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OVERVIEW OF SIZE DATA FOR BIGEYE TUNA CAUGHT BY JAPANESE LONGLINE FISHERY IN THE PACIFIC OCEAN

Hiroaki Okamoto
National Research Institute of Far Seas Fisheries
5 chome 7-1, Orido, Shimizu-Ku, Shizuoka-City, 424-8633, Japan

INTRODUCTION

Size data of Bigeye tuna caught by Japanese longline fishery in the Pacific Ocean has been compiled since 1965 and this data has officially been submitted to WCPFC and IATTC. As explained below, Japanese size data has collected from some data source in length and/or weight.

At the last SPC pre-assessment workshop held in Noumea in April 2013, discrepancy of trend of length and weight size data for Japanese longline fishery was pointed out, and it was suggested that "3) In the short term Japanese length frequency (but not weight frequency) data will be omitted from the bigeye and yellowfin assessments, and SPC scientists will liaise with Japanese scientists about possible investigations" (SPC 2013). The workshop also noted that "it would be useful to examine the spatial and temporal patterns of size data from JP research vessels, training vessels, and commercial vessels".

In this paper, historical change in such a data sources and data types are reviewed and their historical trend of average size will be compared between each sub-area.

MATERIALS AND METHODS

Size data of bigeye tuna from 1965 to 2012 caught by Japanese longline fishery which has been kept in size database of NFIFSF was used in this study. Allowable maximum unit of data used are 2cm and 1kg for length and weight, respectively.

In order to observe the historical trend of average length and weight by region, eight sub-area were prepared as shown in Fig. 1. This sub-area definition was prepared so as to resemble to those which have been used for bigeye stock assessment by WCPFC and IATTC in western and central Pacific Ocean and eastern Pacific Ocean, respectively. Since the definition of this study is not the same as that of WCPFC and IATTC (Fig. 1), it is because the sub-area definition in this study is composed basing on the rectangular unit of 10 latitudinal degree and 20 longitudinal degree, which is the basic unit of Japanese size data, and also because the 180 degree latitude was the boundary of allowable fishing area for Japanese offshore longline fishery until 2002.

When the trend of average weight and average length are compared, weight data was converted from processed (gilled and gutted) weight to whole weight by multiplying 1.13, and each length data was converted to whole weight using Length-Weight relationship (Nakamura and Uchiyama, 1966) as follow.

$$W\ (kg) = 3.661 \times 10\text{-}5 \cdot L\ (cm)^{2.90182}$$

RESULTS AND DISCUSSION

Data sources of Japanese size data for bigeye tuna:

Japanese size data of tunas caught by longline fishery has mainly collected from commercial longline vessel and training and research vessels which make longline operation. Training vessel belongs to prefectural fisheries school for teaching fishing technic and training of vessel officers and crew. Research vessel in this document means vessel which belongs to prefectural fishery research station. Training and research vessels which make longline operation in their cruise are included in this document.

As for the commercial vessel, size data has been derived from onboard and main landing ports. In Fig. 2, the number of weight and length size data of commercial longline catch was expressed by data sources (onboard and port sampling). Onboard measurement started to be requested to commercial fishermen in middle 1970s by distributing notebook of recording format and wooden caliper for measurement (maybe after early 1990s). Fishermen has been requested to measure or weigh their catch up to about 50 individuals regardless fish species in one operation. Since the weight data was requested to be collected until early 1990s, it was changed to request of length measurement, thereafter. Regarding port sampling for commercial longline catch, individual processed weight information for auction purpose has been collected from main fish market at least from 1965, depending on tuna species. Length measurement by researcher was also conducted at the main landing port before 1980 and after 2004 in variable intension. Port sampling has been conducted mainly to collect size data of coastal and offshore longline catch whose fishing area had been limited to the West Pacific Ocean, west of 180 degree longitude. Fishing period and area of these fisheries can be specified to relatively small range because of their relatively short cruise, while the cruise duration of distant water longliner is usually too long to specify their catch date and location. Geographic resolutions of data are principally 1 x 1 (latitude x longitude) degree for onboard data sampling, and 5 x 5 degree, 5 x 10 degree or 10 x 20 degree for port sampling.

As for the Training and research vessels, since most of catch loaded on deck has been individually measured and weighed, length data has basically been compiled into main size database and has been used for submission to RFMO. Geographical resolution of size data derived from training and research vessels is 1 x 1 degree.

Historical change in the number of bigeye size data:

The number of length and weight data of bigeye tuna caught by Japanese longline fishery in the West and East Pacific Ocean (boundary is 180 degree longitude) recorded in the size data base in NRIFSF (National Research Institute of Far Seas Fisheries) are shown in Table 1, by sort of data sources, that is, commercial vessel and training and research vessels (latter will be referred as training vessel hereafter). The same informations were expressed as graphs in Fig. 3.

In the West Pacific, the number of size data which was about 30-60 thousand in 1965 through 1985, increased to around 100 thousand in 1987 and kept at the same level until 2004 after when it has continuously decreased to around 50 thousand in 2009. Weight data of commercial longline fishery has been most part of size data, larger than 70% for most period, in the West Pacific including 10-20% of length data derived from training vessels before around 1980 and 20-30% of length data from commercial vessel since 2005. As for the East Pacific Ocean, the number of total size data which had fluctuated between 40 thousand and 90 thousand until 1984, increased to 140 thousand in 1987 and has continuously decreased to 14 thousand in 2012. In the East Pacific, weight data from commercial vessel and length data from training vessel had been shared major part of size data until 1999 after when that from commercial vessel disappeared rapidly and replaced to length data from training vessel and length data from commercial vessels. After 1986, length data derived from commercial vessel appeared and has accounted for about 30% to 50% since 1991.

Historical change in distribution of size data:

In the Fig. 4, distribution of amount of bigeye catch in number and the number of length and weight data were shown on the map by source of size data in order to indicate the geographical representativeness of size samples to the bigeye catch. Weight data derived from commercial vessel in West Pacific Ocean where offshore longline fishery is the main longline fishery, has relatively well covered the bigeye catch distribution by longline fishery, while that in East Pacific Ocean has also covered the catch distribution well until 1980s, but diminished in 1990s and almost disappeared after 2000. Length data from training vessel which covered relatively wide area until 1980s, have concentrated to the area around Hawaii islands, 180 -140W and 0 – 40N and the data has mostly disappeared from West Pacific Ocean and East Pacific Ocean east of 140E.

Comparison of average size between data source:

Historical change in the average length and average weight of different data source (training and commercial vessels) were shown by area in Fig. 5 and 6, respectively. As the weight data of bigeye from longline fishery in the size data base is basically processed weight,, that is gilled and gutted weight, average weight described below was calculated based on whole weight converted from processed weight by multiplying 1.13 to processed (gilled and gutted) weight. As for the average length, that of commercial vessel in area 2 and 4 has been about 10 to 20 cm larger than that of training vessel. In area 5, average length of training vessel showed declining trend since middle 1970s from around 140cm to 110cm in early 1990s, while that of commercial vessel which appeared from 1986 has been kept the same level, about 140cm. In other areas, difference of average length both data sources is not clear. In the case of the average weight, as weight data was available only from commercial vessel, it can't be compared with that from training vessel. In area 1 and 2, average weight shows continuous declining trend. Since similar declining trends are also observed in area 3, 4 and 6 until early 1980s to some extent, trend after that is not clear.

Comparison of average size between weight and length data:

In Fig. 7, historical change in average weight and average length were overlaid in each area. In order to compare the both trends in the same level, length data was converted into whole weight and averaged in Fig. 8, and compared with average weight derived from original weight data. Historical trends of average weight from both data types (original weight and that converted from length data) showed fairly good coincidence. In area 3, their trends are similar throughout period except after 2007 onward when average length have showed increasing trend and opposite trend for average weight. In areas 1 and 5, and area 2 to some extent, average weight from length and average of original weight data have separated around late 1980s, and weight converted from length are larger than original weight data about 20kg, 10kg and 5kg for area 5, 1 and 2, respectively. As for the area 2 and 5, the separation of both average weight was observed also before 1970, larger value in weight converted from length data. As above separation of average weight has not necessarily occurred at the period of any change in data sources, the factors which would have caused the separation is not clear at present.

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Table 1 Number of bigeye size data in length in West and East Pacific Ocean (boundary is 180 b degree longitude) from Japanese longline fisheries by data source.

	West Pacific Ocean				East Pacific Ocean			
	Length Commercia	Weight Commercia	Length Training	Weight Training	Length Commercia	Weight Commercia	Length Training	Weight Training
1965	1210	46866	7516	0	64	60592	13940	0
1966	922	67492	7505	0	150	32717	16748	0
1967	7331	37053	7603	0		29031	20719	0
1968	8997	27653	8056	0	360	21784	19448	0
1969	5192	22490	6875	0	209	26031	28559	0
1970	8321	17211	6574	0		27024	30982	0
1971	4743	27859	7491	0		62044	35832	0
1972	2503	22659	8852	0		47446	34955	0
1973	804	18831	5918	0		29101	27976	0
1974	750	28638	6415	0		28631	14931	0
1975	1016	26749	4448	0	15	20115	19329	0
1976	1241	23099	4450	0		21406	26707	0
1977	2531	47645	6242	0		26535	36909	0
1978	207	41886	3807	0		15137	35635	0
1979	985	38958	4321	0		10844	42000	0
1980	181	34994	4067	0		12347	31396	0
1981		27520	1196	0		8339	29562	0
1982		41449	3014	0		33849	34920	0
1983		58462	3644	0		42552	40187	0
1984	948	58238	4021	0		57133	32978	0
1985	311	56143	5317	0	49	70171	32451	0
1986	35	84052	4166	0	16245	82294	23437	0
1987		104279	3485	0	3403	96841	39274	0
1988		94435	2898	0	3570	45360	32939	0
1989	369	111744	3154	0	1777	37166	37627	0
1990	425	102360	7805	0	12439	28656	36506	0
1991	1880	88046	6863	0	37274	38993	35017	0
1992	1105	107811	8243	0	30735	23507	42961	0
1993	891	98385	3562	0	31317	8852	36767	0
1994	126	103220	5944	0	33398	8570	41885	0
1995	15	93050	2590	0	41292	6918	33816	0
1996	97	93405	2300	0	37934	14673	40412	0
1997	387	90928	2187	0	26217	11468	48610	0
1998	218	129771	1463	0	28336	23352	47113	0
1999	291	135830	334	0	16209	9384	40569	0
2000	41	110799	1316	14	20322		35826	2142
2001		92020	1060	13	30126	4	32003	590
2002	41	96794	2555	0	29240	13	43000	419
2003	109	101570	1399	0	24242	312	28804	226
2004	40	106936	1515	0	23809	1725	42402	4
2005	13946	57544	2017	0	20195	883	25324	0
2006	24613	72453	1177	0	19477	7	23087	0
2007	23956	48584	1189	0	14426		22426	0
2008	12265	47912	1609	0	11704		17573	0
2009	16737	35479	1025	0	11160		15686	0
2010	4675	39520	1385	1	6073		14097	0
2011	12574	38683	850	0	2580		13217	1
2012	7346	15916	588	0	1964		11842	8

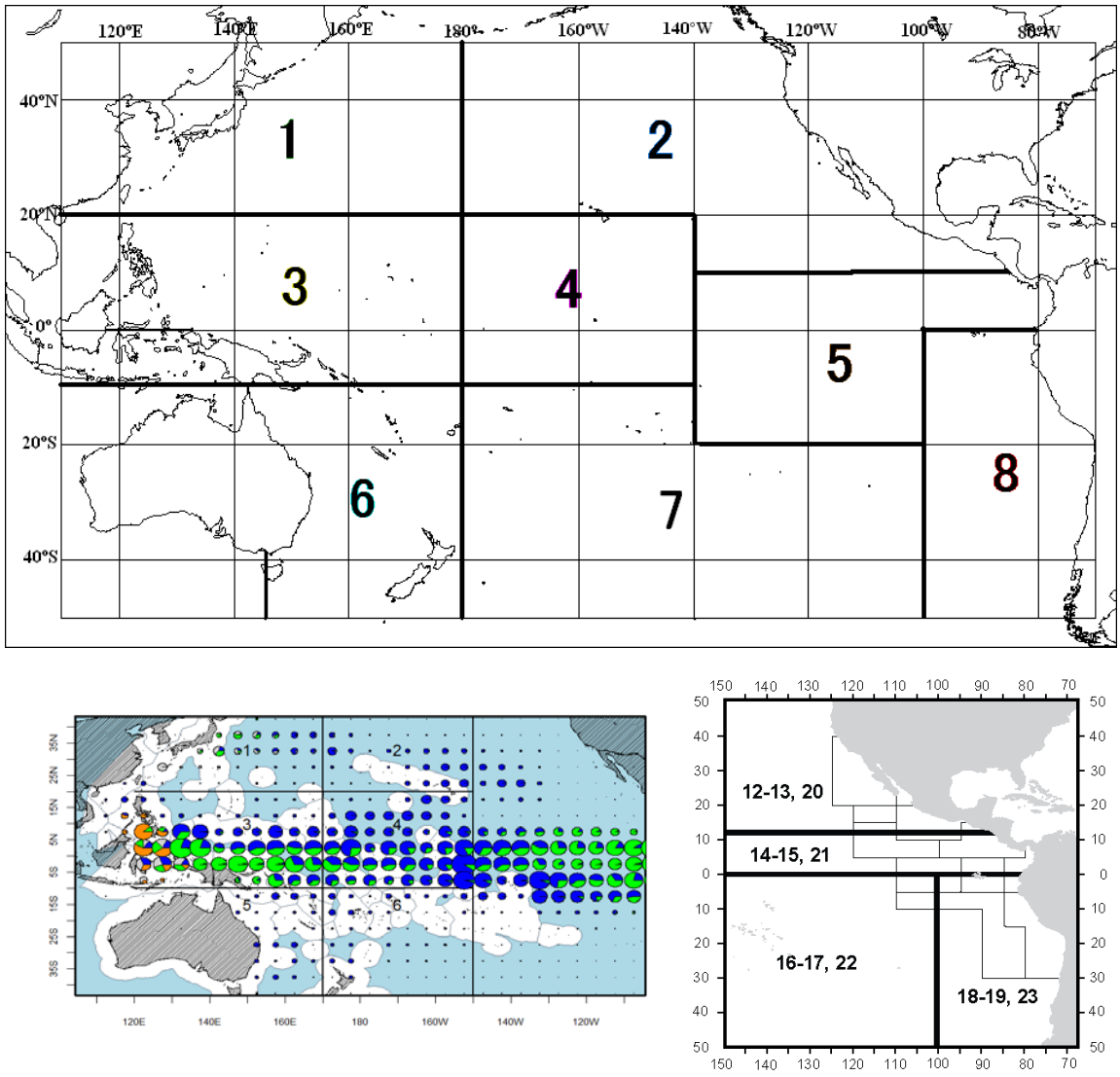

Fig. 1 Area definition used in this analysis (upper), and those used for bigeye stock assessment in western and central Pacific Ocean by WCPFC (bottom-left) and in eastern Pacific Ocean by IATTC (bottom-right).

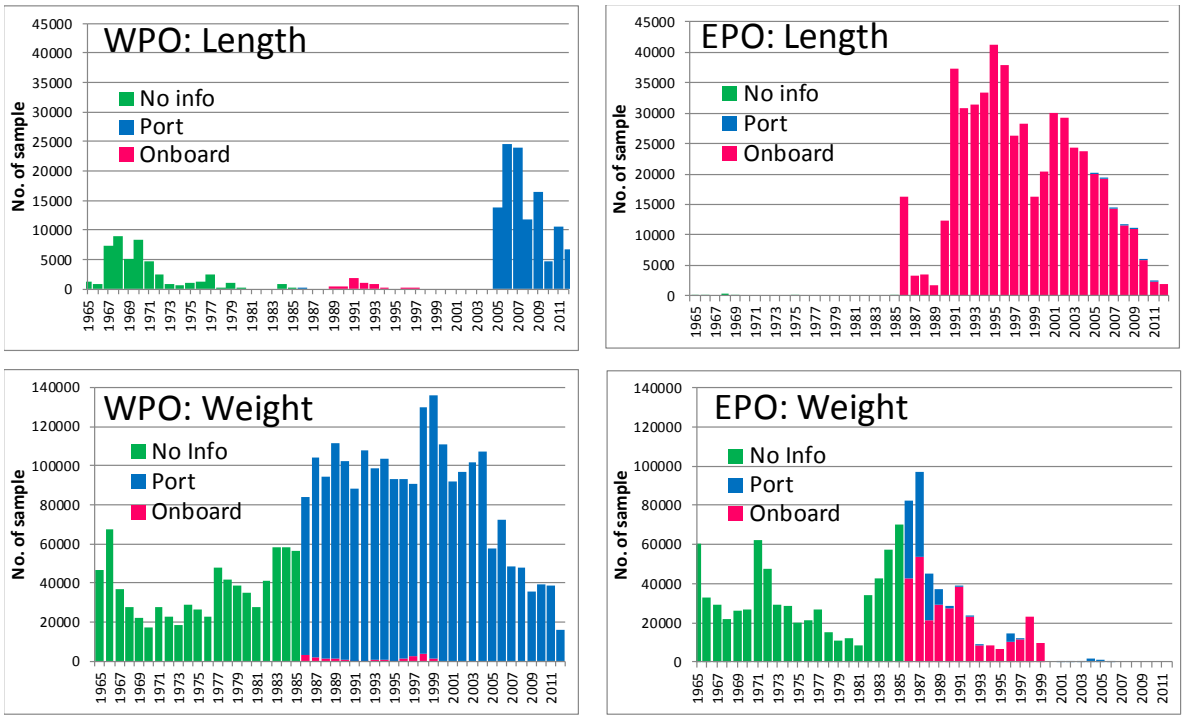

Fig. 2. Historical change in the number length (upper) and weight (bottom) data of bigeye caught by Japanese commercial longline fishery in the West (left) and East (right) Pacific Ocean by sampling place (green: unknown, blue: port sampling and red: onboard).

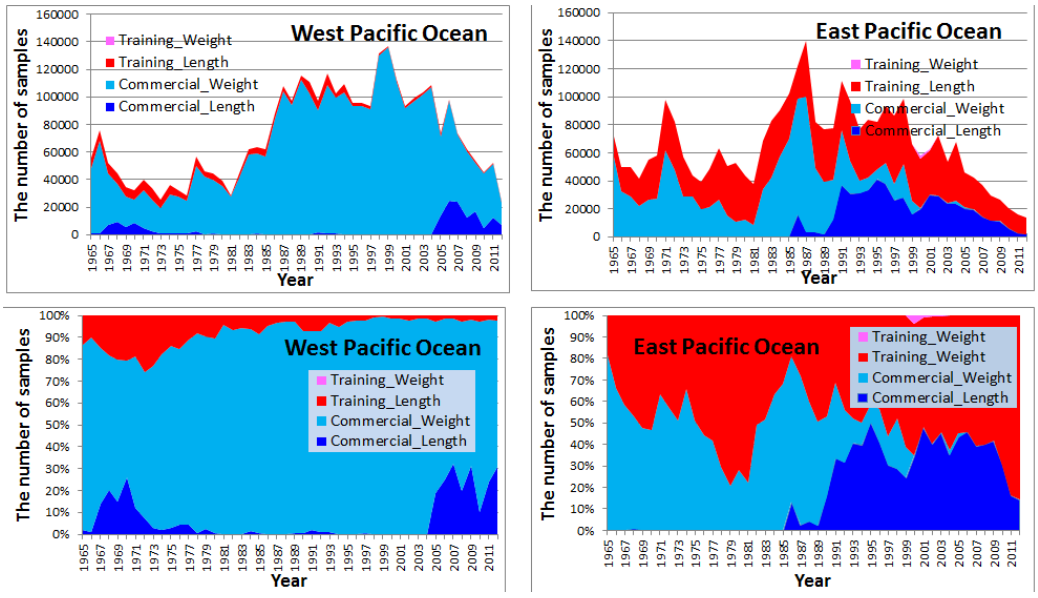

Fig. 3. Historical change in the number (upper) and ratio (bottom) of size data of bigeye caught by Japanese longline fishery in the West (left) and East (right) Pacific Ocean by data sources (commercial and training vessels) and data types (length and weight).

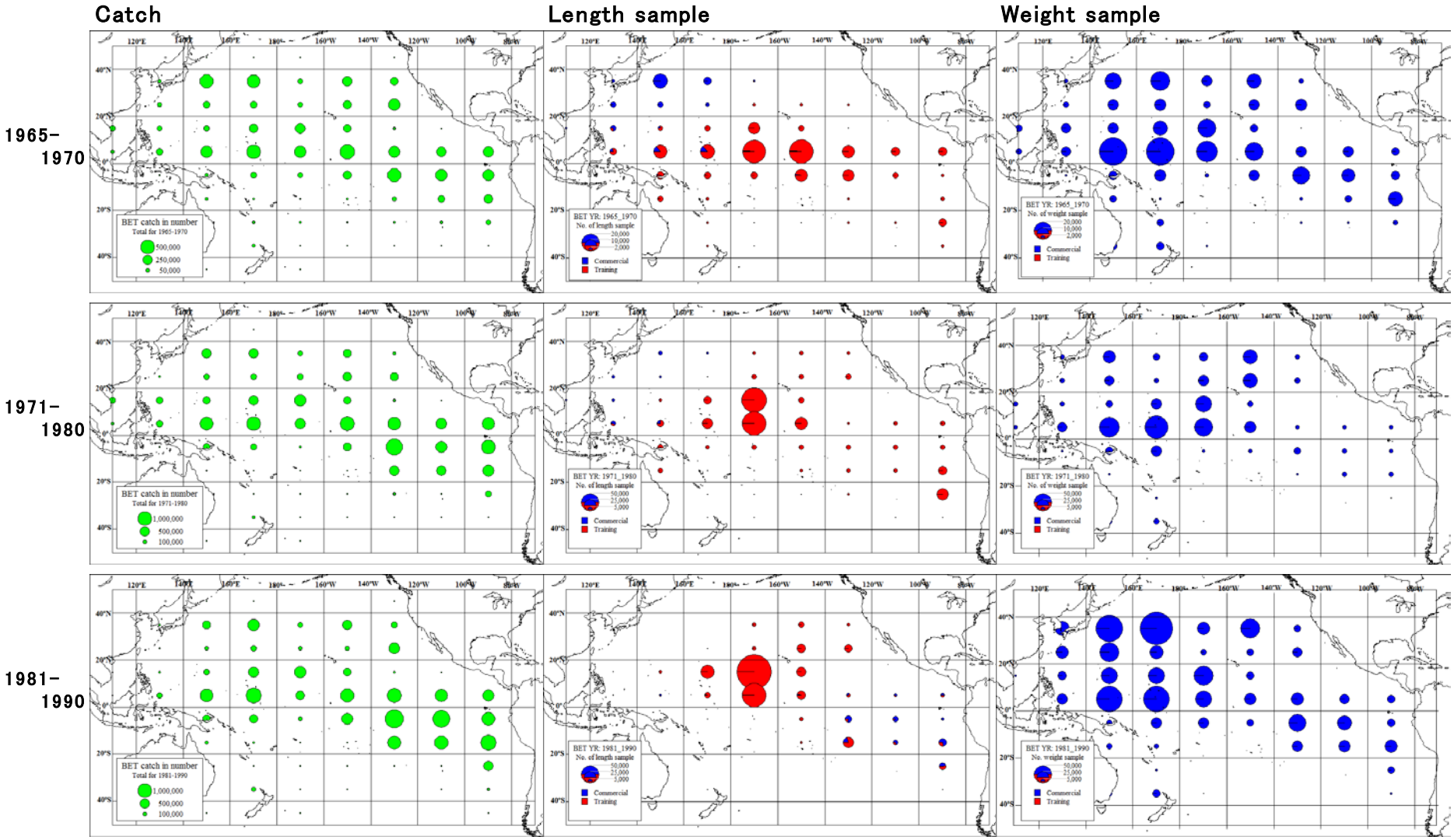

Fig. 4 Distribution of bigeye catch and length and weight sample for Japanese longline fishery aggregated by 10 years, 10 degree of latitude and 20 degree of longitude..

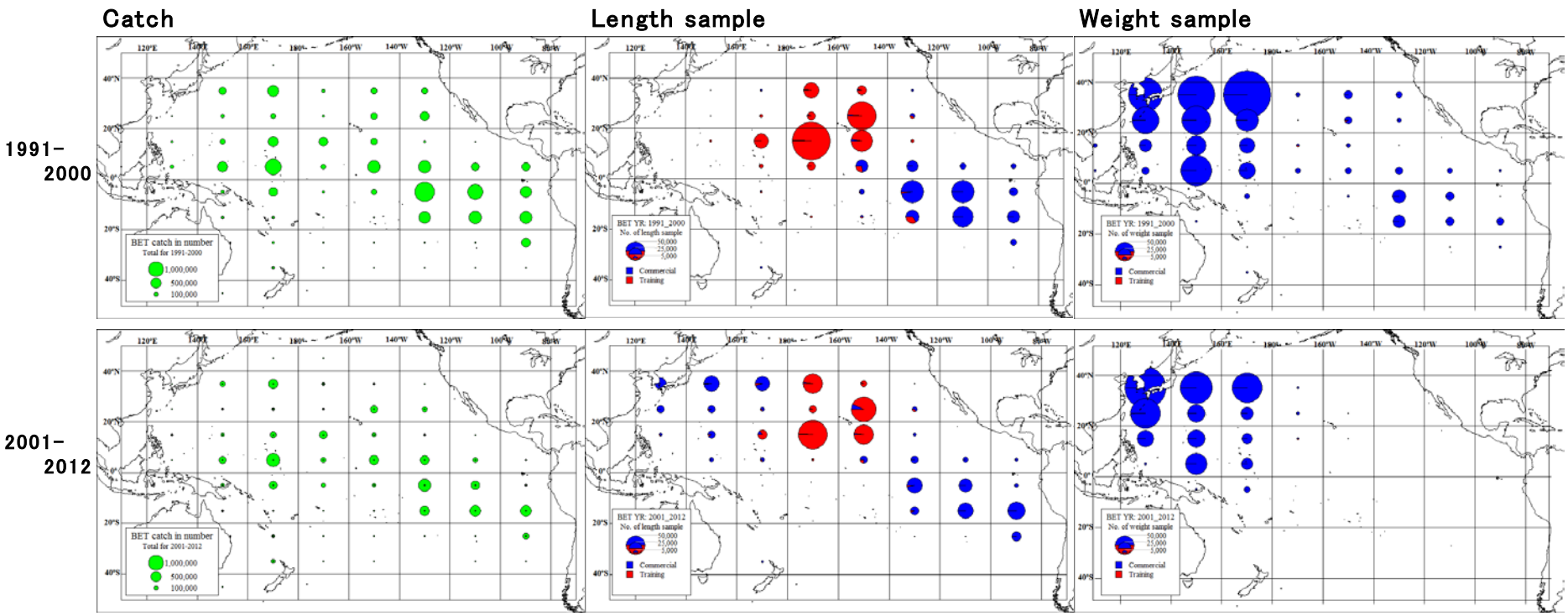

Fig. 4 Continued.

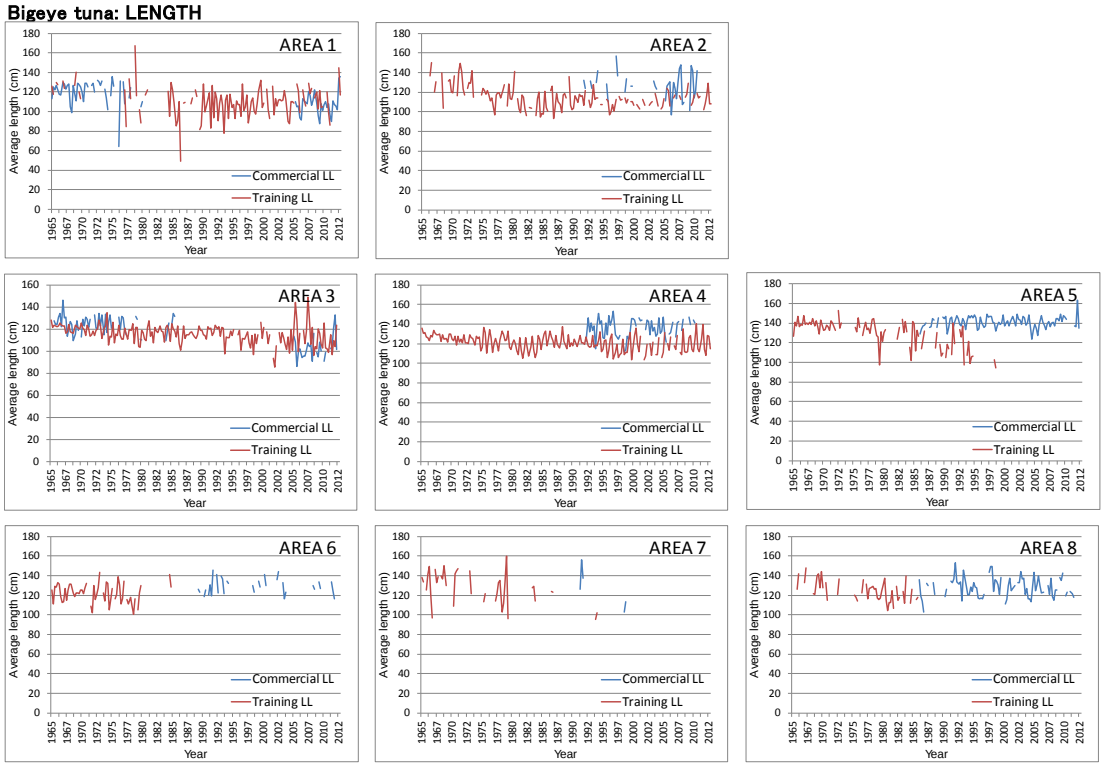

Fig. 5 Historical change in quarterly average fork length of bigeye by data sources (commercial and training longline vessels) by area.

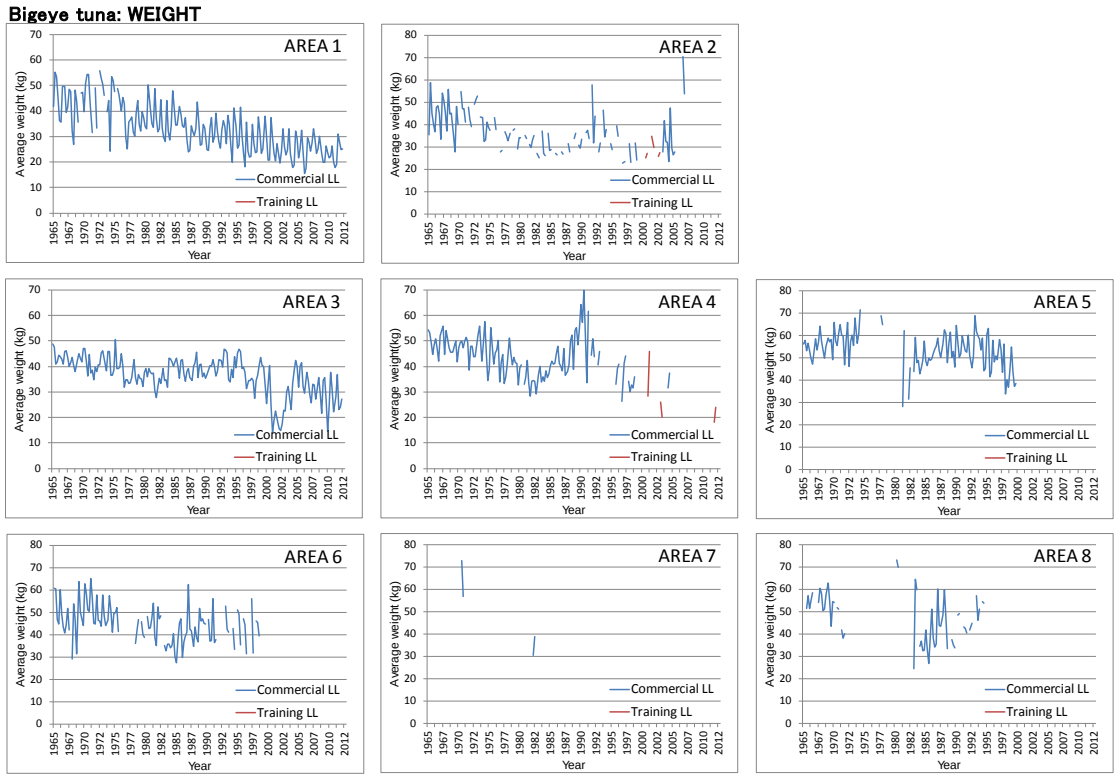

Fig. 6 Historical change in quarterly average whole weight of bigeye by data sources (commercial and training longline vessels) by area.

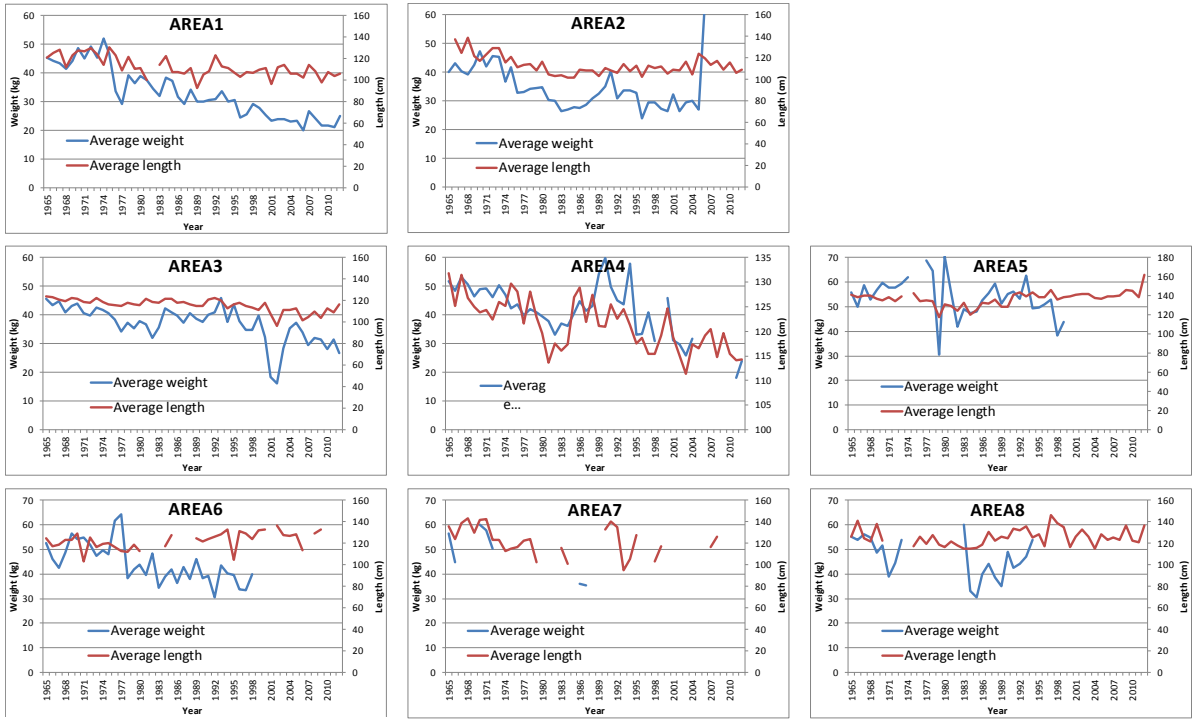

Fig. 7 Historical change in annual average whole weight and average fork length of bigeye by area in which all data sources (commercial and training longline vessels) are combined.

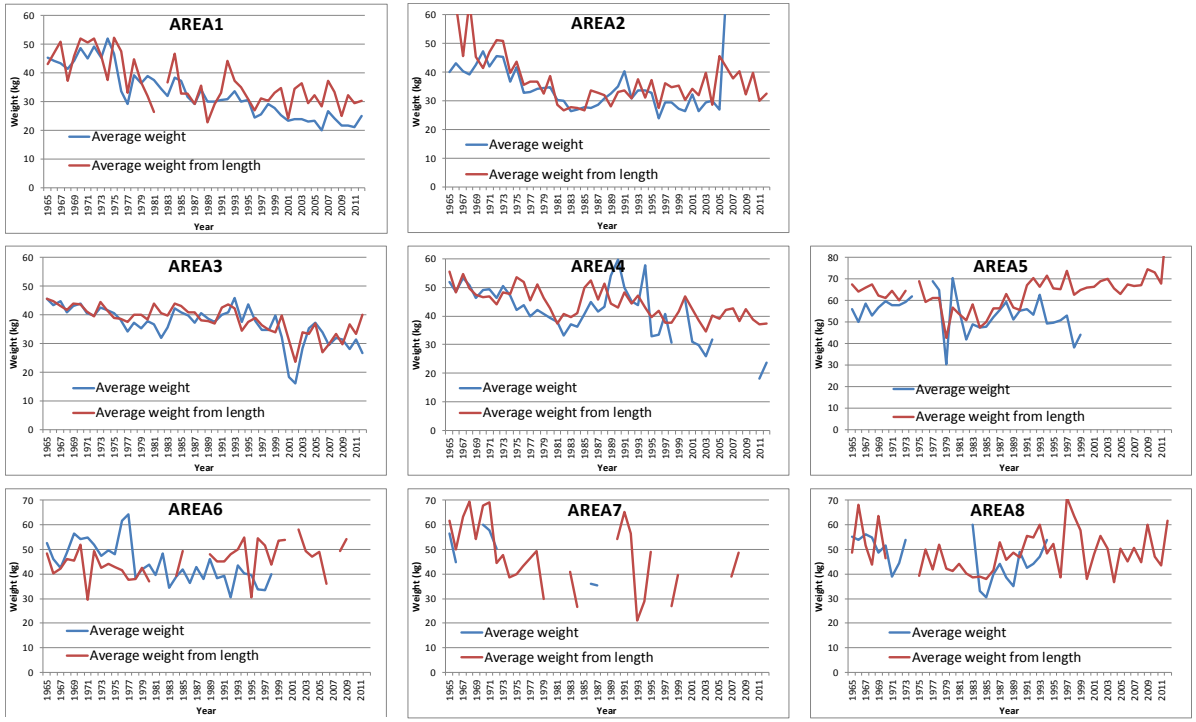

Fig. 8 Historical change in annual average whole weight and that converted from fork length of bigeye by area in which all data sources (commercial and training longline vessels) are combined.