JBO3

Japan Biodiversity Outlook 3

2021 Report of Comprehensive Assessment of Biodiversity and Ecosystem Services in Japan

[Summary for Policymakers]

環境省
Ministry of the Environment
Working Group for Comprehensive Assessment of Biodiversity and Ecosystem Services, Ministry of the Environment

Foreword

I am very happy to publish the third Japan Biodiversity Outlook (JBO3). The first JBO (JBO1) was published to meet the 10th meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP10) held in Nagoya, in line with the Aichi Biodiversity Targets adopted there. The second assessment (JBO2) contained an interim assessment of the Aichi Targets and was published in 2016 to coincide with COP12. Now, JBO3 is being published to give latest information to the final assessment of the Aichi Targets and the development of new targets and frameworks.

We have made some technical progresses with the content through the three reports. The JBO1 started with collecting existing data and barely managed to show the true state of Japan's biodiversity and its changes. Then the JBO2 made it into the mapping of various biodiversity information and the assessment of ecosystem services. Now, this JBO3 mentions trend prediction by scenario analysis, thanks to the progress of academic research.

On a global level, three editions of the Global Biodiversity Outlook (GBO) have been published during this decade: the third report (GBO3) in 2010, with a focus on the Aichi Targets; the GBO4 in 2014, containing an interim assessment of the Aichi Targets; and the GBO5 in 2020, containing the final assessment of the Aichi Targets. In addition, the IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) was established in 2012 and has worked on global assessment, publishing its first assessment report (Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) in 2019. In particular, the GBO5 and the IPBES global report reflect discussions surrounding the SDGs, pointing out the importance of giving consideration not only to direct drivers but also to indirect social and economic drivers in resolving biodiversity issues, as well as the importance of leverage points that trigger transformative change. This JBO3 has put together these latest trends to the greatest extent possible.

The past decade has been declared the decade of biodiversity. However, the same decade has experienced major events that shook our society, such as the Great East Japan Earthquake in the year following the COP10 held in Nagoya, and the COVID-19 pandemic which we are living through now. All this has actually put us under pressure to extensively rethink ecosystem and biodiversity issues during this decade. I hope these experiences have helped us to develop a deeper understanding of the meaning of "Nature-based Solution concept." It is my wish that this JBO3 will be reflected in the new National Biodiversity Strategies and Action Plans will be of some help towards transformative change.

Tohru Nakashizuka
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Preface

Background to Compiling the Japan Biodiversity Outlook 3 (JBO3)

At the Tenth Meeting of the Conference of the Parties (COP10) to the Convention on Biological Diversity held in Nagoya, Aichi Prefecture, Japan in 2010, twenty specific targets (the Aichi Biodiversity Targets) were set for the purpose of taking effective, urgent actions by no later than 2020 to halt the loss of biodiversity, with the aim of realizing a world "living in harmony with nature" by 2050. Each country has continued to make efforts based on these targets. In Japan, the National Biodiversity Strategy of Japan 2012-2020 (hereinafter, the "NBSAP"), which was decided by the Japanese Cabinet in 2012, set targets (national targets) for achieving the Aichi Biodiversity Targets, based on which measures have been implemented.

In addition, the Sustainable Development Goals (SDGs), which were adopted by the United Nations General Assembly in 2015 as integrated economic, social, and environmental international goals for all developed and developing countries, set four goals (Goals 6, 13, 14, and 15) for ecosystem services provided by biodiversity. These 4 goals support all human activities covered by the economic and social goals, and ecosystem services are also related to many goals. Similarly, the 5th Basic Environment Plan, which was decided by the Japanese Cabinet in 2018, aims for integrated improvement of environment, economy, and society by aspiring to realize a "Regional Circular and Ecological Sphere." It is a sustainable society that should be aimed at, where each region forms a self-reliant, decentralized society by efficiently utilizing local resources with mutual partnership with other areas.

In Japan, JBO (Japan Biodiversity Outlook) and JBO2 (The Second Report of JBO) were published in 2010 and 2016, respectively, as comprehensive assessments of biodiversity and ecosystem services. These assessments have shown that the status of biodiversity in Japan is on a long-term deteriorating trend, and that many ecosystem services have declined while some have remained at the same level compared to the past decades.

The Global Assessment Report on Biodiversity and Ecosystem Services published by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in 2019 (hereinafter, the "IPBES Global Assessment Report") points out that biodiversity is declining at an unprecedented rate in human history, nature's contributions to people (NCP) including ecosystem services are deteriorating globally, and that the drivers of change of these trends have increased during the past five decades. In addition, the Global Biodiversity Outlook 5 (GBO5), published in 2020 by the Secretariat of the Convention on Biological Diversity, assesses that while considerable progress has been seen in most of the Aichi Biodiversity Targets, none of the twenty targets has been completely achieved.
These two important documents, assessing the Aichi Biodiversity Targets, commonly state that transformative changes across economic, social, political, and technological factors underlying drivers (i.e., impacts of social and economic activities, or indirect drivers) of biodiversity loss are strongly required to improve the situation.

In 2020, the final year of the Aichi Biodiversity Targets and the NBSAP, threats to human health and welfare brought by the worldwide COVID-19 pandemic deepened our awareness of the relationship between

human activities and changes in the global environment even more than before. Based on the background described above, Japan Biodiversity Outlook 3 (JBO3) was edited by the Working Group for Comprehensive Assessment of Biodiversity and Ecosystem Services established by the Ministry of the Environment (chaired by Tohru Nakashizuka, President of the Forest Research and Management Organization), with cooperation from 114 experts, in order to assess the current state of biodiversity and ecosystem services in Japan and to organize challenges to be worked on under the Post-2020 Biodiversity Framework and the next NBSAP.

Table1 Members of the Working Group for Comprehensive Assessment of Biodiversity and Ecosystem

Name	Affiliation and title (as of March 2021)
Hashimoto, Shizuka	Associate Professor, Graduate School of Agricultural and Life Sciences, The University of Tokyo
Morita, Kanako	Senior Researcher, Forestry and Forest Products Research Institute, Forest Research and Management Organization
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Onuma, Ayumi	Professor, Faculty of Economics, Keio University
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Shirayama, Yoshihisa	Specially Appointed Advisor, Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
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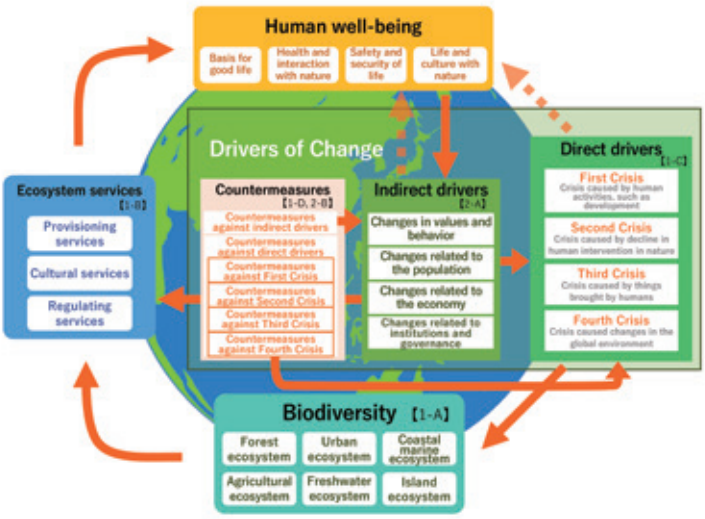
Comprehensive Assessment of Biodiversity and Ecosystem Services in Japan

Our lives are supported by the blessings of "ecosystem services" derived from biodiversity, such as food and water supply and climate stability, and ecosystem services are indispensable for the survival and good quality of life (well-being) of human beings. The drivers of change in biodiversity consist of "direct drivers," which are natural or anthropogenic drivers that directly affect nature, and "indirect drivers," which include: changes in society and economics that lead to those direct drivers, including changes in human activities and decision-making; and changes in human values and behaviors, which underlie those socioeconomic changes. These drivers are intricately intertwined, causing the loss of biodiversity and the deterioration of ecosystem services. In addition, changes in human well-being also affect these indirect drivers through changes in life consciousness and behavior.

The 2019 IPBES Global Assessment Report strongly pointed out that, in order to halt the loss of biodiversity and the deterioration of ecosystem services, it is important to deal not only with the direct drivers, such as changes in land and sea, direct exploitation of organisms, climate change, pollution, and invasion of alien species, but also with the indirect drivers, such as human population dynamics and trends, economy and institutions, as well as values and behaviors underlying them.

In light of these global discussions, this report assesses the trend during the past approximately fifty years (from the 1970s to the present) in the status of biodiversity and ecosystem services in Japan, referring to the conceptual framework of the IPBES (see Annex Appended Figure 1). The previous comprehensive assessments (JBO2) assessed the status of biodiversity [1-A], the status of ecosystem services [1-B], and the status of four biodiversity crises (direct drivers) [1-C]. In addition to these, this report (JBO3) **has newly set indicators for socioeconomic conditions (indirect drivers) to grasp the situation, as well as performing analyses of these indirect drivers' connections with the direct drivers and of effective leverage points and interventions (levers) [2-A].** In light of the results of these assessments and analyses, as well as the future trends in biodiversity and ecosystem services [1-E], the status of implementation of biodiversity-related measures [1-D], and that of measures intended to contribute to transformative change [2-B], this report **has also summarized challenges to be addressed in the next NBSAP in order to halt the loss of biodiversity and to realize transformative changes towards living in harmony with nature [1-F] [2- C].**



Section	Underlying information
1-A~1-C	Statistical information, academic papers, etc.
1-D	Statistical information, academic papers, etc., National Biodiversity Strategy of Japan 2012-2020
1-E	Academic papers, etc.
2-A、2-B	Statistical information, academic papers, etc., National Biodiversity Strategy of Japan 2012-2020, questionnaire survey on experts

Note: Dotted arrows indicate relationships whose importance is recognized but which are not assessed in this report.

Figure 1 Biodiversity and ecosystem services in Japan and their drivers

Japan Biodiversity Outlook 3

Key Messages

Key Messages 1

The status of biodiversity and ecosystem services in Japan has been on a long-term losing or deteriorating trend over the past five decades, with the impacts of direct drivers (the four biodiversity crises) having remained substantial.

An ecosystem supported by abundant biodiversity brings blessings (i.e., ecosystem services), which contribute to securing safe water and food that are indispensable for human survival, support the safety and security of living, and furthermore, provide a basis for nurturing the unique culture of each region, thereby contributing to human well-being. While our lives have been materially enriched by the enjoyment of various blessings of nature, the loss of biodiversity and the deterioration of ecosystem services are advancing due to changes in land and sea use, direct exploitation of living organisms, and climate change, among other things.

1-A. Status of Biodiversity

Japan's biodiversity has been lost continuously for the past five decades. While the rate of loss is slowing down in some ecosystems, the trend of loss is still continuing on the whole.

The results of assessments of six (forest, agricultural, urban, freshwater, marine and coastal, and island) ecosystems indicate an ongoing reduction in size and quality of the ecosystems, such as decreases in the components (farmlands, forests, tidal flats, etc.) of each ecosystem and qualitative changes in habitats. Those results also indicate an ongoing declining trend in the number of species and population that inhabit those habitats. Reduction in the use of farmlands, waterways/reservoirs, forests for agricultural use, etc. has resulted in a reduction in the natural environment constituting *Satochi-Satoyama*. In coastal shallow waters, a total area of approximately 40 km^2 was reclaimed every year from the high economic growth period until around 1980, resulting in reduced numbers of shorebirds that use tidal flats and sandy beaches. The risk of extinction of species has increased particularly in freshwater ecosystems, with more than 50% of the vertebrates listed on the 4th Version of the Japanese Red List (5th revised edition) being freshwater species that spend all or part of their lives in freshwater. On the other hand, some urban, coastal, and other ecosystems have shown improvements: an increase of urban parks nationwide from 1971 to 2018 by 5.4 times and a decrease of red tide events observed in the Seto Inland Sea from 172 times in 1979 to 58 times in 2019.

1-B. Status of Ecosystem Services

The ecosystem services we enjoy from nature have been on a deteriorating trend over the past five decades.

Our lives have been materially enriched by the enjoyment of various blessings of nature. On the other hand, although we must take into account the impact of the socioeconomic conditions including that of changes in diet, most provisioning services, such as food and timber supply, have declined compared to the past. The production of agricultural, fishery, and forestry products has decreased after the peak-time. In particular, the recent marine fisheries catch is around 50% of the peak-time level. The diversity of timber-producing tree species has decreased by about 40% over the past five decades. Furthermore, not only provisioning services but also regulation services that are relevant to our health, such as air and water purification, have shown a deteriorating trend. Some disaster risk reduction services provided by ecosystems, such as surface failure prevention services provided by forests, have been improving as a result of the growth of planted trees. On the other hand, the flood control service provided by wetlands appears to be on a declining trend over the years due to the significant decrease in the area of

wetlands, although this depends on to what land use wetlands are converted. In addition, cultures and traditional knowledge associated with the sustainable use of local resources are being lost. Furthermore, the past two decades have seen an increase in damage to agriculture, forestry and fisheries caused by wildlife, as well as more visible health risks caused by zoonotic diseases, such as tick-borne infection, showing more prominent negative impacts (disservices) of ecosystems.

1-C. Status of Direct Drivers

Of the direct drivers of biodiversity loss, impacts caused by human activity (the First Crisis), decline in human intervention (the Second Crisis), and things newly brought by humans (the Third Crisis) are not as pressing as before, but their impacts are still large. In addition, recent years have seen more visible impacts of the Fourth Crisis associated with changes in the global environment, such as global warming.

Regarding the First Crisis (crisis caused by human activities, such as development and over-harvesting), less than 20% of Japan's total land area remains covered by undisturbed vegetation. Currently, while the pressure of development on ecosystems has lessened compared to the periods of high economic growth and the bubble economy, the effects of past conversions to ecosystems may continue, with relatively small-scale conversions continuing. As for the status of the Second Crisis (crisis caused by decline in human intervention in nature), there is concern that the mosaic pattern of *Satochi-Satoyama* may disappear as a result of the approximate tripling of the area of abandoned farmland during 1975-2015. As for the status of the Third Crisis (crisis caused by things newly brought by humans), while eutrophication of lakes and closed waters has been on a lessening trend over the past two decades, the crisis facing ecosystems caused by invasive alien species has worsened. Regarding the status of the Fourth Crisis (crisis caused by the global environmental changes), the average temperature in Japan has increased at a rate of 1.26°C per century. The climate change over the past three decades typically caused the northward extension of the distribution of certain species of bamboo (Moso bamboo: *Phyllostachys edulis* and Japanese timber bamboo: *Phyllostachys bambusoides*) that grow in warm climates, and the distributional enlargement of southern butterflies to the northern areas, as well as coral bleaching apparently caused by the rise in seawater temperature.

1-D. Countermeasures against the Loss of Biodiversity and the Deterioration of Ecosystem Servicess

Japan has thus promoted establishing and/or enhancing laws, institutions, etc. as countermeasures against the loss of biodiversity and the deterioration of ecosystem services. In particular, recent years have seen various countermeasures being taken against the four crises under the NBSAP, with regional level efforts also being promoted under local BSAPs (LBSAPs).

Through the efforts over the past five decades, designated protected areas have expanded. As a measure to conserve individual species, the designation of domestic rare wild plant and animal species has been promoted under the Act on Conservation of Endangered Species of Wild Fauna and Flora. In addition, several countermeasures have been improved, such as by fundamentally reinforcing the control of wildlife by amendment of the Wildlife Protection and Hunting Management Law, selecting important *Satochi-Satoyama*, controlling alien species by the designation of invasive alien species, and regulating the production and use of chemical substances. With respect to climate change, countermeasures have tended to be improved, such as by pursuing mitigation measures and by assessing and monitoring impacts on ecosystems and considering adaptation measures from the viewpoint of biodiversity.

1-E. Future Trends in Biodiversity and Ecosystem Services

With the recent progress of scenario-based research, it is gradually becoming clear how Japan's biodiversity and ecosystem services will change in the future. It has been pointed out that while climate change may bring major changes in the status of biodiversity, changes in socioeconomic conditions will also affect future biodiversity and ecosystem services in Japan.

It is expected that if climate change continues as it is, biodiversity will be seriously damaged. Furthermore, in the depopulating Japanese society, the future status of biodiversity and ecosystem services may change greatly depending on scenarios considering population distribution (concentrated vs. dispersed population) and the choice of valued capital (produced capital vs. natural capital). This suggests that the conservation of biodiversity and the continuous enjoyment of ecosystem services require not only the existing measures aimed at conserving the natural environment but also measures considering human behavior and social transformation.

1-F. Outcomes and Challenges of Past Efforts

Although the rate of biodiversity loss in Japan has been slowed down in recent decades, the loss in the past has not yet been recovered. It is necessary to further strengthen existing efforts while starting additional efforts. For that purpose, it is important not only to take countermeasures against the direct drivers of biodiversity loss but also to take comprehensive countermeasures to change the way society is.

In Japan, successful results of past efforts have been seen in some specific species and regions, such as recovery in the wild populations of the Japanese crested ibis (*Nipponia nippon*) and oriental storks (*Ciconia boyciana*), reduction in the extinction risk for some rare species by expanding protected areas, and decrease in the habitat area of some alien species. Some indicators, such as the scale and quality of the forest and freshwater ecosystems, and the populations and distributions of species living in cities, have now transitioned from decreasing to a flat trend. However, none of the indicators have transitioned to a recovery trend yet. While the effectiveness of some efforts may become visible in later years, it is also important in the future not only to enhance the measures that have proven effective (conservation of rare species, the control of alien species, and the conservation and management of protected areas etc.), but also to strengthen other measures to restore the integrity of ecosystems (increasing connectivity, developing networks between protected areas and their surrounding areas with a well-conserved rich natural environment, etc.), to introduce an adaptive perspective on climate change, and to utilize various regulating services of ecosystems, such as disaster risk reduction. In order to restore Japan's biodiversity, it is important to aim for transformative change by taking a wide range of measures, including indirect drivers, considering the change of socioeconomic conditions.

Key Messages 2

To halt the loss of biodiversity and to reverse the trend to a recovering one, it is important to generate transformative change through intervening against the indirect drivers, as well as taking measures against the direct drivers.

Japan's biodiversity crisis is caused by changes in the underlying socioeconomic conditions (i.e., indirect drivers). While Japan has had much more material comfort over the past five decades, the socioeconomic conditions have had indirect negative impacts on biodiversity. To maximize the effects of measures in the future, it is important to promote transformative change by remedying the indirect drivers through efforts that focus on the "leverage points" at which interventions (i.e., measures) should be implemented.

2-A. Socioeconomic Conditions (Indirect Drivers) and Approaches to Countermeasures

In Japan, the past five decades have seen significant changes in the socioeconomic conditions (i.e., indirect drivers) and economic development, while these changes had great impacts on biodiversity through the direct drivers. The relationships between the direct drivers, indirect drivers, and leverage points are complicated. Countermeasures against such indirect drivers as "changes in industrial structure" and "production and consumption" are expected to produce a wide range of effects, while countermeasures against such indirect drivers as "global trading of goods" and "energy use" may be significantly effective in remedying some specific direct drivers. In order to generate transformative change, it is important to implement combining measures which act on more than one leverage point.

In order to halt the loss of biodiversity and the deterioration of ecosystem services in Japan, it is essential to generate "transformative change," which fundamentally changes the socioeconomic conditions (i.e., indirect drivers) underlying the four crises (i.e., direct drivers) through measures with respect to leverage points. The direct drivers, indirect drivers, and leverage points have intricately intertwined relationships with each other, without any leverage point that would provide a universal solution. A questionnaire survey of experts indicated that in Japan, such indirect drivers as "changes in industrial structure," "people's interest in nature," and "production and consumption" show strong impacts on the direct drivers in general, while some indirect drivers, such as "global trading of goods" and "energy use," have strong relationships with certain direct drivers. Changes in these major indirect drivers are seen, for example, in Japan's industrial structure. A comparison of the working population between 1970 and 2015 indicates a decrease in the primary industry from around 19% to around 4%, in contrast to an increase in the tertiary industry from around 47% to around 71%, having a strong impact on the decrease in the number of people managing *Satochi-Satoyama*. As for production and consumption, while consumption expenditure per household has been on a decline since 2000, real final consumption expenditure of households increased by approximately 20% in 2019 as compared to 1994, even though it has remained at the same level over the past several years. The increase in consumption is associated not only with an increase in the domestic environmental load caused by waste but also with an increase in global movements of goods. The amount of cargo imports at ports nearly doubled from 1970 to 2018. These movements of goods have become one of the causes of the introduction of alien species. An analysis of the relationships between these indirect drivers and the eight leverage points shown in the IPBES Global Assessment Report indicated that "changes in industrial structure" are broadly related to the eight leverage points, while "production and consumption" is strongly related to "reduce total consumption and waste" and "global movements of goods" is strongly related to "internalize externalities and telecouplings" in addition to "reduce total consumption and waste". It is important to implement a combination of measures that act on multiple leverage points, taking into account these relationships between the indirect drivers and leverage points.

2-B. Status of Implementation of Measures Contributing to Transformative Change

Previous efforts for biodiversity have not fully focused on appropriate leverage points towards transformative change. In order to realize a society living in harmony with nature, it is essential to promote transformative change by implementing appropriate measures through leverage points that are considered to be particularly effective on indirect drivers.

To work on indirect drivers that can be deemed to be the root causes amid the international emphasis on the need for transformative change to conserve biodiversity, finding effective leverage points for each indirect driver will lead to the effective implementation of measures. Under the NBSAP developed in 2012, while many measures were implemented that corresponded to such leverage points as "promote education and knowledge generation and sharing" and "practice justice and inclusion in conservation," such as consensus building with stakeholders, measures implemented for other leverage points were not sufficient. On the other hand, in the context of regional revitalization and the SDGs, there are already measures that can contribute to transformative change. It is needed to enhance synergy effects by linking these measures with measures to be taken under the next NBSAP or under LBSAP to be established by local governments, besides implementing new necessary measures.

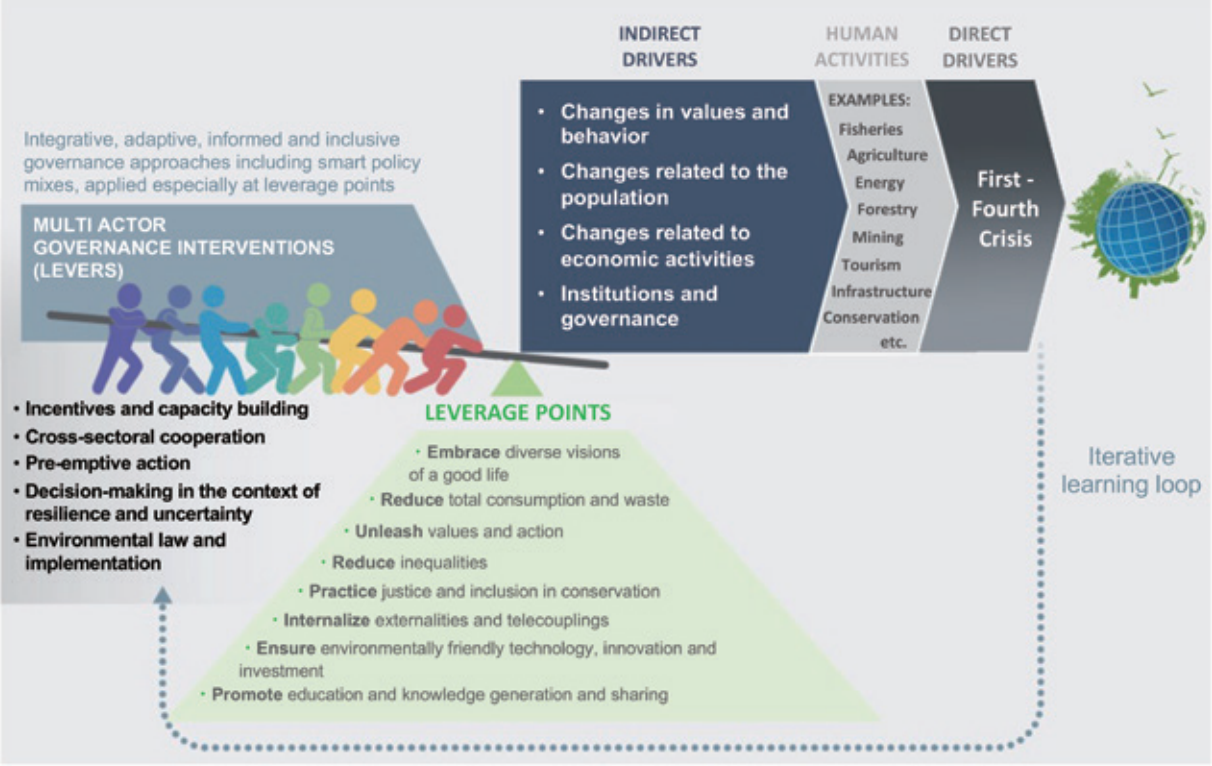
2-C. Challenges to Be Addressed to Achieve Transformative Change

In terms of the direction of transformative change, it is of great significance to reevaluate biodiversity and ecosystem services as a foundation for social and economic activities and to introduce elements of a self -reliant and decentralized society towards realizing a rich and resilient society living in harmony with nature by utilizing local resources. In order for our efforts to be effective, it is essential to involve diverse sectors and to bring all parties together to take actions to restore biodiversity.

From a policy perspective, it is important to take measures against indirect drivers that are considered to affect a number of direct drivers, in order to raise the overall level of dealing with the direct drivers towards transformative change. Specifically, effective measures could include: forming virtuous cycles of business and biodiversity as measures taken through effective leverage points against indirect drivers, such as "changes in industrial structure," "people's interest in nature," and "production and consumption"; and promoting education and the fostering of values that will support these virtuous cycles. In addition, identifying indirect drivers that are particularly affecting each of the four crises will lead to effective efforts. In making these efforts, it is also important not only to deal with issues that have arisen in Japan but also to take into account the issue of telecouplings, in which domestic consumption increases the risk of extinction of animal and plant species overseas. Furthermore, in terms of strategy to reevaluate biodiversity and ecosystem services as a foundation for human social and economic activities, important points include: taking into account the concept of nature-based solutions (NbS) when dealing with social issues in general, including SDGs; and clarifying the synergies and trade-offs between efforts to resolve social issues and the sustainable use of natural capital. In particular, in the era of population decline, and during and post-COVID-19 era, it is becoming more important to shift to a self-reliant and decentralized society living in harmony with nature and utilizing natural capital. It is also of great significance to determine the roles of biodiversity and ecosystem services from various perspectives, such as sustainability, resilience, and affluence, with a view to redesigning the economy and the society.

In order to realize these, it is important not only to continuously observe, and promote the preparation of basic data on the status of biodiversity and ecosystem services and the direct and indirect drivers but also to further develop research and studies to quantitatively clarify the relationships between the direct drivers, indirect drivers, leverage points, and measures, as well as the outcomes of efforts, towards formulating more effective policy.

Furthermore, it is essential to maximize the effect of efforts for transformative change, through planning measures based on scientific knowledge, constructing an adaptive cycle that reflects in the measures the knowledge obtained through implementing them, and having various sectors cooperate with each other in a cross-sectoral, organic manner.



L	Leverage points
L1	Embrace diverse visions of a good life
L2	Reduce total consumption and waste
L3	Unleash values and action
L4	Reduce inequalities
L5	Practice justice and inclusion in conservation
L6	Internalize externalities and telecouplings
L7	Ensure environmentally friendly technology, innovation and investment
L8	Promote education and knowledge generation and sharing

I	Indirect drivers
	Changes in values and behavior
I1	People's interest in nature
I2	People's interest in their community
I3	Changes in values and behavior caused by natural disasters
I4	Changes in values and behavior caused by infectious disease risk
I5	Changes in housing and housing life
I6	Changes in eating habits
I7	Changes in work
I8	Changes in leisure activities
	Changes related to the population
I9	Human population dynamics
I10	Residential population
I11	Nonresident population
I12	Related population
	Changes related to economic activities
I13	Economic conditions
I14	Produced capital
I15	Human capital
I16	Changes in industrial structure
I17	Production and consumption
I18	Traditional industries
I19	Primary industry-related technologies
I20	Non-primary industry-related technologies
I21	Energy use
I22	Global trading of things
I23	Global movements of people
I24	Financial flows for sustainable development
	Institutions and governance
I25	Individual- and corporate-level institutions and governance
I26	Local government-level institutions and governance
I27	National-level institutions and governance

D	Direct drivers
	First Crisis
D1	Development, conversion of ecosystems
	Second Crisis
D2	Reduced use and management of Satochi-Satoyama
D3	Reduced direct use of wildlife
	Third Crisis
D4	Introduction and establishment of alien species
D5	Eutrophication
D6	Effects of chemical substances on organisms
	Fourth Crisis
D7	Changes in the global environment
D8	Effects of global warming on organisms

Source: IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services. (altered by the Ministry of Environment)

Figure 2 Transformative change in global sustainability pathways

Japan Biodiversity Outlook 3

Grounds

Grounds 1

Japan Biodiversity Outlook 3

The status of biodiversity and ecosystem services in Japan have been on a long-term losing or deteriorating trend over the past five decades, with the impacts of direct drivers (the four biodiversity crises) having remained substantial.

1-A. Status of Biodiversity

Japan's biodiversity has been lost continuously for the past five decades. While the rate of loss is slowing down in some ecosystems, the trend of loss is still continuing on the whole.

a. In various ecosystems, their scale and quality have continued to decline over a long-term period *[based on sufficient data]*[1]. {Chapter II, Sections 1-6}[2].

Regarding the scale of ecosystems, agricultural, freshwater, and marine and coastal ecosystems have shown reduction in scale over the past five decades mainly due to the development, conversion, and reduced use of farmlands, grasslands, etc., the reclamation of wetlands and natural lakes, and the reclamation of natural river banks and coasts {Chapter II, Sections 2, 4, and 5}. For example, coastal shallow waters were reclaimed at an annual rate of around 40km^2 from the period of high economic growth until around 1980, followed by a slower but long-term increase in cumulative reclaimed area {Chapter II, Section 5}. As for the quality of ecosystems, remarkable changes have been seen particularly in forest and agricultural ecosystems over the past five decades. Forest ecosystems have experienced changes in the quality of the habitat environment for living organisms, such as the conversion from natural forests to planted forests and changes in species composition and diversity due to abandonment of managed secondary forests, although the rate of these changes has slowed down in recent years {Chapter II, Section 1}. Changes related to agricultural ecosystems include a reduction in the amount of pesticides shipped domestically, which suggests a long-term reduction of the effects of pesticides on the environment. On the other hand, there has been ongoing loss and deterioration of ecosystem elements that make up the *Satochi-Satoyama* environment, resulting from the reduced use of elements of these ecosystems, such as farmlands, waterways and reservoirs, forests including those for agricultural use, and meadows, grazing lands, and other grasslands, generating a concern that *Satochi-Satoyama* landscapes with mosaic patterns may disappear. Those mosaic patterns have decreased particularly in plains where there are many large-scale farmlands. It has also been pointed out that the number of living organisms has decreased due to the conversion of paddy fields to well-drained fields and the concreting of waterways resulting from land consolidation {Chapter II, Section 2}. Changes indicating reduction in the rate of loss include the long-term trend in urban ecosystems after the period of high economic growth, with a reduced rate of loss of forest lands, farmlands, etc. in urban areas. At the same time, the total area of urban parks nationwide increased significantly by the 2000s, with a 5.4-fold increase from 1971 to 2018 {Chapter II, Section 3}. In addition, the quality of water in rivers, lakes, closed waters, etc. has been on an improving trend. In some areas, marine waters have shown changes resulting from improved water quality, such as the reduction in the number of red tides observed in the closed waters of the Seto Inland Sea from 172 times in 1979 to 58 times in 2019 {Chapter II, Section 5}.

b. Changes in the populations and distribution areas of living organisms inhabiting various ecosystems indicate a trend of loss in biodiversity *[insufficient amount of data]* {Chapter II, Sections 1-6}.

In forest ecosystems, due to increase in the distribution and population of Japanese sika deer (*Cervus nippon*), the foraging pressure, treading pressure, etc. on understory vegetation have increased. This has had a significant impact on the avifauna, as seen in reports that on the Odaigahara Plateau spanning across Mie and Nara prefectures, there has been a decrease in species utilizing understory vegetation, such as Japanese bush warblers (*Horornis diphone*), Siberian blue robins (*Larvivora cyane*), and Japanese robins (*Luscinia akahige*), while there has been an increase in red-bellied thrushes (*Turdus chrysolaus*), olive-backed pipits (*Anthus hodgsoni*), and other birds that prefer open spaces {Chapter II, Section 1}. There have been suggestions that changes in agricultural ecosystems may also have had an impact on the

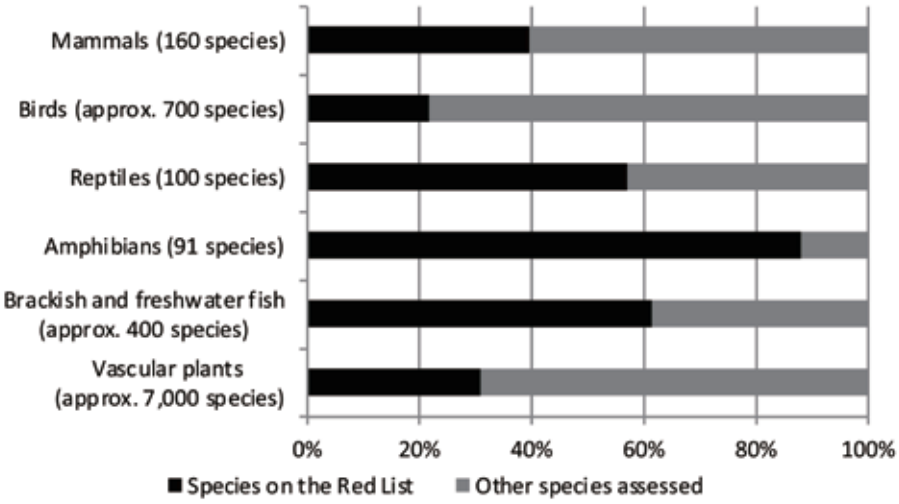
1 In this assessment, the grounds (i.e., the amount of information) for the assessment are described for each of the messages under 1-A to 1-C that provide trend assessments. The method of expressing the grounds (i.e., the amount of information) for assessment is shown in the Annex (p.40).

2 Chapters and sections between curly brackets indicate the chapters and sections in which the relevant information is provided in the detailed version of "2021 Report of Comprehensive Assessment of Biodiversity and Ecosystem Services in Japan (JBO3)."

population of butterflies whose main habitat is *Satochi-Satoyama*, as well as on the population of inland shorebirds that migrate through Japan {Chapter II, Section 2}. Furthermore, marine and coastal ecosystems and island ecosystems have experienced not only a reduction of tidal flats and seagrass beds but also, particularly over the past two decades, an ongoing reduction in scale and quality of coral caused by bleaching. The large-scale bleaching that occurred in 2016 resulted in a dramatic decrease in coral coverage in the Sekisei Lagoon, Okinawa. In terms of fishery resources used in fisheries, 44% of the fishery resources in the waters around Japan have been rated at a low level {Chapter II, Section 5}. Urban ecosystems have experienced an expansion of the distribution of white-eyes (*Zosterops japonicus*), starlings (*Sturnus cineraceus*), and other birds adapted to the urban environment, generating a concern over simplification of biota caused by the remarkable expansion of the distribution of specific species {Chapter II, Section 3}.

c. There are many endangered plant and animal species, with a long-term increase in extinction risk particularly in freshwater ecosystems *[based on a sufficient amount of data]* {Chapter II, Section 4 and Chapter IV, Section 1}

According to the 4th Version of the Japanese Red List (5th revised edition), 39% of mammals, 22% of birds, 57% of reptiles, 88% of amphibians, 61% of brackish and freshwater fish, and 31% of vascular plants assessed are either extinct or endangered. More than 50% of the listed vertebrates are species of freshwater ecosystems that spend all or part of their lives in freshwater. As for marine and coastal ecosystems and island ecosystems, more than 200 endangered and near-threatened species are listed in the Ministry of the Environment's Red List of Marine Species published in 2017, which include an addition of more than 100 species to those listed in the Fisheries Agency's Red Data Book published in 1998.



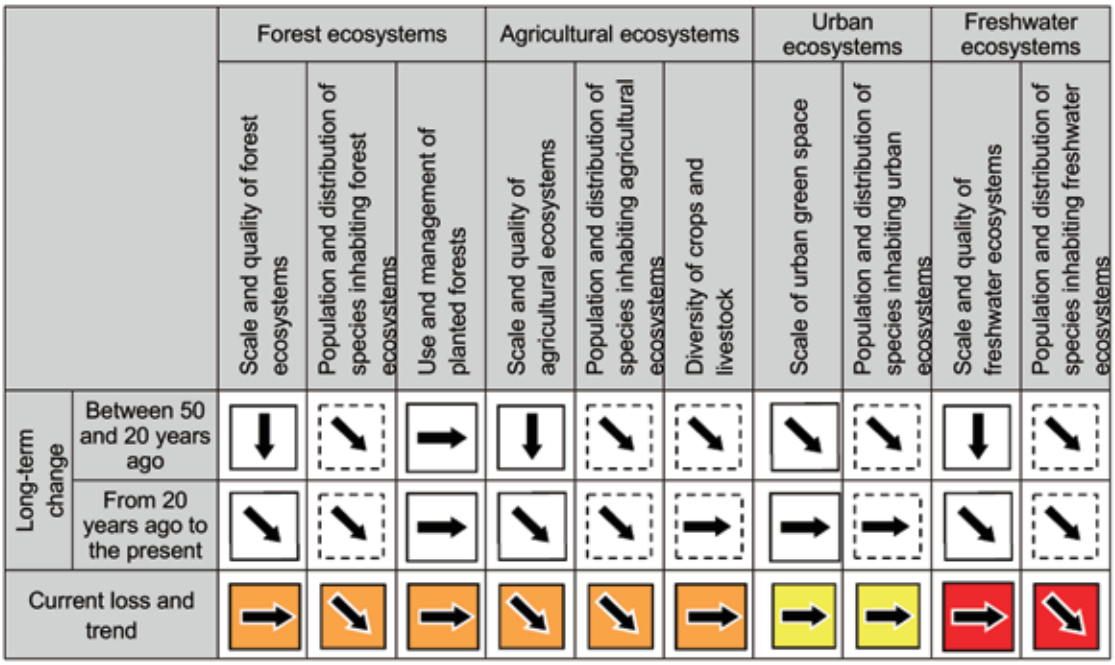
Note: Numbers in parentheses indicate the numbers of species assessed in each class.
Source: Ministry of the Environment, 2020: Press release document titled "Publication of the Ministry of the Environment Red List 2020" (in Japanese), table of numbers of species listed in the Red List 2020.

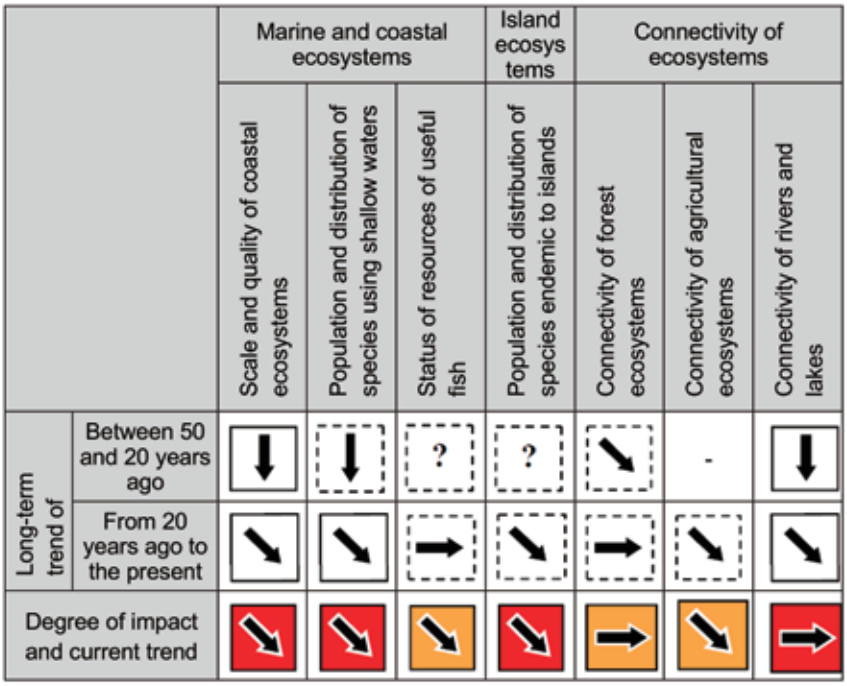
Figure 3 Percentage of listed species and other assessed species in each taxonomic group assessed in the Ministry of the Environment Red List

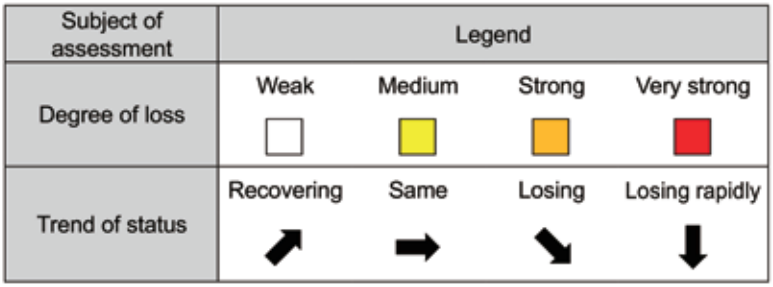
d. Ecological connectivity is on a long-term declining trend in forest, farmland, and freshwater ecosystems [insufficient amount of data] {Chapter II, Section 7}.

Forest ecosystems have experienced a decline in connectivity, particularly in plains, due to forest fragmentation and isolation. In Shikoku, the population of Asiatic black bears (Ursus thibetanus), which need large forest areas to live in, has become isolated and their survival is under threat. As for agricultural ecosystems, nationwide surveys suggest the possibility that the population of Japanese hares (Lepus brachyurus) and martens (Martes melampus) has decreased, as these mammals are vulnerable to habitat loss and fragmentation. With respect to freshwater ecosystems, it has been pointed out that living organisms migrating upstream rivers may be prevented from traveling due to the ongoing fragmentation of rivers caused by the construction of dams and weirs for flood control and irrigation purposes. There is also a concern about a reduction in the connectivity of rivers in the transverse direction, because of the ongoing lowering of the riverbed caused by the fixation of the water route (i.e., the deep line on the riverbed through which water flows at all times), and because of the ongoing tree growth due to the development of sand banks {Chapter II, Section 7}.

Table 2 Indicators and assessment of biodiversity status







Note: Graphic symbols may not represent all of the multiple factors related to the indicators in question.
Note: Arrows surrounded by dotted lines indicate that data is insufficient to make quantitative assessment.

1-B. Status of Ecosystem Services

The ecosystem services we enjoy from nature have been on a deteriorating trend over the past five decades.

a. While our lives have been materially enriched, many of the provisioning services have decreased over the past five decades, including particularly aquatic products which have shown a remarkable declining trend over the past two decades *[based on a sufficient amount of data]* {see Chapter III}.

Assessment of such provisioning services as food and timber needs to take into account the effects of socioeconomic conditions, such as changes in eating habits, and needs both supply and demand perspectives. Japan's self-sufficiency rates in food and other items are on a declining trend compared to 1970 in most items particularly due to an increase in imports from abroad which has been recognized as a drive from the demand side, while timber and some other items have recovered to the level of the 1970s. On the other hand, seen from the supply side, marine fisheries catch (excluding spotline sardine: *Sardinops melanostictus*) decreased to around 50% of the peak-time level and that of inland water fisheries fell to around 20%, showing significant reductions particularly over the past two decades. Agricultural and forestry production has also decreased from peak times, whereas timber production has transitioned to an increasing trend in the last two decades. Changes have occurred not only in production but also in product variety. The variety of tree species produced in forestry has decreased by 40% over the past five decades. In addition, the regulating services related to water and soil, which play important roles in the production of food and other resources, have also shown a deteriorating trend. While different regions have different trends, a comparison of the amount of the national groundwater recharge between 1976 and 2009 reveals an 8% decrease. The amount of soil erosion prevented has also shown a slightly decreasing trend {Chapter III, Section 1}.

b. While air and water pollution that affects our health has been significantly reduced over the past five decades as a result of legal regulations and other measures, such regulating services as cleaning of air and water provided by ecosystems have remained at the same level or decreased over the past two decades *[based on a sufficient amount of data]* {Chapter III, Section 2}.

Japan used to face many environmental issues, including air pollution and heavy metal contamination, but currently the indicators representing air and water pollution have significantly decreased as a result of legal regulations and other measures in and after the 1970s. As for cleaning of air by ecosystems, on the other hand, the estimated absorption of air pollutants by plants remained at about the same level on a nationwide basis when comparing between 2000 and 2010, while the absorption of greenhouse gases by forests, etc. has been decreasing since peaking in 2003. As for water purification, although the number of analyses is limited, a study that analyzed the absorption of nitrogen by ecosystems reported an approximately 7% decrease in services when comparing between 1991 and 2009 {Chapter III, Section 2}.

c. Disaster risk reduction and other regulating services by natural ecosystems that are connected to the safety and security of our lives have improved in some ecosystems over the past five decades, but with different trends in different regions *[insufficient amount of data]* {Chapter III, Section 3}.

The number of people affected by landslide disasters, which was on a decreasing trend from the 1970s to the 1990s, has been increasing over the last two decades, due to such causes as an increase in heavy rain events. Overall, the shallow landslides prevention service has remained at the same level or increased over the past five decades. The soil erosion prevention service has remained at the same level over the last two decades on a national basis. However, some geographical areas have seen a decline in the regulating services, due to the decrease in farmland and forest land caused by such factors as the expansion of urban areas. The flood control service provided by wetlands appears to be on a declining trend over the years due to the significant decrease in the area of wetlands, although this also depends on what land use wetlands are converted to {Chapter III, Section 3}.

d. The cultural services, which are connected to cultures and lifestyles that have been formed in our lives with nature, have decreased significantly with the changes in industrial structure and with the depopulation and aging of rural areas caused by population migration to urban areas, that have occurred over the past five decades *[based on a sufficient amount of data]* {Chapter III, Section 4}.

Continued urbanization has resulted in smaller areas for outdoor playing and fewer opportunities to have experiences in nature for children, as well as in a smaller number of shrines enshrining various gods that have been built since olden times to express thanks and awe for the blessings of nature, and in fewer reports of festivals for these gods. The level of diversity of mosaic-like landscapes has also decreased by around 14% by national average over the past four decades, due to a decline of the number of persons engaged in agriculture, forestry and fisheries, which has decreased to 16% of the level in 1960. On a nationwide basis, Japan's dietary cultures are becoming homogenized, with a significant decrease in the volume of production, and in the number of persons engaged in the production, of traditional crafts. This indicates an ongoing loss of region-based traditional knowledge to draw on the blessings from nature. As for interaction with nature, the number of visitors to national parks has increased over the long term of fifty years with an increase in the number of national parks, but the rate of participation in outdoor leisure activities has been on a declining trend over the last two decades {Chapter III, Section 4}.

e. Damage to agriculture, forestry and fisheries caused by wild animals and other negative impacts (disservices) wielded by ecosystems have become visible [based on a sufficient amount of data], with increasing health risks caused by plants and animals, such as zoonosis *[insufficient amount of data]* {Chapter III, Section 5}.

As described above, ecosystems bring various blessings to our lives, while wielding negative impacts on us. In Hilly and Mountainous Areas, reduced human activities have resulted in conflicts between humans and wild animals. Human damage by bears has been on an increase since 2000, with an escalation of feeding damage and bark damage on trees caused by Japanese sika deer as well as of damage to farm crops caused by various animals. As for human health risks caused by plants and animals, there have been reports of increases in pollen allergy caused by cedar and alien plants and in zoonosis deriving from wild animals, with it having been pointed out that these risks have increased as a result of human disturbance of the natural environment. On the other hand, we must note that ecosystem services and disservices are two sides of the same coin, i.e., those damaging plants and animals provide ecosystem services at the same time. For instance, Japanese sika deer causing feeding damage as mentioned above can also provide meat.

Table 3 Indicators and assessment of the status of ecosystem services

Assessment item		Assessment result		
		Between 50 and 20 years ago	From 20 years ago to the present	Overuse or underuse*
Provisioning services	Agricultural crops	↓	↘	Underuse (based on data)
	Non-timber forest products	↗	↘	Underuse (based on questionnaire)
	Seafood	↗	↘	Overuse (based on data)
	Freshwater	-	→	Overuse (based on questionnaire)
	Timber	↘	↗	Underuse (based on data)
	Raw materials	↘	↘	Underuse (based on data)
Regulating services	Climate	-	↘	-
	Air quality	-	→	-
	Water	-	⇘	-
	Soil	→	-	-
	Disaster mitigation	⇗	→	-
	Biological control	-	⇘	-
Cultural services	Religion/festivals	↓	↘	-
	Education	↘	→	-
	Landscape	-	↘	-
	Traditional arts & crafts	↘	↘	-
	Tourism/recreation	↗	↘	-
Disservices	Damage caused by wild animals	-	→	-
	Health risks	-	-	-

Note: Overuse and underuse have been determined based also on results of the expert questionnaire survey conducted by JBO2.

Subject of assessment		Legend				
Quantitative trend in services received	Result of quantitative assessment	Increasing	Slightly increasing	Same	Slightly decreasing	Decreasing
		↑	↗	→	↘	↓
	Where data is insufficient	⇑	⇗	⇒	⇘	⇓

Note: Graphic symbols may not represent all of the multiple factors related to the indicators in question.
Note: Arrows surrounded by dotted lines indicate that data is insufficient to make quantitative assessment.

1-C. Status of Direct Drivers

Of the direct drivers of biodiversity loss, impacts caused by human activity (the First Crisis), decline in human intervention (the Second Crisis), and things newly brought by humans (the Third Crisis) are not as pressing as before, but their impacts are still large. In addition, recent years have seen more visible impacts of the Fourth Crisis associated with changes in the global environment, such as global warming.

a. The impact of the First Crisis (crisis caused by human activities, such as development) has been very strong for the past five decades and has remained significant on a long-term basis *[based on sufficient amount of data]* {Chapter IV, Section 1}.

Since the period of high economic growth, changes in land use and rapid, large-scale development and conversion activities for irrigation, flood control, and other purposes have resulted in marked reduction in size and quality of highly natural forests, grasslands, farmlands, wetlands, tidal flats, etc., particularly during the period between fifty and twenty years ago, with less than 20% of the total national land area remaining covered by undisturbed vegetation. In terrestrial and coastal waters, continued revetment and straightening of river streams and artificial embankment of lakeshores and seashores caused decreases in natural environments. On the other hand, the pressure exerted by development and conversion activities has decreased over the last two decades as compared to the periods of high economic growth and the bubble economy. For instance, the extraction of sea gravel decreased after peaking in around 1990 and decreased to be stable over the latest decade. However, small-scale development and conversion activities have still continued. Once an ecosystem is altered, its impact on ecosystems continues {Chapter IV, Section 1}.

b. The impact of the Second Crisis (crisis caused by decline in human intervention in nature) has been strong in forest and agricultural ecosystems for the past five decades and has been increasing on a long-term basis *[based on sufficient amount of data]* {Chapter IV, Section 2}.

In *Satochi-Satoyama*, where region-specific semi-natural environments have been formed through human intervention, the use of these environments has decreased particularly due to the population decline and changes in demand for agriculture and forestry over the past five decades, resulting in the approximate tripling of the area of abandoned farmland in 2015 as compared to in 1975. There is also a concern about disappearance of the mosaic patterns of *Satochi-Satoyama* environments, which consist of farmlands, waterways/reservoirs, farm forests and other forests, and meadows, grazing lands, and other grasslands. Reduced use and management of secondary forests have caused changes in species composition and diversity. Deserted villages have negatively impacted the diversity of vascular plants and butterflies, which adapted to the semi-natural environment. Reduced direct use of wild animals due to the drop in hunting wild animals, caused by aging and decrease of hunters, may have been a factor in the increase in the populations of Japanese sika deer and boars (*Sus scrofa*) in and after the 1990s. Although the number of wild animals caught for wildlife damage prevention has increased over the past two decades, the excessive increase in the number of wild animals has impacted vegetation and caused escalating damage to agriculture, forestry and fisheries {Chapter IV, Section 2}.

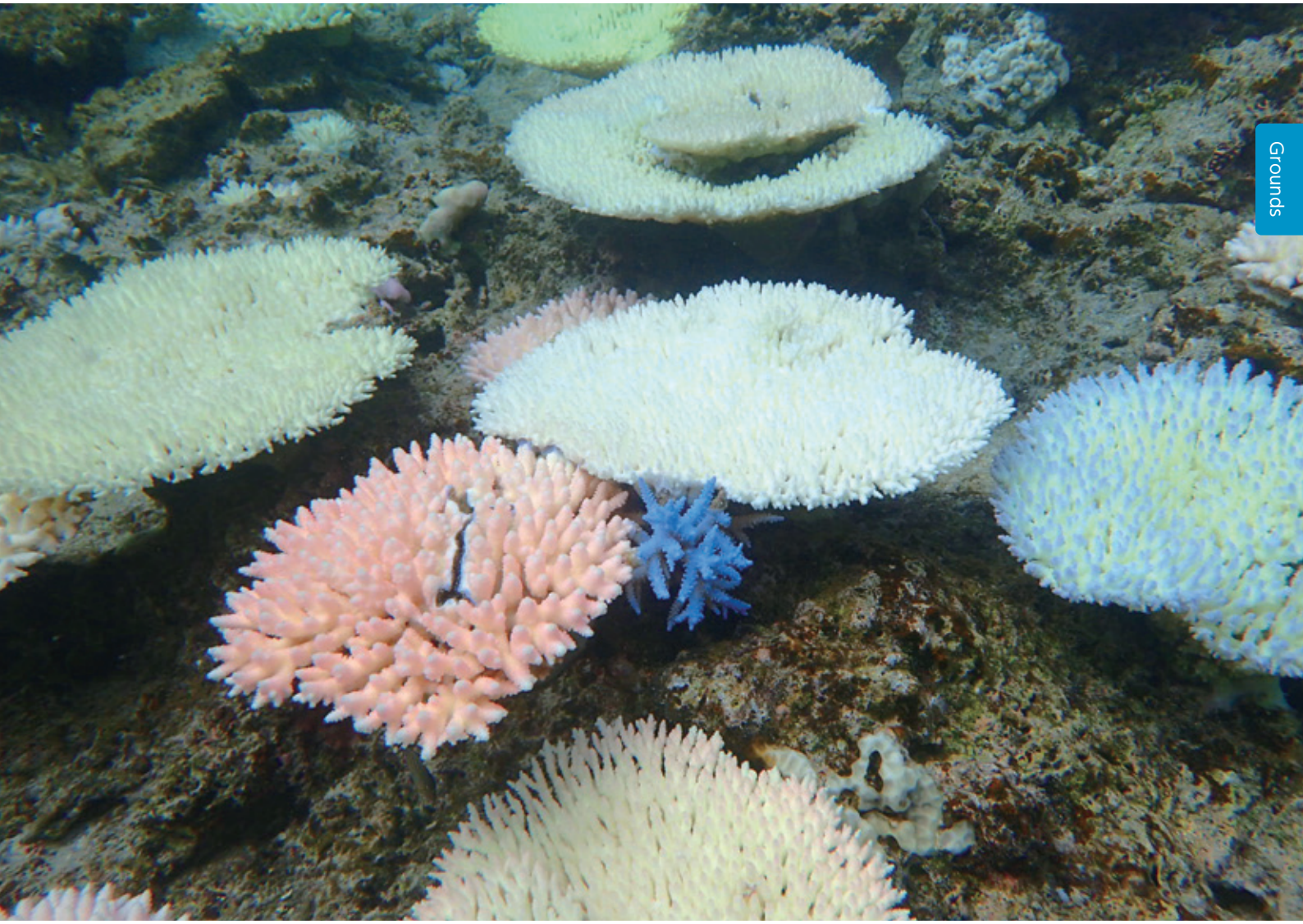
c. The impact of the Third Crisis (crisis caused by things brought by humans) has been very strong for the past five decades, particularly as a result of the introduction and establishment of alien species, and has been increasing on a long-term basis *[based on sufficient amount of data]* {Chapter IV, Section 3}.

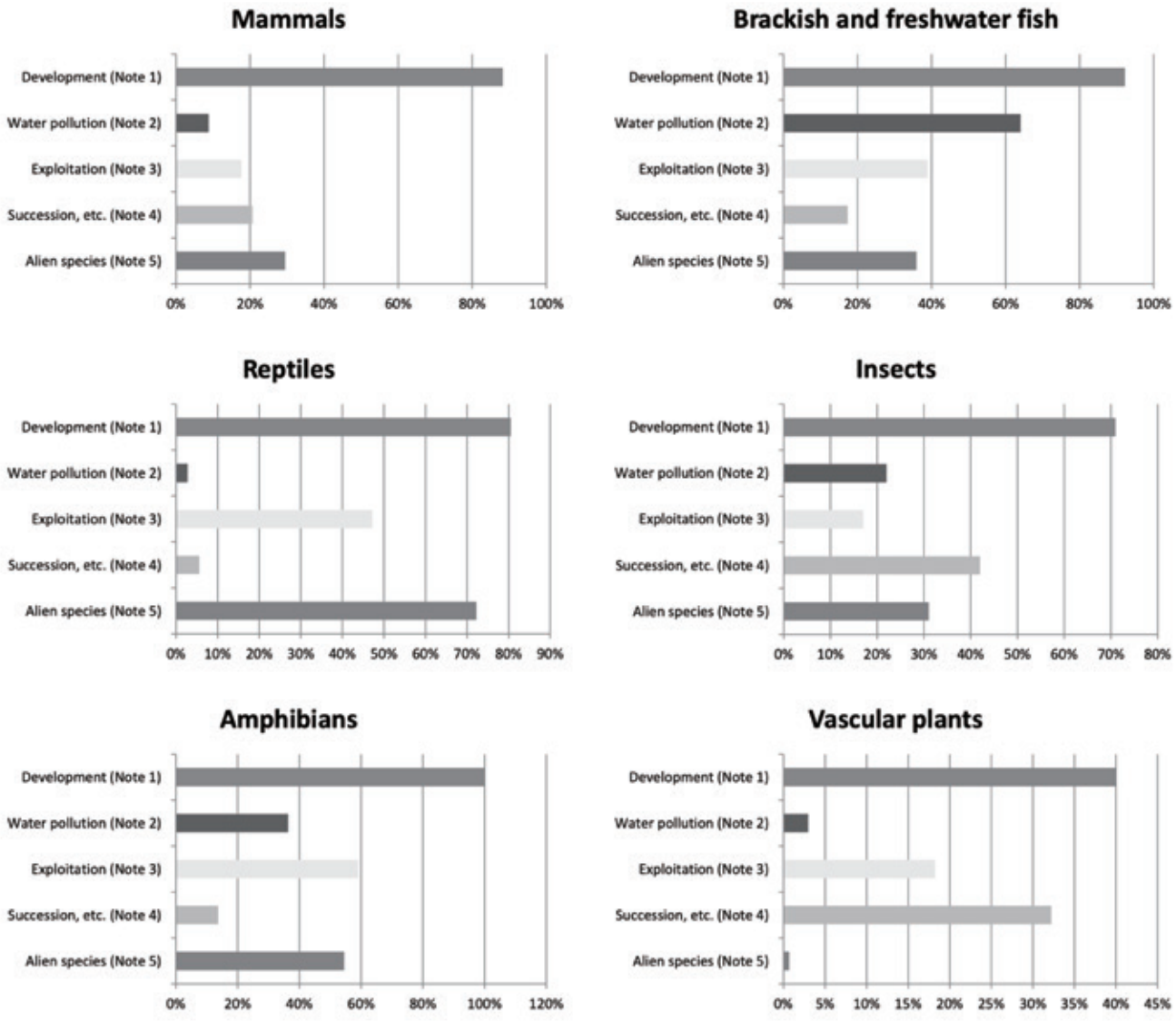
Some alien species have, as a result of marked expansion of their distribution, been significantly affected native species. Alien species contributed to the loss of all analyzed reptile species by 70%, and of other vertebrates by 30%. Eutrophication of waters has been improving since the mid-1980s. Its effect has also become smaller, as seen in the reduction in the red tide frequency observed in the Seto Inland Sea. As for chemical substances, while detection levels of major pollutants in fish have been on a long-term decreasing trend, some reports suggested the reduction of dragonflies and other insects possibly because of systemic insecticides. Although not supported by sufficient data, recent years have seen a global concern over the

effect of marine plastic waste, including microplastics, on ecosystems. Other concerns include the impact of infectious diseases on natural ecosystems, as seen in the detection of highly pathogenic avian influenza virus in hooded cranes (*Grus monacha*), a rare species, as well as the mass mortality of the wild type carp (*Cyprinus carpio*, an endangered regional population) found in Lake Biwa caused by a virus. We must continue to watch these events closely {Chapter IV, Section 3}.

d. The impact of the Fourth Crisis (crisis caused by global environment change, such as warming) has become visible as a driver of biodiversity loss in the past five decades *[based on sufficient amount of data]* {Chapter IV, Section 4}.

While carbon dioxide emissions in Japan have been decreasing continuously since 2013, the average temperature in Japan has increased at the rate of 1.26°C per century, with the number of days with heavy rain having increased. The increases in sea surface temperature along the coasts of Japan and the continuing acidification of oceans are also observed. Such effects of climate change as reduction in the size and quality of ecosystems have become visible particularly over the last two decades. The effects of the increase in temperature on ecosystems have been indicated for the reduction of the number of alpine plant communities since the 1970s, the northward extension of the distribution of alien bamboo species (Moso bamboo and Japanese timber bamboo) over the last three decades, and the increase in the number of southern butterflies to the northern areas. Furthermore, the coral bleaching occurring in Sekisei Lagoon, Okinawa and elsewhere has been caused in part by increased water temperature, along with a concern over the effects of marine acidification and deoxygenation associated with climate change {Chapter IV, Section 3}.





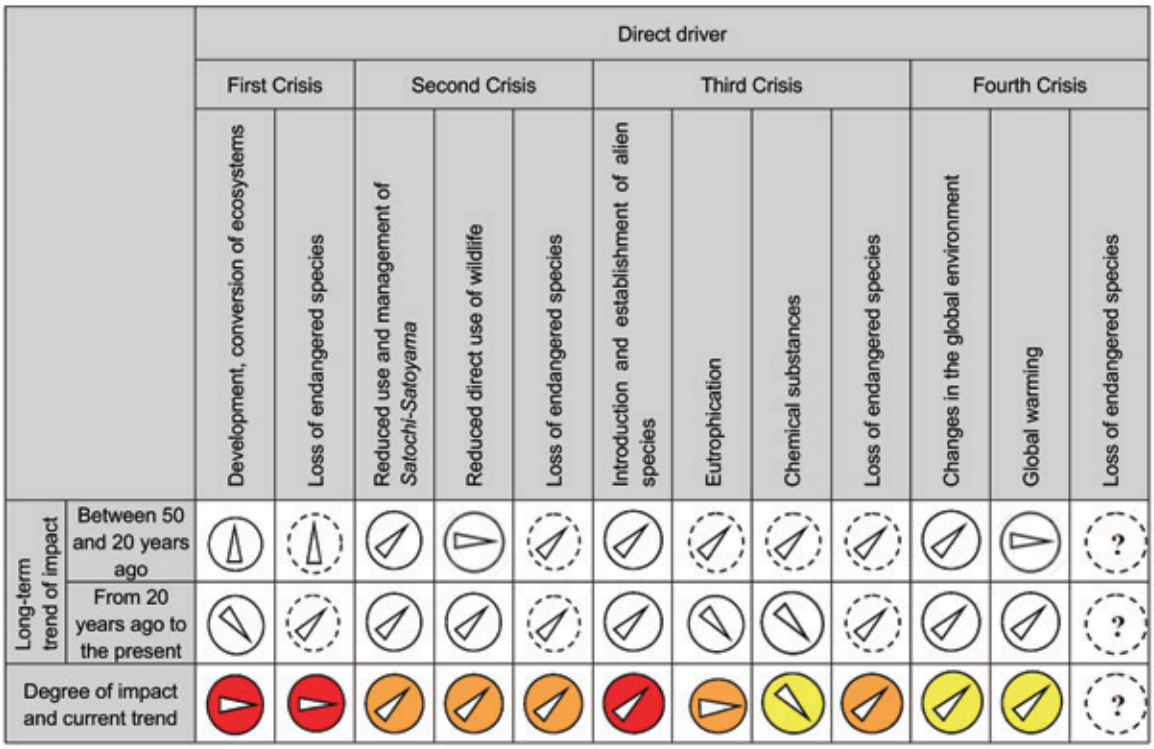
The drivers of loss of the populations of endangered species are roughly classified into “development,” “water pollution,” “exploitation,” “succession,” and “alien (or introduced) species.” The above graphs show the proportions of species associated with these drivers of loss to all endangered species (since two or more drivers may be associated with one species, the total does not come to 100%).

Note 1: Including logging of forests, river, marsh and grassland development, construction of golf courses and ski resorts, land development, road work, dam construction, etc.
Note 2: Including marine pollution, runoff of herbicides, deterioration of water quality, etc.
Note 3: Including extermination, excessive hunting, set net fishery, capture, overexploitation, etc.
Note 4: Including succession, changes in vegetation, changes in the intracavity environment, inbreeding, etc.
Note 5: Including predation by, or competition with, or zoonosis caused by, alien species.

Sources: Based on Ministry of the Environment, 2014: Red Data Book 2014: Threatened Wildlife of Japan, Volume 1, Mammalia, Gyosei Corporation (in Japanese);
Ministry of the Environment, 2014: Red Data Book 2014: Threatened Wildlife of Japan, Volume 2, Aves, Gyosei Corporation (in Japanese);
Ministry of the Environment, 2014: Red Data Book 2014: Threatened Wildlife of Japan, Volume 3, Reptilla/Amphibia, Gyosei Corporation (in Japanese);
Ministry of the Environment, 2014: Red Data Book 2014: Threatened Wildlife of Japan, Volume 4, Pisces -- brackish and fresh water fishes, Gyosei Corporation (in Japanese);
Ministry of the Environment, 2014: Red Data Book 2014: Threatened Wildlife of Japan, Volume 5, Insecta), Gyosei Corporation (in Japanese); and
Ministry of the Environment, 2014: Red Data Book 2014: Threatened Wildlife of Japan, Volume 8, Plants I, Gyosei Corporation (in Japanese).

Figure 4: Drivers of loss in the number of endangered species by biological classes

Table 4 Indicators and assessment of drivers of biodiversity loss



Subject of assessment	Legend			
Degree of impact during assessment period	Weak	Medium	Strong	Very strong
Long-term and current trends of impact	Decreasing	Same	Increasing	Increasing rapidly

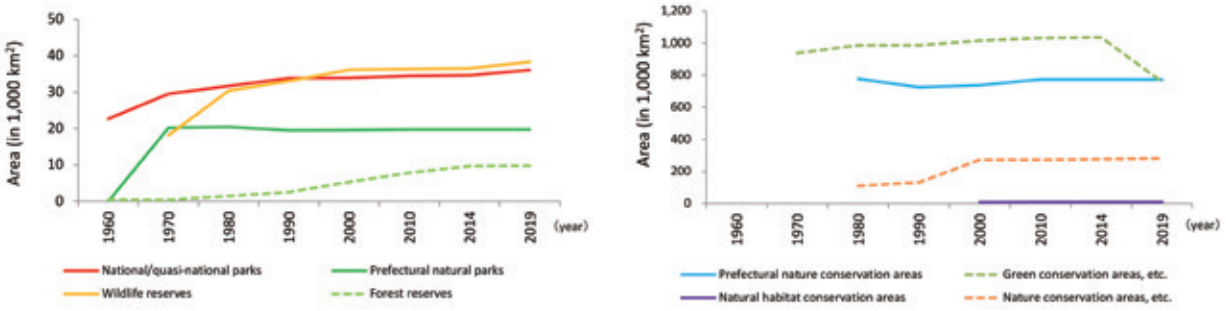
Note: Graphic symbols may not represent all of the multiple factors related to the indicators in question.
Note: Arrows surrounded by dotted lines indicate that data is insufficient to make quantitative assessment.

1-D. Countermeasures against the Loss of Biodiversity and the Deterioration of Ecosystem Services

Japan has thus promoted establishing and/or enhancing laws, institutions, etc. as countermeasures against the loss of biodiversity and the deterioration of ecosystem services. In particular, recent years have seen various countermeasures taken against the four crises under the NBSAP, with regional level efforts also being promoted under LBSAP.

a. Countermeasures against the First Crisis (crisis caused by human activities, such as development) include promotion and long-term improvement of such measures as expansion of protected areas, regulations on exploitation under the Act for the Conservation of Endangered Species of Wild Fauna and Flora and other laws, and protection and reproduction of endangered species {Chapter V, Section 1}.

The protected areas designated under the Nature Conservation Act, the Natural Parks Act, and other laws and regulations have increased on a long-term basis, up to 20.5% of the terrestrial and inland water areas at present. As for coastal and marine areas, 13.3% has been designated as protected areas, creating a new marine protected area system. Regarding the regulations on capturing and collecting rare species and the implementation of programs for their protection and reproduction, the exploitation of rare species has been regulated. The measures through legal regulations have also been improved, enacting the Act for the Conservation of Endangered Species of Wild Fauna and Flora in 1992, with the designation of 395 species as nationally endangered species by January 2021. From the viewpoint of securing the connectivity of habitats of living organisms, the "Green Corridor" project for nationally owned forests and the "Water and Greenery Network" project for cities have been underway. In addition, from around 2010, the concept of biodiversity offsetting has attracted attention, which is the theory that the impact of development on biodiversity can be offset by compensatory action to achieve the same or a better level of biodiversity. In recent years, efforts by local governments and individual businesses have been underway, such as the "Aichi Mitigation" project of the Aichi prefectural government and the development of regional biodiversity strategies. In addition, the procedures under the Environmental Impact Assessment Act enacted in 1997 have been improved to include the procedure of a "document on preliminary environment impact consideration," which is intended to avoid or reduce environmental impact at the planning stage of the project. This has contributed to give appropriate consideration at an earlier stage of the project {Chapter V, Section 1}.



Source: Based on Ministry of the Environment, 1960-2019: Various data on natural conservation (in Japanese); and Forestry Agency, 1960-2019: Statistics on national forest projects (In Japanese).

Figure 5 Changes in the areas of major protected areas

b. Countermeasures against the Second Crisis (crisis caused by decline in human intervention in nature) include enhancement of wildlife protection and management, and promotion of the conservation and restoration of *Satochi-Satoyama* and the protection of rare plants and animals {Chapter V, Section 1}.

In order to reduce or resolve the issue of conflicts between people and wildlife, such as damage to agriculture and forestry caused by wildlife, the Wildlife Protection and Proper Hunting Law was amended in 2014, by which the "control" of birds and mammals was added to the purpose of the law to ensure further promotion of the capturing of birds and animals. The title of the law was also changed to the "Protection and Control of Wild Birds and Mammals and Hunting Management Law" (Wildlife Protection and Hunting Management Law). The control of birds and animals has been enhanced drastically particularly

after 2000, by such means as setting up projects for capturing certain species of animals (i.e., Japanese sika deer and boars) from overgrown populations, mainly under the auspices of prefectural governments.

To promote the activities by various actors for conservation, Important *Satochi-Satoyama* Areas were designated. Other measures include the promotion of agricultural activities that are highly effective on biodiversity conservation, etc. (such as organic farming), as well as support through a direct payment scheme, etc. to activities to maintain and fulfill the multifaceted functions of agriculture and agricultural communities (which correspond to regulating and cultural services). Recent years have seen efforts for conservation and utilization made by various actors, including ecotourism, green tourism, dual residence (a lifestyle in which a person has a second living base other than their main one), agriculture, forestry and fishery considering regional biodiversity, conservation of regional and traditional vegetables as genetic resources; and efforts for production and consumption at the local scale. {Chapter V, Section 1}.

c. Countermeasures against the Third Crisis (crisis caused by things brought by humans) include enhancement of the import regulations on, and prevention and control of alien species, and enhancement of the regulations on chemical substances {Chapter V, Section 1}.

In 2004, the Act on the Prevention of Adverse Ecological Impacts Caused by Designated Invasive Alien Species (Invasive Alien Species Act) was enacted. This act was later amended in 2013 to enhance the measures. As of 2020, 156 species and 54 species have been designated as Designated Invasive Alien Species and Unevaluated Alien Species, respectively. The measures to prevent and control alien species have been enhanced particularly since 2000, creating the "Invasive Alien Species Control Action Plan" in 2015, which contains action guidelines for various entities, and the "The List of Alien Species that May Pose Risks to Ecosystems in Japan" (containing 429 species), as a tool for calling for appropriate action. As for regulations on the manufacture, import, and use of chemical substances, the Act on the Evaluation of Chemical Substances and Regulation of Their Manufacture, etc. (the Chemical Substance Evaluation Act), which was enacted in 1973 from the viewpoint of the effects of chemical substances on human health, was amended in 2003 to give consideration also to the effects on plants and animals. Further, the 2009 amendment extended the scope of risk assessment and management to all general chemical substances, including existing ones. In 2017, the Ballast Water Management Convention took effect, which is intended to prevent transport of organisms between different marine areas through ballast water (water taken and discharged in different marine areas in order to keep the balance of ships). Under the convention, efforts to conserve marine environments have been underway {Chapter V, Section 1}.

d. Countermeasures against the Fourth Crisis (crisis caused by changes in the global environment) include assessment and monitoring of the impact of climate change on ecosystems, and consideration of measures to deal with the impact expected to occur in the future {Chapter V, Section 1}.

In July 2015, the "Basic Concept to Climate Change Adaptation on Biodiversity in Japan" was compiled. Based on the "National Plan for Adaptation to the Impacts of Climate Change," which was approved by the Cabinet in November of the same year, improvements have been made in monitoring activities to more accurately detect changes in ecosystems, species distributions, etc. caused by climate change, and adaptation measures have been considered. In 2018, the legal mechanism for promoting adaptation measures was put in place by the enforcement of the Climate Change Adaptation Act. The Climate Change Adaptation Plan was approved by the Cabinet under this act. In addition, the "Manual for Developing Local Climate Change Adaptation Plan" was published to promote the development of local climate change adaptation plans by local governments, which has resulted in the development of these plans by 53 local governments so far. These efforts have been further improved by the preparation of "A Guide to Consideration of Climate Change Adaptation Measures in National Parks and Other Protected Areas" in 2019. In addition, the Climate Change Adaptation Information Platform (A-PLAT), a website operated by the Center for Climate Change Adaptation of the National Institute for Environmental Studies, publishes information on climate change adaptation in an easy-to-understand manner, as an information platform to support efforts for adaptation activities by various entities {Chapter V, Section 1}.

Table 5 Indicators and assessment of countermeasures

Assessment item		Long-term change: Between 50 and 20 years ago	Long-term change: From 20 years ago to the present	Current trend
Countermeasures against First Crisis	Protected areas	⇗	⇗	⇨
	Regulations on exploitation, protection & reproduction programs	⇗	⇗	⇗
Countermeasures against Second Crisis	Scientific protection and management of wildlife	⇨	⇗	⇗
Countermeasures against Third Crisis	Import regulations, prevention & control of alien species	⇨	⇗	⇗

Subject of assessment	Legend		
Trend of countermeasures	Increasing	Same	Decreasing
	⇗	⇨	⇘

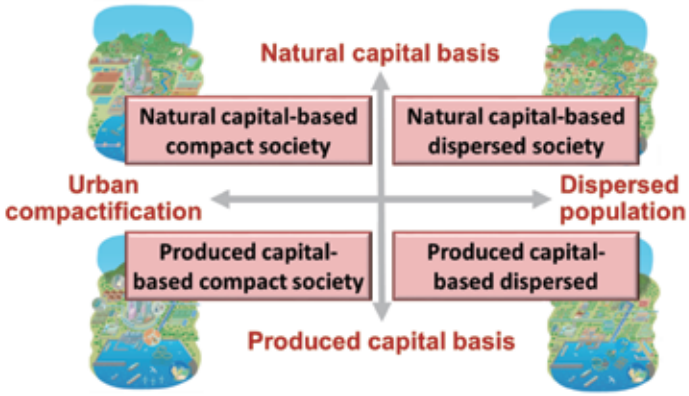
Note: Graphic symbols may not represent all of the multiple factors related to the indicators in question.

1-E. Future Trends in Biodiversity and Ecosystem Services

With the recent progress of scenario-based research, it is gradually becoming clear how Japan's biodiversity and ecosystem services will change in the future. It has been pointed out that while climate change may bring major changes in the status of biodiversity, changes in the socioeconomic conditions will also affect future biodiversity and ecosystem services in Japan.

a. Climate change, if it goes on as is, is anticipated not only to threaten people's health, safety and security, and economic activities, but also to cause significant damage to biodiversity {Chapter VI, Section 1}.

It has been suggested that in terrestrial areas, climate change will significantly affect vegetation, as seen in the northward extension of the distribution of such alien species as Moso bamboo and Japanese timber bamboo, and in the decrease of dwarf stone pines (Pinus pumila) and Veitch's fir (Abies veitchii) in alpine and subalpine zones, etc. In freshwater ecosystems, climate change will cause considerable decrease in the habitats of mountain stream fish species, Whitespotted char (Salvelinus leucomaenis) and Dolly Varden (Salvelinus malma). It has also been suggested that in marine areas, global warming will cause about six of the eleven Laminaria species living in Japan to disappear from coastal areas around Japan, and that there may no longer be any area available for coral growth around Japan. Furthermore, climate change may also affect regulating services provided by coral reefs, such as disaster risk reduction, as well as cultural services such as recreational activities related to natural ecosystems {Chapter VI, Section 1}.



Urban compactification: Population will further concentrate in inner urban areas and city centers
Dispersed population: Population will disperse more into suburbs and hilly and mountainous areas.
Natural capital basis: Domestic natural capital (such as forests) is actively used.
Produced capital basis: Foreign natural capital and produced capital (such as concrete) are actively used.
Source: PANCES, 2020: Policy Brief No. 1, Future Scenarios and Integrated Model of Social-Ecological Systems on National and Regional Scales.

Figure 6 Four national-scale future scenarios

b. It has been pointed out that changes in the socioeconomic conditions will affect future biodiversity and ecosystem services in Japan {Chapter VI, Section 2}.

A study that evaluated the impact on butterflies' diversity reveals that the size of the impact depends on the scenarios of population distributions in the area, suggesting that dispersed human population can mitigate negative effects. Furthermore, the Predicting and Assessing Natural Capital and Ecosystem Services (PANCES) project, supported by the Environment Research and Technology Development Fund (S-15), created four future scenarios based on two drivers for scenario axes that may significantly change Japan's future up to 2050, namely population distribution (compact vs. dispersed) and actively utilized capital (natural capital vs. produced capital). The project suggests that depending on our choices from the above, Japan's future biodiversity and ecosystem services may change significantly. For instance, paddy-rice supply is forecasted to decrease particularly significantly under the produced capital scenario. Spinach (*Spinacia oleracea*) supply is forecasted to increase on a nationwide basis under the natural capital scenario, while it is forecasted to decrease under the produced capital scenario due to reduced productivity if the climate change effects are included. The distribution of Japanese sika deer is estimated to overlap with farmlands to a greater extent under the dispersed population scenario. Furthermore, if land use, depopulation, and changes in consumption behavior are taken into accounts, the natural capital-based dispersed society scenario produces more communities whose supply and demand of rice production, etc. are balanced than does the produced capital-based compact society scenario {Chapter VI, Section 2}.

c. It has been pointed out that in each region, changes in the socioeconomic conditions affect the status of biodiversity and ecosystem services {Chapter IV, Section 2}.

According to a future projection of the status in Sado city, Niigata in 2050 performed using the regional scale participatory scenario, the agriculture-focused scenario is forecasted to produce high overall ecosystem services. Another forecast of the status in the Noto Peninsula suggests that future land use and the future status of ecosystem services and biodiversity may change significantly depending on whether or not domestic natural capital is actively used. Still another forecast of the status in the Bekanbe-ushi River basin suggests that while population distribution affects the spatial distribution of abandoned grazing lands and the connectivity of managed grazing lands, ecosystem services are significantly affected by our choice between natural capital and produced capital. These research results suggest that the conservation of biodiversity and the continuous enjoyment of ecosystem services require not only the existing measures aimed at conserving the natural environment but also measures of varying scale involving how people should act and the way society should be {Chapter VI, Section 2}.

1-F. Outcomes and Challenges of Past Efforts

Although the rate of biodiversity loss in Japan has been slowed down over in recent decades, the loss in the past has not yet been recovered. It is necessary to further strengthen existing efforts while starting additional efforts. For that purpose, it is important not only to take countermeasures against the direct drivers of biodiversity loss but also to take comprehensive countermeasures to change the way society is

a. Japan's efforts have been steadily producing successful results in some individual species and regions {Chapter II, Section 2, Chapter V, Section 1, and Chapter VII, Sections 1 and 2}.

For instance, the reintroduction programs for Japanese crested ibis and oriental storks have resulted in steady growth of the wild populations of these species, which were once deemed extinct {Chapter II, Section 2}. The confirmed populations of some other rare species, such as Amami rabbit (*Pentalagus furnessi*) and cackling goose (*Branta hutchinsii*), have also been growing in recent years {Chapter V, Section 1}. As for alien species, reports have confirmed a decrease in growth area of alien waterweeds in Lake Biwa, such as large-flower primrose-willow (*Ludwigia grandiflora*), as well as a decrease in the number of small Indian mongooses (*Herpestes auropunctatus)* living on Amami-Oshima Island {Chapter V, Section 1}.

b. In some individual ecosystems, the biodiversity loss may have been mitigated, but it has not yet become a recovering situation {Chapters II, III and IV, and Chapter VII, Section 2}.

Although changes in the status of biodiversity over the past five decades are assessed as "Losing" or "Losing rapidly" in terms of the scale and quality of forest and freshwater ecosystems and the population and distribution of species inhabiting urban ecosystems, these deteriorating trends have now been mitigated in some ecosystems. However, a comparison between the trends in the last decade and those at present reveals that in none of the ecosystems has the loss transitioned to recovery, with no observed changes in the direct drivers of loss {Chapters II and IV and Chapter VII, Section 2}.

c. In order to bring the status of biodiversity from a "Same" or "Losing" trend towards "Recovering," we must not only enhance the efforts that have proven effective but also develop measures from fresh perspectives {Chapter VII, Section 2}.

It is an important perspective to restore the integrity of ecosystems in order to allow them to withstand future climate change as well as depopulation and other changes in the social conditions. Examples of efforts from this perspective include: steadily promoting the national and local governments' conservation and restoration of important areas and protection and reproduction of rare animals and plants, as well as these governments' countermeasures against alien species; and developing ecosystem networks through "other effective area-based conservation measures" (OECM), a newly proposed area-based conservation scheme. In making these efforts, it is also important to introduce the perspective of adaptation to climate change, whose impact is considered to further escalate in the future. Other potentially effective efforts include expanding measures that combine biodiversity conservation and the resolution of social issues in an integrated manner, such as: ecosystem-based disaster risk reduction (Eco-DRR) and other efforts to utilize various regulating services available from ecosystems; and efforts to promote regional revitalization through sustainable use of resources while conserving *Satoyama* {Chapter VII, Section 2}.

d. Restoration of biodiversity and ecosystem services cannot be achieved separately from the socioeconomic conditions (i.e., indirect drivers). It is thus urgent to implement measures considering those conditions {Chapters II and IV, and Chapter VII, Section 2}.

It is likely to be difficult to bring the status of Japan's biodiversity towards recovery solely by countermeasures against the four crises (direct drivers), because no significant changes have been seen in the status of Japan's biodiversity during the past decade, and because the drivers of loss have not been remedied as compared to a decade ago. In particular, the underuse of ecosystem services, which is strongly

related to the Second Crisis, has been affected significantly by changes in society, including lifestyle changes. In addition, many of the trends in the status of biodiversity and in the drivers of biodiversity loss have changed since some time after the bubble collapse around 1990 {Chapters II and IV}. This suggests that the bubble collapse, which is a change in society, had a strong impact on the status of biodiversity. It is therefore considered essential to generate transformative change through comprehensive measures, including acting on indirect drivers, in order to bring the status of Japan's biodiversity to recovery {Chapter VII, Section 2}.

Table 6 Assessment of the Status of Biodiversity

	Assessment item	Long-term change		Loss and trend at time of assessment		
		Between 50 and 20 years ago	From 20 years ago to the present	JBO (2010)	JBO2 (2016)	JBO3 (2021)
Forest ecosystems	Scale and quality of forest ecosystems	↓	↘	→	→	→
	Population and distribution of species inhabiting forest ecosystems	↘	↘	↘	↘	↘
	Use and management of planted forests	→	→	↘	↘	→
Agricultural ecosystems	Scale and quality of agricultural ecosystems	↓	↘	↘	↘	↘
	Population and distribution of species inhabiting agricultural ecosystems	↘	↘	↘	↘	↘
	Diversity of crops and livestock	↘	→	↘	↘	→
Urban ecosystems	Scale of urban green space	↘	→	→	→	→
	Population and distribution of species inhabiting urban ecosystems	↘	→	→	→	→
Freshwater ecosystems	Scale and quality of freshwater ecosystems	↓	↘	→	→	→
	Population and distribution of species inhabiting freshwater ecosystems	↘	↘	↘	↘	↘
Marine and coastal ecosystems	Scale and quality of coastal ecosystems	↓	↘	↘	↘	↘
	Population and distribution of species using shallow waters	↓	↘	↘	↘	↘
	Status of resources of useful fishes	?	→	↘	↘	↘
Island ecosy[illegible]	Population and distribution of species endemic to islands	?	↘	↘	↘	↘
Connectivity of ecosystems	Connectivity of forest ecosystems*Note 1	↘	→	→	→	→
	Connectivity of agricultural ecosystems	-	↘			↘
	Connectivity of rivers and lakes*Note 2	↓	↘	→	→	→

Subject of assessment	Legend	
Degree of loss	Weak	□
	Medium	□
	Strong	□
	Very Strong	□
Trend of status	Recovering	↗
	Same	→
	Losing	↘
	Losing rapidly	↓

Note 1: Categorized under forest ecosystems in JBO and JBO2.
Note 2: Categorized under freshwater ecosystems in JBO and JBO2.

Table 7 Assessment of Status of Ecosystem Services

Assessment item		JBO2 (2016)		JBO3 (2021)	
		Between 50 and 20 years ago	From 20 years ago to the present	Between 50 and 20 years ago	From 20 years ago to the present
Provisioning services	Agricultural crops	↓	↘	↓	↘
	Non-timber forest products	↗	↘	↗	↘
	Seafood	↗	↘	↗	↘
	Freshwater	-	→	-	→
	Timber	↘	→	↘	↗
	Raw materials	↘	↘	↘	↘
	Genetic resources	-	-	-	-
Regulating services	Climate	-	↘	-	↘
	Air quality	-	→	-	→
	Water	-	↘	-	↘
	Soil	→	-	→	-
	Disaster mitigation	↗	→	↗	→
	Biological control	-	↘	-	↘
Cultural services	Religion/festivals	↓	↘	↓	↘
	Education	↘	→	↘	→
	Landscape	-	↘	-	↘
	Traditional arts & crafts	↘	↘	↘	↘
	Tourism/recreation	↗	↘	↗	↘
Disservices	Damage caused by wild animals	-	↗	-	→
	Health risks			-	-

Subject of assessment		Legend	
Quantitative trend in services received	Result of quantitative assessment	Increasing	↑
		Slightly increasing	↗
		Same	→
		Slightly decreasing	↘
		Decreasing	↓
	Where data is insufficient	Increasing	↑
		Slightly increasing	↗
		Same	→
		Slightly decreasing	↘
		Decreasing	↓

Table 8 Assessment of Drivers of Biodiversity Loss

	Assessment item	Long-term trend of impact		Degree of impact and trend at the time of assessment		
		Between 50 and 20 years ago	From 20 years ago to the present	JBO (2010)	JBO2 (2016)	JBO3 (2021)
First Crisis	Development, conversion of ecosystems					
	Loss of endangered species					
Second Crisis	Reduced use and management of *Satochi-Satoyama*					
	Reduced direct use of wildlife*Note 1					
	Loss of endangered species					
Third Crisis	Introduction and establishment of alien species					
	Eutrophication*Note 2					
	Chemical substances					
	Loss of endangered species					
Fourth Crisis	Changes in the global environment*Note 3					
	Global warming					
	Loss of endangered species					

Subject of assessment	Legend	
Degree of impact during assessment period	Weak	
	Medium	
	Strong	
	Very Strong	
Long-term and current trends of impact	Decreasing	
	Same	
	Increasing	
	Increasing rapidly	

Note 1: As “direct use of wildlife” was categorized under the First Crisis in JBO, this item is excluded from comparison in this table.
Note 2: Categorized under the First Crisis in JBO and JBO2.
Note 3: A new assessment item added to JBO3.

Grounds 2

Japan Biodiversity Outlook 3

To halt the loss of biodiversity and to reverse the trend to a recovering one, it is important to generate transformative change intervening against the indirect drivers, as well as taking measures against the direct drivers.

2-A. Socioeconomic Conditions (Indirect Drivers) and Approaches to Countermeasures

In Japan, the past five decades have seen significant changes in socioeconomic conditions (i.e., indirect drivers) and economic development, while these changes had great impacts on biodiversity through the direct drivers. The relationships between the direct drivers, indirect drivers, and leverage points are complicated. Countermeasures against such indirect drivers as "changes in industrial structure" and "production and consumption" are expected to produce a wide range of effects, while countermeasures against such indirect drivers as "global trading of goods" and "energy use" may be significantly effective in remedying some specific direct drivers. In order to generate transformative change, it is important to implement combining measures which act on more.

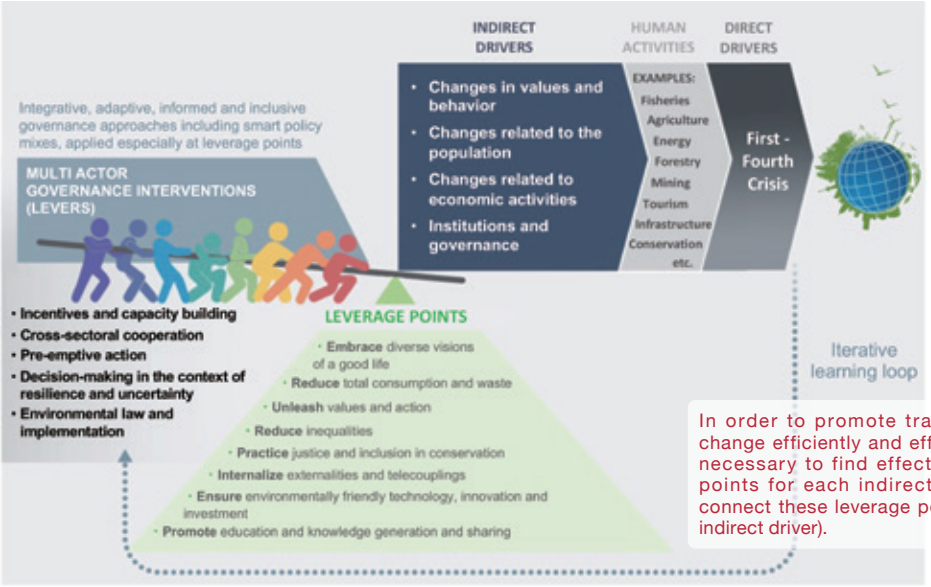
a. In order to halt the loss of biodiversity and the deterioration of ecosystem services in Japan, it is essential to generate transformative change, which fundamentally changes the socioeconomic conditions (i.e., indirect drivers) underlying the four crises (i.e., direct drivers) affecting biodiversity. To change the indirect drivers, it is effective to focus on "leverage points" that maximize the effects of measures {Chapter III, Section 1}.

The indirect drivers of biodiversity loss in Japan can be classified roughly into the following four types: "changes related to the population"; "changes related to the economy"; "changes related to institutions and governance"; and "changes in values and behavior," which further underlie these indirect drivers. To intervene against the indirect drivers, it is considered effective to make efforts through "leverage points," through which transformative change is generated. These efforts are important not only to restore biodiversity but also to resolve a wide range of social issues, such as the achievement of the SDGs. The IPBES Global Assessment Report lists eight leverage points that are effective to make transformative changes (Figure 7). However, knowledge accumulated about the interconnections between the direct drivers, or indirect drivers and leverage points are still limited. In this report, a questionnaire survey was conducted on experts, through over forty relevant academic societies and similar institutions, regarding the relationship between the direct drivers and indirect drivers, which lead to biodiversity loss, and that between the indirect drivers and leverage points, followed by an analysis of expert judgments[3] {Chapter VIII, Section 1}.

b. The results of the questionnaire survey on experts suggest that the direct drivers, indirect drivers, and leverage points have intricately intertwined relationships with each other, without any leverage point that would provide a universal solution. The survey results also clearly show that, while there are certain indirect drivers each affecting more than one direct driver and certain leverage points acting on more than one indirect driver, there are certain indirect drivers each strongly related to a specific direct driver. In order to bring Japan's biodiversity towards recovery, it is important to take comprehensive action by combining measures that act on these effective leverage points {Chapter VIII, Section 2}.

A flow diagram quantitatively representing the questionnaire survey results (Figure 8) indicates that there are extremely complicated interconnections between the direct and indirect drivers, with each direct driver being affected by a variety of indirect drivers at varying levels. This is also the case with the leverage points, each of which is shown to have connections with all direct drivers. At the same time, the diagram suggests that there are certain indirect drivers each affecting more than one direct driver and certain leverage points broadly acting on more than one indirect driver, and that there are certain indirect drivers strongly affecting a specific direct driver. In other words, transformative change is achieved not

through implementing measures each targeting any one leverage point but through implementing a combination of measures each acting on more than one leverage point, in order to address indirect drivers affecting a number of direct drivers or strongly affecting a specific direct driver {Chapter VIII, Section 2}.



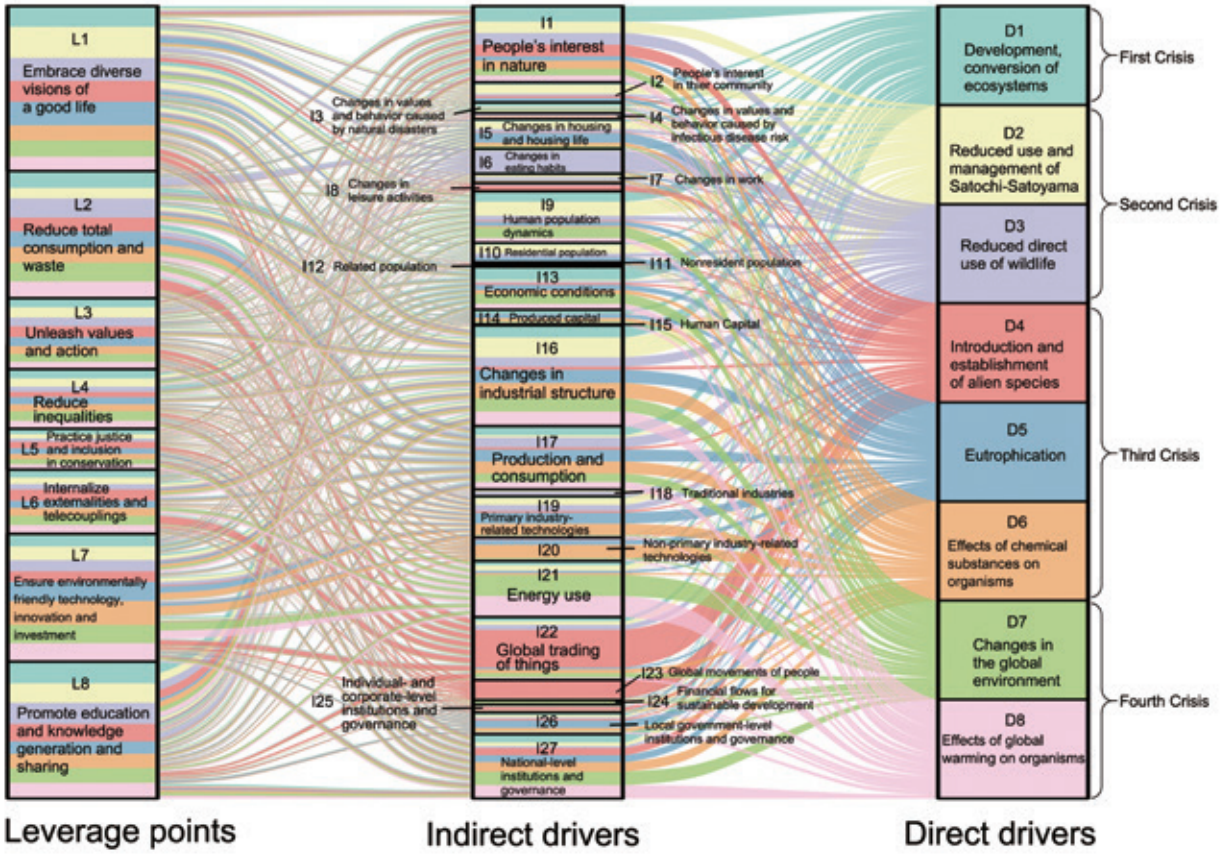
Source: IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services.

	LEVERAGE POINTS	Overview of leverage points	Practical examples of efforts targeting leverage points
1	Embrace diverse visions of a good life	Value not only a sense of well-being rooted in material consumption or economic wealth but also a wide variety of good lives, such as good quality of human relationships or harmony with nature.	Simple life, LOHAS, use and provision of convenient, comfortable public transport, etc.
2	Reduce consumption and waste	Reduce total consumption and waste by changing consumption patterns.	Reducing meat consumption and food waste, reducing advertising targeting children and advertising of environmentally burdensome products, local production for local consumption, sharing economy, etc.
3	Unleash values and action	Promote a sense of responsibility and action for nature and non-human living things by creating social norms that contribute to sustainable action.	Choosing seafood products with MSC eco-labels (MSC certification), paper and timber products with forest certification (FSC, PEFC or SGEC certification) marks, organic food products, sustainable services, etc.
4	Reduce inequalities	Reduce social inequalities, etc. in and across countries, including in terms of income, access to resources, burden arising from climate change, etc.	Providing equal social services to all people, guaranteeing basic income, developing payment schemes based on the benefit principle (such as payment for ecosystem services, water resources tax, and carbon pricing), etc.
5	Practice justice and inclusion in conservation	Allow equal participation of various stakeholders, including local communities, in decision-making processes.	Decision-making systems that allow all stakeholders to participate (open governance, partnership development), etc.
6	Internalize externalities and telecouplings	Include negative effects of commodity production and distribution on the environment and society as costs.	Developing distribution regulation for materials and products with harmful effects on nature, such as illegal timber, certification systems and traceability ones
7	Ensure environmentally friendly technology, innovation and investment	Promote innovation of environmentally friendly technology and its use and the realization of alternative financial mechanisms.	Developing and funding low-carbon technologies, green infrastructure and low-pesticide agriculture, social businesses, industry-government-academia collaboration, ESG investing, etc.
8	Promote education and knowledge generation and sharing	Promote education and the production and sharing of knowledge, including social learning.	Providing opportunities and platforms for children's participation in nature experience activities and cross-generation interaction activities, handing down and utilizing traditional knowledge through communing with local culture, etc. and environmental and civic education, etc.

Note 1: Examples include additional information based on expert opinions. One should note that a practical example does not necessarily correspond to a leverage point on a one-to-one basis but may be related to more than one leverage point.
Note 2: Abbreviations used in the above table are as follows. For ESG investing, see the glossary.
MSC: Marine Stewardship Council, FSC: Forest Stewardship Council,
PEFC: Programme for the Endorsement of Forest Certification Schemes. SGEC: Sustainable Green Ecosystem Council
Sources: Based on IPBES, 2019: Global assessment report on biodiversity and ecosystem services. Abridged translation by IGES; and Chan et al., 2020: Levers and leverage points for pathways to sustainability.

Figure 7 Transformative change towards a society in harmony with nature

3 One hundred fourteen respondents answered the questionnaire. One must note, among other things: that answers may be biased because each respondent's interpretation of, and view on the relationship between, the direct drivers, indirect drivers, and leverage points depend heavily on the respondent's specialty, amount of knowledge, etc.; those judgments are based on current knowledge; and that the indirect drivers under survey have different natures and include links between different drivers.



L	Leverage points
L1	Embrace diverse visions of a good life
L2	Reduce total consumption and waste
L3	Unleash values and action
L4	Reduce inequalities
L5	Practice justice and inclusion in conservation
L6	Internalize externalities and telecouplings
L7	Ensure environmentally friendly technology, innovation and investment
L8	Promote education and knowledge generation and sharing

I	Indirect drivers
	Changes in values and behavior
I1	People's interest in nature
I2	People's interest in their community
I3	Changes in values and behavior caused by natural disasters
I4	Changes in values and behavior caused by infectious disease risk
I5	Changes in housing and housing life
I6	Changes in eating habits
I7	Changes in work
I8	Changes in leisure activities
	Changes related to the population
I9	Human population dynamics
I10	Residential population
I11	Nonresident population
I12	Related population
	Changes related to economic activities
I13	Economic conditions
I14	Produced capital
I15	Human capital
I16	Changes in industrial structure
I17	Production and consumption
I18	Traditional industries
I19	Primary industry-related technologies
I20	Non-primary industry-related technologies
I21	Energy use
I22	Global trading of things
I23	Global movements of people
I24	Financial flows for sustainable development
	Institutions and governance
I25	Individual- and corporate-level institutions and governance
I26	Local government-level institutions and governance
I27	National-level institutions and governance

D	Direct drivers
	First Crisis
D1	Development, conversion of ecosystems
	Second Crisis
D2	Reduced use and management of Satochi-Satoyama
D3	Reduced direct use of wildlife
	Third Crisis
D4	Introduction and establishment of alien species
D5	Eutrophication
D6	Effects of chemical substances on organisms
	Fourth Crisis
D7	Changes in the global environment
D8	Effects of global warming on organisms

Note: The size of each of the boxes representing the indirect drivers and leverage points indicates the strength of the indirect driver's or leverage point's relation to the direct drivers as a whole. The colors correspond respectively to direct drivers D1-D8. The respective proportions for which the colors account in a box representing an indirect director or leverage point indicates the strength of the indirect driver's or leverage point's relation to the respective direct drivers.

Figure 8 Interconnections between direct drivers, indirect drivers and leverage points

c. Indirect drivers recognized by survey respondents as affecting a number of direct drivers included "Changes in industrial structure (I16)[4]," "People's interest in nature (I1)," and "Production and consumption (I17)." Leverage points recognized by survey respondents as related to a relatively large number of direct drivers included "Embrace diverse visions of a good life (L1)," "Reduce total consumption and waste (L2)," "Ensure environmentally friendly technology, innovation and investment (L7)," and "Promote education and knowledge generation and sharing (L8)" {Chapter VIII, Section 2}.

Japan's working population by industry experienced significant "Changes in industrial structure (I16)," with the primary industry population rate decreasing from approximately 19% in the 1970s to approximately 4% in 2015 while the corresponding rates for the tertiary industry increased from approximately 47% to approximately 71%. The eight leverage points are broadly involved in these changes, which requires a complex approach. Public opinion polls conducted by the Cabinet Office have revealed a change in "People's interest in nature (I1)," namely the proportion of respondents who answered "We should give priority to/promote conservation of environments inhabitable by ... living organisms" has decreased since 2006. For this issue, "Promot[ing] education and knowledge generation and sharing (L8)" will serve as an effective leverage point. There have also been changes in "Production and consumption (I17)" in Japan, as seen in the declining trend in consumption expenditure per household since 2000 and in the increasing trend in real final consumption expenditure of households since 1994 after the bubble collapse, although real final consumption expenditure of households has remained at the same level over the past several years. For this issue, "Reduc[ing] total consumption and waste (L2)" was considered an effective leverage point {Chapter VIII, Section 2}.

d. Major indirect drivers of the First Crisis, "Development, conversion of ecosystems (D1)," recognized by survey respondents were "People's interest in nature (I1)," "Economic conditions (I13)," and "Changes in industrial structure (I16)" {Chapter VIII, Section 2}.

Even after the period of high economic growth came to an end in the first half of the 1970s, Japan's real GDP growth rate fluctuated between annual rates of 3% and 6% until the bubble collapse in the first half of the 1990s. While land use changed significantly due to the development of social infrastructure as a foundation for economic growth, resulting in significant improvements in traffic convenience and disaster prevention functions, many ecosystems experienced development/conversion. During the period of high economic growth, the expansion of secondary industries, particularly the manufacturing industry, resulted in the formation of industrial zones in oceanfront and inland areas, with coastal areas undergoing extensive landfill. People's interest in nature would be a condition which ensures that appropriate consideration is given in these infrastructure development projects. Leverage points recognized by survey respondents as strongly related to economic conditions were "Reduce total consumption and waste (L2)" and "Reduce inequalities (L4)" {Chapter VIII, Section 2}.

e. Of the components of the Second Crisis, "Reduced use and management of *Satochi-Satoyama* (D2)" was recognized as relatively strongly related to changes in social structure, such as "Changes in industrial structure (I16)" and "Human population dynamics (I9), whereas the other component, "Reduced direct use of wildlife," was recognized as strongly related to "Changes in eating habits (I6)" and "Production and consumption (I17)." The survey also revealed that "Reduced use and management of *Satochi-Satoyama* (D2)" is strongly related to indirect drivers involved in local socioeconomic conditions, such as "People's interest in their community (I2)" and "Residential population (I10)" {Chapter VIII, Section 2}.

Through the reduced number of primary industry workers resulting from changes in the industrial structure, reduced use and management of *Satochi-Satoyama* has resulted in reduced quality of management of secondary nature, causing deterioration of ecosystems. From the viewpoint of human population dynamics, the population decrease from the mid-2000s was coupled with the net positive flow of people from rural areas to the three major metropolitan areas, with the exception of a brief period in the first half of the 1990s. This has triggered the decline of rural areas, where relatively more people are engaged in the primary industry. With respect to such indirect drivers as "People's interest in their community," "Human

4 Codes D, I, and L in the text are initial letters of the terms "direct driver," "indirect driver," and "leverage point," respectively. The numbers in the text correspond to the numbers assigned in the table of Figure 7.

population dynamics," and "Residential population," "Embrace diverse visions of a good life (L1)" was recognized as a strongly related leverage point.

"Reduced direct use of wildlife" is related to the indirect driver, "Changes in eating habits." Although the long-term trend in Japan's consumption of wildlife as meat is unknown, as it now stands, most of the animal protein consumed in Japan comes from beef, pork, and chicken, which are available for mass production. In addition, approximately 6.1 million to 6.5 million tons of food waste is generated per year in Japan. These circumstances suggest that under the current mass production systems, food is in excess supply, which has created a situation where people are less prone to turn their interest toward wildlife as resources. Although it is said that wildlife has been consumed as game meat more often than before in recent years, only 110 thousand out of 1.16 million Japanese deer (*Cervus nippon*) and boars (*Sus scrofa*) caught by hunting, harmful wildlife control, etc. were consumed as game meat (in FY2018). In addition, while the domestic meat production was approximately 3.4 million tons, the game meat consumption was only 1,887 tons (approximately 0.06%) (FY2018). In this regard, the leverage point of "Reduc[ing] total consumption and waste (L2)" is recognized as effective on "Changes in eating habits" {Chapter VIII, Section 2}.

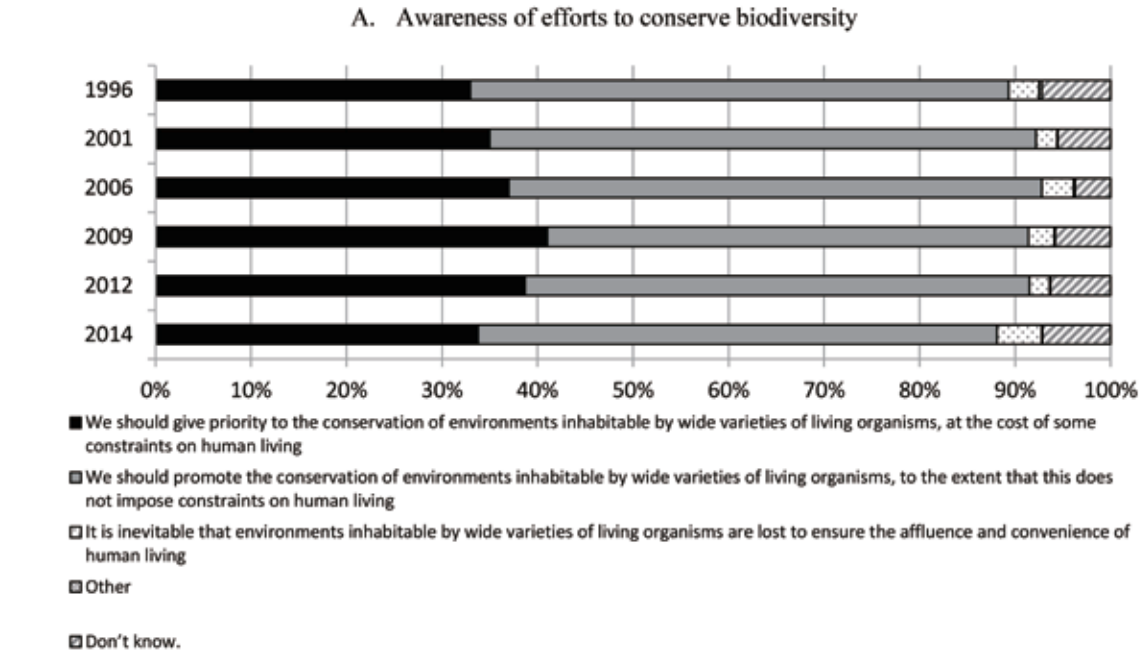
f. Of the components of the Third Crisis, "introduction and establishment of alien species (D4)" is particularly strongly related to "Global movements of things (I22)" and "Global movements of people (I23). On the other hand, "Eutrophication (D5)" and "Chemical substances (D6)" are characterized by their strong relations to "Primary industry-related technologies (I19)" and "Non-primary industry-related technologies (I20), as well as to "Changes in industrial structure (I16)" and "Production and consumption (I17)" {Chapter VIII, Section 2}.

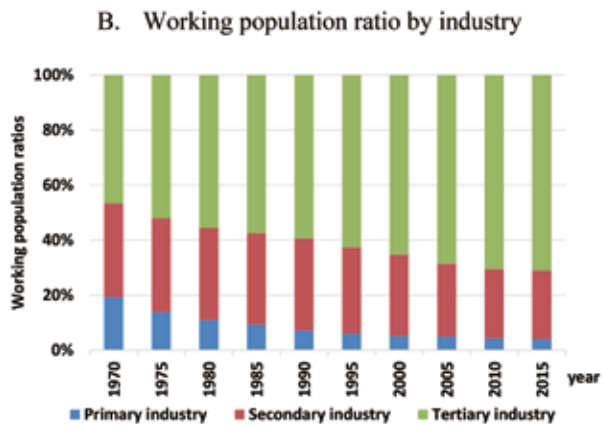
"Introduction and establishment of alien species" is likely to be very significantly affected by globalization as a social change. The amount of import cargo handled at Japanese ports roughly doubled from 1970 to 2018. Imported materials and ballast water are one of the introduction pathways of alien species in Japan. As for relations to leverage points, "Global movements of things" was shown to be relatively strongly related to "Reduc[ing] total consumption and waste (L2)" and "Internaliz[ing] externalities and telecouplings (L6)," while "Global movements of people" was shown to be so to "Embrac[ing] diverse visions of a good life (L1)."

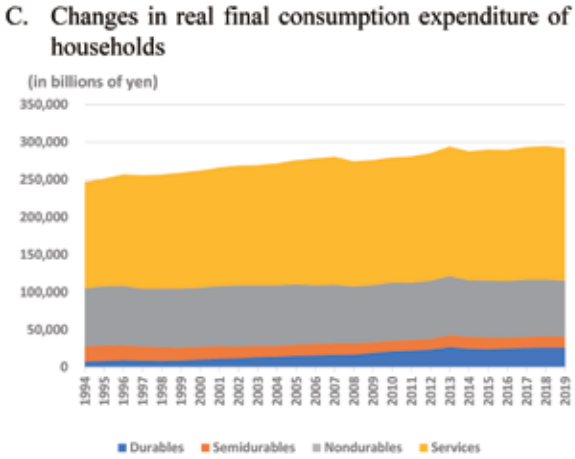
The factors of "Eutrophication" and "Chemical substances" include the increased use of chemical fertilizers and pesticides in the 1970s in the primary industry, and factory wastewater, etc. in other industries. To deal with these issues, the improvement of wastewater treatment technology has played an important role, in addition to legal regulations and other measures. "Primary industry-related technologies" and "Non-primary industry-related technologies" were both recognized as strongly related to "Ensur[ing] environmentally friendly technology, innovation and investment (L7)" {Chapter VIII, Section 2}.

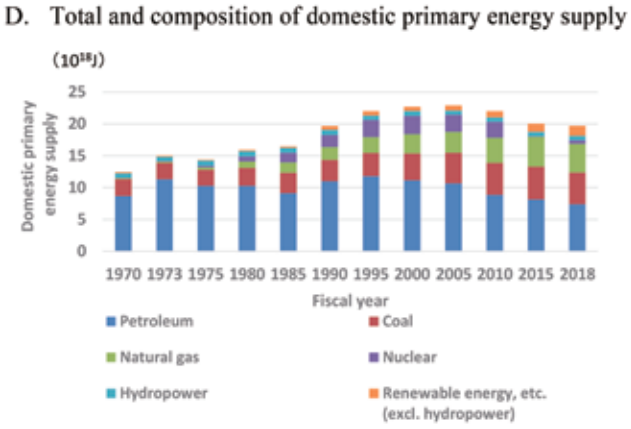
g. The components of the Fourth Crisis, "Changes in the global environment (D7)" and "Global warming (D8)," were both recognized as particularly strongly related to "Energy use (I21)" and "National-level institutions and governance (I27)," in addition to "Changes in industrial structure (I16)" {Chapter VIII, Section 2}.

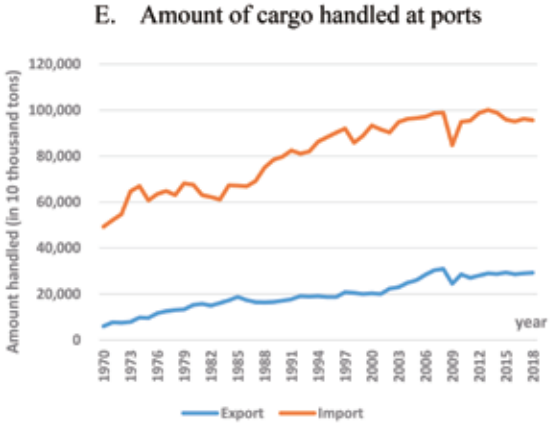
Japan's domestic production of primary energy increased 1.6-fold in 2018 as compared to that in 1970. As Japan relies heavily on fossil fuels to supply primary energy, Japan accounted for approximately 3.2% of the global energy-related carbon dioxide emissions in 2018. An analysis of Japan's energy consumption by sector reveals that the industrial sector, particularly the manufacturing industry, accounts for a large proportion of the total consumption, suggesting that the growth of the secondary industry during the period of high economic growth is partially responsible for the increase in Japan's energy consumption. The leverage point of "Ensur[ing] environmentally friendly technology, innovation and investment (L7)" was recognized as strongly related to "Energy use," indicating that national-level investments, technical innovation, etc. are required to promote the introduction of renewable energy. To this end, it is important to make national-level decisions, such as those on the development of legal systems and on budgetary measures. This underlies survey respondents' recognition that these direct drivers are particularly strongly related to "National-level institutions and governance" {Chapter VIII, Section 2}.











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E: Website of The Ports & Harbours Association of Japan, "Information on port logistics" Changes in amount of cargo handled at ports across Japan. (in Japanese)

Figure 9 Chronological changes in representative indirect drivers

2-B. Status of Implementation of Measures Contributing to Transformative Change

Previous efforts for biodiversity have not fully focused on appropriate leverage points towards transformative change. In order to realize a society living in harmony with nature, it is essential to promote transformative change by implementing appropriate measures through leverage points that are considered to be particularly effective on indirect drivers.

a. In order to achieve transformative change efficiently and effectively, it is necessary to implement measures through leverage points that are considered effective on particularly influential indirect drivers {Chapter IX}.

A review of the NBSAP has suggested that previous measures were insufficient to promote transformative change (see Table 9). On the other hand, since measures that are able to contribute to transformative change already exist in the context of regional revitalization and the SDGs, it is advisable to ensure that the upcoming version of NBSAP will increase the synergy by linking its measures with those existing measures and will implement new necessary measures {Chapter IX}.

Table 9 Interconnections between direct drivers, indirect drivers and leverage points, and status of implementation of measures

Indirect measures targeted for transformative change		Effective leverage points	Status of implementation of measures under NBSAP	Target direct driver (crisis)			
				First	econd	Third	Fourth
Changes in values and behavior	People's interest in nature [2nd]	Promote education and knowledge generation and sharing	○	○	○	○	
		Embrace diverse visions of a good life	×	○	○	○	
	Changes in eating habits	Reduce total consumption and waste	△		○		
		Promote education and knowledge generation and sharing	△		○		
		Embrace diverse visions of a good life	×		○		
Changes related to the population	Human population dynamics	Embrace diverse visions of a good life	△		○		
		Reduce inequalities	△		○		
		Promote education and knowledge generation and sharing	△		○		
Changes related to economic activities	Economic conditions	Reduce total consumption and waste	△	○			
		Reduce inequalities	△	○			
		Embrace diverse visions of a good life	×	○			
	Changes in industrial structure [1st]	Embrace diverse visions of a good life	△	○	○	○	○
		Reduce total consumption and waste	△	○	○	○	○
		Ensure environmentally friendly technology, innovation and investment	△	○	○	○	○
	Production and consumption [4th]	Reduce total consumption and waste	△		○	○	
		Embrace diverse visions of a good life	○		○	○	
	Primary industry-related technologies	Ensure environmentally friendly technology, innovation and investment	△			○	
	Non-primary industry-related technologies	Ensure environmentally friendly technology, innovation and investment				○	
	Global movements of things [5th]	Reduce total consumption and waste	△			○	
		Internalize externalities and telecouplings	△			○	
		Embrace diverse visions of a good life	△			○	
		Ensure environmentally friendly technology, innovation and investment	△			○	
	Global movements of people	Embrace diverse visions of a good life	△			○	
		Unleash values and action				○	
		Ensure environmentally friendly technology, innovation and investment				○	
		Promote education and knowledge generation and sharing				○	
	Energy use	Ensure environmentally friendly technology, innovation and investment	△				○
		Reduce total consumption and waste					○
		Internalize externalities and telecouplings					○
Institutions and governance	National-level institutions and governance [3rd]	Promote education and knowledge generation and sharing	×				○
		Practice justice and inclusion in conservation					○
		Reduce inequalities					○

Legend
○ : Adequate measures
△ : Limited measures, or existing measures are not connected to leverage points
× : Few measures

Note: Higher ranks assigned to indirect drivers indicate larger numbers of responses in the questionnaire survey on experts that these indirect drivers are related to direct drivers.

2-C. Challenges to Be Addressed to Achieve Transformative Change

In terms of the direction of transformative change, it is of great significance to reevaluation biodiversity and ecosystem services as a foundation for social and economic activities and to introduce elements of a self-reliant decentralized society towards realizing a rich and resilient society living in harmony with nature by utilizing local resources. In order for our efforts to be effective, it is essential to involve diverse sectors and to bring all parties together to take actions to restore biodiversity.

a. With respect to "changes in industrial structure," "people's interest in nature," and "production and consumption," which are indirect drivers affecting a number of direct drivers and expected to raise the overall level of dealing with the direct drivers, an important approach should be to create virtuous cycles of business and biodiversity towards sustainable production and consumption and to promote education and the fostering of values that will support these virtuous cycles {Chapter VIII, Section 2 and Chapter X, Section 1}.

As for "changes in industrial structure," since activities classified as industrial are varied in field and nature, it is important to mainstream a virtuous cycle of business and biodiversity in each field or business activity. To this end, collaborative efforts in each field and changes in values of consumption surrounding these efforts are necessary. In particular, it is important for businesses to: acknowledge the risks involved in failing to work on, and opportunities obtained through working on, the conservation and sustainable use of biodiversity; quantitatively understand the relationship between their (including their supply chains') business fields and biodiversity; and make continuous adaptive efforts with decided goals. Measures to promote these efforts include: developing frameworks for certifications and other incentives by the national and local governments; introducing and developing guidelines on payments for ecosystem services (PES); creating information infrastructure for supporting appropriate disclosure to investment markets; and supporting technical innovation that will contribute to the conservation and sustainable use of biodiversity.

As for "people's interest in nature," an effective approach would be to promote, through cooperation of various actors, the dissemination of research and study findings and information related to human well-being, such as safe and secure daily life, health promotion, and the benefits of identity as community members (i.e., the benefits available to be involved in a local community), to make people to feel biodiversity familiar to them and easy to understand. Other efforts for the conservation of biodiversity that may contribute to the development of people's interest in nature include: practicing Education for Sustainable Development (ESD) and environmental education promoting nature experience activities; fostering the value of affluence which requires people to keep sustainable consumption in mind in their daily life; and providing support by introducing the concept of "nudge."

With regard to "production and consumption," it will be important to make concerted efforts in the fields related to resource recycling, including reduction of food waste, which has not always been thought to be in a close relationship with biodiversity. Another important perspective, particularly in efforts to realize sustainable production and consumption in terms of food production, may be to apply a landscape approach in which primary industry collaborates with local governments to identify and integrate the functions of various ecosystems and social conditions {Chapter VIII, Section 2 and Chapter X, Section 1}.

b. In order to restore Japan's biodiversity, it is important to make effective efforts by identifying major indirect drivers affecting each of the four crises, in addition to efforts that are effective on direct drivers as a whole {Chapter VIII, Section 2 and Chapter X, Section 1}.

For the First Crisis, potentially effective efforts include: promoting ESG financial services that will promote more sustainable economic activities and will encourage people to give consideration to the various values of biodiversity and ecosystem services; and developing systems to allow the utilization of natural capital by taking into account various situations of different regions.

Of the components of the Second Crisis, efforts required with respect to "reduced use and management

of *Satochi-Satoyama*" include the following, both fostering values that place value on a good life brought by involvement with nature and enhancing efforts that focus on people's movements related to *Satochi-Satoyama* towards developing a self-reliant decentralized society utilizing domestic natural capital. The latter includes the effort to reduce inequalities in employment and learning opportunities, etc. between urban and rural areas involving residential, nonresident, and related populations. With regard to wildlife management, it would be important to further promote the efforts towards increasing the safe, sustainable use of game meat by the food industry and the general public.

To deal with the "introduction and establishment of alien species" as an important component of the Third Crisis, it is essential to have international cooperation to make concerted efforts with other countries involved, such as, for instance, appropriate application of the Ballast Water Management Convention. Much dependence on overseas resources results in underuse of domestic resources. At the same time, however, it causes the issue of telecouplings that increase the extinction risk of overseas animal and plant species. Therefore, another important perspective is to promote further efforts by general consumers to reduce total consumption and waste and to shift the active use of local resources. It is also effective to support capacity buildings in developing countries. As for "eutrophication" and "chemical substances," it is necessary to impose legal regulations on inappropriate use of chemical fertilizers, pesticides, etc. and to promote the reduction of the burden on the environment through technical innovation and investments.

With regard to the Fourth Crisis, climate change is a major driver of loss of biodiversity. However, there could be some possibility of a trade-off issue between biodiversity and renewable energy; the construction of facilities for solar- or wind-power generation, etc. that are expected to serve as countermeasures against climate change, while they may have negative impacts on biodiversity. Thus, it is necessary to develop wise schemes to introduce renewable energy sources while minimizing their impacts on biodiversity. It is also important to evaluate the climate change mitigation services provided by ecosystems and to strongly promote institutions and governance of the national level for maximizing the synergy between conservation of the natural environment and realization of a decarbonized society {Chapter VIII, Section 2 and Chapter X, Section 1}.

C • In terms of the overall direction of transformative change, it is important to reposition biodiversity and ecosystem services as a foundation for social and economic activities. This will help us to understand, in an integrated manner, the mutual impacts between biodiversity and/or ecosystem services and social and economic activities. which will open the door to the realization of a sustainable society living in harmony with nature {Chapter X, Section 1}.

The concept to resolve social issues based on multiple functions of nature is called "Nature-based Solutions" (NbS). Typical examples are green infrastructure, Eco-DRR or Ecosystem-based Adaptation (EbA), which are efforts to utilize the natural environment for disaster prevention and mitigation, or adaptation measure of climate change, together with other ecosystem services. There are growing trends to apply this concept also in Japan, and it would also be effective to introduce the concept of NbS into dealing with social issues in general, such as those listed in the SDGs, from both national- or subnational-level perspectives on this opportunity. It is also necessary to clarify the synergy and trade-off between efforts to resolve various social issues and the sustainable use of biodiversity and ecosystem services (i.e., natural capital). These efforts may also contribute to the realization of a "Regional Circular and Ecological Sphere," in which the environment and the economy are integrated by achieving decarbonization, resource recycling, and living in harmony with nature in the region {Chapter X, Section 1}.

d. In promoting transformative change in Japan, we must deal with the population decline, the falling birthrate and the aging population, as well as with the era of during and post-COVID-19. At the same time, it is important to introduce perspectives of a self-reliant decentralized society into our efforts towards the realization of a quality-rich and resilient society living in harmony with nature by utilizing local resources {Chapter X, Section 1}.

Biodiversity and ecosystem services play an important role in creating a sustainable, quality-rich and resilient society by dealing with significant changes in society, such as the population decline and the spread of COVID-19. From the viewpoint of sustainability, a further increase in the resource recycling in *Satochi-Satoyama* is expected to promote transition from a society dependent on non-renewable resources to a society based on renewable resources. From the viewpoint of resilience, it would be effective to follow the idea understanding the services and risks of nature, such as Eco-DRR. From the viewpoint of richness, it is effective to promote a transition to a society valuing cultural and spiritual richness, beyond material or economic richness. In doing so, it will also be a probable option to hand down traditional and local knowledge about the use of natural capital. Promoting efforts towards realizing this self-reliant decentralized society living in harmony with nature, with an eye to redesigning economy and society, is also consistent with transformative change which is expected to reach SDGs {Chapter X, Section 1}.

e. In assessing the status of biodiversity and ecosystem services, as well as the direct and indirect drivers affecting the loss of biodiversity and ecosystem services, it is important to promote continuous observation and the creation of basic data, and to elucidate the relationships between the direct drivers, indirect drivers, leverage points, and measures, and to quantitatively assessment of these measures based on their inter-relationships {Chapter VIII, Section 1 and Chapter X, Section 1}.

Since biodiversity and ecosystem services change over time, the impact of the drivers and the effectiveness of countermeasures are all likely to have a time lag to be recognizable. Therefore, it is important to continue assessments made in this report to effective conservation and sustainable use of biodiversity in Japan. Performing assessment requires the long-term, continuous generation of basic data. In conducting research, we are required to introduce effective technologies, to manage various monitoring information from various actors, and to ensure continuous monitoring and analyses. While this report has analyzed the relationships between the direct drivers, indirect drivers, and leverage points based on expert judgments, quantitative and empirical research based on an integrated understanding of the whole process will be required for more effective policies allowing specific measures towards transformative change. In doing so, it is important to apply these policies and measures into actions through setting scenarios with various perspectives, such as multiple levels of community from global to local and the business sector. As for the issue of telecouplings, it is necessary to promote research that visualizes the pathways of biodiversity loss with an eye on global supply chains. It will also be important to keep traditional and local knowledge, which has allowed people to continuously enjoy ecosystem services through interactions between people and nature.

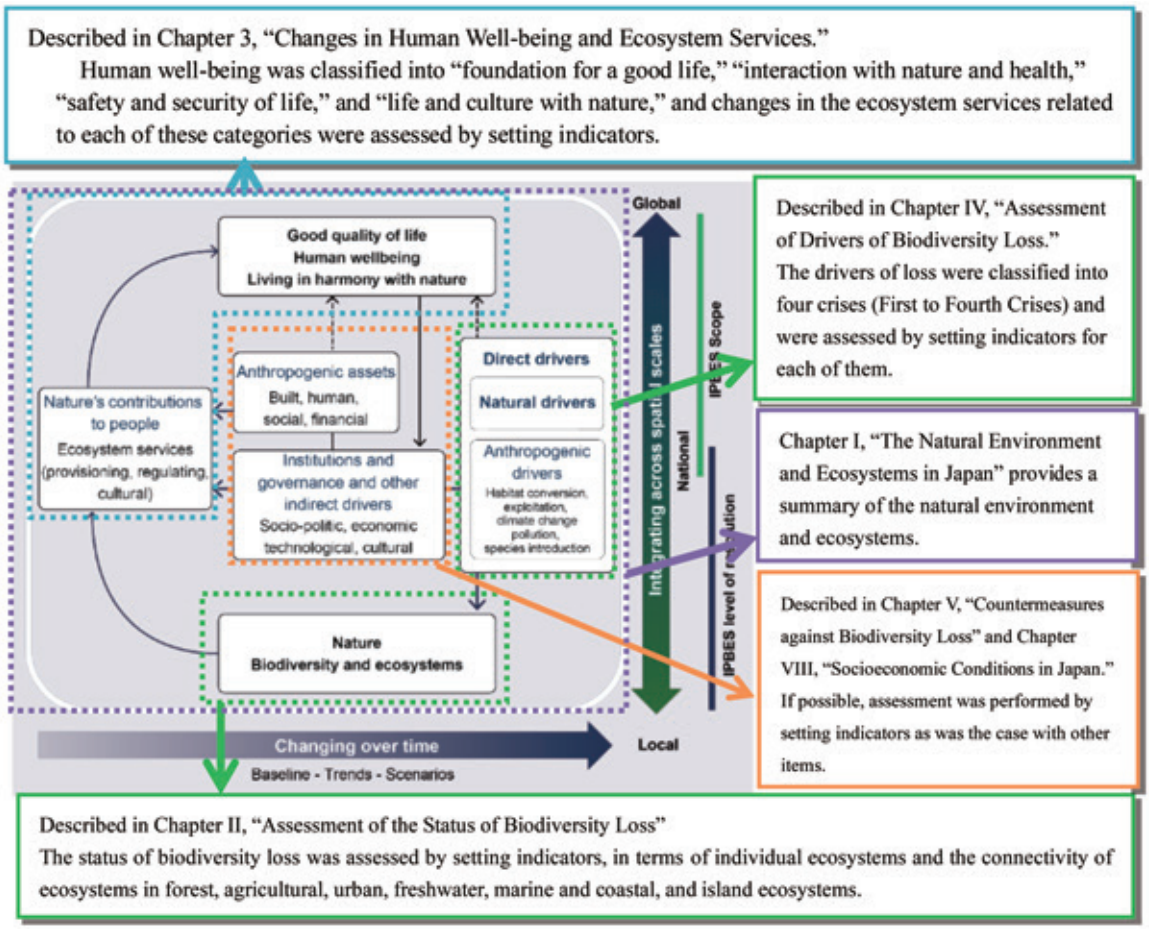
f. In order to achieve transformative change, it is important that the national and local governments adaptively take science-based measures based on enhanced cooperation between science and policy, and that various sectors work together on the efforts to restore biodiversity {Chapter X, Sections 1 and 2}.

Since biodiversity and ecosystem services provide a foundation for a wide variety of social and economic activities, it is necessary to link measures for biodiversity conservation and sustainable use of ecosystems. To enable this, it will be required to have joint discussions between NBSAP and LBSAPs and other higher-level policy plans as the Basic Environment Plan and those in other fields, such as agriculture, forestry and fisheries, and disaster prevention. In doing so, it is necessary to develop measures based on the latest scientific knowledge, and to make adaptive efforts including the feedback between scientific findings and actual applications. It is also important to set appropriate goals and indicators by logically organizing the whole process from the implementation of measures to monitor and evaluate the progress and the status of

outcomes. Not only the national government, but also local governments, companies and other actors are expected to be effective actors, and they should share knowledge and experience. Furthermore, achieving transformative change may require development of new measures acting on social and economic background factors (i.e., indirect drivers). To do so, cross-sectional cooperation is required among diverse actors, including the national government and local governments, the general public, companies, NGOs, educational institutions, and academic communities {Chapter X, Sections 1 and 2}.

Annex

■Conceptual framework of the IPBES and framework of the present assessment



Note: Chapter numbers in the figure indicate the chapters in which the relevant information is provided in the detailed version of the "2021 Report of Comprehensive Assessment of Biodiversity and Ecosystem Services in Japan (JBO3)."
Source: Based on IPBES (2013) Decision IPBES-2/4: Conceptual framework for the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (altered by the Ministry of Environment)

Appended Figure: 1 Assessment framework in 2021 Report of Comprehensive Assessment of Biodiversity and Ecosystem Services in Japan

■Grounds for assessment (amount of data)

In the present assessment, the amount of data underlying an assessment is expressed as follows, based on the relevant indicators, existing research findings, and expert judgments.

Expressions:

- [based on sufficient amount of data]: The assessment result is based on more than one indicator or the same result has been obtained in more than one study.
- [insufficient amount of data]: The amount of data, such as indicators or existing research findings, used in the assessment is insufficient.
- [difficult to assess]: Assessment is difficult because of insufficient grounds. Note: This expression is not used in this report.

Classification of biodiversity

Classification of ecosystems	Characteristics
Forest ecosystems	Ecosystems comprising forests (including secondary forests and planted forests) such as subarctic evergreen coniferous forests, cool-temperate deciduous broadleaf forests, warm-temperate deciduous broadleaf forests, and warm-temperate laurel forests, as well as the flora and fauna living in these habitats.
Agricultural ecosystems	Ecosystems found on agricultural land (paddy fields and fields) and in surrounding forests, woods and freshwaters, as well as the flora and fauna (including agricultural products, farm animals, etc.) living in these habitats.
Urban ecosystems	Ecosystems comprised of forests, agricultural land, urban parks and other green spaces, rivers, and seashores within urban areas, as well as the flora and fauna living in these habitats.
Freshwater ecosystems	Ecosystems comprised of freshwaters, such as rivers, lakes and marshes, and wetlands (excluding waterways and reservoirs for irrigation of agricultural land), as well as the flora and fauna living in these habitats.
Marine and coastal ecosystems	The coast is defined as a land area and a marine area with a coastline in-between. The ocean is defined as any vast marine area offshore from a coast. The marine and coastal ecosystems refer to ecosystems comprised of the flora and fauna living in these habitats.
Island ecosystems	Such ecosystems as forests on the smaller islands of Japan, excluding the four major islands of Hokkaido, Honshu, Shikoku, and Kyushu, as well as ecosystems comprised of the flora and fauna living these habitats.

Classification of human well-being and ecosystem services

Classification of human well-being	Corresponding ecosystem services
[Foundation for a good life] Food and other resources that provide a foundation for our life, as well as ecosystem services supporting the food and other resources.	Services mainly involved in supplying food, water, and raw materials (i.e., agricultural crops, non-timber forest products, fishery products, freshwater, timber, and raw materials), as well as regulating services related to these services (i.e., water and soil regulation, and biological control).
[Interaction with nature and health] Positive and negative effects on physical and mental health arising from water and air purification by the action of ecosystems or from interaction with ecosystems.	Regulating services (i.e., climate, air quality, and water regulation) and cultural services (i.e., tourism/recreation, such as leisure activities), each contributing mainly to health.
[Safety and security of life] Ecosystems' contributions to the safety aspect of life, especially to disaster prevention, as well as human damage caused by wildlife.	Regulating services that contribute mainly to safety and security (i.e., soil erosion prevention, flood regulation, surface collapse prevention, and tsunami reduction), as well as disservices.
[Life and culture with nature] Religions, lifestyles, and other traditional cultures developed from interactions with nature.	Cultural services related mainly to culture, religion, etc. (i.e., religion/festivals, education, landscape, traditional arts & crafts, tourism/recreation, such as rural experience).

Classification of drivers of biodiversity loss (direct drivers)

Classification of crises	Characteristics
First Crisis	The negative impact on biodiversity caused by human activities, including development, habitat conversion, and direct use.
Second Crisis	The impact caused by decline in human intervention in nature (i.e., use and management of *Satochi-Satoyama*).
Third Crisis	The impact caused by alien species, chemical substances, and other consequences of modern lifestyles and human activities.
Fourth Crisis	The impact due to climate and other environmental changes, including global warming, increased occurrence of strong typhoons, change in precipitation patterns, decreased marine primary production, and ocean acidification.

List of academic societies surveyed

Category	Names
Societies with high relevance to broader research fields under survey	The Ecological Society of Japan, Japan Society of Civil Engineers, Ecology and Civil Engineering Society, Japan Association for Landscape Ecology, Japanese Institute of Landscape Architecture, The Japanese Society of Revegetation Technology, Research Association of Coastal Ecosystem Engineering, Japan Society of Hydrology and Water Resources, Japan Society on Water Environment, Japan Society of Erosion Control Engineering, The Society of Eco-Engineering, The Japan Society for International Development, The Society of Tourism and Community Design, and Association of Wildlife and Human Society
Societies with high relevance in terms of characteristics of ecosystems	Japanese Association for Estuarine Science, Japan Wetland Society, The Japanese Coral Reef Society, The Oceanographic Society of Japan, Association of Japanese Agricultural Scientific Societies, The Association of Rural Planning, The Japanese Forest Society, The Society of Applied Forest Science, The Japanese Society of Fisheries Science, Japanese Society of Fisheries Engineering, The Japanese Society of Fisheries Oceanography, Japanese Association for Coastal Zone Studies, Japanese Association of Groundwater Hydrology, The Japanese Society of LIMNOLOGY, Japanese Association for Water Resources and Environment, Architectural Institute of Japan, Japanese Association of Benthology, and The Plankton Society of Japan
Societies focused on human well-being, economic assessment, and other socioeconomic aspects	Society for Environmental Economics and Policy Studies, Japan Association for Environmental Law and Policy, The Japanese Association for Environmental Sociology, Human Ergology Society, The Japanese Society for Environmental Education, The Japanese Society of Education for Sustainable Development, and The Japanese Forest Economic Society
Other	The Union of Japanese Societies for Natural History, Japan Geoscience Union, The Union of Japanese Societies for Biological Science, researchers of PANCES, participants in activities of IPBES, and National Institute for Environmental Studies

Glossary

Biodiversity

The variability among living organisms from all sources, including diversity within species (genetic diversity), between species, and of ecosystems.

Ecosystem services

The benefits provided to humans from ecosystems in which a variety of organisms interact with each other, including food, water, and a stable climate, which support human living.

Disservices

The negative effects of ecosystems on human life and health.

Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES)

An intergovernmental body established in April 2012 to scientifically assess the current status of and changes in biodiversity and ecosystem services and to reflect the results in policy. The IPBES consists of the Plenary, Bureau, and the Multidisciplinary Expert Panel, among others. The main activity areas of the IPBES are "assessments," "policy support," "capacity & knowledge-building," and "communication and outreach."

Global Biodiversity Outlook 5 (GBO5)

Published in September 2020, GBO5 is the fifth version of the report in which the Secretariat of the Convention on Biological Biodiversity analyzes Parties' national reports, national biodiversity strategies, and existing research results and data on biodiversity, and analyzes the status of achievement of the Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets. The present report is an underlying document which provide scientific information to the preparation process for the post-2020 global biodiversity framework.

Predicting and Assessing Natural Capital and Ecosystem Services through an integrated Social-Ecological Systems Approach (PANCES) project, supported by the Environment Research and Technology Development Fund (S-15)

A project which has been implemented since FY2016 to contribute to science and policy in the area of biodiversity, through: developing an integrated model of a social-ecological system focusing on ecosystem-level cases; developing policy options based on predictive assessment and scenario analysis of the natural and socioeconomic values of natural capital and ecosystem services; and providing the ideal style of multi-level governance of natural capital to conserve and nurture inclusive well-being.

Direct drivers

"Direct drivers" refers to natural drivers and anthropogenic drivers that affect nature directly. "Natural drivers" include earthquakes, volcanic eruptions, and extreme weather events, among others. "Anthropogenic drivers" refers to those that are the result of human decisions, such as habitat conversion, exploitation of wild populations, alien species introductions, pollution, and climate change.

Indirect drivers

"Indirect drivers" refers to the ways in which societies organize themselves and changes in societies that are the underlying causes of changes in ecosystems. Indirect drivers affect ecosystems indirectly by affecting the magnitude, trends, rate of impact, etc. of direct drivers. An indirect driver may also affect other indirect drivers.

Transformative change

"Transformative change" refers to a fundamental, system-wide change, and includes considerations on technical, economic, and social factors, including perspectives of paradigms, goals and values.

Interventions

Interventions are means to generate transformative change. The IPBES lists the following five interventions: (1) incentives and capacity-building; (2) cross-sectoral cooperation; (3) pre-emptive action; (4) decision-making in the context of resilience and uncertainty; and (5) environmental law and implementation.

Leverage points

Leverage points are points at which intervention should be targeted. The IPBES lists the following leverage points: (1) embrace diverse visions of a good life; (2) reduce total consumption and waste; (3) unleash values and action; (4) reduce inequalities; (5) practice justice and inclusion in conservation; (6) internalize externalities and telecouplings; (7) ensure environmentally friendly technology, innovation and investment; and (8) promote education and knowledge generation and sharing. The leverage points are important not only for the recovery of biodiversity through transformative change but also for the resolution of a broad range of social issues, such as achieving the SDGs.

Nature-based Solutions (NbS)

According to WCC-2016-Res-069 of the International Union for Conservation of Nature (IUCN), "Nature-based Solutions" is defined as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits."

Nudge

A policy method based on behavioral economics that helps people to voluntarily make a choice that is good for themselves.

Landscape approach

A method to provide a solution to a challenge by comprehensively analyzing a variety of human activities and the natural environment in a certain area or space.

ESG investing

Investments that take into account not only conventional financial information but also environmental, social, and governance factors that are non-financial information.

Telecoupling

The IPBES Global Assessment Report explains "telecouplings" as "nature deterioration from local economic activities and socioeconomic and environmental interactions over distances," and illustrates "international trade" as an example of the causes of the impact on biodiversity.

Regional Circular and Ecological Sphere

A concept advocated in the 5th Basic Environment Plan, which aims that each region will demonstrate its strengths to the fullest by utilizing its available regional resources to the fullest, thereby building a self-reliant and decentralized society, with different communities supporting each other by supplementing each other's resources in tune with local needs, creating integrated circulation of environmental, economic, and social resources.

JBO3

Japan Biodiversity Outlook 3

2021 Report of Comprehensive Assessment of Biodiversity and Ecosystem Services in Japan

[Summary for Policymakers]

This report is a summary of Japan Biodiversity Outlook 3 (2021 Report of Comprehensive Assessment of Biodiversity and Ecosystem Services in Japan). This report was compiled by the members of the Working Group and does not represent the official view of the Ministry of the Environment.

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