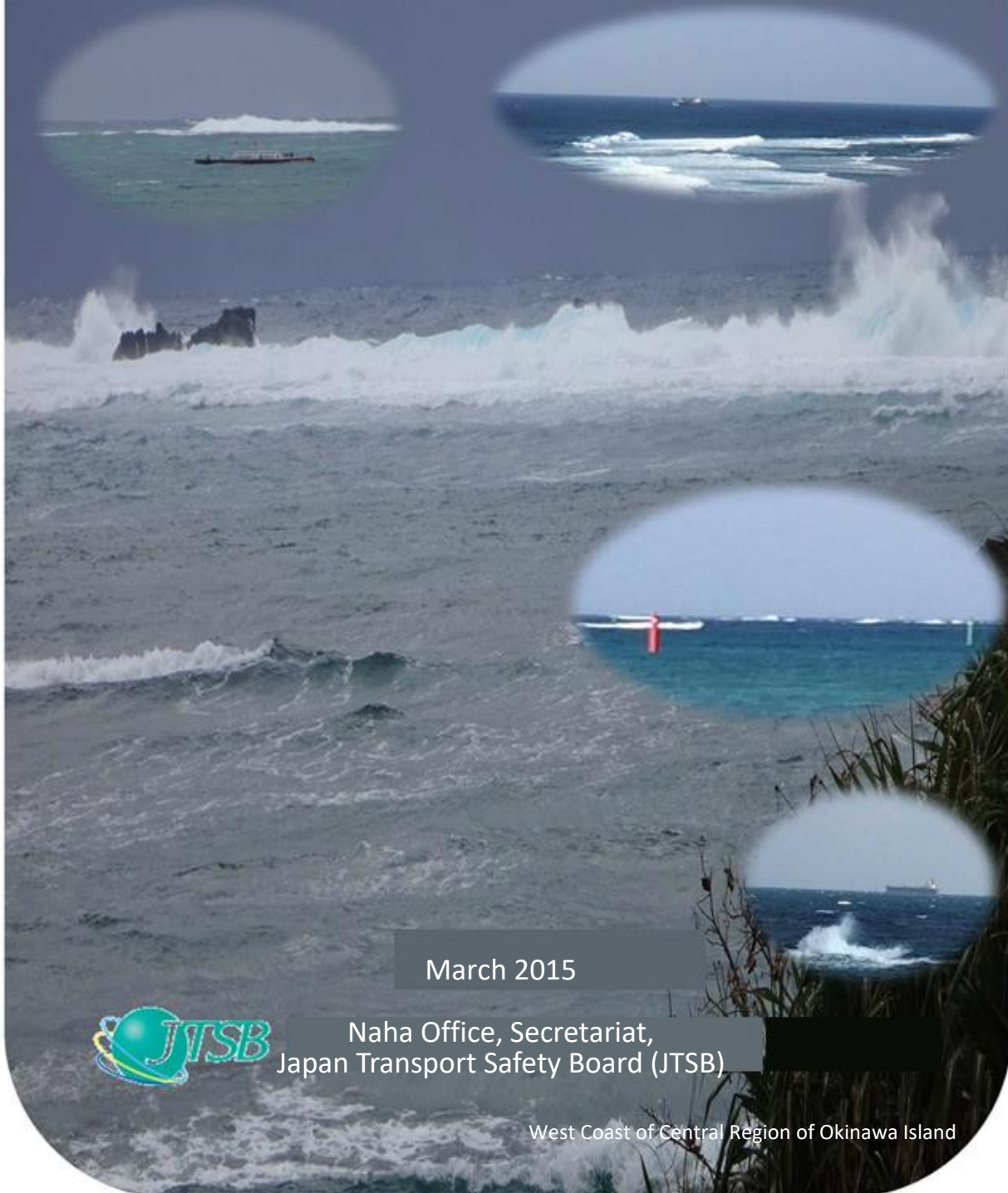


Analysis on capsizing accidents  
in coral reef sea areas  
- for recurrence prevention -



March 2015



Naha Office, Secretariat,  
Japan Transport Safety Board (JTSB)

West Coast of Central Region of Okinawa Island

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**Introduction**

**- Capsizing accidents in coral reef sea areas -**

Japan Transport Safety Board (JTSB) is an organization established in October 2008 aiming at investigating causes of aircraft, railway and marine accidents and incidents ("accidents/incidents"), preventing recurrence of such accidents/incidents, and reducing damages caused by accidents.

Naha Office of the JTSB Secretariat takes charge of the areas covering Amami Islands in Kagoshima Prefecture and Okinawa prefecture, where most of the islands are surrounded by shallow coral reefs, and the ports and fishing ports are also located in the coral-reef sea areas.

In these shallow sea areas, there are many vessel accidents/incidents occurring every year.

Among them, capsizing accidents in the coral reef sea areas are not many, such as 4 cases in 2012 and 3 cases in 2013, but are still constantly occurring.

This leaflet focuses on 22 capsizing accidents occurred in these areas, which were reported in the vessel accidents/incidents investigation reports published in a period between October 2008 and December 2014.

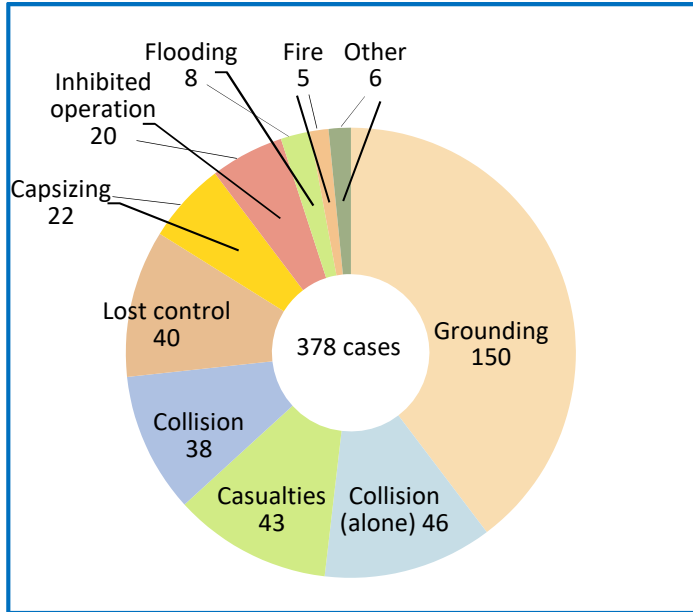
We would be very grateful if this leaflet could contribute to develop a deeper understanding of safe operations in people who are involved in boating in these areas, and thereby preventing similar accidents from occurring.

\*The term "incident" refers to a situation that is recognized to have a likelihood of causing an accident.

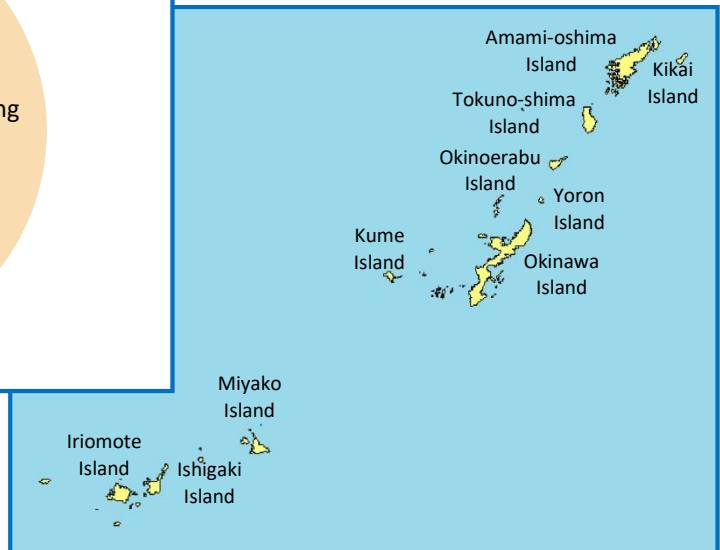
## 1. Numbers of accidents occurred

Among accidents which were made public by JTSB in the vessel accidents/incidents investigation reports between October 2008 and December 2014, there were 378 accidents occurred in the sea areas covered by Naha Office, and 22 (22 vessels) of them were capsizing accidents.

Numbers of accidents by accident types



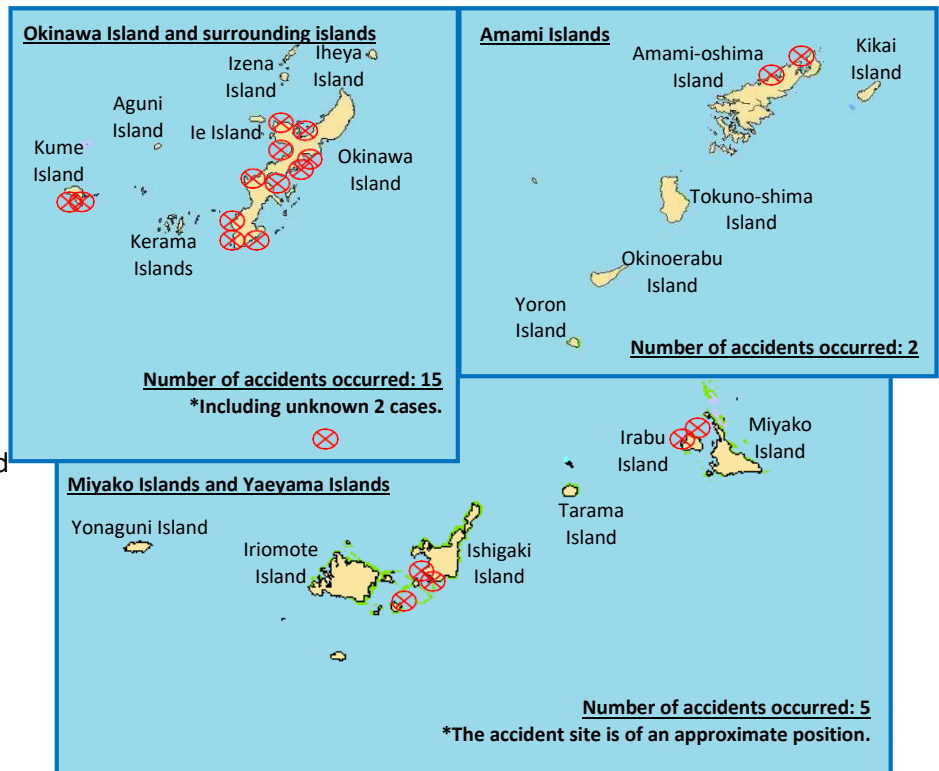
Sea areas covered by Naha Office



## 2. Distribution of accidents by sea areas

Many of the accidents occurred around coral reefs close to the land.

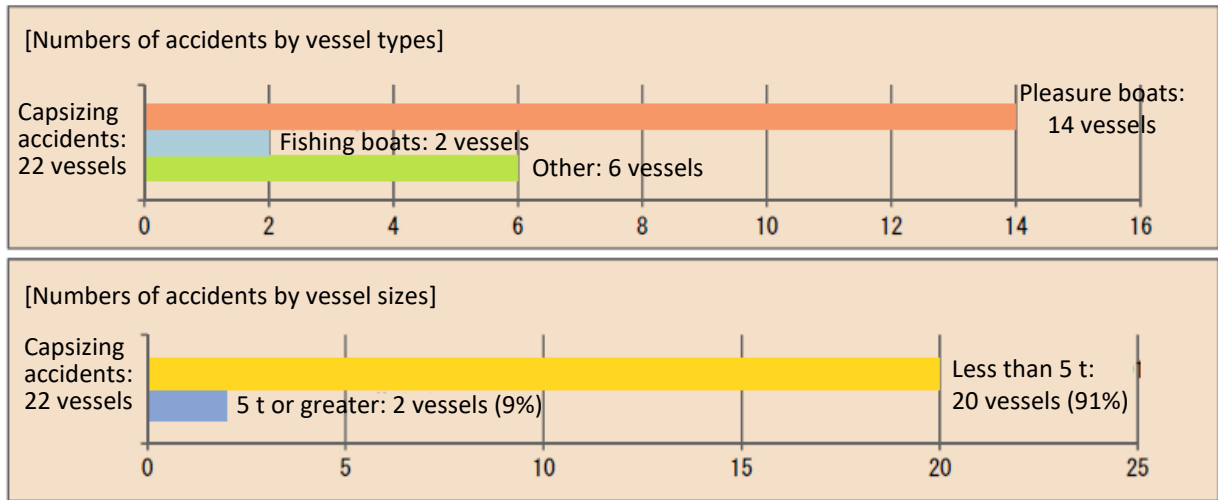
According to the distribution of capsizing accidents by sea areas, 15 cases in the areas of Okinawa Island and surrounding islands are the highest, followed by 5 cases in Miyako Islands and Yaeyama Islands, 2 cases in Amami Islands, and most of the capsizing accidents occurred around coral reefs close to the land.



### 3. Numbers of accidents by vessel types and sizes

Many of them are small vessels of less than 5 tons

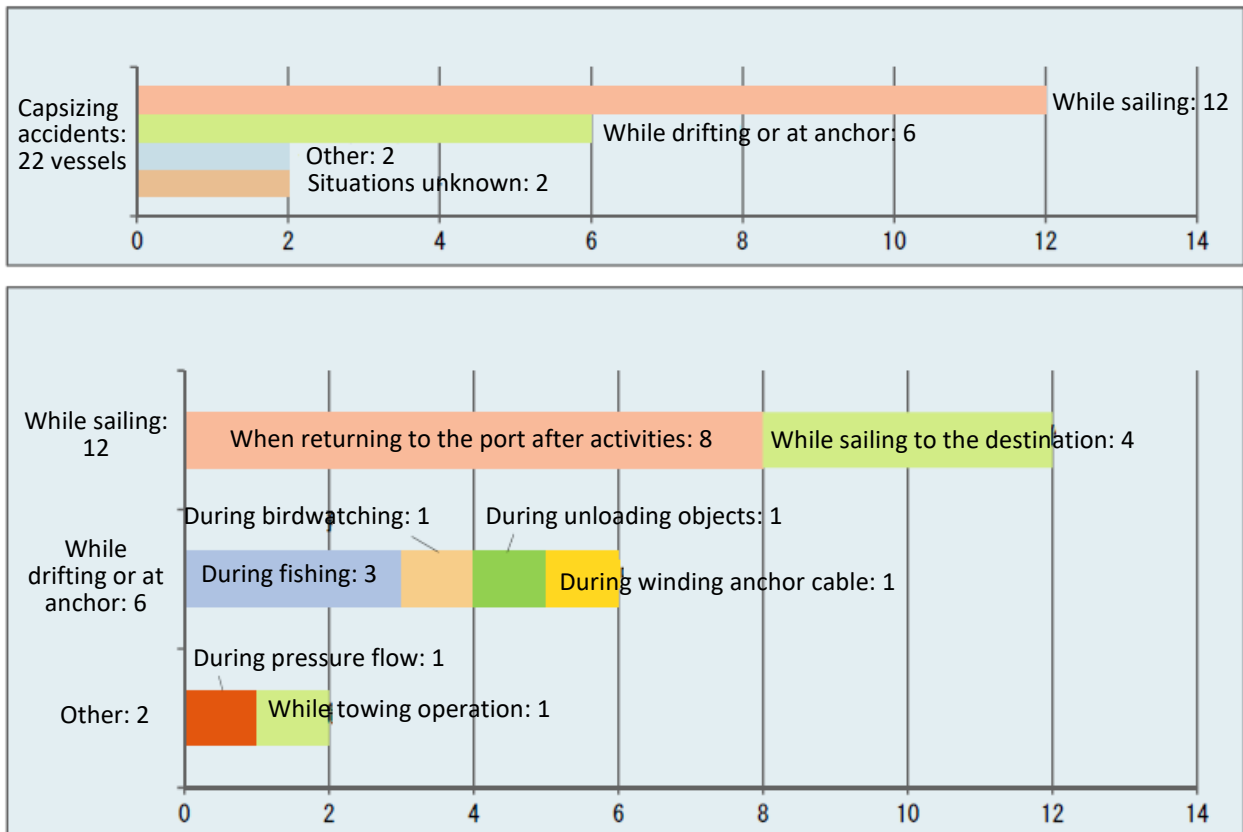
Vessel types of the 22 vessels which caused capsizing accidents are 14 pleasure boats and 2 fishing boats, and as for the sizes, most of them, i.e., 20 vessels (91%), are small vessels of less than 5 tons.



### 4. Vessel operation at the time of accident

Many of them occurred while sailing

Among 22 capsizing accidents, 12 of them were "while sailing" and 6 were "while drifting or at anchor". Many of the capsizing accidents while sailing occurred "when returning to the port after completion of activities (fishing, operations, sightseeing)", and capsizing accidents while drifting or at anchor occurred "during activities (e.g., while fishing or birdwatching)".



## 5. Weather at the time of accident

Many occurred on a clear day, when the wind scale was 3 to 5

13 (59%) of the capsizing accidents occurred on a clear day, and 20 (91%) of them occurred when the wind scale was 3 to 5.

Amami Islands in Kagoshima Prefecture and Okinawa prefecture are surrounded by sea, and thus winds blowing through over the sea directly hit the land, because of which the winds in these areas are generally strong. Use special care when vessels get underway in a shallow reef area.

Weather Wind scale	Clear	Cloudy	Raining	Foggy	Other	Total	Conditions of the sea
0 (0.0-0.2 m/s)	-	-	-	-	-	0	Mirror-like sea surface.
1 (0.3-1.5 m/s)	2	-	-	-	-	2	Some fish scale-like ripples, but no bubbles in combs.
2 (1.6-3.3 m/s)	-	-	-	-	-	0	Smaller wavelets, which are short but distinguishable. Combs look smooth, without breaking.
3 (3.4- 5.4 m/s)	8	4	-	-	-	12	Larger wavelets. Combs start to break. Bubbles look like glasses. Whitecaps may appear at places.
4 (5.5- 7.9 m/s)	2	3	-	-	-	5	Smaller waves, which are longer. Many whitecaps.
5 (8.0- 10.7 m/s)	1	-	2	-	-	3	Medium-sized waves, which are more distinguishable and longer. Quite many whitecaps. (There may also appear splashes.)
6 (10.8- 13.8 m/s)	-	-	-	-	-	0	Large waves start to emerge. White, bubbly combs appear at places in a wide range (many of which give splashes).
7 (13.9- 17.1 m/s)	-	-	-	-	-	0	Waves get bigger and bigger, and white bubbles are getting formed from crushed combs and blown downwind.
Total	13	7	2	0	0	22	

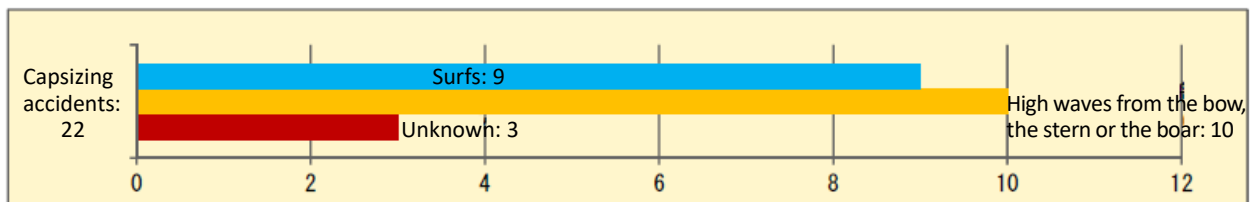
\*Wind scale is according to the Beaufort wind scale.

Pay attention to weather information, and regularly check weather forecasts on newspapers and TVs, or look up weather charts. If stormy weather is expected, carefully consider whether or not you should get underway.

## 6. Causes of accidents

Greatly influenced by waves.

Regarding causes of capsizing accidents, 9 of them are because of surfs, and 10 are high waves from the bow, the stern or the board. Many capsizing accidents are due to influences of waves.



[Cause of capsizing accidents: Part 1]

Causes of capsizing accidents are deeply related to the presence of "propagated waves (swells)". When wind blows heavily and the sea surface far out from the shore looks rough with "wind waves" and "swells", anyone can understand that sailing is dangerous. On the other hand, even if weather is fine and winds and waves appear to be calm, there may be hidden "swells" which have been propagated from a typhoon or low air pressure far away from the shore. Such "swells" are generally invisible far out from the shore. These invisible "swells" sometimes suddenly get rough with high waves to cause capsizing of small vessels in a shallow sea area close to the shore such as a coral reef.

When a small vessel sails to return to the port or sails in a shallow sea area closer to the shore such as a coral reef, the sailing is with "swells" from behind. Thus, it may not be easy for the vessel to notice the "swells" getting bigger behind it.

[Cause of capsizing accidents: Part 2]

When a vessel sails with "swells" from behind, the stern is suddenly lifted up by waves, making the vessel body downwardly on a slope of waves, which is called "surfboarding", and making the vessel's bow inclined to lose control of the helm, which is called "broaching". When the vessel sails in waves, the rolling movement of the vessel and the waves synchronize to cause a large inclination, i.e., trim, which is called "synchronous rolling". These phenomena increase the risk of capsizing the vessel.

The following causes have been pointed out to the accidents while sailing or while drifting or at anchor:

Causes of accidents	
While sailing	While drifting or at anchor
<ul style="list-style-type: none"> <li>➤ The ship entered a sea area where wave actions cause surfs.</li> <li>➤ The ship got underway along reefs where wave actions cause surfs.</li> <li>➤ With no knowledge of the ship sailing along a reef range, the ship was struck by a surf at a height of 3 m.</li> <li>➤ The ship was struck by a wave when it was going over a reef.</li> </ul>	<ul style="list-style-type: none"> <li>➤ The ship went too close to a reef due to inadequate helm control.</li> <li>➤ Flooding due to surfs was not noticed.</li> <li>➤ The ship lost propulsion and was drifted to the sea area where wave actions cause surfs.</li> <li>➤ The ship was struck by waves from behind the stern in a rocky area.</li> </ul>

Even if winds and waves offshore look calm, a high wave may appear closer to the shore. Check whether surfs are generated, and be aware of irregular waves when the ship sails in a shallow reef area.

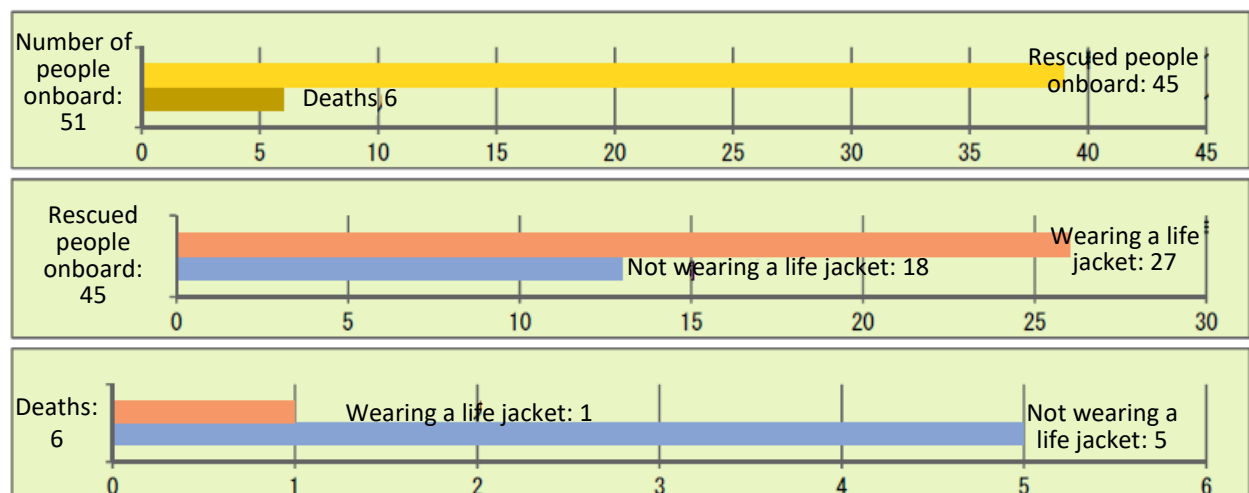
7. Number of deaths

Many of the deaths are due to without wearing a life jacket

6 out of 51 people died onboard the 22 vessels caused capsizing accidents, but no one was missing.

1 of the 6 dead people was wearing a life jacket at the time of the accident, but others were not.

A person wearing a life jacket has more chance of being rescued, because the person can be floated for a longer period of time while minimizing depletion of physical strength.

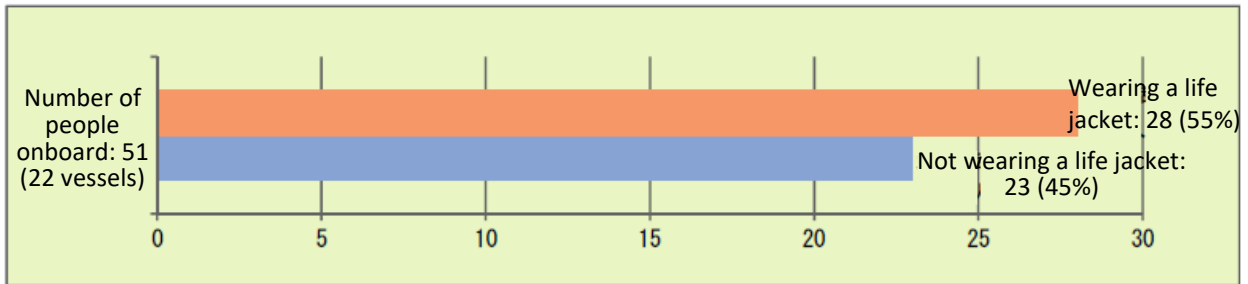


A life jacket is a "lifeline" to return home when people encounter an accident. When onboard, all people should appropriately wear a life jacket. You should also carry a mobile phone (waterproof, with a GPS positional information notification function) in case of an accident, so that you can timely make a first call to the rescue authority.

## 8. Use of life jackets

55% of the people onboard wear a life jacket.

There were 51 people onboard the 22 vessels which caused capsizing accidents, and 28 (55%) of them were wearing a life jacket and 23 (45%) of them were not wearing a life jacket.



[Life jacket mandate and duty to endeavor the wearing]

Based on the **Seaman and Small Craft Operator Act (Act No. 149 of 1951)**, the captain of small vessel such as a pleasure boat, i.e., the operator of the small vessel, has a duty to have people on board wear or endeavor to wear a life jacket.

Mandate	(1) When a person is onboard a sailing special small vessel (e.g., personal watercraft) (2) When a child under 12 years of age is onboard a sailing small vessel (3) When the captain is onboard alone a sailing small fishing boat and engage in fishing work
Duty to endeavor	(4) Besides (1) to (3), when a person is onboard an exposed deck of a small vessel.



## 9. Questions on the accidents

**Why are there so many capsizing accidents of small vessels such as pleasure boats or fishing boats?**

Small vessels generally sail shallow sea areas close to the land such as coral reefs, because of which they often encounter surfs and high waves. These waves have a potential to cause capsizing of small vessels at once, and can appear even if it is not stormy weather.

When a small vessel sails to return to the port or sails shallow sea areas close to the land such as coral reefs, the vessel sails with "swells" behind and thus between these "swells" cannot be seen by the operator. This makes it difficult to recognize the height of the waves, even if the "swells" get bigger.

**What is the wave ("high-wave") that causes capsizing accidents?**

Sea waves (high-waves) can be classified into two main categories: "wind waves" and "swells". These two are completely different in their characters, and depending on the weather, only one of them or a combination of both of them is present.

[Wind waves]

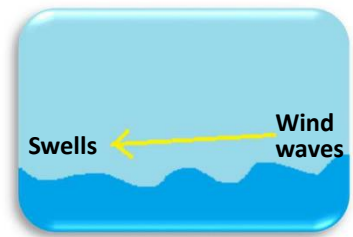
This term means waves generated by wind blowing over the surface of the water, and the direction of the wind and that of the wind wave are generally same. If the wind blows stronger than the speed of waves, the waves are pushed by the wind and continue to grow bigger. The more the waves grow, the higher the wave height is, but the length of the wave is short, and the wave crests easily collapse to generate white-crested waves.



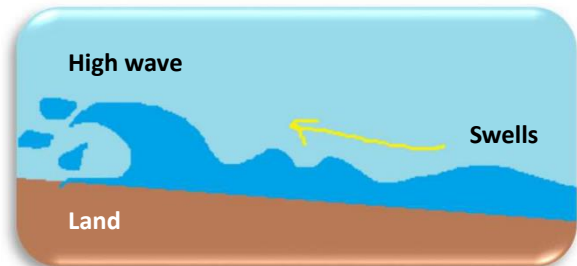
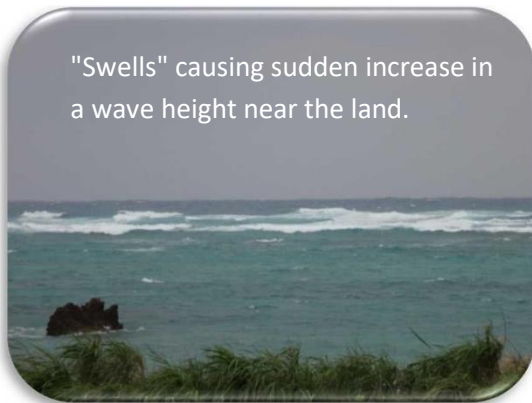


[Swells]

This term means waves consisting of wind waves grown and propagated to an area where no wind blows. In other words, swells can appear without direct relation with the wind blows over the place. The further the traveled distance is the longer the wavelength is. Thus, the off-shore sea surface with sells may be seen clam from the land.



However, when swells reaches a shallow sea area close to the land, its wavelength gets shorter because of an influence of the seabed (shallow sea effect), while the wave suddenly gets higher, which suddenly increases the steepness of the slope of the wave front to collapse the wave structure, forming a breaker. This is so-called "surfs".



10. Typical sea areas with high waves

(1) Shallow sea area near the land

(2) Narrow or shallow area at the harbor entrance.

(3) Seashore sticking out like a cape



Generally, waves suddenly get higher.



Generally, waves are high because of influences of backwater from the breakwater or tides.



Generally waves are high because of the narrow spaces between wave direction lines.

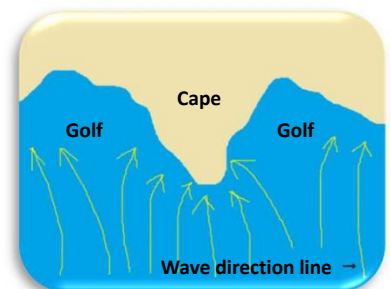
[Wave direction line]

This term means is a line connecting tangents of wave traveling directions.

Waves moves in the direction of wave direction line.

[References]

- Tips to know to prevent small vessel accidents (Miyazaki Coast Guard Division)
- A basic to study high-waves (Ichiro Isozaki, SEIZANDO-SHOTEN PUBLISHING CO., LTD.)
- Capsizing of small vessels -Tips for preventing accidents (Japan Craft Inspection Organization (JCI))





## Accident case example 1

**When returning to the port after fishing, the ship was struck by surfs to the starboard and capsizing.**

### Accident overview

Pleasure motorboat Y (less than 5 t, length 5.02 m, the captain and one other onboard) caused capsizing around 2120 hours, on August 18, 2012, when returning to the Kanegusuku port in Kumejima-cho after finishing fishing offshore southerly from the Tori-shima Island fishing port, Kumejima-cho, Okinawa prefecture.

### Casualties

None

### Weather and water conditions

Weather: clear, wind direction: W, wind scale: 1, surface: clam, tides: midterm of the ebb tide.

### Whether or not a life jacket is on

Captain: No. Other person on board: Yes

### Development until the accident

The ship raised the anchor at the fishing site, and got underway to the returning trip to the port at the speed of about 2 kn.

The captain knew that there were a chain of coral reefs at the periphery of the entrance of the Tori-shima Island fishing port, and high waves are sometimes generated above the reef chain.

The captain generally sail while keeping a distance of 200 m away from the reef chain.

The Tori-shima Island fishing port was located next to the northwest side of the Kanegusuku port, and at the entrance of the Kanegusuku port, there were Kanegusuku port light beacon No. 1 and Kanegusuku port light beacon No. 2, and at the entrance of the Tori-shima Island fishing port, there was the Tori-shima Island portlight beacon.

The captain was mistaken about the light beacons, and sailed above the reef chain.

Suddenly, the ship was struck by a surf at a height of about 3 m from the starboard side, and the ship was capsizing from the bow.

The captain and the other person onboard fell overboard, and drifted offshore, and around 0615 hours on the following day, August 19, found by a search plain of the Japan Coast Guard and rescued by a fireboat.

### Analysis of the findings

#### Possible factors

The captain usually uses the Kanegusuku port light beacon No. 2 as the bow light, but was mistakenly sailing on the mark of the Tori-shima Island portlight beacon.

He did not realize that the ship was sailing above the reef chain.

The ship was struck by a surf at a wave height of about 3 m and capsizing.

#### Probable factors

The captain mixed up the Kanegusuku port light beacon No. 2 with the Tori-shima Island portlight beacon because they are both red lights, and the light-traveling distance was greater from the Tori-shima Island portlight beacon. As a result, the captain believed that the light from the Tori-shima Island portlight beacon is the light of Kanegusuku port light beacon No. 2.

### Causes

The cause of this accident is considered that, during a night time, the captain was mistaken the light beacons while taking a return trip to the Kanegusuku port at a place offshore southerly from the Tori-shima Island fishing port. The captain usually uses Kanegusuku port light beacon No. 2 as the mark, but sails to the Tori-shima Island portlight beacon this time, without knowing that the ship was sailing above the reef chain, and was struck by a surf at a height of about 3 m from the starboard side, and the ship was capsizing.

The investigation report of this case example is accessible from the JTSB website (August 30, 2013).

[http://www.mlit.go.jp/jtsb/ship/rep-acci/2013/MA2013-8-66\\_2012nh0035.pdf](http://www.mlit.go.jp/jtsb/ship/rep-acci/2013/MA2013-8-66_2012nh0035.pdf)



## Accident case example 2

**After sightseeing, the boat was struck by a high wave while returning to the port, and capsizing.**

### Accident overview

Pleasure motorboat U (0.6 t, the captain and two others onboard) caused capsizing around 1200 hours, on November 12, 2012, when returning to the Ishigaki port in Ishigaki city, Okinawa prefecture, after sightseeing.

### Casualties

None

### Weather and water conditions

Weather: clear, wind direction: NE, wind scale: 3, visibility: good, surface: clam, tides: early in the ebb tide.

### Whether or not a life jacket is on

Captain: No, other two persons on board: No

### Development until the accident

After sightseeing, the boat got underway to return trip to the port.

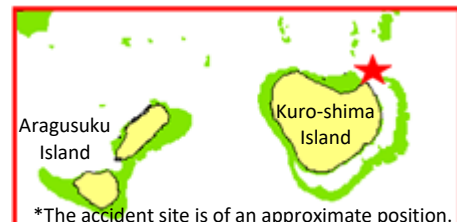
The boat sailed at a very low speed in a shallow reef area surrounded by reefs.

When the boat attempted to sail across a reef, it was struck by a high wave and capsizing.

The captain and the other two persons onboard swam landed Kuro-shima Island on their own.

### Causes

The cause of this accident is considered that when the boat attempted to sail over a reef in a shallow reef area, it was struck by a wind and capsizing.



The investigation report of this case example is accessible from the JTSB website (September 27, 2013)

[http://www.mlit.go.jp/jtsb/ship/rep-acci/2013/keibi2013-9-36\\_2012nh0052.pdf](http://www.mlit.go.jp/jtsb/ship/rep-acci/2013/keibi2013-9-36_2012nh0052.pdf)

## Accident case example 3

**While drifting, the ship was struck by a surf from the stern, and capsizing.**

### Accident overview

Dual-use small ship A (0.9 t, the captain and three others onboard) caused capsizing around 0930 hours, on May 27, 2013, while drifting offshore the Henoko fishing port, Nago city, Okinawa prefecture.

### Casualties

None

### Weather and water conditions

Weather: clear, wind direction: SSE, wind scale: 1, Visibility, good, surface: clam, tides: midterm of the ebb tide.

### Whether or not a life jacket is on

Captain: Yes, other three persons on board: Yes

### Causes

The cause of this accident is considered that, when the ship was drifting near the rocky area offshore the Henoko fishing port, it was struck by a surf from the stern, and capsizing.

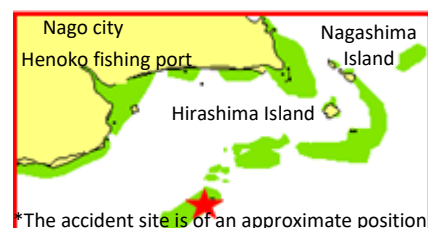
### Development until the accident

The ship started drifting near the rocky area for shooting photos of wild birds.

It was struck by a surf from the stern, which caused flooding in the upper deck.

Before draining, it was struck by the following surf and capsizing.

The captain and the three other persons onboard ejected in the sea, but they requested rescue to an acquaintance and were rescued.



The investigation report of this case example is accessible from the JTSB website (May 28, 2014).

[http://www.mlit.go.jp/jtsb/ship/rep-acci/2014/keibi2014-3-44\\_2013nh0028.pdf](http://www.mlit.go.jp/jtsb/ship/rep-acci/2014/keibi2014-3-44_2013nh0028.pdf)

## Conclusion

### - For preventing capsizing accidents from occurring again -

Capsizing accidents are one of the most tragic accidents as they cause many deaths and missing people at a time. Many of those capsizing accidents involve "small vessels" such as pleasure boats and fishing boats, and the major element of the causes of the capsizing accidents is encountering waves such as surfs or high waves.

In order not to encounter a capsizing accident, or survive a capsizing accident, you may use the following recurrence prevention measures.

#### [Recurrence prevention measures]

- (1) Wear a life jacket while you are onboard.
- (2) Carry a mobile phone (waterproof) with a GPS positional information notification function.
- (3) Pay attention to weather information.
- (4) If stormy weather is expected, carefully consider whether or not you should get underway.
- (5) Check whether surfs are generated in the route.
- (6) Be aware of irregular waves when the ship sails in a shallow reef area.

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**GUIDE** You can search information on "where accidents occur involving what ships" on a map. Please make use of it!

#### JTSB Hazard Map

Accidents, risks and safety information retrievable from a map

<http://jtsb.mlit.go.jp/hazardmap/>



East coast of the southern part of Okinawa Island