

## Small-scale Fisheries in Japan

Environmental and Socio-cultural Perspectives

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# Restoration of Eelgrass Beds by the Fishermen of Hinase in the Seto Inland Sea, Japan

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**Abstract** The paper reviews the activities of fishermen who are members of the Hinase Fishermen's Union in the Seto Inland Sea, Japan, their work to restore damage to eelgrass beds that has been caused over a period of more than 30 years, and the establishment of a sixth industry in the area.

**Summary** 1 Introduction. – 2 Rehabilitation of Eelgrass Beds. – 3 ICM. – 4 Collection of Seabed Debris. – 5 Direct Selling. – 6 Oyster Culture. – 7 Fish Farm. – 8 Eelgrass Summit.

**Keywords** Restoration of eelgrass beds. Oyster culture. Satumi. Sixth industry.

## 1 Introduction

Hinase, a town in the eastern part of Okayama Prefecture in the eastern Seto Inland Sea (the largest semi-enclosed sea in Japan, fig. 1), has a population of about 11,000. Although it was once called “a big fishing town with a thousand fishermen's houses”, the ratio of fishermen is now only 3%.<sup>1</sup>

The Hinase Fishermen's Union numbered 107 full members and 62 associate members as of June 2008. It is famous for developing the drifting net used for mackerel and a small seine net (fig. 2), which are installed around the Hinase fishing grounds (fig. 3). Before World War II, some fishermen moved to Nagoya, Aichi Prefecture in the East and even to Korea in the West with their advanced technology. The seine net has been called the Hinase net (*tsubo-ami* in Japanese). There are many fishermen from Hinase who have relocated to Yamaguchi, Oita, and Fukuoka Prefectures in the western part of Japan.

The Union admits only one full member from each family for the conservation of fishery resources (by preventing over-fishing), and younger, but

1 Statistics and information were obtained from the Hinase Fishermen Union. Pictures are taken by the Author with the cooperation of Hinase Fishermen Union.

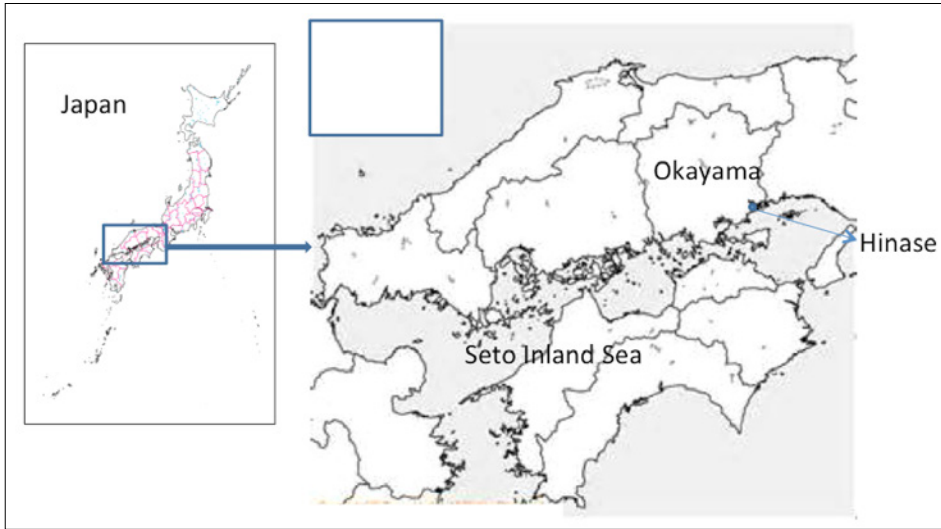


Figure 1. The Seto Inland Sea and Hinase town

not the eldest sons, must migrate to other places to continue fishing. As a result, young fishermen went to Korea and China to fish mackerel with drifting nets before World War II.

By the end of the 1960s, however, the fish catch by fishermen's Union had decreased and many full members had grown old.

The main fishing activities of the present Hinase Fishermen's Union use small seine nets (about 50 families), drifting nets for mackerel (from April to June), drifting nets for bonito (July to August - about 50 families), small trawling nets (about 50 families), oyster culture (about 50 families), and seaweed culture (2 families).

## 2 Rehabilitation of Eelgrass Beds

The areas of eelgrass (sp. *Amamo*; *Zostera marina*) beds in the Hinase coastal area decreased from the early 1960s, mainly because of water pollution in the Seto Inland Sea (fig. 4). A huge typhoon in 1976 caused extensive damage to the eelgrass beds, which failed to recover after that, mainly due to the decrease in the transparency and the inflow of agricultural chemicals from the land.

Eelgrass beds grow in calm coastal sea areas with a sandy silt seabed. They weaken strong tidal currents and strong sunlight, and become the breeding place for squid and the nursery grounds for small fish, as small animals on the leaves of the eelgrass are good bait for them.

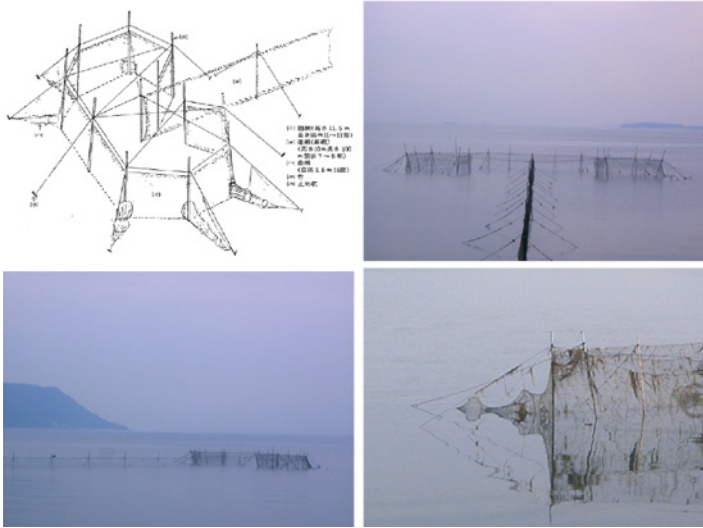


Figure 2. Small seine net (Hinase net, 'Tsubo-Ami' in Japanese)

Some members of the Union used small seine nets with shrimp, blue crab and coastal fish such as red sea bream as their primary targets. They thought that the main reason for the decreased fish catch was the reduction of eelgrass beds' areas, so, in 1985, they began to rehabilitate them under the guidance of scientists from the Okayama Prefectural Fisheries Experimental Station.

Eelgrass is a plant (grass) with flowers and seeds. It can expand its growing area by seeding and by spreading roots (rhizomes). The seeds drift down to the seabed in June, germinate from November to January, and grow until July. It stops growing in summer and becomes a drifting grass, but grows again in autumn.

The rehabilitation of an eelgrass bed is possible using two methods, namely sowing seeds or transplanting roots. The fishermen of the Hinase Fishermen's Union adopted the idea of sowing seeds. In May or June, they gathered seeds from the eelgrass beds and preserved them in a net under the rafts used for oyster culture. They selected good-quality seeds in October and sowed them in suitable areas within the Hinase fishing grounds in November and December (fig. 5).

In 1985, the fishermen sowed 150,000 seeds in eight areas (fig. 6, A to G). By 1988, the number of seeds sown increased to 2,200,000. Area A in figure 6 was an eelgrass bed that had disappeared in 1985 when seeds were sown for the first time. In the following spring, a small patch of eelgrass bed was discovered in area A that survived until autumn 1986. Area B, where they had sown seeds in 1986 and 1987, has now become an es-

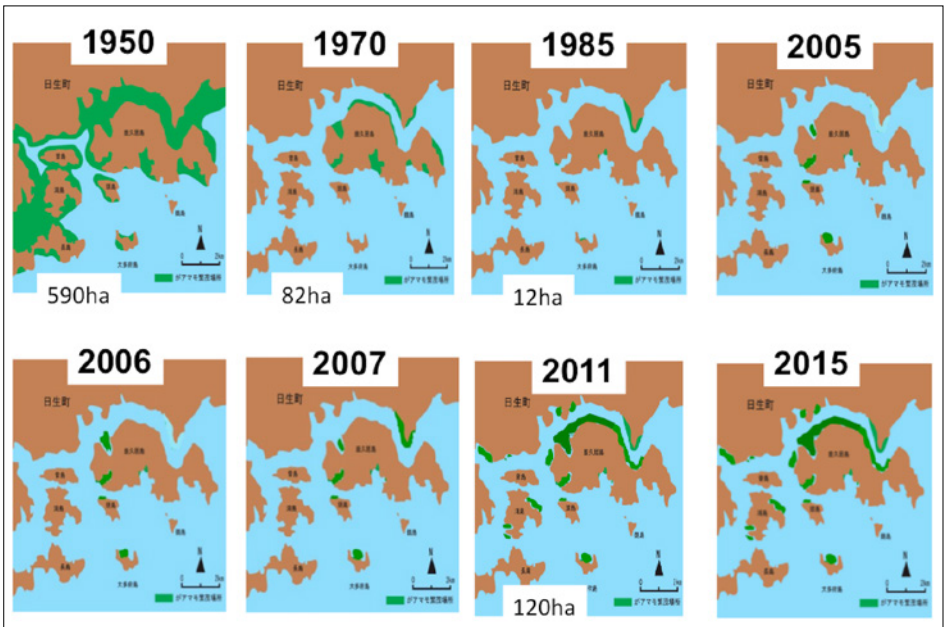
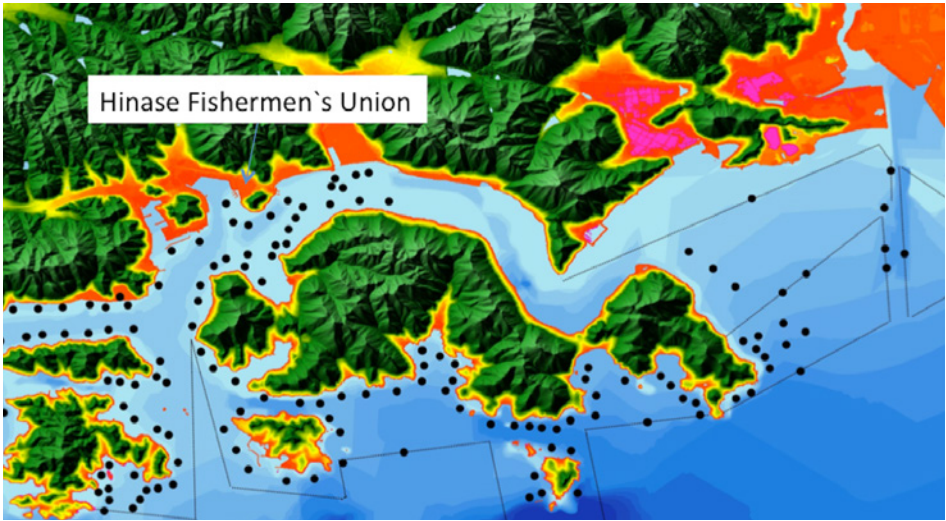


Figure 3. Location of small seine net (black circles) in Hinase fishing ground (from (NPO) Satoumi Research Institute)

Figure 4. Change of Eelgrass beds in the Hinase fishing ground

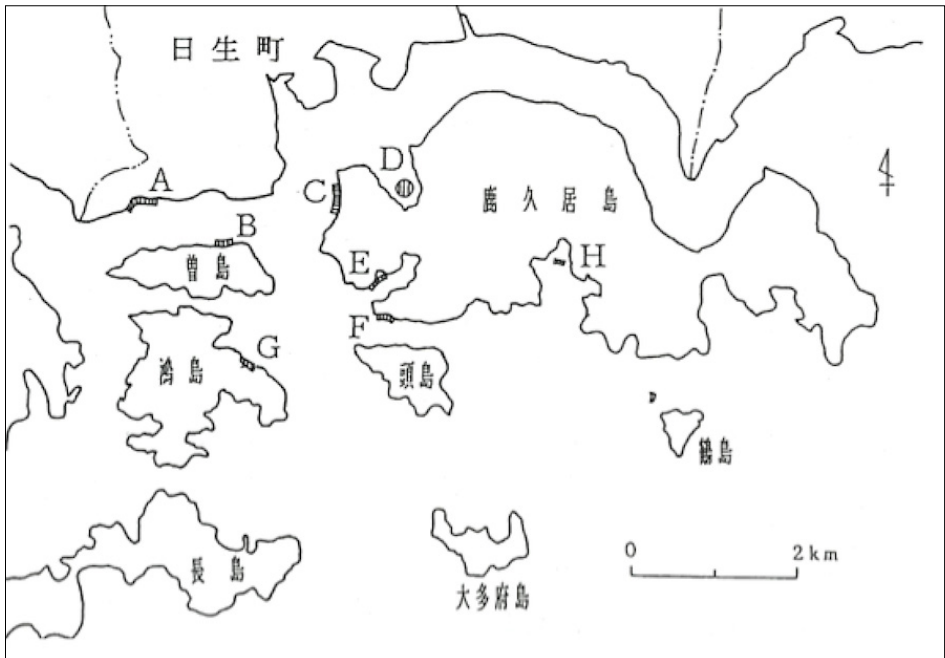
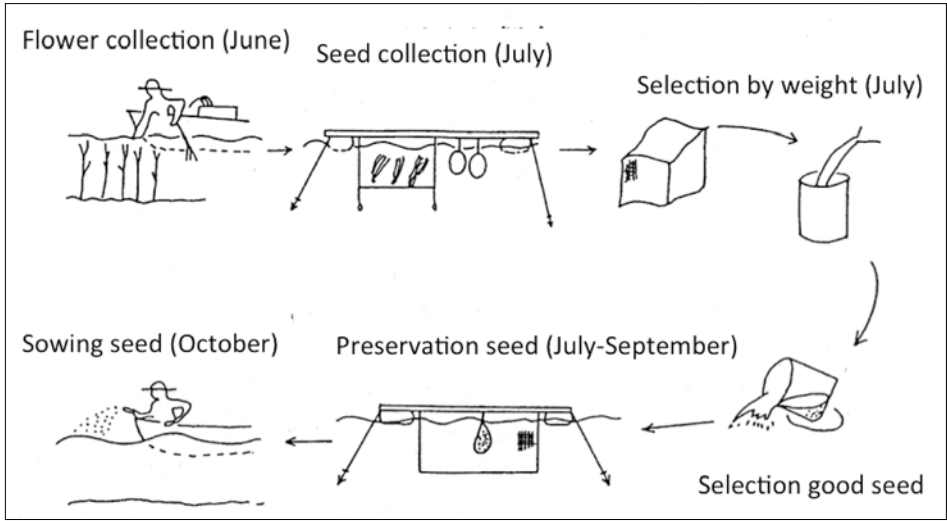


Figure 5. Method for sowing eelgrass seed  
 Figure 6. Areas of eelgrass seed sowing (A-G)

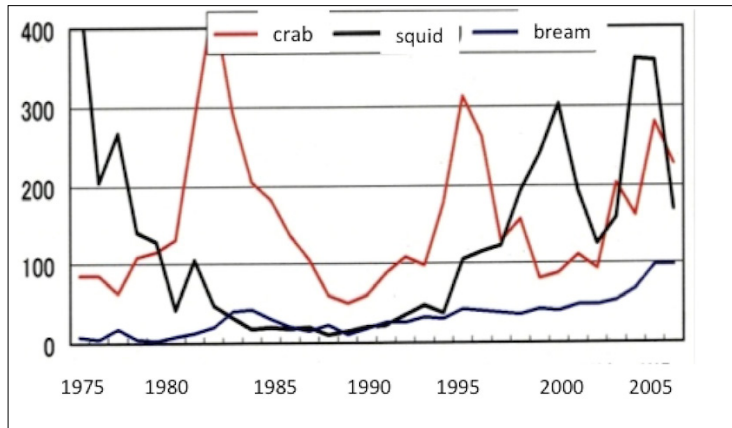


Figure 7. Variation in fish catch in the Hinase fishing ground

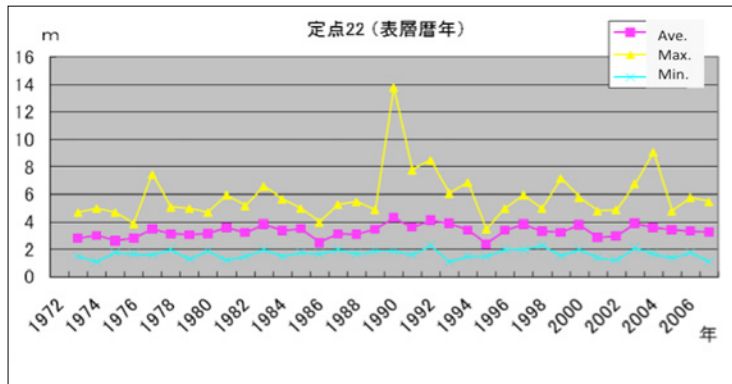


Figure 8. Year-to-year variation in transparency of the Hinase fishery ground (from Okayama Prefectural Fisheries Station)

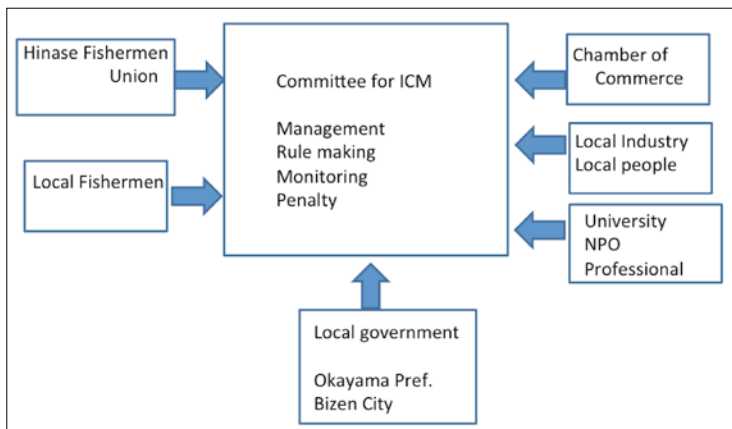


Figure 9. The committee for Integrated Coastal Management at Hinase



Figure 10. Hinase agreement.

established eelgrass bed. However, beds have not formed where seeds were sown in area C. The rehabilitation of eelgrass beds in area D succeeded after improvements were made to the characteristics of the seabed by introducing materials such as oyster shell. In areas E, F and G, rehabilitation was also successful, while it failed in area H, as sand covered the seabed.

The fishermen have reached a number of conclusions on suitable areas for sowing the seeds of eelgrass:

1. areas with a weak tidal current that cannot move the seeds;
2. areas with sandy silt beds where the eelgrass can spread its roots;
3. areas with previous eelgrass beds;
4. areas with a water depth of 0.5-1.0 m at low tide so that sunlight can penetrate as far as the sea bottom;
5. they also figured out that the establishment of a new eelgrass bed takes several years.

Recovery of areas of eelgrass beds went from only 12 ha in 1985 to 120 ha in 2011, as a result of the fishermen continuing such activities, and the fish catch of swimming crab, squid, and red sea bream by seine nets also recovered (fig. 7). Such recovery may be partially the result of the increase in water transparency (Secchi disk depth) in this area (fig. 8). A manual for eelgrass bed rehabilitation was produced by Okayama Prefecture based on their experience in 1990.

### 3 ICM

The Committee for ICM (Integrated Coastal Management) was established in 2010 (fig. 9). Bizen City Office convened this committee and became its secretariat. Committee members discuss what actions are needed for the establishment of a sustainable coastal area at Hinase.



Figure 11. Marine debris deposit place at Hinase Fishing Port



Figure 12. Fish market (Gomi-no-Ichi) operated by Hinase Fishermen's Union

The Hinase Fishermen's Union (fishermen), Okayama Prefecture (local government officers), Okayama Co-op (consumers) and the Satoumi (*sato* 里, 'village' and *umi* 海, 'sea') and Research Institute (scientists) agreed to cooperate in the rehabilitation of eelgrass beds in the Hinase area in May 2012 (fig. 10). Following this agreement, a number of families and their children joined in the fishermen's activities.

#### 4 Collection of Seabed Debris

Fishermen who use small trawling nets suffer from massive marine debris on the seabed, which gets into the trawling nets. With the aid of national government funding, the Hinase Fishermen's Union collected 182.1 m<sup>3</sup> of marine debris on the sea bed (burnable, 40%; unburnable, 60%) from an area of 11.4 km<sup>2</sup> from 1982 to 1984 using 253 fishing boats and 413 fishermen (fig. 11). The marine debris they collected was processed in a debris process factory belonging to the town hall with the help of Bizen City Office. The total cost was 9,790,000 Japanese Yen.

Since that time, the fishermen have continued to clean up the sea bed on a voluntarily basis. At the beginning, 12 tons/day of marine debris was collected, but it has recently decreased to 5 kg/day. However, the amount of marine debris collected increases after heavy rain or a passing typhoon, as massive amount of debris enters through rivers from the land.

#### 5 Direct Selling

Half of the fish caught by the Hinase Fishermen's Union is sold by brokers and the other half by direct sales at the Gomi (*gomi* 五味 'five taste')-no-Ichi



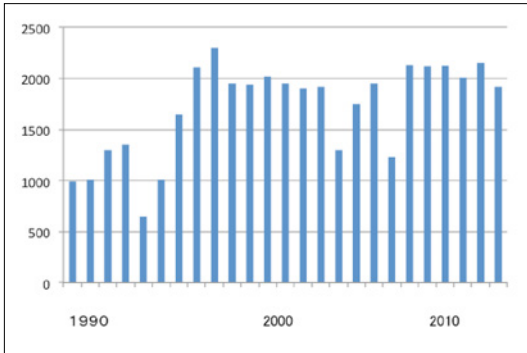


Figure 13. Year-to-year variation in cultured oyster harvest at Hinase from 1989 to 2013

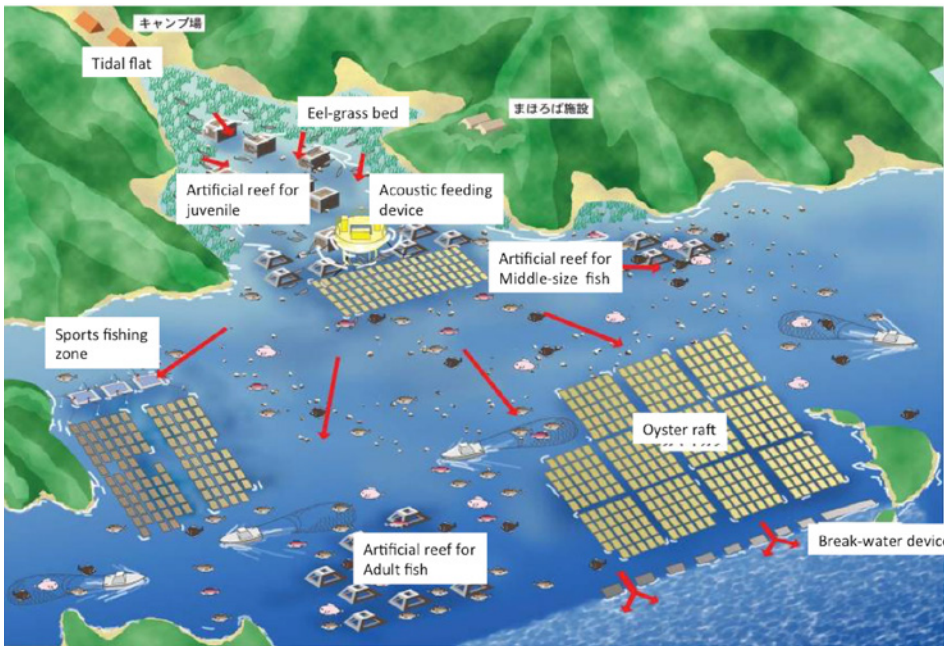


Figure 14. Fish-farm project in Hinase

(*ichi* 市 'market'), the fish market, which is operated by the Fishermen's Union itself (fig. 12). Hinase is reasonably close to large cities – not just Okayama, but places such as Kobe and Osaka, so a variety of individual and commercial consumers come to this shop every day.

## 6 Oyster Culture

Oyster culture has become popular in Hinase since the 1980s, mainly due to market demand. Oyster culture is seasonal, taking place in winter, and the cultivation of seabeds where the oyster culture grounds are located is conducted by small trawling net fishermen after the oyster harvest season so as to conserve the fishing grounds used for oyster culture. The accumulated organic matter on the seabed is easily decomposed by such cultivation. About 100 young people from China work in the factory, which is operated by the Hinase Fishermen's Union, processing the harvested oysters.

The harvest of cultured oysters increased after the expansion of eelgrass beds in the 1990s, as shown in figure 13. The win-win relation between oyster culture and eelgrass bed rehabilitation has been established in the Hinase coastal sea area. Oyster culture is of benefit to eelgrass beds as; 1) oyster rafts decrease the wave height and protect the eelgrass beds, and 2) oysters graze on the phytoplankton and detritus, and thereby increasing the transparency of the water which results in expansion of eelgrass beds. Conversely, eelgrass beds benefit oysters as; 1) expanded eelgrass beds decrease the water temperature during the summer due to the curtain effect on the sea surface, and such decrease in water temperature reduces oyster mortality during the hot summer months, 2) expanded eelgrass beds increase DO concentration through photosynthesis resulting in a decrease in oyster mortality, and 3) the diatoms, animals attached to the eelgrass leaves and dead eelgrass become good food for cultured oysters and result in an increment in the rate of oyster growth.

## 7 Fish Farm

The Hinase Fishermen's Union has proceeded with constructing a fish farm in their fishing grounds, as shown in figure 14. It is composed of rehabilitated eelgrass beds near the coast where spawning is carried out and the nursery ground for juveniles is formed. The artificial reefs for juveniles occupying a small area have been installed near the eelgrass beds. Another artificial reef for medium sized fish with a moderate inner space has been created in the central area of the farm, and those for adults using a large inner space are installed in the offshore area near the cultured oyster rafts for their feeding area. The rafts for cultured oysters



Figure 15. Eelgrass Summit in Japan at Hinase

have become another habitat for juveniles. Along the boundary between the Hinase Fishermen's own fishing ground area and the common fishing ground used for all other fishermen, wave mitigating devices on the water surface have been deployed by the local government to prevent newly-planted eelgrass beds. Such a zoning scheme not only aims to protect fish habitats but also considers the health of the entire marine area in order to achieve sustainable use of future fish resources.

Planning the marine space for this fish farm is carried out by local fishermen, sports fishing groups, the local government, scientists and other stakeholders under the umbrella of the local ICM shown in figure 9.

## 8 Eelgrass Summit

The 10th Eelgrass (*amamo* in Japanese) summit in Japan was held from the 3rd to the 5th of June 2016 in Hinase, which is well known as the spiritual home of Eelgrass bed rehabilitation in Japan (fig. 15).

The scientific symposium entitled, *The present status and future of Eelgrass bed rehabilitation* was held on the 3rd of June in a meeting room of the Hinase Fishermen's Union with about 200 people attending. Ten scientists presented their scientific results on the activities to rehabilitate eelgrass beds in the whole area of Japan. Some scientists talked on the variation in fish species and benthos species and their biomass, related to the expansion of eelgrass beds. Others spoke on the role of eelgrass beds as blue carbon, and one scientist discussed the role that eelgrass beds

play in killing harmful algal bloom. The guide lines for the rehabilitation of eelgrass beds were introduced by three government agencies. In the general discussion, the usefulness of stopping the transfer to the climax stage of eelgrass beds for increasing gathered fish species and biomass, that is, the mutual interaction of humans and nature, was shown to be important for increasing biodiversity in eelgrass beds.

After the opening ceremony on the 4th of June at Hinase City Hall, the students from Hinase Junior High-School presented a drama entitled, *People Sowing Seeds in the Sea* lasting about 30 minutes. It demonstrated the successful story of eelgrass bed rehabilitation by Hinase fishermen. The drama greatly impressed the 600 or so participants at the summit. The first part on this day was a panel discussion on the history of Eelgrass beds rehabilitation in Hinase, and six fishers (five men and one woman) and one NPO scientist introduced the history of activities in the area. The second part was a panel discussion on the rehabilitation of seven eelgrass beds from Sendai in the northern part of Japan to Kagoshima in the south. The third part was a panel discussion on the expansion of goods related to Satoumi, and six people introduced their activities related to the discovery, innovation and sales strategy of the Satoumi brand from their own region.

Also at Hinase City Hall, marine environment conservation activities were introduced on the morning of the 5th of June by students from 12 high-schools from all over Japan with about 500 people in the audience.

The summit ended very successfully with the Hinase Declaration adopted by all the attendees at the closing ceremony in the afternoon of the 5th of June.

The leader of Hinase Fishermen's Union declared: "We have to continue our activities of the Eelgrass beds rehabilitation not only for us but also for our grandchildren, and develop a 'sixth industry', which means the combination of the primary industry of fisheries, the secondary industry of oyster processing and the third industry of direct sales of the harvest for the future of Hinase" (Author's personal annotation).

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