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Examination on Recent Increase in Juvenile Catch of South Atlantic Albacore *Thunnus alalunga*: Observations and Implications

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ABSTRACT

Albacore, *Thunnus alalunga*, caught in the south Atlantic Ocean was examined based upon historical size and catch data collected from longline fishery between 1981 and 1997. There were no apparent changes in size composition in the southern stock between 1981 and 1993. Dominant size of albacore ranged from 70 to 120 cm in most years except for 1994-1997 period when large amount of small albacore (i.e., < 70 cm) were evident. Adjusted catch-per-unit-effort (ACPUE) was higher while mean size of fish caught was smaller in ICCAT statistical area 34 than in 33 in all years. ACPUE decreased continuously from 1981 to 1996 in area 33, but was high in area 34 during 1981-1986 period, decreased to low values in 1987-1993, and increased again after 1993. Increases in catch of small albacore were also seen in areas within and outside Japanese Southern Bluefin Tuna fishing ground. Shift in modes of length frequency distribution for small albacore from 1995 to 1997 coincides with mean growth rate of ages 1 to 3 fish in the southern stock. This observation might suggest an increase in abundance of southern stock in recent years especially in area 34. Implications of such an observation in relation to the management of southern stock were also discussed.

Key words: *Albacore, South Atlantic Ocean, Abundance.*

INTRODUCTION

Albacore, *Thunnus alalunga*, is a highly migratory pelagic fish species that distribute widely in the world oceans. Such a species has been an important fishery resource for several countries such as Japan and Taiwan. In 1997, a total catch of 18,165 mt albacore was landed by Taiwanese longline fishing fleet operated in the South Atlantic Ocean. Such catches constitute more than two-third (in quantity) of the world catch in the region in recent years (ICCAT, 1998). In order to monitor changes in abundance and to prevent over-exploitation of the southern stock, a management plan which incorporates biological and statistical data collected from all countries, especially those obtained from Taiwan, will be necessary.

In recent years (1994-1996), a large increase in small albacore (ages 1-3) especially in the temperate water of the South Atlantic Ocean was noted in the data set obtained from Taiwan (ICCAT, 1998). It was not clear whether such an increase was resulted from change in fishing pattern (i.e., shift of fishing ground for southern bluefin tuna or increase of fishing pressure on small fish) or stock condition (i.e., a strong recruitment) or sampling bias.

The virtual population analysis (VPA) which may provides historical trend of the

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stock has been commonly used for the assessment of many fish stocks (Hilborn and Walters, 1992). The method was also recommended by the Standing Committee on Research & Statistics (SCRS) of the Commission for the Conservation of Atlantic Tunas (ICCAT) to be implemented in the assessment of population status of south Atlantic albacore in 1996. VPA is sensitive to the catch-at-age data which may be obtained from size data of the species. Uncertainty of increases in abundance of small fish as seen in recent years would, therefore, affects result in the assessment. In this paper, we presented results on examination of size and catch data of albacore caught by Taiwanese longline fishing fleet between 1981 and 1997 with emphasis on increases in small fish in recent years. Supplement data reported by Uoaski (1999) was also compared. Although sampling bias could not be totally excluded in the analysis, we contend that discrepancy found between Taiwanese and Japanese data sets may not be explained simply by changes in fishing ground or season. And, a possibility of an increase in abundance of southern stock in the recent years was suggested.

MATERIALS AND METHODS

Size and catch data were collected all year round from Taiwanese longline fishing fleet operated in the South Atlantic Ocean 5°N-50°S, 20°E-55°W (Fig. 1) between 1981 and 1997 period. All size data were measured and recorded in situ by fisherman, and compiled upon return to the port by the Overseas Fisheries Development Council (OFDC) of the Republic of China. Details of data processes can be found in Anonymous (1998). Instead of the by-catch product in Japanese southern bluefin tuna (SBT) fishery, albacore collected in this study is the main target species for Taiwanese longline fishery. A separate data set which included data obtained from regions A and B, the traditional Japanese SBT fishing ground (Fig. 1), was also examined and compared with result reported from Japanese catches in the same region (Uoaski, 1999). The Japanese SBT fishery were concentrated mostly in area B (Fig. 1) instead of area A where only few data were available. Mean weight of individual albacore was estimated based upon number and total weight of catches in each operation day. An index of abundance, i.e., an adjusted catch-per-unit-effort (ACPUE) also was analyzed for each sub-areas and years based on a general linear model (GLM) with factors including year (1981-1997), quarter (4 quarters), subarea (7 for area 33 and 2 for area 34) and bycatch effect (CPUE of bigeye and yellowfin tunas). The CPUE was estimated as: (catch number/hook number) x 1000.

RESULTS

Length frequency distributions of albacore caught in the South Atlantic ocean between 1981 and 1997 were shown in Fig. 2. In general, length distribution patterns were similar among years except for years between 1994 and 1996 where increases in abundance of small fish were evident. Albacore collected during this period ranged from 39 to 140 cm in size.

The size of albacore caught in the ICCAT statistical area 33 has been always larger than those caught in the area 34 (Fig. 3A) since 1981 suggesting a segregation distribution of different age groups of southern albacore within the south Atlantic Ocean. Comparison of annual catch rates between areas (Fig. 3B) also showed that historical ACPUE in area 33 were always lower than those in the area 34. ACPUE were high in early and mid-80s and then decreased to low values during late-80s in both areas. ACPUE in general, decreased continuously during 90's in area 33 while it starts to increase in area 34 after it reached to the lowest value in 1991.

Comparison of length frequency distribution of albacore between areas 33 and 34 also showed that small fish mostly occurred in area 34 instead of 33 (Fig. 4). In addition, mean fishing effort in area 34 was even slightly decreased in later years (i.e., 1994-1996) indicating that an increase in small fish found in area 34 in

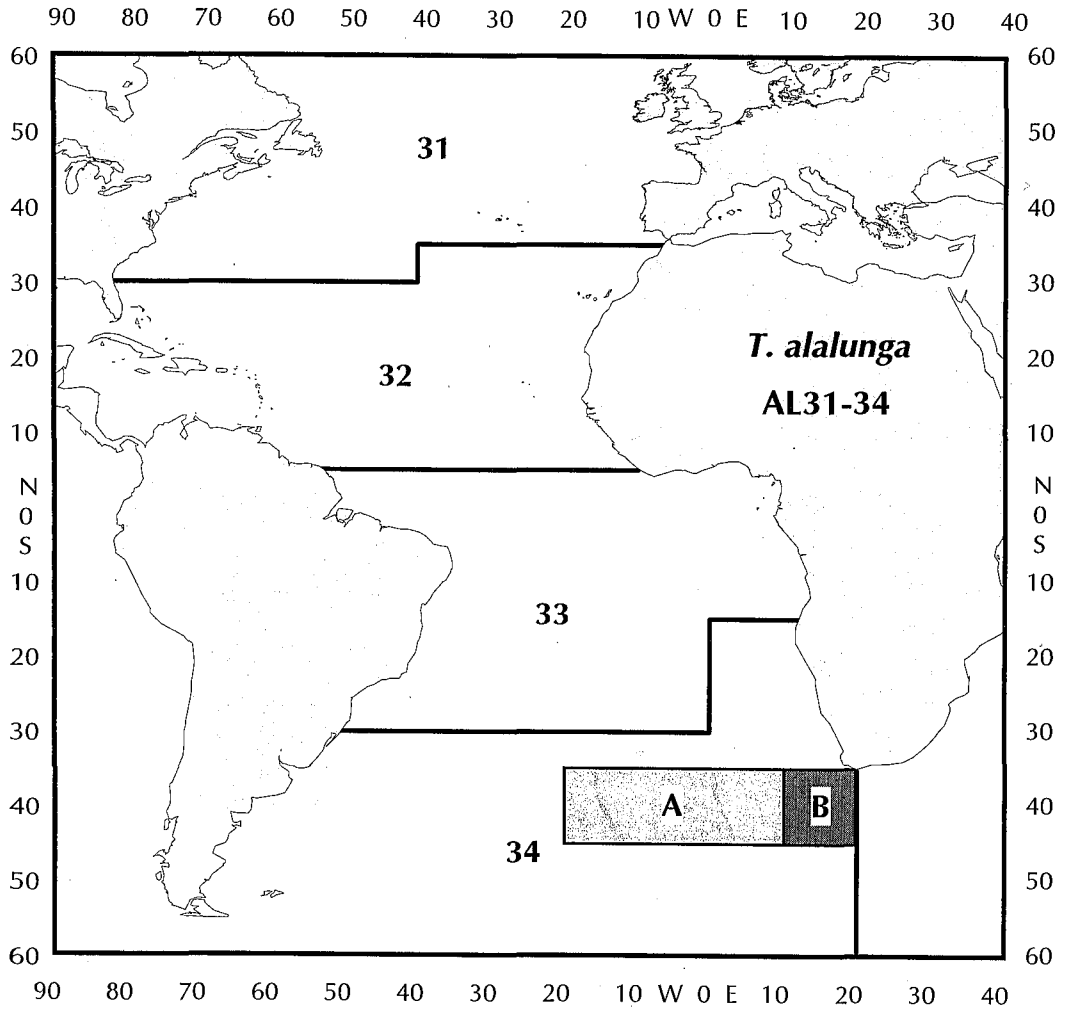

Fig. 1. Map showing ICCAT statistical area and traditional Japanese southern bluefin tuna fishing ground (shaded area). A and B represented areas where less and more fishing efforts concentrated.

recent years was not resulted from increased fishing effort (Fig. 5).

There appear to be, in general, more small albacore (< 70 cm) caught between January and May during 1993-1997 period when compare to the other seasons, although such an observation was not consistent among years (Table 1). Analyses based upon data collected from areas overlap with Japanese SBT fishing ground (Fig. 6) between 1993 and 1997 also showed similar pattern as in Figure 2 except that the amount of small fish was evident not only in 1994 and 1995 but also in 1996 and 1997. Furthermore, small albacore were not only caught within but also outside the major Japanese SBT fishing ground. There were also shifts in mean sizes of small albacore (i.e., modes in length frequency distribution) from 1995 to 1997 (Fig. 2), corresponding to roughly an annual mean growth (about 10 cm/year) of young albacore (i.e., ages 2 to 4).

DISCUSSION

Assessment or management of fish stock has long been a great challenge for

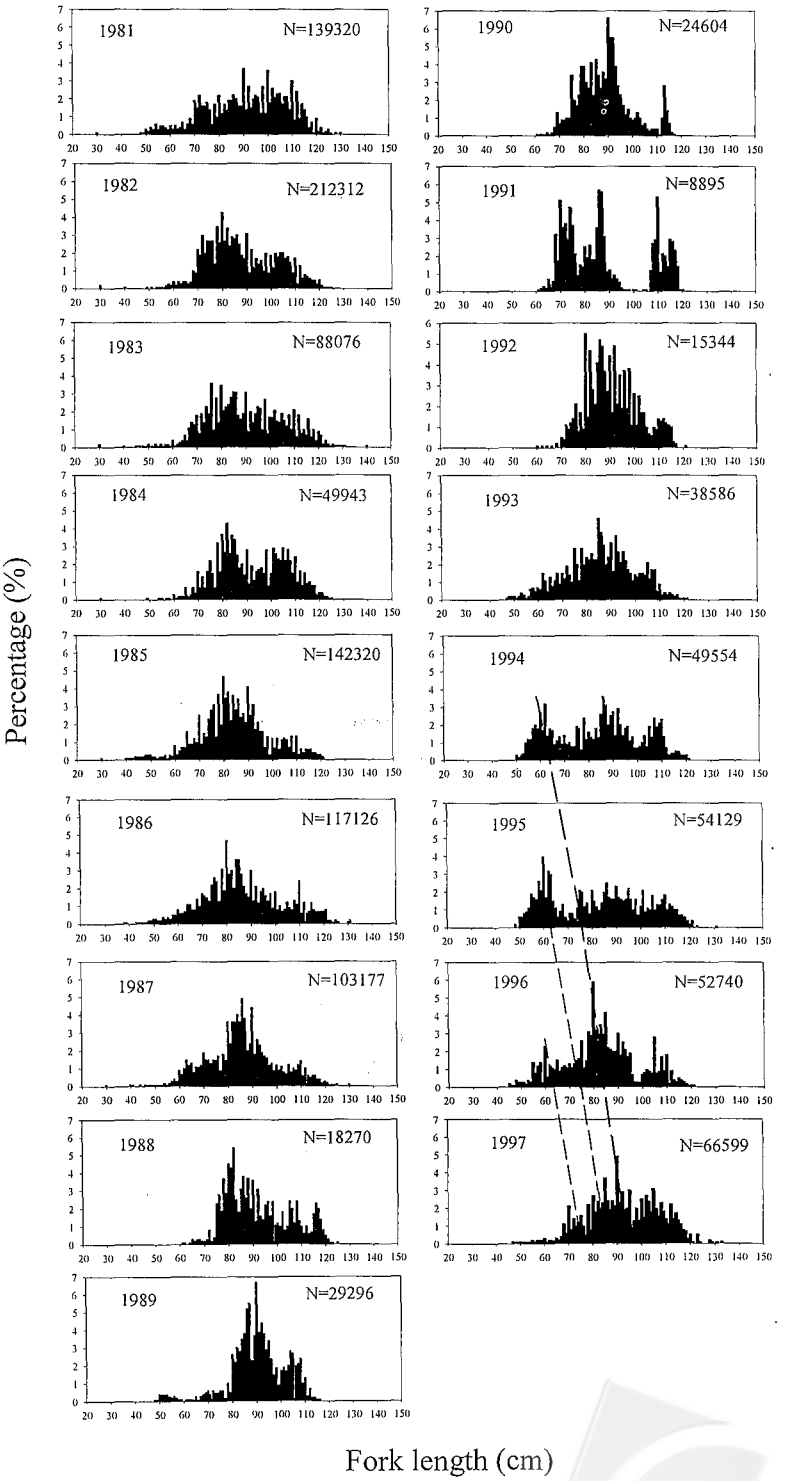

Fig. 2. Length composition of albacore caught by Taiwanese longline fishing fleet between 1981 and 1997. Dotted lines showing estimated growth of young albacore based upon Bard (1981) growth equation recommended by ICCAT.

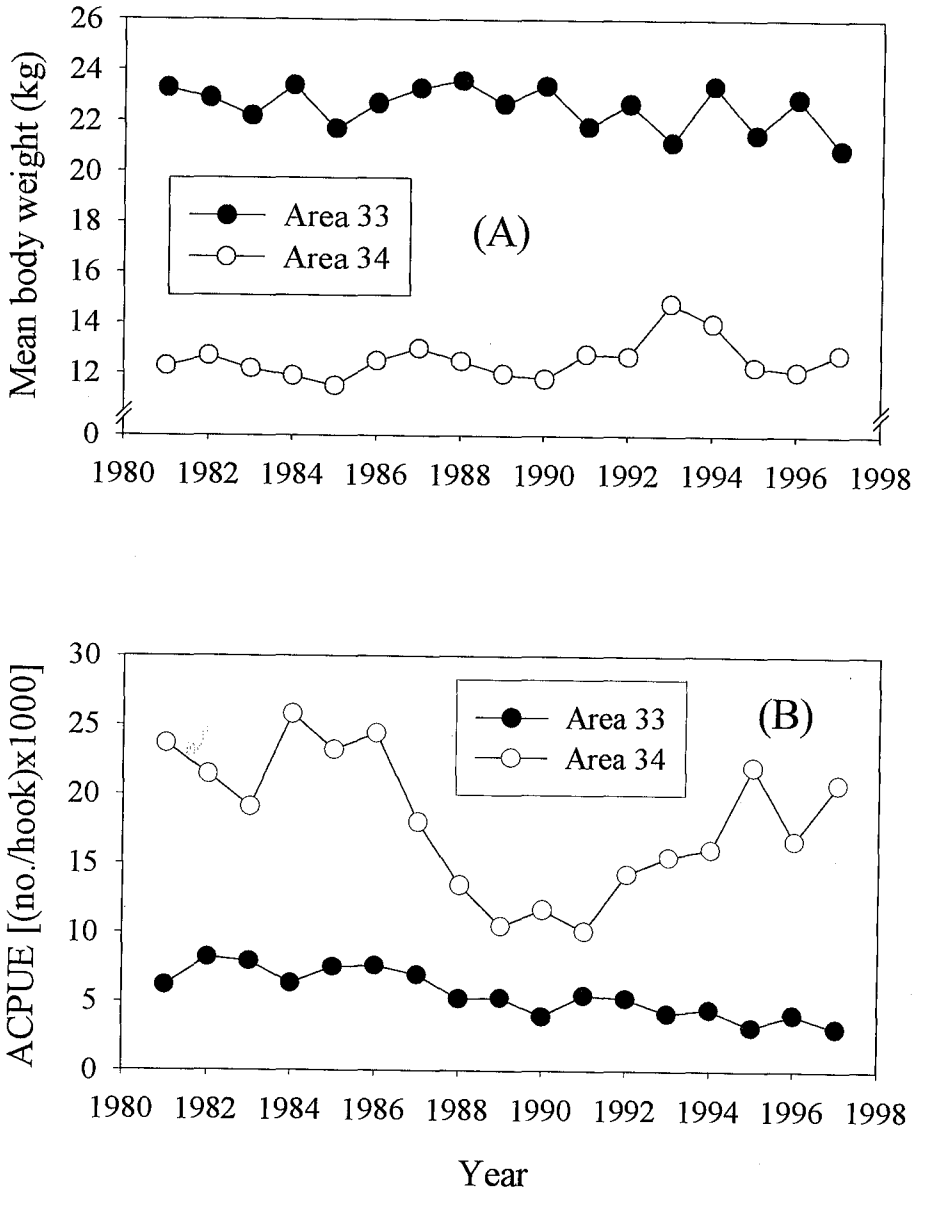

Fig. 3. Comparison of (A) mean body weight (kg) and (B) mean ACPUE of albacore caught in the statistical areas 33 and 34 between 1981 and 1996.

fishery scientists during the past few decades. Difficulties of such a task inherit from uncertainty of source and accuracy of the data collected from target species especially those highly migratory pelagic fish. Example of such a difficulty has been reported for the south Atlantic albacore stock when estimation of maximum sustainable yield (MSY) in 1998 was found inconsistent with result in 1997 due to uncertainty of several indices in stock abundance (ICCAT, 1998).

Small albacore showed between 1993 and 1997, especially during 1994-95 period, may resulted from several possibilities including: (1) a shift in fishing efforts to the southern part of the Atlantic Ocean where small albacore are more abundant;

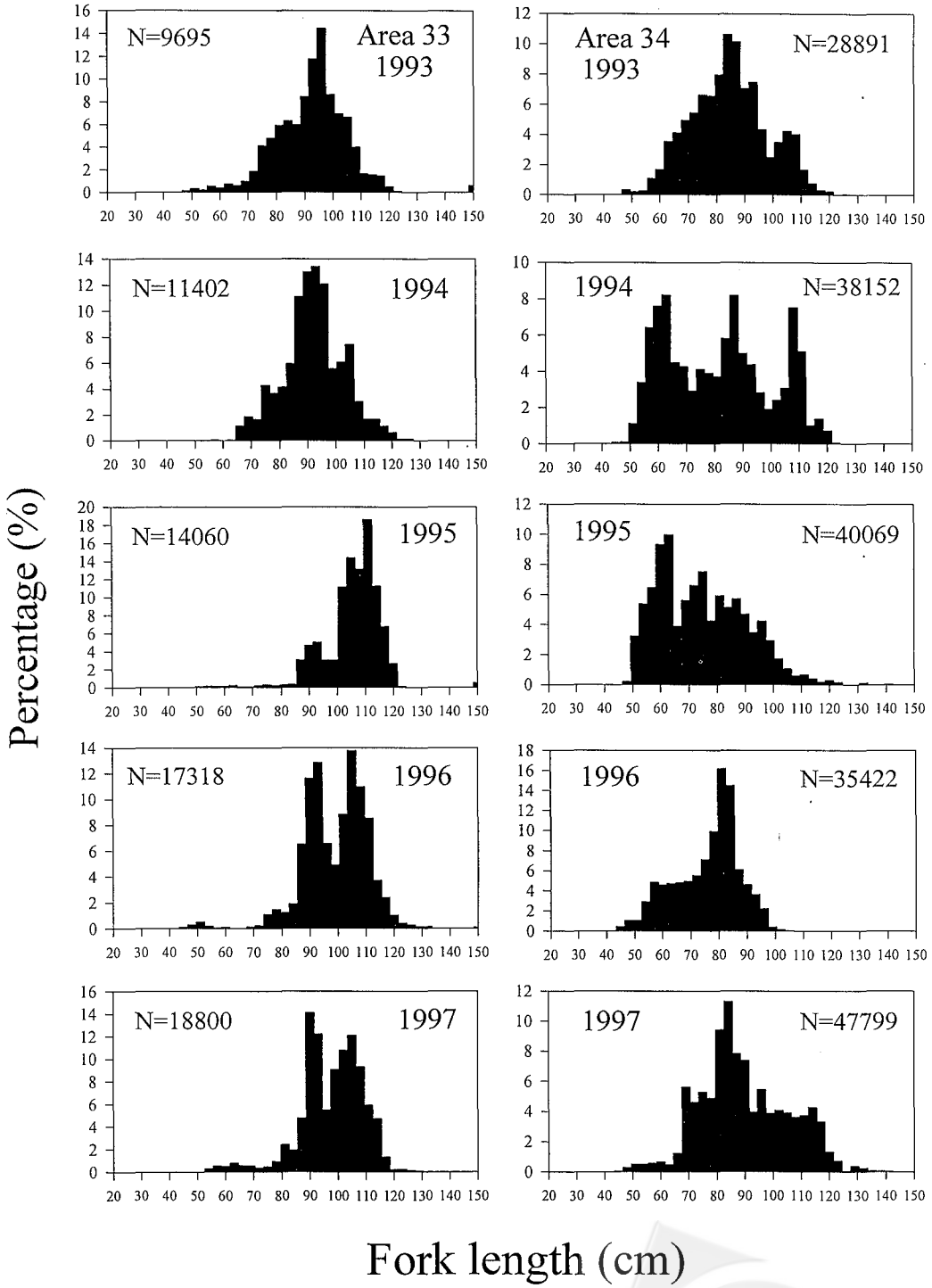

Fig. 4. Length composition of albacore caught by Taiwanese longline fishing fleet in the ICCAT statistical area 33 and 34 during 1993-1997 period.

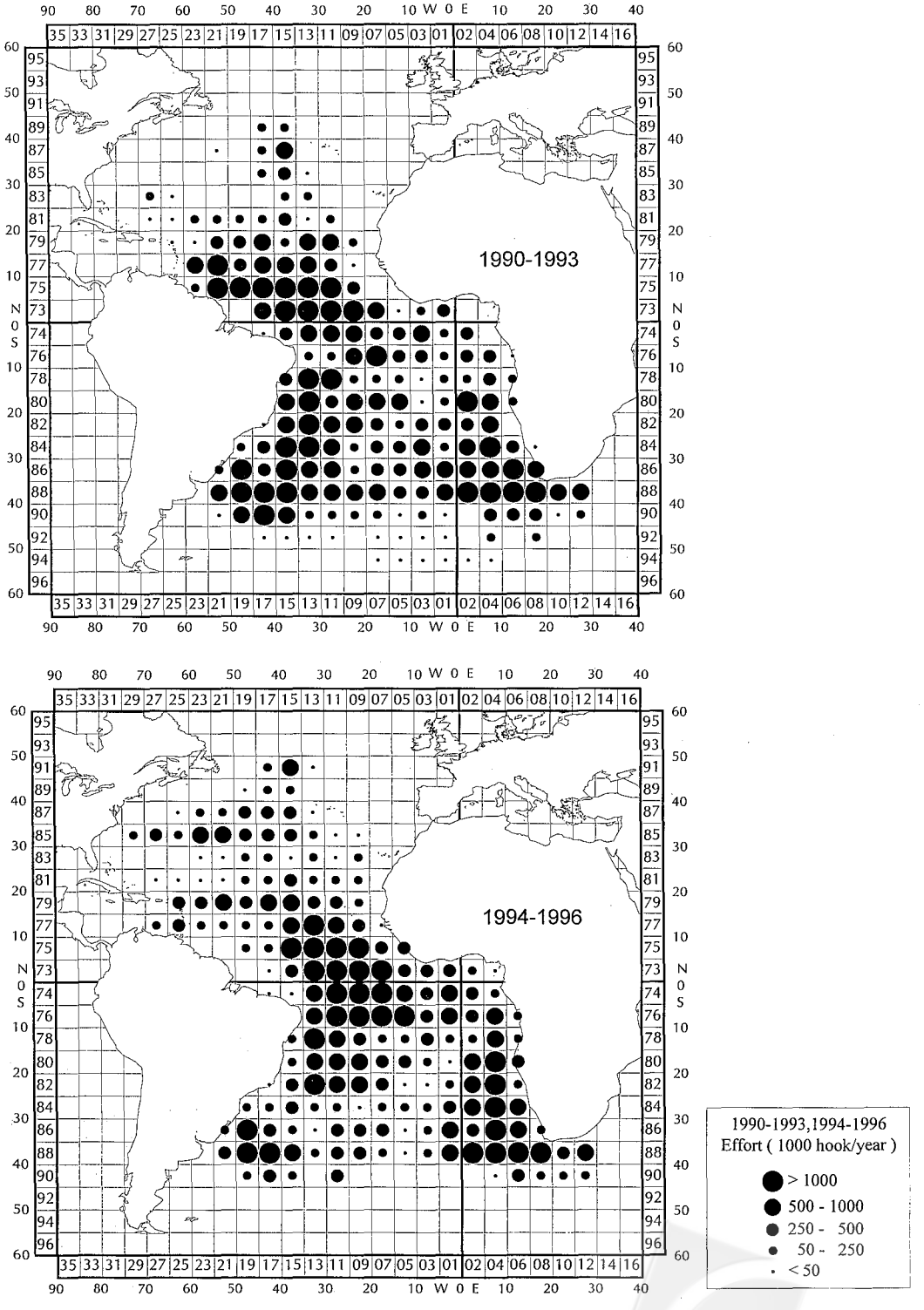

Fig. 5. Distribution of fishing effort of Taiwanese longline fishing fleet between 1990-1993 and 1994-1996 period.

Table 1. Percentage of small fish (<69 cm) caught in the Japanese SBT fishing ground by month and year

Month \ Year	1993	1994	1995	1996	1997
1	12	23	3	14	4
2	13	19	11	15	32
3	16	22	9	8	30
4	14	17	11	20	10
5	21	16	14	18	12
6	10	0	10	4	10
7	10	0	9	0	2
8	0	0	10	3	0
9	0	0	8	6	0
10	2	0	3	5	0
11	3	1	2	5	0
12	0	2	9	1	0

or (2) an increase in fishing mortality on small fish; or (3) an actual increase in abundance of the stock; and (4) a combination of several of these factors.

Uoaski (1999) demonstrated that there were almost no historical, seasonal and spatial trends in the length distribution patterns of albacore caught by Japanese longline fishery between 1981 and 1997, although smaller fish were caught in higher latitude in certain months. Fishing ground of Japanese SBT fishery was located in regions A and B (Fig. 1), although there was almost no data collected in region A, and very few data was available in region B. The author suggested that the discrepancy found between Japanese and Taiwanese catches may resulted from shift of fishing ground of Taiwanese longline fishery to an area outside Japanese main fishing area (i.e., 20°W-10°E) or difference in major fishing season (i.e., December to February) between the two countries during 1994-1995 period.

It has been suggested that small albacore are more abundant in the southern part of the Atlantic Ocean (ICCAT, 1998). This was supported by our result as small albacore were indeed historically more abundant in the area 34 than in the 33 (Figs. 3A and 4). There may be a shift in the fishing effort (to the south) during these years as has been suggested by the ICCAT (1998). If more efforts have been moved to the south while abundance of albacore did not increase, the total number of catches might increase but CPUE would not. However, results of our ACPUE analyses (Fig. 3B) in the area 34 showed an increasing trend in the recent years (1993 to 1996) indicating that abundance of southern albacore did increase during these years. A continued decrease in ACPUE in area 33 may has been related to the change of fishing target in recent years as some vessels in this area start to target bigeye tuna in some seasons.

In addition, we have also demonstrated that increases in abundance of small albacore not only showed within and outside Japanese major SBT fishing ground but also evident in the data set when all areas were combined. There was no evidence of change in fishing gear (and thus increase catches on small fish) during these years. Fishing effort during these years, as we have demonstrated, also remained similar. Furthermore, increases in percentage of age 1-3 fish between 1993 and 1995 period were seen not only in Taiwanese but also in Japanese longline and Namibian catches (NMIRC, 1998).

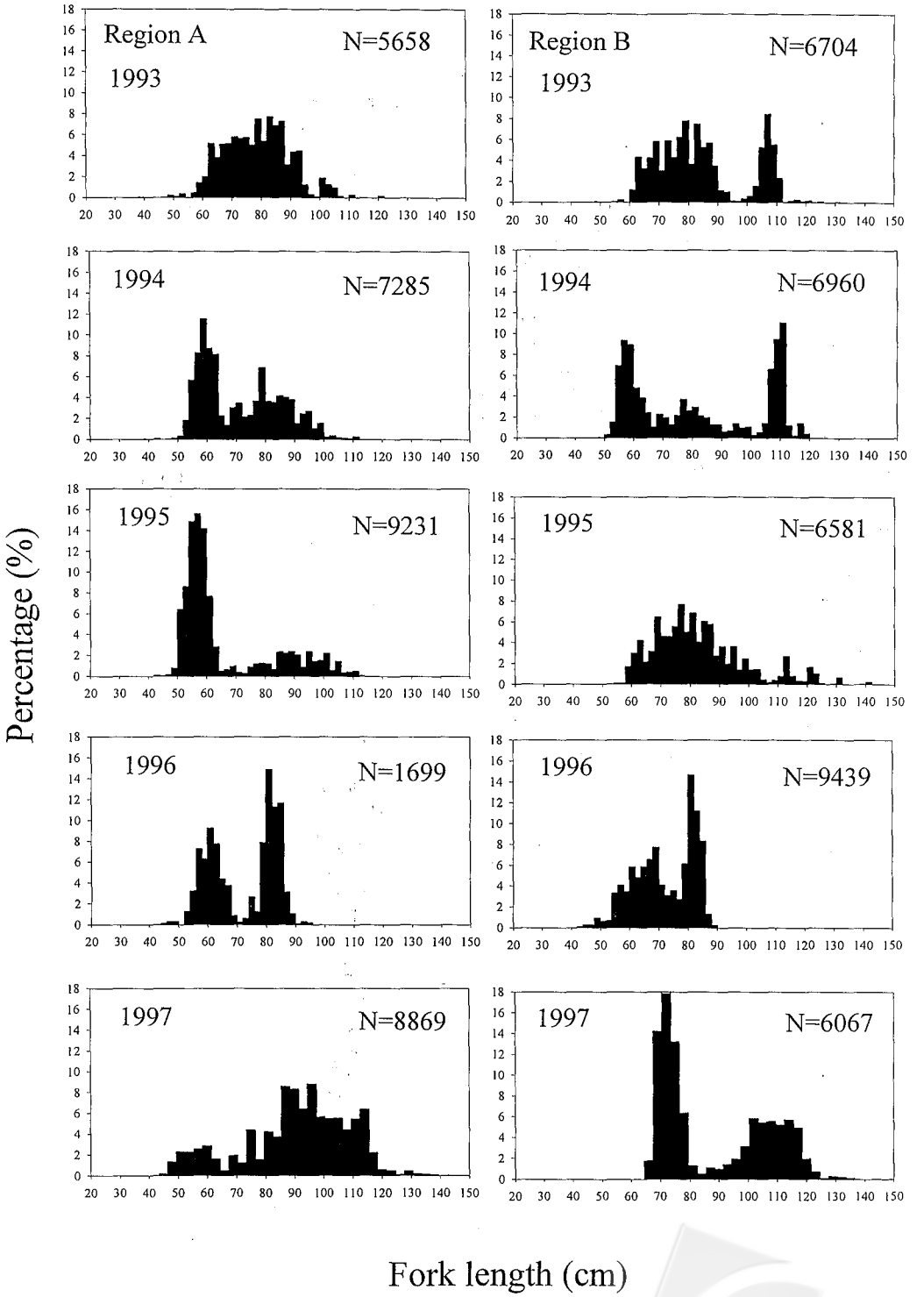

Fig. 6. Length composition of albacore caught by Taiwanese longline fishing fleet within (region B) and outside (region A) major Japanese SBT fishing ground between 1993 and 1997 period (see text for details).

There was also no evidence of difference in percentage of small fish caught between December-February and other seasons in the Japanese SBT fishing ground as has been suggested by Uoaski (1999). Thus, discrepancy shown between Taiwanese and Japanese catches could not be explained simply by difference in fishing seasons between the two countries.

There is however, a possibility of differences in fishing pattern and sampling size between two studies. Albacore caught by Japanese longline fishery is a by-catch product while fish caught in Taiwanese longline fishery is the main target species in the fishery. The sample size obtained in Taiwanese longline fishery (>10,000 samples between 1993 and 1997) is also much larger than those in the Japanese catches (< 210 samples, Uoaski, 1999). In addition, a shift of the small mode in the length frequency distribution from 1995 to 1997 also approximately matches the mean annual growth of young albacore estimated from Bard (1981) and Lee and Yeh (1993). Based upon these observations, we thus concluded that abundance of southern stock may has been increased in recent years especially in area 34.

However, data presented here should be interpreted with caution as biological data on the species is still limited, and the possibilities of other potential biases from reported data could not be totally excluded.

The mechanisms underlie recent increase in abundance of southern stock remain to be identified. However, the symmetric distribution pattern of albacore catches in both hemispheres has been observed, and that there also appears to be an evidence of negative correlation between the activity of North Atlantic Oscillation and the recruitment of northern stock (ICCAT, 1998). Thus, further research on similar correlation of atmospheric and environmental parameters with changes in abundance of southern stock, and improvement of accuracy of statistical data collection will greatly help to improve our ability in successful management of the southern stock.

REFERENCES

Anonymous (1998). Critical review of the data collection and processing system of Chinese Taipei, and revision of statistics for its LL fleet (Taipei, July 1997). *Inter. Comm. Conser. Atl. Tunas. Coll. Vol. Sci. Pap.*, **XLVIII**(3): 205-215.

Bard (1981), F. X. (1981). Albacore *Thunnus alalunga* (Bonaterre 1788) in the Atlantic Ocean - from population dynamics to demographic strategy (in French). Thesis. University of Paris. 330p.

Hilborn, R. and C. J. Waters (1992). Quantative fisheries stock assessment: choice, dynamics and uncertainty. Chapman & Hall. New York. 570 pp.

ICCAT. (1998). Albacore detailed report. *Inter. Comm. Conser. Atl. Tunas. Coll. Vol. Sci. Pap* ., **XLVIII**(1): 115-126.

Lee, L. K. and S. Y. Yeh (1993). Studies on the age and growth of south Atlantic albacore (*Thunnus alalunga*) specimens collected from Taiwanese longliners. *ICCAT Col. Vol. Sci. Pap.* **XL**(2): 354-360.

NMIRC. (1998). A synopsis of the tuna fishery in the EEZ of the republic of Namibia. National Marine Information and Research Center, Namibia. National report submitted to the ICCAT informal multi-lateral consultation meeting for southern albacore quota allocation. Cape Town, South Africa. April 23-24, 1998. 7 pp.

Uosaki, K. (1999). Albacore length composition caught by Japanese longline fishery in the high latitude region of the south Atlantic Ocean. *Inter. Comm. Conser. Atl. Tunas. Coll. Vol. Sci. Pap.*, Vol. **XLIX**(3): 471-476.

近年來南大西洋長鰭鮪*Thunnus alalunga*資源量增加可能性之探討

張水鏘[1]・王世斌[1*]・葉顯樞[2]

本研究利用1981至1997年間台灣鮪延繩釣漁船所採獲之漁獲統計及体長資料，針對南大西洋長鰭鮪 *Thunnus alalunga* 目前之資源狀況做一探討。南大西洋長鰭鮪從1981到1993年間之体長組成大致上類似。在此年間所捕獲之長鰭鮪体長範圍大約從70公分到120公分左右。而1994到1997年間則明顯有小魚(<70公分)出現之情形。在所有之年度，34漁區之單位努力漁獲有高於、而平均漁獲体長則有低於33漁區之現象。在33漁區之單位努力漁獲從1981年持續的降到1996年，而在34漁區則於1981至1986年間維持一高值、在1987到1993年間降到低值、而在1993年後則又回升。小魚增加之情形不僅出現於日本傳統南方黑鮪作業漁場內、在其漁場外亦有類似之情形。体長頻度分佈中小魚峰度由1995到1997年之推移情形亦與南大西洋長鰭鮪小魚之平均年成長相互吻合。由這些觀察顯示南大西洋長鰭鮪資源量於最近幾年有增加之趨勢，尤其是在34漁區之內。本報告針對此結果所顯示之含意及其對國際上南大西洋長鰭鮪資源管理之影響亦做一討論。

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