

Study on the collision prevention of merchant ships and fishing boats based on AIS data

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Abstract

This paper analyzes the intricate track relationship between merchant ships and fishing vessels in Zhejiang coastal which is based on the AIS data. Research shows that fishing boats cannot follow the laws and regulations, and the collision of fishing boats with merchant ships under different sailing conditions for different months. It is found that from December to January of the next year with winds and cold weather and in the June and October, adjacent months of "prohibited fishing periods", the incidence of collision accidents are more. In view of the characteristics and causes of the collision, the article proposes the suggestions of avoiding the collision between the merchant ships and the fishing boats, respectively for the crew of the merchant ships and the fisherman navigating in this water area and other places with the similar situation.

Keywords

AIS, collision, merchant ship, fishing ship.

1. Introduction

The coastal waters, east of Zhejiang province, have a reputation as a fishing treasure house in the east China sea. And There is a huge amount of fish. Therefore, there are more fishing ports in coastal cities of Zhejiang and more fishing ships in coastal waters. However, the east coast of Zhejiang is the main shipping route of the merchant shipping, which is a necessary part of the north and south shipping lanes. There are four main routes running through China's busiest offshore fishing grounds, and Zhoushan waters are one of the key regulatory zones identified by the ministry of transport of P.R. China. In recent years, there have been accidents involving the collision of merchant ships and fishing boats on the coast of Zhejiang province, which caused many fatal accidents involving the fishing ships, resulting in the death of many people.

2. Statistical analysis of collision accident about merchant ships and fishing boats

2.1 The ratio of total collision accidents to merchant ships and fishing boats collision.

The statistics of water traffic accidents around Zhejiang province from maritime bureau from 2008 to 2016 are showed as that in table 1. The total number shows the state of water traffic accidents between the merchant ships and fishing boats in the area that charged by Zhejiang maritime safety administration during the passed nine years. It took 66.6% of the total accidents in 2016, followed by roughly 59% in 2012. 55.9% in 2011, 55.6% in 2013. In 2014 and 2015 the percent of the collision of merchant ships and fishing boats has a decline. Though the rate of merchant ships and fishing boats accident has appeared as the roller coaster, the percent is still high

Table 1 Statistical analysis of water traffic accidents in the area charged by Zhejiang maritime safety administration

year	Accident number	Collision number	Merchant-fish collision	Ratio of Merchant-fish accident
2008	32	13	5	38.5%
2009	82	36	7	19.4%
2010	63	36	8	22.2%
2011	55	34	19	55.9%
2012	52	21	12	57.1%
2013	63	27	15	55.6%
2014	87	10	4	40%
2015	27	9	3	33.3%
2016	44	12	8	66.6%

2.2 The time correlation between the collision accident of merchant ships and fishing boats

According to the collision accident date in the area that charged by Zhejiang maritime safety administration from 2008 to 2016. The distribution of the collision accidents of the merchant ships and fishing boats are showed in table 2. July, August, and September are the "prohibited fishing periods" off the coast of Zhejiang province. It can be seen from the data that there was no accident of merchant ships and fishing boats during the first month of "prohibited fishing periods", that means that at the beginning of the "prohibited fishing periods", seldom fishing boats go out for fishing. The period that fishing activity can be taken is also the period that high rate of collision happened. Especially in the first month before and after the "prohibited fishing periods", collision accident more often. In addition, December and January of the following year, when there is cold wave with strong wind and bad sea condition in this area, especially in the present of foggy day, the collision of the merchant-fishing vessel occurred sharply.

Table 2 Table for the distribution of accident of each year

Month Year	1	2	3	4	5	6	7	8	9	10	11	12	total
2008	2	1	0	1	0	0	0	0	0	0	0	1	5
2009	0	0	1	2	0	0	0	1	1	0	1	1	7
2010	1	1	0	2	0	2	0	1	1	0	0	0	8
2011	2	2	3	2	2	1	0	2	0	2	2	1	19
2012	0	1	2	1	1	1	0	1	3	2	0	0	12
2013	1	1	0	4	2	2	0	2	0	2	1	0	15
2014	1	0	1	0	0	0	0	0	0	0	1	1	4
2015	1	0	0	0	0	0	0	0	0	1	0	1	3
2016	1	1	0	0	0	2	0	0	0	1	1	2	8

2.3 The status of the fishing boats in the collision of merchant ships and fishing boats

The navigation state of the fishing vessel in the collision of merchant fishing vessels is shown in figure 1. Statistical data shows that, accident with the state of fishing operation while sailing, has a large proportion of the fishing boats, which is caused by the overlap of the trajectory of the fishing area and the route of the merchant ship. There are also many normal sailing conditions, mainly due to poor visibility conditions of the sea.

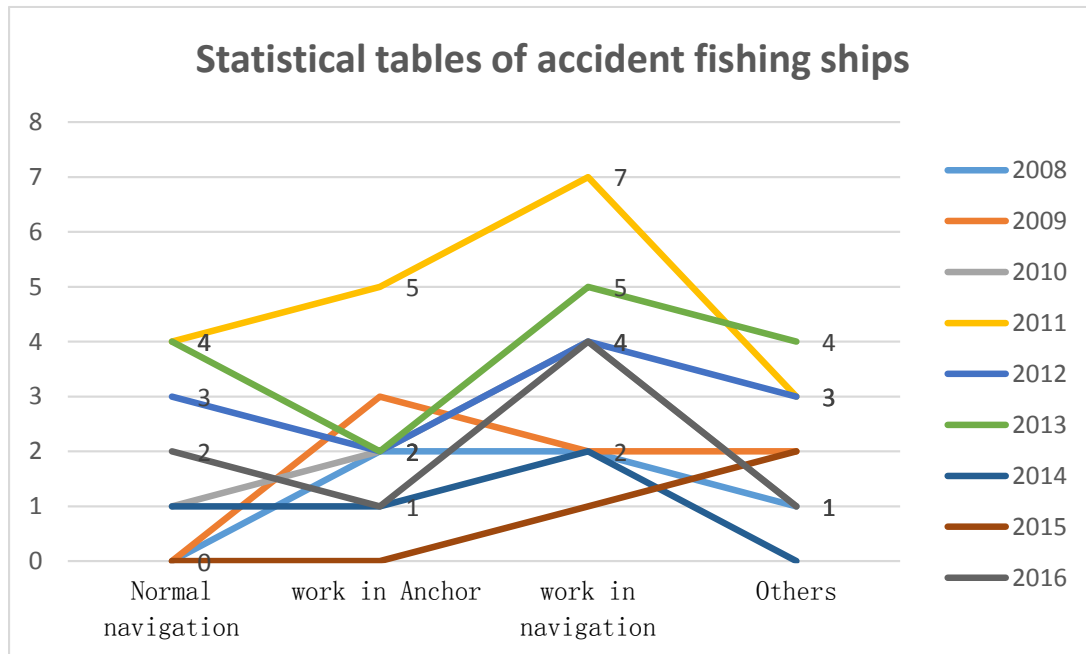


Figure 1 Accident with different state of the fishing boats

2.4 Speed distribution of fishing boats had accidents

According to the statistics on the speed distribution of fishing ships in a period in mid-October 2016, about 50% of the fishing ships are less than 4 knots and can be inferred that more than half of the fishing ships are working. The sailing speed of the vessel is mostly below 12 knots, and the sailing speed is around 8 knots. The lower the speed is, the more difficult of the boat to control when doing collision avoidance. That is why the low speed boats had a large proportion accident.

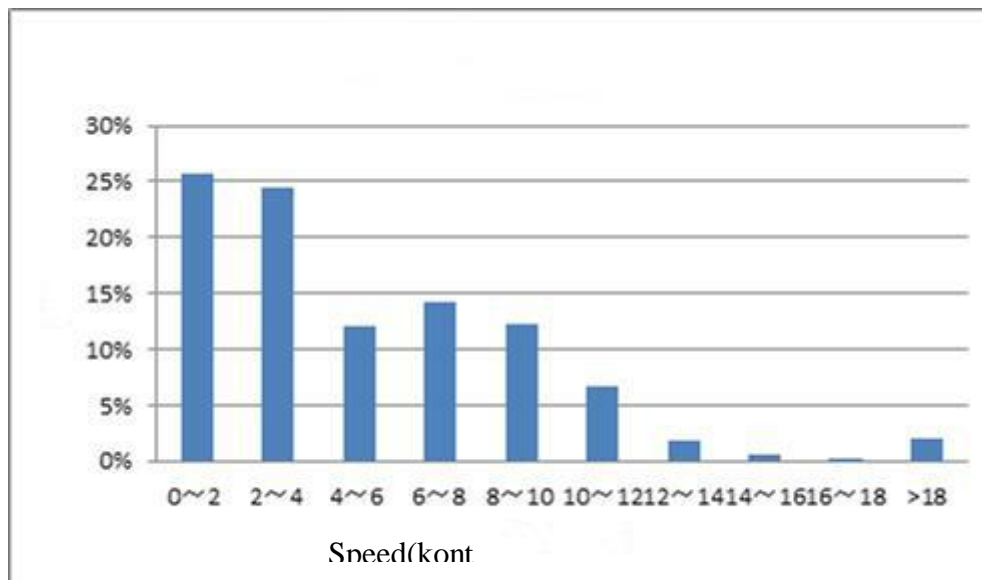


Figure 2 Fishing boats speed distribution

3. AIS data based relationship between the navigation path of the merchant ship and the trajectory of the fishing boats

3.1 Merchant ship condition in the area

The main navigable vessels of the coastal shipping lines of Zhejiang province are bulk cargo ships, container ships and dangerous goods vessels. According to AIS data (including the Class B data), the major coastal vessels density is 680 ships per hour on route. To be statistical, area of 400 km of

Zhejiang coastal, navigation density is up to 730 ships/hour. Ningbo - Zhoushan waters near traffic density significantly is higher, almost to 300 ~ 400 ships/hour.

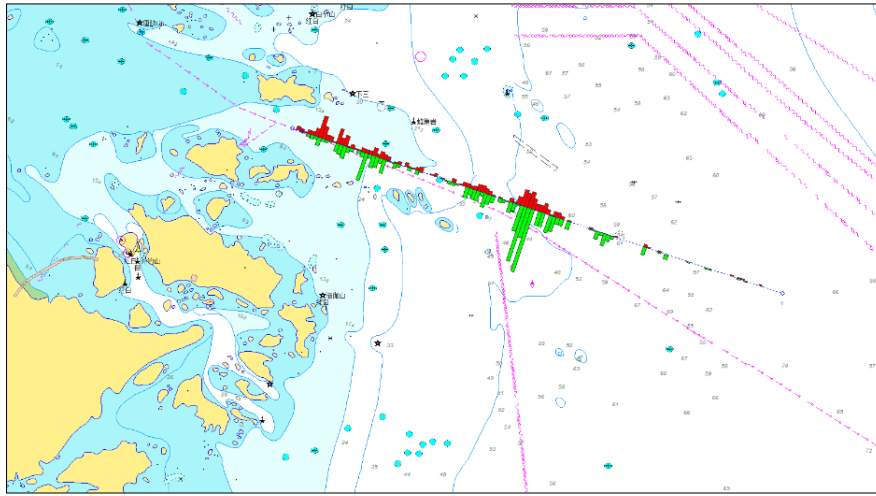


Figure 3 Main channel density

3.2 The AIS data based relationship between the merchant ship routes and fishing boats in the fishery

3.2.1 The relationship between Zhejiang province main route of the South-North route and fishing boats trajectory.

There is a "prohibited fishing periods" every year from July to September in the East China Sea, that is mean that all the fishing boats are forbidden to fish in the fishing ground. So, in the first month before and after the "prohibited fishing periods" that is in October and in June there are many fishing boats working. Figure 4 is showing the trajectory of the merchant ships and the fishing boats navigating in the Zhejiang water area and the Zhejiang main route of the South-North route based on the AIS data of the October. The red lines mean the trajectory of the fishing boats, the green lines mean the merchant ships' trajectory and the yellow line means the main rout of the South-North route. From the figure, it can be seen that there is no regularity of the red trajectory at the water area where the yellow main route goes across. The areas with high density of the red lines are two huge fisheries of East China Sea, Zhoushan fishing ground and Yushan fishing ground.

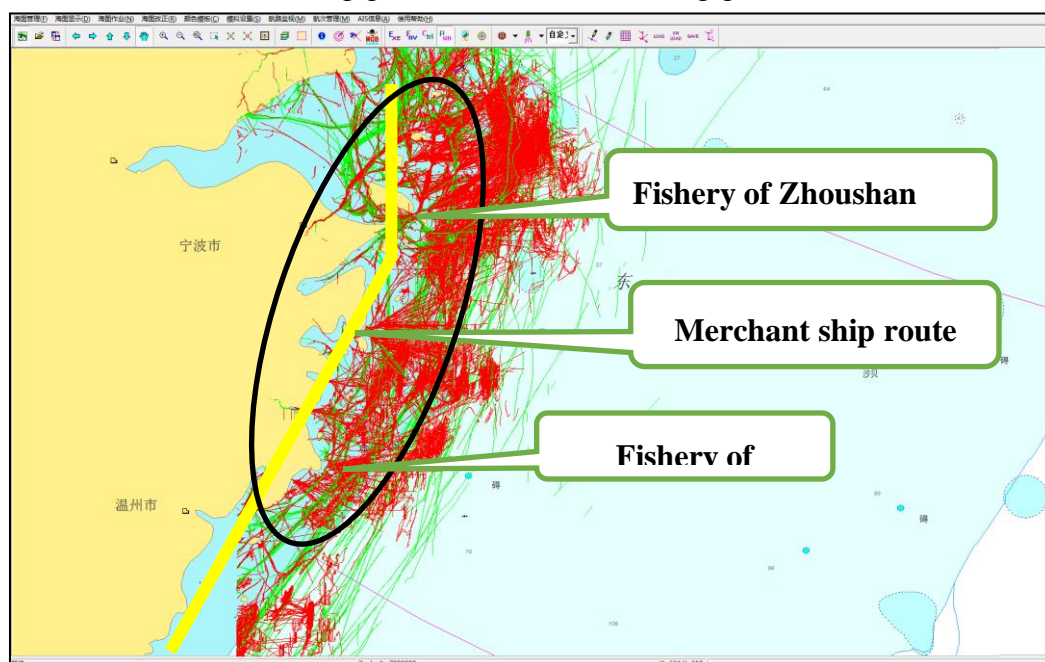


Figure2 The relationship between South-North main merchant ship routes and fishing boats trajectory

3.2.2 The navigation relation between merchant ships and fishing boats at Zhoushan fishery.

The eastern waters of Zhoushan islands are the main areas of fishing activities for fishing ships in Zhoushan, and the trajectory of fishing ships is scattered and the trajectory is not obvious. The traffic flow of fishing vessels in waters near the northern islands of Zhoushan and the core port of Ningbo-Zhoushan is concentrated and overlapped with the traffic flow of the merchant vessels, thus forming the traffic flow path of inbound and outbound traffic. The YongJiang, ShenJia Men and DaiShan island form three distinct traffic flow convergence zones of inbound and outbound. It shows that YongJiang, ShenJia Men and DaiShan island are three important fishing ports of ZhouShan fishery. The fishing ships of ZhouShan fishery are crossing in and out of ShenJia Men and DaiShan Island and the shipping lanes of the merchant ship. There is an overlap between the fishing waters and the foreign shipping routes of the merchant ships.

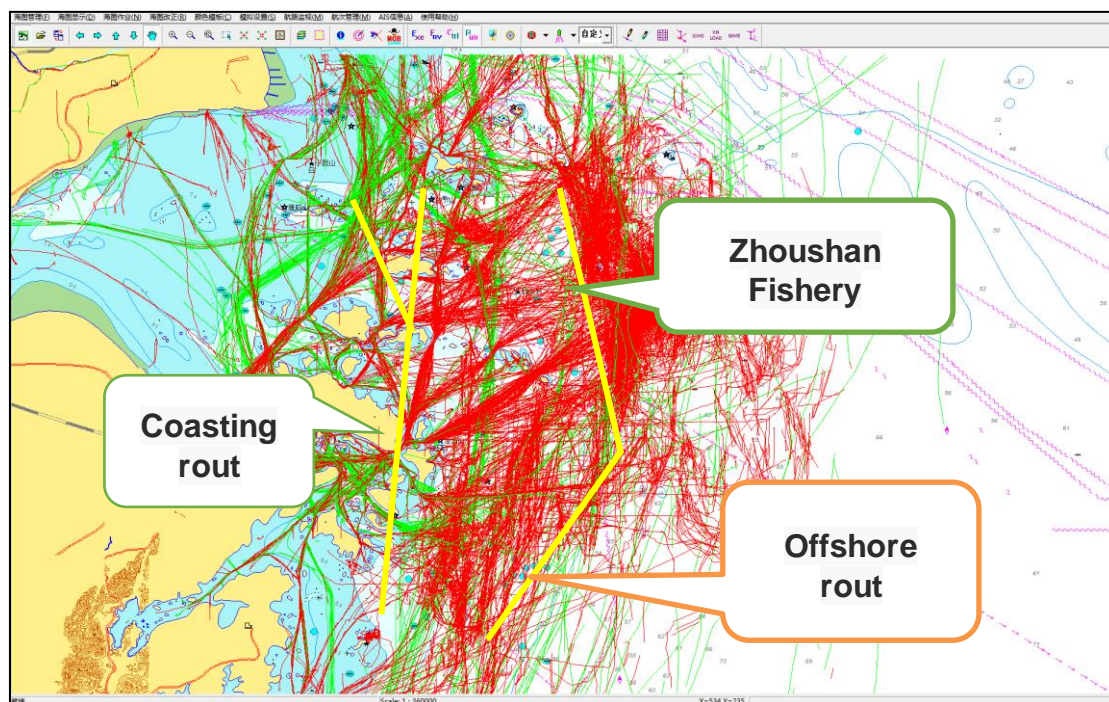


Figure 3 The relationship between merchant ship route and fishing boats in Zhoushan fishery

3.2.3 Navigation relationship between fishing ships and merchant vessels in YuShan fishery

The east waters of Taizhou are the main areas for fishing boats operating fishing work., The mouth of SanMen bay and the mouth of Jiaojiang river are the two areas where most fishing boats concentrated, however, the trajectories of the fishing boats are fragmented and no obvious regularity. There are fishing boats working on the offshore and on the merchant ships' routes, but no centralized operating areas. The traffic flow of fishing boats near Shipu Port and the mouth of Jiaojiang river is concentrated, and there is a trajectory formation of inbound and outbound traffic flow. Three distinct inbound and outbound traffic flow convergence zones appear, it means that Sipu port and Jiaojiang river mouth are the two main important fishery of Yushan .

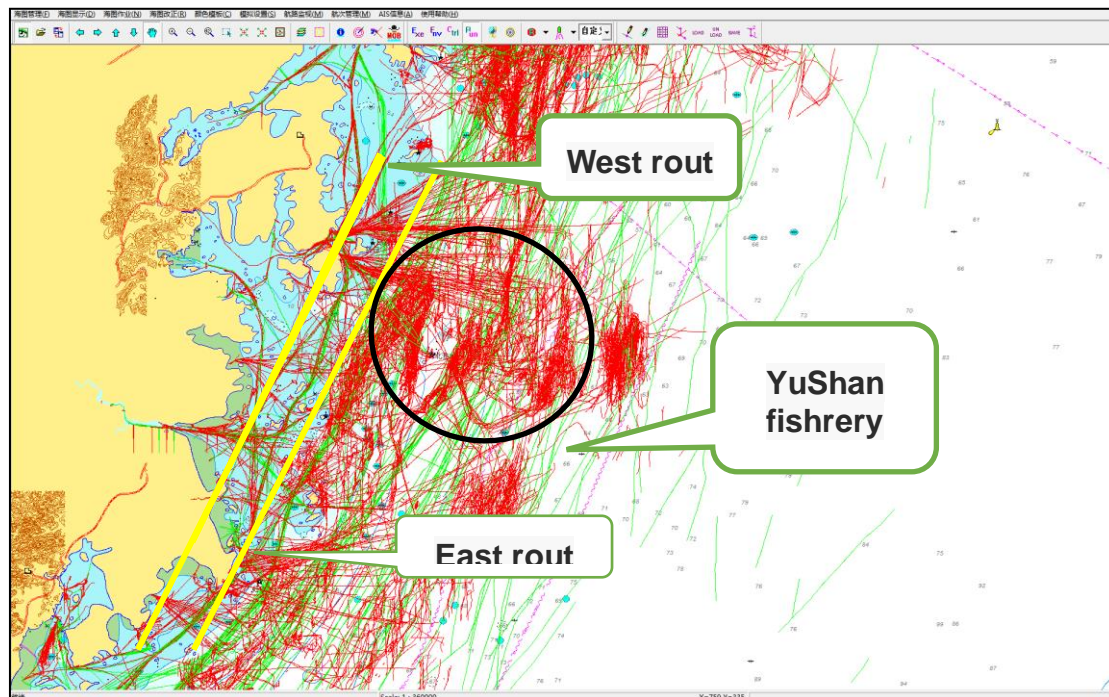


Figure 3 The relationship between merchant ship route and fishing boats in Yushan fishery

4. The characteristics and causes of collision in merchant ships and fishing boats

4.1 The characteristics of collision in merchant ships and fishing boats

4.1.1 No obvious radar echo of fishing boats

China's coastal fishing vessels are partly wooden hulls and small motor boats, as a result, there is no clear reflection on the radar screen of the merchant ship. So, fishing boats are difficult to be found by the merchant crew on watch just via the radar. It takes high proportion that fishing boats as collided by the merchant ships. The result usually is that fishing boats have severely damage or sinking. Worse more, fishing men dies and all the staffs disappear in the water.

4.1.2 The responsible party is usually the merchant ship

According to the collision data showed in the above table, when most of the collision occurred, fishing boats are engaged in fishing operations. International Marine Regulation for Prevention of Collision requires the motor vessel should give way to the fishing boats that are engaged in fishing operations.

4.1.3 Accident is Seasonal

It can be seen from the data, that during the "prohibited fishing periods" from July to September, there are few accidents, especially in the first month of "prohibited fishing periods" there is no collision accident off the coast of Zhejiang province. However, in December and January of the following year, when cold wave with strong wind and bad sea condition in this area, especially in the present of foggy day, the collision of merchant ships and fishing boats occurred sharply.

4.1.4 The merchant ships escape after the collision

Most of collision accidents occurred at night or with bad visibility. A lot of merchant ships escaped from the crash site. on the one hand, a considerable number of merchant ships escaped to evade responsibility after the accident. On the other hand, when the sea condition is severe, large merchant ships can not realize the collision with the fishing boats and still navigate as nothing has happened.

4.2 The factors causing collision of merchant ships and fishing boats

4.2.1 Fishing boats factors

1) Fishing boat navigation equipment and communications equipment is poor.

To reduce costs on the safety infrastructure investment, in general, most of the fishing boats work with aging navigation equipment, expired safety equipment. There was no collision warning facility

so that it was not detected when the collision was about to occur. In addition, the communication equipments are used improperly, unable to be set at the same frequency with the merchant ships, so that the merchant can not get in touch with them. And worse more, fishermen will not use Mandarin and other official languages, which results that merchant ship crew and the fish men cannot understand each other.

2) Fishermen lack of safety awareness

Fishermen in Zhejiang coastal, mostly participate in fishing with the whole family members on the same fishing boat, the fishing boat is passed from one generation to one generation. Most of fishing men have no correct knowledge on collision prevention, as they do not join the system training on Safety and Regulations, lack of judgment on the risk of collision. It often happens that the fishing boats violate the “1972 International Regulations for the Prevention of Collisions at Sea” when sailing just as a motor vessel. Worse more, some fishermen have the obsessiveness that “the closer to the huge vessel bow when crossing in front of the vessel, the better their life will be” resulting in an urgent situation, leading to accidents.

3) Serious negligence of on watch

From the recent years, fishing boats and merchant vessels collision accidents can be found, most of the fishing boats sailors lack of awareness of the safety of the surrounding navigation conditions, the fishing operation is completed directly after the departure of the ship and ignoring the state of navigation. And sometimes the fishermen go to fishing with no man on watch on the bridge, in the case, collision with the merchant ship is easy to happen and after the collision the fishing boats do not even know any information of the merchant.

4) Fishing boats do not provide obvious signal lights and shapes.

The fishing boats do not show the corresponding signal lights and shapes with the ships navigation conditions according to the requirements of the “1972 International Regulations for Preventing Collisions at Sea” or only show a white light at the end of the fishing nets. However, the fishing nets are relatively long and showing the signals only at the end of the fishing nets can not effectively have the fishing boats position shown. The result is that the merchant ships run onto the fishing boats with no detection.

4.2.2 Merchant ships' factors

1) Merchant ships' crew are not familiar with the characteristics of fishing operations

Merchant ships crew lack of the knowledge that the fishing boats like sailing crossing the merchant ship by the head, especially for the eastern part of China's coastal fishing boats. They don't know the words that “the closer to the huge vessel bow when crossing in front of the vessel, the better their life will be”. So at this water area, the Collision Regulation does not work.

2) Overdependence on radar equipment

Some of the limitations of the equipments are not considered. There is little reflection of the wooden boats on the radar screen, or even there is no reflection. On Zhejiang coastal areas, lots of the fishing boats are made of wood, and many of the fishing boats are small. So, the fishing boats can not be find effectively by the radar. And when there is a heavy sea, the echo shown on the radar often be taken as the echo of the waves by mistake.

3) On watch casually

Some crew on watch take it for granted that on watch is carried out just by watch on the radar screen. They neglect the watch by binoculars, even sometimes they watch out of the window, just by a glimpse and can not find the fishing boats nearby the motor vessel. According to the investigation of some accidents, most of the causes are the lack of visual watch. Merchant ships sailing crossing the nets between two fishing boats and dragging the boats far away and making the boats capsized.

5. Safety measures for collision avoidance of fishing boats

5.1 Safety measures of collision avoidance for merchant ships

5.1.1 Route selection

When the ship pass the coast of Zhejiang the routs should be assessed in advance, as far as possible to choose the east route to bypass the fishing boat gathering area, to reduce the urgent situation between fishing boats and reduce the risk of collision.

The ship sailing to the water area which is charged by the authority of the Zhejiang province should be noticed that the ship sailing on the Ships' Routing area, should obey the Ships' Routing Regulations in strict, and the ship sailing on the area without the Ships' Routing should follow the Guide to Port Entry in order to avoid the collision of merchant ships and fishing boats. The captain should comprehensively analysis the characteristics of this voyage, all crew are required to be mentally aware and prepared.

5.1.2 Keep a serious look

Sailing in the coastal coast of Zhejiang, every echo on radar should be carefully and strictly analyzed when borrowing radar, at the same time, person to have visual look should be added to confirm if the radar echo which is not obvious is from fishing boat or to find the fishing nets which is not showed on the radar or to discover the fishing boats which is in the blind area of the radar, so that the collision can be prevented in advance. When there is a fishing boat in the vicinity, radio communication should be taken as soon as possible.

5.1.3 Flexible compliance with collision avoidance rules

Merchant ship should take collision avoidance action initiatively, and take itself as the giving way ship. It should not take it for granted that the fishing boats will compliance with the Regulations for Preventing Collisions at Sea. The merchant ship should carefully verify the effectiveness of avoidance action. In the avoidance action, the "early, large, wide, clear," principles should be followed: according to the relative position, the merchant ship should takes avoidance measures early, in a certain case to significantly adjust the rudder by a large angle to highlight the dynamic changes in the ship, with the circumstances permission, the merchant ship should keep a wide distance with the fishing boats and the merchant ship should not take it as safe until it is highly clear with the fishing boats.

5.2 Safety measures of collision avoidance for fishing boats

5.2.1 Operating waters selection

It is forbidden to carry out fishing operations near the Ship' Routing waters and the recommended coastal routes, for there are many large ships in the waters. On most condition, accident blames to the fishing boats, so once the fishing boats get damaged, they can not get paid.

5.2.2 Sailing on duty

Fishing boats no matter during fishing operation or navigation should maintain a formal watch, they should correctly use the radar, AIS and other navigational instruments. VHF should always kept on the CH16 and working channel, so that the merchant ship can get in touch with.

5.2.3 Participate in safety knowledge training

Regularly participate in safety knowledge training and knowledge update, learn the correct operation of advanced equipment and the provisions of the international collision avoidance rules to cooperate with the merchant ship to take collision avoidance action. In addition, there is an accident with the merchant ship's responsibility, the fisher men should keep the point in mind that remember the merchant ship's name and call sign. learn about the ship number of the type of equipment requirements, the correct state of the ship.

6. Conclusion

The collision accident of merchant ships and fishing boats presents seasonal characteristics, which occurs during fishing season. The accident usually happens during the fishing ships participate on the

fishing operation. According to the analysis, accident was caused by the overlap of the fishing area and the merchant ship's route.

To reduce the accident of merchant ships and fishing boats, merchant ships can choose to stay away from the fishing zone as far as possible, and be flexible to comply with international rules of prevention and control when necessary. In the case of the fishing vessel, avoid the operation near the route and warning area. Advanced navigation aids should applied to the fishing boats doing fishing operation in Zhejiang province water area. When the crew is on duty, use the radar and AIS equipment as correctly as possible. And the fisher men should be given more education on safety and international regulations.

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