

The Japanese serow's colonisation of areas formerly inhabited by humans: Mt. Hakusan, central Japan

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白山におけるニホンカモシカの人間領域への侵入

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Abstract

This study examines the relationship between the distribution of the Japanese serow (*Capricornis crispus*, Bovidae, Artiodactyla) and human activities in the Mt. Hakusan area, central Japan. Information on former patterns of distribution of the serow was collected by interviewing regional residents and hunters. Around 3,000 observation records from each 1-km grid were analysed. The expansion of the serow habitat in Ishikawa prefecture can be observed at intervals of ten years, beginning in 1955. Over 50 years, the extent of the habitat expanded from 300 km² in 1955 to 1,500 km² in 2005.

Despite its legal prohibition, serow hunting for meat and fur continued on a small scale until the 1960s. The practices of shifting cultivation and charcoal making on the mountains had rapidly declined by this time. As a result, large areas have since become available to wild animals. The habitat of the serow has expanded from the highlands to the lowlands and from steep areas to flatter areas. In the foothills, because people have stopped cultivating small rice fields and have taken jobs in urban areas, the landscape, which was once dominated by timber production, now predominantly has natural vegetation. The general attitude towards wildlife has also shifted because of changes in lifestyle and greater awareness of the need for conservation of natural resources. Therefore, the serows have largely lost their fear of humans. Consequently, their population has increased in most forest areas, including those near human settlements.

Keywords: Japanese serow, distribution expansion, Mt. Hakusan, agroforestry area, human depopulation

要旨

ニホンカモシカは、特別天然記念物に指定された1955年頃には、全国各地と同様に白山山系でも、幻の動物と呼ばれるほどに、人がほとんど入り込まない急峻な奥地にもみ少数が分布していた。その後の50年間にカモシカは大きく生息域を拡大し、現在では市街地近くにも普通に見られるようになっている。観察の記録に加え、現地住民からの聞き取り情報、新聞記事からの情報によって、1955年から2005年までの10年間隔で石川県内の分布前線を推定した。1955年に約300km²であった分布域が、2005年には約1,500km²に広がった。

半世紀にわたる生息地での人間活動の急激な変化と、カモシカの分布拡大の背景と要因を考察した。山村での生活形態と農林業の変化、動物資源としての要求低減が、初期の山地での分布拡大の契機となった。次いで地域住民の動物保護の意識変化、都市近郊の森林の変化が続いたことを指摘した。

キーワード: ニホンカモシカ 分布拡大 白山 農山村 過疎化

INTRODUCTION

The Japanese serow (*Capricornis crispus*, family Bovidae, order Artiodactyla) is a wild mountain goat that is endemic to Japan. It inhabits the mountainous areas of Honshu, Shikoku, and Kyushu. In 1934, the species was designated as a natural treasure in the Historic Sites, Places of Scenic Beauty, and Natural Monuments Preservation Law of 1919. In 1955, it was upgraded to a special natural treasure in the Law for the Protection of Cultural Properties of 1950. During this period, it could be found only along the steep mountain slopes which were free of human impact. Because it was difficult to spot the serow in such places, it was sometimes referred to as 'an invisible animal'.

The distributions of several important mammals such as the bear, Japanese monkey, sika deer, and serow have been surveyed in 'the Green Census of Japan', which has been conducted every five years since 1973 under the control of the Environment Agency (Maruyama & Furubayashi, 1979).

Some other studies were initiated in 1973, when the damage to planted white cedar ('hinoki': *Chamaecyparis obtusa*) trees by serows in Gifu prefecture became a problem (Murao, 1983). Most articles in the 1970s focused on arguments against deforestation. Many conservationists and ecologists had not yet realised that the population of serows was increasing in many habitats. Reports tended to emphasise the adverse influences of dam and road development and deforestation on the serow's habitats (Chiba, 1977; Ono *et al.*, 1978).

The serow of Mt. Hakusan has been an important ecological research subject since the beginning of the scientific study of larger animals. A systematic survey of density estimation using the dung method was initiated in a branch of the Tedori River in 1966 (Morisita & Murakami, 1970). A study of the animal's behavioural patterns and activities in winter was conducted by Sakurai (1976, 1981) around the upper stream of the Tedori River. In the same area, density estimation was conducted using the technique of fixed-point observation (Mizuno & Ibaraki, 1980; Mizuno *et al.*, 1982).

The general situation of the serow in its main habitats was addressed by the Nature Conservation Society of Japan for the first time in 1979. The Society's report stated that Mt. Hakusan was one of the sites proposed for the conservation of the serow habitat and of the species itself.

Systematic surveys of density and the environment have been conducted in the 15 Special Natural Treasure Serow Protection Areas that the Agency of Cultural Affairs has established across the country since 1979. An area of 537 km² in the Mt. Hakusan range was designated for this purpose in 1982. Since then, the population of serows and their habitats in this area have been surveyed thrice (Toyama, Ishikawa, Fukui, Gifu Pref. Boards of Education, 1987, 1993, 2000). An estimation of the distribution of the serow was carried out in 2000 after an examination of the results of questionnaires given to local residents (Ueuma & Nozaki, 2003).

In the present report, the author has traced the changes in the distribution of serows in Ishikawa prefecture and has examined the factors that influence serow distribution and patterns of expansion. It has been shown that changes in human lifestyle, agriculture, and forestry, as practiced by the inhabitants of mountain villages, are major factors. In addition, changes in the population of these mountain villages and methods of silviculture are discussed along with issues related to the protection of the serow.

STUDY AREA

This investigation focuses on the distribution of Japanese serows in the Kaga region, the southern part of Ishikawa prefecture. This region is located in the area bordering the Japan Sea in central Honshu, between latitudes 36°00' N and 37°00' N, and longitudes 136°15' E and 137°00' E (Fig. 1). The Hakusan mountain range, running north to south, is located on the eastern side of this region, with its highest peak of 2,702 m. The highlands are classified into subalpine and alpine zones. The Kaga plain includes the lowlands and parts of the Japan Sea coast.

The land area is 3,336 km², of which 2,060 km²

belongs to Ishikawa prefecture. The human population of the Kaga region is about 900,000; most of them live in the cities and the main farming areas of the lower plain. The human population is very low in the mountainous areas.

The snowfall in the Hakusan region is one of the heaviest in Japan. At Shiramine, 480 m above the sea level, the average maximum snowfall is 243 cm, with a record of 682 cm in 1928. Kubo (1970) estimated that the normal snow depth is 360 cm on the highlands at altitudes between 1,500 m and 2,000 m.

The lowland plain is almost entirely cultivated for rice paddy. The hilly region is an area of secondary deciduous forest and Japanese cedar (*Cryptomeria japonica*) plantations. The wide range of the mountainous zone from 400 m to 1,600 m above sea level is classified as the beech area (*Fagetea crenata* region). Secondary forests that give rise to oak (*Quercus crispula* and *Q. serrata*) cover a wide range of the mountainous area. Those secondary forests are sites that were formerly used for charcoal making and shifting cultivation. The virgin beech tree forest (*Fagus crenata*) remains in extensive patches at altitudes between 1,000 m and 1,500 m. The vegetation

of the subalpine zone, the *Vaccinio-Piceetae* region, covers the highlands between the altitudes of 1,600 m and 2,500 m.

Due to regular heavy snowfalls, the amount of planted forest in the Kaga region amounts to only 21% of the area, a low figure compared with the average for the whole of Japan. Most planted forests contain Japanese cedar and there are few plantations of white cedar.

In the Kaga region, there were 16 local administrative divisions until 2005. Of those, Kanazawa-shi, Komatsu-shi and Kaga-shi have large urban areas. Most of the *Machis* are at the foot of the mountains and much of the *Muras* are mountainous.

METHODS

1. Estimation of past distribution

The author participated in the survey of serows in the Jadani Valley conducted by the Hakusan Scientific Research Group from 1967 (Morisita & Murakami, 1970), and on the survey of black bears in Shiramine-mura from 1970 (Morisita & Mizuno, 1970). Since 1973, the author has been stationed in the Mt. Hakusan region for collecting information. Information about the historical distribution of serows was compiled by interviewing elder residents and hunters on their past observations of the animals.

Dezukuri, the system of shifting cultivation by using a seasonal mountain house that existed in the 1950s, was examined in detail. Tanaka & Kouda (1927) and Kouda (1956) have illustrated how the system worked using distribution maps. Studies of *dezukuri* in Shiramine-mura have also been conducted (Iwata, 1987, 1990). In addition to these studies, I collected information from inhabitants and analysed the sites used for *dezukuri*, using 1/50,000 topographic maps from 1953 that were issued by the Geographical Survey Institute.

The serow distribution in the Hakusan mountain range, including the population on the other side of the mountain in the years around 1955, was estimated. The distribution of settlements and geographical characteristics inside Ishikawa prefecture were taken into account.

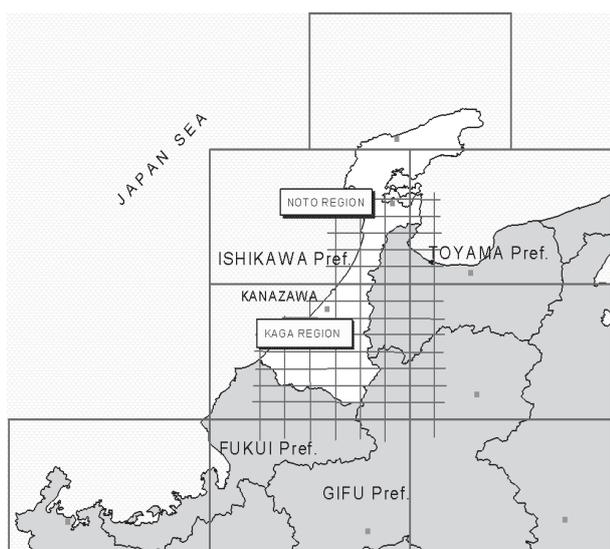


Fig. 1. Study area

The study area is covered by small meshes, which shows 1/25000 maps issued by the Geographical Survey Institute.

2. Estimation of serow expansion

In addition to the author's observations, other data were collected by means of oral discussion with the wildlife guards, hunters and residents of the area. The records collected on occasional opportunities during the Hakusan Serow Protection Area's Special Surveys (Toyama, Ishikawa, Fukui, Gifu Pref. Boards of Education, 1987, 1993) were added to the information database. Recent records also referred to articles in the local newspapers.

Only information with a precise location and which was able to fit into the 1-km grid was used for mesh analysis. Among around 3,000 observation records, the oldest records from each mesh were selected for further analysis. About 800 of those records were analysed. The oldest record of the same site was normally given by early inhabitants. Whenever I recorded the serow at a new site, I asked local people how long it was since the animal had been seen there.

The distribution of serows in 1955, 1965 and 1975 was reported by the author (Mizuno, 1989, 1999). The extent of serow distribution till 1975 was transferred from a map in the previous report to a 1-km grid map. The distribution patterns in 1985, 1995 and 2005 were drawn on a 1-km grid map using new observation records of the expanded distribution. When there was no observation record at intervals of 3 km or more, or even when the forest environment continued uniformly, a trace survey was carried out to investigate the presence of serows in the area.

3. Human activity

The fluctuations in human population in four agroforestry *muras* (administrative areas containing 5-20 villages) were analysed using the Population Census Data of Japan (Prime Minister's Office, from 1950 to 1995), which has been conducted at intervals of 5 years. These *muras* have been inhabited by the serows for many years in the past. To clarify the statistics more easily and to associate them with the changes in the forest environment in the mountainous areas, the population fluctuations of the agriculture

and forestry sectors were assessed using the same census.

The human environment of the mountainous area of Mt. Hakusan has changed drastically since the end of the Second World War. The significant occupations that were carried out in the area were shifting cultivation, charcoal making, and sericulture. To indicate the changes between the relations to forest environment of people, the changes in charcoal production were selected. The figures for charcoal production were collected from Ishikawa prefecture's statistics on agriculture, forestry and fishery.

RESULTS

1. Past distributions of serows in the Mt. Hakusan area

In the 1950s, the serow was seldom seen in Ishikawa prefecture in the areas near the settlements. The old range of the serow's habitat was estimated as being equivalent to the whole range of Mt. Hakusan, including Gifu, Fukui and Toyama prefectures.

The distribution of serow in 1955 as estimated in this report was 731 km² and the area, apart from the subalpine and alpine zone (which is higher than 1,600 m) is about 600 km². This figure represented the local population of the serow, which was isolated from others in central Japan. In the 1950s, the serow lived only in Kawachi-mura, Yoshinodani-mura, Oguchi-mura, and Shiramine-mura and in parts of Kanazawa-shi (Figs. 2, 3)

2. Changes in the serow's range of habitat

Judging from the 800 records of serow observations collected, most of the animals are widely distributed in the mountainous region on the Ishikawa prefecture side of the Hakusan mountain range. Many observation records refer to the valleys of the Tedoru River. A number of records were taken in the broadleaf tree forest area during winter and early spring, when it is easier to observe animals, because the leaves of the trees have fallen and the ground is covered by snow.

We could not find any records of serows above 1,600 m in mid winter. However, some individuals

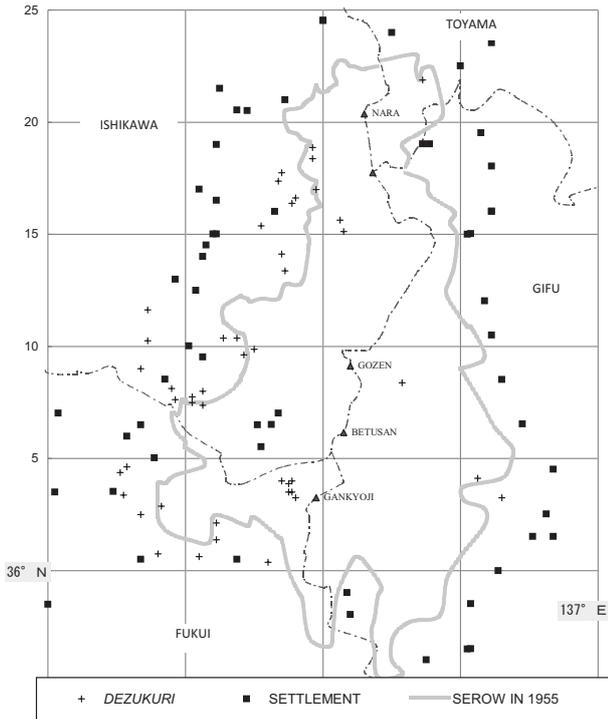


Fig. 2. Estimated distribution of Japanese serow, settlement and dezukuri in the Mt. Hakusan area in 1955

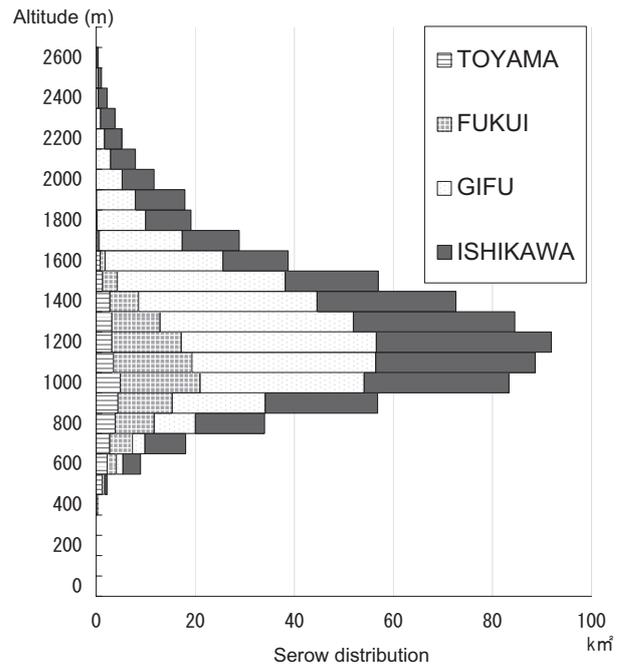


Fig. 3. Estimated area of serow distribution in 1955 in the 100 m altitude belt in Mt. Hakusan

appear to move up to the subalpine zone following the buds of perennial plants after the thaw. A serow drowned in Midorigaike Pond, a crater pond at 2,550 m., near to the summit of Mt. Hakusan. In addition, the manager at the lodge in this alpine zone observed a serow at the summit of Ohnanji Peak (2,684 m) in normal conditions (Kinosita, personal information).

The changes of the distribution fronts from 1995 till 2005 in the area for every 10 years are shown in Fig. 4. Spatial distribution expanded quickly and serows were observed frequently in new areas from the 1970s. The serows even started to appear on the Mt. Iozen range or Mt. Dainichi range (Mizuno *et al.*, 1982).

By 1985, they were seen near large villages and on roadsides. By the 1990s, people started to see them frequently near the cities of Kanazawa-shi, Yamanaka-machi and Tsurugi-machi. The serow's range of habitats had spread to the northern section of Mt. Iozen on the border of Toyama prefecture and to Mt. Kariyasu on the border of Fukui prefecture.

While the estimated distribution area for

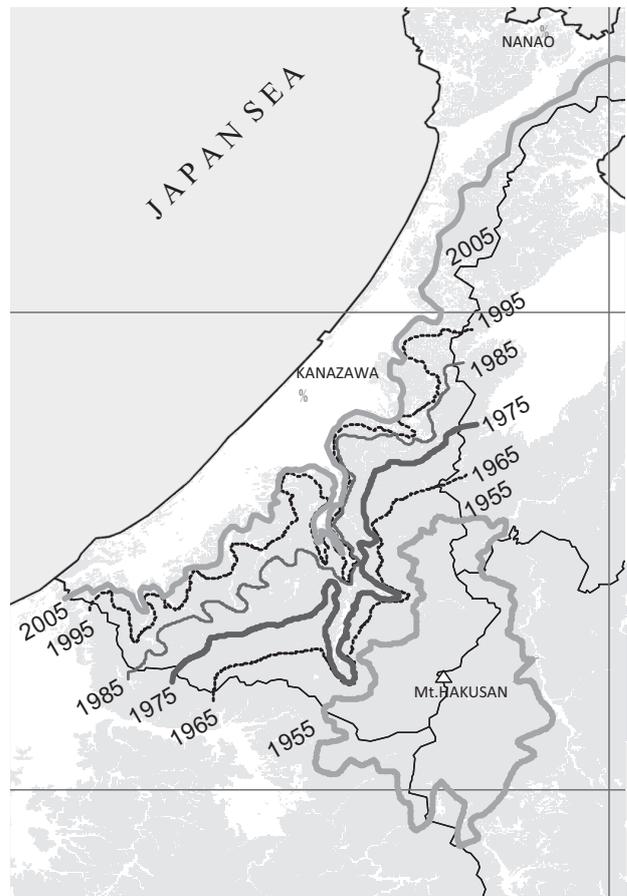


Fig. 4. Expansion of Japanese serow in Ishikawa Prefecture. Lines show distribution front of every 10 years.

serows in Ishikawa prefecture in 1955 was 306 km², it expanded to 501 km², 717 km², 1,041 km² and 1,292 km² in each of the following 10 years and had increased to cover ca. 1,400 km² by 2005 (Table 1). The range of the habitat has expanded five times within 50 years. The serow cannot stay in the subalpine zone, which is more than 1,600 m above sea level in winter. Excluding the subalpine zone, the area has expanded from 222 km² to 1,450 km².

3. Altitude of the serow range

The serow was not seen in zones below 500 m in 1955. Most parts of the serow range were in the highlands above 1,000 m. Now, year by year, the range has expanded to the lower mountains. Recently serows have sometimes even been seen at 50 m at the feet of the mountains in the Kanazawa-shi suburbs. However, the serows do not appear beyond the forest and hilly areas near to the coast of the Japan Sea.

The distribution of the serows in each of the 100 m altitude belts is shown in Fig. 5. It is clear that the serows have expanded from the highlands of the mountainous areas to the lowlands. More than 90% of the area above 1,100 m had been occupied by serows by 1965, that of above 800 m by 1975, 500 m or more by 1985 and 300 m or more by 1995. Subsequently, most of the forest zone of the Kaga region became an area inhabited by serows by 2005.

4. Habitat change in the mountain area

Many small settlements were shown on maps of the Mt. Hakusan area until the 1960s. Shifting

cultivation and charcoal making was carried out extensively in most mountain villages in the central and southern part of Japan until the 1950s. In this region, it was very common for farmers to move to the mountain house, the *dezukuri*, with their family in summer to carry out shifting cultivation and charcoal making.

They burnt shrub forests on steep slopes and planted Japanese millet ('hie': *Panicum crus-galli*) and foxtail millet ('awa': *Setaria italica*) for several years. A field was abandoned when it lost its fertility. Although this life was close to one of self-sufficiency, charcoal making was also carried out as to bring in cash (Kouda, 1956; Sasaki, 1981).

Because of the 'fuel revolution' of the 1960s, firewood and charcoal were replaced by fossil fuel and lost their commercial importance. During the same decade, alternative works such as construction of roads and dams replaced the traditional dependence on agriculture and forestry. With these changes, the use of the *dezukuri* settlements for shifting cultivation and charcoal making sharply declined (Park *et al.*, 1999). Many people who lived among the mountains abandoned the small communities, moving to bigger villages to become wage earners.

Timber and charcoal production had been one of the biggest sources of income in the area for a long time. The timber price decreased because of cheaper wood imported from abroad. The numbers of those who depended on forestry on the mountain decreased rapidly. Although the human population of this area was 11,073 in 1950, it decreased to 8,295

Table 1. Change of distribution area of serow in Kaga region

Altitude	Distribution area of serow (km ²)						*Total Mountain
	1955	1965	1975	1985	1995	2005	
1500-2702 m	84	86	86	86	86	86	86
1000-1500 m	163	216	225	226	226	226	226
500-1000 m	59	193	360	458	464	464	464
0-500 m	0	6	46	272	516	625	808
Total	306	501	717	1,041	1,292	1,401	1,584
Serow areas in mountain	19.3	31.6	45.3	65.7	81.6	88.4	%

*Mountain area does not include Noto region.

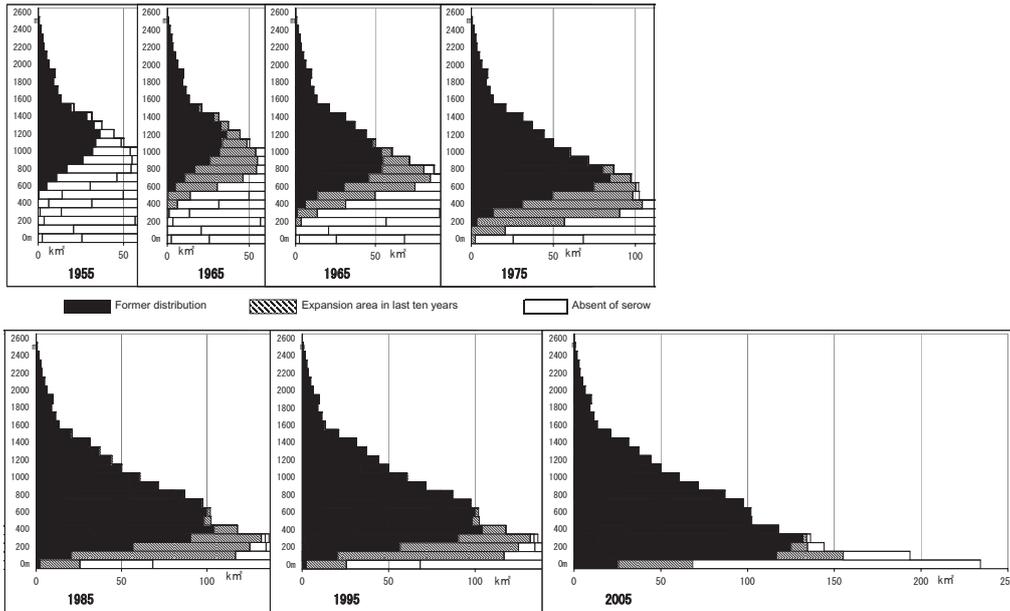


Fig. 5. Serow distribution by altitude levels of the Kaga region.

Area does not include paddy field, urban area and water surface.

in 1960, 6,374 in 1970, and to 4,716 in 1990. The changes in total population and numbers of workers in agriculture and forestry in those four muras can be seen in Fig. 6. The most noticeable is the decrease in the numbers of forestry workers.

In 1955, there were 972 forestry workers in the four muras. This number represented 16.3% of the 5,973 people aged over 15 years. Many of them left work in the forest in the 1960s. The numbers engaged in forestry decreased to 375 people (8.8% of those over 15 years old) in 1965, 124 people (3.1%) in 1975, 79 people (2.9%) in 1985 and 39 people (1.5%) in 1995.

As higher education expanded in the 1960s, most of the students went to high schools in the cities. Many youngsters remained in permanent jobs or in higher education in the cities after graduation in high schools. Thus, the population in the mountain villages who were left behind decreased and the average age of that population increased rapidly.

There were many small settlements in the highlands of Mt. Hakusan until the 1950s. Subsequently, many of these settlements disappeared with the drift to the towns and cities. There were several villages in the upper reaches of the Tadori, Shokawa and Saikawa Rivers. Some of these disappeared because

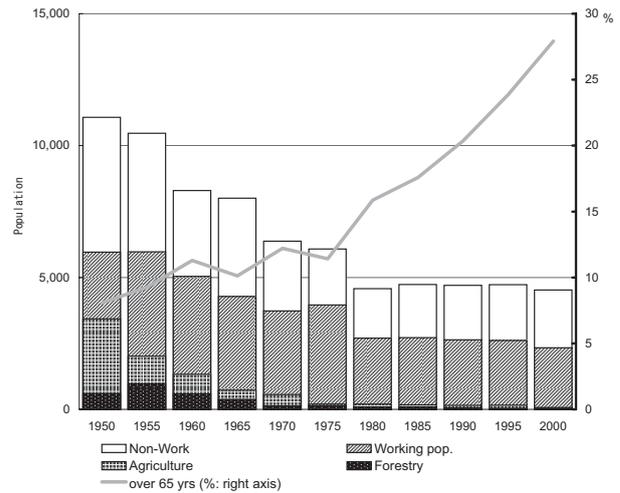


Fig. 6. Change of working population in mountainous villages in Hakusan area.

Areas in Kawachi, Yoshinodani, Oguchi and Shiramine Muras where serow existed before 1955.

of dam construction.

The production of charcoal in Ishikawa prefecture, which had been on the increase since the 1910s, was brisk up to the 1960s (Fig. 7). When roads reached the remote areas from the towns in the 1950s, the price of charcoal rose. In Shiramine-mura, trees like oak (*Quercus crispula*) were widely cut and a shortage of wood sometimes occurred.

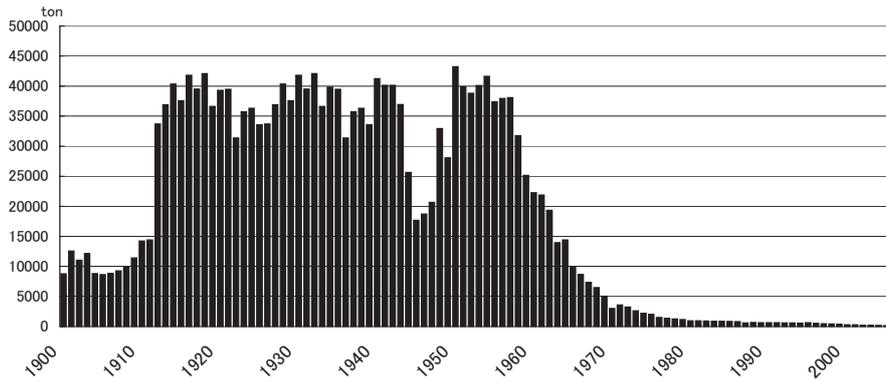


Fig. 7. Charcoal production in Ishikawa Prefecture
Data from Annual Reports of the Agriculture, Forestry, and Fishery Statistics of Ishikawa Prefecture.

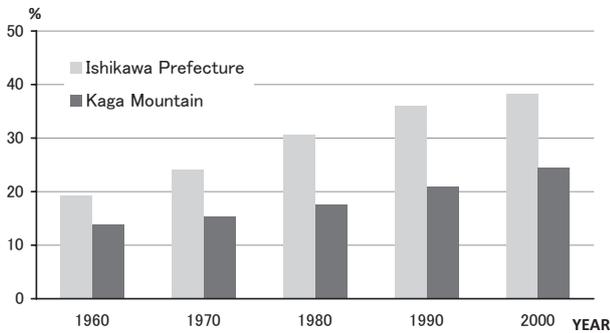


Fig. 8. Plantation forest rate in the forest area in Ishikawa Prefecture and Kaga region

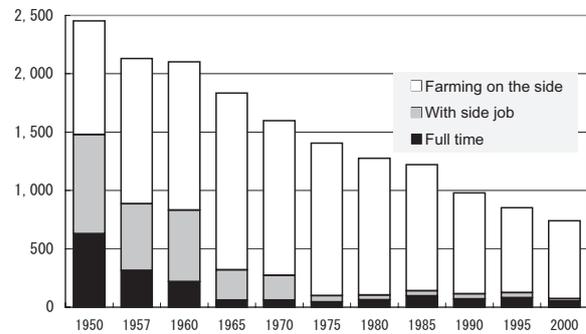


Fig. 9. Number of households and farmhouses in the Kaga region

In the 1960s, charcoal making declined rapidly. Although 3,517 tons of charcoal was produced in 1960 in the catchment of the Tedoru River, this figure had decreased to 185 tons by 1970.

Planting in this area decreased because of the decline of forestry activities. This occurred despite the timber-planting policy which was introduced after the 1950s. The proportion of planted forest in the total forest area of the four muras was 10.4% in 1960 and had increased to 12.5% by 1990 (Fig. 8). The rate of increase of planted timber forest was very slow, in comparison with other areas such as those in the Toukai region (on the Pacific side of Honshu) where the planting increased from 39% to 55%. In spring, people found seedling planting difficult because of the high snowfall.

5. Habitat change at the foot of the mountain

The effects of the changes on the serows living

in the forest environment in the hilly regions and low mountain areas have been studied in detail. Also, the changes in both the numbers of farming families and the overall human population in the agroforestry villages in the Kaga region has been assessed. The main communities are located in the big valleys, and many small settlements exist along the tributaries. The four administrative areas of Kawachi-mura, Yoshinodani-mura, Torigoe-mura and Oguchi-mura were selected to be studied as an agroforestry zone. Although these muras are classified as mountain villages in the World Agriculture Forestry Census, they were reclassified as agroforestry areas in this report because of the low levels of forestry activity over a long period.

The numbers of families in the five muras decreased rapidly between 1950 and 1980. There were 2,453 households in 1950, 1,599 in 1970, 1,277 in 1980, and 853 in 1995. This represented an

overall reduction to one third of the previous number within 45 years. The percentage of full-time farmers within the total of farming families also significantly decreased. The total of first grade part-time farmers, who were working mainly on agriculture, was reduced from 60% to 15% in 45 years (Fig. 9). This trend occurred in most of the hilly zones within the study area.

Because of the depopulation in the agroforestry zone, many small settlements now consist of only a small number of people and there are very few young persons. Some settlements such as Tochio, Meotosugi, and Hatakeo in Kanazawa-shi were abandoned in the 1970–89 period. Even in the small villages which still remained, many farmers have abandoned the cultivation of rice paddy. In the Kaga region, 27 villages became very small. The population decreased to less than one third over 30 years. There were less than ten households with only a family size of 2.5 in 1995. Shinbo, Hisike, Yokotani, and others in Kanazawa-shi have 2.0 or less persons per household. These conditions were seen widely in the hilly zone and across the area.

DISCUSSION

1. Background of survival

The Japanese serow species was designated as a Special Natural Monument in 1955. The distribution of the animals by then was so restricted and the population so small that the serow faced possible extinction. In the Hakusan mountain range, the serows inhabited only parts of the highlands above 1,000 m. This population was isolated from other mountain ranges until the 1970s. Though it is difficult to know when the range of its habitat was at its smallest, it is possible that it was restricted to the highlands of Mt. Hakusan, at least from the 1920s to the 1950s. It was remarkable that the serows survived in the Hakusan mountain range until the 1960s, despite of the prevalence of *dezukuri* at that time, as a result of which the charcoal making and hunting was carried out deep inside the mountain area. Most likely, the serows survived because of a number of environmental factors, which will be explained here.

At that time, no record of serows was found above 1,600 m in mid winter. The snow is so deep in the region that the serows may have been able to stay in the highlands during winter, because of the very low temperatures and food shortages. However, some individuals could move up to the alpine zone by following the buds of perennial plants after the thaw. Researchers in the North Japan Alps reported that some serows stayed in the subalpine zone (Niigata, Toyama, Nagano and Gifu Pref. Boards of Education, 1991).

The serow was able to survive on the very steep rocky slopes where people did not go and in the subalpine zone during summer when enough food was available there. It is conceivable that serow can conduct seasonal migrations when their habitats fluctuate because of seasonal changes or human impact. Individuals that have been observed in summer in the alpine zone will have migrated at least several kilometres from the mountain.

In November, before snow accumulated in the highlands, people from the *dezukuris* and charcoal-making huts descended from the mountain to their home villages, which were at an altitude of below 600 m. Therefore, the serows could use the area after people had left.

For many centuries the serow, the Japanese monkey (*Macaca fuscata*) and the black bear (*Ursus thibetanus*) were game animals. Nevertheless, serows have survived more widely than Japanese monkeys. The social structure of the serow is solitary, like the black bear. Therefore, it was difficult to hunt all of them. The monkey was easily eliminated from many places by 1920, since they form into troops which are easy to find and kill.

Serious damage to forestry and agriculture by serows was not reported in this area. Therefore, people did not consider that the serow was a harmful animal like the monkeys.

2. Range expansion

Following their designation as a Special Natural Monument in 1955, the serows have expanded their population in many places in central Japan (Tokida &

Ikeda, 1992). In Mt. Hakusan, their range of habitats has spread widely westward to Mt. Dainichi and northward to Mt. Iozen, an expansion which included colonization of the abandoned areas when people left the mountain.

The former sites where tree cutting for charcoal or shifting cultivation took place have been afforested on some gentle slope lands. However, most areas were just abandoned and the oak-dominated secondary forest is now regenerating in many places.

A high density of serow fecal pellets was seen at sites after logging and afforestation, followed by a decrease in density as trees grew up in Kyushu (Ono *et al.*, 1978). The density of serows was high in vegetation of 5 to 10 years after the clear cutting of forest in the Shimokita Peninsula, which is the northernmost limit of the range of the serows (Ochiai *et al.*, 1993). In the Hakusan area, the logging and afforestation areas were smaller than in other regions where the snow is less heavy.

In the past, farmers had cultivated beans and millets on the slopes after burning during shifting cultivation. Where the slopes were abandoned, they became meadows. The mountainous tall stem meadow supported many plants such as mugwort (*Artemisia montana*), knotweed (*Fallopia japonica*), angelica (*Angelica pubescens*), and thistles (*Cirsium* spp.), which occur on steep slopes. The meadow is maintained naturally, as snow slides frequently occur and stop tree growth. The author has frequently observed that serows browse these soft grasses from spring through to early summer.

A snow slide trace is important, since these herbivorous animals prefer to browse on uncovered pasture during snow. The tall stem meadows in the Jadani Valley are also used jointly by troops of Japanese monkeys for food in winter and early spring (Suganuma & Haga, 1974). The secondary forest and tall herb meadows have colonised the abandoned sites of shifting cultivation and charcoal making.

The steep valley or cliffs at the upper reaches of some rivers are important for the expansion of the range of the serow's habitat. They were seen in these sites before they were first observed colonizing

adjacent areas. The author has called the areas where serows settle first 'advance bases'. These occur in the Hisike Valley of Mt. Iozen, the Minami Valley of the Daishoji River and the Tsue Valley of the Dainichi River. Serows favour the steep ground as a habitat so that they can escape from humans or other predators. Even after the serows lose the fear of humans, they prefer to stay on the steep ground that provides shelter.

3. Dynamic population factors

According to the census of the Protection Area of 540 km², the serow population was estimated at 1,400 to 2,000 animals in 1985, which increased to 3,000 in 1992 (Toyama, Ishikawa, Fukui, Gifu Pref. Boards of Education, 1987, 1993). The numbers of the serows observed from the Bunaoyama Observatory has hardly changed since 1981. Some 10 to 15 serows can be seen on a slope of 1.5 km² from the window of the observatory when there are good conditions for observation. From discussions we had with former villagers, there is no evidence of a reduction in serow density at any sites in the 1955 range.

From the 1970s, the expansion of the range of the habitat into low mountains below 500 m has been conspicuous. The severe winter period is shorter and snow is low in the lowlands, so there is a better food supply than in the highlands. Winter is the season when serow females are pregnant. It is believed that the shorter snow season provides a better habitat for the animal for breeding and reduces mortality.

On Mt. Hakusan, avalanches were a significant cause of death. Of 30 dead serows found in the area from 1971 to 1980, 12 (40%) were judged to have been caused by snow slides (Mizuno, 1981). However, the mortality rate from snow slides decreased from 22.5% (n = 80) in the period from 1981 to 1986, and by 4.4% (n = 90) in the period from 1987 to 1992 (Mizuno, 1999).

In Shiramine-mura (480 m), the snowy season continues for about four months, from early December to late March. The first snow cover at Mt. Hakusan's summit (2,702 m) comes in early October. At the border of the prefecture (1,450 m) on the

Hakusan Super Forest Road, the road is closed by snow in November. Kubo (1970) estimated that the average last date of snow cover is 26 May at 1,500 m and 20 June in 2,500 m. In the highlands, the snow cover lasts for about six months at 1,500 m and for about eight months at 2,500 m. Deaths due to snow slides must have decreased for those serows living in the lowlands in a less severe climate. In addition, the mortality rate from cold and starvation for calves must have decreased, because the period of food shortages was reduced.

4. Change in human activity and the distribution of serows in mountain areas

1) The shifting cultivation and charcoal making period

Around Mt. Hakusan, the practice of living in *dezukuri* was carried out widely until the 1950s. Farmers stayed for half of the year and were engaged in shifting cultivation and burning shrub forests on steep slopes to plant millet. Charcoal making was carried on as a cash crop. Furthermore, people entered the hinterland to collect edible wild plants and mushrooms in the spring. They would go up to 10 km from a village for a fern (*Osmunda japonica*) that was one of the cash crops. Those people say that they did not see the serow as often as nowadays, and the serow density is thought to have been lower at that time.

It was made illegal to hunt serow in 1925 under the Hunting Law. However, the animal had been a source of meat and good quality fur for thermal insulation in the mountain villages for many centuries. It was not possible to effectively restrict hunting in the mountain villages, even after the serow was designated as a Special Natural Monument in 1955.

Until the 1950s, gun permits and hunting rules were not effectively controlled in such a remote area. Although hunting was illegal, the animals were still caught and eaten when there was an opportunity in any season. In Mt. Hakusan, bear hunting by the enclosed hunting method 'makigari' had been carried out (Mizuno & Hanai, 1983), and hare was hunted as well. It was stated that hunters also captured serow

when hunting bear, if they had the chance to do so.

The police arrested many poachers and illegal traders across the whole country in 1959. Since then there has been a growing understanding of the value of conservation. However, the control of illegal killing was not as strict in the mountain villages until the 1960s. The hunting of serows and monkeys continued for domestic consumption. Older former professional hunters in small villages have told the author many stories of hunting up to the 1970s. They used to hunt serows for their good fur and meat in Ichinose, a very isolated village in the upper Tedor Valley. Another hunter in the Shiramine-mura used to hunt about 20 serows around the village every year in earlier days. The meat of the serow was sold mixed with bear meat, as bear meat was more expensive (resident of Shiramine 1970, personal information).

This traditional form of hunting continued until the 1960s. The fur of the serow and the bears was useful until cheap clothes were introduced to the villages. The meat of wild animals lost value when butchers brought fresh meat and fish from the town after the road became available at all seasons. Since then, hunting in this area has been decreasing, and hunters have stopped going a long way into the mountainous area.

2) Depopulation progress period

The opportunity for cash income from public works increased from 1960 onwards. At the same time charcoal lost its position as a commercial product at the time of the 'fuel revolution' when people switched from firewood and charcoal to fossil fuel for household use. The use of *dezukuri*, shifting cultivation and charcoal making declined sharply from about 1960 (Sasaki, 1981).

Small communities disappeared one after another as many people moved to live in big villages, and became wage earners. Youngsters went to the senior high school in town and very few of them returned to the home village. As many of them went into higher education, or searched for jobs in cities, the population decreased and the average age of the

population who remained in the mountain villages increased. Except for the few forestry workers and hunters who remained, many residents lost interest in nature and the animals in the mountains.

3) The resort development period

Tourist facilities, such as spas and skiing resorts, opened in the mountain villages in the 1970s and created some employment. Much public construction work for the country's reconstruction plan was carried out, including developments such as skiing resorts and mountain roads in the Mt. Hakusan area. The construction business became the most important employer in the area. This change was a nationwide trend in the mountainous regions of the country. Developments such as skiing resorts and spas have not seriously affected the habitat of the serow, as it has already lost its fear of humans.

Packs of free ranging dogs were seen on the village peripheries until the 1970s. Such dogs were a major pressure on all wildlife, especially around settlements, before tourist developments began. For example, the inhabitants of Shiramine-mura reported seeing saw dogs feeding on the corpse of a serow (resident of Kuwajima, personal information). Stray dogs have been controlled since the development of tourist resorts, and house dogs have also been more strictly controlled. Raccoons (*Nyctereutes procyonoides*), foxes (*Vulpes vulpes*), badgers (*Meles meles*) and martens (*Maltes melampus*) now come near to settlements and crop damage by wildlife is a problem for continuous small scale silviculture. Feral dogs have played a role in driving wild animals from settlements, and in reducing problems with agriculture (Mizuno, 1995).

When there were Japanese wolves, it is probable that serows sought shelter from them on the steep slopes far from settlements. Free ranging dogs have taken over the role of the wolves for more than a hundred years. However, a decade or two has now passed since people and dogs stopped chasing wild animals. Because animals have forgotten the fear of humans and inhabited areas, they are now often seen on the borders of villages and on roads.

5. Changes in human activity and distribution of serows in the lowlands

1) Relationship to the forest

At the foot of the mountain in Kanazawa-shi, where serow distribution has recently expanded, the numbers of people engaged in agriculture has decreased by half in the 20 years since 1980. The proportion of over 65 year olds has increased from 11.5% to 15.5%. Many small settlements have turned into ghost villages. Abandoned rice paddies are conspicuous, and pioneer plants such as eulalia ('susuki': *Miscanthus sinensis*), willow trees, and kudzu vines (*Pueraria lobuta*) grow densely.

Part of the background to decreasing rice acreage in the hilly zone is the reduction of demand for rice itself. As eating habits in Japan have changed, rice consumption has been reduced since 1963. As the reduction of the rice crop was promoted by the government from 1971, the small rice paddies in the hilly zones were the first to be abandoned.

A cedar forest planting was initiated after the Second World War as part of an expanding timber-planting policy, but many forests have not been managed effectively and processes such as thinning have often not been carried out. Many mature trees in the forests have been abandoned because there is no profit to be derived from them. At one time, the so-called *satoyama* (mountains around villages) near a city area used to function as the firewood and charcoal reserve of towns. When the collection of firewood and charcoal was active, these areas were covered by a young secondary forest mosaic. In such areas, the deciduous broadleaf forest has recovered to become the predominant natural vegetation, and a better habitat for wildlife such as serows, birds and other species.

Increased mobility has also contributed to separating humans from nature. Car numbers continue to increase year by year and are now approaching an average of two per family. People go to work and play in the city instead of going to the forests. The population is increasing in some of conurbation towns inside the hilly zone. The adults and children

of these new towns are city- oriented and seldom go to the forests. These town inhabitants and their life styles have not yet have an adverse impact on the wildlife of the surrounding areas. People have come to believe that the natural forest should be conserved, and the concept of nature conservation is easier to accept for city dwellers.

Some people still enter the forests of the hilly regions for recreation and to collect edible wild plants or mushrooms. Many of them think of themselves as conservationists and do not kill or chase wild animals.

Wild animals are identified by humans in various ways. To some, they are 'pretty' or 'beautiful' and therefore, in need of protection. To some they are 'delicious', a source of food, to some they are 'unusual', and therefore 'precious'. To others they are 'dreadful' or 'hateful' dangerous wild beasts. Such feelings are interwoven and complicated, even among the inhabitants of any particular area. Feelings such as 'dreadful' are unlikely to be heard in regard to the serow. Few of those who live around Mt. Hakusan consider it as a harmful animal. This feeling has been strengthened with the spread of conservation education. However, many people in the cities do not realise that the range of the habitat of the serow has expanded and that the population has increased.

Several golf courses have been constructed in the hilly zone from the 1970s. Nevertheless, most of the sites are restricted to the feet of hills or plateaus, as the higher parts of Mt. Hakusan are too snowy and too steep. In recent years, the serows' range has expanded to these golf courses on the periphery of the forest areas. In contrast to skiing fields, most golf courses of this area are not utilised during the snowy period. Serows may now be seen at several golf courses such as the Kaga Country Club.

2) The new interactions with human

While the serows have begun living closer to the communities, their opportunities for new types of interactions with human activities have increased. Although we have no record of serow deaths through

falling from a natural cliff, accidental deaths through falling from artificial structures beside roads have rapidly increased. Cases of serows drowning in the artificial waterways of hydroelectric power stations have also increased. In addition, serows are sometimes killed in car accidents on the major roads around the hilly zones.

Some farmers have complained that serows damage cultivated Japanese horseradish ('wassabi': *Eutrema japonicum*) in the mountainous area. However, the damage caused by serows in agriculture is only a minor problem in the areas affected by heavy snow. Some problems with vegetable gardens and rice paddies have been reported recently at the foot of the hills, where serows live near to people. Such problems are caused by the expansion of the serow population into areas in which a high level of human activity is taking place.

The expansion of the serow population will continue into the agricultural zone in the plateau in the future, and then crop damage is likely to increase. At the Kurikara Pass, which is on the border of Ishikawa and Toyama prefectures, the serow expansion had stopped until the 1990s, despite continuing in the mountains and forests. One of the biggest reasons for this is that there is little steep land for the advance of the serows.

Recently the serows have expanded into the Noto region, and have spread rapidly in the Houdatsu-san and Sekidou-san mountain ranges more than 40 km from Kanazawa. In the Noto region, it is likely that the damage to plantations will be more significant, because plantations of *ate arborvitae* (*Thujaopsis dolabrata* var. *hondae*) cover wide areas of the mountains.

Therefore, it is now time to consider how to ensure the separation of wildlife from incompatible human activities such as forestry plantations or agriculture, so that tensions do not arise later.

3) Half year's sanctuary

The sanctuary is an area which people do not enter at all during the winter, as there is heavy snow. Only a few of the staff of the hydraulic power com-

pany and mountain climbers enter the mountainous area, up to about 2,000 km². The area is surrounded by the national road routes 156, 157 and 158. The Mountain Festival is held by the people of the Mt. Hakusan region to thank the mountain for the blessings of the year on 8 December every year. There is a custom that people should finish all the work of the year on the mountains and not enter the mountain region again until after the thaw. Therefore, the people leave the mountains to the wildlife until April.

The forest habitat needs to be diverse and secure to be a suitable haven for wild animals. It is also axiomatic that habitats close to agroforestry sites need to be protected to provide security for agroforestry, while at the same time maximizing the wildlife population. Mt. Hakusan can be considered as one of the model areas for biodiversity conservation.

If the administration is divided as at present, it will be difficult to conserve the diversity of natural resources, including the animals. In many cases, the borders of the prefectures lie at the centres of natural forest or protection areas. These areas are important for larger animals because people seldom pass through them. In this range of mountains, a natural area can be one unit for wildlife management but it may lie within the borders of four prefectures. Although Mt. Hakusan appears to be a wide mountain range, it is recommended that an area of the about 1,000 km² bounded by the Tedoru, Kuzuryu and Shokawa Rivers should be regarded as one unit for environmental conservation purposes.

ACKNOWLEDGMENTS

The author would like to thank the members of the Hakusan Nature Conservation Center for their kind co-operation and assistance in collecting information. Thanks are also due to Dr. Katsuhiko Kano and Dr. Ryoichi Ohgushi, an honorary professor of Kanazawa University, and Dr. Yuichi Ono, an honorary professor of Kyushu University, for their help with the revision of this paper. The author also thanks Mr. David Anstey, ex-Advisor to the Ethiopian Wildlife Conservation Organization, and late Dr. Keith Eltringham of Cambridge, UK, for corrections

to the composition.

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