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FISHERY INDICATORS FOR THE SBT STOCK 2003/04

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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 of (1) assumptions embedded in the model structure, (2) the pooled nature of much of the input data and (3) inconsistencies among different data sources and dynamic assumptions as manifested in sensitivities to the relative weights given to these. Moreover, an evaluation of indicators allows 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. This is particularly true for information from finer spatial/temporal scales or fishery units than the more broad, pooled spatial/temporal scales at which the analytical assessment models operate. Stock assessments are poor at estimating the most recent abundance trends. These inherently have the more uncertainty and are most reliant upon time series consistency assumptions (e.g. in stock/recruitment, selectivities and catchabilities). Thus, fishery indicators provide an important addition and measure of robustness to the overall stock assessment process.

The 1988 Trilateral Scientific Meeting was a watershed for a number of changes in the management of the SBT fishery and led to the development of a number of important research directions /programs (e.g. Real Time Monitoring Program (RTMP) including observers, Recruitment Monitoring Program (RMP) using fishery independent indices, continued tagging, length monitoring programs, etc). This was a consequence of the consensus recommendations from that meeting. The Meeting recommended that "*Global SBT catch limits* <u>*be immediately reduced*</u> *in all sectors of the fishery substantially below current catch levels. Because of the severity of the decline in the SBT population…*" (Anon. 1988). This recommendation was followed by a list summarizing 13 observations on which these conclusions and recommendations were based – only one of which was based on the results from the analytical assessment. Thus, the review of a broad range of fishery indicators was critical to the consensus recommendations of the Trilateral Scientific Committee meeting and their subsequent acceptance by management. These indicators were reviewed in 1998 and again in 2001 (Gunn et al. 1998; 2001).

In 2001, the CCSBT Scientific Committee recommended “that it was not necessary to conduct full assessments every year” noting “that current trends in the status of the SBT stock were not expected to change suddenly” (Anon 2001a). Consequently, no analytical stock assessments were undertaken in 2002 or 2003. However, in recommending that annual assessments were not necessary, the Scientific Committee recognized “that the impact of fisheries, particularly of non-party catches, might unexpectedly change … agreed that some form of monitoring and review of fishery indicators was required on an annual basis” (Anon 2001). Further demonstrating the importance of the fishery indicators in the overall assessment process, the reviews conducted of fishery indicators in 2002 and 2003 were used as the basis for management advice by the Scientific Committee in those two years (Anon. 2002, 2003).

The Scientific Committee is conducting a detailed analytical assessment of the SBT stock in 2004. This will be the first full assessment since 2001. As part of this full assessment, it is important that the analytical model results are considered within the broader context of fishery indicators given the role that such indicators have played and continue to play within the SBT stock assessment process. In this context, it is important to consider both the performance of fishery indicators over the last few years in comparison to changes between 2001 and the updated 2004 assessments and in the context of more recent trends in the SBT stock since 1988. This paper presents results for a range of indicators. It first reviews changes in the status of the indicators that were assessed 16 years ago and formed the basis for the recommendation by the 1988 Scientific Committee. Additional indicators are also presented based on new data and sources of information.

Revisiting the 1988 Indicators

(The 1988 statements regarding indicators are shown below in italics)

Parental Biomass estimates

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

The 1998 assessment completed by the CCSBT Scientific Committee estimated that the parental biomass had declined to less than 10% of its pre-exploitation level (Anon. 1998). In the last CCSBT stock assessment report (e.g. Anon. 2001a,b), the Scientific Committee (SC) considered a wider range of different assessment models and did not provide an overall summary of the parental biomass relative to pre-exploitation levels. Nevertheless, the range of values for assessments which provided such estimates was between 2-19% with the high end of the range being from what was considered less reliable assessment models (Anon. 2001b; Polacheck et al. 2001; Polacheck and Preece 2001; Kolody and Polacheck 2001). With respect to the more recent trends, the 2001 SC concluded:

- At the time of the most recent round of quota reductions (1988), spawning stock size was well below levels in 1980 and earlier, and has declined further since then, with a possible upturn in recent years.
- Overall, stock biomass has been roughly stable since the mid 1990s or early 1990s (depending on the model) with possible slight increases or decreases.

Updated estimates of recent trends in parental biomass will be reviewed at the 2004 Stock Assessment Group meeting. The conclusion reached there should be used to update this indicator.

Catch rate trends for the Japanese fishery

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

It should be noted that after 1989, the Japanese SBT longline fishery concentrated most of its fishing efforts in the second and third quarter of the year. Consequently, in updating this indicator, only nominal catch rates for quarters 2 and 3 are considered. Similarly, most of the targeted SBT effort has occurred in statistical areas 4 to 9. As such, only catch rates from these periods and areas are used as the total nominal catch for this indicator and also for indicators 5 and 6 below. It should be noted that at the time of the 1988 Scientific Committee Meeting the most recent data from the Japanese longline fishery would have been for 1986.

Total nominal catch rates continued to decline by 10% between 1986 and 1988, reaching the lowest historical level ever recorded in 1988 (Figure 1). After 1988, total catch rates increased rapidly until 1993. The total catch rate in 1993 was more than double the historic 1988 low level and somewhat greater than the average experienced in the 1982 to 1984 period. This increase was dominated by increased catch rates of small/young fish (see indicator 5 and 6) and probably reflects a combination of increased escapement from the surface fishery and changes in targeting toward smaller fish. Between 1993 and 1997, total catch rates declined sharply such that the 1997 catch rate was only about 50% of the 1993 level and only 10% greater than the level in 1986[1]. Between 1997 and 2002, catch rates increased by 40% and then declined by 20% in 2003. The 2003 rate is 37% above the historic 1988 low level and 22% above the 1986 level which formed the basis for the 1988 Scientific Committee's recommendations. It is still 40% lower than the 1983 level. It should also be noted that changes in fishing patterns in recent years (i.e. concentration of effort in higher density SBT areas) raises concern about positive biases (i.e. over "optimism") in the most recent trends (Hartog et al. 2004).

[1] To the extent to which this decline between 1993 and 1997 represents a steady decline or a sharp decline after 1996 is not clear. The CPUE time series for 1995 and 1996 is confounded by large numbers of reported non-retained small (<25kg) SBT as a result of an industry policy of releasing live all such fish on non-observed vessels in these years.

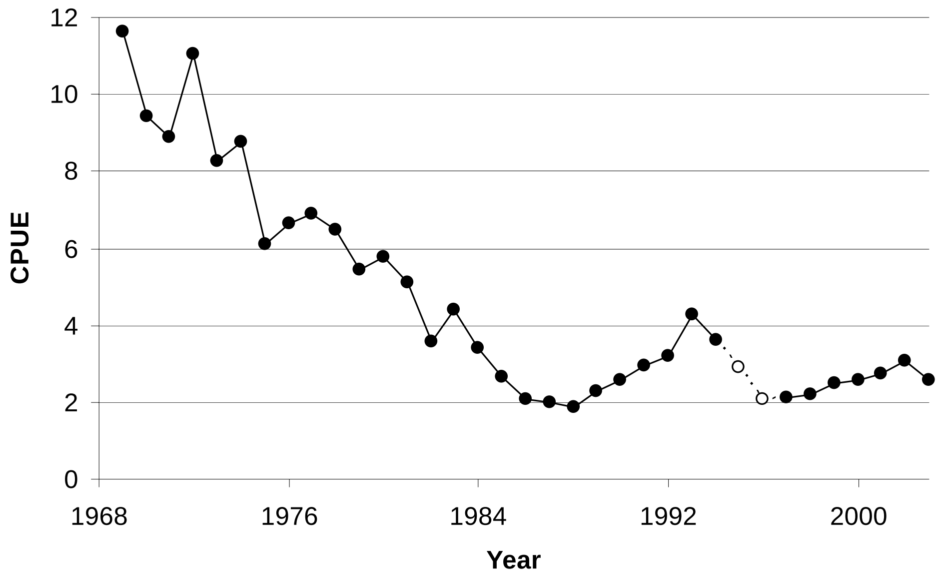

Figure 1: Trends in nominal SBT catch rates (numbers per 1000 hooks) for Japanese longliners operating in statistical areas 4-9 in months 4-9. The 1995 and 1996 values have been plotted as open circles to indicate increased uncertainty about these points due to changes in retention policies for small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

Fishing effort spatial distribution

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

Between 1987 and 2003, the number of 5 degree square/ month strata with any fishing effort has declined by almost 60% (Figure 2). Effort has also become increasingly temporally concentrated (Hartog et al. 2004). Interpretation of the significance of changes in the spatio-temporal patterns of Japanese longline fishing effort has become increasingly confounded by the effects of quotas and regulations on areas and time periods where fishing is permitted. The large and increasing reduction in the number of strata induces increasing uncertainties about the interpretation of CPUE as an index of abundance because of assumptions (either explicit or implicit) required about the density in strata without any effort. Moreover, between 1994 and 2003 there has been a large reduction both in the number of strata without any SBT catches and in the effort in those strata. In 1994, effort in such strata accounted for 37% of the total effort compared to less than 8% of the effort in 2003. The large effort in such strata in 1994 appears to represent effort targeted at catches of non-SBT tuna. The large subsequent reduction suggests increased targeting of effort in areas of high SBT densities and a substantial decrease in effort targeted at non-SBT tuna catches. Such changes in targeting would tend to induce positive biases into the most recent (post 1994) CPUE trends (Hartog et al. 2004).

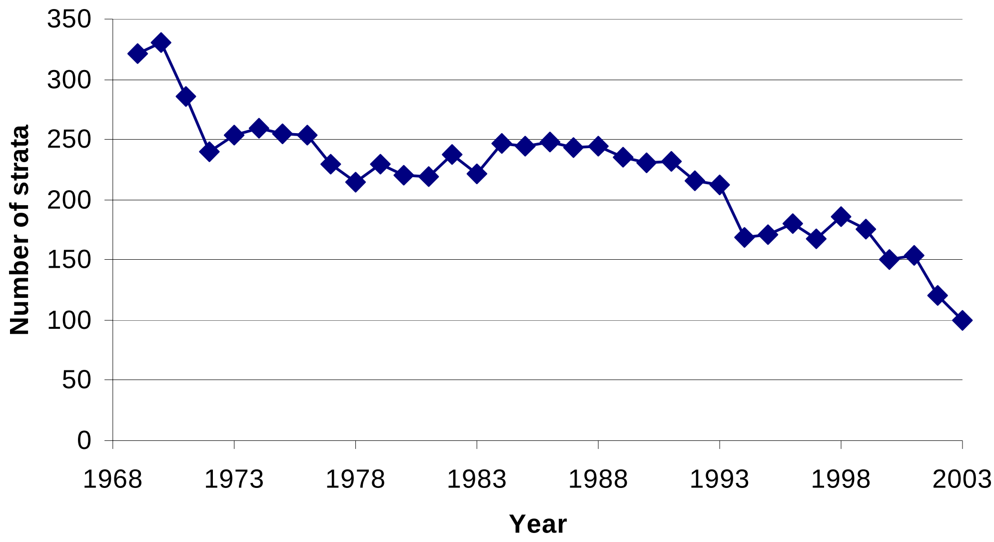

Figure 2: The total number of five-degree/month strata with fishing effort by Japanese longline vessels in statistical areas 4-9 and months 4-9.

Catch Levels

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

Catches in the Japanese longline fishery declined until 1990. Prior to 1990, the Japanese fleet did not catch their full quota. With the reductions in quota, 1990 was the first year that the Japanese quotas were met. Since then, the restrictive quotas suggest that catch levels for Japanese longliners and most other fleets do not provide a meaningful indicator of stock status. Official statistics indicate that Japanese (and Australian and New Zealand) catches have been restrained to close to the levels specified by the agreed CCSBT and previous Tri-lateral TAC and national allocations (with the exception of the additional experimental fishing catches by Japan in 1998 and 1999). It should be noted that with Korea and Taiwan having joined the CCSBT or the extended Commission in 2002 and 2003 (respectively), their catches are now also restricted.

During the 1990s, there were significant increases in SBT catches with estimates of total catches reaching their highest level in 1999 since the 1989 quota cuts (Figure 3). The estimated catches in 1999 were 19 500t, which represents a 40% increase over the 1990 level. Subsequently, catches have declined and the 2003 catches were essentially equal to those in 1990. The decreases in catches are largely the result of decreased catches by the Indonesian longline fishery (1950t decrease), by Japan as a result of cessation of experimental fishing (1800t decrease) and Korea (1200t decrease). The substantial decreases in both Indonesian and Korean catches is of potential concern as neither of the catch reductions were the result of direct management actions limiting either the catch or effort in these fisheries.

The large (86%) decrease in the Korean catches from its peak of 1572t in 1998 to 221t in 2003 has been a steady and progressive decline. This decline is consistent with the declines in SBT imports into Japan from Korea. Estimates of total effort for the Korean longline fleet are not available. Based on the trends in catch rates from vessels for which catch and effort data are available (see below), the large decline in catches would appear to stem from a reduction in both catch rates and effort.

The Indonesian Indian Ocean longline fishery takes place on the SBT spawning ground and SBT catches are largely a bycatch component within a multi-species fishery dominated by yellowfin and bigeye. SBT catches are seasonal (i.e. largely between October and April) reflecting the seasonality of SBT spawning. As such, SBT catch trends are most meaningfully considered in terms of annual spawning seasons (Figure 4). SBT catches in the Indonesian fishery generally increased from 1994 to a peak of nearly 2500t in 2002 reflecting general increasing effective effort and catches over this period. SBT catches declined dramatically in 2003 to 740t and again in 2004 to 430t[2]. The reasons for these large declines are not clear. Andamari et al. (2004) concluded that the declines are due to be a combination of a lower fishing effort due to weather restrictions and fleet dynamics, changes in method of raising sampled catch to total catch, shifts in environmental conditions delaying the arrival of spawners on the fishing ground in the 2003-2004 spawning season and a possible drop in CPUE. Additional possible factors may be changes in the size/age distribution of SBT on the spawning ground combined with different size/age specific catchabilities and/or changes in targeting[3].

Without any direct measure of effort, an examination of SBT catches relative to the target species (i.e. yellowfin and bigeye) appears to be the only available information that might provide some indication of whether the declines in SBT catch may reflect decreases in SBT on the spawning ground. Thus, if SBT were increasing on the spawning ground, their catches should constitute an increasing proportion of the overall catches unless the target species were also increasing at a faster rate (and vice versa with respect to a decline). In the Indian Ocean in general, bigeye catch rates for Japanese longliners have been declining over the last 15 years and were their lowest ever in 2002 while catch rates for yellowfin have varied without trend for over the last 20 years (Anon. 2003b). This would suggest that the proportion of SBT in the Indonesian catch would have been expected to have been increasing if SBT were not declining and if the general trends in the Indian Ocean bigeye catch rates were reflective of the catch rates around Indonesia. During the 2003 and 2004 spawning season, the percentage of SBT in the Indonesian catch relative to bigeye and yellowfin declined from its highest level ever in 2001 (Figure 5). The 2002 percentage was around the level observed through most of the mid-1990s, while the 2003 was the lowest level estimated except for the first year of sampling. While the lack of any direct measure of fishing effort and shifts in environmental conditions confounds any interpretation of the recent declines as an indicator for the SBT stock, the large decline in catch combined with lower or, at best, non-decreasing proportions of SBT in the last few years while bigeye catch rates in the Indian Ocean have steadily declined, raises concerns about the possible implications for the SBT stock.

[2] The 2004 figure is preliminary (see Andamari et al. 2004)

[3] Landing with higher percentages of bigeye tend to have smaller associated SBT catches and the SBT caught tend to be smaller on average (Davis and Farley 2001).

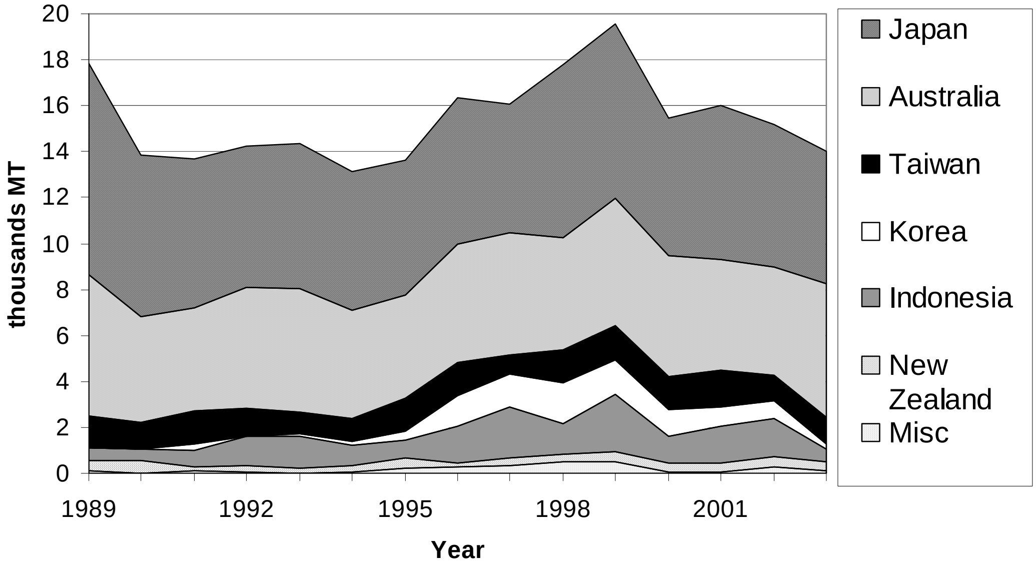

Figure 3: Estimated total catch of SBT by county since 1989 (from Hartog et al. 2004).

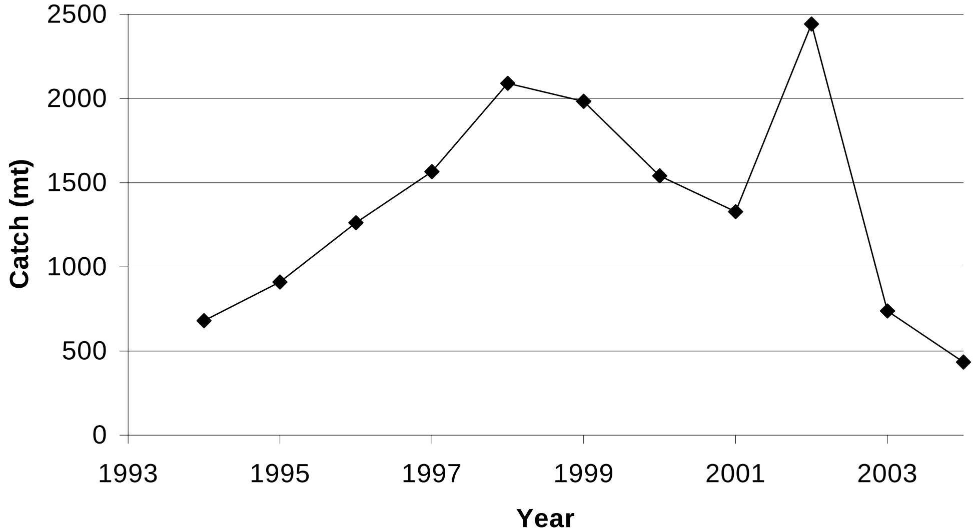

Figure 4: Estimated landings of tunas (tonnes round weight) at Benoa by spawning season. A spawning season is defined as July 1 of the previous year to June 30 of the given year. The catch estimates for 2004 are preliminary and do not include June data. (from Andamari et al. 2004).

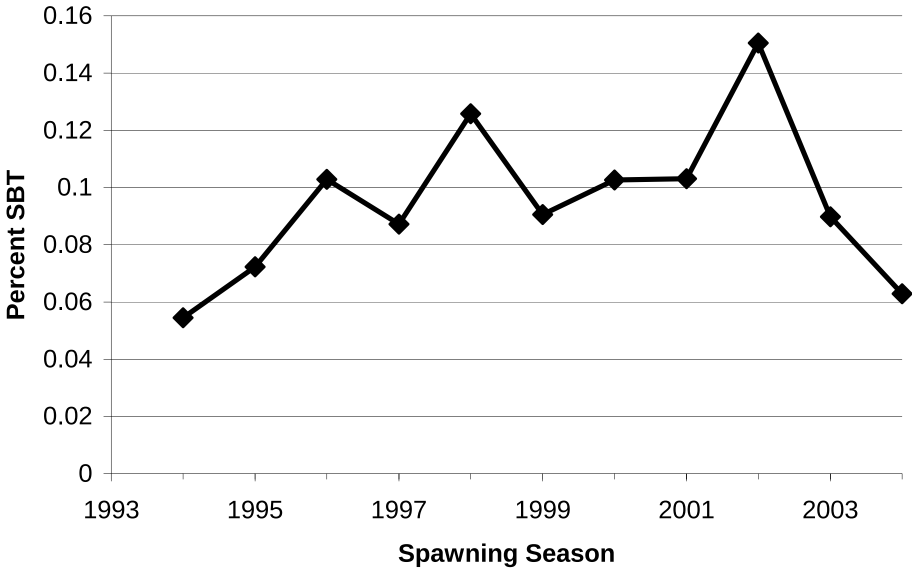

Figure 5: Estimated percent of the tuna (yellowfin, bigeye and SBT) catch that was SBT for the months October through April landed at Benoa by spawning season. The labeling for x-axis refers to the first half of the spawning season (e.g. 1993 stands for the 1993/1994 spawning season) (estimates supplied by Dr. T. Davis, CSIRO).

Abundance of 4-7 year olds in Japanese longline fishery

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

Juvenile and sub-adult catch rates (ages 4-7) remained stable, and low, between 1986 and 1988 (Figure 6). After that time, they increased steadily until 1993 by nearly a factor of four. However, between 1993 and 1996 they declined significantly again. Since then, catch rates of 4-7 year olds have remained stable with some evidence of a small increase in 2000. This increase can be attributed almost solely to a significant increase in the catch rates of these age classes in Area 8 (Polacheck and Ricard 2001). Interpretation of the catch rates for 4 year olds was confounded in late 1995 and 1996 by changes in non-retention practices on the high seas[4]. After 1996, non-retention practices were reported to have reverted back to those in existence prior to 1995. As such, the continued lower rates since then cannot simply be disregarded. Nevertheless, catch rates for ages 5-7 may be a more meaningful indicator and the trend in these age classes generally parallels that for 4-7 year olds. However, the rate of increase in catch rates was not as high up to 1993, nor was the subsequent decline. The 2000 nominal catch rate for 5-7 year olds was higher than in 1986. Between 1999 and 2001 catch rates of 4-7 years old increased. They then declined in 2003 and overall suggest no real trend over the last three years.

[4] In these two years, Japanese industry adopted an active policy of not retaining fish less then 25 kgs that were not dead.

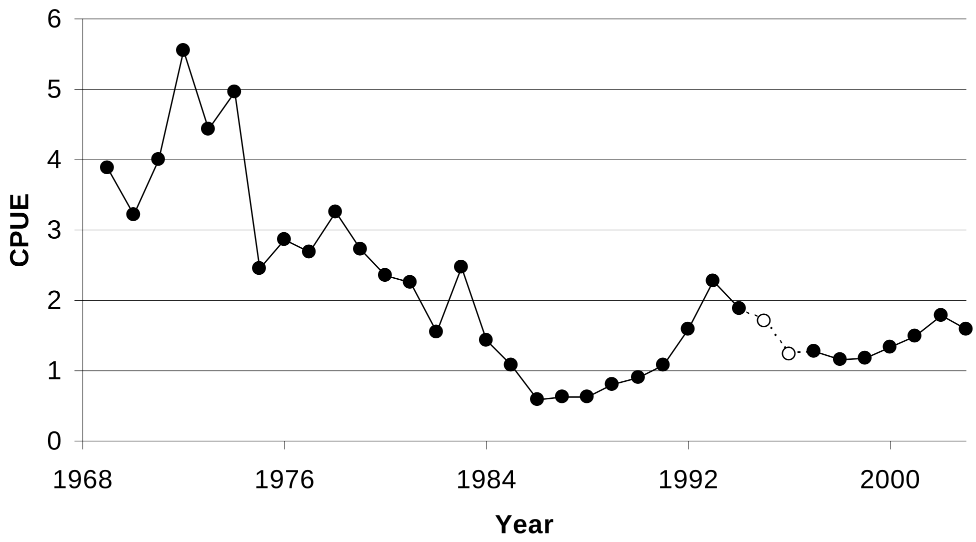

Figure 6: Trends in nominal SBT catch rates of ages 4-7 (numbers per 1000 hooks) for Japanese longliners operating in statistical areas 4-9 in months 4-9. The 1995 and 1996 values have been plotted as open circles to indicate increased uncertainty about these points due changes in retention policies for small fish in these two years.

Abundance of 8-11 year olds in Japanese longline fishery

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

In 1988 this indicator was based on 8-10 year olds. However, because of changes in estimation of age at length, it is more appropriate to redefine this indicator in terms of 8-11 year old fish.

After 1986, catch rate for 8-11 year olds in the Japanese longline fishery continued to decline by another 70% until 1992 (Figure 7). The catch rates then generally increased until ~1999 and have been relatively constant since then. However, they reached a recent high in 2002 and were nearly equal to that observed in 1986. Catch rates declined again in 2003 by about 14%. Considering annual variability, catch rates for 8-11 years olds have been essentially constant and show no real trend since 1999.

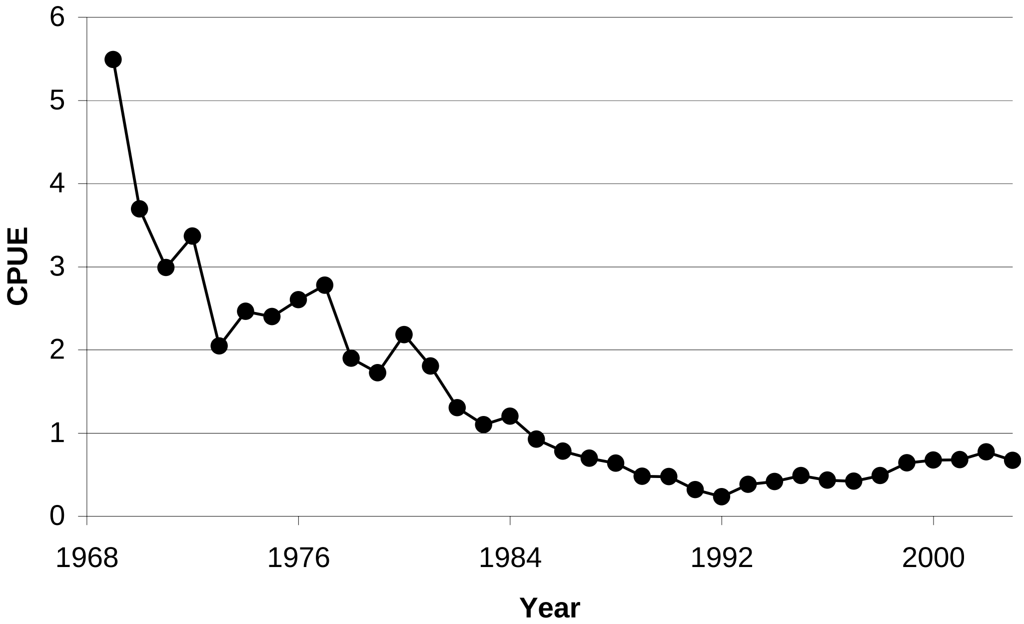

Figure 7: Trends in nominal SBT catch rates for ages 8-11 (numbers per 1000 hooks) for Japanese longliners operating in statistical areas 4-9 in months 4-9.

Catch Rates off New Zealand

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

Figure 8 provides the catch rates for chartered Japanese longline vessels fishing in New Zealand waters from 1989 through 2003. Two series are provided, one for vessels fishing south of 35 degrees south, and the other for vessels fishing north of this. For vessels fishing in the south, there is a large amount of temporal variability but with an apparent increase between 1993 and 1994 followed by a 9-year period with no clear trend. Catch rates in the north have also been variable with no clear longer term trend. However, there were marked decreases in the catch rates in both areas in 2003, and the 2003 rate was the lowest level in the time series for the north.

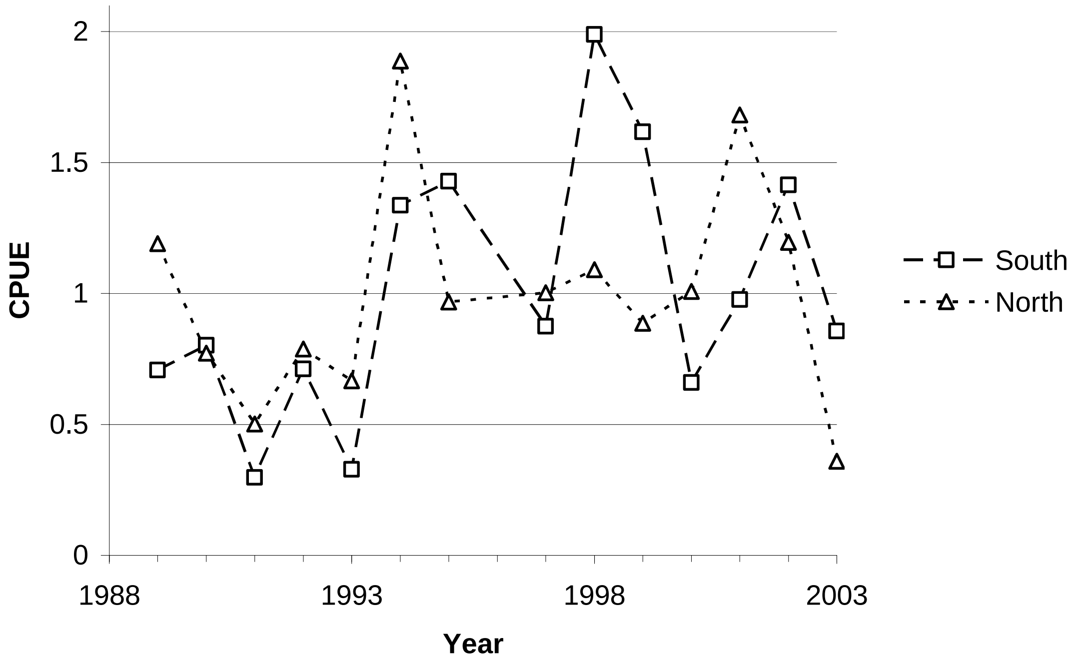

Figure 8: Nominal catch rates (numbers per 1000 hooks) for chartered Japanese longline vessels fishing in New Zealand waters. The time series labeled "South" is for effort south of 35 degrees south and the one labeled "North" is for effort north of this.

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

Figure 9 provides estimates of the proportion of the SBT less than 110cm and 120cm in the catches of chartered Japanese longline vessels fishing in New Zealand waters. The was a marked increase in the proportion of small fish beginning in 1989. This is consistent with the increased escapement of juvenile fish from the surface fishery at this time as the result of the large quota reductions. After 1991, their frequency declined until 1997, at which point it appears to have increased again and remained reasonably stable until 2002. Between 2002 and 2003, the proportion of small fish declined dramatically to near zero and to a level below that of 1988.

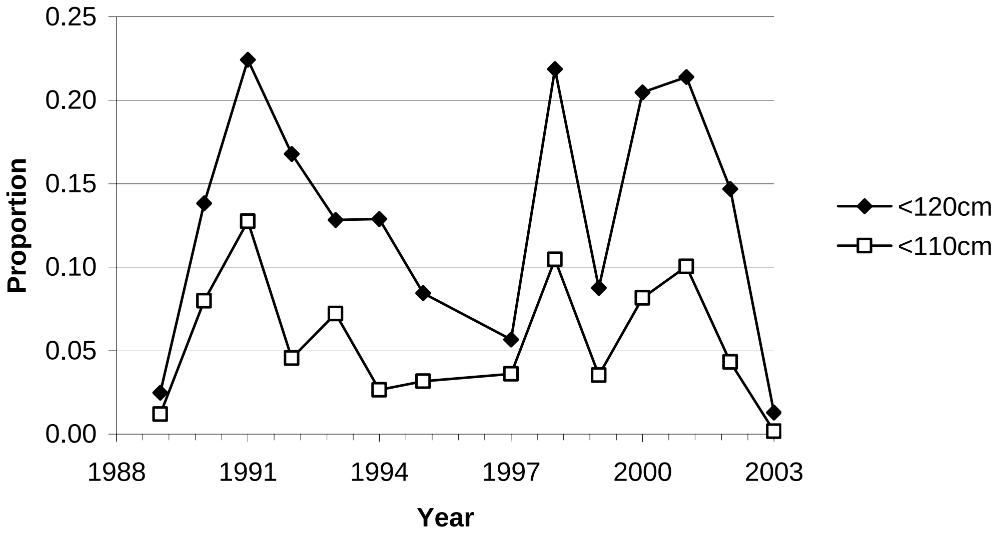

Figure 9: Estimates of the proportion of SBT less then 110 and 120cm caught by chartered Japanese longline vessel fishing in New Zealand waters. The estimates provide here are based on those use in the SBT stock assessment and were derived from the conversion of weight frequencies to length frequencies.

Trends in New Zealand Handline/Troll Fishery

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

These fisheries declined substantially through the 1990s with low levels of effort in almost all years in since 1995. Domestic longlining has replaced handline/trolling as the dominant gear within the New Zealand domestic fishery. As such, catch rates in the domestic New Zealand longline fishery provide a better basis for updating this indicator. Effort prior to 1994 was low (less than 160 sets). This combined with the developmental nature of the fishery suggests that catch rates from these early years are unlikely to be comparable with those observed subsequently. There is no strong trend in the catch rates since 1994 but large positive and negative fluctuations occurred in 1995 and 1997 respectively (Figure 10). Between 1999 and 2003 catch rates consistently declined but given the fluctuations observed previously, it is not clear the extent, if any, that this should be taken as representing a declining trend without additional years of data.

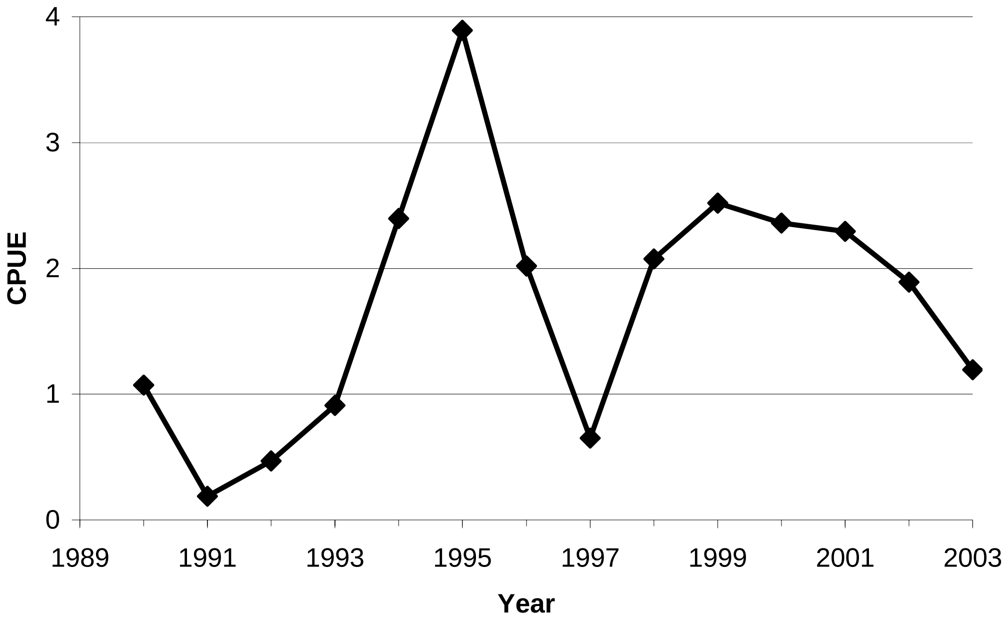

Figure 10: Nominal catch rates of SBT (numbers per 1000 hooks) caught by domestic New Zealand longline vessels.

Surface Schools of Juvenile SBT off the NSW coast

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

Regular surface aggregations of small (5-10kg) juvenile SBT of New South Wales during the 3rd and 4th quarters provided the incentive in the 1950s for development of the Australian SBT surface fishery. They were a major component of the catch until the early 1980s, when they failed to appear.

Small SBT did not re-appear on the NSW coast until the mid-1990's when sporadic surface sightings and low level troll catches raised speculation that return to historic patterns might be in train. Occasional sightings have been reported since then. However, there is no evidence to suggest any substantial abundance of juvenile off the NSW coast or a return to pre-1980's juvenile distributional patterns or levels of abundance off NSW. This is despite a complete cessation of fishing on these size classes in Western Australia (WA), and targeting of larger size classes in South Australia (SA).

Area of Occurrence of SBT Juveniles in Australian Waters

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

Following the closure of the commercial fishery off WA in the mid-1980's, little data on the distribution of juvenile (0-2 year old) SBT has been collected with which to base a comparison with the 1988 indicators. Observations during CSIRO tagging program cruises in WA between 1990-95 suggested that the high concentrations of 1-2 year old SBT that were common in inshore waters off Albany during the 1960's no longer occur. These cruises were conducted on industry vessels run by operators experienced in the situation in the early

1980’s. Similarly, the concentrations of 1-2 year old fish along the canyons between Albany and Esperance remain a thing of the past. During the tagging program fish were found only at Bremmer Canyon. Tagging operations in the summers of 2000/2001, 2001/2002, 2002/2003 and 2003/2004 reported low abundances of 1-2 year olds in the Albany area.

The abundance of juvenile SBT off eastern Tasmania declined after a minor peak in the early 1990’s, until in 2001 very high catches of 2-5 year old SBT were reported by recreational fishers. Anecdotal accounts suggest that 2001 was the “best year in over 30 years” in this area. The high abundance of a number of year classes appears to be related to unusually large and persistent aggregations of baitfish in inshore waters at the time when SBT are making their annual migrations up the Australian east coast. These resulted in SBT remaining resident off the southern east coast, rather than quickly migrating through the area as is usually the case. Recreational catches were again low off Tasmania in 2002, 2003 and 2004.

From these disparate sources, it appears that the spatial extent of 1-2 year old SBT in Australian waters has not expanded significantly over the last few years, and that the contractions noted in 1988 have persisted. The occasional exception to this, and a somewhat positive sign have been some infrequent small catches of 1-2 year old SBT in NSW. Occasional high abundance of small SBT off Victoria and Tasmania appear to be environment related and do not appear to reflect a return to past distributional patterns.

Juvenile Exploitation rates

Indicator # 11: High exploitation rate (40%) in the Australian fishery.

RMP Conventional Tagging

The exploitation rates for the Australian surface fishery used in the 1988 indicators paper were based on a tagging program conducted in the mid 1980’s for which return rates were in the order of 40%. In the 1980’s program there were very few returns from the Japanese longline fishery, in part because at the time it was predominantly catching older fish but tag recovery activities for this fishery were also very limited and reporting rates are thought to have been low.

A large tagging program, conducted between 1990-97 as part of the CSIRO-NIRFSF collaborative Recruitment Program (RMP), provides a basis for comparison with the 1980’s data. It should be noted, however, that between the 1980’s and present there have been major changes in the Australian surface fishery (reduced from 10000-15000t in the mid 1980’s to less than 2000t in 1992 and 1993 and subsequently increasing to approximately 5000t in the late 1990’s). In addition, there have been changes in the Japanese longline fishery (in which the take of 4-8 year old fish as a proportion of the total fishery increased significantly during the 1990’s) and in the global high seas fishery for SBT (in which Taiwan, Korea and Indonesia now take almost 30% of the global catch, with the Taiwanese fleet in particular catching predominantly 2-6 years olds).

In the 1990’s, tags were released every year between 1990 and 1997 and the recovery rates for annual releases range from 9-25% (Figure 11). There is a trend of increasing return rates over this period (even after short term recoveries are discounted), but the peak return rate for the 1996-97 releases are still below the very high levels seen in the 1980’s.

Of the tag returns from releases in the 1990's, more than 80% have come from the Australian fishery (Figure 12) and there is evidence of substantial non-reporting of tags in the main longline fisheries. It is clear that the recovery rates within the Australian surface fishery in the early 1990's were much lower than those recorded during the 1980's. However, the trend in the last few years of the tagging program was towards substantially higher return rates. This combined with substantial non-reporting from longline fleets raise concerns that the overall exploitation rates on these tagged cohorts may have been quite high post 1995 – possibly approaching the levels in early 1980's.

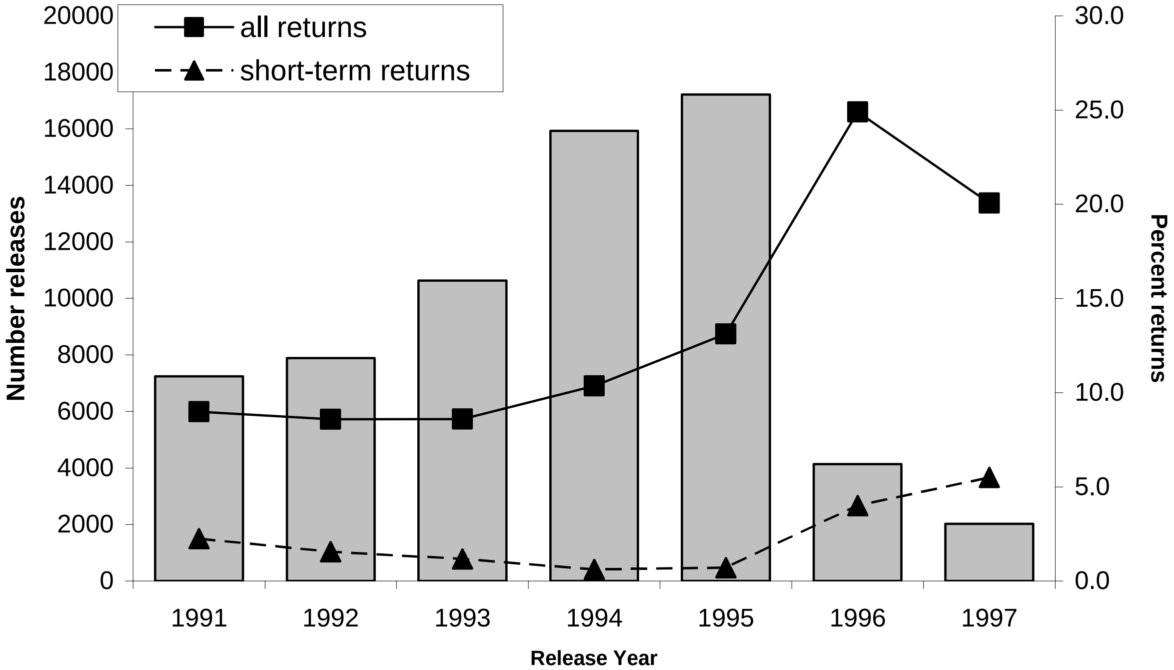

Figure 11: Number of releases and return rates for conventional tags released in South Australia and Western Australia between 1991 and 1997. Note short term refers to tags at liberty for less than 180 days and release year is defined as November 1 to October 31.

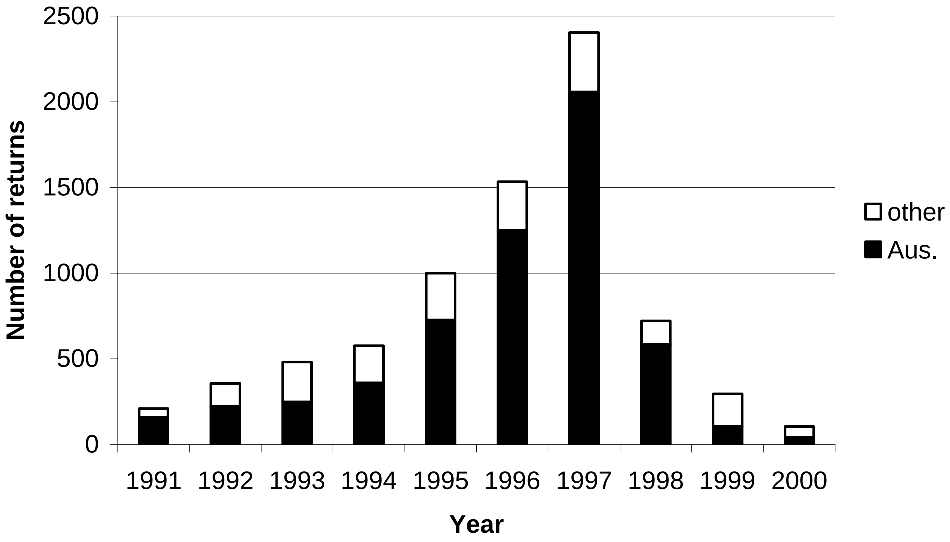

Figure 12: Number of tags returned by nationality of the vessel which recaptured the tagged fish.

SRP Conventional Tagging

The CCSBT commenced a conventional tagging program in 2001 as part of its Scientific Research Program. The objective of the program is to obtain estimates of mortality rates for SBT. The basic program is modelled after the 1990 tagging experiments with releases aimed to tag multiple cohorts of 1, 2 and 3 year olds in multiple years. Tagging is being done in both WA and SA, as in the 1990s. Table 1 summarizes the releases and returns to date. However, the times at liberty for most of the releases are too short to provide meaningful results at this point. In addition, the return data for 2004 is still incomplete and substantially more tags returns are likely from fish from the tuna farms in South Australia. Nevertheless, returns of 6.3% and 8.8% have been obtained for two of the release years from South Australia (although in the latter case a 5.4% of those were recovered within a year of their release). Given the age of tagging and the ages being harvested in the surface fishery, the 2003/2004 season would be the first fishing season where substantial returns might be expected, particularly for releases from West Australia. Only 4% of the returns have been from commercial longline vessels suggesting that reporting rates may be quite low from these fleets. In addition, preliminary estimates of reporting rates for 2002/2003 from farms suggested reporting rates of ~65%. (Polacheck and Stanley 2004). Given the short times at liberty for most of the releases and questions about the reporting rates, it is too soon to attempt meaningful comparisons with the 1990's tag return data.

Table 1: Summary of releases and returns from the SRP tagging program.

Release year	*South Australia* Releases	Returns	% returned	% 1st year	*West Australia* Releases	Returns	% returned	% 1st year
2001/2002	464	29	6.3	0.0	2855	70	2.5	0.1
2002/2003	6412	566	8.8	5.4	6684	129	1.9	0.3
2003/2004	5009	54	1.1	1.1	2848	4	0.1	0.1

Archival Tag returns

Archival tagging commenced in 1993 and provides an alternative from which exploitation rates can be estimated. Archival tags are highly valued by Australian fishermen and non-reporting is thought to be low within the Australian surface and longline fisheries. However, similar to conventional tags, reporting rates for archival tags in the Japanese and other high seas fisheries appear to be low (see below). Table 2 summarizes the releases and return rates to date. Overall, the majority of releases were 3 year olds, the main exception being the tagging of some smaller fish off WA in 2003 and 2004.

From these data it is clear that the return/exploitation rates on the cohorts tagged since 1995 were very high, and significantly higher than those released in 1993 and 1994. The overall recovery rate for releases between 1995 and 2001 has been 29%. Only 17 out of the 125 archival tag recoveries occurred during the first year of release. This indicates that the high return rates are not the result of tagging in the areas of fishing. The return rate of over 10% for 2002 releases after less than two years at liberty are similar to those seen at the same period at liberty for other releases. This suggests return rates well above 20% are also likely for these releases over the next couple of years. The lack of returns from the 2003 and 2004 releases is to be expected given the short times at liberty and that much of the tagging was done on small fish off WA.

About 74% of the archival tag returns have come from the Australian surface fishery (which is similar to the conventional tags). Thus, the archival data suggest very high exploitation of the 1992 and 1995 cohorts within the Australian fishery. These cohorts were also fished heavily by the Japanese (and presumably also the Taiwanese) high seas fisheries, so it is surprising that return rates are not higher. The low numbers of returns from these fisheries can be explained either by under-reporting, or incomplete mixing within the fishery. We have no objective measure of under-reporting for archival tags, but estimates of conventional tag return rates during the 1990's based on observer data suggest that reporting rates were low. Moreover, the data collected by these archival tags (and also from conventional tag returns) suggest that mixing into high seas fishing grounds in the Indian Ocean, and the Tasman Sea is rapid and common to all fish. On this basis alone we would expect higher numbers of recaptures in these fishing grounds

If insufficient mixing is not the main factor for the low returns from longline vessels, it seems probable that exploitation rates on the cohorts tagged are in reality substantially higher than the ~30% recorded to date for releases after 1994.

Table 2: Number of archival tag releases and summary of returns by release year.

Year	Number release	Number recaptured	First year Recaptures	Percent Recaptured	Percent Excluding 1st year
1993	28	3	0	10.7	10.7
1994	148	18	3	12.2	10.1
1995	142	46	4	32.4	29.6
1998	112	32	9	28.6	20.5
1999	61	11	1	18.0	16.4
2000	27	9	0	33.3	33.3
2001	5	3	0	60.0	60.0
2002	24	3	0	12.5	12.5
2003	29	0	0	0.0	0.0
2004	45	0	0	0.0	0.0
total	621	125	17	20.1	17.4

Large fish in the Australian Fishery

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

Because of changes in fishing practices associated with the shift to farming and pole and lining for the fresh chill market combined with contraction in the areas of operation, the proportion of large fish in the South Australia surface fisheries no longer provides a meaningful comparison with the indicator in the 1980’s.

Additional Indicators from the 1990’s

Percentage of small fish in pelagic longline catches

Smaller SBT are generally not targeted by longline fleets targeting SBT. However they have almost always constituted a substantial fraction of the catch (Figure 10) and in the early 1990’s there are indications that targeting on juveniles occurred at least by some vessels in response to implementation of restrictive quotas and the increased escapement of juvenile SBT from the surface fisheries.

In the Japanese longline fisheries, the percentage of the catch that was less than or equal to 2, 3 or 4 years of age respectively was reasonably constant until the mid 1980’s and then began to increase rapidly until around 1992, when over 45% of the catch was comprised of juvenile fish (ages 0-4). Over the period of 1994-1996, the proportion of juveniles dropped sharply to 15% because of an industry policy of not retaining fish less than 25kg in 1995 and 1996. After the cessation of this policy, the proportion of juveniles in the catch increased again, but began declining sequentially for ages less than or equal to 2 after 1998, for ages less than or equal to 3 after 1999, and for ages less than or equal to 4 after 2000. In 2003, the proportion of the catch less than or equal to age 2 or 3 was the lowest ever recorded while the proportion less than age 4 was about equal to the historic low in 1969. Catch rates for 2, 3 and 4 year olds have also followed similar trends, with the catch rates of 2 year olds and younger having declined steadily since 1997, and the catch rates of 3 and 4 year olds declining sharply in 2003 (Figure 11). The catch rate for 3 year olds was near zero in 2003.

The proportion of small fish has also declined to low levels in the Korean catches (Figure 15). Thus, the percentage of the catch less than 120cm has been declining since 1999 and was less than 5% of the total catch in 2002. (No data were available for 2003.) There was virtually no catches of SBT less than100 cm in the Korean catches in 2002.

The percentage of small fish has also been declining in the Taiwanese longline fishery after 2000, although there are only 4 years of data in this time series (Figure 16). This fishery (longline fishery 2) operates generally to the north of the more targeted SBT longline fisheries and juveniles generally constitute a high proportion of the overall catch[5].

The declining and sharp reduction in the presence of small fish in the three principle high seas longline fleets is certainly a concern as it would be consistent with marked declines in recruitment since around 1999/2000. The declines are not fully consistent between fleets in timing or magnitude. However, this would not necessarily be expected given the different areas, timing and modes of operations among the fleets. Alternatively, the marked declines in all fleets could represent major, unreported changes in retention practices. With the changes in the sashimi market (e.g. large increases in farmed bluefin from the Mediterranean), the value of small fish has declined. Australian industry has suggested that the current values are so low that small fish simply are now no longer worth landing and a much larger proportion of small fish may now be discarded.

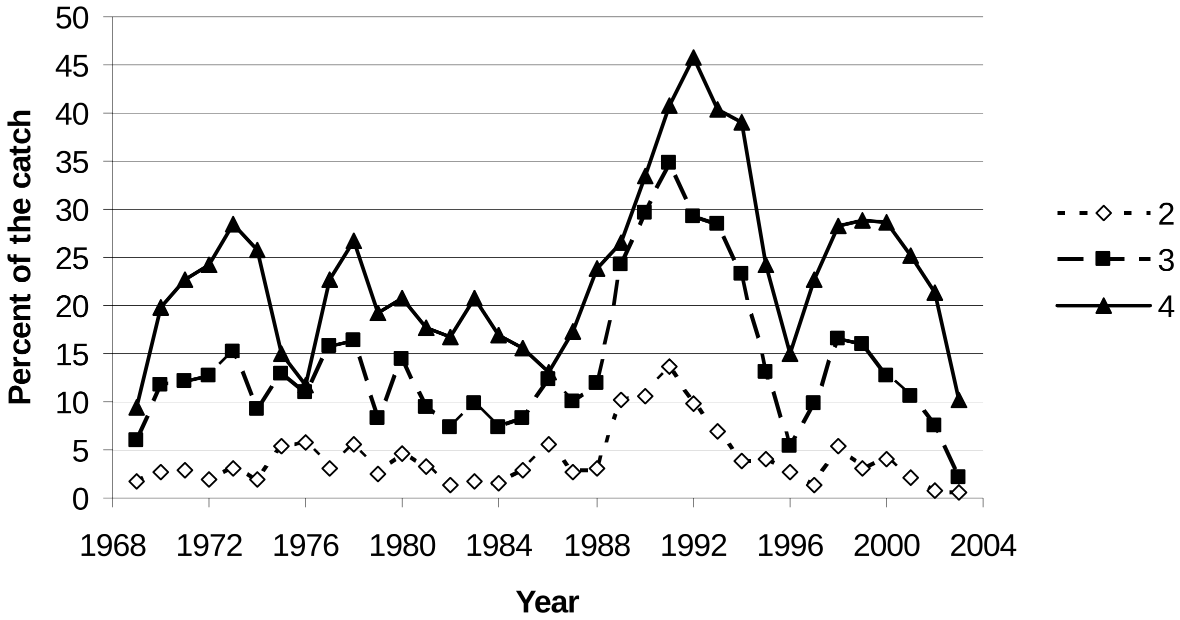

Figure 13: The percent of the SBT catch by Japanese longliners in areas 4-9 and months 4-9 which was less than 2, 3 and 4 years of age respectively.

[5] Attempts to extend this time series backwards with the earlier time series of weight frequency data for 1997-2000 from sampling of log books from Mauritius suggests that the two series are not fully compatible (Table 3). Data within log books sampled in Mauritius were recorded only by weight category (i.e. <15kg. 15-25kg and >25kg). Without detailed information on the measurement techniques (e.g. adjustments for freezer loss in the case of weights, where lengths were over-body, mouth open, etc) it is not possible to know whether in fact the two series are inconsistent.

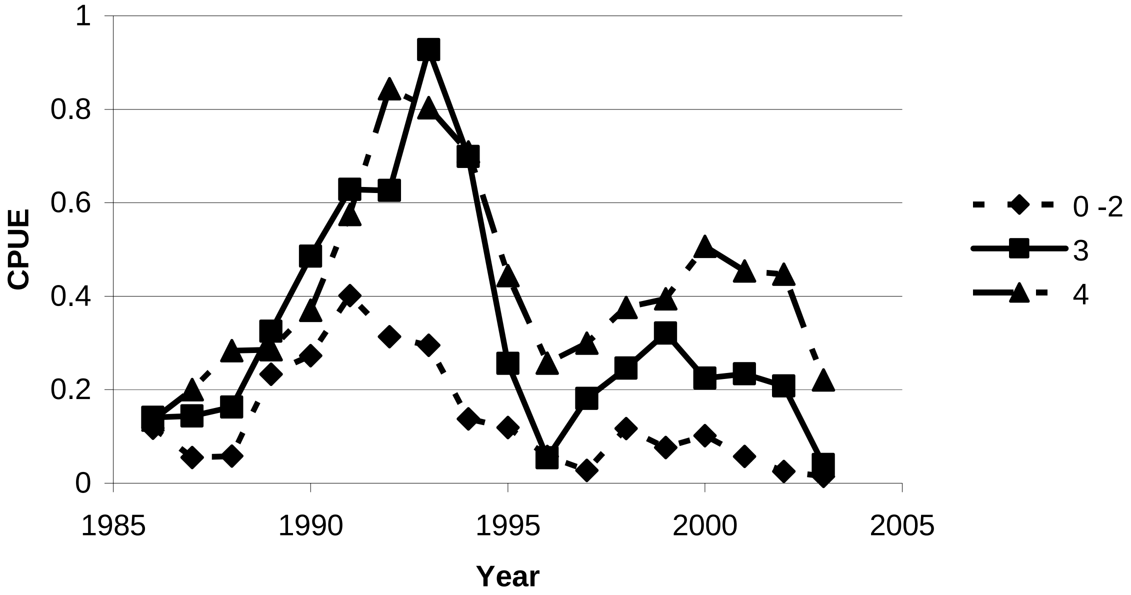

Figure 14: Nominal catch rates (number per 1000 hooks) of juvenile SBT by Japanese longliners in areas 4-9 in the second and third quarters. Shown are the catch rates for ages 0-2 pooled, age 3 and age 4.

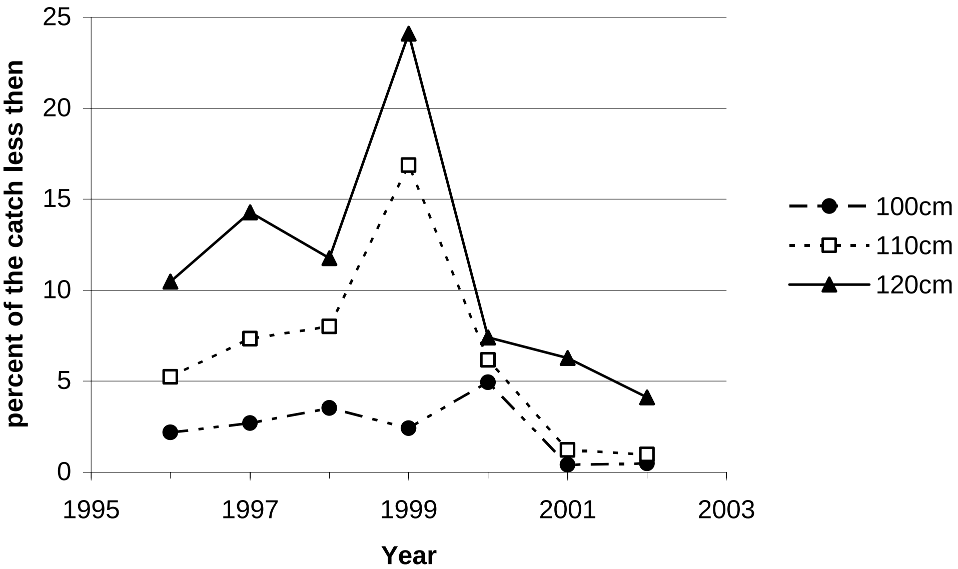

Figure 15: The percentage of the catch reported to be less than 100cm, 110cm and 120cm in the Korean longline catches.

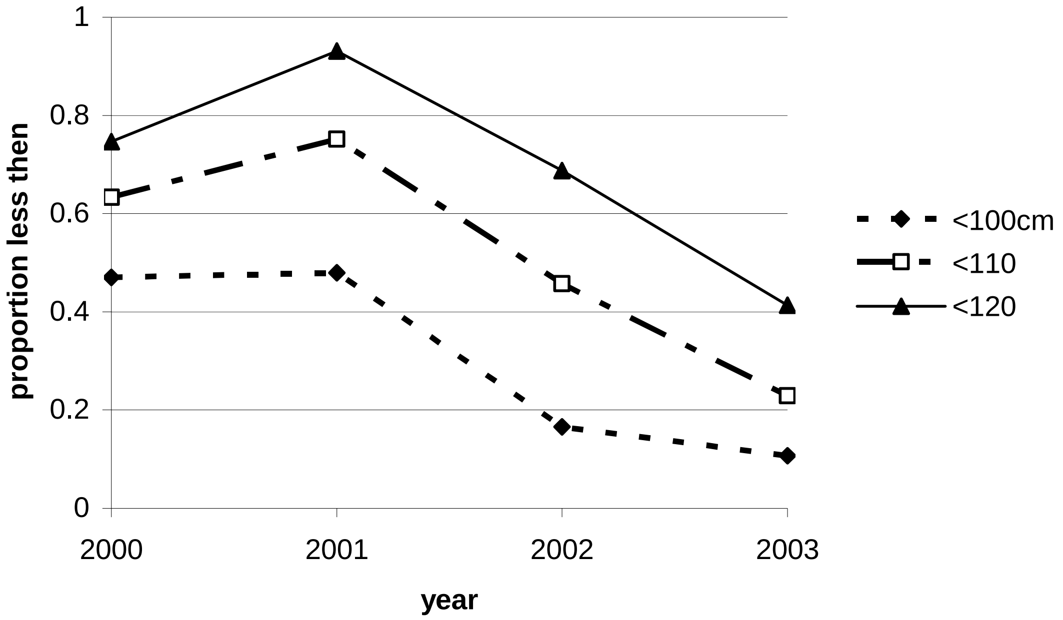

Figure 16: Proportion of fish less than 100cm (diamonds), 110cm (squares) and 120cm (triangles) in Taiwanese longline catch in longline fishery 2 (i.e. the winter, more northern fishery in the Indian Ocean) reported by Taiwan.

Table 3: The precent of the catch less than 15kg and 25kg in Taiwanese catches based on log book sampling in Mauritius compared with the percent less than 10cm and 115cm 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.

	Log book Sampling – Mauritius				Taiwan Report	
	Summer Fishery		Winter Fisher7		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

Percentage of small fish in New Zealand Domestic catches

Figure 17 provides estimates of the proportion of the SBT catch less than 110cm and 120cm caught by domestic vessels from New Zealand. The data for the early years 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. Also, 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 fished in the Japanese longline catches and the increased escapement from the surface fisheries as a results of the large quota reductions. The proportion of small fish remain relatively constant though 2002 with perhaps some decrease. In 2003 the proportion of small fish declined dramatically to levels around those seen in the 1980’s.

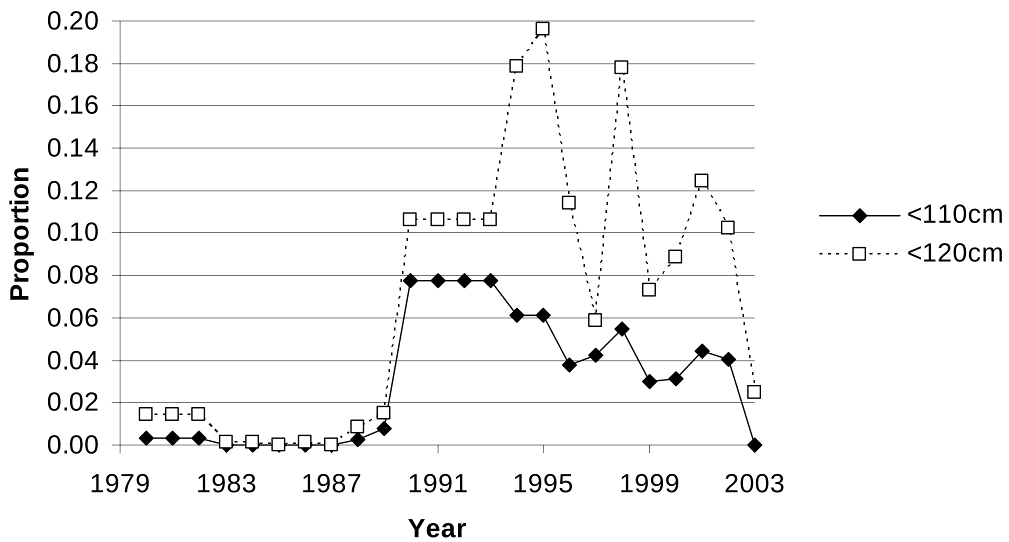

Figure 17: The proportion of fish estimated to be less than 110cm and 120cm in the New Zealand domestic SBT catches.

Catch Rates trends for ages 12 plus

Catch rates of the older fish (i.e. age 12 plus) by the Japanese longline fleet have tended to be inconsistent with trends for younger ages in that they were relatively stable during the 1970's and 1980's. The reason for this is not clear and may relate to changing selectivity/targeting patterns and/or possibly aging errors particularly for cohorts spawned prior to the early 1960's for which there is no information on growth rates (Polacheck et al. 2003). However, catch rates for age 12 plus fish declined between 1994 and 1998 by over 50% (Figure 18). There was a small increase in 1999 and since then the catch rates have fluctuated without a consistent trend.

Figure 18: 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.

Korean longline CPUE Trends

SBT catch rates reported by Korea for its longline fleet have been declining since 1994 (Figure 19). Coverage based on comparing catch reported from log books to total catch has been quite variable and the amount of data for the first prior to 1996 is quite limited (Figure 20). Most of the decline in catch rates occurred between 1994 and 1998 (70% overall). Between 1998 and 2002 catch rates were relatively constant, although the 2002 rate was 14% below the 1998 rate. In 2003, the catch rate declined a further 60% to the lowest ever reported by Korea. However, coverage and thus reported effort also declined to near zero (Figure 15) so it is not clear how representative the 2003 figure may be.

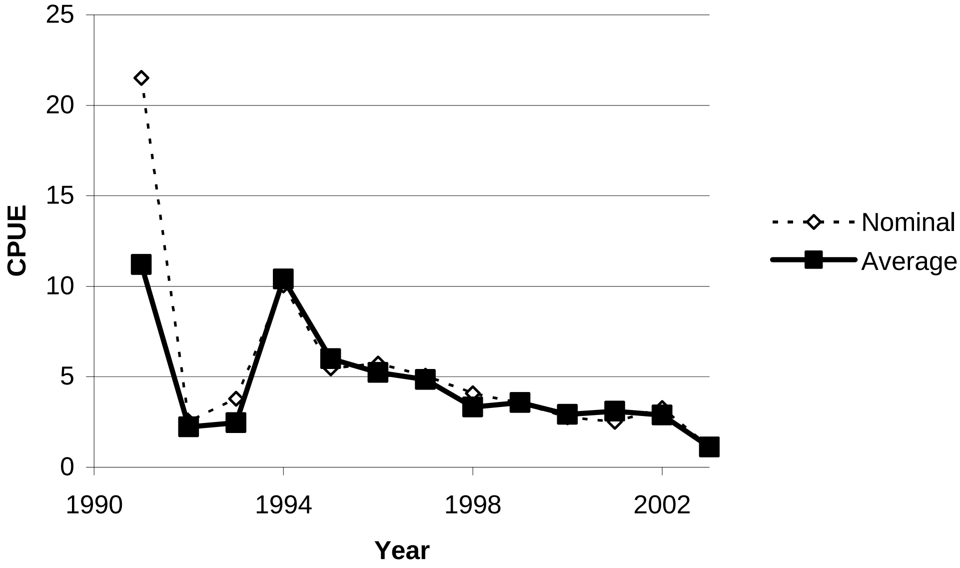

Figure 19: Trends in Korean longline catch rates (number per 1000 hooks) within statistical areas 4-9 during months 4-9. “Nominal” is the total hooks over total effort and “average” is the mean of the nominal rate in each 5x5 square/month strata.

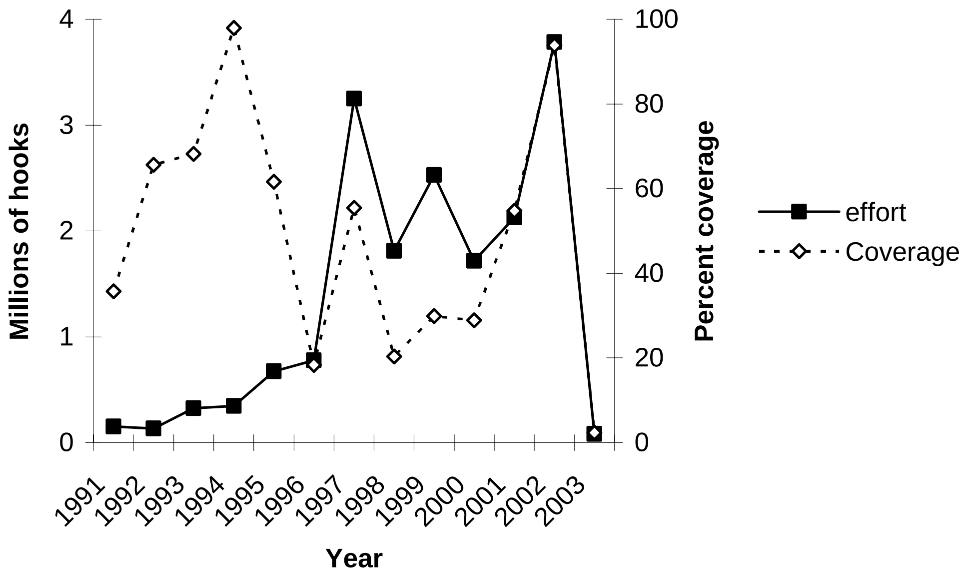

Figure 20: Total effort (millions of hooks) for which catch and effort data are available for Korean longliners fishing in areas 4-9 and months 4-9. Coverage is the percent of the total reported catch by Korea for which catch and effort data were provided.

Taiwanese longline CPUE Trends

Figure 21 provides nominal catch trends SBT for Taiwanese longliners for 1981 to 2002[6]. Catch rates were near zero in the early 1980’s and increased in the late 1980’s and early

1990's. Catch rates since then have been variable (particularly in the first half of the 1990's) and have varied since 1996 without any clear trend. Note that the zero catch rate for statistical areas 8 and 9 for 2002 is based on very little effort data (e.g. 50 000 hooks or ~16 sets).

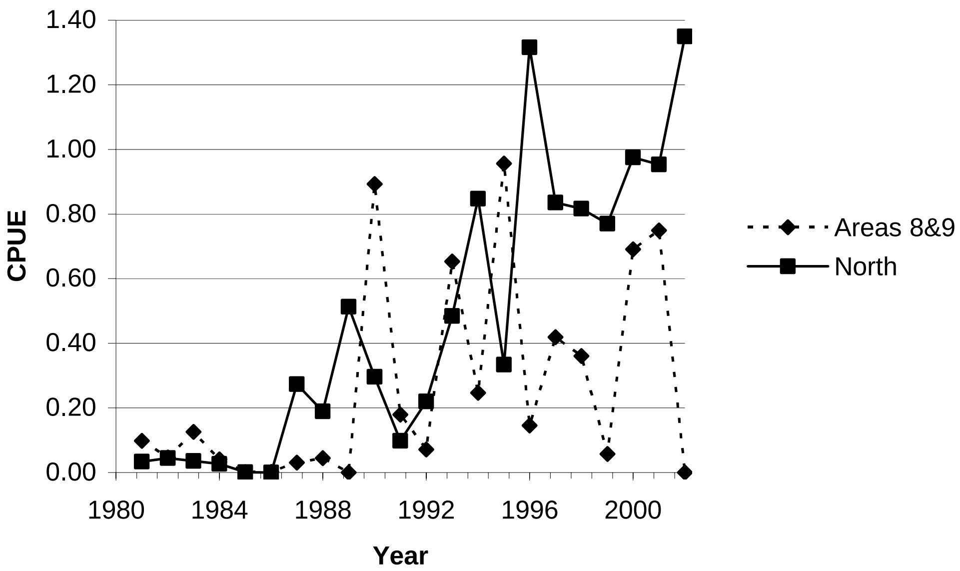

Figure 21: Estimate of nominal catch rates for SBT (number per thousand hooks) by Taiwanese longliners. Catch rates have been calculated for statistical Areas 8 and 9 and for the latitudinal strip between 25 and 35 degrees south in the Indian Ocean where small SBT are frequently caught by Taiwanese longliners as part of their targeted albacore fishery (labelled "north" in the legend)[6]. Both time series were calculated using data only from months 4 to 9.

Juvenile Abundance estimates from tagging

Polacheck et al. (2004) present estimates of abundance for ages 2, 3 and 4 year SBT based on the number of tags recovered in the GAB for releases in the 1990's relative to the number of fish caught (i.e. a "Peterson" type estimator). This is an alternative approach for analysing these tagging data that does not depend upon reporting rates in the longline fishery and in which the information content stems from the proportion of tags in the catch in contrast to rates of return. If tags are fully mixed, this approach provides estimates of the total numbers for each cohort at a given age. If mixing is incomplete, they can provide relative measures of cohort strength as long as mixing and exploitation patterns are reasonably consistent (see Polacheck et al. 2004 for details). One advantage of these estimates is that they can provide an indicator of trends in juvenile abundances over the period of the tagging experiments independent of any assumptions about tag returns and catches in the longline fishery. The estimated trends in abundance from this approach provide no indication of an increase (and possibly indicate a decrease) in the strength for cohorts at age 1 from the first half of the 1990's, and suggest a declining trend by age 2 and 3 in abundance for the surviving members from these cohorts (Figure 22).

[6] Preliminary data for 2003 supplied by Taiwan have not been included in the above figure. This is because the 2002 preliminary data supplied in 2003 were highly inconsistent with the updated data provided in 2004. Also, the preliminary data provided for 2003 in May 2004 does not provide a similar trend at that provided in Taiwan's CCSBT fishery report (Anon. 2004).

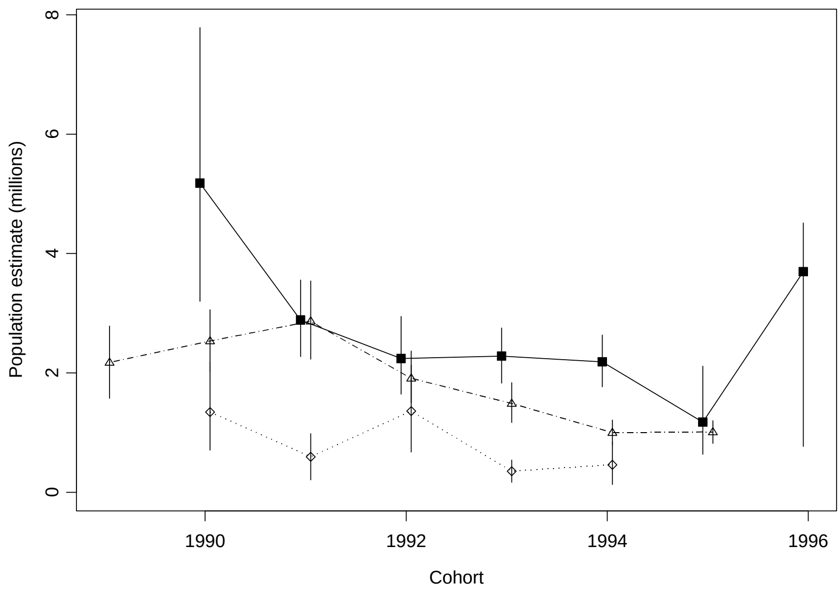

Figure 22: Comparison of Peterson estimates for the number of 1-, 2- and 3-year-old SBT based on age 1 releases (solid squares), age 2 releases (triangles) and age 3 releases (diamonds), respectively, from Western Australia and the Great Australian Bight combined. Note there were no age 3 releases in Western Australia. The estimates shown are based on the pooled returns and catches for each age of release. Error bars are estimated 90% confidence intervals (Polacheck et al. 2004).

Spawning stock size and age distribution

Size monitoring and direct age estimation of SBT caught on the spawning grounds in the Indonesian longline fishery began in 1993. All fish caught are mature, ranging in size from 143cm to 221cm. Initially, very few fish less than 12 years old have been caught and at least 50% of SBT caught in the Indonesian spawning ground fishery were older than 20 years (Farley and Davis 2004). However, there has been a progressive increase in the proportion of younger spawners (e.g. 10-20 years old) being caught (Figure 23). The mode of the age distribution has shifted from age 20 in the 1994/1995 spawning season to age 12 in the 2001/2002 and 2002/2003 spawning seasons. The overall mean age of fish caught remained relatively constant at around 20 between the 1994/1995 and 1999/2000 spawning seasons and then declined to 14.5 by 2002/2003 (Figure 24). Interpretation of the decrease in mean age is confounded somewhat by the interaction between fish size, month and depth fished. Nevertheless, the progressive, increase in the proportion of young SBT is a strong indication that cohorts spawned since quotas were introduced in 1984 have begun to survive to spawning age in significant proportions and that the hole in the age structure of the spawning stock evident in the age distribution of the Indonesian catches as a result of the high fishing mortality rates in the early 1980s has been filled.

Age estimates are not yet available for the 2003/2004 spawning season, although estimates for the size frequency are available (Figure 25). The size distribution for the most recent spawning season has proportionately fewer fish less then a 160cm. This suggests that the apparently strong recruitment into the spawning stock seen in the age distribution in the previous two years may not be as strong in 2003/2004.

Without direct measures of abundance, it is difficult to disentangle how much of the increase in the proportion of smaller/younger fish is due to a reduction in the abundance of larger fish or to the increase in abundance of smaller fish. The estimate of the mean age of fish 20 and above caught on the spawning ground is shown in Figure 24. The mean age has increased somewhat over the period 1994/95 through 2002/2003 by perhaps up to one year. In contrast, the changes in the size distribution of larger fish suggest a decrease in the proportion of the very largest spawners. An increase in the average age/size among the older animals would tend to indicate that the older ages in the spawning stock are not being replaced as fast as they have been removed as a result of fishing and natural causes. It further suggests that increases in recent recruitments of younger ages into the spawning stock do not appear yet to be contributing to these older age classes. This might be expected given the lags and past hole in the spawning age distribution.

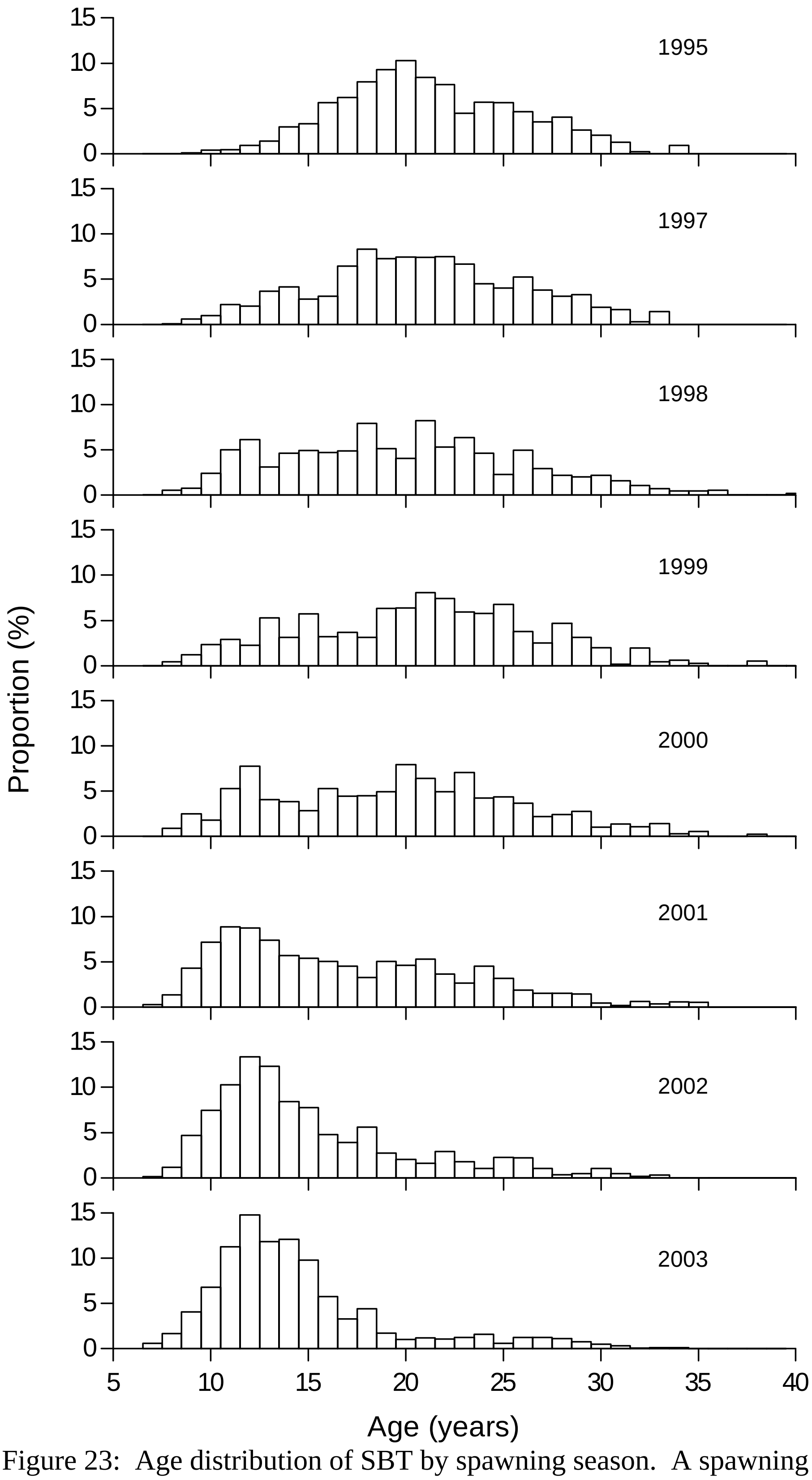

Figure 23: Age distribution of SBT by spawning season. A spawning season is defined as July 1 of the previous year to June 30 of the given year. Age could not be assigned to 22 (2%) fish with length measured in the 2002 season. By using age-length keys developed for SBT caught off the spawning ground (Farley et al. 2001), the majority were estimated to be between five and nine years (from Andamari 2004).

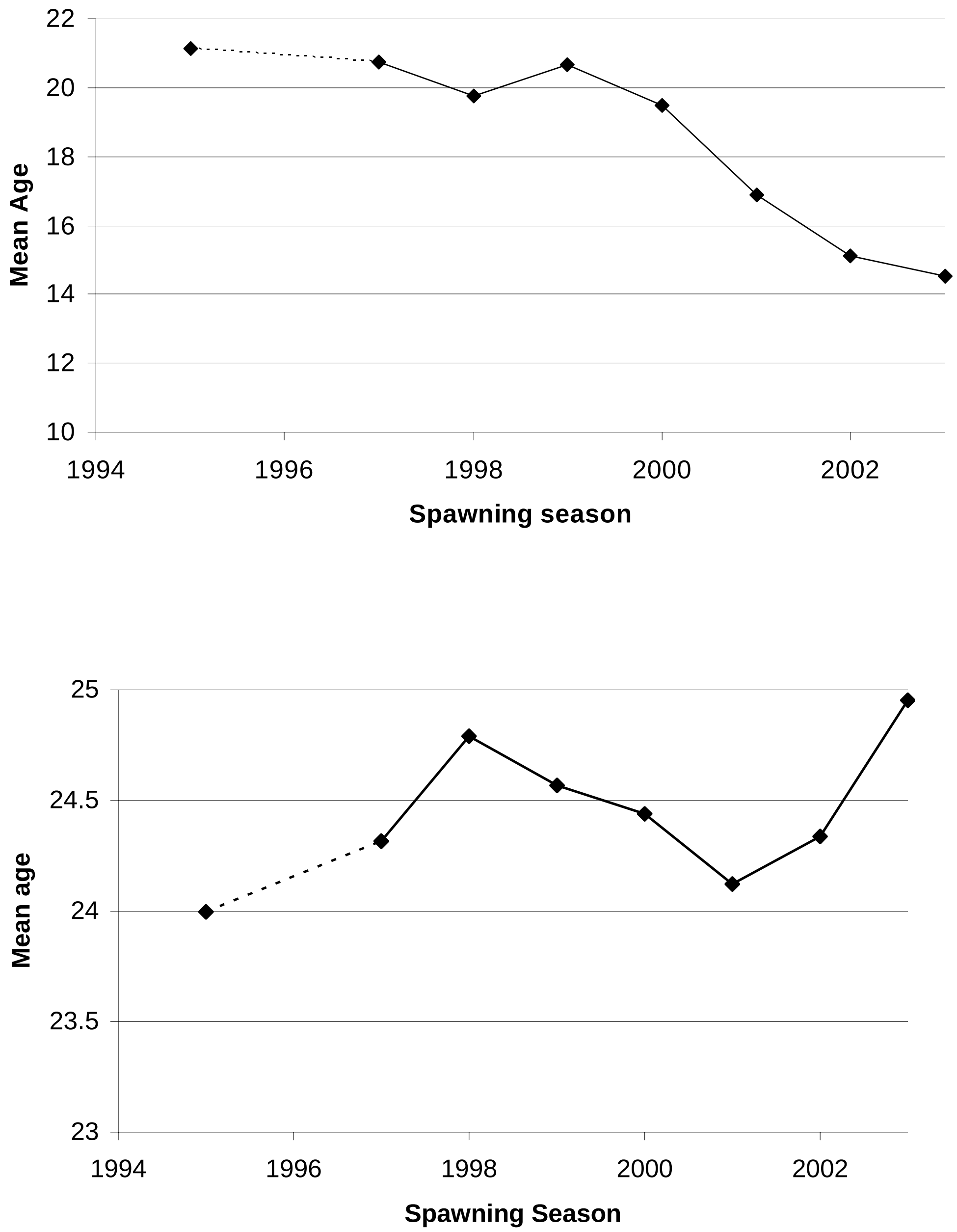

Figure 24: Estimated mean age of the catch of SBT by Indonessian longliners by spawning season. Upper panel is for the entire catch. Lower panel is for the catch for ages 20 and above.

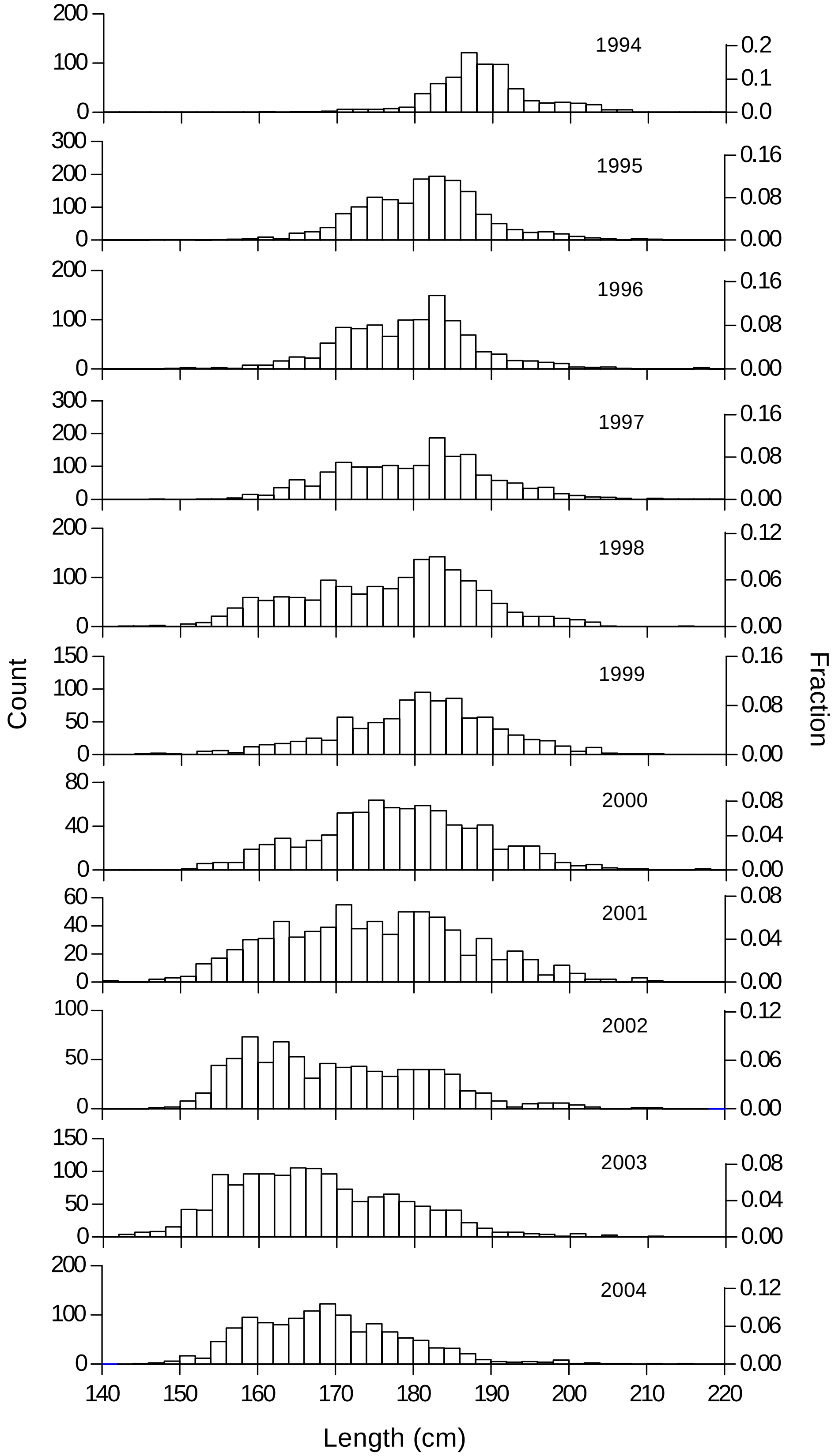

Figure 25: Length frequency (2 cm intervals) of SBT by spawning season. A spawning season is defined as July 1 of the previous year to June 30 of the given year.

Growth rate changes since the 1960's

Analyses of tag return data from the 1960's and early 1980's demonstrate that juvenile SBT growth rates increased markedly over this period (Hearn and Polacheck 1993; Anon. 1994). More recent integrated analyses that use not only the tag return data, but length frequency and direct aging data have confirmed this (Polacheck et al. 2003, 2004). Integrated analyses of subsequent data on growth in the 1990s based on tag return and direct aging data indicates that growth rates for juveniles continued to increase in the 1990's (Figure 26). For these 1990 cohorts, not enough time had elapsed to accumulate sufficient data to provide reliable estimates of growth for older ages (Polacheck et al. 2003, 2004). A plausible hypothesis for the increase in SBT growth rates is that it was a density dependent response to the declining SBT numbers in the intervening period. If this is the case, the continue increase in growth in the 1990's would suggest that the stock (or that component responsible for the density dependent response) has continued to decline.

An additional source of information on growth is that obtained analyzing otolith increments (Gunn and Farley 1998). Back-calculated growth rates from such data for the second year of life in fish spawned between 1958-1994 are shown in Figure 27. These data indicate a significant change in the growth of 1+ fish (i.e. during the second year of life). The chronology of growth rates provided by the otolith data spans the entire history of the SBT fishery – from its beginnings in the 1950's, through the rapid expansion phase of the 1960's and 1970's to the recent period of historically low parental biomass. The data suggest that after a long period of relatively constant growth rates, there was a significant increase in the growth rates of 2-5 year old fish in the late 1970's. Whether this was due to a density-dependent effect, or alternatively to environmental factors, in not known. However, the change in growth rates coincides with the period when the Australian fishery was at its peak, with 1.5-2.5 million individuals per annum being removed from the stock between 1979-1982. At the same time the parental stock was declining rapidly. The otolith data support the indication that the increase in growth continued throughout the 1980's and 1990's.

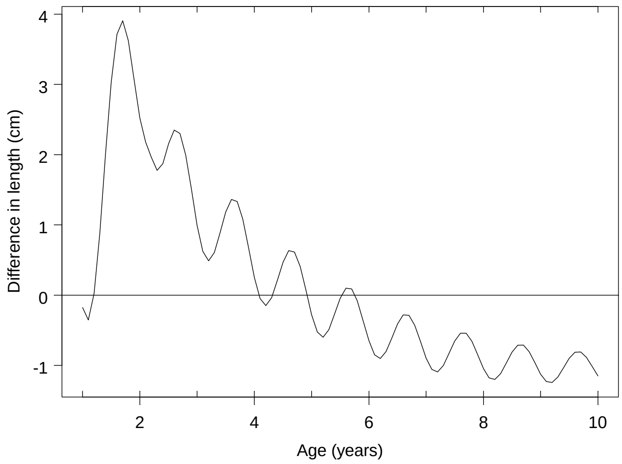

Figure 26: Difference in the estimated mean length at age for cohorts spawned in the 1990's compared to cohorts spawned in the 1980's (from Polacheck et al. 2004). Note the estimates of the difference for older ages are unreliable (see text). The sinal component in the figure is due to the estimated seasonal growth component in the model being displaced somewhat between the two decades.

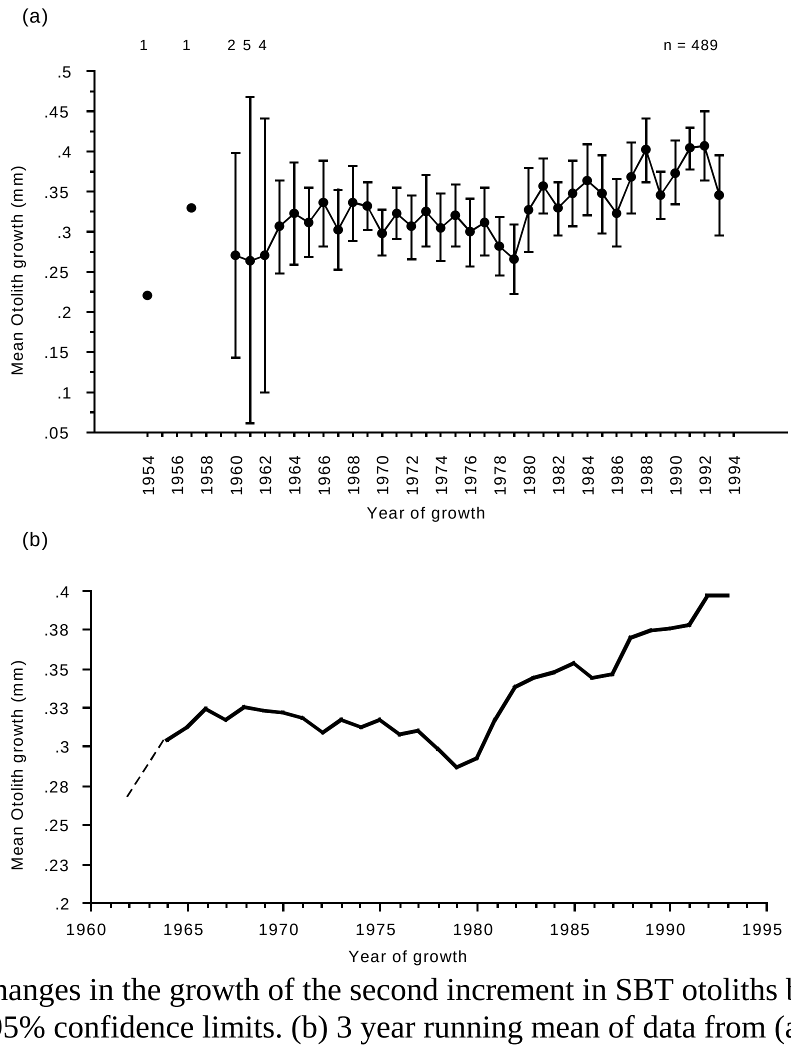

Figure 27 (a) Changes in the growth of the second increment in SBT otoliths between 1954 and 1994 with 95% confidence limits. (b) 3 year running mean of data from (a).

Catch rate trends by cohort since the 1980's

Figures 28 provide estimates of the Japanese longline catch rates by cohort for all cohorts born since 1980. Catch rates at age three for the 1981-86 cohorts were substantially below the 1980 level. Beginning with the 1987 cohort (i.e. the 1990 fishing season), catch rates increased markedly such that for all cohorts between 1987 and 1992, catch rates at ages three and four were at, or above, the catch rate observed for the 1980 cohort. Catch rates for the subsequent cohorts have dropped rapidly and generally have declined faster than for the 1980 cohort. These declines are such that the catch rates for ages 10 and 11 for the 1985 to 1987 cohorts were below those observed for the 1980 cohort and those for 1988 and 1989 were about equal (i.e. below at age 10 and above at age 11). This would suggest a limited potential for these cohorts to contribute to the parental stock relative to the 1980 cohort and that the exploitation rates on these cohorts were relatively high.

For the cohorts of the 1990-1995 cohorts, catch rates as juveniles were either low initially or also tended to decline relatively rapidly. Nevertheless, the catch rates tended to stay above that observed for the 1980 cohort and at age 10 and 11 catch rates were ranged from 7 to 70% higher. For the post 1995 cohorts, catch rates at age 3 and 4 were relatively low. However, for 1996-97 cohorts, catch rates remained relatively stable as they have aged and are substantially above those observed for the 1980 cohorts. This contrasting pattern of relatively low juvenile catch rates combined with little subsequent decline at ages 5, 6 and 7 suggest that selectivity may have changed with possible increased targeting of these post juvenile age class in the latter half of the 1990s and early 2000's. Nevertheless, the patterns of higher CPUE for cohorts spawned at older age since 1990 is a positive indicator and is consistent with the observed increases in abundance of 9-12 year old fish on the spawning grounds (see above).

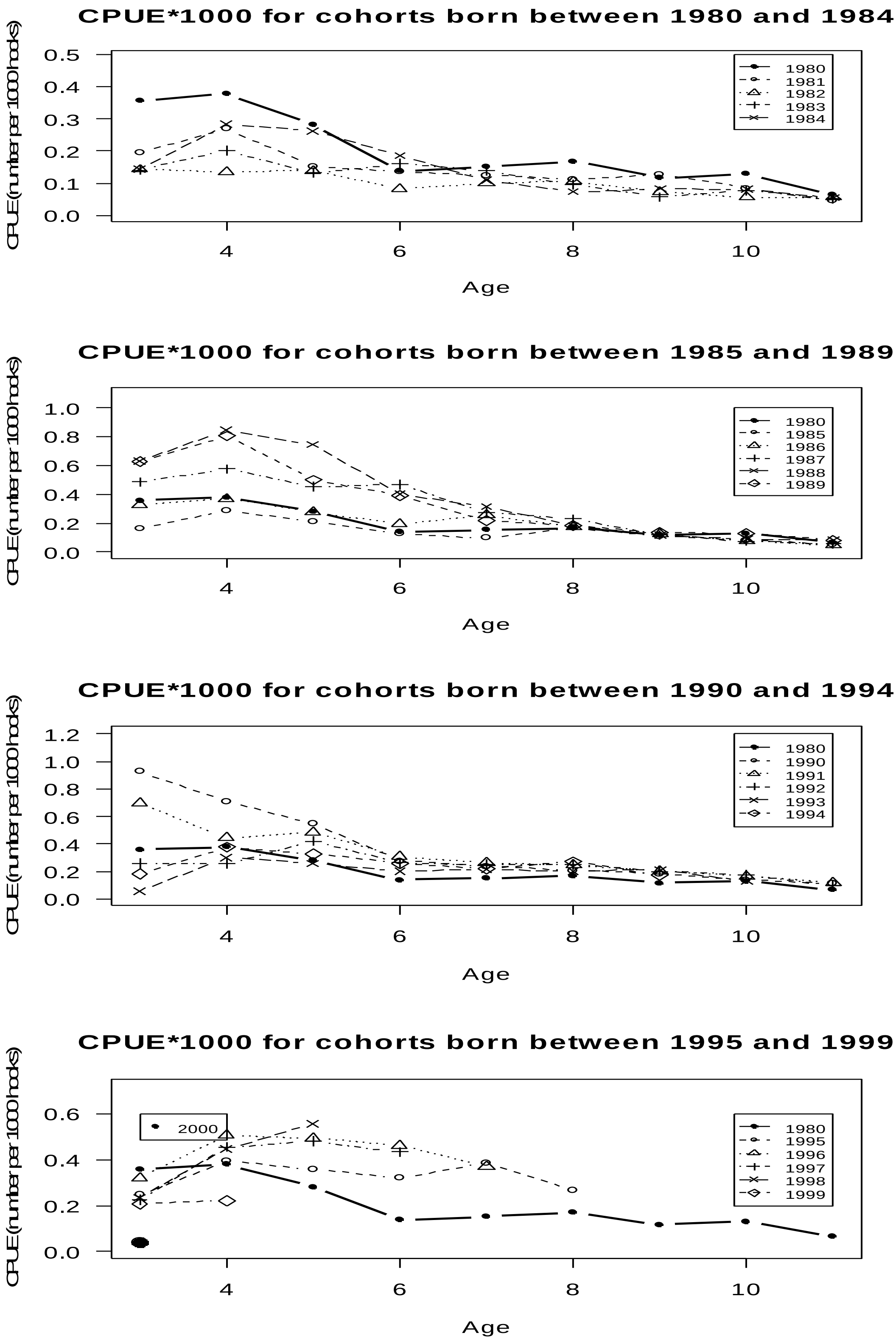

Figure 28: Nominal CPUE in Statistical Areas 4-9, months 4-9 for cohorts born between 1980 and 1999. The cohort born in 1980 is also shown for reference.

SBT Aerial Surveys in the Great Australian Bight

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 1990's, began to decline in 1998 and 1999 and remained low in 2000 (the last year of the survey).

Between 2002 and 2004, a reduced and ad-hoc line transect survey was conducted. Line transects were flown on a voluntary basis when weather conditions were appropriate and spotter planes were available. The constraints on the availability of spotters during suitable weather made it difficult to obtain comparable or interpretable data. Although 12 transect-lines were to be surveyed each season (6 lines twice), this was only achieved in the first season when 17.6 lines were completed. In 2003 and 2004, only 4.2 and 11.1 lines were surveyed respectively (Farley et al. 2004b). Lack of consistency and comparability in the spotters used, the timing and lines surveyed appears to prevent these latter data from being used to extend the previous aerial survey index. As such, the past aerial survey index cannot be meaningfully extended past 2000.

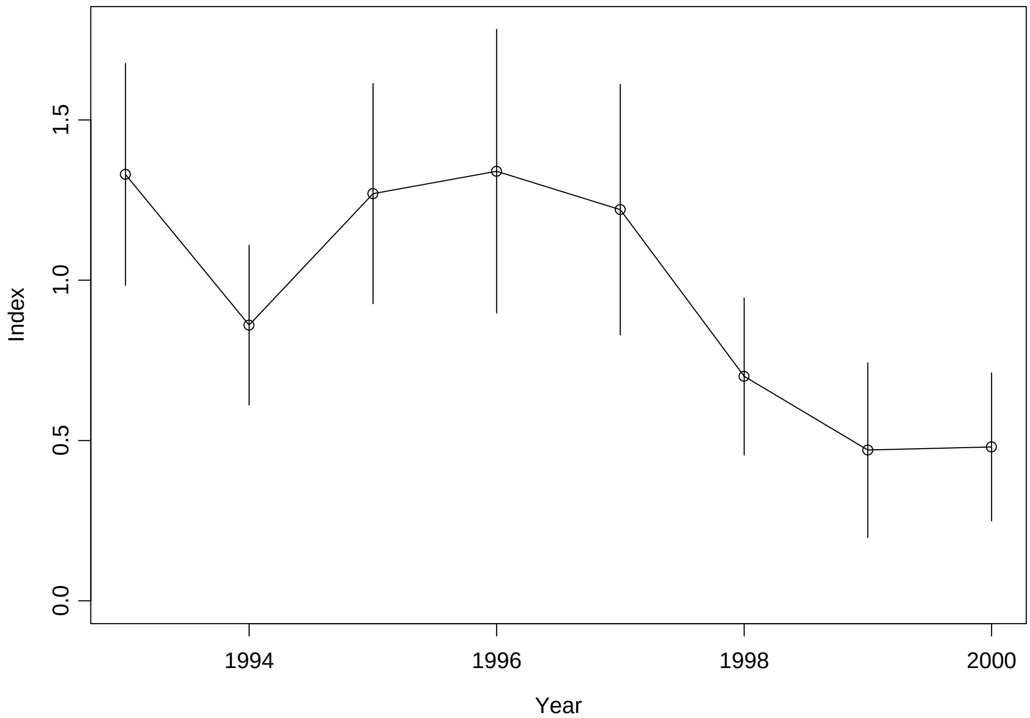

Figure 29: Aerial survey indices of relative abundance (biomass) for surface schools in the Great Australian Bight based on results in Bravington (2002). Error bars represent one standard deviation.

Japanese Acoustic Survey of 1-year old SBT off Western Australia

From 1996 through 2003, 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 at least 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). 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 was suspended 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 4 years following 4 years of consistent detections is of concern.

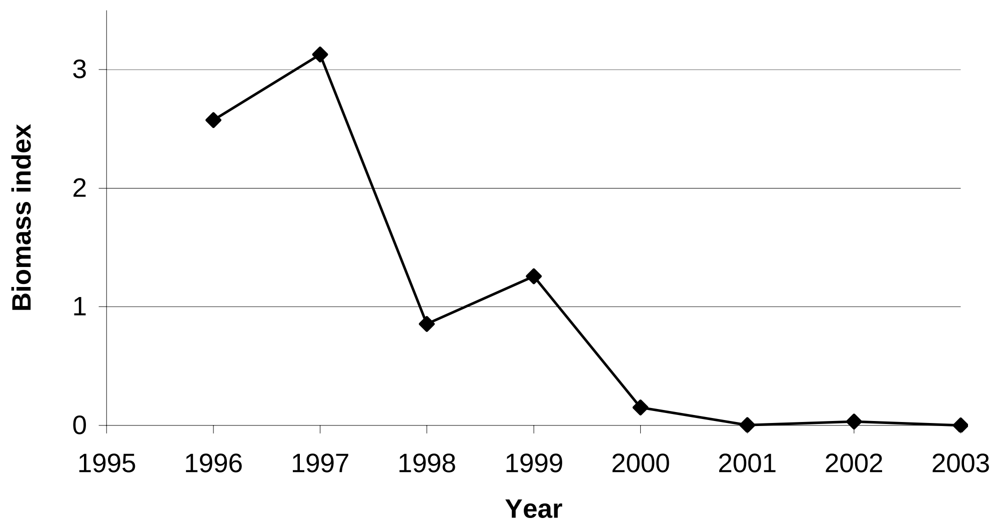

Figure 30: Relative biomass index for one year old SBT off Western Australia from acoustic surveys (from Itoh and Nishida 2003). The index has been standardized to the mean value over all years.

Australian Commercial Spotting in the Great Australian Bight

Aerial fish spotters support the Australian surface fishery that operates in the Great Australian Bight (GAB) each summer. Each fishing company generally has a dedicated spotting plane attached to its pole and line and purse seine operations, and over the years the spotting reports of these “commercial spotters” (as opposed to the spotting done in the aerial surveys) have been used by industry to support their contention that the abundance of 2-4 year old fish in the GAB increased throughout the late 1990’s and early 2000’s. The data collected by the commercial spotters is similar in form to nominal CPUE data, in that it usually involves a record of the number of schools and their associated biomass detected over a recorded search time. Searching effort tends to be highly concentrated and the same areas are often searched repeatedly. Until 2001/2002, the actual recording of data has been patchy and inconsistent and the amount of available recorded data is sparse. In addition, within these data, there are problems in the interpretation of detections and effort, as the planes do not record the exact location of sighting and tend to spend long periods in a location adjacent to the catching vessels. Analyses of the sparsely available data through 2000 suggested that there is not a consistent trend in the data and different trends were seen depending upon the aggregation and weighting used to construct an index (Klaer et al. 2002).

Beginning with the 2001/2002 fishing season, improved and systematic data recording was initiated for commercial aerial spotting with the cooperation of the fishing industry. This involved the use of a data acquisition system which automatically records a planes flight path linked to a computer for recording location and related sighting information (Farley et al. 2004b). Three years of such systematic data collection are available. Similar to commercial catch rate data, there are a number of issues that confounded the interpretation of such sighting data (e.g. see above). Nominal sighting rate indices of biomass per unit of effort (SAPUE- sighting abundance per unit effort) for three years of available data show a substantial decline of 50% between 2001/2002 and 2003/2004 (Figure 31). However, sighting conditions due to poor weather were clearly worse in 2003/2004, which further confounds interpretation of these sighting rates.

Preliminary analyses which attempt to standardise these commercial sighting rate data for prevailing environmental conditions also indicated 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. However, the extent of the decline between the first two seasons depended to some extent on the nature of the standardisation model used (Farley et al. 2004).

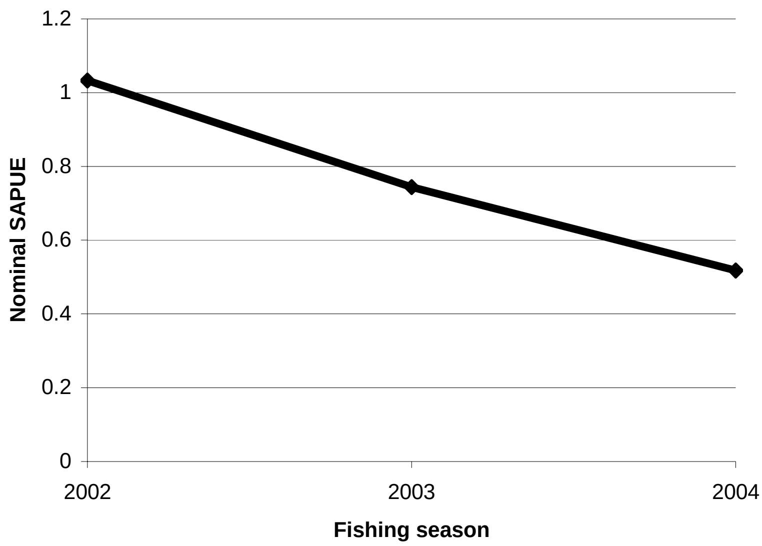

Figure 31: Biomass sighed per mile search (SAPUE) in aerial commercial spotting in the Great Australian Bight (from Farley et al. 2004).

Concluding Remarks

Table 4 attempts to summarize the set of indicators reviewed in this current paper. For each indicator an overall assessment/judgment was made of the performance of that indicator over the last 10- 14 years and over the last 3 to 4 years. An attempt was made to classify the overall performance as either “positive”, “negative”, “neutral” or “not applicable (NA)”. A classification of “negative” is meant to signify either that the indicator suggested an overall negative trend with respect to the stock or that it suggested concerns relative to exploitation rates or stock status. A classification of “positive” is meant to signify that the indicator suggested an overall positive trend or a general improvement in the indicator relative to 1986 in the case of the 10-14 year horizon or a recent improvement in the case of the 3-4 year horizon. A classification of “neutral” is meant to signify that the indicator suggested no clear trend over the period or no strong indication of a net improvement or deterioration. NA signifies that the indicator is no longer relevant, that data are not available or are non-interpretable. The classification often requires some judgment given the variability in trends and the multi-dimensional aspect of some indicators (e.g. the age/size distributions of the spawning ground catches).

Over the 10-14 year time horizon, the indicators suggest a mixture of positive, neutral and negative results. This mixture of indicators is not unexpected and is consistent with recent past stock assessment results (e.g. those in 1998 and 2001). These results suggest that the large quota cuts in the 1980s and particularly large reduction in 1988 had a positive effect in increasing escapement of juveniles from the surface fishery, slowing down, if not arresting, the decline in the spawning stock biomass and in roughly stabilizing stock biomass since at least the mid 1990s with possible slight subsequent increases or decreases. It is perhaps worth noting that positively classified indicators are associated with the change in the age distribution on the spawning ground and increases in Japanese longline catch rates, while negative and neutral classification are generally associated with more fishery independent indicators primarily related to juvenile abundance and exploitation rates (e.g. tagging, aerial survey, etc.).

Over the more recent shorter time horizon of three to four years, there is a preponderance of neutral and negative indicators. It is not surprising that “neutral’ classifications should tend to dominate this shorter time horizon classification as only large and substantial changes in the stock or fishery would be expected to yield clear signals given the level of variability that could be expected among years for many of the indicators. However, there are a number of indicators which suggest strong negative trends over the last 3-4 years. Almost all of these are associated with indicators of recent recruitment or juvenile abundances. In most cases, there are a number of factors which confound the interpretation of these indicators and suggest that caution needs to be used when drawing conclusions. Nevertheless, these negative indicators are of substantial concern. In particular, the large number of indicators that point towards substantial declines in juvenile abundances (especially the near absence of small fish in all longline fisheries) would suggest recruitment “failure” may have occurred in recent cohorts unless there have been large and wide-spread operational changes across all fisheries (e.g. changes in discard practices) and/or environmental factors which has only affected the catchability of small fish. Given the low spawning stock, even a few years of recruitment failures would have large implications for the sustainability of current catches. A major challenge for the 2004 Scientific Committee will be to decide what interpretation and likelihood should be given to these indicators suggesting a possible recruitment failure and how this should be incorporated into the scientific management advice provided to the Commission.

Finally, it should be noted that there are a large number of indicators that are classified as NA either with respect to the shorter or longer time horizons (or both). In addition, as noted above, interpretation of recent indicators is often confounded by a number of potential complicating factors. All of this reflects increasing problems with the quality and interpretability of the data available for assessing the SBT stock. These problems stem from a combination of (1) lack of continuity and consistency in data collection (2) large operational changes in the fishery and management arrangements; (3) lack of information that would allow such operational changes to be assessed (e.g. by-catch, retention/discard practices, etc); (4) lack of information and verification on data collection procedures and sampling designs that allows for proper statistical analyses and (5) truncated and short time series for many of the more fishery independent sources of information. While the CCSBT Scientific Research Program is intended to rectify some of these problems (e.g. catch characterization, observers, large-scale tagging program), as of yet these have not translated into large tangible improvements because of issues of coverage, data access, implementation/logistical difficulties and transparency/verification. Unless these are resolved and there are real improvements in the information, assessments of the SBT stock (both the analytical modeling and analyses of indicators) are likely to become increasingly more uncertain and difficult to interpret, particularly in the absence of large and very dramatic changes in stock status.

Table 4: Summary of the indicators reviewed in the current paper. 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

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