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61

BIOLOGICAL AND CULTURAL DIVERSITY IN COASTAL COMMUNITIES

Exploring the Potential of *Satoumi* for Implementing the Ecosystem Approach in the Japanese Archipelago

UNEP

Convention on Biological Diversity

UNITED NATIONS UNIVERSITY
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FOREWORD FROM THE EXECUTIVE SECRETARY OF THE CBD

Like many, I was deeply distressed and sorrowed by the tragedy that fell on the Northeastern Japanese coast this year. The global community was shocked by the demonstration of human fragility before wrathful seas, and humbled by the dignity of the coastal communities that collectively withstood the unleashed violence of nature. "Collective" is a word that comes to mind throughout this edition of the CBD Technical Series on *satoumi*.

Our planet is endowed with beautiful coastal landscapes, hosting a great diversity of life and providing abundant resources that are vital to many countries. Over a third of the world population lives within 100 km of the shoreline, and this proportion is growing rapidly. Communities among the most vulnerable depend critically on these ecosystems, whose degradation would directly threaten many livelihoods. Coastal ecosystems provide a multitude of indispensible services to industrialised economies as well; the economic evaluation of such services is difficult but invariably yields daunting figures. Finally, coastal biodiversity harbours vast, yet unexplored resources that should be preserved for future generations.

Regrettably, study after study confirms that this heritage is under threat due to the rapid decline in the biodiversity of coastal ecosystems. Our shores are a strategic frontline in the global biodiversity crisis. But conserving biodiversity in coastal areas is particularly challenging, one reason being the ever-increasing demand for coastal space from a variety of users. Parties to the Convention on Biological Diversity (CBD) recognise the importance of effectively protecting our coasts. Of utmost importance as well is to better manage biodiversity in coastal seas where human influence is significant, because of their geographical extent, the biodiversity they harbour, and their connectedness and influence on protected areas.

Developing and exchanging good practices will be essential to successfully address this challenge. *Satoumi*, as an experience capitalising on traditional coastal cultures for management in a modern context, is a welcome contribution to the growing knowledge base in this field. The case studies in this report show that valuable improvements to the management of biodiversity in human-influenced coastal ecosystems are possible while satisfying the needs of various sectors. I hope that reporting on these practices will foster fruitful exchanges between coastal communities facing similar challenges around the world.

I would like to thank the researchers that have contributed to this report, the United Nations University Institute of Advanced Studies, the Government of Japan and the Prefecture of Ishikawa, whose support to this edition of the CBD Technical Series is an inspiring show of commitment to help address the biodiversity crisis, from the host country to the 10th meeting of the Conference of the Parties and President of the Conference of the Parties to the Convention. As Japan bequeathed to the world the word "tsunami" to describe the destructive might of seas, so perhaps the word "*satoumi*" may remain to describe the peaceful harmony that can also exist between communities and their sea.

Ahmed Djoghlaf
Executive Secretary, Convention on Biological Diversity

FOREWORD FROM THE GOVERNOR OF ISHIKAWA PREFECTURE

I still vividly remember the day in April 2008 when the United Nations University Institute of Advanced Studies Operating Unit Ishikawa/Kanazawa (UNU-IAS OUIK) was established in Ishikawa. Since that day, UNU-IAS OUIK has strived to find solutions to the global issue of sustainable development from a local perspective. Through these research activities, UNU-IAS OUIK has collaborated with both domestic and international research organizations. As about sixty per cent of Ishikawa's land consists of *satoyama* environments, in addition to long coastlines, research projects that focus on *satoyama* and *satoumi*, in particular, are quickly progressing.

Along with support for the UNU-IAS OUIK's research projects, Ishikawa Prefecture is also taking part in a variety of efforts to conserve and utilize biodiversity that specifically focus on *satoyama* and *satoumi*. These efforts are being positively communicated throughout the world on occasions such as a side event at COP 9 in May 2008, the Asia-Pacific Forum for Environment and Development (APFED) in August 2009, a presentation during a visit to the Secretariat of the Convention on Biological Diversity in September 2010 and a side event at COP 10 in October 2010. We are extremely grateful to UNU-IAS OUIK for their support during these events.

This edition of the CBD Technical Report, on *satoumi*, complied by UNU-IAS OUIK, is immensely significant from the perspective of biodiversity conservation in *satoyama* areas.

Much about *satoumi*, as well as marine biodiversity, is still unknown. In fact, the need to increase knowledge on this topic is outlined in the National Strategy for the Conservation and Sustainable Use of Biodiversity 2010, formulated by the Japanese Government. I believe this report makes an important contribution to enhancing this knowledge.

I would also like to express my deep respect for Ms. Anne McDonald, Director of UNU-IAS OUIK, and for all those who participated in creation of this report.

I sincerely hope that biodiversity conservation efforts continue to grow and I look forward to further development of the United Nations University Institute of Advanced Studies Operating Unit Ishikawa/Kanazawa.

Masanori Tanimoto
Governor of Ishikawa Prefecture

EXECUTIVE SUMMARY

The alarming rates of decline in coastal biodiversity are well documented, and the resulting decrease in vital ecosystem services may have vast and adverse consequences for many countries. While protected areas are an indispensible tool for conservation, in many areas relying solely on the exclusion of human use is problematic. In the particular case of Japan, reviving *satoumi*, a coastal sea with high human influence together with high productivity and biodiversity, is one culturally appropriate way to integrate conservation and sustainable use of biodiversity.

Satoumi has enabled the effective involvement of stakeholders from different sectors in coastal conservation. The nuanced view of human interaction with coastal nature in *satoumi* accommodates a wide range of conservation and restoration practices, including some involving human labour on the ecosystem, such as reforestation of watershed slopes, restoration of seagrass beds or maintenance of artificial habitats. Available data is encouraging on their effectiveness and their potential to mobilize communities and fishers.

Satoumi conservation has facilitated the mainstreaming of biodiversity concerns in various sectors involved in the coastal zone. Several ministries use *satoumi* to enhance conservation in their policies and field activities, and fishers voluntarily led and invested labour and resources into conserving the local ecosystem. This effective integration of conservation costs by ecosystem users appears to rest on collective, largely hereditary ownership and empowered collective structures that can harmonise economical and technical consideration with cultural and non-utilitarian views of life on the coast.

Uptake in wider management frameworks and processes, and multidisciplinary, international collaboration are priorities to further the contribution of *satoumi* to biodiversity conservation. *Satoumi* is currently being scaled up from a largely community-level practice to the national level. International collaboration and sharing of similar experiences is progressing, beginning with Asian countries with highly human-influenced coastal seas.

Overall, although further research and practice are necessary, where it has been applied, *satoumi* has proven to be an effective, culturally appropriate concept for coastal conservation. The experiences reported herein can thus be a useful contribution to the knowledge-base for biodiversity management in human-influenced coastal seas.

Oyster farming in Nanao Bay, an enclosed sea area with a long history of mariculture.

Below the surface of coastal waters surrounding Japan's capital megacity, sea anemones, three spot damsel fish and other marine life inhabit Tokyo Bay.

Adding color to marine life, seahorses are found in abundance in the sea around Notojima Island, Nanao Bay, Ishikawa Prefecture.

Sub-tropical waters sustain a colorful mosaic of marine life as exhibited here with the pink anemone fish in Kerama, Okinawa.

Food culture of fishing communities often reflect the local marine ecosystems and marine resources it supports. A staple for northern fishing communities, salmon is being dried in the sun in Rausu, Shiretoko Penninsula, Hokkaido.

Muroran blenny thrive in the cool northern waters in Rausu, Shiretoko Penninsula, Hokkaido

The ice flows reach the shores of Shiretoko Peninsula in mid-winter carrying with them plankton and other sea life. Fringed blenny below the sea ice flows in Utoro, Shiretoko Penninsula, Hokkaido.

With autumn comes the changing of leaves of the forests of Hokkaido and the rivers are painted with the colors of the dog salmon beating upstream. Rausu, Shiretoko Penninsula, Hokkaido.

Found throughout the Japanese Archipelago, stretching 3,000 kilometers from northern Hokkaido to southern Okinawa, here is the octopus and rich kelp of the northern waters surrounding Shiretoko Penninsula, Hokkaido.

A divers' mecca in the winter, divers gather from around Japan to share the wonders of marine life beneath the ice flows in Utoro, Shiretoko Penninsula, Hokkaido.

Traditional fishing communities in Ishikawa Prefecture maintain the annual summer custom of drying fish to be used as fish broth throughout the year.

Carrying on with the traditions of her ancestors, the female ama divers on Hegura Island are the guardians of artisinal fishing methods and culture transmitted from generation to generation for over 1,000 years.


I. Introductory Articles

Introductory Article

1

RELEVANCE OF *SATOUMI* TO THE CBD MANDATE

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SATOUMI AND THE CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

Yanagi[1] (2008) defines *satoumi* as "high productivity and biodiversity in the coastal sea with human interaction". *Satoumi* both as a concept and a management strategy provides a culturally-appropriate method for implementing provisions of the Convention on Biological Diversity (CBD) related to coastal areas. On a very basic level, *satoumi* is an expression of the CBD ecosystem approach, which is considered the primary framework for action under the CBD. *Satoumi*'s roots in traditional ecological knowledge and cultural history also provide a way to implement aspects of Article 8(j) on traditional knowledge, innovations and practices. Finally, *satoumi* is of particular relevance to the CBD programme of work on marine and coastal biological diversity (decision VII/5).

The programme of work on marine and coastal biological diversity was originally adopted in 1998 (decision IV/5). One of the earliest programmes of work developed by the CBD Parties, it was a reflection of the importance attached to the conservation and sustainable use of marine and coastal biodiversity following the 1995 Jakarta Mandate (a Ministerial Declaration reflecting a global consensus on the importance of marine and coastal biodiversity). The purpose of the programme of work was to provide countries with specific activities that could be undertaken to implement the Jakarta Mandate according to national priorities. Amongst those were five priority areas: (1) Integrated marine and coastal area management (IMCAM); (2) Sustainable use of marine and coastal living resources; (3) Marine and coastal protected areas (MCPAs); (4) Mariculture; and (5) Invasive alien species. The programme of work was reviewed and updated in 2004 (decision VII/5), and 2010 (decision X/29) but the priority areas remained the same.

Of the five priority areas, *satoumi*-related activities address three: IMCAM, sustainable use of living resources, and mariculture. Various *satoumi* projects have incorporated activities relevant to coastal management and integrated river basin management. The intricate connection between the coast and the sea has been repeatedly highlighted in CBD decisions related to marine and coastal biodiversity, and the management of the coastal area from the mountaintop to the sea is basic to *satoumi*. *Satoumi* relies on participation of all relevant stakeholders, with a strong emphasis on community involvement. The ethic of participation is also central to the CBD, particularly its provisions related to IMCAM and the ecosystem approach. Many of the specific *satoumi* activities, such as restoration of seagrass beds, sustainable cultivation of oysters, and restoration of coastal fisheries are activities found in the CBD programme of work on marine and coastal biodiversity.

Satoumi also brings something new to the CBD's work on marine and coastal biodiversity. Since only 53 per cent of the Japanese coastline is natural, many *satoumi* projects have focused specifically on urban areas. This emphasis on restoration of urban water quality and biodiversity through means based on modern science and traditional cultural heritage is new to the CBD. As such, techniques employed as part of *satoumi* provide a learning opportunity for all urban nations with coastal zones highly altered by human development.

As our understanding of the role of biodiversity in climate change adaptation increases, so does the need to implement projects that enhance the resilience of both biodiversity and coastal human communities in a changing world. *Satoumi*-related projects provide one way for building this type of resilience. This area of research is still new to the CBD, but is likely to gain more prominence following the 10th meeting of the Conference of the Parties (COP 10).

THE ECOSYSTEM APPROACH AND *SATOUMI*

The ecosystem approach was adopted as the primary framework for action under the CBD at COP 2 in Jakarta in 1995. The approach provides for a holistic management strategy that goes beyond the single species management strategies of yesteryear to encompass management of entire ecosystems and their component species (including humans), and the often dynamic and complex interactions between them and their physical and biological environment. In 2000, COP 5 endorsed a description of the ecosystem approach as follows:

1 "*Satoumi*, a new concept for sustainable fisheries" in *Fisheries for Global Welfare and Environment, 5th World Fisheries Congress,* 2008, pp. 351-358. Tsukamoto et al. eds, Terrapub, Tokyo. Regarding this definition, it should be noted that the concept of *satoumi* is still evolving and thus it is possible that the definition will also further evolve with broader application of *satoumi* as a management approach.

The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Application of the ecosystem approach will help to reach a balance of the three objectives of the Convention. It is based on the application of appropriate scientific methodologies focused on levels of biological organization which encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems.[2]

The description was underpinned by 12 principles and 5 points of operational guidance. The principles were considered complementary and interlinked, and should be applied together, rather than one at a time. When combined, the definition, principles and operational guidance provide a flexible framework that is meant to be applied in locally meaningful ways.

The commonalities between *satoumi* and the ecosystem approach can be seen when each of the 12 principles of the ecosystem approach is considered in the context of *satoumi*-related activities. The results, as can be seen from the table below, show that *satoumi* provides a culturally appropriate way to implement the CBD ecosystem approach in Japan.

TABLE 1. Commonalities between the 12 principles of the ecosystem approach and *satoumi*.

Principle (from decision V/6)	Explanation (from decision V/6)	*Satoumi* relevance
1. The objectives of management of land, water and living resources are a matter of societal choices.	Different sectors of society view ecosystems in terms of their own economic, cultural and societal needs. Indigenous peoples and other local communities living on the land are important stakeholders and their rights and interests should be recognized. Both cultural and biological diversity are central components of the ecosystem approach, and management should take this into account. Societal choices should be expressed as clearly as possible. Ecosystems should be managed for their intrinsic values and for the tangible or intangible benefits for humans, in a fair and equitable way.	Different government departments and the general public view and apply *satoumi* in accordance with their own priorities. The concept is broad enough to encompass priorities of diverse sectors, as well as scientific, cultural and spiritual values.
2. Management should be decentralized to the lowest appropriate level.	Decentralized systems may lead to greater efficiency, effectiveness and equity. Management should involve all stakeholders and balance local interests with the wider public interest. The closer management is to the ecosystem, the greater the responsibility, ownership, accountability, participation, and use of local knowledge.	*Satoumi*-related activities are generally implemented on the community level, with government support. Conservation activities undertaken as part of *satoumi* have proven valuable in mobilising communities to care for and better understand their local coastal ecosystem.
3. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.	Management interventions in ecosystems often have unknown or unpredictable effects on other ecosystems; therefore, possible impacts need careful consideration and analysis. This may require new arrangements or ways of organization for institutions involved in decision-making to make appropriate compromises, if necessary.	In *satoumi*, there is an emphasis on understanding and regulating how activities taking place on land affect the sea downstream. Examples include regulation of nutrient cycling and pollution.
4. Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should: (a) Reduce those market distortions that adversely affect biological diversity; (b) Align incentives to promote biodiversity conservation and sustainable use; (c) Internalize costs and benefits in the given ecosystem to the extent feasible.	The greatest threat to biological diversity lies in its replacement by alternative systems of land use. This often arises through market distortions, which undervalue natural systems and populations and provide perverse incentives and subsidies to favor the conversion of land to less-diverse systems. Often those who benefit from conservation do not pay the costs associated with conservation and, similarly, those who generate environmental costs (e.g. pollution) escape responsibility. Alignment of incentives allows those who control the resource to benefit and ensures that those who generate environmental costs will pay.	*Satoumi* is grounded in an understanding of the local socio-cultural context and focuses on restoring ecological services and enhancing livelihoods, particularly in regards to fisheries. Active conservation measures, where fishers contribute time and resources to planting trees, kelp, *Sargassum* beds, etc. are examples of *satoumi*-related activities, which provide a potentially interesting way for users of biodiversity resources to internalize the costs of conservation.
5. Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.	Ecosystem functioning and resilience depends on a dynamic relationship within species, among species and between species and their abiotic environment, as well as the physical and chemical interactions within the environment. The conservation and, where appropriate, restoration of these interactions and processes is of greater significance for the long-term maintenance of biological diversity than simply protection of species.	Central to *satoumi* is the maintenance and/or restoration of the material cycle and creation of a resilient coastal zone, including through restoration or construction of habitats essential for the structure and functioning of the coastal ecosystem.
6. Ecosystems must be managed within the limits of their functioning.	In considering the likelihood or ease of attaining the management objectives, attention should be given to the environmental conditions that limit natural productivity, ecosystem structure, functioning and diversity. The limits to ecosystem functioning may be affected to different degrees by temporary, unpredictable of artificially maintained conditions and, accordingly, management should be appropriately cautious.	One of the noteworthy aspects of *satoumi* is its application to urban coastlines, where previously unproductive and polluted areas are recovered and restored through community activities such as eelgrass planting and non-intensive aquaculture of oysters.
7. The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.	The approach should be bounded by spatial and temporal scales that are appropriate to the objectives. Boundaries for management will be defined operationally by users, managers, scientists and indigenous and local peoples. Connectivity between areas should be promoted where necessary. The ecosystem approach is based upon the hierarchical nature of biological diversity characterized by the interaction and integration of genes, species and ecosystems.	*Satoumi* projects have been undertaken on scales ranging from relatively large (Seto Inland Sea) to small (a single small bay around a village). Connectivity with adjacent areas and the open sea are generally taken into account.

2 Decision V/6 of the CBD Conference of the Parties.

Principle (from decision V/6)	**Explanation (from decision V/6)**	***Satoumi* relevance**
8. Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.	Ecosystem processes are characterized by varying temporal scales and lag-effects. This inherently conflicts with the tendency of humans to favour short-term gains and immediate benefits over future ones.	While *satoumi* as a concept is a little over 10 years old, its continuation in the long term is ensured through incorporation into policy, including Japan's Third National Biodiversity Strategy and Basic Plan on Ocean Policy.
9. Management must recognize that change is inevitable.	Ecosystems change, including species composition and population abundance. Hence, management should adapt to the changes. Apart from their inherent dynamics of change, ecosystems are beset by a complex of uncertainties and potential "surprises" in the human, biological and environmental realms. Traditional disturbance regimes may be important for ecosystem structure and functioning, and may need to be maintained or restored. The ecosystem approach must utilize adaptive management in order to anticipate and cater for such changes and events and should be cautious in making any decision that may foreclose options, but, at the same time, consider mitigating actions to cope with long-term changes such as climate change.	*Satoumi* projects include a monitoring component, which provides a basis for adaptive management.
10. The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.	Biological diversity is critical, both for its intrinsic value and because of the key role it plays in providing the ecosystem and other services upon which we all ultimately depend. There has been a tendency in the past to manage components of biological diversity either as protected or non-protected. There is a need for a shift to more flexible situations, where conservation and use are seen in context and the full range of measures is applied in a continuum from strictly protected to human-made ecosystems.	*Satoumi* focuses on realistic conservation and sustainable use measures in coastal seas with significant human activities. These include conservation, creation and restoration of seagrass beds, tidal lands and coral reefs; measures for reducing water pollution in semi-enclosed seas; and sustainable resource management and livelihood enhancement.
11. The ecosystem approach should consider all forms of relevant information, including scientific, indigenous and local knowledge, innovations and practices.	Information from all sources is critical to arriving at effective ecosystem management strategies. A much better knowledge of ecosystem functions and the impact of human use is desirable. All relevant information from any concerned area should be shared with all stakeholders and actors, taking into account, inter alia, any decision to be taken under Article 8(j) of the Convention on Biological Diversity. Assumptions behind proposed management decisions should be made explicit and checked against available knowledge and views of stakeholders.	*Satoumi* is based both on scientific research and traditional cultural values. Local knowledge is employed in monitoring activities and environmental restoration technology. As well, *satoumi* provides ways to capitalise on traditional knowledge for conservation in a modern world.

Principle (from decision V/6)	**Explanation (from decision V/6)**	***Satoumi* relevance**
12. The ecosystem approach should involve all relevant sectors of society and scientific disciplines.	Most problems of biological-diversity management are complex, with many interactions, side-effects and implications, and therefore should involve the necessary expertise of stakeholders at the local, national, regional and international level, as appropriate.	Application of *satoumi* involves a broad range of participants, including local, prefectural and national governments, fishermen, scientists, civil society and concerned citizens.

Introductory Article

2

MAINSTREAMING *SATOUMI* IN JAPANESE NATIONAL POLICY: INTRODUCTION TO THE CASE STUDIES

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> "A key lesson from the failure to meet the 2010 biodiversity target is that the urgency of a change of direction must be conveyed to decision-makers beyond the constituency so far involved in the biodiversity convention" (Global Biodiversity Outlook 3, 2010, p. 83).

INTRODUCTION

The *Global Biodiversity Outlook 3*, published by the Secretariat of the Convention on Biological Diversity in preparation for the tenth meeting of the Conference of the Parties (COP 10) in Nagoya, October 2010, makes clear the dire state of global biodiversity and our failure to meet the 2010 target for reducing the rate of biodiversity loss globally. The report highlights the urgent need to change the direction of global policy and make environmental conservation a top priority. It underlines the importance of mainstreaming biodiversity protection and integrating CBD strategies into relevant sectoral or cross-sectoral plans, programmes and policies. The report sees this as the key to initiating and sustaining the level of effort needed to meet the challenge of global action that can halt the loss of biodiversity and bring about real changes in our environment.

Mainstreaming the idea of conserving biodiversity in the work of production sectors is considered one of the most challenging tasks for CBD implementation. One reason that mainstreaming is so difficult for CBD, it is argued, is because biodiversity loss affects different sectors in different ways and to varying degrees, and so policy interests among different sectors often clash. Another barrier to cross-sectoral integrative policies is that CBD-related issues have traditionally been seen as primarily environmental policy concerns. This tendency often ignores the way sectors, development models, policies and programmes operate in reality, thus underscoring the cross-sectoral nature of environmental challenges. A wider appreciation that integrative approaches can have both immediate and long-term benefits in improved environmental quality and productivity could help create a long-term safeguard for sustainable development.

Transcending inter-ministerial sectoral tendencies is a challenge Japan shares with its global counterparts. As has been the case in other countries, it has been difficult to mainstream the implementation of CBD priorities into Japanese policy because of conflicting interests among government bodies. Typically, conservation of marine biodiversity has been overwhelmed by other national concerns, including development of fisheries and coastal infrastructure. Thus, issues related to biodiversity were traditionally regarded as part of a separate, independent agenda of the environmental sector.

Yet, because of global and local efforts to educate people about biodiversity, and as a result of efforts to implement the ecosystem approach in the context of coastal activities (see previous chapter), such trends have been gradually changing. In part because of Japan's role as host country of the tenth meeting of the Conference of the Parties to Convention on Biological Diversity in October 2010, public awareness of the importance of biodiversity and of the CBD has been raised. Additionally, the ecosystem approach, which stresses cross-sectoral interests in government discussions and policy-making, has been promoted by policymakers. At the community level, conservation and sustainable use of biodiversity has been supported by vigorous conservation activities organized by local governments, NGOs, and commercial organizations.

This edition of the CBD Technical Series presents 10 case studies of *satoumi* activites, which serve as examples of successful initiatives promoting marine and coastal biodiversity concerns in Japanese policy, including, importantly, mainstreaming it into cross-sectoral government measures. To set the stage for those case studies, the present chapter puts forward three core discussion points regarding the role of *satoumi* as a mainstreaming strategy for CBD implementation.

For the purpose of this chapter, *satoumi* is considered both a concept and a type of sea-landscape that coastal communities in Japan hope to recreate and conserve as an integral part of community-based efforts to achieve locally designed and implemented sustainable ecosystem-based management.

The following three discussion points concern biodiversity mainstreaming strategies that can be identified as we review ongoing *satoumi* activities in national and sectoral policy implementation:

1. Incorporating the ecosystem approach into sectoral strategies, plans, and programmes that promote active and effective participation by government, including national and local governments, as well as local communities and industry.
2. Upgrading community-level initiatives to implement the ecosystem approach, and coordinate and integrate them with national-level strategies, plans, and programmes to both empower communities and promote the notion of biodiversity and sustainable use of natural resources without diminishing local sense of ownership.
3. Creating a national policy that can transcend sectoralism and bridge differences among sectoral policies and interests, as well as integrate sectoral approaches.

As we examine these points, we will look at different ideas of *satoumi* held by the three Japanese ministries in charge of coastal environments: the Ministry of Land, Infrastructure, Transport and Tourism (MLIT); the Fisheries Agency (FA); and the Ministry of the Environment (MOE). We will then present national policies related to the idea of *satoumi*, namely, Japan's Basic Plan on Ocean Policy and its Third National Biodiversity Strategy. We will use these policies in discussing how and why the notion of *satoumi* is brought into national policy: firstly, because of its inclusiveness, and secondly, because of the way it reflects the Japanese sense of place—traditional coastal landscapes and local environmental wisdom combined with natural science.

SATOUMI APPROACHES IN GOVERNMENT PROGRAMMES

Chapter 1 presented *satoumi* as an expression of the CBD ecosystem approach that combines Japanese cultural notions of coastal life and traditional resource management methods with advanced scientific ideas about restoration and conservation of a healthy marine environment, including nutrient circulation. The three government ministries identified above have initiated different *satoumi* programmes to improve the coastal environment. Each programme was dedicated to preservation of the unique characteristics of several different coastal environments in Japan.

i) Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

The earliest ministerial initiative involving the notion of *satoumi* was introduced by MLIT in 2003. This programme, called the Bay Renaissance Project, was implemented in four different locations, all in highly industrialized coastal landscapes facing major enclosed sea areas, including Tokyo and Osaka bays. The selection of these urban locations stemmed from a larger ministerial project to manage Japanese urban planning strategy that included shoreline protection and a highly efficient sewage system connecting urban residential areas and the coastal environment.

Carried out only in urban areas built up along stretches of enclosed coastline, the programme first focused on thorough scientific research on the coastal environment to identify and assess locations where marine habitats capable of nurturing high biodiversity, such as mud flats, could be successfully reintroduced. In these cases, however, the scale of the newly reintroduced habitats is small and the recovery of marine biodiversity in such limited areas is not sufficient to have a substantial ecological impact on the whole enclosed sea area. For example, one-third of Tokyo Bay has been artificially altered by large-scale landfill, which destroyed most of the original habitat, including shoreline mud flats, and the total area of mudflat that the programme has been able to restore is limited.

Nevertheless, the newly reintroduced *satoumi* area, artificially created mudflats and a seagrass bed, is adequate for use in community education and for promoting public involvement by the public in restoring marine biodiversity. The initial scientific efforts and constant monitoring by those participating in the public outreach project ensure the sustainability of the re-created areas, which can be used as examples of habitats with a high level of marine biodiversity. Furthermore, participants in the public outreach project have gathered abundant historical documents, including maps and old photographs of the coastal area before urban development changed it. Together with the detailed scientific information that is now available, these materials remind people of the state of the coastal environment before the radical transformation of the landscape. Thus, although the programme was only designed in response to a sectoral interest in demonstrating the potential development of ecologically high value areas in densely developed urban bay locations, and although it is still experimental and applied at a small-scale, MLIT has succeeded in demonstrating the synthesis of the three elements in *satoumi*: (i) scientific knowledge, (ii) community participation and governmental initiative, and (iii) the importance of high marine biodiversity.

ii) Fisheries Agency (FA)

Another ministerial programme associated with the notion of *satoumi* was implemented by the Fisheries Agency as a part of its initiative to promote the "multifunctionality of Japanese coastal fisheries". In contrast to MLIT's programme, it is more focused on the activities of Japanese coastal fishing communities and their role in the conservation of marine ecosystems and coastal environments. FA's concept of multifunctionality refers to the benefits of community-based activities in restoring marine ecosystems and sustainable resource use. The programme, called "Promoting the multifunctionality of fishing communities and fisheries", facilitated community-based activities to restore nursery habitats, such as seagrass beds (see case study 8 on Okayama), and to establish voluntary management of locally important species (see case study 2 on Akita and case study 10 on Okinawa). These activities are carried out by local fishing communities, mainly based on their environmental knowledge and traditional management systems.

The FA programme makes use of the strong sense of environmental ownership among people in fishing communities and the cultural heritage of the coastal marine environment that have been passed down through generations of fishers. In each case, the local fishing cooperative organized the programme activities, working closely with the FA, whose policy direction has moved from emphasis on catching more fish towards protection of fisheries. The programme incorporated this way of thinking when it was introduced, thus giving recognition to the historical role that local fisheries have played in the sustainable use of coastal fish stock. Almost 200 local projects are conducted all over Japan, and each was supported by modest funding from FA. The progress of each project was monitored by local scientists or trained government scientific officers with expertise not only in fisheries but also in ecological issues, such as the red tide phenomenon and marine waste. The programme has succeeded in encouraging fishers to re-engage the knowledge built up in their communities, and – albeit in a limited way – it has also encouraged community initiatives in marine conservation. Many of the initiatives are too small in geographical scale to fully restore the local ecosystem.

iii) Ministry of Environment (MOE)

In June 2007, with the announcement of a new policy for Japan labelled "Becoming a Leading Environmental Nation Strategy in the 21st Century: Japan's Strategy for a Sustainable Society", the MOE introduced a holistic approach to restoring the ecosystems of both land and sea. The strategy consists of eight measures aimed at enabling Japan to become a leading nation in the effort to restore a healthy global environment. It suggests that Japan can become a model for the achievement of sustainable societies by building upon its assets: a traditional culture founded on respect for the natural environment, cutting-edge technologies, and experience and knowledge gained from successfully overcoming serious pollution issues. *Satoumi* is incorporated in measure 6: creation of vibrant local communities that utilize the blessings of nature. In an effort to implement this measure, the MOE launched a three-year project to support the creation of *satoumi* in April 2008.

The ministry solicited applications from local governments conducting projects with communities under the themes "Conserving marine coastal environmental systems" and "Humans living in harmony with the oceans". Providing small grants, the programme supports local activities that follow the *satoumi* concept. At the same time, the programme is conducting a national survey on *satoumi* activities by collecting case studies, which will be compiled into national guidelines for the *satoumi* approach to ecosystem-based management.

For the survey, MOE has prepared a chart for *satoumi* activities in order to demonstrate their diverse operations and background (figure 1). The chart documents the geographic location of each activity, its content, the body leading the activities and their purposes, and provides the cultural context for the activities. Currently, *satoumi* activities are typically categorized by geographic location into one of three major types: fishing village, urban area or river basin (from ridge to reef). The major types of activities involve cleaning waterfront areas, creating artificial mud flats or seagrass beds to compensate for the loss of habitat due to development, and those that potentially contribute to climate change adaptation. The cultural context categories are *satoumi* activities based on religious beliefs and activities aimed at promoting public engagement, particularly through tourism for residents of urban areas and people who live in non-coastal areas. (See case study 1 on Shiretoko and case study 4 on Nanao Bay.)

Among those categories, the "fishing village" type refers to *satoumi* activities conducted by fishing communities. Many of these activities are supported and monitored under the FA *satoumi* programme noted earlier. "Urban" refers to activities conducted in urban coastal areas, for the most part organized, supported and monitored by MLIT in the programme outlined above. Finally, "river basin" *satoumi* activities (from the ridge to the reef) are operated through the mountaintop to reef, and from the river basins to their estuaries, where different water ecosystems are linked and communities are connected by water (see case study 9 on the Yamaguchi Estuary and also Box 5 on a case study from Kyoto). They are also undertaken in terrestrial environments that support water accumulation and circulation. Activities of this type are particularly relevant to MOE sectoral interests, which aim to remedy water pollution in rivers all the way to the coast, removing contaminants introduced in the course of Japan's post-World War II industrial development of coastal areas.

FIGURE 1. MOE's seven categories of *satoumi*-creation activities[3]

The MOE survey of the various *satoumi* activities in Japan takes full account of different conservation efforts to protect Japanese coastal and marine ecosystems, including projects supported by the MLIT and FA. Using the survey, the MOE aims to formulate strong guidelines for the *satoumi* approach to environment and ecosystems by emphasising the necessity for strict scientific standards as well as high management standards. On the one hand, the criteria for scientific assessment and analysis must be adequate to ensure the protection of marine ecosystems and promote sound atmospheric interaction and material circulation between the land, sea and sky as part the Earth's environmental system (for instance, the circulation of nutrients between rivers and the sea). On the other hand, management of activities must successfully build on community initiatives and maximize the participation of multi-sectoral stakeholders. The scientific and management criteria, however, should not be considered as locked into a single monolithic approach. Some of the most valuable parts of the survey are the variations in activities, which call for flexibility in judgment and response. For that reason, a premise of the national guideline for *satoumi* is the importance of adaptability and variation as observed in the different *satoumi* activities. MOE gives high priority to quantitative scientific data on environmental recovery and restoration acquired from the monitoring of each project as it progresses, so as to determine whether or not the project fulfills the required criteria. That said, the key to sustaining the operational structure of each project is adaptability in management.

3 http://www.env.go.jp/water/heisa/satoumi/en/06_5_e.html#figure01.

SATOUMI IN NATIONAL POLICY

In November 2007, the Third National Biodiversity Strategy of Japan was approved by the Cabinet. The idea behind it is to make Japan into a nation that can maintain a balance between human society and nature and that nurtures biodiversity through conservation and sustainable use. The strategy defines *Satoumi* as coastal sea areas where people have traditionally depended for their livelihood on the bounty of nature. The Strategy document goes on to describe *satoumi* as an approach that involves human intervention to sustain high productivity and biodiversity while maintaining harmony with the natural environment.

The Cabinet also approved a Basic Plan on Ocean Policy in March 2008. Its purpose was to put the Basic Act on Ocean Policy enacted in July 2007 into action by setting forth practical plans for the following five years. *Satoumi* is mentioned in section 2, described as "measures that should be implemented by the government in a comprehensive and well-planned manner". This reference appears in text discussing the promotion of development and use of marine resources. Here

satoumi is presented as a conceptual framework for the creation of rich and beautiful marine areas by conserving biodiversity and maintaining productivity through human intervention while preserving harmony with the natural environment.

While the three policy statements noted above all use the term *satoumi*, the thrust of the concept is interpreted in slightly different ways. The Third National Biodiversity Strategy of Japan depicts *satoumi* as marine areas to be conserved or protected, while Japan's Strategy for a Sustainable Society and its Basic Plan on Ocean Policy stress the need to create *satoumi*, implying either restoring or constructing rather than protecting. Furthermore, the Third National Biodiversity Strategy of Japan and the Strategy for a Sustainable Society see *satoumi* in terms of physically defined areas, while the Basic Plan on Ocean Policy takes *satoumi* to be a conceptual framework. Thus, in the formation of national policy, there has been room for discrepancies and therefore inclusiveness in the way *satoumi* is defined.

ACADEMIC DISCUSSIONS AND PUBLIC AWARENESS ON *SATOUMI*

Judging by its use in the media, *satoumi* has also made its way into the discourse of various spheres in Japanese society. It crops up increasingly as a key term in discussions of sustainable development or is cited as a unique innovative concept representing the Japanese notion of human co-existence with the sea. The coverage of *satoumi* by national newspapers has tripled in the past 10 years. Conferences and seminars on *satoumi* have been organized throughout Japan, and numerous grassroots activities are designed and implemented in reference to the term.

In short, *satoumi* has proven to be adaptable—it lends itself to thinking about and planning coastal management, ecosystem conservation and sustainable development. This very flexibility has, in fact, appealed to many academics who find it to be both inclusive—it encourages broad, comprehensive approaches—and also practical, as it supports specific actions taken to conserve ecosystems. In other words, it conveys more than simply a theory of conservation. Yanagi (1998), for example, defines it as a spatial entity, "a coastal area that has achieved high productivity and biological diversity due to human intervention". Matsuda (2007), on the other hand, links *satoumi* with the important element of Japan's marine cultural heritage, which, by implication, includes the multifunctional roles of fisheries, particularly the knowledge and practices of traditional and community-based marine management. Nakajima (2009), who interviewed community members engaged in *satoumi* projects, approaches the concept from the perspective of ocean governance. He considers *satoumi* to express a concerted effort to manage the oceans by involving civil society and governments, thus creating a new type of commons and thereby re-establishing the rich relationship between the oceans and the people.

National and regional governments, grassroots organizations, and the media have understood the *satoumi* approach in various ways, and different elements of the ecosystem approach are emphasised, depending on the nature and mission of the sector or community and its expertise and interests. Looked at in a positive light, this variability in defining *satoumi* gives the concept a broad inclusiveness and has also generated debate and discussion over what, exactly, Japan's coastal environment encompasses, how all communities in the area fit in and who decides the answers to these questions.

CONCLUSION

This chapter has discussed the process by which the *satoumi* approach has been adopted into different sectoral and national policy initiatives. Based on this discussion, we can focus on three points in mainstreaming CBD, namely, (1) the incorporation of an ecosystem approach into sectoral strategies, plans and programs; (2) scaling up community-level ecosystem management to the level of national strategy, planning and programmes; and (3) the integration of various sectoral approaches into a national policy.

Regarding the first point, we have seen how different government ministries have incorporated elements of *satoumi* into their projects, such as recreating biodiversity-rich habitats (although on a small scale), or reconfiguring local environmental knowledge and traditional management systems, or establishing networks of communities connected by water in areas stretching from rivers and river basins to the coast. Having been incorporated into the general direction of each ministerial policy, the *satoumi* approach has been a successful tool in promoting active and effective participation in government, community, and industry, each of which has had a specific and pragmatic interest in mainstreaming environmental protection policy of coastal marine ecosystems, but has not been integrated under a shared concern for ecosystem-based management and biodiversity protection.

As to the second point, this chapter has described the way each ministerial programme values local initiatives and public participation, while at the same time emphasising scientific objectivity. The MLIT programme provides the scientific data that constitutes the foundation for project activities and the organization of community participation, including monitoring and gathering historical materials to remind the public of what the coastal ecosystem—which sustained diverse types of fisheries—was like before it was spoiled by industrial development. In contrast, activities conducted under FA programmes are based on the fishers' environmental knowledge, but rigorous scientific research is also carried out, ensuring that project activities have a solid scientific base beyond the experiential knowledge of fishers and is accounted for vis-à-vis other stakeholders. The inclusiveness of this approach is reflected in the way the MOE values how the diversity of *satoumi* activities were adapted to suit different locations and socio-cultural backgrounds.

Finally, concerning point three, and the integration of various sectoral approaches into a national policy, we emphasised in this chapter the flexibility of the *satoumi* approach and the practice of focusing on nature. National policy has incorporated different definitions and interpretations of *satoumi*, but that has not created confusion or obstacles in carrying out *satoumi* projects. Rather, the flexibility of the term gives it a valuable inclusiveness. Clearly, the academics who initially configured the *satoumi* approach lent it legitimacy as they supported the flexibility of definitions, the focus on hands-on practice of *satoumi* activities, and the inclusiveness of different policy approaches and interpretations. In this regard, *satoumi* is similar to the CBD ecosystem approach, which lacks a definition (though it has a "description"), and is, in practice, applied in ways that are appropriate to different environmental and cultural circumstances.

In conclusion, the progressive mainstreaming of the *satoumi* approach into national policy has succeeded due to two elements found in all *satoumi* projects: first, the cooperation between local fishers and scientists that enables a synthesis of scientific knowledge and local environmental knowledge, and second, the flexibility of the concept and the possibility of gearing it to the policy and programmes of different ministries by emphasizing certain aspects while not compromising its inclusiveness.

In the pages that follow, 10 case studies of *satoumi* activities are presented to show how the approach of each one embodies a synthesis of science, community involvement and policy. Further, the very success of this culturally specific ecosystem approach, as demonstrated in the case studies, attests to how the Japanese people are accepting the challenge to protect the cultural and ecological diversity of their marine and coastal environments.

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II. Case Studies

Case Study

1 SHIRETOKO: EXPANDING FISHERIES CO-MANAGEMENT TO ECOSYSTEM-BASED MANAGEMENT

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This chapter is based on two previously published articles (Makino et al. 2009; Matsuda et al. 2009).

ABSTRACT

Designated as a UNESCO Natural World Heritage Site in 2005, the waters of Shiretoko, seasonally covered with ice floes, are the northernmost ecosystem presented in this report. Communities there have fished a wide variety of species since ancient times. *Satoumi*-oriented conservation implied recognition of these fishers' communities as an integral component of an ecosystem they used sustainably for centuries. This recognition, along with conservation objectives that integrated sustainable use of biodiversity components, and a cross-sectoral management framework, helped overcome the fisheries sector's initial apprehension towards the requirements of a natural world heritage. Shiretoko fishers became indispensible, self-driven actors in conservation. Shiretoko is an example of *satoumi* that successfully involved local communities and combined their knowledge with science to conserve a priceless world heritage, inclusive of its communities and their livelihood.

INTRODUCTION

The Shiretoko peninsula is located at the far northeast corner of Hokkaido and is one of the world's richest north temperate ecosystems. The area of Shiretoko, including the peninsula and its adjacent sea, is one of three Natural World Heritage sites in Japan. A coastal community with a long history and far-reaching involvement with its natural surroundings, the area demonstrates a uniquely balanced interaction between terrestrial and marine ecosystems. The area is unusually rich in biological diversity, which includes several endangered species, and it has a deep-rooted cultural heritage built up over many generations of fishing families.

The singularity of the ecological characteristics of the Shiretoko peninsula and its adjacent marine areas is explained partly by the fact that it lies at the southernmost limit of the seasonal ice floes in the northern hemisphere, and partly by its exposure to both the East Sakhalin cold current and the Soya warm current. These two currents, each bringing a different set of oceanographic conditions, have helped to create the great diversity that characterizes the Shiretoko environment. Furthermore, borne on cold water from the Sea of Okhotsk, a stream-like marine ecosystem—where a welter of organisms live and migrate—also passes through (Ministry of Environment, Hokkaido Prefectural Government 2007). The area's exceptional ecology is matched by its cultural significance, in that it provided the historical landscape for Ainu communities. These indigenous people of Hokkaido traditionally practised sustainable use of regional resources in compliance with an animistic system of beliefs that affirmed a close spiritual link between nature and humans. "Shiretoko" means the end of the world in Ainu language.

The Shiretoko peninsula was nominated for UNESCO World Heritage listing in 2004, and subsequent conservation measures have been implemented in collaboration with local fishing communities to manage the ecosystem. With fishers' activities as the central component, a co-management system was formed that expanded its objectives and capacity into an ecosystem approach to management in the Shiretoko area, combining scientifically-grounded modes of sustainable use of local marine resources with conservation of the ecosystem in a Heritage site. This paper presents the "Shiretoko approach" as an example of *satoumi* that successfully involved local communities and combined their knowledge with science to conserve a priceless world heritage, inclusive of its communities and their livelihood.

ECOLOGY AND FISHERIES OF SHIRETOKO

In early spring, when the sea ice melts, the bloom of ice algae and other phytoplankton attract diverse marine life in the higher trophic strata, including a wide variety of fish. The area's high primary productivity (phytoplankton productivity) supports a wide variety of species—fish, as well as marine mammals and seabirds (Sakurai 2007). The area lies on a migration route for salmonids, walleye pollocks and a rich diversity of commercially-important fish species, such as arabesque greenlings, rockfish, cods, flatfish and cephalopods. Also, a large number of anadromous salmonids return from the sea to spawn in the streams where they were born, providing food for large terrestrial mammals like brown bears and Blakiston's fish-owls, and in that way connecting biogeochemical fluxes between terrestrial and marine ecosystems. The food web in the Shiretoko Natural World Heritage (NWH) area is depicted in Figure 1.

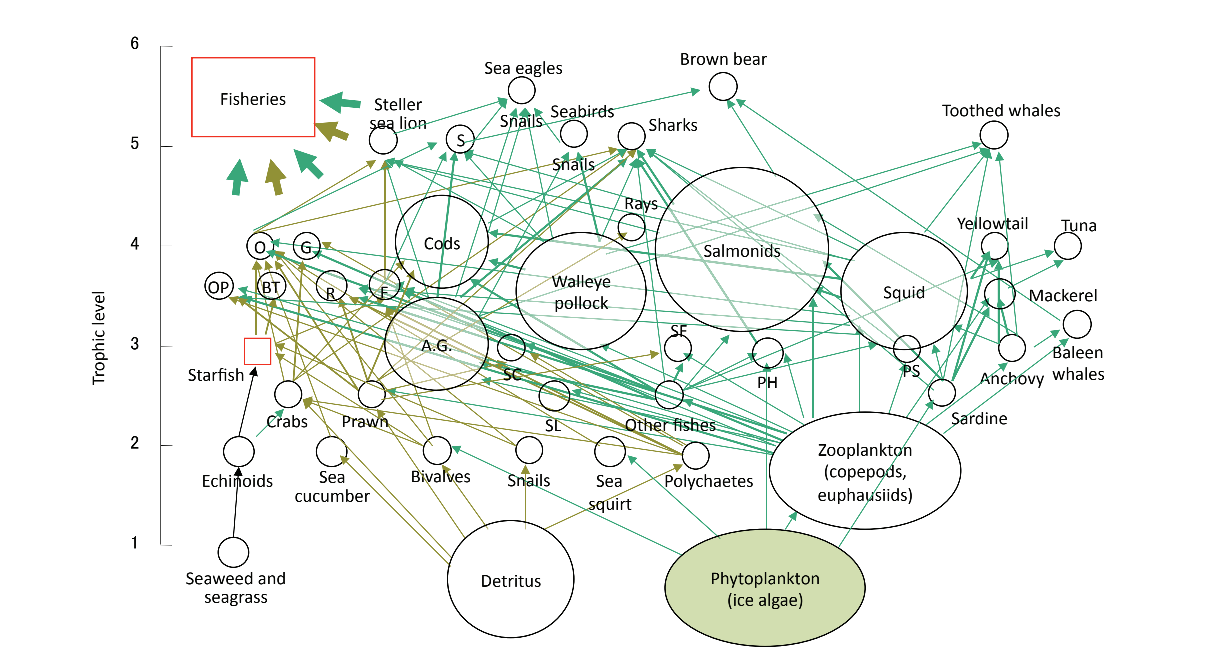

FIGURE 1. Food web in the Shiretoko World Natural Heritage (WNH) area (as depicted by the Shiretoko WNH Site Scientific Council). AG: arabesque greenling; BT: bighand thornyhead; F: flatfishes; G: greenlings; O: octopus; OP: ocean perch; PH: Pacific herring; PS: Pacific saury; R: rockfish; S: seals; SC: saffron cod; SF: sandfish; SL: sand-lance.

Archaeological surveys show that people have been living in this area for more than two thousand years; clay pots and the bones of Steller sea lions, seals, and fish have been excavated. Today, the fisheries sector is still the most important industry in the regional economy, supporting one of the most productive fisheries in Japan. Their main target species and fishing gear include salmonids caught by set net, common squid by jigging, and walleye pollock, cod, and arabesque greenling by gillnet. In 2006, there were 851 fishers engaged in the industry. The average production per fisher is 3.4 times the national average by volume and 4.0 times by value. Catch statistics are shown in Figure 2, on which it can be noted that total catch and mean trophic level—two key indicators both of sustainability and economic potential of fisheries—have remained remarkably constant.

SHIRETOKO: WORLD HERITAGE SITE

On account of the outstanding features of the Shiretoko region, the Government of Japan formulated a management plan and proposed the region for World Heritage listing in January 2004. UNESCO and the World Conservation Union (IUCN) reviewed the proposal and management plan, and conducted a field evaluation in July 2004. The IUCN expressed concern that the level of protection for the marine components was not high enough; in particular, they urged that walleye pollock, a main food source for the Steller sea lions, be managed properly. They recommended that the impact

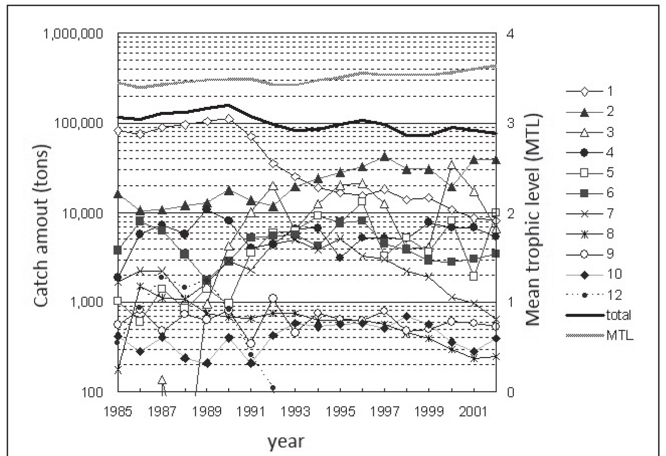

FIGURE 2. Catch statistics for twelve major exploited taxa, total catch and mean trophic level (MTL, Pauly and Watson 2005) in the Shiretoko World Natural Heritage area, 1985 to 2002 (Japan Ministry of the Environment, and Hokkaido Prefectural Government 2007). 1: walleye pollock, 2: chum salmon, 3: common squid, 4: Arabesque greenling, 5: Pacific cod, 6: scallop, 7: kelp, 8: bighand thornyhead, 9: octopus dolfleini, 10: pointhead flounder, 11: ivory shell, 12: Japanese sardine.

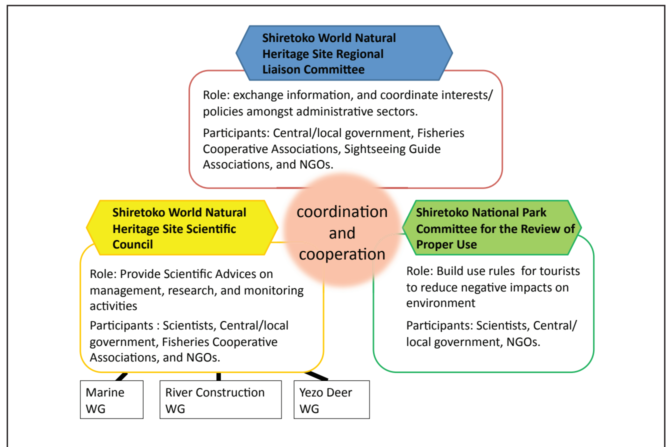

FIGURE 3. Cross-sectoral coordinating system in the Shiretoko WNH.

of construction along rivers in the peninsula on wild populations of salmonids, which link the marine and terrestrial ecosystems, be examined. In February 2005, IUCN formally requested that the marine component of the site be expanded and that a marine management plan be promptly formulated to ensure the protection of marine species. IUCN's concerns about the level of protection of marine species heightened apprehension in the fisheries sector, where listing Shiretoko as a World Heritage Site was initially unwelcome.

In response, in March 2005 the Japanese Government committed to (i) extend the marine boundary from one to three kilometres from the coastline; (ii) formulate a marine management plan within three years, and (iii) ensure appropriate management measures for the conservation of walleye, pollock, sea mammals and other marine species in the plan. With those assurances, Shiretoko was placed on the UNESCO World Heritage list in July 2005.

SATOUMI IN SHIRETOKO: WORKING WITH FISHERIES FOR CONSERVATION MANAGEMENT

In Japan, there is no domestic law specific to World Heritage listing, and management measures are implemented under a combination of several laws and policies (Table 1). In addition, administrative procedures in Japan, as in many other countries, are vertically structured, hindering cooperation and coordination across ministries and departments. For example, the Natural Park Law of 1957 does not give the Ministry of Environment enough authority to regulate the impact of fisheries activities on marine ecosystems, as those activities are managed by the Fisheries Agency. Therefore, a new system of coordination among sectors and ministries was established for the management of the Shiretoko WNH area, as shown in Figure 3.

In July 2004, prior to Shiretoko's WNH listing, the Shiretoko World Natural Heritage Candidate Site Scientific Council (presently Shiretoko World Natural Heritage Site Scientific Council, hereinafter called Scientific Council), composed of experts in marine and terrestrial ecosystems, was established with the aim of obtaining advice from a scientific perspective on integrating management of its marine and terrestrial ecosystems and other issues. The Scientific Council and working groups are composed of natural scientists, social scientists, and representatives of ministries and departments in central and local governments, of fisheries cooperatives, and NGOs. The council has three working groups: the Marine Working Group for marine ecosystem management, the River Construction Working Group for improvement of river-related constructions, and the Yezo Deer Working Group for Yezo deer management.

The Multiple Use Integrated Marine Management Plan was drawn up by the Marine Working Group in December 2007. It defines management measures to conserve the marine ecosystem, strategies to maintain major species, monitoring methods, and policies for marine recreational activities. The fisheries sector has participated from the beginning of the drafting process. Local people have fished in this area for a long time and have compiled data for over fifty years. This information has been incorporated into the monitoring scheme of the Shiretoko ecosystem, enabling observation of the changes in the functions and structure of the marine ecosystem. In this way, fishers are recognized as an integral part of the ecosystem, and their data is utilized to monitor the ecosystem in a cost-effective way, following the Management Plan.

Based on this plan, three management measures have been implemented for the Shiretoko World Heritage site:

(1) *Walleye pollock and Steller sea lion management*

Walleye pollock is one of the most important fisheries targets in the Shiretoko area. Shiretoko fishers catch

TABLE 1. Major laws and administrative authorities for Shiretoko WNH area management.

Service	Legal basis	Administrative authority
Fisheries management	Fisheries Law of 1949, Fisheries Resource Protection Law of 1951, Law Concerning the Conservation and Management of Marine Life Resources of 1996	Fisheries Agency (Ministry of Agriculture, Forestry and Fisheries)
Pollution control	Law Relating to the Prevention of Marine and Air Pollution from Ships and Maritime Disasters of 1970, Waste Management and Public Cleansing Law of 1970, Water Pollution Control Law of 1970	Coast Guard (Ministry of Land, Infrastructure, Transport and Tourism), Ministry of Environment
Landscape conservation and material circulation	Law on the Administration and Management of National Forests of 1951, Natural Parks Law of 1957, Nature Conservation Law of 1972	Ministry of Environment, Forestry Agency (Ministry of Agriculture, Forestry and Fisheries)
Species protection	Law for the Protection of Cultural Properties of 1950, Law for Conservation of Endangered Species of Wild Fauna and Flora of 1992, Wildlife Protection and Appropriate Hunting Law of 2002	Ministry of Environment, Ministry of Education, Culture, Sports, Science and Technology

the Nemuro stock of walleye pollock mainly by gillnet. Gillnet fishers have divided the fishery ground into 34 areas, based on their local knowledge and experience, and to conserve resources they declared seven of these areas protected, including a portion of the walleye pollock spawning ground. After Shiretoko's nomination for World Heritage listing, another six areas were designated as protected, and the protected areas are re-examined every year on the basis of the previous year's performance and scientific advice from the local research station.

The Okhotsk and Kuril population of the Steller sea lion migrate from Russia to the Shiretoko WNH area in winter. Fortunately, its size has been gradually increasing 1.2 per cent per year since the early 1990s (Burkanov and Loughlin 2005) and in 2007, the Fisheries Agency of Japan revised the procedure for setting the cull limit, basing it on the potential biological removal theory (Wade 1998), which is used under the US Marine Mammal Protection Act.

(2) *Supporting the interrelationship between marine and terrestrial ecosystems*

Many anadromous salmonids return to rivers in Shiretoko to spawn in fresh water. Wild salmonids (including hatchery-derived chum and pink salmon that reproduce naturally in rivers) running upstream serve as an important source of food for terrestrial mammals and birds of prey, and they contribute to biodiversity and sea-land material circulation. To maintain and facilitate the interactions between marine and terrestrial ecosystems, dams and other engineering works have been modified since 2005 following scientific advice from the River Construction Working Group. The working group surveyed 118 artificial constructions in Shiretoko and evaluated their impact on salmonids. It investigated possible structural modifications, taking into account their effects on disaster risk. Some of the constructions were retained because modifications could have increased the risk level of disaster in densely populated areas. As of end of January 2008, 25 structures had been modified or were being modified. To evaluate the effects of these measures, a three-year programme is monitoring the upstream run, number of spawning redds, substrate composition, current velocity and discharge.

(3) *Marine recreational activities*

To prevent negative impacts from tourism on local fisheries and the marine ecosystem, the Marine Management Plan specifies that recreational activities are to be managed under rules formulated by the Shiretoko National Park Committee for the Review of Proper Use. This committee is composed of academics, tourism and guide representatives, environmental NGOs, and officers representing forestry, coast guard, environment and local government. The committee stipulates patrols and other activities to monitor tourist uses, formulates rules for tourists and promotes ecotourism.

CONCLUSION

Under the Japanese fisheries co-management system, coordination and stakeholder participation is limited to the fisheries sector only, and no other marine ecosystem users are included in the decision-making process. In the Shiretoko case, however, a new coordinating system was established, and a wide range of stakeholders from several sectors are now integrated. This system facilitates the exchange of information and opinions, and strengthens the legitimacy of the management plans and rules. The long and central institutional involvement of fisheries in Japan has resulted in a different ecosystem-based management framework from, for example, that of Iceland or New Zealand, where market-based individual transferable quotas are the central policy tool, another illustration that there is no unique path to conserve marine ecosystems and sustain livelihoods (Grafton 2008).

Careful assessment of the existing institutional framework and the potential role of the fisheries sector in marine ecosystem management was critical for successfully managing conservation in this World Heritage Site. In the Shiretoko case, *satoumi*-oriented conservation meant that the local fishers, who had exploited a wide variety of species sustainably for many centuries, were seen as an integral component of the ecosystem rather than unwanted extras to be eliminated from the "original ecosystem". In the Shiretoko approach, local fishers are not something to be managed or controlled, but indispensable, self-driven role players in ecosystem-based management, through the provision of critical ecosystem monitoring information and their proactive involvement in conserving the resource. The Shiretoko approach provides a field-tested case of ecosystem-based management, satisfying the conservation requirements of a UNESCO World Heritage, of most relevance to regions where large numbers of small-scale fishers are utilizing a wide range of species under a fisheries co-management regime.

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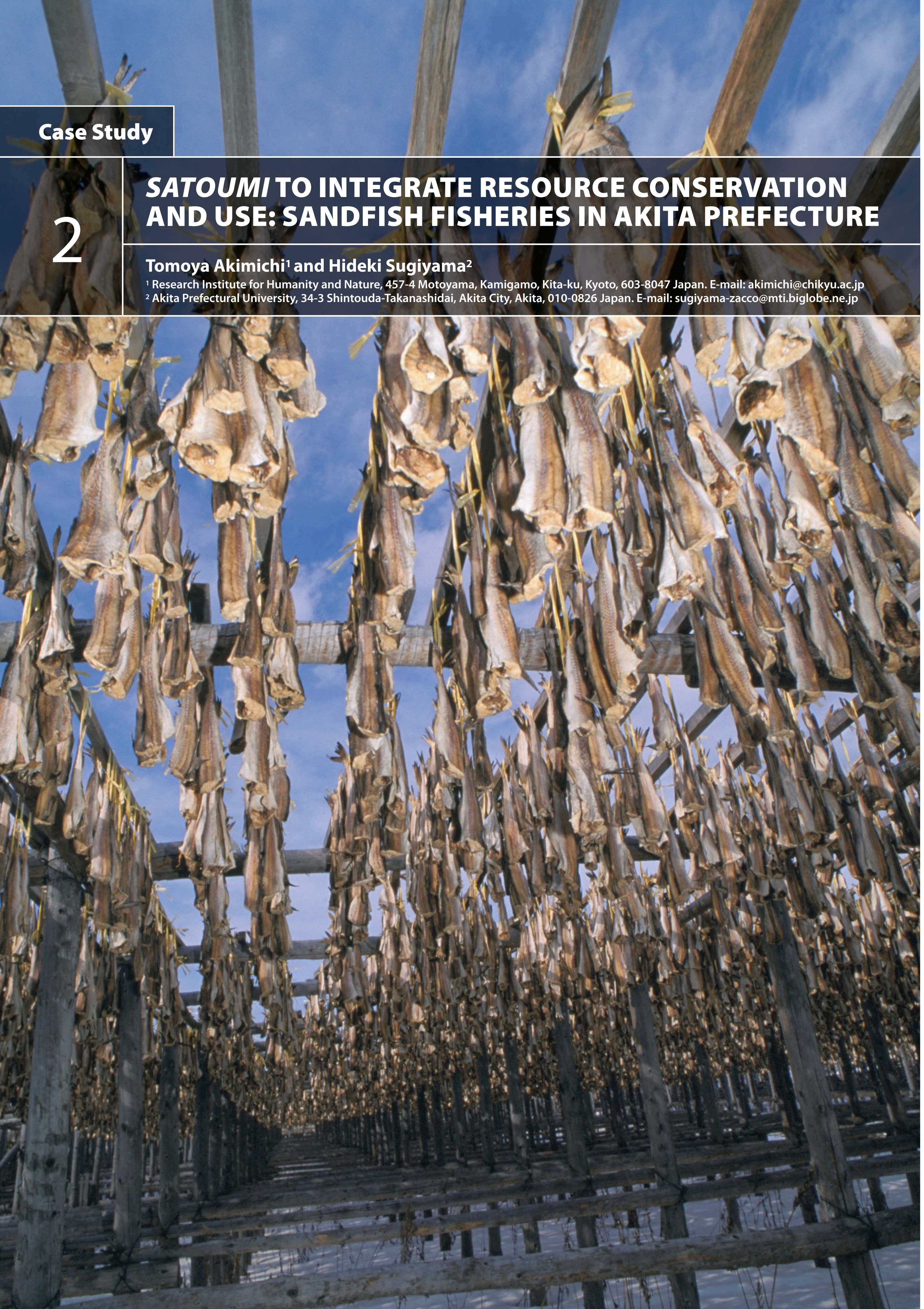

Case Study

2

SATOUMI TO INTEGRATE RESOURCE CONSERVATION AND USE: SANDFISH FISHERIES IN AKITA PREFECTURE

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ABSTRACT

Conservation efforts to protect the *sargassum* seaweed beds that provide spawning grounds for Japanese sandfish (Jp. *hatahata*; *Arctoscopus japonicus*) are a good example of local fisheries management that highlights traditional practices of the *satoumi*. Sandfish fisheries in Akita are active in coastal *satoumi* waters as well as offshore waters in north-west Japan. After a drastic decline in catch in 1991, a three-year moratorium was enforced between 1992 and 1995. The reason for the decline was presumed to be complex, but three major overall factors are relevant: (1) a climate change induced regime shift, (2) overfishing and inappropriate fisheries practices, and (3) degradation of the *satoumi* over the past few decades. Since the resumption of sandfish fisheries in 1995, total allowable catch (TAC) allocations, use of artificial hatcheries, and restoration programs for seaweed beds have been launched to support sustainable sandfish fisheries. The focus, however, has tended to be on the governance of TAC allocations among user groups, rather than on ecosystem-oriented approaches such as restoration of *sargassum* beds. The concept of *satoumi* provides a basis to integrate conservation of coastal biodiversity with the sustainable use of its components in sandfish fisheries, as illustrated by the seaweed transplantation and forestation programmes launched by coastal communities. Efforts to conserve seaweed beds to nurture sandfish fisheries are expected to lead to an integrated coastal management framework linking forests and offshore waters through *satoumi*.

SEAWEED BEDS AS HOMELAND OF AQUATIC LIFE AND SANDFISH

The Japanese sandfish (Figure 1) migrates between coastal spawning grounds and offshore feeding areas (Watanabe et al. 2005). It is found widely in the waters of the Sea of Japan, and is an important fishery resource in the area. Abundant runs of sandfish towards coastal waters occur in the midst of the thunderstorms in winter along the Akita coast, and have long brought in a rich food resource to local inhabitants. This case study reports on the sandfish fisheries in Akita Prefecture as an example of consensus-making for resource conservation, and as it provides keys for understanding the valuable role of *satoumi* for the conservation of coastal ecosystems.

FIGURE 1. Photograph of female (upper) and male (lower) sandfish.

The life cycle of the Japanese sandfish is unique (Figure 2). Young adult and adult fish live in 250m-deep waters of 1.5°C temperature. As their gonads mature, the fish move towards coastal waters during the seasons when the water surface temperature decreases to about 13°C (Sakuramoto et al. 1997). Hitherto, these spawning runs start around the end of November and continue through the middle of December in the stormy winter weather. Spawning occurs in *sargassum* seaweed beds at a depth of 1.5-2.5m and continues for a few weeks in December. The roe stick together in golf ball-sized lumps weighing about 10-60g, each lump consisting of 600 to 2,500 eggs. Numerous roe lumps are found entwined in the seaweed beds. Besides natural seaweed beds, suspended nets also serve as spawning sites where fertilization takes place. After fifty to sixty days the adult fish return to deep waters, and the fingerlings start to swim soon after the roe hatch in the middle of February to the beginning of March. Juvenile fish remain in coastal waters until May and then move down to cold waters 200m deep and further. Juvenile sandfish feed on zooplankton in coastal waters, but young adult and adult fish forage mainly on temist (small-sized shrimp) in the deep sea. Thus, an abundance of seaweed beds in a *satoumi* is key to ensuring the life cycle of the sandfish. Seaweed beds also enrich the coastal ecosystem for other diverse forms of marine life. The sandfish fishing grounds in Akita Prefecture are shown on Figure 3.

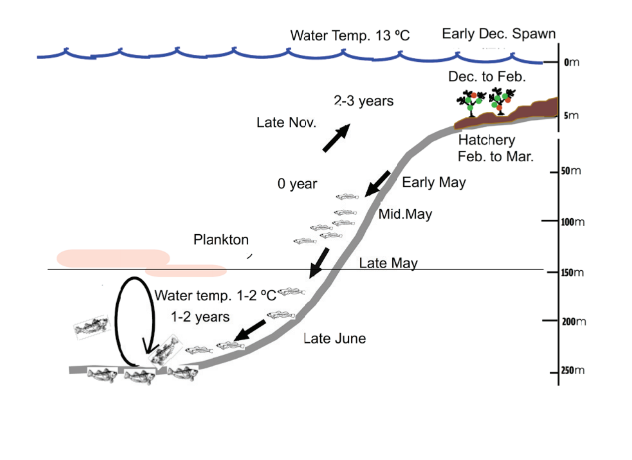

FIGURE 2. Schematic diagram of the life cycle of the Japanese sandfish. Spawning occurs in *sargassum* seaweed beds, an important habitat for many species in this ecosystem. Through this life cycle, the sandfish connects the ecosystem in deep offshore waters with nearshore processes.

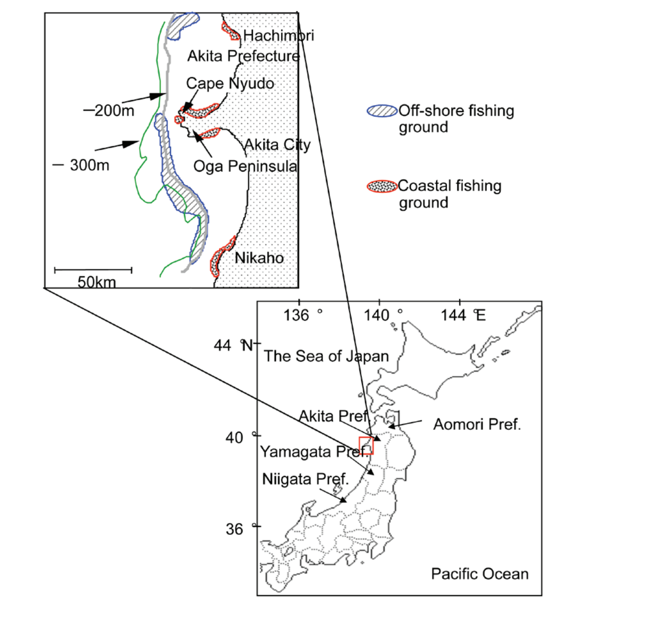

FIGURE 3. Fishing grounds of sandfish in Akita Prefecture.

SANDFISH FISHERIES AND RESOURCE MANAGEMENT

Pre-moratorium phase, 1896-1992

According to catch records in Akita between 1896 and 2010, the catch of sandfish has had important fluctuations (Figure 4). The figures show that total catch rose rapidly to over 10,000 tons between 1963 and 1975, then abruptly decreased after 1976. In 1983, total catch fell to less than 1,000 tons, and in 1991 to only 74 tons.

The cause of this collapse is debated. Certain fishery scientists point to inappropriate management and overfishing; others argue that the abrupt local effects of global climate change occurring is the main cause (Watanabe et al. 2005). The Akita Fisheries Promotion Centre reported that the fluctuation cycle of the sandfish population is about 37 years. At present, the sharp decline in catches during the mid-1970s is thought to be due to environmental factors, while the continuous poor catch since then is ascribed to overfishing.

The collapse prompted fishermen, prefectural government officials and fisheries scientists to explore every possible means to recover the fish stock. In 1985, Akita Prefecture established a Council on Fisheries Resource Management, whose conclusions led to the proposition of a moratorium or zero TAC (total allowable catch). From the beginning, consensus-making among the stakeholders was difficult, but the fisheries sector ultimately did adopt a moratorium, and its success was made possible by a long process of consensus building.

Unfortunately, the role of the degradation of the *satoumi* in the decline of catches received little attention at that time. Modifications of the coastal landscape, land reclamation and land-based sources of pollution could have been seen as critical factors in the destruction of the sandfish habitat. Although certain fishers recognized that the decline of the catches came in the wake of the construction of a new fishing port and the installation of breakwater blocks, they dared

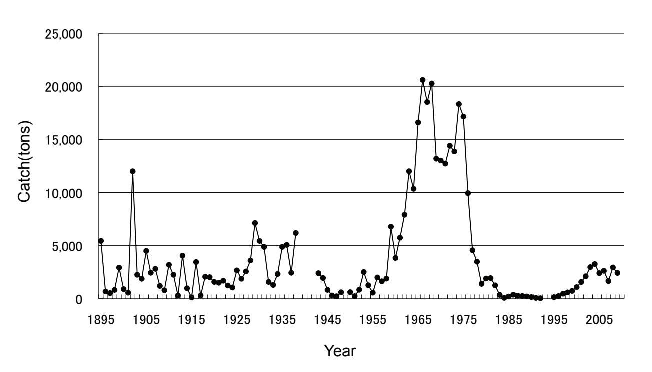

FIGURE 4. Time series of sandfish landing reported in Akita Prefecture, 1896-2010, showing the rapid rise in the 60s followed by the collapse in 1976, and the positive result of the three-year moratorium from 1992-1995.

not oppose the government policy of public works projects that promoted coastal fisheries development, without sufficient attention to the need to conserve seaweed beds for sustainable fisheries.

The moratorium policy and its enforcement

As the local Fishery Cooperation Association (FCA) perceptions and attitudes towards the moratorium policy were diverse, serious political antagonism had to be overcome, entailing a time-consuming negotiation process. Certain FCAs were opposed to the moratorium because of the dependence of local fishers on sandfish catches during the spawning season. Other FCAs that operate bottom-trawling vessels on a year-round basis also opposed the policy because of the income loss for their operations. This was a case of negative spiral of fisheries: the decrease in stock led to an increase in the price of sandfish (Figure 5), which in turn led the fishers to intensify their efforts, further depleting the stock. Fisheries scientists argued energetically to persuade fishermen to comply with the moratorium to allow the stock to recover and break out of this negative spiral. Following a series of intense discussions, a consensus was reached and the fishers agreed on a moratorium in 1992. All of the local FCAs in Akita came to follow the governmental proposal in the hope that a three-year ban would give twice as much harvest as before. It is worth mentioning that the Akita FCAs went ahead with the ban in spite of then-unresolved negotiations with neighbouring prefectures which shared the resource, and did not enforce a ban. Eventually, a treaty of sandfish resource management prohibiting the catch of young fish less than 15cm long was reached with the neighbouring prefectures in March 1999. The treaty was renewed and is effective to 2014.

Consensus building in the post-moratorium phase

Since the resumption of sandfish fisheries in 1995, after the three-year ban, the Akita prefectural government, together with the FCAs, began to negotiate the allocation of TAC for the sustainable management of the sandfish stock. In 1995, a maximum TAC of 170 tons was allocated among the stakeholders. An ethic of equitable allocation of TAC, based on past fishing records by each of the FCAs, was key to the success in balancing immediate demand for sandfish with considerations for conserving the resource (Nakanishi and Sugiyama 2004). Throughout the pre-moratorium, moratorium and post-moratorium stages, numerous meetings were held at different levels and on various occasions. It is noteworthy that 40 per cent of the total meetings were those held at the district level (Table 1).

***SATOUMI*-ORIENTED RESOURCE MANAGEMENT**

Marine resources management in Japan cannot be simply dictated from above, as is widely documented for many cases around the world. Marine Protected Areas (MPAs) have many times been successful in providing benefits in coastal fisheries, but in Japan, time-honoured territorial claims and relevant institutions in near-shore waters (Ruddle and Akimichi 1984) further complicate the consensus and compliance of stakeholders from various sectors for establishing MPAs. For sandfish, various types, of restrictions, including catch quotas, mesh size, closed seasons, and fishing gear types have been implemented, but the most effective measure so far has been the TAC system. However, adequately accounting for important fluctuations in the population of sandfish is an important challenge.

Thus, there are compelling reasons to complement these restriction-based measures with a more distinctly *satoumi*, ecosystem-oriented approach involving the protection and conservation of spawning sites in coastal waters, to ensure the long-term resource supply not only of sandfish but also other marine life. In Akita Prefecture, alterations of the coastal environment during the 1960s and 1970s, with little knowledge and consideration for the ecosystem

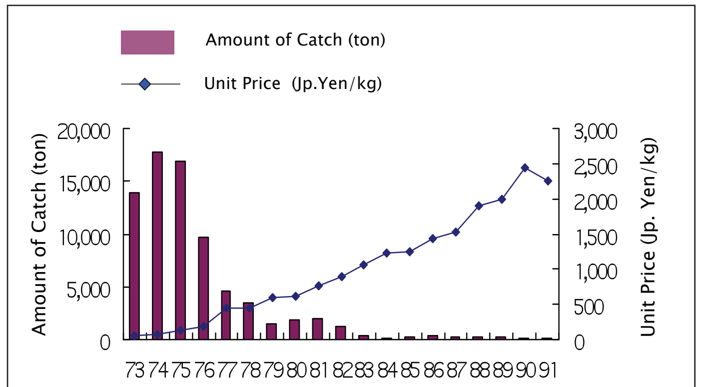

FIGURE 5. Relationship between sandfish catch and price. The price increase due to reduced catch led the fishers to intensify their efforts, further depleting the resource in a negative spiral (see text).

TABLE 1. Number of meetings held at different levels, from fishers to nationwide, as part of the efforts to manage the sandfish resource sustainably. FCA: local fisheries cooperation association, WG: working group of the prefectural government. The Sea District covers the coastal waters off Aomori, Akita, Yamagata and Niigata Prefectures.

	Fisher*	District	FCA	WG	League	Sea District	Nation	Total
Pre–moratorium (1992 Jan.–Sept.)	14	14	6	4	14	3	3	58
Moratorium (1992 Oct.–1995 Aug.)	5	70	15	17	21	17	2	147
Post–Moratorium (1995 Sept.–1997 Aug.)	0	9	0	23	7	2	1	42
	19	93	21	44	42	22	6	247

* Fisher: Fishermen's level.

structure and functions, brought about the deterioration of coastal seaweed beds. As a case in point, in the 1970s a coastal protection levee some 600m long was constructed in the midst of the seaweed beds at Kitaura, which had been one of the major spawning grounds for sandfish on the Akita coast. A decline in the seaweed beds during this period was linked to the spectacular increase in sandfish roe (*buriko*) washed ashore during the winter season. The shore was found covered with piles of *buriko*. Research on artificial sandfish spawning sites, carried out since 1998, estimates the average number of *buriko* that adhered to the base of drifting seaweed as 58.5 per unit base, 31.7 for large mesh sized net, and 5.8 for a small mesh net. These figures suggest that seaweed beds have the greatest potential as spawning sites, as had long been recognized by fishers.

Between 1997 and 2008, the Akita prefectural government attempted to create seaweed beds on artificial blocks. A total of 4.5 hectares on the Akita coastal zones were set aside for this purpose, with the prefectural government investing the equivalent of US$ 2 million over three years.

Also, since 1996, coastal communities have started forestation programmes, including in Kisagata where more than 8,200 beech (*Fagus crenata*) and oak (*Quercus mongolica*) trees were planted to enhance the various ecological roles played by forests (MEA 2005). These forests are expected to nurture a rich supply of nutrients which will be transported to coastal waters via ground water, streams, and rivers. Kisagata, the coastline at the base of Mt. Chokai (2,236m), is well known as a spawning site of sandfish and as a good habitat for Japanese oysters (*Ostrea nipponica*). In Akita, sea-bottom springs bring nutrient-rich ground water from the forest and mountains that favour growth of seaweed and oysters (Taniguchi 2010; Sugiyama 2010). The *satoumi* ecosystem and landscape is hence underpinned by this link between sea and mountain. The sandfish, on the other hand, migrate between the deep seas and the nearshore *Sargassum* beds, linking coastal and offshore waters. In part thanks to *satoumi*, this link was eventually reflected in the cooperation of offshore trawling fishers and nearshore set net fishers to more sustainably manage and nurture the shared stock of sandfish.

The ominous warning from the story of *hatahata* fishing in Akita is that consensus could not be reached until after the collapse of the fisheries. The positive lesson, however, is that in the face of many challenges, sustained effort for dialogue with local fisheries cooperative organizations, energetic involvement of scientists and political will eventually allowed rapid progress towards more sustainable fishing practices. The moratorium and fishing regulations were complemented with more *satoumi*-oriented conservation measures, with the fishers and coastal communities' engagement in forestation, and through active restoration of *sargassum* seaweed beds with transplants and creation of artificial beds. The life cycle of the *hatahata*, from spawning in *sargassum* beds which grow in waters enriched with mountain forest nutrients, to maturing in deep offshore waters, calls for such management integrating offshore, nearshore and mountain regulations and activities.

ACKNOWLEDGEMENTS

This article presents certain results of the project on "Ecosystem Services Assessment of *Satoyama*, *Satochi* and *Satoumi* to Identify New Common Ground for a Nature-Harmonious Society (E-0902)" promoted by the Japanese government's Environment Research and Technology Development Fund, Ministry of Environment. The authors would like to express their gratitude for the financial support of the Ministry of Environment. We are indebted to Mr. Kikuji Sasaki, former representative of the Akita Fisheries Cooperative Association, for providing useful information during our field survey.

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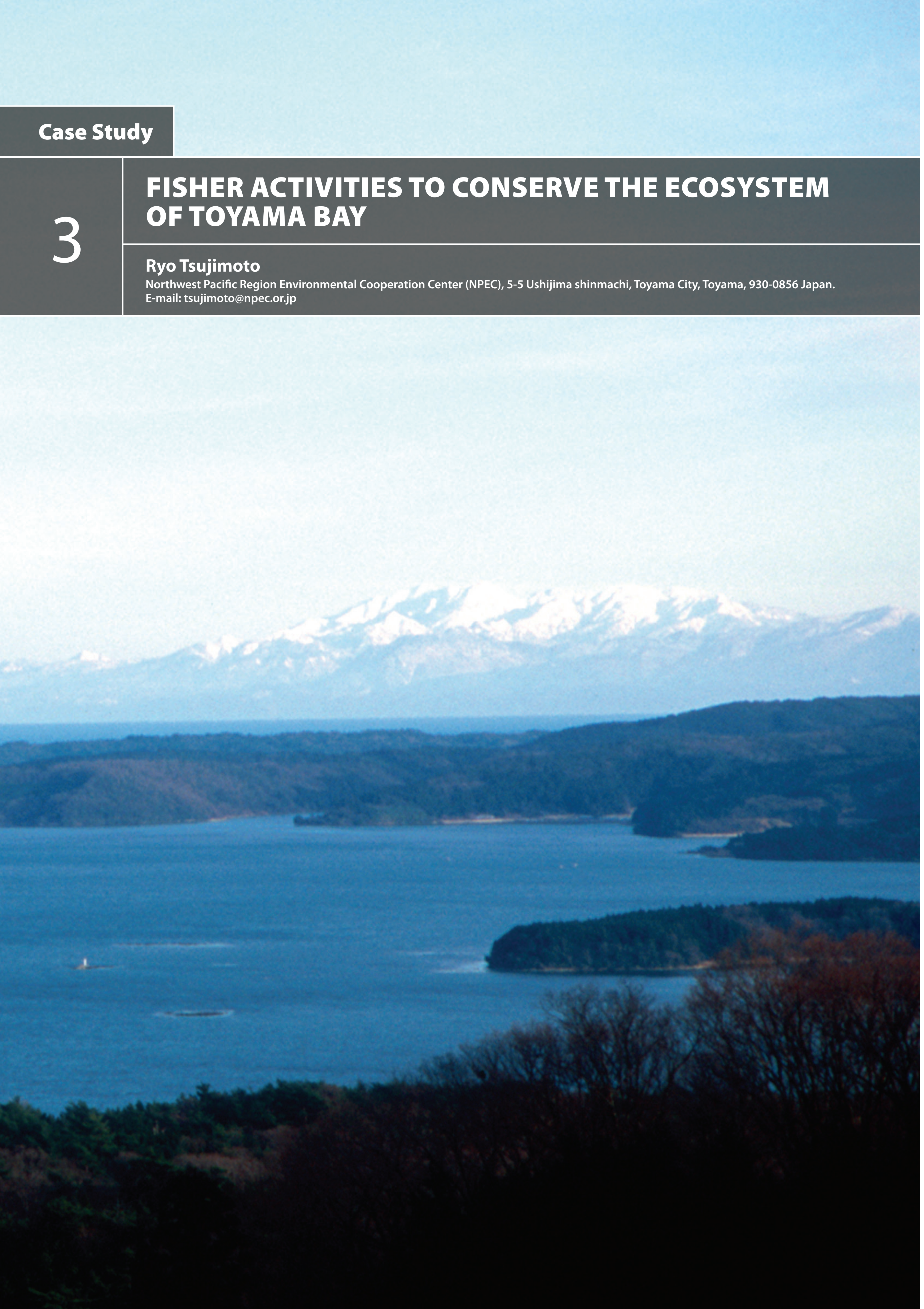

Case Study

3

FISHER ACTIVITIES TO CONSERVE THE ECOSYSTEM OF TOYAMA BAY

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ABSTRACT

For over 400 years, the waters of Toyama Bay have been fished with set nets (*teichi ami*), and the local culture and cuisine has evolved in ways that made sustainable use of the harvest of this locally-invented fishing method. In recent years, set net fishing has drawn attention as potentially more sustainable than trawling and the other methods employed in the bay, in part because set nets let over two-thirds of the fish escape. Although total fish catch in Toyama Bay has remained relatively stable, the ecosystem degradation has been severe, and local fishers, often the first to observe and bear the consequences, have been spurred to preserve their resources. Results of early attempts at releasing farmed fish fry in the bay were not satisfying, and the awareness steadily rose that the bay ecosystem, its habitats and its biodiversity had to be conserved all together in order to preserve the fishing resource. The fishers now take part in watershed forestry to help manage runoff into the bay. To combat eutrophication and provide essential habitat for juveniles, they cultivate and harvest *makombu* kelp and transplant *Zostera marina* seagrass. By these contributions to ecosystem conservation, the fishers are patiently nurturing a *satoumi* seascape that is respectful of their world view, at the core of which is a deep gratitude for the bounty bestowed by the sea.

THE HISTORY OF ECOSYSTEM USE IN TOYAMA BAY

Located on the West Coast of Japan in the bend of the Noto Peninsula on its east side, Toyama Bay is an inner bay open to the sea with a total surface area of approximately 2,120km^2, a maximum water depth of 1,250m, and a total volume of 1,280km^3 (Imamura et al. 1985; Figure 1). Toyama Bay is a deepwater bay in which the continental shelf is narrow and goes extremely deep, and the deep area of the bay has a complicated seafloor topography including submarine valleys and spurs (Fujii 1985). The main water masses in the bay are those of the Tsushima Warm Current (TWC) in areas of depth less than 300m, and of the Japan Sea Proper Water (JSPW) in areas deeper than 300 m (Uchiyama 2005). Toyama Bay lies between two prefectures, Toyama and Ishikawa[4], with the smaller Nanao Bay (in Ishikawa Prefecture; see Case Study 4), lying westward in the bend of the peninsula. Five class-A rivers and 29 class-B rivers[5] flow into Toyama Bay and strongly influence its environment (Tsujimoto 2009).

Toyama Bay's deep, complicated seafloor topography, as well as two heterogeneous water masses, results in a large number of fish species in its waters. Of the estimated 3,362 fish species present on the Japanese islands, 774 fish species are thought to live in the Sea of Japan, of which 524 species are found in Toyama Bay (Masuda et al. 1988; Tsuda 1990). Another 31 species (25 squid species and 6 octopus species) also inhabit the bay (Hayashi 1997). This abundance of organisms has supported a wide variety of fishery activities with set net fishing as the mainstay.

Birthplace of the set net

A set net is a fishing device made up of a leader net and a main net (Figure 2). Migrating fish are directed to the main net along the leader net. Daily hauling in

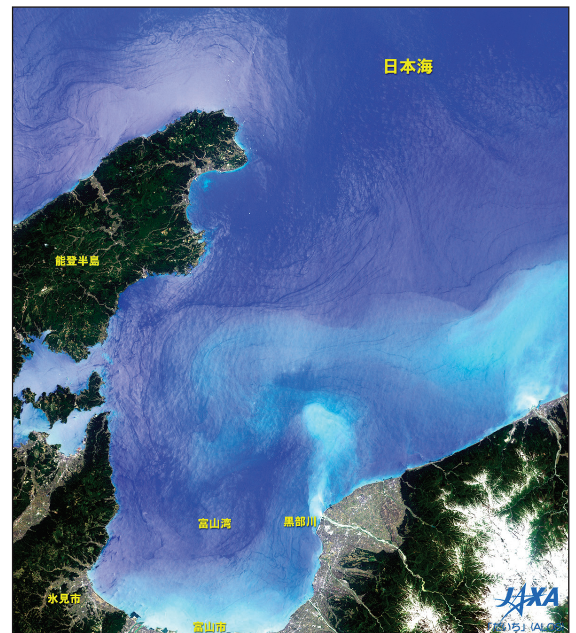

FIGURE 1. JAXA-ALOS Satellite image of Toyama Bay on May 25, 2006. Note river plumes spreading into the bay. Image courtesy of JAXA.

4 Statistical data referred to in this report is for the Toyama Prefecture, unless otherwise indicated.

5 In Japan, Class A refers to rivers of national significance, and consequently nationally administered, while Class B rivers are administered by prefectural governments.

FIGURE 2. Set net fishing in Toyama Bay neighbouring *satoyama*. Photograph courtesy of Toyama Prefectural Fisheries Research Institute.

of the main net makes it possible to catch live fish. The projection of the Noto Peninsula protects the bay from the northwest winter wind, ensuring calm seas suitable for the installation of set nets.

Toyama Bay is one of the birthplaces of set net fishing in Japan, along with Nagato and Hizen, Oga Peninsula, and Mutsu and Hokkaido (Hayashi 1996). Set net fishing in the bay for at least four centuries is attested by its mention in a tax receipt from 1615[6]. This fishing method and equipment were continuously improved and passed on to the present. Up until the 1940s, the set net was made of natural materials—rice straw cord or hemp thread, bamboo, and sticks of wood. Cord made of twisted straws was woven into nets, and buoys made of bamboo and the paulownias wood (Jp. *kiri*; *Paulownia tomentosa*) were used to suspend the net from the surface.

Since the 1940s, most of the nets for set net fishing have been replaced with synthetic fibre, while wood buoys are now made of glass, plastic, or aluminium. One exception is for firefly squid (Jp. *hotaru-ika*; *Watasenia scintillans*) fishing, in which the leader net of the set net continues to be made of rice straw cord. The firefly squid has a mantle length of approximately 5cm and photophores covering its body. The primary harvesting season is from March to June. The luminous firefly squid has become a tourist attraction for the region, and is served sliced as *sashimi* (i.e. raw) and as boiled seafood, both local delicacies. Once, an attempt was made to replace the rice-straw nets and straw nets with synthetic fibre nets. But the firefly squid catch was poor that year, so the fishers returned to the use of straw-made nets. It is believed that the natural straw materials make it possible to direct the firefly squid to the main part of the net without scaring them. The nets are fixed with anchors made of sandbags filled with river gravel. Fishers go to sea even in winter to haul in the nets. They light wood fires on their ships to warm themselves while going to and returning from the fishing grounds. The materials for the straw nets, firewood and gravel traditionally used are all found in the nearby mountains, one of many ways in which fisheries have linked the *satoyama* and *satoumi* since long ago.

Fisheries production

Figure 3 shows fisheries production in Toyama Prefecture from 1953. Total catch increased from 21,000 tons to 43,000 tons between 1953 and 1983. During this time, fishing efficiency developed through improvement of equipment, and total fish resources were increased with the species replacement by horse mackerel (Jp. *ma-aji*; *Trachurus japonicas*), Japanese anchovy (Jp. *katakuchi-iwashi*; *Engraulis japonicas*), and Japanese sardine (Jp. *ma-iwashi*; *Sardinops melanostictu*). In recent years, fisheries production has stabilised at around 20,000 tons, in contrast to many areas where overexploitation through commercial large-scale fishing has caused a collapse of stocks. Set net fishing contributes 70 to 80 per cent of total fisheries production, in recent years mostly through fishing of yellowtail (Jp. *buri*; *Seriola quinqueradiata*), horse mackerel, chub mackerel (Jp. *ma-saba*; *Scomber japonicas*), Japanese Spanish mackerel (Jp. *sawara*; *Scomberomorus niphonius*) and common squid (Jp. *surume-ika*; *Todarodes pacificus*). The abovementioned fish seasonally migrate all the way from the Yellow Sea. In set net fishing, migratory fish are dominant, but local sedentary fish are also harvested.

6 This historical document could be translated as "Receipt of the tax claimed to the summer set net settlement called Sawa-no-niban in Himi-gun Unami-ura for 1614 by the Kaga Domain (Jp. *kaga-han*)".

Coupling of mountain and bay ecosystems

A large volume of river water flows into Toyama Bay, creating a low salinity water area that extends some 10 km from the shore. Rivers supply nutrients and sediments to the coastal sea, playing an important role in sustaining a high level of biological productivity and biodiversity in the coastal ecosystem. The rivers supply nutrients essential for phytoplankton primary production. In addition, in the eastern coastal area of Toyama Bay, submarine seepage of groundwater has been identified (Zhang and Satake 2003; Hatta et al. 2005). Downwind of Toyama Bay, the Japanese Northern Alps soar to over 3,000 meters, resulting in a large quantity of precipitation and snow (Figure 4). Mountain rainfall eventually drains down to the Toyama Bay coastal area, part of it after a long transit as groundwater. Land-supplied freshwater and nutrients sustain a high primary productivity (phytoplankton growth) that supports a luxuriant food web attracting a wide variety of fish species that migrate great distances to feed in the bay.

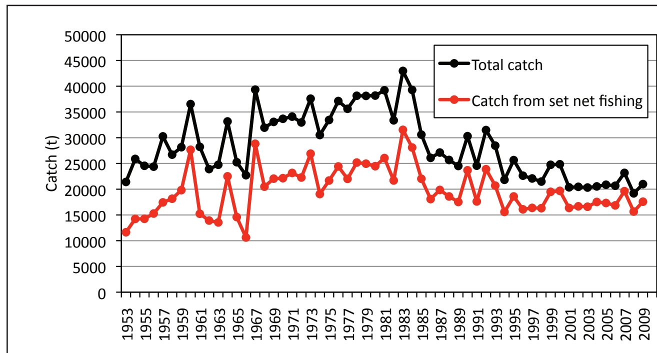

FIGURE 3. Total catch and catch from set net fishing in Toyama Bay (1953–2010). *Source*: Toyama Prefecture Bulletin of Statistics on Forestry and Fisheries (1953-2000) and Toyama Prefecture Fisheries Research Institute (2001 to 2010).

FIGURE 4. Set nets in Toyama Bay with the Japanese Northern Alps (Mt. Tateyama) in the background. Photograph courtesy of Touzawa Art Printing Co., LTD.

Management systems

In Toyama Bay, set net fisheries are governed under a specific management regime, while other coastal fisheries are governed under the district regime. Set nets are classified as either large set nets or small set nets depending on the depth of the water in which the net is installed, with different names such as "*buri* (yellowtail) set net", "*iwashi* (sardine and anchovy) set net" and "*hotaru-ika* (firefly squid) set net", depending on the sought-after species. Licenses are given to the owners and the Fisheries Cooperative Associations based on set net rights and common fishery rights.

Allocation of resources between set net fishing and other types of large-scale fishing has been problematic. Other methods can (at least temporarily) increase harvest through a more aggressive pursuit of fish, which set net fishing cannot, and yields from the latter will decrease in proportion to the increase for the former. Fair resource allocation is important in order to achieve more sustainable exploitation.

Potential advantages of set net fishing for sustainability

While a great diversity of fishing methods are used in the bay, the set net is by and large the most common. In contrast to large encircling nets and trawling, where fishers pursue fish, set net fishing is a "passive method" in which fishers catch only the fish that come into the net. It is estimated that only 20 to 30 per cent of such incoming fish are actually caught. Over the centuries, the local communities developed knowledge and technology that made effective use of all harvested marine resources, from large to small fish. Set nets typically operate in fishing grounds within 4km of the port, reducing fuel consumption significantly compared to other fishing methods.

Finally, and perhaps most crucially, in other methods fish can be hunted down over large distances, so that fishers may look to compensate for a drop in ecosystem productivity by fishing further/longer, or invest labour saved by gear improvement into increasing their area of exploitation. In contrast, set net fishing can only harvest over a fixed area, fishing time cannot be increased either, and the prerequisite for viable operation is that a wide variety of fish and shellfish inhabit and migrate to this area—in other words, the local ecosystem must remain healthy. Hence, for set net fishing, labour saved by technology is more readily invested into actions that sustain ecosystem productivity, as is illustrated in the many labour-intensive conservation activities that the fishers of Toyama Bay are conducting, as described in the section on resource and ecosystem conservation activities below. For these reasons, set net fishing has drawn attention as a fishing method that could more readily accommodate sustainability and conservation requirements, provided exploitation remains within sustainable levels. Nonetheless, many structural changes, including those taking place within the setting of the economy and market, remain to be enacted to take advantage of set net fishing's features for sustainability.

International cooperation

The Himi Fisheries Cooperative, Himi City, the Japan International Cooperation Agency (JICA), the Southeast Asian Fisheries Development Center (SEAFDEC), and the Tokyo University of Marine Science and Technology have collaborated in a project to share the set net fishing method with fishers in Thailand. Fishers from the city of Himi visited Thailand and Thai fishers were invited to Himi to see demonstrations of set net fishing operations. Encouraging results led to replication of this project in other countries including Indonesia, Costa Rica, Cambodia, and Morocco.

ANTHROPIC PRESSURES ON THE ECOSYSTEM

Eutrophication

Excess supply of nutrients to coastal sea areas causes eutrophication, deteriorating water quality, favouring the occurrence red tides, hypoxia or anoxia in bottom water, and a decline in benthos abundance and diversity. Areas adjacent to urban river mouths are particularly impacted. Since the 1960s and the subsequent rapid economic growth period, factories have been continuously constructed along Japan's coasts, and discharge from these plants, together with household effluents, has significantly impacted water quality in many coastal areas, including Toyama Bay. Fisheries have been adversely affected by the resulting degradation of the ecosystem. One example has been the rise in the predominance of jellyfish. Transported from distant eutrophic areas by ocean currents, jellyfish have been caught in set nets in Toyama Bay in large quantities. This phenomenon has steadily increased in frequency, much to the detriment of the fisheries industry (Uye 2008).

Forest, rivers and sea

According to Mr. Tsunenobu Yano, a fisherman who engaged in set net fishing near the mouth of the river, "Disaster comes from the upper reaches of the river". In addition to pollution, rivers have carried an increased amount of driftwood. This is linked to the decline in the quality of forest management in the mountains of the local watershed. Driftwood tangles the set nets and tears their netting, and to remove it is painstaking and time-consuming. Driftwood damage tends to occur frequently after heavy rains that trigger landslides in mountainous areas. A revival of managed forestry should increase the water-retaining capacity of the mountains, prevent driftwood outflow, and stabilise soil erosion and nutrient input in the bay. It is hoped that such good forest-management practices will pave the way for enhanced marine productivity.

Natural threats

Set nets are also vulnerable to certain ocean conditions, particularly high waves, and *kyucho* tend to cause damage. *Kyucho* refers to abnormally strong currents induced after the passage of typhoons or low pressure systems, which can break or sweep away coastal set nets (Matsuyama 2005). *Kyucho* damage in the several billions of yen is reported in Toyama and the Noto Peninsula (Hayashi and Ino 2005; Okei et al. 2008). Although it has been recorded in this region since ancient times, the mechanisms of *kyucho* remain poorly understood. Set net fishers know from experience that they can prevent damage to their nets by hauling them out before storms break, but this entails significant labour. Recently-developed *kyucho*-resistant fishing equipment and more accurate forecasting improved through numerical modelling are expected to help in managing this risk.

RESOURCE AND ECOSYSTEM CONSERVATION ACTIVITIES

Water quality conservation measures

Fishers were the first to raise their voices about the need to address the problem of eutrophication in Toyama Bay during the rapid growth period. The

Japanese government enacted the Water Pollution Control Act in 1970, and local authorities enacted stricter municipal regulations on factory effluents.

Marine environment monitoring

Concerned about the accelerating pollution of their coastal waters, local fishers have long monitored their fishing ground environment. Once a month, fishers collect water samples and measure water temperature in 36 set net locations. The Toyama Federation of Fisheries Cooperative Associations collects and transports water samples, which are analysed by the Toyama Prefectural Fisheries Research Institute for Chemical Oxygen Demand (COD), salinity, turbidity and pH. These three parties in collaboration have continuously monitored these parameters since 1971. In addition, fishers notify governmental agencies and other organizations of the occurrence of red tide and oil pollution. Set net fishers have thus provided crucial data for managing the ecosystem of the bay (Tsujimoto 2005).

Stock enhancement and management

As fish farming technology developed, fishers began releasing fish fry into the bay with the hope that this would increase stocks. Stock enhancement has been promoted by the Japanese government and local authorities since the 1960s. A fish farming centre was established in this region in 1978, where the youth group of the local fishery cooperative association contributes to the production and release of fish fry.

In the meantime, coastal development resulted in a decrease of shallow areas and seagrass beds. The fishers were quick to observe that the lack of results from the release of fish fry was related to the gradual disappearance of these habitats, which are essential nursery and feeding grounds for juveniles. It soon became apparent that simply attempting to increase the number of the exploited species, with no regard for the ecosystem and the rest of the food web, would not be effective. The conservation and restoration of shallow areas and seaweed beds, on the other hand, provides habitats for a wide diversity of species.

Fishers discussed and implemented stock management measures, such as regulating fishing season and fishing gear and setting size limitation. For example, small red seabream (Jp. *ma-dai*; *Pargus major*) had to be released and their sale was prohibited, mesh size was increased for pot fisheries targeting pink shrimp (Jp. *hokkokuaka-ebi*; *Pandalus eous*), and annual allowable catch was imposed for the deep sea red snow crab (Jp. *benizuwai-gani*; *Chionoecetes japonicus*).

Tree planting and watershed-scale ecosystem conservation

The expression, "Mori wa umi no koibito" (the forest is the sweetheart of the sea) (Hatakeyama 1994) aptly expresses the way the mountains, rivers and coastal ecosystems coupled, and has become a kind of catchphrase reminding fishers to turn their eyes to the mountains. Fishers in Toyama and their family members began visiting mountain areas in neighbouring regions located in the upper reaches of rivers flowing into Toyama Bay. In these mountain areas, they engaged in tree planting activities toward creation of what are known as "fisher forests" (Figure 5).

FIGURE 5. Tree planting by fishers and their family members in the upper reaches of the rivers flowing into Toyama Bay. Photograph courtesy of JF Uozu.

Several times a year, fishers go to the mountain slopes, planting over one hundred trees at a time, with a total of over a thousand trees every year. While forests in Japan tend to be planted with conifers for forestry purposes, fishers preferentially planted deciduous trees with the expectation that fallen leaves will enrich the nutrients cycling out to the sea. These include chestnut (Jp. *kuri*; *Castanea crenata*), zelkova (Jp. *keyaki*; *Zelkova serrata*) and cherry (Jp. *yamazakura*; *Prunus jamasakura*). Oak acorns are picked and planted, and saplings are transplanted the following year. The launching of a study to quantitatively assess fisher forest influence on the coastal waters is anticipated in the near future.

Box 1: Uotsukirin—the fish-breeding forest

Osamu Matsuda, Hiroshima University

From the perspective of current challenges in biodiversity management, two noteworthy aspects of *satoumi* are the seamless internalisation of the labour involved in essential ecosystem management practices, and the role of humans in regulating the interaction of the terrestrial and marine parts of coastal and watershed ecosystems. The ancient tradition of the *uotsukirin*, or fish-breeding forest, combines these two aspects. The *uotsukirin* system was formalised into a modern legal system during the Meiji Era in 1897 as part of the forest law, but it is based on practices already well established over much of Japan in the 17th century, and even mentioned in 10th century literature. *Uotsukirin* practices expanded rapidly after the 17th century in the context of efforts to promote sardine fisheries, an essential food source and widely-needed ingredient for lamp oil and agricultural manure. The crucial role of watershed forestry in coastal ecosystem productivity was well-known to fishers since these times. In the 20th century scientific investigation revealed some of the mechanisms underpinning this relationship. Nowadays, tree planting activities of fishers' cooperatives contribute significantly to watershed forestry, reviving an ancient connection between *satoumi* and *satoyama*. These practices are central to many of the *satoumi* activities around Japan, and are described in more detail in the Akita and Toyama case studies and in the box on ecological links between terrestrial and coastal areas in the Yura river estuary and the Tango Sea.

Seaweed cultivation

Seaweed is an important food in Japan, and its cultivation can have many benefits for the environments, such as provision of nursery grounds for juvenile fish, water purification and carbon dioxide sequestration. The youth group of the fisheries cooperative cultivates *makombu* kelp (Jp. *makombu*; *Saccharina japonica*) as part of its environmental preservation activities (Figure 6; Yano 2006; Matsuda 2010). The primary purpose is to utilise the strong nutrient absorption capabilities of seaweed to prevent eutrophication. Due to the high water temperature in summer in Toyama Bay, kelp does not survive through the summer. Therefore, the youth groups plant sporophytes in December and harvest the kelp in May and June of the following year. In addition, seaweed beds have been developed through the introduction of concrete algal reefs and placement of natural rocks. Moreover, as a part of their practical training, local high school students studying marine science are transplanting eelgrass (Jp. *amamo*; *Zostera marina*).

FIGURE 6. Youth group activities of local fisheries cooperatives include cultivation of *makombu* kelp to purify the water and help prevent eutrophication in the Bay. Photograph courtesy of JF Shinminato.

CONCLUSION

Set net fishing has been practiced for over 400 years in Toyama Bay, with the local food culture adapting to best use the available species for each season. Over the centuries, the fishers in the bay have constantly adapted their activities, shifting from developing new fishing grounds, to improving their fishing techniques; they later practised stock enhancement and resource management, and are now in the process of expanding environmental conservation activities such as watershed forestry, and restoration and enhancement of the seaweed beds. These more holistic (more ecosystem-based) approaches to conserving fishery resources naturally came forth as awareness rose that a rich diversity of organisms is necessary for the ecosystem to be both sustainable and productive. The *satoumi* in Toyama Bay may be described as a coastal sea that fishers have made productive and sustainable. A strong sense of gratitude for the bounty bestowed by the sea remains central to the worldview that has driven fishers' conservation efforts to nurture this seascape.

ACKNOWLEDGEMENTS

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Case Study

4 MULTI-STAKEHOLDER DIALOGUE INITIATIVES IN NANAO BAY

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ABSTRACT

Mainstreaming biodiversity and securing linkages among forests, the countryside, rivers and the sea are two of the four basic strategies of the National Biodiversity Strategy of Japan 2010. To achieve this by 2012, the national government has designed an action plan that includes 720 specific measures. Collective efforts by national and local bodies of government, researchers and civil interest groups will be needed to develop working solutions to meet the ambitious goals of the national biodiversity strategy. How these stakeholders work together to complement each other's strengths as one collective whole will be key. The Nanao Bay case study explores how this may potentially be achieved. In 2008, Nanao Bay was selected as one of four pilot sites for the Ministry of the Environment's *Satoumi* Creation Project to design and implement integrated community-based management of coastal marine ecosystems. Although the project was initiated by the central government, inferring a one-way top-bottom approach to policy initiatives, local initiatives were also already in motion, providing the bottom-up platform to combine with and facilitate the central government initiatives. Though it is yet premature to make any conclusive assessments about final or achievable outcomes, this case study is one example of how local community efforts, supported by locally-based scientific research activities, can link with national efforts to mainstream biodiversity.

OVERVIEW OF NANAO BAY

Nanao Bay is an enclosed-coastal sea located on the east side of Noto Peninsula, Ishikawa Prefecture. Due to its topographical features as a calm natural bay closed off from the ocean, the bay has a long history as a marine haven for fishers and marine traders. During the Tokugawa Era (1603-1868) it served as a port for *kitamaebune* cargo ships transporting marine products such as herring and kelp and other commodities from northern Hokkaido through the Kanmon Straights and Seto Inland Sea to the feudal capital in Kyoto. Salt produced on the peninsula was a much sought-after commodity as a preservative for the marine products transported along this marine trade route. With limited arable farmland on the peninsula, holistic approaches to integrated watershed human activities of fishing, farming and forestry have traditionally been practiced and *satoyama* traditional socio-ecological production landscapes, and their marine counterpart *satoumi*, have long coexisted. The future of these traditional landscapes, however, is a growing concern among local policymakers as recent demographic trends indicate aging and decreasing population of fishers and farmers in the area.

The enclosed bay area is approximately 183km^2 (Figure 1). Nanao Bay is divided into north, west and south bay areas based on depth and other marine environment characteristics. The average depth of the bay is between 20-30m, and is deepest in the north bay area entrance at 60m. The waters gradually grow shallower from the north bay entrance towards the west bay area where there is an intertidal zone made up of sand and mud. Fishing activities are more concentrated in the north and west bay areas. Fish catches include greasyback shrimp, mantis shrimp, blood clam, Japanese cockle and Jedo Venus clam. The enclosed bay produces many species that do not inhabit other marine coastal areas in Ishikawa Prefecture and are considered commercially non-viable due to the low yield potentials and lack of consumer demand for the species. Of the commercial marine species, over 80 per cent of the sea cucumber

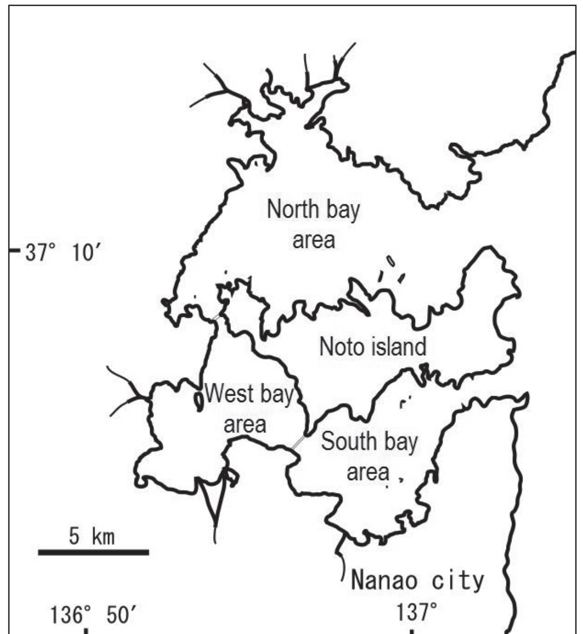

FIGURE 1. Map of Nanao Bay.

catch of Ishikawa Prefecture comes from Nanao Bay. Sea cucumber, *mozuku* (*Nemacystus decipiens*, an alga-like seaweed) and shellfish account for approximately 70 per cent of the annual catch. Pacific oyster farming, introduced to the bay area in the 1920s, is currently the largest production area of any coastal community along the west coast of Japan from northern Hokkaido to southern Kyushu.

Juxtaposed to the fishing activities of the north and west bay areas is the south bay area where urbanization and industrial development have resulted in land reclamation and artificial coastal zone construction activities. Located at the mouth of Misogi River, the south bay area serves as a cargo port surrounded by an industrial zone of marine product processing plants and other small-scale industrial factories, including a timber basin.

Human activities in the bay reflect the symbiotic mutualism of human society's relationship with the natural environment. A commonality throughout human history, human activities have been shaped by the natural terrestrial and marine environment of the enclosed-coastal sea. As human communities have developed, the impacts of human activities have conversely shaped and changed the natural environment, affecting resource availability on both land and sea (Worster et al. 1990). With increased human development, resource use and management conflicts have also emerged. These very conflicts, in turn, have both indirectly and directly stimulated public dialogues and intensified the need to explore integrative approaches to address resource use and management. *Satoumi*-based activities are one such emergence.

LINKING FISHERS OBSERVATIONS TO SCIENTIFIC RESEARCH: EXPLORING THE POTENTIAL IMPACTS OF HUMAN ACTIVITIES

Degradation of the marine environment, declining annual fish catches and potential links to land-based human activities have become the focus of cross-sectoral policy discussions of *satoumi*-based activities in the Nanao Bay area since 2008, when the area was selected as one of four pilot sites for the Ministry of the Environment (MOEJ) *satoumi* creation project (see chapter 2, section I). Attention to integrated management needs grew not so much from policy-making interests initiated by central government top-down as from bottom-up observations of declining annual fish catches and monitoring of water quality carried out in the bay. As is exhibited in Nanao Bay, fishers' observations supported by scientific data can potentially instigate cross-sectoral policy dialogues on both local and national levels.

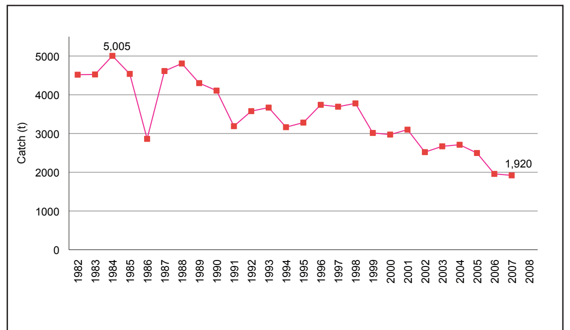

FIGURE 2. Interannual change of oyster catch in Nanao Bay.

Observations that led to research activities and public dialogue date back to the late 1980s, when fish catches started to decline in the bay area. Significant declines in annual fish catch and oyster farming yields from the late 1980s through the 1990s aroused concern among fishers, field station researchers, and more recently among fisheries and environmental policymakers (Ishikawa Prefecture 2003). Annual fish catches prior to decline were 2,000 metric tons. The current average in recent years is half that, approximately 1,000 tons (Ministry of the Environment 2009). Since the late 1990s, fish catches have stabilized, but oyster yields have continued to decline and the oyster harvest recorded for 2006 was 1,920 metric tons, a mere 38 per cent of the peak yield in the past (Figure 2). These declines have led to investigations of the bay marine environment, specifically water quality and sea bottom environment studies to identify the causes for the declines in yields.

Comparing fish catches with pH levels revealed that pH levels in 1990, the year yields drastically declined, were above 8.5, indicating red tide potentials in the bay (Ocean Policy Research Foundation 2009). High concentrations of ammonium nitrogen were recorded in 1991, possibly resulting from deterioration of the sea bottom environment by anthropogenic eutrophication. Declines in fish catches have been linked to this and studies show that the fish populations are decreasing relatively more than that of the actual fish catch, suggesting that recent decreases of fish catch are not due to fishing activities alone, but in part due to

Box2: Oyster shell nurseries—using aquaculture waste for biodiversity management

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Proper disposal of by-products and waste is one important issue amongst the many challenges involved in developing a more sustainable and biodiversity-friendly aquaculture. Oyster cultivation in Japan leaves large amounts of shells as by-products. The cement industry became a major user of what was once left as waste, and other uses include animal feed ingredient and agricultural soil improvement. A rapidly developing application that could be promising for *satoumi* is taking advantage of the highly organism-friendly characteristics of the oyster shell's porous surface. When used in artificial reefs, oyster shells are an excellent substrate that allows many organisms to attach, which in turn attract fish. Studies have demonstrated the effectiveness of such reefs for fish collection. Recent developments focus on using these reefs as a habitat for a diversity of small animals whereby aquaculture waste would be recycled within the marine ecosystem as one tool for local biodiversity management.

an overall decrease of productivity in the bay, possibly caused by land-based anthropogenic activities such as discharge from factories, household sewerage and agricultural chemical run-off.

Studies have indicated sea bottom environment degradation in the west and south bay areas (Taniguchi and Kato 2008; Ministry of the Environment 2009). Though not conclusive, fisheries researchers in the area also suggest environmental degradation may be the cause of declining catches of blood clam; specifically, despite substantial annual releases of young shells into the bay to increase stocks, poor survival rates of the young shells has been attributed to the deterioration of the sea bottom environment (Ishikawa Prefecture Fisheries Research Center 2005).

As researchers increasingly focus on the impact of anthropogenic factors on the bay's marine environment, interest in the role of land-use changes has grown, and research exploring the cause and effect of land-use changes on marine ecosystems has gained momentum on the peninsula. A comparison of images observed by the Landsat satellite in May of 1973 and 2001 shows that land-use change and degradation in the bay area has taken two polar paths: overexploitation and underuse, two of the four threats to biodiversity identified in the National Biodiversity Strategy of Japan 2010 (Figure 3). Species and habitat degradation due to overexploitation has mostly been caused by conversion of agricultural lands into urban lands for residential housing and industrial activities, land reclamation and other construction activities in coastal areas. Juxtaposed to degradation caused by excessive human activities and development is the degradation of inland forests and upland agricultural lands caused by underuse, under-management and abandonment (JSSA – Hokushinestu Cluster 2010).

Of the land-use changes, urban expansion is most prominent along the bay's coastal areas. Approximately 90 per cent of the Nanao Bay shoreline has concrete revetments, resulting in reduced habitats for plants and animals, which can reduce marine biodiversity. More notable, however, is that most of these concrete revetments are vertically settled. This not only prevents seaweed and fish species that prefer rocky shores from growing, but also reduces the rate of water exchange and inhibits the sea-to-land migration of organisms such as Japanese mitten crab, which inhabit both fresh and salt water. Moving beyond these observations

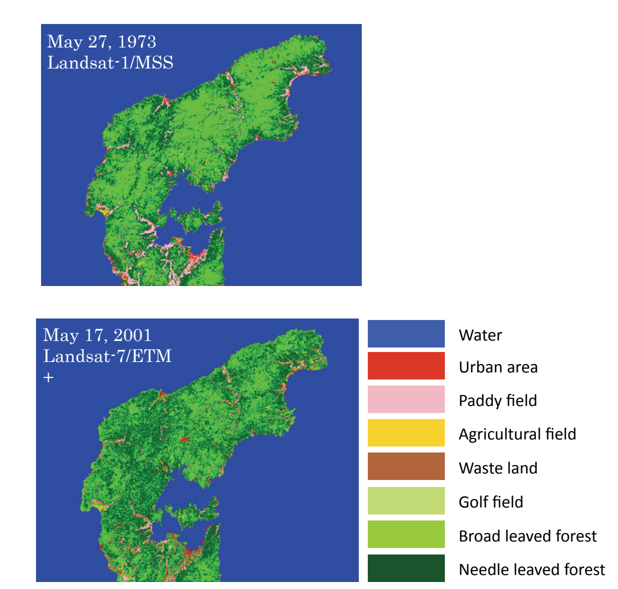

FIGURE 3. Comparison of land use change observed by Landsat satellite on May 27, 1973 and May 17, 2001.

towards active measures to regenerate marine life in these human-made artificial environments, as has been done in Tokyo Bay on a minimal scale for example (see Tokyo Bay case study), has yet to be explored on the bay.

Land-use change and ridge-to-reef correlations of forest management and marine environment has been the focus of studies on the peninsula as part of the ongoing work of the United Nations University Institute of Advanced Studies (UNU-IAS) led *satoyama satoumi* ecosystem assessment work by the Hokushinetsu Cluster working group. This work builds on studies by Ishikawa Prefecture's Fishing Environment Conservation Policy paper (2003) that reported a correlation between the area of broad-leaved forests and catches of fish that inhabit in the bay, including *mozuku*, sea cucumber and striped mullet. The results suggested that diminishing fish catches from the 1970s to 2002 is related to the reduced area of broad-leaved forests (Ishikawa Prefecture 2003). This indicates a potential link between land and coastal marine environmental degradation of *satoyam*a-type landscape forest management where diverse species are maintained under a more holistic integrative approach akin to contemporary ecosystem-based management approaches caused by monoculture plantation forest management practices.

Land-use change studies in the bay tend to focus on land-based human activities, implying a linear flow of impacts. Although quantitative analysis as yet is limited, impacts of changing human activities on land and sea have been mutual. Specifically, on the bay, land-based activities have been influenced by technological innovations in the fishing industry. Up until the 1960s, timber self-sufficiency rates were about 70 per cent and locally produced timber was used not only for housing needs but to build fishing boats and fishing equipment. In Nanao Bay, many fishers were also foresters and farmers. Distinct to the bay area was *marukibune*, a dugout boat used for fishing on the calm bay waters and for transporting agricultural crops through the canals of coastal communities. Bamboo forest management also benefited from fishing activities as locally grown *mosou* bamboo was used to make the oyster rafts for oyster farming. The floats for nets were also made from locally produced *paulownia* or variant species of Japanese cypress (Nanao City 2003). These interconnected forester-farmer-fisher activities on the bay began to change as Japan entered the rapid economic growth period of the 1960s. With rapid development came the mechanization of boats and the introduction of FRP and plastic materials for boat making and fishing equipment, resulting in the decline of timber demand driven by local fishing activities and integrated land-to-sea resource use and management practices on the peninsula.

More exploratory studies on land-use change impacts and the inter-linkages of human activities on terrestrial and marine environments have been recommended by researchers to policymakers at meetings of the prefectural government's committee for *Satoyama Satoumi* Vision Planning and Biodiversity Strategy (Ishikawa Prefecture 2010). Further, agricultural practices in Ishikawa Prefecture are currently being reviewed by the Ministry of Agriculture, Forestry and Fisheries' Hokuriku regional policy office as part of the national government's evaluation of the agricultural lands, water and environmental conservation management program. Though yet premature to preclude concrete effective results from these initiatives, integrated approaches to integrated watershed studies and exploratory policy discussions in linking forestry, agriculture and fishery practices, and the policies that support them, are underway.

BRIDGING DIFFERENCES: EMERGING COMMUNITY-BASED PARTNERSHIPS AND MULTI-STAKEHOLDER DIALOGUE INITIATIVES

As societies change and evolve, so do their relationships with nature. From hunter-gatherer based communities where animism is practiced and taboos are often the mechanisms that guide resource use and mitigate conflicts that arise within the community, to industrialized communities where litigation and government legislation guide and regulate people's relationship with nature, nature views in our ever-increasing global world are a continually evolving multilayered mosaic (Hughes 2009). Nanao Bay provides an interesting illustration of how these different world views can coexist.

Indigenous animism, feudal era based hereditary fishing rights and resource use practices, along with contemporary regulations and laws influenced by Western thought, coexist and influence nature views, resource use rights and perspectives. As human activities in the bay area have evolved from fisher-farmer based communities to an increasingly industrialized urban society, lifestyles have changed. With these changes, homogeneity of traditional nature views have become fractured and diversified, resulting in differing, sometimes competing, views of human society's relationship with nature and rights regarding its use. In the case of Nanao Bay, this has arisen in the form of marine resource use conflicts among fisheries and tourist-driven interests.

Fishing and tourism have co-existed in Nanao Bay since the thirteenth century. Marine and land travellers visited the medicinal natural hot springs of *Wakura Onsen* for relaxation and trekked through mountain and coastal footpaths on religious pilgrimages to Shinto shrines and Buddhist temples. As society has changed, so have the trends of tourism in the bay area. Over the last decade, cultural tourism and eco-tourism have grown (Nanao City 2009). Eco-tours include outdoor mountain trekking, farming and forestry education experiences in traditional *satoyam*a socio-ecological production landscapes, and more recently, marine outdoor activities such as diving and dolphin watching, the latter of which is at the centre of debate among tourist and fisher interests in the bay.

As in other regions in Japan, recreational marine sports and fisher relations have often been tenuous as spatial planning and regulations of bay use have traditionally placed fishers' use rights above others. Divers negotiate with the local fisher cooperative associations to gain access to diving spots on the bay. Consensual agreement through discussion between diving and fisher interests was until recently rather conflict free, as end use interests did not compete. From 2001, when Indo-Pacific bottlenose dolphins migrated into the bay area and settled, this has gradually changed. There are no traditional practices of dolphin hunting in the bay, thus hunting versus conservation protection is not an issue. What is contentious, however, is that diver and tourist interests argue for conservation regulation needs to protect the dolphins' habitat, while fishers are concerned about the potential impacts of the dolphins—specifically, impacts on already declining fish stocks of an increasing settled population.

In an effort to resolve these issues, the Nanao Bay Research Group, a multi-stakeholder group made up of a Nanao city-NPO citizen's group, local government officials, researchers, tourist interests, divers and fishers was established in July 2004 (Shikida and Moriyama 2005). This research group facilitates discussion between various stakeholders that previously had limited interactions with each other. The group functions as a coordinating body of ocean users by establishing rules for diving and dolphin watching. As dolphin watching tour numbers increase, however, fishers whose fishing grounds fall in the areas inhabited by the dolphins are increasingly concerned about the potential impacts on their fishing activities. Both interest groups have called for the need to develop a new management structure and regulations for the growing tourism activities.

Resource use conflict discussions, growing concern over declining fish stocks and degradation of the bay environment have resulted in a growing collective awareness among community leaders of the need for integrated approaches to explore working solutions for marine resource use, conservation and management issues in the bay. Awareness of the issues supported by sound scientific studies and generating the civil will to work together to find working solutions is a step Nanao Bay community has made. The next step of mitigating competing interests under one overarching body did not easily take form until MOEJ initiated the *Satoumi* Creation Project in 2008 (see Chapter 2).

Nanao Bay became one of four pilot sites selected by MOEJ in 2008 as a model where integrated river basin activities could be explored for a two-year period to provide scientific and socio-economic data on issues including local government policy. The project was designed to develop *satoumi* activities that would go beyond the enclosed coastal waters linking mountain and agricultural lands along waterways flowing into the bay. Selection by the national government as one of four pilot sites (the following year another two pilot sites were added) provided the impetus, as well as facilitated local efforts to bring various stakeholders together. A steering committee was established at the prefectural environmental division office and members included researchers, Nanao Bay Research Group representatives, and fisher cooperative association representatives. To respond to national government initiatives of cross-sectoral approaches to *satoum*i-based activities, government division representation included the environment division; fisheries section of agriculture, forestry and fisheries division; and land, infrastructure, transport and tourism division from both local municipal government bodies and the prefectural government (Ministry of the Environment 2009).

Allowing for local community self-initiative is a key element of MOEJ's *Satoumi* Creation Project, perhaps signalling a new direction in policy development and implementation in a country where central government is often the primary guiding force in policy design and implementation at both the national and local government level. Although the three-year project is now in its final year, it is still premature to make any conclusive assessments, but by allowing for local initiative in designing activities, the national government has contributed to local empowerment potentials. Data collection, monitoring activities, social-science based interviews with the different interest groups on the bay and meetings to discuss the research activities were a requirement of the project. How each pilot site met the requirements was left to its discretion. In Nanao Bay, meetings to discuss and design the research and monitoring related activities were convened in the local bay community. Public outreach activities were another requirement, both within site communities and among pilot sites. Local workshops and forums along with visual and written communication materials describing the *satoumi* concept and related activities were developed by the local steering committee, while inter-pilot site meetings and joint forums were organized by MOEJ. This multi-scale approach to public outreach has benefited all partners by facilitating exchange of information and network building among pilot sites, increasing dialogue between national government and local government bodies, and creating public platforms to engage both bay community members and civil society in *satoumi*-based activity discussions (Ministry of the Environment 2010).

CONCLUSION AND FUTURE PROSPECTS

Though further analysis is required, it can be argued in the case of Nanao Bay that mutual aims working in the same direction have been key to linking central government initiatives related to *satoumi*-based activities to local community efforts. Moreover, the two are interdependent; substance and effectiveness of one depend on the other. National initiatives often evolve from locally voiced and/or perceived local needs. The effectiveness, however, of national government initiatives is often dependant on local activities already in motion and the capacities of communities to become active and ideally equal partners in the national initiatives.

In the case of Nanao Bay, central government initiatives for *satoumi*-based activities as part of efforts to mainstream biodiversity came at a time when community awareness of growing coastal marine environmental issues was supported by sound scientific studies. The scientific backing to fisher and other interest group observations of potential degradation and ensuing impacts was a key element, as it provided the impetus for local initiatives. Not only were research findings key to stakeholder mobilization, but researcher interaction with the various interest groups, from fishers to tourist groups to the cross-sectoral local government offices, and participation in the multi-stakeholder local dialogues has also been instrumental in strengthening local initiatives and providing the scientific validity needed to effectively link local efforts to national initiatives.

National and locally intertwined initiatives facilitated by multi-stakeholder dialogues have been successful thus far in engaging the differing resource user interests in the bay. Under the guidance of the *Satoumi* Creation Project steering committee the differing issues have been discussed and debated in the same forum, thus facilitating an integrated approach to policy discussions. Research and policy needs have been identified by the steering committee and presented to both the local and national government offices. Implementation of integrated policy is the next challenge. Scientific activities once again will be key in meeting this next challenge; specifically, marine spatial planning designed from ecosystem based management approaches is yet only a final aim and will require the collaborative efforts of scientific, civil and political will to achieve.

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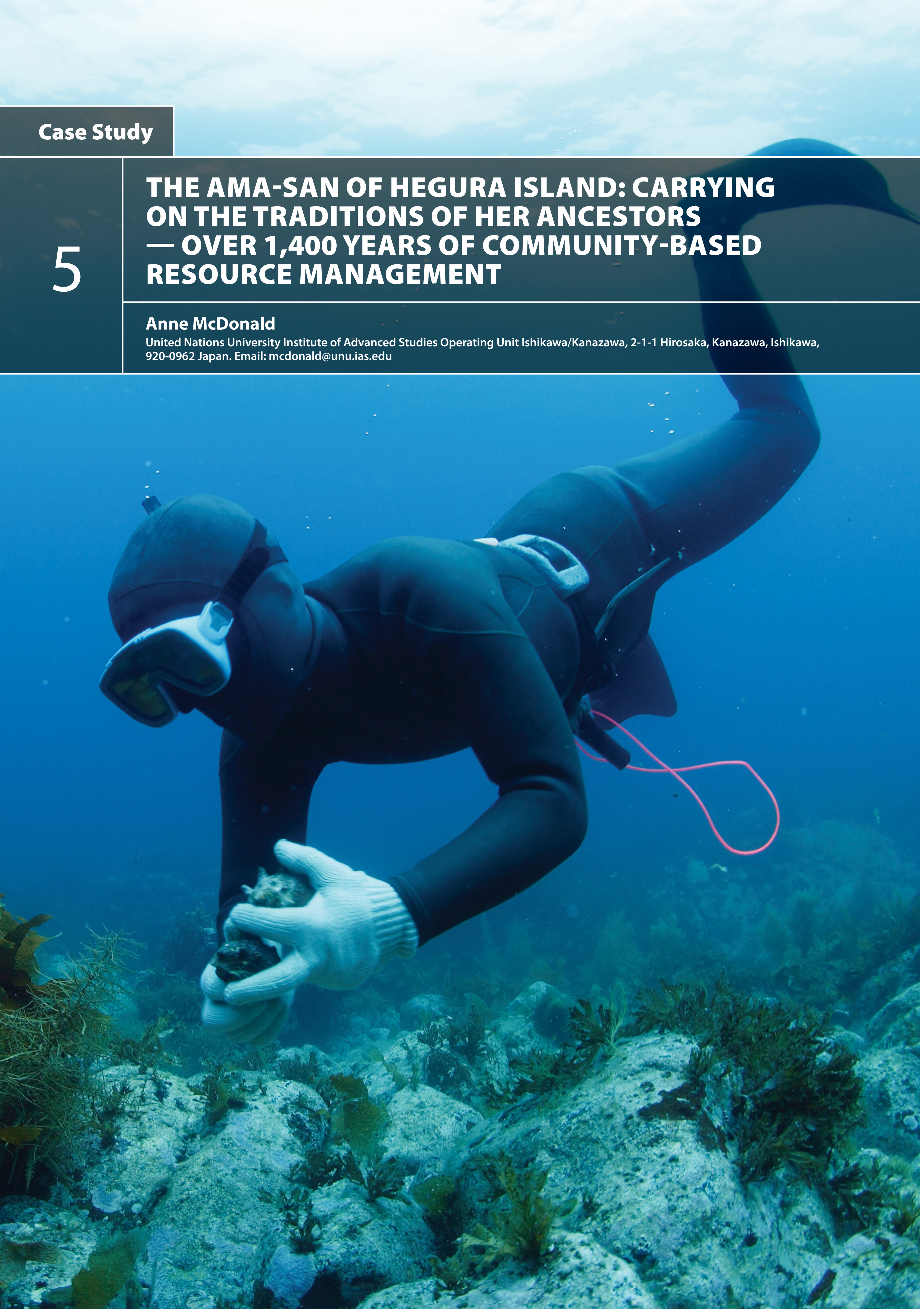

Case Study

5

THE AMA-SAN OF HEGURA ISLAND: CARRYING ON THE TRADITIONS OF HER ANCESTORS — OVER 1,400 YEARS OF COMMUNITY-BASED RESOURCE MANAGEMENT

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ABSTRACT

The a*ma*, literally "sea-women", have for centuries made a livelihood of diving to collect shellfish. On Hegura Island, long, daily immersions in the ocean since generations have over time built coastal communities in which a uniquely intimate relationship with the sea is a key part of the cultural identity, providing a distinctive case of the interaction of a culture with its coastal ecosystem. Like many other female divers communities, the a*ma* of Hegura are characterised by strong, women-led hereditary collectivism. Community-level collective structures regulate the use of the commonly owned coastal resources, making management decisions including on the introduction of new technology. An intriguing example is the collective decision to not introduce SCUBA diving technology, which seems impossible to make sense of from the viewpoint of economic efficacy alone. Cultural identity and a non-utilitarian view of their ecosystem were considered in the collective deliberations, and took precedence over short-term gains in time or financial efficacy. Yet in the long run, the indications are that such decisions led to better outcomes socially, environmentally, and even economically, as it appears the Hegura *ama* community has a lower debt ration than most other fishers communities – although further research is needed to quantify this. It should be clarified that the community is far from systematically rejecting modernity, as illustrated in the cooperation with scientists to address new challenges such as climate change impacts. On the contrary, this community's particular path to conciliate tradition and modernity is a valuable example that compels more research on its effective use of cultural identity and traditional knowledge for sustainability in a modern context.

OVERVIEW AND HISTORICAL CONTEXT OF HEGURA ISLAND

Over 6,850 islands make up the Japanese Archipelago, stretching approximately 3,000 km through northern temperate to subtropical zones along the Eurasian continent. Of these islands, 6,847 are designated as remote islands whose governance laws differ from those of the main islands of Honshu, Hokkaido, Shikoku, Kyushu and Okinawa. Only 258 of these remote islands are currently inhabited (MLIT 2010).

Hegura Island is just one of the 258 inhabited remote islands. With a land area of 1.04 km^2 and a circumference of 5 km, it is located 50 km offshore from mainland Honshu on the Noto Peninsula, Ishikawa Prefecture, and is the northernmost habitat for the hermatypic stony coral colony, made up of R*hizapsammia minuta mutuensis*, *Culicia japonica tenuisepes*, O*ulastrea crsipata* and other reef-building coral (Hokkoku Shimbun 2010). The island is located at the intersection of the Tsushima Warm Current—a substream of the Kuroshio Warm Current from the Pacific—and Oyashio Current—a cold ocean current from the northern Pacific Ocean—contributing to the climatic and marine biodiversity of the area (Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands 2011). Plants from both southern and northern regions coexist on this island, creating a unique vegetation landscape not observed on the mainland just 50 km away (Kanazawa University and Hokkoku Shimbun Natural Environment Research Team 1961; Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands 2011). An estimated 300 migratory birds, including rare birds such as the meadow bunting and black headed bunting, pass through Hegura Island annually (Shikida 1996).

Another migrant to the island are the *ama-san*, women free divers. Referred to as sea gypsies, both in classical literature dating back over 1,300 years and in historical accounts of nomadic marine lifestyles referred to as *ama-aruki* (literally meaning "women divers' walking", it refers to the nomadic movement of *ama* divers from island to island as they harvested abalone and laver), ethno-historical theories suggest that over 1,500 years ago the *ama* divers travelled with the currents from the Korean peninsula across to southern Japan. From there, they split into two distinct nomadic communities. One group travelled across to the Pacific Ocean coastline; the other, carried by the Tsushima Warm Current, moved northwards along the Japan Sea coastline, one break-off group eventually reaching Noto Peninsula and Hegura Island (Tanabe 2007; Hokkoku Shimbun 1986). According to historical annals of the feudal Tokugawa Era (1603-1868), the *ama* divers' seasonal migration to Hegura from summer through the early autumn months to harvest abalone and *ama* village settlement on the mainland were granted official recognition in 1649 by the Kaga domain, thus legally recognizing their exclusive rights to harvest marine resources on the coastal waters of the mainland peninsula and Hegura Island (Hokkoku Shimbun 1986). Both the seasonal migration and exclusive rights are maintained today.

During the Tokugawa Era (1603-1868), Japan implemented a policy of seclusion, and for almost three centuries natural resources were basically limited to those available domestically. The Tokugawa regime enacted resource use laws and initiated scientific studies on soil, silviculture, crop rotation, water and other natural resources as part of integrative policies aimed at sustainable resource use and management of limited domestic resources (Totman 1989; McDonald 2005; Richards 2003). Detailed recordings of resource use and management were compiled during this era of self-imposed seclusion. Among these is a book from 1841 that includes maps of *ama* diving activities and marine resource management throughout the Japanese archipelago, as the abalone they harvested was highly valued (Ohkita 1989; Tanabe 2007). Despite the end of feudalism and the abolition of the socio-political and legal systems that ruled resource access and management, the *ama* divers of Hegura Island continued as their sea gypsy ancestors, carrying on the traditions of hereditary collectivism.

CARRYING ON THE TRADITIONS OF HER ANCESTORS: HEREDITARY COLLECTIVISM AND COMMUNITY-BASED RESOURCE MANAGEMENT

Hereditary fishing rights are integral to resource management and the social structure of all fishing communities in Japan (see chapter 1, section III: "*Satoumi* and institutional characteristics of Japanese coastal fishery management"). What is unique amongst the Hegura Island *ama* divers and other female *ama* diver communities in Japan is the matriarchal foundations of those rights.

Where patriarchy governs, the fishing rights will dictate not only the fishing grounds and fishing seasons, but also species and/or fishing methods for each patriarchal household. Social stratification often emerges from these fishing rights, as certain commercial species and/or fishing methods will generate more income than others, thus resulting in income disparities and unspoken—though visible—social strata in any given community. Target species, harvesting grounds and seasons are collectively shared, thus income disparities amongst *ama* divers are driven by individual diving skills (McDonald 2008). Another differentiation is that in patriarchal fishing communities women are often invisible non-wage laborers unaccounted for in official labor statistics, whereas in female *ama* diver communities, women are often the primary wage earners (McDonald 1995-2008; McDonald 2006).

Empowerment of women in food production activities is viewed by many as critical to mainstreaming biodiversity and achieving equitable resource access. The Gender Action Plan under the Convention on Biological Diversity emphasizes the importance of gender equality amongst men and women, stating that it "has the cumulative effect of improved biodiversity management and protection and poverty alleviation for communities". Current research on female *ama* diver resource management approaches and their potential in mainstreaming biodiversity is limited in Japan (Kanazawa University and Hokkoku Shimbun Natural Environment Research Team 1961; Maraini 1989; Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands 2011), but further research and examination could potentially assist in shedding light on gender differences and similarities in resource management perspectives, which in turn could potentially contribute to more integrative and holistic gender-neutral biodiversity management practices in coastal communities.

Maintaining hereditary *ama* diving rights is dependent on financial payments. Annual charges of 8,000 Japanese yen are applied to all households who wish to maintain their claim to their hereditary rights. Regardless of whether or not a member actively dives in a given year, all must pay this fee to their collectively run *ama* community associations. Failure to pay their annual fee may result in the loss of rights to that household. There are currently 364 households registered, making this the second-largest female *ama* diver population in Japan next to the Mie Prefecture, famous for pearl diving in the Ago Bay area (see chapter 7, section II). Of those registered in 2010, there are 179 active individuals, ranging in age from 20 to 93. As with all fishing communities in Japan where annual fishing licenses ensure active use of a household's fishing rights for that given year, Hegura Island *ama* divers must pay annual fishing (harvesting) license fees to the *ama* community association in order to legally enter

Box 3: Agehama-style salt making traditions in Noto Peninsula, Ishikawa Prefecture

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For centuries, salt production from seawater has been an important marine resource used in the Noto Peninsula, a strip of land that juts out into the sea from the West Coast of Japan's main island, Honshu. Traditional salt making in Noto is reflective of how resource use traditions are shaped by the combined effects of local ecological and socio-cultural conditions. It is also representative of productive human activities that rely on ecosystem services of both *satoumi* and *satoyama* landscapes, having developed aspects of integrated resource management that links coastal and inland human activities. The salt production technique practised in Noto for more than five centuries is known as the "*agehama* style". It relies on human power to draw and transport water from the ocean and then spread it uniformly on banked sand terraces, where it evaporates, leaving a highly saline brine that is then boiled to salt crystals using wood from the nearby *satoyama* forest as fuel.

The socio-cultural context played a decisive role in the development of the salt manufacturing industry in Noto, where the rice-based tax system was prevalent during the Edo Period (1603-1868) and was difficult to implement due to the scarcity of cultivable land. Instead, local ruling authorities used salt as a substitute for tax payments, converting salt production into an important subsistence basis. When the salt tax system was abolished at the end of the feudal era and new policies were introduced, traditional salt manufacturing declined.

In recent years, renewed interest in the traditional knowledge associated with *agehama*-style salt production is one of the reasons for the revalorization of old practices. In particular, elements of integrated management of sea and land resources are attracting attention for their potential contribution to the conservation and sustainable use of biodiversity. In the past, salt makers owned forest areas that they managed for a sustainable supply of fuel wood. The highly valued character of wood is illustrated by the two-stage manufacturing method and the kiln house structure, which have been devised to minimize fuel use. Through their forest management activities, salt makers maintained a sunlit woodland environment that provided habitats for a rich biodiversity. They also planted and looked after various tree species with different burning properties. Such linkages between terrestrial and marine resource management are currently being explored for the value they might add to salt making and other traditional industries, as a step towards the design of integrated policies for sustainable rural development in Ishikawa.

For more information on *agehama*-style salt making, please refer to the related UNU Media Centre video brief *Salt of life—Traditional Knowledge and Wisdom of Satoumi* (http://ourworld.unu.edu/en/preserving-japans-sea-salt-making-tradition/) and the accompanying booklet *Traditional Knowledge and Wisdom of Satoyama/Satoumi*, produced as part of a joint research project between the Ishikawa Prefectural Government, Kanazawa University and United Nations University Institute of Advanced Studies Operating Unit Ishikawa/Kanazawa.

the community designated harvesting waters. For the 140 *ama* divers under 70 years of age, the fee is 20,000 Japanese yen. For the 39 *ama* divers over 70 years of age, the fee is 10,000 Japanese yen (McDonald 2008-2010; JSSA – Hokushinestu Cluster 2010).

Annual harvesting license fees are discussed and decided by the collective *ama* community, not by government regulatory bodies, as is common practice in Japan (see chapter 2, section I). In 2009, discussions were held regarding the growing concern over decreasing stocks. The collective whole agreed to raise the annual harvesting licensing fee by 5,000 yen per person in order to increase collective monies used for resource management. Approximately 2 million Japanese yen from the combined fees are currently used for resource regeneration activities, specifically, the purchase and release of abalone and turban shell seedlings (McDonald 2010).

Fees are but one item decided by the collective whole. Another custom, which is passed down from ancestors as an *ama* diver tradition and obligation, dictates that all decisions about harvesting activities are discussed—sometimes heatedly debated—but ultimately decided by the collective whole (McDonald 2008). Harvesting seasons, harvesting grounds, allowable size of harvested species, and community-implemented no-take zones are decided collectively and regulated by the *ama* community association. Daily harvest time regulations for each species are also discussed and decided. In 2007, growing concern about decreasing stocks of abalone and turban shell, despite the implementation of no-take zones and regeneration efforts, led to discussions about regulating harvesting activities by imposing limits on harvesting times. After a series of discussions, all agreed to decrease harvesting times by half, from eight to four hours (JSSA – Hokushinestu Cluster 2010).

Though interviews were conducted with less than 25 per cent of the *ama* divers in Hegura, when asked why they were willing to decrease their harvesting times and adhere to other harvesting and resource management regulations, an obligation to her ancestors to pass on viable traditions to future generations and an understanding that sustainability of marine resources is interlinked with their own viability and very existence were noted as primary reasons for adhering to the collectively reached decisions (McDonald 2008-2010). Reviewing the responses of *ama* divers interviewed, one cannot help but ponder the weight of consciousness of traditional obligation over scientific reasoning as a motivating factor in guiding resource management decisions amongst the female *ama* divers of Hegura.

CULTURAL IDENTITY AS A LEVER IN SUSTAINABILITY

Attitudes, beliefs and values towards nature influence how a given society interacts with and uses nature. How humans use nature results in both environmental and human consequences, often causing irreversible changes in the relationship humans have with nature. The adoption and application of technological innovation is one example of human use of nature, the potential socio-economic benefits of which are often perceived as outweighing the consequences (Hughes 2001; McNeill 2000; Merchant 2002).

Debates on the trade-offs of technological adoption have been a part of female *ama* diver communities since the late 1800s, when goggles were first introduced. Final decisions resulting from debate on whether or not to adopt this practice were made by the collective whole (Nakada 1987; Tanabe 2007). Written records detail the debates in southern Japan, where increased visibility underwater was perceived as a potential danger to overharvesting. Thus, goggles were initially prohibited, then limited to one set of goggles per boat to be shared among five to seven divers. By the early 1920s, all *ama* diver communities, including Hegura, had adopted goggles (Tanabe 2007).

The next technological innovation to be introduced was wetsuits. As with the goggles, debate ensued. Until wetsuits were introduced in the mid-1960s, *ama* divers harvested without any body protection and would have to frequently surface to warm themselves around the stoves on the boats being manned by their husbands and fathers. Because a wetsuit allowed a person to dive longer, thus enabling them to harvest more per daily dive, wetsuits on Hegura were initially prohibited, then allowed on the condition that a full suit was not worn and two women shared a suit so that they would only be half covered. By the mid-1970s, all wore full suits. Flippers followed wetsuits in the technology adoption debates. Diving depths could be altered by 10 to 15 metres, resulting in an increase in total harvest area and yields. As with the goggles and wetsuits, concern over the potential risks the technology could have on availability of resources resulted in conditional adoption. By the late 1970s, all were equipped with goggles, full wetsuit and flippers, with unlimited use by all (JSSA – Hokushinestu Cluster 2010; McDonald 2008-2010).

Cautious adoption of new technologies gradually led to full adoption amongst the female *ama* divers of Hegura. One wonders if the end result of full adoption negates the community deliberations on potential trade-offs of adoption and caution about risks to overharvesting. Caution about the impacts of technology on natural resources did not develop to discussions on how to regulate people's use of the technology (McDonald 2008). And yet, caution overruled in the next debate. This time the collective whole said no to the adoption of oxygen tanks. Perhaps this grew out of an unconscious recognition of their inability to control the technology they adopt. Or perhaps, as some of the elders interviewed commented, oxygen tanks would end their existence as free divers. Natural lung capacity and instinct are what defines their very identity and existence, many commented. Adopting an oxygen tank would end over 1,000 years of the heritage that defines them (McDonald 2008-2010).

Trade-off discussions exploring short- and long-term socio-economic benefits are an undercurrent of the cautious technological adoption debates among *ama* divers. Though further research is required, one may argue that the *ama* divers' collective choice and control of technological adoption is one reason for their fishing practices remaining more labour-intensive and less capital-intensive compared to many other fisheries in this region in Japan (McDonald 1995-2008, 2008-2010). Although quantifiable data is required, this seems to have led to smaller debt ratios than in other fishing communities, where, in Japan as in the rest of the world, fishers' debt is often high and may contribute to pressure towards unsustainable fishing practices.

Cultural identity as a driving factor in resource management is not unique to the female *ama* divers and has been recorded in the writing of many ethnobiologists (Roué 2006). Cultural identity of the female *ama* divers as a leverage to sustainable resource management requires further exploration. The social and environmental outcomes of their collective deliberations on the trade-offs of technological innovation are instructive. A key question is how this experience could be used on a larger scale to mainstream a form of community-based management that encourages, if not enforces, trade-off discussions prior to the adoption of new technologies, which in turn could potentially have an impact on resource use and biodiversity conservation.

LIMITS OF HER ANCESTORS' TEACHINGS: DIRECTING QUESTIONS TO SCIENTISTS

The ama community of Hegura also provides us with an illustration of how traditional knowledge can be combined with modern science. Information about individual harvesting grounds within the collectively designated grounds are family secrets transmitted from mother to daughter; it is currently locked up in a safe at the *ama* association on handwritten maps. These describe marine life and identifying characteristics of the marine habitat in the harvesting ground; information on the location of marine life, currents, water temperatures and depths are among the knowledge passed down through the generations (McDonald 2008-2010).

Yet this knowledge is no longer sufficient, nor always reliable. The ocean their ancestors knew is no longer the ocean they need to know in order to continue as *ama* divers. It is a changing one, and to be able to adequately respond and adapt to these changes, the teachings of the ancestors have limitations (Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands 2011; McDonald 2008-2010). Climate change and its potential impacts on marine biodiversity in their harvesting grounds is a question the *ama* divers have begun discussing, first among themselves, then recently with researchers as they search for information on a changing environment.

To answer some of these questions about changing environments on both land and in the sea, the Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands spent from 2008 to 2010 carrying out field studies. Results showed surface air temperatures and marine temperatures have increased. The average temperature for the month of April between 1967 and 1984, the *wakame* (*Undaria pinnatifida*) and *mekabu* harvesting season on the island for the *ama* divers, was 10.5°C. In 2009, it was 12.7°C (Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands 2011). Similar trends have been recorded for the sea. Between 1909 and 2009, recorded ocean temperatures around Hegura Islands rose by 1.2°C; the global average for the same time period was 0.5°C (Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands 2011).

With warming, scientists have observed what they believe are signs of migration of southern species northwards (Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands 2011). On land, meadow buntings native to the southern islands of Kagoshima and Okinawa have migrated north to Hegura Island, and southern insects and their habitats, including C*ercion sexlineatum* and P*reneopogon catenalis*, have been observed (Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands 2011). Marine life migrations have also been observed, and of 25 shellfish species investigated, seven were found that normally inhabit waters further south (Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands 2011). Though yet premature to draw definitive links between warming and changes in marine biota around Hegura Island, scientists' findings have validated some of the *ama* divers' observations of a changing environment. Though interactive dialogue between *ama* diver community leaders and scientists has been a positive step forward, there remain some challenges in integrating local ecological knowledge and scientific knowledge for effective resource management.

Warming temperatures, degradation of seagrass beds, declines not only in the target species abalone and turban shell but other marine life, and the increased frequency in appearance in their waters of marine life typical of waters further south have been observed by *ama* divers, particularly among those over 50 years old (Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands 2011; McDonald 2008-2010). As observations of change increase, so does concern about community resilience and their ability to adapt to change. Efforts to regenerate marine resources have thus far been negligible (McDonald 2008-2010). Ocean desertification is seen by *ama* divers as a possible reason for the lack of success in their regeneration efforts, which include releasing seeds, enforcing no-take zones and reduced diving times (Group for Research of Natural Environment in Hegurajima and Nanatsujima Islands 2011). Some of the elder *am*a divers interviewed commented, "Has the marine environment changed so much that it no longer can sustain marine life?" (McDonald 2008-2010).

CONCLUSION

Though further analysis is required, it can be argued in the case of Hegura Island that community-based resource management, with its roots in hereditary fishing rights, contributes to mainstreaming biodiversity conservation. It is clear that the collective community has a keen sense of the importance of resource management in order to ensure sustainability and biodiversity conservation. Collective will and an understanding that resource management is something that must first come from within the community, combined with empowerment, self-initiative and a strong consciousness of community responsibility ensure the ongoing viability of one's community, based on sustainable resource management. The *ama* divers of Hegura, though by no means presenting a perfect picture, do embody the strengths of community-based resource management, driven by a strong sense of cultural identity and inclusive egalitarian decision-making, where trade-offs are debated and final decisions are made by the collective whole.

The science of resource use and biodiversity conservation is given much attention by policymakers and yet factors driving human behavior are often overlooked. Cultural identity as a driving factor in resource management is something to be learnt, or at least considered, from this case study. There are many aspects which compel further exploration regarding the interrelation of the *ama* divers' cultural identity and the sustainable management of the resources. One promising topic is their collective deliberation of benefits and trade-offs prior to the adaption of new technology, and how this may be used for decision-making in larger management frameworks.

A strong sense of cultural identity, hereditary-based resource access and use rights as the foundations of community-based management can potentially run the risk of a community distancing themselves from and being distanced by the mainstream community in any given country. This can ultimately lead to the weakening of that community when the answers to sustainable resource use management cannot be found from within. Community viability requires communities to be able to reach beyond the borders of their communities to work with non-community members to find working solutions to community challenges. That the *ama* divers of Hegura Island have welcomed scientists into their community is a sign of their potential strength in eventually finding answers to the questions of how to adapt to a changing environment and how to develop resource management practices that their ancestors' teachings do not provide them with, including the tools to answer these modern-day challenges. The *ama* divers teach us that community resilience that potentially leads to successful biodiversity conservation, and the continuing viability of the community itself and the resources it depends on to survive is built on the strong foundations passed down from one's ancestors, but strengthened by a community's ability to reach beyond its traditions.

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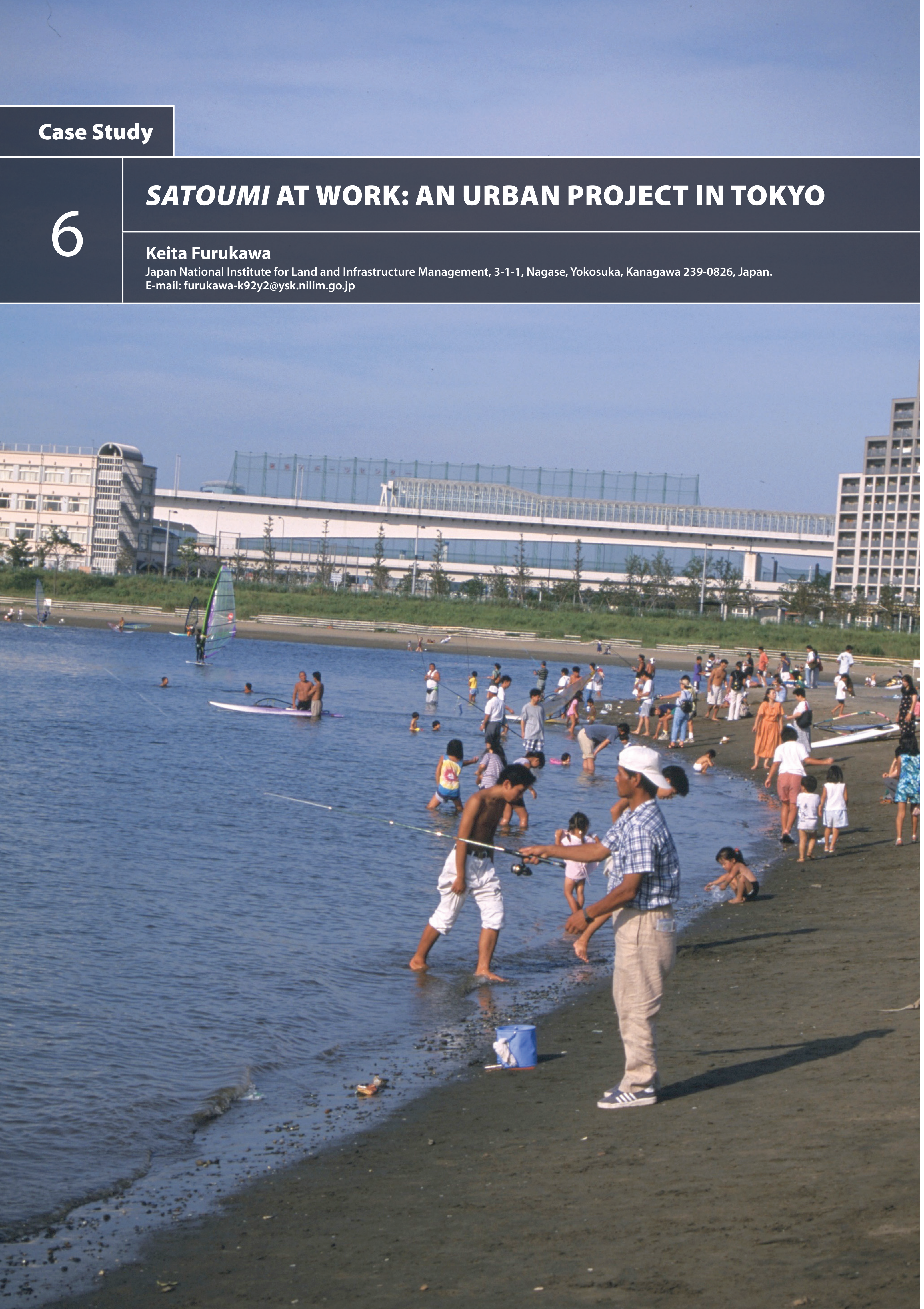

Case Study

6

SATOUMI AT WORK: AN URBAN PROJECT IN TOKYO

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ABSTRACT

The shores of industrialised nations are often laden with human-made structures that replaced large segments of natural habitats, and the seascapes of emerging economies are rapidly coming to resemble them. Urbanised sections have far-reaching influence on ecosystems through their fragmentation of the remaining littoral. Managing coastal biodiversity will thus entail work within human-built environments, and its applicability in urban settings is perhaps just as relevant a test of *satoumi*'s value for biodiversity conservation as is its use in more pristine areas.

This case study reports on the practical application of *satoumi* concepts in the management of the Tokyo Bay Renaissance Action Plan. The *satoumi* approach proved appealing to a metropolitan coastal community, providing it with new and useful possibilities for engagement in conservation. In the Tokyo Bay area, constructing artificial habitats can be considered an urban expression of *satoumi*'s premise that certain human actions can enhance coastal ecosystem biodiversity. Observations showed that human-made tide pools rapidly became host to target species and increased biodiversity in adjacent areas as well. Basic lessons for urban biodiversity management include: (1) the need to look for benefits other than biodiversity. In this case, authorisation to build the tide pools was obtained largely because of their value in stabilising seawalls to minimize damage from earthquakes and/or high tide; (2) the need to carefully adjust tide pool parameters to the requirements of target species; and (3) artificial habitat monitoring and management constitute an opportunity for conservation action that is welcomed by the riparian community.

This case study demonstrates the value of *satoumi* in urban settings for biodiversity management at the community level. An important upcoming task now is to effectively apply lessons learned from successful efforts at the community level to implementation within larger management frameworks and at the level of national policy.

THE TOKYO BAY ENVIRONMENT

The environs of Tokyo Bay are an enclosed, heavily populated and densely used bay area in Japan. The outer bay is open to the Pacific Ocean, and the inner bay is approximately 50 kilometres NE to SW, 20 kilometres wide and with an average depth of 15 metres (Figure 1). A total of 25 million people reside in the inner bay catchment area of $7500km^2$. Beginning around 1950, the concentration of population and industry in this river basin has brought radical changes to Tokyo Bay's coastal areas.

The changes include significantly altered coastline and sediment fraction of the bay seafloor. In the 1950s, the bay was enclosed by an oval-shaped, smooth coastline with a fringe tidal flat about two to six kilometres wide, and the seafloor of the shoreward area was covered with sand. Today, the coastline is jagged with the straight lines and sharp angles of a multitude of docks, and the seafloor of the region is covered by fine particle mud and silt with high organic matter content due to anthropogenic pressures on the ecosystem, including nutrient input that exceeds the capacity to absorb it.

The reclamation of mudflats and tidal flats in particular resulted in marked declines in tidal current speeds, which in turn contributed to fine particle accretion, and nutrient concentration caused eutrophication and an accumulation of rich organic sediment on the bottom.

Water circulation characteristics in the Bay were profoundly modified by the reduction of its surface area by some 80 per cent between 1960 and 2000 due

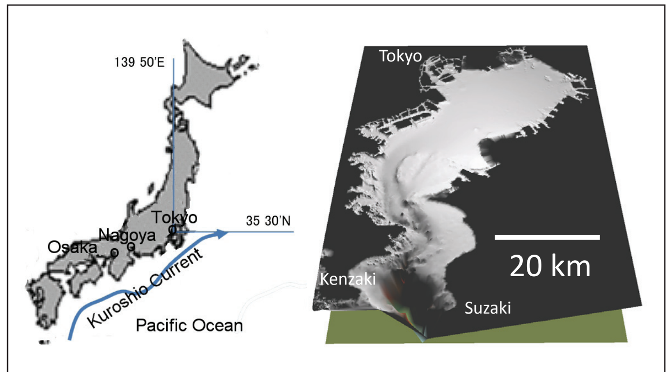

FIGURE 1. Location of Tokyo Bay and its topography.

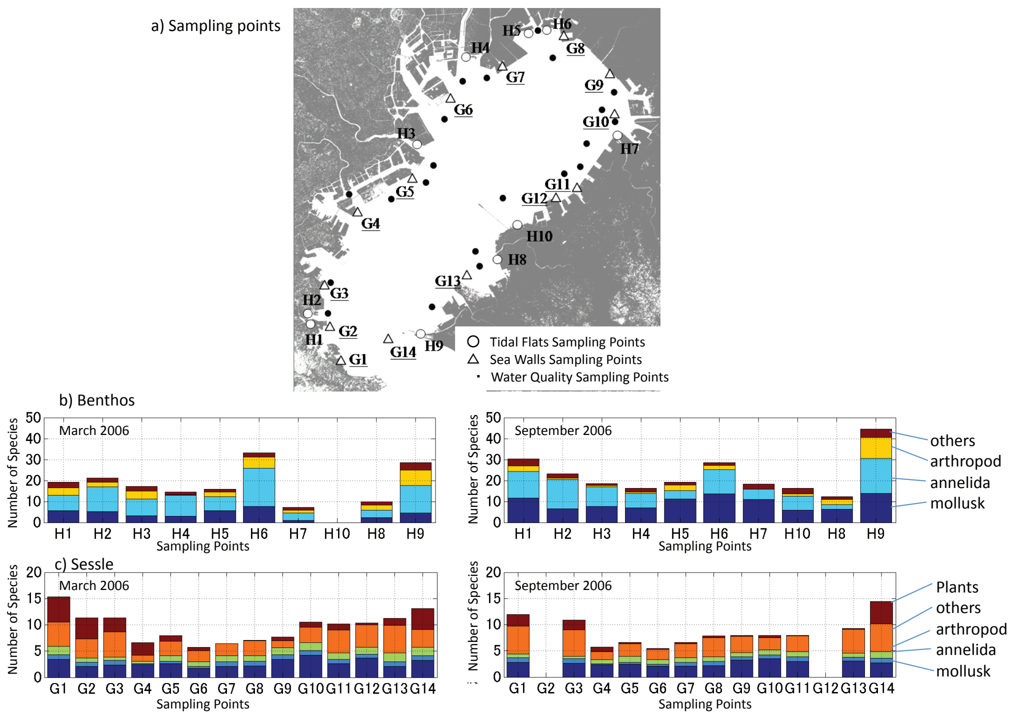

FIGURE 2. Benthos and sessile distribution in Tokyo Bay.

to landfill and reclamation. There has been an 11 per cent decrease in the tidal range in the inner part of the bay and a 20 per cent decrease in the tidal current in the section where the bay narrows (Unoki and Konishi 1999; Yanagi and Onishi 1999). In addition to the reduction of barotropic circulation, baroclinic[7] circulation has been enhanced due to the rising demand for fresh water in urban areas resulting in an increase in fresh water discharge into the bay (from about $350m^3$ in the 1920s to $450m^3$ in the 1990s). This thicker top layer of fresh water usually increased stratification and hence enhanced baroclinic circulation, reducing average residence time of water from 30 days to 20 days in summer, and from 90 days to 40 days in winter (Takao et al. 2004).

These changes appear to have affected the distribution of plants and animals. Igarashi and Furukawa (2007) have drawn a distribution map of benthos and sessile on tidal flats and seawalls (Figure 2). The data show that (1) even in the inner, highly eutrophic part of the bay, tidal flats maintained rich benthos diversity, and (2) sessile diversity was strongly influenced by the spatial distribution of water properties, including transparency or salinity. Severe anoxic water expansion during summer to autumn also affected faunal distribution in the inner part of the bay.

The ecological network[8] was severely disrupted by the anthropogenic impact on both habitats and transport, and urbanisation has in all likelihood fragmented key connections of the network. Hinata and Furukawa (2006) studied certain characteristics of the ecological network in the Bay, including that of the short-necked clam larvae. Changes in the hydrodynamic circulation have weakened the flow field over the north-western

7 Barotropic circulation is the part of the water motion where horizontal velocities do not depend on depth, while baroclinic circulation is depth-dependent part.

8 Ecological networks, or environmental connectivity, are important aspects of marine ecosystems, in part due to the number of and long distance travelled by larvae. Since some living creatures have unique patterns of life stages, larvae juveniles and adults are transported to and make their habitats in different places at different stages. These patterns together make up what is known as an environment network. The existence of a healthy network is one of the most important criteria in assessing the bay environment. The network is established with nodes and passes. Nodes are the habitats, and passes are corridors in the bay formed mainly by the effects of water circulation. For more information on environment networks, see for example, Planes et al. (2009).

part of the bay, which should be an area of high priority in restoration plans.

ACTION PLAN FOR TOKYO BAY RENAISSANCE

On 26 March 2003, the Tokyo Bay Renaissance Promotion Council, composed of six central government agencies[9] and eight regional government bodies[10] endorsed an "Action Plan for Tokyo Bay Renaissance". Rather than examining the overall management framework, we will focus below on two ways in which *satoumi* objectively enhanced the effectiveness of biodiversity management within the Action Plan: artificial habitat construction and community involvement.

The Action Plan for Tokyo Bay Renaissance was initiated by decision of the Urban Renaissance Project of the Japanese Cabinet in December 2001. Prefectures and cities surrounding the bay and relevant central government ministries formed a council to promote the restoration of Tokyo Bay in 2003 (Figure 3). Its goal is to restore the beautiful coastal environment for people to enjoy and sustain its natural biodiversity. It is to be achieved through collaboration among the agencies involved within ten years (by 2012), and is subject to an annual review of related activities; Two internal appraisals were conducted in 2006 and 2009, and management adopted their findings.

Several places to be monitored and assessed for restoration and management (called "appeal points", Figure 4) have been designated in an area of priority implementation. Each point has specific targets for restoration, allowing the use of objective and quantifiable indicators of progress toward the restoration objectives. The hope is that achieving these appeal point targets will contribute to enhanced ecosystem health in areas surrounding them as well. In addition, by providing node habitats, successful activity around the appeal points could strengthen environmental connectivity throughout the bay and hence promote overall bay ecosystem health. Finally, activities at the appeal points helped develop a model for urban type *satoumi* implementation, as described in more detail herein.

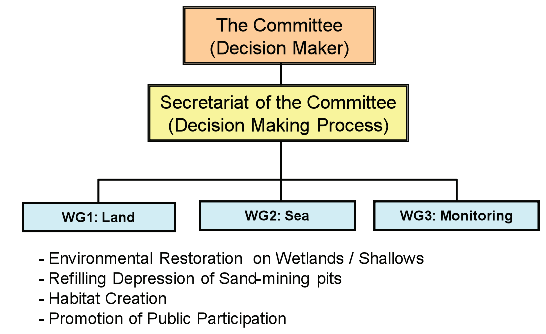

FIGURE 3. Structure of the Tokyo Bay Renaissance Promotion Council.

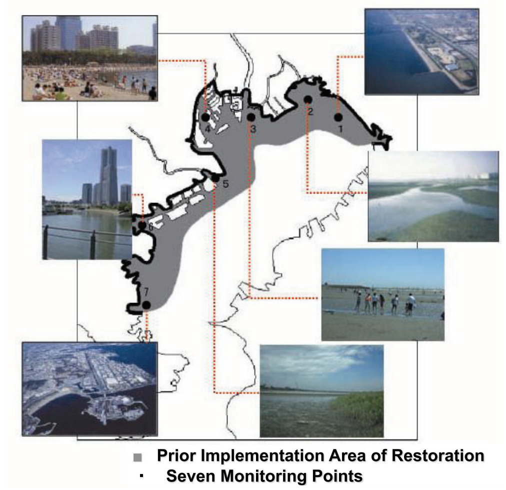

FIGURE 4. Zoning and monitoring points of action plans for Tokyo Bay renaissance.

Source: Tokyo Bay Renaissance Promotion Conference: Action Plan for Tokyo Bay Renaissance, 2004. http://www1.kaiho.mlit.go.jp/KANKYO/TB_Renaissance/index.html

HABITAT CREATION PRACTICES IN SHIBAURA ISLAND, TOKYO

Habitat creation, a cornerstone of biodiversity management in the Tokyo Bay Renaissance Action Plan, is one of the two major contributions of *satoumi* to this particular framework for managing biodiversity. A habitat creation project with public participation has been implemented in an urban canal on Shibaura Island, Tokyo, since December 2005 and provided

9 Ministry of Land, Infrastructure, Transport and Tourism; Japan Coast Guard; Ministry of Agriculture, Forestry and Fisheries; Forestry Agency; Fisheries Agency; Ministry of the Environment; and Cabinet Secretariat.

10 Tokyo metropolitan city, Chiba prefecture, Kanagawa prefecture, Saitama prefecture, Yokohama city, Kawasaki city, Chiba city and Saitama city.

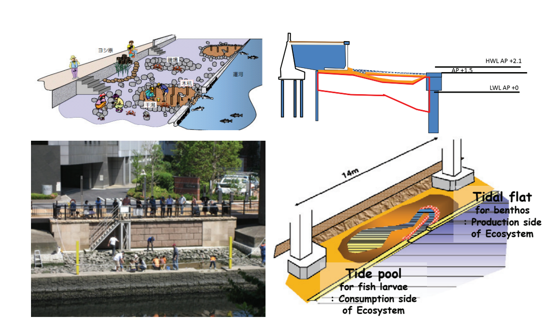

FIGURE 5. Schematic image and cross section of Shibaura Island.

valuable lessons for urban *satoumi*. Since 2004, private developers have transformed this former warehouse zone into to a neighbourhood of high-rise residential facilities housing approximately 10,000 people.

On one side of Shibaura island is Shibaura canal, which receives major inflows of sewage water discharge and empties into Tokyo Bay through two sluices. It is a typical urban brackish water area with a complex flow pattern. Two 4m x 8m pools have been constructed on the rocky flat terrace of the sea wall (Figure 5). The height of the terrace was designed to be lower than the high water level but higher than the mean water level. The depth of the pools is around 0.5 metres, and they are 80 per cent filled with sand. Each pool has a small inlet section (-0.1m deep, 1.5m wide) through the seawall to enhance water circulation during inundation and drainage.

Hydraulic and water quality parameters in tide pools and surrounding canals were carefully monitored (Satoh et al. 2007). A float experiment was carried out with the participation of local volunteers (Satoh et al. 2006), and showed an estuarine water circulation driven by density due to stratification. This confirmed that the canal network can act as tidal courses do, although only in a limited area.

Dissolved oxygen (DO) has been monitored in the pools and surrounding canal water. DO is a vital parameter for animal life as respiration necessitates sufficient oxygen, and a useful indicator of overall health of an aquatic environment in areas where human influence is strong. DO in the pools is more variable than in the canal because of daytime DO production driven by benthic algae photosynthesis. The combination of diurnal solar radiation and semidiurnal tides in summer causes high levels of anoxic water (waters with very low values of DO, in other words with no significant oxygen available) even in a tide pool. The critical depth of the pool can be 0.3-0.5m. In deeper pools, the daytime production of DO by photosynthesis from plants does not compensate for DO consumption during the night by animal respiration and plant metabolism. This is because photosynthetic production of oxygen increases slower with larger depths than respiration. This critical depth is a function of canal DO, relative height of the terrace, sediment properties and depth of the pool (Umeyama et al. 2010). As well, due to its small thermal capacity, water temperature in the pool is higher than the surface waters of the canal in spring and summer, and lower in autumn and winter. To turn a tide pool in a canal area into a healthy, well oxygenated urban wetland, pool depth and dimension, a fresh water supply and other hydraulic parameters must be adjusted rather precisely.

In pools where these parameters have been carefully set and controlled, only half a year after construction, juvenile gobies, mullets and sand worms populated the pools (Table 1). The mean size of the gobies in pools and surrounding water indicate the interesting role of pools (Figure 6). It seems that the size of gobies increases during June-August and decreases from August to February. Gobies (*Acanthogobius flavimanus*) hatch from eggs from January to March in the bay. Juveniles (approx. 5-15cm) remain in shallow estuaries from April to October, and adults (approx. 20cm) come down to the river mouth and bay from November to January, after which they spawn in the deeper mud bed of the bay. As their size increases, adult gobies move from the pool into the surrounding water, where their presence is confirmed by field observation. It seems that bigger gobies tend to prefer deeper pools, presumably in relation to their cooler summer temperature and richer DO.

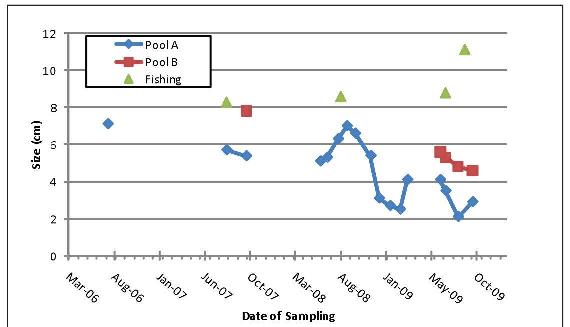

FIGURE 6. Mean size of sampled gobies in pools A, B and surrounding water by fisheries census.

TABLE 1. Abundance of fish in the pools (total number of abundance in pool A and B).

Date	Eel	Goby	Mullet	Prawn
July 06	3	504	580	28
Sep. 06	2	119	201	4
June 07*	1	310	50	0
Aug. 07	0	1168	213	37
Oct. 07	1	222	26	235

* Only Pool A was sampled.

For managers looking for realistic options to manage biodiversity (or reduce its rate of decline) in urban and peri-urban coastal areas, it is perhaps worth mentioning that the winning argument to convince local authorities to allow construction of these tide pools was not biodiversity but safety. In case of earthquake, the artificial terrace on the seaside of the seawalls provides extra stability against sliding failure. Such multi-benefit approaches are likely to become essential for biodiversity management in urban areas where safety and economics often get higher priority than less tangible biodiversity concerns.

Satoumi can be seen as underpinning these biodiversity management practices based on habitat creation. Artificial marine habitat creation in urban areas and/or human-made coastal structures is currently an active field, and such initiatives are hardly unique to Japan or *satoumi* (e.g. Chapman and Blockley 2009; Martins et al. 2010). In *satoumi*, such approaches to conservation devolve naturally from the basic premise that human interaction with ecosystems can be positive. In this case, human interaction involves artificial habitat creation, and such active work on the environment may well become a valuable tool at the disposal of managers interested in preserving or restoring biodiversity in significantly human-transformed coasts.

HUMAN INVOLVEMENT AND IMPACT ON SHIBAURA ISLAND'S HABITAT

The second contribution of *satoumi* to the effectiveness of biodiversity management in the Tokyo Bay Renaissance Action Plan is its value in involving local communities. With the support of scientists and local governments, citizens were actively engaged in partnership-type collaboration. Local communities, participants were taught specially-designed observation methods and objectives, and their contribution of routine monitoring was essential in demonstrating the high habitat hosting potential of the tide pools for fish (gobies) and benthos (sand worms and crabs).

One of the public participation monitoring tasks is a habitat creation project (Hayakawa et al. 2008). This project is led by researchers with the objective of teaching people about and raising awareness of the workings of nature in neighbouring environments. It involves classroom orientation, workshop activities, and field observation (Figure 7). These activities have greatly enhanced the participants' interest in continual involvement in the project. Citizen volunteers also participate in fisheries census of gobies, which have been carried out once or twice a year since 2008 involve about 200 people. Participants in the census measure the size and species of their catch over two hours of fishing, thus providing and indicators of abundance, age and health of gobies and other valuable data for the study of the ecosystem network.

Starting in 2009, the community's interaction with their environment went beyond monitoring and into experimenting with habitat-building. To create a site more attractive to juvenile gobies, sand was added in one of the artificial tidal pools, elevating its bottom and decreasing the pool depth. Ongoing monitoring is carried out by a partnership of citizens, scientists and local governments. The group is trying to use this biodiversity-focused endeavour to create an attractive, leisure-oriented piece of shoreline (Sakurai et al. 2007).

FIGURE 7. Habitat creation project photographs, including classroom orientation, workshop activities, and field observation.

Box 4: Partnership for environmental education and ecosystem restoration: The case of eelgrass bed reestablishment

Eri Ota, Research Fellow of Ocean Policy Research Foundation and Member of Amamo Revival Collaboration in Kanazawa-Hakkei, Tokyo Bay Area

The rehabilitation of eelgrass beds brings about valuable opportunities to accomplish both environmental education and ecosystem restoration through innovative partnerships. Eelgrass (*Zostera marina, Amamo* in Japanese) is the most widespread species of seagrass in Japan. As discussed in several of the case studies (see in particular the Okayama case study), *amamo* beds fill essential functions in coastal ecosystems. Due to changes in the Japanese coastal environment since the early 1970s, associated with rapid industrialization and coastal area development, eelgrass bed areal coverage has decreased drastically. However, recent efforts to restore them through the partnership of various stakeholders have been met with success at a number of sites. The 2008 Amamo Summit brought together people involved in such activities from more than 15 sites. In the case of Kanagawa, the rehabilitation of eelgrass beds in Tokyo bay has been conducted with the collaboration of non-profit organisations, elementary schools, the Marine Fisheries Research Center, and central and local governments. The reestablishment of eelgrass beds requires continuous efforts, such as seedling, picking whips and picking seeds, and involves significant manual labour for which volunteer participation is essential. These activities are conducted throughout the year and have been ongoing for almost a decade. Elementary schools use the reestablishment sites for environmental education, and teachers, students and their parents provide a valuable workforce. Thanks to their and other partners' efforts, eelgrass bed areal coverage in restoration sites has expanded remarkably. As a result, biodiversity and overall marine ecosystem health in surrounding areas has improved. Further, the participation of children is expected to yield long-term benefits in terms of both environmental and civic education for the community.

Satoumi was an essential part of the discourse that mobilised the local community, and provided habitat construction activities that brought out a surprisingly strong yearning among participants for a deeper connection with the nature surrounding them, nature all but annihilated in this heavily urbanised area. Reviving consumers' connection with coastal ecosystems and food-producing seascapes is increasingly recognized as essential to foster more sustainable behaviour and consumption patterns in the long run, and is a central aspect of the modern *satoumi* discourse.

CONCLUSIONS AND THE WAY FORWARD

This case study reported on the role of *satoumi* in the Tokyo Bay Renaissance Action Plan. The study focused on the two areas in the management framework where *satoumi* was most useful. The first, carefully controlled biodiversity restoration through the creation of artificial habitats, can be seen as the modern, urban expression of the basic *satoumi* hypothesis that humans can nurture nature in coastal ecosystems. The second is community involvement in biodiversity conservation, another pillar of modern *satoumi* practice. In this case study, the local urban community provided valuable ecosystem monitoring and took part in an artificial habitat creation project.

For staff involved in urban biodiversity restoration on the ground, one important consideration reported here is that constructing artificial tide pools that are effective for biodiversity restoration necessitates careful tuning of key parameters, such as tide pool depth, sediment thickness and dissolved oxygen, depending on the target species to be hosted. Observations demonstrate that if these parameters are set correctly, artificial tide pools will be rapidly populated by target species, even in an enclosed bay with severe environmental degradation and very little remaining natural habitat, such as Tokyo Bay. It is worth noting that the argument that convinced coastal authorities to accept the construction of the tide pools was the stabilising role of the terrace on the adjacent seawall, as a safety-enhancing structure in case of earthquake and high tide. As such, these types of artificial tide pools constitute a promising, cost-effective, multi-benefit approach for coastal managers interested in biodiversity preservation. Artificial coastal habitat creation is certainly not unique to *satoumi*, but it is an approach coherently fitting in a *satoumi*-oriented project, as *satoumi* is underpinned by the assumption that human action on the marine environment can, under certain circumstances, enhance ecosystem health and biodiversity.

Satoumi was also essential in formulating a management framework that ensures the effective engagement of local communities, providing them with options for positive interaction with their local marine environment. As an alternative to a discourse focused on restricting human interaction with nature, it provided possibilities for constructive action by this urban community, where the desire to reclaim their local natural environment was surprisingly strong.

Local community participation should remain a major element in scaling up activities and exploiting these field-tested *satoumi* practices. Further research, continued engagement of scientists with local communities and government, and knowledge sharing will be important in ensuring that community level good practices are effectively used in larger scale management and policy frameworks. Certainly one of the major challenges for *satoumi* implementation in the coming years will be to bring a still largely community-level practice into national policy. Experiences reported in this *satoumi* case study support the view that biodiversity conservation in urban and peri-urban environment will benefit from complementing restriction-based approaches with active measures involving further human modification on the ecosystem for conservation purposes.

ACKNOWLEDGEMENTS

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Case Study

7 TOWARDS *SATOUMI* IN AGO BAY

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ABSTRACT

Amid the stunning landscapes of Ago Bay, humans made abundant yet sustainable use of high local biodiversity for centuries. Until the onset of severe environmental degradation from overexploitation and land-use changes starting in the 1960s, this place represented the archetype of traditional *satoumi* in both its physical and cultural environment. *Satoumi* became a central feature of environmental restoration activities in the bay, and eventually the idea took firm hold in local communities, today actively engaged in conservation. Their contributions include essential routine environmental monitoring and other critical tasks. Carefully designed artificial tidal flats demonstrated a clear increase in species diversity. Controlling nutrient fluxes and water exchange between the seaward and landward sides of a dyke brought water and sediment parameters within the optimal range for macrobenthos biodiversity, which rapidly rose in response. In these cases, restoring water, sediment, and biodiversity conditions closer to pre-industrial conditions was best achieved by more, rather than less, human action on the environment – a crucial aspect in building modern *satoumi*. From a management perspective, *satoumi* carried out at the grassroots level has proven to be effective in engaging local Ago Bay communities. At the level of cities and larger jurisdictions, incorporation of *satoumi* concepts and processes into an integrated coastal management framework is a promising avenue now being explored by decision-makers for Ago Bay.

INTRODUCTION

Ago Bay is located in Mie Prefecture, central Japan, and is a typical enclosed coastal sea with a complex rias-type coastline (Mie Fisheries Research Institute 2009; Figure 1). The bay is central to Ise-Shima National Park which, because of its scenic beauty, valuable natural endowments and long cultural history, was the first national park to be established in Japan. Historically, the area was known as *Miketsu-kuni*, a name that indicated its special status as a supplier of foods, particularly marine products in this case, to the imperial court and to Ise shrine, one of Japan's most revered and ancient Shinto shrines. This combination in Ago Bay of a quiet enclosed sea and a rich historic heritage has imbued the local community with an inborn sense and ages-old image of Japan's traditional *satoumi* (Yanagi 2010). Such a place is symbolic; it stirs an ancient nostalgia for seascapes of rugged, green and hilly coastlines, where people could thrive on the rich bounty of a diverse and healthy marine ecosystem.

FIGURE 1. Pearl oyster rafts are a traditional feature in the scenic beauty of Ago Bay.

Ago Bay is also known for its pearl culture, which is extremely well suited to the mild climate and enclosed marine environment whose rias coastline protects the waters of the bay from sea-wave disturbance. Pearl culture in Ago Bay goes back well over a hundred years. The bay originally provided a healthy natural habitat for the *akoya* oyster, and its development as a centre of aquaculture began with these oysters. Later, benefiting from techniques learned from Akoya pearl culture, the local people launched other kinds of aquaculture-based fisheries. It was in Ago Bay, in fact, that the world's cultured pearl industry was started. It began in 1893, when a local marine products trader together with fisheries scientists succeeded in producing a semi-circular pearl after inserting a pearl nucleus, obtained from a shell bead, into an oyster and then letting the pearl form inside. With this technical development, pearl culture carried on by local fishers prospered in Ago Bay, and after World War II pearl production in the Mie Prefecture dominated the Japanese market for ornamental pearls. Besides cultured pearls, Ago Bay is also one of the largest producers of *aonori,* or green laver (*Monostroma* sp.), which has been cultivated since the late 1960s.[11]

11 Harvested green laver is sold as a food product after drying. Thirty to forty per cent of Japan's green laver is produced in Ago Bay.

The twentieth century development of pearl and green laver culture has become the basis of human interaction with the bay. Together, these enterprises contribute to vistas that evoke in the popular imagination a much-loved, quintessential *satoumi* seascape, where, on the calm surface of a small enclosed sea surrounded by sturdy green hills, nets and oyster rafts sway quietly on the water, continuing the ages-old, harmonious interplay between ocean and humans. Nets for green laver culture deployed along the coast can be seen all over the bay from autumn to spring, reflecting the changing seasons and echoing the transient nature of the seascape. As in many parts of Japan, however, the coastal area of Ago Bay was transformed during the post–World War II decades of industrialization. Its marine ecosystem was steadily degraded by artificial eutrophication, caused mainly by industrial and residential run-off and by human manipulation of the coastline that converted natural tidal flats into landfill.

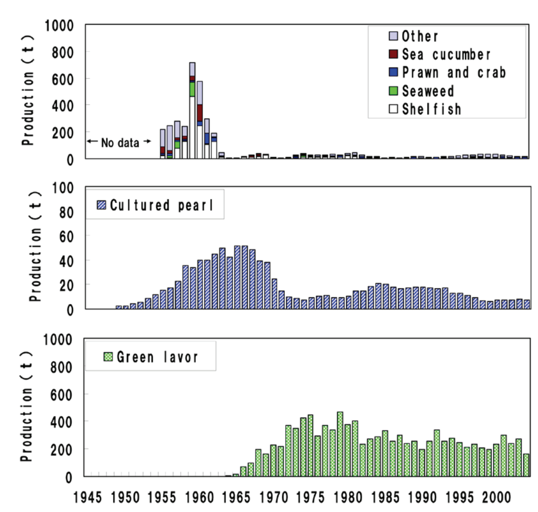

FIGURE 2. Changes in fish catch and production of cultured pearls and green laver.

This case study offers a glimpse into the long-term commitment of scientists and communities to revitalize the Ago Bay marine ecosystem by restoring deteriorated tidal flats and seagrass beds. Inseparable from that and equally important is their goal of mainstreaming *satoumi* activities into the basic development plan of the local government, which is the foundation of all development policies concerned with the area. Thus, they are working to meet the challenge of applying the ideas of *satoumi* in a specific case by successfully combining the views of scientists, the local community and policy processes.

HISTORY OF AGO BAY FISHERIES AND CHANGES IN THE MARINE ECOSYSTEM

In 1960, total catch, including shellfish, sea cucumbers, prawns and seaweed, was over 600 tons in Ago Bay. But this figure fell dramatically after 1965, partly because of the deterioration of the bay environment and the change from traditional fish-catch fisheries to pearl oyster culture (Figure 2, upper panel). Subsequently, green laver culture was developed in response to the decline of pearl oyster culture in the late 1960s, resulting from overproduction and the rapid increase in the proportion of low quality pearls produced (Figure 2, lower panel).

More recently, cultured fisheries have been damaged by eutrophication and red tides. In 1992, a red tide of *Heterocapsa circularisquama* occurred in Ago Bay for the first time, and since then there have been frequent harmful algal blooms of this micro-algae that have caused mass mortality of the pearl oyster. In the mid-1990s, hypoxia (abnormally low levels of oxygen) began occurring every year in the deeper layers of Ago Bay water, usually from June to October, when the concentration of dissolved oxygen plummets in the central and inner parts of the bay (Figure 3). Seasonally occurring hypoxia has caused severe decline in the number of shellfish, polychaeta and other benthic organisms which, unlike fish, are unable to move out of hypoxic waters (Figure 4). During the summer of 2002, large-scale hypoxia covered the Ago Bay marine ecosystem and eradicated a large part of its aquatic life, including its pearl culture, in the inner part of the bay. Because of hypoxia and red tide, much of the marine biological diversity of the bay was lost, and the aero-

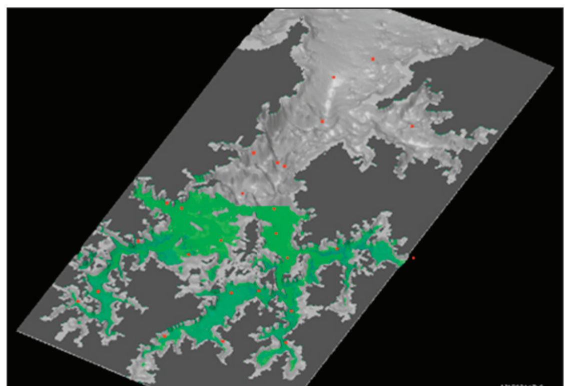

FIGURE 3. Areas in Ago Bay affected by hypoxia (Ugatahama 2002).

FIGURE 4. Mass mortality of bivalves by hypoxia (Ugatahama 2002).

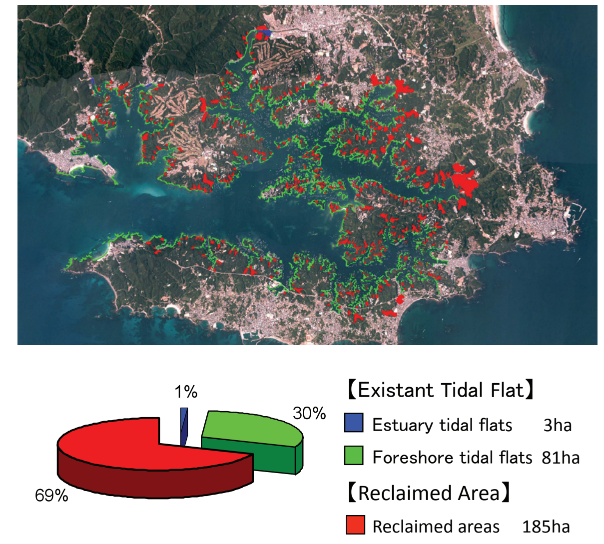

FIGURE 5. Distribution of tidal flats in Ago Bay.

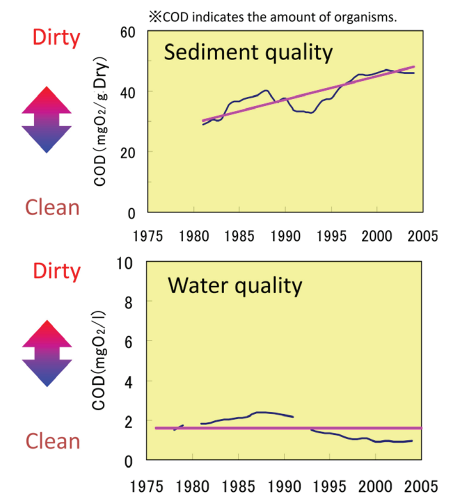

FIGURE 6. Changes in water and sediment quality in Ago Bay.

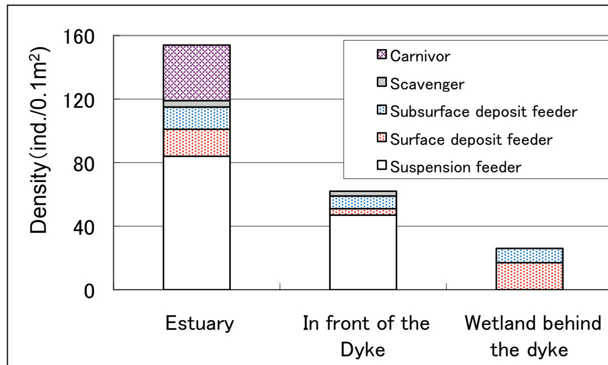

FIGURE 7. Composition of benthos by type of tidal flat in Ago Bay.

bic decomposition of organic material was disturbed, disrupting nutrient circulation in the water.

As for physical changes in Ago Bay's coastal geography, surveys indicate that approximately 70 per cent of tidal flat and shallow areas have been lost to land development, namely dyke construction and land reclamation. Figure 5 (upper panel) shows existing natural and reclaimed tidal flat areas estimated from multi-spectrum aerial picture analysis. The tidal flats were classified into three types (estuary, tidal flat in front of the dyke and wetland behind the dyke). The relative areas of estuary tidal flats, foreshore tidal flats and reclaimed areas are shown in Figure 5 (lower panel).

The estimated nutrient load to Ago Bay in terms of total nitrogen (TN) steadily increased from 1950 to 1990, mainly because of relentlessly rising volumes of industrial and domestic runoff. The bay sediment's chemical oxygen demand (COD), an indicator of concentration in organic component, is rising every year due to the accumulation of organic material, even though COD in the water itself shows little change (Figure 6). Macrobenthos on both sides of the dyke became rare, because sediment quality was relatively oligotrophic in front of the dyke, and it was hypertrophic behind the dyke. Physical transformation of the coast, particularly by dyke construction, and the rising levels of polluted residential and industrial river discharge into the bay caused serious deterioration in the benthic ecosystem, resulting in the decrease in biological diversity and productivity in Ago Bay (Figure 7). In order to assess the present condition of Ago Bay, a health examination scheme developed by the Ocean Policy Research Foundation (OPRF) was applied. In addi-

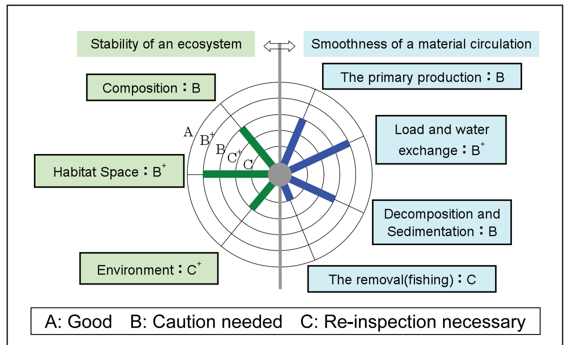

FIGURE 8. Results of the preliminary health examination of Ago Bay with the OPRF health examination system (see text).

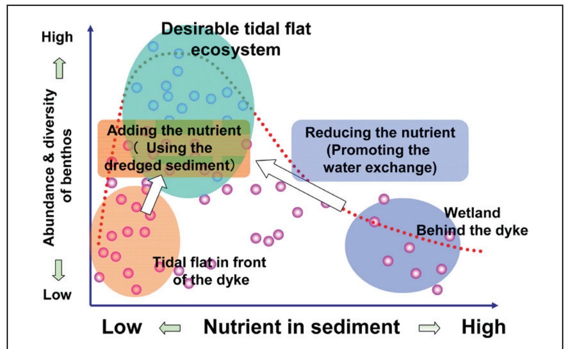

FIGURE 9. Conceptual diagram of the relationship between sediment nutrient concentration and abundance of macrobenthos as determined from monitoring six experimental tidal flats with different sediment qualities for three years. The experiment showed the optimal range for the sediment nutrient content for macrobenthos abundance and diversity.

tion to water quality, the scheme evaluates ecosystem stability and smoothness of material circulation. Results are shown in Figure 8.

RESTORING AGO BAY MARINE ECOSYSTEM AND BIODIVERSITY

Responding to the negative ecosystem changes and their effect on local fisheries, fishing communities, scientists and local government officials together adopted a *satoumi* approach to restoration. They saw *satoumi* not simply as focused on restoring a traditional, nostalgia-evoking seascape, but also as a practical framework for conservation that can put to work carefully controlled human modification of the environment. That is, they aimed to recreate a productive and functional Ago Bay based on scientific data and community initiative. Called the "Environmental Restoration Project on Enclosed Coastal Seas in Ago Bay", it was managed under a regional programme of the Japan Science and Technology Agency. Then, in 2008, the Committee for the Promotion of Environmental Restoration in Ago Bay was formed with the objective to reproduce the symbiotic relationship between Ago Bay and regional communities, establishing collaborations to conduct a variety of activities to enhance biological diversity and biological productivity, including controlling sediment quality, improving seagrass beds and enhancing water circulation in strategic areas.

Part of the restoration programme was to create six experimental tidal flats, with sediments of different organic content, which could be used to investigate sediment conditions suitable for macrobenthos habitat. The flats were monitored for three years. The experiment revealed an optimal range in sediment parameters for the macrobenthos, of 3-10mg/gDW for COD and 15-35 per cent for mud content, roughly indicating organic content (Kokubu and Okumura 2010). The relationship between sediment nutrient content and density of macrobenthos is shown in Figure 9. These results show that the balance of organic matter and mud content in the sediment must be carefully adjusted and maintained to provide a sound habitat for macrobenthos. By utilizing those findings, we developed practical methods to control sediment conditions and enhance biological productivity in two types of shallow areas in Ago Bay.

One area, the tidal flat in front of the dyke, was relatively oligotrophic, and the other, the wetland behind the dyke, was hypertrophic, so the biological diversity in both areas remained low (Figure 10). In the case of the relatively oligotrophic tidal flat in front of the dyke, the sediment is coarse (gravel) and contains low organic matter because the dyke shuts out the nutrient supply from the land. These sediments were improved by mixing them with organic-rich dredged sediment. We found that these were effective in bringing sediment parameters within the optimal range for macrobenthos diversity, represented in Figure 9.

In a hypertrophic wetland landward of a dyke, water exchange with the sea was increased using a pump. Sediment quality and abundance and diversity of species were then continuously monitored. The results

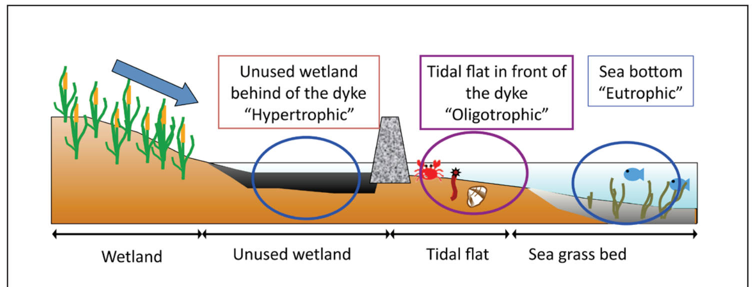

FIGURE 10. Schematic diagram of the characteristics of shallow areas in Ago Bay, with nutrient content too high landward of the dyke, and too low seaward of the dyke, to provide sound habitat for macrobenthos.

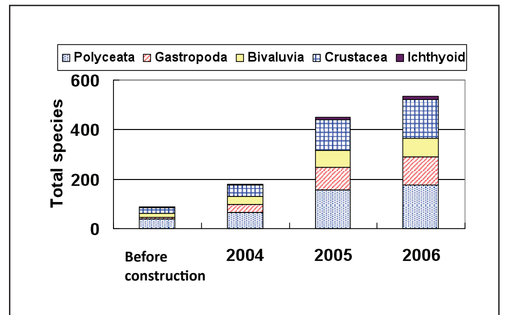

FIGURE 11. Annual changes in total number of macrobenthos species in the experimental tidal flat.

showed that sediment was hypertrophic and anaerobic before water exchange and *Chironomidae* were the dominant species at that time, because the wetland was brackish. But both wet weight and diversity were small. After water exchange, the macrobenthos changed from brackish type to marine type. The diversity and wet weight gradually increased with water exchange while COD and AVS in sediment decreased. These results indicated that the sediment status in wetlands was gradually changed to aerobic conditions by promoting water exchange.

Building on these results, another artificial tidal flat field experiment was carried out to further assess the potential of this method to restore biodiversity. First benthic algae came to inhabit them and then the number of macrobenthos increased. On the other hand, after construction, deposit feeders, in addition to suspension feeders, became more abundant. These results suggested that the artificially constructed tidal flat ecosystem had changed into a system that could support much higher biological diversity. Seasonal changes in abundance of macrobenthos in the experimental tidal flat are shown in Figure 11. The macrobenthos were classified into polyceata, bivalvia, gastropoda, crustacea and ichtyoid. Immediately after construction, gastropoda and crustacea were the dominant species. After six months, polyceata and bivalvia increased, and after ten months, species number also increased remarkably compared with that of before construction. After four months, the abundance of macrobenthos increased significantly, to four times the value before construction at the end of the first year, then they remained stable. As well, the exper-

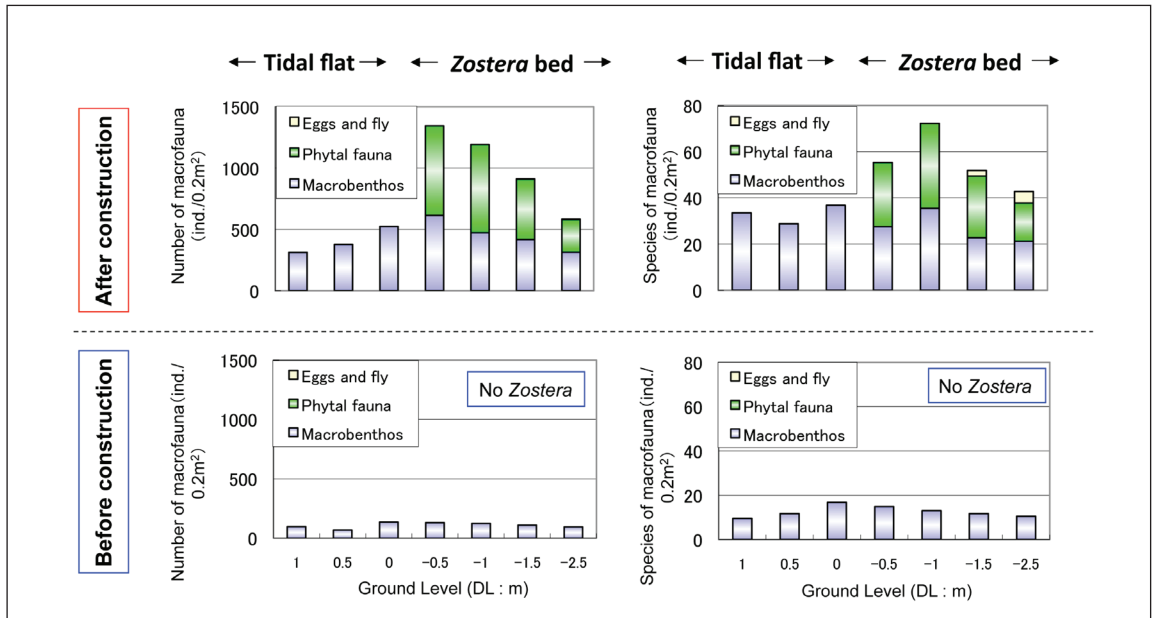

FIGURE 12. Effect of restoring tidal flats and *Zostera* beds.

iment showed that comprehensive restoration, that included not only tidal flats but also seagrass beds, showed clear evidence that numbers and species of macrofauna significantly increased after restoration (Figure 12).

In October 2009, a full-fledged tidal flat restoration project was launched in Ago Bay in which water exchange between an unused reclaimed area and the sea was set in motion by opening a flap gate in the concrete dyke. Local fishers and volunteer citizens in the area participated by transplanting seagrass and releasing juvenile clams to initiate the ecosystem recovery. In addition, as a community education effort, the Shima Nature School was established in 2005 to provide experience and education in nature, including a variety of field activities, such as sea kayaking. Systematic monitoring of seashore animals by local people started in 2009 when sampling and observation of aquatic organisms in tidal flats were undertaken by school children. Results of this continuous monitoring will be used as an indicator of the database on biodiversity in Ago Bay. This project is financially supported by the Ministry of Environment of Japan.

CONCLUSION

Besides its pearl production, Ago Bay is well known as a particularly beautiful part of Ise-shima National Park. Mismanagement for several decades led to ecological deterioration, especially in terms of sediment quality, hypoxia in bottom water, and frequent, harmful algal blooms. Tidal flats and seagrass beds that play an important role in material circulation and as habitats were severely degraded. Dyke construction, landfill, and water pollution from industrial and residential pressure severely reduced the resilience of the area.

For those reasons, restoration activities focused on controlling nutrient loading in tidal flats and wetland sediments to the optimal range for macrobenthos biodiversity. This has been done by enhancing water circulation in order to reduce excess organic matter and enriching nutrient-poor sediments with unused dredged organic rich sediments. As a result, periodic surveys on the bay ecology convincingly demonstrate that regulating water and material circulation across dykes has enhanced biological productivity and diversity in and around shallow areas, and improved sediment quality and seagrass beds.

Citizen groups are now actively engaged in regular monitoring of tidal flat macrobenthos and *satoumi* restoration, and their participation has been incorporated into the new city planning policy of the Shima city government, which is in charge of most aspects of Ago Bay management. Therefore, on the local government level, *satoumi* is now mainstreamed into the policy priorities of the city, enabling the coastal management of the area to proceed in a more sustainable and integrated way.

Long-term commitment of scientists to the local community in cooperation with the administrative staff of the city office, many local volunteers, and NGOs were essential in *satoumi* activities for restoration. It is hoped that their efforts will continue to support the area's conservation projects and encourage sustainable use of the marine environment within the *satoumi* framework.

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Case Study

8

MOBILIZING LOCAL WISDOM AND SCIENTIFIC KNOWLEDGE: RE-CREATING EELGRASS BEDS IN OKAYAMA

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ABSTRACT

This case study presents a local fishing community that took the initiative in *satoumi* activities, mobilizing both local wisdom and scientific knowledge. It is noteworthy that the activities were aimed not only at recovering the stock of a few commercial species, but to conserve the surrounding marine area as a whole. Hinase is a small fishing town located on the Seto Inland Sea in Okayama Prefecture. It has a long tradition of fishing due to a highly productive, enclosed marine ecosystem. In this town, the fishing community itself initiated a project to restore the marine ecosystem by planting eelgrass (Jp. *amamo*; *Zostera marina*), both to maintain their level of catch on a sustainable basis and to support the ecosystem of the surrounding sea for sustainable use, not just for fisheries but for other ecosystem services. The success of their restoration project can be explained by the collaborative network of different agents that was created on the basis of close cooperation between the local fishing community, scientists and the local government. That kind of integration is considered one of the most effective features of *satoumi* activities for advancing ecosystem-based management, to conserve marine biodiversity and support sustainable use of marine resources.

INTRODUCTION

Hinase is located on the southern coast of Honshu island, facing Japan's largest enclosed body of ocean, the Seto Inland Sea. The town is known for its rich marine heritage, and is still one of the most commercially successful fishing towns in the Seto Inland Sea area. About 200 fishing families make their living by coastal fisheries, including oyster farming, small scale trawling, and coastal pound netting, the techniques and lore of which, including the design of the pound nets, were originally developed by Hinase fishermen. All fishing activities in Hinase are coordinated by the local Fisheries Cooperative Association (FCA), which also plays the main role in managing and coordinating *satoumi* activities in the area, and the effort to recover the decline of the coastal habitat by recreating the eelgrass bed and removing marine waste has been undertaken voluntarily by the fishing community. This chapter discusses the effort to recreate the eelgrass beds as a *satoumi* activity based on both local wisdom and scientific knowledge gathered by fisheries officials. Besides activities to recover the habitat loss, local fishery officials, scientists and fishermen are now constructing a new spatial management plan of the marine environment, including setting up areas for restricted trawling in order to promote more efficient and sustainable use of their marine environment.

FIGURE 1. The Seto Inland Sea (aerial photo of the Hinase inlet area). Photograph courtesy of Bizen Higashi Shoukou Kai.

THE SETO INLAND SEA

The commercial success of Hinase fisheries derives from the highly productive marine ecosystem resulting from the geographical characteristics of the Seto Inland Sea. Generally, the Inland Sea is known for its beautiful scenery, dotted with approximately 3,000 small islands with their tree-covered mountains standing out against the deep blue of the sea. The scenery is much prized by the tourist industry and the national government, which designated the entire marine area of the Inland Sea as a national park; the Seto Inland Sea National Park, established in 1934, is one of the earliest of Japan's national parks.

The coastline of the Seto Inland Sea is also known for the development of small-scale fisheries, the output of which represents 25 per cent of Japan's entire fisheries production, including aquaculture. This is due to the abundance of its unique marine habitat, resulting from the convergence of two types of geographical settings, narrow channels called *seto*, divided by scattered islets from wider bodies of open sea (*nada*). Due to these settings in the highly enclosed marine geography off Hinase, water circulates to the Pacific slowly (circulation of the entire waters of the Inland Sea takes more than a year), allowing accumulated micronutrients released from river basins pouring into its waters to nurture the primary production of the marine ecosystem. Simultaneously, the current of the *seto* channels prevents hypoxia in the water, re-suspending the sediment and creating a healthy turbulence in the water. The habitat thus formed accommodates great marine biodiversity, nurturing over 500 species of fish and other rare marine species including porpoise and Japanese horseshoe crab.

However, the precious ecosystem of the Seto Inland Sea, so rich in both cultural and biological diversity was ravaged by coastal development during the period of rapid industrialization between 1950 and the 1980s. Sixty per cent of the natural coast line of the Seto Inland Sea was lost over those 30 years. The geographical and environmental changes that took place severely damaged the coastal ecosystem: many species of marine life disappeared as swaths of the natural habitat, including mud flats and eelgrass beds, were destroyed, and the quality of the water in the highly enclosed seas was degraded by river run-off polluted by household sewage and toxic chemicals drained into the sea from industrial plants. The result was extreme cases of anthropogenic eutrophication and chemical contamination of the marine ecosystem. Naturally, the coastal fisheries of the entire Seto Inland Sea were deeply affected, and the ample stocks of fish and the varieties of catch once seen suffered severe damage; after 2000, catches declined to half of what they had been in 1985.

HINASE AND ITS FISHING HERITAGE

Located in the eastern part of the Seto Inland Sea, Hinase presides over a typical seascape of the region, with an enclosed marine area dotted with 30 small islands and characterized by diverse marine habitats. The town prides itself on its long heritage as a fishing community. The more than 200 full-fledged members of the Hinase Fisheries Cooperative Association (FCA) practice either oyster farming, small scale trawling or a type of coastal pound netting called *Bizen* (*Tsubo*) *ami*, whose methods, including the technique and design of the net, were originally developed locally (Bizen is the name of the city of which Hinase is administratively a part and *ami* means net). Most of those engaged in fishing in Hinase belong to the local FCA and operate family businesses. There is some seasonal employment of overseas workers for the oyster shelling process.

In Hinase, membership in the Fisheries Cooperative Association is by family rather than by individual, as is the case more often than not in other parts of Japan. The chairman of the cooperation explained that this membership system was initially established as a tool to control fishing in the area, and functioned in the management of spatial use of local waters in association with small pound netting. Positions for the small pound nets deployed in the coastal area were determined and distributed to each fishing family by the FCA. In this way, the local fishing community maintained the units of pound nets in their coastal area and contrived to prevent over-harvest of their marine resources by providing the membership only to local families, thereby limiting the entrance of new persons to the business to heirs taking over the family business. (Consequently, this encouraged other children to

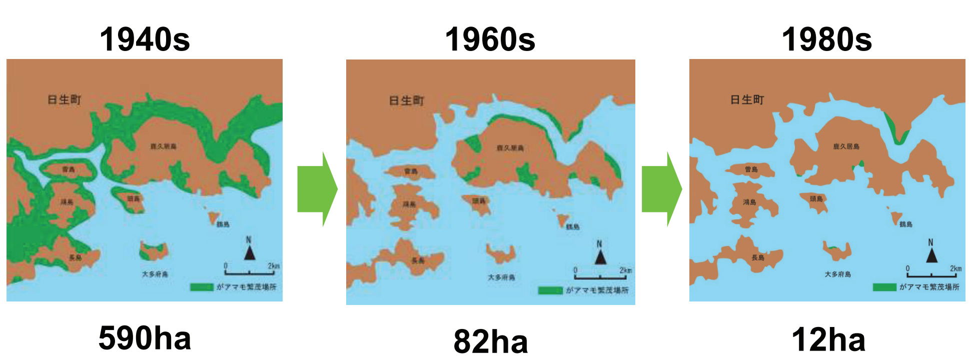

FIGURE 2. Decline of eelgrass sea floor in Hinase marine area.

migrate to other coastal areas and establish new fishing operations. Such migrants were able to succeed by bringing with them the sophisticated techniques and knowledge acquired in the use of *Bizen* (*Tsubo*) *ami* pound net fishing. The efficiency and wide applicability of the small pound net is evident in the way the fishing method is popular both in Japan and overseas, including Korea and China).

Nonetheless, the main type of commercial fisheries in Hinase shifted to oyster farming due to market demand and the decrease in catch and changes in fish prices that made traditional pound netting less economical and commercially viable. Despite these changes in fisheries, the Hinase FCA membership system retains its initial form and the members support community traditions and solidarity, which the chairman believes is the key to sustaining their fishing heritage.

In the 1960s, a new governmental project to enhance local fish stock was begun in the Seto Inland Sea. The project, known for its slogan "From catching fish to cultivating fish", involved releasing cultured juvenile fish stock into the coastal enclosed sea in order to enhance stocks of commercially valuable fish. This was in response to the damage dealt to fish stock by the environmental changes that took place in the region due to postwar urban and industrial development. Although there was relatively limited coastal development in the Hinase inlet, the combination of water pollution and landfill at the coastline has altered the coastal environment by destroying the natural coastal habitats, including eelgrass beds and mud flats. It was at that time that local fishermen, particularly those who used small-scale pound nets to catch shrimp, blue crab and coastal fish such as sea bream, observed the depletion of fish stock. Juveniles of those species were propagated and released in the area as part of the aquaculture scheme, but the catches did not increase and the stocks were not recovered. The culture and release of sole and blue crab juveniles had the same disappointing result.

After several attempts to increase fish stock by releasing juveniles and observing the results, the fishing community in Hinase recognized that it would not be possible to recover fish stocks simply by artificially increasing the number of juveniles. Instead, the loss of fish stock had been caused by environmental changes in the coastal ecosystem—such as destruction of the high biodiversity marine habitat—by landfill projects and artificial shoreline protection works undertaken during the post-war coastal development drive—a situation suffered by most of the coastal habitats of the Seto Inland Sea (Oura 2010).

The operators of pound nets who work closely with the coastal marine waters declared the failure of the scheme, particularly to the absence of eelgrass beds—*amamo-ba*—that had radically decreased in Hinase and generally in the Seto Inland Sea due to water pollution and coastal development. The decrease in Hinase was from 590ha in the 1940s to 82ha in 1971(Torii et al. 2008).

LOCAL EFFORTS TO RESTORE THE EELGRASS BEDS

The daily routine of pound net fishing starts with fishermen sailing out to small nets (*Bizen/Tsubo ami*) set in shallow waters between three and five meters off the coastal areas, only a few hundred meters off shore. They bring the nets back to the shore in the early morning and sort their catch. After collecting the nets, the fishermen spend their days mending the nets on the beach. During the time when they sail their small boats to collect the nets and also repair nets on the beach, they closely observe the coastal waters, noticing even minor changes in the marine environment. From this close observation, the pound net fishermen were familiar with the way the eelgrass beds functioned as the nurturing habitat of coastal fish where juveniles protect themselves from predators. Thus, as explained by some experienced pound net fishermen, releasing cultured juveniles into coastal waters with almost no eelgrass beds was the same as releasing them straight into predators' mouths.

Once this local wisdom was recognized, in 1985 the members of the Hinase FCA initiated the project to recreate the eelgrass beds. The local research institute for fisheries (the Okayama Prefectural Fisheries Experiment Station) provided instruction on techniques for cultivating and planting eelgrass, and members of the fishing community undertook to plant them in the areas where they remember the original *amamo-ba* had been found. The eelgrass survives by photosynthesis, so the water where it flourishes needs to be clear and shallow, less than three meters. The pound net fishers knew the exact location of such areas because they had customarily avoided the eelgrass beds when moving in their boats to pound nets in order to

FIGURE 3. Preparing to plant the seed of eelgrass.

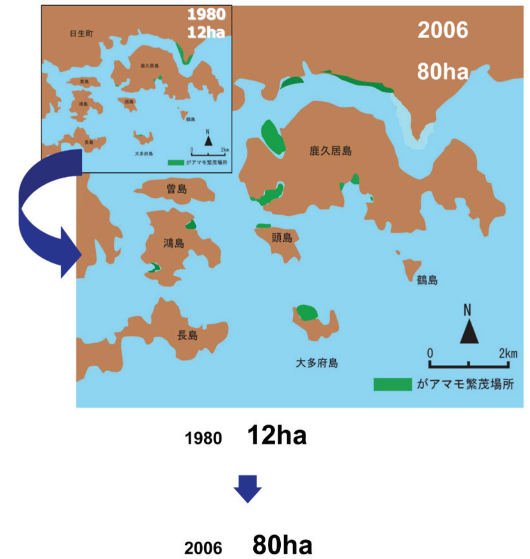

FIGURE 4. Recovery of Eelgrass sea floor in Hinase marine area.

prevent the boats' propellers from becoming entangled in the eelgrass (Tanaka 1998).

Later, this local wisdom was supplemented by scientific research conducted by local fisheries officials. Together with scientists, the officials studied the ecological factors determining the quantitative growth of the eelgrass, such as water salinity, seabed conditions and wave movements. Through the research, they found that in some of the areas where the eelgrass beds had been, recent environmental changes had affected the water salinity and seabed conditions, making the artificially planted eelgrass less resilient to the movements of the current. Having understood that the habitat could not be recovered only by replanting eelgrass, the local fishery officials then sought to artificially adjust the seabed conditions and salinity by raising the seabed floor and mitigating the wave movements by use of floating wave dissipating devices. As a consequence of these local governmental supports, together with continuous community efforts in planting eelgrass, the *amamo-ba* in Hinase increased from only 12ha in 1985 to almost 100ha in 2009 (Fujii et al. 2006).

CONCLUSION AND FUTURE PLANNING OF MARINE SPATIAL USE

Quantatively, the recovery of Hinase's *amamo-ba* is still in progress, as only 20 per cent of the initial beds reported in 1940 have been recovered, despite almost 25 years of community and local governmental effort. So far, the application of both local and scientific knowledge has been advantageous in practically recreating the habitat and in orchestrating cooperation by the governmental sector, scientific experts and the fishing community.

The cooperation of those sectors has been realized under a scheme of ecosystem-based approaches to both management of fish stocks and restoration of natural habitats. Through the use of both scientific knowledge and local environmental lore, the community has implemented a zoning scheme in coastal areas, designating appropriate areas for fish nurseries and slightly deeper water for feeding areas for adult fish. Then, to enhance the productivity and ecological linkage between those zones, the community has reconstructed original habitats such as eelgrass beds and created artificial reefs, even deploying wave mitigating devices on the water surface to protect newly planted eelgrass. The zoning scheme fundamentally aims to protect fish habitats but considers the health of the entire marine area in order to achieve sustainable future resource use. Furthermore, the scheme incorporates more integrated marine space planning in order for more efficient use of marine space for a wider scope of stakeholders, including space for educational areas for access by students and for no-take zones for marine conservation. Above all, the Hinase fishing community appreciates the multiple services that the marine environment can offer and the importance of designing an inclusive marine spatial plan to enhance the local economy and achieve sustainable use of the marine ecosystem. Thus, although the future plans for multiple use of the marine area have

been designed to enhance the natural productivity of the marine ecosystem through artificial optimization of ecological conditions, they also take into consideration conservation of biodiversity and sustainable use of such ecosystem services without diminishing the balanced interaction between the fishing community and other stakeholders.

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Case Study

9 TIDAL FLAT RESTORATION IN THE YAMAGUCHI ESTUARY

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ABSTRACT

The once fertile environment of the Yamaguchi Estuary and adjacent tidal flats has been seriously degraded over the past 50 years, and local communities once intimately attached to this ecosystem are now largely indifferent to its plight. The efforts presented in this case study are by no means of a scale sufficient to reverse this trend, but are reported as an example of manual efforts for the purpose of conservation of a tidal flat ecosystem that illustrate well the opportunities and challenges for reviving *satoumi*.

In attempts to make the tidal flat more hospitable to short-necked clams (*asari*), local volunteers have regularly manually tilled the tidal flat mud to soften it and favour aerobic conditions, covered the mud surface with nets to protect the clams against eagle ray feeding, and participated in seagrass seed collection and sowing projects. Data shows that these and other actions in this environment have been successful. Manually tilling the tidal flat to find *asari* used to be a typical enjoyment for local communities in this *satoumi*. Today, tidal flat tilling and seagrass sowing are symbolic of *satoumi*, when human interaction with the coastal environment nurtures nature and contributes to the enhancement of biodiversity, beyond what would be by hunter gatherers.

From the perspective of biodiversity management, the practices presented herein could become valuable complements to restriction-based conservation measures in human-influenced coastal seas. We believe it is important to develop policy frameworks that effectively reflect the experience of such local-scale successes. Key considerations in applying these practices in wider policy frameworks include establishing a model less reliant on volunteer labour, and that is effectively integrated with other ecology-oriented watershed practices in agriculture, forestry and fisheries, with particular attention to ecological networks, and, for the longer term, with due attention to developing culturally appropriate environmental ethics.

OVERVIEW OF THE FUSHINO RIVER BASIN AND YAMAGUCHI ESTUARY

Yamaguchi Prefecture is located at the western end of Honshu Island, its southern part facing the Suo Sea, the western part of the Seto Inland Sea. The Fushino River passes through the city of Yamaguchi and empties into Yamaguchi Estuary (Figure 1). Annual precipitation in the area is 1,500 to 2,300mm. The mean temperature rose in the last 20 years from 14-15°C to about 15-16°C.

The Fushino River basin, which covers 322 square kilometres, has a population of 163,000. The river is 30.3km long with a maximum altitude of 688m. In geological terms, the west side of the basin is relatively abundant in soft black schist and the east side in solid granite. Land use in the old city of Yamaguchi, which occupies most of the river basin, is 64.5 per cent forest, 13.1 per cent farmland and 22.4 per cent urban residential area. The city centre and the prefectural office are located in the middle reaches of the river. Dams have been constructed in three places, but their total catchment area occupies less than 5 per cent of the entire river basin. The Fushino River drainage area is not particularly large, and a great deal of natural landscape has been preserved from the upper to lower reaches. The river mouth and adjacent coastal areas are also quite accessible to local residents, making it well-suited to examine the connections between the forests, river and sea.

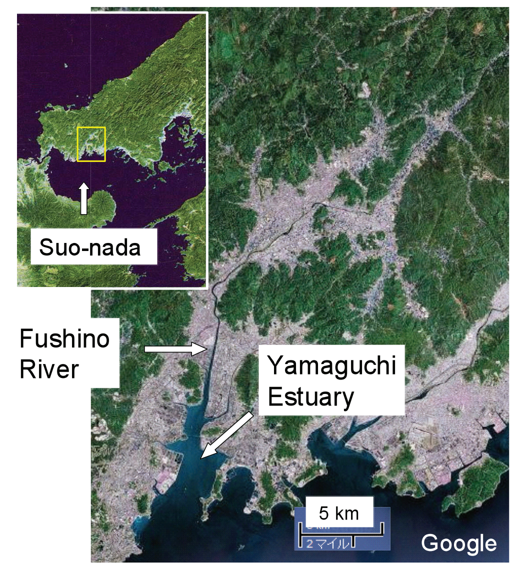

FIGURE 1. Location of Fushino River and Yamaguchi Estuary.

The area of the estuary is about 1,700ha, with three tidal flats with a total area of approximately 350 to 400 hectares: Naka-gata, (located near the river mouth), Shinchi-gata and Minami-gata situated respectively on the western and the eastern sides of the estuary. The maximum tidal difference is approximately three metres. Located 7.3km upstream from the river mouth is an intake dam for irrigation.

The main freshwater fishery products of the Fushino River basin include sweetfish (*ayu*): 10-20 tons; freshwater corbicula clams (*shijimi*): 20 tons; small crab (Jp. *mozukugani*; *Eriocheir japonica*): 5 tons; eel: 100-200kg; and trout. Many of the commonly consumed fish are propagated or farmed here. Marine fishery products of the Yamaguchi Estuary are numerous, including conger, eel, *Muraenesox*, blue crab, gilt head, perch, flathead, flatfish, squid, trepang, shrimp, whiting and clams. Fishermen observe that a wider variety of fish could be caught in the 1960s. A local farmer also reported that in tidal flats at low tide he once gathered laver and green laver seaweed, short-necked clams, rapa whelk, pen shell, minor octopus and oysters. He also caught flatfish, flathead, shrimp and other small fish—even by hand—until about 1965. Short-necked clams were so widely available that they had little market value at the time.

The horseshoe crab, which is an endangered species of a shape that has remained unchanged for 200 million years, still inhabits the Yamaguchi Estuary. The numbers are falling in other areas of the Seto Inland Sea. They are troublesome when they become entangled in fishnets, however, and fisherman often end up having to kill them even knowing they are protected. They said that 15 horseshoe crabs were caught in 2008.

Many species of birds inhabit the estuary—71 species according to a survey conducted from 2003 to 2005—including precious endangered species like the black-faced spoonbill (*Platalea minor*) and the bean goose (*Anser fabalis*). Among 68,544 individuals observed, *Galloanserae* (ducks; *kamo*) occupy 74 per cent; *Scolopacidae* (sandpipers; *shigi*): 7 per cent; *Ardeidae* (herons; *sagi*): 5 per cent; *Sibley* (gulles; *kamome*): 5 per cent; and *Phalacrocoracidae* (cormorants; *u*): 4 per cent. Many of these are migratory birds from Southeast Asia, Australia and Siberia. There are colonies of six species of herons in nearby forests. Recently, due to the effects of climate change, cormorants have been spending the winter in Yamaguchi Prefecture, where they are proving to be a pest for the *ayu* and other fish farms.

CHANGES IN HUMAN ACTIVITIES AND THEIR IMPACT ON THE ECOSYSTEM

The human population of the river basin increased from 117,000 in 1960 to 163,300 in 2000, owing mainly to the growth of the tertiary industry. Meanwhile, the population of workers in the primary industry began to fall from around 1960. The area of farmland decreased with urbanization. In 1966, the farmland and urban areas of the old city of Yamaguchi respectively occupied 14.7 per cent and 16.7 per cent of the total land area. In 2004, they occupied 12.2 per cent and 22.4 per cent, respectively. Impervious surface area increased due to these changes. The area of paddy fields in the river basin fell from 70km^2 in 1965 to 30km^2 in 2000, and methods of agriculture were significantly modernized with the use of efficient irrigation systems, agricultural machines, chemical fertilizers and pesticides. The ratio of households connected to centralised wastewater treatment systems increased from 18 per cent in 1985 to 75 per cent in 2005.

Major public works projects included the extension of the Shinkansen (bullet train) to Yamaguchi Prefecture in 1975, and the completion of the Chugoku Expressway in 1983. Two main dams were constructed by 1984 and 1988. Sixty-seven small dams to control debris flow were built with the planned total capacity of sand storage at 680,000m^3. A total of 75 irrigation water intake dams were installed. The amount of soil and sand deposited in these dams was estimated at roughly 570,000m^3.

Land reclamation between 1947 and 1969 of 340ha for farmland had a direct impact on the tidal flats and sea grass fields in Yamaguchi Estuary (Figure 2). While seawalls are a necessity to protect against typhoons and other coastal hazards, they disrupt the seepage of nutrient and iron enriched water from the forest, and the increased water agitation from wave reflection off the walls inhibit settlement of *asari* and seagrass. As well, seagrass fields were impacted by the rise in water temperature by about 1°C during those three decades.

Reflecting these changes, annual fisheries productivity in Yamaguchi Estuary declined from 2,825 tons in 1967 to approximately 1,600 tons in the early 1970s and recently to 200 tons. The production of short-

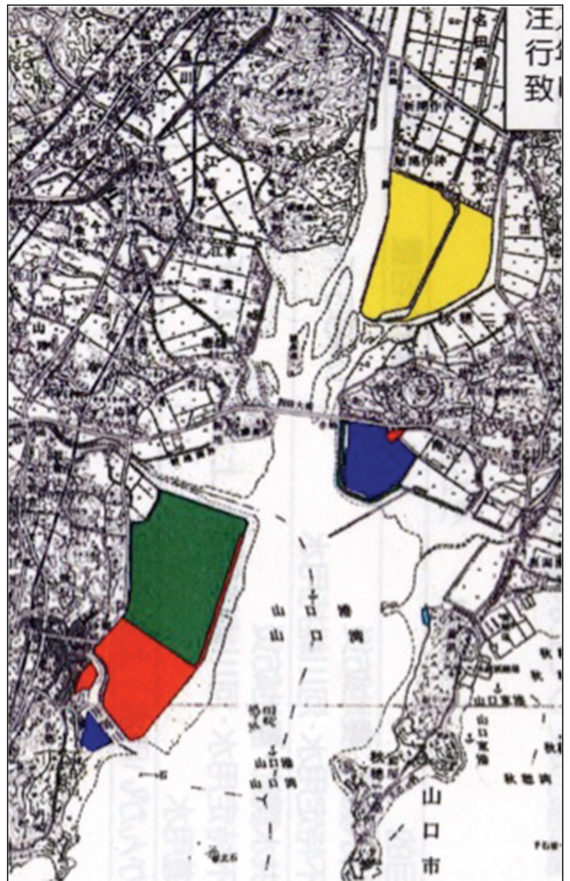

FIGURE 2. Land reclamation area.

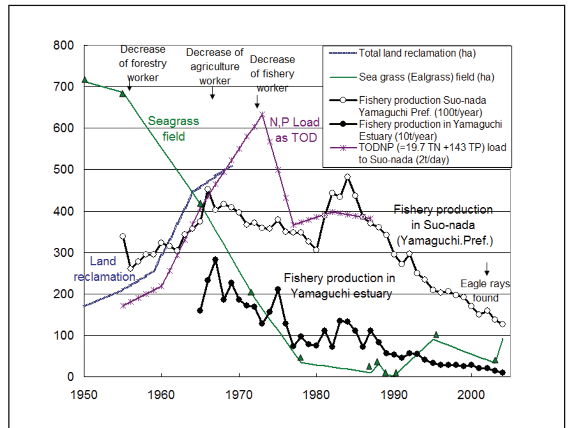

FIGURE 3. Time series of land reclamation and *zostera* (eelgrass) coverage in ha, fisheries landings in Suo Nada in the prefecture, fishery production in the Yamaguchi Estuary and Total Organic Nitrogen and Phosphate into Suo Nada. Note how the increase in reclaimed land area and associated decrease in eelgrass fields was shortly followed by the increase in nutrient loading. For a short period, this eutrophication enhanced primary production and compensated for the loss of eelgrass fields in terms of fishery production, however, the decreasing trend has then dominated since about 1985. The decreasing trend in eelgrass field coverage has been reversed since 1990, but so far the recovery is modest compared to the coverage in 1950.

necked clams, in particular, declined from 1,500 tons in 1970 to near zero since 1991. Other plausible reasons for the decrease of the clam harvest, other than the direct impact of land reclamation, include: (1) decrease of nutrients such as nitrogen (N), phosphorus (P) and iron (Fe), (2) sedimentation of fine particles on the tidal flats, (3) increased feeding on the clams by eagle rays due to the effects of climate change, (4) collection of mother shells in the Suo Sea.

As for (1), despite the increase in the number of urban households connected to the public sewerage system, the concentration of N and P in downstream areas of the Fushino River tended to increase. It is notable, however, that the concentration of N and P in the western part of the Suo Sea clearly decreased from 1984. Regarding to (2), it should be noted that changes in cultivation methods, such as in paddy field irrigation systems, have contributed to increased runoff of fine soil particles; at the same time, thorough flood control measures have led to the decrease of sand supply to the coast. In any case, the median size of soil particles in Naka-gata and Minami-gata has decreased, respectively from 0.28 and 0.63mm in 1988 to 0.11 and 0.27mm in 2003. Field observations of water quality examining suspended solid (SS) and chlorophyll a (Chl-a) levels at the river mouth were conducted on the same day of August in 1982 and 2004. The results clearly showed that both the Chl-a and SS levels had declined. This has significantly deteriorated the conditions for feeding by short-necked clams, both in quantity and quality, in those 20 years.

Figure 3 shows the relationship between the decline in fisheries productivity and changes in human activities in the last 50 years. The line with solid black circles indicates fisheries productivity in the Yamaguchi Estuary, while the line with open white circles indicates productivity levels in the Suo Sea. The first thing we notice is the decline in the area of sea grass fields as the area of reclaimed land increases. In 1952, sea grass fields occupied 720ha and the primary production there was estimated at 9,500t C/year. However, in 1978, sea grass fields had dwindled to 30ha and almost disappeared in 1990.

The line with x-marks shows the loading of N and P, converted to TOD, flowing in the Suo Sea, including that from the island of Kyushu. Comparing these levels with fisheries productivity levels, we can see that during the 1970s and early 1980s, the nutrient load mainly from adjacent industrial cities caused eutrophication, which in turn enhanced primary production by phytoplankton and mitigated the impact of land reclamation on fisheries in the Suo Sea and Yamaguchi Estuary. However, from 1985 to the present, fisheries productivity levels have declined significantly.

Fisheries productivity in Yamaguchi illustrated both the possibility of a temporary increase in catch with eutrophication, and the following decrease in ecosystem productivity linked to decline in biodiversity. It should be noted that eagle ray predation damage as an effect of global warming appeared only recently, in 2002.

RESTORING THE FUSHINO RIVER TIDAL FLATS ENVIRONMENT

Yamaguchi Prefecture established a committee to discuss environmental management of its river basins, resulting in a proposal in March 2003 entitled "The Concept of Sound Watershed Development", taking the Fushino River basin as a model. Among various measures to be promoted, it focused on restoration of the natural environment of tidal flats and sea grass fields in river estuaries, where the impact of human activities on the river basin is concentrated. Then, in August 2004, the Committee for Tidal Flats Restoration of Fushino River Estuary was inaugurated under the management of Yamaguchi Prefecture. The goal of the 60-member committee is "restoration of *satoumi*".

In 2004, Yamaguchi Prefecture embarked on a pilot study aimed at improving the soil quality of its tidal flats. In particular, one objective was to soften the soil surface to make it a more hospitable habitat for the short-necked clam larvae, and favour more aerobic conditions in the sediment. In the muddy soil of Naka-gata, ploughing was conducted using cultivator machines, mixing soil, turning over the sediment and crushing oyster shell deposits. In both cases, either crushed pebbles or dredged sand were added to the surface layers (Figure 4). We observed a certain effect of these efforts on the survival of short-necked clams until October, probably because of the improvement of particle size and surface roughness.

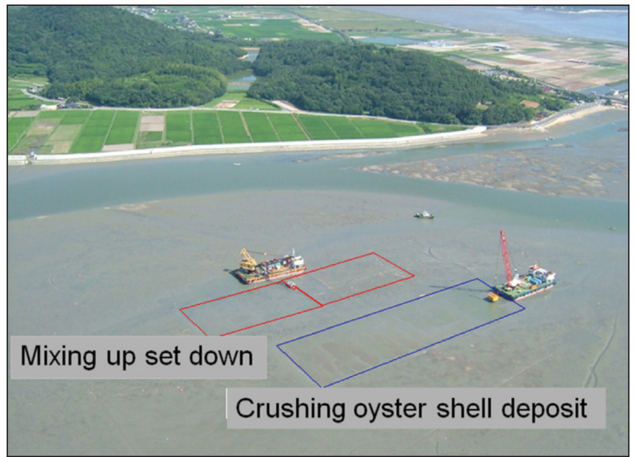

FIGURE 4. The site of a pilot study improving soil in Nakagata.

In the sandy tidal flats of Minami-gata, local volunteers tilled the soil by hand. This activity has been ongoing twice a year. Approximately 150 people have participated on each occasion (Figure 5). In the past, when short-necked clams were abundant, a popular activity with local communities was to till the tidal flat mud at low tide in search of short-necked clams. This seasonal activity presumably made the mud more hospitable for short-necked clam larvae and could then be seen as one example of traditional *satoumi* practice, where the customary use of local resources contributed to sustaining it by making the coast more hospitable to the species it exploited. After 50 years of severe environmental degradation, however, the short-necked clam is scarce, offering little incentive to till the tidal flats. The bonds between the community and this coastal ecosystem have also weakened; clam-gathering, a pleasant pastime that once brought people into hands-on contact with the tidal flats and the natural environment close at hand, is no longer popular. In this case, our limited-scale attempt at *satoumi* revival for the purpose of conservation was made possible by the hard manual labour of "environment volunteers".

FIGURE 5. Ploughing the tidal flat mud, making ridges parallel or orthogonal to the wave direction using a shovel and plough. The goal of the local community here is to favour aerobic conditions and larval deposition in the sediment (see text for details).

FIGURE 6. Planting the seedlings of *zostera marina* on the tidal flat of an offshore site in Minami-gata.

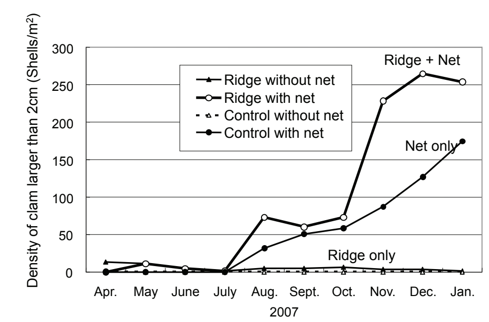

FIGURE 7. Effect of soil improvement works in Minami-gata on the density of short-necked clam in 2007, after a net with a 9mm mesh size covered part of the plowed area (100m² out of 2,250m²) and after making ridges in May 2007.

Finally, in order to prevent predation damage by eagle rays, we have been protecting the clams by covering the tidal flats with 9mm-mesh fishnets since 2007. To date, we have observed that net covering is effective in improving survival rates, and tilling the soil results in a slight increase in the body weight of the clams. These efforts could be seen as specie-targeted biodiversity conservation. While conservation on land has long included this kind of active measures (e.g. reintroduction of species that had been exterminated from an ecosystem), at sea it has mostly been limited to decreasing or temporarily halting catch. That is, curtailing human interaction and letting nature recover by itself. Unfortunately this may not be sufficient, or take a very long time, in severely degraded environments. Available data suggests that the active conservation measures reported here, including habitat construction, mud ploughing and protection from predators, were at least moderately successful.

Concerning the restoration of sea grass fields, the Fisheries Promotion Division, Yamaguchi Prefecture, started a project to restore eelgrass (*Zostera marina*) from 2002. From 2004, local resident participation was incorporated into the program. In early periods, transplanting of the shoots was tried together with sowing (Figure 6). However, sowing has been conducted mainly, considering the efficiency. We participate in parts of the project, such as collecting seeds in May and preparing the mud flats for sowing the seed in November, following instruction provided by experts from the Fishery Research Center. As a result, the area of sea grass fields had recovered to 142ha as of 2008.

As mentioned above, our activities over the past six years are, in a modest way, mostly successful, as indicated by the results shown in Figure 7. Given the complicated structural changes that took place over 50 years, however, what can be achieved in rather short terms by mainly volunteers who are only just periodically participating in such activities is necessarily very limited so far.

RESEARCH WORKSHOPS AND ENVIRONMENTAL NETWORKS IN THE ESTUARY

In 2009, 10 workshops on biological resources in the Yamaguchi Estuary were organised. Several important points were confirmed at these networking events. The first was the importance of the two-dimensional ecosystem networks of river areas. The importance of the continuity between the forest and the estuary along the river axis has long been recognized, although the actual situation is far from satisfactory. However, more attention needs to be paid to the cross-sectional continuities between river channels and paddy fields, waterways, ponds, flood control basins and wetlands, as shown in Figure 8. In Japan, as in other countries based on rice culture, paddies and agricultural waterways once played an important role as spawning and nursery grounds for fish. Now such functions have

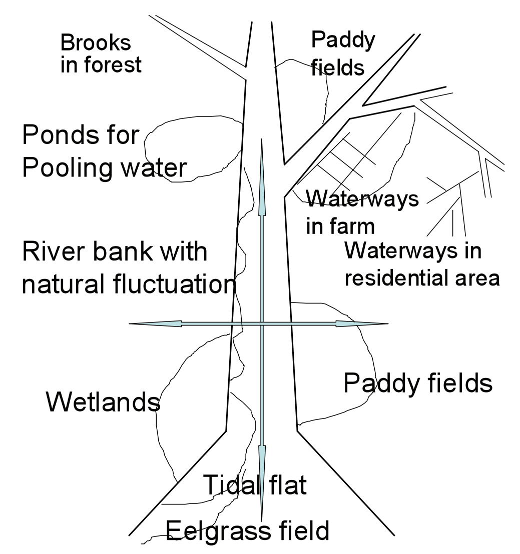

FIGURE 8. Two-dimensional schematic diagram of the river basin ecosystem.

disappeared due to the modernization of agriculture and the reinforcement of riverbanks for flood control. Even during times of flooding, fish are unable to move into wetlands and rice paddies. As well, in urban areas the once natural waterways hosted various organisms. These waterways have often been replaced by concrete storm-water drains where little organic life can survive. Ecosystems in urban areas have become extremely depleted. Herbicides and other chemicals have also affected the ecosystems adjacent to the areas where they are used, and such chemicals may also indirectly affect life in the tidal flats. The flow of Fe and other nutrients through the ecological food web must be studied further.

Another point is the importance of the networks of short-necked clam larvae or of eelgrass seed supply in the sea area. According to the National Research Institute of Fisheries and Environment of the Inland Sea, short-necked clam larvae float on the tide for two weeks. During that time, the larvae that hatch in the Yamaguchi Estuary are carried offshore by the tide, to Onoda in the fall and the Bungo peninsula in the spring. Larvae that hatch off the shore of Onoda are carried westward towards Shimonoseki in the fall and southwest to the Buzen coast (on Kyushu) or even offshore Bungo in the spring. As short-necked clam resources have declined overall in the Suo Sea, the networks that nurtured the production of larvae have weakened, so that it may not be easy to achieve effective outcomes for restoration efforts such as ours in the Yamaguchi Estuary. Although the spatial scale of sea grass restoration is much smaller, the situation is the same.

FINAL REMARKS AND FUTURE PROSPECTS

This report presents efforts being made to revive the tradition of *satoumi* in the Fushino river estuary and adjacent coastal areas. While we would emphasize that the good will of a few local volunteers is not sufficient to combat the effects of 50 years of environmental degradation, it is worth reporting that without waiting for an ideal conservation-focussed management framework, there is still room for immediate, positive action to restore the tidal flat environment's biodiversity by concerned local communities. In this case study, this included human modification of the environment in the form of actions such as manually tilling mud in tidal flats.

From the perspective of biodiversity management, bringing this locally successful initiative in biodiversity conservation practice to the level of larger, policy-driven action will be a key challenge. Furthermore, examination of the ecosystem changes in the estuary and catchment areas, including changes in agricultural practice, suggest that it will be difficult to restore a fully healthy, productive ecosystem in the Yamaguchi Estuary without simultaneously achieving recovery of agriculture, forestry and fisheries practices that are friendly to the environment. Although this was not the focus of this short presentation, the authors believe it will be difficult to revive *satoumi* without due consideration for aspects such as higher self-sufficiency of food and timber, challenges to the still-prevailing practice of single-minded pursuit of short-term economic efficiency, and changes in biodiversity-related societal behaviours and philosophy.

ACKNOWLEDGEMENTS

The authors would like to thank the people of Yamaguchi Prefecture, the Committee for Tidal Flats Restoration, EMECS, the presenters of the Research Workshops '09 for their active cooperation, and the Toyota Motor Corporation for its financial support of the workshops.

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Box 5: Ecological links between terrestrial and coastal areas in the Yura River estuary and the Tango Sea

Yoh Yamashita, Maizuru Fisheries Research Station, Field Science Education and Research Center, Kyoto University

A central aspect in *satoumi* is the coupling of coastal marine and terrestrial ecosystems in the watershed. Through these links, humans have had a profound influence on marine coastal ecosystems and biodiversity through their on-land activities. Adequate knowledge of land-sea interaction will be crucial to the management of biodiversity in coastal seas. The research summarised here provides an illustration of these interactions in the case of the Yura River in Kyoto Prefecture, with field surveys of nutrients, carbon and various other constituents that provide insight into the nature of the land-sea ecosystem tied together by rivers.

In Kyoto Prefecture, commercial landings from coastal fisheries have shown a continuous decrease after a peak in 1988 (106,000 tons) and is currently only about 12 per cent of the peak year (12,400 tons in 2005; see Figure 1). Four possible causes have been cited for this decline: climate change, overfishing, deterioration of the coastal environment, and deterioration of the natural links between terrestrial areas, rivers and the coastal environment. In coastal areas, the latter in particular is considered to play an important role in the decline of biological resources. In addition, unusual ecological phenomena such as the appearance of massive numbers of jellyfish are thought to be associated with human activities.

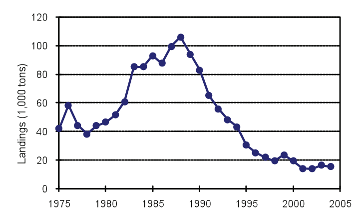

FIGURE 1. Annual change of fisheries landings in Kyoto Prefecture.

The Ashiu Forest Research Station and the Maizuru Fisheries Research Station of Kyoto University's Field Science Education and Research Center (FSER) are both located near the Yura River, and scientists in marine and terrestrial ecology have been collaborating there in the study of the ecological links between terrestrial areas in the Yura River watershed and the coastal waters of the Tango Sea (Figure 2). The research is basically testing the hypothesis that the decrease of aquatic biological productivity and diversity can be attributed to the disruption of ecological links between forests and coastal waters. The main disruptions are thought to be: (1) sediment flux (increased flow of fine sediment into coastal waters from poorly managed and maintained forests, paddy fields, and irrigation reservoirs); (2) fluxes and consumption of organic matter; (3) water flow; (4) nutrient flux (disturbances in the balance of such nutrients as C, N, P, Si, Fe from terrestrial areas; artificial control of river water discharge for human activities); and (5) animal migration (obstruction of aquatic animal ontogenetic migrations by dams and drainage improvement programs of concreting the banks of the river etc.).

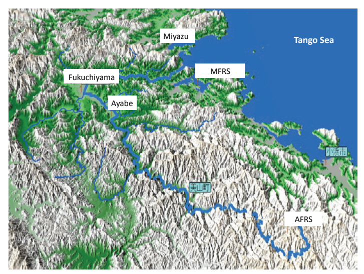

FIGURE 2. Satellite photograph of the Yura River watershed (1880km²). The Yura River, with a total length of about 146 km, flows into the Tango Sea, the western part of Wakasa Bay. MFRS (Maizuru Fisheries Research Station), AFRS (Ashiu Forest Research Station).

Studies have been conducted of particulate and dissolved nutrients, including dissolved iron and humic matter, input to the river system, the primary production mechanisms of the river and coastal waters, the influx and interaction between river discharge and sea water, and the utilization of matter of terrestrial origin by planktonic and benthic organisms. Figure 3 shows an example of composition of anthropogenic matter, phytoplankton and benthic algae in particulate organic carbon (POC) collected in the river between ca. 20km and 120km from the river mouth, areas not influenced by sea water. It is notable that phytoplankton production drastically increased in the Ono dam reservoir at midstream. In addition, organic matter produced in the forests was not clearly detected, suggesting that it may be mainly transported during flooding.

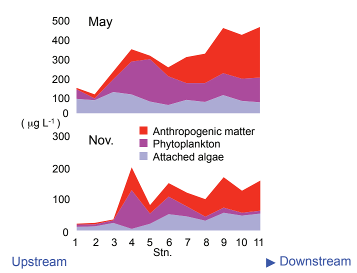

FIGURE 3. Composition of anthropogenic matter, phytoplankton and benthic microalgae in particulate organic carbon (POC) collected in the Yura River between ca. 20 and 120km from the river mouth in 2006 (Suzuki et al. unpublished).

From early summer to late autumn, sea water enters the river from the bottom layer and forms a long brackish estuarine zone up to about 20km from the river mouth due to low river discharge and increase of the sea surface height during this season. In the river estuary, a high primary production layer occurs in the boundary layer between the freshwater and the seawater areas where marine phytoplankton utilizes nutrients transported in the freshwater originally from terrestrial areas (Figure 4).

In midstream and downstream areas, benthic organisms utilize terrestrial organic matter (carbon), but from the shallow coastal to offshore areas the benthos community primarily use marine products (Figure 5). Terrestrial matter contains high amounts of refractory compounds such as cellulose and lignin, which are difficult to digest and assimilate by most coastal benthic animals which do not have digestive enzymes capable of breaking down the glycosidic bonds of cellulose into oligosaccharides (Antonio et al. 2010a). Other studies suggest that the smaller consumers such as meiobenthos and bacteria in the coastal sediment can consume terrestrial organic matter.

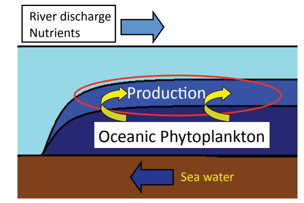

FIGURE 4. The primary production system in the brackish water from river mouth to ca. 20km upstream (Kasai et al. 2010).

The straightening of rivers and the construction of concrete banks for flood prevention have resulted in the loss of freshwater pools and sections of rapids typical of a naturally winding river, sections that are precisely the habitats where the freshwater benthic community consumes terrestrial matter. Such constructions shorten and streamline the rivers, meaning that terrestrial organic matter is transported much more quickly to coastal waters and increasing the likelihood that the decomposition of accumulated terrestrial organic matter by bacteria will take place further downstream, ultimately resulting in oxygen depletion in coastal areas.

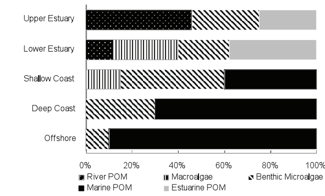

FIGURE 5. Per cent composition (%) of potential food sources in the diet of benthic communities. Shallow coast 5-10m, deep coast 30-60m and offshore 100-150m in depth (Antonio et al. 2010b).

The collaborative structure that links research facilities studying forests, rivers and coastal ecosystems provides exciting new research opportunities for graduate students. They can expand the scope of their research from a limited ecological unit to encompass the linkages between several ecological units with an interdisciplinary interest. We have developed an education program of field exercise courses on "The Forest to Ocean Linkages" focusing on the Yura River and the Tango Sea. In this programme students study the structure of forests, water quality and changes in the structure of the aquatic fauna community from upstream to downstream/coastal waters through field observation and sampling (Figure 6). This field-based educational program will also provide us with many new perspectives on both education and research.

FIGURE 6. Photos of students in the field research education programs.

FSERC is planning from 2011 to conduct a large-scale thinning experiment of artificial forests neglected by poor forest management in the upstream basin of the Yura River. In addition to providing field study material for students, we expect this experiment to yield valuable data on the effectiveness of managing under-used forests for forest, river and coastal ecosystems conservation (Figure 7). This will form the basis of practical options for effectively managing watershed forests in the changing socio-economic setting of Japan, which is recognized as one of the key challenges for conserving biodiversity in coastal areas.

Thinning	Top Thinning	Bottom Thinning	Whole Thinning
Forest Understory Vegetation	Slight Increase	Increase	Large Increase
Forest Biological Diversity	Slight Increase	Increase	Large Increase
Nutrients to Rivers	Slight Increase → Recover	Increase → Recover	Large Increase → Decrease
Fine Sediments to Rivers	Slight Increase → Recover	Increase → Recover	Increase → Decrease
Aquatic Biological Diversity	No Change	Decrease → Increase	Decrease → Increase

FIGURE 7. Expected effects (compared to non-thinned forest) of the thinning experiment. Arrows indicate the expected effect in the longer term (e.g. top thinning is expected to result first in a slight increase in nutrient input to rivers, followed by recovery).

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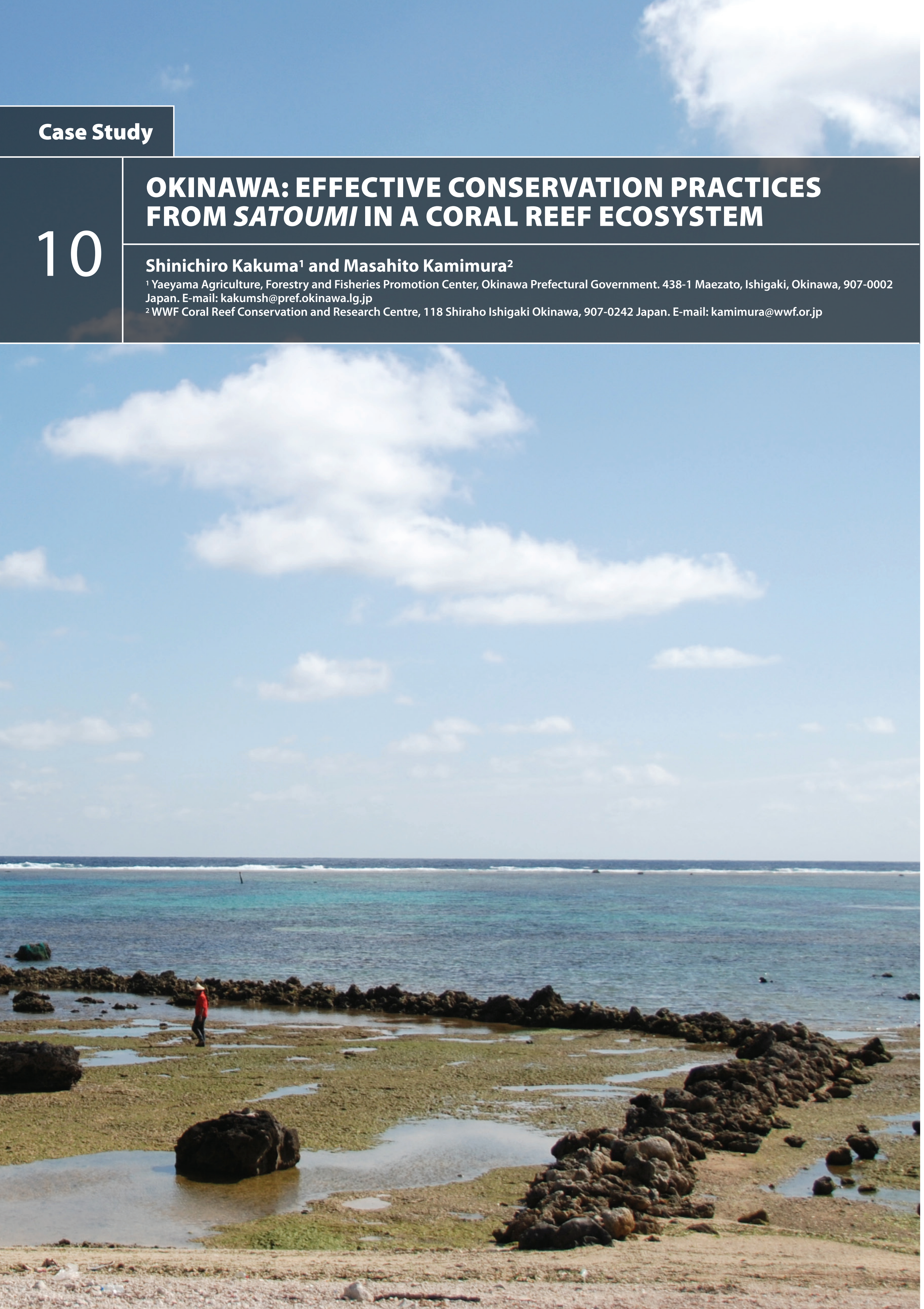

Case Study

10

OKINAWA: EFFECTIVE CONSERVATION PRACTICES FROM *SATOUMI* IN A CORAL REEF ECOSYSTEM

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ABSTRACT

The coral reef ecosystems of Okinawa are the southernmost case study represented in this report. As with other reef peoples, those of the local communities of Shiraho and Sekisei lagoon have, over the centuries, developed a *satoumi* culture intimately linked to the reef ecosystem and adapted to an abundant but sustainable use of its resources. The biodiversity that developed in this traditional equilibrium is threatened in ways similar to that of other human-influenced coral reefs of the world's oceans. This case study reports on a number of good practices that emerged in response to these threats.

While a consensus was reached among fishers on the establishment of marine protected areas, "passive" measures based on curtailing human interaction with the environment were found to be insufficient. They were then complemented by "active" measures involving conservation-purposed manual labour for protection of the environment. These included controlling populations of reef-damaging crown-of-thorns starfish, constructing biodiversity-enhancing habitats of traditional stone fishing weirs (*ishihimi*) and propagating *mozuku* seaweed. Preliminary data on the effectiveness of these actions for biodiversity is encouraging.

For management purposes, the *satoumi* tradition supported a discourse adequate to engage local communities in conservation efforts. The active conservation work undertaken may be of interest to managers of ecosystems where there is considerable human interaction with the environment and a restriction-only approach does not suffice to conserve biodiversity. In this case study, these practices stemmed from the view that careful, conservation-purposed measures to restore and enhance the coastal environment by human hands can provide positive results for biodiversity and sustainability, the central hypothesis of *satoumi*.

INTRODUCTION

The ecosystems targeted in this study were the coral reefs in the areas of Shiraho and Sekisei lagoons in the Yaeyama district of Okinawa Prefecture (Figure 1). Essential aspects of Okinawa *satoumi* include commons and local rules (Nakajima 2008). "Commons" are resources that are shared and used by local people; "local rules" refers herein to resource-use regulations that are autonomously determined by local communities. Okinawa's *satoumi* feature *ino*, or shallow, calm waters located between the offshore coral reefs, where the waves break, and the shore. Since ancient times, those who fish for a living have collected their catch in the outer seas, while village residents relied on the fishery resources of the *ino* inside the reefs as commons, and have led a semi-agrarian-, semi-fishing-reliant lifestyle (Tamanoi 1995). This commons-type usage is practised even today, particularly in the outer islands. On the other hand, as many sedentary resources are subject to common fishery rights, members of Fishing Cooperative Associations (FCAs) have the right, in principle, to harvest or capture them. This has greatly complicated the relationship between traditional customs regarding the *ino* and the fishery rights system. Legal and management aspects must hence be considered, in addition to technical issues, for the enhancement of productivity and biodiversity in the *ino*. For this reason, the local people, who are the most closely involved with the *ino*, must create local rules and observe them.

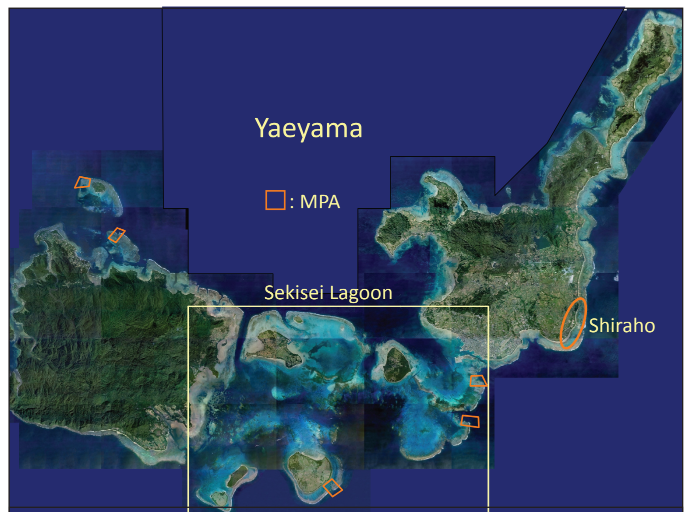

FIGURE 1. Composite photographs showing the areas discussed in this case study: the Sekisei Lagoon, Shiraho, and the Marine Protected Area in Yaeyama.

THREATS TO THE ECOSYSTEM

Some of the anthropogenic influences of greatest impact include increase in soil runoff, excessive input of nutrients and chemical substances, land reclamation, dredging, illegal harvesting of coral, fisheries, aquaculture, and excessive tourism. Powerful natural influences include typhoons, massive coral bleaching, predation damage by crown-of-thorns starfish and shellfish, and diseases (Kakuma 2009). Coral bleaching and the increasing magnitude of typhoons are associated with climate change, and it is possible as well that crown-of-thorns starfish outbreaks and the spread of diseases are the indirect impact of human activities. These phenomena might be viewed as anthropogenic influences as well. The following is a summary of two disturbance factors: the problems of runoff of red soil and excessive nutrients.

So-called red soil pollution (*akatsuchi osen*) is a grave environmental problem in Okinawa (Omija 1987). Massive runoff of the red-coloured soil found on Okinawa, Ishigaki and Iriomote Islands has increased, one of the reasons being coastal development. The red soil does not contain toxic components but damage results from the sheer quantities that flow into coastal waters, silting over the reefs. Even small quantities are sufficient to stress the coral, which secretes mucus in response. Clouding of seawater by red soil, moreover, adversely affects the photosynthesis of *zooxanthella*, an alga that has a symbiotic relationship with the reef. Furthermore, coral larvae cannot settle to the ocean floor if it is covered in red soil sediment. Red soil pollution affects not only coral, it also has a direct impact on fisheries and aquaculture.

The guiding principle of red soil pollution countermeasures is preventative measures at the pollution source. In 1995, Okinawa Prefecture instituted the Okinawa Prefecture Red Soil Runoff Prevention Ordinance. Red soil pollution associated with development has apparently decreased due to this ordinance, but runoff from farmland and other areas continues. For this reason, agricultural management-related measures must be strengthened.

Growth of *Acropora* corals was found to be poor in marine areas where there were high concentrations of nutrients (Omija et al. 2003). Coral reef ecosystems have adapted to nutrient-poor environments, so the influx of excessive land-based nutrients is a serious problem. Although the direct effects of the nutrient influx on coral reefs are not fully understood, high nutrient conditions are known to favour phytoplankton development, which clouds the water, and the excessive nutrients results in increased macroalgae growth as well. As algae and coral compete with one another, the fast-growing algae propagate, and the coral reefs go into decline.

The growth of the livestock industry in Okinawa increased nutrient loading from the effluent of cattle, pig and other stock farms. In 2004, The Law on Promoting Proper Management and Use of Livestock Excreta was amended to prohibit the open-air storage of manure. Farmers are now obliged to lay down concrete to prevent faeces and manure from percolating underground, and to cover such material with a roof or tarpaulin. Enforcement includes fines of up to 500,000 yen. However, although countermeasures have been strengthened, the handling of manure is still inadequate at some farms. Another problem that must be addressed is nutrient-rich urban household effluents.

Deterioration of the coral reefs in the Yaeyama district continues. Not only did the area suffer from the extensive coral bleaching that occurred worldwide in 1998, it experienced more coral bleaching in 2007 on a scale that surpassed the 1997 levels, with reports that approximately half the coral had died. Damage caused by major typhoons, the runoff of red soil and excessive nutrients from terrestrial areas also had a significant impact. The predation of corals by crown-of-thorns starfish has recently become the greatest threat.

Catches of coral reef fish species such as *Lethrinidae*, *Serranidae*, *Scaridae*, *Caesionidae* and *Siganidae* have decreased by half in the last 15 years. Not only have catches declined, catch per unit effort (CPUE) has fallen and resources have diminished (Figure 2, Ota et al. 2007). Although over-fishing is probably the main cause, coral reef degradation is also thought to be responsible. For this reason, there is a pressing need for fishery resource management, including in the form of Marine Protected Areas (MPAs).

Thus, the conservation of coral reefs and the management of fishery resources are central issues in Okinawa's *satoumi*. While "passive" measures, such as curtailing excessive nutrient input from terrestrial areas and imposing catch limits, are strategic pillars of conservation efforts, they do not suffice, even in the case where a consensus can be built for their significant expansion. As described below, "active" measures involving manual labour for the purpose of regenerating coral and eradicating the crown-of-thorns starfish have proved to be invaluable complements to passive conservation measures.

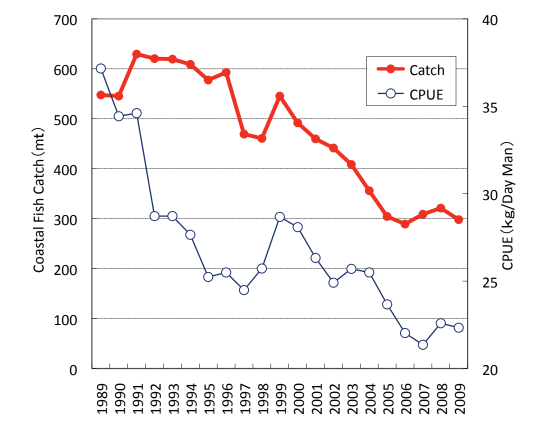

FIGURE 2. Time series of catch and catch per unit effort of coastal fish (after Ota et al. 2007), showing a steady decline since 1989.

ACTIVITIES AND THEIR OUTCOMES

Shiraho Lagoon

The village of Shiraho on Ishigaki Island looks out over a 12km stretch of coral reef. The *ino* within this reef is a central element of the local community's culture and livelihood. Local inhabitants consume a wide variety of fishery resources from the *ino* waters, and festivals and religious rituals are part of what could be described as a coral reef cultural-sphere lifestyle that is intimately connected to the sea. The historically semi-agrarian, semi-fishing, subsistence lifestyle of the villagers had a light environmental footprint and the natural environment was sufficiently resilient. Human use of nature's resources here, therefore, did not significantly infringe on the biodiversity of the reef. Inasmuch as the coastal seas were common village property since the time of the Ryukyu Kingdom (15th to 19th century), and as the local community there developed an intimate and sustainable relationship with the sea, they could well be called a *satoumi*.

The relationship between the people of the village and the sea has weakened, however, with the modernization that took place after the end of World War II, the reversion of Okinawa to Japan (1972) and the recent assimilation of Okinawa into mainland Japanese culture. The increased runoff of red soil from construction sites and the influx of household effluents into the sea have increased the burden on the environment of human presence on the island. In environmental monitoring surveys conducted over the 10 years since the World Wildlife Fund of Japan Coral Reef Conservation and Research Centre was established in the village, fixed monitoring points on Shiraho Reef have revealed that the amount of coral has significantly decreased (WWFJ 2010). The shadow of that decrease has been felt on the biodiversity of the Shiraho *ino*, once known as "the sea that teems with fish" (*sakana waku umi*).

Meanwhile, in 2006, a charter setting down seven basic policies for village development was established at a general meeting of community members held at the Shiraho Community Centre. As one of its basic policies, the Charter advocates "protecting our coral reef environment, which is one of the best in the world, and leading lives that are based on nature". Thus, the whole village has started working to conserve the biodiversity and to manage the resources of the sea directly in front of the village in a sustainable manner. This Charter was enacted because it had become difficult to maintain village norms and pass down culture on the strength of oral tradition alone. In addition to passing on traditional culture to the next generation, the Charter also represents a basic stance vis-à-vis local rules. The local community in Shiraho thus positioned itself to maintain and manage the *satoumi* within the sphere of its regional autonomy, and is using these approaches as a platform for "cultural transmission" and "learning experiences".

The Shiraho Coral Reef Management Council, established in 2005, plays a central role in coral reef conservation and resource regeneration activities conducted by the local community. The coral reefs of Shiraho are viewed as commons. Thus, in addition to fishers and tour guides, residents of the villages, including agricultural and livestock farmers, participate and cooperate in actions to invigorate the region through the conservation and sustainable use of the reef. In 2006, the Council developed the "Self-Determined Rules for Coral Reef Tour Guides" and "Dear Visitors to Shiraho…" (a collection of instructions on tourism etiquette) and restored the traditional *ishihimi* (stone fishing weirs) (Figure 3; Kamimura 2007). In 2007, the Council launched a program for planting shell flower (*getto*, a species of ginger; *Alpinia speciosa*) around fields as a means of preventing red soil from flowing into the sea.

FIGURE 3. Photograph of a traditional stone fishing weir (*ishihimi*) in Shiraho. *Ishihimi* has been shown to provide habitat for many species and contribute to local biodiversity.

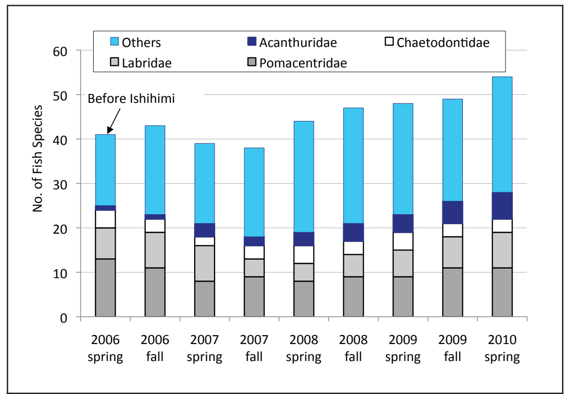

FIGURE 4. Fish species counts near *Ishihimi* after construction and in the five subsequent years, suggesting a positive effect of *Ishihimi* on local fish biodiversity (WWFJ 2009).

In 2009, the Council embarked on a stock enhancement project, restocking 7,000 giant clam (*Tridacna crocea*) juveniles cultured in a hatchery. A survey conducted one year later revealed that the average survival rate was 43 per cent, indicating that the project could be considered a successful first attempt. The aim of restocking the clams is not to harvest them, but to increase the resources of the surrounding area. The clams will be protected and nurtured for approximately four years, so that they will spawn. This is one example of increasing productivity through human interaction.

The use of *ishihimi* is another example of "enhancing productivity and biodiversity through human interaction". *Ishihimi* are the infrastructure of an ancient fishing method where rocks are piled up in walls on the shore or in shallow areas of the coral reef in order to use the tides to catch fish (Tawa 2006). Replaced by more efficient net fishing techniques, this method had almost sunk into obscurity. Recently, however, the technique has been reconsidered for its value for environmental education and interest to tourists, and thus a movement has emerged to revive this fishing method. *Ishihimi* do not merely function as fishing infrastructure; they also enhance biodiversity as the crevices of the piled up rocks create habitats for a variety of organisms. The algae that grow densely on the rocks attract sea life that feeds on it, which in turn causes fish species to increase in the area. A study conducted by WWF Japan confirmed that in the *ishihimi* areas, shellfish and fish species have increased (Figure 4; Figure 5; WWFJ 2009).

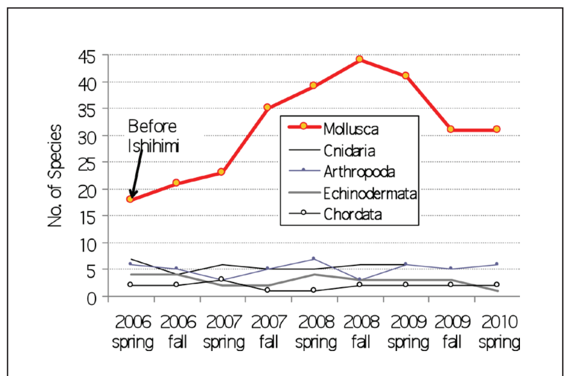

FIGURE 5. Species count near *Ishihimi* after construction and in the five subsequent years, suggesting a positive effect of *Ishihimi* on the diversity of mollusca (WWFJ 2009).

SEKISEI LAGOON

Local restoration activities

The Sekisei Lagoon Nature Restoration Committee, on which serve local residents, researchers, marine business owners, representatives of local and national government organizations and other individuals from the Yaeyama area, was established in 2006 to deliberate on ways of protecting and restoring the coral reef. The main secretariat is in the Ministry of the Environment. The activities of the committee are principally aimed at reef conservation and regeneration. However, the Sekisei Lagoon Nature Restoration Project Master Plan describes the vision for the Sekisei Lagoon as "schools of green parrotfish, abundant giant clams and fields of coral resplendent in all their glory". Thus, important goals of this project include not only the regeneration of the coral, but also the restoration of fishery resources that inhabit the reef.

The Ministry of the Environment has proposed an implementation program based on the Law for the Promotion of Nature Restoration and is conducting nature restoration initiatives in accordance with this legislation. One of the main projects is a coral reef restoration project in which coral larvae settled on special ceramic devices. These are then replanted to carefully selected marine locations on a priority basis (Naha Nature Conservation Office, Ministry of the Environment 2007).

Predations of crown-of-thorns starfish

Starting in the 1970s and continuing through the 1980s, crown-of-thorns starfish outbreaks occurred throughout Okinawa, severely damaging the corals. Eradication projects failed to protect the corals, and the objective now is not to kill masses of this starfish, but rather to protect the precious corals. Conservation areas of greatest importance have been designated for each marine area, and in these locations, the efforts for thorough eradication are concentrated there (Okinawa Prefecture Nature Conservation Division 2004).

In the 1980s, the coral of Yaeyama marine areas was also devastated by predations of crown-of-thorns starfish. The coral recovered afterwards, but another outbreak occurred around 2008. Eradication efforts (mainly by fishers and diving associations) are underway, with 65,000 starfish killed in 2008 (20 times the number killed in 2007), and 96,000 killed in 2009 (Figure 6). The basic eradication policy in Yaeyama is to focus extermination efforts on priority marine areas. Nevertheless, the marine areas of Yaeyama are vast, so focusing on areas of high priority is no easy task, and this is complicated by the different preferences of fishers and divers. For example, while fishers may be inclined to eradicate starfish in fish spawning grounds set in no-take marine reserves, divers would prefer to protect those locations dotted throughout the vast Yaeyama marine area that they use frequently. Currently, eradication programs are being implemented by the Ministry of the Environment, the Ministry of Agriculture, Forestry and Fisheries and local organizations. In 2009, The Yaeyama COTS Eradication Committee was established to link these projects together. Committee members include national, prefectural and municipal government entities, the Yaeyama FCA and the two Diving Associations. The committee first selects high priority marine areas, then fishers and divers join forces to intensively and continuously eradicate the starfish.

FIGURE 6. Diver participating in the attempt at mitigating outbreaks of crown-of-thorn starfish, currently the single largest threat to the coral in Yaeyama.

Managing fishery resources by way of Marine Protected Areas (MPAs)

From 1998 to 2002, in order to allow fishery resources that had declined to recover, the fishers of Yaeyama managed resources through the establishment of Marine Protected Areas (no-take marine preserves), targeting Pacific yellowtail emperor (Jp. *isofuefuki*; *Lethrinus atkinsoni*), one of their most important resources. Furthermore, in 2008, as catches not only of Pacific yellowtail emperor, but of all coral reef fish species fell dramatically after this management was discontinued, a new fishery management programme was launched. The cornerstones of this programme are no-take marine preserves and fish size limitations.

The number of the target fish species increased significantly, not only the Pacific yellowtail emperor, but also the most important species such as grouper (*Serranidae*). Fishing was prohibited during the main spawning season, from April to June. The number of no-catch marine preserves increased in number—from the four main spawning grounds where the programme had been previously implemented, to five (Figure 1)—expanding the total marine area to five times its previous size. Past resource management of the emperor fish had not resulted in a full recovery of the resource. One possible reason for this is that the no-take marine preserve area was too small. Increasing the size of the area was significant in achieving restoration.

A feature of this type of resource management is that not only those who fish for a living, but also recreational fishers and divers, work together to manage the resources. In addition to familiarizing people with resource management through posters and mass media, the fishers hold discussions with diving associations and request divers to cooperate by not entering no-take marine preserves.

The management of marker buoys and surveillance are important in terms of giving teeth to the rules against entry to no-take marine preserves. Surveillance is currently conducted by fishing cooperative youth groups. Fishing cooperative regulations have provided that "trespassers must pay fines equivalent to five times the value of takings for that day". Thus in Okinawa, MPAs function to protect fishery resources through self-imposed rules set by fishing cooperatives. A feature of the MPAs that should be noted is that they do not offer protection throughout the whole year, but only temporarily, such as during spawning seasons or periods when juvenile fish congregate (Kakuma 2007).

OTHER ZONES (ONNA)

In Onna Village on the main island of Okinawa, fishers are engaged in aquaculture of *mozuku* seaweed and sea grapes (Jp. *umibudo*; *Caulerpa lentillifera*) and other seaweed for much of their livelihood (Onna Village Fishing Cooperative, 2008). *Mozuku* aquaculture, where nets are stretched over sandy bottom areas of coral reef, enhances the biodiversity of those areas not only by providing homes for small organisms such as shrimp that live among the seaweed, but also by providing food for fish such as rabbit fish (*Siganidae*), which feed on *mozuku*. The fishers also propagate *mozuku* seedlings, maintaining the water level by enclosing some areas of the tidal flats with sandbags, rocks or other material. This forms seagrass beds, and the biodiversity of the area is clearly greater than in the tidal flats surrounding them (Figure 7). A further initiative is the planting of iron reinforcing bars (called "re bars") in sandy areas for coral aquaculture, which is conducted on top. If coral grows on the re bars, small fish congregate and the biodiversity of the areas is enhanced. Although some of the new growth is cut off and used for transplants, it is anticipated that this initiative will also function to supply larvae to the surrounding areas, as the cultured coral spawns.

FIGURE 7. Nursery areas of m*ozuku* in Onna. *Mozuku* aquaculture contribute to fishers livelihood, as well as providing habitat for many species, and appears to enhance local biodiversity.

FUTURE PERSPECTIVES

The World Ishihimi Summit was held in Shiraho at the end of October 2010. Stone fishing weirs are found outside Japan, including in Taiwan, South Korea, the Philippines, France, Spain and Micronesia. Therefore, this summit was intended to be a conference where people from all over the world who are associated with this fishing gear could share their experience and discuss the relationship of such approaches to the *satoumi* and ecosystem.

Through the Sekisei Lagoon Nature Restoration Project, in addition to working independently to formulate countermeasures for tackling problems such as red soil pollution and efflux of excessive nutrients from terrestrial areas, there is also the issue of how to join forces with fishers to sustain fishery resource management, which is part of the restoration of the natural environment.

The crown-of-thorns starfish outbreak in Yaeyama is expected to continue for several years. Thus, in addition to securing a budget, fundraising and other volunteer initiatives are needed to support starfish population control operations.

There is wide consensus that coral reef ecosystem conservation is essential and even vital for many coastal communities around the world, and is a critical aspect of global marine biodiversity preservation as well. There is, however, considerable debate on the best way to achieve this, with at one end the view that natural wilderness environments, protected from all human impact, should be sought for the protection of biodiversity (Bellwood et al. 2004; Pandolfi et al. 2003). In many cases, this would deprive local communities of essential ecosystem services and often of their very livelihood, and would therefore not be a realistic policy option. It is thus essential to enhance the knowledge base available to conservationists and coastal managers in charge of managing biodiversity in such areas where human interaction with the ecosystem must remain significant for the foreseeable future. The *satoumi* experiences reported here, although still work in progress, illustrate a number of good practices for managing biodiversity in reef ecosystems under significant anthropogenic influence. It is hoped that they may be of use for the management of similar ecosystems around the world.

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III. Overview Articles

Overview Article

1

SATOUMI AND INSTITUTIONAL CHARACTERISTICS OF JAPANESE COASTAL FISHERY MANAGEMENT

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ABSTRACT

A survey conducted by a team from the University of Tokyo identified 1,161 marine protected areas (MPAs) in Japan. Approximately 30 per cent of them take the style of self-imposed community no-take zones. Free-riders of the conservation activities are uncommon, because agreements are usually made to maximize the benefit to the group of fishers, and each member of the group monitors the compliance status of other members. The government has provided territorial use right for fishers, and this may have helped in maintaining their self-governance framework. Additional *satoumi* activities are reported in Japan that are also based on voluntary habitat rehabilitation to improve ecosystem services.

INTRODUCTION

Seafood harvested in the coastal areas has played a significant role in fulfilling people's dietary needs and livelihoods for many centuries. During and before the Edo Period (1603-1868) various remote coastal communities developed their own fishery resource management rules. The Meiji government, established in 1868, rigorously surveyed such traditional local rules and attempted to incorporate them into the new government legal system (Takahashi 2007).

Nevertheless, many local rules have been left unlisted in the government regulations to this day, presumably because they are too site-specific. Such local rules are still in force today as self-imposed agreements among local fishing communities. Various marine protected areas (MPAs) and other area-based conservation activities are established as bottom-up self-imposed instruments of local communities. Such activities are not fully reported to the government or the public, therefore the complete picture of the MPAs in Japan is still largely unknown.

A survey was conducted in an effort to grasp a comprehensive picture of MPAs in coastal Japan. The results of the survey, as well as the nature and institutional characteristics of these community-based management approaches, are discussed in this chapter.

CURRENT STATUS OF MPAS IN JAPAN

A team from the University of Tokyo collected information on the location and areal extent of MPAs in Japan from 2009 to 2010. Some 1,161 MPAs were identified and located (Yagi et al. 2010).

As shown in Table 1, of the 1,161 locations, 1,055 (52+616+387) are implemented in conjunction with fishery regulations. Specifically, they take the form of no-take zones for certain species. The number of bottom-up self-imposed MPAs (387 locations in the study) had not been available for many years in Japan, and Yagi et al. (2010) was the first publication to show that approximately 30 per cent of MPAs in Japan are community-based self-imposed no-take zones.

TABLE 1. Number of MPAs in Japan classified by their management mechanisms. Protections are provided through various legal instruments. The six types of MPAs are: marine park areas established by the natural parks law (managed by the Ministry of the Environment, hereafter MOE); marine special areas established by the Nature Conservation Law (managed by MOE); special protected zones inside the wildlife special protection areas, which are established by the wildlife protection and appropriate hunting law (managed by MOE); protected waters established by the Act on the Protection of Fishery Resources (managed by the Ministry of Agriculture, Forestry and Fisheries, hereafter MAFF); legally binding no-take zones of aquatic animals and plants established under the Fishery Act and prefectural fishery coordinating regulations (managed by MAFF); and no-take zones established through self-imposed agreements among the members of the fishery cooperative associations.
Based on Yagi et al. 2010.

MPA type	Management authorities	Legal framework	Number of sites
Marine park areas	Ministry of the environment	Natural Parks Act	82
Marine special areas	Ministry of the environment	Nature Conservation Act	1
Wildlife protection areas	Ministry of the environment	Wildlife Protection and Proper Hunting Act	23
Protected waters	Ministry of agriculture, forestry and fisheries	Act on the Protection of Fishery Resources	52
Legally-binding no-take zones	Ministry of agriculture, forestry and fisheries	Prefectural fishery coordinating regulations	616
Community-based self-imposed no-take zones	Local fisheries cooperative association (FCA)	Published and unpublished FCA rules	387

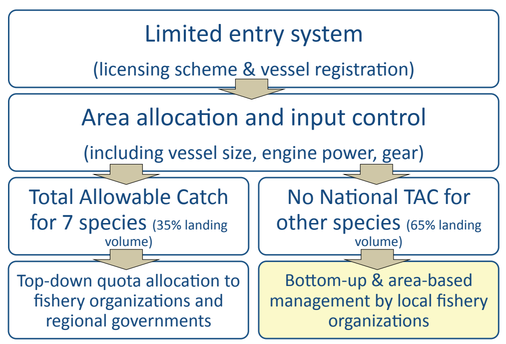

FIGURE 1. Fishery management measures in Japan.

MPAs managed by the Ministry of the Environment take a top-down approach where the central government is a major driver for conservation, while fishery-related MPAs managed by the Ministry of Agriculture, Forestry and Fisheries (MAFF) take a bottom-up approach in which informal functions of local Fishery Cooperative Associations (FCAs) are critical.

The total area of MPAs in Japan was not provided by this study. Information on the possible overlaps between different types of MPAs, as well as the exact size of some areas in community-based self-imposed no-take zones, is missing and this makes an accurate calculation on the total coverage difficult at this stage (Yagi et al. 2010).

NATURE OF AREA-BASED MANAGEMENT IN COASTAL FISHERIES

The relevance of the number of such no-take zones is better understood in the context of the fisheries management system in Japan. Traditional Japanese fishery management systems are based on a limited entry system and area allocations. The Government's licensing scheme limits the number of vessels and entities which can operate fisheries. In coastal Japan, fishing areas are allocated to FCAs. In many cases, these area allocations are based on a traditional tenure system in managing coastal fishery resources, which assumes rights-based co-management of resources in the community.

The introduction of output control (i.e. setting quotas for fish harvest) came relatively late in Japan. In 1997, seven fish species, representing 34 per cent of the national landing volume in 2007, were subject to output control regulations under the Government of Japan's Total Allowable Catch (TAC) system. Other species are still managed using input control methods that involve limitations on vessel tonnage, horse power, gear, seasons, and seasons of operation (see Figure 1). Details of these regulations, which often involve the management of no-take zones, are usually decided and imposed by the members of local FCAs through their regular decision-making processes.

The number of FCAs in Japan was 1,092 as of March 31, 2009, according to the Fisheries Agency of the Government of Japan. Many FCAs owned one no-take zone, while other FCAs had two or more and still others possessed none. The number of the no-take zones is reasonable, judging from the fact that it roughly corresponds to the number of FCAs, which is a local co-management unit of coastal fisheries in Japan (Yagi et al. 2010).

Such zones can be regarded as MPAs. At the seventh meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 7, 2004), it was noted that "'Marine and coastal protected area' means any confined area within or adjacent to the marine environment, together with its overlying waters and associated flora, fauna, and historical and cultural features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine and/or coastal biodiversity enjoy/enjoys a higher level of protection than its surroundings" (decision VII/5). The Japanese bottom-up MPAs described herein fall within this definition.

GOVERNANCE MECHANISM OF SELF-IMPOSED MPAS

A question may arise on the status of enforcement for these self-imposed areas. Yagi et al. (2010) described a mechanism for compliance to the rules as follows:

Firstly, the economic logic of self-imposed no-take zones and their peer monitoring among members of the same FCAs must be considered. Because the limited entry system in coastal fisheries is strictly maintained by the fishery rights regime imposed by the government, the same group of persons who belong to the same FCA assume long-standing rights to collectively use fishery resources in their waters. In other words, the same group of fishers both bears the

Box 6: Kisetsu-sadame

Tetsuo Yanagi, Kyushu University

Although this report focuses on management options in a modern setting, it should be noted that many contemporary *satoumi* practices are rooted in traditions and local knowledge often dating back several centuries. This is particularly true of customary co-management or community-based management practices. One example is the resource management by the fishers union on Himeshima Island in Oita Prefecture, which is still based on *kisetsu sadame*, a document written in 1904 that summarises much older traditions. *Kisetsu sadame* details areas and periods where fishing is prohibited, such as the harvest of sea algae, permitted only in designated areas during the period 15 January to 5 February, or the trapping of red sea-bream, permitted only during the period 25 February to 15 June. These traditional rules are regularly updated or complemented to follow technical developments. For example, in 1916 the fishers decided to ban the use of red sea-bream trapping, a fishing method which led to an abrupt decrease in catch a few years after its introduction in the area in 1909. Today there are 197 members in the Himeshima Fishers Union. All matters related to the management of fishing resources around Himeshima Island are decided in official meetings where 56 representatives of 7 villages on the island update *kisetsu sadame*, including changes in the periods and/or areas of fishing prohibition.

cost of conservation and receives the benefits inside their local waters. Once they mutually agree to create a no-take zone as a means to maximize their collective benefit, they have a strong incentive to adhere to it, and peer-monitoring activities would be initiated to deter poachers. Several fishers informed the authors that they in fact monitor positions of boats of their peers in the sea using vessel positioning devices, cell-phones, or other communication tools. Sanctions among cooperative members and the local societies are often levied in the case of infringement.

Secondly, self-imposed no-take zones are perceived as being just as legally binding as other no-take zones among FCA members. The majority of legally binding no-take zones and protected waters listed in prefectural fishery coordinating regulations are considered to be originated from historic voluntary no-take zones. Community-based coastal fisheries management started more than 250 years ago in Japan (Aotsuka 2000). The record shows that the fishery regulation of Tokushima Prefecture, for instance, which was enacted in 1895, contained provisions of closed areas and seasons. Such provisions were not a new creation at the time of the legislation about 115 years ago but merely a legalization of measures that already existed as self-imposed community rules (Aotsuka 2000). This observation is reasonable judging from the fact that creating new no-take zones from scratch usually requires more transaction cost than just reauthorizing already existing customary rules. It can be argued that, because starting points for voluntary and legally binding no-take zones were similar, the members in FCAs tend to adhere to both rules in similar manners.

Why are many self-imposed MPAs left unlisted in the government legal framework? FCAs usually have both published and unpublished rules, and many MPAs are unpublished. Yagi et al. (2010) explain the reason why some of them are left unpublished in official documents as follows: first, the non-binding ones are relatively new and therefore missed the timing of major revisions of prefectural fishery coordinating regulations. Members of FCAs would prefer to avoid the rigorous documentation process required to register such areas as legally authorized protected areas, when good compliance for such local MPAs are maintained even without the formal legal status. Second, fishers prefer flexibility in protecting migratory species. In the case of the sand eel fishery in Ise Bay, the area of the autonomous MPA changes weekly to allow timely escapement of moving fish stocks (Matsuda et al. 2010). Were the regulation formalised through legislation, it would not be fully adaptive to the rapidly changing biological distributions of target species for protection (Yagi et al. 2010).

SATOUMI AND MPAS

Activities for habitat rehabilitation are not counted as MPAs in the study of the University of Tokyo because they do not constitute activities to reserve confined areas. Rather than simple area reservations, they take the form of positive interactions of users with

FIGURE 2. Local activities for habitat restoration for native bivalve species through the removal of alien predator shellfish species, and for the improvement of a tidal flat ecosystem by tilling the bottom sediment (Photo: Nobuyuki Yagi, Iwate Prefecture).

the ecosystem, and they include seagrass planting, sediment removal from the ocean bottom, removal of alien species, or tree planting adjacent to upland rivers to improve the water quality entering the ocean. Nonetheless, it can be considered that such activity also has "the effect that its marine and/or coastal biodiversity enjoy/enjoys a higher level of protection than its surroundings" like many other MPAs.

Such local bottom-up activities for habitat rehabilitation are a central feature of *satoumi*, a traditional stakeholder initiative to conserve and sustainably use ecosystem services. The term "sato" means "residential area" and "umi" means "the sea". Reports on such activities are detailed throughout this technical series and available in various publications and websites (see http://hitoumi.jp/hozen/).

The effectiveness for conservation and/or biodiversity management of such interaction with coastal ecosystems should be duly taken into account in intergovernmental processes to complement the current focus on total area coverage of MPAs. In certain settings, taking into account the intensity of activities as described above, not based on area reservation yet effective at conservation, would benefit the fair and holistic evaluation of marine conservation activities.

ARE JAPANESE STYLE *SATOUMI* AND MPA PRACTICES APPLICABLE IN OTHER SETTINGS?

The potential relevance of Japanese *satoumi* practices in other contexts should be examined. To this end, we should recall that compliance mechanisms of Japanese style *satoumi* and MPAs are based on peer monitoring and sanctions by community stakeholders who share the cost and benefit of conservation activities.

Satoumi and self-imposed MPAs are management tools that can jointly benefit the members of the co-management group. As argued above, *satoumi* and autonomous MPAs are not a product of simple altruism, but rather are logical extensions of the tenure system guaranteed by the government legal system.

Users must be interested in the sustainability of the particular resource so that the expected benefits will outweigh current costs (Ostrom et al. 1999). To this end, the role of the government is important in keeping the non-stakeholders from gaining access to no-take zones (Francour et al. 2001). In the case of Japan, the fishery right issued by the government allows exclusive access to fishery resources for the license holder and is treated as a non-transferrable property right under the fishery act. In return, FCAs are expected to establish their collective management rules for resource exploitation in the tenure area (World Bank 2006). It can be concluded that, unless similar strong territorial use-rights are guaranteed by government or similar authorities, the Japanese style *satoumi* or self-imposed MPAs are difficult to transfer to other countries.

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Overview Article

2

SYNTHESIS: EMERGING *SATOUMI* PRACTICES FOR BIODIVERSITY MANAGEMENT IN HUMAN INFLUENCED COASTAL ECOSYSTEMS

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ABSTRACT

The preceding case studies report on the progress of *satoumi* practices as field tested, culturally appropriate attempts to integrate conservation and use of biological diversity in human-influenced coastal seas. While the enhancement of exclusionary (protected area-based) and mitigating (e.g., reducing fishing or pollution) approaches to conservation remain a high priority, there is also a pressing need to develop the knowledge base for managing biodiversity on the large and growing proportion of our shores where exclusion is difficult and mitigation insufficient. *Satoumi*'s nuanced view of human interaction with nature coherently incorporates conservation measures involving more—rather than less—human interaction with the ecosystem. Preliminary results from the study sites suggest that in human-influenced seas, such "active" measures are useful and even indispensible complements to "passive" conservation, when the ecosystem cannot recover by itself and human nurture is needed. There is also reported evidence demonstrating that, under certain conditions, human nurture has enhanced marine ecosystem services in a sustainable manner. The case studies further report on modern-day practices effectively engaging local communities in conservation, and on the ownership of conservation measures by fishers that voluntarily internalise conservation costs in *satoumi* co-management. The latter appears to rest on collective ownership, with limited access and empowered collective structures that can reflect a not purely economic view of the ecosystem. Overall, *satoumi* appears to be a versatile approach that coherently incorporates a wide variety of considerations, from economic to spiritual, community-based to scientific, traditional to modern. Encouraging results in biodiversity conservation at the community level present a compelling argument for further research and assessment, effective uptake in wider integrated coastal management frameworks, and catalysing of international mechanisms to share and account for related practices effectively.

INTRODUCTION

The *Global Biodiversity Outlook 3* (CBD 2010a) confirms the alarming decline of marine biodiversity, reported earlier in the Millennium Ecosystem Assessment (MEA 2005). In response, the tenth meeting of the Conference of Parties to the Convention on Biological Diversity (COP 10, Nagoya, Japan, 18-29 October 2010) adopted the Aichi Biodiversity Targets, including the aim of 10 per cent of marine and coastal areas being protected or benefiting from other area-based conservation measures by 2020 (target 11, CBD 2010b). Marine protected areas (MPAs), which have been the cornerstone of most biodiversity conservation strategies, have proven their effectiveness in many cases (CBD 2004a). Nonetheless, disappointing results and hardship to local communities are documented in other settings (Hilborn et al. 2004; Jones 2006; Charles and Wilson 2009). There is a growing consensus that for conservation to succeed, societies must find ways to balance and integrate conservation and use of biodiversity, as Parties to the Convention on Biological Diversity (CBD) agreed in Principle 10 of the CBD Ecosystem Approach (EA, CBD 2000): "The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity." In the face of ever-increasing demand for coastal space and accelerating ecosystem degradation over much of the world's coastlines, there is a pressing need to rapidly expand the knowledge base for managing biodiversity through ways that can complement the sole exclusion of human influence.

The case studies report progress in both field implementation and the assessment of culturally appropriate conservation practices at the community level in human-influenced coastal seas, attempting to integrate conservation and resource use in ecosystems ranging from a well-preserved UNESCO World Heritage site to a fully urbanised one, from ice-floe covered waters to coral reefs. *Satoumi* evokes *satoyama* (Takeuchi et al. 2003) and other cultural landscapes, where human hands patiently nurtured nature to enhance ecosystem services sustainably (CBD 2010c), but the question of whether this has also happened at sea is not the focus of the case studies or this synthesis chapter. Notwithstanding the importance of traditional knowledge in *satoumi*, this synthesis will focus primarily on practical options for ecosystem management in modern, industrialised settings—currently the main thrust of *satoumi* activities in Japan.

In line with the founding definition of *satoumi* (Yanagi 2007) as a coastal sea with high productivity and biodiversity combined with human interaction, in a modern context *satoumi* holds a nuanced view of human interaction with the coastal environment, in which human presence is not always destructive. *Satoumi*-oriented conservation measures can put to work carefully controlled human influence on the ecosystem. These will be referred to herein as active measures in order to distinguish them from passive conservation measures that reduce human influence on the ecosystem through exclusion or mitigation. Passive measures rely on the ecosystem to recover on its own without human interaction, or to sustain itself if human interaction is sufficiently curtailed.

Typical exclusionary approaches include MPAs, moratoria or seasonal restrictions on fishing; mitigating approaches include fishing quotas and regulations on or treatment of industrial effluents. Expanding the application and effectiveness of such measures remains a central challenge in biodiversity management. Nonetheless, in certain cases, and particularly in human-influenced ecosystems, they are neither sufficient nor the most effective and most realistic conservation option available. Human nurture is sometimes necessary in order to reintroduce biodiversity in severely degraded ecosystems, as is the case in Ago Bay (case study 7 and Matsuda, personal communication 2010), and is demonstrated in restoration efforts in many different settings (e.g., Ingram 2010). In the rapidly expanding proportion of inhabited coastlines, it is likely that active conservation measures will often be useful complements to exclusion and mitigation. This chapter proposes a synthesis of the progress reported in the case studies in developing such measures in Japan's *satoumi*.

SATOUMI CONSERVATION THROUGH HUMAN INFLUENCE ON BIOGEOCHEMICAL CYCLES

The role of humans in nutrient and material cycling between coastal and terrestrial ecosystems is a central aspect in *satoumi*, and is one way by which traditional human interaction may have enhanced ecosystem productivity and biodiversity (Yanagi 2007). For example, human uptake of fish or seaweed removes reduced organic carbon from the coastal sea, which is then returned in oxidised form through rivers to the coastal sea. In stratified enclosed seas, such human activity may reduce hypoxia and enhance nutrient content in the euphotic layer. In enclosed seas, where humans have interacted with nature in such ways for a long time and these activities have changed sufficiently slowly for the ecosystem to adapt, this human influence may have brought the coastal sea to a more productive, yet sustainable, resilient and biodiverse state. In modern times, however, disruption of these cycles by abruptly changing human activities is a major destructive anthropic pressure, and restoration or conservation will include carefully controlling anthropogenic impact on these cycles. As illustrated in the case studies, active measures may be a valuable tool in such efforts.

Table 1 lists active conservation measures modifying biogeochemical cycles in the case studies. A wide variety of essential environmental variables can be influenced: dissolved oxygen in the water (through the culture and harvesting of seaweed or the adjustment of the depth and other parameters of artificial tidal flats); aerobic conditions in the tidal flat sediment (manual tilling of the sediment or enhancement of the water exchange with the open sea); suspended sediment in lagoon waters (planting flowers around fields or trees in mountains to reduce soil erosion and runoff); wetland nutrient loading reduction (promoting water exchange with less nutrient-rich seawater); tidal flat nutrient loading enhancement (using dredged, eutrophic wetland sediment); reduction of nutrient loading in a bay (planting and harvesting of kelp); and regulation of various geochemical cycles through transplants of *Zostera marina* (eelgrass). Tree planting and forestry management in the river basin are important aspects in nearly all *satoumi* sites. Besides providing a host of other important ecosystem services for the land itself, well-maintained forests and watershed ecosystems regulate land input of nutrients, sediment and driftwood into coastal seas. Although some of these practices are relatively new and are still being evaluated, others are time-tested practices (centuries old in the case of tree planting; see for instance box 1 on the fish-breeding forest), and still others are of scientifically documented effectiveness, as indicated in this table.

A wide range of parameters in the coastal environment can thus be influenced and brought back or "adjusted" through active measures to a range more optimal for the ecosystem productivity and observed biodiversity. Several of the case studies report encouraging data on locally enhanced biodiversity as a result of these actions. These include an increase in abundance and size of the target species for conservation, such as the

TABLE 1. Human influence on biogeochemical cycles for ecosystem conservation or productivity. Active conservation measures involving human action to influence biogeochemical cycles in the coastal environment as reported in the case studies. Shaded cells in column 4 (Benefits for conservation) indicate those where one or more of the case study report observations showing locally enhanced biodiversity as a result of the measure (refer to case study for details). Numbers in parenthesis in the last column refer to the case study number.

Parameter to influence	Action	Effect	Benefits for conservation	Illustrated in case study
Dissolved oxygen in water	Green laver culture	Photosynthesis oxygenates, reduced carbon removed before oxidation in water as seaweed is harvested	Helps mitigate or prevent anthropogenic hypoxia	Ago Bay (7)
	Adjusting depth and other properties of artificial tidal flat	Daytime photosynthesis compensates for oxygen consumption at night	Sufficient oxygen to host target species for conservation	Tokyo Bay (6)
Oxygen in the sediment	Tilling mud by hand	Favour aerobic conditions in the sediment	Better habitat for clams (and presumably other species)	Yamaguchi (9)
	Promoting water exchange with open sea	Favour aerobic conditions in the sediment	Better habitat for macrobenthos	Ago Bay (7)
Suspended sediment in lagoon	Planting shell flowers around agricultural fields	Reduces red soil runoff and thus sediment load in lagoon	Prevents damage to the reef (red soil disturbs photosynthesis and larvae deposition)	Okinawa (10)
Nutrient loading reduction in a wetland	Enhancing water exchange with the bay	Circulation of oligotrophic coastal waters reduces further eutrophication in the wetland	Enhances macrobenthos biodiversity	Ago Bay (7)
Nutrient loading enhancement in a tidal flat	Spreading of dredged wetland sediment	Eutrophic wetland sediment enhances nutrient load in the tidal flat	Enhances macrobenthos biodiversity	Ago Bay (7)
Reduce nutrient load in Bay	Planting and harvesting of makombu kelp	Kelp has a strong nutrient absorption capacity	Helps prevent eutrophication	Toyama (3)
Land/sea material cycling	Transplanting *Zostera marina*	The seagrass bed regulates many parameters, including nutrients, sediment transport, oxygen ...	Regulation of fluxes, structuring habitat for the ecosystem, and more	Ago Bay (7), Kanagawa (Box 4), Toyama (3), Yamaguchi (9)
	Planting trees in river basin	Prevents excessive soil erosion and siltation, nutrient input, debris ...	Regulation of fluxes and more.	All case studies

TABLE 2. Reported practices for maintaining or enhancing existing habitats (2.1), restoring or expanding natural habitats through propagation, transplant or aquaculture of macro-algae or coral (2.2), and creating artificial habitats (2.3). Shaded cells: in column 3 (purpose) indicate that the activity was motivated by conservation, in column 4 (conservation benefit), indicates that the case study provides data suggesting the conservation benefit is achieved locally. Numbers in the parenthesis in the last column refer to the case study number.

TABLE 2.1. Habitat maintenance or "improvement" in the case studies.

Habitat	Activity	Purpose	Conservation benefit	Illustrated in case study(ies)
Tidal flat	Tilling tidal flat mud by hand	Traditionally: harvesting of short-neck clams Today: softened sediment more hospitable to clam larvae, and favour aerobic conditions in the mud	Conservation of short-neck clams, a local species emblematic of the traditional *satoumi*	Yamaguchi (9)
Tidal flat	Crushing oyster shells	More hospitable to clams	Conservation of the short-neck clam	Yamaguchi (9)
Tidal flat	Net covering of mud	Protect clam from eagle ray predation	Conservation of short-neck clam	Yamaguchi (9)
Various	Modification of biogeochemical fluxes to maintain oxygen, sediment loading, nutrient loading within optimal range		Various	See Table 1

TABLE 2.2. Habitat restoration or expansion through "cultivation" in seawater in the case studies.

Habitat	Activity	Purpose	Conservation benefit	Illustrated in case study(ies)
Mozuku aquaculture nets (and other edible seaweed)	Set nets, propagate *mozuku* seaweed, harvest, maintain water levels at low tide by enclosing area	Food production, but provides habitat and food for various organisms	Enhanced local biodiversity	Okinawa (10)
Zostera marina beds	Includes some or all of: transplant of eelgrass, nurture, use special mats, seed collection and sowing	Habitat for various fish	Ecosystem conservation and structuring	Ago Bay (7), Box 4, Toyama (3), Yamaguchi (9)
Sargassum seaweed beds	Transplant, artificial blocks as seaweed beds	Spawning ground for sandfish	Resource conservation and nurture, and others	Akita (2)
Makombu kelp	Plant sporophytes (Dec), harvest kelp (May)	Nursery ground for juveniles. As well, food production, prevent eutrophication, carbon sequestration	Resource conservation, regulate Bay nutrient loading	Toyama (3)
Coral reef	Install iron bars in sandy areas	Coral reef aquaculture and regeneration	Enhance local biodiversity, reef conservation, others	Okinawa (10)

TABLE 2.3. Artificial marine or aquatic habitats in the case studies.

Habitat	Activity	Purpose	Conservation benefit	Illustrated in case study(ies)
Rice paddies	Build and maintain rice paddies	Purpose is agriculture, but traditionally provided spawning ground for various fish	Ecosystem structure and biodiversity	Yamaguchi (9)
Stone weir in coral reef lagoon (*ishihimi*)	Building *ishihimi* with stones	Traditionally: fishing Today: habitat for a variety of species	Enhance local biodiversity	Okinawa (10)
Set net gear	Set net	Fishing, but provides habitat and egg laying site	Resource conservation	Toyama (3)
Suspended nets	Set net	Spawning site for sandfish	Resource conservation and nurture	Akita (2)
Concrete algal reef	Building reef and transplanting *sargassum*	Spawning site for sandfish	Resource conservation and nurture	Akita (2)
Experimental tidal flat	Construction, then maintain optimal nutrient loading through water exchange or use of dredged wetland sediment	Identify, and then maintain, optimal range of nutrient loading for macrobenthos biodiversity	Local biodiversity and ecosystem structure	Ago Bay (7)
Artificial tidal pool	Construction, determination of optimal parameters, monitoring effectiveness	Identify optimal tidal pool features for conservation, field test applicability and involve neighbourhood citizens in local conservation	Enhance local biodiversity, restore part of the ecosystem connectivity in the bay	Tokyo Bay (6)

short-neck clam (case study 9, Yamaguchi Estuary), *gobi* fish (case study 6, Tokyo Bay), or macrobenthos (case study 7, Ago Bay).

Many of what are referred to here as active measures are commonly used in restoration efforts worldwide. It should also be noted that these measures, except possibly tree planting, basically bring geochemical fluxes and residence times back to pre-industrial, less human-influenced levels. Hence, in the longer term, these measures bring about a decrease in human influence on the cycles. However, they are classified here as active conservation (or active restoration) because bringing these fluxes to a range more suitable for biodiversity was achieved through more, rather than less, human interaction with the environment. For example, planting and harvesting kelp as a means of combating eutrophication (case study 3, Toyama Bay) clearly entails more human influence on the marine ecosystem, as opposed to a mitigating approach such as stricter regulations on agricultural runoff, even though both measures aim at decreasing nutrient concentration in coastal waters. The results reported in the case studies suggest that active measures can be useful complements to protection or mitigation in certain cases, particularly those where compromise with other coastal uses result in insufficiently stringent/enforced regulation for effective conservation.

HABITAT IMPROVEMENT OR PROVISION

In *satoumi*, another way human labour on the environment may be used for conservation is through the improvement or creation of habitats for marine species. In tables 2.1, 2.2 and 2.3, the practices reported in the case studies have been classified into those modifying existing habitats to make them more hospitable for certain species (e.g., tilling tidal flat mud, installing nets to protect one species against new predators), those restoring or expanding existing habitats through transplant, propagation or aquaculture of various types of macro-algae and coral, and those involving the creation of entirely human-made, artificial marine/aquatic habitats (e.g., rice paddies, artificial tidal flats, concrete algal reefs). All of these entail significant human work and attention, often in the form of careful manual labour in a marine environment. In certain cases the purpose of the activity is conservation, while in others a habitat is provided for an exploited species with the aim of growing and harvesting the resource; in other cases, the habitat provision is an unintended side benefit of an activity that has no conservation purpose.

Preliminary results showing locally enhanced biodiversity are reported in the case studies (Table 2, column 4, shaded cells). Hence, while further research is needed, these practices appear to be worth exploring as part of the tools available for biodiversity conservation in human-influenced coastal seas.

Habitat provision at sea is evidently neither new nor a distinguishing characteristic of *satoumi.* Humans have built structures to provide a habitat for oyster culture for centuries; more recently they have constructed artificial reefs (e.g., Baines 2001) and replanted mangroves (e.g., Bosire et al. 2008), and there are many ongoing coral reef regeneration projects. Artificial aquatic or marine habitats are currently being built in many areas, and their effectiveness for ecosystem conservation or restoration is being assessed, particularly along urbanised coasts (Martins et al. 2010; Chapman and Blockley 2009).

Habitat provision involves elaborate human interaction with the ecosystem and is thus qualitatively different from exclusionary or mitigating measures for conservation. Several of the case studies show local communities carefully tending to their coastal ecosystem and patiently (re)generating a nurtured nature in a marine environment. As such, habitat provision is one example where wise use of marine resources goes beyond sufficiently curtailed hunting-gathering activities. The results suggest that, under certain conditions, humans can actively enhance coastal ecosystem services in a sustainable manner, and such options should be fully explored and taken advantage of for marine conservation.

SATOUMI IN CO-MANAGEMENT FOR SUSTAINABLE FISHERIES

Compared to the high seas, where overfishing is regularly pointed out as the single largest threat to biodiversity (e.g. Worm et al. 2006; Pauly et al. 1998), coastal ecosystems are affected by a variety of other anthropic pressures, such as land-use changes and pollution. Yet overfishing also remains one of the most important drivers of biodiversity depletion in coastal waters (Jackson et al. 2001), and developing wise fisheries management practices is naturally one of the cornerstones of *satoumi* practices.

In many of the world's coastal seas, the disappointing results of overly centralised, government-based fisheries management regimes in delivering progress towards sustainability have led to approaches devolving more responsibility to local users in the management of the resource, such as co-management (FAO 2009; Pomeroy and Rivera-Guieb 2006). In fisheries co-management, authorities at various levels and local fishers share responsibility in the management and conservation of the resource. Co-management regimes have many advantages in implementing an ecosystem approach to fisheries management and are typically better suited than centralised ones to making effective use of local users' knowledge of the ecosystem (Thorburn 2000), an important dimension of *satoumi* practice. Co-management is in many ways part of the traditional fisheries management regime in Japan, and has proved useful for conservation (Makino and Matsuda 2005), with over 30 per cent of marine protected areas designated and self-imposed by agreement among the members of co-management organisations (chapter 1, section III; Yagi et al. 2010).

Table 3 provides examples of participation of resource users in management and of their contribution to resource conservation, as reported in the case studies. There are many promising practices through which fishers have effectively contributed to more sustainable fisheries in a co-management framework. Fishers' organisations have facilitated the consensual establishment and enforcement of limits on resource use in Akita and Okinawa (case studies 2 and 10), and the previous chapter reports on the existence of many self-imposed, self-enforced MPAs. In Toyama (case study 3), fishers played a key role in monitoring ecosystem health through routine observations and the provision of environmental parameters, and in all the case studies they contributed essential local ecosystem knowledge to the management framework, with case study 1 (Shiretoko) and 8 (Okayama) having a particular emphasis on this aspect. More distinctly, *satoumi*-oriented fishers contributions to resource conservation include active measures, such as transplanting of *Zostera marina* to restore seagrass beds in Okayama or cultivation of *makombu* kelp in Toyama to provide a habitat for juveniles, transplanting *Sargassum* to spawning sites in Akita, or fishing village communities actively contributing to watershed afforestation (Toyama, Akita, and to some extent in all *satoumi* sites).

For fisheries to be sustainable through co-management, effective understanding and cooperation between resource users (fishers) and conservationists is crucial. It appears from several case studies, and in particular Shiretoko (case study 1), that *satoumi* provides a backdrop that facilitates a convergence of views between users and conservationists. The traditional *satoumi* landscapes were shaped in large part by humans, with fishers and other users a central part in the popular imagery of *satoumi*. The nostalgia evoked by *satoumi* is exempt of the fascination for a wilderness unspoiled by human contact that has been a guiding vision for many conservationists, at least since John Muir. Nostalgia in *satoumi*, rather, is a longing for a society close to the nature it nurtures. The importance of this imagery should not be underestimated. Recent research demonstrates the importance of implicit images in fisheries governance. In fact, it appears that the less explicit, the more such images can influence governance outcomes, so that their explicitation may be necessary to avoid

TABLE 3. Example of fishers' participation in the management and conservation of the resource in the case studies. Conservation practices limiting human interaction with the ecosystem (first row), practices unrelated to direct human interaction with the ecosystem (second row), and practices involving increased human interaction with the ecosystem (third row). The latter are more distinctly *satoumi*-oriented practices in fisheries resource management (see text). Numbers in parenthesis refer to the case study number.

Decreasing human interaction with the ecosystem	Setting limits to resource use	• Fisheries cooperatives play a key role in establishing consensus for a moratorium (2) • Fishers establish consensual resource sharing rules (2) • Female divers collectively discuss and sometimes reject new technology (2) • Fisheries cooperative establish self-imposed no-take marine reserves (10) • Fisheries youth group participate in enforcing the no-take reserves (10)
Neutral	Monitoring the ecosystem	• Contribute local knowledge of the ecosystem to the management framework (all case studies, particularly important in 1 and 10) • The first to raise voice on eutrophication problems (3) and environmental degradation (7) • Provision on essential data on ecosystem productivity and health (1) • Provision of long-term, routine monitoring of water quality (3)
Increasing human interaction with the ecosystem	Nurturing the resource	• Population control efforts for crown-of-thorn starfish, the most significant threats to coral reefs (10) • Tree planting activities in the watershed to mitigate soil runoff and debris input to the bay (3) • *Sargassum* transplants for spawning area for exploited fish (2) • Transplants of *Zostera marina* to regenerate seagrass beds, critical habitat for juveniles (8) • Cultivation of Makombu kelp (*Saccharina japonica*) as food source, and carbon sequestration, but also to help prevent eutrophication and provide habitat for fish (3) • Raising *mozuku* seedlings for livelihood, that also provide habitat for certain species (10) • Coral regeneration, provides habitat for many fish species (10)

self-fulfilment (Jentoft et al. 2010). If the backdrop that attracts conservation actors is one in which the ideal nature is devoid of fishers (or indeed of any humans), it will be more difficult to enrol the support of fishers. It is difficult to engage constructively with people whose livelihood is seen as a nuisance. These are just some of the aspects that may explain why, in the cultural context of the case studies, *satoumi* was a discourse that was effective for cooperation with fishers.

Another advantage of *satoumi* in co-management lies in the diversity of active conservation practices that it accommodates and to which fishers can contribute, beyond remaining inactive during moratoria or staying away from protected areas. These practices, listed in the third row of Table 3, include reforestation of mountain slopes in the river basin to regulate discharge of nutrients and sediment, growing and harvesting of kelp to provide habitat for juveniles and help prevent eutrophication, *sargassum* seaweed transplants to beds that will provide spawning grounds and a habitat for juveniles in order to nurture the sandfish resource, and participation in coral reef regeneration activities.

It is worth noting that as the fishers are contributing time, labour and resources, these active measures are internalising some of the costs of maintaining the ecosystem structure and function within an economic activity that benefits from conservation. In exclusionary and mitigating approaches, fishers' contribution to conservation is to stay *inactive* during the off-season, or to stay out of no-take areas, neither of which readily internalises costs. As such, resource nurturing in *satoumi* is an interesting implementation of Principle 4c of the CBD ecosystem approach: "Internalize costs and benefits [of ecosystem-management] in the given ecosystem to the extent feasible" (CBD 2000), as a way to ensure that those who benefit from conservation pay the costs associated with conservation. It is worth noting that the main driving force of active conservation in *satoumi* is typically manual labour, rather than financial investment. Consequently this type of internalisation circumvents the difficulties posed by certain measures that necessitate financial investment from fisher communities, such as, for example, the complications that arose from requiring fishers in developing countries to install turtle-excluding devices on their nets (WTO 1998).

One aspect worth considering is that through practices such as kelp cultivation or eelgrass transplanting, the fishers reinvest the labour saved by mechanisation (or by fishing restrictions) into the ecosystem to maintain its productivity. In economic terms, rather than a natural wealth to be exploited while externalising costs as much as possible, the *satoumi* is treated more like a fixed capital worth investing labour in, a situation reminiscent of rice paddies (Berque 1982) or other cultural landscapes where human nurture significantly contributed to ecosystem productivity. This may be a framework that more readily accommodates internalisation within the ecosystem of conservation costs.

The collective ownership structure upon which this *satoumi* styled co-management has evolved cannot be overlooked. As demonstrated in chapter 1, section III (institutional characteristics of Japanese fishery management), the ecosystem users (fishers) invest labour in conservation and enforcement of collectively agreed regulations because they can be confident that they will be the beneficiaries of ecosystem productivity and sustainability. Government-enforced exclusive access to the resource, with non-transferable property and territorial use rights, thus appear as *sine qua non* conditions for the successful internalisation of ecosystem conservation costs in Japanese *satoumi*. Schematically, 1) limited access to the resource ensures a collective interest on the part of the local users community in sustainably using the ecosystem, then 2) strong local community associations or fishery cooperatives ensure that individual users follow the collectively agreed rules, and finally 3) the importance of hereditary transfer of use rights, over market-based transfer, ensure that the interest of future generations is considered in the collective decisions.

The importance of hereditary collectivism for ecosystem conservation and biodiversity management in *satoumi* is brought up in various ways in several case studies; one striking illustration is given in case study 5 on Hegura Island where female diver (*ama*-san) communities manage their resource. Again making a parallel with the case of rice paddies, where community investment of labour, in the form of an irrigation system for example, is necessary for ecosystem productivity, collective decision-making and action is essential in the *ama*-san's management of Hegura island's marine resources. As such, sustainable use in *satoumi* is achieved not through ever-increasing privatisation and individualisation of responsibilities, as has often been advocated as the chief solution to the tragedy of unregulated commons (Hardin 1968), but, to the contrary, through collective property, strong collective structures and collective responsibility for the ecosystem.

TABLE 4. Communities engagement in *satoumi* activities, from those with no direct action on the environment to those involving manual labour on the ecosystem. The expected results are described in the right-hand column. Numbers in front of the case study indicate the case study number.

		Type of activity	Community engaged	Expected results
No direct modification of the environment	Awareness and participation in decision-making	Awareness raising and school participation activities in artificial habitats (6 Tokyo)	Neighbourhood residents, school children	Awareness and knowledge of local marine environment raised
		Participation in committees, local organisations and discussion groups for the management of the coastal environment (all case studies)	Local communities	Enhanced decision-making process
	Monitoring of the environment	Seashore animals monitoring (7 Ago Bay)	School children	Routine biodiversity data on ecosystem health and biodiversity
		Public participation in study of water circulation with float experiment (6 Tokyo)	Bay community	Data on water circulation in the Bay
		Fishing census to monitor gobies size around site, 2 hours fishing effort, (6 Tokyo)	Local Community	Better knowledge of the environment network and of target specie preferred habitat
Controlled modification of the environment	Control population of target species for conservation	Mitigate outbreaks of crown of thorn starfish (10 Okinawa)	Recreational divers	Prevent damage to the coral from starfish predation
		Nets to protect clam larvae from eagle ray (9 Yamaguchi)	Local community	Foster repopulation of tidal flat by the target specie
	River basin cultivation	Planting of shell flowers around fields to prevent soil runoff (10 Okinawa)	Local community	Prevent stress to coral and other benefits)
		Reforest river basin slopes (2 Akita, Box 5 Yura River)	Local community, volunteers, students	Control soil erosion and input into coastal waters of nutrients, sediments, debris
	Habitat improvement	Manually till the tidal flat mud (9 Yamaguchi)	Local community	Favour aerobic conditions in sediment and soften soil surface to host clam larvae
	Habitat construction	Building *ishihimi* stone fishing weir (10 Okinawa)	Local community	Provides habitats for a variety of species
		Participate in setting optimal tidal flat depth (6 Tokyo)	Neighbourhood residents	Improved habitat for the target specie
	"Cultivating" at-sea	Transplanting *sargassum* seaweed (2 Akita)	Local community	Provide habitat for sandfish
		Transplanting of *Zostera marina*, or eelgrass (7 Ago Bay, Box 4 Kanagawa, 3 Toyama, 9 Yamaguchi)	Local community	Restoration of habitat, nutrient cycling, enhanced purification capabilities of the ecosystem and others.

COMMUNITY ENGAGEMENT IN *SATOUMI*

Community participation in conservation and natural resource management is crucial for many reasons, including the effective use of local ecosystem knowledge, leverage of limited resources, and ownership or simple acceptance of the management programme, as is widely documented in diverse settings (Roe et al. 2009; Dahl 1997; Primavera 2000), including industrialised coasts (Edwards et al. 1997). The effective use of community-based conservation practices in a modern context is the subject of much research both in international cooperation (IFAD 2006; Danida 2007) and academia (e.g. Bjerkes 2006; Raymond et al. 2010). For such reasons, the development of modern-day practices engaging local communities is a central aspect in *satoumi* (EMECS 2008; PEMSEA 2009; MoEJ 2010). In addition, because active *satoumi* conservation measures often require many hands and/or sustained attention and care, community participation is particularly important for successful implementation.

The case studies report promising engagement of local communities in *satoumi*, as compiled in Table 4. Communities have participated in awareness-raising and decision-making activities (all case studies), provided essential routine ecosystem monitoring data (Tokyo and Ago Bay, respectively case studies 6 and 7), and, in more distinctly *satoumi*-oriented practices, have contributed crucial manual labour for conservation activities, such as planting trees or shell flowers to manage land-based nutrient input (all case studies, especially Okinawa, case study 10), tilling tidal flat mud to soften the soil and favour aerobic conditions in the sediment (Yamaguchi, case study 9), building stone fishing weirs as biodiversity-enhancing habitats (Okinawa, case study 10), or transplanting and nurturing *sargassum* seaweed or *Zostera marina* (Toyama, Ago Bay and Yamaguchi, respectively case studies 3, 7 and 9). (Note: community-based activities where fishers are the main contributors are not reported in Table 4, as they are already reported in Table 3). Reported factors of success in community engagement include widely recognised good practices such as long-term engagement of scientists, decision-makers, locally anchored organisations and other stakeholders, as was the case in all the case studies. As well, although it is difficult to precisely delineate their specific contribution, *satoumi*-specific aspects appear to have been valuable as discussed below.

It is clear from Table 4 that active *satoumi*-oriented conservation provides for a great diversity of opportunities to engage in conservation practice close to nature. Many of these activities, originating in *satoumi*'s nuanced view of human interaction with the environment, put to work a positive role of humans in nature (see lower part of Table 4, rows labelled "Controlled modification of the environment"). In contrast, mitigating approaches naturally tend to lead to activities grappling with the negative side of humankind's role in nature, such as garbage and pollution. Volunteer participation in garbage pick-up and oil spill cleanups on beaches is vital, but such activities may be less rewarding, and typically happen in less pleasant environments, than nurturing seagrass beds, planting trees, or building and monitoring new habitats for nurturing fish as reported in the case studies. One could conjecture that the basic premise of *satoumi*—that humans can learn to nurture nature at-sea—can more readily appeal in positive ways to communities, compared to exclusive or mitigating approaches that essentially request humans to stay away from nature in order to preserve it (except when it is to clean up the mess left by others).

It is worth noting that success in involving communities in conservation-purposed manual labour on coastal ecosystems is documented in vastly different cultures, from Senegal, where tens of thousands have mobilised to plant mangrove trees (Bassene 2010), to British Columbia, where the popularity of eelgrass transplanting is used to involve communities in environmental restoration (Wright 2005). Such active measures diversify engagement opportunities for communities, and the results reported in different contexts suggest a valuable appeal to active measures in engaging communities.

Finally, it appears that in the cultural and social context of these projects, *satoumi* provided an appealing backdrop for local communities to become engaged. There is an emotional dimension to *satoumi* that may be considered as one of the underlying motives for community participation. The word *sato*, which could be translated as "home village", implies a certain sense of longing that in *satoumi* evokes nostalgia for a society more intimate with coastal landscapes and nature. *Satoumi* is also in the realm of emotions and sensations, of a sense of self where relationship with place and nature is essential, and as such, appears useful in grounding what might seem abstract conservation concepts in a closer reality for local communities.

For example, the *satoumi* activities in Tokyo Bay (case study 6) included the collection and display of available photographs that showed neighbourhood residents how different and beautiful the place had been not so long ago (K. Furukawa, personal communication 2010). The short-neck clam chosen as the target species for conservation had special meaning to older residents in the Yamaguchi Estuary (case study 9), many of whom had grown up enjoying tilling the tidal flat mud in search of the clams. Childhood memories are reported to be an essential aspect of a community's emotional attachment to their coastal landscape (Satake and Kamihogi 2006). Community participation in activities to restore a healthier lagoon ecosystem in Okinawa (case study 10) is linked to a broader movement to conserve their cultural identity as "reef people".

Further research is required to precisely assess the contribution of emotional and/or spiritual dimensions in community engagement in *satoumi*. At any rate, the importance of such motives in community participation is widely reported in cultures from South America to Scandinavia (Folke et al. 2005), India (Stone et al. 2008) and the South Pacific (Jolland and Harmsworth 2007). The importance of intangible ecosystem services is also recognised in many intergovernmental processes, including the CBD ecosystem approach (CBD 2000). While economic valuation of these intangible services is important to guide decision-makers in conservation (Vejre et al. 2010), conversely, to enrol communities and volunteers, the reverse may be true: rather than economic or scientific arguments, linking conservation to intangible values may be the most effective (Koss and Kingsley 2010). In the long run, providing this link in a modern setting is possibly the most valuable advantage of *satoumi* in the coastal conservation efforts reported in the case studies.

FUTURE PERSPECTIVES: SCIENCE NEEDS, POLICY UPTAKE AND INTERNATIONAL COOPERATION

The case studies may best be seen as progress reports. Regarding further research needs, in general, there are encouraging results on the conservation (and possibly enhancement) of local biodiversity through a wide range of site-specific active measures in coastal ecosystems; however, there is a need to further assess those practices over longer periods of time and evaluate their effectiveness when applied on a larger scale. The case studies raise a number of specific research questions for subsequent projects, including the need to quantitatively assess the conservation effectiveness of fisher forests (case study 3, Toyama) or other forest management efforts (e.g. box 5, Yura River); modelling, observation and further studies of the ecological network in Tokyo Bay (case study 6, Tokyo); assessment of environmental restoration technologies (case study 6, Tokyo); sharing international experience in habitat-providing stone fishing weirs (case study 10, Okinawa); further assessment of the contribution of the fisheries sector to ecosystem management (case study 1, Shiretoko); and refining assessments of the carrying capacity of semi-enclosed seas for oyster farming (case study 3, Nanao, based on previous research not reported in this case study).

Several of the case studies advocate the development of multidisciplinary approaches, taking into account socio-economic components of research on *satoumi* (case studies 7 and 9, respectively Ago Bay and Yamaguchi, and less explicitly in several others). As pointed out in the Yamaguchi case study, in other investigations (Arrow et al. 1996; Vatn 2010) and in the CBD ecosystem approach (CBD 2005), the current economic system does not readily internalise the costs of ecosystem use/depletion, and this may be one of the greatest threats to biodiversity. This failure to internalise costs may be of particular concern for marine ecosystems (Kullenberg 2010). This would argue for adequate study and documentation on *satoumi*'s often successful internalisation of conservation costs by ecosystem users through collective ownership and responsibility (see the section on co-management for more details), and how centuries-old hereditary collective practices have evolved and adapted to modern settings.

While furthering current research on the appropriate economic valuation of ecosystem services remains of the utmost importance, at a fundamental level, non-economic and non-utilitarian analysis may need to be better integrated into the knowledge base in order to achieve sustainable use of biodiversity components (Kosoy and Corbera 2010). In particular, community participation in some cases cannot be understood if values such as altruism are ignored (Stone et al. 2008), or if a purely "economic" view of development is the unsurpassable horizon of all conservation efforts (Jollands and Harmsworth 2007). Promoting more sustainable individual behaviour—a crucial step towards securing sustainable coasts—will require collaboration with other fields, including psychology (Atran et al. 2005). The refusal of the women diver community to adopt time- and effort-saving technology on the grounds that it will alter their cultural identity and relationship with their environment (Hegura Island, case study 5) is an ostensible incompatibility with the dominant view on the value and utility of work, time and economic effectiveness. Although further research is needed, the female divers' low debt ratio appears to be an example of how collective choices, taking into account cultural, environmental and social (employment) consequences of capital investment in technology, can in the long run be more beneficial both for the ecosystem and for ecosystem users than short-term economic considerations alone. *Satoumi*, as illustrated in the case studies, is a versatile approach that coherently incorporates considerations from economic to spiritual, community-based to scientific knowledge, traditional and modern. As such, multidisciplinary research on *satoumi* may develop practical options for conservation that integrate a broad range of knowledge sources and map culturally appropriate ways to achieve Aichi Biodiversity Targets 18 and 19 on knowledge management and participatory planning (CBD 2010b).

Another priority pointed out in several case studies (Tokyo, Ago Bay and Yamaguchi, respectively case studies 6, 7 and 9) is the need to adequately reflect good practices developed at the community-level in broader management frameworks and in national policy. This is needed if *satoumi* practice is to have a significant effect on the coastal environment. Effectiveness was demonstrated at the community-level in the case studies and summarised in the tables in this chapter, but the application of community-level practice to larger management frameworks is not necessarily straightforward (Berkes 2006). The Japanese government is currently experimenting with precisely such an endeavour, mainstreaming *satoumi* in its Strategy for a Sustainable Society as a way to achieve productive, sustainable coastal environments that are enjoyed and valued by communities (GoJ 2007). *Satoumi* is also an important element of marine conservation and restoration for productive and beautiful coasts in the Basic Ocean Policy (GoJ 2008a), and a central element for marine and coastal biodiversity conservation in the Third National Biodiversity Strategy (GoJ 2008b). The Ministry of Environment, the Ministry of Agriculture, Forestry and Fisheries, and the Ministry of Land, Infrastructure, Transport and Tourism have recently increased the prominence of *satoumi* in policy as well as in supporting field implementation, with one or several of these ministries playing a leading role in initiating and/or supporting *satoumi* in several of the case studies. The reader is referred to chapter 2, section I for a review and discussion of *satoumi* mainstreaming and relevant policy.

The next few years should provide valuable insight from this particular experience in the uptake of community-level practices in national policy, and from relatively small experimental areas to larger sections of the Japanese coast. For the time being, *satoumi*'s broad applicability has proved valuable in ways encompassing the distinct priorities of different sectors in relatively coherent ways. From this perspective, *satoumi* may link effectively to an integrated coastal management framework, an effective approach to both conservation and use of biodiversity components (CBD 2004b; PEMSEA 1996; UNESCO 1997). The Ago Bay case study (7) provided an early progress report on such endeavours, and the Shiretoko case study (1) reported on the successful implementation of management involving three ministries at various levels.

International collaboration will be important both for *satoumi* progress in Japan and for the adaptation of practices field-tested in Japan in other places, as appropriate, bearing in mind the specific territorial use rights and collective structures on which hinge key aspects of *satoumi*, such as co-management, which may limit the applicability of *satoumi* practices to certain coasts (see the previous chapter for a detailed discussion of *satoumi*-related fishing rights). Such collaborations are now taking shape, including through a number of international events where *satoumi*-related experiences from various countries were discussed (EMECS 2009; PEMSEA 2009). The Okinawa case study reports on the organisation of a world *ishihimi* summit in Shiraho, Japan, in October 2010, where the experience in the use of stone fishing weirs for conservation and *satoumi* in many countries was shared, and several events on *satoumi* which were held at the 10th meeting of the Conference of Parties to the CBD, Nagoya, Japan 18-29 October 2010. There is also increasing attention worldwide to active conservation measures. Seagrass transplanting for environmental management is now conducted in many countries and is the subject of much research (e.g. Li et al. 2010; Van Katwijk et al. 2009), and the study of artificial marine habitats for conservation of urbanised coastlines is swiftly progressing (Martins et al. 2010; Chapman and Blockley 2009). In general, there is thus a rapidly expanding worldwide knowledge base for the management of biodiversity in human-influenced coastal seas, to which the Japanese *satoumi* experience should be contributed. Fostering appropriate international and intergovernmental processes will be important in accelerating advances in this domain.

Links to international processes will become increasingly necessary for any strategy for coastal conservation. Coastal ecosystems are linked to the offshore through many processes (see case study 2 on Akita for an interesting example) which often cross borders. In the Millennium Ecosystem Assessment (MEA 2005) typology, *satoumi* at this stage fits into an "adapting mosaic scenario", with watershed-scale focussed ecosystem management and a strong community-base. In this scenario, the local impacts of global environmental problems eventually make it impossible to manage successfully only at this scale. The impact of overfishing in high seas, climate change, ocean acidification, and global marine biodiversity depletion, to name but a few, will not somehow stop at the outside boundary of the coastal zone. In the end, for *satoumi* to prosper in local ecosystems, the global ocean must be managed with the same care and precautions as traditional communities have for their *satoumi* cultural landscapes.

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