

**RELIABILITY OF THE SIZE COMPOSITION DATA OF THE CATCHES FOR THE ATLANTIC BLUEFIN TUNA***T. Nagai*

## SUMMARY

The reliability of the size composition data was examined, duly taking into consideration actual sample size, the total number of fish caught by area-nation-gear (fishery) stratum and substitutions made for no-data strata. The reliability is remarkably low, regardless of the area (west Atlantic, east Atlantic and Mediterranean) before 1970. In later years, the reliability is still low in the east Atlantic and the Mediterranean Sea, while it has improved in the west Atlantic.

## RESUME

Le degré de fiabilité des données de composition de taille a été étudié attentivement en tenant compte du volume réel de l'échantillon, le nombre total de poissons pris par strate zone-pays-engin (pêcherie) et les substitutions faites pour les strates sans données. Avant 1970, les données sont remarquablement peu fiables quelle que soit la zone (Atlantique ouest, Atlantique est, Méditerranée). Ces dernières années, la fiabilité demeure faible en Atlantique est et en Méditerranée, alors qu'elle s'améliore en Atlantique ouest.

## RESUMEN

Se examinó la fiabilidad de los datos de composición por talla, teniendo debidamente en cuenta el tamaño de la muestra, el número total de peces capturados por estratos de zona/país/arte (pesquería) así como las sustituciones efectuadas en los estratos sin datos. La fiabilidad es marcadamente baja en cualquiera de las zonas (Atlántico Oeste, Atlántico Este y Mediterráneo) antes de 1970. En años posteriores, esta fiabilidad se mantiene baja en el Atlántico Este y Mediterráneo, si bien ha mejorado en el Atlántico Oeste.

We, ICCAT scientists, have employed the analytical method using the annual catch-at-age data to assess the Atlantic bluefin tuna resources as is done for many other species. In the case of bluefin tuna, there have been some discussions in the past concerning the representability of the size composition data actually collected. It seems, however, that such discussions have been lacking in concreteness. Accordingly, the purpose of this paper is to study the reliability of size composition data by duly taking into consideration actual sample (in which body length or body weight was measured) size and the total number of fish caught by area-nation-gear (fishery).

Regarding the question of what the sample size should be, both an old and new problem, it may be difficult to establish a general criterion for the appropriate sample size, since the conditions may be species and/or gear specific. Baranov (1918) who studied this question with a simplified model pointed out the following:

- (1) A sample of less than 200 fish, is not sufficient. It is desirable that the sample be more than 1,000 fish.
- (2) It is not desirable to divide the sample into too many small groups. If the sample consists of 500 ~ 1,000 fish, it should not be divided into more than 10 to 15 groups.

The bluefin tuna has a distinct habitat segregation by growth stage. Therefore, one kind of fishery can not completely cover the whole habitat of this species. There are many kinds of fishing gear used for catching bluefin tuna and each gear has a specific selectivity. For these two reasons, it may be necessary to take samples appropriately by subdividing fishing areas, fishing gear and time to estimate size composition of catch by sea area (west Atlantic, east Atlantic and Mediterranean) correctly. In particular, taking into consideration of a long life span of bluefin tuna, the sample size within strata would have to be increased as fish consisted of many age groups are targeted. I would like to check here to what extent actual samples could be relied upon from the following standpoints.

- (1) It is not important whether the sampling fraction exceeds a given level or not in terms of percentage within the whole area. It must, however, satisfy a given sampling size for each fishery.
- (2) In cases where the number of fish caught is small, the smaller sample size is acceptable.

- (3) Let us translate to what extent desired minimum sample size is satisfied into marks (grade).
- (4) If the sample exceeds the minimum sample size which is determined by the number of fish caught, we give it a mark of 100 and in other cases, a percentage derived from the actual sample size divided by the minimum sample size to give a percentage or its mark.
- (5) The individual marks by gear are weighted in terms of corresponding catches in number to obtain the mark for each area.

Then, based on simple random sampling (Doi, 1975) sample size (n) is calculated by:

$$\epsilon = \frac{\sigma(P)}{P} = \sqrt{\frac{1-P}{P} \frac{N-n}{n(N-1)}} \dots\dots\dots (1)$$

where N = population number (actual total catch in number by gear),  
 P = ratio (the number of fish at age i or at size i/total fish),  
 ε = desired precision.

Generally, ε is 0.2 in case of fish population study. Concerning P it may be fairly small value less than 0.1 when we intend to estimate the number of old-aged fish caught exactly because of longevity of the species concerned. On the other hand, P should be smaller than that aforementioned when the number of fish by size is estimated. For more than 300 length classes often appear in the sample classified into 1 cm interval. Table 1 shows some examples of sample size calculated from equation (1).

In the following analyses, three levels of m.s.s. (minimum sample size) were decided remembering the results above-mentioned.

	Level 1	Level 2	Level 3
C ≥ 1000	300	200	100
1,000 > C ≥ 500	95	63	32
500 > C ≥ 100	67	45	22
C < 100	30	20	10

C: Annual total catch by area-nation-gear (in number).

For example, in a given fishery, if the total number of fish caught is 2,000 and the sample size is 150 in a given year (Case A) and the former is 400 and the latter is 50 in another year (Case B), the marks calculated in each of the cases would be as follows.

	Level 1	Level 2	Level 3
Case A	50	75	100
Case B	75	100	100

The above method was applied to the appendix tables A and B of the Trapani meeting report (Anon., 1983) and the marks of each sea area were calculated. The result of this calculation is given in Table 2. The figures of SEISEKI 1 to 3 in Table 2 mean the marks corresponding to the levels 1 to 3. The following can be pointed out about this table.

- (1) The marks don't differ greatly even if the levels are different. Thus, regardless of these levels, the pattern of yearly change of marks are the same.
- (2) As for the marks for the west Atlantic, high marks of greater than 90 can be seen after 1970. Before 1969 the marks are rather high but relatively low compared to those after 1970. The high marks in the 1960's are resulted from the large sample reported from the purse seine fishery of the United States.
- (3) For the east Atlantic, except for the specific years of 1974, 1975 and 1977, the marks are more than 50 after 1970. The marks before 1969 are, however, fairly low on the whole.
- (4) In the Mediterranean Sea, not a single mark of any given year exceeds 50. The marks before 1968 are less than 20.
- (5) If the data of the east Atlantic and Mediterranean Sea are combined, the marks continue to stay at more or less 50 after 1970. Before 1969, there are many years of less than 20.
- (6) What can be gathered by comparing the marks of each sea area is that the marks before 1969 are considerably lower than those of the following years and in the years after 1970, it is low on the whole in the east Atlantic, Mediterranean Sea and in the combined area of the east Atlantic and Mediterranean Sea compared to the west Atlantic.

Incidentally, it must be noted that because of a lack of data, there was no other way but to assume the mark of 100 from the very beginning in some fisheries for a certain number of years. This is to say that actual sample sizes are not known in each case given in Table 3 although it is recorded that samplings were made. The calculation in this case clearly overestimates the marks. In another example, the handline fishery of the United States list 1767 and 1199 fish sampled in 1976 and 1977, respectively. However, actual catches reported from the fishery are only 520 and 741 fish. It would add another bias to the results of calculation.

The result of calculations made by assuming the mark as zero when the actual sample size was not known is given in Table 4 for reference. It is clear from this table that in the cases where actual sample size is unknown, this assumption has a large effect on the mark of the overall sea area in the east Atlantic and Mediterranean Sea.

Thus in the foregoing descriptions, the degree to which the sample size of each fishery satisfies the m.s.s. was checked to examine the reliability of size composition of the bluefin tuna catch.

Although the m.s.s. was arbitrarily decided in this paper, it may seem to be a rough standard from the examples of Baranov (1918), Doi (1975), and Miyake & Hayasi (1978). If a more accurate data on size range, age and the range of age are known for each fishery, it would be possible

#### Addendum

to study a desirable sample size in more detail and on a theoretical basis. However, even if this was done there would be no change, disregarding the differences of sea areas, in the two facts that first, the reliability on the size composition of catch before 1969 is low and secondly, it is comparatively low in the east Atlantic and Mediterranean Sea compared to the west Atlantic in the years after 1970.

We scientists of ICCAT studying bluefin tuna have estimated length composition of catch by area by expanding the data when there were samples and by substitution without samples. As a matter of fact, in terms of the number of years in which fishing was conducted by area-nation-gear, substitution was implemented for 35% in the west Atlantic, 46% in the east Atlantic and 79% in the Mediterranean Sea. The data of body length composition of catch by area obtained by this method is considerably incomplete as a matter of course. It should not be thought that the data we have on hand is complete, simply because of the fact that there are no alternative data on length composition. Before anything else, the processing of data fit for the degree of precision or corresponding to the degree of detailedness obtained is hoped for. In this same context, when interpreting the result analysed by this data, a flexible approach is recommended by taking into consideration the biological information on fisheries such as annual trends of catch and CPUE, etc. It is indeed such flexibility which translates into a scientific and intelligent guess without which our work would only become like a fairy tale story.

This paper was submitted for discussion to the Bluefin tuna workshop held in Japan based on the data base prepared at Trapani meeting in May, 1983. The present paper is now revised using the newly compiled data after the workshop.

#### References

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Table 2. The marks of each sea area on the assumption that the mark of 100 is assigned in cases where sampling size is unknown.

Table 1. Sampling size under the assumption that desired precision is fix at 0.2.

P	N			
	100	1000	10000	100000
0.01	96	712	1984	2415
0.02	93	551	1091	1210
0.03	89	447	748	802
0.04	86	375	566	596
0.05	83	322	454	473
0.06	80	281	377	390
0.07	77	249	322	331
0.08	74	223	280	287
0.09	71	202	247	252
0.1	69	184	220	225
0.2	50	91	99	100
0.3	37	55	58	58
0.4	27	36	37	37
0.5	20	24	25	25
0.6	14	16	17	17
0.7	10	11	11	11
0.8	6	6	6	6
0.9	3	3	3	3
1.0	0	0	0	0

N: Population number.

P: Ratio.

	Year										
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
<b>West</b>											
Catch(10 <sup>3</sup> fish)	12	24	149	307	260	351	296	146	72	87	349
Sample(No)	934	570	3800	6565	1791	2350	1198	1823	1371	1186	11094
Seiseki 1	12	56	77	69	78	78	69	88	71	81	99
Seiseki 2	14	75	79	72	81	78	71	88	73	85	94
Seiseki 3	16	77	82	80	91	79	78	90	76	95	90
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Catch(10 <sup>3</sup> fish)	358	312	243	140	261	125	95	75	71	64	90
Sample(No)	7606	3829	5566	8274	11743	9943	16507	11028	11120	4787	3451
Seiseki 1	100	99	97	98	100	97	98	98	98	98	98
Seiseki 2	100	100	98	98	100	97	98	98	98	98	98
Seiseki 3	100	100	98	98	100	97	98	98	98	98	98
<b>East</b>											
Catch(10 <sup>3</sup> fish)	907	1134	740	820	754	412	778	780	232	366	254
Sample(No)	1430	1332	996	381	487	442	1197	1319	1059	1132	1427
Seiseki 1	2	6	68	34	3	6	25	14	34	39	58
Seiseki 2	2	6	81	34	3	6	25	14	34	39	58
Seiseki 3	2	6	81	34	3	7	25	14	34	39	58
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Catch(10 <sup>3</sup> fish)	120	244	231	272	832	172	318	254	149	172	183
Sample(No)	1051	531	417	244	4274	1997	2303	473	940	1022	933
Seiseki 1	91	75	87	39	22	50	46	94	66	58	85
Seiseki 2	91	88	98	40	22	50	47	95	66	58	85
Seiseki 3	91	98	98	42	22	52	47	96	66	58	85
<b>Medit</b>											
Catch(10 <sup>3</sup> fish)	51	80	261	1188	119	65	556	793	835	160	99
Sample(No)	0	0	0	0	0	232	152	768	1771	2059	172
Seiseki 1	6	5	2	13	12	17	2	3	11	36	29
Seiseki 2	6	5	2	13	12	19	2	4	12	36	31
Seiseki 3	6	5	2	13	12	19	2	4	12	36	32
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Catch(10 <sup>3</sup> fish)	288	219	210	374	458	606	605	500	214	323	473
Sample(No)	229	0	0	1	909	363	1674	717	867	1179	2318
Seiseki 1	24	32	34	20	31	37	47	37	42	16	40
Seiseki 2	24	32	34	20	32	37	47	37	43	16	40
Seiseki 3	24	32	34	20	32	37	47	37	44	16	40
<b>East + Medit</b>											
Catch(10 <sup>3</sup> fish)	958	1214	1000	2007	873	477	1334	1573	1066	526	353
Sample(No)	1430	1332	996	381	487	674	1349	2087	2830	3191	1599
Seiseki 1	3	6	51	21	4	8	15	9	16	38	50
Seiseki 2	3	6	60	21	4	8	15	9	17	38	51
Seiseki 3	3	6	60	21	4	8	15	9	17	38	51
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Catch(10 <sup>3</sup> fish)	403	463	440	646	1290	777	923	755	363	495	656
Sample(No)	1280	531	417	245	5183	2360	3977	1190	1807	2201	3251
Seiseki 1	44	54	61	28	25	40	47	56	52	31	52
Seiseki 2	44	61	67	28	25	40	47	57	53	31	52
Seiseki 3	44	67	67	29	25	41	47	57	53	31	52

Remarks: The figures of Seiseki 1-3 represent the marks corresponding to the levels 1-3 of the desired sampling size.

Table 3. Fishery( gear ) and fishing years in the cases where actual sample size is unknown.

Area	Country	Gear*	Year
West	Canada	TRAP	'67-'72
	USA	RR	'80-'81
	USA	PS	'80-'81
	USA	HAND	'80-'81
	USA	HARP	'77-'78, '80-'81
East	France	BB	'66-'79, '81
	Norway	PS	'60-'81
	Spain NE	BB	'66-'81
	Spain Canary	BB	'79-'81
	Spain Atl.	TRAP	'79-'81
	Spain	HAND	'78-'81
	Spain	LL	'75, '79, '81
	Spain	SURF	'63
Medit.	France	PS	'70-'79, '81
	Italy Adriatic	PSFS	'71-'73, '76-'78
	Libya	UNCL	'64
	Spain	BB	'81
	Spain	TRAP	'60-'73
Spain	SPOR	'77-'81	

\* : ICCAT code.

Table 4. The marks of each sea area on the assumption that the mark of zero is assigned in cases where sampling size is unknown.

West	Year										
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Catch(10 <sup>3</sup> fish)	3	3	19	70	86	89	25	19	12	4	171
Sample(No)	65	229	79	547	852	656	406	165	296	205	2227
Seiseki 1	12	56	77	69	78	78	69	88	71	80	99
Seiseki 2	14	75	79	72	81	78	71	88	72	85	99
Seiseki 3	16	77	82	80	91	79	79	89	76	94	99
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Catch(10 <sup>3</sup> fish)	143	27	62	29	45	54	43	31	21	30	52
Sample(No)	3507	1598	3691	4177	3556	5343	3110	7049	5705	4787	3651
Seiseki 1	99	98	97	98	100	97	98	97	98	46	46
Seiseki 2	99	99	98	98	100	97	98	97	98	46	46
Seiseki 3	99	99	98	98	100	97	98	97	98	46	46
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
East	907	1134	740	820	754	412	778	780	232	366	254
Catch(10 <sup>3</sup> fish)	1430	1332	996	381	487	442	1197	1319	1059	1132	1427
Sample(No)	0	3	58	1	2	4	1	2	3	3	4
Seiseki 1	0	3	71	1	2	4	1	2	3	3	4
Seiseki 2	0	3	71	1	2	4	1	2	3	3	4
Seiseki 3	0	3	71	1	2	4	1	2	3	3	4
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Catch(10 <sup>3</sup> fish)	120	244	231	272	832	172	318	254	149	172	183
Sample(No)	1051	531	417	244	4274	1997	2303	473	940	1022	933
Seiseki 1	3	27	50	2	4	8	5	2	4	2	2
Seiseki 2	3	41	61	2	4	9	6	3	4	2	2
Seiseki 3	3	51	61	4	4	10	6	4	4	2	2
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Medit	51	80	261	1188	119	65	556	793	835	160	99
Catch(10 <sup>3</sup> fish)	0	0	0	0	0	232	152	768	1771	2055	172
Sample(No)	0	0	0	0	0	7	1	2	11	35	3
Seiseki 1	0	0	0	0	0	10	1	2	11	35	5
Seiseki 2	0	0	0	0	0	10	1	2	11	35	5
Seiseki 3	0	0	0	0	0	10	1	2	11	35	5
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Catch(10 <sup>3</sup> fish)	288	219	210	374	458	606	605	500	214	323	473
Sample(No)	229	0	0	1	909	363	1674	717	867	1179	2318
Seiseki 1	1	0	0	0	6	1	3	2	3	5	2
Seiseki 2	1	0	0	0	6	1	3	2	3	5	2
Seiseki 3	1	0	0	0	6	1	3	2	3	5	2
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
East + Medit	958	1214	1000	2007	873	477	1334	1573	1566	526	353
Catch(10 <sup>3</sup> fish)	1430	1332	996	381	487	674	1349	2087	2830	3191	1599
Sample(No)	0	3	43	1	2	5	1	2	9	13	3
Seiseki 1	0	3	53	1	2	5	1	2	10	13	4
Seiseki 2	0	3	53	1	2	5	1	2	10	13	4
Seiseki 3	0	3	53	1	2	5	1	2	10	13	4
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Catch(10 <sup>3</sup> fish)	408	463	440	646	1290	777	923	755	361	495	656
Sample(No)	1280	531	417	245	5183	2360	3977	1190	1807	2201	3251
Seiseki 1	2	14	26	1	5	2	4	2	4	4	2
Seiseki 2	2	21	32	1	5	3	4	2	5	4	2
Seiseki 3	2	27	32	2	5	3	4	3	5	4	2

Remarks: The figures of Seiseki 1-3 represent the marks corresponding to the levels 1-3 of the desired sampling size.