Technical Reports of the Institute of Cetacean Research (2019) pp. 41–51

*Technical Report (not peer reviewed)*

# Distribution of blue, fin, humpback and North Pacific right whales in the western North Pacific based on JARPN and JARPNII surveys (1994–2014)

Koji Matsuoka* and Takashi Hakamada

*Institute of Cetacean Research, 4–5 Toyomi-cho, Chuo-ku, Tokyo 104–0055, Japan*

**Contact e-mail: matsuoka@cetacean.jp*

**ABSTRACT**

This paper examines the geographical and temporal patterns of distribution of blue, fin, humpback and North Pacific right whales in the western North Pacific. The analyses were based on sighting data collected systematically by JARPN and JARPNII surveys during May to September in the years 1994–2014. A total of 269,728.1 n. miles was surveyed in the entire research period. The Density Index (No. of individual whales sighted/100 n. miles) was calculated and its geographical and temporal (monthly) distribution plotted for each individual species. Fin whale was the species most frequently sighted, followed by humpback, blue and right whales. The geographical and temporal pattern of distribution was described for each whale species. The large sighting data set collected systematically by JARPN and JARPNII has made a substantial contribution to understanding the pattern of geographical distribution and habitat use of whales in the western North Pacific ecosystem.

## INTRODUCTION

One of the main sources of sighting data for assessing the population status of whale species in the western North Pacific was the JARPN, which was conducted between 1994 and 1999, and its second phase JARPNII conducted between 2000 and 2014.

The sighting data collected by JARPN and JARPNII have been used for studying the distribution pattern and abundance estimation of several large whale species in the western North Pacific (Okamura *et al.*, 2001; Matsuoka *et al.*, 2009). Details of the sighting survey procedures in JARPN and JARPNII are available in Fujise (2000) and Tamura *et al.* (2009), respectively.

This technical report summarizes the Institute of Cetacean Research (ICR)'s investigation of the pattern of geographical and temporal distribution of blue (*Balaenoptera musculus*), fin (*B. physalus*), humpback (*Megaptera novaeangliae*) and North Pacific right (*Eubalaena japonica*) whales in the western North Pacific. The investigation was based on sighting data collected systematically by JARPN and JARPNII surveys in the period 1994–2014.

## MATERIALS AND METHODS

### Research area

The research area comprised the western part of the North Pacific, specifically the International Whaling Commission (IWC) management sub-areas 7, 8, 9 and 11 (used for management of the common minke whale), north of 35°N, excepting the 200 n.mile EEZ's of foreign countries (Figure 1).

### Sighting data

Primary sighting and effort data were collected by JARPN (1994–1999) and JARPNII (2000–2014) systematic surveys. Surveys were conducted by sighting and sampling vessels (SSV) (vessels engaged in sighting and sampling of whales) and dedicated sighting vessels (SV) (vessels engaged only in sighting of whales). Sighting data obtained by SSVs and SVs were combined for the calculation of the Density Index (see below).

### Sighting procedures

The sighting procedures for SSVs and SVs in JARPNII (2000–2014) was not significantly changed with regard the procedures in JARPN (1994–1999) with only some minor changes made (see details in Matsuoka *et al.*, 2016). The research vessels were equipped with a top barrel, where three top men conducted sightings. On the upper bridge, a captain, a gunner, a helmsman and a researcher also conducted the sightings. The sighting activity was conducted under acceptable weather conditions (see below), from 60 minutes after sunrise to 60

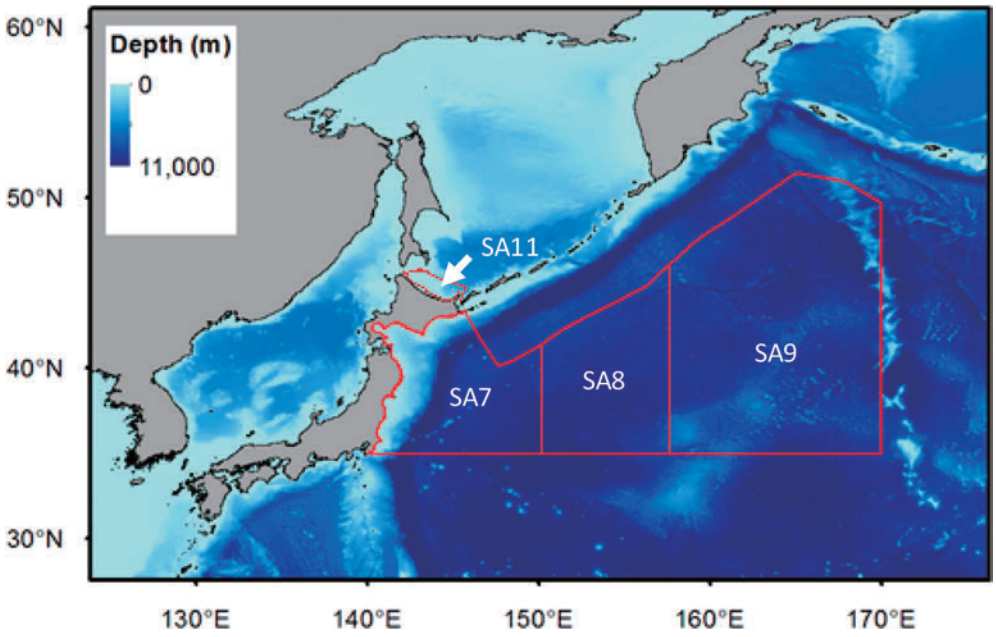


Figure 1. Research area in the western North Pacific indicating the sub-areas used for management of common minke whale.

minutes before the sunset.

**Survey modes**

*SSV*

Searching was conducted under two survey modes: NSC (Normal Search Closing) mode and NSS (Normal Search Closing Special). The NSC mode corresponds to 'closing mode' conducted under the normal weather conditions defined as visibility of 2 n.miles or more and wind velocity 4 or below. The NSS corresponds to 'closing mode' conducted under more unfavorable weather conditions but under which, the collection of whale samples was possible (Tamura *et al.*, 2009).

*SV*

Searching was conducted under two survey modes: ASP and NSP modes. The ASP mode corresponds to 'closing mode' conducted under normal weather conditions defined as visibility of 2 n.miles or more and wind velocity 4 or below. The NSP mode corresponds to 'passing mode' conducted under the normal weather conditions defined above (Matsuoka *et al.* 2016).

**Cruise track design**

For the main survey, the zigzag-shaped track line was established to cover the survey area. Furthermore, the 'Special Monitoring Survey (SMS)' was adopted in areas where the density of whales was expected to be high (see Fujise, 2000; Tamura *et al.*, 2009). The vessels conducted sighting surveys 6 and 4 n.miles apart from each other in the main and SMS surveys, respectively. These data were combined for the analyses.

**Confirmation of the sightings**

When a sighting was made, the vessels closed the school immediately in order to identify the species, estimate the school size and get other biological information such as the number of calves, estimated body length, etc. Surface temperatures were recorded at the location of each whale sighting.

**Density Index of Whales**

The Density Index of Whales (DIW) (the number of individual whales sighted by 100 n.miles) was calculated by each Lat.1°× Long.1°grid squares, for each species. Calculations were made for the entire research period (1994–2014) as well by month. For the calculation sighting data collected by the SSV and SV were combined.

## RESULTS AND DISCUSSION

**Searching efforts**

A total of 269,728.1 n.miles were surveyed in sub-areas 7, 8, 9 and 11 (Figure 1) between 1994 and 2014 (including transit surveys in the Sea of Japan). Figure 2 show the research area and the primary searching effort (n. miles) by Lat.1°×Long.1° grid square.

**Geographical and temporal distribution pattern of whales**

Table 1 shows the summary of all primary whale sightings

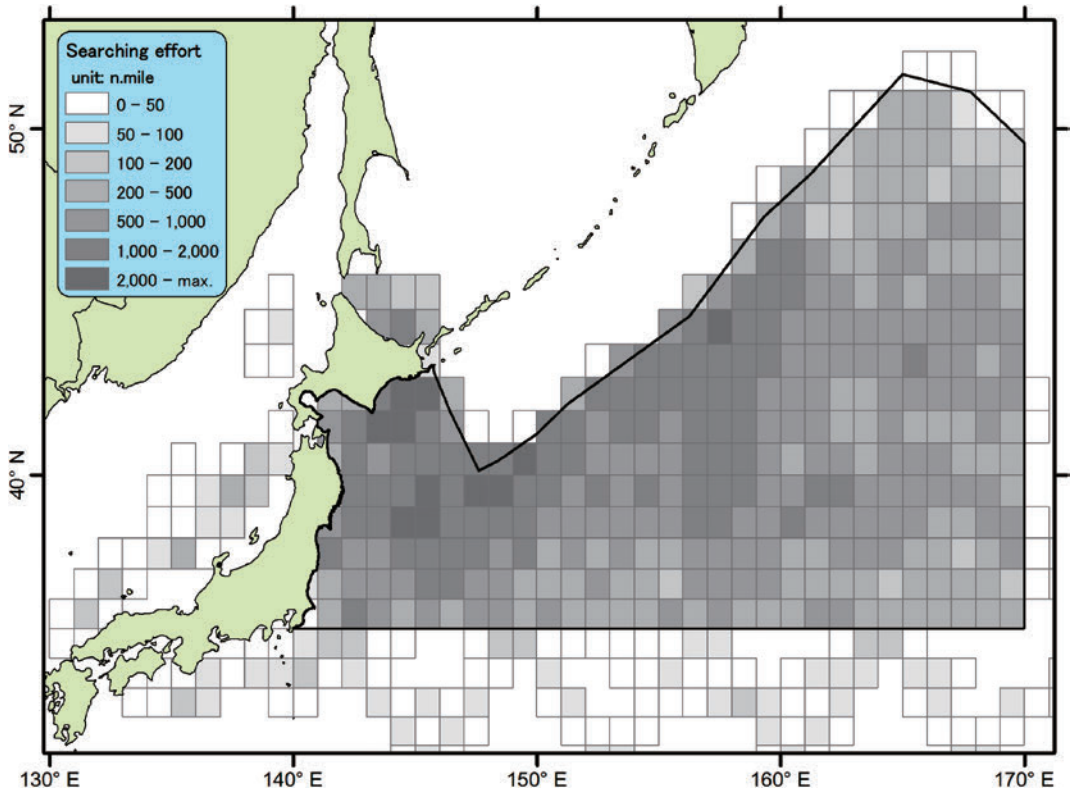


Figure 2. The searching effort by each Lat.1°× Long.1° grid square by JARPN and JARPNII surveys during 1994 to 2014 (including transit surveys in the Sea of Japan).

Table 1

Summary of all primary sightings of blue, fin, humpback and North Pacific right whales during the JARPN and JARPNII in the entire period (1994–2014) including transit surveys to and from the research areas.

| Species | Indices | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sch. | Ind. | Calf | Mss | DIS | DIW | WT |
| Blue whale | 374 | 508 | 23 | 1.36 | 0.14 | 0.19 | 3.0–25.8°C |
| Fin whale | 799 | 1,125 | 37 | 1.41 | 0.30 | 0.42 | 2.9–26.9°C |
| Humpback whale | 492 | 685 | 42 | 1.39 | 0.18 | 0.25 | 2.8–24.1°C |
| N.P. right whale | 48 | 68 | 9 | 1.42 | 0.02 | 0.03 | 2.7–17.0°C |

Sch.: number of the primary sightings of schools; Ind.: number of the primary sightings of individuals; Calf: number of calves; Mss: mean school size (Ind./Sch.); DIS: Density Index of Schools (schools/100 n.miles); DIW: Density Index of Whales (individual whales/100 n.miles); WT: range of surface temperature of the species sighting positions.

for blue, fin, humpback and North Pacific right whales in the entire period (1994–2014), including transit survey in the Sea of Japan. Fin whale (799 schools/1,125 individuals including 37 calves) was the species most frequently sighted (DIW: 0.42). Next was the humpback whale (492 schools/685 individuals including 42 calves) (DIW: 0.25). It was followed by the blue whale (374 schools/508 individuals including 23 calves) (DIW: 0.19) and North Pacific right whale (48 schools/68 individuals including 9 calves) (DIW: 0.03).

*Pattern of geographical distribution*

Figures 3a, 3b, 3c and 3d show the geographical distribution of the DIW of blue, fin, humpback and North Pacific right whales, respectively, for the entire period (1994–2014).

Blue whale (Figure 3a)

Blue whales were widely distributed mainly north of 35°N in sub-areas 8 and 9 from May to September. Surface temperature ranged from 3.0°C to 25.8°C (Table 1). A high-density area was observed north of 45°N, southeast off the Kamchatka Peninsula in sub-area 9.

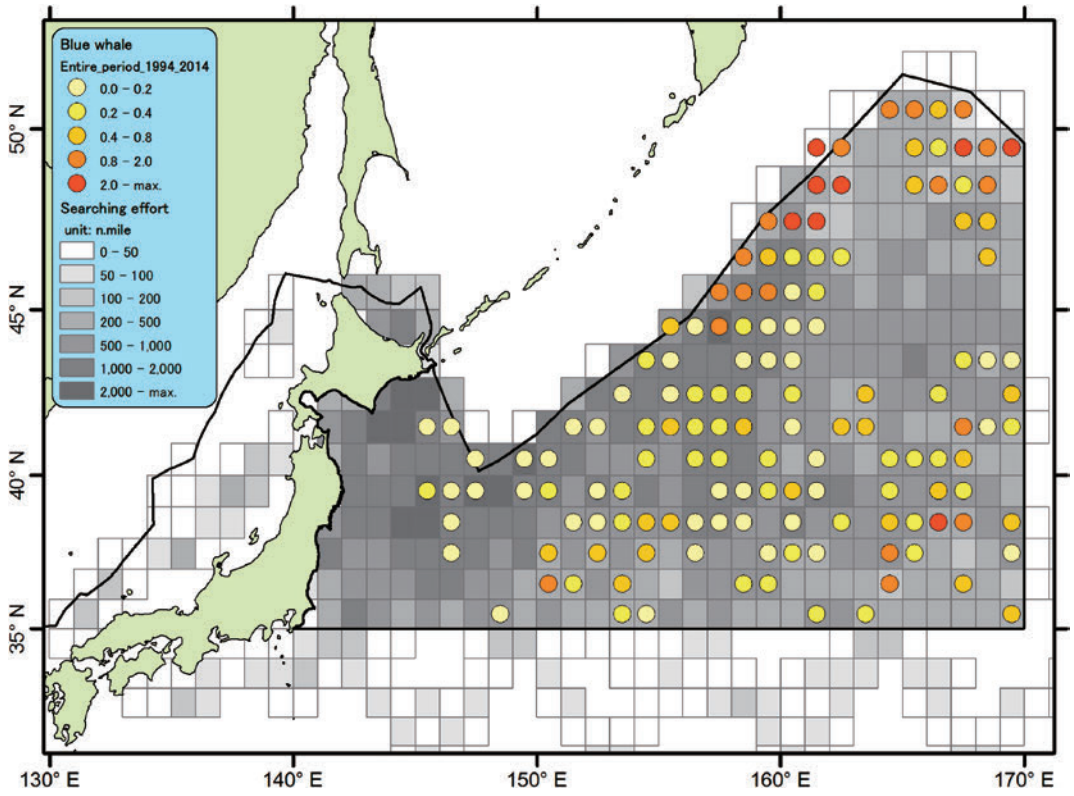


Figure 3a. Distribution of DIW of blue whales by Lat.1°× Long.1° grid squares. The DIW was calculated using JARPN and JARPNII sighting data in the entire period (1994 to 2014).

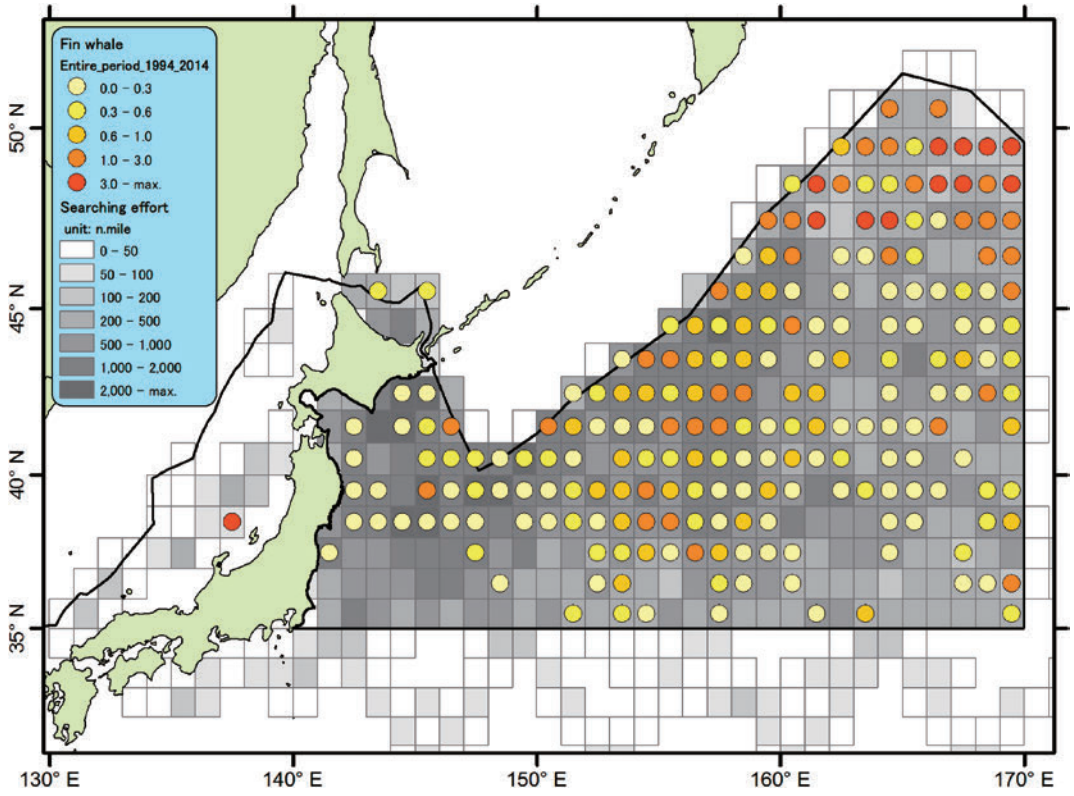


Figure 3b. Distribution of DIW of fin whales by Lat.1°× Long.1° grid squares. The DIW was calculated using JARPN and JARPNII sighting data in the entire period (1994 to 2014).

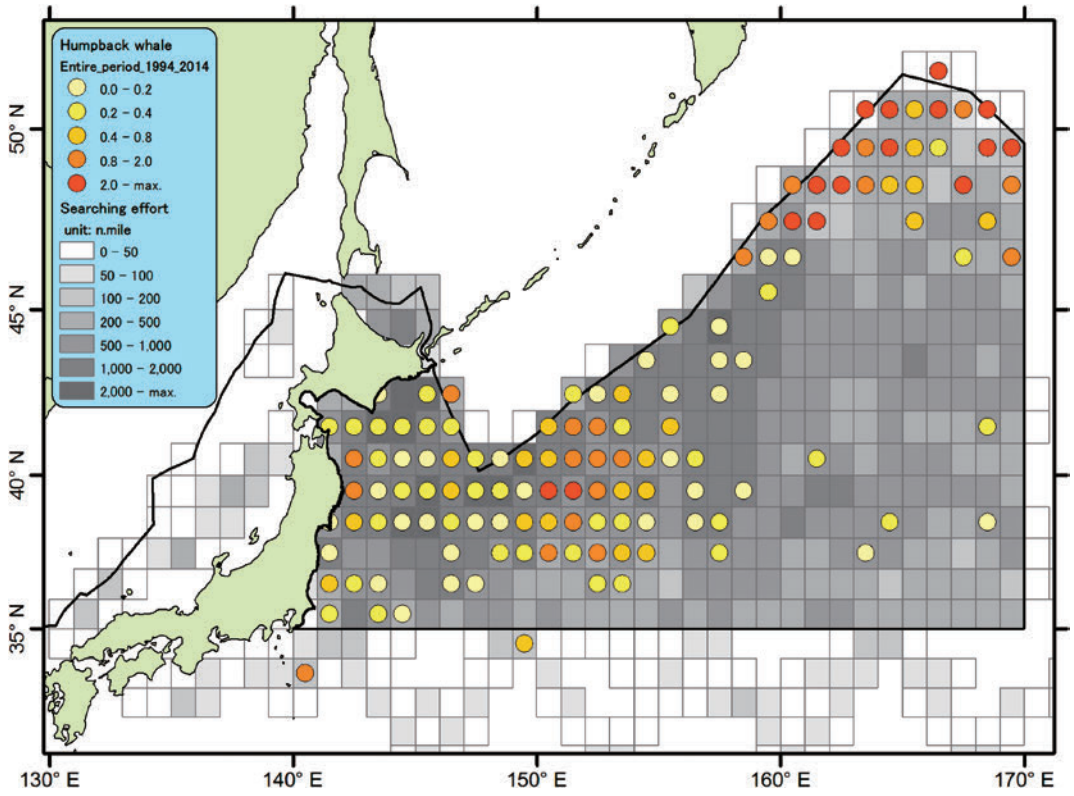


Figure 3c. Distribution of DIW of humpback whales by Lat.1°×Long.1° grid squares. The DIW was calculated using JARPN and JARPNII sighting data in the entire period (1994 to 2014).

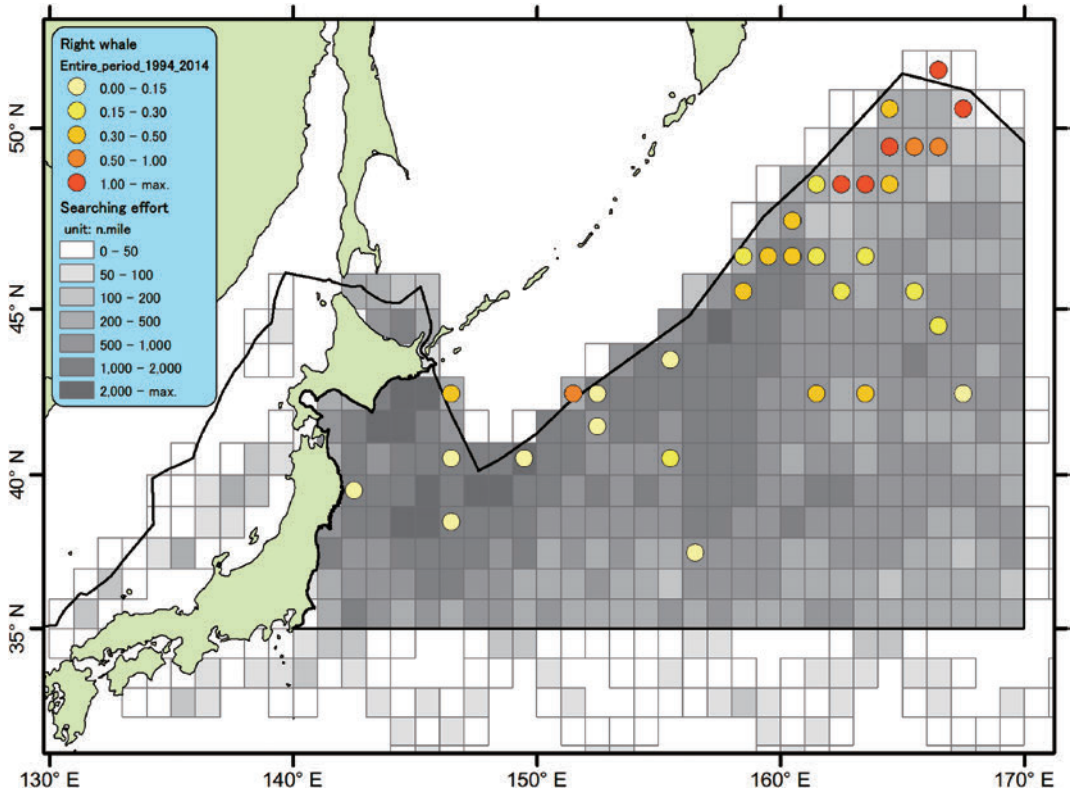


Figure 3d. Distribution of DIW of North Pacific right whales by Lat.1°×Long.1° grid squares. The DIW was calculated using JARPN and JARPNII sighting data in the entire period (1994 to 2014).

Blue whales were caught in the past around the rim of the western North Pacific. In summer, they concentrated along the edge of the continental shelf and along the south side of the Aleutian Archipelago. The catch data showed a distribution gap between sub-areas 7 and 9 in summer (Nishiwaki, 1966). However, JARPNII data showed no such gap. The previous gap may have been caused by regulation of the whaling operations between coastal (land base type) and offshore (mother ship type) whaling. Further, according to sighting data collected by the Japanese Scouting Vessel (JSV) between 1966 and 1990, blue whales were not sighted in sub-areas 7, 8 and 9 in June. However, JARPN and JARPNII sighting data suggested that this species was widely distributed in those sub-areas in June in the period 1994–2014.

The design-based abundance of this species in sub-areas 7, 8 and 9 was estimated as 38 whales during May to June (2009) and as 958 whales during July to August (2008) (Hakamada and Matsuoka, 2016).

Fin whale (Figure 3b)

Fin whale was the most frequently sighted species. This species was mainly sighted in sub-areas 8 and 9, and the distribution pattern was similar to that of the blue whale. They were mainly distributed north of 37°N in sub-areas 7, 8 and 9 from May to September. Surface temperature ranged from 2.9°C to 26.9°C (Table 1). A high-density area was observed north of 45°N in sub-area 9.

Fin whales were caught in the past along the outer shelf and south of the Aleutian Islands. A distribution gap between sub-areas 7 and 9 was previously observed for this species in summer (Nishiwaki, 1966). However, as in the case of the blue whale, the present results showed no such gap. The previous gap may have been caused by regulation of the whaling operations between coastal (land base type) and offshore (mother ship type) whaling.

The design-based abundance of this species in sub-areas 7, 8 and 9 was estimated as 413 whales during May to June (2009) and as 3,958 whales during July to August (in 2008) (Hakamada and Matsuoka, 2016).

Humpback whale (Figure 3c)

Humpback whales were mainly distributed north of 37°N in sub-areas 7, 8 and 9 from May to September. Surface temperature ranged from 2.8°C to 24.1°C (Table 1). High density areas were observed north of 35°N in sub-areas 7 and 8, and north of 45°N in sub-area 9.

The design-based abundance of this species in sub-areas 7, 8 and 9 was estimated as 1,136 whales during May–June (2009) and as 392 whales during July–August (2008) (Hakamada and Matsuoka, 2016).

North Pacific right whale (Figure 3d)

North Pacific right whale was the least frequently sighted species. This species was mainly distributed north of 37°N in sub-areas 7, 8 and 9 from May to September. Surface temperature ranged from 2.7°C to 17.0°C (Table 1).

According to Miyashita *et al.* (1995), there were no sightings in waters outside of the Okhotsk Sea, north of 40°N. However, present results confirmed the existence of this species in the offshore region during 1994–2014 from May to September.

The design-based abundance of this species in sub-areas 7, 8 and 9 was estimated as 1,147 whales during May–June (2011–2012) and 416 whales during July–August (2008) (Hakamada and Matsuoka, 2016).

*Pattern of temporal distribution*

A more detailed description of the monthly distribution of the species is presented here based on Figures 4a, 4b, 4c and 4d, which show the monthly changes in the density index of blue, fin, humpback and North Pacific right whales, respectively. As a whole, the main distribution of blue, fin, humpback and North Pacific right whales moved northward from 35°N to 45°N from May–August, which coincided with the results of previous large-scale distribution pattern reported by Miyashita *et al.* (1995).

Blue whale (Figure 4a)

A northward migration pattern was observed for this species. The main distribution from 35°N to 40°N in May to June moved north of 40°N in July to August in sub-areas 8 and 9.

Fin whale (Figure 4b)

A northward migration pattern of fin whale was also observed. The main distribution from 35°N to 40°N during May–June moved north of 40°N during July–August in sub-areas 8 and 9. There were almost no fin whale sightings in the west of 144°E in June, and west of 150°E in July.

Humpback whale (Figure 4c)

A northward migration pattern of humpback whales was also observed. The main distribution from 37°N to 43°N in sub-area 7 during May to June moved to north of 45°N during July–August in sub-areas 8 and 9.

The present results revealed that the distribution pattern of this species changed from that reported in previous studies. Humpback whales were not sighted in

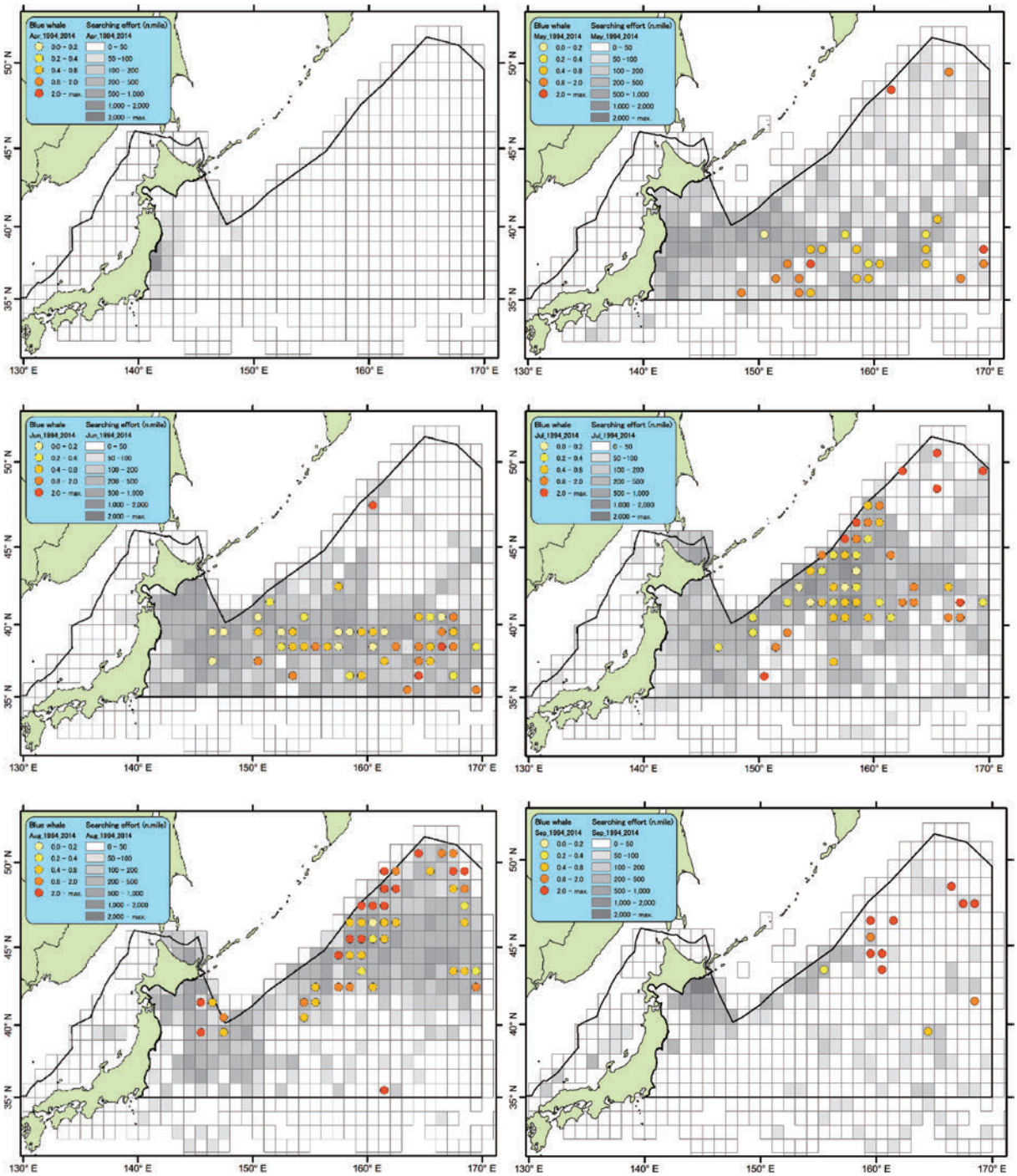

Figure 4a. Monthly change of DIW of blue whales during JARPN and JARPNII from 1994 to 2014 surveys, by Lat.1°×Long.1°square. Top left: April; Top right: May; Middle left: June; Middle right: July; Bottom left: August; Bottom right: September.

sub-areas 7 and 8 in May and June by the JSV surveys (1966–1990), however they were present in those sub-areas and period by the JARPN and JARPNII surveys in 1994–2014.

North Pacific right whale (Figure 4d)

A northward migration pattern of this species was observed. The main distribution area was north of 42°N during July to August in sub-area 9. The distribution pattern of this species was reported using historical catch and JSV data (Omura, 1986; Miyashita and Kato, 1998; Clapham *et al.*, 2004). The present results confirm the existence of this species in sub-areas 7, 8 and 9 during 1994–2014, and the distribution pattern in May–September is similar to that reported previously.

There are two migration routes along both sides of the

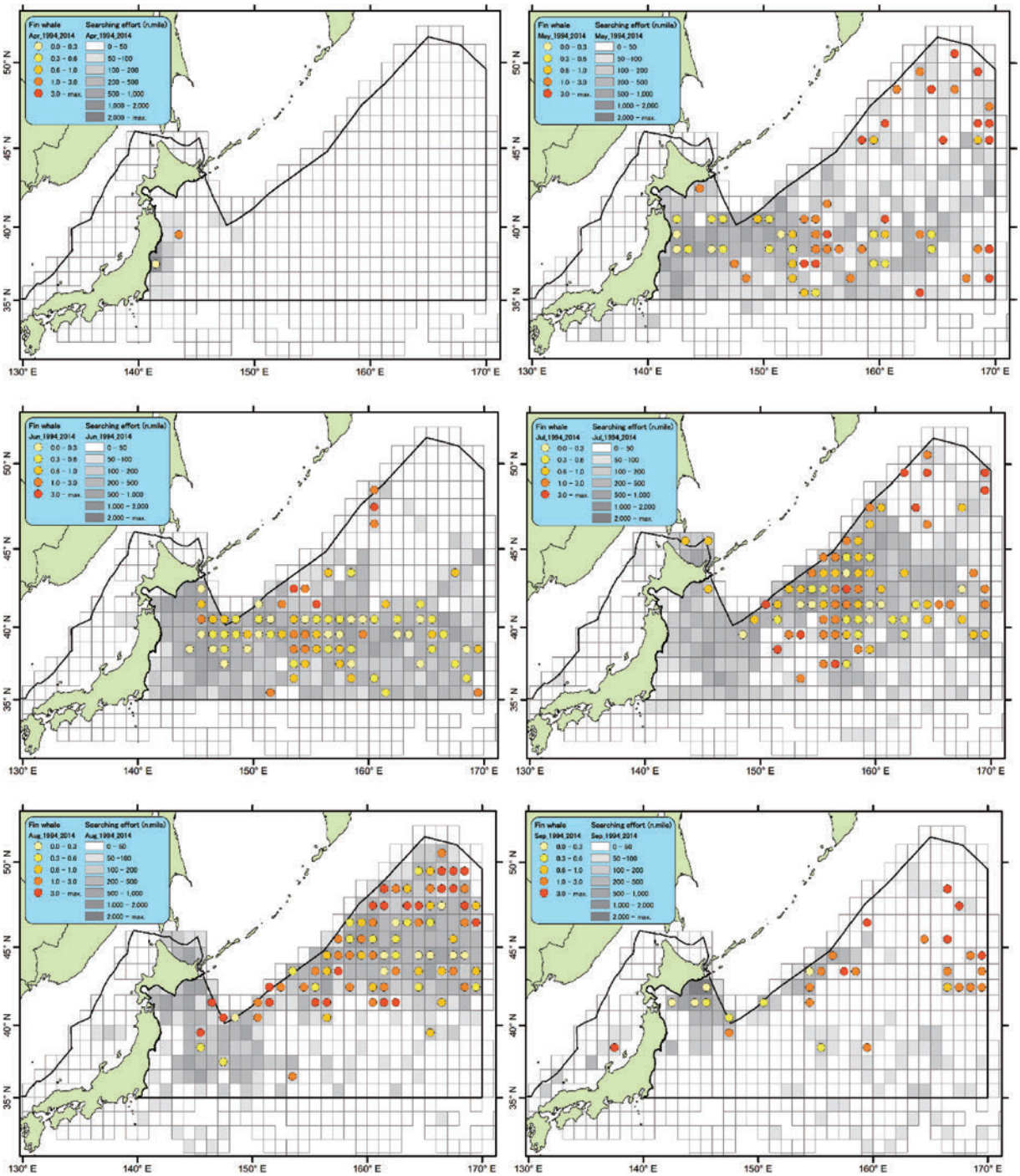

Figure 4b. Monthly change of DIW of fin whales during JARPN and JARPNII from 1994 to 2014 surveys by Lat.1°× Long.1°square. Top left: April; Top right: May; Middle left: June; Middle right: July; Bottom left: August; Bottom right: September.

Japanese main Island, based on historical whaling data (Omura, 1986). Several scientists have suggested that the Kuril Islands and Kamchatka coasts are likely to be major summer feeding regions, based on historical and recent new information (Matsuoka *et al.*, 2009; Brownell *et al.*, 2001; Clapham *et al.*, 2004; Sekiguchi *et al.*, 2014). A northward migration pattern was also observed from the Pacific to the Sea of Okhotsk during the winter to summer in recent analyses using Japan and Russian sighting data (Matsuoka *et al.*, 2018).

## CONCLUSIONS

Sighting data of large whales in the western North Pacific, collected systematically by JARPN and JARPNII for a long period of time, were valuable in providing information on the geographical and temporal pattern of distribution of

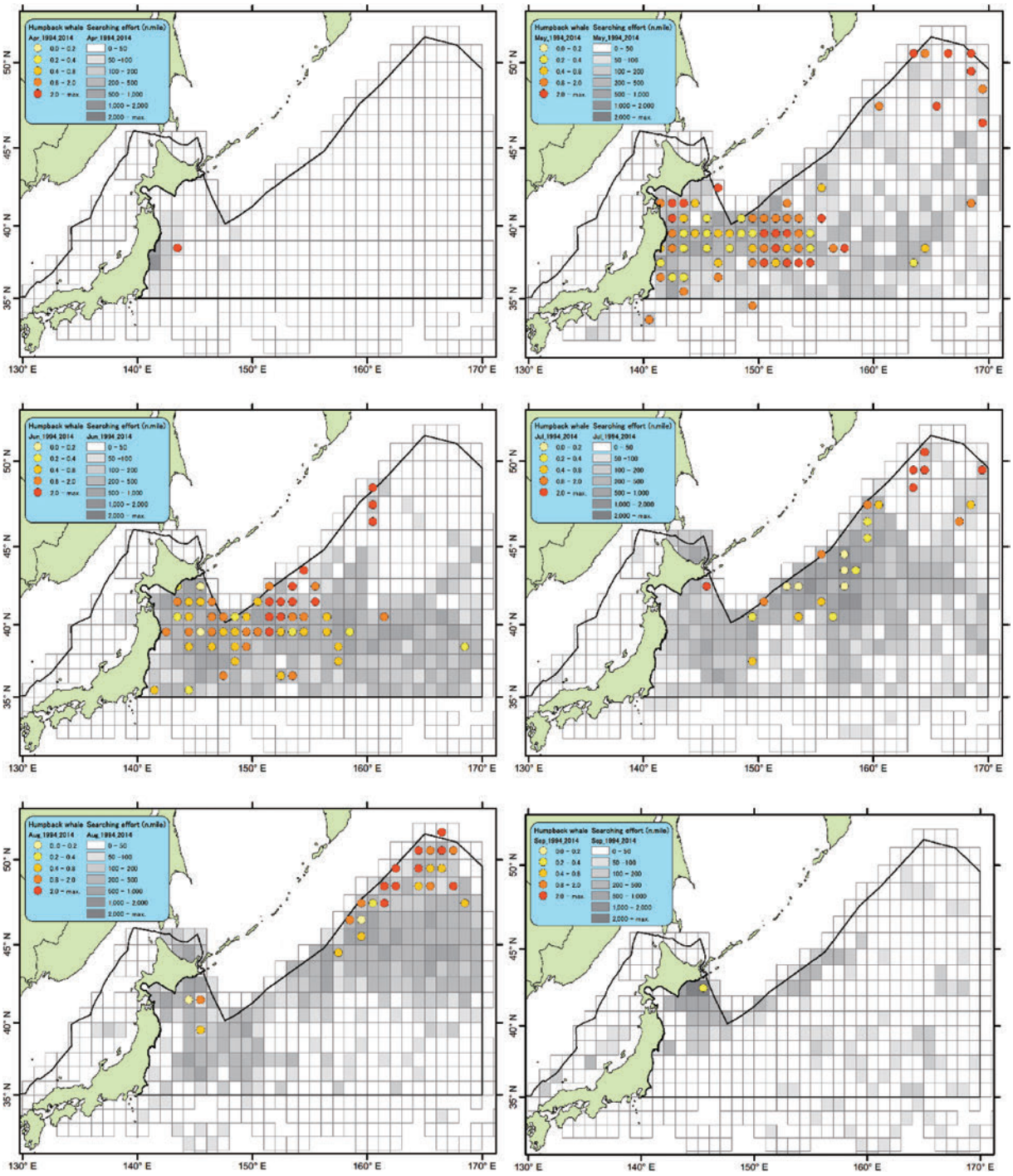

Figure 4c. Monthly change of DIW of humpback whales during JARPN and JARPNII from 1994 to 2014 surveys by Lat.1°×Long.1°square. Top left: April; Top right: May; Middle left: June; Middle right: July; Bottom left: August; Bottom right: September.

blue, fin, humpback and North Pacific right whales in this oceanic basin. The data indicate that some species have been expanding their distribution in recent years. The same sighting data have been used for abundance estimates of these species, however, future studies on distribution and abundance should take into consideration the available information on stock structure.

## ACKNOWLEDGEMENTS

We thank all cruise leaders, captains, officers, crew and researchers involved on the JARPN and JARPNII surveys for their effort to collect sighting data.

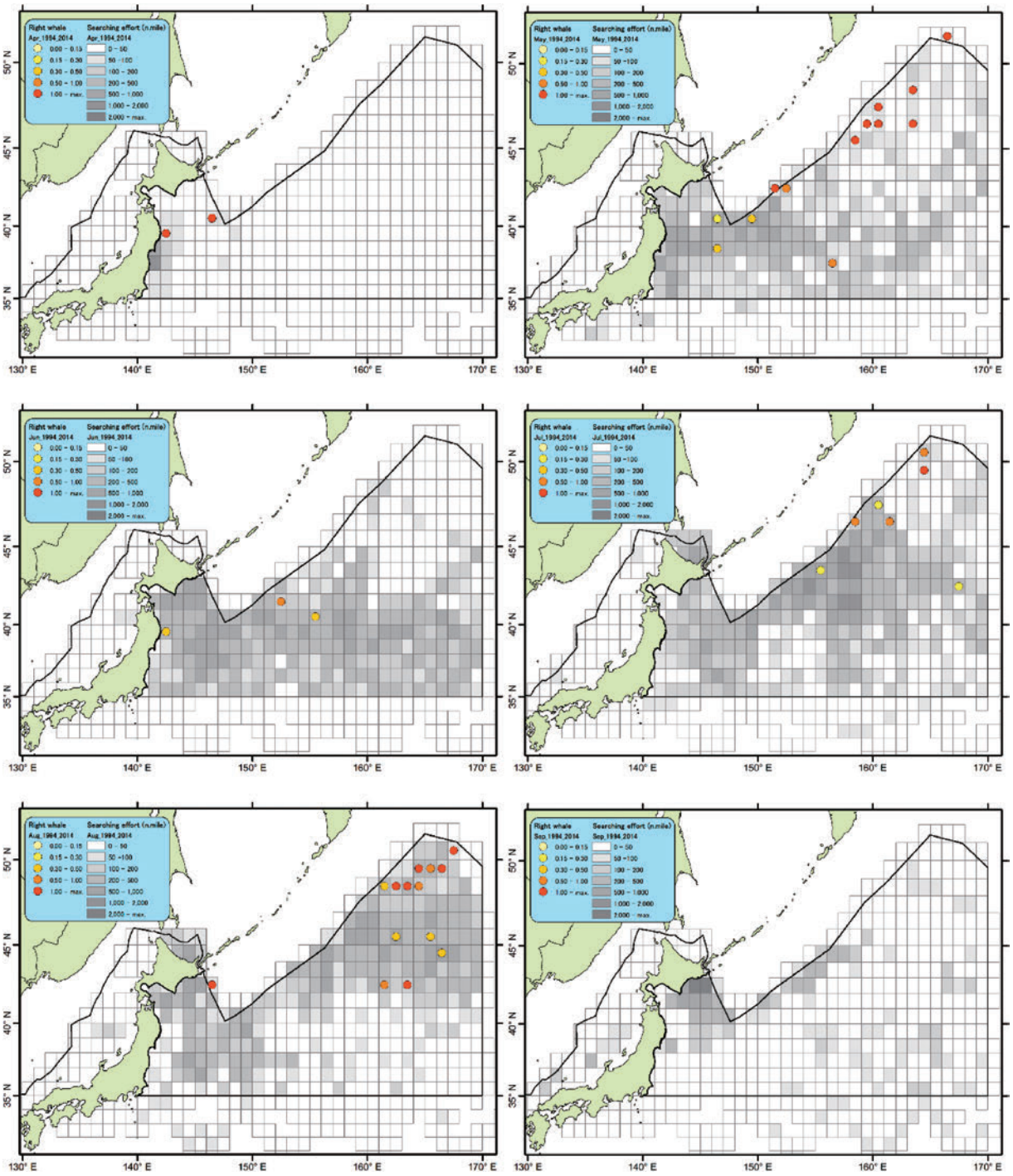

Figure 4d. Monthly change of the Density Index (number of primary sightings of whales/100 n.mile) of North Pacific right whales during JARPN and JARPN II from 1994 to 2014 surveys by Lat.1°× Long.1°square. Top left: April; Top right: May; Middle left: June; Middle right: July; Bottom left: August; Bottom right: September.

## REFERENCES


Brownell Jr., R.L., Clapham, P.J., Miyashita, T. and Kasuya, T. 2001. Conservation status of North Pacific right whales. *J. Cetacean Res. Manage*. (special issue) 2: 269–286.

Clapham, P.J., Good, C., Quinn, S.E., Reeves, R.R., Scarff, J.E. and Brownell, R.L. 2004. Distribution of North Pacific right whales (*Eubalaena japonica*) as shown by 19th and 20th century whaling catch and sighting records. *J. Cetacean Res. Manage.* 6 (1): 1–6.

Fujise, Y. 2000. Outline of the research activities under the Japanese Whale Research Program under a special permit in the North Pacific (JARPN) from 1994 to 1999. Paper SC/F2K/J8 presented to the Workshop to Review the Japanese Whale Research Program under Special Permit for North Pacific

Minke Whales (JARPN), February 2000 (unpublished). 30 pp. [Available from the IWC Secretariat].

Hakamada, T. and Matsuoka, K. 2016. The number of blue, fin, humpback, and North Pacific right whales in the western North Pacific in the JARPNII Offshore survey area. Paper SC/F16/JR13 presented to the JARPNII Review Meeting, February 2016 (unpublished). 14 pp. [Available from the IWC Secretariat].

Matsuoka, K., Kiwada, H., Fujise, Y. and Miyashita, T. 2009. Distribution of blue (*Balaenoptera musculus*), fin (*B. physalus*), humpback (*Megaptera novaeangliae*) and North Pacific right (*Eubalaena japonica*) whales in the western North Pacific based on JARPN and JARPNII sighting surveys (1994 to 2007). Paper SC/J09/JR35 presented to the JARPNII Review Meeting, 26–30 January 2009 (unpublished). 12 pp. [Available from the IWC Secretariat].

Matsuoka, K., Hakamada, T. and Miyashita, T. 2016. Methodology and procedure of the dedicated sighting surveys in JARPNII—Offshore component—2016. Paper SC/F16/JR2 presented to the JARPNII Review Meeting, 22–26 February 2016 (unpublished). 14 pp. [Available from the IWC Secretariat].

Matsuoka, K., Zharikov, K., Hakamada, T. and Miyashita, T. 2018. Sightings of the North Pacific Right whales (*Eubalaena japonica*) in the western North Pacific (1982 to 2016). Paper SC/67A/NH07 presented to the IWC Scientific Committee, May 2017 (unpublished). 10 pp. [Available from the IWC Secretariat].

Miyashita, T., Kato, H. and Kasuya, T. (eds). 1995. *Worldwide Map of Cetacean Distribution based on Japanese Sighting Data* (Volume 1). National Research Institute of Far Seas Fisheries, Shimizu, Shizuoka, Japan. 140 pp.

Miyashita, T. and Kato, H. 1998. Recent data on the status of right whales in the NW Pacific Ocean. Paper SC/M98/RW11 presented to the IWC Special Meeting of the Scientific Committee towards a Comprehensive Assessment of Right Whales Worldwide, 16–25 March (unpublished). 15 pp. [Available from the IWC Secretariat].

Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North pacific as shown by Japanese whaling results. pp. 171–191. *In*: K.S. Norris (ed.) *Whales, dolphins, and porpoises*. University of California Press, Berkely. CA. 789 pp.

Okamura, H., Matsuoka, K., Hakamada, T., Okazaki, M. and Miyashita, T. 2001. Spatial and temporal structure of the western North Pacific minke whale distribution inferred from JARPN sightings data. *J. Cetacean Res. Manage.* 3: 193–200.

Omura, H. 1986. History of right whale catches in the waters around Japan. *Rep. int. Whal. Commn* (special issue) 10: 35–41.

Sekiguchi, K., Ohnishi, H., Sasaki, H., Haba, S., Iwahara, Y., Mizuguchi, D., Otsuki, M., Saijo, D., Nishizawa, B., Mizuno, H., Hoshi, N. and Kamito, T. 2014. Sightings of the western stock of North Pacific right whales (*Eubalaena japonica*) in the far southeast of the Kamchatka Peninsula. *Marine Mammal Science* 30 (3): 1199–1209.

Tamura, T., Matsuoka, K. and Fujise, Y., 2009. Methodology and survey procedure under the JARPNII—offshore component—with special emphasis on whale sampling procedures. Paper SC/J09/JR4 presented to the JARPNII Review Meeting, January 2009 (unpublished). 16 pp. [Available from the IWC Secretariat].