～Introduction and analysis of accident investigations ～

JTSB Digests

JTSB (Japan Transport Safety Board) DIGESTS

No.41 (Issued in February 2023)

Digests of marine accident analysis

Safe navigation of recreational fishing vessels

For prevention of accidents involving vertebral fractures of anglers

1. Introduction

Many people enjoy boat fishing, because it offers different types of angling and entertainment that allows anglers to forget busy daily life amid the smell of ocean in a rocking ship in the waves. On the other hand, it becomes difficult to ensure safety of vessels if care is not taken to weather and sea conditions, since they float on unstable water surface despite external forces such as constant winds and waves.

The number of accidents involving casualties of anglers of recreational fishing vessels between October 2008 when the Japan Transport Safety Board was established, and February 2023 is 37 among accidents whose investigation reports have been published. A total of 46 anglers died or were injured. When we looked at those accidents involving casualties in detail, 18 out of 37 accidents (49%) were caused by pitching (the body of anglers is lifted up and then fall due to pitching of ship's body) (See Figure 1). Moreover, 14 out of 46 persons who died or were injured (30%) experienced vertebral fracture (mainly fracture near the border between the thoracic spine and the lumbar spine), and all of them were injured by accidents due to pitching (See Figure 2).

Therefore, the JTSB (Japan Transport Safety Board) DIGESTS summarize the situations where these accidents occurred, their cases, and points for preventing accidents with the aim of preventing accidents involving vertebral fractures of anglers.

※ "Accidents involving casualties" refer to marine accidents with casualties caused not by collision, grounding, capsizing, flooding, or fire. Casualties are caused by pitching and rolling due to waves or the like or overboard, etc.

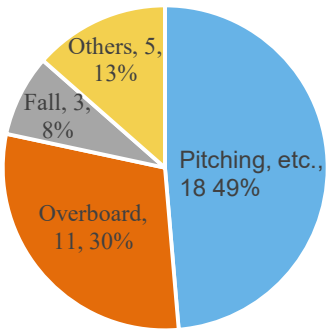


Figure 1: Cause of accidents of recreational fishing vessels involving casualties

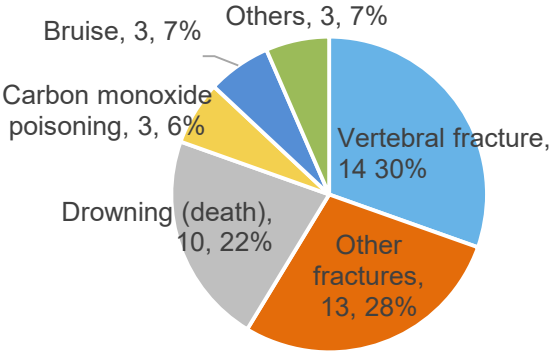


Figure 2: State of casualties in accidents involving fatality or injury

2. Situations where accidents occurred due to pitching, etc.

2.1 Sea conditions and navigational conditions at the time of accident

This type of accidents is caused by **pitching of the ship's body. When the ship's body pitched up and down and the bow is lifted, bodies of the anglers were lifted up and fell**.

As a result of classifying 18 accidents due to pitching, etc. by sea condition and navigational condition, the following facts were found out.

(1) Sea conditions at the time of accident

i. Wave direction

The wave direction was classified. **In most of cases, the accidents occurred by receiving waves from the bow direction** (See Table 1).

Table 1: Wave direction at the time of accident

Unit: case

Wave direction					Total
From the bow	From the starboard bow	From the port bow	From the stern	Unknown	
11	4	2	0	1	18

ii. Wave height

As a result of classifying the wave height, we found out that 7 accidents were caused by high waves over 2.0m. It was also found out that **some accidents were caused by waves around 1.0m**. For example, 4 accidents by waves between 1.0~1.5m and 1 accident by waves between 0.5~1.0m.

It should be noted that when the wave height is described with a range in investigation reports, the minimum value is adopted (See Table 2).

Table 2 Wave height at the time of accident

Wave height (m)	Number of accidents	%
Lower than 0.5	0	0
0.5 ~ lower than 1.0	1	6
1.0 ~ lower than 1.5	4	22
1.5 ~ lower than 2.0	3	17
Higher than 2.0	7	39
Unknown	3	17

(2) Speed

After we classified the speed, we found out that 7 accidents occurred at the speed between 5~10 knots. On the other hand, we found out that **a number of accidents have occurred at a relatively low speed** of "slow" and "lower than 5 knots".

It should be noted that when the wave height is described with a range in investigation reports, the minimum value is adopted (See Table 3).

Table 3: Speed at the time of accident

Speed (knots)	Number of accidents	%
Slow	1	6
Lower than 5	1	6
5 ~ 10	7	39
10 ~ 15	4	22
15 ~ 20	4	22
Higher than 20	1	6

2.2 Seating position of anglers and state of their injury

25 anglers were injured by accidents due to pitching, etc.

(1) Seating position

The seating position of anglers was classified. 24 anglers were injured at the front (bow) and **most of accidents occurred at the bow side (See Table** 4)

Table 4: Seating position of anglers

Seating position	Number of	%
Front (Bow)	24	96
Midship	1	4
Rear (Stern)	0	0

(2) Type of injury

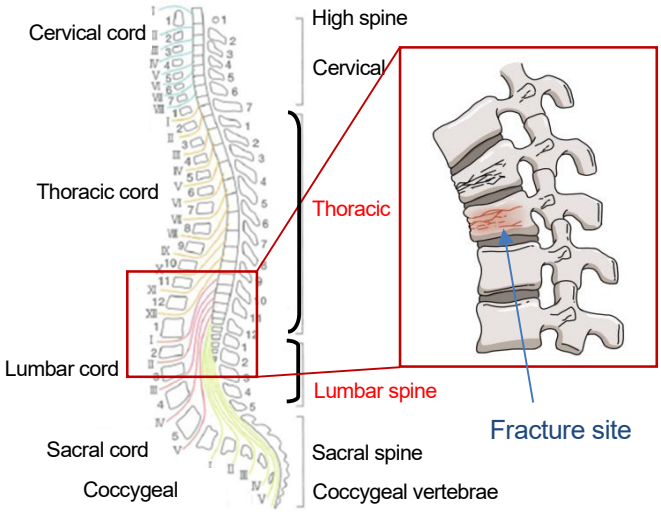
When we classified the type of injury of anglers, it was found out that **14 anglers experienced vertebral fracture (about 60%)** (See Table 5).

Table 5: Type of injury of anglers

Type of injury	Number of	%
Vertebral fracture	14	56
Other factures	7	28
Bruise	3	12
Others	1	4

Reference

Vertebral fracture refers to compression fracture in which the spine suffers from hyperflexion injury and burst fracture in which the spine is damaged due to vertical axial compression. The spine may be damaged by shocks or external forces due to fall and falling on one's bottom.



Reference: Examination Standard for Orthopedic Specialist Vol.1: Spine and Spinal Cord

3. Cases of accidents due to pitching, etc.

Case 1: 2 anglers suffered from vertebral fractures who sit on the starboard front when the starboard bow pitched and rolled due to heavy surges

Summary of the accident: When a recreational fishing vessel (19 tonnes, 1 crew and 20 anglers, hereinafter referred to as "the Vessel") was heading toward south-southeast and pitched due to heavy surges, 3 anglers who sit on fishing seats on the starboard front suffered from vertebral fractures, etc. after their bodies thrown into the air and fell to the deck. They hit their buttocks on fishing seats.

Weather and see conditions: Weather - sunny, Wind direction –southwest, Wind speed – approximately 4m/sec, Sight – clear, Wave height – approximately 0.5~1.0m, a high surf advisory was issued.

Process of the accident

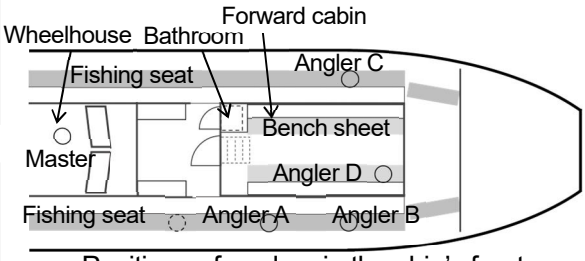
The master did not explain precautions about pitching and rolling before setting sail, because the master thought that the anglers were aware of precautions.

While the ship was heading to south-southeast toward a fishing spot, the master reduced the speed to approximately 15 knots because of heavy surges and sailed, controlling the engine speed in accordance with heavy surges.

The master made an announcement prior to the arrival to a fishing spot. Angler A and Angler B moved to the fishing seat on the starboard front.

Angler A, Angler B, and Angler D hit their buttocks due to pitching and rolling approximately 5 minutes after the announcement prior to the arrival.

Structure of the ship



Positions of anglers in the ship's front

・Even after heavy surges were observed, the master **made an announcement prior to the arrival as usual** and allowed angers to choose a waiting position, because the wave height was low and **heavy pitching and rolling were not felt after reducing the speed**.

・The master **could not feel heavy pitching and rolling at the bow** when the anglers were injured, because the master navigated the Vessel in the wheelhouse near the midship area and did not see how Angler A and Angler B on the starboard front.

Cause: In this accident, it is supposed that Angler A and Angler B who sit on the fishing seat on the starboard front were lifted up and then fell and their buttocks hit the fishing seat, because the starboard bow of the Vessel, while heading toward south-southeast at the speed of approximately 15 knots, pitched due to heavy surges.

Safety Actions (measures to prevent accidents) Opinions about the Fisheries Agency are included

- The masters and operators of recreational fishing vessels must **set standards for moving anglers to the stern side from the midship such as wind direction, wind speed, wave direction, and wave height (with respect to the vessel speed)**.
- If the standards are exceeded while sailing, the masters and operators of recreational fishing vessels must **ensure safety by stopping to sail or reducing the speed sufficiently and then move anglers to the stern side from the midship**.
- The masters and operators of recreational fishing vessels must obtain information on winds and waves of sea areas where they plan to sail. If the standards are exceeded, the masters and operators of recreational fishing vessels must **set sail after verifying that anglers have moved to the stern side from the midship**.
- The masters of recreational fishing vessels, etc. must **comply with the operational rules (regulations on prevention of accidents involving injuries due to pitching and rolling)**.

The investigation report of this accident is available on the Board's website (published on February 16, 2023).
https://www.mlit.go.jp/jtsb/ship/rep-acci/2023/MA2023-2-8_2022yh0025.pdf

Case 2: 3 anglers on the forward deck suffered from vertebral fractures, etc. when the ship pitched

Summary of the accident: When a recreational fishing vessel (4.3 tonnes, 1 crew and 12 anglers, hereinafter referred to as "the Vessel") was heading toward northwest and pitched by waves, 3 anglers who sit on the fishing seat on the starboard front suffered from vertebral fractures, etc. after their bodies were thrown into the air and fell to the deck.

Weather and sea conditions: Weather - cloudy with occasional rain, Wind direction – south-southeast, Wind speed – approximately 5-6m/sec, Sight – clear, Wave height – approximately 1.0m, a high surf advisory was issued

Process of the accident

The Vessel started to return after anglers enjoyed fishing and headed toward west-northwest at the speed of approximately 15 knots.

The master observed waves in the traveling direction and those waves reflected toward different directions off the breakwater and company's dock near the entrance to the waterway continuing to the dock where the Vessel was going to be decked at. The wave height was approximately 1.0m.

3 anglers who sit on coolers, etc. on the forward deck were thrown into the air due to pitching of the Vessel's body and fell to the deck. They felt pain in the low back.

State of the Sea Area

・The master **has a lot of experience in sailing the Sea Area and knew that waves are higher than the coast**.

・According to the master's experience, no angler on the forward deck has been injured in the past while sailing on the Sea Area.

・The master **thought that it was possible to safely sail by reducing the speed and did not move the anglers on the forward deck to the afterdeck.**

When waves hit a cliff coast or artificial breakwaters, it is possible that waves are bounced back and change their direction. This phenomenon is called reflection. In this case, **if the top of incident waves and that of reflective waves overlap, the height of waves can reach nearly twice as high as the original wave height**. (Japan Meteorological Agency's website)

Cause: In this accident, the master continued to sail with 3 anglers on the forward deck, while the ship headed toward northwest on the Sea Area. The body of 3 anglers was hit on the deck when wave directions varied and the ship's body pitched by receiving waves of approximately 1.0m.

Safety Actions (measures to prevent accidents)

- The masters of recreational fishing vessels must **check the ocean surface** while sailing and strive to control pitching and rolling due to waves by **sufficiently reducing the speed** or by other means. If waves are generated in **a sea area surrounded by breakwaters and docks**, it is possible that **wave directions vary due to reflection and the wave height rises**.
- The masters of recreational fishing vessels must **move anglers to the cabin or afterdeck** if pitching and rolling are expected.
- The masters of recreational fishing vessels must **promptly check** if there is any injured passenger, and **immediately take appropriate measures such as calling an ambulance** in cases where it is confirmed that any passenger is injured.

The investigation report of this accident is available on the Board's website (published on March 24, 2022).
https://www.mlit.go.jp/jtsb/ship/rep-acci/2022/MA2022-3-14_2021kb0081.pdf

4. Results of questionnaire survey on initiatives to prevent accidents due to pitching at the bow

The Japan Transport Safety Board conducted a questionnaire survey (July ~ August, 2022) with the aim of ascertaining the state of initiatives to prevent injuries of anglers due to pitching at the bow in cooperation with 19 recreational fishing vessel operators of the Tokyo Bay. The outline of results is presented here.

The gross tonnage and sea speed of recreational fishing vessels surveyed are 5~19 tonnes and 5~20 knots, respectively. 17 operators offer fishing services in the Tokyo Bay.

Operational Rules

All operators subject to this questionnaire survey are aware of the following instructions on how to prevent accidents involving injuries of anglers due to pitching of the bow set forth in the Operational Rules.

(1) The masters and chiefs of operations of recreational fishing vessels shall act as follows in order to ensure safety of passengers.
- ∗ When the ship's body bounces due to waves while sailing, they must appropriately monitor waves, change the course with respect to waves, and strive to control bouncing by sufficiently slowing down to a speed that ensures safety.
- ∗ If a danger is expected to be caused by bouncing due to waves while sailing, they must instruct passengers to move to the stern side where bouncing is less severe than the midship.

(2) The chiefs of operations of recreational fishing vessels shall make sure to notify passengers of the following information by placing a notice on the ship or by other means.
- ∗ While sailing, passengers should stay at the stern side from the midship where pitching and rolling are less severe, because the ship's body may pitch and roll due to waves.

Awareness raising for anglers

In order to prevent accidents involving injuries, 14 operators give anglers an oral explanation about precautions, while three operators place a notice on the ship in addition to oral explanation (See Figure 3).

Sea areas that require special attention

13 operators are ware of sea areas that require special attention where waves can be high due to the wind and tides. More specifically, they chose the sea areas around the first and second artificial fortresses, off the coast of Kurihama, off the coast and south of Kannonzaki, and off the coast of Tsurugizaki (See Figure 4).

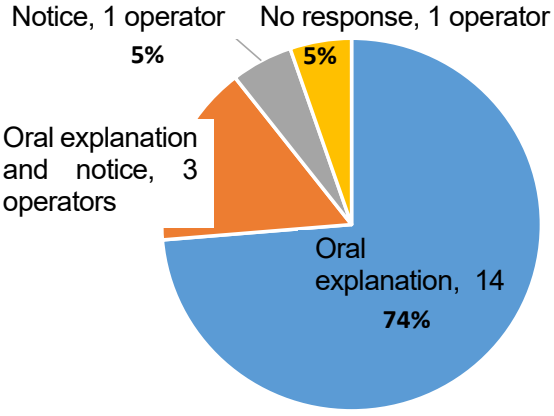


Figure 3: Method of explanation to anglers

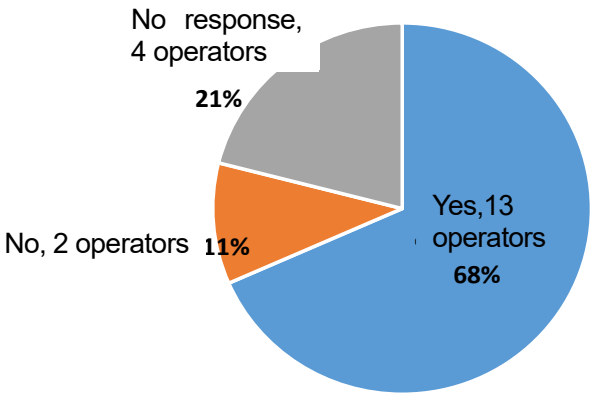


Figure 4: Recognition of sea areas that require special attention

Measures for controlling pitching and rolling

Slowdown and course change are some of measures for controlling pitching and rolling. The timing of slowdown is when the bow pitches (30~200cm), the wind speed reaches 8~15m/s (depending on wind direction), or the wave height reaches 0.5~2.5m (depending on wave height). Some operators have set a policy of reducing the speed to approximately 10 knots, but half of operators have set a policy of reducing the speed until the bow does not bounce or pitching and rolling calm down (5~10 knots).

Moreover, the timing of course change is almost the same as that of reducing the speed. A changed direction should be where pitching and rolling are less severe.

Timing of slowdown

・When the bow pitches		
	Pitch: 200cm	1 operator
	Pitch: 50～100cm	2 operators
	Pitch: 30～40cm	1 operator
・Wind speed	10～15 m/s	6 operators
	8 m/s	1 operator
・Wave height	2.0～2.5 m	2 operators
	1.0～1.5 m	6 operators
	0.5 m	1 operator

Degree of slowdown

・Until the bow does not bounce	9 operators
・Down to approximately 10 knots	2 operators
・Down to approximately 5 knots	1 operator

Course change

・To a direction where waves are not high	3 operators
・To a direction where pitching and rolling calm down	1 operator
・Depending on the situation and sea area	1 operator

Movement of anglers to the stern side from the midship

11 operators have meteorological and hydrographic standards for moving anglers to the stern side from the midship. The most common wind speed is around 10 m/s and falls under 7~15 m/s (depending on wind direction), while the most common wave height is 1.0~1.5m and falls under 0.5~2.5m (depending on wave direction), before the ship sets sail or moves to another fishing spot. Other operators move anglers to the stern side when the ship's body is expected to pitch and roll significantly depending on the situation.

If anglers refuse to move, operators have a policy that the ship does not set sail until they cooperate or sets sail at a low speed.

The timing of moving anglers while sailing is when the bow pitches (30~100cm) or when meteorological or hydrographic conditions become similar to those before sailing or changing a fishing spot.

Standards for moving anglers before sailing

・Wind speed	7~12m/s	8 operators
	13~15m/s	3 operators
・Wave height	2.0~2.5m	2 operators
	1.0~1.5m	7 operators
	0.5m	1 operator
・Others		
When the ship's body is expected to pitch and roll significantly		1 operator
When the bow is likely to hit waves		1 operator

If an angler refuses to move

・The ship does not set sail until the angler cooperates	11 operators
・The ship sets sail at a low speed	8 operators

Timing of moving anglers while sailing

・When the bow pitches and rolls (30~100cm)	4 operators
・When meteorological or hydrographic conditions become similar to those before sailing or changing a fishing spot	10 operators

Other initiatives to prevent accidents

Additionally, operators have taken initiatives to prevent accidents such as exchange of meteorological and hydrographic information and information on pitching and rolling with consorts, communication with consorts about the appropriateness of setting sail, and placement of cushions on seats.

The results of this questionnaire survey reveal that more than half of operators have set meteorological and hydrographic standards for moving anglers to the stern side from the midship before sailing, before moving to another fishing spot, or while sailing.

5. Summary (conclusion)

The accidents of recreational fishing vessels involving casualty or injury have the following characteristics based on the situations where they occurred.

- **About 50%** of accidents involving casualty or injury of anglers occurred **due to pitching, etc**.
- **About 30%** of anglers suffered from **vertebral fracture due to pitching, etc.**

Therefore, after we looked at the situations where these accidents due to pitching, etc. occurred, the following characteristics were found out.

- The accidents occurred, because **the anglers' bodies were thrown into the air and fell when the ships are hit by waves from the bow side, the ship's body pitched, and the bow was lifted up**.
- Accidents were caused not only by high waves over 2.0m but also **by waves around 1.0m**.
- **Many accidents have occurred at a relatively low speed of 5~10 knots**.
- According to seating positions of anglers, **most of accidents occurred in the front**.

We found out that the following points are important to prevent similar accidents.

- The masters and operators of recreational fishing vessels should **set standards for moving anglers to the stern side from the midship such as wind direction, wind speed, wave direction, and wave height (depending on vessel speed)**.
- If the standards are exceeded while sailing, the masters and operators of recreational fishing vessels **ensure safety by stopping to sail or reduce the speed sufficiently and then move anglers to the stern from the midship**.
- The masters and operators of recreational fishing vessels obtain information on winds and waves of sea areas where they plan to sail. If the standards are exceeded, the masters and operators of recreational fishing vessels **set sail after checking that anglers have moved to the stern from the central part**.
- The masters of recreational fishing vessels, etc. **comply with the operational rules (regulations on prevention of accidents involving injuries due to pitching and rolling)**.

Comment from the Director of the Analysis, Recommendation and Opinion Office

We understand and appreciate that you pay special attention to safe navigation, while avoiding congestion of anglers as a measure against COVID-19.

It is our sincere desire that the measures for preventing accidents presented in the JTSB (Japan Transport Safety Board) DIGESTS help all of you to further ensure safety.

JTSB Secretariat, MLIT
15F Yotsuya Tower
1-6-1, Yotsuya, Shinjuku-ku
Tokyo, 160-0004 Japan
(Staff in charge: Director of the Analysis, Recommendation and Opinion Office, General Affairs Division)

TEL 03-5367-5026
URL https://www.mlit.go.jp/jtsb/index.html
e-mail hqt-jtsb_bunseki@gxb.mlit.go.jp

We welcome your comments on "JTSB Digests" and requests for outreach lecturers