R8-2 Arrangements for returning nutrients to the sea

In a Seto Inland Sea that has become clean, how far do the rules for safely returning nutrients go, and where are the gaps?

Readers	Local governments (staff in charge of the environment, fisheries and sewerage), fishery cooperatives, research institutions and others without specialist knowledge. Those who want to know where the law and the prefectural plans on nutrients in the Seto Inland Sea stand now.
Takeaways	1. The law on the Seto Inland Sea has changed from one that "reduces" the nitrogen and phosphorus entering the sea to one that "manages" them. With the 2021 amendment, the governors of prefectures became able to set a plan for increasing nutrients appropriately (a nutrient management plan). 2. As of November 2026, the prefectures that have set a plan are the 4 prefectures of Hyogo, Kagawa, Yamaguchi and Ehime. In all 4 prefectures, the mainstay of the plan is the adjustment of effluent from sewage treatment plants and factories. Fertilising by fishers and efforts to till the seabed are not included among the measures of the plans, for the reason that their effect cannot be shown quantitatively. 3. In December 2025, the company proposed a method in which the surface of fishing gear is made to hold nutrients and release them little by little, and the making of rules for its quality and use. There is not yet any record of a trial of this method in the sea. The component that the proposal gave as an example was iron, not the nutrients that the law refers to (nitrogen and phosphorus).
After reading	Check whether your prefecture has a nutrient management plan, and check the sea it covers, its target values and its rules for stopping. If you are carrying out efforts to add nutrients on a fishing ground, keep a record of the days and amounts added, and of the colour of the surrounding water and whether there is a red tide.

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

1. Key points

- The law on the Seto Inland Sea has changed from one that "reduces" the nitrogen and phosphorus entering the sea to one that "manages" them. With the 2021 amendment, the governors of prefectures became able to set a plan for increasing nutrients appropriately (a nutrient management plan). [S2]
- As of November 2026, the prefectures that have set a plan are the 4 prefectures of Hyogo, Kagawa, Yamaguchi and Ehime. In all 4 prefectures, the mainstay of the plan is the adjustment of effluent from sewage treatment plants and factories. Fertilising by fishers and efforts to till the seabed are not included among the measures of the plans, for the reason that their effect cannot be shown quantitatively. [S4, S5]
- In December 2025, the company proposed a method in which the surface of fishing gear is made to hold nutrients and release them little by little, and the making of rules for its quality and use. There is not yet any

record of a trial of this method in the sea. The component that the proposal gave as an example was iron, not the nutrients that the law refers to (nitrogen and phosphorus).

2. What is happening

From the era of red tides

In 1972 (Showa 47), a large red tide occurred in Harima-nada, and about 14 million farmed young yellowtail (hamachi) died. The damage was 7.1 billion yen. [S1] In the following year, 1973, a temporary measures act for the conservation of the environment of the Seto Inland Sea was enacted, and in 1978 it was revised into a special measures act. [S1, S2] From then on, efforts to reduce the nitrogen and phosphorus entering the sea from factories and households continued.

A sea short of nutrients

Later, a shortage of nutrients in the sea became a problem. According to Hyogo Prefecture's fisheries technology centre, in Harima-nada from December to March, when nori aquaculture is at its height, the concentration of nitrogen dissolved in seawater (DIN) has been falling over the years. From the late 1990s, the frequency with which it falls to or below the concentration at which discolouration of nori begins to occur (3μM) has increased. [S8] μM is a unit of concentration, and 3μM of nitrogen corresponds to about 0.04 milligrams per litre. Since 1973, the same centre has continued monthly observations at 19 points in Harima-nada. Over 50 years, the DIN concentration fell by 5.25μM. It fell sharply around 2000, and since then it has hardly ever been above the normal-year value. The centre considers that a large effect has come from nitrogen becoming subject to total load control (a regulation that sets the total of the amounts that may be discharged into the sea) in 2001 and from the decrease in the nitrogen entering from the land. [S8] Discoloured nori has poor colour and lustre and also tastes worse, so it is either not sold or traded at a very low price. [S8]

Japanese sand lance (ikanago) has also decreased. Hyogo Prefecture's catch fell from 11,082 tonnes in 2016 to 1,001 tonnes in 2017 and to 142 tonnes in 2020. In 2021–2023 it recovered to 1,224–1,709 tonnes, but in 2024 it was 26 tonnes (values that include fish other than shinko, the juveniles). [S9] In Osaka Bay, measures to suspend fishing were taken in 2024 and 2025, and in Harima-nada, fishing in 2025 took place on 3 days. [S9] In February 2026, Hyogo Prefecture announced that, for that year's fishing season too, almost no catch was expected in the 3 sea areas of Harima-nada, Osaka Bay and the Kii Channel. [S9]

Why the sand lance has decreased is not clear. The stock assessment of the national research institution, while stating that the factors are not clear, lists 4 that have been pointed out. They are the degradation of their habitat through the extraction of sea sand and the like, a decrease in food due to nutrient depletion of the sea, fishing pressure, and an increase in the proportion that die during their summer dormancy because of rising water temperature and predation. [S9] Nutrient depletion is one of the 4.

3. The law and the plans

Towards a "bountiful sea"

The 2015 amendment added basic principles to the Act on Special Measures concerning Conservation of the Environment of the Seto Inland Sea. Their content is that the aim is to make the Seto Inland Sea a "bountiful sea" in which biological diversity and productivity are secured. [S2]

The 2021 amendment (promulgated on 9 June 2021, in force from 1 April 2022) created the system of nutrient management plans. Article 12-6 of the Act states that the governors of the prefectures concerned, alone or jointly, "may set" such a plan. Whether to set one is decided by the prefectures. [S2]

As measures for increasing nutrients, the Act lists "the input of nutrients in sea areas" and "a change in the method of treating wastewater and the like at factories or business establishments". A plan sets out the following. [S2]

- The area of the plan
- The substances to be increased (nitrogen and phosphorus) and the target values for water quality. The target values are set within the range of the water quality standards set by the national government (environmental quality standards)
- The persons who carry out the measures, the places and the methods
- The points, methods and frequency of measurement
- The methods of investigating, analysing and evaluating water quality based on the results of measurement

The governor regularly examines and evaluates the water quality, and changes the plan if necessary. [S2]

Guides for stopping

In March 2022, the Ministry of the Environment issued guidelines for reference when making a plan. As examples of measures, they list the input of nutrients into the sea by fishers, seabed tilling by fishers (digging over the seabed), changes in the methods of treating effluent at factories and business establishments, releases of water from dams, and the discharge of water when draining irrigation ponds. [S3]

The guidelines state that it is desirable for the plan to include management criteria that serve as a guide, so that a response can be made at once when effects appear on the surrounding environment. This statement concerns the measures as a whole, including input by fishers. They also state that when a concentration far above the prediction is measured, it is necessary to stop or change the measures immediately and to consider revising the plan. [S3]

Hyogo Prefecture's lower-limit values

In October 2019, before the national amendment, Hyogo Prefecture amended its ordinance and set desirable concentrations of nutrients in the sea. Total nitrogen (the total of nitrogen, including the part that is not dissolved) is 0.2 milligrams or more per litre, and total phosphorus (the total of phosphorus) is 0.02 milligrams or more. Both are within the range of the environmental quality standards. The public notice came into force on 28 October 2019. [S5, S6] Setting a lower limit on the concentration is where this differs from the earlier regulations that "reduce".

The plans of the 4 prefectures

As of November 2026, 4 prefectures have set plans (Table 1). [S4, S5] "Seasonal operation" in the table means operation in which, only during the period when nori is grown, effluent is discharged with more nitrogen left in it.

Table 1 The 4 prefectures that have set nutrient management plans

Prefecture	When set	Living things for checking the effect	Target values (per litre)	Measures to increase nutrients
Hyogo Prefecture	October 2022	Not specifically set	Total nitrogen 0.2mg or more and total phosphorus 0.02mg or more, and at or below the environmental quality standard values (for the time being, total nitrogen only)	5 factories (all year) and 28 sewage treatment plants (seasonal operation, basically from November to April)
Kagawa Prefecture	March 2024	Farmed nori	Upper limits only: total nitrogen 0.3mg, total phosphorus 0.03mg	Seasonal operation of 5 sewage treatment plants (roughly October to March)
Yamaguchi Prefecture	February 2025	Nori	Total nitrogen 0.2–0.6mg, total phosphorus 0.02–0.05mg (for the time being, total nitrogen only)	3 business establishments. Seasonal operation from October to April at the 2 purification centres, and all year at the 1 factory
Ehime Prefecture	October 2025	Nori (Hiuchi-nada), seaweeds (Iyo-nada)	Upper limits only: total nitrogen 0.3mg, total phosphorus 0.03mg	8 public wastewater treatment facilities. The 2 facilities in Saijo City from October to March; the facilities on Iyo-nada all year (stopped in summer as necessary)

The source is [S5] (each prefecture's plan). Hyogo Prefecture's plan covers 7 water areas, including Osaka Bay and Harima-nada. "For the time being, total nitrogen only" means that, for the time being, what is to be increased is limited to nitrogen.

All 4 prefectures' plans set out the response when something abnormal appears in the surrounding environment. Kagawa Prefecture's plan states that if something unexpected happens, the prefecture will immediately decide on stopping or changing the measures and will ask those carrying out the measures to respond. Hyogo Prefecture's plan states that if a marked effect on water quality is found, the prefecture will ask for the amount of nutrients supplied to be adjusted. Within the range we checked, there was no plan that set the value for stopping as a number. [S5]

Hiroshima Prefecture invited comments on the preliminary draft of its plan from 9 October to 9 November 2026. The preliminary draft covers 8 water areas, including Hiroshima Bay; the target living things are oysters, wakame and nori; and the measure is the seasonal operation (roughly October to March) of 33 sewage treatment facilities and the like. [S7] In material for its council in 2022, Okayama Prefecture answered, on whether to set a plan, that the departments concerned would study the matter. We could not confirm any developments after that. [S7] In June 2026, Osaka Prefecture asked its council for its opinion on how the conservation and other aspects of the environment of Osaka Bay should be approached in future. As one of the points to be examined, it lists how nutrients in the southern part of the bay should be managed. The council's answer is scheduled (draft) for June–July 2027, and whether a plan will be set is not indicated. [S12]

At present, this system covers the Seto Inland Sea. Material of the Ministry of Land, Infrastructure, Transport and Tourism states that an extension of its scope is being considered. [S4]

4. Where the gaps are

Apart from the adjustment of effluent, outside the plans

In the 4 prefectures' plans, the only things designated as measures for increasing nutrients are the adjustment of effluent from sewage treatment plants and factories. Fertilising on fishing grounds, seabed tilling and the like are not included among the measures in any of the prefectures. The reason the prefectures give is that the effect cannot be grasped quantitatively. The efforts they take up differ from prefecture to prefecture. [S5]

These efforts are not prohibited. Hyogo Prefecture's plan calls them "other efforts" that fishers and others are still carrying out, and explains fertilising as an effort in which materials registered as fertilisers are applied locally. Yamaguchi Prefecture's plan also describes them as activities that are still being carried out. Kagawa Prefecture's plan says that they are not designated as measures, but that this does not prevent them from being carried out. Hyogo and Ehime Prefectures state that they will consider including them among the measures once their effect can be shown quantitatively. [S5]

Methods that have been tried

Methods of adding nutrients on fishing grounds have been tried in national subsidy programmes. A collection of cases that summarises the results of a Fisheries Agency subsidy programme (fiscal 2013–2017) contains 5 cases. [S10]

- Adjusting the operation of sewage treatment facilities (Hyogo Prefecture)
- Seabed tilling (Okayama Prefecture)
- A combination of curtains surrounding nori nets and fertilising (Kagawa Prefecture)
- Commercially available fertiliser agents and a laid net (Ehime Prefecture)
- A method of hanging fertiliser agents from aquaculture facilities (Tokushima Prefecture)

The Kagawa Prefecture case states that discolouration of nori can be suppressed if a concentration of about 10μM is maintained for about 1 hour every day. In calm water at the head of a bay, discolouration was prevented. It is stated that, in combination with a device that slows the current, it was also prevented in water where the tidal currents are somewhat faster. Fishing grounds with even faster currents, and cost, are the remaining issues. The Tokushima Prefecture case is wakame aquaculture; because spreading on the sea surface does not suit sea areas where the tidal currents are fast and the water is also deep, the method of hanging is used. The collection of cases states that the techniques are not ones that apply to every fishing ground, and that attention is needed to changes in the surrounding water quality and to red tides. [S10]

How things placed in the sea are treated

When materials or fishing gear that release nutrients are placed in the sea, it is also necessary to confirm that they do not count as waste. A notice of the Ministry of the Environment states that whether something is waste is judged by taking 5 points together. They are the nature of the thing, the circumstances in which it was discharged, the way it is usually handled, whether it has trading value, and the intention of its owner. The same way of thinking is also shown in a Supreme Court decision of 10 March 1999. The notice states that it looks at such things as whether the quality suits the use, whether there is a market for it as a product, and whether there are transactions in which money is paid for it. [S11] There are also other laws that concern putting things into the sea. This paper has not examined them (chapter 6).

What we did not find

Within the 4 prefectures' plans for the Seto Inland Sea and the national guidelines, we found none of the following.

- Public standards setting how much may dissolve out of materials or fishing gear that release nutrients
- Guidance setting when, and at what value, fertilising on nori fishing grounds is to be stopped
- An established method for measuring quantitatively how much of the nutrients added on nori fishing grounds was delivered

Outside the Seto Inland Sea, there are similar examples. In Saga Prefecture on the Ariake Sea, a council of the prefecture, fishery cooperatives and researchers applies criteria for adding nutrients to nori fishing grounds. It is an arrangement in which, with a nitrogen concentration in seawater of 7μM as the upper limit, instructions on the amount to be added are given on the basis of measurements by the prefecture's fisheries research and development centre. The conditions for stopping are also set in numbers. Adding ends when plankton increase (such as 30 micrograms or more per litre in terms of the amount of chlorophyll) or when the annual upper limit (420 tonnes of nitrogen) is exceeded (a 2011 report). According to the same report, in Saga Prefecture from 1985 to 1992 (except 1990 and 1991), a method was used in which containers of additive were hung around the nets and the additive was allowed to dissolve out little by little. It was abandoned because it did not pay and its effect was not sufficient either. [S13] For seaweed and seagrass beds, the Fisheries Agency issued a technical document in 2015. Its content calls for grasping the rate at which fertiliser materials dissolve out, and for checking the effect by comparing fertilised and unfertilised plots. [S13]

For the adjustment of effluent, the law, guidelines and prefectural plans are all in place. For methods of adding nutrients on fishing grounds in the Seto Inland Sea, there are cases of trials, but a method for showing the effect quantitatively and a procedure for stopping have not been set within the plans. In this paper's view, the starting point for showing the effect quantitatively is a record of the days on which nutrients were added and of the amounts.

5. The proposal the company submitted

On 13 December 2025, the company submitted a written proposal to a public call for policy proposals. Its title is "Drawing up quality standards and operational guidelines towards the social implementation of a controlled nutrient supply system (smart fishing gear) as a measure against 'nutrient depletion' in the Seto Inland Sea".

The method considered

What the proposal considered was a method of treating the surface of fishing gear that fishers already use, so that it holds components that become nutrients and releases them little by little. The fishing gear means floats, ropes, nets and the like. The components the proposal gave as examples were fulvic acid iron (iron in a form that dissolves easily in water) and others. Because fishing gear can be hauled up, it was thought that, if something abnormal happened, the adding could be stopped by hauling it up. Releasing little by little from something placed on aquaculture facilities is close in form to the Tokushima Prefecture case of hanging fertiliser agents from the facilities (chapter 4). Making use of the fact that the gear can be hauled up and recovered is the company's own idea. What has already dissolved out does not come back when the gear is hauled up. As for the method of hanging something and letting it dissolve out little by little, there is an example of it being abandoned in Saga Prefecture on grounds of profitability and effect (chapter 4).

For the surface treatment, the company considered using its technology, which Kensuke Kuroda (Representative, Nagoya Surface Technology; Specially Appointed Professor, Institute of Innovation for Future

Society, Nagoya University) supervises as an individual. The idea of fishing gear made to hold nutrients comes from the use that the company calls the "Help it take hold" direction (C2 "Solving the problems of the sea in combination"). R8-1 "Hull paint and the sea" deals with the "Keep it off" direction.

There is not yet any record of fishing gear that releases nutrients by this method having been made and tried in the sea. How fast the components are released, and how they act on nori and on the sea, have not been checked.

The rules requested

The proposal asked for the following 3 things.

1. To put in order the criteria of judgement under which processed materials whose safety has been confirmed can be treated as products
2. To draw up guidelines on use for avoiding the risk of red tides. These include the frequency of measurement and the criteria for hauling up
3. To create a framework for trials in the sea for checking whether those guidelines are useful

Looking at it now

After submitting the proposal, we re-examined public materials in order to write this paper. We found 3 things.

The first is that procedures for stopping already exist. The national guidelines state that it is desirable to include in the plan a guide for suspending the measures, and the 4 prefectures' plans set out procedures by which the prefecture asks for stopping or adjustment when something abnormal appears (chapter 3). The proposal wrote that "there are no standards". For the adjustment of effluent, these procedures apply. [S3] However, within the range we checked, there was no plan that set the value for stopping as a number (chapter 3). Because fertilising on fishing grounds is not included among the measures of the plans, it lies outside these procedures.

The second is that fertilising on fishing grounds is not prohibited, and that the plans of Hyogo and Yamaguchi Prefectures describe it as an effort that is still being carried out (chapter 4). The reason it is not included among the measures of the plans was that its effect cannot be grasped quantitatively. The second and third requests of the proposal asked for rules for stopping and a framework for trials, and do not include a method for showing the effect quantitatively as such. To be included among the measures of a plan, it is additionally necessary to be able to measure the amount delivered and to estimate the effects in advance.

The third is the difference in components. The nutrients that the law refers to are nitrogen and phosphorus. [S2] The iron that the proposal gave as an example is not among them. Fishing gear that releases iron does not, as it stands, fit within the framework of nutrient management plans. Methods of adding iron are dealt with in the technical document on fertilising seaweed and seagrass beds. [S13]

6. What is not yet known

What we could not confirm

- We have not, this time, examined materials showing how the nutrients in the sea or the discolouration of nori have changed since the 4 prefectures' plans began.
- For Okayama Prefecture, we have checked only as far as the 2022 material. Whether there are any other prefectures that have set plans, we checked in the October 2026 material of the Ministry of Land, Infrastructure, Transport and Tourism and on the public pages of each prefecture. We have not seen every public announcement.

- Hyogo Prefecture's yearly DIN values are published only in charts, and we could not confirm the numbers. [S8]
- Of the laws that concern putting things into the sea, the only thing this paper examined was the judgement of what is waste. We have not examined the rules on the prevention of marine pollution or on the registration of fertilisers. The Saga Prefecture report describes the course of an inquiry made to the Coast Guard office. [S13]
- We have not examined whether there are cases in which a red tide occurred because nutrients were added.

Reliability and the publisher's position

We checked the law, the guidelines, the prefectural plans and the notice in their published original texts. The situation in Okayama Prefecture is based on material as of 2022. Hiroshima Prefecture's is a preliminary draft, not a decided plan.

The proposal that the company submitted in 2025 contained figures for catches and nori prices, and the voices of fishers. When we re-checked the sources in writing this paper, there were some that could not be confirmed, so this paper contains only values that could be confirmed in public materials.

The publisher of this paper (SeatecHIROSHIMA Ltd.) runs a business that treats the surfaces of materials, and is in a position to profit if the method in chapter 5 comes into use. Chapter 5 is the company's own idea and has not been checked by a third party.

7. Sources

We examined materials published up to 25 November 2026. Reliability: A = laws and regulations, notices, materials of the national government and prefectures; B = reports of research institutions.

ID	Source (publisher, year)	Type	Reliability	Chapters used
S1	Setouchi Net: fishery damage caused by red tides; Act on Special Measures concerning Conservation of the Environment of the Seto Inland Sea (Ministry of the Environment) (in Japanese)	Explanatory	A	Chapter 2
S2	Act on Special Measures concerning Conservation of the Environment of the Seto Inland Sea (Act No. 110 of 1973 (Showa 48); Articles 2-2, 12-6 and 12-7); explanation of the 2021 amendment (Ministry of the Environment) (in Japanese)	Law	A	Chapters 1–3, 5
S3	guidelines on drawing up nutrient management plans (in Japanese) (Ministry of the Environment, March 2022)	Guidelines	A	Chapters 3, 5
S4	material on the active operational management of nutrients (in Japanese) (Ministry of Land, Infrastructure, Transport and Tourism, 22 October 2026. Material 5 of the 2nd meeting of the study committee on revising the guidelines for surveys for comprehensive basin-wide sewerage development plans. The entry on the prefectures that have set plans)	National	A	Chapters 1, 3
S5	Each prefecture's nutrient management plan: Hyogo Prefecture (October 2022); Kagawa Prefecture (March 2024); Yamaguchi Prefecture (February 2025); Ehime Prefecture (October 2025) (in Japanese)	Prefecture	A	Chapters 1, 3, 4
S6	Hyogo Prefecture: ordinance on the conservation and creation of the environment (extract); Public Notice No. 513 (25 October 2019) (in Japanese)	Prefecture	A	Chapter 3
S7	Hiroshima Prefecture nutrient management plan (preliminary draft); call for comments (Hiroshima Prefecture, 2026); material for an Okayama Prefecture council (2022) (in Japanese)	Prefecture	A	Chapter 3

ID	Source (publisher, year)	Type	Reliability	Chapters used
S8	Hyogo Prefectural Technology Center for Agriculture, Forestry and Fisheries: effects of changes in nutrients in northern Harima-nada on nori aquaculture; results of 50 years of observations in the shallow-sea fixed-line survey; nutrient supply from the land and nori aquaculture (in Japanese)	Report	B	Chapters 2, 6
S9	Japanese sand lance: stock assessment of the eastern Seto Inland Sea stock, fiscal 2025 (Reiwa 7) (Japan Fisheries Research and Education Agency); forecast of fishing conditions for the 2026 (Reiwa 8) fishing season (Hyogo Prefecture, 24 February 2026) (in Japanese)	Report	B	Chapter 2
S10	collection of cases of demonstration trials of nutrient supply techniques at nori and wakame aquaculture grounds (in Japanese) (National Research Institute of Fisheries and Environment of Inland Sea, Japan Fisheries Research and Education Agency, and others, 2018. Results of a Fisheries Agency subsidy programme)	Report	B	Chapter 4
S11	Judging whether something is waste: on the guidelines for administrative dispositions (notice) (Ministry of the Environment, 14 April 2021); Supreme Court decision of 10 March 1999 (Heisei 11) (in Japanese)	Notice	A	Chapter 4
S12	on the future approach to the conservation, restoration and creation of the environment in Osaka Bay (material for the request for an opinion) (in Japanese) (water quality subcommittee of the Osaka Prefecture environmental council, 23 June 2026)	Prefecture	A	Chapter 3
S13	Fertilising on fishing grounds: the present state of nutrient addition carried out in the Ariake Sea in Saga Prefecture (research report No. 25 of the Saga Prefectural Ariake Fisheries Research and Development Center, 2011); technical document on fertilising in measures against barren ground (isoyake) (Fisheries Agency, March 2015) (in Japanese)	Report	B	Chapters 4–6

Related materials

- R2 "Seaweed and seagrass beds and the living things of the sea": the role of seaweed and seagrass beds and how they have decreased
- R8-1 "Hull paint and the sea": the limits when the same surface technology is used in the "Keep it off" direction
- C2 "Solving the problems of the sea in combination": why the company uses the same technology separately for "Help it take hold" and for "Keep it off"