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Expanding Fisheries Co-management to Ecosystem-based management: A case in the Shiretoko World Natural Heritage area, Japan

(Short title: Ecosystem-based management in Shiretoko)

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Abstract

Fisheries co-management in the Shiretoko World Natural Heritage area was expanded to ecosystem-based management, in which the fisheries sector plays an essential role in management. A Marine Management Plan was drawn up to define the management objectives, strategies to maintain major species, and methods for ecosystem monitoring. A network of coordinating organizations from a wide range of sectors was established to integrate policy measures. Experience from this case could inform ecosystem-based management in other countries where large numbers of small-scale fishers take a wide range of species under a fisheries co-management regime.

Keywords:, fisheries co-management, ecosystem-based management, integrated management, UNESCO World Heritage.

1. Introduction

Shiretoko Peninsula, located in the northeast of Hokkaido, Japan, is the southernmost seasonal limit of sea ice in the Northern Hemisphere (Fig. 1). This region is characterized by closely linked terrestrial and marine ecosystems, and by a number of marine and terrestrial species, including several endangered species. Shiretoko is a very famous fisheries production area in Japan, and the fisheries sector is the most important industry here. To maintain responsible fisheries [1], local fishers have implemented a wide range of autonomous measures under a co-management framework [2].

<Figure 1 here>

Since the nomination of the peninsula and its surrounding marine areas for UNESCO World Heritage Listing in 2004, various measures have been implemented to conserve its outstanding ecosystems. The approach was not to eliminate local fishers from the area, but to place their activities at the core of the management scheme to sustain ecosystem structure and function. That is, fisheries co-management [3],[4],[5] was expanded to ecosystem-based management[1] to achieve ecosystem conservation. We call this the “Shiretoko Approach”.

This article focuses mainly on management of the marine ecosystem in the Shiretoko World Natural Heritage (WNH) area. Section 2 presents an overview of the area, its fisheries, and its inscription on the World Heritage List. Section 3 describes new management measures implemented under the Shiretoko Approach. Section 4 presents a brief cost analysis of the Shiretoko Approach. Finally, section 5 summarizes institutional features of the Shiretoko Approach and discusses issues to be resolved.

2. Shiretoko World Natural Heritage area

[1] There are several terms such as ecosystem management [6],[7], ecosystem-based management [8], and ecosystem approach [9] [10], all encompassing the expansive, holistic, and cross-sectoral methods needed to conserve ecosystems, with the clear recognition of the interconnected nature of living systems and human ecosystems. In this study, we use the term “ecosystem-based management” following [8].

2.1 Overview of the Shiretoko WNH area's ecosystems

Shiretoko Peninsula and its adjacent marine areas (the Shiretoko WNH area) mark the southernmost limit of seasonal sea ice in the Northern Hemisphere, and are affected by the East Sakhalin cold current and the Soya warm current. The area has a complicated marine character created by these two currents and the intermediate cold water derived from the Sea of Okhotsk, and is home to a marine ecosystem in which a welter of organisms migrate and live [11]. In early spring, sea ice melts, and blooms of ice algae and other phytoplankton become the most characteristic part of the lowest trophic level of the Shiretoko ecosystems. The area's high productivity supports a wide range of species, including marine mammals, seabirds, and commercially important species [12].

A distinguishing character of this site is the interrelationship between the marine and terrestrial ecosystems. A lot of anadromous salmonids run up rivers in the peninsula to spawn. They serve as an important source of food for upstream terrestrial species such as the brown bear, Steller's sea eagle, and white-tailed eagle (Figure 2). The peninsula is also internationally important as a stopover point for migratory birds [13].

<Figure 2 here>

It is thought that people have been living in this area for more than two thousands years. A lot of clay pots and bones of Steller sealions, seals, and fish have unearthed from the archaeological excavation sites within the area. Today, total of 7 706 households, 19 184 people are living in Shari and Rausu town. The main industries are fisheries, agriculture, and tourism.

2.2 Fisheries activities in the Shiretoko WNH area

Shiretoko, literally meaning "the utmost end of the earth" in the local Ainu language, had long remained out of the jurisdiction of the feudal government in mainland Japan. According to "A report of Yezo (*Relatione del Regno di Iezo*)" by an Italian missionary priest, Geronimo de Angelis, in 1618, the local Ainu people had no concept of government or

lordship [14].Commercial fisheries off Shiretoko began in 1790 with the foundation of a fishery market by the rulers of mainland Japan. The main products at that time were dried or salt-cured salmon, trout, and herring [15]. After the Meiji revolution of 1868, offshore fisheries targeting halibut and cod started.

The Shiretoko fisheries developed rapidly after the Second World War [16]. Today, the marine areas around the peninsula are among the most productive fisheries in Japan. The fisheries sector is one of the most important industries in the regional economy. In 2006, 851 fishers were engaged in the industry, yielding 73 641 t, worth 22 966 million yen [17]. The industry produces 5.9% by volume and 9.1% by value of the total production in Hokkaido, and 1.4% and 1.6% in Japan. The average production per fisher is 3.4 times the national average by volume and 4.0 times by the value.

Figure 3 shows the changes in total catches compiled by three fishery cooperatives in the Shiretoko WNH area (Rausu, Shari-daiichi, and Utoro Fisheries Cooperative Associations). Their main target species and gear types are salmonids by set net, common squid by jigging, and walleye pollock, cod, and arabesque greenling by gillnet. The fish processing and marketing industries are also very active here. Further, dried kelp produced in this area is one of the most highly appreciated kelps in Japan, and trades at high prices.

<Figure 3 here>

2.3 Official steps to inscription on the World Heritage List

On account of the outstanding features of the Shiretoko region, the government of Japan formulated a management plan and nominated the region for World Heritage Listing in January 2004. The World Conservation Union (IUCN), as the consultative body of UNESCO, reviewed the proposal and management plan, and conducted a field evaluation in July 2004. The IUCN expressed the following concerns: (i) The level of protection for the marine components was not high enough. In particular, walleye pollock, which is one of the main food sources of the Steller sealions, should be managed properly. (ii) Impacts of constructions along the rivers in the peninsula on wild populations of salmonids, which link the marine and terrestrial ecosystems, should be investigated. In February 2005, IUCN officially requested: (iii) the marine component of the site should be expanded. (iv) A marine management plan should be promptly formulated to ensure the protection of marine species. Points (i) and (iv)

amplified the worries in the fisheries sector, which initially did not welcome inscription on the list.

In March 2005, the government replied to UNESCO and officially promised (i) to expand the marine boundary from 1 km to 3 km from the coastline, (ii) to formulate a marine management plan within 3 years, and (iii) to include appropriate management measures for the conservation of marine species such as walleye pollock and sea mammals in the plan. On this basis, Shiretoko was inscribed on the UNESCO World Heritage List in July 2005.[2]

Table 1 shows the legal framework relating to the management of the Shiretoko WNH area. In Japan, there is no domestic law specific to World Heritage Listing, and management measures are implemented under a combination of several laws and policy measures.

<Table 1 here>

Administrative procedures in Japan, as in many other countries, are vertically structured, hindering cooperation and coordination across ministries and departments. For example, Natural Park Law of 1957 does not give Ministry of Environment enough authorities to regulate impacts on marine ecosystems from fisheries activities, which are managed by the Fisheries Agency. Therefore, a new system of coordination among sectors and ministries was established for management of the Shiretoko WNH area, as described in section 3. Because the fisheries sector has a long history as the core of the regional economy, coordination with fisheries was especially important.

3. The Shiretoko Approach

3.1 New organizations for coordination across sectors

One of the most important new measures implemented in the Shiretoko WNH area is a system for coordination among the wide range of sectors involved (Figure 4).

[2] For more details on the process of inscription, see [18].

<Figure 4 here>

In October 2003, the Shiretoko World Natural Heritage Site Regional Liaison Committee was established to discuss the proper management of the site, exchange information, and coordinate various interests. The committee is composed of officers from a wide range of ministries and departments in central and local government (Table 1). Fisheries cooperative associations, the tourism sector, the Scientific Council (described in the next paragraph) and NGOs also participate. The committee serves as the core arena for policy coordination among administrative bodies.

In July 2004, the Shiretoko World Natural Heritage Site Scientific Council was established, aiming at providing scientific advice on the formulation of the management plan and on research and monitoring activities. The council has three working groups: the Marine Working Group for marine ecosystem management,[3] the River Construction Working Group for improvement of river constructions, and the Yezo Deer Working Group for Yezo deer management.[4] The Scientific Council and working groups are composed of natural scientists, social scientists, and representatives of ministries and departments in central and local government, of fisheries cooperative associations, and of NGOs.

The Shiretoko National Park Committee for the Review of Proper Use, founded in 2001 and extended in 2004, has conducted research and discussions on proper-use rules for tourists. It formulated the rules described in section 3.5.

These organizations and their interrelationships have helped to ensure participation, to exchange information and opinions, and to build consensus between the wide-ranging interests of multiple users of the ecosystem services, supporting the legitimacy of the management plans and rules. This is the core institutional framework for the integrated management under the Shiretoko Approach.

3.2 The Marine Management Plan

[3] The authors belong to the Marine Working Group.
[4] Yezo deer have a significant impact on the volume and diversity of forest floor vegetation, especially in their wintering grounds on the peninsula, owing to bark stripping and foraging. The Yezo deer management plan was formulated in 2007 to cover population size control and monitoring activities.

The Multiple Use Integrated Marine Management Plan was drawn up by the Marine Working Group in December 2007. It defines management measures to conserve the marine ecosystem, strategies to maintain major species, monitoring methods, and policies for marine recreational activities. Its objective is "to satisfy both conservation of the marine ecosystem and stable fisheries through the sustainable use of marine living resources in the marine area of the heritage site" [11]. The fisheries sector has participated from the beginning of the drafting process. Because the ecosystem is disturbed, unclear, and complex, the Marine Management Plan stipulates the introduction of adaptive management [19] [20] as a basic strategy.

To monitor the Shiretoko marine ecosystem, the Marine Working Group drew up a food web (Fig. 2), identified indicator species, and specified monitoring activities. The identified indicator species are salmonids, walleye pollock, arabesque greenling, Pacific cod, Steller sealion, seals, spectacled guillemot, slaty-backed gull, Japanese cormorant, Steller's sea eagle, and white-tailed eagle. The catch data compiled by local fishers (Fig. 3) includes many of the indicator species and other major marine species in the food web. Local fishers have fished in this area for a long time and have compiled data for over 50 years. For some species, more detailed information such as size, time and place of catch, and maturity have been accumulated. This information is an important foundation for monitoring changes in the functions and structure of the Shiretoko marine ecosystem. Under the Shiretoko Approach, the local fishers are recognized as an integral part of the ecosystem, and their data are officially utilized to monitor the ecosystem cost-effectively.

However, catch data are not enough for monitoring the entire marine ecosystem, because fishers' behavior is based on economic contexts. Therefore, the Marine Management Plan specifies monitoring of non-commercial species, as well as basic environmental indices such as weather, water quality, sea ice, and plankton.

The Marine Management Plan clearly stipulates the adoption of adaptive management, so ecosystem monitoring is a necessary component. Usually, adaptive management plans determine criteria and feedback control rules for indicator species; for example, monitoring of indicator species and implementation of conservation actions to maintain each species above a threshold abundance or to recover its abundance above a numerical goal by a given date [18]. However, the current Marine Management Plan does not set these threshold or numerical goals. A future task is to develop reference points representing the overall status and long-term trends of the ecosystem, to be adaptively referred to in the overall management scheme.

3.3 Measures to manage walleye pollock and Steller sealion

IUCN expressed concerns for the conservation of the Steller sealion and the proper management of its prey, walleye pollock.

Walleye pollock is one of the most important fisheries targets in the Shiretoko area. Shiretoko fishers catch the Nemuro stock of walleye pollock mainly by gillnet (Fig. 5). This stock is officially managed by the national government under the total allowable catch system based on the Law Concerning the Conservation and Management of Marine Life Resources of 1996. In addition to this official management, various fisheries co-management measures have been implemented, as explained below. It is important to note that the Nemuro stock is shared by Russian trawlers operating around the southern Kuril Islands, where Japan and Russia have had territorial conflicts since the Second World War.[5]

<Figure 5 here>

The total annual catch was around 100 000 t in the late 1980s, but dropped drastically since 1990: in 2006, it was only 9200 t. It was believed that both the climate change and increased fishing effort in late 80s have caused the stock collapse in early 90s [22]. However, because of the limitation of catch and biological data on the Russian side, the chief factor in the stock decline has not been identified yet by the Japanese researchers. To cope with the decline in catch, local fishers and researchers have cooperatively introduced additional autonomous management measures. Local fishers compile data on catch size, time, area, body size, maturity, etc. These data are provided to the prefectural research station for analysis. The results are returned to the fishers, and management measures are discussed. For example, the local fishers voluntarily enlarged the mesh size of pollock gillnet from 91 mm to 95 mm in 1990s, in accordance with research results provided by the research station.

Gillnet fishers divide the fishery ground into 34 areas based on their local knowledge and experience. They declared 7 of these areas protected to conserve resources. These protected areas include a portion of the spawning ground of walleye pollock. The protected areas are re-examined every year on the basis of the previous year's performance and

[5] Issues relating to this point are discussed in section 5.

scientific advice from the local research station. After the nomination for World Heritage Listing, another 6 areas were designated as protected.

Another example of autonomous measure to conserve resources is the reduction of fishing capacity. The number of gillnet vessels in the late 1980s was 193. To reduce fishing capacity in accordance with stock status, local fishers have disposed of more than half of their vessels since 1996. Compensation for the disposal, about 1.1 billion yen, was jointly funded by the remaining fishers and the fisheries cooperative associations. Government bore the interest costs. In 2002, fishers introduced a joint operation system to reduce fishing pressure by 20% and further reduce operation costs: Five boats form a group, with each suspending operation in turn.

Various autonomous measures are implemented for other resources as well. The fisheries cooperative associations fund their own monitoring and research vessel. Although these co-management measures are not well defined or described, they regulate the impact of fishing on stock. The Marine Management Plan recognizes such feedback control as adaptive management, and officially incorporates these autonomous measures. An important next step is the scientific verification of the validity of these measures.[6]

Next, Steller sealions. The Okhotsk and Kuril population of the Steller sealion migrate from Russia to the Shiretoko WNH area in winter. Because this population is listed as Endangered on the IUCN Red List, it should be properly conserved. Fortunately, its size has been gradually increasing at 1.2% per year since the early 1990s [26]. On the other hand, from the viewpoint of fishers operating in the Shiretoko WNH area, the Steller sealion is a competitor for walleye pollock resource. In addition, sea lions sometimes come inside the set nets to eat fish and then break the nets to escape. This damage is a huge cost for the fishers.

Therefore, in order to mitigate the damage, 116 Steller sealions have been culled each year under the Fisheries Law. However, this cull size had no strong scientific basis. So in 2007, the Fisheries Agency of Japan revised the procedure for setting the cull limit to base it on the potential biological removal theory [27], which is used under the US Marine Mammal Protection Act. The calculated potential biological removal for Steller sealion was 227, and the revised cull limit for 2007 was 120 [18]. The culled sea lions are not wasted but are eaten locally.

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[6] For other examples of adaptive fisheries co-management in Japan, see [23] and [24]. For examples of adaptive co-management of other natural resources, see [5] and [25].

3.4 Measures to support interrelationship between marine and terrestrial ecosystems

Many anadromous salmonids return to rivers in Shiretoko to spawn. Wild salmonids (including hatchery-derived chum and pink salmon that reproduce naturally in the rivers) running upstream serve as an important source of food for terrestrial mammals and birds of prey, and contribute to biodiversity and material circulation [11]. Salmonids are also important target species for set net fishers. Under the Fisheries Resource Protection Law of 1951, fishing has been prohibited in all rivers and near the mouths of some rivers in Shiretoko.

To maintain and facilitate the interactions between marine and terrestrial ecosystems, artificial constructions such as dams have been modified since 2005 on scientific advice from the River Construction Working Group. The working group surveyed 118 artificial constructions in Shiretoko and evaluated their impacts on salmonids. It investigated possible structural modifications, taking into account their effects on disaster risk. Some of the constructions were retained because the modifications could have increased the risk of disaster in densely populated areas. As a result, 25 structures have been modified or are under modification as at the end of January 2008. To scientifically verify the effects of these measures, a 3-year program will monitor the upstream run, number of spawning redds, substrate composition, current velocity, and discharge.

3.5 Measures for marine recreational activities

The Shiretoko WNH area is a popular tourist destination, and since its inscription on the World Heritage List, the number of tourists has increased considerably. The marine area is used for sight-seeing, sea kayaking, personal boating, scuba diving, and recreational fishing, among other uses. These activities not only bring economic benefits to the local economy, but also are regarded as important for cultural and educational purposes [11].

However, there has been a growing concern that unregulated recreational use of the marine areas may have adverse effects on the fishing industry. Notably, some fishers complain of obstruction by tourists. Also, passage by boats and unregulated feeding and watching at close range may affect the survival of seabirds and marine mammals.

To prevent these negative impacts on local fisheries and the marine ecosystem, the Marine Management Plan prescribes that recreational activities are to be managed under rules

formulated by the Shiretoko National Park Committee for the Review of Proper Use (Fig. 4). This committee is composed of academics, tourism and guide representatives, environmental NGOs, and officers representing forestry, coast guard, environment, and local government. The committee prescribes patrols and activities to monitor tourist uses, formulates rules for tourists, and promotes ecotourism.

4. Administrative costs

From the practical point of view, financial resource is one of the most important challenges to pursue ecosystem-based management [28]. Table 2 shows the administrative costs for the Shiretoko WNH area in 2006. Information on budget and personnel was provided by the Ministry of Environment, the Forestry Agency, and Hokkaido Prefecture. The personnel accounted for in Table 2 are engaged mainly in Shiretoko affairs: 5 full-time and 4 part-time in the Ministry of Environment, 1 full-time in the Forestry Agency, and 7 full-time in Hokkaido Prefecture.[7] The personnel cost was calculated as the number of officers multiplied by the average wage of government officers.

<Table 2 here>

Fisheries production in 2006 brought in 22 966 million yen [17], and tourists spent an estimated 36 617 million yen.[8] Therefore, the total administrative cost corresponds to 0.8% of this income. Intuitively, this value seems small as the total cost of bringing ecosystem-based management into practice, but comparative analysis should be carried out with other cases with different fishery management regimes.

5. Discussion

About 190 000 fishers operate around the coastline of Japan. They live directly off

[7] Of course, many officers from other departments and ministries listed in Table 1 support their work, spending time on side assignments.

local marine ecosystems, and their interests are legally protected by fishing rights or licenses. Their knowledge of the local seas has accumulated over generations and should be fully utilized along with scientific knowledge to support ecosystem-based management [29]. As presented in section 3.3, fisheries co-management has many institutional advantages such as decentralized management, adaptive management, and the use of both local and scientific knowledge [30]. In the Shiretoko Approach, these advantages are recognized and formally incorporated in the Marine Management Plan. Therefore, if local fisheries activities are managed responsibly and non-target species are additionally monitored, comprehensive ecosystem monitoring can be done cost-effectively. A future task is to develop a reference point representing the overall status and long-term trends of the ecosystems, to be adaptively referred to in the overall management scheme. Progress should be facilitated in the scientific understanding of interrelationships between fisheries operations, indicator species, and ecosystem structure, function, and processes.

Under the Japanese fisheries co-management system, coordination and stakeholder participation are limited to the fisheries sector only, and no other marine ecosystem users are included in the decision-making process. In addition, the autonomous rules implemented by local fishers are usually shared only within fisheries sector, which often causes problems in the use of resources or areas. In the Shiretoko Approach, a new coordinating system was established (Figure 4), and a wide range of stakeholders from various sectors are now integrated. This system facilitates the exchange of information and opinions, and strengthens the legitimacy of the management plans and rules.

Science-based measures implemented in rivers facilitate interactions between marine and terrestrial ecosystems, and procedures to set a limit for the culling of the Steller sealion have mitigated fishery damage without increasing the risk of extinction.

Several lessons on building consensus with the fisheries sector on ecosystem-based management can be learned. Originally, local fishers did not welcome the World Heritage Listing because of their fear that inscription would lead to additional regulation for the sole purpose of environmental protection. Therefore, before nomination for listing in January 2004, the Ministry of Environment and Hokkaido Prefecture promised that both the conservation of the ecosystem and stable fisheries would be essential. This promise was also stipulated as an objective of the Marine Management Plan. The fisheries sector has participated from the beginning in all the coordinating organizations shown in Figure 4 and in the drafting of the

[8] Estimates came from the Shari and Rausu town offices.

Marine Management Plan. Explanatory meetings have been held several times with local fishing communities. The participation of the fisheries sector, official guarantees, and accountability of administrators were keys to the building of consensus.

In addition, territorial disputes with Russia have fostered the fisheries sector's participation. Russian trawlers are much bigger (700–4000 gross tonnes) than Japanese gillnet vessels (10–19 gross tonnes) and catch smaller fish [21]. At the moment, there is no coordination between Japan and Russia to deal with this conflict. Shiretoko fishers expect that the World Heritage Listing will attract international attention to this situation and lead to some form of cooperative management of walleye pollock in the near future. This is an important task to be dealt with by the national government. Resolving this cross-scale linkage of management [31] is important at the ecosystem level: Because ecosystems are inherently open, the Shiretoko ecosystems are closely linked with adjacent areas, so ecosystem management measures should be coordinated. Although there are serious territorial disputes over the southern Kuril Islands, dialog between scientific groups is the first step to a resolution.

The Shiretoko Approach is based on the Japanese fisheries co-management framework. Following the Copes and Charles [32], Japanese co-management can be categorized as a kind of "community-based co-management", which recognizes fishers as the primary participants of the management, and the involvement and support of the broader community is essential. It is open to consider a wide range of human needs in the community, and therefore lends itself to implementation of a balanced mix of biological, social and economic objectives. This fisheries institutional background in Japan naturally leads to a different ecosystem-based management framework from, for example, that of Iceland or New Zealand, where market-based individual transferable quotas are the central policy tool. There is no unique transition path to conserve marine ecosystems and sustain livelihoods [33].

Therefore, what is required is careful assessment of the existing institutional framework and the potential role of the fisheries sector in marine ecosystem management. In the Shiretoko Approach, the local fishers are an integral component of the ecosystem, rather than unwanted extras to be eliminated from the "original ecosystem". Moreover, local fishers are not something to be managed or controlled, but are expected to play an indispensable part of ecosystem-based management. In this sense, we hope the experiences in the Shiretoko Approach could contribute to future ecosystem-based management in other regions where large numbers of small-scale fishers are utilizing a wide range of species under a fisheries co-

management regime.[9]

A new act, the Ocean Basic Act, was legislated in Japan in April 2007. This act covers all the ministries involved in marine activities and research. To sweep away the obstacles caused by the vertically structured administrative system and to integrate and coordinate wide-ranging policy measures by marine-related ministries, the Integrated Marine Policy Headquarters was founded, and is directly headed by the prime minister. The Integrated Marine Policy Headquarters has just formulated the Basic Plan of Integrated Marine Policy in March 2008. It is expected that this basic plan will facilitate the future ecosystem-based and integrated management in Japan, such as those found in Shiretoko WNH area.

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References

[1] FAO. Code of conduct for responsible fisheries. Rome: FAO; 1995.
[2] Makino M, Matsuda H. Co-management in Japanese coastal fishery: it's institutional features and transaction cost. Marine Policy 2005; 29: 441–450.
[3] McCay BJ, Acheson JM, editors. The question of the commons: the culture and ecology of communal resources. Tucson: University of Arizona Press; 1987.
[4] Pinkerton E. editor. Co-operative management of local fisheries: New directions for improved management and community development. Vancouver: UBC Press; 1989.
[5] Armitage D, Berkes F, Doubleday N, editors. Adaptive Co-management: Collaboration, Learning, and Multi-Level Governance. Vancouver: UBC press; 2007.
[6] Christensen NL, Bartuska AM, Brown JH, Carpenter S, D'Antonio C, Francis R, Franklin

[9] According to a media report by *Mainichi* newspaper on 22 February 2008, the deputy director of the UNESCO World Heritage Center, Mr. Kishore Rao, visited the Shiretoko WNH area, and valued the Shiretoko Approach as a new model of environmental conservation under the World Heritage Program.

JF, MacMahon JA, Noss RF, Parsons DJ, Peterson CH, Turner NG, Woodmansee RG. The report of the Ecological Society of America committee on the scientific basis for ecosystem management. Ecological Applications 1996; 6: 665–691.
[7] Pirot JY, Meynell PJ, Elder D. Ecosystem Management: Lessons from Around the World. A Guide for Development and Conservation Practitioners. Gland and Cambridge: IUCN ; 2000.
[8] UNEP/GPA. Ecosystem-based management: Markers for assessing progress. Hague: UNEP/GPA; 2006.
[9] Convention on Biological Diversity. Decision V/6; 2000.
[10] Morishita J. What is the ecosystem approach for fisheries management? Marine Policy 2008; 32: 19–26.
[11] Ministry of Environment of the Government of Japan, Hokkaido Prefectural Government. The multiple use integrated marine management plan. December 2007.
[12] Sakurai Y. An overview of the oyashio ecosystem. Deep-Sea Research 2007; II 54: 2526–2542.
[13] IUCN. Technical evaluation report, Shiretoko (Japan) ID No: 1993. 2005.
[14] Rausu Town History editing committee. Rausu Town History. Rausu Town; 1970 (in Japanese).
[15] Shari Fisheries History editing committee. Shari Fisheries History. Shari Town; 1979 (in Japanese).
[16] Shiretoko Museum. Fisheries in Shiretoko. Association for Shiretoko Museum: Shari; 2001 (in Japanese).
[17] Hokkaido. Hokkaido Fisheries White Paper. Hokkaido Prefectural Government; 2007
[18] Matsuda H, Makino M, Sakurai Y. Development of adaptive marine ecosystem management and co-management plan in Shiretoko World Natural Heritage Site. Biological Conservation. in review.
[19] Holling CS, editor. Adaptive environmental assessment and management. New York: John Wiley and Sons; 1978.
[20] Walters CJ. Adaptive management of renewable resources. New York: Macmillan; 1986.
[21] Fisheries Research Agency of Japan. Stock assessment report of fiscal year 2006 for Nemuro stock of walleye pollock; 2007. (http://www.jfa.maff.go.jp/release/19/081001.pdf)
[22] Ishida R, Torisawa M, Shida O. Fisheries and fisheries resource in Shiretoko (continental shelf area). Kaiyo Monthly 2006; 38: 626-631 (in Japanese).
[23] Makino M. Marine Protected Areas for the Snow Crab Bottom Fishery off Kyoto

Prefecture, Japan. In: Townsend R, Shotton R, Uchida H, editors. Case studies in fisheries self-governance. FAO Fisheries Technical Paper No. 604. Rome: FAO; 2008.
[24] Tomiyama M, Komatsu T, Makino M. Sandeel fisheries governance in Ise Bay, Japan. In: Townsend R, Shotton R, Uchida H, editors. Case studies in fisheries self-governance. FAO Fisheries Technical Paper No. 604. Rome: FAO; 2008.
[25] Berkes F, Colding J, Folke C, editors. Navigating Social-Ecological Systems: Building Resillience for Complexity and Change. Cambridge: Cambridge University Press; 2003.
[26] Burkanov NV, Loughlin TR. Distribution and abundance of Steller sea lions, Eumetoias jubatus, on the Asian Coast, 1720's-2005. Marine Fisheries Review 2005; 67: 1–62.
[27] Wade PR. Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. Marine Mammal Science 1998; 14: 1–37.
[28] Barnes C. McFadden KW. Marine ecosystem approaches to management: challengees and lessons in the United States. Marine Policy (doi:10.1016/j.marpol.2007.08.006).
[29] Gadgil M, Olsson P, Berkes F, Folke C. Exploring the role of local ecological knowledge in ecosystem management: three case studies. In: Berkes F, Colding J, Folke C, editors. Navigating social-ecological systems: building resillience for complexity and change. Cambridge: Cambridge University Press; 2003. p. 189–209.
[30] Makino M. The Ecosystem Approach of the CBD and fisheries management in Japan. Global Environmental Research 2005; 7: 95–104.
[31] Ostrom E, Dietz T, Dolsak N, Stern PC, Stonich S, Weber EU, editors. The Drama of the Commons. National Academy Press: Washington DC; 2002.
[32] Copes P, Charles A. Socioeconomics of Individual Transferable Quotas and Community-based Fishery Management. Agricultural and Resource Economics Review 2004; 33: 171-181.
[33] Grafton RQ, Hilborn R, Ridgeway L, Squires D, Williams M, Garcia S, Groves T, Joseph J, Kelleher K, Kompas T, Libecap G, Lundin CG, Makino M, Matthiasson T, McLoughlin R, Parma A, Martin GS, Satia B, Schmidt, CC, Tait M, Zhang LX. Positioning fisheries in a changing world. Marine Policy 2008; 32: 630-634.

Table 1 Major laws and governing authorities covering Shiretoko WNH area management

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

Table 2 Total administrative costs for Shiretoko WNH area in 2006

Cost item	Amount (1000 yen)	Purpose
Running costs for Scientific Council and working groups	17 548	Giving scientific advice on management plan
Running costs for Committee for the Review of Proper Use and Shiretoko Eco-tourism Association	15 120	Development of strategies for proper tourism
Research and monitoring activities	54 731	Monitoring and research on adaptive management
River improvement	284 927	Modification of river constructions
Personnel	101 778	Administrative staff in Ministry of Environment and Hokkaido Prefecture
Total	473 474	

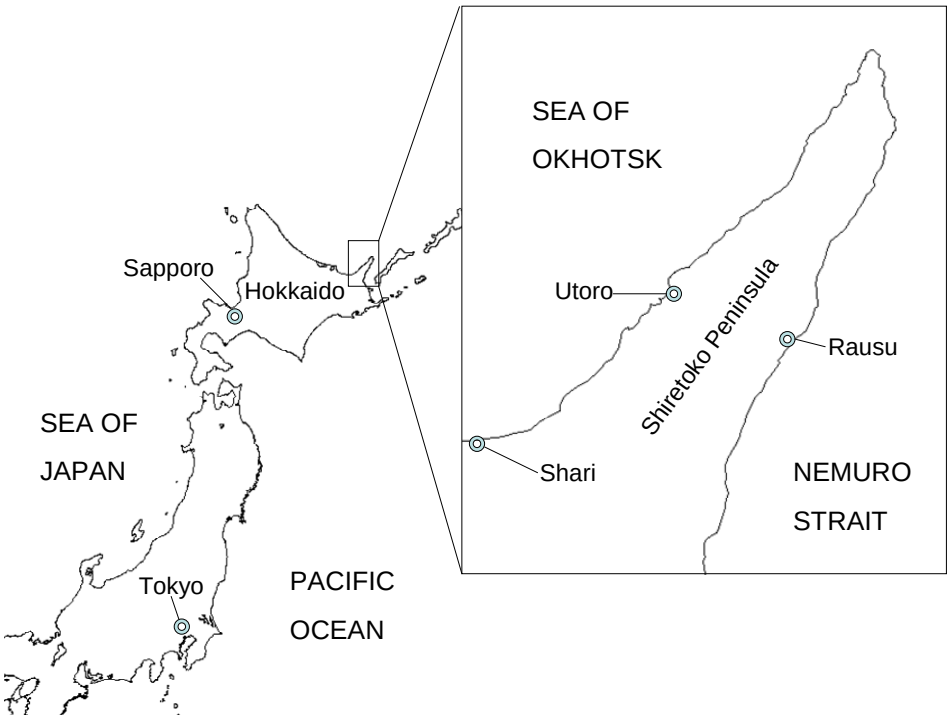

Figure 1. Shiretoko peninsula.

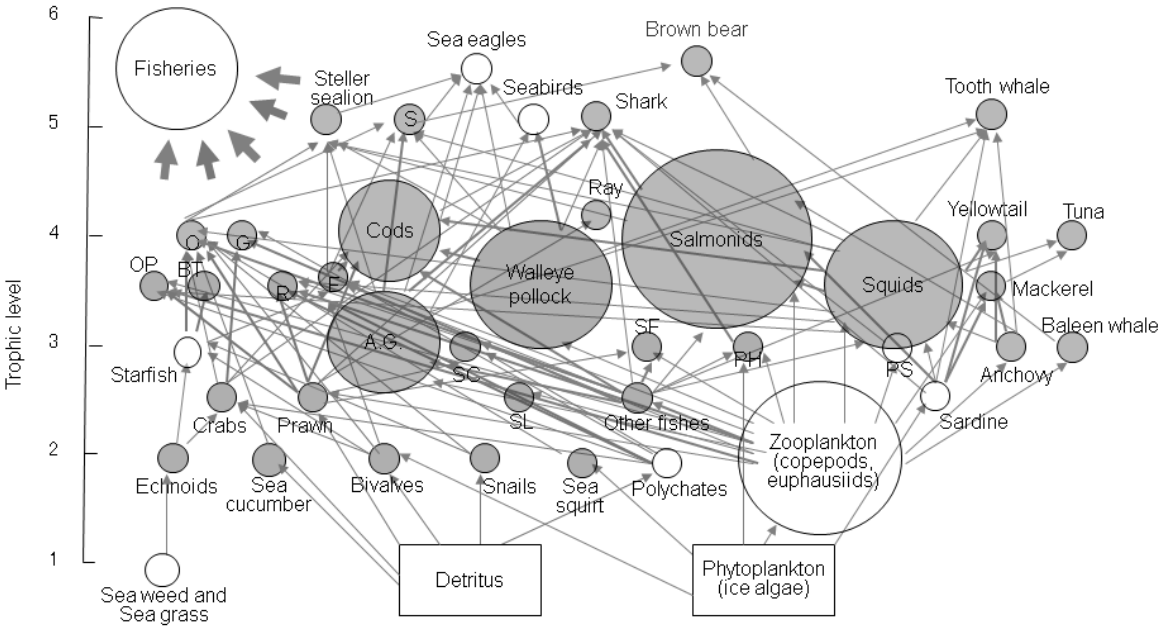

Figure 2. Food web of the Shiretoko WNH area (as depicted by the Marine Area Working Group of the Scientific Council). AG: arabesque greenling; BT: bighand thornyhead; F: flatfishes; G: greenlings; O: octopus; OP: ocean perch; PH: Pacific herring; PS: Pacific saury; R: rockfish; S: seals; SC: saffron cod; SF: sandfish; SL: sand-lance.

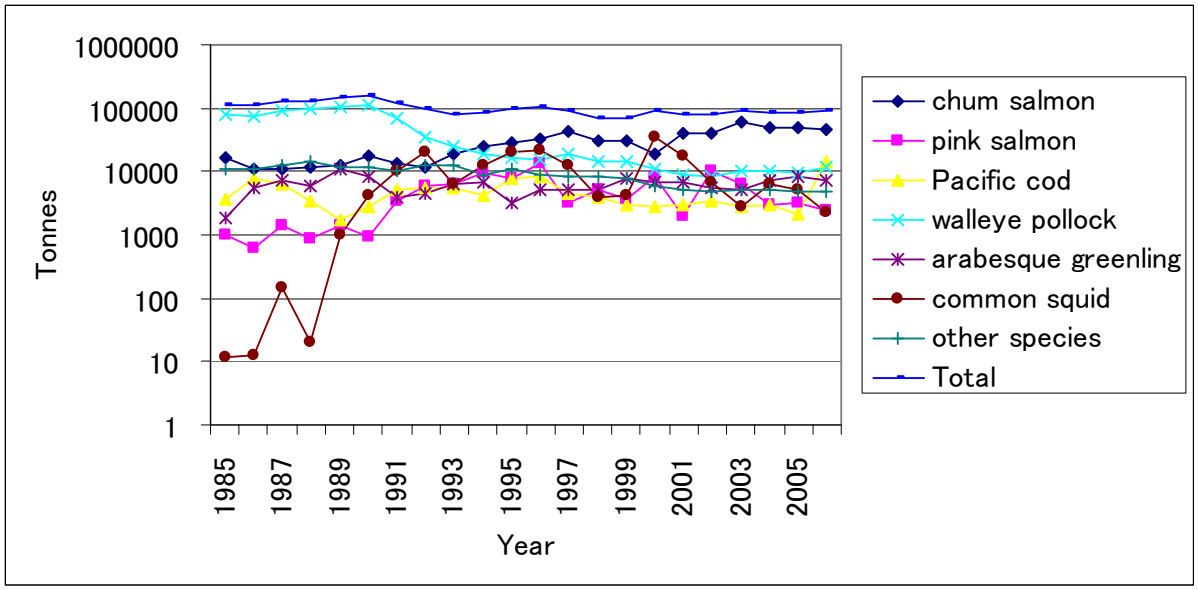

Figure 3. Fisheries production of major species in Shiretoko ([17]).

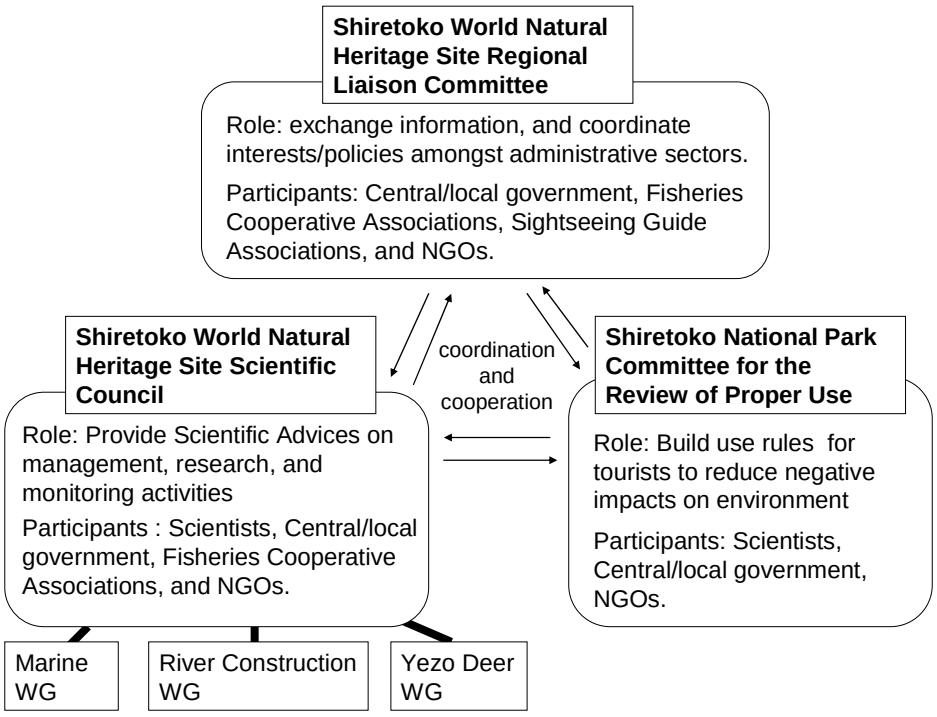

Figure 4. Coordinating system in Shiretoko WNH.

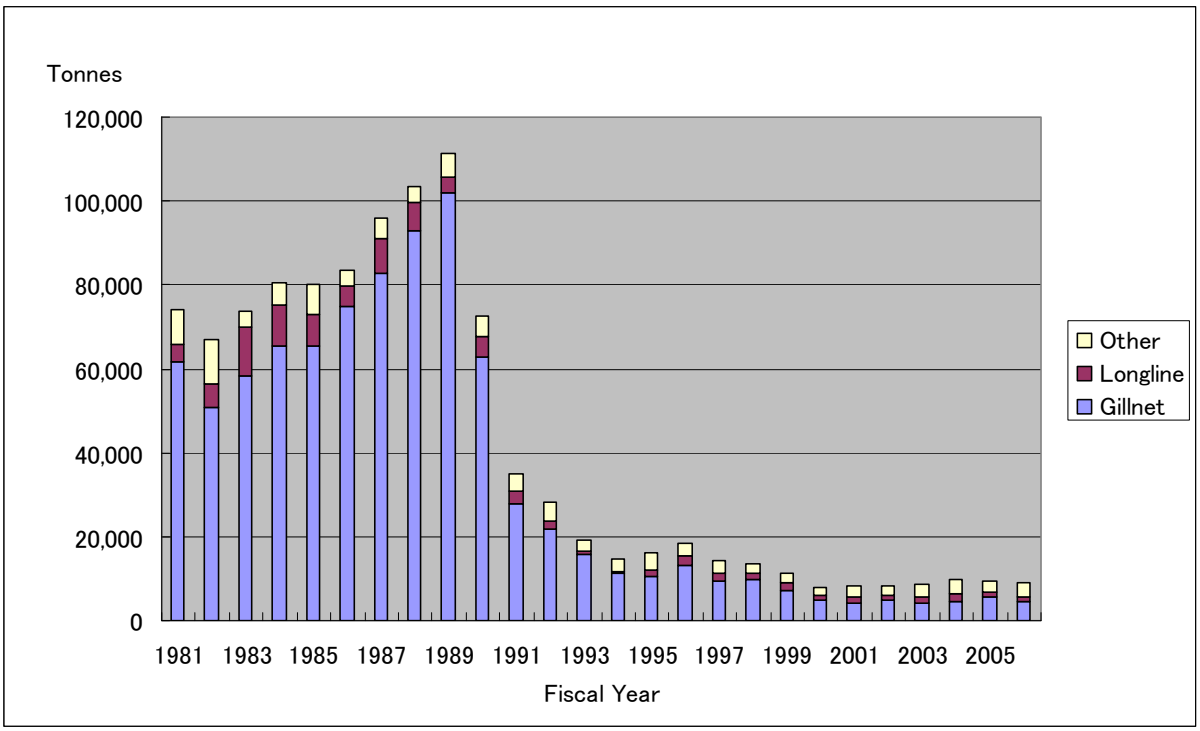

Figure 5. Catch of Nemuro stock of walleye pollock ([21]).