

Shiretoko Peninsula: Dynamic Interaction Between Geology, Geomorphology, and Ecology at The Interface of Terrestrial and Marine Systems

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Abstract

This chapter describes and analyzes the Shiretoko Peninsula World Heritage area as a complex and dynamic system comprising of geological, geomorphological, and ecological characteristics. Declared a national park in 1964, Shiretoko became a World Heritage Site in 2005. The area is noted as an exceptional example of the interaction between marine and terrestrial environments, as the most southerly location of drift sea ice in the Northern Hemisphere, and as an environmental system that links tiny diatoms to whales and brown bears. Several endangered and iconic species such as the Blakiston's Fish Owl and the Steller's Sea Eagle can be seen here, and the surrounding waters support many fish species and large marine mammals such as the Steller's Sea Lion, the Orca, and the Sperm Whale. However, the area has witnessed landscape fragmentation and change in ecosystem dynamics in the past due to anthropogenic impact and is also currently threatened by Global Environmental Change. This narrative evaluates Shiretoko as a combined and complex geo-ecological system, emphasizing the complexity, uncertainty, and plurality of the interaction between its different components as fundamental properties that have implications for its management as well.

Keywords

Shiretoko Peninsula • Complex system • Combined geo-ecological system • Endangered species • Landscape level process • Fragmentation

4.1 Introduction: The Shiretoko Peninsula World Natural Heritage, An Outline

The Shiretoko Peninsula is a jutting peninsular landmass stretching nearly 70 km into the Pacific Ocean (Sea of Okhotsk) in Northeast Hokkaido. Located on the Chishima (Kurile) arc, the peninsula bears a history of submarine and terrestrial volcanism that goes back nearly 9 Ma. While the base of the peninsula is covered by submarine volcanic depositions, the topography is dominated by uplift and Quaternary volcanic

processes driven by the magma produced as the Pacific Plate subducts under the continental margin (North American Plate). It has been noted that the Chishima (Kurile) arc shows episodic explosive volcanism (Prueher and Rea 2001), and while the magnitude of volcanic events is currently significantly reduced, the area still features active volcanoes such as Mt. Rausu (1661 m asl, the highest point of the peninsula) and Mt Io (1563 m asl). Rapid uplift and volcanic depositions on the narrow land (land gets narrower closer to the tip) have resulted in a steep topography that did not allow human habitation or sedentary activities (Natural Parks Foundation 2015), which in turn has contributed to the wild and diverse nature of Shiretoko persisting to this day. In addition, the area is affected by heavy snowfall from November to April, resulting in relative restriction of human activity (MOE 2012) (Fig. 4.1).

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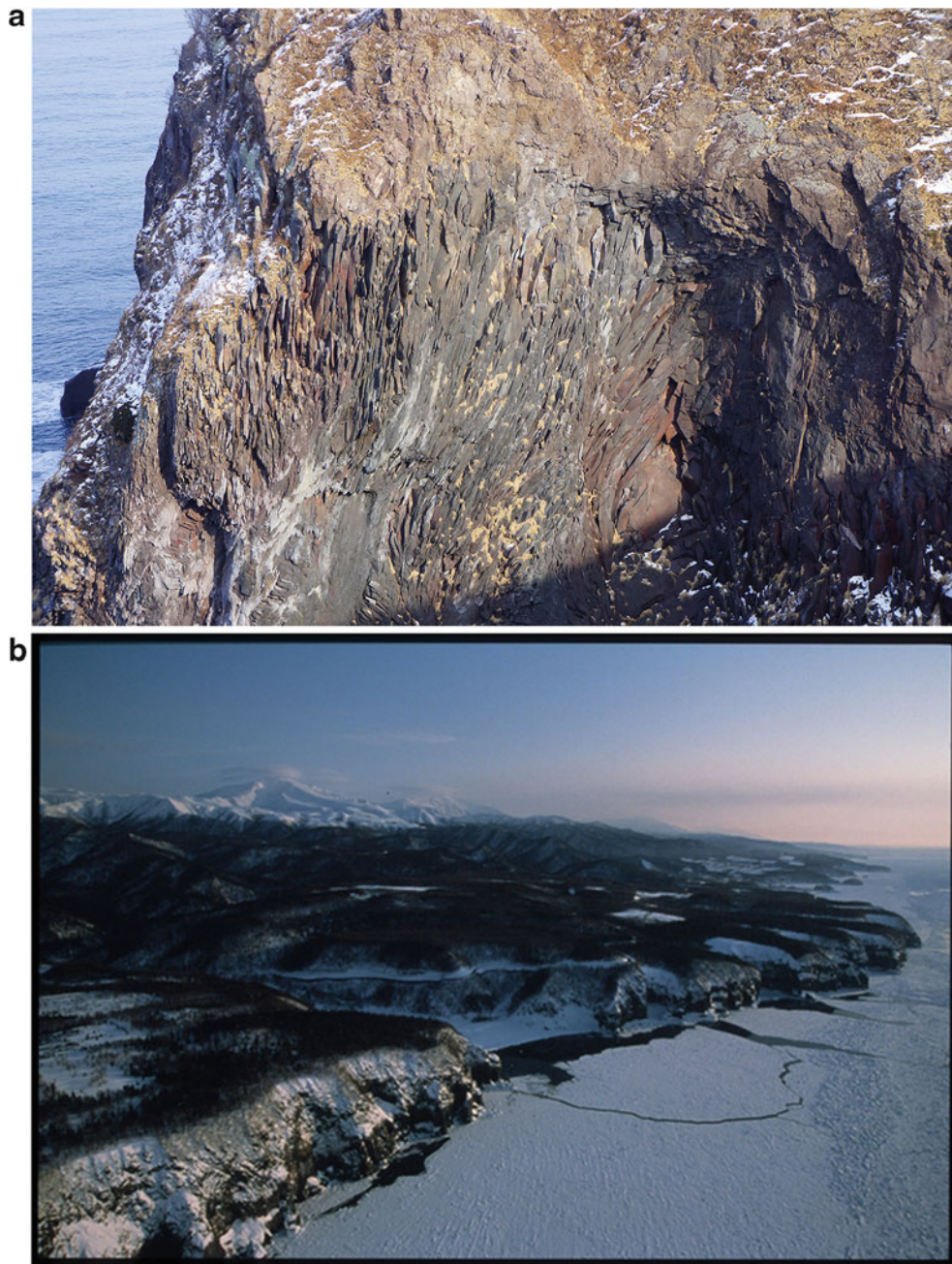


Fig. 4.2 (a) Weathered cliffs reveal mechanisms of volcanism in Shiretoko (Photo by author). (b) Iwaobetsu Rivermouth from air, showing the formation of sea ice around a peninsula dominated by

volcanic mountains. (Photo copyright Shiretoko Nature Foundation, reproduced with permission)

national park territory). The terrestrial part of the property is distributed between the Shari and Rausu Towns. The main reasons for inscribing the property and therefore the Outstanding Universal Value (OUV) are an outstanding example of interaction between terrestrial and marine ecosystems (Shiretoko is described as one of the best examples of integrated ecosystems on the WHS list); the formation of drift (sea) ice at the lowest (most southerly) latitude in the Northern Hemisphere; nutrient-rich seawater of the Sea of Okhotsk underpinning a diverse food web based on a rich

phytoplankton production that in turn supports numerous marine mammals such as cetaceans and sea lions; and endemic and endangered species such as the *Viola kitamiana*, the *K. blakistoni*, and salmonid species that spawn in the rivers (UNESCO nd). The WHS inscription raised the value of the area to a global level, and thus, evaluating the natural heritage, the challenges it faces, and possible solutions become a matter of global significance.

Apart from being a major tourist attraction of the area, drift ice is a special geomorphological feature that sustains

the Shiretoko ecosystems. The formation of the sea ice is due to a complex mechanism of marine currents, topography, and atmospheric circulation. In their seminal paper on the formation of drift ice, Ohshima et al. (2001) describe how continental drainage (input of nutrient-rich freshwater from the Amur River) creates prominent stratification at 50–100 m of mean depth that suppresses winter convection at greater depths, leading to the formation of drift ice which is then advected southward under the combined influence of sea (the East Sakhalin current) and atmospheric (northerly winds) circulation (Ibid, Hiwatari et al. 2008). Sea ice provides ideal conditions for growth of phytoplankton that forms classical algal bloom in spring when the drift ice melts. This attracts a range of zooplankton, which in turn attracts larger species of predators, sustaining a vast cycle that includes the microscopic algae and species at the top of food chains such as the Orca and the Seller Sea Lion in the waters, the Brown Bear on the land, and the Steller's Sea Eagle roaming the sky. This functioning web of geo-ecological interactions sustains the natural heritage and its more touristic components of Shiretoko. Some key species and their interaction with the system components are described below.

How the continental shelf topography and oceanic circulation combine to create the unique geo-ecological conditions of the area, and that of the broader Oyashio Large Marine Ecosystem (spanning nearly 530,000 km²), is described in detail by Sakurai (2007). The Shiretoko system therefore is a part of the larger Sea of Okhotsk and Oyashio (literally meaning “parent current” for its productivity) system (Ibid). Sakurai (2007) observes that the system could be in a state of *flux* or *regime shifts* over long timescale by demonstrating temperature fluctuations in relatively recent years and consequent change in the biomass. Fluctuations occurring over much longer time scale are described by Kawahata et al. (2003) where they describe oscillations in the southern Sea of Okhotsk in the Holocene. As the system provides considerable benefits to local residents, the economic repercussion of such change is also keenly felt.

This chapter focuses particularly on a “systemic appraisal” of the Shiretoko Peninsula, albeit from a mainly terrestrial point of view. The terrestrial landmass of the World Heritage Area provides an excellent body of evidence of how marine and terrestrial ecosystems interact and how, at the species and habitat levels, anthropogenic change impacts the system functions or exacerbates the influences of Global Environmental Change (GEC). The chapter analyzes Shiretoko as a complex adaptive and combined geo-ecological system and explores the stress on various system components. The observations are deemed significant for the conservation and management of this dynamic and complex natural heritage.

4.2 Data Collection and Analysis Method

This chapter is based on a review of key literature and empirical data gathered during two field trips in the territory. The field trips were conducted in order to confirm leads gained from the literature review and further explore angles that were deemed significant. During the fieldwork, local stakeholders such as National Park officials, visitor center officials, tourism operators and guides, and specialists (scientists) working on different facets of the Shiretoko ecosystem were interviewed. Identification of current threats faced by the property was done based on two important compilations brought out by the Yomiuri Shimbun (2006) and Shiretoko Museum (2010), which provide an exhaustive review of environmental issues.

As this chapter provides an explanation of the *characteristics* of the Shiretoko system, it ventures to do so from an angle of the *qualitative aspects* of this dynamic system. While complex adaptive systems and complex ecological systems have been documented and analyzed from quantitative points of view that typically focus on the interaction(s) between a limited number of variables, that approach needs to be complemented with analysis of the inherent complexity of these systems that are fundamentally irreducible, with appraisals that are synthetic, and with appreciation of the fundamental uncertainty and plurality of knowledge itself (Stirling 2010). Most available analyses on complex systems such as Shiretoko, to my knowledge, are based on reductive knowledge that seeks to clarify questions on uncertainty by showing clear causal relations. However, as today's increasingly complex and *wicked* problems show, such reductive analysis is not enough for addressing complex environmental problems. Thus, the analysis provided here consciously attempts to look at the holistic picture by focusing on conduits of connectivity in the system and aims to draw *connections* across categories because, in reality, the value of this natural heritage is based on a yet poorly understood complex web of feedbacks between its different components. The lessons from this chapter are revisited in the Synthesis chapter to draw broad conclusions about multifaceted conservation and governance of natural heritage.

4.3 Landscape Level and Ecosystem Level Characteristics of Shiretoko

The Shiretoko Peninsula, as described above, is characterized by volcanism and uplift that resulted in a steep terrain dominated by volcanic mountains. There are 871 species of plants in the area out of which 97 are endangered, including species such as the *V. kitamiana* and *Carex stylosa* C.A. Mey that are endemic to this region

(Ishikawa 2010). A good description of the zonation of vegetation can be seen in the vicinity of the 1661 m Rausudake, where 0–500 m elevation areas feature species adapted to coastal cliffs and mixed forests of conifers and broadleaf species; the 500–1000 m zone is marked by species such as the *Betula ermanii* and *Alnus Maximowiczii* and the region above 1000 m typified by mixed patches of *B. ermanii* and *Pinus pumila*, and *P. pumila* colonies (MOE 2012). On windswept mountainsides that are unsuitable even to the hardy *P. pumila*, uniquely adapted shrub colonies persist, and snow-patch communities are observed in locations that are covered by snow for most of the year. *V. kitamiana*—often cited as a plant symbolizing the unique ecological conditions of Shiretoko—is suited particularly to rocky high-altitude locations. Thus, at every level of the landscape, a strong feedback between the prevailing geomorphic conditions and plant adaptation is observed (Fig. 4.3).

The peninsula has many drainage channels due to heavy snowfall, but rivers are short and rapid and they flow with a steep gradient and high bedload. Nearly 90 moderate and small streams cascade down from highlands to the sea in Shiretoko (Fig. 4.4), sometimes plunging into the sea as waterfalls. Under natural conditions, such rivers perform the two vital tasks of actively eroding and shaping the landscape (carrying the mountains to the sea) and supporting a high natural variation of species some of which straddle marine and terrestrial ecosystems (such as fish species that swim upriver to spawn and swim downriver to the sea after hatching). The rivers of Shiretoko are known to be the southernmost limit for the sea run of Dolly Varden as well as a variety of Pacific salmonids (Chum, pink, masu Salmon, and White-spotted Charr are some notable species) (UNESCO nd). These species support mammals such as the Brown Bear (*U. arctos*) and endangered avian species such as the Blakiston's Fish Owl (*K. blakistoni*). While the former's hibernation cycle is closely associated with the migration of the salmonids, the latter is nearly completely reliant on rivers and valley forest compositions for habitat. In addition, biomass derived from the fish that end their life cycle in the upstream and from the excreta of their predators produce vital nutrients for the forests which in turn support both predator and prey species. Currently, rivers in the peninsula are significantly affected by anthropogenic impact: dams, check weirs, artificial embankments, and channel engineering hamper the flow of material along the channels and the functioning of the river corridors. The Yomiuri Shimibun (2006) compilation mentions how the Iwaobetsu River drastically changed in the 1960s after check weirs prevented any significant upstream migration of the masu salmon species *Oncorhynchus masou masou*.

Shiretoko is known for its Brown Bears, a species that is found all over Hokkaido (Fig. 4.5). The omnivorous Brown

Bear feeds on an extremely broad range of diet, and although 90% of its diet is based on plants, it can occasionally be seen scavenging carcasses of large animals such as the *Cervus nippon yesoensis* (Ezoshika Deer) and cetacean species. The estimated range of activity of a Shiretoko individual is confined within 15 km² (Natural Parks Foundation 2015). While this is a fraction of the more extensively roaming habits of its North American counterparts, this characteristic is quite possibly the result of adaptation to a habitat shaped by geomorphological conditions and aided by the ample food source provided by those conditions.

The Blakiston's Fish Owl (*K. blakistoni*), considered to be the largest owl species in the world, is another iconic species. Large individuals can attain a body length of nearly 70 cm and a wingspan of nearly 2 m. The Shiretoko area is considered as the habitat for nearly half of all Blakiston's Fish Owl population of Hokkaido (Takenaka 2010). Currently, the species is adversely affected by a lack of large trees (of over 1 m diameter at breast height) and the decline of fish in the rivers (due to damming and other engineering inputs in the river valleys) (Ibid), but a moderate increase of numbers has been reported, indicating success of the fish owl conservation program (Fig. 4.5).

Finally, Shiretoko is an important place for migratory birds and avian species that are adapted to the terrestrial–marine interface. Every year in spring, the Short-tailed shearwater (*Puffinus tenuirostris*) arrives in large flocks from the Southern Hemisphere, crossing vast distances to feed on the zooplankton that thrive on the phytoplankton bloom. The sight of these small birds diving into the waves is considered symbolic of spring in Shiretoko. In the winter, one of the largest species of eagles, the Steller's Sea Eagle (*Haliaeetus pelagicus*) arrives in search for food in the relatively warmer Shiretoko from its reproductive habitat in the Kamchatka region (Fig. 4.6). Currently, this majestic species is considered vulnerable in the IUCN list of threatened species. The White-tailed Eagle (*Haliaeetus albicilla*) is another familiar bird of prey. The Spectacled Guillemot (*Cepphus carbo*) finds its reproductive habitat in the rocky ledges that define the coastline of the peninsula (MOE 2012).

The description above is a bare outline of some of the most iconic species found and observed in the Shiretoko World Heritage area, mainly pertaining to the terrestrial environment. The marine environment around the peninsula supports many more iconic and endangered species such as the Sperm Whale (*Physeter macrocephalus*) Orca (*O. orca*), Steller's Sea Lion (*Eumetopias jubatus*), Dall's Porpoise (*Phocoenoides dalli*), Spotted Seal (*Phoca largha*), and Ribbon Seal (*Phoca fasciata*)—many of these species are inadequately studied to date, implying much uncertainty remains on their habitat conditions, their interactions with a changing environment, and their population dynamics.

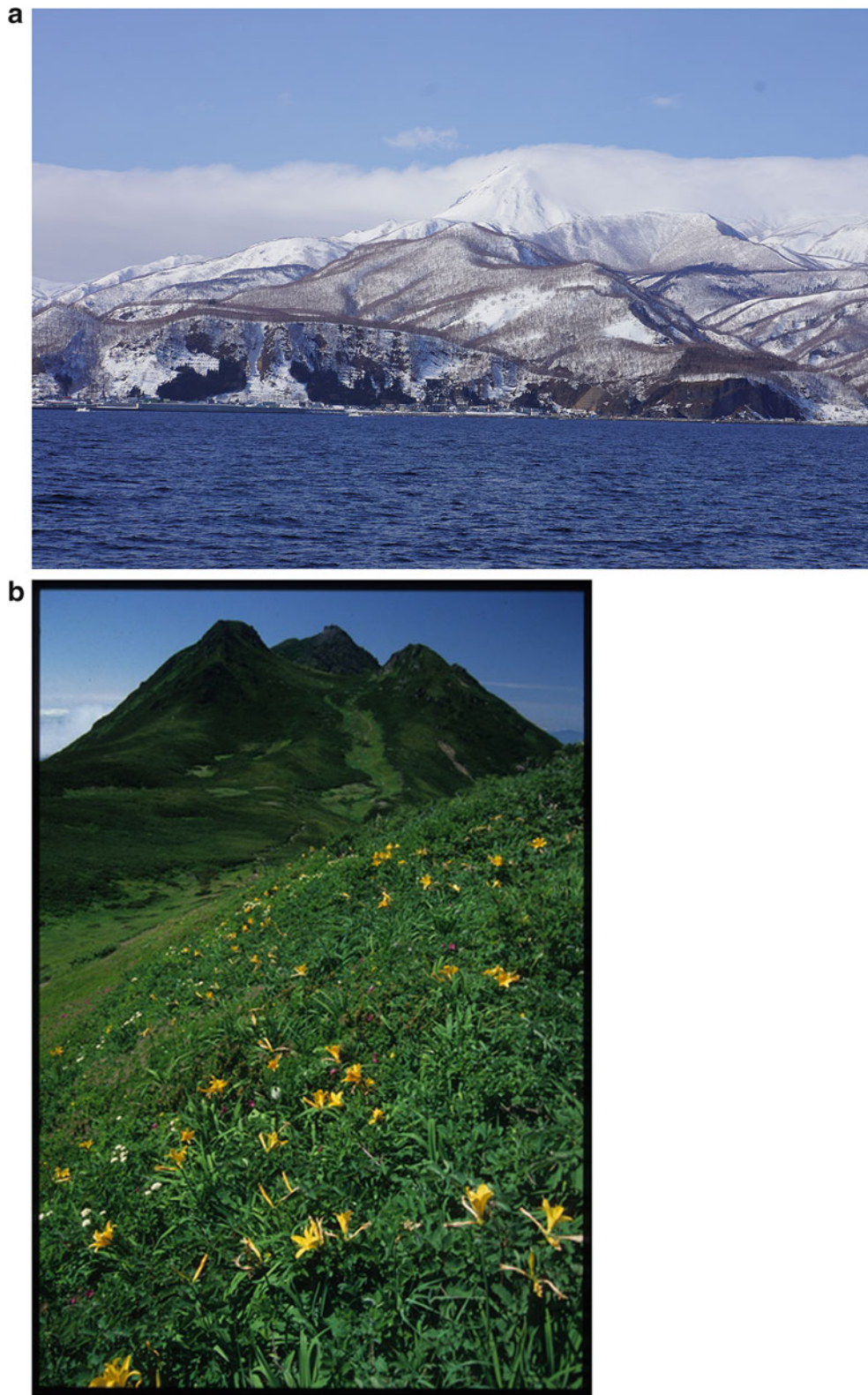


Fig. 4.3 (a) Looking toward Mt. Rausu from a wintry day reveals snowcover on the highlands (Photo by author). (b) *Hemerocallis dumortieri* (C. Morren) var. *esculenta* (Koidz.) Kitam. ex

M. Matsuoka and *M. Hotta* near Mt Rausu. Mountains of the peninsula are known for rich alpine flowers. (Photo copyright Shiretoko Nature Foundation, reproduced with permission)



Fig. 4.4 Short and rapid rivers coming out of mountains are a major landscape feature of this area. However, many river courses are artificially altered, hampering movement of species and biomass. (Photo by author)

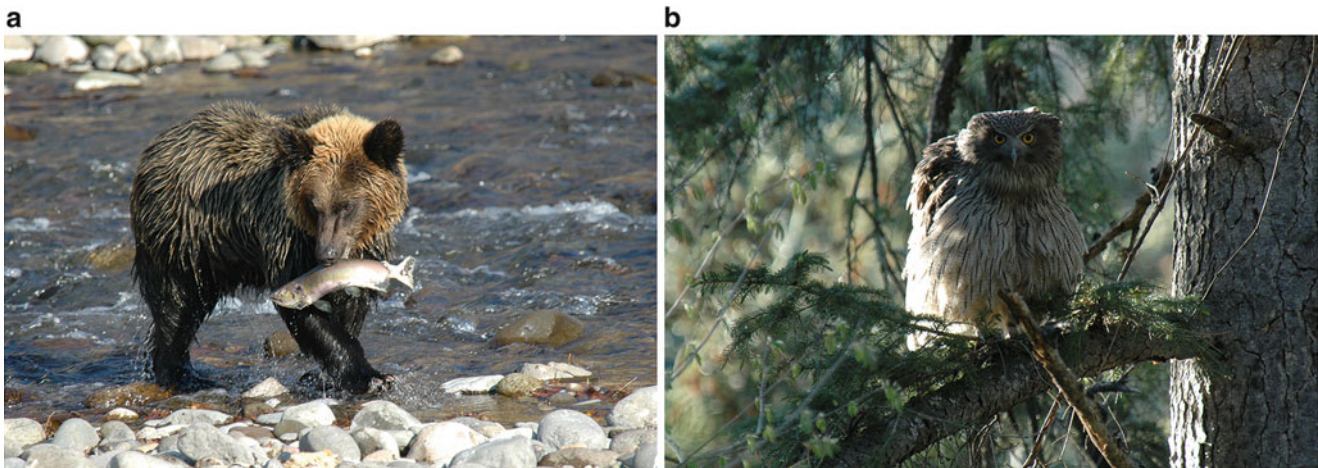


Fig. 4.5 (a) A Brown Bear (*U. arctos*) grabbing a pink salmon (Photo by Takeshi Takenaka). (b) Blakiston's fish owl (*K. blakistoni*) is the largest owl species of the world (Photo by Takeshi Takenaka)

4.4 Tourism Activities in Shiretoko World Heritage Area

Shiretoko Peninsula and the waters off it count as a major ecotourism and wildlife-watching destination in Japan. Nearly, 2.5 million tourists visit the peninsula every year (Natural Parks Foundation 2015). In the two administrative units of Shari Town and Rausu Town, tourism foci are contrasting: while in Shari most tourist activities are centered around terrestrial attractions, the fishing town of Rausu

offers tourism packages—especially those in the winter—with a marine environment-related theme.

In Shari, the Five Lakes of Shiretoko (Shiretoko Go-ko) form a notable tourist attraction. The area offers a scenic view of the volcanic mountains, a pleasant walking experience in the forests and around the five lakes that formed due to large-scale landslide, transport, and deposition of volcanic products. There are several viewpoints to observe and understand the major land features of the peninsula, and there is a wooden walkway that can be used from spring to autumn. This walkway, completed in 2010, is an example of good



Fig. 4.6 A Steller's Sea Eagle (*H. pelagicus*) (Photo by author)

practice and innovative engineering. The walkway is barrier free and is fenced with an electric hedge that allows visitors to walk freely in a territory that is also a natural habitat of brown bears. Electricity for fence protection is generated by solar panels at the parking area (Natural Parks Foundation 2015). While constructing the structure, care was taken not to cut down any tree in the location, a series of poles are used to hold the entire structure above ground (Ibid). While it cannot be used in the winter, the walkway almost certainly contributes to minimizing the effect of trampling of the vegetation during peak seasons. In winter, snowshoe tours are organized in the area, and these tours have gained popularity over the years. Visitors can enjoy the view of the frozen Furepe Waterfall, and wildlife such as Ezoshika Deer and Red Fox (*Vulpes vulpes schrencki*) walking on the snow covered landscape, and on clear days, these experiences can be complemented by a panorama of snowy mountains. Crossing the peninsula via the trans-Shiretoko road is another popular sightseeing activity from late spring to autumn. In late spring and early summer, “walls” of snow are seen along the roadside. The road allows visitors to begin their trip at Shari and end at Rausu or do it the other way around. The road is closed in the winter due to heavy snow. The Shari area also has a number of scenic waterfalls (Fig. 4.7).

Sea kayaking is popular along the Shari coast. As most of the core area is out of bounds for tourists, kayaking allows visitors to get a close view of the coastal topography and forests. Kayaking packages in nearshore areas are available

in winter as well. Alternatively visitors can enjoy coastal landscape and wildlife from sightseeing boats.

In Rausu, the focus of tourism is mainly on marine wildlife. All year round, cruise packages that offer glimpses of cetaceans, other large marine mammals such as seals and sea lions, and migratory birds (mainly in winter) are available. Some cruise packages can be combined with staying in the facilities operated by the same company. In the winter, cruise tours are particularly popular among birdwatchers aiming to photograph rare species such as the Steller's Sea Eagle. A lodging facility named the “Fish Owl Observatory” is also popular since it offers chance to see and photograph the elusive Blakiston's Fish Owl. Enjoying hot springs (including some secluded ones) and local seafood delicacies and hiking to the Rausu Lake are some other notable tourism activities in this area.

In addition, hiking the volcanoes of Shiretoko is popular in summer and autumn. The 1661 m tall Rausudake can be hiked from both Shari and Rausu Towns. Hikers walk through diverse natural forests and wildlife in the lower part of the hiking course. The upper section of the trail offers chance to see a number of alpine flower species, including the rare *V. kitaminana* [which can be seen in the vicinity of Mt. Iozan (1562 m)]. The 1547 m Sharidake is another popular hiking destination (the trailhead is located in the nearby Kiyosato Town). While none of the hikes require advanced mountaineering skills and nor are they particularly physically demanding, visitors must be aware that there is no toilet facility beyond the trailhead. Visitors should carry

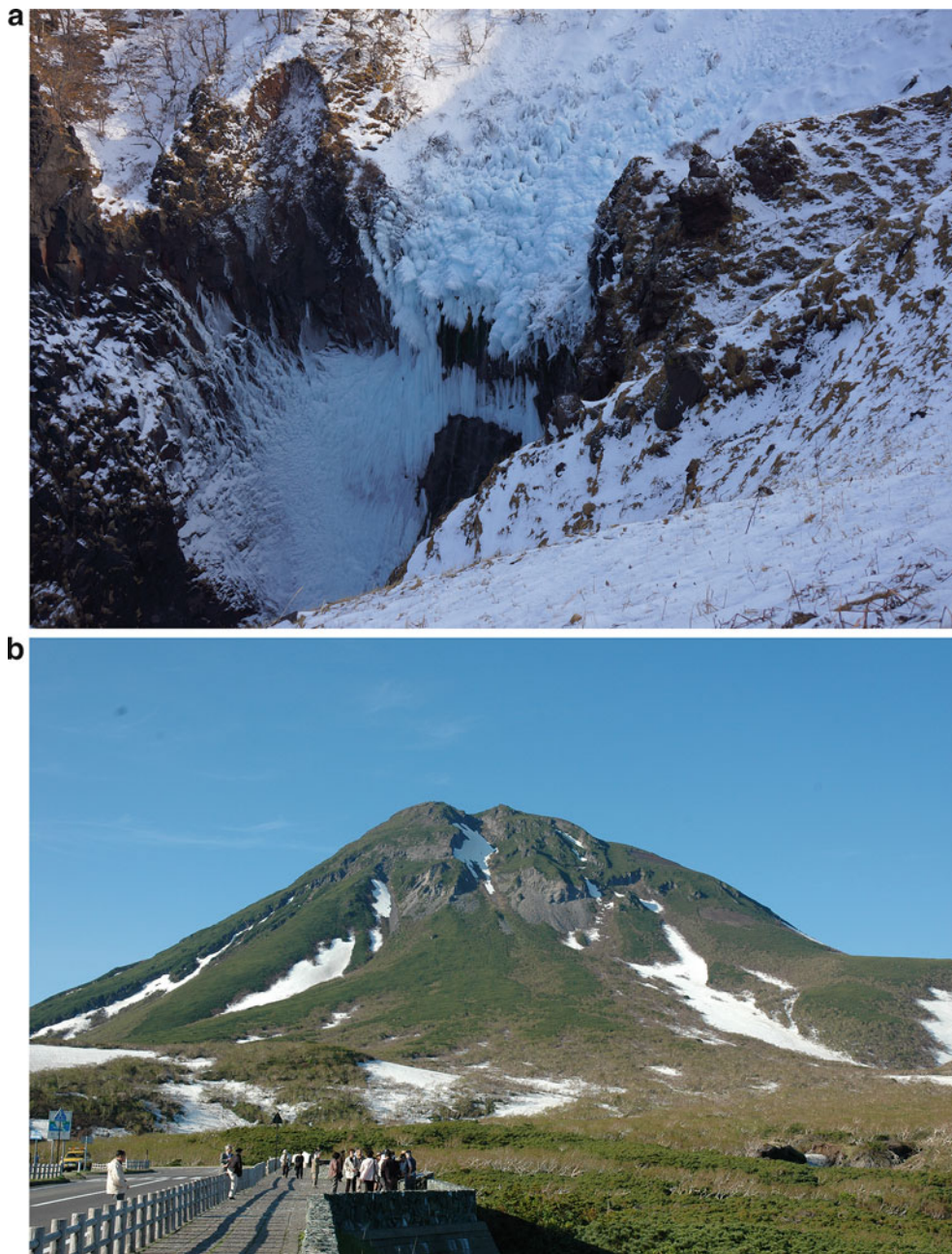


Fig. 4.7 (a) The frozen Furepe waterfall is a major tourist attraction in the winter (Photo by author). (b) Mt. Rausu in summer (Photo by Takeshi Takenaka)

portable toilets and should refrain from relieving themselves in the wild or discarding tissue papers in order to protect the sensitive mountain ecosystem.

As a World Heritage area, Shiretoko possesses excellent visitor centers at multiple locations with knowledgeable staff. The World Heritage Center of Shari (Utoro Visitor Center of the Shiretoko National Park) is conveniently located at the road station *Shirietoku* at the gateway of the Utoro area (where most of the lodging facilities are concentrated). The center features an excellent and

interactive exhibition, committed staff, a variety of pamphlets and information brochures, and a small library, though most documents are available in Japanese only. The Shiretoko Nature Center, managed by the Shiretoko Nature Foundation, serves as the second visitor center of Shari with its knowledgeable staff and exhibits. It is also a hub of wildlife management experts. This facility is open all year round (excepting the new year break). The World Heritage and National Park Visitor Center of Rausu is another excellent facility to learn about the nature of Shiretoko: the visitor

center has exhibits of an Orca skeleton and stuffed specimens of a number of other important animal and bird species in addition to thematic panels that guide the visitor to different characteristics (geology, geomorphology, ecology, and landscape) of the area (Fig. 4.8).

As the description above shows, the Shiretoko area has strong credentials as a World Heritage as it offers good quality nature experience packages and adequate facilities to explain about the natural heritage of the area. Adequate management expertise is also available. Due to these factors, the area typically elicits a comparatively high degree of satisfaction among its visitors and a significant ratio of visitors express their desire to visit the area again; a fuller account of those aspects is available in Romao et al. (2014). However, there are some challenges associated with tourism as well, and a brief description of those challenges and their implications for natural heritage management is provided below and some points are followed up further in the analysis.

A major problem is the conflict of wildlife and tourists. There is an apparent increase of brown bears venturing close to tourists, possibly lured by scraps of food thrown by tourists (Shiretoko Nature Foundation nd), and there is a consequent pressure to chase off or even shoot and kill bears in some cases. The Shiretoko Nature Foundation is currently trying to educate tourists to behave responsibly and stop feeding wildlife (Ibid), noting that the responsibility to

avoid accidents fall on the visitors. It is difficult to gauge to what extent the rising popularity of the destination creates more pressure on managers to take proactive measures (in this case disturbing the bear in its natural habitat), but the issue deserves continued attention.

The feeding problem is arguably even more pronounced on the avian species. Particularly in the Rausu area, wildlife cruise boats throw fish to attract birds of prey such as eagles. Shiraki (2010) has observed that the problem has become serious to the extent that most of the birds visible to the birdwatchers are dependent on this artificial feeding, which is subject to tourist demand of the resource (birds in this case). This problem is further discussed below (Fig. 4.9).

Additionally, there are problems such as the lack of multilingual communication ability of guides (resulting in their relative inability to communicate with foreign tourists), discarding of garbage in sensitive mountain environments, lack of visitor knowledge about vulnerable vegetation (particularly in the high-altitude areas), and a perceived lack of interest among tour operators to interact with scientists and conservation experts (Takenaka 2010; personal correspondence). Tour operators could also incorporate visits to the excellent visitor center facilities into their tour packages and educate their clients about the natural environment. But perhaps the most serious issue is the lack of systematic tourism impact monitoring by tourism service providers.



Fig. 4.8 The Shiretoko World Heritage Visitor Center in Rausu has excellent exhibits such as a skeleton of an Orca and stuffed specimens (photo by author)



Fig. 4.9 Birds flocking to a remaining ice floe in search of food thrown from sightseeing boats. Such artificial feeding has repercussions for the natural ecosystem (photo by author)

4.5 Heritage Management Nature Conservation Efforts at Shiretoko: An Overview

The Shiretoko Peninsula World Heritage site is managed by a diversity of stakeholders including the national ministries such as the Ministry of the Environment (MOE) and the Ministry of Agriculture, Forestry and Fisheries (MAFF), local administrative units (Shari and Rausu Towns), the Shiretoko Nature Foundation, and fishery cooperatives. The decision-making structure is supported by a scientific council comprising of natural resource management specialists. Shiretoko is evaluated as a good example of co-management with local stakeholders; Makino et al. (2009) and Sakurai (2010) outline a marine resource management plan which they define as the “Shiretoko Approach.” The plan entails autonomy of the local fisherfolk, selective fishing, voluntary restraint measures including limitation of fishing vehicle number and type, and fishing zones and seasons, and it is aided by scientific advice when applicable. The authors also point out that the local fisherfolk possess rich traditional knowledge of the marine environment, which can be utilized for scientific decision-making. However, it is somewhat unclear how “adaptive” the structure is, as Makino et al. (2009) observe that it does not specify numerical targets at species level, nor is it clear

to what extent the measures taken by the fisheries are in coordination with other potential stakeholders such as river management specialists (due to the fact that rivers in the peninsula are vital conduits linking terrestrial and marine ecosystems) and wildlife conservation experts.

As for the terrestrial environment, a major turning point of landscape level conservation came in 1977 when the “100 Square Meter Movement” for replanting forests began. The initial goal was to protect areas that were affected by deforestation from construction and development pressure, by reforesting them (Natural Parks Foundation 2015; Shiretoko 100 Square-Meter Movement Trust nd). The main current goal of the project is to protect forests and help increase old-growth forest cover; and the movement breaks this task down in terms of 5-year (short-term), 20-year (mid-term), and 100-year (long-term) timescale goals (Shiretoko 100 - Square-Meter Movement Trust nd). The projects are aided by donations from individuals, groups, and corporations, and the reforestation activities are supported by forestry and forest ecology experts. Expert knowledge is an important facet of this movement: for example, while *Larix kaempferi* is used as a pioneer species for reforestation, plans are set to reduce the total area covered by this species under longer term scenarios.

A related conservation program is the habitat regeneration and reproduction aid project for the Blakiston’s Fish Owl in Hokkaido. This program started in 1984 (Natural

Parks Foundation 2015), and two key focus areas of the project are provision of artificial nests for the endangered species in the light of the fact that large trees suited for nesting have declined and measures to prevent electrocution deaths by erecting protective fencing as such accidents are a main cause of untimely death of grown individuals (Takenaka 2010). These projects are carried out by dedicated scientists and voluntary participants and are supported by national level nature conservation programs and private nature conservation initiatives (Ibid; Takenaka 2016 personal interview with author). In the initial stage, the main aim was to protect the fish owl at an individual level. In the past two decades this effort has shown signs of steady success, and the focus of conservation activities is now on both protection of individuals and their breeding environment and on eventually regenerating a diverse natural forest cover that allows the species to exist without threat (Takenaka 2010). This point is followed up in the next section.

The Shiretoko Nature Foundation, established in 1988, is the most prominent stakeholder of wildlife management and forest ecosystem conservation in the area. The organization advocates the need to conserve the integrity of wilderness in the area, noting that the Shiretoko Peninsula is a rare location in the Japanese Islands where large predators such as bears can roam freely across the landscape (their natural habitat), and this wild nature is of fundamental value for this region (Shiretoko Nature Foundation nd). As of 2015, the Shiretoko Nature Foundation undertook 64 projects of conservation and wildlife management with a total budget of more than 338 Million JPY (Ibid).

Thus, the Shiretoko area possesses several significant nature conservation examples, the significance of which extend beyond the local dynamics. Whether it is about protecting keystone species, regenerating forests, or integrating resource users such as fisherfolk into conservation and environmental management, the lessons from these ongoing programs will undoubtedly be valuable for natural heritage management at the global level.

Heritage in a Nutshell: Shiretoko Peninsula

Location: Shari and Rausu Towns in NE Hokkaido

Type of Heritage: Composite Geo-ecological (terrestrial and marine ecosystems of exceptional diversity and value underpinned by geological and geomorphic processes), coastal landforms, volcanic landforms, and

unique geomorphological conditions such as the drift (sea) ice formation.

The property is evaluated highly for the connectivity of terrestrial and marine ecosystems that link tiny diatoms to whales (in the sea) and to the Brown Bear on the land. Shiretoko is habitat for a large number of endangered species of plants and animals such as the *Viola kitamiana* plant and the Blakiston's Fish Owl (the largest owl species in the world). The Steller's Sea Eagle (the largest eagle species in the world), the White-tailed Eagle, and the Spectacled Guillemot are notable bird species. The seas around the peninsula support a large variety of fish and large marine mammals including the Sperm Whale, the Orca, the Steller's Sea Lion, and several types of seals. The rivers are known for supporting several salmonid species.

Drift ice formation is both visually spectacular and ecologically significant, as it drives the process of algal blooms, which in turn sustains the higher order components of ecosystems.

Shiretoko is a place where the connectivity between geological, geomorphological, and ecological systems is conspicuous. The Shiretoko National Park highlights the intrinsic value of "wild nature" and commits to protect the natural environment. Land formation is dominated by uplift and volcanism, and the many rivers act as potent erosion agents. However, over the years drift ice has thinned, leading to the possibility that the system might undergo significant change in the near future.

What to see: The area offers excellent ecotourism and wildlife experience packages all year round. Visiting the "Five Lakes of Shiretoko" is highly popular, as are hiking to the Rausu Lake and hiking up the mountains. Off the coast, activities range from diving, sea kayaking, walking on drift ice (in winter), and wildlife viewing cruise packages. More details are available in Sect. 4 of this chapter. The World Heritage Visitor Centers of Shari and Rausu are also excellent facilities where visitors can learn about the natural heritage of the area.

Useful websites:

MOE Shiretoko Peninsula <https://www.env.go.jp/en/nature/nps/park/shiretoko/index.html>

Shiretoko Nature Foundation <http://www.shiretoko.or.jp/en/>

4.6 Challenges for Managing the Natural Heritage: Landscape Level Fragmentation, Anthropogenic Pressure, and Global Environmental Change

Although Shiretoko is often perceived as a “pristine” natural environment, the area witnessed several types of anthropogenic impact. This section provides an outline of some key issues and challenges.

In their authoritative study on forest fragmentation in Hokkaido, Shoyama and Braimoh (2011) note that since 1869 (when land conversion for development projects began in Hokkaido), forests in Hokkaido have declined drastically both in quantity and quality; old-growth forests spanning 4360 km² were converted to farmland (22), and citing municipal government data, the authors note that for particular areas such as the Horobetsu-Iwaobetsu plateau, forest loss became drastic in the twentieth century—showing a strong positive correlation with rapid cultivation and land conversion (*kaitaku* in Japanese) that took place between 1945 and 1966, but the trend was somewhat reversed due to reforestation from 1978 (Ibid: 23). Their findings indicate that out of the mixed conifer-broadleaf forests that characterize low elevation sections of the peninsula, broadleaved species showed a consistent net decrease from 1947 to 2004 (time of data collection). A further important insight from the study reveals that natural forest succession occurred in the areas which were abandoned after a phase of deforestation, and the sequence of dwarf bamboo brush pioneering the forestscape, followed by broadleaf species, to the eventual regeneration of broadleaf-conifer mixed canopy, was observed. However, despite natural regeneration and reforestation programs, forests did not recover their pre-cultivation integrity; the mean patch size in 2004 was only 24% of the pre-cultivation mean patch size (28). Thus, there is strong evidence that agriculture and pastureland conversion in the area was a major cause of primary forest fragmentation in this area in the twentieth century and that despite natural succession and planned reforestation, the forest landscape is still significantly fragmented and its ecosystem connectivity compromised to a large extent.

Fragmentation at the landscape level is also indicated from the extensive damming and other forms of engineering that waterways of the peninsula have been subjected to. There are an estimated 247 small and moderate sized dams and flood or silt control structures on the rivers in this area (Takahashi 1999; Morita and Yokota 2002). The Yomiuri Shimbun (2006) compilation also notes that due to extensive check weir construction on the waterways, the land and sea connectivity in the ecosystems was damaged and the effect is particularly serious on the fish species that

spend most of their life cycle in the rivers such as the Dolly Varden (*Salvelinus malma*) (Fig. 4.10). The species is adversely affected and is currently threatened. It is worth noting that healthy river fish stocks are vital for keystone species such as the Blakiston’s Fish Owl, which are forced to search for food across larger distance when rivers go devoid of fish and can become susceptible to accidental deaths. Thus, from the viewpoint of long-term conservation of an iconic species like the fish owl, both regeneration of large patch size of naturally diverse forests and restoration of nutrient and species conduits that sustain those forests (such as natural river basin mechanisms) are required.

Among the changes occurring spontaneously (without direct anthropogenic impact) to the ecosystems is the overgrazing by the Ezoshika Deer. The Ezoshika spread to Shiretoko in the 1970s from the nearby Akan area (Uno 2010) and subsequently their numbers multiplied rapidly. Although there were natural “breaks” in the form of starvation deaths in the winter (such as a starvation-related decrease of the total population by over 60% in 1999), numbers have recovered quickly to the extent that overgrazing by these animals has become a threat. Particularly worrying is the effect on overgrazing on the Shiretoko Cape area that is home to many endangered and endemic plant colonies; it was reported that colonies of *Empetrum nigrum* var. *japonicum*, an alpine plant that adapted to the post-glacial environment and has an ecological history of nearly 10,000 years, were decimated by overgrazing at the cape area (Yomiuri Shimbun 2006). Other endangered or sensitive species such as the *Aconitum misaoanum* f. *album* and *V. kitamiana* could be affected as well (Uno 2010). Currently, the MOE and the Shiretoko Nature Foundation are conducting planned reduction of Ezoshika numbers by selective culling to control overgrazing damage.

Along with such fragmentation of landscapes, pressure brought by urbanized lifestyle and tourist demands on the



Fig. 4.10 A Dolly Varden (*S. malma*); this species is a preferred food of *K. blakistoni*, but human interference in river regimes has resulted in its swift decline in local streams (Photo by Takeshi Takenaka)

natural ecosystem is also significant. During field research, I witnessed the artificial feeding of sea eagles in Rausu, an issue that has potential ramifications at the species and ecosystem levels. Shiraki (2010) analyzed how the sudden and brief increase of Alaska Walleye Pollock (*Theragra chalcogramma*) in the Rausu area attracted large flocks of Steller's Sea Eagle and White-tailed Eagle between the mid-1980s and early 1990s, with an estimated 2500 individuals belonging to these species feeding from fishing remnants. Estimates indicate that nearly 90% of the Steller's Sea Eagle population migrated to Shiretoko in winter at that point (Yomiuri Shimbun 2006). Walleye Pollock fishing proved unsustainable due to the rapid decline of the species in the 1990s, and eagle numbers started to decline as well. However, this decline was somewhat reversed from the late 1990s, when fishing vehicles started to throw fish in order to attract eagles (Ibid) which became a tourist attraction (supplanting Walleye Pollock fishing as income source in some cases). This practice continues to this day. Shiraki's data collected in 2007 reveal that 80–90% of the eagles were concentrated on the artificial breakwaters near the port, clearly showing their dependence on artificial feeding. According to Shiraki, prominent problems that arise in the process are (1) unnatural frequenting of human inhabited areas by eagles leading to increased chance of accidental deaths, (2) vulnerability to pathogens due to unnatural density of birds in small areas, (3) possible change of feeding patterns due to change in tourist demand scenario, and (4) the possibility that species such as the *Larus schistisagus* and *Corvus macrorhynchos* that actually take a large share of the thrown food to multiply and affect the ecosystem (2010: 57–59). It is also documented that a number of Steller's Sea Eagles were victims to lead poisoning as they were attracted to deer carcasses left out by hunters in the late 1980s (Yomiuri Shimbun 2006). Although it can be argued that bird watching currently provides an environment-friendly method of local income generation, visitor pressure amounting to “loving nature to death” (Hall 2015) is a common problem and needs to be addressed by educating visitors about the value of wildlife in its natural habitat. The problem is exacerbated by the aforementioned fragmentation of rivers; with the rivers not able to provide adequate feeding opportunities (fish), sea eagles that migrate to Shiretoko are even more attracted to artificial feeding. This case shows the problem of how positive valuation of wildlife as a tourism resource (or commodity for indirect consumption through activities such as bird watching) can possibly degrade the resilience of natural ecosystems and affect species behavior and adaptation, thereby initiating further change in the role of species in its food web.

Human–wildlife conflicts are probably most conspicuous in case of large marine mammals. From the documentation done by Yomiuri Shimbun (2006), two cases stand out:

(1) the culling of the Orca (*O. orca*) and (2) the culling of the Steller's Sea Lion (*E. jubatus*) by fisherfolk. While the Orca was culled in large numbers in the postwar period leading to a speculation that the local population around Shiretoko had become extinct at one point (the species has currently recovered and is a major tourist attraction), the Steller's Sea Lion is culled for causing harm to the local fish catch. A particular problem surrounding marine species is that their ecosystems are poorly understood in comparison to terrestrial ecosystems, implying that it is particularly difficult to understand the nature of anthropogenic pressure on them.

Of late, the most conspicuous change, at least at the level of local perception, has taken place in the dynamics of drift ice formation. Nearly, everyone who was interviewed during the field research phase replied that drift ice characteristics have changed over the past few years, including change in the timing of onset, (possible reduction of) volume, drifting pattern, and abrupt breakup. Such changes appear to persist despite year-to-year variations of the drift ice conditions (i.e., the footprint of Global Environmental Change (GEC) was identifiable above the “noise” of natural variation). Such local opinions tally well with the more extensive field data collected by the Yomiuri Shimbun (2006), where it is indicated that till the 1990s, the drift ice was so thick that boats and trawlers were confined within the ports in the height of winter. A key indicator is the start of the sightseeing trips on the *Aurora*, a 490-ton icebreaker. The very fact that this ship started operating in the 1990s was a testimony to the thinning of drift ice, as small icebreakers would not have been able to navigate thick drift ice that prevailed before the 1990s. Experienced sailors spoke of how the thinning trend continued into this century, and in the words of one diver, the ice has become increasingly “softer” in recent years. While the effect of this change on marine and terrestrial ecosystems cannot be adequately clarified due to deficiency of data, the effects are likely to be far-reaching considering the multiple and complex feedback loops between geological formations, geomorphological processes, and ecological characteristics that together form the dynamic natural heritage of Shiretoko (Figs. 4.11 and 4.12).

4.7 A Systemic Appraisal as a Pathway for Better Management?

This study highlighted the challenge of comprehending a dynamic natural heritage and the pathways of recent changes from the case of Shiretoko Peninsula. Apart from the effects of GEC, a number of drivers of change originate locally, or at least, could be addressed locally in order to achieve more effective and holistic governance of this heritage. A systems appraisal is thought to be useful toward this end.



Fig. 4.11 (a) Drift ice around the Shari coast (Photo by author). (b) Drift ice in the sea off the Shari coast (Photo by author)

The natural heritage of Shiretoko is an evolving system that is supported by geological processes such as volcanism and uplift, geomorphological processes such as erosion by multiple agents (water and ice in this particular case are most important), and transport of material; together these processes sustain the ecosystems of the area. It was noted how the Shiretoko system is influenced by larger geomorphological processes in action such as the Amur River's drainage, the dynamics of atmospheric and oceanic circulation, and changing temperature. It is important to appreciate the facts

that the system involves many variables, that their interaction pathways are poorly defined or even chaotic, and that a large degree of uncertainty will always prevail over quantified interrelationship or knowledge describing this system. Such uncertainty is not something to be frustrated about; it is evidence that the system is complex enough to generate new discoveries. In addition, the existence of "uncertainties" must be perceived for their worth at the planning and management levels, which implies that any new program or activity should be thoroughly checked



Fig. 4.12 Drift ice breaking apart. Over the years drift ice has thinned, raising questions about continuity of vital ecological processes (Photo by author)

with scientific knowledge and monitored when it is implemented. Important insight about this system can be gained from *describing* the system from top-down (landscape level to species level) and bottom-up (from species level to landscape level) and by analyzing its key components and interconnectivity in discrete units of space and time. This particularly applies to activities such as tourism, which brings additional and new inputs (pressure and change) to the system. This approach requires exploring the system with *how* questions: some examples of a top-down description involving *how* questions could be: *how* does the flow of water from mountain to sea connect the species along the way? Or, *how* does the drift ice formation affect the feeding behavior of species and *how* are they connected in that process? It is not enough to describe these relationships based on a single year's data; they must be described *over time* to show additional relationships, or *emergence* in the system. To complement this approach, a bottom-up description using *which* and *how* questions could likely be: *which* species are affected by flowing water or the lack of it and *which* species are affected by shrinking sea ice and *how*? Such species (for operational ease, keystone species such as the Blakiston's Fish Owl and the Steller's Sea Eagle could be chosen for the cases provided in the examples, respectively) will need to be monitored over long temporal scales (considering, for example, a fish owl needs a large broadleaf tree to raise its young, and in deforested patches regeneration of such tree cover to appropriate density for the fish owl population will be determined

by the revegetation and recovery processes of mixed canopy and is very likely to be influenced by the patch size). A key theoretical lens that can be used for this purpose is the approach of analyzing species-landscape connectivity through the concept of *trophic cascades* (for detailed explanation, see Terborgh and Estes 2010).

Over the past few decades, theoretical explorations have begun to be matched by planning based on ecological connectivity in Europe and North America; a key approach is through the concept of *ecological networks* (Jongman and Pungetti 2004). Lessons from those projects are very much pertinent for places like Shiretoko. A key practical approach has been to "break down" the concept of connectivity in a local scale by considering a given landscape (could be either natural or cultural) and *de-anthropization* of the landscape (i.e., giving more consideration to the ecological characteristics of that site) and considering how they are connected in space and time in order to improve its interconnectedness and environmental continuity (Pungetti and Romano 2004). For monitoring and ecological network planning, typically four approaches are used. These are the census-based, population viability analysis (PVA), landscape index-based, and the spatial standard-based approaches (Verboom and Pouwels 2004). The census-based approach analyzes species distribution in a given spatial area; the PVA approach focuses on the life history of a species (usually an indicator or a keystone species) in order to bring out parameters of a viable population over time; the landscape index-based approach typically uses GIS

data to calculate the extent of fragmentation, connectivity of patches, and habitat area size; and the spatial standard-based approach uses Ecologically Scaled Landscape Index (ELSI) for understanding what spatial characteristics imply for a certain species (Ibid: 57–59). While all of these approaches are pertinent for analyzing natural heritage, the adoption of an ELSI-based spatial standard is particularly instructive as it provides important information on both spatial extent and species life history (i.e., landscape–species interaction). However, one important caveat in this regard is that it should be kept in mind that species life history also “adapts” to spatial change over time, and there is a lag effect between species population and landscape change (fragmentation) (Tillman et al. 1994). The lesson from this observation is that the indices should be evaluated through timescale data, or compared with other areas that have similar geo-ecological characteristics but different degrees of change, if possible.

4.8 Conclusion

This chapter analyzed the Shiretoko Peninsula World Heritage Area as a complex, dynamic, and evolving system involving geological, geomorphological, and ecological components. Shiretoko is one of the last remaining “wilderness” areas in Japan; its unique characteristics include interaction between terrestrial and marine environments, species diversity, presence of numerous endangered and endemic species, and occurrence of drift ice at the most southerly latitude in the Northern Hemisphere. The Shiretoko area is remarkable for the tight feedback loops between its geology, geomorphology, and ecological components; the area shows unique landscape ecological attributes as a result. In addition, it is a system that extends far beyond its immediate geographical boundaries and is coupled with geo-ecological systems in the Sea of Okhotsk and northern Pacific. As a World Heritage, Shiretoko has a unique value also because the area featured nature conservation activities from an early date and is managed through consensus building among local stakeholders and advice by a scientific advisory council. However, although Shiretoko has a rich natural environment, there are several “stressors” on this system such as landscape fragmentation (including retardation of functional properties of rivers that are among the most important geomorphological agents), change of forest ecosystems, anthropogenic pressure on keystone species such as the Blakiston’s Fish Owl, Steller’s Sea Eagle and the brown bear, and GEC (in the form of an apparent warming trend leading to early fragmentation and loss of drift ice). The chapter outlined these “threats” and argued that a systemic appraisal of the property that integrates species level dynamics with the

integrity and continuity of geomorphic processes as the key for long-term governance of such complex adaptive and combined geo-ecological systems.

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