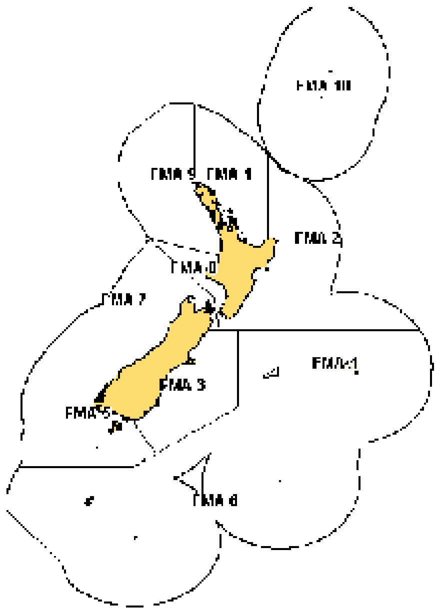
ALBACORE (ALB)

(*Thunnus alalunga)*



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 resolution relating to conservation and management measures for tunas. Key aspects of this resolution 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 200S 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.*

(a) 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 5 337 t (largest landing 6 525 t in 1997-98).

The earliest known commercial catch of tuna (species unknown but probably skipjack tuna) was by trolling and was landed in Auckland (1 t) 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 from the South Pacific Ocean (t) of albacore tuna from 1991 to 2005.

Year	NZ fisheries waters	South WCPO	Year	NZ fisheries waters	South WCPO	Year	NZ fisheries waters	South WCPO
1972	240	39,512	1987	1 236	25,042	2002	5 566	63,003
1973	432	47,324	1988	672	37,863	2003	6 744	62,320
1974	898	34,743	1989	4 884	48,562	2004	4 455	55,582
1975	646	23,595	1990	3 011	34,124	2005	3 446	Not available
1976	25	29,077	1991	2 450	32,693			
1977	621	38,735	1992	3 481	37,246			
1978	1 686	34,674	1993	3 327	34,670			
1979	814	27,071	1994	5 255	41,606			
1980	1 468	32,536	1995	6 159	37,331			
1981	2 085	34,783	1996	6 320	31,442			
1982	2 434	30,788	1997	3 628	32,011			
1983	720	25,092	1998	6 525	44,218			
1984	2 534	24,704	1999	3 903	35,542			
1985	2 941	32,328	2000	4 428	40,341			
1986	2 044	36,586	2001	5 349	53,469			

Source: WCPFC Yearbook 2004, NZ Annual Report to SPC for 2004, LFRR and MHR for most recent years

Table 2: Reported albacore catch by Fisheries Management Area (FMA) in the New Zealand exclusive economic zone (EEZ) from 1989 to 2005.

Year	FMA1	FMA2	FMA3	FMA4	FMA5	FMA6	FMA7	FMA8	FMA9	FMA10	Total
1989	472	2189	6	3	27	0	732	0	899	558	4884
1990	199	797	2	3	194	0	1620	11	51	136	3011
1991	192	431	5	1	81	0	1663	5	41	32	2450
1992	266	489	12	1	57	1	2462	68	121	4	3481
1993	647	267	7	0	30	0	1658	185	530	3	3327
1994	1098	497	0	0	50	0	2409	186	1013	3	5255
1995	1118	552	1	0	58	0	2792	354	1279	3	6159
1996	1320	834	4	1	41	0	2052	1085	981	1	6320
1997	1133	321	12	0	35	0	1528	267	331	0	3628
1998	1905	621	0	0	34	0	2404	456	1104	1	6525
1999	1623	511	0	0	19	0	1513	47	184	6	3903
2000	763	719	1	0	31	0	2525	135	248	5	4428
2001	869	932	1	1	29	0	1765	509	1225	19	5349
2002	550	1366	2	1	47	0	2110	700	779	11	5566
2003	497	1757	0	4	15	0	1898	577	1785	209	6744
2004	173	673	1	3	3	0	1268	704	1630	0	4455
2005	171	276	1	1	27	0	1923	333	713	1	3446

Total South Pacific albacore catches have fluctuated between 25 - 45 000 t since 1960, with the average catch over the period 1990 to 2000 being approximately 41 000 t (see 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 handline gear. Pole-and-line catches of albacore have been reported from FMA 1, FMA 2, FMA 5, FMA 7, and FMA 9. Handline catches have been reported from FMA 1 and FMA 7.

(b) 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 as follows:

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	2 000	10
	FMA 8	5 000	26
	FMA 9	8 000	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 245-260t.

(c) 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.

(c) Illegal catch

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

(d) 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 size for 1996–97 to 2004–05 being 63.7 cm (Figure 1). Clear length modes associated with cohorts recruiting the troll fishery are evident in catch length distributions. In 2004–05 three modes with median lengths of 53, 62cm and 70 cm were visible, that correspond to the 1, 2, and 3 year old age classes. The mean length of troll-caught albacore in 2004–05 was 66.5 cm reflecting the broad mode of large fish (> 66 cm). These modal progressions in the available catch length frequency time series from 1996–97 to 2004–05 are of utility for estimating annual variations in albacore recruitment. Longline fleets typically catch much larger albacore over a broader size range with variation occurring as a function of latitude and season. The mean length of longline-caught albacore from 1987 to 2004 is 80.0 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 2004–05 fishing year, and is continuing during the present year, 2005–06. The ports of Auckland and Greymouth have been sampled each year and New Plymouth has been included since 2003. Lengths were recorded from 1000 fish per month in each port and 100 fish per month per port were sub-sampled for weight. Length frequency distributions follow:

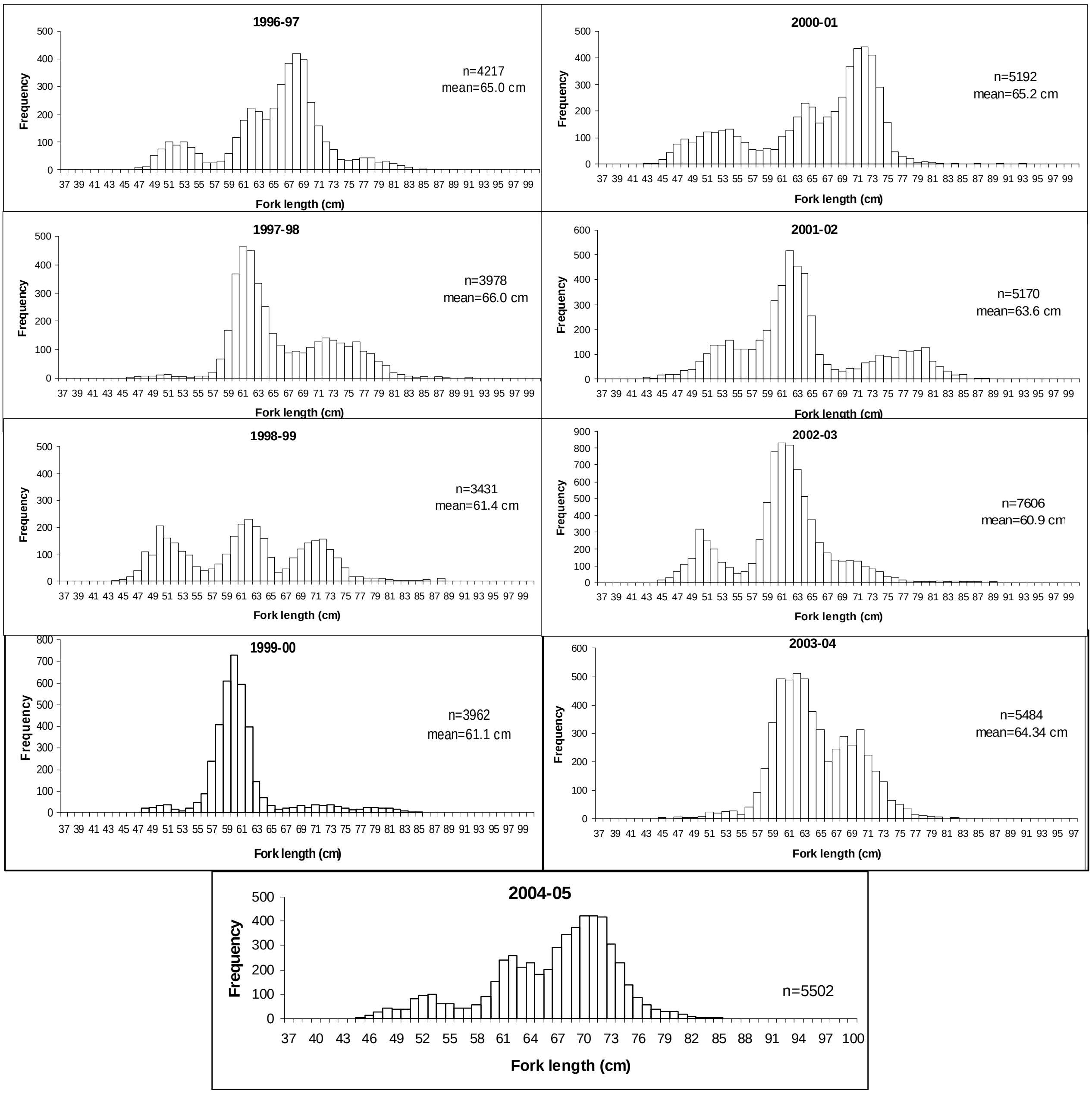


Figure 1: Size composition of albacore taken in the commercial troll fishery for 1996-97 to 2004-05.

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 as follows:

	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:

	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 49º S. 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 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 2005 using MULTIFAN-CL. The fisheries data used covered the period 1952–2003 by quarter. Spatial coverage of the model is the South Pacific Ocean, and although model scenarios were considered having four spatial strata, a base case model was selected that assumed a single homogeneous stratum. Seasonality in catch rates between fisheries, indicative of fish movement, were modelled using seasonal catchability parameters. More detailed specifications for fisheries were applied compared to previous assessments with catch, effort and size data for 23 fisheries (19 longline, 2 troll, and 2 driftnet) used in the analysis. Tagging data from the SPC's Albacore Tuna Tagging Project (1991–1992) were also incorporated. Length-frequency data are available from all fisheries, most obtained from port sampling programmes. New Zealand provides length frequency data from shed sampling of the troll fishery and from at sea sampling by observers in the longline fishery.

The major stock assessment conclusions of the South Pacific albacore analysis are:

- the more detailed specifications of the fisheries allows the results to be related to individual domestic longline fisheries, thereby having immediate utility for management at scale consistent with Exclusive Economic Zones
- there is insufficient data from which to directly estimate movement dynamics of the stock, and the single area model was preferred that maintains the region definitions of the fisheries
- long term decadal trends in recruitment were estimated, being low from the initial population in 1952, high during the 1960's and early 1970's, and then stable at high levels during the 1980's and early 1990's, followed by a return to low recruitments to 2004.;
- the estimated recruitment pattern was interpreted as a consequence of model recruitments being estimated that reconcile the conflicting temporal patterns in longline length compositions and CPUE for the Taiwanese longline fishery, and is a major source of uncertainty in the assessment;
- biomass levels largely reflected the estimated recruitment variation, peaking in the late 1960’s and 1970’s with a decline in the mid-1980’s, and there remains considerable uncertainty regarding the overall level of stock size;
- current biomass is estimated to be about 74% of the estimated equilibrium unexploited biomass;
- the impact of the fisheries on total biomass is estimated to have increased over time, but is likely to be low;
- fishing mortality is much higher for adult albacore than for juveniles, reflecting the predominantly longline exploitation. Fishing mortality rates are considerably lower than natural mortality rates ; and
- the model results indicate that recent catches are less than MSY (around 30%), aggregate fishing mortality is less than F_{MSY} and the adult biomass is greater than B_{MSY}.

No processes were included in the model to relate recruitment variation to environmental variables such as *El Niño* years (e.g., negative values of the Southern Oscillation Index).

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

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 south Pacific Ocean 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 targetting 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.

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. 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.

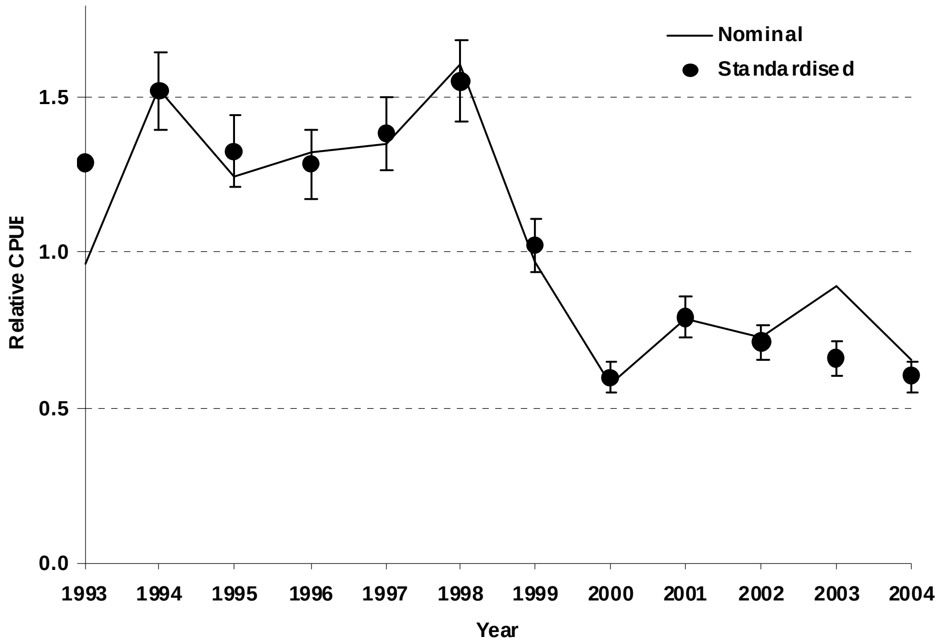


Figure 2: Nominal and standardised annual CPUE indices (normalised about the geometric mean for each time series) for the longline fishery, 1993-2004. Vertical bars indicate two standard errors.

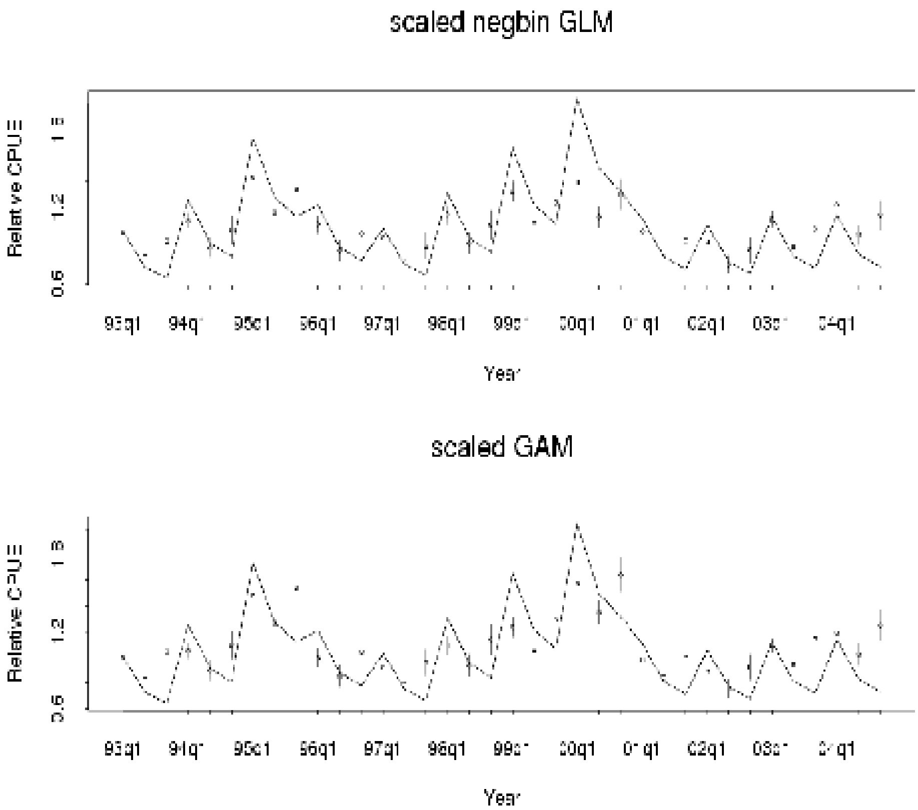


Figure 3: Quarterly time series of nominal and standardised CPUE for troll-caught albacore (line and circles respectively) estimated using the negative binomial GLM and quasi Poisson GAM.

(a) 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.

(b) 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.

(c) Estimation of Maximum Constant Yield (MCY)

No estimates of MCY are available.

(d) Estimation of Current Annual Yield (CAY)

No estimates of CAY are available.

(e) Other yield estimates and stock assessment results

No other yield estimates are available.

(f) 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 2nd meeting of the Western and Central Pacific Fisheries Commission Scientific Committee provided the following summary on the status of south Pacific albacore:

> *"A stock assessment was undertaken during 2005 and is the first since 2003. An examination of catch trends in 2005 indicated that total catches of albacore were relatively stable over the period from 1960 to 1995, but that they have increased in recent years. . The key conclusions of the stock assessment were similar to 2003, i.e. that over fishing is not occurring (Fcurrent / FMSY <1) and the stock is not in an over-fished state (Bcurrent / BMSY >1). Overall, fishery impacts on the total biomass are low (10%), although considerably higher impacts occur for the portion of the population vulnerable to longline.*
>
> *Current catch levels from the South Pacific albacore stock appear to be sustainable and yield analyses suggest increases in fishing mortality and yields are possible. However, given the age-specific mortality of the longline fleets, any significant increase in effort would reduce CPUE to low levels with only moderate increases in yields. CPUE reductions may be more severe in areas of locally concentrated fishing effort.*
>
> *The South Pacific albacore assessment shows that current levels of catch and effort are sustainable. While future increases in albacore catch are likely to be sustainable, estimates of MSY are highly uncertain because of the extrapolation of catch and effort well beyond any historical levels. Projections demonstrated that longline exploitable biomass, and hence CPUE, would fall sharply if catch and effort were increased to MSY*

levels. Therefore, the economic consequences of any such increases should be carefully assessed beforehand."

Therefore, the most recent assessment was undertaken in 2005 and covered the south Pacific stock. The New Zealand catches represent 10% of the total. The stock is presently above the level necessary to produce the maximum sustainable yield. Current catches from the stock are sustainable under average recruitment conditions. Current catches will move the stock towards a size that will support the maximum sustainable yield.

6. FOR FURTHER INFORMATION

Anon (1946). Marine Dept. Fisheries Tables for the Years 1941, 1942, 1943, and 1944.

Anon (1962). Marine Dept. report on Fisheries for 1961.

Bailey, K. (1988). Albacore tagging produces results. Catch, 15(11): 10–11.

Bertignac, M.; Lehodey, P.; Hampton, J. (1996). An analysis of the South Pacific albacore tagging data: estimation of movement patterns, growth and mortality rates. SPAR-6 working paper 3.

Best, E. (1929). Fishing methods and devices of the Maori. Dominion Museum Bulletin No. 12.

Bigelow, K.; Hampton, J.; Fournier, D. (2001). Stock assessment of albacore tuna in the South Pacific Ocean. SCTB14 Working Paper ALB-1.

Bradford, E. (1996). Marine recreational fishing survey in the Ministry of Fisheries North region, 1993–94. *NZ Fisheries Data Report No. 80.*

Bradford, E. (1998). Harvest estimates from the 1996 national marine recreational fishing surveys. *NZ Fisheries Assessment Research Document 98/16.*

Chow, S.; Ushiama, H. (1995). Global population structure of albacore (*Thunnus alalunga*) inferred by RFLP analysis of the mitochondrial ATPase gene. *Marine Biology 123:* 39–45.

Davies, N.M.; Griggs, L.; Unwin, M. (2005). Information available for developing a stock assessment for New Zealand albacore (*Thunnus alalunga*). Final Research Report for Ministry of Fisheries Research Project TUN2002/03 Objective 4. 38 p

Griggs, L.; Murray, T. (2000). Determination of size composition, sex ratio, and length:weight relationships of albacore tuna during the 1998–99 fishing year from samples collected in fish sheds. NIWA Final Research Report. For MFish Research Project TUN9801.

Griggs, L. (2004). Monitoring the length structure of commercial landings of albacore tuna during the 2003-04 fishing year. Final Research Report for Ministry of Fisheries Research Project ALB2003/01, Objective 1. 17 p.

Griggs, L. (2005a). Historical and biological data summaries for albacore (Thunnus alalunga). Final Research Report for Ministry of Fisheries Research Project TUN2002/03 Objective 1 and 2. 36 p.

Griggs, L. (2005b). Monitoring the length structure of commercial landings of albacore (Thunnus alalunga) during the 2004-2005 fishing year. Final Research Report for Ministry of Fisheries Research Project ALB2003/01, Objective 2. November 2004. 21 p.

Hamilton, A. (1908). Fishing and sea-foods of the ancient Maori. Dominion Museum Bulletin No. 2.

Labelle, M.; Hampton, J.; Bailey, K.; Murray, T.; Fournier, D.; Sibert, J. (1993). Determination of age and growth of South Pacific albacore (*Thunnus alalunga*) using three methodologies. Fishery Bulletin 91: 649–663.

Laurs, R.M.; Nishimoto, R. (1989). Summary of South Pacific albacore tagging conducted during 1986–1989. NOAA Admin. Report. NMFS-SWFC, La Jolla, LJ-89-15.

Murray, T. (1994). A review of the biology and fisheries for albacore, *Thunnus alalunga*, in the South Pacific Ocean. *FAO Fisheries Technical Paper 336/2: 188–206.*

Ramon, D.; Bailey, K. (1996). Spawning seasonality of albacore, *Thunnus alalunga*, in the South Pacific Ocean. Fishery Bulletin 94: 725–733.

Ratty, F.J.; Laurs, R.M.; Kelly, R.M. (1990). Gonad morphology, histology, and spermatogenesis in South Pacific albacore tuna *Thunnus alalunga* (Scombridae). Fishery Bulletin 88: 207–216.

Strickland, R.R. (1990). Nga tini a Tangaroa, a Maori-English, English-Maori dictionary of fish names. NZ Fisheries Occasional Publication No. 5.

Unwin, M.; Richardson, K.; Davies, N.; Uddstrom, M.; Griggs, L.; Wei, F. (2005). Standardised CPUE indices for longline- and troll-caught albacore tuna in the New Zealand EEZ, 1993-2004. Final Research Report for Ministry of Fisheries Research Project TUN2002/03 Objective 3. 42 p.