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EXTRACTING TAIWANESE LONGLINE CATCHES TARGETED ON ATLANTIC ALBACORE THROUGH DAILY CATCH COMPOSITION

Shui-Kai Chang[1] Chien-Chung Hsu[2] and Hsi-Chiang Liu[2]

ABSTRACT

A misleading fish abundance estimation can result when the effort used to compute CPUE is not directed to the species concerned. This misleading has occurred in the appraisal of the stock status of Atlantic albacore ever since some longliners have shifted their target species. A simple segregation procedure was applied in the present study, therefore, to extract Taiwanese longline catch data that are assumed to target Atlantic albacore. The albacore CPUE from the segregated data showed a rather different trend to that of the non-segregated one. Some discussions on this and the other two segregation procedures are also made in this study.

RESUME

Une estimation trompeuse de l'abondance du poisson peut découler du fait d'utiliser dans le calcul de la CPUE un effort qui ne vise pas directement l'espèce concernée. Cette situation s'est présentée dans l'évaluation de l'état du stock de germon atlantique depuis que quelques palangriers ont changé d'espèce cible. Une simple procédure de ségrégation a donc été appliquée à la présente étude pour extraire les données de capture des palangriers taïwanais qui visent le germon atlantique. La CPUE du germon extraite des données isolées montre une tendance assez différente de celle des données non isolées. La présente étude fait également état de quelques délibérations sur cette méthode et sur deux autres méthodes de ségrégation.

RESUMEN

Puede tener lugar una estimación errónea de la abundancia de peces cuando el esfuerzo aplicado para calcular la CPUE no se dirige a la especie concernida. Este error se ha producido en la evaluación del estado del stock del atún blanco del Atlántico desde que algunos palangreros cambiaron de especie-objetivo. En consecuencia, se aplicó un procedimiento de segregación simple en el estudio presente, para extraer datos de captura de palangre de Taiwan que ahora persiguen atún blanco atlántico. La CPUE del atún blanco, a partir de los datos segregados, mostró una tendencia relativamente diferente de los datos no segregados. En este estudio también se llevan a cabo discusiones sobre este y los otros dos procedimientos de segregación.

1. INTRODUCTION

Catch per unit of effort (*CPUE*) has always been applied as an index of fish abundance. However, in cases where the effort used is not directed at the species concerned, applying the obtained *CPUE* could result in an inaccurate abundance estimation. This has become a problem in the appraisal of the stock status of Atlantic albacore ever since some longliners have shifted their target species from albacore to bluefin, southern bluefin, or bigeye tunas (Nakano 1996; Uozumi 1996).

This problem, especially associated with Japanese longliners which experienced an explicit shift of target species around the early-1980s (Table 2 of Uozumi 1996), has made the albacore *CPUE* decrease sharply on the surface, with the increase of fishing effort targeting tunas for the "sashimi" market (Figures 4 & 6 of Uozumi 1996). An underestimation of the albacore *CPUE* trend can, therefore, easily be derived. A similar problem was observed in the

[1] Taiwan Fisheries Research Institute, 199 Hou-Ih Rd., Keelung, Taiwan
[2] Institute of Oceanography, National Taiwan University, P.O. Box 23-13, Taipei, Taiwan

estimation of Taiwanese longline fishery (Hsu and Chang 1993), where the estimated albacore *CPUE* trend has also shown a sharp decrease in recent years. Therefore, how much effort is really being directed to catching albacore should always be determined to ensure that the subsequent *CPUE* trend is reliable.

There are three procedures that can be used to segregate the fishing effort targeting albacore. These can be by means of the number of branch lines between floats (Suzuki *et al.* 1977; Uozumi 1996) and by registered fishing type or whether the vessel is equipped with the so-called "super-freezer" (Chang *et al.* 1993). These two procedures were not applied in the present study due to the dearth of information on branch line numbers between floats and for some other reasons to be discussed later in this study. The third procedure, which was used in this study to segregate the Taiwanese longline catch data of the Atlantic Ocean, was carried out by means of daily catch composition data through the clustering approach, as in Chang *et al.* (1993) for segregating Indian longline catch data. Since this procedure was followed in view of the species targeted and not of gear types or vessel types, the segregated Taiwanese data groups are referred to temporarily in this study as data of "species-specified regular longline" (SRL), of which albacore is assumed to be the main target species, and "non-albacore-targeted longline" (SDL), of which yellowfin or bigeye tunas are assumed to be their target, for clarity.

2. MATERIALS AND METHODS

Data used were the 1980-1993 logbook data of Taiwanese longline fishery of the Atlantic Ocean. (Due to new information which has recently come to light, data for 1984, 1991 and 1993 were updated after this paper was submitted.) These data included fishing effort (hooks deployed) and catches in number by species (13 species in all), and were collected by vessel, day and 5^0 x 5^0 statistical area. On the assumption that Taiwanese longliners targeted mainly albacore, bigeye or yellowfin tunas, catch data other than for these three species were discarded from the data set to lessen disturbance in the analysis. These catches were then transformed into catch composition by vessel and day.

A simple clustering procedure in SAS (FASTCLUS) was applied to each year's data to extract SRL and SDL data records from the 1980-1993 catch composition data, with the assumption that no more than two clusters were included in the three species data sets (cf. Figure 1 of Chang *et al.* 1993). A description of the clustering approach can be found in Hartigan (1975), SAS (1987) and Chang *et al.* (1993).

3. RESULTS AND DISCUSSIONS

3.1 Segregating results

Table 1 shows the mean catch composition, in percentage, of the segregated SRL and SDL clusters. The albacore catch compositions of SRL clusters are all higher than 90%. The bigeye and yellowfin catch compositions of SDL clusters are higher than 80%, except those in 1986 for the north Atlantic and 1980, 1986-1988 and 1993 for the south Atlantic.

Effort distribution of the two segregated clusters is shown in Figure 1. The effort spent on achieving high albacore catches (SRL) was much greater than that spent on achieving high tropical tuna species catches (SDL). Most of the effort in SRL clusters was concentrated within the block of 15^0 N-40^0 N and east of 30^0 W for the north Atlantic, and of 10^0 S-40^0 S for the south Atlantic, especially within the coastal areas off South America and South Africa. These areas are the traditional albacore fishing areas.

Not until 1990 was most of the effort in SDL clusters distributed in the tropical areas, where tropical species usually concentrate. There were some occurrences of SDL efforts found around the fishing area of SRL before 1990. After that, SDL efforts concentrated in the equatorial area, with the exception of 1993 when fairly few logbooks were returned from Taiwanese longline vessels. This might indicate, with comparisons of effort distribution and effort level in SRL and SDL clusters, that most of the Taiwanese longline operations in the Atlantic Ocean before 1990 were mainly to catch albacore; but after 1990, some part of the operations were shifted to catch bigeye or yellowfin tunas.

The *CPUE* trend computed from SRL and SDL clusters, and overall longline data (OVERALL) for albacore were plotted in Figure 2. Basically, these figures show a similar trend before 1990. From 1990 onward, however, the trends shown were rather different.

The trend from the overall data set indicated a sharp decline in the catch rate for the north Atlantic, and a continuous declining trend for the south Atlantic. Nevertheless, after the longline data were segregated by means of catch composition, the trend from SRL showed a leveling off at 20 fish per 1000 hooks for the north Atlantic, and about 17 fish per 1000 hooks for the south Atlantic. Using *CPUE* from the overall data will derive a rather different conclusion from using *CPUE* from segregated SRL data: With overall data, the stock ran into a poor condition after 1990; while with segregated SRL data, the stock was still in good condition. Such a discrepancy means a lot to the stock management, and should be recognized before any decisions are made.

3.2 Discussion on the segregation procedures

As mentioned above, there are two other segregation procedures which could be used to extract data of real albacore targeting. One is done in view of the gear pattern: the greater the number of branch lines between floats, the deeper the hooks set, and consequently, the higher the probability of catching fish that inhabit the deeper layer (such as adult bigeye). Generally, the gears with 4-7 branch lines between floats were referred to as conventional (or regular) longline gear and mainly targeted albacore; and the gears with more than 8 branch lines between floats were referred to as deep longline gear, mainly targeting bigeye tuna. Variations of the Japanese bigeye *CPUE* (computed from Table 1 of Uozumi 1996), coupled with their deep longline gear composition (Table 2 of Uozumi 1996), have born witness to this. They showed that those years using high percentages of gears with 8-20 branch lines between floats (deep longline gear) have higher bigeye *CPUE* or composition than those with high percentages of gears with 4-7 branch lines (the conventional longline gear). Where the highest bigeye *CPUE* (9.0-9.8 bigeye per 1000 hooks) occurred at a time when a high percentage of gears with 8-15 lines between float were used.

Some uncertainties, however, existed in the results of this procedure. The catches of four combinations of branch lines between floats of Japanese longline (Table 3 of Uozumi 1996), for example, showed that 92% of bluefin and southern bluefin tunas were caught by gears with 4-7 branch lines between floats in 1985-1992. Excepting the case of a specifically low level of bluefin tunas which were the real target of, and caught by, gears with more than 8 branch lines between floats (for example, those tunas with higher quality of meat or larger size), this might indicate that the conventional gear pattern did not solely target albacore, but also bluefin tunas - one of the target species of Japanese longliners after the early-1970s.

From the historical catches of albacore, bigeye and yellowfin tunas (Table 1 of Uozumi 1996) and the Japanese longline effort distribution (Figure 1 of Uozumi 1996), it was found that: before 1976, when deep longline operations were introduced in the Atlantic Ocean (Koido and Yonemori 1987), Japanese longliners deployed a lot of fishing operations in the tropical areas and caught high levels of yellowfin or bigeye tunas, not only of albacore tuna. Nakano (1996) reported that Japanese longliners targeted yellowfin tuna in the early stages of their fishing history. Therefore, during the time conventional longline gear pattern was supposed to be used (before 1976), Japanese longliners still targeted species other than albacore. Thus, taking efforts of conventional gears to be the effort directed at catching albacore might produce a certain level of underestimating of albacore *CPUE*.

Some other uncertainties that might exist in this procedure could be: the actual depth of hooks deployed might not depend only on the number of branch lines, it might also be affected by the current, wind and some other oceanographic conditions (Koido 1985); the habitat depth of the target species for "sashimi" may vary by season and by area, following the thermocline depth (Suzuki *et al.* 1977), and the number of branch lines the fishermen use may change accordingly (Nakano 1996).

The other procedure, which has been used by the Tuna Research Center of the National Taiwan University, is carried out on the basis of vessel type. This procedure considered all the data records from vessels registered with the Government as "regular longliners" as targeting albacore, and all the data records from vessels registered as "deep longliners" as targeting bigeye or yellowfin tunas.

Data obtained of this sort might be misleading when allowances for commercial considerations are made or when they come to the area that the supposed non-target species is abundant (personal communication with Taiwanese longline skippers, 1992). We found from the logbook data that, about 40 to 50% of the Taiwanese longliners which have caught more than 70% albacore in one area (where albacore was abundant) and on the same voyage caught more than 70% bigeye-yellowfin tunas in another area (where bigeye/yellowing tunas were abundant), no matter what type of operating patterns they registered. Fishermen might go to an area that is abundant in a species, say A, but not target species A but target another species instead, say B, which is not abundant in that area but has a high commercial value. In this view, it might be acceptable that the species which the longliners targeted was not closely related to the fishing types which the longliners registered.

For commercial reasons, fishermen normally hope to catch more of the higher valued species which they are targeting. In extreme cases, especially for demersal fisheries, fishermen discard the non-target species to save space on board for the target species. Therefore, fishermen would always change the length of line, the number of hooks or the distance between floats to maximize the catches on board or catch composition of the species they targeted. When they change their target species, they will also change the location of longline gear set and other fishing operations for the new target species, as discussed in Nakano (1996). Uozumi (personal communication 1994) has included both the gear effect (branch lines between floats) and species effect (*CPUE* of species that deep longliners targeted) in his GLM model for standardizing Japanese albacore longline data. He found from his results that the gear effect is not so significant. The species effect, however, accounts for most of the common variance. Therefore, focusing the segregation procedure on the "target species" itself might be simpler and more straightforward than focusing on types of gear or vessel to reduce the effect of fishing effort on non-targeted species.

If the idea of "maximizing target species catch or catch composition" were accepted, then the target species effect might be referred to using the percentage of the particular species in a landing, as in Stocker and Fournier (1984). Segregating catch data of targeted albacore from the mixed catch data by means of catch composition therefore might be an applicable procedure, especially in the case where the information on branch line numbers between floats were unavailable. The segregated results from the procedure applied in this paper, though not yet satisfactory, should be more reliable than those without segregation or those singly segregated based on the vessel's registration type.

There may, however, still be some objections to the above mentioned idea. One possible case for such objections may be that in an area where both albacore and bluefin tunas were abundant, or where albacore was more abundant than bluefin tuna, fishermen that targeted bluefin tuna might be satisfied with a landing composed of a high quantity of albacore and a low quantity of high-quality bluefin tuna. In this case, the segregation procedure using catch composition was not applicable. But for Taiwanese longline fishery which mainly target mainly albacore, yellowfin and bigeye tunas, this kind of error might not be so significant.

Table 1. **Mean catch composition in percentage of the segregated SRL and SDL clusters. ALB: albacore, BE+YF: bigeye and yellowfin tunas combined**

YEAR	NORTH ATLANTIC				SOUTH ATLANTIC			
	SRL		SDL		SRL		SDL	
	ALB	BE+YF	ALB	BE+YF	ALB	BE+YF	ALB	BE+YF
80	95.05	4.94	2.15	97.84	96.28	3.72	32.06	67.94
81	95.51	4.49	0.00	100.00	96.58	3.42	4.82	95.18
82	97.26	2.74	5.25	94.75	97.33	2.67	15.97	84.03
83	97.92	2.09	14.34	85.66	96.77	3.23	20.36	79.63
84	96.96	3.03	0.00	0.00	96.72	3.28	1.29	98.71
85	96.56	3.45	19.30	80.71	97.41	2.58	1.62	98.38
86	95.30	4.69	59.07	40.93	97.35	2.65	54.85	45.15
87	93.28	6.72	17.09	82.90	96.22	3.78	43.32	56.68
88	99.36	0.64	0.00	0.00	94.70	5.30	58.30	41.70
89	100.00	0.00	7.00	93.30	94.25	5.75	18.40	81.60
90	100.00	0.00	5.20	94.79	95.33	4.67	10.32	89.68
91	100.00	0.00	3.97	96.03	93.12	6.88	12.24	87.77
92	99.35	0.65	2.84	97.16	94.16	5.83	14.29	85.71
93	99.33	0.67	3.70	96.30	94.82	5.18	45.88	54.12
Overall mean	96.44	3.55	7.20	92.80	96.54	3.46	21.16	78.84

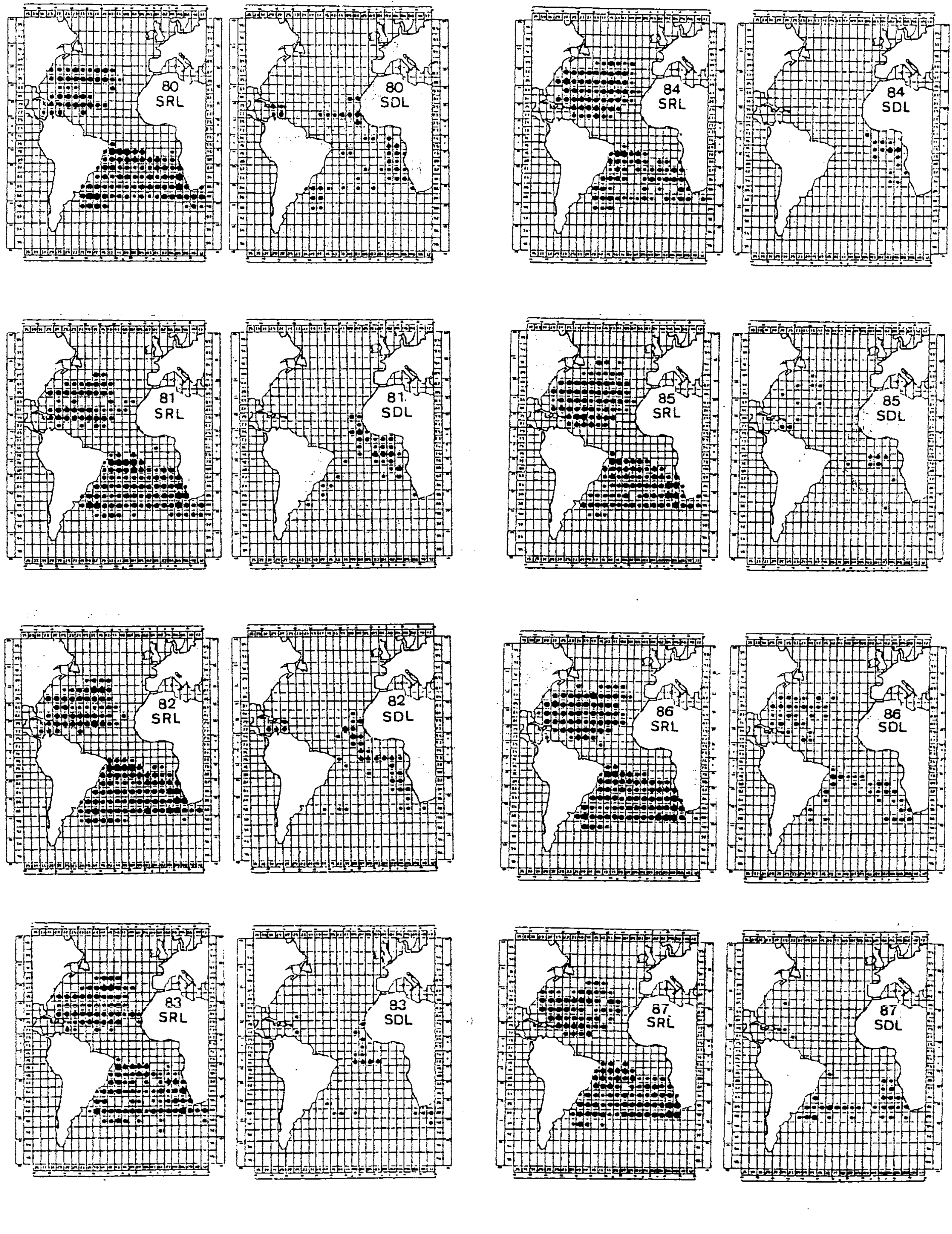

Fig. 1. Effort distribution of segregated Taiwanese SRL (targeted on albacore) and SDL (targeted on bigeye or yellowfin tunas), 1980-1993.

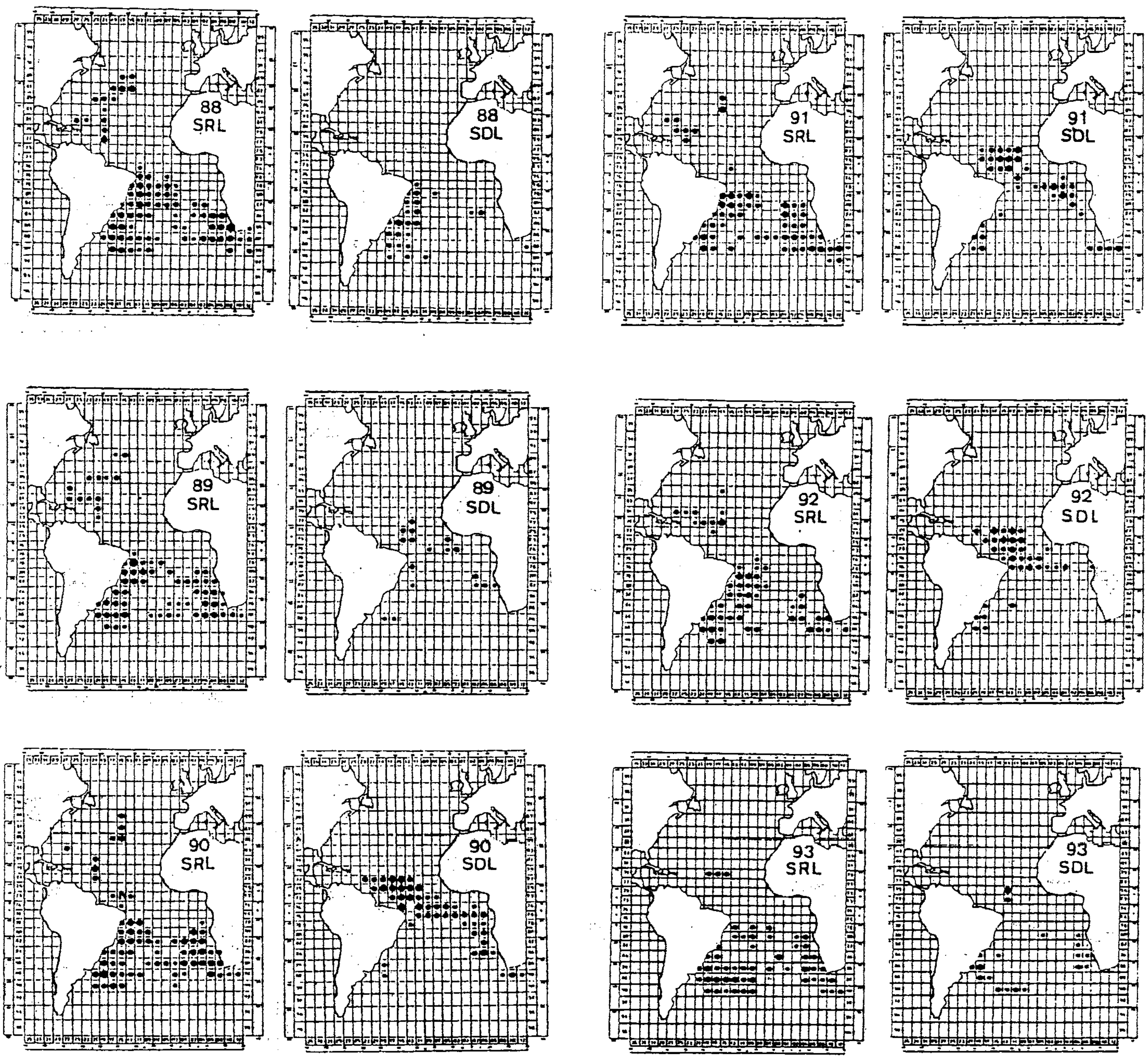

Fig. 1. Continued.

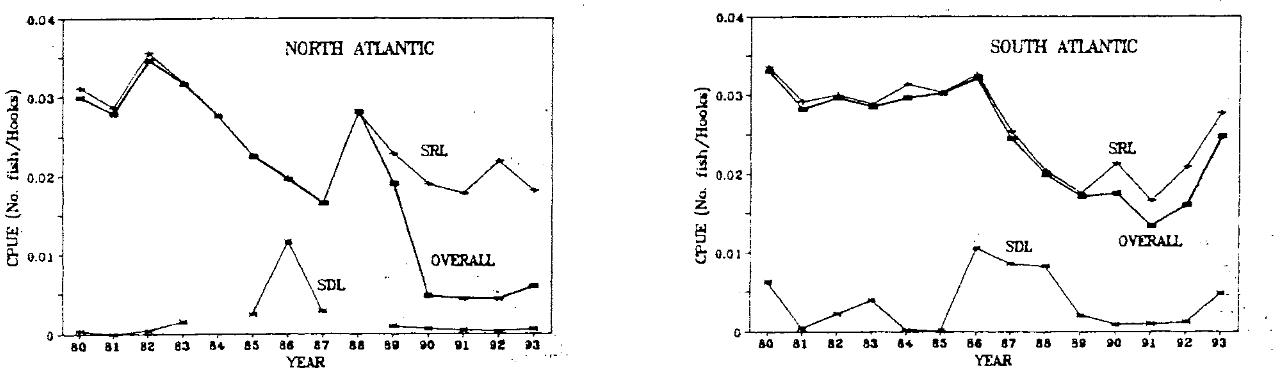

Fig. 2. **Nominal CPUE trends estimated from SRL, SDL and overall longline data (OVERALL) for albacore.**