Aerial Visual Surveys on Tuna Species in the Sea of Japan in 2016 and 2017

Masahiko Mohri*, Hideaki Tanoue*, Takanori Takei*, Kiyohiko Fukami, Tadashi Kamano**, Hideki Nishioka***, Kazuhiro Hata***, Kenichi Sakai* & Shinya Shimokawa***

*** National Fisheries University, Dept. of Fishery Science and Technology, Japan**
**** National Fisheries University, Koyomaru, Japan**
***** National Fisheries University, Tenyomaru, Japan**

Abstract

With an aim to save time and labors for finding tuna species known as a highly migratory fish that inhabits the Pacific Ocean extensively, aerial visual surveys for these individuals were conducted in the Sea of Japan. In the case of bluefin tuna (*Thunnus orientalis*), the fish schools were found in the vicinity of 36°50' N latitude and 135°10' E longitude as well as 36°40' N latitude and 135°00' E longitude. The communication time required between one small aircraft and two vessels from the start of recording to the end of each survey was 3.4 hours in 2016 and 11.7 hours in 2017.

1 Introduction

The tuna species are widely found in the temperate and tropical waters of the Pacific Ocean and caught by some countries. Especially in Japan, the Pacific bluefin tuna (PBFT hereinafter) is caught by various fishing methods using a fishing rod, towrope, longline, set net, round haul net, or the like. Also, PBFT is sold at a higher price and very popular in various countries, which causes concerns for depletion of PBFT as a resource.

Under such a circumstance, since the fiscal year 2010, investigations regarding PBFT larvae have been conducted mainly by the Fisheries Research Agency (present Japan Fisheries Research and Education Agency) in cooperation with the National Fisheries University (present Japan Fisheries Research and Education Agency), fisheries experimental stations, and similar facilities. Furthermore, with the goal of sustaining

PBFT resources for the future, studies on the ecology of PBFT are being advanced. These studies cover the water temperatures as well as the spawning period and grounds of this species [1] - [5]. PBFT spawns mainly in waters around the Nansei Islands and Daitojima Island and some of this species are reported to spawn in the Japan Sea [6]. In addition, another study on PBFT focuses on the physiology because it is known that this species can maintain the body temperature warmer than the surrounding water temperature through the action of counter-current exchange system [7].

Tuna species are highly migratory individuals found widely in the Pacific Ocean: It means that it would require so much labor and time to find these species in nature for studies.

To save such time and efforts, one of the authors boarded one small aircraft and the others boarded two vessels. After the aircraft took off, the former conducted a visual survey from above and sent data to the latter. Based on the survey data, the vessels moved to the area where tuna species, especially PBFT may inhabit so that we can complete the survey in as much detail as possible.

2 Materials and Methods

Based on the information from fishermen who having watched spawning PBFT, we narrowed the survey area to the waters off Cape Kyogamisaki (Wakasa Bay) where PBFT is more likely to be found and started the visual survey using an aircraft. The survey was conducted on fine weather from July 18 in 2016 to July 14 -16 and 19 in 2017 (total five days more than visibility 7).

The airport where the small aircraft took off and landed changed depending on the year because of the schedule of operation: Kounan Airport (Okayama Prefecture) in 2016 and Tajima Airport (Hyogo Prefecture) in 2017. Aerial visual surveys conducted by height from 2000 m to 3000 m and with speed of about 200km/h. The aircraft was a four-seater one, which consisted of one pilot, one copilot who observes and records, one of the authors, and one camera crew.

Multiple cameras were used for the aerial visual survey. Two cameras were fixed on the aircraft and one head camera was mounted on the head of the author to collect aerial video data as well as the visual survey data.

Two vessels were used for the survey: the Koyo Maru and the Tenyo Maru which belong to the National Fisheries University. The author aboard the aircraft sent the visual data of fish schools and others to the other authors aboard each vessel. The fish schools and others found based on the above-mentioned communication and video data is described in the following Results section.

3 Results

Fig. 1 shows the survey area dated July 18 in 2016. Airport (◎), waypoint (○), fish school (●), bird flock (in the sky targetting same bait with underwater tuna species) (▲), and whales (■) are marked in the figure. The area ranged between northern latitudes of 36° 10’ to 36° 50’ and east longitudes of 134° 50’ to 135° 50’. As shown in this figure, whales were found (13 to 15 whales confirmed visually) near 36°10’ N latitude and 136°50’ E longitude. In addition, one school of fish was found near 36°50’ N latitude and 135°10’ E longitude. This fish school never escaped immediately when our aircraft approached it and the individuals were bigger in size, which suggests the existence of PBFT.

Fig. 2 shows the survey area dated July 14 in 2017. The area ranged between northern latitude of 36°00’ to 36°30’ and east longitudes of 134°30’ to 135°00’. On this day, whales were confirmed near 36°20’ N latitude and 134°40’ E longitude.

Fig. 3 shows the survey area dated July 15 in 2017. The area ranged between northern latitude of 36°10’ to 36°50’ and east longitudes of 135°00’ to 135°20’. On this day, none of fish schools, bird flocks, and whale schools could be confirmed visually.

Fig. 4 shows the survey area dated July 16, 2017. The area ranged between northern latitude of 36°10’ to 37°00’ and east longitudes of 134°40’ to 135°50’. On this day, none of fish schools, bird flocks, and whale schools could be confirmed visually.

Fig. 5 shows the survey area dated July 19 in 2017. The area ranged between northern latitude of 35°50’ to 37°00’ and east longitudes of 135°00’ to 135°50’. On this day, one bird flock and one fish school were confirmed in the vicinity of 36°40’ N latitude and 135°00’ E longitude. Later, there was a flock of approximately 150 birds confirmed in the camera image.

4 Discussion

In this survey, it took 3.4 hours in 2016 and 11.7 hours in 2017 to communicate between the small aircraft and the vessels from the start of recording to the end of each survey. The result of the aerial visual surveys during this period showed that one school of fish which might be PBFT judging from information by expert observer and one school of whales were found in 2016 and one school of fish, one flock of birds, and one school of whales were found in 2017. The sighting per unit effort for fish, birds, and whales varied yearly.

Fig.6 shows horizontal distributions of surface water temperature in 2017. The preceding year, in the waters from 25.5℃ to 27.0℃ where one school of fish was

found during the aerial survey in 2016, 3300 individuals / 1 operation in maximum of PBFT larvae was sampled by the Shunyo Maru serving as a fishery research vessel which belongs to the National Research Institute of Far Seas Fisheries [8]. Hence, it is considered that aerial visual data is useful for surveys on the spawning and hatching of PBFT.

Aerial visual surveys using small aircraft are very expensive. So, the authors tried to use of drone, too on this survey. About a result, we are going to report it in the next opportunity. In future, we want to aim at getting more a lot of information from expert fishermen. Furthermore, we intend to examine that research vessel will navigate the back of the expert fishing vessel if possible.

5 Acknowledgements

We are grateful to Mr. Y. Koyama and the staff of the NHK Enterprises, Mr. T. Sugiyama and the staff of the Suisan Aviation, and many other people for their kind assistance.

References

[1] T.Kitagawa, H.nakata, S. Kimura, T. Itoh, S. Tsuji and A. Nitta: Effect of ambient temperature on the vertical distribution and movement of Pacific Bluefin tuna, *Marine Ecology Progress Series*, **206**(2000), 251-260.

[2] T.Kitagawa, H.nakata, S. Kimura, and S. Tsuji: Thermoconservation mechanism inferred from peritoneal cavity temperature recorded in free swimming Pacific Bluefin tuna, *Marine Ecology Progress Series*, **220**(2001), 253-263

[3] T.Kitagawa, S. Kimura, H. Nakata and H. Yamada: Thermal adaptation of Pacific Bluefin tuna to temperature waters, *Fisheries Science*, **72**(2006), 149-156.

[4]M. Mohri, K. Fukada, T. Takikawa, T. Nishida and M. Imamiya :Analysis of relationship between water temperature and catch for Pacific Bluefin tuna and longtail tuna off Futaoi Island using the Jaraque-Bera test, *Mathematical and Physical Fisheries Science*, **7**(2009), 58-68.

[5]S. Kawatsu, M. Mohri, T. Takikawa, Y. Kajikawa and J. Kawasaki: Analysis of relationship between watere temperature and catches of longtail tuna and Pacific Bluefin tuna off Futaoi Island using expotential approximation, *Mathematical and Physical Fisheries Science*, **9**(2011), 48-61.

[6] Announcement by the Ministry of Agriculture, Forestry and Fisheries (MAFF) on Actions toward effective conservation and management for Pacific bluefin tuna, *Journal of Fishing Boat and System Engineering Association of Japan, 108* (2013)

[7] H. Abe: *Secrets of bonito and tuna* (in Japanese), Tokyo, Kouseisha Kouseikaku Co.,Ltd. (2009)

[8] Press release of survey on Pacific Bluefin tuna in Japan sea (in Japanese) https://www.fra.affrc.go.jp/pressrelease/pr2016/20160825/20160825press.pdf

Received : November 21, 2017
Accepted : February 9, 2018

Academic backgrounds:

Masahiko Mohri:

04/1983 – 03/1987	Undergraduate course of Department of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/1987 – 03/1988	Advanced course of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/1988 – 03/1990	Master's course of Graduate School of Tokyo University of Fisheries, Tokyo, Japan
04/1990 – 03/1991	Doctor's course of Graduate School of Tokyo University of Fisheries, Tokyo, Japan
04/1991 – present	Department of Fishery Science and Technology, National Fisheries University, Shimonoseki, Japan
Research field:	Fisheries information analysis

Hideaki Tanoue:

04/1997 – 03/2001	Undergraduate course of Department of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/2002 – 03/2004	Master's course of Graduate School of National Fisheries University, Shimonoseki, Japan
04/2005 – 03/2009	Doctor's course of Graduate School of The University of Tokyo, Tokyo, Japan
04/2009 – 03/2010	Ocean Research Institute, The University of Tokyo, Japan
04/2010 – 03/2011	Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Japan
04/2011 – 03/2013	Policy Research, Ocean Policy Research Foundation ,Tokyo, Japan
04/2013 – present	Department of Fishery Science and Technology, National Fisheries University, Shimonoseki, Japan
Research field:	Behaviour, Ecology and Observation systems, Fisheries resources management, Integrated Costal Management

Takanori Takei:

04/2014 – present	Undergraduate course of Department of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan

Kiyohiko Fukami:

04/1986－03/1990	Undergraduate course of Department of Fishery Science and Technology of National Fisheries University,

Shimonoseki, Japan
04/1990－03/1991 Advanced course of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/1991-present Fisheries Agency
Research field: Navigation

Tadashi Kamano:
04/1980－03/1984 Undergraduate course of Department of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/1984－03/1985 Advanced course of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/1996-present Fisheries Agency
Research field: Navigation

Hideki Nishioka:
04/1991 – 03/1995 Undergraduate course of Department of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/1995 – 03/1996 Advanced course of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/1996 – present Fisheries Agency
Research field: Navigation

Kazuhiro Hata:
04/1980－03/1985 Undergraduate course of Department of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/1985－03/1986 Advanced course of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/1996-present Fisheries Agency
Research field: Navigation

Kenichi Sakai:
04/1995 – 03/1999 Undergraduate course of Department of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/1999 – 03/2000 Advanced course of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/2000-03/2012 Fisheries Agency
04/2012 – present Department of Fishery Science and Technology, National Fisheries University, Shimonoseki, Japan
Research field: Seamanship

Shinya Shimokawa:
04/1979 – 03/1983 Undergraduate course of Department of Fishery Science and Technology of National Fisheries

University, Shimonoseki, Japan
04/1983 – 03/1984 Advanced course of Fishery Science and Technology of National Fisheries University, Shimonoseki, Japan
04/1984 – 03/1986 Maruha Corporation
04/1986 – present Department of Fishery Science and Technology, National Fisheries University, Shimonoseki, Japan
Research field: Seamanship

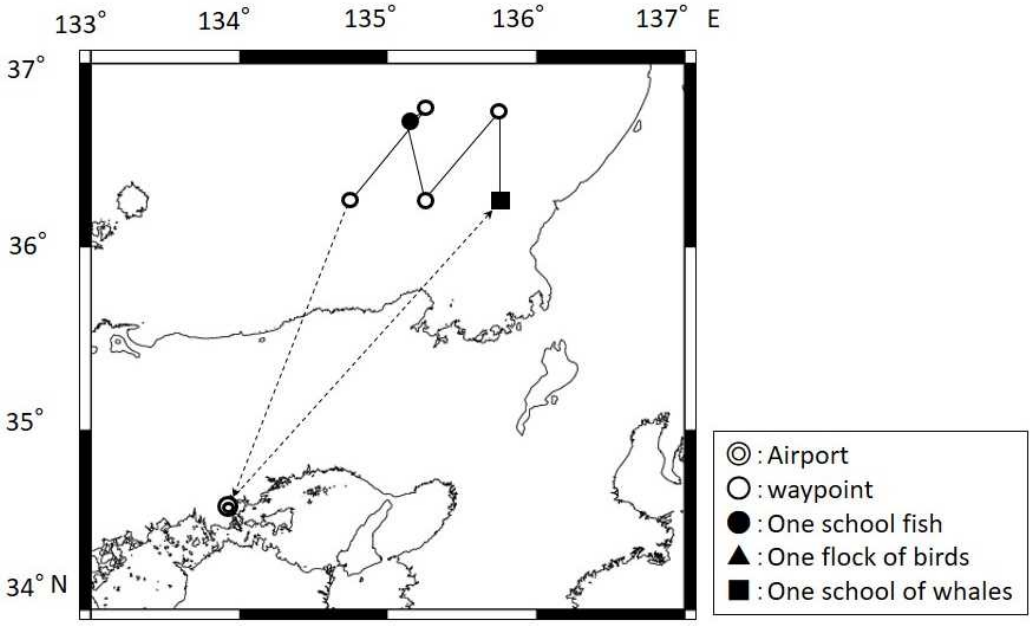

Fig.1 Survey area (on July 18, 2016)

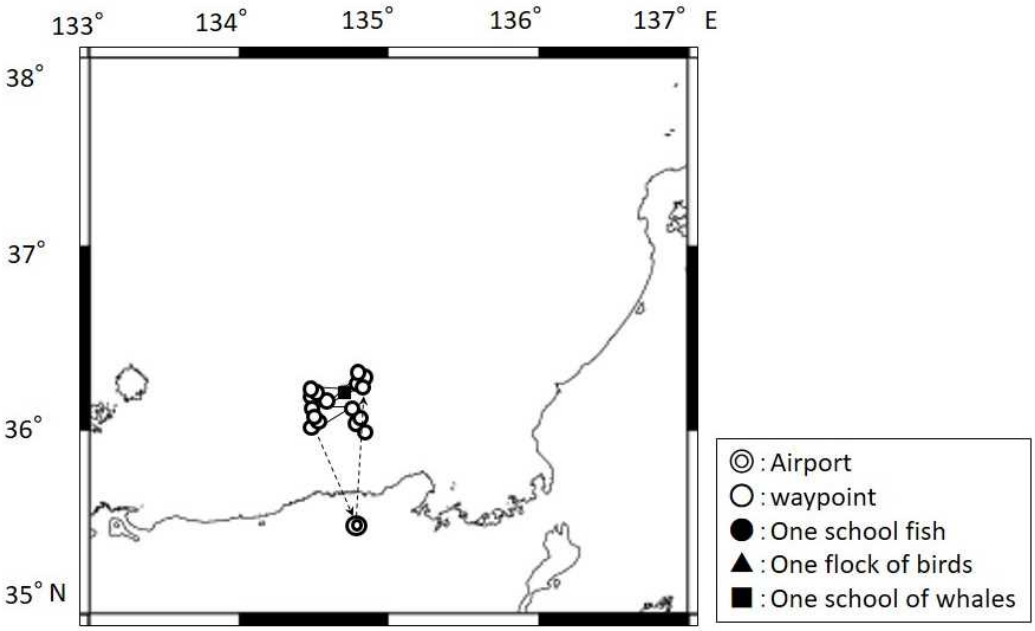

Fig.2 Survey area (on July 14, 2017)

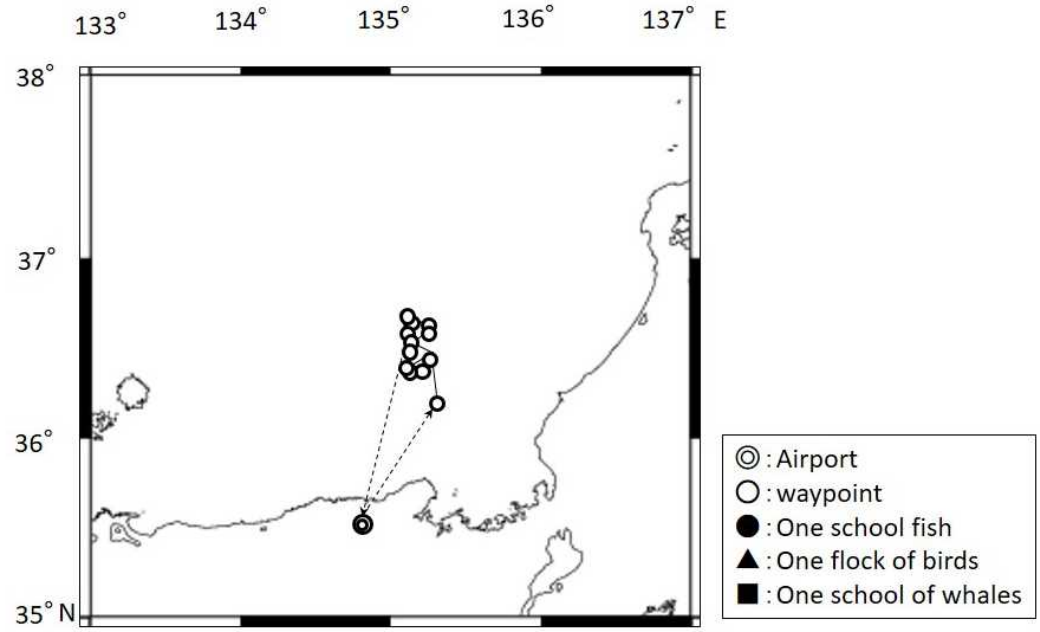

Fig.3 Survey area (on July 15, 2017)

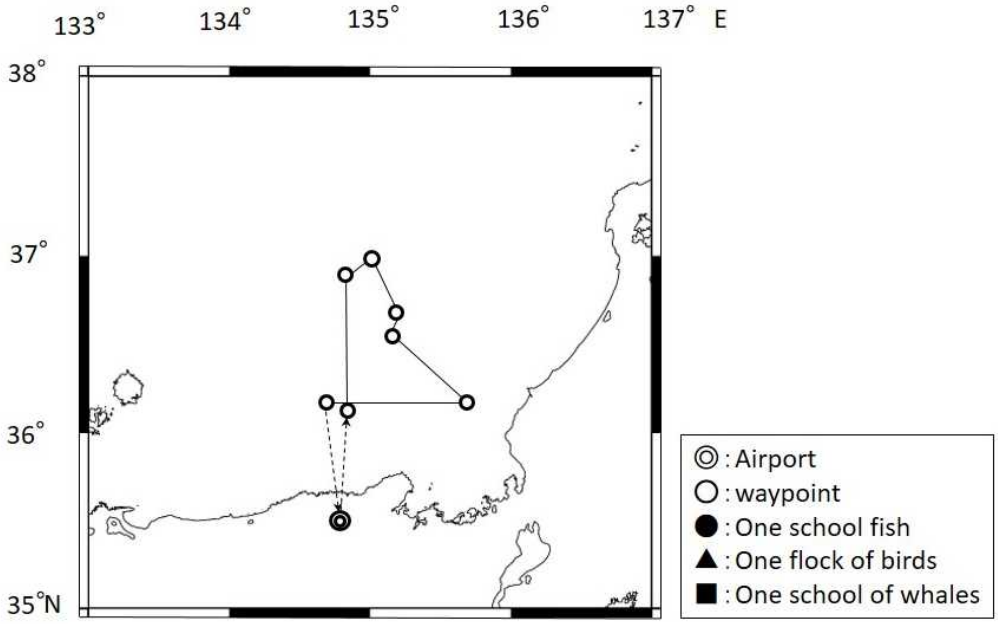

Fig.4 Survey area (on July 16, 2017)

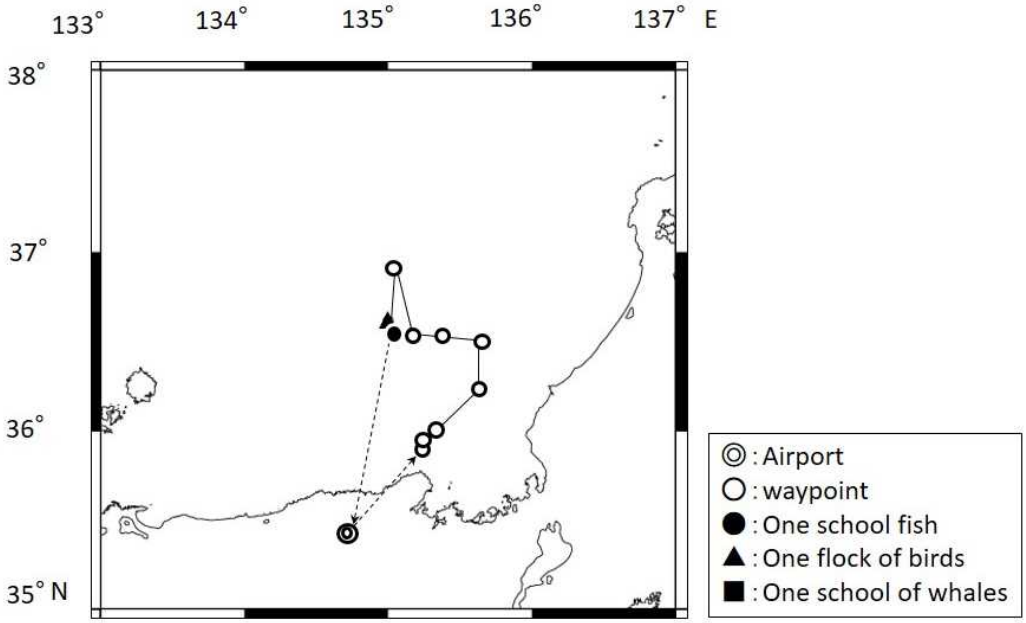

Fig.5 Survey area (on July 19, 2017)

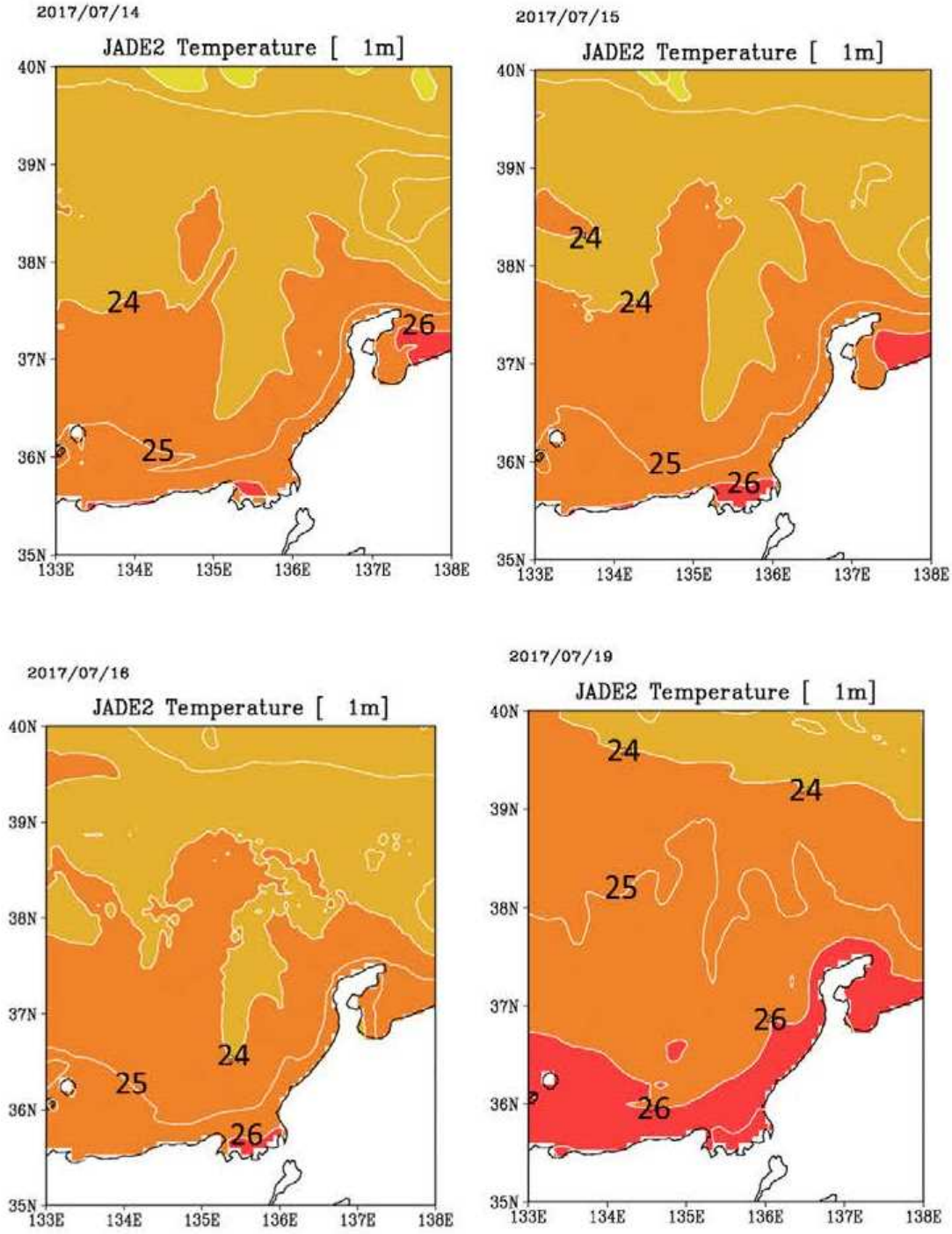

Fig.6 Sea surface temperature 7/14,15,16,19/2017 (downloaded from the website Japan sea data assimilation Experiment: http://jade2.dc.affrc.go.jp/jade2/)