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Review of size data of blue shark caught by Japanese training vessels in the central Pacific[1]

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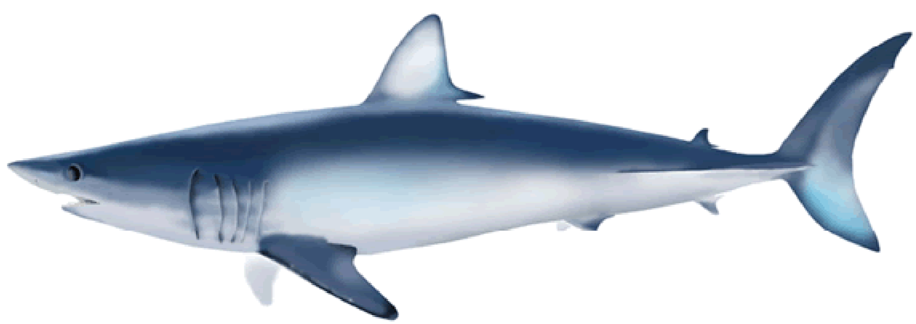

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Introduction

The size data of blue shark collected by Japanese training and research vessels offered useful and important information about size composition of the blue shark caught by Japanese longliners mainly in the central north Pacific (Kleiber et. al., 2009). This document updated this information as well as conduct additional analysis about the seasonality and sex specific migration pattern.

Materials and Methods

The Fishery Agency of Japan, with the support of National Research Institute of Far Seas Fisheries (NRIFSF), has initiated the bycatch data collection project of the local training and research longline vessels in 1992, and this project has been collected species specific catch, effort and size data of pelagic sharks. The shark related data collected through this project were error checked and digitized by NRIFSF, and sexed size data collected by this project is used in this study. The length of blue shark is measured as precaudal length (PCL) to the nearest cm on board, and each vessel requested to measure their shark catches. The size data of Japanese training and research longline vessels (JTRLV) were aggregated by sex and by 10 cm bin to construct the length frequency.

Results and Discussions

The collection of the shark length data by had started in 1992, and the number of data collected by JTRLV stayed larger than 10 thousands until the end of the 1990 when it showed rapid decreasing (Table 1) . The reasons of this decreasing trend could be attributed to the 1) the decrease of the number of vessels, 2) the conduction of the traditional tagging study requested by NRIFSF, 3) the increase of the number of dead discards and live release. The length data was only available in the western Pacific (areas 1 and 3) since 2001, and it further decreased down to less than one thousand since the mid 2000s. In recent years, the length frequencies obtained by the collected size samples would not represent the blue shark catches by JTRV.

The distribution of the length data seems to spread over the operational areas of JTRV in the 1990s (Fig. 1 and Table 1), and especially the relatively larger number of size samples were constantly available in the tropical and subtropical areas in the north central Pacific in these periods (Fig. 2). During the 1990s in the central Pacific, the size samples collected mainly in the tropical area during 1st and 2nd quarters of the year, and the main sampling position move up to the subtropical area during 3rd and 4th quarters. To investigate the effects of the sampling season and position, smaller subareas were developed in the north central Pacific where large numbers of samples were available during the 1990s (Fig. 3).

The general positions of the modes of the length compositions in the two tropical areas (subareas 1 and 2) were same by years and quarters (120 cm PCL – 180 cm PCL, Figs 4 and 5), while male to female ratio and sex ratio at length class changed largely by years and quarters. In subarea 1, the female become more dominant in the 3rd and/or 4th quarters and male were dominant in the 1st and/or 2nd quarters. When the ratio of males are dominant in the 1st quarter, this tendencies are more apparent in the larger length classes than 150 – 180 cm PCL, while this tendency is not so clear in the 2nd quarter. In the case of 3rd and 4th quarters when females were more dominant, ratio of female were larger than male for most of length classes. It seems that male dominant period and female dominant period replaced alternately within a year while the peak of the male/female dominant season changes annually, which supposed to be a effect of environmental condition. The similar patterns were also observed in the length composition in subarea 2, but some exceptions were observed. For example, males were more dominated 4th quarter in 1997 or 3rd quarter in 1999, and females were more dominated 1st quarter in 2000. These exception may simply reflect the change of operational pattern of JTRV in these years which could not covered by the season and subarea stratifications used in this study, but might also suggest the effects of the environmental condition on the migration pattern of blue shark.

In subareas 3 and 4, enough numbers of size samples were only available for 3rd and 4th quarters (Figs. 8 and 9). In compare to the subareas 1 and 2, larger sized individuals were caught in most of season and year strata and the ratio of males were equal to/large than females for almost of the size classes.

The sex and grow stage specific migration pattern of the north Pacific blue shark is outlined in Nakano and Seki (2003) as well as Nakano (1994). Based on these information, subareas 1 and 2 in this study corresponding to the distribution area of adult, subarea 3 corresponding to the area of mating group and subarea 4 corresponding to area of mating group and nursery ground of sub adult. These two papers also indicated sexual segregations of the distribution. The results of this study indicated that males and females are migrated into the designated subarea in the different timing of the year but they also stay together in other timing. This suggests that males and females have different migration pattern in both tropical and subtropical areas in the north central Pacific, and their migration pattern seasonally overlapping.

The results of this study also indicated that annual variability of the seasonal sex ratio pattern in all analyzed subareas. This may suggests that inter-annual variability of the size sampling, but also suggests the possibilities that migration patterns of males and females are affected by the change of the environmental condition. This does not mentioned in the previous studies by Nakano and Seki (2003) as well as Nakano (1994), but the areal coverage of data used by these studies were rather wide but the coverage of time series are limited. The areal coverage of sexed size data used in this study are limited but they continuously available in the 1990s.

Nakano and Seki (2003) mentioned that the sex and growth stage specific migration pattern of blue shark in the north Pacific are related to their reproductive and survival (mating, feeding and avoidance of cannibalism) strategy. Though Nakano and Seki (2003) addressed a model to describe sex and growth stage specific migration pattern of blue shark in the north Pacific, the results of this study suggested the addressed migration model by Nakano and Seki (2003) may change by season and by area. Because sex and growth stage specific migration pattern is quite important for the estimation of sex specific catch at age as it should be estimated using the method reflecting the migration pattern of blue shark. Fur the analysis of the seasonal and annual variability with extended sexed size data as well as the mechanisms to cause these variability should be investigated to conduct reliable age specific stock analysis model.

Reference

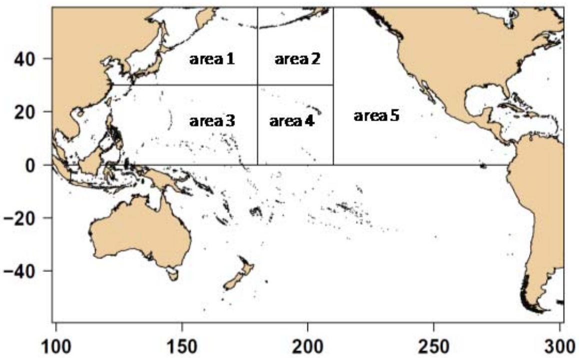
Kleiber, P., S. Clarke, K. Bigelow, H. Nakano, M. McAllister and Y. Takeuchi (2009); North Pacific blue shark stock assessment. NOAA Technical Memorandum NMSF-PIFSC-17, 83p.

Nakano, H., and M. P. Seki (2003); Synopsis of biological data on the blue shark, *Prionace glauca* Linnaeus. Bull. Fish. Res. Agen. No. 6, 18-55.

Nakano, H. (1994); Age, reproduction and migration of blue shark in the North Pacific Ocean. Bull. Nat. Res. Inst. Far Seas Fish., No. 31, 141-256pp.

Table 1. Number of blue shark size samples collected by Japanese research and training vessels in the north Pacific (left), and the area stratification for the table.

	area 1	area 2	area 3	area 4	area 5	Total
1992	216	107	6187	11368	0	17878
1993	195	188	4164	17485	30	22062
1994	86	48	5983	13239	117	19473
1995	161	702	1755	11862	30	14510
1996	251	1233	1316	11643	12	14455
1997	4101	1418	2673	12176	151	20519
1998	114	785	1135	10689	0	12723
1999	238	656	509	11922	0	13325
2000	191	0	970	5291	0	6452
2001	173	0	1165	0	0	1338
2002	441	0	924	0	0	1365
2003	373	0	736	0	0	1109
2004	199	0	648	0	0	847
2005	259	0	853	0	0	1112
2006	94	0	364	0	0	458
2007	119	0	30	0	0	149
2008	1	0	143	0	0	144
2009	2	0	1	0	0	3
2010	6	0	13	0	0	19
2011	1	0	109	0	0	110
total	7221	5137	29678	105675	340	148051



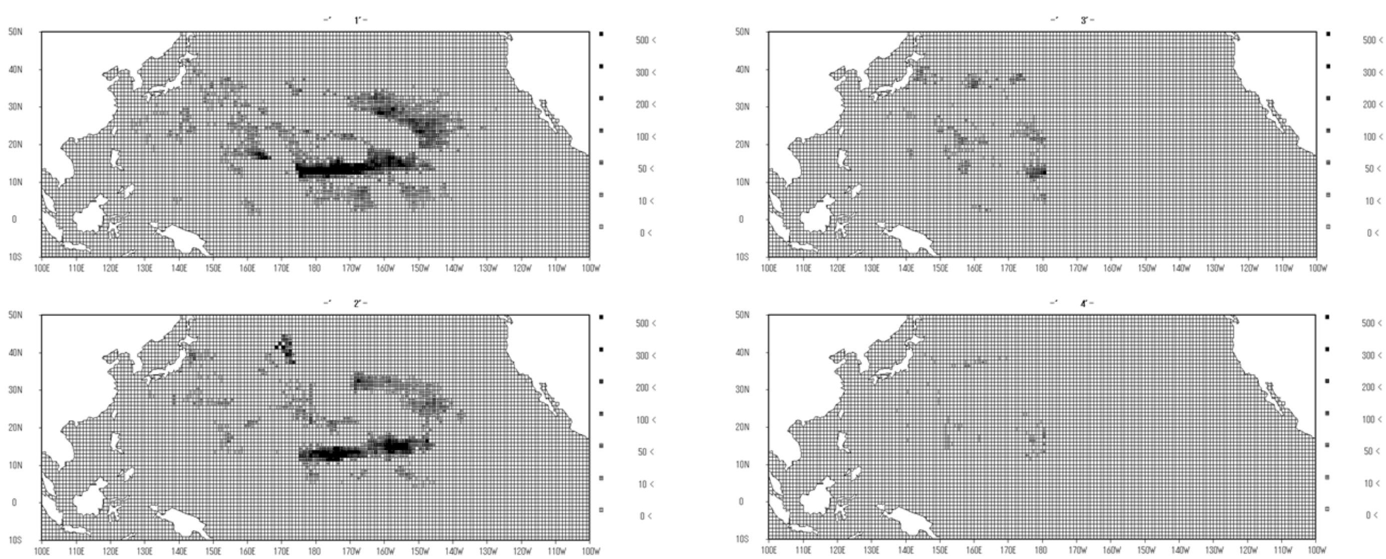


Fig. 1. Distribution of size sample of blue shark caught by Japanese research and training longline vessel in the period between 1992 – 1996 (left top), 1997 – 2001 (left bottom), 2002 – 2006 (right top), and 2007 – 2011 (right bottom)

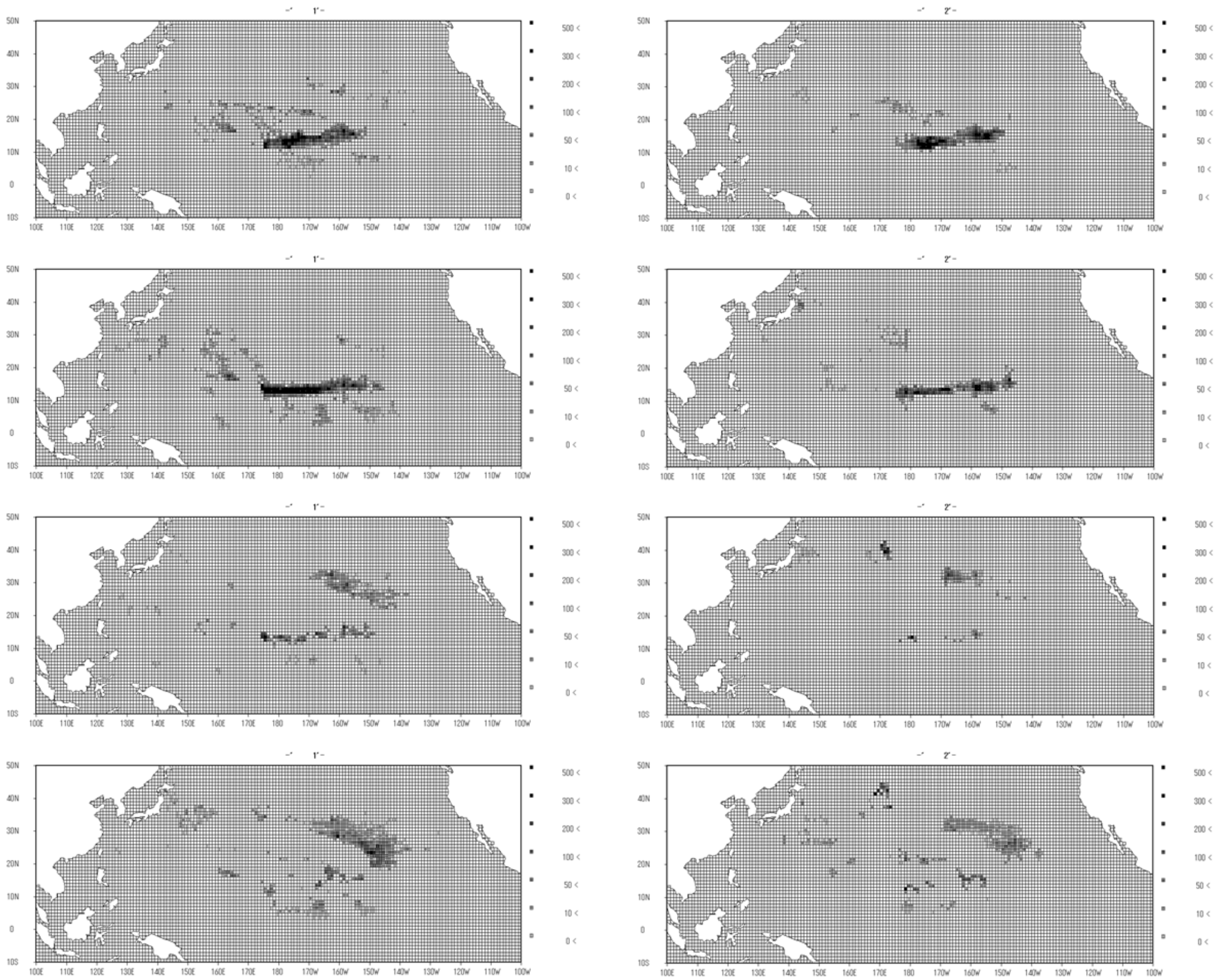


Fig. 2. Quarterly distribution of the size sample of blue shark caught by Japanese research and training longline vessel in the periods between 1992 – 1996 (left column) and 1997 – 2001 (right column). The 1st to 4th panels indicate the sample distribution of 1st to 4th quarters.

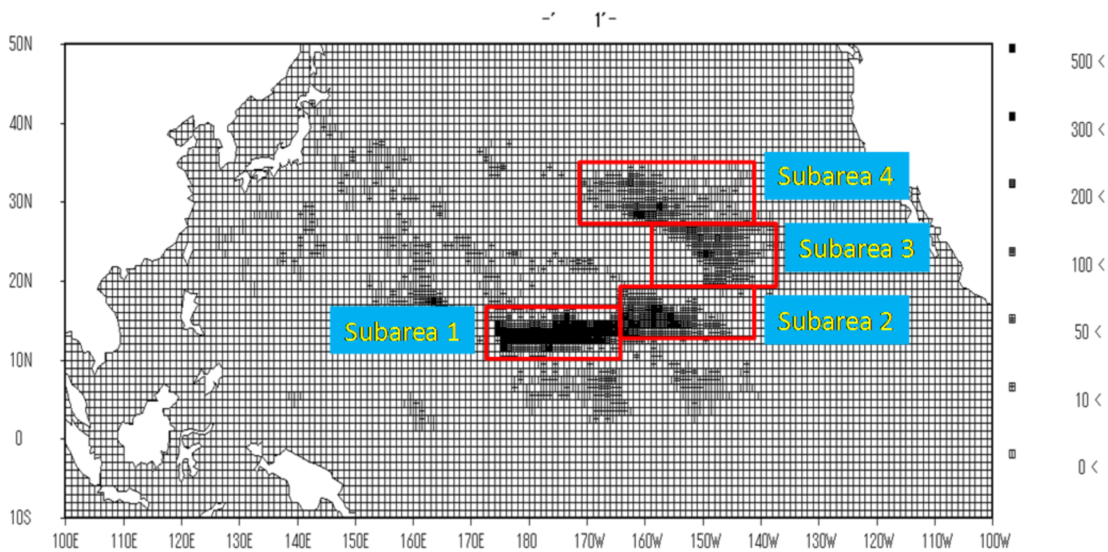


Fig. 3. Subarea stratification used in the analysis of the size sample data.

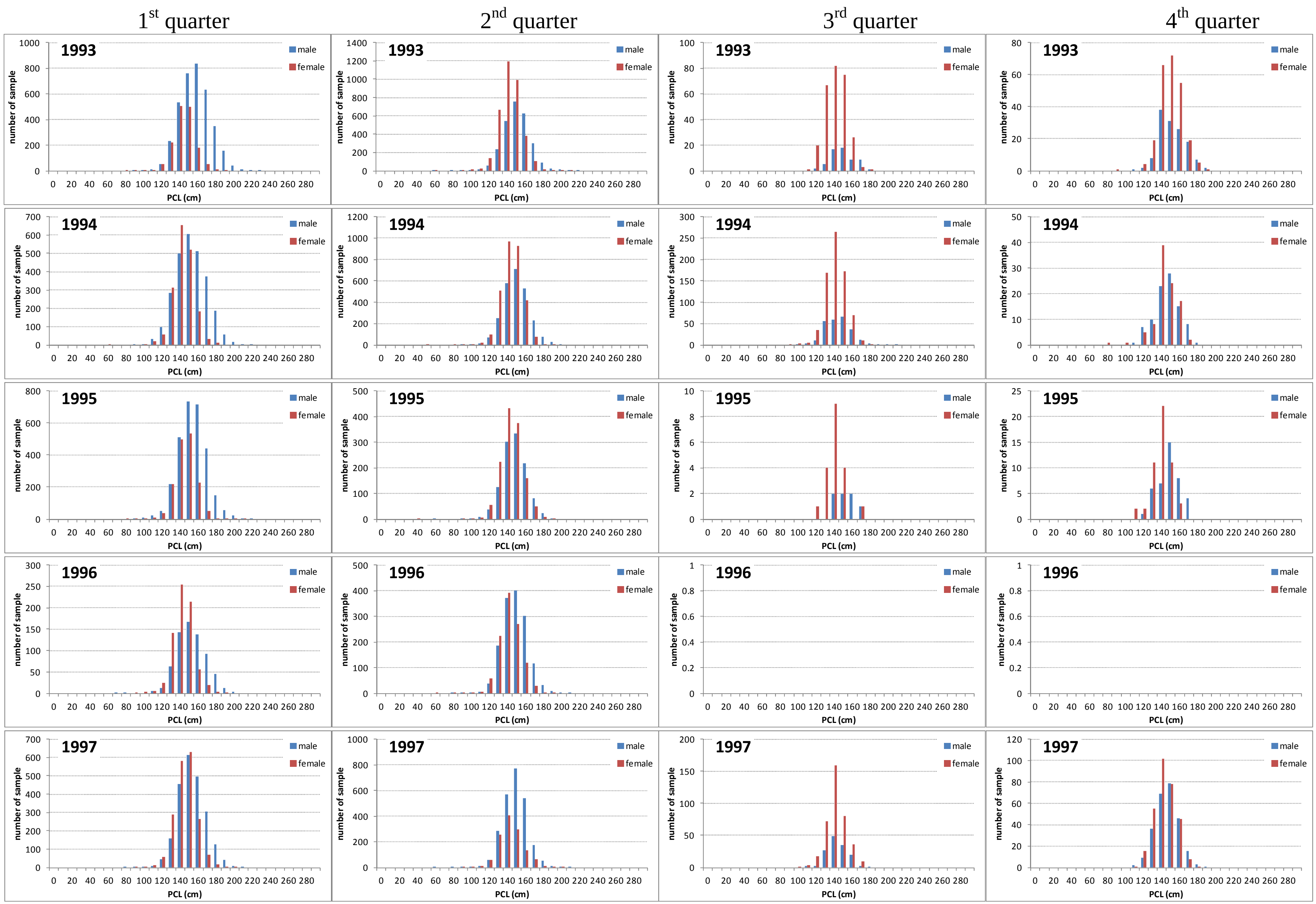


Fig. 4. The quarterly length frequency of male and female blue shark caught by Japanese research and training vessels in subarea 1 in the period between 1993 (top line) and 1997 (bottom line).

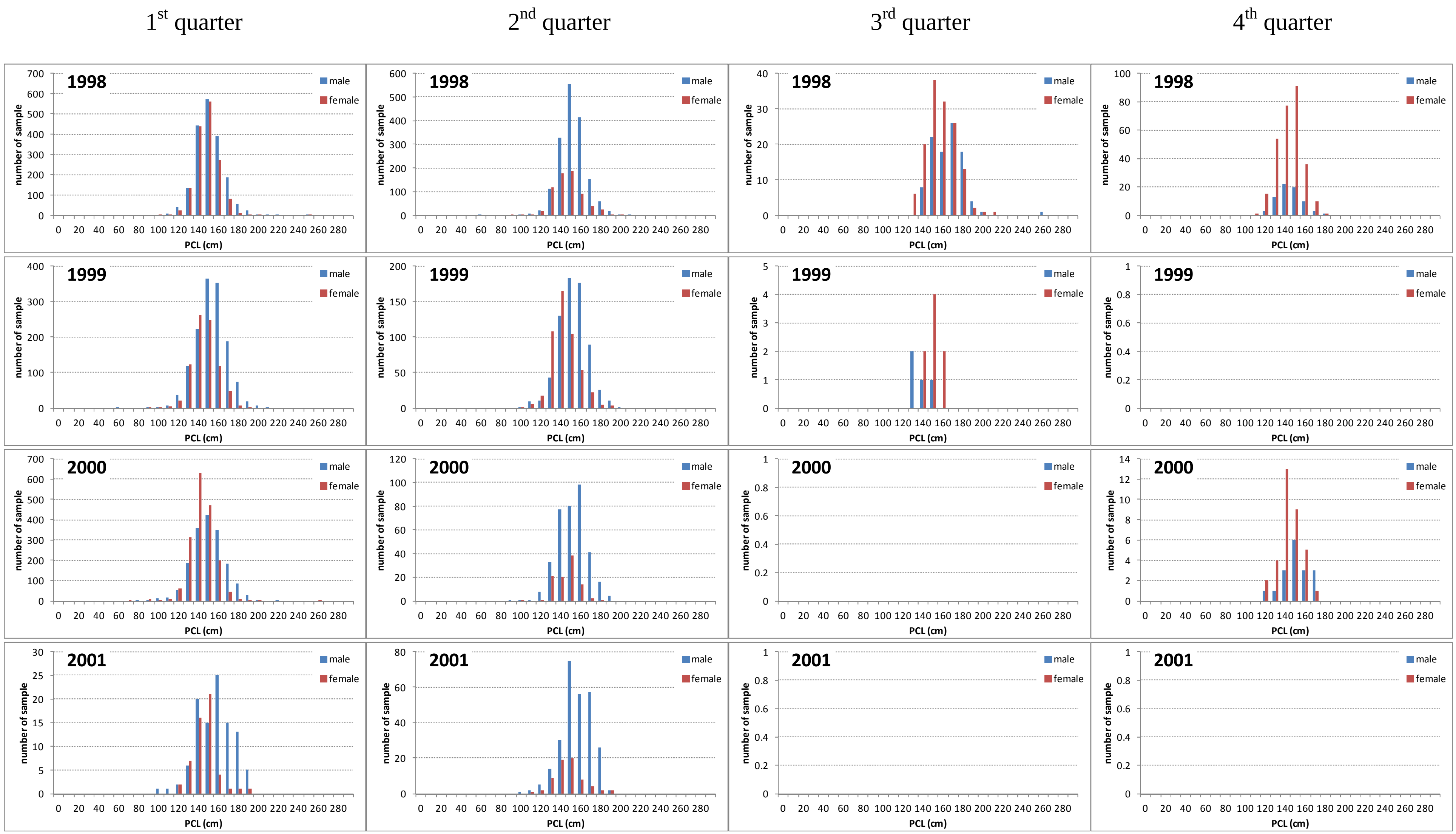


Fig. 5. The quarterly length frequency of male and female blue shark caught by Japanese research and training vessels in subarea 1 in the period between 1998 (top line) and 2001 (bottom line).

1st quarter 2nd quarter 3rd quarter 4th quarter

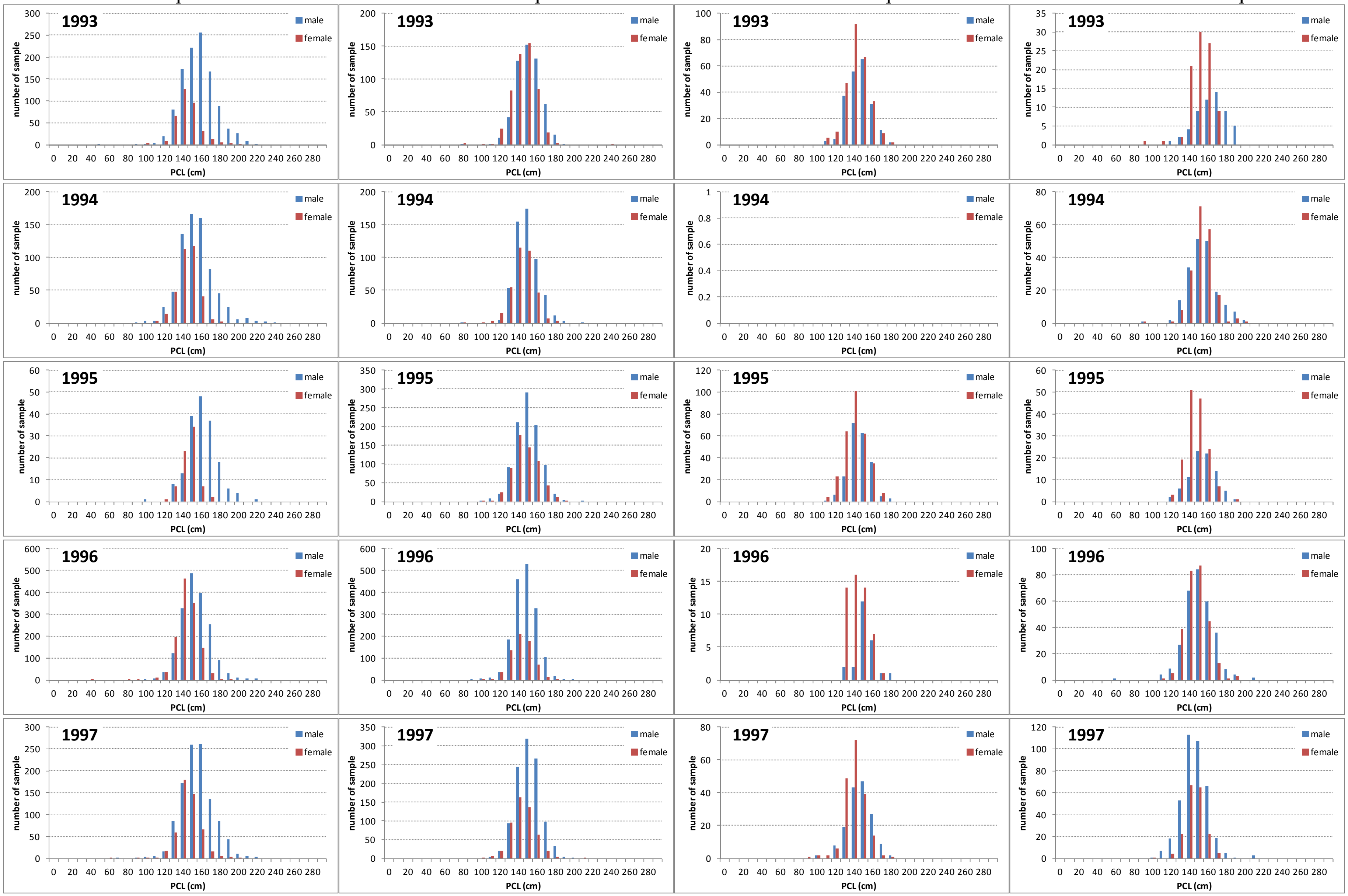


Fig. 6. The quarterly length frequency of male and female blue shark caught by Japanese research and training vessels in subarea 2 in the period between 1993 (top line) and 1997 (bottom line).

1st quarter 2nd quarter 3rd quarter 4th quarter

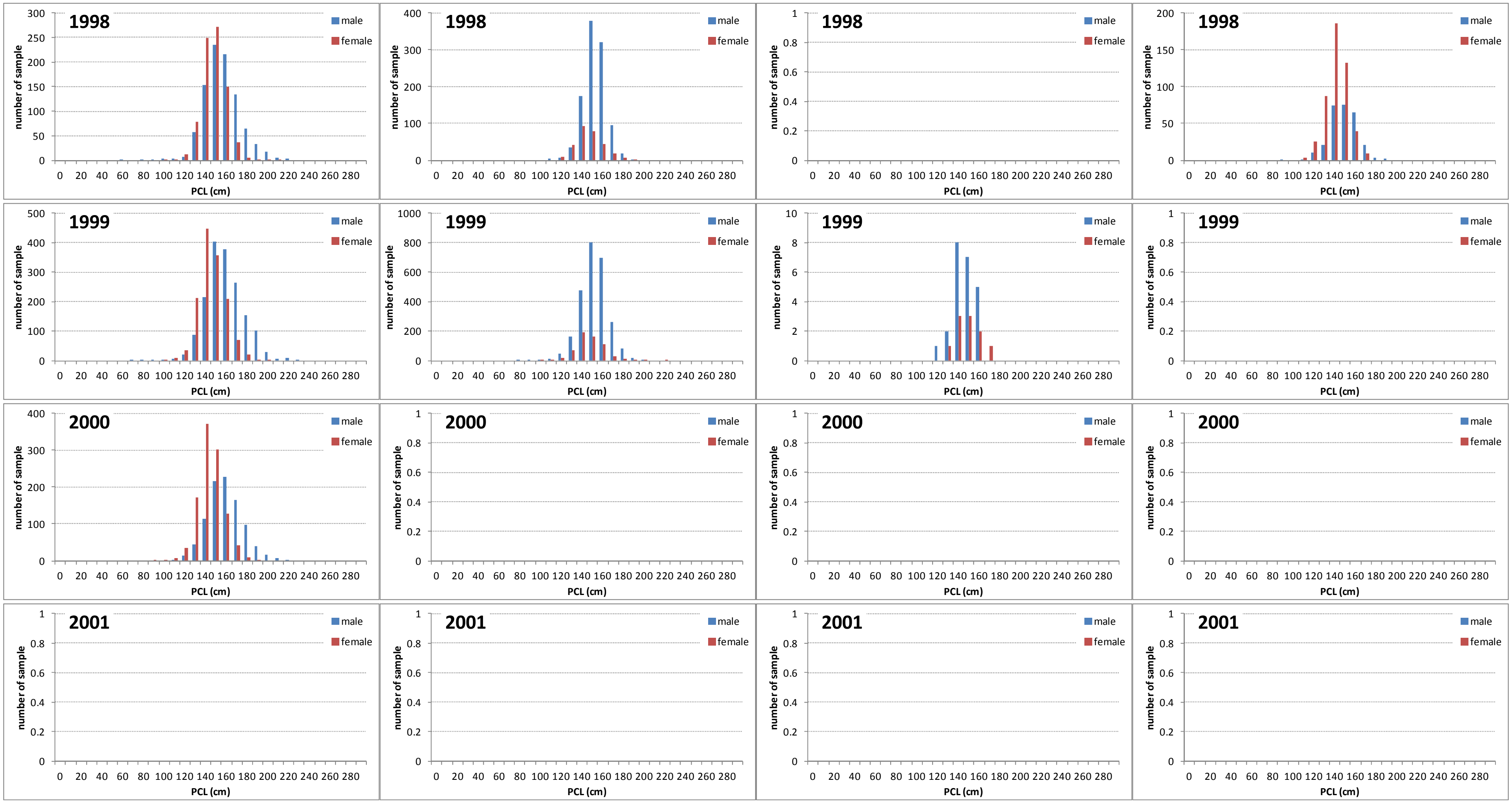


Fig. 7. The quarterly length frequency of male and female blue shark caught by Japanese research and training vessels in subarea 2 in the period between 1998 (top line) and 2001 (bottom line).

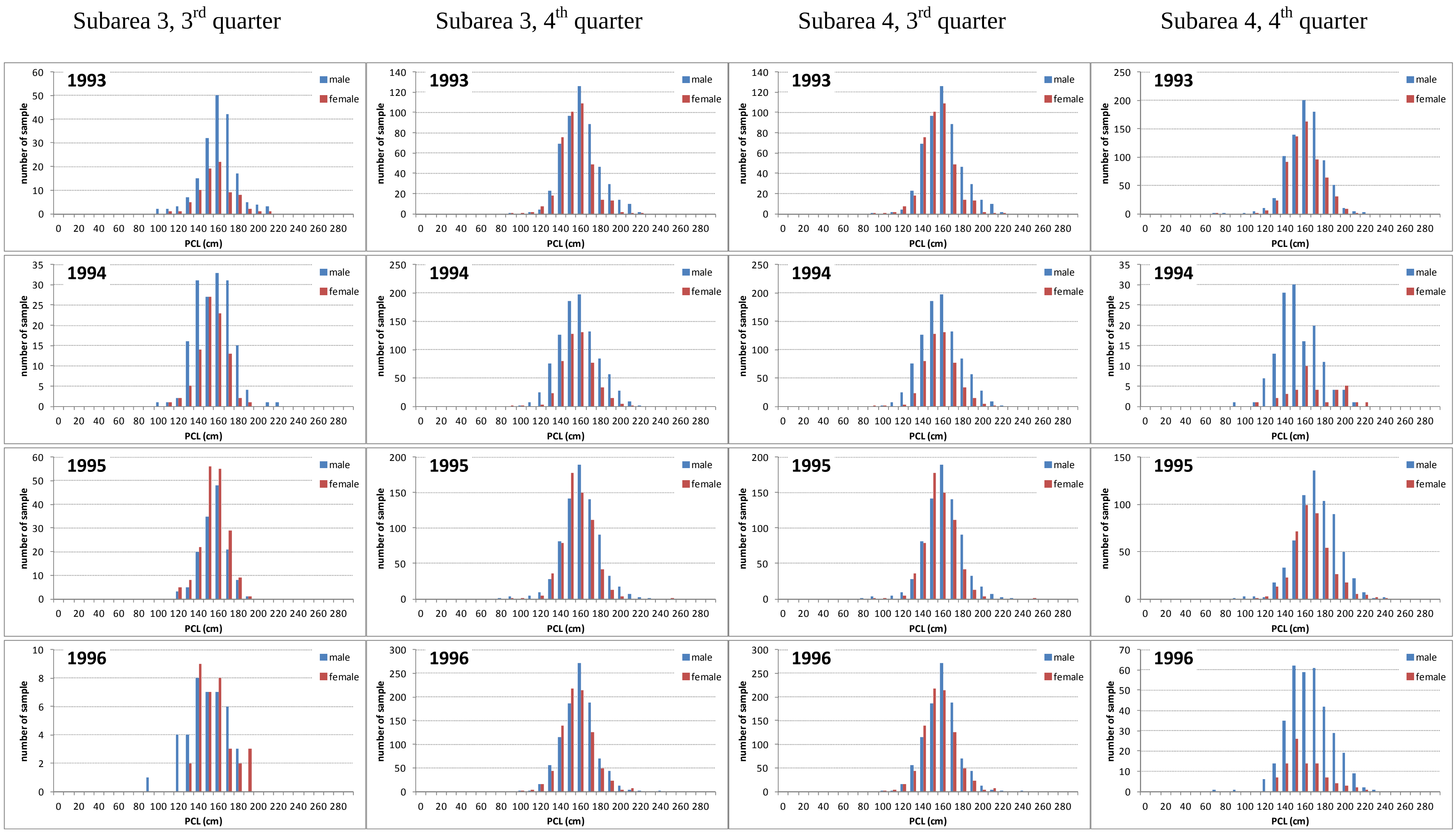


Fig. 8. The length distributions of blue shark caught by Japanese research and training longline vessels in Subareas 3 and 4 in 3rd and 4th quarters in the period between 1993 and 1996.

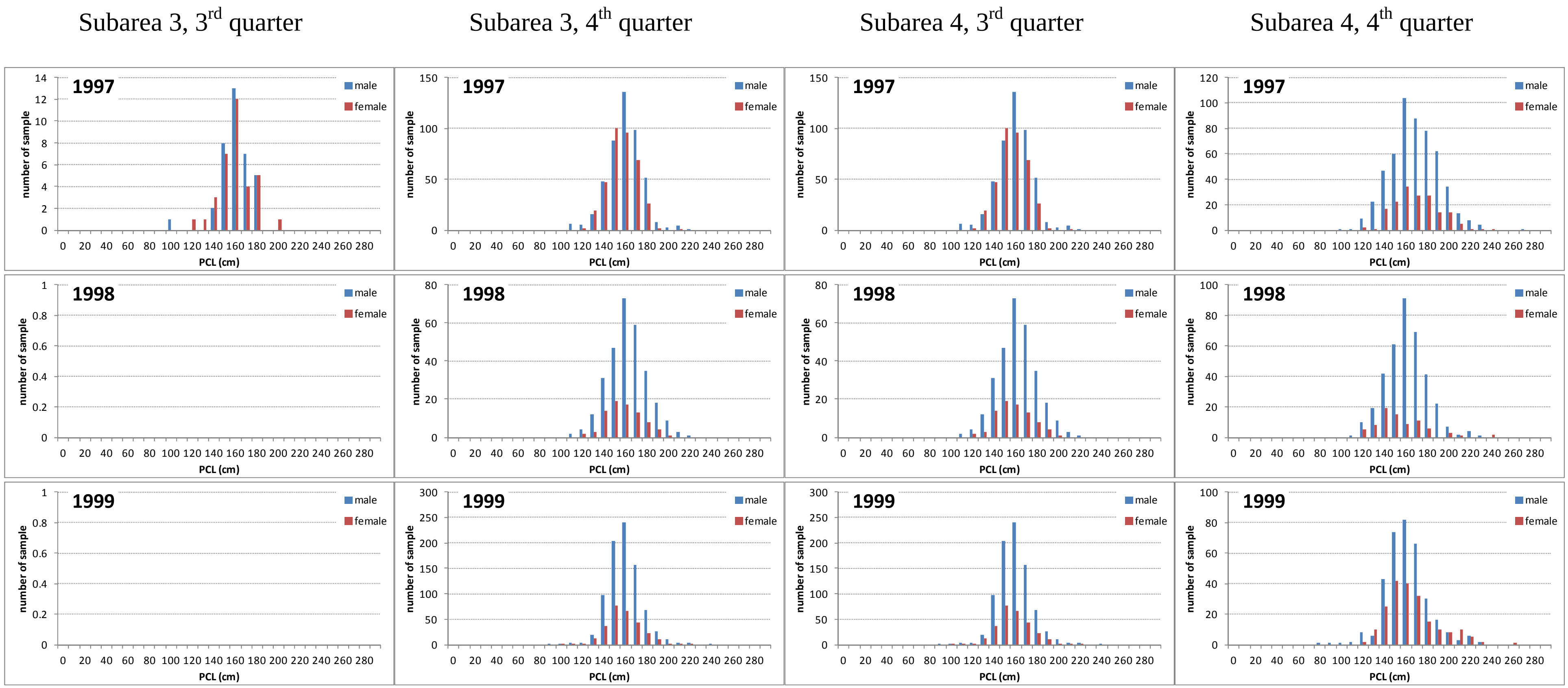


Fig. 9. The length distributions of blue shark caught by Japanese research and training longline vessels in Subareas 3 and 4 in 3rd and 4th quarters in the period between 1997 and 1999.