（博士論文）

A study on the influences of human utility on marine and coastal management in Japan

（日本の海洋・沿岸域管理に対して人の効用が及ぼす影響に関する研究）

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Abstract

Utility, which forms the basis of preferences and choices of individuals, is the key in marine and coastal management, for it affects decision making by stakeholders. In spite of its importance, utility has been lacked in studies on marine and coastal management. To address this paucity, I conducted a structured study to clarify influences of utility on marine and coastal management, aiming at acquiring insights for success of marine and coastal management.

As a starting point, in Chapter 2, I conducted a questionnaire survey and analyzed results by using factor analysis and structural equation model to examine how residents in Japan perceive marine ecosystem services and how utility of marine ecosystem services would influence their behavioral intentions for marine conservation. Building on a presumption that the higher the perceived indispensability, the greater the utility, a hypothesis has been developed that the greater the indispensability, the greater its influence on enhancing behavioral intentions for marine conservation. As the result, the hypothesis was rejected. Three hidden factors of respondents' perceived indispensability of marine ecosystem services were constructed, namely "Essential Benefits", "Indirect Benefits", and "Cultural Benefits", which are different from the pervasive four classifications used in the academic world. The analysis clarified that "Essential Benefits" was deemed to be the most indispensable, but had a lower influence than "Cultural Benefits" on the behavioral intentions for marine conservation, while "Indirect Benefits" had the second highest degree of perceived indispensability, but did

not find any significant causal relationships between “Indirect Benefits” and the behavioral intentions, and “Cultural Benefits” had the lowest degree of indispensability but the greatest influence on the behavioral intentions. Based on the above findings, three implications were discussed: first, the classification of marine ecosystem services used in the academic world would not be always considered reasonable by people; second, in order to increase support from the general public in Japan for marine conservation, measures enhancing “Cultural Benefits” would be more effective than measures stressing indispensability of marine ecosystem services for sustaining their lives; and third, applying “scarcity principle”, which is used in both economics and psychology, the discrepancies between perceived indispensability and behavioral intentions might be caused because of their perceiving “Cultural Benefits” as scarce, while perceiving “Essential Benefits” as abundant and secured. These findings clarified complex nature of utility and raised the importance of taking utility into account in marine and coastal management.

In Chapter 3, to examine influences of utility on the failure of the national policy on planning marine and coastal management, I conducted policy analysis through international comparison and interviews of academics and national and local government officials, with a hypothesis that lack of considerations of stakeholders’ utility is one of the causes of the failure of the national policy. For the analysis, the Guideline for Integrated Coastal Management Plans (Guideline), one of the most important national policies on marine and coastal management planning in Japan, was selected. The analysis clarified that the fundamental reason of stumbling block of the

Guideline's implementation lies in both national and local levels. At the national level, it was clarified that there is the lack of concrete understandings on the sectoral mindset of the local government officials, i.e., their utility, and that measures to provide incentives for implementation of the Guideline were not amply designed. At the local level, it was found that sectoral "Essential Benefits" - utility that local government officials derive from the work to address needs from stakeholders of each sector - is habitually more prioritized than the "Cultural Benefits" that would be least indispensable in most sectors yet have potential to be common benefits among multiple sectors and citizens. The analysis clarified the hidden influences of local stakeholders' utility on the failure of the national policy on marine and coastal management, thus, the hypothesis was supported.

In Chapter 4, to explore what status of uses of marine space would enhance stakeholders' utility, I took *Pyropia yezoensis* farming in Tokyo Bay as an example. Tokyo Bay, one of the most difficult marine and coastal areas in Japan to coordinate conflicting interests of diverse stakeholders, is worth a case study through which insights for future planning could be obtained. At the same time, *Pyropia yezoensis* farming in Tokyo Bay is not only important as one of the major fisheries products but distinctive with cultural value, for it is an icon that has been succeeded since Edo era. I identified an area good for *Pyropia yezoensis* farming in Tokyo Bay based on water environment and explored causes of inconsistency between the area identified and actual areas under operation by conducting interviews of *Pyropia yezoensis* farming fishermen. In exploring above, I set a hypothesis that pursuing optimum uses of a marine and coastal space would enhance the stakeholders' utility. As the result, the

hypothesis was not supported. Through conducting spatial cluster analysis based on five water environmental variables, Tokyo Bay was classified into six groups. Then, by comparing water environmental characteristics of respective groups using growth and health criteria for *Pyropia yezoensis* farming, one group, spreading out to 388 km^2 in Tokyo inner bay covering Kisarazu, Futtsu Cape North, and Hashirimizu *Pyropia yezoensis* farming areas, was identified as a group having good conditions for *Pyropia yezoensis* farming. Thus, it was found that other *Pyropia yezoensis* farming areas under operation such as Chiba North are located in sea areas having water environment not optimum for its farming. By the interviews of the *Pyropia yezoensis* farming fishermen, major motivation of their farming is judged as their pride in succeeding traditional pole-style farming and its farming from their ancestors, which is interpreted as “Cultural Benefits”, rather than “Essential Benefits” for their livelihood, thus, *Pyropia yezoensis* farming has been succeeded even in the sea areas having water environment not optimum.

In Chapter 5, to validate the importance of “Cultural Benefits” and further deepen discussion on how “Cultural Benefits” would influence on marine and coastal management, I analyzed results of interviews of fishermen of Shima City and Bizen City, where each respective marine and coastal management is judged successful. The analysis clarified the influences of “Cultural Benefits” perceived by the fishermen on success of marine and coastal management, namely, when fishermen recognize “Cultural Benefits” of their fisheries not only to themselves but also to other stakeholders and share the “Cultural Benefits” with others, it is likely that marine and

coastal management would be successful.

The results of this study suggest the importance of considering stakeholders' utility, especially "Cultural Benefits" in marine and coastal management, for "Cultural Benefits" is considered having greater potential to be common benefits for various stakeholders, regardless sectors to which they belong. The essence of difficulty of marine and coastal management is neither administrative boundaries nor institutional sectoral framework, but how to deal with stakeholders having diverse utility. Hence, deeper understanding of utility is essential to find common benefits among stakeholders towards success of marine and coastal management.

Contents

List of figures

List of tables

Chapter 1: General Introduction

1.1. Importance of marine ecosystem services, marine and coastal management, and related policies

The importance of ecosystem services has been recognized by our ancestors, one example of notions in early time could be Plato's understanding of the causal relationships between deforestation of Attica, soil erosion, and drying of springs (Mooney and Ehrlich, 1997). Marine ecosystem services, which compose considerable part of whole ecosystem services, indisputably provide various benefits to people, which eventually contribute to human well-being. According to Costanza et al. (1997), value of marine ecosystem services accounts for 65 % of total value of whole ecosystem services of the world. Thus, sustainably benefiting from them is one of the imperatives towards sustainable development. In order to ensure sustainable receipt of their benefits, proper management of marine and coastal areas is crucial, and development of marine and coastal management planning with sound implementation is one of the keys.

At the beginning of this study, an overview of previous studies on definition, classifications, and valuation of marine ecosystem services is introduced, followed by a historical review of evolution of marine and coastal management.

1.1.1. Definition, classifications, and valuation of marine ecosystem services

Definition of marine ecosystem services

The origin of the term "ecosystem services" traces back to 1970 in the Study of Critical Environmental Problems (1970), which describes the functioning of ecosystems

in terms of delivering services to people. Following on that, Westman (1977) offered the word "nature's services" to mean the social value of the benefits provided by ecosystems, and the term "ecosystem services" is considered firstly used by Ehrlich and Ehrlich (1981), which refer to the "nature's services" used by Westman (Fisher et al., 2009). To date, various definitions or interpretations of the term "ecosystem services" have been explored, among which the following are the three definitions commonly cited (Fisher et al., 2009):

- ✓ "Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life" (Daily, 1997).
- ✓ "Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions. For simplicity, we will refer to ecosystem goods and services together as ecosystem services" (Costanza et al., 1997).
- ✓ "Ecosystem services are the benefits people obtain from ecosystems" (Millennium Ecosystem Assessment (MA), 2003).

In this study, the term "ecosystem services" is used to mean the benefits people obtain from ecosystems, in line with the definition provided by the MA (2003). The definition of ecosystem services by the MA (2003) includes both natural and human-modified ecosystems reflecting the definition by Costanza and his colleagues (1997), at the same time, it signifies both the tangible and the intangible benefits people obtain from ecosystems, following Daily (1997). Thus, it is considered as the most

holistic among the three. The term “marine ecosystem services” used in this study covers benefits people obtain from both marine and coastal ecosystems. Marine and coastal areas cover both the area where sea is deeper than 50 meters and the area between 50 meters below mean sea level and 50 meters above high tide level or extending landward to a distance 100 kilometers from shore, in line with the definition used in the MA (2003).

Classification of marine ecosystem services

Classification is a crucial consideration when undertaking valuation of ecosystem services which often serves as information for stakeholders to make decisions. Different methods for categorizing ecosystem services have been endeavored, including functional groupings (De Groot et al., 2002; MA, 2003), organizational groupings (Norberg, 1999), and descriptive groupings (Moberg and Folke, 1999). Among these, the classification by the MA (2003) is currently judged as one of the most pervasive classification systems due to its broad scope and number of applications. Thus, in this study, I use the classification of ecosystem services by the MA (2003) as a reference classification of marine ecosystem services.

The MA (2003) classifies ecosystem services into four categories, namely “provisioning services”, “regulating services”, “cultural services”, and “supporting services”, each of which is explained in the MA (2003) as follows:

- ✓ Provisioning services: the products obtained from ecosystems, including food and fiber, fuel, genetic resources, ornamental resources, and fresh water.
- ✓ Regulating Services: the benefits obtained from the regulation of ecosystem

processes, including air quality maintenance, climate regulation, water regulation, erosion control, water purification and waste treatment, regulation of human diseases, biological control, pollination, and storm protection.

- ✓ Cultural services: the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences, including cultural diversity, spiritual and religious values, knowledge systems, educational values, inspiration, aesthetic values, social relations, sense of place, cultural heritage values, and recreation and ecotourism.
- ✓ Supporting services: those that are necessary for the production of all other ecosystem services, including primary production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

Review of valuation of marine ecosystem services

Valuation of ecosystem services has been flourished as one useful approach to quantify ecosystem-related values for decision-making. Notable research on valuation of ecosystem services has accumulated over the past 20 years. Some of their representative examples include Bingham et al. (1995) proposing necessary issues to make ecosystem valuation useful for decision-making, Costanza et al. (1997) calculating the total value of world's ecosystem services, Loomis et al. (2000) remedying double counting of ecosystem services, and De Groot et al. (2002) providing a standardized framework for the comprehensive assessment of ecosystem functions, goods and services. However, majority of previous studies focus on terrestrial

ecosystem services with a notable exception of Beaumont et al. (2007) that conducts case studies to delve into the quantification of ecosystem services provided by marine biodiversity.

1.1.2. From sectoral to integrated approach in marine and coastal management

The marine and coastal area, where marine ecosystem services are cradled, is a unique space where people live and undertake a variety of social and economic activities unlike anywhere else on the planet. Its ecology, rich in biodiversity, is important to human well-being, but is also vulnerable to human activities on both land and sea. Intensification of these activities in recent decades has led marine and coastal management to evolve from single to multiple use approaches that emphasize the ecosystem and interdependencies. In step with the global movement towards sustainable development, as seen in the Stockholm Conference in 1972 and United Nations Conference on Environment and Development, United Nations Framework Convention on Climate Change, and Convention on Biological Diversity in 1992, the need for marine and coastal management using an integrated approach became widely recognized (Cicin-Sain and Knecht, 1998; United Nations Environment Programme, 1995).

Marine and coastal management in Japan is considered one of the most elaborate sectoral management, and because of that, it lacks integrated approach (Kisugi, 2007). And how to overcome challenges by the sectoral management is universal (Cicin-Sain and Knecht, 1998; Chua, 2006). Thus, this study takes marine and coastal management

in Japan as one of the typical cases facing challenges towards its implementation in an integrated manner. In a Japanese framework of coastal management, responsibilities for coastal management are delegated to various agencies at the national, prefectural and municipal levels (Figure 1-1, Figure 1-2). For example, around half of the coastal areas designated by the Seacoast Act as extending 50 meters from each side of the Low Water Level (LWL) and High Water Level (HWL) are managed by prefectural River Bureaus. The majority of shipping ports and harbors are managed by the Ports and Harbors Bureaus of the prefectures in which they are located (Ports and Harbors Bureau, Ministry of Land, Infrastructure, Transport and Tourism (MLIT), 2011), and most fishing ports are managed by municipalities (Fisheries Agency, 2011). Riverine systems important for national land conservation or the national economy are designated as first-class rivers by the Minister of MLIT and are managed at the national level by MLIT. Rivers of less importance to the public interest are designated as second-class rivers by governors and are managed by prefectures. Smaller rivers and streams are managed by municipalities.

In Japan, realization emerged during the 1990's that some marine and coastal problems may have been caused by sectoral management and the call for vertically and horizontally integrated coastal management has become more common (National Land Agency, 1998; Research Committee on Integrated Coastal Management, 2003). Here, "vertical integration" means coordination and necessary integration of policies and measures among national and local governments, whereas "horizontal integration" means coordination and necessary integration of policies and measures among different

sectors, such as fisheries, maritime industries, environmental NGOs, academics, and government officials. The marine and coastal problems mentioned above include unexpected beach erosion and sediment deposit due to insufficient coordination between fisheries and seacoast protection authorities (Uda, 2006), lack of nutrients in the sea because strict regulation has only focused on water quality without due consideration of the entire ecosystem and coastal area nutrient cycling (Ministry of the Environment, 2011), etc.

Having the background above, to promote integrated approach in marine and coastal management, the Guideline for Integrated Coastal Management Plans (Guideline) was agreed upon at the Grand Design for the 21st Century Promotion Liaison Conference (GD21PLC) in 2000, and is now considered the most important national Integrated Coastal Management (ICM) policy of the last 40 years in Japan. Although the Guideline, which was formulated by seventeen ministries and agencies related to coastal management, is not binding on local governments, it is the first and only detailed national strategic document that approaches coastal areas to be managed as integrated spaces encompassing land and sea that cut across activities by multiple sectors in marine and coastal areas.

1.2. Lack of consideration of utility in previous studies

In spite of the progress of valuation of ecosystem services and evolution of marine and coastal management towards integrated approach, both study areas lack consideration of utility. Utility is the term used in economics, which means satisfaction

gained through consumption of a good or service (Ito, 2009). Each individual is assumed to have preferences for one thing over another, and these ordered preferences can be converted mathematically into a "utility function" that assigns a higher number to the options that rank higher (Elster, 1989). That is, utility forms the basis of preferences and choices of individuals. Therefore, utility is considered as the key in valuation of marine ecosystem services and management of marine and coastal areas, both of which require understanding on preferences and choices of people that affect decision-making.

At this point, relations among the term "marine ecosystem services", "benefits", and "utility" in this study should be explained. As defined, the "marine ecosystem services" are the benefits people obtain from marine ecosystems. The "benefits" mean help, improvement, or advantage that people get from something. Therefore, the "benefits" are considered influencing the "utility", i.e., it is likely that the bigger the "benefits", the greater the "utility".

1.2.1. Lack of consideration of utility in valuation of marine ecosystem services

As pointed out by Simon (1957), the utilitarian approach, which is a premise of economic valuation, contradicts human nature by postulating individuals as utility maximizers. If human perceptions and values should be at the heart of environmental management (Gregory et al., 2006), a socio-psychological approach to the valuation of marine ecosystem services is desirable, as it is inseparable from the choices and decisions people make about ecosystems. The general public's perception of ecosystems

is also quite different from what is conceptualized by conventional economists (Kumar and Kumar, 2008). Learning about these perceptions is therefore an important step towards better valuation of marine ecosystem services based on a classification system that takes human perceptions into consideration. This, in turn, could lead to better consultation and decision-making in marine and coastal management.

To date, new valuation techniques such as the contingent valuation method and conjoint analysis have been developed (Turner et al., 1993; Kuriyama, 2000) to convert the value people place on targeted environmental goods and services into monetary terms. However, these techniques are limited in their capacity to explore the origins of these values, since these do not capture causes of satisfaction or their concrete utility, dealing instead in abstract values only. Despite calls for furthering inter-disciplinary research (Daily et al., 2000; Kumar and Kumar, 2008; Wallace, 2007), new techniques for valuation of ecosystem services have yet to be established that satisfactorily merge economic and socio-psychological valuations into a single approach.

Furthermore, classification of ecosystem services based on consideration of human perceptions and values has been limited, with the studies by Wallace and his team (Wallace, 2007; Wallace et al., 2003) among the few exceptions. Additionally, little research has been conducted to assess if these classifications are realistic or viable in terms of human perceptions and values. Even the classification of the MA (2003), which uses functional grouping (provisioning, regulating, cultural, and supporting services), is limited by its lack of consideration of how ecosystem services are perceived by the general public.

1.2.2. Lack of consideration of utility in marine and coastal management

Globally, the identification of successes and failures underlying ICM progress and the expected roles of national governments in encouraging initiation and implementation of ICM at the local level have long been of major concern, as shown by analyses of international policies, demonstration projects, and programmes (Chua, 2006; Cicin-Sain and Knecht, 1998; EC, 2002; Rupprecht Consult, 2006). Nationally, following the Guideline's publication, there have been notable attempts to promote development of ICM plans and insightful focus research has been carried out. For example, the National and Regional Planning Bureau of MLIT (NRPB) (2002, 2003, 2004, 2009, 2010) explored potential development of ICM plans initiated by local governments, Shikida and Suenaga (2003) developed a model for coastal management at the local level, and Kinoshita (2005, 2008) discussed the possibility of establishing an integrated coastal management act similar to the one adopted in the United States (US).

The above studies provide insights on how to promote ICM planning and implementation through an empirical approach with viewpoints of system and institutional arrangement. However, little studies have been conducted to examine the failure of the policy on ICM based on the viewpoint of utility with exceptions of two studies, one by NRPB (2005) and another by the Ocean Policy Research Foundation (OPRF) (2010), which slightly touch upon how local governmental officials viewed the national policy on ICM through questionnaires.

1.3. Objectives

In light of the limitations above, I set the key concept as utility over the course of this study. With this concept, I define the objective of this study to explore utility of marine and coastal management and how the utility influences on marine and coastal management, through which aim at acquiring insights for success of marine and coastal management.

In Chapter 2, utility of marine ecosystem services is explored to obtain basic understanding on people's perceptions and their influences on behavioral intentions for marine conservation. Next, in Chapter 3, to analyze the failure of the national policy on planning marine and coastal management, detailed causes of the failure are examined from the viewpoint of utility. In Chapter 4, to explore what status of uses of marine and coastal space would enhance utility that stakeholders derive from its uses, optimum areas for a specific use are examined through spatial environmental analysis coupled with stakeholder interviews, taking *Pyropia yezoensis* farming in Tokyo Bay as an example. To conclude this study, in Chapter 5, roles of utility on marine and coastal management are further examined and discussed through case studies, and perspectives for future study are envisaged.

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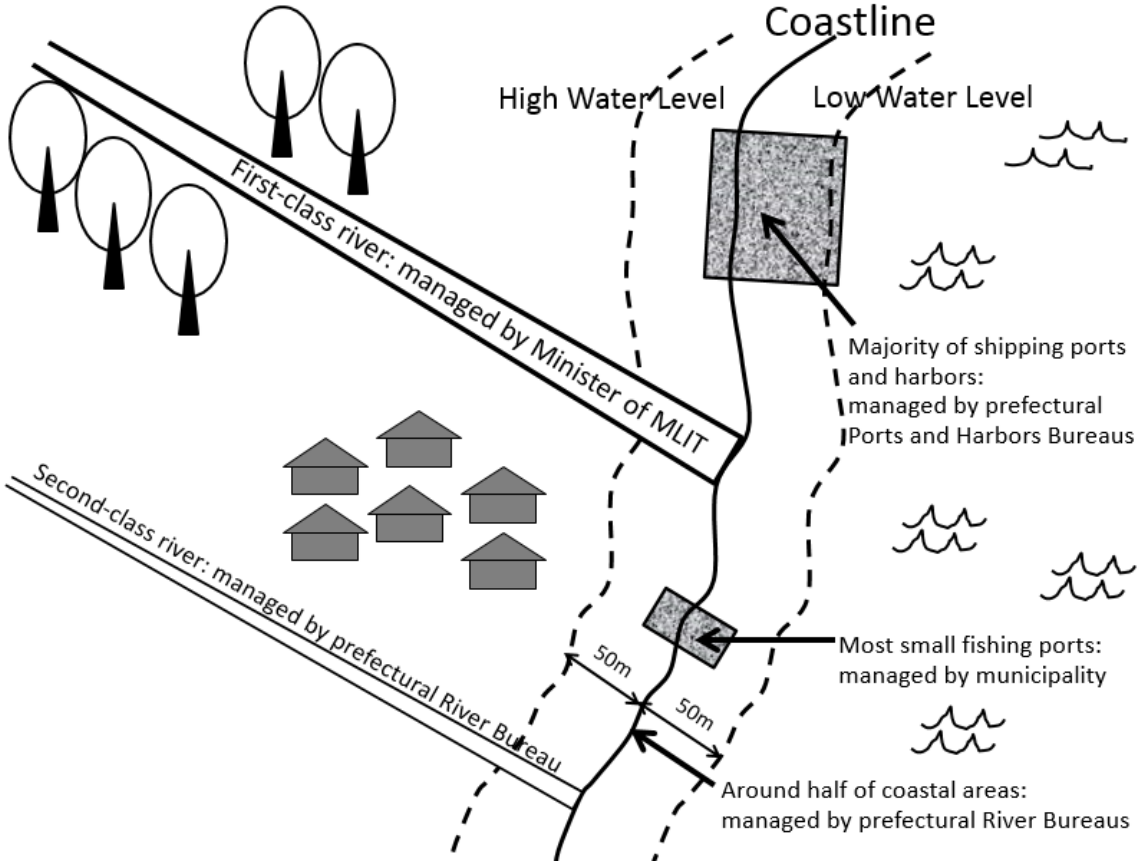

Figure 1-1 Responsibilities for coastal management in Japan

(Author's original)

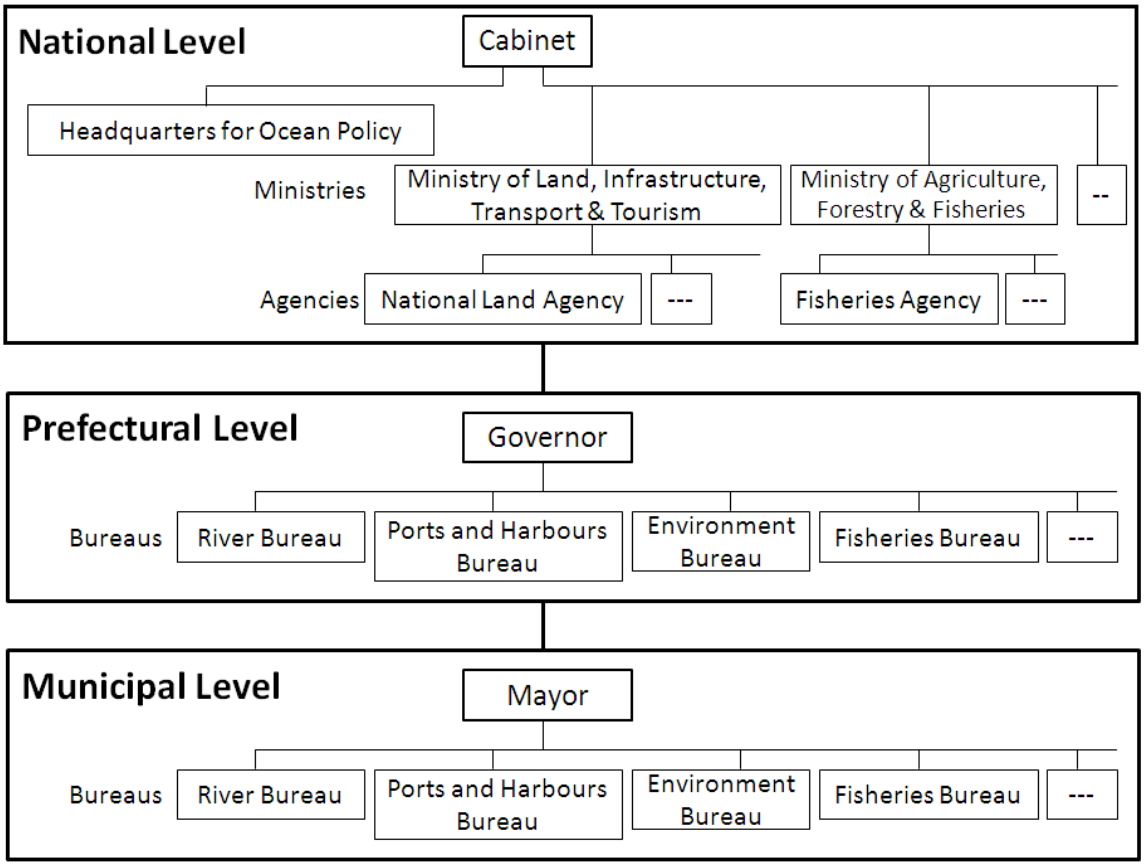

Figure 1-2 Japanese government framework related to ICM

(Developed by author with reference to Cabinet Secretariat (2011))

Chapter 2: Utility of marine ecosystem services and behavioral intentions for marine conservation in Japan

2.1. Introduction

Traditionally, Japanese have shared strong relationships with the sea, as encompassed by the concept of "satoumi", which resonates strongly in Japan, and refers to traditional human interactions with marine ecosystems based on sustainable use (Berque and Matsuda, 2013; United Nations University Institute of Advanced Studies Operating Unit Ishikawa/Kanazawa, 2011). Another distinguishing aspect of these strong connections is the high level of seafood consumption per capita, equalling 54.5 kg per capita in Japan, which significantly surpasses the world average of 18.4 kg per capita (Food and Agriculture Organization of the United Nations, 2012). Also, the level of Japanese dependency on fish protein is high at 21.1%, well over three times the world average of 6.4% (Food and Agriculture Organization of the United Nations, 2012). Considering these features, exploring Japanese residents' perceptions and values of marine ecosystem services and their influences on behavioral intentions for marine conservation would serve as a useful example to understand the human perceptions and values of marine ecosystem services and their influences on behavioral intentions for marine conservation. The Japanese perceptions and values to be explored in this chapter would also provide a useful example of how to classify marine ecosystem services based on human perceptions and values, which could lead to their improved valuation.

At the same time, as pointed out by Goulder and Kennedy (1997), there is variation in how the value or importance of ecosystems is viewed and expressed, depending on

different disciplines, cultural norms, philosophical views, and schools of thought, and various studies have been conducted to explore how cultural differences influence valuation of ecosystem services (Hoyos et al., 2009; Hynes et al., 2013). Hence, this Japanese case study could also be useful as a comparative example for better understanding differences in perceptions and values of marine ecosystem services across different cultures and places.

Throughout this chapter, I set the indispensability of marine ecosystem services as a key concept for representing utility, and presume that the higher the perceived indispensability, the greater the utility. Based on this presumption, a hypothesis has been developed that the perceived indispensability of marine ecosystem services by Japanese residents would have a positive influence, enhancing their behavioral intentions for marine conservation. In other words, it is hypothesized that the more indispensable the ecosystem services are perceived to be, the greater the impact will be on people's behavioral intentions for marine conservation.

The findings of this chapter are expected to fill a current research gap regarding valuation of ecosystem services including examining differences of classifications of marine ecosystem services by people and the four classifications by the MA (2003), while also contributing to an understanding of how to effectively develop policies that enhance people's behavioral intentions for marine conservation. Understanding the analytic potential of causal relationships between perceived indispensability of marine ecosystem services and its influence on enhancing the general public's behavioral intentions for marine conservation may also generate deeper understanding of the

variance in causal relationships across different cultures and locations, while also supporting context-appropriate policy development to motivate people towards marine conservation.

2.2. Materials and methods

2.2.1. Sample and design

Data for this study were ultimately obtained from 814 responses from individuals in Japan to a self-explanatory web-based questionnaire distributed by Macromill Inc., a research company. The distribution of the questionnaire as well as the collection of responses took place over the period from 15-17 February 2013. The respondents received 60-90 online points, equivalent to approximate 60-90 Japanese yen, which can be used for online shopping. The procedure for conducting the questionnaire was as follows.

First, representative areas were selected taking into account geographical balance in regards to the seas: Tokyo and Osaka representing metropolitan areas facing bays, Shizuoka and Ishikawa representing largely rural prefectures facing seas, and Nagano representing landlocked prefectures, reflecting Japan's ratio of coastal to landlocked prefectures[1]. The targeted respondents were twenty years of age or above, and the questionnaire was sent to all people registered with the research company who met the above conditions. The research company sent the questionnaire to 6,416 registrants, to receive 220 responses from each respective area, constituting a total sample of 1,100

[1] Japan has 47 prefectures, of which 39 are coastal, and 8 are landlocked.

respondents.

Next, the representativeness of the respondents in terms of age-based hierarchy was examined. Although 42 respondents over 70 years of age answered the questionnaire, the data was excluded from the sample in consideration for the fact that internet usage by people over this age was below 50% at the end of 2012 (Ministry of Internal Affairs and Communications, 2013), and the respondents were judged as not being a representative sample of the population of age over 70. The remaining 1,058 collected questionnaires were then randomly selected through a stratification process in accordance with the specific age demographics of each respective prefecture, based on data from the Statistics Bureau, Ministry of Internal Affairs and Communications (Statistics Bureau, Ministry of Internal Affairs and Communications, 2010). Thus, the number of questionnaires ultimately used in the analysis fell to 814, i.e., 173 from Tokyo, 141 from Osaka, 168 from Shizuoka, 157 from Ishikawa, and 175 from Nagano.

Items on the questionnaire were developed based on a comprehensive review of existing literature and focusing on two perspectives, namely the indispensability of respective marine ecosystem services and behavioral intentions for marine conservation. Items associated with people's perceptions of marine ecosystem services and their indispensability were adapted from seven existing empirical studies (Beamount et al., 2007; Costanza et al., 1997; De Groot et al., 2002; Farber et al., 2006; Hein et al., 2006; MA, 2003; UNEP, 2006), while the items associated with behavioral intentions for marine conservation were adapted from studies related to environmental behavior (Imai et al., 2010; Karp, 1996; Oishi et al., 2011). After the initial development of a set of

question items, a pilot test was conducted with some university students and marine resource managers to further refine the question items. Subsequently, eighteen question items regarding the indispensability of marine ecosystem services and five question items on behavioral intentions for marine conservation were administered to the respondents (Table 2-1). The web questionnaire actually

The eighteen question items are largely composed of the four groupings by the MA (2003), namely provisioning services (P), regulating services (R), cultural services (C), and supporting services (S), and each grouping has three to six question items. An example of question items on provisioning services of food (P_{food}) is "Without foodstuffs like fish and seaweed provided by the sea, our diet would be extremely affected", and the respondents are asked to choose one of five degrees, which is closest to their thoughts on indispensability of the services targeted. A five-point Likert-type scale was utilized in the questionnaire for the five degrees of consent, labeled as 1=strongly agreed, 2=agreed, 3=neither, 4=disagreed, and 5=strongly disagreed. One question item on regulating services by beaches (R_{beach}) is "Without sandy beaches to reduce waves, I would be extremely vulnerable to high waves". For cultural services, one question item about services for religion ($C_{religion}$) is "Without the sea to be utilized for religious and traditional events, our culture would be extremely impoverished". An example of question items on supporting services for life (S_{life}) is "Because the sea exists, life continues and nature is sustained". Similarly, for five question items on behavioral intentions for marine conservation, the respondents are asked to what extent they agree or disagree; one example ($MC_{donation}$) is described "I would donate money for

marine conservation".

Possible problems with this questionnaire design should be noted. First, no special information was provided to the respondents prior to being asked the questions except the first sentence, "We are asking your opinions on values and services provided by the sea". Second, the term marine conservation is used only in the most general sense. These may cause very different understandings of marine conservation from one respondent to another, which could lead to discrepancies in the responses of behavioral intentions. However, aiming at grasping a big picture of behavioral intentions for marine conservation by Japanese residents, the questionnaire does not elaborate on details but leaves the term marine conservation in its general sense.

2.2.2. Statistical analysis and proposed model

Data analysis was performed in two stages. In the first stage, a factor analysis was conducted using SPSS Statistics Version 21 to examine hidden factors of respondents' perceived indispensability of respective marine ecosystem services. Factor analysis is a statistical approach that is used to define the underlying structure of the interrelationships among a large number of variables, as factors represent the underlying constructs that account for the original set of observed variables. This study utilized factor analysis to search for and define the fundamental structure among eighteen observed variables on perceived indispensability of marine ecosystem services by respondents. A reliability analysis was also conducted to assess the degree of

consistency among the variables in a summated factor[2].

In the second stage, SPSS Statistics AMOS Version 20 was used to assess the goodness-of-fit for a proposed Structural Equation Model (SEM) and to then verify it. The SEM is a multivariate technique for testing and estimating causal relationships among multiple concepts or constructs. It combines aspects of factor analysis and multiple regression that enables researchers to simultaneously examine a series of interrelated "dependence relationships" among the "measured variables" and "latent constructs" as well as between several latent constructs, as explained by Hair et al (2010)[3]. A latent construct cannot be measured directly but is composed of one or more observed variables. In this study, the latent constructs identified in the factor analysis represent hidden factors influencing the perceptions being studied, and are incorporated into the SEM to show their influence over Japanese residents' behavioral intentions for marine conservation.

Many studies on relationships between value and behavioral intentions apply the cognitive hierarchy model developed by Fulton et al. (1996), which include value orientation, attitudes and norms, and behaviors. However, as an initial exploration of the direct linkages between perceptions of indispensability of marine ecosystem services and behavioral intentions for marine conservation, this study proposes a simplified model, which focuses on possible direct causal relationships between respective latent constructs regarding perceived indispensability of marine ecosystem services by the respondents and their behavioral intentions.

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[2] Further information on factor analysis can be found in Hair et al. (2010).
[3] Further information on the SEM can be found in Bollen (1989).

2.3. Results

2.3.1. Perceived indispensability of marine ecosystem services

Table 2-2 shows the collected responses regarding the indispensability of respective marine ecosystem services on a scale ranging from '1: strongly agreed' to '5: strongly disagreed'. Respondents placed a high level of indispensability on all three items under the supporting services category contained in the MA (2003). Services related to food provision were also highly valued, while items classified under the component of cultural services by the MA (2003), especially cultural services related to religion, recreation, and health received a low assessment in terms of essentialness.

2.3.2. Construction of cognitive variables

Three underlying factors of perceived indispensability of respective marine ecosystem services were identified by conducting a factor analysis using Promax with Kaiser normalization, and principal component analysis as the extracting method with the variables related to indispensability of marine ecosystem services in Table 2-1 (KMO=0.929; $p<0.001$). Only factors with an eigenvalue of 1 or above were retained (Kaiser-Gutmann retention criterion). Rotated factor loadings were used to identify relevant variables to be used in the construction of latent variables for the SEM. Variables were retained if their rotated loadings were above the threshold value of 0.4. In the exploratory analysis, the variable that measured respondents' perceived indispensability of "provision of corals and beautiful shells as ornaments from the sea"

was excluded due to its low rotated loadings (below 0.4). The final results are shown in Table 2-3.

With factor 1 loadings, I constructed an index called "Essential Benefits", composed of items reflecting respondents' perceptions regarding provision of food, beautiful scenery, lives, nutrient cycles, and living places for marine organisms:

$$\text{Essential Benefits} = P_{food} + C_{scenery} + S_{life} + S_{ncycle} + S_{place}^{4}. \quad (1)$$

In terms of the categorization system presented in the MA (2003), this latent construct indicates the indispensability of food of provisioning services, scenery of cultural services, and supporting services. Items from factor 2 loadings form an index named "Indirect Benefits":

$$\text{Indirect Benefits} = P_{med} + P_{mineral} + P_{energy} + P_{water} + R_{beach} + R_{reef} + R_{tidal} + R_{cd} \quad (2)$$

This index indicates the perceived indispensability of marine ecosystem services that provide medicine, minerals, energy, and water, that regulate waves (beaches and reefs), that purify water (tidal flats), and that absorb carbon dioxide. Factor 3 loadings identified respondents' perceptions of marine ecosystem services associated with religion, recreation, health, culture and scenery. This index termed "Cultural Benefits" captures the indispensability of various benefits from marine ecosystem services that contribute to enriching religious events and recreational opportunities, promoting good health, nurturing unique cultures, and composing beautiful scenery, which correspond to the cultural services category of the MA (2003):

[4] Capital letter "P" represents provisioning services, "C" represents cultural services, and "S" represents supporting services. Capital letter "R" in the following represents regulating services. The words in lower case specify the services.

Cultural Benefits = $C_{religion} + C_{rec} + C_{health} + C_{culture} + C_{scenery}$. (3)

The percentage of respondents who chose scales 1 and 2 (strongly agree and agree) was 80% for "Essential Benefits", 67% for "Indirect Benefits", and 47% for "Cultural Benefits", respectively (Table 2-4). This reflects the perceived indispensability of each respective latent construct of marine ecosystem services.

2.3.3. Reliability Analysis

Reliability analysis was used to evaluate the stability and consistency of the measured items of each latent construct. The criteria used to decide whether to delete an item were each tested for corrected item-total correlation and based on whether elimination of an item improved the corresponding alpha value (Parasuraman et al., 1988). In general, items with corrected items-total correlations below 0.30 are eliminated. The corrected items-total correlations and Cronbach Alpha Coefficients for latent construct variables are shown in Table 2-5.

The latent construct named "Essential Benefits" had a Cronbach Alpha Coefficient of 0.88 with no increase resulting if any of the five variables were deleted (P_{food}, $C_{scenery}$, S_{life}, S_{ncycle}, S_{place}). This Cronbach Alpha Coefficient exceeds Nunnally and Bernstein's (Nunnally and Bernstein, 1994) recommendation of 0.70, and supports the use of these variables. The latent constructs named "Indirect Benefits" and "Cultural Benefits" had Cronbach Alpha Coefficients of 0.91 and 0.83 respectively, with no increase if any of the respective variables deleted. The latent construct of "Behavioral Intentions for Marine Conservation" consisted of five variables, namely MC_{tax}, $MC_{donation}$, $MC_{volunteer}$,

MC_{supcom}, and $MC_{envgoods}$[5] and had a Cronbach Alpha Coefficient of 0.89 with no increase if any of the five items were deleted. Therefore, this study made no exclusions, and used all the variables for all the latent constructs.

2.3.4. Evaluation of proposed Structural Equation Model

Figure 2-1 shows the standardized model as estimated by AMOS. Each of the observed variables is displayed in a rectangle, and each of the latent constructs is displayed in an oval. The goodness-of-fit index (GFI) is acceptable at 0.846, the adjusted goodness-of-fit index (AGFI) is acceptable at 0.807, and the root mean square error of approximation (RMSEA) falls within acceptable, but not optimal, limits at 0.089 (Hooper et al., 2008). The explained variance was R^2=0.33.

The path hypothesis that "Essential Benefits" has an influence on enhancing behavioral intentions for marine conservation was supported by an optimal level of t=3.584 ($p<0.001$). The path hypothesis that "Indirect Benefits" has an influence on enhancing behavioral intentions for marine conservation was rejected with t=0.341 ($p>0.10$), while the path hypothesis that "Cultural Benefits" has an influence on enhancing behavioral intentions for marine conservation was supported with an optimal level of t=7.733 ($p<0.001$).

A strongly positive path coefficient (0.42) was calculated between "Cultural Benefits" and behavioral intentions, while the path coefficient between "Essential Benefits" and behavioral intentions was somewhat weaker (0.21). In this model, therefore, behavioral

[5] The abbreviation "MC" represents behavioral intentions for marine conservation. Words in lower case specify the respective means for marine conservation.

intentions for marine conservation are more strongly driven by “Cultural Benefits” than “Essential Benefits”. The analysis did not find statistically significant evidence for a correlation along the path from “Indirect Benefits” to behavioral intentions.

The collected responses regarding the behavioral intentions for marine conservation are shown in Table 2-6.

2.4. Discussions

The significance of this chapter’s results lies in two separate findings: i) three hidden factors regarding the indispensability of marine ecosystem services, as perceived by randomly selected Japanese residents, were identified through the factor analysis, namely “Essential Benefits”, “Indirect Benefits”, and “Cultural Benefits”, which are different from the four categories by the MA (2003) but have relevance to the categorization system within the MA (2003); and ii) degree of indispensability and influence on behavioral intentions vary for the three hidden factors. “Essential Benefits” has the highest degree of indispensability, but lower influence than “Cultural Benefits” on behavioral intentions for marine conservation, “Indirect Benefits” has the second highest indispensability, but this analysis found no statically significant causal relationships with behavioral intentions, and “Cultural Benefits” has the lowest indispensability, but the highest influence on behavioral intentions. A more detailed explanation of these findings follows.

Firstly, interpretation of the three latent constructs by the factor analysis and their respective characteristics should be discussed. The variables that make up “Essential

Benefits" (benefits of eating seafood, enjoying beautiful coastal scenery, sustaining nature, regulating nutrient cycles, and providing places for marine organisms to live) can be interpreted as being directly and tangibly essential to sustaining ecosystems around the world and lives of the people, as reflected in the perceived indispensability of "Essential Benefits" being the highest among the three latent constructs (Table 2-4). The benefits of the respective variables of "Indirect Benefits" (provision of medicines, minerals, energy, and water, reduction of height of waves, purification of water, and absorption of carbon dioxide) are considered to be rather beyond one's reach or long-term, making it difficult for respondents to have a sense of actually receiving benefits. Despite these characteristics of "Indirect Benefits", from the result it can be interpreted that the indirect benefits are perceived and appreciated by the respondents as benefits from marine ecosystems, since the perceived indispensability of "Indirect Benefits" is second among the three latent constructs (Table 2-4). The third latent construct identified by the factor analysis, "Cultural Benefits", is composed of benefits from marine ecosystem services that provide venues for religious events, recreational opportunities, health, unique coastal cultures, and beautiful coastal scenery. This can be interpreted as embodying life enhancement values, and the perceived indispensability of "Cultural Benefits" is the lowest of the three latent constructs (Table 2-4).

Considering the typologies of ecosystem services by the MA (2003), there is some correlation with the three hidden factors influencing perceived indispensability of marine ecosystem services: "Cultural Benefits" corresponds to cultural services, "Indirect Benefits" corresponds to combination of provisioning services (except food)

and regulating services, and “Essential Benefits” corresponds to the sum of supporting services, provisioning services of food, and cultural services of coastal sceneries as defined in the MA (2003). Likewise, “Cultural Benefits” is also similar to the socio-cultural fulfilment described by Wallace (2007), and exercises the greatest influence on promoting behavioral intentions for marine conservation. This finding seems reasonable, considering that in previous studies, residents generally assessed cultural benefits more highly than other benefits such as provisioning, regulating and supporting services (Bryan et al., 2010; Raymond et al., 2009; Ruiz-Frau, 2011). Although there are some relevances between respondents’ perceptions and the four categories by the MA (2003), still, differences between people’s perceptions and the scientific classification by the MA (2003) should be noted. Because this implies that scientific classification of marine ecosystem services would not be always considered reasonable by people.

The policy implications of the second findings should also be discussed. This chapter identified a discrepancy between the value of marine ecosystem services that respondents identified as the most indispensable, and how this affects their behavioral intentions for marine conservation. Hence, the hypothesis was rejected, namely that the greater the perceived indispensability, the stronger its influence on enhancing behavioral intentions for marine conservation. This finding carries policy implications that measures emphasizing the value of cultural services could be a more powerful tool to enhance Japanese people’s behavioral intentions for marine conservation than measures emphasizing the indispensability of marine ecosystem services. Therefore, providing

good opportunities for people to enjoy marine recreation, unique coastal cultures, and beautiful coastal scenery would be a good intervention to raise people's perceptions of the cultural services generated by marine ecosystems, which in turn could enhance their behavioral intentions for marine conservation.

Lastly, I would like to discuss possible interpretations of the discrepancy found in this chapter, based on the scarcity principle, which is used in both economics (Cassel, 1928) and psychology (Mittone, 2009), and is sometimes referred to as the paradox of value or diamond-water paradox (Smith, 1776). "Essential Benefits" was identified as the most indispensable among the three latent constructs for human beings to survive, but surprisingly "Cultural Benefits" was found to have the strongest influence on enhancing behavioral intentions for marine conservation. Applying the scarcity principle, this discrepancy might be interpreted as being caused by a perception gap, namely if the Japanese residents perceive cultural services as scarce, while perceiving seafood and supporting services as abundant and secured. Building on the scarcity principle, it could be assumed that the value placed by people on marine ecosystem services, or utility of marine ecosystem services, would fluctuate in accordance with the scarcity of the services in their places of residence. If this observation is correct, the respective weight of indispensability and effectiveness on influencing behavioral intentions for marine conservation would be different across cultures and locations, reflecting the status and scarcity of respective marine ecosystem services. The value of ecosystem services would also be assessed differently by people, reflecting cultural norms and philosophical views (Goulder and Kennedy, 1997). Thus, further research in different

cultural and geographical settings would generate a deeper understanding of causal relationships between perceived indispensability of marine ecosystem services and behavioral intentions for marine conservation, which in turn contribute to developing more appropriate policies that could gain residents' support for marine conservation.

Towards future study, limitation of this chapter should be pointed out. First, as Table 2-2 shows, frequency distribution of agreement regarding the indispensability of marine ecosystem services has skewness, which might cause some statistical error. In order to avoid possible statistical error, the questionnaire items should be further examined and improved so that the skewness of frequency distribution gets smaller. Second, this chapter might be vulnerable to some of the criticism attributed to Contingent Valuation Method, such as volatility of results affected by the wording of the questionnaire and acceptance bias based on whether respondents are pessimistic on given scenario (Arrow et al., 1993). To address these possible challenges, future studies that further examine appropriateness of wordings of questions and include subsidiary questions to confirm respondents' characteristics and understanding of the questions would be necessary, which in turn should contribute to deeper understanding of differences of perceived indispensability and their influence over behavioral intentions for marine conservation among different cultures and places.

2.5. Conclusions

The hypothesis that the greater the perceived indispensability, the greater the influence on enhancing behavioral intentions for marine conservation was rejected by

this sampling of Japanese residents. Three hidden factors of Japanese respondents' perceived indispensability of marine ecosystem services were constructed, namely "Essential Benefits", "Indirect Benefits", and "Cultural Benefits", which are different from the four classifications by the MA (2003). This chapter found that "Essential Benefits" was deemed to be the most indispensable, but had a lower influence than "Cultural Benefits" on behavioral intentions for marine conservation, while "Indirect Benefits" had the second highest degree of perceived indispensability, but did not find any significant causal relationship between "Indirect Benefits" and behavioral intentions, and "Cultural Benefits" had the lowest degree of indispensability but the greatest influence on the behavioral intentions. In order to increase support from the general public in Japan for marine conservation, measures enhancing cultural benefits would be more effective than measures stressing the indispensability of marine ecosystem services for sustaining their lives. Values placed on marine ecosystem services by people could vary across different cultural and geographical settings, and there may also be differences in terms of the marine environmental status of respective places based on the scarcity principle. Further research is expected to examine variations across different cultures and places regarding perceptions of indispensability and their influences on enhancing the general public's behavioral intentions for marine conservation in order to develop more appropriate policies that could gain their support for marine conservation.

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Table 2-1 Items and their codes to measure the indispensability of marine ecosystem services and behavioral intentions for marine conservation

Component	Abbreviation	Items
Provisioning Services	P_{food}	Without foodstuffs like fish and seaweed provided by the sea, our diet would be extremely affected.
	$P_{oranament}$	Without corals and beautiful shells, which can be used as ornaments, our lives would be extremely colorless.
	P_{med}	Without marine resources, which can be utilized as medicine, our health would be extremely endangered in the future.
	$P_{mineral}$	Without mineral resources such as cobalt and nickel in the seabed, high-tech industries would be extremely hampered.
	P_{energy}	Without energy resources such as natural gas and methane hydrate in the seabed, supplies of energy would be severely limited.
	P_{water}	Without water for human consumption and irrigation produced through desalination of seawater, our lives would be extremely inconvenient.
Regulating Services	R_{beach}	Without sandy beaches to reduce waves, we would be extremely vulnerable to high waves.
	R_{reef}	Without coral reefs and mangroves to calm waves, we would be extremely vulnerable to high waves.
	R_{tidal}	Without clams and other sea creatures living in tidal flats to purify the water, water quality would experience severe deterioration.

	R_{cd}	Without the sea to contribute to carbon dioxide absorption, there would be severe advancement of global warming.
Cultural Services	$C_{religion}$	Without the sea to be utilized for religious and traditional events, our culture would be extremely impoverished.
	C_{rec}	Without recreational opportunities such as swimming, diving, and surfing, our recreation opportunities would be far less interesting.
	C_{health}	Without opportunities to spend time by the sea, our health would be considerably worsened.
	$C_{culture}$	Without the sea, our coastal cultures would be far less attractive and far more monotonous.
	$C_{scenery}$	Without white sandy beaches, pine trees, and night views along the coasts, we would have far fewer opportunities to be moved by coastal scenery.
Supporting Services	S_{life}	Because the sea exists, life continues and nature is sustained.
	S_{ncycle}	Because the sea exists, the nutrient cycle of the earth is well regulated and nature is sustained.
	S_{place}	Without the sea, there would be no place for marine organisms to live, causing fatal damage to the earth.
Behavioral intentions for marine conservation	MC_{tax}	I would accept a tax increase for marine conservation.
	$MC_{donation}$	I would donate money for marine conservation.
	$MC_{volunteer}$	I would volunteer for marine conservation.
	MC_{supcom}	I would support companies that contribute to marine conservation.
	$MC_{envgoods}$	I would purchase pro-environmental goods for marine conservation even at higher prices.

Table 2-2 Indispensability of marine ecosystem services according to the respondents

Component	Abbreviation	Degree of agreement regarding the indispensability of marine ecosystem services*					
		1	2	3	4	5	Total
Provisioning Services	P_{food}	369	323	103	16	3	814
	$P_{oranament}$	153	305	238	97	21	814
	P_{med}	154	323	280	48	9	814
	$P_{mineral}$	196	328	235	47	8	814
	P_{energy}	232	353	182	40	7	814
	P_{water}	155	312	258	73	16	814
Regulating Services	R_{beach}	188	373	214	33	6	814
	R_{reef}	186	385	209	28	6	814
	R_{tidal}	238	378	166	27	5	814
	R_{cd}	240	329	200	38	7	814
Cultural Services	$C_{religion}$	89	273	320	112	20	814
	C_{rec}	68	237	292	173	44	814
	C_{health}	65	179	361	165	44	814
	$C_{culture}$	110	337	297	59	11	814
	$C_{scenery}$	153	386	226	41	8	814
Supporting Services	S_{life}	358	313	129	11	3	814
	S_{ncycle}	313	336	144	16	5	814
	S_{place}	415	273	112	12	2	814

* 1: strongly agreed, 2: agreed, 3: neither, 4: disagreed, 5: strongly disagreed

Table 2-3 Results of factor analysis with the loadings of the rotated factors for the variables representing the indispensability of marine ecosystem services

Component	Variable	Factor 1	Factor 2	Factor 3
			Explained variance	
		7.44	46.25	5.46
			Rotated loadings	
Provisioning Services	P_{food}	**0.52**	0.33	-0.12
	P_{med}	-0.14	**0.80**	0.13
	$P_{mineral}$	0.00	**0.82**	-0.06
	P_{energy}	0.10	**0.75**	-0.10
	P_{water}	-0.09	**0.72**	0.10
Regulating Services	R_{beach}	0.13	**0.64**	0.05
	R_{reef}	0.18	**0.59**	0.08
	R_{tidal}	0.37	**0.47**	-0.01
	R_{cd}	0.21	**0.52**	0.07
Cultural Services	$C_{religion}$	-0.12	0.26	**0.60**
	C_{rec}	-0.08	0.01	**0.68**
	C_{health}	-0.16	0.02	**0.80**
	$C_{culture}$	0.32	-0.11	**0.66**
	$C_{scenery}$	**0.46**	-0.07	**0.48**
Supporting Services	S_{life}	**0.90**	-0.07	0.00
	S_{ncycle}	**0.81**	0.03	0.04
	S_{place}	**0.90**	0.04	-0.16

Table 2-4 Indispensability of marine ecosystem services according to the respondents

Latent constructs	Degree of agreement regarding the indispensability of marine ecosystem services*					
	1	2	3	4	5	Total
Essential Benefits	39.6%	40.2%	17.6%	2.4%	0.3%	100%
Indirect Benefits	24.4%	42.7%	26.8%	5.1%	1.0%	100%
Cultural Benefits	11.9%	34.7%	36.8%	13.5%	3.1%	100%

* 1: strongly agreed, 2: agreed, 3: neither, 4: disagreed, 5: strongly disagreed

Table 2-5 Reliability analysis of observed variables

Latent constructs and description of observed variables		Corrected items-total correlation	Alpha value (for item deletion)
Essential Benefits			**0.88**
P_{food}	Food provision	0.64	0.87
$C_{scenery}$	Scenery provision	0.60	0.89
S_{life}	Life source	0.80	0.84
S_{ncycle}	Nutrient cycle	0.79	0.84
S_{place}	Living place for organisms	0.77	0.84
Indirect Benefits			**0.91**
P_{med}	Medicinal resources provision	0.71	0.90
$P_{mineral}$	Mineral resources provision	0.72	0.90
P_{energy}	Energy resources provision	0.71	0.90
P_{water}	Water resources provision	0.67	0.90
R_{beach}	Wave reduction by beach	0.74	0.90
$R_{reef\text{-}mang}$	Wave reduction by reefs and mangroves	0.75	0.89
R_{tidal}	Water purification by tidal flats	0.70	0.90
R_{cd}	Carbon dioxide absorption	0.68	0.90
Cultural Benefits			**0.83**
$C_{religion}$	Religious usage	0.61	0.79
C_{rec}	Recreation provision	0.58	0.80
C_{health}	Health provision	0.62	0.79
$C_{culture}$	Culture nurturing	0.70	0.77
$C_{scenery}$	Scenery provision	0.61	0.79

Behavioral Intentions for Marine Conservation			**0.89**
MC_{tax}	Support level for tax increase for marine conservation	0.68	0.89
$MC_{donation}$	Support level for donation for marine conservation	0.78	0.86
$MC_{volunteer}$	Support level for volunteering for marine conservation	0.76	0.87
MC_{supcom}	Support level for private companies which contribute to marine conservation	0.72	0.88
$MC_{envgoods}$	Support level for buying goods which have a low-impact on marine environment	0.78	0.86

Table 2-6 Degree of agreement regarding the behavioral intentions for marine conservation

Component	Abbreviation	Degree of agreement regarding the behavioral intentions for marine conservation *					
		1	2	3	4	5	Total
Behavioral intentions for marine conservation	MC_{tax}	76	267	335	97	39	814
	$MC_{donation}$	56	229	350	129	50	814
	$MC_{volunteer}$	54	253	327	137	43	814
	MC_{supcom}	76	316	330	70	22	814
	$MC_{envgoods}$	46	206	408	116	38	814

* 1: strongly agreed, 2: agreed, 3: neither, 4: disagreed, 5: strongly disagreed

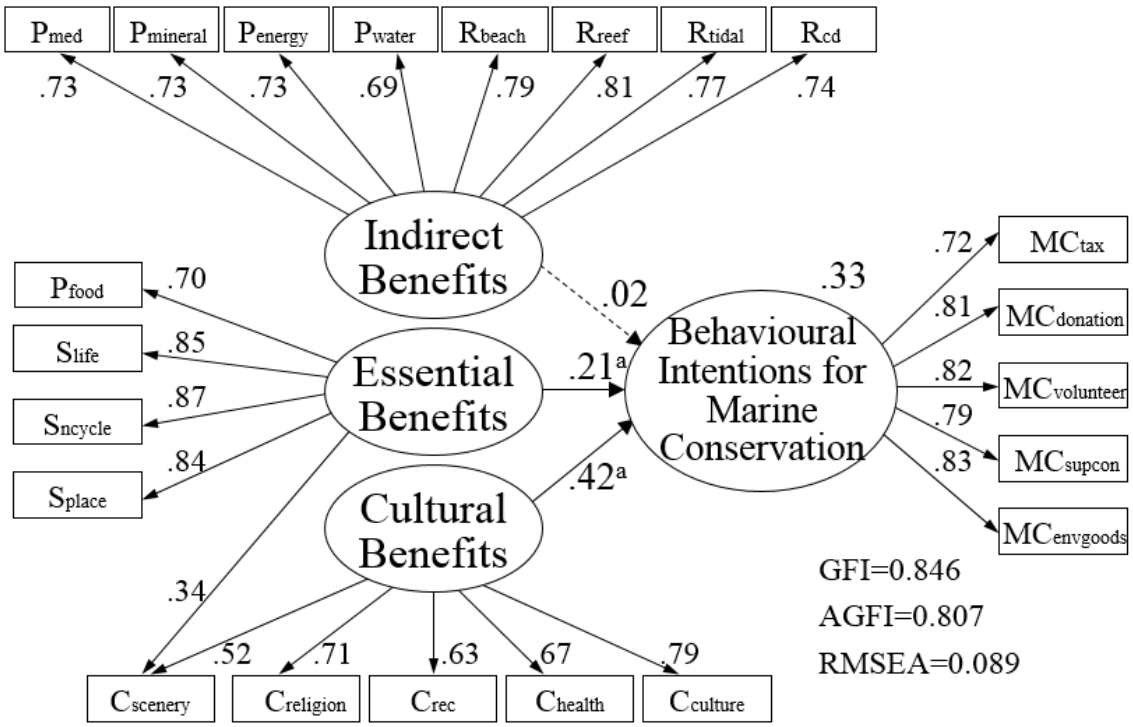

Figure 2-1 Standardized estimated hypothetical model. (a) indicates significance at 0.001 level. Dashed line indicates path that is not significant at 0.05 or better. Detailed explanations of abbreviations such as P_{food}, S_{life}, R_{beach}, and MC_{tax} can be found in Table 2-1.

Supplementary Table 2-1 Questionnaires administered to respondents

Questionnaires on nature						
Following are questionnaires asking you about values and services that the sea provides to people. To what extent do you agree or disagree with each of the following statements? Please select the most applicable one from the following choices.						
Question items	Degree of agreement	1. strongly agreed 2. agreed 3. neither 4. disagreed 5. strongly disagreed				
1	Without foodstuffs like fish and seaweed provided by the sea, our diet would be extremely affected.	1	2	3	4	5
2	Without corals and beautiful shells, which can be used as ornaments, our lives would be extremely colorless.	1	2	3	4	5
3	Without marine resources, which can be utilized as medicine, our health would be extremely endangered in the future.	1	2	3	4	5
4	Without mineral resources such as cobalt and nickel in the seabed, high-tech industries would be extremely hampered.	1	2	3	4	5
5	Without energy resources such as natural gas and methane hydrate in the seabed, supplies of energy would be severely limited.	1	2	3	4	5
6	Without water for human consumption and irrigation produced through desalination of seawater, our lives would be extremely inconvenient.	1	2	3	4	5
7	Without sandy beaches to reduce waves, we would be extremely vulnerable to high waves.	1	2	3	4	5
8	Without coral reefs and mangroves to calm waves, we would be extremely vulnerable to high waves.	1	2	3	4	5
9	Without clams and other sea creatures living in tidal flats to purify the water, water quality would experience severe deterioration.	1	2	3	4	5

10	Without the sea to contribute to carbon dioxide absorption, there would be severe advancement of global warming.	1	2	3	4	5
11	Without the sea to be utilized for religious and traditional events, our culture would be extremely impoverished.	1	2	3	4	5
12	Without recreational opportunities such as swimming, diving, and surfing, our recreation opportunities would be far less interesting.	1	2	3	4	5
13	Without opportunities to spend time by the sea, our health would be considerably worsened.	1	2	3	4	5
14	Without the sea, our coastal cultures would be far less attractive and far more monotonous.	1	2	3	4	5
15	Without white sandy beaches, pine trees, and night views along the coasts, we would have far fewer opportunities to be moved by coastal scenery.	1	2	3	4	5
16	Because the sea exists, life continues and nature is sustained.	1	2	3	4	5
17	Because the sea exists, the nutrient cycle of the earth is well regulated and nature is sustained.	1	2	3	4	5
18	Without the sea, there would be no place for marine organisms to live, causing fatal damage to the earth.	1	2	3	4	5
19	I would accept a tax increase for marine conservation.	1	2	3	4	5
20	I would donate money for marine conservation.	1	2	3	4	5
21	I would volunteer for marine conservation.	1	2	3	4	5
22	I would support companies that contribute to marine conservation.	1	2	3	4	5
23	I would purchase pro-environmental goods for marine conservation even at higher prices.	1	2	3	4	5

Chapter 3: Influences of utility on national policy on planning marine and coastal management in Japan

3.1. Introduction

The complex causal relationships between people's perceived indispensability and their behavioral intentions are clarified in Chapter 2. The respondents' perception on "Cultural Benefits" is found most influential on enhancing their behavioral intentions for marine conservation in Japan, in spite of its lowest indispensability among the three perceptions of marine ecosystem services, namely "Essential Benefits", "Indirect benefits", and "Cultural Benefits". On the other hand, "Essential benefits" does not have significant influences on behavioral intentions for marine conservation, in spite of its highest perceived indispensability. These discrepancies originate from the complex utility that forms people's preferences and bases of their choices among alternatives (Elster, 1989).

Based on the above understanding, utility should be given high priority in planning marine and coastal areas to ensure their viability and effectiveness to implement. However, as reviewed in the section 1.2 of Chapter 1, the previous studies on marine and coastal management have been focused on institutional arrangement, lacking ample consideration on utility. Anchored in the realization above, in this chapter, I examine causes of the failure of the national policy with a hypothesis that the previous national policy on planning marine and coastal management has lacked considerations of utility.

The Guideline, which is judged as the most important national policy on planning marine and coastal management (section 1.1 of Chapter 1), is selected as the national policy to be analyzed in this chapter. To date, in spite of the significance of the

Guideline as explained in Chapter 1, no local governments have developed ICM plans in line with the Guideline. Thus, this chapter explores reasons of poor implementation of the Guideline with the hypothesis above, with focusing on utility. Using combination of a policy implementation analysis with international policy comparisons and interviews of stakeholders, I evaluate the Guideline and examine influences of utility on its failures.

3.2. Materials and methods

3.2.1. Method selection

In evaluating the Guideline, I adopt the Policy Implementation Framework (PIF), one of the frameworks under the top-down approach developed by Mazmanian and Sabatier (1989).

Policy implementation research has two major approaches, namely top-down and bottom-up. The bottom-up approach focuses on local implementation structures, hence it is suitable for assessing the dynamics of local variation of policy implementation (Son, 2010). On the other hand, the top-down approach is useful in cases when: i) the focus is on the extent of structure or constraint in the overall policy system and mean responses are desired, ii) there is dominant legislation or policy structuring for the situation to be analyzed, iii) the policy process operates with at least moderate clarity and consistency, and iv) research funds are limited (Elson, 2006; Mazmanian and Sabatier, 1989). Whilst i), ii) and iii) are demonstrated by Japanese ICM policy, iv) applies to this study. Therefore, the top-down approach is employed. Critics of the top-down approach claim that it is likely to underestimate the strategies used by street level bureaucrats (Berman, 1978). Another weak point is its tendency to neglect actors other than central decision

makers because it starts from their perspective (Hjern and Hull, 1982). Despite these weaknesses, this study employs the top-down approach, because the objective of this chapter is not to examine the dynamics of ICM implementation at local levels, but to evaluate the ICM Guideline of Japan at the national level with the viewpoint of utility by coupling with interviews of local government officials to incorporate influences of stakeholders on-the-ground.

Among various frameworks possible under the top-down approach, the one used here is that developed by Mazmanian and Sabatier (1989). Starting from an analysis of an implementation deficit in the early 1970's, attempts to provide some conceptual order for the study of implementation emerged and the top-down or bottom-up debate flourished during the 1980's (Mazmanian and Sabatier, 1981; Pressman and Wildavsky, 1973; Sabatier, 1980; Sabatier and Mazmanian, 1979; Van Meter and Van Horn, 1975). The PIF by Mazmanian and Sabatier is chosen here because it is recognized as a leading proponent of the top-down approach (Alterman, 1983; Goggin, 1984) and builds on the works of Pressman and Wildavsky (1973) and of Van Meter and Van Horn (1975); it has been subjected to extensive empirical testing in over twenty research projects and proven to be well adapted to various policies, e.g., statutory and non-statutory policies covering environmental regulation to nonbinding compacts in various regions and countries (Elson, 2006; Goggin, 1984; Mazmanian and Sabatier, 1989; Sabatier, 1986; Winter, 1990; Zhang et al., 2011). The suitable time span for analysis is seven to ten years (Mazmanian and Sabatier, 1989), thus the present is still an appropriate time to conduct the Guideline assessment.

In its development, Mazmanian and Sabatier (1989) identified and summarized six key conditions determining implementation success:

Condition 1: Clear and consistent objectives

Condition 2: Causal theory, i.e., sound theory of what kinds of actions will result in the achievement of its policy goals

Condition 3: Structuring implementation processes involving sufficient financial resources and assignment of implementation authority with adequate hierarchical integration and few veto points[6]

Condition 4: Commitment and skill of top implementing officials

Condition 5: Public and stakeholder support

Condition 6: Supportive socioeconomic and policy environment

Conditions 1, 2 and 3 are statutory variables which can be dealt with by the initial policy decisions, whereas conditions 4, 5 and 6 are non-statutory variables, largely the product of subsequent political and economic pressure during the implementation process.

3.2.2. Data collection

Data from documents are used to evaluate the statutory variables, whereas semi-structured face-to-face interviews of academics and national government officials are used to evaluate the non-statutory variables. In order to explore causes of failures of the Guideline from the viewpoint of utility, semi-structured face-to-face interviews are conducted to local government officials.

The documents used for evaluation of statutory variables are listed in Table 3-1. In order to assess the Guideline's effectiveness, the following are reviewed for

[6] "Veto points" can be rephrased as "clearance points". Veto points are considered as agencies or persons that have the right to reject a decision. The more veto points, the more difficulty implementing a policy.

comparison: i) the Coastal Zone Management Act of the United States (US CZMA) (1972), as one of the first laws on ICM; ii) the Coastal Zone Management Act of the Republic of Korea (CZMA ROK) (1999), as an advanced example in East Asia; iii) ICM principles of the European Union (EU), namely Council recommendation of the European Parliament and of the Council of 30 May, concerning the implementation of Integrated Coastal Zone Management in Europe (2002/413/EC) (2002) as a policy set by a supra-national body; and iv) Sustainable Development Strategy for the Seas of East Asia (PEMSEA (Partnerships in Environmental Management for the Seas of East Asia), 2003), an ICM approach of PEMSEA, as a framework developed by regional ICM experience.

The interviews of academics and national government officials were conducted for the analysis of non-statutory variables and for clarifying the limitations of a new law, the Basic Act on Ocean Policy (2007) in promoting implementation of the Guideline. Five academics (referred to as A, B, C, D and E in Table 3-4) were selected based on their experiences as advisers to the national government on ICM as well as their general expertise, namely law, marine policy, public administration, coastal management, coastal environment. As for the national government officials, three (referred to as a, b and c in Table 3-4) were chosen in light of their work experiences related to ICM with expertise of port and harbor management and fisheries. All interviewees are male with age group from forties to sixties. The interviews were conducted from May 2011 to February 2013 sporadically, amounted to 14 hours in total.

For in-depth analysis of the policy failures from the viewpoint of utility, interviews of five local government officials (referred to as L1, L2, L3, L4, and L5 in Table 3-5) were conducted from January to February 2012 for 8 hours in total. The five interviewees

were selected based on their work experiences in planning of marine and coastal management which somehow incorporate the Guideline's integrated approach as ICM and/or have knowledge on ICM. Among five interviewees, three are from city level, whereas two are from prefectural level. Major fields of their work are fisheries, environment, development and construction, and commercial and industries. All interviewees are male with age group from forties to fifties.

3.3. Results and discussions

Table 3-2 shows a summary of the Guideline's evaluation for statutory and non-statutory variables. Table 3-3 shows results of comparisons between the Japanese Guideline and acts/policies of other countries and regions for statutory variables, i.e., conditions 1, 2 and 3. The interview results of the academics and the national government officials for non-statutory variables, i.e., conditions 4, 5 and 6 are presented in Table 3-4. Table 3-5 shows interview results of the local governmental officials for in-depth analysis on causes of the failures from the viewpoint of utility. Details of the evaluation of each condition are explained below.

3.3.1. Condition 1: Clear and consistent objectives

The Guideline has set multiple and well-balanced, though perhaps ambiguous, targets: "… ICM implementation should aim at developing diverse functions and conserving resources along with promoting multifaceted use of the coastal area through the following goals: i) create and/or rehabilitate the coastal areas to be beautiful, safe and dynamic, as an inheritance for future generations, ii) create good and safe environments and multifaceted use, and iii) realize attractive and autonomous regions

through the involvement of diverse stakeholders" (GD21PLC, 2000). The emphasis on pursuing three aspects, i.e., the environment, safety and coastal area use left the Guideline objectives somewhat unfocused.

The lack of clarity is understandable however, considering that different coastal areas have unique environmental and socioeconomic characteristics and are facing local challenges. The objectives will be clarified only when specific prefectures or municipalities develop and implement an ICM plan to address their own problems and needs. As shown in Table 3-3, this kind of ambiguity is a reasonable one, given the complex nature of ICM and has been seen in the acts and policies of other countries and regions. Therefore, this should not be considered a failure of the Guideline objectives, but one of the inevitable difficulties to be faced in pursuing ICM, which must be tailored to respective localities and cover broad issues to achieve sustainable coastal area development.

3.3.2. Condition 2: Causal theory

The Guideline stipulates that ICM requires consideration for the mutual influences which coastal areas exert: "Coastal areas have ecologically diverse and rich resources and offer beautiful scenery. At the same time, they are used for industry, shipping, tourism and recreation. To meet environmental, social and economic coastal area demands, integrated coordination and management is inevitable. … Water environment, sediment transportation and ecology in coastal areas exert mutual influences that require broad coordination. To deal with problems that might occur as a result of such mutual influences, it will be necessary to apply an integrated management policy for their proper coordination and to take into account such diverse environments and broad

geographical coverage as river catchment areas, bays and outer oceans" (GD21PLC, 2000). As the description above shows, the mutual influences of various activities related to coastal areas are complex.

The ambiguity of causal theory is considered a common characteristic of international ICM and not the failure of the Guideline of Japan, as this lack is also seen in the acts and policies of the US, ROK, EU and PEMSEA (Table 3-3). Characteristics of the Guideline that emphasize the process involved in the development of an ICM plan are similar to the ones in the US CZMA, which Lowry (1985) assessed as unique among national environmental programmes in its lack of an explicit causal theory.

3.3.3. Condition 3: Implementation processes

The analyses of implementation processes are shown below.

a. Assigning implementation responsibility

Responsibility for the Guideline's implementation is ambiguous both at the national and the local levels. At the national level, the Guideline only stipulates that "the national government should support and encourage local governments to promote the establishment of ICM plans through enhancement of public awareness, providing information, introducing and/or sending experts, providing policy inducement for mobilizing support from the private sector and NGOs, and utilizing related projects and programmes". It does not specify which ministry or agency should take the lead role. As seen in Table 3-3, this is not a rare case compared with the situation of EU and PEMSEA, although there are cases of national acts such as the US CZMA and CZMA ROK designating a responsible office and ministry. In Japan, while the Headquarters for Ocean Policy directly under the Cabinet (HOP), along with a Secretariat, have been

newly established in accordance with the Basic Act on Ocean Policy, they have not been assigned implementation responsibility for development of ICM plans. Through the interview of the government officials of the Secretariat of HOP, one interviewee explicitly pointed out, “As is stipulated in Article 30 of Basic Act on Ocean Policy, the role of HOP is to coordinate important ocean issues which cannot be coordinated among related ministries. And as of now, ICM planning and implementation have not been determined to be important issues to be handled by HOP”.

At the local level, the Commentary on the Guideline identifies prefectures and major cities of over five hundred thousand population expected to be the leading players for development and implementation of ICM plans, reflecting their financial capabilities (National Land Agency, 2000). Yet the Commentary on the Guideline does not stipulate or designate the leading department, providing only a flexible framework that enables local governments to develop ICM plans to meet specific needs, a reasonable approach given the variety of coastal area challenges. The assignment of responsibility within local governments is at their discretion and a specific department can only be responsible through actual implementation. As seen in Table 3-3, this approach is similar to the coastal management policies and programmes in other countries and regions, where the responsible agency varies according to administrative and political settings, as well as respective state, province and municipality structures.

b. Assigning implementation authority with adequate hierarchical integration and few veto points

As Table 3-3 represents, clear hierarchy among local ICM plans and federal or national coastal activities is provided in the cases of the US and ROK, which is called “consistency provision”. The US CZMA calls for national activities, e.g. construction

permits, licenses and grants, to be consistent with the state ICM programmes approved by the Office of Ocean and Coastal Resource Management (OCRM) of the National Oceanic Atmospheric Administration (NOAA) as stipulated in Section 307. Moreover, in 15 CFR Part 930 (NOAA, 2000), the regulation entitled 'Federal Consistency with Approved Coastal Management Program' provides detailed federal consistency procedures. In the case of the CZMA ROK, similar authority is given to ICM plans through Article 14.

However, in the case of Japan, neither clear "consistency provision" is arranged by the Guideline, nor is authority provided to the governor or mayor of a local government who establishes an ICM plan to prioritize the local ICM plan over other statutory and non-statutory plans including national plans. This is considered not tempting for local government to develop ICM plans. The Guideline provides a basic policy about relationships among a new ICM plan and existing plans related to coastal areas. It describes their relationships as follows: "In establishing an ICM plan, efforts should be made to keep consistency with existing coastal area plans by the national and local authorities… After an ICM plan has been established, new coastal area projects and measures need to seek consistency with the ICM plan newly established" (GD21PLC, 2000). From these descriptions, paying respect to newly developed local ICM plans is recognized. Nevertheless, the Guideline neither stipulates clear priority of local ICM plans over national coastal activities, nor does it provide concrete measures to secure top priority of local ICM plans over other statutory and non-statutory marine and coastal plans.

This unsecured "consistency provision" can be interpreted as lack of consideration of local stakeholders, especially of local government officials'. This is supported by the

interview results of the local government officials, as is pointed out by the interviewee L5: “We have limited budget and human resources. Hence mandatory plans are given high priority to develop, whereas an ICM plan under the Guideline comes lower without clear incentives, such as national subsidies or concrete coastal projects” (Table 3-5). To be more precise, without provisions of priority to a local ICM plan or hierarchical integration between local and national, the Guideline is not convincing enough to be implemented by local government officials who are working on mandatory issues under limited budget and human resources. This could be one of the major causes of poor implementation of the Guideline.

c. Financial resources

The Guideline does not provide local governments financial incentives, i.e. no national subsidies prepared. After the Guideline resolution, NRPB has conducted several case studies to examine expected processes of developing ICM plans and desirable institutional arrangements at various scales, i.e., Ise Bay and Seto-Inland Sea at the regional level, Kinuura Bay and Fukuyama coastal areas at the prefectural level, and Tateyama and Munakata coastal areas at the municipality level[7] (NRPB, 2002a, 2003, 2004, 2005, 2009). However, aside from these case studies, no funding has been provided to local governments for developing and implementing ICM plans.

Participation in developing ICM plans by local governments is voluntary in all cases, i.e., the US, ROK, EU and PEMSEA. However, except for the Japanese Guideline, all others provide some measures to support development and implementation of ICM plans as summarized in Table 3-3. The Japanese Guideline set the procedures for an

[7] As a result, the model ICM plans developed by experimental coordinating mechanisms in coastal areas, were not approved by respective local governments.

ICM plan to be approved by the local government, e.g., the governor of the prefecture, which is different from the US CZMA and CZMA ROK, where the plan is to be approved by the national government. After approval of the national government of the US and ROK, the states of the US and the local governments of ROK get subsidies for development and implementation of ICM plans from the national governments, respectively. On the other hand, the Japanese framework of approval of ICM plans and associated national funding support is not structured the same way as the US and ROK. Neither approval of ICM plans nor subsidy from the national government is provided to local governments. And this lack of national subsidy would also result in low utility of implementing Guidelines to local government officials, as is validated by the comments by L5 (Table 3-5).

3.3.4. Condition 4: Commitment and skill

In the interviews with academics and national government officials, all eight interviewees pointed out the low commitment and skill levels of national and local government officials (Table 3-4). All five academics pointed this out as a cause, as the Guideline was not binding and no actual ICM plans have been developed. One government official from the Secretariat of HOP admitted that national and local government officials did not sufficiently understand the ICM concept itself when the Guideline was issued. During my interviews of local government officials, four out of five interviewees confessed that they did not know ICM at the time of the Guideline resolution in 2000. These assessments and findings are also supported by a survey results which show a low percentage of local governments conversant with ICM; out of 33 coastal prefectures, only 2 were “conversant” with ICM, 23 were “cognizant” and 6

were even “unaware” (OPRF, 2010).

Internationally, it is recognized that ICM experience leads to a corresponding increase in both skill and commitment, e.g., in the United States, based on his experiences as director of OCRM, Matuszeski (1985) emphasized the importance of the skills acquired by OCRM’s officials that had been developed through a series of state negotiations during the programme’s planning years. Thus, it is reasonable that commitment and skill of Japanese government officials are judged as low under the condition of no experiences.

3.3.5. Condition 5: Public and stakeholder support

The interviewees of academics and national government officials assessed public and stakeholder support as from Medium to High (Table 3-4). This assessment is supported by rich proposals for promoting ICM after the Guideline had been issued. For example, the Japanese Association for Coastal Zone Studies (2000) developed “An Appeal in 2000: A proposal for sustainable use and environmental conservation of coastal areas” which proposed that an ICM act should be established and that the national and local governments should share the cost on ICM equally. Towards establishment of Basic Act on Ocean Policy in 2007, various stakeholders submitted proposals on promotion of ICM to be incorporated into the Basic Plan on Ocean Policy (2008), e.g., the Japanese Association for Coastal Zone Studies (2007), the Research Institute for Ocean Economics (2007), the Japanese Society of Fisheries Science (2007), and the World Wide Fund for Nature Japan et al. (2007).

In Japan, awareness of coastal conservation emerged in the 1960’s in response to intense reclamation and water pollution during the rapid economic growth between

1955 and 1973. Evidence for the intensity of reclamation is provided by Shikida and Koarai's (1997) estimated percentage decrease of natural Japanese coastlines from 78 % in 1960 to 55 % in 1993. Public coastal management initiatives initially focused on conservation in response to environmental degradation. Some of the major NGO environmental conservation actions include the "Common tideland use rights declaration", appealed by the Coastal Access Right Movement Group (1975) and "The Tokyo Bay conservation basic law: a tentative plan" proposed by the Committee of Measures against Pollution and Consumption of Tokyo Bar Associations (1986). Gradually, the coverage and characteristics of public and NGO coastal management activities expanded and diversified (Kawabe, 2004; NRPB, 2002b), and it is recognized that continuous stakeholder support has been provided to promote ICM before and after the Guideline 2000.

3.3.6. Condition 6: Supportive socioeconomic and policy environment

The interviewees of academics and national government officials assessed the socioeconomic and policy environment before and after the Guideline 2000 as from Medium to High (Table 3-4). This is supported by the fact that ICM has been promoted in the national land/spatial development planning over some decades, from the Third Comprehensive National Development Plan (National Land Agency, 1977) to the National Spatial Strategies (NRPB, 2008) in Japan. In addition, promotion of ICM is also stipulated in Basic Act on Ocean Policy (2007). Another supportive environment for promoting Japanese ICM has been seen in movements outside Japan. For example, the EU has funded demonstration projects on ICM (EC, 2000), while PEMSEA set a 2015 integrated coastal management implementation target of at least 20 percent of the

region's coast (PEMSEA, 2006). As Rupprecht Consult (2006) pointed out, ICM has progressed in the United States and each EU country at the national level. Another good example is the progress made by ROK, where all regional coastal zone management plans have been established; CZMA was revised in 2010, and the Ministry of Land, Transport and Maritime Affairs (MLTM) promoted the revision of regional coastal zone management plans through setting the Guideline (MLTM, 2011). It is considered that all these ICM initiatives have had positive effects on promoting ICM in Japan.

3.3.7. Limitation of a new act, the Basic Act on Ocean Policy

Even after enactment of Basic Act on Ocean Policy, the Guideline implementation has not improved. Some of the reasons for this have been clarified as follows through review of the articles of Basic Act on Ocean Policy as well as the interviews of the government officials.

First, the articles of Basic Act on Ocean Policy do not assign responsibility for ICM planning and implementation to the Secretariat of HOP, newly established at the national level under the Cabinet Office. The Secretariat of HOP consists of officers from various administrative bodies related to the Basic Plan on Ocean Policy. Yet, Basic Act on Ocean Policy does not grant authority over ICM planning and implementation to the Secretariat of HOP. Its jurisdiction is limited to "matters with regard to synthesis coordination of measures of implementation by relevant administrative bodies based on the Basic Plan on Ocean Policy". During the interview, one officer from the Secretariat of HOP explicitly pointed out this limitation: "The Secretariat of HOP is not the commander for all other national administrative bodies related to the Basic Plan on Ocean Policy. We, staff of the Secretariat of HOP coordinate only important issues

which cannot be coordinated among concerned national administrative bodies themselves".

Second, responsibility of the Secretariat of HOP on ICM is vague in Basic Act on Ocean Policy. Basic Act on Ocean Policy does not provide authority to the Secretariat of HOP, such as to withhold funding of other ministries if they have not implemented ICM. In addition, Basic Act on Ocean Policy does not stipulate provision of subsidies from the Secretariat of HOP to local governments for promoting ICM planning and implementation.

Considering the limitations noted above, it must be judged that Basic Act on Ocean Policy does not serve as a remedy for the poor implementation of the Guideline 2000.

3.3.8. Important factors for the Guideline besides the six conditions of Policy Implementation Framework (PIF)

Through international comparison of acts and policies as well as the interviews of academics, two important factors hindering Guideline implementation have been identified, other than the six conditions of PIF.

a. Unviable setting of coastal areas. The Guideline sets up forty-eight coastal areas, with interconnectivities of their ecosystems as boundaries for the respective ICM plans to be developed. Around one third of the forty-eight ICM plans to be developed exceeds the administrative boundaries of more than two prefectures. As summarized in Table 3-6, this setting of the boundaries is considered exceptional, compared with settings in the acts and policies of other countries and regions. As indicated by Chua (2006) and Cicin-Sain and Knecht (1998), an ICM plan which shares a boundary with the administrative boundary of a single local government is considered more feasible than

one with a broader boundary. This is also judged reasonable in terms of local government officials' utility, because coordination with adjacent local governments would result in low utility, reflecting the mindset that "local government officials see any works from the viewpoint of sectoral territory", as pointed out by the local government officials L5 (Table 3-5). Hence, in terms of viability, I must conclude that the Guideline's coastal area partitioning is inappropriate.

b. Existence of similar initiative. In Japan, various sectoral plans related to marine and coastal areas have existed since before issuance of the Guideline. Among them, one of the most important is the Seacoast Conservation Plan (SCP), pointed out by several of the academics interviewed. The SCPs are legally compulsory for the coastal prefectures based on the Seacoast Act. In 1999, the Seacoast Act was amended. Before the amendment, its objective was solely for disaster prevention. Yet, after the amendment, it incorporates environmental conservation and use of the seacoast areas which extends 50 meters from each side of the LWL and HWL. Succeeding the amendment of the Seacoast Act, the National Basic Policy for Seacoast Conservation was issued in May, 2000, which was only three months after the Guideline agreed upon in February, 2000. After the issuance of the National Basic Policy for Seacoast Conservation, all coastal prefectures were mandated to develop SCPs, with all complying by March 2006 (Seacoast Office of River Bureau of MLIT, 2009). Although the geographical coverage of the SCPs are limited to 50 meters from each side of the LWL and HWL to seaward and landward, they do cover the whole coastline of Japan in sum. In addition, as described, some of the objectives of SCPs are similar to those of an ICM plan, e.g., pursuing the three aspects of environment, safety, and coastal area use. Furthermore, the procedures of development of SCPs also enable participation of

various stakeholders, which is also similar to those of the Guideline. Hence, SCPs and ICM plans are considered as overlapping, at least in their general objectives and procedures. Given the above situation, and as the development of SCPs are legally mandated to the coastal prefectures with specific assignment of responsibility to the prefectural River Bureaus, the call for development of SCPs would have been more enforceable than ICM plans. This can thus be considered as one of the main factors for the poor implementation of the Guideline. The above discussion is further validated by the interview results of the local government officials, as pointed out by L5 (Table 3-5). This is also supported by the results of a questionnaire conducted by NRPB (2005), in which 33 out of 62 coastal prefectures and big cities felt no necessity of developing an ICM plan because they thought that other coastal plans including SCPs could be used as substitutes.

3.3.9. Bottleneck caused by nature of sectoral mindset and lack of consideration of utility

Based on the interview results of the local government officials, their "sectoral mindset" is clarified, as evidently described by the interviewees L1, L2, L3 and L5 (Table 3-5). As pointed out by the interviewees L2 and L5, this "sectoral mindset" often causes lack of considerations on common benefits of citizens. In other words, sectoral benefits within local governments surpass overall benefits of citizens, habitually. And as is pointed out by the interviewee L3, to overcome this sectoral mindset of local government officials is considered the key to implement the Guideline. Evidenced by these actual voices from the local government officials, who are considered main actors for its implementation, the Guideline is judged lacking effective measures to let each

local government official work in an integrated manner beyond sectors. That is, the Guideline lacks considerations of the local government officials' utility. Thus the hypothesis is supported.

More importantly, these interview results of the local government officials reveal the striking hidden fact that benefits of actual stakeholders, i.e., coastal citizens, are not necessarily taken as the utmost priority. This is the lack of considerations of on-the-ground stakeholders' utility, which supports the hypothesis. This can be also interpreted as a disposition of both national and local government officials reflecting existing sectoral administrative structure. At the same time, it is judged as an inevitable nature acquired by pressures from respective sectoral stakeholders, as demonstrated by the opinion of the interviewee L4. And the disposition and the working habit are the cause of power games among multiple sectors, which is considered the source of the bottleneck of the Guideline implementation.

The observation and interpretation above could further elicit possible origin of the cause of poor implementation of the Guideline, relating to "Essential Benefits" and "Cultural Benefits" in Chapter 2. Respective ministries and agencies at national level and sectoral departments at local level work for maximizing benefits of respective sectoral stakeholders, which is essential for survival of respective sectors. In other words, national and local governmental officials would feel sectoral benefits as mandatory and most indispensable, which could be interpreted as "Essential Benefits" in Chapter 2. On the other hand, common benefits for stakeholders of all the sectors are considered as least indispensable and voluntary, which could be interpreted as "Cultural Benefits" in Chapter 2. Although "Cultural Benefits" are least indispensable, as is clarified in Chapter 2, it has stronger possibilities to influence people's behavioral

intentions for marine and coastal management than “Essential Benefits”. Considering the nature of the “Cultural Benefits” as nonmaterial and enhancing quality of life, it is considered least controversial among sectors, thus, it would be likely to turn into common benefits beyond sectors.

3.4. Conclusions

In terms of institutional arrangement with the viewpoint of utility, the reasons for poor implementation of the Guideline can be summarized as follows: i) Neither clear stipulation nor provision of measures to prioritize a local ICM plan over other national and local plans, ii) lack of a scheme to provide national subsidies to local governments after approval of their ICM plans by the national government, iii) setting of the coastal areas for ICM plans are unviable because many of the planning boundaries are not consistent with but exceed a single administrative boundary of a local government, and iv) SCPs, similar yet legally compulsory plans, were mandated to coastal prefectures to be developed at almost the same time as the issuance of the Guideline, possible overlapping with the ICM plans. All of these lead to local stakeholders’ low utility.

Based on the above findings and the result of interviews of local government officials, the fundamental reason of stumbling block of implementing the Guideline is clarified as the lack of considerations of utility. Thus, the hypothesis is supported. As is discussed, the Guideline has been developed at the national level but lacks concrete understandings and insights on the sectoral mindset of the local government officials, in other words, their utility. Moreover, “common benefits” of local citizens, which “Cultural Benefits” would have strong potential to be, are not always taken as the first priority by the government officials with the sectoral mindset that could be acquired by demands of the

“Essential Benefits” by the sectoral stakeholders. This is the very lack of considerations of the on-the-ground stakeholders’ utility. Thus, I would conclude that prioritizing the sectoral “Essential Benefits” is the origin of the poor implementation of the Guideline and further presume that this would be interpreted as the possible lack of considerations on “Cultural Benefits” that could be the common benefits among various stakeholders and be source of promoting people’s behavior towards implementing ICM.

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Table 3-1 Documents for evaluation of statutory variables

Category	Name of the documents and acts	Year issued
Evaluation of statutory variables	1. Guideline for ICM plans	2000
	2. Commentary on the Guideline for ICM plans	2000
	3. 10 annual reports of National and Regional Planning Bureau of MLIT	2001-2010
International Comparison	1. Coastal Zone Management Act of the United States	1972
	2. Coastal Zone Management Act of the Republic of Korea	1999
	3. Council recommendation of the European Parliament and of the Council of 30 May, concerning the implementation of Integrated Coastal Zone Management in Europe (2002/413/EC)	2002
	4. Sustainable Development Strategy for the Seas of East Asia (PEMSEA)	2003

Table 3-2 Extent to which Guideline met the six conditions of effective implementation

Condition	Assessment	Discussion
Condition 1: Clear and consistent objectives	Reasonable	The Guideline has set multiple and well-balanced, though ambiguous, targets. This is common internationally and reasonable given the complex nature of ICM.
Condition 2: Causal theory	Reasonable	Internationally, factors affecting diverse problems of coastal areas are complex, and emphasis on the development process is common. Hence, the ambiguity of causal theory is reasonable.
Condition 3: Structuring implementation processes		
a. Assigning implementation responsibility	Reasonable	Responsible division at the local level is at discretion of the local government, which is a reasonable approach given the variety of coastal area challenges.
b. Assigning implementation authority with adequate hierarchical integration and few veto points	Low	Unclear provision of priority to a newly developed local ICM plan is not tempting for local government officials to develop an ICM plan.
c. Financial resources	Low	No funding support is provided for local governments in developing and implementing ICM plans.
Condition 4: Skill and commitment of critical implementing officials	Low	National and local government officials have not developed ICM skills because no ICM plans have been established in line with the Guideline.
Condition 5: Public and stakeholder support	Medium to High	Various proposals by academic associations, industries, and NGOs, and action by the public towards better coastal management are considered supportive to the Guideline.
Condition 6: Supportive socioeconomic and policy environment	Medium to High	Nationally and internationally, socioeconomic and policy environment are considered supportive to ICM.

Table 3-3 Comparison among international ICM acts and policies

Condition	Country / Document				
	Japan/Guideline	US/US CZMA	ROK/CZMA ROK	EU/Commentary	PEMSEA/SDS-SEA
Condition 1: Clear and consistent objectives	Ambiguous: Conservation of diverse functions and resources as well as multifaceted use of the coastal area	Ambiguous: Preserve, protect, develop, and, where possible, restore or enhance the resources of the Nation's coastal zone	Ambiguous: Create coastal areas as a basis for good life of the people through protecting the environment and promoting sustainable development	Ambiguous: The coastal zone is of great environmental, economic, social, cultural and recreational importance	Ambiguous: Sustainable use of resources, preservation of marine environment, and economic development
Condition 2: Causal theory	Ambiguous	Ambiguous	Ambiguous	Ambiguous	Ambiguous
Condition 3: Implementation processes					
a. Assigning implementation responsibility					
- national level	No specification of a single ministry or agency as the responsible node.	New office (OCRM) created. Single office is responsible.	Ocean Policy Bureau, Ministry of Maritime Affairs and Fisheries (MOMAF) assigned. *	Prerogative of each Member State	Prerogative of each country
- local level	Prerogative of each local government	Prerogative of each state	Prerogative of each local government	Depends on the focus of each project and local government	Prerogative of each site. Some environmental, some fisheries.
b. Assigning implementation authority with adequate hierarchical	Neither clear priority of a local ICM plan	Consistency provision stipulated in	Article 14 mandates related agencies' plans to be consistent with	Depends on how national and local governments of	Except for the case of Xiamen, China, basically no

integration with few veto points	over other national and local plans stipulated, nor secured measures to prioritize a local ICM plan.	Section 307.	an ICM plan.	respective Member States structure their implementation processes in line with Chapter IV, Article 3 (a)~(d).	hierarchical authority integration caused by ICM programmes.
c. Financial resources	No subsidy prepared for local governments developing and implementing ICM plans.	Administrative grants for states stipulated in Section 306.	Not stipulated in the Act., yet MOMAF provided funding support to the local governments (NRPB, 2005).	Sources of durable financing to be identified both at European Community and at national level, as per Chapter IV, Article 3 (e).	Some ICM programmes financially supported by both the Global Environmental Facility and the local governments.

* Ministry of Maritime Affairs and Fisheries was assigned as responsible when the act was issued in 1999. As of April 2013, the Ministry of Ocean and Fisheries is responsible.

Table 3-4 Interview results of academics and national governmental officials on non-statutory variables

Condition	Interviewees / Academics					Interviewees / Government officials		
	A	B	C	D	E	a	b	c
Condition 4: Commitment and skill	Low	Low	Low	Low	Low	Low	Low	Low
Condition 5: Public and stakeholder support	Medium	Medium to High	Medium	High	Medium to High	High	Medium to High	High
Condition 6: Supportive socioeconomic and policy environment	Medium	Medium to High	Medium	High	Medium	Medium to High	Medium to High	Medium

Table 3-5 Interview results of local government officials on their views on difficulties to implement the Guideline and ICM

Category	Views on the Guideline and ICM	Interviewees/Local government officials
Sectoral mindset	✓ "Local government officials see any works from the viewpoint of sectoral territory, that is, if a plan or programme brought up, one considers whether it is under Ministry of Land, Infrastructure, Transport and Tourism or Fisheries Agency, and judges whether it has relevance to him or her".	L1
	✓ "Local governmental officials have habits to choose sectoral benefits within local government offices than benefits for the citizens from holistic view".	L2
	✓ "To break up the nature of sectoral works within the local government is the challenge to pursue ICM".	L3
	✓ "At the local government offices, sectoral benefits often surpass benefits of the citizens".	L5
Pressures from sectoral stakeholders	✓ "In spite of the planning stage, we were asked by city council members to show what kind of sectoral programmes would be implemented with budget confirmation".	L4
Limited resources and incentives	✓ "We have limited budget and human resources. Hence mandatory plans are given high priority to develop, whereas an ICM plan under the Guideline comes lower without clear incentives, such as national subsidies or concrete coastal projects".	L5

Table 3-6 Comparison of boundaries of ICM plans and programmes

Partition Scheme	Country / Document				
	Japan / Guideline	US/US CZMA	ROK/CZMA ROK	EU/Commentary	PEMSEA/SDS-SEA
Partition scheme of coastal areas	The country's entire coastal area is partitioned into 48 areas. Around one third of boundaries of ICM plans are far bigger than the administrative boundaries of a single prefecture because it signifies an ecosystem approach.	Boundaries of ICM plans are consistent with the administrative boundaries of states.	The country's entire coastal area is partitioned into 8 areas. However, actual planning boundaries are set at the local level in coordination with the administrative boundaries of coastal cities, etc.	Boundaries of ICM plans and respective projects are the prerogative of respective Member States and programmes.	Boundaries of ICM programmes are in line with the administrative boundaries of provinces and municipalities that implement ICMs.

Chapter 4: Utility and optimum uses of marine space: A case study of *Pyropia yezoensis* farming in Tokyo Bay

4.1. Introduction

Marine and coastal areas are used for multiple objectives by various stakeholders, and different stakeholders have different views or values on marine ecosystem services. If we are to pursue "the greatest happiness principle" of utilitarian approach founded by Bentham (1970) in marine and coastal management, exploring how to enhance stakeholders' utility is one of the imperatives. At the same time, utility is complex as clarified in the previous chapters; individuals are not moved only by the perceived values of the "Essential Benefits", but more positively moved by the "Cultural Benefits", although government officials are pressured to work for maximizing sectoral "Essential Benefits"; and the "Cultural Benefits" could possibly have a key role to pursue the "common benefits" among different stakeholders in marine and coastal management, which would eventually move people for action.

With the understanding of the complex nature of the utility above, I set the objective of this chapter to explore what status of uses of marine and coastal areas would enhance the stakeholders' utility to obtain insights for future planning and stakeholder coordination of marine and coastal management. In exploring this, I set a hypothesis that "pursuing optimum use of a marine and coastal area would enhance the stakeholders' utility". Here, the "optimum use" means optimum zoning of marine and coastal areas for uses based on water environmental characteristics. To examine the hypothesis, I take *Pyropia yezoensis* farming in Tokyo Bay as an example to conduct a case study.

Rationale for choosing *Pyropia yezoensis* farming in Tokyo Bay as an example should be explained. First, Tokyo Bay, where population of river basins accounts for 26 million (Kikkawa, 2011), is one of the most intensely used marine and coastal areas in Japan for various objectives, such as maritime transportation, fisheries, scientific research, environmental education, bathing, gathering of clams, and etc. Hence, it is one of the most difficult marine and coastal areas in Japan to coordinate conflicting interests of diverse stakeholders, thus, it is worth a case study through which insights for future planning could be obtained. Second, *Pyropia yezoensis* is an important product of the fisheries, which accounts for 73.4 billion Japanese yen per year, equivalent to 6% of total annual fishery production value (Fisheries Agency, 2013). Among diverse objectives of sea use in Tokyo Bay, *Pyropia yezoensis* farming is one of the icons, which has been succeeded since Edo era. Some Nori produced in Tokyo are labeled and sold with the title of "Edo-mae Nori" (Supplementary Figure 4-1). At the same time, the *Pyropia yezoensis* farming in Tokyo Bay is considered one of the most difficult *Pyropia yezoensis* farming in Japan, which is affected by intense anthropogenic activities of river basins of Tokyo Bay. Discoloration of *Pyropia yezoensis* had been exacerbated from 1998 to 2003 in Tokyo Bay (Ishii et al., 2008). On the other hand, decline of price of Nori sheet has been occurring for ten years (Japan fisheries cooperatives nori business promotion council, 2013), thus, efficient *Pyropia yezoensis* farming with high quality is expected. However, identifying optimum areas for *Pyropia yezoensis* farming is difficult, for the *Pyropia yezoensis* farming is influenced by multiple elements, by both natural and anthropogenic events. To date, notable studies have been accumulated on temporal and spatial distribution of water environmental variables in Tokyo Bay, such as water temperature, salinity and nutrients from 1980 to early 2000's (Andoh et al.,

2005; Ninomiya et al., 1996a; 1996b; 1997). Yet, neither studies on temporal and spatial distribution of water environmental data in recent years nor classifications of marine space of Tokyo Bay from the viewpoint of *Pyropia yezoensis* farming have been conducted. Furthermore, previous studies only deal with water environmental data of a single institution. Thus, I choose *Pyropia yezoensis* farming in Tokyo Bay as the object of the case study, identify an area good for *Pyropia yezoensis* farming by making use of multiple institutional data in a recent year, and examine causes of inconsistency between the area identified and actual areas under *Pyropia yezoensis* farming operation by making interviews of *Pyropia yezoensis* fishermen.

4.2. Materials and methods

The hypothesis was examined in the following three steps. First, I classified marine space of Tokyo Bay into several groups based on water environmental variables for *Pyropia yezoensis* farming through spatial cluster analysis utilizing the Geographic Information System (GIS) software of ArcGIS (version 10.0 ESRI co. ltd.). For spatial analysis, considering distribution density of monitoring points of monitoring points of all institutions, I set 30-second as mesh size, which divided Tokyo Bay into 1,954 meshes, and selected Kriging with Spherical model as an interpolation method. Second, I identified an area good for *Pyropia yezoensis* farming through comparing respective water environmental characteristics of respective groups categorized by the cluster analysis, using growth and health criteria for *Pyropia yezoensis*. Third, I explored causes of inconsistency between the area identified and actual areas under *Pyropia yezoensis* farming operation by conducting interviews of *Pyropia yezoensis* farming fishermen with the viewpoint of utility to examine the hypothesis. Details of each step

are explained below.

4.2.1. Classifying Tokyo Bay based on water environment for *Pyropia yezoensis* farming

For classifying Tokyo Bay, I integrated water environmental data from three institutions, namely the Fisheries Environment Monitoring Result by Tokyo Bay Fisheries Research Institute of Chiba Prefectural Fisheries Research Center (CPRFC), the Public Water Quality Survey Result by the National Institute of Environmental Studies (NIES, 2010), and the Broad Comprehensive Survey Result of Water Quality by the Ministry of Environment (Ministry of Environment (MOE), 2010). When multiple data of the same points are available from different institutions, average values were calculated and used for analysis. Figure 4-1 shows monitoring points of respective institutions and *Pyropia yezoensis* farming areas in Tokyo Bay (Monitoring points of CPFRC are based on Ishii et al., 2008). Although the *Pyropia yezoensis* farming areas in Figure 4-1 represents the data of the year 1985, considering the least possibility of big change of the designated area for *Pyropia yezoensis* farming and that it is the newest data available from the National Land Numerical Information download service (National Information Division, National and Regional Policy Bureau of Ministry of Land, Infrastructure, Transport and Tourism, 2012), the data was used. Peak of harvest of *Pyropia yezoensis* at farming areas in Chiba prefecture, which are major production areas of *Pyropia yezoensis* in Tokyo Bay, is from December to February (Chiba Prefecture, 2014). Considering the peak and availability of data from the three institutions, water environmental data of December 2009, January 2010, and February 2010 were selected to be used for analysis. Average values of respective water

environmental variables of three months were calculated and used. Table 4-1 shows details of data from respective institutions.

In order to identify water environmental variables influencing growth of *Pyropia yezoensis*, a review of previous studies (Commission of promoting health through Nori, 2012; Kito Ed., 2004; Kudo, 2003) were conducted, and conditions affecting its growth were summarized in Table 4-2. Building on Table 4-2, seven water environmental variables were judged influencing the growth of *Pyropia yezoensis*, namely, water temperature, salinity, dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP), COD, transparency as a variable related to light intensity, and water depth related to choices of farming method such as pole-style (Shicyu-Shiki) or floating-style (Beta-Nagashi) (Supplementary Figure 4-2). Following steps were conducted for classifying Tokyo Bay.

Step 1: Calculating supplementary data

To address inconsistency of data among three institutions, I calculated water environmental items through conducting spatial interpolation using the ArcGIS. As seen in Table 4-2, DIN and DIP influence the growth of *Pyropia yezoensis*. However, only total nitrogen (TN) and total phosphorus (TP) are measured by NIES (Table 4-1). Thus, using the MOE data which equip data of TN, TP, DIN, and DIP, spatial interpolation of average values of DIN/TN and DIP/TP of February from 2001 to 2010 was conducted. The MOE data are measured four times a year, namely February, May, August, and November, and February is within the stable period for growth of *Pyrpopia yezoensis.* Thus, the data of February were used for the interpolation. Reason for using the 10-year average values of DIN/TN and DIP/TP is to avoid possible use of outliers, since the MOE data are only available for February 2010. Then, respective

values of DIN and DIP of monitoring points of NIES were calculated by multiplying grid values of DIN/TN and DIP/TP interpolated.

Step 2: Spatial interpolation of seven water environmental variables affecting growth of *Pyropia yezoensis*.

I conducted spatial interpolation of seven water environmental variables affecting growth of *Pyropia yezoensis* as identified, namely water temperature, salinity, DIN, DIP, COD, transparency, and water depth. In interpolating DIN and DIP, difference of data units between CPFRC, NIES and MOE needs to be noted. The data unit of DIN and DIP of CPFRC is μM/L, whereas that of NIES and MOE is mg/L. Thus, to synchronize the unit, data of CPFRC were calculated into mg/L using 1 mg/L = 71 μM/L for DIN and 1 mg/L = 32 μM/L for DIP. Data used for the interpolation are average values of respective variables of December 2009, January 2010, and February 2010, considering that the peak of harvesting period of *Pyropia yezoensis* is from December to February.

Step 3: Cluster analysis of water environment for *Pyropia yezoensis* farming in Tokyo Bay

I calculated correlation coefficients to identify which environmental variables should be used for cluster analysis (Table 4-3). Variables having coefficients above 0.5 with three or more variables were excluded from the cluster analysis. Using the selected variables with normalization, I conducted hierarchical cluster analysis and visualized the result using the ArcGIS. Cluster analysis was conducted using SPSS Statistics 21. The Ward method and the Euclidean distance were employed. In order to clarify water environmental characteristics of each group categorized by the cluster analysis, I calculated average values, minimum and maximum values, and standard deviations of respective water environmental variables. At the same time, I calculated DIN:DIP of

each group that affects growth of *Pyropia yezoensis*. (Detailed condition of DIN:DIP for *Pyropia yezoensis*. growth is explained in subsection 4.2.2). I further examined respective percentages of *Pyropia yezoensis* farming areas in Tokyo Bay as distributed across groups identified by the cluster analysis.

Step 4: Validation of the classification of Tokyo Bay for *Pyropia yezoensis* farming

To validate the result of classification, I conducted a multiple comparison test of water environmental variables used for the cluster analysis among groups identified. Also for validation, I made interviews of *Pyropia yezoensis* farming fishermen and experts related to growing and marketing *Pyropia yezoensis*. Interviewees were selected in line with advice of an academic who has been working for environmental research and rehabilitation project of Tokyo Bay. Six interviewees consist of two *Pyropia yezoensis* (Nori) farming fishermen, one officer of Japan fisheries cooperatives (Zengyoren), one officer of Chiba prefectural fisheries cooperatives Nori cooperative sales, and two specialists for Nori-dukuri environmental education. All the interviewees are male with the age group from forties to fifties. The interviews were conducted on 3 and 5 September and 4 October, 2013 for 6 hours in total.

4.2.2. Identifying an area good for *Pyropia yezoensis* farming in Tokyo Bay

To identify an area good for *Pyropia yezoensis* farming in Tokyo Bay, I compared average, minimum, and maximum values and standard deviations of water environmental variables of each group using growth and health criteria for *Pyropia yezoensis*. (Kito Ed., 2004; Ishii et al., 2008; Kudo, 2003) (Table 4-2). A previous study (Kawaguchi et al., 2003) found the ratio of DIN to DIP is 26:1 in leaf body of *Pyropia*

yezoensis. And it can be presumed that same ratio of DIN to DIP is necessary for growth of *Pyropia yezoensis* in Tokyo Bay (Ishii et al., 2008). Thus, using the criteria for discoloration of DIP and DIN shown in Table 4-2 and the presumption above regarding necessary ratio of DIN to DIP for growth of *Pyropia yezoensis*, I evaluated Tokyo Bay as a place for *Pyropia yezoensis* farming.

4.2.3. Exploring influences of utility of *Pyropia yezoensis* farming to fishermen by interviews

I conducted semi-structured face-to-face interviews of two *Pyropia yezoensis* farming fishermen on 5 September, 2013 for 3 hours to explore their utility of *Pyropia yezoensis* farming and investigated its influences on inconsistency between an area identified as good for *Pyropia yezoensis* farming and existing areas under operation.

4.3. Results and discussions

4.3.1. Classification of Tokyo Bay based on water environment for *Pyropia yezoensis* farming

Step1: Result of spatial distribution of DIN/TN and DIP/TP

Results of spatial interpolation of average values of DIN/TN and DIP/TP of February from 2001 to 2010 are shown in Figure 4-2 (a) and (b). The Figure 4-2 (a) shows that high value of DIN/TN concentrates in northwest area of inner Tokyo Bay, along coastlines from Arakawa towards Tsurumigawa. Minimum value, maximum value, average value, and standard deviation of DIN/TN are 0.53, 0.82, 0.62, and 0.04, respectively. On the other hand, high value of DIP/TP distributes both northwest area of inner Tokyo Bay as well as near Futtsu Cape in outer Tokyo Bay, as shown in Figure 4-2

(b). Minimum value, maximum value, average value, and standard deviation of DIP/TP are 0.25, 0.76, 0.40, and 0.08, respectively. The minimum value, maximum value, and the average value of DIP/TP are all below those of DIN/TN.

Step 2: Results of spatial distribution of seven water environmental variables affecting *Pyropia yezoensis* growth

Figure 4-3 (a)-(g) shows results of spatial interpolation conducted using the ArcGIS. They show spatial distribution of average values of December 2009, January and February 2010 of water temperature (Wtemp), salinity, DIN, DIP, COD, transparency, and water depth (Wdepth), respectively, which are the seven water environmental variables affecting *Pyropia yezoensis* growth. Spatial distribution of water temperature is high in outer Tokyo Bay and declines towards inner Tokyo Bay. The lowest water temperature is 10.5 degrees centigrade, the highest water temperature is 16.2 degrees centigrade, and average water temperature is 13.7 degrees centigrade. Salinity shows similar distribution characteristics with that of water temperature, with notable concentration of low salinity in northwest inner Tokyo Bay. The lowest salinity is 29.9, the highest salinity is 34.5, and average salinity is 32.8. Spatial distribution of DIN and that of DIP are similar, having high value in northwest inner Tokyo Bay along coastlines of from Arakawa to Tsurumigawa. The lowest DIN is 0.14 mg/L, the highest DIN is 3.80 mg/L, and average DIN is 0.39 mg/L. Regarding DIP, the lowest is 0.007 mg/L, the highest is 0.283 mg/L, and average is 0.022 mg/L. Spatial distribution of COD shows similar tendency with those of DIN and DIP, yet showing broader distribution of high COD value throughout inner bay. The lowest COD is 0.06 mg/L, the highest COD is 3.61 mg/L, and average COD is 0.79 mg/L. Transparency is high in southern part of outer Tokyo Bay with decrease towards inner bay, especially having

low transparency along coastlines of inner bay. Regarding transparency, the lowest is 0.84 m, the highest is 22.0 m, and average is 10.5 m. Spatial distribution of water depth is extremely deep in center of outer Tokyo Bay, whereas water depth in inner bay is generally shallow, less than around 20 meters. The shallowest water depth is 0 m, the deepest water depth is 200m, and average water depth is 35 m.

Step 3: Result of cluster analysis of water environment for *Pyropia yezoensis* farming in Tokyo Bay

Result of correlation coefficients of the seven water environmental variables, namely water temperature, salinity, DIN, DIP, COD, transparency, and water depth are shown in Table 4-3. In line with the criteria described in the Step 3 of subsection 4.2.1, DIN and COD which have coefficients above 0.5 with three or more variables are excluded from the variables to be used for cluster analysis. Figure 4-4 is result of the cluster analysis using the five variables, namely water temperature, salinity, DIP, transparency, and water depth. The marine space of Tokyo Bay, which is divided into 1,954 meshes for spatial analysis, is now classified into 6 groups with the criteria of Euclidean distance of 3.5 or above by the cluster analysis. Figure 4-5 shows result of spatial mapping of 6 groupings classified by the cluster analysis, which I develop by using the ArcGIS. Results of average values, minimum and maximum values, and standard deviations of respective water environmental variables, namely water temperature, salinity, DIP, DIN, transparency and water depth, DIN:DIP, and sea areas of respective groups are shown in Table 4-4.

Group 1 is distributed close to coastlines at mouth of Tokyo Bay, spreading out to 171 km^2. Average values of water temperature, salinity, transparency, and water depth are higher than those average values of whole Tokyo Bay, respectively. On the other hand,

average values of DIN and DIP are lower than those average values of whole Tokyo Bay. Chiba South *Pyropia yezoensis* farming area is located in Group 1. Group 2 is distributed in middle part of the mouth of Tokyo Bay between Chiba and Kanagawa, spreading out to 82 km^2. Average water depth of Group 2 is extremely higher than those of other groups. Each average of water temperature, salinity, transparency of Group 2 is highest among all groups. On the other hand, average values of DIN and DIP, as well as the DIN:DIP ratio of 35 to 1 are the lowest among all the groups. No *Pyropia yezoensis* farming area is located in Group 2. Group 3 is distributed in northern part of outer Tokyo Bay of 159 km^2. It stretches from Kenzaki to Kannonzaki along Kanagawa side, whereas stretches from southern edge of Futtsu *Pyropia yezoensis* farming area to Futtsu Cape along Chiba side. Boundary between Group 3 and Group 4 is near borderline of the inner bay and the outer bay. Average values of water temperature, salinity, and transparency of Group 3 are higher than those of all the groups, respectively. To the contrary, average values of water depth, DIP, and DIN of Group 3 are lower than those averages of all the groups, respectively. Group 3 has Futtsu Cape South *Pyropia yezoensis* farming area, a part of the biggest farming areas of Tokyo Bay and Miura and Uraga *Pyropia yezoensis* farming areas of Kanagawa prefecture. Group 4 stretches from middle of Tokyo Bay to its inner bay towards Chiba side of 388 km^2. Averages of water temperature, salinity, transparency, water depth, DIP, and DIN all fall below averages of all the groups. Group 4 has Kisarazu and northern Futtsu *Pyropia yezoensis* farming areas of Chiba prefecture and Hashirimizu farming areas of Kanagawa prefecture. Group 5 is mainly distributed in upper part of inner Tokyo Bay except river mouth areas of between Arakawa and Tamagawa, spreading out to 473 km^2. Average values of water temperature, salinity, transparency, and water depth are lower

than those of all the groups, respectively. To the contrary, average values of DIP and DIN of Group 5 are higher than those of all the groups, respectively. Also, DIN ration of 59 to DIP is highest among all the groups. Average water temperature of Group 5 is lowest among all the groups. Chiba Norh *Pyropia yezoensis* farming area is located in Group 5. Group 6 stretches near coasts from Arakawa to Tamagawa river mouth area. Averages of salinity, transparency, and water depth are lowest among the six groups. To the contrary, averages of DIN and DIP are higher by one order of magnitude than those of other groups. Average water temperature is lower than that of whole Tokyo Bay. No *Pyropia yezoensis* farming area is located in Group 6.

Existing *Pyropia yezoensis* farming areas in Tokyo Bay are overlaid on the mapping of groupings in Figure 4-5. It clarifies that existing *Pyropia yezoensis* farming areas belong to four groups, namely, Group 1, Group 3, Group 4, and Group 5 among six groups classified. Figure 4-6 shows distribution of existing *Pyropia yezoensis* farming areas in Tokyo Bay across groups identified by the cluster analysis. It clarifies that 56 % of existing *Pyropia yezoensis* farming areas in Tokyo Bay is distributed to Group 4.

Step 4: Validation of the classification of Tokyo Bay

Result of multiple comparison test is shown in Table 4-5. The test signifies differences among all the five variables of water temperature, salinity, DIP, transparency, and water depth. Each respective difference of salinity and of DIP between Group 1 and Group 2 is not significant. Except that, differences among all variables among all groups are significant at 0.05. Hence, the classification into 6 groups is judged as valid.

Results of the interviews of *Pyropia yezoensis* fishermen and experts to validate the six classification are shown in Table 4-6. Fisherman A pointed out that *Pyropia yezoensis* in Kisarazu farming area would be less vulnerable to discoloration compared

with that in Futtsu farming area and southern part of Chiba farming area, which could support validity of classification between Group 3 and Group 4. Although concrete validation of the six classification by the interviews was difficult, opinions which support possible utilization of the method of classification were obtained.

4.3.2. Identification of an area good for *Pyropia yezoensis* farming in Tokyo Bay

Following shows an examination of water environmental variables of respective groups as shown in Table 4-4 using growth and health criteria of *Pyropia yezoensis* farming (Table 4-2).

As for Group1, 15.3 degrees centigrade of average water temperature, 14.5 degrees centigrade of minimum water temperature, and 16.0 degrees centigrade of maximum water temperature are all within the range of the water temperature good for *Pyropia yezoensis* growth (Table 4-2, Table 4-4) (Kito Ed., 2004). Average, minimum, and maximum salinity of Group 1 all surpass average salinity of all the groups. Yet, this is not a problem for *Pyropia yezoensis* farming because high salinity does not cause difficulties of its farming (Commission of promoting health through Nori, 2012). Regarding DIP, 0.33μM of average, 0.29μM of minimum, and 0.40μM of maximum values all fall below the discoloration criterion value of 0.5 μM (Ishii et al., 2008); thus, all points within Group 1 have lower value of DIP than the discoloration criterion. On the other hand, 11.8 μM of average and 10.3 μM of minimum values of DIN both surpass the discoloration criterion value of 7 μM (Ishii et al., 2008). Moreover, the DIN:DIP ratio of 36 to 1 surpasses the 26 to 1 ratio required for growth of *Pyropia yezoensis*. (Kawaguchi et al., 2003). Hence, water environment of Group 1 is judged unbalanced, having ample DIN but lacking DIP for *Pyropia yezoensis* growth.

Regarding Group2, 15.5 degrees centigrade of minimum water temperature and 15.9 degrees centigrade of its average of this group are both highest among all the groups, which is close to the high limit of water temperature good for *Pyropia yezoensis* growth, i.e. 16.0 degrees centigrade (Table 4-2, Table 4-4) (Kito Ed., 2004). The maximum water temperature of Group 2 is 16.2 degrees centigrade, surpassing 16.0 degrees centigrade of the high limit (Kito Ed., 2004). The confidence level for water temperatures below 16.0 degrees centigrade, however, is 99.99% with z=4.44. Therefore there is a 99.99% certainty that the water temperature of Group 2 falls within the range of water temperatures that are good for *Pyropia yezoensis* farming. Average, minimum and maximum salinity of this group are all within the range of salinity good for *Pyropia yezoensis* growth (Commission of promoting health through Nori, 2012). Average DIP of 0.31μM is the smallest among the six groups, which falls below the discoloration criterion 0.5 μM (Ishii et al., 2008). Also, maximum DIP of 0.35μM falls below the discoloration criterion 0.5 μM (Ishii et al., 2008). 11.0μM of average DIN and 10.7μM of minimum DIN both surpass the discoloration criterion value of 7 μM (Ishii et al., 2008). Furthermore, considering that the DIN:DIP ratio of 35 to 1 surpasses the 26 to 1 ratio required for growth of *Pyropia yezoensis* (Kawaguchi et al., 2003), this group is judged as an unbalanced area which has enough provision of DIN but lacks DIP.

Average, minimum and maximum water temperature of Group 3 all fall within the range of water temperature good for *Pyropia yezoensis* farming, i.e. from 6 to 16 degrees centigrade (Table 4-2, Table 4-4) (Kito Ed., 2004). Average, minimum and maximum salinity of this group are all within the range of salinity good for *Pyropia yezoensis* growth (Commission of promoting health through Nori, 2012). Average DIP is 0.49 μM, minimum DIP is 0.36 μM, and maximum DIP is 0.58 μM. The confidence

level that DIP surpasses the 0.5μM of discoloration criterion (Ishii et al., 2008) is 0.09% with z=3.13, meaning there is a 99.91 % certainty that DIP of Group 2 falls below the discoloration criterion. On the other hand, 17.5 μM of average DIN and 12.1 μM of minimum DIN both surpass the discoloration criterion value of 7 μM (Ishii et al., 2008). Furthermore, since the DIN:DIP ratio is 36 to 1, it surpasses the 26 to 1 necessary for growth of *Pyropia yezoensis* (Kawaguchi et al., 2003). Group 3 is judged as an unbalanced area which has enough provision of DIN but lacks DIP, having possibility of discoloration of *Pyropia yezoensis*.

Regarding Group 4, 11.8 degrees centigrade of its minimum water temperature and 12.7 degrees centigrade of its average value are both within the water temperature optimum for growth of *Pyropia yezoensis* from 10 to 13 degrees centigrade (Table 4-2, Table 4-4) (Mie Prefecture Fisheries Research Institute, 2013). Average, minimum and maximum salinity of this group are within its range of good for *Pyropia yezoensis* farming (Kito Ed., 2004). The minimum DIP (0.40μM) falls below the discoloration criterion of 0.5μM (Ishii et al., 2008). On the other hand, the maximum (0.89μM) and average (0.58 μM) DIP levels surpass the discoloration criterion (Ishii et al., 2008). The confidence level of DIP falling below 0.5μM of the discoloration criterion (Ishii et al., 2008) is 0.01% with z=20.7, thus, it is judged as having enough provision of DIP. Regarding DIN, the average (31.2μM) and minimum (19.7μM) DIN both surpass the discoloration criterion value of 7 μM (Ishii et al., 2008). Furthermore, considering that the DIN:DIP ratio of 54 to 1, this surpasses the ratio of 26 to 1 necessary for growth of *Pyropia yezoensis* (Kawaguchi et al., 2003), Group 4 is judged as having good water environment, i.e. water temperature, salinity, DIP, and DIN enabling growth of *Pyropia yezoensis* (Table 4-4).

With regard to Group5, the average water temperature (11.7 degrees centigrade) and minimum water temperature (10.5 degrees centigrade) are both the lowest among the six groups. Yet, both of them are within the range of water temperature optimum for growth of *Pyropia yezoensis* (Mie Prefecture Fisheries Research Institute, 2013). Maximum water temperature of Group 5 surpasses the optimum water temperature by 0.6 degrees centigrade, still within the range of water temperature good for growth of *Pyropia yezoensis*. Average, minimum and maximum salinity of this group are within its range of good for *Pyropia yezoensis* farming (Kito Ed., 2004). Minimum DIP is 0.40μM which falls below the discoloration criterion of 0.50 μM (Ishii et al., 2008), whereas 0.78μM of average DIP and 2.49μM of maximum DIP surpasses the discoloration criterion (Ishii et al., 2008). Confidence level of DIP falling below 0.5μM of the discoloration criterion (Ishii et al., 2008) is 0.01% with z=17.3, thus, it is judged as having enough provision of DIP. Both averages of DIN and DIP are higher than those averages of whole Tokyo Bay, respectively, and DIN:DIP ratio of 59 to 1 is the largest of the six groups. By comparing observed values of COD of Group 5 with the criterion for causing significant symptom for *Pyropia yezoensis* diseases (Table 4-2) (Kudo, 2003), observed COD surpass the criterion of 2 mg/L at 31 monitoring points (Figure 4-7), and that of monitoring point 5A in Figure 4-7 is 3 mg/L, which equals to the criterion of incapability of *Pyropia yezoensis* farming. Regarding NH_4-N, observed values surpass the criterion of 21.3 μM for causing significant symptom for diseases at 4 monitoring points (Kudo, 2003). Considering these aspects, certain points in this area is judged as difficult for *Pyropia yezoensis* farming, to which Chiba North *Pyropia yezoensis* farming area belongs.

Regarding Group 6, average transparency of 2.6m is lowest among the six groups. To

the contrary, average values of DIN and DIP are highest among the six groups respectively, higher by one order of magnitude than those values of other groups. These implicate severe eutrophication of Group 6. The minimum DIP (2.66μM), maximum DIP (8.06μM), and average DIP (4.40μM) all surpass 0.5μM of the discoloration criterion (Ishii et al., 2008). Average salinity of 30.3 is lowest among the six groups, which is considered an influence of inflows from Arakawa, Tamagawa, and other rivers pouring into this sea area. Minimum salinity of Group 6 is 30.2, which causes no problem, since it surpasses the salinity threshold of 18 (Kudo, 2003). The minimum water temperature (11.0 degrees centigrade) and maximum water temperature (14.4 degrees centigrade) are both within the range of water temperatures good for *Pyropia yezoensis* farming from (6-16 degrees centigrade) (Kito Ed., 2004). Average water temperature is 12.4 degrees centigrade, within its optimum range for growth of *Pyropia yezoensis* between 10 and 13 degrees centigrade (Mie Prefecture Fisheries Research Institute, 2013). By comparing observed NH_4-N and COD with respective criteria for showing significant symptom for *Pyropia yezoensis* diseases (Table 4-2) (Kudo, 2003), observed NH_4-N at the point 6F (Figure 4-7) surpasses the criterion of 21.3 μM, whereas observed CODs surpass the criterion of 2 mg/L at 12 monitoring points. Further, the observed CODs of 7 monitoring points from 6A to 6G surpass the criterion of 3 mg/L for incapability of *Pyropia yezoensis* farming (Table 4-2) (Figure 4-7).

Based on the examination above, the area having good water environment for *Pyropia yezoensis* farming is judged as Group 4 in Tokyo Bay, which extends to 388 km^2. It also shows that 76.2km^2, or the equivalent to 56% of total existing *Pyropia yezoensis* farming areas of Tokyo Bay, can be considered within Group 4, which is judged as a good area for *Pyropia yezoensis* farming (Figure 4-6). On the other hand, 44% of

existing *Pyropia yezoensis* farming areas locates in Group 1, Group 3, and Group 5, where judged as having water environment not good for growth of *Pyropia yezoensis*. That is, existing *Pyropia yezoensis* farming areas do not necessarily locate in the only area good for *Pyropia yezoensis* farming, i.e. Group 4.

4.3.3. Utility of *Pyropia yezoensis* farming to its farming fishermen

Results of the interviews of two *Pyropia yezoensis* farming fishermen on their utility are presented in Table 4-7. One interviewee referred to as Fisherman A in Table 4-7 operates *Pyropia yezoensis* farming in Chiba North Area, where considered one of the most difficult areas for *Pyropia yezoensis* growth. Another interviewee referred to as Fisherman B in Table 4-7 operates *Pyropia yezoensis* farming in Kisarazu area, where considered an area having good conditions for *Pyropia yezoensis* farming.

Fisherman A points out difficulties in continuing *Pyropia yezoensis* farming in the area under difficult water environment that locates in Group 5 (Table 4-7). At the same time, he is proud of continuing the pole-style (Shicyu-shiki), which is a traditional way of *Pyropia yezoensis* farming and is said to produce better quality of *Pyropia yezoensis* than that produced by floating-style (Beta-nagashi). Further, the fact that he quit an office work and has changed his field to *Pyropia yezoensis* farming shows his pride and commitment as a successor of his father, *Pyropia yezoensis* farmer in Tokyo Bay who carries “Edo-mae” brand. From these results, major cause of his continuing *Pyropia yezoensis* farming under the difficult condition is judged as his pride and perceived values in succeeding traditional way of *Pyropia yezoensis* farming and producing good quality of *Pyropia yezoensis* with the name of “Edo-mae Nori” in Tokyo Bay. That is, these are one of the causes of inconsistency between Group 4, an

area having good conditions for *Pyropia yezoensis* farming and existing *Pyropia yezoensis* farming areas. In other words, Fisherman A values “Cultural Benefits” of *Pyropia yezoensis* farming in Tokyo Bay, and this “Cultural Benefits” is one of the causes of making him continue *Pyropia yezoensis* farming in the area difficult for *Pyropia yezoensis* farming.

Similarly, Fisherman B also shows his determination to traditional pole-style farming because of his willingness to produce good quality of Nori. His love and pride in quality of Nori are also endorsed by the fact that he has been trying to revive producing Asakusa-nori with his colleague fishermen in his place. Also, he clearly told me that he would not relocate even if the water environment at his farming place were to become unsuitable for *Pyropia yezoensis* farming, regardless of whether fishing rights were to be granted for another location. This attitude of Fisherman B is also supported by another fact that he has opened his fisheries to visitors and children to let them experience fisheries for their joy as marine recreation. His words and actions as explained above imply that he continues *Pyropia yezoensis* farming mainly because of succeeding traditional style of *Pyropia yezoensis* farming at his place and recognizes values of it. In other words, he recognizes the “Cultural Benefits” in *Pyropia yezoensis* farming not only for himself but also for others.

At this point, relationships between economic gain from *Pyropia yezoensis* farming and utility that Fisherman A and B derive from the farming should be explored. As explicitly described by Fisherman B, *Pyropia yezoensis* farming is not very profitable, yet he continues it. Each price of Nori Sheet of each major *Pyropia yezoensis* farming area is 9.9 Japanese yen per sheet for Kisarazu area, 10.3 Japanese yen per sheet for Futtsu area, and 8.5 Japanese yen per sheet for Chiba North area (Chiba prefectural

fisheries cooperatives Nori cooperative sales office, 2010). And it is known that Futtsu area has the highest price because of its mass production with consistent quality of Nori through floating-style (Ukinagashi-shiki), which meets needs of market (Personal communication with officials of Japan Fisheries Cooperatives and of Chiba prefectural fisheries cooperatives Nori cooperative sales office, on 3 September 2013 and 5 October 2013, respectively). Hence, if a fisherman wants to earn more money through *Pyropia yezoensis* farming, the floating-style would be the one to choose. Yet, Fisherman B as well as Fisherman A sticks with the pole-style farming of *Pyropia yezoensis*. This can be interpreted that their commitment to producing high quality Nori using traditional pole style method outweighs the incentives of switching to more lucrative floating style cultivation.

Based on the above findings, both of two fishermen recognize the "Cultural Benefits" of their *Pyropia yezoensis* farming in Tokyo Bay at respective places. And their recognition of the "Cultural Benefits" is judged as one of the causes of inconsistency between an area good for *Pyropia yezoensis* farming and areas actually operated. Also, their attitudes not aiming at maximizing economic gain only are considered another cause of the inconsistency. Therefore, it is concluded that pursuing optimum use of Tokyo Bay does not always enhance the stakeholders' utility, i.e., the *Pyropia yezoensis* farming fishermen in this case. Thus, the hypothesis, i.e. "pursuing optimum use of a marine and coastal area would enhance the stakeholders' utility" is not supported.

4.3.4. Policy implications for sustainable *Pyropia yezoensis* farming and future planning of marine and coastal areas

The area good for *Pyropia yezoensis* farming in Tokyo Bay is identified as Group 4, which expands 388km^2 in the inner bay, based on water environmental characteristics through comparisons with the growth and health criteria for *Pyropia yezoensis*. Group 1, Group 2, and Group 3, which are equivalent to one third of Tokyo Bay marine space, are judged as the areas lacking DIP which could lead to *Pyropia yezoensis* discoloration. This is consistent with the result of study by Ishii and his colleagues (Ishii et al., 2008). Southern part of Futtsu *Pyropia yezoensis* farming area, which is the largest *Pyropia yezoensis* farming area and has the highest unit price of Nori sheet among *Pyropia yezoensis* farming areas in Tokyo Bay, belongs to Group 3 that lacks DIP. Thus, in order to ensure sustainable *Pyropia yezoensis* farming in the southern part of Futtsu area, consistent and long-term monitoring would be important so that trend of DIN can be better understood. Integrated design and implementation of monitoring with coordination of monitoring dates and points among multiple institutions are expected, which could capture more detailed temporal fluctuation and spatial distribution of water environment to contribute to risk avoidance for *Pyropia yezoensis* farming.

In parallel with these efforts, discussion and examination of possible measures for DIP provision or possibility of managing level of nutrient salt should be explored. In order to achieve stable *Pyropia yezoensis* farming, provision of optimum DIN and DIP for *Pyropia yezoensis* growth is necessary. In Seto Inland Sea, where total pollution load control was firstly introduced in Japan, exploration of management of level of nutrient salt has been initiated in line with a recent report on poor growth of *Pyropia yezoensis* due to lack of DIN (Central Environmental Chamber, 2012; Matsuoka et al., 2005). However, as pointed out by Matsuda (2004), appropriate nutrient level should not be determined unambiguously, but in accordance with objectives of uses of marine and

coastal areas. Therefore, careful discussion is essential for future planning of marine and coastal areas, utilizing not only water environmental data but also other data such as sea uses and biological data.

At this point, I would like to discuss possible utilization of the method demonstrated in this chapter for future planning and management of marine and coastal areas. In this chapter, I integrated water environmental data from multiple institutions and classified marine space through spatial and statistical analysis, through which water environmental characteristics useful to discuss marine and coastal management has been spatially and quantitatively understood and visualized. The result could contribute to securing sustainability and promotion of *Pyropia yezoensis* farming as an industry. The identification of good *Pyropia yezoensis* farming areas could prove useful if the need arises to search for substitute areas, for example, if *Pyropia yezoensis* farming grows difficult in currently authorized areas due to possible diseases or discoloration of *Pyropia yezoensis*.

At the same time, limitation of the estimate demonstrated in this chapter should be noted. First, aiming at possible zoning of Tokyo Bay, this chapter used spatial cluster analysis to identify good “areas” or “space” for *Pyropia yezoensis* farming. On the other hand, there is another approach to identify good “points” for *Pyropia yezoensis* farming, i.e., by superposing water environmental data, “points” where good for *Pyropia yezoensis* farming can be identified. Therefore, comparing the area or spatial zone identified as good for *Pyrpopia yezoensis* farming through this chapter and points to be identified through superposing the data needs to be conducted to further validate the result of this study and examine usability of this approach. Second, it deals with average water environmental variables of December 2009, January 2010, and February 2010

only and does not reflect temporal fluctuation. Thus, the result of groupings does not capture episodic changes of water environment, such as red tide and is not sensitive to temporal fluctuation of water environment. Not all of the locations within the respective groups that are classified as good for *Pyropia yezoensis* growth meet the conditions due to variance in data within the respective groups. Third, to evaluate sea areas as *Pyropia yezoensis* farming places in real, not only water environment but also distances from the shore should be considered, since farther areas are unsuitable from economical viewpoint because more gasoline would be needed. Still, the method is useful to grasp a big picture of potential areas for specific sea use objectives, which is applicable to other sea areas than Tokyo Bay for both broader and smaller marine spaces. Furthermore, it can be utilized for grasping long-term changes of classifications of marine spaces by using past data, which would be beneficial for discussing measures for use and conservation of marine and coastal spaces in the future.

4.3.5. Needs on ample consideration of utility in marine and coastal management

Having been discussed as above, spatial planning to explore optimum uses and management of marine and coastal areas would be expected to utilize limited marine and coastal space, including examining optimum spatial zoning or classification in line with objectives of uses. With the movement of this future planning and management, utility should be placed high priority and should be received due consideration. As is clarified in this chapter, the “Cultural Benefits” of *Pyropia yezoensis* farming is judged as one of the causes of the discrepancies between an area good for *Pyropia yezoensis* farming and existing *Pyropia yezoensis* farming areas. Hence, the hypothesis that “pursuing optimum use of a marine and coastal area would enhance the stakeholders’

utility" is not supported. The following facts are proofs of the rejection of the hypothesis, i.e., Fisherman A does operate *Pyropia yezoensis* farming in the difficult area for *Pyropia yezoensis* growth; Fisherman B denies possibility of his moving to an optimum area for *Pyropia yezoensis* farming; and both of them are proud of traditional farming style and succeeding the *Pyropia yezoensis* farming areas from their ancestors. Therefore, utility should be given ample consideration in planning and managing marine and coastal areas, because pursuing optimum spatial allocation for uses does not always enhance satisfaction of stakeholders, i.e., utility.

In addition to the above findings, it is also validated that the utility does not necessarily coincide with economic gain. As discussed in the subsection 4.3.3, the Nori sheet produced in Futtsu area has the highest price, whereas the price of Nori sheet produced in Kisarazu area comes lower, and the Fisherman B points out that *Pyropia yezoensis* farming is not very profitable. If the economic gain contributes to enhancing the utility that Fisherman A and Fisherman B derive from the farming, they should have employed "floating-style" for producing Nori, same style employed in Futtsu area, which enables gaining higher price of Nori sheet because of mass products and consistency of quality. However, they stick to the traditional farming style called "pole-style" and show their persistence to produce good quality of Nori sheet. This demonstrates complicated nature of utility, especially the "Cultural Benefits".

In light of above findings and discussion, the stakeholders' utility, especially the "Cultural Benefits" should be considered carefully in developing plans of and managing marine and coastal areas. At this point, limitation of this chapter should be noted in relation to an area good for *Pyropia yezoensis* farming and history of reclamation of Tokyo Bay. *Pyropia yezoensis* farming was operated along almost all of the coastlines of

Tokyo Bay before intense reclamation of Tokyo Bay from 1960s to 1970s (Shimizu and Ikeda, 2006; Koarai and Nakano, 2013; Information gained through interviews of Fisherman A and Fisherman B). However, many *Pyropia yezoensis* farming areas and their fishing rights were lost because of reclamation, and existing *Pyropia yezoensis* farming areas as of now are, after all, the ones which escaped from the reclamation and/or moved to offshore areas reflecting anthropogenic influences (Nishizaka, 1971; Tokyo Bay environmental information center, 2014). Also, fishing rights of *Pyropia yezoensis* farming are authorized to fishermen for specified places. That is, fishing rights are restricted to specific localities and fishermen in combination with their living places, thus the fishing rights are unable to be transferred to other places in principle. Despite the limitation above, utility, especially "Cultural benefits" of *Pyropia yezoensis* farming to fishermen is judged as an important factor to be considered in planning and stakeholder coordination in marine and coastal management of Tokyo Bay.

4.4. Conclusions

The hypothesis that "pursuing optimum use of a marine and coastal area would enhance the stakeholders' utility" is not supported by coupling the identification of an area good for *Pyropia yezoensis* farming in Tokyo Bay and the interviews of *Pyropia yezoensis* farming fishermen. The area having water environmental characteristics good for *Pyropia yezoensis* growth is identified spreading out to 388 km^2, stretching from middle of Tokyo Bay to inner bay towards Chiba side. Although 56% of existing *Pyropia yezoensis* farming area locates in the area identified, 44% exists in areas not good for *Pyropia yezoensis* farming. And one of the causes of this condition is the utility, especially the "Cultural Benefits" of *Pyropia yezoensis* farming recognized by the

Pyropia yezoensis farming fishermen. Further, it is also clarified that the utility that the *Pyropia yezoensis* farming fishermen derive from the farming is not always enhanced by economic gain. These findings all reinforce complex nature of the utility, especially the “Cultural Benefits”.

Based on the findings and discussion above, I would conclude the importance of consideration of the utility, especially of the “Cultural Benefits” in future planning and stakeholder coordination for marine and coastal management. Without human centered approach with due consideration of the utility, particularly the “Cultural Benefits”, happiness or satisfaction of stakeholders would not be enhanced in the pursuit of marine and coastal management.

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Table 4-1 Overview of data items and units, sampling frequency, sampling months used for analysis, monitoring points, and number of data used for analysis by Chiba Fisheries Research Center, Public Water Quality Survey by the Ministry of Environment, and Broad Comprehensive Water Quality Survey by the Ministry of Environment

Parameters [units]	Chiba Fisheries Research Center	MOE* Public Water Quality Survey**	MOE* Broad Comprehensive Water Quality Survey
Water sampling depth	0 [m]	Upper layer	Upper layer
Water temperature [degrees C]	x	x	x
Water depth [m]	x	x	x
Density	x		
pH	x	x	x
DO [mg/L]	x	x	x
Salinity	x		x
Transparency [m]		x	x
Chlorophyll [mg/L]			x
COD [mg/L]		x	x
Escherichia coliform [MPN/100ml]		x	
n-hexane extract [mg/L]		x	
TN [mg/L]		x	x
TP [mg/L]		x	x
NH_4-N	x [μg/L]		x [mg/L]
NO_2	x [μg/L]		x [mg/L]
NO_3	x [μg/L]		x [mg/L]
DIN (NH_4-N+NO_2+NO_3)	x [μg/L]		x [mg/L]
DIP (PO_4-P)	x [μg/L]		x [mg/L]
Pheophytin [mg/L]			x
TOC [mg/L]			x
DOC [mg/L]			x
Sampling frequency	Once a month	Once a month	Four times a year (Feb., May, Aug., and Nov.)
Sampling months used for analysis	Dec. 2009, Jan. and Feb. 2010	Dec. 2009, Jan. and Feb. 2010	Feb. 2010
Monitoring points	29	80	21
Number of data used for analysis	81	240	21

Note: Units are indicated in columns of each institution when they are inconsistent. "x" indicates data available.

* MOE: Ministry of Environment

** General Items File, Living Environment Items File, and TN and TP File were used from MOE Public Water Quality Survey.

Table 4-2 Summary of conditions influencing growth of *Pyropia yezoensis* based on literature and information released by a public fisheries research institute

Parameters	Conditions	References
Water temperature	✓ Water temperature from 10-13 degrees C is optimum for growth of thalli.	Mie Prefecture Fisheries Research Institute, 2013
	✓ Water temperature from 6-16 degrees C is good for growth of thalli.	Kito Ed., 2004
Salinity	✓ Low salinity has an adverse effect on growth. High salinity does not cause any problems.	Commission of promoting health through Nori, 2002
	✓ *Pyropia yezoensis* becomes vulnerable for diseases when Salinity falls below 18.	Kudo, 2003
DIN (Dissolved Inorganic Nitrogen)	✓ DIN is utilized for growth.	Commission of promoting health through Nori, 2002
	✓ High DIN is expected as far as diseases would not be triggered by high NH4-N.	Kudo, 2003
	✓ Discoloration occurs when DIN falls below 7 μM. *	Ishii et al., 2008
NH_4-N	✓ Laver becomes vulnerable for diseases from 21.3-42.6 μM of NH4-N.	Kudo, 2003
	✓ *Pyropia yezoensis* farming is incapable if NH4-N exceeds 71μM.	
DIP (Dissolved Inorganic Phosphorus)	✓ DIP is utilized for growth.	Commission of promoting health through Nori, 2002
	✓ Discoloration occurs when DIP falls below 0.5 μM. *	Ishii et al., 2008
COD	✓ Laver becomes vulnerable for diseases if COD reaches 2 mg/L. *Pyropia yezoensis* farming becomes incapable if COD exceeds 3 mg/L.	Kudo, 2003
Light intensity	✓ Optimum light intensity for *Pyropia yezoensis* thalli is from 4,000-7,000 lux.	Kito Ed., 2004

Note: Pole-style (Shicyu-shiki) farming can be operated only at shallow coastal areas, whereas floating-style (Uki-nagashi or Beta-nagashi) farming can be operated at offshore areas.

* For DIN, 1 mg/L = 71 μM. For DIP, 1 mg/L = 32μM.

Table 4-3 Correlation coefficients among water environmental variables per each group categorized by cluster analysis

	Wtemp	Salinity	DIN	DIP	COD	Transp	Wdepth
Wtemp	1.00						
Salinity	**0.52**	1.00					
DIN	0.09	**-0.82**	1.00				
DIP	0.08	-0.45	**0.88**	1.00			
COD	-0.11	N.D.	**0.91**	**0.86**	1.00		
Transp	0.46	N.D.	-0.41	-0.41	**-0.58**	1.00	
Wdepth	0.30	0.38	-0.18	-0.18	-0.27	**0.56**	1.00

Note: N.D. means No Data. "Wtemp" indicates water temperature, "Trasnp" indicates transparency, and "Wdepth" indicates water depth. Correlation coefficients above 0.50 are in bold letters.

Table 4-4 Characteristics of water environmental variables per each group categorized by cluster analysis

		Wtemp [degrees C]	Salinity	Transparency [m]	Wdepth [m]	DIP [μM]	DIN [μM]	DIN:DIP	Number of meshes	Sea areas [km^2]
Group 1	average	15.3	34.2	16.5	68.4	0.33	11.8	36:1	253	171
	minimum	14.5	33.7	11.6	2.1	0.29	10.3	-	-	-
	maximum	16.0	34.5	21.9	128.5	0.40	16.0	-	-	-
	SD*	0.4	0.2	3.2	33.2	0.03	1.6	-	-	-
Group 2	average	15.9	34.4	18.7	152.6	0.31	11.0	35:1	122	82
	minimum	15.5	34.1	16.3	117.9	0.29	10.7	-	-	-
	maximum	16.2	34.5	21.2	194.3	0.35	13.1	-	-	-
	SD	0.2	0.1	1.2	19.1	0.01	0.6	-	-	-
Group 3	average	13.9	33.4	9.5	32.6	0.49	17.5	36:1	236	159
	minimum	13.2	32.8	6.2	5.7	0.36	12.1	-	-	-
	maximum	14.7	34.1	12.1	68.6	0.58	22.8	-	-	-
	SD	0.4	0.3	1.5	17.9	0.06	2.3	-	-	-
Group 4	average	12.7	31.9	8.5	21.2	0.58	31.2	54:1	574	388
	minimum	11.8	30.9	4.7	8.9	0.40	19.7	-	-	-
	maximum	13.5	33.0	10.4	35.6	0.89	51.1	-	-	-
	SD	0.4	0.5	1.1	5.9	0.09	6.4	-	-	-
Group 5	average	11.7	31.0	5.6	15.8	0.78	46.1	59:1	700	473
	minimum	10.5	29.9	1.8	5.1	0.40	30.7	-	-	-
	maximum	13.6	31.9	9.7	29.8	2.49	103.4	-	-	-
	SD	0.7	0.4	1.8	6.1	0.43	15.4	-	-	-
Group 6	average	12.4	30.3	2.6	8.2	4.40	161.9	37:1	69	47
	minimum	11.0	30.2	0.9	1.5	2.66	98.2	-	-	-
	maximum	14.4	30.7	4.0	15.5	8.06	308.2	-	-	-
	SD	1.1	0.1	0.7	3.5	1.42	49.0	-	-	-
Average		13.0	32.2	9.1	34.5	0.73	35.7	49:1	Total: 1,954	Total: 1,320

* SD means standard deviation.

Table 4-5 Significant results of multiple comparisons of water temperature, salinity, DIP, transparency and water depth among Groups 1, 2, 3, 4, 5, and 6

Groups compared	*p* value				
	Wtemp	Salinity	DIP	Transp	Wdepth
Group 1 - Group 2	***	0.056	0.999	***	***
Group 1 - Group 3	***	***	***	***	***
Group 1 - Group 4	***	***	***	***	***
Group 1 - Group 5	***	***	***	***	***
Group 1 - Group 6	***	***	***	***	***
Group 2 - Group 3	***	***	***	***	***
Group 2 - Group 4	***	***	***	***	***
Group 2 - Group 5	***	***	***	***	***
Group 2 - Group 6	***	***	***	***	***
Group 3 - Group 4	***	***	0.035*	***	***
Group 3 - Group 5	***	***	***	***	***
Group 3 - Group 6	***	***	***	***	***
Group 4 - Group 5	***	***	***	***	***
Group 4 - Group 6	***	***	***	***	***
Group 5 - Group 6	***	***	***	***	0.001**

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 4-6 Results of interviews of *Pyropia yezoensis* farming fishermen and specialists related to *Pyropia yezoensis* about categorization of Tokyo Bay by cluster analysis and issues related to *Pyropia yezoensis* farming

Interviewee	Date of interview	Views and opinions on categorization of Tokyo Bay by cluster analysis and issues related to *Pyropia yezoensis* farming
Fisherman A from Kisarazu farming area	13:00-14:30, September 5, 2013	✓ "I think this area (Kisarazu Area) is less vulnerable to discoloration compared with the Futtsu area and southern part of Chiba." ✓ "Important conditions for growth of *Pyropia yezoensis* are water temperature, DIP, DIN, potassium, sunlight, salinity, sea current, and wind. The most critical condition for growth is water temperature." ✓ "Distance to *Pyropia yezoensis* farming areas should be considered when judging whether a place is good for farming or not. Because if it is far, more fuel is necessary to reach the farming place, which is costly."
Fisherman B from Chiba North farming area	15:30-17:00, September 5, 2013	✓ "I cannot judge if the categorization by cluster analysis is valid or not, but it is difficult to keep operating *Pyropia yezoensis* farming in this place (Chiba North Area), so it is important to continue trying to successfully raise *Pyropia yezoensis*." ✓ "During winter, especially when we have little rain around January every year, *Pyropia yezoensis* tends to be discolored. Also, when red tide occurs during winter, it damages *Pyropia yezoensis* growth."
Specialist A	13:00-14:30, September 3, 2013	✓ "Various conditions influence the growth of *Pyropia yezoensis*. Environmental conditions such as water temperature, DIN, DIP, and salinity affect its growth. Also, the quality of Nori sheet is influenced by whether the farming style is pole-style (Shicyu-shiki) or floating-style (Beta-nagashi)." ✓ The price of Nori sheet and environmental suitability for *Pyropia yezoensis* farming do not always coincide. The price of Nori sheet is determined by market needs, so the price of the Futtsu farming area, where the floating-style is used, is the highest in Tokyo Bay. The floating-style is good for mass production with consistent quality, whereas the pole-style is not."

Specialist B	15:30-17:00, September 5, 2013	✓	"Categorizing Tokyo Bay based on water environment and evaluating whether categorized sea area is suitable for *Pyropia yezoensis* farming is interesting and would be useful when planning sea use in the future."
Specialist C	15:30-17:00, September 5, 2013	✓	"When I ate different Nori sheets farmed in different areas from Tokyo Bay, I thought that the Nori sheets grown in the Chiba North farming area were the tastiest. The good taste might be related to the rich nutrients in the area."
Specialist D	14:00-15:30, October 4, 2013	✓	"The price of Nori sheet is determined by market needs, such as usability and availability of a large amount of the same quality. Therefore, *Pyropia yezoensis* raised in sea areas having a suitable environment for farming do not have the highest price of Nori sheet. In Tokyo Bay, the floating-style is used in the Futsu area, which is good for mass production with consistent quality. For example, Nori used for Onigiri (rice ball) should not tear easily. Also, food-processing companies that make rice balls usually request large amounts of Nori sheet, and the only providers who can meet the market needs are producers of *Pyropia yezoensis* in the Futtsu area, since they use the floating-style."

Table 4-7 Interview results of fishermen on *Pyropia yezoensis* farming and their utility

Interviewees (Farming Area)	Category	Views and opinions
Fishermen A (Chiba North)	Farming environment	✓ "To keep on operating *Pyropia yezoensis* farming in this place (Chiba North Area) is, of course, difficult. Thus, making continuous effort to successfully grow *Pyropia yezoensis* is crucial."
		✓ "During winter, especially when little rain, *Pyropia yezoensis* tends to be discolored. Also, when red tide occurs, it damages *Pyropia yezoensis* growth."
	Farming style	✓ "I stick to the traditional farming style called pole-style (Shicyu-shiki). Because it makes the taste of Nori much better than floating-style."
	Commitment	✓ "I quitted an office job and became a *Pyropia yezoensis* farming fisherman here to succeed my father. I think that continuing traditional *Pyropia yezoensis* farming in Tokyo Bay and producing "Edo-mae Nori" are socially important. Besides, operating *Pyropia yezoensis* farming in Tokyo Bay is cool, I think."
Fisherman B (Kisarazu)	Farming environment	✓ "I think this area (Kisarazu Area) is less vulnerable to discoloration compared with the Futtsu area or southern part of Chiba."
	Farming style	✓ "I stick to the pole-style (Shicyu-shiki) farming. The natural drying process because of the tide, which only occurs in pole-style makes the quality of Nori very good. It makes the taste of Nori totally different from that of Nori produced in floating-style."
	Commitment	✓ "Even if it is recommended to move to an optimum area for *Pyropia yezoensis* farming, I would stick to here and would not move to another place."
		✓ "*Pyropia yezoensis* farming is not profitable, yet I have continued and will continue to do it."

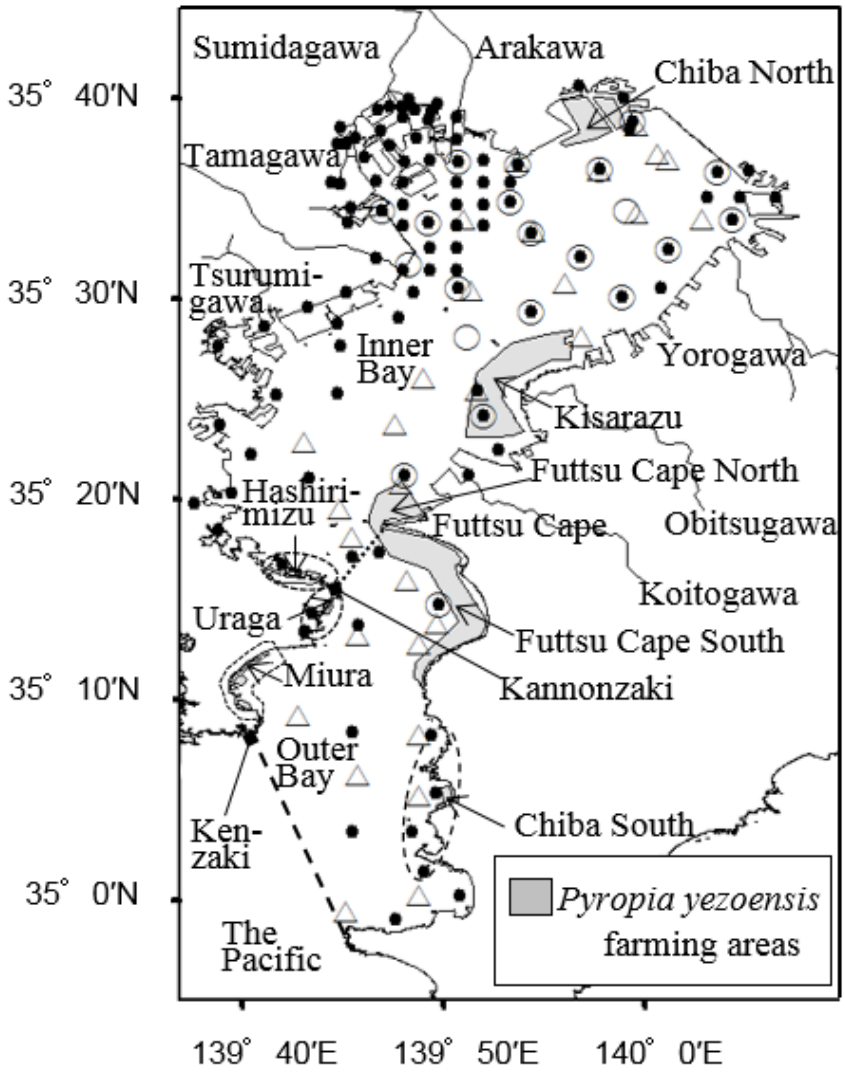


Figure 4-1 Monitoring points and *Pyropia yezoensis* farming areas in Tokyo Bay. Open triangles are monitoring points of Chiba Fisheries Research Center (Ishii et al., 2008). Closed circles are monitoring points of Public Water Quality Survey by the Ministry of Environment. Open circles are monitoring points of Broad Comprehensive Water Quality Survey by the Ministry of Environment. Areas colored with gray are major *Pyropia yezoensis* farming areas. Small *Pyropia yezoensis* farming areas are also located in areas surrounded by dashed lines. Dotted line represents boundary between Inner Bay and Outer Bay of Tokyo Bay. Dashed line represents boundary between Outer Bay of Tokyo Bay and the Pacific.

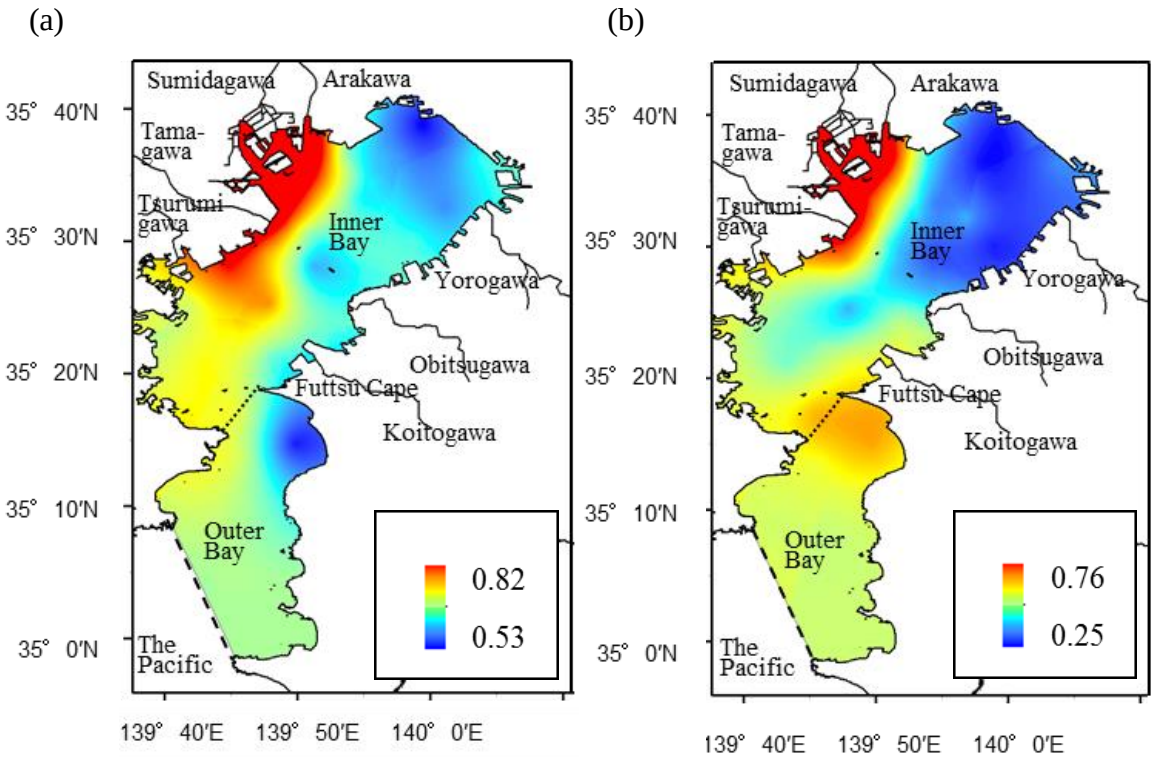
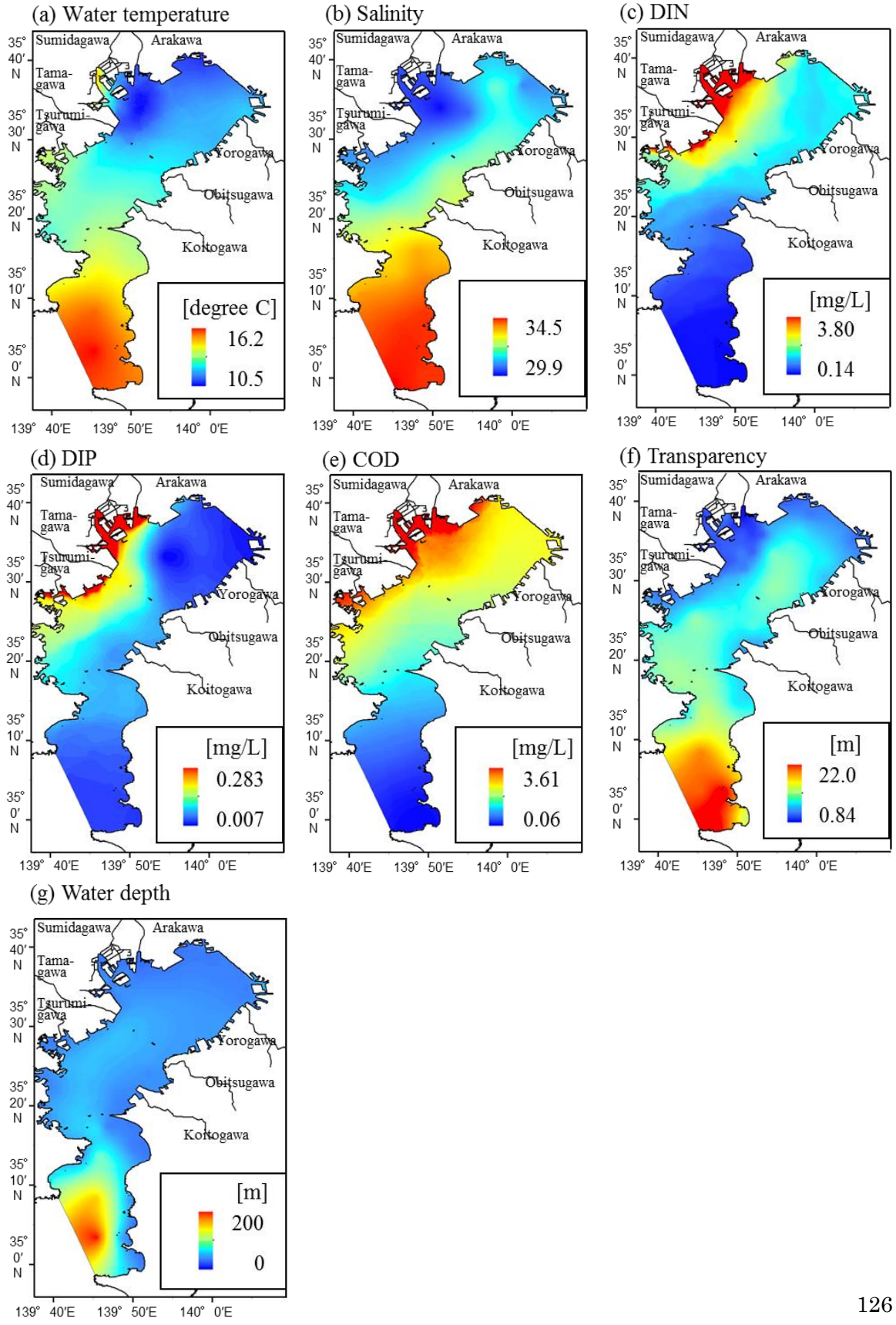


Figure 4-2 Spatial distribution of average values of (a) DIN/TN and (b) DIP/TP of February from 2001 to 2010 in Tokyo Bay. Dotted line represents boundary between Inner Bay and Outer Bay of Tokyo Bay. Dashed line represents boundary between Outer Bay of Tokyo Bay and the Pacific.

Figure 4-3 Spatial distribution of average value of each water environmental variable of December 2009, January 2010 and February 2010 in Tokyo Bay



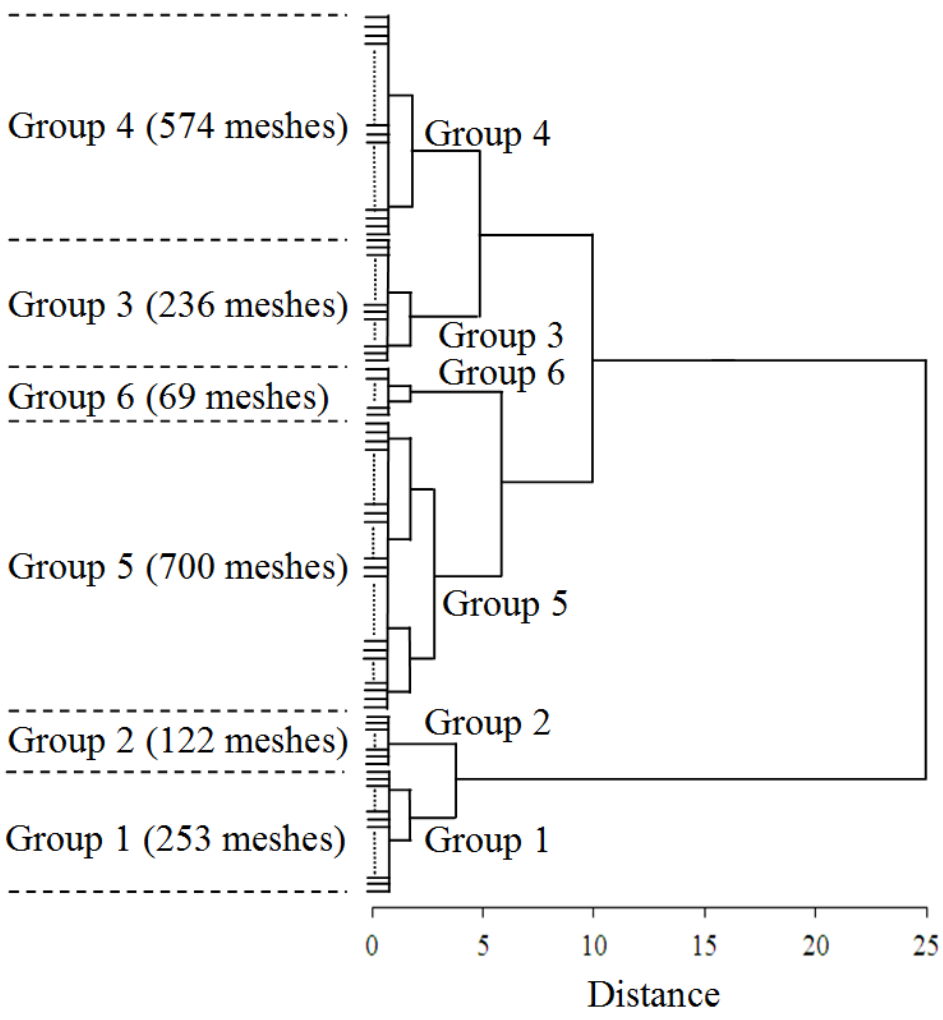


Figure 4-4 Dendrogram of cluster analysis by Ward's method based on water temperature, salinity, DIP, transparency and water depth of 1,954 meshes

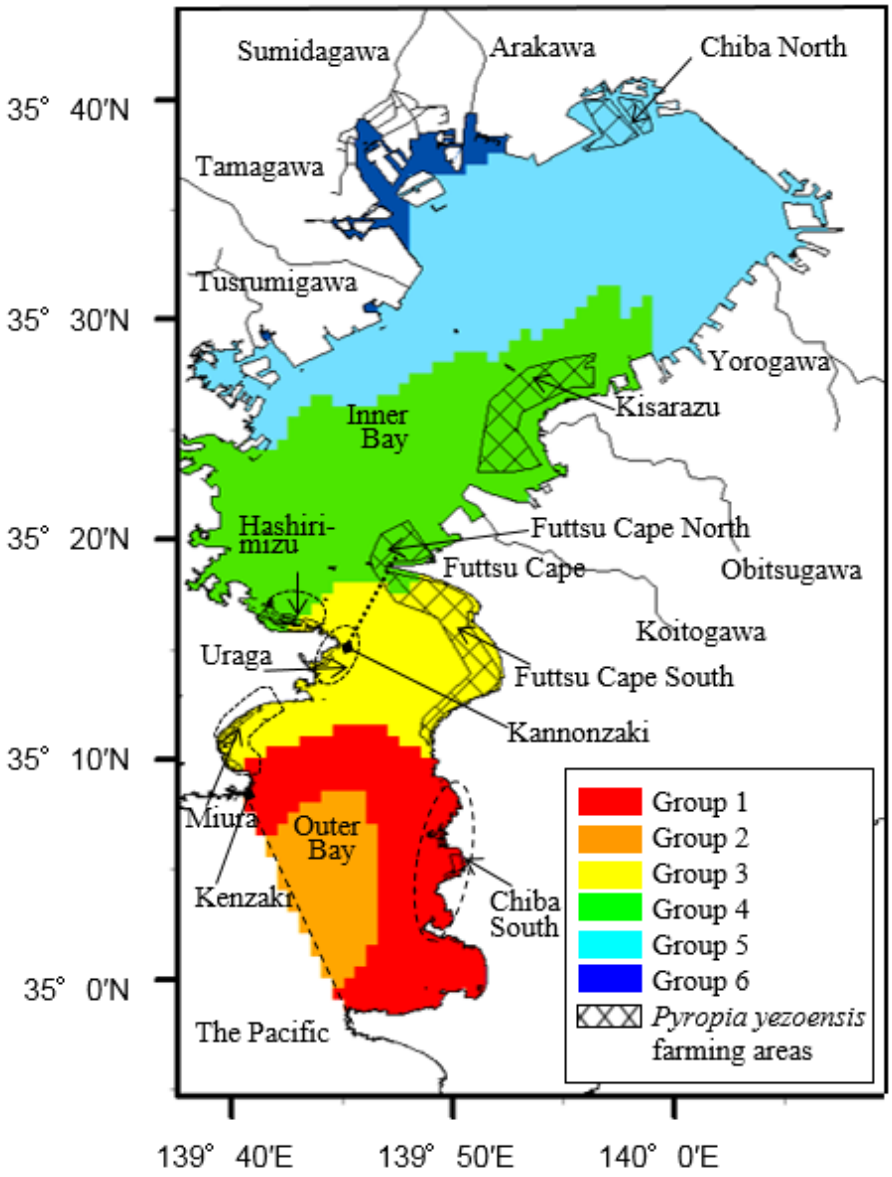


Figure 4-5 Spatial distribution of 6 groups categorized by cluster analysis of Tokyo Bay based on average values of water temperature, salinity, DIP, transparency and water depth of December 2009, January 2010 and February 2010. Dotted line represents boundary between Inner Bay and Outer Bay of Tokyo Bay. Dashed line represents boundary between Outer Bay of Tokyo Bay and the Pacific.

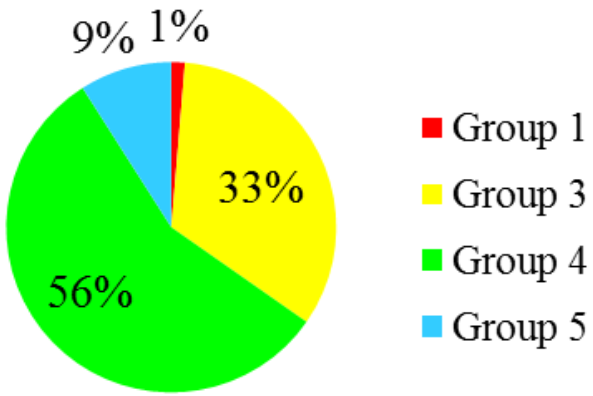


Figure 4-6 *Pyropia yezoensis* farming areas in Tokyo Bay as distributed across groups identified by cluster analysis

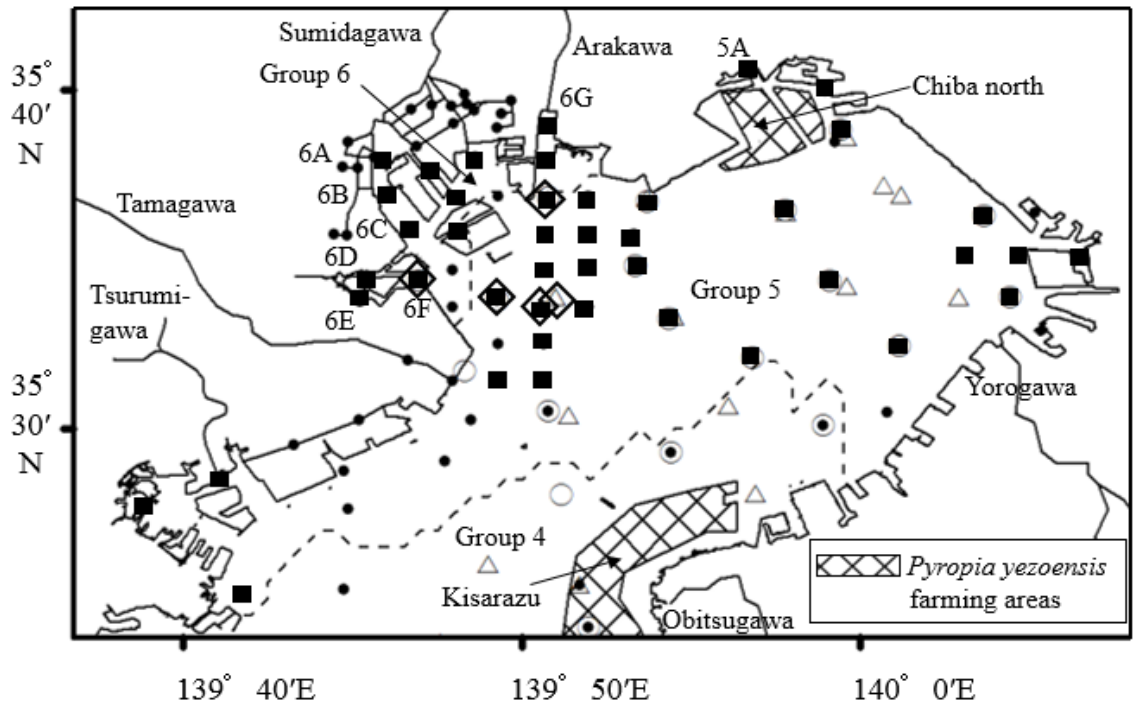
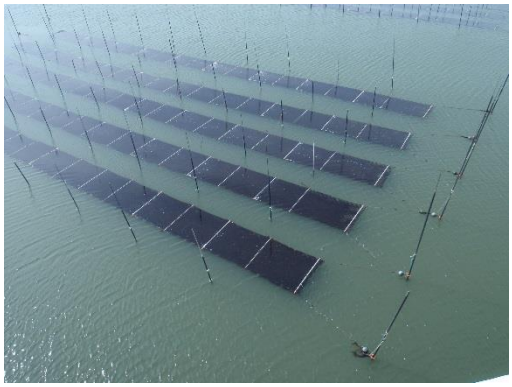


Figure 4-7 Monitoring points in Tokyo Bay where considered vulnerable for diseases of *Pyropia yezoensis* in Group 5 and Group 6. Open diamonds are points where NH4-N surpass 21.3 μM/L, whereas closed squares are points where COD surpass 2 mg/L, both of which are considered vulnerable to the diseases. Dashed lines are boundaries between groups categorized by the cluster analysis. Open triangles are monitoring points of Chiba Fisheries Research Center (Ishii et al., 2008). Closed circles are monitoring points of Public Water Quality Survey by the Ministry of Environment. Open circles are monitoring points of Broad Comprehensive Water Quality Survey by the Ministry of Environment.

Supplementary Figure 4-1 Nori labeled and sold with the title of “Edomae” (Photo taken by Kazumi Wakita)



The pole-style Nori farming	The floating-style Nori farming

Supplementary Figure 4-2 The pole-style farming and floating-style farming of Nori (Photos courtesy of Motoya Tamaki)

Chapter 5: General discussion

5.1. Importance of utility and "Cultural Benefits" in marine and coastal management

Behavioral change must be realized if visible impacts of marine and coastal governance are to be realized (Chua, 2006). In order to achieve this, utility is the key, for it forms basis of preferences and choices of individuals, which influences their behavior. To address this challenge, I set the utility as the key concept and conducted a series of research. In Chapter 2, I analyzed causal relationships between utility and behavioral intentions for marine conservation, employing a socio-psychological approach with insights of economics. As the results, there are three novel findings. The first finding is that the respondents in Japan perceive marine ecosystem services in three categories, namely "Essential Benefits", "Indirect Benefits", and "Cultural Benefits", which is different from the academic four categories by the MA (2003) based on functions of marine ecosystem services. This implies that the categories which are considered scientifically appropriate still have possibilities to be deemed as not rational by people. The second finding is that, contrary to the hypothesis that "the more indispensable the marine ecosystem services are perceived to be, the greater the impact will be on people's behavioral intentions for marine conservation", the complex and non-proportional relationships between indispensability and behavioral intentions for marine conservation are clarified. That is, "Cultural benefits" is the least indispensable, however, it has the greatest influences on enhancing behavioral intentions for marine conservation. Based on this finding, it is expected that measures raising people's appreciation on the "Cultural Benefits" would be more effective in enhancing their behavioral intentions for marine conservation than measures fanning people's fear of

possible loss of the “Essential Benefits”. The third finding is the possible scarcity of the “Cultural Benefits” perceived by the Japanese respondents, which is presumed based on the second finding. Further research is necessary to validate this presumption. Considering above all, it is summarized that deepening understanding on utility is essential in pursuing successful marine and coastal management.

Based on above understanding of the complex nature of the utility, in Chapter 3, I examined causes of the failure of the national policy on planning marine and coastal management with the hypothesis that the previous national policy has lacked consideration of utility. The analysis supported the hypothesis through two major findings: one is the lack of consideration of the sectoral mindset of local government officials; and another fundamental yet striking finding is the lack of consideration of common benefits for related stakeholders regardless of sectors. This is judged as natural based on the sectoral system that makes government officials work to gain the utmost benefits for their own sectors. However, it would have caused a disregard of pursuing and working towards the common benefits for all the stakeholders, i.e., advancing human well-being, which should be the principal mission of the government officials. Further, I discussed the possibility that this has been caused by the lack of considerations of “Cultural Benefits” for the sake of pursuing “Essential Benefits”, sectorally.

Aiming at furthering examination of characters of roles or influences of the utility in marine and coastal management, I explored what status of uses of marine and coastal areas would enhance the stakeholders’ utility in Chapter 4. As the result, the set hypothesis that “pursuing optimum use of a marine and coastal area would enhance the stakeholders’ utility” was not supported. In combination of spatial cluster analysis and

interviews of *Pyropia yezoensis* farming fishermen, it was clarified that 44% of existing farming areas locate outside the optimum areas, and one of the causes of this mismatch is the "Cultural Benefits" perceived by the *Pyropia yezoensis* farming fishermen. It is judged that their prides in the farming areas that are succeeded from their ancestors, love for their localities, and commitment in producing good quality of Nori through traditional pole-style farming are judged as the major causes of the mismatch. Furthermore, these also form their attitudes that they place higher priority in "Cultural Benefits" of *Pyropia yezoensis* farming than economic gain. Based on the above findings, I should conclude that pursuing optimum uses of marine and coastal areas does not always enhance the stakeholders' utility. Rather, sometimes policies and measures which pursue maximizing effectiveness might cause decreasing of the utility.

In light of all the discussion above, the "Cultural Benefits", after all, is judged as the key in pursuing marine and coastal management that targets at enhancing stakeholders' utility.

5.2. Roles of "Cultural Benefits" for success of marine and coastal management

5.2.1. Success of marine and coastal management

As summarized in the section 5.1, the "Cultural Benefits", which is one of the elements of the utility that people derive from marine ecosystem services, is judged as the key to promote enhancing not only people's behavioral intentions for marine conservation but also the stakeholders' utility in marine and coastal management. In this section, I would like to further explore validity of the discussion above by conducting case studies which examine causal relationships between the "Cultural Benefits" and success of marine and coastal management. At this point, meaning of "success" in this

study should be defined under the context of the utility and integration in marine and coastal management.

To date, prominent studies have accumulated which develop set of indicators of successful ICM, co-management of resources, community-based management, and marine protected areas to measure their progress and outcomes or principles of success (Costanza et al., 1998; Guiterrez et al., 2011; Hilborn, 2007; Ostrom, 2009; PEMSEA, 2011; Pollanc et al., 2001; Stojanovic: 2004; UNESCO, 2006). However, these sets of indicators of success do not contain or reflect the utility, directly. Yet, many of the previous studies incorporate social, economic, and ecological indicators of success in marine and coastal management, which would eventually affect the utility. Therefore, with a judgment that the indicators in the previous studies somehow take the utility into considerations, I would proceed to further discussion.

Among the notable studies on indicators of success related to marine and coastal management, the study by Guiterrez and his colleagues (2011) is judged as most holistic and having the highest feasibility of assessment. Although it has a limitation of its specific focus on fisheries resource management, success of fisheries resource management is considered as a requisite for success of marine and coastal management, because fishermen are one of the stakeholders who would be most affected as well as most influential in most cases of marine and coastal management in Japan. Therefore, I would claim that “no success of fisheries resource management, no success of marine and coastal management”. Based on this proposition, I have set minimum requirement for success of marine and coastal management as success of fisheries resource management.

Guiterrez et al. (2011) develops a set of indicators based on their review and

judgment of indicators identified in previous studies to assess success of fisheries resource management. They identified 19 variables as indicators of the success, namely, defined geographic boundaries, sedentary/low mobility resources, central government support (local), scientific advice, minimum size restrictions, long-term management policy, global catch per quotas (e.g., TAC), monitoring, control and surveillance, protected areas, spatially explicit management (separate areas of management and/or spatially-explicit tools), individual or community quotas, co-management in law (national), seeding or restocking programs, territorial use rights for fishing, social cohesion, self-enforcement mechanisms, leadership, tradition in self-organization, and influence in local market. These variables prove that they cover broad aspects including resource system, resource unit, governance system, and users system (Ostrom, 2009). At the same time, their study examines all the papers which contain terms either "community-based" or "co-management" or "self-governance" to cover whole spectrum of co-management arrangement from formal consultation mechanisms between government and users to self-governance. Thus, it is judged as covering the spectrum of marine and coastal management in an integrated approach, validating its applicability for this study. Moreover, the number of variables is manageable with binary judgment. Considering above all, indicators identified by Guiterrez and his colleagues (2011) is used in this study as the minimum requirement for success of marine and coastal management.

Having set the minimum requirement for success of marine and coastal management as above, I set two additional variables as success indicators, each of which as compulsory for success considering the importance of integration, in other words, coordination and collaboration across different sectors in marine and coastal

management. One variable, which I name “participation in multi-sectoral coordination mechanism”, is to examine if there is a participation of fishermen in multi-sectoral coordination mechanisms. The other variable, which I name “spontaneous collaboration among different sectors”, is to examine if collaboration among multiple sectors has been spontaneously initiated by fishermen. Adding the above two variables that represent integrated aspect of marine and coastal management to the 19 variables set by Guiterrez and his colleagues, 21 variables with binary scale in total have been set to measure success of marine and coastal management with the concept of utility and integration.

5.2.2. Case studies of Shima City and Bizen City

In order to further explore causal relationships between the “Cultural Benefits” perceived by fishermen and success of marine and coastal management, I conducted two case studies, namely Shima City and Bizen City where I made interviews of respective local fishermen and also have been communicating with local government officials and academics involved in marine and coastal management at each city since 2011. The case studies were conducted in two steps. First, applying the 21 variables as explained in the section 5.2.1, I examined whether marine and coastal management of Shima City and that of Bizen City are respectively judged as success or not. Second, I explored causal relationships between the “Cultural Benefits” perceived by the fishermen and success of marine and coastal management, by delineating interview results of the fishermen of respective cities.

At the first step for measuring success of two case studies, I examined the 21 variables for each city by reviewing publications and gray literature, analyzing data of the interviews of a local government official which I conducted. Aiming at validating

my initial assessment of the 21 variables, I further conducted interviews of academics and experts. The documents and interview structures are represented in Table 5-1. The academics and experts were chosen considering their involvement in marine and coastal management at respective sites. In order to prevent possible bias by the interviewees on the assessment of the variables, two interviewees were chosen for each city. According to Guiterrez and his colleagues (2011), it is judged that fisheries are most successful when at least 8 variables among 19 are present. As for Shima City, 13 variables were assessed as present, whereas 17 variables were assessed as present for Bizen City (Supplementary Table 5-1). Thus, respective cases were judged successful as minimum requirement of the success of marine and coastal management. Regarding the two compulsory variables, namely "participation in multi-sectoral coordination mechanism" and "spontaneous collaboration among different sectors", both of which are present for Shima City and Bizen City, thus, marine and coastal management of Shima City and of Bizen City were assessed as success.

At the second step, in order to examine how "Cultural Benefits" of fishermen of Shima City and Bizen City would have possibly influenced the success of respective marine and coastal management, comments of the fishermen during the interviews, which I conducted sporadically from 2011 to 2013, were retrieved from interview data. As Table 5-2 shows, comments of the fisherman of Shima City reveals that he recognizes importance of roles of fishermen of pearl oyster culture as educators and collaborators for conducting environmental education at the local school. That is, he sees values of them and of the pearl oyster culture that provide the "Cultural Benefits" for the school kids. In other words, he recognizes that children's getting firsthand experience of culturing pearl oysters provides them recreational fun and learning of

traditions of local fisheries, which would eventually provide them spiritual benefits. Also, he emphasizes importance of creating “Sato-umi brand” as Shima City to promote sales increase of every product of Shima City supported by the ecosystem services, including the pearls. From his comments, it is apparent that he clearly recognizes an added value of the pearl if it is in market with a story of Sato-umi of Shima City, which will deliver spiritual benefits or the “Cultural Benefits” of the customers. Similarly, the fisherman of Bizen City emphasized importance of fisheries as a part of promotion of local development and collaboration with tourism and education of children. He recognized potential “Cultural Benefits” of fisheries that would bring joy and spiritual satisfaction to the people who are not fishermen when they experience the fisheries. The fisheries are primarily the “Essential Benefits” for fishermen, which is necessary for their lives as a mean of earning money. On the other hand, the same fisheries could be the “Cultural Benefits” which provide spiritual enrichment, cognitive development, and recreation as nonmaterial benefits to people who are not fishermen. Furthermore, for both cases of Shima City and Bizen City, the fishermen are happy with volunteering let kids experience the fisheries at the minimal necessary cost for materials. This spirit for contributing to enriching the “Cultural Benefits” of children might be another point for successful marine and coastal management.

With the results and discussion above, it is concluded that the “Cultural Benefits” perceived by the fishermen has influences on success of marine and coastal management, when the “Cultural Benefits” derived from the fisheries are shared among various stakeholders. This discussion might be vulnerable to a possible criticism on validity because of the small number of the case studies. To address this challenge, further case studies are needed to examine the causal relationships between the

“Cultural Benefits” perceived by fishermen and success of marine and coastal management in various localities.

5.3. Challenges and perspectives

Managing marine and coastal areas is managing people, which is similar to the realization that managing fisheries is managing fishermen (Hilborn, 2007), yet rather complex. Although needs on marine and coastal areas would be more diversified and intense, they would never decrease. Hence, understanding the utility, which is the basis of preferences, choices, and behavior of people, becomes more and more important.

The findings of this study highlight possible importance of the “Cultural Benefits” and complex causal relationships between the utility and behavioral intentions, which might be caused by the scarcity principle. Compared to previous studies on valuation of ecosystem services which lacks considerations of utility and limited their capacity to economic valuation only, I raised the needs on careful considerations on how people perceive and value marine ecosystem services, which is not always same as the classification used in the academic world, and should be different reflecting social, economic, and ecological conditions at their respective places. Also, causal relationships between perceived value of marine ecosystem services and behavioral intentions would differ similarly, according to their locality. Another point which I raised through this study is the influences of the “Cultural Benefits” perceived by stakeholders on successful marine and coastal management. The major causes of the failures of the national policy on planning marine and coastal management is judged as lacking consideration of the “Cultural Benefits” because of prioritizing sectoral “Essential Benefits”. Also, by taking *Pyropia yezoensis* farming in Tokyo Bay as an example, I

clarified that pursuing optimum use of a marine and coastal space does not always enhance utility, because of the importance of “Cultural Benefits”, as evidenced by the fishermen interviews. Furthermore, by conducting case studies on Shima City and Bizen City to examine causal relationships between “Cultural Benefits” and marine and coastal management, I validated the effects of “Cultural Benefits” on success of marine and coastal management. One of the possible reasons of the high influence of the “Cultural Benefits” on marine and coastal management is considered its greater potential to be common benefits for various stakeholders, regardless sectors to which they belong.

Before concluding the paper, limitation of this study should be pointed out. First, although this study strengthen the importance of “Cultural Benefits” based on the findings, the research was conducted only for the residents of and stakeholders related to marine and coastal management in Japan. As discussed in this research, how marine ecosystem services are viewed and valued would be different reflecting the scarcity of marine ecosystem services of their places of residence and cultural background. Thus, further research to explore importance of “Cultural Benefits” and related utility derived from marine ecosystem services and marine and coastal management in other countries should be conducted. Second, the importance of “Cultural Benefits” was explored only qualitatively, not quantitatively. Where there is a benefit, there is a cost. In spite of this, the study looked at benefits only. Therefore, in future study, cost to gain “Cultural Benefits” and other benefits should be also explored. In addition, this study did not explore other factors which might enhance utility and influence success of marine and coastal management. Future research should investigate possible factors other than “Cultural Benefits” which might influence success of marine and coastal management,

and examine weight of influence of respective factors. Third, possible bias of the results derived from the interviews should be noted. In Chapter 4 and Chapter 5, interviewees were selected from distinguished fishermen, in other words, fishermen who are leading fisheries communities or having been engaged in various activities other than fisheries were interviewed. Therefore, if undistinguished fishermen were selected and interviewed, the results might have been different. In addition, concrete interview techniques to avoid unintended manipulation of interview results has not been established. Thus in future study, when interpreting and discussing the interview results, possible bias should be further examined carefully. To avoid the risk of unintended manipulation of interview results, selecting more interviewees having various attributes and improved process of interviewee selection would be helpful, at the same time, interview techniques to avoid unintentional manipulation of results need to be explored.

Again, the heart of marine and coastal management should be managing behavior of people. The essence of its difficulty is neither administrative boundaries nor institutional sectoral framework, but diverse utility which creates both conflicts and cooperation among people. Thus, I would strengthen the essentiality of deeper understanding of the utility, which would lead to find the common benefits among stakeholders towards success of marine and coastal management that should eventually make people happy.

5.4. References

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Yanagi T. Satoumi-Sosei-ron. Tokyo.Koseisya-Koseikaku. 2010. In Japanese.

Table 5-1 Documents and interview structures for assessment of 21 variables as indicators of success of marine and coastal management

	Shima City	Bizen City
Documents	✓ Shima City. Satoumi-sosei-suishin-keikaku. 2012. Shima City. ✓ Japan Science and Technology Agency. Sangakukan-renkei Journal 2008; June. http://sangakukan.jp/journal/journal_contents/2008/06/articles/0806-04-13/0806-04-13_article.html (accessed on February 15, 2014) ✓ Suisangyo-kyodo-kumiai-hou (Act on fisheries cooperatives) (http://law.e-gov.go.jp/htmldata/S23/S23HO242.html) (accessed on February 8, 2014)	✓ Yanagi T. Satoumi-Sosei-ron. Tokyo.Koseisya-Koseikaku. 2010. ✓ Tanaka T. Satoumi with eelgrass and oyster beds, "Hinasesengen-ryoshimachi". Nippon Suisan Gakkaishi (Japanese Society of Fisheries Science) 2014; 80 (1): 72-75. ✓ Suisangyo-kyodo-kumiai-hou (Act on fisheries cooperatives) (http://law.e-gov.go.jp/htmldata/S23/S23HO242.html) (accessed on February 8, 2014)
Interviewees (attribute of interviewee) <interview date and measure>	✓ Interviewee S1 (an academic working with Shima City over 20 years) <March 11, 2014 through correspondence> ✓ Interviewee S2 (an expert of community development working with Shima City around 5 years) <February 19, 2014 through face-to-face>	✓ Interviewee B1 (a government official of Okayama prefecture) <January 18, 2011 through face-to-face > ✓ Interviewee B2 (a researcher of marine protected area working with Bizen City around 2 years) <February 17, 2014 through face-to-face > ✓ Interviewee B3 (an expert of community development working with Bizen City around 5 years) <February 19, 2014 through face-to-face >

Table 5-2 Interview results of fishermen with leadership related to perceptions of the "Cultural Benefits"

Places	Shima City	Bizen City
Dates (interview duration)	August 22, 2012 (2 hours)	18 January, 2011 (2 hours)
Interviewees	Fisherman of pearl oyster culture who is one of the leading members establishing a collaborative study group on coastal environment of Shima City in 1987	Executive Director of a local fisheries cooperative who initiated eelgrass rehabilitation activities in 1985 in collaboration with government officials and researchers
Comments/ Views	We, fishermen of pearl oyster culture have been cooperating with the local elementary school to provide school kids "pearl oyster culture experience". We are proud that we have become essential members for the environmental education at the school. Also, we should sell our cultured pearl as "the pearl cultured in Shima City of satoumi", i.e., "Pearl of Sato-umi Brand". Since Shima City has been working on and promoting creation of Sato-umi, we had better develop the "Sato-umi Brand" for our products including the pearl, in collaboration with Shima City Government, through which we could add extra values and deliver stories to customers.	We have a guest house named "Mahoroba-no-sato" on top of a hill, from where we can have a good view of marine areas along the coasts of Bizen City. Thus, we could utilize the guest house for observing all the activities of fisheries including leisure fishing, through which we could monitor and manage marine uses. Furthermore, in collaboration with the guest house, we could offer fisheries experiences for tourists and school kids who would stay at the guest house. I am envisaging these things and would keep on collaborating with various stakeholders. That would be fun.

Supplementary Table 5-1 Presences of fisheries co-management attributes and integration and spontaneous collaboration among sectors

Group	Variables	Shima City (Tategami Pearl Fisheries Cooperative)	Bizen City (Hinase Fisheries Cooperative)
Resource System	1. defined geographic boundaries	Present	Present
Resource unit	2. sedentary/low mobility resources	Present (Pearl oyster)	Present (Oyster)
Governance system	3. central government support (local)	Present	Present
	4. scientific advice	Present	Present
	5. minimum size restrictions	Not applicable for pearl oysters	Present
	6. long-term management policy	Not present	Present
	7. global catch per quotas (e.g., TAC)	Not applicable	Not applicable
	8. monitoring, control and surveillance	Present	Present
	9. protected areas	Not applicable for pearl oysters	Present
	10. spatially explicit management (separate areas of management and/or spatially-explicit tools (e.g., rotational harvest strategies))	Present	Present
	11. Individual or community quotas	Not applicable for pearl oysters	Not present
	12. co-management in law (national)	Present	Present
	13. seeding or restocking programs	Present	Present
	14. TURF (territorial use rights for fishing)	Present	Present
Users system	15. social cohesion	Present	Present
	16. self-enforcement mechanisms	Present	Present
	17. leadership	Present	Present
	18. tradition in	Present	Present

	self-organization 19. influence in local market	Not present (under development)	Present
Integration among sectors	20. Participation in multi-sectoral coordination mechanism	Present (Shima City Sato-umi creation promotion committee)	Present (Committee for integrated management of Bizen coastal areas)
Spontaneous collaboration among different sectors	21. Spontaneous collaboration among different sectors	Present (Pearl oyster culture fishermen spontaneously initiated and established a collaborative study group in 1987 on coastal environment of Shima City, which is composed of multi-sectoral stakeholders.)	Present (Hinase Fisheries Cooperative spontaneously initiated and has been working on restoration of eelgrass since 1985 in collaboration with scientists, Okayama Prefectural Fisheries Research Institute.)
Number of variables assessed as “present” for 19 variables by Guitterez et al.	-	13	17

Note

A part of Chapter 2 was published as:

Wakita K, Shen Z, Oishi T, Yagi N, Kurokura H, Furuya K.
Human utility of marine ecosystem services and behavioural intentions for marine conservation in Japan.
Marine Policy 2014; 46: 53-60.

A part of Chapter 3 was published as:

Wakita K, Yagi N. Evaluating Integrated Coastal Management planning policy in Japan: Why the Guideline 2000 has not been implemented.
Ocean & Coastal Management 2013; 84: 97-106.

A part of Chapter 4 was published as:

Wakita K, Yamakita T, Yamada K, Yagi N, Kurokura H.
An evaluation of Tokyo Bay as a marine space for Porphyra spp. farming: Evaluating marine spaces through quantitative examination of water environmental variables across categorized marine spaces, making use of multiple institutional data.
Nippon Suisan Gakkaishi 2014; 80: 689-701.