# Examination of the distribution and reproductive status of western North Pacific minke whales collected in sub-areas 7, 8 and 9 during JARPN and JARPN II from 1994 to 2001.

Ryoko Zenitani*, Yoshihiro Fujise*, Shigeyuki Kawahara** and Hidehiro Kato**

*: The Institute of Cetacean Research, 4-18, Toyomi-cho, Chuo-ku, Tokyo 104-0055, Japan.
**: National Research Institute of Far Seas Fisheries, 5-7-1, Orido, Shimizu, Shizuoka 424-0902, Japan.

## ABSTRACT

This paper examines the distribution and reproductive status of minke whales in sub-areas 7, 8 and 9 from body length distribution and maturity composition in order to clarify the distribution of juvenile (immature) animals using JARPN and JARPN II data from 1994 to 2001, supplemented with the information from the past small-type whaling. We used the biological data of 558 individuals (500 males and 58 females) collected during JARPN and JARPN II surveys and of 2,692 individuals (1,817 males and 875 females) collected during the small-type whaling. The body length frequencies for males during JARPN and JARPN II surveys shows a dominance of large (mature) animals and few small (immature) animals in May and June in all sub-areas. The body length distribution of samples from small-type whaling indicates immature animals are dominant in coastal sub-area 7 (from waters off the Sanriku coast to the Pacific coast of Hokkaido) especially in May and June. Maturity compositions of animals indicate dominance of mature males with few immature animals and few mature females distributed in all the sub-areas during JARPN and JARPN II surveys and dominance of immature animals during small-type whaling especially in April and May. Incomplete representation (few mature females and few immature animals) of sex and sexual status of minke whales found in sub-areas 7, 8 and 9 during JARPN and JARPN II surveys indicated it is unlikely that independent stocks exist in each sub-area. Compared with sub-areas 8, 9W and 9E, more immature animals were found in sub-area 7 during JARPN and JARPN II surveys, where many immature animals had been collected by the small-type whaling. Therefore it was reasonable to assume that the majority of immature animals are distributed in the coastal sub-area 7 especially in April and May. In conclusion, it is likely that one independent stock of western North Pacific minke whales is distributed widely from coastal sub-area 7 to offshore sub-area 9 with segregation depending on sex and reproductive status.

## INTRODUCTION

The JARPN surveys showed that mature males are dominant from coastal sub-area 7 to offshore sub-areas 8 and 9 in May to September and that minke whales distributed in sub-areas 7, 8 and 9 represented incomplete composition of sex and sexual status (dominant mature males, few mature females and few immature animals) (Fujise *et al.*, 1998; Zenitani *et al.*, 1999, 2000). Analyses using the JARPN data support the likelihood of one independent stock in whole area from sub-areas 7, 8 and 9. However, as JARPN has shown that there are some juveniles in sub-area 9 the RMP sub-committee in 2001 noted that the age 4 entries in the mixing matrices should be examined (IWC, 2002).

This paper examines the distribution and reproductive status of minke whales in sub-areas 7, 8 and 9 from body length distribution and maturity composition in order to clarify the distribution of juvenile (sexual immature) animals using JARPN and JARPN II data from 1994 to 2001, supplemented with the information from the past small-type whaling. Furthermore, mean body length at age 4 is estimated in response to the discussion in the PMP sub-committee in 2001.

## MATERIALS AND METHODS

### Grouping of samples

Analyses were based on the sub-areas defined for North Pacific minke whale under RMP. Based on the results of the mtDNA analysis that found some degree of genetic heterogeneity in the western part of sub-area 9 in two years, 1995 and 2000 (Goto *et al.*, 2000, 2001), we examined sub-area 9 for two sectors western and eastern divided at 162°E (9W: western part of sub-area 9, 9E: eastern part of sub-area 9).

### Biological data used in the present study

Table 1 indicates data obtained during JARPN and JARPN II surveys from 1994 to 2001, by sub-area and month. The present study used the biological data obtained from 213 individuals (188 males and 25 females) from sub-area 7, 112

individuals (106 males and 6 females) from sub-area 8, 149 individuals (134 males and 15 females) from sub-area 9W and 84 individuals (72 males and 12 females) from sub-area 9E. In addition, data from 2,692 individuals (1,847 males and 875 females) from sub-area 7 (from waters off the Sanriku coast to waters off the Pacific coast of Hokkaido) taken during small-type whaling from 1977 to 1987 (accumulated by the National Research Institute of Far Seas Fisheries) are used for the purpose of comparing biological data.

**Age and sexual maturity determination**

Age reading by Kato used the standard method developed in Kato (1987) of counting the number of growth layers in the core of the earplug with stereoscopic microscope under reflecting light. Sexual maturity for males was determined by examination of histological status of testis tissues. Males with seminiferous tubules over 100 $\mu$ m diameter or spermatid in the tubule were determined to be sexually mature (Kato, 1986; Kato *et al.*, 1990, 1991). Sexual maturity for females was determined by the presence of at least one corpus luteum or albicans in both ovaries.

In biological data of small-type whaling, the criteria used for maturity status follows that of Kato (1986): males are assumed sexually mature if at least one testis weights over 300g; females are mature if at least one corpus luteum or albicans is present in the ovaries.

## RESULTS

**Distribution of whale samples**

The geographical location of whales sampled during JARPN and JARPN II surveys from 1994 to2001 shown in Fig. 1. Minke whales ware collected in sub-areas 7, 8 and 9 from May to September. The geographical location shows minke whales were distributed in all sub-areas and that mature males ware dominant. Immature males tended to be distributed in coastal sub-area 7 in comparison with other sub-areas. Distribution of minke whales collected in small-type whaling in near coastal sub-area 7 (Sanriku: waters off the Sanriku coast, E.Hokkaido: waters off the Pacific coast of Hokkaido) is shown in Fig.2 (Kato, 1992).

**Body length distribution**

Fig. 3 shows the frequency of body length for males collected during JARPN and JARPN II surveys and small type whaling by maturity status, sub-area and month. The length frequencies for males during JARPN and JARPN II surveys show that large (mature) animals were dominant in all sub-areas. Few small (immature) males were found in May and June in sub-areas 8, 9W and 9E and even fewer in July and August. In sub-area 7, few immature males were found in May, June and September. In these months, immature males were found other sub-areas. These data shows seasonal and geographical changes of distribution for the few immature males sampled. In contrast, the length frequencies in sub-area 7 for animals taken by during small-type whaling show immature males distributed from April to September and especially dominantly in April and May.

Fig. 4 indicates the frequency of body length for females collected during JARPN and JARPN II surveys and small type whaling by maturity status, sub-area and month. The length frequency data of females from JARPN and JARPN II surveys are insufficient to draw conclusions because of small sample size however there were more immature females sampled in May and June in sub-area 7. In contrast, length frequency of samples taken during small-type whaling show immature females distributed from April to September and especially dominantly in April and May. The body length distribution data indicates that immature animals that hardly found during JARPN and JARPN II surveys were dominant in coastal sub-area 7 (waters off the Sanriku coast to waters off the Pacific coast of Hokkaido).

**Maturity composition**

Maturity composition of animals collected in sub-areas 7, 8, 9W and 9E during JARPN and JARPN II surveys and in sub-area 7 during the small-type whaling are shown in Fig. 5. Maturity compositions indicate dominance of mature males with few immature animals and mature females distributed in all sub-areas during JARPN and JARPN II surveys. More immature animals were found in sub-area 7 in comparison with other sub-areas 8, 9W and 9E. The maturity composition of animals taken the small-type whaling indicates a dominance of immature animals was distributed in sub-area 7 especially during April and May. Maturity composition in sub-area 7 during JARPN and JARPN II surveys was similar to that in sub-area 7 during the small-type whaling rather than that in sub-area 8, 9W and 9E.

**Body length of juvenile animals (younger than 4 years)**

Distribution of juvenile animals younger than 4 years is problematic for the mixing matrix. We estimated mean body length of males by earplug reading to be 4 years old. There were 12 males estimated to be 4 years old and mean body length of these animals is 6.41m (S.D.=0.53, range: 5.55-7.01m). Consequently, body length of the juvenile males at 4 years is regarded as 6.4m in the present study. Mean body length juvenile females was not estimated because sample size of females was very small. This estimate for male is almost same as the mean body length at sexual maturity for males (6.3m; Kato, 1992).

## DISCUSSION

The present study provided information on distribution of western North Pacific minke whales in sub-area 7, 8 and 9 with sexual and reproductive segregation. This information showed a dominance of mature males with few immature animals and few mature. Distribution of immature animals was found to change with month and sub-area. It was clear that minke whales distributed in sub-area 7, 8 and 9 showed incomplete representation of sex and sexual status (dominant mature males, few mature females and few immature animals). Incomplete representation of sex and sexual status in every sub-area indicates the unlikely existence of one independent stock in each sub-area. Very few immature animals were distributed in sub-areas 7, 8, 9W and 9E. The main distribution of immature animals could not explain by JARPN and JARPN II data alone. More immature animals were found in sub-area 7 during JARPN and JARPN II surveys where many immature animals had be collected by the small-type whaling. Also the maturity composition of animals collected in sub-area 7 was similar to that of catches by the small-type whaling, that is, relatively more immature males are found in sub-area 7 than in the offshore sub-areas. Therefore it was reasonable to assume that the majority of immature animals are distributed in the coastal sub-area 7. In conclusion, it is unreal that only very few immature animals and dominance of mature males formed one and independent stock is considered and it is reasonable that one and independent stock unit of western North Pacific minke distributed in widely from coastal sub-area 7 to offshore sub-area 9 with segregation depending on sex and reproductive status.

## ACKNOWLEDGEMENTS

We are greatly indebted to Dr. Hiroshi Hatanaka of the Fisheries Research Agency and Dr. Seiji Ohsumi of the Institute of Cetacean Research (ICR). We thanks to Takeharu Bando of ICR for assistance with data processing. We are also greatly indebted to Dr. Dan Goodman and Dr. Luis A. Pastene of ICR for valuable suggestion in preparing this manuscript.

## REFERENCES

Fujise, Y., Zenitani, R. and Kato, H. 1998. An examination of the W-stock hypothesis for North Pacific minke whales, with special reference to some biological parameters using data collected from JARPN surveys from 1994 to 1997. Paper SC/50/RMP12 presented to the IWC Scientific Committee, April 1998 (unpublished). 14pp.

Goto, M., Abe, H. and Pastene, L.A. 2000. Additional analyses of mtDNA control region sequences in the western North Pacific minke whales using JARPN samples. Paper SC/F2K/J32 presented to the IWC International Working Group to Review Of the Japanese Whale Research Programme under Special Permit for North Pacific minke whales: JARPN, February 2000 (unpublished). 5pp.

Goto, M., Kanda,N and Pastene, L.A. 2001. Genetic examination of western North Pacific minke whales including sample from JARN II. Paper SC/53/RMP11 presented to the IWC Scientific Committee, July 2001 (unpublished). 11pp.

International Whaling Commission, 2002. Report of the sub-committee on the revised management procedure. Annex D. J. CETACEAN RES. MANAGE. (SUPPL)4 (in press.).

Kato, H. 1986. Study on changed in biological parameters and population dynamics of southern minke whales. Doctoral Thesis, Hokkaido University. 145pp. (in Japanese).

Kato, H. 1987. Density dependent changes in growth parameters of the southern minke whale. Sci. Rep. Whales Res. Inst., Tokyo 38: 47-73.

Kato, H. 1992. Body length, reproduction and stock separation of minke whales off Northern Japan. Rep. int. Whal. Commn 42:443-53.

Kato, H., Kishino, H. and Fujise, Y. 1990. Some analyses on age composition and segregation of southern minke whales using samples obtained by the Japanese feasibility study in 1987/88. Rep. int. Whal. Commn 40:249-56.

Kato, H., Fujise, Y. and Kishino, H. 1991. Age structure and segregation of southern minke whales by the data obtained during Japanese research take in 1988/89. Rep. int. Whal. Commn 41: 287-92.

Zenitani, R., Kato, H. and Fujise, Y. 2000. Some analyses on biological parameters of western North Pacificminke whales, from a view point of stock sdentification. Paper SC/F2K/J13 presented to the IWC International Working Group to Review Of the Japanese Whale Research Programme under Special Permit for North Pacific minke whales: JARPN, February 2000 (unpublished).

Zenitani, R., Fujise, Y., Okamura, H. and Kato, H. 2001.Futher examination of the distribution of western North Pacific minke whales applying alogistic regression analysis for reproductive data collected by the JARPN surveys. Paper SC/52/RMP17 presented to the IWC Scientific Committee, June 2001 (unpublished). 8p.

Table 1. Biological data used for the present analysis by sub- area and month obtained during JARPN and JARPN II surveys from 1994 to 2001 and small- type whaling from 1977 to 1987.

| | sub- area | Month | Male | Female | Total |
|---|---|---|---|---|---|
| JARPN and JARPN II surveys | 7 | May | 74 | 10 | 84 |
| | | Jun. | 67 | 7 | 74 |
| | | Jul. | | 1 | 1 |
| | | Aug. | 20 | 1 | 21 |
| | | Sep. | 27 | 6 | 33 |
| | | Total | 188 | 25 | 213 |
| | 8 | May | 7 | 1 | 8 |
| | | Jun. | 33 | 3 | 36 |
| | | Jul. | 61 | 2 | 63 |
| | | Aug. | 5 | 0 | 5 |
| | | Total | 106 | 6 | 112 |
| | 9W | May | 2 | 2 | 4 |
| | | Jun. | 25 | 3 | 28 |
| | | Jul. | 81 | 9 | 90 |
| | | Aug. | 26 | 1 | 27 |
| | | Total | 134 | 15 | 149 |
| | 9E | May | 18 | 5 | 23 |
| | | Jun. | 24 | 2 | 26 |
| | | Jul. | 2 | 1 | 3 |
| | | Aug. | 24 | 4 | 28 |
| | | Sep. | 4 | 0 | 4 |
| | | Total | 72 | 12 | 84 |
| Small- type whaling | 7 | Apr. | 346 | 315 | 661 |
| | | May | 316 | 198 | 514 |
| | | Jun | 255 | 111 | 366 |
| | | Jul. | 299 | 119 | 418 |
| | | Aug. | 242 | 52 | 294 |
| | | Sep. | 359 | 80 | 439 |
| | | Total | 1,817 | 875 | 2,692 |

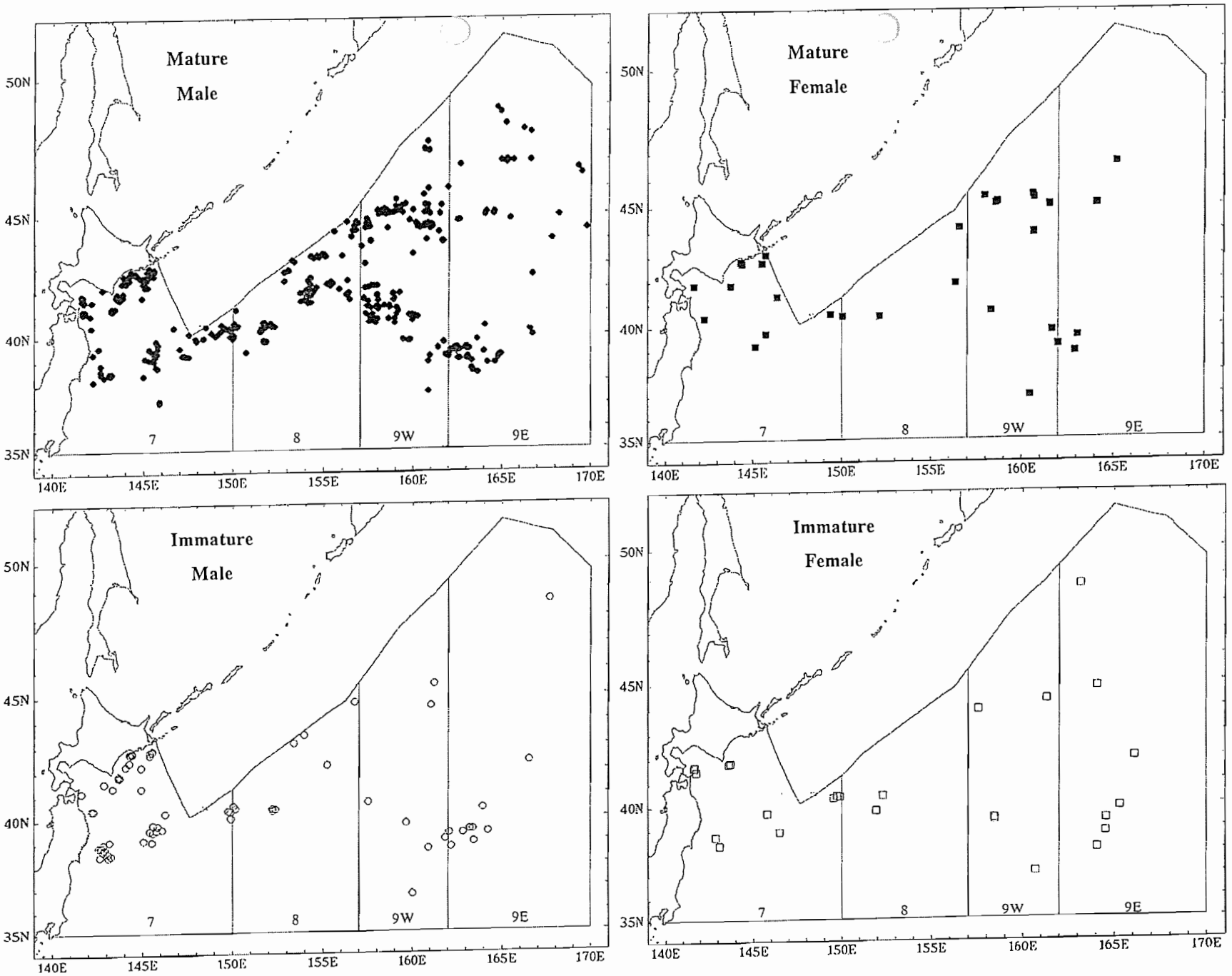


Fig. 1. Geographical position of minke whales sampled during JARPN and JARPN II surveys from 1994 to 2001, based on the sighting position.

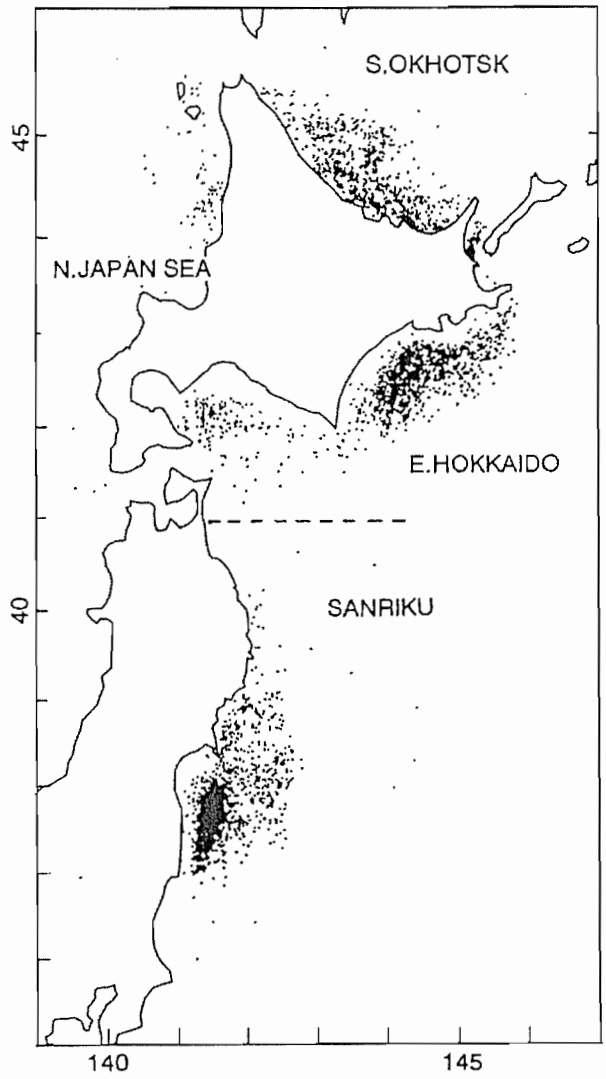


Fig. 2. Distribution of minke whales captured by the small-type whaling from 1977 to 1987 inclusive (After Kato, 1992).

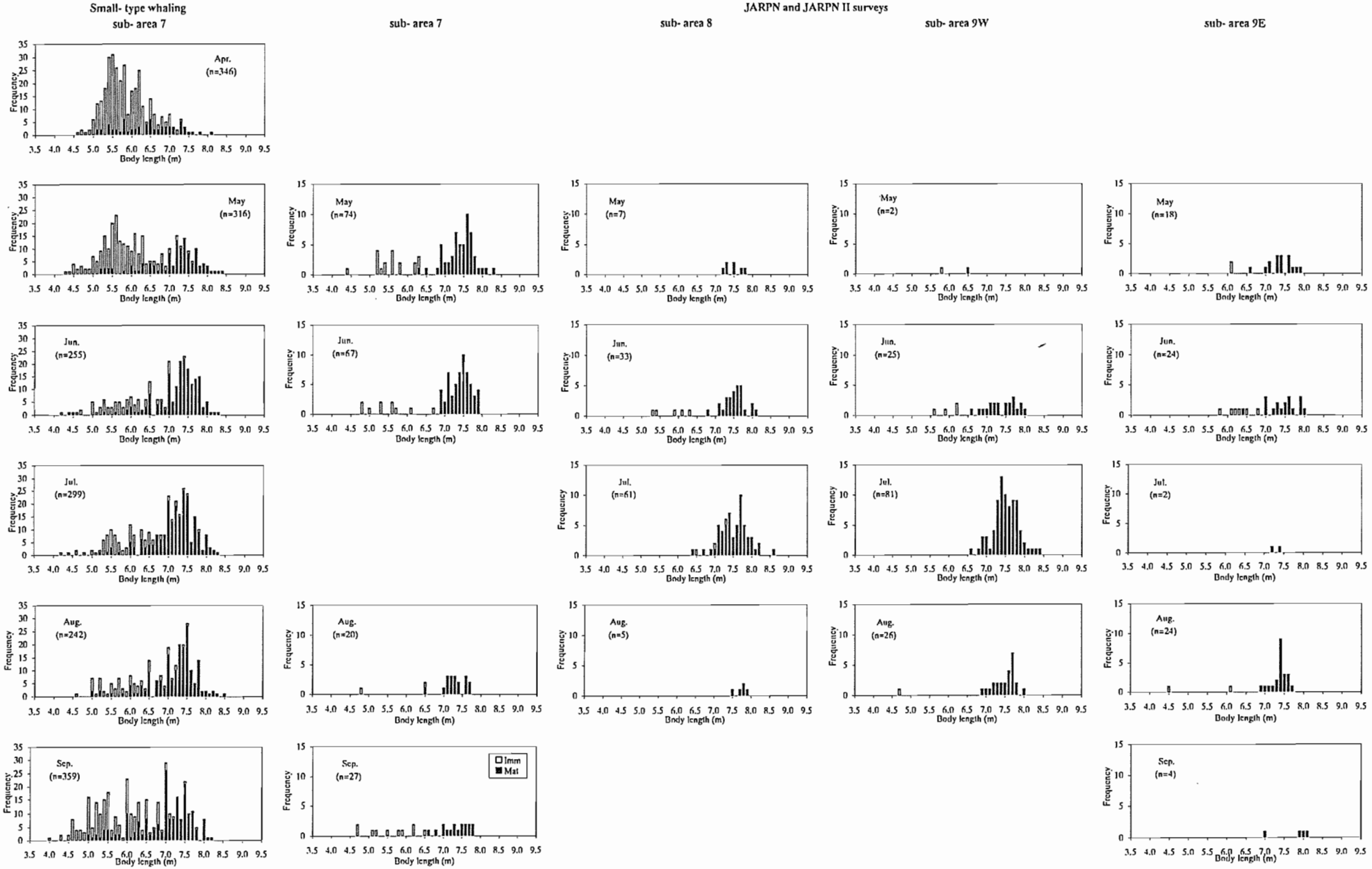


Fig 3. Body length distribution of male minke whales collected by the 1994- 2001 JARPN and JARPN II surveys and the 1977- 1987 small- type whaling, by sub- area and month.

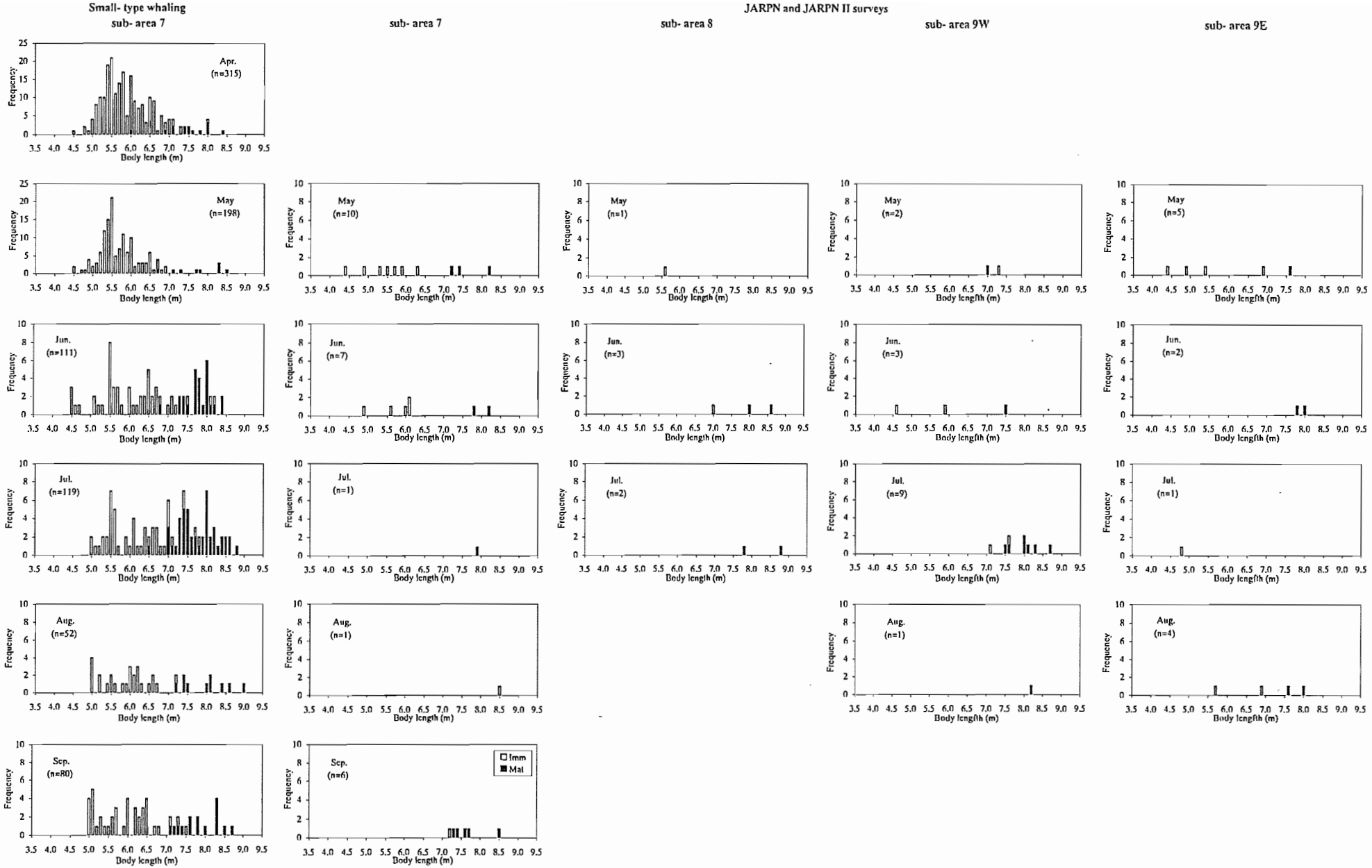


Fig 4. Body length distribution of female minke whales collected by the 1994- 2001 JARPN and JARPN II surveys and the 1977- 1987 small- type whaing, by sub- area and month.

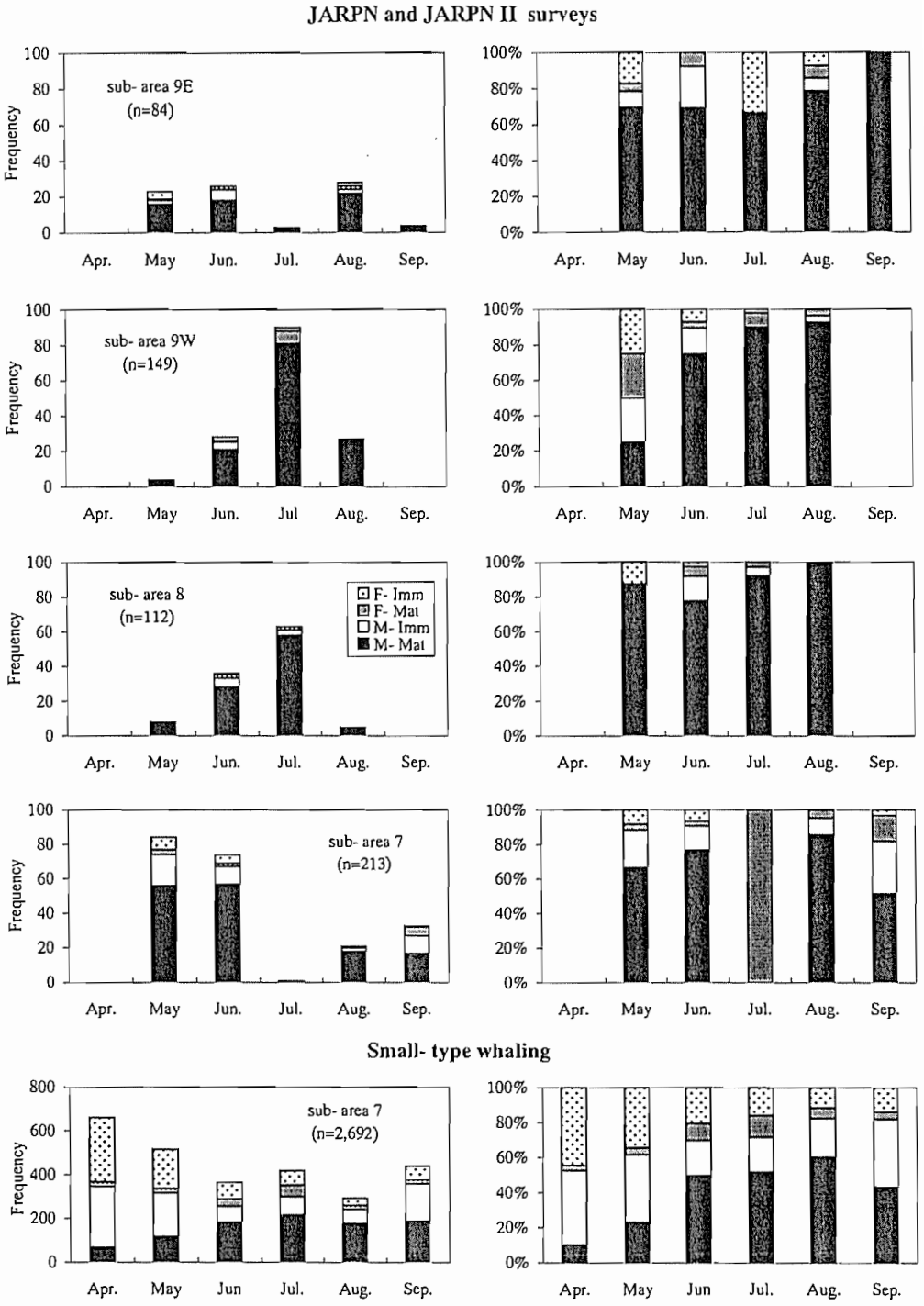


Fig. 5. Maturity composition of minke whales collected during JARPN and JARPN II surveys from 1994 to 2001 and small- type whaling from 1977- 1987.