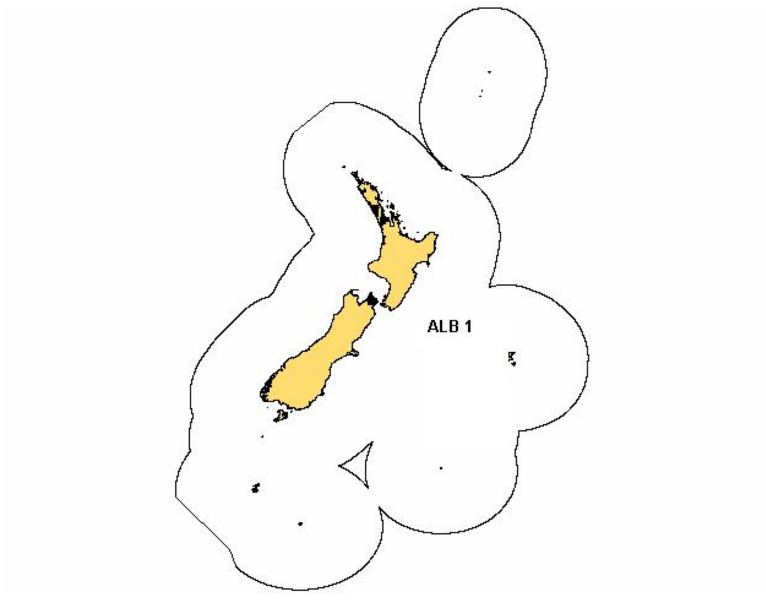
ALBACORE (ALB)

(*Thunnus alalunga)*
Ahipataha



1. FISHERY SUMMARY

Albacore is currently outside the Quota Management System.

Management of albacore stock throughout the South Pacific will be the responsibility of the Western and Central Pacific Fisheries Commission (WCPFC). Under this regional convention New Zealand will be responsible for ensuring that the management measures applied within New Zealand fisheries waters are compatible with those of the Commission.

At its second annual meeting the WCPFC passed a Conservation and Management Measure (CMM) (this is a binding measure that all parties must abide by) relating to conservation and management measures for tunas. Key aspects of this CMM are repeated below:

1. "Commission Members, Cooperating Non-Members, and participating Territories (CCMs) shall not increase the number of their fishing vessels actively fishing for South Pacific albacore in the Convention Area south of 200°S above current (2005) levels or recent historical (2000-2004) levels.

2. The provisions of paragraph 1 shall not prejudice the legitimate rights and obligations under international law of small island developing State and Territory CCMs in the Convention Area for whom South Pacific albacore is an important component of the domestic tuna fishery in waters under their national jurisdiction, and who may wish to pursue a responsible level of development of their fisheries for South Pacific albacore.

3. CCMs that actively fish for South Pacific albacore in the Convention Area south of the equator shall cooperate to ensure the long-term sustainability and economic viability of the fishery for South Pacific albacore, including cooperation and collaboration on research to reduce uncertainty with regard to the status of this stock.

4. This measure will be reviewed in 2006 on the basis of advice from the Scientific Committee on South Pacific albacore."

1.1 Commercial fisheries

In New Zealand, albacore form the basis of a summer troll fishery, primarily on the west coasts of the North and South Islands. This fishery accounts for a large proportion of the albacore landings. Albacore are also caught throughout the year by longline (1000–2500 t per year). Total annual landings over the past 10 fishing years have averaged 4521 t (largest landing 6744 t in 2003) (Table 1).

The earliest known commercial catch of tuna (species unknown but probably skipjack tuna) was by trolling and was landed in Auckland in the year ending March 1943. Regular commercial catches of tuna, however, were not reported until 1961. These catches (species unknown but primarily albacore and skipjack with some southern bluefin and yellowfin tuna possible) are summarised in Table 1. Prior to 1973 the albacore troll fishery was centred off the North Island (Bay of Plenty to Napier and New Plymouth) with the first commercial catches off Greymouth and Westport (54% of the total catch) in 1973. The expansion of albacore trolling to the west coast of the South Island immediately followed experimental fishing by the *W. J. Scott*, which showed substantial quantities of albacore off the Hokitika Canyon and albacore as far south as Doubtful Sound. Tuna longlining, the subject of early trials in 1964 did not establish itself as a fishing method in the domestic industry until the early 1990s.

While albacore trolling occurs in most FMAs during summer months, albacore caught incidentally during longline sets for bigeye and southern bluefin tuna has become increasingly important and since 1999 represents 30–50% of domestic albacore landings by calendar year. In addition to trolling and longline, some albacore are reported caught by pole-and-line and hand line.

The New Zealand albacore fishery, especially the troll fishery has been characterised by periodic poor years that have been linked to poor weather or colder than average summer seasons. Despite this variability, albacore landings have steadily increased since the start of commercial fishing in the 1960s. The average catch in the 1960s of 19 t, increased in the 1970s to 705 t, in the 1980s to 2256 t and in the 1990s averaged 4571 t.

Table 1: Reported total New Zealand landings (t) and landings (t) from the South Pacific Ocean (SPO) of albacore tuna from 1972 to 2007.

Year	NZ fisheries waters	SPO	Year	NZ fisheries waters	SPO	Year	NZ fisheries waters	SPO
1972	240	39 521	1987	1236	25 043	2002	5566	65 334
1973	432	47 330	1988	672	37 863	2003	6744	60 378
1974	898	34 049	1989	4884	48 562	2004	4455	65 348
1975	646	23 600	1990	3011	34 126	2005	3446	60 327
1976	25	29 082	1991	2450	32 693	2006	2542	69 202
1977	621	38 740	1992	3481	37 246	2007	2251	59 131
1978	1686	34 676	1993	3327	34 670			
1979	814	27 076	1994	5255	41 439			
1980	1468	32 541	1995	6159	37 300			
1981	2085	34 784	1996	6320	31 382			
1982	2434	30 788	1997	3628	31 937			
1983	720	25 092	1998	6525	44 198			
1984	2534	24 704	1999	3903	35 541			
1985	2941	32 328	2000	4428	40 478			
1986	2044	36 590	2001	5349	54 016			

Source: Lawson (2008), LFRR and MHR for most recent years

Total South Pacific albacore catches have fluctuated between 25 - 65 000 t since 1960, with the average catch over the period 1990 to 2005 being approximately 44 094 t (Table 1). Catches from within New Zealand fisheries waters are about 10% (average for 2000 through 2004) of those from the greater stock inhabiting the South Pacific Ocean.

Most albacore troll fishery catches are in the 1st and 2nd quarters with the 4th quarter important in some years (1994 to 1996). Most of the troll fishery catch comes from FMA7 off the west coast of the South Island although FMA 1, FMA 2, FMA 8 and FMA 9 have substantial catches in some years. High seas troll catches have been infrequent and a minor component (maximum catch of 42.2 t in

1991) of the New Zealand fishery over the 1991 to 2000 period. Albacore are caught by longline throughout the year as a bycatch on sets targeting bigeye and southern bluefin tuna. Most of the longline albacore catch is reported from FMA 1 and FMA 2 with lesser amounts caught in FMA 9. While albacore are caught regularly by longline in high seas areas, effort and therefore catches are small.

Small catches of albacore are occasionally reported using pole-and-line and hand line gear. Pole-and-line catches of albacore have been reported from FMA 1, FMA 2, FMA 5, FMA 7, and FMA 9. Hand line catches have been reported from FMA 1 and FMA 7.

1.2 Recreational fisheries

Recreational fishers catch albacore by trolling. There is some uncertainty with all recreational harvest estimates for albacore as presented below. Bradford (1996, 1998) provides estimates of the recreational catch of albacore. While the information provided is restricted to 1993 and 1996 information on where and when catches are made and by what fishing methods is provided. Bradford indicates that recreational albacore catches are made in summer (91%) and autumn (9%) months by a mixture of trolling (73%) and lining from boats (27%) in the parts of FMA 1, FMA 2 and FMA 9 surveyed. The recreational survey in 1996 provides greater area coverage and Bradford provides estimates of the albacore catch from FMA 1, FMA 2, FMA 3, FMA 5, FMA 8 and FMA 9.
The available estimates of recreational catch of albacore are in Table 2.

Table 2: Estimates of recreational albacore catch by number and weight (t).

Year	Area	Catch (number)	Catch (t)
1993	MFish. North region	48 000	245
1996	FMA 1	16 000	82
	FMA 2	20 000	102
	FMA 3	< 500	< 2.5
	FMA 5	2000	10
	FMA 8	5000	26
	FMA 9	8000	41
	1996 total	51 000 to 51 500	260 to 263

Source: Bradford (1996, 1998).

The RTWG recommends that the harvest estimates from the diary surveys should be used only with the following qualifications: a) they may be very inaccurate; and, b) the 1996 and earlier surveys contain a methodological error.

The historic survey results suggest annual recreational catches of albacore were around 245-260 t.

1.3 Maori customary fisheries

It is uncertain whether albacore were caught by early Maori, although it is clear that they trolled lures (for kahawai) that are very similar to those still used by Tahitian fishermen for various small tunas. Strickland notes the unexpected absence of a Maori name for albacore while giving names for a number of other oceanic pelagic species. However, given the number of other oceanic species known to Maori, and the early missionary reports of Maori regularly fishing several miles from shore, albacore were probably part of the catch of early Maori.

An estimate of the current customary catch is not available.

1.4 Illegal catch

There is no known illegal catch of albacore in the EEZ or adjacent high seas.

1.5 Other sources of mortality

Discarding of albacore has not been reported in the albacore troll fishery (based on limited observer coverage in the 1980s). Low discard rates (average 3.3%) have been observed in the longline fishery over the period 1991/92 to 1996/97. Of those albacore discarded, the main reason recorded by observers was shark damage. Similarly the loss of albacore at the side of the vessel was low (0.6%).

Mortality in the longline fishery associated with discarding and loss while landing is estimated at 1.8% of the albacore catch by longline.

2. BIOLOGY

The troll fishery catches juvenile albacore typically 5 to 8 kg in size with the mean fork length for 1996–97 to 2006-07 being 63.5 cm (Figure 1). Clear length modes associated with cohorts recruiting the troll fishery are evident in catch length distributions. In 2006–07 three modes with median lengths of 51, 61, and 72 cm were visible, that correspond to the 1, 2, and 3 year old age classes. The mean length of troll caught albacore in 2006–07 was 61.4 cm. These modal progressions in the available catch length frequency time series from 1996–97 to 2006–07 are of utility for estimating annual variations in albacore recruitment. Longline fleets typically catch much larger albacore over a broader size range (56-105 cm) with variation occurring as a function of latitude and season. The mean length of longline-caught albacore from 1987 to 2007 is 80.4 cm. The smallest longline caught albacore are those caught in May to June immediately north of the Sub-tropical Convergence Zone (STCZ). Fish further north at this time and fish caught in the EEZ in autumn and winter are larger. There is high inter-annual variation in the longline catch length composition although length modes corresponding to strong and weak cohorts are often evident between years.

Sampling of troll caught albacore has been carried out from the 1996–97 fishing year to the 2006–07 fishing year, and is continuing during the present year, 2007–08. The ports of Auckland and Greymouth have been sampled each year and New Plymouth was briefly included in 2003. Lengths were recorded from at least 1000 fish per month in each port and at least 100 fish per month per port were sub-sampled for weight. Length frequency distributions are presented in Figure 1.

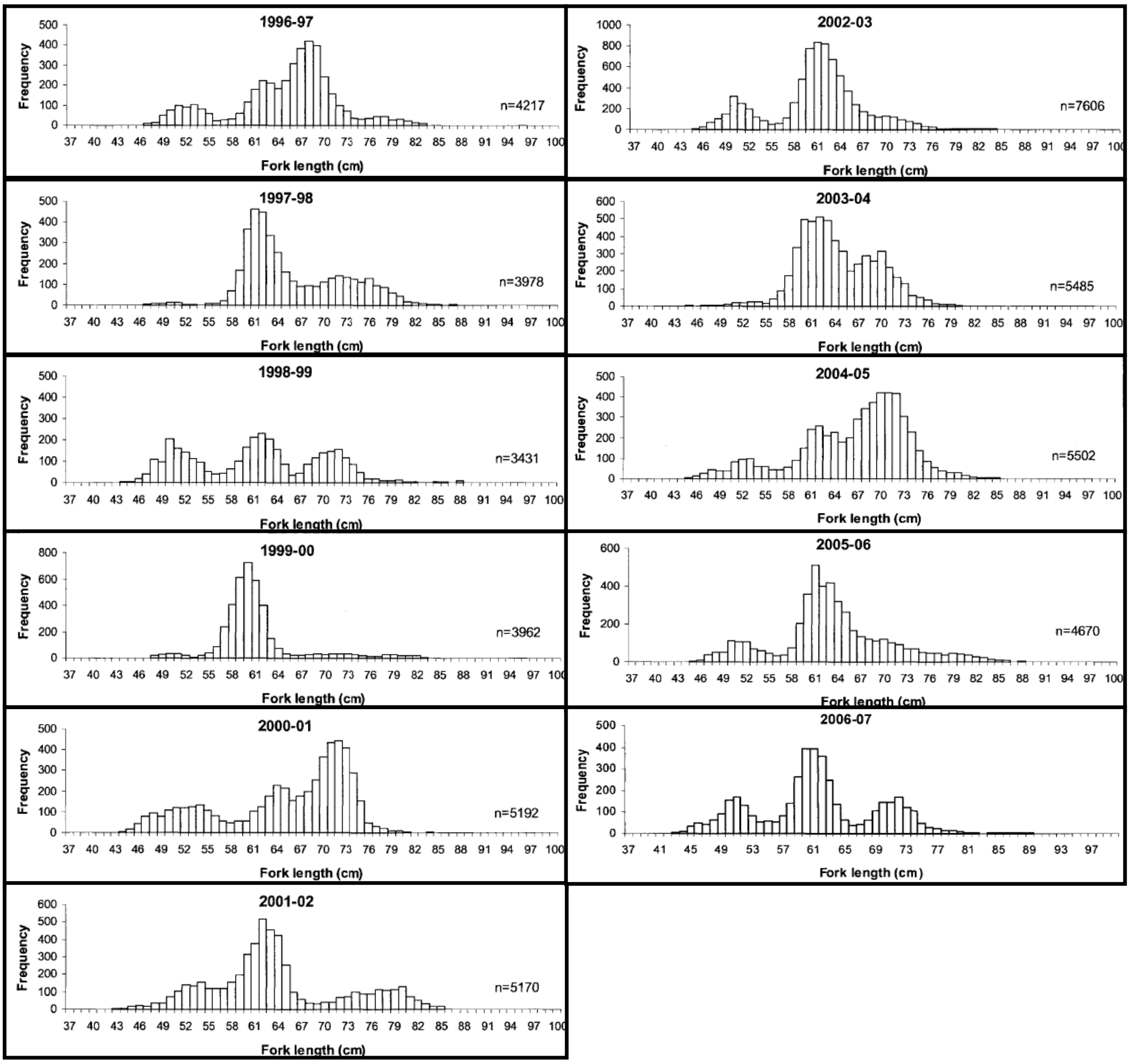


Figure 1: Size composition of albacore taken in the commercial troll fishery for 1996-97 to 2006-07.

Female albacore from New Caledonian and Tongan waters are reported to spawn during the November–February summer season as evidenced by histological studies and a critical gonadosomatic index (≥1.7).

Based on histological studies of South Pacific albacore, males larger than 71 cm fork length and females larger than 82 cm fork length can be sexually mature. These values represent minimum size at maturity as no maturity ogive has been estimated for South Pacific albacore.

Sex ratios (males:females) appear to vary with fishery from 1:1 in the New Zealand troll and longline fishery and, 2:1 to 3:1 in the Tonga–New Caledonia longline fishery.

The parameters of length/weight relationships for albacore based on linear regressions of ln(greenweight) vs. ln(fork length) where weight is in kg and length in cm are in Table 4.

Table 4: Parameters for length/weight relationships of albacore.

	n	b_0	SE b_0	b_1	SE b_1	R^2
Males	160	-10.56	0.18	2.94	0.04	0.97
Females	155	-10.10	0.26	2.83	0.06	0.93
troll caught	320	-10.44	0.16	2.91	0.03	0.95
longline caught	21 824	-10.29	0.03	2.90	0.01	0.91

Estimates of von Bertalanffy growth parameters for the South Pacific albacore stock based on length frequency analysis using MULTIFAN and counts of vertebral rings are in Table 5.

Table 5: Estimates of von Bertalanffy growth parameters for South Pacific albacore.

	Length frequency based	Vertebral ring based
L_∞, cm	97.1	121.0
K, cm per year	0.239	0.134
t_0	–	-1.922
number of age classes	9	10
Youngest age class	3	2

Source: Labelle et al. 1993.

These estimates were largely based on troll caught albacore. Recent analyses using MULTIFAN on a larger data set, including longline caught albacore, gave a lower estimate of K (0.09 per year) and higher estimate of L_∞ (141.7 cm). Growth rates estimated from a MULTIFAN-CL stock assessment model were slightly higher for the first seven age classes than that derived from the parameters from Labelle et al. (1993).

Preliminary estimates of average annual natural (M) and fishing (F) mortality rates have been estimated from a MULTIFAN-CL stock assessment model developed in 2005 for the south Pacific Ocean regional assessment. A natural mortality rate of 0.34 per year was estimated constant over all age classes.

The annual fishing mortality rates suggest very low fishing mortality on juveniles (around 0.01) until the late 1980s when the driftnet fishery briefly operated, before again declining. In contrast the F's for adults (6+ year classes), are higher (around 0.04 in the past 5 yeas) but when compared to the estimates of M for adults they are also very low. Fishing mortality for adults has increased in the past five years in response to higher catches and lower levels of adult biomass. The estimated impact of fishing is almost negligible for juveniles while that for adults is currently around 15%.

3. STOCKS AND AREAS

Two albacore stocks (North and South Pacific) are recognized in the Pacific Ocean based on location and seasons of spawning, low longline catch rates in equatorial waters and tag recovery information. The South Pacific albacore stock is distributed from the coast of Australia and archipelagic waters of Papua New Guinea eastward to the coast of South America south of the equator to at least 49ºS. However, there is some suggestion of gene flow between the North and South Pacific stocks based on an analysis of genetic population structure.

Most catches occur in longline fisheries in the EEZs of other South Pacific states and territories and in high seas areas throughout the geographical range of the stock.

Troll and longline vessels catch albacore in all FMAs in New Zealand and there may be substantial potential for expansion to high seas areas.

4. STOCK ASSESSMENT

With the establishment of WCPFC in 2004, stock assessments of the South Pacific Ocean (SPO) stock of albacore tuna are now undertaken by the Oceanic Fisheries Programme of Secretariat of the Pacific Community under contract to WCPFC.
No assessment is possible for albacore within New Zealand fisheries waters as the proportion of the greater stock found within New Zealand fisheries waters is unknown and likely varies from year to year.

The most recent assessment was undertaken in 2008 using MULTIFAN-CL. A summary of that assessment can be found below (Hoyle *et al* 2008):

"Since the last assessment, many of the underlying structural assumptions of the model have been reviewed. Major changes to model structure include: moving the central latitudinal boundary north by 5° to 25°S; separating data from the Japanese and Korean longline fisheries; including standardised CPUE data as relative abundance indices for the Japanese, Korean and Chinese Taipei longline fisheries, and the New Zealand troll fishery; reducing the weight given to length frequency data; making the selectivity of longline fisheries seasonal; removing length frequency data collected in Pago Pago before 1971; changing the biological parameters for natural mortality and reproductive potential; reducing the influence of CPUE from non-standardized fisheries; and permitting declining (i.e. dome-shaped) selectivity to be estimated for most longline fisheries.

The cumulative effect of these changes was to reduce the biomass estimates and raise the fishing mortality estimates compared to previous assessments. Model diagnostics indicate that some sources of bias have been removed, but that problems remain.

Lower levels of stock size and MSY than in previous assessments appear to be more realistic, since many sources of potential bias have been removed. However, given the evidence of remaining bias, there is considerable uncertainty about current levels of fishing mortality. The stock status indicator $F_{2004-2006}/F_{MSY}$ is strongly affected by structural uncertainty in the model, some of it related to the failure to model the increasing length of fish selected (selectivity) by the fishery through time, and some related to uncertainty about whether the recent large decline in standardized Chinese Taipei CPUE accurately reflects a decline in biomass.

Models that permit selectivity to vary through time tend to give lower biomass relative to B_{MSY}, and higher fishing mortality relative to F_{MSY}, throughout the time series. On the other hand, models that give less weight to the recent decline in Chinese Taipei CPUE tend to estimate higher biomass relative to B_{MSY}, and lower fishing mortality relative to F_{MSY}, in recent years.

Estimates of $F_{2004-2006}/F_{MSY}$ and $SB_{2004-2006}$ / SB_{MSY} are highly variable between model configurations. In all credible model configurations, $F_{2004-2006}$ is estimated to be below F_{MSY}, $B_{2004-2006}$ is estimated to be above B_{MSY}, and $SB_{2004-2006}$ is estimated to be above SB_{MSY}. There is no indication that current levels of catch are not sustainable.

Given the uncertainty in the results, the evident sources of potential bias, and the less optimistic implications of the results than in previous assessments, further efforts to improve the model should be considered a high priority. A number of potential research directions are suggested."

4.1 Catch per unit effort indices (CPUE)

Relative abundance indices are an essential input to stock assessment models and are typically derived from a standardised CPUE time series. This information is a fundamental input to the regional stock assessment model for albacore. A recent study is complete that calculated CPUE indices for albacore caught in the longline and troll fisheries with fishing operational variables and environmental effects being examined as potentially significant factors in explaining the variance in CPUE models.

Catch and effort data collected using the detailed TLCER forms for the tuna longline fishery from 1993 to 2004 was groomed for input to the standardised CPUE analysis. A total of 51 004 data records were available with detailed effort information for individual fishing operations. This data has been linked to a range of environmental variables including remotely sensed observations for sea surface temperature (SST) and ocean colour (chlorophyll) at a spatial resolution corresponding closely with each individual fishing operation. These variables have been expressed in relation to oceanic fronts, climatology and oceanographic indices of mesoscale dynamics on both a seasonal and monthly temporal scale. Other potential explanatory variables include moon brightness (phase), day length, fraction of longline set during night hours, depth and depth variation.

Catch and effort information from the troll fishery, as reported on CELR forms, was collated from 1993 to 2004 and comprised 107 763 records. The troll fishery operates mostly on the west coast of NZ. Environmental data was unavailable for part of this area, and records associated with operations with this area (48.7% of total number of records) were necessarily excluded from the CPUE analysis. In addition to the removal of records to maintain quality assurance, the total number of records used in the analysis was reduced to 49 622.

(i) Longline

The categorical variables: year, quarter, nationality, experience, and target species, were significant in explaining catch rate variability. Of the continuous variables sea surface temperature (SST) had the strongest effect, with highest catch rates in the range 18 to 19°C. SST features associated with ocean fronts were of lesser significance. In a SPO albacore CPUE analysis, only a weak relationship was found between CPUE and the southern oscillation index (SOI), and this was largely attributed to recruitment fluctuations in response to SST variability associated with the index.

There is a dramatic decline in the longline albacore CPUE time series from 1998 to 2000 that corresponds closely to a large increase in swordfish catch from 1600 fish in 1997 to over 12 000 in 2001. This reciprocal pattern most likely reflects a shift in fishing practice in the longline fleet towards targeting for swordfish since the mid-1990s. This is likely to have altered the catchability of the longline fishery for albacore through a physical change in the configuration of the fishing gear. Despite this operational factor, the general decline in since the mid-1990s is consistent with the trend observed in Taiwanese longline CPUE in the southern parts of the south Pacific region, and with the substantial decline in biomass since the late 1990s predicted by the regional assessment model. The decline following a peak in catch rates that occurred in 1995, has been attributed to a 7-year cycle in albacore catch rates that has been evident since 1978, and is a result of YCS variation in response to SOI cycles. This explanation describes a process that would potentially affect catch rates of albacore throughout the south Pacific region, and hence, the NZ longline fishery. It is therefore possible the factors contributing to the dramatic decline observed in the NZ fishery include stock-wide changes in availability, and a change in fishing practices.

(ii) Troll

The estimated relationship between troll standardised CPUE and SST was weak, but this was attributed to the limitations imposed by the spatial resolution of the catch and effort data. Environmental data was necessarily summarised to correspond to the coarse spatial scale of the catch and effort data, and this will have masked any localised environmental effects. It is likely that oceanographic features on a relatively small spatial scale are strongly related to catch rates, and this has been observed directly in the South Pacific troll fishery and in other surface fisheries having similar selectivity, age and length composition to the NZ troll fishery. Ocean agitation that determines the depth of the seasonal thermocline appears to influence the vertical availability of albacore to surface gears, such that high agitation increases thermocline depth, making age 2 year albacore less available at the surface. To increase the utility of troll CPUE for an albacore assessment by taking account of this covariate, it will be necessary to improve the spatial resolution at which troll catch and effort data is recorded.

Peaks in the standardised troll CPUE indices appears to correspond closely to modal patterns in the troll catch length frequency distributions (Figures 2 & 3). These multi-modal annual length frequency distributions reveal progressions of distinct modes associated with strong year classes. In 1999 a mode is evident in the length intervals 46-55 cm, and dominates the catch length distribution in the following year. It remains evident in 2001, and then in 2002 as a large component of the broad mode in the large length classes, indicating this to be a strong cohort. This apparently strong year class that entered the fishery in 1999-2000 and subsequently formed the basis of catches in 2000-01 is likely to have contributed to the peaks in CPUE in 1999 and 2000. The modal pattern in 1997 and high mean length may reflect the presence of a large cohort that dominated the fishery in 1995 and is likely to have caused the peak in CPUE in 1995. Although qualitative, this pattern points to the potential utility of the troll CPUE for the albacore stock assessment in respect of its consistency with inferred relative year class strengths.

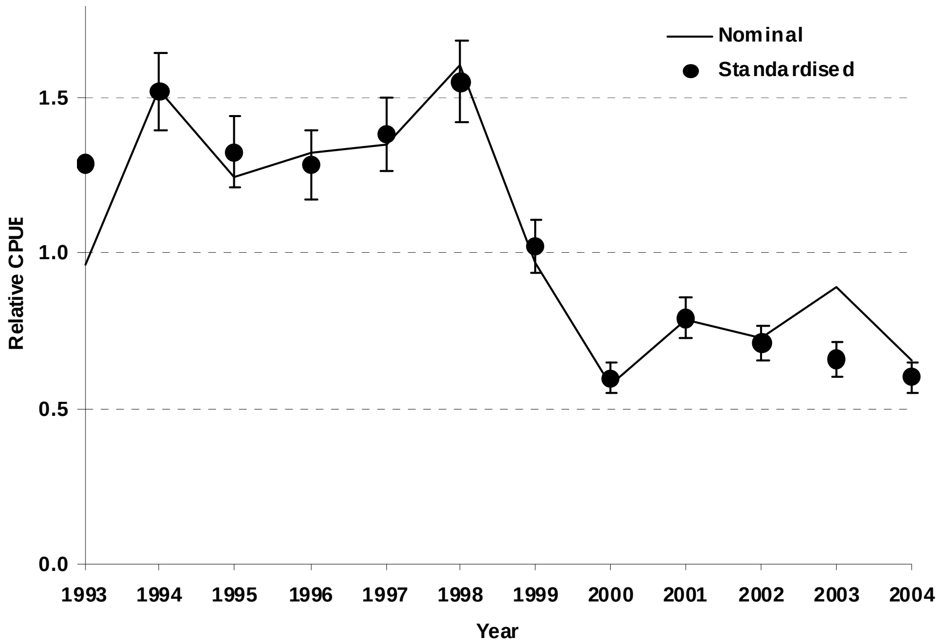


Figure 2: Nominal and standardised annual CPUE indices (normalised about the geometric mean for each time series) for the longline fishery, 1993-2004. Vertical bars indicate two standard errors.

4.1 Estimates of fishery parameters and abundance

There are no fishery-independent indices of abundance for the South Pacific stock. Relative abundance information is available from catch per unit effort data. Returns from tagging programmes provides information on rates of fishing mortality, however, the return rates are very low and lead to highly uncertain estimates of absolute abundance.

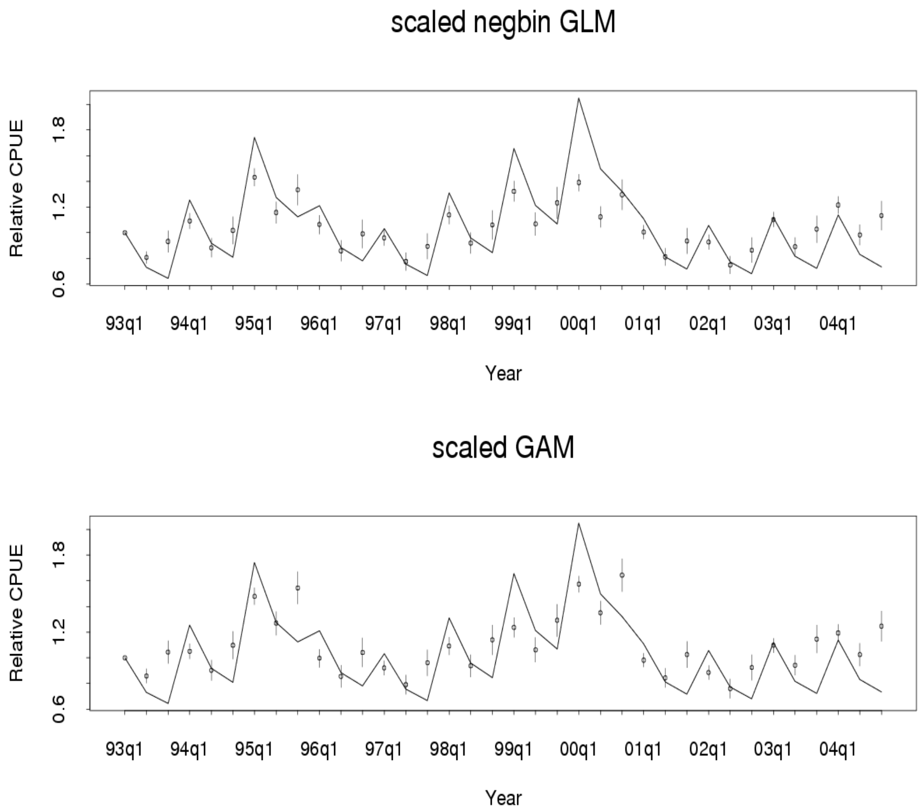


Figure 3: Quarterly time series of nominal and standardised CPUE for troll-caught albacore (line and circles respectively) estimated using the negative binomial GLM and quasi Poisson GAM.

4.2 Biomass estimates

Estimates of absolute biomass are highly uncertain, however, relative abundance trends are thought to be more reliable. Currently, the total biomass is estimated to be 74% of its unexploited level.

4.3 Estimation of Maximum Constant Yield (MCY)

No estimates of MCY are available.

4.4 Estimation of Current Annual Yield (CAY)

No estimates of CAY are available.

4.5 Other yield estimates and stock assessment results

No other yield estimates are available.

4.6 Other factors

In recent years (particularly in 2003), declines in CPUE were observed in some Pacific Island fisheries. Investigations have shown that these declines appear to be a consequence of changed oceanographic conditions, though high levels of localised effort may also be impacting on CPUE in these fisheries.

5. STATUS OF THE STOCK

The 4th meeting of the WCPFC Scientific Committee (SC) provided the following summary on the status of south Pacific albacore (Anon 2008):

"The assessment results from the base-case model differ substantially from results from the 2006 assessment, due to the changes in relative abundance indices, selectivity and biological parameters for natural mortality and reproductive potential. These changes represent both refinements to the model and substantive changes to model structure which reduced the biomass estimates and raised fishing mortality. The key conclusion of the models presented is that overfishing is not occurring and the stock is not in an overfished state. Reference point levels estimated in the 2008 assessment were more pessimistic than the 2006 assessment, depletion levels estimated in 2008 were 0.70 compared to 0.90 in 2006, $F_{current} / \tilde{F}_{MSY}$ was 0.44 compared to 0.04 in 2006, $B_{current} / \tilde{B}_{MSY}$ was 1.26 compared to 1.34 in 2006 and $SB_{current} / S\tilde{B}_{MSY}$ was 2.21 compared to 4.10 in 2006."

The New Zealand catches represent 10% of the total. The stock is presently above the level necessary to produce the maximum sustainable yield. The WCPFC SC reported that "The current assessment indicates lower levels of stock size and maximum sustainable yield which appear to be more realistic than previous assessments. There is uncertainty regarding the sustainability of the south Pacific albacore stock and the SC recommended that catches of south Pacific albacore remain at current levels considering the current rates of fishing mortality on adult albacore.

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