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Keynote Lecture

# Education for Sustainable Development (ESD) and Sustainable Fisheries

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## Abstract

We compile common ideas on integrated management of coastal and ocean resources. Marine protected areas for seeking balance between biodiversity and sustainable use, adaptive management to avoid risk arisen from uncertainties. There are two measures of fisheries management: input control regulates fishing opportunities, while output control regulates the amount and quality of fisheries landings. The idea of marine protected areas (MPAs) is one of the input controls. The idea of MPAs can have a variety of definitions, from no-take zones to areas where the impact of fisheries is weaker than the neighboring areas. In conclusion, we seek balance between sustainable use and biodiversity conservation based on co-management that consists of top-down and bottom-up control, in a variety of marine resources. Therefore stakeholder participation is important for consensus building. Area-based management is a key concept of integrated marine management. Collaboration between fishers and other sectors are also important and fisheries yield is a part of total ecosystem services from marine ecosystems. To avoid risks arisen from uncertainties and serious disasters, adaptive management is useful. Capacity building and education are important for making sustainable society.

Key words: Eco-tourism, Fisheries management, Co-management, Shiretoko World Heritage, Sustainable Development Goals, Payment for Ecosystem Services

## 1. What is Education for Sustainable Development

Education for Sustainable Development (ESD), one of key concepts adopted in United Nations in 2002, includes key sustainable development issues, e.g., climate change, disaster risk reduction, biodiversity, poverty reduction, human rights, peace, and sustainable consumption. These key issues are now compiled in Sustainable Development Goals (SDGs) adopted in United Nations, 2015. ESD also requires participatory teaching and learning methods to change learners' behavior and take action for sustainable development. ESD consequently promotes competencies like critical thinking, imagining future scenarios and making decisions in a collaborative way (Mannix-McNamara and Simovska, 2014). As SDGs is beyond environmental issues, the relevant of ESD is linked from the standpoint of establishing a sustainable society from a comprehensive approach (MEXT, 2014).

ESD has four thrusts (McKeown and Nolet 2012). (1) ESD promotes and improve basic education, and accesses to basic education remains a problem for many vulnerable people. (2) ESD reorients existing education at all levels to address sustainable development to rethink and revise education from nursery school through university. (3) ESD develops public understanding and awareness of stainability. (4) Training in ESD is very important for all sectors of the workforce to contribute to local, regional, and national,

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sustainability. The development of specialized training programs has been identified as a critical component of ESD.

We introduce a learning plan of "Sustainable Fisheries Management Inquiry: A simulation activity" by UNESCO (2014). It is characterized by the following description, teaching techniques, grade levels, objective, materials, and required time that is learned. It describes that sustainable management of a resource pool is complex, involving ecological, social and economic variables. Toothpicks in this simulation represents inland fish surrounded by a fishing village. Fisheries is indispensable for residents of the village for sustenance and economic well-being. Teaching techniques consist of simulation, hands-on and class discussion. It is made for lower and upper secondary students. The objective of this learning plan is to learn about sustainable resource management and the necessity for community cooperation. Materials of this learning plan is toothpicks or pebbles (about 120/group of 4 pupils). The education time is as short as 30-60 minutes.

## 2. Education for Sustainable fisheries

One of the origins of sustainability is the concept of "maximum sustainable yield" (MSY) in fisheries, which was developed by Russell (1931). Suppose a renewable resourse whose stock biomass changes by the following dynamical equation:

$$dB/dt = r(1 - B/K)B - C$$

where $B$ is the stock biomass; $C$ is the instantaneous catch amount per unit time, $t$ is time; $r$ and $K$ are the intrinsic growth rate of population increase and the carrying capacity, respectively. The equilibrium that satisfies $dB/dt = 0$ exists if $C \leq Kr/4$. This mathematical analysis implies that sustainable fishery is achieved when neither no catch nor overexploitation. Overexploitation in fisheries or overfishing that meets the condition that $C > Kr/4$ makes no positive equilibrium, implying that it is impossible to get a big yield forever. However, in the case of ban-on-fishing, we cannot get any fisheries benefit. The ultimate goal of sustainable society is not merely environmental protection but sustainable development to enhance human well-being.

In general, "sustainable development" is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Committee 1987). It contains two key concepts, "the essential needs of the world's poor" and "the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

Despite of a long history of MSY concept, there are many cases of overfishing (Hannesson 1996). In accordance with a classical textbook of fisheries science, there are two reasons of overfishing, economic discounting and the tragedy of the commons (Clark, 1985). These are very good exercises of sustainability science in general. In addition, the concept of the present values and the mathematical exercise of limited quantity of infinite series are important in the balance between the present benefit and future load. The tragedy of the commons is a good exercise how to build cooperative relationship between nations or agents, using mathematical technique of game theory.

There are two measures of fisheries management: input control regulates fishing opportunities, while output control regulates the amount and quality of fisheries landings. The idea of marine protected areas (MPAs) is one of the input controls. The idea of MPAs can have a variety of definitions, from no-take zones to areas where the impact of fisheries is weaker than the neighboring areas (Table 1).

Management bodies of MPAs also vary, governed either by the government or by fisheries cooperative associations

**Table 1.** Categories of MPAs in Japan (1-4: Simard 1995, 5-6: Takahashi 2004)

| |
|---|
| Nature Park Law (1957, 1970) |
| 1) Ordinary area – Seto Inland Sea and Shiretoko |
| 2) Marine parks – 64 Sites, 2690.1 ha |
| Nature Environment Protection Law (1972) |
| 3) Marine Special Area –1 site (Sakiyama Bay 128ha) |
| Law of Fisheries Resource Conservation (1951) |
| 4) Fisheries conservation area – 120 sites including inland areas |
| MPAs defined by other area-based management measures |
| 5) Voluntary fishing-ban area – Shiretoko, Kyoto, Aichi<br>ca. 30% of > 1161 sites (Yagi et al. 2010: Marine Policy) |
| 6) UNESCO's MAB (Man and the Biosphere Program) Biosphere Reserve<br>– Yakushima and Kuchinoerabujima 183.25 ha |

(FCAs). World Heritage Sites have usually been managed by the government as a Member State of World Heritage Convention, whereas bottom-up control is encouraged in biosphere reserves. Both top-down regulation with legitimacy and bottom-up management by local stakeholders are important in any category of MPAs. OECD (1998) defined co-management as "a process of management in which government shares power with resource users, with each given specific rights and responsibilities relating to information and decision-making".

Co-management of coastal fisheries is common in Asia. In Japan, fisheries co-management is based on the territorial user rights for fisheries (TURFs) and spatial overlap between a variety of fisheries (Mizuta et al. 2016). Japanese local fishers belong to local FCAs and regulate their own fishing gears, season and fishing ground in operation by themselves (Makino et al., 2009), utilizing an array of good practices of fisheries co-management (Matsuda et al., 2010). Such examples include the fishing grounds surrounding the Shiretoko Peninsula, which was inscribed a World Natural Heritage site in 2005 (Fig. 1); the snow crab fisheries in Kyoto Prefecture. which succeeded in stock recovery and received the first Marine Stewardship Council (MSC) certification among Asian fisheries. Furthermore, fish-breeding forests are traditional practices based on local ecological knowledge related to ecosystem-based fisheries management. All the aforementioned ideas comprise the Satoumi concept (Yanagi 2007).

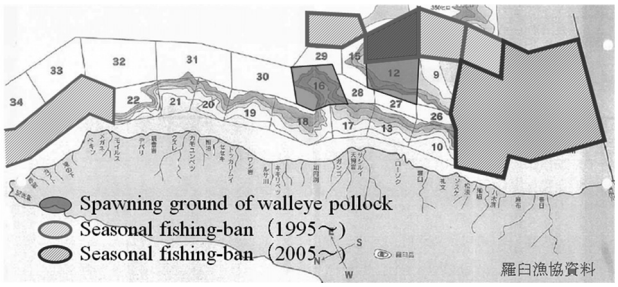


**Fig. 1.** Autonomous MPA in Shiretoko World Heritage Site (Makino et al. 2010).

More recently, conflicts of fishers with other new stakeholder groups have arisen. Leisure or eco-tourism including whale-watching and recreational snorkeling in coral reefs (Fig. 2), offshore wind farms; restoration movements of seagrass beds as payment for ecosystem services (PES) are typical examples of such conflicts. In Japan, fishers and Fisheries Agency of Japanese Government hesitate to develop an integrated coastal management framework because common fisheries rights or TURFs have existed throughout the Japanese coasts (Matsuda et al. 2012).

In Kochi Prefecture, Japan, skipjack tuna fishery is important in local economy and culture. Tosakatsuo Skipjack Pole and Line Fishery Company got a MSC Certificate in 2009. This is the 2nd Asian MSC fishery after the Kyoto Danish Seine Fishing Federation on snowcrab and flathead flounder fishery awarded MSC Certificate in 2008 (Wakamatsu 2014). Unfortunately certification of MSC has not well worked in Japan. Snowcrab fishery in Kyoto did not continue the MSC certificate. In addition, the Tosakatsuo Company was bankrupt in 2012. Another company in Miyagi awarded MSC certificate for skipjack tuna fishery in 2016.

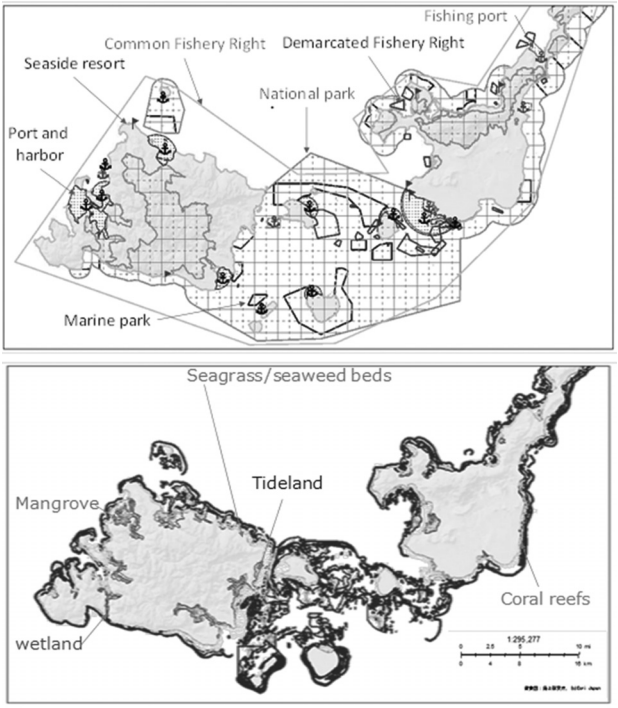


**Fig. 2.** Map showing different coastal areas and uses in Sekisei Lagoon between Ishigaki and Iriomote Islands, Okinawa, Japan, drawn by Japan Coast Guard Database (http://www4.kaiho.mlit.go.jp/CeisNetWebGIS/).

## 3. Area-Based Management Tools in Marine

We investigated conditions that promote collaboration between fishers and other marine stakeholders including marine transport, eco-tourism, offshore wind farms, activities of payment for ecosystem services, seabed mining in offshore areas, and other development in coastal and offshore areas. In some offshore wind farms, fishers receive benefit from wind farm operation and recognized that the impact of wind farms on fisheries resources is negligible or even enhance fisheries resources. It is effective for fishers, who have a deep understanding of marine ecosystems, to seek engagement with other marine activities on conservation of marine ecosystems. However, Japanese fishers usually negotiate with other fishers

(Makino 2012), but they are not familiar with collaboration with other marine sectors such as eco-tourism and wind power companies.

One of traditional ecosystem-based fisheries management in Japan is fish-breeding forest. Japanese fishers and their families have paid attention to plantation of backyard forests, despite lack of scientific evidence how forest to improve fishing ground (Matsuda et al., 2016). Recent global communities such as UN encourage to seek a comprehensive activities for sustainable society and to use the Sustainable Development Goals (SDGs). The purpose of fisheries management is not only for stock enhancement of natural resources and for improvement of fisheries yield, but for prevention of hunger, gender inequality, handicaps of minorities, climate change effects. The UN organizes the Ocean Conference to enhance interlinkage between marine issues and other SDGs. Both Illegal, Unreported and Unregulated (IUU) fisheries and artisanal fisheries in small island developing countries are key issues in the Ocean Conference. In Chile and other south American nations, artisanal fisheries are prioritized in coastal zones under co-management and bigger fishing vessels operates in offshore areas under top-down management (Matsuda et al. 2010). This is another case of area-based fisheries managements.

Also in the case of seabed resources of heavy metals, area-based management tools (ABMTs) are used to seek balance between conservation of benthic biodiversity and wise use of manganese nodules (Wedding et al. 2013). Heavy metal developers defined seabed areas for mining exploration and “Areas of Particular Environmental Interest” that are protected from mining. If there is a positive relationship between heavy metal rich areas and rich biodiversity areas, it is difficult to explore all mining resources but we can make a spatial planning to develop some areas for mining and to conserve the other areas for biodiversity conservation. In the deep sea areas in the Area Beyond National Jurisdictions (ABNJ), the International Seabed Authority manages the area-based management plan under the international legally-bound instrument determined by United Nations. Even in the exclusive economic zone (EEZ) or the continental shelf of a country, some environmental impact assessment for exploration of seabed mining is needed based on an international standard, whereas it is not restricted by ILBI. ISO (International Organization for Standardization) standard for seabed mining may be useful for the exploration of mines within EEZ and the continental shelf (Shibata et al. 2017).

## 4. Conclusion

In conclusion, we seek balance between sustainable use and biodiversity conservation based on co-management that consists of top-down and bottom-up control, in a variety of marine resources. Therefore stakeholder participation is important for consensus building. Area-based management is a key concept of integrated marine management. Collaboration between fishers and other sectors are also important and fisheries yield is a part of total ecosystem services from marine ecosystems. To avoid risks arisen from uncertainties and serious disasters, adaptive management is useful. Capacity building and education are important for making sustainable society.

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