環境省
Ministry of the Environment

Ministry of the Environment, Japan

ENVIRONMENTAL IMPACT ASSESSMENT TECHNICAL GUIDEBOOK

PRELIMINARY TRANSLATED VERSION

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MARCH 2021

PREFACE

This Environmental Impact Assessment Technical Guidebook was translated into English for the purpose of promoting capacity development of the officers and staff of Environmental Conservation Department (ECD), Ministry of Natural Resources and Environmental Conservation (MONREC) of the Republic of the Union of Myanmar. Ministry of the Environment, JAPAN (MOEJ) initiated the work as part of Environmental Impact Assessment Cooperation Project with Myanmar. Intended users are required to get the approval from Ministry of the Environment, Japan when diverting the Guidebook for other purpose not related to capacity building of ECD.

MOEJ hopes that this Guidebook will assist environmental authorities in the review of Environmental Impact Assessment (EIA) reports, develop strategies and enforce the effective implementation of environment management in the country.

Chapter I
Environmental Impact Assessments on Biodiversity and Contact with Nature

Chapter I. Environmental Impact Assessments on Biodiversity and Contact with Nature

Japan's Basic Environment Law (Law No. 91), enacted in 1993, recommends that environmental impact assessments be carried out as part of basic measures for environmental conservation. This formed the basis for the later enactment of the Environmental Impact Assessment Act (Law No. 81) in 1997.

The Environmental Impact Assessment Act stipulates procedures and approaches designed to ensure that environmental impact assessments are carried out appropriately and smoothly for large-scale projects that could have a serious impact on the environment. It requires that the project proponent conduct in advance proper surveys, forecasts, and evaluations of the impact that implementation of the project may have on the environment, inviting the opinions of the general public, local governments, and those with the authority to grant approvals and licenses in consideration of the views of the Minister of the Environment, in order to ensure that appropriate consideration is given to environmental conservation via procedures for reflecting these opinions in the approvals and licensing related to the project. It specifies 13 types of projects subject to environmental impact assessments, among them roads, dams, railways, airports, and power plants. A government ordinance was also issued to define for each of these categories the scope of projects with sufficient scale to potentially have a serious impact on the environment.

General concepts for selecting the required environmental impact assessment items as well as the survey, forecast, and evaluation methods for specifically advancing the Environmental Impact Assessment Act are defined in polices formulated via ministerial ordinances issued by the competent minister for each of the project categories defined in the government ordinance. Concepts that are common to all project categories are defined in "The Basic Matters relating to the Guidelines etc. to be Established by the Competent Minister in Accordance with the Provisions of the Environmental Impact Assessment Act" (the "basic matters). These basic matters are listed under four categories, three of which are environmental components subject to environmental impact assessments (maintenance of sound condition of natural components of the environment, ensuring biodiversity and systematic conservation of the natural environment, and beneficial contact between people and nature) and one (environmental loads) that cuts across all three of these categories in order to appropriately grasp the amount of load placed on the environment. The basic matters were later revised in June 2013 in the wake of the Fukushima Daiichi nuclear disaster to include a fifth category, radioactive materials in the general environment. Table 1-1 shows environmental components for each of these five categories.

Table 1-1. Scope of environmental components subject to the Environmental Impact Assessment Act

Maintenance of sound condition of natural components of the environment	Air quality	Ambient air quality, offensive odors, noise and infrasound, vibration, other
	Water quality	Water, sediment, groundwater, other
	Soil quality and other environmental components	Topography/geology, ground, soil, other
Ensuring biodiversity and systematic conservation of the natural environment*	Plants, animals, ecosystems	
Beneficial contact between people and nature*	Landscapes, places for activities with nature	
Environmental loads	Waste, greenhouse gases, etc.	
Radioactive materials in the general environment	Radiation quantity	

*Environmental components covered in this guide

Here, "natural components of the environment" includes a wide variety of elements that make up the natural environment, among them air, water, and soil. These are not only the components important for

protecting human health and conserving the living environment in terms of the seven major forms of pollution (atmospheric pollution, water pollution, soil pollution, noise, vibration, ground subsidence, and offensive odors), but also components important for properly preserving the natural environment (hydrologic cycles, topography, geology). In addition to ambient air quality, noise and infrasound, vibration, and offensive odors, the "air quality" category includes an "other" designation for environmental components related to atmospheric and spatial conditions, such as wind damage. The "water quality" category includes water, sediment, and groundwater as well as an "other" category for things like thermal effluent and river discharge volume. The "soil quality and other environmental components" category lists topography/geology, ground, soil, and an "other" category that includes shading, shadows cast by windmills, and so on.

Ensuring biodiversity and systematic conservation of the natural environment ("biodiversity") includes plants, animals, and ecosystems in recognition of the importance of conserving biodiversity and the ecosystems made up of diverse lifeforms that support it.

Beneficial contact between people and nature ("contact with nature") includes landscapes—a concept that recognizes human beings as subjects in the sense that nature providing us with benefits is itself a critical component of the environment that must be preserved—as well as places where people can engage in activities with nature.

Environmental loads refers to identifying the amount of environmental impact something has. It includes waste and greenhouse gases, with the former including byproducts like soil displaced as a result of construction and other recyclable resources in addition to standard waste products.

Radioactive materials in the general environment is defined as "radiation quantity" in the sense that the status of environmental pollution from radioactive materials depends on the aggregate radiation from the different radioactive nuclides contained in various environmental components.

This guide will focus on plants, animals, and ecosystems that are part of the environmental components listed under "biodiversity", and the landscapes and places for activities with nature components listed under "contact with nature".

Note that the environmental components listed under "maintenance of sound condition of natural components of the environment" and "environmental loads" are separately covered in the *Technical Guide to Environmental Impact Assessments: Air Quality, Water Quality, Soil Quality, and Environmental Loads*, while radioactive materials in the general environment are covered in the *Technical Guide to Environmental Impact Assessments: Radioactive Materials*.

Reference: Environmental impact assessment systems under local governments

Local governments have their own unique environmental impact assessment systems. All of Japan's prefectures and most of its cities designated by government ordinance have established these systems according to their local ordinances, and even non-designated cities, towns, and special wards are starting to set up environmental impact assessment programs based on their bylaws and guidelines.

Local government systems tend to target small-scale projects and other project categories that fall outside the scope of the Environmental Impact Assessment Act. They are tailored to local conditions and may involve the holding of public hearings to collect feedback from residents or the establishment of deliberation councils made up of experts and the like. The environmental components subject to environmental impact assessments under these local systems also include factors not targeted for environmental conservation under Japan's Basic Environment Law in the Environmental Impact Assessment Act, such as disasters, traffic safety, community splits, electromagnetic interference, and cultural assets (other than those related to the natural environment). In this way, systems are being set up according to regional conditions from an environmental component standpoint as well.

1. Characteristics of biodiversity

1-1. Importance of biodiversity in environmental impact assessments

Japan is a long country running north-south, which places it across a broad range of climate zones ranging from subarctic Hokkaido to subtropical Okinawa. This results in a variety of landforms, geological conditions, and soil types—as well as differences in the way people use the land—which in turn gives the country an incredible amount of biodiversity. It is therefore comprised of biological communities containing species that reflect the various local environments and of diverse ecosystems whose characteristics match those local environments as well.

Article 14-2 of the Basic Environment Law stipulates as an objective "the protection of biodiversity, such as the diversity of ecosystems and wildlife species, and the orderly conservation of the various features of natural environment, such as forest, farmland, and waterside areas in accordance with the natural and social conditions of those areas." This is what is included in the scope of "environmental conservation" under the Environmental Impact Assessment Act. The Environmental Impact Assessment Act therefore calls for ensuring biodiversity and the systematic conservation of the natural environment, listing plants, animals, and ecosystems and components targeted for environmental impact assessments. Surveys, forecasts, and evaluations as well as investigations into environmental mitigation measures therefore target plant and animal species or communities that are important (primarily from a scientific perspective or because they are rare), focal habitat areas, and so on. Environmental impact assessments are also carried out on the ecosystems that form the basis for these targets.

1.1.1. Characteristics of plants and animals

Given Japan's diverse ecosystems, its plant and animal characteristics span a broad range of taxonomic groups, making it home to an extremely varied collection of species. A good number of those species are facing the threat of extinction, however, with 3,596 included on the 2015 Red List issued by the Ministry of Environment. Therefore, when it comes to the plants and animals that are environmental components in environmental impact assessments, the degree of impact on (1) the distribution and the habitat/growth status of species that are critical (either for scientific reasons or because they are rare), (2) the distribution of critical communities, and (3) the distribution of focal animal habitats should be identified. Animals should be assessed in terms of nesting areas for sea turtles or critical species on the Red List or similar registers, sea turtle nesting areas, bat colony habitats, firefly habitats, migration grounds for migratory birds, and other focal habitats. Plants targeted for assessment include those on the Red List as well as marshland vegetation and other plant communities that either the national or local governments have designated as important.

One of the characteristics of plants and animals that needs to be taken into consideration when conducting environmental impact assessments is that it is often difficult to identify them and collect information with on-site surveys. This is due multiple factors, among them the extremely limited timeframes during which target species can be identified, the huge fluctuations in how habitats are utilized at different times of year, and the difficulty of accurately identifying target species whose populations are already so limited in number. In addition, there are many cases where the plant and animal ecology itself is unknown or it is unclear how it will respond to project implementation, which frequently makes forecasts unreliable. To further complicate things, the habitat/growth status of plants and animals frequently relies on basic environmental conditions, relationships with other species, historical trends, and other factors. For this reason, a project's impact on plants and animals goes beyond direct changes to their habitats to include the fracturing or fragmentation of a network of habitat sites as well as indirect impacts on those habitats via the physical or chemical environment in the form of sound, light, wind, waves, the amount and flow of water, water quality, soil, and so on. In short, there are a tremendous number of factors that need to be considered.

1.1.2. Characteristics of ecosystems

Ecosystems can be roughly divided into terrestrial ecosystems, inland water ecosystems (lakes, marshes, rivers, and so on), and marine ecosystems (primarily coastal areas) based on the basic features of the environment. Each of these ecosystem categories has their own unique characteristics, yet function in close relationship to one another. Terrestrial ecosystems like forests have their own topography and geological features that make up the basic environment, plus a basic structure created by the vegetation that grows there, the animals that use them and make them home, the flow of matter and energy through them, and so on. Inland water ecosystems like lakes, rivers, and marshes have a basic environment whose major structural features come from factors like the flow of water and the movement of earth—and these water flows as well as water quality are in turn affected by the condition of terrestrial ecosystems. Marine ecosystems have a basic environment that is primarily determined by the condition and flow of seawater as well as the makeup of the seafloor, but they are also closely tied to terrestrial and inland water ecosystems via the hydrologic cycle and the circulation of matter. For example, as a terrestrial environment changes (as in forest growth), it also impacts inland water and marine ecosystems through the soil it supplies over the long term. Table 1. 1-1 summarizes the characteristics of each type of ecosystem .

Ecosystems can also be categorized and understood or defined at various spatial scales. Large ecosystems (such as deciduous broad-leaved forests consisting mainly of beech trees) result from factors like elevation, differences in vegetation, or the gradient or drift of rivers. Small ecosystems (such as caves, areas of sulfurous volcanic activity, and ecosystems around spring-fed ponds) can arise in response to unique topography, geological features, soil, sediment, moisture conditions, and so on. Each ecosystem also has a different distribution of plants and animals based on geographical and historical factors, so the fact that their functions and structure can change depending on the area is another characteristic.

In short, some of the main characteristics of ecosystems that need to be taken into consideration when conducting environmental impact assessments are: (1) ecosystems whose different basic environments result in divergent characteristics are connected to and depend on one another, (2) ecosystems can be understood/defined at different scales, and (3) ecosystems are affected by a variety of physical and chemical environments just as plants and animals are. It is also important to note that ecosystems maintain a dynamic state of equilibrium (for example, in terms of matter circulation or the flow of energy) based on the interplay of the environment and the living things within the system, food chains, and so on as they repeatedly undergo disruption and recovery. The fact that typhoons or even rarer occurrences like volcanic eruptions or other unexpected natural phenomena can dramatically change ecosystems and result in a long-term recovery process must also be taken into account. For example, when looking at an ecosystem that is maintained via characteristic disruptive action to a river or coastline, it is important to consider the impact that the project may have on those natural and inherent disruptive forces. In this way, the studies, forecasts, and evaluation methods used in an environmental impact assessment should be selected based on the characteristics of each ecosystem involved and their reciprocal relationships.

Table I. 1-1 Characteristics of different ecosystems

Ecosystem	Characteristics
Terrestrial ecosystems	Primary production in terrestrial ecosystems mainly involves vascular plants with foliage (trees and grasses), with each ecosystem made up of a unique layered vertical foliage structure (production structure). The vertical structure of this foliage produces a variety of discontinuous environments within the ecosystem in both the horizontal and vertical directions, and a variety of distinctive species may exist in each ecosystem. The existence of these diverse species is maintained according to food chains that start with primary production, but compared to aquatic ecosystems (including marine areas), grazing food-chains contribute less to the matter cycle (a maximum of 12–13% except in cases of herbivore outbreaks), with a majority of matter dying and falling to the earth where plant and animal remains decompose instead (this is called a detritus food-chain). Still, terrestrial ecosystems are maintained through the coexistence of a variety of species, and internal grazing food-chains are a critical factor in supporting the mechanisms by which those species coexist.

	Terrestrial ecosystems also have distinctive structures and functions based on their various species compositions, which result from the basic environment (the air, water, topography, geological features, and so on) as well as the ways in which humans interact with them. For this reason, unique landscapes may arise through the combination of various ecosystems in response to the basic environment. These ecosystems have a mutual relationship in which dynamic equilibrium and change in any one of them impacts the others. Certain species may also travel through more than one ecosystem, many of them having a home in each. This makes it critical to understand the compound environmental characteristics that are formed across multiple ecosystems.
Inland water ecosystems	Inland water ecosystems include bodies of water and the terrestrial or transitional zones related to those bodies of water, which means they contain both land and water components. They therefore are home not only to species that rely on water, but also those that live in the transitional zone or those that only rely on the water for part of their life cycles—in other words, living things that depend on the continuities between water and land. This characteristic is what drives the diversity in inland water ecosystems. Water level, water quality, water temperature, daily fluctuations in river flow rate, seasonal changes, and yearly transitions are just some of the critical components that make up inland water ecosystems. Changes in river flow rate and water level produce transitional zones, while the movement of soil, for example, brings with it a variety of other substances. This leads to a diverse array of basic environments that have different effects at different sites. Bodies of a certain depth that contain large amounts of water (such as natural or dammed lakes) are made up of thermoclines which go through drastic seasonal changes in water temperature that have a major effect on the distribution of aquatic organisms. The tides affect the hydrology of river mouth areas, which are extremely diverse ecosystems featuring complex interactions that involve both inland water and marine characteristics. Changes in the basic environment that occur due to unexpected fluctuations, such as dramatic rises water level during typhoons, are also critical to these ecosystems. River flooding, ocean waves hitting lakes and marshes, or droughts that bring water levels below normal alter riverbed composition, water quality, and sediment and disturb river bottom or lakeshore plant life. At the same time, however, there are certain plants and animals whose existence depends on sudden changes like these. Riparian (riverside) forests, for example, are home to plant communities that are regenerated during flood levels that occur once every few decades. Certain fish populations interact during floods to enhance genetic diversity and increase the hardiness of the group. Erosion and deposition in rivers, lakes, and marshes forms the topography that serves as the foundation for plant and animal life in these ecosystems. Erosion creates new basic habitats by cleansing the sediment or wearing away the surface of pebbles and gravel, for example. Deposition can shape coastlines or change riverbed composition. Geographical and genetic isolation in inland water ecosystems can result in the formation of distinctive ecological systems, that includes isolated species or populations. For example, species or populations that that only travel through river channels (such as freshwater fish) may find those channels blocked over the course of geologic history and end up only in certain bodies of water or with a disjunct distribution.
Marine ecosystems	Ocean areas, particularly those whose primary production is mainly supported by offshore phytoplankton, generally have ecosystems that experience rapid turnover (production speed/biomass) compared to land ecosystems that depend on trees or other large plants for primary production. Put another way, marine ecosystems are large “flow” ecosystems undergoing constant change, while terrestrial ecosystems are

	"stock" ecosystems supported by stable plant communities. At the same time, while terrestrial ecosystems have prominent detritus food changes that originate with large plants, one of the features of marine ecosystems is the prominence of their grazing food chains. That said, coastal areas that contribute greatly to seaweed production have characteristics that resemble those of terrestrial areas. At the same time, the phytoplankton that are the basic producers and the zooplankton that are the main primary consumers are always moving with the ocean currents, meaning that many other living things move with them. This means that many marine organisms change their feeding habits and/or morph over the course of their growth cycles (floating, swimming, bottom-dwelling, attached, and so on). Another feature of marine ecosystems is that because there are no stable, long-term plant communities in the oceans like there are on land, the distribution of marine animals is largely determined by factors like the makeup of the seafloor (how solid it is, for example) and the physical and chemical environmental components of the open sea and inland waters. Coastal areas, which are often the site of project implementation and therefore a marine ecosystems subject to environmental impact assessments, are ecotones (transitional areas) rich in biodiversity. The environment in intertidal areas, for example, which are repeatedly exposed and submerged as the tides go in and out, forms beltlike zones that are each home to numerous plant and animal species adapted to those specific conditions. River mouths, where saltwater and freshwater meet, as well as tidal flats, seaweed beds, and coral reefs are examples of shallow-water ecosystems—each consisting of their own basic environments and biological communities. These areas are also notable for their strong connection to the land, as many get their nutrient salts and soil from rivers or underwater springs. When conducting environmental impact assessments on marine ecosystems, it is important to take these characteristics into account, considering factors such as geological features, makeup of the seafloor, variability due to waves and currents, the makeup of transitional areas, matter cycles and energy flows, the life cycles and growth of plants and animals, seasonal transitions, and the relationships between predators and prey when looking at the target marine areas.

1-2. Recent trends affecting biodiversity

One of the major shifts affecting biodiversity in recent years was the establishment of the Basic Act on Biodiversity (Act No. 58 of 2008). Given that biodiversity is both fundamental to the survival human beings and a source of diversity among cultures, and that it is facing critical threats both within Japan and around the world, the purpose of this law is to conserve its richness and help realize a society that coexists with nature and where human beings can continue enjoying the benefits of biodiversity for years to come—while also helping to conserve the global environment.

At the Convention on Biological Diversity and Conference of the Parties 10 (CBD/COP 10) held in October 2010, a long-term goal of creating a world where people lived in harmony with nature was set as a long-term target, while taking efficient and urgent action to halt the loss of biodiversity by was set as a short-term target. These were included as part of new global targets for 2011 and beyond, adopted as the Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets ("the Aichi Targets"). Given the outcomes of COP 10 and the experiences learned during the Great East Japan Earthquake that struck in March 2011, Japan went on to formulate the National Strategy for the Conservation and Sustainable Use of Biological Diversity (2012–2020) in 2012 as a legally binding plan based on the Basic Act on Biodiversity that defined its new principles for living in harmony with nature. The vision defined under this national strategy is that "by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people", while its strategic goal is for each country to achieve its national targets aimed at reaching the Aichi Targets by 2020. In this way, the strategy serves as a roadmap for the achievement of the Aichi Targets. It also lays out a grand design for

national land that looks ahead a century from now, using this as a guidepost for formulating the initiatives that need to be largely implemented by 2020. These take the form of five basic strategies: (1) mainstreaming biodiversity in our daily lives, (2) reviewing and rebuilding relationships between people and nature in local communities, (3) securing linkages between forests, the countryside, rivers and the sea, (4) taking action from a global perspective, and (5) strengthening scientific foundations and utilizing them in policies. The national strategy also lists four factors threatening biodiversity, which are outlined in table 1. 1-2). Japan is also looking into formulating ecosystem-specific strategies, such as a Strategy for the Conservation of Marine Diversity and a Ministry of Agriculture, Forestry and Fisheries Strategy for the Conservation of Biodiversity—each listing critical items for the conservation and sustainable use of natural resources.

Some of the other key basic laws on the natural environment that were established or revised in Japan are the Basic Act on Ocean Policy (Act No. 33 of 2007), the Fisheries Basic Act (Act. No. 89 of 2001), the Forest and Forestry Basic Act (Act No. 161 of 1964), the Food, Agriculture and Rural Areas Basic Act (Act No. 106 of 1999), the Basic Act on the Water Cycle (Act No. 16 of 2014). Revisions have also been made to related laws like the Forest Act (Act No. 249 of 1951), the River Act (Act No. 167 of 1964), and the Coast Act (Act No. 101 of 1956), and Japan is in the process of putting together region-specific plans based on these pieces of legislation.

Around the time that the Basic Act on Biodiversity was established, the Japanese government was also moving forward with efforts to put together and revise related laws like the ones listed in table I. 1-3. Japan is currently looking at the National Strategy on Biodiversity and related documents to help decide the scope of critical environmental factors that needed to be considered as basic items in environmental impact assessments as well. Properly conducting environmental impact assessments in Japan requires a solid grasp of the current status of biodiversity and ecosystems as well as of related systems and frameworks.

The areas that are protected under these systems and frameworks and similar information has largely been released to the public in recent years as electronic map data, and most related documents are available in digital form as well. They are particularly important when going through the Document on Primary Environmental Impact Consideration procedures (see chapter II), which are based on the surveys this existing documentation. It is critical to make full use of these resources even when environmental impact assessments are conducted during the project implementation stage in order to fully understand regional characteristics as well as ensure that surveys, forecasts, and evaluations are efficient and effective.

There have also been integrated projects in recent years in the agriculture, forestry, and fisheries industries as well as those that combine disaster preparation, for example, with environmental restoration. These projects incorporate trial efforts to conserve regional biodiversity and should serve as a valuable reference for initiatives designed to maximize the impact of environmental mitigation measures taken under environmental impact assessments.

The National Plan for Adaptation to the Impacts of Climate Change is a November 2015 cabinet decision that states the importance of considering conservation, restoration, and creation of natural environments in such a way that ensures that adaptation measures do not themselves cause adverse environmental impacts and of utilizing the many functions of natural environments according to specific purposes and regional characteristics. More work still needs to be done, however, and scientific research is now moving forward for the purpose of addressing gaps in our understanding and technology so that we can better predict and assess the impact that climate change is having on our species and ecosystems.

Table I.1-2. Four threats to biodiversity

Threat #1	• Human activity (e.g. development) Human activity impacts natural environments by damaging or destroying habitats through excessive hunting, fishing, or gathering (for recreational or commercial purposes), land reclamation, and other forms of development.
Threat #2	• Environmental threats due to habitat shrinkage

	Secondary forests and grasslands that have fallen into disuse cause ecosystems to become unbalanced, threatening the extinction of the plants and animals native to Japan's rural *satochi* and *satoyama* areas. Meanwhile, regional ecosystems are also being heavily impacted by growing populations of animals like deer and wild boar.
Threat #3	• Exotic species introduced by humans Exotic species pray on native species, take over their habitats, and cause genetic disturbances through crossbreeding. There are also chemical substances that are toxic to plants and animals and thus negatively impact ecosystems.
Threat #4	• Climate change Global warming is a major problem that transcends national boundaries. With average temperatures rising between 1.5 and 2.5 degrees Celsius, ice is melting earlier in the season, alpine regions are shrinking, and ocean surface temperatures are rising. These and other related factors are said to threaten some 20–30% of the world's plant and animal species with extinction.

Table I.1-3 Overview of key systems and frameworks on biodiversity and their relevance to environmental impact assessments

Framework	Overview	Relevance to EIAs
Basic Act on Biodiversity (Act No. 58 of 2008)	This act outlines basic concepts to guide Japan's biodiversity policies, including basic principles on biodiversity conservation and use, the formulation of a national biodiversity strategy, preparation of white papers and 13 basic policies to be implemented by the national government. Its stipulations include obligations at the national and local government level as well as for businesses, citizens, and nongovernmental organizations.	This act calls for a reduction in environmental impacts related to biodiversity during the business plan formulation stage and more.
Nature Conservation Act (Act No. 85 of 1972)	The provisions of this act stipulate fundamental items for conservation of the natural environment. It also includes those on implementation of basic environmental conservation surveys as well as designations of national environmental conservation areas with the aim of comprehensively promoting proper natural conservation efforts.	Natural parks, natural environmental conservation districts, and similar areas require particular attention when conducting environmental impact assessments, and these pieces of legislation should serve as foundational references.
Natural Parks Act (Act No. 161 of 1957)	This act aims to protect outstanding natural landscapes, encourage efforts towards enhanced usage, promote citizen health, recreation, and education, and help maintain biodiversity by designating natural parks and stipulating park planning and other provisions aimed at conservation and/or usage of these areas.	
Act on the Promotion of Nature Restoration (Act No. 148 of 2002) and the Act on the Promotion of Regional Cooperation for Biodiversity (Act No. 72 of 2010)	The provisions of this act promote nature restoration policies and encourage coordination among diverse regional actors in activities to conserve biodiversity.	Because this law stipulates the promotion of natural environment conservation and restoration activities It is likely that the sites of activities based on it are critical in terms of conserving local biodiversity. The results of activities to conserve biodiversity also serve as important case examples when considering environmental mitigation measures.

Framework	Overview	Relevance to EIAs
Wildlife Protection and Hunting Act (Act No. 88 of 2002)	This act designates wildlife sanctuaries in areas that are particularly critical for the protection of wildlife. It was revised in 2014 for the purpose of implementing drastic countermeasures to optimize wildlife habitat conditions, as deer and other animals have been causing increasing damage to ecosystems as well as to the agriculture and forestry industries in recent years.	This act specifies wildlife species targeted for conservation as well as legally-defined invasive alien species. Depending on regional and project characteristics, it may be necessary to look at the need for related surveys, forecasts, and evaluations as well as include these factors when considering environmental mitigation measures.
Invasive Alien Species Act (Act No. 78 of 2004)	This act regulates the importation and breeding of plants and animals defined as invasive alien species and stipulates control measures in order to prevent damage to ecosystems, industry (agricultural, forestry, and fisheries), and to protect human life and prevent injury from invasive alien species.	
Endangered Species Act (Act No. 75 of 1995)	This act is designed to protect endangered wild animal and plant species by nationally designating endangered wild fauna and flora within Japan as well as critical habitat areas, regulating the treatment of individuals in those populations, protecting their habitats, and carrying out projects to protect and increase their numbers.	The species and areas designated under legislation like this define the critically important plant and animal species as well as critical habitat areas and populations that are subject to surveys, forecasts, and evaluations during environmental impact assessments. The designation of species and the like under these laws are revised as needed, so it is important to get access to the latest information.
Red List/Red Data Book (national and local government bodies)	The Ministry of the Environment regularly reviews its Red List (the latest edition is the 2015 MOE Red List) and encourages updates to Red Data Books. Every prefecture issues region-specific Red Data Book, and Red Data Books are also issued by certain local governments and NGOs for critical geological formations, ecosystems, and populations.	
Act on Protection of Cultural Properties (Act No. 214 of 1950)	This act designates particularly valuable plants and animals as Natural Monuments or similar cultural assets.	
Forest Conservation System	This system designates certain nationally-owned forests and fields (e.g. as virgin forests) for the purpose of contributing to the maintenance of natural environments that are made up of forest ecosystems, the protection of wild plant and animal species, the protection of genetic resources, the development of forest practices and management techniques, the promotion of scientific research, and so on.	
Ramsar Convention (went into force in Japan in 1980) World Heritage Convention (accepted by Japan	These conventions stipulate critical plant and animal species as well as sanctuary areas.	

Framework	Overview	Relevance to EIAs
in 1992), Migratory Bird Convention (US, Russia, Australia, China)		
UNESCO Biosphere Reserves (MAB, geoparks)	This stipulations of this program are designed to conserve biospheres (primarily core regions) as well as promote research and ecotourism in these areas.	The existence of critical geological formations and ecosystems that are likely to be subject to conservation under environmental impact assessments may be stipulated under this program.
National Strategy on Biodiversity 2012–2020 (2012)	The National Strategy on Biodiversity is a basic national plan for the conservation and sustainable use of biodiversity. It is based on the Convention on Biodiversity (which Japan signed in 1993) as well as on the Basic Act on Biodiversity.	The National Strategy on Biodiversity discusses the importance of environmental impact assessments.
Regional strategies on biodiversity	Regional strategies on biodiversity of basic plans for the conservation and sustainable use of biodiversity stipulated by regional and local government bodies. They are based on the Basic Act on Biodiversity.	These strategies often list natural environment areas that are likely to be subject to conservation under environmental impact assessments as well as other regions that require particular consideration when conducting EIAs.

Reference: From "National Biodiversity Strategy of Japan 2012-2020: Roadmap towards the Establishment of an Enriching Society in Harmony with Nature" (Ministry of the Environment 2012), Section 4: Environmental Impact Assessments and Other Measures

"For the conservation of biodiversity, it is extremely important to give consideration to environmental conservation prior to formulating and implementing large-scale projects that are expected to have significant environmental impacts. Therefore, the Environmental Impact Assessment Act (put into force in June 1999) provides that proponents of such large-scale projects shall survey, predict and assess the likely environmental impacts prior to project implementation and reflect the results of the assessment in the contents of the project, thereby ensuring appropriate consideration for environmental conservation. The law also requires that the project proponents shall report and publish the results of environmental conservation measures, etc. after the project implementation. In addition, almost all prefectures and cabinet-order designated cities (major cities) have their own environmental impact assessment systems stipulated in their regulations, which
require that fine-tuned environmental impact assessments should be conducted by taking into account the environmental conditions and other conditions of each local area.

The government established the "Basic Guidelines" based on the law, which are common guidelines for all types of projects subject to the law concerning the methods for carrying out environmental impact assessments. The guidelines ensure biodiversity conservation by setting out the following guidelines. At the project planning stage, the project proponent should in principle create multiple plans concerning the location, etc. of the project, and conduct comparative assessments that are part of the consideration process for the avoidance or reduction of critical environmental impacts. At the stage of considering the detailed contents of the project, items that the project proponent is required to assess include the "protection of biodiversity and systematic conservation of the natural environment" and "rich interaction between people and nature." In the assessment of these items, the project proponent is required to incorporate better environmental consideration into the project contents by assessing not only the fauna and flora that are important from academic or scarcity-value viewpoints and outstanding natural landscapes, but also places where people can interact with nearby nature and familiar living

organisms that characterize the local ecosystems. In addition, with regard to environmental conservation measures, the guidelines provide that the
project proponent should first consider avoiding or reducing environmental impacts, and then consider compensation measures for still remaining environmental impacts, such as the creation of the same type of environment as the one that would be lost because of the project.

Since it is important to introduce environmental consideration at an early stage of a project, it is necessary to consider creating a strategic environmental assessment system, which incorporates environmental consideration into the formulation and implementation of superordinate plans and policies that precede the stage of considering the site, size and other details of individual projects."

Reference: National Strategy for the Conservation and Sustainable Use of Biological Diversity (2011–2020)
Strategic Plan for Biodiversity 2011–2020

- Vision (2050)
  - "Living in harmony with nature"
  - By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people.
- Mission (2020)
  - Take effective and urgent action to halt the loss of biodiversity

The Aichi Biodiversity Targets

Target #1	People are aware of the value of biodiversity and the steps they can take to conserve and use it sustainably
Target #2	Biodiversity values have been integrated into national and local plans and are being incorporated into national accounting, as appropriate, and reporting systems
Target #3	Incentives, including subsidies, that are harmful to biodiversity are eliminated or reformed and positive incentives are developed and applied
Target #4	Stakeholders at all levels have implemented plans for sustainable production and consumption
Target #5	The rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced
Target #6	Marine resources are managed and harvested sustainably
Target #7	Areas under agriculture, aquaculture and forestry are managed sustainably
Target #8	Pollution has been brought to levels that are not detrimental
Target #9	Invasive alien species are controlled or eradicated
Target #10	Negative pressures on coral reefs and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized
Target #11	At least 17 percent of terrestrial and inland water, and 10 percent of coastal and marine areas are conserved through protected area designations and similar measures
Target #12	The extinction and decline of threatened species has been prevented
Target #13	The genetic diversity of crops and livestock is maintained, and genetic erosion has been minimized
Target #14	Ecosystems that provide essential services are restored and safeguarded
Target #15	Contributions have been made to climate change mitigation and adaptation through the restoration of at least 15 percent of degraded ecosystems
Target #16	The Nagoya Protocol on ABS is in force and operational
Target #17	Each party has developed and commenced implementing an effective and participatory biodiversity strategy
Target #18	Traditional knowledge is respected and mainstreamed
Target #19	Knowledge and scientific technologies related to biodiversity are improved
Target #20	Resources for effectively implementing the Strategic Plan have been increased substantially from current levels

Recent years have brought the development of various technological tools that can be utilized for environmental impact assessments on biodiversity. Table III. 1-28 list some of the main ones. In addition to the technological tools on this list that are actually being used for environmental impact assessments, there are also those that contribute to better survey efficiency, less uncertainty, and more objectivity, which improves the sophistication of the assessments. There are also tools that have not yet been put into actual practice very many times, but are expected to produce a good track record as they are further tested (see chapter 3 for details on how each of these technologies is used).

More basic environmental data is being collected all the time. Results of studies like the National Survey on the Natural Environment conducted by the Ministry of the Environment and the Regional Monitoring Promotion Project for Critical Ecosystems (Monitoring Site 1000) are made publicly available online and in other formats, various information on local natural environments is being stored in databases, map information is being put together, there is an increasing amount of information (literature) on the characteristics and dynamics of plants, animals, and ecosystems, and there is more data on the movement of earth and water. Tools for analyzing this data and information infrastructure (e.g. logs of living things) designed to collect resident data, for example, are being put together, while other systems are being built or studied for the purpose of carrying out environmental mitigation measures unlike these implemented in the past (such as seed banks or conservation outside natural habitats). More case examples of environmental mitigation measures are becoming available and more are being classified according to project type or environmental component and released—so it is critical that project proponents make use of this information.

It is also ideal to actively utilize this information in environmental impact assessments in the interest of adopting workable and better technologies. That said, evaluation methods need to be selected according to the accuracy of forecast results for individual environmental components or follow-up survey results from other projects. Also, because the speed of technological development has increased so markedly in recent years, it is important to consider whether it is possible to use new technologies that allow for more accurate assessments rather than sticking with the same methods over a long period of time.

2. Characteristics of contact with nature

2.1 Importance of contact with nature in environmental impact assessments

Article 14 of the Basic Environment Law states that one of the purposes of formulating basic policies for environmental conservation is “to maintain rich and harmonious contacts between people and nature”, thus establishing contact with nature a central pillar of conservation efforts. The Environmental Impact Assessment Act also includes landscapes and places for activities with nature within the scope of its environmental components. These examples point to the benefits that nature provides human beings and establish that content as an environmental component that must be preserved and passed down to future generations.

2.1.1 Characteristics of landscapes

Landscapes exist in relationship to the people (subjects) viewing them. They include not only the vistas that make up the local landscape, but also values that people assign to them—the love, pride, peace, and comfort that people take in their hometowns. Environmental views also include the historical and cultural background that goes into them. The concept of a “landscape” is one that is rooted in earth or the land itself, expresses the essential features or characteristics of a place, and is reflected in the lifestyles, activities, and culture of the people who are tied to that area.

Article 2 of the Landscape Act (Act No. 110 of 2004) states that “a good landscape is produced by the harmony between the nature, history and culture of the area and people's lifestyles and economic and other activities” and that “a good landscape of an area is closely related to peculiar characteristics of the area”.

When considering landscapes for environmental impact assessments, it is important to consider them not only as visual phenomena (nothing more than visual points of interest and the vistas that connect them), but as spaces that include familiar places where people go about their lives. It is also important to see them as visual environments that arise from natural conditions as well as social conditions (the local history, culture, and so on).

When treating landscapes as an environmental component within environmental impact assessments, it is important to have a good understanding of how they differ from other components. The following lists their special characteristics and relevant considerations.

- It is difficult to evaluate landscapes using a cookie-cutter approach, since each landscape has distinctive features that are unique to the local community or region.

- Landscapes have developed over long periods of time through the interactions between people and nature, so there needs to be an awareness of the value imbued in their history—not just their visual characteristics.

- Local residents and others have an intuitive understanding of landscapes based on their visual characteristics, so when determining the impact of a project, it is important to develop shared awareness and mutual understanding.

- It is important to keep in mind that projects subject to environmental impact assessments tend to be large in scope, which means that they can have a major impact on landscapes and do damage that cannot easily be undone.

- In some cases, projects can actually generate new perspectives or landscape resources, which means they need to be considered from the perspective of creation as well as conservation.

Landscape EIAs need to be able to address nearby scenes (surrounding landscapes) as well. This is done by understanding not only the visual changes that the project might bring to the target landscape and its sights, but also including surveys, forecasts, and evaluations driven by an awareness of the values associated with those features as well.

2.1.2 Characteristics of places for activities with nature

Places for activities with nature are more than just physical locations. They are the spaces that are created when people use those sites to interact with nature through various activities. For this reason, it is important to first understand what those activities are when addressing places for activities with nature in environmental impact assessments.

Places for activities with nature may be the site of countless types of activities. People may simply observe or enjoy the natural landscape, engage with it through various forms of recreation depending on the type of site, collect or harvest natural resources, travel through it by climbing or hiking, or use equipment to enjoy it as in skiing or cycling. For this reason, "places for activities with nature" is a category that includes not only campsites, walking paths, swimming areas, or other outdoor recreation sites equipped with facilities and known to the public, but also woodlands, grasslands, groves surrounding village shrines, streams, ponds, and other natural sites that may or may not have associated facilities or even names. In short, any natural environment that supports human activity falls under "places for activities with nature".

Environmental impact assessments that target places for activities with nature need to be able to address nearby natural areas and places for daily contact with nature. This is done by understanding not only the condition of the places that support human activity and the status of those activities, but also including surveys, forecasts, and evaluations driven by an awareness of the value that those activities bring people. It is also necessary to consider ways in which construction or other project activities may affect people's access to the places in which they normally engage in outdoor activities.

2.2 Recent trends concerning contact with nature

Table I.2.1 lists legal frameworks (such as the Landscape Act, the Ecotourism Promotion Act (Act No. 105 of 2007) and the Act on the Promotion of Environmental Conservation Activities through Environmental Education (Act No. 130 of 2003)) that have helped make the importance of familiar natural settings part of people's everyday awareness in recent years. These frameworks make protecting rich interactions between people and nature a critical core concept when it comes to conserving the environments that allow people to enjoy the benefits of nature and are used to implement forecasts and evaluations for many projects subject to environmental impact assessments involving contact with nature.

Environmental impact assessment items related to contact with nature can be difficult to assess quantitatively, but they are usually easy to assess intuitively without the need for expert knowledge or codified standards. For this reason, it is important to take steps to sufficiently communicate with local residents and other stakeholders when conducting environmental impact assessments.

Table 1.2-1 lists key systems and frameworks on conserving landscapes and places for activities with nature as well as their relevance to environmental impact assessments.
In addition, it is also necessary to consider ecoparks (biosphere reserves) designated under UNESCO's Man and the Biosphere Programme (MAB), geoparks designated by UNESCO and Japan Geopark Committee, Globally Important Agricultural Heritage Systems, and other efforts to conserve traditional industries, sights, land use, cultures, and landscapes that make use of distinctive natural or regional environments.

Table I.2-1 Overview of key systems and frameworks on landscapes and places for activities with nature and their relevance to environmental impact assessments

Framework	Overview	Relevance to EIAs

Landscape Act (Act No. 110 of 2004) and townscape ordinances	This act promotes the formation of quality landscapes in cities as well as rural agricultural, fishing, and mountain villages through the formulation of landscape plans and the comprehensive implementation of other policies.	This act can be used as a basic reference for environmental impact assessments, as local government agencies are formulating landscape plans while gradually studying important scenic spots, landscape resources, and the like.
City Planning Act (Act No. 100 of 1968)	This act stipulates frameworks for land use and urban development in city areas (including the designation of urban planning zones and the formulation of city master plans).	This act can be used as a basic reference for environmental impact assessments, as it designates landscape areas, areas of scenic beauty, and so on.
Natural Parks Act (Act No. 161 of 1957)	This act aims to protect outstanding natural landscapes, encourage efforts towards enhanced usage, promote citizen health, recreation, and education, and help maintain biodiversity by designating natural parks and stipulating park planning and other provisions aimed at conservation and/or usage of these areas.	Natural parks, natural environmental conservation districts, and similar areas require particular attention when conducting environmental impact assessments, and these pieces of legislation should serve as foundational references.
Nature Conservation Act (Act No. 85 of 1972)	The provisions of this act stipulate fundamental items for conservation of the natural environment. It also includes those on implementation of basic environmental conservation surveys as well as designations of national environmental conservation areas with the aim of comprehensively promoting proper natural conservation efforts.	
Act on Protection of Cultural Properties (Act No. 214 of 1950)	This act designates five categories of cultural properties (including historic, scenic, and natural monuments as well as traditional structures) and stipulates measures to protect them.	This act can be used as a basic reference for environmental impact assessments, as it designates traditional structure conservation areas, important cultural landscapes, historic/scenic/natural moments, and other cultural properties.
Urban Green Space Conservation Act (Act No. 72 of 1973)	This act promotes the greening of urban areas and the formation of urban parks in order to preserve green spaces in cities.	This act can be used as a basic reference for environmental impact assessments, as it designates special green space conservation areas and the like.
Ecotourism Promotion Act (Act No. 105 of 2007)	This act stipulates a comprehensive framework for ecotourism that creatively engages local communities while taking environmental conservation into account.	This act can be used as a basic reference for environmental impact assessments, as it designates special natural tourism resources and the like.
Act on the Promotion of Environmental Conservation Activities through Environmental Education (Act No. 130 of 2003)	This act stipulates basic principles for the promotion of environmental conservation and education activities while also listing critical items for motivation enhancement and cooperative initiatives to encourage the provision of more opportunities for people to experience nature.	This act can be used as a basic reference for environmental impact assessments on activity sites and the like, as it promotes the creation of spaces for school education or NGO activities as well as opportunities for people to experience managed natural settings.
Act concerning Special Measures for the Preservation of Historic Natural Features in Japan's	This act stipulates measures for the appropriate preservation of historic natural features as shared national cultural assets in ten cities, towns, and	This act can be used as a basic reference for environmental impact assessments, as it stipulates historic natural preservation zones, special historic natural preservation zones (urban plans), and the like.

Ancient Capitals (Act No. 1 of 1966)	villages designated as ancient Japanese capitals.	
Act on Maintenance and Improvement of Traditional Scenery in Certain Districts (Act No. 40 of 2008)	This act aims to maintain, improve, and pass on to future generations quality environments (historic scenic beauty) featuring historical structures such as castles, shrines, Buddhist temples, and the surrounding traditional residences that capture the distinctive charm, atmosphere, and appearance of a place.	This act can be used as a basic reference for environmental impact assessments, as it designates critical districts for plans to maintain and improve historic scenic beauty and the like.
Act on the Conservation of Suburban Green Zones in the National Capital Region (Act No. 101 of 1966) and Act on the Arrangement of Conservation Districts in the Kinki Area (Act No. 103 of 1967)	This act stipulates suburban green zones in the Tokyo and Kinki areas for the purpose of maintaining and promoting good mental and physical health among urban residents while conserving cultural properties, green spaces, tourist resources, and the like.	These acts can be used as basic references for environmental impact assessments, as they designate suburban green zones and special suburban green zone conservation areas (as stipulated by governors).
Productive Green Land Act (Act No. 68 of 1974)	This act preserves quality urban environments with steps towards the systematic conservation of remaining agricultural areas in cities.	This act can be used as a basic reference for investigating activities for contact with nature, as it designates productive green land and community farming areas.
Act on Promotion of Development of Community Farms (Act No. 44 of 1990)	This act aims to develop quality urban environments and revitalize rural districts by encouraging the establishment of community farms and securing areas for residents to engage in healthy, relaxing activities.	
Act Concerning the Utilization of National Forest Land (Act No. 246 of 1951)	This act designates certain nationally-owned forests and fields that have outstanding natural scenery or are ideal for forest healing, nature observation, outdoor sports, or similar activities as “recreation forests”.	This act can be used as a basic reference for environmental impact assessments, as it designates recreation forests and similar areas.
Forest and Forestry Basic Act (Act No. 161 of 1964)	This act defines “forests shared with people” as those ideally suited as sites for environmental conservation, forest recreation, or environmental education.	This act can be used as a basic reference for environmental impact assessments, as it designates “forests shared with people” and similar areas.
World Heritage Convention (accepted by Japan in 1992)	This convention lists natural assets of special importance that are designated as World Heritage Sites and require conservation as shared inheritances of the world’s people.	This convention can be used as a basic reference for environmental impact assessments, as it contains a list of World Heritage Sites.
Globally Important Agricultural Heritage Systems	This UN Food and Agricultural Organization (FAO) program designates globally important lands that are used for agriculture, are historic in their development or constitution, and of cultural/scenic significance and/or rich in biodiversity with the aim of preserving them for future generations.	These documents can be used as basic references for environmental impact assessments, as they designate Globally Important Agriculture Heritage Systems, ecoparks (biosphere reserves), and geoparks.

UNESCO Biosphere Reserves	This program designates biosphere reserve areas for the purpose of harmonizing the preservation and sustainable use of ecosystems. These areas are also considered promising as educational sites for local sustainable development.	
Geoparks	These naturally abundant environments (which may include important geological strata, rocks, geological features, volcanos, fault lines, etc.) are either recognized as natural heritages under the Global Geoparks Network or as Japan geoparks under the Japanese Geoparks Network.	

As with biodiversity, a variety of important technological tools that can be utilized for environmental impact assessments on contact have been developed in recent years. Those that make use of information and communication technologies (ICT) in particular are likely to be quite promising.

Geographic information system (GIS) technologies are already being used for visual analyses (various landscape and accessibility analyses) and to create images that predict landscape changes. Computer graphics technologies are used to create animations as well. These technologies will likely become easier to use in the future, and there is also great potential for the use of virtual reality technologies as well.

These tools not only help improve the accuracy of forecasts and save labor for project proponents, but also have the potential to be useful vehicles information exchange among stakeholders during environmental impact assessment procedures.

Chapter II
Environmental Impact Assessments at the Project Implementation Stage

Chapter II. Environmental Impact Assessments at the Project Implementation Stage

Environmental impact assessments are frameworks for ensuring that environmental conservation is properly considered when implementing projects. They require that project proponents conduct surveys, forecasts, and evaluations in advance to determine the impact that their project is likely to have on the environment, publish the results, and invite feedback from the general public, local governments, and other stakeholders. The outcomes are then reflected in environmental mitigation measures and project plans.

The Environmental Impact Assessment Act stipulates procedures and approaches designed to ensure that environmental impact assessments are carried out appropriately and smoothly. It also includes planning and implementation procedures tailored to each stage of project development.

It is often difficult to flexibly address environmental mitigation in order to avoid or reduce environmental impacts during the project implementation stage. For this reason, planning stage procedures (Document on Primary Environmental Impact Consideration procedures)* call for a comparative review of the environmental impact of multiple project plan proposals at an early stage, looking at factors like location, scope, distribution, and composition beforehand in order to avoid or reduce serious environmental impacts.

Project implementation stage procedures (Scoping Document, Draft Environmental Impact Statement, and Environmental Impact Statement procedures) make use of the results of investigations carried out during planning stage procedures while selecting environmental impact assessment items and carrying out surveys, forecasts, and evaluations based on more detailed project plans and in line with project and regional characteristics. These procedures also involve a review of specific environmental mitigation measures aimed at avoiding or reducing environmental impacts for each of the selected EIA items.

By avoiding or reducing serious environmental impacts at the planning stage and then reviewing environmental mitigation measures in the environmental impact assessment during the project implementation stage, investigations can be carried out at each stage according to the maturity of the project planning process—since integrated environmental conservation is something that should be considered throughout project development.

Ultimately, the environmental mitigation measures reviewed these integrated procedures need to be reviewed to make sure that they are delivering the expected results, ensuring that the purpose of the environmental impact assessment has been achieved.

*Details on environmental impact assessments at the planning stage are summarized in the *Guide to*

Environmental Assessment Techniques: Planning-stage Environmental Consideration Documents (Concepts and Practices). The Environmental Impact Assessment Act also specifies the following two procedures to be carried out prior to the project implementation stage, though some local government systems that are based on EIA ordinances and the like do not include them.

Document on Primary Environmental Impact Consideration procedures

Procedures for the Document on Primary Environmental Impact Consideration involve making a comparative review of the environmental impact of multiple project plan proposals at an early stage, looking at factors like location, scope, distribution, and composition beforehand in order to avoid or reduce serious environmental impacts. They were newly established in 2011 with the revision of the Environmental Impact Assessment Act. When selecting items for primary environmental impact consideration, note that in cases where (1) it seems possible to avoid or lesson impacts during the project implementation stage using environmental mitigation measures or (2) impacts are reversible or can be limited to a short period of time, determine for each project whether it is necessary to select these items as primary environmental impact consideration items for each project. If it is not necessary, project proponents can forgo treating them as serious environmental impacts during the planning stage and make them review items during the project implementation stage instead.

Procedures for the Document on Primary Environmental Impact Consideration typically involve conducting surveys based on existing documents held by national or local governments. For more information on specific technical tools, see the *Guide to Environmental Assessment Techniques: Planning-stage Environmental Consideration Documents (Concepts and Practices)*.

Note that these procedures are voluntary for those looking to implement Class-2 projects.

Determination of Class-2 projects (screening procedures)

A Class-2 Project is defined as a project whose scope is equivalent to that of a Class-1 project and for which determination (screening) procedures must be carried out to decide whether it is necessary to carry out an environmental impact assessment based on individual project and regional characteristics.

For basic matters, the competent ministry determines (1) judgement criteria based on individual project details and (2) judgement criteria based on the status of the environment and other conditions in the district where the Class-2 project should be implemented and the surrounding area for use during the screening process.

The party who receives the submission from the person looking to implement the Class-2 project and who has the authority to issue licensure or approval must invite opinions from relevant

prefectural governors and then determine whether environmental impact assessment procedures need to be carried out for the project based on judgement criteria stipulated by the competent ministries.

Note that project proponents are allowed to independently move ahead with scoping documents and other procedures without going through the screening process.

Reference: Environmental impact assessment documents

The documents that project proponents prepare in the course of environmental impact assessment procedures are called environmental impact assessment documents, or "assessment documents" for short. The assessment documents stipulated in the Environmental Impact Assessment Act are Documents on Primary Environmental Impact Consideration, Scoping Documents, Draft Environmental Impact Statements, Environmental Impact Statements, and Reports. Procedures based on local government ordinances on environmental impact assessments generally follow the same pattern, though these ordinances sometimes refer to the documents by different names or may require the preparation of a written opinion report, for example.

■ Planning Stage Document on Primary Environmental Impact Consideration (Document on Primary Environmental Impact Consideration): The purpose of this document is to communicate the results of investigations into which items should considered for the purpose of environmental conservation when the location, scope and other key project elements are being determined. It includes the following key items:

- Name and address of the person looking to implement the Class-1 project
- Purpose and contents of the Class-1 project
- General conditions in the target project implementation area and its surroundings
- A summary of survey, forecast, and evaluation results for each primary environmental impact consideration item

■ Environmental Impact Assessment Scoping Document (Scoping Document): The purpose of this document is to communicate the methods that will be used for the upcoming environmental impact assessment. It includes the following key items:

- Name and address of the project proponent
- Purpose and contents of the project
- General conditions in the target project implementation area and its surroundings
- Environmental impact assessment items as well as survey, forecast, and evaluation methods relevant to the project (add to the above what project proponents did during the procedures for the Document on Primary Environmental Impact Consideration)
- A summary of survey, forecast, and evaluation results for each primary environmental impact consideration item
- Opinions of the competent minister on the Document on Primary Environmental Impact Consideration from the standpoint of environmental mitigation plus project proponent commentary
- If opinions were invited from relevant government agencies and/or the general public on the Document on Primary Environmental Impact Consideration or its proposals, a summary of those opinions and commentary from parties intending to implement the Class-1 project
- Evolution and details of investigations into environmental mitigation considerations during the process of deciding on the expected project implementation area and other items

■ Draft Environmental Impact Statement (Draft EIS): The purpose of this document is to communicate the results of the environmental impact assessment. It includes the following key items:

- Name and address of the project proponent
- Purpose and contents of the project

・General conditions in the target project implementation area and its surroundings
・Opinions invited from the general public on the Scoping Document from the standpoint of environmental mitigation plus project proponent commentary
・Opinions from prefectural governors and other officials on the Scoping Document from the standpoint of environmental mitigation plus project proponent commentary
・Environmental impact assessment items plus survey, forecast, and evaluation methods
・Results of the environmental impact assessment (including the status of investigations leading up to the implementation of measures for environmental mitigation and other relevant measures) (add to the above what project proponents did during the procedures for the Document on Primary Environmental Impact Consideration)
・A summary of survey, forecast, and evaluation results for each primary environmental impact consideration item
・Opinions of the competent minister on the Document on Primary Environmental Impact Consideration from the standpoint of environmental mitigation plus project proponent commentary
・If opinions were invited from relevant government agencies and/or the general public on the Document on Primary Environmental Impact Consideration or its proposals, a summary of those opinions and commentary from parties intending to implement the Class-1 project
・Evolution and details of investigations into environmental mitigation considerations during the process of deciding on the expected project implementation area and other items

■ Environmental Impact Statement (EIS): This document includes any required revisions to the Draft Environmental Impact Statement based on solicited opinions and feedback. It includes the following key items:
・Any revisions made to the Draft Environmental Impact Statement as needed
・Summary of opinions from the general public on the Draft EIS from the standpoint of environmental mitigation plus project proponent commentary
・Opinions from prefectural governors and other officials on the Draft EIS from the standpoint of environmental mitigation plus project proponent commentary

■ Report on Environmental Mitigation Measures (Report): The purpose of this document is to communicate the implementation status of environmental mitigation measures and the like. It includes the following key items:
・Name and address of the project proponent
・Basic project information (name, class, scope, implementation area, and similar details)
・Follow-up survey items, methods, and results
・Description of environmental mitigation measures along with results and level of uncertainty
・Description of expert advice received, if any
・Statement of the intention to make public the plans for and results of any follow-up surveys or environmental mitigation measures conducted after the preparation of the Report

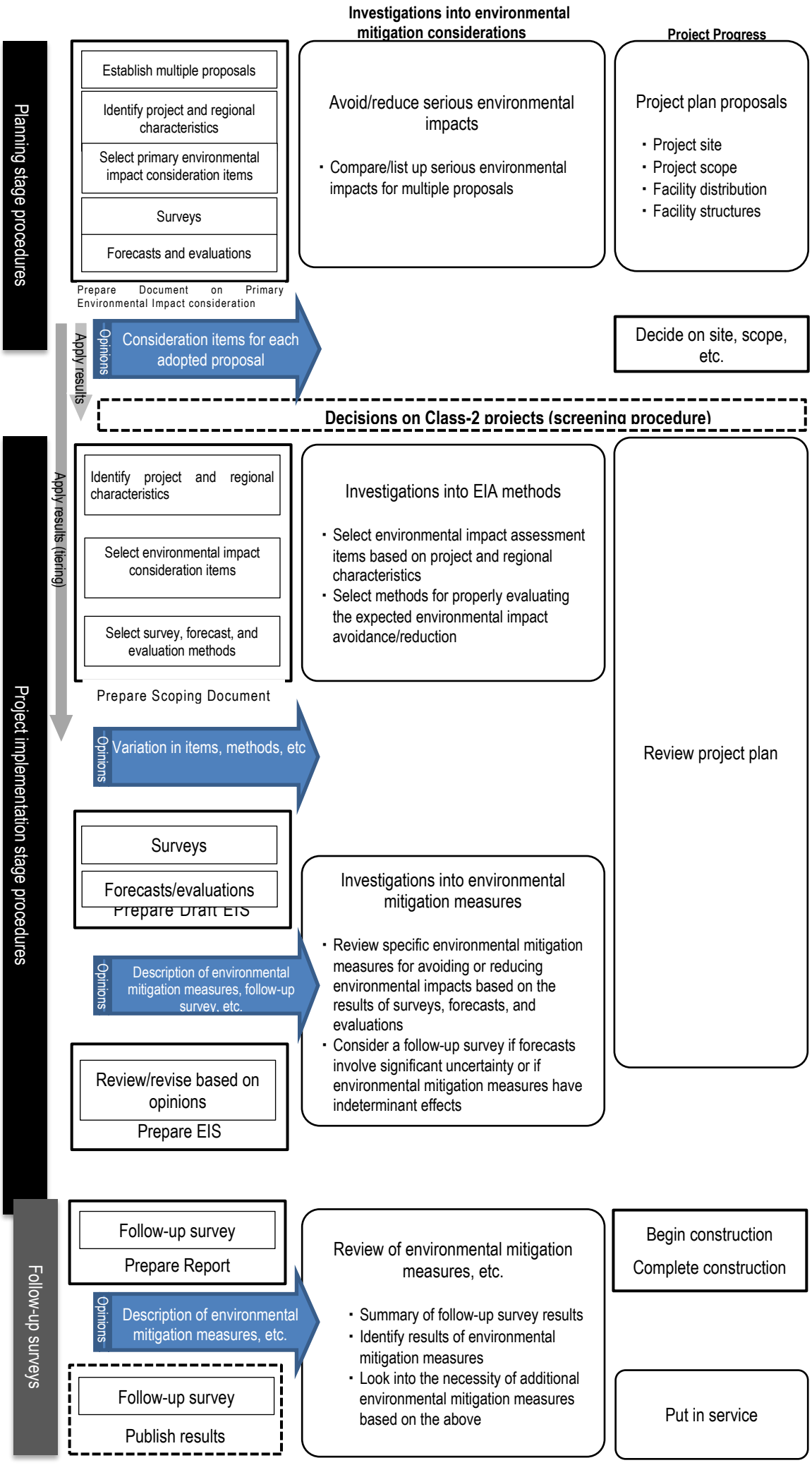

Figure II-1. Positioning of investigations related to environmental impact assessments and environmental

1. Application of the results to planning stage procedures (procedures for the Document on Primary Environmental Impact Consideration)

1.1 Concepts

Tiering is the process of utilizing and reflecting the results, feedback, and other outcomes from the procedures for the Document on Primary Environmental Impact Consideration (done during the planning stage) so that environmental impact assessments can be conducted efficiently and logically during the project implementation stage.

> **Commentary**: Tiering
> "Tiering" means "layering" or "accumulating". In environmental impact assessments, it is the process of utilizing and reflecting investigation results and other outcomes from the previous stage into the current one.

1.1.1 Application to project plan explanations

If relevant feedback has been solicited from government agencies and/or the general public during planning-stage procedures for the Document on Primary Environmental Impact Consideration, then the evolution and details of investigations into environmental conservation considerations that took place when making decisions (on where to implement the project, for example) should be included in the Scoping Document. When explaining the project planning decision-making process in the Scoping Document, it is a good idea to outline the investigations that took place during planning-stage procedures for the Document on Primary Environmental Impact Consideration.

- Project plans in the Scoping Document should be formulated after the Document on Primary Environmental Impact Consideration has been prepared and will likely include the results of inquiries into social and economic factors as well. They will therefore not necessarily be in line with the best suggestions from an environmental perspective as discussed during the planning-stage procedures for the Document on Primary Environmental Impact. In some cases, the project plan may not be identical to any of the suggestions proposed in the Document on Primary Environmental Impact. For this reason, it is important to document the project plan investigation process as it continues beyond the Document on Primary Environmental Impact procedures.

1.1.2 Application to selecting EIA items and survey, forecasting, and evaluation methods

The results of surveys, forecasts, and evaluations for primary environmental impact consideration items in the Document on Primary Environmental Impact can be used to select items for the environmental impact assessment as well as EIA survey, forecast, and evaluation methods.

- If project proponents are selecting a project plan from among those listed in the Document on Primary Environmental Impact that will avoid or reduce serious environmental impacts on

important species, for example, project proponents should be able to make project implementation stage procedures more efficient by adopting limited and simplified survey or forecasting methods that allow project proponents to identify environmental other than the serious ones identified in the planning stage.

- If there are primary environmental impact consideration items that forecasts show will have serious environmental impacts or items deemed to have a large degree of uncertainty, try prioritizing survey and forecast methods during the project implementation stage. Ideally, their work during the planning stage should help project proponents select a balanced and varied array of environmental impact items as well as survey, forecast, and evaluation methods.

1.1.3 Application to survey results (data)

Survey results from existing documentation collected and organized during the procedures for the Document on Primary Environmental Impact Consideration can be utilized in surveys during project implementation stage procedures as well.

- Regional environmental information collected and organized in the Document on Primary Environmental Impact Consideration can be used to describe general conditions in the target project implementation area during project implementation stage procedures, for example. This should make work during this stage go more efficiently.
- Survey results obtained during procedures for the Document on Primary Environmental Impact can be utilized for surveys conducted during project implementation stage procedures as well—which should make the surveys, forecasts, and evaluations conducted during the implementation stage more sophisticated and more efficient. Note, however, that environmental impact assessment items may require surveys of different scope in the planning and implementation stages, so make sure to be mindful of this when utilizing existing results.
- With landscapes and places for activities with nature, for example, the existing documentation collected and organized during procedures for the Document on Primary Environmental Impact, the regional characteristics or survey scope concepts that were arrived at through investigations based on those documents should be useable during the project implementation stage as well. Project proponents can make implementation-stage surveys more sophisticated by obtaining the most recent information from updated documents during project implementation stage procedures or reviewing survey target scope, for example, based on documents and data that were not collected and organized during procedures for the Document on Primary Environmental Impact.

1.1.4 Application to forecast results

Project proponents can utilize the results of forecasts conducted during procedures for the Document on Primary Environmental Impact in forecasts conducted during the project implementation stage.

- If project proponents are conducting relatively detailed forecasts during procedures for the Document on Primary Environmental Impact, project proponents can use the same or updated forecast criteria in their forecasts during the project implementation stage. This should make the surveys, forecasts, and evaluations conducted during the implementation stage more sophisticated and more efficient.
- If the project plans developed during the planning stage are thorough and detailed enough, project proponents may be able to show the same forecast results from the Document on Primary Environmental Impact during the project implementation stage by conducting on-site surveys and the like (with landscape or places for activities with nature, for example). In this situation, project proponents can use the forecasts results from the procedures for the Document on Primary Environmental Impact during implementation stage procedures as well, which means that project proponents can forego doing surveys and forecasts again during the project implementation stage except in cases where they seem particularly necessary (e.g. when it is anticipated that environmental impacts will be severe or when major changes are made to the project plan).

1.1.5 Application to explanations on avoiding or reducing environmental impact

When considering environmental mitigation measures during project implementation stage procedures, project proponents must clearly indicate the results of reviewing multiple proposals for avoiding or reducing environmental impacts during procedures for the Document on Primary Environmental Impact alongside the results for avoiding or reducing environmental impacts during series of project plan reviews.

2. Selection of EIA items and survey, forecasting, and evaluation methods

2.1 Concepts for understanding project and regional characteristics

It is important to get a thorough understanding of target project details (referred to here as "project characteristics") as well as the natural and social conditions of the target project implementation area and its surroundings (referred to here as "regional characteristics"). The purpose of this is to get the information project proponents need to be able to outline project plans for the target project and their social context, identify the distinctive natural and social features of the region, select environmental impact assessment items, and select survey, forecasting, and evaluation methods. For this reason, project characteristics and regional characteristics, must be thoroughly and comprehensively understood—regardless of whether they end up being selected as environmental impact assessment items.

- When selecting environmental impact assessment items, project proponents must clearly identify the reason for those selections. This means that project proponents must get a thorough enough understanding of project and regional characteristics to explain those reasons.
- Project proponents should understand and organize information on project and regional characteristics to a certain extent as they are carrying out procedures for the Document on Primary Environmental Impact, so if project proponents have enough information to determine which items should not be selected as environmental impact assessment items, there is no reason to work towards a more in-depth understanding of project and regional characteristics for those particular items. Note that they will need to incorporate them if project proponents end up collecting additional relevant information after the procedures for the Document on Primary Environmental Impact.
- The project characteristics and regional characteristics needed to select environmental impact assessment items as well as survey, forecast, and evaluation methods differ for each EIA item, but if project proponents are looking to incorporate a broad a range of these characteristics and list them in the Scoping Document and other materials, they can include area maps or information on past trends and/or future expectations of natural and social conditions as needed to make it easier to get an overall picture of project and regional characteristics.

2.1.1 Understanding project characteristics

The purpose of thoroughly understanding project characteristics is to be able to list up the actions and behaviors that will be the key factors impacted the environment during project implementation. We refer to these here as "impact factors".

- Information on the project characteristics that need to be thoroughly understood is

stipulated by the competent ministries for each type of project specified under the law. In general, it will include the following items. When selecting environmental impact assessment items or survey, forecast, and evaluation methods during stages when project plan details have yet to be finalized and it is difficult to organize detailed information (particularly information on carrying out construction work), it is best to understand project characteristics by referring to examples of similar projects.

- Project category
- Location of target project implementation area
- Project scope
- Overview of project sharing plan
- Overview of project construction plan
- Other items relevant to the project

- Thoroughly understanding project characteristics includes recording the history and content of investigations into environmental mitigation considerations carried out during the process of hammering out project details. Clearly outlining the progress of looking into environmental mitigation considerations will help stakeholders and others who read the Scoping Document gain a better understanding of the project, which will in turn allow project proponents to gather more detailed and constructive opinions as well as gather feedback earlier in the project planning process.
- Information on project characteristics needs to be further specified through Draft Environmental Impact Statement procedures in line with the process used to flesh out the project plan and reflected in the selection of environmental impact assessment items as well as survey, forecast, and evaluation methods.

2.1.2 Understanding regional characteristics

Regional characteristics include those that are relevant to the selection of environmental impact assessment items as well as survey, forecast, and evaluation methods. They can be understood by gathering up-to-date literature and a wide variety of other resources, looking at surveys of general local conditions primarily through easy-to-obtain documents and data. In the process, it is important to collect information not only on the environmental situation in a region, but also on what in particular needs to be addressed when considering environmental conservation as well as the status of designated areas and regulations (as specified in laws and ordinances, for example).

1) Scope

The scope of regional characteristics that needs to be understood must be sufficient to select environmental impact items as well as survey, forecast, and evaluation methods. Consider the impact factors listed up as project characteristics and include the surveyed

regions for impact factors selected as environmental impact items.

- If procedures for the Document on Primary Environmental Impact have been carried out, project proponents can use the regional environmental information that they collected and organized for that document as well as general conditions in the region as described in the Scoping Document to make this step go more efficiently.
- When it comes to the regions surveyed when selecting environmental impact assessment items, the basic matters are defined as "Regions that include the scope of changes to environmental conditions of or beyond a certain extent or the scope within which the environment will undergo direct modification as a result of implementation of the target project, as well as the surrounding area." The "scope of changes to environmental conditions of or beyond a certain extent" is different for each environmental impact assessment item. Furthermore, "changes of or beyond a certain extent" in terms of the impact that changes to environmental conditions have on people's health, living environments, or the natural environment also varies by environmental impact assessment item.
- For this reason, the scope of regional characteristics that needs to be understood is not decided uniformly using squares drawn on a topographical map or some fixed distance from the project implementation area, or by administrative district. Instead, it should be determined according to each environmental impact assessment item or the components that make up the target regional characteristics. In addition to the project implementation area, it is necessary to designate a scope that sufficiently takes into account water systems, access roads and other traffic flows, and so on as well as natural features like river basins and topography.
- When determining the scope of regional characteristics to be understood, pay attention to those components while conducting an exhaustive survey of the area where the environmental conditions will undergo substantial change while flexibly addressing areas that will not undergo much change in environmental conditions; for example, by conducting surveys on targets that are particularly vulnerable to impacts. At the same time, if project proponents are able to anticipate targets particularly vulnerable to impacts in the surrounding area, it's best to identify and make an effort to thoroughly understand those as well.
- Finally, if project proponents are in the process of conducting surveys for the purpose of understanding regional characteristics and feel that there is a need to broaden their target area; or if project proponents determine that there will be no ill effects from shrinking it, feel free to adjust the scope of those surveys as appropriate.

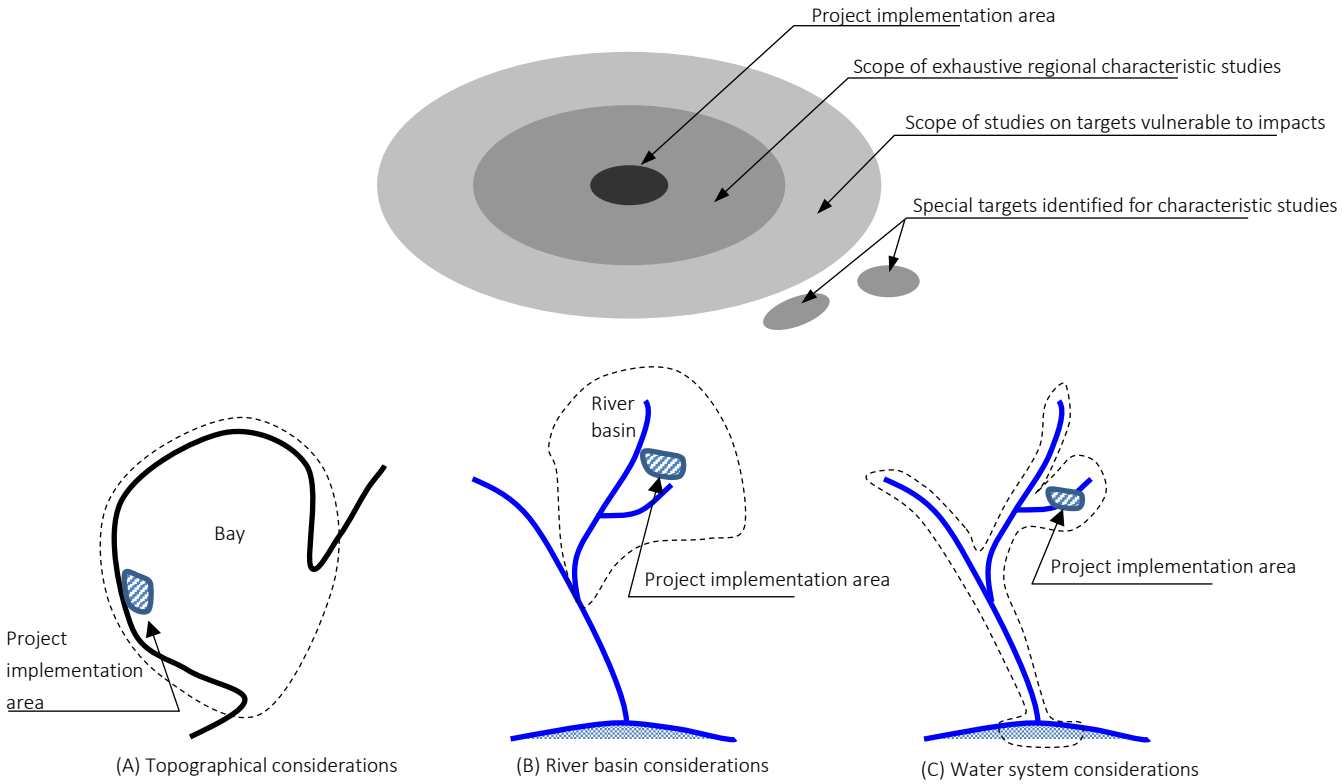

Figure II.2-1. Concepts for identifying scope of regional characteristic studies (visual)

2) Timeframe

Obviously the current status of an area should be given priority when studying regional characteristics, but for large projects subject to environmental impact assessments, it is necessary to take into account future project implementation and ongoing, long-term impacts once project structures are in service, tracking past status trends as well as future conditions.

- For example, when trying to understand the impact on the natural environment, looking at past vegetation trends and their causes (such as tracking how riverbed vegetation has changed as a result of human and/or natural factors) should allow project proponents to identify the current plant succession stage and thus investigate and determine how the succession will progress going forward.

3) Methods

To fully understand regional characteristics, collect and organize existing references (documents, topographical maps, results of past studies, etc.), interview experts and other relevant parties, and conduct on-site investigations and field studies. When studying regional characteristics, project proponents should collect as much case study information as project proponents can (for example, on other projects in progress or past large-scale projects in the region) to gain critical perspectives on evaluating the impacts that implementing their project will have.

(1) Collect and organize existing references

Existing references on environmental conditions as well as data on population, industry, and other basic regional characteristics is often compiled as part of government documents, so it's important to start study of existing references by collecting and organizing materials from government agencies in the target region. If project proponents need more detailed information, they can usually get it by going back to the source documents for those references or contacting the department or agency that compiled them. In addition to government agencies, entities like electrical companies or road management companies (that run tollways, for example) often collect long-term monitoring data. Finally, when doing existing reference study, make sure to collect the latest available information and indicate sources when project proponents are organizing the data.

The following forms of documentation are typically collected as existing references on regional characteristics:

- Information on current environmental conditions: White papers on the environment, circular economies, and biodiversity; documents on the current environmental conditions in XX region, various databases made publicly available by the national or local governments, etc.
- Population, industry, or other basic information on social characteristics: Prefectural or municipal handbooks, statistical white papers, etc.
- References on history and culture: Prefectural or municipal histories, etc.

In addition, check the environmental conservation policies issued by national and local governments to find out whether there are areas/targets vulnerable to environmental impacts or legally designated from an environmental conservation perspective, or regions where the level of adverse environmental impact is already significant or that are at high risk for adverse impacts (see tables II.2-1 through II.2-4).

Table II.2-1. Examples of regions/targets vulnerable to environmental impacts

Classification	Description
Regions vulnerable to pollutant accumulation	Bodies of water that are largely closed off, areas where pollutants emitted during project implemented will tend to accumulate
Regions where maintaining human health and the living environment must be considered	Schools, hospitals, and residential areas; areas requiring particular consideration in terms of maintaining human health and the living environment (e.g. drinking water intake points)
Natural environments largely untouched by human modifications, natural environments serving as critical wildlife habitats, etc.	Virgin forests, marshlands, marine forests, tidal flats, coral reefs, natural coastlines, or other natural environments largely untouched by human modifications; vulnerable natural environments that would be hard to restore once modified
	Satochi-satoyama areas (secondary forests, managed forests, farmland, reservoirs, grasslands, etc.), marshlands that serve as riverside floodplains, riparian forests, and similar natural environments that are disappearing or in decline
	Watershed forests, windbreak forests, tidal flats that serve a water purification function, greenspaces that prevent sediment disasters, and other natural environments that perform critical functions
	Surviving forests and greenspaces in urban areas (mountainside forests, temple forests, forests surrounding private residences, etc.), waterside areas, and other natural environments that lend important characteristics to the region

Table II.2-2(1). Examples of areas/targets legally designated from an environmental conservation perspective

Classification	Relevant legislation	Article	Description
Areas designated for air pollution control	Air Pollution Control Act (Act No. 97 of 1968)	Article 5(2)-1	Specified areas subject to standards for controlling total emissions of sulfur oxides and nitrogen oxides
Areas designated for countermeasures against nitrogen oxides/particulates	Law Concerning Special Measures for Total Emission Reduction of Nitrogen Oxides from Automobiles in Specified Areas (Act No. 70 of 1992)	Article 6-1	Specified areas subject to fundamental policies to reduce the total volume of nitrogen oxide emissions
		Article 8-1	Specified areas subject to fundamental policies to reduce the total volume of particulates
Roads targeted for roadside improvement	Act on Improvement of Areas Along Trunk Roads (Act No. 34 of 1980)	Article 5-1	Roads that meet the following conditions and are designated by the prefectural government: ・ Roads with a daily traffic volume of over 10,000 vehicles ・ Roads with nighttime traffic noise of more than 65 dB/daytime noise of more than 70 dB ・ Roads in dense residential areas
Water areas and specified areas designated for water pollution control	Water Pollution Control Act (Act No. 138 of 1970)	Article 4(2)-1	Specified water areas and surrounding areas subject to total control standards for chemical oxygen demand and nitrogen/phosphorus
Designated lakes and designated areas	Law concerning Special Measures for the Conservation of Lake Water Quality (Act No. 61 of 1984)	Articles 3-1 and 3-2	Lakes and surrounding areas which are not assured or extremely likely of not being assured of environmental water quality standards
Seto Inland Sea areas	Act on Special Measures Concerning Conservation of the Environment of the Seto Inland Sea (Act No. 110 of 1973)	Article 2-1	Seto Inland Sea
		Article 2-2	Relevant prefectural areas (excludes areas designated under Article 3 of the Enforcement Order on the Act on Special Measures Concerning Conservation of the Environment of the Seto Inland Sea (Cabinet Order No. 327 of 1973))
Designated regions for collecting underground water	Industrial Water Act (Act No. 146 of 1956)	Article 3-1	Regions designated under the stipulations of the Industrial Water Act, the Act on the Regulation of Pumping up Underground Water for Use in Buildings, and similar legislation
	Act on the Regulation of Pumping up Underground Water for Use in Buildings	Article 3-1	

	(Act No. 100 of 1962)		
National Parks, Quasi-National Parks, Prefectural Natural Parks	Natural Parks Act (Act No. 161 of 1957)	Article 5-1	National parks (natural scenic areas outstanding enough to represent the scenery of Japan)
		Article 5-2	Quasi-national parks (excellent natural scenic areas equivalent to national parks)
		Article 72	Prefectural natural parks (excellent natural scenic areas)

Table II.2-2(2). Examples of areas/targets legally designated from an environmental conservation perspective

Classification	Relevant legislation	Article	Description
Wilderness Areas, Nature Conservation Areas, Prefectural Nature Conservation Areas	Nature Conservation Act (Act No. 85 of 1972)	Article 14-1	Wilderness areas: Areas that preserve and maintain their original characteristic ecosystems without any influence of human activities.
		Article 22-1	Nature conservation areas: Natural areas in particular need of conservation due to their natural and/or social characteristics)
		Article 45-1	Prefectural natural conservation areas: Areas equivalent to nature conservation areas with natural and/or social characteristics in the surrounding areas that make them in particular need of conservation.
Natural Heritage	Convention Concerning the Protection of World Cultural and Natural Heritage	Article 11-2	Areas listed on the World Heritage List as natural heritage sites of particular importance and requiring conservation as forming part of the cultural heritage and natural heritage of all peoples of the world.
Suburban greenspace conservation areas	Act on the Conservation of Greenspaces around the Tokyo Region (Act No. 101 of 1966)	Article 3-1	Areas designated as greenspaces having a significant effect on maintaining/promoting the health of local residents in Tokyo or the surrounding region or in preventing pollution/disasters
	Act on the Arrangement of Conservation Districts in Kinki Area (Act No. 103 of 1967)	Article 5-1	
Greenspace conservation areas, special greenspace conservation areas	Urban Greenspace Conservation Act (Act No. 72 of 1973)	Article 5, Article 12-1	Areas designated in urban plans that are of the right location/scope to provide the functions essential to blocking, absorbing, or providing refuge to stop pollution or disasters; or well-suited to conservation in that they provide habitats for plant and animal life
Natural habitat protection areas	Act on Conservation of Endangered Species of Wild Fauna and Flora (Act No. 75 of 1992)	Article 36-1	Areas important for conservation of nationally endangered species
Wildlife sanctuaries	Act on the Protection and Control of Wild Birds and Mammals and Hunting Management (Act No. 88 of 2002)	Article 28-1	Important areas for the protection of wildlife

Table II.2-2(3). Examples of areas/targets legally designated from an environmental conservation perspective

Classification	Relevant legislation	Article	Description
Wetlands designated under the Ramsar Convention	The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat	Article 2-1	Wetlands of international importance especially as waterfowl habitat and wetland areas listed as wetlands of international importance for the purpose of promoting the conservation of the plants and animals that live there
Scenic sites and natural monuments	Act on Protection of Cultural Properties (Act No. 214 of 1950)	Article 109-1	Scenic sites (gardens, parks, bridges, and embankments are limited to those that have been deemed integrated with the surrounding natural environment) or natural monuments (excludes relevant species and specimens when those plant and animal species are individually designated)
Historic natural preservation zones	Act concerning Special Measures for the Preservation of Historic Natural Features in Japan's Ancient Capitals (Act No. 1 of 1966)	Article 4-1	Structures and other sites of historical significance that are integrated with the surrounding natural environment and embody the tradition and culture of Japan's ancient capitals as well as land zones that are critical for maintaining the status of the lands that make up these sites
Landscape areas	City Planning Act (Act No. 100 of 1968)	Article 8-1-7	Zones designated in city plans as maintaining the urban landscape, such as (1) forested, hilly, waterside, or similar zones or sites that preserve quality natural environments (2) zones containing shrines and temples; and (3) zones that maintain quality residential environments
Protected forests	Forest Act (Act No. 249 of 1951)	Articles 25-1 and 25-2	Protected forest zones (limited to those forests designated as achieving the purposes set forth in articles 1-8, 1-10, and 1-11 of the act)
Protected water surfaces	Act on the Protection of Fishery Resources (Act No. 313 of 1951)	Articles 15-1 and 15-4	Water surfaces ideally suited to the hatching and growth of aquatic animals and/or the seeding of aquatic plants, and therefore designated as requiring measures for the protection and culture of aquatic life

Table II.2-3. Regions where the environment is already significantly compromised or is at high risk

Classification	Description
Areas not yet governed by environmental standards	Areas where environmental standards pertaining to atmospheric pollution, water pollution, land pollution, and noise are not maintained ・ Environmental Standards for Air Pollution (Environment Agency Notification No. 25 of 1973) ・ Environmental Standards for Nitrogen Dioxide (Environment Agency Notification No. 38 of 1978) ・ Environmental Standards on Air Pollution Due to Benzene and Similar Substances (Environmental Agency Notification No. 4 of 1997) ・ Environmental Standards on Air Pollution Due to Particulate Matter (Ministry of Environment Notification No. 33 of 2009) ・ Environmental Standards on Noise (Environment Agency Notification No. 64 of 1998) ・ Environmental Standards on Aircraft Noise (Environment Agency Notification No. 154 of 1973) ・ Environmental Standards on Bullet Train Noise (Environment Agency Notification No. 46 of 1975) ・ Environmental Standards on Water Pollution (Environment Agency Notification No. 59 of 1971) ・ Environmental Standards on Underground Water Pollution (Environment Agency Notification No. 10 of 1997) ・ Environmental Standards on Soil Pollution (Environment Agency Notification No. 46 of 1991)
Aras in excess of maximum permissible noise levels	Areas in excess of maximum request levels Article 17-1 of the Noise Regulation Act (Act No. 98 of 1968)
Aras in excess of maximum permissible vibration levels	Areas in excess of maximum request levels Article 16-1 of the Vibration Regulation Act (Act No. 64 of 1976)
Land subsidence areas	Areas where considerable land subsidence is occurring

(2) Interview experts and other relevant parties

Supplement study of existing references as needed by interviewing researchers and others well-versed in the regional environment. The interviews might be with university researchers, teachers of higher education, museum curators, local government officials (such those in the environmental administration or environmental impact assessment screening departments), nongovernment organizations involved in environmental conservation activities, local residents, and so on.

(3) Conduct on-site surveys or field investigations

Field investigations involve having technical experts with a certain amount of survey experience (they should be at the level of coordinators of the environmental impact assessment of leaders of working groups assigned to individual environmental components) going out to the site to check the local natural and social conditions. The purpose of this is not so much to obtain detailed survey results; the priority is to get an idea of regional characteristics that can't be grasped through documents and other references. When surveying, also make sure to be aware of the need to identify targets vulnerable to impacts under the project, such as facilities which require special consideration when it comes to environmental mitigation.

If nticipate selecting environmental impact assessment items during this stage, it should be possible to get a rough idea of the areas and sites that will be subject to surveys, forecasts, and evaluations during the field investigation.

Note that if project proponents cannot obtain sufficient information from existing references, or if the information they get is extremely dated, it is still possible to conduct on-site surveys to a certain extent during this stage with the purpose of getting the data they need to set up an appropriate environmental impact assessment action plan.

Table II.2-4 Examples of facilities likely to be vulnerable to impacts

Classification	Example facilities
Educational facilities	Nursery schools, kindergartens, elementary schools, junior high schools, high schools, universities, vocational schools, and other schools
Medical facilities	Hospitals, clinics offering residential services, long-term care facilities, etc.
Other public facilities	Libraries, foster homes, social services facilities, etc.
Parks	Children's playgrounds, city parks, etc.

2.2 Selecting environmental impact assessment items

2.2.1 Listing up environmental factors

Use the project characteristics to come up with a list of impact factors for the project.

- List up factors that could emit chemical or other harmful substances or damage or change the existing environment (1) during the construction work associated with the project, (2) due to the land or structures that will exist once construction is complete, and (3) while the project outputs are in service or use.
- It a portion of the project involves removing/scrapping structures in the target project implementation area, or if there are plans to remove/scrap structures as part of project activities (including when this is the goal of the project), impact factors related to this

removal/scrappage need to be listed up as well.

Reference: Comparison with general projects (projects subject to legislation)

When selecting EIA items as well as survey, forecast, and evaluation methods for environmental impact assessments carried out according to the Environmental Impact Assessment Act, project proponents need to start by comparing the description of general projects stipulated in the ordinances of the competent ministry and compare them to the description of individual projects to identify the differences.

General projects as described in the competent ministry ordinances typically list reference items and methods as for each type of project as stipulated by the competent minister. Project proponents are to compare the details of their individual target projects with this general project description in order to determine the items and methods they should adopt, based on the reference items and methods given.

Note that the reference items are to be used simply as such (references) when selecting environmental impact assessment items; it is critical to give priority consideration to the actual project and regional characteristics. Also note that whether or not project proponents end up adopting the reference items, they must clearly indicate the reason for the environmental impact assessment items selected in the Scoping Document.

2.2.2 Listing up environmental components

Use the regional characteristics in the project implementation area and the surrounding area to come up with a list of environmental components at risk for impacts due to changes in the environment.

- Project proponents do not need to look too closely at the relationship between environmental factors and environmental components at this stage, but they do need to look at environmental components while taking impact factors into consideration so that they do not end up selecting environmental components that have nothing to do with environmental factors for EIA items or failing to select environmental components for EIA items when there are relevant environmental factors at play.

2.2.3 Selecting environmental assessment items

Select environmental assessment items for the target project based on the relationship between the impact factors and environmental components.

- A matrix is useful for showing how impact factors and environmental components relate to one another without exception. An impact flowchart, on the other hand, can be used to look at how environmental components relate to one another, how impact factors and regional characteristics relate to other factors, and for identifying any secondary environmental impacts likely to arise. To avoid leaving out environmental impacts not sufficiently expressed in the matrix, prepare an impact association flowchart and use it to look more closely at the target impact factors and environmental components (see figure

II.2-2).

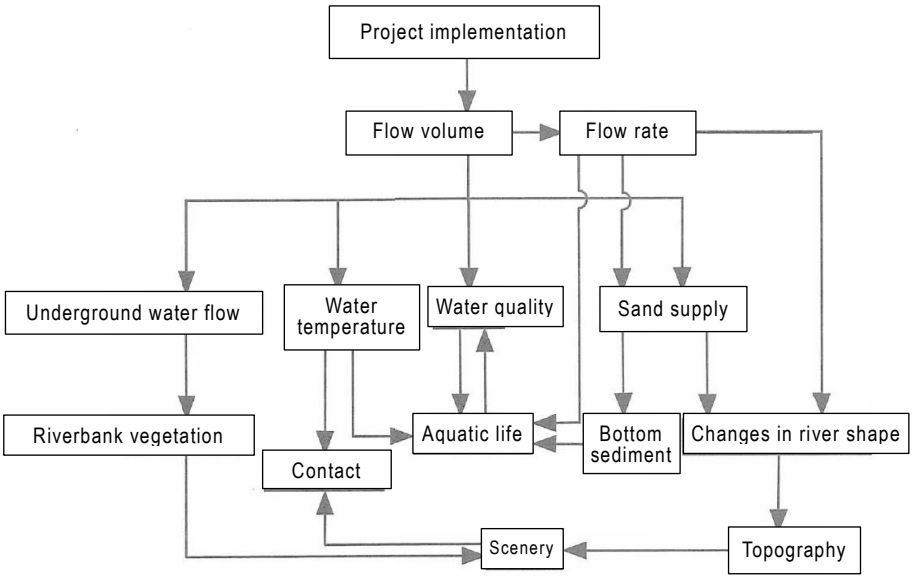

Figure II.2-3. Impact association flowchart (example)

- The environmental components “air quality”, “water quality”, and “soil quality and other environmental components” are closely linked to environmental “plants”, “animals” and “ecosystems” environmental components as well as the “places for activities with nature” component. For this reason, project proponents need to consider environmental components related to plants, animals, ecosystems, and places for activities with nature in the project implementation area and the surrounding environment when selecting environmental impact assessment items for air quality, water quality, and soil quality/other as well as when project proponents are looking into survey, forecast, and evaluation methods.
- Meanwhile, the information project proponents collect on components related to plants, animals, ecosystems, and places for activities with nature as it relates to air quality, water quality, and soil quality/other environmental components will also be useful for selecting the environmental impact assessment items related to these categories as well as looking into survey, forecast, and evaluation methods—so prior to conducting surveys, they need to sufficiently investigate the possibility of using the relationships among the different components and the information collected prior to the survey.
- For forecasting, the results from forecasts related to air quality, water quality, and soil/other can be used as basic forecast information for plants, animals, ecosystems, and places for activities with nature.
- The goal is to sufficiently consider the relationships among the different environmental components when selecting environmental impact assessment items and selecting survey, forecast, and evaluation methods. An impact flowchart investigation can make it easier to

map out those relationships.

- If project proponents find that (1) project implementation will create no impact or extremely limited impact compared to general project descriptions, (2) the project implementation area or surrounding area is not one susceptible to impacts, (3) there will not be any other targets for a certain period of time, or (4) the level of impact is clear from similar case examples, they can consider not selectin environmental impact assessment items for the relevant environmental components. In that case, it will be necessary to provide information that explains the basis for the above decision under the "project description" and "general regional conditions" items in the Scoping Document and so on.

2.3 Selecting survey, forecast, and evaluation methods

2.3.1 Method investigation concepts

It is critical that the purpose of every task project proponents carry out as part of environmental impact assessment processes is well-defined so that associated surveys, forecasts, and evaluations can be conducted logically and effectively. Since surveys and forecasts are carried out for the purpose of evaluations, project proponents need to look into the methods they will use for each of the three processes in reverse of the order they will actually be carried out for the purpose of the EIA. This order of inquiry (evaluation methods, forecast methods, survey methods) is shown in figure II.2-4.

- If project proponents do not sufficiently look into surveys, forecasts, and evaluations beforehand, they may end up conducting unnecessary surveys or have to do follow-up surveys to make up for shortcomings.
- As with selecting environmental impact assessment items, it is important to consider project and regional characteristics when selecting survey, forecast, and evaluation methods.

Points for consideration: When referring to survey, forecast, and evaluation methods used in similar case examples conducted nearby, it is a good idea to look at the final EIA documents (e.g. Environmental Impact Statements) produced during the project implementation stage. Keep in mind that the survey, forecast, and evaluation methods listed in the Scoping Document and the Document on Primary Environmental Impact Consideration may have ended up changing prior to actual implementation as a result of feedback and so on.

Points for consideration: Describing reasons for selecting survey, forecast, and evaluation methods

Project proponents should ideally provide specific details on why and how they arrived at the survey, forecast, and evaluation method selections.

- Lacking in specificity
  "We used a dispersion simulation to select our forecast method."
- Ideal
  "The project implementation area is located in a valley, and based on past air pollution status, we found that the inversion layer, especially in winter (February) caused atmospheric

pollutants tend to reach high concentrations. Due to the amount and characteristics of the atmospheric pollutants generated by the project… Based on the status of the surrounding area and the project characteristics described above, we decided to adopt a XX forecast model with XX characteristics. For XX, where this model could not be applied, we adopted the XX model for forecasting in line with those conditions."

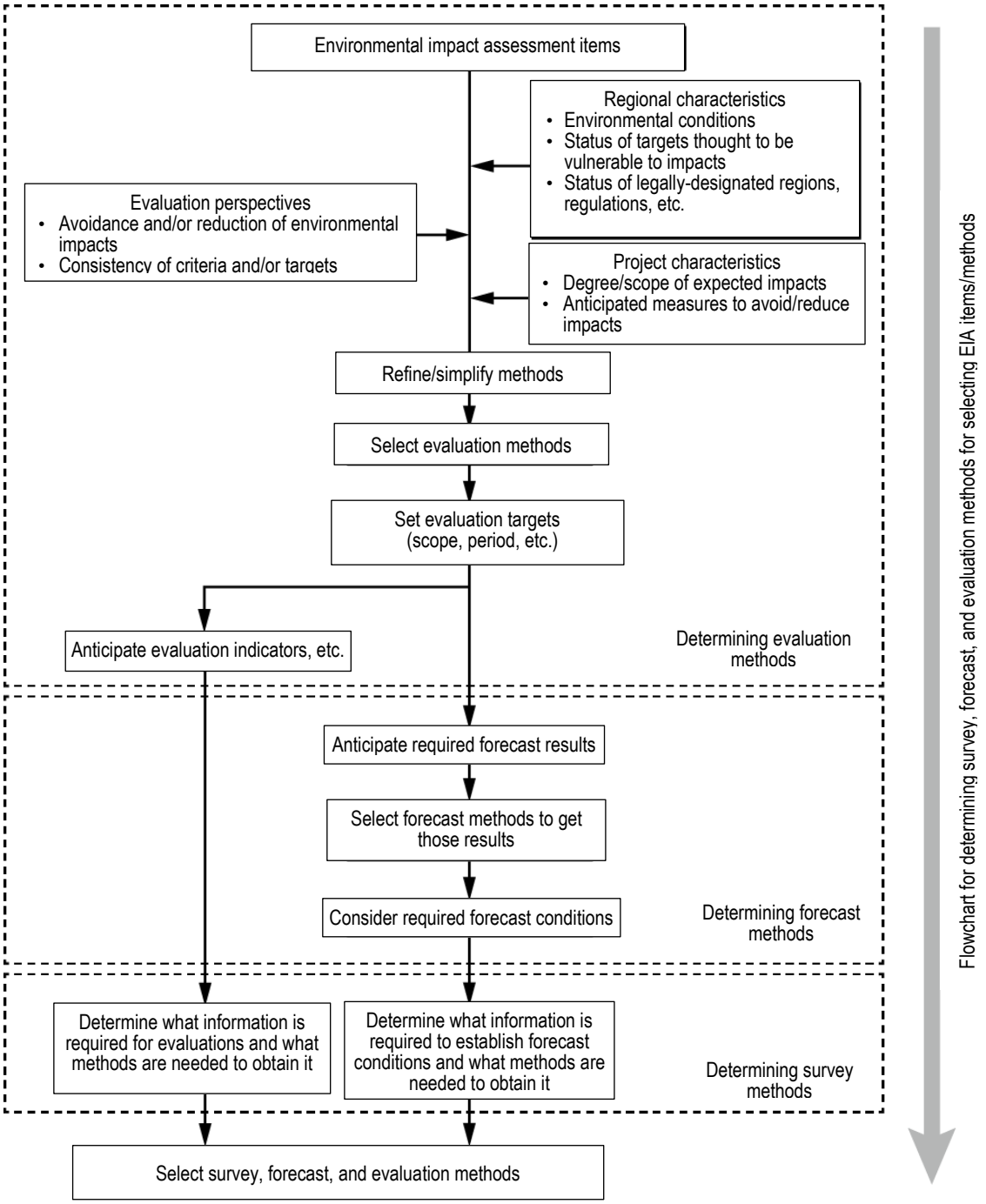

Figure II.2-4. Flowchart for determining survey, forecast, and evaluation methods

2.3.2 *Refining and simplifying survey and forecast methods*

As project proponents study the items selected as environmental impact assessment items ("selected items"), if they find that there is a chance that significant environmental impacts can be expected during the project planning stage, consider adopting survey/forecast methods that are more detailed than the reference methods (refining). On the other hand, if it becomes clear that environmental impacts will be minimal, for example, consider adopting survey/forecast methods that are simpler than the reference methods (simplifying).

Note that refining or simplifying survey/forecast methods does not only mean using more sophisticated or simpler methods in terms of technique, but also selecting more or less detailed survey/forecast sites and forecast conditions. The following are some examples of when refining or simplifying survey/forecast methods might be appropriate.

Examples of situations when using survey/forecast methods that are more detailed than the reference methods should be considered

- When it is determined from the forecast results in the Document on Primary Environmental Impact Consideration that forecasts will have a high degree of uncertainty
- When project characteristics indicate that there is a chance that environmental impacts will be significant
- When the region is vulnerable to environmental impacts or when there are vulnerable targets (see table II.2-1)
- When the region is legally-designated for environmental conservation or when there are legally-designated targets (see table II.2-2)
- When the regional environment is already significantly compromised or at high risk (see table II.2-3)
- When project or regional characteristics will likely make it difficult to conduct forecasts using general-purpose methods (e.g. reference methods) from a technical standpoint
- When local governments or project proponents have specific priorities when it comes to environmental conservation

Examples of situations when using survey/forecast methods that are simpler than the reference methods should be considered

- When it becomes clear from the forecast results in the Document on Primary Environmental Impact Consideration that environmental impacts will be minimal
- When there are not expected to be any regions subject to environmental impact or any targets for a certain period of time
- When it becomes clear from similar case examples that environmental impacts will be minimal

3. Surveys

3.1 Survey concepts

The purpose of surveys is to collect information that was not clear when surveys were done to identify regional characteristics during the procedures for the Document on Primary Environmental Impact Consideration and the Scoping Document (when collecting and organizing existing documentation, on-site investigations and field studies, etc.). They allow project proponents to understand the current status of the survey area in detail while also providing the information needed for forecasting and evaluations.

A variety of databases that can be utilized for environmental impact assessments have been set up and maintained in recent years. It is hoped that the use of these databases will improve the quality and efficiency of environmental impact assessments.

Reference: Databases that can be used for environmental impact assessments

■ Kankyo Tenbodai (Environmental GIS)
The Kankyo Tenbodai ("Environmental Observation Tower") service uses the Geographic Information System (GIS) to provide information on environmental conditions within Japan. It has information on measurement sites, measurement results, regulated areas, category designations, and so on—primarily on topics related to living environments (such as results from regular air pollution monitoring, water quality measurements from public bodies of water, and results from regular auto noise monitoring).

■ Japan's Integrated Biodiversity Information System (J-IBIS)
Japan's Integrated Biodiversity Information System collects and widely distributes a variety of information on biodiversity and natural environments in Japan. In addition to results from the National Survey on the Natural Environment (the "Green Census") and information on endangered species, the J-IBIS also has a search function (which it calls the "biodiversity information clearinghouse mechanism") that allows project proponents to find biodiversity-related data information sources across a wide range of sites run by universities, museums, researchers, and a variety of other groups and individuals. It also uses the Geographic Information System (GIS) to provide results from the Natural Survey on the Basic Environment, which includes surveys on plants, lakes and rivers, coastlines, marine areas (marine forests, tidelands, and coral reefs), national park boundaries, and more.

■ Monitoring Site 1000
This site collects ongoing data such as changes in the number of individuals in certain species (an ecosystem indicator) in around a thousand survey areas, including forests, tidelands, coral reefs, and various other ecosystems. Reports providing the results of these surveys are available for viewing and download.

■ Ikimono Log
The Ikimono Log ("Log of Living Things") is a system that records and shares distribution information for living things throughout Japan. In addition to listing information logged by the Ministry of the Environment, it allows regional research institutes, researchers, and everyday citizens to record and view information as well. Information on endangered species is not normally available, but if project proponents are using it for the environmental impact assessment, for example, project proponents can contact the Biodiversity Center of Japan, which will release it under certain conditions.

■ Basic Environmental Information Database for Environmental Assessments

The Basic Environmental Information Database for Environmental Assessments was set up for the purpose of increasing the quality and efficiency of environmental assessments. It uses the Geographic Information System (GIS) to provide the results of environmental surveys conducted in information management pilot districts across Japan as well as data on natural and social conditions—which can be used to identify regional characteristics.

Points for consideration: Utilizing results of environmental monitoring and other activities conducted by previous project proponents

The data from surveys, environmental monitoring, and similar activities conducted by other project proponents prior to implementing the environmental impact assessment for the target project can be utilized for their EIA as well, once its objectivity and validity has been confirmed via expert interviews and similar checks.

3.2 Survey methods

3.2.1 Selecting survey items

Survey items should be selected (1) to supplement insufficient information on conditions related to environmental components selected as environmental impact assessment items from surveys conducted to understand regional characteristics and (2) because they are necessary to conduct forecasts and evaluations.

3.2.2 Survey method concepts

As mentioned earlier, survey methods need to be considered using the following order of inquiry: evaluation methods forecast methods, survey methods. This is because the forecast and survey targets will change based on target periods and timeframes for forecasts and evaluations as well as the anticipated environmental impacts; these factors will also in large part determine which forecast methods and survey methods selected.

Project proponents therefore need to look at which forecast methods are appropriate for the regional characteristics (e.g. topographical and climate conditions) after defined evaluation targets. Once that is done, project proponents can then look into the survey methods project proponents need to perform those forecasts.

3.2.3 Survey area/site concepts

The Basic Matters include the following stipulations on the range of the area and sites targeted for surveys (the “survey area” and “survey sites”, respectively).

B. Survey area
By taking into consideration the characteristics of information subject to survey as well as the project characteristics and regional characteristics, the area which includes the range in which the condition of its environment will be changed to some extent by the implementation of the target project, or the area in which the condition of its environment will be directly modified and its surroundings, etc. shall be defined as the survey area.
C. Survey sites
In defining survey sites within the survey area, representative sites of the area and other sites which are appropriate and effective in information gathering shall be defined as the survey

sites, based on details of information to be comprehended in accordance with the characteristics of the selected items and the condition of the objects which are likely to be seriously impacted.
(Basic Matters Section 4-5(1): Basic Matters concerning the Guidelines for the Selection of the Items for Environmental Impact Assessment etc.)

1) Survey area

Survey areas are naturally determined in accordance with environmental component characteristics, but the impact factors selected as environmental impact assessment items need to be taken into account as well—even when environmental components are the same. For example, if the operation of construction equipment will impact air quality, include areas along major transportation routes in the survey area; if gas emissions form a thermal power plant will impact air quality, use the dispersal area of the gases emitted from the smokestacks as the survey area. On the other hand, if there are environmental impact assessment items that are expected to have a strong relationship to one another, coordinate those survey areas in advance according to the evaluation methods used for each item to make survey more efficient.

Note that if project proponents are using the survey results obtained during procedures for the Document on Primary Environmental Impact, keep in mind that their concepts for determining the target survey area may change as project plans become more complete during later stages of the process (after procedures for the Document on Primary Environmental Impact and Scoping Document are complete).

Points for consideration: Addressing the areas surrounding the target project implementation area under provisions for "minor modifications"

The Cabinet Order for Enforcement of the Environmental Impact Assessment Act stipulates project specification elements and modification conditions for "minor modifications" (articles 13, 18, 26, and 27) in each project category in its appended tables 2 and 3.

Depending on the type of project, specification elements may include the "location of the target project implementation area" with the condition that "an area located XXX meters or more (the exact distance depends on the individual project category) away from the target project implementation area prior to revision will not be included in a new target project implementation area".

This provision naturally applies to changes in construction plans set to take place within the target project implementation area, but may change the location of the project itself in the surrounding area up to XXX meters away—meaning that areas located up to XXX meters away are at risk for sustaining the same environmental impacts as the project implementation area. For this reason, consider carrying out equivalent surveys to those conducted on the project implementation area up to XXX meters away in order to ensure that these areas are sufficiently addressed even if project plans change; project proponents can anticipate having to establish a survey area that includes the surrounding area up to a XXX-meter radius.

Note that even project types that do not list the "site of the target project implementation area" as part of their specification elements may include similar provisions, so attention must be paid to these as well.

2) Survey sites

The following sites are among those that are important to keep in mind when selecting survey sites.

- Sites that are representative of the region
- Sites that allow project proponents to properly understand survey targets
- Sites at risk for particularly major impacts
- Sites that include targets requiring particularly careful consideration of environmental conservation
- Sites where environmental conditions are already significantly compromised
- Sites where pollution or other environmental harm is already advancing

Note that if project proponents are using the results of surveys on regional characteristics from existing documentation in forecasts, it is important to look at how well the existing measurement sites represent target area and clearly indicate the results of inquiry.

3.2.4 Survey period and timing concepts

The Basic Matters define survey period and timing as follows.

> *D. Period and timing of surveys*
> *In defining the period and timing of survey, an appropriate and effective period and timing of the survey shall be defined based on the details of information to be comprehended in accordance with the characteristics of the selected items, meteorological and hydrospheric characteristics of the region, and social circumstances, etc. In this case, concerning the survey objects whose seasonal fluctuation must be comprehended, survey period necessary to appropriately comprehend such fluctuation shall be ensured, and as for a year-round survey, it shall be launched as necessary from the time when less fluctuation in observation results is expected.*
> *In addition, in the cases where a long-term observation result is available and field study will be conducted, the said observation result and the results obtained from the field study shall be compared.*
> (Basic Matters Section 4-5(1): Basic Matters concerning the Guidelines for the Selection of the Items for Environmental Impact Assessment etc.)

- The period and timing of surveys need to be determined while considering fluctuations in the natural environment, in human activity, and so on. If project proponents are conducting a year-round survey, for example, they need to set a survey period that is not impacted by abnormal seasonal phenomena that only occur during certain years.
- Also make sure to sufficiently consider the fact that the required survey period and timing may change depending on the evaluation targets project proponents select (average values, maximum values, etc.).

Points for consideration: When to initiate year-round surveys

If project proponents are studying the number of people that use a park famous for cherry blossoms over the course of a year and use the Japanese fiscal year (which starts April 1) as their survey period, project proponents may not get an accurate grasp of the number of annual users depending on how early or late the cherries bloomed each season. In situations like these, where survey results depend heavily on when the survey period starts, project proponents need to set yearlong period in such a way that the survey begins during a time of year where there is relatively little fluctuation in the data.

4. Forecasts

4.1 Forecast concepts

Forecasts use a variety of methods (including numerical modeling, experiments, excerpts or analyses from case examples, and so on) to understand changes in environmental conditions and/or environmental loads in the target region so that the degree of environmental impact resulting from project implementation can be properly evaluated.

Note that project proponents may be able to utilizes forecast results from the Document on Primary Environmental Impact Consideration when needed in cases where relatively detailed forecasts were conducted during those document procedures.

- As project proponents are making inquiries in the proper order (evaluation methods, forecast methods, survey methods), the stage where they carry out forecasts is also the stage where project proponents will further specify the forecasting methods. Remember, however, that project proponents must work to attain the latest insights on forecasts and evaluations as well as reconsider survey results. This means that there may be cases where project proponents will have to revise the forecast and/or evaluation methods that originally anticipated using.
- When selecting forecast methods, project proponents essentially want to pick the method that will allow them to get the most accurate quantitative results based on the insights project proponents have at the time. Keep in mind, however, that forecasts are always subject to error, and that there may uncertainties arising from the forecast methods or conditions project proponents use.
- Project proponents may be able to reduce error by verifying the accuracy of the data they are using for the forecasts or by conducting a sensitivity analysis on parameters. Forecast uncertainty, however, is something project proponents will need to consider when implementing environmental mitigation measures and follow-up surveys as well as during evaluations.
- Note that if project proponents want to help minimize the uncertainty of future forecasts, it is important to continue collecting and analyzing insights that come out of research on forecast methods and conditions as well as those from the results of follow-up surveys and environmental mitigation measures.

4.2 Forecast methods

4.2.1 Forecast method concepts

The forecasting methods project proponents use must take into account the characteristics of environmental components themselves as well as project and regional characteristics while upholding the required standards for evaluations related to the selected items.

- If project proponents are using forecasting models to run calculations that replicate current conditions, for example, they should make sure that they are maintaining the required standards for evaluation by checking thy calculated and observed values. If project proponents are using excerpts or analyses from similar case examples, they need to list up the similarities and differences to the target project in order to clearly demonstrate that the case is similar enough to be suitable.
- When it comes to current conditions, there may be environmental components without established forecasting methods—which means that project proponents may need to refer to scientific papers or forecast methods from overseas in order to understand the latest insights. Note that if project proponents are referring to overseas methods, remember that they may have been developed based on climatological or topographical features, for example, that are different than those in the country they are working in.

1) Forecast conditions: concepts

Forecasting things like air and water quality means tracking the behavior of pollutants under certain environmental conditions. In cases like these, project proponents will need to establish the environmental conditions they will use as a baseline. When establishing environmental conditions, project proponents may use maximum impact or average impact conditions—but in either case, they need to consider any fluctuations that may occur in the baseline environmental conditions and the range of those fluctuations. Also keep in mind that average conditions are not necessarily equivalent to average environmental impact.

Points for consideration: Establishing future environmental conditions

When forecasting, project proponents will establish future environmental conditions based on the forecast target period. The forecast results then need to clearly separate those future environmental conditions from changes in environmental conditions arising from the target project in order to clearly indicate the degree of impact that the target project will have.

Organize the basic items so that it is clear what the future environmental conditions in the region will be as a result of business and other activities unrelated to the target project (background conditions), and then consider this as project proponents make their forecast. If there is some logical reason that makes it difficult to estimate future environmental conditions (e.g. lack of availability of current scientific standards and information), it is possible to use the current environmental conditions instead, but even in this case, project proponents should at

least identify qualitatively what the future trends will be; in other words, whether conditions are likely to improve or decline.

Reference: Adaptation to climate change

The Intergovernmental Panel on Climate Change has approved and published its Fifth Assessment Report, a compilation of the latest scientific insights collected over 2013 and 2014 that includes findings from three reports: *The Physical Science Basis*, *Impacts, Adaptation, and Vulnerability,* and *Mitigation of Climate Change*.

The Fifth Assessment Report indicates that there is no doubt as to the warming of climate systems and that there is an extremely high possibility that human impacts are the predominant factor driving this warming in recent years. It also states that climate change has spread to every ocean and continent, impacting both natural systems and human societies. It also predicts that no matter what scenario we adopt for our future greenhouse gas emissions volume, average global temperatures will rise and the threat of climate change impacts will increase towards the end of the 21st century.

Measures to address climate change can be roughly divided into two categories. The first category is mitigation, which includes measures designed to curb emissions of the greenhouse gases that cause global warming in order to stop the progress of climate change. The second category is adaptation, which includes measures that adjust how natural environments or societies respond to the impacts that are either already happening or have the potential to happen. According to the IPCC, "mitigation and adaptation are complementary approaches for reducing risks of climate change impacts", and must therefore be considered as two sides of the same coin.

Japan is also experiencing higher temperatures, more frequent heavy rains, fewer precipitation days, and rising sea surface temperatures, and the impact of these aspects of climate change are already manifesting as lower-quality crops due to higher temperatures, a deterioration or redistribution of plant life in alpine and subalpine zones, coral bleaching in subtropical areas due to higher ocean temperatures, plants blooming earlier in the year, and more. And as temperatures continue to rise, heavy rains become more frequent, precipitation days become fewer, sea surface temperatures continue to rise, rainfall amounts from storms increase, maximum intensity of typhoons increase, and ocean levels rise in the future, we are likely to see diverse impacts in a wide range of areas—from agriculture, forestry, and fisheries to aquatic environments, water resources, natural ecosystems, natural disasters, and human health.

Research and initiatives on adaptation to climate change are underway on a global scale. In Japan, the entire government came together in November 2015 to issue a Cabinet decision on the National Plan for Adaptation to the Impacts of Climate Change as a governmentwide coordination efforts to systematically and comprehensively promote initiatives to address a variety of climate change impacts. Going forward, it is expected that the government will continue to collect insights and make adaptation a priority in its plans. Finally, as research and technological development related to the impacts that climate change has on biodiversity, aquatic environments, water resources, and so on as well as to planning and implementation methods for adaptation measures progresses, and as related insights and case examples are collected, climate change impacts will need to be considered as part of environmental impact assessments.

2) Forecast uncertainty

When selecting forecast methods for environmental impact assessments, project proponents essentially want to pick the method that will allow them to get the most accurate quantitative results based on the insights project proponents have at the time.

Keep in mind, however, that forecasts are always subject to error and uncertainty.

Forecast uncertainty comes from measurement errors when attempting to understand the current status of and fluctuations in the natural and human factors used as a baseline for project proponents forecasts as well as from the limits, parameters, basic units, and other features inherent to the forecast model itself.

- These forecast uncertainties exist at many different levels, so consider how they will impact the forecast results, describe the extent of the uncertainty when recording those results, and avoid getting stuck on individual forecast conditions—have the flexibility to use strategies like including results from multiple forecast conditions. Project proponents must sufficiently verify both the validity and uncertainty level of their forecast conditions, especially when project proponents are working with conditions that themselves include estimates (such as traffic volume, for example).

Points for consideration: Forecast uncertainty

・Forecasting involves error and uncertainty

Forecast targets like pollutant concentration, climate conditions that involve forecasts, or traffic volume conditions are things that change moment to moment. Most of the time their fluctuations can be accurately understood, but they also demonstrate abnormal fluctuations when viewed over the longer term.

In addition to the forecast uncertainties that probabilistic fluctuations and abnormalities bring, there are assumptions about the natural and social fluctuations that largely drive future-oriented trends. These should be treated as phenomena that cannot be assumed to be known when conducting forecasts, and therefore represent another form of forecast uncertainty.

When it comes to the forecast methods, make sure project proponents understand the characteristics of the phenomena they are subjecting to forecasts (whether they are localized or occur across a wide area, whether the exposure is short- or long-term, etc.), which are essentially based on project characteristics and regional characteristics. Also make sure that project proponents are fully aware of the uncertainty inherent in their parameters and in the scope of application of methods, understanding that there will be a great degree of uncertainty in the forecast results if project proponents deviate from those applications.

・Measures to address forecast error and uncertainty

○ Fluctuations in phenomena
Be aware that probabilistic fluctuations introduce error into forecasts. When it comes to abnormal fluctuations, project proponents can verify whether something is occurring during an abnormal year, for example, or conduct a null hypothesis test to estimate abnormal values brought by fluctuations.

○Forecast methods
Use forecast methods and basic units whose accuracy level is well-understood as a result of data collection, accumulated insights, experimental verification, and similar means. In many cases, regular improvements are made as researchers gain more insight into these methods, so make sure project proponents are aware of these technical trends and select forecast methods and basic units that maintain the necessary standards project proponents need to conduct

evaluations on their selected items.

If there are technical issues such as the uncertainty inherent in forecast model parameters or the suitability of the application scope, do not get stuck on a single result derived from a single forecast condition. Instead, have the flexibility to address the issue by including results derived from multiple forecast conditions, for example. Note that in some cases comparative research has been conducted on different forecast models, so including excerpts from these studies can be an effective strategy as well.

○ Baseline forecast conditions
Setting up multiple scenarios and running forecasts for each can be an effective strategy for forecast conditions that are greatly affected by future social conditions (such as road development plans, for example). If project proponents are dealing with future traffic volume, for example, they could conduct forecasts for both maximum-level and minimum-level scenarios.

4.2.2 Forecast area/site concepts

The Basic Matters include the following stipulations on the range of the area and sites targeted for forecasts (the “forecast area” and “forecast sites”, respectively).

B. Forecast area
The range of the area subject to forecast (hereinafter referred to as the "forecast area") shall be appropriately defined out of the survey areas according to each selected item by duly considering the project characteristics and regional characteristics.
C. Forecast sites
Forecast sites within the forecast area shall be set from sites such as representative sites of the area, sites which are highly likely to be affected, sites suitable to accurate comprehension of possible impact on objects etc. to be protected, in accordance with the characteristics of the selected items and the condition of the objects to be protected, geographical, meteorological, and hydrospheric characteristics, etc.
(Basic Matters Section 4-5(2): Basic Matters concerning the Guidelines for the Selection of the Items for Environmental Impact Assessment etc.)

1) Forecast area

Forecast areas typically include the range in which environmental conditions will change by a certain minimum amount as a result of project implementation. This range will vary depending on the size and type of project, and must also be appropriately determined while taking into account forecast uncertainty and regional characteristics.

Note that project proponents may be able to refer to the concepts they used to determine the survey area and set the the same range for the forecast area, but if after considering the way project proponents plan to conduct their evaluations based on the forecast results project proponents find that it is not necessary to make the entire survey area the forecast area, they do not necessarily have to match.

2) Forecast sites

If fixed-point evaluations are unnecessary, project proponents do not necessarily need to

establish forecast sites. However, if there are sites that are at particular risk for major impacts or if there are sites that include targets requiring particularly careful consideration of environmental conservation, project proponents may want to define them as forecast sites. Ideally, project proponents will also consider the sites where they anticipate conducting follow-up surveys and monitoring surveys when establishing forecast sites.

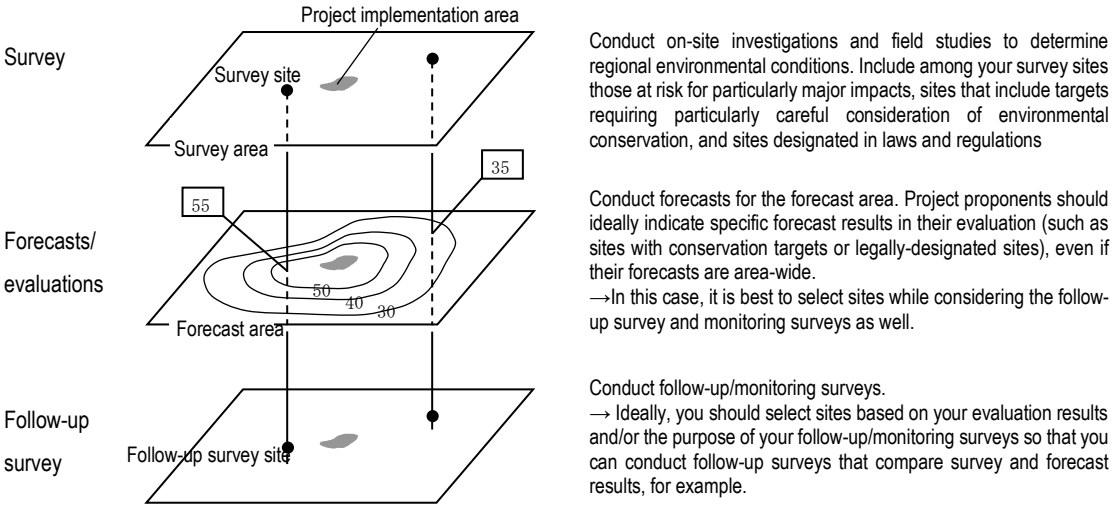

Figure II.4-1. Determining forecast sites in consideration of follow-up surveys

4.2.3 Forecast period concepts

The Basic Matters define the period subject to forecast as follows.

D. Period subject to forecast
The period subject to forecast shall be defined, by duly considering the project characteristics, meteorological and hydrospheric characteristics of the region, and social condition etc., in terms of the time when steady state is maintained or the environmental impact is at its maximum once the service begins (limited to when defining such period is possible), or the time when the environmental impact is at its maximum during the construction, etc., so as to accurately comprehend the environmental impact for each of the selected items.
In addition, in cases where it takes an extended period from the time of putting lands etc. into service upon the completion of construction to the achievement of steady state or where the preconditions of forecast significantly vary within the forecast period, or where lands etc. are scheduled to be put into use before the completion of the construction relating to the target project, a midterm forecast shall be conducted as necessary.
(Basic Matters Section 4-5(2): Basic Matters concerning the Guidelines for the Selection of the Items for Environmental Impact Assessment etc.)

1) During construction

The forecast period during construction is defined as the period during which impacts on the environment due to construction work are greatest. Look at factors like changes in construction volume and in the construction area over time across the entire span of the construction plan (see figure II.42(A)). Note that in cases where the construction period is extremely long or where forecast conditions are likely to fluctuate (because traffic routes for construction vehicles will change during the course of construction, for example), project proponents should consider conducting intermediate forecasts during the construction period as well.

2) After being put into service

The forecast period after the project is put into service is defined as the period when facility operation or traffic flow has reached a steady state (see figure II.4-2(A)). In cases where there will be a long period of time before the post-service steady state is reached, or where significant fluctuations are expected in forecast preconditions leading up to the steady state (traffic will be temporarily limited to two lanes, for example), project proponents should consider setting a target period for intermediate forecasts as well (see figure II.4-2(D)).

3) Other times

If the project calls for construction in phases, project proponents can anticipate that the start of the service period will overlap the construction period (figure II.4-2(B)). In cases like these, consider adding impact factors due to service to impact factors due to construction during the forecast period for construction (e.g. equivalent traffic volume that considers both large and small vehicles as basic units), and use the point in time where project proponents anticipate that environmental impacts will be at their maximum. Also note that in cases where project proponents anticipate the new emergence of targets requiring particular consideration during the construction period to project proponents should set a forecast period that takes into account the period during which those targets will be a factor when necessary (see figure II.4-2(C)).

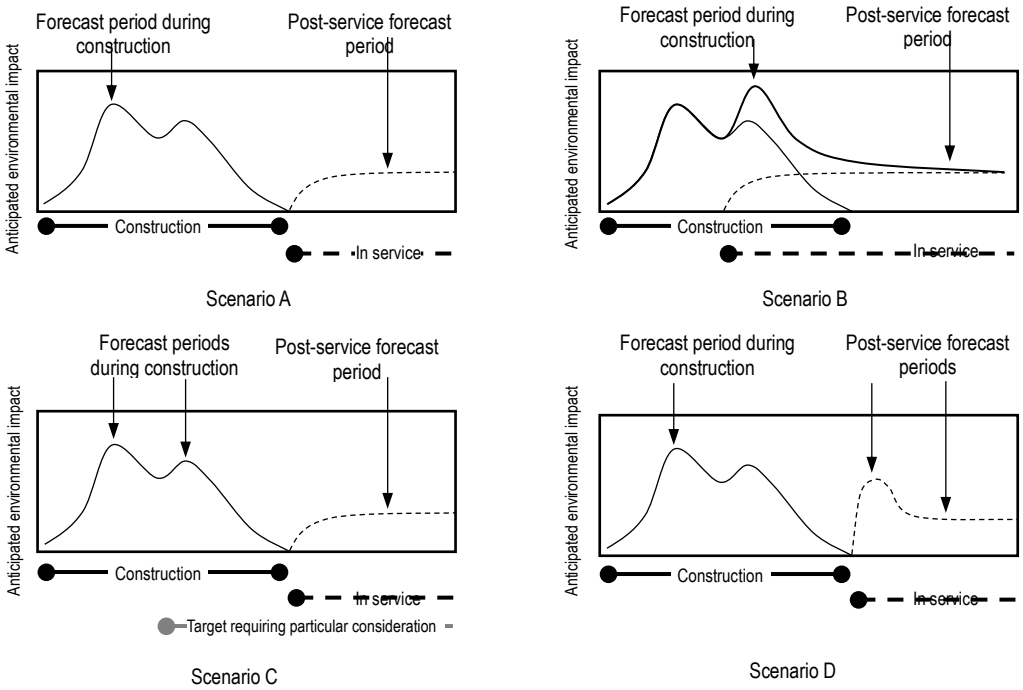

Figure II.4-2. Forecast period concepts

5. Environmental mitigation measures

The Basic Matters define environmental mitigation measures as follows.

> *Environmental mitigation measures shall be considered by the project proponent, within the practicable bounds, regarding the environmental impact on the environmental components relating to the selected items likely to be caused by the implementation of the target project, with the purpose of avoiding or reducing the said impact or satisfying the environmental mitigation standards or targets relating to the said impact.*
> (Basic Matters Section 5-1(2): Basic Matters concerning the Guidelines for Environmental Mitigation Measures)

5.1 Concepts

Environmental mitigation measures are considered by project proponents during the process of surveys, forecasts, and evaluations for the purpose of avoiding or reducing the impact of implementing the target project within a feasible scope. Because environmental mitigation measures are designed to build proper environmental consideration into project plans, they are a critical part of the environmental impact assessment process and must be considered and structured in as much detail as possible throughout the course of project planning—particularly in light of their content, effects, and suitability.

Note also that when considering environmental mitigation measures during the project implementation stage, it is important to specify the effects of avoiding or reducing severe environmental impacts while looking at multiple proposals during the planning stage and to indicate the environmental impact avoidance/reduction effects through the entire series of project planning considerations.

- When looking at environmental mitigation measures, project proponents need to consider whether there are areas or targets that are vulnerable to environmental impacts based on the impact factors of the target project, whether there are areas or targets legally designated from an environmental conservation perspective, or whether there are regions where the level of adverse environmental impact is already significant or that are at high risk for adverse impacts.
- In addition, while environmental mitigation measures include a broad range of approaches (from measures to avoid environmental impacts to compensation measures when impacts cannot be avoided), make sure to prioritize impact avoidance and/or impact reduction when devising environmental mitigation measures, considering compensation measures as needed only when project proponents have reached the limit of those avoidance and reduction efforts.
- Note that avoidance, reduction, and compensation are defined as follows in this document.

Avoiding impacts: Avoiding impacts involves not taking actions (project actions that constitute impact factors) in whole or in part in order to avoid impacts (prevent them from occurring). It could also mean keeping impact factors away from environmental components forecast to undergo severe impacts and thereby preventing those impacts from occurring. In other words, these are measures that prevent impact factors or the resulting impacts from materializing.
Examples: Suspending the project, modifying the project (e.g. changes to project details so that impact factors do not occur), changing project implementation area or routes

Reducing impacts: Reducing impacts includes environmental mitigation measures that minimize, correct, or lessen/eliminate. Minimizing means limiting the extend or scope of project actions to make impacts as small as possible. Correcting means repairing, restoring, or recovering the environment subjected to impacts in order to fix the damage. Lessening/eliminating means taking steps to protect or steadily manage the environment during the period when actions are being taken in order to lessen or eliminate impacts. In short, impact reduction measures use some method to keep the materialization of impact factors and/or impacts to a minimum or to correct any impacts that may have occurred.
Examples: Changing the construction process, modifying facility structures, erecting soundproofing walls

Compensating for impacts: Compensating for impacts means adding value back into environmental components from an environmental conservation perspective to make up for what was lost. It involves creating similar environmental components to those that are compromised by the project. In short, compensation measures create new places or functions that offer value to compensate for environments that are lost or impacted so that the overall negative impact is mitigated.

- Note that it is difficult to strictly classify whether the environmental mitigation measures actually implemented had the effect of avoiding or reducing environmental impacts. Take altering construction vehicle routes as an example. If we consider residential areas as targets requiring protection, impacts could either be considered either reduced or avoided depending on the extent of the detours implemented.
- The concepts of avoidance and reduction vary depending on the perspective and to what degree environmental impacts are seen as having been reduced. For this reason, the important thing is not deciding whether or not the environmental mitigation measures project proponents take are avoidance measures or reduction measures, but instead finding ways to reduce environmental impacts as much as possible.
- Also note that if the project will affect environmental quality (e.g. involves air or water

pollution) taking a compensation approach and creating a similar environment is rarely feasible. In these cases, finding ways to avoid or reduce environmental impact as project proponents consider environmental mitigation measures is critical.

- Finally, note that measures classified as “indemnifications” under the Environmental Impact Assessment Act are not considered environmental mitigation measures.

5.2 Consideration procedures

5.2.1 Environmental impact assessment guidelines

When considering an approach to environmental mitigation measures, project proponents should do so while looking at impacts to other environmental components as well, based on the project characteristics and regional characteristics associated with each component (for example, the positional relationships between the project implementation area and particularly important targets in terms of environmental consideration). Do this while taking into account the effects of avoiding or reducing severe environmental impacts while looking at multiple proposals during the planning stage as well.

5.2.2 Environmental mitigation measures in line with the maturity of project plans

When considering environmental mitigation measures, inquiry needs to be in line with the maturity of the project plan. Difficulties frequently arise if project proponents attempt to find the right environmental mitigation measures for a plan that is nearly finalized already. Project proponents should therefore outline their approach to environmental mitigation measures while the project is still in the planning stages and then hammer out the specifics (details and methods) as the plan matures. This will allow project proponents to implement the proper measures.

Note also that when considering environmental mitigation measures during the project implementation stage, it is important to specify the effects of avoiding or reducing severe environmental impacts (considerations made while looking at multiple proposals as well as indicate the environmental impact avoidance/reduction effects through the entire series of planning considerations.

Points for consideration

What happens if project proponentsr project plans change after the Environmental Impact Statement has been released? If the details of the change reduce the scope of the project or results in negligible changes as stipulated under the various environmental impact assessment frameworks, there is no need to go through the environmental impact assessment process again. However, even changes that are negligible in scope may increase environmental impacts on certain environmental components compared to the previous project plan. There may also be changes in regional characteristics, such as when the environmental status of the target project implementation area and its surrounding area changes while the environmental impact assessment is being implemented.

Therefore, when finalizing project plans, take the time to once again ensure that project proponents have gone through the proper considerations regarding environmental conservation with the project, based on a thorough review of their approach to conservation throughout all stages of the environmental impact assessment process. This includes the details of the investigation into avoiding or reducing severe environmental impacts while looking at multiple proposals during the planning stage, the degree of environmental impact identified during Draft Environmental Impact Statement and Environmental Impact Statement procedures, and details of the process of hammering out specific environmental mitigation measures.

5.2.3 Considering multiple proposals and tracking the investigation process

Considering environmental mitigation measures involves comparing multiple proposals in terms of their implementation effects and feasibility as well as whether there are superior technologies that might be feasibly incorporated. In practice, project proponents need to repeatedly carry out forecasts and evaluations as they prioritize the selection of the most feasible environmental mitigation measures that will more efficiently avoid/reduce the environmental impacts due to project implementation.

When project proponents are looking to incorporate superior technologies within the scope of feasibility, note that even if project proponents have gotten a satisfactory result in terms of standards or targets resulting from environmental mitigation measures they chose for a certain reason, there is no guarantee that those results are ideal from an effectiveness or feasibility standpoint. Therefore, it is important to compare multiple environmental mitigation measures and decide, for example, whether project proponents want to adopt measures that they expect to be more effective (even if they are somewhat low in feasibility) or adopt those whose feasibility project proponents can be sure of even if they are somewhat less effective. The Environmental Impact Assessment Act clearly outlines this process of comparing multiple proposals, so project proponents are required to be as specific as possible in describing their investigation process and results in the Draft Environmental Impact Statement and the Environmental Impact Statement.

- Note that environmental mitigation measures are carried out within a scope that is feasible for project proponents. If they are deemed sufficiently practical in terms of technology, cost, feasibility, and specificity, there is a chance that the results of the inquiry into environmental mitigation measures may end up changing the project plans (e.g. distribution plans or construction methods). If project proponents need to make major changes to their project plans for the purpose of reducing environmental load, it is important to clearly outline the evolution of consideration of environmental mitigation measures over time and organize it so that it is easy for residents and other stakeholders to understand.

5.2.4 *Checking for impacts on other environmental components and impacts that will remain even after measures are implemented*

Project proponents also need to evaluate any negative impacts on other environmental components as a result of implementing environmental mitigation measures and objectively list, wherever possible, the extent of (including the degree of uncertainty associated with) any remaining environmental impacts even after mitigation measures are carried out.

- When implementing environmental mitigation measures, there is a possibility that project proponents may introduce new environmental impacts to environmental components other than the ones project proponents are addressing—even if project proponents have sufficiently tackled the target component (this may happen, for example, if a soundproofing wall erected as a countermeasure against noise ends up blocking sunlight). In this case, make sure that project proponents sufficiently consider the extent of the new environmental impacts project proponents are causing and take additional mitigation measures as needed or appropriate steps to correct the impacts.

5.3 Verification of the adequacy of environmental mitigation measures

The Basic Matters stipulate the following when it comes to verifying the adequacy of environmental mitigation measures.

> *In considering environmental conservation measures, adequacy of the environmental mitigation measures which are being considered for adoption shall be verified through means such as comparative examination of multiple proposals concerning environmental mitigation measures and examination of whether a feasible and better technology is employed etc., and the proceedings of these examinations shall be compiled for clarification. In this case, if the said examination is conducted on a step-by-step basis, specific contents of environmental mitigation measures shall be compiled for clarification for each step of examination. In addition, in cases where multiple plans concerning location etc. have been compared, the details of the process of decision-making on the location etc. relating to the target project from multiple plans shall be compiled so as to clarify how environmental impact is avoided or reduced in the course of such decision-making.*
> (Basic Matters Section 5-2(5): Basic Matters concerning the Guidelines for Environmental Mitigation Measures)

- Verifying the adequacy of environmental mitigation measures basically involves comparing multiple proposals and looking into whether feasible and better technologies are being employed. These considerations involve several perspectives, including how effective the measures are at avoiding/reducing impacts, uncertainty level, and the potential for impacts affecting other environmental components.
- Comparing multiple proposals means first looking at how well the different environmental mitigation measures address the forecasted environmental impacts. For each measure, consider factors like effectiveness, level of uncertainty, and impact on other environmental components. Compare the results and the adopt the environmental mitigation measures

deemed to have the proper and sufficient effects.

- In determining whether feasible and better technologies are being employed, it is necessary to objectively indicate the effects of the environmental mitigation measures as far as possible. This is done by referencing the latest research outcomes and similar case examples, taking direction from experts, and in some cases conducting preliminary experiments. If project proponents decide in the course of doing so that the effects of the environmental mitigation measures they have decided to adopt are unreliable or uncertain, they need to also make the level of that uncertainty clear.
- Project proponents must use the results of the above examinations of adequacy to decide whether to adopt environmental mitigation measures. The Environmental Impact Assessment Act stipulates that details on the process and results of decision-making be included with as much specificity as possible in the Draft Environmental Impact Statement and the Environmental Impact Statement so that the results of these examinations are clear during the evaluation process.
- Note that if project proponents plan to adopt environmental mitigation measures that lack established technologies or without sufficient insight as to their effects, project proponents will need to carry out their project while confirming the effects of whatever measures project proponents adopt during follow-up surveys.
- Note also that if project proponents adopt environmental mitigation measures without sufficient insight, project proponents must consider the possibility that they will affect other environmental components and look into implementing a relevant follow-up survey as needed.

5.4 Determination of the necessity of a follow-up survey

Follow-up surveys are designed to compensate for forecast uncertainties and other limitations of the environmental impact assessment. The Basic Matters outline consideration of the necessity of follow-up surveys as follows.

> *In the case where forecast uncertainty relating to the selected items is significant, or where environmental mitigation measures whose effect is not sufficiently confirmed by expert knowledge are being taken, or where the contents of environmental conservation measures will be made more detailed during construction or after the launch of the service, then, according to the degree of seriousness of environmental impact, and in the case where compensating measures will be taken, then based on the degree of uncertainty of the effect expected from the said compensating measures as well as the degree of sufficiency of expert knowledge concerning the said compensating measures and according to the seriousness of environmental impact caused by the said project, necessity of a survey to comprehend the environmental condition etc. during construction or after the service begins (hereinafter referred to as "follow-up survey") shall be considered. At the same time, the intention shall be made known to publish the items for the follow-up survey and details of its method, the results of the follow-up survey and a policy regarding measures to be taken when the seriousness of environmental impact*

becomes apparent by the results of the follow-up survey.
(Basic Matters Section 5-2(6): Basic Matters concerning the Guidelines for Environmental Mitigation Measures)

- When selecting a forecast method for environmental impact assessments, project proponents should use one whose degree of accuracy project proponents sufficiently understand and ideally select a method that allows them to quantitatively arrive at the most probable results. Keep in mind, however, that every forecast involves some level of uncertainty.
- The environmental mitigation measures project proponents implement will be in line with the project's degree of impact while taking project and regional characteristics into account, but that doesn't mean project proponents will always have sufficient knowledge of their effects. Therefore, if project proponents determine that there is a significant degree of uncertainty in the forecasts or that project proponents are taking environmental mitigation measures whose effects are not sufficiently understood (making these determinations based on the degree of impact that uncertainty or lack of knowledge has on the forecast results), then project proponents will need to decide, based on the severity of potential environmental impacts, whether project proponents need to use a follow-up survey to identify post-project environmental conditions.
- For longer projects, it can be nearly a decade between the time project proponents consider environmental mitigation measures for the environmental impact assessment and the time actually carry those measures out. In many cases, project proponents will need to conduct another survey during construction or once the project is in service in order to hammer out the details of their environmental mitigation measures. Surveys like these are also considered to be follow-up surveys.
- If project proponents are implementing compensation measures, consider them in light of the degree of uncertainty associated with their effects and in terms of how well those compensation measures are understood. Depending on the severity of the environmental impacts, follow-up surveys may be necessary as well.

5.4.1 Forecast error and uncertainty

When implementing forecasts, project proponents need to do everything possible to reduce the level of uncertainty stemming from various factors—keeping in mind that there is no way to completely eliminate uncertainty from the forecast results. Considering conducting follow-up surveys in a way that accounts for the level of uncertainty in the forecasts, the severity of environmental impacts, and so on.

- When conducting follow-up surveys, project proponents of course need to understand the impacts that the target project has on the environment. Ideally, however, they will also

consider an effective follow-up survey method for revealing the status of factors that project proponents think have a high degree of forecast uncertainty during construction or at the start of service (examples include traffic volume used to forecast noise or precipitation levels used to forecast water turbidity).

- Project proponents also need to select a follow-up survey method (survey items, survey sites, survey period, etc.) in order to fully understand which factors involve forecast uncertainty and to make it possible to compare the results of the follow-up survey with the results of the environmental impact assessment.

5.4.2 Environmental mitigation measures whose effects are not sufficiently understood

Environmental measures whose effects are not sufficiently understood (confirmed by experts) are those for which there is little insight into their effects due to the use of new technologies, for example. There may also be a lack of understanding due to forecast conditions or differences in survey equipment standards or other methodological variations, with the result that their effects cannot be anticipated with accuracy.

- Consider conducting a follow-up survey that takes into account the degree of uncertainty in the effects of the environmental mitigation measures (due to insufficient insight) as well as the severity of environmental impacts.
- In conducting the follow-up survey, project proponents need list up the aspects of the anticipated environmental mitigation measure effects for which project proponents lack insight and then use this information to select a specific follow-up survey method.

5.4.3 Severity of environmental impacts

When selecting follow-up survey methods, project proponents need to consider the severity of environmental impacts based on project and regional characteristics. Note that even if there is forecast uncertainty or a lack of insight regarding the environmental mitigation measures, project proponents do not necessarily need to conduct a follow-up survey in cases where they do not anticipate any major environmental impacts.

- Making a definitive decision as to forecast uncertainty and how sufficiently environmental mitigation measures are understood is not an easy task. Project proponents should therefore make their determination based on either the general level of uncertainty or on the degree of impact that the lack of understanding has on the forecast and/or evaluation results.

6. Evaluations

The Basic Matters include the following stipulations on evaluation methods.

> *A. Evaluation relating to avoidance or reduction of environmental impact*
> *An evaluation shall be conducted on whether environmental impact caused by the implementation of the target project on the environmental components relating to the selected items has been avoided or reduced, using the measures such as chronological or simultaneous examination and comparison of multiple plans concerning a wide range of environmental conservation measures including those related to the structure and site of buildings, environmental conservation facilities, and construction method, etc. and examination of whether a feasible and better technology is employed. In this case, efforts shall be made to clarify the grounds for the evaluation and background of the examination.*
> *These evaluations shall be conducted by the project proponent within practicable bounds.*
> *B. Examination of whether consistency with environmental mitigation measures by the national or local government is maintained*
> *In conducting an evaluation, in cases where standards or targets concerning environmental components relating to the selected items have been established through environmental mitigation measures including environmental quality standards, the Basic Environment Plan and other such measures taken by the national or local government, then the said evaluation shall also include examination on the status of achievement of the said standards, etc. as well as on whether consistency is maintained between the targets and contents of the Basic Environment Plan, etc. and the results of surveys and forecasts, while making efforts to establish the view that the said standards or targets are referred to in the said evaluation.*
> *Moreover, regarding the environmental components that are likely to be affected for an extended period by the implementation of construction activities and for which the environmental standards relating to the said environmental components have been established, an examination shall also be conducted on whether consistency with the said standards is maintained.*
> *C. Other points for consideration*
> *In cases where the effect of the environmental mitigation measures etc. implemented by persons other than the project proponent are included in the evaluation, the contents of the said measures, etc. shall be clarified.*
> (Basic Matters Section 4-5(3): Basic Matters concerning the Guidelines for the Selection of the Items for Environmental Impact Assessment etc.)

6.1 Concepts

Evaluations during the project implementation stage include assessments on avoidance/reduction of environmental impacts and assessments of how consistent environmental mitigation measures are with national or local government initiatives. In evaluating the avoidance/reduction of environmental impacts, note that while it is impossible for a project to have zero environmental impact, project proponents should ideally demonstrate the extent to which the project plan avoids or reduces those impacts as well as how thoroughly and repeatedly project proponents engaged in considerations towards that end.

6.2 Methods

6.2.1 Evaluating avoidance/reduction of environmental impacts

Evaluating the avoidance or reduction of environmental impacts means determining whether the environmental impacts generated by the project have been avoided or reduced as a result of environmental mitigation measures. It involves detailing the efforts that the project proponent makes to avoid/reduce impacts and looking at whether the environmental mitigation measures incorporated into the project are demonstrably adequate in terms of effects and technologies from an objective standpoint.

- Relative evaluation methods provide a clear summary describing (the form of an opinion) avoidance/reduction efforts, and include things like comparative evaluations of a broad range of environmental mitigation proposals or looking at whether feasible and better technologies were incorporated. Comparisons of multiple proposals can be demonstrated by providing a timeline of environmental mitigation measure considerations, while documentation on the effects of multiple environmental mitigation measures can be used to determine whether feasible and better technologies were used.
- When incorporating this information on whether the implemented environmental mitigation measures were effective for the project as part of the avoidance/reduction evaluation, project proponents need to clearly indicate that the environmental mitigation measures are equivalent to those adopted for projects with similar characteristics, scope, and other features and that they have demonstrable effects.
- The most important consideration in evaluating avoidance/reduction in cases where consistency with the environmental mitigation policies of national or local government agencies (e.g. in regions where environmental standards are not currently achieved) cannot be devised is to first consider measures that will result in even greater avoidance/reduction and then evaluate comprehensively with both sides' assessments taken into consideration. In this case, provide details on how and why consistency cannot be achieved in terms of existing standards and the like and on the extent to which the avoidance/reduction measures will lessen the additional impacts brought by project implementation (e.g. reduction rate). Finally, use this information to consider whether feasible and better technologies can be incorporated as part of the evaluation.

Points for consideration: The "feasible and better technology" concept

The Basic Matters give "examination of whether a feasible and better technology is employed" as an example of a way to evaluate avoidance/reduction.

"Feasible and better technology" is a concept introduced in US and European permits and one that also has precedence in Japanese environmental impact assessments for power plant projects. It involves evaluating the functionality of the various technologies adopted by the target project in terms of environmental conservation, identifying various types of technologies considered to be of a high standard, and adopting the ones that are within practicable bounds for the project proponent while considering regional and project characteristics. If we look at

US/European example, feasibility is determined primarily by looking at the technological side first and then adding in a consideration of economic and other features while gathering feedback from a variety of stakeholders—including industry representatives and NGOs.

With Japanese environmental impact assessments—in the case of a new thermal power plant site, for example—evaluations have been done using the guideline of whether technologies of a high standard have been employed from the perspective of environmental conservation. These technologies, which are primarily combustion technologies and technologies to counteract emissions, are understood by looking at those that have been adopted or are scheduled to be adopted in similar case examples and by reviewing academic research on the subject and the status of technical development, while also making sure that they can be adopted by the time project construction work starts.

Avoidance/reduction evaluations within environmental impact assessments essentially evaluate the specific efforts that project proponents make towards environmental conservation. Even when the introduction of "feasible and better technology" is assessed, what is critical is whether the project proponent has worked to employ them or has considered (is considering) them and the process of soliciting feedback from residence and local government bodies once the effects of their introduction have been clarified. This evaluation method can be applied not only to power plant projects, but to any type of project—and it is expected that project proponents will take an active role in doing so.

When considering whether feasible and better technologies can be introduced, project proponents need to present information on the kinds of technologies that can be introduced in line with project implementation and what has been adopted for the project in order to objectively determine the adequacy of those evaluations. It is also considered necessary to quantitatively demonstrate the effects of those technologies as far as possible, and if there are any technologies that could not be adopted, giving clear reasons for it.

6.2.2 Evaluating consistency with standards and/or targets

Although the basic evaluation is on the avoidance/reduction of environmental impacts, if environmental standards have been set or if there are specific standards or clear targets in environmental basic plans, environmental management plans, and the like as part of "environmental mitigation measures by the national or local government", project proponents need to consider the details of these measures and whether they are maintaining consistency with them alongside the evaluation of avoidance/reduction of environmental impacts.

- Evaluations of consistency with standards and targets evaluate whether environmental mitigation measures and other target project initiatives are in line with the environmental mitigation measures formulated by the national or local government. Once project proponents understand how reference standards and/or targets are positioned as environmental mitigation measures, they need to clarify the concepts used to evaluate those standards and targets.
- For example, if regional environmental basic plans or environmental management plans indicate targets that take regional characteristics into consideration, project proponents need to evaluate consistency between the two sets of targets by listing the concepts used to compare them based on the positioning of the government targets within environmental mitigation measures, the background on how the targets were set, and

similar factors.

- When comparing standards or targets with forecasted effects, it is important to look not only at whether the forecasted effects satisfy the standards or targets, but also to compare the standards and targets to evaluate them in terms of whether the degree of impact generated by the target project is at risk of presenting obstacles to environmental conservation.

6.2.3 Other points for consideration

If environmental mitigation measures are being taken by someone other than the project proponent, then the project proponent cannot take responsibility for their implementation. Evaluations that count on those types of environmental mitigation measures must at least evaluate the scope of responsibility involved in intending to use them and outline the specific details of those measures.

- Project proponents must demonstrate, based on objective data and documentation, that the details, effects, and implementation period of environmental mitigation measures implemented outside the project plan and by someone other than the project proponent are highly consistent and that there are goals set for hammering out specific budgetary measures and the like.

7. Follow-up surveys

The Basic Matters include the following stipulations on follow-up surveys.

> *In cases where forecast uncertainty relating to the selected items is significant, or where environmental mitigation measures whose effect is not sufficiently confirmed by expert knowledge are being taken, or where the contents of environmental mitigation measures will be made more detailed during construction or after the launch of the service, then, according to the degree of seriousness of environmental impact, and in cases where compensating measures will be taken, then based on the degree of uncertainty of the effect expected from the said compensating measures as well as the degree of sufficiency of expert knowledge concerning the said compensating measures and according to the seriousness of environmental impact caused by the said project, the necessity of a survey to comprehend the environmental conditions, etc. during construction or after the service begins (hereinafter referred to as a "follow-up survey") shall be considered. At the same time, the intention shall be made known to publish the items for the follow-up survey and details of its method, the results of the follow-up survey and a policy regarding measures to be taken when the seriousness of environmental impact becomes apparent by the results of the follow-up survey.*
>
> *Moreover, in cases where a follow-up survey is conducted, attention shall be paid to the following matters:*
>
> *A. Items for a follow-up survey and its method shall be established so as to make them adequate according to the degree of necessity of the follow-up survey, the characteristics of the items on which such follow-up survey will be conducted, and the regional characteristics etc. and based on objective and scientific grounds secured by means of obtaining advice, etc. from experts as necessary, and also to enable comparative examination of the results of the follow-up survey and those of the Environmental Impact Assessment;*
>
> *B. A method of follow-up survey with least environmental impact to avoid or reduce the environmental impact caused by the implementation of the follow-up survey itself shall be selected and adopted to the extent possible;*
>
> *C. In conducting a follow-up survey, in cases where environmental monitoring, etc. conducted by local governments or others will be utilized and where facilities, etc. relating to the said target project will be apparently transferred to another entity, etc., a method and details of cooperation with or making requests to the other entity shall be made known;*
>
> *D. Objective and scientific examination shall be conducted by means of obtaining advice, etc. from experts as necessary when determining the completion of a follow-up survey and the implementation and completion of environmental mitigation measures based on the results of the follow-up survey.*
>
> (Basic Matters Section 5-2(6): Basic Matters concerning the Guidelines for Environmental Mitigation Measures)

7.1 Concepts

Because environmental impact assessments are carried out before projects are implemented, follow-up surveys are used to compensate for the uncertainty of their results. In cases where there is a large degree of uncertainty in forecasts or where environmental mitigation measures are carried out without sufficient understanding of their effects, consider whether a follow-up survey is needed based on the severity of environmental impacts. Project proponents must also look at adding or revising environmental mitigation measures as needed based on the results of the follow-up survey.

Within the environmental impact evaluation procedures, plans for follow-up surveys (detailed items and methods) are to be included in the Environmental Impact Statement. In addition, if it is clear from follow-up survey results that environmental impacts are significant, the approach to countermeasures should also be descried. Note that the results of follow-up surveys are to be included in Reports.

7.2 Items and methods

7.2.1 Selecting follow-up survey items

Follow-up surveys are designed to compensate for uncertainties in the forecasts and effects of environmental mitigation measures presented in environmental impact assessments. The Environmental Impact Assessment Act stipulates that follow-up surveys be conducted in line with the severity of environmental impacts in cases where there is a high degree of forecast uncertainty or when there is insufficient knowledge about the effects of environmental mitigation measures.

For these reasons, when considering follow-up survey items, project proponents need to first organize each item they selected for the environmental impact assessment in a way that clearly specifies the uncertainty associated with forecasts and with the effects of environmental mitigation measures project proponents intend to carry out.

7.2.2 Follow-up survey methods

Follow-up surveys identify the environmental impacts associated with actual project implementation, and their basic premise is creating a comparison against the results of surveys and forecasts carried out during environmental impact assessments. When conducting follow-up surveys, it is important to consider the appropriate methods based on the characteristics of environmental impact assessment items, regional characteristics, and so on.

Follow-up survey methods ideally generate results that make it possible to do a comparison with current status surveys. They should also utilize methods that allow project proponents to be as specific as possible with each follow-up survey item.

- There are often official methods for measuring things like atmospheric pollutants or noise, so in most cases project proponents should adopt the established methods.
- After the Environmental Impact Statement has been released,
- Project proponents should consider changing or adding follow-up survey methods in order to ensure that project proponents have properly considered environmental conservation in implementing the target project, based on changes in environmental conditions in the target project implementation region and its surrounding area as well as on the status of

other environmental characteristics.

- An objective, scientific rationale must be used to determine follow-up survey methods, so make sure to seek the advice of experts as needed.
- Consider making effective use of applicable results from surveys not conducted by the project proponent, such as results from national or local government environmental surveys (these may include results from continuous monitoring of air pollution, traffic censuses, water quality measurements from public bodies of water, observation data on the location of underground water, and so on).
- Note that in some cases, project proponents elect to voluntarily conduct environmental monitoring surveys separately from follow-up surveys and provide the results to local residents after environmental impact assessments have been implemented.

7.2.3 Follow-up survey areas and sites

Follow-up survey sites should basically be the same sites where current status surveys and forecasts were carried out. Ideally, these should be sites that have not been impacted by other projects and that are not influenced by surrounding features.

For this reason, it is important to select the right sites when conducting surveys and forecasts for environmental impact assessments (for example, by selecting survey/forecast sites away from prevailing winds that might bring in atmospheric pollutants from other projects).

Note that if areas requiring follow-up surveys emerge after the Environmental Impact Statement is published, it is appropriate to consider adding them as follow-up survey sites as needed.

7.2.4 Follow-up survey period and timing

Ideally, project proponents should set a follow-up survey period that allows them to make a comparison with the results of the environmental impact assessment. Basically, project proponents should conduct the follow-up survey during the forecast target period they set for the environmental impact assessment. If project proponents carried out forecasts/evaluations anticipating a static state period for post-service project activities, conduct the follow-up survey during the stage once the forecast conditions have been established.

If there is a long period leading up to the forecast timing, project proponents still need to carry out the follow-up survey during an appropriate period given the progress of the project so that project proponents can understand its progression—even if project proponents are still waiting for the forecast timing to arrive.

When project proponents are conducting follow-up surveys for environmental conservation

measures whose effects are not sufficiently understood, project proponents need to do so at a timing that will allow them to properly understand the effects of those measures.

7.3 Consideration of additional environmental mitigation measures

If the results of the follow-up survey confirm significant environmental impacts beyond the forecast results, add or reconsider that environmental mitigation measures as needed. Follow-up surveys are designed to compensate for forecast uncertainties and other limitations of the environmental impact assessment, so the most important thing about them is using their results to consider additional environmental mitigation measures.

- If it is possible to consider additional environmental mitigation measures, project proponents need to create a follow-up survey action plan that allows them to do this.
- Note that if discrepancies with forecast results arise, looking into their causes is a useful way to improve the accuracy of future forecast methods as well as provide additional insight into environmental mitigation measures.

The decision to terminate a follow-up survey needs to be made based on an objective and scientific rationale, so make sure to seek expert opinions on the matter when required. For example, if project proponents are at a stage where certain countermeasures have been implemented and follow-up survey results are well within the bounds of preliminary forecasts, project proponents may be able to stop the environmental mitigation measures.

Reference: Follow-up surveys conducted by local governments

Local governments may stipulate their own environmental impact assessment frameworks in their local ordinances, guidelines, and so on, and every prefecture in Japan has guidelines for follow-up surveys. The follow-up surveys defined in local government frameworks may include stipulations that target a broader range of environmental impact assessment items for follow-up than the Environmental Impact Assessment Act, or define specific methods and specific timing guidelines for each environmental component subject to follow-up surveys. These frameworks are designed to ensure that the environment is properly considered according to actual conditions in individual regions.

8. Reports

The Basic Matters include the following stipulations regarding the preparation of reports and similar documents.

> *(1) A report relating to a target project shall be prepared based on the provisions of Article 38-2, paragraph (2) of the Act in accordance with the Guidelines for Preparation of the Report.*
> *(2) A report in principle shall be prepared once when the construction relating to the target project has been completed, and in this case, the effect of the environmental mitigation measures taken when the said construction was implemented shall be confirmed, and the results of such confirmation shall be included in the report.*
> *(3) The results, etc. of a follow-up survey or environmental mitigation measures shall be published as necessary during construction or after the launch of the service.*
> (Basic Matters Section 6-1. Basic Matters concerning the Guidelines for Preparation of the Report)

8.1 Preparation of reports and similar documents

The process of preparing reports involves making the effects of environmental mitigation measures and the results of follow-up surveys publicly available, which is an effective strategy not only for enhancing environmental considerations during construction and after the start of service, but also for securing trust from residents and others stakeholders while maintaining transparency and objectivity.

Reports should include information on a variety of measures as well as on follow-up surveys with an eye to compensating for the uncertainties anticipated in forecast and environmental mitigation measure effects in the environmental impact assessments conducted prior to project implementation. These include environmental mitigation measures in environments recognized as requiring special conservation measures due to the difficult of restoring them but whose effects are not certain (more specifically, when effects are uncertain for measures related to habitats for endangered plant and animal species, measures required to protect endangered plant and animal species, and measures taken in situations where conservation is deemed particularly important in the surrounding area due to the difficulty of restoring the natural environment there) as well as additional environmental mitigation measures taken based on follow-up survey results.

Items recorded in reports should be those listed in the Draft Environmental Impact Statement and the Environmental Impact Statement, so specific details on environmental mitigation measures and their effects, items targeted for follow-up surveys, follow-up survey methods, and so on should ideally be compiled as early as possible so that project proponents can take steps to widely distribute them to residents and other stakeholders as well as seek advice from experts as needed in order to maintain objectivity and transparency.

8.2 Report preparation timing

In general, reports are prepared once in the period after construction is complete. The prepared report is made publicly available and copies are also forwarded to those who issued permits and licenses. There are special cases for certain project types where making reports publicly available is sufficient; for example, if a power plant is built according to the regulations in the Electricity Business Act after project implementation.

Note that in addition to preparing reports, project proponents should disclose the effects of their environmental mitigation measures and results of follow-up surveys during construction and/or after the start of service as needed.

- When environmental mitigation measures target plant and animal species, it is often unclear whether the effects are apparent immediately after the measures are taken, so reports should ideally be prepared once the relevant effects have been confirmed.
- Project proponents may also voluntarily disclose the results of follow-up surveys or environmental mitigation measures carried out during the construction stage or service stage. In this case, project proponents should ideally find a way to properly compare the disclosed details against forecast results.

8.3 Items to include in reports

The Basic Matters include the following stipulations regarding items to include in reports.

> *(1) Matters to be stated in the report shall be as follows:*
> *A. basic information regarding the target project such as the name and address of the project proponent (in the case of a corporation, its name, the name of its representative, and the location of its principal office), the name, type, and scale of a target project, the area in which the target project was implemented;*
> *B. items, method, and results of the follow-up survey;*
> *C. details, effects, and degree of uncertainty of the environmental mitigation measures;*
> *D. details etc. of expert opinions, if such opinions were received;*
> *E. in cases where a follow-up survey will be conducted or environmental mitigation measures will be taken after the preparation of the report, then its schedule and intention to publish its results.*
> *(2) In cases where business operation is transferred to another person during construction relating to the target project, or where the business operator and the entity in charge of operation and management after the launch of the service are not the same entity, the method and details of cooperation with or making request to the other entity shall be included in the report.*
> (Basic Matters Section 6-2. Basic Matters concerning the Guidelines for Preparation of the Report)

Items included in reports should basically be in line with the details of environmental mitigation measures listed in the Environmental Impact Statement and follow-up survey plans. However,

when the information in the Environmental Impact Statement includes details finalized after construction is complete or the results of environmental mitigation measures or follow-up surveys—or when ongoing environmental conservation measures or follow-up surveys are necessary, be as specific as possible in including information on relevant plans and the like.

- If the project details specified in the project plan included in the Environmental Impact Statement differ from actual implementation content, reports need to include details on the changes as well as on the process leading up to them. Also make sure to sufficiently consider the degree of resulting environmental impact and review the details of environmental mitigation measures and follow-up surveys as necessary. This will allow project proponents to avoid/reduce environmental impacts due to project implementation as much as possible, which should in turn lead to proper environmental consideration.
- When it comes to follow-up survey details and results, project proponents must show a comparison against the environmental impact assessment results; and if they differ, it is important to consider why. Also note that if follow-up survey items or methods were added or changed after the Environmental Impact Statement was published, reports must include details as well as information on the examination process leading up to them and the reasons behind those changes.
- Also include in the report additional environmental mitigation measures taken in response to environmental conditions that came to light during follow-up surveys. If there were any additions or changes to environmental mitigation measures after the Environmental Impact Statement was published, reports must include details as well as information on the examination process leading up to them and the reasons behind those changes.
- The report should include the effects of environmental mitigation measures as well as the confirmation status of those effects after the measures were implemented.
- The process of determining follow-up survey items/methods, deciding to terminate follow-up surveys, and reflecting results in environmental mitigation measures should have involved seeking advice from experts. Include in reports a description of that advance as well as their consultants' fields of expertise. Project proponents should also include a basic profile of their experts, such as the organizations to which they belong.
- When follow-up surveys or environmental mitigation measures will be carried out after the report has been prepared, include information on those plans, how the results will be disclosed, and future approaches to the situation based on the results of follow-up survey results already conducted. Reports should ideally also contain the means of disclosure as well as the period during which the information will be publicly available.
- If follow-up surveys will be conducted after the start of service, or if the results of environmental mitigation measures will become clear once service begins, information must continue to be disclosed appropriate—particularly if the project proponent and the operator

during the service stage are different.

8.4 Making reports publicly available

Making reports publicly available means publishing environmental impact assessments and making them available for inspection in the target region. Thirty days is generally considered an appropriate period for keeping written documents out for display.

If reports are made available online, they should ideally be continuously published on a website so that insights on the effects of the implemented environmental mitigation measures, results from follow-up surveys, and so on ca be widely utilized by the general public. Accumulated information, including comparisons between forecast results and follow-up survey results, effects of environmental mitigation measures, and so on can be used to improve environmental impact assessment techniques (e.g. establishing appropriate survey methods and better forecasting techniques) and will hopefully contribute to the establishment of more effective environmental mitigation measures in the future.

Reference: Follow-up survey results and other reports issued by local government bodies

Local governments may stipulate their own environmental impact assessment frameworks in their local ordinances, guidelines, and so on, and projects subject to the Environmental Impact Assessment Act must take these into consideration if they are required to address procedures (e.g. report creation) other than those based on the Environmental Impact Assessment Act.

For example, the environmental impact assessment framework of a local government may call for the creation and publication of follow-up survey results as part of procedures to be carried out once the project starts. In that case, it may also stipulate specific timing for these reports (such as once the project is in service as well as during construction, once a year, and so on) and may also call for specific publication and inspection procedures. These frameworks are designed to ensure that the environment is properly considered according to actual conditions in individual regions.

Chapter III
Explanation of Major Technical Methods

1. Biological Diversity (Plants, Animals, and Ecosystems)

1.1 Basic Methods and Points (Plants, Animals, and Ecosystems)

Of the three major areas (plants, animals, and ecosystems) of research on biological diversity, ecosystems are addressed in the "Technical Guide for Environmental Assessment — Ecosystems" published in 2002, in which technical methods for evaluation of environmental impact of ecosystems are described with examples focusing on principles in selection of items subject to environmental impact assessment and methoda for survey, forecast, and evaluation for ecosystems in land, interior drainage and sea areas.

Since then, various new laws and regulations on biodiversity conservation have been enacted, and efforts have been made for the accumulation of research results on plants, animals, and ecosystems and the development of technologies for new survey, forecast, and evaluation methods. With such a background, this guide summarizes the basic methods and points to be considered when conducting environmental impact assessment. This guide also provides information on how to use new technical methods for environmental impact assessment and points to note upon its use. Please refer to other existing guides as appropriate for details and case studies of each method.

1.1.1 Selection of Items subject to Environmental Impact Assessment and Selection of Methods for Survey, Forecast, and Evaluation

To permit the selection of items subject to environmental impact assessment and methods for survey, forecast, and evaluation, it is necessary to understand the project characteristics of the target project and the regional characteristics of the surrounding areas. Fig. III.1-1 illustrates the flow of steps from the identification of project and regional characteristics to the selection of items subject to environmental impact assessment, and also shows relationships among these items and methods for survey, forecast, and evaluation. Plants, animals, and ecosystems are indirectly affected by changes in underlying environmental elements, and their relationships are complicated (examples of indirect effects are given in Table III.1-1). Therefore, study based on an impact flow diagram can serve to clearly show their relationships with impact factors and identify project and regional characteristics correctly. For example, in inland water ecosystems (rivers), variations in water flow or sediment movement can lead to changes in plants, animals, and ecosystems, such as changes in vegetation in forests, and accordingly it is necessary to understand the relationships between project and regional characteristics and the water flow and sediment movement. In addition, seasonal and interannual changes in fundamental environmental elements may contribute to the maintenance of habitats of plants and animals and therefore, changes in the range and timing of their fluctuations (e.g., reduction in the frequency of flooding on riverbanks and lakeshores) should be studied based on the impact flow and taken into account in selecting items subject to environmental impact assessment and methods for survey, forecast, and evaluation. Fig. III.1-2 shows a diagram of a typical impact flow chart.

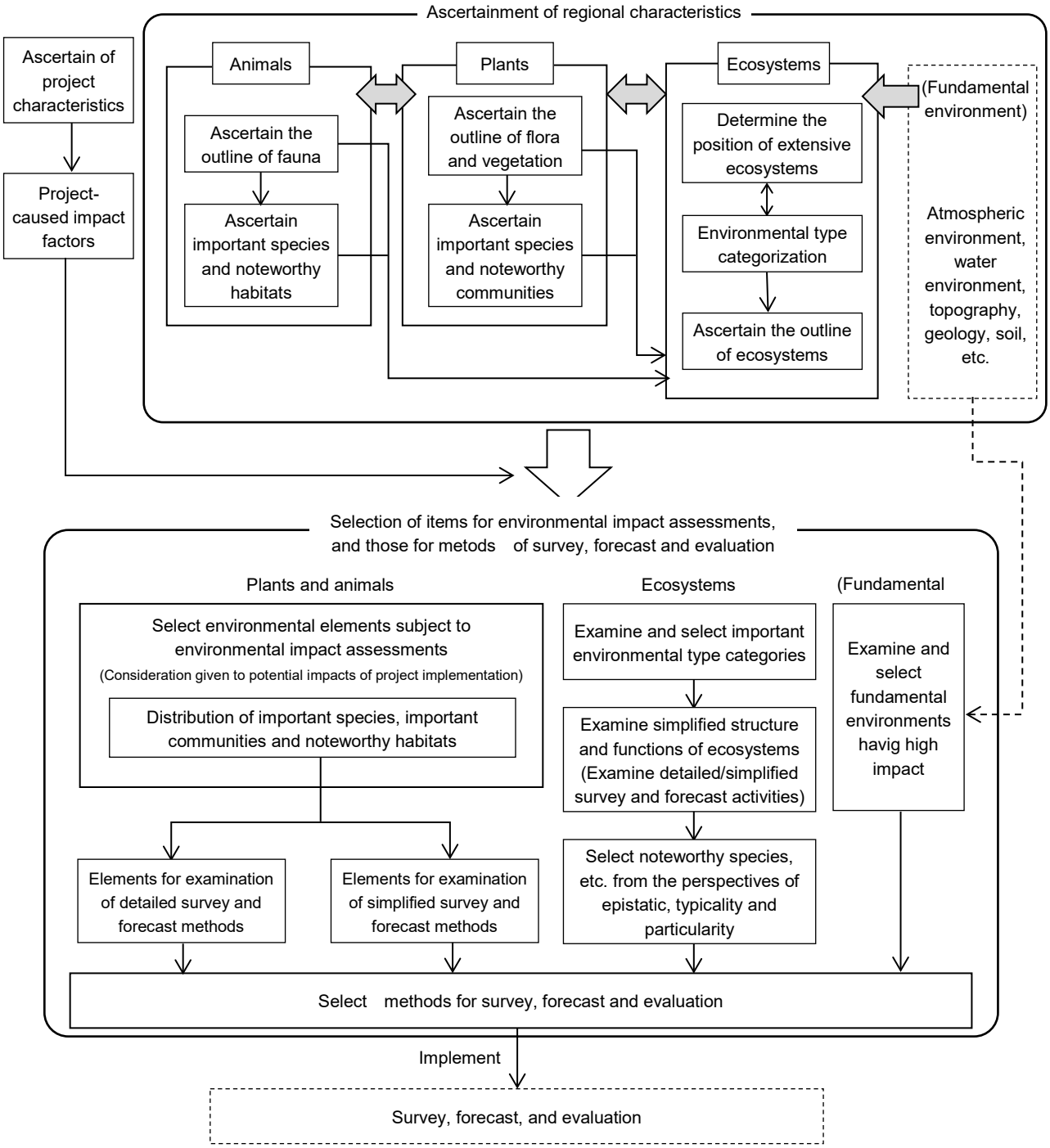

Fig. III.1-1 Flow chart for selection of items subject to environmental impact assessment and methods for survey, forecast and evaluation focusing on relationships among the items

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Table III.1-1 Examples of indirect impact on animals, plans, and ecosystems by project implementation

Types of fundamental environment	Changes in environmental elements	Examples of indirect impact
Light	Changes in solar radiation	Changes in plant growth environment
	Changes in light conditions at night	Changes in breeding behavior of animals
Sound	Noise generation	Inhibition of breeding behavior etc. of animals
Atmosphere	Generation of air pollutants	Inhibition of plant growth
	Changes in sunshine, wind, humidity, etc.	Changes in plant growth environment due to aridification
Water	Changes in water quality	Changes in habitats and growth environments of plants and animals due to changes in water quality such as in turbidity, water temperature, pH, eutrophication, and dissolved oxygen
	Changes in water volume	Changes in habitats and growth environments of plants and animals due to changes in water volume
	Changes in flows and waves	Changes in disturbance due to changes in flow velocity, waves, and water level fluctuations Changes in habitats and growth environments of plants and animals due to changes in bottom sediment caused by changes in flow direction and velocity
Sediment	Changes in sediment movement and supply	Changes in habitats and growth environments of plants and animals due to changes in topography
Continuity of space	Breakage of continuity	Inhibition of migration and dispersion of populations
Planting	Invasion by alien species etc.	Changes in habitats and growth environments of plants and animals

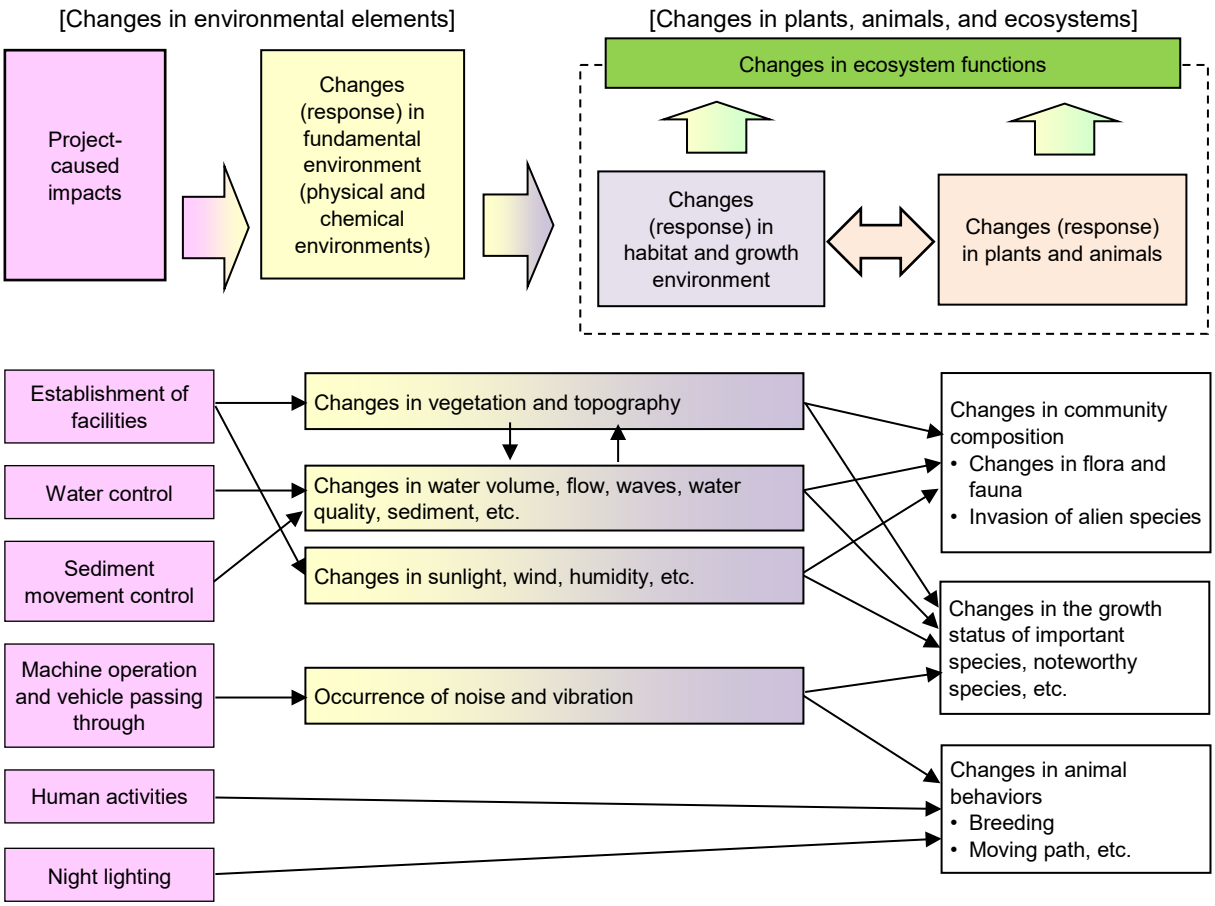


Fig. III.1-2 A typical impact flow chart

1) Understanding of project characteristics

When investigating project characteristics, it is necessary to keep in mind not only that direct modification caused by the implementation of construction and the existence and use of land and structures can affect the habitats and ecosystems of plants and animals, but also that there are species and ecosystems for which various indirect effects of changes in light, sound, air, water flows, etc., should be taken into consideration as shown in Table III.1-1. Investigation of the characteristics of the target project should include examination concerning whether the physical and chemical environmental elements which may cause indirect effects are likely to be affected by the project implementation or not. Therefore, in addition to referring to pre-existing similar cases as shown in Table III.1-2, various technical guides related to environmental impact assessment should also be examined to ensure that selection of impact factors and environmental elements will be performed appropriately from a wide range of perspectives based on project characteristics.

2) Understanding of regional characteristics

Understanding of regional characteristics is required to learn the distribution of important plants and animals and general features of ecosystems to permit appropriate selection of items for environmental impact assessment. This requires collection and arrangement of information on the distribution of the flora, fauna, vegetation, habitats, etc., and fundamental environment (topography, geology, vegetation, etc.) in the project implementation area and surrounding areas.

i) Scope of understanding of regional characteristics

Areas that can be affected by the implementation of a project include (1) project implementation areas, (2) areas directly affected by the project (areas directly affected by the implementation of construction or the existence and use of facilities), and (3) areas indirectly affected by the project (areas secondarily affected by the direct impact of the project).

Accordingly, it is necessary to assume a eide range from the standpoint of safety in consideration of the mobilization capacity of animal species (if there is apparent existence of animals with a wide range of activity) , conssidering environmental impacts likely from the project characteristics and natural environment characteristics likely from the regional characteristics. Here, it is also important to consider topographical features such as catchment basins and bays in terms of a cohesive natural environment.

ii) Methods for Understanding of regional characteristics

Understanding of regional characteristics is achieved through collection and arrangement of existing data (literature, topographical maps, geological maps, vegetation maps, aerial photographs, etc.), interviews with experts, etc., rough reconnaissance, etc.

For plants and animals, a summary of flora and fauna is prepared. Thus, the basic procedure

includes the arrangement of data on fundamental environments related to ecosystems such as atmospheric environment, aquatic environment, topography, geology, and soil environment, including data collected through surveys of other environmental elements, and comprehensive analyses of structures and functions of the ecosystems based on these data.

(1) Collection and arrangement of existing data

A variety of data are collected and arranged including the results of the Basic Surveys for Natural Environment Preservation (Green Census), Red Data Books issued by the government and prefectures, topographical maps issued by the Geographical Information Authority of Japan Fundamental Land Classification Surveys, River Front Censuses, marine cadastre, and other nationally conducted surveys. In recent years, many of them have been digitized in databases, and are relatively easily available.

Table III.1-2 (1) Examples of general impact factors (changes in land environmental elements)

Project phase	Impact factors		Impact of changes in land environmental elements on plants, animals, and ecosystems
Construction work	Transportation of materials etc.	Introduction of construction materials	Escape of plants and animals due to noise and vibration, and changes in plants and animals due to invasion of alien species
		Traveling of construction vehicles	Escape and inhibition of breeding of mammals, birds, etc. due to generation of noise, vibration, and exhaust gas
	Operation of construction equipment (heavy equipment, etc.)		Escape and inhibition of breeding of plants and animals due to generation of noise, vibration, or turbid water
	Creation of construction yards and large material storage areas		Disappearance of habitat space due to terrain modification
	Preparation of construction sites	Felling of trees, etc.	Changes in vegetation, etc., due to changes in amount of sunlight, increase in alien species
			Changes in habitats due to topsoil erosion and drying of soil
			Changes in habitats of forest animals and migration inhibition of plants and animals due to decrease and loss of forests
	Excavation and other earthworks	Soil cover removal	Changes in habitation base due to deterioration in water source recharge function, and changes in groundwater and its flow volume
		Excavation, cutting, banking, etc.	Changes in habitats due to erosion/loss of topsoil and outflow of soil
		Road paving work	Changes in habitats due to road drainage (turbid water)
		Concrete work	Inhibition of development and growth and repelling of plants and animals in water areas due to concrete efflorescence
		Revetment and embankment construction	Changes in habitation status and habitats of plants and animals in water areas due to concrete efflorescence
		Improvement of ground	Inhibition of development and growth and repelling of plants and animals in water areas due to changes in water quality and use of toxic substances
		Drilling of wells	Changes in habitats due to turbidity of water and due to changes in surface water and groundwater
	Creation of temporary structures	Creation of construction roads	Changes in habitats of forest animals and migration inhibition of plants and animals due to decrease and loss of forests
		Construction facilities creation work	Changes in distribution of plants and animals and migration inhibition of plants and animals due to decrease and loss of habitat spaces
	Dismantling and removal of existing structures		Escape and inhibition of breeding of mammals, birds, etc. due to generation of noise and vibration
	Use of hazardous substances		Inhibition of development and growth of plants and animals due to hazardous substances
	Night lighting		Inhibition of plant growth, and escape, attraction, and inhibition of development and breeding of birds, insects, etc. due to changes in light environment

Project phase	Impact factors		Impact of changes in land environmental elements on plants, animals, and ecosystems
Existence and use of land and structures	Roads, large forest roads, railways, and tracks	Existence of roads	Migration inhibition of plants and animals due to habitat fragmentation, and population changes due to collision accidents
		Existence of bridges	Changes in habitats of plants and animals in water areas due to changes in flow conditions
			Inhibition of plant growth due to changes in light environment
	Dam	Crude rock extraction	Loss of and changes in habitats due to alteration of fundamental environments such as topography and vegetation
			Inhibition of vegetation growth due to deterioration in water source recharge function
		Existence of dam embankment	Fragmentation of longitudinal movement pathways of terrestrial plants and animals
			Changes in habitats due to disruption of downstream sediment supply and fixation of riverbed
		Use of dam	Changes in riverside forests due to changes in water level and volume
		Existence of reservoir	Disappearance of fundamental environments such as topography and vegetation, and narrowing of habitat spaces and migration inhibition of animals
		Release of stored water	Changes in the habitats of plants and animals in water areas due to changes in water temperature and flows
		Existence and use of accessory roads	Fragmentation of habitats due to alteration of water system
			Changes in population due to collision accidents of traveling automobiles
	Weir	Existence of embankment and revetment	Changes in habitats due to fragmentation of water-land area continuum
		Existence of waterlogged area	Changes in flora and fauna and increase in alien species due to alteration of riverbed substrate
	River discharge channel	Existence and use of discharge channel	Fragmentation of habitats of terrestrial animals
	Airfield	Existence	Changes in habitats due to deterioration in water retention function and fragmentation of surface water, groundwater, etc. (in inland areas)
		Use	Evasion of birds, etc. caused by aircraft noise and occurrence of collision accidents
	Power plants (thermal, geothermal, nuclear)	Heated water discharge and water discharge	Changes in habitats of plants and animals in water areas due to changes in water temperature and flows
	Final waste disposal site	Landfill with waste	Inhibition of development and growth and evasion of plants and animals due to pollutant runoff and turbidity
	Surface improvement	Existence and alteration of land	Changes in distribution of plants and animals and migration inhibition of plants and animals due to decrease and loss of habitat spaces
		Water discharge	Inhibition of development and growth and evasion of plants and animals due to turbidity
	Final waste disposal site (waste incineration plant)	Collection of waste	Changes in habitats due to air pollution and water contamination
		Exhaust gas washing, etc.	Changes in habitats due to air pollution and micrometeorological changes
	Creation of agricultural land	Existence of agricultural land	Changes in habitats due to changes in water volume and groundwater
		Spraying of pesticides, etc.	Changes in habitation base, and inhibition of development and growth and evasion of plants and animals in land areas due to water pollution
	Livestock facility	Existence	Changes in water quality and habitation base due to generation of turbid or contaminated water
	Wind power generation	Use	Evasion of birds, etc. from the facilities viewed as obstacles, and collisions with windmills

Project phase	Impact factors		Impact of changes in land environmental elements on plants, animals, and ecosystems
	Recreational facilities (golf courses, ski slopes, etc.)	Existence of facilities and alteration of land	Changes in habitat space and fundamental environment
			Changes in vegetation base and water quality caused by turbid or contaminated water
		Spraying of pesticides, etc.	Changes in habitation base due to degradation in water quality
			Death of plants and animals, inhibition of development and growth, and evasion of fishes, etc.
	Sand mining and mineral extraction	Terrain alteration (structures)	Changes in habitats due to changes in surface water and groundwater
		Disposal of leftover soil	Changes in vegetation and water quality caused by turbid or contaminated water
	Construction of new buildings, factories and workshops	Existence	Changes in habitats of plants and animals in land areas due to microclimatic changes, wind damage, and contaminated water
	Night lighting		Escape, attraction, and inhibition of development and breeding of birds, insects, etc. due to changes in light environment
	Disposal of waste		Inhibition of development and growth and evasion of plants and animals due to pollutant runoff
	Construction of ancillary facilities (e.g., greenbelt)		Changes in genetic structure of plants, attraction of birds, insects, etc.
	Operation of ancillary facilities (e.g., rest areas)		Escape of plants and animals due to tread pressure
	Operation of ancillary facilities (e.g., rest areas) (night lighting)		Inhibition of plant growth, and escape, attraction, and inhibition of development and breeding of birds, insects, etc. due to changes in light environment
	Drainage from ancillary facilities (e.g., rest areas)		Changes in habitats due to changes in water volume, flow, and quality caused by drainage
	Human intrusion		Escape of plants and animals due to tread pressure
	Use of groundwater		Changes in fundamental environments due to changes in groundwater volume and water veins
	Use of river water		Changes in fundamental environments due to decrease in water and sediment volume and changes in water quality

*The table shows only some of the expected cases, but not all.

Table III.1-2 (2) Examples of general impact factors (changes in environmental elements in land water areas)

Project phase	Impact factors		Impact of changes in environmental elements in land water areas on plants, animals, and ecosystems
Construction work	Transportation of materials etc.	Introduction of construction materials	Changes in habitats due to noise and vibration
		Traveling of construction vehicles	Escape and inhibition of breeding of mammals, birds, etc. due to noise, vibration, and exhaust gas
	Operation of construction equipment (heavy equipment, etc.)		Escape and inhibition of breeding of plants and animals due to noise, vibration, and turbid water
	Creation of construction yard		Inhibition of development and growth and evasion of fishes, etc. due to turbidity
	Preparation of construction sites	Felling of trees, removal of roots, etc.	Changes in vegetation due to changes in sunshine, changes in fundamental environments due to changes in water temperature, and increase in alien species
			Changes in habitats of forest animals and migration inhibition of plants and animals due to decrease and loss of forests
	Excavation and other earthworks	Soil cover removal	Changes in fundamental environments due to deterioration in water source recharge function and changes in groundwater and its flow volume
		Excavation, cutting, banking, etc.	Changes in fundamental environments of plants and animals, and inhibition of development and growth and evasion of fishes, etc. due to turbidity
		Road paving work	Changes in habitats due to changes in fundamental environments of plants and animals and road drainage (turbid water)
		Concrete work	Inhibition of development and growth and evasion of plants and animals in water areas due to concrete efflorescence
		Revetment and embankment construction	Changes in habitation status and habitation base of plants and animals in water areas due to concrete efflorescence
		Dredging and excavation work	Inhibition of development and growth and evasion of fishes, etc. due to turbidity
		Landfilling and reclamation work	Changes in distribution of plants and animals due to changes in waves, flows, water quality, etc.
			Disruption of transition zone, changes in fundamental environments due to fall in water surface, and changes in distribution of plants and animals
		Land improvement	Changes in water quality, changes in fundamental environments due to use of hazardous substances, inhibition of development and growth of fishes, etc., and their evasion
		Drilling of wells	Changes in habitats due to turbidity of water and due to changes in surface water and groundwater
	Creation of temporary structures	Creation of roads for construction	Inhibition of development and growth and evasion of plants and animals due to turbidity
		Construction facilities creation work	Inhibition of development and growth and evasion of plants and animals due to turbidity
	Dismantling and removal of existing structures		Inhibition of development and growth and evasion of plants and animals due to turbidity
	Crude rock extraction		Changes in fundamental environments of plants and animals, and changes in groundwater level and river flow rate due to deterioration in water source recharge function
	Use of hazardous substances		Inhibition of development and growth of plants and animals caused by hazardous substances and flocculants
	Night lighting		Escape, attraction, and inhibition of development and breeding of birds, insects, etc. due to changes in light environment
Existence and use of	Dam		Inhibition of spawning and growth of fishes, etc. due to blocking of migration channels

Project phase	Impact factors		Impact of changes in environmental elements in land water areas on plants, animals, and ecosystems
land and structures		Existence of dam embankment	Changes in fundamental environments due to disruption of sediment supply and fixation of riverbed
		Use of dam	Changes in fundamental environments of plants and animals in water areas due to changes in water level and volume
		Existence of reservoir	Disappearance of habitat spaces, land locking, and inhibition of development and spawning of fishes and other aquatic plants and animals due to submergence of branch rivers
			Changes in flora and fauna due to alteration of riverbed substrate
			Changes in distribution of plants and animals due to changes in waves, flows, water quality, etc.
			Red tide, and growth and accumulation of toxic planktons due to stagnation of flowing water
		Release of stored water	Changes in habitats of plants and animals in water areas due to changes in water temperature and flows
		Existence and use of accessory roads	Fragmentation of habitats due to alteration of water system
			Inhibition of spawning and growth of fishes, etc. due to road drainage
	Weir	Existence of embankment and revetment	Changes in habitats and distribution of plants and animals due to fragmentation of water-land area continuum
		Existence and use of weir	Inhibition of spawning and growth of fishes, etc. due to blocking of migration channels
			Changes in fundamental environments of plants and animals in water areas due to changes in water level and volume
		Existence of waterlogged area	Changes in flora and fauna and increase in alien species due to alteration of riverbed substrate
	Lake level control facility	Existence of embankment	Changes in distribution of plants and animals due to changes in waves, flows, water quality, etc.
		Use of sluice gate	Inhibition of spawning and growth of fishes, etc. due to blocking of migration channels
	River discharge channel	Existence and use of discharge channel	Inhibition of spawning and growth of fishes, etc. due to blocking of migration channels, and immigration of plants and animals
	Water power generation	Water intake	Changes in flow, and capture of animals
			Changes in habitation environments due to fall in water level
		Existence of intake weir	Inhibition of spawning and growth of fishes, etc. due to blocking of migration channels
		Transfer of water	Inhibition of spawning and growth of fishes, etc. due to blocking of migration channels
	Landfilling and reclamation of public water areas	Existence of landfill	Disappearance of habitation base of plants and animals due to disappearance of transition zone
	Creation of agricultural land	Existence of waterway	Changes in flora and fauna due to emergence of new substrate
		Existence of intake weir	Inhibition of spawning and growth of fishes, etc. due to blocking of migration channels
		Spraying of pesticides, etc.	Changes in habitats, inhibition of development and growth, and evasion of fishes, etc. due to water pollution
	Livestock facility	Existence of facility	Changes in water quality and habitation base due to generation of turbid or contaminated water
	Recreational facilities (golf courses, ski slopes, etc.)	Existence of facility	Changes in habitats of fishes, etc. due to water contamination
		Spraying of pesticides, etc.	Changes in habitats due to changes in water quality
			Death of plant and animal species, and inhibition of development and growth and evasion of fishes, etc.

Project phase	Impact factors		Impact of changes in environmental elements in land water areas on plants, animals, and ecosystems
	Sand mining and mineral extraction	Terrain alteration (structures)	Changes in habitats due to changes in surface water and groundwater and deterioration in water source recharge function
		Disposal of leftover soil	Changes in water quality and vegetation due to turbid or contaminated water
	Sewage treatment plant	Discharge of treated water	Changes in habitats due to changes in water volume, flow, and quality
	Operation of ancillary facilities (e.g., rest areas) (night lighting)		Escape, attraction, and inhibition of development and breeding of birds, insects, etc. due to changes in light environment
	Drainage from ancillary facilities (e.g., rest areas)		Changes in habitation base due to changes in water volume, flow, and quality caused by drainage
			Red tide, and growth and accumulation of toxic planktons due to eutrophication
	Use of groundwater		Changes in fundamental environments due to changes in decrease in groundwater volume and changes in water veins
	Use of river water		Changes in fundamental environments due to changes in water volume and level, decrease in sediment volume, and changes in water quality
			Changes in habitat status and genetic composition of fishes, etc. due to migration of populations from other water systems

*The table shows only some of the expected cases, but not all.

Table III.1-2 (3) Examples of general impact factors (changes in environmental elements in sea areas)

Project phase	Impact factors		Impact of changes in marine environmental elements on plants, animals, and ecosystems
Construction work	Transportation of materials etc.	Traveling of vehicles	Evasion of birds, etc. from noise and vibration, and impact of exhaust gas on birds, etc.
		Traveling of vehicles	Evasion of fishes, etc. from noise and vibration
	Creation of construction yards and large material storage areas		Inhibition of development and growth and evasion of plants and animals due to turbidity
	Operation of construction equipment (heavy equipment, etc.)		Evasion of birds, etc. from noise and vibration, and impact of exhaust gas on birds, etc.
			Evasion of fishes, etc. from noise and vibration
	Excavation and other earthworks	Landfilling and reclamation work	Inhibition of development and growth and evasion of plants and animals in sea areas due to turbidity
		Excavation, cutting, banking, etc.	Inhibition of development and growth and evasion of plants and animals in sea areas due to turbidity
		Use of ground improvement agent	Inhibition of development and growth and evasion of plants and animals in sea areas due to water quality changes and harmful substances
	Clearing of trees, leveling of ground, etc.		Decrease in algae growth due to decrease in fish-bearing forest effects and decrease in trace matter
			Inhibition of development and growth and evasion of plants and animals in sea areas due to turbidity
	Creation of structures	Weir and revetment works	Inhibition of development and growth and evasion of plants and animals in sea areas due to turbidity and concrete efflorescence
		Embankment and breakwater construction work	Inhibition of development and growth and evasion of plants and animals in sea areas due to turbidity and concrete efflorescence
		Creation of final disposal site	Inhibition of development and growth and evasion of plants and animals in sea areas due to turbidity and concrete efflorescence
	Creation of temporary structures	Creation and widening of roads for construction	Inhibition of development and growth and evasion of plants and animals in sea areas due to turbidity
		Construction facilities creation work	Inhibition of development and growth and evasion of plants and animals in sea areas due to turbidity
	Dismantling and removal of existing structures		Evasion of birds, etc. from noise and vibration
			Inhibition of development and growth and evasion of plants and animals in sea areas due to turbidity
	Dredging work		Inhibition of development and growth and evasion of plants and animals in sea areas due to turbidity, water quality changes, and harmful substances
	Use of hazardous substances		Inhibition of development and growth of plants and animals in sea areas due to hazardous substances and flocculants
	Night lighting		Attraction of birds, etc. and evasion of reptiles (turtles, etc.) from lighting
Existence and use of land and structures	Terrain alteration	Existence of landfill, reclaimed land, dredged shipping lanes, etc.	Loss of habitat spaces of animals and plants in sea areas, and deterioration in water purification and other functions
			Changes in distribution of plants and animals due to changes in waves, flows, beach topography, water quality distribution, etc.
			Red tide, and growth and accumulation of toxic planktons due to stagnation of sea water
			Changes in water temperature and generation of poorly oxygenated water due to stagnation of sea water
	Existence of structures	Existence of levees, breakwaters,	Loss of habitat spaces of animals and plants in sea areas, and deterioration in water purification and other functions
			Changes in flora and fauna due to alteration of seabed substrate

Project phase	Impact factors		Impact of changes in marine environmental elements on plants, animals, and ecosystems
		bridges (piers), and floating bodies	Inhibition of development and growth of plants and evasion of fishes due to changes in undersea illuminance
			Changes in distribution of plants and animals due to changes in waves, flows, beach topography, water quality distribution, etc.
			Red tide, and growth and accumulation of toxic planktons due to stagnation of sea water
			Generation of poorly oxygenated water due to stagnation of sea water
		Existence of river discharge channel	Emergence of habitat spaces of plants and animals in sea areas
		Existence of weir	Impact of blocking of migration channels on spawning and growth of fishes, etc.
	Existence of intake or discharge channels		Emergence of substrate
	Operation of automobiles, railways, aircraft, and ships		Evasion of birds, etc. from noise and vibration, and impact of exhaust gas on birds, etc.
			Coastal erosion by ship wake
			Changes in flora and fauna due to invasion of alien species borne in ballast water
	Constriction and operation of workshops	Use of dams and weirs	Impact of blocking of migration channels on spawning and growth of fishes, etc.
			Changes in habitats of plants and animals in sea areas due to changes in sediment supply and river flow rate
		Use of discharge channels	Changes in habitats of plants and animals in sea areas due to changes in water quality (especially salinity)
		Operation of power plants (warm drainage)	Changes in habitats of plants and animals in sea areas due to changes in water temperature and flows
			Red tide, and growth and accumulation of toxic planktons due to rise in water temperature
			Decrease in plants and animals in sea areas due to rise in water temperature
	Disposal of waste	Landfill with waste	Inhibition of development and growth of plants and animals in sea areas due to hazardous substances
		Operation of leachate treatment facilities	Inhibition of development and growth and evasion of plants and animals in sea areas due to water quality changes and harmful substances
			Red tide, and growth and accumulation of toxic planktons due to eutrophication
	Wind power generation	Use	Evasion of birds, etc. from the facilities viewed as obstacles, and collisions with windmills
			Evasion of marine mammals, reptiles, and fishes due to underwater noise
	Operation of ancillary facilities (e.g., rest areas) (night lighting)		Attraction of birds, etc. due to lighting
	Drainage from ancillary facilities (e.g., rest areas)		Inhibition of development and growth and evasion of plants and animals in sea areas due to turbidity and water quality changes
			Red tide, and growth and accumulation of toxic planktons due to eutrophication
	Operation of intake or discharge channels		Changes in flow, and capture of animals
	Use of groundwater		Changes in habitats of plants and animals in water areas due to changes in groundwater volume and water veins
	Use of river water		Changes in habitation environments of plants and animals in sea areas due to decrease in water and sediment volume and changes in water quality

*The table shows only some of the expected cases, but not all.

Information more local to a particular region may be obtained from past data on that region and those on other neighboring regions with similar environments. Specifically, there are a variety of materials including survey reports on natural environments published by prefectures, and prefectural histories, books, municipal histories published by municipalities, journals published by private sector organizations such as clubs and local academic associations, and other existing materials such as environmental impact assessment reports and related materials. Some local governments have established regional biodiversity strategies based on the Basic Act on Biodiversity to provide basic plans for the conservation and sustainable use of biodiversity within particular regions and arranged a variety of data on, for example, forums for important natural environments. Environmental impact assessment reports are useful for collecting information on various plans and projects performed in the vicinity (see Table III.1-3).

However, these existing data have variations in accuracy and include old or incorrect information. Basically, the most recent data should be adopted and their sources and validity should be examined to ensure this. If the existing data do not provide sufficient information or only very old data are available, implementation of a field investigation should be considered to obtain information required for an appropriate environmental impact assessment. When handling information on the habitats and growth of rare plant and animal species, sufficient attention should be paid from the viewpoint of nature conservation.

Table III.1-3 Examples of existing materials to be collected and arranged for understanding regional characteristics

Purpose of collection and arrangement	Examples of existing materials to be collected and arranged
To obtain information on fundamental environment	Maps (topographic maps, nautical charts, present status maps, geological maps, vegetation maps, land use maps, aerial photographs, water system maps, etc.) Hydrological conditions such as water flow (hydrological quality database, etc.) Aerial photography and satellite photography
To identify important items for environmental conservation	Basic Surveys for Natural Environment Preservation, bird banding, river front census, natural environment survey reports published by prefectures, results of Monitoring Site 1000 survey, prefectural history, municipal history, journals published by private sector organizations such as clubs and local academic associations, existing environmental impact assessment reports and related materials available in the vicinity, local natural magazines, materials on flora and fauna, Red Data Book, regional biodiversity strategies, “Ikimono-Logs” and databases of identified species managed by local governments, etc.
To identify regional transitions and future environmental conditions	Various environmental planning materials (city planning, river improvement planning, port planning, regional biodiversity strategies, etc.)

(2) Interviews with experts, etc.

To supplement the collection and arrangement of existing materials, interviews are conducted, as necessary, with researchers and others who are familiar with local natural environments.

Targets of interviews include researchers at universities and other research institutes, teachers of high schools, curators at museums, staff of local governments (e.g., departments in charge of nature conservation administration and boards of education), workers in agriculture, forestry, and fisheries, members of nature conservation organizations, and local nature lovers, who are engaged in investigation covering the local areas.

It is considered that themes of interviews include the presence/absence and distribution of important species and ecosystems to be investigated, knowledge on the characteristics and transitions of flora and fauna and ecosystems in the relevant region, the characteristic topography and existing facilities of the local area, routes effective for the survey, points to note in suevey and forecasting, and the existence of reference documentary sources.

When receiving advice from experts, etc., care should be taken to collect the latest information while striving to receive advice from multiple experts, etc. from various perspectives. When advice has been received from an expert, etc., it will be sure to arrange the information according to the title of the advice received, the content of the advice, the specialized field of the expert, etc., and the attributes of the organization to which he/she belongs, and record them in the environmental impact assessment report to ensure improved transparency.

(3) Field survey of outline

To obtain information necessary to study the selection of items of environmental impact assessment and develop methods for survey, forecast, and evaluation, field suevey is performed mainly for actual confirmation of information obtained through collection and arrangement of existing materials and interviews, taking in consideration the possibility of distribution of important species and the environment type classification of ecosystems.

iii) Understanding of regional characteristics of plants and animals

Study on regional characteristics of plants and animals is performed though obtaining (1) an outline of flora and fauna, vegetation, and habitats (hereinafter referred to as “animal and plant species, etc.”) and (2) an outline of the distribution of important species, important communitiesand noteworthy habitats of plant and animal, (hereinafter referred to as “important plant and animal species, etc.”).

(1) Outline of flora and fauna, vegetation, and habitat

The flora and fauna are estimated from flora and fauna published in prefecture and records available in neighboring municipalities, etc., based on arranged data on the distribution of plant and animal species in the relevant area and the state of natural environment in the areas. Also, consideringother findings of the fielf survey of outline and results of interviews an outline of the flora and fauna is assumed at this point.

In addition, an outline of vegetation and habitat are estimated based on information obtained from existing vegetation maps, other existing materials, and information on the distribution of communities obtained from aerial photographs, field survey, interviews, etc, and an outline of major communities is assumed at this time. In doing so, efforts are made to collect and arrange available existing materials, including existing vegetation maps, community composition tables, and aerial photographs, that are as detailed as possible.

(2) An outline of distribution of important animal and plant species, etc.

Important plant and animal, etc. expected from the information available at this stage are extracted based on the above-mentioned materials including an outline of flora, fauna, vegetation and habitats, an outline of major communities, existing vegetation maps, and community composition tables, etc.,and summary tables of their distribution status, habitation and growth status, details of ecology, etc. is prepared, and if data on their distribution have been obtained, a schematic distribution chart (in a scale of about 1/10,000 to 1/50,000) is prepared. the data on ecosystems will be easily understood through preparing this distribution map so that it can be compared with the vegetation map and the environment type classification by the of developed for conducting the environmental impact assessment of the ecosystems. If the information obtained is referred to as required when selecting an investigation method, it serves, for example, to allow a good survey route to be found in accordance with data on the ecology of the target species, etc. of the investigation, thereby permitting efficient implementation of the investigation.

The important plant and animal species are extracted carefully considering reason of selection and regional characteristics as followed; while taking into account the academic viewpoints and concept of scarcity (that there is greater importance in species characterized by smaller populations, smaller habitation and growth areas, or fears of extinction or disappearance of habitats, or greater decreasing rate of habitats), and paying attention to those species designated by laws and regulations (see Table III.1-4), those which constitute the reason for the designation of a designated district, those listed in the literature from the viewpoint of academic importance and scarcity, those considered to be liable to environmental impacts, and those cited for the reason of shrinkage of their populations over the nation or a district (see Table III.1-5), as well as interviews with experts who are familiar with local plants and animals and results of field survey of outline.

Table III.1-4 Major laws and regulations as likely basis for selection of important plant and animal species, etc.

Standpoint for selection	Basis, etc. for selecting important plant and animal species, etc.
Species, etc. designated by laws, regulations, etc. from the standpoint of environmental conservation	• Natural monuments and special natural monuments designated under the Act on Protection of Cultural Properties • Natural monuments designated under the local government ordinance for the protection of cultural properties • Domestic rare wild plant and animal species, temporarily designated endangered species, and protected areas such as habitats established under Act on Conservation of Endangered Species of Wild Flora and fauna • Designated plants and animals in special areas and marine park districts designated in natural parks under Natural Parks Act, and species, communities, and ecosystems important as reason for selection or as constituents of special protection areas • Designated plants and animals and designated marine plants and animals in nature conservation areas under Nature Conservation Act, and species, communities, and ecosystems important as basis for designation or as constituents of nature conservation areas
Species, etc. selected by various surveys, groups, etc.	• Species listed on Red List of Environment Ministry • Species listed in Red Data Books of local governments • Wetlands listed in registers under Ramsar Convention • Forests protected and managed under Forest Reserve System • Communities listed Red Data Book of Plant Communities (1996, Nature Conservation Society of Japan) • Important wild bird habitats selected by IBA (Important Bird Areas) Program • Specified plant communities based on National Survey on the Natural Environment • Sites and noteworthy species designated for monitoring by Monitoring Site 1000 • Species and communities having outstanding features and universal values in World Natural Heritage sites and candidate sites • Species, mass breeding sites, egg-laying sites, etc., drawing attention from local organizations

Table III.1-5 Perspective for selection of important plant and animal species

Environmental factors	Academic perspective	Important plant and animal species to be selected (examples)
Important species of plant and animal	Indigenousness	• Plant and animal species distributed in limited areas (including sub-species groups) • Morphologically distinctive populations (having many morphological variations)
	Distribution limit	• Limits of horizontal and vertical distribution of plant and animal species
	Disjunct distribution	• Species showing disjunct distribution
	Importance for education and research	• Continuously observed and investigated populations • Persistent species important for research • Plant and animal species populations in type localities • Giant trees, old trees, etc.
Noteworthy habitats and important communities of animals	Naturalness	• Communities with species compositions close to native state and habitats close to native state • Highly natural communities and habitats covering with a certain area
	Prominence	• Large-scale communities such as large beech forests and wetlands • Large-scale habitats such as mass migration sites of birds and mass breeding sites
	Diversity	• Natural communities and habitats with large diversity of constituent species • Communities and habitats with large diversity of constituent species maintained through traditional management • Important communities as basis for habitation environment and ecosystem of diverse plants and animals
	Dependence of rare plant and animal species	• Communities strongly linked to academically important or rare plant and animal species, and places strongly depended upon as important habitats
	Typicality	• Habitats important for study of characteristics of communities because of having typical species compositions • Habitats characteristic of local landscapes, and particularly containing communities with typical characteristics • Shrine and temple forests with high naturalness
	Distribution limit	• Communities located on limits of horizontal and vertical distribution of plant and animal species
	Location specificity	• Communities meeting specific location conditions such as wetlands, special rock land, sand dunes, and special weather conditions • Habitat meeting specific locational conditions such as wetlands, caves, and special rock land
	Vulnerability	• Communities and habitats vulnerable to environmental changes
	Importance for education and	• Communities and habitats covered by surveys and research on communities and animals, and important

	research	for educational and research purposes • Communities with characteristic species compositions different from the general species composition • Artificially planted forests not logged for a long period of time

iv) Understanding of regional ecosystem characteristics

Understanding of the regional characteristics related to ecosystems is achieved by clarifying major features of the ecosystems on the basis of broad-based features (such as importance for environmental conservation) of the regions covered in environmental impact assessment and the pattern classification of the underlying environment.

(1) Wide range features

Understanding from a wide-area viewpoint of the features of the environment, flora and fauna, etc. in a region to be covered in an environmental impact assessment is important in examining the distributions, etc. of the species and communities characterizing the region. Therefore, based on existing data and findings, investigation is performed to clarify the characteristic features of the target area (e.g., importance for environmental conservation) in light of the geographical or wide-area conditions of flora and fauna and the mobilization capacity of animals. Even for habitats for animals that are not regarded as noteworthy in existing data, for example, it is necessary to consider the possibility that it could be an important migration route for birds or a site where fish go upstream or downstream.

If the document on primary environmental impact consideration at the early stage specifies a habitat as having wide-area importance in relation to the role of the target region in the ecosystem network, etc., such data can also be used.

(2) Environment type classification

In order to understand the structure of an ecosystem, environment type classification is established by collecting and arranging data on fundamental environments (topography, geology, vegetation, etc.) and processing them by the overlay technique, etc. to classify environments by the size of space. For the environmenttype classification, not only the data on plant and animal species are arranged, but also data on fundamental environments, their relationship with the species, and the relationship between the categories according to the environment type classification are arranged.

(3) Points to note in understanding of regional characteristics

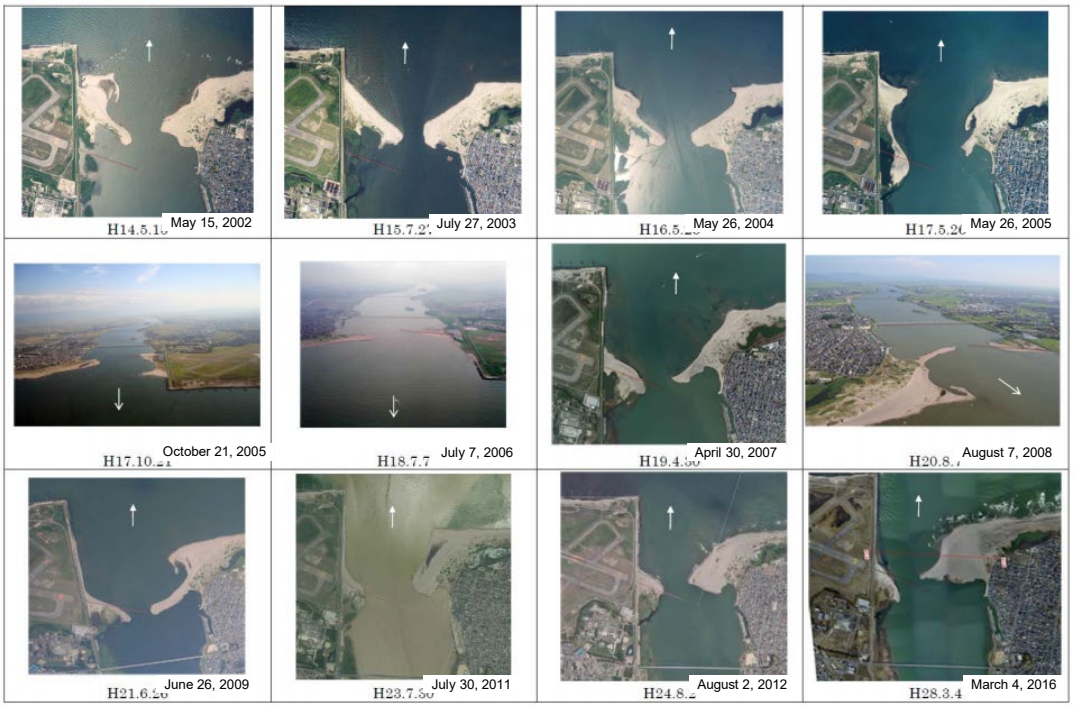
In recent years, damage caused by animals such as deer and an increase of alien species have been significant factors causing changes in the natural environment in some regions, and it has been pointed out that environmental impacts of project implementation and

environmental conservation measures such as greening by alien species may precipitate these changes. Therefore, when studying the environmental impact of project implementation, the state of the environments in the surrounding areas, the transition of the environments from the past, the possibility of future changes and so on should be carefully considered. In particular, the arrangement of information on the human effects on the natural environment in the region at particular points in time and their changes to date leads to an understanding of why the current environment was established and maintained, based on the characteristics of the ecosystems such as vegetation transition, and will be helpful in the study for forecasting and examination of environmental conservation measures.

Such data arrangement is carried out focusing on the characteristics of ecosystems in land areas, land water areas, and sea areas. In the ecosystems in some land water and sea areas, for example, short-term environmental changes such as those in flow rates and ocean currents are larger than changes caused by the influence of project implementation. Therefore, when arranging data on the transition of the natural environment, attention should be paid not only to long-term changes, but also to the occurrence of periodic changes and low-frequency singular phenomena.

[Reference information] Arrangement of data on changes in natural environment

- A basic method of arranging data on the transition of the natural environment is to collect and arrange aerial photographs, etc. taken in the past. Aerial photographs are available from the map and aerial photograph browsing service of the Geospatial Information Authority of Japan. In addition, vegetation maps in some areas are also available. For some rivers, data on characteristic topographical changes can be obtained from aerial photographs provided every few years by the Ministry of Land, Infrastructure, Transport and Tourism, and for other places, the trend of environmental changes over time can be estimated from the National Survey on Natural Environment in River and Watershore conducted over multiple years.



Source: Aganogawa River Office, Hokuriku Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism (2016)

Fig. III.1-3 Examples of arranged data on topographical and environmental transitions based on aerial photography

[Reference information] Climate change and ecosystems

In March 2015, the Central Environment Council compiled a "Report on the Evaluation of Effects of Climate Changes in Japan and Opinions on Future Challenges," in which the impacts on natural ecosystems including those related to terrestrial, freshwater, coastal, and marine ecosystems as well as biological seasons and changes in distribution and population are roughly divided into two categories: the impacts on natural ecosystems themselves and the impacts on ecosystem services.

As for the impacts on natural ecosystems themselves, it was pointed out that significant impacts could arise over a wide range of areas, including changes in the range of plant distribution in the present and future terrestrial areas, such as possible reduction in the areas suitable for distribution of dwarf stone pine and Japanese beech forests at the end of the 21st century, expansion of habitat areas of some wild birds and animals such as Japanese deer, reduction and disappearance of coral reefs, and effects on river biota such as a reduction of areas suitable for habitats of cold-water fish to about half of the present that can occur when the maximum water temperature rises by 3°C. (Cited from Ammual Report on the Environment, the Sound Material-Cycle Society, and Biodiversity in Japan, 2015 ed. (Ministry of the Environment, 2012))

It is a future issue to what extent the socio-economic and natural impacts and adaptations of these climate change should be considered as future environmental changes in individual environmental impact assessments. However, in order for environmental conservation measures to function effectively, environmental changes caused by climate changes, such as the spread of animal damage, need to be considered.

3) Selection of items subject to environmental impact assessment

i) Relationship between items subject to environmental impact assessment

Environmental impact assessment should be carried out with due consideration to the relationship between those items subject to environmental impact in the fundamental environments, such as plants, animals, ecosystems, and water quality (Fig. III.1-1). Plants and animals are components of ecosystems, and important plant and animal species, etc. live and grow on the basis of ecosystems. Depending on project characteristics and regional characteristics, water environment items such as water quality and groundwater and air environment items such as weather are the foundations of ecosystems, and activities in contact with nature are based on ecosystems, indicating that there are also close relationships between environmental elements that are covered by the forecast. Therefore, it is possible to improve the efficiency of environmental impact assessment by selecting environmental elements of plants, animals, and ecosystems that are likely to be affected after understanding the project characteristics and regional characteristics in an integrated manner.

ii) Selection of important plant and animal species, etc. and ecosystems to be target in environmental impact assessment

(1) Selection of important plant and animal species, etc.

For each impact factor of the project.the extent of the influence on the important plant and animal species, etc. that are distributed in and around the area where the project is implemented, among the plant and animal species that are affected by the project, is examined As a result, if there is possibility that any of them will be significantly affected, the relevant important plant or animal species, etc. possibly affected by the project are selected as subjects for environmental impact assessment.

For the selected important plant and animal species, etc., the reasons for their selection (e.g., being listed in the Red List), data obtained from the results of study on regional characteristics (distribution status, habitation and growth status, ecological information, etc.), information sources, etc. are showed in summary tables, and their relationships with impact factors and with effects on the important plant and animal species, etc. subject to environmental impact assessment are also included in the tables. In addition, the distribution status, etc. will be shown together with the project plan in a positional map (in a scale of approximately 1/10,000 to 1/50,000), so that the positional relationship between the impact factors of the project and the areas of influence can be easily understood, and that the relationship with the effects of the project are also understood by superimposing it on the vegetation map or the environmental type categorization chart. For some important plant and animal species, etc., there may be a distribution model that serves to estimate the potential distribution using existing data, which may be helpful for clarifying the relationship between the potential distribution and the project characteristics (however, care should be taken when applying models created from data of areas other than the relevant study area, and the estimation results may include uncertainty. For details, refer to “1.2 Utilization of Technical Methods and Points to Note (Plants, Animals, and Ecosystems)”).

For the important plant and animal species, etc. that may be affected by the project, information is collected through interviews with experts, etc. at the stage of selecting the subject species, and supplemented with information obtained through field surveys as necessary.

Table III.1-6 Exmple summary of impact factors and important animal species, etc. subject to environmental impact assessment

Environmental elements	Categories of impact factors	Construction work			Existence and use			
	Impact factors	Generation of turbid water	Noise generation	Night lighting	Terrain alteration	Felling of trees	Emergence of structures	Discharge of air pollutants
Important animal species	Mountain hawk-eagle		○	○	○	○	○	○
	Tokyo salamander	○		○	○	○	○	
	Japanese eight-barbel loach	○		○	○	○	○	
	scarlet dwarf				○		○	
	Japanese luehdorfia			○	○	○	○	
	great purple emperor					○	○	
Noteworthy habitats	●● Wetlands	○			○	○	○	
	Collective breeding place of ○○						○	
	Primary forest of ▲▲				○	○	○	

○: Items likely to have impact and adopted as items subject to environmental impact assessment

Table III.1-7 Example summary of impact factors and important plant species, etc. subject to environmental impact assessment

Environmental elements	Categories of impact factors	Construction work		Existence and use				
	Impact factors	Generation of turbid water	Downward flow of sediment	Terrain alteration	Felling of trees	Emergence of structures	Tread pressure	Changes in groundwater level
Important animal species	Oriental penthorum		○	○		○		○
	minute duckweed	○	○	○		○		○
	Japanese eight-barbel loach		○	○	○	○	○	
	scarlet dwarf			○	○	○		
	golden orchid				○	○	○	
Important communities	water shield-pygmy waterlily community	○	○	○		○		○
	sawtooth oak-jolcham oak community		○	○	○	○	○	

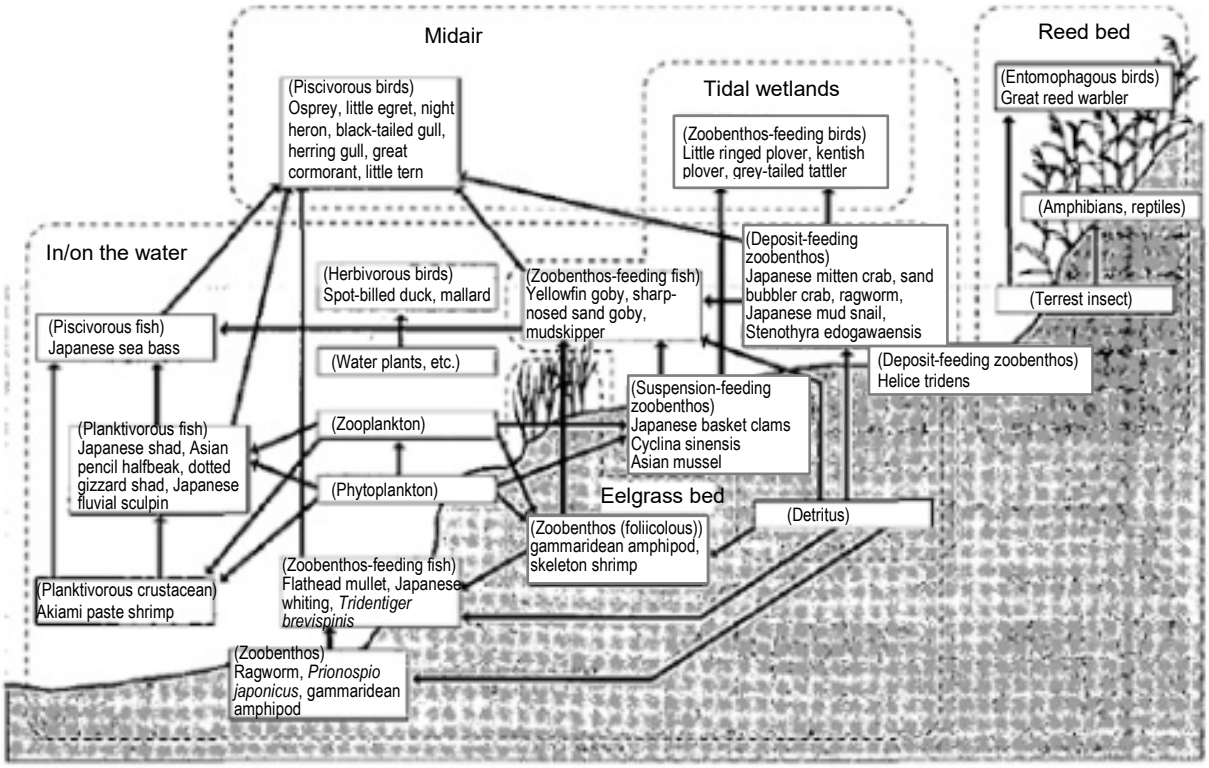
(2) Selection of ecosystems

Selection of ecosystems subject to environmental impact assessment is carried out according to the following procedures (a) to (d).

(a) Understanding of rough features of structures and functions of ecosystems

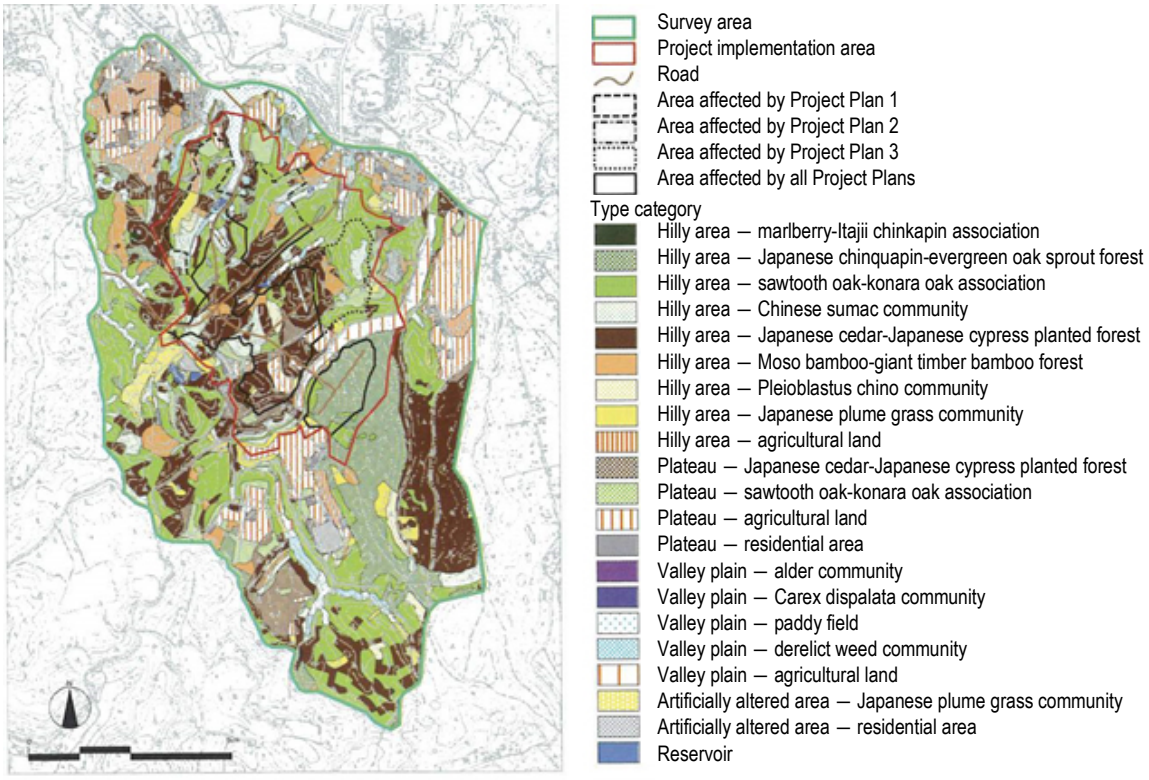
Study is performed to undesrstand outline features of the structures and functions of ecosystems in the target.

As for the structures, it is understoodby classifying the ecosystems into several categories according to the vegetation distribution, topography, etc. (environment type classification). Based on the environment type classification, arrangement of informations on the plant and animal species characteristic of the region and the distribution of their communities and habitats , assumption of food webs, preparation of schematic diagrams, etc. are carried out, the structure is arranged by focusing on the relationship between the fundamental environment and plant and animal species, etc., food webs, diversity and ecological characteristics of plant and animal species, etc. The functions of ecosystems are arranged taking into account the regional characteristics of the plant and animal species, etc. with important functions and the environmental type classification, from the viewpoinst of the formation and maintenance of ecosystems, and the production and circulation of energy and materials, and so forth.



Source: Japan Wildlife Research Center (2002b)

Fig. III.1-4 Example of organization of environmental type classification and food webs



Source: Japan Wildlife Research Center (2002b)

Fig. III.1-5 Example of arrangement of environmental type classification and distribution of noteworthy species, etc.

(b) Arrangement of important categories according to environment type classification

Linkage maps, etc. are used to estimate to what extent various impact factors of project implementation can directly or indirectly affect on each category according to the environmental type classification, and environmental categories considered to be important in environmental impact assessment are identified.

(c) Classification of impacts on ecosystems by each impact factor of projects

impacts of projects on ecosystems is classified in relation to each impact factor taking into consideration not only direct impacts but also indirect impacts extending through their effects on fundamental environments such as water environment and vegetation.

(d) Selection of noteworthy species, etc. serving as indicators

Based on the above results, taking attention to the hierarchical nature of ecosystems and the food webs, etc., noteworthy species (hereinafter referred to as noteworthy species, etc.) are selected from the plant and animal species, etc. that may be affected by a project, having the viewpoint of superiority (i.e., being ranked high in an ecosystem), typicality (i.e.,

being typical in an ecosystem), and specificity (i.e., being helpful as an indicator of a peculiar environment). Perspectives for the selection are summarized in Table III.1-8, and the selection procedure and points to note are summarized in Table III.1-9. For the selected noteworthy species, etc., not only data on their ecology and life history are arranged, but also their relationships with other plant and animal species, etc. are arranged.

Table III.1-8 Prospectives fot selection of noteworthy species, etc.

	Perspectives for selection
Superiority	Species ranked at a high trophic level among the plant and animal species constituting an ecosystem are target for selection. Among the relevant speciesthat ranked at a high trophic level, and the species that arelikely to be affected by the disturbance of an ecosystem and changes in an environment are selected as an indicator of overall impacts. To ensure selection of suitable species, attention is paid also to the food webs in ecosystems of various spatial scales in the target area, such as small-scale wetlands and ponds. Therefore, the target species may include somrtimes small vertebrates such as reptiles and fishes and invertebrates such as insects, in addition to large vertebrates having wide home ranges of activity such as mammals and birds.
Typicality	The following species present in the ecosystems in the target area are to be selected.as target species; plant and animal species, etc representing the interrelationships between. those in each environmental type category and a environment or those. in the fundament, those playing an important role in the function of an ecosystem (e.g., plant species existing in large volumes or occupying large areas, as well as playing major roles in the material circulation in ecosystems, animal species with large populations, species belonging to a representative guild*, etc.), those characterizing the diversity of plant and animal species, etc., those characterizing ecological transition, and those migrating between different ecosystems, such as recreational fishes, In addition, the spatial hierarchical structure in each environmental type classification is also focused when selecting species.
Specificity	Areas that are relatively small in scale compared to the subject project and present in an environment under special establishment conditions, such as a spring, cave, vicinity of fumarole, limestone area, and isolated rock or shellfish reef on muddy sand bottom in sea area, are focused , and plant and animal species, etc. inhabiting them are to be selected. The relevant plant and animal species, etc. include those having habitats that are strongly defined by special environment factors or the existence of a unique area.

* Guild: a group of species belonging to the same trophic level and living on a common resource

Table III.1-9 Procedure and points to note for selection of fnoteworthy species, etc.

Procedure	• From among the plant and animal species, etc. that are likely to live and grow in the vicinity of the survey area, list a plurality of plant and animal species, etc. that show similar responses to changes in ecosystems. • Collect data on the ecology of the listed plant and animal species, etc. and examine whether there are sufficient findings and surveys. • Arrange about the availability of data required for surveys and forecasts, the likelihood of occurrence of changes in response to environmental changes, and the particular time when such changes occur, etc. • Examine whether they have characteristics commonly seen in or strongly dependent on important environment type categories. • Collect opinions from experts who are familiar with the ecosystem of the relevant area.

	• Based on the above, extract representative ones from the standpoint of superiority, typicality, and specificity.
Points to nnote	• Review as appropriate based on opinions of experts, etc. and results of field surveys. • Confirm whether the plant and animal species, etc. show regional characteristics of the relevant ecosystem. • Select noteworthy species, etc. by using an analysis method that produces objective selection results. • Arrange the data on their relationship with project characteristics by using, as required, a model that can show potential distribution areas of plant and animal species, etc. (See "1.2 Utilization of Technical Methods and Points to Note (Plants, Animals, and Ecosystems)").

[Reference Data] Superiority of raptors

Many of the raptorial species living in Japan are ranked highest in the food web of an ecosystem. Their populations are small, and they are susceptible to environmental alterations, pollution, etc. Many of these species are listed in the Red List published by the Ministry of the Environment, it should be noted that, regardless of their rarity, species that are ranked high in the ecosystem should be selected, as required, as noteworthy species, etc. with high superiority in an ecosystem. In examining the conservation measures, etc. for these raptorial species, it will be helpful to consult "How to Protect Raptorial Species (revised edition)" (the Ministry of the Environment, 2013), "How To Protect Grey-Faced Buzzard" (the Ministry of the Environment, 2013), and "How to Protect Eastern Marsh Harrier" (the Ministry of the Environment, 2016).

4) Selection of methods for survey, forecast, and assessment

The characteristics of each ecosystem should be considered when selecting a method for survey, forecast, or assessment. For example, large fluctuations can occur in a short period of time in some cases in inland water and sea areas, and it is necessary to adopt a method that takes into account such fluctuations and the characteristic changes seen in the past in the areas.

i) Setup of survey and forecast areas

Basically, survey and forecast areas are set up in consideration of the scope and extent of direct and indirect effects of the relevant project, the grouping and connection of ecosystems estimated from topography, geology, water systems, etc., the distribution and home range of important or noteworthy plant and animal species, etc., and other characteristics such as ecology and life history. Results of numerical simulations of fundamental environments, etc. such as water environment and similar case studies are consulted when estimating the scope of impacts of a project. The following points should also be noted.

- Establish an appropriate scope for study of environmental conservation measures.
- Review the range of forecasts, as appropriate, based on results of surveys, etc.
- Assume a wider scope from a safety-side perspective considering the possibility of changes in the project plan.
- Consider the distribution of populations in the region
- If long-term or wide-area surveys and forecasts, such as for seasonal long-distance migration, are required, use existing data to supplement required data to set up an area.
- Consider the spread of an environment that defines the distribution of plant and animal species, etc.

ii) Selection of methods for survey

A survey method is selected by taking into consideration the ecological characteristics of important plant and animal species, etc., project characteristics, regional characteristics, etc. necessary for appropriate forecast and evaluation of the important plant and animal species, etc. to be subject to environmental impact assessment. In particular, considering the relationship between the scope of impacts of the project and the distribution of important plant and animal species, etc.,he home range and life history of animals, selection is performed with the following points in mind

- Plants and animals often change their preferred environments, such as habitats and foraging ranges, according to their life history. Survey areas and points, and the timing, period, and frequency of the survey should be set up so as to ensure highly detailed study of the life history of the relevant plant and animal species, etc., and others that have a close relationship with the former.
- Examine the temporal changes in impacts of the project, when survey areas and points, and the timing, period, and frequency of the survey are studied. t.
- When a candidate survey method that have the possibility of affecting individuals or habitats of local plants, animals, etc. are used, its necessity and substitutability, etc. are thoroughly examined and the discussion with local experts, etc. are performed before deciding on its adoption.
- In some cases, effective surveys can be facilitated by using a method for analyzing places (hot spots) where many important plant and animal species, etc. and identifying places for intensive survey.

iii) Selection of methods for forecast

Methods for forecast should be selected so as to ensure accuracy required for evaluation, taking into consideration the ecological characteristics of important animal species, etc, project characteristics, and regional characteristics, etc.. For forecasting, there are qualitative and quantitative methods, of which quantitative forecasting should always be adopted to the extent possible within the scope of current science level. In forecasts of direct impacts of projects, are made as quantitatively as possible focusing on reproduction, behaviors, populations, and existing quantities, etc., based on quantities of habitats and food resources and degree of alteration of fundamental environments. Indirect impacts are predicted quantitatively based on degrees of changes in impact factors, and when this is difficult, it is considered that qualitative forecasts may be made based on data on similar existing cases and opinions of experts, etc. For impacts on ecosystems, it is considered that forecasts may be made based on the degree of diversity of plant and animal species, etc., locations in the food webs, hierarchy of trophic levels, functions for formation and maintenance of the environments, etc. In setting the forecast timing, the following points are mainly taken into consideration.

- Appropriate forecast timing is set to ensure an accurate grasp of the impacts of the project in considering the ecological characteristics of important plant and animal species, etc. and noteworthy species, etc.
- Fot timing fo forecasts of impacts of construction work and the existence and use of facilities, timing are made upon reaching a steady state after use, taking into consideration the temporal changes of the impacts of the project. Furthermore, in consideration of the possibility that a plurality of different influences occur at different times, a plurality of forecast times may be set, or an appropriate time in a period is set so that the accumulated impact during the period is maximized.
- Attention should also be paid to the possibility that the impacts on important plant and animal species, etc. and noteworthy species, etc. may differ depending on the timing. For example, when considering the life history of noteworthy species, etc., the season in which the impacts of the project are assumed to reach a maximum may be set as the forecast time.
- Forecasts period in developing environmental conservation measures should cover a period in which each measure for the subject project are expected to produce good effects and the ecosystem is expected to become stable.

iv) Examination for development of more detailed and simplified methods for survey and forecast

As for more detailed survey and forecast method, , for example, it is expected to use genetic analysis, population viability analysis (PVA), etc. in caseswhere important plant and animal species, noteworthy species, etc. that are particularly susceptible to environmental impacts inhabit the project implementation area. For ecosystem investigation, it is consideed that devices for remote sensing, sonar sensing, etc. may be used to conduct surveys that can obtain regional data from a wide region considering the relationship between the importance of the survey area and surrounding areas.

As for more simplified survey and forecast method,it is considered that thespecies are excluded from a survey of animals in cases, for example, where animals of the species used to have an habitat in the survey area, but existing findings clearly show that they do not exist there in recent years.

[Reference Data] BACI (before-after/control-impact) design

When setting up a survey of items affected by a project, BACI design is a useful technique to design a survey to determine whether a particular degree of impact has actually occurred (or did not occur).

It is method to conducte before and after the occurrence of impact of a project, and to select and to compare affected environments (impact) and unaffected environments (control). For the surveys, data are required to be acquired by the same technique and under the same conditions as

long as it is possible, and it is necessary to develop a survey method that can detect changes in the environment and clarify the reasons in them.

According to the concept of BACI design, the survey conducted for environmental impact assessment and the follow-up survey are considered to give “before” and “after” data and the survey plan should be constructed so that they can be mutually compared with each other, suggesting the need to establish to some extent details of the follow-up survey upon preparing the methodology document.

The following points should be kept in mind when setting up the survey and follow-up survey based on the concept of BACI design.

- When setting a control (place, confirm that it has a similarity not only in terms of vegetation, etc., but also in the establishment condition of the environment.
- If it is impossible to set a control, the surveys should be designed to be able to obtain enough amount of data for comparison between the states before and after the occurrence of impact of the project.

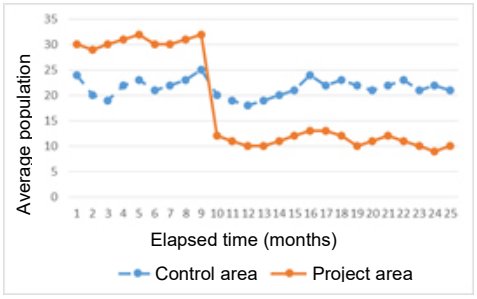
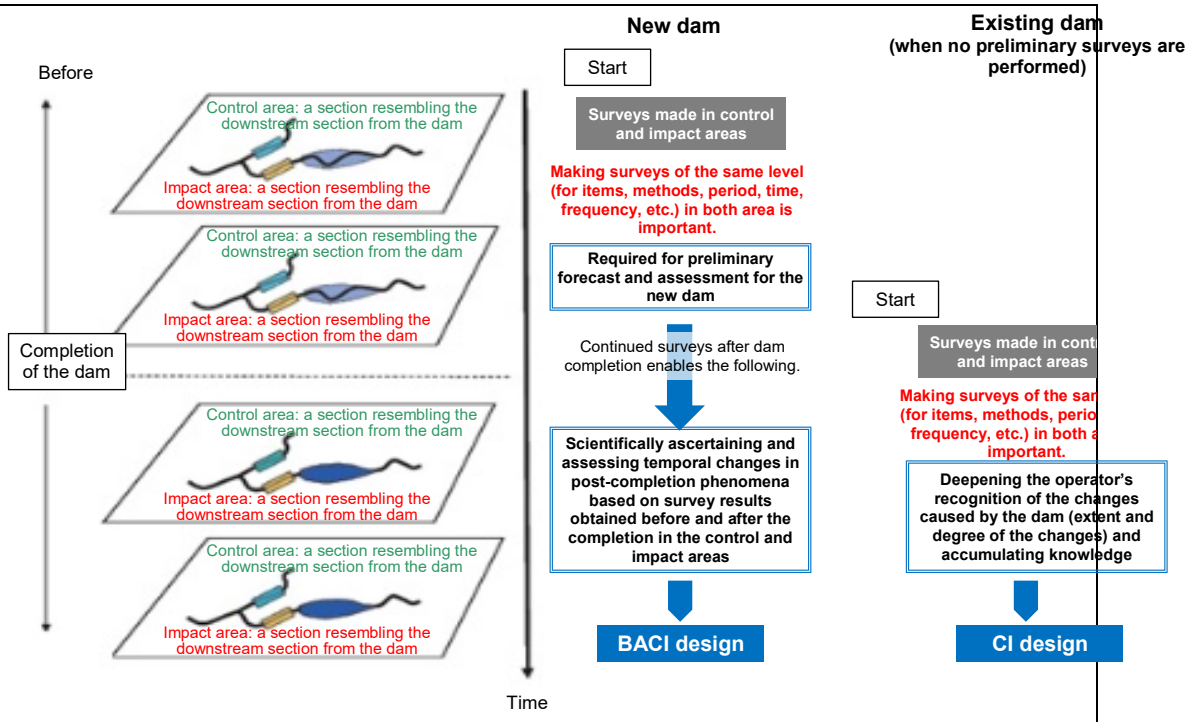


Fig. III.1-6 Examples of results of monitoring temporal changes based on BACI design

- The effects of environmental conservation measures are also studied taking BACI design into account.
- In some cases, when restoring and regenerating an environment, a target place or state (reference) is set and a survey is designed so as to determine to what extent the target has been reached (BARCI design).



Source: National Institute for Land and Infrastructure Management, Public Works Research Institute (2009)

Fig. III.1-7 Concept of BACI design for dam project as example

[Reference Data] Example of procedure for arranging data on uncertainties

Causes of uncertainty in a forecast are divided into those of various levels such as uncertainty in forecasting conditions, uncertainty in parameters, etc. used for calculation, and uncertainty in forecast techniques. Table III.1-10 shows major uncertainty factors appearing at different stages of environmental impact assessment of biodiversity, and these factors should be taken into considereation when arranging data on project characteristics and performing surveys and forecasts. At the stage of arranging project characteristics, for example, the degree of possibility of modifying the project plan is examined, and at least when a modification of the project plan is likely to cause an increase in environmental impact, it is necessary to make a forecast that anticipates it or clearly show the range of changes occured in the project plan.

Table III.1-10 Major factors in uncertainty at various stages of environmental impact assessment

Stage of environmental impact assessment	Major factors
Arrangement of project characteristics	Possibility of modification in project plan, etc.
Survey	Lack of data, occurrence of data bias due to survey methods, etc.
Forecast	Inadequate precision and verification (sensitivity analysis) of general-purpose tools and models, etc.
Environmental conservation measures	Lack of knowledge on characteristics of plant and animal species, etc. and ecosystems

Examples of procedures for arranging data on the degree of uncertainty are shown below with reference to “Uncerttainties in the IPCC TAR: Recommendationsto lead authors for mor consistent assessment and reporting” (Moss and Schneider (2000)) and a report offered by Tsunekawa (2005).

Procedure 1: If there are multiple factors that affect the uncertainty of forecast conclusions, identify the most important factors and uncertainties that are likely to affect the conclusions. Also specify which important factors/variables are being treated exgenously or fixed, as it will almost always be the case that some important components will be treated in this way.

Procedure 2: Document ranges and distributions in the literature, including sources of information on the key causes of uncertainty. Note that it is impotant to consider the types of evidence available to support a finding. Distinguish findings that are well established through observations and tested theory from those that are not do established.

Procedure 3: Given the nature of the uncertainties and state of science , is the state of science such that only qualitative estimates ara possible, or is quantification possible, and is so, to

how many significant digits? As the assessment proceeds, recalibrate level of precision in response to your assessment of new information and knowledge of science.

Procedure 4: Quantitatively or qualitatively characterise the distribution of values that a parameter, variable, or outcome may take. First identify the end points of the range that the writing team establishes, and/or any high consequence, low probability outcomes or "outliers." Particular care needs to be taken to specify what portion of the range is included in the estimate (e.g., this is a 90% confidence interval) and what the range is based on. Then provide an assessment of the general shape (e.g., uniform, bell, bimodal, skewed, symmetric) of the distribution. Finally, provide your assessment of the central tendency of the distribution (if appropriate)..

Procedure 5: Describe the state of scientific information on which the conclusions and/or estimates are based.

Procedure 6: Prepare a "traceable account" of how the estimates were constructed that describes the writing team's reasons for adopting a particular probability distribution, including important lines of evidence used, standards of evidence applied, approaches to combining/reconciling multiple lines of evidence, explicit explanations of methods for aggregation, and critical uncertainties.

v) Selection of evaluation methods

The selection of evaluation methods is performed taking into account whether important plant and animal species, etc., important environment type classification, and noteworthy species, etc. are maintained (including the perspective of maintenance of community compositions of plants and animals, and functions, values, and importance of ecosystems).

1.1.2 Survey

1) Study on survey items and survey methods

The survey items include fauna, important species, and noteworthy habitats for animals, flora, important species, and important communities for plants and conditions of fundamental environments, status of environmental type classification and noteworthy species, etc., and functions of ecosystems. for ecosystems

As for the survey methods, survey areas and survey timing, etc. are set, taking into consideration the project characteristics and regional characteristics, so that data needed for appropriate forecast and evaluation for the plant and animal species, etc. and the noteworthy species, etc. can be obtained.

For comprehensive study of the data needed for forecast, it is efficient to examine the items and methods for surveys of plants, animals, and ecosystems as integrally as possible. Based on the data obtained, additional survey items and survey methods are reviewed as necessary and sufficient consideration is also given to the relationships with other environmental elements such as water quality and environmental conservation measures.

Major points to note in the survey of each environmental element are shown below.

i) Major points to note for survey of animals

(1) Points to note for survey of fauna and animal habitats

Survey of fauna and animal habitats is conducted in view of the points to note shown in Table III.1-11.

Table III.1-11 (1) Major points to note for survey of fauna and animal habitats

Points to note	Major points
Identification of species	• In the basic survey of fauna, samples and photographs of individuals and traces of life are collected to ensure species identification, and the date of verification, name of the place, name of the verifier, and name of the identifier are recorded. For species that are difficult to identify, experts should be asked to perform their identification. In cases where sample collection is restrained by laws, ordinances, etc. or where the number of inhabitants is so small that collection of samples is likely to have an impact on their inhabitation, the survey is limited to taking photographs of individuals (communities) and recording the places where their habitat is confirmed. • As for arranging the identification results, lists of names of species and Red Lists arranged by academic societies, administrative agencies, etc. may be used effectively, but it should be noted that these names may differ from their scientific names or Japanese names.
Collection of ecological data	• For species newly identified by the survey or for those short of collected ecological data at the stage of general survey on regional characteristics, necessary ecological data are collected from literature and interviews with experts, etc.
Survey routes and survey sites	• Surveys of fauna are conducted after setting appropriate survey routes and survey sites in advance. • Using topographical classification maps, existing vegetation maps, water system maps, etc., survey routes and survey sites are set so as to cover fundamental environmental elements that are important as habitats. • Survey routes and survey sites are set so as to comprehend the conditions of areas that are likely to contain bird migratory routes or other noteworthy habitats. • Selection of survey routes should focus not only on paths etc. that are easy to survey and include positions clearly found on topographical maps, but also on river beds, ponds, marshes, wetlands, springs, open rock land, rock reefs, caverns, etc. to cover all special environments that are likely to contain animals living in extremely limited habitats. • Survey sites in water areas are set after grasping the water depths, characteristics and distributions of sediment, etc. in advance since the distributions of animals vary depending on water depth and sediment characteristics. • The survey routes and survey sites should be arranged so as to carry out

	the survey safely.

Table III.1-11 (2) Major points to note for survey of fauna and animal habitats

Points to note	Major points
Linkage with survey of ecosystems	• The habitat and distribution of animals and relationships among different species are covered by surveys of ecosystems. Therefore, confirmed inhabitation points and distributions are recorded so that the relationship between habitats and environmental type categories of ecosystems are clearly seen. • By setting up a survey route focusing on fundamental environmental factors、 the survey results on fauna are summarized according to environmental type categories of ecosystems and the community composition is understood.
Survey time	• To properly grasp the fauna, habitats of animal species, and usage conditions of noteworthy habitats, an appropriate survey time is set in consideration of the life cycle of the animal species and animal groups to be surveyed. For animal species whose inhabitation can be surveyed only at limited times of the year, a particularly appropriate survey time should be set with this in mind. • There are differences in the hours of activity depending on the species, such as nocturnal and diurnal, so attention should be paid to the hours of activity of the day.
Others	• To estimate the number and density of animal inhabitants of particular species, there are a variety of methods including use of traps, root census, and quadrat technique. When preparing a list of fauna, it is desirable to compare the frequencies of confirming their habitats and add the results in simple manner (high, low, etc.) to the list. • When capturing animals, it should be kept in mind that relevant laws, ordinances, rules, etc. must be observed and, when necessary, permission for capturing animals must be obtained in advance from local governments, etc. • Great care should be taken not to allow the survey itself to cause disturbances in habitats (e.g., by rough treads) or inhibit breeding behaviors, etc. of animals. • Locations such as confirmed inhabitation points of animal species are shown on existing vegetation maps, water system maps, etc. so that their relationships with habitats can be seen.

(2) Concept and major points to note for surveys of important species and noteworthy habitats of animals

Using the results of the survey of fauna and habitats, the degree of importance of the animal species, etc. in the survey area are determined from a scientific or scarcity point of view, and iimportant species and noteworthy habitats of the animals that have been confirmed in the project implementation area are identified for survey. Surveys of these animal species, etc. are made based on these findings. Examples of expected survey items are showed in Table III.1-12.

Useful study methods may include existing data-based examination and field surveys. Field surveys are conducted by using methods proper to clarify the conditions of important species

and noteworthy habitats of animals in the region, based on the arrangement of information from literature and other existing data.

Field surveys can sometimes find the species not listed in existing data, etc. or not recorded in distribution data in the region. If such species are identified, careful examinations should be made including interviews and identification work sought from local experts, etc. as necessary.

Major points to note in the surveys of important species and noteworthy habitats of animals are summarized in Table III.1-13.

Table III.1-12 Examples of survey items of important species and noteworthy habitats of animals

Subjects of survey	Examples of items for survey	
Important animal species	Distribution and life history	• Distribution (location of confirmation) in the survey area • Breeding conditions in the survey area • Sedentariness (seasonal migration) in the survey area
	Number and density of inhabitants	• Number and density of individuals
	Habitat	• Fundamental environment Climate, elevation, topography, geology, soil, water quality, and hydrological conditions • Vegetation as habitat Emerging communities • Other habitat conditions Conditions of impacts of artificial objects such as cultivated land and river levees
	Feeding habits	• Major food organisms (feeding spaces) • Distribution and density of major food organisms
	Spatial use of environment	• Range of activity and its internal structure • Migration paths, etc.
	Distribution of important resources	• Resources required for inhabitation and breeding
	Others	• Existence and location of potential inhabitable areas • Relationships between species
Noteworthy habitats	Distribution of habitats	• Habitat locations and distribution range
	Habitat structure	• Community composition
	Location environment	• Fundamental environment Climate, elevation, topography, geology, soil, water quality, and hydrological conditions • Other location environments Status of management
	Status of use by animals	• Status of use as breeding grounds, resting grounds, migration paths, etc. Species, populations, periods, and way of use
	Others	• Transition and updates of community • Existence and location of areas where communities can potentially be established

Table III.1-13 Major points to note in survey of important species and noteworthy habitats of animals

Points to note	Major points
Study of habitats	• For study the status of habitats, regional characteristics are investigated and arrangement on the changes in fundamental environmental elements are performed from meteorological phenomena, air quality, water quality, and topographical and geological features that were obtained from surveys of other environmental elements.In field surveys data on the meteorological conditions, such as air temperature and the degree of human impacts, such as water temperature, water depth, flow rate, flow speed, etc. as well as noise are collected. • In light of the persistence of habitats of important animal species, attention is paid to their relationships with other species and relationships between the habitats of important species and fundamental environmental elements. Particularly in land areas, detailed surveys are conducted on the hierarchical structure of vegetation, and animal species, etc. that use large-diameter trees, decayed/fallen trees, ground surface, and sediment as habitats, particularly as possible focusing on determination of fundamental environmental elements working as limiting factors on the inhabitation of important species. • It is desirable that locations such as confirmed inhabitation points are shown on existing vegetation maps, water system maps, etc. so that their relationships with habitats can be seen.
Reduction in impacts of surveys	• It is important for surveys on breeding to use methodsconsidering the behavioral characteristics of the animal species to be surveyed and strongly minimize the impacts on the breeding of the subject species by avoiding behaviors such as stepping on the survey area thoughtlessly.
Survey area	• A survey of important species and noteworthy habitats of animals focuses on the species, habitats, and surrounding areas related to their inhabitation (feeding locations, etc.). The survey should be conducted not only in the areas altered by the project, but also the surrounding areas, which should be surveyed with the same amount of effort as in the altered areas, while being careful to ensure that there is no bias in the amount of survey effort.

(3) Area and period of surveys of animals

A survey should cover a region required to evaluate the impacts of the relevant project based on the project and regional characteristics, including the areas where impacts of the project are likely to occur. The area affected by the implementation of a project is changed depending on impact factors, topography, season, and the animal species as target. For this reason, the survey area is not set as a range defined by a certain distance from the project implementation area, but is set in consideration of geomorphic units and range of activity of the animals, etc. The survey area is basically the same as the area where the existing vegetation is surveyed, but if the range of activity of an animal species subject to survey, such as raptors, is wider, the survey area is expanded as appropriate with reference to existing cases. In principle, the survey area is set within the scope of study of regional characteristics, but it is necessary to carefully perform flexible setting by, for example, limiting the area as appropriate depending on the results of the study of regional characteristics.

Here, it is desirable to assume the implementation of a follow-up survey and establish, as necessary, survey sites that can be used as control spots in the follow-up survey, in

communities adjacent to areas directly subject to alteration such as leftover forests in the project implementation area, inflow/outflow points in a water system in the project implementation area, etc.

The survey period should be one that allows seasonal changes in habitat conditions, etc. to be grasped appropriately and basically more than one year. If the following changes are expected in the life history of an animal subject to the survey, an appropriate survey time is set so that its inhabitation status can be comprehended appropriately.

- Migration as that of birds, ascending and descending rivers, migration of fish, and post-breeding dispersal included in a cycle of life history
- Specific morphology and behavior during breeding season
- Cessation of activities due to hibernation, etc.
- Shift in location according to the stage of growth such as transformation
- Appearance at a specific time (flight behavior of fireflies, egg-laying behavior of fish, etc. during spring tide)

If a new important animal species or noteworthy habitat is found by the survey, another survey is conducted for an appropriate period based on the ecological characteristics of the animal species, etc.

ii) Points to note for surveys of plants

(3) Points to note for surveys of flora and vegetation

Survey of flora and vegetation is conducted in view of the points to note shown in Table III.1-14. Important species and important communities of plants selected for the survey in the stage of selecting items subject to environmental impact assessment areincreased and reviewed as appropriate in accordance with the results of the survey.

Table III.1-14 (1) Major points to note for survey of flora and vegetation

Points to note	Subjects of survey	Major points
Identification of species	Flora	• In the basic survey of fauna, samples and photographs of individuals and traces of life are collected to ensure species identification, and the date of discovery, name of the place, name of the discoverer, and name of the identifier are recorded. If it is difficult to identify the species, an expert should be consulted to do so. • As for arranging the identification results, lists of names of species and Red Lists compiled by academic societies, administrative agencies, etc. may be used effectively, but it should be noted that these names may differ from their scientific names or Japanese names. • In cases where sample collection of species is restrained by laws, ordinances, etc. or where the number of inhabitants is so small that collection of samples is likely to have an impact on their inhabitation, care should be taken to, for example, limit the survey to taking photographs of individuals (communities) and recording the location of their habitats.
Collection of ecological data	Flora and vegetation	• For species and communities newly confirmed by the survey or for those short of collected ecological data at the stage of general survey on regional characteristics, ecological data are collected from literature and interviews with experts, etc.
Survey routes and survey sites	Flora	• Surveys of flora are conducted basically after setting appropriate survey routes and survey sites in advance based on field surveys. • Using topographical classification maps, existing vegetation maps, water system maps, etc. survey routes are set so as to cover fundamental environmental elements that are important as habitats. • It is necessary to set survey routes not only along paths that allow easy implementation of the survey and clear identification of positions on topographical maps, but also in a variety of special environments such as forest floors, river beds, ponds, wetlands, and cliffs so that species that are considered to have limited range of activity can be discovered. • Survey sites in water areas are set after grasping the environmental conditions in advance since the distributions of plants are affected easily by water depth and substrate.
	Vegetation	• Locations where phytosociological surveys are to be conducted are set in all communities that have been found in the light of physiognomic vegetation maps, etc. prepared based on aerial photographs taken prior to the field survey. The number of required survey sites is set according to the size, physiognomic type, etc. of each community so that the composition table prepared will have a sufficient number of locations to enable identification and classification of the communities. • In water areas, locations are set in light of aerial photographs and bottom sediment distribution maps prepared based on sound wave exploration, etc. so that the survey will cover all water depth zones and all types of bottom sediment expected to exist in the extent where

		communities are distributed. • In a transition zone, the constituent species gradually shift, making it difficult to comprehend its characteristics from vegetation maps, phytosocial vegetation surveys, etc. In such a case, an appropriate method capable of comprehending the characteristics, such as belt transect (belt-shaped area) survey, is selected. • The survey routes and survey sites should be compiled so as to carry out the survey safely.

Table III.1-14 (2) Major points to note for survey of flora and vegetation

Points to note	Subjects of survey	Major points
Linkage with animals and ecosystems	Flora	• Setting up a survey route focusing on fundamental environmental elements serves to summarize the survey results on flora according to environmental type categories of ecosystems and comprehend the community composition.
	Vegetation	• Differences in planar arrangement and vertical structure among communities are important for the estimation of different habitats of animals and environmental categorization of ecosystems. Therefore, good techniques should be adopted to obtain necessary data by, for example, determining the community structure from cross-sectional vegetation diagrams, etc., and the community height (forest stand height) from aerial photographs, etc. used for preparing existing vegetation maps, etc.
Survey time	Flora	• The survey of flora is basically conducted a sufficient number of times, centering on the time when plant growth is noticeable, considering that the time of appearance, flowering time suitable for identification, fruiting time, etc. differ among different species.
	Vegetation	• The survey of vegetation should include the measurement of the cover degree (dominance) and sociability of the constituent species, so it should be conducted at a time when the main constituent species of the community have fully developed leaves.
Others	Flora	• Though the appearance frequency and the cover degree of plant species can be roughly estimated based on existing data produced by phytosociological surveys, it is desirable to obtain rough estimates such as simply high or low by mutually comparing the results of flora surveys. • Great care should be taken not to allow the survey itself to cause disturbances in habitats (e.g., by rough treads).
	Vegetation	• For the estimation of potential natural vegetation, it is necessary to comprehend the characteristics of fundamental environments by carrying out a soil profile survey, soil auger survey, etc. in combination with the vegetation survey.

(2) Concept and major points to note for surveys of important species/communities of plants

Results of the flora and vegetation surveys are examined to determine the degree of importance of the plant species, etc. in the survey area from a scientific or scarcity point of view and surveys are performed focusing on those plant species that have been found in the project implementation area and decided to be included in the surveys. Examples of expected survey items are listed in Table III.1-15.

Useful study methods may include existing data-based examination and field surveys. Field surveys are conducted by using appropriate methods selected to clarify the inhabitation conditions and habitats of important species/communities of plants in the region on the basis of arrangement and analysis of information including literature and other existing data.

Field surveys can sometimes find species not listed in existing data or not included in distribution records in the region. If such species are found, careful examinations should be made including interviews and identification work sought from local experts, etc. as necessary. Major points to note for the surveys of important species/communities of plants are summarized in Table III.1-16.

Table III.1-15 Examples of survey items for important species/communities of plants

Subjects of survey	Examples of items for survey	
Important plant species	Distribution and life history	• Distribution (location of confirmation) in the survey area • Breeding conditions in the survey area
	Volume and number of plant inhabitants	• Number, cover degree, and density of individuals
	Habitats	• Fundamental environment Climate, elevation, topography, geology, soil, water quality, and hydrological conditions • Vegetation as habitats Emerging communities • Other habitat conditions Conditions of impacts of artificial objects such as cultivated land and river levees
	Others	• Existence and location of potential inhabitable areas • Relationships between species
Important communities	Distribution of communities	• Habitat locations and distribution range
	Phytosocial survey of communities	• Community composition
	Location environment	• Fundamental environment Climate, elevation, topography, geology, soil, water quality, and hydrological conditions • Other location environments Circumstances related to requirements for establishment such as presence/absence of human management
	Others	• Transition and updates of communities • Existence and location of areas where establishment of communities is potentially possible

Table III.1-16 Major points to note for surveys of important species/communities of plants

Points to note	Major points
Survey of population	• For perennial grasses undergoing clonal growth, the genetic dynamics and the possibility of survival of populations differ greatly depending on the composition and spatial location of genets and ramets* in the population to be surveyed, and special forecast techniques and environmental conservation measures may be required accordingly. Therefore, caution is needed during the survey.
Survey of habitats	• To study the status of habitats, data on fundamental environmental elements, including meteorological phenomena, air quality, water quality, and topographical and geological features, obtained from investigation of regional characteristics and surveys of other environmental elements, are collected and compiled. In field surveys, which are performed from the viewpoint of the persistence of important species/communities of plants, detailed study is conducted on the relationship between their growth conditions and fundamental environmental elements, particularly focusing on clarifying fundamental environmental elements acting as limiting factors on growth.
Survey area	• The survey of important species/communities of plants also covers the range related to the growth in habitats of the species and communities being surveyed and in surrounding areas. The survey should be conducted not only in the altered areas, but also the surrounding areas, which should be surveyed with the same amount of effort as in the altered areas, while being careful to ensure that there is no bias in the amount of study effort.
Survey time	• To comprehend the distributions of the plant species to be surveyed, and the characteristics of the ecology and growth environments of the plant species and communities, it is necessary to set appropriate survey times and frequency (flowering time, fruiting time, winter, etc.) separately in view of flora and vegetation characteristics.
Others	• To comprehend the distribution in a survey area of important species/communities of plants confirmed from existing data, surveys are performed at appropriate survey sites and times taking into the growth environment, life history, etc. of the plant species and communities being surveyed.

* A genet is a group of genetically identical ramets, and is an individual derived from a single seed. A group of individuals derived from the same clone is regarded as one individual even if they are physiologically or ecologically isolated from each other. A ramet is an individual living as physiological and ecological unit. Thus, though being a clone, a ramet can be regarded as an individual if grown independently.

(3) Area and period of surveys of plants

A survey should cover a region required to forecast and evaluate the impacts of the relevant project based on the project and regional characteristics, including the areas where impacts of the project are likely to occur. If a follow-up survey is planned, it may be appropriate in some cases to set a survey site that can be used in the follow-up survey in a place that is not directly affected such as a forest left in the project implementation area.

The survey period should be one that allows seasonal changes in growth status, etc. to be grasped appropriately. Basically, a survey period longer than one year is considered necessary, but if a new item, such as important plant species or community, that requires investigation

is found in the field survey, a new survey is set for a period starting at that time considering their ecological characteristics.

iii) Major points to note for survey of ecosystems

A survey of ecosystems focuses on the functions of ecosystems that cannot be sufficiently grasped by the surveys of the relationship between fundamental environments and species/communities of plants and animals or those of noteworthy species, etc.

(1) Survey focusing on the relationship between fundamental environments and the species/communities of plants and animals

Species/communities of plants and animals as well as ecosystems composed of them are maintained dynamically depending on the degree of changes in the fundamental environments, and it is important to comprehensively and broadly investigate the impacts of project implementation on the species/communities of plants and animals through a forecast of its impact on the fundamental environments involving the project. It is important to conduct surveys focusing on such relationships to obtain an overview of the ecosystem structure in the relevant area.

A survey of the relationship between fundamental environments and species/communities of plants and animals is carried out by arranging existing data and results of studying fundamental environmental elements, which include water environments, topography, geology, plants, animals, etc., and also arranging results of field surveys, performed as necessary, focusing on environmental type categories and species/communities of plants and animals.

Based on existing knowledge, etc., fundamental environments having clear relationships with species/communities of plants and animals, etc. are selected as subjects of the surveys (Table III.1-17).

High efficiency is ensured if data collection is performed in combination with surveys of other environmental elements. For example, it is effective to conduct fundamental environment surveys of animals in a river (such as survey of distribution of shallows and pools and materials constituting river beds) in combination with ecosystem surveys (Table III.1-18). In addition, study of the relationship between fundamental environments and the status of species/communities of plants and animals can be facilitated by arranging the changes from the past to the present. The environment type categories that represent the structure of an ecosystem are reviewed as necessary, and its relationships with plant and animal species, communities, etc. are compiled. Some quantitative analysis methods are available for more objective environmental type classification (see “1.2 Utilization of Technical Methods and Points to Note (Plants, Animals, and Ecosystems)”), and they should be used as necessary.

Table III.1-17 Major items for survey of relationship between fundamental environments and animal and plants species, etc.

Viewpoint	Survey items
Status of fundamental environments	Meteorological phenomena, topography, soil, geology, hydrological environment, conditions of spring water and underflow water, water temperature, salinity, water quality, etc.
Correspondence relationship between fundamental environments and plant and animal species, etc.	Animal species: general distribution characteristics, habitat characteristics, characteristics of space in use, use patterns of survey area, life history Plant species: characteristics of habitat location Communities: general distribution characteristics, characteristics of habitat location, sere, distribution status in the survey area
Interrelationships between plant and animal species, etc.	Animal species: size (weight, etc.) of individuals, population and density of individuals, life history, diet, trophic level, predators, parasites, etc. Plant species: communities to which it belongs, association with animals (pollination, seeding, eating), etc. Communities: Perception, sere, seral stage, hierarchical structure of communities, planar distribution, species composition, dominance, etc.

Table III.1-18 Major points to note for surveys focusing on the relationship between fundamental environment and species/communities of plants and animals, etc.

Points to note	Major points
Implementation of surveys in cooperation with other environmental elements	• Fundamental environmental elements necessary to comprehend impacts on ecosystem structure are examined in light of characteristics of the survey area and project. • The targets in survey should include major plant and animal species that are considered necessary for examining characteristics of the ecosystem in the survey area and changes in ecosystem caused by the project. • To comprehend fundamental environments, it is necessary to determine scales and classifications suitable for the purpose. For example, terrain classification may be performed at different levels, such as shape, origin, geographical history, and stability of terrain. Classification by shape (largely undulating mountains, lightly undulating mountains, etc) is suitable for comprehending regional features in a wide area. A classification method that reflects the stability of terrain (irregularities of slopes, etc.) is suitable for comprehending characteristics of habitats/growing places at the species level. • Care should be taken not to overlook environments that are small but important for comprehending ecosystems in the survey area (such as wetlands and limestone-surfaced rocky stretch) and the survey and data arrangement are performed on a scale suitable for examining such environments.
Arrangement of data on relationships with other environmental elements	• Life history of species/communities of plants and animals, etc. should be considered. For animals, for example, whether or not a site is a breeding ground is an important matter. When arranging data on relationships between fundamental environmental elements and life history of species/communities of plants and animals, etc., sufficient information is collected from collection and arrangement of existing materials and field surveys. • Survey of important fundamental environments should also be intended to obtain data necessary to forecast impacts of the project. • Diagrams showing relationships with fundamental environments and

	relationships between predation and prey (food webs) and maps showing compiled data on distributions facilitate the explanation of impact factors affecting plant and animal species. • Species/communities of plants and animals are always changing due to changes in fundamental environments and human impacts. To comprehend these relationships, relationships between temporal changes in species/communities of plants and animals, etc. and human impacts are studied, but since it is difficult to obtain data on long-term trends, etc. only from results of field surveys, the data from existing materials should be fully utilized. • If details of fundamental environments and distributions of species/communities of plants and animals, etc. are revealed in field survey, environmental type classification charts are reviewed based on the current status and revised as necessary.

(2) Survey of noteworthy species, etc.

In a survey of noteworthy species, etc., it is required to obtain data that allow the changes in fundamental environments caused by impact of the project and resulting changes in the noteworthy species to be forecast as quantitatively as possible.

Survey items are examined on the basis of impact elements, relationships with changes in fundamental impact elements and with the affected noteworthy species, etc., and impact flow charts prepared based on assumed transmission routes of impacts. For the survey of noteworthy species, etc., it is sometimes difficult to quantitatively comprehend the impacts from changes in fundamental environmental elements, but study is performed to examine which part of the impact flow should be investigated with priority in conjunction with study on survey methods, by fully utilizing the knowledge and results of case studies available at that time. Major points to note for survey of noteworthy species, etc. are shown in Table III.1-19.

Table III.1-19 Major points to note for survey of noteworthy species, etc.

Points to note	Major points
Comprehending of life history and ecology, and formulation of survey plans	• Noteworthy species, etc., tend to undergo changes in their preferred environments such as habitats and food organisms, etc. according to their life history and ecology, occasionally leading to establishing important places or depending on very small places in a certain period of life history. So survey sites, times, periods, frequency, etc. of surveys should be set in consideration of the life history and ecology of the noteworthy species, etc. and other species/communities of plants and animals, etc. which have strong relations with. • Some noteworthy species, etc. may require a long survey period because of unavailability of established survey methods, but a feasible survey plan should be formulated by fully utilizing data on the ecological characteristics of the noteworthy species, etc. to be surveyed and available knowledge related tothose.
Comprehending of habitats	• A habitat of a noteworthy species, etc., is comprehended as a spatial expanse of land instead of complex ecological aspects.
Necessity of experimental survey	• Experimental surveys are also conducted as necessary if knowledge is lacking. For migratory fishes, for example, findings from experiments of ascending behaviors and ability are occasionally helpful for forecasting

	impacts of changes in stream regime, effects of environmental conservation measures, etc.

(3) Survey of impacts on functions of ecosystems

To develop a survey of functions of ecosystems, data on the relevant environmental elements, such as water quality, sediment, plants, animals, etc, are compiled for each function and these environmental elements together with indicators of functions of these ecosystems themselves, such as matter production and water purification rate, are adopted as survey items. Impact flow charts (such as shown in Fig. III.1-8) may be helpful in examining survey items.

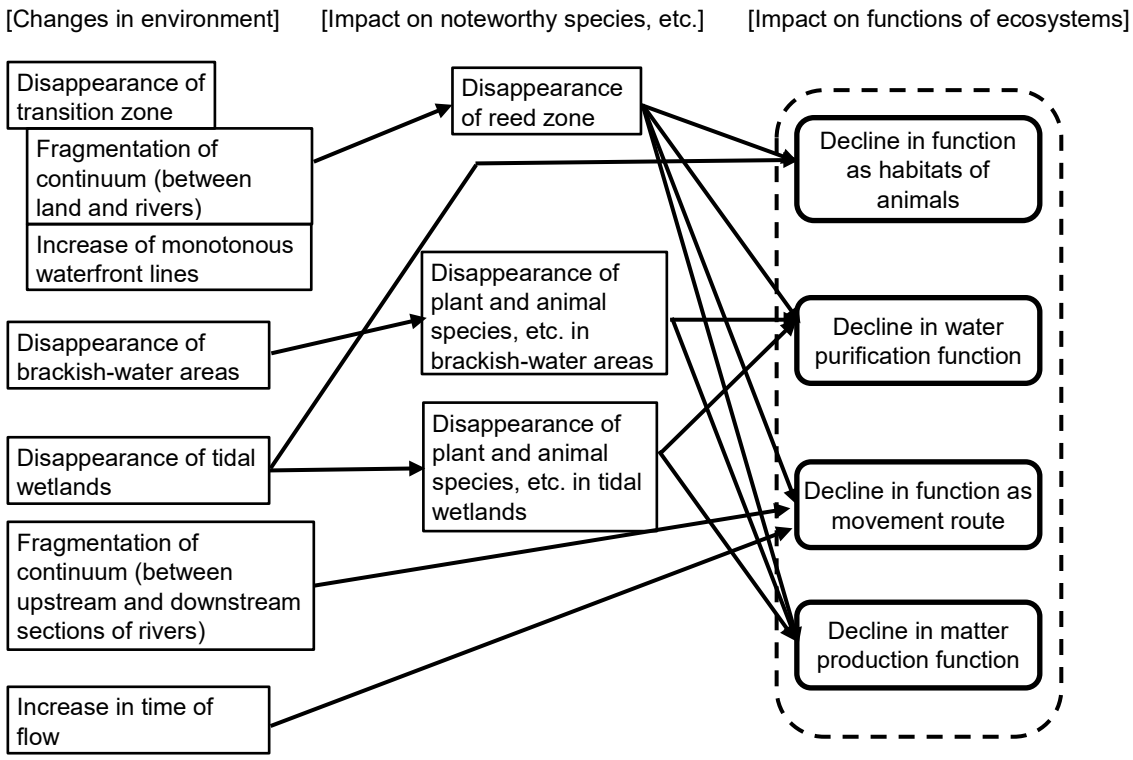


Fig. III.1-8 A typical flow chart of impacts on functions of ecosystems

It is often difficult to quantitatively examine and forecast all relationships shown in the impact flow chart.

In practice, therefore, only some of the functions of an ecosystem are forecast, in many cases, from calculations based on numerical models.

To permit such calculations based on numerical models, the establishment of appropriate regions, calculation conditions, parameters, etc. is examined, and a survey plan is established so that necessary data can be obtained appropriately. On the other hand, the functions of ecosystems that can be forecast by numerical models are currently limited to biological production, material circulation, water purification, etc., and many other functions have to

be examined and forecast by qualitative or example analysis-based methods. Even in this case, it is necessary to develop a survey plan in which the basis of the forecast results and the data used for the forecast are shown as quantitatively as possible.

For example, a noteworthy species having a water purification function, such as Japanese littleneck clam, may be adopted as an indicator of the function of the relevant ecosystem, so that the impact on the function is comprehended indirectly.

2) Arrangement of survey results and confirmation of validity

Since results of a survey will influence the degree of objectivity of subsequent forecast and evaluation, it is desirable to confirm their validity upon arranging the results. Table III.1-20 shows major confirmation items related to arrangement of survey results, their validity, etc. Essentially, it is necessary to thoroughly examine the survey methods in advance to ensure that the validity is not impaired, but if it becomes obvious that validity is impaired at that time, it is necessary to take such measures as complementing the survey results based on other analyses and advice from experts, etc., conducting an additional supplementary survey, and making forecasts designed to give more conservative results.

For analysis of the validity of survey results, widely disclosed general-purpose software may be available in some cases, and there are many programs that give some value (result) when entering a numerical value.

However, if not used properly, such analysis tools may give a forecast or evaluation based on wrong conditions. Therefore, it is necessary to avoid using them in a simplistic way and understand the preconditions for the use of such analysis tools, requirements for data, etc. Similarly, in some cases, a model of species distribution is constructed and used to estimate the present status of plants, animals, and ecosystems from survey results, but the construction of a highly accurate model requires examining the preconditions, obtaining a sufficient volume of data, and using an appropriate sampling method (survey sites, etc.). If these conditions cannot be met, it is better not to make uncertain estimates using an inaccurate model, but to confirm the actual distribution in a field survey. In recent years, as sophisticated devices such as GPS are available, field surveys can be performed at reduced costs and improved accuracy, thus permitting efficient implementation of field surveys.

Table III.1-20 Major confirmation items related to arrangement of survey results, their validity, etc.

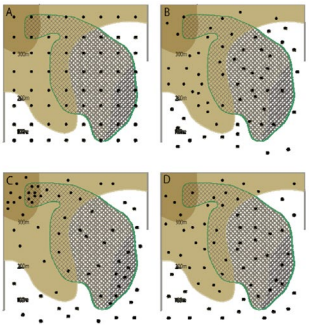
Confirmation items	Details of confirmation
Arrangement of survey results	• To ensure an appropriate grasp of the status of local ecosystems, study is performed to confirm whether there is a bias in the amount of survey efforts for various environment type categories.
	• Results of field surveys will be easy to understand if compiled together with ecological characteristics of plant and animal species, etc. It is desirable that the ecological characteristics in this case are compiled with an emphasis not only on fundamental data such as on life history, but also on information related to habitation and growth environments necessary for examining environmental conservation measures.
	• Considering the characteristics of the project and affected environmental elements, examination is made for the validity of physical and chemical methods for surveys on fundamental environments and survey results (e.g., positional relationship with the locations of water quality survey, etc.).
	• Particularly for ecosystems that undergo large fluctuations over a short period of time, such as ecosystems in land or sea areas, whether survey results obtained at a location are attributed to a specific situation existing there is examined considering the regional characteristics.
	• Based on survey results, the necessity of surveys over a wider area or over a longer period is examined, and findings are reflected in the survey methods as necessary.
	• The noteworthy species, etc. for ecosystem surveys (superiority, typicality, and specificity) is reconsidered as necessary based on the survey results, forecast methods, environmental conservation measures, etc. For specificity, in particular, careful examination is desired since priority is given to the avoidance of project impacts. Careful examination is also desirable for the selection of plant and animal species, etc. that are difficult to survey in light of current knowledge.
Validity of survey plan	• Maps containing project plans, vegetation, topography, geology, habitat, etc. overlaid on survey areas and survey sites are prepared to check, for example , whether the survey sites reflect the impacts of the project and the spread of the environment based on an assumed environmental type classification, while paying attention to the typical environment in each category.
	• When a single type of vegetation, such as planted cedar trees, is widely distributed to permit the assumption of the same type of environment, the revision of the environmental type classification and the validity of the arrangement of survey sites ae confirmed, paying attention to the possibility that differences in plant and animal species, etc. or the community composition arise due to other factors (e.g., difference in altitude).
	• Data on survey time of year and day are compiled for each survey subject and it is confirmed whether the survey is conducted at an appropriate time of year and time of day and whether the survey methods adopted are appropriate, for example, on account ofthe characteristics of the survey subject, such as important species and noteworthy habitat.
Validity of confirmed species	• Species confirmed in existing data on plants, animals, or ecosystems, or by field surveys are generally included in the list of confirmed species that represents the status of flora and fauna. The names of species adopted in this list should be conformed with those given in the list of general species names. If the name of a species found in an existing material, etc. is changed according to the conforming list of species

	names, this change should be recorded. This procedure is required, for example, when extraction of important species is mechanically performed, and in such cases, it is necessary to match the names of species in the Red List, etc. to the conforming list of species names.
	• It is advisable to confirm the distribution of these confirmed species by referring to existing data, picture books, etc. in the region. Advice obtained from local experts, etc. is also helpful to confirm the validity of their distributions.
Necessity of additional supplementary surveys	• Necessity of additional supplementary surveys is examined in considering of overview of survey results, and validity of survey plans, etc.

[Reference Information] Data bias and sampling methods

For environmental impact assessment, field surveys are conducted to, for example, confirm rare plant or animal species. Survey routes are generally set so that various environments in the survey area are covered to permit examination of the flora and fauna contained, and when rare plant and animal species are found, the environments in which they are likely to appear is investigated in detail. For such a survey method, however, techniques selected for examining the environment, setting the survey routes, etc. may depend on the experience of the researchers, and as a result, there is a possibility of adopting biased data. To correct such a bias in data, it may be effective, for example, to specify the amount of survey effort in terms of observation duration per area. In addition, good sampling methods (e.g., layout of survey sites) for field surveys may be devised to permit estimation of habitats of rare plant and animal species to be used for forecast. For example, it is important to obtain data indicating that a certain species is "absent" (not confirmed) in a certain place, and therefore, it is necessary to set up survey sites and recording methods in light of environmental type classification and distribution of environmental conditions in the survey area.

There are various approaches for determining good sampling methods. An appropriate number of survey sites and survey methods should be set up based on the spatial scale used by the survey subjects, accuracy of estimation, conditions for applied analysis methods and costs, etc. For example, Fig. III.1-9 shows layouts of survey sites selected by four different methods (64 locations in total for each method). Population data are required when viability analysis is performed using a population dynamics model, while only evidence for presence or absence of the relevant species in the habitat is required when using a patch occupancy model. Elaboration of a suitable sampling method for required estimation results will permit efficient survey implementation.



The diagrams show that in a forest (hatched area) covering a range of altitude in an assumed space, the sampled points differ among different sampling methods.
A: regular sampling
B: random sampling
C: equal-stratified sampling
D: proportional-stratified sampling
In each method, 64 points are sampled.

(Modified from study by Hirzel & Guisan [2002])

Fig. III.1-9 Layout of survey sites set up by various sampling methods

The volume of data should be as large as possible when constructing a model used for estimation of habitats, etc. However, since surveys of plants and animals reqire usually cost, it is necessary, in the case of environmental impact assessment, to determine the amount of survey effort required while ensuring a certain degree of accuracy. A survey should be conducted in light of the minimum required volume of data while referring to case studies of existing analysis methods. In such a case,

it is effective to refer to literature describing studies on the dependence of accuracy on the volume of data.

[References]

- Bookhout T. A. (Eds.) (1996) “Research and Management Techniques for Wildlife and Habitats, Fifth ed.”, The Wildlife Society, Bethesda (edited and translated by Masatsugu Suzuki (2001), Yaseidobutsu no Kenkyu to Kanri-Gijutu, Buneido Publishing)
- Manly, B. and Jorge A. Navarro Alberto (Eds.) (2015) “Introduction to Ecological Sampling”, CRC Press

1.1.3 Forecast

1) Concept of Forecast

Forecast is a method of estimating the changes in forecast targets due to major identified impact factors, and it is carried out by performing simulations and analyses based on existing materials and results of field surveys, as well as by estimating the extent of impact based on existing knowledge, interviews with experts, etc. and reference to preexisting similar cases, etc.

Forecast should be performed as objectively and quantitatively as possible. It is often difficult to conduct quantitative forecast on the changes of plant and animal species and their communities, etc. except in the case of disappearance, etc, of individuals or habitats due to direct alteration; however, forecast should be carried out as objectively as possible based on the physiological and ecological characteristics of plant and animal species and their communities, etc. and survey results as well. In some cases, quantitative forecast may be possible for the changes in fundamental environmental elements for plant and animal species and their communities, etc., such as topography, water quality, etc. However, care should be taken since the fluctuation range of nature may be larger than the changes caused by the effects of a project. For forecast, it is also necessary to fully understand the regional characteristics and refer to preexisting similar cases and existing knowledge.

With regard to forecast methods actually introduced, the reasons for the selection and the applicable conditions and scopes need to be clearly described.

If forecast results are uncertain, the details and degree of the uncertainty should be clarified to compare the follow-up survey results to the forecast results. If the impact is larger than forecasted, additional environmental conservation measures, etc. should be discussed.

i) Forecast items for plants and animals

Examples of forecast items for plants and animals are shown in table III.1-21. Forecast items include the direct alteration and disappearance of the growth environment of plants and animals, as well as the impacts of the emerging new environment on plants and animals, etc.

Table III.1-21 Examples of forecast items for plants and animals

Environmental element	Example of forecast items
Animals	• Extent of the alteration and disappearance of animal species inhabiting a project implementation area and the whole growth environment • Extent of the alteration and disappearance of important animal species and their noteworthy habitats • Changes in the growth environment around the area directly subject to alteration and the impacts of the changes on animal species • Impacts of an emerging new growth environment, such as planted area in an altered area, on animals • Impacts, etc. of in-service target projects on animals
Plants	• Extent of the alteration and disappearance of plant species and their communities inhabiting a project implementation area and the growth environment • Extent of the alteration and disappearance of important plant species (individuals and populations) and their communities • Changes in the growth environment around the area directly subject to alteration and the impacts of the changes on plant species and their communities • Impacts of the introduction of plants due to greening and planting on surrounding plant species and their communities • Impacts, etc. of in-service target projects on plants

Examples of forecast targets for plants and animals and the details of impacts are shown in table III.1-22. Forecast targets include the emergence, behaviors, and growth environment of individuals, forecasting how they are changed. Table III.1-23 shows major matters to be noted for forecasting the impact on plants and animals.

Table III.1-22 Examples of targets and impacts forecasted regarding plants and animals

Environmental element	Forecast target	Examples of forecasted impacts
Animals	Species, individuals or populations, behaviors	• Disappearance, shrinkage, changes in age structure, changes in populations and existing quantities • Escape • Impacts on acts, such as feeding, rest, and migration • Impacts on reproduction rate
	Growth environment	• Impacts on the range of activity • Impacts on feeding environment, dens, resting environment, and migration paths • Impacts on breeding environment • Impacts due to changes in fundamental environmental elements, such as topographic, geological, and soil environments, water quality, hydrological environment, hydrographic phenomena, and

		micrometeorological phenomena
Plants	Species, individuals or populations, communities	• Disappearance, damage, shrinkage and expansion, and changes in the composition and structure of communities • Changes in existing quantities and changes in vitality and health performance • Impacts of growth and breeding
	Growth environment	• Impacts due to changes in fundamental environmental elements, such as topographic, geological, and soil environments, water quality, hydrological environment, hydrographic phenomena, and micrometeorological phenomena

Table III.1-23 Major matters to be noted for forecasting plants and animals

Points to note	Major matters to be noted
Environmental changes	• There are some years that the volume of production of seeds and the reproduction rate are decreased according to weather conditions, and it means that environmental changes can have a significant impact on populations in some cases. In forecasting the change in populations, therefore, it is necessary that not only the impacts of implementing projects and taking environmental conservation measures, but also environmental changes should be taken into consideration.
Change in populations	• Note that there are some plants and animals whose populations largely fluctuate from year to year, such as zoo- and phytoplankton and insects.
Impacts of a newly created environment	• In addition to impacts caused by an environment that disappears or shrinks by projects, consideration should also be given to impacts from the invasion of alien species, etc. and an increase in the volume of urban organisms due to a newly created environment.
Temporal change in impacts	• Large impact can be seen during construction work, while the restoration of vegetation may help mitigate the impact after the construction work is completed; on the contrary, a larger impact may appear over time in some cases. The possibility of such temporal change in impacts should be taken into consideration.
Reference to preexisting similar cases and scientific knowledge	• It is important to refer to preexisting similar cases and scientific knowledge. However, in terms of impacts of target projects, there may be regional differences according to species or environmental conditions; thus, due consideration should be given to the background of the referred data.
Forecast of control spots	• In order for a follow-up survey to clarify the effect of environmental conservation measures, if control spots (areas assumed to be free from impacts, such as leftover forests) are established, the impact on the control spots needs to be forecasted to examine its appropriateness.

ii) Forecast methods regarding plants and animals

(1) Basic forecast methods

In forecasting the impacts of projects, in addition to direct impacts that include the disappearance of individuals, populations, or communities due to tree felling, etc., or the disappearance of growth environment due to topographic alteration, indirect impacts also need to be forecasted, i.e. the changes such as sunshine, humidity, air quality, the occurrence of noise and vibration, strong wind, water temperature, water quality, tidal current, the expansion of human activities may also affect the living and growth environment, leading to gradual change in the physiological condition, behaviors, and growth conditions of plant and animal species, etc. The overlay technique shown in the Reference Data below is frequently used today to forecast these impacts. For surveying the impacts on the fundamental

environmental elements supporting the living and growth of plants and animals, it will be helpful to use the forecast results of other environmental elements, including the water environment and the atmospheric environment, as well as the forecast methods and results shown in “2) Forecast methods regarding ecosystems” in this section. If there may be multiple impact factors, a comprehensive evaluation needs to be performed on the impacts on the forecast targets.

[Reference Data] Examples of forecast methods

The overlay technique is a basic and popular method used in an environmental impact assessment.

Specifically, various thematic maps (a distribution map of plant and animal species; an estimated map of existing quantity of communities; a location classification map; an estimated map of resources that include habitats, the range of activity, and food organisms, etc.; a habitat density map, etc. and so on) are created and overlaid with the project plan map to make a quantitative estimate of disappearancesin population and a decline habitats due to direct alteration. If there are multiple project plans, each of them is overlaid with the thematic maps to make a comparative review of the project drafts (a scenario analysis). This technique is useful in forecasting the impacts of direct alteration on plant and animal species, etc. and their habitats.

It is difficult for this technique to make a quantitative forecast of the following factors: impacts, etc. of project-caused gradual changes in the fundamental environment (sunshine, humidity, strong wind, etc.) on the remaining individuals, populations, and growth environment after the construction work begins; competition that occurs after the invasion of other plant and animal species; impacts due to isolation or segmentation of the remaining populations; a relative increase of the browsing pressure due to a decline in distribution area; and impacts on animal behaviors, such as migration, while this technique is helpful in making a qualitative forecast.

In addition, if project-affected populations are important in the survival of the populations in the whole area, population viability analysis (PVA) and other methods may be employed to forecast the viability of populations. If the isolation of populations is likely to eliminate gene flow among other populations and reduce the fitness of local populations, it may be important to incorporate the technique of genetic analysis into the forecast. In this way, it is favorable to introduce new academic knowledge and technical methods, not limited to conventional techniques (See “1.2 Utilization of Technical Methods and Points to Note [Plants, Animals, and Ecosystems]”).

(2) Setup of forecast areas

Basically, forecast areas are set in consideration of the area to which projects afford the impacts and the distribution of targets that receive the impacts, etc. Considering the home range of animal species subject to the forecast, the forecast areas should be expanded or shrunk as necessary based on existing cases. For example, if there is an area that has been judged unnecessary to be a target of the forecast on the grounds of the previous survey results, forecast areas may need to be narrowed down, instead of survey areas.

Basically, with regard to direct impacts of project implementation, the project implementation area, including the area involving direct alteration, is prioritized in forecast; for indirect impacts, the area that includes the survey area estimated to be affected by the

impacts is forecasted. Note that since animals generally migrate, impacts may not be limited to the area to be altered.

(3) Setup of forecast timing

Forecast is basically performed when the impact of a project on the environment reaches its peak, while taking into consideration the project characteristics as well as the regional characteristics regarding noteworthy habitats that include important species and communities. For example, if noise generated during the construction work is an impact factor to the breeding of certain animals, the time of greatest impact is when the loudest noise is generated or noise is produced to the widest extent. If indirect impacts are likely to gradually spread in a wider area than the area to be altered under the construction work after the existence and use of facilities, the time of greatest impact of the project implementation is when the environmental changes become stable after a certain period of time from the existence and use of the facilities. In the case where a project takes a long time, the forecast timing should be set based on an assumption that all impacts are happening simultaneously.

2) Forecast methods regarding ecosystems

An ecosystem is built on material circulation and energy flow, with each relating interaction like as stream regime, water quality, and bottom sediments in a river. For this reason, potential impacts of project implementation need to be forecasted in a comprehensive manner based on the forecast results of individual environmental elements.

Impacts on ecosystems may emerge after a long period of time from the existence and use of facilities; thus, it is important to perform forecast in considering temporal change. For example, it is needt to consider not only to the impacts caused by an environment that disappears or shrinks by projects, but also the impacts caused by the change in the sediment dynamics in rivers and coasts, the invasion of alien species and urban organisms into a newly created environment, and an increase in the number of specific wild birds and animals, etc. that affect the vegetation.

In recording forecast results, figures and tables should be attached for clear explanation. In addition, the results should contain explanations about the preconditions for the forecast, the grounds for parameter setting, the process of forecast calculation, the accuracy of data and forecast models, and the extent of uncertainty about the results, and so on. The following also should be noted when performing forecast.

- When using a forecast model, for example, the gap between the hydrological values calculated by the model and the actual habitats should also be taken into consideration, including the fact that the estimated river flow rate indicates the flow rate of the center line of the stream, while the flow rate around the river is more important to certain plants and animals.

- In some cases, experimental techniques may be effective as a forecast method, such as measurement experiment of a change in the basic production rate due to a change in the environmental conditions and measurement experiment of behavioral changes of plants and animals (reaction to aversive substances, etc.). Feasible experimental techniques should also be discussed, as necessary.

i) Forecast using numerical models

(1) Utilization of numerical models

The major advantage of numerical model-based forecast is that spatial and temporal changes in environmental elements, including plant and animal species and their communities, etc. can be estimated and forecasted in a quantitative manner. To date, this is the only technique that can quantitatively and promptly indicate the extent to which environmental elements that need to be forecasted may change when the impacts of a project are added.

The recent rapid evolution of computers helps achieve faster caluculating speed and lower cost, making them more accessible to numerical model-based quantitative forecast. For example, this is useful in considering that the project's impact could be reduced by how to change the location and shape of the landfill or the shape and direction of a chimney or sewage outlet.

Another advantage of numerical modelsis the function as analysis tools. For example, a sensitivity analysis is performed using a material circulation model incorporating certain plants (an ecosystem model) to find the environmental elements that most affect the growth of the plant and forecast the potential impacts of a project on these environmental elements, allowing us to make an indirect forecast of impacts on the growth of the plant. Numerical models can also be used to analyze how the impacts spread and how large the impacts are.

Today, these models are applied to analyze changes in the fundamental environment, such as air quality (pollutants, etc.) in land area and water quality (SS, BOD, COD, nitrogen, phosphorus, DO, etc.), water temperature, waves, flows, shoreline configuration, and river configuration in sea and interior drainage areas. A material circulation model (an ecosystem model) containing certain plants and animals is also used in sea and lake areas. There are numerical models for the dynamics of populations of individual plant and animal species, while there are few cases used in an environmental impact assessment.

The suitable habitat model is a technique of estimating the distribution of growth environment for noteworthy species, etc. based on fundamental environment-related information, which is used as a technique to make a quantitative measurement of impacts. Calculation results of numerical models for fundamental environment can also be used to comprehend changes in the distribution of growth environment.

Such forecast results from the models serve as information on the growth environment for plants and animals and are important in forecasting ecosystems. However, numerical models simplify and illustrate a part of complex natural phenomena, but do not perfectly reproduce

the actual natural phenomena, meaning that they should be used with attention to the maters in the following section.

(2) Points to note in forecast using numerical models

What is most important in performing numerical model-based forecast is to fully understand the objectivity and validity of forecast results when employing the models. Forecast using numerical models is intended to be performed based on specific preconditions. If the program contents, the preconditions for calculation, or input conditions are changed, the results will consequently be changed, requiring attention when using the models.

Also, forecast using numerical models often indicates the average or typical status for a certain period, instead of an ever-changing actual environment. For this reason, if there is a possibility of short-term environmental changes having significant relevance to the growth of plants and animals, it is necessary to separately examine potential impacts of the changes on the forecast results and also consider the width of environmental changes for the average status of forecast results. There is also a need to consider how to evaluate the difference between the average status calculated by numerical models and the actual status of habitats, and the validity of the calculation results as well. If forecast results are quite different from the actual situation, or if the forecast shows unusual results in terms of existing knowledge, the calculation conditions should be examined to identify causes and make an improvement.

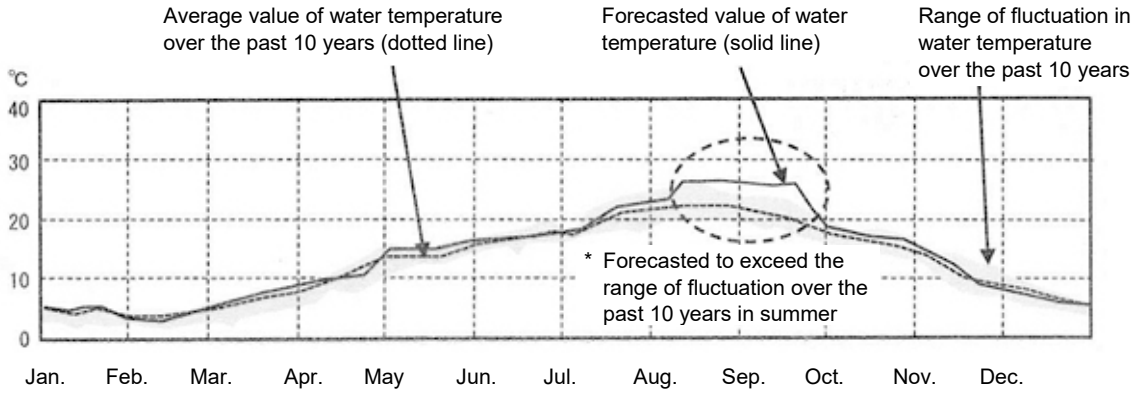


Fig. III.1-10 Case forecasted by comparing the calculation results of water temperature using numerical models to the actual fluctuation range (for illustrative purposes)

Note: The part colored in green shows the maximum and minimum water temperature values in the past. The blue and pink lines indicate water temperatures in a given year calculated using a model. The blue line shows no impacts of the project (within the fluctuation range), while the pink line means there are impacts.

[Reference Data] Verification of the validity of numerical model-based forecast results

In some cases, the estimates of a certain numerical model conveniently fit into the actual observation data. This may be because an adequate model was successfully built; but there is also

a possibility of "overfitting" that conveniently fits only into the data used in building the model. In order to verify whether the model is adequate and versatile, it is preferable to perform a cross-validation and also check the reproducibility by using a dataset not used in building the model.

If a model for forecast is built, a sensitivity analysis is carried out to evaluate the degree of impact for an explanatory variable based on the fluctuation range of results found by fluctuating a certain explanatory variable, etc. If the explanatory variable to be mainly used (changed) can be identified, for example, it becomes possible to clarify the environmental conservation measure that is most likely to change the forecast results by manipulating the measure.

[References]

- Provost, F., and Fawcett, T. (Translation supervised by Masakazu Takeda [2014]). "Introduction to Strategic Data Science," O'Reilly Japan

ii) Forecast techniques

(1) Forecast of impacts with a focus on the relationship between fundamental environment and plant and animal species and their communities, etc.

Forecast of ecosystems is performed by forecasting potential impacts of a project on the fundamental environment and also comprehensively and widely understanding changes in plant and animal species and their communities, etc. that may be affected by the impacts, and changes in other reciprocal relationships. Direct impacts are forecasted based on the project plan drawings and the degree of alteration of the environmental type categories to be altered. With regard to indirect impacts, possible changes of the habitats of plant and animal species and their communities, etc. are estimated with reference to preexisting similar cases and existing knowledge. It should also be considered that the fundamental environment and the vegetation change over time affect the habitats of plant and animal species and their communities, etc. If a new water area or green space is created when implementing a project, plant and animal species, etc. that emerge in the new environment are estimated with reference to the characteristics of the fundamental environment, the constituent species of plant and animal species and their communities, etc. inhabiting near areas with similar characteristics, and their ecology as well.

[Perspectives on examining potential impacts on plant and animal species and their communities, etc.]

- Changes in the environmental type category due to changes of environmental elements, and changes in the area ratio of the environmental type categories in the forecast area
- Changes in plant and animal species and their communities, etc. due to changed water environment

- Changes in the mutual relationship of environmental elements and the existence situation of the growth space
- Changes in the mutual relationship of plant and animal species, etc., such as food webs
- Changes in the range of activity and distribution areas of major plant and animal species and their communities, etc., and the status of use of the water area in life history (in particular, changes in breeding environment), etc.

(2) Forecast regarding noteworthy species, etc.

Forecast of project impacts on noteworthy species, etc. is performed by forecasting changes in the noteworthy species, etc. due to the project impacts.

Specific forecast procedures are as follows:

(a) Mainly, the impacts on the fundamental environment which are important for the growth of noteworthy species, etc.and living/growth place, and its impacts on the living/growth itself of the noteworthy species, etc. are forcasted, based on preexisting similar cases, existing knowledge, and field surveys

(b) It is also forecasted how changes in noteworthy species, etc. are related to other plants and animals and how the impacts spread. It is also necessary to examine the possibility and extent of the impacts of changes in the relationships among different species due to project implementation (increasing number of predators, suppression of native species by alien species, changes in food organisms, etc.) on noteworthy species, etc. In such cases, consideration should be given to the fact that the physiological and ecological characteristics of noteworthy species, etc. and the status of use of their habitats vary depending on area. If changes in noteworthy species, etc. have a significant impact on other plant and animal species, the impact also needs to be forecasted and evaluated.

(c) Based on the forecast results above, impacts of project implementation on the ecosystem are forecasted by understanding changes in the structure and functions of ecosystem where noteworthy species, etc. serve as indicators.

In some cases, experimental techniques and detailed field surveys may be useful in understanding the relationship between the physiology and ecology of noteworthy species, etc. and environmental elements, such as the relationship between basic production and turbid water in sea areas and the relationship between salinity change and the growth environment of plants and animals. Therefore, it is preferable to quantify forecast and make a model of forecast techniques based on the most accurate information, in combination with such techniques, etc.

[Perspectives to forecast the changes of the structure and functions of ecosystem due to noteworthy species, etc.]

- Changes of plant and animal species and their communities, etc. having the same trophic level, life history and life form as those of noteworthy species, etc.
- Changes in plant and animal species and their communities, etc. having a reciprocal relationship with noteworthy species, etc. (predation, prey, symbiosis, parasitism, competition, habitat segregation, etc.), and changes in plant and animal species, etc. whose growth space is similar to noteworthy species, etc.
- Changes of ecosystem functions related to noteworthy species, etc., and changes of plant and animal species and their communities, etc. related to the functions, etc.

(3) Forecast regarding ecosystem functions

Ecosystem functions involve various environmental elements and plant and animal species, etc. in a complicated manner, and there is no established forecast technique to examine many functional changes.

Those that can be forecasted in a relatively quantitative manner include basic production, material circulation, and breakwater function by coral reefs and other plants and animals in sea areas. In these cases, several numerical models are employed, and appropriate models can be selected and utilized to meet the survey's needs. For interior drainage area's brackish water adjacent to a sea area, or lakes and dam lakes that are regarded as water mass, such numerical models are helpful. In some instances, forecast can be performed with reference to simple calculations and preexisting cases. Also, actual measurement may provide necessary knowledge, such as capturing pollutants discharged by plants and animals and their deposition-promoting function in seaweed beds. Other functions are forecasted using feasible methods.

The functions of ecosystems that cannot be forecasted in a quantitative manner using numerical models are forecasted using qualitative or example analysis methods. In this case, the forecast should be carried out based on the forecast results of the fundamental environment and plant and animal species and their communities, etc. related to ecosystem functions, as well as the forecast results of other environmental elements, etc. Even in this case, it is important that the changes of fundamental environment serving as the grounds for the forecast results are shown as quantitatively as possible.

[Reference Data] About ecosystem services

The ecosystem functions are partially seen as ecosystem services (Fig. III.1-11) from a standpoint of the relationship with human well-being, and attempts are made to quantify them.

Recent foreign development projects have established methods and criteria that evaluate the absorption greenhouse gases generated by projects and the services of biodiversity conservation, etc. The Climate, Community and Biodiversity (CCB) Standards are one of these criteria that are used in designing projects and evaluating the environmental and social considerations of projects

Classification of ecosystem services (excerpt)

Supply service	Classification
Food	Grain
	Livestock
	Capture fisheries
	Wild foods
Fibers	Wood and other wood fibers
	Other fibers (cotton, linen, silk, etc.)
Biomass fuel	
Freshwater	
Genetic resources	
Biochemical materials, natural medicine, pharmaceuticals	

Adjustment service	Classification
Air quality adjustment	
Climate adjustment	Global
	Extensive, local
Water adjustment	
Soil erosion adjustment	
Water purification and waste disposal	
Disease prevention	
Control of pests and weeds	
Pollination	
Protection from natural disasters	

Cultural service
Recreation and ecotourism
Ethical values

Fundamental service
Nutrient salt cycle
Primary production
Water cycle

Source: Ministry of the Environment (2009)

Fig. III.1-11 Classification of ecosystem services (excerpt)

1.1.4 Environmental conservation measures

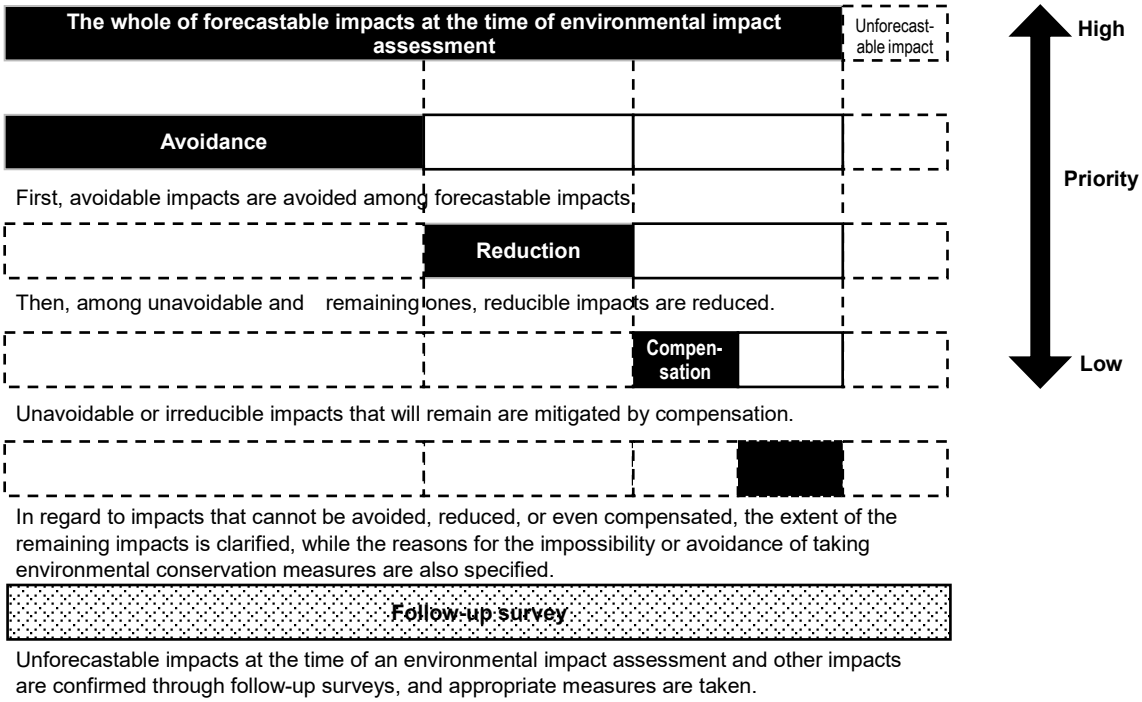
1) Examining the policy of environmental conservation measures

In examining the policy of environmental conservation measures, it is important to show clearly the points of view on environmental conservation measures by taking into due consideration the project characteristics, the regional characteristics, and the opinions made in process of the document on primary environmental impact consideration, etc. In such cases, targets of the environmental conservation measures are determined in regard to the important species, communities, noteworthy habitats, and noteworthy species, etc. that are likely to be affected by the project. Then, the concepts of environmental conservation in avoiding or reducing the impact or taking compensatory measures are arranged according to the importance and characteristics of each environment.

i) Concept of the policy of environmental conservation measures

In regard to environmental conservation measures, the situation of examining the avoidance and reduction of impacts on the important species and habitats that were made during the development of the project plan is compiled first. On this basis, matters that can further avoid the impacts and their details are examined with reference to the results of forecast and evaluation based on the project plan. If the impacts cannot be avoided, the reason thereof and

other remaining impacts are compiled. On this basis, environmental conservation measures for reducing the unavoidable impacts and compensation measures are examined further.



Source: Japan Wildlife Research Center (2002b)

Fig. III.1-12 Relationship among the priority of environmental conservation measures, remaining impacts, and follow-up surveys

ii) Targets of environmental conservation measures

Targets of environmental conservation measures are determined based on the results of evaluation for forecast targets that include important species, important communities, noteworthy habitats, noteworthy species, etc., and ecosystem functions, etc. In determining the targets of environmental conservation measures, due consideration should also be given to the spatial and temporal extent where the environmental conservation measures are taken. If it is judged unnecessary to take environmental conservation measures, the reasons thereof are compiled as objectively as possible based on the forecast results.

The following matters should be taken into account when determining important plant and animal species, etc. subject to environmental conservation measures.

- Lists of major conservation targets in regional biodiversity strategies and regional environment management plans of the national government and local governments, if any, are referred to. However, since the targets of environmental conservation measures include species, etc. featuring a strong local aspect, due consideration should be given if there are regional plans, etc.

- Among the important plant and animal species, etc., noteworthy species, etc. and ecosystem functions that are subject to forecast,some are decided to be inappropriate as the target of environmental conservation measures by the result of survey concludes that they already disappeared or their importance is low today. This fact is clearly described to exclude them from the targets of the environmental conservation measures.
- If it is desirable to collectively conserve communities, groups of plants and animals, or habitats where certain species are constituent species rather than other specific species, the communities, groups of plants and animals, or habitats are subject to the environmental conservation measures.

2) Contents of environmental conservation measures

At the stage of project planning, multiple drafts of environmental conservation measures are examined; then, measures that are thought to be most suitable for avoiding, reducing, or compensating impacts are employed in view of the effects of individual environmental conservation measures and their environmental impacts. Examples of environmental conservation measures for each stage of a project are shown in Table III.1-24, and major points to note in examining environmental conservation measures in Table III.1-25.

For some habitats of rare plant and animal species or specific ecosystems, etc., there are no effective environmental conservation measures, the uncertainty of the effect is high, or environmental conservation measures may even become new impact factors. Thus, it is important to sufficiently examine such potential problems.

Table III.1-24 Examples of environmental conservation measures

Environmental elements	Project stage	Environmental conservation measures
Animals	Before construction work	• Avoid direct alteration to noteworthy habitats, or reduce alteration area within the distribution area to mitigate impacts. • Introduce construction methods and types designed to control the alteration volume. • Adopt construction period and methods that take into consideration the breeding season and breeding sites of important animal species. • Ensure the migration paths of animals by conserving forests with a certain area or maintaining the continuity with the surrounding forests. • Move to areas suitable for habitats that are not to be altered. • Secure alternative sites, such as noteworthy habitats.
	During construction work	• Mitigate impacts on vegetation within the marginal zone in altered areas and unaltered areas. • Restore habitats through vegetation restoration, greening, etc. • Mitigate impacts of construction-caused water pollution on plants and animals in water areas (advanced treatment of discharged water, reduction in use of pesticides and fertilizers, etc.). • Eliminate impacts of improper management of construction sites on animals, such as littering and unnecessary lighting. • Educate construction workers about local natural environment and matters to be considered before construction work starts.
	Existence and use of facilities, etc.	• Control road drainage, exhaust gas, facility drainage, etc. • Create and manage an environment serving as an alternative habitat or breeding site and transplant, etc. important animal species. • If the business operator and the facility operator, etc. are different, before use starts, educate the facility operator, etc. about the local natural environment and matters to be considered, and appropriately hand over the operation to them. • Educate the facility users about the local natural environment and matters to be considered. • Ensure flow fluctuation and sediment movement that take natural disturbance into consideration. • Exterminate alien species and manage populations of vermin.
Plants	Study stage of project planning	• Avoid direct alteration to the distribution area of important plant species and important communities, or reduce the area to be altered within the distribution area to mitigate the impacts. • Introduce construction methods and types designed to control the alteration volume. • Preserve a block of forests to ensure continuity with surrounding forests. • Develop a planting and greening plan that takes existing vegetation, potential natural vegetation, etc. into consideration. • Educate construction workers about the local natural environment and matters to be considered before construction work starts.
	During construction work	• Avoid using the distribution area of important plant species and important communities as construction sites. • Transplant to a suitable growth site that is not altered. • Prevent the occurrence or spread of turbid water that has impacts on aquatic plants. • Reduce impacts on communities through restoration and greening of forest-edge vegetation within the marginal zone of altered areas and unaltered areas.

Environmental elements	Project stage	Environmental conservation measures
		• Utilize large-diameter trees distributed around altered areas for greening. • Preserve the topsoil in altered areas and use it as soil dressing for greening around the areas. • Educate construction workers about the local natural environment and matters to be considered before construction work starts.
	Existence and use of facilities, etc.	• Restore vegetation through greening, etc. at construction sites after the construction work completes. • Control impact factors, such as road drainage, exhaust gas, facility drainage, etc. • Transplant important plant species and important communities and manage their habitats. • If the business operator and the facility operator, etc. are different, before use starts, educate the facility operator, etc. about local natural environment and matters to be considered and appropriately hand over the operation to them. • Educate the facility users about the local natural environment and matters to be considered. • Ensure flow fluctuation and sediment movement that take natural disturbance into consideration. • Exterminate alien species.
Ecosystems		• Basically, the same measures for plants and animals need to be taken. Compensatory measures, which focus on the functions and area of ecosystems to be altered, are examined as well.

Note: In indicating the migration of plants and animals in a collective manner, the term “transplant (transplantation)” is used for all the expressions regarding migration.

Table III.1-25 (1) Major points to note in examining environmental conservation measures

Points to note	Environmental elements	Matters to be noted
Reduction in impacts on surrounding area	Animals Plants Ecosystems	• In regard to the habitats or communities of plant species and the habitats and ecosystems of insects and other animal species with low migration capacity, it is necessary to control impacts on the surrounding area where they remain. Examples include measures taken before construction work to grow and protect the mantle or fringe community around forest-edge areas generated by deforestation, and measures taken to prevent the outflow of sediment and turbid water to the communities or habitats where they remain.
Consideration given to the period when the effect starts to be noticeable	Animals Plants Ecosystems	• Some environmental conservation measures may take a certain period of time to produce the desired effect, similar to planting. The timing of selecting and starting environmental conservation measures, etc. is considered based on the ecology of conservation targets.

Points to note	Environmental elements	Matters to be noted
Maintenance of growth environment	Animals Plants	• Environmental conditions necessary for the growth of individuals and populations are clarified, and measures to maintain the growth environment are examined. • In addition to physical and chemical environments, the growth of dispersing insects (pollinators) or animals serving as seed dispersers may be needed in some cases. • In developing a planting plan as migration paths and habitats for animals, the plan needs to be developed with consideration given to planting density and hierarchical structure, so that the plan can fulfill the function. • Ensure disturbance necessary to maintain growth environment in view of natural fluctuations.
Consideration given to impacts of planting and greening	Plants Ecosystems	• In order to prevent plant species used for planting and greening from having impacts on plant individuals and populations in the project implementation area or its surrounding areas, techniques of, and materials, etc. used for, environmental conservation measures are fully examined with attention to an increase in the number of alien species and attraction of deer and other animals. It is important to use local materials because using materials from different areas may cause genetic disturbance and have impacts on native populations, even if greening is conducted using local species.
Consideration given to meta populations*	Animals	• For conservation of populations, it is important to prevent complete isolation of populations due to alteration and maintain the reciprocal relationship among individual habitats. Examination is needed based on the spatial structure of surrounding populations, such as whether there are local populations within the range where they can migrate and disperse.
	Plants	• In order for plant populations to survive, new local populations may be needed through dispersal of individuals to a new habitat where the species have not prevailed. In this case, both existing populations and a new habitat where they can disperse are needed.
Transplantation	Animals Plants	• In transplanting individuals, populations, or communities, the following uncertainties should be taken into consideration. (1) Adequacy of the environment to which species are transplanted: Evaluation is needed to identify whether that species to be transplanted can be fully used and become sedentary. (2) Possibility of migration or dispersal from the area to which species are transplanted: With consideration for the linkage with the environment around the area to which species are transplanted, whether the migration and dispersal of target species are ensured to be maintained as sound populations is examined. (3) Possibility of environmental disturbance of the area to which species are transplanted: It needs to be examined whether the growth environment of the area to which species are transplanted, or populations including such species or competing species, are adversely affected by density effect, genetic disturbance, changes in relationships among different species, propagation of pathogens and parasites, unintentional introduction of alien species, and other factors. (4) Establishment of a post-transplantation maintenance management and follow-up survey system: The maintenance management necessary for the period between transplantation and sedentariness, as well as the success of transplantation, are confirmed to establish a system capable of addressing unforeseen circumstances.

* If multiple local populations interact with one another in the form of transportation of genes and individuals, the group is called meta populations. In other words, the extent to which pollens and seeds are mutually dispersed for genetic interaction can be called meta populations.

Table III.1-25 (2) Major points to note in examining environmental conservation measures

Points to note	Environmental elements	Matters to be noted
Facilitation of smooth escape	Animals	• Especially, a construction plan needs to be developed so as to encourage animal species with low migration capacity to smoothly escape from the altered area, as well as to allow them to escape to remaining habitats by dividing construction zones. Consideration should also be given to the construction period, i.e., the construction period also needs to be coordinated so that trees are not felled during the breeding season of tree-nesting mammals (Japanese squirrel, etc.) and birds, and that water areas are not landfilled during the breeding season of amphibians.
Installation of nest boxes, etc.	Animals	• Nest boxes and other structures helping birds build nests are often installed as part of environmental conservation measures for bats and birds; however, these environmental conservation measures are never effective unless these nest boxes and structures are sufficiently managed after installation. The number of species in which installation of nesting sites is effective is limited; in this case, measures against predators and management, etc. of the structures are necessary after installation. If nest boxes become unnecessary after nesting trees are restored, the manager is responsible for removing the boxes, not leaving them.

[Reference Data] Concept of compensatory measures

(1) Difficulty of compensatory measures

When compensatory measures regarding plants and animals, or ecosystems, are taken, it is needed that examination is fully taken in considering the technical difficulties. It is extremely difficult to artificially create an ecosystem whose values and functions are equivalent to those in a well-balanced ecosystem or a long-established ecosystem.

There are many cases in which individuals of rare plant and animal species are transplanted as compensatory measures. However, since some species have a low sedentariness rate, consideration should be given to the possibility of disturbance to the area to which the species are transplanted, requiring a certain amount of effort and cost for maintenance management after transplantation. For this reason, it is needed that examination is fully taken in considering the uncertainty of the effect of compensatory measures and the time required to confirm the effect of the compensatory measures (the time gap between disappearance and compensation), and the uncertainty of the criteria to judge the effect of the measures. While taking technical difficulties into account, it is also need to be fully examined about the type of environmental elements to be created, their contents, the time required to achieve the goals, and the management system.

In examining environmental elements created through compensatory measures, it also is necessary to comprehend potential environmental impacts caused by the measures, with consideration for the current environmental conditions at the site where the measures are taken. When compensatory measures are taken, consideration should be given to the fact that in many cases the effect of the measures greatly varies depending on the type of environmental elements to be created and the site where measures are taken, or there is also possibility that the forecasted effect may not be obtained even though they are fully examined.

(2) Examination of the effect of compensation measures

As for compensation measures, it is preferable to create an environment similar to the one to be disappeared near the place where impacts occur. If compensatory measures are taken outside a project implementation area, it is necessary to consider the most effective method and place, etc. after full examination of the each value of the environment to be disappeared by the project, the one to be created by compensatory measures, and the one to be disappeared by the measures, respectively. Even if the certainty of the effect of compensatory measures is thought to be high, it is important to have a concept of accommodative management: continuously comprehending the changes in the environment and flora and fauna, providing additional measures and management according to the changing situation, and promoting the gradual creation of an ecosystem that is an objective.

If compensatory measures are taken outside a project implementation area, the contents of compensatory measures to be taken must be fully consistent with environmental preservation measures (basic environmental plans, environmental consideration guidelines, etc.,) stipulated outside the area where the measures are scheduled to be taken and other project plans, at the stage of examining the policy of environmental conservation measures.

(3) Avoidance/reduction and the presentation of compensatory measures

In order to obtain local support f, it is important that a business operator clarify his environmental elements, forecast targets, and the concept of environmental conservation and present avoidance/reduction and compensatory measures in distinction from each as much as possible, while taking into consideration the relationship between impact factors and environmental elements. For example, all environmental conservation measures in a project can be seen as reduction on a region-wide level; if there are important plant and animal species, etc. in the region, this means that impacts on them are avoided. For compensatory measures, it is important thatflexible examination is considered not only on creating a new habitat in the region, but also on providing alternatives by reducing environmental burdens in the region, etc.

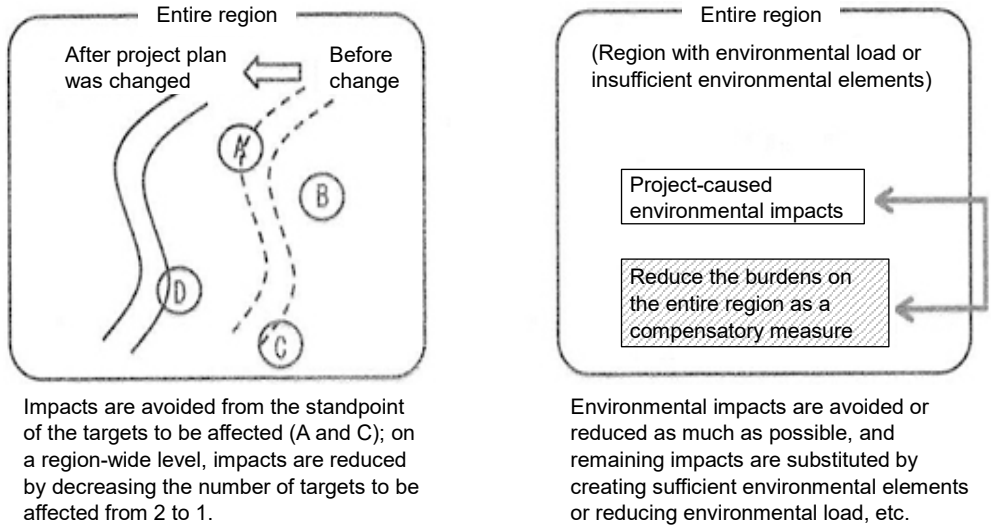


Fig. III.1-13 Concept of examining the policy of environmental conservation measures

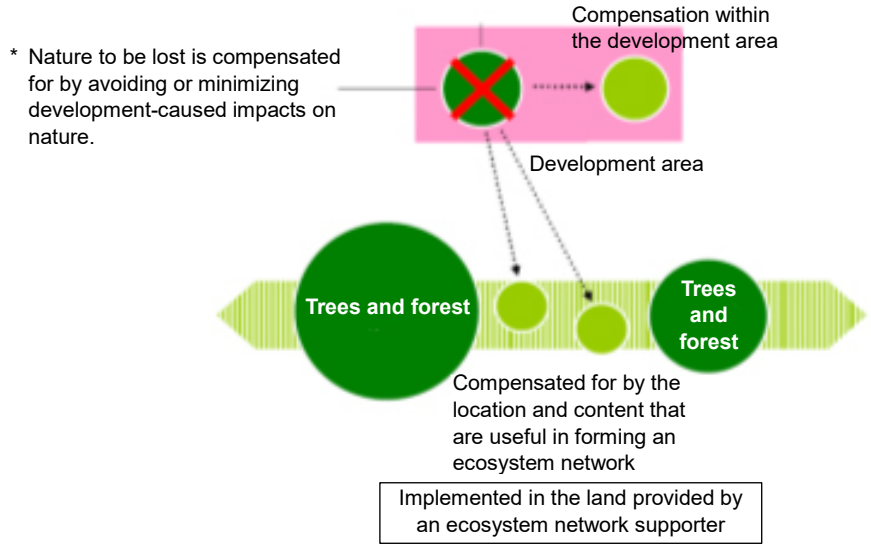
[Reference Data] Biodiversity offset

Biodiversity offset is a concept of setting project-caused impacts (loss of the functions and values of ecosystems) to zero (no net loss) by to indicating quantitatively the extent of remaining impacts and taking measures necessary to offset (or substitute) them, based on the Polluters Pay Principle (PPP), after the project operator fully considers avoiding or minimizing the impacts. This also includes cases where measures are taken to exceed the loss and have positive impacts on the environment (net gain).

A compensatory measure similar to biodiversity offset is carbon offset that cancels out the emission and absorption of greenhouse gases like carbon dioxide. In carbon offset, it is capable to quantify the emission, reduction, and absorption of greenhouse gases to some extent and is easy to judge the degree of offset, while it is difficult for biodiversity offset to quantify all the ecosystem functions, values, and quantity that are lost, and there is a problem whether alternatives say to have the same value as those that are lost or not. Accordingly, it is considered that there is a difficulty for showing objectively whether the no net loss or net gain is achieved. However, in order to reduce the loss of the ecosystem functions and values as much as possible, biodiversity offset has been already carried out in many countries based on various concepts and systems, leading to proposal of offset methods according to the social and natural situation of each country. The ecosystem functions and values are often calculated based on the concept “environmental quality × area × coefficient,” while there are many aqtual calculation methods. For facilitating the calculation, reference charts, etc. of environmental (habitats) quality are used in some countries.

Biodiversity offset has not yet been enacted in Japan, but some local governments are promoting compensation based on the similar concept (Fig. III.1-14). There are also some cases investigating whether existing methods (habitat hectare method, etc.) are applicable in Japan as

an approach to compare the ecosystem functions and values. There are also qualitative comparison methods based on the judgement of experts. For future consideration of compensatory measures, it is preferable to use the concept of biodiversity offset as well.



Source: Aichi Prefecture (2013)

Fig. III.1-14 Aichi Mitigation

In performing biodiversity offset, the following points should be taken into consideration.

- Compensation may be provided in an environment different from the one to be disappeared (decreasing environment in the region), but it is important to build regional consensus for the necessity, etc.
- The indicators for evaluating ecosystem functions and values and the criteria for judging the degree of offset achievement also need to have scientific evidence and obtain consent from the communities.
- Similar to other compensatory measures, it is important to conduct follow-up surveys and comprehend the degree of the effect.

[References, etc.]

- Forest Partnership Platform website, http://www.env.go.jp/nature/shinrin/fpp/maintenance/new/bdoffset.html.
- For Biodiversity Offset in Environmental Impact Assessment in Japan (Draft), Ministry of the Environment (2014).

- Guidelines for Natural Environmental Conservation and Restoration (2013/2014 Trial Version), Aichi Prefecture.

[Reference Data] Small Nature Restoration

Recently in Japan, stones and logs are stacked as a porous environment in a relatively small space, while stones are placed in rivers to diversify the river flow. Such "small nature restoration" activities can be seen in many places in the country, which are effective with a constant extent (Fig. III.1-15). These activities producing effective environmental conservation with a little ingenuity are published as a collection of examples. The basic policy of Law for the Promotion of Nature Restoration, whose review was decided by the Cabinet in October 2014, also states that small nature restoration activities are expected to conserve and restore natural environment over wide areas. Since many of these activities can be carried out at low cost without advanced techniques, there are many cases where local civic groups and administrative bodies, etc. are working together to engage in the activities, which are also anticipated to serve as regional cooperation initiatives. Case examples and techniques used in the activities are also useful information in taking environmental conservation measures in an environmental impact assessment.

Since even small nature restoration activities make changes to the environment, the following points should be taken into consideration.

- Continuous maintenance management is often required to continuously fulfill the functions of environmental conservation, meaning that a dedicated system needs to be built.
- It is important to conduct surveys for verification of the presence/absence of environmental impacts and the effect of the measures, as well as to perform accommodative management that provides flexible response to possible changes, which are supposed previously.

Source: Tamai (2015)

Fig. III.1-15 Restoration of Sandbank (Gojō River, Aichi Prefecture)

[References, etc.]

- "Collection of Examples of Small Nature Restoration Activities," Ministry of the Environment (2015).

- "Let's Start with What We Can Do-Examples of Small Nature Restoration Activities on the Waterside," Supervised by Nobuyuki Tamai (2015), Japan River Restoration Network (JRRN).

1.1.5 Evaluation

1) Evaluation methods

Evaluation is carried out by clarifying the views of business operators as to whether forecasted impacts can be sufficiently avoided or reduced by taking adopted environmental conservation measures for the plant and animal species and their communities, etc. subject to the measures that are clarified in the policy of environmental conservation measures. Business operators explain the bases for their views as objectively as possible.

If goals or policies regarding the conservation of plants, animals, and ecosystems are defined in basic environmental plans, environmental conservation ordinances and other various guidelines stipulated by the national government or local governments for natural conservation, it is also need to mention about the consistency with the goals or policies as one of the bases for their views.

2) Ensuring of objectivity of evaluations

Ensuring the objectivity of evaluations is important in showing the bases for taking the best avoidance or reduction measures. For examples, it is considerd to show the results of forecast based on the numerical calculations of fundamental environmental elements and the ecosystem-conscious material circulation models as one of the criteria to judge the evaluation. When a qualitative forecast was performed with reference to preexisting similar cases and existing knowledge, better objectivity of evaluation can be ensured by comparing the referred cases and knowledge to the survey and forecast conditions in the project, as well as by presenting academic documents, research reports, etc. regarding the effectiveness of the environmental conservation measures. When goals or policies regarding the conservation of plants, animals, and ecosystems are defined in the contents of the basic environmental plans or regional biodiversity strategies prepared by local governments, various guidelines, or air/water environment standards, etc. for environmental conservation, it is also need to take the goals or policies into consideration in performing evaluation.

1.1.6 Follow-up survey

1) Concept of follow-up survey

Follow-up surveys for plants, animals, and ecosystems may be performed in the following cases. Follow-up survey methods are examined on a case-by-case basis with consideration for the characteristics of important plant and animal species or noteworthy species, etc. As example of items subject to follow-up survey, hose shown in Table III.1-26 are considered.

i) In case where the uncertainty of forecast regarding selection items is large

For example, the uncertainty of forecast becomes larger, when a part of habitats s disappears due to direct alteration, if knowledge about area of habitats, etc. is limited that are required to maintain important plant and animal species or noteworthy species, etc. just as before, or if the resistance of important plant and animal species or noteworthy species, etc. to changes in habitats (water quality, etc.) is unclear.

ii) In case of taking environmental conservation measures which - knowledge for the effect is insufficient

For example, when important plant and animal species or noteworthy species, etc. are transplanted, there are the case that transplantation case is few, the extent of the sedentariness rate is unknown, and knowledge to evaluate the effect of the measures is insufficient.

iii) In case of making the content of environmental conservation measures more detailed

For example, when environmental conservation measures are taken with consideration for breeding behavior, etc. of animals (noise reduction, etc.) during construction work, there is the case that fine-tuned responses (suspension or resumption of construction work, etc.) are provided after comprehending the details of breeding behavior, etc. through follow-up surveys.

iv) In case of taking compensatory measures

For example, when compensation is made by creating an environment similar to the one to be disappeared in a different place, it may be needed that the effect is confirmed by follow-up surveys, since the factors forming habitats are slightly different from the ones in the place where the environment is to be created.

Table III.1-26 Example items subject to follow-up survey

Animals	• Fauna • Populations, habitat density • Distribution conditions, range of activity • Breeding conditions • Environmental conditions for animal habitats (plant cover degree, water place conditions, flow rate, river beds, etc.) • Collision with facilities
Plants	• Flora • Growth conditions of individuals (growth locations, distribution conditions, populations, growth increment, health performance, etc.) • Community structure, composition • Distribution conditions of communities • Fundamental environmental elements for growth of plants (sunshine conditions, soil conditions, etc.)
Ecosystems	• Distribution conditions of noteworthy species, etc. (distribution, populations, reproduction rate, range of activity, etc.) • Conditions and fluctuation range of fundamental environmental elements • Functions (water purification function, etc.)

2) Follow-up survey methods

i) Examination of follow-up survey methods

In follow-up survey for plants, animals, and ecosystems methods setting up survey sites is considered. In this case, since multiple entries to the same place are required, there is possibility of impacts by surveys on the environment, such as impacts of surveyors' tread pressure on understory vegetation and impacts of frame sampling on marine algae communities. Therefore, in the surveys confirming the growth conditions and breeding conditions, etc. attention should be given so that surveyors approach do not impede breeding . In order to avoid such impacts, employing automatic photographing equipment is considered.

With attention to cutting-edge technology in a follow-up survey, for example, DNA analysis and other latest technologies may be used to confirm the migration segmentation of populations.

ii) Sites and scope of follow-up survey

Basically, a follow-up survey is carried out mainly in the survey and forecast target area. However, if impacts of a project are observed outside the survey and forecast area, the area subject to the follow-up survey needs to be expanded, etc.

Follow-up survey sites are set by including the sites used for forecast in an environmental impact assessment, and specific sites are ensured so as to be able to evaluate the changes in follow-up survey targets quantitatively. Since indirect impacts on long-lived plants and animals gradually appear in many cases, some follow-up surveys need to be conducted for a multi-year

period; thus, survey sites and routes that can be used until completion of follow-up surveys are selected. In order to comprehend project impacts and the effect of environmental conservation measures in distinction from impacts associated with changes in weather conditions and other environmental elements, control survey site need to be established, for the purposes of comparison, in locations with no project impacts whose environment is the same as the follow-up survey site and locations where environmental conservation measures, etc. are not taken. When naturally generated environmental fluctuations are larger than project-caused environmental fluctuations, which can be found in interior drainage areas and sea area ecosystems, it is difficult to distinguish impacts on the environment between natural fluctuation-driven ones and project-caused ones; thus, special attention should be given to how to set control survey site.

Due to the migratory behavior of animals and the seasonal difference in available resources, etc. depending on the mode of life of target species, etc., some migrate for breeding and wintering. For this reason, surveys need to be conducted by including other areas than their major habitats, such as migration paths, according to the target species, etc. and goals of the follow-up survey. Therefore, it is necessary to consider specific responses to each of the target species, etc. in setting the areas subject to a follow-up survey.

When a survey covers the structure, composition, existing quantities and growth increment of communities, the survey is performed by installing quadrat, etc. In locations where the extent of project-caused impacts and the fundamental environment conditions gradually change, survey sites and areas are set based on the target species, etc. of the follow-up survey and regional characteristics, such as by installing belt transect (belt-like survey areas).

iii) Period and timing of follow-up survey

The implementation period, timing, and frequency of a follow-up survey vary depending on important species, communities, and noteworthy habitats subject to an environmental impact assessment, as well as on the content of the environmental conservation measures taken. It is preferable that a follow-up survey is compared to the forecast results of the environmental impact assessment and is continued until the convergence of changes in environmental elements is confirmed. In planning a over time survey, the timing of the survey should be at the same time each year with consideration for the life history of the plant and animal species, etc. subject to the environmental impact assessment.

In order to confirm that the target species, populations, and habitats of animals maintain stability, it is preferable that the survey frequency and period should be sufficient enough to confirm that the environment, the structure of populations, etc. are stable and that constant alternation of generations happens. The survey frequency should also be set so as to detect the fluctuation in the environment where animal species subject to the survey live.

When plants are subject to a survey, for grass plants and algae even a relatively short-term follow-up survey can investigate populations of several generations, but for arbors a long-term survey is preferred to study. On the contrary, seasonally frequent surveys are required to identify the changes in grass plants and algae, while it is difficult to capture clear changes in arbors unless they are monitored in a time span of several years. The survey frequency should also be set so as to detect the fluctuation in the environment where plant species subject to the survey grow.

The concept of survey period are considered as the following examples .

- When the goal of an environmental conservation measures is to restore the populations and communities of plant species, it is preferable that the survey period cover the time until the populations and the structure of communities are restored to the same condition as before the project is implemented.
- When the goal is to restore communities that require a long period of time for complete restoration, such as climax forests, it is preferable that the survey period cover the time until the seral changes in the communities are expected to be restored after steady progress, or the time until the succeeding young trees of plant species composing the target communities are recognized to have grown up healthily.
- When a stable fundamental environment is important to species growing in tideland, wetland, etc., it is preferable that the follow-up survey period cover the time until the fundamental environment becomes stable.
- Some environmental conservation measures are intended to maintain a natural disturbance, etc. In this case, the probability of such a disturbance should also be taken into consideration in examining the follow-up survey period.

3) Implementation of follow-up surveys

In light of the results obtained by conducting a follow-up survey, environmental impacts and the effect of environmental conservation measures are analyzed based on the changes in the environment during construction work and after the use, as well as in the targets of the follow-up survey in the environmental conservation measures. Additional environmental conservation measures also need to be examined, as necessary. In such cases, the following points should be taken into account.

- When local governments, etc. conduct environmental monitoring for survey targets in which environmental standards are stipulated, this activity is useful in identifying background changes.
- Appropriate follow-up surveys are performed at each stage according to project phases, such as partial use, to comprehend the extent and details, etc. of environmental impacts caused by the project.

- It is preferable that the results of a follow-up survey are compared to those of an environmental impact assessment to analyze the causes of differences, if any.
- When additional environmental conservation measures have been taken, a relevant follow-up survey is carried out as necessary to verify the effect.
- The results of a follow-up survey should be shared among the people concerned for appropriate environmental management after the existence and use of facilities, etc.

4) Accumulation and utilization of follow-up survey results

There are case examples where the results of follow-up surveys conducted in multiple projects across Japan were collected and compiled with consideration for project characteristics and regional characteristics, and the data were used for analysis per project type and environmental conservation measure type. Major case examples are shown in Table III.1-27. In addition, there are some other case examples, including the one that compiled the data of roadkill cases that occurred in road projects, as well as of changes in lakeside vegetation flooded by a dam project.

These findings are expected to be useful in conducting surveys and forecasts and examining and evaluating environmental conservation measures. Therefore, business operators are anticipated to collect as much information as possible on how the follow-up survey results have been utilized and summarized and examine how such data can be used in their projects.

In summarizing follow-up survey results by business operators, emphasis is placed on comparison with changes before the project starts and with other cases. In accumulating and using follow-up survey results, on the other hand, if follow-up survey methods, etc. are significantly different from surveys conducted before the project or from other cases, or if preconditions that include the amount of survey effort are unclear, sufficient arrangement and analysis may not be possible, thereby requiring careful attention.

Based on follow-up surveys results, the validity of survey, forecast, and evaluation methods in an environmental impact assessment and the techniques are expected to improve. Thus, utilizing follow-up survey results is anticipated to be useful in making environmental impact assessments more effective.

Table III.1-27 Case examples of utilizing follow-up survey results

Case example	Description
Confirmation of the growth of raptors	Data obtained before and after construction work in many projects were utilized to summarize relationships, etc. with the presence/absence of continued growth of raptors, changes in reproduction rate, etc.
Analysis of plant transplantation cases	Information on plant transplantation situations in road projects throughout Japan was collected and analyzed to consider transplantation techniques in a case example of orchid species.

1.2 Utilization of Technical Methods and Points to Note (Plants, Animals, and Ecosystems)

When plants, animals and ecosystems are surveyed, forecasted, and evaluated in an environmental impact assessment, uncertainties may occur at various stages, such as data collection, ascertainment of ecosystem structure, and modeling for analysis of the fundamental environment. In order to achieve better effectiveness and efficiency of environmental conservation measures and build consensus among the people concerned, it is need to reduce such uncertainties as much as possible, and to ensure the reliability of forecast results. On the other hand, there is remarkable scientific and technological progress on the natural environment in recent years, greatly contributing to reducing uncertainties and it becomes possible to use technical methods to obtain better results. It is need to widespread these technical methods to streamline surveys and to reduce uncertainties.

This section summarizes several examples of methods that are likely to be available to use so far and are expected to contribute to streamlining surveys; reducing uncertainties in surveys, forecasts, environmental conservation measures, and follow-up surveys; and improving objectivity, on each stage of an environmental impact assessment (Table III.1-28). Some methods can be used at several stages. On this basis, scenes applied, outlines, points to note, case examples, references, etc. of each technical method are summarized.

Among the technical methods, there are one that have recently been established scholastically, that have been rarely utilized in Japan, that require a huge amount of effort in utilization, and that need expensive equipment, on the other hand, that make the cost affordable by recent technological innovations, and option is increasing. Therefore, the technical methods to be introduced here are for reference purposes only, not intended to recommend specific methods; there are other methods available to use. Some technical methods have already been used in an environmental impact assessment at some stages of project implementation. However, the reliability and accuracy, etc. differ from method to method at this point, meaning that attention should be given to the fact that some methods need stringent requirements for use. An environmental impact assessment should be carried out using a method suitable for its purpose with consideration for the trends in rapid technical development.

See the listed references, etc. for more details about the procedures, etc. for actually using the technical methods.

Table III.1-28 (1) Outline of major technical methods available

Stage	Purpose of method	Scene where methods are used in environmental impact assessment	Technical methods and usage example	Technical methods and usage example
Selection of survey, forecast and evaluation methods	Estimate the outline of the distribution area of plant and animal species	Selection of survey methods for efficient confirmation of important species, etc.	Estimation of a distribution range using a species distribution model	2-1
Survey (field survey, analysis)	Comprehend topography, vegetation, etc.	Labor-saving, and efficient ascertainment of the fundamental environment, such as vegetation type, land cover situation, the structure of growth sites (micro-topography, tree height, etc.), topography, water depth, and bottom sediments	Ascertainment of land cover situation and natural spring water sites in rivers using remote sensing devices (multifunctional sensors, thermography, etc.)	1-1
			Ascertainment of seafloor topography, etc. using acoustic survey devices (side scanning sonar, narrow multibeam echo sounder, etc.)	1-2
			Underwater exploration and photography of seafloor topography and aquatic creatures using a remotely operated vehicle (ROV) or next-generation autonomous underwater vehicle (AUV)	1-3
			Aerial photography using a small unmanned aerial vehicle (UAV)	1-4
	Confirm animal species and comprehend the status of use of sites, etc.	Confirmation of important species, noteworthy species, and alien species; estimation of their range of activity; identification of populations and existing quantities	Photography using a sensor camera, etc. and ascertainment of underwater topography, etc. using an acoustic camera	1-5
			DNA analysis of excrement, body hair, etc.	1-6
			DNA analysis of the environment	1-7
			Bio-logging (time depth recorder [TDR], GPS telemetry)	1-8
			Ascertainment of the flight paths of birds using radar	1-9
	Comprehend the genetic diversity of plant and animal species	Ascertainment of the genetic diversity of important species	Examination of the possibility, etc. of inbreeding depression by genetic analysis of populations	1-10
Survey (analysis of results) and forecast	Estimate the distribution conditions and scope of activity of plant and animal species and the possibility of survival of species	Estimation of the distribution of important species and noteworthy species and their hot spots (sites where many important species appear)	Estimation of the distribution range using a species distribution model (SDM: GLM, MAXENT, etc.) and forecast of impacts by overlaying project implementation areas	2-1
		Estimation of the range of activity of important species	Estimation of the range of activity using the kernel method, etc.	2-2

		and noteworthy species		
	Estimate the structure of ecosystems and ecosystem networks	Estimate the important migration paths of plants and animals and the connectivity of ecosystems	Estimation of important network sites through ecosystem network analysis, such as graph theory	2-3

Table III.1-28 (2) Outline of major technical methods available

Stage	Purpose of method	Scene where methods are used in environmental impact assessment	Technical methods and usage example	Technical method number
Survey (analysis of results) and forecast	Estimate the structure of ecosystems (structure of communities, etc.)	Environmental type category of ecosystems and extraction of noteworthy species	Objective environmental type categorization of ecosystems using a method of classifying biological communities (TWINSPAN, etc.)	2-4
			Extraction of similar biological communities using an ordination method and consideration of environmental type categorization	2-5
			Objective extraction of noteworthy species for each environmental type categorization of ecosystems (IndVal)	2-6
	Estimate changes in plant and animal species	Estimation of the possibility of extinction of important species	Forecast of changes in population viability due to partial extinction of habitats (PVA)	2-7
Environmental conservation measures	Efficient consideration of more appropriate environmental conservation measures	Avoidance of impacts of construction work according to the activity of important species, etc.	Camera monitoring	1-4 1-5 4-1
		Comparison of multiple environmental conservation measures	Comparison of cost-effectiveness, etc. by population viability analysis (PVA)	2-7
		Planning of environmental conservation measures utilizing flora and fauna migration and ecosystem networks	Examination of appropriate arrangement of habitats to be newly established to improve the possibility of survival of populations using a meta population model, etc.	2-3 2-4 2-5
		Extraction of the scope of optimal conditions, such as areas to which species are transplanted, etc.	Examination of areas to which species are transplanted using species distribution models and complementation analysis	2-1
		Consideration given to DNA types of species subject to transplantation	Transplantation of individuals that do not disturb the genetic group structure by genetic analysis	1-10
		Restoration and compensation of affected populations	Conservation of important species using transplantation, breeding, and multiplication technologies (seed bank, ex-situ conservation)	3-1
Follow-up survey	Comprehend changes in plant and animal species and ecosystems	Confirmation of the results of forecasts and evaluations, environmental	Monitoring of environmental changes using a visual plankton recorder, etc.	4-1

	(community structure)	conservation measures, and unexpected impacts		

1.2.1 Implementation of field survey, etc.

1) Remote sensing technology (Technical method number 1-1)

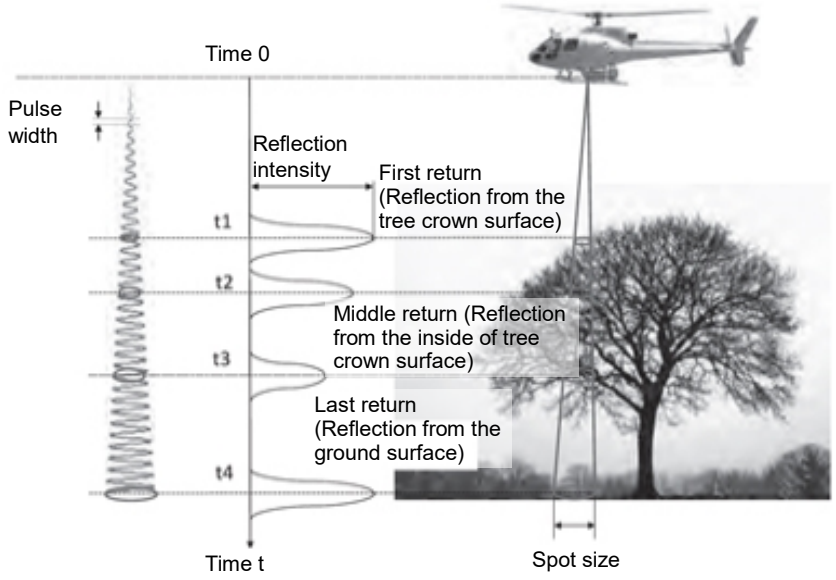
[Application of the method to environmental impact assessment]

- In an environmental impact assessment of plants, animals, and ecosystems, a highly accurate or widely covered vegetation map and aerial photos serving as the foundation thereof and data used to analyze the quality and structure of ecosystems may be required to comprehend the current situation of growth environment and ecosystems. Remote sensing technology, which is increasingly evolving in recent years, contributes to the efficient acquisition of such resources.
- Aerial photography and other measurements by aircraft are still expensive in general; thus, they are not always used in an environmental impact assessment. On the other hand, a variety of satellite image data available to purchase are nowenrichment, leading to an increasing number of purchases and uses of such images.
- Satellite images make it possible to track the temporal changes in vegetation based on accumulated data and to comprehend the detailed changes, etc. in land use due to improved resolution, thereby enabling organization of the changes in vegetation in ecosystems to comprehend regional characteristics.
- The hierarchical structure of vegetation is an important element in determining the quality of habitat space for animals. Using laser imaging detection and ranging (LiDAR) makes it relatively easy to regionally comprehend the hierarchical structure, helping examine the typicality, etc. of ecosystems.

[Outline of the method]

- This is a technique of estimating the situation, etc. of vegetation types and land cover by analyzing satellite images and multispectral images, etc. taken from the sky using an aircraft, and a sensor mounted on radio-controlled helicopter, etc. .
- Conventionally, vegetation maps are created manually by vegetation experts based on the results of field vegetation surveys and aerial photography analysis. However, using remote sensing technology can automate the creation process to some extent, which is expected to save labor.
- Resolution and analyzable information vary depending on satellites and the type of sensors, thereby requiring appropriate selection for use according to the purpose and the scope of targets. For example, using a sensor for a thermography in water areas can, in some cases, extract important growth environment (springs, etc.) and comprehend distribution situations over wide areas.
- If vegetation types in target data are clearly known thanks to a field survey, etc., the data in the field are used as a sample to classify the vegetation through automatic judgment of the field to which other data are the closest (supervised classification).
- In such cases, since using high-resolution image data leads to a high misclassification rate due to the shadows of tree crowns, it is thought to be effective to make a classification per block of pixels characterized by topography or statistics (object-based classification).

- Attempts are also being made to comprehend hierarchical structures by using LiDAR that irradiates the target with a pulsed laser and identifies the distance to the target and its characteristics. These attempts take advantage of the characteristic that the laser light spreads out as it reaches the ground, and some of the light finally returns to the measuring equipment after it is reflected in stages due to foliage, reaches the surface of the ground, and is reflected again.
- Remote sensing data have three limits: spatial resolution power, spectral resolution power, and temporal resolution power.
- Especially in regard to physiognomic vegetation maps covering wide areas, there are established models for the characteristics of each vegetation type, making it possible to automate most of the analysis processes.



Source: Katō et al. (2014)

Fig. III.1-16 How to comprehend hierarchical structures

Table III.1-29 Major image data used for remote sensing

Name of image data	Description
Satellite images from Landsat and RapidEye	Easily used to comprehend an extensive area larger than municipal level due to relatively low resolution power
Satellite images from Ikonos, GeoEye, and QuickBird	Easily used to comprehend an area narrower than municipal level in details due to relatively high resolution power
Image data from aircraft, etc.	Used for more detailed ascertainment than the cases above. A radio-controlled helicopter, etc. is used in some cases to cover a local area.

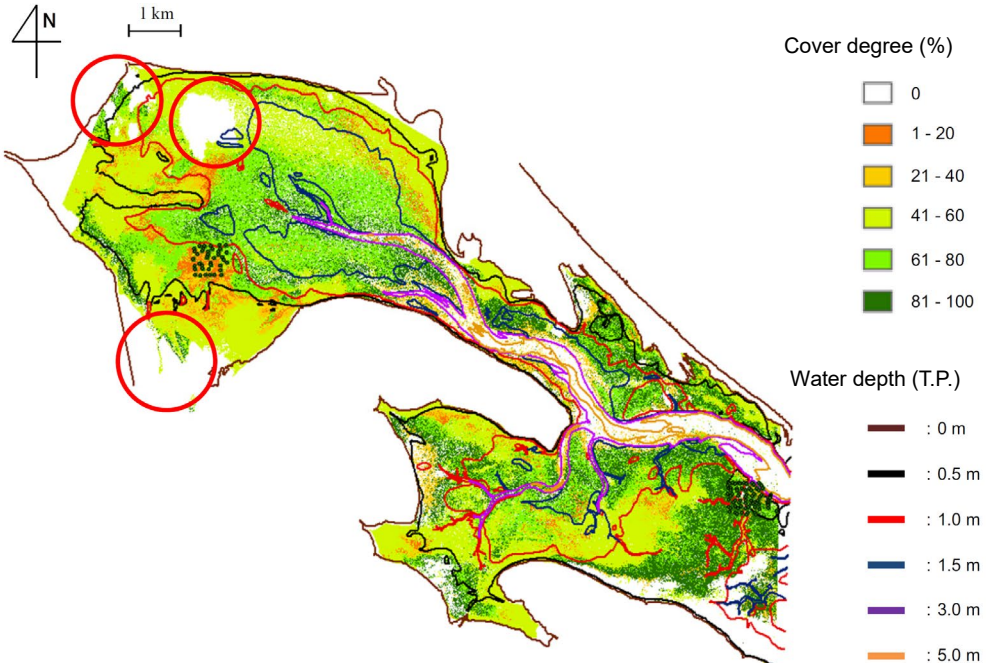
[Points to note]

- Remote sensing data have three limits: spatial resolution, spectral resolution, and temporal resolution.
- Object-based analysis is effective to analyze images for creation of a vegetation map since the analysis can be performed using an open source GIS (Free and Open Source Software for Geospatial: FOSS4G).

- In analyzing vegetation based on image data, not all vegetation legends can be analyzed automatically at this point. Instead, such an analysis greatly depends on the skills of professional technicians with reference to field survey results as training data.

[Case example]

- There is a case where the distribution of eelgrass beds was estimated in Lake Furen, Nemuro, Hokkaido (Tokoro et al. [2015]).
- Eight-band data were employed in this analysis to use the data of eelgrass beds observed on the spot as training data serving as judgement criteria, and an estimation was done through supervised classification.
- As a result, the percentage of the sites where estimation results accorded with the on-the-spot observation was 84% (95 out of 114 sites), demonstrating high-accuracy classification.



Source: Tokoro, et al. (2015)

The circles indicate that the coverage degree is judged as zero due to clouds or cloud shadows, but seaweed beds are actually distributed.

Fig. III.1-17 Distribution conditions of eelgrass beds estimated based on supervised classification of satellite images

[References, etc. for the method]

- Tsunekawa, A. (2005). "Monitoring and Evaluation of Green Environment," Asakura Publishing.
- Nagasawa, R., and Hara, K. (2007). "Remote Sensing for Natural Environment Analysis / GIS Handbook", Kokon Shoin (also refer to http://www.env.gr.jp/gishandbook/).

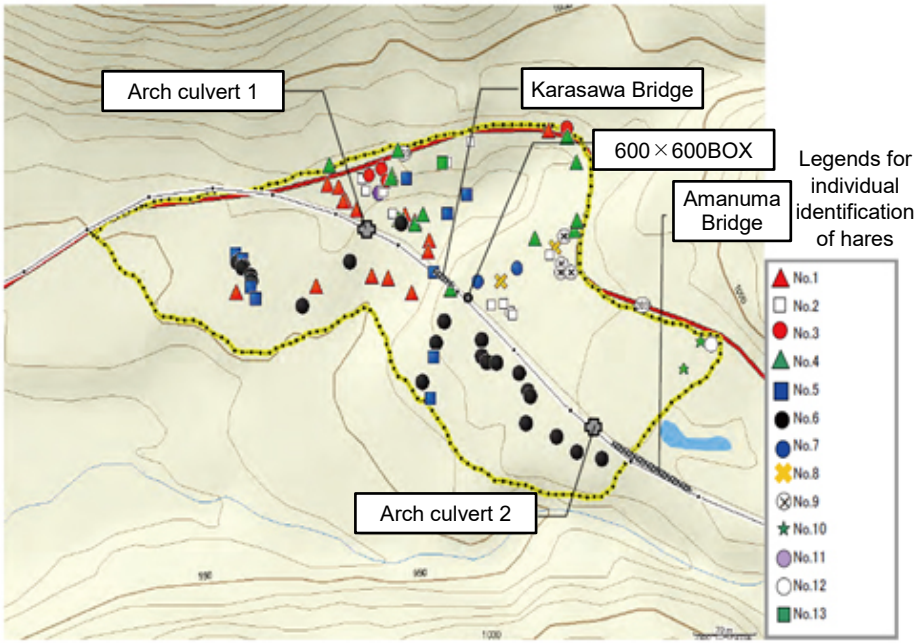
- Jones, H., and Vaugham, R. (2010). “Remote Sensing of Vegetation,” Oxford University Press. (Translation supervised by Atsushi Kume and Kenji Ōmasa [2013] “Remote Sensing of Vegetation”, Morikita Publishing Co., Ltd.)

2) Acoustic survey technology (Technical method number 1-2)

[Application of the method to environmental impact assessment]

- In regard to the growth factors of plants and animals in water areas and the formation factors of ecosystems, water depth and bottom sediments in addition to water quality and flow rate are the fundamental environment and the major formation factors of the growth environment. In recent surveys to comprehend the situation of the fundamental environment, various acoustic survey devices become to be available to comprehend the habitats of rare species and the typicality of ecosystems. This technology is useful in an environmental impact assessment of a project whose implementation area includes a water area.

- In order to verify the effect of arch culverts, etc. installed as an environmental conservation measure in a road project, fecal DNA was analyzed that revealed that multiple individuals of a hare species traveled between both sides of the road.



Source: Partially altered Matsue and Sonoda (2010)

Fig. III.1-25 Confirmation of individuals of a hare species through DNA analysis

[References, etc. for the method]

- Hayama, S., Miura, S., Kaji, K., and Suzuki, M. (2012). *Wildlife Management—Theories and Techniques*, Buneido Publishing.

- Higuchi, H. (1996). *Conservation Biology*, University of Tokyo Press.

7) Analytical techniques of environmental DNA (Technical method number 1-7)

[Application of the method to environmental impact assessment]

- In a field survey, the existence of plants and animals is confirmed mainly by capturing individuals, performing visual observation, hearing the calls of animals, and investigating the traces of excrement, body hair, etc. On the other hand, it is sometimes difficult to discover species growing underwater and species with few populations. By utilizing environmental DNA techniques such species. could be found
- Using this technique is making it possible to ascertain the presence/absence of important species subject to environmental conservation measures around a project implementation area. For example, it is expected to contribute to reduce the risk of requiring the survey to be redone, since important species are confirmed at a progressed stage of a project,
- Since this is a new technique, there are few examples of using it in past environmental impact assessments. However, there has been a remarkable decline in the DNA analysis cost in recent years, while databases are also being developed for many species; thus, this technique is expected to be further used in the future. Particularly, this method enables comprehending the distribution of rare species without investing a great amount of effort in the field survey. Therefore, this should be applicable to the stage of comprehending the regional characteristics used to list the species that are likely to inhabit the place around the target area, as well as to distribution surveys of important species.

[Outline of the method]

- Water and soil contain a large amount of DNA fragments liberated from animal excrement, scales peeled off, and skins, as well as DNA derived from microorganisms. These DNAs are called “environmental DNA” (also refer to Bohmann et al. [2014], Thomsen and Willerslev [2015], etc. for the definition).
- Analyzing environmental DNA can estimate the flora and fauna and their growth mass without capturing living organisms or sampling.

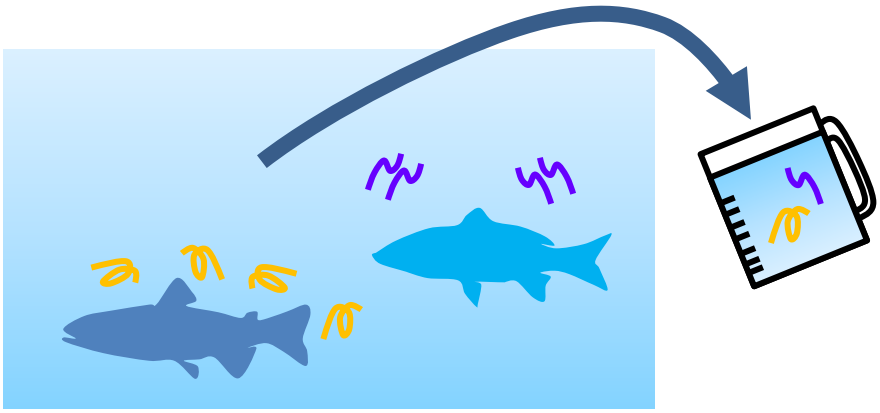


Fig. III.1-26 Environmental DNA-based identification of species

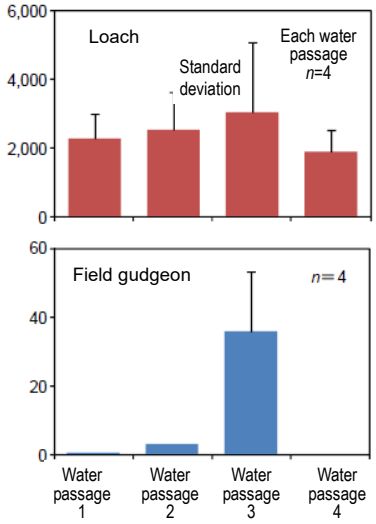
- Seawater, lake water, river water, and soil are collected to extract environmental DNA contained in them and to estimate the flora and fauna and biomass by PCR method, etc.
- An experiment using American bullfrogs in a water tank or pond without water supply demonstrated that environmental DNA was detectable for a maximum of about one month even after the bullfrogs were removed (however, note that the detectability period varies depending on the environmental conditions, etc. of the site).
- Most previous studies used environmental DNA in the water as a sample, which is mainly applied to fish to date; this method is also applied to shellfish, aquatic insects, marine mammals, etc.
- This method is expected to become one of follow-up survey techniques, after information on this technique is accumulated by future studies and criteria are determined by experts for the appropriate scope of survey to judge the presence/absence of organisms, as well as for the number of sampling sites and the volume of samples to be collected.

[Points to note]

- This method is intended to clarify DNA of organisms contained in collected samples. Therefore, results could significantly vary even in the same lake or river depending on the number and range of sampling sites.
- If DNA is contained, the identified species are highly likely to inhabit the place. However, since DNA also flows down from the upper stream, for example, it cannot be definitively said that the species inhabit the place where the sampling is performed. Fast flow may make it impossible to capture DNA.
- Even if the species inhabit the place, it is impossible to detect them if their DNA is not contained in the sample, meaning that this is just a supplmenary method supporting a field survey.

[Case example]

- DNAs of loach and field gudgeon were detected in the water of an agricultural waterway (Fig. III.1-27).
- Converting the DNA content into copy number per liter (number of DNA strands) showed around 100 times higher DNA content of loach than field gudgeon.
- The DNA content among the waterways tended to be larger in the order of waterways 3, 2, 1 and 4 for both species. It was also assumed that the DNA content of loach and field gudgeon may reflect their growth mass.
- For sea areas, there is a case where 15 common species and one rare species were identified in the 500 cc seawater sample collected in a coastal area (Thomsen et al. [2012]).



Source: Koidemizu et al. (2014)

Fig. III.1-27 Results of the analysis of environmental DNA

[References, etc. for the method]

- Washitani, I., Miyashita, T., Nishihiro, J., and Kadoya, T. (2010). *Methods in Conservation Ecology*, University of Tokyo Press.
- Taberlet, P., Coissac, E., Hajibabaei, M., and Rieseberg, L. (2012). "Environmental DNA," *Molecular Ecology* vol.21 (8), 1789–93.
- Bohmann, K., Evans, A., Thomas, M., Gilbert, P., Carvalho, G., Creer, S., Knapp, M., Yu, D., and de Bruyn, M. (2014). "Environmental DNA for Wildlife Biology and Biodiversity Monitoring," *Trends in Ecology & Evolution* 29(6).
- Tōju, H. (2016). *Exploring Ecosystems with DNA Information*, Kyoritsu Shuppan.

8) Techniques of collecting positional information, etc. of animals (bio-logging) (Technical method number 1-8)

[Application of the method to environmental impact assessment]

- In examining impact forecasts or environmental conservation measures, it may be necessary to comprehend the range of activity and important growth environments (breeding and feeding sites) for some animal species. For this reason, surveys are carried out through visual observation, while the evolution of bio-logging technology (a Japanese-English expression combining the words "bio" and "logging," meaning a technology of tracking organisms using a transmitter and other electronic equipment) is expected to achieve a greater amount of data, better accuracy, and lower survey cost, etc.
- This method is used in field surveys, etc. in environmental impact assessments to comprehend the range of activity of important species, the details of their activities, and the situation of the environment used by them.

[Outline of the method]

- This is a method of attaching a radio transmitter or a transceiver with a GPS logging function to the body of animals to obtain the positional information, etc. of target individuals for a certain period of time. This is done by collecting and receiving the positional information stored in the loggers or acquired through tracking activities by humans.
- The GPS collar system shown in Fig. III.1-28 has a GPS receiving function in the collar part that records time and positional information, as well as postures and other motional data. The positional information and motional data can also be downloaded to a tablet device, etc. by using the communication controller.

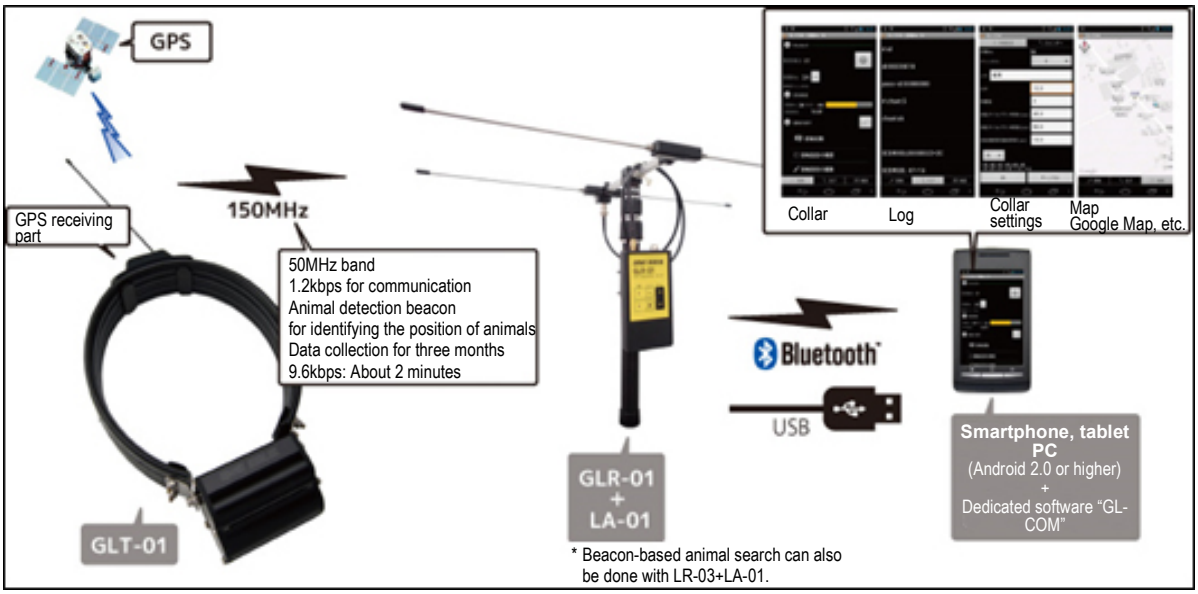


Fig. III.1-28 GPS collar system

A boar wearing a GPS collar

Downloading GPS data

Fig. III.1-29 Primary devices used for GPS telemetry

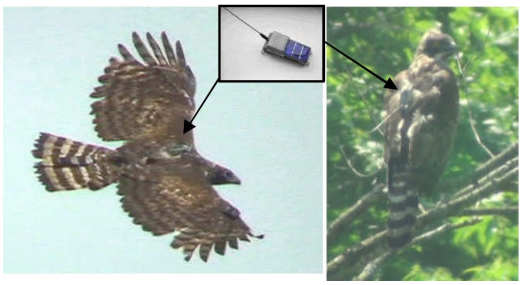
- Lighter GPS transceiver, smaller and lighter data loggers, increase of data storage capacity and battery capacity, and more sophisticated receiving technology (utilizing satellites) lead to a rapidly growing number of examples of using the method. Tracking time differs depending on battery performance.
- This method is applied to various animals (monkeys, raccoons, boars, deer, bears, whales and other mammals, mountain hawk-eagles and other raptors, salmons and other fish, etc.).
- Attaching an acceleration sensor, temperature sensor, or depth gauge (time depth recorder: TDR), etc. makes it possible to comprehend the activities of animals, the environment they use, and their physical states, etc.
- Remote measurement of information is also possible with a receiver on a ship or on land by attaching a device (a pinger) that transmits ultrasonic waves even in the water.

[Points to note]

- Capturing animals is necessary, requiring support of a veterinarian, etc. in some cases. It may also take time to capture individuals (sedentary individuals in a certain area) to be surveyed.
- If a long-term measurement is performed, extra care is needed, such as controlling the behavior of the device to save battery life during the time when a survey is not conducted (sleeping hours or non-breeding period). Taking non-nocturnal birds as an example, it is effective to set operating hours with consideration given to seasonal sunrise and sunset times.
- In order to minimize impacts on individuals, technical measures should be taken so that the transceiver drops off the body by itself, or the device needs to be collected by humans, after the battery runs down or necessary data are collected. Methods using gunpowder, a motor drive, etc. are utilized to drop the device off the body.

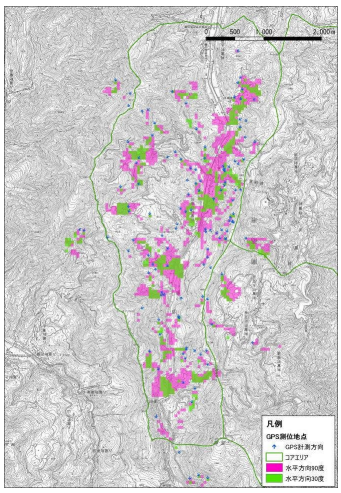
[Case example]

- There is a case where a GPS transceiver was attached to the back of mountain hawk-eagles to track their activities for the purpose of forecasting impacts of a dam project on them and examining environmental conservation measures.



Source: Yamamoto et al. (2012)

Fig. III.1-30 A G PS transceiver attached to the target



Source: Yamamoto et al. (2012)

Fig. III.1-31 Estimation of mountain hawk-eagle's visual field

- This case example also provided information, such as stop positions and the direction in which individuals are looking based on their posture, etc. The visible range of mountain hawk-eagles (assuming a visibility of 500 meters with a 90- or 30-degree field of view) was assumed as well (Yamamoto et al. [2012]).

[References, etc. for the method]

- Japan Bio-Logging Science (2009). *Bio-logging*, Information Design Associates Kyoto.
- Japan Bio-Logging Science (2016). *Bio-logging 2*, Information Design Associates Kyoto.
- Urbano, F., Cagnacci, F., Calenge, C., Dettki, H., Cameron, A., and Neteler, M. (2010). "Wildlife Tracking Data Management: A New Vision," *Philosophical Transactions of the Royal Society* B: Biological Sciences, 365: 2177–85.
- Hayama, S., Miura, S., Kaji, K., and Suzuki, M. (2012). *Wildlife Management—Theories and Techniques*, Buneido Publishing.
- Higuchi, H. (1996). *Conservation Biology*, University of Tokyo Press.
- Wilmers, C., Nickel, B., Bryce, C., Smith, J., Wheat, R., and Yovovich, V. (2015). "The Golden Age of Bio-logging: How Animal-borne Sensors Are Advancing the Frontiers of Ecology," *Ecology* Vol.96(7): 1741–53.

9) Techniques of comprehending the flight paths of birds using radar (Technical method number 1-9)

[Application of the method to environmental impact assessment]

- For birds, among animals, bridges or power-generating windmills constructed on the migration paths of birds may become obstacles hindering their migration or even kill or injure individuals. Therefore, it is necessary to conduct a field survey, etc. to comprehend whether the project implementation area is located on the important migration paths of birds.
- Conventional field surveys were intended mainly to confirm the existence of birds by hearing their calls or performing visual observation during their migration period, etc.; there were few follow-up surveys on the flock of birds or individuals using radar in the surveys for an environmental impact assessment.
- With the recent development of wind power generation projects, surveys using shipboard radar, etc. have increasingly been conducted to comprehend the migration paths of birds.

[Outline of the method]

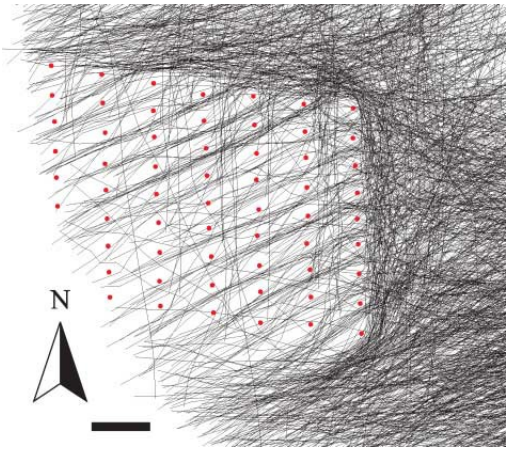
- Normal horizontal radar scan allows for comprehending the horizontal migration of birds and their spatial expansion. Vertical scan also provides data on the altitude at which birds fly. Since no obstacles exist in the direction of the sky, radar can be operated at high output power, making it possible to keep track of small birds with the radar.
- Surveying birds with shipboard radar is popular in overseas countries. In Japan, there are similar cases conducted by Ito and Ogi (1999), Sōda (2004), Ueta et al. (2008), etc.

[Points to note]

- When shipboard radar is actually installed, a license issued by the Minister for Internal Affairs and Communications for the establishment of radio stations is required under the Radio Act. A radio operator license, etc. is also necessary to operate the radar.
- There are the following problems: it is not easy to use and approve the equipment; it is impossible to perform close-range recording (a radius of several dozen meters from the location where the radar is installed); species cannot be identified; and the survey accuracy may be reduced by reflex disturbance attributable to snowfall, rainfall, etc.

[Case example]

- There is a case where shipboard radar was used to record and analyze the flight trajectory around windmills and confirm the avoidance behavior of birds.
- Desholm and Kahlert (2005) defined two probabilities that birds enter the ocean windfarm and the area within a 50-meter radius of the windmills, figuring out the crash rate by multiplying the probabilities. Specifically, shipboard radar was used to collect data on the flight trajectory of birds and figure out the crash rate by converting the inputs into GIS data. According to the calculation, the probability that birds enter the windfarm during the day was 4.5%, and the one that they enter the area within a 50-meter radius of the windmills was 12.3%, figuring out the crash rate of 0.6%. In other word, it was estimated that 99.4% avoided crashing into the windmills.



Black circle: Wind turbine
Black line: Flight trajectory of waterfowls

Source: Desholm and Kahlert (2005)

Fig. III.1-32 Example of comprehending the flight paths of birds using radar on the ocean windfarm

[References, etc. for the method]

- Ministry of the Environment (2011). "Guidelines on Appropriate Locations for Wind Power Generation Facilities Concerning Birds."
- Desholm, M., Fox, AD., Beasley, P.L.D., and Kahlert, J. (2006). "Remote Techniques for Counting and Estimating the Number of Bird Wind-turbine Collisions at Sea," *A Review Ibis* (s1) 148, 76–89.
- Krijgsveld, K. L., Fijn, R. C., Japlink, M., Van Horssen, P. W., Heunks, C., De Fouw, J., Collier, M., Pool, M.J.M., Beuker, D., and Dirksen, S. (2011). "Effect Studies Offshore Wind Farm Egmond aan Zee. Flux, Flight Altitude and Behaviour of Flying Birds," *Bureau Waardenburg Report*, 10–219.

10) Techniques of genetic analysis of populations (Technical method number 1-10)

[Application of the method to environmental impact assessment]

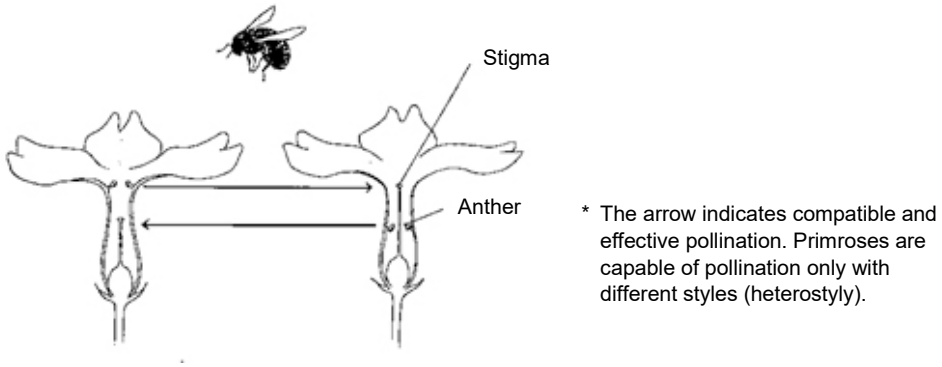
- The genetic constitution of some plants and animals varies regionally even if they are the same species; thus, forecast may be required to find whether a project could diminish such characteristics. Although the number is small, there are some cases that star magnolias, giant salamanders, etc. were analyzed for the genetic constitution of their populations in environmental impact assessments.
- Forecast may include a method that estimates the genetic distance and parent-child relationship among individuals in order to presume the gene flow status in the populations and forecast changes, etc. in genetic diversity caused by project-caused segmentation or shrinkage of habitats.

[Outline of the method]

- Plants are characterized by easy formation of clones through vegetative propagation; genetically, there may be a case where the number of seedlings is a couple of individuals at most. Groups with the same gene information are called a "genet." Even if plants are physiologically and ecologically independent, they are regarded to be the same in terms of genet if they are populations derived from

the same clone. In examining environmental conservation measures or forecast of impacts on projects, consideration should be given to the genet constitution.

- For plants like star magnolias that perform layering regeneration and form clone groups around them, the existing populations are highly likely not to reflect the number of genets. Identifying the genet constitution by genetic analysis enables comprehending impacts of inbreeding depression attributable to disappearance of some individuals.
- For species like primroses that have high self-incompatibility and need different stylar individuals for breeding, imbalanced styles have a low possibility of survival of groups even if the population number is large. Therefore, it is necessary to comprehend the genetic diversity of populations by genetic analysis.
- In order to comprehend the genetic constitution of important species, some leaves, etc. of the populations are sampled to conduct genetic analysis and identify the genet constitution.



Source: Washitani (1998)

Fig. III.1-33 Heterostyly of primroses

[Points to note]

- Since there is still little knowledge about the genetic diversity of some plant and animal species, attention needs to be paid to interpretation, etc. of locus to be used and genetic diversity, while support of experts is also essential. Obtaining knowledge of genetic diversity may require a great amount of effort, such as processing a large number of specimens for analysis. Other problems include unavailability of a sufficient number of samples for species with few individuals.
- In addition to economic and temporal costs, there is also a technical risk of damaging individuals; thus, due consideration should be given first to avoidance or reduction of impacts on habitats, etc. before using this technique.

[Case example]

- In the environmental impact assessment for the 2005 World Exposition, Aichi, Japan, the allozyme enzyme polymorphism of star magnolias were analyzed to identify the genetic constitution of small groups of star magnolias, the genetic diversity of each group, and the genetic relationship among the groups. Forecast was made to clarify the position of the group of star magnolias subject to direct

alteration and also to identify the extent of changes in the genetic diversity of the group of star magnolias in case the group of star magnolias subject to direct alteration disappears, as well as changes in the genetic relationship among the groups (Japan Association for the World Exposition [2006]).

[References, etc. for the method]

- Matsuda, H. (2000). *Environmental Ecology*, Kyoritsu Shuppan.
- Washitani, I., Miyashita, T., Nishihiro, J., and Kadoya, T. (2010). *Methods in Conservation Ecology*, University of Tokyo Press.
- Washitani, I. (2006). *Molecular Ecology of Primroses*, University of Tokyo Press.

1.2.2 Arrangement and analysis of survey results

1) Practical techniques of using the species distribution model(Technical method number 2-1)

[Application of the method to environmental impact assessment]

Species Distribution Model (SDM) is a technique of estimating, etc. the distribution of species to be surveyed and forecasted based on survey data, environmental conditions, etc. and is useful at the following stages of an environmental impact assessment.

(Stages of comprehending regional characteristics and selecting methods)

- This method is useful in estimating the inhabitable range of important species and noteworthy species of ecosystems whose distribution conditions are unclear, even referring to previous data.
- In conducting surveys, establishing an SDM while increasing the number of species confirmation sites can carry out effectively field surveys to gain higher accuracy.

(Analysis and forecast of survey results)

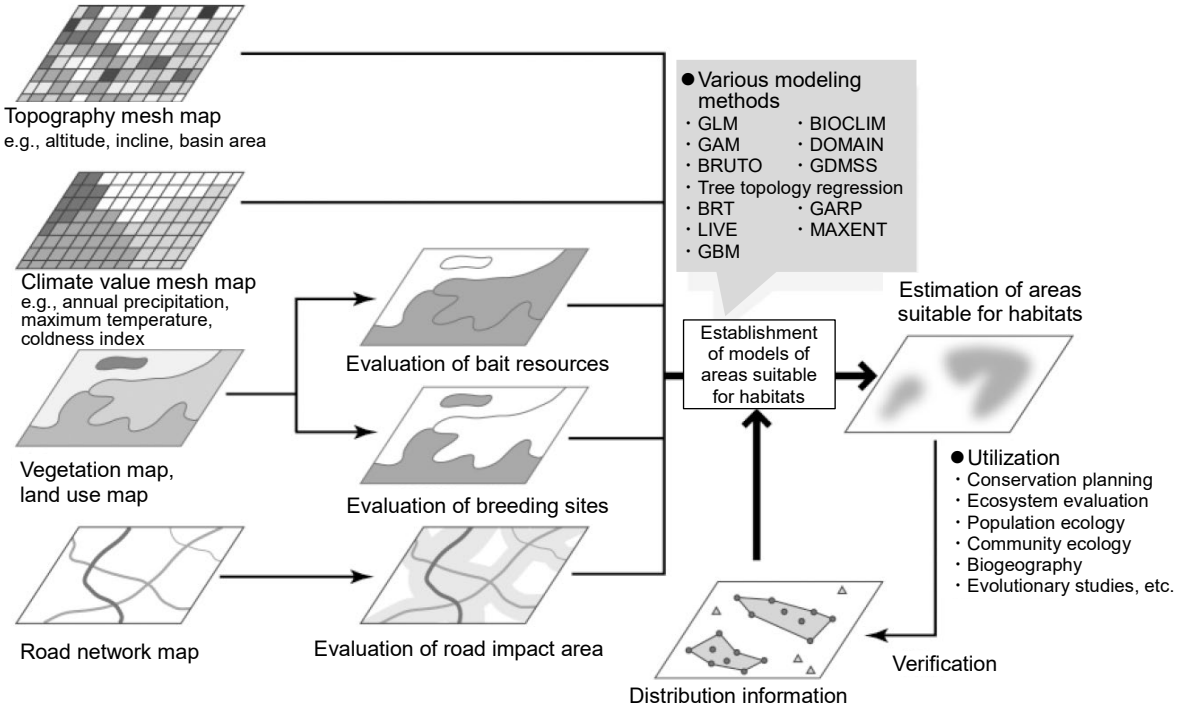
- Field survey data are used to estimate the inhabitable range of important species and noteworthy species of ecosystems whose distribution conditions are unclear within the target project implementation area and its surrounding areas.
- Maps of estimated important species are overlaid with one another to identify the locations of hot spots (places where many important species emerge).
- Inhabitable range of target species is estimated to overlay a project plan site on another site and compare the extent of impacts.
- If environmental conditions after project implementation have been estimated, the post-project environmental conditions (explanatory variables) are used to forecast the future distribution of target species.

(Environmental conservation measures)

- This method allows for obtaining estimation results of potential growth environments, which is useful in selecting places which are suitable for transplantion of the species .

[Outline of the method]

- SDM is a model of estimating the potential target range where target species emerge, based on environmental conditions and other spatial information.
- SDM is featured by various techniques, such as logistic regression, decision tree (CART), and neural network (ANN), which use data of sites where target species have been or have not been confirmed (data with "1" as "confirmed" and "0" as "unconfirmed" [presence/absence data]). In addition, there are the generalized linear model (GLM), general additive model (GAM) and other models that calculate using categorical data (classifying the extent of emergence into brief ranks), populations and other numerical data, such as MAXENT, ENFA, DOMAIN, and BIOCLIM, that calculate using the only data of sites where target species have been confirmed (presence data). This means that SDM can be used properly according to the purpose of using such models, and the quality and quantity of available information, etc.
- Comparing to forecasts and evaluations conducted as the distribution range of sites where target species have been confirmed, as well as of growth environments qualitatively estimated, this method is expected to reduce uncertainty in estimating important sites for target species.
- Estimating the distribution area of target species using an SDM makes it possible to narrow the extent of impacts for a close-to-reality forecast.



Source: Mitsuhashi (2009)

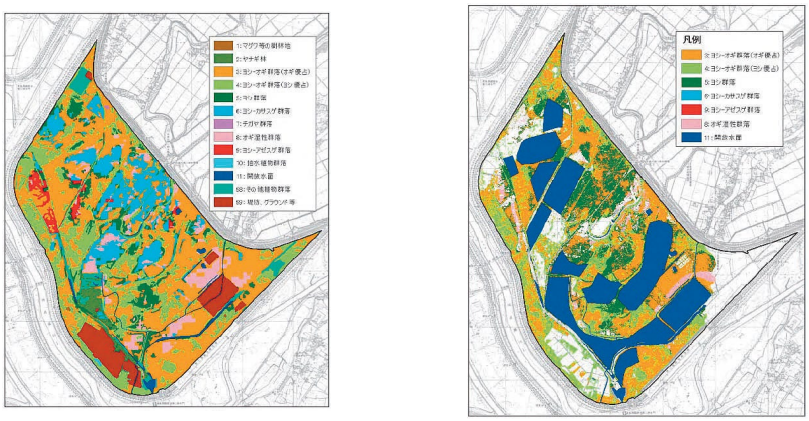
Fig. III.1-34 Image of estimating the distribution area of species using an SDM

[Points to note]

- SDM also has simplified methods other than statistically accurate ones. There are cases where the method was used to evaluate the adequacy of individual habitats or examine substitutability. If a simplified method is used, its applicability needs to be fully examined; it is also necessary to verify the applicability with other highly reliable methods on an as-needed basis.
- At present, there are few examples of using the method, and estimation results tend to be susceptible to the experience and skill, etc. of the technicians.
- SDM is also useful at the stage of preparing the document on primary environmental impact consideration. In the environmental impact assessment at the stage of project implementation, a field survey should be conducted to verify the SDM developed at the stage of preparing the document on primary environmental impact consideration, and it is also preferable to develop and use an SDM with higher estimation accuracy.

[Case example]

- In order to discover the habitats of important species, their distribution areas are estimated before exploration. According to Guisan et al. (2006), for example, advance estimation of the distribution area successfully reduced the outdoor survey hours by approximately 70%.
- Taking *Phaedranassa brevifolia*, a rare species of plant in Ecuador, as an example, an SDM (utilizing the maximum entropy method) developed using data on multiple existing habitats was used to estimate places with high viability, and field surveys conducted within the estimated area found three new habitats (Oleas et al. [2014]).
- There is a case where, for planning an excavation project in the Watarase Retarding Basin, an SDM (decision tree method) was developed with the parameters of (1) altitude, (2) groundwater-level depth, and (3) groundwater-level fluctuations to estimate the distribution of present plant communities and the future community distribution after the excavation plan (Satō et al. [2009]).



(Present) (After excavation)

Source: Satō et al. (2009)

Fig. III.1-35 Current situation of the Watarase Retarding Basin and the estimated distribution of plant communities after the project plan is implemented

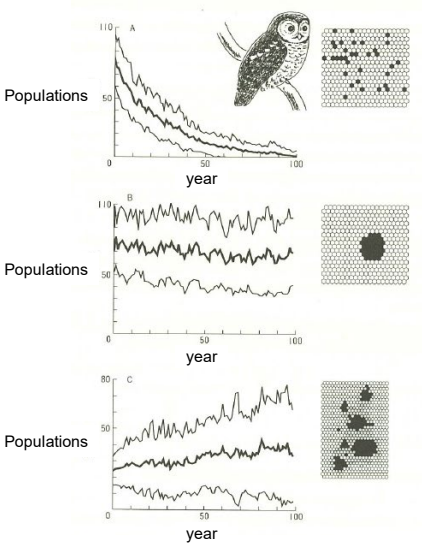
[References, etc. for the method]

- Washitani, I., Miyashita, T., Nishihiro, J., and Kadoya, T. (2010). *Methods in Conservation Ecology*, University of Tokyo Press.
- Ministry of the Environment (2014). "Draft of Methods of Comprehending and Using Spatial and Geographical Information for Biodiversity Conservation in Environmental Impact Assessments (Ver. 1.0)."
- Franklin, J. (2009). *Mapping Species Distributions*, Cambridge University Press.
- Yamamoto, Y., Inoue, R., Sone, S., Kadoyu, K., Kurihara, M., Matsue, M., Ueno, Y., and Sonoda, Y. (2013). "The Technical Reference on Environment Impact Assessment Technique for Road Project Fauna, Flora and Ecosystem on 1． Planning Stage Consideration Items" Technical Note of National Institute for Land and Infrastructure Management, No. 720

2) Population viability analysis (PVA) (Technical method number 2-2)

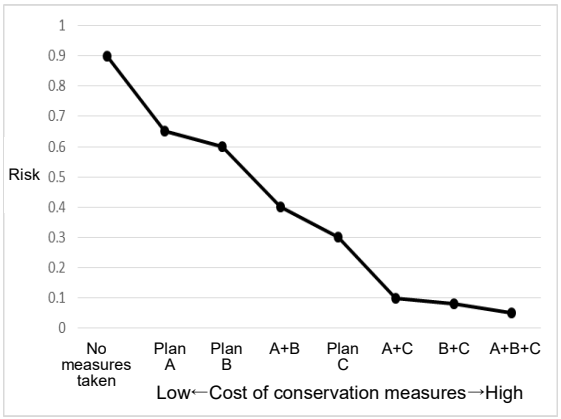
[Application of the method to environmental impact assessment]

- In an environmental impact assessment of plants or animals, when important species will be affected by environmental impacts, whether the species can survive in the area is often forecasted based on the alteration ratio and other factors. For especially important species, quantitative forecast and evaluation may be required by calculating the probability of survival (extinction) of populations based on the population dynamics model. One of the methods is population viability analysis (PVA).
- The effect and cost of environmental conservation measures can be quantitatively compared in the form of the probability of survival of populations.



Source: Higuchi (1996)

Fig. III.1-36 Example comparison of the effect of environmental conservation measures



A, B and C are individual conservation measures.

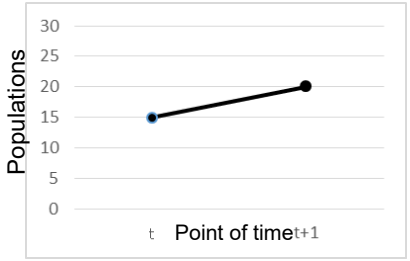
Fig. III.1-37 Example relationship between the cost of conservation measures and viability

[Outline of the method]

- This is a method of estimating how much the extinction probability will be changed from the current situation based on the project-caused fluctuations in population density, birth rate, death rate, etc., while taking into consideration the variability of probability of birth, death and migration of target populations.
- The method includes the population dynamics model that estimates the increase and decrease in the population numbers of target species, the individual-based model representing the activity of each individual, and the patch occupancy model that estimates the temporal occupation status of the habitats of target species.
- Performing a sensitivity analysis of parameters in the model such as the survival rate and reproduction rate of adult animals, comparing the extent of change in the survival probability among the parameters, and conducting extensive field surveys of highly sensitive (highly susceptible) parameters (focusing on surveys) are useful in achieving higher model accuracy, examining important environmental conservation measures, reducing survey cost, and reviewing the details of cost-effective environmental conservation measures.

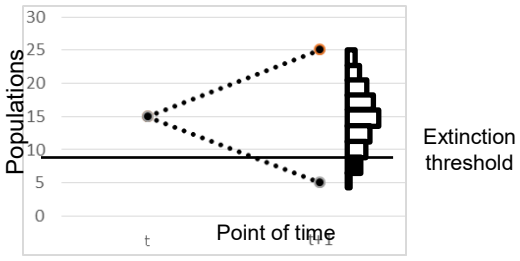
  There is a variety of software available for PVA, such as ALEX, the RAMAS series, VOLTEX, Meta-X, and SPOMSIM, etc.. Each of the software systems can examine genetic diversity or the dispersal among local populations of meta populations, while it is necessary to select an appropriate one as needed, such as the one calculating using presence/absence data of target species on each patch.
- The scarcity in the red data book of vascular plants issued by the Ministry of the Environment is determined with consideration given to the results of simplified PVAs.

Deterministic model output



Deterministic model
(Calculated based on constant birth rate, death rate, and other factors)

Probabilistic model output



Probabilistic model
(Death rate and other factors vary in a probabilistic manner depending on points in time, meaning that populations at a certain point in time are not constant.)

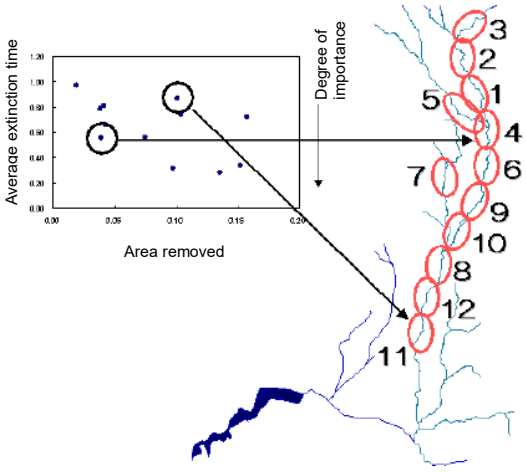
Fig. III.1-38 Image of calculating populations using the deterministic model and the probabilistic model (PVA)

[Points to note]

- The problem of PVA is that there are few chances of verifying the present state repeatability and other validities; the validity depends on how the hypothesis and the parameters in models are realistic . This means that the survival probability of populations obtained in a PVA is not absolute. Therefore, it is preferable to consider the probability as a reference material for estimating important conditions for populations and performing comparative review of better conservation measures, based on the difference in behaviors of populations (sensitivity analysis) under various environmental conditions.
- Attention should be paid to the following: if only the variability of probability is considered in a PVA, the minimum viable population (MPV) to be obtained in the analysis will be underestimated; and if there are factors that lead to low survival rate and reproduction rate, the timing of extinction will be earlier than forecast.
- The calculation results of a PVA vary depending on parameters set and other factors; therefore, the validity should be verified by checking with both experts of target species and those specialized in PVA calculation.
- In many cases, parameters necessary for implementing a PVA, such as reproduction rate, are unknown. In order to estimate these parameters, multiple continuous surveys need to be conducted to identify the life history cycle of target organisms and obtain relevant data.
- Since field surveys for an environmental impact assessment are conducted for several years in some cases, PVA calculation may become possible by carefully examining survey plans and obtaining data in advance.
- Even in case of species whose population statistical data are difficult to obtain, their viability can be forecasted in a qualitative manner based on the relationship among the land space and distribution conditions of areas suitable for habitats necessary to maintain most MVPs, the continuity thereof, and the dispersal ability of plant and animal species.

[Case example]

- Targets of a PVA conducted in environmental impact assessments include giant salamanders (a dam project) and dugongs (a landfill project).
- There is a case where SPOM, general software for the patch occupancy model, was used to analyze the important places for fish (Dolly Varden trout). In this example, the difference in the magnitude of impacts in altered habitats is shown by PVA.



Source: Koizumi (2004)

(The area of the habitats is smaller than 11, while it shows that 4 is more important for the survival of populations.)

Fig. III.1-39 PVA estimation of the extent of impacts on the Dolly Varden trout populations

[References, etc. for the method]

- Higuchi, H. (1996). *Conservation Biology*, University of Tokyo Press.
- Akcakaya, H.R., Burgman, M.A., and Ginzburg, L.R. (1997). "Applied Population Ecology. Second Edition," *Applied Biomathematics*. (Translated by Hisafumi Kusuda, Keiichi Onoyama, and Yasuo Konno [2002] "Leaning Applied Population Ecology with Computer—For Conservation of Rare Organisms," Bun-ichiSogo Shuppan.)
- Miura, S. and Horino, S. (2002). "Dynamics of Wild Animal Populations—Population Viability Analysis," *Ecosystem and Simulation* 91–114.
- Natsuhara, Y. (2005). "Population Viability Analysis (PVA)," available from http://www.info.human.nagoya-u.ac.jp/~natu/epub/PVA200506.pdf, accessed on November 15, 2016.
- Burgman, M., Ferson, S., and Akcakaya, R. (1993). *Risk Assessment in Conservation Biology*, Chapman & Hall.
- Beissinger, S., and McCullough, D. (Eds.) (2002). *Population Viability Analysis*, University of Chicago Press.
- Watanabe, K., Ichiyanagi, H., Abe, T., and Iwata, A. (2014). "Analysis of the Possibility of Survival of the *Parabotia curtus* population in Lake Biwa and the Yodogawa River System," *Japanese Journal of Ichthyology* vol. 61: 69–83.

3) Techniques of analyzing the range of activity of animals (the kernel method, etc.) (Technical method number 2-3)

[Application of the method to environmental impact assessment]

- Spread of the bio-logging technology has contributed to obtain plenty of accurate data on the behavior of animals with low cost, while the tracking of the activity of important species has also become popular in the surveys in environmental impact assessments. The techniques of analyzing the data obtained include the Kernel method and these technical methods that are used in many places to estimate the range of activity.
- This technical method is useful in estimating the range of frequently used areas and the places used as migration paths for animals and by combining the estimation results with project plans, the extent of potential impacts could be estimated.

[Outline of the method]

- The simplest way of estimating the range of activity of animals is the minimum convex polygon method, which performs estimation by connecting the external sides of the sites where target individuals are confirmed. The range and area of activity have been calculated by this method in some cases. However, this method cannot estimate the details (importance of the environment); thus, a variety of software is utilized for quantitative estimation of important places (internal structure of the range of activity) using the information on the sites where target individuals are confirmed. According to Ozaki and Kudō (2002), there are at least each five t softwares capable of using the minimum convex polygon method, or the fixed or variable kernel method, respectively.
- The kernel method is a technique of quantitatively estimating the internal structure of the range of activity with consideration given to the density of the confirmation site. This method is expected to achieve better objectivity and lower uncertainty for qualitative estimation.
- New methods have also been developed that examine positional information and elapsed time and estimate species whose important places vary depending on seasons and their life history (T-LoCoH: Lyons et al. [2013], BBMM: Horne et al. [2007], dBBMM: Kranstauber et al. [2012], etc.).

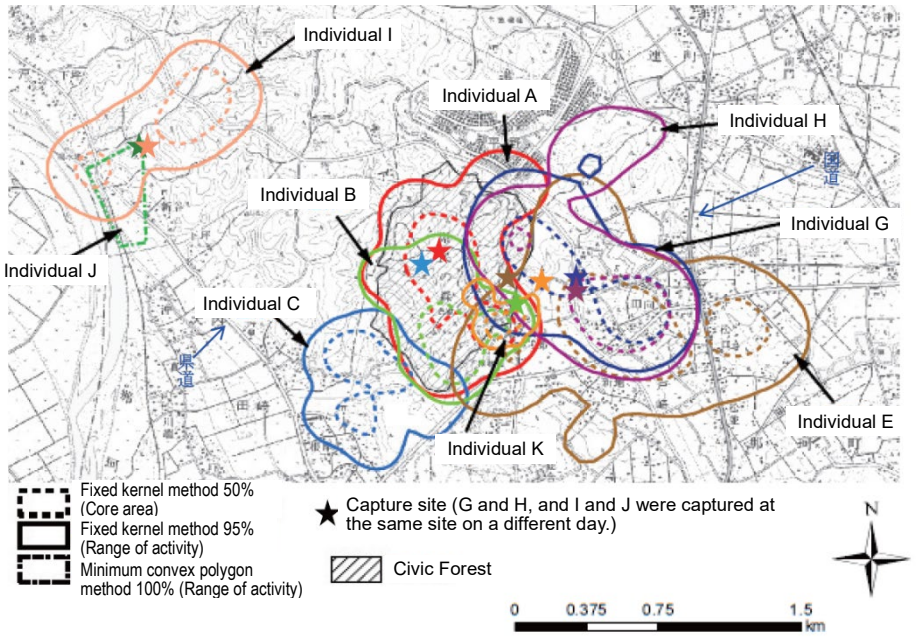
[Points to note]

- It is preferable for analysis to use data from telemetry surveys, etc. that obtain balanced data on many confirmation sites.

  Most kernel methods do not consider temporal transition and generate spatially autocorrected data to treat confirmation sites equally; thus, it is necessary to narrow down data that secure the independence of each site (to the contrary, the BBMM method and other techniques developed in recent years consider temporal transition and reduce spatial self-correlation-related problems to some extent).
- Even if the same data are used, the results may significantly vary depending on the software used (Mitchell [2006]); therefore, it is preferable to check it in advance using multiple estimation methods.

[Case example]

- There is a case where the positional information of Japanese raccoon dogs was obtained and compiled by a telemetry survey, and the range of activity (95% kernel in this example) and core areas (50% kernel in this example) of nine individuals were estimated using the kernel method.
- This case revealed that, among the targets, Individual E was frequently crossing the heavily trafficked road and Individuals G and H were not crossing the road, and that most dens of each individual were located in forests, and the lower layer was a flat area covered with bamboo grass.



Source: Matsue et al. (2006)

Fig. III.1-40 Analysis of the range of activity of Japanese raccoon dogs using the kernel method

[References, etc. for the method]

- Bookhout, T.A. (Eds.) (1994). *Research and Management Techniques for Wildlife and Habitats*. 5th Rev. Edition, The Wildlife Society, Bethesda. (Edited and translated by Masatsugu Suzuki [2001] "Wildlife Management—Theories and Techniques," Buneido Publishing.)
- Ozaki, K., and Kudō, T. (2002). "Home Range: Its Estimators and Effects of Autocorrelation Between Locations," *Japanese Journal of Ecology* 52: 233–42.
- Hayama, S., Miura, S., Kaji, K., and Suzuki, M. (2012). *Wildlife Management—Theories and Techniques*. Buneido Publishing.
- Higuchi, H. (1996). *Conservation Biology*, University of Tokyo Press.
- Seki, Y., Enari, H., Kodera, Y., and Tsuji, Y. (2015). *Field Survey Method for Management of Wild Animals*, Kyoto University Press.

4) Techniques of analyzing ecosystem networks (Technical method number 2-4)

[Application of the method to environmental impact assessment]

- In environmental impact assessments for plants, animals, and ecosystems, forecasts are carried out based mainly on the extent of alteration to the growth environment of important species and the environmental type categories of ecosystems. However, there are few cases that focus on how the alteration has impacts on the growth environment and ecosystem connections (ecosystem network structure) as well as on the populations.
- In recent years, on the other hand, importance is placed on ecosystem networks in regional biodiversity strategies, etc.; therefore, future forecasts and evaluations may be required to cover ecosystem networks.
- There is a case where, as a technical method of analyzing the ecosystem network structure, DNA analysis of animal feces was performed for qualitative examination of whether road projects may segment the migration of certain individuals. Graph theory and other analytic techniques have rarely been used in environmental impact assessments, but they are expected to become powerful tools for future ecosystem network analysis.

[Outline of the method]

- Assumed organisms that finish their life history in a narrow environment within target project implementation areas include small plants with low mobility and small insects. Importance is placed on ecosystem networks to maintain the sustainability of there populations and the soundness of ecosystems. In environmental impact assessments, the relationship between projects and ecosystem networks, as well as relevant conservation measures, may be required to be examined.
- The term “ecosystem network” means the situation where individuals can travel between habitats to maintain the sustainability of the populations of plants and animals and the soundness of ecosystems.
- In order to comprehend the current status of ecosystem networks, there are several methods of qualitatively confirming the continuity and connectivity* with the surrounding areas based on land-use maps, vegetation maps, topographic maps and other maps, as well as of estimating the connectivity situation using analytic techniques.
- For some target cases, it is sufficient to demonstrate some case examples of migration between two points by camera traps and DNA analysis of animal feces. In addition to the complex land use and topography, if the connectivity among habitats is so complicated that it is difficult to qualitatively identify important sites, it may be preferable to perform objective extraction using the graph theory and other analytic techniques.

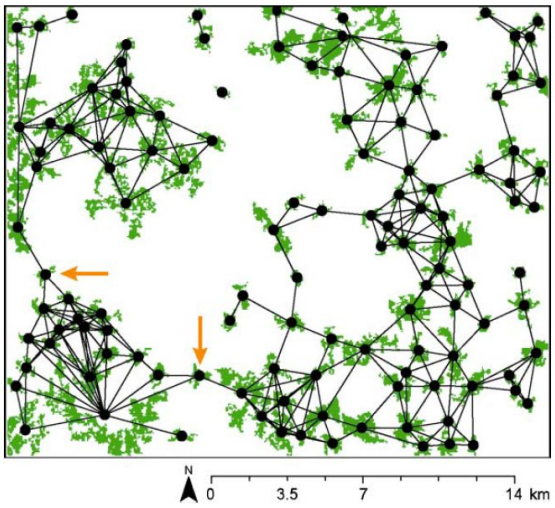
* In some cases, the term *continuity* means the situation where target habitats and ecosystems are physically connected, while the term *connectivity* means the situation where target organisms, etc. can travel between the same habitats or ecosystems by temporarily using spaces other than target habitats or ecosystems.

[Points to note]

- It is difficult to comprehend whether they are actually connected and how much the connectivity affects the sustainability. On the other hand, once impacts attributable to segmentation become pronounced, a great amount of time and effort will be required to recover the impacts.
- Preventive measures will be carried out for the time being, while going forward it is necessary to focus on the ways of estimating the importance by conducting follow-up surveys and accumulating case examples.

[Case example]

- The figure below shows the forest network in North Carolina under conditions of a dispersal distance threshold of 2.5 kilometers for wood thrushes. The arrows indicate the location of patches that generate multiple networks from one network after one patch disappears.



Source: Chetkiewicz et al. (2006)

Fig. III.1-41 Extraction of important patches based on the graph theory

[References, etc. for the method]

- Yamamura, Y. and Mori, A. (2012). "Management of Segmentation Landscape," Mori, A. "Ecosystem Management," pp. 44–72, Kyoritsu Shuppan.
- Ministry of the Environment (2014). "Draft of Methods of Comprehending and Using Spatial and Geographical Information for Biodiversity Conservation in Environmental Impact Assessments (Ver. 1.0)."

5) Classification method of biological communities (the TWINSPAN method, etc.) (Technical method number 2-5)

[Application of the method to environmental impact assessment]

- When conducting environmental impact assessments for ecosystems, the distribution of vegetation and the situation of biological communities are analyzed for environmental type classification, and

impacts are forecasted and evaluated based on the extent of alteration for each category. As technical methods for objective examination of this environmental type classification, the TWINSPAN method and other classification methods for biological communities are utilized. Doing so makes it possible to estimate what kind of environment similar biological communities are formed.

[Outline of the method]

- There are two approaches: an intensive technique of classifying biological communities by hierarchically arranging the degree of similarity in species composition found in multiple sites and organizing similar sites, and a division technique of dividing the groups of sites having the most different composition (See Table III.1-31). More hierarchical classification method includes the K-means cluster method (Leps and Smilauer [2003]).

Table III.1-31 Method of hierarchically classifying biological communities

Classification Method		Outline	Remarks
Intensive method	Centroid method	Each group is represented by the barycentric coordinates in Euclidean space. The characteristics of the centroid method vary depending on the combination of similarity indexes.	There is less influence of sites than the nearest/furthest neighbor method. However, if there is a huge gab between the number of sites "n_A" and "n_B" that consist of Groups A and B, the barycenter of Group K generated by combining A and B tends to lean to the larger sides of A and B, and the characteristics of smaller groups are apt to be underestimated.
	Median method	The tendency that the characteristics of smaller groups are underestimated, which is a problem of the centroid method, can be corrected by temporarily supposing $n_A = n_B$. This means that the distance between two groups is represented by the distance between the medians of both groups. Therefore, this can be called a weighted centroid method.	The results of the centroid method and the median method rarely vary with data with the low number of sites; if there are many sites, result values are different as groups become larger.
	Group average method	This is a method of using unweighted mean; the distance between two groups is given by the average of the distances among sites included in each group.	This is the most popular classification method with excellent results. In some cases, non-metric indexes (e.g., correlation function) are inappropriate to figure out the arithmetic mean of several values. Since the similarity between groups is represented by the average distance among sites included in each group, the results are simple and tractable, while they have no geometric clarity like the centroid method.
	Classification method using C'_λ developed by Morishita (1971)	C'_λ represents the extent of the average overlap between two sites in regard to all the possible combinations of two sites extracted from Site q. In this method, C'_λ for q sites is calculated first, and then combinations are merged in sequence from the highest value to the lowest (i.e., the highest similarity among sites).	In principle, this includes the group average method, but uses weighted mean, meaning that the results are slightly different from those calculated by the group average classification method. ・This is a classification method not affected by sample size and the total number of populations in each site.

Division method	Single criterion method	Method of determining division positions based on the inter-site distribution of one specific species. e.g., Association analysis	
	Multi-criteria method	Method of determining division positions in light of the distribution of multiple types of species (or all species). e.g., Indicator species analysis (INSPAN), TWINSPAN	

Source: Created based on Kobayashi (1995)

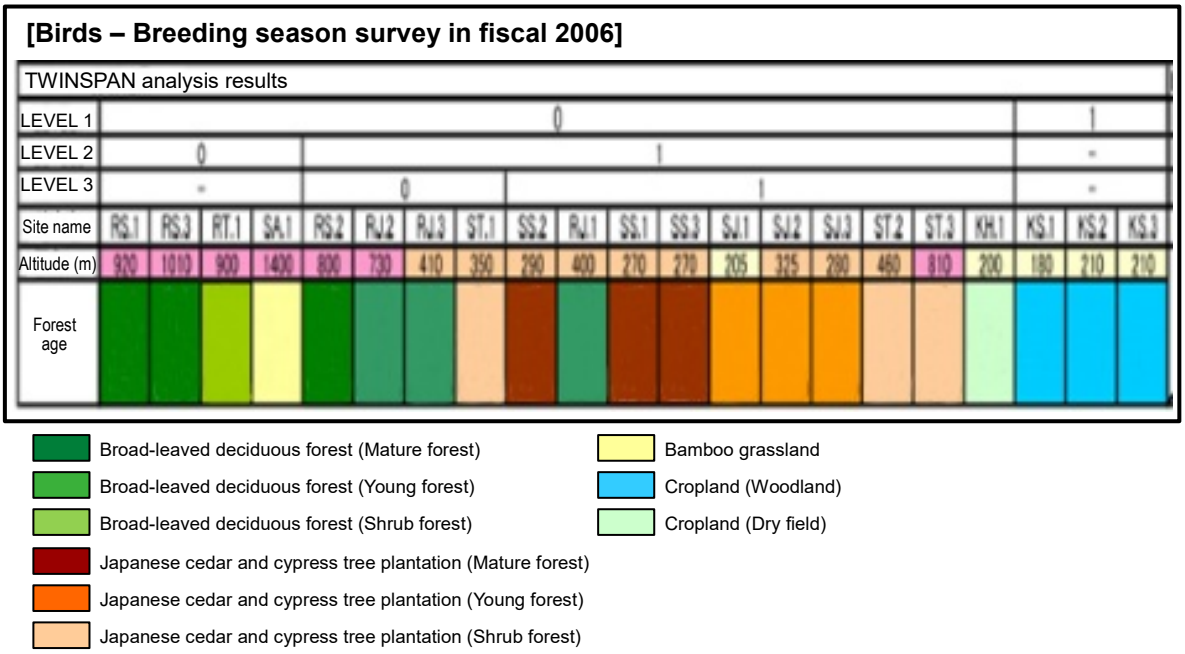
- Cluster analysis has traditionally been performed as an intensive technique, while the dual-partitioning TWINSPAN method has also become popular.
- TWINSPAN, which is an acronym for Two-way INdicator SPecies ANalysis, is a technique of rearranging biological community data developed by Hill in 1979 that is intended to coordinate data on emerging species and emergence sites and repeat dual partitioning.
- Since an imbalanced amount of survey effort occurring among the environmental type categories, such as different survey methods, hinders the selection of suitable indicator species, a field survey plan should be developed so that data can be obtained under appropriate conditions.

[Points to note]

- Due to the computational characteristics of TWINSPAN, this analysis method should be more suitable for the case where pattern classification is performed in regard to the environment with environmental gradients aligned in a single direction, rather than the case where any continuous environmental gradient does not appear on the plane of a land area (upstream and downstream of river environments, vertical direction of mountains, etc.).
- The intensive method varies in the number of communities to be classified, depending on the distance between communities applied as a same group. In order to eliminate such an arbitrary classification, a method for objective classification has been proposed (Struass [1982], Farias and Jaksic [2006], etc.)

[Case example]

- For the environmental type classification of ecosystems (land area) associated with the environmental impact assessment of a dam project, TWINSPAN was conducted using the species composition data of multiple species groups (taxa).
- In the following case example, most species were classified into lignose areas (paddy fields) in LEVEL1, classified into high-altitude deciduous forests and other ones in LEVEL2, and divided into deciduous broadleaf forests (young forests) and Japanese cedar and cypress tree plantation in LEVEL3.
- Based on the results, environmental type classifications were established with consideration given to vegetation, forest age, etc. (Fig. III.1-42).



Source: Kinki Regional Development Bureau of the Ministry of Land, Infrastructure and Transport (2013)

Fig. III.1-42 Case example of TWINSPAN-based classification of bird communities

[References, etc. for the method]

- Kobayashi, S. (1995). *Multivariate Analysis of Ecological Communities*, Sōju Shobō.
- Fukushima, T. (2005). *Vegetational Management*, Asakura Publishing.
- Katoh, K. (2002). "What Can 'Classification' of Multivariate Analysis Do?," *Bulletin of the Biogeographical Society of Japan* Vol.57 3-17.
- Gauch, H.G. (1982). *Multivariate Analysis in Community Ecology*, Cambridge University Press.
- Leps, J., and Smilauer, P. (2003). *Multivariate Analysis of Ecological Data Using CANOCO*, Cambridge University Press.

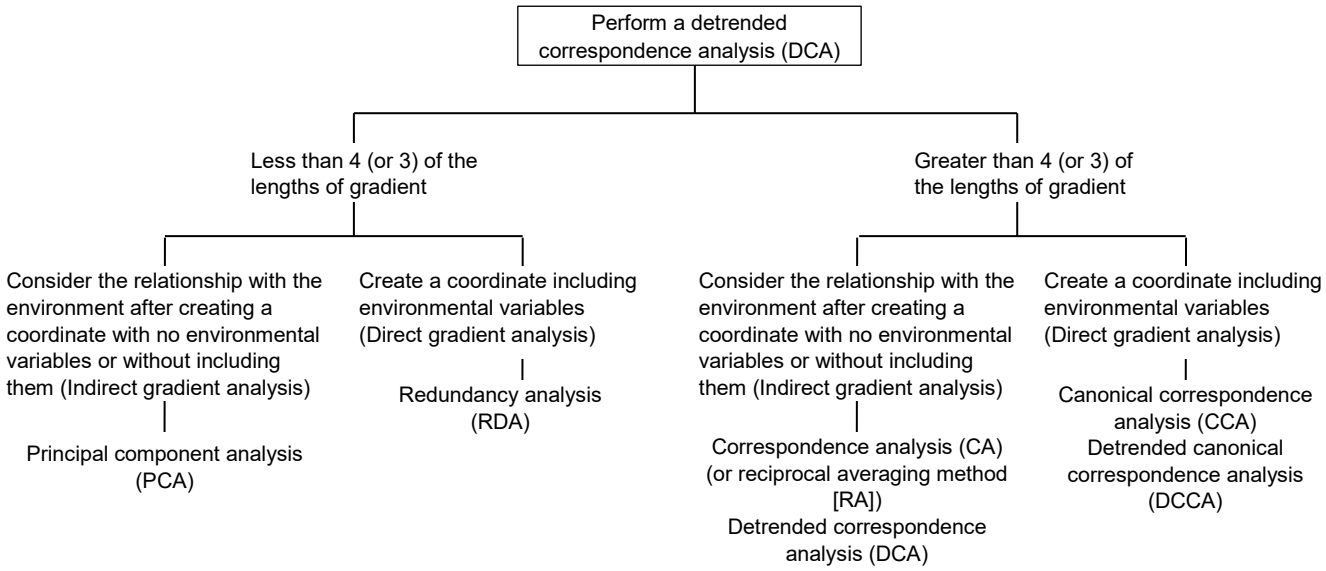
6) Method of the ordination of biological communities (Technical method number 2-6)

[Application of the method to environmental impact assessment]

- Ordination is a method that, according to the environmental gradients or the extent of similarity in biological community composition in certain survey sites, quantifies the positional relationship with one another. This method enables performing estimation by classifying multiple representative ecosystems at survey sites into several environmental type categories.
- The positional relationship between the environmental gradients and emerging organisms can be used to estimate what kind of community composition will be formed by changes in environmental conditions.

[Outline of the method]

- Ordination is a quantitative method of positioning the relative positional relationship between survey sites and species on an arbitrary coordinate, based on the emergence of species (presence/absence data, populations, existing quantities, and other actual data) per survey site, in order to comprehend their similarity.
- This technique includes indirect gradient analysis methods (CA, DCA, PCA, etc.) that do not directly connect with environmental conditions and direct gradient analysis methods (RDA, CCA, etc.) that directly link to the conditions.
- In many cases, analysis results are generally shown on a plane (two-dimensional) with the first and second axes. The closer sites are to each other, the more similar the biological community composition between the sites, meaning that the ecosystem structure is also estimated to be similar.
- Before the analysis is performed, the lengths of gradient are figured out by detrended correspondence analysis (DCA); then, a method suitable for the ordination of target data is selected as shown in Fig. III.1-44.
- Other techniques include the non-metric multi-dimensional scaling (NMDS) capable of handling qualitative data and other non-metric data (Sasaki et al. [2015], Leps and Smilauer [2003]).



Source: Modified the study by Sasaki et al. (2015)

Fig. III.1-43 Selection of methods according to the actual data of analysis targets

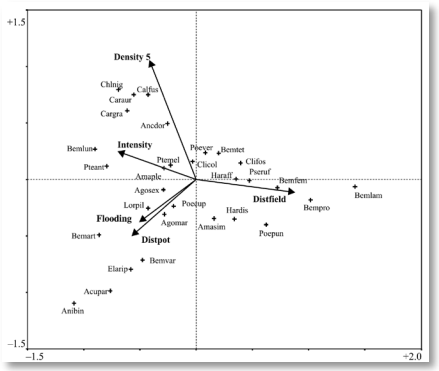
[Points to note]

- Direct gradient analysis does not produce appropriate results, if environmental conditions (variables) not influencing the species composition of each site are included in the calculation (Katoh [1995]). That is to say, if the correspondence relationship between the emergence of biological communities and the environmental conditions is unclear, the direct gradient analysis is not appropriate to extract factors with different species composition.

- These methods may be useful in the environmental type classification of ecosystems, while there have been few cases so far. However, they are recognized as quantitative analysis techniques, thereby requiring attention to future trends.

[Case example]

- There is a case where the canonical correspondence analysis (CCA) was conducted to identify the species composition of ground beetles and the environmental conditions thereof in 30 wetlands temporarily formed in the farmlands in the northeastern Germany (Brose [2003]).
- Five out of the 10 factors of the environmental conditions set were determined to be statistically significant, and the emergence of ground beetles is judged to have already been defined by these factors (compiled with the first and second axes in this example).
- This showed that the first axis has a relatively strong relationship with Distfield (distance from the cropland boundary) and the second axis with Density 5 (density of temporary wetlands within 5 km^2).
- Perpendicular lines are drawn to the arrow axes of each environmental factor; the species located farthest from the center have a strong relationship with the factors of the arrows, as shown in the figure below (for example, the longer the distance (Distfield) from the cropland boundary, the more Bemlam and Bempro emerge).



No.	Variable	λ_a	*P value*	Axes 1	Axes 2	Inflation factor
1	Intensity	0.11	0.010	−0.4205	0.1154	1.026
2	Distfield	0.11	0.010	0.5302	−0.0542	1.091
3	Density 5	0.09	0.035	−0.2504	0.4922	1.307
4	Distpot	0.09	0.020	−0.3459	−0.2310	1.316
5	Flooding	0.09	0.025	−0.3044	−0.1736	1.059
6	Density 1	0.06	0.070			
7	Distwet	0.05	0.130			
8	Density 2	0.05	0.165			
9	Density 1.5	0.05	0.165			
10	Area	0.04	0.170			

Source: Brose (2003)

Fig. III.1-44 Ordination of the ground beetle communities emerging in temporary wetlands of farm lands

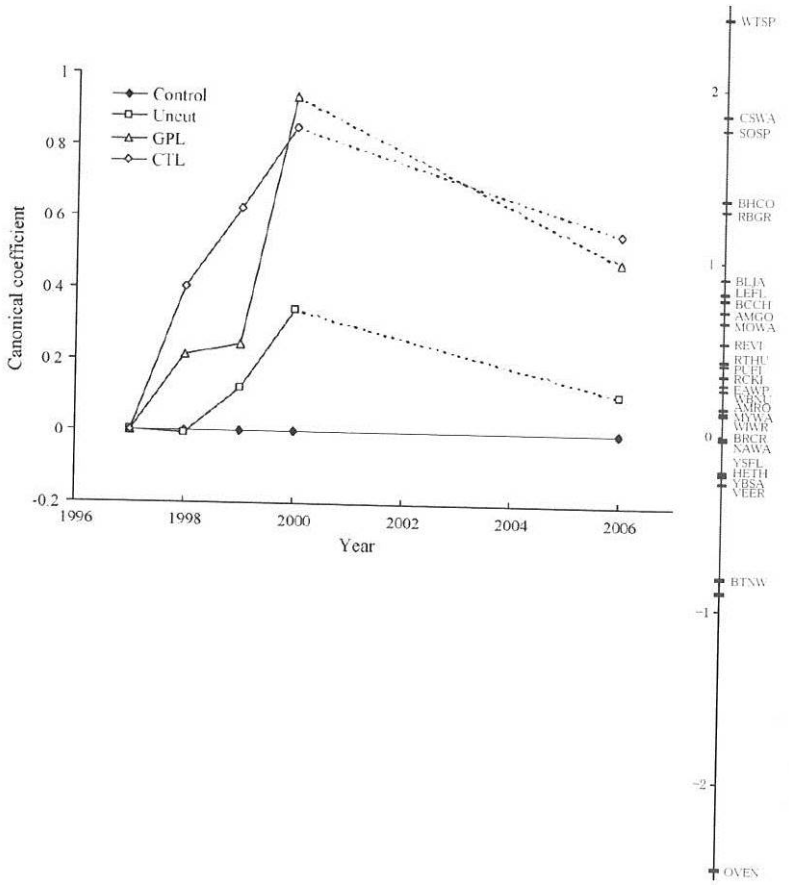
[References, etc. for the method]

- Sasaki, Y., Koyama, A., Koyanagi, T., Furukawa, T., and Uchida, K. (2015). "Data Analysis of Plant Community Structure and Diversity," Kyoritsu Shuppan.
- Kobayashi, S. (1995). "Multivariate Analysis of Ecological Communities," Sōju Shobō.
- Katoh, K. (1995). "A Comparative Study on Ordination Methods in Ecological Community Analysis," *Environmental Science* 8: 339–52.

- Terashima, I., Takenaka, A., Osaki, M., Ōhara, M., Kachi, N., Kohyama, T., Kitayama, K., Koike, T., Hikosaka, K., and Tsuyuzaki, S. (2004). *Plant Ecology*, Asakura Publishing.
- McCune, B., and Grace, J. (2002). *Analysis of Ecological Communities*, MjM Software Design, Gleneden Beach, Oregon.
- Shaw, P. (2003). *Multivariate Statistics for the Environmental Sciences*, Arnold, 233 pp.
- Jongman, R., Ter Braak, C., and Van Tongeren (Eds.) (1995). *Data Analysis in Community and Landscape Ecology*, Cambridge University Press.
- Leps, J., and Smilauer, P. (2003). *Multivariate Analysis of Ecological Data Using CANOCO*, Cambridge University Press.

[Reference Data] Principal response curves (PRC)

- In the eco-toxicology area, the principal response curves (PRC) are most commonly used recently to recognize visually the response of biological communities to chemical substances.
- In PRC, the elapsed time is shown on the horizontal axis, while the extent of changes in biological communities variously treated against the controls is indicated on the vertical axis, so as to make a comparison of the values.
- There are few cases where PRC was used in outdoor experiments or comparisons of before and after project implementation. In this method, however, the community changes controlled under natural conditions are constantly set as zero on the vertical axis, making it possible to simultaneously show the relative changes in sites subject to anthropogenic impacts and the extent of contribution of every species to the changes in community composition. This method is expected to be further used in the future.
- Fig. III.1-45 constantly sets the changes found in target spots as zero in regard to the temporal change in bird communities in the valley forest due to the different timber harvest techniques (control spots, Uncut, GPL, and CTL in the figure) in the forest adjacent to the valley forest, and shows the relative changes in other spots. According to the figure, the biggest contributors to the significant changes of bird communities in the GPL- and CTL-processed spots compared to the control spots for three years and the changes in the communities are an increased number of a sparrow species (WTSP in the figure) and a decrease in the number of a warbler species (OVEN in the figure). The figure also shows that all the tree felling spots are closer to the bird community composition in the control spots nine years later in 2006.



Source: Hanowski et al. (2003)

Fig. III.1-45 The extent of changes in, and the secular change of, bird communities in the valley forest due to different timber harvest techniques

7) Techniques of selecting noteworthy species (the IndVal method, etc.) (Technical method number 2-7)

[Application of the method to environmental impact assessment]

- In performing environmental impact assessments of ecosystems, noteworthy species are selected, and impacts on them are forecasted and evaluated. In such case, after an environmental type claasification is done, representative species are qualitatively selected from the perspective of epistatic and typicality based on the results of surveys on biota, etc. in each category (confirmation status, ecological information, etc.), and then the indicator species of ecosystems are designated as noteworthy species. One of the methods of quantitatively selecting noteworthy species based on survey results is IndVal.
- There is a case where this method was used in the environmental impact assessment of a dam project, which contributed to providing a certain objective basis for the selection of noteworthy species.

[Outline of the method]

- IndVal (or Indicator Value) developed by Dufrêne and Legendre (1997) is a method of extracting indicator species characterizing target groups of organisms.
- This is intended to figure out the index value of the species "i" in the classified sites "j," and the following formula is used for the calculation. "A" indicates the imbalance of emerging populations in a certain category, while "B" represents the imbalance in the number of emergence sites in a certain category.
- "A" means how much the species emerge on average in each environmental type category in regard to the entire target area, while "B" shows whether the species emerging in the target environmental type categories widely appear in the environmental type categories or in a limited area. The maximum value for both "A" and "B" is 1; thus, it is reasonable to think that this formula represents the typicality of each environmental type category while taking into account the emergence in the entire target area and each environmental type category.

$$A_{ij} = \mathrm{Nindividuals}_{ij}/\mathrm{Nindividuals}_{i.}$$
$$B_{ij} = \mathrm{Nsites}_{ij}/\mathrm{Nsites}_{.j}$$
$$\mathrm{IndVal}_{ij} = A_{ij} * B_{ij} * 100$$

A*ij* (measure of specificity): "Nindividuals*ij*" indicates the total of average populations per survey site of the species "i" in the environmental type category "j," while "Nindividualsi" represents the total of average populations in each pattern classification of the species "i." If the species "i" exists only in the environmental type category "j," the value of "A*ij*" is the maximum (=1).

B*ij* (measure of compatibility): "Nsites*ij*" indicates the number of survey sites where the species "i" emerged in the environmental type category "j," while "Nsite*j*" represents the number of survey sites in the environmental type category "j." If the species "i" emerge in all the survey sites of the environmental type category "j," the value of "B*ij*" is the maximum (=1).

- Since this method gives consideration to both the emerging populations and the number of emergence sites, it is more suitable for extraction of organisms serving as an indicator of a target category than an indicator only of populations and the number of sites.
- Since an imbalanced amount of survey effort occurring among the environmental type categories, such as different survey methods, hinders the selection of suitable indicator species, a field survey plan should be developed so that data can be obtained under appropriate conditions.

[Points to note]

- There must be two or more target analysis communities for calculation (if the indicator species in an environmental type category is figured out, two or more environmental type categories are needed). In other words, if the target is a single biological community, the indicator species cannot be extracted.

- If there are environmental type categories with no species to be extracted, noteworthy species are qualitatively extracted from the species constituting the communities in a conventional manner.

[Case example]

- There is a case where, in the environmental impact assessment of a dam project, IndVal was performed to extract noteworthy species of ecosystem typicality, and the results were used to designate noteworthy species for the typicality (land area).

Table III.1-32 Example of examining noteworthy species in each environmental type category using IndVal

Environmental type category	Survey period	Species name	IndVal value	Emergence frequency (Populations/Number of sites)					Verification result
				Broad-leaved deciduous forest (Mature forest)	Broad-leaved deciduous forest (Mature forests excluded)	Japanese cedar and cypress tree plantation	Cropland (Woodland)	Other	
Broad-leaved deciduous forest (Mature forest)	Breeding period in fiscal 2006	Siberian blue robin	65.0	13. /3	0./ 0	0./ 0	0./ 0	1./ 1	**
		White-backed woodpecker	61.4	6./ 3	1./ 1	0./ 0	0./ 0	0./ 0	**
	Wintering period in fiscal 2006		No values greater than 60						No significant results
Broad-leaved deciduous forest (Mature forests excluded)	Breeding period in fiscal 2006	Japanese thrush	66.7	2./ 1	5./ 3	3./ 2	0./ 0	0./ 0	**
		Asian stubtail	64.9	2./ 1	4./ 3	2./ 2	0./ 0	0./ 0	**
	Wintering period in fiscal 2006	Japanese marsh tit	68.5	3./ 1	18./ 3	18./ 5	0./ 0	0./ 0	**
		Japanese green woodpecker	66.7	0./ 0	2./ 2	0./ 0	0./ 0	0./ 0	**
Japanese cedar and cypress tree plantation	Breeding period in fiscal 2006		No values greater than 60						No significant results
	Wintering period in fiscal 2006		No values greater than 60						No significant results
Cropland (Woodland)	Breeding period in fiscal 2006	Swallow	82.7	0./ 0	0./ 0	4./ 4	35./ 3	4./ 2	**
		Grey wagtail	60.0	0./ 0	0./ 0	1./ 1	3./ 2	0./ 0	**
	Wintering period in fiscal 2006	Sparrow	100.0	0./ 0	0./ 0	0./ 0	44./ 3	0./ 0	**
		Japanese wagtail	100.0	0./ 0	0./ 0	0./ 0	6./ 3	0./ 0	**
		Rustic bunting	78.7	1./ 1	0./ 0	1./ 1	4./ 3	0./ 0	**
		Black vulture	66.7	0./ 0	0./ 0	0./ 0	3./ 2	0./ 0	**

Note) The statistical significance of IndVal is determined through randomization, and the results are shown as below.
**: Statistically significant (set as $p < 0.05$ in this example)

Source: Kinki Regional Development Bureau of the Ministry of Land, Infrastructure and Transport (2013)

[References, etc. for the method]

- Niwa, H., Mitsuhashi, H., and Morimoto, Y. (2011). “Appropriate Sampling Method for High Indexability Stream Classification of Vegetation at the Catchment Scale,” *Japanese Journal of Conservation Ecology* 16: 17–32.
- Dufrêne, M., and Legendre, P. (1997). “Species Assemblages and Indicator Species: The Need for a Flexible Asymmetrical Approach,” *Ecological Monographs* vol. 67(3): 345–66.
- McCune, B., and Grace, J. (2002). *Analysis of Ecological Communities*, MjM Software Design, Gleneden Beach, Oregon.

1.2.3 Examination of environmental conservation measures

1) Complementation analysis (Technical method number 3-1)

[Application of the method to environmental impact assessment]

- There are numerous cases of transplanting important plant and animal species, etc. as environmental conservation measures in environmental impact assessment. However, there is no case which the species are transplanted to the places where are extracted based on data analysis, etc. in an objective and quantitative manner.
- Complementation analysis is a method capable of preferentially showing the places extracted according to the conditions which is set as the prioritized conditions, such as lower cost and more species to be conserved, , in order to efficiently conserve multiple important species. This method is expected to facilitate efficient and effective environmental conservation measures, including transplantation.
- Due to its capability of extracting multiple candidate sites to which species are transplanted, this method is useful in building local consensus for environmental conservation measures.

[Outline of the method]

- Complementation analysis is a method for extract areas to be preferentially conserved to help the conserved areas function in a complementary style when selecting conservation areas for important species, etc. By setting extraction conditions well, it is possible to extract areaes, for example, to ensure the maximum benefit at the lowest cost. There are various programs, including Marxan, Zonation, and C-Plan. Due to their distinctive features, the extent of conservation areas to be selected may vary by program.
- Complementation analysis is a method for achieving the conservation goal of “conserving all species at one or more sites” at the lowest possible cost by using the distribution data of all target species and selecting a set of (highly complementary) blocks not overlaid with the species composition.
- Taking the goal of “conserving all species at one or more sites” to the following emergence as an example, if Block A has already been selected as a conservation area, focusing only on the number of species will lead to selecting Block B with more species than Block C. In a complementation analysis,

on the other hand, (highly complementary) Block C with species less overlaid with Block A will be selected. As a result, Blocks A and C will be selected as target conservation blocks. Complementation analysis is designed to set an arbitrary target number of blocks that should be at least conserved for each of the target species according to the procedures, and to identify a feasible set of blocks with as few total blocks as possible based on the goal (Ministry of the Environment [2012]).

Block A	Species 1	Species 2	Species 3	Species 4		
Block B	Species 1	Species 2		Species 4		
Block C					Species 5	Species 6

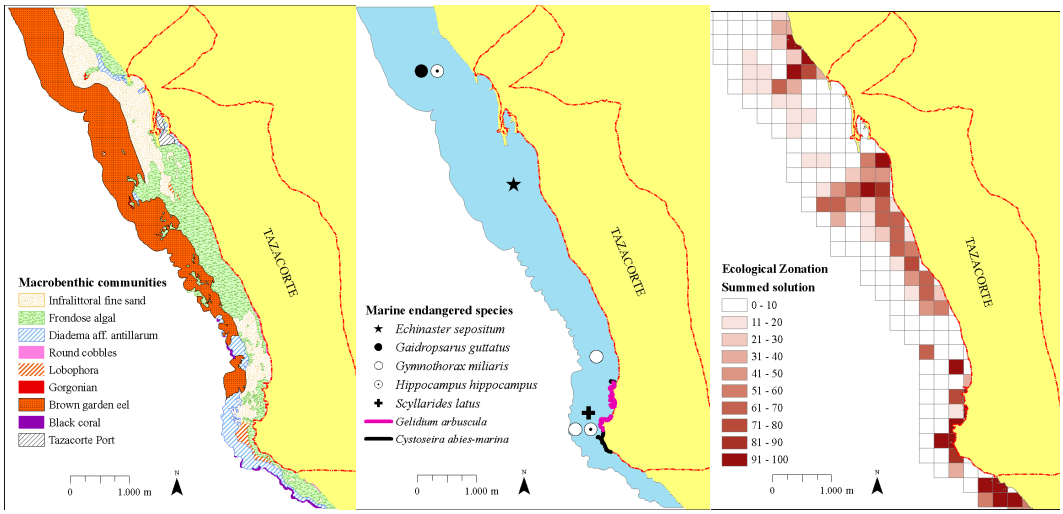
- Complementation analysis can not only be used in extracting places that should be avoided, but also can be applied to the selection of new conservation areas and reclaimed areas based on the distribution conditions of important species and local important sites.
- If important sites disappear due to a project, comprehending the relative changes in important sites in the entire target area, this method is useful in extracting priority areas to be conserved in the future or examining the potential locations of compensatory lands that contribute to higher value of the entire area as an environmental conservation measure.

[Points to note]

- In conducting this method, the conditions for important sites should be fully understood in the target area. If there is insufficient information on necessary items, attention should be given to the fact that outputs may differ depending on the extraction conditions.
- In a complementation analysis, one of the optimal combinations of sites for achieving goals is output per calculation. Therefore, consideration should be given to the fact that the results can vary if a certain place is (or is not) designated as being subject to conservation, and this analysis need to be repeated for the each draft of alternative plan.
- Outputs vary depending on extraction conditions; thus, the results can further reflect the purposes and opinions of community residents, etc. by incorporating the elements judged by them to be important into the extraction conditions.
- This is an effective approach if the area subject to the analysis is relatively wide. However, this is not suitable if environmental conservation measures are taken in a limited area, such as spaces around the project implementation area.
- In comprehending regional characteristics (including the stage of preparing the document on primary environmental impact consideration), performing a complementation analysis may possibly comprehend important sites. In this case, it is preferable to conduct a field survey to check whether the assumption was adequate.

[Case example]

- There is a case where, in the special area of conservation (SAC) designated under Habitat Directive on western margin of La Palma Island, located at the northwestern of the Canary Islands, conditions that should be conserved preferentially were set from the perspectives of the (1) diversity representation and heterogeneity, (2) imminence, and (3) designation priority conservation zone of the biological communities in coastal areas, and MARXAN was performed to classify the sea areas that reflect the conditions to the maximum extent possible.
- As a result, the littoral zone with rocky bottoms and seawood communities and deep rocky with high complexy bottom that correspond with the gorgonian and black coral communities were sellected as priority conservation zones.



Source: Garcia et al. (2010)

Fig. III.1-46 Example of extracting important sites through complementation analysis

[References, etc. for the method]

- Akasaka, M., and Mori, A. (2012). "Management of Natural Sanctuaries, Ecosystem Management," 73–95, Kyoritsu Shuppan.
- Margules, C., and Sarker, S. (2007). *Systematic Conservation Planning*, Cambridge University Press.
- Moilanen, A, Wilson, K., and Possingham, H. (Eds.) (2009). *Spatial Conservation Prioritization: Quantitative Methods and Computational Tools*, Oxford University Press.
- Chee, Y., Parris, K., and Wintle, B.A. (2011). "Methodologies and Tools for Strategic Assessments under the EPBC Act 1999. A Report to the Department of Sustainability, Environment, Water, Communities and Population," The University of Melbourne.

1.2.4 Follow-up survey

1) Utilization of image analysis technology (Technical method number 4-1)

[Application of the method to environmental impact assessment]

- Follow-up surveys in an environmental impact assessment are required to be conducted in an efficient and effective manner. New image and audio devices may be useful in follow-up surveys on ecosystems, while image analysis technologies as a visual plankton recorder (VPR) are expected to be used in exploring marine organisms.
- Image analysis technologies including VPR are currently at a research stage and have not yet been employed in environmental impact assessments. These technologies are anticipated to be used for monitoring, etc. of project-caused impacts especially in sea areas and dam lakes by achieving early ascertainment of the changes in emergence of plankton and detecting the signs of emerging red tides, etc. to reflect them in measures to be taken.

[Outline of the method]

- VPR is a device that automatically photographs plankton and suspended substances in the water and records them in addition to water temperature, water depth, and other environmental data. This method is capable of recording natural images of organisms without causing damage to samples that may occur during plankton net sampling.
- Using image analysis software now makes it possible to automatically extract the images of plankton, roughly organize classification groups, and even measure their size. So far, there have been no techniques capable of identifying detailed species.

[Points to note]

- When using this method in a follow-up survey, measures need to be taken to compare with data obtained before the project is implemented.

[Case example]

- There is a case where zooplankton was photographed using a VPR, which obtained clearer images with fewer foreign substances than the images of samples collected using plankton nets.

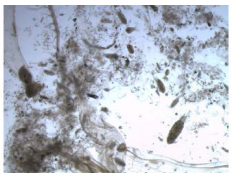


Fig. 1 Samples captured by plankton net
Samples tend to form a mass or to bend, which is unclear whether the phenomenon can be seen underwater.

Fig. 2 Visual Plankton Recorder
The device on the front right side (circular wheel) is a strobe, and the left one is a lens.

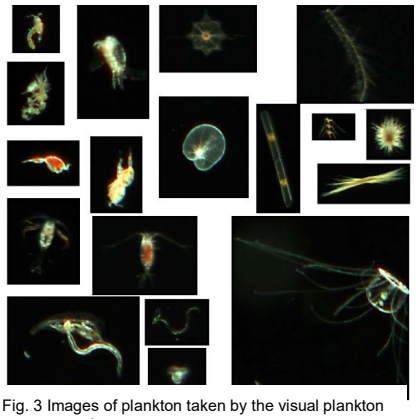


Fig. 3 Images of plankton taken by the visual plankton recorder

Source: Kitajima (2014)

Fig. III.1-47 Samples collected using plankton nets and VPR images

[References, etc. for the method]

- Kitajima, S. (2014). "How Food for Fishes Live in the Water—Plankton Research Using Visual Plankton Recorder," Seikai National Fisheries Research Institute, Japan Fisheries Research and Education Agency. Research and Development Journal *Seikai* no.16:3.

2. Interaction with Nature (Landscape, Place for Recreation Activities)

In regard to interaction with nature, the concept of selecting environmental impact assessment items and the technical methods, etc. of surveys, forecasts, and evaluations are discussed and exemplified in *A Guide to Environmental Impact Assessment for Landscape and Recreation Activities*, published in 2002, whose content is still useful today. In light of changes in public awareness about the landscape, establishment of relevant laws and regulations including the Landscape Act (2004), progress in landscape administration, and the 2007 revision to the basic matters based on the Environmental Impact Assessment Act, *Technical Guidance on Environmental Impact Assessment for Landscape* was published in 2008 and organizes the main points of the conclusions made at the review meeting for *Technical Guidance on Environmental Impact Assessment (Related to Landscape) for Surveys*. This guidance classifies the measures for issues in conducting a landscape environmental impact assessment into several steps and also explains about the relationship with landscape planning.

The basic techniques and points in conducting environmental impact assessments are organized in this guidance with consideration given to the background. This guidance also provides information on how to utilize new technical methods for future environmental impact assessments, as well as points to note in using them. Refer to other existing guidelines, as needed, for the details and case studies of various techniques.

2.1 Basic Methods and Key Points (Landscape)

2.1.1 Selection of environmental impact assessment items and survey, forecast, and evaluation methods

1) Comprehending project characteristics

In comprehending project characteristics, for the purpose of obtaining information necessary to select environmental impact assessment items and survey, forecast, and evaluation methods, impact factors that may produce project-caused impacts are selected assuming of direct alteration to major scenic viewpoints, landscape resources, and views due to construction work or the existence and use of land or structures, or potential impacts of changes in the usage status of scenic viewpoints, including noise occurrence and disrupted access (see Table III.2-1). Project characteristics are also comprehended with consideration to the timing when such impacts occure during construction work or at the time of existence and use of the land or structures.

Table III.2-1 Major impact factors for the landscape and their potential impacts

Category of impact factors	Sub-category of the factors	Potential impacts
Implementation of construction work	Use of construction vehicles	Occurrence of noise and disrupted access (views and surrounding landscape: changes in the usage status)
	Operation of construction machines	Occurrence of noise and disrupted access (views and surrounding landscape: changes in the usage status)
	Temporary impacts, such as land reclamation	Emergence of a bare ground for land reclamation (views and surrounding landscape: changes in the status of scenery) Occurrence of turbid water due to sediment outflow (views and surrounding landscape: changes in the status of scenery)
	Removal of existing facilities Establishment of makeshift structures	Disappearance of facilities with high value recognition (views and surrounding landscape: changes in site and scenery) Emergence of makeshift structures (views and surrounding landscape: changes in the status of scenery)
Existence and use of land or structures	Alteration to land	Alteration to landscape components (views and surrounding landscape: changes in site, use and scenery)
	Existence of structures	Emergence of structures (views and surrounding landscape: changes in the status of scenery)
	Use and operation of facilities	Occurrence of noise and disrupted access (views and surrounding landscape: changes in the usage status)

2) Comprehending regional characteristics

In comprehending regional characteristics, it is need to comprehend the natural foundation that constitute the regional framework and the features of regional historical and cultural backgrounds, and the characteristics of people's lives and the relating places, zones, activities, etc. from various perspectives of not only major scenic viewpoints and landscape resources but also nature, history, and culture, and to compile them as basic information (see Table III.2-2). In terms of environmental conservation, the designation of areas, etc. under laws, regulations, or ordinances and the sites, etc. which are considered to be important in the designated areas are the targets of ascertainment also.

Information on regional characteristics compiled in the process for document on the primary environmental impact consideration is also utilized, if any.

i) Collection and arrangement of basic information

(1) Collection and arrangement of existing materials

If there are existing materials that have been collected in preparing the document on the primary environmental impact consideration, they are utilized and rearranged in light of the project characteristics, the maturity of project plans and the regional characteristics.

xisting materials are collected basically from those published and disclosed by public agencies, and as target from among those about targets, etc. selected in landscape plans and tourism administration and those about sites and facilities available for visitors at viewing spots, etc. Some commercial tourist guidebooks and materials published by individuals and organizations contain useful information; thus, relevant information should be tried to collecte as extensively as possible. Some target areas have not been designated by laws and regulations; even satochi-satoyama, farmlands, and other potential sites as natural resources and scenic viewpoints are also the target areas where existing materials need to be collected and compiled.

The survey results of existing materials should undergo a synoptic survey on an as-needed basis to ensure that the results are up-to-date and highly accurate information before use.

Table III.2-2 Characteristics of project plans and regional characteristics that should be comprehended from the landscape perspective

Characteristics of the project plan	Regional characteristics that should be comprehended from the landscape perspective	
	Areas or targets designated by laws and regulations from the perspective of environmental conservation	Areas or targets that are not designated by laws and regulations, but should be selected as important sites according to the areas
• Direct alteration to scenic viewpoints and landscape components, including landscape resources • Changes in scenery after emergence of tall structures between scenic viewpoints and landscape resources • Changes in surrounding scenery due to long and large structures with high visibility • Changes in surrounding landscape	• Zones protected and restricted under landscape protection regulations, etc. of local governments • Nature parks • Specified natural tourism resources designated under the Ecotourism Promotion Act • Natural landscape resources on natural environment maps, etc. • Basic environmental plans of local governments, regional landscape goals in landscape formation plans, etc. • Protected species designated under the Act for the Protection of Cultural Properties, etc. • Long-distance nature trails, etc.	• Satochi-Satoyama (secondary forests and artificial forests), farmlands, reservoirs, grasslands, riparian forests, etc. that have been decreasing or deteriorating on a regional scale • Woodlands, green spaces (forests on slope, temple and shrine groves, homestead woodlands, etc.), and riparian areas, etc. that remain in urban areas and are important natural environments characterizing the regions • Temples, shrines, historic sites, etc. • Target areas of nature restoration, reforestation, and activities for conservation of Satochi-Satoyama

(2) Synoptic field survey

In order to obtain information necessary to select major scenic viewpoints subject to environmental impact assessments and examine survey, forecast, and evaluation methods, synoptic field surveys are conducted with appropriate means, such as walking and using vehicles, for the purpose of on-site confirmation of information from existing materials.

(3) Interviews with experts, etc.

Interviews with experts, etc. are carried out on an as-needed basis to support the results of survey on existing materials and synoptic surveys. Interviewees may include academic experts, museum curators, officials from local governments (departments/sections related to the environment, nature conservation, tourism, commerce, and education), environmental protection groups, community development groups, tourism business operators, and local intellectuals. In particular, local governments may have detailed information on tourist spots, viewing spots, landscape resources that include local activities and cultural properties, and scenic viewpoints, which should be focused on in interviews. In conducting interviews, consideration should be given to the extraction of elements familiar among community residents, including scenic viewpoints and landscape resources, while relevant information should also be collected to prepare for the secondary use of surrounding landscapes in historical and cultural activities, such as ritual sites.

(4) Arrangement of resultsof collection and claasification of existing materials

In order to lay a foundation for selecting targets of environmental impact assessments and determining survey, forecast, and evaluation methods, in arranging the results of of collection and claasification of existing materials, synoptic sfield urveys and interviews with experts, it is preferable to comprehend the topography and other fundamental environments (characteristic topography, water system, etc.); identify the spatial structure focused on land cover (vegetation); and compile population distribution and other regional natural backgrounds so that such information can be overlaid with one another using geographical information systems, and visual analysis can also be conducted with simplified topographical models.

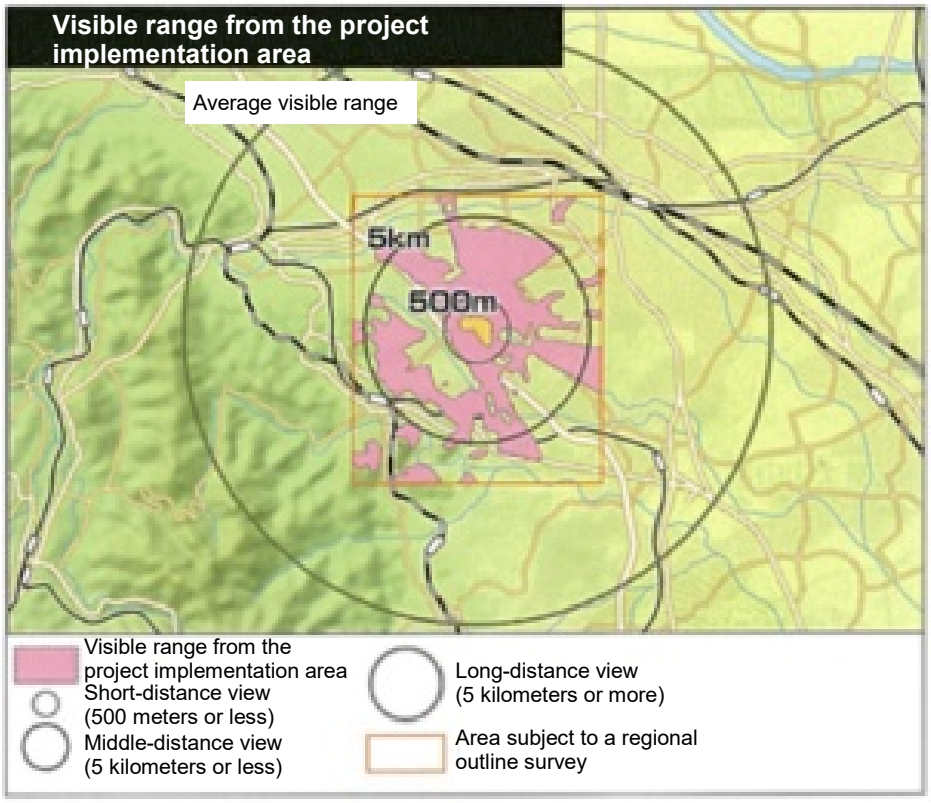
Table III.2-3 Example regional characteristics, etc. that should be comprehended based on the results of existing materials collected and classified

Region	Viewpoint	Reference for the accuracy and scope that should be comprehended	Regional characteristics, etc. that should be comprehended		
Mountainous natural areas	Relatively abundant virgin and excellent nature can be found in mountainous natural areas. Out-of-the-ordinary natural experience-based recreation is mainly provided in these areas; the scope of activities, the extent of views, and the scale of resources tend to be larger. Attention should also be paid to unique distinctive livelihood cultures as traditional mountain religion.	• 1/200,000 to 1/50,000 • 20- to 30-km radius	Topographical elements	Characteristic topographies	Moderate slopes, rapid slopes, mountaintops, mountain paths, ridgelines, ridges, cliffs, caves, topographical transition points, etc.
				Water systems	Canyons, rivers, waterfalls, swamps, wetlands, hot springs, etc.
				Inland waters	Lakes, ponds, dams, etc.
			Biological elements	Animals	Habitats of medium- to large-size organisms, habitats of wild birds, etc.
				Plants	Natural forests, grasslands, communities of specified plants, etc.
			Humanity elements	Roads	Mountain trails, nature trails, nature observation paths, etc.
				Historical culture	Objects of worship (giant trees, giant stones, etc.), cultural properties, temples and shrines, etc.
				Public facilities	Visitor centers, park facilities, etc.
				Outdoor recreation sites	Ski resorts, fishing spots, campsites, etc.
				Population distribution	N/A
				Legally designated areas, etc.	Natural parks, wild bird sanctuaries, reserved forests, protected species, etc.
Satochiand natural areas	Satochi and natural areas have historical relationships between humans and nature and are the reminiscence of nostalgic original scenery. These areas enjoy abundant secondary natural resources, and activities that give nostalgic, friendly, and comfortable feelings are mainly conducted. Human-intervened nature generally leads to smaller scope and size of activity than those in the mountains, while many elements are concentrated in a mosaic pattern, requiring attention to the fact that the features make it possible to provide various interactions.	• 1/50,000 to 1/10,000 • 10- to 20-km radius	Topographical elements	Characteristic topographies	Moderate slopes, rapid slopes, mountaintops, mountain paths, terraces, cliff lines, valley-style topography, and topographical transition points, etc.
				Water systems	Rivers, river beaches, canyons, banks, irrigation canals, etc.
				Inland waters	Lakes, ponds, reservoirs, etc.
			Biological elements	Animals	Habitats of medium-size organisms, habitats of wild birds, etc.
				Plants	Wooded areas, symbolic plants (massive trees, giant trees, sacred shrine forests, etc.), grass fields, communities of specified plants, etc.
			Humanity elements	Roads	Old roads, walking trails, nature observation paths, cycling paths, hiking paths, etc.
				Farmlands	Paddy fields, fields, orchards, etc.
				Historical culture	Objects of worship, ruins and historic places, temples and shrines, cultural properties, landmarks, etc.
				Public facilities	Schools, museums, parks, etc.
				Outdoor recreation sites	Field athletics, famous cherry blossom-viewing spots, guest ranches and farms, campsites, etc.

Region	Viewpoint	Reference for the accuracy and scope that should be comprehended	Regional characteristics, etc. that should be comprehended		
				Population distribution	Population distribution, densely populated areas, etc.
				Legally designated areas, etc.	Natural parks, wild bird sanctuaries, reserved forests, protected species, etc.
Non-mountainous natural areas	Highly dense human activities are conducted in non-mountainous natural areas; important elements include green spaces, watersides, and other natural components that remain in places closer to humans where they can interact with nature in their daily lives. The size of resources generally tends to be smaller, requiring attention to the fact that place-specific elements, which people easily overlook with traditional values, are the main actors.	• 1/25,000 to 1/several thousand • 10-km radius	Topographical elements	Characteristic topographies	Moderate slopes, hills, topographical transition points, etc.
				Water systems	Rivers, banks, riverbeds, irrigation canals, sandbanks, etc.
				Inland waters	Lakes, ponds, reservoirs, etc.
			Biological elements	Animals	Animal observation sites, etc.
				Plants	Pedestrian paths, school forests, homestead woodlands, symbolic plants, grass fields, communities of specified plants, etc.
			Humanity elements	Roads	Walking trails, walkways, cycling paths, etc.
				Farmlands	Paddy fields, fields, orchards, community farms, etc.
				Historical culture	Objects of worship, ruins and historic places, temples and shrines, cultural properties, landmarks, etc.
				Public facilities	Schools, museums, city parks, open spaces, etc.
				Outdoor recreation sites	Famous cherry blossom-viewing spots, boat piers, etc.
				Population distribution	Population distribution, densely populated areas, etc.
				Legally designated areas, etc.	Natural parks, wild bird sanctuaries, green conservation areas, protected species, etc.
Coastal areas (Satoumizones)	Coastal areas are places to support the interaction between the sea and humans and are composed of natural coasts, artificial coasts, cliffs, sandy beaches, and various other elements. The greater the access to the waterfront line and the more natural it is, the wider the scope of acceptable activities and the greater the size of resources. Attention should be paid to the fact that, even if there is no continuity in a land area, ships and other means of transportation may cause correspondence, or there may be visual correspondence on the opposite shore across the sea area.	• 1/200,000 to 1/25,000 • Set larger value with consideration given to the continuity by the sea area, with reference to the scope of the land area of hinterland.	Fundamental elements	Characteristic topographies	Rocky shores, sandy beaches, tidelands, brackish-water lakes, seashore lakes, river mouths, capes, cliffs, coral reefs, seaweed beds, tide pools, etc.
			Biological elements	Animals	Habitats of animals in coastal areas (including fresh-caught fish), coral reefs, etc.
				Plants	Seashore vegetation, coastal forests, communities of specified plants, mangrove forests, seaweed, etc.
			Humanity elements	Roads	Walking trails, walkways, cycling paths, etc.
				Historical culture	Objects of worship, ruins and historic places, temples and shrines, cultural properties, landmarks, etc.
				Public facilities	Ports, lighthouses, piers, schools, museums, etc.
				Outdoor recreation sites	Bathing beaches, diving spots, fishing spots, etc.
				Population distribution	Population distribution, densely populated areas, etc.
				Legally designated areas, etc.	Port areas, coastal conservation zones, natural parks, wild bird sanctuaries, reserved forests, protected species, etc.

ii) Selection of major landscapes subject to environmental impact assessments

Based on the results of classification of information on project characteristics and regional characteristics, landscape resources and scenic viewpoints are comprehended in terms of the relationship with various landscape resources and the positional and visual relationship with the project implementation area. Then, such data are extensively extracted from as many perspectives as possible to organize them in a distribution map or list. Targets of environmental impact assessments for landscape resources are selected in the context of the major perspectives of aesthetics, endemism, affinity, historicity, and visibility. In regard to scenic viewpoints, the targets are selected according to availability, view property, and historicity based on humanity elements (walking paths, densely populated areas, observation sites, etc.). In selecting the targets, a visible range map is prepared using a geographical information system (GIS) as shown in Fig. III.2-1 to simulate the outline of the types and scope of the influence of project-caused impact factors on landscapes, while taking into consideration the area, height, etc. to be altered by the project.



Source: Japan Wildlife Research Center (2002a)

Fig. III.2-1 Example of comprehending the visible range for the selection of landscape resources and scenic viewpoints

3) Selection of the targets of environmental impact assessment

i) Extraction of impact factors

The positional relationship between the project content/planned site acquired by comprehending project characteristics and the major landscape resources/scenic viewpoints obtained by comprehending regional characteristics is used to extract potential impact factors, such as the implementation of construction work and the existence and use of lands or structures, and impacts on the view and use of various landscape resources, etc.

ii) Selection of the targets of environmental impact assessment

Targets of an environmental impact assessment for the landscape are selected with consideration given to the usage status of major landscape resources and scenic viewpoints that may be affected by the project. In such cases, scenery is comprehended based on the relationship between landscape resources and scenic viewpoints using a visible range map, etc., while also considering the site of the project implementation area. In such cases, possible changes in major scenic viewpoints and the distant landscape of landscape resources therefrom are counted as impacts on the distant landscape. On the other hand, project-caused direct alteration to landscape resources and changes in their characteristics, as well as changes in the usage status and scenery, are counted as impacts on the surrounding landscape. These efforts make it possible to make examination so that the targets of the impact forecast and evaluation include impacts on regionally prominent landscapes, as well as on the landscape from the sites used by local residents every day and the landscape that is important for community people.

[Reference Data] Distant landscape and surrounding landscape

In environmental impact assessments, distant landscape and surrounding landscape are compiled as follows.

<Distant landscape: Two-dimensional landscape focused on visually recognized images>

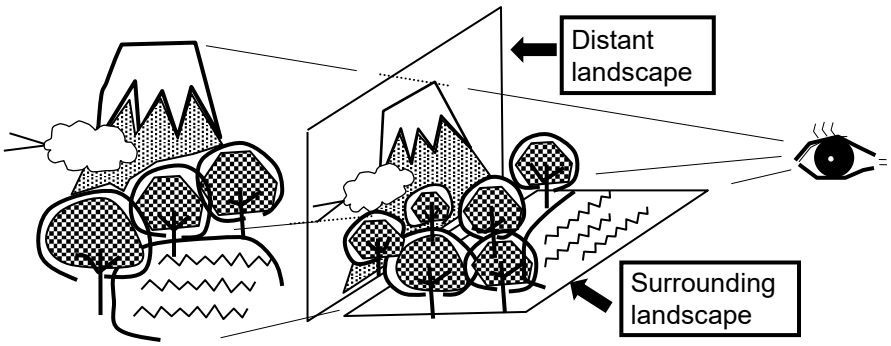
A distant landscape in an environmental impact assessment means the scenery of a project implementation area viewed from a place distant from the project implementation area. Changes in distant landscapes are captured according to changes in the visual images caused by the project.

Thus, the scope of possible impacts on the distant landscape is the extent where project-caused changes can be visually recognized, meaning that generally the relatively wide area outside the project implementation area is included in the scope of impact. In the case of the distant landscape, however, it is common to capture project-caused impacts on behalf of the scenery from specific scenic viewpoints or the scenery of specific landscape resources.

<Surrounding landscape: Three-dimensional landscape focused on the status of physical space around scenic viewpoints and the status of sites>

A surrounding landscape in an environmental impact assessment means the scenery of the project site and its adjacent area. Changes in the surrounding landscape are captured according to changes in the status of physical sites associated with project implementation and in the act of watching (use), as well as changes in the visual images associated therewith.

Thus, the scope of possible impacts on the surrounding landscape is limited to the project implementation area and its adjacent area. In the case of the surrounding landscape, however, even if no famous scenic viewpoints or prominent landscape resources are available, it is necessary to capture in detail changes in the landscape around the community, with a focus on the sites used by local residents every day or the scenery that has attracted community people since historic times. This is important in conserving locally distinctive landscape and the relationship with surrounding nature.



Source: Shiota et al. (1967)

Fig. III.2-2 Conceptual diagram of distant landscape and surrounding landscape

If the selection of impact factors and environmental elements has found possible changes in major scenic viewpoints, landscape resources, distant landscape (scenery of landscape resources viewed from major scenic viewpoints), and surrounding landscape, these are selected as the targets of the environmental impact assessment.

4) Selection of survey, forecast, and evaluation methods, etc.

i) Concept of survey, forecast, and evaluation methods

The scope of survey on the distant landscape and the surrounding landscape is set in light of the extent where impacts may occur due to the relationship with impact factors and environmental elements for each landscape. Survey, forecast, and evaluation methods are also selected in consideration of changes in the value recognition of the landscapes. For landscape, it is common to use photomontage and other approaches that create images for forecasting changes in landscape. It is preferable, for example, to examine indicators to quantify the impacts and

capture changes in the value recognition, based on the images created. In addition to direct impacts on landscape resources and scenic viewpoints, it is also necessary to examine survey and forecast methods to address indirect environmental impacts, such as noise to the usage status of scenic viewpoints.

ii) Sophistication and simplification of survey and forecast methods

Examination is made so as to sophisticate or simplify survey and forecast methods in light of the importance of the distant landscape and the surrounding landscape and the extent of their impacts. For example, if there may be impacts on the surrounding landscape regarded important in the area, a detailed extraction of scenic viewpoints should be performed. On the other hand, if the project implementation area is less visible in its surrounding area from any scenic viewpoints, survey sites and survey timing should be limited and simplified.

2.1.2 Survey

1) Examination of items to be surveyed

Items to be surveyed for landscape include comprehending the status and value recognition in regard to the distant landscape and the surrounding landscape. Fig. III.2-3 indicates the sequence of comprehending the distant landscape, the surrounding landscape, and their value recognition. Since the value of landscape changes according to the human values, it is necessary not only to comprehend its status in physical characteristics, etc., but also to compile the value recognition based on the view of users' perception for values.

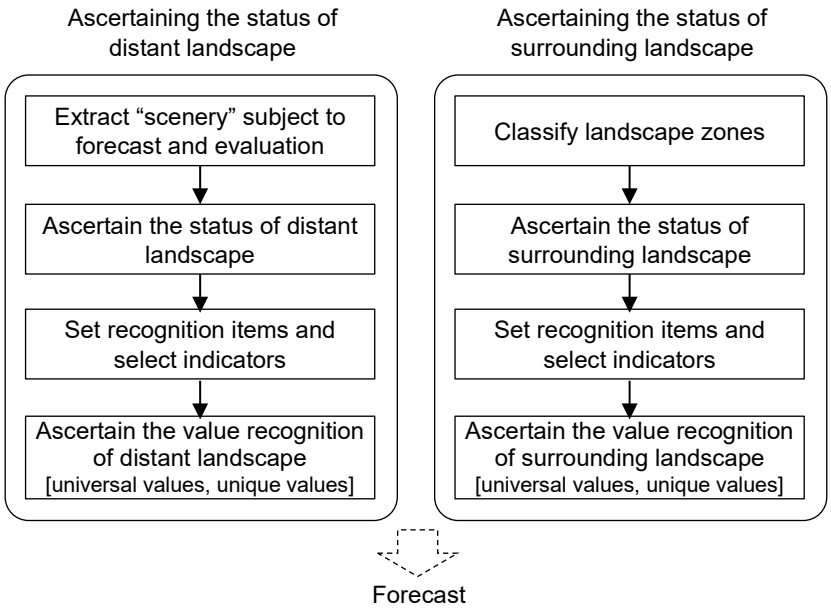


Fig. III.2-3 Items to be surveyed for landscape and survey procedures

2) Concept of survey methods

i) Survey methods for the distant landscape

(1) Comprehending scenery

Before comprehending the status of the distant landscape, the scenery of landscape resources is comprehended for forecast and evaluation by using the results of a GIS-based analysis on visible range from major scenic viewpoints and also images obtained from on-site surveys.

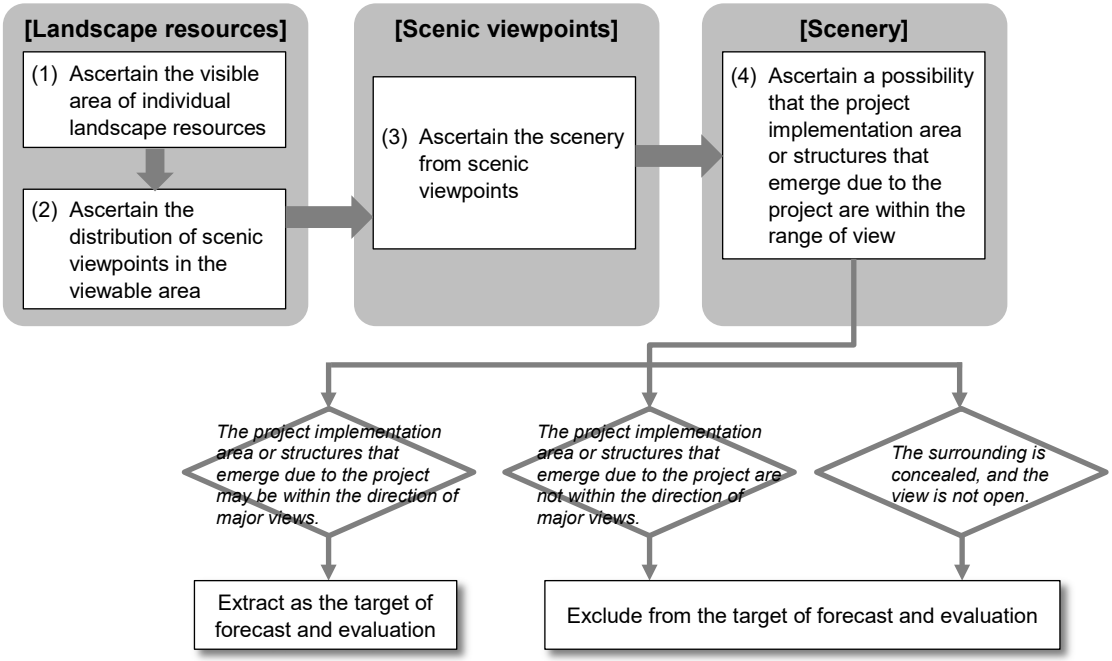


Fig. III.2-4 Example procedures of extracting the sceneries to be forecasted and evaluated

(2) Comprehending the status of the distant landscape

As shown in Table III.2-4, the status of the distant landscape is comprehended by identifying the usage status and the status of scenery in regard to the landscape. The status is comprehended by carrying out visual confirmation in on-site surveys, photography, user count surveys, interview surveys, questionnaire surveys, etc. In this case, it is necessary to pay attention to changes in weather, the seasons, and activities of nature and humans, as well as to take the survey period and survey time (sunshine, ebb and flow of the tide, etc.) into consideration.

Table III.2-4 Items and content of surveys to comprehend the status of the distant landscape

Survey items		Survey content
Usage status	Number and attribute of users	Number of users, age groups, group compositions, departure point, frequency, seasonal variations, annual change, etc.
	Usage form	Usage priority, usage characteristics, usage types other than views, etc.
	Visual image	Record in the form of image data, such as photos and videos

Status of scenery	Data on topography, etc.	Elevation data, vegetation data, position, size, and configuration data of structures, etc.
	View target	Presence/absence of major view targets, positional relationship between view targets and landscape resources or project implementation area, etc.
	Direction and vision of views	The spread angles in major directions/orientations in which the views are available, and the positional relationship among major view targets, landscape resources, and the project implementation area in the angles
	Landscape compositions	Positional relationship between the status of data on topography, etc., and major view targets, landscape resources and project implementation area
	Visibility analysis	Confirmation of scenic viewpoints and comprehending landscape resources and the visibility of the project implementation area based on the visible range from specific scenic viewpoints or by a visibility frequency analysis in terms of multiple groups of viewpoints

(3) Selection of targets and indicators of value recognition

Based on the results of comprehending the status of the distant landscape, important perspectives for the value recognition of the distant landscape in the region are comprehended, while indicators for value recognition are also selected. In such cases, in view of the classification of the universal values and unique values of the landscape, targets whose value recognition is thought to be important in the region are selected based on the foregoing values, and representative indicators deeply involved with the targets are identified as survey targets. Since the perspective on the value recognition varies between community residents and visitors, including tourists, it is important to conduct surveys based on the two perspectives and compile the survey results.

(4) Comprehending the value recognition of the distant landscape

In regard to the distant landscape subject to forecast and evaluation, questionnaire surveys (e.g., questionnaires on the differences in impression between visual images and photomontage images) necessary for each distant landscape are conducted using the selected indicators to compile the recognition status of values for the distant landscape.

Table III.2-5 Targets of the recognition of the distant landscape, example representative indicators, and survey methods

Classification of values	Target of recognition	Representative indicator (example)	Survey method
Universal values	Naturalness	Green coverage rate, occupancy rate within the visual field of artifacts	• Questionnaire survey • Interview survey • Count survey • Physical quantity measurement using visual
	View property	View angle, view quantity (visual space quantity, sight defilade) Visual composition (composition of upward and downward views and short, middle, and long-distance views)	
	Availability	Number of users, availability, attribute width of users	

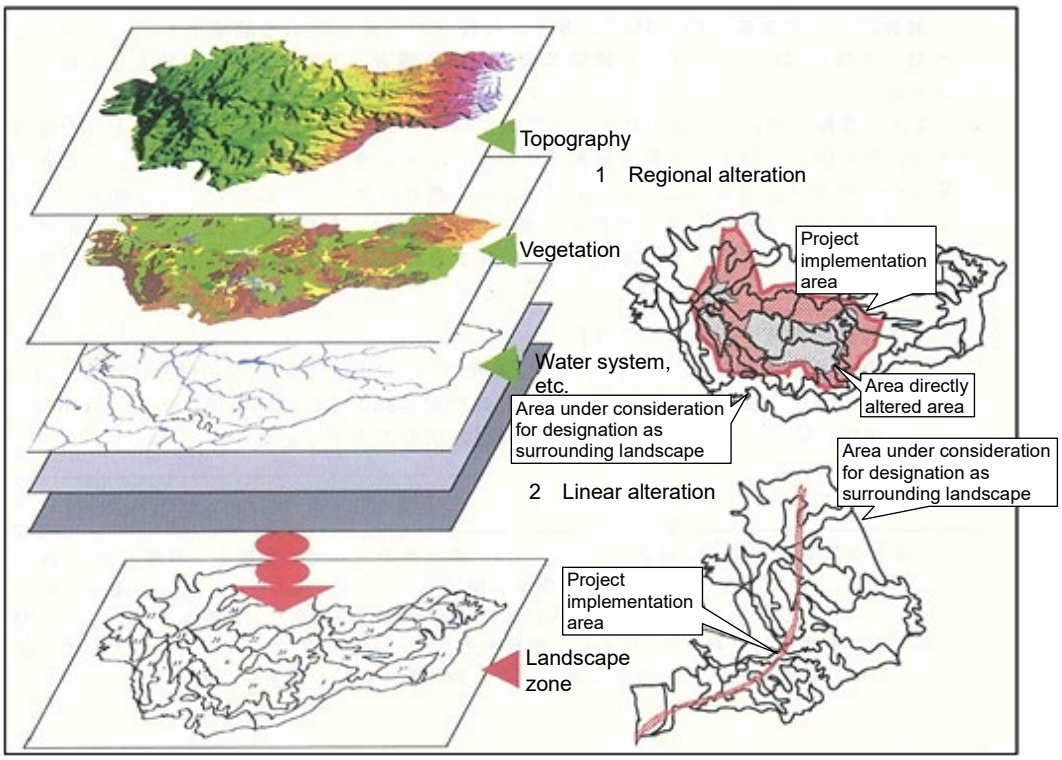
	Theme	Presence/absence of major subjects of interest Prospective angle of subjects of interest (visual size of the horizontal and vertical directions of subjects of interest) Topography, groundcover, and features lying between subjects of interest Clearness of visual axes	images • Sensory quantity measurement using visual images • On-site physics measurement and sensory quantity measurement • Visualization analysis and topographical analysis by creating numerical topography models • Reading topographical map data • Visual observation and acquisition of visual images by on-site survey
	Competence	Visual distance, visual area, elevation angle, depth feel, height	
	Harmonic content	Color contrast against the background (brightness, saturation, luminance) Presence/absence of disconnected background skyline Silhouette rate Structural similarity with background skyline Scale ratio to the background Positional relationship with subjects of interest	
	Uniformity	Complexity (morphological similarity, color similarity) Coherence (layout regularity, sense of rhythm)	
	Aesthetics	Beauty (comprehensive indicators for universal values)	
Unique values	Endemism	Unique and distinctive visual features	• Questionnaire survey • Interview survey • Survey on materials • Sensory quantity measurement using visual images • On-site sensory quantity measurement
	Historicity	Visual features that have been passed down since ancient times Visual features evoking historical facts	
	Locality	Visual features evoked as original local landscape Visual features recognized as local symbols	
	Depletion	Visual features that have been gradually disappearing in the region	
	Affinity	Visual features familiar among community residents	

ii) Method of surveying the surrounding landscape

(1) Classification of landscape zones

The methods to comprehend the surrounding landscape include a technique of classifying the space where the surrounding landscape is comprehended into spaces having several relatively homogeneous landscapes (landscape zones) (see Fig. III.2-5) to comprehend the status of sites of each landscape zone, the usage status, and the status of scenery. This classification is done by combining several pieces of information, such as water system, altitude, incline-based classification, topographical classification, vegetation classification,

and results of visual observation. Classification is also performed on appropriate scaling depending on the project characteristics (altered area, etc.) and regional characteristics (topographical complexity, etc.).



Source: Japan Wildlife Research Center (2002a)

Fig. III.2-5 Example classification of landscape zones

Table III.2-6 Example selection of landscape zones

Name of landscape zone	Target of landscape
○○ Village	○○ Village, paddy fields in the village, houses in the village, secondary forests behind the village, shrines, stone Buddhist images
Downstream part of ○○ River	Canyon landscape along ○○ River, waterfalls, deciduous forests

Representative scenic viewpoints are selected according to the status of each landscape zone. In selecting scenic viewpoints, it is necessary to take their historicity and locality into consideration and also pay attention to immediate landscapes, especially those familiar among community residents.

(2) Comprehending the status of the surrounding landscape

The status of the surrounding landscape is comprehended by arranging the status of sites, usage status, and status of scenery in regard to the landscape zones and selected scenic viewpoints. The status is comprehended by carrying out visual confirmation in on-site surveys, photography, user count surveys, interview surveys, questionnaire surveys, etc. In this case, it is necessary to pay attention to changes in weather, seasons, and activities of nature and humans, as well as to take the survey period and survey time (sunshine, periods of ebb and flow, etc.) into consideration.

Table III.2-7 Example survey targets for comprehending the status of the surrounding landscape

Classification of status	Survey target	Survey content
Status of sites	Topographical elements, natural phenomena, biological elements, humanity elements	The status of physical, biological, and humanity targets that constitute the surrounding landscape is comprehended.
Usage status	Number of users, attribute of users, intended use/periods of use	The status of the behaviors of humans who recognize the surrounding landscape is comprehended.
Status of scenery	Visual images (sketches, photos, CG, etc.) Physical quantity of visual stimulus (brightness, color of components, etc.)	The status of the surrounding landscape is visually comprehended.

(3) Selection of recognition targets and indicators

Based on the results of comprehending the status of the surrounding landscape, targets that should be recognized and are thought to be important in the respective regions are selected each in the category of universal values and unique values, and a survey is conducted for the representative indicators.

Table III.2-8 Targets of the recognition of the surrounding landscape, example representative indicators, and survey methods

Classification of values	Target of recognition	Representative indicator (example)	Survey method
Universal values	Diversity	Topographical complexity, vegetation, the degree of mosaic for land use	• Questionnaire survey • Interview survey • Count survey • Physical quantity measurement using visual images • Visualization analysis and topographical analysis by creating numerical topography models • Reading topographical map data • Visual observation and acquisition of visual images by on-site survey
	Naturalness	Vegetation naturalness, green coverage rate, existence of large-diameter trees, form of waterfront lines, shape of river flow channels, purity of water	
	Prominence	Height, largeness, width, depth, length, oldness	
	Visibility	Noticeability (visibility frequency)	
	Availability	Number of users, availability, attribute width of users	
	Comfort	Visibility in forests Accessibility to waterside Spatial expanse Extent of oppressive feeling caused by artifacts Status of the color harmony among artifacts	
Unique values	Endemism	Existence of elements deeply involved with the name of places Existence of unique and distinctive elements	• Questionnaire survey • Interview survey • Survey on materials • Sensory quantity measurement using visual images • On-site sensory quantity measurement
	Historicity	Existence of elements that have been passed down since ancient times Existence of historical legacies and historic sites	
	Locality	Existence of elements deeply involved with the lifestyle and culture of the region Existence of elements that distinguish the inside and outside of the region Existence of elements recognized as local symbols	
	Depletion	Existence of elements that have been gradually disappearing in the region	
	Affinity	Existence of elements familiar among community residents	

(4) Ascertainment of the value recognition of the surrounding landscape

The value recognition of the surrounding landscape is comprehended for the landscape zone subject to forecast and evaluation, basically by carrying out questionnaire surveys for each

landscape zone (e.g., questionnaires on differences between visual images and photomontage images) using the indicators selected as the targets of the recognition of the surrounding landscape. These survey results are used to compile the status of the value recognition of the surrounding landscape.

2.1.3 Forecast

Forecast for the distant landscape is mainly performed on changes in the scenery at major scenic viewpoints, while forecast for the surrounding landscape is done by comprehending changes in the status of sites usage status, and scenery of each landscape zone,. Changes in the value recognition due to changes in each landscape are also forecasted by analyzing the results of questionnaire surveys.

1) Forecast of the distant landscape

As the method of forecasting changes in the distant landscape, it is common method that use a photomontage technique or computer graphics (CG) and compare the images (visual images) of the current situation with the images in which the changes are reflected, viewed from the scenic viewpoints comprehended by surveys, so as to show quantitatively the changes as visual differences. Since there are many research outcomes and cases for such a method, up-to-date knowledge is used to compile the amount of change, etc. of the indicators while also taking forecast conditions, etc. into consideration.

Changes in the value recognition of the distant landscape should, based on the status of visual changes, be estimated with a focus on the recognition items in each value categoy set at the survey stage. It is also preferable to show sensory changes as objectively and quantitatively as possible.

2) Forecast of the surrounding landscape

As the method of forecasting the surrounding landscape, it is common method that the category of landscape zone comprehended by surveys and the directly altered area in the project plan are overlaid on a topographical map with the same accuracy, and that landscape zones whose status of the surrounding landscape is changed due to direct alteration are selected, and then the ratio of altered area in the landscape zone is figured out to estimate changes in the status of sites and usage status.

In regard to changes in the status of scenery in the surrounding landscape, it is difficult to specify the scenery from specific scenic viewpoints in sifferent with the distant landscape, meaning that conventional forecast methods may not be sufficient enough to comprehend the changes. For this reason, it is preferable to consider using forecast techniques by introducing CG technology–based animation or virtual reality (VR) methods, or utilizing miniature.

3) Method of forecasting indirect impacts

In addition to the extent of direct alteration to the environment, indirect impacts on the landscape are also confirmed referring to the results of forecasting physical environmental elements such as noise.

In particular, air pollutants, noise, offensive odor, night lighting, changes in water quality and ecosystems are indirect impact factors for landscape; thus, forecast should be performed in view of the results of forecasting these foregoing factors.

4) Utilization of quantitative forecast methods

There are a limited number of quantitative forecasts of landscape, while it is possible to apply and utilize the index values, thresholds, etc. that have been showed in existing studies. Specific forecast methods include semantic differential method (SD method), fractal analysis, contingent valuation method (CVM method), and questionnaire survey to comprehend the intention of continued use.

Going forward, active use of quantitative forecast methods should be encouraged to accumulate the number of cases and improve environmental impact assessment techniques, including forecast methods.

5) Accumulation of knowledge, etc. acquired from stakeholders, etc.

The landscape in environmental impact assessments has a side which anyone can intuitively judgewithout expert knowledge. Environmental changes related to the landscape are in the field accompanied with changes in the everyday lives of community residents. Therefore, it is important to recognize that these changes play a impottant role in the process of consensus formation in environmental impact assessments.

Under the Environmental Impact Assessment Act, a scoping document and a draft environmental impact statement must be publicly notified, and after meeting to explain the community residents, etc. are able to submit their opinions. In this way, the proponent notifies relevant bodies of the content described in the environmental impact assessment documents to local residents and other stakeholders , and stakeholders, etc. may submit information and opinions from the perspective of environmental conservation. It is important to effectively utilize the environmental conservation–related information from community residents, etc. in this opportunity and minimize project-caused environmental impacts. To do so, the proponents should try to explain accurately and easilyy- in the meetings from the stage of preparing a scoping document. In order to encourage sending of information and opinions by community residents, etc., the proponents also need to arrange and showthe relevant information using VR technology and other visual image methods for easy understanding the details referring previous case examples.

2.1.4 Environmental conservation measures

1) Examination of environmental conservation measures

As for environmental conservation measures for the landscape, the position, size, arrangement or structure of a project may be changed depending on the stage of the project plan, while construction methods may also be altered to mitigate noise in planting or construction work. It is necessary to consider as prioritly on avoiding or reducing impacts based on the forecast results and also examine to take appropriate environmental conservation measures by considering compensation as-needed basis. Examples of environmental conservation measures are shown in Table III.2-9 and Table III.2-10. It is also essential to consider feasible and better techniques and compile the content and background of the consideration clearly.

Table III.2-9 (1) Examples of avoidance and reduction measures for the landscape

	Example conservation measures for distant landscape	Example conservation measures for surrounding landscape
Conservation measures for impacts of existence and use	Measures for site and layout	
	■Avoid sites with easily noticeable topographical conditions • Conserve skylines • Avoid mountaintops and ridge lines • Avoid straight flat lands and arranging in a hollow topography • Avoid places where topographical lines are concentrated ■Do not disturb the morphological characteristics of the natural landscape • Avoid mountainsides and select the lowest possible position • Do not disturb the flow direction of landscape composition lines • Set to the boundaries of land use and vegetation to make them less noticeable ■Use the surrounding rugged topography for concealment and suppression • Use the topographical folds to reduce the apparent size ■Avoid visual axes and the focus of views • Set a site so as not to block the view from scenic viewpoints • Avert them from valleys, road axis waterfront lines, etc. ■Set a layout with consideration given to the line of sight • Locate messy-looking facilities in a less noticeable place • Set a layout so as to provide a picturesque composition against the visual axes • Provide frontality against the line of sight ■Provide regularity to the facility layout • Provide regularity to the facility layout ■Set a layout so as to avoid felling of existing forests as much as possible • Leave existing forests to conceal buildings, etc.	■Minimize alteration to landscape zones with high value recognition • Minimize the volume of direct alteration to landscape zones with high value recognition ■Minimize the changes in representative indicators • Avoid alteration to forest areas with tall trees that determine the value of the landscape zone ■Avoid alteration to landscape zones with irreplaceable value recognition ■Avoid the segmentation of landscape zones with continued homogeneous value recognition

Table III 2-9 (2) Examples of avoidance and reduction measures for landscape

	Example conservation measures for distant landscape	Example conservation measures for surrounding landscape
Conservation measures for impacts on existence and use	**Measures for design, landscaping, and equipment**	
	Measures for size and structure	
	■Do not disturb the scale sensitivity of landscape around the site • Reduce the scale ratio to the body of the mountain serving as the background of structures so as not to have impacts on the landscape ■Ensure the continuity with surrounding forests, sea coasts, etc. • Keep it lower than the height of surrounding forests ■Minimize the apparent size of artifacts • Minimize the visual angle of facilities ■Fit the facility form into the control lines of the landscape around the site • Match the roof inclination with the form of the background skyline • Align the height and wall surface with the existing structures around the site ■Carry out land reclamation with a focus on the topographical conditions • Segment the land reclamation topography to fit it into the surrounding topography • Minimize the emergence of revetment and other structures	■Do not disturb the scale sensitivity of landscape zones • Keep the structures lower than the relief in landscape zones ■Ensure the continuity of landscape zones with high value recognition • Subdivide the land reclamation area in landscape zones ■Minimize the apparent size of artifacts in landscape zones • Minimize the apparent size of artifacts seen from the viewing sites in landscape zones ■Fit the facility form into the control lines of the surrounding landscape in landscape zones • Match the roof inclination with the form of the background skyline • Align the height and wall surface with the existing structures around the site ■Integrate the size and structure into the representative indicators • Keep the structures lower than the height of forests in landscape zones
	■Adopt locality-conscious designs • Use surrounding traditional architectural designs as a motif ■Provide regularity to the designs of multiple facilities • Unify the form, design, and color of multiple facilities ■Adopt designs that do not produce large-scale smooth surfaces • Give variety by segmenting wall surface and processing shadows ■Adopt designs that make architecture-related structures less noticeable • Use wall surfaces to conceal architecture-related structures, such as emergency staircases and water supply systems • Use simple designs ■Adopt materials that easily fit into the landscape around the site • Use natural materials or those imitating natural materials • Do not use glossy materials ■Adopt colors that easily fit into the landscape around the site • Employ low brightness and low color saturation in areas where natural landscape is the primary element • Use locality-conscious colors ■Make textures better • Use surface textures to provide shadows ■Carry out screening planting • Conduct planting to conceal structures (Attention should also be paid to the adoption of plant species that do not disturb the surrounding ecosystems in areas with good natural environment.)	■Perform landscaping using landscaping techniques in landscape zones • Mitigate visual impacts of structures through visual guidance in landscape zones • Mitigate visual impressions by carrying out planting at the base of structures • Provide a feeling of seclusion by placing water surface between structures ■Unify the colors in landscape zones • Adopt colors that fit into the standard colors in landscape zones ■Fit the geological shape in landscape zones into the site • Mount the angles and shapes of land reclamation slope in line with the topographical lines in landscape zones ■Ensure the continuity of vegetation in landscape zones • Ensure the continuity between slope planting and forests in landscape zones
	Measures for management and operation	

	■Give consideration to the availability of scenic viewpoints (noise, access, etc.) ■Ensure concealment functions through the maintenance management of retained forests or forests for land reclamation	■Give consideration to changes in the availability in landscape zone ■Ensure the continuity with surrounding retained forests through maintenance management of forests for the landscape zone in landscape zones
Conservation measures for impacts of construction work	■Give consideration to the layout and emergence period of large construction equipment • Shorten the emergence period of cranes, avoid busy season of use ■Prevent the occurrence of turbid water by installing a settling basin ■Carry out early greening of land reclamation areas, etc. • Conduct greening for landscaping promptly after construction work in land reclamation areas, etc. ■Give consideration to the availability of scenic viewpoints (noise, access, etc.)	■Minimize the off-limits areas established due to construction work in landscape zones • Minimize off-limits areas, shorten the off-limits period, avoid restrictions during busy season of use ■Prevent the occurrence of turbid water by installing a settling basin ■Carry out early greening of land reclamation areas, etc. • Conduct greening for landscaping promptly after construction work in land reclamation areas, etc. ■Give consideration to changes in the availability in landscape zone

Table III.2-10 Examples of compensatory measures for landscape

	Example conservation measures for distant landscape	Example conservation measures for surrounding landscape
Compensatory measures	■Create new scenic viewpoints that replace altered scenic viewpoints • Create the same view targets as scenic viewpoints that have been lost due to direct alteration, as well as scenic viewpoints where viewing directions can be seen ■Improve the existing view conditions of scenic viewpoints • Ensure good visibility by removing structures or pruning trees located in the direction of important views ■Improve the existing use conditions of scenic viewpoints • Secure new access routes to scenic viewpoints to ensure better accessibility to the scenic viewpoints	■Restore the altered environment with high representative indicators in the same landscape zone • Develop by replacing the same form of the river that has been lost due to direct alteration • Restore forests with high value recognition by planting them in a land reclamation area ■Create a new environment with high indicators that determine the value recognition • Mow the underbrush of dense forests with currently low value recognition ■Create new value recognition elements in the landscape zone • Create new rivers in a landscape zone with few waterside spaces ■Improve the value of landscape zones with low value recognition • Manage the vegetation of forests in a landscape zone with low comfort to improve the comfort

2) Verification of the validity of environmental conservation measures

The validity of environmental conservation measures for the landscape is verified by comparing the effects of environmental conservation measures for the landscape with potential impacts of the measures on other environmental elements. For example, it is need to consider whether or not planting for the conservation of landscape may cause the growth of alien species or unwanted animals and afford impacts on other plants and animals. It is also preferable to ask local stakeholders (tourist agents, etc.) and experts, etc who highly interested in landscape. for their opinions on whether the environmental conservation measures are sufficiently effective.

2.1.5 Evaluation

1) Evaluation methods

Evaluation is carried out by clarifying the views of proponent as to whether forecasted impacts could be sufficiently avoided or reduced by taking adopted environmental conservation measures for the major scenic viewpoints, landscape resources, distant landscape, surrounding landscape, etc. which are targets of the measures showed in the policy of environmental conservation measures. This evaluation process is also conducted by clarifying the views of business operators as to whether the measures are consistent with the landscape plans, etc. stipulated by local governments.

Evaluation should be performed as objectively and quantitatively as possible; however, even if a qualitative evaluation has been conducted, it is necessary to utilize visual images for clear explanation and describe as objectively as possible the presence or absence of environmental changes, including value recognition and the extent of project-caused impacts.

2) Arrangement of uncertainties

At the forecasting of impacts on landscape, it is supposed that there are the case that the detailed site and structure of a project plan, such as the facility's height and color, may not have been decided finaly, or the viewable range of the planned site in the distant landscape may need to be changed after a forecast has been done. In the evaluation process, therefore, there is a need to compile the content, cause, and degree of uncertainties of forecast due to differences in the degree of maturity, etc. of the project plan. It is also preferable to make fuether forecast at the stage where the plan has been matured and then examine an evaluation thereof.

2.1.6 Follow-up survey

Since there may be large uncertainties in environmental conservation measures for the landscape, including the restoration of forests serving as a component of the landscape, implementation of follow-up surveys is examined after considering the content and degree of the uncertainties, the accumulation of relevant knowledge, and opinions from community residents, etc. If follow-up surveys are not conducted, it is important to show objective and specific reasons why the adopted environmental conservation measures have no uncertainties.

In implementing follow-up surveys for the landscape, when considering survey sites and methods, attention should be paid so that the sites of the follow-up surveys include the scenic viewpoints, etc. set at the survey stage. In view of the fact that it takes time to restore forests in some environmental conservation measures, the survey timing should be determined to be done at the period when the effects of the environmental conservation measures can be identified.

2.2 Utilization of Technical Methods and Points to Note (Landscape)

In examining surveys, forecasts, evaluations, and environmental conservation measures for the landscape, there has been a popular technical method that virtually creates landscapes and scenic viewpoints and simulates various structures and landscapes. photomontage method and computer graphics (CG) technology are major. The recent development of information technology (IT) has made VR technology and other new technical methods available. Some of the methods require a huge amount of labor in utilization and have been less used in environmental impact assessments thus far in Japan, while some contribute to efficient and effective consensus formation and need be used more actively.

This section compiles several examples of methods that are likely to be available to use so far and are expected to contribute to streamlining surveys; reducing uncertainties in surveys, forecasts, environmental conservation measures, and follow-up surveys; and improving objectivity, in environmental impact assessments. On this basis, scenes to which the technical methods are applied, outlines, points to note, case examples, references, and so on are summarized. Therefore, the technical methods to be introduced here are for reference purposes only, not intended to recommend specific methods; there are other methods available to use.

(i) Virtual Reality (VR): Three-dimensional landscape simulation

[Application of the method to environmental impact assessment]

The three-dimensional landscape simulation (VR) technology provides an easy-to-understand description of structure situation and landscapes after planting and is used for making it possible to confirm the effects of the environmental conservation measures at forecast of landscape during construction work and at the time of existence,. In particular, this method can set arbitrary perspectives, create sequences (videos), and even swiftly switch between structures, etc. and planting with software operations, which enables comprehending the value recognition of the distant landscape and forecasting the surrounding landscape. This is expected to be used as an effective tool for consensus formation. This method can also be applied to forecasting changes in the landscape from the serial scenic viewpoints, such as roads, railroads, and water routes.

[Outline of the method]

VR is a technology that reproduces an actual space, virtually creates structures and other objects to be installed, and simulates the landscape. The closer the VR space it is to reality, the easier it is to convey the images.

[Points to note]

This method uses 3-D data, which makes it more expensive than the photomontage method. On the other hand, topographic data, etc. have become available for the public, leading to lower cost in the future.

[Case example]

There is a case that a landscape simulation was performed during construction work and after the use of the facility to examine the townscape and the impacts caused by the height of buildings (see Fig. III.2-6).

<Constructing a park>

<After construction of buildings>

Source: Kasaki, et al. (2009)

Fig. III.2-6 Landscape simulation using VR technology

[References, etc. for the method]

- Fukuda, T., Ito, Y., Takei C., and Seki, F. (2008). "VR Presentation and New Town Development," X-Knowledge.

(ii) Augmented Reality (AR)

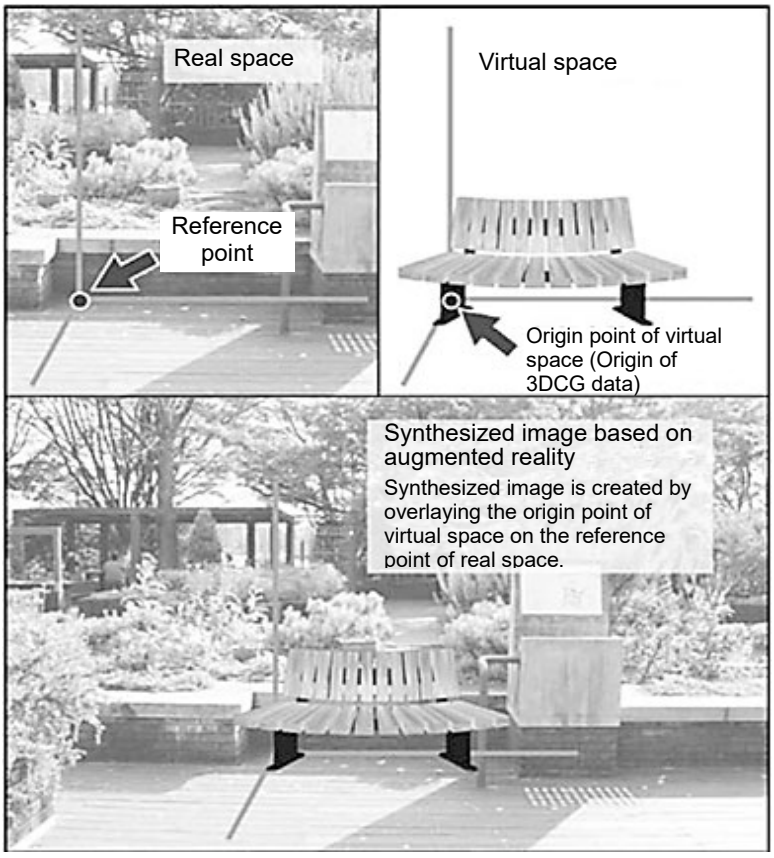
[Application of the method to environmental impact assessment]

One possible application of this method is to wear a goggle-type display, etc. and overlap the real view with the post-project structures, etc. created by CG technology for visualization in the project implementation area, allowing for on-site ascertainment of changes in the value recognition. Those who may be affected in landscape and places for contact activities are the general public, including community residents; using this method in explanatory meetings and other opportunities is expected to give effective explanations of the environmental conservation measures, which cannot be achieved in writing, etc.

[Outline of the method]

AR is a technology that synthesizes information in a virtual world managed on a computer with the real world and presents them. Wearable AR is also under development in Japan in which

electronically generated information is integrated into the real world of humans through an information network and is presented in a multilayered and real-time manner. The smartphone app “Sekai Camera” (no longer available) is known as one of the most famous apps. Google Glass and other AR devices are also available on the market.



Source: Yoshikawa et al. (2012)

Fig. III.2-7 Utilization of AR technology

[Points to note]

The challenge is to integrate virtual structures into the real world with as little artificiality as possible, and it is essential to ensure geometric consistency with taking perspectives and behaviors into consideration and optical consistency, including shadows. In addition to this, since there are few published examples of using this method and few study cases thereof, changes in the value recognition and the effectiveness of consensus formation are still unclear, and a certain amount of cost is also required. For these reasons, attention should be paid to its applicability before use.

Source: Hirasawa (2011)

Fig. III.2-8 Example uses of AR technology

[Case example]

There are examples of using Sekai Camera, Google Glass, and other goggle-type displays mentioned above, while the number of cases where they have been used in environmental impact assessments is limited.

[References, etc. for the method]

- Supervised by Kurata, T. and Kiyokawa, K. and edited by Ōkuma, T. (2015). "AR Augmented Reality Technology Basics, Development and Practice," Kagakujyoho Shuppan.

[Reference Data] Utilization of AR technology

Using AR technology enables a simulation of the landscape from an arbitrary point.

Street View, a free map service offered by Google, allows users to view 360-degree camera images from an arbitrary point on the map. Users can move around continuously from one point to another and even enjoy virtual driving on roads or the sea in a browser using a very wide range of publicly available images.

Using such a 360-degree camera and map information makes it possible to establish an AR space based on the Google Street View–like map information and to use it to explain the current situation of the landscape in the survey area. It is also possible to use CG technology and display a landscape altered by a project in the AR space, such as a landscape where structures, etc. created

with 3-D technology exist, allowing for presenting a future landscape viewed from an arbitrary point.

Moreover, providing images containing map information online just like Google Street View enables many community residents to easily comprehend the changes in the landscape, thereby streamlining future forecast of changes in the landscape and comprehending changes in the value recognition.

In the case of a project in a sea area or a lake, using a whole-sky landscape camera on a regular sea line, etc. can forecast changes in the distant landscape from a viewpoint field both on land and water.

Map information that may be useful in establishing such an AR space includes various free maps, open street maps for sharing geographical information, and so on.

2.3 Basic Methods and Key Points (Place for Recreational Activities)

2.3.1 Selection of environmental impact assessment items and survey, forecast, and evaluation methods

1) Comprehending project characteristics

In comprehending project characteristics, for the purpose of arranging information necessary to select environmental impact assessment items and survey, forecast, and evaluation methods, environmental factors that may produce project-caused impacts are selected on the assumption of direct alteration to places for recreational activities due to construction work or the existence and use of land or structures, or project-caused impacts, such as changes in environmental elements that support the activities of noise occurrence and disrupted access (see Table III.2-11). Project characteristics are also comprehended with consideration given to the occurrence timing of such impacts, such as during construction work or at the time of existence and use of the land or structures.

Table III.2-11 Major impact factors related to places for recreational activities and their potential impacts

Classification of impact factors	Sub-classification of the factors	Potential impacts
Implementation of construction work	Use of construction vehicles	Occurrence of noise and disrupted access (activity characteristics, changes in access characteristics)
	Operation of construction machines	Occurrence of noise and disrupted access (activity characteristics, changes in access characteristics)
	Temporary impacts, such as land reclamation	Emergence of a bare ground for land reclamation (activity characteristics: changes in resources) Occurrence of turbid water due to sediment outflow (activity characteristics: changes in resources)
	Removal of existing facilities Establishment of temporary construction	Disappearance of existing facilities used (activity characteristics: changes in convenience, changes in access characteristics) Emergence of temporary construction (activity characteristics: changes in convenience, changes in access characteristics)
Existence and use of land or structures	Alteration to land	Alteration to sites or the environment that supports activities (activity characteristics: changes in resources, convenience, and comfort) Alteration to access routes (changes in access characteristics)
	Existence of structures	Emergence of artificial structures (activity characteristics, changes in access characteristics)
	Use and operation of facilities	Occurrence of noise, water pollution, offensive odor, and light pollution, disrupted access (activity characteristics, changes in access characteristics)

2) Comprehending regional characteristics

In comprehending regional characteristics, the features of natural foundation and regional historical and cultural backgrounds that constitute the regional framework, as well as the

characteristics of people's lives and the places, zones, activities, etc. that are related thereto, need to be comprehended and compiled as basic information from various perspectives of not only major places for, and the situation of, recreational activities, but also nature, history, and culture, just like the landscape (see Table III.2-12). In terms of environmental conservation, the targets of ascertainment also include the designation of areas, etc. under laws, regulations, or ordinances, and the sites, etc. considered to be important in designated areas.

If regional characteristics, etc. have been compiled for preparing a document on primary environmental impact consideration, it is preferable to use that information.

i) Collection and arrangement of basic information

(1) Collection and arrangement of existing materials

In collecting and arranging existing materials, if there are existing materials that have been collected at the time of preparing the document on primary environmental impact consideration, they are rearranged in light of the regional characteristics and the maturity of project characteristics and project plans.

Existing materials to be collected include basically those published and disclosed by public agencies, those containing targets, etc. those for objects selected in tourism administration, and those available for visitors to viewing spots at sites, facilities, etc. Some commercial tourist guidebooks and materials published by individuals and organizations contain useful information; thus, relevant information should be collected as extensively as possible. In some areas subject to project plans and surveys, even if satochi-satoyama, or farmlands are not sites or facilities indented to be used as places for recreational activities, but may have been used virtually as places for recreational activities, existing materials available in these places should be collected and compiled as well.

The survey results of existing materials should undergo a synoptic field survey on an as-needed basis to ensure that the results are up-to-date and highly accurate information before use.

Table III.2-12 Characteristics of project plans and regional characteristics that should be comprehended from the perspective of recreational activities

Characteristics of the project plan	Regional characteristics	
	Areas or targets designated by laws and regulations from the perspective of environmental conservation	Areas or targets that are not designated by laws and regulations, but should be selected as important sites according to the areas
• Direct alteration to recreational activity sites • Alteration to the quality of the site	• Zones of natural parks • Areas, etc. designated under the Nature Conservation Act and the Cultural Assets Preservation Act • Specified natural tourism resources designated under the Ecotourism	• Satochi-satoyama reservoirs, grasslands, riparian forests, etc. that are used by community residents • Woodlands and green spaces that remain in urban areas and are used by community residents

environment for recreational activities and to access characteristics	Promotion Act • Areas designated under the Urban Green Space Conservation Act, the Act for the Conservation of Green Belts around the National Capital Region, and the Productive Green Area Act • Community farms under the Act on Promotion of Development of Community Farms • Areas, etc. designated under the Hot Spring Act • Long-distance nature trails, etc.	• Participatory biological and ecosystem monitoring sites • Habitats for organisms subject to observation and recreation • Temples, shrines, historic sites, etc. • Schools • Outdoor recreation sites (campsites, bathing beaches, fishing spots, walking trails, etc.)

(2) Synoptic field survey

In order to obtain information necessary to select recreational activity sites subject to environmental impact assessments and examine survey, forecast, and evaluation methods, synoptic field surveys are conducted with appropriate means, such as walking and using vehicles, for the purpose of onsite confirmation of information from existing materials.

(3) Interviews with experts, etc.

Interviews with experts, etc. are carried out on an as-needed basis to support the results of survey on existing materials and synoptic field surveys. Interviewees may include academic experts, museum curators, officials from local governments (departments/sections related to the environment, nature conservation, tourism, commerce, and education), environmental protection groups, local development groups, tourism business operators, and local intellectuals. In particular, local governments may have detailed information on tourist spots, ritual sites, and other historical and cultural activities, as well as on sites for recreational activities and other local activities, which should be focused on in interviews.

(4) Arrangement of resultsof collection and classification of existing materials

In order to lay a foundation for selecting targets of environmental impact assessments and determining survey, forecast, and evaluation methods, in arranging the results of collection and classification of existing materials, synoptic field surveys and interviews with experts, it is preferable to comprehend the topography and other fundamental environments (characteristic topography, water system, etc.); identify the spatial and qualitative structure focused on land cover (vegetation); and compile population distribution and other regional natural backgrounds so that such information can be overlaid with one another using geographical information systems, and topographical conditions and access analysis can also be handled.

Table III.2-13 Example regional characteristics, etc. that should be comprehended based on the results of existing materials collected and compiled

Region	Viewpoint	Reference for the accuracy and scope that should be comprehended	Regional characteristics, etc. that should be comprehended		
Mountainous natural areas	Relatively abundant virgin and excellent nature can be found in mountainous natural areas. Out-of-the-ordinary natural experience-based recreation is mainly provided in the areas; the scope of activities, the extent of views, and the scale of resources tend to be larger. Attention should also be paid to traditional mountain religion and other distinctive livelihood cultures.	• 1/200,000 to 1/50,000 • 20- to 30-km radius	Topographical elements	Characteristic topographies	Moderate slopes, rapid slopes, mountaintops, mountain paths, ridgelines, ridges, cliffs, caves, topographical transition points, etc.
				Water systems	Canyons, rivers, waterfalls, swamps, wetlands, hot springs, etc.
				Inland waters	Lakes, ponds, dams, etc.
			Biological elements	Animals	Habitats of medium- to large-size organisms, habitats of wild birds, etc.
				Plants	Natural forests, grasslands, communities of specified plants, etc.
			Humanity elements	Roads	Mountain trails, nature trails, nature observation paths, etc.
				Historical culture	Objects of worship (giant trees, giant stones, etc.), cultural properties, temples and shrines, etc.
				Public facilities	Visitor centers, park facilities, etc.
				Outdoor recreation sites	Ski resorts, fishing spots, campsites, etc.
				Population distribution	N/A
				Legally designated areas, etc.	Natural parks, wild bird sanctuaries, reserved forests, protected species, monitoring sites, etc.
Mountain villages and natural areas	Satochi and natural areas have historical relationships between humans and nature and are the reminiscence of nostalgic original scenery. These areas enjoy abundant secondary natural resources, and activities that give nostalgic, friendly, and comfortable feelings are mainly conducted. Human-intervened nature generally leads to smaller scope and size of activity than those in the mountains, while many elements are concentrated in a mosaic pattern, requiring attention to the fact that the features make it possible to provide various interactions.	• 1/50,000 to 1/10,000 • 10- to 20-km radius	Topographical elements	Characteristic topographies	Moderate slopes, rapid slopes, mountaintops, mountain paths, terraces, cliff lines, valley-style topography, and topographical transition points, etc.
				Water systems	Rivers, river beaches, canyons, banks, irrigation canals, etc.
				Inland waters	Lakes, ponds, reservoirs, etc.
			Biological elements	Animals	Habitats of medium-size organisms, habitats of wild birds, etc.
				Plants	Wooded areas, symbolic plants (massive trees, giant trees, sacred shrine forests, etc.), grass fields, communities of specified plants, etc.
			Humanity elements	Roads	Old roads, walking trails, nature observation paths, cycling paths, hiking paths, etc.
				Farmlands	Paddy fields, fields, orchards, etc.
				Historical culture	Objects of worship, ruins and historic places, temples and shrines, cultural properties, landmarks, etc.
				Public facilities	Schools, museums, parks, etc.
				Outdoor recreation sites	Field athletics, famous cherry blossom-viewing spots, guest ranches, farms, campsites, areas for conservation of village-vicinity mountains and mountain villages,

Region	Viewpoint	Reference for the accuracy and scope that should be comprehended	Regional characteristics, etc. that should be comprehended		
					etc.
				Population distribution	Population distribution, densely populated areas, etc.
				Legally designated areas, etc.	Natural parks, wild bird sanctuaries, reserved forests, protected species, monitoring sites, etc.
Non-mountainous natural areas	Highly dense human activities are conducted in non-mountainous natural areas; important elements include green spaces, watersides, and other natural components that remain in places closer to humans where they can interact with nature in their daily lives. The size of resources generally tends to be smaller, requiring attention to the fact that place-specific elements, which people easily overlook with traditional values, are the main actors.	• 1/25,000 to 1/several thousand • 10-km radius	Topographical elements	Characteristic topographies	Moderate slopes, hills, topographical transition points, etc.
				Water systems	Rivers, banks, riverbeds, irrigation canals, sandbanks, etc.
				Inland waters	Lakes, ponds, reservoirs, etc.
			Biological elements	Animals	Animal observation sites, etc.
				Plants	Pedestrian paths, school forests, homestead woodlands, symbolic plants (massive trees, giant trees, sacred shrine forests, etc.), grass fields, reed fields, communities of specified plants, etc.
			Humanity elements	Roads	Walking trails, walkways, cycling paths, etc.
				Farmlands	Paddy fields, fields, orchards, community farms, etc.
				Historical culture	Objects of worship, ruins and historic places, temples and shrines, cultural properties, landmarks, etc.
				Public facilities	Schools, museums, city parks, open spaces, etc.
				Outdoor recreation sites	Famous cherry blossom-viewing spots, boat piers, etc.
				Population distribution	Population distribution, densely populated areas, etc.
				Legally designated areas, etc.	Natural parks, wild bird sanctuaries, green conservation areas, protected species, etc.
Coastal areas (enhanced coastal zones)	Coastal areas are places to support the interaction between the sea and humans and are composed of natural coasts, artificial coasts, cliffs, sandy beaches, and various other elements. The greater the access to the waterfront line and the more natural it is, the wider the scope of acceptable activities and the greater the size of resources. Attention should be paid to the fact that, even if there is no continuity in a land area, ships and other means of transportation may cause correspondence, or there may be visual correspondence on	• 1/200,000 to 1/25,000 • Set larger value with consideration given to the continuity by the sea area, with reference to the scope of the land area of hinterland.	Fundamental elements	Characteristic topographies	Rocky shores, sandy beaches, tidelands, brackish-water lakes, seashore lakes, river mouths, capes, cliffs, coral reefs, seaweed beds, tide pools, etc.
			Biological elements	Animals	Habitats of animals in coastal areas (including fresh-caught fish), spawning grounds for sea turtles, coral reefs, seabird colonies, migration waters for whales, etc.
				Plants	Seashore vegetation, coastal forests, communities of specified plants, mangrove forests, seaweed, etc.
			Humanity elements	Roads	Walking trails, walkways, cycling paths, etc.
				Historical cultures	Objects of worship, ruins and historic places, temples and shrines, cultural properties, landmarks, etc.
				Public facilities	Ports, lighthouses, piers, schools, museums, etc.
				Outdoor recreation sites	Bathing beaches, diving spots, fishing spots, etc.
				Population distribution	Population distribution, densely populated areas, etc.

Region	Viewpoint	Reference for the accuracy and scope that should be comprehended	Regional characteristics, etc. that should be comprehended		
	the opposite shore across the sea area.			Legally designated areas, etc.	Port areas, coastal conservation zones, natural parks, wild bird sanctuaries, reserved forests, protected species, etc.

ii) Selection of the sites for major recreational activities subject to environmental impact assessments

Based on the results of classification of information on project characteristics and regional characteristics, the status of recreational activity sites and the content of the activities are comprehended in terms of the relationship with other recreational activity sites, the positional relationship with the project implementation area, and the relationship with access routes. Then, such data are extensively extracted from as many perspectives as possible to organize them in a distribution map or list. Recreational activity sites that should be comprehended in particular are selected based on regional characteristics (patterns) to simulate the outline of the types and scope of the influence of project-caused impact factors on activity characteristics and access characteristics.

3) Selection of environmental impact assessment targets and survey, forecast, and evaluation methods

i) Extraction of impact factors

The positional relationship between the project content/planned site acquired by comprehending project characteristics and the activity characteristics/access characteristics for recreational activity sites obtained by comprehending regional characteristics is used to extract potential impact factors, such as the implementation of construction work and the existence and use of lands or structures.

ii) Selection of the targets of environmental impact assessments

The activity characteristics and access characteristics for recreational activity sites that may be affected by the project are extracted as environmental elements. Access characteristics are comprehended based on the relationship among the topography, the site of the project implementation area, and the recreational activity sites. Other elements that need to be comprehended include direct impacts due to project-caused alteration to recreational activity sites and access routes, as well as indirect environmental changes that may affect the activity characteristics (e.g., changes in water quality of rivers in campsites, changes in waves on the coast).

If the extraction of impact factors and environmental elements has found possible changes in activity characteristics and access characteristics, these are selected as the targets of the environmental impact assessment.

4) Selection of survey, forecast, and evaluation methods

i) Concept of survey, forecast, and evaluation methods

The scope of survey is set in light of the extent where impacts may occur due to the relationship with the activity characteristics and access characteristics for recreational activity sites. Activity characteristics are basically comprehended around the project implementation area, while a wider survey area may need to be set for access characteristics. Survey, forecast, and evaluation methods are also selected in consideration of changes in the value recognition due to project-caused impacts.

Overlay forecast is frequently used to comprehend impacts on recreational activity sites and access characteristics. It is also needed to consider survey and forecast methods that cover not only direct impacts on activity characteristics, but also indirect changes in the environment that may have impacts on the activity characteristics.

ii) Sophistication and simplification of survey and forecast methods

Survey and forecast methods may need to be sophisticated or simplified according to the activity characteristics and access characteristics for recreational activity sites, as well as on the extent of project-caused impacts. For example, if there may be impacts on the recreational activity sites regarded as important in the area, a detailed survey on the usage status, etc. should be performed. On the other hand, if there are multiple access routes, survey targets and survey timing should be limited and simplified based on the results of arranging basic information.

2.3.2 Survey

1) Examination of items to be surveyed

Items to be surveyed for recreational activity sites include comprehending changes in the status and value recognition in regard to activity characteristics and access characteristics. Fig. III.2-9 indicates the sequence of comprehending activity characteristics and access characteristics. Since the value of recreational activities changes according to human values, it is necessary not only to comprehend its physical characteristics, etc., but also to compile the value recognition based on the users' perception of value for the recreational activity sites.

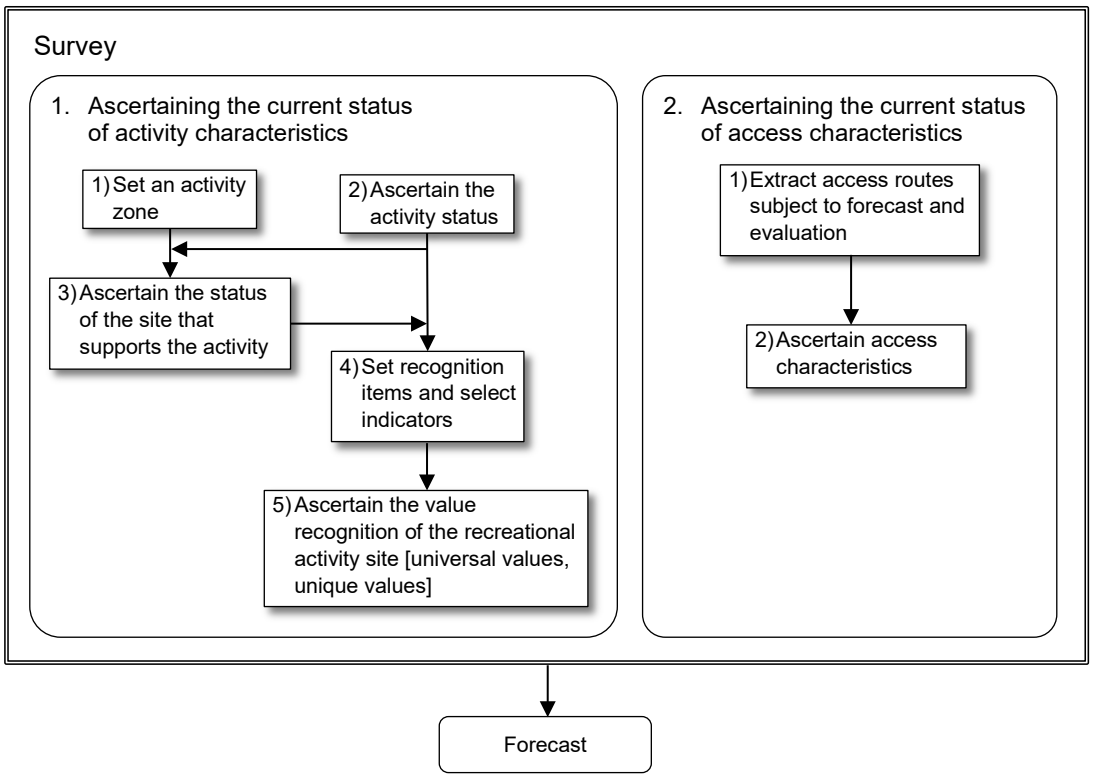


Fig. III.2-9 Survey procedures for recreational activity sites

2) Concept of survey methods

i) Survey methods for activity characteristics

In regard to activity characteristics, survey areas are classified into several activity zones, which are the groups of environments, and then the situation of activities (usage status and users' situation) in the zones are comprehended, while taking vegetation and topography into consideration. Since the frequency and form of using the sites and the perspective on the value recognition vary between community residents and visitors, including tourists, surveys on activity characteristics are conducted based on the two perspectives, and the survey results are compiled.

(1) Setup of activity zones

The groups of homogeneous spaces are classified as activity zones within the extent where there may be project-caused impacts on activity characteristics. As for the classification of activity zones, the results of on-site surveys and various data, such as vegetation zone, land use zone, incline zone, water systems, and topographical elements are combined with one another, while the types of activity zones shown in Table III.2-14 and the content of the activities are also compiled.

Table III.2-14 Examples of the types of activity zones and content of the activities

Type of activity zones		Content of activities
Sites for outdoor activities, etc.		Sites where the following activities utilizing nature are conducted
	Observation and sampling activities	Fishing, insect collection, plant collection, collection of edible wild plants and mushrooms
	Observation and conservation activities	Nature observation, participatory biological and ecosystem monitoring, nature restoration activities, activities for conserving village-vicinity mountains and mountain villages, etc.
	Playing, experience	Tree climbing, playing at the river, playing with flowers, experiences of farming, forestry, and fishing, etc.
	Walking activity	Climbing, trekking, hiking, walking, forest bathing, etc.
	Camping, picnic	Camping, picnic, barbecue, stewed potato party, etc.
	Outdoor sports	Canoe, boat, surfing, paraglider, ski, etc.
	Rest, break	Hot springs bath, enjoying the cool of the evening, etc.
Sites deeply involved with life and culture		Sites deeply involved with local life and culture, etc.
	Religion, spirituality	Nature with shrines and temples, nature worshipped by people, places of folklore and legends, wells, sites as local symbols, etc.
	Festivals, events	Sites for festivals and other local traditional events, nature as the original background to local events, etc.
Plant and animal species, etc. deeply involved with life and culture		Plant and animal species, etc. deeply involved with local life and culture, etc., as well as the areas where they are distributed
	Species subject to utilization	Species utilized as materials for foods and processed foods and in local life and industries, etc.
	Religion, spirituality	Species and targets that are familiar among community residents and regarded important as religious objects, folklore and legends, or other local symbols

(2) Comprehending the status of activities

The status of activities is comprehended based on both perspectives of usage status and users' situation (see Table III.2-15).

Surveys are conducted mainly by on-site count surveys on the number of users, while it is preferable to carry out interview and questionnaire surveys to support the information obtained. Also, appropriate targets are selected according to the characteristics of users and the content of their activities, such as community residents, schools and groups, and visitors

from outside the area. Then, an appropriate method is chosen that is suitable for the survey targets.

In setting survey timing, it is necessary to pay attention to weather, seasons, and activities of nature and humans, as well as to take the survey period and survey time into consideration.

Table III.2-15 Examples of survey content for the status of activities

Classification	Example of survey content
Usage status	Types of nature recreational activities, content of activities, etc.
	Site, area, and range of sites and routes that are used, etc.
	Number of users per type of nature recreational activities, etc.
	Usage frequency, seasons, time, etc.
	Resources and environmental conditions used for activities, etc.
Users' situation	Age groups of users, structure, type of users (schools, companies, individuals, etc.), etc.
	Domiciles of users, served areas, etc.

(3) Comprehending the status of sites that support activities

The status of the sites that support the nature recreational activities is comprehended for each status of the comprehended activities from the perspectives of resources, convenience, and comfort (see Table III.2-16). The survey results of comprehending the status of the sites that support the activities are compiled per activity zone.

Table III.2-16 Examples of survey content for comprehending the status of sites that support activities

Aspect	Example of survey content	
Resources	Fundamental resources	Fundamental resources other than organisms, such as water systems, grass fields, viewing spots, walking trails, and springs, as well as resources that excite the senses of hearing, smell, and touch, etc.
	Biological resources	Organisms that people can interact with, plants and animals for nature recreation, academically valuable plant and animal resources, etc.
	Humanity resources	Historical facilities familiar among local people, recreation sites such as cherry blossom-viewing spots and resorts, sites used by community residents, including farmlands and walkways
Convenience	Elements that support convenience per activity, such as facility development status, space development status, access, and existence of open spaces	
Comfort	Elements that support comfort per activity, such as safety, quietness, and gentle slope	

(4) Selection of recognition targets and indicators

In order to comprehend the people's value recognition for the activities at recreational activity sites after comprehending the activity status and the status of the sites that support the activities, representative indicators highly correlated with the value recognition of universal values and unique values are selected, respectively, and then surveys are conducted. Representative indicators are shown in Table III.2-17.

Table III.2-17 Examples of recognition targets and representative indicators

Classification of values	Target of recognition	Example of representative indicators	
		Indicators that should be generally comprehended	Indicators that should be secondarily comprehended
Universal values	Dissemination	Number of users	• Served area
	Diversity	Diversity in the types of nature recreational activities	• Diversity in the served area • Diversity in users • Diversity in utilization time and period
	Prominence	Notability of activity	• Level of non-substitutability
Unique values	Locality	Degree of established custom	• Level of symbolic value
	Affinity	Daily utilization	• Utilization by community residents • Relationship with clothing, food, and housing
	Historicity	Historical background to utilization	• Publication in local history books, etc. • Designation as intangible cultural properties

(5) Comprehending the value recognition of recreational activity sites

The value recognition of each type of recreational activity site is comprehended based on selected indicators. In regard to the comprehended results of the values of recognition targets, ingenuity of expression is needed for easy comparison of the characteristics, such as by using a radar chart to show the survey results of selected indicators. The status of the recognition of recreational activity sites is comprehended based on the survey results.

ii) Survey methods for access characteristics

Project-caused impacts on access characteristics may include direct alteration to access routes and access impacts on users of recreational activity sites due to project vehicles, etc. Therefore, changes in access characteristics, including the routes used by visitors to recreational activity sites, are comprehended.

(1) Selection of access routes

In regard to the routes, etc. used by visitors to recreational activity sites, routes that may face changes in access characteristics are selected as access routes subject to forecast and evaluation, while also taking the content of the project plan into consideration. Arrangement should be made with consideration given to the fact that some access routes are included in hiking routes and other activity zones and that some are characterized by a wide range of areas just like greenways on forest roads.

(2) Comprehending access characteristics

As for access characteristics, the status of access routes and the access to recreational activity sites are comprehended (See Table III.2-18).

In comprehending the status of access routes, the traffic volume at the peak of the activity must be comprehended. The survey results in the environmental impact assessment items for noise and the results of existing traffic census are also utilized.

In comprehending the status of the access to recreational activity sites, it is necessary to conduct a survey on the activity status and the status of sites that support the activities; however, since they do not have impacts on recreational activity sites, there is no need to comprehend the details and the value recognition.

Table III.2-18 Examples of survey targets for access characteristics

Classification	Example survey target
Status of access routes	• Type of access routes (types of walking paths, farm roads, city roads, prefectural roads, etc.) • Location • Length, width • Shape, road surface condition • Current traffic volume • Time required between specific sites • Safety, etc.
Status of access to recreational activity sites	• Total number of users, usage status of the access routes • Number of users • User base • Usage period and time • Major means of transportation (walk, bicycle, car, etc.), etc.

2.3.3 Forecast

Forecast of recreational activity sites should be conducted as quantitatively as possible. As for activity characteristics, the degree of changes in the status of sites that support activities after project implementation is forecasted first; then, changes in the activities are forecasted, and the degree of changes in the value recognition of the recreational activity sites is forecasted in comparison to the current situation. Access characteristics are forecasted based on changes in the location and status of the access routes and changes in traffic volume.

1) Forecast methods for activity characteristics

i) Forecast methods for changes in the status of sites that support activities

In addition to the degree of direct alteration to recreational activity sites due to land reclamation, tree felling, and establishment of facilities, etc., possible changes in the status of sites that support activities are compiled and forecasted per activity zone, such as the resources,

convenience, and comfort of recreational activity sites due to project-caused noise, offensive odor, night lighting, water quality, air pollution, changes in landscape, and other various causes.

ii) Forecast methods for changes in the status of activities

Based on the results of forecasting the changes in the status of sites that support activities, the extent of impact on the status of individual activities is forecasted in a unit of activity zone for each activity type from the perspectives of activity status and possibility of survival. Comprehensive forecast of impacts on all the activities is also performed with consideration given to the continuity of activities inside and outside the survey area.

iii) Forecast methods for changes in the value recognition of recreational activity sites

Based on the results of forecasting the changes in the status of sites that support activities and in the status of the activities, the extent of project-caused impacts on the value recognition of recreational activity sites is compiled and forecasted in a unit of activity zone.

2) Forecast methods for access characteristics

Comprehending needs to be done in regard to the extent and content of impact due to changes in the site or shape of access routes attributable to a project plan and impacts due to changes in the usage characteristics attributable to vehicles during construction work and vehicles after the access routes start to be used. Then, the status and actual situation of the access routes are forecasted, and the results are compiled and forecasted as changes in the access characteristics. Furthermore, forecast is performed to comprehend the degree of changes in the usage status of the recreational activity sites that change the access characteristics.

3) Forecast methods for indirect impacts on recreational activity sites

In addition to the extent of project-driven direct alteration to recreational activity sites, indirect impacts on the recreational activity sites are also forecasted based on the results of forecasting noise and other environmental elements.

In particular, air pollutants, noise, offensive odor, night lighting, changes in water quality and ecosystems may have indirect impacts on recreational activity sites; thus, forecast of indirect impacts on the recreational activity sites should be performed in view of the results of forecasting other environmental elements, including the foregoing factors.

4) Accumulation of knowledge, etc. acquired from stakeholders, etc.

Similar to landscape, impacts on recreational activity sites can be intuitively judged by anyone without expert knowledge and standard. Environmental changes related to recreational activity sites are accompanied by changes in the everyday lives of community residents. Therefore, it is

important to recognize that these changes play a pivotal role in the course of consensus formation in environmental impact assessments.

Under the Environmental Impact Assessment Act, a scoping document and a draft environmental impact statement must be publicly notified, and community residents, etc. may submit their opinions after explanatory meetings. In this way, proponents are required to notify local residents and other stakeholders and relevant bodies of the content described in the environmental impact assessment documents, and stakeholders, etc. may submit information and opinions from the perspective of environmental conservation. It is important to effectively utilize the environmental conservation-related information from community residents, etc. at this opportunity and minimize project-caused environmental impacts. To do so, proponents should provide accurate and easy-to-understand explanations in the explanatory meetings from the stage of preparing a scoping document. In order to encourage community residents, etc. to provide information and opinions, the proponents also need to compile previous case examples and other relevant information to help the general public understand the detail.

2.3.4 Environmental conservation measures

As for environmental conservation measures for recreational activity sites, the position, size, arrangement, or structure of a project may need to be examined depending on the stage of the project plan. It may also need to mitigate noise during construction work, consider construction methods to address traffic volume, and establish alternative access routes. Therefore, it is necessary to consider as prioritly on avoiding or reducing impacts based on the forecast results and also examine to take appropriate environmental conservation measures by considering compensation as-needed basis. Examples of environmental conservation measures are shown in Table III.2-19 and Table III.2-20. It is also essential to consider feasible and better techniques and compile the content of, and background to, the consideration in a clear manner.

Table III.2-19 (1) Example measures for avoiding and reducing impacts on recreational activity sites

	Example environmental measures for activity characteristics		Example environmental measures for access characteristics
	Environmental measures for direct alteration	Environmental measures for an environment that supports activities	
Conservation measures for impacts of existence and use	**Measures for site and arrangement**		
	■Avoid setting a site in activity zones where types of activities with high value recognition are conducted • Fully avoid setting a site in activity zones where activities are conducted • Avoid alteration to activity zones serving as core spaces for activities		■Avoid alteration to access routes by changing the site and arrangement • Do not block access routes by changing the planned facility site • Do not block access routes by undergrounding the routes
	Measures for size and structure		
	■Minimize alteration to activity zones used for activities with high value recognition • Avoid spatial segmentation of activity sites by building a bridge serving as a road or undergrounding the facilities • Minimize the altered area of important activity zones by reducing the size of facilities	■Reduce the size of facilities located in activity zones that support resources for activities • Reduce alteration to the habitats of wild plants and animals, etc. • Reduce the altered area of activity zones serving as the source of resources that support activities ■Maintain the continuity of activity zones • Ensure the continuity of activity zones with the homogeneous environment ■Compile the size and structure of facilities so as to maintain the resources that support activities • Maintain the growth of organisms by making a landscaping plan or establishing a facility that can coexist with the habitat space of wildlife • Maintain the growth environment of wild plants and animals by controlling the height of buildings to maintain sunshine conditions ■Control alteration to activity zones that support the comfort of activities • Maintain the spatial structure conducive to activities according to types of activities • Prevent the disturbance of the silence enjoyed by users by designing the structure so as to control noise, etc. • Maintain the texture enjoyed by users by using appropriate road surface materials and securing airflow ■Minimize impacts by controlling the size of facilities located in the activity zones that support the convenience of activities • Avoid alteration to activity zones where convenient facilities, etc. are located • Avoid setting a site in activity zones used as meeting places, etc.	■Avoid alteration to access routes by changing the size and structure
	Measures for designs and equipment		
		■Maintain the resources by installing necessary equipment or appropriately designing facilities located at the site • Give consideration to the installation of fences and lighting equipment so as to protect wildlife from light pollution ■Maintain the comfort by installing necessary equipment or appropriately designing facilities located at the site	■Pedestrian-vehicle separation • Ensure safety and the comfort of access by securing walking paths and maintaining surrounding environments

		• Maintain the odor that is enjoyed by users and provides comfort by controlling offensive odors • Prevent noise by installing green belts between activity sites and facilities or introducing noise-reducing equipment • Install equipment that prevents offensive odors • Take measures to mitigate environmental impacts such as water pollution ■Maintain the convenience by installing necessary equipment or appropriately designing facilities located at the site • Ensure convenience by designing facilities that incorporate meeting places and convenient facilities (lavatories, water fountains, etc.)	

Table III.2-19 (2) Example measures for avoiding and reducing impacts on recreational activity sites

	Example conservation measures for activity characteristics		Example conservation measures for access characteristics
	Environmental measures for direct alteration	Environmental measures for the environment that supports activities	
Conservation measures for impacts of existence and use	Measures for management and operation		
		■Maintain resources through management and operation • Ensure the breeding of wild plants and animals by controlling vehicle traffic for a certain period of time • Ensure an environment conducive to activities by controlling vehicle traffic, etc. • Release water to maintain water volume ■Maintain the comfort of activities through management and operation • Maintain the comfort by cleaning lavatories, etc. • Maintain the comfort by processing waste, etc. ■Maintain the convenience through management and operation • Prevent project-caused reduction in use by providing information on activity sites • Prevent project-caused reduction in use by developing a program with interpretation	■Control vehicle traffic hours
Conservation measures for impacts of [illegible]	Measures for construction methods		
	■Adopt construction methods that reduce the area to be altered • Reduce the area subject to land alteration for construction work • Reduce the volume of scattered materials and the outflow of sediment ■Select a construction method that has a small impact on the environment that supports activities • Select a construction method that produces less light leak • Select a construction method that makes less construction-caused noise • Select a construction method that controls offensive odors • Select a construction method that has a small impact on the changes in water volume and water quality • Establish a temporary area for temporary relocation of aquatic creatures, etc. • Perform temporary relocation of plants, etc.		■Select a construction method that has a small impact
	Measures for the types of construction machines		

	■Select construction machines that have a small impact on the environment that supports activities • Select construction machines that make less noise • Select construction machines that produce less air pollution, etc.	■Select construction machines that have a small impact on the comfort and safety of users in access routes
	Measures for construction process	
	■Minimize impacts on the environment that supports activities • Give consideration to the period and hours when construction work should not be done to maintain the resources, such as avoiding impacts on the breeding of wild birds subject to observation ■Minimize the period of prohibited access to land reclamation areas ■Minimize impacts on activities • Avoid the period, days of the week, and hours when activities are conducted	■Give consideration so as not to block activity access • Avoid construction work during the period, days of the week, and hours when activities are conducted
	Measures for the traffic of construction vehicles	
	■Minimize impacts on the environment that supports activities • Give consideration to the period and hours that should be avoided to maintain the resources ■Minimize impacts on activities • Avoid the period, days of the week, and hours when activities are conducted	■Give consideration so as not to block activity access • Avoid construction work during the period, days of the week, and hours when activities are conducted

Table III.2-20 Example compensatory measures for recreational activity sites

	Example conservation measures for activity characteristics		Example conservation measures for access characteristics
	Environmental measures for direct alteration	Environmental measures for the environment that supports activities	
Conservation measures for impacts on existence and use	■Secure an alternative site where the same activities can be maintained • Secure a new activity site where activities to be lost can be conducted ■Relocate resources to a different place • Relocate the resources and convenient facilities existing in the activity zone serving as a core of activities ■Restore activity sites • Recover the habitats of wild animals by restoring forests • Develop unused land, etc. to secure a place where activities can be conducted • Improve the environment in the remaining places to attract activities that had been conducted in the altered zones		■Develop new access routes • Develop bypasses

(i) Verification of the validity of environmental conservation measures

The validity of environmental conservation measures for recreational activity sites is verified by comparing the effects of environmental conservation measures for the recreational activity sites with potential impacts of the measures on other environmental elements. For example, it is needs to consider whether or not the establishment of access routes for recreational activity sites may have impacts on plants and animals and landscape. It is also preferable to ask local stakeholders highly interested in recreational activity sites (tourist agents, etc.), experts, etc. for their opinions on whether the environmental conservation measures are sufficiently effective.

2.3.5 Evaluation

1) Evaluation methods

Evaluation is carried out by clarifying the views of proponent as to whether forecasted impacts could be sufficiently avoided or reduced, or have been compensated when necessary, by taking adopted environmental conservation measures for the activity characteristics and access characteristics subject to the measures that have been clarified in the policy of environmental conservation measures.

Evaluation should be performed as objectively and quantitatively as possible. Even if a qualitative evaluation has been conducted, it is necessary to utilize visual images for clear explanation and describe as objectively as possible the presence or absence of environmental changes, including value recognition and the extent of project-caused impacts.

Views of business operators may also need to be presented from the perspective of whether the environmental conservation measures are consistent with the basic environmental plans, environmental conservation ordinances, and other various guidelines stipulated by local governments for natural conservation. New recreational activity sites or access routes may emerge in some projects; evaluation should take this into consideration as well.

The views of business operators in the evaluation results should be compiled in an easy-to-understand manner, and the grounds thereof also need to be compiled and clarified as objectively as possible.

2) Arrangement of uncertainties

At the forecasting of impacts on recreational activity sites it is supposed that there are the case that the detailed location and structure of the project plan may not have been decided finaly. In the evaluation process, therefore, there is a need to compile the content, cause, and degree of uncertainties of forecast due to differences in the degree of maturity, etc. of the project plan. It is also preferable to make further forecast at the stage where the plan has been matured and then examine an evaluation thereof.

2.3.6 Follow-up survey

Environmental conservation measures for recreational activity sites may include restoration and relocation of the recreational activity sites or establishment of alternative access routes; follow-up surveys need to be performed to confirm whether they will actually be used.

Since there may be large uncertainties in the restoration of forests, etc. serving as a component of recreational activity sites, implementation of follow-up surveys is examined after considering the content and degree of the uncertainties, the accumulation of relevant knowledge, and opinions from community residents, etc. If follow-up surveys are not conducted, it is important to show objective and specific reasons why the adopted environmental conservation measures have no uncertainties.

For implementation of follow-up surveys for recreational activity sites, when considering survey sites and methods, attention should be paid so that the sites of the follow-up surveys are set in light of the activity characteristics and access characteristics that have been set at the survey stage. In view of the fact that it takes time to restore forests in some environmental conservation measures, the determination of survey timing should be the period when the effects of the environmental conservation measures can be identified.

2.4 Utilization of Technical Methods and Points to Note (Place for Recreational Activity)

Count survey and questionnaire survey are generally used to comprehend places for recreational activity, and forecasts and environmental conservation measures have been examined based on the survey results. In addition to the methods that have traditionally been used, it is also preferable to actively employ environmental economic methods, such as CVM and TCM.

(i) Contingent Valuation Method (CVM)

[Application of the method to environmental impact assessment]

The contingent valuation method is capable of making a monetary evaluation of the degree of impacts on places for recreational activity. the contingent valuation method can make a quantitative evaluation based on the opinions of many people, andcan also compare environmental cost (expenses for environmental measures) with environmental benefits (effects of environmental measures). The contingent valuation method is also characterized by its extensive scope of application, making it possible to evaluate public property, the local landscape, and ecosystems, etc.

[Outline of the method]

This is a method of making a monetary evaluation of environmental value by asking people about the amount of money they are willing to pay for environmental conservation (amount of willingness to pay). In concrete terms, the monetary value of a natural environment is evaluated by conducting a questionnaire survey to ask people about the amount of money they are willing to pay for environmental improvement or prevention of environmental deterioration in cases where the environment will be improved by conservation measures or where the environment will be deteriorated by development.

The evaluation process is as follows: (1) collecting information on evaluation targets, (2) creating a questionnaire, (3) conducting a pretest, (4) performing a survey, and (5) estimating environmental value.

[Points to note]

The contingent valuation method is a technique of presenting the present and changed environment conditions, asking people about the amount of willingness to pay to address the changes in the environment, and then making an evaluation of the environmental value. Thus, if the people are not appropriately informed of the environmental conditions, they may not be able to answer with the appropriate amount of money they intend to pay (bias). For this reason, the questionnaire survey needs to be designed strategically to mitigate the bias.

(ii) Travel Cost Method (TCM)

[Application of the method to environmental impact assessment]

This method is capable of making a monetary evaluation of the degree of impacts on recreational activity sites by converting the degree into expenses necessary for travel (travel cost).

[Outline of the method]

This is a method of evaluating recreation value based on the expenses necessary for travel. In this method, recreation value is evaluated by converting the value into monetary value based on the travel expenses to be paid (or travel expenses respondents are willing to pay) and the number of visits (or visit rate), based on the assumption that expenses for travel to the destination of a certain activity will affect the demand of the activity.

The TCM procedures are as follows:

(1) Setting of evaluation targets (current development status, new development projects, status of competitive facilities, etc.)
(2) Data collection (data obtained at the departure and arrival points)
(3) Estimation of demand forecast models (the relationship between visit rate and travel is analyzed to estimate a demand curve)
(4) Estimation of benefits (consumer surplus = total utility in demand curve – expenses paid to obtain utility)
(5) Analysis of results (measurement of recreation benefits at the destination)

Table III.2-21 Example survey items for access routes

Necessary data on a departure point basis	• Relevant data on residents at the departure point (population by age) • Characteristics of domiciles (urbanization situation, competitive facilities with a homogeneous environmental quality)
Necessary data on an arrival point basis	• Relevant data on users (departure/arrival points, ages, and other personal data) • Data used to estimate population (visit frequency, etc.)
Necessary data for commonization	• Flight expenses per facility • Travel expenses, such as the amount of consumption at facilities • Degree of attraction of facilities (including competitive facilities)

[Points to note]

This method is used on the assumption that the evaluation target is worth for visit, meaning that it is difficult to evaluate targets not inducing visits. Since evaluation is performed based on travel expenses and other opportunity costs, it is difficult to make an evaluation without travel

(estimation of target facilities to be evaluated). For example, when roadside noise is getting worse after road inprovement, it is difficult to evaluate the detriment imposed on the community residents due to environmental changes, since the opportunity cost is zero.

When it comes to adopting a method, a departure point–based method is appropriate for neighboring parks and city parks whose served area for facilities can be identified to some extent. On the other hand, it is appropriate to use an arrival point–based method when evaluating large-scale facilities, Michi-no-Eki (Roadside Stations), and other similar facilities with many and unspecified users.

In fact-finding surveys, attention should be paid to the fact that a departure point-based method may need to collect a large number of samples to maintain the estimation accuracy, while an arrival point-based method needs to accurately comprehend the attribute of survey targets. Points to note regarding this method include methods of measuring available properties (private cars, etc.) even at other destinations; allocation of expenses to multiple destinations; handling of food expenses and other living costs; validity of transportation fees in cases where the preference of activities affects the selection of domicile; and handling as time opportunity cost.

(iii) Person Trip Survey

[Application of the method to environmental impact assessment]

In environmental impact assessments, this method can be used to evaluate the importance of the value recognition of sites using the indicators based on the wide of served areas and the length of staying time.

For example, a person trip survey makes it possible to obtain detailed daily traffic data (trip data), such as the starting/ending points and purposes of traffic behaviors, modes of transportation, and activity timing. This method can also be utilized to survey the flows of humans in a certain space and even comprehend the traffic volume at a specific point. Data disclosed by the national and local governments may also be useful in some target areas.

In acquiring traffic data, survey sheets need to be distributed to individuals, and they are asked to complete and submit the sheets. If a survey is conducted in a limited survey area with few target respondents, surveyors may visually confirm the usage status.

[Outline of the method]

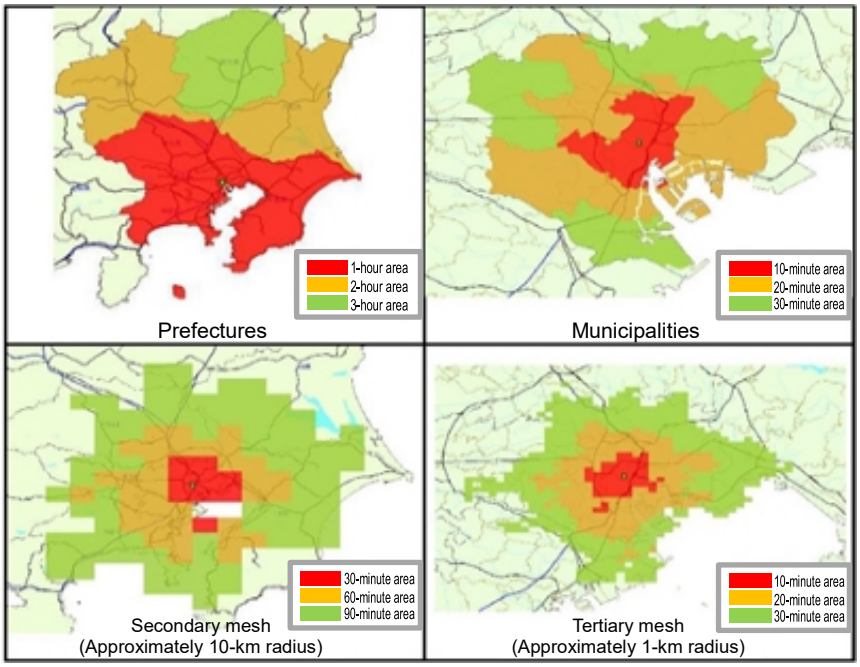
This method is intended to investigate the movements of humans in a certain area and comprehend the situation of transportation systems, which is also called traffic survey. This is a utilization observation survey to comprehend the daily travel situation of individuals and identify what, when, how, and by who transportation systems are used, as well as the departure point and destination of transportation users.

[Points to note]

In order to obtain traffic data in an extensive area, it is necessary to comprehensively survey and comprehend many transportation systems, including buses, trains, subways, and cars. In other words, the survey is less significant in areas with undeveloped transportation systems. Since short-distance trips are not covered in this survey, the actual number of trips may also be underestimated. Short-time activities tend not to be recorded in the survey sheets, or activity hours are sometimes rounded off.

[Reference Data] National Integrated Transport Analysis System

Using a geographical information system (GIS) allows for comprehending and analyzing access routes in a certain area. One of the examples using this technique is the National Integrated Transport Analysis System (NITAS). NITAS is capable of making a comprehensive analysis of traffic systems by combining various means of transportation, such as roads, railroads, aircraft, and vessels. Road networks and various statistical data are pre-installed in this system so that users can utilize them. This system can visualize and quantify the current situation of traffic infrastructure and the effects of maintenance work and even project the analysis results, such as area maps of access time, on an electronic map. NITAS is available only to public institutions, such as government agencies, local governments, and universities.



Source: Ministry of Land, Infrastructure and Transport (2016)

Fig. III.2-10 Comparison of zone-classified area maps showing the time required to access the Ministry of Land, Infrastructure and Transport

Similar to NITAS, using a GIS makes it possible to create an area map of access time around a project implementation area, analyze the conditions of access to places for recreational activity, and forecast potential project-caused impacts. In this case, access routes and other relevant data are required to be input to the GIS.