FISHERY INDICATORS FOR THE SBT STOCK 2004/05

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Abstract
Fishery indicators have played an important role in the provision of advice to managers on the status of the SBT stock by the CCSBT Scientific Committee and its Trilateral predecessor extending back to at least 1988. They can provide a broad perspective on recent changes in the status of the stock independent of more formal, analytical stock assessments and allow for information that is not readily incorporated into an analytical assessment to be assessed with respect to the consistency of the results from analytical assessments. As such, fishery indicators provide an important addition and measure of robustness to the overall stock assessment process. This paper presents results for a range of indicators. It reviews changes in the status of the indicators that were first assessed by the Scientific Committee in 1988. Additional indicators on the health of the SBT population and fishery are also presented based on our review of other information not available in 1988.

Introduction

Fishery indicators have played an important role in the provision of advice to managers on the status of the SBT stock by the CCSBT Scientific Committee and its Trilateral predecessor extending back to at least 1988 (e.g. Anon 1988). Indicators have been used to provide a broad perspective on recent changes in the status of the stock independent of more formal, analytical stock assessments. While the SBT analytical assessments attempt to integrate all available data into a single model framework it can be difficult to evaluate the overall consistency and robustness of the results because (1) the highly aggregated nature of much of the input data ignores important trends that can be observed on fine temporal and spatial scales, and (2) model results are sensitive to the arbitrary, untested assumptions that are inevitably embedded in the model structure, related to population and fishery dynamics, and the statistical properties of observations and processes. Stock assessment models are generally poor at estimating the most recent abundance trends (particularly for the youngest ages). These inherently have more uncertainty and are most reliant upon time series consistency assumptions (e.g. in stock/recruitment relationships, selectivities and catchabilities). Thus, fishery indicators provide an important additional input to the overall stock assessment process. A reminder of the 1988 indicators are attached as appendix 1 of this report. These indicators were reviewed in 1998, and again in 2001 (Gunn et al. 1998; 2001) and 2004 (Polacheck et al 2004; summary attached as Appendix 2).

In 2004, there was a model-based assessment of the SBT stock using methods developed for conditioning an operating model for the evaluation of Candidate Management Procedures (CMPs). This assessment strongly suggested that current catches were not sustainable, and that the stock likely suffered one or more very poor recruitments around 1999-2001. These inferences have been a recurring feature in the revised operating model for CMP evaluation. However, these inferences are uncertain, and some of the results (e.g. extremely high mortality rates on some recent cohorts) are not intuitively consistent with our understanding of the fishery. The manner in which the information about the youngest cohorts enters the model could be misleading (e.g. due to errors in catch-at-age sampling and assumptions about consecutive years of constant selectivity). At this stage, the detailed information from several fisheries indicators will probably prove more informative regarding the interpretation of recent trends than an update of model-based assessments.

This paper updates many of the indicators from Polacheck et al (2004) with the most recent data, and adds additional indicators related to spawning grounds catch rates from Indonesian training fisheries. While Polacheck et al 2004 provides a reasonably detailed historical perspective on the SBT status, this paper is focused on the most recent data, and what they might tell us about the plausibility of alternative operating model scenarios used for the evaluation of CMPs.

Indicators and Analyses for 2005

CPUE Indices

Japanese CPUE

The Japanese longline fishery is generally assumed to provide the most information about stock status in the form of catch rates interpreted as relative abundance indices. Major problems in interpretation arise when catchability (or reported catch) changes over time (this could relate to SBT in general (e.g. technological efficiency improvements, changes in fished areas), or could affect age classes differently (e.g. selectivity changes, discarding)). We note the following points in relation to recent Japanese CPUE (mostly extracted from Hartog et al. 2005):

- In 2004, the nominal (aggregate age 4+) CPUE declined to the lowest level since 1998 (**Figure 1**). Past experience indicates that the 2004 provisional value will likely drop even lower when the data are updated in 2006.

- The recent declining CPUE trend is not an obvious result of major shifts in selectivity within the SBT age structure, as the nominal age-disaggregated indices (4-7, 8-11 and 12+) all show declines over the last 3 years similar to the age-aggregated series (Figure 2 - Figure 4).

- In 2003 and 2004, catch rates of ages 0-2, 3 and 4 year old fish in the Japanese longline fishery were near or below the lowest ever levels (**Figure 5**). These very young fish are only weakly vulnerable to the longline fisheries, and are generally assumed to be most affected by temporal changes in selectivity.

- Age 5 catch rates were low in 2004, though not as low as observed in the mid-1990s (2003 catch rates were not markedly low). The somewhat low catch rates of the 5 year olds in 2004 seems to be partly related to an atypical spatial pattern. The Eastern region of the SBT fishery (areas 4-7) had very low age 5 catch rates, while areas 8 and 9 were consistent with or even above recent averages (**Figure 6**). A qualitatively similar pattern was observed for 4 year olds, though it was more pessimistic in all regions.

- The number of unfished space/time cells has trended strongly downward over time (**Figure 7**), potentially leading to over-optimism in the aggregate catch rates through a spatial hyper-stability effect on the relationship between abundance and CPUE. Slightly more cells were fished in 2005 than 2004, but the actual strata fished has shifted somewhat (discussed in Hartog et al 2005).

- Standardized catch rate time series suggest that CPUE could have increased (B-ratio proxy and Variable Squares) or decreased (all others) from 2004 to 2005 (Figure 8). The difference between series is likely driven by the increase in fished cells. The erratic behaviour of the Laslett core area index is likely related to changing effort within historically identified core regions (such that they may no longer be appropriate).

- Nominal CPUE by cohort (**Figure 9**) suggests that the 1999-2001 cohorts are smaller than 1995-8. This interpretation is particularly sensitive to the assumption that selectivity and discarding has remained constant over this period because these young fish are only weakly recruited at this time. At this time, it appears that the 1995-98 cohorts have all remained more abundant than the 1980 cohort was at a similar age.

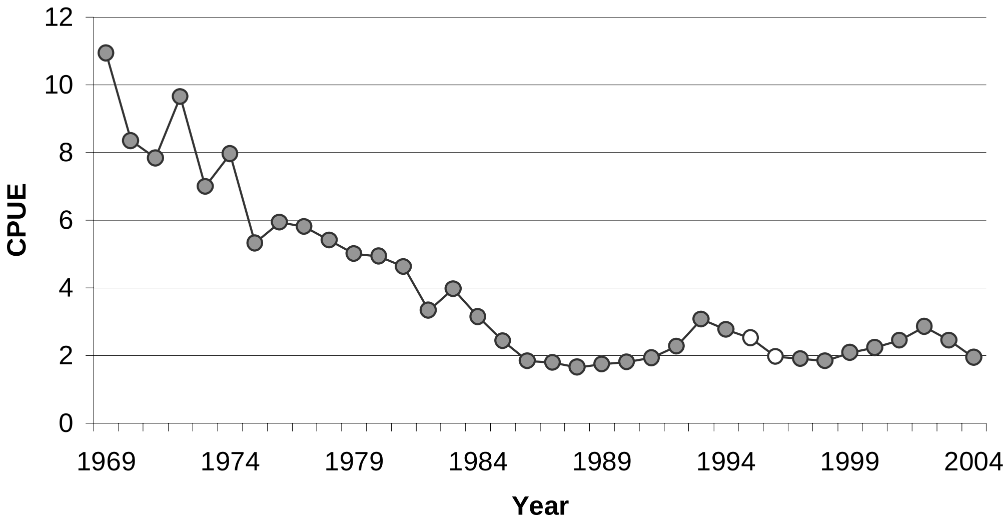

Figure 1: Trends in nominal SBT catch rates (numbers per 1000 hooks) for Japanese longliners operating in statistical areas 4-9 in months 4-9, including ages 4+ only. The 1995 and 1996 values have been plotted as open circles to indicate increased uncertainty about these points due to changes in retention policies for small fish in these two years.

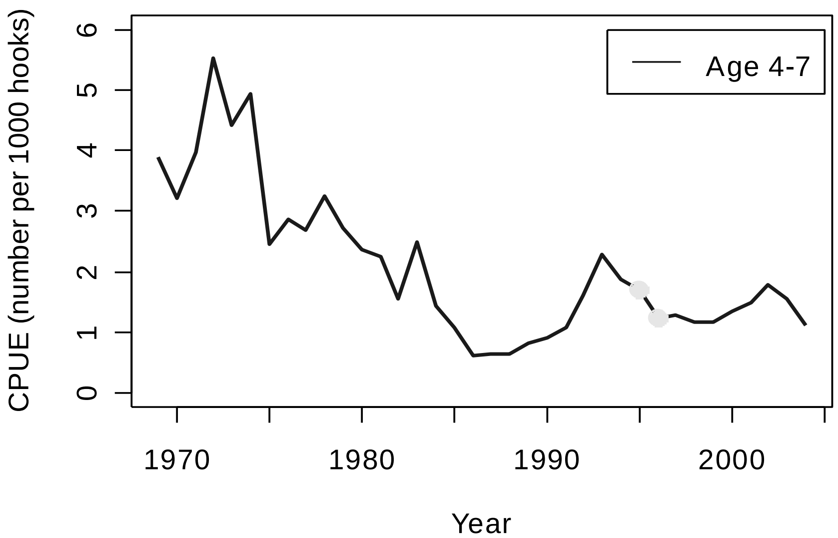

Figure 2: Trends in nominal SBT catch rates of ages 4-7 (numbers per 1000 hooks) for Japanese longliners operating in statistical areas 4-9 in months 4-9. The 1995 and 1996 values have been plotted as filled circles to indicate increased uncertainty about these points due changes in retention policies for small fish in these two years.

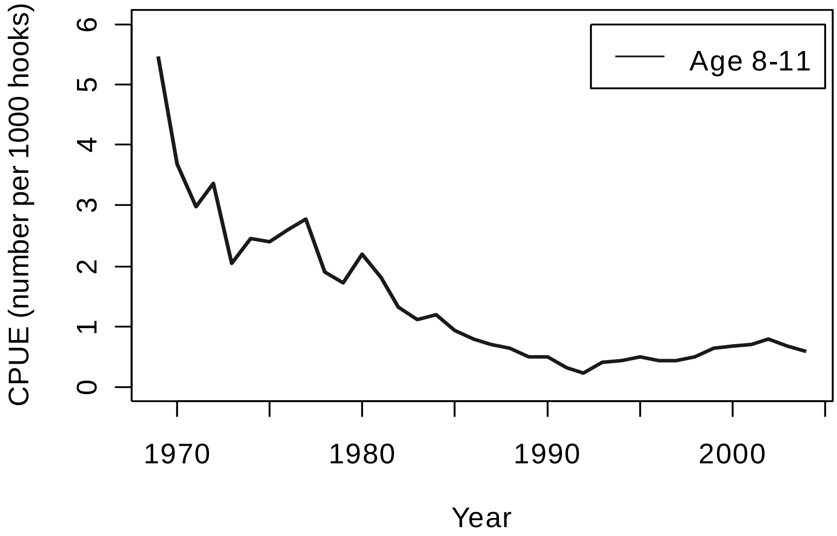

Figure 3: Trends in nominal SBT catch rates for ages 8-11 (numbers per 1000 hooks) for Japanese longliners operating in statistical areas 4-9 in months 4-9.

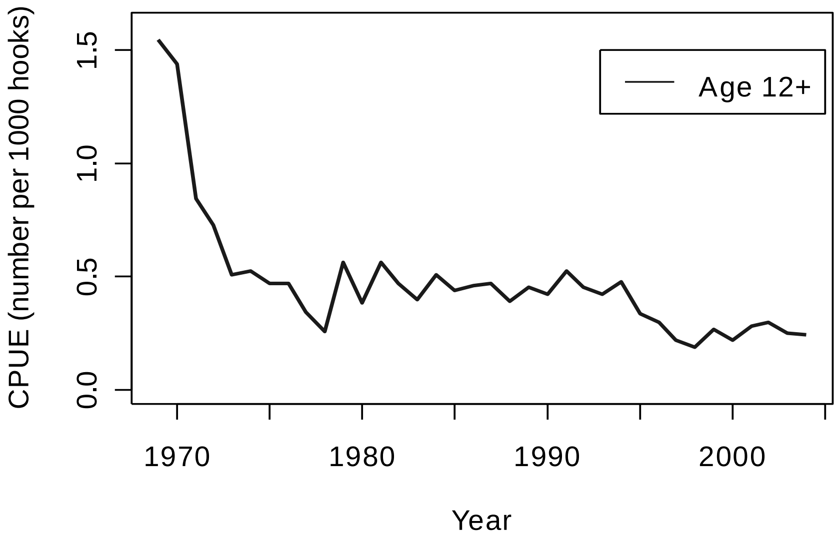

Figure 4: Nominal catch rates (number per 1000 hooks) of age 12 plus SBT by Japanese longliners in areas 4-9 in the second and third quarters.

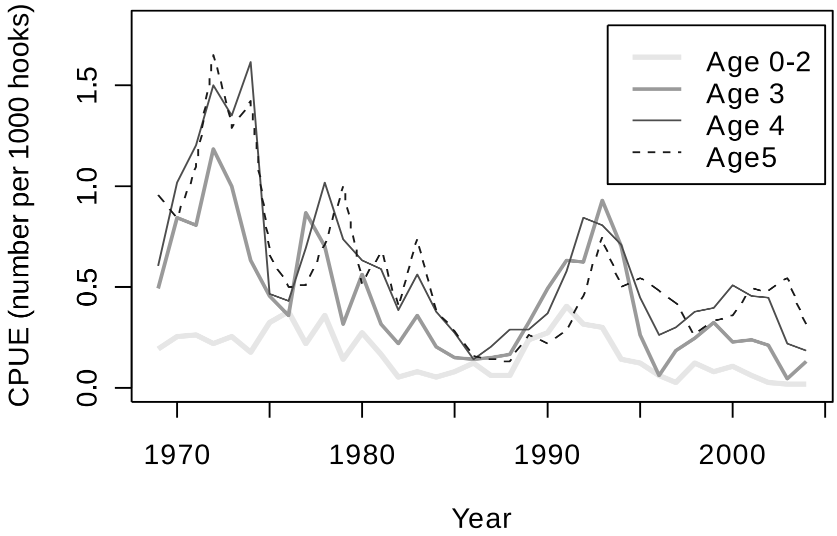

Figure 5: Nominal catch rates (number per 1000 hooks) of very young (ages 0-2 pooled, and 3,4 and 5 individually) SBT by Japanese longliners in areas 4-9 in the second and third quarters.

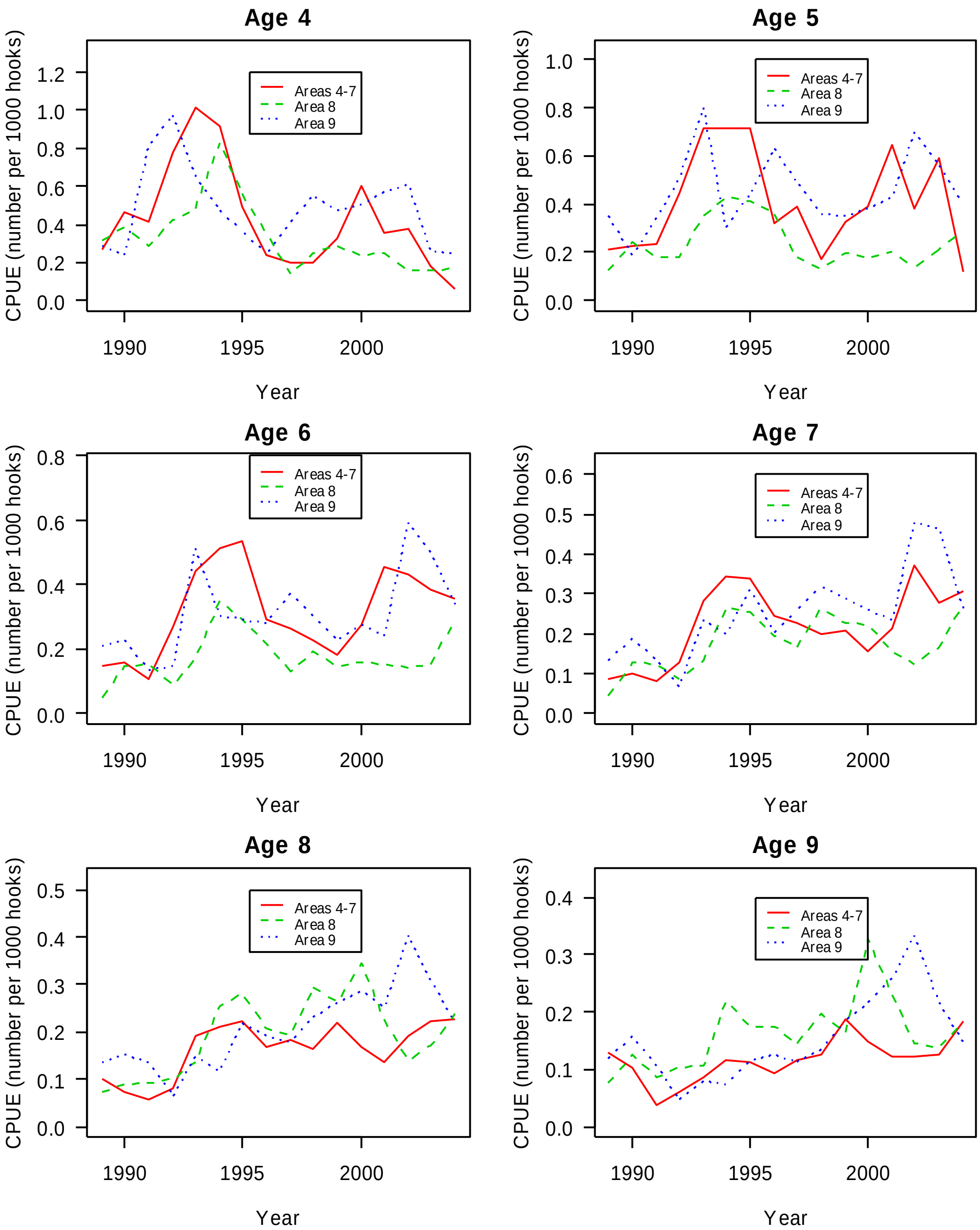

Figure 6. Comparison of age-specific nominal catch rates (number per 1000 hooks) in recent years for different fishing regions.

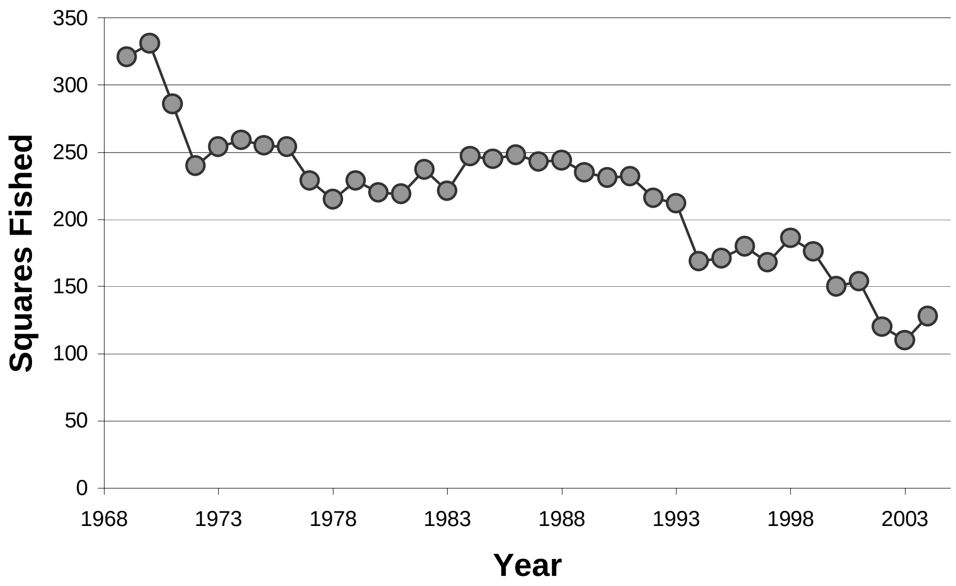

Figure 7: The total number of five-degree/month strata with fishing effort by Japanese longline vessels in statistical areas 4-9 and months 4-9.

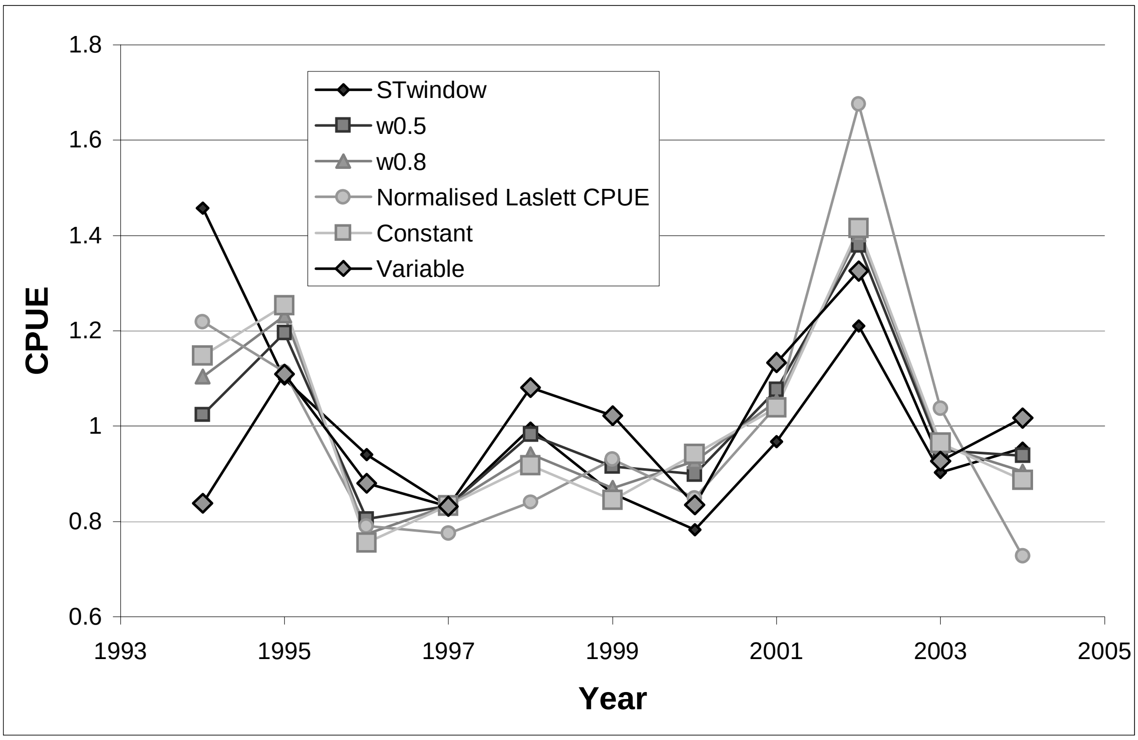

Figure 8 Comparison of the various standardized CPUE series for the last ten years. All series have been normalized by dividing by the mean for the last 10 years. Note that there may be an error in the data affecting all these standardized CPUE series (except Laslett). This could not be confirmed at the time of document submission. If the error is present, all these series (except Laslett) are probably slightly low in the last two years.

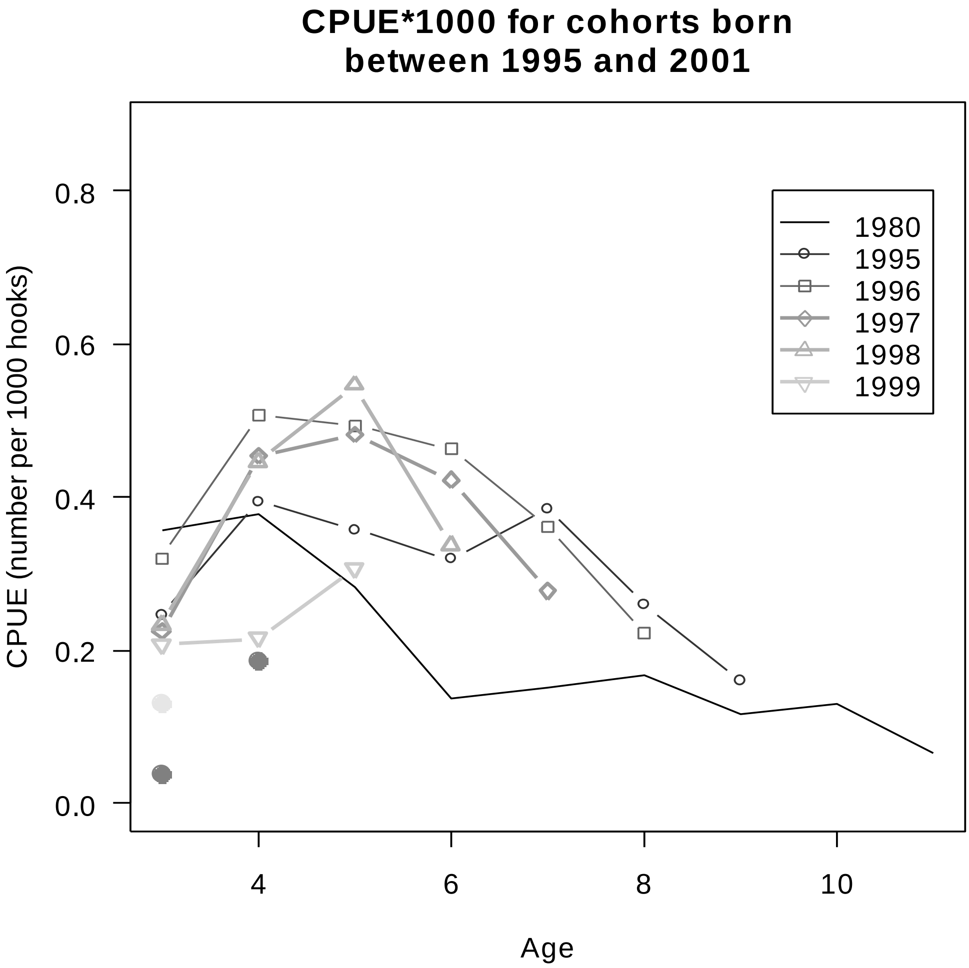

Figure 9: Nominal CPUE in Statistical Areas 4-9, months 4-9 for cohorts born between 1995 and 2001. The cohort born in 1980 is also shown for reference. The cohorts born in 2000 (solid dark grey circle) and 2001 (solid light grey circle) are not connected by lines.

<u>*Korean CPUE*</u>

Korean catch rates have generally declined since 1994 (Figure 10), but there was very little effort in 2003 and we have no data for 2004 (Figure 11), so we do not consider this time series to be very useful in the context of this paper.

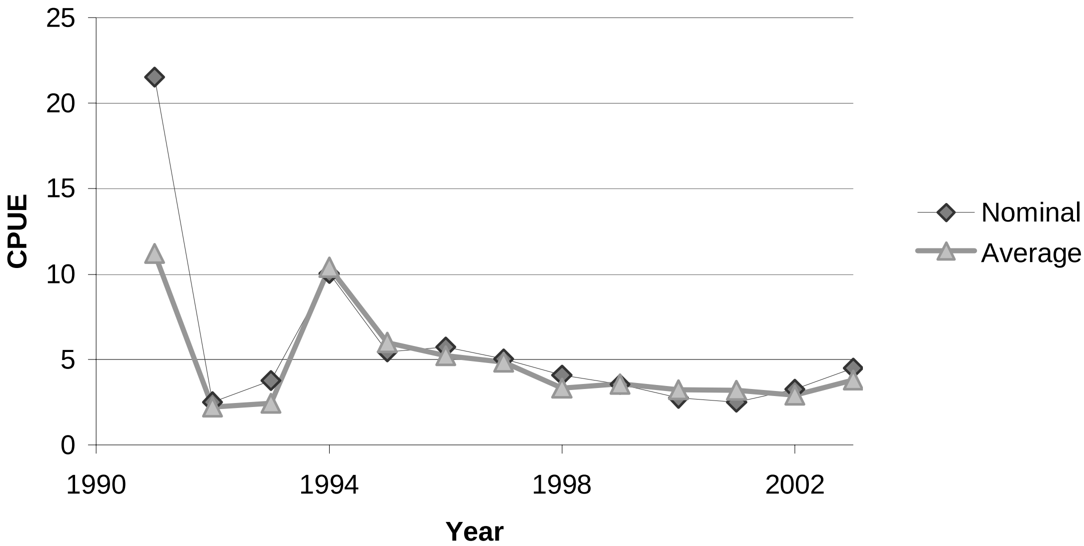

Figure 10: Trends in Korean longline catch rates (number per 1000 hooks) within statistical areas 4-9 during months 4-9. "Nominal" is the total hooks over total effort and "average" is the mean of the nominal rate in each 5x5 square/month strata.

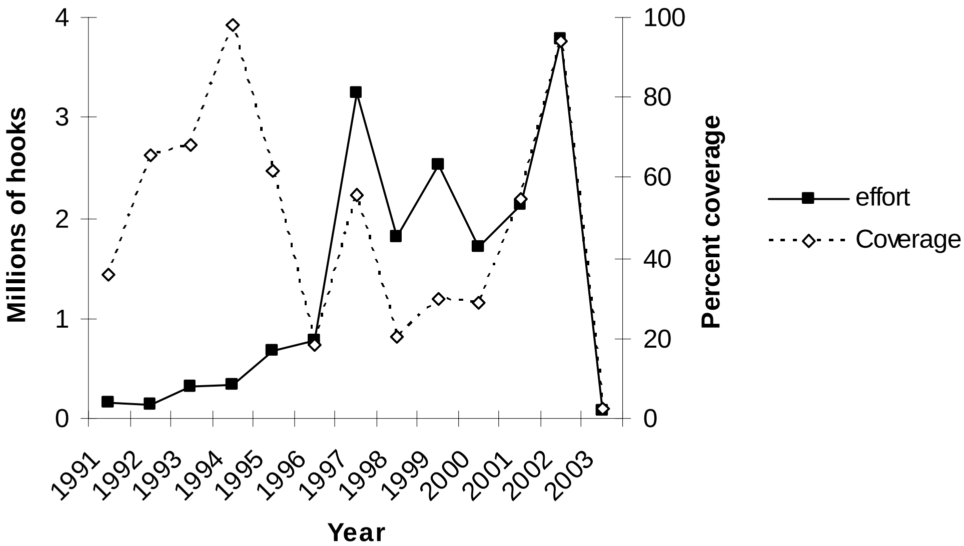

Figure 11: Total effort (millions of hooks) for which catch and effort data are available for Korean longliners fishing in areas 4-9 and months 4-9. Coverage is the percent of the total reported catch by Korea for which catch and effort data were provided.

Taiwanese CPUE

We focused on two main fishery regions of the Taiwanese fishery (**Figure 12**). The northern, primarily albacore targeting region, suggest an increase in CPUE over time since the mid-1980s. The Areas 8 and 9 fishery has been fairly constant but erratic since sizeable SBT catch rates began in the late 1980s. Given the inconsistencies with the Japanese fishery, we do not think that these data are very informative with respect to recent abundance changes, at least not when summarized in this form. These fisheries show patterns that are presumably related to rapid developments in the industry. However, both fisheries show a large increase from 2003 to 2004.

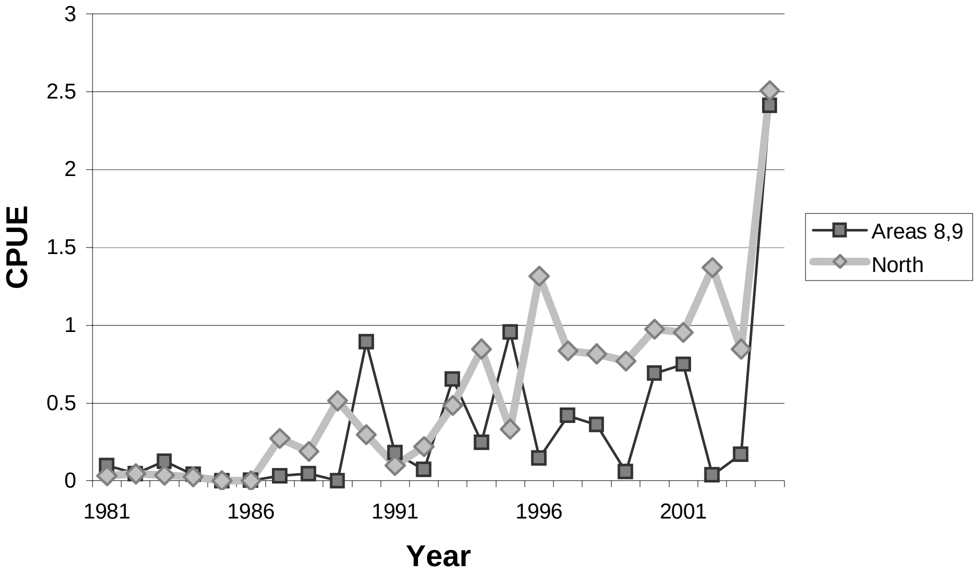

Figure 12: Estimate of nominal catch rates for SBT (number per thousand hooks) by Taiwanese longliners. Catch rates have been calculated for statistical Areas 8 and 9 and for the latitudinal strip between 25 and 35 degrees south in the Indian Ocean where small SBT are frequently caught by Taiwanese longliners as part of their targeted albacore fishery (labelled "north" in the legend). Both time series were calculated using data only from months 4 to 9.

<u>*New Zealand CPUE*</u>

The New Zealand fleets fish a relatively small portion of the SBT stock, such that the interpretation of catch rates might be particularly sensitive to inter-annual variability in SBT spatial distribution characteristics. The following discussion relates only to the longline fleets, as the handline/troll fishery virtually disappeared in the 1990s

Figure 13 illustrates the catch rates for chartered Japanese longline vessels fishing in New Zealand waters from 1989 through 2004, partitioned into effort allocated north and south of 45 degrees South. Both of these fleets tend to show similar trends, with a step function increase in CPUE beginning in 1994, and low CPUE in 2003-2004 relative to the period 1994-2002.

The New Zealand domestic longline fleet shows a similar time series to the charter fleet, with 2003-4 lower than the rest of the 1994-2002 period (except for the extremely low catch rate in 1997).

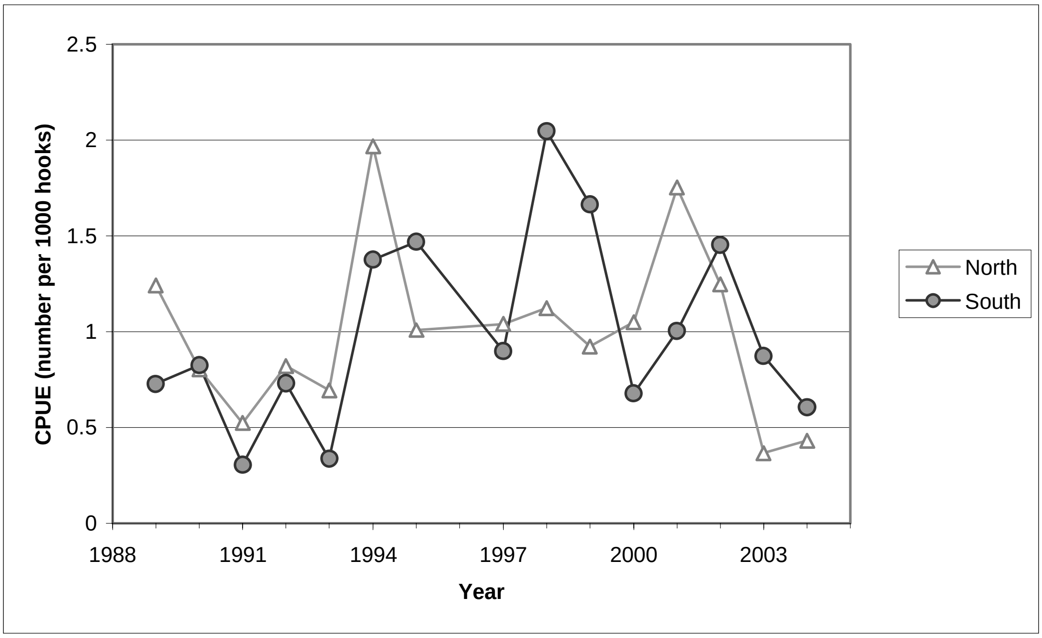

Figure 13: Nominal catch rates (numbers per 1000 hooks) for chartered Japanese longline vessels fishing in New Zealand waters (45 degrees south is the division between "South" and "North" indices).

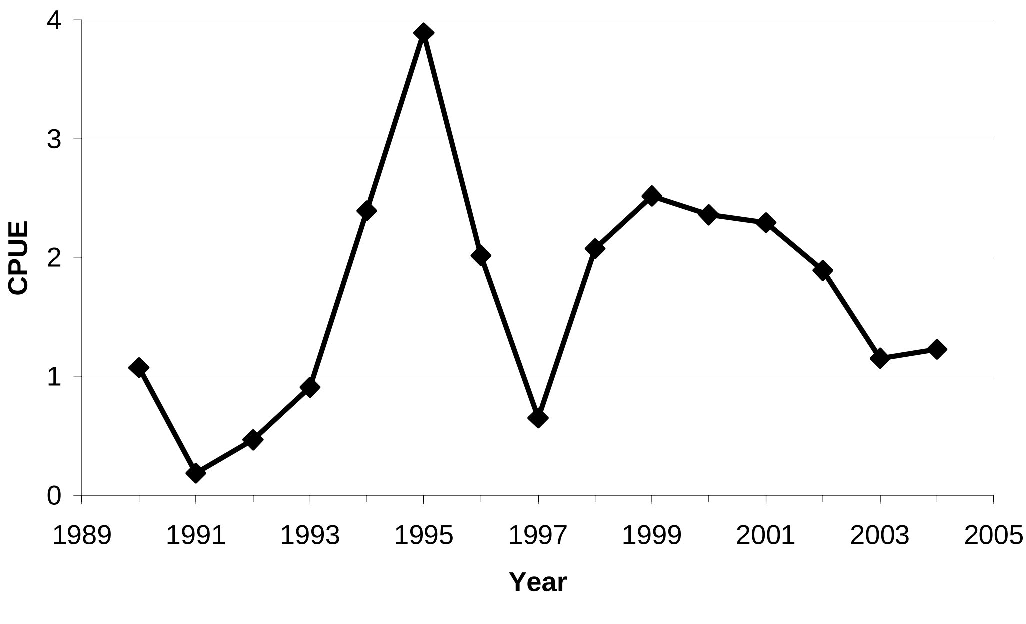

Figure 14: Nominal catch rates of SBT (numbers per 1000 hooks) caught by domestic New Zealand longline vessels.

Indonesian CPUE

We have not obtained a reliable effort series for the main Indonesian spawning grounds fishery to date, such that the only catch rate interpretation is made in relation to assumed catch rates of yellowfin tuna in the section on total catch and age composition below. However, there is an Indonesian fisheries training program which sends students out on commercial fishing vessels prior to graduation. The students collect detailed data on the fishing operations of the vessel including detailed records of catch by species for each set. A preliminary analysis of these Fishery School data, for the period October 2000 to May 2005, is presented in Basson et al (2005). **Figure 15** illustrates that nominal catch rates as well as the proportion of sets with at least 1 SBT appears to have declined in Area 1 (10S-20S and 100E-135E) between 2001 and the 20004/5. The intention is to more fully analyse theses data with the hope of developing a standardised index of abundance over the coming year.

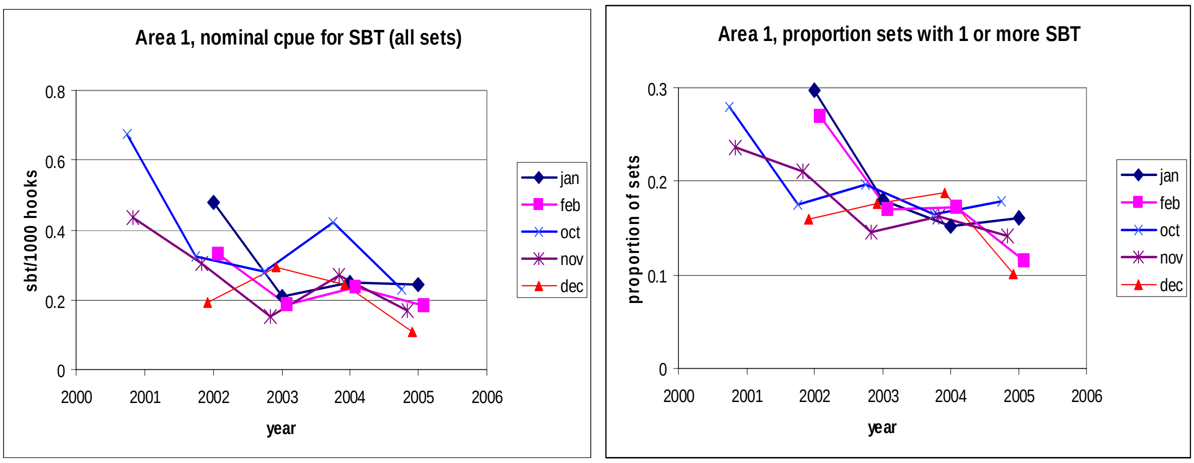

Figure 15. Indonesian training fishery nominal CPUE for sets in the SBT spawning grounds (Area 1). Left panel: number of SBT per thousand hooks by month and year for ALL sets (i.e. including those where no SBT was caught). Right panel: proportion of sets with 1 or more SBT in the catch (by year and month).

Total Catch

Estimate of total global catch of SBT

Total SBT catches have been generally declining over the last few years from a recent high of 19 500 t in 1999 down to 13 500 t in 2004. Korean, Indonesian and miscellaneous fleets had the sharpest drops in catch (as a proportion of 1999 levels). On their own, these numbers are not particularly informative about current stock status. They may provide information about the success of the Trade Information Scheme, or suggest that the SBT fishery is no longer economically viable for Korean longliners (as they have failed to catch their quota in recent years); but these are indirect inferences.

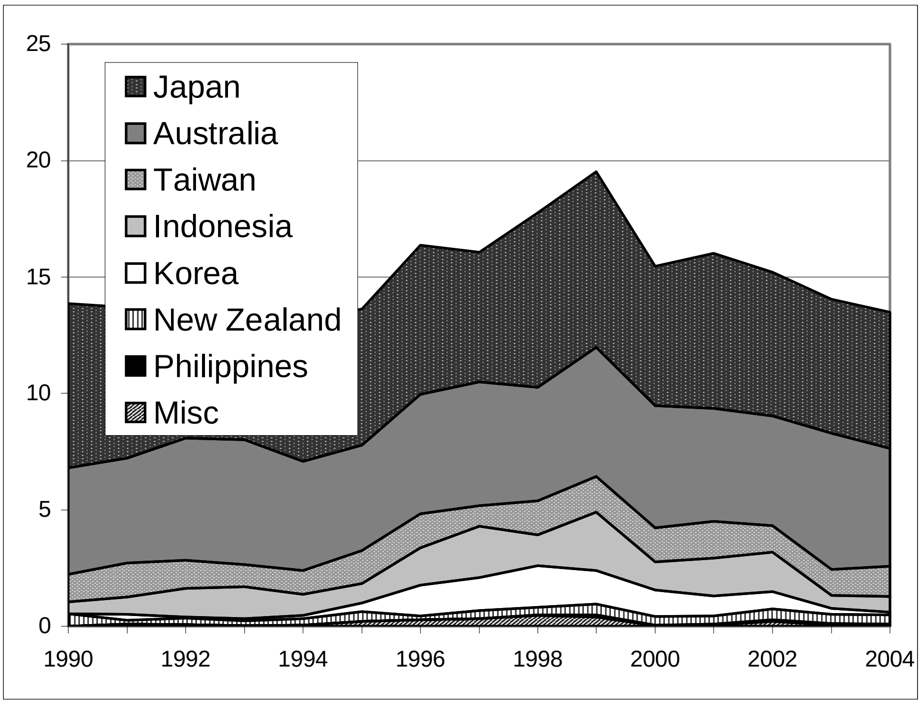

Figure 16: Estimated total catch of SBT by county since 1989 (from Hartog et al. 2005).

Indonesian Spawning Grounds Total Catch

Total catches estimated from the CSIRO/RIMF Benoa sampling programme indicate that total Indonesian SBT longline catches have generally declined since 1998 (**Figure 17**). This is encouraging from the perspective of third party catch control, but it is unclear how it relates to stock status given the non-target nature of the SBT fishery, and the difficulty in effort standardization. Data from this fishery can be interpreted as a relative abundance index, under the tenuous assumption that effective SBT fishing effort is proportional to yellowfin tuna catch (the main target species) and the even more dubious assumption that yellowfin tuna abundance has remained constant over time. In this case, the SBT spawning grounds abundance is estimated to be more variable over time, with 2004 the lowest observed since 1994 (**Figure 18**). However, we note that yellowfin tuna abundance is estimated to have declined substantially in the western Pacific Ocean over the last 10 years.

If this is also true for the Eastern Indian Ocean, then this pseudo-SBT-abundance index would have an optimistic bias.

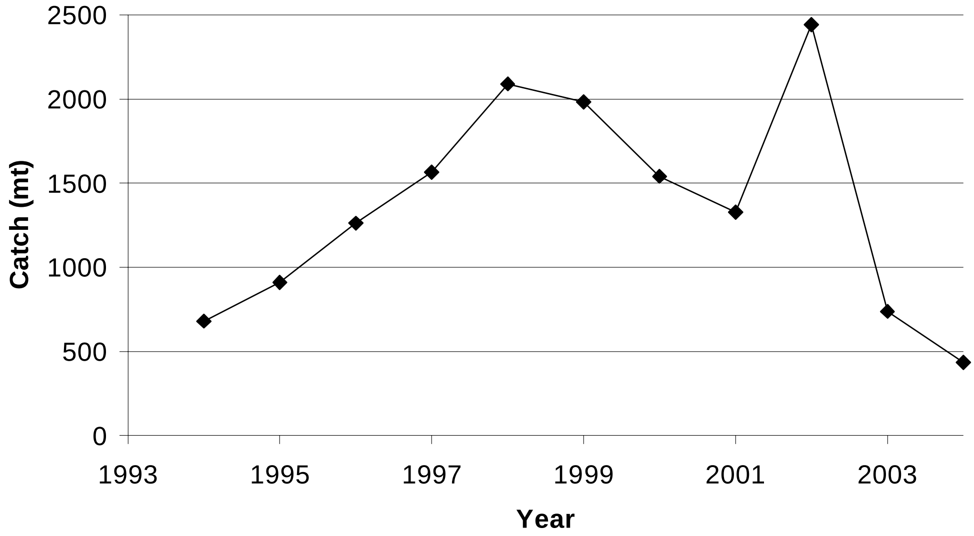

Figure 17: Estimated landings of tunas (tonnes round weight) at Benoa by spawning season. A spawning season is defined as July 1 of the previous year to June 30 of the given year. The catch estimates for 2004 are preliminary and do not include June data. (from Andamari et al. 2004).

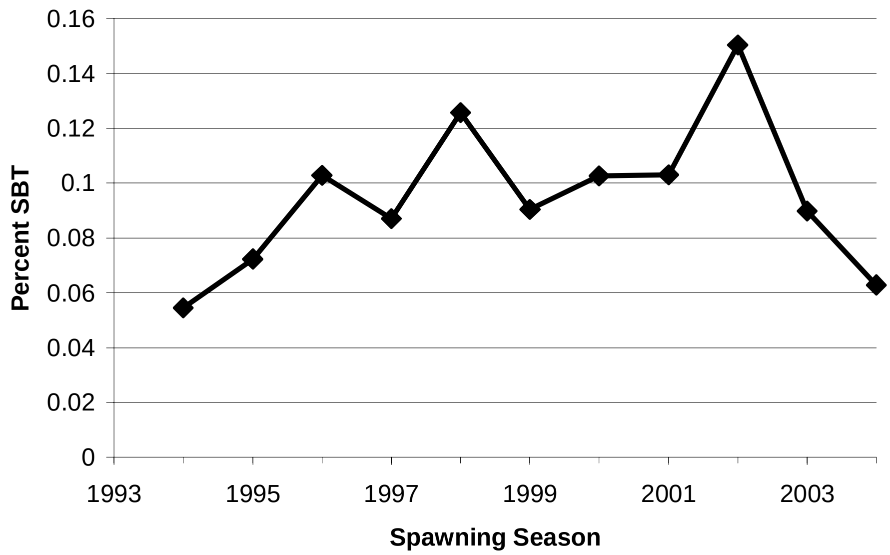

Figure 18. Estimated percent of the tuna (yellowfin, bigeye and SBT) catch that was SBT for the months October through April landed at Benoa by spawning season. The labeling for x-axis refers to the first half of the spawning season (e.g. 1993 stands for the 1993/1994 spawning season) (estimates supplied by Dr. T. Davis, CSIRO).

Catch Size/Age Composition

Below, we examine the age composition (via direct ageing methods or inferred from lengths) of the different fleets for evidence of changes in relative cohort strength. We note that directly interpreting catch composition in this manner involves the implicit assumptions that fishery selectivity and catch retention (discarding) remains fairly constant over the relevant time period.

In 2005, we are particularly interested in examining recent SBT cohort strength. These results differ somewhat from previously defined indicators (proportions of fish less than 110 and 120 cm), because we attempt to track individual cohorts. In the following, we assume that fish of size <86cm correspond to age-classes 0-2, 86-102 cm = age 3; 102-114 cm = age 4 and 114-126 cm = age 5.

Japanese Longline Fishery Catch Size/Age Composition

The Japanese longline fishery age composition data are presented below (**Figure 19**). The age-specific CPUE indicators use this same data in a more informative manner, so we do not repeat that discussion here.

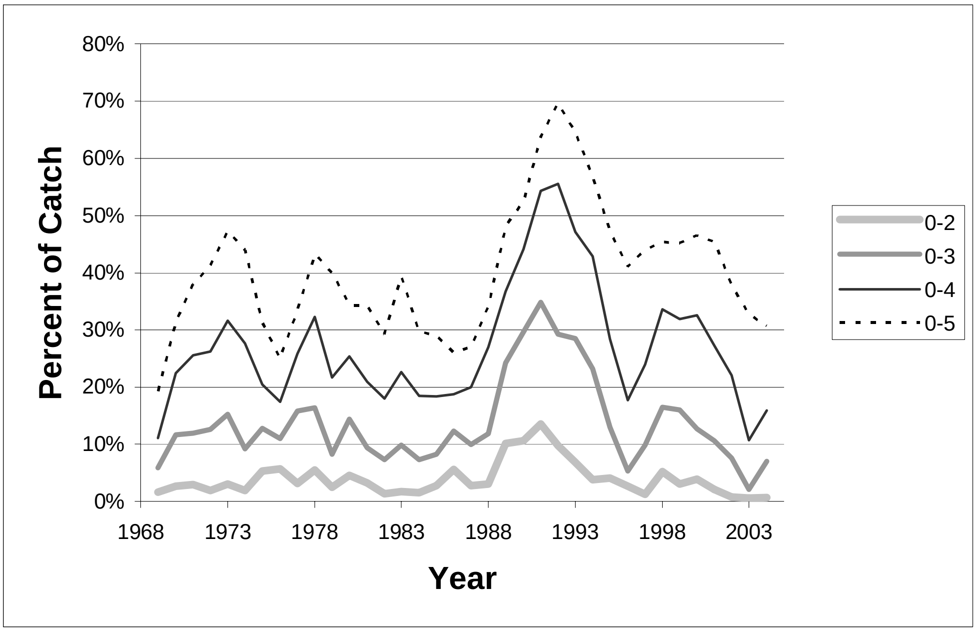

Figure 19: The percent of the SBT catch by Japanese longliners in areas 4-9 and months 4-9 which was less than or equal to 2, 3 and 4 years of age respectively.

Korean Longline Fishery Catch Size/Age Composition

The proportion of age 3 fish (86-102 cm) in the Korean catch appears to have dropped since 2000 (Figure 20), but the time series are erratic and lack clear trends for the other young age classes examined. Given the low effort in recent years and the lack of consistent patterns, we do not consider the Korean data to be informative about relative cohort strength.

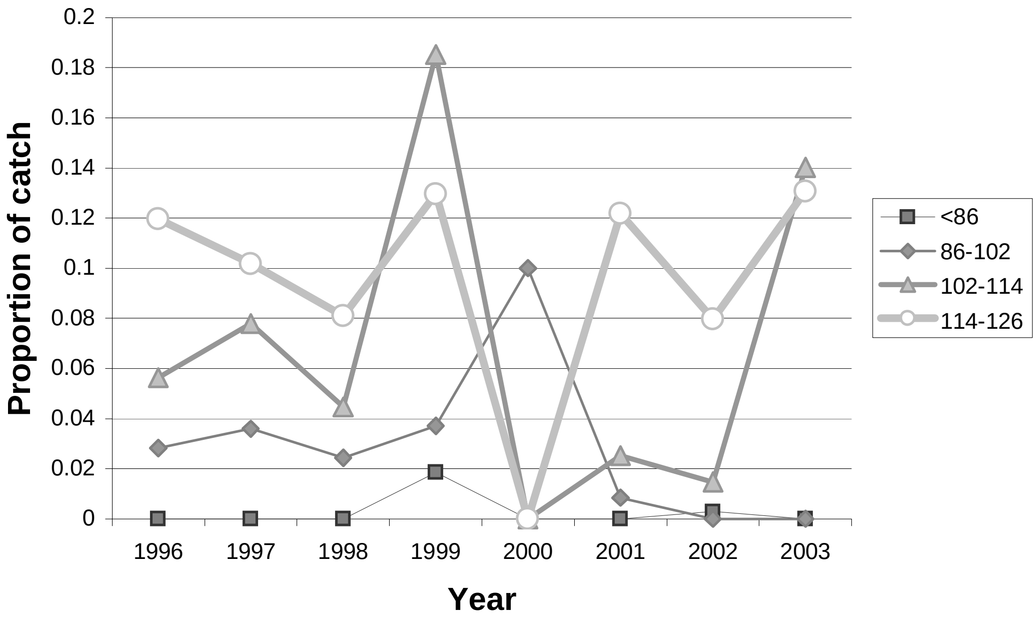

Figure 20: The percentage of the catch reported to be less than 86 cm (ages 0-2), 88-102cm (age 3), 104-114cm (age 4), and 116-126cm (age 5) in the Korean longline catches. For discussion, we assume that fish of size <86cm correspond to age-classes 0-2, 86-102 cm = age 3; 102-114 cm = age 4 and 114-126 cm = age 5.

Taiwanese Longline Fishery Catch Size/Age Composition

The percentage of small fish (<114 cm; ~ ages 0-4) has declined in the Taiwanese longline fishery since 2000 (Figure 16). This fishery (LL 2) operates generally to the north of the more targeted SBT longline fisheries and juveniles generally constitute a high proportion of the overall catch. However, the trends are noisy, and seem to be inconsistent with the smallest group (ages 0-2), prior to 2000. The 116-126 cm class (~age 5) seems to become more abundant in 2003-4, which would suggest above average recruitment in 1998-99.

Additional data comparing Taiwanese data with port sampling results from Mauritius is generally consistent with these results (Table 1).

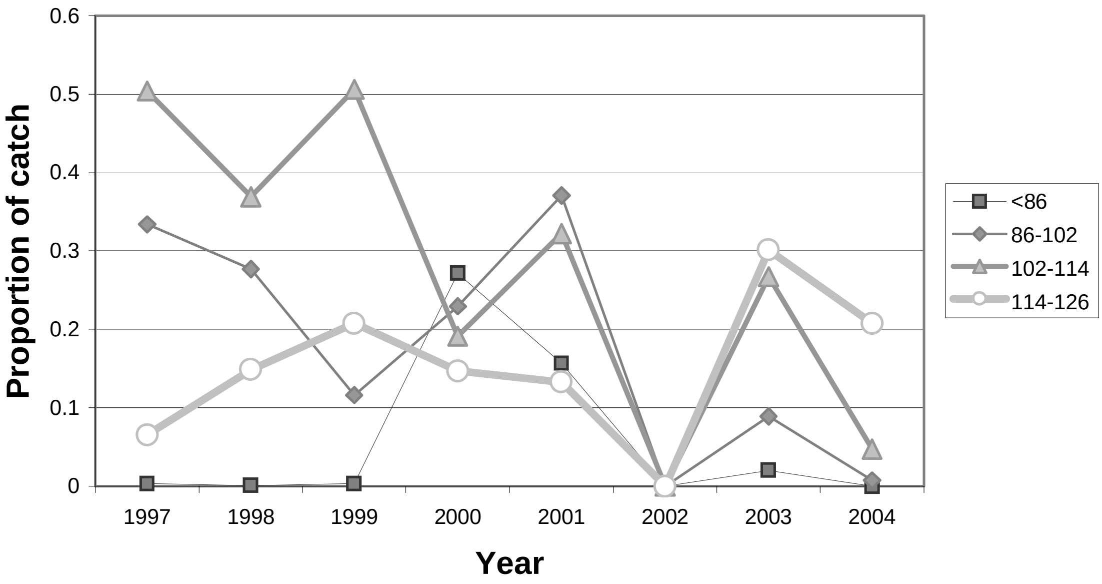

Figure 21: Taiwanese longline catch size/age composition in the northern fishery in the Indian Ocean (as reported by Taiwan in 2005). For discussion, we assume that fish of size <86cm correspond to age-classes 0-2, 86-102 cm = age 3; 102-114 cm = age 4 and 114-126 cm = age 5.

Table 1. The percent of the catch less than 15kg and 25kg in Taiwanese catches based on log book sampling in Mauritius compared with the percent less than 100cm and 116cm in data reported to CCSBT. Note that 100cm and 116cm correspond approximately to the estimated weight of a 15kg and 25kg fish (processed weight) being used in the CCSBT assessments. (Jessica Farley, pers. Comm..)

	Log book Sampling – Mauritius				Taiwan Report	
	Summer Fishery		Winter Fishery		Longline Fishery 2	
Year	<15 kg	<25kg	<15 kg	<25kg	<100cm	<116cm
1997	38.5	96.9	4.5	74.8	-	-
1998	29.4	86.1	1.9	58.4	-	-
1999	11.1	65.7	4.7	69.2	-	-
2000	13.3	68.9	2.4	51.7	47.0	71.3
2001	-	-	-	-	47.9	89.7
2002	-	-	-	-	16.6	60.1
2003	-	-	-	-	10.7	32.4
2004	-	-	3	48	-	-

New Zealand Longline Fishery Catch Size/Age Composition

Small fish, up to and including age 5, seem to have disappeared almost completely from the New Zealand domestic and charter fisheries in 2004 (**Figure 22** and **Figure 23**). The data for the early years of the domestic fishery is dominated by handline and troll caught fish and in more recent years by longline vessels. As such, caution should be used in interpreting the full time series because of this discontinuity. However, the age 4 and 5 fish have historically made a substantial and fairly consistent contribution to the SBT catch. Given the 100% observer coverage in the charter fishery, this recent effect does not seem to be attributable to discarding.

The absence of small fish in NZ fisheries is consistent with the Japanese catch rates in Areas 4-7 as described in the Japanese CPUE section. However, since age 5 fish were observed in substantial numbers in 2004 Japanese catches in Areas 8 and 9 (plus Taiwanese fisheries), the absence of age 4-5 fish in NZ is partly attributable to a shifting spatial distribution.

Figure 23 provides estimates of the proportion of the SBT catch for younger ages caught by domestic vessels from New Zealand. Note that the data for the earlier years is sparse. Nevertheless, small fish appear to have become relatively common in the catches by domestic vessels in around 1990. This corresponds reasonably well to the period of increasing abundance of small fish in the Japanese longline catches and the increased escapement from the surface fisheries as a result of the large quota reductions. The proportion of small fish remain relatively constant though 2002 with perhaps some decrease. In 2003 and 2004 the proportion of small fish declined dramatically to levels around those seen in the 1980's.

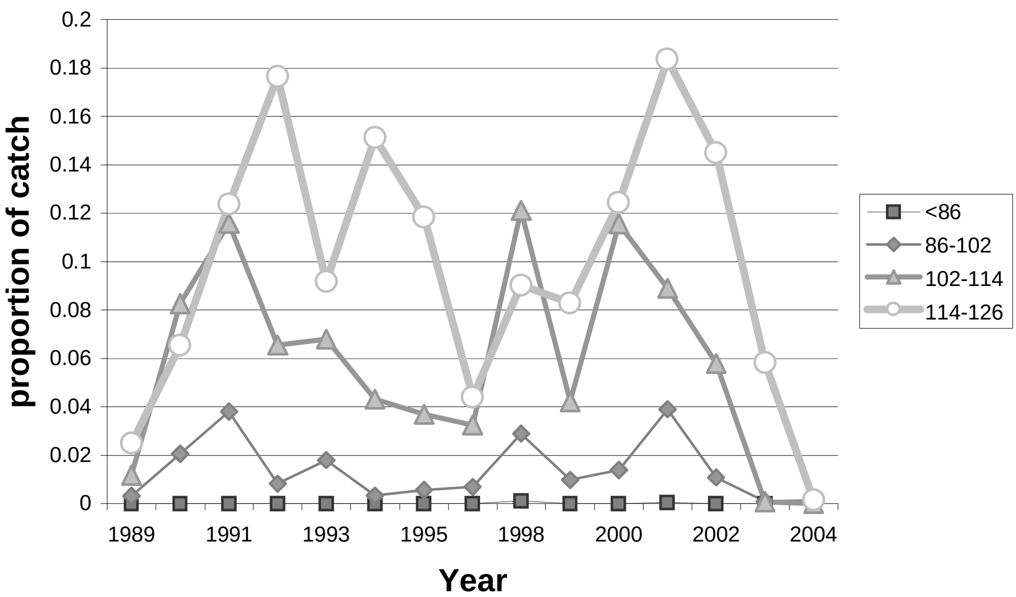

Figure 22: Estimates of the proportion of SBT less then 110 and 120cm caught by chartered Japanese longline vessel fishing in New Zealand waters. The estimates provide here are based on those use in the SBT stock assessment and were derived from the conversion of weight frequencies to length frequencies. For discussion, we assume that fish of size <86cm correspond to age-classes 0-2, 86-102 cm = age 3; 102-114 cm = age 4 and 114-126 cm = age 5.

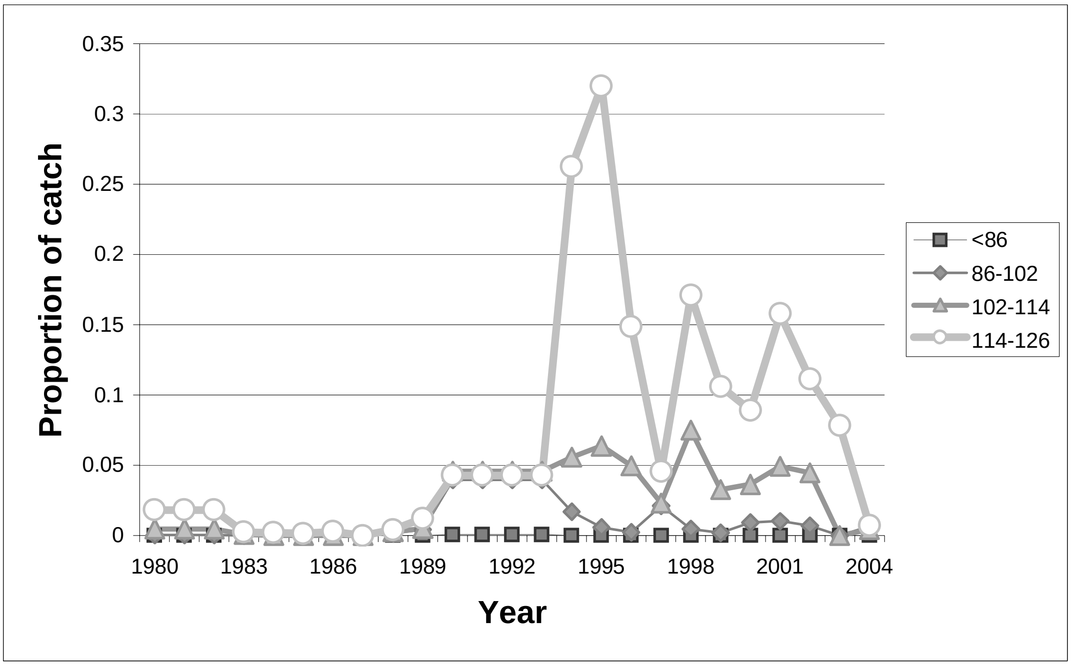

Figure 23: New Zealand domestic SBT catch estimated size/age composition. For discussion, we assume that fish of size <86cm correspond to age-classes 0-2, 86-102 cm = age 3; 102-114 cm = age 4 and 114-126 cm = age 5.

<u>*Australian Surface Fishery Catch Age Composition*</u>

The age composition of the Australian surface fishery has proved very stable over the last 6 years, with a predominance of age 3 fish in the catch (**Figure 24**). The targeting practices of this fishery are generally believed to be sufficiently flexible to obtain a targeted size composition, despite the inter-annual variability in age composition within the Great Australian Bight. Thus the fishery selectivity can change dramatically from year to year and these data are assumed to provide less information about relative cohort strength than the longline fisheries. Different ageing methods seem to estimate somewhat different proportions of 2 and 4 year olds in the 2004 Australian catch, but the dominance of 3 year olds is a robust result.

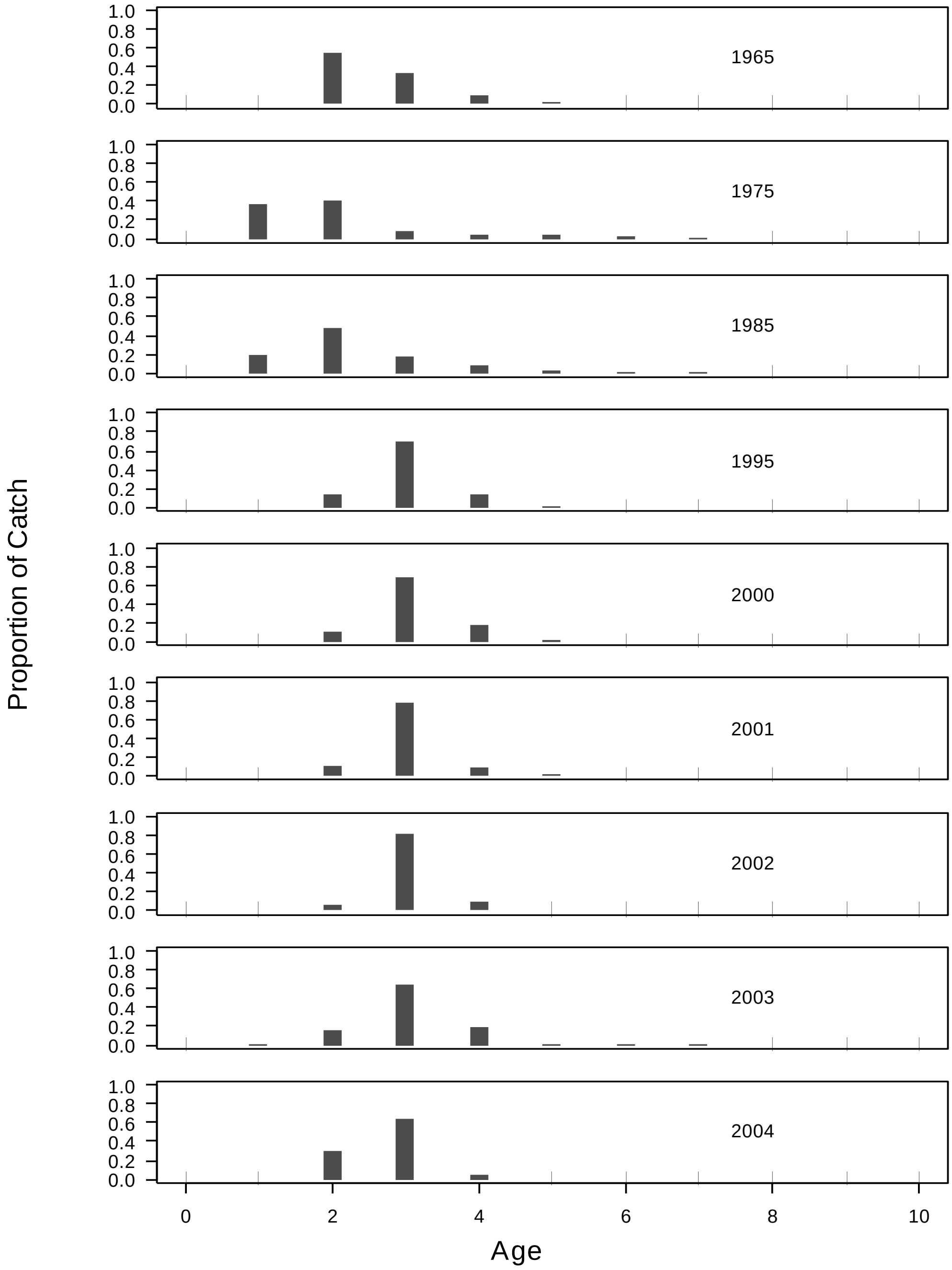

Figure 24. Estimated age composition of the Australian surface fishery.

Indonesian Spawning Grounds Age/Size Composition

The SBT age composition from the Indonesian spawning grounds longline fishery has been estimated since 1993, and is thought to provide considerable information about the spawning population, predicated on the assumption that fishery selectivity is reasonably constant over time. All fish caught are mature, ranging in size from 143cm to 221cm. We note the following (primarily from Farley and Davis 2005):

- The median of the age distribution has shifted from age 19-21 (1995-2000) down to 13-14 (2002-4) (**Figure 25 - Figure 26**), while the average age of fish in the 20+ category has been increasing.

- The age distributions in 2003 and 2004 seem to have a smaller proportion of young spawners (ages<10) compared to 2001-2002 (**Figure 25**). This suggests that the rate of recruitment of young spawners may have declined in the most recent years. However, this interpretation may be deceptive in that a healthy constant recruitment will appear to be an increasingly smaller proportion of the stock over time, if the accumulation starts from a highly depleted state. Age estimates are not yet available for the 2004/2005 spawning season, but a comparison of length frequencies does not suggest much difference from 2003 – 2005 (**Figure 27**).

- These data are a strong indication that cohorts spawned since quotas were introduced in 1984 have survived to reach spawning age in significant proportions. However, in the absence of reliable effort data it is impossible to determine the degree to which the greater proportion of young fish reflects recruiting young spawners or the disappearance of old spawners. Both processes are occurring simultaneously. We have no reason to suspect that the 20+ spawners suffered disproportionately high mortality around 2000-2002, so we are inclined to interpret the shift in age distribution as an optimistic sign of incoming recruits.

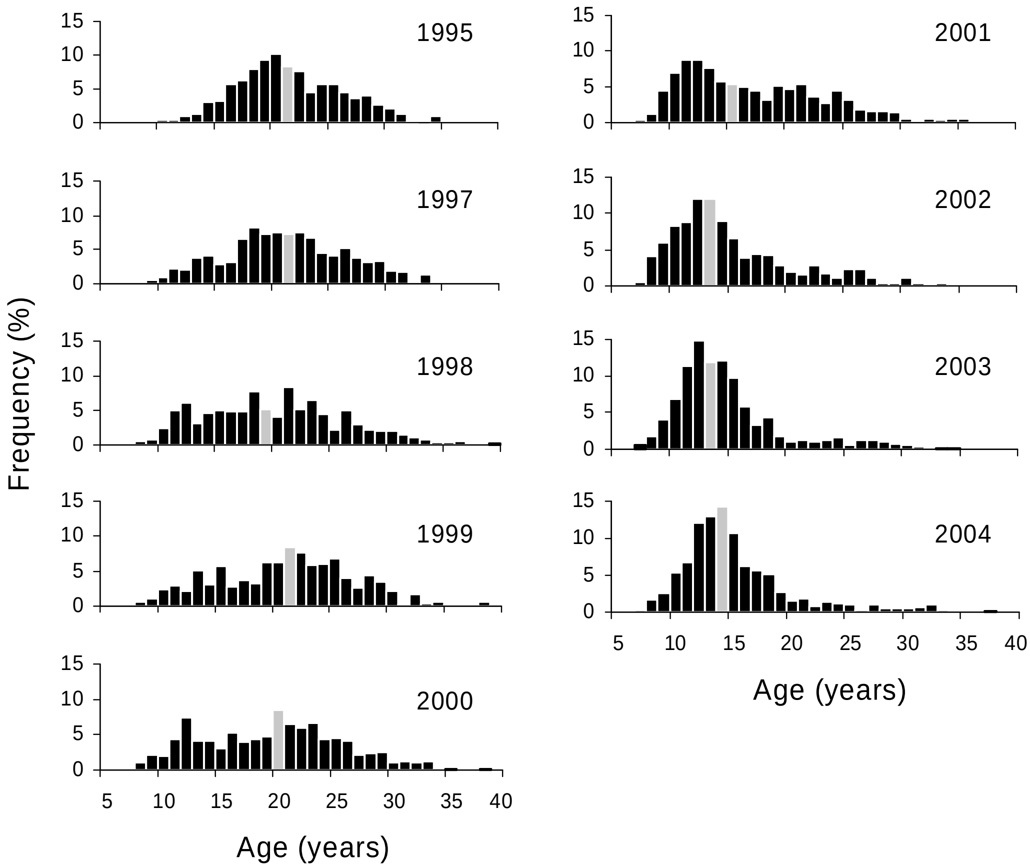

Figure 25: Age distribution of SBT by spawning season. A spawning season is defined as July 1 of the previous year to June 30 of the given year. Age could not be assigned to 22 (2%) fish with length measured in the 2002 season. The pale bar represents the median age.

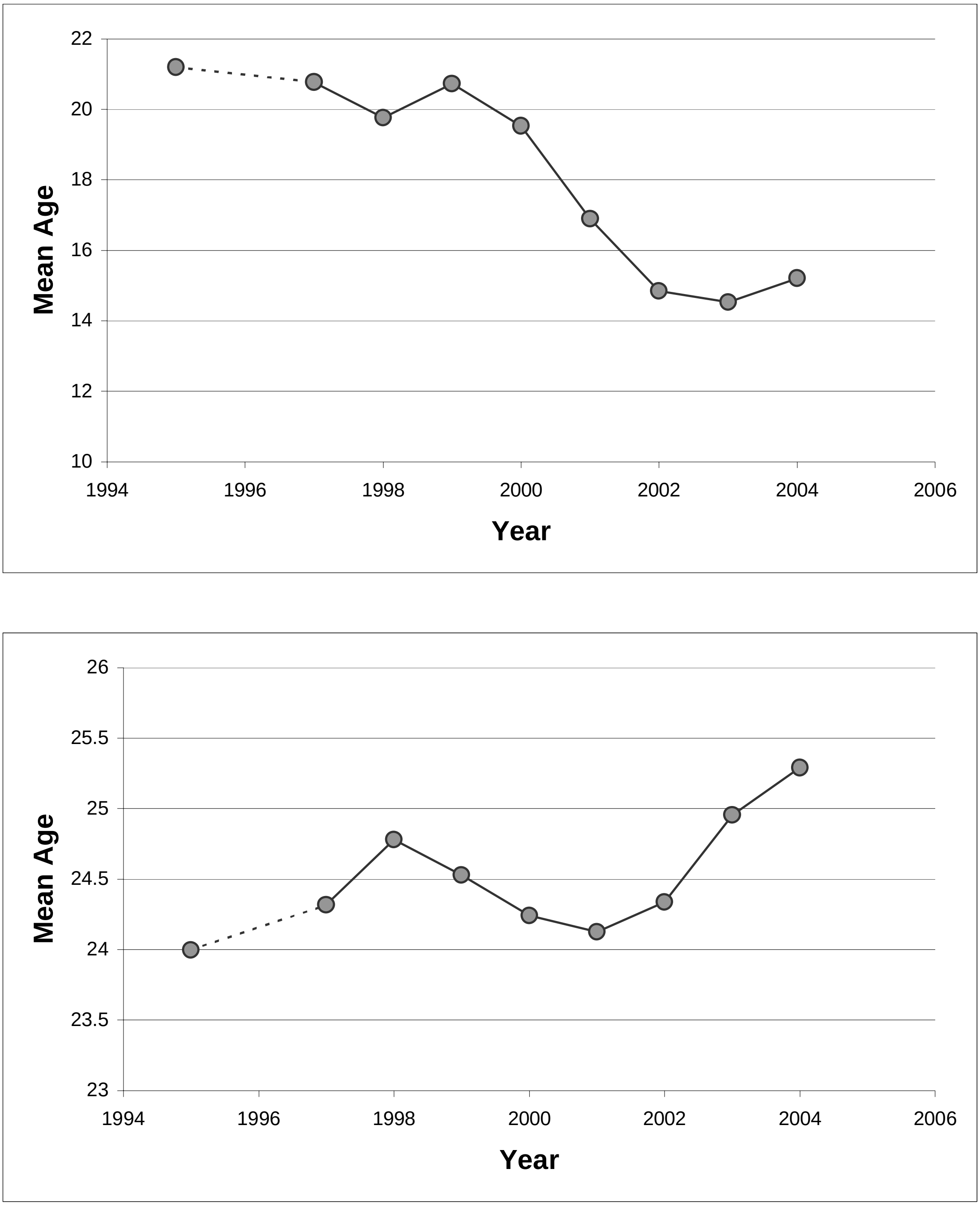

Figure 26: Estimated mean age of the catch of SBT by Indonessian longliners by spawning season. Upper panel is for the entire catch. Lower panel is for the catch for ages 20 and above.

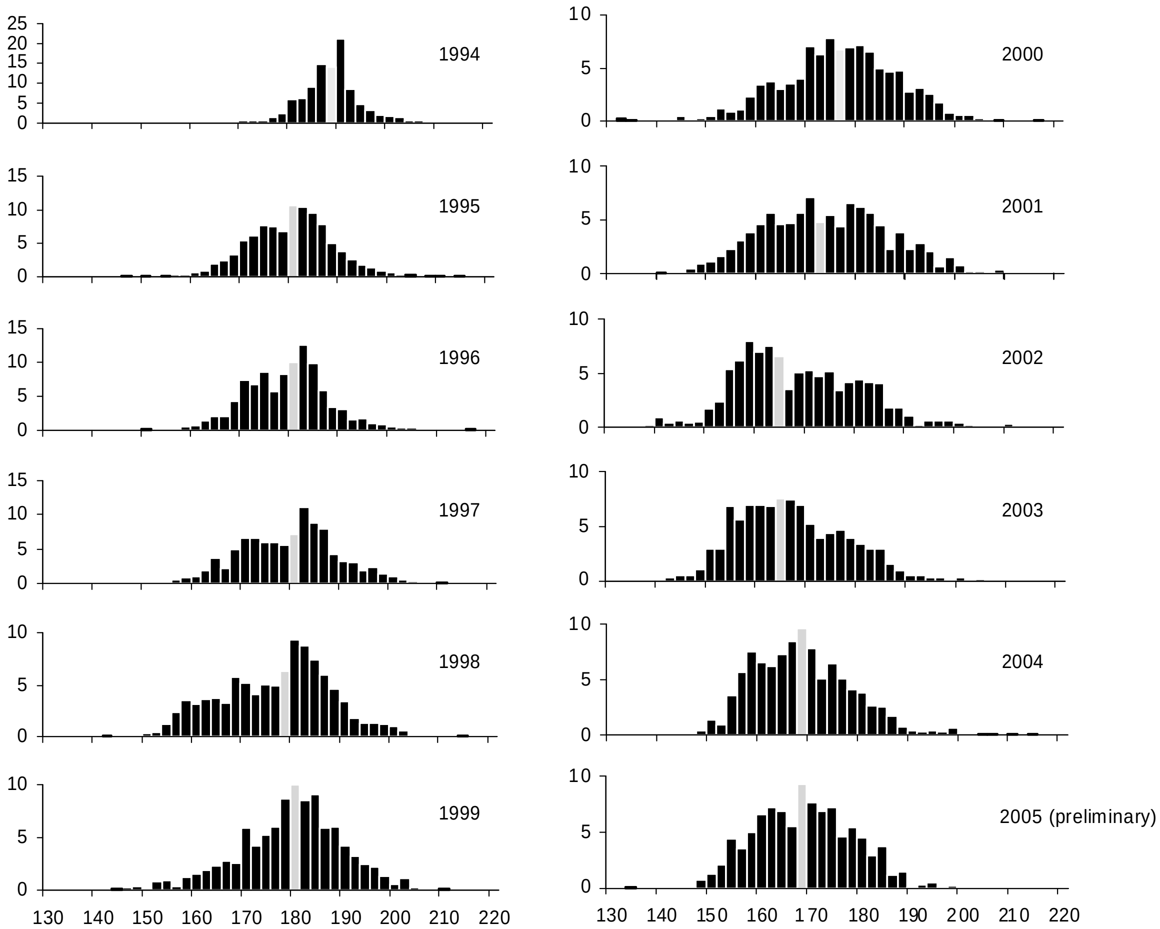

Figure 27. Length frequency (2 cm intervals) of SBT by spawning season. The grey bar shows the median length class. A spawning season is defined as July 1 of the previous year to June 30 of the given year. The pale bar represents the median length.

Acoustic estimates of age 1 off Western Australia

From 1996 through 2005, the Japanese National Research Institute for Far Seas Fisheries (NRIFSF) and collaborating agencies in Japan have conducted an acoustic survey of 1 and 2 year old SBT in the Albany area off the southern coast of Western Australia. The survey has employed standard line transect survey methods, and a standardized acoustic methodology. Age 1 fish are estimated to have been the dominant age class detected and a standardized index has been estimated for this age class (Itoh and Nishidia 2003, Itoh 2005). Between 1997 and 2000, the survey index for age 1 declined by over 200% and since then has been close to zero (and in fact was zero in 2003) (Figure 30). The survey did not operate in 2004. While substantial uncertainty exists about the adequacy of the survey to provide a quantitative direct measure of abundance, the near total absence of SBT in the survey area for 5 consecutive surveys, following 4 years of consistent detections, is of concern.

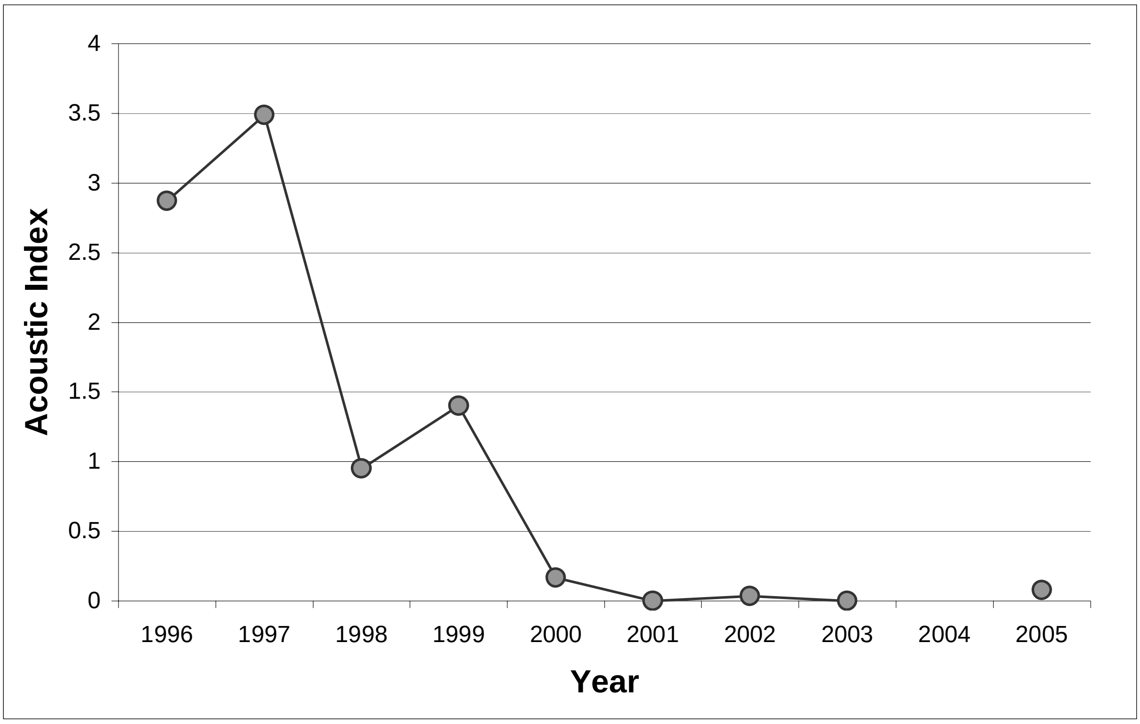

Figure 28: Relative biomass index for one year old SBT off Western Australia from acoustic surveys (Itoh and Nishidia 2003, Itoh 2005). The index has been standardized to the mean value over all years.

Aerial spotting data in Great Australian Bight

Aerial Survey

Annual aerial surveys were conducted over the GAB between 1991 and 2000 based on line transect methodology using a consistent survey with broad spatial and temporal coverage (Cowling et al. 2002). The data from the surveys have been used to provide annual indices of surface density for juvenile SBT (Figure 29) and constitute a fishery independent of aggregated 2-4 year old abundance (Bravington 2002). The results indicate that juvenile abundance were relatively stable during the mid-part of the 1990s, began to decline in 1998 and 1999 and remained low in 2000. The survey was suspended until 2005, at which time the juvenile estimate was similar to 2000. Bravington et al (2005) note that unadjusted sighting rates and patch biomasses were higher in 2005 than in either 1999 or 2000, but the efficiency of the observer teams in 1999 and 2000 is very uncertain and makes direct comparisons difficult. The comparison with the mid-90s is therefore more reliable.

Figure 29: Time series of relative abundance estimates based on January and February (not March), with 90% confidence intervals (from Bravington et al 2005).

Commercial Sightings (SAPUE Index)

Data on the sightings of SBT schools in the GAB were collected by experienced tuna spotters during commercial spotting operations over four fishing seasons (2001-02 to 2004-05). The nominal surface abundance per unit effort (SAPUE) index suggests that age 2-4 SBT abundance in core fishing areas of the GAB declined dramatically between 2002 and 2004, before increasing dramatically in 2005 (Figure **30**). The 'broad search' index in 2005 should, however be interpreted with caution because it is not directly comparable with previous years (see Basson and Farley 2005) Preliminary analyses, which attempt to standardise these commercial sighting rate data for prevailing environmental conditions and differences between spotters, indicated a similar pattern to the nominal series (Figure **31**). There was a large decrease (between 45-55%) in sighting rates between the 2002 and 2003 summer seasons, with the lower sighting rate generally being maintained between the 2003 and 2004 seasons, and an increase back to 2002 levels in 2005. However, the extent of the difference is somewhat sensitive to the assumptions used in the standardization model (Basson and Farley 2005). These data cannot be calibrated with the aerial survey described above, because they only overlap for one year.

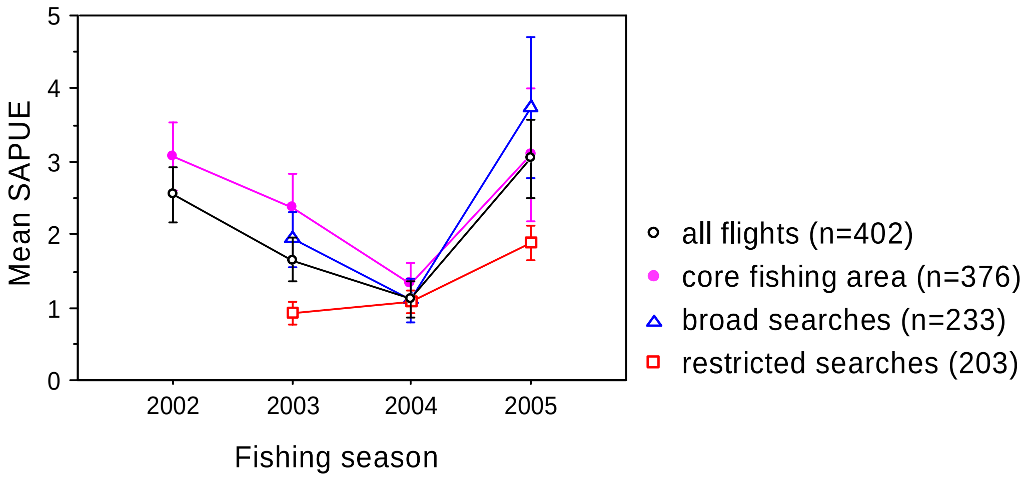

Figure 30: Nominal SAPUE indices (+/-se) for the 2002-2005 fishing seasons. Classifying search effort as either broad of restricted started in 2003 (ie the 2002/2003 fishing season) (from Basson and Farley 2005).

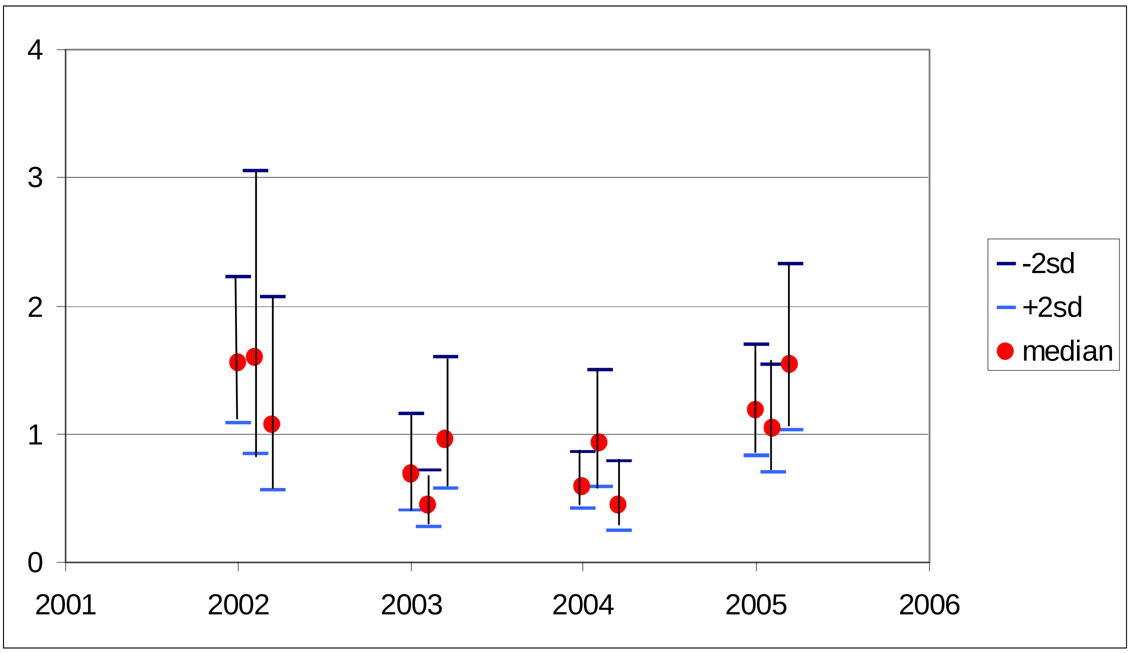

Figure 31. Standardized estimates of SAPUE (surface abundance per unit effort) for companies 1,3, and 6 in each of the 4 past seasons. The median and exp(predicted value + or – 2 standard deviations) are shown. (from Basson and Farley 2005)

Tagging data and estimates of fishing mortality

Polacheck and Eveson (2005) used a tag attrition model to estimate cohort- and age-specific fishing mortality rates for different groups of SRP tag releases conditional on estimates of natural mortality, tag shedding and reporting rates (the latter from Polacheck and Stanley

2005). Preliminary analyses suggest high fishing mortality rates in 2003 and 2004 for those fish tagged at age 2 and above. However, rates based on age 1 releases primarily in Western Australia tend to be lower. High rates of recovery were obtained from age 3 fish released in December in the Great Australian Bight (GAB) during the same season they were released in. Overall the results suggest high fishing mortality rates for fish in the GAB (Table 2), but it is not clear to what extent this represents the overall juvenile population. A number of apparent inconsistencies in the tagging study results are mentioned in the paper.

We did not consider that analyses related to the RMP tagging program could provide any new insight on the status of the stock this year.

Table 2. Summary of the range of age specific fishing mortality rates in year 2003 and 2004 for age 3 and 4 from the CCSBT SRP tagging projects for tags released at different ages. Ranges are presented for all tags released and those released only by tagger group 1. The values present are the range of values over the two reporting rate options and two mortality vectors considered. (Polacheck and Eveson 2005)

		Age at	All Taggers			Tagger 1		
Year	Age	tagging	# Tagged	range		# Tagged	range	
2003	3	1	1921	0.16	0.22	401	0.19	0.27
		2	492	0.26	0.68	242	0.28	0.39
	4	2	750	0.25	0.45	58	0.28	0.32
2004	3	1	2748	0.16	0.23	1015	0.32	0.51
		2	5869	0.50	0.66	2301	0.61	0.86
	4	1	1921	0.06	0.13	401	0.08	0.22
		2	492	0.31	0.56	242	0.55	1.05
		3	3277	0.21	0.27	1655	0.21	0.27

Growth rates

The most recent analysis of growth for southern bluefin tuna (SBT) was conducted in 2001-2002, integrating growth information from three data sources to provide comprehensive estimates of mean length-at-age (as well as variance in length-at-age) for each of the past four decades (1960s, 1970s, 1980s and 1990s) (e.g. Polacheck et al 2004). Since then, additional data pertaining to growth of juvenile SBT during the late 1990s and early 2000s has been collected from tag-recapture studies and from otolith sampling in the Australian surface fishery. Preliminary analyses of these data (Eveson et al 2005) have been conducted and suggest that growth of juveniles has remained similar to the early 1990s, perhaps increasing marginally.

Information of fishermen's experience and knowledge

In discussions with Australian Industry – including skippers, spotters, managers and owners – following the most recent catching season, the main feedback we received was that this season (2004/05) has been good. Just how good, differed a little between individuals: some indicated that it has been "the best year ever", others that it was "very good". There was general agreement that this year (2004/5) was better than last year (2003/4). Other comments were that:

- there was a wide range of sizes – small fish (<10kg), medium sized fish and large fish (>40kg)
- the wide range of sizes were well mixed (it was argued that this was considered to be a good sign of a healthy population)
- there were large numbers of small (<10kg) fish in the Bight this year
- there were still large numbers of fish in the Bight after fishing operations had finished (around March)
- SBT were seen in areas where they haven't been seen in the recent past

Concluding Remarks

This paper summarizes a diverse range of fishery indicators, thought to be informative about different aspects of SBT stock dynamics. We attempt to summarize the results (Table 3) in a manner that is relevant to the most critical assessment objectives that we perceive for 2005. Generally speaking, we are interested in new insight about stock status trends relative to the stock status in 2004, and it is hoped that this insight will help the CCSBT SAG/SC to make informed decisions in relation to the appropriateness of different operating model scenarios defined for the evaluation and selection of an SBT Management Procedure in 2005. In this light, we attempt to report on spawning stock abundance indices, non-spawning abundance indices (defined as either immature fish, or combined immature and mature fish in unknown proportions) and individual cohort strength from 1998-2002. While we hope that Table 3 provides a useful summary, we recognize that opinions may vary regarding the interpretation of many of the entries, and the relative credibility of each index. Overall, we conclude:

1. There have probably been between 2 and 4 weak cohorts spawned between 1999 and 2002.

2. There has probably been at least one cohort hatched between 2002-4 that is considerably more abundant than the recent weak cohorts

3. The spawning stock biomass may have decreased or increased slightly in the last two years. The encouraging signs of recent recruitment of younger fish into the spawning population seems to have continued over the last two years.

The major change in our perception of the stock status from the 2004 assessment relates to the recruitment estimates. This year we are more confident that there were multiple poor cohorts in the recent past, and it is likely that the series of poor recruitment has been interrupted (at least temporarily).

Table 3. Qualitative summary of recent fishery indicators. Positive indicators (+) suggest increasing trends or support the notion that the indicated cohort strength is not substantially below the recent ~5-10 year average). Negative (-) indicates the opposite; 0 indicates a neutral indicator. Non-spawning biomass in this case is defined to mean some portion of the stock which is not restricted to ages 12+ or the spawning ground (i.e. it could include 12+ individuals in addition to younger ages, or it could be simply juveniles, depending on the context). Missing values are not thought to be informative with respect to the particular category (because the indicator is irrelevant or we have strong reasons not to believe it).

Indicator	Non-Spawning Biomass Last 1-3 years	Spawning Biomass Last 1-3 years	Cohort Strength (age 0)				
			1999	2000	2001	2002	2004
Catch Rates							
Japanese CPUE	-	-	0/-	-	-		
Korean CPUE							
Taiwanese CPUE	+						
New Zealand CPUE	-						
Indonesian Fishery School CPUE		-					
Total Catch							
Korea	-						
Indonesia		-					
Catch Size / Age Composition							
Japan			0/-	-	-		
Korean							
Taiwan			+	-	-		
New Zealand			-	-	-		
Indonesia		+					
Australia							
Other							
Acoustic Survey	-		-	-	-	-	-
GAB Aerial survey (2005 relative to mid-1990s)	-						
Commercial spotting SAPUE	+						
SRP Tag Returns			-	-			
Australian Fishing Industry Comments	+						

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Appendix 1. The 1988 SBT Stock Status Indicators

Thirteen fishery indicators were used to justify the 1988 tri-lateral meeting recommendation that "…*Global SBT catch limits* be immediately reduced *in all sectors of the fishery substantially below current catch levels. Because of the severity of the decline in the SBT population…*" (Anon. 1988):

Indicator #1: Reduction of unexploited biomass to less than 25%.

Indicator #2: Reduction in hook rate in the Japanese longline fishery between 1983 and 1986 of 50%.

Indicator #3: Contraction in the area of Japanese fishing effort to two of the nine fishing areas

Indicator #4: Reduction of the peak Japanese longline catch to less than 20%.

Indicator #5: Reduction in the abundance of 4-7 year old fish in the longline fishery from 1972-86 to 10%

Indicator #6: Reduction in the abundance of 8-10 year old fish in the longline fishery since 1980 to about 30%.

Indicator #7: Reduction in the hook rate in the Japanese longline fishery off New Zealand between 1980 and 1987 to 33%.

Indicator #8: Disappearance of small fish from the Japanese longline fishery in New Zealand waters.

Indicator #9: Reduction from the peak New Zealand handline/troll fishery catches to less than 25%.

Indicator #10: Sudden and continued absence of SBT from NSW coast.

Indicator #11: Continued contraction in the area of occurrence of juvenile SBT in the Australian waters to 40%

Indicator #13: Progressive reduction in the availability of large fish to the Australian fishery since 1982-83.

Appendix 2. Stock status summary table reproduced from Polacheck et al (2004)

For each indicator an overall assessment was made of the performance of that indicator over the last 10 to 14 years and over the last 3 to 4 years. A label of negative is meant to indicate either that the indicator suggested an overall negative trend with respect to the stock or suggested potential concern relative to exploitation or stock status. A label of positive is meant to indicate that the indicator suggested an overall positive trend or improvement in the indicator relative to 1986. Neutral is meant to indicate that the indicator suggested no change over the period or no net improvement or deterioration. NA signifies that the indicator is no longer relevant, or that data are not available or are not interpretable.

Indicator	Last 10-14 years	Last 3-4 years
Parental Biomass estimates	Negative	NA (awaiting 2004 Assessment results)
Catch rate trends for the Japanese fishery	Positive/neutral	Neutral
Fishing effort spatial distribution	Negative	Negative
Catch Levels - Japan	NA	NA
Korea	NA	Negative
Indonessia	NA	Negative
Abundance of ages 4-7 in Japanese longline fishery	Positive	Neutral
Abundance of ages 8-11 in Japanese longline fishery	Positive	Neutral
Catch Rates off New Zealand (Japanese longline)	Positive	Neutral/negative
Small Fish in the Japanese longline Fishery off NZ	Positive/neutral	Negative
Trends in New Zealand Handline/Troll Fishery	NA	NA
Trends in New Zealand Domestic longline	Neutral	Neutral (?negative)
Surface Schools of Juvenile SBT off the NSW coast	Neutral	Neutral
Area of occurrence of SBT in Australian Waters	Neutral	Neutral
Juvenile exploitation rates –conventional tagging	Negative ?	NA
Juvenile exploitation rates – archival tagging	Negative	Negative
Large fish in Australian Fishery	NA	NA
Small fish in pelagic longline catches: Japan	NA	Negative
Korea	NA	Negative
Taiwan	NA	Negative
Small fish in NZ domestic fishery catches	Neutral (?positive)	Negative
Catch rate for 12 plus	Negative	Neutral
Korean Longline CPUE trends	Negative	Neutral/negative
Taiwan Longline CPUE trends	NA	NA
Juvenile abundance estimates from tagging	Negative	NA
Spawning ground Catch Age/Size distributions	Positive	Positive (?Negative)
Growth rate change	Negative	NA
Catch Rate trends by cohort	Positive	Positive
Aerial Survey	Negative	NA
Acoustic Survey	Negative	Negative
Commercial aerial spotting	NA	Negative