The Adaptive Management Strategy for Climate Change for the Shiretoko World Natural Heritage Site

Contents

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1. The value of Shiretoko World Natural Heritage

(1) The value recognized as a World Natural Heritage

In July 2005, the World Heritage Committee inscribed the site on the World Heritage List as meeting Criteria ix (Ecosystem) and Criteria x (Biodiversity) for the following reasons.

- Criteria ix (Ecosystem): This site is an outstanding example of important ongoing ecological or biological processes in the evolution and development of terrestrial, freshwater, coastal, or marine ecosystems or plant and animal communities.
- Criteria x (Biodiversity): This site includes the most important natural habitats for in-habitat biodiversity conservation, such as habitats of endangered species with outstanding universal value from academic or conservation viewpoints.

[1] (Criteria (ix) Ecosystem)

The property has the lowest latitude seasonal sea ice extent in the Northern Hemisphere. It is heavily influenced by the formation of seasonal sea ice, which occurs earlier than other sea ice areas. It exhibits unique ecosystem productivity and is a remarkable example of the interrelationship between marine and terrestrial ecosystems. As one of the ecosystem processes, phytoplankton blooms occur due to nutrients provided by melting sea ice and nutrients supplied from the deep ocean through ocean circulation. The food web, which begins with the proliferation of phytoplankton and includes fish, birds, mammals, and other organisms, forms a dynamic ecosystem that spans the oceans, rivers, and forests.

[2] (Criteria (x) Biodiversity)

The property is quite crucial for many marine and terrestrial species. The property is a habitat of a wide range of species, with a mixture of northern species from the continent and southern species from the island of Honshu. It includes many rare and endemic species, such as Blakiston's fish owl and *Viola kitamiana*, as well as brown bears in one of the highest-density conditions in the world.

The property is a globally rare seabird habitat and an important area for migratory birds. Many small watersheds are habitats for Pacific salmonid species, including white-spotted char, cherry salmon, salmon, and pink salmon, as well as Dolly Varden, the world's most southerly anadromous species.

The site is the home to many marine mammals, such as Steller's sea lions, *Phoca largha*, ribbon seals, killer whales, minke whales, sperm whales, Dall's porpoises, rare fin whales, and *Berardius minimus*, which were newly inscribed after the heritage registration.

[3] Integrity

The property's boundaries coincide with the existing conservation area. It covers an area of 71,100 hectares and encompasses the entire conserved region of a complex ecosystem consisting of a vibrant coastal marine ecosystem and a pristine terrestrial ecosystem. It includes all primary terrestrial property values and major marine ecosystem areas for marine biodiversity.

The land boundary is reasonable and protects the significant land features. The marine boundary extends 3 km from the coastline and includes a depth of 200 m, which is ecologically essential for

marine biodiversity.

Fishery has been a vital local industry in the marine area for many years. Recent efforts to ensure sustainability have contributed to the conservation of the area's natural values while ensuring important economic income for the community. Through active dialogue with local stakeholders, an integrated multiple-use marine management plan has been developed to assist the management agency in achieving sustainable industry and ongoing long-term conservation objectives for the property.

The property's land boundary protects significant land features, from the coastline to a mountain ridge at 1,600 meters. Most of the land area is in primitive or quasi-primitive condition, and the property's natural scientific features continue to maintain a high level of natural integrity. The management agency has adequate resources to implement the provisions of the management plan, including strategies for high-density bear and deer populations.

(2) Other Values of Shiretoko

Besides being recognized as a World Heritage Site, the Shiretoko Peninsula has a variety of other values, including natural scenery and cultural value.

The arrival of sea ice in the ocean changes the blue ocean surface into a white ice field. The coastline is made up of sea cliffs and oddly shaped rocks created by volcanic activity and the erosion of the sea ice, creating a unique and beautiful landscape. The prehistoric ruins on the Shiretoko Peninsula tell us about the long history of people’s lives centered around fishing and hunting. The Ainu people, who emerged after the period of the Okhotsk culture around the 10th century, used many strangely shaped rocks as landmarks for fishing or as places to pray for good catches and safety. Numerous place names in the Ainu language remain where such rocks are located. The area is rich in resources such as salmonid species and Atka mackerel, and the fishing industry is still thriving as a representative industry of the region.

In the land area, various vegetation zones are formed on the steep terrain; in the autumn, when the leaves change color, a vibrant landscape can be seen. The area near Mount Io, which is roughly in the center of the Shiretoko Peninsula, once ejected large amounts of high-purity molten sulfur. Even today, there is characteristic scenery of fumaroles and streams with hot spring water flowing, retaining the historical aspect of the old sulfur mining site.

Another attraction of the natural landscape of the heritage site is that it allows visitors to observe many wild animals. In winter, seals, Steller's sea eagles, and white-tailed eagles appear on the sea ice, and in summer, many colonies of seabirds form on the sea cliffs. In autumn, we see salmonid species swimming up the rivers and brown bears preying on them.

However, not all of the ecosystem on the Shiretoko Peninsula has been preserved as pristine; in many places, some environments have been formed by the influence of human activities over a long period of time. In 1977, the "100 Square-Meter Forest Movement Trust" was launched to restore land at risk of development reaching the virgin forest through donations from supporters around the country, and the initiative is still ongoing today. In this way, Shiretoko continues to generate diverse values through the involvement of local residents and various stakeholders.

2. Basic principles for strategy consideration

This strategy summarizes measures for adaptive management of climate change to maintain the Outstanding Universal Value (OUV) of the Shiretoko World Natural Heritage Site into the future. This strategy's adaptive management is based on the Long-Term Monitoring Plan for the Shiretoko World Natural Heritage Site. It involves monitoring the impact on biological species and changes in the ecosystem and then flexibly reviewing management and utilization methods based on the results. With these in mind, and based on the Basic Concept of Climate Change Adaptation on Biodiversity in Japan (2015, Ministry of the Environment), this strategy focused on the following eight perspectives. At present, without taking adaptive measures through active intervention, the strategy focuses on grasping the current situation through monitoring and striving to conserve and restore sound ecosystems that are highly adaptable to climate change based on the actual situation.

[1] Grasp the current situation to evaluate the impact of climate change.
[2] Predict and evaluate climate change impact, and monitor the impact in the biodiversity field.
[3] Reduce stresses other than those caused by climate change, such as development, environmental pollution, overuse, and invasion by alien species to maintain healthy ecosystems.
[4] Further promote existing measures for the conservation of biodiversity taking into account the expected impact of climate change.
[5] Expand or connect protected areas.
[6] Regenerate nature to eliminate the division of ecosystems.
[7] Consider the impacts of climate change in planning measures related to the natural environment including park planning and management/operating plan of national parks, Evaluation of red list species and invasive alien species, and review those measures as necessary.
[8] Ensure opportunities for consensus building for the consideration and implementation of adaptation measures.

Table 1: Basic Concept of Climate Change Adaptation on Biodiversity in Japan (2015, Ministry of the Environment)

Types of measures		Policies	Examples of specific initiatives
Expansion and evaluation of the monitoring		◎ Survey of climate change impacts	○ [1] Grasp the current situation to evaluate the impact of climate change. ○ Identify and monitor areas vulnerable to climate change and shelters for organisms in the event of rising temperatures.
		◎ Promotion of research and technical development	○ [2] Predict and evaluate climate change impact, monitor the impact in the biodiversity field, and accelerate and promote research/technical development related to adaption promotion.
		◎ Survey of impacts on ecosystem services	○ Focus on initiatives to address the impact of changes in biodiversity on ecosystem services, where knowledge is lacking.
Conservation and Restoration of Sound Ecosystems with Good Adaptability to Climate Change		◎ Identifying areas less vulnerable to climate change and prioritizing their conservation	○ Identify sound ecosystems and areas less vulnerable to climate change and prioritize their conservation.
		◎ Reducing stresses other than those caused by climate change	○ [3] Reduce stresses other than those caused by climate change, such as development, environmental pollution, overuse, and invasion by alien species to maintain healthy ecosystems. ○ [4] Further promote existing measures for the conservation of biodiversity taking into account the expected impact of climate change.
		◎ Securing routes for organisms to migrate and disperse	○ [5] Expand or connect protected areas.
		◎ Promoting formation of ecosystem networks	○ [6] Regenerate nature to eliminate the division of ecosystems. ○ Restore natural conditions in areas that are difficult to maintain due to population decline, etc., and use them as protected areas or a part of an ecosystem network, based on the prediction of the social environment, such as reducing population and aging society.
Note: The necessity of the following adaptation measures shall be judged individually based on their relationship with conservation goals, the pros, and cons of interfering with or not interfering with the impact on ecosystems and ecosystem services, the existence of effective measures, feasibility, and costs/benefits.			
Active Intervention	Management to maintain existing ecosystems and species	◎ Maintenance and restoration of ecosystems	○ For key landscapes of national parks, the maintenance of which is desirable, management to control changes such as removal of invading plants, improvement cutting, and restoration of vegetation may be considered.
		◎ Reintroduction and the addition of individuals	○ Reintroduction and the addition of individuals to conserve the species in their current habitat may be considered.
	Ex situ conservation	◎ Ex situ conservation	○ If it is deemed difficult to conserve species in their current habitat due to reduced suitable habitats, you may preserve them in zoos, botanical gardens, etc.
	Management conductive to adaptation to climate change	◎ Reconstruction of the ecosystem	○ If the communities do not change soundly because of a loss of some species due to a divided ecosystem and other reasons, consider reconstruction of the ecosystem involving artificial translocation.
		◎ Conservation introduction	○ When the risk of extinction increases for certain species that cannot migrate or disperse because they are distributed in isolation at high altitudes or their habitat is artificially divided, you may very carefully consider conservation introduction by species.
Mainstreaming climate change into each policy		◎ Considering climate change in each policy	○ [7] Consider the impacts of climate change in planning measures related to the natural environment including park planning and management/operating plan of national parks. Evaluation of red list species and invasive alien species, and review those measures as necessary.
		◎ Ensuring opportunities for consensus building	○ [8] Ensure opportunities for consensus building for the consideration and implementation of adaptation measures.

3. Survey of current state of climate change

Based on the long-term data analysis and previous research results, there are concerns about the impacts of climate change in the areas surrounding the Shiretoko World Natural Heritage Site. Some examples of the analysis results are shown below.

- Rising trends in annual average temperatures (Figure 1)
- Declining trends in the ice floe period (number of days) (Figure 2)
- Future projections of winter sea ice area (total sea ice area) (Figure 3)

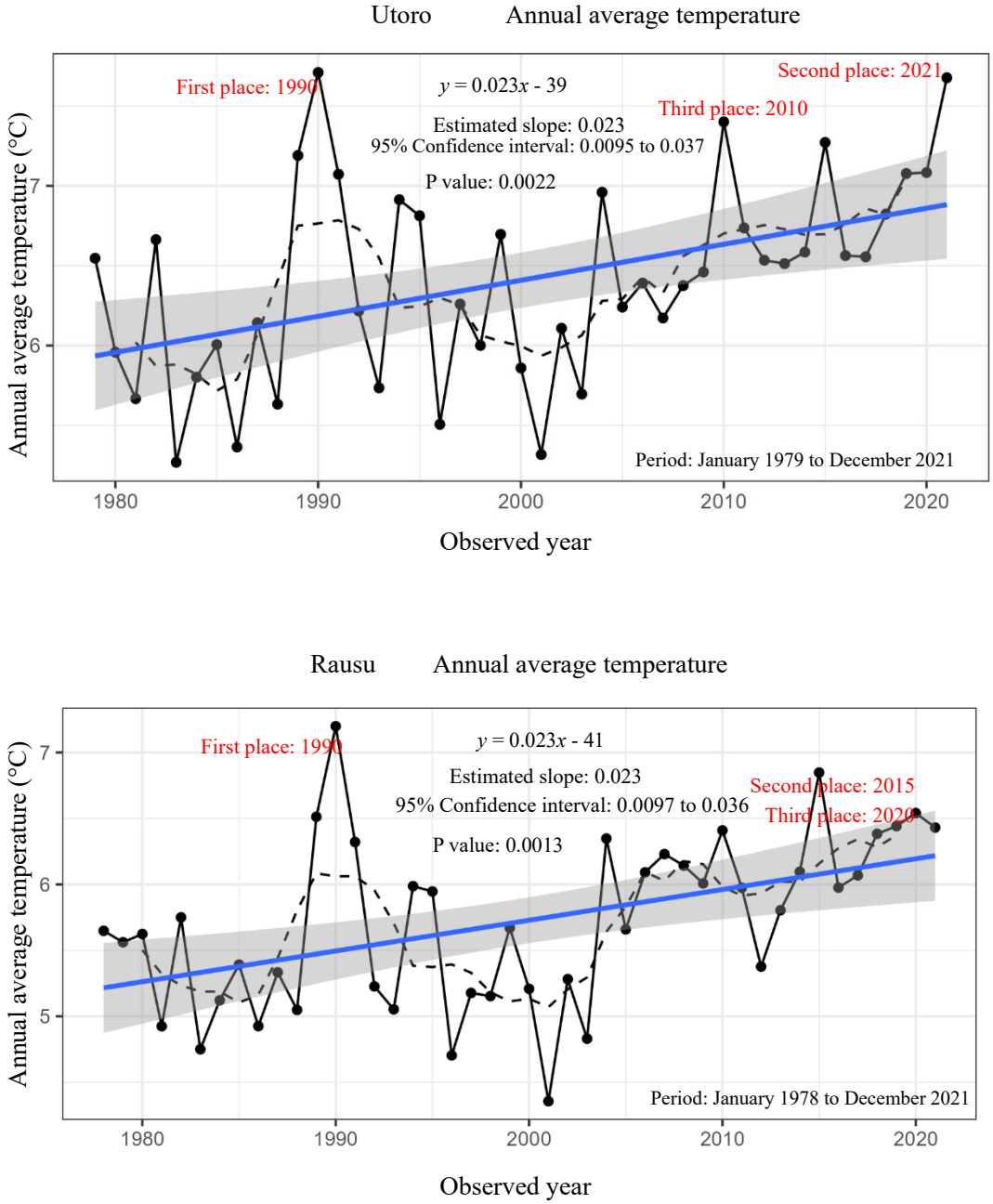


Figure 1: Changes in average annual temperature in the Shiretoko World Natural Heritage Site (upper, Utoro; lower, Rausu)

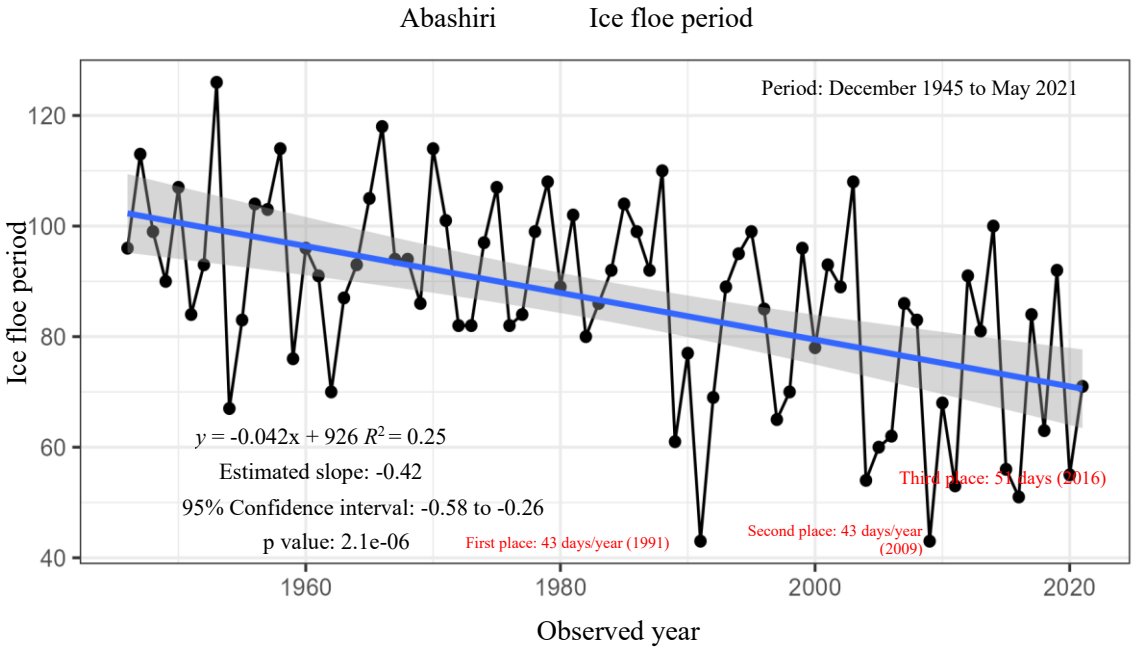


Figure 2: Changes in the duration of annual ice floe period (number of days) near the Shiretoko World Natural Heritage Site

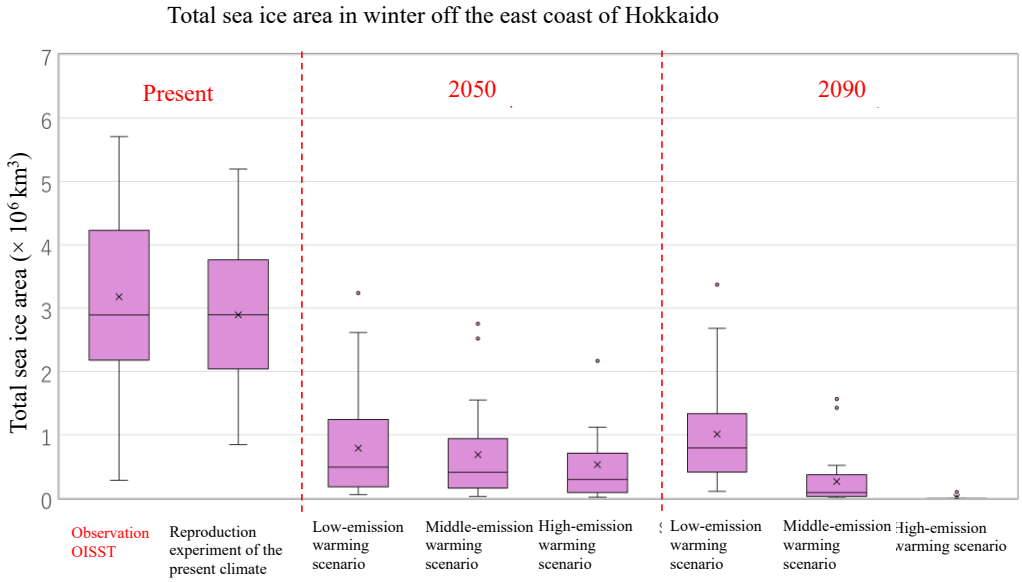


Figure 3: Box-and-whisker plots of the total (cumulative total) sea ice area estimations in the winter of 2050 and 2090 off the east coast of Hokkaido in the southern part of the Sea of Okhotsk

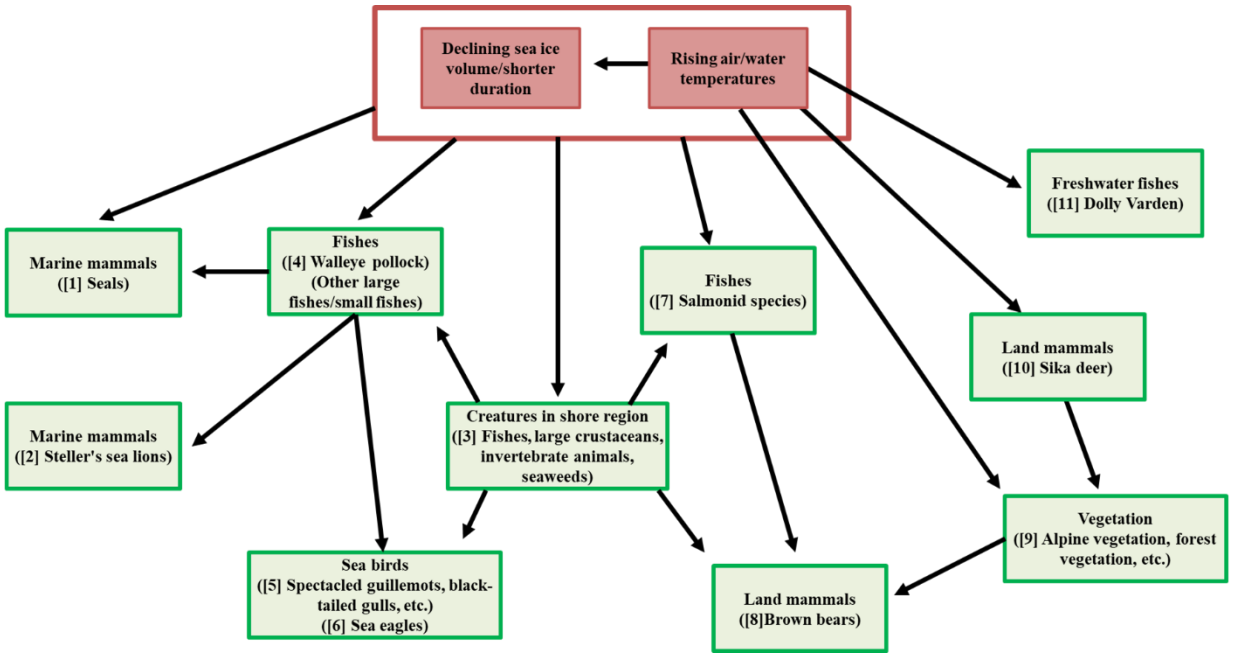
The tips of the plots represent the maximum and minimum values. The boxes represent the 25th to 75th percentiles of sea ice area (percentiles are sorted from smallest to largest and expressed as a percentage). The line inside the box indicates the median and the cross (×) indicates the mean value. The box-and-whisker plots of sea ice distribution based on NOAA's Optimal Interpolation Sea Surface Temperature (OISST) are shown as the observed values.

Source: Humio Mitsudera (Hokkaido University), 2024 Prediction of Sea Ice and Ocean Variations and Climate Change Risk Assessment on Marine Ecosystems in the Southern Sea of Okhotsk Including Shiretoko, a World Natural Heritageelopment Fund).

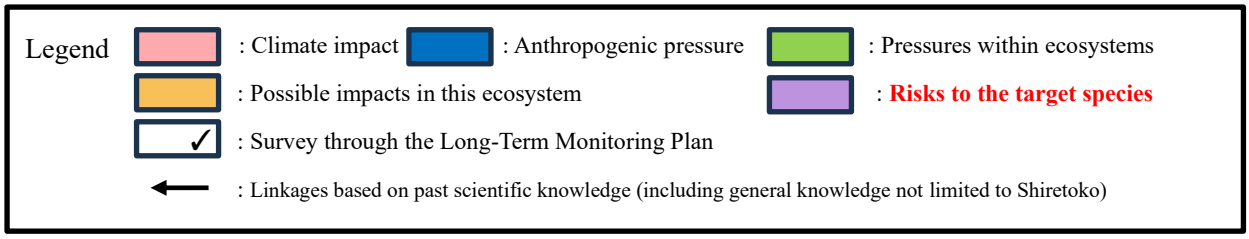
4. Assumption of climate change scenarios specific to Shiretoko

An impact chain (climate change scenario) specific to Shiretoko was created, targeting the major biological species and interspecific relationships that support OUV. An impact chain is an analytical tool for organizing the causes of a system. In the Shiretoko World Natural Heritage Site, starting from the formation of seasonal sea ice, the interrelationships among the sea, river, and land ecosystems have formed a rich biodiversity. Therefore, climate change's impacts on the Shiretoko World Natural Heritage Site are expected to affect individual OUVs directly and indirectly through inter-species interactions. In this study, the impact chain was used to visualize the relationship between ecosystem connections and climate change impacts, and monitoring items were organized to grasp the risks to target species and climate change impacts.

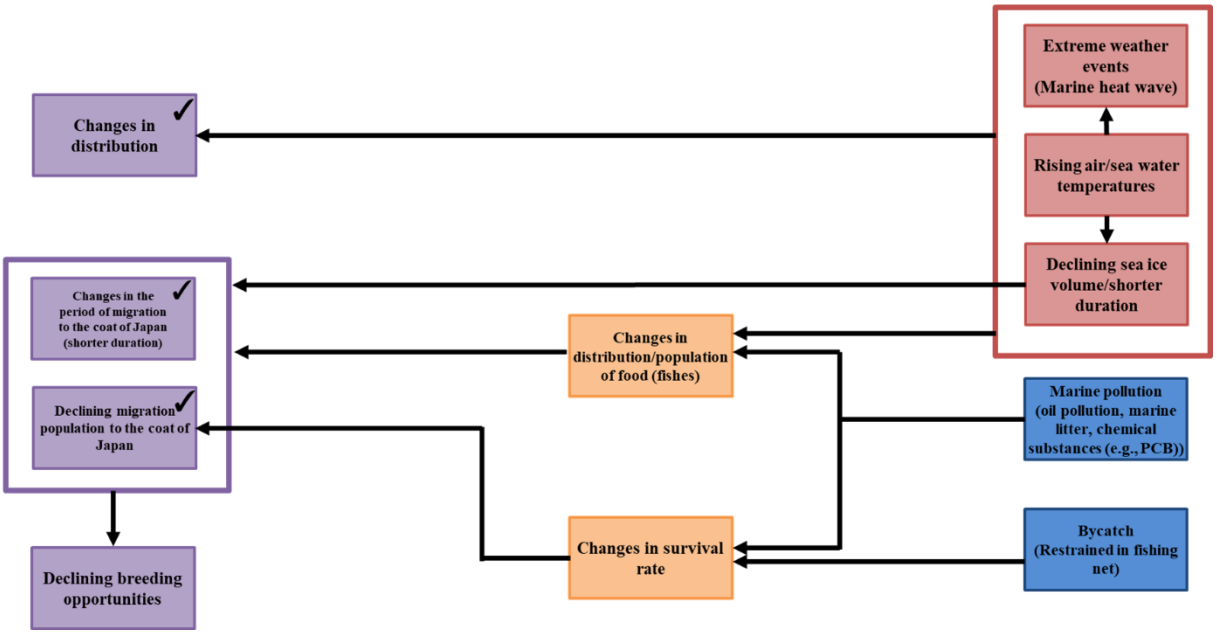
[Linkage of the impacts within the ecosystem caused by rising air and water temperatures (Overall picture in Shiretoko)]



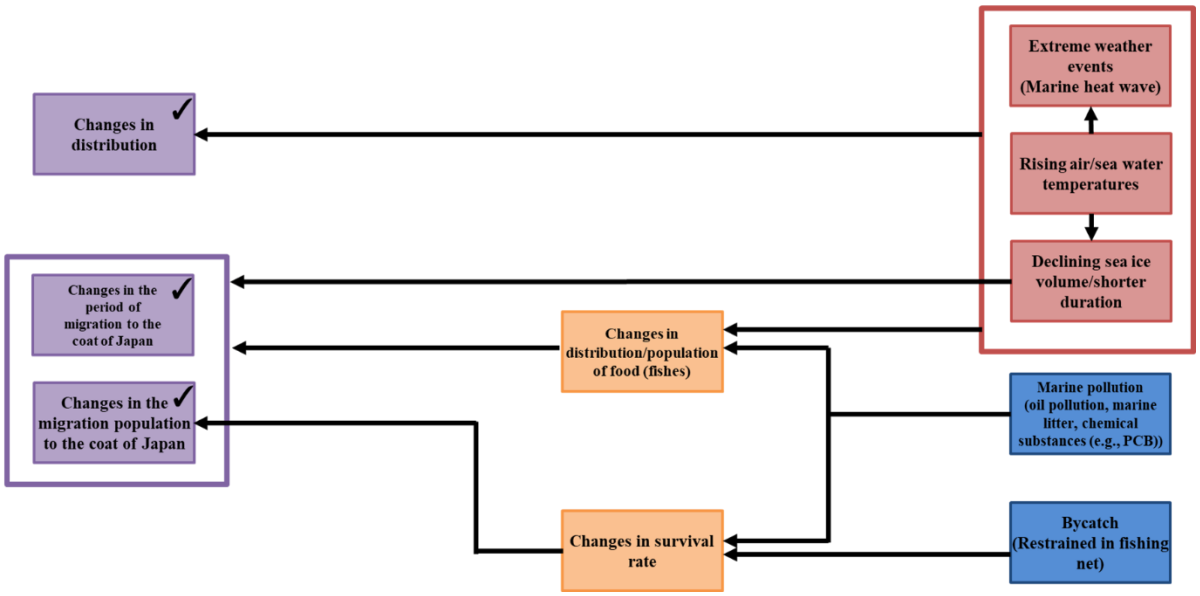
Note: In particular, the linkages within the ecosystem were examined, focusing on [1] to [11], which are the main biological species that support the OUV in the Shiretoko World Natural Heritage Site.



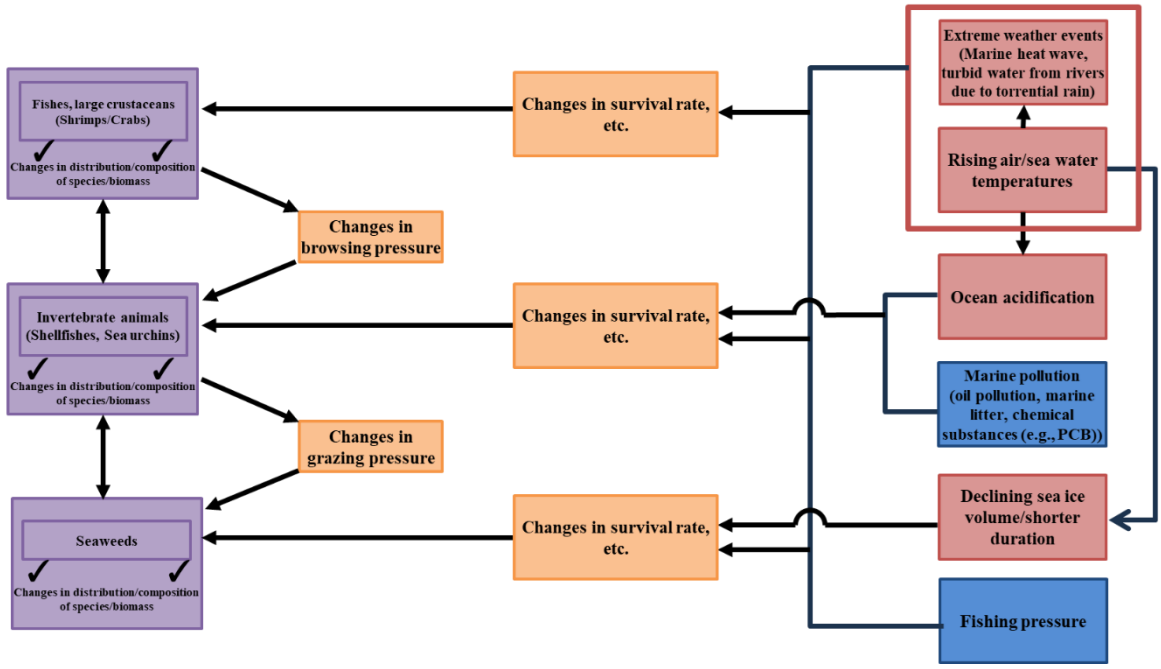
[1] Seals (Phoca largha)



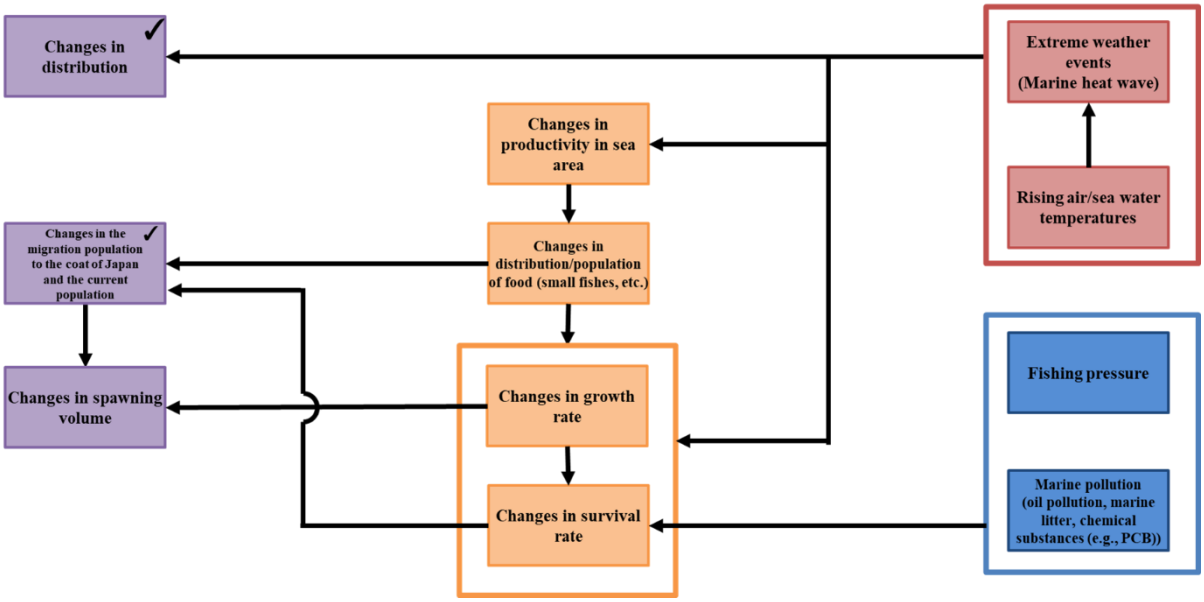
[2] Steller's sea lions



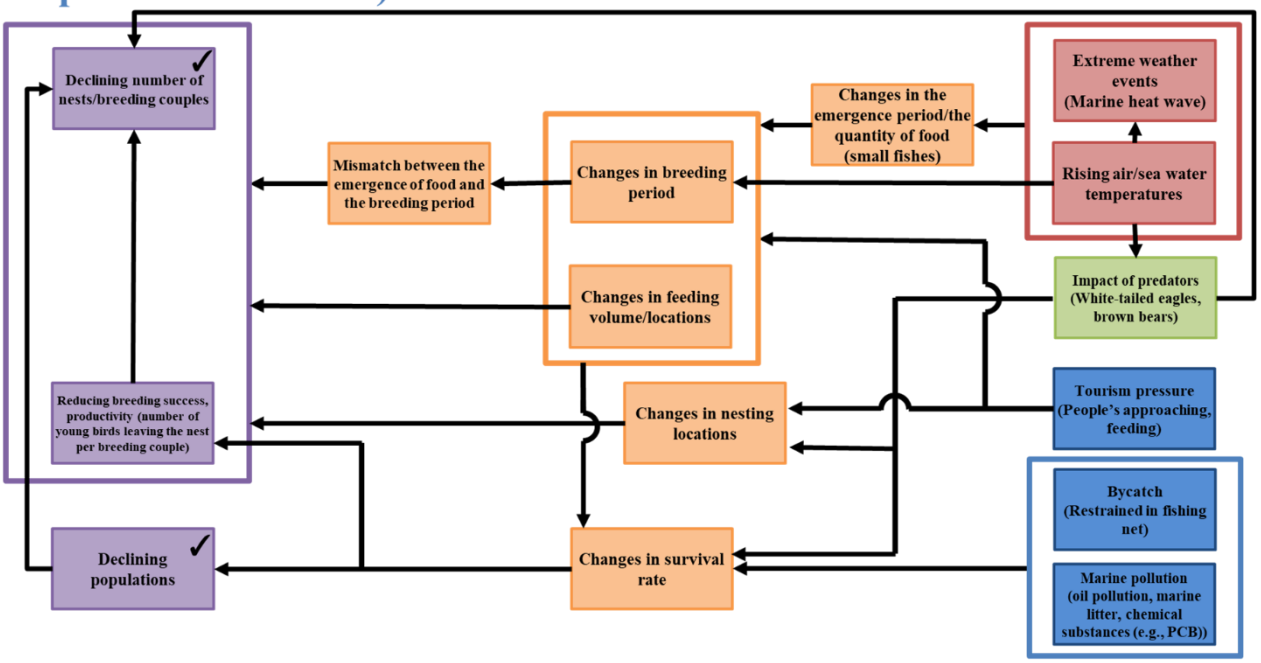
[3] Creatures in shore region (fishes, large crustaceans, invertebrate animals, seaweeds)



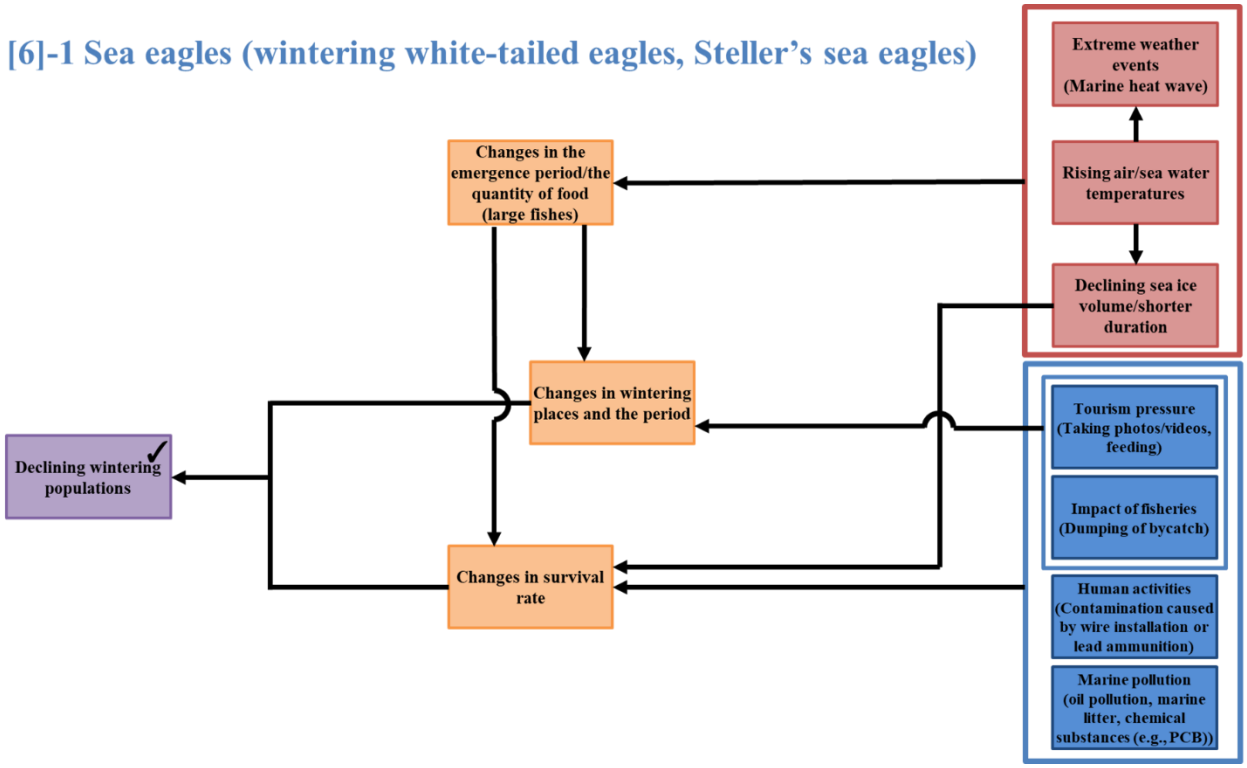
[4] Fish (Walleye pollock)



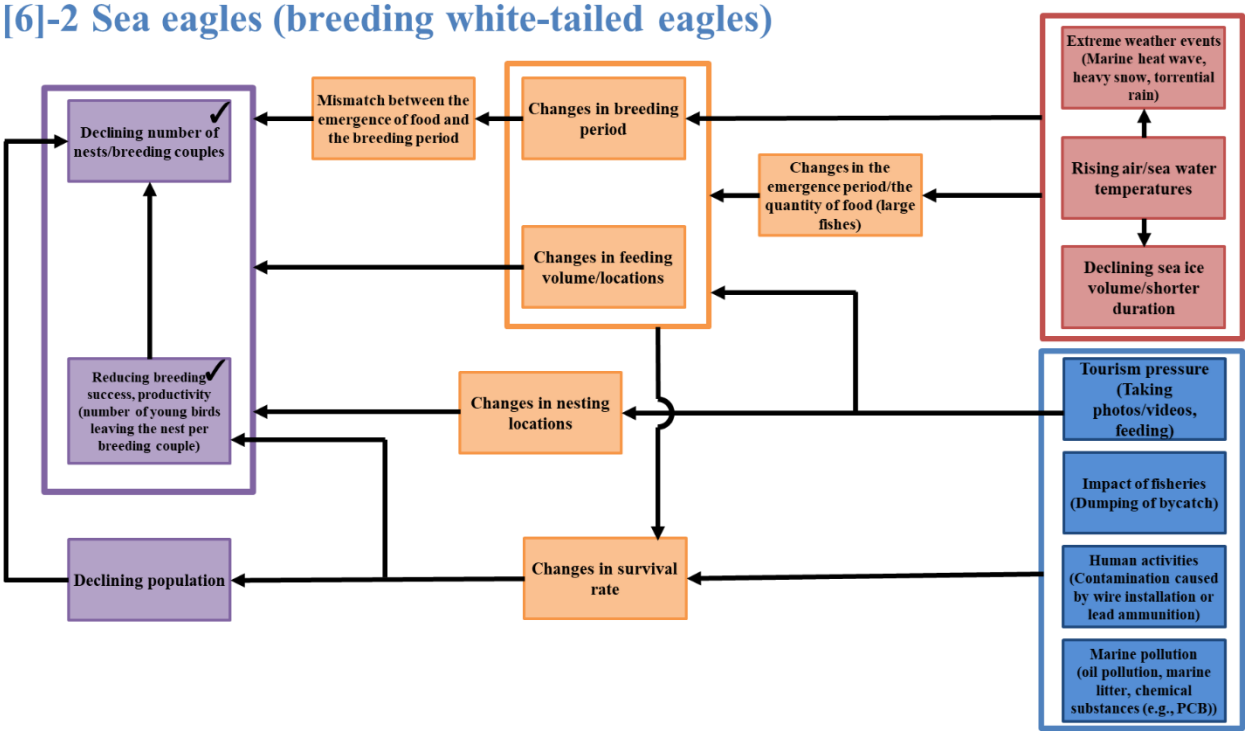
[5] Sea birds (spectacled guillemots, black-tailed gulls, slaty-backed gulls, Japanese cormorants)



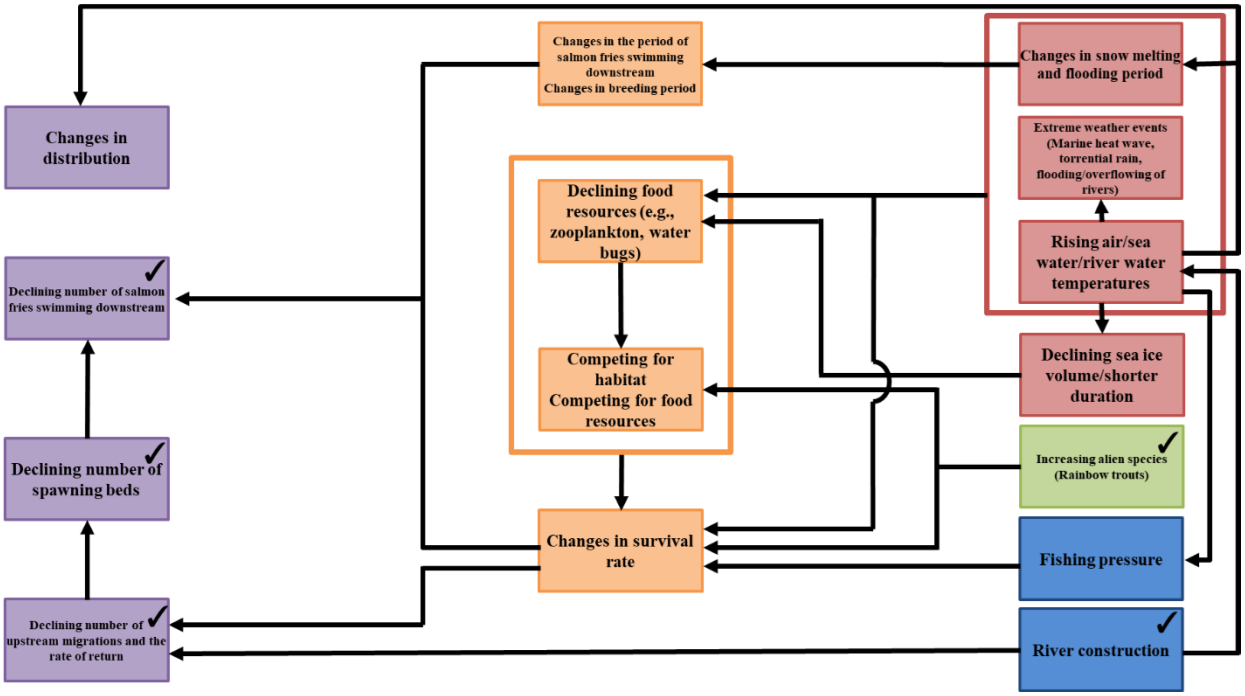
[6]-1 Sea eagles (wintering white-tailed eagles, Steller's sea eagles)



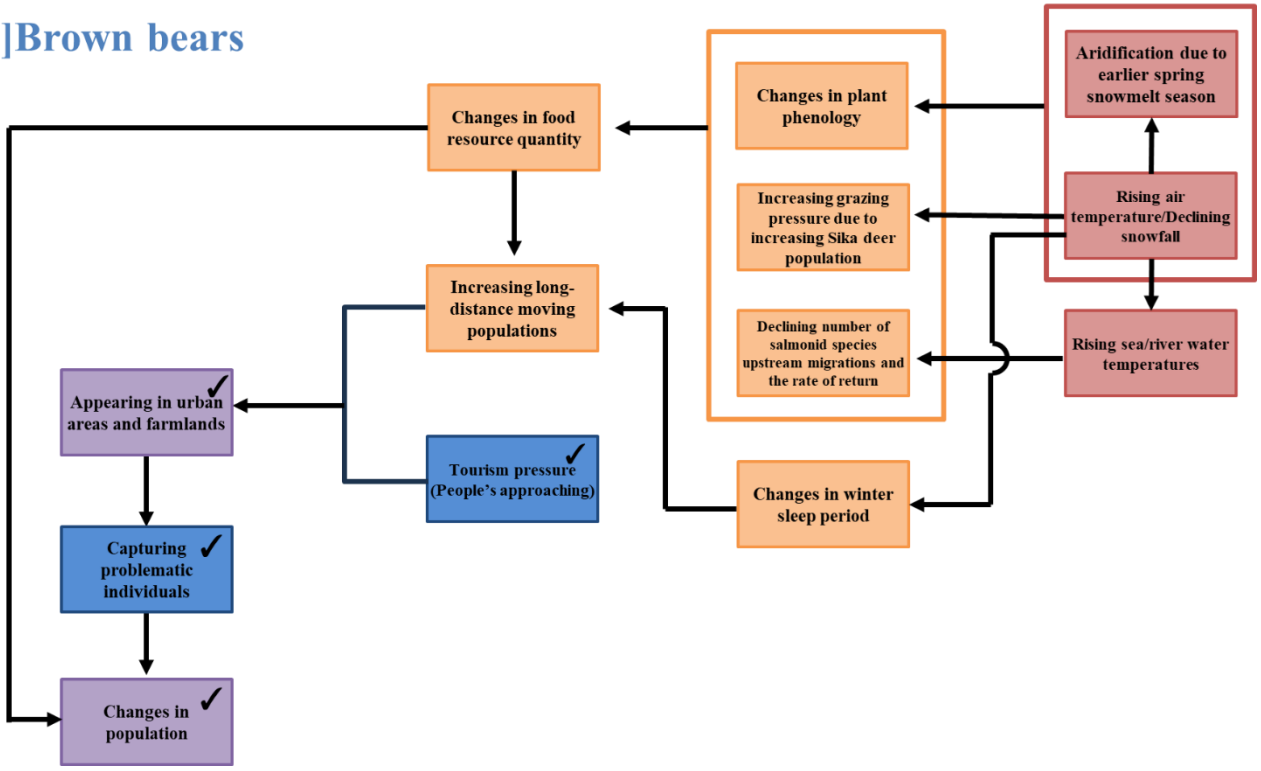
[6]-2 Sea eagles (breeding white-tailed eagles)



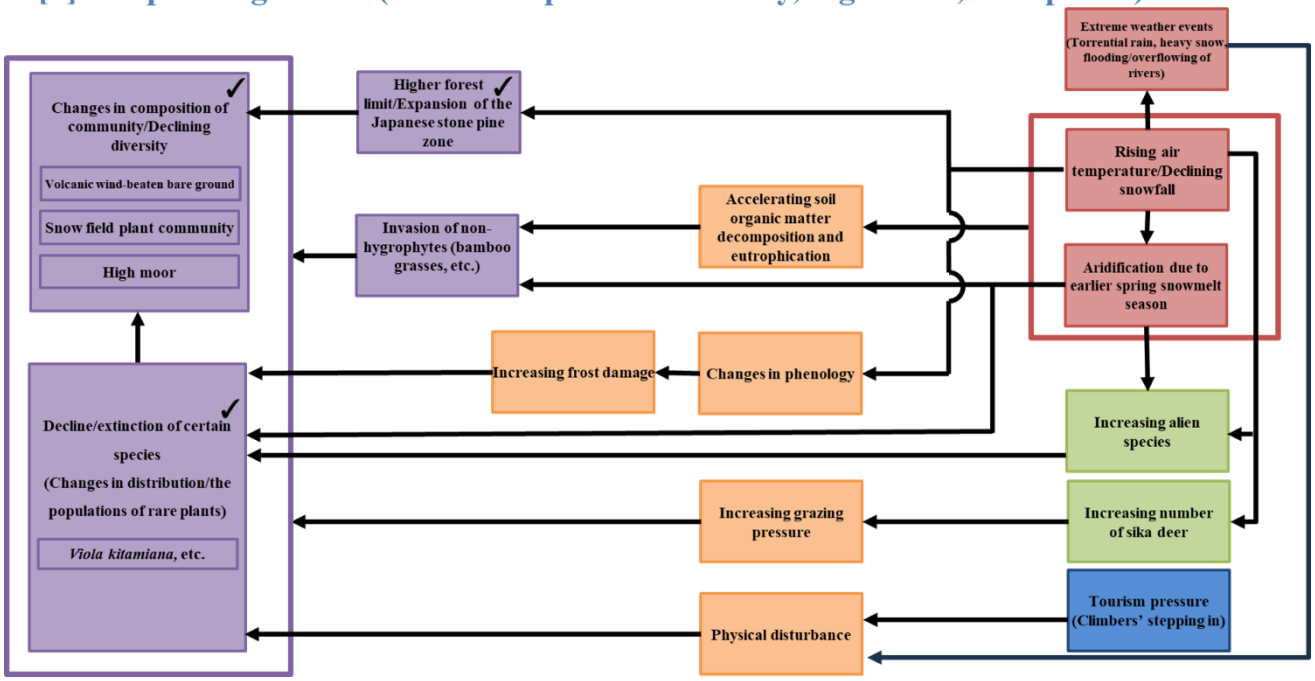
[7] Salmonid species (Salmon, pink salmon, cherry salmon)



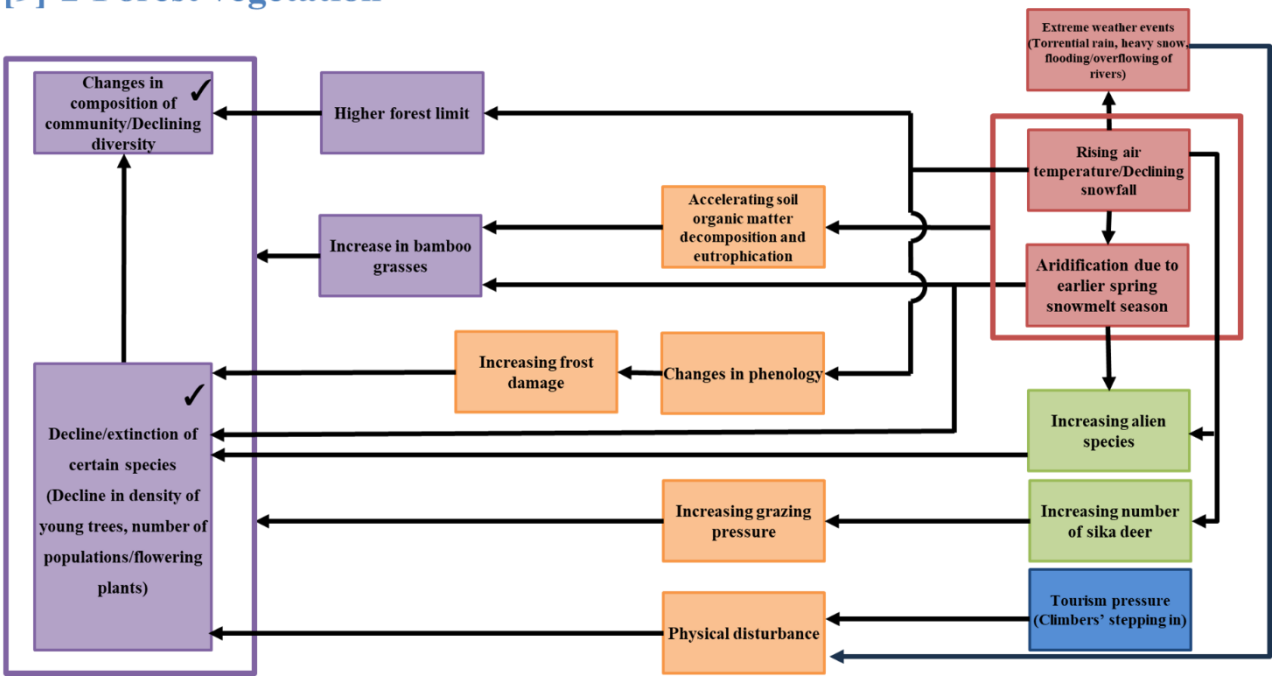
[8]Brown bears



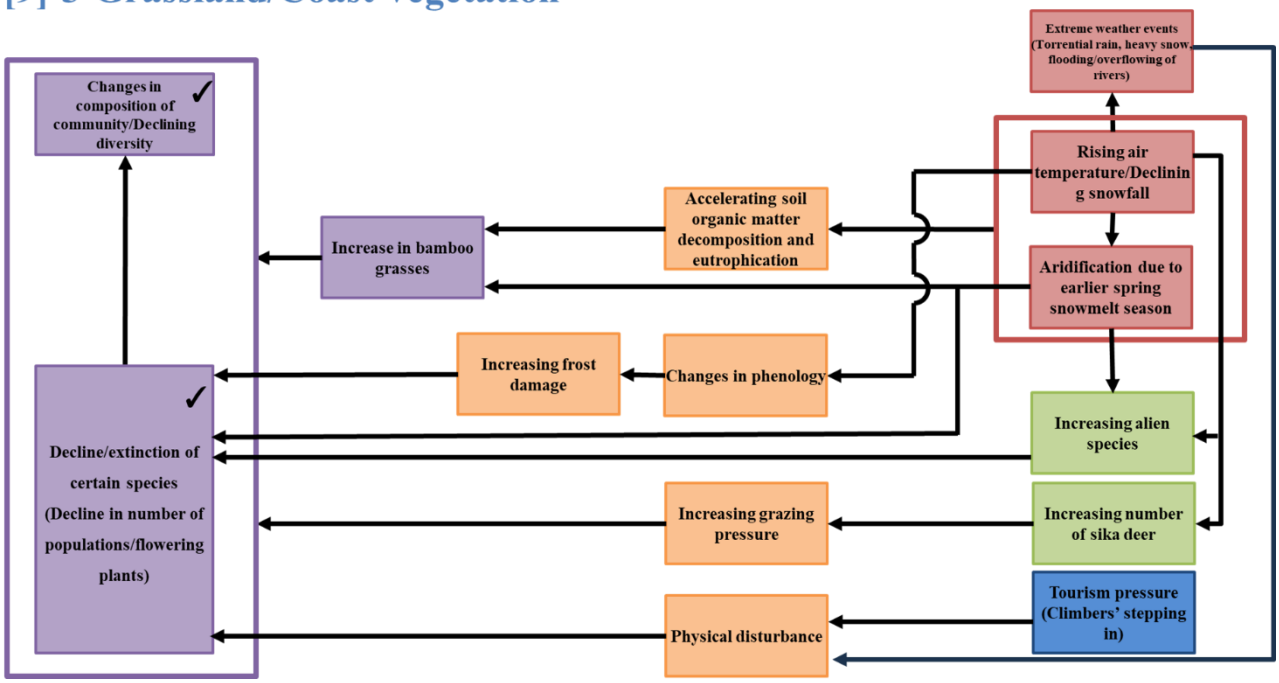
[9]-1 Alpine vegetation (snow field plant community, high moor, rare plants)



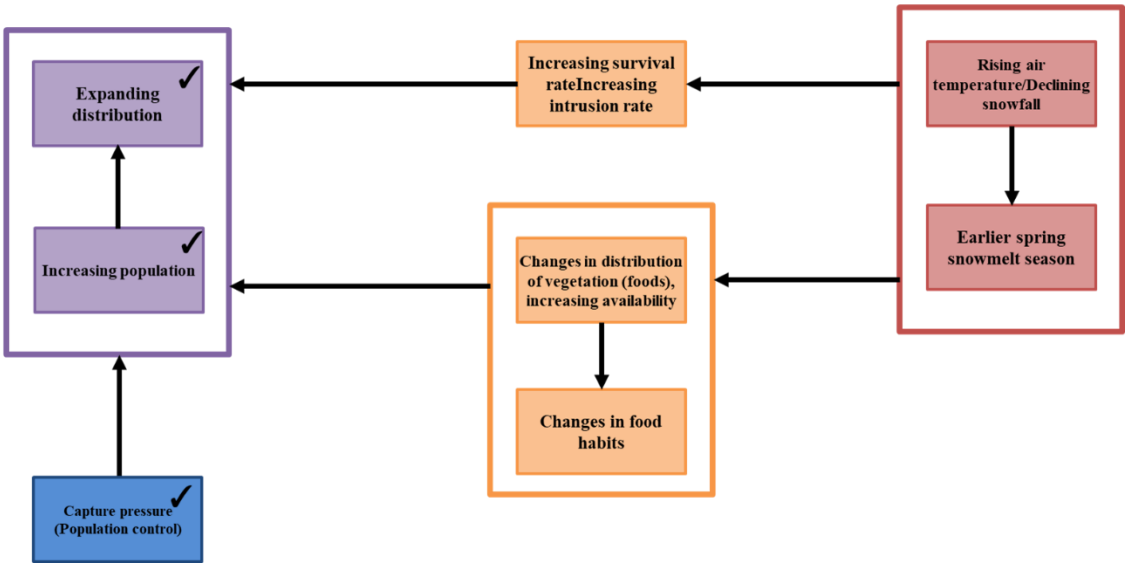
[9]-2 Forest vegetation



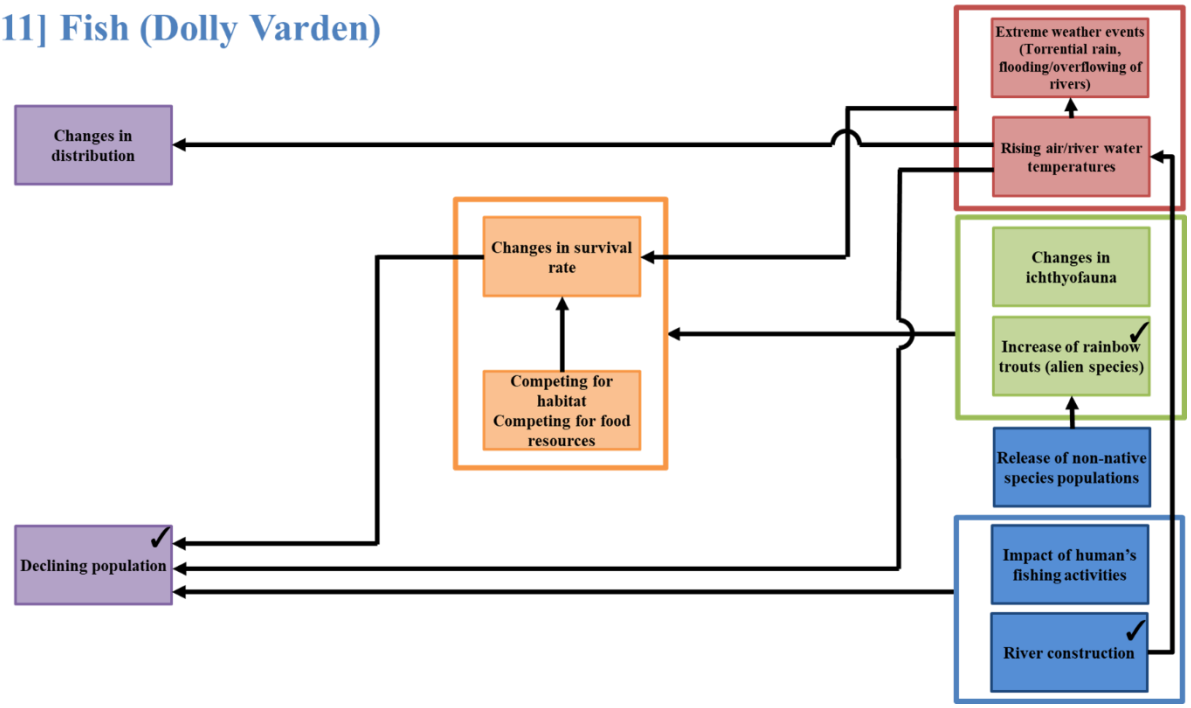
[9]-3 Grassland/Coast vegetation



[10] Sika deer



[11] Fish (Dolly Varden)



5. Evaluation of risks of impact due to climate change

Considering climate change scenarios (impact chains), the risks to ecosystems for each species that are currently anticipated were compiled from the following perspectives. The data shall be updated periodically and any impacts shall be determined based on a comprehensive Evaluation of the Long-Term Monitoring Plan.

[1] Impacts caused by climate change (possibility based on general knowledge)

- Based on the findings obtained from various past studies, the possibility of impacts caused by climate change is evaluated on a three-step scale: High, Medium, and Low.

[2] Impacts caused by climate change (possibility based on knowledge obtained at Shiretoko)

- Based on the knowledge obtained from the past research and monitoring at the Shiretoko Peninsula and surrounding areas, the possibility of impacts caused by climate change is evaluated on a three-step scale: High, Medium, and Low.

[3] Significance of the impact (Significance of the impact on the value of the Shiretoko Heritage Site)

- The severity is rated as "High" when it becomes difficult to maintain the criteria (ecosystem/biodiversity) or when the impact on other species is significant.
- Also, monitoring items linked to Evaluation items A, B, and C in the Phase 2 Long-Term Monitoring Plan, for which maintenance of Criteria is evaluated, are rated as "High" in terms of severity.
- In addition, a "Medium" or "Low" rating is relatively determined based on factors, such as the relationship with other species.

[4] Recent trends in Shiretoko (current state of each species based on the 2022 comprehensive Evaluation)

- Referring to the results of the comprehensive Evaluation of the Phase 1 Long-Term Monitoring Plan, recent trends are compiled (not limited to the trends due to climate change impacts).
- Findings from research results on Shiretoko are added.

[5] Determination of whether or not there is an impact

- Determine whether or not there is an impact based on the results of a comprehensive Evaluation of the Long-Term Monitoring Plan.
- However, regardless of the timing of the comprehensive Evaluation (Note), if the results of various monitoring indicate that the impacts of climate change are significant and the severity is "High," measures shall be taken at that time, such as accelerating the implementation of adaptation measures.

(Note) The time of the comprehensive evaluation in the Phase 2 Long-Term Monitoring Plan

- Interim evaluation: Fiscal 2027
- Comprehensive Evaluation: Fiscal 2032

Table 2: Compilation of the risk evaluation

	Assumed impacts	Impacts caused by climate change		[3] Significance of the impact on the value of the Shiretoko Heritage Site	[4] Recent trends in Shiretoko (current state of each species based on the 2022 comprehensive evaluation) Note: Not limited to the trends due to climate change impacts
		[1] Possibility based on general knowledge	[2] Possibility based on knowledge obtained at Shiretoko		
[1] Seals (*Phoca largha*)	Changes in distribution	High	High	Medium	Maintained the status quo at the time of heritage registration
	Changes in the period of migration to the coat of Japan (shorter duration)	High	High	High	
	Declining migration population to the coat of Japan	High	High	High	
	Declining breeding opportunities	High	High	High	
[2] Steller's sea lions	Changes in distribution	Medium	Unknown	Medium	Lack of information
	Changes in the period of migration to the coat of Japan	High		Medium	
	Changes in the migration population to the coat of Japan Changes in the habits (food habits)	High		High	
[3] Creatures in shore region (Fishes, large crustaceans, invertebrate animals, seaweeds)	Changes in distribution	High	Unknown	High	Maintained the status quo at the time of heritage registration
	Changes in the composition of species	High		High	
	Changes in biomass	High		Medium	
[4] Walleye pollock	Changes in distribution	Medium	Unknown	High	Maintained the status quo at the time of heritage registration
	Changes in the migration population to the coat of Japan and the current population	Medium		High	
	Changes in spawning volume	Medium		High	
[5] Sea birds (Spectacled guillemots, black-tailed gulls, slaty-backed gulls, Japanese cormorants)	Declining number of nests/breeding couples	High	Unknown	High	Declining number of Japanese cormorants and gulls
	Reducing breeding success, productivity (number of young birds leaving the nest per breeding couple)	High		High	
	Declining population	Medium		High	
[6]-1 Sea eagles (wintering white-tailed eagles, Steller's sea eagles)	Declining wintering populations	Low	Unknown	High	Maintained the status quo at the time of heritage registration
[6]-2 Sea eagles (breeding white-tailed eagles)	Declining number of nests/breeding couples	High	Unknown	High	Has been improved since the time of heritage registration
	Reducing breeding success, productivity (number of young birds leaving the nest per breeding couple)	High		High	
	Declining population	Medium		High	
[7] Salmonid species (Salmon, pink salmon, cherry salmon)	Changes in distribution	High	Unknown	High	Upstream and downstream migrations have been promoted because of the improved river construction
	Declining number of salmon fries swimming downstream	High		High	
	Declining number of spawning beds	High		High	
	Declining number of upstream migrations and the rate of return	High		High	
[8] Brown bears	Appearing in urban areas and farmlands	High	Unknown	High	Maintained the status quo at the time of heritage registration
	Changes in population	High		High	

	Assumed impacts	Impacts caused by climate change		[3] Significance of the impact on the value of the Shiretoko Heritage Site	[4] Recent trends in Shiretoko (current state of each species based on the 2022 comprehensive evaluation) Note: Not limited to the trends due to climate change impacts
		[1] Possibility based on general knowledge	[2] Possibility based on knowledge obtained at Shiretoko		
[9]-1 Alpine vegetation	Changes in composition of community/Declining diversity	High	Unknown	High	Maintained the status quo at the time of heritage registration
	Decline and extinction of certain species (Changes in distribution and the population of rare plants)	High		High	
[9]-2 Forest vegetation	Changes in composition of community/Declining diversity	High	Unknown	High	
	Decline and extinction of certain species (Decline in density of young trees, number of populations, and flowering plants)	High		High	
[9]-3 Grassland/Coast vegetation	Changes in composition of community/Declining diversity	High	Unknown	High	
	Decline and extinction of certain species (Changes in distribution and the population of rare plants)	High		High	
[10] Sika deer	Expanding distribution	High	Unknown	High	Maintained the status quo at the time of heritage registration
	Increasing population	High		High	
[11] Dolly Varden	Changes in distribution	Low	Unknown	High	Although some rivers show an increasing trend, the overall trend is on a decrease.
	Declining population	Medium to High		High	

[5] Determination of whether or not there is an impact
Determine whether or not there is an impact based on the results of a comprehensive evaluation of the Long-Term Monitoring Plan.

6. Consideration of specific and feasible measures

Based on the assumed risks, specific and feasible adaption measures were examined. The basic policy is to further promote existing measures, focusing on reducing stress factors other than climate change and strengthening adaptability while considering whether anthropogenic measures against risks are possible.

Target species	Adaptation measures to climate change
[1] Seals (*Phoca largha*) [2] Steller's sea lions	● Reducing existing stress source (pressure caused by human activities, such as litter and oil contamination) ● Building collaborative relationships with stakeholders ● Protection by laws and regulations
[3] Creatures in shore region (fishes, large crustaceans, invertebrate animals, seaweeds) [4] Walleye pollock	● Promoting sustainable fishery based on the integrated multiple-use marine management plan, considering the changes in distribution and food resource amounts ● Reducing existing stress source (pressure caused by human activities, such as litter and oil contamination)
[5] Sea birds (spectacled guillemots, black-tailed gulls, slaty-backed gulls, Japanese cormorants)	● Reducing existing stress source (pressure caused by human activities, such as litter, oil pollution, and tourism) ● Conserving breeding sites considering the impact of predators, tourism pressure, etc. ● Protection by laws and regulations ● Raising awareness to foster conservation momentum
[6]-1 Sea eagles (wintering white-tailed eagles, Steller's sea eagles) [6]-2 Sea eagles (breeding white-tailed eagles)	● Reducing existing stress source (pressure caused by human activities, such as litter, oil pollution, and tourism) ● Conserving breeding sites based on tourism pressure, etc. ● Protection by laws and regulations ● Rising public awareness (strict ban on lead ammunition) ● Rescuing injured or sick birds
[7] Salmonid species (Salmon, pink salmon, cherry salmon)	● Reducing existing stress source (fishing pressure) ● Improving river construction to ensure the continuity between sea areas and rivers and controlling rising water temperature ● Protection by laws and regulations
[8] Brown bears	● Reducing existing stress source (tourists' approach) ● Conserving and improving habitat/growing environment for primary food resources (salmonid species and nuts of Japanese stone pine and *Quercus crispula*) ● Strengthening and improving measures to prevent the intrusion into urban areas (avoiding extermination as problematic individuals)
[9]-1 Alpine vegetation [9]-2 Forest vegetation [9]-3 Grassland / Coast vegetation	● Reducing existing stress resources (trampling by tourists, grazing pressure of sika deer) ● Exterminating/controlling alien species ● Protection by laws and regulations and conservation of rare species

Target species	Adaptation measures to climate change
[10] Sika deer	● Reasonable population control based on the habitat status ● Promoting measures to prevent intrusion to protect vegetation Note: Adaptation measures for sika deer include managing target species and reducing the impact on other target species.
[11] Dolly Varden	● Reducing existing stress source (fishing) ● Improving river construction to ensure the continuity between sea areas and rivers and controlling rising water temperature ● Exterminating/controlling alien species (rainbow trouts) ● Rising public awareness (strictly prohibit the release of non-native species populations)

7. Implementation system

(1) Systems for administrative authority of the Heritage site and local governments

The conservation and management of the heritage site are executed by related administrative organizations under close cooperation based on the Management Plan for the Shiretoko World Natural Heritage Site while sharing necessary information. In implementing this strategy, necessary adaptation measures shall be conducted in cooperation with relevant organizations.

(2) Systems for taking adaptive management based on scientific advice

The Management Plan for the Shiretoko World Natural Heritage Site stipulates that a Scientific Council shall be established to evaluate the natural environment in the heritage site and promote adaptive management based on scientific data. Expert committees (working groups and advisory councils) shall also be established under the Committee to advise from a scientific perspective. This strategy also utilizes appropriate advice from the Scientific Council and the expert committees to properly evaluate the risks of climate change impacts and reflect the advice in promoting specific adaptive measures and reviewing the strategy.

In addition, based on the discussions at the Scientific Council, a Long-Term Monitoring Plan has been formulated, and based on this monitoring plan, relevant administrative organizations, local governments, related organizations, and experts are working together to conduct monitoring and research to accumulate scientific knowledge. Such monitoring and research results are used to grasp the occurrence of climate change impacts quickly.

(3) Systems for cooperation among stakeholders

When considering the conservation and management of the heritage site, adjustments are expected to balance the demands of natural environment conservation with local lifestyles and industries. In implementing this strategy, while utilizing forums, such as the Shiretoko World Natural Heritage Site Regional Liaison Committee, which aims to foster practical cooperation and collaboration among relevant government agencies, local governments, and related organizations, a wide range of opinions and proposals from residents and related organizations shall be considered and the local knowledge of those who have traditionally used nature shall be utilized.

In addition, in advancing adaptive measures to climate change, collaborative relationships with local civic organizations shall be established, and based on these relationships, activities shall be developed in the entire site with active participation and cooperation of residents to build activities.