Council for Promoting Agriculture, Forestry and Fisheries
Coexistent with Lake Biwa in Shiga

October 2019
(revised as of July 2022)
Summary information

Name/Title of the Agricultural Heritage System:

Biwa Lake to Land Integrated System

Requesting Agencies / Organizations:

- Organization: Council for Promoting Agriculture, Forestry and Fisheries Coexistent with Lake Biwa in Shiga
- Component Organizations: Shiga Prefectural Federation of Fishery Co-operative Association; Shiga Agricultural Union Central Association; Shiga Prefectural Federation of Land Improvement Project Association; Shiga Federation of Forestry Unions; Shiga Livestock Promotion Association; Biwako Visitors Bureau; Shiga Youth Farmer Club Liaison Council, and Council for Promotion of Life-Nurturing Rice Paddies Connected to Lake Biwa; Otsu City, Hikone City, Nagahama City, Omihachiman City, Kusatsu City, Moriyama City, Ritto City, Koka City, Yasu City, Konan City, Takashima City, Higashiyama City, Maibara City, Hino Town, Ryuoh Town, Aisho Town, Toyosato Town, Kora Town, Taga Town, and Shiga Prefecture (plus 95 other organizations and 572 individuals)

Responsible Ministry (for the Government):

Ministry of Agriculture, Forestry and Fisheries

Location of the Site:

- Site name: Lake Biwa Region
- Details of the site location:
  - Oumi Basin located in the central part of the Japanese archipelago
  - (See p.5 for details)
- Geographic coordinates:
  - 34°47'-35°42'N 135°46'-136°27'E

Accessibility of the Site to Capital City or Major Cities:

(Railway) Approx. 2 hours 15 min from Tokyo Station to Maibara Station on the Tokaido Shinkansen line
- Approx. 10 min from Kyoto Station to JR Otsu Station on the JR line
- Approx. 35 min from Shin-Osaka station to JR Otsu Station on the JR line

(Air) Approx. 1 hr 30 min from Itami Airport (Osaka) to JR Otsu Station on JR line via Shin-Osaka
- Approx. 1 hr 45 min from Kansai Airport (Osaka) to JR Otsu Station on JR line via Shin-Osaka

Area of Coverage:

- Lake (fishing area): 670km²; Land: 511 km² (lake to land-focused environmentally sound agricultural area: 342km²; water source forest conservation area: 169km²)

Agro-Ecological Zones

Inland fisheries in a lake surrounded by agricultural land and forests in a temperate zone

Topographic features:

Located in the basin surrounded by mountain ranges at an altitude of 1,000m with agricultural land and forests in the marginal areas, Lake Biwa is the largest lake in Japan.
Climate Type:
Temperate humid climate: High temperature and humidity with abundant rainfall in the summer and some snowfall in the winter. Average annual temperature is 15°C and average annual rainfall is 1,570mm (at the Hikone Regional Meteorological Observatory).

Approximate Population (Beneficiary):
29,240: approximately 680 in Lake Biwa fishery, approximately 26,550 in lake to land-focused environmentally sound agriculture and approximately 2,010 in conserving forests as water source.

Ethnicity / Indigenous Populations:
n/a

Main Source of Livelihoods:
Fisheries and agriculture

Executive Summary:

Biwa Lake to Land Integrated System is centered on traditional inland water fisheries which have developed along with paddy agriculture. It comprises paddy agriculture that provides safe breeding grounds for spawning lake fish. Traditional fishing methods enable the selective catching of only a required amount of lake fish of a certain size. Traditional social system allows fishermen organizations autonomously conserve lake resources. This system has a history of more than 1,000 years that integrates agriculture and fisheries, and it has continued to provide sustainable resource use in freshwater systems located in an area where urbanization has taken its course.

Lake Biwa, located close to Kyoto, Japan’s old capital, is home to 47 native fish species, including sixteen endemic species. Lake fish such as the round crucian carp (*carassius buergeri grandoculis*) have migrated up the water channels to breed in the rice paddies that has been developed in the low wetlands surrounding the lake for 2,000 years. People developed various passive fishing methods to catch migrating fish as they worked their fields, establishing an agro-fishery mixed livelihood that enhanced their food self-sustainability.

A major fishing method is *eri* fishing using a fixed fish net, which allows selective retrieval of fish while avoiding catching juvenile fish. The *eri* is a traditional set-gear that has created the landscape/lakescape, together with rice paddies. The system has achieved a sustainable resource use and conservation. Local fishermen established a social system to manage and conserve fishery resources that are supported by lake to land-focused environmentally sound agriculture and reed conservation, which have contributed to preventing the water quality of Lake Biwa from declining. Furthermore, afforested water source forests have contributed to the prevention of floods and droughts, consequently contributing to conserving the breeding grounds of lake fish that migrate upstream from the Lake Biwa to spawn.

The local food culture featuring *narezushi*, a preserved food made by fermenting various fish in rice, developed against this background and in turn also supports the system. *Funazushi*, is a leading type of *narezushi* that is often referred to as the origin of sushi as we know it today, and continues to be offered in traditional festivities held by local communities. The food culture and
festivities have led to the fostering of human ties, which have served as the spiritual and social foundation for local cooperation in addressing pressures on fisheries, floods and droughts.

Amid economic growth in the late 20th century, the proposed system has faced various challenges, including population increase, urbanization, modernization of agriculture, feeding damage by invasive alien fish species against native fish species. However, after the 1970s, not only fishermen but also agricultural farmers, forestry workers, consumers and other diverse actors have joined forces to preserve and pass down the proposed system to future generations. Campaigns by civil society have led to the establishment of prefectural ordinances for the prevention of eutrophication. The rice paddies and water channels that people have maintained, offering spawning grounds for lake fish, symbolize the efforts.

These collaboration of diverse actors build social capital, and contribute to the conservation of the water quality and ecosystem functions of Lake Biwa as a vital water source supplying drinking water to 14.5 million people living in urban areas downstream such as Osaka. The Lake Biwa region has maintained area-wide ecosystem conservation that has led to the achievement of high resilience amid waves of modernization.

The Lake Biwa region has also been greatly involved in academic research for the conservation of available freshwater resources, which accounts for less than 0.5% of global waters. International conferences have been held to share information and trainees from overseas have been received. These efforts are taken with a view to soundly balancing economy, society and environment, enhancing the sustainability of the proposed system, and communicating and sharing the value of the lake to land-focused system that fosters the ecosystem.
Outline of proposal

Biwa Lake to Land Integrated System

A system centered on traditional inland fisheries
(supported by paddy agriculture and passed down across 1,000 years)

- Paddy agriculture that contributes to the reproduction of fishery resources
  - Lake fish come to the rice paddies to spawn
  - Juvenile fish grow rapidly with a high survival rate
  - Contributes to the conservation of biodiversity

- Environment-friendly traditional fishing techniques
  - Selecting and catching only required amounts and sizes (structured to let immature fish escape)
  - Passive method operable while engaging in agriculture

- Traditional social system for conserving fishery resources
  - Fishermen-led rule-making and implementation
  - Documents on the local history of resource conservation dating back to the 13th century

Urban areas, modern farming areas and general water source forests are eliminated from the proposed designated area. (Details are provided in the map on the next page.)

【Global significance】 ~Long-term sustainable resource use in a freshwater area~

Historical significance
- Resources are used and reproduced to modern times through the following practices with supporting evidence in historical documents:
  1. Traditional fishery techniques that enable catching only the fish required
  2. Traditional and social fishery resource conservation scheme led by fishermen
  3. Lake to land-focused environmentally sound agriculture that provides lake fish spawning grounds and conserves ecosystem traditionally
  4. Traditional water source forest conservation that prevents floods and droughts and conserve the spawning grounds of lake fish

Contemporary significance
- Collaboration among producers and consumers amid urbanization, evolving a self-governance system originating in village community traditions for conserving water quality and ecosystem that supports both inland fisheries and agriculture
- Conserving the water source for 14.5 million people while promoting academic research and international collaboration

Diverse blessings of Lake Biwa
Conserving ecosystems in the rice paddy with public participation
Establishment of an international conference
Proposed designated area (①~⑤) and Buffer zone

Reed bed
Inlet river to Lake Biwa

Buffer zone: Areas excluded from the proposed designated area, but included in the target areas of the Action Plan for their topographical impact on the conservation of Biwa Lake to Land Integrated System (urban areas, modern farming areas and general water source forests).

Legend

① Proposed designated area (①~⑤) and Buffer zone
② Reed bed
③ Inlet river to Lake Biwa
④ Buffer zone: Areas excluded from the proposed designated area, but included in the target areas of the Action Plan for their topographical impact on the conservation of Biwa Lake to Land Integrated System (urban areas, modern farming areas and general water source forests).
⑤ Traditional eri fisheries passed down along with social structures for fishery resource conservation

④ Rice paddies where lake fish come to spawn (Fish Cradle Rice Paddies)
Juvenile fish hatch in the rice paddies and grow rapidly, then swim down to Lake Biwa where they grow larger.

⑤ Lake to land-focused environmentally sound agricultural area
passing down traditional drainage management that contribute to the conservation of Lake Biwa’s water quality and ecosystem

Managing agricultural discharge (Digging sludge out of the channels)

⑥ Water source forest conservation area
Upstream areas where lake fish migrate and where local residents participate in water source forest conservation efforts (to prevent floods and droughts and to protect the spawning grounds of lake fish) as well as preserved fish-breeding forests

Tree-planting by fishermen and residents

※Note. Some years, in the proposed designated area and buffer zone, wheat, soybeans, and other crops are temporarily grown in place of paddy rice in order to maintain demand-supply balance of rice production.
This illustration shows the following important elements of the proposed system:

- Migratory lake fish in Lake Biwa (e.g. carp) traveling upstream to paddies from ancient times and their subsequent spawning and reproduction in the paddies
- Traditional *eri* fishing performed jointly by men and women
- Pickling traditional *narezushi (funazushi, etc.)* and offering the food to the gods
- Biodiversity and human activity in paddies and Lake Biwa
- Lake to land-focused environmentally sound agriculture and the conservation of water source forests that recharge water and protect the breeding environment for lake fish (e.g., salmonid) that spawn in rivers.

*The numbers correspond to those in the glossary on the next page.*
**Glossary** (The numbers correspond to those on the illustration on the previous page.)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Biwa Catchment Area / water source forests (①)</td>
<td>The Lake Biwa Catchment Area is the water source area of Lake Biwa, shaped like a mortar. It composes an integrated bioregion formed by the Omi Basin, surrounded by mountains (drainage divides) 1,000m above sea level. The forests of the mountains bear the function of preventing floods and drought, which is enhanced through afforestation. The area has developed as one cultural zone, in which the Shiga local government was established.</td>
</tr>
<tr>
<td>Ancient lake (②)</td>
<td>Many lakes on Earth are believed to have been formed in the last 10,000 years and will disappear in the next 10,000 years. However, a limited number (around 20) of long-lasting lakes have been formed over 100,000 years ago. These lakes are referred to as ancient lakes and embrace rich fauna and flora, including many endemic species. Lake Biwa is an ancient lake with a history of 4 million years.</td>
</tr>
<tr>
<td>Lake fish (②)</td>
<td>Lake Biwa is home to 47 native species, ranging from cyprinid, which prefer warmer waters, to salmonid, which prefer colder waters. 16 of them are endemic to the lake. Many of these fish species migrate to the rice paddies and rivers around Lake Biwa and use these waters as spawning grounds.</td>
</tr>
<tr>
<td>Sato (③)</td>
<td>An agricultural village located among rice paddies where people lead vibrant lives. People living in a Sato have dealt with various challenges, including floods, droughts and wars, appreciating nature, using water wisely, and coexisting with other living things.</td>
</tr>
<tr>
<td>Fish Cradle Paddy (④)</td>
<td>Rice paddies where round crucian carp and other lake fish migrate from Lake Biwa to spawn. These fish run up the water channels during the rainy season when the water level is high. The larvae and juvenile fish that hatch grow with a high survival rate and swim out to Lake Biwa on their own. This has led to the conservation of natural fishery resources. This coexistence of humans and fish is believed to have continued since rice paddies were first developed around the lake, 2,000 years ago. It is a practice distinguished from “Rice-Fish Culture (rice-fish farming system) (designated a GIAHS in 2005)”</td>
</tr>
<tr>
<td>Okazutori (⑤)</td>
<td>Catching fish for private consumption (for dinner). Fisheries conducted in between farm work.</td>
</tr>
<tr>
<td>Agro-fishery mixed livelihood (⑤⑥)</td>
<td>A lifestyle that pursues both fisheries and agriculture as livelihoods. From ancient times to the present, the self-sufficiency of carbohydrates (rice) and proteins (fish) has contributed to stable life.</td>
</tr>
<tr>
<td>Lake to land-focused environmentally sound agriculture (⑥)</td>
<td>Traditional farming style that has contributed to conserving the water quality and ecosystem of Lake Biwa through traditional drainage management, which has prevented soil runoff and helped maintain fertility of the farmland. It has nurtured biodiversity such as fishery resources of the lake, combined</td>
</tr>
</tbody>
</table>
with the Fish Cradle Paddies that are located in the lake to land-focused environmentally sound agricultural areas. Modern farming areas are distinguished from the lake to land-focused environmentally sound agricultural areas.

<table>
<thead>
<tr>
<th>Passive fishing method (⑦)</th>
<th>A fishing method that does not involve chasing after fish, but instead waits for the fish to come. These methods do not require fishermen to stay and constantly watch their fishing devices, and thus enable practicing agriculture and fisheries simultaneously.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eri (⑦)</td>
<td>A stationary fishing device, representative of all passive fishing methods. Fish are funneled through a path made with woven mats (su) or nets (ami) and into the pound at the end of the path where they are caught. Eri allows only a required amount of fish of the target size to be caught alive. A certain number of the fish that enter the trap find their way out. Eri fishing is a masterpiece of created based on traditional knowledge of the ecology and behavior of fish, the water flow, the topography of the lake basin, etc. Having been continued for more than 1000 years, the method is emblematic of Lake Biwa fisheries.</td>
</tr>
<tr>
<td>Secondary nature (⑧)</td>
<td>Nature that has been preserved through human intervention.</td>
</tr>
<tr>
<td>Satoumi (⑧)</td>
<td>The secondary nature of the area around Lake Biwa that has been formed as a result of traditional livelihoods, including paddy agriculture, <em>eri</em> fishing and reed crafts. Such secondary nature has formed the landscape and lakescape unique to the Lake Biwa region that has achieved food and material production, as well as the conservation of biodiversity and resources for more than 1000 years.</td>
</tr>
<tr>
<td>Narezushi (⑨)</td>
<td>A preserved food made by pickling fish by lactic fermentation. The fish is placed in cooked rice. Narezushi does not spoil even during hot and humid summers and can be preserved for a long time. The local people have prepared narezushi with various types of fish and it has been used as offerings to the gods or to welcome guests.</td>
</tr>
<tr>
<td>Funazushi (⑨)</td>
<td>An emblematic type of narezushi made with round crucian carp with a history of more than 1,000 years. By pickling fish in rice for 6 to 24 months, the fish is softened to the bones and develops a rich savor. Highly nutritious, <em>funazushi</em> has also been used for nourishment.</td>
</tr>
<tr>
<td>Sakana-kuyou (⑩)</td>
<td>A ritual to thank and console the spirit of fish, originated in the internal debate over taking the life of a fish. Safe sea travels are also prayed for.</td>
</tr>
</tbody>
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Description of the Agricultural Heritage System

1 Global Significance of the Proposed GIAHS Site

Traditional inland fisheries in Lake Biwa, which have developed along with paddy rice farming, play a central role in the “Biwa Lake to Land Integrated System.” The system is centered on traditional eri fishing dating back over 1,000 years that has been passed down across generations by the local people. The Lake Biwa region has traditionally strived to use freshwater resources sustainably, and it currently supplies vital drinking water to 14.5 million people living in the watershed area (including Kyoto and Osaka, not covered by the proposed site).

The local people have nurtured rich biocultural diversity through historical interaction between an ecosystem embracing fish and a culture founded on agriculture. They have passed down to modern times traditional resource-friendly fishing methods, social structures for resource conservation that have continued from the medieval period, paddy agriculture practices that provide safe spawning areas for lake fish, and food culture[1].

Lakes being inland bodies of water, are vulnerable due to their closed nature. Once the water quality or ecosystem becomes unbalanced, it is difficult to recover the original state and conservation efforts are not politically appealing. Around the world, many lakes are challenged with serious water quality issues.

Areas surrounding Lake Biwa have become urbanized and the area has been challenged with various issues, including eutrophication, feeding damage by alien invasive species and reduced catch. However, since the 1970s, citizens and experts have joined producers in directly dealing with promoting the pursuit of both agriculture and fisheries, as well as conserving the local ecosystem and water quality.

It should be particularly noted that traditional knowledge and spiritual culture have been passed down and integrated with modern measures to enhance sustainability. Some examples include organizational efforts made by fishermen in resource conservation, rice paddy agriculture contributing to water quality conservation, and water source forest conservation involving downstream areas and local residents. The proposed site is home to a self-governance system originating in village community traditions that has evolved into its modern shape.

These social initiatives along with human ties and rules have led to building social capital and enabled us to: pass down across generations traditional local knowledge and practices, conserve biodiversity, supply water resources and promote international collaboration.

![Photo 1-1  Eri fishing in the morning haze](image)
Details of the significance of the proposed system are elaborated in the following sections, and its relevance to the five criteria for GIAHS designation are described in depth:

1.1 Mechanism and Historical Background of the proposed system
1.1.1 Climate of the Lake Biwa Region
1.1.2 Mechanism of the System
1.1.3 Origins of the System
1.1.4 About the Proposed Designated Area

1.2 The Global Significance of the proposed system
1.2.1 Threats to Inland Fisheries in the World and Responses of the Food and Agriculture Organization (FAO) of the United Nations
1.2.2 Characteristics of the System
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      (Multi-tiered resource conservation by various small communities)
   ii Management of Fishery Resources and Conservation of Breeding Environments
      (Management of Fishery Resources)
         〈Part I〉 Restrictions and Regulations on Fishing Catch
         〈Part II〉 Fishing Rights Governed by Fishermen Organizations
      (Management of Lake Fish Breeding Environments)
         〈Part I〉 Paddies as the Spawning Grounds
         〈Part II〉 Participation of Diverse Actors for the Conservation of Water Quality and Ecosystem
1.2.3 Importance of the System in a Contemporary Context
   (Supplying Food to the Region)
   (Strong Female Participation and Intergenerational Continuity)
   (Creating Environmental Business)

1.3 Efforts in Collaboration with Various Partners in the World
1.1 Mechanism and Historical Background of the proposed system

1.1.1 Climate of the Lake Biwa Region

Located at the center of the Japanese archipelago, at the easternmost edge of the Asian Monsoon System, Lake Biwa is a closed body of water in the center of the Oumi Basin (figure 1-1), with 460 rivers flowing in and only one river flowing out. The Lake Biwa is a globally significant ancient lake formed by tectonic shifts 4 million years ago. To date, 2,300 species (including subspecies and taxa) have been reported to inhabit Lake Biwa and its surrounding areas [2]. The diverse local fauna and flora have nurtured a rich local culture [3]. To be specific, the geographic feature, biological feature and a social and cultural local feature are as follows:

The geographic feature of the Lake Biwa catchment area is that it resembles a mortar, with all of the water running from surrounding rice paddies and forest flowing into Lake Biwa, situated at the center of the basin (figure 1-2). This causes the following vulnerabilities:

- It takes approximately 4.7 years for the lake water to be renewed; and therefore, it is difficult to recover the water quality once it is contaminated.
- Running down steep slopes, the rivers are short; and therefore, the site is prone to flood and drought.

Biological features include the presence of anadromous fish that migrate upstream from the lake to surrounding rice paddies and water source forests. The southern Cyprinidae that spawn in the rice paddies in springtime, and the northern Salmonidae, which spawn in the rivers in autumn, both inhabit Lake Biwa. It is home to a diversity of fauna and flora. Sixteen of the 47 native fish species are endemic to Lake Biwa.

Furthermore, a social and cultural local feature is that people have developed a social system in the catchment area of Lake Biwa where they catch these fish and at the same time conserve the water and ecosystem and mitigate natural disasters. In the last century, the
catchment area of Lake Biwa is experiencing high population growth and urbanization, with the population living in the catchment area increasing from 600,000 people to 1.4 million people.

Hence, the lake, rice paddies, rivers and forest have formed an integrated bioregion, where people have formed a “lake to land integrated system.” This system is built on the local history of developing catchment-based social networks that date back to more than one thousand years ago. These social networks together formed a politically united area which led to the establishment of the wider local authority, “Shiga Prefecture.”

1.1.2 Mechanism of the System

In Lake Biwa, often referred to as a "reservoir of freshwater fish," many fish migrate to different areas of the lake, seasonally or in accordance with their stage of growth. Many fish spend their maturity in the deep offshore areas, but stay in the lakefront reed bed areas and rivers, closer to areas of human livelihood, during their early development stages, and to spawn. Traditional local fishing methods have developed for more than twenty fish species, including endemic species, based on such traditionally accumulated knowledge. These methods involve strategically setting fishing gear at points where fish are likely to pass.

One of the most well-known traditional fishing methods is eri fishing, which is still practiced in approximately 100 spots today. This method allows fishermen to catch only a required amount of fish of a certain target size, alive. The literature provides evidence of not only eri fishing practices but also local rules on fishery resource conservation agreed upon among fishermen that date back to as far as the 13th century. This traditional social mechanism has continued to evolve until modern times, contributing to the enhanced sustainability of fisheries in Lake Biwa. Measures include limiting
the setting of *eri* fishing gear in order to control competition over catch, organizationally sharing fishing rights and establishing no-take zones.

Passive fishing methods, of which *eri* fishing is a typical example, have developed through close interaction with paddy agriculture. Since paddy fields were first developed close to the lake, lake fish species, such as the round crucian carp (*Carassius buergeri grandoculis*), have come to the paddies through water channels to spawn; and thus, traditional passive and stationary fishing methods developed so that farmers could catch fish before and after their daily farm work. These paddies and water channels maintained by farmers have continued to provide safe spawning sites to date. Therefore, the traditional co-existence of humans and fish is a heritage that has been passed down to modern times. Paddy fields not only bear the function of growing staple rice, but also constitute a part of the lake fish habitat, thus contributing to conserving fishery resources.

*Eri* fishing and paddy farming, together have formed a unique landscape and lakescape over many hundreds of years. A unique and traditional preserved food culture of fermenting various types of lake fish in rice has also developed, taking advantage of both the rice and fish provided by the local environment. The preserved food is called *narezushi*, which includes the local *funazushi*. The wide variety of fishes are used to make *narezushi*. *Narezushi* is served at traditional festivities held by local communities and contributes to forming the human ties that serve as the foundation of the local social system.

Such practices are supported by the traditional local system of conserving water quality and ecosystem as well as preventing floods and droughts. Under this system, the local people have used and conserved the reed bed along the lake shore, engaged in agricultural drainage management that prevent soil runoff and the degradation of water quality and afforestation efforts in mountain forests to prevent floods and droughts.
1.1.3 Origins of the System

The proposed system dates back to the Yayoi period (BC300-AD300). There is archeological evidence of paddy development around Lake Biwa. Since water channels connected these paddies with Lake Biwa, when the rainy season came and the water level rose, lake fish (such as the round crucian carp) would travel upstream into the paddies to spawn, passing through the reed beds where they originally laid their eggs. The water being warmer in the paddies compared to Lake Biwa, higher concentrations of plankton were created, thus boosting the survival rate of the fish. The paddies provided ideal breeding grounds for lake fish.

People devised passive and stationary fishing gear to catch lake fish swimming towards the paddies while they worked in the fields. This method of paddy fishing, called okazutori (literally translated as “main dish catching”), led to the local agro-fishery mixed livelihood, enhancing the stability of self-sufficiency. Experimenting with various fishing methods in the waters near their paddies, people found the most efficient method to be eri fishing, which is mentioned in waka poetry from 1,000 years ago. Eri is a fishing method based on traditional knowledge, compiled across generations, of changes in the water flow that occur as a result of the geographical features of the lake floor, as well as on the ecological characteristics of various fish species (Photo 1-11).

Eri were initially placed close to the reed beds but were extended offshore, in response to increasing demand for lake fish and to local food culture needs that called for the early capture of fish with roe. The fishing gear became larger and more complex in order to land more fish, enabling people to catch a wide variety including Biwa salmon, which migrate offshore.

"Sasakizu ni sugakisa hoseri haru goto ni, eri, sasu tami no shiwaza narashimo" (A waka poem about fishermen drying eri mats on a sunny day in early spring on the lakefront in present-day Omihachiman City)

By poet Yoshitada Sone of the mid-Heian era (the 10th century)
On the other hand, paddy fields spread inland with drainage management that reduce soil runoff while having difficulties to secure water supplies. Besides, the rice produced in these paddy fields was used to ferment the landed fish for preservation. The traditional delicacy funazushi also has been recognized as the prototype of Japanese Sushi [7], and has a history of more than 1,000 years, as confirmed by documentation in detailed enforcement regulations of the Ritsuryo Codes from the Heian period (Engishiki, completed in 927AD). Along with narezushi made from other types of fish, it has been offered to guests for dinner or as a gift, and to the Gods as offerings at festivities.

A document from the 9th century (Daijoukanpu (an official document of the Daijokan sent to local governments) dated October 26, 883 [Genkei 7]) reveals that the imperial court required the offering of fishery products as tribute. In addition, there were government offices called “Mikuriya” on the east and west coasts of Lake Biwa (currently Chikuma, Maibara City and Wani, Otsu City, respectively) from which officials offered fishery products as tribute to powerful shrines in the capital city of Kyoto [8].

According to this document, the eri used for funding offerings for the shrine was damaged, so the shrine and villages decided to stop the villagers’ eri and set up another eri to catch fish for offerings. However, residents of a neighboring village cut the nets, so the shrine filed a case and summoned both parties, and the neighboring village admitted to cutting the eri.
Additionally, animal killing was prohibited based on Buddhist teachings. Therefore, no-take zones were established and rites were held for fish. In addition, at latest in the 13th century, increasing competition over fishing grounds had led to dispute over catch from *eri* fishing [8].

By the Edo period (17th to mid-19th century), the setting up of new *eri* and the extension of existing fishing gear were restricted, leading to the establishment of a social system for the autonomous co-management of *eri* by each village, laying the groundwork for developing the local social system as we know it today, including fishermen’s organizations [9].

After the Meiji Restoration (1868), comprehensive regulations on resource conservation and fisheries control in Lake Biwa were established: regulations and taxes on fishing, collecting seaweed and collecting dirt from the lakes and river (1874); and the Shiga Prefecture fisheries regulations (1908). Today, fishery workers and the government jointly engage in resource management based on scientific survey results. Because Lake Biwa is an enclosed water area and not an ocean, the local order established in the Edo period (17th to mid-19th century) has been maintained relatively strongly in the area. Therefore, management by family-owned small-scale fisheries and community-led fishery rights management has continued to be passed down from generation to generation, even after the Fishery Laws was established in 1903 [9] without local fishery management being exposed to modern investment of external capital or pressures for enlargement.

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**Photo 1-17**
1903 application for an *eri* fishing license for a combination of *eri* nets and *eri* mats. The mesh size of the nets and mats are indicated, implying the local awareness of protecting juvenile fish.
The mountain forests at the water source of Lake Biwa faced increasing deforestation from the Edo to Meiji periods (17th to 19th century). Given the low water retaining capacity of the granitoid mountains surrounding Lake Biwa and the short extent of rivers, the area was challenged by frequent flooding of the rivers and inundation of the entire lake area, which caused great damage to the farming and fishing villages, as well as drought in the rivers, which was devastating for the lake fish that breed in the rivers. Thus, since the late 19th century to the present, local residents have been engaged in greening the mountains and conserving the waters source forests. These efforts have led to recharging Lake Biwa’s water source and stabilizing the water volume in the rivers, consequently contributing to conserving the breeding grounds of lake fish that migrate upstream from the Lake Biwa to spawn.

During the high economic growth period of the 1970s, when fishermen, or the “Guardians of Lake Biwa” who come in contact with the waters of the lake daily, reported freshwater red tide [10], this drew attention to eutrophication issues. Pioneering public campaigns to use soap instead of synthetic phosphorus detergents led to the enactment of the Ordinance Concerning the Prevention of Eutrophication of Lake Biwa (enacted by Shiga Prefecture in 1979), based on which reduced fertilizer use and measures to treat agricultural wastewater were promoted in the agricultural area surrounding Lake Biwa. Efforts have been supported by traditional water quality conservation measures, such as purifying domestic draining through coexistence with lake fish and engaging in agricultural practices that reduce the outflow of muddy waters.
Later, amidst challenges such as decreasing catch due to an increase in invasive alien fish species, the area launched a certification system of Lake to Land-Focused Environmentally Sound Agricultural Produce to support farmers’ further efforts, such as reducing the use of agrochemicals and chemical fertilizers by 50% in addition to traditional drainage management, giving added value to the certified produce (figure 1-3). In the procedure, farmers submit farming plans. Prior to harvest, the prefectural government verifies production records and farming sites, and provides the certification. In 2003, Shiga Prefecture enacted the Ordinance Concerning the Promotion of Lake to Land-Focused Environmentally Sound Agriculture, and village-based system for agricultural discharge management were also promoted.

Various parties, including consumers as well as agricultural and forestry workers, have been engaged in trial and error to develop these initiatives, which bear significant meaning in passing down traditional practices, such as fisheries in Lake Biwa. They are supported by the social ties reinforced through the local food culture and festivities centered on lake fish and the shared spirit of "Coexisting with Lake Biwa." These efforts resulted in the legislation of the “Law Concerning the Conservation and Restoration of Lake Biwa” in 2015. The law includes measures to conserve the proposed system, such as the promotion of the proper management of fishery resources and fisheries, the prevention of water contamination attributable to agriculture, the management and conservation of water source forests, and the promotion of partnership among stakeholders.

The following figure illustrates the historical timeline of the system and the origin of the main practices.
Figure 1-4  Historical timeline of the system

Historical timeline

Yayoi period (BC300-AD300)
- Development of rice paddies closely connected to Lake Biwa (Expansion of the water body)
- Lake fish migrate upstream to paddies from Lake Biwa to spawn (Beginning of Fish Cradle Rice Paddies)
  - Fishing alongside farming

Kofun period (around 3rd-7th century)
- Development of passive fisheries
- Spread of rice paddies inland with drainage management, preventing soil and nutrient runoff

Around 10th century
- Fermentation and preservation of lake fish in rice
  - Thanksgiving for blessings
  - Offerings to the Imperial court and shrines in the ancient capital of Kyoto
- Establishment of no-take zones based on Buddhist teachings prohibiting the killing of animals
  - Restrictions on setting up eri to address conflicts over fishing grounds
- Imposition of taxes based on determination of borders
  - Small-scale local resource management, including village-based eri management

Around 13th-18th century (Medieval times)
- Planting mountain forests to prevent floods and droughts that affect farming villages, fishing grounds and lake fish spawning grounds

19th century
- 1970s
  - Red tide outbreak
    - Citizen-led campaigns for restoring water quality
    - Ordinance Concerning the Prevention of Eutrophication of Lake Biwa
  - 1980s
    - Establishment of World Lake Conference
  - 1990s
    - Extraordinary increase of invasive fish species and aquatic plants

20th century

Traditional practices that have been passed down to modern times

Environment-friendly farming practices using aquatic plants as compost
- Lake fish breeding in rice paddies (coexistence of humans and fish in rice paddies)
- Agro-fishery mixed livelihood
- Lake Biwa fisheries centered on eri fisheries
- Lake to land focused environmentally sound agriculture that prevent eutrophication
  - Food culture and festivities in which narezushi is offered to the gods
    - (fear of nature, spirit of valuing water and living creatures, fostering human networks)
  - Restrictions on catch for resource conservation
  - Organizational management of eri (common fishery rights)
  - Water source forest conservation (participation of fishermen, local residents, companies, downstream organizations)
  - Resolution of challenges based on the participation of citizens and experts
    - (partnership between producers and consumers)
    - Promotion of lake to land focused farming
    - Measures to address invasive species
    - International partnerships
1.1.4 About the Proposed Designated Area

The proposed designated area is limited to the following areas that inherit the Biwa Lake to Land Integrated System. (see the proposed designated area on page 5.)

○ Lake Biwa
  Home to traditional fishing methods targeting migratory lake fish, which have function as effective means for resource conservation.

○ Lake to land-focused environmentally sound agricultural areas
  Agricultural lands that have contributed to conserving the water quality and ecosystem of Lake Biwa through traditional drainage management, which has prevented soil runoff. It has nurtured biodiversity such as fishery resources of the lake, combined with the Fish Cradle Paddies that are located in the lake to land-focused environmentally sound agricultural areas.

○ Water source forest conservation areas
  Upstream areas where lake fish migrate and where local residents and downstream organizations have participated in the traditional water source forest conservation to prevent floods and droughts and to protect the spawning grounds of lake fish as well as preserved fish-breeding forests. These forests cover 8.5 percent of total water source forests of the catchment area of Lake Biwa.

Note: Modern farming areas and general water source forests that do not positively contribute to the proposed system, and urban areas are eliminated from the proposed designated area, even though the entire catchment area compose an integrated bioregion [11].

In particular, the relationship between Lake Biwa and rice paddies and forests are described as follows:

<Relationship between Lake Biwa and surrounding rice paddies; defining the proposed designated site>

As a result of the geographic features described above, the water discharge from the rice paddies in the catchment area flow into Lake Biwa. The traditional drainage management settles and holds soil inside the paddy field. It prevents nutrient runoff, which has contributed to conserving water quality and ecosystem, preventing eutrophication of the lake that is located downstream in the bowl-shaped basin.

The traditional function of plot to plot irrigation, which drains relatively clear upper water from paddy field to paddy field, has been developed in the "culture of..."
not letting contaminated water flow downstream" in the region and has been passed on to drainage management using water stoppage boards and shallow soil paddling.

Traditional practices, such as the village practice of raising mud out of channels and using water plants of the lake as fertilizer in farmlands, have also been passed down to the present day, contributing to the conservation of the lake's water quality and ecosystem. These practices also help maintain fertility and reduce the use of chemical fertilizers. Frequent meetings and close communication in agricultural communities contribute to handing down the traditional knowledges. (refer to p. 83) Besides, the traditional drainage management is practiced in the Fish Cradle Paddy as well.

These traditional practices have been passed down in the lake to land-focused environmentally sound agricultural areas. The area covers approximately 66 percent (342 km²) of total agricultural lands in the Lake Biwa basin. In contrast, we have excluded modern farming areas (175km²) from the proposed designated site.

<Relationship between Lake Biwa and surrounding forests; defining the proposed designated site>

Forests in the Lake Biwa catchment area are all water source forests of Lake Biwa, due to the geographic characteristics described above. Lake fish migrate upstream towards the cool water flowing out of the water source forests and local fisheries target the lake fish. While water source forests cover a vast area of approximately 2,000km² in total, only forests feature the proposed system have been included in the proposed designated site (Figure 1-5).

These forests (169km²) meet both of the following conditions or are preserved fish-breeding forests that provide sunshade, insects and the carbon source of the food web along the coast. (refer to pp.51, 88-89, 96-101)

(Conditions)

・ The forest is located in the water source area of Lake Biwa’s inlet rivers where lake fish migrate upstream and spawn and where local fisheries are continued.

・ Water source forest conservation activities initiated over a century ago (in the late 19th century) to prevent floods that damage villages and fishing grounds and mitigate dry spells that will inhibit the upstream migration of lake fish and cause droughts have been passed down to and continue to be conducted with the participation of local residents and downstream organizations.
1.2 The Global Significance of the proposed system

1.2.1 Threats to Inland Fisheries in the World and Responses of the Food and Agriculture Organization (FAO) of the United Nations

Inland fisheries play an important role in providing food, employment, and supporting culture throughout the world. To date, the global fishery issues have been mainly focused on marine fisheries, but inland fisheries are an essential source of nutrition for hundreds of millions of people [12].

Amid rapid population growth, the demand for inland fisheries is increasing in the world (Figure 1-6), thus posing a risk of freshwater resource depletion. Some human factors contributing to these threats are overfishing, the improper management of fishery resources, and water contamination and eutrophication caused by the wastewater from agricultural land that have increased production in response to population growth. However, these problems are not fully acknowledged by the general public, partly due to the complexity of the interacting factors [13].

The depletion of fishery resources induced by growing demand has become a serious issue for inland and coastal fisheries in the world. While governments have made efforts to establish resource management systems for the conservation and sustainable use of resources [17], few have been successful. Lakes and marshes, which are enclosed waters areas, are particularly vulnerable inland waters, easily affected by human living. The inflow of sediment due to soil erosion in the river basin, overfishing, invasion by alien species, and water contamination tend to make fishery resources prone to depletion [15].

Furthermore, traditional fishing methods that resemble eri fishing previously seen in many other areas in Japan have disappeared, as few other areas embraced the abundance of fishery resources and consumption level seen in Lake Biwa.

In 2015, in response to global threats to inland fisheries, FAO held the Global Conference on Inland Fisheries, where participants confirmed the various universal problems concerning the value of inland fisheries and threats to their sustainability. Given the status of insufficient data collection and resource management, conference participants shared the acknowledgement that information on fishery management based on scientific evidence, inter-sector collaboration on water use and water resource management are important [18].
1.2.2 Characteristics of the System

While global inland fisheries are challenged with increasing threats, the proposed system bears the following characteristics based on the abundance of historical materials and many academic studies in archeology, history, and folklore conducted in this region.

i Sustainability of the proposed system

(Food and livelihood security through agro-fishery mixed lifestyles and inheriting the local food culture)

The origin of the Biwa Lake to Land Integrated System’s resilience lies in the traditional agro-fishery mixed livelihood. This occupational integration has contributed greatly to the local food and livelihood security through self-supplied carbohydrates (rice) and protein (fish), nutrients essential for humans to live. Furthermore, even if the rice paddies were flooded as a result of the rising waters in Lake Biwa, the local people could catch fish in their paddies.

Furthermore, festivities that use lake fish, which were traditionally caught in this way, have contributed to strengthening the local human network and passing down and preserving the local food culture.

(Multi-tiered resource conservation by various small communities)

The social structures which people have traditionally built for resource and water quality conservation also serve as foundations for resilience. The traditional community-based joint management of *eri* and agricultural discharge management are examples of local self-governance. Such social structures are exist around Lake Biwa at multiple levels, leading to the resilience of the entire Biwa Lake to Land Integrated System.

Today, given advancements in urban development, such traditional structures have been reorganized into modern systems to securely promote water quality and ecosystem conservation.

Such social structures are supported by the local water-oriented culture. Household accessible water (Photo 1-23) is an example of traditional water conservation system that continue to allow coexistence with lake fish today. Other activities seeking to live in harmony with nature include engaging adults and children in looking for fireflies to check the local water quality.
Management of Fishery Resources and Conservation of Breeding Environments

As mentioned above, countries are need of measures for the sustainable use of fishery resources. The proposed system features a policy mix of traditionally developed resource conservation measures led by fishermen and ecosystem conservation measures taken by various actors, including consumers and farmers, against the backdrop of forests, sato and lake interlinked by water [20]. The system also follows the eight principles of a “self-organized system,” as described by Professor Ostrom (Understanding Institutional Diversity, Princeton University Press, 2005), awardee of the Nobel Memorial Prize in Economics in 2009. While in the US and Europe, fisheries management methods often consist of quotas set by fish species, the proposed system is a method where fishermen follow traditional practices in managing fishing methods and fishery rights. The participation of consumers in ecosystem conservation makes the system unique.

Part I Restrictions and Regulations on Fishing Catch

In Lake Biwa, fishermen organizations have led the implementation of restrictions on fishing methods and techniques and establishment of no-take periods and zones with regard to the spawning season. Through collaboration with government and research institutions, fishermen organizations have formulated more effective rules, and by enforcing them, they have succeeded in increasing catches of important endemic species, such as round crucian carp and Honmoroko. This corresponds to co-management by fishermen and the government [21], which is acknowledged as indispensable in global fisheries, and to resource management based on scientific evidence, as emphasized at the FAO Global Conference on Inland Fisheries. At the same time, these practices compose the social order that had taken root by the Edo period (17th to 19th century) and have been passed down to the present.

Rules for setting up eri developed as disputes emerged over catch [18], and no-take zones were established based on Buddhist teachings that ban the killing of animals [19].

Part II Fishing Rights Governed by Fishermen Organizations

From before the Edo period, frequent competition for fish catch over eri fishing in Lake Biwa led to the development of a system where exclusive fishing rights were possessed and managed communally by the local communities. Membership of these community bodies gave individual fishermen the rights to use and make profits from the lake resources, while overfishing was prevented through the practice of mutual monitoring [22][23]. American
Professor Elinor Ostrom, co-winner of the 2009 Nobel Memorial Prize in Economics, proposed the principle of “self-governance not by the state or by the market but by internal parties” as an effective method of conservation and management of common-pool resources (CPR) [24] in 1990 and presented the concept of the aforementioned “self-organized system” in 2005. The management of the eri fishing has almost corresponded to the eight principles that Professor Ostrom offered [23]:

- Define clear group boundaries.
- Match rules to local needs and conditions.
- Ensure that those affected can participate in modifying the rules.
- Develop a system for monitoring members’ behavior by community members.
- Use graduated sanctions for rule violators.
- Provide accessible means for dispute resolution.
- Make sure the rule-making rights of community members.
- Build responsibility for governing the common resource from the lowest level up to the entire interconnected system.

The basic framework in Lake Biwa instituted during the Edo period for conservation and management of fishery resources has been inherited by Fishery Cooperatives (FC) today.

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The basic framework in Lake Biwa instituted during the Edo period for conservation and management of fishery resources has been inherited by Fishery Cooperatives (FC) today.

(Management of Lake Fish Breeding Environments)

(Part 1) Paddies as the Spawning Grounds

In many lakes around the world, agriculture has had negative effects on the ecosystem. However, around Lake Biwa, the rice paddies that people developed have provided optimal breeding grounds for important target fish such as the round crucian carp.

A similar system is “Rice-Fish Culture” [25], which was designated a GIAHS in 2005. This is a traditional rice-fish farming system in China, where people produce rice and simultaneously farm fish, which are traded among farmers with a focus on the color of the fish in order to maintain genetic diversity [26].

The distinctive difference between rice-fish farming and the proposed system is that the lake fish have themselves chosen rice paddies - created and maintained by humans - as their spawning and early breeding grounds. This has led to not only ecosystem conservation but also the conservation of natural fishery resources that are targeted in Lake Biwa fisheries. Where rice paddies were elevated for the purpose of sustainable paddy rice farming, the water level became lower in the channels; and therefore, farmers and consumers placed flashboards in the channels to help lake fish travel upstream to spawn.
This practice has contributed to maintaining the paddy fields and water channels that offer spawning grounds for lake fish. (refer to pp.45-50, 74-75)

In the proposed system, farmers have continued to offer the paddy fields and water channels as spawning and early breeding grounds for lake fish from ancient times. These paddy fields are called “Fish Cradle Paddies.”

\[\text{Photo 1-26} \quad \text{Fish swimming up to the paddies.} \]
\[\text{Photo 1-27} \quad \text{Round crucian carp laying eggs in the paddies.} \]
\[\text{Photo 1-28} \quad \text{Juveniles that grew in the paddies.} \]

\[\text{Part II} \quad \text{Participation of Diverse Actors for the Conservation of Water Quality and Ecosystem} \]

The initiatives for the conservation of water quality and ecosystem contributing to the conservation of lake fish breeding grounds evolved based on lessons learned from the eutrophication and other environmental issues faced in the 1970s. The participation of various actors has helped turn these initiatives into a multi-faceted effort for enhanced resilience.

These efforts are mainly based on traditional knowledges. For example, agricultural wastewater management to prevent soil runoff by farmers and local residents, the conservation of water source forests by forestry workers and companies, and measures against invasive alien fish species implemented jointly the government and residents led by fishermen, and the conservation of Lake Biwa reed beds led by companies and local residents.

The historically nurtured human ties have become more widespread and this system has generated a virtuous cycle based on trust and cooperation with people outside the region. This contributes to building social capital and the conservation of the water source supporting the lives of 14.5 million people in neighboring cities downstream, including Kyoto and Osaka.

\[\text{Photo 1-29} \quad \text{Shallow soil puddling} \]
\[\text{(measure against waste water)} \]
1.2.3 Importance of the System in a Contemporary Context

In addition to the features described above, the proposed system bears other functions: securing food and livelihood (e.g. supplying food to the region), contributing to improving wellbeing and quality of life (e.g. strong female participation and intergenerational continuity), and creating economic and ecological service (e.g. environmental business).

(Supplying Food to the Region)

Today, approximately 700 fishermen supply fishery products to the region by landing approximately 1,000 tons of catch annually. Furthermore, lake to land-focused agriculture supplies safe and reliable agricultural products, while also conserving the water quality and ecosystem.

(Strong Female Participation and Intergenerational Continuity)

Fisheries in Lake Biwa are primarily operated by family units, and fishing activities on the lake are commonly carried out jointly by married couples. Women also play an important role in processing the fisheries products.

Furthermore, the social ties that have been nurtured by a food culture based on the diversity of lake fish and by the use of such foods in festivities contribute to increased wellbeing and higher quality of life among people.

The local people, including children, enjoy many other opportunities to have a close relationship with nature through fishing experiences and observations of life in the rice paddies, as well as programs to learn about the lake, rice paddies and forests. This is important not only in terms of wellbeing, but also for the proposed system to be passed on to future generations.
One of the prime examples of economic and ecological services born from the proposed system is branding the rice grown in rice paddies that support upstream migration of lake fish. This measure ensures not only environmental but also economic sustainability.

Joint programs co-hosted by fishermen's cooperatives and the tourism industry are also available. Such programs include the popular funazushi-making workshop (sponsored by the local FC and tourism industry), ecotourism programs making use of the unique landscape and lakescape, and conservation of reed beds and water source forests supported by private companies.

### 1.3 Efforts in Collaboration with Various Partners in the World

Lake Biwa, which lies at the center of this system, has been called “the mirror that reflects our daily lives.” Even with 1.4 million people living in the catchment area, the Lake Biwa region endeavors to achieve true coexistence between human and nature, managing to conserve its water quality and ecosystem and passing down the proposed system centered on traditional fisheries across generations [11]. The system has continued to play the vital role of sourcing water to the 14.5 million residents (approximately 11% of the Japanese population) in the major cities of Kyoto and Osaka (urban areas downstream not covered by the proposed site). In 1984, Lake Biwa hosted the first World Lake Environment Conference (predecessor of the World Lake Conference which has been held 17 times) to address the challenges faced by lakes and inland fisheries worldwide. The region has endeavored to communicate the lessons learned in Lake Biwa and to join forces with international partners.

We are determined to continue to communicate the significance of coexistence between the ecosystem and humans in a freshwater area, engaging in further international partnership. (refer to pp.102-104)
2. Characteristics of the Proposed Site

The proposed system meets the five criteria of the GIAHS which are elaborated below:

2.1 Food and Livelihood Security

2.1.1 Fishery Products of Lake Biwa as Local Food
2.1.2 Status of Fisheries Catch and Operations
2.1.3 Food Processing and Partnership with other Industries for the Intergenerational Continuity of the Local Food Culture and Financial Sustainability
2.1.4 Agricultural Production Based on “Lake to Land-Focused Environmentally Sound Agriculture” that Contributes to the Conservation of Lake Fish Breeding Grounds

2.2 Agro-biodiversity

2.2.1 Diversity of Endemic Fish and Other Fisheries Target Species in Lake Biwa
2.2.2 Native Fish Species that Connect Lake and Land
2.2.3 Diversity of Agricultural Products
2.2.4 Conserving the Ecosystem and Fishery Resources

2.3 Local and Traditional Knowledge Systems

2.3.1 Eri Fishing, Continued Across Generations for over 1,000 years
2.3.2 Social Structures for Fishery Resource Conservation and Fisheries Control Dating Back to Before the Edo Period (1603-1868)
2.3.3 Human Activity in the Reed Beds

2.4 Cultures, Value Systems, and Social Organizations

2.4.1 Traditional Lake-Fish Oriented Food Culture
2.4.2 Festivities Using Lake Fish that Contribute to Strengthening Community Ties
2.4.3 Participation of Diverse Actors for Improved System Sustainability

2.5 Landscapes and Seascapes Features (including Lakescapes)

2.5.1 Leading Landscapes and Lakescapes
2.5.2 History of Landscape and Lakescape Development
2.5.3 International Relevance of the Landscape and Lakescape and the Messages Communicated
2.1 Food and Livelihood Security

Around Lake Biwa, fisheries, particularly traditional *eri* fishing, which provides animal proteins important for the local people, have been passed down through small-scale, mostly family-operated fisheries to present times, supporting the livelihoods of fishermen. Furthermore, as diets diversified with economic globalization, the local people have sought to secure food and livelihoods for future generation by passing down the food culture, collaborating with other sectors, and fostering successors.

In the area around Lake Biwa and its vicinity, people have been engaged in agriculture that is friendly to the water and ecosystem that support the lake fish, contributing to the continuation of the system while supplying safe and reliable agricultural products, notably rice. A tax program has been introduced to promote community collaboration towards conserving the water source forests of Lake Biwa and maintain the breeding grounds for the lake fish that swim up the rivers for spawning.

Details will be discussed in the order provided below:

2.1.1 Fishery Products of Lake Biwa as Local Food
2.1.2 Status of Fisheries Catch and Operations
2.1.3 Food Processing and Partnership with other Industries for the Intergenerational Continuity of the Local Food Culture and Financial Sustainability
   (Food Processing by Fishermen and the Significant Role of Women)
   (Partnership with Fishery Product Processing Businesses)
   (Partnership with the Tourism Industry)
2.1.4 Agricultural Production Based on “Lake to Land-Focused Environmentally Sound Agriculture” that Contributes to the Conservation of Lake Fish Breeding Grounds

Photo 2-1-1  Beautiful scenery of a fishing port where colorful nets are neatly dried. The fishing nets are colored to protect them from dirt (Oki Island, Omihachiman City)
2.1.1 Fishery Products of Lake Biwa as Local Food

The fishery products of Lake Biwa have been an important source of protein for the local people. A survey by Shiga Prefecture conducted in January 2018 revealed that 40% of the 319 respondents eat fishery products from Lake Biwa once or twice a month, with one fourth eating fishery products from Lake Biwa once or twice a week.

It is often said that the diversification of the diet has decreased fish consumption among the Japanese people, but Lake Biwa continues to provide a variety of fisheries products today. Local fishermen, fisheries processing businesses and restaurants jointly promote the local lake fish that symbolize the blessings of Lake Biwa and are engaged in efforts to have more people savor them.

The lake fish is also used in the school lunch served at elementary schools in Shiga Prefecture, for example on “Furusato (=hometown) School Lunch” day, to offer the children who will lead the next generation an opportunity to taste the blessings of Lake Biwa. On days when lake fish is served for lunch, local fishermen are invited as guest lecturers to talk about local fisheries and lake fish.

Lake Biwa has also traditionally shared strong ties with Kyoto as a market for the lake fish, and some stores in Nishiki Market, known as the “Kyoto’s kitchen,” still sell fish caught in Lake Biwa.
2.1.2 Status of Fisheries Catch and Operations

In 2016, fisheries production in Lake Biwa amounted to a total of 1,138 tons (Ministry of Agriculture, Forestry and Fisheries, Statistics on Fishery and Aquaculture 2016). Fish alone (excluding shrimp and shellfish) accounted for 1,009t. Changes in annual catch are shown in Fig. 2-1-2. About 2,000t were consistently caught each year since the end of WWII, peaking at 3,701t in 1983. However, since the 1990s, fisheries catch has followed a decreasing trend, dropping to around 1,000t, the level at which recent catch has drifted. The causes of this decrease varies among different species, with some attributable to feeding damage by alien species and a decrease in spawning and breeding sites due to the drying of wet paddies.

The majority of fisheries operations are small-scale and family-based and do not target a single fish species. Local fisheries have been sustained as a livelihood by fishing for different species depending on the season, simultaneously practicing agriculture to achieve self-sufficiency in food, and sharing the work on the fishing boat between husband and wife.

According to the most recent fisheries census (2013), there were 530 entities engaged in fisheries in Lake Biwa (operating at least 30 days per year). Only 62 fishery management entities were organizations, while 468 entities, or 90% of the total, were independently managed. Furthermore, approximately 65% of individual fishery management entities simultaneously run farms or other secondary businesses. The high rate of farmers who are also fishermen is characteristic of fisheries in Lake Biwa, where small-scale fishery management for okazutori,
coupled with farming, has contributed to the conservation of the fishery resources. The average household income of such fishermen are estimated to be 2.5 – 3.0 million yen annually, with around 2.0 million yen (66-80%) coming from fisheries (based on interviews with fishermen).

Six hundred eighty-seven individuals are engaged in fisheries (at least 30 days per year), but the number of workers aged over 65 has been on the increase, accounting for approximately 60%.[27]

In 2016, total fisheries catch in Lake Biwa was worth 760 million yen, with the average catch and average revenue per enterprise estimated to be 2.15t and 1.44 million yen, respectively (based on calculations using the fisheries catch volume and value reported by the Shiga Prefecture Federation of Fishery Cooperatives in 2016 which were 738t and 493.8 million yen, from which the per kilogram value of 669 yen can be derived). In reality, revenue greatly varies among entities.

Against this backdrop, orientations and training programs are offered to foster successors of Lake Biwa fisheries.

Since ancient times, fisheries have been passed down from parent to child, but due to changes in lifestyle associated with rapid economic growth and the aging of society accompanied by low birth rates, fishermen’s children do not always choose to take over the family profession. In contrast, there has been a growing interest among young adults from urban communities in living in nature and in pursuing a life in harmony with nature, increasing the number of people who seek to become fishermen.

A fisheries training program was launched in 2016 to offer opportunities for people wishing to work in fisheries in Lake Biwa to learn as an apprentice to local fishermen about operating a fishing boat, fishing techniques, and living in a fishing village. Currently, young men in their 20s and 30s who participated in this program are going through further training to acquire the skills required to become independent fishermen who will lead the future of Lake Biwa.

Table 2-1-1
Number of fishery management entities and sales amount

<table>
<thead>
<tr>
<th>Sales amount</th>
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<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 yen</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>~300,000 yen</td>
<td>115</td>
<td>149</td>
</tr>
<tr>
<td>~500,000 yen</td>
<td>61</td>
<td>67</td>
</tr>
<tr>
<td>~1,000,000 yen</td>
<td>88</td>
<td>63</td>
</tr>
<tr>
<td>~3,000,000 yen</td>
<td>123</td>
<td>97</td>
</tr>
<tr>
<td>~5,000,000 yen</td>
<td>73</td>
<td>72</td>
</tr>
<tr>
<td>~10,000,000 yen</td>
<td>88</td>
<td>55</td>
</tr>
<tr>
<td>10,000,000 yen +</td>
<td>32</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>592</td>
<td>536</td>
</tr>
</tbody>
</table>

Average sales 229 —

Source: Ministry of Agriculture, Forestry and Fisheries, Department of Statistics
Note: Approximately 100 yen is one U.S. dollar.

Photo 2-1-4  Fisheries training program (eri fishing)
2.1.3 Food Processing and Partnership with other Industries for the Intergenerational Continuity of the Local Food Culture and Financial Sustainability

While connections between producers and consumers are disappearing in other regions, the Lake Biwa community has encouraged fishermen to produce processed foods for direct sales and has promoted collaboration among Japan Agricultural Cooperatives (JA), fishery product processing businesses, and the tourism industry. Such efforts add new value that can lead to the development of ecotourism and contribute to passing down the food culture unique to Lake Biwa to future generations and to communicating the attractiveness of the local cuisine to a wide audience, as well as to strengthening the management resources of fishery management entities and ensuring local livelihoods.

(Food Processing by Fishermen and the Significant Role of Women)

In many locations around Lake Biwa, fresh lake fish and cooked foods, such as fish tempura and tsukudani (a preserved food made by simmering small pieces of fishery product, meat or seaweed in soy sauce, sugar and mirin), are sold directly to consumers at morning markets. The Fishery Cooperative (FC) and JA collaborate from time to time in similar initiatives, which are appreciated by many people from cities nearby, including Kyoto, Osaka and Kobe, as well as from neighboring areas.

Food processing and sales offer opportunities particularly for women from fishing villages who play a leading role in the community. Fisheries in Lake Biwa are commonly supported by couples who work together [28]. Women bear an especially important role in preparing the products for sale and catering boxed lunches.

Women who engage in fisheries go out to the lake with the men and land the catch together. Once they return to the port, the women engage in processing fishery products and sales, while the men manage their vessels and fishing equipment. Women bear a large role in partnerships with the tourism industry and local revitalization projects. Women also perform farm work with the men in their agro-fishery mixed lifestyles.

Photo 2-1-5 Significant roles of women

Catching fish in eri fisheries (two women in center)  Landing fish in gill net fisheries

Cooking freshly caught fish  Selling processed fishery products
(Partnership with Fishery Product Processing Businesses)

On the lakefront, more than 90 small businesses process fishery products, providing local consumers with traditional delicacies, including funazushi, whose annual sales is estimated to be 460 million yen (according to a 2016 survey by the Shiga Prefecture Fisheries Division) and ebi-mame (a local dish made of shrimps cooked with soybeans). Some businesses have a history of 400 years; for example, a long-established store specializing in funazushi with distribution channels in Kyoto.

An association of fisheries processing businesses has developed a certification system for that food products made from fresh fishery products from Lake Biwa (photo 2-1-8).

(Partnership with the Tourism Industry)

Funazushi making is another example of hands-on workshops offered by the FC in collaboration with other industries. The number of participants is increasing every year, with some popular programs, such as the “Funazushi-making Workshop Cruise,” offered jointly by the FC and a travel agency.

Other programs include eri fishing tours and ecotourism-based boat tours that offer participants the opportunity of experiencing the food culture and livelihood unique to Lake Biwa, while improving the vitality of fishery management entities and ensuring livelihoods.
2.1.4 Agricultural Production Based on “Lake to Land-Focused Environmentally Sound Agriculture” that Contributes to the Conservation of Lake Fish Breeding Grounds

Lake to land-focused environmentally sound agriculture unique to the region has contributed to conserving the water quality of Lake Biwa and its ecosystem through traditional drainage management. It prevents nutrient runoff and contributes to maintaining fertility of the farmlands. Those farmlands cover 34,179 ha, approximately 66% of cultivated land in Lake Biwa catchment area.

In addition, further efforts are promoted with measures to create value-added produce for the sustainability. One is the “Lake to Land-Focused Environmentally Sound Agricultural Produce” certification program, and the other is “Fish Cradle Paddy Rice” certification program. Both of them contribute to the conservation of lake fish breeding grounds, developing traditional practices in the proposed designated area.

Lake to Land-Focused Environmentally Sound Agricultural Produce is certified on a total of 15,609 ha by reducing the use of synthetic agrochemicals and chemical fertilizers by 50% in addition to applying drainage management to prevent soil runoff, protecting the water quality and ecosystem of Lake Biwa [29].

There are approximately 6,565 agricultural entities (as of 2016) that participate in this initiative, of which 93%, or 6,120 entities are rice farmers, producing rice amounting to approximately 14.36 billion yen, which is approximately 2.4 million yen per entity. The rice grown as “Lake to Land-Focused Environmentally Sound Agriculture-certified rice” are sold at prices as high as 5% more than rice grown by modern farming. (see figure 1-3, p20)

In the scheme for helping fish run up to the rice paddies, pesticide and agrochemical use is limited to 50% or less that the level of use in modern farming. The use of chemical herbicides is also limited to those that have no negative impacts on aquatic plants and animals (fish and crustaceans). People work together to make fish passes (fish ladders) in the water channels by placing incremental panels to form a stair-like water passage to facilitate the upstream migration of lake fish. Rice paddies that participate in this scheme covered an area of approximately 130 ha across 24 regions in 2017, with the area varying from year to year, depending on circumstances such as crop rotation and precipitation.

Rice cultivated in these rice paddies certified as "Fish Cradle Paddy Rice" to give it value-added. It is currently sold at a premium price approximately 10% higher than rice from modern farming in order to reflect consumer demand for safe and reliable food. Fish Cradle Paddy Rice is also used to brew sake and to manufacture confectionery, and farming experience workshops and observations of life in rice paddies are hosted to encourage exchange among different actors. Furthermore, in addition to promoting green tourism and urban-rural exchange through welcoming school groups on excursions and foreign tourists, events to celebrate good harvests are held in distant cities such as Tokyo. These efforts contribute to
securing profits for the sustainability of farming practices and are attractive efforts as well for reinvigorating the region. (refer to pp.50, 87-88)

<Related practices>

In order to reduce degradation of the lake’s ecosystem and fisheries, various practices are employed in the proposed designated area. These practices are based on traditional knowledges and traditional community ties fostered to secure water as a common resource. Frequent social gatherings and the closeness of the network among neighboring communities have a significant role in the continuation of traditional practices and in the development of the lake to land-focused environmentally sound agriculture [30]. The Prefectural Ordinance Concerning the Prevention of Eutrophication of Lake Biwa and the Prefectural Ordinance Concerning the Promotion of Lake to Land-Focused Environmentally Sound Agriculture also help pass down those practices and efforts.

The main practices and efforts are as follows:

○ Water quality conservation: Prevention of eutrophication of the lake by preventing the runoff of nutrient-rich soil

(Other water quality conservation activities)

• Prevention of muddy water leaks from the paddy field by reinforcing raised footpaths between rice paddies and using water shielding sheets for the raised footpaths.

• Use of slow-release chemical fertilizers with controlled dissolution rates. (Reduction of chemical fertilizers)

○ Conservation of ecosystem: Securing habitats for a variety of aquatic organisms

(Other conservation activities)

• Installation of waterways in paddy fields

• Creating biotope paddy fields

• Installation of stone canals

• Planting ground cover plants to avoid the use of herbicides

• Using a mower to avoid the use of herbicides
Other ecosystem conservation measures

- In order to support the habitat of living organisms in the paddy fields, water stoppage boards are installed at the drainage outlets after the rice harvest to prevent the paddy fields from becoming too dry (moisture management).
- Release crucian carp and other parent fish into the paddies after rice planting and let the juvenile fish swim down to the lake.
- Effective use of local resources such as food waste compost and non-native fish.
- Organic farming

Awareness-raising: Sharing information and providing experiences based on traditional community ties (including nurturing the next generation)

For other details, refer to pp. 73-78 of the attachment of the proposal.

<Effects of efforts>

Outflow loads of nitrogen, suspended substances (SS) and synthetic agrochemicals are as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Total nitrogen (kg/day)</th>
<th>Total phosphorus (kg/day)</th>
<th>COD (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>2,241</td>
<td>119</td>
<td>5,231</td>
</tr>
<tr>
<td>2015</td>
<td>1,843</td>
<td>101</td>
<td>4,611</td>
</tr>
<tr>
<td>Reduction rate</td>
<td><strong>18.2%</strong></td>
<td><strong>15.1%</strong></td>
<td><strong>13.3%</strong></td>
</tr>
</tbody>
</table>

(Source: Seventh Biwa Lake Water Quality Conservation Plan, Shiga Prefecture and Kyoto Prefecture, 2017)
2.2 Agro-biodiversity

Agro-fishery mixed lifestyles not only brought stability to local life, based on rice and fish, but also enriched it.

In addition to rice varieties that are processed into mochi (rice cake) and sake, ancient varieties (red rice, black rice, green rice) are produced. Furthermore, other than the round crucian carp, various fish species, including the Biwa salmon, ayu, honmoroko, isaza, three-lips, are caught from season to season. People have enjoyed cooking the fish with local agricultural products. “Amenoio (Biwa salmon) rice” and ebi-mame (shrimp stewed with soy beans) are major examples. The local dinner table is rich with a variety of other local agricultural products, including traditional vegetables.

These local cuisines are supported by the local ecosystem and biodiversity. A great diversity of aquatic fauna and flora inhabit Lake Biwa, with approximately 1,700 species reported to date [31].

The distribution of organisms is concentrated in this area, where terrestrial and aquatic ecosystem exist, partially overlapping, with a number of animals and plants (including 12 submerged plants, 45 benthic animals, 35 fishes, and 24 bird species) classified under one of the four categories of the Ministry of Environment Red Lis.[2].

It should be noted that Lake Biwa, an ancient lake with a history of 4 million years, is home to 16 endemic fish species that have uniquely evolved in the diverse lakeside environment over a long period of time, and that these endemic species are included in the lake fishes caught in the local fisheries. Secondary nature, managed through human intervention, has contributed not only to cereal production but also conserving genetic and fishery resources, as seen in the endemic round crucian carp, which use the rice paddies around the lake as spawning grounds.

In addition to rice paddies that fosters biodiversity, reed beds that people utilized and conserved provide habitats for various organisms, including fishes and birds, bearing diverse functions, such as controlling lake shore erosion, conserving water quality, and supplying resources.

Based on the evidence provided above, the proposed system embraces diverse genetic resources deeply associated with fisheries and agriculture, and has conserved biodiversity despite population growth and urbanization in areas surrounding Lake Biwa, through water source forest conservation and agricultural practices that take water quality and ecosystem into
consideration. In this region, water and food have been secured and culture has been nurtured based on ecosystem services supported by biodiversity.

Details will be discussed in the order provided below:

2.2.1 Diversity of Endemic Fish and Other Fisheries Target Species in Lake Biwa
   (Growth and Migration of Fisheries Target Species)

2.2.2 Native Fish Species that Connect Lake and Land
   (Lake Fish that Migrate to Spawn in the Rice Paddies)
   (Diversity of Organisms in the Environment Surrounding Lake Fish in Paddies)
   (Conserving Water Quality and Ecosystem through Lake to Land-Focused Environmentally Sound Agriculture)
   (Conserving Lake Fish Breeding Grounds in Rivers by Conserving Water Source Forests)

2.2.3 Diversity of Agricultural Products
   (Traditional vegetables that enrich the local dinner table)

2.2.4 Conserving the Ecosystem and Fishery Resources
   (State of Invasive Alien Fish Species)
   (State of Cormorants)
   (State of Underwater Weeds)
   (Climate Change Impacts)
2.2.1 Diversity of Endemic Fish and Other Fisheries Target Species in Lake Biwa

Lake Biwa is currently home to 47 native fish species, of which 16 are endemic species that inhabit only Lake Biwa. Lake Biwa has the most diverse and unique variety of freshwater fish in Japan [32].

Twenty-five species, or approximately half of the 47 native species are fisheries target species. A characteristic of freshwater fish is that they tend to be caught in great numbers at a particular time of year but are perishable. Hence, in order to preserve the freshwater fish caught, the lactic fermentation technique of *narezushi* was developed in the area surrounding Lake Biwa. Other than the round crucian carp, *narezushi* can be made from fishes such as three-lips, Japanese dace, *Ischikauia steenacker*, common minnow, ayu, Honmoroko, Biwa salmon, and even loach and catfish.

Lake Biwa has 45 native shellfish species, of which 29 are endemic species. Four species, including the seta basket clam (*Corbicula sandai*) are fisheries target species. Another endemic species, the pearly freshwater mussel, is used to implant freshwater pearls.

(Growth and Migration of Fisheries Target Species)

In Lake Biwa, many species of warm water *Cyprinidae* use reed beds and rice paddies as spawning grounds, while cold water *Salmonidae* spawn in the river flows out of the forest and use Lake Biwa as a substitute for the ocean [33].

Major fisheries target species include endemic species such as round crucian carp (*Cyprinidae*), Honmoroko (*Cyprinidae*), and *Biwa salmon* (*Salmonidae*), as well as ayu that have adapted to the environment of Lake Biwa and now bear traits unique to those inhabiting Lake Biwa.

[Round crucian carp (*Cyprinidae/endemic; adult fish length: 25cm*)]

The round crucian carp migrates to reed beds and rice paddies in the coastal areas from spring to early summer to spawn, then develops into adult fish in the deep layers of the offshore waters in fall through winter. Banding surveys have revealed homing behavior of round crucian carp: juveniles that have grown in the rice paddies swim downstream to Lake Biwa, then return to the same rice paddy area during the spawning season. Round crucian carp is known as the fish that makes tastiest *narezushi*. 
[Honmoroko (Cyprinidae/endemic; adult fish length: 12cm)]

The Honmoroko inhabits the shallow coastal areas from spring through fall, and spawns on the banks. In winter, it migrates to deep layers, 60-80m underwater, in the offshore area [14]. It is considered to be most delicious among Cyprinidae, especially the female Honmoroko with roe, which can be caught in early spring.

[Biwa salmon (Salmonidae/endemic; adult fish length: 40cm)]

The Biwa salmon hatches in the rivers in winter, swims down to Lake Biwa in early summer, and migrates for two to four years. During spawning season in fall, they run up their home river toward the forests and arrange their spawning grounds in the gravel at the river bottom. They are also called ameno-uo (literally, “rain fish”) because they tend to run upstream after rainfall, when the water level is high. During this season, male fish bear a reddish nuptial color. They can also spawn near human-populated areas. Called the “Gem of Lake Biwa”, the Biwa salmon is popular for its flavor.

[Ayu (Osmeridae; adult fish: approx. 10cm )]

The ayu spawn on gravel river bottoms in autumn. After hatching, they swim downstream into Lake Biwa and reach maturity in one year at a small size, feeding on plankton offshore. Some run upstream and grow large. Ayu of Lake Biwa have differentiated and are unable to survive in the ocean, unlike other species of ayu that commonly swim downriver to the ocean.
Three-lips (Cyprinidae)
Approx. 30cm long at maturity.
The only species belonging to the Cyprinidae family that feeds on other fish. Migrates in the surface to middle layers of the Lake Biwa chasing after small fish, and runs upstream to spawn in late spring through early summer.

Isaza (Gobiidae/endemic)
Approx. 8 cm long at maturity. Lays eggs on the back side of rocks on the lakeshores in April and May. The male fish protect the eggs. Newly hatched larvae float on the surface of the water and, in July, begin their daily vertical migration in the northern offshore area between the lake bottom and surface layer.

Biwayoshinobori (Gobiidae/endemic)
Approx. 4cm long at maturity. Lives in the offshore area of Lake Biwa for most of the year except during the summer spawning season when they come near the shore[13].

Sujiebi (shrimp) (Palaemonidae)
Commonly known as Suji Ebi. Small shrimp that are 2-4 cm long and weigh 1-2g. Distributed widely in depths of 50 m or below and has a transparent caramel-color body.

*Please refer to the attachment for details regarding around 20 other species of fisheries target species.

2.2.2 Native Fish Species that Connect Lake and Land

In the local food web, native fish feed mainly on zooplankton and benthic animals and are preyed upon by larger native fish and birds. Lake Biwa is home to 47 native fish species, some of which migrate dynamically to surrounding waters, including rice paddies and midstream areas. This enriches the biodiversity of the Lake Biwa region. An ancient lake, Lake Biwa is also home to sixteen endemic fish species.

Figure 2-2-1
Table 2-2-1 List of major fish species inhabiting Lake Biwa and surrounding bodies of water, including water channels and rice paddies (Warm water species, such as Cyprinidae and catfish, mainly migrate upstream to the rice paddies. The chart below also shows that Biwa salmon and Ayu also migrate to the water channels.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Lake Biwa catfish</th>
<th>Inlet rivers of Lake Biwa</th>
<th>Water channels</th>
<th>Rice paddies</th>
<th>Ponds</th>
</tr>
</thead>
<tbody>
<tr>
<td>★Honmoroko</td>
<td>Gnathopogon caeruleus</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>★Isaza</td>
<td>Gymnogobius isaza</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>★Biwa salmon</td>
<td>Oncorhynchus sp.</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>★Ayu</td>
<td>Plecoglossus altivelis altivelis</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>★Okawa</td>
<td>Opsarichthys platypterus</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Oily bitterling</td>
<td>Tanakia limbata</td>
<td>△</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>★Gigi</td>
<td>Tachysurus nudiceps</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>★Japanese common catfish</td>
<td>Silurus asotus</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Oryzias</td>
<td>Oryzias latipes</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>★White crucian carp</td>
<td>Carassius cuvieri</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>★Round crucian carp</td>
<td>Carassius buergeri grandoculis</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>★Gin-bun</td>
<td>Carassius sp</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>★Common carp</td>
<td>Cyprinus carpio</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Weather loach</td>
<td>Misgurnus anguillicaudatus</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Stone moroko</td>
<td>Pseudorasbora parva</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Golden venus chub</td>
<td>Hemigrammocyparis rasborella</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Kawamutsu</td>
<td>Candidia tenminckii</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Harivo</td>
<td>Gasterosteus aculeatus</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Dark sleeper</td>
<td>Odontobutis obscura</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Torrent catfish</td>
<td>Liobagrus reiniti</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Kawayoshinobori</td>
<td>Rhinogobius flumineus</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

Note: O:Used by adult fish / ◊:Used by eggs and larvae / △:Details unknown

References: Kokoku biwa ko no sakanatachi (Fish of Lake Country of Biwa) (1990, Biwako Bunkakan); Mizube kankyou no hozon (Conservation of Waterfront Environment) (1998, Asakura Shoten); Mizubi Ason no Seitaigaku (Ecology of Playing on the Waterfront).” (2000, Nobunkyo)

(Excerpted from Masahide Yuuma .”Kasen to suiden.” [Rivers and the paddies] [Partially modified] [40]

(Lake Fish that Migrate to Spawn in the Rice Paddies)

Traditional eti fishing originated in paddy fishing, in which lake fish running upstream to spawn in rice paddies by the lake were caught along the way. This fishing method has a history of over 1,000 years, and lake fish continue to breed in the rice paddies today.

What is interesting is that the agricultural work in the paddies from April through June, including puddling, irrigating, and planting, coincide with the life history (life cycle, including spawning, hatching, and initial stage of growth) of lake fish such as the round crucian carp. In spring, when the paddies are filled with water, the dormant resting eggs of Moina macrocopa, etc. are activated [36]. When the rice is planted in May and water levels increase with each rainfall, the warm water containing plankton flows out from the rice paddies into the lake. When this water flows into the lake, the round crucian carp and other lake fish know that it is time to run up the channels to the source to the flow – the rice paddies.
After hatching, larvae and juveniles grow so rapidly that they gain as much as 50% of their weight in one day and can grow to be as long as 2–3 cm in approximately one month. Fish develop with a higher survival rate in the rice paddies than in Lake Biwa. Compared to a survival rate of 0.1% or less on the shores of Lake Biwa [36], it is not unusual for more than 50% of lake fish growing in rice paddies to survive up to 30-40 days [37]. Once they are ready to search for new foods and environments, juveniles swim down to Lake Biwa where they grow even larger. Today, this period coincides with the midseason drainage period; and therefore, the water flowing out of the paddies facilitate...
the downstream migration of juvenile fish.

Hence, rice paddies along the lake, with a history of approximately 2,000 years, have contributed to the reproduction of lake fish, and thus the conservation of fishery resources [38].

Photo 2-2-9
Lake fish trying to jump over the weir after rainfall

Photo 2-2-10
Lake fish running up channels (Photo taken 1-2m downstream of the area shown in the photo 2-2-9)

Photo 2-2-11
Sign prohibiting catching immature fish (installed in response to reports from the community)

Photo 2-2-12
Lake fish caught by local people in the channel for "okazutori" (immature fish are released)

Photo 2-2-13
Lake fish running up the channels to the paddies
(Diversity of Organisms in the Environment Surrounding Lake Fish in Paddies)

In their larval and juvenile stages, many fish species of Lake Biwa grow feeding on zooplankton such as protozoa, rotifers, and crustaceans. In the rice paddies they similarly feed on cladocerans, which are found in abundance in the rice paddies. This supports the biodiversity of the paddies.

Mainly birds sit above the lake fish in the food chain and feed on insects, crayfish, frogs, and fish in the rice paddy. Many water birds inhabit the lakeshores, which become a feeding place and resting spot for 140,000 water birds, such as the tundra swan (Cygnus columbianus), particularly in wintertime. Some birds feed on the gleanings in the rice paddies and others use them as resting spots; and therefore, the rice paddies also contribute to the wintering of water birds. Hence, Lake Biwa is a registered site under Ramsar Convention of Wetlands of International Importance that proposes wise use.

The rice paddies introduced in the low-lying wetland environment around Lake Biwa lakefront are valuable habitats for organisms that are not seen elsewhere. A leading example is the Pelophylax porosusbrevipodus, a subspecies of the daruma pond frog, and the Drawida hattamimizu, the longest worm in Japan. Both species are widely distributed in the areas around Lake Biwa but are significantly limited in other areas [41].
The certification program of Lake to Land-Focused Environmentally Sound Agricultural Produce is an initiative unique to the region that promotes further efforts for the water quality and ecosystem of Lake Biwa, as aforementioned in sections 1.1.4 (p. 22) and 2.1.4 (p. 38). A comparison between Lake to Land-Focused Environmentally Sound Agriculture-certified paddies and the other modern farming paddy revealed that biodiversity was increased in the former, as provided in the table below.

Table 2-2-2 Comparison of biodiversity in fields practicing lake to land-focused agriculture and those practicing modern methods

<table>
<thead>
<tr>
<th>Cultivation method</th>
<th>Location</th>
<th>Aquatic beetles</th>
<th>Daruma Pond frogs</th>
<th>Damselflies (imago)</th>
<th>Wolf spiders</th>
<th>Tetragonatha praeclara</th>
<th>Total score</th>
<th>Overall evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake to land-focused</td>
<td>Field I</td>
<td>No. found 10</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>15</td>
<td>7</td>
<td>A</td>
</tr>
<tr>
<td>Field II</td>
<td>No. found 2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td>5</td>
<td>A</td>
</tr>
<tr>
<td>modern</td>
<td>Field III</td>
<td>No. found 0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>17</td>
<td>3</td>
<td>B</td>
</tr>
</tbody>
</table>


1) Diversity was evaluated from the number of index organisms found based on the ‘Nougyou ni yuuyou na seibutsu tayousei no shihyou seibutsu chousa hyouka manyuuru’ (Manual on Survey and Evaluation of Index Organisms Effective for Agriculture)

2) The ratings in overall evaluation based on the manual are provided below. Values in parentheses indicate total scores. S (8+): Very high diversity. Efforts should be continued; A (7-5): High biodiversity. Efforts should be continued; B (4-2): Relatively low biodiversity. Efforts require revision; C (1-0): Low biodiversity. Efforts require revision.
Efforts to conserve water source forests also contribute to the conservation of the ecosystem. It is particularly important to note that as mentioned above, in Lake Biwa, fisheries target species, such as Biwa salmon and ayu, spawn in the river [43]; and therefore, carefully managed and conserved forests stabilize water volumes and control fine sediment runoff, thus leading to the conservation of the breeding environment of these lake fish.

Inlet rivers of Lake Biwa are prone to droughts in decreased rainfall. When there is not enough flow in the rivers, Biwa salmon cannot reach their natural spawning grounds in the midstream area where the temperature is low, and sometimes end up spawning in warmer waters near the estuaries. The spawning season for Biwa salmon is around October and November, when the waters in the estuaries are still warm. The mortality rate of Biwa salmon roe is known to be high when the water is warmer than 13°C [44].

Furthermore, the ideal diameter of gravel in rivers where ayu spawn is 2–16mm [45]. To conserve this spawning environment, it is important to prevent runoff of fine earth by covering the mountainside. This requires proper forest management, including thinning, to increase the amount of sunlight reaching the forest floor and thus facilitate the growth of understory vegetation [46]. (refer to pp. 88-89, 96-101)

### 2.2.3 Diversity of Agricultural Products

The diversity of agricultural products is characterized by varieties of rice and traditional vegetables, mainly kabu radishes. The majority of farmland practicing the Lake to Land-Focused Environmentally Sound Agriculture taking into consideration the water quality and ecology of Lake Biwa are rice paddies that cultivate multiple rice varieties such as Koshihikari, Akinouta, and Kinuhikari, from the viewpoint of dispersing the harvesting work across the busy harvest season. In addition to these varieties, other rice varieties that are processed into mochi (rice cake) and sake, and ancient varieties such as red rice, black rice, green rice are produced. The Shiga Prefecture Agricultural Technology Promotion Center has also developed a new rice variety called Mizukagami, a heat resistant variety to adapt to climate change.
Traditional vegetables that enrich the local dinner table

In the crop fields surrounding rice paddies, farmers grow not only common vegetables but also a variety of traditional vegetables, such as hinona (Japanese variety of long-rooted turnip often used for pickles), Shimoda nasu (Shimoda eggplant), and hatashou no yamaimo yam, toira negi (Welsh onion), which when cooked with fish effectively kills fishy smells, Ibuki soba (buckwheat), and Mandokoro-cha (green tea). The traditional vegetables that enrich the local dinner table are grown from seeds which have been carefully handed down from more than 100 years ago, communicating today the local tastes that have been nurtured over time with great effort and passion.

The region features an extremely wide variety of native kabu, or radishes. Nine of the 17 species of traditional vegetables grown in the applicant region are radishes (including two daikon radishes). The applicant region is situated on the boundary of the cultivation of the southern and northern radishes and the sandy soil of the alluvial fan of the lakeside areas are suitable for the cultivation of kabu radishes. Hence, the region is also known by the name “Kingdom of Radishes.” A diversity of native species, varying in shape and color - red, white or purple, round or long – are grown and pickled after harvest [4, 47].
2.2.4 Conserving the Ecosystem and Fishery Resources

As shown below, the rich fishery resources and biodiversity of Lake Biwa have been conserved through the joint efforts of various actors who are sensitive to water quality and ecosystem:

(State of Invasive Alien Fish Species)

There are more than ten invasive fish species inhabiting Lake Biwa, with the black bass and bluegill population dramatically growing and causing serious damage to the local environment.

Increases in the black bass population peaked in the late 1980s, after which many native fish species inhabiting the coastal waters decreased, reducing the black bass population that fed on them. In turn, blue gills increased explosively.

Hence, activities to remove invasive fish species that were initiated by fishermen in 1984 were enhanced in 1999. Furthermore, in 2003, an ordinance was enacted to prevent recreational fishermen from re-releasing of invasive species.

Efforts are also being made to effectively utilize the alien fish species caught. A fishermen association has sought help from a local sushi restaurant to develop croquettes using fish meat from alien species, and another restaurant serves tempura using alien fish species.

These efforts have recently proven to be effective (as shown in the graph on the right side), implying signs of increases in native fish species.

During the period when the damage caused by invasive species was significant, Fish Cradle Paddies contributed to the conservation of native species by maintaining a high survival rate. Rice paddies were too shallow for invasive fish species to inhabit; and therefore, rice paddies have offered important breeding grounds for the crucian carp and other native fish species.
In addition to the invasive alien fish species, the common cormorant, which feeds on fish, impose threats to local fish.

Common cormorants are 80-85 cm tall and have a wingspan of 130-150cm. They weigh around 1.5-2.5kg. They can dive as deep as 1-9.5m and as long as 70 seconds chasing their prey. They are reported to eat amounts equivalent 26.2% of their own weight.

Common cormorants increased explosively in the 1990s and by 2008, Lake Biwa was inhabited by 37000 common cormorants. The feeding behavior of large population of common cormorants have greatly damaged Biwa Lake fisheries. Furthermore, they have caused vegetation damage, by breaking branches for nest building and dropping feces, consequently killing trees. In order to prevent such damages, bird-control strings have been installed in rivers to which lake fish migrate. Large breeding grounds have also been exterminated employing rifles and their population has gradually declined to a level that allows humans and common cormorants to co-exist.

As a result, in 2017, the common cormorant population decreased to 7,800 and some nesting grounds have become revegetated. However, the amount of fish consumed annually by common cormorants is estimated to be approximately 500 tons, equivalent to almost half of annual fisheries catch. Therefore, efforts will be continued to reduce damage on local fisheries by taking measures to control the bird population under a protection and management plan with an aim to reduce the number to 4,000, the common cormorant population when damages were still manageable.
(State of Underwater Weeds)

Underwater weeds are important factors of the ecosystem of Lake Biwa, as they offer spawning grounds or habitats for fish, as well as feeding grounds for birds. Uprooting underwater weeds such as *Potamogeton maackianus* and *Ceratophyllum demersum* and utilizing them to make compost for agriculture have also contributed to the removal of nutrient salts from the lake. The removal contributes to purifying the lake.

*Oumi Suisan Zufu* (Illustrated Atlas of Oumi Fisheries), published in around 1890, contains a refers to how water plants were used as fertilizers. The wet weight of water plants collected in Southern Lake in 1933 amounted to 17,730t, according to statistics compiled by Shiga Prefecture, with the estimated mass of phosphorus and nitrogen contained was 5t and 47t, respectively. This means that massive amounts of nutrients have been removed from Lake Biwa since the middle ages, in the form of seaweed collection for fertilizer [6].

Since the great drought in 1994, underwater weeds increase drastically in southern area (8% of the lake surface), covering approximately 90% of the lake floor (45 km²) in summertime. This has seriously impacted the natural environment and ecosystem through lake current stagnation, further sludging of the lake floor, reduced dissolved oxygen levels. This has also caused damage to fisheries, obstructed ship navigation.

However, underwater

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**Figure 2-2-9** Mass of phosphorus and nitrogen collected in water plants and other sources in 1933 (from presentation of Professor Shizuyo Sano of Department of Literature, Doshisha University)

**Figure 2-2-10** Expansion of area covered with underwater weeds (southern area of Lake Biwa)

**Figure 2-2-11** Recent result of fixed point uprooting (weight [ton]) (southern area of Lake Biwa)
weed volumes have significantly declined since 2017, presumably because weed growth has been hindered as result of decreased transparency levels from early spring to summer and efforts on the part of local fishermen to uproot the weeds. Other measures include following traditional methods to make compost to effectively utilize weeds.

The area covered by invasive alien plant species (*Ludwigia grandiflora subsp grandiflora, Alternanthera philoxeroides*) in Southern Lake has been reduced during these past few years as a result of major extermination efforts, but they have been spreading in parts of northern area, raising concerns over potential impacts.

(Climate Change Impacts)
A rise of 1.3 degrees Celsius in the local average temperature has been observed in last 100 years. It can be attributed to climate change.

Lake Biwa is often referred to as the “canary in a coal mine” because it is a small
body of water compare to the ocean, and thus more strongly affected by the climate change.

A closed system in a catchment area, the proposed site would be appropriate for monitor the impacts of climate change and the efficiency of adopted policies with the support of research institutes. The Lake Biwa Environmental Science Research Center and the Shiga Prefecture Fisheries Experiment Station are engaged in studies on the following events and their impacts:

- water temperature rises in Lake Biwa and inlet rivers
- incomplete water circulation in Lake Biwa during wintertime and resulting reductions in dissolved oxygen (DO) in the bottom layer
- increases in load affecting water quality due to inflows of substances accompanying increased heavy rainfall events

Given concerns regarding reduced yield and quality of paddy rice, we have developed a new highly heat-resistant variety, *Mizukagami*, has been developed and are promoting its wider adoption.
2.3 Local and Traditional Knowledge Systems

A traditional local knowledge system is *eri* fishing, with a history of more than 1000 years. *Eri* fishing is a passive method that ingeniously utilizes knowledge of the biology of lake fish to catch only required amounts of fish of a target size alive. The method also features a social system based on traditional order that has been passed down to date and contributes to resource conservation. Social aspects include the establishment of no-take zones associated with Buddhist teachings that prohibit the killing of animals, limits on the setting up of *eri* devices and village-based co-management of *eri* which had already been in place in the Edo period (17-19 century), are all social mechanisms of the traditional order that have contributed to resource conservation and are still in operation today.

The use and conservation of reed beds, which have supplied materials used in daily life and have also contributed to conserving the water quality and ecosystem, also constitute a part of the resource management system rooted in traditional knowledge.

Local knowledge of the biology of lake fish and water currents, the physical features of the lake bottom and the vegetation of the lake shores have developed in close relation with the lives of the local people who have passed them down across generations. It should also be noted that there remains a rich collection of historical accounts and resources.

Detailed descriptions will follow in the following order:

2.3.1 *Eri* Fishing, Continued Across Generations for over 1,000 years
- (Traditionally Accumulated Knowledge on the Biology of Lake Fish)
- (Central Role of *Eri* Fishing in Modern Fisheries in Lake Biwa)
- (Mechanism of *Eri* Traps: Free Entry and Exit)
- (Techniques for Setting up *Eri*)
- (Uniqueness)
- (Evolution of *Eri*)
- (Other Diverse Traditional Fishing Methods)

2.3.2 Social Structures for Fishery Resource Conservation and Fisheries Control Dating Back to Before the Edo Period (1603-1868)
- (Limit to Installation or Expansion of *Eri* and No-Take Zones)
- (Management of Fishery Rights by Villages and their Development as Fishermen Organizations)
- (Evolution of Co-Management by Fishermen and the Government)
- (Supporting the Spawning Run and Spawning of Lake Fish Based on Traditional Knowledge)

2.3.3 Human Activity in the Reed Beds
- (Breeding Grounds for Lake Fish and in turn, Fishing Grounds)
- (A Source of Raw Materials for Daily Commodities)
- (Human Intervention in Maintaining the Reed Beds)
2.3.1 Eri Fishing, Continued Across Generations for over 1,000 years

(Traditionally Accumulated Knowledge on the Biology of Lake Fish)

Around Lake Biwa, people have caught lake fish that come to their rice paddies and water channels for their daily meals since the Yayoi period (BC300-AD300). This traditional practice is called “okazutori,” done while working in the rice paddies, and sometimes done recreationally. Based on knowledge of the seasonal variations in species types and catch, the local people explored different fishing methods through trial and error and accumulated knowledge on the migratory patterns of lake fish, thus laying down the groundwork for the development of these fishing methods.

(Central Role of Eri Fishing in Modern Fisheries in Lake Biwa)

After the trial and error of many fishing methods, people found that eri fishing was the most efficient way to fish while engaging in agricultural work. The method is still used at approximately 100 locations on the lakeshores and provides the most catch among Lake Biwa fisheries.

Eri refers to a stationary fishing device. The device guides fish into its interior. Its unique arrow-like shape stretches from various points of Lake Biwa’s shores to offshore, and it is enjoyed as part of the trademark lakescape of Lake Biwa. This fishing method has been used to catch crucian carp, carp, gudgeon, Biwa salmon, and ayu by ingeniously taking advantage of their biological characteristics of returning to the lakeshores or rice paddies to spawn from spring to summer.

Table 2-3-1 Catch by fishing method (2016)

<table>
<thead>
<tr>
<th>Fishing method (total licenses and permits)</th>
<th>Eri (103)</th>
<th>Gill net (407)</th>
<th>Ebi tatsube (91)</th>
<th>Mondori (119)</th>
<th>Oisade (16)</th>
<th>Yotsudeami (10)</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catch (t)</td>
<td>461</td>
<td>320</td>
<td>23</td>
<td>4</td>
<td>330</td>
<td>1,138</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of total</td>
<td>41%</td>
<td>28%</td>
<td>2%</td>
<td>0.3%</td>
<td>29%</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(Mechanism of Eri Traps: Free Entry and Exit)

Eri fishing is a passive fishing method that involves waiting for fish to wander into a chamber in the back of the eri called the tsubo (pound), created by stretching across a su (mat originally made of reed) or a net, and has the following characteristics:

- Fish that are guided to the tsubo can continue to survive there and trace back their path to exit through the entrance.
- Small and immature fish can be excluded from the catch by setting mats and nets that are more coarsely woven.
- Once installed, eri enable the catching of the required amount fish of a target size through limited operations called tsubokaki that can be performed in between agricultural work.

The key mechanisms of the eri are as follows: First, the part called harizu that extends from the lakeshores to offshore hinders the fish’s egress by taking advantage of their instincts to only swim forward, and to escape to deeper waters when they encounter an obstacle, ultimately guiding them to the tsubo, which is located at the deepest point of the umbrella-shaped opening. Fishermen approach the tsubo on their boats and perform tsubokaki, or collecting lake fish alive from the tsubo with a scoop net. Fishermen are not required to constantly stay near the net.[48] The entry of the tsubo has a flap that makes it difficult for fish to exit,[49], but a certain proportion of fish always escapes from the tsubo. Fishermen have also passed down their techniques to be selective of the lake fish species caught in the eri without having to touch them, according to their instinctive behaviors, including tendencies to stay near the lake bottom or to swim.

Notes
1. Fish are not chased into the trap by humans but are guided in naturally.
2. As shown in the two diagrams, there can be one tsubo (pound) on one side of the eri (top) or one each on both sides (bottom)
3. Built symmetrically on both sides of the harizu so fish can enter from both sides, depending on the direction of the current
4. Sometimes, a kozuru is installed in the kagami to add one more step before the tsubo

(Kurata Toru “Biwako kaihatsu no rekishi to genkyou (History and current status of the development of Lake Biwa)”Jiji Press, 1975)
against the flow. Thus, fish that are not to be fished can be selectively released. Tsubo can also be kept open outside of fishing season. Thus, it is a controlled fishing method that does not overexploit limited resources.

**(Techniques for Setting up Eri)**

*Eri* are set up by stretching mats and nets out in the shape of an umbrella from the lakeshores to offshore. Installing *eri* is called “*eri* tate (*eri* building).” There were giant *eri* that extended over 1,000m offshore in the past, but today, they are limited to a maximum length of 500m. *Eri* can reach as deep as approximately 18m.

*Eri*-tate requires the knowledge and techniques that have been passed down and refined over 1000 years. A broad range of knowledge, ranging from that on lake bottom topography, air current, the associated direction and speed of water currents, lake fish behaviors, and historical catch data are all used to determine where to set up the *eri* using ropes to drive the stakes into the lake bottom.

Recently, it has been proven that the catch increases when a relatively slow water current washes perpendicularly against the *harizu*, a part of the *eri* pointing offshore, demonstrating that evidence of the knowledge that minute differences in the angle affects the outcomes in catch, which has been passed down by fishermen (See fig.2-3-2).[89].

Eri must be set up in shallow waters in the migratory path of the fish. Relevant traditional knowledge and technologies are passed down among fishermen across generations.

Important migratory paths are located in estuaries, rice paddies, waters near reed beds, and areas close to shallow waters. These spots are most suitable for *eri* fisheries; and therefore, fishery rights are set up in *eri* fishing zones as indicated in the map below:
Lake Biwa is known to have the most advanced *eri* fishing equipment. Long ago, *eri* devices were seen in inland waters and shallow seas all over Japan. Records reveal that Lake Biwa fishermen communicated *eri-tate* techniques to other regions that tried to introduce *eri* fishing. However, *eri* fishing has faded in most of these areas due to limited fishery resources or consumption areas compared to those of Lake Biwa. In that sense, Lake Biwa is a valuable fishing ground where *eri* fishing still plays a central role today [51, 6].

Additionally, *eri* is globally unique due to a history of more than 1,000 years of forming a social system for fishery resource conservation that can be traced back in historical materials and documents to the 13th century.

(Evolution of *Eri*)

A relic of an ancient *eri* that dates back to the Kofun period (3rd to 7th century) has been found in the Akanoi Bay ruins [52]. The earliest written account of *eri* is a tenth-century *tanka* poem written by the poet Yoshitada Sone, whose *tanka* is also included in the Hyakunin Isshu card game: “*Sasakizu ni sugaki**
sa hoseri haru goto ni eri susu tami no shiwazanarashimo” [53]. (a poem about fishermen drying reed mats on a sunny early spring day on the lakefront in present-day Omihachiman city)

Eri devices in its most primitive forms consisted of simple and small-scale fishing tools used to catch carp and crucian carp in the reed beds. It was a technological system that supported the self-sufficiency of people who engaged in both rice cultivation and fishing in the low-lying wetlands [54].

Primitive eri fishing that started in the reed beds were found in various parts of Japan. However, it developed most extensively in Lake Biwa in response to several factors. First, increased demand in adjacent capital of Kyoto (a major consumption site) necessitated increased efficiency in fishing; and therefore, the trap section became more sophisticated. Secondly, the devices became larger and extended farther offshore as the changing culinary culture called for capturing round crucian carp carrying roe offshore. The knowledge and techniques of eri fishing deepened from the medieval period through modern times, and the eri owners and eri-tate experts also diverged.

Eri-tate became very specialized, encompassing tasks such as bamboo chopping and reed mat waving. Some farmers who came to be called eri-shi passed on their knowledge of eri-tate primarily during wintertime, as a revenue source when there was no farm work. Even eri that substantially reached 1.280m in length have been documented over 100 years ago in the “Suisan in tori shirabe eri ryou keihi shueki kin sonota torishirabe chou hensatsu (Book of the Fisheries Committee Survey on the Costs and Revenues of Eri fishing) (1884) [55,6].

There are two large categories of eri: the “coarse-netted eri” for catching carp and crucian carp, and the “fine-netted eri” for catching ayu. The fineness of eri refers to the intervals between the reeds or bamboo used to weave a mat. Vinyl chloride mats were available by 1970 and by the 1980s replaced the net eri that had been devised in the Edo period (the 1700s) as an alternative to the mat eri made with reeds and bamboo that required re-weaving each year [53].

This increased the durability of eri, making them last for years, as well as the number of simplified forms of eri. Eri, which were at one point built exclusively by skilled specialist farmers, returned to something that fishermen generally set up by themselves. In addition to the large-scale eri that extend offshore, as described

Photo 2-3-9 Contemporary eri

Photo 2-3-8 Drawing of eri fishing scene in mid-Meiji era (the 1890s) [56] (reproduction of photo 1-16)
above, primitive small-scale *eri* set in reed fields and rivers have also been passed down to the present.

![Photo 2-3-10](image)

**Photo 2-3-10** Meiji-era (around 1900) *eri* installation diagram illustrating various forms of *eri*

### (Other Diverse Traditional Fishing Methods)

*Noboriyana* fishing is another traditional fishing method for catching lake fish that run up the inlet rivers to Lake Biwa. By setting reed mats facing downstream in the shape of a fan slightly upstream from the mouth of the river to direct the flow to one point so that lake fish that try to swim against it are directed to the “*kattori guchi*” on the river bank or to the “*andon*” in the center of the river, where they are caught.

*Noboriyana* fishing is a subtype of *yana* fishing, of which *kudariyana* fishing, a method for catching fish headed downstream is more common in Japan. In Lake Biwa, *noboriyana* fishing, has evolved historically to catch Biwa salmon, *ayu*, and other lake fish that run upstream from Lake Biwa to spawn and grow. *Noboriyana* fishing has been practiced for 1,500 years, with evidence from the *noboriyana* fishing ruins (Tononishi Iseki) [57].

Gill net fishing, in which migrating lake fish are caught offshore with nets stretched out like screens was already practiced in the Edo period (the 17th to mid-19th century) and continues to be practiced today. “*Oisade*” fishing, which involves scooping out schools of fish without using a boat, is also in practice today.
Photos 2-3-11 (Left) and 2-3-12 (Right)
Modern “kattori yana” fishing with equipped with a cage on both ends (left) and diagram from mid-Meiji period (around 1890) (right)

Photos 2-3-13 (Top), 2-3-14 (Bottom)
“Andon yana,” a type of noboriyana placing with a fish cage in the center (top) and birds waiting before the cage (bottom)

Photos 2-3-15 (Bottom), 2-3-16 (Top)
Modern “haranba” fishing, a type of noboriyana using a net (bottom) and diagram from around 1890 (Top)

Photos 2-3-17 (Left), 2-3-18 (Right) Gill net fishing with thin-stringed nets set offshore (left) and diagram from mid-Meiji era (around 1890) (right)

Photo 2-3-19 Oisade fishing: chasing fish with crow feathers
The following small-scale fishing methods are also passed down traditionally. Recreational fisheries are limited to these small-scale methods including trolling.

Figure 2-3-4 Small-scale fishing methods that has been passed down traditionally

- **Fishing hook**
- **Cast net fishing** (limited to methods not using vessels)
- **Mondori** (limited to rivers)
- **Tatsube** (limited to rivers)
- **Ue** (limited to rivers)
- **Bamboo tubes** (limited to rivers)
- **Push net**
2.3.2 Social Structures for Fishery Resource Conservation and Fisheries Control Dating

Back to Before the Edo Period (1603-1868)

In addition to the passive fishing methods of small-scale, family-operated fisheries, modern rules related to fisheries resource conservation and fisheries adjustment are based on traditions that go back to before the Edo period. Social structures, such as no-take zones associated with Buddhist teachings that prohibit the killing of animals, limits on the setting up of new or additional eri devices and village-based co-management of eri have all been passed down to present times and continue to exist in the form of limitations on catch and fishing methods for resource conservation and the management of fishing rights by FCs [22].

(Limit to Installation or Expansion of Eri and No-Take Zones)

Rules for fishery resource conservation and fisheries adjustment have been formulated over the long history of Lake Biwa. The high awareness of local fishermen toward resource conservation and fisheries adjustment, as well as associated social systems originated in pre-Edo times [58].

According to historical materials, in the 9th century, bureaucratic offices called mikuriya were established on the east (Chikuma, Maibara City) and west (Wani, Otsu City) shores of Lake Biwa with the mandate of delivering fisheries products as payments to the Imperial court in the capital [42]. It is also known that there were privileged fisheries, including fisheries for offerings to the gods in Katata (Otsu City) by Shimogamo Shrine (Kyoto City) and in Kitafunaki (Takashima City) by Kamigamo Shrine (Kyoto City) in around the 10th century [59].

Since the 13th century, after distribution routes to the capital, Kyoto, were established, and demand for lake fish in the larger area including Kyoto increased, a considerable number of disputes arising from competition over catch, including catch from eri fishing, occurred [8]. A dispute between neighboring villages over damage done to eri and over setting up eri is recorded in a 1298 document preserved by the Oshima-Okutsushima Shrine (Omiyachiman City) (see photo 1-13, p.17).

There was frequent dispute and it became common to see the phrase “new fisheries shall not be permitted” in documents on fishery disputes [59], implying that by the Edo period, it became an ironclad rule that the installation of new eri or extensions of existing ones were restricted [18]. This came to be used as grounds for asserting fishery rights, along with records of tax payments as a village community, defining village waters on the basis of geographic adjacency, and theory of survival based on engaging in fisheries as a livelihood [1].
During the Edo period, there were more than ten no-take zones. Fishing was banned in areas near Zeze Castle (Otsu city) and Hikone Castle for defense purposes, and hunting and fishing was prohibited for religious reasons in areas around Miidera Temple (Otsu City), Chomeiji Temple (Omihachiman City), Shirahige Shrine, and Chikubu Island (Nagahama City). Among these, there is a record that eri near Chomeiji Temple was cut off in 1262 by a monk calling for prohibition of hunting and fishing before the Kannon, a Buddhist deity of mercy. Chikubu Island enshrines “Benten san,” the god of the lake is enshrined, and the island manager reproached a Katata fisherman just for docking his boat on it. A letter of apology, delivered after the incident (1831), has been preserved. Chikubu Island also has a stele on which is engraved, “Killing prohibited in waters within 8 chou [obsoletes unit of distance: 1 chou=110m] from this island” (see photo 2-3-21). It is certain that the problem of limited resources and their management has been perpetual since the ancient to the modern times.

(Management of Fishery Rights by Villages and their Development as Fishermen Organizations)

In the Edo period, when limitations to setting up eri and no-take zones were in place, but no unified rules to manage Lake Biwa as a whole, the establishment of an autonomous system for managing fishery rights led by village communities is believed to have also played an important role in controlling the overexploitation of resources.

In the Edo period, there were approximately 200 villages on the lakefront of Lake Biwa. The village-based taxation system called for the management of not only village territories in accordance to explicit boundaries on land, but also the boundaries that also extended from the shore out to the surface waters of the lake. This also sparked a new dispute over which village fishery rights belonged to in terms of setting stationary fishing devices such as eri and yana.

Simultaneously, cooperation and mutual assistance among village people within villages were practiced, for example by distributing eri catch. In some places, eri were considered to belong to the shrine, so that fear of divine punishment and other notions of religious taboos would limit selfish use and a sense of equality would be maintained before the gods, thus preventing overfishing based on private ownership and promoting sustainable catch.

Fisheries cooperatives inherited this form of management of village co-ownership of fishery rights even after the new Fisheries Act was enacted in 1902. Two hundred villages formed fisheries cooperatives either individually or in groups. Fishermen would be granted fishery rights by becoming a member of a cooperative. Fishery rights were neither privately or
publicly owned, but were subject to communal ownership, implying that fishermen would not be granted access to fishing grounds without membership to an organization (fisheries cooperative). Based on the results of a government survey on customary fisheries practices conducted around 1890, the conventional village communities were formally institutionalized as “fisheries cooperatives.”

Under communal ownership, the group possesses the power to execute rights, while constituent members have rights to the profits generated from use. The major difference with the co-ownership, in general, is that ownership cannot be divided into individual shares. This type of relationship imposes restrictions on the social status of individuals, and thus been criticized for being feudal. However, it is also understood to have been a wise way to provide a legal solution to accommodate the needs of fishermen who wished to continue communal fishing in the fishing grounds [62].

Fishery rights as addressed in the Meiji Fisheries Law enacted in 1902 were succeeded by the Fisheries Cooperative Act of 1949, which laid the foundation of the rights of modern fisheries cooperatives.

Lake Biwa is a region where the fisheries regime which originated in the Edo period has been preserved and inherited strongly. This can be explained by the following factors: Compared to marine fisheries, fisheries in Lake Biwa cover a closed body of water with no unexplored areas. The basic form of small family-operated fisheries has been maintained to present, fishery resources in Lake Biwa are limited, and fishing methods, such as eri fishing, have not undergone change. Furthermore, the fisheries cooperatives established based on the Fisher Cooperative Act, inherited the fishery rights granted under the Meiji Fishery Act and have remained small-scale. These factors are all supported by the concept of community-based self-management [9].

While the mainstream belief is that the conservation and

![Figure 2-3-5 Village boundaries around Lake Biwa and boundaries of fisheries cooperative governance in the 1980s (from Yukiko Kada “Mizube gurashi no kankyougaku” [Environmental Studies on Life on the Waterfront]) (Showado, 2001)](image)
management of common-pool resources (CPR) cannot be left to the voluntary will of people and can only be resolved by states or the market, Professor Elinor Ostrom (co-winner of the 2009 Nobel Prize in Economics), proposed a third method in 1990: the potential of self-governance of CPR where parties with interests would appropriately and voluntarily determine the rules and engage in the conservation and management [63]. This idea is often referred to as the greatest contribution to economics made by Professor Ostrom, recognized for her research on the governance of CPR [24]. In Lake Biwa, self-management of CPR has been practiced historically from before the Edo period as a social structure constituting a part of the traditional knowledge system. (refer to section 1.2.2. ii , pp.26-27)

Today, there are 36 fisheries cooperatives along Lake Biwa. The prefecture grants these cooperatives, as the managing bodies of eri, permits, and members of the cooperatives engage in fisheries based on common fishery rights. The fisheries cooperatives manage fishing grounds associated with the common fishery rights, such as those for eri fishing, but also serve other important roles, such as taking measures to exterminate alien fish species, conserving fishing grounds, managing fishing ports and harbors, and engaging in sales operations. Some fisheries cooperatives are wholesalers running auctions for local businesses or provide cooperative shipping services. Thus, fisheries cooperatives play paramount roles in modern times, maintaining livelihoods, conserving the ecosystem, and passing down traditional fishing methods to future generations.

(Evolution of Co-Management by Fishermen and the Government)

Self-management by fishermen organizations thus developed traditionally and have today evolved into more effective systems with increased sustainability by incorporating public frameworks such as the Shiga Prefecture Fisheries Adjustment Regulations and the Lake Biwa Fisheries Adjustment Commissions. Management rules include limitations on fishing methods, including restrictions on the total length of eri (no longer than 500m), limits on catch for the purpose of juvenile fish protection by controlling the fineness of mats and net gauges (e.g., 22cm for round crucian carp), setting up sanctuaries to protect spawning, and prohibiting the use of fishing lights in addition to the restriction on the recreational fishing methods.

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Fishing method</th>
<th>Other restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recreational fisheries</td>
<td>Self-consumption, recreations</td>
<td>Limited to small-scale fishing methods</td>
</tr>
<tr>
<td>Traditional fisheries as occupation</td>
<td>Sales</td>
<td>Eri, yana, gill nets (eri fishery rights and yana fishery rights are issued to fishery cooperatives, which issue permits to fishermen (cooperative members) based on their respective rules)</td>
</tr>
</tbody>
</table>

Table 2-3-2 Differences between recreational fisheries and traditional fisheries as occupation
Table 2-3-3 Restrictions on fishing periods to protect spawning habitats

<table>
<thead>
<tr>
<th></th>
<th>Restricted period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biwa salmon</td>
<td>October 1st – November 30th</td>
</tr>
<tr>
<td>Ayu</td>
<td>August 21st – November 20th</td>
</tr>
</tbody>
</table>

Table 2-3-4 Restrictions on fish size to protect spawning habitats

<table>
<thead>
<tr>
<th></th>
<th>Restricted fish length (total length)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biwa salmon</td>
<td>30cm or smaller</td>
</tr>
<tr>
<td>Round crucian carp</td>
<td>22cm or smaller</td>
</tr>
<tr>
<td>Japanese eel</td>
<td>35cm or smaller</td>
</tr>
</tbody>
</table>

Figure 2-3-6 No-take zones to protect spawning habitats

Legend

- No-take zones accompanied with designation of protected water surface
- Other no-take zones

Lake Biwa
- rivers

Lake Biwa rivers

N
When a more dramatic recovery of resources is required, fishermen have engaged in voluntary resource management based on surveys conducted at fisheries experimental stations in order to pass down Lake Biwa fisheries to the next generation.

In the case of fisheries that involve catching diverse species of fish using a variety of fishing devices on large number of boats, as seen in Asian inland fisheries, government-led top-down resource management based on fishing quota like those adopted in Western countries tend to be costly and inefficient. Therefore, given the local history of village-based voluntary management, fisheries in Lake Biwa have attached importance to having local fisheries stakeholders select and implement a combination of management measures through discussion along with government-led public management. This is an example of practicing “co-management,” the realistic option for avoiding the “tragedy of the commons” in fisheries worldwide [21], and can also be a model for resource management in inland fisheries widely practiced in Asia.

Co-management of resources by the government and fishermen has involved setting no-take zones and limiting the size of target fishes, resulting in increased catch of the round crucian carp and Honmoroko, both of which are endemic species of Lake Biwa. Detailed measures by fish type are as follows.
Round crucian carp
Round crucian carp is an endemic species of Lake Biwa. In addition to limitations based on fish length, fishermen have voluntarily set closed seasons that extend over seven months. Round crucian carp spawn multiple times in their lifespans of four to five years. Thus, fishing is limited to large fish (22+cm) that have already spawned once, during in the spawning season when their commercial value is highest.

Until 2006, the Shiga Prefectural Fisheries Adjustment Regulations (hereinafter, “Fisheries Adjustment Regulations”) banned fishing for fish measuring less than 15cm, whereas fishermen voluntary prohibited catching fish measuring 18cm or less. Therefore, the area has a history of strengthening local resource conservation efforts [36], and as a result, catch recovered to 52 tons in 2016 after dropping to 18 tons in 1997.

Honmoroko
Many Honmorokos (honmoroko, Gnathopogon caerulescens) live for only one year; and therefore, in order to protect spawning, fishing is prohibited during the two months of May and June, when they spawn. Recently, no-take zones that also apply to recreational fishermen have also been established [64]. As a result, catch increased to 15 tons in 2016 after dropping to 5 tons in 2004.

Figure 2-3-8 Status of recovery of round crucian carp and Honmoroko catch
Source: before 2009, “Annual Report of Shiga Prefecture Agriculture, Forestry and Fisheries Statistics” (Shiga Agricultural Administration Office, Kinki Regional Agricultural Administration Office)
2010- “Statistical Survey on Inland Fisheries Production” (Ministry of Agriculture, Forestry and Fisheries)
(Supporting the Spawning Run and Spawning of Lake Fish Based on Traditional Knowledge)

Another aspect of social systems based on traditional knowledge of lake fish is the joint efforts by a diversity of actors, including farmers and local residents, to support their spawning run to rice paddies as well as spawning. This practice has contributed to maintaining the paddy fields and water channels that have offered spawning grounds for lake fish from ancient times.

Some residents around Lake Biwa have first-hand experience of *iwojima* and *okazutori*, which are believed to have its roots in the Yayoi period (BC300-AD300). *Iwojima* is a term that describes schools of lake fish in spawning season that travel up channels into the paddies. *Okazutori* describes catching these lake fishes between farm work for daily food.

The traditional knowledge that lake fish swim upstream to the paddies in the rice-planting season formed the basis of the evolution of *eri* and other fishing methods. In around 1870, channels called “*obikiyose suiro*” (baiting channels), each with respective fishing rights, were constructed systematically; that is, land use accounted for lake fish travel to the paddies and catching some of them (see figure 2-3-9). However, as paddies were elevated to prevent inundation with the modernization of agriculture, differences were created in the water level between rice paddies and channels. Traditional knowledge was disappearing from these paddies. However, farmers with this knowledge and experience are leading initiatives to set fish passes (weirs) to help lake fish swim into the paddies in what is called the Fish Cradle Paddy Project (refer to section 2.1.4, p38).

This project involves assisting lake fish, including the round crucian carp, to swim up to the rice paddies—their “cradles”—to spawn, and is a way to pass on the co-existence of people and lake fish to the future. Recent sampling studies that used techniques to mark the otolith have demonstrated the round crucian carp’s instinct to return to the paddies where they hatched and bred. The Fish Cradle Paddy Project, which started in 2001, has been successful; and currently, lake fish swimming up to rice paddies have been observed in 27 areas around Lake Biwa, collectively covering approximately 160ha (surveyed by the Shiga Prefecture...
Projects that facilitate the entering of fish into rice paddies are widely practiced in other Japanese regions as well. However, although weir-style fish passes are technically more simple and economical, “single-paddy fish passes” individually installed for each plot of rice paddy are more common in areas other than Lake Biwa. This is because installing and managing weir-style fish passes requires agreement and cooperation among all farmers who own rice paddies along the same branch drainage channels. Given the need for considering the rice-planting plans of the entire village, deciding which paddies to be connected to fish weirs, deciding on a common variety of rice to plant and integrated water management arrangements, cooperating in the maintenance and management of drainage canals where mud tends to accumulate, weir-style fish passes are difficult to install in many regions. However, in the Lake Biwa region, farmers, researchers, government, private companies, non-profit organizations (NPOs), and students have successfully collaborated in installing weir-style fish passes in many areas.

As aforementioned (pp.27-28), this system resembles the well-known “rice-fish farming system” in China. However, the proposed system is distinct from other systems because in Lake Biwa, fish that live in nature return to the rice paddies to breed by instinct.

In addition to efforts to support lake fish running up the channels to the rice paddies, members of the Lake Biwa community have also launched efforts to build fish passes and prepare spawning grounds for the Biwa salmon, another important fishery target species prized as the “Jewel of Lake Biwa,” in the inlet rivers to the lake. This activity also contributes to protecting the ecosystem and fishery resources [66, 67].
2.3.3 Human Activity in the Reed Beds

Activities in the reed beds on the lakeshore are another part of the traditional knowledge and technology system that has been passed down to the present. Humans have managed the reed beds which provide an environment for fishing grounds and raw materials for daily commodities. New findings have shown the role of these reed beds in protecting the lakefront ecosystem and water quality. New regulations have been implemented as part of the management system for natural resources and community residents and companies have been participating in these conservation efforts.

(Breeding Grounds for Lake Fish and in turn, Fishing Grounds)

The shores of Lake Biwa are vast and are divided into three types: rocky shores, sandy shores, and sandy and muddy shores. Of these, the shallow waters 1-2 m deep in sandy and muddy banks formed by sediment transported by the inlet rivers to Lake Biwa, not largely affected by the waves created by seasonal winds during winter, are suitable for the growth of reeds.

Underwater, among the dense jungle of reeds, are the spawning grounds for lake fish, such as the round crucian carp and Honmoroko, as well as shrimps, amphibians, and aquatic insects, while the surface waters and the shore have been breeding grounds for birds, such as the reed babbler and grebe, as well as land insects.[68]

Japanese white crucian carp and round crucian carp migrate from offshore to the coastal zones of Lake Biwa in early summer as they enter their breeding season, and run up to shallow waters, including the rice paddies, laying their eggs on water plants and reeds. The water around the reed beds near the banks have low dissolved oxygen levels, and therefore does not attract other larger fish. These waters are rich in the zooplankton that the fish feed on and provide an important environment for larvae and juveniles.

Crucian carp migrate to the offshore areas of Lake Biwa during the winter and are therefore difficult to catch in deep waters, but large schools of crucian carp arrive at the reed beds in the coastal area during the spawning season in early summer, when they are relatively easy to catch. Eri fishing is the most effective for catching these “yoruo” (approaching fish). Other small pitfall type of fishing tools have also been used in the corners of the reed beds in shallow waters[54].

(A Source of Raw Materials for Daily Commodities)

Reed has been used as a raw material for daily commodities, including fishing tools. The most iconic
Fishing device using reed is *eri*, originally used in small-scale *eri*. *Yana* reed mats used to capture lake fish running up the rivers have been discovered in Kofun period relics (the 3rd to 7th century).

Reed has also been used around the home, such as in roofing and screens, as well as for fertilizer to be put in to the fields. It is also used in the *Ohtaimatsu* in the festival-eve ritual of the traditional Hachiman Matsuri, which, according to a theory, originates in the use of water for irrigation [69].

Villages had a central role in the management of reeds, which have high utility value in fishing and various other aspects of daily life. However, in the Muromachi period (the 14th to 16th century) there was a dispute between two neighboring manors (Komatsu and Hira) over the ownership of the reed beds on the West coast of Lake Biwa. Awaji, Yasu City, a famous self-governing village from medieval times, wrote out intra-village agreements on the amounts and timing of reed harvest. Such sixteenth-century documents on the management of reed beds and village regulations on their use remain today [6].

*(Human Intervention in Maintaining the Reed Beds)*

As seen in the recent reappraisal of “*satoyama*,” the reed beds, which have been an important source of materials for daily commodities, can be considered “secondary nature” that has been maintained through balanced human intervention [52]. Continued intervention by humans over many years has prevented aggradation by plant residue and succession into willow forests, thus maintaining the vegetation in the form of reed beds [6].

Kayomon Nishikawa, a reed producer of Maruyama, Omihachiman City, left an instruction manual called the *Nishikawa Saijiki* (Nishikawa Literary Calendar), a detailed historical text whose compilation was begun in 1897 to document this traditional management method. The volume documents that, to produce quality reed, it should be harvested, stimulated by burning, well-sorted, and sun-dried. The tasks associated with each process are described in detail [68].

Recent changes in lifestyles and the development of the lakefront have decreased not only the industrial use of reed but also reed beds themselves. This has inspired new efforts for the conservation of lake fish and their water quality, harnessing the aforementioned traditional knowledge. (refer to pp.86, 95)
2.4 Cultures, Value Systems, and Social Organizations

The proposed system has historically nurtured a diverse food culture centered on lake fish. *Narezushi*, a preserved food made by pickling various local lake fish in rice to promote lactic fermentation, is emblematic of the co-evolution of culture and biodiversity. It is served on special occasions as a delicacy to guests and as an offering to the gods at festival held by villages, and has also cultivated human ties, or the social solidarity essential to carry on their livelihoods, such as fishing and farming.

These human ties have led to modern efforts aimed at enhancing the sustainability of the local system, in which various parties, including workers in fisheries, agriculture and forestry, and consumers.

Details are provided in the sections below:

2.4.1 Traditional Lake-Fish Oriented Food Culture
   (Biwa Cuisine: a Rich Combination of Lake Fish and Local Produce)
   (Heritage of *Narezushi* as a Main Component of Local Food Culture)
   (Evolution of *Funazushi* as a Gift and Delicacy)

2.4.2 Festivities Using Lake Fish that Contribute to Strengthening Community Ties
   (Shinto Rituals Using *Narezushi* as Ambrosia)
   (Social Structures Founded on Community Ties to Pass on Livelihoods)
   (Inheritance of Rites for Fish)

2.4.3 Participation of Diverse Actors for Improved System Sustainability
   i  Role of Educational Institutions in Fostering the Next Generation
   ii Consumer and Corporate Participation Promoted Through Educational Programs
      (Lake-Wide Cleanup on “Lake Biwa Day”: an Expansion of Fishermen’s Efforts to the Entire Catchment Area)
      (Corporate and Local Participation in Reed Bed Conservation)
   iii Participation of Agricultural and Forestry Workers
      (Efforts of Farmers)
      (Participation of Forestry Workers through Water Source Forest Conservation)
   iv Sharing Challenges and Opportunities for Inter-sector Cooperation
2.4.1 Traditional Lake-Fish Oriented Food Culture

(Biwa Cuisine: a Rich Combination of Lake Fish and Local Produce)

In areas around Lake Biwa, a sophisticated food culture using fish caught in Lake Biwa has developed through passive fishing methods to catch fish while working in the fields. A nutritiously well-balanced cuisine developed as a result of small-scale but complex livelihoods embracing both agriculture and fisheries [70].

Lake Biwa fisheries target various species other than the round crucian carp that breed in the paddies, according to the season: the Biwa salmon, Honmoroko, ayu, and three-lips, as well as crustaceans and shellfish such as lake prawn and Seta freshwater clams. By combining lake fish with other ingredients, such as the rice, azemame (soy beans cultivated on the bunds between rice paddies), and vegetables, various flavors developed, epitomizing the rich biocultural diversity of the region. Amenio gohan, made by steaming Biwa salmon and rice together, ebi-mame, made by stewing small shrimp with azemame, and junjun (sukiyaki), prepared by cooking lake fish with vegetables are examples of the local cuisine [57].

(Heritage of Narezushi as a Main Component of Local Food Culture)

The most notable dish in the local cuisine is the narezushi, a preserved food made by pickling lake fish in rice for fermentation. This recipe developed given the local circumstances that freshwater fish are more perishable than marine fish and that rice was available. The narezushi culture remains strongly in many communities of the area [70], and it is still made with a wide variety of fish, such as the round crucian carp, three-lips, and Japanese dace, symbolizing the rich local biocultural diversity [71,72].

Narezushi has been an important source of protein for the local people, with funazushi made from round crucian carp as the most representative of the area. Funazushi represents the co-existence of fisheries and rice paddy farming, and is still enjoyed by many people today, as the most savory narezushi.
Narezushi is a preserved food that supplies good proteins and calcium, and has also been valued for its nourishment. Recent studies have revealed that the lactic acid bacteria in narezushi act as an intestinal regulator; and therefore narezushi has been recently be reappraised as a food with high nutritional value.

Narezushi is found widely in the areas around Lake Biwa, extending to inland rural areas, as shown in the figure on the right (figure 2-4-1).

(Evolution of Funazushi as a Gift and Delicacy)

Funazushi has a history of more than 1,000 years and is as old as the history of traditional fishing methods. The development of narezushi culture began as a means to preserve the massive amount of lake fish caught during spawning season around Lake Biwa as fermenting techniques took root among the local people. It was a course of nature that the crucian carp running up the channels to the rice paddies were fermented in rice harvested from the same rice paddies [73].

Table 2-4-1 Combination of fisheries and agriculture by an eri operator: Calendar of events

<table>
<thead>
<tr>
<th>Month Type</th>
<th>1</th>
<th>2</th>
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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eri fishing</td>
<td></td>
<td></td>
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<tr>
<td>Rice farming</td>
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<td>funazushi</td>
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</table>

The oldest record of funazushi is the characters written on a wooden plate excavated from the Heijo Palace remains. The next is the record in the Engishiki, (“Procedures of the Engi Era”; a document of the rituals and system of the palace completed in 927 AD (mid-Heian period)), requiring the Province of Omi to pay its taxes in funazushi and amenouozushi (Biwa salmon narezushi) [73].

Funazushi has been recognized as the prototype of Japanese sushi [7] as described in subsection 1.1.3, p.17, and recently, as a cultural artifact unique to Shiga Prefecture [74].
mentioned above, lactic acid fermentation in the form of *narezushi* was indeed a very effective method for preserving perishable freshwater fish [75].

A similar culinary culture exists in Southeast Asia [76] where the fish is generally not salted but is sliced and pickled for only a few days, after which it is cooked before it is eaten. In contrast, in the Lake Biwa area, fish are salted whole. In the case of *funazushi*, the salted fish is fermented in rice for half a year to two years and eaten raw. These points suggest that this method of fermentation evolved uniquely in the temperate climate zone.

The fact that it is also used for gifts or as offerings to the gods is another difference between *narezushi* and similar fish dishes of Southeast Asia. *Funazushi* pickled in the summertime mature just around New Year’s, which is why it has been a delicacy served on special occasions and festivities or to host guests, and given as a gift. It has been used as ambrosia and included in the *Naoraizen* feast enjoyed at the end of Shinto rituals [70].

| Table 2-4-2 Differences between *funazushi* in Lake Biwa and similar fermented fish recipes in Southeast Asia |
|-------------------------------------------------|-------------------------------------------------|
| Pickling period | 6 – 24 months | 3 – 7 days |
| Form of fish for pickling | Whole fish | Sliced |
| How it is eaten | Raw | Cooked |
| Social significance | Preserved food, gifts, religious offerings/Naoraizen, nourishing food | Preserved food |

It has also been documented that from the medieval period age to more recent times, samurai used *funazushi* to foster relationships. Oda Nobunaga built his castle on the lakefront in present-day Azuchi Town, Omihachiman city, and gave special privileges regarding fishery rights in Lake Biwa to fisherman on Okishima Island in exchange for their compulsory labor in the naval forces [22]. Later when he invited Tokugawa Ieyasu, who would rule all of Japan, he offered *funazushi* as a part of the most luxurious feast of the time, as described in the 1582 *Azuchi Okondate “Zoku zoku Gunsho rui juu”* [57]. It is also recorded in *Bunka Bukan* written in 1812 that the Hikone and Zeze Clans offered *funazushi* to the Shogunate family in Tokyo, 450km away from Lake Biwa [73].
2.4.2 Festivities Using Lake Fish that Contribute to Strengthening Community Ties

(Shinto Rituals Using Narezushi as Ambrosia)

As mentioned above, narezushi has been associated with festivities around Lake Biwa.

The most exemplary of these is the Sushikiri-matsuri (Sushi cutting festival). When presenting the funazushi as ambrosia, it is cut in the manner of ancient fish filleting ceremony. The Sushikiri-matsuri at Shimonikawa Shrine (Moriyama City) is the most famous of these rituals, with two young people preparing the funazushi according to the traditional procedures. The ritual is closely associated with the continuity of the local social structures [9].

Rituals using narezushi made from Japanese dace and other fish as offerings to the gods have also been preserved and passed down. Lake fish cuisine, including funazushi, is an essential part of village events such as the “Okonai,” a local ritual. This is considered evidence supporting the theory that narezushi, which uses rich amounts of precious staple rice began as a divine food symbolizing the co-existence of fish and people [57].

In other festivities, small fish are offered alive to the god of the rice paddies to express gratitude for a good harvest. The “Ta no kamisama no gyoji” (ritual for the god of rice paddies) is performed in late autumn in the storehouse where the harvested rice is stored by offering mochi, daikon radish and live lake fish in a dish before a rice bale. The fish are released into the river after worship [57].

Locally brewed sake is also offered to the gods in these Shinto rituals. Sake made from staple rice, is offered to the gods with prayers for more blessings and people drink the sake to exchange courtesies with the gods [77].

By cooperating in holding these festivals and rituals to offer lake fish and agricultural produce to...
the gods, the people around Lake Biwa have nurtured community ties while cultivating respect for water and life. This has enhanced social solidarity, leading to passing down of traditional livelihoods, such as fisheries and agriculture.

(Social Structures Founded on Community Ties to Pass on Livelihoods)

Strong human ties reinforced by these festivals and rituals have helped to form village structures with high solidarity and unity. In Sugaura, a fishing and farming village in the northern part of Lake Biwa, the Sou, a joint structure based on self-governing and land-based ties among residents, was formed in the fourteenth century, as written in Sugaura Monjo (designated a National Treasure in 2018), a document detailing village trends in the Kamakura to Edo period (the 17th to mid-19th century).

By the Edo period, a common ownership system for eri developed in fishing villages. These systems became the precursor of the modern fisheries cooperatives, which play an important role in increasing the sustainability of Lake Biwa fisheries. In addition to cooperation within communities, many fisheries cooperatives along the lake form an association in order to join forces for enhanced resilience to improve the sustainability of Lake Biwa fisheries, engaging in various efforts in resource management and managing the environment of fisheries grounds. The Shiga-prefecture Federation of Fishermen’s Co-operative Association Seinenkai, comprising the younger members of the association, in particular, has played an important role in the sustainable development of Lake Biwa fisheries and in passing on the proposed system to future generations, working on projects to spread the food culture and campaigns to promote Biwa lake fish in and outside the region.
In the agricultural areas of the region, close communication is promoted through village communities called “Zaisho” which pride themselves on the holding the largest number of meetings to discuss and take measures against challenges, such as frequent water shortages (Number of Rural Communities by Frequency of Holding Meetings, 2010 Census of Agriculture and Forestry in Japan). These led to the pioneering development of community-based farm cooperatives before such trends were seen in the rest of Japan. (Shiga Prefecture is currently home to 820 community-based farm cooperatives, ranking third in Japan, according to the February 2018 Survey on Community-based Farm Cooperatives.) This laid the foundation for the social solidarity of the region that has led to a high level of participation by various actors in efforts, such as the Fish Cradle Paddy Project that serves to facilitate the spawning run of lake fish headed toward the rice paddies, that seek to conserve the water quality and ecosystem.

(Inheritance of Rites for Fish)

In addition to the food culture and rituals and festivals that have been preserved, the practice of sakana kuyou (rites for the souls of dead fish) has been continued by fisheries cooperatives along Lake Biwa associated with fisheries. Many fisheries cooperatives have built shrines worshiping Konpira-san, the god of abundant catch, and memorial towers for fish.

This struggle with killing living creatures is believed to have maintained people’s consciousness to hold religious and spiritual rites such as sakana kuyou and fish releasing rites (houjoue) [8]. Indeed, according to the 1998 survey, there are 14 fisheries cooperatives that hold sakana kuyou and others that hold houjoue (see figure 2-4-3) [61]. In interviews, fisheries cooperative members responded that sakana kuyou was still heavily practiced today, with many rituals held around Obon season in August, not just by fishery cooperatives, but by neighborhood community associations and in the homes of individual fishermen.
2.4.3 Participation of Diverse Actors for Improved System Sustainability

Embracing Lake Biwa, the looking glass reflecting people’s lives, fishermen, consumers, NPOs, farmers, forestry workers, research institutions, private companies, and other various actors of the Lake Biwa catchment area all participate in efforts to conserve the proposed system. Values that cherish water and life were nurtured in the local history of living with nature, and continue to be passed down through education.

The Law Concerning the Conservation and Restoration of Lake Biwa was promulgated and enacted in 2015 to lead Japan in achieving a society coexisting with nature where the lake’s blessings can be enjoyed into the future. While the law emphasizes the importance of participation by various actors and encourages participation in agriculture and forestry conservation, wide participation by various actors such as those introduced below had been promoted in this region long before the enactment of this law.

i Role of Educational Institutions in Fostering the Next Generation

Educational institutions and companies offer a variety of educational programs to deepen local understanding of the biodiversity of Lake Biwa and the fisheries and food culture that depend on it. These efforts help relay this knowledge to future generations.

Since 1983, a program teaching the biodiversity of Lake Biwa and its blessings on a boat has been offered to elementary school students of the Lake Biwa region. Children also participate in programs that teach the interaction among rice paddies, forests and Lake Biwa. Some elementary schools have included GIAHS in their lessons and have their students present what they have learned to community audiences. The outcomes of students’ independent learning have gained high appraisal.
Consumer and Corporate Participation Promoted Through Educational Programs

Heightened public awareness through local educational programs serve to encourage the participation of consumers and companies. One indicator of this is the fact that Shiga Prefecture tops all prefectures in Japan in the public participation rate in volunteering activities, including those in environmental conservation (Ministry of Internal Affairs and Communications “Basic Survey on Social Life 2016”). The Lake Biwa Day cleanup campaign and reed bed conservation activities are some prominent examples of extensive and successful consumer and corporate participation.

(Lake-Wide Cleanup on “Lake Biwa Day”: an Expansion of Fishermen’s Efforts to the Entire Catchment Area)

July 1 is the day of an important annual event in Lake Biwa when local residents and companies all participate in cleaning the entire catchment area. This event has been continued for 37 years by a cumulative total of 5.8 million people who have participated out of their devotion to Lake Biwa.

Lake Biwa Day originated in a lake-wide no-fishing day initiated by local fishermen despairing the devastating state of Lake Biwa on July 1, 1971. Later, Shiga Prefecture became the first prefecture in Japan to enact an ordinance for the prevention of eutrophication on the same date in 1980. The following year July 1 was designated Lake Biwa Day.

(Corporate and Local Participation in Reed Bed Conservation)

Multiple companies participate in activities to conserve reed beds, which contribute to conserving water quality and ecosystem. The Biwa Lake Ordinance of Reed Beds Conservation, Shiga Prefecture, (enacted in 1992) was the first ordinance in Japan to actively stipulate the conservation of ecosystem and has attracted not only donations but also volunteer work. The Network for Preserving Lake Biwa with Reeds, with more than 100 member companies around Lake Biwa, recruits 500-600 people every year to participate in reed cutting volunteer efforts. (refer to pp.76-77, 95)
Participation of Agricultural and Forestry Workers

Various actors are also involved in the conservation of water quality and ecosystem in the agricultural land and forests that are the water source of Lake Biwa waters, and thus contribute to passing on the system to future generations.

(Efforts of Farmers)

Geographical factors, including the short lengths of the rivers around Lake Biwa, often caused water shortages in local irrigation systems. This nurtured a culture of using water wisely in local farming villages, as well as a belief that gods resided in rivers and channels. Therefore, people share respect for downstream areas and have admonished the discharging of dirty water into the rivers and the channels [78]. Furthermore, traditional agricultural practices that impose a smaller impact on the environment, such as plot-to-plot irrigation, have also helped to conserve the water quality and ecosystem of Lake Biwa.

This spirit has laid down the groundwork for efforts that take into consideration the water quality and ecosystem of Lake Biwa. (refer to p.22)

In addition, farmers bear an extremely important role in conserving fishery resources from the perspective of providing spawning and breeding grounds for lake fish and conserving the water quality. This is supported by traditional agricultural culture and agricultural drainage management. Details are provided below:

<Fish cradle rice paddies>

a. Providing spawning and breeding grounds

In fish cradle rice paddies, filling the paddies with water and growing rice lead to the provision of spawning and breeding grounds for lake fish, including round crucian carp. The water in these rice paddies is warmer than that of Lake Biwa; and therefore, the rice paddies are rich in plankton. Furthermore, alien invasive fish species cannot come in. Hence, the survival rate of juvenile fish is extremely high, marking an average of 30%. (The survival rate in Lake Biwa is less than 0.1%)

b. Managing water channels

Farmers also raise the water level in drainage channels in order to facilitate the upstream migration of lake fish into rice paddies. Drainage channels are joint-use
facilities; and therefore, region-wide discussions are held to prepare for the upstream migration of lake fish.

c. Awareness-raising among consumers and children

Farmers offer food and agriculture education on the biodiversity of rice paddies and the lake to land-focused agriculture. Many urban residents attend the nature observation workshops and farming experiences hosted by farmers. These workshops are valuable opportunities for field-based learning.

<Fishery resource management>

a. Managing agricultural drainage

By installing water gates in the drainage channels, farmers prevent turbid water from flowing into Lake Biwa during rice planting and soil puddling. This is a basic fishery resource management measure implemented in more rice paddies for the conservation of water quality and ecosystem. It is based on traditional practices and promoted by the certification program of Lake to Land-Focused Environmentally Sound Agricultural Produce.

b. Nursery

Farmers also provide their rice paddies to juvenile lake fish (Honmoroko, etc.) as initial breeding sites. Since fish do not have to be fed in a rice paddy and have a higher chance of surviving juvenile fish spend approximately one month in the secondary nature provided by farmers, before they migrate down to Lake Biwa on their own. This should be distinguished from aquaculture (rice paddy fish culture) practices that involve breeding fish and catching them once they have grown into adult fish.

(Participation of Forestry Workers through Water Source Forest Conservation)

The water source forests of Lake Biwa surround the lake, covering approximately half of the catchment area and serving the important functions of recharging the water source and preventing floods and droughts. Thus, the conservation of forests that recharge the water source of Lake Biwa is another important element supporting the proposed system.

Some fishery target species that are important to Lake Biwa fisheries, such as the Biwa salmon, run up the water channels to spawn. Thus, forest conservation and management lead to preventing the rivers from drying up and controlling fine sediment runoff, which causes the sand gravel that fish use as spawning grounds to sink, thus contributing the conservation of the breeding grounds of lake fish.
Fishermen, loggers and local residents all participate in tree planting activities in the “Gyomin no mori” (Fishermen’s Forest) initiative. Traditional Lake Biwa fisheries have been supported by water source forest conservation efforts led by various actors, such as corporate participation in efforts under the “Partnership Agreement for Lake Biwa Forestation” initiative and century-old partnerships among local governments (and some administrative cooperatives) located both upstream and downstream for forest conservation for over 100 years, and conservation efforts of populations of giant Japanese horse chestnut trees, which have high water source recharging capacities.

These efforts are continued today under the “Lake Biwa Afforestation Ordinance” (enacted in 2004, Shiga Prefecture), which promotes the collaboration of residents to preserve the forests that support Lake Biwa and the lives of the local people and pass them on to future generation in a healthy state. (refer to p.22)

### Sharing Challenges and Opportunities for Inter-sector Cooperation

Many meetings are held to facilitate cooperation among different actors and to promote their participation in Lake Biwa projects and industries.

The Mother Lake Forum was organized in 2012, inviting local residents, farmers, fishermen and loggers, companies, NPOs, experts, and local governments to share their feelings and challenges associated with Lake Biwa and its ecosystem with mutual respect for the positions and experiences of each participant, as well as for differences in opinion.

A similar initiative is the Oumi River-Building Forum, held annually since 2003 with a focus on activities around Lake Biwa and the rivers that flow into it. It offers an opportunity for sharing ideas and practices and engaging in in-depth discussion.
2.5 Landscapes and Seascapes Features (including Lakescapes)

The landscape and lakescape of the system have evolved over many years through interaction between humans and nature, achieving sustainable resource use and conservation. Embracing the rice paddies developed along the lakeshores and the *eri* set up to catch the lake fish that use the paddies, they were formed gradually through deep interaction with nature, including fish.

What is more remarkable about it, however, is how both physical mechanisms, such as sophisticated fishing methods based on traditional knowledge passed on over many generations, and intangible social structures sustaining the system have been maintained even in the increasingly urbanizing present. These physical mechanisms and social structures have been developed through human ties that have been nurtured within the system, and a host of historical documents are evidence of this. These actions shall provide a lot of information to the world.

The following topics will be discussed in detail below.

2.5.1 Leading Landscapes and Lakescapes

2.5.2 History of Landscape and Lakescape Development
- (Expanding Lake Fish Spawning Grounds through Rice Paddy Development)
- (*Okazutori* [Dinner Catching] Practiced Alongside Farming)
- (Development of *Eri* fishing)
- (Landscapes and Lakescapes Achieving Increased Sustainability through Social Systems)

2.5.3 International Relevance of the Landscape and Lakescape and the Messages Communicated
- (Efforts to Share the Lessons Learned)
- (Global Cooperation)
2.5.1 Leading Landscapes and Lakescapes

The landscape and lakescape embracing both rice paddies and *eri* on the lake shores are typical of the proposed system which has been preserved and passed down across 1,000 years, has enabled the circulation between resource use and conservation.

Since around 2000 years ago, people have been carving out mud from under water plants and the lake bottom to expand the rice paddies. *Eri* have been installed in the waters extending before the rice paddies for more than 1,000 years and have been perfected in terms of both location and forms optimal for fishing through repeated trial and error. Rice production, provision of lake fish breeding grounds, and lake fish fisheries—i.e. symbiotic activities of humans and fish—have been conducted in a shared space. Therefore, food production in coexistence with nature and the regeneration of fisheries resources have occurred in one common space.

Our predecessors gathered their knowledge and wisdom regarding the geographical environment and fauna and flora, and engaged in fisheries and agriculture, linking their knowledge with local demand for food, food culture, and economy. Combined with the conservation and use of reed beds, which have provided materials for daily commodities, and the use of water plants raked out from the lake shores as fertilizer, these livelihood practices, which have supported both the use and conservation of the waterfront, have created a secondary nature that can be referred to as “satoumi,” enabling coexistence with various living creatures through interaction between human activities and nature [6,52,79,80].

Traditional *yana* fishing that ingeniously takes advantage of the biology of lake fish, the agricultural land that extends from the lake shores into upstream forest area, the water channels supplying water to rice paddies that have been maintained and managed under local cooperation to prevent droughts caused by frequent water shortages [81] and the forests that have increased their water recharging functions as a result of tree-planting efforts in deforested mountains to prevent flooding have all been formed in the long years of interaction between humans and nature. They have also contributed to our coexistence with nature.

Photo 2-5-1  Landscape and lakescape embracing rice paddies and *eri* (reproduction of photo 1-3)
2.5.2 History of Landscape and Lakescape Development

The history of landscape and lakescape development is described below:

(Expanding Lake Fish Spawning Grounds through Rice Paddy Development)

The fish of Lake Biwa inhabited the lake long before humans began to populate its shores. In particular, some lake fish species have spawned in the reed beds that temporarily become coastal waters with seasonal rises in the water level during the rainy season.

In contrast, humans only came to live on the lakeshores several tens of thousands of years ago. Mounds of fish bones and shells have been found from the Awazu ruins (Otsu City), and other archaeological sites dating back to the Jomon era (before the 3rd century B.C.). Stone and clay anchors presumed to have been used for fishing nets have been found, suggesting that humans practiced fishing in its primitive forms.

Evidence from Dainaka no ko minami ruins (Omihachiman City), Hattori ruins (Moriyama City), Karasuma ruins (Kusatsu City), and other ruins from the same period reveal that rice production had begun in the Lake Biwa area by the Yayoi period (BC300-AD300). Humans have been sculpting paddies and channels by raking out the mud from the ecotones of the lake, tilling the land with water plants and building stone walls for coastal protection. Lake shores and reed beds were thus partially converted into paddies, but the lake fish that spawned there recognized the rice paddies extending inland (secondary nature) as new optimal spawning grounds and came to use the rice paddies as their breeding grounds, where they spend an important stage of their life cycles [5].
(Okazutori | Dinner Catching| Practiced Alongside Farming)

Since ancient times, people have referred to lake fish running in piles up the channels to spawn in rice paddies as “iwojima” (fish island). They eventually came to catch lake fish for their daily food in between their farm work. An important source of animal protein, lake fish were caught using snare fishing tools such as “uke,” sunk in the water, and eri set up in the reed beds where the lake fish swim through [57].

In other words, people developed a way to catch fish without having to go to Lake Biwa or stay close to their fishing devices. During the busy rice-planting season, people could look forward to collecting their catch in the water channels on their way back home from the rice paddies at the end of the day.

This is the origin of fishing for self-consumption called okazutori. This practice later came to support the livelihoods of farmers as a secondary income and evolved into the passive fishing method adapted to the ecology of fish that lies at the center of Lake Biwa fisheries as we continue to see today.

The rice paddies faced risks of flood due to the flooding (or raised water levels) of Lake Biwa during the rainy season, or in heavy rainfall. However, people knew how to take advantage of such disasters by regarding their rice paddies to be fishing grounds [9]. This system was a complex livelihood system based on an agro-fishery mixed livelihood in which resilience originated.

(Development of Eri fishing)

This passive fishing method has evolved through repeated trial and error based on traditional knowledge accumulated across generations of the ecology of lake fish and the topology of the lake bottom. Primitive eri made from reed were set up in the reed beds to catch round crucian carp returning to the coastal zones to spawn in April to May, and people extended their eri further offshore to catch more fish [51, 55].
The Edo period saw increased preference for *narezushi* using crucian carp with roe and higher demand for crucian carp triggered by the popularity of crucian carp served raw in the capital city of Kyoto. This inspired further technical developments for increased catch from *eri* fishing, main fishing method in Lake Biwa fisheries [6].

(Landscapes and Lakescapes Achieving Increased Sustainability through Social Systems)

Increased catch to meet increased demand later triggered disputes over catch and restrictions on *eri* installation. Based on the human ties nurtured through the local food culture, festivals and rites also helped to create village-led systems for *eri* management. The same can be said about *yana* fisheries that take advantage of the biology of lake fish that swim upstream. This led to the determination of rules for resource conservation and the adjustment of fishing rights to prevent overfishing, or the “tragedy of the commons.” This has developed into more effective co-management by fishermen and governments today, forming the foundations for passing down Lake Biwa fisheries to future generations.

The landscape and lakescape of the proposed system embrace not only physical systems such as traditional fisheries, but also a traditional social system founded on human ties nurtured within the system. Those social system and human ties have played a central role in conserving resources and passing down the system to the present.

The same can be said about the landscape including the water use in the farming-fishing villages, utilizing and conserving reed beds, and the flood control and conserving water source forests.

*<The water use>*

Local water channels have been developed over many years of interaction between humans and nature. They are the result of untiring efforts
by the local people to secure irrigation water and maintain the quality of the waters that flow from the villages into the paddies or into Lake Biwa. While spreading the paddies inland for food security, people developed the drainage management that prevent soil runoff. In addition, people purify the water in villages through cohabitation with fish, devise ingenious traditions such as household accessible water system that have contributed to the conservation of biodiversity.

The community-led social system has a significant role to inherit these traditional practices.

< The reed beds >

Another feature of the traditional social system is the use and management of non-crop plants, such as the reeds on the lakeshores. The reed beds of yoshi (Phragmites australis), tsuruyoshi (Phragmites japonica Steud) and seitakayoshi (Phragmites karka [Retz.]) help conserve the water quality and ecosystem around the lake; and these functions are maintained through regular cutting. Harvested reed has traditionally been used for thatch roofing and traditional reed products such as blinds, as well as for torches used in festivals, as described in the section 2.3.3 (p.76-77).

However, the reed bed area of Lake Biwa has decreased significantly after the high economic growth period in the 1970’s, as shown in the graph below. Therefore, in 1992, the Shiga Prefecture enacted the Biwa Lake Ordinance of Reed Beds Conservation to implement the efforts to protect, grow and utilize reeds. As a result, reed bed area increased to 262 ha in 2018.

Based on study results from the Shiga Prefecture Fisheries Experiment Station, reed bed conservation efforts have involved creating letting them extend more than 30 meters into the water, in order to offer suitable spawning and breeding grounds for Cyprinidae, including crucian carp that can accommodate decreasing...
water levels.

Furthermore, multiple companies participate in activities to conserve reed beds as described in the section 2.4.3.ii (p.86).

< The flood control and conserving water source forests >

The rivers of the Lake Biwa region all flow down from the surrounding mountains, creating a web-like network across the entire region, supplying water to rice paddies and fostering diverse organisms.

However, these rivers have challenged the local people by frequently causing floods and increasing the water level of Lake Biwa. Rice paddy agriculture that can retain vast amount of rain water in the Lake Biwa catchment area, forest conservation and river improvements have effectively served to prevent such flood damage.

(Source: Journal of the Japanese Society of Irrigation, Drainage and Rural Engineering, Vol. 50 No. 1, etc.)

Furthermore, conserved water source forest have also enhanced the resilience of the system. The basic relationship between forest and lake/fisheries are as provided section 1.1.4 (p.22-23). To provide more details, forests are mainly located at the uppermost upstream area and bear the following three functions: water retention, sediment control, and water quality conservation and fostering ecosystem. These functions contribute to controlling the outflow of water and sediment into rivers, and conserving the spawning environment of anadromous fish and fishing grounds, and are thus closely related to the passing down of the proposed system.
Given the low water retaining capacity of the granitoid mountains surrounding Lake Biwa and the short extent of rivers, the area was challenged by frequent flooding of the rivers and inundation of the entire lake area, which have created flood-prone raised bed rivers (*) and caused great damage to the farming and fishing villages, as well as drought in the rivers, which was devastating for the lake fish that breed in the rivers.

* raised bed river: a river whose riverbed is raised above the surrounding ground due to repeated deposits of sediment flowing from the mountain forests and creation of levees

Thus, in order to enhance those forest functions, local residents and downstream organizations have engaged in tree planting and forest conservation since the late 19th century (figure 2-5-5). From more than a century ago, the local people have made efforts to enhance resilience by planting forests, in addition to benefiting from the conventional functions of supplying lumber and organic fertilizer.

In recent years, Shiga Prefecture introduced the Lake Biwa Afforestation Ordinance in 2004 and the Ordinance for the Prefectural Tax for the Forestation of Lake Biwa in 2006, the tax revenue of which would be used for promoting “environment-conscious forestation” with an emphasis on the sustainable fulfillment of the multidimensional forest functions and “collaborative forestation” activities encouraging the participation of the wide community, such as companies and local residents in addition to fishermen while focusing on the relationship between Lake Biwa and surround water source forests.

As explained in section 1.1.4 (p.22-23), we have included a limited area of water source forests into the proposed designated area which have featured the proposed system. However, because forests, along with rice paddies, contribute to enhancing the resilience of the proposed system, the action plan includes general water source forests located outside of the proposed designated site.
Role of forest in the proposed System (impact on fisheries)

Water source forests with limited conservation efforts
(Focus on use of forest resources: lumber production and supplying organic fertilizer)

Flood/drought-prone geographic factors
① Low water retention capacity
② Short rivers

Destroyed fishing grounds, damaged villages
Buried lake fish spawning grounds (gravel)
Increased flood risks due to elevated river bed
Dying lake fish unable to migrate
Lack of agricultural irrigation

Participation of downstream organizations, including fishing villages
(Okaki Mountain Forest Cooperative since 1893)
(Carrying and planting baby trees [photo taken in 1970])

Local participation in the 1910s
Participation of local residents, fishermen and companies today

Proposed designated site includes only traditional water source forests that meet both conditions:
① Located in the upstream area of rivers where lake fish migrate upstream
② Site for forest building efforts with local participation

Stable water flow
Supplying nutrition

Lake fish spawning in rivers
Lake fish trapped in the eri

Legislation of public participation
2004 Enacted Lake Biwa Afforestation Ordinance (water source forest conservation, local participation)
2006 Introduced Forest Tax
2016 Designated water source forests and regulations on forest land transactions
**Function 1  Water retention**

Forests bear the function of preventing floods and droughts and stabilizing the water volume of rivers.

Embracing short rivers and granitoid mountains with small water retention capacity, the proposed site was often hit by floods and droughts. Floods cause serious damage to farming and fishing villages as well as fishing grounds. Furthermore, droughts inhibit the upstream migration and spawning of lake fish, and cause irrigation water shortage.

The graph below offers evidence that the water retention function of forests mitigates such natural disaster events and lead to securing the water flows required for lake fish to run upstream. The water flow from mountain forests are more stable in vegetated zones than in non-vegetated zones during and after rainfall.

![Figure 2-5-6 Hydrograph for mountain forests (test grounds in Otsu City)](Source: Masakazu Suzuki and Yoshihiro Fukushima (Kyoto University) “Fuka-kakogan sanchi ni okeru rachi to shinrin no dosha seisanryo (Sediment produced in vegetated and non-vegetated lands in weathered granitoid moutanins),” *Water Science*, 1989)

**Function 2  Sediment control**

Forests control the accumulation of sediment in rivers and Lake Biwa as presented in the graph below:

Sediment outflow buries the gravel surface of the river bed which are suitable spawning grounds for anadromous fish. Furthermore, the river bed is elevated, and thus causes floods. Around the world, forest degradation has caused some lakes to decrease in area or water level.
Function 3  Water quality conservation and fostering ecosystem

In the forest watershed, water infiltration has various buffering effects on the water quality. The data below shows evidence of this phenomena in the area south of Lake Biwa. In the soils of established forests, the nitrate nitrogen (NO$_3$-N) content and pH offer evidence of large buffering effects.

Katsuhiko Matsunaga (Professor emeritus, Hokkaido University) wrote in his book, *The sea will die with disappearing forests* (Kodansha, 2010), that in forests, dead leaves and branches in forest are decomposed by small animals and are exposed to chemical processes in the soil, including fermentation. This organic matter is weathered and mixed with microscopic mineral particles, forming humus, which have an important effect on living organisms. Humus absorbs high concentrations of phosphorus and bears a denitrogenation function of turning high-concentration nitrogen compounds to nitrogen gas. Therefore, forests supply nutrients to phytoplankton, thus increasing the fish population through the food web, while controlling nutrient salts. Furthermore, this system supplies the iron required by photosynthetic organisms. Trees standing near the water prevent temperatures from rising acutely under the sun. Moreover, the insects that fall into the river from these trees are essential for the development of fish and fallen leaves provide the carbon source of the food web.

Thus, overall forests in the catchment contribute to water quality conservation from forests downstream to the lake, as in the case of Biwa Lake to Land Integrated System.
In addition to the abovementioned measures, we have excavated Setagawa River, the only river flowing out of Lake Biwa and conducted river improvement construction works in the inlet rivers of Lake Biwa. Many of the inlet rivers are raised bed rivers, and thus sediment control works have been implemented.

Based on the abovementioned experiences, in 2014, the proposed site became the first in Japan to formulate an ordinance stipulating a program that focused not only on measures taken in rivers but also those addressing areas surrounding rivers. The ordinance is known as the River Basin Management Ordinance and involves enhancing measures to prepare for flood damage, including retaining water outside the rivers.

(Source: Yuko Asano et al “Change of hydrochemical processes along forest succession -Catchment observation on the three different successional stages-”, Bulletin of the Kyoto University forests(1996), 68: 25-42)
2.5.3 **International Relevance of the Landscape and Lakescape and the Messages Communicated**

The landscape and lakescape of the proposed system communicate to us the long history of interactions that have occurred between humans and nature in a tangible way, while also conveying to us the secrets of maintaining the sustainability of the system amid the advancement of urbanization, that is, the importance of the social system that passes on livelihoods, simultaneously conserving the water quality and biodiversity. This overarching system has developed not only physical systems (such as fishing methods) but also social systems (for the implementation of agreements on resource conservation and the conservation of water quality and biodiversity) in which various actors participate.

This shows that the landscape and lakescape of the proposed system can demonstrate not only its history and culture, but the community’s efforts through trial and error to support both food production and biodiversity. Moreover, this experience can be conveyed not only to the local people but to other countries of the world that are also struggling with the preservation and sustainability of water resources and inland fisheries, as modernization takes its course [82].

Therefore, trainees from overseas have been received. We provides valuable opportunities for ecotourism, and promotes international partnerships to share the lessons learned.

**{(Efforts to Share the Lessons Learned)}**

The Lake Biwa region offers eco-boat tours, as a way of using the landscape and lakescape of the Lake Biwa System as a setting for learning. A local example of international cooperation is hosting trainees under a Japan International Cooperation Agency program that provide experiences of Lake Biwa fisheries (including *eri* fishing), and water quality surveys.

The Fish Cradle Paddy also receives trainees mainly from Asia and Africa. Participants have commented that they “learned about the importance of regulating fisheries and the benefits that societies can reap from it” and that “[they] would like to adapt the “Fish Cradle Paddy” model in [their] countries as a method that simultaneously conserves freshwater fishes, produces rice and increases awareness among citizens.”

Local efforts to provide assistance to fish swimming upstream to the rice paddies have been
introduced at the 12th meeting of the Conference of the Parties to the Convention on Biological Diversity (COP12, Korea, 2014) and the World Lake Conference (Indonesia, 2016). We have cooperated with other regions in Japan and overseas in promoting their local efforts.

We have also been invited four times to deliver presentations on our Lake to Land-Focused Environmentally Sound Agriculture program and our system of public participation at the Korea Agricultural Best Management Practice International Conference, hosted by the Korea Rural Community Corporation to discuss ways to decrease water stress induced by agricultural land (2011, Seoul; 2016, Jeonju, etc.). In 2017, we welcomed guests from the Korean Ministry of Agriculture and Rural Affairs and the Korea Rural Community Corporation and guided them through Shiga Prefecture’s lake to land-focused agriculture, Fish Cradle Paddy Project, and community-based efforts to control water contamination at the source, including patrols and monitoring of water discharged from agricultural land.

(Global Cooperation)

The Lake Biwa region, home to the proposed system, has widely communicated the initiatives locally taken for the integrated conservation of Lake Biwa, which supplies water to approximately 14.5 million residents (including residents living in downstream areas, not covered by the proposed GIAHS site). It has also been pursuing international partnerships to conserve healthy lakes and marshes that support freshwater fisheries.

In 1984, the region proposed and held the World Lake Conference, where government representatives, researchers, and citizens involved in the conservation of the world’s lakes and marshes gathered to discuss and encourage concrete actions towards common goals. We have supported subsequent World Lake Conferences, held in various parts of the world biennially.
In 1986, the International Lake Environment Committee (ILEC) was established based on partnership with the United Nations Environment Program and international aid, to collect and provide information, conduct studies and research and offer on-site training associated with the conservation of the world’s lakes and marshes.

We also co-hosted the World Water Forum (2003) (jointly hosted by Shiga, Kyoto, and Osaka prefectures, home to the Lake Biwa and the Yodogawa River catchment areas), the largest international conference on waters, and hosted the Ancient Lakes Forum (2016). Through efforts to collaborate with global partners and make international contributions, we have received many site visits and have been working together on increasing sustainability.

In conclusion, we have shared the lessons learned and endeavored collaboration with other regions of the world, especially the countries that have lakes in temperate and tropical zones. We will continue to communicate the significance of coexistence between the ecosystem and humans, passing on the proposed system to future generations as a living heritage of landscapes and lakescapes embracing livelihoods. This will also contribute to achieving the United Nations Sustainable Development Goals, which seek harmony among economy, society, and environment (refer to section 1.3, p30).

〈Goals and targets that this system will contribute to achievement〉
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