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ABSTRACT

This document outlines the plan for a systematic vessel-based sighting survey in the North Pacific in the summer 2023. The main objective of this survey is to attain the sighting data required to estimate the abundance of large whale species in the North Pacific Ocean. The survey will be conducted using the research vessels *Yushin-Maru* (*YS1*) and *Kaiyo-Maru No. 7* (*KY7*) from late July to early October 2023, and will cover the area comprised between 20°N-30°N, 140°E-180°. For more precise abundance estimation of whales, distance and angle estimation experiments will be conducted. Furthermore, photo-identification experiments on blue, North Pacific right, humpback and killer whales will be collected on an opportunistic basis. Biopsy skin samples of large whale species such as blue, fin, sei, North Pacific right, humpback and killer whales, and satellite tagging experiments on fin, sei, common minke and Bryde's whales will be also conducted. Data and samples obtained during these experiments will be used in future studies on distribution, abundance, movement and stock structure of the species involved, required for assessment and management purposes.

KEYWORDS: LARGE WHALES, SIGHTING SURVEY, NORTH PACIFIC, PHOTO-ID, BIOPSY, SATELLITE TRACKING

INTRODUCTION

In the western North Pacific, dedicated cetacean sighting surveys have been conducted by the Institute of Cetacean Research (ICR) since 1997. The sighting surveys were based on the survey procedures of the International Whaling Commission/Southern Ocean Whale and Ecosystem Research (IWC/SOWER) (Matsuoka *et al*., 2003) and more recently the IWC/Pacific Ocean Whale and Ecosystem Research (IWC/POWER) (IWC, 2021). Based on the collected data, the distribution pattern of large whales such as blue, fin, sei, Bryde's, common minke, humpback, North Pacific right and sperm whales and abundance estimate of those whale species were investigated and reported to the IWC SC (IWC, 2001; 2010; 2016; Hakamada *et al*., 2017; 2019). The Fisheries Resources Institute (FRI) has also conducted dedicated sighting survey for cetaceans in the North Pacific since the 1980s (Buckland *et al.,* 1992; Miyashita and Kato, 2004; 2005).

Sighting surveys were conducted under the New Scientific Whale Research Program in the western North Pacific (NEWREP-NP) in 2018 and 2019 (Government of Japan, 2017; IWC, 2017).

As in the previous sighting surveys conducted during 2018-2022, the surveys in 2023 are planned considering the following aspects:

a) The use of the Independent Observer (IO) mode survey to estimate $g(0)$,
b) The setting of the appropriate survey track in order to avoid double-counting,
c) The setting of temporal stratification based on information on the migration pattern of each target species/population.

As in previous surveys, the design, protocols, and implementation of the 2023 surveys will follow the 'Requirements and Guidelines for Conducting Surveys and Analyzing Data within the Revised Management Scheme (RMS)' (IWC, 2012). Data collected in this survey will be used for abundance estimates, which is essential for assessment and management of large whales in the North Pacific.

The objective of this paper is to outline the research plan for dedicated sighting surveys in the North Pacific in summer 2023.

OUTLINE OF THE 2023 RESEARCH PLAN

Research vessels

The sighting surveys will be based on the research vessels *Yushin-Maru* (*YS1*) *and Kaiyo-Maru No. 7* (*KY7*) (Figure 1). These vessels are equipped with a top barrel platform (TOP), IO platform (IOP) and upper bridge. The ICR research data collecting system is set on the vessels. Specifications of the vessels are shown in Table 1.

Research schedule
The sighting surveys will be conducted from late July to early October. The tentative survey itineraries for *YS1* and *KY7* are shown in Tables 2A and 2B, respectively. The vessels will return to Japan in the middle of the survey for refueling. The planned numbers of research days are 64 and 68 days for *YS1* and *KY7*, respectively.

Researchers on board
Experienced researchers on line transect whale sighting surveys, biopsy sampling, photo-id and satellite tag experiments will be selected in each vessel.

Research area and track line design
The research area will be comprised between 20°N-30°N and 140°E-180° (Figure 2). Hereafter, light blue and light green areas in Figure 2 are referred as southern block (consisting of sub-block between 20N°-25°N and 140°E-175°E and sub-block between 20°N-30°N and 175°E-180°), and northern block (between 25°N-30°N and 140°E-175°E), respectively.

Table 3 shows the waypoints (WP) in the survey blocks. The *YS1* will start the survey at WP101 and will end at WP160 in the southern block. The *KY7* will start the survey at WP201 and will end at WP248 in the northern block. All vessels will survey in ascending order of WP number. Track lines in foreign Exclusive Economic Zone (EEZ) will not be surveyed.

The planned searching distances are 2,944.8 n.miles for *KY7* and 3,827.8 n.miles for *YS1*. The start points of the track lines is decided at random using the Distance program ver. 7.3 (Thomas *et al.*, 2010), and the number of lines (width in the longitude) is decided by the research schedule following IWC survey guideline (IWC, 2012).

Survey modes
Sighting activities will be classified into two principal types: 'On-effort' and 'Off-effort'. On-effort means sightings activities conducted under weather and sea state conditions considered acceptable. Off-effort means all activities that are not On-effort. All sightings to be recorded On-effort will be classified as 'Primary Sightings'. All other sightings will be classified as 'Secondary Sightings'. Sighting effort will be conducted by the boatswain and topmen from the TOP (there will be always two primary observers on the TOP) and the upper bridge where the helmsman, captain or officer on-watch, researchers, and the chief engineer (or second engineer) will be also present (two primary observers and four secondary observers will be always present in the upper bridge).

The sighting survey will be conducted using (1) Passing with abeam closing mode (NSP) and (2) Passing with Independent Observer mode (IO) in order to estimate whale abundance considering estimated $g(0)$. Both survey modes follow the protocol endorsed for the IWC/SOWER surveys (e.g., Matsuoka *et al.*, 2003; IWC, 2008).

Under NSP mode, there will be two primary observers on the TOP. These observers will search for cetaceans by using angle board and binoculars (7x), which include the distance estimate scales. Members of two observer teams on TOP will be fixed and will operate in one or two hours-shifts. There will be open communication between the upper bridge and the TOP. These observers report sighting information to researchers and other observers on the upper bridge for data recording.

Under IO mode, there will be two primary observers on the TOP and two primary observers on the IOP. These observers on TOP and IOP will conduct searching for cetaceans by using angle board and binoculars (7x). Members of the two observer teams on TOP will be fixed and will operate in one or two hours-shifts. There will be no open communication between the IOP and the TOP observers. The observers on the upper bridge will communicate to the TOP (or IOP) independently, with the topmen required only to clarify information without distracting them from their normal search procedure. These observers report sighting-information to researchers and other observers on the upper bridge for data recording.

Experiments

Distance and angle experiment
Distance and angle measurement experiment consists of the following two steps. Firstly, distance and angle measurement training will be conducted at the first stage of the survey. Then, the experiment to evaluate measurement error will be conducted at the last stage of the survey. Observers on each vessel will be required to assess eight sets of angles and distance from TOP, IOP, and upper bridge. All trials will be conducted under

the acceptable weather and sighting conditions.

Photo-id
Photo-identification experiments will be carried out on an opportunistic basis. Protocols for photo-id are similar to those used in the IWC-POWER surveys. Target species will be the blue, North Pacific right, humpback and killer whales. The first three species have high priority.

Biopsy
Biopsy sampling experiments will be carried out on large whale species such as blue, fin, sei, North Pacific right, humpback and killer whales on an opportunistic basis using the Larsen system. The first four species have high priority. Protocols for biopsy sampling are similar to those used in the IWC-POWER surveys.

Satellite tagging
Routine telemetry experiments using satellite tag (SPOT6) will be conducted following the same protocols and equipment used during the JASS-A surveys (see also Konishi *et al*., 2020). The target species for this experiment will be fin, sei, common minke and Bryde's whales. The first three species have higher priority.

The study of satellite tagging will be also conducted in order to obtain information on dive time of large whales using the satellite-linked Time-Depth-Recorder (TDR) tags (SPLASH10). The target species for this experiment will be the fin, sei, common minke and Bryde's whales. The data of mean dive-time and diving behaviour of the animal are key results for abundance estimate considering availability bias.

Data and samples obtained during the sighting, photo-id, biopsy and satellite tracking experiments will be used in future studies on distribution, abundance, movement and stock structure of the species involved.

DATA STORAGE
The researcher will input data collected (weather, effort, sighting and experiments data) to the computer on board during the survey as was done for the previous surveys conducted by ICR (e.g., IWC-POWER, JARPAII/JARPNII). These data will be stored at the ICR.

Scientists at the ICR will analyze the sighting data collected using the methods developed and modified by previous studies such as a design-based abundance estimation using line transect data assuming g(0)=1. Abundance estimation considering $g(0)$ estimate and model-based abundance estimation (e.g., Hakamada *et al.*,2009; Matsuoka *et al*., 2011; Okamura and Kitakado,2004; Murase *et al*., 2016) will be also conducted, if possible. Collaboration work will be conducted for abundance estimation of cetaceans in the surveyed area.

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Table 1. Specification of the research vessels participating in the 2023 sighting surveys in the North Pacific.

	Yushin-Maru	*Kaiyo-Maru No. 7*
Call sign	JLZS	JECL
Length overall [m]	69.61	60.02
Molded breadth [m]	10.4	10.6
Gross tonnage [GT]	724	649
Top barrel height [m]	19.5	17.5
IO platform height [m]	13.5	12.7
Upper bridge height [m]	11.5	9.6
Bow height [m]	6.5	4.5
Engine power [PS/kW]	5,280/3,900	2,100/1,544

Table 2A. Tentative itinerary of the *YS1* for the 2023 sighting survey in the North Pacific.

Date	Event
28-July	*YS1* departs Shimonoseki, Japan
1-August	*YS1* arrives at the starting point (WP101) in the southern block
21-August	*YS1* leaves the southern block and moves to Sendai, Japan
26-August	*YS1* arrives at Sendai
30-August	*YS1* departs Tokyo, Japan
4-September	*YS1* arrives at the restarting point in the southern block
23-September	*YS1* completes the southern block and moves to Shiogama, Japan
2-October	*YS1* arrives Shiogama

Table 2B. Tentative itinerary of the *KY7* for the 2023 sighting survey in the North Pacific.

Date	Event
29-July	*KY7* departs Kurihama, Japan
2-August	*KY7* arrives at the starting point (WP201) in the northern block
23-August	*KY7* leaves the northern block and moves to Kurihama
28-August	*KY7* arrives at Kurihama
30-August	*KY7* departs Kurihama
4-Septembert	*KY7* arrives at the restarting point in the northern block.
26-September	*KY7* completes the northern block and move to Shimizu, Japan
5-October	*KY7* arrives Shimizu

Table 3. Waypoint (WP) in each survey block during the sighting survey in 2023 in the North Pacific. Mode indicates survey mode planned, Course and Dist indicate planned course and distance to next WP, respectively. Asterisks (*) in Mode row indicate that sighting survey will not be conducted between the WP and next WP. Total planned survey distances are 3827.8 n.miles and 2944.8 n.miles for *YS1* and *KY7*, respectively.

Waypoint for southern block surveyed by the *YS1*

WP	Lat			Lon			Mode	Course	Dist.
101	23°	15.8	N	140°	0.0	E	NSP	041	68.2
102	24°	7.9	N	140°	48.4	E	IO	041	68.2
103	25°	0.0	N	141°	37.1	E	NSP	139	65.4
104	24°	10.0	N	142°	23.8	E	IO	139	65.3
105	23°	20.1	N	143°	10.2	E	NSP	139	65.4
106	22°	30.1	N	143°	56.3	E	IO	139	65.5
107	21°	40.1	N	144°	42.2	E	NSP	139	65.4
108	20°	50.0	N	145°	27.7	E	IO	139	65.5
109	20°	0.0	N	146°	13.2	E	NSP	041	65.5
110	20°	50.0	N	146°	58.6	E	IO	041	65.4
111	21°	40.0	N	147°	44.2	E	NSP	041	65.5
112	22°	30.0	N	148°	30.1	E	IO	041	65.4
113	23°	20.0	N	149°	16.2	E	NSP	041	65.5
114	24°	10.0'	N	150°	2.7'	E	IO	041	65.4
115	25°	0.0'	N	150°	49.4'	E	NSP	139	65.4
116	24°	10.0'	N	151°	36.1'	E	IO	139	65.5
117	23°	20.0'	N	152°	22.6'	E	NSP	139	65.4
118	22°	30.0'	N	153°	8.7'	E	IO	139	65.5
119	21°	40.0'	N	153°	54.6'	E	NSP	139	65.4
120	20°	50.0'	N	154°	40.2'	E	IO	139	65.4
121	20°	0.0'	N	155°	25.5'	E	NSP	041	65.4
122	20°	50.0'	N	156°	10.8'	E	IO	041	65.4
123	21°	40.0'	N	156°	56.4'	E	NSP	041	65.5
124	22°	30.0'	N	157°	42.3'	E	IO	041	65.4
125	23°	20.0'	N	158°	28.4'	E	NSP	041	65.5
126	24°	10.0'	N	159°	14.9'	E	IO	041	65.4
127	25°	0.0'	N	160°	1.6'	E	NSP	139	65.5
128	24°	10.0'	N	160°	48.4'	E	IO	139	65.4
129	23°	20.0'	N	161°	34.8'	E	NSP	139	65.5
130	22°	30.0'	N	162°	21.0'	E	IO	139	65.4
131	21°	40.0'	N	163°	6.8'	E	NSP	139	65.5
132	20°	50.0'	N	163°	52.5'	E	IO	139	65.4
133	20°	0.0'	N	164°	37.8'	E	NSP	041	65.5
134	20°	50.0'	N	165°	23.2'	E	IO	041	65.4
135	21°	40.0'	N	166°	8.8'	E	NSP	041	65.4
136	22°	30.0'	N	166°	54.6'	E	IO	041	65.5
137	23°	20.0'	N	167°	40.8'	E	NSP	041	65.4
138	24°	10.0'	N	168°	27.2'	E	IO	041	65.4

139	25°	0.0'	N	169°	13.9'	E	NSP	139	65.5
140	24°	10.0'	N	170°	0.7'	E	IO	139	65.4
141	23°	20.0'	N	170°	47.1'	E	NSP	139	65.4
142	22°	30.0'	N	171°	33.2'	E	IO	139	65.5
143	21°	40.0'	N	172°	19.1'	E	NSP	139	65.4
144	20°	50.0'	N	173°	4.7'	E	IO	139	65.4
145	20°	0.0'	N	173°	50.0'	E	NSP	041	65.4
146	20°	50.0'	N	174°	35.3'	E	IO	041	65.5
147	21°	40.0'	N	175°	21.0'	E	NSP	041	65.4
148	22°	30.0'	N	176°	6.8'	E	IO	041	65.5
149	23°	20.0'	N	176°	53.0'	E	NSP	041	65.5
150	24°	10.0'	N	177°	39.5'	E	IO	041	65.4
151	25°	0.0'	N	178°	26.2'	E	NSP	139	65.9
152	24°	9.7'	N	179°	13.3'	E	IO	139	65.9
153	23°	19.3'	N	180°	0.0'		*	-	-
154	26°	28.2'	N	180°	0.0'		IO	321	68.0
155	27°	21.1'	N	179°	11.8'	E	NSP	321	68.1
156	28°	14.1'	N	178°	23.1'	E	IO	321	68.1
157	29°	7.1'	N	177°	34.1'	E	NSP	321	68.1
158	30°	0.0'	N	176°	44.6'	E	IO	219	73.2
159	29°	2.6'	N	175°	52.0'	E	NSP	219	73.1
160	28°	5.3'	N	175°	0.0'	E	-	-	-

Waypoint for northern block surveyed by the *KY7*

WP	Lat			Lon			Course	Dist.	Mode
201	29°	55.3'	N	140°	0.0'	E	039	6.0	NSP
202	30°	0.0'	N	140°	4.4'	E	141	64.3	NSP
203	29°	10.0'	N	140°	51.1'	E	141	64.3	IO
204	28°	20.0'	N	141°	37.5'	E	141	64.3	NSP
205	27°	30.0'	N	142°	23.5'	E	141	64.3	IO
206	26°	40.0'	N	143°	9.2'	E	141	64.3	NSP
207	25°	50.0'	N	143°	54.5'	E	141	64.3	IO
208	25°	0.0'	N	144°	39.5'	E	039	64.3	NSP
209	25°	50.0'	N	145°	24.5'	E	039	64.3	IO
210	26°	40.0'	N	146°	9.8'	E	039	64.2	NSP
211	27°	30.0'	N	146°	55.4'	E	039	64.3	IO
212	28°	20.0'	N	147°	41.4'	E	039	64.3	NSP
213	29°	10.0'	N	148°	27.8'	E	039	64.3	IO
214	30°	0.0'	N	149°	14.5'	E	141	64.3	NSP
215	29°	10.0'	N	150°	1.2'	E	141	64.3	IO
216	28°	20.0'	N	150°	47.6'	E	141	64.3	NSP
217	27°	30.0'	N	151°	33.6'	E	141	64.2	IO
218	26°	40.0'	N	152°	19.2'	E	141	64.3	NSP
219	25°	50.0'	N	153°	4.5'	E	141	64.3	IO

220	25°	0.0'	N	153°	49.5'	E	039	64.3	NSP
221	25°	50.0'	N	154°	34.5'	E	039	64.3	IO
222	26°	40.0'	N	155°	19.8'	E	039	64.2	NSP
223	27°	30.0'	N	156°	5.4'	E	039	64.3	IO
224	28°	20.0'	N	156°	51.4'	E	039	64.3	NSP
225	29°	10.0'	N	157°	37.8'	E	039	64.3	IO
226	30°	0.0'	N	158°	24.5'	E	141	64.3	NSP
227	29°	10.0'	N	159°	11.2'	E	141	64.3	IO
228	28°	20.0'	N	159°	57.6'	E	141	64.3	NSP
229	27°	30.0'	N	160°	43.6'	E	141	64.2	IO
230	26°	40.0'	N	161°	29.2'	E	141	64.3	NSP
231	25°	50.0'	N	162°	14.5'	E	141	64.3	IO
232	25°	0.0'	N	162°	59.5'	E	039	64.3	NSP
233	25°	50.0'	N	163°	44.5'	E	039	64.3	IO
234	26°	40.0'	N	164°	29.8'	E	039	64.2	NSP
235	27°	30.0'	N	165°	15.4'	E	039	64.3	IO
236	28°	20.0'	N	166°	1.4'	E	039	64.3	NSP
237	29°	10.0'	N	166°	47.8'	E	039	64.3	IO
238	30°	0.0'	N	167°	34.5'	E	141	64.3	NSP
239	29°	10.0'	N	168°	21.2'	E	141	64.3	IO
240	28°	20.0'	N	169°	7.6'	E	141	64.3	NSP
241	27°	30.0'	N	169°	53.6'	E	141	64.2	IO
242	26°	40.0'	N	170°	39.2'	E	141	64.3	NSP
243	25°	50.0'	N	171°	24.5'	E	141	64.3	IO
244	25°	0.0'	N	172°	9.5'	E	040	59.8	NSP
245	25°	46.3'	N	172°	51.7'	E	040	59.9	IO
246	26°	32.7'	N	173°	34.2'	E	040	59.8	NSP
247	27°	19.0'	N	174°	17.0'	E	040	59.8	IO
248	28°	5.3'	N	175°	0.0'	E	-	-	-

A) B)

Figure 1. Research vessels participating in the dedicated sighting surveys in 2023 in the North Pacific: A) *Yushin-Maru*, B) *Kaiyo-Maru No. 7*.

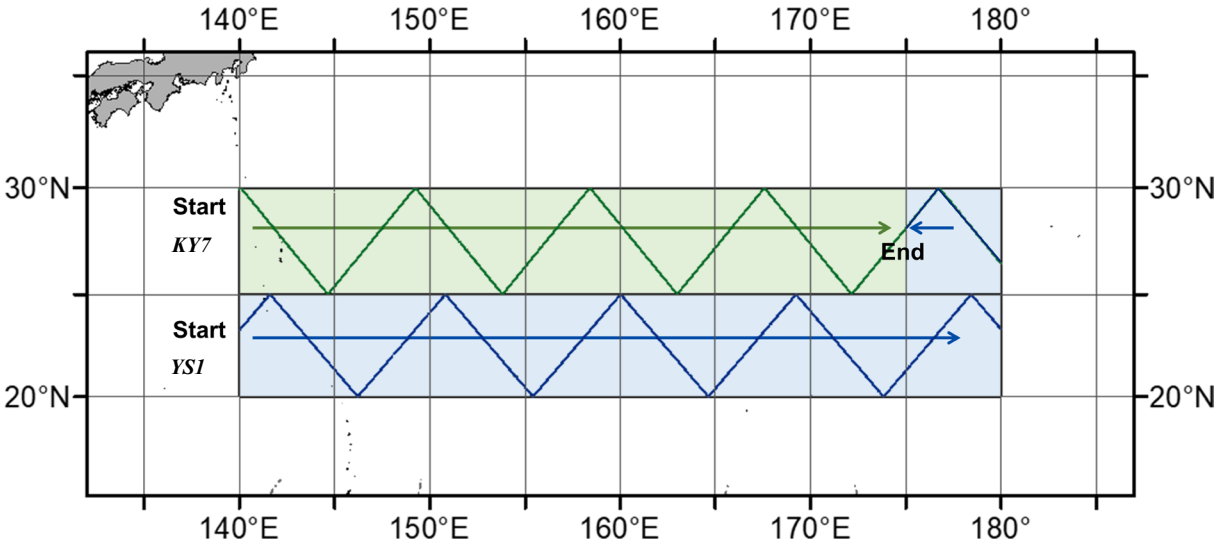

Figure 2. Research areas (light blue are the southern block to be covered by *YS1*; light green is the northern block to be covered by *KY7*), and pre-determined track lines (blue zigzag lines to be covered by *YS1* and green ones to be covered by *KY7*) of the 2023 sighting survey from late July to early October. Blue and green allows indicates survey direction of *YS1* and *KY7*, respectively. Track lines in foreign Exclusive Economic Zone (EEZ) will not be surveyed.