

## **Methodology and survey procedure under the JARPN II – coastal component of Sanriku and Kushiro-, with special emphasis on whale sampling procedures**

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### **ABSTRACT**

This paper summarized the methodology of the whale sampling surveys in the coastal component of JARPN II using small-type whaling catcher boats. The coastal component started with two feasibility surveys: one in the autumn of 2002 off Kushiro and the other in the spring of 2003 off Sanriku district under the full JARPN II research plan. The surveys were introduced to cover the temporal and spatial gaps in sampling, which cannot be covered by the *Nisshin Maru* research unit used for offshore sampling. After the two feasibility surveys with a sampling of 50 common minke whales in each year, the coastal component was revised with a maximum sample size of 60 whales for each of the spring and autumn seasons. The first revised survey was conducted in the autumn of 2004 off Kushiro. No spring sampling off Sanriku was done in 2004. Both areas were surveyed in every year from 2005 to 2007 with a sample size of 60 for each area. Research periods of each survey lasted 23 to 46 days in April and May (off Sanriku) and 33 to 52 days in September and October (off Kushiro). The whale sampling was done by three or four small-type whaling catcher boats in the waters within the maximum of 50 nautical miles from the Kushiro port or the Ayukawa port. A land station with a research head office was established near each of Kushiro and Ayukawa port. The office principally determined searching area and routes of the sampling boats everyday, based on the weather conditions, whale distribution and information on coastal fisheries, and all boats returned to the port every night. All common minke whales sighted were targeted for sampling, except for cow-calf pairs. Once the boat sampled a whale, she returned to the port as soon as possible. At the port, whales were lifted up from the boat by a crane, and transported to the land station by a freight trailer. All whales sampled were biologically examined at the station in almost the same manner as that for the offshore component. In addition, a dedicated sighting survey using line transects methodology was carried out by small-type whaling catcher boats as part of the 2004 survey off Kushiro.

KEYWORDS: COMMON MINKE WHALE; NORTH PACIFIC; COASTAL WATERS OF JAPAN; SCIENTIFIC PERMITS

## 1. BACKGROUND

The full-scale surveys of the second phase of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) started in 2002 (Government of Japan, 2002a). The objectives of the surveys are: i) feeding ecology and ecosystem studies, involving prey consumption by cetaceans, prey preferences of cetaceans and ecosystem modeling, ii) monitoring environmental pollutants in cetaceans and marine ecosystem, and iii) stock structure of whales (Government of Japan, 2002a).

The former JARPN (1994-1999) and the JARPN II feasibility study (2000-2001) showed that common minke whales were widely distributed from the offshore to the coastal waters and fed on various prey species such as Japanese anchovy, Pacific saury and walleye pollock (Government of Japan, 2002b; Tamura and Fujise, 2002). Especially, the coastal area of Japan was an important fishing ground and the competition between the whales and fisheries was likely to be severe. However, the *Nisshin-Maru* research vessels could not survey in the near shore areas or in the seasons from late autumn to early spring because of the practical availability of the vessels. Under this situation, sampling of common minke whales in the coastal areas by using small-type whaling catcher boats was introduced as a 'coastal component' to cover the temporal and spatial gaps, in the full-scale JARPN II (Government of Japan, 2002a).

The coastal component started with a two-year feasibility survey to examine the logistic aspects of the methodology (Government of Japan, 2002a). First survey was carried out in the coastal waters off Kushiro, northeast Japan, during 10 September to 12 October 2002 (Kishiro, *et al.*, 2003) and second survey was conducted in the waters off Sanriku district, from 8 April to 2 May 2003 (Yoshida, *et al.*, 2004). Both surveys took 50 common minke whales, respectively, in the coastal waters within a 30 nautical miles radius from the port in respective survey area. After detailed examination of the results of the logistic aspects, it was concluded that no substantial problem occurred in conducting the survey and the coastal survey could be continued as a component of the JARPN II using same kind of vessels (small-type whaling catcher boats) and methodology (Kato, *et al.*, 2004). However, re-calculation of required sample size using data obtained from those surveys suggested that sample size should be modified to be 60 individuals in each area/season (Tamura, *et al.*, 2004), and taking account of the possible geographical and/or temporal variations of prey consumption of the whales, the coastal surveys thought to be needed on a yearly bases in each local area (Government of Japan, 2004a). Based on these results, revised JARPN II research plan was submitted to the 56<sup>th</sup> IWC/SC annual meeting (Government of Japan, 2004b), and coastal component was revised with a maximum sample size of 60 common minke whales for each of the spring (off Sanriku) and autumn (off

Kushiro) seasons. The first revised survey was conducted in the autumn of 2004 off Kushiro (Kishiro, *et al.*, 2005). No spring sampling off Sanriku was done in 2004. Then, both local areas were surveyed in every year from 2005 to 2007 seasons (Kishiro, *et al.*, 2006; 2008, Yoshida, *et al.*, 2006; 2007, Goto, *et al.*, 2007; Bando, *et al.*, 2008). These surveys were authorized by the Government of Japan in compliance with Article VIII of the International Convention for the Regulation of Whaling. The National Research Institute of Far Seas Fisheries (NRIFSF), Fisheries Research Agency, and the Institute of Cetacean Research (ICR) conducted the surveys cooperate with the Tokyo University of Marine Science and Technology.

The coastal component principally consisted of three research units as follows; 1) Whale sampling survey by small-type whaling catcher boats, 2) Prey species survey by echo sounder-trawler survey vessel, 3) Dedicated sighting survey by independent research vessel. Among them, this paper summarized the methods of the whale sampling surveys conducted in 2002 to 2007, with special reference to methodology of searching and sampling by small-type whaling catcher boats. Methodologies of prey species surveys were summarized in Watanabe, *et al.*, 2009 for Kushiro surveys, and Yonezaki, *et al.*, 2009 for Sanriku surveys, respectively. Methodology of the dedicated sighting survey was summarized in Kiwada, *et al.*, 2009.

## **2. GENERAL METHODOLOGY OF THE WHALE SAMPLING SURVEY**

Small-type whaling catcher boats are very small sized vessels (Table 1), extremely weak in bad weather conditions such as big waves and strong wind, and cannot stay on the sea for a long period. Thus, we incorporated a land-based operation system for whale sampling in the coastal component. Sampling procedure was designed taking account of operational capacity, ability, and arrangements of the small boats. These procedures was different from the random sampling system adopted by the JARPA II and the JARPN II offshore component using large vessels, but thought to be acceptable in terms of stomach contents collection if the samples evenly cover the area where whales were seen in the targeted small local area (Kato, *et al.*, 2004). Table 2 shows an outline of all sampling surveys in the coastal component of JARPN II from 2002 to 2007 season.

### **2.1 Research area and season**

Research area were set in the coastal waters off Kushiro, southeastern part of the Pacific coast of Hokkaido, in autumn season and off the Sanriku district, northeastern part of the Japanese main island, in spring season (Fig. 1). Both waters were known to be major whaling grounds of the past commercial whaling for common minke whales in respective season (Hatanaka and Miyashita, 1997) and also important fishing grounds for other commercially important species such as Pacific saury, Japanese anchovy, and sand lance. The possible competition between the whales and the

fisheries in these areas was suggested by the JARPN and the JARPN II feasibility study (Tamura and Fujise, 2002). Thus, the research areas were set in these waters. These areas were located in the northern and middle part of the sub-area 7 established by the IWC. In order to maintain freshness of samples for biological examination at the land station, especially, to maintain freshness of stomach contents for feeding study, surveys were mainly conducted within a 30 nautical miles radius from the port in respective area (the Kushiro port or the Ayukawa port), and limited within the maximum of 50 n. miles radius from the port.

## 2.2 Sampling vessels

Following small-type whaling catcher boats were used as sampling vessels. Details of the boats were shown in Table 1 and Figure 2.

<i>Sumitomo Maru</i> No. 31	(31S, 32.0GT)
<i>Koei Maru</i> No. 75	(75K, 46.2GT)
<i>Taisho Maru</i> No. 28	(28T, 47.3GT)
<i>Katsu Maru</i> No.7	(7K, 32.0GT)

Three boats (31S, 28T, 7K) were used in the first survey off Kushiro in 2002, and then, all of four boats (31S, 75K, 28T, 7K) were used in 2003 and afterwards.

## 2.3 Land station (JARPN II research station)

A land station with a research head office was established in the respective season for biological sampling, flensing, and commanding the operation of the sampling vessels. In the survey off Kushiro, one station was established in the Kushiro port area (42°58'N, 144°22'E) in 2002 or in the suburbs of Kushiro City (42°58'N, 144°05'E) in 2004 and after (Fig. 3). In the survey off Sanriku, another station was established in the Ayukawa port area (38°17'N, 141°30'E). The head office continued to communicate with the sampling vessels during the survey, using radio or marine telephone. Once the sampling vessel took a whale, the carcass was pulled onto the rear deck of the vessel and she returned to the port as soon as possible. At the port, whale was lifted up from the vessel by a crane, using a wire net and transported to the station by a 11-tons freight trailer (Fig. 3).

## 2.4 Searching methods of the sampling vessels

### 2.4.1 Feasibility surveys in 2002 and 2003

Predetermined research track line was not settled. Searching was conducted generally following the traditional manner of the coastal small-type whalers, to maintain the ability for sighting and capturing the whales by small boats with few members of the crew. Searching route of the sampling

vessels within the research area was arbitrarily determined based on the experience of gunner on the leading catcher boat (28T) in every day. Meetings among the head of the office, researchers, gunners, and captains of the boats were often held at the port to determine the searching route and tactics of the operation. General procedure of searching was follows:

- (1) The boats depart the port about two miles apart from each other in the direction of expected whale concentrations.
- (2) The boats cruise at 10-11 knots in speed, and change the course along with the leader boat.
- (3) Searching is carried out from the top barrel (6 to 7 m above the water surface) with almost all crew members (4 to 5 persons) except for persons handling the boat. Searching is also conducted in some times from upper bridge by one or two crews and a researcher.
- (4) Each boat tries to take her first encountered whale.
- (5) If boat captured whale, she returned to the port as soon as possible. During the return cruise, searching was resumed but sampling was not conducted even if whales were sighted. After the whale was transported to the station, the boat re-departed from the port as long as a situation allows.
- (6) After whale was sighted or boat was arrived at 30 n. miles from the port, boats change the course freely and continue to searching within the 30 n. miles radius from the port.
- (7) Searching is principally continued until 30 minutes before sunset, and then all boat return to the port.

At least one researcher was on board in each of all boats, and recorded information on sighting, sampling and searching effort, e.g., time and location of sighting and sampling, species and school size sighted, and activity and cruise tracks of boat. Weather information (weather, visibility, wind force, and sea surface water temperature) was also recorded for every hour. Sightings of whales were classified into primary and secondary sightings. The primary sightings were those seen during normal searching period (crew searched from the top barrel). The secondary sightings were those seen in out of normal searching, e.g., during closing or chasing target whales, no observer in the top barrel, or off the research time.

Resultant cruise tracks of the sampling vessels made by the 2002 Kushiro survey and the 2003 Sanriku survey were shown in Figure 6 and 7, respectively. In Kushiro survey, the searching areas almost covered the waters within 30 n. miles from the port in the direction of east and west, but southern part of the offshore area was not covered. In Sanriku survey, the searching areas were concentrated in the southwestern part of the research area (the middle part of the Sendai Bay).

#### 2.4.2 Revised survey in 2004

In considerations of the results on the feasibility surveys, the searching and sampling procedure was thought to be acceptable in terms of stomach contents collection from the coastal local area, but it was also pointed out that some modification might be required to take in somewhat random manner for the choice of the searching direction to avoid the concentration of the sampling areas (Kato, *et al.*, 2004). In response to this, the searching procedure was modified in 2004 as follows:

- (1) The predetermined course at an angle of regular intervals (usually 10-15 degree intervals) are set up by the head office, and allocated to the respective boat (Fig.4A). The boats start to search from the port with respective course.
- (2) The boats continue to search along the course until whales are captured, or boats arrive at 30 n. miles from the port (Fig. 4B). If the boats missed the targeted whale, they resumed searching along the course.
- (3) After arriving at 30 n. miles from the port, the boats change the course freely within a 50 n. miles radius from the port (Fig. 4C and D).
- (4) When the weather or sea state were expected to be changed to worse before arriving at 30 n. miles from the port, then the boats changed the course freely at that point. When the weather changed to more badly (around 2.5m height of the waves or Beaufort 4 or more), the boats returned to the port.
- (5) The predetermined course is changed every day to cover broad areas.

Furthermore, following two types of methods were tentatively introduced.

##### (1) Type 1 sampling

The research area was divided into three or four sectors based on the direction from the port (Fig. 5). One of those sectors was selected as a restricted searching area in random turn every day, and the predetermined courses of all boats were settled within the selected sector. After all sectors were surveyed (If the number of sectors was four, it took at least four days), type 2 sampling was started.

##### (2) Type 2 sampling

The searching area and the courses were determined regardless of the sectors, and settled to cover the expected whale concentration areas, based on the information on whale distribution obtained by the type 1 sampling survey and/or dedicated sighting survey. Weather conditions, sea status, and information on fishing grounds were also considered in determining the course. Type 2 sampling was principally conducted for three days, and then type 1 sampling was re-started.

In 2004 survey off Kushiro, the combination of these two types of sampling was implemented from the start of the survey (13 September) to 4 October. However, difficulty in collecting the planned sample size within the survey period was expected in early October mainly due to the bad weather conditions such as typhoons and low atmospheric pressures. Thus, only type 2 sampling was conducted in the remaining survey periods (5 to 31 October). Resultant cruise tracks were shown in Figure 6. As a result, the searching areas could cover widely coastal waters within a 30 n. miles radius from the Kushiro port as compared with those of the 2002 survey.

#### *2.4.3 Surveys in 2005 and afterwards*

In 2005 survey off Sanriku, the same methods introduced in 2004 off Kushiro were planned to be implemented. However, it was very difficult to conduct the survey in offshore waters, especially in the sector 2 and 3 (Fig. 5), because of changeable weather condition and bigger wave in those area for the small boats. As a result, even though the type 1 sampling was tried to be carried out in several times and the searching area was slightly expanded compared with the 2003 survey, most searching had to be carried out by the type 2 sampling, and searching area was concentrated again in the middle part of the Sendai Bay (Fig.7).

In consideration of the difficulty in collecting the planned sample size within the survey period, and bad sea status in the offshore areas, the surveys in 2005 off Kushiro, 2006 off Sanriku and afterwards were substantially conducted by the type 2 sampling methods, and the type 1 sampling was treated as a supplemental option, which was planned to be carried out as long as a situation allows. Resultant cruise tracks of the Kushiro surveys in 2005 to 2007 and the Sanriku surveys in 2006 to 2007 were shown in Figure 6 and 7, respectively. In Kushiro surveys, the type 1 sampling was not carried out, since almost whole research area (at least within 30 n. miles from the port) could be covered by the type 2 sampling. In Sanriku surveys, the type 1 sampling could not be conducted due to the same reason in the 2005 survey, and the searching efforts was concentrated again in almost same areas in the former surveys.

#### *2.4.3 Some considerations for the searching area in the surveys off Sanriku*

In the surveys off Sanriku, it was practically difficult to conduct the surveys in the whole areas within a 30 miles radius from the port. Main reason was the bad weather and sea state for small boats in the outside of the Sendai Bay. As a result, the searching area had to be concentrated in the Bay. However, this point was thought to be not so large problem if taking account of the following points.

- (1) Results of the dedicated sighting surveys by other large vessels in broad area indicated that distribution of common minke whale was also concentrated in the Sendai Bay, and sparse in the

outside. In the offshore area, the influence of the cold Oyashio current was extremely high compared with those in the Bay, and difference of such oceanographic structures also brought concentrated distribution of the whales in the Bay. Thus, it seems to be acceptable at least in terms of stomach contents collection from the area where whales were densely seen.

- (2) Searching area and sampling positions was concentrated in the waters on the continental shelf or the areas less than 200 m water depth. This means that the samples were expected to be collected from the geographically even environment. It seems to be acceptable that those samples were treated as a single unit to represent one of the coastal environmental features such as the continental shelf regions in considering the ecosystem modeling.

## **2.5 Sampling methods**

All common minke whales sighted were targeted for sampling. Cow-calf pair was planned to be excluded from the target, but such pairs were not sighted during the surveys. When a sighting consisted of more than one animal, first targeted animal was selected using a random digit table. Sampling was made by 50 mm whaling cannon. In order to avoid the vomit of stomach contents from whale, and to maintain the human safety during the operations, chasing was usually limited to a maximum of 120 minutes against one animal. Distributions of common minke whales sampled by the respective surveys are shown in Figure 8 and 9. Locations of these samples covered almost all of the areas searched by the boats in respective surveys.

## **2.6 Biological survey**

All the whales sampled were biologically examined by researchers on the land station in almost the same manner as that for the offshore component. Research items of the biological studies were summarized in Table 3, with the number of data and samples obtained. These items were related to the studies on feeding ecology, stock structure, life historical biology and pollution studies.

## **3. ADDITIONAL SIGHTING SURVEY (BY SMALL-TYPE WHALING CATCHER BOATS)**

In order to examine the logistic capability of the small-type whaling catcher boats for acting as the sighting research vessels, a dedicated sighting survey using the boats was tentatively carried out in the whale sampling survey off Kushiro in 2004. During the period from 13 September to 4 October, one of four boats alternatively carried out the sighting surveys.

### **3.1 sighting methods**

The small blocks (A to D) were established in the coastal waters within 50 n. miles from the port and systematically designed track lines were settled in respective blocks (Fig.10). Every day, one boat was designated as a dedicated sighting vessel, which was not engaged in sampling activity. The

survey largely followed the guidelines of Hammond (1986) and Hammond and Donovan (1993). Searching was carried out at 10 knots during the day and the vessels returned to the port every night. The vessel cruised along the predetermined cruise track using closing mode, principally closing on primary sightings to confirm species and school size. After closing, the vessel returned to the nearest point on track line that had not been surveyed and resumed searching. Generally, searching was only conducted when the sea conditions were below Beaufort 3 and visibility was more than 1.5 miles. Searching was carried out from the top barrel by two persons. Similar sighting data forms to those developed for Japanese North Pacific whale sighting cruises were completed. Weather and sea conditions were recorded each hour. The experiments to evaluate the accuracy of estimated distances and angles from the top barrel were carried out in the first day of the survey for each boat.

### **3.2 Applicability of the sighting survey by small boats**

Searching effort and the number of sightings of common minke whales made by the survey are listed in Table 4, and cruise tracks and sighting positions are shown in Fig.11. In the first period from 13 to 16 September, the survey was conducted as the exercise cruises in block B with the experiments for estimation of sighting distances and angles. Since, there was no practical problem in conducting the survey, the second and third periods covered all small blocks, respectively. Total searching distance was 641.8 n. miles, and a total of 17 schools/17 individuals of common minke whales were sighted. The surveys could be conducted with no substantial problem. However, it was difficult to continue the survey during the full research period due to the logistic reasons such as the difficulty in collecting the whales by remaining three boats, i.e. the shortage of the boats for acting as the sampling vessels. The sighting survey area was also restricted in small area compared with that of the large sized vessel due to the capability of the boats against the bad sea state. Thus, the dedicated sighting survey using boats was suspended in the middle of the survey period. Taking account of these situations, it was recommend that large-scale dedicated sighting survey using large vessel was still needed even if the small-type whaling catchers could be used as a dedicated sighting vessels in small area.

## **4. OUTLINE OF THE RESPECTIVE SURVEY**

Table 2 summarizes outline of the whale sampling surveys in the coastal component of JARPN II from 2002 to 2007 season. Following are summary of procedures and results in respective survey. Details of each survey are described in cruise reports of the JARPN II coastal component (see Reference). Cruise tracks of the respective surveys are shown in Figure 6 and 7. Distributions of common minke whales sampled by the surveys are shown in Figure 8 and 9.

#### **4.1 Autumn season, off Kushiro, 2002 (Kishiro, *et al.*, 2003)**

The first feasibility survey was conducted from 10 September to 12 October 2002 (33 days) in the coastal waters off Kushiro, using three small-type whaling catcher boats. The whale sampling was conducted in the coastal waters within a 50 n. miles radius from the Kushiro port. During the survey period, a total of 3,522.8 n. miles (330.4 hours) was searched for whale sampling, 171 schools/ 177 individuals of common minke whales were sighted and 50 whales were sampled. The searching areas almost covered the coastal waters within 30 n. miles from the port and sampling positions were relatively concentrated on the continental shelf and slope in the southwestern and southeastern regions from the port. The samples were consisted of 32 males and 18 females. Major prey species found in the stomach of those samples were Japanese anchovy, walleye pollock, Pacific saury, Japanese common squid, and Krill.

#### **4.2 Spring season, off Sanriku, 2003 (Yoshida, *et al.*, 2004)**

The second feasibility survey was carried out from 8 April to 2 May 2003 (23 days), in coastal waters off the Sanriku district, using four small-type whaling catcher boats. Research area was set within 50 nautical miles from the Ayukawa port. During the survey, a total of 3,833.6 n. miles (342.9 hours) was surveyed for whale sampling, and 184 schools (188 individuals) of the common minke whale were sighted and 50 animals were caught (21 males and 29 females). The searching was conducted mainly in southwestern part of the research area, where occurrence of common minke whales concentrated. Dominant prey species found from the first stomach of the animals were Japanese sand lance and Krill.

#### **4.3 Autumn season, off Kushiro, 2004 (Kishiro, *et al.*, 2005)**

The first survey of the revised JARPN II research plan was conducted from 13 September to 31 October 2004 (49 days) in the coastal waters off Kushiro, using four small-type whaling catcher boats. In addition, dedicated sighting survey using one small-type whaling catcher boat was tentatively carried out. During the survey, a total of 6,923.9 n. miles (635.4 hours) was searched for whale sampling, 151 schools/ 156 individuals of common minke whales were sighted and 59 whales were sampled. The searching areas covered widely coastal waters within 30 n. miles from the port. Sampling positions were dispersed on the continental shelf and relatively concentrated in the southern offshore regions. The samples were consisted of 47 males and 12 females. Most dominant prey species in the stomach was Japanese anchovy, and next dominant species was Pacific saury. The walleye pollock, Japanese common squid, and krill were also detected.

#### **4.4 Spring season, off Sanriku, 2005 (Yoshida, *et al.*, 2006)**

The second survey of the revised JARPN II research plan was carried out from 11 April to 21 May

2005 (41 days), in coastal waters of the Sanriku district, using four small-type whaling catcher boats. Searching was conducted mainly in 30 n.miles from the Ayukawa port. During the survey, a total of 5245.8 n. miles (466.9 hours) was surveyed for whale sampling, the 202 schools/ 205 individuals of common minke whales were sighted, and all the 60 animals were caught (23 males and 37 females). Dominant prey species was Japanese sand lances. Krill and Japanese anchovies were also observed, but their occurrence frequency was much lower.

#### **4.5 Autumn season, off Kushiro, 2005 (Kishiro, *et al.*, 2006)**

The third survey off Kushiro was conducted from 7 September to 12 October 2005 (36 days), using four small-type whaling catcher boats. During the survey, a total of 6,653.7 n. miles (602.3 hours) was searched for whale sampling, 144 schools/ 145 individuals of common minke whales were sighted and 60 whales were sampled. The searching areas covered almost same areas in the 2004 surveys off Kushiro, but concentration of the distribution of sampling positions was slightly shifted to the southwestern regions. The samples were consisted of 45 males and 15 females. Most dominant prey species in the stomach was Japanese anchovy, and next dominant species was Krill.

#### **4.6 Spring season, off Sanriku, 2006 (Goto, *et al.*, 2007)**

The third survey off Sanriku district was conducted from 12 April to 24 May 2006 (43 days), using four small-type whaling catcher boats. The sampling vessels tried to cover widely research areas within 30 n. miles from Ayukawa port. In offshore waters, however, searching activity was very difficult from changeable weather condition and bigger waves for small sampling vessels, which resulted in more searching effort within Sendai Bay. During the survey, a total of 6340.0 n. miles (634.1 hours) was surveyed for whale sampling, the 139 schools (143 individuals) of common minke whales were sighted, and 60 animals were caught. The samples were consisted of 26 males and 34 females. Dominant prey species was Japanese sand lance during the first half of the survey period. However, both Japanese sand lance and Japanese anchovy were dominant during second half period. Krill was observed from only one individual in the second half period.

#### **4.7 Autumn season, off Kushiro, 2006 (Yoshida, *et al.*, 2007)**

The fourth survey off Kushiro was carried out from 11 September to 31 October 2006 (52 days), using four small-type whaling catcher boats. During the survey, a total of 10385.1 nautical miles (958.0 hours) was searched, 84 schools/ 85 individuals of common minke whales were detected, and 35 individuals were collected (25 males and 10 females). Most of the animals were sampled southwest of the port. The Japanese anchovy was only one dominant prey species. The Pacific saury, walleye pollock, Japanese common squid, and krill were also detected, but their occurrence frequency was low.

#### **4.8 Spring season, off Sanriku, 2007 (Bando, *et al.*, 2008)**

The fourth survey off Sanriku district was conducted from 16 April to 31 May 2007 (46 days), using four small-type whaling catcher boats. The sampling vessels tried to cover widely research areas within 30 n. miles from Ayukawa port. However, as same as the 2006 survey, searching activity was very difficult from changeable weather condition and bigger waves for small sampling vessels in offshore waters, which resulted in more searching effort within Sendai Bay. During the survey, a total of 7793.7 n. miles (716.5 hours) was surveyed for whale sampling, the 166 schools (171 individuals) of common minke whales were detected, and 57 animals were caught. The samples were consisted of 21 males and 36 females. Dominant prey species was adult Japanese sand lance and Japanese anchovy throughout survey period. Krill was observed from only one individual in the third period.

#### **4.9 Autumn season, off Kushiro, 2007 (Kishiro, *et al.*, 2008)**

The fifth survey off Kushiro was conducted from 10 September to 31 October 2007 (52 days), using four small-type whaling catcher boats. During the survey, a total of 6,827.7 n. miles (637.6 hours) was searched for whale sampling, 98 schools/ 99 individuals of common minke whales were sighted and 50 whales were sampled. The searching areas covered almost all areas within a 30 n. miles radius from the port. Sampling positions were slightly concentrated on the continental shelf in the southeastern regions. The samples were consisted of 33 males and 17 females. Most dominant prey species in the stomach was Japanese anchovy, and next dominant species was walleye pollock.

### **DISCUSSION**

Searching and sampling methods implemented in the 2002-2007 coastal components of JARPN II were different from those conducted by the offshore components, and did not follow the usual random manner such as a line transect method with predetermined track lines due to the operational capacity and ability of the small boats. Especially, to maintain the ability for sighting and capturing the whales by small boats for obtaining the samples within the limited survey periods, it was difficult to implement the systematical line transect manner for whale sampling. This means that searching efforts of whale sampling was relatively concentrated in the waters where whales were seen. Therefore, sighting data obtained from those boats could not be used for abundance estimation of the whales in the surveyed area. However, it was thought to be acceptable at least in terms of collecting the whale samples as a representative from the whale concentrated area in the restricted coastal small area, because all common minke whales sighted were targeted for sampling, and as a results, locations of the samples covered almost all of the areas where whales were seen in respective surveys. Information for estimating distribution and abundance of the whales was independently and

successfully collected by the dedicated sighting surveys with large vessels (as well as information for the prey environments by the prey species surveys) under the other units of the coastal component of JARPN II.

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## REFERENCES

- Bando, T., Kato, H., Kishiro, T., Goto, M., Saito, T., Tabata, S., Morita, Y., Okamoto, R., Maeda, H., Inagaki, M., Nagatsuka, S., Ebisui, T., Nakai, K., Matsumoto, A., Gokita, A. and Kawahara, S. 2008. Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2007 - Coastal component off Sanriku. Paper SC/60/O6 submitted to the 60<sup>th</sup> IWC Scientific Committee, 26pp.
- Goto, M., Kato, H., Zenitani, R., Yoshida, H., Saito, T., Tabata, S., Morita, Y., Sato, H., Okamoto, R., Maeda, H., Odagawa, A., Ebisui, T., Nakai, K., Matsumoto, A., Fujimori, S., Nishiwaki, S. and Kawahara, S. 2007. Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2006 - Coastal component off Sanriku. Paper SC/59/O6 submitted to the 59<sup>th</sup> IWC Scientific Committee, 34pp.
- Government of Japan, 2002a. Research plan for cetacean studies in the western North Pacific under special permit (JARPN II). Paper SC/54/O2 submitted to the 54<sup>th</sup> IWC Scientific Committee.
- Government of Japan (Fujise, Y., Kawahara, S., Pastene, L.A. and Hatanaka, H. eds.), 2002b. Report of 2000 and 2001 feasibility study of the Japanese Whale Research Program under Special Permit in the western North Pacific-Phase II (JARPN II). Paper SC/54/O17 submitted to the 54<sup>th</sup> IWC Scientific Committee, 202pp.
- Government of Japan (Fujise, Y., Tamura, T., Kato, H. and Kawahara, S. eds.), 2004a. Some considerations of the feasibility components of the JARPN II research plan. Paper SC/56/O2 submitted to the 56<sup>th</sup> IWC Scientific Committee, 36pp.
- Government of Japan, 2004b. Revised research plan for cetacean studies in the western North Pacific under special permit (JARPN II). Paper SC/56/O1 submitted to the 56<sup>th</sup> IWC Scientific Committee, 14pp.
- Hammond, P. S. 1986. Line transect sampling of dolphin populations. Pp.251-279. *In*: M. M. Bryden and R. Harrison (eds.) Research on Dolphins. Clarendon Press, Oxford. 478pp.
- Hammond, P. S. and Donovan, G. P. 1993. Suggestions for draft guidelines for conducting surveys

- and analyzing data. Paper SC/45/O13 submitted to the 45<sup>th</sup> IWC Scientific Committee, 18pp.
- Hatanaka, H. and Miyashita, T. 1997. On the feeding migration of the Okhotsk Sea-West Pacific Stock of minke whales, estimates based on length composition data. *Rep.int. Whal. Commn* 47:557-564.
- Kato, H., Kishiro, T., Yoshida, H. and Kawahara, S. 2004. Feasibility of coastal surveys in the JARPN II, from the viewpoint of logistics. Appendix 1, pp4-12. *In: Government of Japan (Fujise, Y., Tamura, T., Kato, H. and Kawahara, S. eds.), Some considerations of the feasibility components of the JARPN II research plan. Paper SC/56/O2 submitted to the 56<sup>th</sup> IWC Scientific Committee, 36pp.*
- Kishiro, T., Kato, H., Ohizumi, H., Yoshida, H., Saito, T., Isoda, T., Tabata, T., Sakakibara, M., Saino, S., Hara, T., Hayashi, T., Miyashita, T., Fukudome, K., Kiwada, H. and Kawahara, S. 2003. Report of the 2002 JARPN II survey in the western North Pacific. Part II: Coastal component – Coastal survey off Kushiro, northeast Japan. Paper SC/55/O8 submitted to the 55<sup>th</sup> IWC Scientific Committee, 26pp.
- Kishiro, T., Kato, H., Yoshida, H., Miyashita, T., Ryono, T., Tabata, S., Okamoto, R., Yasui, K., Sato, H., Morita, Y., Saino, S., Hara, T., Ebisui, T., Kuroishi, H., Nishiwaki, S. and Kawahara, S. 2005. Cruise report of the coastal survey on common minke whales off Kushiro, northeast Japan: the 2004 JARPN II survey (Part II)-Coastal component. Paper SC/57/O4 submitted to the 57<sup>th</sup> IWC Scientific Committee, 37pp.
- Kishiro, T., Kato, H., Yoshida, H., Miyashita, T., Ryono, T., Tabata, S., Yasui, K., Sato, H., Morita, Y., Kumagaya, K., Tokuda, D., Nakai, K., Funabashi, N., Ebiui, T., Wakatsuki, T., Sakaguchi, M., Houhana, T., Nishiwaki, S. and Kawahara, S. 2006. Cruise report of the Second phase of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) in 2005 – Coastal component off Kushiro. Paper SC/58/O10 submitted to the 58<sup>th</sup> IWC Scientific Committee, 32pp.
- Kishiro, T., Kato, H., Yoshida, H., Miyashita, T., Iwasaki, T., Kanaji, Y., Ryono, T., Tabata, S., Morita, Y., Okamoto, R., Maeda, H., Nagatsuka, S., Ogawa, N., Nakai, K., Ebisui, T., Matsumoto, A., Gokita, A., Kiwada, H. and Kawahara, S. 2008. Cruise report of the Second phase of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) in 2007 – Coastal component off Kushiro. Paper SC/60/O7 submitted to the 60<sup>th</sup> IWC Scientific Committee, 33pp.
- Kiwada, H., Kumagai, S. and Matsuoka, K., 2009. Methodology and procedure of the dedicated sighting surveys in JARPN II –Offshore and coastal component of Sanriku and Kushiro-. Paper SC/J09/JR2 presented to the JARPN II Review Workshop, Tokyo, January 2009 (unpublished). 16pp.
- Tamura, T. and Fujise, Y. 2002. Geographical and seasonal changes of the prey species on minke

- whale in the Northwestern Pacific. *ICES Journal of Marine Science*, 59:516-528.
- Tamura, T., Hakamada, T., Konishi, K., Fujise, Y., Kishiro, T., Yoshida, H., Ohizumi, H. and Kato, H. 2004. Recalculation of sample size of common minke whales in coastal areas required for estimating consumption of various prey items based on results of JARPN II. Appendix 2, pp13-17. *In*: Government of Japan (Fujise, Y., Tamura, T., Kato, H. and Kawahara, S. eds.), Some considerations of the feasibility components of the JARPN II research plan. Paper SC/56/O2 submitted to the 56<sup>th</sup> IWC Scientific Committee, 36pp. Paper SC/56/O16 submitted to the 56<sup>th</sup> IWC Scientific Committee, 36pp.
- Watanabe, H., Yonezaki, S., Kiwada, H., Kumagai, S., Kishiro, T., Yoshida, T. and Kawahara, S. 2009. Methodology and procedures of common minke whales's prey surveys in JARPN II -Coastal component of Kushiro-. Paper SC/J09/JR6 presented to the JARPN II Review Workshop, Tokyo, January 2009 (unpublished). 12pp.
- Yonezaki, S., Nagashima, H., Murase, H., Yoshida, H., Bando, T., Goto, M., Kawahara, S. and Kato, H. 2009. Methodology and procedures of surveys of prey of common minke whales JARPN II -Coastal component of Sanriku-. Paper SC/J09/JR5 presented to the JARPN II Review Workshop, Tokyo, January 2009 (unpublished). 6pp.
- Yoshida, H., Kato, H., Kishiro, T., Iwasaki, T., Miyashita, T., Ryono, T., Tabata, S., Sakakibara, M., Saino, S., Hara, T., Hayashi, T., Tomizawa, Y., Tamai, K., Okamoto, R., Fukuoka, M., Watanabe, H., Tsunekawa, M. and Kawahara, S. 2004. Report of the coastal survey on common minke whales off Sanriku coast, northeast Japan: the Japanese whale research program under special permit in the western North Pacific – Phase II (JARPN II) in 2003 (Part II) – Coastal component. Paper SC/56/O14 submitted to the 56<sup>th</sup> IWC Scientific Committee, 31pp.
- Yoshida, H., Kato, H., Kishiro, T., Iwasaki, T., Miyashita, T., Saito, T., Tabata, S., Morita, Y., Sato, H., Okada, A., Tomizawa, Y., Saino, S., Kuroishi, H., Ebisui, T., Nakai, K., Nishiwaki, S. and Kawahara, S. 2006. Cruise report of the second phase of the Japanese Whale Research Permit in the western North Pacific (JARPN II) in 2005-Coastal component off Sanriku. Paper SC/58/O9 submitted to the 58<sup>th</sup> IWC Scientific Committee, 30pp.
- Yoshida, H., Kato, H., Kishiro, T., Miyashita, T., Iwasaki, T., Minamikawa, S., Ryono, T., Tabata, Morita, Y., Sato, H., Okamoto, R., Toyoda, Y., Nakamura, G., Ebisui, T., Nakai, K., Matsumoto, A., Nishiwaki, S. and Kawahara, S. 2007. Cruise report of the Second phase of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) in 2006 – Coastal component off Kushiro. Paper SC/59/O7 submitted to the 59<sup>th</sup> IWC Scientific Committee, 43pp.

Table 1. Details of the small-type whaling catcher boats used in the coastal component of the JARPN II.

Vessel	Size (tons)	Length (m)	Width (m)	Horsepower (HP)	Number of the crew*
<i>Smitomo Maru</i> No.31 (31S)	32.00	19.96	4.30	330	7
<i>Koei Maru</i> No.75 (75K)	46.24	25.17	4.62	380	7
<i>Taisho Maru</i> No.28 (28T)	47.31	25.53	4.64	380	7
<i>Katsu Maru</i> No.7 (7K)	32.00	19.97	4.30	400	7

\* excluding researcher

Table 2. Outline of the whale sampling surveys in 2002-2007 coastal component of the JARPN II. 28T: *Taisho Maru* No.28; 31S: *Smitomo Maru* No.31; 7K: *Katsu Maru* No.7; 75K: *Koei Maru* No.75; KY3: *Kaiyo Maru* No.3; KY7: *Kaiyo Maru* No.7; KS2: *Kyoshin Maru* No.2; SM1: *Shonan Maru*; SYO: *Syunyo Maru*; TAK: *Takiyo Maru*; KK: *Kaiko Maru*

Year	Area	Season	Survey period [days]	Sampling vessels	Survey distance (n.miles)	Collected sample size	Concurrent survey vessels for	
							prey species	dedicated sightings
2002*	Kushiro	Autumn	10 Sept.- 12 Oct. [33]	28T, 31S, 7K	3,522.8	50	KY3	KS2
2003*	Sanriku	Spring	10 Apr.- 2 May [23]	28T, 31S, 7K, 75K	3,833.6	50	KY7	SM1
2004	Kushiro	Autumn	13 Sept.- 31 Oct. [49]	28T, 31S, 7K, 75K	6,923.9	59	SYO	KS2
2005	Sanriku	Spring	11 Apr.- 21 May [41]	28T, 31S, 7K, 75K	5,245.8	60	TAK	SM1
2005	Kushiro	Autumn	7 Sept.- 12 Oct. [36]	28T, 31S, 7K, 75K	6,653.7	60	KY7	KS2
2006	Sanriku	Spring	12 Apr.- 24 May [43]	28T, 31S, 7K, 75K	6,340.0	60	TAK, SYO	SM2
2006	Kushiro	Autumn	11 Sept.- 31 Oct. [51]	28T, 31S, 7K, 75K	10,399.5	35	KK	KS2
2007	Sanriku	Spring	16 Apr.- 31 May [46]	28T, 31S, 7K, 75K	7,793.7	57	TAK	-
2007	Kushiro	Autumn	10 Sept.- 31 Oct. [52]	28T, 31S, 7K, 75K	6,827.7	50	KK	KK

\*Feasibility survey for logistics of the coastal component.

Table 3. Summary of biological data and samples collected in 2002-2007 coastal component of the JARPN II.

Samples and data	Off Kushiro					Off Sanriku			
	2002	2004	2005	2006	2007	2003	2005	2006	2007
Body length and sex	50	59	60	35	50	50	60	60	57
External body proportion	50	59	60	35	50	50	60	60	57
Photographic record and external character	50	59	60	35	50	50	60	60	57
Diatom film record	50	59	60	35	50	50	60	60	57
Diatom film sampling	50	59	60	-	-	50	60	-	-
Body scar record	50	59	60	35	50	50	60	60	57
Measurements of blubber thickness (five points)	50	59	60	35	50	50	60	60	57
Detailed measurements of blubber thickness (eleven points)	50	59	60	5	5	50	60	3	2
Detailed measurements of blubber thickness (fourteen points)	1	-	3	-	-	1	3	-	-
Body weight	50	59	60	35	50	50	60	60	57
Body weight by parts	1	-	3	5	5	1	3	3	2
Skin tissues for DNA study	50	59	60	35	50	50	60	60	57
Muscle, liver, and heart tissues for isozyme analysis	50	59	60	-	-	50	60	-	-
Muscle, liver, kidney, and blubber tissues for various analysis	50	59	60	35	50	50	60	60	57
Spleen, heart, and ventral groove for various analysis	-	-	-	35	50	-	-	60	57
Muscle, liver, kidney, and blubber tissues for heavy metal analysis	50	59	60	35	50	50	60	60	57
Muscle, liver, kidney, and blubber tissues for organic chlorine analysis	50	59	60	35	50	50	60	60	57
Muscle and vertebrae for lipid analysis	1	-	3	5	-	1	3	3	2
Urine for various analysis	-	-	-	9	31	-	-	-	8
Blood serum or plasma for various analysis	-	-	-	25	48	-	-	43	54
Mammary gland; lactation status, measurement and histological sample	18	12	15	10	17	29	37	34	36
Uterine horn; measurement and endometrium sample	18	12	15	10	17	28	37	34	36
Collection of ovary	18	12	15	10	17	28	37	34	36
Photographic record of foetus	3	-	-	1	-	8	13	3	6
Foetal length and weight	3	-	-	1	-	8	12	3	6
External measurement of foetus	3	-	-	1	-	8	1	3	5
Collection of foetus	1	-	-	-	-	9	12	3	1
Testis and epididymis; weight and histological sample	32	47	45	25	33	21	23	24	21
Stomach content, conventional record	50	59	60	35	50	50	60	60	57
Volume and weight of stomach content in each compartment	50	59	60	35	50	49	60	56	57
Observation of marine debris in stomach	50	59	60	35	50	50	60	60	57
Stomach contents for feeding study	48	58	60	35	47	49	60	59	50
Stomach contents for lipid analysis	1	-	3	-	-	1	3	-	-
Record of external parasites	50	59	60	35	50	50	60	60	57
Sampling of the intestine contents	-	-	-	-	-	10	-	-	-
Earplug for age determination	50	58	60	35	49	50	60	60	57
Tympanic bulla for age determination	49	58	60	35	36	50	60	59	57
Crystalline lens in eyeball for age determination	-	-	-	35	50	-	-	58	57
Largest baleen plate for morphologic study and age determination	50	59	60	35	50	50	60	60	57
Baleen plate measurements (length and breadth)	50	59	60	35	50	49	60	60	56
Photographic record of baleen plate series	50	59	60	35	50	50	60	60	57
Length of each baleen plate series	50	59	60	35	50	50	60	60	57
Vertebral epiphyses sample	49	59	60	35	50	50	60	60	57
Number of vertebrae	48	59	60	-	-	50	60	-	-
Number of ribs	50	59	60	35	50	50	60	60	57
Skull measurement (length and breadth)	50	59	60	34	50	48	57	60	57
Collection of skull	1	-	-	-	-	-	-	-	-
Collection of whole skeleton	1	-	1	-	-	-	-	-	-

Table 4. Searching days, distances and number of sightings of common minke whales made by the dedicated sighting surveys using small-type whaling catcher boats in the 2004 JARPN II coastal component off Kushoro.

Period	Days	Distances (n.miles)	No. of sightings					
			Primary		Secondary		Total	
			Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
First period (13 Sept.-16 Sept.)	4	170.42	7	7	-	-	7	7
-----								
Second period (17 Sept.-23 Sept.)	6	243.30	5	5	1	1	6	6
-----								
Third period (24 Sept.-4 Oct.)	7	228.03	4	4	-	-	4	4
-----								
Total	17	641.76	16	16	1	1	17	17

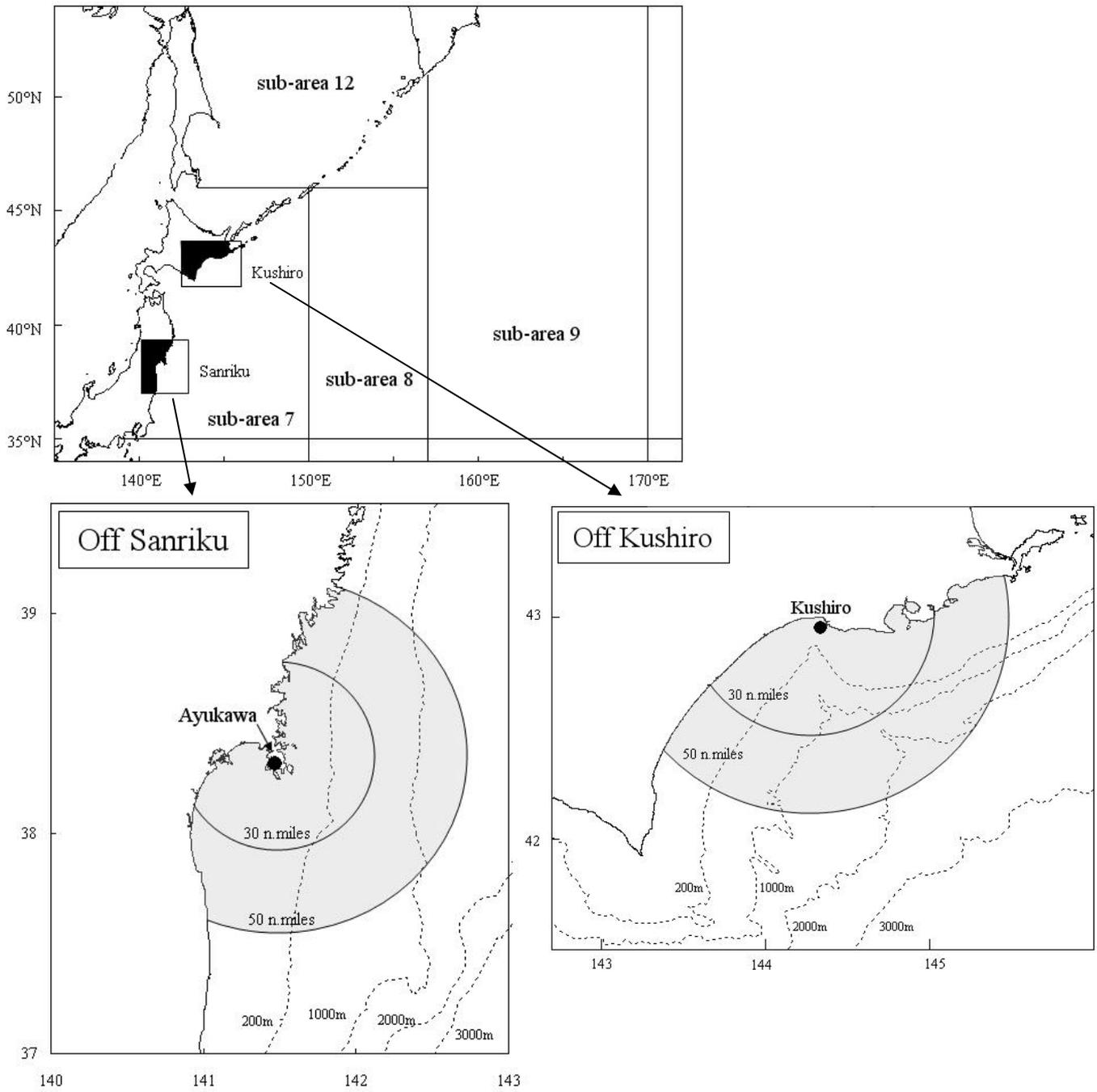


Fig.1. Research areas of the whale sampling surveys in the coastal component of the JARPN II.

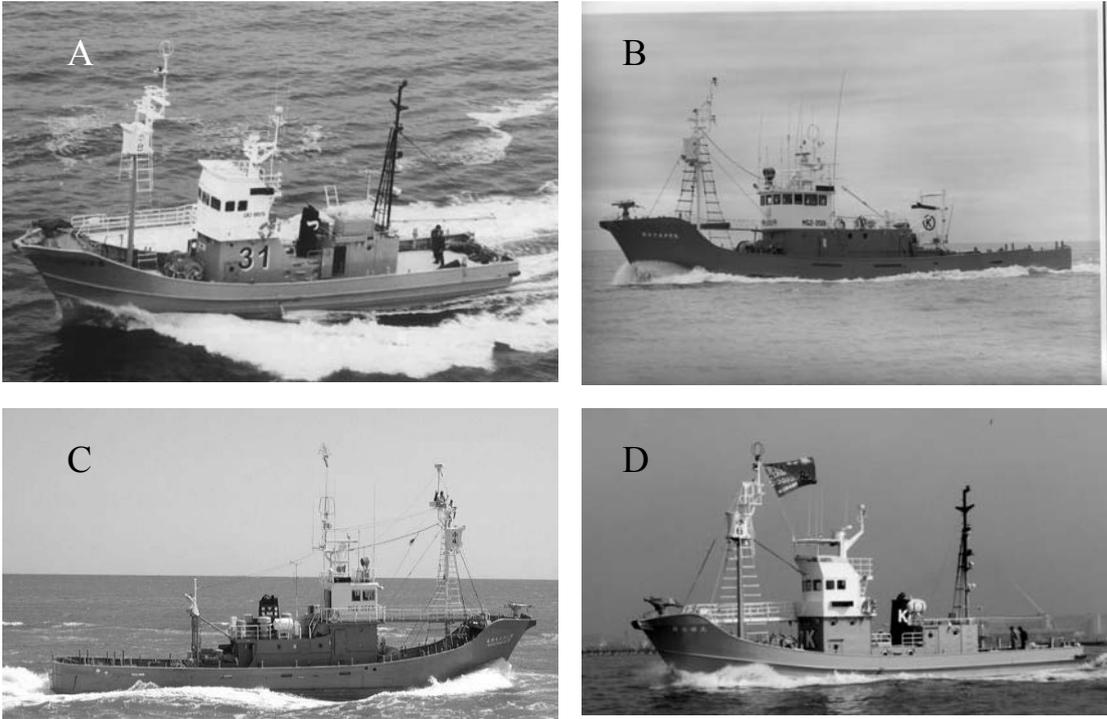


Fig.2. Small-type whaling catcher boats used in the coastal component of the JARPN II.  
 A: *Sumitomo Maru* No. 31(31S); B: *Koei Maru* No.75 (75K); C: *Taisho Maru* No.28 (28T);  
 D: *Katsu Maru* No.7 (7K)

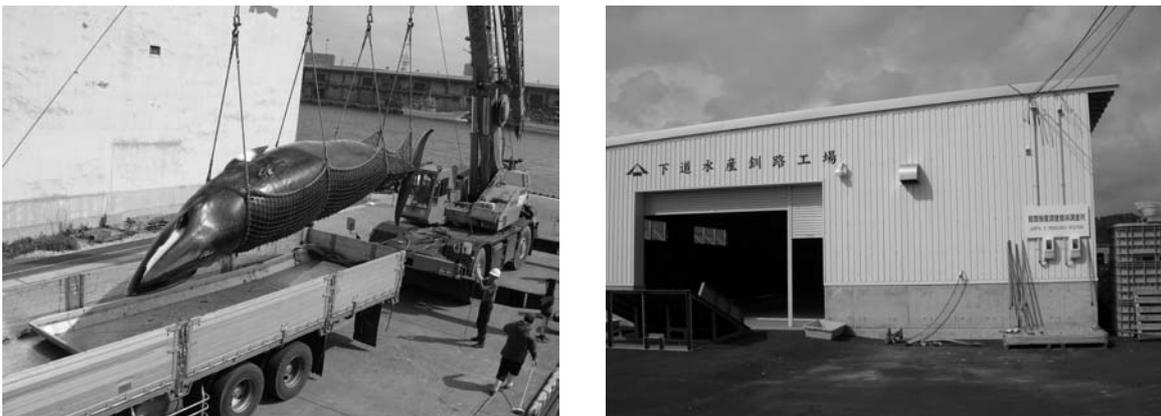


Fig.3. Left photo: At the port, sampled whale was lifted up from vessel by a crane, using a wire net and transported to the station by a freight trailer. Right photo: The JARPN II research station established in the suburbs of Kushiro for biological examination.

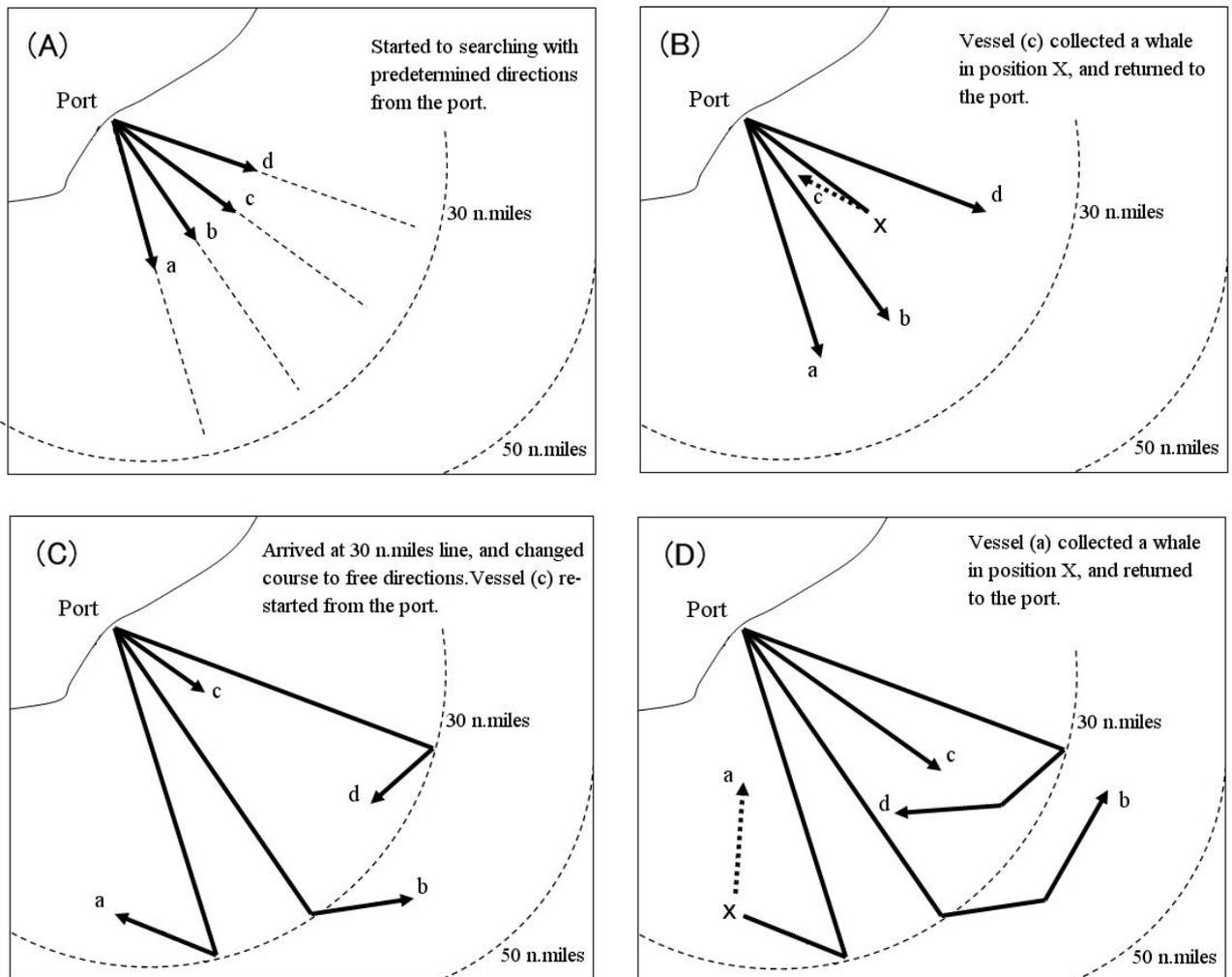


Fig.4. Schematic diagram of the manner of searching for whale sampling in the research area in the coastal component of the JARPN II conducted in 2004 and afterwards. Arrows with letters 'a' to 'd' indicate examples of the movements of respective small-type whaling catcher boat.

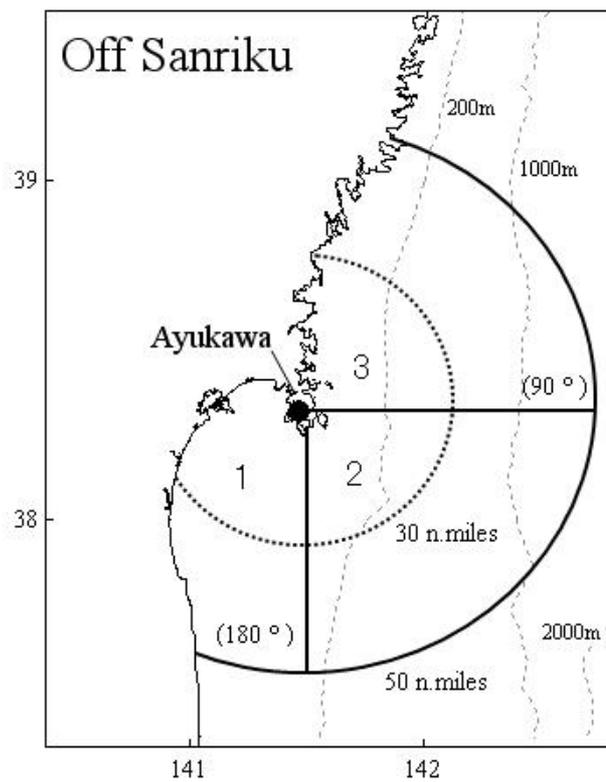
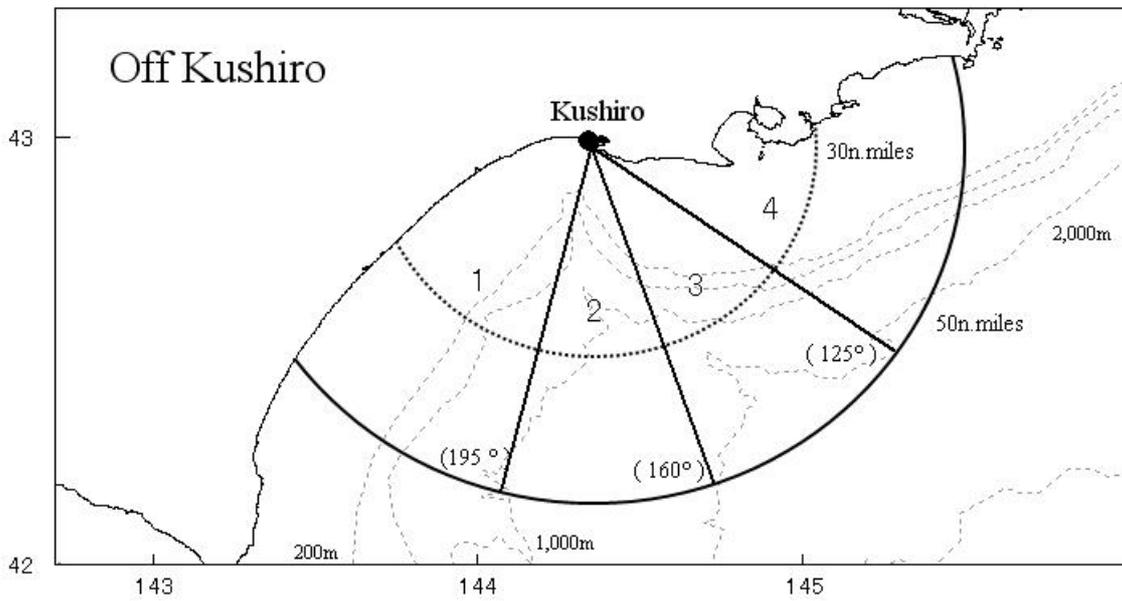


Fig.5. Allocation of the sectors for type 1 whale sampling in the coastal component of the JARPN II.

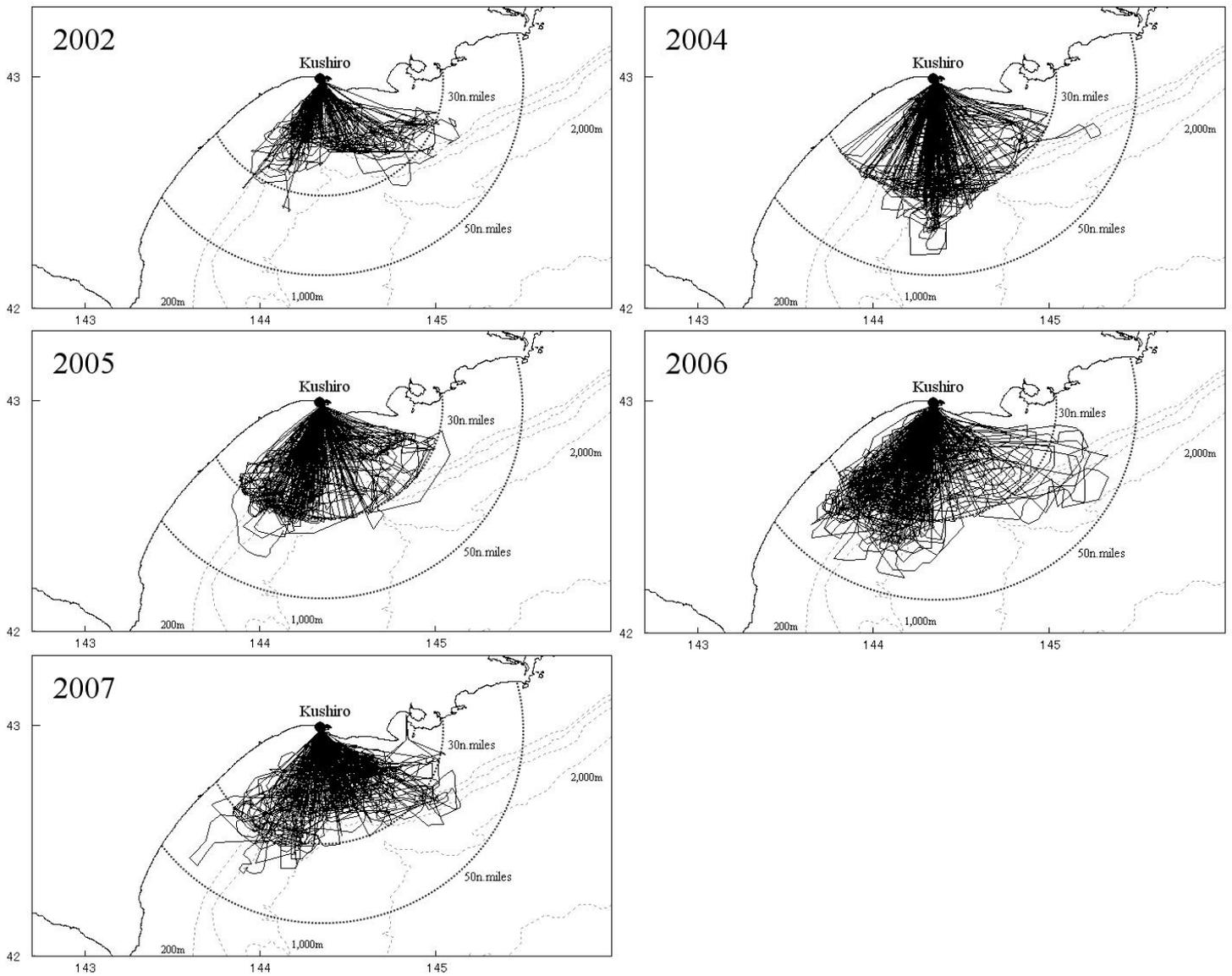


Fig.6. Cruise tracks of the whale sampling surveys in the coastal component off Kushiro in 2002 to 2007.

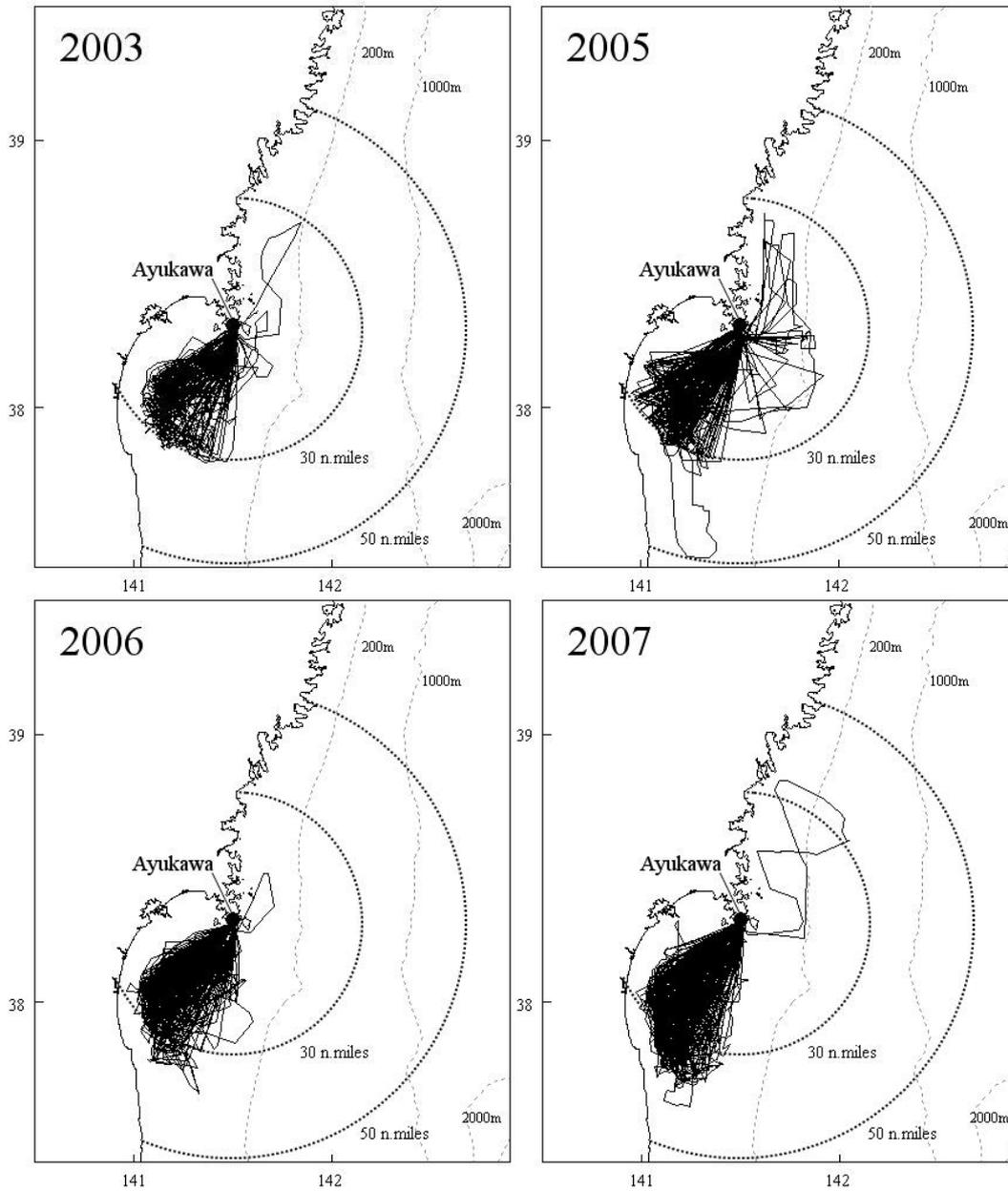


Fig.7. Cruise tracks of the whale sampling surveys in the coastal component off Sanriku in 2003 to 2007.

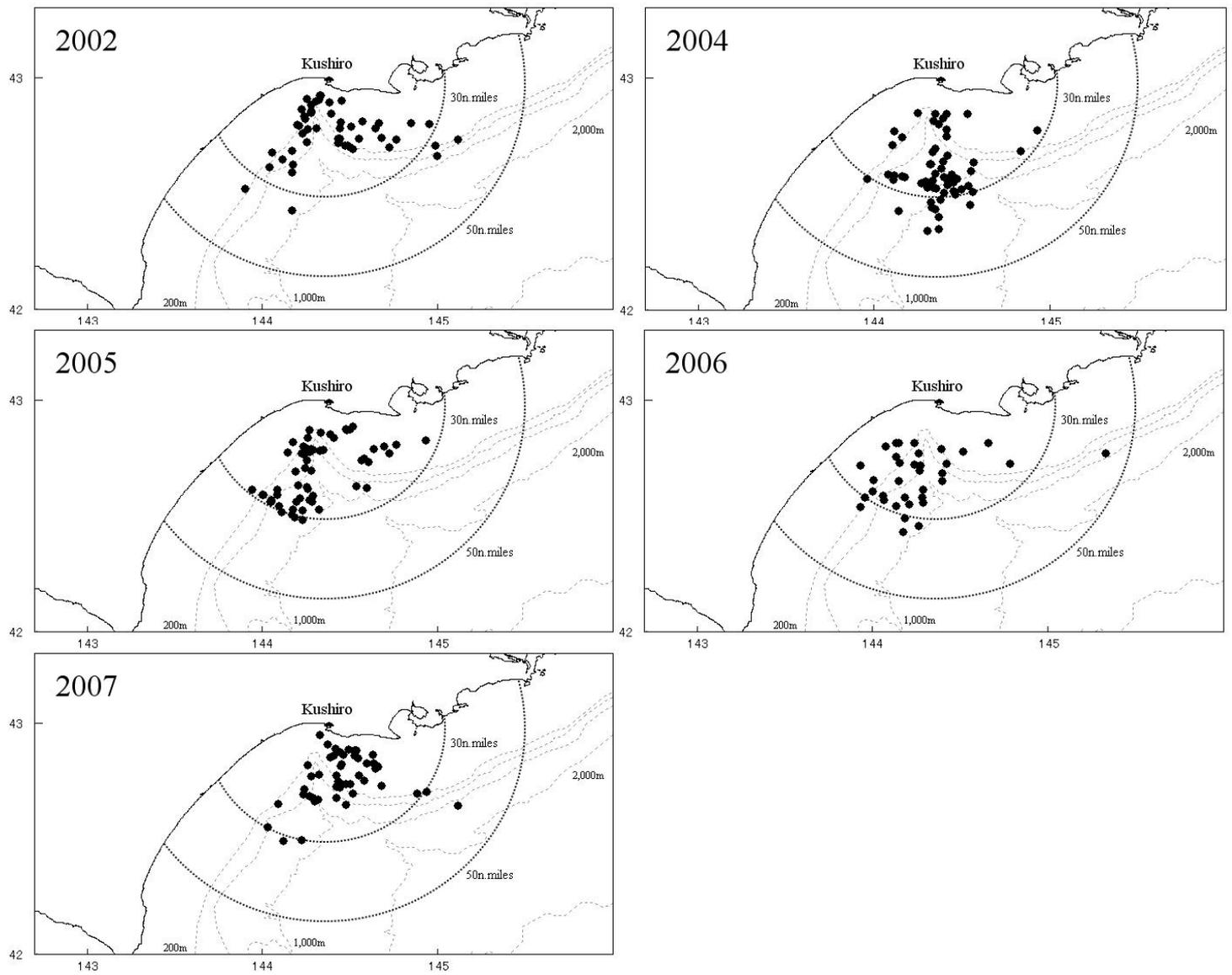


Fig.8. Distributions of common minke whales sampled by the coastal component off Koshiro in 2002 to 2007.

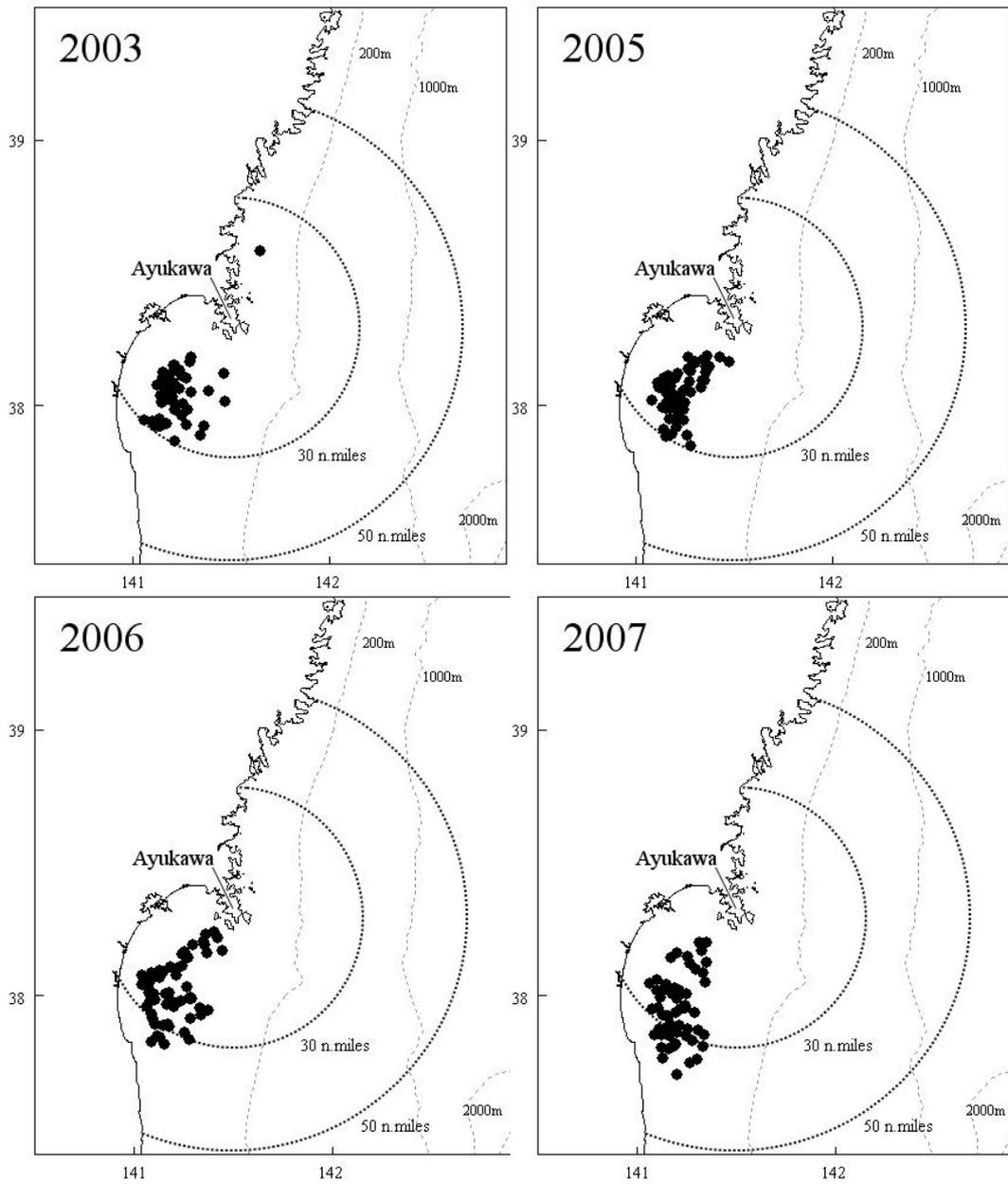


Fig.9. Distributions of common minke whales sampled by the coastal component off Sanriku in 2003 to 2007.

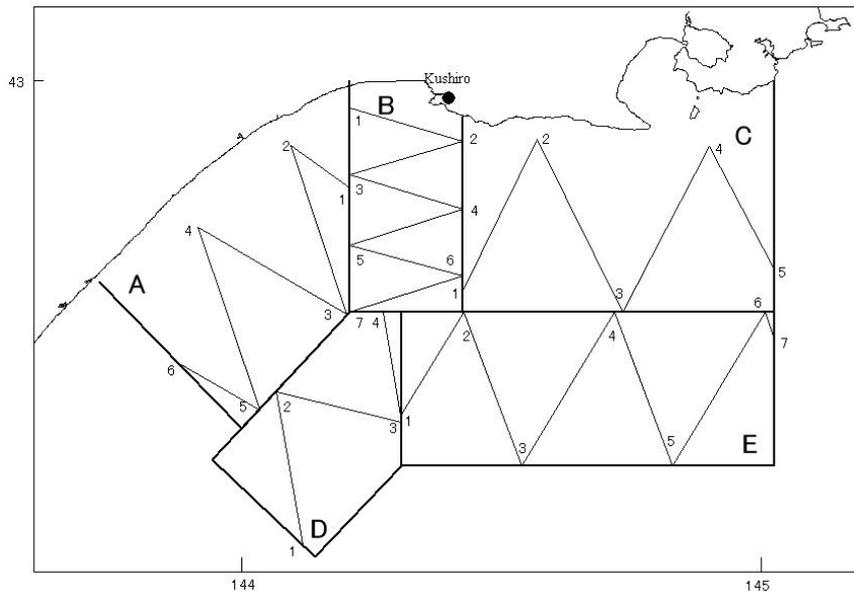


Fig.10. Survey blocks and example of the planned track lines for the dedicated sighting survey by small-type whaling catcher boats in the 2004 coastal component off Kushiro.

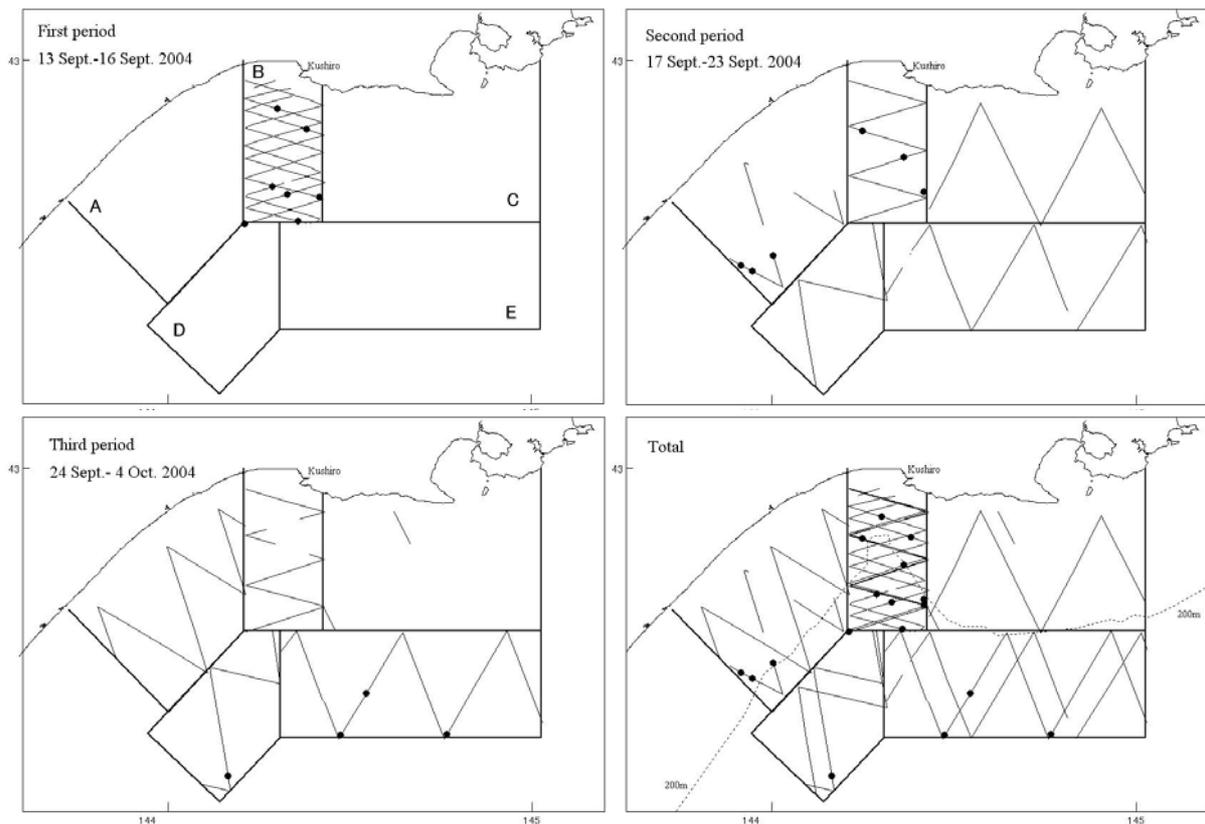


Fig.11. Cruise tracks with searching effort and sighting positions of common minke whales from the dedicated sighting survey by small-type whaling catcher boats in the 2004 coastal component off Kushiro.