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THE INFLUENCE OF CHANGES IN LENGTH FREQUENCY SAMPLING METHODOLOGIES ON THE SOUTH PACIFIC ALBACORE STOCK ASSESSMENT

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Abstract

Length frequency data are a key component of stock assessments that use Multifan-CL, and it is important to have consistent, representative time series. Detailed information about sampling protocols is needed in order to establish that sampling is unbiased, and is consistent. In the south Pacific albacore stock assessment, conflict is evident between the length frequency data and the CPUE data. The organization responsible for port sampling at the albacore canneries in Pago Pago changed in 1971, and so did the sampling protocol. However, details of the sampling protocol before 1971 are not available. The statistical distribution of the data also changes at this time, and this change affects the stock assessment. Removing pre-1971 Pago Pago sampling data from the south Pacific albacore stock assessment changed the assessment results, and improved the fit of the model to the data. We recommend omitting these data from future stock assessments, due to lack of information about the sampling protocol. We further note the importance of representative sampling, thorough documentation, and consistent methodologies. We also note the importance of resolving conflicts in information between data sources, either by adjusting the model or excluding some of the data. A 'compromise' solution that ignores the conflict is likely to give a less reliable result.

Introduction

Stock assessments for south Pacific albacore based on integrated analysis of catch at length data have consistently shown large increases in biomass during the late 1960s (Fournier *et al.* 1998, Hampton 2002, Hampton and Fournier 2000, Langley and Hampton 2005, Langley and Hampton 2006). However, analysts have been aware of contrasting information about this increase from two different data sources, which is apparent in the residuals. The catch per unit of effort declines during this period of estimated biomass increase, resulting in large negative residuals. Length frequency residuals also show lack of fit. The conflicting information coming from the two data sources suggested that closer examination of the data would be useful. In this paper, the early length frequency data are examined. The CPUE data are examined in another paper (Bigelow and Hoyle 2008), and other aspects of the length frequency data are examined in a third paper (Langley and Hoyle 2008).

When length frequency is used in the Multifan-CL stock assessment, it is assumed that these data represent the size structure of the population, filtered by the selectivity of the fishery. Consistent biases in the sample collection process can sometimes be accommodated by the model, which incorporates them into the selectivity of the modeled fishery. Such effects, if they are small, may not significantly affect the results of the assessment. However, temporal changes in the bias of length frequency sampling cannot be absorbed in this way, and are more likely to affect the outcomes of the assessment.

Length frequency data prior to 1975 for south Pacific albacore come from two sources: the US Pago Pago based sampling program and the Japanese longline sampling program (Table 1). The Pago Pago data were collected through the operation of a field station in American Samoa, established in 1963, and manned continuously through December 1970 by personnel from the US National Marine Fisheries Service (NMFS), Honolulu. In January 1971 the field station was taken over by the Office of Marine Resources, Government of American Samoa. In the beginning, the length, weight, and sex of 50 albacore, randomly chosen, were obtained from each trip landing. For various reasons, e.g., changes in cannery operating procedures, changes in the sampling procedures were necessitated in subsequent years. The collection of sex and weight data was discontinued in early 1971 (Yoshida 1975).

We sought to determine whether the changes in sampling procedures referred to above may have affected the representativeness of the length frequency sampling. We were unable to find any further documentation of these changes, so investigated whether the length frequency distribution changed, coincident with the changed sampling practices. We also examined the likely effect of any such changes on the results of the stock assessment.

Methods and Results

The length frequency data prior to 1979 were examined for signs of changes in distribution through time to assess whether such changes might account for the observed conflict between the information in the CPUE and length frequency data. The mean and variance for origin, flag, quarter and region data were estimated and each time series checked for consistency and coverage (Figure 1). Two origins account for these data: Pago Pago (SRUS) for all flags (5° latitude × 5° longitude) and

JPLL for the Japanese boats (20° latitude × 20° longitude). A temporal discontinuity in the length distributions of data from the Pago Pago sampling program was observed with an increase in variability after 1970 apparent in all strata of the Pago Pago data (Table 2). This trend was not observed in the Japanese sampling data (Table 2).

The methods used to collect the length frequency data were also reviewed to determine whether there were any changes, or if there was anything in the methods that might lead to sampling bias. The raw data available to SPC from the Pago Pago sampling program report sex for 100% of albacore measured from March 1962 until November 1970 inclusive. In December 1970 only 36% of albacore were sexed. From 1971, no albacore were sexed, apart from sporadically in 1974-75 and 1979-80 (Figure 2). This is consistent with Yoshida's (1975) description and confirms the possibility that sampling methods may have changed around 1970-1971.

Given these observed changes in length frequency data, we tested whether they impacted upon the 2006 stock assessment model (Langley and Hampton 2006). First we separated the length frequency data by splitting the relevant fisheries (Japan/Korea and Taiwan) into 2 groups at 1971; prior to 1971 and post 1971. Catchability was kept the same for the two groups, but we allowed selectivity to vary. Secondly, as an alternative we removed all length frequency data (both JPLL and SRUS) before 1971. The 2006 stock assessment model was then re-estimated with these two length frequency configurations and the outcomes compared with the 2006 base case.

The length frequency data from before 1971 strongly influence the results of the stock assessment (Figure 3). Splitting the time series did not have a large effect, but removing the data resulted in the biomass trend following the CPUE series more closely. This result points to changes in sampling protocol, rather than a change in the selectivity of the fishery at that time.

Discussion

Length frequency data are very influential in the south Pacific albacore stock assessment and conflicts between information in the length frequency data and the CPUE data have been evident for a number of years (Langley and Hampton 2005, Langley and Hampton 2006). In such situations, it is important to examine the data closely in order to determine the source of the conflicts and determine how to resolve them (Langley and Hoyle 2008). Data conflicts must be resolved, either by adjusting the model, or rejecting some of the data in order to improve the reliability of the stock assessment. Alternative models may be constructed if it is not possible to choose one dataset over the other, however a 'compromise' solution that ignores the conflict is unlikely to provide reliable results.

The US sampling program based at Pago Pago comprises the majority of the length frequency records for south Pacific albacore. Our analyses demonstrate that the early length frequency data are highly influential upon stock assessment outputs. We identified that changes in sampling methodology occurred in 1971 in the Pago Pago data, and that there is less variability in the pre-1971 length frequency data. Methodologies before 1971 are unclear, but the determination of sex implies a change in the sampling practices that may have affected length frequency. Canneries often sort their fish prior to processing, and it is important for sampling to occur before sorting. Sorting tends to reduce the variability in the data. It is for this reason that port sampling in Pago Pago currently occurs as fish are removed from the vessel.

However, when fish are removed from the vessel, they are in a frozen state, and determining the sex of albacore requires that the fish be thawed, which may take up to a day. This delay may have provided a greater opportunity for fish to be sorted (either occasionally or consistently). This suggests a possible significant change (and improvement) to sampling practices at the start of 1971.

Sampling meta-data (i.e. how the data were collected) are important for determining how to model the data. The provision of such data allows the statistical technique used to model the data to account for biases and limitations. We were not able to model the pre 1971 Pago Pago data differently as this meta information was not available. It is not unexpected that changes may occur in the early period of a sampling program, nor that meta-data associated with early sampling programs may be difficult to obtain. However, without such meta-data we cannot be confident of the sampling methodologies. Given this lack of certainty and the potential influence of such data, it is advisable to consider their inclusion carefully before using in a stock assessment. In order to clarify the situation, we recommend a review of sampling practices in Pago Pago during the 1960s.

The trend estimated for south Pacific albacore without the pre-1971 data was more consistent with the Taiwanese CPUE data. It also improved consistency with the CPUE trends implied by standardizing the CPUE data from the Japanese, Korean, and Taiwanese distant water longline fisheries over the same period (Bigelow and Hoyle 2008); the trend that you might expect in a developing tuna fishery with increasing catch and effort; and the CPUE trends in other tuna fisheries. These observations support the contention that, until the pre-1971 Pago Pago length frequency sampling practices are clarified, it may be appropriate to model the south Pacific albacore stock without these data.

References

Bigelow, K. A. and Hoyle, S. D. (2008). Standardized CPUE for distant-water fleets targeting south Pacific albacore. No. WCPFC SC4 ME-WP-3.)

Fournier, D. A., Hampton, J., and Sibert, J. R. (1998). MULTIFAN-CL: a length-based, age-structured model for fisheries stock assessment, with application to South Pacific albacore, Thunnus alalunga. *Canadian Journal of Fisheries and Aquatic Sciences* 55, 2105-2116.

Hampton, J.(2002). Stock assessment of albacore tuna in the south Pacific Ocean. *15th Meeting of the Standing Committee on Tuna and Billfish. Honolulu, Hawaii, ALB-1* 31.

Hampton, J. and Fournier, D. (2000). Update of MULTIFAN-CL based assessment of South Pacific albacore tuna. *13th Meeting of the Standing Committee on Tuna and Billfish. Noumea, New Caledonia, ALB-1, 25pp.*

Langley, A. and Hampton, J. (2005). Stock assessment of albacore tuna in the South Pacific Ocean. *WCPFC SC1 SA WP-3.*

Langley, A. D. and Hampton, J. (2006). An update of the stock assessment for South Pacific albacore tuna, including an investigation of the sensitivity to key biological parameters included in the model. In 'Western and Central Pacific Fisheries Commission, Scientific Committee 2'.).

Langley, A. D. and Hoyle, S. D. (2008). Report from the stock assessment preparatory workshop, Noumea, February 2008. No. WCPFC SC4 SA-IP-5 (SPC: Nouméa, New Caledonia.)

Yoshida, H. O.(1975). The American Samoa longline fishery, 1966-71. US Nat. *Mar. Fish. Serv. , Fish. Bull* 73, 747-765.

Table 1: The number of fish measured by vessel flag, sampling program, and year prior to 1980.

		JPLL	SRUS				JPLL	SRUS		
		JP	JP	KR	TW		JP	JP	KR	TW
Region						Region				
1	1962	-	-	-	-	3	-	-	-	-
	1963	-	-	-	-		-	-	-	-
	1964	-	55	-	300		-	-	-	-
	1965	8647	50	-	100		7876	-	-	-
	1966	16178	1090	200	1325		6656	-	-	-
	1967	15893	1431	200	1950		2242	-	-	-
	1968	6007	122	50	1250		1793	-	-	50
	1969	7491	83	750	1150		760	-	-	50
	1970	10542	148	524	1544		654	-	100	-
	1971	3327	-	348	1325		360	-	100	-
	1972	3903	-	203	898		336	-	-	100
	1973	2261	-	3020	1929		1835	-	2676	50
	1974	1794	-	1984	1305		379	-	2236	150
	1975	1683	-	1557	391		28	-	150	-
	1976	2776	-	1996	325		-	-	50	-
	1977	4980	-	1245	375		-	-	150	-
	1978	3438	-	427	100		228	-	-	-
2	1962	-	3545	350	-	4	-	-	-	-
	1963	-	16019	1874	-		-	250	-	-
	1964	-	12816	2344	1012		-	50	-	-
	1965	2474	12090	5998	3573		1403	-	-	-
	1966	4798	8507	8956	11737		1086	673	248	-
	1967	3223	6022	10382	13798		1712	1787	950	700
	1968	1594	3549	9469	11575		84	800	600	150
	1969	379	1724	13177	8501		100	100	50	50
	1970	934	450	9987	9422		692	200	1575	250
	1971	1200	390	9584	9265		307	150	1649	843
	1972	160	50	8180	9802		-	-	1849	199
	1973	1095	-	7446	9321		-	-	2277	445
	1974	124	-	3586	4484		-	-	2683	1789
	1975	126	-	4313	2654		-	-	150	250
	1976	463	-	4448	1833		-	-	150	249
	1977	5329	-	3802	3550		102	-	400	292
	1978	6559	-	1858	703		777	-	375	466

Table 2: Standard deviation of length distribution for the periods 1962-1970 and 1971-1979, for the Japanese longline (JPLL) and US Pago Pago (SRUS) length frequency sampling programs, by region and vessel flag.

Sampling program	Flag	Region	Period 1964-1970	1971-1979
JPLL	JP	1	7.5	6.8
		2	7.4	7.4
		3	9.9	7.8
		4	9.7	9.0
SRUS	JP	1	8.0	-
		2	6.3	8.0
		3	-	-
		4	9.0	11.2
	KR	1	5.4	8.6
		2	5.9	7.6
		3	7.4	10.2
		4	9.0	10.7
	TW	1	5.5	7.2
		2	5.7	7.3
		3	5.6	10.2
		4	8.7	11.2

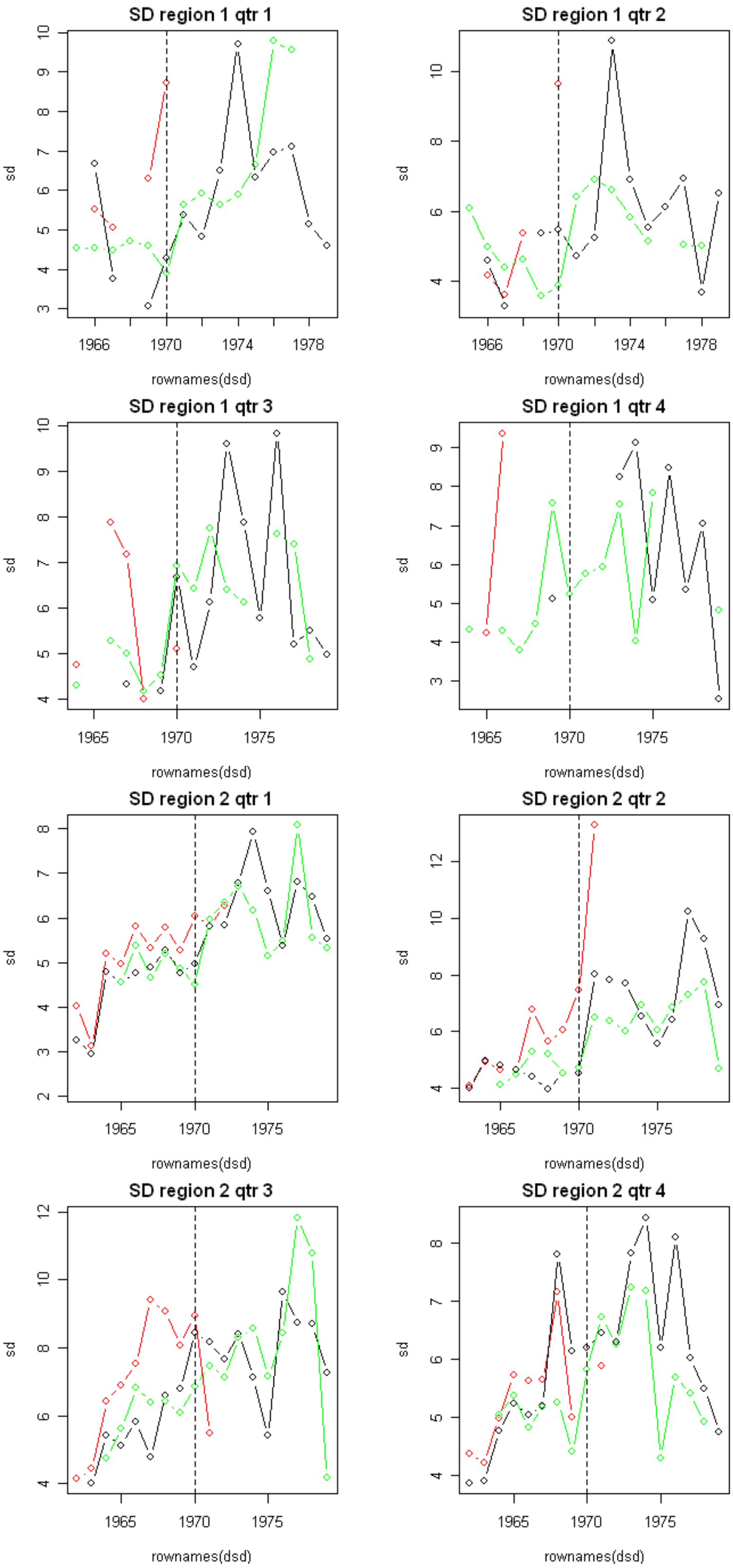

Figure 1: Standard deviation of length frequency data by quarter for region 1 and region 2 of the MFCL stock assessment, for Japan (red), Korea (black), and Taiwan (green).

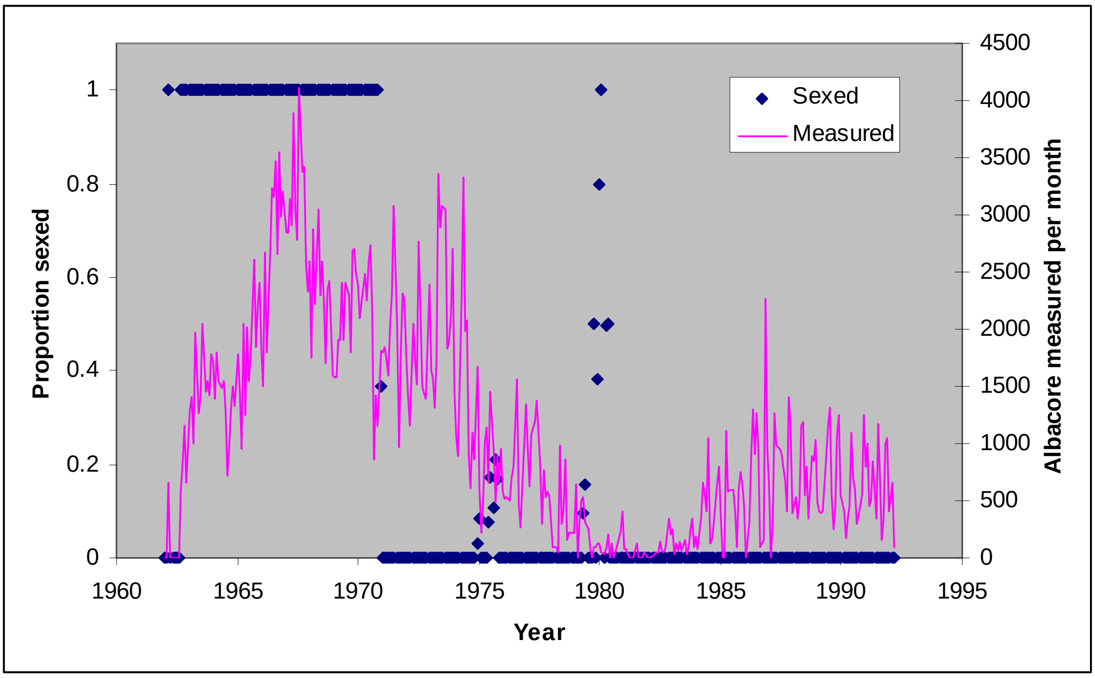

Figure 2: Number of albacore measured and proportion sexed during sampling at the Pago Pago canneries between March 1962 and February 1994.

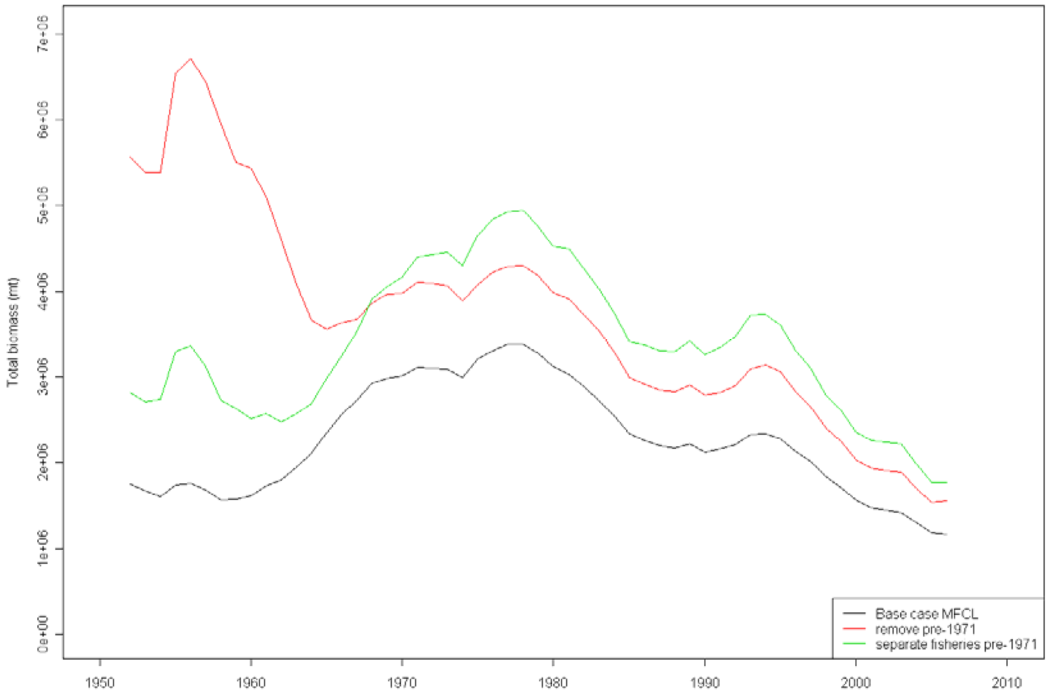

Figure 3: Estimates of total biomass by year based on the data used in the 2006 assessment (Base case MFCL), removing all JP length frequency data prior to 1971, and using separate fisheries to estimate different selectivity pre-1971.