



out the relationship between snails and a kind of snake whose predation is specialized to snails. The report shows that the specialized snake predation drives prey (snail) speciation. Snail Eating Snake (*Pareas iwasakii*), which is specialized predator of snails, is distributed broadly from the Yaeyama Islands of Okinawa to southern China, India, and Southeast Asia. This snake has specialized its jaw to eat dextral (clockwise coiled) snails, because many snails are clockwise coiled. This speciation causes sinistral (counterclockwise coiled) snails survive predation by the snake: the snake tends to

miss capture of the snails when the snake is given sinistral snails. This works as an advantage to sinistral snails, and as a result, many sinistral snails can be observed in regions where the Snail-Eating Snakes is distributed.

According to the Ministry of the Environment's Red List, approximately 30% of terrestrial Molluscan species, including snails, are endangered due to human activities such as logging forests and developing land in their habitats, as their means of movement is crawling over the ground on their bellies and this is a barrier for their survival.

### Pareas Snake Preying on a Snail



Successful predation of a right-coiled shell



Failed predation of a left-coiled shell



The numbers of teeth differ between the left and right sides of the jaw.

Source: Hosono, M., Kameda, Y., Wu, S. P., Asami, T., Kato, M. & Hori, M. (2010)

A speciation gene for left-right reversal in snails results in anti-predator adaptation

Photographs provided by Masaki Hosono

## Section 2 Relationship between the Earth's Environment and Living Organisms

In Section1 we looked at the close relationship between our everyday lives and biodiversity. Our everyday lives depends on biodiversity, and the biodiversity is depend on keeping the living organisms and the ecosystems in good health and preserving the interaction between those

ecosystems and living organisms.

Here focusing on dynamic migration of birds and fish and dispersal of animals, we will discuss the relationship between ecosystems and organisms in order to understand it.

### 1. The Relationship between Organisms and the Earth

#### (1) The Flyway - Crossing in the Sky

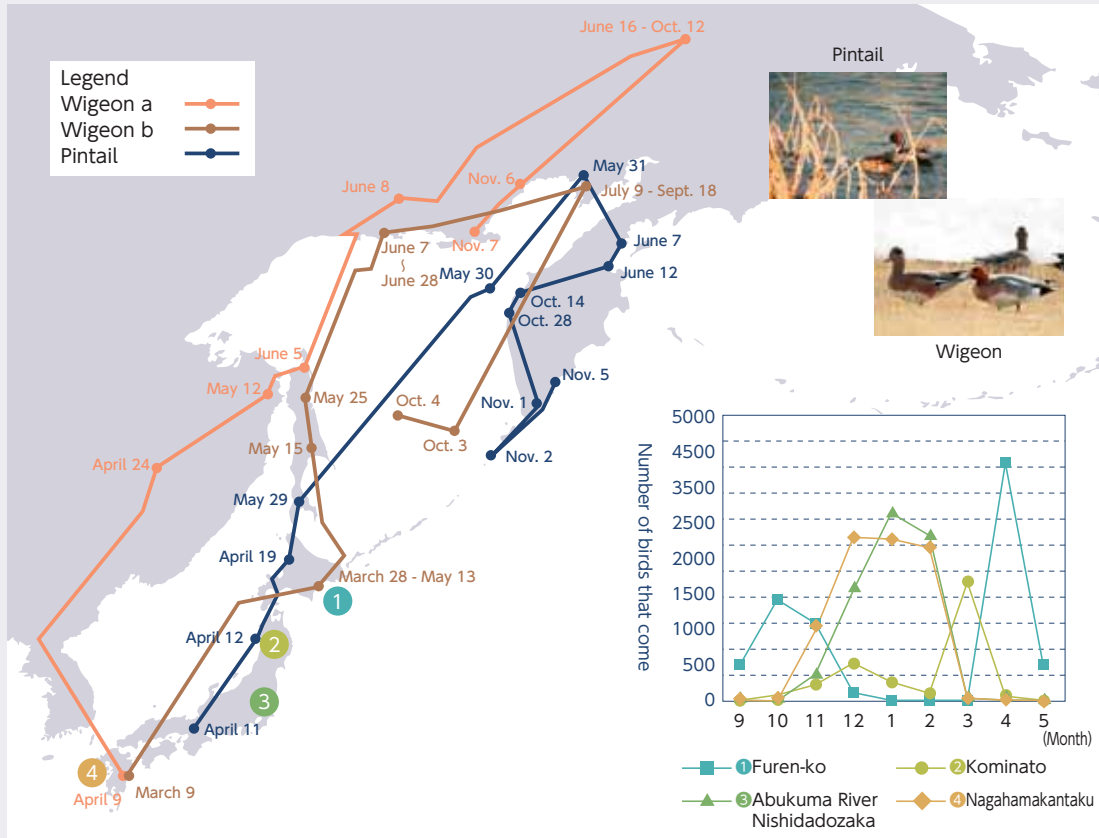
In the Heian Period (8<sup>th</sup> to 12<sup>th</sup> Century), Sei Shonagon, who was a court lady to Empress around year 1000, wrote "The Pillow Book" (in Japanese "Makura no Sōshi"): "In autumn evenings...more charming still is a file of wild geese, like specks in the distant sky." This expresses the sight of aquatic birds migrating over Japan before winter comes, which has an aesthetic of autumn. In recent years, the migrating route of some bird species has been coming clearly due to the development of bird banding surgery, and tracking study technology that uses satellites to ducks and hawks. For example, Wigeon and Pintail, which can be seen in large numbers across Japan from autumn to winter, breed in Russia's Kamchatskaya Peninsula in the summer and then fly to Hokkaido in

autumn. These ducks take a rest of their wings in lakes on their way to the south of Japan, feeding themselves. And they pass the winter in south regions of Japan.

Here we will look at this migration through the trend in number of Pintails that fly to wetlands in Japan. The number of Pintails in Hokkaido reaches a peak around December. After that they fly to the south, and there are hardly few Pintails in Hokkaido's Lake Furenko. Large number of Pintails pass the winter in Japan's southern areas. After they leave for the north before spring, they are no longer seen in the places where they passed the winter. In spring, reaching a peak around April for crossing Hokkaido again, almost none remain in Japan around May (Figure 2-2-1).

Aquatic birds thus use wetlands not by staying in a single place but instead use them like stepping stones.

Figure 2-2-1 Migration Routes for Pintails and Anas Penelopes; and Shifts in the Number of Pintails that Come, by Location



Source: Ministry of the Environment's Study on the State of Bird Migration (FY2009) and Report on Study to Clarify Bird Migration Routes (FY2007)

Each of the wetlands plays an important role for aquatic birds to rest their wings. This interaction of wild bird habitats through the flyway is referred to as a “flyway network,” meaning an interaction of habitats through their flight path. Because this flyway network can be a borderless interaction on a global-scale, it is an important ecosystem network internationally.

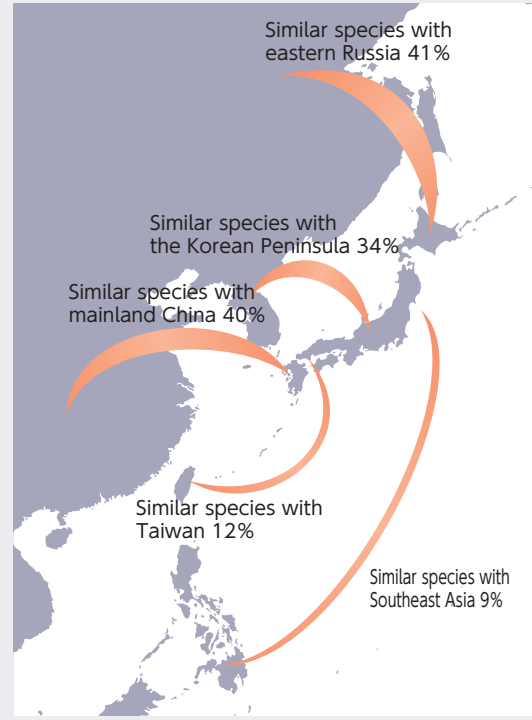
## (2) Diversity of Species Due to Dispersal and Geographic Isolation

The Japanese archipelago in the glacial age differed from today, because it geographically connected to the Eurasia. At that time, various living organisms moved into the Japanese archipelago from Taiwan in the south and the Korean Peninsula and Sakhalin in the north. Many of the mammals and other living organisms that can be seen in Japan today are descendents of the living organisms that came to Japan in the glacial age (Figure 2-2-2).

Those living things were distributed widely across the Japanese archipelago, but they were blocked by the deeply cut Tokara Strait. This geographic isolation causes the difference of species distribution between the north and south of that strait.

In the case of Japan, this appears especially in the diversity and distribution of amphibians. 40 species and subspecies of frogs are distributed in Japan. Almost all of them are distributed either south of the Amami Islands or north of the Tokara Archipelago, and only a few species are distributed on both sides of the Tokara

Figure 2-2-2 Commonality Between Japan's Mammals and Neighboring Regions



Source: Ministry of the Environment's "Japan's Biodiversity - Coexistence of Nature and People"

Strait. For example, the black-spotted pond frog and the Japanese brown frog, which are distributed north of the



Tokara Archipelago, cannot be seen south of the Amami Islands, and the same species and allied species inhabit the Far East, the Korean Peninsula, and northern China. Meanwhile, species distributed south of the Amami Islands cannot be seen north of the Tokara Archipelago, including in Honshu, and most of their allied species are distributed from the southeast portion of China through Southeast Asia (Figure 2-2-3).

Organisms that have been geographically isolated are separated into other species after many years have passed. The 5 species of Okinawa tip-nosed frog, which are distributed in islands south of the Amami Islands on the Ryukyu Archipelago, were isolated approximately 8.7 million years ago. They were separated from their continental ancestors because the sea level rose after the last glacial age, and then after approximately 7 million years they separated into 5 species such as the Amami tip-nosed frog (*Rana amamiensis*) and Utsunomiya's tip-nosed frog (*Rana utsunomiyaorum*) and so on, which are endemic species of the Ryukyu Archipelago. In addition, in the Ornate narrow-mouthed frog (*Microhyla ornate*), which is an endemic species of the Ryukyu Archipelago, extremely large genetic differences have been identified on each of the islands in the Ryukyu Archipelago. This is thought that the Ornate narrow-mouthed frog is separating into different species on each island in the Ryukyu Archipelago.

A characteristic of the amphibians in Japan is that many of them are endemic species. This is because amphibians, which inhabit wetland areas, have become geographically isolated on individual islands or separated due to Japan's mountainous landscape. Of the 64 species and subspecies of amphibians that inhabit Japan,

approximately 80% are endemic to Japan. This is the eleventh highest ratio in the world (Figure 2-2-4).

### (3) The Vast Interaction between Forests and the Sea

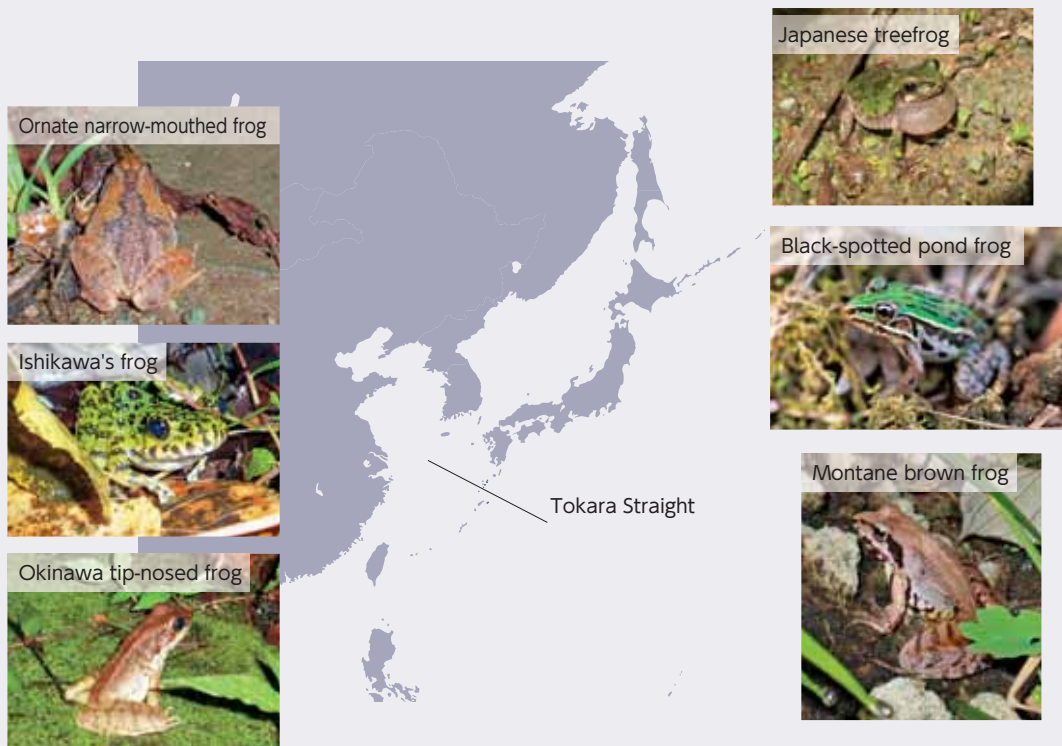
Nutrients flow from forests into the sea through rivers. In the sea, phytoplankton and seaweed grow by using those nutrients. This phytoplankton and seaweed becomes food for zooplankton, small fish and shellfish, and these small living organisms are consumed by bigger fish. The fish and shellfish are used as food by birds and humans. In this way, it is possible to think that ocean and land are connected ecosystems. This ocean-land interaction is sometimes expressed by the phrase "the forest is the ocean's sweetheart."

This kind of interaction is not only the forests and the sea, but also at the borders of ocean and land there are sandy beaches and rocky shores, and a wide variety of organisms inhabit the area. Tidal flats and seaweed beds are particularly rich in organisms and have high water purification capacity. The amount of production of organisms in such coastal areas is extremely abundant, and the juvenile fish are grown in these areas.

A large-scale example of the ocean-land interaction is Amur River and the ocean. Nutrients flow out of the Amur River into Sea of Okhotsk and are carried by the dense and cold flow of seawater that occurs when the sea ice is formed in the northern area of the Sea of Okhotsk. This nutrients nurture rich offshore fishery in the southern area of the Sea of Okhotsk and in the Pacific Ocean.

The Amur River (Chinese name is *Hēilóng Jiāng River*)

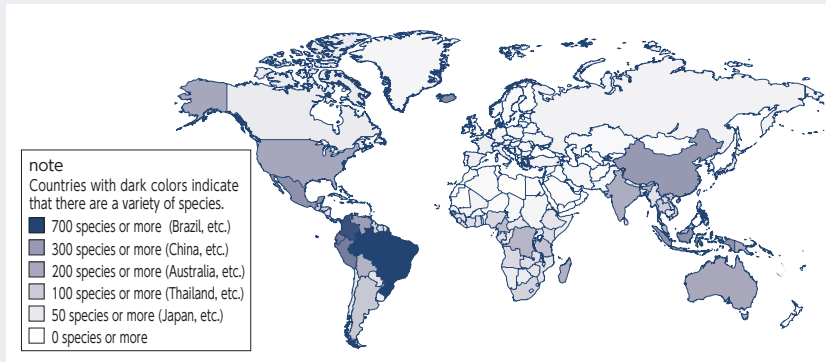
Figure 2-2-3 Distribution of Frogs in Regions on Both Sides of the Tokara Strait



Photographs: Japanese tree frog photograph provided by Tomohiko Shimada. All others by the Ministry of the Environment

Figure 2-2-4 World Distribution of Amphibian Species

Approximately 6,400 species of amphibians have been confirmed in the world, and many of them are distributed mainly in tropical areas (figure on the left). Although the number of species of amphibians that inhabit Japan is less than in countries in such areas, Japan is characterized by having many endemic species (table on the right).



Rank	Country	Endemic species/ Inhabiting species (%)
1	Jamaica	100
2	Seychelles	100
3	Sao Tome and Principe	100
4	New Zealand	100
5	Fiji	100
6	Palau	100
7	Madagascar	99
8	Cuba	96
9	Australia	93
10	Sri Lanka	84
11	Japan	80
12	Philippines	79
13	Puerto Rico	78
14	Chile	70
15	Papua New Guinea	70

Source: Created by the Ministry of the Environment, using information from the IUCN Global Amphibian Assessment (GAA)

is a large river that flows in the northeast area of the Eurasian continent. Its length is approximately 4,400 km, and the land area of its basin is approximately 2.05

million km<sup>2</sup>. Sea ice in the Sea of Okhotsk is formed when the Amur River pours into Amur Bay. In the northern area of the Sea of Okhotsk, freshwater from the Amur

Column

“The Forest is the Ocean’s Sweetheart Movement” and Damage from Earthquakes

The phrase “the forest is the ocean’s sweetheart” became known throughout Japan from a book of the same name written by Shigeatsu Hatakeyama, who works in the fishery in Karakuwa Town, Miyagi Prefecture. Here we will refer to “The Forest is the Ocean’s Sweetheart (by Shigeatsu Hatakeyama)”.

“Miyagi Prefecture’s Kesenuma Bay is an unparalleled good port with deep water and calm waves, which is unique to the deeply indented coastline. It is one of the nation’s leading fishing ports and at the same time aquaculture industry is vigorous, with oysters, scallops, and kelp being produced. What increases the value of the fishing grounds of this bay is the Ogawa River, which originates in Murone Village, Iwate Prefecture and pours into Kesenuma Bay, carrying nutrients of the forest all the way to the distant Karakuwa Peninsula. In the past, the delta at the mouth of the Ogawa River was famous as a seed home for premium-quality Nori (*Porphyra tenera*), and the ocean downstream at Matsuiwa and Hashikami were famous as fishing grounds where good-quality seaweed could be harvested. Kesenuma Bay’s seaweed cultivation boasted of such outstanding quality and amounts, but the situation changed around 1961, and it turned seaweed cultivation there into a shambles.”

Mr. Hatakeyama came to recognize that changes in the watershed as a whole including the sequence of forests, rivers, and the sea, are having major effects on Kesenuma’s fishing industry. Such changes included reclaiming land in the tidal flats of the mouth of the Ogawa River that pours into Kesenuma Bay, filling the rivers that feed into the Ogawa River

with concrete blocks, reduction of the water level of rivers, and a change of broadleaf tree forests upstream into forest plantations of coniferous trees.

Based on the belief that we cannot protect the rich resources of the sea without the interaction between forests, rivers, and the sea, Mr. Hatakeyama continued to talk with people who live near rivers and in forests, and began to interact with the people of fishery that cultivate oysters and the people who live along the Ogawa River.

After that he expanded his interactions to people in various positions who live in the basin from upstream to the river mouth area, which developed into forestation activities in the upstream area by local fishing people. As a result of those efforts, the forest of Oak (*Quercus crispula*), Beech, and other trees in upstream Muroneyama was named “Oyster Forest” and it has been carefully preserved. This movement has also spread across the nation, and in each region people have become aware of the necessity for management that connects forests, rivers, and the sea.

Due to the massive magnitude 9.0 earthquake centered off the Sanriku coast that struck on March 11, 2011 and the resulting tsunami, fishing industries across a wide area, mainly in areas along the Pacific Coast in the Tohoku region, suffered catastrophic damage. The fishing industry in Kesenuma also had enormous damage; fishing industry facilities such as offices, fishing boats, and cultivation floats were washed away by the tsunami. A ring of support by NPOs and others has begun to spread, and steps are being made in the direction of recovery of the sea.



River mixes with the seawater, and in winter the low-salt content water freezes and turns into sea ice, caused by extremely cold seasonal winds from the northwest. As the sea ice is formed, cold and high salinity seawater, which is heavy, sinks and flows out from the continental shelf. In that process iron supplied by the Amur River is carried to the southern area of the Sea of Okhotsk and the North Pacific Ocean. In the Sea of Okhotsk, these nutrients are used by large amounts of phytoplankton, which becomes food as salmon, trout, cod, herring, saury, crabs, pink shrimp, Hokkai shrimp, scallops, kelp, and oysters, which nurtures the rich offshore fishery of the Sea of Okhotsk.

Seawater that includes nutritional elements has a heavy specific gravity and sinks as far as a depth of 200-500 meters, and it is blocked by the Kuril Islands and changes course. However, because there is a deep trench more than 2,000 meters deep in the Bussol' Strait to the northeast of Iturup Island, it passes through this strait while still containing the nutritional elements, and it is churned by merging with the Oyashio Current on the Pacific Ocean side.

This iron is again supplied to the surface layer by the seawater cycle system that is caused by the cooling of the ocean surface in winter. This supply of the iron causes an increase of growth of phytoplankton. It is known to support the marine and terrestrial ecosystems of the North Pacific. The rich nutrients flowed out of the Amur River nurture phytoplankton and form rich offshore fishery in the seas near Japan (Figure 2-2-5).

Next we will take a look at living organisms in the ocean. There are various patterns in breeding of marine animals and migrating fish and patterns in the processes of growth and development of young fish. For example, there are some fish like salmon, which hatch in inland water areas, swim to the ocean as young fish, grow up in the ocean, and then return again to rivers. There are some fish like eels, which hatch in the ocean, make their way up to rivers as young eels, grow up in inland water areas, and then return again to the ocean. In addition to

these migration patterns, there are fish which do something in between, such as sweetfish, that hatch in inland water areas and swim to the ocean as young fish, but return to inland water areas before they grow up, and grow into adult fish there. Japanese perch, which hatch in the ocean, swim to rivers as young fish, and then return again as young fish to the ocean, where they grow up.

For fish that migrate between the two different water areas of ocean and inland water, it is extremely important for their process of growth and development to preserve both environments.

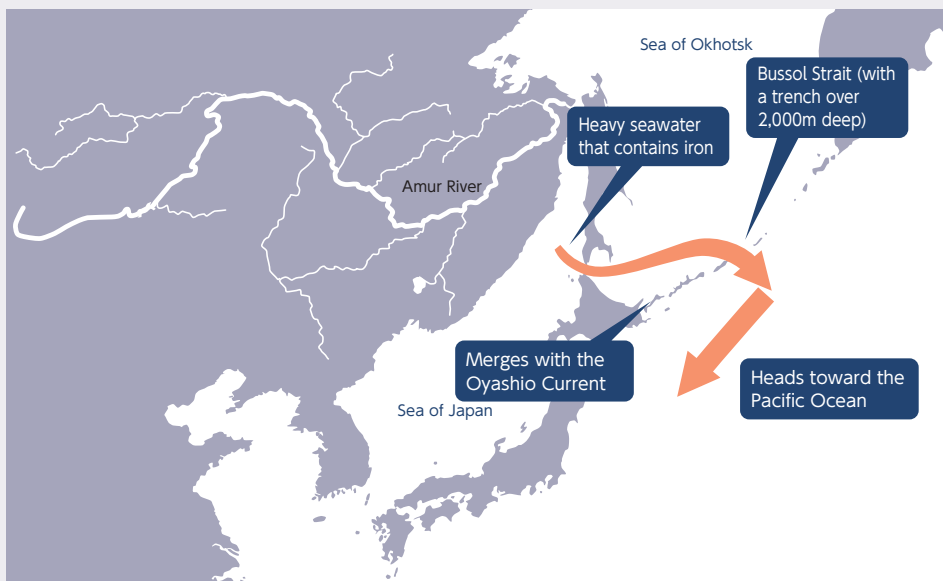
Tracking studies on these migration routes are difficult, and their actual model of life has been a mystery. But

Figure 2-2-6 Eel Migration Route



Figure: Created by the Ministry of the Environment, using information from the article "Amazing Discovery of Eel Eggs" in the February 12, 2011 Nihon Keizai Shimbun morning edition

Figure 2-2-5 Iron That Flows From the Amur River, Carried by Ocean Currents



Source: Created by the Ministry of the Environment

recently a portion of the migration route of sea turtles has been clarified by tracking using satellites, baby eel and eel eggs have been discovered in oceans far away from Japan, and accumulation of knowledge related to such animal movement has made remarkable progress (Figure 2-2-6).

Lastly, in contrast to the flow of nutrient from land to ocean, there are also flows that go from ocean to land through rivers. For example, nutrients from the ocean are carried up in rivers by salmon swimming upstream. The salmon that have come upstream are preyed on by brown bears and sea eagles and become wastes such as leftovers and excrement. Nutrient salts are supplied to land by sea birds, which catch fish in the ocean and carry them to their nests in land and return them to soil as waste. These organic molecules are used by the plants and animals living in the forest (Figure 2-2-7)

Figure 2-2-7 Connections based on the Food Chain between Land Areas and Sea Areas in Shiretoko



Source: Shiretoko National Park pamphlet (Ministry of the Environment)

Column

The History of Bird Dropping and Humans

From the time that agriculture began until the present, we humans had a serious problem concerning how to obtain the nutrient salts necessary for fertilization. The three major elements necessary for growing plants are nitrogen, potassium and phosphorous. Potassium is an element that is found in greater amounts in land areas than in the sea. Nitrogen is an element that is circulated through the air and soil by bacteria that can fix nitrogen from the air to the ground. However, phosphorous is abundant in the sea but scarce in land areas, and natural cycle systems for circulating the soil of ocean and land were limited.

Chile and Peru have large amounts of mineral ore derived from bird excrement called “guano” that sea birds such as Cormorant built up over the past several thousand years. Since the era of the Inca Empire, “guano” has been used as precious phosphorous and nitrogen fertilizer. It is believed that on Chincha Island, which is one of the islands that has guano, there were sediments derived from bird excrement that exceeded 30m. From the 19<sup>th</sup> century to the 20<sup>th</sup> century, countries mainly in Europe imported this mineral ore as a resource necessary for fertilizer. It contributed greatly to the increase of food production of in the European region at that time and was treated as important mineral resource for the region.

Great Cormorants Building a Nest



Photograph provided by Kentaro Takagi of the NPO Japan Bird Research Association

In Japan as well, it was a known wisdom from long ago to use the excrement of water birds as a means of solving problems related to a shortage of phosphorous. The Great Cormorant in the photograph on the left is one of such water birds.

The Great Cormorant is a fish-eating water bird that inhabits all of Japan. It dives into the water to catch fish across a wide range of water areas from ocean areas to brackish water areas in coastal regions and in freshwater areas in inland regions. It is also known that they cause enormous damage to inland fishery because of the greedy appetite. In order to raise their chicks, Great Cormorants build nests in the tree crowns of forests near waterfronts, and in recent years in Japan they have formed a giant colony of tens of thousands of birds on Chikubu Island in Shiga Prefecture.

Amounts of excrement of Great Cormorants is so large that it causes large impact on vegetation and trees around the colony wither and die. On the other hand, since long ago that excrement has been utilized as very valuable in the form of fertilizer for agriculture.



At Daiganji Temple, which was designated by Chiba Prefecture in 1935 as a natural treasure, there are records of Great Cormorants building colonies from 400 years ago. It is said that the residents carpeted with straw and sand under their nests and they made the fertilizer from the collected excrement until around 1960. The price of the fertilizer reached several thousand yen at that time as important income

for the residents. This colony disappeared in 1971 because of development in the surrounding area.

Although the excrement of these birds is no longer used as resource because of the introduction of chemical fertilizers, this can be considered a piece of important wisdom toward coexistence between nature and humans that depend on a nutrient cycle between water and land.

## 2. Loss of interaction between human and ecosystem

All living organisms, including humans, are deeply interacted with each other. In order to keep interactions in good condition, it is necessary for us to maintain the Earth's environment such as land, ocean and biodiversity, which serves healthy cycle systems of water and air. These biotic interactions in ecosystems are referred to as the ecological network, in which the multi-faceted functions of biodiversity are fully performed. The ecological network provides wildlife habitat and human interaction with nature.

However, in recent years urbanization and other various human activities have caused the loss of ecosystems, fragmentation of the network, and trans-boundary environmental problems that spread through global-scale cycle systems of water and air. Photochemical oxidant causes trans-boundary air pollution, coming from the emission sources through the air and cross national borders to affect even regions thousands of kilometers away. Marine litters comes via the ocean, drifts ashore, and disperses. Here we will consider loss of healthy interactions in the earth's environment caused by human activities.

### (1) Loss of interactions in Forest Ecosystems

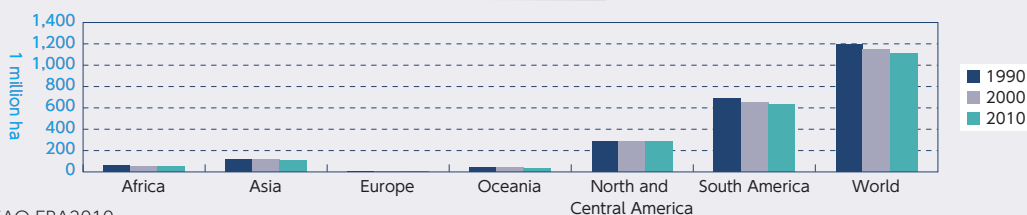
As seen in Chapter 1, the world's forests have been decreasing due to human-caused effects such as commercial logging, excessive logging for wood fuel or converting forests to other purposes such as agricultural land, and due to natural causes such as forest fires.

From 2000 to 2010, each year around 13 million hectares of forests were converted to other uses. In this ten-year period, there has been an annual net reduction of 5.2 million hectares of forests, and although the speed of reduction is shifting slower than the annual 8.3 million hectares of the 1990s, it remains at a high level.

Primary forests, which are important for conservation of biological diversity, exist approximately 1.1 billion hectares around the world and are distributed mainly in North America, South America, and Southeast Asia. Primary forests are declining around the world, with approximately 88.6 million hectares of them disappearing between 1990 and 2010.

It is important to evaluate the degree of the size and connection for measuring the biodiversity of forests. In the tropical forests of Southeast Asia, the fragmentation of forests causes major impacts on the biodiversity of the

Figure 2-2-8 Annual change of forest area by country 2005-2010 (Upper Illustration) and Area of primary forest by region (Lower Graph)



Source: FAO FRA2010

forests. In Thailand, large elephants and tigers are distributed national parks with land area of 1,400 km<sup>2</sup> or more, while neither animal are distributed two-thirds of national parks with 500 km<sup>2</sup> or less. In Malaysian-ruled Sarawak and Sabah on the island of Borneo, orangutans are distributed the approximate area of 2,800 km<sup>2</sup> around the Hose Mountains, while there is no natural distribution of orangutans in national parks of 700 km<sup>2</sup> or less. Large herbivorous animals such as elephants and orangutans have functions of seed dispersal by eating the fruit of plants and moving around expansive areas within forests. Thus fragmentation of forests causes serious impact on plant reproduction that depends on these animals.

Quantitative evaluation methods of the degree of fragmentation has been developed. In Europe, fragmentation of forests is quantified according to the size of patches and distances between patches on maps. From 2000 until 2006, forest fragmentation is increasing in Sweden and Portugal, while forest land size does not decline. In Finland the level of connections is recovering (Figure 2-2-10). In Finland, forest managements based on the Finnish Forest Certification System (FFCS) as a means of sustainable forest management are proceeding, and more than 90% of the forests in Finland are managed under that system.

As for Japan, there remain forests with relatively high connection that run along the mountainous backbone, and around them there are small-scale forests fragmented by agricultural land, city land, and roads. Figure 2-2-11 shows the ratios of forests included in the 500m pixels of the figure on the left and the 4km pixels of the figure on the right, of which color-coding is according to the ratio. These figures suggest tendencies of low fragmentation in the Hokkaido, Tohoku, and Chubu areas and high fragmentation in the Kinki, Chugoku, and Kyushu regions (Figure 2-2-11).

The habitats of wildlife become separated due to fragmentation. Asiatic black bear, a large mammal living in forest, is reported to have a large range of activity;

an annual range of movement is about 5,000 hectares for males and 1,000-3,000 hectares for females. Asiatic black bears are regional endangered species of the Shimokita Peninsula, the Kii Peninsula, East Chugoku, West Chugoku, Shikoku, and Kyushu, in which the forests are isolated from the others. They have listed on the Ministry of the Environment's Red List as threatened local populations.

Migration paths called "green corridors" have been established in 24 locations in national forests in Japan, which link the "forest reserve" and serve as networks in order to keep interaction among habitats of plant and animal and to preserve genetic diversity.

## (2) Loss of Interactions in Fresh Water Ecosystem

The interactions in fresh water ecosystem are extremely important for living organisms that habit in fresh water areas. For example, adult Tokyo salamanders

Figure 2-2-9 Relationships between Forest Land Area and Existence of Habitats for Large Animals

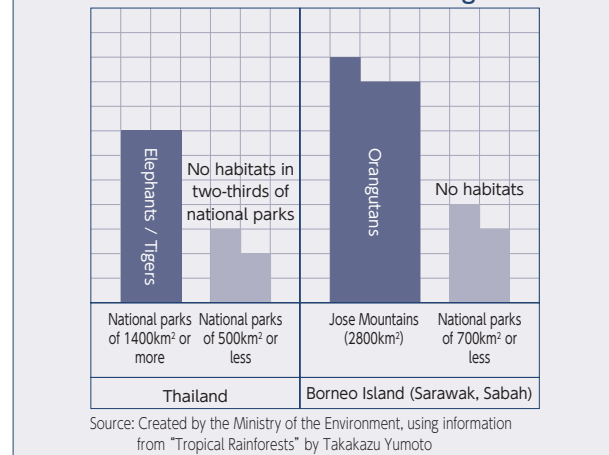


Figure 2-2-10 Changes in Forest Fragmentation in the EU

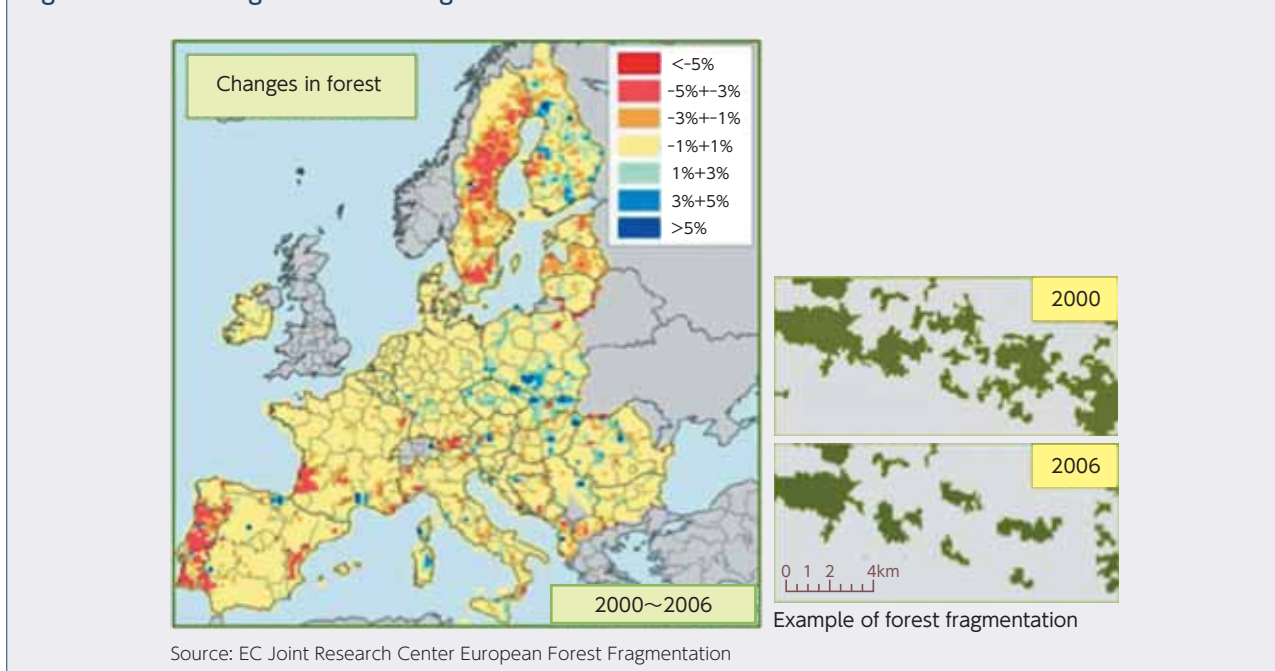
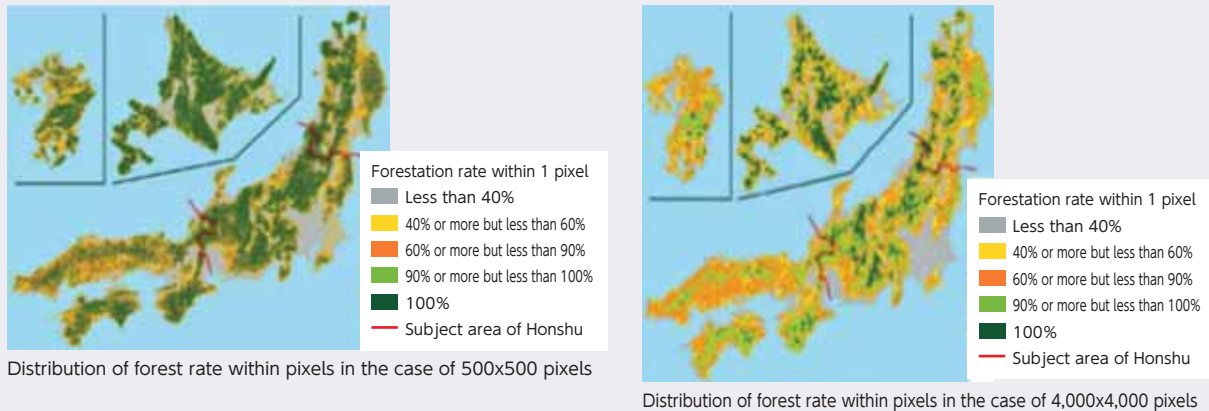




Figure 2-2-11 Distribution of Forestation Rates in Japan and an Image of a Green Corridor



Distribution of forest rate within pixels in the case of 500x500 pixels

Distribution of forest rate within pixels in the case of 4,000x4,000 pixels

[Image of a green corridor]

Forest reserve

Green corridor

Source: Forestry Agency Montreal Process Second Report by Country and an image of a green corridor (available in the website)



(*Hynobius tokyoensis*) inhabit forests, but, during their larval stage they move to moist environment such as rice paddies and mountainous wetlands and lay their eggs in water. The distance of movement for their egg laying is approximately 50-130 meters, and they need interaction between forest and water ecosystems such as rice paddies within a relatively narrow range.

As another example, Japanese giant salamander (*Andrias japonicus*) spends most of their lives in the water of a river. During their breeding season, they move several hundred meters or several kilometers upstream and downstream in the river. It is difficult for them to move back upstream if there is an obstruction of approximately 80cm in height lying across the river. So they rely on a river environment with few obstructions in their habitat.

River ecosystems have been affected significantly by various impacts such as water shortage, changes of river course, fragmentation of river flow, reduction of sand and gravel supply, reduction of flood disturbance and river water pollution. These are because of residential housing and other infrastructural development around riverside and of conversion of floodplains, wetlands and riverfront forests into agriculture land.

According to the United Nations Environment Programme - World Conservation Monitoring Center (UNEP-WCMC), fragmentation due to dams and river deposits can be seen in two-thirds of the world's large rivers. Rivers tend to be highly fragmented in dry areas or in countries with extremely large populations, such as the United States, Europe and China. On the other hand,

ivers in areas with low population density, such as Alaska, Canada, and Russia, tend to be not fragmented, and flow freely in their original state (Figure 2-2-12).

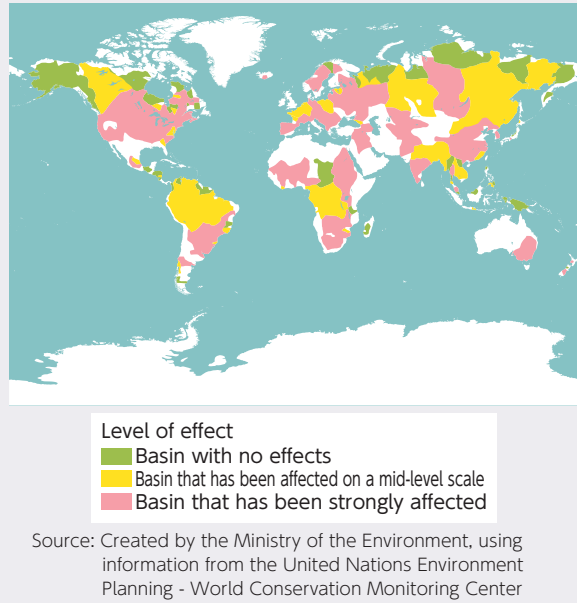
In Japan as well, fragmentation caused by dams can be seen since around 1930s. In the 1990s, Ministry of the Environment had a survey about the range of river flows in which it is possible for fish, such as cherry salmon and sweetfish with strong ability for swimming up, to swim up freely from river mouth to upstream. The 41 % of main rivers in Japan (46 of the 113 rivers) are fragmented rivers in which the range possible for fish to swim up from the river mouth is half or less of the river flow. The 15% of main rivers (17 of 113 the rivers) are highly fragmented rivers in which the range is only a quarter or less (Figure 2-2-13).

It was also reported that change of river basin environments impacts on the ocean environments. Here is an example of the relationship between Sagami River and Sagami Bay in Kanagawa Prefecture.

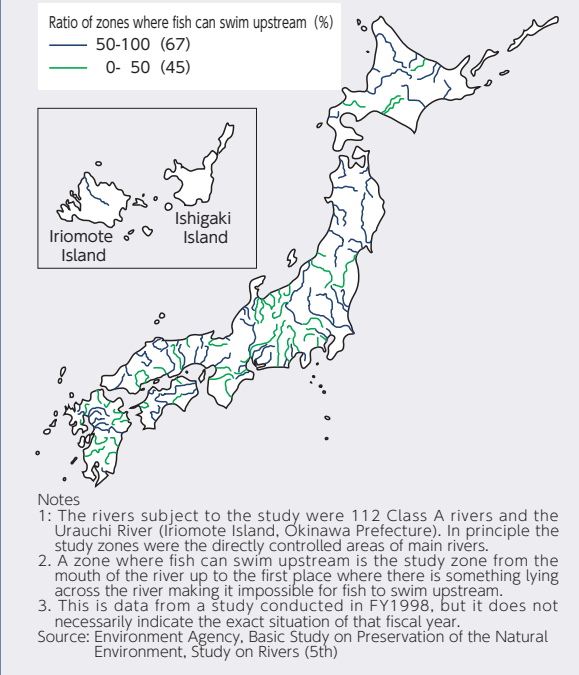
In the Sagami River, which flows into Sagami Bay, various human activities such as erosion control, construction of dams, and gravel extraction have been carried out. These human activities have various benefits for people's everyday lives, but they also change the dynamics of sediment transport, which recently causes the reduction of dam's capacity for water storage and the impacts on ecosystem of the river basin.

The dams in Sagami River are affected by these changes of sediment transport. In Sagami Dam, sand deposition in the dam is proceeding and the water storage capacity is declining. From Shiroyama Dam to the mouth

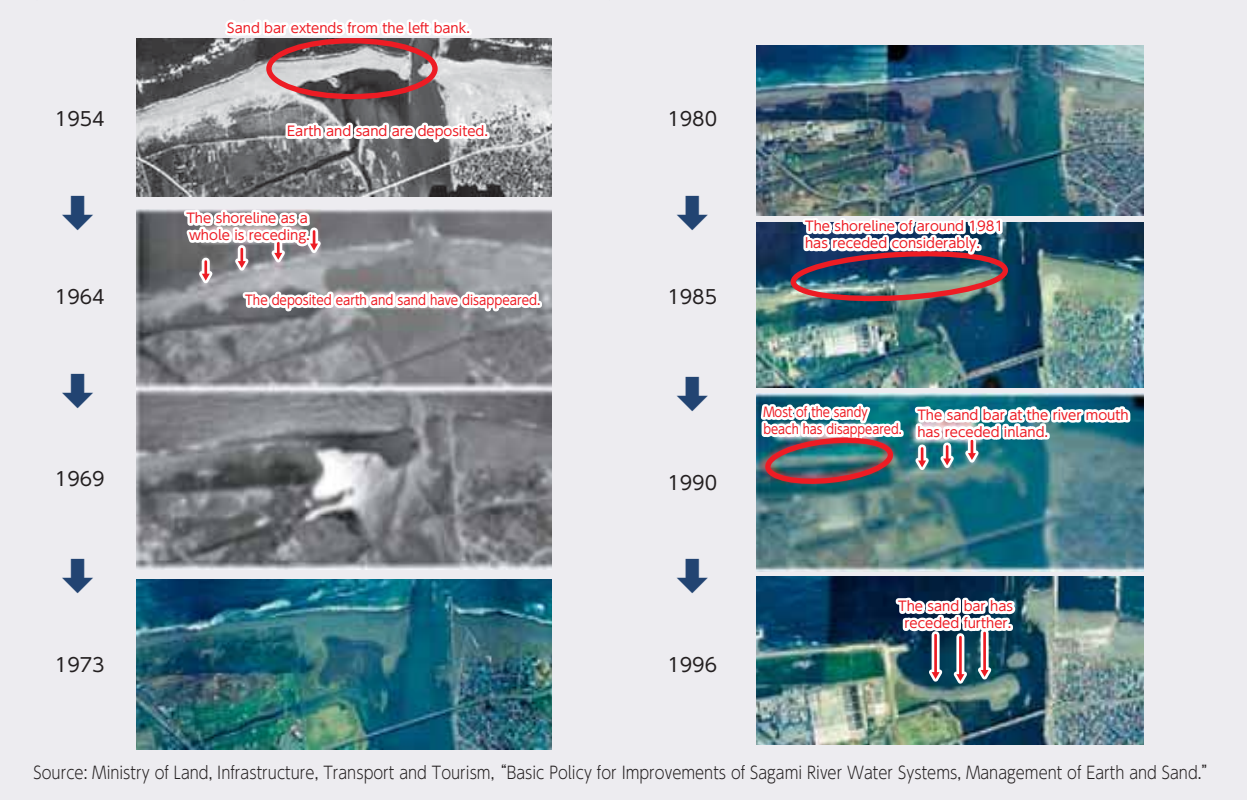
**Figure 2-2-12 State of Fragmentation of the World's Rivers**



**Figure 2-2-13 Ratios of Zones Where Fish Swim Upstream**



**Figure 2-2-14 Changes in the River Mouth of the Sagami River**



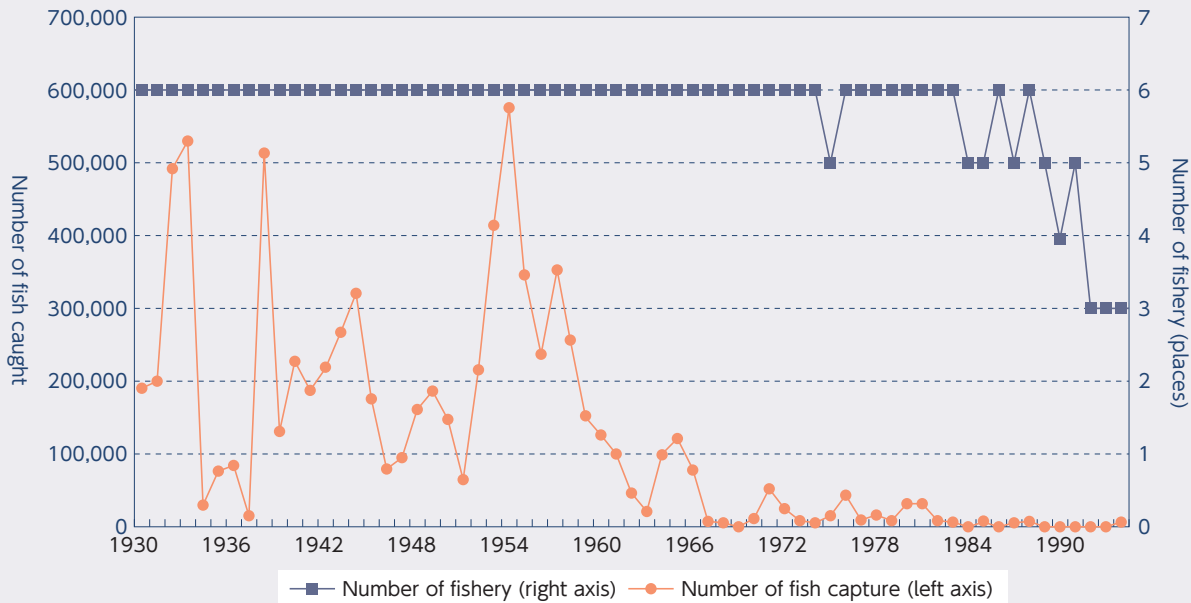
of the river, which is the mid- to downstream of the Sagami River, riverfront ecosystems are destroyed due to reduction of gravelly dry riverbeds. The environment of rapids and pools of the river become to worsen, which is needed for aquatic organisms as their habitat. These are because of a reduction in the amount of gravel movement due to dam construction. In coastal areas around the Sagami River mouth, there is a decline of tidelands that are stopover site for migrating birds, and

the sandy beaches on the Chigasaki coast are receding (Figure 2-2-14).

In ocean areas of Sagami Bay, the fish migratory path way of yellowtail has changed. Around 1955 Sagami Bay was one of Japan's leading near shore fishery for yellowtail and there were maximum captures of approximately 600,000 fish. But since the 1990s the numbers have decreased between several dozen fish and several thousand fish (Figure 2-2-14). There are various



Figure 2-2-15 Shifts in the Number of Yellowtail Capture in Sagami Bay



Source: Created by the Ministry of the Environment, using information from "Changes of Set Net Type - Changes of Set Net Type in Sagami Bay - 2. Big Set Net Type" by Taisuke Hiramoto

Figure 2-2-16 Image of Marine Recovery Action



- The pollution load from land areas is large.
- Purification abilities in ocean areas are declining.



Recover of a beautiful, approachable, rich ocean, through a forest-river-ocean network  
 ※This image depicts Osaka Bay.

Source: Japan Coast Guard, Bay recovery Project website

conceivable causes for this, but in order to restore yellowtail capture, local government are trying to keep the interaction with forests and the sea by restoring the forests in the upstream region of the Sakawa River, which flows into Sagami Bay (Figure 2-2-15).

In the perspective of management of the wide-range environment from land areas to ocean through rivers, integrated management of the river basins is being promoted. As an effort to promote improvement of the environment, there is a Bay recovery Project that is being jointly implemented by the national government, local governments, and various organizations (Figure 2-2-16). At present, work is being done in the four places of Tokyo Bay, Osaka Bay, Ise Bay, and Hiroshima Bay to conduct monitoring based on quantitative scientific data, and efforts are taken to improve ocean area environments, improve sewage systems in basins, reduce pollution from river, and collect waste in ocean areas.

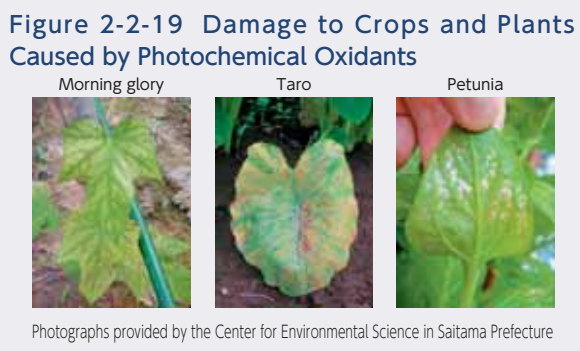
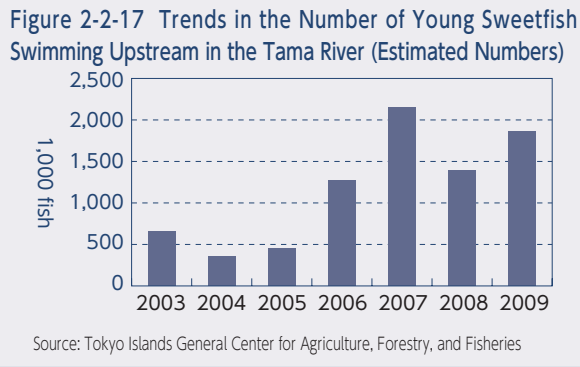
In recent years some of basin environments are heading in the direction of improvement. The environment of the Chikuma River in Nagano Prefecture was improved

through adjustment of water amount, and in 2010 salmon swam upstream for the first time in 65 years.

The water quality of Tama River, which flows out from Mount Kasatori in Yamanashi Prefecture and flows into Tokyo Bay, has been improved and in recent years the population of young sweetfish swimming upstream is increasing. These are results of improvements of sewage treatment in the basin, while it has still been affected by environmental impacts such as spread of invasive alien species like black bass and a trend of increasing river water temperature (Figures 2-2-17, 18). Further, Tama River was designated a model river since 1991 under the "Program for Improving Rivers of Fish Easily Swimming up" and fish passages has been made on dams that were obstacles for fish swimming up.

### (3) Trans-Boundary Pollution

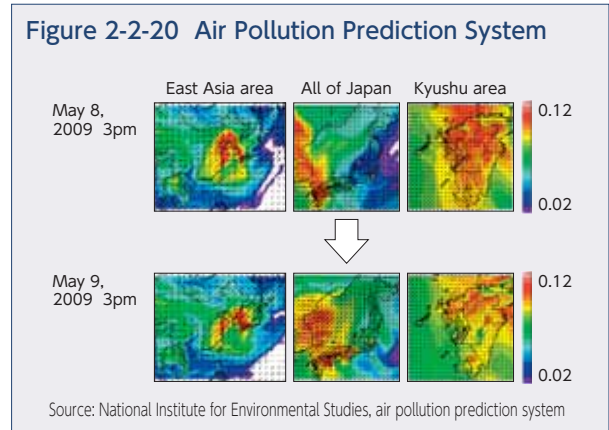
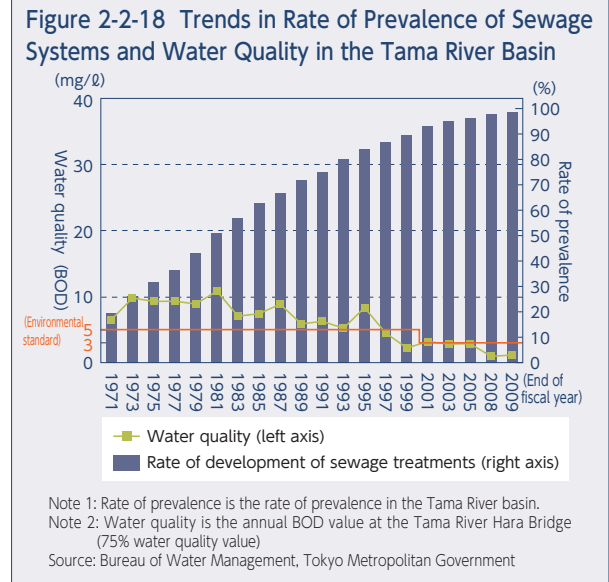
The first time that trans-boundary air pollution became a problem was in the 1960s and 1970s when acid rain was affecting the ecosystems of lakes and forests and



traditional buildings in North America and Europe. It is known that through air cycle systems on a global scale acid rain damages on areas several thousand kilometers away from the source of the material that caused it, and it is an environmental problem that crosses national borders.

In Japan, efforts related to trans-border air pollution, which was initially targeted at acid rain, have in recent years broadened to target photochemical oxidants. Photochemical oxidants are the substances that cause photochemical smog, which damages human health, crops, and plants (Figure 2-2-19).

Highly concentrated photochemical oxidants continue to be observed. In May 2009 an increase of concentration was seen across a wide area in the Kyushu and Chugoku regions, and a photochemical oxidant warning was issued for the first time in Kagoshima Prefecture. When it is predicted that photochemical smog can easily develop across a wide area, the Japan Meteorological Agency announces information about general smog weather. The National Institute for Environmental Studies uses an “air pollution prediction system” to predict the air pollution concentration of photochemical oxidants and nitrogen dioxide in the East Asian region from a weather model and a chemical transport model, and announces the results every hour on a trial basis in the form of a distribution map of pollution concentration (Figure 2-2-20). This prediction system divides East Asia into meshes of 100 km<sup>2</sup> and Japan into meshes of 25 km<sup>2</sup>, and since April 2010 it has been possible to indicate prediction results for all of Japan. Figure 2-2-20 shows in color gradation from yellow to red the areas for which highly concentrated photochemical oxidants were predicted by the air pollution prediction system in May 2009. Meanwhile, Figure 2-2-21 shows the distribution of concentration actually measured by the Ministry of the Environment’s “Sora Mame Kun (Atmospheric Environmental Regional Observation System)” and the



state of photochemical oxidant warnings issued. According to these figures, on May 9 in each of the areas of Japan where highly concentrated photochemical oxidants were predicted, air pollution was actually measured.

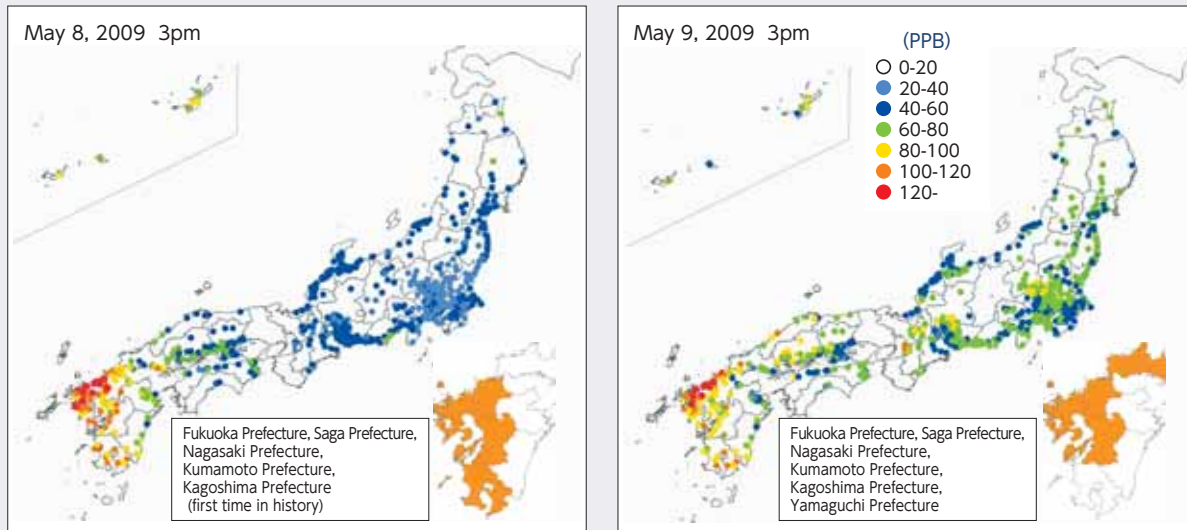
There is also an environmental problem of trash that drifts via circulation in the ocean: it affects scenery and leisure; it affects security of everyday life, which is especially caused by medical waste; it affects the fishing industry and marine transport due to interference with navigation; and it affects living organisms in the ocean by entangling their bodies.

In Japan, related ministries and agencies are tying up under the Council for Promoting Measures Against Marine Litters, which was newly established based on the Law Concerning the Promotion of Disposal of Marine Litters for Conservation of Good Scenery and Environment on the Coasts. And monitoring of marine litters, studies for source of them, and actions against marine litters are going forward. Moreover, in order to strengthen world-wide measures to this problem, cooperation such as mutual information exchanges and policy dialogues for investigating for resource of marine litters come from are being promoted through.

All of the organisms on the Earth, including humans, are able to receive various benefits from the Earth by keeping ecosystem in good condition. The healthy interactions between ecosystems and organisms are essential to the existence of all organisms.



Figure 2-2-21 State of Photochemical Oxidant Warnings Issued



Source: Ministry of the Environment's Atmospheric Environmental Regional Observation System

## Section 3 Wisdom in Order to Take over the Earth to Future Generations

The loss of biodiversity caused by changes in our society and economy affects the interaction between organisms on the Earth as well as our everyday and traditional lifestyle. What are necessary for taking over our life and culture across generation, and for

preservation and sustainable use of biodiversity?

In this section we will focus on “wisdom” and consider how to achieve a sustainable society which reflects the geographical and climates conditions in regions.

### 1. Wisdom in Our Everyday Life

Here we try to get the hints of the wisdom from our everyday life through clothing, cooking and housing.

#### (1) Wisdom in Life Cycle of Japanese Traditional Clothing

Japanese traditional clothing “Kimono” is made from linear parts of cloth. A piece of rolled cloth called a “*tan-mono*”, that is about 12 meters in length and 36 centimeters wide (for clothes of a woman who is 160cm tall), is cut into several liner parts and then sewed them flatly together. Kimono is “incomplete”, in a sense, at the product stage because they acquire a function as clothes when it is “wrapped and fitted” to fit one’s body shape who wears it, while western clothing is made “completely” by sewing parts of cloth together three-dimensionally at the product stage (Figure 2-3-1).

Because of this style of Japanese traditional clothing, it is relatively easy to return it from clothes (“Kimono” state) to rolled cloth (its original “*tan-mono*” state). In addition, silk, which is one of the materials used in the fabric of Japanese traditional clothing, is a very strong fiber that silkworms produce within their bodies. If managed appropriately, it can use over an extremely long time, and rolled clothes can be retailored to fit one’s body shape and preferences.

Kimono that was tailored in a parent’s generation can be retailored to fit preferences and body shape, and then passed on to a child’s generation and in some cases even carefully passed on to a grandchild’s generation. After that, when the clothes finally can no longer, it can be reused as house hold uses such as children’s dolls and wallets. This important resource from living organisms can be used to the end with none to waste.

This recycling system of Kimono was general in the Edo Period. Clothes were so expensive that people needed to continue to wear as long as possible. This was a spirit to use the value and role of the products to the end. This is summarized in a word “*mottainai*” (means “what a waste!”), and this spirit is one of important wisdom in our everyday life for the sustainable use of resources.

#### (2) Local Production for Local Consumption and Seasonal Production for Seasonal Consumption: Wisdom for Controlling Consumption

Next we will discuss the wisdom for sustainable use of resources, focusing on Japan’s dining table.

Agriculture, forest, and fishery products are important products that are derived from the ecosystem services that are based on biodiversity. We have obtained,