance table for quasi-likelihood Poisson
GAM

	Df	Npar Df	Npar F	Pr(F)
(Intercept)	1			
year	11			
FMA	11			
lo(SOI)	1	2.7	29.76054	0.0000104
lo(moonphase)	1	3.2	7.38757	4.0099E-05

Bigeye tuna longline fishery

Analysis of deviance table for quasi-likelihood Poisson
GAM

	Df	Npar Df	Npar F	Pr(F)
(Intercept)	1			
year	22			
month	11			
lo(SOI)	1	2.8	37.64722	0.00E+00
lo(SST)	1	2.1	88.64949	0.00E+00
lo(depth)	1	3.0	6.93222	0.000121
lo(lat)	1	2.7	87.37543	0.00E+00
lo(long)	1	2.7	13.32763	0.000000
lo(moonphase)	1	3.2	6.07681	0.000287

Southern bluefin tuna longline fishery (east coast north of 44° S)

Analysis of deviance table for quasi-likelihood Poisson
GAM

	Df	Npar Df	Npar F	Pr(F)
(Intercept)	1			
year	22			
month	4			
lo(lat)	1	2.1	137.1287	0.00E+00
lo(long)	1	3.3	34.3984	0.00E+00
lo(moonphase)	1	3.2	34.5708	0.00E+00
lo(SST)	1	2.2	18.1463	3.68E-09
nation	1			

Appendix 1 continued:

Southern bluefin tuna longline fishery (east coast south of 44° S)

Analysis of deviance table for quasi-likelihood Poisson
GAM

	Df	Npar Df	Npar F	Pr(F)
(Intercept)	1			
year	17			
month	4			
lo(SOI)	1	3.2	32.9167	0.00E+00
lo(lat)	1	2.3	11.7950	2.30E-06
lo(long)	1	2.5	147.9226	0.00E+00
lo(moonphase)	1	3.2	98.1675	0.00E+00
SST	1	3.0	16.6334	1.04E-10

Southern bluefin tuna longline fishery (west coast)

Analysis of deviance table for quasi-likelihood Poisson
GAM

	Df	Npar Df	Npar F	Pr(F)
(Intercept)	1			
year	17			
month	6			
lo(SOI)	1	2.3	34.76449	0.00E+00
lo(SST)	1	3.2	6.47739	0.000139
lo(lat)	1	2.7	68.54419	0.00E+00
lo(long)	1	2.9	23.69840	0.00E+00
lo(depth)	1	2.4	6.76222	0.000530
lo(moonphase)	1	3.2	46.14747	0.00E+00

Appendix 2: Catch per unit effort by method, target species and FMA for 2001 and 2002 (ET, high seas areas; unkn., unknown)

Albacore: CPUE as t/vessel day for troll, t/1000 hooks for longline

Year	Method	Target	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.
2001	Troll	Albacore	0.27	0.26	0.22	0.49	0.16	0.00	0.38	0.38	0.37	0.00	0.18	0.38
2002	Troll	Albacore	0.24	0.16	0.14	0.20	0.25	0.00	0.35	0.37	0.44	0.00	0.48	0.55
2001	Longline	Bigeye tuna	0.15	0.23	0.00	0.07	0.00	0.00	0.48	0.35	0.27	0.09	0.18	0.29
		Southern bluefin tuna	0.30	0.28	<0.01	0.00	0.02	0.00	0.05	0.89	0.29	0.50	0.12	0.22
		Albacore	0.24	0.39	0.00	0.00	0.00	0.00	0.00	0.69	0.46	0.00	0.59	0.48
2002	Longline	Bigeye tuna	0.09	0.29	0.00	0.08	0.00	0.00	0.21	0.24	0.17	0.05	0.16	0.30
		Southern bluefin tuna	0.30	0.28	0.00	0.25	<0.01	0.00	0.03	0.31	0.17	0.03	0.00	0.28
		Albacore	0.15	0.59	0.06	0.00	0.00	0.00	0.21	0.30	0.41	0.02	0.20	1.10

Bigeye tuna: CPUE as t/1000 hooks

Year	Method	Target	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.
2001	Longline	Bigeye tuna	0.07	0.04	0.00	0.00	0.00	0.00	0.01	0.03	0.07	0.13	0.09	0.07
2002	Longline	Bigeye tuna	0.03	0.01	0.00	0.00	0.00	0.00	0.02	0.03	0.02	0.03	0.03	0.01

Pacific bluefin tuna: CPUE as t/1000 hooks

Year	Method	Target	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.
2001	Longline	Bigeye tuna	<0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	<0.01	<0.01	0.01	0.00
		Southern bluefin tuna	0.01	0.01	0.00	0.00	0.00	0.00	<0.01	0.00	0.00	0.06	0.00	0.00
		Pacific bluefin tuna	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	Longline	Bigeye tuna	<0.01	0.01	0.00	0.00	0.00	0.00	<0.01	0.00	<0.01	<0.01	0.01	0.00
		Southern bluefin tuna	<0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.00	0.01
		Pacific bluefin tuna	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.00	0.00	0.00

Skipjack tuna: CPUE as t/purse seine set

Year	Method	Target	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.
2001	Purseseine	Skipjack tuna	10.90	19.50	0.00	0.00	0.00	0.00	20.00	13.50	26.89	0.00	22.63	27.53
2002	Purseseine	Skipjack tuna	12.05	9.94	0.00	0.00	0.00	0.00	0.00	15.79	8.25	0.00	20.91	28.18

Southern bluefin tuna: CPUE as t/1000 hooks

Year	Method	Target	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.
2001	Longline	Southern bluefin tuna	0.05	0.12	0.10	0.00	0.19	0.12	0.33	0.29	0.00	0.08	0.29	0.00
2002	Longline	Southern bluefin tuna	0.04	0.09	0.02	0.08	0.20	0.02	0.23	0.00	0.01	0.00	0.24	0.11

Yellowfin tuna: CPUE as t/set for purse seine, t/1000 hooks for longline

Year	Method	Target	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.
2001	Purseseine	Skipjack tuna	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.79	0.00
		Yellowfin tuna	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.87	0.00
2002	Purseseine	Skipjack tuna	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.28	0.00
		Yellowfin tuna	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.82	0.00
2001	Longline	Bigeye tuna	0.02	0.02	0.00	0.00	0.00	0.00	0.00	<0.01	0.01	0.02	0.02	0.00
		Yellowfin tuna	0.08	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.08	0.00	0.00
2002	Longline	Bigeye tuna	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.01	0.01	0.01	0.00	0.00
		Yellowfin tuna	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00

Swordfish: CPUE as t/1000 hooks

Year	Method	Target	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	ET	unkn.
2001	Longline	Bigeye tuna	0.08	0.17	0.00	0.00	0.00	0.00	0.12	0.06	0.09	0.12	0.18	0.13
		Southern bluefin tuna	0.10	0.13	<0.01	0.00	0.04	0.00	0.05	0.06	0.26	0.50	0.13	0.17
		Albacore	0.06	0.16	0.00	0.00	0.00	0.00	0.00	0.06	0.08	0.00	0.10	0.00
2002	Longline	Bigeye tuna	0.06	0.12	0.00	0.03	0.00	0.00	0.09	0.15	0.11	0.13	0.12	0.06
		Southern bluefin tuna	0.05	0.09	0.00	0.01	0.01	0.00	0.06	0.05	0.16	0.12	0.06	0.09
		Albacore	0.08	0.11	0.05	0.00	0.00	0.00	0.13	0.17	0.07	0.00	0.24	0.28