STOCK STATUS OF SOUTHERN BLUEFIN TUNA

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Introduction

The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) was established in May 1994 as the body with competence for the management of southern bluefin tuna. The fourth meeting of the Scientific Committee of the CCSBT was held during 3-6 August 1998 in Tokyo, after the meeting of the Stock Assessment Group, which was held in Shimizu during 23–31 July.

This document briefly describes the assessment results of these two meetings and current situation of southern bluefin tuna management, in addition to a brief review of the biology of and fishery for this species.

Biology of Southern bluefin tuna

Southern bluefin tuna are distributed exclusively in the southern hemisphere, with a circumglobal distribution between 30° and 50°S in the Indian, Pacific and Atlantic Oceans. A single spawning ground is located in an area south of Java, Indonesia and off northwest Australia. Two spawning peaks, during October-November and January-February, are identified from seasonal changes in the gonad index of fish caught in the spawning area and from the birth date distribution of juveniles determined from daily increments in the otoliths. However, no significant genetic differences have been confirmed between these two groups, and for this reason, and also their morphological uniformity and the results of tag returns, southern bluefin tuna is treated as a single global stock.

Southern bluefin tuna are considered to be mature at age 8, at the length of 155 cm. Recent studies of Indonesian catch suggested that larger fish would continue spawning activities much longer than smaller fish. Juveniles migrate southwards along the West coast of Australia and stay in the coastal waters southwest, south, and southeast of Australia. Preliminary results from recaptured archival tags suggest that young fish migrate seasonally between waters off southern Australia and the middle of the Indian Ocean. As the fish grow, they extend their distribution to cover the circumpolar area throughout the Indian, Pacific and Atlantic Oceans.

The life span of this species was considered to be about 20 years, based on the longest period at liberty recorded for a tagged fish, but a recent analysis of direct aging based on otoliths revealed that a significant number of fish larger than 160 cm were over 25 years old. The maximum age obtained from otolith analysis was 42.

Age-specific natural mortality, higher for young fish and lower for old fish, is suggested by tagging experiments and applied to stock assessment. The range of the natural mortality vector used in the current assessment is shown in Table 1.

Growth of southern bluefin tuna is determined mainly from tagging results. A two-stanza von Bertalanffy growth model is accepted and the growth rate is considered to have changed during the 1970s. The von Bertalanffy growth parameters for the period before 1970 and after 1980 are determined in Table 2.

Back-calculation from otolith annuli suggested that this change in the growth rate occurred in a short time during the late 1970s.

Description of Fisheries

Historically, the stock has been exploited by Australia and Japan since the early 1950s. The Japanese longline fishery (taking older fish) recorded its peak catch of 77,927 t in 1961, and the Australian catches of young fish taken by the surface fishery peaked at 21,501 t in 1982. New Zealand, Taiwan, and Indonesia have also exploited southern bluefin tuna, and Korea started its fishery in 1991.

Historical catches by nation are shown in Table 3. The catches of Australia, Japan and New Zealand have been controlled with quotas since 1986, and the current catch limits, which have remained at the same level since 1990, are 5,265 t for Australia, 6,065 t for Japan, and 420 t for New Zealand. The catches by other nations have increased steadily; they stayed around 2,200 t during 1991–1994, doubled to 4,689 t in 1996, and stayed high at 4,539 t in 1997.

Japan developed a fishery for southern bluefin tuna in the spawning area during the 1950s, which spread southward in the Indian Ocean to the West Wind Drift region. The major fishing areas are south of South Africa, south-west of Australia in the Indian Ocean, off Tasmania and around New Zealand. Fishing in the spawning ground has ceased voluntarily since 1971 for the protection of spawning stock. The season and area of operation have contracted drastically since the implementation of the quotas in 1989. In recent years, the season and number of vessels to be operated has been voluntarily controlled for each of the major fishing grounds in order to maximize the economic benefit under a limited quota. Figure 1 shows the distribution of the Japanese catch of southern bluefin tuna for 1960, 1970, 1980, 1990 and 1997.

The Taiwanese fleet catches southern bluefin tuna mainly as a bycatch of longline operations targeting albacore. Because of differences in target species, the distribution of the catch of southern bluefin tuna by the Taiwanese fleet is located further north than that of the Japanese fleet. This seems to result in a higher ratio of small fish in the catch than in Japanese operations. It is considered that drift gillnets also catch some southern bluefin tuna as bycatch, but the amount of that catch has not been estimated.

The Indonesian domestic longline fishery started in the mid-1970s and has developed rapidly since the mid-1980s, corresponding to a developing demand for fresh tuna in Japan. This fishery operates on the spawning ground. The size of fish caught is between 150 to 200 cm FL, with a mode around 180 cm, which is about 10 to 20 cm bigger than those historically caught in the same area by the Japanese fleet. In collaboration with Australia, the total catch has been estimated, based on the total amount of exported tuna in official records and the proportion of the southern bluefin tuna in longliner landings that is sent for export, monitored at major processing plants. A substantial discrepancy is noted between the estimated

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exports of southern bluefin tuna from Indonesia and Japanese import statistics.

The coastal area of Australia is a nursery ground for southern bluefin tuna, and Australia has exploited aggregations of juvenile using various surface gears. Pole-and-line fishing started in South Australia (targeting age 2-4 fish) during the early 1950s and in Western Australia (targeting age 2 fish) in the late 1960s. The South Australia fishery expanded in scale by incorporating spotting from aircraft as well as by developing purse seining, while the Western Australia fishery remained small-scale and virtually stopped in the 1990s. Since 1992, surface-caught fish have been successfully reared and fattened in pens. This practice has expanded rapidly and accounted for 65 % of the Australian catch in the 1995-1996 season.

The proportion of the catch made by the surface fishery peaked around the 1980s at a level of close to 50 % of the total catch, but declined afterwards to 13 % in 1992. However, the proportion of surface catch has started increasing again since 1994, corresponding to the development of captive rearing, and has now reached around 30 %.

The catches in number by age are shown in Figure 2 for both longline and surface fisheries, for every decade and for the most recent year (1997). In the figure, the surface fishery corresponds to the Australian domestic catch, and catches by all other fisheries are included in the longline category. Most of the fish, in number, are taken by surface fisheries. The age distribution of the longline catch showed a single mode in 1960, but then spread toward younger age groups, reflecting a shift to fishing grounds outside the spawning area. A distinctive mode is noted in juvenile catch (age 2 and 3) in 1990 but the mode shifted back toward older age groups in 1997. This is considered to be the result of a combination of changes in the relative availability (abundance) of the fish and changes in fishing patterns corresponding to quota regulation. The mode in the surface catch shifted from age 1 to age 3 from 1980 to 1997, reflecting changes in fishing areas and exploitation patterns.

Figure 3 shows a comparison of the relative impact of catches on stock. The catch of each fishery is transformed into a number of age 0 fish at the time of recruitment, using Pope's approximation with natural mortality vector V6 in Table 1. Fisheries are divided into three categories with distinctive differences in selectivity patterns: surface (Australian domestic), longline, and Indonesian longline fisheries. The relative impact of the surface fishery shows a peak during the 1980s, drops rapidly until 1992, and then increases steadily and rapidly, while that of the longline fishery is almost continuously declining. The recent rapid increase in the impact of the Indonesian catch should also be noted.

Current stock status and future projection

The fourth meeting of the Scientific Committee of the CCSBT examined the new biological information and the catch per unit of effort (CPUE) and virtual population analyses (VPAs) presented, and discussed the current status of stock.

The major tuning indices used in the VPAs are the Japanese longline CPUEs. After the implementation of quota regulations, the fishing area and season contracted drastically, with the result that many of the temporal and spatial cells historically fished are not covered by the fleet. Various hypotheses were presented on fish density in those cells from which fishery data could not be obtained in recent years, ranging from zero density (variable-square model) to the same density as those in fished cells in the same time/area strata (constant-square model). Some examples are shown in Figure 4, standardized to the level of 1980.

The CPUE for the parental stock (age 8 and older) declined until the early 1990s, and then stabilized, except in one hypothesis (variable-square model). The juvenile CPUE declined through the 1970s to the mid-1980s, but increased in 1993 to the different levels hypothesized and then stayed at about the same level. The sequential increases in the global CPUE by age for fish born in the late 1980s can be followed from 3-year-olds in 1990 to 8-year-olds in 1995.

The VPAs were conducted using various model structures, hypotheses on biological parameters, and different interpretations of Japanese CPUE series. Three typical examples are shown in Figure 5: the Japanese and Australian base cases (Case 1 and Case 2, respectively), and one using a forward VPA approach with allowance for errors in the catch-at-age matrix and changes in selectivity over time (Case 3).

The recruitment trends were similar in all the VPAs presented, and were very robust to the uncertainties considered in the assessment. All VPAs showed a marked decline in recruitment from the 1970s to the mid-1990s, and the most recent recruitment estimate is about one-third of the 1970 level. Tagging data and results of aerial surveys suggested that the recruitment of the 1993 to 1995 cohorts, for which no VPA results were available, remained at low levels.

All VPAs also suggested that the parental biomass is notably lower than the 1980 level, the management target level for stock recovery. However, the recent trend in parental biomass varied from a continuous decline to an upturn since 1994. These trends depend greatly on the way the "plus" group is treated and the CPUE series used. The overall estimates of current biomass level, after incorporating the different hypotheses supported by different nations, ranged from 25 % to 53 % of the 1980 level.

Japan initiated an Experimental Fishing Programme (EFP) in July and August of 1998, trying to resolve uncertainties relating to CPUE series. The survey was designed to estimate fish density in areas without commercial operations relative to those in areas freely chosen by fishers. Preliminary analysis indicated that the non-commercial fishing area contained on average 30 % to 120 % of the density of fish found in commercially-selected areas, but this ratio widely varied with the month of operation and the age group of the fish, which suggested the need for further surveys to cover a wider range of areas and conditions.

Future projections were performed to examine the medium- to long-term consequences of current global catch on parental biomass as well as the probability of recovery to the 1980 level, based on a set of VPAs incorporating an agreed range of uncertainties. The probability of stock recovery to the 1980 parental biomass level by 2020 ranged between 6 and 87 %, reflecting different interpretations of the plausibility of various hypotheses. As noted above for the parental biomass estimates, the differences in treatment of the plus group and different interpretations of CPUE indices had major impacts on the assessment of the probability of recovery.

Management schemes

Australia, Japan and New Zealand commenced discussions on the biological status of the southern bluefin tuna stock in 1982, and established a collaborative management scheme in 1984. The stock has been managed through quotas by Australia, Japan and New Zealand since 1985. At that time, these three fleets took most of catch, except for bycatch of the Taiwanese fleet.

Scientists at these trilateral discussions continued to express concern about the severe decline of the stock indicated by both assessment results and fishery indicators, such as a large reduction in CPUE and the contraction of the fishing grounds. As a result, the global quota was reduced several times, from 38,650 t in the 1984–1985 season to 11,750 t (Australia 5,265 t, Japan 6,065 t, and New Zealand 420 t) in the 1989-1990 season. The amount caught by the Australian surface fishery was further reduced by shifting to longline operations or by freezing the quota in collaboration with the Japanese industry. This large reduction in surface catch succeeded in allowing more juveniles to survive to recruitment to the longline fishery, and a recovery of the stock came to be observed from the younger age group.

The global quota was maintained at the same level even when a sign of stock recovery became clear. However, the catches by nations other than the aforementioned three have shown a marked and continuous increase during the 1990s and have contributed to the erosion of benefits over this period.

The CCSBT was established in May 1994 and all activities under the informal trilateral arrangement were transferred to the CCSBT. However, the catch of CCSBT member nations accounted for only 83 % of the global catch in 1994, when the CCSBT was established, and dropped to 71 % in 1997. In other words, about one-third of the global catch is now out of the control of the CCSBT. Although the CCSBT has made every effort to encourage other fishing nations to participate in the Commission, no other nations have become members. It should be noted that these non-member fishing nations often attend both the Scientific and Commission Meetings of the CCSBT and cooperate by providing information on their fisheries.

The Scientific Committee of the CCSBT has not been able to deliver a unified view on stock status and necessary management recommendations since the CCSBT was established because of differences in views among participating scientists. The 1997 Commission Meeting remains suspended without an agreement on the total allowable catch for the 1997-1998 season, and the date for the 1998 Commission Meeting has not been fixed after the first agreed date was cancelled by Australia and New Zealand. Under these circumstances, the members have voluntarily limited their commercial catches to the previous year's level. The 1998-1999 season has now already started in some of the member nations.

Recommendation

While the CCSBT has competence for the management of southern bluefin tuna as a whole in the three oceans, the IOTC is responsible for the management of this species in the Indian Ocean. The responsibility of the IOTC for this species is very great, considering that most of major fishing grounds are located within the Indian Ocean.

Although many projections suggest stock recovery with the current level of catch, the continued low abundance of parental biomass is a cause for serious concern. The increasing fishing pressure on the parental biomass, particularly in the spawning grounds, is contributing to its continued low level. Also, the recent increase in the fishing mortality of juvenile fish is expected to lead to lower recruitment from these cohorts to the parental stock.

In addition to concerns on stock status, a substantial portion of the global catch cannot be managed under the current management scheme. Furthermore, the scheme itself does not function in the way it should. The IOTC should take appropriate action to secure the sustainable use of southern bluefin tuna as soon as possible in collaboration with the other fisheries management organizations.

Table 1. Natural mortality (M) vectors used in current assessment projections of Southern bluefin tuna.

Age	V2	V6	V9
0	0.500	0.400	0.300
1	0.450	0.350	0.267
2	0.400	0.300	0.233
3	0.350	0.250	0.200
4	0.300	0.233	0.200
5	0.250	0.217	0.200
6	0.200	0.200	0.200
7	0.175	0.175	0.175
8	0.150	0.150	0.150
9	0.125	0.125	0.125
10	0.100	0.100	0.100
11	0.100	0.100	0.100
12+	0.100	0.100	0.100

Table 2

		First stanza		limit	Second stanza	
	t_0	K	L_∞	L^*	K	L_∞
before 1970	-0.8176	0.289	134.6	102	0.203	175.1
after 1980	-0.7798	0.109	311.9	89	0.180	183.9

Table 3: Historical catch of southern bluefin tuna by nation

	Australia	Chinese Taiwan	Indonesia	Japan	(Indian Ocean)*	Korea	NZ	Others
1952	264			565				
1953	509			3890				
1954	424			2447				
1955	322			1964				
1956	964			9603				
1957	1264			22908				
1958	2322			12462				
1959	2486			61892				
1960	3545			75826				
1961	3678			77927				
1962	4636			40397				
1963	6199			59724				
1964	6832			42838				
1965	6876			40689				
1966	8008			39644				
1967	6357			59281				
1968	8737			49657				
1969	8679	80		49769				
1970	7097	130		40929				
1971	6969	30		38149	(21068)	500		
1972	12397	70		39458	(21544)	100		
1973	9890	90		31225	(22827)	100		
1974	12672	100		34005	(24066)	182		
1975	8833	15		24134	(17963)	99		
1976	8383	15	12	34099	(23514)	28		
1977	12569	5	4	29600	(19274)	7		
1978	12190	80	6	23632	(11615)	94		
1979	10783	53	5	27828	(12595)			4
1980	11195	64	5	33653	(17359)		130	7
1981	16843	92	1	27981	(13413)		173	14
1982	21501	182	2	20789	(11548)	6	305	9
1983	17695	161	5	24881	(17409)		132	7
1984	13411	244	11	23328	(15798)	1	93	3
1985	12589	241	3	20396	(15580)		94	2
1986	12531	514	7	15182	(10935)		82	3
1987	10821	710	14	13964	(10285)		59	7
1988	10591	856	180	11422	(9173)		94	2
1989	6118	1395	568	9222	(7606)		437	102
1990	4586	1177	517	7056	(4206)		529	4
1991	4189	1460	759	6774	(3947)	214	165	77
1992	4448	1222	1232	6937	(5190)	36	60	141
1993	4723	959	1369	6970	(2707)	117	217	18
1994	4430	1111	926	6334	(3264)	147	277	55
1995	3858	1474	832	6338	(3145)	317	436	201
1996	5128	1610	1609	6373	(4351)	1179	139	291
1997	5316	640	2241	5588	(4532)	1325	334	333

* The boundary of this area is 20°E and 145°E and no boundary for latitude.

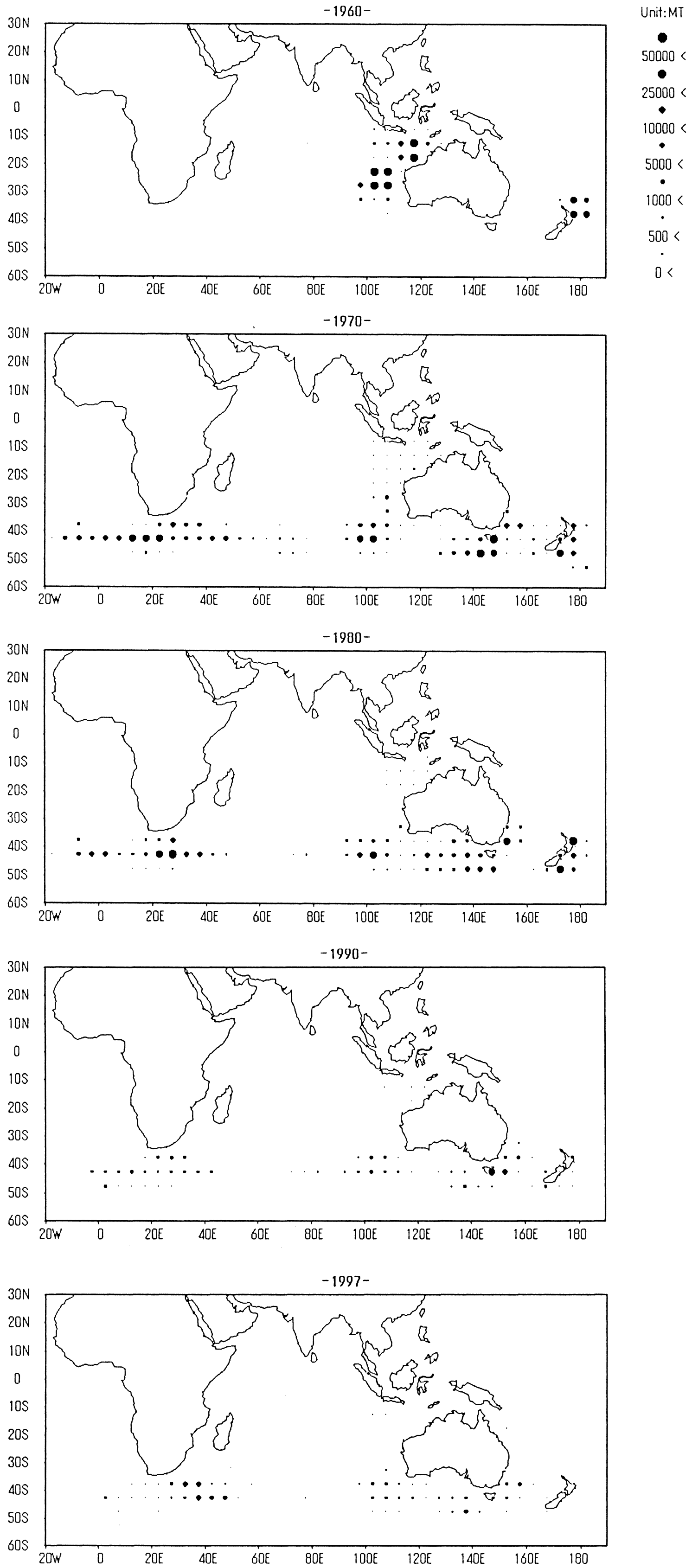

Figure 1: Historical change in geological distribution of southern bluefin tuna catch by Japanese fleet.

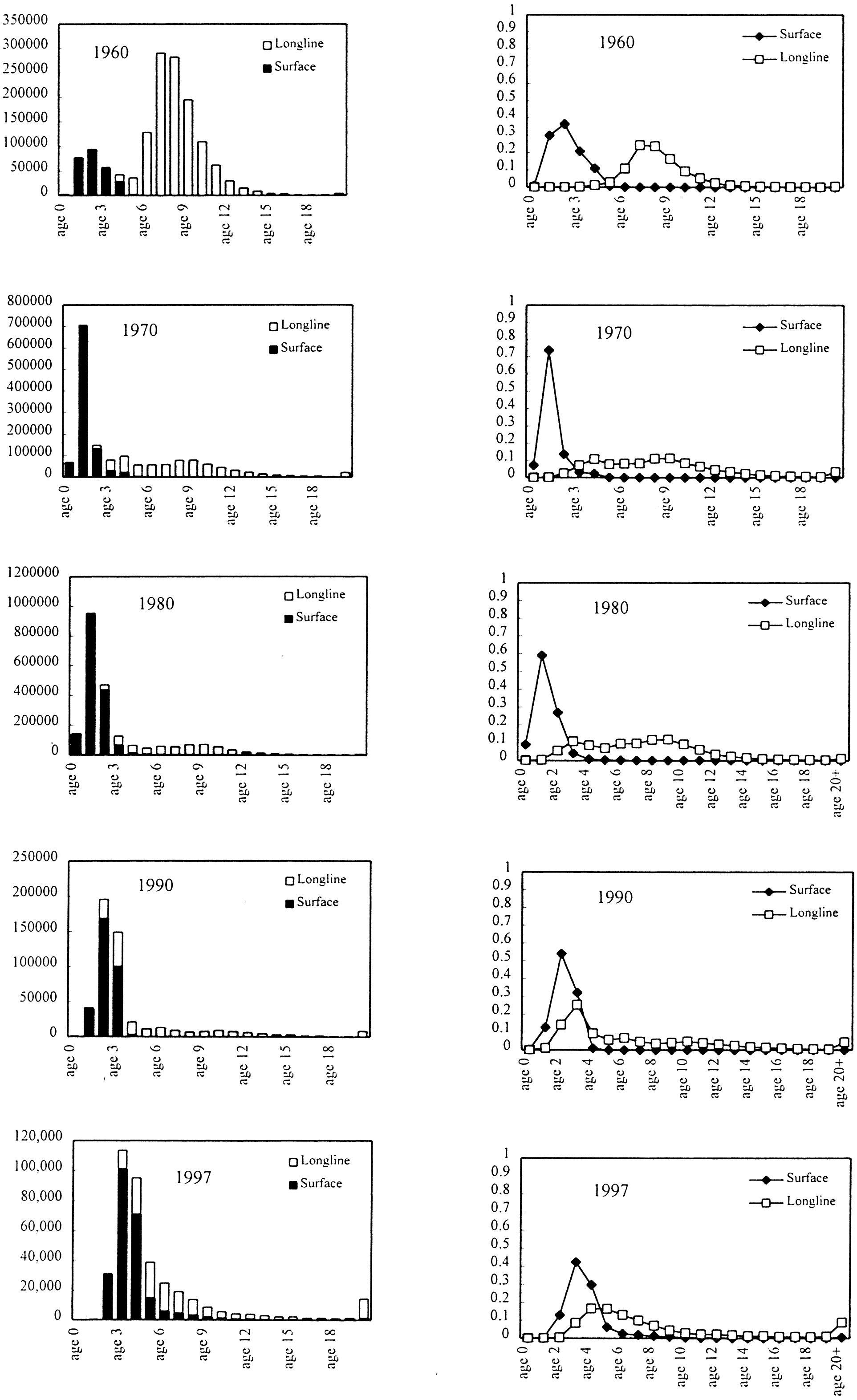

Figure 2: Catch in number by age and exploitation pattern of longline and surface fisheries for 1960, 1970, 1980, 1990 and 1997.

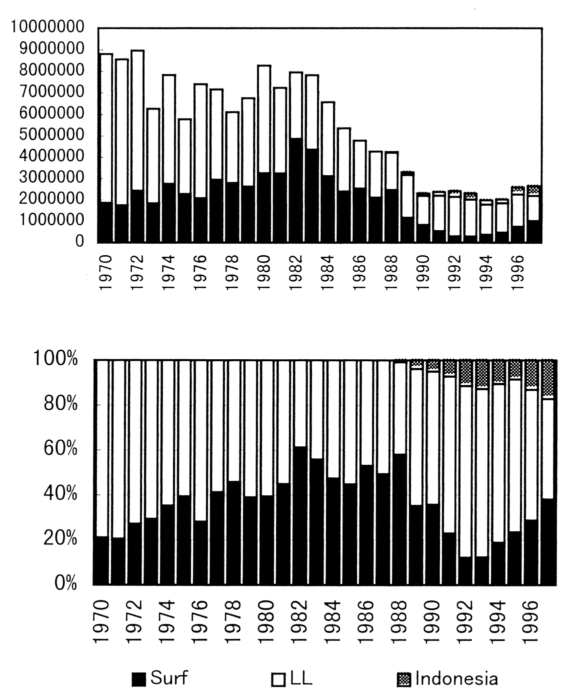

Figure 3: Impact of surface, longline, and Indonesian catch when translated into recruit numbers at age 0.

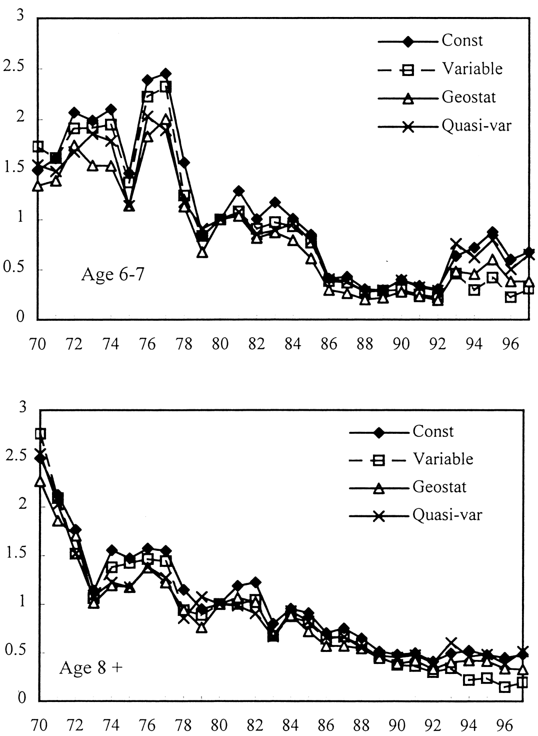

Figure 4: Standardized CPUE of Japanese longline relative to 1980 for juvenile (age 6-and parental (age 8+) southern bluefin tuna. Different lines corresponded to different hypotheses on fish abundance within time-area strata without fishing effort. (Reference: CCSBT/SC/9807/27, and 37)

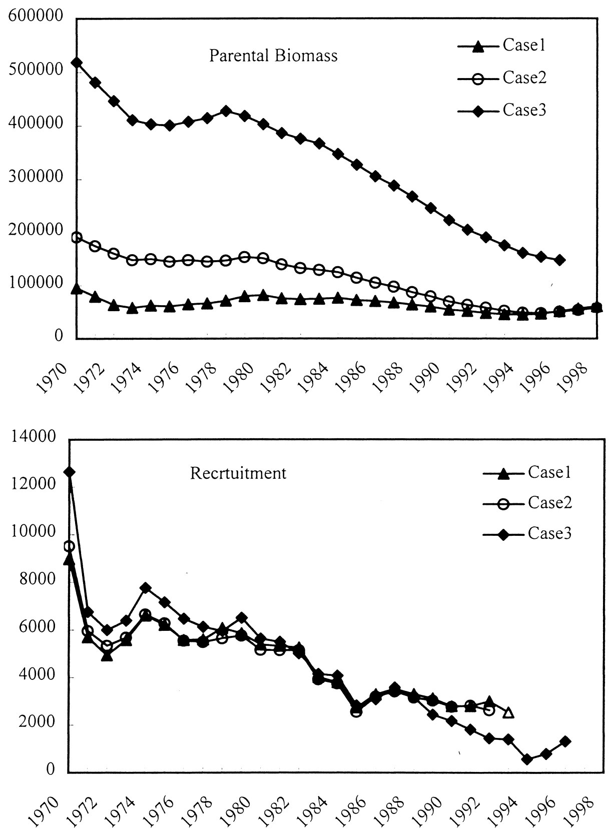

Fig. 5 VPA (with marks) and projection (without marks) results. Japanese and Australian reference cases (Case 1 and Case 2) and the result based on different approach (Case 3) were selected for presentation. (Reference : CCSBT/SC/9807/17, 27, and 31 with a modification to make them comparable.)