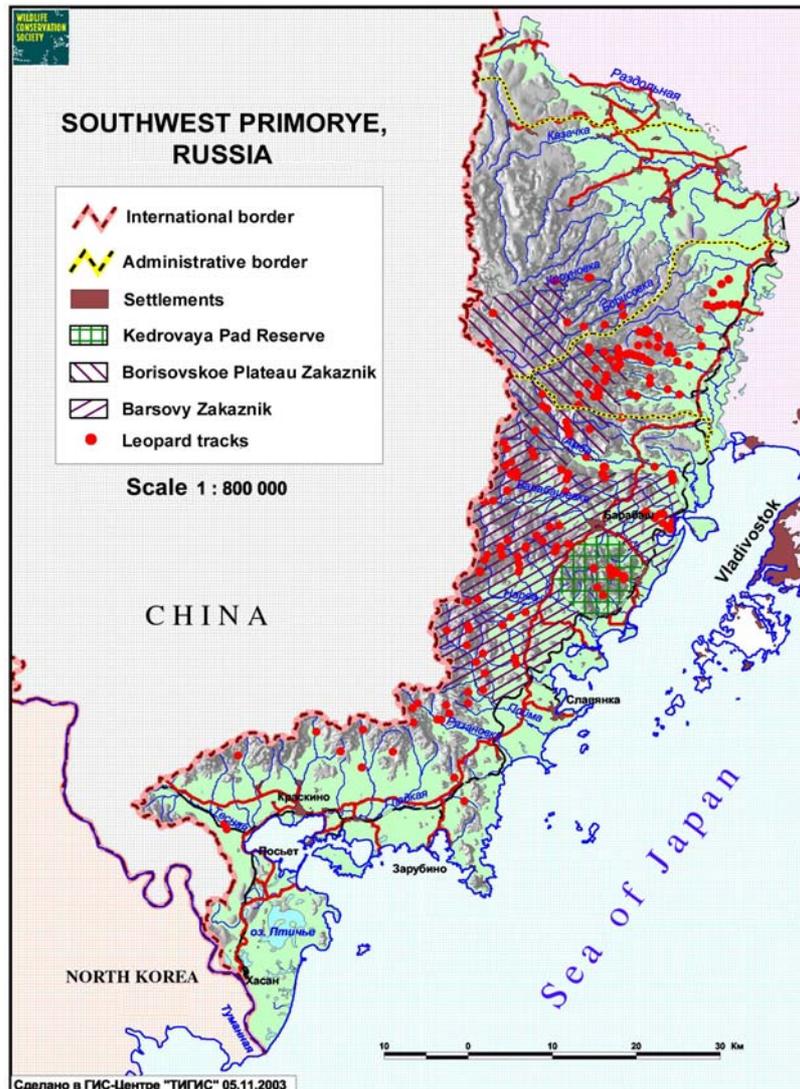


“Attachment to the final report “*Habitat Assessment and Land-use Planning for Siberian tigers and Amur leopards in the Russian Far East*” to PIN-MATRA

## A SURVEY OF FAR EASTERN LEOPARD AND AMUR TIGER POPULATIONS IN SOUTHWEST PRIMORSKI KRAI, RUSSIAN FAR EAST (FEBRUARY 2003)

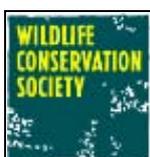
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Vladivostok 2003

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## 1. INTRODUCTION

The Far Eastern leopard is one of the rarest representatives of the North Asian faunal complex and is the focus of attention of many Russian and international conservation organizations, which work for global biodiversity conservation.

The subspecies of Far Eastern leopards (*Panthera pardus orientalis*) is listed by IUCN as endangered, and it is included in the Russian Federation Red Book of endangered species. Monitoring the numbers and conditions of leopard habitat is specifically listed as a priority in the Russian National "Strategy for Conservation of the Far Eastern Leopard in Russia." Full range surveys are recommended at least once every three years (the last survey was conducted in 2000), but yearly observations are also recommended, as are assessments of changes in quality of leopard habitat, and comparisons of new and existing census methods. All these tasks were undertaken in the context of survey plans for 2003.

Results of previous surveys suggest that status of this unique animal is close to catastrophic. Surveys conducted in 1998 suggests that leopards are mostly likely extinct in northeastern provinces of North Korea (Institute of Geography 1998). Little evidence of leopards was found in northeastern provinces of China (Jilin and Heilongjiang): an international team of scientists found only several leopard tracks in Jilin Province, most of which were situated near the international border between China and Russia (Yang et al. 1998, Baogang et al. 1999). Today the single remaining Far Eastern leopard population resides only in a small habitat fragment in southwest Primorye (Russia).

All previous surveys through 2000 conducted in Russia confirmed that numbers of Far Eastern leopards are extremely low. This unique predator is clearly on the verge of extinction. Only

intensive efforts are likely to save this population.

From the beginning of the 1970s Russian scientists have repeatedly raised the question of the critical situation of the Far Eastern Leopard, and have achieved a certain amount of success. In 1979, the First All-Union Conference of Rare Species of Mammals adopted a resolution creating the Barsovy Zakaznik (106,000 ha) for the protection of the leopard. In 1990 the Far Eastern Chapter of the Academy of Sciences developed a "long-term plan for the Protection and Rational Use of the Resources of Primorskii Krai until the Year 2005" which was approved by the Regional Congress of People's Deputies in 1992. In 1995, a committee for the protection the Far Eastern leopard was organized in Vladivostok, with the participation of specialists from IUCN. But it was not until the end of 1996 that an international conference on saving the leopard was convened in Vladivostok, on the initiative of the EPT USAID Project. This conference designed a unified program of measures to accomplish its goals. Based on these recommendations an International Leopard Working Group was organized, and in 1998 its members developed "Strategy for Conservation of Far Eastern leopard in Russia", which was adopted by State Committee for Nature Protection. In 2001 a second conference was held, and specific recommendations and resolutions were adopted by the conference attendees. One of the resolutions was the creation of a Far Eastern Leopard Steering Committee to provide advice in implementing conservation actions for the leopard.

Nevertheless conditions for the Far Eastern leopard continue to deteriorate, due mainly to economic development of southwest Primorye. In leopard habitat logging (legal and illegal), and hunting of ungulates continues; forest fires regularly impact habitat in both spring and fall. High levels of unemployment force local people to look to the forests as a source of

revenue, collecting non-timber forest products and poaching to get by. Deer farms have become bankrupt and liquidated. During the 1970-1980s deer farms maintained about 40,000-42,000 animals, which represented an alternative prey source of leopards. Today deer numbers are 10 times less (A.S. Bogachov, pers. comm.). Deer from farms supported predator populations during critical situations, when ungulate densities decreased after severe winters. Highway construction continues in Khasansky raion. All these factors as well as proposed development in southern Khasansky raion, existing and proposed coal mining, and other mining in several river basins destroy every hope not only for natural growth of leopard population but also for its survival in the wild in the future.

In southwest Primorye status of other large predator and ungulate populations (especially Amur tiger population) is also critical. It was known in 1979 that large animals inhabiting forests of Jilin and Heilongjiang Provinces (China) freely mixed with animals in western and southwestern Primorye, and represented a single population (Abramov, et al 1976, Pikunov 2002). After the construction of border control fence along the international border in 1979, the southwestern populations were nearly isolated from China and North Korea. The Russian population represents the only population which can serve as a source for natural dispersal into northeastern areas of China and north areas of North Korea to recover former ranges. Therefore this southwest group of predators deserves special attention (Pikunov and Miquelle, 2002).

The last leopard survey in 2000 suggested that 22-27 Far Eastern leopards inhabit the territory of Southwest Primorye. This is close to the results of 1997 leopard survey, when 25-31 animals were registered (Pikunov et al. 1999).

Nevertheless, economic development of southwest Primorye continues with increased speed, free economic zone is

proposed as well as construction of oil-pipe line. Intensive destruction of last and the best leopard habitats continues.

## 2. GOALS AND OBJECTIVES

The ultimate goal of a 2003 winter survey of Far Eastern leopards is to assess the current status of Far Eastern leopard subspecies across its entire existent range in the Russian Far East. This methodology used should provide a means of comparing new information with past surveys, provide a means of assessing conservation measures programs, and provide an "early warning system" in the event of rapid changes in leopard numbers. Specifically, this survey should achieve the following objectives:

1. *Determine status of Far Eastern leopard population.* Survey results should act as an indicator that can indicate dramatic changes in leopard abundance. If conducted often, such surveys should act as an "early warning system." Ideally, surveys should be conducted yearly. However, the last full range survey was conducted in 2000.

2. *Determine numbers of leopards based on an expert assessment.* An expert assessment of leopard numbers, conducted with the same methodology as in most previous surveys, will provide an estimate of leopard numbers. It is widely recognized that all survey methods have their limitations and biases. Therefore, using the same methodology as in past surveys provides a higher probability of detecting changes in the leopard population. In Russia, there have been tremendous efforts and significant support from regional, Krai-wide, federal, and international levels for implementation of tiger conservation efforts that range from anti-poaching programs to conservation education. All these efforts are aimed at protecting the existing Far Eastern leopard population in Russia, yet without regular

surveys that can determine trends in leopard numbers, the ultimate effectiveness of these conservation programs will remain unknown.

3. *Better define range of Far Eastern leopards.* By expanding the number of survey routes to be covered (see below) we will seek to better define the existing range of leopards in southwest Primorski Krai. Information obtained from China (Miquelle, pers. comm.) and a habitat analysis conducted with data from past surveys (Miquelle and Murzin 2000), suggests that there may be leopards in areas that have not received adequate attention in past surveys. We plan to rectify this problem by expanding the number of survey routes and placing them in areas not adequately covered in the past.

4. *Develop a track abundance estimate that will provide estimates of relative abundance.* By developing a track abundance estimate, we will be able to compare relative abundance of leopards across their range, and determine which areas retain higher densities of leopards. A mechanism for developing such a track abundance estimate has been intensively examined in development of a monitoring program for Amur tigers (see Methodology for Monitoring Amur tigers 2002). We plan to adopt this protocol to estimate relative density of leopards in various areas.

5. *Assess relative abundance of key prey species.* Obtaining information on track densities of ungulates and hares along survey routes will provide information on relative abundance of ungulates in various parts of leopard range. This information is vital in determining suitability of habitat for leopards. Changes in ungulate populations which are primary prey for leopards may provide important clues to potential impacts on leopard numbers.

6. *Assess importance of different land ownerships for Far Eastern leopards.* Far Eastern leopards exist in zapovedniks, zakazniks, deer farms, and hunting lease

areas in southwestern Primorski Krai. Information obtained from this survey will provide evidence of the relative importance of these various parcels of land for leopards.

7. *Assess reproductive status of leopards.* There has been concern about genetic inbreeding of this population of leopards (Uphyrkina et al. 2002). One of the indicators of genetic inbreeding is reduced levels of productivity of a population. By obtaining information on litter abundance and litter size of leopards, we will be able to provide some indication of whether reproduction rates appear to be low.

8. *Assess competition with tigers.* There has been concern that tigers outcompete leopards, and can exclude them from some areas. Habitat analyses indicated that there is spatial separation of these two species (Miquelle and Murzin 2000), but more information would be helpful in assessing the importance of this factor.

### **3. HISTORIC RANGE AND NUMBER OF FAR EASTERN LEOPARDS**

The Far Eastern leopard is the northernmost of all leopard subspecies. In China, its southern boundary is marked by the merger point with the North Chinese subspecies *japonensis*. The exact location differentiating the two races is debatable, and due to habitat loss, will probably never be known precisely, although it has been suggested that *P. p. orientalis* may have ranged as far south as Beijing (Heptner and Sludski 1972). Its original range in China extended throughout northeastern ("Manchurian") China, including Jilin and Heilongjiang Provinces, and was originally distributed throughout the Korean Peninsula.

In Russia, information from the previous century is scarce. At the turn of this century the leopard was found throughout much of southern Primorye

Table. 1. Surveys of Far Eastern leopards conducted between 1972 and 2003 in Northeast Asia

Year	Methodology	Organizers	Sponsors	Area	Leopard numbers
1972 - 1973	Traditional	Pikunov, Abramov	GlavOkhota of Russian Federation	Southwest, Pogradichny, South Sikhote-Alin (Primorye)	38-46
1983 - 1984	Traditional	Pikunov, Korkishko	GlavOkhota of Russian Federation	Southwest Primorye	25-30
1990 - 1991	Traditional	Pikunov, Abramov, Korkishko	PIG FEBRAS	Southwest Primorye	30-36
1997	Traditional	Pikunov, Aramilev	WCS	Southwest Primorye	25-31
1998	Simultaneous count	Aramilev, Fomenko, Miquelle et al.	WCS	Southwest Primorye	40-44
1998	Investigation and questionnaire	Shihe et al., Institute of Geography	UNDP, WCS	Eastern Jilin Province, China	4-7
1998	Investigation and questionnaire	Institute Geography, Pyongyang	WCS	Paektusan, North Korea	3-5
1999	Investigation and questionnaire	Sun et al.	WCS	Eastern Heilongjiang Province, China	
2000	Traditional	Pikunov et al.	Tigris, WCS, WWF	Southwest Primorye	22-27
2000	Simultaneous count	Aramilev, Fomenko	Tigris	Southwest Primorye	48-50

Krai, although always at lower densities than the Amur tiger (*Panthera tigris altaica*). Heptner and Sludski (1972) report occasional intrusions of leopards far north of this region in northern Primorye (e.g. Bikin Basin) southern Khabarovsk (e.g. Khor Basin) and even in the southeastern TransBaikal Region. However, most of these reports probably represent dispersal of individuals from China, and do not represent permanent establishment of a breeding population. Some of these movements may have been related to long distance migrations of roe deer (*Capreolus capreolus*), a key prey species for the Far Eastern leopard. The permanent range of a leopard population in Primorye Krai at the turn of the century

can be delineated as the region south of a line running from Olga Bay west, including the upper reaches of the Ussuri Basin (southern Chugueveski Raion), extending north of the Spassk-Dalneya region, and west to the Chinese border, but not including the region immediately surrounding Lake Khanka (Arseniev 1914, Heptner and Sludski 1972, Pikunov and Korkishko 1992) (Figure 1).

The distribution and numbers of leopards in the Russian Far East has decreased throughout this century, due primarily to habitat loss and hunting. For instance, between 1934 and 1965, 39 skins were officially registered, the actual number of animals killed obviously being significantly more than that.

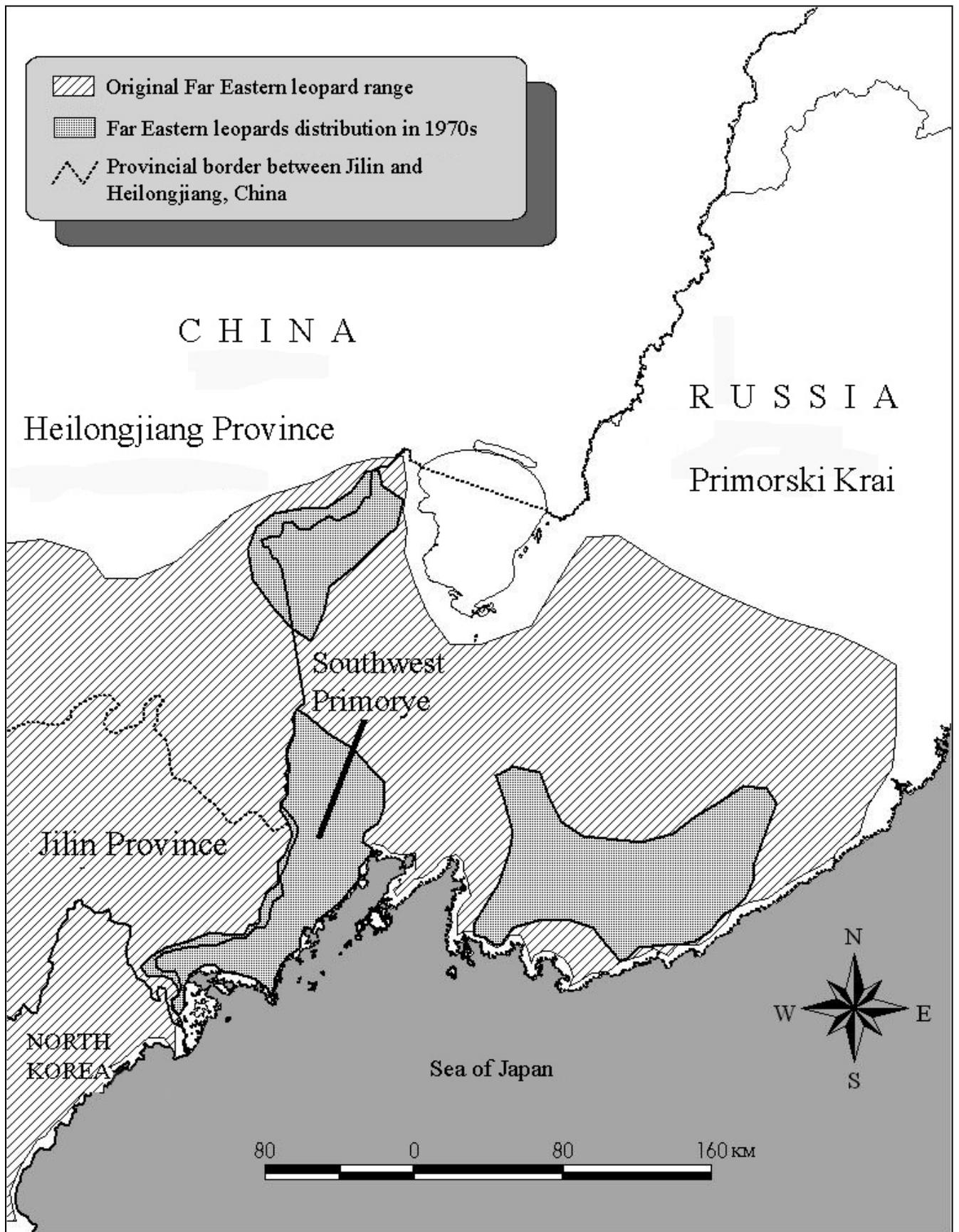


Figure 1. Historic range of Far Eastern leopards

The first reliable estimate of leopard numbers in Russia was conducted by Abramov and Pikunov (1974) in the 1972-1973 winter. By this time, the population in Primorye had contracted from one contiguous to three isolated populations: 1) in southern Sikhote-Alin Mountains leopards were most common along the coastal regions, but there were only an estimated 8-10 animals remaining; 2) in the western section of Pogranichny Raion (west of Lake Khanka), primarily within Komissarovka Basin there were 5-6 animals that moved back and forth across the boundary with China; and, 3) in the southwestern region that included nearly all of Khasanski Raion, and the western sections of Ussuriski and Nadeshdenski Raions there were an estimated 25-30 animals (Abramov and Pikunov 1974, Heptner and Sludski 1972). Therefore, by 1973, there were an estimated 38-46 Far Eastern leopards remaining in Russia, many of which were dependent on habitat on both sides of the Russian-Chinese border.

A census in 1985 by Pikunov and Korkisko (1985) suggested that leopards had disappeared from the western section of Pogranichny Raion. Furthermore, they were not able to confirm the presence of leopards in southern Sikhote-Alin. The population in southwestern Primorye remained approximately the same as the 1972 survey: 25-30 animals (Pikunov and Korkisko 1985). A more recent count in the 1990-1991 winter revealed the population size in southwest Primorye to be stable, with 30-36 animals counted, if migrants to and from China were included (Korkisko and Pikunov 1994). In southern Sikhote-Alin there have been occasional reports of leopards and leopard tracks during the past 5-10 years, but as yet there are no confirmed reports of leopards in this region since the 1972 survey.

Ten previous surveys have provided valuable indicators of the status of this population since 1972 (Table 1)

#### **4. STUDY AREA AND SURVEY CONDITIONS**

The existing range of Far Eastern leopards is confined to the southwest portion of Primorski Krai in the forested mountains of the East Manchurian Mountain Range. Suitable habitats within this region include to low (300-600 m) forest-covered mountains. In winter, especially when snow is deep, leopards rarely occur at high elevations. Usually in fall or early winter after the first snowfalls leopards come down to middle sections of river basins (where melt off on southern slopes is rapid, often even in winter) following herds of sika deer and roe deer. Leopards prefer mountainous areas covered with forest with narrow divides and steep slopes. In winter leopards rarely occur on plateaus in the upper parts of river basins, especially when snow is deep. To the west the study area borders China, and at higher elevations, it represents areas with the deepest snow. Available evidence indicates that leopards (even in comparison with tigers) are not well adapted for deep snow.

Leopards rarely occur in lower sections of river basins that have mostly been degraded by fire, even though there is less snow cover there. Secondary forests degraded by fires (for instance, haze/lespedeza/oak forests) are not suitable habitat for leopards to live and to hunt (Abramov, Pikunov, 1974).

The results of nearly all previous leopard surveys indicated that tracks are rarer in the southern portion of the study area, including Ryazanovka river basin. In the 1960-1970s when roe deer herds annually migrated from adjacent Chinese areas leopard numbers temporarily increased in this area. However,

construction of the border patrol fence has prevented animal migrations and movements (of both ungulates and predators) and disturbed traditional migratory patterns. Therefore, areas to the north, especially territories of Barsovy Zakaznik, Borisovskoe Plateau Zakaznik, Kedrovaya Pad Zapovednik and Nezhinskoe Hunting Lease, are the most densely populated areas by tigers and leopards. Average tiger and ungulate densities are slightly higher in protected areas than in local hunting leases. This difference in predators and ungulates distribution is evident even after hunting season or during temporary bans on hunting, as was the case in winter 2002-2003. There are vast tracts of fir-spruce-pine forests in this region, which are ideal habitat for ungulates, and therefore predators.

The northern and northeastern parts of the study area adjacent to Razdolnaya river basin, are covered with secondary broadleaved forests, and distribution of leopards and tigers tends to be sparse, as in the south.

Eastern part of the territory north from Borisovka river is forest-steppe and flat river valleys, where agricultural lands and road network take place. Despite this, upper basins of Medvediza and Krounovka rivers are not much developed and some parts of this territory are still covered with pine-deciduous and fir-spruce forests. Tigers are still common here.

Therefore, the central part of study area and particular the western portion of the central part, covered with fir-spruce forests and least accessible to people, probably represents the best remaining habitat for both predators and wild ungulates.

The survey area was restricted to forested areas of Southwest Primorye, but most of the region has been logged with varying intensities (excluding Kedrovaya Pad Zapovednik). Unfortunately, today logging continues and the most intensive logging takes place in Borisovskoe

Plateau, which is the best tiger and leopard habitat.

The network of survey routes established in Southwest Primorye are largely in a east-west orientation, consistent with the drainages of the region. This pattern allows effective use of roads along river valleys, where they exist and are passable.

The survey was conducted between 4<sup>th</sup> and 28<sup>th</sup> of February, 2003. Snow conditions were favorable for track counts, even though Southwest Primorye generally has the lowest snowfall in the region. The last snowfall prior to the survey fell on January 28, i.e. 5 days before the survey. There were no heavy snowfalls during the survey to disrupt work. Two light snows (February 9 and February 24) did not obliterate old tracks, but assisted us in determining age of tracks.

Deepest snow cover was registered in the upper elevations (western and northwestern regions to the west of the border control fence) of study area, i.e. near the international border. Maximum snow cover was reported for upper river basins of Borisovka, Krounovka and Medvediza.

## 5. METHODS

We chose traditional survey methods because it provides data, which could be compared with survey results of previous years.

### Identification of tracks of large carnivores

#### Far Eastern Leopard (*Panthera pardus orientalis*)

**Track parameters.** Similar in shape to tiger tracks, but considerably smaller. Leopard tracks are round, about 12x12 cm in size. As with other felids, claws are never visible in the track. The "straddle" (width of a leopard trail from

outer edge of left paw to outer edge of right paw) of adult leopards is 15-18 cm. The average stride of adult animal is 40-45 cm.

Leopard tracks, including the pad, are distinct, with little space between toe pads and the main pad. The front foot pad of a male leopard is 6.5-7.5 cm wide (rarely up to 8 cm), females have front foot pads 5.5-6.5 cm wide (rarely up to 7.0-7.5 cm). Kittens traveling with female will have tracks that vary greatly, dependent of their age, but are commonly found to be between 4.5 and 5.5 cm.

Leopard prefers to walk along deer trails, ridge tops, base of cliffs, and in its own former trails. Tracks can be found on ice of frozen forest rivers and creeks, on divide ranges, and on old deserted forest roads along river valleys. Leopards are less capable of negotiating deep snow than tigers, and therefore often prefer traveling on southern slopes where snow depth is less. Leopards hide their prey in secluded nooks, but never cover it with leaves or snow.

Like tigers, leopards will create scrapes alongside trails, but scrapes of leopards are markedly smaller than those of tigers: average length of leopard scrapes is under 40 cm, and average width is 15-25 cm.

***Distinguished from similar species.*** Tracks of large adult male leopards can look like tracks of young tigers (due to similarity in pad size). Leopard tracks can be distinguished from tiger tracks by the following features:

1. The leopard track is more compact – toes are relatively larger (in relation to total track size) and there is a little space between toes (toe pads are closely packed).
2. In tiger tracks there is more space between toe pads and large main plantar pad, whereas in leopard tracks toes are only slightly separated from the main pad.

Other clues to help distinguish tiger and leopard tracks include:

3. Young tigers with a front pad width of 7-8 cm (which can occur for very large male leopards) are usually still in association with their mother, so tracks of an adult female tiger should be nearby;
4. A young tiger with a pad width less than 8 cm is unlikely to create a scrape (which are created predominately by adult females and males). Scrapes are very likely to be found in association with tracks of an adult male leopard (i.e., with front pad widths of 7-8 cm).

Lynx tracks can be distinguished from leopard tracks by:

1. Total size of lynx tracks are 7.5-7.7 cm long and 7.3-7.5 cm wide, while a leopard track on crumbly snow is 12 cm long and 12 cm wide. Pad width of male leopards is 6.5-7.5 (occasionally to 8.0 cm), of female – 5.5-6.5 (occasionally to 7.0 cm), and lynx pad is 4 cm, rarely up to 5 cm.
2. Paws of lynx are covered by dense hair, making its track indistinct in contrast to sharply defined features of a leopard track.
3. In winter lynx cover their large prey with snow, while leopards do not. Leopards will drag prey to a secluded place – to tree butt, under fallen tree, etc. A long drag is typical for tigers (up to 400 m); leopards drag their prey a shorter distance, and lynx – even shorter.

### **Amur Tiger (*Panthera tigris altaica*)**

***Track parameters.*** Tracks of tigers are large and have an overall roundish appearance, showing four slightly elongated toes, and a large central pad. Claws are never visible, as they are retracted during travel. Width and length of the front track of tigers is approximately equal, while hind tracks are longer than they are wide. However, when traveling in snow tigers usually place their hind foot directly onto the track left by the front foot, resulting in the appearance of a single track similar in size and shape to the front paw. Most measurements of tiger tracks taken in

Table 2. Track measurements of Amur tigers (cm)

	Adult male		Adult female		Cubs	
	Front paw	Hind paw	Front paw	Hind paw	Front paw	Hind paw
Total width	15,5-16,5	13-14	13-14	12-13	-	-
Total length	15-16	14,5-15	14,5-15	13-14	-	-
Pad width	10,5-13,0	1 cm < front	8,0-9,5	1 cm < front	5,5-10,5	1 cm < front

snow therefore represent a “combination” track of the front and hind paw, but characteristics of this “combined” track are generally similar to those of the front track. Care must be taken in measurements, however, because size can vary depending on how precisely the front and rear paws coincide as a single track.

Track size of subadult females will be slightly smaller than those of adult females. Cubs start traveling with their mother from 2-3 months of age, and disperse from their mother from 16-22 months of age, so track size of cubs obviously varies greatly. Subadult males still traveling with their mother often have track sizes larger than that of an adult female.

Stride of adult male tiger when walking usually equals 60-70 cm on a hard surface and in shallow snow, but varies from 55 to 80 cm. Stride length when trotting is 80-110 cm, when jumping – 2,5-5 m. Females and cubs have a shorter stride.

Tigers often take advantage of forest roads, trails, or frozen rivers (any place where snow is more shallow, or travel is easier), and will often travel long distances on snow packed trails created by humans on foot or snowmobile.

Traveling straight along forest trail, tigers will occasionally approach inclined trees, uprooted trees or rock outcrops to check for scent of other tigers, and to deposit its own scent. At these marking sites, tigers will often rub against the tree, leaving thin white hairs, characteristic of tiger cheek region, and then pause to spray urine directly onto these objects. Often, trees that are repeatedly marked are

identifiable by a dark brown stain (on the underside of leaning trees) usually about 1 m in height that retains a distinct, musky scent of tigers. Occasionally, tigers will reach up to scratch such trees with their claws, resulting in 4 thin, parallel scratches on each side of a tree.

Tigers also make “scrapes” along the side of trails by vigorously scraping hind paws backwards, clearing the ground of leaves and vegetation (very similar to domestic dogs). At the far end of scrapes tigers will deposit either urine or scat about half of the time. Scrapes generally average 40-70 cm long, and 20-30 cm wide (scrapes made by leopards are significantly smaller). Scentmarks on trees and scrapes on the ground provide a means of communicating presence and status amongst tigers, and are therefore most commonly found in “merger” zones most likely to be found by other residents (i.e., natural travel corridors where movements of animals would be channeled).

Tigers never cover kills with leaf litter or snow. Kills can generally be identified by large canine holes on the neck or throat. Tigers generally drag their kill some distance (10 to 400 m) to a secure spot before beginning to feed. Hair is removed from the kill, and scattered around the kill site. Tigers normally begin to feed on a carcass from the rear end. Stomach and contents are not eaten, and usually removed from the kill.

***Distinguished from similar species.*** Both species of bears found in the range of tigers (brown and Himalayan) have tracks as large as or larger than tigers. However, these tracks are easily

distinguished from tigers by the following characteristics:

1. Bear tracks will show presence of claws, which, unlike felids, do not retract while walking;

2. Rear tracks of bears are elongated, human-like, while both front and rear tracks of tigers are roundish.

3. Bear trails are much wider than tigers' – when traveling left and right paws are widely spaced and paws point inward slightly.

### **Lynx (*Felis lynx*)**

**Track parameters.** The roundish shape of lynx paws is typical for all cats. In winter their feet are densely covered by hair and tracks are always “fuzzy” or indistinct (in contrast to those of leopards or tiger cubs). Thick layers of fur surround the toes, making the lynx better adapted for traveling in deep snow than other cats. Lynx tracks are round; claws are retracted and therefore do not appear in a track. Front foot length is 5.5 -7.7 cm, width – 6.0-7.5 cm. Hind foot length is up to 8 cm, width – up to 6.5 cm. Prints of front feet are round, prints of hind feet are elongated. Adult male lynx have a front foot pad width of 4.0 - 5.0 cm. Tracks in snow may appear larger than actual paw size. When walking in snow more than 5 cm deep hind feet of lynx will be positioned directly on top of the front feet, giving the appearance of a single track.

In winter yearling lynx have tracks slightly smaller than those of females: pad width of a yearling lynx is approximately 4 cm, while adult females will have pads up to 4.5 cm wide. The trail of lynx is usually straight (left and right feet placed directly in front of each other), similar to that of a wolf. For their size, lynx have long legs, with a normal walking stride of 35-49 cm (in comparison, an average wolf walking stride averages 60-68 cm, a tiger walking stride length is 50-60 cm). When lynx are walking in shallow snow or on hard ground

the hind feet usually register in front of the fore feet (paired prints, hind foot is first).

Because of their light weight and wide paws, even in deep snow lynx will rarely sink deeply. Lynx always bury kills to prevent scavenging by birds or other mammals.

***Distinguished from similar species.*** Lynx tracks are distinguished from those of most other moderate-sized predators in winter by their cat-like paw print, the absence of claws, and the characteristic fuzzy, or indistinct print that is the result of the thick fur surrounding the paw. See leopard for distinguishing characteristics from that species.

## **6. ELEMENTS OF LEOPARD ECOLOGY RELATED TO EXPERT ASSESSMENT OF LEOPARD NUMBERS**

### **Leopard home range size**

An estimate of leopard numbers is dependent on understanding how much area an individual animal of specific sex and age requires. Long-term study of leopard ecology using their tracks and signs allowed revealing specific patterns. In Kedrovaya Par Reserve in 1971-1976 an adult female used a home range of about 50 km<sup>2</sup> (Yu. B. Shibnev “Letopis prirody Zapovednika”). N. G. Vasiliev (1965) reported about a home range size of 40 km<sup>2</sup> for a female; V.G. Korkishko indicated that home ranges of adult female leopards within Kedrovaya Pad reserve were up to 60 km<sup>2</sup> (Pikunov and Korkishko 1992). Subadults use home range of about 20-25 km<sup>2</sup> and female with little kittens, which do not leave the den, uses the area of 10-20 km<sup>2</sup> (Pikunov 1976, Shibnev – pers. comm.).

Using radiocollared animals in and around Kedrovaya Pad Zapovednik, the Hornocker Wildlife Institute used two methods to define home range size.

*First*, they delineated a polygon that connected the outermost locations (called a 100% minimum convex polygon) of each animal. This estimate probably over represents the amount of land a leopard actually uses because there are likely spaces within the polygon that are rarely frequented by leopards. Nonetheless, this estimation has value for conservation planning because it likely more closely represents the amount of land individual leopards require: much of the land designated as potential habitat in any planning process will be of marginal quality.

Two radiocollared females varied greatly in home range size. Female #1 used an area of approximately 33 km<sup>2</sup>, while female #2 used 62 km<sup>2</sup>. The single male that was followed extensively had a much larger home range, approximately 280 km<sup>2</sup>. While females were able to meet all habitat requirements within the boundaries of Kedrovaya Pad, the male ranged widely outside the Zapovednik, and spent considerably time in Barsovy Zakaznik. The full scope of his range may not have been defined because he often moved out of tracking capabilities near the Chinese border.

*The second* method employed to estimate home range size used a 95% minimum convex polygon method, a more conservative estimate of home range size that deletes 5% of the outlying locations. While this method more likely represents the actual ecological requirements of the animal, it likely underestimates the amount of land required by a leopard for conservation planning. Home range size of the two females is considerably smaller using this method: female #1 home range size was only 18.3 km<sup>2</sup>, female #2 used 45.4 km<sup>2</sup>, while male home range size was the same – 280 km<sup>2</sup>.

Based on the traditional tracking method, we know that another adult female is using a range on the southern border of Kedrovaya Pad that includes the Amurski AOZT deer farm. Though the exact size of

her range is not known thoroughly, it is thought to be similar to the other adult females.

We can use the information acquired from radiotracking, combined with the information from traditional snow tracking to estimate that, on average, adult female leopards use 35-45 km<sup>2</sup>. While some animals will require more or less land, dependent on habitat quality, this information provides a key piece of information for conservation planning. For males, we know less precisely how much land is used, but if the lone male that was studied provides a reasonable measure, males will use an area 4-6 times larger than that of females.

### **Social structure of leopard population**

Understanding of the social structure of the leopard population is critical for land-use planning and conservation of this animal. Before we can ask, “how much land does a viable population of leopards need?” we must have information about the home range requirements of individuals (addressed above) and social structure. Information on home range size tells us how much space each individual animal requires, and information on social structure tells us how many leopards can be “packed” into a given area. For instance, if leopards are territorial, and each animal requires its own space from which it excludes other leopards, then a population will require a much larger land area than if there is overlap in home range amongst neighbors.

The results of our analyses indicate that both females and males are territorial, but only to members of the same sex. That is, an adult resident female retains control of an area exclusively for herself and young. Resident males will visit for breeding purposes, and are tolerated on the female territory, but other adult females are excluded.

Males, as described above, have much larger home ranges, and are also apparently territorial, in that they exclude

other adult males. Male territories will include one or more adult females. We believe that the adult male radiocollared ranged over an area that included 3 resident females.

### **Behavior and movement patterns of leopards**

It is known that Far Eastern leopards are conservative in choosing their home ranges. Usually leopard home range is situated in one creek or river basin and is limited by natural topographic borders. Home ranges of individuals of different sex and age overlap slightly and rarely (Pikunov, Korkishko 1985, 1992, Pikunov et al. 1999). In winter leopard trails in forested mountains pass along specific places with the least snow cover. Usually leopard trails can be found on rocky cliffs or along creeks or small rivers. Sometimes leopards use ridges along basin divides for travel, especially if they share the territory with tigers, which usually use river valleys and frozen rivers for traveling. Leopards usually avoid traveling along mountain slopes even when hunting. For hunting purpose leopards focus on those territories, where ungulates concentrate. In such areas fieldworkers should be very attentive because here leopards often use ungulate trails. Leopards usually walk along old forest roads if they are not frequently used by humans.

Leopards prefer fir-spruce-pine-broadleaved and broadleaved forests on low mountain slopes. This forest type has generally been relatively little impacted by logging and fires. In winter leopards and especially females with litters stay in confined areas for extended periods, leaving numerous tracks, trails, and scrapes.

### **Leopard population density**

As a basis for estimating actual numbers of leopards, it is helpful to have a general idea of what leopard densities can be expected across the region under optimum conditions. Although it is

impossible to know exactly how many animals inhabit an area at any given time, combining knowledge of radiocollared animals with traditional snow tracking techniques provides means of assessing with greater accuracy. For instance, in winter 1995-1996 it was clear from tracks that besides radiocollared leopards four more leopards regularly use the territory of Kedrovaya Pad Reserve. With the combined information obtained from snow tracking and radio telemetry, we were able to determine that leopard density averaged 1.2-1.5 individuals per 100 km<sup>2</sup>. If to take into account subadults and kittens, then total leopard density within Kedrovaya Pad Reserve in 1995-1996 was 2.9-3.2 individuals per 100 km<sup>2</sup>. Based on our knowledge of other areas within leopard range including unprotected ones, we believe this density represents close to the maximum likely density that can be achieved in this region.

## **7. SURVEY DESIGN**

### *Location of survey routes.*

Monitoring of leopard numbers in southwest Primorye since 1961 has assisted in identifying habitats most likely to be used by leopards, and allows surveyors to focus efforts in those areas with greatest likelihood of finding leopard sign. Survey design and route placement is intended to determine presence or absence of animals in all potential leopard habitat, and to determine sex-age characteristics (Figure 2).

We made an effort to investigate all suitable leopard habitat in southwest Primorye, and to insure coverage of all areas surveyed during 5 previous leopard surveys (from 1985) (Figure 4). Additional routes were added from those used in previous surveys to account for changes in habitat availability, and to insure coverage of all potential habitat. For instance, southernmost part of Khasansky Raion (including Ryazanovka river basin) and northern portion of

southwestern forested mountains (including Krounovka, Medvediza and Abrikosovka river basins) were investigated more thoroughly.

The network of survey routes used in 2003 was nearly the same as that used for the 2000 leopard survey (Pikunov et al. 2000). For the 2000 survey 131 routes were covered, while in the present survey 151 routes were covered. Survey routes were covered by 4WD vehicles (26 routes or 17%), “Buran” snowmobiles (12 routes or 8%); 14 routes (9%) were “mixed”, i.e. partly covered by vehicle or snowmobile and partly on foot or skies. Most of survey routes (99, or 66%) were covered on foot or skies.

We divided the study area in southwest Primorye into 3 study units: **Southern** (1158.6 km<sup>2</sup>), **Central** (1897.3 km<sup>2</sup>) and **Northern** (1544.4 km<sup>2</sup>) (Figure 3). Our study area, estimated at 4600 km<sup>2</sup>, was covered by 1603 km of survey routes.

The **Southern unit** consisted of the western part of Khasansky Raion and abuts the international border. In the north this unit widens especially in Ryazanovka river basin. Leopard habitat area comprises about 1158 km<sup>2</sup> in this southern unit. Three people covered 38 survey routes totaling 367 km (3 “mixed”, 8 covered by vehicle and 27 on foot). The **Central unit** included the territories of Barsovy Zakaznik and Kedrovaya Pad Zapovednik. Sixty-one routes, totaling 658 km (4 “mixed, 7 covered by vehicle and 50 – on foot and skies) were set up in an area covering 1987 km<sup>2</sup> from the left bank of Ryazanovka river up to Amba river basin. Routes were covered by 6 specialists. **Northern unit** included territories of Borisovskoe Plateau Zakaznik, Nezhinskoe, Borisovskoe and Pavlinovskoe Hunting Leases, where 52 survey routes totaling 578 km were covered (7 “mixed, 11 covered by vehicle, 12 – by snowmobile and 22 – on foot and skies). Survey routes were covered by 5 specialists.

Data from each survey route was entered in a Field Diary, which included instructions on how to collect the following information:

- # and name of survey route, including information about river basin or hunting lease or protected area, where this route was set;
- Name of fieldworker;
- Date when survey route was traveled;
- Type of transportation (vehicle, snowmobile, on foot, skies or “mixed”);
- Snow depth (measured at start, middle and end points of the route) and occasional information about forest density where snow depth was measured.

The Field Diary contained two tables:

1. Predator tracks on survey routes – tracks of leopards, tigers, lynxes, wolves and bears were included here. Each track had a unique number and description of its location. The main parameter recorded for predators was pad width of front paw. Specialists identified track age, and if possible sex and age of animal.
2. Fresh (24 hours and less) tracks of ungulates and hares on survey routes were reported. Specialists registered animal species (wild boar, sika deer, roe deer or musk deer) and the number of animals crossing the survey route.

Field Diary contained two maps (1:100,000) with survey routes. All encountered tracks of large predators were recorded on the first map (each track had the unique #, which corresponded with track # in Table 1). After the survey route had been traveled fieldworker compiled the information and identified the number of predators encountered on survey route and gave evidence if necessary.

All fresh ungulate tracks (of potential leopard prey species) were reported on the second map. Ungulate numbers was calculated for each species separately (for sika deer, roe deer and wild boar). Ungulate abundance was assessed based on track encounter rates (number of

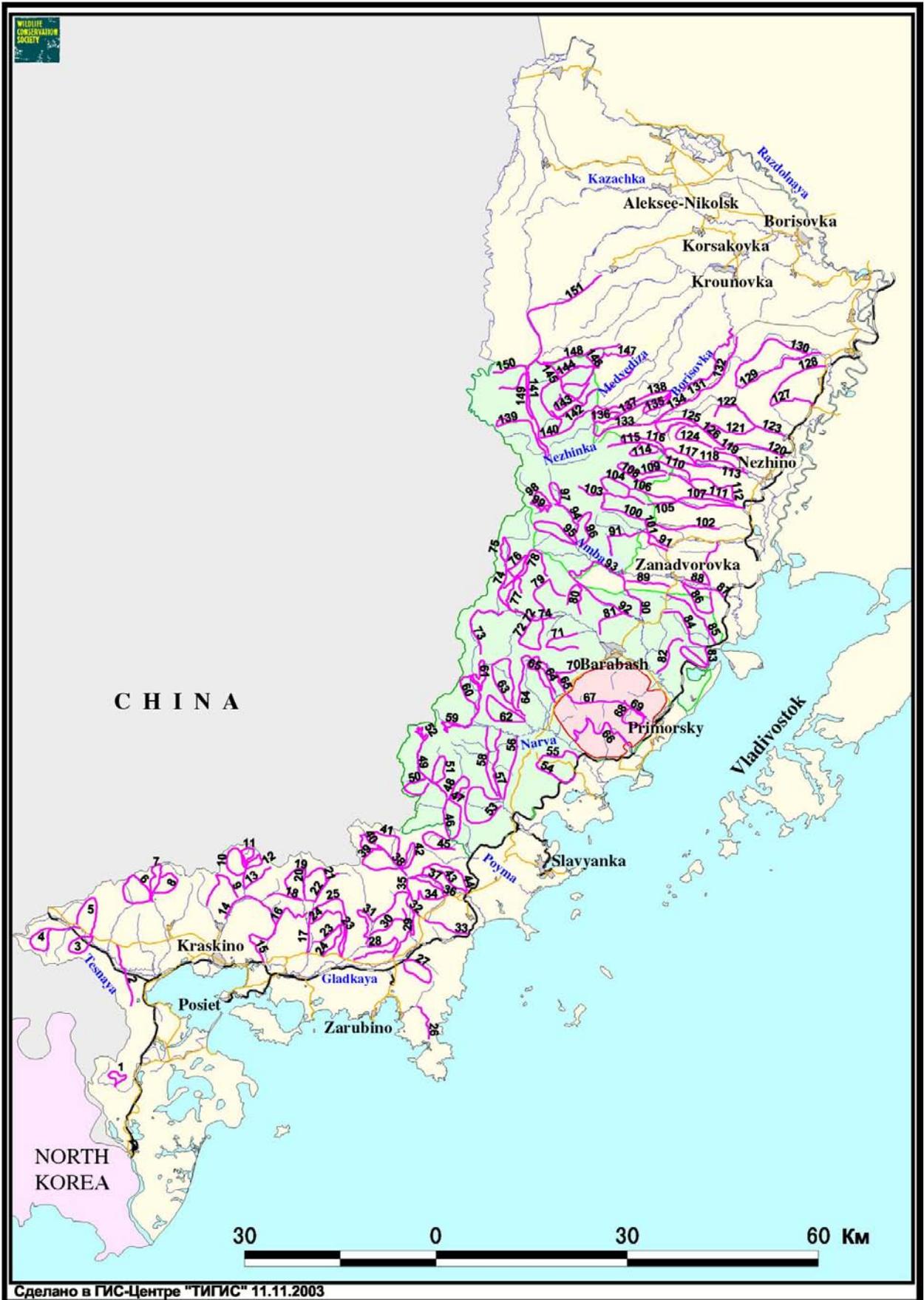


Figure 2. Survey routes location within southwest Primorye, February 2003

fresh tracks per 10 km of survey route) for each ungulate species.

Based on the results obtained in 3 survey units (Northern, Central and Southern) the following information was shown on maps (scale 1:100,000):

- All survey routes covered, each with unique #;
- All tiger and leopard tracks encountered, each with unique #;
- Lynx, wolf and bear tracks (with front paw pad width measured), each with unique #.

Animal sex was identified based on track size (see above), litter presence or absence, shape and size of scrapes, urine marks and bed size (females' beds are not longer than 70-80 cm without tail), playing behavior of kittens, etc. Leopards and tigers were identified by survey coordinators separately for each survey unit. The main criteria used were the following:

- Track size – if pad width between sets of tracks varied by more than 1 cm, they were considered as belonging to different individuals. This rule was not absolute, because when the weather is warm tracks can melt within few days or even hours. Therefore track age, day-time temperature and even cloud cover were the important criteria for track size identification and consequently identifying individuals.
- Home range size and possible daily travel distance – vary for leopards and tigers of different sex and age (females with kittens under one year old have home ranges of about 10-20 km<sup>2</sup>, females with older kittens and single females have home ranges of about 35-45 km<sup>2</sup>, adult resident males have home ranges of about 250-300 km<sup>2</sup>).
- Date and direction of travel – daily travel distance of male tiger unlikely exceeds 25-28 km,

therefore male tigers' tracks of the same age encountered 30 km from each other were considered as belonging to different individuals. The same distance for females does not exceed 20 km.

For each survey unit (Northern, Southern and Central) track data from field diaries was mapped (scale 1:100,000) and coordinators identified individuals based on criteria mentioned above. Tracks encountered near the borders between two survey units were identified cooperatively by two coordinators of these units.

Leopard and tiger abundance was assessed based on the number of tracks per 10 km of survey routes. Leopard and tiger densities were assessed per 100 km<sup>2</sup> of suitable habitats for each survey unit. Densities were also determined for zapovedniks, zakazniks and some hunting leases.

Assessment of leopard and tiger reproduction rates was based on counts of litters and cubs in association with females. Data obtained during this survey was compared with those of previous surveys in southwest Primorye to assess reproduction trends.

Habitat status was assessed in different parts of southwest Primorye based on suitability of territories for predators. The main criteria were forest status and composition, extent of ecosystem degradation due to human impact, predator and ungulate densities as well as human disturbance.

Competition between leopards and tigers was assessed in the following way. First, optimal leopard habitats in southwest Primorye were compared with those of tigers. Then data collected on survey routes was observed to determine what percentage of routes contained both tiger and leopard tracks, only tiger tracks and only leopard tracks; and finally what percentage of routes were not intersected by predator tracks. This approach cannot provide a full assessment of the



Figure 3. Survey units and leopard densities in southwest Primorye, February 2003



Figure 4. Far Eastern leopard range based on survey results, February 2003

relationship of these two predators, but does provide an indication of how they interact spatially.

**Data storage.** Our experience indicates that original raw data, if not created in an electronic, standardized format, is often lost, or unrecoverable, after 2-4 years. At this point, it becomes impossible to conduct future analyses or comparisons. Therefore, it is essential that an electronic version of the original data is created and stored properly. We have significant experience in creating geographically referenced databases from our work with the Amur Tiger Monitoring Program, previous leopard surveys, and the 1996 Tiger Survey. We have developed a format from previous leopard surveys that will form the basis for this new data.

## 8. RESULTS OF LEOPARD SURVEY 2003

Total 197 leopard tracks and 229 tiger tracks were found on 151 routes in southwest Primorye in February, 2003.

### Far Eastern leopard (*Panthera pardus orientalis*)

**Southern unit** – 11 leopard tracks were found on 10 survey routes (26.3% of all routes). The track encounter rate was 1 leopard track per 33 km. All tracks were identified based on criteria mentioned above as belonging to the following individuals:

#1 – adult female; most of her tracks were found in middle part of Tesnaya river basin (south of Kraskino);

# 2 – adult leopard of unknown sex; whose home range was located in upper Tsukanovka river basin. This animal may cross the international border but lives mainly on the Russian side;

# 3 – adult resident male; most of his tracks were found in Gladkaya and

Vinogradovka river basins, but in the north his home range extends up to Ryazanovka and Poyma river basins;

# 4 – adult female; her home range was located in the divide area between Ryazanovka and Poyma rivers (middle reaches).

In the Southern unit leopard density was estimated at 0.35 individuals/100 km<sup>2</sup>, the lowest of the three units.

**Central unit** – 103 leopard tracks were found on 45 survey routes (74% of all routes). The following individuals were identified:

# 5 – resident male; probably the core of his home range is situated in divide area between Ryazanovka and Poyma rivers. Based on the criteria used for individual identification coordinators excluded the possibility that male # 3 and male # 5 are the same individual;

# 6 – leopard of unknown sex and age; inhabits the area on right bank of Narva river and occasionally visits Bezverkhovskiy deer farm;

# 7 – leopard of unknown sex and age; inhabits basins of left tributaries of upper Narva river;

# 8 – adult female; inhabits the territory west of Kedrovaya Pad Reserve and occasionally visits this reserve. It is possible that two young female leopards (# 10 and # 11) found in Kedrovaya Pad Zapovednik are relatives of female # 8;

# 9 – resident male; inhabits Kedrovaya Pad Zapovednik, but often leaves the reserve;

# 10 – young female; inhabits Kedrovaya Pad Zapovednik;

# 11 – young leopard (probably female); inhabits Kedrovaya Pad Zapovednik; # 10 and # 11 are probably former littermates of female # 8.

# 12 – resident male; inhabits middle part of Amba river basin, in Skalistaya mountain area;



Figure 5. Location of leopard tracks registered during the survey in southwest Primorye, February 2003

# 13 – resident male; found in upper Barabashevka river basin behind border control fence;

# 14 – adult female; found in Skalistaya mountain area, close to den used for many years by females with cubs;

# 15 – adult leopard of unknown sex; inhabits upper Maljutinka river basin;

# 16 – adult female; inhabits upper Amba river basin, occurs in upper Pravaya and Levaya Gryaznaya river reaches.

In the Central unit leopard density was estimated at 0.63 individuals/100 km<sup>2</sup> (Figure 3).

The **Northern unit** includes some of the best leopard habitat. Zero counts of tiger and leopard tracks were registered only on 6 survey routes. Eighty-three leopard tracks were found on 45 routes (74% of all routes). The following individuals were identified:

# 17 – resident male; inhabits middle parts of Ananievka and Malaya Ananievka river basins and occasionally visits middle reaches of Nezhinka river;

# 18 – adult female with 2 year old kitten; inhabits upper Ananievka river basin;

# 19 – 2-year old kitten; traveled in association with adult female # 18;

# 20 – adult female with kitten; inhabits Malaya Ananievka river basin, Kabarginskiy creek area, probably visits northern tributaries of Nezhinka river;

# 21 – kitten of the female # 20; inhabits the same area;

# 22 – resident male; core of his home range is situated in middle part of Nezhinka river basin;

# 23 – adult female with kitten; walks in upper Vtoraya Rechka river basin;

# 24 – kitten of the female # 23; inhabits the same area;

# 25 – adult female with kitten; inhabits the area near Kedrovskiy deer farm. In early winter this female was recorded in the middle part of Bolshaya Kedrovka river basin;

# 26 – kitten of the female # 25; inhabits the same area;

# 27 – resident male; inhabits middle part of Borisovka and Malaya Borisovka river basins;

# 28 – adult female with kitten; inhabits upper Krounovka and Medvediza river basins;

# 29 – kitten of the female # 28; inhabits the same area;

# 30 – resident male; was found in Polkovniza river basin behind border control fence;

In the Northern unit leopard density was estimated at 0.91 individuals/100 km<sup>2</sup> (Figure 3).

Based on our assessment it is not possible to confirm whether some tracks represent additional individuals or not. Female # 18 with kitten # 19 found on 3 routes of Northern unit (two teams registered litter tracks twice in upper Ananievka river basin on February 5 and 6, 2003). On February 7 and 8 tracks of the same size belonging to female # 20 and kitten # 21 were registered 15-20 km from mountains mentioned above. Their trail was not found probably due to high ungulate (sika deer) density in this area. Based on track data it is difficult to determine if there is one litter or two, because animals could cross the area by deer trails or rocky areas, which were partly free of snow. Therefore we consider them as “doubtful” individuals (i.e. # 18 and # 19 may be the same individuals as # 20 and # 21 or different ones).

If we exclude these questionable individuals, density in the northern unit was 0.78 individuals/100 km<sup>2</sup>.

Therefore, based on the results of survey conducted in southwest Primorye in February 2003 we estimate 28-30 leopards are present in Southwest Primorski Krai (Table 3, Figure 6).

Table 3. Summary results of leopards recorded in 2003 winter survey, in Southwest Primorski Krai	
<b>Males</b>	<b>9</b>
<b>Females</b>	<b>7</b>
<b>Females with kittens</b>	<b>4-5</b>
<b>Kittens</b>	<b>4-5</b>
<b>Individuals of unknown sex</b>	<b>4</b>
<b>TOTAL</b>	<b>28-30</b>

### **Amur tiger (*Panthera tigris altaica*)**

In the **Southern unit** tracks of tigers were registered 19 times on 11 routes. The following individuals were identified:

# 1 – subadult male; was found in upper Tsukanovka river basin behind border control fence;

# 2 – adult female; was found in the same area as # 1;

# 3 – adult resident male; inhabits the middle part of Ryazanovka river basin;

# 4 – adult female; was found in upper Ryazanovka and Poyma river basins, occasionally came down to Sukhanovskiy pass.

Female # 4 is “questionable;” according to the information from local people she approached Gamovskiy deer farm or went behind border control fence. Possibly this female was also registered in the Central unit. Males # 1 and # 3 are likely one individual - although there is almost 1 cm difference in their pad widths. Measurements were made 2 days apart, and melt-out may explain the difference.

Because there appear to be the same number of individuals of tigers and leopards in the Southern unit, density is the same– 0.35 individuals/100 km<sup>2</sup>.

**Central unit** – 95 tiger tracks were recorded on 36 survey routes (59% of all routes) and 5-6 individuals were identified:

# 5 – adult male; inhabits the area west of Kedrovaya Pad Zapovednik (upper left tributaries of Narva river);

# 6 – subadult male; tracks are smaller than those of the male # 5, but he inhabits the same area;

# 7 – adult female with little cub # 8; inhabits the area west of Kedrovaya Pad Zapovednik, which they often visit;

# 8 – cub of female # 7; probably subadult male # 6 also relates to female # 7, but there are no enough data to demonstrate this;

# 9 – resident male; this is the most “questionable” individual – probably it a resident male, whose home range includes Ananievka and Nezhinka river basins, but most likely this male came from the south and tracks of male # 5 could belong to this individual;

# 10 – adult female; inhabits Mramornoe area and upper Amba river basin, including the area behind border control fence.

Tiger density in this unit, excluding the questionable tiger #9, was 0.25 animals/100 km<sup>2</sup>.

**Northern unit** – 115 tiger tracks were found on 37 survey routes (75% of all routes). These tracks most likely belong to 8-10 individuals. Two females were registered, each of them has two cubs. The following individuals were identified:



Figure 6. Far Eastern leopards distribution in southwest Primorye based on survey results, February 2003

Table 4. Summary results of Amur tigers recorded in 2003 winter survey, in Southwest Primorski Krai	
<b>Males</b>	<b>5-7</b>
<b>Females</b>	<b>4</b>
<b>Females with cubs</b>	<b>3-4</b>
<b>Cubs</b>	<b>4-6</b>
<b>Individuals of unknown sex</b>	<b>0</b>
<b>TOTAL</b>	<b>16-21</b>

# 11 – female with cub; inhabits Ananievka and Malaya Ananievka river basins;

# 12 – tiger cub of female # 11; inhabits the same area;

# 13 – adult resident male; inhabits Nezhinka, Borisovka and Krounovka river basins;

# 14 – adult female; inhabits Nezhinka and Vtoraya Rechka river basins;

# 15 – adult female with two cubs; was found on divide between Sanduga and Borisovka rivers, also occurs in upper Borisovka river basin;

# 16 – tiger cub of female # 15; inhabits the same area;

# 17 – tiger cub of female # 15; inhabits the same area;

# 18 – resident male; inhabits upper Krounovka and Medvediza river basins. It is possible that it is the same male as # 13, who visits Nezhinka river;

# 19 – adult female with two cubs; inhabits Krounovka and Medvediza river basins and Ananievskiy creek area;

# 20 – tiger cub of female # 19; inhabits the same area;

# 21 – tiger cub of female # 19; inhabits the same area.

We can not exclude the possibility that #15, # 6 and #17 are the same individuals as #19, # 20 and # 21. Based on the information on track sizes and dates of traveling we cannot determine for sure if there is one litter or two. It is also possible that tracks of males ## 1, 3, 5 and 16 belong to 3 or 4 individuals, and tracks of males ## 9, 13 and 18 found in northern part, belong to 2 individuals.

Therefore maximum tiger density in this unit was 0.71 animals/100 km<sup>2</sup>.

Based on these analyses across the entire region surveyed in Southwest Primorski Krai in winter 2003, we estimated a total of 16-21 tigers present (Table 4, Figures 7, 8)

### Other large Carnivores

In February 2003 within leopard range in southwest Primorye tracks of the lynx, wolves, and bears were also found.

### Lynx (*Felis lynx*)

The territory of southwest Primorye covered with broadleaved and pine-fir-spruce-broadleaved forests has been inhabited by lynx for an extended period. This species was never abundant but was common enough to be commercially hunted. When migrating roe deer concentrated in this area or density of Manchurian hares peak, lynx numbers can increase significantly. There is evidence that leopards and lynxes compete for prey, including:

1. Lynx tracks have never been found near deer farms, which are usually visited by leopards (Peschany, Bezverkhovskiy and Kedrovyy deer farms);

Lynx tracks and even tracks of lynx litters were registered in Komissarovka, Bolshaya Ussurka and other river basins

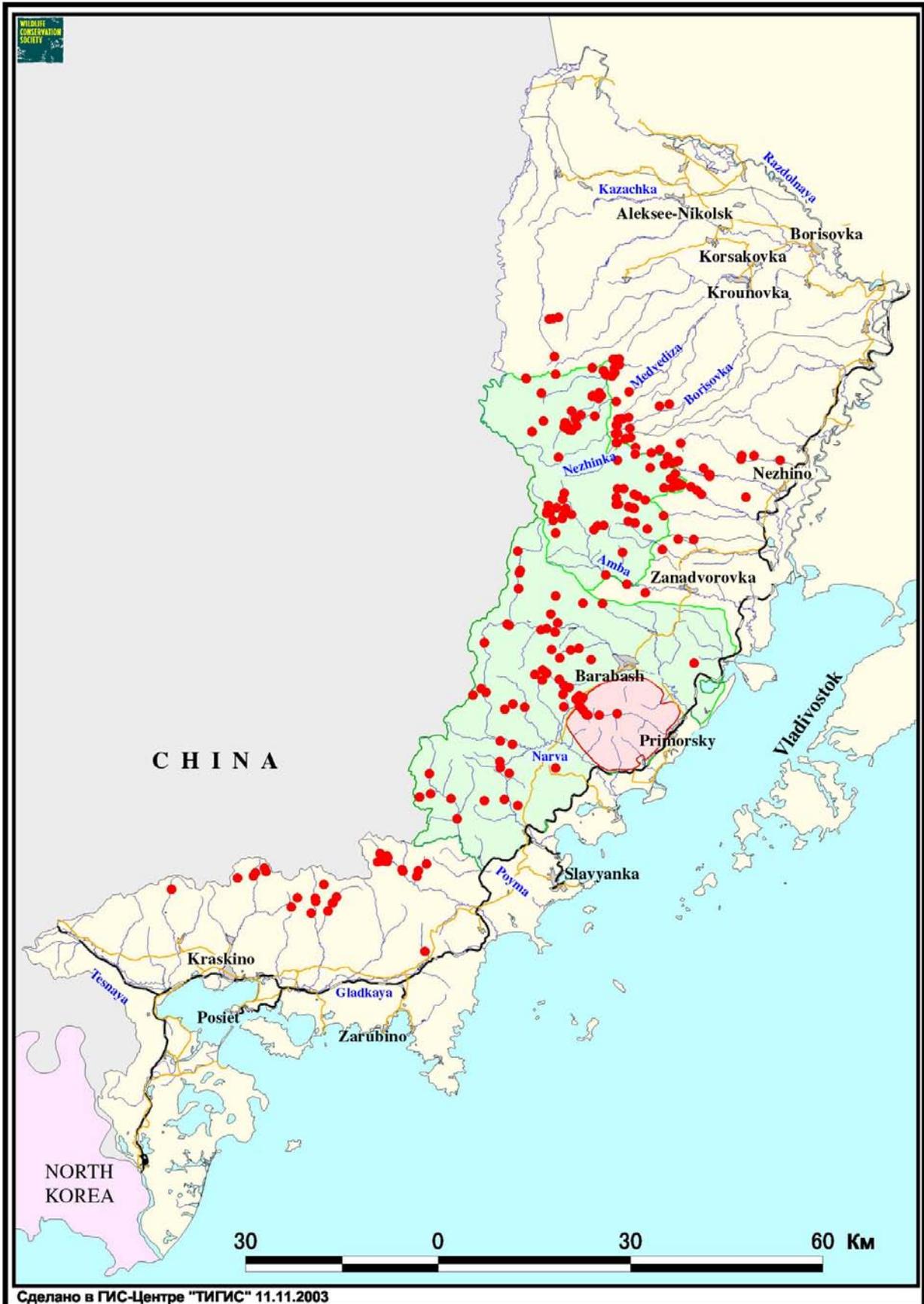


Figure 7. Location of tiger tracks registered during the survey in southwest Primorye, February 2003

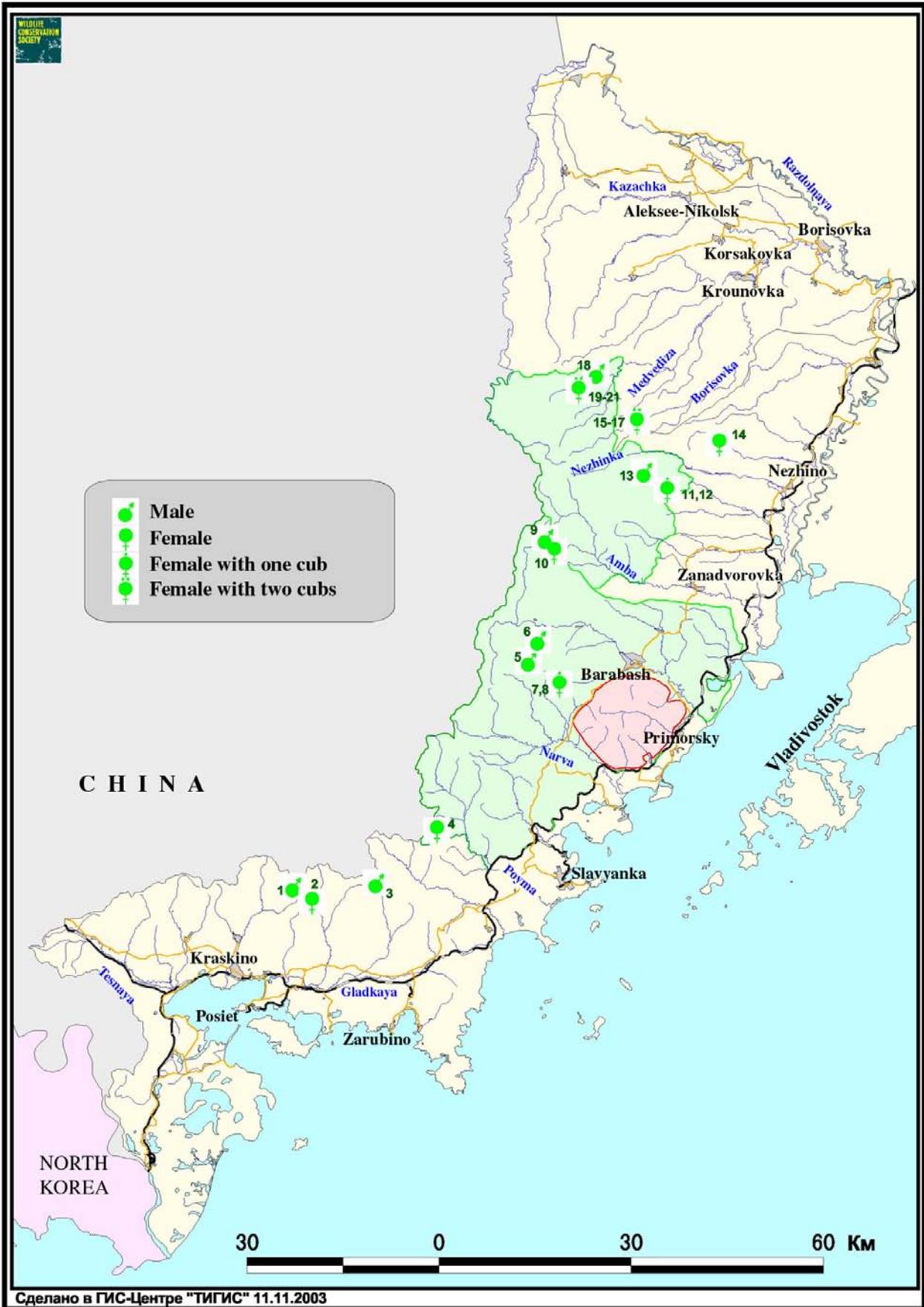


Figure 8. Amur tiger distribution in southwest Primorye based on survey results, February 2003

Table 5. Lynx tracks found on survey routes

##	Location	Observer	Pad width of front paw, cm	Front paw length, cm	Track age	Animal age	Snow depth near the track, cm
1	Tsukanovka river basin	Kosach	4.0	6.5	1 day	Adult	6
2	Vinogradovka river basin	Abramov	3.5		2-4 days	Young	Snow drift
3	Upper Ryazanovka river basin	Kosach	4.3		1-2 days	Adult	15
4	Divide between Gryaznaya and Ananievka rivers	Seredkin	4.5		2 days	Adult	10
5	Divide between Gryaznaya and Ananievka rivers	Seredkin	4.2		2 days	Young	10
6	Ananievka river basin	Seredkin	4.2		1 day	Young	12
7	Upper M. Khokhoninskiye creeks basin	Pikunov	Less than 5.0		3-4 days	young	5

(Pogranichny and Khankaiskiy Raions), where leopards have not been found for a long time. During this survey seven lynx tracks were found in southwest Primorye (Table 5):

Home range size of adult lynx is 2-3 times smaller than that of adult leopard. Additionally, all lynx tracks were found on rocky slopes (more often on northern slopes) or on rocky divides. Lynx tracks are even more difficult to find because they use animal trails on slopes more often than leopards and move on top of crusted snow, which can bear the weight of a lynx. During previous surveys lynx tracks were often found in Skalistaya mountain area, Siniy Utyos and Krasny Utoys areas as well as regions where tracks were reported in this survey (Table 5).

Based on the results of survey conducted in February 2003 we estimate that in southwest Primorye at least 6-7 lynx occur: 2 adult males (Tsukanovka and Ryazanovka river basins), 2 females (Vinogradovka river basin and Khokhoninskiye creeks area) and a female with a kitten (Ananievka- Gryaznaya river basins). Tracks found on the road along Ananievka-Gryaznaya divide were considered questionable.

### **Wolf (*Canis lupus*)**

Until recently wolves were rare in Southwest Primorye, occasionally dispersing from China or Khankaisky Raion. In 1990 border guards shot a big male wolf in Tsukanovka river basin. In the northern part of the study area packs of stray dogs are common, but their tracks are easily distinguished from those of wolves a pack of dogs will invariably consist of animals of varying size. Recently wolf numbers have began to increase in Primorye (especially in Khankaisky Raion) but they rarely visit forest tracts in southwest Primorye. During this survey wolf tracks were found near the northern and northeastern borders of southwest Primorye. About 10 wolves were identified. However we can not exclude the possibility that some of these animals could be big stray dogs.

### **Bears (*Ursus arctos*, *Ursus thibetanus*)**

Tracks of two brown bears and one Himalayan bear were found in Ananievka river basin in Khokhoninskiye creeks area, in Borisovka river basin and upper Krounovka river basin. Bear densities are reasonably high in some part of Borisovskoe Plateau. It is likely that the majority of bears were still in their dens during the February survey.

Table 6. Ungulate densities in protected areas and hunting leases of southwest Primorye based on the results of survey, February 2003

Territory status	Total length of survey routes, km	Sika deer		Roe deer		Wild boar	
		# of tracks	tracks/10 km	# of tracks	tracks/10 km	# of tracks	tracks/10 km
Protected areas	752.8	1595	21.2	444	5.9	386	5.1
Hunting leases	849	799	9.4	307	3.6	624	7.3

## Ungulates

In Southwest Primorye the main prey of leopards in winter are sika deer, roe deer and wild boar. Until mid-1970s roe deer were the dominate ungulate species in southwest Primorye and main prey of leopards. However after the border control fence was constructed in 1979 (preventing migration from China) and in association with intensive hunting, roe deer numbers decreased rapidly. Since that time sika deer numbers have increased rapidly and have become the main prey species for tigers and leopards in this territory (Pikunov and Korkishko 1985, 1992).

In winter 2001-2002, when there were unusually deep snows, significant numbers of sika deer and roe deer died from starvation and poaching. Evidence of this event was confirmed by the results of monitoring program conducted in winter 2001-2002 in this area. In December 2002 roe deer was almost absent in Borisovskoe Plateau, and few roe deer remained in Kedrovaya Pad Reserve and small adjacent area.

This year the ban on hunting ungulates in Neshinskoe hunting lease helped ease the situation. However, in hunting leases where hunting hazel-hens and hares was not banned it was impossible to control hunting of ungulates.

In recent years highest ungulates densities were registered in protected areas and lowest densities in hunting leases, despite the restrictions on hunting (Table 6). Ungulates are very responsive to human disturbance, and densities are generally

lowest in areas often visited by people, especially where poachers is prevalent (e.g. along forest roads). For example, ungulate densities are very low in the area along forest road between Pushkino village and upper Borisovka river basin. In lower Borisovka river basin in secondary oak forests ungulates are largely absent for dozens of kilometers. Extremely low ungulate densities are registered in Bolshaya and Malaya Kedrovka river basins, especially in hunting season. However, when hunting is banned, ungulates concentrate in this area by late winter and stay feeding on horse-tail. Extremely low ungulate densities were registered in the area along Ananievka river, where a new forest road was constructed.

In general ungulate distribution in southwest Primorye is very irregular, with low human disturbance, low snow cover and forage availability the main factors influencing where concentrations can be found.

The highest density of sika deer was registered within protected areas (21.2 fresh tracks/10 km of survey routes) (Table 6), a density two times higher than in hunting leases. The high density of sika deer probably explains why most tigers concentrate in protected areas despite the fact that the highest density of wild boar (favorite prey for tigers) was registered in middle river basins of Borisovskoe Plateau, i.e. within hunting leases.

The reason of this unusual tiger behavior was not the predilection for sika deer but inaccessibility of wild boars due

Table 7. Distribution of ungulates' and predators' tracks in Borisovskoe Plateau in February 2003

Territory status	Total length of survey routes, km	Roe deer	Sika deer	Wild boar	Leopard		Tiger	
					# of tracks	Tracks/10 km	# of tracks	Tracks/10 km
Borisovkoe Plateau Zakaznik	312	32	979	54	37	1.2	96	3.1
		34.1 ungulate tracks/10 km						
Hunting lease	266	89	326	260	47	1.8	18	0.67
		25.4 ungulate tracks/10 km						

to high human disturbance from numerous hunters. Highest roe deer density in southwest Primorye was registered in secondary oak forests in lower river basins. Roe deer probably cannot successfully compete with sika deer: roe deer are generally absent in areas where sika deer density is stable and high.

Total ungulate density (wild boar, roe deer and sika deer) is 1.3 times higher in protected areas (Borisovskoe Plateau Zakaznik) than in adjacent hunting leases (Table 5). Human disturbance is lower in the zakaznik due to its inaccessibility. Tiger density in this area is higher than in hunting leases: 3.1 tracks/10 km of survey routes in zakaznik versus 0.67 tracks/10 km in hunting leases. Probably here the competition between tigers and leopards is more evident: habitats of higher quality are occupied mainly by tigers and to a lesser extent by leopards.

During the survey conducted in February 2003 in southwest Primorye no less than 97-99% of suitable tiger and leopard habitats were investigated. Only the northwestern part of Northern unit was not investigated, in particular the Ploskiy Ridge and Pologaya mountain area behind border control fence. This mountainous area in the upper Borisovka, Nezhinka and Ananievka river basins had 50-60 cm of snow in February 2003 therefore it is highly unlikely that ungulates or predators were using this area.

## 9. HABITAT STATUS

Leopards are generally more restricted in habitat use than tigers (Pikunov and Korkishko 1992, Pikunov 2002). Currently the most suitable leopard habitat are the black fir-Korean pine-broadleaved forests. Most of these forest stands have already been logged, and logging continues in the upper and middle Ananievka river basins, the middle Kedrovka river basin, Pervaya and Vtoraya Rechka river heads, and in plateaus between Nezhinska and Borisovka rivers. Roads built to provide access to logging sites are intensively used in winter and poorly controlled. Illegal firewood cutting by local people, logging without permits, and forest fires continue to diminish and degrade the best remaining leopard habitat. Primary forests are replaced by secondary degraded oak forests that result from repeated fires. For instance, within Borisovskoe Plateau the area covered by secondary oak forests has increased by 25-30% since 1961 and continues to increase (Pikunov 2002). Oak forests with lespezeza have never been good habitat of tigers and leopards because they are not particularly productive and ungulate densities are consequently low there. If logging is not stopped in the black fir-Korean pine forests, further degradation will certainly threaten the future of tiger and leopard populations in Southwest Primorye.

Table 8. The relative density leopard, tiger and ungulates (roe deer, wild boar and sika deer), reported as tracks/10 km of survey routes in Southwest Primorye, based on February 2003 data.

Species	Southern unit Total length of survey routes – 367 km	Central unit Total length of survey routes – 685 km	Northern unit Total length of survey routes – 587 km
Leopard	0.3	1.5	1.4
Tiger	0.5	1.4	2.0
Ungulates*	13.5	31.5	32

\* only fresh (24 hours and less) tracks were registered

The distribution of leopards and tigers within Southwest Primorye (shown in Table 8) demonstrates that the Central and Northern units contain optimal habitat with adequate ungulate densities and are the primary habitat for both tigers and leopards. The Southern unit is covered mostly with secondary, poorer quality forests (oak/haze/lespedeza) and consequently has lower densities of predators and ungulates.

Highest density of prey species was registered in the Northern unit – 32 tracks/10 km of survey routes – mostly due to the high density of sika deer here. Wild boar populations also appear to be increasing over the last 3-5 years, and it is not uncommon now to encounter herds of 20-30 individuals in the Central and Northern units. Forage availability and low snow cover this past winter could result in high recruitment rates for the coming year. It is possible that increases in wild boar numbers may lead to increases of tiger numbers not only within Borisovskoe Plateau but in southwest Primorye in general.

Leopard and tiger habitat in the Northern and Central units are in good condition due to:

- Black fir-Korean pine-deciduous forests remain here;

- A large percentage of the territory is protected as zapovednik or zakazniks; where human disturbance is low and hunting is illegal;
- Consequently, ungulate densities are the highest here in southwest Primorye.

As yet there is insufficient information to fully understand competition between tigers and leopards. However, if competition is occurring, it appears that tigers are benefiting, as they appear to occupy the best quality habitat (Table 8).

Table 9 shows that leopard tracks or tiger tracks were registered on most of routes. 34.4% of routes contain both tiger and leopard tracks. Taking into consideration the average route length, which is close to 10 km and average daily travel distances of tiger and leopard (also close to 10 km) we can suppose that home ranges of these two predators often overlap. Overlap of home ranges is probably possible when ungulate densities are high and predators have sufficient prey, but overlap may also be due to insufficient suitable habitat due to human disturbance and economic development of the territory.

Table 9. Number of routes with leopard and tiger tracks

Number of routes with:	Southern unit, 38 routes	Central unit, 61 routes	Northern unit, 52 routes	Total area, 151 routes	%%
Leopard tracks	6	21	9	36	23.8
Tiger tracks	7	12	13	32	21.2
Both tiger and leopard tracks	4	24	24	52	34.4
Without tracks	21	4	6	31	20.5

## 10. EXISTING REPRODUCTION RATES IN LEOPARD POPULATION

Based on this and other recent survey results reproduction takes place mainly on the Borisovskoe Plateau, Kedrovaya Pad Zapovednik and central and western parts of Barsovy Zakaznik. Since the mid-1980s evidence of reproduction (litters) has disappeared from the northernmost and southernmost parts of southwest Primorye. During surveys conducted in 1997 and 2000 no litters were not found in Borisovskoe Plateau (the first time in 30 years), even in the areas where they have always been registered. This change may be the result of increased human disturbance associated with the intensive logging now ongoing in these areas (Pikunov et al. 1999, Pikunov 2002).

A decrease in the number of reproductive females and a reduction in litter size have been observed for the past 10 years. There are probably several reasons for this, including the potential impacts of inbreeding depression, low and unstable densities of prey species, loss of deer farms which has in the past supported leopards, especially females with young (Miquelle and Murzin 2000), intensive logging, forest fires, and rapidly increasing human disturbance.

Results of the survey 2003 confirmed the presence of 4-5 females with cubs, each with a single kitten per litter. The litter found in Vtoraya Rechka river basin is questionable. There a female with kittens walked along frozen river in canyon, leaving numerous tracks that appeared to be a female with two kittens. However

several other routes in this area did not confirm the presence of a female with two kittens.

All females with litters were found in the Northern unit. Three of five litters were registered in Borisovskoe Plateau Zakaznik and one near Kedrovskiy deer farm.

Results of three last surveys (including survey 2003) suggest that 10-12 individuals of the present population are adult females. In the Russian Far East adult female leopards generally reproduce once every 2-3 years (Pikunov 1976, Pikunov and Korkishko 2002), although there are reports in Kedrovaya Pad Zapovednik of at least one female who reproduced after 15 months (Pikunov and Korkishko 1992). Based on these figures, we estimate that annual recruitment does not exceed 6-8 individuals.

Today mortality factors apparently are approximately equivalent to recruitment, resulting in a stable population. However, any change in this precarious balance could have disastrous consequences for the leopard population..

Tiger reproduction in southwest Primorye appears to be most common in northwestern Borisovskoe Plateau, where three females with a total of five cubs were found. The only additional female with a litter (one cub) was found in Barsovy Zakaznik not far from the borders of Kedrovaya Pad Reserve. The reasons for such a concentration of females in this one region are not clear. For instance wild boar (a preferred prey species) mostly were found in eastern part of the territory (where they would not have been accessible to the reproductive females), where they

Table 10. Results of Far Eastern leopard surveys in southwest Primorye in 2000 and 2003

Sex and age of registered leopards	Leopard numbers in 2000	Leopard numbers in 2003
Males	4-5	9
Females	8-9	7
Females with kittens	1-2	4-5
Kittens	1-3	4-5
Sex and age unknown	8-9	4
TOTAL	22-28	28-30

concentrated in swamp valleys of eastern Borisovskoe Plateau or in valleys of middle river reaches to exploit an abundant crop of Manchurian walnuts.

In general, the survey results suggest that the present distribution of tigers and leopards within southwest Primorye is an issue of great concern. Tigers and leopards inhabit a restricted area in Central and Northern survey units where habitat conditions are suitable for both predators. However, this tract of suitable habitat is very small and continues to shrink. The potential for direct competition between leopards and tigers has increased as tiger numbers increase in Southwest Primorye, from 8 individuals in 1996 (Matyushkin et al. 1996) to 16-21 based on these survey results.

A lack of adequate prey species has also become more evident. In the 1980s and 1990s a lack of wild prey was compensated for by the high numbers of sika deer in deer farms - in Khasansky and Nadezhdinsky Raions alone there were 30,000-35,000 sika deer in farms (A. Bogachev, pers. comm.). In those years up to 50% of all leopards fed near deer farms (Pikunov et al. 1999). After liquidation of most of deer farms (Peschany, Bezverkhovskiy, Monakinskiy, Gvozdevskiy and partly Gamovsky and Kedrovskiy) the number of deer present on farms has dropped at least 10-fold. Consequently it appears that predators have largely abandoned the eastern and southern parts of their range (where these deer farms were located) and concentrated

in confined areas in central and northern areas, where densities of wild ungulates can satisfy their nutritional requirements and improve their reproduction potential (Figures 5 and 7). Unfortunately it is unrealistic to expect compensation for this loss of potential prey in deer farms via an increase in wild ungulate numbers. While a ban on hunting and more intensive habitat management may help, it is evident that low living standards and locally high unemployment lead to high poaching levels that will limit recovery of ungulate numbers.

## 11. DISCUSSION AND CONSERVATION RECOMMENDATIONS

The most important parameters necessary for large carnivore conservation are high prey densities, low road densities to reduce access by humans, and low human disturbance (ideally via a protected areas network). The importance of these parameters is reflected in the distribution leopard and tiger tracks on survey routes. Only 16% of tiger tracks (37 out of 229) and 25% of leopard tracks (50 out of 197) were recorded outside protected areas (Figure 7). At the same time, competition with tigers may have forced leopards to move east and occupy the middle sections of river basins.

Comparing the results of this survey with the result of survey conducted in 2000 it appears that the population has slightly

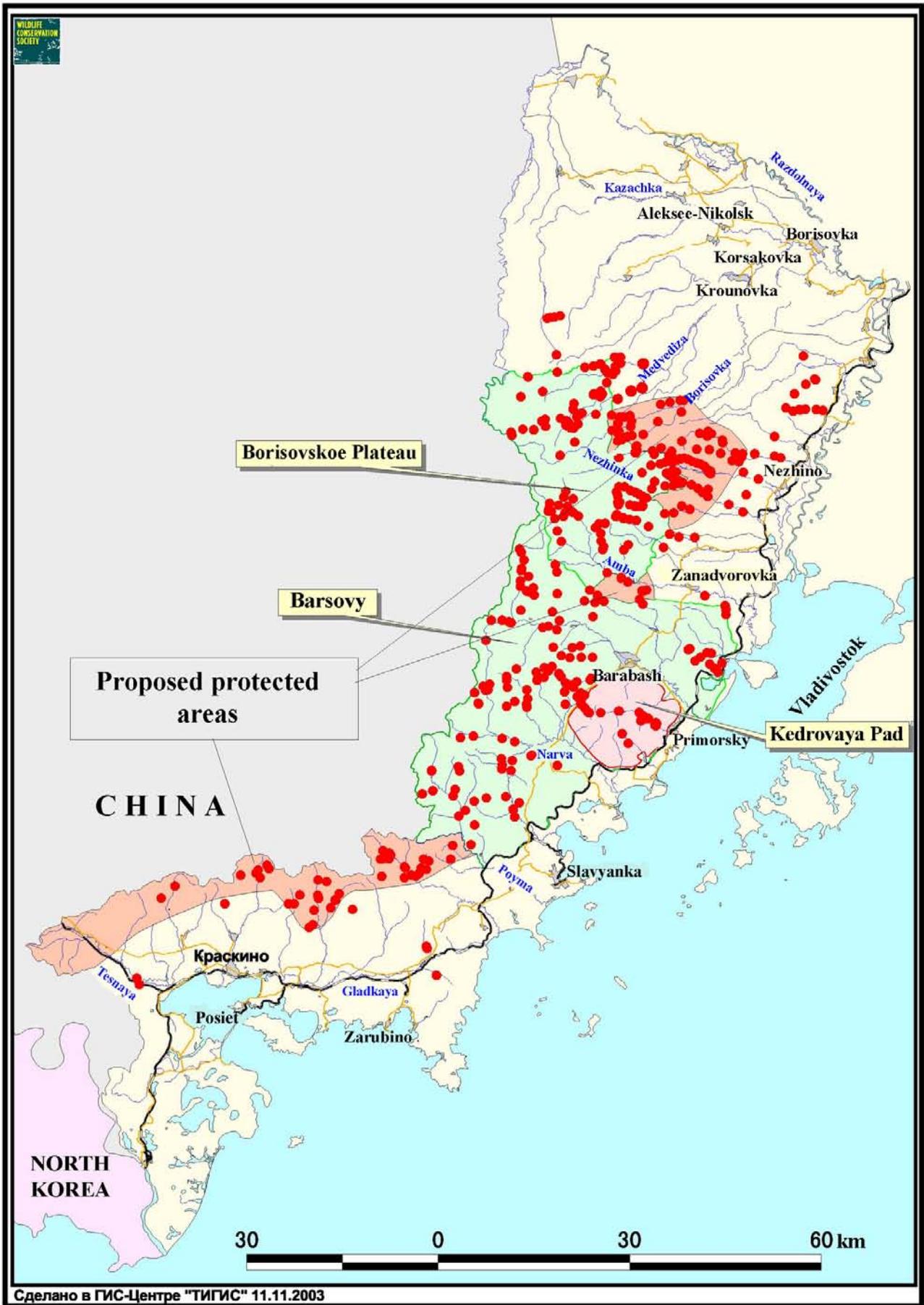


Figure 9. Proposed protected areas for Far Eastern leopard and Amur tiger conservation

increased (Table 10). The number of males has increased twice (although this may be related to fewer animals of undetermined sex), the number of adult females without cubs has remained approximately the same, but the same. Most significantly, this year it appears that and the number of female with kittens has increased significantly. The greater numbers of reproducing females likely explains the increase in population size. Analysis of the 2003 leopard survey indicates that most suitable leopard habitat is located in the Northern survey unit in Borisovskoe Plateau and adjacent areas. The highest densities of not only leopards, but tigers and ungulates were registered here. Lower densities were registered in Central survey unit despite the fact that it includes the territories of Barsovy Zakaznik and Kedrovaya Pad Zapovednik. Lowest densities were registered in Southern survey unit, where degraded oak forests extend as a narrow band along the international border. This southern territory along with Hunchun Reserve in China should act as an ecological corridor connecting southwest Primorye with the Korean Peninsula and eastern Jilin Province (China) (Figure 9).

Based on our data we have tried to determine which territories are most important for conservation of the core of wild leopard population (Figure 6). The highest leopard density was registered in Kedrovaya Pad Zapovednik (1.7 individuals/100 km<sup>2</sup>). Slightly lower densities (1.5 individuals/100 km<sup>2</sup>) were registered in Borisovskoe Plateau Zakaznik. Along the border of the Zakaznik and Neshinskoe Hunting lease there is a confined area where leopard density is very high, probably higher even than in in Kedrovya Pad Zapovednik. This quality tract of habitat along Nezhinka river from Toginskiy creek head to zakaznik border, along Vtoraya Rechka from Kedrovy creek head to its upper reaches, as well as Malaya Ananievka river basin (from Bolshevistskiy creek) and

Ananievka river basin (from Osetinskiy creek) has been retained since the 1960s (Figure 10). Leopard reproduction has been reported in this area in nearly every survey. Because of its importance to leopards, we recommend increasing the level of protection for this territory within Nezhinskoe hunting lease to a “no-hunting zone,” to clearly demarcate this land with signs, and to increase anti-poaching activities in this region. Designating these areas as “quiet zones” could also be beneficial to Nezhinskoe Hunting lease because this region will act as a source population of ungulates for the lease. Therefore, existing protected areas (two zakazniks and one zapovednik) along with proposed “no-hunting zone” will be the main protected habitat for tigers and leopards in southwest Primorye (Russia). We are hopeful that creation of such a no-hunting zone will eliminate the necessity of a total ban on hunting in these areas to save the existing leopard population.

Based on the results of all recent surveys we concur with recommendations to include forested area of Borisovskoe Plateau and Barsovy Zakaznik into a proposed national park and establish a single administrative center. The status of protected areas should be elevated to federal level (Borisovskoe Plateau Zakaznik is only a provincial level protected area).

To protect the best remaining leopard habitat within protected areas network (specifically within Borisovskoe Plateau Zakaznik) we strongly recommend a ban on logging in the basins of Koreiskiy and Razdolnenskiy Creeks, in upper Perveya and Vtoraya river basins, along Bolshevistskiy creek (Ananievka river basin) and in Malaya. Khokhoninskiye creek. Based on the results of this survey all these areas represent prime habitat for tigers, leopards and ungulates. Construction of forest roads should be prohibited in these areas and all existing roads should be closed or thoroughly controlled. Because of its proximity to



Figure 10. Far Eastern leopard densities in protected areas and hunting leases in southwest Primorye based on survey results, February 2003

Vladivostok, this region is one of favorite recreational places for citizens of Vladivostok, Ussuriisk and Artyom, and subject to intensive human disturbance. Insuring that this region is adequately protected is vital to long-term security of the leopard population in Southwest Primorye.

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