PRELIMINARY RESULTS OF STANDARDIZED CPUE FOR SHORTFIN MAKO SHARK CAUGHT BY JAPANESE LONGLINE FISHERY IN THE ATLANTIC OCEAN

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SUMMARY

The standardized CPUE for shortfin mako shark caught by Japanese longline fishery in the Atlantic Ocean was given using the filtered less than 40% logbook reporting category for shark during 1971-2000. Those logbook data includes shark catch classified as sharks. Another shortfin mako shark standardized CPUE were obtained for the period of 1993-2000 using species-specific catch record without 0% reporting category for the comparison. The sensitivity was checked using less than 20, 30, 40 and 50% filtered data for species combined data sets. Shortfin mako shark CPUEs indicate continually decreasing trends during past three decades for North, South and whole Atlantic stock hypothesis.

RÉSUMÉ

La CPUE standardisée du requin-taupe commun capturé par les palangriers japonais dans l'Atlantique a été obtenue en filtrant les moins de 40% de la catégorie de déclaration des requins dans les livres de bord pour les années 1971-2000. Ces données des carnets de pêche comprennent des prises de requins classées en tant que requins. Une autre CPUE standardisée du requin-taupe commun a été obtenue pour la période 1993-2000 en utilisant des registres de capture spécifiques de l'espèce sans la catégorie 0% aux fins de la comparaison. La sensibilité a été vérifiée en utilisant moins de 20%, 30%, 40% et 50% des données filtrées pour les jeux de données toutes espèces combinées. La CPUE du requin-taupe commun montre une tendance constante à la baisse depuis une trentaine d'années selon les hypothèses Atlantique nord/Atlantique sud et Atlantique entier.

RESUMEN

La CPUE estandarizada del marrajo dientuso capturado por la pesquería de palangre japonesa en el océano Atlántico se obtuvo utilizando la categoría de declaración de cuadernos de pesca filtrada inferior a 40% para los tiburones durante 1971-200. Los datos de estos cuadernos de pesca incluyen capturas de tiburones clasificadas como tiburones. Se obtuvo otra CPUE estandarizada de marrajo dientuso para el período 1993-2000 utilizando declaraciones especificadas por especies con una categoría de declaración del 0% para la comparación. La sensibilidad se comprobó utilizando datos filtrados de menos del 20, 30, 40 y 50% para las series de datos de especies combinadas. Las CPUE de marrajo dientuso indican la existencia de una tendencia decreciente continua durante las últimas décadas para la hipótesis de un solo stock Atlántico y de un stock del Atlántico Sur y Norte.

KEYWORDS

Catchability, Time series analysis, Population dynamics, High seas fisheries, Long lining, Pelagic fisheries, Tuna fisheries, Logbooks, Shortfin mako shark

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1. INTRODUCTION

Nakano and Honma (1996) reviewed CPUE of pelagic shark in the Atlantic Ocean using Japanese longline logbook data with filtering by shark reporting category, e.g. the ratio of operations shark caught to total number of operations in a cruise. Shiode (2001) examined shark species composition and level of CPUE by reporting category comparing with records of shark catch by Japanese observer and concluded the CPUE using filtered logbook data could indicate abundance index of blue and shortfin mako sharks. Although ratio of shortfin mako shark are relatively small with blue shark, the filtered logbook data less than 40% reporting category includes approximately 40% of mako shark catch in number and the level of CPUE were in the range of variation of observed CPUE recorded by observer on boards.

The standardized CPUE of pelagic sharks caught by Japanese longline fishery in the Atlantic Ocean was introduced previous reports submitted to ICCAT sub-committee on by-catches (Nakano and Honma 1996). Since Japanese longline fishery has covered widely in the high seas of the Atlantic Oceans, its fishery statistics must be one of the most valuable resources, which describe stock status of pelagic shark. International concern over the conservation of elasmobranch species has been continued. Therefore, it is useful to examine recent trend of stock status of shortfin mako shark by updating logbook of tuna fisheries. This paper estimated the standardized CPUE of mako sharks in the Atlantic Ocean using the logbook data of Japanese longline fishery from 1971 to 2000.

2. MATERIALS AND METHODS

The filtering was adapted and the data less than 40% of shark reporting category were used for analysis. The data which reporting category less than 20, 30 and 50% were used for sensitivity test. Time series of the data were 30 years from 1971 to 2000, although data for 2000 is provisional. The Japanese logbook system was modified from 1993 and sharks catch record were separated by species (blue, porbeagle, shortfin mako and other sharks from 1993 and blue, porbeagle, shortfin mako, oceanic whitetip, thresher sharks and other sharks from 1997). Then species specific logbook data for blue shark was used for comparison.

Standardized CPUE (number of sharks caught per 1,000 hooks) were calculated using Mixed procedure of SAS to eliminate some biases by change of fishing ground and fishing seasons. A Mixed procedure is a generalization of the standard linear model that provides with flexibility of modeling not only the means of the data but their variances and covariance (SAS Institute 1996). Although Mixed procedure can handle random-effect parameters, only fixed-effects parameter was used in this time. Therefore MLM model is same as GLM model for this analysis. It is useful for the model selection which the mixed procedure of SAS produces several information criteria values.

For standardization, CPUE was calculated shot by shot of operations. The area strata used for the analysis were shown in Figure 1. Numbers of branch line between floats were classified into three categories. CPUEs of mako shark were obtained for the three geographical units, *i.e.* the north, south and overall Atlantic Ocean. The north unit includes area 1 to 5; the south includes area 6 to 9. The equation for standardizing CPUE was as follows:

$$\ln(CPUE_{ijkl} + const) = \ln(\mu) + \ln(YR_i) + \ln(QT_j) + \ln(AR_k) + \ln(br_l) + \ln(INTER) + \varepsilon$$

where ln: natural logarithm, $CPUE_{ijkl}$: nominal CPUE (catch in number per 1,000 hooks, in year i, quarter j, area k, branch line criteria l), const : 1/10 of overall mean, μ : overall mean, YR_i : effect of year i, QT_j : effect of quarter j, AR_k : effect of area k, br_l : branch line criteria l, INTER : any combination of two way interaction, and ε : normal error term. The same effects selected for previous report including interaction terms were used for analysis. The interactions included for the models were QT*AREA, QT*br for the North, South and overall Atlantic stock hypothesis. Analysis was

made through the mixed procedure of computer software, 'SAS System for windows Ver. 6.12'.

3. RESULTS AND DISCUSSION

Table 1 shows number of observations in each year by geographical unit and reporting category 20, 30 and 40%. Type III analysis revealed that all main effects and interaction of selected models were significant (Table 2).

Figure 2 shows the standardized CPUE for the North, South and overall units. The values of CPUE ranged around 0.005 to 0.03 and were in the range of reported CPUE by observer on board for pelagic sharks caught by longline fishery. The sensitivity of data sets were checked using the data of reporting category 20, 30, 40 and 50% (Fig.3). The higher reporting categories, 40 and 50% reveals decreeing trends, although lower reporting categories indicate more stable states. There is some trade-off problems how to select appropriate reporting category. Since proportion of shortfin mako shark decreasing according the reporting category, smaller reporting category can represent shortfin mako catch. However, the level of CPUE is much lower than it obtained by observer program. Therefore, the reporting category of less than 40% was selected comparing the level of CPUE observed by observer and checking the proportion of shortfin mako in the catch (about 40% for the reporting category less than 40%).

The results indicate continuously decreeing trends with small fluctuation in the North, South and overall units, although the CPUE of South unit indicates increasing trend recent three years. Therefore results of the analysis suggests that stock status of shortfin mako shark gradually decreasing past three decades.

Standardized CPUEs using species specific data were shown in Figure 4. The CPUE of each stock unit indicate similar trends reveled by species combined data. Species specific CPUEs and CPUEs used species combined data set were compared (Fig. 5). Both CPUEs indicated similar trends and same level of CPUE among stock units.

The shortfin mako shark is one of the sub target species for Japanese tuna longline fishery. Fishermen keep shortfin mako shark and land at fishery market. There is few information of long-term stock status for shortfin mako shark, which inhabits in the high sea area. It is necessary to conduct further research activities on board, such as observer program, to examine the population dynamics for the species.

4. REFERENCE

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Table 1. Number of observations by geographical unit and reporting categories in each year.

	20%			30%			40%		
	North	South	overall	North	South	overall	North	South	overall
1971	968	427	1,395	2,060	866	2,926	3,538	1,308	4,846
1972	1,161	900	2,061	1,894	1,241	3,135	2,671	1,652	4,323
1973	476	890	1,366	768	1,406	2,174	988	2,048	3,036
1974	851	852	1,703	1,429	1,065	2,494	1,970	1,209	3,179
1975	1,688	545	2,233	3,069	899	3,968	4,393	1,221	5,614
1976	1,072	364	1,436	1,703	581	2,284	2,669	695	3,364
1977	630	662	1,292	965	840	1,805	1,343	1,195	2,538
1978	475	646	1,121	736	857	1,593	967	1,153	2,120
1979	1,914	4,418	6,332	2,664	5,378	8,042	3,107	5,663	8,770
1980	1,934	2,956	4,890	2,971	3,750	6,721	4,039	4,619	8,658
1981	3,897	2,094	5,991	4,993	2,786	7,779	6,299	3,814	10,113
1982	2,427	3,814	6,241	3,638	5,000	8,638	5,107	6,095	11,202
1983	1,633	2,549	4,182	2,907	3,093	6,000	3,983	3,767	7,750
1984	1,496	2,817	4,313	2,179	4,016	6,195	2,957	4,790	7,747
1985	1,281	3,428	4,709	2,318	4,696	7,014	3,060	5,407	8,467
1986	1,549	2,184	3,733	2,736	2,941	5,677	3,269	3,626	6,895
1987	1,364	1,348	2,712	2,028	1,981	4,009	2,753	2,504	5,257
1988	1,625	2,546	4,171	2,470	3,102	5,572	3,359	3,912	7,271
1989	2,014	2,718	4,732	2,822	3,601	6,423	3,619	4,640	8,259
1990	2,162	3,995	6,157	3,114	5,370	8,484	3,697	6,491	10,188
1991	2,361	4,439	6,800	3,141	5,629	8,770	3,701	6,449	10,150
1992	2,111	2,729	4,840	3,048	3,722	6,770	3,574	4,472	8,046
1993	1,214	4,303	5,517	1,727	5,290	7,017	1,957	5,937	7,894
1994	2,238	5,557	7,795	2,792	6,861	9,653	2,851	7,532	10,383
1995	2,224	7,534	9,758	2,700	8,235	10,935	2,999	8,847	11,846
1996	3,443	6,635	10,078	4,459	7,609	12,068	4,926	7,906	12,832
1997	2,802	3,775	6,577	3,483	4,465	7,948	4,005	5,012	9,017
1998	3,118	4,052	7,170	3,589	4,873	8,462	3,828	5,294	9,122
1999	2,154	3,585	5,739	2,703	4,256	6,959	3,068	4,703	7,771
2000	1,237	1,303	2,540	1,352	1,501	2,853	1,390	1,629	3,019
Total	53,519	84,065	137,584	76,458	105,910	182,368	96,087	123,590	219,677

Table 2. Outputs of Type III analysis for the models selected in each unit.

NDF is the numerator degrees of freedom, and DDF is the denominator degrees of freedom.

North Atlantic: **Tests of Fixed Effects**

Source	NDF	DDF	Type III ChiSq	Type III F	Pr > ChiSq	Ord ChiSq	Pr > F	Ord F
YR	29	9.60E+04	538.78	18.58	0.0001	0	0.0001	0
QT	3	9.60E+04	51.52	17.17	0.0001	0	0.0001	0
AREA	4	9.60E+04	153.49	38.37	0.0001	0	0.0001	0
BR	2	9.60E+04	42.64	21.32	0.0001	0	0.0001	0
QT*AREA	12	9.60E+04	253.15	21.1	0.0001	0	0.0001	0
QT*BR	6	9.60E+04	203.2	33.87	0.0001	0	0.0001	0

South Atlantic: **Tests of Fixed Effects**

Source	NDF	DDF	Type III ChiSq	Type III F	Pr > ChiSq	Ord ChiSq	Pr > F	Ord F
YR	29	1.20E+05	1331.15	45.9	0.0001	0	0.0001	0
QT	3	1.20E+05	83.38	27.79	0.0001	0	0.0001	0
AREA	3	1.20E+05	944.04	314.68	0.0001	0	0.0001	0
BR	2	1.20E+05	65.66	32.83	0.0001	0	0.0001	0
QT*AREA	9	1.20E+05	406.33	45.15	0.0001	0	0.0001	0
QT*BR	6	1.20E+05	239.31	39.89	0.0001	0	0.0001	0

Tests of Fixed Effects

Source	NDF	DDF	Type III ChiSq	Type III F	Pr > ChiSq	Ord ChiSq	Pr > F	Ord F
YR	29	2.20E+05	1428.04	49.24	0.0001	0	0.0001	0
QT	3	2.20E+05	19.58	6.53	0.0002	0	0.0002	0.0003
AREA	8	2.20E+05	1077.34	134.67	0.0001	0	0.0001	0
BR	2	2.20E+05	84.16	42.08	0.0001	0	0.0001	0
QT*AREA	24	2.20E+05	736.03	30.67	0.0001	0	0.0001	0
QT*BR	6	2.20E+05	376.53	62.76	0.0001	0	0.0001	0

Table 3. Annual, standardized CPUE for shortfin mako shark from the models selected in each unit.

	North Atlantic:			South Atlantic:			overall Atlantic:		
Year	**CPUE**	**Lower**	**Upper**	**CPUE**	**Lower**	**Upper**	**CPUE**	**Lower**	**Upper**
1971	**0.0292**	**0.0269**	**0.0317**	**0.0212**	**0.0187**	**0.0239**	**0.0250**	**0.0233**	**0.0267**
1972	**0.0198**	**0.0176**	**0.0222**	**0.0199**	**0.0177**	**0.0223**	**0.0184**	**0.0169**	**0.0199**
1973	**0.0219**	**0.0185**	**0.0257**	**0.0213**	**0.0191**	**0.0236**	**0.0221**	**0.0202**	**0.0240**
1974	**0.0224**	**0.0199**	**0.0252**	**0.0186**	**0.0162**	**0.0213**	**0.0200**	**0.0183**	**0.0218**
1975	**0.0253**	**0.0233**	**0.0273**	**0.0189**	**0.0165**	**0.0216**	**0.0213**	**0.0199**	**0.0228**
1976	**0.0266**	**0.0241**	**0.0293**	**0.0219**	**0.0186**	**0.0257**	**0.0230**	**0.0212**	**0.0249**
1977	**0.0255**	**0.0223**	**0.0290**	**0.0192**	**0.0167**	**0.0219**	**0.0214**	**0.0194**	**0.0235**
1978	**0.0232**	**0.0197**	**0.0270**	**0.0169**	**0.0146**	**0.0194**	**0.0194**	**0.0174**	**0.0215**
1979	**0.0225**	**0.0205**	**0.0247**	**0.0103**	**0.0093**	**0.0113**	**0.0143**	**0.0134**	**0.0152**
1980	**0.0212**	**0.0194**	**0.0231**	**0.0150**	**0.0139**	**0.0163**	**0.0180**	**0.0170**	**0.0191**
1981	**0.0194**	**0.0179**	**0.0208**	**0.0252**	**0.0234**	**0.0270**	**0.0204**	**0.0193**	**0.0214**
1982	**0.0196**	**0.0181**	**0.0212**	**0.0133**	**0.0123**	**0.0144**	**0.0161**	**0.0152**	**0.0170**
1983	**0.0217**	**0.0199**	**0.0236**	**0.0159**	**0.0146**	**0.0173**	**0.0184**	**0.0173**	**0.0195**
1984	**0.0217**	**0.0197**	**0.0239**	**0.0131**	**0.0120**	**0.0142**	**0.0170**	**0.0159**	**0.0180**
1985	**0.0213**	**0.0193**	**0.0234**	**0.0119**	**0.0109**	**0.0129**	**0.0158**	**0.0149**	**0.0168**
1986	**0.0182**	**0.0164**	**0.0201**	**0.0131**	**0.0119**	**0.0144**	**0.0155**	**0.0145**	**0.0166**
1987	**0.0247**	**0.0224**	**0.0271**	**0.0146**	**0.0131**	**0.0162**	**0.0193**	**0.0180**	**0.0206**
1988	**0.0207**	**0.0188**	**0.0227**	**0.0143**	**0.0130**	**0.0156**	**0.0174**	**0.0164**	**0.0186**
1989	**0.0203**	**0.0186**	**0.0222**	**0.0121**	**0.0110**	**0.0132**	**0.0158**	**0.0148**	**0.0168**
1990	**0.0183**	**0.0166**	**0.0200**	**0.0111**	**0.0102**	**0.0120**	**0.0145**	**0.0136**	**0.0153**
1991	**0.0189**	**0.0172**	**0.0207**	**0.0116**	**0.0107**	**0.0125**	**0.0151**	**0.0142**	**0.0160**
1992	**0.0182**	**0.0166**	**0.0200**	**0.0098**	**0.0088**	**0.0108**	**0.0136**	**0.0128**	**0.0146**
1993	**0.0194**	**0.0171**	**0.0219**	**0.0085**	**0.0077**	**0.0093**	**0.0123**	**0.0115**	**0.0132**
1994	**0.0117**	**0.0102**	**0.0133**	**0.0079**	**0.0072**	**0.0086**	**0.0103**	**0.0096**	**0.0110**
1995	**0.0157**	**0.0140**	**0.0175**	**0.0063**	**0.0057**	**0.0070**	**0.0097**	**0.0091**	**0.0104**
1996	**0.0165**	**0.0151**	**0.0179**	**0.0062**	**0.0055**	**0.0069**	**0.0101**	**0.0095**	**0.0107**
1997	**0.0139**	**0.0126**	**0.0154**	**0.0077**	**0.0069**	**0.0086**	**0.0108**	**0.0100**	**0.0115**
1998	**0.0111**	**0.0098**	**0.0124**	**0.0063**	**0.0055**	**0.0071**	**0.0086**	**0.0079**	**0.0093**
1999	**0.0124**	**0.0109**	**0.0140**	**0.0069**	**0.0061**	**0.0078**	**0.0095**	**0.0087**	**0.0103**
2000	**0.0079**	**0.0061**	**0.0099**	**0.0072**	**0.0058**	**0.0086**	**0.0080**	**0.0069**	**0.0092**

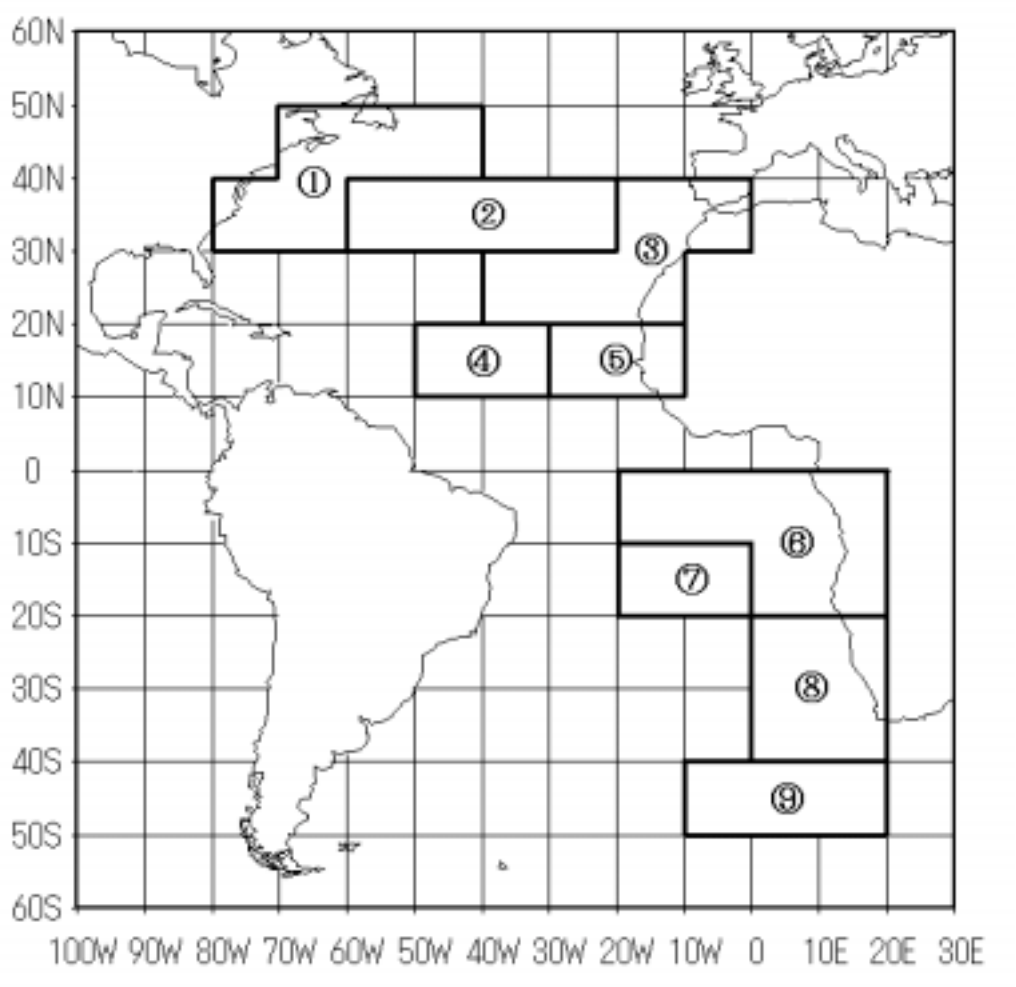

Figure 1. Area classification used for the analysis for shortfin mako shark.

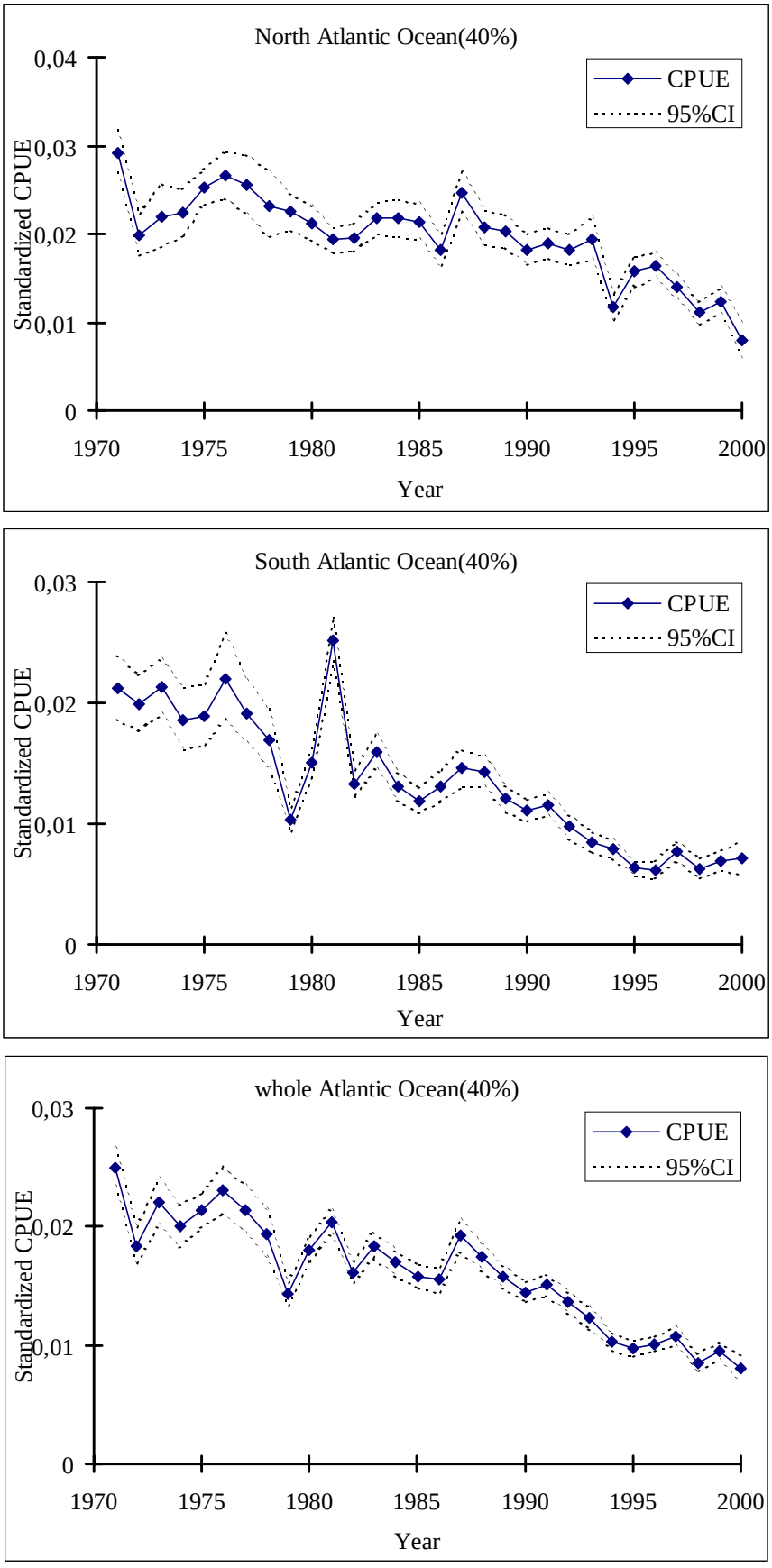

Figure 2. Standardized shortfin mako shark CPUE and 95% confidence intervals based on the logbook data of Japanese longline fishery in the Atlantic Ocean.

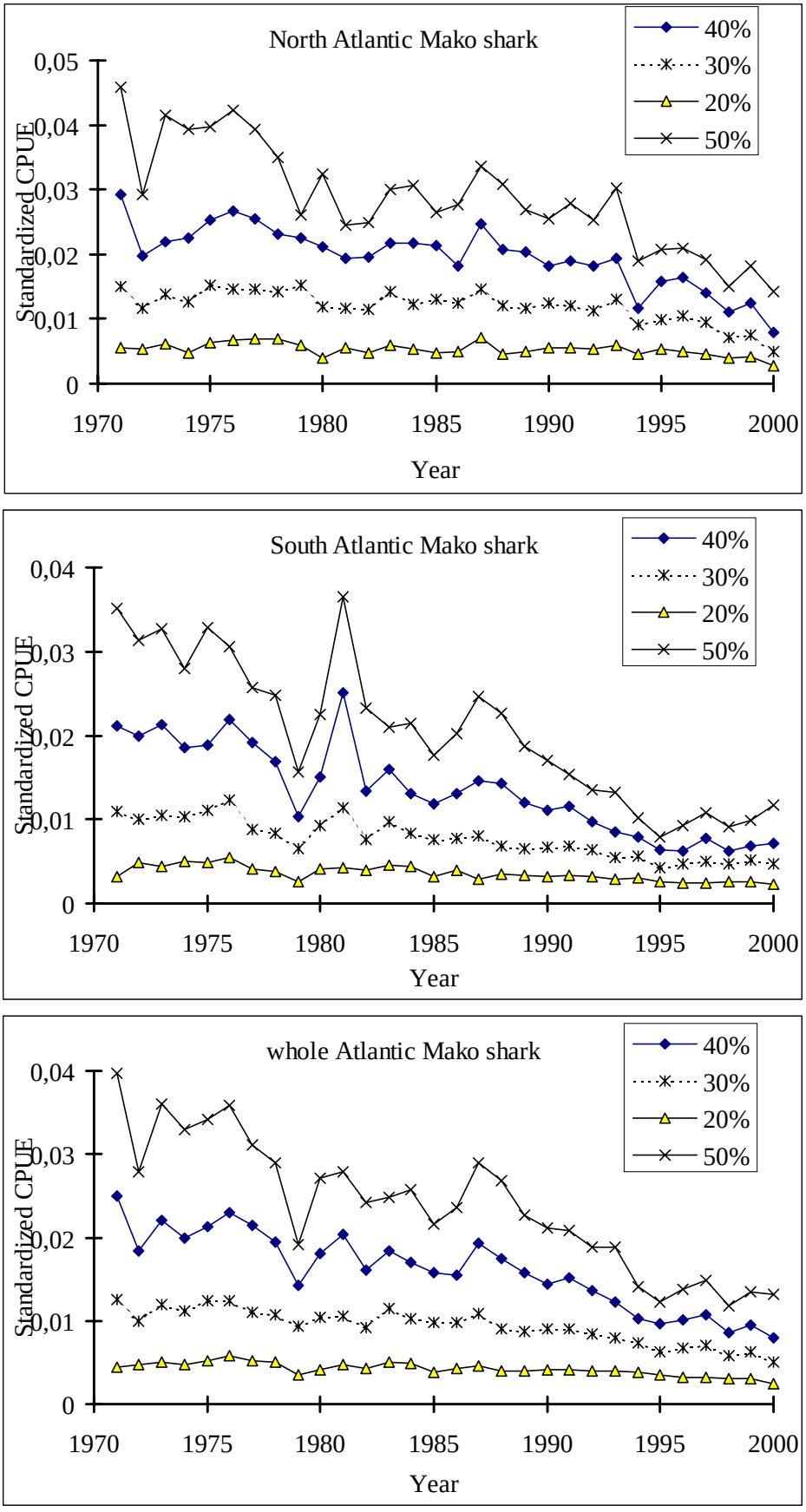

Figure 3. Sensitivity test of Standardized CPUE for blue shark using filtered data by 20, 30, 40 and 50% reporting category.

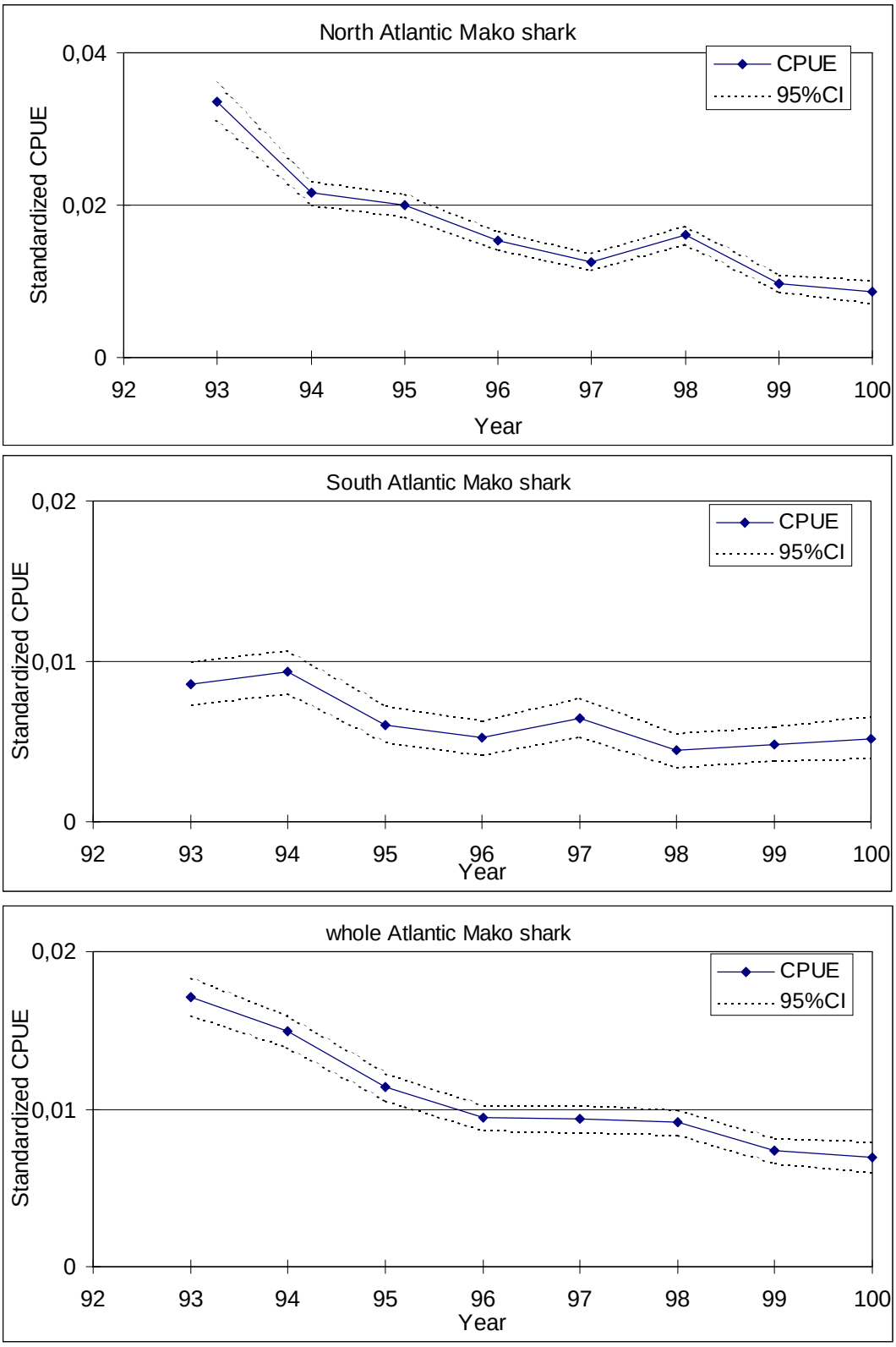

Figure 4. Standardized CPUE for shortfin mako shark using species-specific logbook data without zero reporting category.

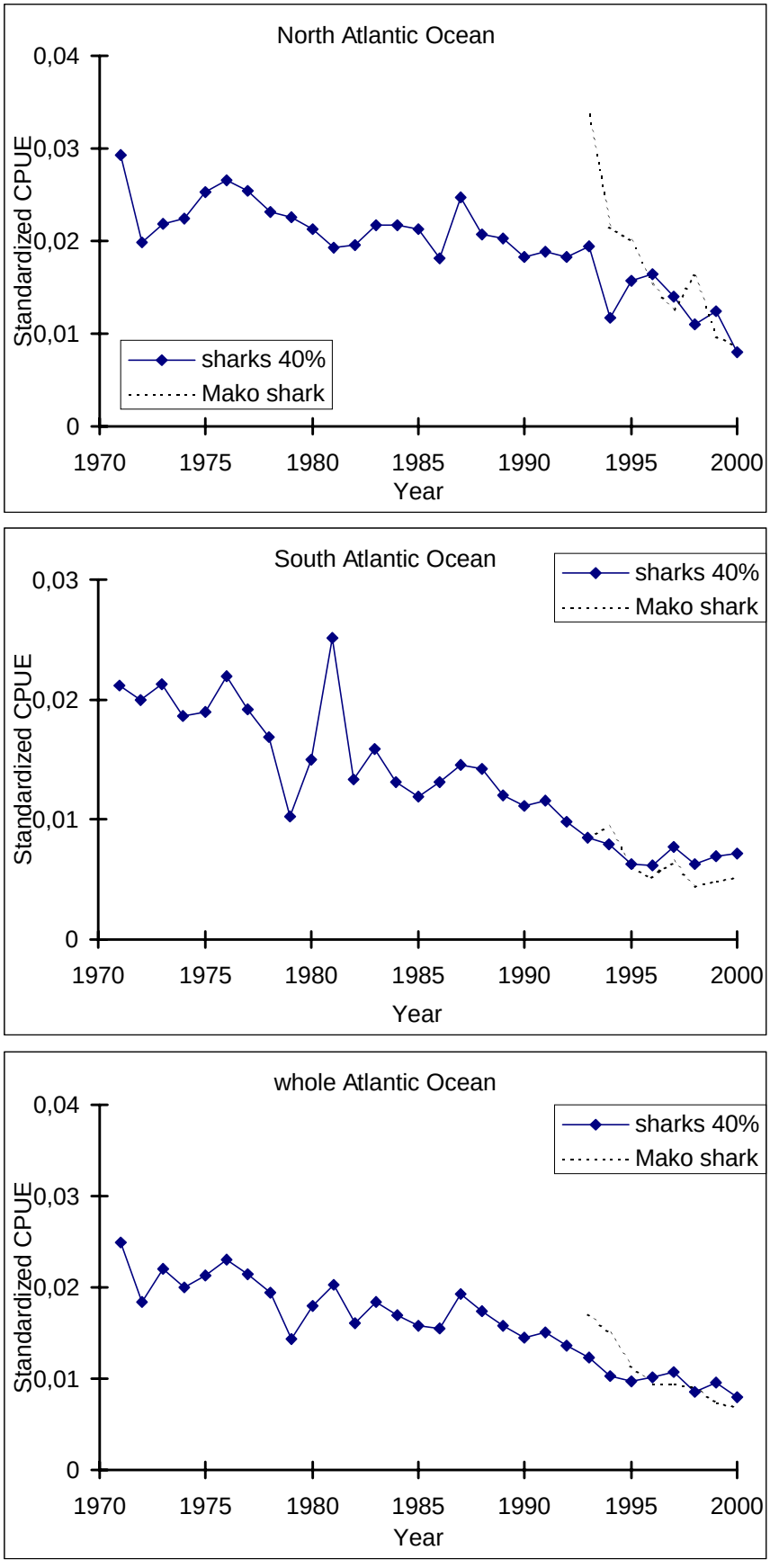

Figure 5. Comparison of standardized CPUEs using filtered logbook data as classified sharks and shortfin mako shark.