R7-B10 The decline of the offshore-side seaweed beds of the Sotoura coast of Suzu (tsunami or winter waves)

At Nagahashi, Kinoura and Noroshi on the Sotoura coast of Suzu City, what had become of the seaweed beds of the shallow sea offshore of the places that dried out through uplift, after the earthquake? Is their decline due to the tsunami or to winter waves, and how reliable is that view?

Readers

Fishers, fisheries cooperatives, local governments (staff in charge of fisheries and coasts), research institutions and others without specialist knowledge, who want to check, with figures and sources, what is said to have happened to the offshore-side seaweed beds of the Sotoura coast of Suzu and how reliable the view of the reason is.

Takeaways

1. At Nagahashi, Kinoura and Noroshi on the Sotoura coast of Suzu City, the earthquake of 1 January 2024 lifted the coast, and the shallow seaweed and seagrass beds dried out. In the diving survey of June 2025, large perennial seaweeds were scarce even in today's shallow sea, offshore of the places that dried out. Perennial seaweeds are seaweeds that go on living for many years; here they are Sargassum species and the like. In their place, seaweeds that die back within 1 year, such as ishimozuku, covered the rocks and stones widely.
2. The view that this is a decline still rests on weak evidence. The survey looked at 1 line per site, 1 time only. There are no records of the offshore side from before the earthquake, and the old records that can be compared are observations down to a water depth of about 0.5 m. What tells us that the seaweed grew thickly before the earthquake is the account of 1 local fisher, which the report quoted from a newspaper article. In the places deeper than about 6 m at Noroshi and at the point at a water depth of 8 m at Nagahashi, many perennial seaweeds were seen, and at Kinoura they were scarce even at the 8 m point (read from the figures).
3. The report raises the possibility that the stones on the bottom were rolled by the tsunami or by high winter waves, and that the large seaweeds were lost. Which of them it was has not been confirmed. On the Kinoura side, traces showing that the tsunami ran up to an elevation of 4.4 m were measured. Near the observation station at Nagahashi, the Japan Meteorological Agency found no traces of tsunami inundation. It is said that there was little inundation of the land on the north coast because the coast was uplifted.
4. Winter waves, too, are not measured on the north coast of Suzu. The nearest national wave observation is off Wajima Port, about 39 km west of Noroshi. In January–February 2024, immediately after the earthquake, almost nothing could be measured. The wave heights of November–December 2024, which could be measured, were not large compared with the winters since 2015 (this paper's tabulation). The values for January–March 2025, before the diving survey, have not yet been published.
5. For the tsunami of the Great East Japan Earthquake, there are reports of places where beds of large seaweeds such as arame hardly decreased, and of places where sea urchins were washed away and the beds expanded. On the other hand, it has been confirmed in Japan and abroad that storm waves tear off large seaweeds and turn stones over. The seaweed and seagrass beds of the Suzu City district are 1,795 ha, a value 13.5% smaller than in the prefecture's survey of fiscal 2018, but this includes Uchiura. The report expects that the beds will return as time passes, and calls for continued surveys. We found no survey that keeps watching the offshore-side seaweed and seagrass beds of the Sotoura coast of Suzu, and no initiative to protect them.

After reading	When using the decline of the offshore-side seaweed beds of the Sotoura coast of Suzu in documents or plans, add that it is the result of a diving survey made only 1 time, in June 2025, that there are no records of the offshore side from before the earthquake, and that whether it was the tsunami or winter waves is conjecture. Treat the area of the seaweed and seagrass beds of the Suzu City district as a value that includes Uchiura.

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This is an English translation. The Japanese edition is the authoritative text.

1. Key points

- At Nagahashi, Kinoura and Noroshi on the Sotoura coast of Suzu City, the earthquake of 1 January 2024 lifted the coast, and the shallow seaweed and seagrass beds dried out. In the diving survey of June 2025, large perennial seaweeds were scarce even in today's shallow sea, offshore of the places that dried out. Perennial seaweeds are seaweeds that go on living for many years; here they are Sargassum species and the like. In their place, seaweeds that die back within 1 year, such as ishimozuku, covered the rocks and stones widely. [S1]
- The view that this is a decline still rests on weak evidence. The survey looked at 1 line per site, 1 time only. There are no records of the offshore side from before the earthquake, and the old records that can be compared are observations down to a water depth of about 0.5 m. What tells us that the seaweed grew thickly before the earthquake is the account of 1 local fisher, which the report quoted from a newspaper article. In the places deeper than about 6 m at Noroshi and at the point at a water depth of 8 m at Nagahashi, many perennial seaweeds were seen, and at Kinoura they were scarce even at the 8 m point (read from the figures). [S1, S2, S8]
- The report raises the possibility that the stones on the bottom were rolled by the tsunami or by high winter waves, and that the large seaweeds were lost. Which of them it was has not been confirmed. On the Kinoura side, traces showing that the tsunami ran up to an elevation of 4.4 m were measured. Near the observation station at Nagahashi, the Japan Meteorological Agency found no traces of tsunami inundation. It is said that there was little inundation of the land on the north coast because the coast was uplifted. [S1, S3, S4, S6]
- Winter waves, too, are not measured on the north coast of Suzu. The nearest national wave observation is off Wajima Port, about 39 km west of Noroshi. In January–February 2024, immediately after the earthquake, almost nothing could be measured. The wave heights of November–December 2024, which could be measured, were not large compared with the winters since 2015 (this paper's tabulation). The values for January–March 2025, before the diving survey, have not yet been published. [S12]
- For the tsunami of the Great East Japan Earthquake, there are reports of places where beds of large seaweeds such as arame hardly decreased, and of places where sea urchins were washed away and the beds expanded. On the other hand, it has been confirmed in Japan and abroad that storm waves tear off large seaweeds and turn stones over. The seaweed and seagrass beds of the Suzu City district are 1,795 ha, a value 13.5% smaller than in the prefecture's survey of fiscal 2018, but this includes Uchiura. The report expects that the beds will return as time passes, and calls for continued surveys. We found no survey that keeps watching the offshore-side seaweed and seagrass beds of the Sotoura coast of Suzu, and no initiative to protect them. [S17, S15, S19, S20, S1]

2. What is happening

Japan and the world: the decline of seaweed and seagrass beds, and perennial seaweeds

Seaweed and seagrass beds are places where seaweeds and seagrasses (plants that flower in the sea) grow thickly. Places where Sargassum species grow thickly are called Sargassum beds, and places where kajime species grow thickly are called kajime beds. They are home to shellfish such as abalone and turban shells and to young fish, and they are also fishing grounds where ama divers and fishers gather seaweed. How seaweed and seagrass beds are decreasing across Japan is covered in R2 "Seaweed and seagrass beds and the living things of the sea". [S15]

Among the seaweeds of these beds, some live for many years and some die back within 1 year. According to the Fisheries Agency's Isoyake Countermeasure Guidelines (3rd edition, March 2021), many Sargassum species are perennial, and from the annual rings of the holdfast at the base (the part that attaches to the rock), yoremoku and nokogirimoku in Aomori Prefecture are said to live for about 9 years, and fushisujimoku on Rishiri Island in Hokkaido for 6–7 years (quoted from other studies). Annual seaweeds, on the other hand, die back in about 1 year, so a bed will not necessarily form in the same place the next year. Perennial beds form in the same place every year, because the holdfasts remain. [S15]

The state in which a seaweed bed has declined greatly and does not return is called barren ground (isoyake). The guidelines define isoyake as follows: in rocky places and places with boulders (stones lying loose on the rock of the sea floor) in the shallow sea, the seaweed bed declines markedly or disappears, beyond the range of the change of the seasons and of some change from year to year, and the place becomes poor in seaweed. They state that there are 4 routes by which seaweed decreases, namely being eaten, dying back, no longer sprouting and being washed away, and that when the sea is rough, seaweed is torn off the rock or torn apart. [S15]

To say that the seaweed bed of a certain place has declined, one needs to know what it normally looks like and how it normally changes. The Fisheries Agency's guidance on watching (monitoring) seaweed and seagrass beds (April 2024) states that the season when seaweed grows thickly is often spring to early summer but differs with the species, the sea area and the year, and so recommends checking the timing of the survey with a local research institution. If a change is seen, such as the bed being in poorer condition than in a usual year or the species of seaweed having been replaced by others, it recommends suspecting isoyake and carrying out simple field experiments and surveys to look for the cause. [S16]

Japan and the world: examples in which large seaweeds were lost to storm waves

It has been confirmed many times, in Japan and abroad, that storm waves tear off large seaweeds and move the stones of the sea floor. However, the examples in the papers could be stated only because the same place had been surveyed continuously, or because the matter was confirmed by experiment. [S19, S20, S21, S15]

On a boulder shore in the intertidal zone (the part of a rocky shore that is under the sea at high tide and exposed as land at low tide) in California in the United States, the overturning of stones by the waves of winter storms was the main disturbance. The smaller the stone, the more often it was overturned, and on such stones there were only early-stage organisms such as sea lettuce and its relatives. On stones laid bare in an experiment, sea lettuce and its relatives settled within 1 month, and if there was no other disturbance, perennial red algae (red seaweeds) covered 60–90% in 2–3 years (according to the abstracts of 2 papers of 1979). [S19]

In forests of kelp (large seaweeds related to kombu), too, there are examples in which storm waves had a large effect. In southern California, strong winter storms destroyed almost all of the upper layer of the giant kelp forest, but the kelp of the lower layers remained (according to the abstract of a 1984 paper). A study that surveyed 17 sites in central and southern California for 9 years states that in the central part, where the waves of

winter storms are strong, the amount of kelp lost to waves was 2 times the average for the southern part, and that the difference between the regions was determined by the difference in wave disturbance rather than by nutrients or by the abundance of animals that eat seaweed (according to the abstract of a 2011 paper). In Nova Scotia in Canada, the hurricane of September 2010 reduced the proportion covered by kelp (the cover) at water depths of 5–15 m from 71.0% to 38.7% on the average of the sites (according to the abstract of a 2012 paper). [S20, S21]

In Japan as well, there are examples in which large seaweeds were lost to typhoon waves. The guidelines give the example in which the natural kombu beds on the Pacific side of Hokkaido declined greatly through the 4 typhoons that came one after another in 2004, and the example in which, in the period of high water temperature in the summer of 2013, typhoon waves pulled arame and kajime species on Iki in Nagasaki Prefecture out from the base of the stem and washed them away. They state that on Iki the later recovery differed from place to place, and that there were also places where almost no young seaweed appeared and the ground became barren (isoyake). The guidelines state that the washing away of seaweed by typhoons is also conspicuous on the Sea of Japan side of southern Honshu and elsewhere. [S15]

Japan and the world: tsunami and seaweed beds (the Great East Japan Earthquake)

For the tsunami of the Great East Japan Earthquake of 2011, there are many reports that beds of large seaweeds did not decrease much. At Tomarihama on the Oshika Peninsula in Miyagi Prefecture, the same place had been surveyed since 2008. After the tsunami, there was no noticeable decrease in the arame forest in the shallow area. The adult abalone in the forest fell to less than half, and the juvenile abalone and the sea urchins that had been on the coralline algae (hard red algae that cover rock) in the deep area fell to 14% and 5%, respectively, of the numbers just before the tsunami. The abstract states that the fact that most of the juveniles and sea urchins were in the deep area, where the forest does not weaken the movement of the water, could be the reason for the large decrease (according to the abstract of a 2013 paper). A 2017 paper states that the loss of arame at Tomarihama was limited and that, because the sea urchins decreased greatly, young arame plants grew over a wide range of water depths and the forest expanded into the deep area. At Nagane (written "Nagane" in the abstract) in Otsuchi Bay in Iwate Prefecture, there was no difference in the amount of annual kombu before and after the tsunami (according to the abstract). [S17]

The guidelines also present an example of arame and sea urchins on the coast of Minami-Sanriku (the name of the site is not given; from the origin and the content of the figure, it appears to be the result for Tomarihama; this paper's reading). Before the earthquake, arame was found only down to a water depth of 2.4 m. In a survey 4 months after the earthquake, the sea urchins had been carried offshore by the tsunami and their density had fallen to about 10% of that before the earthquake, and young arame plants had appeared in large numbers in the deep area. Some of them grew, and arame expanded to a water depth of 7 m. From 3 and a half years after the earthquake the sea urchins increased, and the arame retreated towards the shore. The figure in the guidelines states that immediately after the earthquake the boulders were disturbed and the sea urchins disappeared. The guidelines state that after the tsunami there were also places on the stricken coast where the original seaweed beds returned temporarily. The 5% in the preceding paragraph is the value that the 2013 paper gave for sea urchins in the deep area, and its origin differs from that of the guidelines' "about 10%". [S15, S17]

For the living things of the intertidal zone, too, the effect of the tsunami itself is said to have been small. Taking as the baseline the values of a survey that had been continued since before the earthquake, the decrease in the attached organisms of the rocky intertidal zone caused by the tsunami was within the range of the normal change from year to year (a 2016 study; as presented in an explanatory article by a Tohoku University researcher in an outreach magazine). This researcher states that movements of the ground such as uplift and subsidence were a larger event than the tsunami. In the intertidal zone of Tohoku that subsided, the recovery differed from species to species, and the communities were still changing even 6 years after the earthquake. [S18, S10]

The Oshika Peninsula and Otsuchi Bay are examples from the Pacific side. The size of the tsunami, the size of the stones on the sea floor and the abundance of sea urchins differ from those of Noto, so the examples cannot be applied as they are. Examples in Japan and abroad in which shallow seaweed beds dried out through uplift are covered in R7-B08 "Shallow seaweed and seagrass beds that dried out through uplift, and the decrease in the area of the seaweed and seagrass beds of Sotoura". [S17, S18]

Table 1 Examples of what happened to large seaweeds in storm waves and tsunami

Event	Place	What happened	Material
Waves of winter storms	Intertidal boulders in California, United States	The smaller the stone, the more it is overturned. Bare stones are covered by sea lettuce and its relatives in 1 month, and perennial red algae reach 60–90% in 2–3 years	Abstracts of papers (1979, 2 papers)
Winter storms	Kelp forests of southern California	Almost all of the upper layer of giant kelp was destroyed, and the lower layers remained	Abstract of a paper (1984)
Waves of winter storms	17 sites in California (9 years)	In the central part, where waves are strong, the amount of kelp lost was 2 times the average for the southern part	Abstract of a paper (2011)
Hurricane (September 2010)	Nova Scotia, Canada (water depths of 5–15 m)	Kelp cover went from 71.0% to 38.7%	Abstract of a paper (2012)
4 typhoons (2004)	Pacific side of Hokkaido	The natural kombu beds declined greatly	National guidelines
Typhoon (summer 2013)	Iki, Nagasaki Prefecture	Arame and kajime species were pulled out from the base. In some places no young seaweed appeared and the ground became barren (isoyake)	National guidelines
Tsunami of the Great East Japan Earthquake (2011)	Tomarihama, Oshika Peninsula, Miyagi Prefecture	There was no noticeable decrease in the arame forest, and with fewer sea urchins it expanded into the deep area. In the guidelines' example from Minami-Sanriku (it appears to be Tomarihama; this paper's reading), it expanded from a water depth of 2.4 m to 7 m, and retreated from 3 and a half years later	Abstracts of papers (2013 and 2017), national guidelines
Tsunami of the Great East Japan Earthquake (2011)	Nagane, Otsuchi Bay, Iwate Prefecture	No difference in the amount of annual kombu before and after the tsunami	Abstract of a paper (2017)
2024 Noto Peninsula Earthquake	Sotoura coast of Suzu City	The "Region (Sotoura)" sections of this chapter	Survey report (2026)

Note: The examples in the papers are results obtained by surveying the same place continuously or by confirming the matter in an experiment. Both the species of seaweed and the sea are different, so they cannot be applied as they are to the Sotoura coast of Suzu (chapter 5). [S19, S20, S21, S15, S17, S1]

Region (Sotoura): the 3 sites on the Sotoura coast of Suzu

Sotoura is the Sea of Japan coast of the Noto Peninsula. In this paper it means the coast of Shika Town, Wajima City (including Monzen, Hegurajima Island and the Nanatsujima Islands), and the north coast of Suzu City as far as Jike. The boundary between Sotoura and Uchiura (the coast on the inner side of the peninsula, facing Toyama Bay) is Cape Rokko at the tip of the peninsula. What this paper covers is the seaweed beds offshore of the places

that dried out, at the 3 sites of Nagahashi (Nagahashi-machi), Kinoura (Orito-machi) and Noroshi (Noroshi-machi) on the north coast of Suzu City. From Nagahashi to Kinoura is about 12 km to the east, and from Kinoura to Noroshi is about 2 km to the east (the report's values). [S31, S1]

The 3 sites were uplifted in the earthquake of 1 January 2024. The prefecture's provisional values, measured at the quay walls and other points of the fishing ports near the sites, are 2.8 m at Nagahashi Fishing Port, 1.2 m in the Orito district of Noroshi Fishing Port (Orito-machi, where Kinoura is located) and 0.8 m in the Noroshi district. The survey report of the Kanazawa Association of Corporate Executives, a business association (March 2026; hereafter, "the report"), gives the uplift at Kinoura as 1.8 m, but in the prefecture's values this is the value for the Takaya district of Noroshi Fishing Port (this paper's cross-check). According to the report, the uplift moved the coastline offshore by about 60 m at Nagahashi, about 15 m at Kinoura and about 65 m at Noroshi. The size of the uplift is covered in R7-B01 "The earthquake uplift of Sotoura", and the shallow seaweed beds that dried out are covered in R7-B08. [S7, S1]

The "offshore side" in this paper is not the deep open sea; it means today's shallow sea, just offshore of the places that dried out. The report's diving survey covered the stretch from the water's edge of before the earthquake to a water depth of 8 m, which is regarded as the lower limit of the ama divers' fishing. Reading from the figures, the water depth along the surveyed lines was mostly shallower than 5 m at Nagahashi; at Kinoura it was about 4 m at 120 m offshore and 6–7 m at 200 m; and at Noroshi it was about 7 m in a hollow 140 m offshore and 6–7 m at 170–200 m (read from the figures). [S1]

The sea floor at the 3 sites has many rocks and stones. A 2020 research report of the prefecture's Noto Marine Center describes Nagahashi as a boulder shore of large stones, dotted with rocks about 1–5 m in diameter. The report describes the whole of the Nagahashi line as rock and gravel (stones), the part of the Kinoura line from about the middle offshore as sand and bedrock, and the part at Noroshi offshore of today's shoreline (the line of the water's edge) as rock, gravel and sand. A 2026 research report of the same Center examines, at Noroshi, the holes bored by bivalves, by breaking open boulders of the former sea floor that dried out through the uplift. [S8, S1, S14]

Before the earthquake, the prefecture regarded the large brown algae of the Suzu district as being in good condition. The prefecture's Ishikawa Prefecture Seaweed and Seagrass Bed Vision (March 2022) states, from a survey of fiscal 2018 using satellite images and other means, that the large brown algae (brown seaweeds) are considered to be keeping a good condition in the Suzu district and other districts that face the open sea. This is a view of the district as a whole, not a value for the offshore side of the 3 sites. The same Vision states that on the prefecture's coast, feeding damage by aigo (rabbitfish), small snails and purple sea urchins has been confirmed, but not in an amount that would lead to the decline of the seaweed beds. [S11]

The seaweeds of the 3 sites are also a target of fishing. According to the prefecture's Ishikawa Sea Area fishing ground plan (changed on 30 June 2026), Nagahashi falls within the area of common fishery right Kyo No. 13, Kinoura within Kyo No. 14 and Noroshi within Kyo No. 15, and all of them include fishing that gathers seaweeds such as hondawara (Sargassum), kajime, akamoku, mozuku and wakame (the matching of the areas is this paper's reading). The area is, for Kyo No. 14 and Kyo No. 15, within 1,090 m of the coastline at the highest tide, and for Kyo No. 13, the place enclosed by the coastline and a line joining points given by coordinates, together with the places within 1,090 m in some stretches; the term of the rights is from 1 September 2023 to 31 August 2033. According to Suzu City's Plan for Revitalising Fishing Communities (Hama Plan) (fiscal 2026–2030), of the 152 fishery management entities within the jurisdiction of the Suzu Branch of the Ishikawa Prefecture Fisheries Cooperative Association, 44 engage in shellfish and seaweed gathering (fishing that gathers shellfish and seaweed) (as of 1 November 2023; a value for the whole of Suzu City, including Uchiura). [S24, S25]

Region (Sotoura): what the diving survey of June 2025 showed

The only material that shows the state of the offshore-side seaweed beds at the 3 sites is the diving survey of the report. The report is the report of a survey that the Kanazawa Association of Corporate Executives carried out with a grant from The Nippon Foundation and the special cooperation of the Hokkoku Shimbun newspaper company, with the prefecture's Fisheries Division and Fisheries Research Center as observers; the diving survey was undertaken by a survey company (Shizen Kankyo Chosa, a limited company). The dives were made on 7 June 2025 at Noroshi, on 8 June at Nagahashi and on 9 June at Kinoura. 1 line was laid from the shoreline of before the earthquake to a water depth of 8 m, and the seaweeds and animals within 1 m on both sides of the line were recorded every 10 m. The length of the line was up to 200 m, and where a water depth of 5 m or 8 m was not reached within that length, a point observation was made at the place of that water depth (5 m and 8 m at Nagahashi; 8 m at Kinoura and Noroshi). [S1]

At all of the 3 sites, large perennial seaweeds were scarce offshore of the places that dried out. The report states that over the whole of the line at Nagahashi, on the part of the line from about the middle offshore at Kinoura, and in the stretch from today's shoreline (70 m from the shore) to 170 m at Noroshi, perennial large brown algae were scarce, and annual seaweeds such as ishimozuku, habamodoki and its relatives, and fukuronori covered the bottom widely (Table 2). [S1]

Table 2 The offshore-side seaweed beds of the 3 sites, as seen in the diving survey of June 2025

Site (date surveyed)	Where perennial seaweeds were scarce	What was seen
Nagahashi (8 June)	The whole of the line	Wakame, yanagimoku and yoremoku were found along the whole of the line, and joromoku, isomoku, yatsumatamoku, mametawara and others on the shore side of the middle, but the perennial large brown algae "cannot be called abundant". Annuals such as ishimozuku, habamodoki and its relatives, and fukuronori cover the bottom widely. At the point at a water depth of 8 m, the cover of yoremoku is in the 50–75% class. The overall cover on the line at 70–200 m from the shore is in the 50–75% class, and in the same stretch the cover of the crust-like seaweeds that cover rock (crustose coralline algae) is also in the 50–75% class. The overall cover at the point at a water depth of 5 m is in the class of 75% or more (read from the figures)
Kinoura (9 June)	From about the middle of the line offshore	From about the middle offshore the bottom is sand and bedrock, and annuals such as ishi - mozuku, futomozuku, habamodoki and its relatives, and fukuronori cover it widely. Around the middle of the line there is ebiamamo, a seagrass that the national government and the pre - fecture list as Near Threatened. At 120–150 m from the shore and at the point at a water depth of 8 m, the overall cover (the proportion of the bottom covered by seaweed as a whole) is in the class of less than 5%. At 150–160 m from the shore it is in the class of 75% or more (the annual wakame is in the 50–75% class), and at 160–200 m it is in the 5–50% classes (read from the figures)
Noroshi (7 June)	70–170 m from the shore	The overall cover at 70–170 m is in the 5–25% class. Offshore of 170 m and at the point at a water depth of 8 m, yanagimoku, yoremoku, yatsumatamoku and others are abundant, and the overall cover is in the classes of 50% or more (read from the figures)

Note: From the main text and Table 4-1 of the report, and from the vegetation cross-section figures (figures that show cover in colour-coded classes). What was read from the figures is marked "read from the figures". The report states that the number of seaweed species on the Kinoura line is the same as at Nagahashi (12 species of large seaweeds and 28 species of small seaweeds), but the rows for large brown algae in the figure number 13 species, which does not agree with the number in the main text (this paper's count). [S1]

There are sites where many perennial seaweeds were seen in the deep area. A page of the Hokkoku Shimbun (31 July 2025; a PR feature on the survey, included in the appendix of the report) states that at Noroshi there were many perennial large seaweeds such as Sargassum species in the places deeper than a water depth of 6 m, while the places shallower than that were sparse and small annual seaweeds grew thickly there (read from the newspaper page). At Kinoura, even at the point at a water depth of 8 m, the only large brown algae were small amounts of wakame and yatsumatamoku (read from the figures). [S2, S1]

There are no records of the offshore side from before the earthquake. What the report compared with the time before the earthquake was the Noto Marine Center's survey of 9 June 2020 at Nagahashi and Kinoura, which looked, with rubber boots and a glass-bottomed viewing box, down to a depth of about 0.5 m below the sea surface. Much of that level has now dried out. From this comparison, the report states that the combination of species of large brown algae at Nagahashi has not changed greatly, and that umitoranoo and others in the places that dried out had disappeared (R7-B08). For Noroshi there are no records from before the earthquake. [S1, S8]

What tells us about the state of the offshore side before the earthquake is the account of 1 local fisher. The report quotes, from the morning edition of the Hokkoku Shimbun of 3 June 2025, a fisher of Takaya-machi in Suzu City as saying that the seaweed, which had grown densely before the earthquake, had decreased sharply, and that this year almost nothing but iwa-mozuku caught the eye. This paper could not find the original article. [S1]

Along the surveyed lines there were also shellfish and sea urchins that eat seaweed. According to the report, at Nagahashi there were scattered places with 1 or more turban shells per 1 m^2, small snails numbered 20 or more per 1 m^2 where they were most abundant, and purple sea urchins were around 1 per 1 m^2 on the shore side of the middle. At Noroshi, purple sea urchins were found only near the shore, and there were also places with 10 or more per 1 m^2. The report does not link the decline on the offshore side of the 3 sites to these animals. The isoyake and sea urchins from before the earthquake are covered in R7-B11 "The barren ground (isoyake) that has continued since before the earthquake, and the decline of the seaweed beds of the offshore islands". [S1]

At the 2 sites on the Uchiura side, the seaweed beds are said to have hardly changed. According to the report, at Mitsukejima Island in Suzu City, the boulders larger than about the size of a person's head were all covered with perennial Sargassum species. Koura in Noto Town, too, was a dense Sargassum bed, as in the survey of 2006. The surveys from before the earthquake that were used for comparison were of 1976 for Mitsukejima Island and 2006 for Koura, and the report also states that at Mitsukejima Island growth as dense as in 1976 could not be confirmed. The same report states that in part of the sea area of Uchiura, from Mitsukejima Island to beyond Tsukumo Bay, the seaweed was poorer the shallower the place, in places shallower than a water depth of 5 m. It infers that the reasons are that the bottom there is of small stones, which are easily disturbed by stormy seas and tsunami, and that the effect of the tsunami was stronger the shallower the place. Uchiura is outside the scope of this paper, so it is mentioned only as something to compare with. [S1]

Region (Sotoura): the reasons the report considered

The report takes the reason for the decline on the offshore side to be the tsunami or high winter waves. In the main text for each site, it states that the boulders, which made up much of the bottom, may have been rolled by the tsunami at the time of the earthquake or by high winter waves, and that many of the large brown algae may have disappeared. In its summary, after stating that the seaweed beds may have declined because of the tsunami or winter waves, it states, from the account of the fisher of Takaya-machi, that it is highly likely that they declined because, among other things, the stones on the bottom were turned over by the tsunami. [S1]

The way the reason is written differs slightly from place to place even within the report. The table for each site (Table 4-1) states that the effect of the tsunami or winter waves was suggested, or was presumed to have existed,

and the legend of the map (Figure 4-1) has only "decline due to tsunami". The overall conclusion states that the effect of the tsunami was limited to the tip of the peninsula, near the epicentre, and that the possibility was shown that disturbance occurred in the seaweed beds as well, but that it did not amount to catastrophic damage and natural recovery is awaited. The PR features of the Hokkoku Shimbun that appeared before the report (29 June and 31 July 2025) give only the tsunami and do not mention winter waves (read from the newspaper pages). [S1, S2]

The way the bottom on the offshore side at Kinoura is described does not match the explanation of the reason. The report describes the part of the Kinoura line from about the middle offshore as "sand and bedrock", while giving the reason as being that "boulders were rolled" (this paper's view). [S1]

Region (Sotoura): how much tsunami reached the 3 sites

The report considers the height of the tsunami at the 3 sites from the value for Kinoura. According to the material on Suzu City from the survey report meeting (27 January 2024) of the Coastal Engineering Committee of the Japan Society of Civil Engineers, at Kawaura, Orito and Kinoura the survey of 6–7 January 2024 found traces showing that the tsunami ran up to an elevation of 4.4 m (height above the mean sea level of Tokyo Bay), but there was no damage from water entering houses. The prefecture's recovery policy also carries this value. The report presumes that Nagahashi received a tsunami of a height comparable to that at Kinoura, about 12 km to the east, and that Noroshi received about the same as Kinoura, about 2 km to the west. [S6, S7, S1]

At Nagahashi, no traces of the tsunami have been found. The field survey of the Japan Meteorological Agency (11–20 January 2024) states that near the tsunami observation stations at Wajima Port and at Nagahashi in Suzu City, where observation had been interrupted after the earthquake (missing data), no traces of inundation by the tsunami were recognised. The material of the report meeting, too, writes only "uplift" for the Nagahashi district. From the absence of inundation traces on land, it cannot be said that the currents in the sea were also weak (this paper's view). The observation station at Nagahashi is covered in R7-B01. [S3, S6]

The data of the joint survey by universities and others (2024; published as a peer-reviewed data paper) contain values for the north coast of Suzu City here and there (Table 3). About 70 people collected 303 records between 4 January and mid-February 2024 along about 340 km of coast from Ishikawa Prefecture to Niigata Prefecture. There is no point with the name Nagahashi, and there are no points between Maura and Orito (as read by this paper). In the data, the 2 points at Orito, the point at Kawaura and some others are marked as points that do not represent their surroundings, and many of the points at Orito and Noroshi carry a note that wind and waves may have had an effect. The heights in the data appear to be values measured from the ground and the sea surface on the day of the survey (after the earthquake), not values from which the amount of uplift has been subtracted (this paper's reading, from the way the method is written in the paper). [S4]

Table 3 Tsunami heights on the north coast of Suzu City and at Jike (data of the joint survey, elevation in m)

Place	Kind	Height	Note in the data	Date surveyed
Maura	Run-up height	3.71	Represents its surroundings	11 February 2024
Orito (2 points)	Run-up height	4.535, 3.045	Do not represent their surroundings. Wind and waves may have had an effect	7 January 2024
Kawaura	Trace inside the port	3.635	Does not represent its surroundings	7 January 2024

Place	Kind	Height	Note in the data	Date surveyed
Noroshi (2 points)	Run-up height, inundation height	3.226, 2.71	3.226 represents its surroundings, but wind and waves may have had an effect. 2.71 does not represent them	2 February 2024, 6 January
Jike (the eastern end of the area covered)	Run-up height, inundation height	3.32–5.64	Most represent their surroundings	6 January to 12 February 2024

Note: From the values and notes in the column of height above the mean sea level of Tokyo Bay (T.P.) in the data (NP2024TS, version of 1 July 2024). For the dates surveyed, this paper converted the date column of the data into dates. Whether the elevation of 4.4 m that the material of the report meeting gives as the value for the Kinoura side corresponds to the point of 4.535 m at Orito in these data has not been checked. [S4, S6]

On the north coast, inundation of the land is said to have been slight. The data paper states that on the north and north-west coasts almost no inundation of the land was seen, because of the uplift of up to 4 m. A 2025 paper that mapped the extent of inundation over the whole of the Noto Peninsula states that the inundated area was continuous on the west and east coasts whereas it was broken into separate patches on the north coast, and gives the maximum tsunami height as 11.3 m at Kuroshima in Monzen, Wajima City (according to the abstract). The outreach magazine of the Noto Marine Center (December 2024) also states that the slight tsunami damage in Sotoura is said to be due to the uplift of the coast. [S4, S5, S10]

At the tip of the peninsula, the tsunami arrived early. According to the data paper, the tsunami reached Noroshi within a few minutes of the earthquake. At Jike, at the eastern end of Sotoura, there were inundation traces at an elevation of 4.9 m, and there were traces showing that the tsunami came several times from the south-east (material of the report meeting). The tsunami values as a whole and the preparations for the next tsunami are covered in R7-B02 "The active faults just off the coast, and preparing for the next earthquake and tsunami". [S4, S6]

Region (Sotoura): how large the winter waves were

Sotoura is a sea with rough winter waves. The report describes Sotoura as a sea where the rough waves of winter are severe and where the "wave flowers" (nami no hana) are a seasonal sight of winter. The material of the review committee for the prefecture's basic coastal protection plan (November 2025) gives the wave height used for planning, off Sotoura, as 9.3 m on the value for Wajima Port, and as 9.7 m for the future (if the temperature rises by 2°C) (R7-B05 "Redrawing the basic coastal protection plan (uplift and growing waves)"). [S1, S31]

On the north coast of Suzu, waves are not measured. The nearest national observation is the waves that the Hokuriku Regional Development Bureau of the Ministry of Land, Infrastructure, Transport and Tourism measures every 2 hours at a water depth of 52 m off Wajimazaki at Wajima Port. The observation point is about 39 km west of Noroshi (this paper's calculation from the latitude and longitude of both). Because these are values for a deep place offshore, they differ from the waves in the shallow places of the 3 sites. The shortage of observations of the sea of Sotoura is covered in R7-B04 "The changed topography of the shallow sea, and the shortage of maps and observations that fishers can use". [S12]

In the winter immediately after the earthquake, almost nothing could be measured. In January 2024, only the 12 observations from 0:00 to 22:00 on the 1st could be measured, and the rest could not (proportion missing, 96.8%). In February not even 1 observation could be measured, and in March 316 of the 372 observations could be measured. [S12]

The winter waves that could be measured were not larger than usual. The monthly maximum of the significant wave height (the average height of the highest one third of the waves; the value meant when people ordinarily

say "wave height") was 3.94 m in November 2024 and 4.80 m in December (at 2 a.m. on 23 December; waves from the north-north-west). The December maxima of 2015–2023 were 4.69–6.90 m, and December 2024 ranks 2nd from the lowest among them. The maxima of the 8 winters (November–March) from 2015/16 to 2022/23 were 4.69–7.51 m, and the highest was the 7.51 m of 29 January 2021 (all are this paper's tabulation; Table 4). The values for the latter half of the 2nd winter after the earthquake (January–March 2025) have not yet been published. The tables of the national observation are published 1 year at a time, and the file of the table for 2024 was last updated on 16 June 2026. [S12]

Table 4 Monthly maximum significant wave height (m) in winter off Wajima Port (water depth 52 m)

Winter	November	December	January	February	March	Winter maximum
2015/16	5.43	5.56	5.31	4.28	5.36	5.56
2016/17	4.47	5.30	5.37	5.17	2.83	5.37
2017/18	5.18	6.50	6.01	5.08	5.96	6.50
2018/19	3.20	4.69	4.00	3.46	4.29	4.69
2019/20	4.36	5.13	5.18	5.00	4.85	5.18
2020/21	3.22	5.43	7.51	5.46	4.06	7.51
2021/22	5.24	6.90	5.85	5.02	4.67	6.90
2022/23	3.86	6.20	6.07	3.72	2.81	6.20
2023/24	5.11	5.40	3.59 (0:00–22:00 on the 1st only)	Not measured	4.24 (316 of 372 observations)	—
2024/25	3.94	4.80	Not published	Not published	Not published	—

Note: This paper tabulated the maximum for each month from the wave summary tables for Wajima Port of the Hokuriku Regional Development Bureau (values every 2 hours). In the tables for 2015–2018 the order of the columns is reversed, and we read them after correcting the order. The earthquake was at about 16:10 on 1 January 2024. The January maximum for 2023/24 (3.59 m) is a value from before the earthquake, at 0:00 and 2:00 on the 1st. Of the 12 observations that could be measured, the 3 at 18:00–22:00 are values from after the earthquake, and nothing could be measured from 0:00 on the 2nd. [S12]

The winter before the diving survey is said to have been one in which a winter-type weather pattern tended to persist in Hokuriku. According to the summary for the Hokuriku region by the Niigata Local Meteorological Office, in the winter from December 2024 to February 2025 the winter-type pressure pattern tended to persist in December and February, and there were 2 cold waves in February. This summary has no values for wave height. As for a different living thing, in March–April 2025 a relative of the sea urchins that lives in sandy sea floors (hiratabunbuku) was washed ashore in large numbers on 2 coasts, at Jike and in Uchiura, and a research report of the Noto Marine Center takes mass death caused by the 2 strong cold waves of the preceding winter to be the main reason. This is not about seaweed beds. [S13, S14]

We found no material that confirmed locally that winter waves damaged the seaweed beds of the 3 sites. Winter waves come every year, so even in a winter when the waves are not especially large there can be places where stones roll (this paper's view). [S1, S12]

Region (Sotoura): the area of the seaweed and seagrass beds of the Suzu City district, seen by satellite

The report measured the area of the seaweed and seagrass beds of the Suzu City district with satellite images. The area in 2025 was 1,795 ha, a value 13.5% smaller than the 2,074 ha of the prefecture's survey of fiscal 2018 (a value that the report recalculated after adjusting the divisions). This district includes Uchiura, and no value for Sotoura alone is given. As a place where the area decreased, the report gives the eelgrass beds on the Uchiura side, along the coast in the south of the district. [S1]

By type of bed, the decrease in eelgrass beds is the largest. The values for 2025 (with fiscal 2018 in parentheses) are 94 ha (132 ha) of kajime beds, 145 ha of places where Sargassum beds and kajime beds are mixed (not separated in fiscal 2018), 1,495 ha (1,750 ha) of Sargassum beds, 43 ha (192 ha; a decrease of 77.6%) of eelgrass beds, and 19 ha (not separated) of small seaweeds. Because the way the beds are classified differs between the 2 surveys, the increases and decreases by type cannot be compared as they are. The total of 1,795 ha also includes the 19 ha of small seaweeds, which were not separated in the survey of fiscal 2018, and the dates on which the images were taken also differ from place to place, so the decrease of 13.5% is a rough guide (this paper's view). [S1]

The value for Suzu before the earthquake differs from one material to another. The prefecture's Seaweed and Seagrass Bed Vision gives the seaweed and seagrass beds of Suzu in fiscal 2018 as 2,251.4 ha, of which the places where Sargassum beds and arame beds are mixed are 173.1 ha. The difference from the report's 2,074 ha is about 177 ha, and the reason for it is not stated (the difference is this paper's calculation). The difference is a value close to the 173.1 ha of places where Sargassum beds and arame beds are mixed in the prefecture's values (this paper's calculation). The report's value for fiscal 2018 comes to 2,074 ha when the 3 categories of kajime beds, Sargassum beds and eelgrass beds are added, and it has no category for mixed places. This may be due to a difference in the way of counting, but it cannot be confirmed from the materials (this paper's view). The prefecture surveys Suzu as part of the district on the Uchiura side (the Noto and Uchiura district). [S11, S1]

The images of Suzu were taken on different days in different places. The image of the north coast (Suzu Sotoura) was taken on 5 June 2025, 2–4 days before the diving survey. The Uchiura side was taken on 21 April 2025. The sea north-north-east of Cape Rokko, which the report calls "off Suzu" (read from the figure), was taken on 19 March 2024. The report states that near Suzu City and elsewhere, where the uplift was especially large, it was confirmed in the satellite images as well that the distribution of the seaweed beds has moved further offshore than before. What is shown in the figure is the area around Kataiwa-machi on the north coast. [S1]

There are seaweed beds in the deep sea offshore as well. In the report's survey with an underwater camera from a boat (3 May 2025), 7 of the 8 points at water depths of 10.5–30.7 m in the sea north-north-east of Cape Rokko (read from the figure) were sparse Sargassum beds, or places where Sargassum beds and kajime beds are mixed, with a cover of 30–40%. The report states that kajime species are distributed in the places at a water depth of around 25 m that jut out offshore of Noroshi. For these offshore points there is no comparison with values from before the earthquake. The areas for the districts of Wajima City and Shika Town in Sotoura are covered in R7-B08. [S1]

Region (Sotoura): the view of fishers, and matters covered in other papers

In the interviews with fishers, only a few people gave the tsunami. The report interviewed 32 fishers who gather shellfish and seaweed in the 4 cities and towns of Oku-Noto (20 October 2025 to 16 January 2026). Of the 31 who answered about the cause of the decrease in catch, about 6% gave "roughening of the rocky shore by the tsunami", and among the factors for the decrease in resources, too, "roughening of the rocky shore in the tsunami" was about 6% (read from the figures). The most common factor for the decrease in resources was the inflow and accumulation of mud, at 58%. Winter waves are not among the answer items shown in the figures.

The 32 people live in Wajima City (16), Suzu City (8), Noto Town (6) and Anamizu Town (2), and they include people of Uchiura, so the proportions are not values for Sotoura alone. [S1]

Other things, too, overlap in the seaweed beds of the 3 sites. All of them are covered in other materials of this series.

- The shallow seaweed beds that dried out: through the uplift, the seaweed beds near the coastline at the 3 sites dried out and disappeared. The perennial seaweeds that remain near today's coastline and are not suited to shallow places are expected to die back in time (R7-B08). [S1]
- The living things of the intertidal zone: in the uplifted intertidal zones of Nagahashi and Kinoura, the number of species of living things decreased (R7-B07 "The wiping out of the living things of the intertidal zone and the shallow rocky reefs, and the recovery afterwards"). [S9]
- Mud: of the 5 sites in Sotoura, the one where the seaweed bed was said to have declined because of mud is Kaiso in Wajima City, not the 3 sites (R7-B09 "The mud and turbidity that keep coming in from river mouths (the seaweed beds and rocky-shore fishing grounds of the Wajima coast)"). [S1]
- Summer water temperature: covered in R7-B12 "High summer water temperatures (the shallow sea of Sotoura)".
- Shellfish and seaweed fishing: abalone and turban shells are covered in R7-B13 "The mass death of abalone and turban shells, and the fall in catches that continues for some years", and the rocky shores where iwanori (rock laver) and wakame are picked are covered in R7-B14 "The rocky shores of iwanori and wakame (the drying out of the nori beds, footing and processing sites)". The prefecture's list of damage has no item for seaweed beds, and under "Other" it gives 18 places (of which 3 are in Suzu City) where iwanori beds and aquaculture facilities were damaged. [S34]

3. Existing measures, and how they are assessed

In the materials this paper looked at, we found no measures directed at the offshore-side seaweed beds of the Sotoura coast of Suzu (creating seaweed beds, setting out mother plants [parent seaweeds that release seed], removing sea urchins and so on). What the materials contain are 3 things: surveying and recording, the seaweed and seagrass bed projects of the prefecture and the national government, and local fishing plans. There is no material that surveyed the offshore side of the 3 sites by the same method 2 or more times, and we also found no material that assessed the effect of any initiative.

Surveying and recording

The offshore side of the 3 sites has been surveyed only 1 time, in the diving survey of the report in June 2025. The report states that the beds are thought to change back to their original state as time passes, but that it is necessary to keep watching them regularly in future as well. Who will continue this, when, and with what budget is not stated. [S1]

The intertidal zones of the 3 sites are being watched by the prefecture's research facility and by university researchers. The Noto Marine Center surveyed Nagahashi and Shakuzaki at Kinoura in June 2020, and in May–June 2024, after the earthquake, it surveyed Nagahashi, Shakuzaki and Noroshi at today's shoreline. Both are observations down to about 0.5 m below the sea surface. In April 2025, a researcher of Tohoku University and others placed 25 cm square frames at fixed locations, at places of different heights, on 7 coasts of Sotoura including Nagahashi, Kinoura and Noroshi, and carried out the 1st survey in June. Both are surveys of the intertidal zone, and the offshore-side seaweed beds are not their subject. The watching of the intertidal zone is covered in R7-B07. [S8, S9, S10]

The prefecture, too, is surveying the distribution of seaweed and seagrass beds. The material of the review committee for the prefecture's new fisheries promotion vision (September 2026) shows the distribution of seaweed and seagrass beds after the earthquake as the "R7–R8 survey" (the survey of fiscal 2025–2026), in a figure of the whole coast of the prefecture. The same material states that in the surveys after the earthquake, the decline of the coastal seaweed and seagrass beds has been confirmed (this is a statement about the prefecture as a whole). Values for each district have not been published. [S33]

There is no long-term national monitoring in Ishikawa Prefecture. The seaweed bed survey of the Ministry of the Environment's Monitoring Sites 1000 is continued every year at 6 places in Japan (Muroran, Shizugawa, Izu-Shimoda, Takeno, Awaji-Yura and Satsuma-Nagashima), and on the Sea of Japan side there is only Takeno in Hyogo Prefecture. The Ministry of the Environment's survey of the natural environment of the Noto Peninsula in fiscal 2025 (Reiwa 7) surveyed Kinoura on 22 October and 11 November 2025, but its subjects were land plants, insects, birds, mammals and the like, and the words for seaweed beds and seaweed do not appear in its report (counted by this paper). [S22, S23]

The projects of the prefecture and the national government to protect seaweed and seagrass beds

The seaweed and seagrass bed projects of the prefecture and the national government do not extend to the north coast of Suzu. According to the prefecture's Seaweed and Seagrass Bed Vision, the only place in Suzu City where seaweed beds have been created so far is Iida in Uchiura (1.4 ha, fiscal 2015–2017). In the plan for fiscal 2022–2031, the places are Hegurajima Island and the Nanatsujima Islands in Sotoura and 10 places such as Horyu in Uchiura, and the north coast of Suzu is not included. In the prefecture's fishing ground improvement for the Kaga and Noto Sotoura district (fiscal 2022–2031), too, the cities and towns concerned run from Kaga City to Wajima City, and Suzu City is not included. [S11, S28]

Nor is there, in Suzu City, an organisation under the national programme in which fishers protect seaweed and seagrass beds. Among the activity organisations in Ishikawa Prefecture under the measures to bring out the multiple functions of fisheries (a programme in which the national government supports activities by fishers and others to protect seaweed and seagrass beds and tidal flats), the only organisations that protect seaweed and seagrass beds are the Wajima Satoumi Protection Group (Wajima no Satoumi o Mamoru Kai) in Wajima City and the Ishizaki Satoumi Conservation Group in Nanao City. The conservation coastal fishing grounds under the Fisheries Act (fishing grounds where a fisheries cooperative carries out conservation activities) also number only 1 place, off the shore of Wajima City. The activities of the Wajima group are covered in R7-B26 "Rebuilding the local activities that protect the seaweed beds of Wajima". [S24, S26, S27, S30]

The national government's approach is first to survey and look for the cause. The Fisheries Agency's guidance recommends that, if a decline is seen, simple field experiments and surveys be carried out to look for the cause. As the method, it points to the guidelines' "Simple field experiments and surveys to identify the factors" as a reference. We found no material showing whether such surveys were carried out at the 3 sites. [S16, S15]

Local fishing plans, and support after the earthquake

The local plans of Suzu contain no initiatives for seaweed and seagrass beds. The 3rd phase of Suzu City's Plan for Revitalising Fishing Communities (Hama Plan) (fiscal 2026–2030; the plan of a regional committee formed by the Ishikawa Prefecture Fisheries Cooperative Association, Suzu City and the prefecture) gives, as initiatives to increase resources, the release of seed (reared young) of abalone and turban shells, and fishing operations that make use of the survey of the bottom trawl fishing grounds after the earthquake; the words for seaweed beds and seaweed do not appear in it. Suzu City's reconstruction plan (February 2025) also has no project for seaweed and seagrass beds. [S25, S32]

After the earthquake, there was national support for fishers to survey the fishing grounds themselves. The prefecture's recovery policy (August 2024) gives, as immediate support for fishers, surveys of the actual state of fishing grounds whose topography has changed and the removal of material deposited by the tsunami and other causes, and gives the national fishing ground restoration support project as an example. The report states that this project was scheduled to end in fiscal 2025. Whether this project was used for surveys of seaweed beds on the Sotoura coast of Suzu could not be determined from the materials. The gaps in support are covered in R7-B24 "The income of fishers affected by the disaster, and the gaps in support". [S7, S1]

The prefecture's new projects for fiscal 2026, too, appear not to cover the shallow seaweed beds of the north coast of Suzu. The prefecture's initial budget for fiscal 2026 included a survey of the sea-floor topography and resources of the bottom trawl fishing grounds by the prefecture's research vessel Hakusan Maru (6.8 million yen) and, towards rebuilding the ama divers' fishing, support for activities to protect seaweed beds such as removing driftwood that has flowed in and propagating seaweed (3.5 million yen). A newspaper advertisement by the prefecture's Fisheries Division (22 February 2026) describes the survey of the bottom trawl fishing grounds as a 3-year plan for fiscal 2026–2028 in the sea off Suzu City to Wajima City, and states that the support for activities by ama divers to protect seaweed beds will be carried out from fiscal 2026 in cooperation with the national government and Wajima City as well. [S29, S1]

Assessment of the initiatives

We found no material that assessed the effect of any initiative. What the materials show are outlooks and requests. The report states that the beds are thought to change back to their original state as time passes, and calls for regular monitoring. In the Tohoku examples, the effect of the tsunami could be stated in quantities because the same place had been surveyed since before the earthquake. The seaweed bed at Tomarihama expanded after the tsunami as the sea urchins decreased, and retreated when the sea urchins returned. The fate of the seaweed bed was determined not only by the tsunami but also by the increase and decrease of the animals that eat seaweed (chapter 2). [S1, S17, S15]

4. What is changing

We found no material showing what has become of the offshore-side seaweed beds of the 3 sites since then (as of 12 November 2026; the latest survey is of June 2025). Much of what this chapter covers is the outlook in the materials, and plans and schedules.

The succession of the seaweed beds

The report expects that the beds will return as time passes. In its summary, it states that they are thought to change back to their original state with the passage of time, and in its overall conclusion, that the damage did not amount to catastrophic damage and natural recovery is awaited. The overall conclusion states that through the uplift, rock that had been buried under sand has been exposed on the offshore side of the seaweed beds, and that succession has begun there from small annual seaweeds, and that it is necessary to watch over this without haste (written without specifying sites). [S1]

On the other hand, concern has also been expressed. In the PR feature of the Hokkoku Shimbun (31 July 2025), the leader of the diving survey team likened the shallow area at Noroshi to land covered with nothing but annual grasses, and spoke of the concern that when the annual seaweeds die back, a scene resembling isoyake will spread (read from the newspaper page). [S2]

There is no material that gives, for the 3 sites, the number of years until the beds return. In the examples from Japan and abroad, on the boulders of California it took 2–3 years until perennial red algae covered them. Among

the perennial Sargassum seaweeds, there are species that live for about 9 years. The arame of Tomarihama retreated from 3 and a half years after the tsunami, as the sea urchins increased (chapter 2). All of these are examples in which both the species and the sea are different. [S19, S15]

Plans and schedules

- Fiscal 2026: the prefecture's new fisheries promotion vision is to be drawn up, with a target of within fiscal 2026 (the 1st meeting of the review committee was on 4 September 2026). The current plan gives "conservation and effective use of seaweed and seagrass beds" as 1 of its priority issues. [S33]
- Fiscal 2025–2026: the prefecture's survey of the distribution of seaweed and seagrass beds (the "R7–R8 survey"). Only a figure of the whole coast of the prefecture has been published. [S33]
- Fiscal 2026–2030: the 3rd phase of Suzu City's Plan for Revitalising Fishing Communities (Hama Plan). The initiatives for resources are the release of seed of abalone and turban shells, and so on. [S25]
- Fiscal 2026–2028: the survey of the bottom trawl fishing grounds in the sea off Suzu City to Wajima City by the prefecture's research vessel Hakusan Maru. [S29, S1]
- Fiscal 2026: the redrawing of the prefecture's basic coastal protection plan. The wave height used for planning for Sotoura is 9.7 m for the future (R7-B05). [S31]
- 30 June 2026: the prefecture changed the Ishikawa Sea Area fishing ground plan (licences of 1 November 2026). The common fishery rights of the north coast of Suzu (Kyo No. 13–15) have not changed, and their term runs until 31 August 2033. [S24]
- By the end of fiscal 2029 (medium to long term): under Suzu City's reconstruction plan, sea data such as seawater temperature and ocean currents are to be collected using a low-power, wide-area wireless network. [S32]
- The 2025 table of the waves off Wajima Port had not been published as of 12 November 2026. If it is published, the waves of the winter before the diving survey (January–March 2025) can be checked. [S12]

5. What is not yet known

Things for which there are no figures

- We found no records of the seaweed beds on the offshore side of the 3 sites from before the earthquake. The only records from before the earthquake are the observations of June 2020 at Nagahashi and Kinoura, down to about 0.5 m below the sea surface, and there are no records for Noroshi. [S1, S8]
- We found no material that surveyed the offshore side of the 3 sites later than June 2025. [S1]
- We found no tsunami heights for the places the report surveyed at Nagahashi and Noroshi. At Nagahashi no inundation traces on land have been found, and at Noroshi there are points in the data of the joint survey (elevations of 2.71 m and 3.226 m). We also found no material that measured, in Sotoura, the tsunami moving stones or seaweed in the sea. [S3, S4, S1]
- We found no observed wave values for the north coast of Suzu. The nearest observation, off Wajima Port, is also missing for January–February 2024, and January–March 2025 has not been published. [S12]
- We found no figure for the Sotoura portion of the area of the seaweed and seagrass beds of the Suzu City district. The values for each district from the prefecture's survey of fiscal 2025–2026 have not been published either. [S1, S33]
- We found no material showing whether animals that eat seaweed, such as sea urchins, increased or decreased at the 3 sites after the earthquake. [S1]

- We did not find the original newspaper article with the account of the fisher of Takaya-machi (Hokkoku Shimbun, morning edition of 3 June 2025). [S1]

Limits of the comparisons

- The diving survey was made only 1 time, in June 2025, with 1 line (up to 200 m) at 1 site. The season, too, is June only, and it is not stated whether the timing was checked with a local research institution as the guidance recommends. [S1, S16]
- Only the shallow places that dried out can be compared with the time before the earthquake. What the report compared with the time before the earthquake is the species seen in the observations down to a water depth of 0.5 m (umitoranoo, narasamo and sugimoku); it did not compare the abundance of perennial seaweeds on the offshore side. The "decline" on the offshore side is an inference from today's make-up (many annuals and few perennials). [S1, S8]
- That many perennial seaweeds were seen in the places deeper than about 6 m at Noroshi and at the point at a water depth of 8 m at Nagahashi is not written in the main text of the report; it is what this paper read from the figures and from the newspaper page of the PR feature. [S1, S2]
- The waves off Wajima Port are values at a water depth of 52 m, about 39 km west of Noroshi. They differ from the waves in the shallow places of the 3 sites at water depths of 0–8 m. [S12]
- The heights in the tsunami data were measured from the ground and the sea surface after the earthquake. Where the uplift is large, they differ from the height above the sea surface at the time of the earthquake, so care is needed when comparing between sites (this paper's reading). [S4]
- The comparisons for Mitsukejima Island and Koura in Uchiura are comparisons with the old surveys of 1976 and 2006. The same report also saw, in another part of the sea area of Uchiura, poor seaweed beds that it infers were disturbed by stormy seas and tsunami. It cannot be asserted that "Uchiura did not change". [S1]
- The examples of the tsunami in Tohoku and of storms overseas differ in the sea, the species of seaweed, the size of the stones on the bottom and the abundance of sea urchins. [S17, S19, S20, S21]
- The 32 people interviewed were chosen in consultation with the prefecture's fisheries staff, as people who had been fishing keenly since before the earthquake, and they include people of Uchiura. [S1]

Figures that do not agree

- The uplift at the 3 sites, and the width by which the coastline moved, differ from one material to another (Table 5). This appears to be because the time and place of measurement, and what was taken as the coastline, differ, but it cannot be confirmed from the materials.

Table 5 The uplift at the 3 sites, and the width by which the coastline moved (differences between materials)

Site	Uplift	Width by which the coastline moved	Material
Nagahashi	2.8 m	About 60 m offshore	The report (the uplift is the same as the prefecture's provisional value for Nagahashi Fishing Port)
Nagahashi	226 cm	Shoreline advanced 44 m	Research report of the Center (survey of May 2024; the uplift is quoted from a photograph collection)
Nagahashi	2.3 m, about 2 m	—	Explanatory article by the Tohoku University researcher, outreach magazine of the Center
Kinoura	1.8 m	About 15 m offshore	The report (the uplift is the same as the prefecture's value for the Takaya district of Noroshi Fishing Port)

Site	Uplift	Width by which the coastline moved	Material
Kinoura	1.2 m	—	The prefecture's provisional value for the Orito district of Noroshi Fishing Port
Kinoura	171 cm	Shoreline advanced 33 m (Shakuzaki)	Research report of the Center (survey of May 2024)
Kinoura	About 2 m	Coastline retreated about 60 m	Outreach magazine of the Center (survey of March 2024)
Kinoura	1.7 m, about 1.5 m	—	Explanatory article by the Tohoku University researcher, PR fea - ture of the Hokkoku Shimbun
Noroshi	0.8 m	About 65 m offshore	The report (the uplift is the same as the prefecture's value for the Noroshi district of Noroshi Fishing Port)
Noroshi	117–147 cm, 1.3 m	—	Research report of the Center (survey of June 2024), explanatory article by the Tohoku University researcher

Note: The values are given in the wording of each material. The "retreated" of the outreach magazine appears to mean that the sea drew back, that is, that the coastline moved out offshore (this paper's reading).
[S1, S7, S9, S10, S2]

- For the tsunami at Nagahashi, the report presumed a height comparable to that at Kinoura, whereas the Japan Meteorological Agency recognised no inundation traces near the observation station at Nagahashi. Whether the place the report surveyed and the position of the observation station are the same cannot be determined from the materials. [S1, S3]
- The way the reason is written differs within the report. The main text for each site has "the tsunami or high winter waves", the summary has that the tsunami is highly likely, the legend of the figure has the tsunami only, and the overall conclusion has "did not amount to catastrophic damage" (chapter 2). [S1]
- The area of the seaweed and seagrass beds of Suzu before the earthquake is 2,074 ha in the report's recalculated value and 2,251.4 ha in the fiscal 2018 value of the prefecture's Seaweed and Seagrass Bed Vision. The reason for the difference of about 177 ha is not stated. It is a value close to the 173.1 ha of mixed places in the prefecture's values (this paper's calculation). [S1, S11]
- Winter waves are given by the report as a candidate for the reason, but the waves of November–December 2024, which could be measured, were not large compared with the winters since 2015 (this paper's tabulation). Whether the stones were rolled by ordinary winter waves, or whether there were exceptionally large waves after the earthquake, cannot be determined from the materials. [S1, S12]

Reliability, and the standpoint of the materials

The reliability differs from item to item. That in June 2025, in the shallow sea offshore of the places that dried out at the 3 sites, annual seaweeds were abundant and large perennial seaweeds were scarce is the result of a diving survey that stated its method, and the main text, the figures and the newspaper page of the PR feature agree. However, because it was 1 survey, with only 1 line at 1 site, and there is no separate survey, the reliability is medium. That this is the result of a decline from before the earthquake rests on the secondary quotation of the account of 1 fisher and on inference from today's make-up, there being no records of the offshore side from before the earthquake, so the reliability can be said to be low. Whether the reason is the tsunami or winter waves is written by the report itself as a possibility; at Nagahashi no traces of tsunami inundation have been found, and winter waves are not measured at the 3 sites, so the reliability can be said to be low. The height of the tsunami on the Kinoura side (an elevation of around 4.4 m) comes from field measurement by the joint survey of

universities and others, and its reliability can be said to be medium (in the data, the nearby points at Orito carry the notes that they do not represent their surroundings and that wind and waves may have had an effect). Also, it is not a value for the places the report surveyed at Nagahashi and Noroshi. The wave values off Wajima Port come from national observation, and the reliability of the values themselves can be said to be high, but it is not known whether they represent the waves in the shallow places of the north coast of Suzu, and there are no values for the winter immediately after the earthquake or for the winter at the beginning of 2025, so their reliability as material for checking the winter-wave explanation can be said to be low. That many perennial seaweeds were seen in the deep area comes from reading the figures and the newspaper page, and its reliability is low to medium. That the beds will return as time passes is the report's expectation, and there is no survey that has kept watching, so the reliability can be said to be low. That the seaweed and seagrass beds of the Suzu City district decreased by 13.5% is a value from a survey that checked satellite images against field surveys, but it includes Uchiura, the way the beds are classified differs from the earlier survey, and the value for before the earthquake does not agree with the prefecture's value, so the reliability is medium. The examples from Japan and abroad come from papers and national guidelines, and their reliability can be said to be high, but they cannot be applied as they are to the Sotoura coast of Suzu.

Care is also needed about the standpoint of the materials. The report is the report of a survey that the Kanazawa Association of Corporate Executives, a business association, carried out with a grant from The Nippon Foundation and the special cooperation of the Hokkoku Shimbun newspaper company, and it is not peer-reviewed. The leader of the survey team is Daisuke Fujita, president of the Japan Seaweed Association; the diving survey was undertaken by a survey company (Shizen Kankyo Chosa, a limited company), the satellite analysis by a surveying company (Kokusai Kogyo), and the interviews by Ryoko Ishikawa of Wajima Seaweed Lab; and people from the prefecture's Fisheries Division and Fisheries Research Center take part as observers. The PR features of the Hokkoku Shimbun conveyed the results of the same survey team and do not serve as a check on the report. The newspaper pages were read from the images included in the report, and the small print may have been misread. The account of the fisher of Takaya-machi comes from the newspaper article that the report quoted, and this paper has not checked the original article. The material of the report meeting of the Japan Society of Civil Engineers and the data paper of the joint survey are results of the same joint survey, and the tsunami values in the prefecture's recovery policy also refer to the material of the report meeting. For that reason, the agreement of the values for the Kinoura side cannot be called independent confirmation. The material of the report meeting is a presentation that is not peer-reviewed. The research reports and the outreach magazine of the Noto Marine Center are from the same prefectural facility, and the explanatory article by the Tohoku University researcher is also a contribution to that outreach magazine. The content of the study of the intertidal zone in the Great East Japan Earthquake (2016) was read through the account given in this contribution. The monthly maxima of the waves off Wajima Port are values that this paper tabulated from the national tables. Of the English-language papers, we read only the abstracts of the 2 on the Oshika Peninsula, the 5 on storms, the 1 on the intertidal zone of Tohoku (2020) and the 1 on the extent of inundation in Noto.

The publisher of this paper (SeatecHIROSHIMA Ltd.) runs a business that controls biofouling by surface treatment of materials. This is both preventing fouling from attaching (antifouling) and making it easier for eelgrass (a kind of seagrass) to take root for the regeneration of seaweed and seagrass beds. It is also developing a system that identifies the positions of oyster rafts and notifies ships of them. This paper does not cover the company's own technology or results. This paper deals with the decline of seaweed beds itself, and the regeneration of seaweed and seagrass beds overlaps with the field of the publisher's business. This paper also touches on the area of the seaweed and seagrass beds of the Suzu City district measured with satellite images. The publisher is developing, in joint research with Hiroshima University and others, a system that identifies the positions of oyster rafts using satellite data, and the analysis of satellite images overlaps with the field of the publisher's development. The relationships with the bodies taken up in this paper, and with bodies active in Sotoura, are as follows (as of 12 November 2026; based on information the publisher has made public, the

publisher's contracts and records, and the research for this paper). With Ishikawa Prefecture, there is the relationship of having been selected (September 2025) for the prefecture's (Commerce, Industry and Labour Department, Industrial Policy Division) "survey project for attracting startups to Noto" (fiscal 2025 [Reiwa 7]). In this project, specialists accompany and support the selected companies in drawing up business plans and building connections in Noto (according to the prefecture's announcement). Many of the materials this paper cites are the prefecture's plans and materials, and the prefecture's Fisheries Division and Fisheries Research Center take part as observers in the survey of the report. In October 2026, in the "Startup Business Plan Contest Ishikawa 2026" held by Ishikawa Prefecture and the Ishikawa Sunrise Industries Creation Organization (a public interest incorporated foundation), the publisher received the Best Entrepreneur Award for a plan on the subject of Nanao Bay (according to the announcement on the Organization's website). The Organization's website states that this award comes with a subsidy and with the free loan for 3 years of a room in a facility that rents rooms to newly founded companies, among other things. In Noto, the publisher works in collaboration, under non-disclosure agreements, with Nanaibe LLC and Yamaguchi Suisan of Nanao City, with Atsumasa Nakamura of Kanazawa University, and with the Noto Fisheries Profit Improvement Council. With the Ishikawa Prefecture Fisheries Cooperative Association (it also has branches in Sotoura; its president is a member of the review committee for the prefecture's basic coastal protection plan, and its representative director and senior managing director is a member of the review committee for the prefecture's new fisheries promotion vision), there is the relationship that the publisher secured the site for its demonstration through its collaboration partner Nanaibe LLC. Suzu City's Plan for Revitalising Fishing Communities (Hama Plan), which this paper cites, is that of a committee whose representative is the chair of the steering committee of the same cooperative association's Suzu Branch, and this paper also cites the rules that the same cooperative association laid down as a coastal fishing ground management body. In the interviews for the report, each branch of the same cooperative association was asked to cooperate. The publisher is not a member of the Noto Fisheries Profit Improvement Council. The area in Ishikawa Prefecture with which the publisher has been involved is mainly Nanao Bay, and Nanao Bay is covered in R7-A (Nanao Bay) of this series. In Sotoura (Shika Town, Wajima City and the north coast of Suzu City as far as Jike), the publisher is not active. Among the materials this paper cites, researchers of Kanazawa University are among the authors of the data paper of the joint survey, of the paper on the extent of tsunami inundation on the Noto Peninsula (2025) and of the Noto Marine Center's 2026 research report on hiratabunbuku, and in the survey team of the material on Suzu City of the report meeting of the Japan Society of Civil Engineers, and researchers of the same university also cooperate in the monitoring of the intertidal zone by the Tohoku University researcher and others. The chair and 1 of the members of the review committee for the prefecture's basic coastal protection plan, and 1 of the members of the review committee for the new fisheries promotion vision, are also people of the same university. The name of Atsumasa Nakamura does not appear among the authors or cooperators of these materials, nor in the lists of members of the 2 committees or of the survey team of the report. With Hiroshima University, the publisher has taken part since October 2025, as one company of a consortium, in a research centre of the university (JST COI-NEXT). Michio Imai, the publisher's joint representative CEO, has served since 1 November 2026 as a researcher (part-time) at a research institute of the university (the institute for the future of the ocean and maritime affairs) (concurrently with being the publisher's joint representative CEO). In addition, the publisher joined joint research under the Town & Gown concept of Kure City and Hiroshima University (a concept under which the city and the university work together) (the research period is October 2025 to August 2026, and the contract was made in March 2026). This joint research is funded by a research grant of Kure City, and the publisher received an allocation of research funds from that grant (April 2026). It has also been selected for the research grant of Kure City for the 2nd year (from September 2026). There are researchers of Hiroshima University among the authors of the paper on the extent of tsunami inundation on the Noto Peninsula (2025) and of the Noto Marine Center's 2026 research report, both cited in this paper, and among the cooperators in the monitoring of the intertidal zone by the Tohoku University researcher and others, but the researchers who are the publisher's partners in the joint

research are not among any of them. This paper does not use the data or results of this joint research. With Tohoku University, there is the relationship that in October 2026 the publisher applied to a public call for research of a research centre led by the university (COI-NEXT) (the result had not come out as of 4 November 2026). The author of the explanatory article on the monitoring of the intertidal zone cited in this paper, the authors of the data paper of the joint survey, and the survey team of the material on Suzu City of the report meeting of the Japan Society of Civil Engineers include researchers of Tohoku University. Apart from the above, there are no relationships between the publisher and the bodies taken up in this paper (national bodies, the prefecture and the cities and towns, universities and research institutions, academic societies, the business association and its survey team, the companies and bodies named in this paper, overseas universities and research institutions, and so on) or the bodies active in Sotoura (fisheries cooperatives, local bodies and so on) that would affect the content of this paper. The relationships meant here are transactions, funding, joint research, and officers or staff of the publisher concurrently serving as staff or officers of the body. This is the publisher's judgement, made after checking the information the publisher has made public, the publisher's contracts and records, and the research for this paper.

6. Sources

We examined materials that had been published by 12 November 2026. Centring on materials of the national government and the prefecture, peer-reviewed papers and reports of research institutions, we used figures that we checked in the very materials listed as sources (for papers of which we read only the abstract, the table says so). Among the figures that the materials quote from other studies, there are some that we have not checked back to the original study, and these are marked "quoted" in the text. Values that this paper tabulated or calculated from the values in the sources are written as "this paper's tabulation" or "this paper's calculation", and what was read from figures or newspaper pages as "read from the figures" or "read from the newspaper page". Reliability: A = laws and regulations, statistics, materials and observations of the national government and the prefecture; B = papers, reports of research institutions that state their method; C = explanatory materials for the general public, explanations by organisations, presentations at meetings; D = news reports.

ID	Source (publisher, year)	Type	Reliability	Chapters used
S1	Kanazawa Association of Corporate Executives, special committee for the survey of the effects of the earthquake disaster on the coast of the Noto Peninsula: Report of the fiscal 2025 (Reiwa 7) survey of the effects of the earthquake disaster on the coast of the Noto Peninsula (in Japanese) (published 24 March 2026. The team leader is Daisuke Fujita [president of the Japan Seaweed Association]. Grant from The Nippon Foundation, special cooperation of the Hokkoku Shimbun newspaper company. The prefecture's Fisheries Division and Fisheries Research Center are observers. Not peer-reviewed. "The report" in this paper. The diving survey is on pp. 111–131, the area for the Suzu City district on p. 89 and p. 97, the overall conclusion on p. 203, the interviews on pp. 135–156, and the advertisement by the prefecture's Fisheries Division on p. 198 of the appendix)	Report	C	Chapters 1–5
S2	Hokkoku Shimbun: PR features on the Kanazawa Association of Corporate Executives' survey of the effects of the earthquake disaster on the coast of the Noto Peninsula (in Japanese) (29 June and 31 July 2025. Special cooperation of the Hokkoku Shimbun newspaper company. Read from the images of the newspaper pages included on pp. 189–199 of the appendix of S1)	News	D	Chapters 1, 2, 4, 5
S3	Japan Meteorological Agency: Results of the field survey on the tsunami by the Japan Meteorological Agency Mobile Observation Team (JMA-MOT) for the "2024 (Reiwa 6) Noto Peninsula Earthquake" (in Japanese) (26 January 2024. The survey was on 11–20 January. The values are preliminary figures)	Announcement	A	Chapters 1, 2, 5

ID	Source (publisher, year)	Type	Reliability	Chapters used
S4	Yuhi et al. (Japan Society of Civil Engineers, Coastal Engineering Committee, 2024 Noto Peninsula Tsunami Joint Survey Group): Dataset of Post-Event Survey of the 2024 Noto Peninsula Earthquake Tsunami in Japan (Scientific Data 11, 786, 2024. The data are the 1 July 2024 version of NP2024TS)	Paper	B	Chapters 1, 2, 5
S5	Iwasa et al.: Distribution of tsunami inundation area and tsunami height asso - ciated with the 2024 Noto Peninsula earthquake, central Japan (Earth, Planets and Space 77, 2025. CC BY. Abstract only checked)	Paper	B	Chapter 2
S6	Japan Society of Civil Engineers, Coastal Engineering Committee: Survey report meeting on the tsunami of the 2024 (Reiwa 6) Noto Peninsula Earthquake (in Japanese) (27 January 2024), material "Field survey report on tsunami damage: Suzu City" (Hideomi Gokon of the Japan Advanced Institute of Science and Technology and others. The survey team includes researchers of Kanazawa University, Tohoku University and others. Not peer-reviewed)	Announcement	C	Chapters 1, 2
S7	Ishikawa Prefecture and the council for the recovery of the fisheries-related ports of Noto: Recovery policy for the fisheries-related ports of Noto (in Japanese) (drawn up in August 2024. The PDF on the website is the revised version of December 2024. The uplift for each fishing port is the provisional values on p. 6, the tsunami values are on p. 7, and the immediate support is on p. 28)	Plan	A	Chapters 2, 3, 5
S8	Noto Marine Center: Monitoring survey on the rocky coasts of Ishikawa Prefecture (in Japanese) (Research Report of the Noto Marine Center 26: 55-66, 2020. Nagahashi and Shakuzaki were surveyed on 9 June 2020)	Report	B	Chapters 1, 2, 3, 5
S9	Higashide, Arakawa and Nakade (Noto Marine Center): Monitoring survey of benthic invertebrates and of seaweeds and seagrasses on the rocky coasts after the 2024 (Reiwa 6) Noto Peninsula Earthquake (in Japanese) (Research Report of the Noto Marine Center 30: 83-102, 2025. The uplift values are quoted from a photograph collection [2024])	Report	B	Chapters 2, 3, 5
S10	Noto Marine Center: "Noto no Kaichurin" No.61 (December 2024); No.63 (No - vember 2025. Contribution by Aiko Iwasaki [Tohoku University], "The effects of earthquakes on the organisms of the rocky intertidal zone, and the project to monitor organisms after the Noto Peninsula Earthquake") (in Japanese)	Explanatory	C	Chapters 2, 3, 5
S11	Ishikawa Prefecture: Ishikawa Prefecture Seaweed and Seagrass Bed Vision (Ishikawa Prefecture seaweed and seagrass bed creation plan) (in Japanese) (March 2022. The view of Suzu is on p. 3, the fiscal 2018 values for Suzu are in Table 2 on p. 5, and the places where seaweed beds are created are in Table 6 and Table 8)	Plan	A	Chapters 2, 3, 5
S12	Ministry of Land, Infrastructure, Transport and Tourism, Hokuriku Regional Development Bureau, Niigata research and engineering office for ports and airports: Wajima Port wave summary tables (in Japanese) (the observation station is in the Wajimazaki district of Wajima Port, a wave and current meter [kaishokei], water depth 52 m. Tables for 2015–2024. The file of the table for 2024 was last updated on 16 June 2026. The monthly maxima are this paper's tabulation)	Observation	A	Chapters 1, 2, 4, 5
S13	Niigata Local Meteorological Office: The course of the weather in winter 2025 (December to February) (in Japanese) (3 March 2025. Summary for the Hokuriku region. It has no wave values)	Announcement	A	Chapter 2
S14	Research Report of the Noto Marine Center 31 (2026): Tsunoda et al.: Mass stranding of hiratabunbuku on the coasts of the north-eastern Noto Peninsula (27-34); Miyazaki et al.: Comparison of the forms of the burrows of boring bi - valves at Noroshi, Suzu City (17-21) (in Japanese)	Report	B	Chapter 2

ID	Source (publisher, year)	Type	Reliability	Chapters used
S15	Fisheries Agency: Isoyake Countermeasure Guidelines, 3rd edition (in Japanese) (March 2021. Lifespans are on p. 14, annual seaweed beds on pp. 15–16, the definition and the routes of decrease on pp. 18–19, wave disturbance on p. 35, Iki on p. 64, Hokkaido on p. 73, and the arame and sea urchins of Minami-Sanriku on pp. 71–72. The content of the studies it quotes is secondary quotation)	Guidelines	A	Chapters 1–4
S16	Fisheries Agency: Guidance on effective and continuous monitoring of seaweed and seagrass beds (in Japanese) (April 2024. The timing of surveys, and the surveys to make when a decline is seen, are on p. 11)	Guidelines	A	Chapters 2, 3, 5
S17	The tsunami of the Great East Japan Earthquake and seaweed beds: Takami et al. (Fisheries Oceanography 22(2): 113-120, 2013); Muraoka et al. (Fisheries Oceanography 26(2): 128-140, 2017) (for both, abstract only checked)	Paper	B	Chapters 1, 2, 3, 5
S18	The intertidal zone in the Great East Japan Earthquake: Iwasaki et al. (Ecological Impacts of Tsunamis on Coastal Ecosystems: 35-46, 2016. The content is according to the account in S10); Noda et al. (Journal of the Marine Biological Association of the UK 96(8): 1549-1555, 2016); Kanamori et al. (Ecological Research 35(1): 95-105, 2020. Abstract only checked)	Paper	B	Chapter 2
S19	Sousa: Disturbance in Marine Intertidal Boulder Fields (Ecology 60(6), 1979); Experimental Investigations of Disturbance and Ecological Succession in a Rocky Intertidal Algal Community (Ecological Monographs 49(3), 1979) (for both, abstract only checked)	Paper	B	Chapters 1, 2, 4, 5
S20	Storms and kelp forests: Dayton and Tegner (Science 224: 283-285, 1984); Reed et al. (Ecology 92(11): 2108-2116, 2011) (for both, abstract only checked)	Paper	B	Chapters 1, 2, 5
S21	Filbee-Dexter and Scheibling: Hurricane-mediated defoliation of kelp beds and pulsed delivery of kelp detritus to offshore sedimentary habitats (Marine Ecology Progress Series 455: 51-64, 2012. Abstract only checked)	Paper	B	Chapters 2, 5
S22	Ministry of the Environment, Biodiversity Center of Japan: Monitoring Sites 1000 seaweed bed survey, fiscal 2025 preliminary report (in Japanese) (2026)	Survey	A	Chapter 3
S23	Ministry of the Environment, Biodiversity Center of Japan: Survey report of the fiscal 2025 (Reiwa 7) Noto Peninsula natural environment survey work (in Japanese) (March 2026)	Report	A	Chapter 3
S24	Ishikawa Prefecture: Ishikawa Sea Area fishing ground plan, Attachment 1, matters concerning fishery rights (changed on 30 June 2026); licences of fishery rights (1 November 2026) (in Japanese)	Plan	A	Chapters 2–4
S25	Suzu district regional fisheries revitalisation committee: Plan for Revitalising Fishing Communities (Hama Plan) (3rd phase, fiscal 2026–2030) (in Japanese) (website of the Fisheries Agency. The number of fishery management entities is as of 1 November 2023)	Plan	A	Chapters 2–4
S26	hitoumi.jp (information website on the measures to bring out the multiple functions of fisheries): List of the state of activities in Ishikawa Prefecture (in Japanese) (viewed 12 November 2026)	Explanatory	C	Chapter 3
S27	JF Zengyoren (National Federation of Fisheries Co-operative Associations) and others: Survey report of the fiscal 2025 (Reiwa 7) commissioned project to support measures for strengthening fishing ground productivity and the multiple functions of fisheries (in Japanese) (project commissioned by the Fisheries Agency, March 2026)	Report	A	Chapter 3
S28	Ishikawa Prefecture: Fisheries environment improvement project, Kaga and Noto Sotoura district, plan drawing (in Japanese) (updated June 2026)	Plan	A	Chapter 3
S29	Ishikawa Prefecture: Main projects of the fiscal 2026 (Reiwa 8) initial budget (in Japanese) (20 January 2026. p. 7 of the PDF)	Budget	A	Chapters 3, 4

ID	Source (publisher, year)	Type	Reliability	Chapters used
S30	Ishikawa Prefecture Fisheries Cooperative Association (coastal fishing ground management body): Coastal fishing ground management rules (in Japanese) (posted by the prefecture)	Rules	A	Chapter 3
S31	Ishikawa Prefecture: Review committee for the basic coastal protection plan for the coasts of the Noto Peninsula, 2nd meeting, Material 3 (in Japanese) (5 November 2025. The wave height used for planning is on p. 21, and the boundary between Sotoura and Uchiura on pp. 30–31)	Meeting	A	Chapters 2, 4
S32	Suzu City: Suzu City reconstruction plan (in Japanese) (February 2025. Fisheries and sea data are on pp. 60–61)	Plan	A	Chapters 3, 4
S33	Ishikawa Prefecture: Review committee for drawing up the new "Ishikawa Fisheries Promotion Vision" (meeting materials of the 1st meeting, 4 September 2026. The distribution map of seaweed and seagrass beds is on p. 11 of the materials [page 24 of the PDF]) (in Japanese)	Meeting	A	Chapters 3–5
S34	Ishikawa Prefecture Fisheries Division: State of damage related to fisheries (in Japanese) (the PDF was updated in February 2025)	Material	A	Chapter 2

Related materials: R2 Seaweed and seagrass beds and the living things of the sea, R7-B01 Earthquake uplift on the Sotoura coast, R7-B02 The active faults just off the coast, and preparing for the next earthquake and tsunami, R7-B04 The changed topography of the shallow sea, and the shortage of maps and observations that fishers can use, R7-B05 Redrawing the basic coastal protection plan (uplift and growing waves), R7-B07 The total die-off of living things in the intertidal zone and on shallow rocky reefs, and their recovery afterwards, R7-B08 Shallow seaweed beds dried out by uplift, and the decrease in the area of seaweed beds in Sotoura, R7-B09 Mud and turbidity that keep entering from river mouths (the seaweed and seagrass beds and rocky-shore fishing grounds of the Wajima coast), R7-B11 Barren ground (isoyake) that has continued since before the earthquake, and the decline of the seaweed beds of the offshore islands, R7-B12 High summer water temperatures (the shallow sea of Sotoura), R7-B13 The mass death of abalone and turban shells, and the fall in catches that continues for some years, R7-B14 The rocky shores of iwanori and wakame (the drying out of the nori beds, footing and processing sites), R7-B24 The income of fishers affected by the disaster, and the gaps in support, R7-B26 Rebuilding the local activities that protect the seaweed beds of Wajima, I1 List of assessments