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Matsumoto, Hirofumi

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Fuchi, Masaki

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RESEARCH ON THE UTILIZATION OF AIS FOR FISHING BOAT

Hirofumi MATSUMOTO[*]
Masao FURUSHO[**]
Masaki FUCHI[***]

ABSTRACT

In Japan, about 98 percent of collisions by fishing boats were caused by human errors, such as improper maneuver and lookout, in 2013. In the same year, 163 fishing boats had collisions due to improper lookout (Japan Coast Guard 2013). This research involved equipping fishing boats (gross tonnage of less than 5 tons) which operate in congested waters around the Akashi Strait in Japan, with Class B AIS (Automatic Identification System) and investigated the benefits of using AIS on small fishing boats.

This paper analyzes and verifies the transmission interval of the Class B AIS during fishing operations and the Distance at Closest Point Approach (DCPA) between fishing boat/vessels and the positional shift of the fishing boat.

This is especially important when a fishing boat instantly increases from hauling at a speed of less than 2 knots and then instantly increases the speed. When assessing the conditions of navigation solely relying on AIS, small trawlers equipped with a Class B AIS in particularly must be given a sufficient distance (0.4 miles or more).

Keywords: AIS, Class B, Fishing boat, Fishery, small trawler

[*] Instructor, National Fisheries University, 2-7-1, Nagata-Honmachi, Shimonoseki, Yamaguchi, 759-6595, Japan. Email : hmatsumoto@fish-u.ac.jp
[**] Professor, Graduate School of Maritime Sciences, Kobe University. 5-1-1 Fukaeminamimachi, Higashinada, Kobe, Hyogo, 658-0022, Japan. Email : furusho@maritime.kobe-u.ac.jp
[***] Associate professor, Graduate School of Maritime Sciences, Kobe University. 5-1-1 Fukaeminamimachi, Higashinada, Kobe, Hyogo, 658-0022, Japan.
Email : mfuchi@maritime.kobe-u.ac.jp

1. INTRODUCTION

Japan is surrounded by the sea and is active in fishery, especially coastal fishery. It follows that there are many marine accidents involving fishing boats and no end of collision due to improper lookout. On February 19, 2008, an Atago of Japan's Marine Defense Force collided with a fishing boat off the coast of Nojimazaki, Chiba Prefecture, where two crew members of the fishing boat, who were actually a father and son, went missing (Marine Accident Inquiry Agency 2009). The trial is focusing on the position of the fishing boat which sunk as a result. A collision involving a Bulk carrier and a fishing boat in September 2012 occurred because the radar of the cargo ship did not detect the fishing boat due to the weather and the sea conditions (Japan Transport Safety Board 2014).

Other marine accidents that focus on the ability to detect fishing boats have similarly occurred. The International Convention for the Safety of Life at Sea (SOLAS), Chapter V, Article 19, Regulation 2.4 stipulates vessels must install an AIS. Fishing boats required to install AIS include those engaged in international voyages with gross tonnage of 300 tons or more, or those which are not engaged in international voyages with gross tonnage of 500 tons or more. However, 98% of fishing boats in Japan have a gross tonnage of less than 20 tons (Ministry of Agriculture Forestry and Fisheries 2013). In other words, there is a need for countermeasures for preventing collisions in fishing boats with a gross tonnage of less than 20 tons.

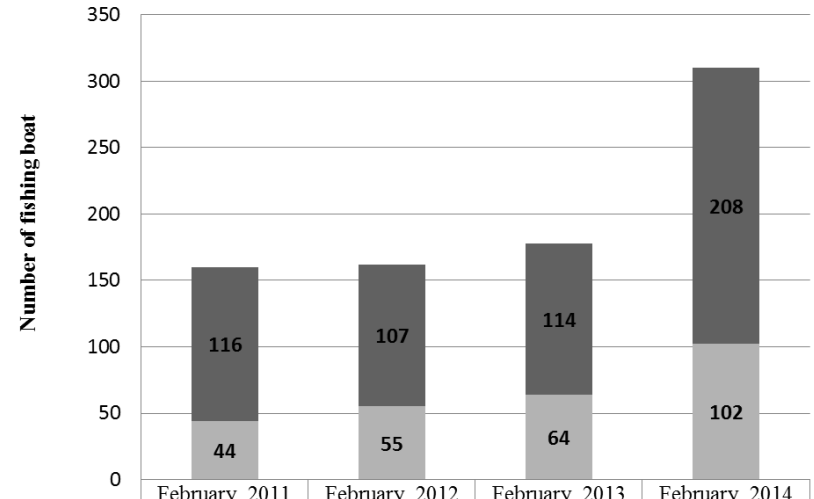
The objectives of this study are as follows:

- Verify the transmission interval of the Class B AIS during fishing operations.
- Analyze the Distance at Closet Point Approach (DCPA) between a fishing boat and other vessels.
- Analyze the positional shift of the fishing boat and the transmission interval.

2. AIS UTILIZATION RATE OF FISHING BOATS

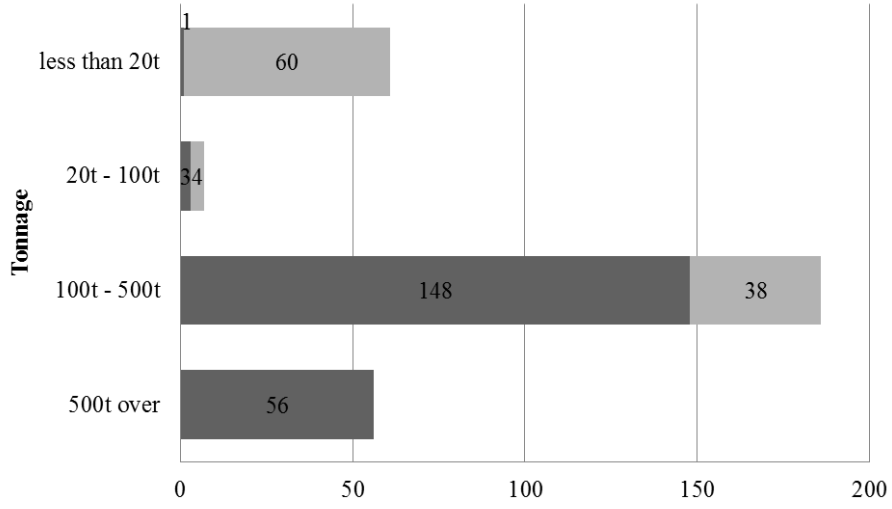
2.1 The number of the fishing boat for AIS utilization

Fig.1 shows the number of fishing boats equipped with AIS in Japan. As of February 2014, 208 fishing boats had a Class A AIS, while 102 had a Class B AIS, totaling 310 altogether. Compared to three years before, the number of Class B AIS is 2.3 times more, with the total number of devices roughly having doubled. This fact indicates that fishing boats not requiring an AIS tend to install a Class B AIS, which is inexpensive and requires no license. Fig.2 shows the status of AIS installation for fishing boats according to tonnage. The number of fishing boats with a gross tonnage of less than 20 tons equipped with AIS is 61, among which 60 have a Class B AIS installed.



	February, 2011	February, 2012	February, 2013	February, 2014
Class A AIS	116	107	114	208
Class B AIS	44	55	64	102

Fig.1 Number of fishing boats equipped with AIS
(Source: Ministry of Internal Affairs and Communications 2014)



	500t over	100t - 500t	20t - 100t	less than 20t
Class A AIS	56	148	3	1
Class B AIS		38	4	60

Fig.2 AIS installation for fishing boats according to tonnage
(Source: Ministry of Internal Affairs and Communications 2014)

2.2 Characteristics of Class B AIS

A Class B AIS are meant for ships not required to have an AIS, and do not require a licensed radio operator to be on board. These devices have an output power of 2W which is smaller than a Class A AIS, which are meant for ships that require AIS, and employs a Carrier Sense Time Division Multiple Access (CSTDMA) communication system, and does not synchronize with Coordinated Universal Time (UTC). Thus, a

Class B AIS may not be able to transmit its own AIS data, unlike a Class A AIS which uses the Self-Organized Time Division Multiple Access (SOTDMA) communication system. Further, a Class B AIS only has two states of transmission intervals, i.e. 3 min for 2 knots or less, or 30 sec for more than 2 knots. In contrast, a Class A AIS has an interval of 10 sec for 14 knots or less, and 3 sec when changing course.

The net trawling speed of the small trawlers in this test is 2 knots or less . Therefore, those small trawlers equipped with a Class B AIS updates the AIS data in intervals of 3 minutes (Table 1). Furthermore, in cases in which a fishing boat engaged in net trawling at a speed of 2 knots or less fails to transmit AIS data, the transmission interval is set to 6 minutes, during which the AIS data may not be updated.

Table 1 Characteristics of AIS

	Class A	Class B (CS)
Transmission power	12.5[w]	2.0[w]
Access scheme	SOTDMA	CSTDMA
Unit transmits	Locate a vacant time slot reserve	Free time slot
Transmission interval	2 second – 3 minutes depending on the speed over ground(SOG)	3 minutes 2 knots ≧ SOG 30 second 2 knots < SOG

3. SMALL TRAWLER

In japan, the number of surface-operation fishing boats is 81,664, including 53,959 of those with a gross tonnage of less than 20 tons (The 2013 census of fisheries). Among these, there are 8,310 small trawlers (gross tonnage of less than 15 tons). Further, many of the small trawlers are known to have a gross tonnage of less than 5 tons (see Fig.3). Small trawlers are utilized for a fishing method which catches fishes by towing a bag-like net. For vessels with a gross tonnage of less than 5 tons, many of the fishing boats are independently operated. The operation procedures include casting the net, trawling, retrieving, opening, casting, and then catch sorting. It is common to sort the catch during trawling the net in order to increase the productivity since casting the net requires about one hour. Thus there are tasks that must be completed throughout the operation, which tends to leave the lookout rather neglected (Matsumoto & Furusho 2013).

Fig.3 Small trawler (gross tonnage of less than 5 tons

4. EXPERIMENTS

The experiment was conducted in the vicinity of the Akashi Strait (Fig.4) where ship traffic is the highest in Japan. The narrowest point of the channel is 3.6 km wide, which is connected to Japan's main island by the world's longest suspended bridge. The current reaches a maximum of 7 knots. About 800 vessels navigate the strait each day. The strait is also a good fishing ground due to the strong current. Therefore, the area has many fishing boats, making it necessary to pay special attention during navigation. The area is provided with an Osaka-wan Vessel Traffic Service Center, also known as "Osaka MARTIS". Established and operated by the Japan Coast guard, its mission is to maintain and improve safety and efficiency of vessel traffic in the Akashi Strait and its vicinity. The vessels tested in this study are 3 small trawlers (each less than 5 tons) that regularly operate in the western region of the Akashi Strait waterway. They were each fitted with a Class B AIS, and 3 of them were fitted with a transmitter and a receiver, while the other three had only a receiver. None of the fishing boats is equipped with radar. Each fishing boat records AIS data (AIVDM, AIVDO sentences) and recommended minimum data for GPS (GPRMC sentences) among the AIS data. AIVDM is AIS data received by the fishing boat regarding other vessels, and AIVDO is data regarding the fishing boat itself transmitted to other vessels. GPRMC data allows the position and the ground speed of the fishing boat to be obtained every second.

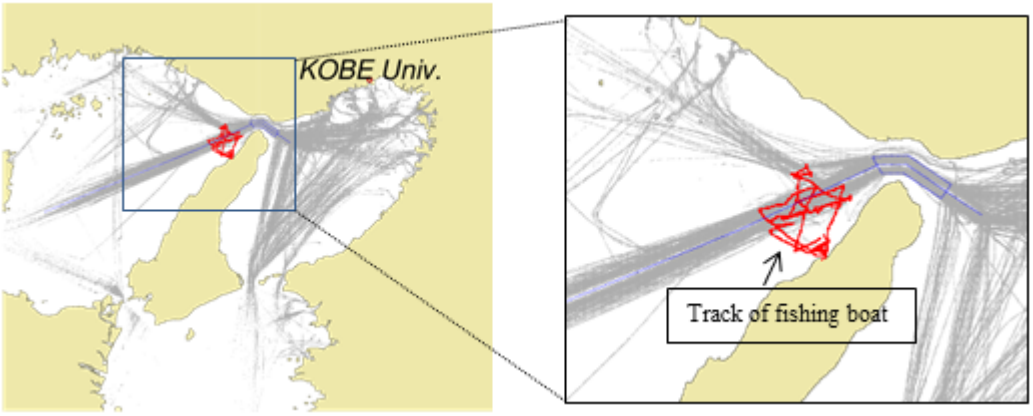


Fig.4 Operation area (24hours)

5. ANALYSIS

5.1 Transmission interval of the Class B AIS during fishing operation

Data transmitted on either channel A or B from AIVDO records of each fishing boat were extracted. The transmission intervals were calculated from this data, and the distances were calculated based on the position records. The positional shift of the fishing boats corresponding to the updated AIS data is thus obtained.

5.2 DCPA and positional shift of the fishing boat and the transmission interval

First, the latitude and longitude of the fishing boats in which the date and time match the AIS data received by the fishing boat are extracted from GPRMC. The distances and bearings were calculated from the extracted latitude and longitude. Only the Distance at Closet Point Approach (DCPA) of the fishing boats and other vessels navigating in the vicinity were extracted from the results. In this paper, the DCPA was calculated from the distance between the GPS antennas of the fishing boats/vessels.

The positional shift and transmission interval were extracted from the AIVDO data transmitted on channel A or B. Then, the positional shift of the fishing boat and the transmission interval were calculated from the latitude and longitude.

6. RESULT

6.1 Transmission interval of the Class B AIS during the fishing operation

The net-trawling speed of the small trawler was 2 knots or less as shown in the Fig.5. Thus, the transmission interval of the AIS data during the operation was 3 min. In contrast, when the fishing boat moves to the next fishing ground upon complete retrieval of the net, it rapidly increased its speed and headed to the next operation area. The small trawler repeatedly increased and decreased speed during operation throughout each day.

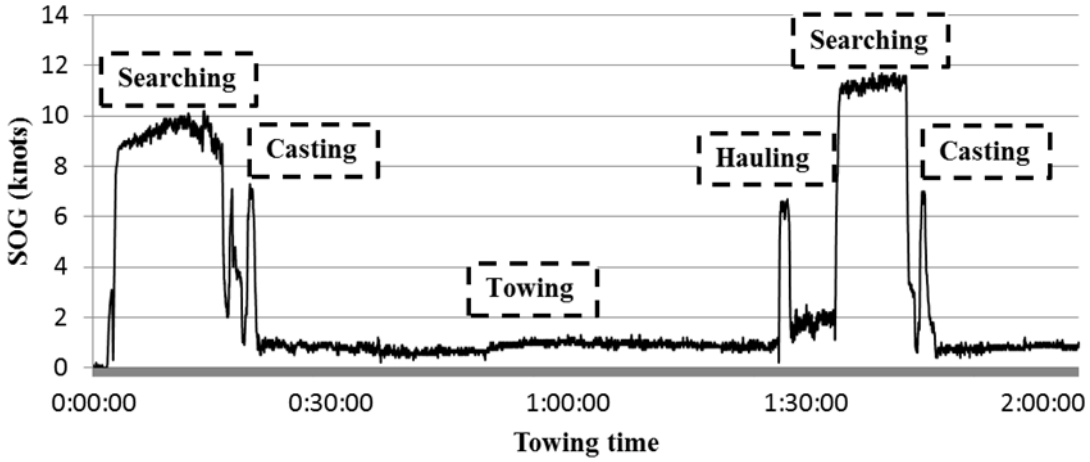


Fig.5 Speed of the small trawler in operation

6.2 DCPA of the fishing boats and other vessels

Fig.6 shows the Distance at Closet Point Approach (DCPA) between the fishing boat and other vessels. We can see from Fig.6 that the largest number of DCPA is from 100 meters to 300 meters. The results were calculated based on the fishing boats operating in the area near the other vessels.

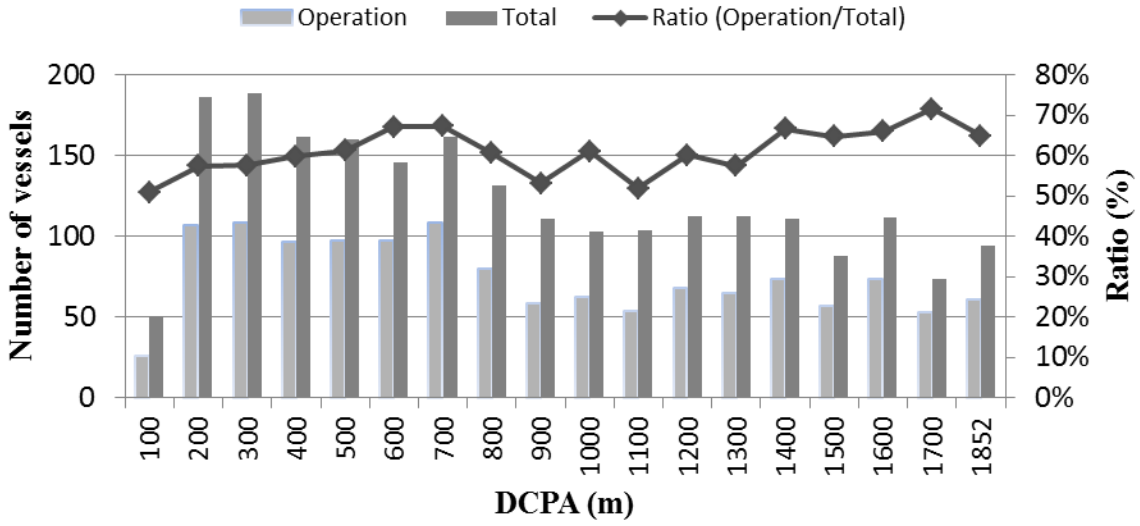


Fig.6 DCPA of the fishing boats and other vessels

6.3 Positional shift of the fishing boat and the transmission interval

The Fig.7-9 shows the relation between the transmission intervals and the positional shift found in the transmission records of the AIVDO sentences. When the transmission interval is 30 sec, the positional shift is less than 0.1 miles. However, when the transmission interval is 3 min with SOG being less than 2 knots, the positional shift varies, though is mainly around 0.05 miles. Further, Fig.9 depicts the case in which the transmission interval is 6 min. In this case, the positional shift remains within 0.1 miles even though the transmission interval is 6 min.

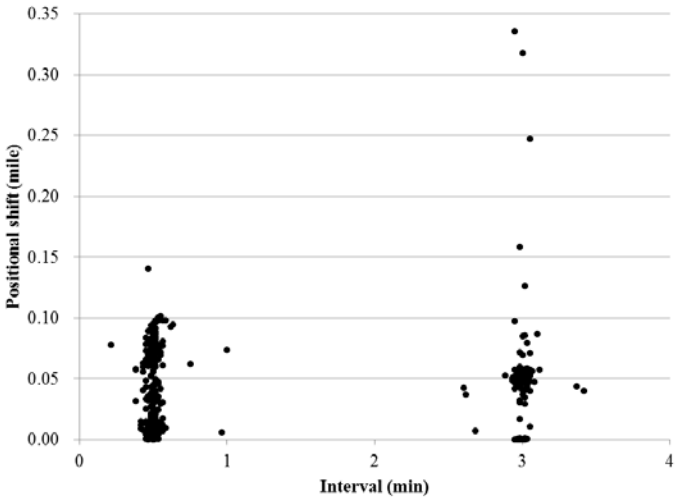


Fig.7 Transmission intervals and the positional shift.

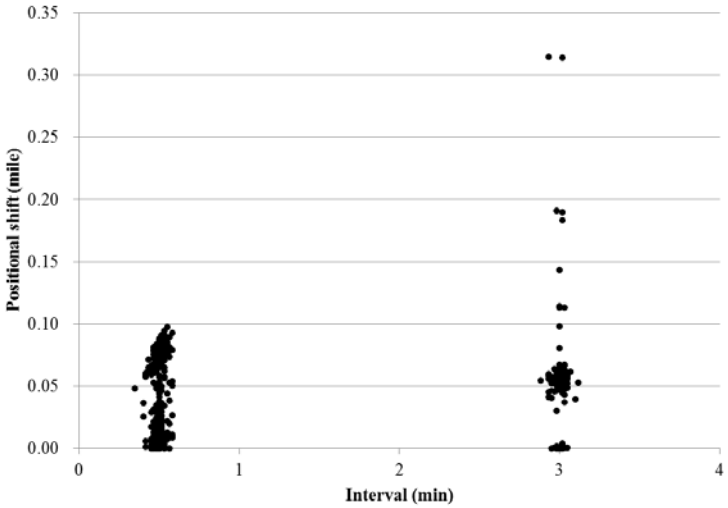


Fig.8 Transmission intervals and the positional shift.

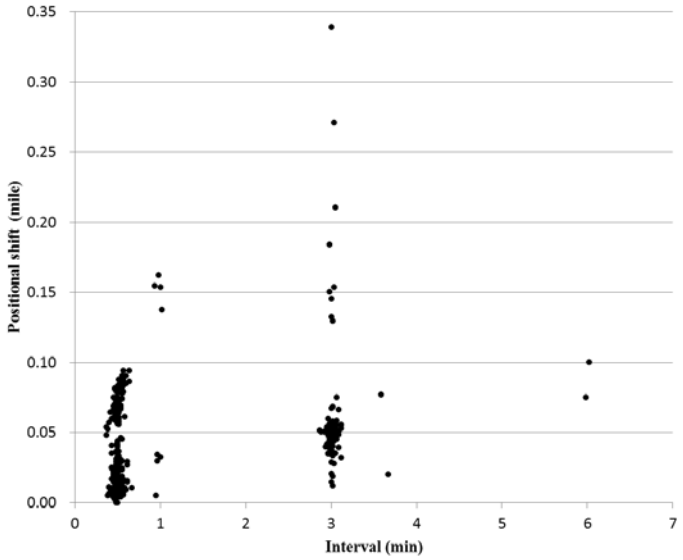


Fig.9 Transmission intervals and the positional shift.

7. CONSIDERATION

For the cases in which the positional shift in the fishing boat's AIVDO sentences is 0.3 miles or more, the fishing boat's activity status is confirmed from the data of a GPS unit fitted on the fishing boat. As a result, it reveals that the positional shift of 0.3 miles or more occurs when the fishing boat is operating at a speed of 2 knots upon completing the retrieval of the net, and then instantly increases the speed to travel to next fishing ground (see Fig.10). Usually, the small trawler performs 5 to 6 cycles of the operation in a day. Also, the trawler repeatedly increases and decreases speed when exploring fishing grounds

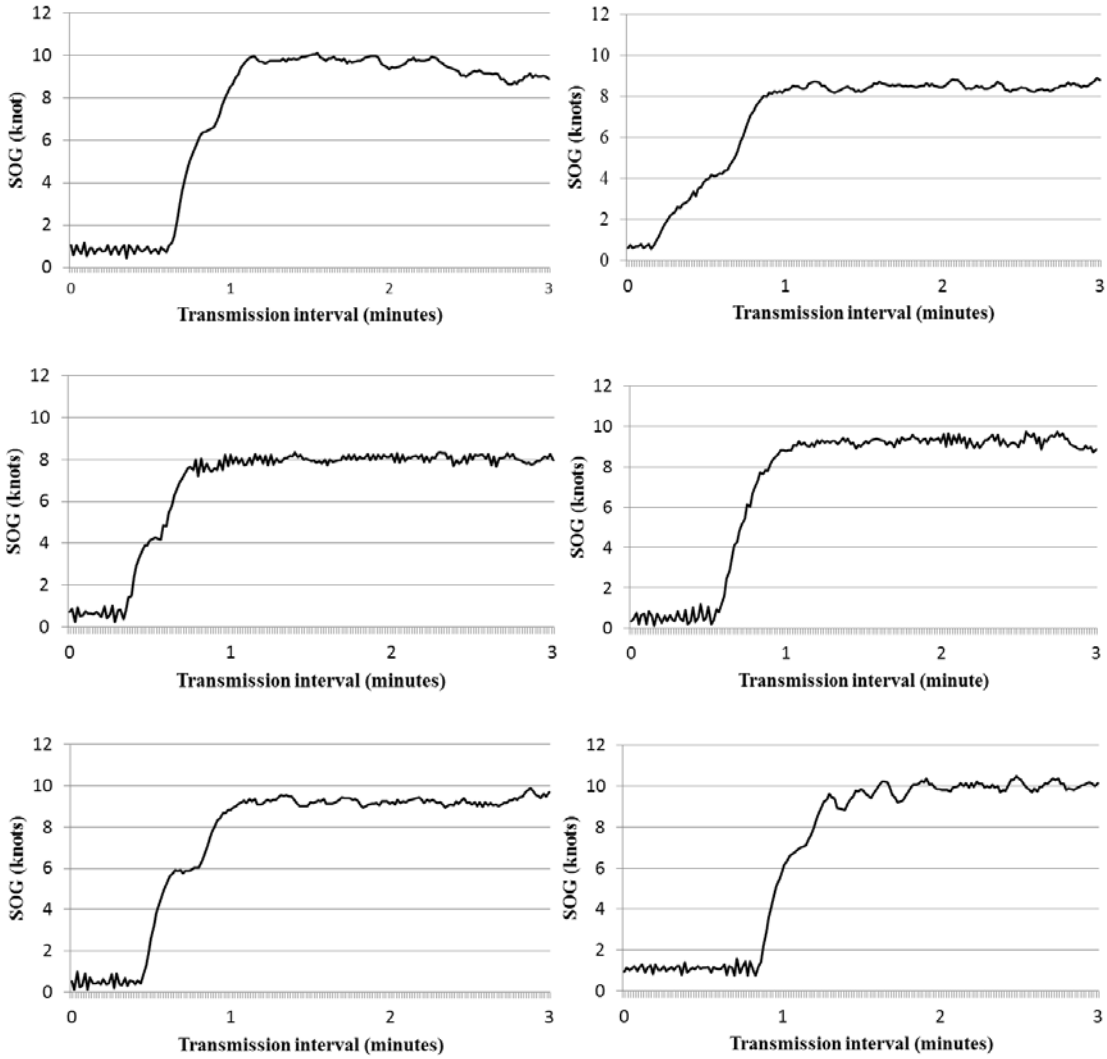


Fig. 10 SOG of fishing boat (0.3miles over).

8. CONCLUSION

In this study, small trawlers which operate in a congested sea area were equipped with a Class B AIS, and the positional shift of the fishing boats' positions were verified based on the boats' operation activity status as well as the transmission interval and the

communication system of the Class B AIS. Also, the status of the fishing boats were clearly indicated by calculating the Distance at Closest Point Approach (DCPA) to vessels navigating in the vicinity based on the GPS data and the AIS data of the fishing boats. This study revealed the following points:

- The positional shift of the fishing boat is about 0.1 miles when the transmission interval is 30 seconds, and the positional shift is 0.15 miles even when the transmission interval is 1 min.
- When the transmission interval is set to 6 min, the positional shift of the fishing boats converges around 0.1 miles.
- When the transmission interval is 3 min, most of the positional shift of the fishing boats converge around 0.05 miles, though variation up to 0.35 miles (about 648 meters) was noticed.
- A state in which the transmission interval is 3 min and the positional shift is 0.3 miles corresponds to the state in which the fishing boat completes retrieving the net at a speed of less than 2 knots and then instantly increases the speed.
- When assessing the conditions of navigation solely relying on AIS, small trawlers equipped with a Class B AIS in particularly must be given a sufficient distance (0.4 miles or more).
- In order to utilize Class BAIS on fishing boats data effectively, it is imperative to incorporate the use of superimposed radar.

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