

Efforts by Fishers and Support Activities to Conserve and Rehabilitate Seaweed Beds: Adaptive Management of the Fishery Resources and Habitats in Japan

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Seaweed beds in coastal waters serve as spawning and rearing grounds for fish and shellfish. The recent reduction of seaweed beds, called “isoyake” in Japanese, has been considered as a cause of the recent decrease of some fishery resources in the coastal waters of Japan. In order to address such concerns, the fishers have undertaken various activities aimed at managing seaweed beds. Recognizing that conservation and rehabilitation of seaweed beds is an important policy issue, the Fisheries Agency of Japan has found it necessary to provide technical support to the efforts of the fishers by enhancing activities for the regeneration and conservation of seaweed beds, starting with the development and dissemination of the “Isoyake Recovery Guidelines (2007)”. This report introduces some brief examples of the fishers’ efforts to conserve seaweed beds and the supporting activities by local and central governments in Japan, as well as the situation of the seaweed beds, importance of seaweed, and adaptive management of seaweed beds in Japan, which could serve as useful information for the countries in Southeast Asia.

Furthermore, a variety of seaweed are directly targeted in fishing activities, because in Japan many species of seaweed are used as source of healthy food and delicious soup stock. Therefore, seaweed fishing is an important activity in Japan where a number of fishers are engaged in collecting seaweed.

Tendency of Seaweed Beds Becoming Barren

The phenomenon of barren seaweed beds, called isoyake in Japanese, where the seaweed beds become denuded or apparently burned, has been reported in Japan for more than one hundred years. Considering that for the past two decades in a number of places, seaweed beds have decreased remarkably on a large-scale, and the trend of barren seaweed beds continuously becomes eminent, the need to conserve the seaweed beds was therefore deemed necessary. As reported, the recent occurrence of barren seaweed beds has been caused for example, by the influx of floating mud from rivers (**Photo 1**) and by overgrazing of sea urchins and herbivorous fish (**Photo 2**) brought about by the increasing water temperature. This recent degradation of the seaweed beds has become a serious problem in Japan, where many people became aware of such situation through various television programs and in the national newspapers.

Seaweed Beds in Coastal Waters of Japan

Seaweed beds are widely distributed in the coastal waters of Japan, with three principal types of seaweed beds on rocky sea bottoms. In general, *Laminaria* beds are found in the country’s northern waters, *Eisenia* and/or *Ecklonia* beds mainly in the Pacific Ocean, and *Sargassum* beds mainly in the Nippon Sea/East China Sea (**Fig.1**). In Japan, these seaweed beds and other kinds of seaweed beds are indispensable for preserving the coastal fishery resources.



Fig. 1. Principal seaweed beds in coastal waters of Japan

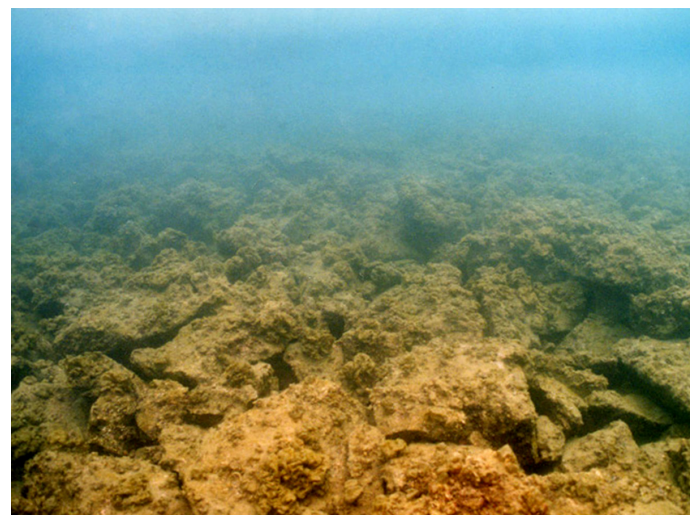


Photo 1: Barren seaweed beds due to piling of floating mud
(Source: Isoyake Recovery Guideline)



Photo 2: Barren seaweed beds due to overgrazing by parrotfish on a large scale (Source: *Isoyake Recovery Guideline*)

Functions of Seaweed Beds

It is generally well known that seaweed beds play a major role in fisheries. Specifically, seaweed beds function as: *spawning grounds* for the fishery resources and other marine organisms; *nursery grounds* for larvae, juveniles and adult of fish as seaweeds tend to decrease the current of seawater, and also provides a refuge from enemies by hiding among the seaweeds; *feeding grounds* for fish that feed on seaweed and/or on microorganisms and small animals gathering around seaweed beds; *absorber of nutrients* in the seawater keeping the water clean; and *absorber of carbon dioxide*, among others.

Regarding the function of absorbing carbon dioxide, seaweeds are known to release large amounts of slimy liquid made of organic compounds with carbon from their surface to the seawater. Together with these organic compounds are un-dissolved organic compounds that have been present in seawaters for several hundred years that perform the role of fixing carbon in seawater. The above functions of seaweed beds therefore show that seaweed plays an important role not only in fisheries but also in preserving the marine environment, which humankind has always depended on for food and livelihood.

Adaptive Management and the “Isoyake Recovery Guideline”

Recent environmental issues emerging around the world such as climate change have been serious and their impacts are considered irreversible. In addressing such concern, the concept of “adaptive management” has often been promoted through environmental conservation policies. In general, adaptive management which is a management technique involves gradual carrying out of measures through repeated monitoring and giving feedback, and analyzing the results.

Adaptive management is commonly applied in the field of ecosystem restoration, specifically for marine and inland habitats.

Rehabilitation of barren seaweed beds on a large scale is more difficult for the fishers to undertake than in the ordinary management activities in seaweed beds. In order to rehabilitate the seaweed beds and support the corresponding efforts of the fishers, the Fisheries Agency of Japan therefore conducted technical pilot projects from 2004 to 2006 with the cooperation of a number of technical staff/researchers from 17 prefectures and 19 specialists. Taking into consideration the results of the pilot studies and the scientific knowledge gained, the “Isoyake Recovery Guideline” was published in 2007 which includes the concept of adaptive management for the rehabilitation of seaweed beds. The main users of the Guideline are the fishers who are at the forefront of the restoration efforts.

The Guideline consist of, among others, adaptive management for successful rehabilitation through adaptive learning and feedback mechanism; flow chart for the selection techniques; support to fishers through organized cooperation of specialists, local governments, citizens and other stakeholders; useful viewpoints for detecting decreased seaweed resources and finding critical factors in recovering seaweed beds; explanation of each technique; and other relevant topics. Also included in the Guideline are results of a number of case studies, research studies, and model practices.

The adaptive management approach for the rehabilitation of seaweed beds in the Guideline is shown in **Fig. 2**, which indicates that when the first target of recovery of seaweed beds is achieved, a new target could be aimed by starting from C: “Target of Recovery”. If the target has not been

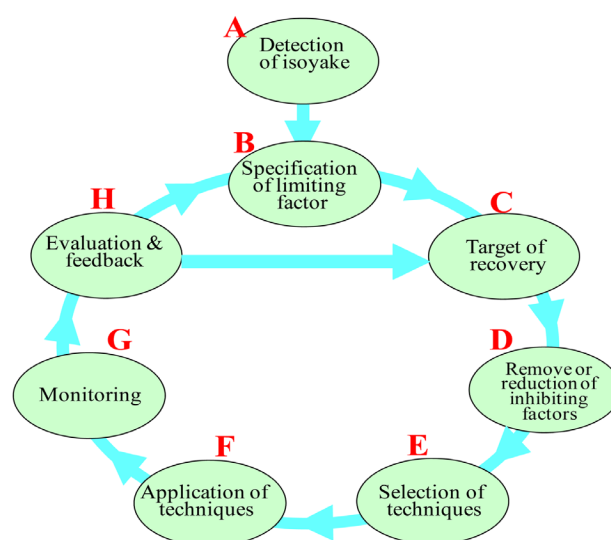


Fig. 2. Adaptive management for isoyake recovery (Source: *Isoyake Recovery Guideline*)

achieved yet, restart from B: “Specification of Limiting Factors” to clarify the reason for the failure. Once clarified, the new approach can be started all over again. In addition, the Guideline also contains additional features related to adaptive management as shown in **Box 1**.

In particular, a number of countermeasures or applicable techniques for recovering seaweed with regards to management activities are introduced in the Guideline. **Fig. 4** shows an example of the techniques for stock enhancement of seaweed, where planting includes transplantation of adult seaweed, utilization of cultured juveniles, and supplying the spores.

In the adult seaweed transplantation, adult seaweed is fixed with adhesive anchors on the sea bottom. A simpler method is to throw the adult seaweed with weights from the sea surface. Cultured juveniles are attained by transplanting seaweed using ropes or plates where embryos of seaweed grow. Maintaining the supply of spores includes putting mesh bags with adult seaweed and weights in the sea bottom, using mid-level nets with seaweed, and use of drifting catchers to trap seaweed that float near the sea surface.

Box 1. Some features in the “Iyosake Recovery Guideline” relevant to adaptive management

1. Due to limitation of implementing abilities, feasibilities, among others, the Guideline recommends implementation activities in a “Step by Step” process.
2. The Guideline targets specifications of limiting factors of recovery rather than the reasons of barren seaweed beds occurrence, in considering countermeasures for adapting changes of environment.
3. Since overgrazing by herbivores (sea urchins and/or herbivorous fish) is a serious issue that prevents recovering the seaweeds in many coastal prefectures, a major theme of the Guideline is how to strike a new balance between seaweed production and grazing pressure by herbivores (**Fig. 3**), i.e. by decreasing herbivores and/or by increasing seaweed production under a changed environment.

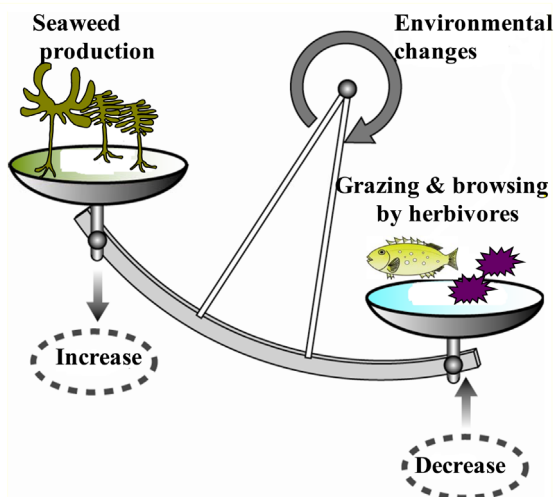


Fig. 3. Balancing seaweed production and grazing pressure by herbivores (Source: Iyosake Recovery Guideline)

Examples of Fishers’ Efforts in Conserving and Utilizing Seaweeds

Sustainability of seaweed fisheries in Hidaka Waters

An example of fishing ground management activities for fisheries of *Laminaria* kelp or “Kombu” in Japanese could be observed in the Hidaka Waters in Hokkaido, Japan. During the 1860s in the Edo era, improvement works for kelp fishing ground expansion were done by throwing stones into the sea. Before such works started, kelp production was about 75 tons, but the production kept on increasing year by year.

In addition, cleaning the fishing grounds and renewal of the stone grounds have been continued in Hidaka Waters for several decades. Such fishing ground management activities has contributed to the stable kelp production of Hidaka Waters, which increased from 3,500 tons to 6,500 tons every year from the 1870s. The total number of fishery establishments in Hidaka seashores is 1,510 of which 1,384 are engaged in seaweed production.

In Hidaka waters, there are several types of fisheries such as seaweed gathering/fishing, gill-net fishing, long-line fishing, shellfish gathering, large fixed-net fishing, among others. In particular, more than 90% of the fishery establishments are engaged in seaweed gathering/fishing (**Photo 3**). Therefore, since seaweed fisheries have important role in providing income for a number of fishers, the fishers in each village established their respective regulations for seaweed gathering/ fishing and rules including the self-obligation of cleaning their respective fishing grounds.

Seaweed management activities by fishers of the Shioya Fishery Cooperative

Situated at Aomori Prefecture in the northern part of Japan, Shioya is famous for its seaweed (*Saccharina japonica*) management. Seaweed fishing and gathering of shellfish such as abalone and sea urchins which co-exist with seaweed in the fishing ground, is an important fisheries activity in Shioya. Marine conservation activities by the fishers group (about 30 fishers at present) of the Shioya



Photo 3. Drying kelp on Hidaka seashores in Hokkaido (Photo by Akito SATO)

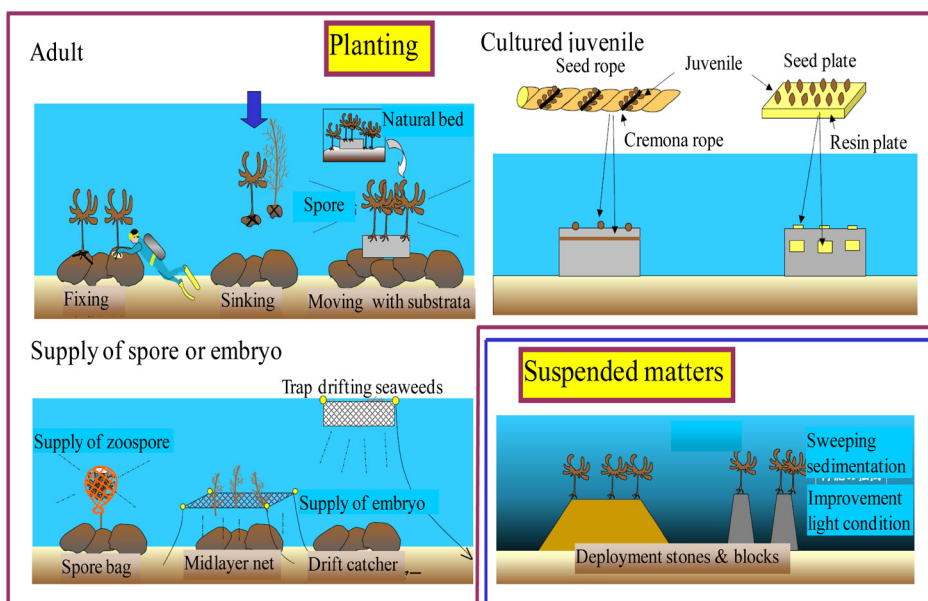


Fig. 4. Techniques for stock enhancement of seaweed
(Source: *Isoyake Recovery Guideline, etc.*)

Fishery Cooperative (**Photo 4**) have been ongoing for half a century, and monitoring surveys of the seaweed as well as abalone and sea urchins, have also been conducted by the fishers group every year for about 30 years, in spite of minimal annual budget of the fishers group for conservation activities, which is about 150 thousand yen a year.

At one time, when seaweed in Shioya waters was seriously damaged due to volcanic ash, cultured juveniles were planted by the fishers group using seed ropes, and seaweed beds were rehabilitated by such fishers' efforts. As a result, the production of kelp had recovered from almost zero yen to several hundred million yen. However, in addition to this difficult experience, seaweed was sometimes overgrazed by sea urchins because of changing seawater temperature, and recently the barren seaweed beds have largely expanded again. In addressing the decrease of seaweed resources, the fishers group started a new management activity for



Photo 4. Members of the fisher's group in the Shioya Fishery Cooperative (Source: *Report of Isoyake Countermeasures Promotion Project, 2008, Fisheries Agency of Japan*)

controlling the density of sea urchins. This has been done by removing sea urchins from barren seaweed beds and transplanting those sea urchins to other seaweed beds in order to balance between seaweed production and grazing pressure by the herbivores.

The areas with barren seaweed beds (a few hectares per year) where the fishers group removed the sea urchins have recovered within that same year. This strategy takes into consideration the fact that coastal marine resources are local fisher's common properties for the livelihood of the communities, and where fishers derive their income from the Shioya waters. For this reason, the management activities have been passed on to generations of fishers by encouraging them to develop the frame of mind to continue such management activities.

Example of Local Governments' Support in Reforesting Barren Seaweed Beds

Isoyake recovery efforts supported by local governments in the Hainan area

Along the coast of Hainan, extending from Sagara to Omaezaki on the west coast of Suruga Bay, Shizuoka, large seaweed beds encompassing more than 7,000 ha where seaweed species such as *Eisenia arborea* and *Ecklonia cava* are abundant, have reduced since 1985 and almost disappeared by 2000. As a result, production of abalone and other marine fish as well as shellfish also declined sharply along the coasts (**Fig. 5**). The damage brought about by the isoyake phenomenon exceeded the abilities of fishers to rehabilitate seaweed beds. In this regard, support activities to recover the seaweed beds were initiated with support from the Shizuoka Prefecture, which involved four fishery cooperatives and three towns in the neighboring area, as well as specialists.

Monitoring of the status of seaweed beds was conducted by Shizuoka Prefecture through its fishery research center. Initially, the concrete causes of the radically degrading seaweed beds were not clear, but based on results of several research studies by the center, it was found that the main possible causes were the effects of increased water temperatures and grazing by herbivorous fishes due to climate change as well as the continuous flow of large quantities of floating mud from the rivers. The productivity of seaweed could be lowered by worst light conditions, which in turn increase the rate of damage from overgrazing

by herbivorous fishes because of the influence of high water temperatures. In other words, the environmental conditions of the seaweed beds lost the balance between seaweed production and grazing pressure by herbivorous fish. In order to rehabilitate the barren seaweed beds again, activities that include supplying seeds through the use of ropes implanted with *Ecklonia cava* juveniles and deploying blocks implanted with *Ecklonia cava* on the barren bottom,

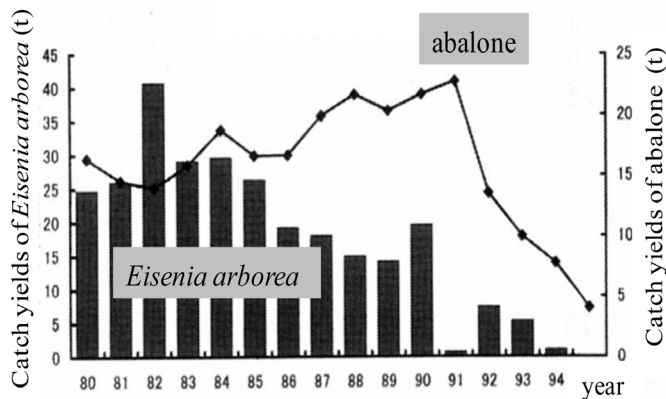


Fig. 5. Relationship between *Eisenia arborea* and abalone production in the Hainan Area (Source: *Isoyake Recovery Guideline*)

have been implemented by the Shizuoka Prefecture, while removing rabbit fish (herbivorous fish) using fixed nets and gill nets had been carried out by the fishers.

Although the shoreline survey conducted in February 2008 revealed that the *Ecklonia cava* beds of about 55 ha along the coast had already recovered, countermeasures have been implemented continuously by the local governments and fishers. It could also be noted that the recovered seaweed grounds serve as a nucleus to supply seaweed seeds to surrounding waters. The expansion of seaweed beds is ongoing little by little, while the rehabilitation of seaweed beds is aimed at adapting to changes in environmental conditions.

Examples of Support for Conserving/Recovering Seaweed Beds by the Fisheries Agency of Japan

Knowledge sharing for conserving/recovering seaweed grounds through National Conferences

The Fisheries Agency of Japan has been conducting National Conferences on Isoyake Recovery Measures every year since 2004. The purpose of these conferences is to reinforce all efforts towards effective isoyake recovery measures through the exchange of plans and results of surveys/studies, technical development and practical countermeasures by fishers, among others. The participants in the conference include technical staff/researchers from the local governments and specialists, who work towards the goal of accumulating knowledge from experimental scale to

practical project scale based on basic research and studies.

In addition, along with the conferences, several meetings such as technical exchange workshops and on-site workshops have also taken place. These conference activities are extremely beneficial for sharing the most recent information and challenges for the effective conservation and utilization of seaweed. Even without budgetary support, every year about 200 participants gather at the Fisheries Agency to present their support activities and to exchange information on other relevant activities. In organizing these workshops, it is important to provide the latest and most useful information, and to obtain effectively a common understanding within the time of the conference. Through knowledge sharing, the participants could substantially advance their own projects year by year. It is mainly due to these kinds of knowledge sharing among stakeholders that the technical development of practical methods for isoyake recovery countermeasures was achieved within several years.

Training in seaweeds monitoring research for technical staff/researchers of local governments

Since 2008, the Fisheries Agency has been conducting the “Seaweed Monitoring Research Training Course” which aims to impart knowledge and skills on the survey techniques of seaweed monitoring, know-how for utilizing survey instruments, investigation methods of herbivores, and analysis of the acquired data. The training course, which also generally aims to enhance the capabilities of the administrative staff/researchers of the local governments, is being conducted at the Tateyama Station of Tokyo University of Marine Science and Technology. It is important for staff/researchers of local governments as well as fishers to know the real situation of the seaweed beds by observing with their own eyes in order to enhance the adequate supporting activities for fishers (Photo 5 and Photo 6).

Support program for fishers’ contribution to restoration of the coastal marine environment

Since it is necessary to constantly observe the seaweed beds, it is under this framework where the fishers play a crucial role. In particular, it is indispensable that for sustainable isoyake recovery measures, fishers who have detailed knowledge of the circumstances of local seaweed beds should participate in the monitoring and conservation activities. For this purpose, the Fisheries Agency of Japan recently launched “the support program for fishers’ contribution to restoration of the coastal marine environment”, and provided financial and technical support for the environmental/ecosystem conservation activities initiated mainly by the fishers. Such support for environmental/ecosystem conservation activities covers various kinds of activities such as planning (e.g. discussions,



Photo 5. On-the-job training on monitoring survey (Source: Report of Isoyake Countermeasures Promotion Project, 2008)



Photo 6. Lecture on age-identification of sea urchins (Source: Report of Isoyake Countermeasures Promotion Project, 2008)

planning formulation, dissemination, and human awareness activities), monitoring (e.g. investigation of current status and the effects), conservation/recovery activities (e.g. placing mother algae, nursing and planting young algae, removal of herbivores), and other related activities. This program also supports the activities for conservation of other important habitats such as improvement of the productivity of tidal flats, and coral propagation activities for restoration of coral reefs (Photo 7 and Photo 8).

Discussion

Through effective knowledge sharing, technical development and implementation of practical methods by fishers for *isoyake* recovery, countermeasures could be advanced to some extent during short period of time. These efforts and practices have often been presented in the newspapers and TV programs in Japan. Thus, the *isoyake* recovery measures by fishers have contributed in addressing a social problem which has become a concern to the people in general.

Recently, the influence of human activities and impact of climate change have been serious and irreversible, resulting in the occurrence of barren seaweed beds on a large scale and which fishers have been having difficulty in coping with such condition. Nevertheless, there is still the possibility of rehabilitating barren seaweed beds little by little, by adapting to changes in environmental conditions and using practical countermeasures that can be done mainly by the fishers (Photo 9).



Photo7. Removal and transplantation of sea urchins from barren seaweed beds in Aomori Prefecture (Source: Report of Isoyake Countermeasure Promotion Project, 2008)



Photo 8. Clean-up of rocky sea shores to recover *Sargassum fusiformis* beds in Shizuoka Prefecture (Source: Report of Isoyake Countermeasure Promotion Project, 2008)

In general, monitoring and conservation activities need sufficient human resources and budget. Since the central and local governments cannot provide the needed budgets, self-management of seaweed beds by fishers groups in communities has been effectively pursued in Japan. This has been achieved mainly because the fishers perceive the incentives that they could gain from their efforts such as the right to use the fishery resources as secured by laws



Photo 9. Recovery of barren seaweed beds by supply of spore bag and removal of herbivores in Nagoya districts of Oita Prefecture (Source: *Isoyake Correspondence Articles Vol. 1: Nagoya, 2009*)

and regulations of the government. Furthermore, the fishers group also wishes to keep the seaweed beds intact for future generations.

Way Forward

This report has mainly focused on the conservation or recovery activities for seaweed beds. However, it should also be considered that many fishers groups and fishery cooperatives have also been making efforts to develop new products and expand the markets for seaweeds in the region. Recently, seaweeds have been brought to the attention of consumers in new food markets such as the salad market, new health markets, and soup stock markets, among others. For the sustainability of utilizing seaweeds in many communities, it may be also useful to support marketing development in addition to the conservation activities.

In Japan, a number of coastal fishers are engaged in seaweed gathering/fishing and aquaculture. Specifically, in a number of fishing communities, seaweed gathering and farming play an important role in sustaining the fishers' income and economies of fishing communities. Based on the experiences of Japan, seaweed industries in Southeast Asia also have the potentials to be developed with adequate initiative and support by the governments in order to sustain the fishing communities.

Environmental/ecosystem conservation activities led by the fishers have just begun in Japan, and several practical and technical problems still remain to be unsolved, including the human and financial resource aspects. However, some hints to solve these problems can be found in the fishers' efforts and attempts to carry out the solutions on-site.

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