

# Chapter 33

## Sika Deer in Russia

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**Abstract** Sika deer (*Cervus nippon hortulorum*) were originally distributed over much of Primorsky Krai (an administrative division in the Russian Far East similar to a U.S. state) in Far East Russia, occupying coastal and inland valley deciduous and mixed deciduous-pine forests up to about 500 m elevation, with isolated individuals in favored habitat at higher elevations. Their limits to the north extend into southern Khabarovsk Krai along the Ussuri River Valley, and along the seacoast to the village of Malaya Kema. These limits are set by winter snow depth, which also limits their occupation of higher elevations in the Sikhote-Alin mountain range. Sika deer were translocated in the late nineteenth and early twentieth centuries to other countries and to European Russia where they have shown considerable adaptive capacity by acclimatizing to severe winter conditions. Sika deer feed primarily on forest understory vegetation and on herbaceous plants in forest openings. Their native forage is deficient in sodium so they seek sources of salt at the seashore, from mineral soils and springs, or from aquatic freshwater plants with high sodium content. Sika deer displace other ungulate competitors from their preferred habitats and, in high numbers, can have serious impacts on vegetation. There is some interbreeding between sika deer and wapiti, but intermediate phenotypes are rare. Overhunting beginning in the late 1800s and extending through World War II resulted in a severe decline in the sika deer numbers and distribution. At the same time, many sika deer were raised in farms for commercial production of antlers and other products. In the last 25 years there has been an increase in the wild population and expansion of the distribution across Primorsky Krai. Now sika deer occupy most of their original range, apparently colonizing all suitable habitats. Serious anthropogenic pressure, both a loss of habitat and hunting, has not hindered this growth in the number and dispersal of sika deer, although some former habitat along the seacoast has been lost to human development. Sika deer in farms are not very economically viable at present. The re-occupation of the original range consisted of both wild and farm-escaped deer, but genetic studies show that they are all of the original genetic stock. Their increase has occurred despite serious predation pressure by tigers and leopards, and illegal hunting; they are currently managed for sustainable harvest.

## Original Distribution

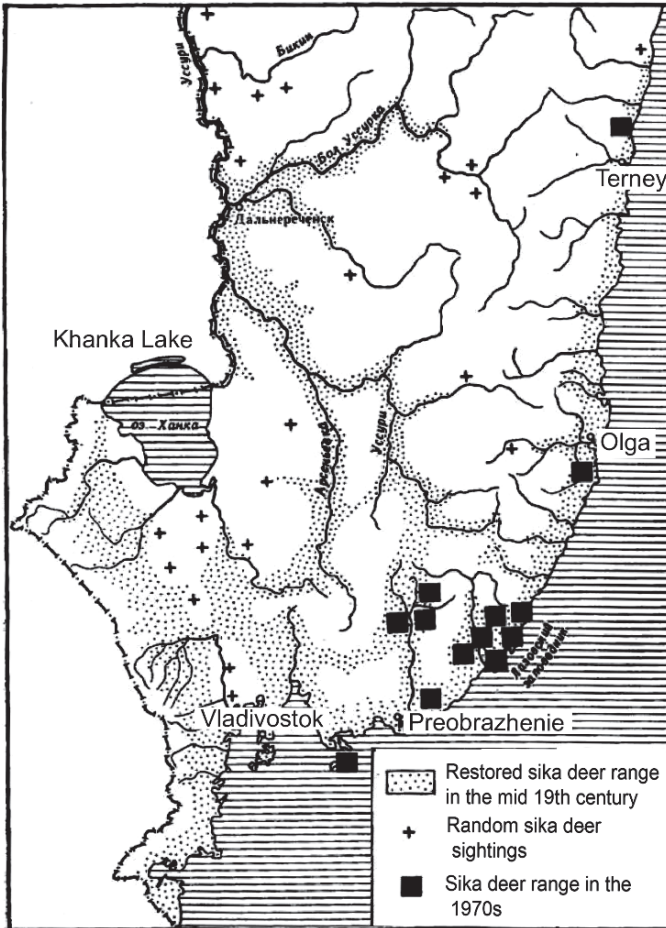
The first references to wild sika deer in Primorsky Krai are found in the works of explorers and researchers investigating the south of the Russian Far East (Maak 1861; Przhevalsky 1870; Yankovsky 1882; Emelyanov 1927; Abramov 1928; Zolotarev 1937; Bromley 1956; Geptner et al. 1961; Bromley and Kucherenko 1983; Arsenev 2003). The numbers and distribution of sika deer in Far East Russia have shown considerable fluctuation over the last century, due primarily to human influences, especially uncontrolled hunting. Climatic fluctuations, while influencing occupation by sika deer of the more extreme parts of the distribution, were minor in relation to the broad-scale impacts of humans that affected the population over their entire range.

Bromley and Kucherenko (1983) provided a map of the approximate range of sika deer in the mid-nineteenth century (Fig. 33.1). The historical distribution of sika deer was principally in Primorsky Krai where sika deer were distributed along the coast and inland along lower elevation river courses (Fig. 33.2). To the west, the original range extended along the Ussuri River as a tongue into southern Khabarovsk Krai and adjacent Heilongjiang Province of China, where the northern edge fluctuated depending on the vagaries of climate and sequences of mild and hard winters.

Until the mid-nineteenth century sika deer, in what is modern Primorsky Krai, occupied primary and secondary oak (*Quercus*) broad-leaved deciduous forests in river valleys and on adjacent mountain slopes to an altitude of about 500 m. On the western slopes of the Sikhote-Alin Mountains deer were regularly encountered as far north as 30 km south of the confluence of the Bolshy Ussurka River with the Ussuri River. From here, and apparently from adjacent areas in China, individual groups, and most likely, lone males, made their way to the foothills and along river courses south of Dalnerechensk. Lone sika deer were often encountered along the Ussuri River valley as far north as Dalnerechensk. This was apparently the extreme northern edge of their range for, since the end of the nineteenth century, there have not been regular sightings of sika deer farther north than Dalnerechensk. Wild sika deer did not range at this time along the Bolshy Ussurka River Valley east of Dalnerechensk.

To the south of Dalnerechensk, until the 1880s sika deer were encountered in almost all oak broad-leaved deciduous forests. At the confluence of the Arsenevka and Ussuri Rivers a mosaic-like distributional range ran along the valleys of the middle and upper drainages of the Artemovka, Ilistyi, Komissarovka, and Nesterovka Rivers that flow into the Sea of Japan and Peter the Great Bay south of 44°N latitude. Sika deer occurred sporadically along these river valleys (Fig. 33.1).

On the eastern slopes of the Sikhote-Alin Mountains, facing the Sea of Japan, the mouth of the Bolshy Kema River was the northern extreme of sika deer distribution although it is not out of the question that these were feral deer that had escaped from farms. Wild sika deer ranged in separate herds farther south of the mouth of the Cheremukhovy, Zerkalny, and Rudny Rivers. A more or less solid, though



**Fig. 33.1** Sika deer range in Primorsky Krai as restored in the nineteenth century (stippled area), and in 1970 (solid squares) (taken from Bromley and Kucherenko 1983).

mosaic-like range, was found along the seacoast to the south of  $44^{\circ}\text{N}$  latitude along the Avvakumovka, Margaritovka, Milogradovka, Chernyi, and Kievka Rivers to the south of Primorsky Krai where deer lived in almost all oak broad-leaved deciduous forest, ranging up mountain slopes to the lower edge of Korean pine (*Pinus koraiensis*)-broad-leaved deciduous forest belts.

Sika deer made their way to the large islands in Peter the Great Bay—Russky, Putyatin, and even the relatively distant Askold—apparently by swimming from the mainland or crossing the ice in winter. There are no data on when sika deer arrived on Askold Island. Information on the Askold Island sika deer population was lacking until the development of mining on the island in the mid-nineteenth century. At that time the deer were hunted by lighthouse workers and miners and, beginning

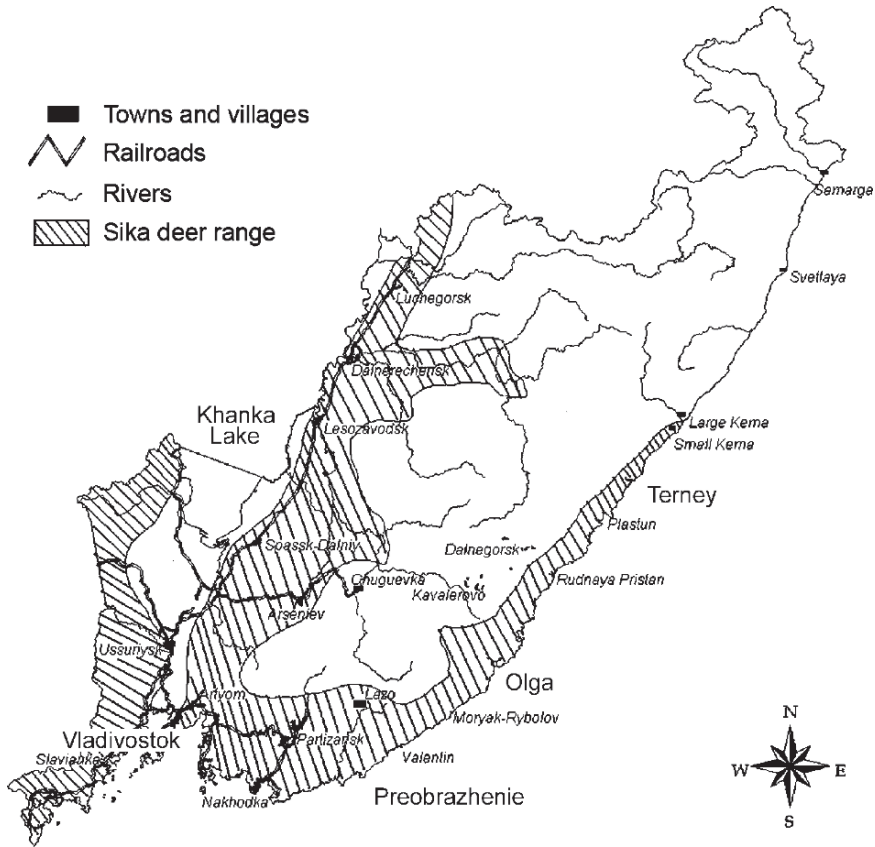


Fig. 33.2 Current distribution (cross-hatched area) of sika deer in Primorsky Krai.

in 1885, by members of the Vladivostok Society of Sport Hunters. In a report on sika deer written by the Vladivostok Society of Sport Hunters (1897), "... deer numbers on Askold Island are high. Their annihilation in other areas of the krai calls for even more dedicated protection on Askold Island. There is no doubt that the Society can effectively carry out such a program since its charter obliges members to establish strict and correct hunting, to protect and breed valuable animals."

An isolated population of deer lived to the west and southwest of Lake Khanka, along the tributary valleys of the Razdolny River and in the Komisarovka and Nesterovka river valleys that flow into Lake Khanka (Fig. 33.1). This population moved along the valleys of rivers (the Kedrovka, Narva, and Poima) flowing from the west into Peter the Great Bay. In the nineteenth century a rare, two-way interchange apparently continued to operate in the tall grass of the Ussury-Khanka plains; this area connected the wild deer of this southwest range with the Sikhote-Alin Mountains. Deer from the western and southwestern areas of Primorsky Krai

made irregular contact with individuals in adjacent areas of China (Bromley and Kucherenko 1983).

Additional references to sika deer in other areas of Primorsky Krai in the nineteenth century do exist but they do not contain detailed habitat descriptions. With the turn of the twentieth century records become more available. For example, Arsenev's diary for 1906 (2003) contains the following: "Earlier the deer's range extended to Svyaty Olga Bay, but as immigrants and Chinese settled southern Ussuriysky Krai, hunters began to aggressively track the animal, and in the last 60 years the animal has been observed moving slowly to the north. Lone deer have now made their way to the Tkhe-Tu-Be (Dzhigitovka) River."

## Farmed Deer

When N. M. Przhevsky visited Primorye in the mid-nineteenth century, the southern portion of the region, where sika deer lived, was sparsely settled by humans. During this period the Chinese began to actively trade in non-timber forest products, including animal products. Antler velvet ("panty"), deer fetuses ("lutai"), tails, and sinew were highly valued. The number of sika deer began to decline markedly and this provided an incentive to establish deer farms. It is likely that deer farming and captive breeding techniques were obtained from the Chinese.

S. Y. Ponosov, the first deer farmer in Primorsky Krai, began breeding deer in Shkotovsky District and subsequently moved his operation to Olginsky District where, in 1912, his herd numbered approximately 500 head. By the beginning of the twentieth century M. I. Yankovsky farmed around 2,000 head: 1,500 on Putyatin Island and 500 at Cape Gamov. There were deer farms at Cape Peschanyi and on Popov, Rikord, and Rimsky-Korsakov Islands, with a number of smaller operations spread out along the coastline and in the Prikhankaisky lowlands; the total number of deer at these latter operations was around 1,500 head.

During the Russian Civil War (1917–1924), and the following period of collectivization, many of the deer farms were destroyed. By the end of 1922 there were around 3,000 head at all the remaining farms. During the Russian Civil War and the consolidation of Soviet power, the number of farm-bred sika deer declined to 3,000 head (Abramov 1928; Menard 1930; Bromley 1956). Subsequent immigrants to the Primorsky region recognized the value of sika deer antler velvet in East Asian markets and they began to re-establish deer farms. By the mid-1920s there were at least 10,000 sika deer in captivity in Primorsky Krai (Ryashchenko 1976).

Deer numbers were saved from destruction at farms during World War II. Sika deer breeding at other locations in Russia began after the war, with the breeding stock having been derived from wild and farm-bred deer in Primorsky. The number of deer at farms was around 20,000 by the mid-1950s (Ilina 1956), and in 1968 that figure reached 36,000. In 1978 there were 56,000 deer, of which 48,000 were located in Primorsky Krai (Sidorov 1980). At the beginning of the 1980s, Bromley and Kucherenko (1983) wrote that "Antler velvet, at the current time, is successfully

obtained from animals living in captivity. Practice shows that for the future acclimatization and re-acclimatization of sika deer, it is significantly simpler, from a technical point of view, to use animals from deer farms than wild animals. Wild sika deer should be kept and used only to occasionally revitalize the genetic fund of farm-bred deer.”

By the mid-1980s the number of farm raised deer reached 60,000, with 15,000 deer located in the Altai region (Bogachev et al. 1983). Sika deer farm collectives in Primorye were located along the coast of southwest Primorsky, in the Prikhankaisky Lowlands, and along the Sea of Japan coastline to the east and north of Vladivostok to Port Plastun. Deer held at farms regularly escaped and mixed with wild deer, while at the same time deer farmers regularly set live traps along the perimeters of farms and successfully captured wild deer to supplement their captive herds.

Farm-raised deer today are not experiencing the best of times in Primorsky Krai. This is a consequence of a drop in the price for antler velvet on foreign markets and the lack of demand on domestic markets. Antler velvet and hides currently have almost no value. All government and collective deer farms have been purchased by private owners. The sector, due to low prices for its products, is not expanding, deer numbers are dropping markedly, and the number of captive deer in Primorsky Krai is currently less than several thousand. Although they face similar problems, deer farms in the Altai region are surviving. Sika deer released in the late twentieth century at hunting collectives in western Russia are a common commercial hunting target.

## Relocation to European Russia and Other Countries

Two hundred forty head from Primorsky Krai deer farms were released in Russian *zapovedniks* (nature reserves): Khopersky, Teberdinsky, Zhigulevsky, Buzuluksy Bor, Oksky, Ilmensky, and Mordovsky in 1938 (Arsenev 1949; Ilina 1956; Pavlov et al. 1974). These animals acclimatized in different ways. In the second half of the twentieth century farm-bred deer from Primorsky Krai and the Altai were introduced at the Khopersky and Askaniya Nova Zapovedniks in the European portion of Russia. The current number of sika deer outside their natural range is 3,700 (Danilkin 1999).

In the late nineteenth and early twentieth centuries, sika deer were exported to other countries, including Ireland, Denmark, Czechoslovakia, and other European countries. In 1900 Primorsky sent 15 head to New Zealand where there are now tens of thousands of sika deer (Bromley and Kucherenko 1983).

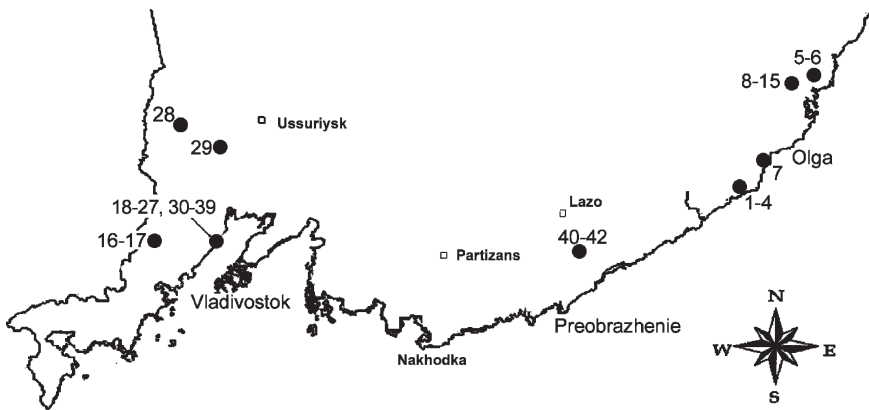
## Genetics

Following the dramatic decline in wild sika deer numbers in the 1940s and 1950s, several Russian wildlife specialists asserted that genetically pure sika deer were to be found only in Lazovsky Reserve and adjacent areas (Prisyazhnyuk 1974,

1978; Bromley and Kucherenko 1983). They held that there were two forms of sika deer in the population in Primorsky Krai: wild sika deer of the original stock, and individuals derived from farm-raised animals. According to Prisyazhnyuk (1978), the domestic sika had a smaller body and antlers, its internal organs weighed less, and it differed in several biochemical indicators in comparison to wild deer. Fifteen years later, however, the first tentative statements appeared that the differences cited above “fall into a range of differences and modifications within a single subspecies” (Bogachev and Alymov 1990).

Modern DNA analysis techniques now allow us to rigorously examine the relationships among sika deer in Primorsky Krai. In 1999 we collected skin samples from sika deer at various locations throughout their modern range in Primorsky Krai. Samples were taken from 42 deer: 24 deer at the western extreme of their range, four from the wild and 20 from deer farms; 18 samples were taken from their eastern range in the Sikhote-Alin Mountains, 10 from the wild and eight from deer farms (Fig. 33.3). Three of the samples came from wild deer in the Lazovsky Reserve. According Wilson (2000) and Simon Goodman et al. (unpublished data), analysis of DNA samples for sika deer in Primorsky Krai showed a high degree of genetic diversity for this subspecies in comparison with other subspecies. However, the results indicated that there are no genetic distinctions between farmed and wild deer.

Taking genetic, demographic, and geographic factors together, we consider the sika deer in Primorsky Krai to be a single native population. This was to be expected since sika deer initially captured for farms in Primorsky Krai were taken from the wild around 100–150 years ago. Genetic change in such a short time would not be expected, especially since farm-bred deer have regularly intermixed with wild deer. Neither is it likely that a native form of sika deer would arise in Lazovsky and Olginsky Districts since in the late nineteenth and early twentieth centuries both areas contained privately owned deer farms and in the 1970s two



**Fig. 33.3** Location of tissue sample collections (dots, numbers) in Primorsky Krai, Far East Russia for DNA analysis.

large, state-run farms, one in the village of Glazkovka (Lazovsky District) and another in the village of Vesely Yar (Olginsky District) were operating. The breeding stock for these collectives was Primorsky-derived from deer farms located in southwest Primorsky Krai.

## Conservation Status

Despite the lack of genetic distinction between native and farm-bred sika deer in Primorsky Krai, wild sika deer are included on the Russian Federation Endangered Species List (IUCN Red Book) and noted as a “native population.” Hunting sika deer is prohibited in Lazovsky and Olginsky Districts of Primorsky Krai. The sika deer on Askold Island, located in Peter the Great Gulf, are also listed in the Red Book. At the time sika deer were added to the USSR Red Book, many scientists believed they survived only in Olginsky and Lazovsky Districts, and on Askold Island, so these were the only regions described in the Red Book.

## Population Size Changes over Time

According to longtime residents and hunters, until the mid-nineteenth century there were around 25,000 sika deer in Primorsky Krai. The highest density was along the shores of Peter the Great Bay and to the north along the Sea of Japan coast to Olga Bay (Fig. 33.1). The oak and the mixed broad-leaved deciduous forests preferred by sika deer still dominate in these areas (Bromley and Kucherenko 1983).

Populations declined sharply in the first half of the twentieth century although there are no solid census figures. Abramov (1939), at the end of the 1920s, estimated the number of sika deer in the Russian Far East at 900–1,100 head. As a result of the Civil War, localized military conflicts (during the 1930s and 1940s), and World War II (1941–1945), the number of wild deer dropped precipitously. This was partially a consequence of no control of hunting during war times and also the creation of special brigades to shoot wild ungulates to supply the army. Heavy winter snows and predator impacts also took a toll on deer numbers. By 1949 the number had fallen to about 300 (Bromley 1956), 150 of which were located in the Sudzukhinsky (later named Lazovsky) Reserve, about 20 in the Sikhote-Alin Reserve, up to 30 in both the Suptinsky (later named Ussuriisky) and the Kedrovyy Pad Reserves, with 60 or more outside of the reserves (Geptner et al. 1961).

The creation of reserves provided protection for the remaining deer until the outbreak of World War II. In 1938, as conflict with Japan escalated, the Red Army opened the Far Eastern Front. Initially manned by two army units, an additional unit was added two years later. The term “front” in Soviet military language meant army units numbering from several hundred thousand to a million soldiers. A single unit required up to 60,000 head of cattle a month for rations (Suvorov 1998).



On April 13, 1941 Russia signed a neutrality agreement with Japan. Even so, the army units in Far East Russia were not decommissioned.

The Far Eastern Front ran from TransBaikal to Primorsky and one of the three units was stationed in the south and southwest of Primorsky, that is, in sika deer habitat. Special brigades operated between 1938 and 1947 whose mission was to shoot wild game to supply the army with meat. These brigades operated year round, and despite their small size—four or five soldiers with a vehicle and a horse-drawn trailer—they took several hundred ungulates a year (I. N. Nesterenko 1985 personal communication). Local people also hunted wild ungulates since livestock was annexed in full for the war effort (N. P. Ponomareva 2002 personal communication). The pressure from such unregulated hunting was bound to have an impact on sika deer numbers.

The war years nearly wiped out the sika deer population in the southwest and west of Primorsky Krai; in the southern end of the Sikhote-Alin Mountains sika deer remained alive only in the areas difficult to access along the coastline between Port Olga south to Vrangel on Nakhodka Bay. In Kedrovyy Pad Reserve, created in 1916, there were 90 head in 1924, and by 1928 around 200. Later the population grew to 300 but by 1948 less than 30 remained. By 1967 there were no sika deer at all left in Kedrovyy Pad Reserve (Bogachev 1982). In the Sudzukhinsky (Lazovsky) Reserve the number was around 500 by 1936, but by 1944 the population had decreased by half and in 1948 there were only 150 (Bromley 1956, 1981). Census data for 1974 in Lazovsky Reserve showed 280 deer (Prisyazhnyuk 1975a, b). There were around 30 deer in the Sikhote-Alin Reserve in 1935 (Pavlov et al. 1974). The approximate distribution of sika deer in the 1970s is shown in Fig. 33.1.

In the 1950s and 1960s farm-raised deer from collectives were introduced into Primorsky Krai reserves. Deer were introduced into the Suputinsky (Ussuriisky) Reserve in 1950 through 1952 (Pavlov et al. 1974). Seventeen deer from the Silinsky deer farm collective were introduced into the Kedrovyy Pad Reserve in 1968. By 1974 there were fewer than 40 deer in Kedrovyy Pad, including deer that may have escaped from the Amursky deer farm collective. Fifteen to 18 deer were released into the Ussuriisky Reserve in 1960 and 10 more in 1962 (Bogachev 1982).

The deer population increased thereafter. Dormidontov (1977) estimated there were 1,000 wild sika deer in Primorsky and Pikunov et al. (1973) reported 670–700 in the 1960s all mainly in the Lazovsky Reserve, Khasanskii District, and on Askold Island. Tracking sika deer dispersal across their entire range is problematic since no special research of this kind has been undertaken and survey data are contradictory.

Sika deer recovered from low population numbers and restricted distribution following excessive hunting in earlier years, and this process continued over the last few decades. By the end of the 1960s in Olginsky District, groups of sika deer remained in locations difficult to access along the coast from Moryak-Rybolov Bay to Olga Bay. According to V. M. Mashutin, the manager of the Nizmenny lighthouse, at the beginning of the 1960s the number of sika deer was less than 100. By the early 1980s sika deer were widely dispersed, their numbers difficult to estimate, and the wapiti (*Cervus elaphus xanthopygus*) had by then all but disappeared near the lighthouse. Makovkin (1999) also reported that sika deer replaced wapiti in

Partizansky Creek during their expansion, thus showing the competitive dominance of sika deer as presented in greater detail below.

In the early 1980s sika deer began to intensively colonize the Vasilkovka River Valley, which is 10–15 km from the coast. By the early 1990s they began to colonize the left tributaries of this river, and by 2000 they had moved up into elevations of 600–700 m, 25–30 km from the sea. Sika deer dispersed with equal rapidity into the interior of the coastal mainland.

Not just wild sika deer colonized the area in the 1960s and 1970s, but also deer that escaped from deer farms at the villages of Valentin (Lazovsky District), Vesely Yar (Olginsky District), and Plastun (Terneisky District). They also dispersed along river valleys. In 1983 sika deer occupied the steep southern slopes in the middle drainage of the Avvakumovka River, and in 10 years had stretched upwards along the river and its branches for a distance of 30–35 km. Dispersal across Olginsky District at this time was 3–3.5 km a year.

Observations on sika deer since 1982 for Olginsky and Lazovsky Districts reveal that deer distribution has moved 5–10 km inland from the coast. Over time, sika deer have spread along river valleys and across low mountain passes in directions leading away from the sea and, in the last 20 years, they have moved 60–80 km inland along river valleys. According to Makovkin's (1999) observations, as soon as the number of sika deer in Lazovsky Reserve exceeded 500 and the forage in the coastal areas was exhausted, the deer began to colonize adjacent areas. This process was gradual and the rate was not uniform for all areas. Indicative of the process is Benevka River, where colonization occurred from two directions: from the sea coast across the Zapovednyi Ridge and along the Kievka and Benevka River Valleys. The deer colonized the area much more quickly from the coast, the rate reaching 5 km a year. From the south, the valleys were colonized only half as quickly.

## Current Distribution

Sika deer currently occupy the range that they occupied in the mid-nineteenth century (compare Fig. 33.1 with Fig. 33.2). A comparison of the modern range with a reconstructed range reveals some differences in the survey data from the nineteenth century that can logically be explained as data gaps. The sika deer apparently now occupy all suitable habitats in the south of the Russian Far East.

Most sika deer in Far East Russia live in Primorsky Krai, although in recent years there have been regular encounters with groups of animals and lone deer in southern Khabarovsk Krai in the eastern tributaries of the Ussuri River. The northern most location for sika deer in the Ussuri River valley is the city of Vyazemsky in Khabarovsk Krai.

Their range in Primorsky Krai consists of three interconnected areas. The southwestern area is in southwest Primorye, in the Cherny Mountains, and on the Borisovsky Plateau where sika deer range from the seashore to the border with

China. Isolated populations of sika deer are found on the left bank of the Tumangan River, in the mountains along the southern portions of Ekspeditsy Bay. A north-west area is located to the west of Lake Khanka, on the Pogranichny Ridge, and in the forested portion of the Prikhankaisky lowlands. Contact with the southwest group takes place across forested areas in the headwaters of the Slavyanka and Nesterovka Rivers.

The main group is located in the Sikhote-Alin mountain system. The southern boundary of the range crosses from the mouth of the Razdolny River and runs along the coast to the east, and then up the coast, to the north, to the port of Rudny Pristan. Sika deer densities decrease to the north toward the left bank of the Dzhigitovka River. Sika deer are found on a regular basis starting at the left bank of the Dzhigitovka River and running to the village of Ternei, this being the territory of the Sikhote-Alin Biosphere Reserve (Zapovednik). North of Ternei the deer range to the village of Malaya Kema, and individuals are spotted near the village of Amgu. See Voloshina and Myslenkov (chapter 34) for a more detailed discussion of sika deer at the northern edge of their range in Russia.

A purported natural break in sika deer range in Primorsky Krai along the Razdolny River Valley (between Vladivostok and Lake Khanka; Figs. 33.1 and 33.2) is not an insurmountable barrier. Although the valley is characterized by urbanization and agriculture, there is sufficient remaining habitat to allow passage of some deer. A broad-leaved deciduous forest runs along the Vladivostok–Ussuriisk highway and railroad right-of-way and the Razdolny River valley is largely meadow containing areas of wetlands overgrown with reeds 2–2.5 m tall, and areas of sparse forest and scattered individual trees. Sika deer swim well and the Razdolny River is not a serious obstacle; in winter deer cross the river on the ice. During recent Amur leopard (*Panthera pardus orientalis*) field surveys, fresh sika deer tracks were regularly encountered crossing the Razdolny-Khasan highway and moving into the Razdolny River flood plain.

## Sika Habitat and Its Condition

Sika deer in Primorsky Krai live primarily in oak broad-leaved deciduous forests and mixed broad-leaved-Korean pine forest of the Manchurian flora subregion. The distribution of sika deer and these mixed forest types are nearly identical. These forests have well-stocked undergrowth. The region's slopes support abundant broad-leaved deciduous forests of *Quercus mongolica* (oak), *Tilia amurensis* (linden), *Acer tegmentosum* (maple), *Fraxinus mandshurica* (ash), *Phellodendron amurense* (Amur cork tree), *Juglans mandshurica* (Manchurian walnut), *Aralia elata* (aralia), *Lespedeza bicolor* (lespedeza), and other heat-loving plants. They grade into Korean pine stands at the higher elevations. These forests contain numerous small meadows and light gaps, and shady valleys and gullies that are very suitable for sika deer (Bromley and Kucherenko 1983). Sika deer are less often encountered in Korean pine-broad-leaved deciduous forests above 500 m and are

entirely absent from Korean pine-dark coniferous taiga. In river valleys sika deer are found in broad-leaved deciduous valley forests and low-light coniferous valley forests. On the eastern macro-slope of the Sikhote-Alin Mountains sika deer are found in both broad-leaved deciduous and narrow-leaved forests.

Sika deer also like forests where fire promotes young growth as well as narrow-leaved deciduous forests. Extensive or repeated fire, conversely, is a genuine habitat threat and is, as a rule, human-caused to promote agricultural or forestry purposes. Fire completely destroys the forest understory, and herbaceous species composition decreases with repeated fires.

Depending on forage availability and degree of protection, deer density changes in various habitat types. Deer distribution is restricted by elevation and degree of slope. They prefer gentler slopes. Sika deer currently live year round in southwest Primorsky Krai at elevations up to 800–900 m. On the eastern macro-slope of the Sikhote-Alin, depending on the latitude, sika deer use habitats at 600–700 m, and on the western macro-slope 400–500 m.

## Winter Snow and Sika Deer

The key factor limiting sika deer distribution is snow depth. Wild sika deer are typical representatives of thermophilic fauna of the south of the Russian Far East. The subspecies *C. n. hortulorum* occurs at the extreme distribution of its ecological range in Primorsky Krai. Prime sika deer conditions occur where: (1) winter snow totals do not exceed 800–1,000 cm; (2) the first snowfalls are comparatively late in the season; (3) there are fewer than 45 days of snow cover; and (4) the average snow pack is less than 25–30 cm.

Sika deer are encumbered in snow deeper than 40–50 cm and are helpless in very deep snow. Consequently, in winter sika deer seek the southern and southeastern coastal areas of Primorsky, a 10–15 km wide forest belt adjacent to the Sea of Japan. The deer prefer south and southeastern facing slopes where the snow pack as a rule does not accumulate. Southern Primorsky generally has little snow and what does fall usually remains on the ground for relatively short periods (usually not more than five to eight days), and is often melted by rain (Abramov 1928, 1939; Bromley 1956). Topographic relief plays a significant role since on steep slopes snow depth is always less, and the snow is more quickly dispersed by wind and sublimated by the sun.

The severity of winter influenced deer numbers, particularly during periods when their populations were high. Bromley and Kucherenko (1983) examined the data for 70 years during the twentieth century, and deep-snow winters have been registered 11 times: 1909–1910, 1914–1915, 1924–1925, 1932–1933, 1941–1942, 1947–1948, 1957–1958, 1961–1962, 1965–1966, 1972–1973, 1978–1979. From our data in Sikhote-Alin there was a deep-snow winter in 1985–1986, but it did not extend to the coast where the major part of sika deer range was located. We have not observed mortality of deer due to deep snow in recent years.

## Migration

Long migrations of sika deer in Primorsky Krai have not been described. In the opinion of many authors, sika deer in Primorsky Krai are a resident, non-migratory species (Bromley 1956; Prisyazhnyuk 1974; Bromley and Kucherenko 1983). Although some sika deer in the interior distribution at highest elevations may migrate seasonally like sika deer in Japan (Igota et al. chapter 19; Yabe and Takatsuki chapter 20) and as do some wapiti (32% of the population) in the Sikhote-Alin Reserve in Far East Russia (D. Miquelle 2001 personal communication), most parts of the sika range in Primorsky Krai are low elevation habitats and coastal environments.

Thus, sika movements in response to snow tend to be short in distance, and often reverse repeatedly in direction as snow falls and melts over the winter. From our observations, there are short vertical local shifts when depth of snow increases. Sometimes heavy wet snow breaks down young trees, and incidentally results in bringing food within reach of sika deer, which counteracts the difficulty of deer moving around in deep snow. Sometimes sika deer simply move to steep slopes with a southern exposure where snow does not accumulate. These movements are from several kilometers up to several tens of kilometers long and are directed downwards into valleys of springs and rivers. Most of these movements are probably best viewed as local shifts rather than seasonal migrations.

The longer movements are observed in deep snow winters, when the general direction of movement is toward the seashore, where the depth of a snow cover is always lower. On our counting areas at the seashore, where average population density is 2.5–3.0 per km<sup>2</sup>, in deep snow winters population density is seven to 10 per km<sup>2</sup>. Because such movements are irregular depending on snow depth, it is debatable if they constitute migrations. Movements of sika deer on the interior margins of their range in Primorsky Krai have hardly been investigated. Very likely a large sample of radio-tracked sika deer would reveal some small percentage of the population in the highest elevations of their distribution that performs what could be considered seasonal migrations, but that must await further study.

## Food Habits and Use of Salt

Sika are predominantly a “disturbance” species, using wooded areas for escape and shelter, and coming into forest gaps or other disturbed areas for feeding. Post-harvest oak stands are rich in herbaceous and shrub layers and in sedges, grass, and mixed grass meadows. Our observations show that sika deer are not fastidious feeders, and this is especially obvious in winter. In contrast to wapiti and roe deer (*Capreolus pygargus*), a herd of 25–30 sika deer can live in an area of 10–15 ha for 15–20 days. Wapiti and roe deer occur in small groups and move about more regularly to obtain preferred forage species.

Since sika deer habitat in Primorsky Krai is sodium-deficient, the deer must find ways to supplement sodium in their diet. If additional sources of sodium are not available, habitat quality declines (Aramilev 2000). There are three natural sources of sodium in Primorsky Krai: (1) seaweed, (2) natural mineral salts (*solonetz*) from mountain rock and soil deposits or from springs, and (3) halophytic freshwater vegetation in rivers. All three sources have high sodium concentrations, 10 or 100 times that of the sika deer's typical forage (Aramilev 2002). Artificial salt licks set up by hunters provide additional non-natural sources of sodium.

The most readily available source of sodium, seaweed on coastal beaches, coincides with their preferred habitat. Deer regularly visit beaches in coastal bays covered with seaweed provided these bays have not undergone extensive anthropogenic impact. Makovkin (1999) repeatedly refers to the intensive use of seaweed both in Lazovsky Reserve and in areas outside the boundaries of the reserve.

The deer living along river valleys and in low elevation areas 40–50 km from the sea journey to the sea. The deer living at the more remote territories seek out natural mineral *solonetz* deposits; these occur on the Lazovsky and Ussuriisky Reserves. Another sodium source for the deer is freshwater vegetation in rivers like Vasilkovka and Avvakumovka Rivers in Olginskii District. We have studied natural mineral *solonetz* formed from outcrops of zeolite, a mountain rock at Lazovsky Reserve, and *solonetz* deposits at mineral springs in Ussuriisky Reserve. In both cases, based on tracks and visual sightings, our observations confirm that sika deer actively visit these locations.

According to Makovkin (1999), sika deer use the mineral springs on Sukhoi Creek year-round, although the most active period of sodium uptake is April and May. As many as 15–20 deer visit a site at a given time. In the area surround Melkovodny Bay most deer replenish sodium needs at a natural *solonetz* located about 2 km from the sea. The deer fearlessly visit this site, even during the day. In mid-May 1984, in 3 h of observations between 1400 and 1700 h, 17 deer made their way to the *solonetz*. Further evidence that this *solonetz* is used very intensively is the enormous pit that has been dug where deer eat the “salty” clay.

During field research on the Avvakumovka River and its tributaries, we discovered bays with freshwater vegetation containing elevated concentrations of sodium; sika deer actively visit these areas.

## Impacts on Sika Habitat by Humans

Sika deer habitat has undergone serious anthropogenic changes since the mid-nineteenth century, but timber harvest is not the primary problem. The broad-leaf deciduous and coniferous-broad-leaved deciduous forests that sika deer prefer, as a rule, have very little commercial-grade ash or oak, the major timber species at present in Primorsky Krai. In fact, small patches of logging increase the forage opportunities for deer because grasses and sedge, oak seedlings, and young, broad-leaved softwood species grow rapidly. Selective cutting of oak and the harvest of birch for firewood by local people has the same effect.

The main human impact was the establishment of towns and villages, vacation areas, and camping spots along the seacoast in the last 150 years. The bays on the eastern shoreline of Primorsky Krai, from Vrangal to the village of Malaya Kema, have experienced human development in some sections so that access to the sea is blocked. This has seriously reduced the primary sika deer habitat. The bays suitable for the deer as additional sources of sodium are now intensively used by commercial fishermen, farmers, and vacationers. In last 150 years sika deer have lost around 15–20% of their best habitat.

## Impact of Sika Deer on Their Environment

Sika deer are conservative in selection of habitat. If left undisturbed, they will remain for a long period in a limited area. To collectively overcome difficult winter conditions, dozens, and sometimes hundreds of deer will gather in some areas. There are extensive hectare-sized fields in coastal oak groves on the eastern macro-slope of the Sikhote-Alin Mountains where the deer give no relief to the young oak trees, foraging on young shoots. Some of the oaks die, others continue to attempt to put out new shoots.

Along the seacoast from south of Olga to Nakhodka is a belt of oak forests with a park-like appearance that lacks the shrub and herbaceous strata. On southern, steep slopes protected from winter sea breezes, where deer group up in winter, the grass cover, herbaceous growth, and shrub layer are destroyed by deer feeding and trampling. Deer incessantly gnaw the bark of deciduous tree species such as maple, linden, and elm, similar to deer in Japan (Ando and Shibata chapter 15). Deer also congregate when seeking seaweed at the coast, resulting in destruction of forage areas and damage to soil cover. Thus, sika in Russia can have impacts on the environment as severe as those reported for Japan.

According to Makovkin (1999), deer have completely destroyed the understory on test plots set up by the Preobrazhensky Forest District in the coastal area of Lazovsky Reserve. Forest-forming species such as linden, Amur cork tree, Manchurian walnut, Japanese ash, Mongolian oak, various maple species, and others are entirely absent. Such species as aralia, *Lonicera maackii* (honeysuckle), *Rubus komarovii* (raspberry), *Actinidia kolomikta* (magnolia vine), *Sumphoricarpus vulgaris* (snowball berry), *Philadelphus tenuifolius* (syringa), *Panax ginseng* (Siberian ginseng), *Acanthopanax sessiliflorus* (acanthopanax), *Euonymus sacrosancta* (wahoo), and *Ribes komarovii* (currant) have disappeared. *Corylus heterophylla* and *C. mandshurica* (Siberian and Manchu) filbert trees are browsed down everywhere. To forage on the thinnest, and thus, the highest shoots, sika deer break the filbert stems, thus causing significantly more damage than by simply feeding. According to Konkov (1999) the area of very great damage to vegetation in Lazovsky Reserve now covers 33,000 ha, or one quarter of the reserve.

Makovkin (1999) also notes that in the coastal zone of the Lazovsky Reserve there has been no reforestation for almost 20 years, and a number of tree species have begun to disappear from the composition of the forest. Some simply reach a certain age limit and die; other small trees are weakened by frequent browsing, and are unable to withstand the autumn and winter winds and are blown down, disturbing the surrounding ground. Since the root area of an upturned tree can cover 10 m<sup>2</sup>, the damage to the forest is significant.

Ugolny Bay illustrates the impacts of sika deer on a landscape. Herds of up to 90 deer can be found seeking sodium in April and May when the snow is deep elsewhere. The gentle coastal terrace, with its abundant grass and thin stands of bushes, is a preferred deer foraging area. Under the pressure of endless grazing and trampling, the vegetation at Ugolny Bay has disappeared, and following two catastrophic floods, the characteristic 25–30 cm thick dark brown topsoil layer has washed away to the bedrock (Makovkin 1999).

Sika deer also exert a serious impact on the young growth of coniferous species. According to Makovkin (1999), deer have damaged 99% of the 1,532 Korean pines left at Ugolny Bay. Sixty percent have antler damage. Fourteen percent of the total damaged trees have died.

The level of damage outside the reserve depends upon population density. Even so, when a deer herd remains in a limited area for an extended period of time, forage is damaged. A herd of 20–25 deer has repeatedly spent seven to 10 winter days on a 5-ha area near our field station in Avvakumovka River (Olginsky District). Following such extensive forage damage, wapiti and roe deer refrain from visiting the area for five or six years, until such time as the understory regrows.

## Recent Sika Deer Density and Numbers

Since the mid-1970s, in large part due to improved protection and several winters with little snow, there has been a significant and rapid increase in sika deer, both in its natural range and in reintroduction areas. By the early 1980s there were 1,400–1,600 head in Primorsky Krai (Petrashev 1993), and by mid-decade the number was 2,500 (Khakhin and Prisyazhnyuk 1985), although these reported figures were significantly lower than official data which estimated sika deer numbers at 10,000. Numbers in the 1990s declined dramatically: 1991 = 7,100, 1992 = 6,000, 1993 = 5,000, 1994 = 4,700, and 1995 = 5,900 head. From 1989 until 1994 the number of sika deer steadily declined by an average of 10% per year. There was a significant 25% increase in 1995. Typical sika deer densities in 2002 (Aramilev and Aramileva 2002) are given in Table 33.1. Density declines as one moves from south to north in the sika deer distribution because of natural reductions in the carrying capacity of the habitat.

This general dynamic for sika deer numbers in Primorsky Krai is similar to what was also observed for roe deer, which were subjected to similar hunting pressures.



**Table 33.1** Sika deer densities in various habitat types (site survey in Olginsky and Lazovsky Districts, Primorsky Krai).

Habitat type	Survey area (ha)	Average density/1,000 ha (minimum–maximum)		
		North	Central	South
Hilly broad-leaf deciduous forest	20,000	2.0 (1.0–3.0)	9.0 (4.0–30.0)	16.0 (7.0–26.0)
Low elevation broad-leaf deciduous forest	20,000	7.3 (5.0–11.0)	6.8 (1.0–16.0)	25.4 (12.0–77.0)
Low elevation coniferous deciduous forest	20,000	1.0 (1.0–1.0)	3.0 (1.0–9.0)	17.0 (1.0–61.0)

Note: North – Northern and central portion of Olginsky District

Central – Southern portion of Olginsky District

South – Lazovsky District (outside of the Lazovsky Reserve)

## Competition with Other Ungulates

A notable feature of sika deer in the south of the Russian Far East is competition with roe deer and wapiti (Makovkin 1999). The sika deer displace wapiti and roe deer from the sika's preferred habitat. In some cases the sika deer have displaced goral (*Nemorhaedus caudatus*) as well. Sika deer compete with goral only in coastal areas. A high sika deer density will force the goral to forage on cliffs inaccessible to the deer.

Habitats of roe deer in places where sika deer are found are broad-leaved forests, cedar-broad-leaved forests, and narrow-leaved forests on hills and low mountains. Also roe deer live in valley forests, including farmlands. Roe deer in Primorsky Krai live in open landscapes where sika deer do not live. Therefore, when sika deer occupy roe deer habitats, roe deer use areas and forages less suited to sika deer. Roe deer also began to shift into cedar-broad-leaved forests in mid-mountain elevations and in logged areas less used by sika deer. Another roe deer strategy to avoid sika deer is to retreat into low and mid-elevation coniferous forests that have a shallower snow pack; something significant for roe deer. Forage availability is less than in broad-leaf deciduous forests, but the underbrush and herbaceous growth along creeks provide a way for roe deer to survive in winters with deep snow.

Even though sika deer are smaller in size and weigh less than wapiti, sika deer displace the latter into the mountains or to the north. There have not, however, been observations of direct aggression, so the displacement appears to be driven primarily by competitive exclusion. Observations of sika deer foraging amidst groups of wapiti are common. We have repeatedly found sika deer and wapiti foraging together with no aggression between the species being observed. We have also encountered wapiti bedding areas adjacent to the bedding areas of sika deer.

Where sika have been introduced to areas of Europe and New Zealand, hybridization with red deer and wapiti has been a major concern (Bartos chapter 39; Swanson and Putman chapter 40; Banwell chapter 42). Here in Far East Russia, the only place where the natural ranges of sika and wapiti overlap, hybridization

also occurs. Female sika deer have been encountered in the wild with young male wapiti, and a hybrid between sika deer with wapiti, with the latter's rack and other mixed features, has been encountered. Because the sika lineage split originally from the wapiti lineage (Tamate chapter 4) it is likely that the two species were isolated for considerable times during climatic changes in the past, and the current overlap on the extremes of their respective ranges represents a secondary contact.

DNA analysis of 42 sika deer previously noted in the section on genetics showed that hybridization with wapiti does occur occasionally, but it is fairly rare (S. Goodman 1999 personal communication), as would be expected from the fact that sika deer usually displace wapiti from their common ranges. Thus, hybridization must be occurring only on the fringes of the sika deer distribution. This is similar to the situation reported of sika and red deer in the British Isles (Swanson and Putman chapter 40). No  $F_1$  hybrids (first generation) were found, only backcrosses, which indicate that the hybrids were fertile. Both species show introgression of alleles from the opposite species suggesting that hybridization is not a recent phenomenon, but has occurred over a long time period.

Despite occasional hybridization, most individual deer retain the phenotype of sika or wapiti, much like has been reported when hybridization occurs where sika has been introduced into red deer (Swanson and Putman chapter 40) or wapiti (Banwell chapter 42) ranges in other countries. These results points to natural ("disruptive") selection against hybrids with intermediate phenotypes. Thus, even though hybridization does occasionally occur, hybrid swarms of intermediate phenotypes have not developed, even though hybridization has been happening for a long time. This suggests that the sika and wapiti are "good" species, and should be retained despite some difficulties with the biological species concept in the strictest sense.

Hybrids of sika deer and roe deer do not occur, and as previously noted, roe deer do abandon forage areas used by sika deer to occupy forest free valley areas and agricultural fields.

## Predation

As their range and numbers increased, the significance of sika deer as prey for the Siberian tiger (*Panthera tigris altaica*) and Amur leopard (*P. pardus orientalis*) also increased. Food habits studies in southwest Primorsky Krai in 2000–2001 show that fur and bones of sika deer are present in 67% of the scats of the leopards ( $n = 87$ ); sika deer fur was found in 100% of the tiger scats ( $n = 27$ ) in this region (author's unpublished data). In sika deer habitat in the Sikhote-Alin Mountains 70% of the tiger kills were of sika. The other 30% of kills examined were wild boar and wapiti. These findings, from 2000 through 2002, were during a period when wild boar numbers in this area were high. It would appear that when wild boar numbers are low, the percentage of sika deer killed by tigers is even higher.

Kucherenko (1985), who worked in sika deer habitat in Olginsky District in the 1970s, does not include the sika deer in his list of tiger prey. In a book about the Lazovsky Reserve (Valova et al. 1989), it is written that "... with an increase in tiger numbers within the Zapovednik, the role of the sika deer as prey also increases. Annually, within the Zapovednik and in adjacent areas, there are from several to a dozen incidents of sika deer killed by tigers." This same publication states that "... lynx (*Lynx lynx*) inflict considerable damage in years with heavy snow, when the deer concentrate in small areas making hunting easier. In 1966, in three winter months, in the area of Proselochnyi, several lynx killed 12 deer, which was more than 10% of the herd that was overwintering in that area."

Pikunov and Korkishko (1990) showed that in the 1970s, in southwest Primorsky Krai, leopards only occasionally preyed on sika deer, but in the 1980s, the sika deer became its main prey. Incidents of leopards and tigers killing sika deer are regularly recorded during Amur leopard surveys (Aramilev and Fomenko 1999, 2000).

In the 1960 and 1970s, when tiger numbers in the Sikhote-Alin were lower, wolves were reported to attack sika deer. As a rule, wolves preyed on sika deer at the end of winter when overflow ice appeared. Wolf attacks on sika deer in southwest Primorsky Krai have also been reported in recent years. However, as tigers have increased from earlier over-hunting, wolves have declined. In both Lazovsky Reserve (Makovkin 1999) and Sikhote-Alin Reserve (Miquelle et al. 2005) as tiger populations came back, wolves went to extinction, suggesting competitive exclusion. Thus, the predation picture for sika deer is complicated by variations in numbers of competitors and predators, and the human influences on all of them.

## Hunting

The first information on sika deer hunting in Russia is found in Przhevalsky (1870), Yankovsky (1882), Baikov (1915), and Arsenev (2003), in reports and other archive materials. According to Przhevalsky (1870), a herd of 40–60 sika deer was located in the outskirts of Vladivostok and sika deer meat for sale on local markets was significantly less expensive than beef. According to Yankovsky (1882), there were so many sika deer in the south of Primorsky Krai that up to 400 pairs of antlers could be taken. Herds reached several hundred head in some areas of southern Primorsky Krai and even the most mediocre of hunter could take five to 10 sets of antlers without much trouble; to shoot a couple of deer in the winter for meat presented no problem (Ryashchenko 1976).

The Vladivostok Society of Sport Hunters annually shot deer on Askold Island to finance its activities. Between 14 and 19 sets of antlers were taken annually, with a pair selling for 80–300 rubles, this at a time when a cow cost 30 rubles. This was the Society's main source of income (Vladivostok Society of Sport Hunters 1897). Few hunting rules or other restrictions existed at the turn of the twentieth century and sika deer were taken year round. Male deer were the primary target, taken for

their antlers, and this not only reduced total deer numbers but also changed the sex ratio in the population.

Sika deer were a stable source of income for local people at the turn of the twentieth century, with people selling antler velvet, deer fetuses, tails, sinew, skins, and other parts. Meat and deer fat were used as food, tails and fetuses as medicine. A sika deer provides 40–50 kg of dressed game meat per animal taken. The hides were turned into chamois and sewn into clothing, including hunting wear. Deer were trapped in pits, driven onto overflow ice, and with the introduction of rifles, the harvest increased markedly.

From then until the mid-1980s sika deer played little practical role in the local economy. Hunting was banned in Primorsky Krai, although poaching continued at a low level in many areas. Poaching occurred in Khasansky, Nadezhdinsky, Ussuriisky, Lazovsky, and Olginsky Districts and on Askold Island. At this point sika deer densities began to increase in several areas, reaching critical numbers that resulted in depletion of forage and massive die-offs in years with heavy snow (Lazovsky Zapovednik, Nezhinsky, and Borisovsky Hunting Collectives). Hunting of so-called farm bred sika deer living in the wild was again permitted in 1985. Following the opening of licensed hunting, the number and the range of the sika deer continued to grow and forage problems in areas where hunting was banned continued.

Today in Russia all wild animals are the property of the state. In each administrative area of Primorsky Krai there are some hunting facilities; in some areas there are also general purpose hunting lands (not rented by any organization of hunters). In these lands it is possible to hunt deer, but regional hunting managers have to supervise the activity. In all hunting facilities annually in winter, when the hunting season is over, an estimate of harvested animals, including sika deer, is performed. Proceeding from these data, hunting managers of each facility estimate autumn numbers and recommend a hunting quota. On general purpose lands this work is done by the regional hunting manager.

The data on number and required quotas is sent to the Primorsky Hunting Department in Vladivostok. The Department checks and analyzes the data and finally asserts a quota on harvesting of sika deer and other species across Primorsky Krai. They produce a general report for all Primorsky Krai and send the data to the Department of Hunting in Moscow. In Vladivostok the Primorsky Hunting Department distributes the determined quota to hunting facilities and to general purpose lands. The hunting facilities receive a quantity of licenses corresponding to the quota that are sold to hunters.

The license is a legal form that gives a hunter the right to hunt, but also is a report form to fill in information on any animals taken. The information includes the sex, approximate age, weight of an animal, and the number of embryos if it is female. The hunter has to hand over the license to the hunting facility within five days after the end of the hunting season, and the facility turns them all in to the Primorsky Hunting Department in Vladivostok. There the data are analyzed to determine the kill. This system works for legal hunters. However, in Primorsky Krai there also are poachers who do not buy licenses and do not report animals taken.

By our estimate, poaching of sika deer in different properties makes up from 10–40% of the total kill.

Owing to massive, induced resettlement of more than 4,000 head of sika deer, few extremely snowy winters, and improved protection in Primorsky Krai, the number of sika deer in Russia in the second half of the 1980s grew to approximately 20,000, and in introduced areas alone, the number reached 10,000. The number of licenses issued for the 1994–1995 season was 648, which is 7.7% of the total post-season number of sika deer in Russia (Mirutenko 1996).

The number of sika deer in the early 1990s, as with other ungulate species, dropped sharply due to decreased protection measures, increased poaching, and greater natural predation. According to Hunting Resources Census Bureau data, there were at this time 9,000–10,000 wild sika deer in Russia, including 3,700 wild sika located outside of their natural range (Mirutenko 1996) that is, fewer than were released in the European portion of Russia (Danilkin 1999).

According to Primorsky Hunting Department data, the number of sika deer in the years 1996–2000 has tended to increase: 1996 = 7,900; 1997 = 7,400; 1998 = 9,590; 1999 = 8,160; 2000 = 12,000 head. Data on current numbers are derived from a census conducted in February and March at the end of the commercial hunting season (Mirutenko 1996). Primorsky Hunting Department data are from a “winter trail census.” (At winter routes ungulates prints of daily prescription are counted and by Formozov’ formula transferred into population density per unit area.) This method uses a relative count of numbers that, given conditions in Primorsky Krai, results in a total that is 1.5 times lower than an absolute count on fixed census plots.

If official data are used as the baseline, then the post-commercial hunting season number for the year 2000 was around 12,000 deer (Table 33.2). These are figures for sika deer at hunting leases where hunting is allowed. There are also sika deer in all three nature reserves, on four wild-life refuges and in two administrative districts where hunting is not allowed. In the winter of 2001 a “census plot count” was conducted in various types of sika deer habitat in Olginsky and Lazovsky Districts. Sixty census plots, totaling 60,000 ha, were set up at random. The plots recorded 1,460 sika deer in the north of Olginsky District and 825 in south, with 4,950 in Lazovsky District (outside of the reserve), for a total of 7,235 deer. The winter trail method was used in three reserves and the numbers obtained were: Lazovsky, 700; Ussuriysky, 250; and Sikhote-Alin Biosphere Reserve, 150, for a total of 1,100 sika deer.

**Table 33.2** Pre-hunting season number of ungulates in Primorsky Krai, 1996–2000 (data from Primorsky Hunting Department).

Species	Winter trail census				
	1996	1997	1998	1999	2000
Sika deer	7,900	7,400	9,590	8,160	12,000
Red deer	25,580	21,000	23,500	27,810	26,440
Wild boar	27,400	20,720	18,300	19,280	22,430
Roe deer	28,000	27,100	26,700	27,200	33,170
Musk deer	9,700	10,930	15,000	21,000	21,000
Moose	3,500	3,500	3,700	3,700	3,700

Counts were held at monitoring sites at wildlife refuges, but it is impossible to assess the quality of the counts. According to the Primorsky Hunting Department, the number for the Barsovy wildlife refuge is around 700, for the Borisovsky Plateau wildlife refuge at least 300, for the Vasilovsky wildlife refuge around 400, around 40 at the Poltavsky wildlife refuge and about 200 recorded in the Chernyie Cliffs wildlife refuge, for a total number of 1,640 sika deer.

Thus, the total number of sika deer in Primorsky Krai is estimated at 22,000. We should note, however, that this is a post-hunting season count. With a 25% increase in numbers by the following autumn, the number of sika deer would increase to 31,250. If correct, the nineteenth century peak estimate of 25,000 head has now been exceeded.

The goal of management is to have a sustainable harvest while maintaining relatively high, stable populations. Table 33.3 shows targets and actual take of sika deer in Primorsky Krai based on licenses returned to the Primorsky Hunting Department. Other species are provided for comparison. According to the Primorsky Hunting Department, due to the low rate of return of used licenses, these data underestimate the kill. When working at model hunting territories where all licenses are returned, the actual take indicated on the licenses varies, for various species, from 40–60% of the permitted take. This occurs because in Primorsky Krai a license to hunt ungulates has an element of prestige, so some hunters, those with a lot of money or influence, obtain licenses even if they don't go hunting or have little ability. At the same time, local hunters will use one license to shoot several animals. Estimating the illegal take of sika deer is extraordinarily difficult, but judging by the continued dispersal of deer and an increase in their numbers, both the legal and illegal take, as well as natural mortality and predation, do not exceed the population's replacement capacity.

Our estimate is that hunters from the city currently take around 500 sika deer, with local hunters taking an equivalent number. A practical estimate is that between 500 and 700 licenses can be issued annually, taking into account the hunting success rate.

According to data obtained at census plots in Olginsky and Lazovsky Districts, the post-hunting season number of sika deer for the region is around 7,200, and for

**Table 33.3** Hunting targets and take for licensed species (data from Primorsky Hunting Department).

Species	1996–1997		1997–1998		1998–1999		1999–2000		2000–2001	
	Target	Take	Target	Take	Target	Take	Target	Take	Target	Take
Sika deer	500	367	390	270	540	417	600	494	700	292
Red deer	1,300	632	1,400	650	1,500	695	2,000	1,003	2,000	399
Wild boar	2,100	940	2,100	1,080	2,100	1,175	2,100	1,533	2,100	577
Roe deer	2,000	1,166	1,500	992	1,600	1,167	1,630	1,304	1,700	619
Musk deer	550	69	550	148	550	124	550	462	500	107
Moose	100	17	100	80	100	65	100	32	100	2

the rest of Primorsky Krai, according to the data of the Primorsky Hunting Department, the number is around 12,000, for a total of 19,200. Given annual recruitment, set by the Primorsky Hunting Department at 25%, in autumn the number of sika deer in Primorsky Krai (excluding reserves) is 24,000. If hunting is allowed in Olginsky and Lazovsky Districts, with a take limit of 10% of the population, 2,400 sika deer can annually be taken in Primorsky Krai. This is almost five times the current limit. Such a volume would help to regulate deer numbers in relationship to forage capacity and increase the practical value of sika deer for sport and commercial hunting in Primorsky Krai.

Sika deer populations currently have recovered, and management efforts appear to be holding the population approximately stable, with a sustainable harvest, both legal and illegal and predator kill. We can hope that these conditions continue so that sika deer contribute to the local economy while remaining in reasonable balance with their habitat, and support a natural take by native carnivores, including the threatened Amur leopard and Siberian tiger.

## Literature Cited

- Abramov, K. G. 1928. *Spotted deer—Basic information on antler horn management*. AO Primorsky Zoopitomnik, Vladivostok. 149 p. (In Russian.)
- Abramov, K. G. 1939. Distribution patterns for spotted deer in Primorsky Krai. *Practical Scientific Notes of the Chief Department of Zapovedniks*. Issue 3, Pages 34–42. (In Russian.)
- Aramilev, V. V. 2000. Hunting management and large predators. Pages 116–123 in *Reference book of hunting users and hunters*. Vladivostok, Russia. (In Russian.)
- Aramilev, V. V. 2002. Pages 120–123 in *Added sources of sodium in the ecology of the Primorye ungulates*. Kirov, Russia. (In Russian.)
- Aramilev, V. V., and P. V. Fomenko. 1999. Simultaneous census of the Far Eastern leopard (*Panthera pardus* Linnaeus) in Southwest Primorsky Krai. Pages 12–13 in *VI Congress of the Mammal Society*. Moscow, Russia. (In Russian.)
- Aramilev, V. V., and P. V. Fomenko. 2000. Distribution and number of Far Eastern leopard in southwest Primorsky Krai. Pages 50–63 in *Protection and rational use of plant and animal resources*. Irkutsk, Russia. (In Russian.)
- Aramilev, V. V., and T. S. Aramileva. 2002. Pages 125–128 in *Issues of protecting and using native sika deer populations in Primorsky Krai*. Kirov, Russia. (In Russian.)
- Arsenev, V. A. 1949. Acclimatization of sika deer in European zapovedniks of the USSR. Collection 7, Pages 79–96. *Environmental protection*: Izd. VOOP, Moscow. (In Russian.)
- Arsenev, V. K. 2003. Expedition diaries of 1906. *Notes of Society of Research of Primorsky Krai* 30:1–88. (In Russian.)
- Baikov, N. A. 1915. *In the mountains and forests of Manchuria*. Petrograd. 120 p. Manchuriankrai Research Society. (In Russian.)
- Bogachev, A. S. 1982. *Protection, acclimatization and domestication of deer*. Nauka, Moscow. (In Russian.)
- Bogachev, A. S., and A. N. Alymov. 1990. Eco-genetic mechanism in the sika deer population. Pages 116–117 in *Evolution and genetic research of mammals*, Part 2. Dalnauka, Vladivostok. (In Russian.)
- Bogachev, A. S., G. Vakhreev, A. Velizhanin, and V. Troinina. 1983. Sika deer of Primorye. *Hunting and Wildlife Management* 2:12–13. (In Russian.)

- Bromley, G. F. 1956. The ecology of wild sika deer. Pages 148–215 in *Materials on research findings in government reserves*. Nauka, Moscow. (In Russian.)
- Bromley, G. F. 1981. Sika deer (*Cervus nippon* Temmink, 1838) of Primorsky Krai—past and present population condition. Pages 93–103 in *Rare and endangered terrestrial animals of the Far East of the USSR*. Dalnauka, Vladivostok. (In Russian.)
- Bromley, G. F., and S. P. Kucherenko. 1983. *Ungulates of the Russian Far East*. Nauka (Science), Moscow. (In Russian.)
- Danilkin, A. A. 1999. *Mammals of Russia and adjacent regions. Deer*. GEOS, Moscow. (In Russian.)
- Dormidontov, R. V. 1977. Sika deer. Pages 10–28 in *Ungulates*. Lesnaya Promyshlennost, Moscow. (In Russian.)
- Emelyanov, A. A. 1927. Commercial animal species of the land of the Orochi. *Production capacity of the Far East*. Volume 4. Knizhnoe Delo, Khabarovsk-Vladivostok. (In Russian.)
- Geptner, V. G., A. A. Nasimovich and A. G. Bannikov. 1961. *Mammals of the Soviet Union. Volume 1: Artiodactyls and perissodactyls*. Vysshaya Shkola (Higher Education), Moscow. (In Russian.)
- Iliina, G. I. 1956. Ecological features of sika deer and possibilities for acclimatization in the European portion of the USSR. *Scientific Notes of the Potemkin Moscow City Pedagogic Institute* 61(4–5):77–89. (In Russian.)
- Khakhin, G. V., and V. E. Prisyazhnyuk. 1985. Current status and number of sika deer in the USSR. *Ecological features of wildlife protection*. Nauka, Moscow. (In Russian.)
- Konkov, A. J. 1999. Infringement of forest regeneration in places with intensive grazing by sika deer. Pages 238–239 in *Woods and forest forming processes in the Far East*. Dalnauka, Vladivostok.
- Kucherenko, S. P. 1985. *Tiger*. Agropromizdat, Moscow. (In Russian.)
- Maak, R. K. 1861. *Travel through the Amur. 1855. Historical Account*. Publishing House of Geographical Society, Saint Petersburg. (In Russian.)
- Makovkin, L. I. 1999. *Wild sika deer in the Lazovsky Zapovednik and surrounding areas*. Almanac “Russki Ostrov.” Dalpress, Vladivostok. (In Russian.) (Simultaneously published in English as *The sika deer of Lazovsky Reserve and other territories*.)
- Menard, G. I. 1930. *Antler horn management*. Gostorgizdat, Moscow-Leningrad. (In Russian.)
- Miquelle, D. G., P. A. Stephens, E. N. Smirnov, J. M. Goodrich, O. J. Zaumyslova, and A. E. Myslenkov. 2005. Tigers and wolves in the Russian Far East: Competitive exclusion, functional redundancy, and conservation implications. Pages 179–207 in J. C. Ray, K. H. Redford, R. S. Steneck, and J. Berger, editors, *Large carnivores and the conservation of biodiversity*. Island Press, Washington, DC, USA.
- Mirutenko, V.S. 1996. Sika deer. Pages 121–124 in *Resources of main hunting species and hunting collectives of Russia: 1991–1995*. Press of Rosselkhozacademy, Moscow. (In Russian.)
- Pavlov, M. P., I. B. Korsakova, and N. P. Lavrov. 1974. *Acclimatization of game animals and birds in the USSR*. Part 2. Volgovytskoe Knizhnoe, Kirov. (In Russian.)
- Petrashev, V. V. 1993. *Introduction to neocenology*. MSKhA Izdatelstvo, Moscow. (In Russian.)
- Pikunov, D. G., V. K. Abramov, and A. A. Skripchinsky. 1973. Several features of the distribution and protection of rare mammals in the south of the Far East of the USSR. Pages 25–28 in *Rare mammal species of the USSR and their protection*. Nauka, Moscow. (In Russian.)
- Pikunov, D. G., and V. G. Korkishko. 1990. *The leopard in the south of the Far East*. Nauka, Moscow. 192 p. (In Russian.)
- Prisyazhnyuk, V. E. 1974. Several biochemical indicators for the sika deer of southern Primorye. *Sika deer of southern Primorye*. Izdatel'stvo Kyrgyzstan, Frunze. (In Russian.)
- Prisyazhnyuk, V. E. 1975a. Population census of sika deer in Lazovsky Reserve. Pages 1–58 in *Ungulates of USSR fauna*. Nauka, Moscow.
- Prisyazhnyuk, V. E. 1975b. Unique population of native sika deer in Primorsky Krai. Pages 240–254 in *Scientific articles of Nature Conservation Lab*. Ministerstvo Selskogo khozyaistva SSSR, Moscow.



- Prisyazhnyuk, V. E. 1978. *Morphological features of wild native sika deer and means to protect the animal*. 24 p. Ph.D. dissertation, Institute of Ecology, Evolution and Morphology of Animals. (In Russian.)
- Resources of the main hunting species and hunting collectives of Russia: 1991–1995*. 1996. L. K. Lomanov, editor. Press of Okhotdepartament, Moscow.
- Przhevalsky, N. M. 1870. *Traveling around Ussorisky Krai in 1868–1869*. Publishing House of Geographical Society, Saint Petersburg.
- Ryashchenko, L. 1976. *Deer farming for antlers in Primorsky Krai*. Dalnevostochnoe Knizhnoe Izdatelstvo, Vladivostok. (In Russian.)
- Sidorov, S.V. 1980. Dispersal of sika deer in the northern Caucasus. Pages 259–260 *Ungulates of the USSR*. Nauka, Moscow. (In Russian.)
- Suvorov, V. 1998. *Icebreaker*. Moscow. (In Russian.)
- Valova, Z. G., N. G. Vasilev, V. I. Zhivotchenko, L. I. Marovkin, T. I. Oliger, V. E. Prisyazhnyuk, N. P. Prisyazhnyuk, N. V. Solomkina, V. S. Khramtsov, and S. L. Shaldybin. 1989. *Lazovsky Zapovednik*. Agropromizdat, Moscow. (In Russian.)
- Vladivostok Society of Sport Hunters. 1897. *Report for his imperial majesty Aleksandr Mikhailovich of the Vladivostok Society of Sport Hunters 1888–1896*. Dalny Vostok, Vladivostok. (In Russian.)
- Wilson R. L. 2000. An investigation into the phylogeography of sika deer (*Cervus nippon*) using microsatellite markers. M.Sc. thesis, University of Edinburgh, Scotland, UK.
- Yankovsky, M. I. 1882. Sika deer, leopards and tigers of Ussuriisky Krai. *Bulletin of the Vostochno-Sibersky Branch of the Geographic Society, Irkutsk*. 13(3):76–79. (In Russian.)
- Zolotarev, N. T. 1937. *Mammals of the Imana River basin*. Izdatelstvo AN USSR, Leningrad. (In Russian.)