# Comparison of Parameters to Obtain Abundance Estimates in the Japanese Whale Research Programme Under Special Permit in Antarctic (JARPA) and the International Decade Cetacean Research (IDCR)

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## ABSTRACT

This paper compares the sighting data collected by the 1992/93 Japanese Whale Research Programme Under Special Permit in Antarctic (JARPA) in Area V and the 1985/86 and the 1991/92 International Decade Cetacean Research (IDCR) IDCR cruises to qualitatively examine factors which caused a discrepancy in the estimates of abundance and the values of their coefficients of variation (c.v.). Relative to IDCR, JARPA has shown a higher rate of missing whales which occurred ahead of a vessel. Also it was found that its effective search width tends to be wider because distribution of whales sighted inclined toward both sides of a vessel. It was considered that such factors as the fluctuation of the distribution of whales sighted and the variation of the estimates of effective search width have some effect on the c.v. of estimates of abundance. In addition the estimates of abundance of IDCR showed the lower value when the JARPA's estimate method was applied. Based upon these findings it is assumed that JARPA underestimates an estimate of abundance and produces a higher c.v.

## INTRODUCTION

The Japanese whale research programme under special permit commenced it full-scale research activities from the 1989/90 season based upon the results of the feasibility studies conducted in Area IV and a part of Area V in the 1987/88 and the 1988/89 season respectively. The estimate of abundance of minke whales is an integral part of this programme (Kishino *et al.*, SC/43/Mi22, Nishiwaki *et al.*, SC/44/SHBa8, SC/46/SH12). Also estimates of abundance in these areas in the peak period of migration of minke whales is calculated with use of the sighting data of IDCR cruises (Butterworth SC/40/Mi14, Haw SC/42/SHMi3, Borchers SC/45/SHBa20).

The results of analysis of data obtained by JARPA has been presented to the scientific committee of International Whaling Commirree (IWC/SC). The results of data analysis occured what have to be improved in surveys which had not been originally recognized and the ways to conduct survey is being improved every year. In the 1989/90 and the 1990/91 season, an abundance was estimated based on the sighting data collected by sighting/sampling vessels (SSVs).It is recognized that there are differences between JARPA and IDCR in terms of the period and timing of surveys and allocation of searching efforts in survey areas (Kishino, *et al* SC/43/Mi22, Nishiwaki *et al*., SC/44/SHBa8). Effects of yearly and seasonal changes were considered to cause such differences. Also it was thought that the activity of JARPA is restricted by the timing and the period of research and its searching effort is affected by sampling activity. In order to examine the effect of sampling, a vessel which is solely dedicated to sighting was deployed in the southern part of JARPA's survey area (including *Prydz Bay*) in 1991/92 and in the entire research area in 1992/93. The dedicated sighting vessel (SV) maintained independence by always preceding more than 12 n. miles from SSVs, so as not to be affected by sampling activities. This paper compares JARPA in 1992/93 and IDCR in 1985/86 and 1991/92 because of comparability of conditions of survey including the area, timing and searching effort devoted to survey areas in order to examine factors which affect estimates of abundance and associated coefficients of variation with differences of research vessel and analysis method.

## MATERIALS AND METHODS

Discrepancy of estimate precision is examined by comparing parameters which are used to calculate an estimate of abundance with use of sighting data of JARPA in 1992/93 and IDCR in 1985/86 and 1991/92. With regard to survey items for examination, the sighting data of JARPA in 1992/93 and IDCR in 1985/86 and 1991/92 (records of sighting data and effort data), the values quoted from the results of preliminary analysis of various cruise reports and from papers pertaining to estimate of abundance (Butterworth SC/40/Mi14, Borchers SC/45/SHBa20, Nishiwaki *et al*., C/46/SH12) were used and sorted out. The method of analysis is summarized as following;

Number of animals sighted ($n$):
the number of minke whales of primary sighing within 2 n.miles ahead and away from the truck line was applied a smearing process by Method 2 of Buckland and Anganuzzi (1988) with use of the results of the experiment of distance and angel estimation conducted during the same survey.

Mean school size ($S^*$):
the sighting data collected by the closing mode was used to estimate an average school size with the following equation using the IWC' method (IWC 1988). Using this methodology we have

$$S^*=S_{SC}(W_S/W_{WC})$$

where $S_{SC}$ = mean school size of confirmed schools
$W_S$ = estimated effective search half-width for all schools
$W_{WC}$ = effective search half-width for whales

(estimated using comfirmed schools only)

Density index (DI):
the schools of the primary sighting per unit searching distances represented. Using this methodology we have

$$DI = ns/L * 10 \text{(n.miles)}$$

where $ns$ = schools of the primary sighting
$L$ = searching distances

Effective search width (ESW):
after estimating parameters contained in the hazard rate model;

$$g(y \mid a,b) = 1-\exp(-(y/a)^{1-b} \quad \text{(Hayes and Buckland, 1983)}$$

using Discovery data, the following formula was used to estimate an effective search width(ESW);

$$ESW = 1/f(0), \quad (f(y) = g(y)/ESW)$$

the variance of estimate is evaluated with the bootstrap method (Efron, 1979) by doing re-sampling for every leg.

Density (D) and Abundance (P):
after estimating an effective search width, the density and abundance were by

$$D = \frac{ni}{2wiL}$$

$$P = \frac{niA}{2wiL}$$

Where $ni$ = the number of individuals
A = the size of the research area
$wi$ = the estimated half effective search width
$L$ = the searching distance

## RESULTS

*1) Number of research days and searching efforts*
In the 1992/93 season, JARPA deployed a SV in the entire survey area to increase searching efforts and enhance coefficients of variation. Also the survey period was set up in the same manner as IDCR for the entire reseach area so that efforts could concentrate on January and February which are the peak period of migration of minke whales. One SV and SSVs conducted sighting in the closing mode for the period of 61 days in the stratified subareas in given sequence, while IDCR in 1985/86 carried out

sighting survey with three research vessels for the period of 54 days. In the 1991/92 cruise of IDCR, two survey vessels were undertaking sighting for 40 days. Both closing and passing modes were used alternately in IDCR so that they could be allocated evenly to the research course.

The amount of sighting effort devoted to a survey are and its density varies according to the number of vessels for sighting and the days of research allocated to the area. The total searching distance of the SV in the closing mode in 1992/93 JARPA was 3670.6 n.miles. As two SSVs simultaneously steamed on the each survey courses which are running parallel in the sub-area, their average total searching distance used for analysis was 2175.7 n.miles. On the other hand, that of IDCR was 1691.3 n. miles in 1991/92 and 4049.0 n. miles in 1985/86. The searching effort index per square mile of the survey area for the total searching distance was 0. 42 for the SV and 0.26 for the SSVs, while that of IDCR was 0.38 in 1991/92 and 0.43 in 1985/86. This indicates that the indices of searching effort present no substantial difference between JARPA and IDCR except for SSVs. As the SSVs conducted survey for the same period and in the same area as the SV, the searching distance was shorter due to the effect of sampling activity (table. 1).

*2) Density index*

The research area was divided in accordance to the stratification of 1985/86 IDCR as the way of stratification differed according to each surveys.

The table 2 shows the density index of minke whales of each survey. There is a difference in the density index between SSVs and the SV and it is particularly conspicuous in the southern area where the number of animals sighted is high. In comparing the JARPA's SV with IDCR's. there is no notice able difference in density index between the two with the exception in the northern part of the western sector and the southern part of the eastern sector of IDCR in 1991/92. The c.v of JARPA is higher than that of IDCR, which indicates a great variation in finding whales in the survey. Such discrepancy is also observed in the SSVs whose searching distance is shorter than the SV. It is assumed that this is attributable to the higher rate of non-survey area assosiated with shorter searching distance or the greater variation of searching distance of each survey leg as the minimum steaming distance of a day is set up in order to cover the whole survey course within the given period.

*3) Effective search width*

The table 3 shows the effective search width obtained from minke whales found in the primary sighting. The effective search width of JARPA in 1992/93 is considerably wider than that of IDCR in 1985/86 and comparable to the IDCR in 1991/92. It tends to be wider in JARPA than in IDCR The effective search width of the SSVs is substantially wider than the SV.

*4) Mean school size*

The mean school size of minke whales in the closing mode is shown in the table 4. It is smaller in JARPA than in IDCR. It is also found that SSVs show a smaller size than the SV. As it is easier to find a bigger school than a small school, this implies the situation that JARPA tend to find smaller schools than IDCR does.

*5) Density*

The table 5 shows the estimate of density of minke whales. The estimate density is low in SSVs the number of whales found is smaller than the SV and it is affected by the wider effective search width. The figure also shows that the density estimate of the JARPA' dedicated sighting vessel comes between those of IDCR in 1991/92 and 1985/86. Also the density estimates of the IDCR cruises are found to vary greatly according to the research areas.

*6) Estimate of abundance*

The estimate of abundance by the dedicated sighting vessel was 59,640 animals, while it was 211,150 by IDCR in 1985/86 with the closing mode (Butterworth SC/40/Mi14). The latter becomes 184,380 according to the JARPA's method of estimation. The estimate of JARPA with IDCR's were no noticeable discrepancy.

*7) Research fleet and observation platform*

*Kyomaru No. 1 (KO1)*, *Toshimaru No. 25 (T25)* and *Toshimaru No.18 (T18)* were used for the JARPA of 1992/93, while the IDCR cruise of 1985/86 employed *Kyomaru No. 27 (K27)* which is the same type as the JARPA's, *Shonanmaru (SM1)* and *Shonanmaru No.2 (SM2)* which have a top mast on top of the front bridge. In the IDCR cruise of 1991/92, two instead of three research vessels, SM 1 and SM 2, were used. There are three observation spots in Toshimaru-type research vessels that are engaged in JARPA; the barrel, the upper bridge and on the asdic hut that is located on the upper rear of the upper bridge. In the Shonanmaru-type vessels which are used for IDCR cruises, sighting is conducted on the barrel and the front bridge (which corresponds to the upper bridge). With regard to the number of observers (exclusive of researchers) in each place in the passing mode, JARPA has three people on the barrel, three on the upper bridge and three on the searching cabin, of which six people on the barrel and the upper bridge are the primary observers. On the other hand, IDCR cruises deploy two on the barrel and three on the front bridge, totaling five people. Two people each on the barrel and the upper bridge are primary observers. The Toshimaru-type vessel, K 27, has the same number of observers as the Shonanmaru-type vessels, but two observers are located on the upper bridge and the remaining one on the asdic hut.

The range of observation in front of the upper bridge and the top of the searching cabin is blocked by the top mast in the Toshimaru-type research vessels. There is no obstacles which block the range of vision toward both sides of the vessels. Although nothing obstacts the range of observation ahead of the front bridge as the top mast is located immediately on its above, the props of the top mast which are placed in both sides affect views around them. The figure 1 plots the locations where minke whales were found (the relationship between sighting distance and angle from a vessel) by place of observation and by type of vessel. A comparison of the locations of sighting animals on barrel did not present any difference by year of survey or by vessel. With the location of sighting from the barrel as a base, it was found that the locations of finding whales on the front bridge of Shonanmaru-type vessels concentrated ahead of the vessels and there was less number of sighting locations of particulary longer distance toward both side from the vessels. This is obviously the effect of the props of the front bridge on both sides. The Toshimaru-type vessels had extremely low number of sighting in front of the vessel as the top mast blocks the observation range, which makes the situation as if whales were found only on both sides of the vessel. Such situation is observed in K27 which was used in the IDCR cruise of 1985/86. It is considered, therefore, that the sighting at places other than barrel is greatly affected by the biased range of observation associated with type of vessels.

*8) Experiment of distance and angle estimation*

JARPA has conducted the experiment of distance and angle estimation, which is introduced in IDCR cruises, with a view of assessing the estimate precision of sighting angle and distance and adjusting sighting data used for abundance analysis. The result of experiment does not present any differences in vessels in use between JARPA and IDCR.

9) Sighting distance

The figure 2 shows the distribution of sighting distance by observation platforms. The Toshimaru type vessels differed the distribution of sighting distance by observation platforms. The barrel was a high ditribution in the class between 1.2 and 1.5 n. miles and observation places other than a barrel was a high distribution in the class of 0.3 n. miles. The Shonanmaru-type vessels present no differences associated with observation platforms. However the observation platforms other than a barrel have shown the higher distribution rate in shorter than the class of 1.5 n.miles.

Compare the palce of observation with vessel type, it was presented no difference in the barrel. In the observation palaces other than a barrel, the rate of finding beyond the class 1.2 n.miles is better in the Shonanmaru-type than in the Toshimaru-type, which makes a distinctive differnce between the two. Therefore it is found that the difference in the range of observation associated with type of vessels and the place of observation has an effect on the distribution of sighting distance.

*10) Sighting angle*

The figure 3 shows the distribution of sighting angles by observation platforms. The sighting angles on the barrel present no difference between JARPA and IDCR by type of vessel. The difference by place of observation varies according to type of vessels. Relative to the Shonanmaru-type vessels, the Toshimaru-type vessels showed higher frequency of sighting with an angle of more than 20° and lower frequency of sighting with an angle of less than 20°in platforms other than the barrel. This indicates that the JARPA's sighting tends to occur horizontally relative to the barrel as the top mast blocks the view ahead of the vessel.

*11) Composition of species sighted*

The figure 5 shows the composition of species sighted with a closing mode. In the IDCR cruise of 1991/92, minke whales accounted for 64.3 %, followed by beaked whales with 15 %, sperm whales with 10.7 % and humpback whales with 4.7 % (Ensor *et al.*, 1992). On other hand in JARPA in the 1992/93 season, minke whales accounted for 65.6 %, beaked whales; 14.9 %, sperm whales; 8.1 %, humpback whales ;2.0 % (Fujise *et al.*, SC/45/SHBa12). The composition of species sighted here is almost identical to that of 1991/92IDCR. In IDCR 1985/86, minke whales accounted for 80.2 %, followed by sperm whale with 8.4 % and beaked whales including southern bottlenose whales with 3.8 % (Joyce *et al.*, 1986). The sighting rate of minke whales was extremely higher than those of other species. However, it is unlikely that the difference in composition of species sighted was caused by different survey methods or type of vessels, instead a yearly change is considered to be attributable to the above difference.

## DISCUSSION

It was recognized that the estimate of abundance by the SSVs of JARPA for 1989/90 and 1990/91 was underestimated as opposed to that of the 1985/86 IDCR. The following reasons were presented (Kishino *et al.*, SC/43/Mi 22, Nishiwaki *et al.*, SC/43/SHBa 8);

1) Yearly change of the scale of migration of minke whales
2) Seasonal change in the timing and the period of survey
3) Oceanographical condition which affects searching efforts on the survey course
4) Effect of the non-survey area on the survey course due to the restriction that sampling activities impose on searching efforts
5) Effect of the non-survey area on the survey course due to the restriction that the survey schedule imposes on searching efforts
6) Effect of the density of whales on the survey course as whales disperse or concentrate in response to sampling activities
7) A bias in the range of observation caused by the allocation of three observers on a barrel

In order of examine the causes above 1) - 7), a SV which is free from sampling was deployed in the 1992/93 JARPA so that it could concentrate its sighting effort on the peak of migration of minke whales (from January to February) in the same manner as IDCR's. The effect of sampling indcated to compare the parameters to obtain abundance estmates between SV and SSVs.

There are several possible causes for discrepancy of the estimate of abundance between JARPA and IDCR. With the exception of the yearly change in the migration scale of minke whales, no difference was recognized in the survey period as stated above. Differences in survey methods, vessels in use and calculation methods are considered. However the difference in a research method is not likely because the survey method of 1992/93 JARPA was designed comparable to that of IDCR and the SV proceeded more than 12 n. miles ahead of SSVs and conducted survey to avoid the effect of sampling.

Parameters associated with a vessel in use showed distinctive differences. The most conspicuous difference was that the Toshimaru-type vessels for JARPA had a large number of sighting on both sides and the small number in front of the vessels in the observation places other than a barrel, while the Shonanmaru-type vessels for IDCR showed a large number in front and a small number on both sides of the vessels (Fig 1). Probably because of a better view ahead, the Shonanmaru-type vessels relative to the Toshimaru-type tend to find whales with a longer sighting distance. In addition, the sighting rate of a barrel is around 50 % in JARPA and 60-70 % in IDCR (Kasamatsu 1993, Nishiwaki *et al.*, SC/46/SH12). In summary, the effective search width is narrower for the Shonanmaru-type research vessels than that of the Toshimaru-type due to the difference in the range of observation associated with type of vessels, which causes a higher sighting rate on a survey course, results in a higher estimate of abundance (g(0) gets bigger ). JARPA calculates sighting data of singleton and a school of two or more animals separately to obtain an estimate of abundance because of the difference in objectives, while an estimate of abundance in IDCR is calculated by multiplying an average school size by the number of animals sighted. Because of this, in IDCR, finding of a large school could enlarge an estimate of abundance. The estimate of abundance in the closing mode for 1985/86 IDCR was 211,150 animals (Butterworth SC/40/Mi 14), but it becomes 184,380 when the method of estimation used in JARPA is applied. Although the difference in the estimate of abundance between the dedicated sighting vessel for 1992/93 JARPA and IDCR does not presents any significant discrepancy when a statistical testing is conducted (Nishiwaki *et al.*, SC/46/SH12), it should be noted that there are some causes for lowering an estimate of abundance of JARPA.

The 46th scientific committee of IWC pointed out that the c.v. for the esimate of abundance of JARPA is higher than the IDCR's. The estimate of abundance in the closing mode for 1992/93 JARPA was 159,640 (c.v. 0.383, Nishiwaki *et al.*, SC/46/SH12), 1991/92 IDCR; 78,461 (c.v. 0.399, Borchers SC/45/SHBa 20), 1985/86 IDCR; 211,150 (c.v. 0.174, Butterworth SC/40/Mi 14) The c.v. for 1992/93 JARPA was higher than that of 1985/86 IDCR and about the same as that of 1991/92 IDCR. The c.v. for an estimate of abundance is composed of two factors; variation of sighting in a survey and variation of estimation of an effective search width. The survey period for 1985/86 IDCR was 54 days and three sighting vessels carried out survey in parallel in a respective survey area. The survey period for 1991/92 IDCR was 40 days and two sighting vessels were deployed in the reduced survey area. As a result of the reduced period and the number of vessels, the c.v. was higher than that of 1985/86. Although the survey period for 1992/93 JARPA was longer than that of IDCR, the c.v. was still high. It is assumed to be resulted from the effect of a seasonal change within a survey period associated with the sequence of survey in the survey area by one dedicated sighting vessels. Also the variation of searching effort for each survey leg associated with a limited survey schedule is another possible cause.

In addition to the above, in JARPA, the range of observation toward ahead is blocked by a top mast on the observation places other than a barrel (upper bridge and top of searching cabin), which caused a larger missing rate of sighting on the track line. As sighting efforts gets more concentrated toward a horizontal direction to a vessel, the range of distribution of horizontal distance of sighting becomes wider. Because of theabove reasons as well as the difference in the distribution of finding by place of observation, the variation of estimate of an effective search width for JARPA is considered to be larger than that of IDCR.

This paper examined parameters pertaining to an estimate of abundance and its c.v for JARPA and IDCR from a qualitative perspective and presents a difference associated with type of vessels. Further quantitative examination has to be done to evaluate the effect of such difference on these estimates. Also it is necessary to evaluate discrepancies caused by different calculation methods by conducting a variety of simulation trials.

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Table-1. Comparison of sighting manner of JARPA and IDCR surveys.

| Research | vessel | no. vessel | Research Period | day* | Total distance** | Area (n.m^2) | Effort index*** |
|---|---|---|---|---|---|---|---|
| JARPA-1992/93 | SV | 1 | 30.Dec- 6.Mar | 61 | 3,670.6 | 847,525 | 0.43 |
| JARPA-1992/93 | SSVs | 2 | 30.Dec- 6.Mar | 61 | 2,175.7 | 847,525 | 0.26 |
| IDCR-1991/92 | SV | 2 | 31.Dec- 8.Feb | 40 | 1,691.3 | 443,804 | 0.38 |
| IDCR-1985/86 | SV | 3 | 22.Dec-17.Feb | 54 | 4,049.0 | 963,104 | 0.42 |

* :exclude transit navigation
** : n.miles
***: Searching effort index

Table 2. Comparison of density index (DI) in JARPA and IDCR surveys.
The numbers in parentheses are the C.V.

| Sub-area | 1992/93-JARPA SSVs | | 1992/93-JARPA SV | | 1991/92-IDCR SV | | 1985/86-IDCR SV | |
|---|---|---|---|---|---|---|---|---|
| East(60°-66°S) | 0.026 | (0.142) | 0.022 | (0.567) | - | | 0.044 | (0.413) |
| East(66°-73°S) | 0.045 | (0.419) | 0.163 | (0.360) | 0.170 | (0.212) | 0.139 | (0.294) |
| East(73°-78°S) | 0.045 | (0.419) | 0.163 | (0.360) | 0.074 | (0.251) | 0.188 | (0.235) |
| West(60°-62°S) | 0.017 | (0.235) | 0.050 | (0.322) | - | | 0.034 | (0.516) |
| West(62°-65°S) | 0.017 | (0.235) | 0.050 | (0.322) | 0.009 | (0.349) | 0.079 | (0.488) |
| West(65°-69°S) | 0.022 | (0.276) | 0.106 | (0.280) | 0.458 | (0.296) | 0.610 | (0.256) |

Table 3. Comparison of effective search half-width in JARPA and IDCR surveys. The numbers in parentheses are the C.V.

| Sub-area | 1992/93-JARPA SSVs | | 1992/93-JARPA SV | | 1991/92-IDCR SV | | 1985/86-IDCR SV | |
|---|---|---|---|---|---|---|---|---|
| East(60°-66°S) | 0.755 | (0.131) | 0.434 | (0.072) | - | | 0.301 | (0.145) |
| East(66°-73°S) | 0.879 | (0.264) | 0.549 | (0.157) | 0.594 | (0.171) | 0.470 | (0.104) |
| East(73°-78°S) | 0.879 | (0.264) | 0.549 | (0.157) | 0.497 | (0.378) | 0.413 | (0.078) |
| West(60°-62°S) | 0.495 | (0.109) | 0.524 | (0.217) | - | | 0.224 | (0.190) |
| West(62°-65°S) | 0.495 | (0.109) | 0.524 | (0.217) | 0.545 | (0.179) | 0.388 | (0.163) |
| West(65°-69°S) | 1.019 | (0.105) | 0.615 | (0.322) | 0.296 | (0.990) | 0.438 | (0.147) |

Table 4. Comparison of Mean school size in JARPA and IDCR.

| Sub-area | 1992/93 JARPA SSVs | 1992/93 JARPA SV | 1991/92 IDCR SV | 1985/86 IDCR SV |
|---|---|---|---|---|
| East(60°-66°S) | 1.4 | 7.5 | 3.5 | 2.6 |
| East(66°-73°S) | 2.3 | 2.8 | 1.9 | 2.7 |
| East(73°-78°S) | 2.3 | 2.8 | 1.9 | 3.3 |
| West(60°-62°S) | 1.3 | 1.6 | 3.5 | 1.9 |
| West(62°-65°S) | 1.3 | 1.6 | 3.5 | 2.8 |
| West(65°-69°S) | 3.4 | 2.9 | 1.9 | 5.0 |

Table 5. Comparison of estimate density (10n.mile^2) in JARPA and IDCR surveys. The numbers in parentheses are the C.V.

| Sub-area | 1992/93-JARPA SSVs | | 1992/93-JARPA SV | | 1991/92-IDCR SV | | 1985/86-IDCR SV | |
|---|---|---|---|---|---|---|---|---|
| East(60°-66°S) | 0.040 | (0.142) | 0.181 | (0.704) | - | | 0.191 | (0.468) |
| East(66°-73°S) | 0.127 | (0.236) | 0.416 | (0.579) | 0.416 | (0.444) | 0.393 | (0.346) |
| East(73°-78°S) | 0.127 | (0.236) | 0.416 | (0.579) | 0.066 | (0.403) | 0.757 | (0.245) |
| West(60°-62°S) | 0.043 | (0.470) | 0.062 | (0.565) | - | | 0.144 | (0.580) |
| West(62°-65°S) | 0.043 | (0.470) | 0.062 | (0.565) | 0.021 | (0.523) | 0.283 | (0.584) |
| West(65°-69°S) | 0.145 | (0.450) | 0.261 | (0.465) | 0.041 | (0.506) | 0.350 | (0.426) |

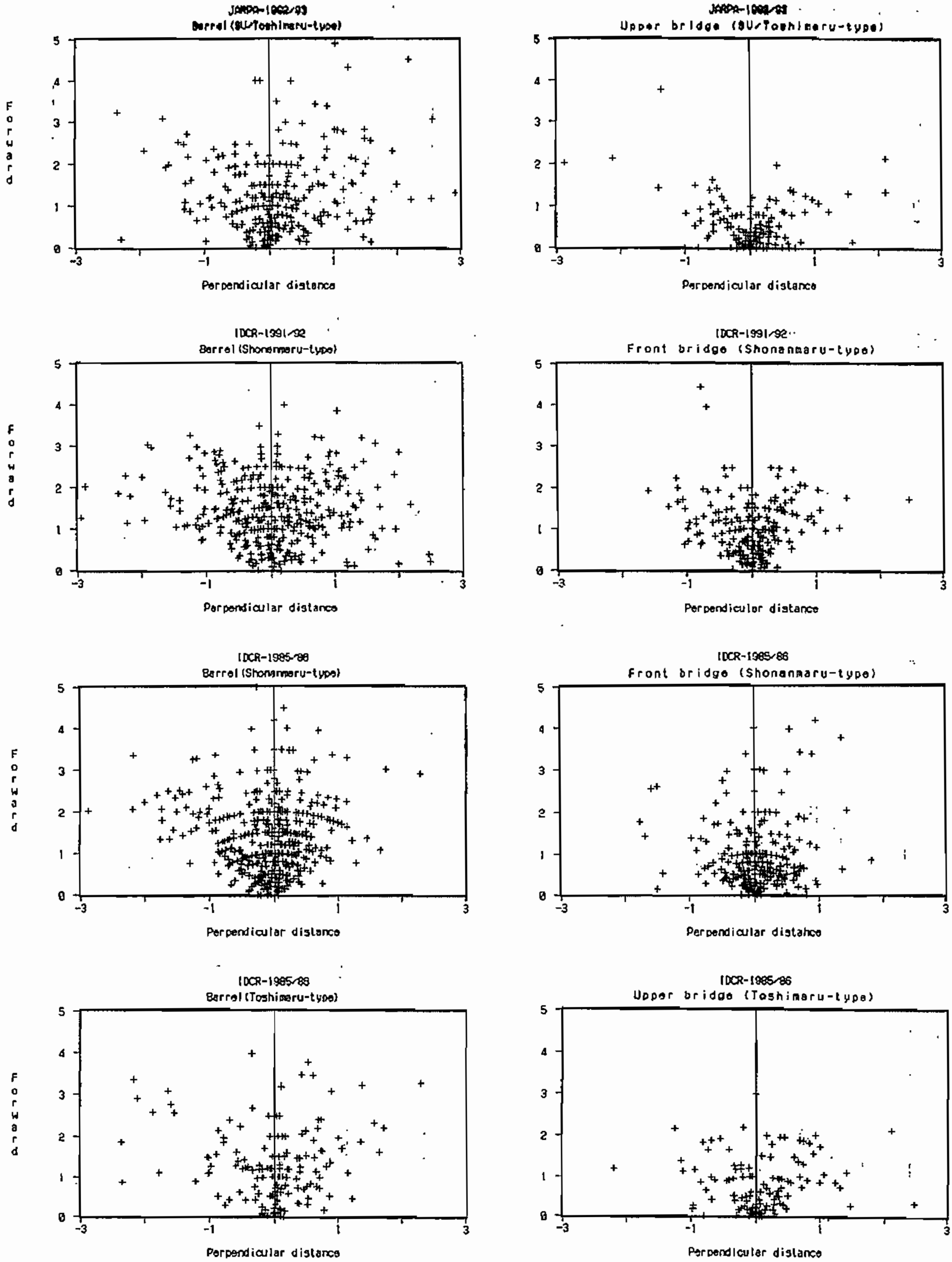


Fig 1. Comparison of sighting distribution of minke whale primary sighted by platform and by type of vessels (only IDCR-1985/86) in JARPA and IDCR surveys.

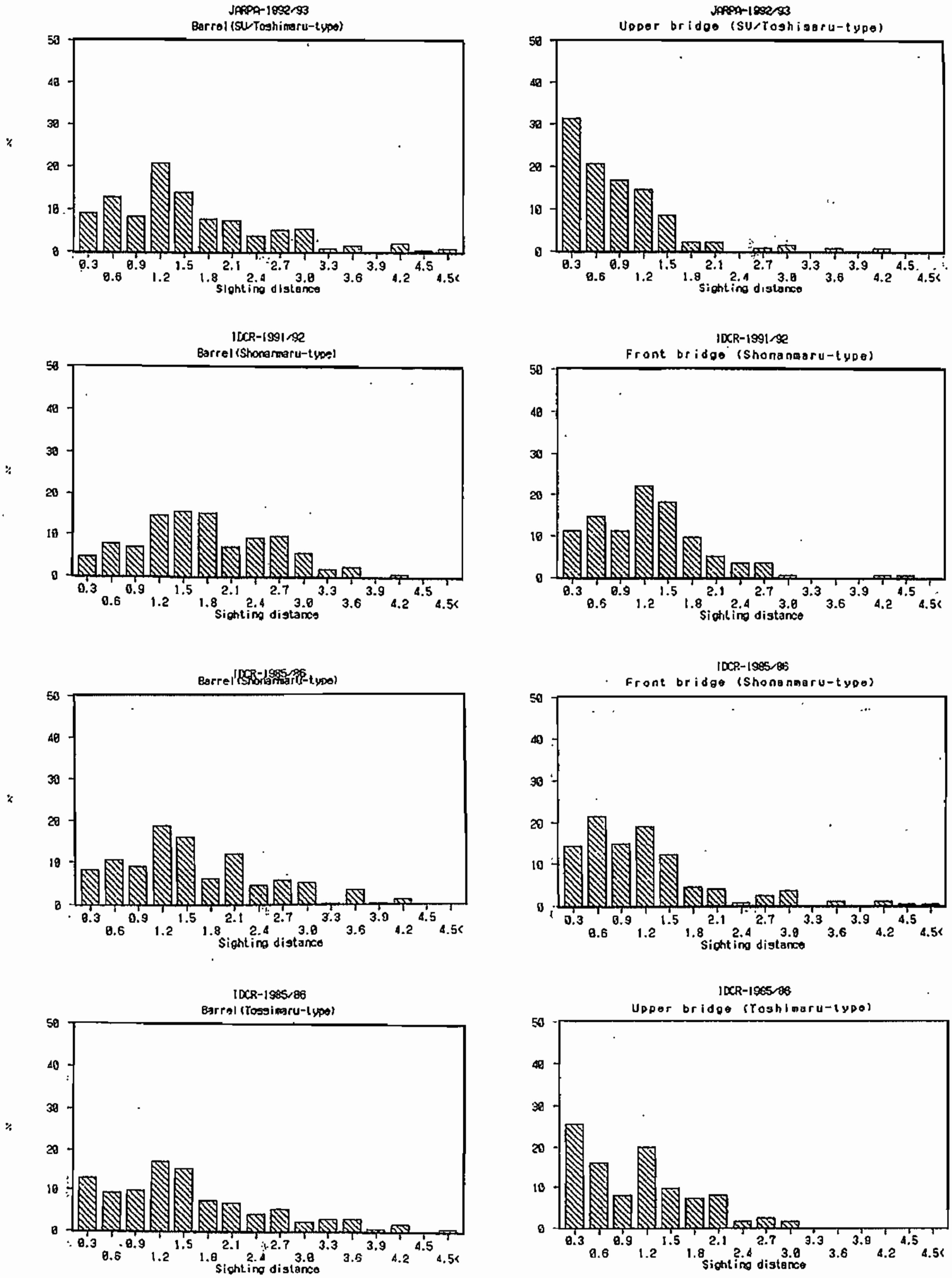


Fig 2. Comparison of sighting distance of minke whale primary sighted by platform and by type of vessels (only IDCR-1985/86) in JARPA and IDCR surveys.

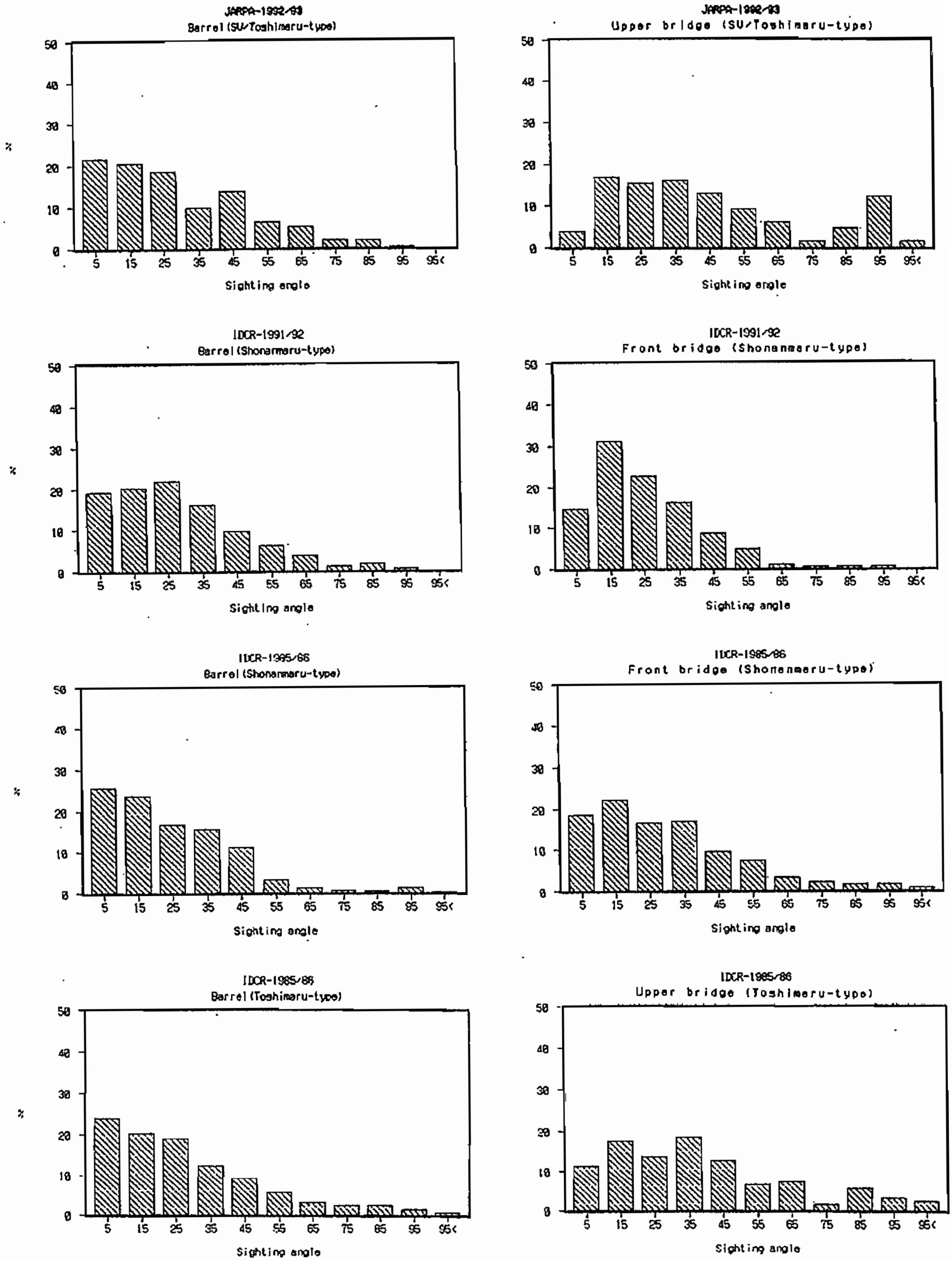


Fig 3. Comparison of sighting angle of minke whale primary sighted by platform and by type of vessels (only IDCR-1985/86) in JARPA and IDCR surveys.

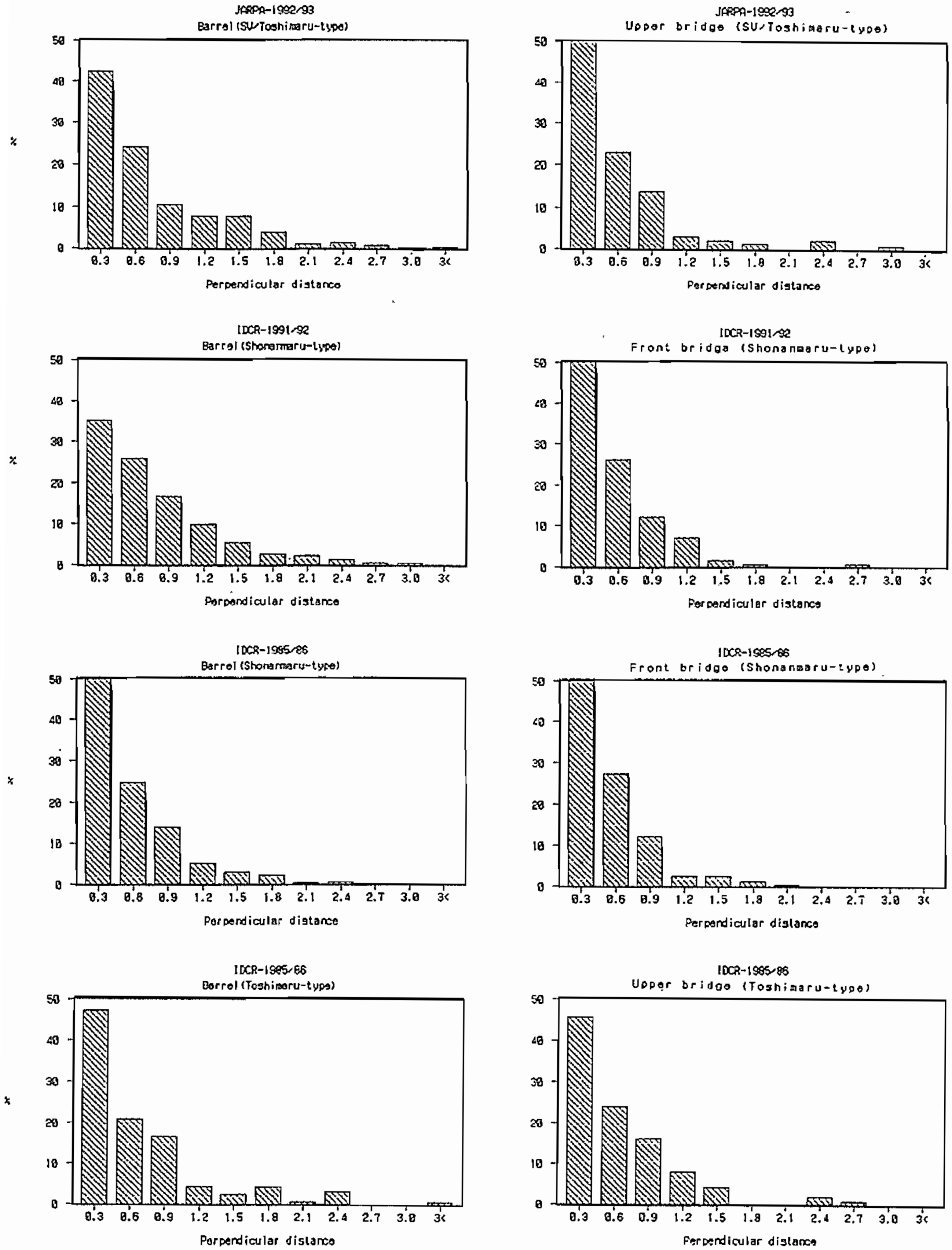


Fig 4. Comparison of perpendicular distance of minke whale primary sighted by platform and by type of vessels (only IDCR-1985/86) in JARPA and IDCR surveys.

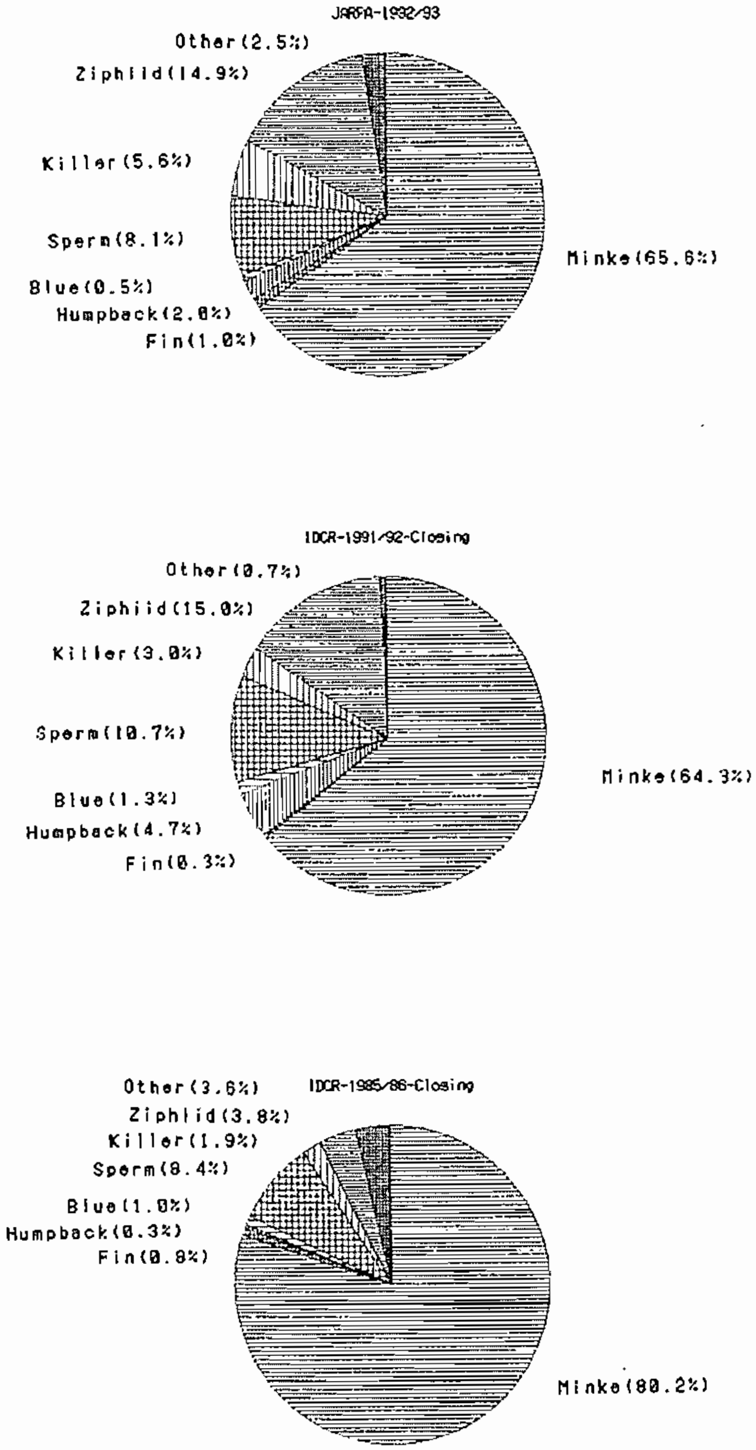


Fig 5. Comparison of whale spieces primary sighted in JARPA and IDCR surveys.