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A Survey of Far Eastern Leopards and Amur Tigers in Southwest Primorye Krai, in 2000

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"Sweep" survey of Far Eastern leopards and Amur tigers in Southwest Primorski Krai, winter 2000 – D. G. Pikunov, V. K. Abramov, V. G. Korkishko, I. G. Nikolaev, A. I. Belov
Simultaneous survey of Far Eastern leopards and Amur tigers in Southwest Primorski Krai, winter 2000– V. V. Aramilev and P. V. Fomenko

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INTRODUCTION

The Far Eastern leopard is one of the rarest subspecies of felids in the world. Its habitat has already been fragmented for an extended period, connectivity with other subspecies has been lost, and the bulk of the subspecies present range has been lost.

The Far Eastern leopard is presently the most endangered mammal in the Russian Far East, and immediate conservation actions are critical if this animal is to be saved for the region and the whole world. Even in captivity there are no more than 10 individuals with of pure Far Eastern leopard lineage.

At present, Far Eastern leopards occur only in the southwestern parts of Primorsky Krai, where, according to the most recent surveys, numbers have been estimated at 25-31 individuals (Pikunov et al. 1999), or, according to other sources – 40-44 individuals (Aramilev and Fomenko, 1999). A 1998 surveys conducted by an international team of scientists along the Sino-Russian border in Jilin Province (China) confirmed the presence of no more than 5-7 individuals there (Yang et al. 1998), while in 1999 no evidence of leopards was found in Heilongjiang Province (Sun et al. et al. 1999). These Chinese provinces border the present leopard range in the southern Russian Far East. Investigations conducted in the mountainous Paektusan region of North Korea adjacent to China also did not confirm the presence of leopards here, and the presence of leopards in the mountains of the Korean peninsula is doubtful (Kim Jin Rak et al 1998).

Therefore, the present distribution of Far Eastern leopards appears to be restricted to the southern portion of the Russian Far East and, if to be more exact – to the southwest region of Primorskii Krai, Russia, and the immediately adjacent territories of China. Most likely the leopards that still exists in Primorye represent the only remaining viable population of this rare subspecies. Retaining connectivity to leopards in China will be a key aspect of conserving this subspecies as a component of the world's wild fauna.

At present the Far Eastern leopard is protected on the territories of Kedrovaya Pad Zapovednik (Reserve) (18 000 ha), the federal Barsovy Zakaznik (wildlife refuge) (106 000 ha) and the regional Borisovskoe Plateau Zakaznik (64 000 ha). Thus, 188 000 ha or 51% of the 370 000 ha that are considered suitable leopard habitat, is already protected in this region. A border patrol fence extends some distance inside Russian territory from the actual Sino-Russian border, effectively making about one-third of southwest Primorye territory inaccessible to local people. Therefore, development of new protected areas in southwest Primorye is problematic. At the same time conflicts between local people and guards of protected areas occur regularly. Resolution of this problem is possible only if local people become involved in leopard conservation. Opportunities must exist for local people to be able to exploit natural resources in ways compatible with leopard conservation. Therefore along with our attempts to estimate size of the existing leopard population, our objective was to develop recommendations that would optimize the existing protected areas management regime, taking into consideration the limitations mentioned above.

"SWEEP" SURVEY OF FAR EASTERN LEOPARDS AND AMUR TIGERS IN SOUTHWEST PRIMORSKI KRAI, WINTER 2000

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Results of the 1998 leopard survey indicated 10-15 individuals more than during a 1997 survey, along with indications of higher levels of leopard reproduction in 1998 led us to thoroughly reconsider our leopard survey methods and the "simultaneous" survey methods used in 1998.

A "frontal" or "sweep" survey of Far Eastern leopards in February 2000 was conducted using earlier accepted and repeatedly approved methods. The objectives of this project, "Far Eastern leopard range and numbers" were the following:

1. to estimate the present number of Far Eastern leopards, to characterize the sex-age structure of the Far Eastern leopard population and delineate characteristics of its spatial distribution within the southwestern portion of its range;
2. to estimate the quality of leopard habitat for the purpose of optimizing the protected areas system and to determine the appropriate areas to include as:

- strictly protected reserves (zapovednik);
    - wildlife refuge (zakaznik) regime on a federal level, including a complete ban on hunting and industrial logging; and,
    - zones with limited economic activity.

D.G. Pikunov from Pacific Institute of Geography of the Far East Branch of the Russian Academy of Sciences was the coordinator of the frontal leopard survey in the southwestern range. Other specialists with many years' experience also participated in organizing and conducting the survey: V. K. Abramov from Ussuriisky Zapovednik of Far East Branch of Russian Academy of Sciences assisted in organizing and conducting leopard surveys in 1972-1973, 1990-1991 and 1997; V. G. Korkishko from Kedrovaya Pad Zapovednik of Far East Branch of Russian Academy of Sciences took part in leopard surveys in 1984-1985, 1990-1991 and 1997; I. G. Nikolaev from Institute of Biology and Soils of Far East Branch of Russian Academy of Sciences took part in leopard surveys in 1997 and was also a representative of the international team which conducted leopard and tiger surveys in Heilongjiang and Jilin Provinces in China in 1998, 1999 and also in North Korea; A.I. Belov from Barsovy Zakaznik took part in the 1997 and 1998 leopard surveys.

Additional fieldworkers with extensive experience in such work and good knowledge of the habitat that was investigated who also participated in the survey included:

1. Kosach S. P. – senior nature inspector of Ussuriisky Reserve;
2. Zaev A. P. - nature inspector of Kedrovaya Pad Reserve;
3. Ivanov E. V. - nature inspector of Kedrovaya Pad Reserve;
4. Kostin V. D. – senior research scientist of Institute of Biology and Soils of Far East Branch of Russian Academy of Sciences;
5. Savin V. S. – ranger of Barsovy Zakaznik;
6. Schukin M. A. - ranger of Barsovy Zakaznik;

7. Seredkin I. V. – post-graduate student of Pacific Institute of Geography of Far East Branch of Russian Academy of Sciences;
8. Getmanov V. V. - post-graduate student of Pacific Institute of Geography of Far East Branch of Russian Academy of Sciences;
9. Savchenko A. M. – ranger of Borisovskoe Plateau Zakaznik;
10. Sumernin Yu. M. - ranger of Borisovskoe Plateau Zakaznik.

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1. Conditions for the survey

Reliable information indicting presence of leopards in its former range in southern Sikhote-Alin and the northwestern section of its range (Pogranichny Raion) is absent. Therefore, this February 2000 survey of Far Eastern leopards was conducted only within the southwestern section of its range (Abramov, Pikunov, 1974; Pikunov, Korkishko, 1991).

Habitat in the Southwest stretches north to south approximately 150 km, with its widest point located in the north, near Borisovskoe Plateau (45-50 km wide). Far Eastern leopards occur in the warmest and least snowy regions of the Russian Far East. Even during the harshest season (the second half of winter), southern slopes, cliffy watersheds, frozen creeks and rivers quickly become snow-free, even after heavy snowfalls. Predators prefer traveling in these areas, leaving tracks of their "hunting" and "border patrol" forays (Pikunov 1976, Pikunov, and Korkishko 1992).

The "sweep" survey of Far Eastern leopards was conducted from February 6 to February 24, 2000, with the exception of Kedrovya Pad Zapovednik and adjacent areas, including Bezverkhovsky Deer Farm, where work was finished by the beginning of March. Surveys done in 1984-1985 and 1990-1991 were conducted nearly at the same time and using the same methods.

Snow conditions during the survey were favorable for organization and implementation of such work. Heavy snowfalls occurred in the first ten days of January, amounting to 50-60 cm. Afterwards a series of light snowfalls were reported regularly throughout the study area just prior to initiation of the census, providing a fresh blanket of snow to identify new tracks. A moderate snowfall (5-10 cm) occurred on February 12 during the census, but tracks of large predators (leopard, tiger, lynx) left on the old solid snow were still discernable, and in many instances it was still possible to measure them.

Snow distribution within Southwest Primorye varied greatly. Maximum snow depth occurred on the plateaus of the western part of study area along the Chinese-Russian border. A thick crust of ice over snow generally formed on southern slopes. Nevertheless, even these "warm" slopes retained a snow cover (15-25 cm) over most of the territory due to low temperatures in January and February. Under these conditions leopards preferred traveling on deer trails, ridgetops, and frozen creeks, making it relatively easy for experienced fieldworkers to find predator tracks.

On a sizeable portion of leopard habitat, lands are leased by sport hunting associations, and during the hunting season such areas are heavily used. Such pressures force deer to concentrate within zakazniks or relatively inaccessible, roadless areas. Deer were concentrated in such areas in large herds (a few dozen to hundreds of individuals) for an extended period. It is rather difficult to discern leopard tracks in such places and only experienced fieldworkers are capable. With the end of the hunting season, deer moved down to the middle and even lower reaches of rivers and dispersed more evenly throughout leopard habitat. In the lower reaches of rivers snow depth was distinctly less, and abundance of acorns was relatively high, resulting in a relatively homogeneous

distribution of sika deer and leopards in well known (due to the previous surveys) regions. Slight movements of ungulates forced movements of predators; however the amplitude of movements by predators were considerably less. As a result, for example, almost no leopards tracks were found within Nezhinskoe hunting lease, and the overwhelming majority of leopards were concentrated within Borisovskoe Plateau Zakaznik. An analogous situation occurred with the majority of tigers found on this territory. Leopard home ranges were temporarily compressed during the period of deep snow, and predators were generally confined to mountainous regions that harbored high densities of deer. In general fieldworkers were well aware of established and preferred pathways and crossing points of predators, which made the organization and implementation of sweep leopard survey in February of 2000 much easier.

2. Sweep survey methods

It is known that the Far Eastern leopard is very conservative in choosing its home range. Usually home ranges are situated within a single river basin with territorial boundaries formed by natural topographic features, and home ranges of individuals of different sex and ages rarely overlapping significantly (Pikunov, Korkishko et al. 1990, Pikunov et al. 1999). The results of snow-tracking and radiotracking leopards of varying sex and age classes (conducted by our own and other scientists, e.g. J. Whitman, unpubl. data) showed that the size of home ranges are generally 10-20 thousand ha. In winter, trails and commonly used pathways cross over forested mountains at specific and least snowy sites. Even heavy snowfalls do not influence their location. Usually leopards move along creek beds, but only if there are no heavily used roads situated there. Regions heavily used by people may temporarily, and sometimes permanently, be abandoned by predators. When leopards do not abandon such preferred areas, their movements shift to bases of cliffs and nearby ridgetops. Animals only cross over hill slopes, avoiding moving along them even during hunting. Usually animals go along cliffy ridges, creek-beds, or river valleys, especially if there is a forest road along the valley; predators cross (valleys) by ravines or old creek beds. In such places it is necessary for fieldworker to be more attentive, especially in places with numerous tracks of foraging ungulates.

Preferred habitats of leopards include black-fir - broadleaved and broadleaved (oak) forests, which cover the slopes of small ridges and hills. In winter leopards (especially females with litters) stay within confined territories, leaving numerous tracks, trails and scrapes there. The scrapes differ from tiger's ones only by size: leopard's scrapes are 20-25 x 30-40 cm. The most difficult aspect of leopard surveys is to find a track and then to accurately determine the species that left it, because on this region tigers are common and lynx also occur.

A leopard track is round, 12 x 12 cm in size, the trail is distinct and wide, and the stride length is 40-45 cm. Shape, size and pattern of leopard track are similar to tracks of young tigers or big lynx, but there are some significant differences. A leopard trail is wide – 15-18 cm, while a lynx's trail line is narrow, with tracks almost in a straight line when in a gentle pace. Leopard tracks are round, even when snow cover is low, and dragging of the paws in snow is generally absent. The pattern of leopard tracks is distinct, the paw is compact, while lynx tracks are indistinct because of hair on the pads.

The front pad size of mal leopard is 6.5-7.0 cm, very rarely is up to 8 cm; female pad size ranges from 5.5-6.5 cm, while pads of leopard cubs are 4.5-5.0 cm. Pad size of adult lynx are generally less, rarely exceeding 4.0-4.5 cm. Pad width of lynx cubs is less than 4 cm (usually 3.5 cm). In summary, all tracks with a pad width less than 4 cm usually belong to lynx. Lynx also often travel along hare trails, and generally do not fall through the crust of these trails.
Tiger cubs with a front pad width of 7.5 cm and even of 8 cm are usually accompanied by their mother, whose track is larger (Oshmarin and Pikunov 1990).

Hence we consider all leopard tracks with a front pad width of 7 cm or more as belonging to males. All tracks with front pad width of 5.5-6.5 cm are considered to be a female if it was followed by cubs, or if other criteria (shape of scrape, scent (urine) marks, etc.) indicate it is an adult female. Other tracks (with other pad sizes) we defined as leopards of unknown sex and age. Although we have identified in our data set young (subadult) males with a track size of 6.0-6.5 cm which are living independent of their mother. Felid tracks of 4.0 cm and even 4.5 cm that were not accompanied with larger tracks with indistinct pad pattern were allocated as lynx or as undetermined. Yearly field surveys in different parts of southwestern Primorye (1961-2000), monitoring surveys implemented during 3 last winters in the Borisovskoe Plateau region, previous "sweep" surveys (in which coordinators of this survey took part) provided necessary information about boundaries of leopard distribution and primary travel corridors of leopards. This background information was critical in planning and creation of survey routes. The positioning of survey routes were developed in agreement with all coordinators on the basis of known leopard habitat, and were placed to maximize the probability of encountering tracks.

Table 1. Participation of project coordinators in previous leopard surveys in southwestern section of their range and in China.

Coordinators of frontal leopard survey of 2000	The year of conducting of leopard survey in Russia				In China	
	1972-1973	1984-1985	1990-1991	1997	1998	1999
Pikunov D.G.	+	+	+	+	+	+
Abramov V.K.	+	-	+	-	-	-
Korkishko V.G.	-	+	+	+	-	-
Nikolaev I.G.	-	-	-	+	+	+
Belov A.I.	-	-	+	+	-	-

Ten experienced fieldworkers, together with coordinators, took part in conducting the sweep survey by working in three field teams. During 16 working days, 130 routes were traveled (from 6th to 22nd of February). Each field team worked autonomously, using its own GAZ-66 truck as a base for spending nights in the forest. One or two coordinators with extensive experience in previous field surveys and a good knowledge of study area were included in each team.

Leopard habitat of Southwest Primorye was split into the following units for organization and collection of field data and analysis of survey results:

- southern part of Khasanski Raion up to Ryazanovka River Basin;
- Barsovy Zakaznik and Kedrovaya Pad Reserve (the central part of Khasanski Raion);
- Borisovskoe Plateau Zakaznik and Nezhinskoe Hunting Lease (northern part of Khasanski and western part of Nadezhdinski Raion);
- Borisovskoe and Pavlinovskoe Hunting Leases (western part of Ussuriiski Raion and southern part of Oktyabrski Raion).

The southern part of study area, up to the border of Barsovy Zakaznik, was examined by all field teams moving progressively from south to north investigating each rivers basins with a series of survey routes (see the map of survey routes). Further north, each team worked separately in 4 areas:
1st – on Borisovskoe Plateau and northern adjacent area;
2nd – within Barsovy Zakaznik;
3rd – on the territory between technical border construction line and international China-Russian border;

4th – Kedrovya Pad Reserve and adjacent area was investigated by Reserve's employees.

Territories of deer farms were examined by fieldworkers walking the entire perimeter of the fenced area. If there was additional information about leopards or tigers within or near deer farms, then additional routes were covered in the appropriate region (e.g., Peschany, Gamov, Gvozdevsky, Bezverkhovsky deer farms). The total length of all 130 routes amounted to 1535 km. Foot routes were traveled on skis, as a rule. Routes located along forest and border roads were sometimes traveled by vehicle (Figure 1).

Maps with a scale 1:100 000 were used in the work. Fieldworkers walked along predefine route, which were defined prior to initiation of fieldwork, reported all information in a Field Diary (derived from the field diary used for tiger monitoring program, but slightly reduced). Fieldworkers delineated all tracks along a route on a map, and for each track the following information was reported: a unique number was assigned (for tigers and leopards), the date the track was found, estimated date of predator's passage, direction of travel, and pad size (front, rear or joint). Sex and age of animal which left the track were estimated, and substratum and snow depth at the location of the track were also described. If the tracks of tiger or leopard family (female with young) were found, all measurements mentioned above were made for each animal within the group. Where possible, additional information about presence of predators in the region were gathered from rangers, hunters and locals. The same data were also reported for all tracks of tiger and lynx (Table 3).

Information about potential leopard prey – ungulates (numbers, distribution and species composition) was gathered on all routes. Only fresh tracks (no more than 24 hours old) crossing the survey route were registered. All entries of ungulate data into the field diary included two parameters: number of tracks crossings the route and number of individuals in the region (single individuals could cross the track multiple times). Data on ungulates were summarized to estimate prey abundance for predators (Table 4).

Based of survey data, a summary map was developed with the following information:

- survey routes with consecutive numbers,
- all leopards and tigers found on routes, each of them with a number.

Other information about predators tracks, routes and wild ungulates were recorded in tables. Sex of leopards was determined (as mentioned above) by track size (pad width), by presence or absence of cubs and by other parameters.

Delineation of individuals (derived from track data) was made collectively in collaboration with all coordinators reviewing field data. The main criteria used for defining individuals were:

- size of track;
- possible daily travel distance by leopards;
- date and direction of predator's passage;
- possible home range sizes of animals of different sex and age, determined on a basis of winter tracking results (Pikunov, Korkishko 1992) and with the help of radio telemetry data of some individuals (our unpubl. data) in Kedrovaya Pad Reserve and Borisovskoe Plateau.

3. Survey results

The results of the survey are reported for each section of southwestern Primorye.

1. *Southern Khasanski Raion.* A total of 43 routes (36 on foot, 7 by vehicle), totaling 429 km, were traveled in the southern part of Khasanski Raion, including Slavyanskoe Hunting Lease, and in the marginal southeastern part of Primorye up to Ryazanovka River Basin. The entire mountainous forested area, including all know and most possible leopard habitat was covered evenly with routes. A total of 16 leopard tracks were found on 13 routes, and were identified by coordinators as belonging to 5 individuals, including:

- adult (resident) male # 1, whose tracks were found in upper basin of Fatosha River (behind the technical border (KSP) construction line); this may be the same animal as # 7, reported by border guards in upper basins of Vinogradovka and Poyma Rivers;
- adult male # 2, whose tracks were found with the tracks of female # 3, on Gamov peninsula, within the deer farm territory;
- tracks of adult female # 4 and young female # 5 were found in the upper basin of Vinogradovka River; probably these two females represent sisters recently split up from a family litter (Figures 2, Table 2).

Tigers were also reported in this region. Tigers tracks were found on 22 routes, and classified as representing the following individuals:

- adult tiger male # 1 – his tracks were regularly found in middle basins of Tsukanovka, Vinogradovka and Ivanovka Rivers;
- adult male #2 resided in Sukhanovsky pass area, to the north;
- female tiger # 3 resided in the Ivanovka and Vinogradovka Rivers Basins;
- female tiger # 4 resided on Gamov peninsula, near the deer farm, with a cub (# 5);
- female tiger # 6 was regularly reported near the Bezverkhovsky deer farm, but sometimes she traveled over the KSP border patrol fence (Figure 2, Table 3).

2. *Barsovy Federal Zakaznik and Kedrovya Pad Reserve.* Based on the results of previous surveys (up to the 1997 survey), leopard numbers in this region have in the past been relatively high and stable here (Pikunov et al. 1999). During the present survey, 47 routes totaling 562 km were covered here. Thirty-seven routes were traveled on foot (skis), all others by vehicle. Leopard tracks were reported on 20 routes, from which we estimated there were 12 individuals:

- home range of female # 6 and young independent individual # 7 of unknown sex was determined to be in the upper basin of Poyma River (behind the "KSP" border fence). It is likely that #7 recently split off from the family unit;
- female # 8 and young independent individual # 9 of unknown sex were registered in upper basins of Narva and Kuznetsovka Rivers;
- resident female # 10 and individual # 11 of unknown sex were registered with Kedrovya Pad Zapovednik in upper basin of Kedrovya River. These animals probably also represent a recently split family;
- adult female # 12, accompanied by young individual # 13 (probably young male) was registered on Barsovy ridge within the territory of Peschany deer farm. These two animals represent the only family group registered;
- the only adult male that was registered in this region, # 14, probably a resident, occurred behind the KSP border fence in the upper basin of Barabashevka River;
- female # 15 followed by two cubs (#16 and # 17) was found. Nevertheless, the tracks of this family group were very old (nearly of 2 weeks), and were found only once by one fieldworker. This fieldworker found more fresh tracks of two lynx shortly before he found tracks of this leopard family, bringing into question the validity of the presence of this family group of leopards in Skalistaya mountain area. Coordinators concluded that this family (#15, #16, and #17) be reported as "questionably identified" individuals.

Thus, within this region at the moment of sweep survey the following individuals were identified: #6 and #7 - Poyma River Basin, #8 and #9 - Narva River Basin, # 10 and #11 - Kedrovaya Pad Reserve, #12 and #13 (female with a cub) - Peschany deer farm – Barsovy ridge, #15, #16, #17 (questionably identified family) - Skalistaya mountain area (Figure 2, Table 2).

Within this region the following tigers were identified: adult male # 7 in upper basin of Barabashevka River, # 8 – in upper basin of Amba River (possibly the same animal as #7); Tiger # 9 of unknown sex and age was found in Malyutinka River Basin and near Peschany and Penezhinsky deer farms, however only his old tracks (at least 10-15 days old) were reported on all routes.

3. *Borisovskoe Plateau Zakaznik and Nezhinskoe Hunting Lease.* Until winter 1990-1991 this region of Southwest Primorye was considered to represent some of the best remaining leopard habitat. Based on three previous surveys results, 60-70% of leopards were generally reported in this territory. Only the results of 1997 survey did not coincide with this pattern, which, in our opinion, was a result of inappropriate survey methods. Due to the abundance of roe deer up to the 1970's (which was traditionally the primary prey of leopards) and the consequent rapid increase in sika deer numbers (which now represent the main prey for leopards), Borisovskoe Plateau has always been considered one of the best remaining tracts of leopard habitat.

Forty survey routes, totaling of 386 km (plus additional information gathered during tiger monitoring within Borisovskoe Plateau in January 2000 that was used) were covered in this region. Leopards tracks were found on 20 routes and were believed to represent the following individuals:

- leopards tracks belonging, in our opinion, to 3-4 individuals were found in the basins of Ananievka and Gornaya Rivers: male # 19, adult female # 20 and two young independent individuals # 22 and # 23 of unknown sex;
- adult male # 18, which periodically used Penezhinsky deer farm, inhabits the territory between lower reaches of Amba River and Gryaznaya River near Penezhinsky deer farm (taking into consideration the size of tracks it is possible that male #18 is the same animal as male #19);
- taking into consideration old and fresh tracks, leopards were consistently present in the middle and upper basins of Nezhinka River. Two individuals can be definitely identified here: adult female #21 (without cubs) and animal #24 of unknown sex and age;
- during the survey, leopards tracks were not found in Vtoraya Rechka River Basin, although monitoring survey conducted during hunting season revealed tracks of a big leopard male, whose fate could not be determined during the period of the sweep survey. Possibly, it was the tracks of this male that were found on Pervaya Rechka (#25). Tracks were covered with newly-fallen snow and we were therefore forced to report them as belonging to an animal of unknown sex and age;
- leopards tracks were not found near Kedrovski deer farm (in 1997 leopards also were not found here) nor in the Bolshaya and Malaya Kedrovka River Basins (Figures 2, Table 2)

In addition to leopards, tracks of tigers belonging, in our opinion, to 2-3 individuals (adult male #10 and adult female #11 – Table 3) were found in upper basins of Gornaya-Ananievka, Nezhinka and Borisovka Rivers.

- *Borisovskoe and Pavlinovskoe Hunting Leases – Ussuriisky Raion and southern part of Oktyabrsky Raion.* This territory represents the northernmost part of southwestern Primorye leopard range. Leopard numbers have never been high here except during the 1972-1973 winter. During the 1997 survey, leopards tracks were not found here, although tigers were common. During the 2000 survey 10 routes totaling 186 km were traveled on this territory, including about 100 km of routes traveled by vehicle.

Table 2. Leopard tracks registered on routes during “sweep” survey of leopards and tigers in Southwest Primorye, winter 2000

Route #	Track #	Joint pad width, cm	Front pad width, cm	Rear pad width, cm	Track age	Sex	Age	Snow depth, cm	Notes	Fieldworker
7	1	-	-	-	unknown	unknown	unknown	25		Korkishko
8	2	-	-	-	unknown	unknown	unknown	25		Korkishko
10	3	-	-	-	unknown	unknown	unknown	25		Korkishko, Abramov
11	4	-	6.3	-	1-2 days	female	adult	5	Track on the ice overflow	Korkishko
13	5	-	7.3	-	unknown	male	adult	10	On the road	Korkishko, Abramov
14	6	6.1	-	-	unknown	female	adult			Zaev A.
17	7	-	5.5	-	24 hours or less	female	subadult	5	On ridge top	Korkishko
17	8	-	7.5	-	> 7 days	male	adult	5	On ridge top	Korkishko
18	9	-	6.3	-	24 hours or less	female	adult	5	River flood-plain	Korkishko
19	10	-	6.5	-	unknown	female	adult	2	Creek ice overflow	Kosach
20	11	-	6.5	-	unknown	female	adult	5	Ice overflow	Korkishko
21	12	-	6	-	unknown	female	adult	15		Seredkin
25	13	-	6	-	unknown	unknown	unknown	6	On the old road	Nikolaev
35	14	-	-	-	unknown	unknown	unknown	35		Zaev
37	15	-	5.7	-	unknown	unknown	subadult	40		Zaev
37	16	-	6.6	-	1-2 days	female	adult	10		Zaev
45	17	-	6.5	-	24 hours or less	unknown	unknown	1	On the road	Nikolaev
45	18	-	6.7	-	24 hours or less	unknown	unknown	1	On the ice covered with snow	Nikolaev
48	19	-	-	-	unknown	unknown	unknown	23		Zaev
49	20	-	-	-	unknown	unknown	unknown	23		Belov
50	21	-	6.5	-	unknown	unknown	unknown	20		Savin
51	22	-	6.1	-	unknown	unknown	unknown			Pasyuk
56	23	-	6.7	-	unknown	unknown	unknown	7		Korkishko
56	24	-	6.7	-	unknown	unknown	unknown	7		Abramov
58	25	-	6.5	-	4-7 days	unknown	unknown	6		Zaev
59	26	-	5.6	-	1-2 days	female	adult	1		Belov
59	27	-	6.7	-	4-7 days	male	adult	1		Belov

Table 2 (cont.)

Route #	Track #	Joint pad width, cm	Front pad width, cm	Rear pad width, cm	Track age	Sex	Age	Snow depth, cm	Notes	Fieldworker
59	28	-	6.9	-	24 hours or less	male	adult	1		Belov
60	29	-	5.4	-	1-2 days	unknown	subadult	1		Savin
63	30	-	6.8	-	2-4 days	male	adult	1		Savin
64	31	-	6.6	-	unknown	male	subadult	1		Belov
67	32	-	5.4	-	24 hours or less	unknown	unknown	8		Ivanov
68	33	-	5.3	-	1-2 days	unknown	subadult	5		Ivanov
68	34	-	6.6	-	24 hours or less	female	adult	5		Ivanov
69	35	-	6.5	-	24 hours or less	female	adult	8		Ivanov
73	36	-	-	-	unknown	unknown	unknown	15		Zaev
74	37	-	7	-	unknown	male	adult	26		Abramov
75	38	-	-	-	unknown	unknown	unknown	20		Korkishko
79	39	-	-	-	unknown	unknown	unknown	20		Korkishko
81	40	-	6.5	-	unknown	female	adult	38		Seredkin
81	41	-	5	-	unknown	unknown	cub	38		Seredkin
81	42	-	5	-	unknown	unknown	cub	38		Seredkin
86	43	-	6.5	-	24 hours or less	female	adult	25	Heard the voice	Pikunov
86	44	-	6	-	24 hours or less	unknown	subadult	25		Pikunov
91	45	-	7	-	2-4 days	male	adult	22	Near the deer farm	Seredkin
93	46	-	6.5	-	1-2 days	female	adult	28		Pikunov
94	47	-	-	-	unknown	female	adult	26		Schukin, Pikunov
95	48	-	5.5	-	1-2 days	unknown	subadult	23		Schukin
96	49	-	6.7	-	unknown	unknown	subadult	23		Getmanov
98	50	-	6.8	-	unknown	unknown	unknown	20		Seredkin
100	51	-	-	-	unknown	unknown	unknown	26		Seredkin, Getmanov
101	52	-	7.2	6.7	2-4 days	male	adult	2		Schukin, Getmanov
103	53	-	7.2	-	2-4 days	male	adult	1		Seredkin
106	54	-	7.5	-	1-2 days	male	adult	3		Pikunov
107	55	-	7.5	-	1-2 days	male	adult			Seredkin
107	56	-	-	-	unknown	unknown	unknown	25		Seredkin

Table 2 (cont.)

Route #	Track #	Joint pad width, cm	Front pad width, cm	Rear pad width, cm	Track age	Sex	Age	Snow depth, cm	Notes	Fieldworker
108	57	-	6.8	-	1-2 days	unknown	unknown	23		Getmanov
108	58	-	6.5	-	unknown	unknown	unknown	23		Getmanov
109	59	-	7.5	-	unknown	male	adult	10		Schukin
110	60	-	6.5	-	unknown	unknown	unknown	27		Seredkin
110	61	-	5.5	-	1-2 days	unknown	unknown	1		Getmanov
112	62	-	-	-	unknown	unknown	unknown	39		Pikunov, Seredkin
115	63	-	6	-	24 hours or less	female	adult	3		Getmanov
116	64	-	-	-	unknown	unknown	unknown	30		Schukin, Getmanov
123	65	-	5.5	-	> 7 days	unknown	subadult	2		Savchenko
125	66	-	6.7	-	4-7 days	unknown	unknown	1		Sumerkin

Table 3. Tiger tracks registered on routes during “sweep” survey of leopards and tigers in Southwest Primorye, winter 2000

Route #	Track #	Joint pad width, cm	Front pad width, cm	Rear pad width, cm	Track age	Sex	Age	Date of last snowfall	Snow depth, cm	Notes	Fieldworker
6	1	-	11.5	-	unknown	male	adult	Jan. 6, 2000	20		Korkishko, Abramov
7	2	-	11.5	-	unknown	male	adult	Jan. 6, 2000	25		Korkishko
9	3	-	12	-	unknown	male	adult	Jan. 6, 2000	16		Zaev
18	4	-	11.5	-	unknown	unknown	unknown		20		Korkishko
18	5	-	-	10.5	unknown	male	adult		28	Tiger, trail along the valley	Abramov
15	6	-	10.5	-	> 7 days	unknown	unknown		31	In river Vil valley	Abramov
21	7	-	10	-	unknown	unknown	unknown	Jan. 6, 2000	18		Seredkin
22	8	-	11	-	unknown	male	adult		13		Pikunov
24	9	-	8.7	-	24 hours or less	female	adult		25		Zaev
25	10	-	11	-	unknown	male	adult		5	Track on the road	Nikolaev
25	11	-	9.6	-	> 7 days	female	adult		25		Nikolaev
26	12	-	12	-	unknown	female	adult		25	Ridge top	Getmanov
27	13	-	11.5	-	unknown	male	adult			On the road	Kostin
28	14	-	9.5	-	unknown	female	adult			River flood-plain	Korkishko
29	15	-	9.5	-	unknown	female	adult			Near border patrol fence	Korkishko
30	16	-	11.5	-	unknown	male	adult		26		Kosach
30	17	-	9.5	-	unknown	female	adult		26		Kosach
32	18	-	-	-	unknown	unknown	unknown		25		Zaev
36	19	-	11.5	-	2-4 days	male	adult		40		Nikolaev
36	20	-	8.5	-	1-2 days	female	adult		20		Kostin
37	21	-	10	-	1-2 days	unknown	unknown		7	Dense snow	Zaev
39	22	-	-	-	unknown	unknown	unknown		30		Getmanov
40	23	-	9	-	1-2 days	female	adult		26		Abramov
41	24	-	10.5	-	4-7 days	male	adult		30		Pikunov
42	25	-	-	-	unknown	unknown	unknown		30		Pikunov
42	26	-	-	-	unknown	unknown	subadult		30		Pikunov
44	27	-	9.5	-	unknown	female	adult		30		Kostin

Table 3 (cont.)

Route #	Track #	Joint pad width, cm	Front pad width, cm	Rear pad width, cm	Track age	Sex	Age	Date of last snowfall	Snow depth, cm	Notes	Fieldworker
44	28	-	11	-	unknown	male	adult		30		Kostin
45	29	-	10	-	unknown	unknown	unknown		31		Nikolaev
45	30	-	9.2	-	unknown	female	adult		30		Nikolaev
46	31	-	8.5	-	1-2 days	unknown	subadult		3		Korkishko, Abramov
47	32	-	-	-	unknown	female	adult		29		Kosach
49	33	-	8.6	-	unknown	female	adult		23		Belov
52	34	-	10.5	-	unknown	male	unknown		27		Kostin
52	35	-	11	-	unknown	male	unknown		28		Kostin
56	36	-	8.5	-	1-2 days	female	unknown		4	Ice overflow	Korkishko, Abramov
57	37	-	9.5	-	2-4 days	female	adult		27		Kosach
58	38	-	9.4	-	2-4 days	female	adult		29		Zaev
72	39	-	10.5	-	24 hours or less	male	adult		29	Went after new-fallen snow	Kosach
75	40	-	10.5	-	1-2 days	male	adult		1	Along the road	Korkishko
76	41	-	8.7	-	2-4 days	female	adult		24		Zaev
77	42	-	8.5	-	unknown	female	adult		11		Kosach
79	43	-	-	-	unknown	unknown	unknown		20		Korkishko
80	44	-	10.5	-	unknown	male	adult		18		Abramov
83	45	-	-	-	unknown	unknown	unknown		25		Pikunov, Schukin
87	46	-	9	-	unknown	female	adult		25		Schukin
87	47	-	8	-	unknown	unknown	cub		25		Schukin
89	48	-	-	-	unknown	unknown	unknown		25		Pikunov
95	49	-	10	-	unknown	unknown	unknown		25		Schukin
98	50	-	10	-	unknown	unknown	unknown		22		Seredkin
101	51	-	9.5	-	24 hours or less	female	adult		1		Getmanov
101	52	-	11.5	-	24 hours or less	male	adult		5		Schukin
102	53	-	9.7	-	24 hours or less	female	adult		1		Seredkin
102	54	-	11.5	-	24 hours or less	male	adult		1		Getmanov

Table 3 (cont.)

Route #	Track #	Joint pad width, cm	Front pad width, cm	Rear pad width, cm	Track age	Sex	Age	Date of last snowfall	Snow depth, cm	Notes	Fieldworker
103	55	-	11	-	24 hours or less	male	adult		17		Seredkin
104	56	-	9.7	-	24 hours or less	female	adult		15		Seredkin
106	57	-	-	-	unknown	unknown	unknown		30		Pikunov
109	58	-	10	-	unknown	unknown	unknown		13		Schukin, Seredkin
110	59	-	10.7	-	unknown	male	adult		30		Getmanov
124	60	-	-	-	unknown	unknown	unknown		15		Sumerkin
125	61	-	9.4	-	1-2 days	female	adult		1	On the ice	Sumerkin
125	62	-	8.4	-	1-2 days	unknown	subadult		1		Sumerkin
127	63	-	9	-	1-2 days	female	adult		1	On the ice	Savchenko
128	64	-	8.8	-	1-2 days	female	adult		1	On wild boar trail	Nikolaev
129	65	-	-	-	unknown	unknown	unknown		30	Crossed the road	Abramov

Table 4. Fresh ungulates tracks registered on routes during “sweep” survey of leopards and tigers in Southwest Primorye, winter 2000

Route #	Route location	Date	Kind of transportation	Elk		Wild boar		Roe deer		Sika deer		Moose	
				tracks	indiv.	tracks	indiv.	tracks	indiv.	tracks	indiv.	tracks	indiv.
1	Krainov frontier post	02/12/00	on foot	0	0	1	1	42	0	7	0	0	0
2	Krainov frontier post	02/12/00	on foot	0	0	0	0	48	21	19	8	0	0
3	Krainov frontier post	02/12/00	on foot	0	0	1	1	0	0	17	8	0	0
4	Krainov frontier post	02/12/00	on foot	0	0	0	0	37	18	7	7	0	0
5	Krainov frontier post	02/12/00	vehicle	0	0	0	0	0	0	0	0	0	0
6	Verkhnyaya frontier post	02/13/00	on foot	0	0	0	0	3	3	7	7	0	0
7	Verkhnyaya frontier post	02/13/00	vehicle	0	0	0	0	5	5	25	0	0	0
8	Verkhnyaya frontier post	02/13/00	on foot	0	0	0	0	0	0	0	0	0	0
9	Pchelnik creek, upper	02/13/00	on foot	0	0	0	0	2	2	22	12	0	0
10	Verkhnyaya frontier post	02/13/00	mixed	0	0	0	0	5	3	4	4	0	0
11	Uglovaya frontier post	02/14/00	mixed	0	0	0	0	0	11	0	0	0	0
12	Uglovaya frontier post	02/14/00	on foot	0	0	0	0	3	3	1	1	0	0
13	Upper Tsukanovka, behind patrol fence	02/14/00	on foot	0	0	0	0	20	0	0	0	0	0
14	Tsukanovka-Uglovaya, behind patrol fence	02/14/00	on foot	0	0	0	0	3	3	36	16	0	0
15	Tsukanovka-Vinograd, along patrol fence	02/07/00	on foot	0	0	0	0	27	15	8	4	0	0
16	Tsukanovka-Vinogradovka (middle)	02/07/00	on foot	0	0	0	0	18	8	0	0	0	0
17	Baranovskaya, upper	02/15/00	on foot	0	0	6	6	33	0	32	0	0	0
18	Upper Vinogradovka, behind patrol fence	02/15/00	on foot	0	0	0	0	0	0	0	0	0	0
19	Bezymyanny creek (Shkolnaya)	02/15/00	on foot	0	0	5	5	1	1	6	2	0	0
20	Rotnaya Pad (Shkolnaya)	02/15/00	mixed	0	0	0	0	2	2	18	18	0	0
21	Upper Vinogradnaya	02/07/00	on foot	0	0	0	0	8	5	10	4	0	0
22	Vinogradovka (deer farm)	02/07/00	on foot	0	0	0	0	6	2	22	18	0	0
23	Vinogradovka (valley)	02/07/00	vehicle	0	0	0	0	5	3	2	2	0	0
24	Vinogradovka-Ivanovka	02/07/00	on foot	0	0	0	0	14	8	8	8	0	0
25	Ivanovka	02/07/00	on foot	0	0	0	0	18	6	20	11	0	0
26	Gladkaya (middle)	02/07/00	on foot	0	0	0	0	17	8	12	11	0	0
27	Gladkaya (lower reaches)	02/07/00	on foot	0	0	0	0	0	0	5	5	0	0
28	Ivanovka	02/10/00	on foot	0	0	0	0	20	20	9	9	0	0
29	Ryazanovka-Ivanovka divide	02/09/00	on foot	0	0	0	0	0	0	10	10	0	0
30	Gladkaya upper reaches (flood-plain)	02/10/00	on foot	0	0	2	2	2	2	2	2	0	0

Table 4 (cont.)

Route #	Route location	Date	Kind of transportation	Elk		Wild boar		Roe deer		Sika deer		Moose	
				tracks	indiv.	tracks	indiv.	tracks	indiv.	tracks	indiv.	tracks	indiv.
31	Sukhanovski pass	02/09/00	on foot	0	0	0	0	4	2	1	1	0	0
32	Sukhanovski pass - Ryazanovka	02/09/00	on foot	0	0	0	0	1	1	2	2	0	0
33	Partizanskaya (Ryazanovka bassin)	02/16/00	on foot	0	0	0	0	0	0	0	0	0	0
34	Ryazanovka (upper)	02/16/00	mixed	0	0	0	0	4	4	5	5	0	0
35	Ryazanovka (left)	02/16/00	on foot	0	0	0	0	4	4	15	12	0	0
36	Deer farm	02/06/00	on foot	0	0	0	0	0	0	0	0	0	0
37	Gamov	02/06/00	on foot	0	0	0	0	0	0	0	400	0	0
38	Krasny Utyos	02/06/00	on foot	0	0	0	0	4	4	0	0	0	0
39	Ryazanovka-Ivanovka divide	02/09/00	on foot	0	0	0	0	0	0	1	1	0	0
40	Ryazanovka (middle)	02/09/00	on foot	0	0	0	0	22	13	2	1	0	0
41	Ryazanovka (flood-plain)	02/09/00	on foot	0	0	1	1	0	0	8	6	0	0
42	Ryazanovski ridge	02/09/00	on foot	0	0	0	0	3	3	3	3	0	0
43	Ryazanovka (flood-plain)	02/09/00	on foot	0	0	0	0	4	2	4	2	0	0
44	Poyma (middle)	02/09/00	on foot	0	0	0	0	2	2	3	3	0	0
45	Slavanskaya deer farm-Sukh. bay	02/09/00	on foot	0	0	13	12	13	6	65	17	0	0
46	Poyma, upper (behind patrol fence)	02/17/00	mixed	0	0	0	0	13	0	27	0	0	0
47	Poyma (behind patrol fence), B. Kazachiy	02/17/00	on foot	0	0	0	0	10	5	7	2	0	0
48	Poyma – Maly Kazachiy	02/17/00	on foot	0	0	0	0	11	9	13	10	0	0
49	Ridge – Poyma -Brusiya	02/12/00	on foot	0	0	0	0	18	8	19	6	0	0
50	Zolotaya Podkova	02/12/00	on foot	0	0	1	1	8	8	10	10	0	0
51	Brusiya, upper	02/12/00	on foot	0	0	0	0	11	0	8	0	0	0
52	Semiverstka (Bamburovo)	02/12/00	on foot	0	0	0	0	16	0	19	0	0	0
53	Brusiya (Siniy Utyos)	02/12/00	on foot	0	0	6	2	24	9	19	8	0	0
54	Amurskaya deer farm	03/01/00	on foot	0	0	0	0	3	3	19	0	0	0
55	Bezverkhovo – deer farm	03/01/00	mixed	0	0	0	0	6	3	0	0	0	0
56	Narva – upper	02/19/00	mixed	0	0	0	0	24	0	10	0	0	0
57	Andrusova sopka	02/19/00	on foot	0	0	0	0	18	9	8	2	0	0
58	Siniy Utyos	02/19/00	on foot	0	0	27	7	9	3	26	12	0	0
59	Bolshaya Pugachevka	02/13/00	on foot	0	0	5	4	12	4	24	9	0	0
60	Kuznetsovka	02/13/00	on foot	0	0	0	0	21	13	22	15	0	0
61	Malaya Pugachovka	02/13/00	on foot	0	0	3	2	15	0	8	0	0	0

Table 4 (cont.)

Route #	Route location	Date	Kind of transportation	Elk		Wild boar		Roe deer		Sika deer		Moose	
				tracks	indiv.	tracks	indiv.	tracks	indiv.	tracks	indiv.	tracks	indiv.
62	Narva	02/13/00	on foot	0	0	0	0	14	4	0	0	0	0
63	Bocharnik – Artilleriisky	02/14/00	on foot	0	0	11	11	10	7	0	0	0	0
64	Bogatka	02/14/00	on foot	0	0	5	3	25	12	1	1	0	0
65	Krasny Utyos	02/14/00	on foot	0	0	0	0	10	0	6	0	0	0
66	Frunze mnt. – Petrovka frontier post	02/14/00	on foot	0	0	1	1	13	4	0	0	0	0
67	Sukhaya Rechka	03/04/00	on foot	0	0	16	6	22	9	7	2	0	0
68	Kedrovka – B. Zolotoy	02/17/00	on foot	0	0	6	3	28	16	46	12	0	0
69	Zapovednik	02/19/00	on foot	0	0	8	3	18	7	22	9	0	0
70	Barabash-Filipovka	02/16/00	on foot	0	0	0	0	7	4	1	1	0	0
71	Shirokaya - Izvestkovaya	02/16/00	on foot	0	0	2	1	24	0	6	0	0	0
72	Barabashevka, upper (behind patrol fence)	02/20/00	on foot	0	0	0	0	13	7	0	0	0	0
73	Oleniy Utyos	02/20/00	on foot	0	0	0	0	5	2	50	15	0	0
74	Poperechka	02/20/00	on foot	0	0	0	0	5	2	39	15	0	0
75	Poperechka, upper	02/20/00	mixed	0	0	0	0	3	3	24	0	0	0
76	Mramorny creek	02/21/00	on foot	0	0	0	0	0	0	65	20	0	0
77	Antonov creek	02/21/00	on foot	0	0	7	2	2	2	1	1	0	0
78	Upper Amba	02/21/00	on foot	0	0	5	2	12	4	8	6	0	0
79	Mramornaya frontier post	02/21/00	mixed	0	0	0	0	0	0	0	0	0	0
80	Barkhatnaya	02/21/00	on foot	0	0	0	0	5	4	26	18	0	0
81	Skalistaya	02/13/00	on foot	0	0	3	2	0	0	25	20	0	0
82	Amba river-bed	02/13/00	vehicle	0	0	0	0	12	12	10	10	0	0
83	Dvoynovski	02/14/00	mixed	0	0	7	3	19	8	16	8	0	0
84	Korabl	02/13/00	on foot	0	0	3	1	20	11	10	4	0	0
85	Peschanaya deer farm	02/13/00	on foot	0	0	0	0	1	1	0	0	0	0
86	Barsovy ridge	02/13/00	on foot	0	0	0	0	0	0	0	0	0	0
87	Peschanaya deer farm	02/13/00	on foot	0	0	150	45	0	0	0	0	0	0
88	Malyutinka	02/12/00	vehicle	0	0	0	0	3	3	2	1	0	0
89	Malyutin - Amba (lower)	02/12/00	vehicle	0	0	0	0	9	7	1	1	0	0
90	Amba (lower)	02/12/00	mixed	0	0	0	0	2	2	0	0	0	0
91	Penezhinsky	02/12/00	on foot	0	0	6	5	5	3	3	3	0	0
92	Gusevsky pass	02/14-15/00	on foot	0	0	12	12	0	0	22	16	0	0

Table 4 (cont.)

Route #	Route location	Date	Kind of transportation	Elk		Wild boar		Roe deer		Sika deer		Moose	
				tracks	indiv.	tracks	indiv.	tracks	indiv.	tracks	indiv.	tracks	indiv.
93	Gryaznaya divide	02/15/00	on foot	0	0	0	0	0	0	54	28	0	0
94	Upper Elduga	02/15/00	vehicle	0	0	0	0	0	0	65	62	0	0
95	Maly Khakhoninsky	02/15/00	on foot	0	0	16	16	0	0	54	54	0	0
96	Gornoe pass	02/15/00	on foot	0	0	0	0	0	0	94	33	0	0
97	Lower Elduga	02/16/00	vehicle	0	0	0	0	0	0	68	58	0	0
98	Osetinsky	02/15/00	on foot	0	0	0	0	0	0	26	15	0	0
99	Barachny	02/14/00	on foot	0	0	1	1	0	0	17	11	0	0
100	Lower Malaya Elduga	02/17/00	vehicle	0	0	0	0	8	6	2	2	0	0
101	Kabaniy creek	02/17/00	mixed	0	0	24	24	0	0	65	45	0	0
102	Upper Malaya Elduga	02/17/00	mixed	0	0	5	5	0	0	36	16	0	0
103	Malaya Elduga – Sanduga	02/17/00	mixed	0	0	45	12	0	0	24	21	0	0
104	Sanduginsky creek ridge	02/17/00	on foot	0	0	4	4	0	0	18	13	0	0
105	Lower Sanduga	02/20/00	vehicle	0	0	4	1	0	0	31	28	0	0
106	Upper Sanduga	02/21/00	on foot	0	0	6	6	0	0	138	57	0	0
107	Tochinsky – Zapovednik	02/20/00	on foot	0	0	10	9	0	0	15	12	0	0
108	Razdolnoe	02/20/00	on foot	0	0	3	3	0	0	34	19	0	0
109	Koreisky-Razdolnensky	02/21/00	on foot	0	0	20	12	0	0	76	29	0	0
110	Krutoy – Severny	02/21/00	on foot	0	0	0	0	0	0	53	16	0	0
111	Nezhinsky ridge	02/19/00	on foot	0	0	4	4	5	5	2	2	0	0
112	Vtoraya Rechka	02/19/00	mixed	0	0	29	15	10	8	187	59	0	0
113	Kedrovy creek	02/19/00	on foot	0		12	12	0	0	13	9	0	0
114	Petrischensky creek	02/19/00	on foot	0	0	6	6	0	0	31	16	0	0
115	Zolotoy creek	02/19/00	on foot	0	0	15	5	6	3	45	11	0	0
116	Kedrovskaya deer farm	02/18/00	on foot	0	0	10	3	0	0	9	5	0	0
117	Bolshaya Kedrovka	02/18/00	vehicle	0	0	0	0	0	0	100	20	0	0
118	Malaya Kedrovka	02/18/00	vehicle	0	0	5	5	9	3	26	11	0	0
119	Pervaya Rechka	02/18/00	on foot	0	0	20	20	2	2	49	28	0	0
120	Lower Shufan	02/18/00	vehicle	0	0	0	0	1	1	15	15	0	0
121	Upper Shufan	02/18/00	vehicle	0	0	0	0	0	0	40	10	0	0
122	Maly Shufan	02/19/00	on foot	0	0	12	12	3	2	30	10	0	0
123	Upper Malaya Kraunovka	02/19/00	on foot	0	0	0	0	0	0	60	21	0	0

Table 4 (cont.)

Route #	Route location	Date	Kind of transportation	Elk		Wild boar		Roe deer		Sika deer		Moose	
				tracks	indiv.	tracks	indiv.	tracks	indiv.	tracks	indiv.	tracks	indiv.
124	Upper Abrikosovka	02/19/00	on foot	0	0	1	1	8	3	40	13	0	0
125	Medveditsa	02/18/00	on foot	0	0	50	20	0	0	70	70	0	0
126	Ridge Smerti (Death Ridge)	02/18/00	on foot	0	0	1	1	3	3	7	7	0	0
127	Upper Kraunovka	02/18/00	on foot	2	2	15	5	6	2	68	37	0	0
128	Upper Pavlinovka	02/18/00	on foot	0	0	12	11	4	2	34	19	0	0
129	Polkovnitsa	02/22/00	vehicle	0	0	0	0	8	8	5	5	0	0
130	Monakinsky	02/23/00	vehicle	0	0	0	0	0	0	0	0	0	0

Leopards tracks were found only on two routes, tigers tracks on four routes.

Results of the survey in this region indicate:

- adult female #26 was identified in the upper basin of Kraunovka River;

animal #27 of unknown sex and age was registered in the area around Abrikosovy Creek. It is possible that animal #26 and #27 are one in the same animal.Tracks of female tiger #11, which apparently traveled from Borisovka River Basin, were found in upper basins of Kraunovka and Medveditsa Rivers.

Thus, during the sweep survey of 2000 at least 95% of potential leopard habitat in southwestern Primorye was investigated.

Areas that were not examined during the survey include:

- the most southern part of Khasansky Raion, located behind KSP border fence along the international Chinese-Russian border;
- the northwestern and most mountainous and most snowy parts of upper basins of Borisovka and Kraunovka Rivers.

The total area of the regions not examined amounts to no more than 12,000 - 15,000 ha. We have reliable information from border guards that confirm the absence of leopard sign from both areas during the winter 1999-2000. In February 2000, in the northern region that was not covered (upper Borisovka and Kraunovka Rivers) snow depth was 40-60 cm deep on average, and the possibility of leopards being present there during the period of the survey was unlikely.

In summary, results of the frontal leopard survey within the southwestern section of the range in the Russian Far East in February 2000 indicate the following:

Males:	4-5 individuals
Females:	8-9 individuals
Females followed by cubs:	1-2 individuals
Cubs:	1-3 individuals
Unknown sex:	8-9 individuals
Total population of adults:	21-25
Total population of adults and cubs:	22-27

Tigers registered within southwestern section of leopard range:

Males:	3-4 individuals
Females:	4-5 individuals
Unknown sex and age:	1 individuals
Females followed by cub:	1 individuals
Cubs:	1 individuals
Total:	9-11 individuals

Lynx were also reported during the survey:

2 individuals in Vinogradovka and Ivanovka Rivers Basins,
2 individuals in Barabashevka River Basin, in Skalistaya Mountain area,
1-2 individuals in Borisovskoe Plateau area.

Total: 5-6 individuals.

4. Leopards and deer farms

In original habitat of Far Eastern leopard, including southwestern Primorye, large carnivore depredations on deer farms has always taken place. Some individuals, such as females with cubs, become accustomed to seeking prey at deer farms, and end up living and hunting within deer farm territories for many years, including deer farms as their territory. This scenario existed in the 2000 winter. The only positively identified leopard female with a subadult cub was reported on Barsovy ridge on the territory of Peschany Deer Farm.

During the 1997 survey leopard depredations on occurred on 6 of 7 deer farms (Pikunov et al. 1999). Today the situation with deer farms has worsened for leopards. Many farms have become bankrupt or are on the verge of collapsing. Will that segment of the leopard population which has come to rely on deer farms (through our fault) be able to adapt to life in the wild? Taking into account our estimate that nearly 50% of the leopard population feeds only in deer farms, what will be the future of this population without such opportunities? Will this part of population be able to adapt to life in the wild if deer farms cease to exist? This question remains unclear.

In February 2000 leopards tracks were not found in Kedrovski and Bezverkhovski Deer Farms. As a result, the number of resident leopards in Kedrovya Pad Reserve and Barsovy Zakaznik has decreased.

Leopards have continued to visit Gamovsky, Gvozdevsky, Peschany and Penezhinsky Deer Farms. It is essential that we resolve the existing conflict between predators and deer farms. Today the liquidation of deer farms poises a real threat to the leopard population. Funds are necessary to support deer farms and to provide compensation for depredations caused by large carnivores. Another possibility is to buy deer farms in order to create a type of protected territory. In the meantime, the threat to a sizeable portion of the remaining leopard population living near farms remains very high.

Reproductive Potential of Leopard Population. According to survey results the reproductive potential of the population is decreasing rapidly. The past and present spatial distribution of leopards suggests that reproduction occurs primarily in the central and western parts of Borisovskoe Plateau, western parts of Barsovy Zakaznik and Kedrovaya Pad Reserve, all areas covered with black fir. During the 1997 survey, four females (each having only one cub) were recorded within these areas. During the 2000 survey, only one female with cub was positively identified on the Peschany Deer Farm. The presence of a female with two cubs in region of Skalistaya Mountains (right bank of Amba River) is doubtful. We estimate that during the last 30 years the reproductive potential of the population has decreased more than twice and continues to decrease. The 1972-1973 survey (Abramov and Pikunov 1974) demonstrated that females, on average, had litter sizes of two cubs. During the simultaneous count in 1998 when fieldworkers with varying degrees of experience conducted the fieldwork, family groups of three and four individuals (females with two or three cubs) were reported (Aramilev and Fomenko 1999). However, we noted in that survey data that the track sizes of cubs (front pad size) were less than 4 cm, no doubt indicating that these tracks represented a litter of lynx, and not leopards. Field data we gathered from 1960 till 2000 confirm that young leopards, which are capable of following their mother in winter, have pad sizes no less than 4.5 cm (Oshmarin and Pikunov, 1990; Pikunov and Korkishko 1992). During surveys in 1990-1991, 1997, 2000 and also during the surveys in China (on adjacent territories to southwestern section of range) when the work was done by professional experienced fieldworkers, not one litter with more than 1 cub was confirmed (Figure 2, Table 5).
On the whole, results clearly indicate that the number of family groups and the average litter size is decreasing steadily.

Table 5. Data on leopard and tiger litters, gathered during "sweep" survey of leopard and tiger in Southwest Primorye, winter 2000

Location	Route #	Litter size
Leopard		
Skalistaya	81	2
Barsovy Ridge	86	1
Tiger		
Ryazanovski Ridge	42	1
Peschany deer farm	87	1

The sex ratio of the leopard population can only be partially determined. Frequent snowfall, daytime thaws typical for February, the short period of time during which the survey was implemented made it impossible to determine sex and age of 30% of individuals recorded. Therefore, a valid estimate of the population's reproductive potential is impossible. Nevertheless, we propose that there likely exists 10-12 individuals in population are mature females. Assuming that adult females breed once every 2-3 years, then annual population recruitment is unlikely to exceeds 6-8 kittens. As there exists a decreasing trend for most population parameters, natural mortality (10%) and poaching probably completely eliminate potential recruitment. Therefore, if conditions for this small population do not improve, then degradation may occur with progressive speed.

5. Prey base

The key to effective conservation of leopards in the wild will be an understanding of the ecological needs of this carnivore, especially habitat quality and prey requirements (Seidensticker 1987).

The main prey of leopards in winter are sika deer, roe deer and to a lesser degree wild boar and musk deer. In the past (up until the 1980's), red deer were relatively abundant in southwestern Primorye, and it comprised a portion of the leopard's diet (Pikunov 1976). At present red deer are virtually absent in this region, and it is probable that its niche is totally occupied by sika deer.

A critical imbalance between the ratio of primary prey species and leopards has not yet been recorded. However, a decrease of sika deer numbers is obvious over most regions of leopard habitat. The fact that a portion of the leopard population constantly lives inside deer farms is an indicator of insufficient prey numbers.

In other words, this carnivore has been forced into a conflict situation with people. Leopard and ungulate distributions, based on survey results, clearly confirm the fact that only specific ungulate densities satisfy leopard food requirements. In particular, decrease of ungulate numbers in hunting leases has resulted in the fact that leopards occur within hunting areas more rarely than previously. The causes for this change are low prey densities and a high level of human disturbance, especially during the hunting season.
As we see in Table 6, occurrence of leopards is dependent on prey densities. From our data we an see that leopards tracks were found only in those habitats where wild ungulates (sika deer, roe deer, and wild boar) were abundant (no less than 20-30 fresh tracks per 10 km of route).

It is becoming increasingly evident that the human pressures on hunting leases, high harvest rates and a lack of control on human activities within leopard habitat is becoming increasingly undesirable. Results of the present survey confirmed the absence of leopards in Slavyanskoe and Nezhinskoe Hunting Leases (Table 6).

Table 6. Presence of leopards in relation to relative prey densities in different regions of leopard habitat.

Leopard habitat	Number of fresh ungulate tracks per 10 km of route	Presence of leopards
South of Khasansky Raion (behind the technical border construction line)	25-30	+
Ryazanovka River Basin, Slavyanskoe Hunting Lease	8-9	-
Barsovy Zakaznik, western part, Kedrovaya Pad Reserve	32	+
Nezhinskoe Hunting Lease	16	-
Borisovskoe Plateau	60-70	+

6. Discussion and conclusions

Works on conservation of large carnivores in different regions of the world has shown that the main problem in species recovery is the negative human impact on the environment, and the capacity of the carnivore to adapt to this impact (Weber and Rabinowitz 1996; Seidensticker 1996).

Results of sweep survey conducted in February 2000 confirmed a decrease of leopard numbers and a reduction of its range. According to the 1997 survey results the area inhabited by this population did not exceed 2,600 km^2, which is a twofold reduction since the beginning of 1970's (Abramov and Pikunov 1974; Pikunov et al. 1999). Today, leopards have almost disappeared from southern part of Khasanski Raion and from the northern section of its range in most part of Borisovka and Kraunovka River Basins. Leopards were not found in the Ryazanovka and Brusiya Rivers Basins. Leopard numbers have decreased greatly in Barsovy Zakaznik, where leopards tracks were found only behind the KSP border fence and inside or nearby deer farms. Within Kedrovya Pad Zapovednik leopard numbers have decreased twofold. Leopards were practically absent in Nezhinskoe and Borisovskoe Hunting Leases, where they usually occurred. Special attention should be paid to the territory inside the KSP border fence. Some parts of this territory represent prime leopard habitat (for example Siniy Utyos tract, Oleniy Utyos, Teply Ridge, Zolotaya Podkova, etc) because forests are conserved and there is limited access to hunters and gatherers of wild plants. These regions have been undisturbed zone for a long time. Today the situation has changed – on some border posts hunting, mostly illegal, occurs year-round; commercial logging, sometimes also illegal, has become more intensive. In reality, this territory is out of state hunting control.

Intensive logging continues throughout the Southwest: forests in lower river basins are heavily logged by local people for firewood. Commercial logging of oak and ash occurs in the middle and upper river basins behind the KSP border fence, which often also represents prime leopard habitat. Valuable timber species are being sold both on home and foreign markets. Good roads are developed to logging sites, making some of the best and most remote habitats accessible. Greatly increased human disturbance and in some cases direct habitat destruction is resulting in fragmentation of the entire range into separate small disconnected patches.

Low salaries of state wildlife conservation officers and rangers of hunting leases is resulting in massive year-round poaching. Due to road construction, nighttime hunting with use of technical equipment has become the norm, resulting in a rapid decrease of sika deer and roe deer numbers. As a result, ungulates and large carnivores are forced to concentrate on very constricted territories (10-20 km wide) where roads are still absent. Many regions have lost their importance as good leopard

habitat and no longer represent areas where reproduction occurs; leopards have either completely or partially stopped visiting them. Forest fires in spring and autumn is also resulting in habitat destruction and degradation. Mass logging without any control results in constantly increasing risk of fire. Logging and the resultant fires lead to a steady reduction of black fir forests (the best leopard habitats) and expansion of fire-degraded oak forests with hazel and lespedeza - the least productive forest types for ungulates and large predators.

Comprehensive surveys of Jilin and Heilongjiang Provinces (China) have eliminated the illusion that leopard and tiger populations of southwestern Primorye have contact with Chinese populations, a potential source of new individuals. The status of these species in China is much worse than in Russia (Yang S. et al. 1998). Only 5-7 leopards were found in Jilin Province, and no tracks of this predator were found in Heilongjiang Province (Sun B. et al. 1999). It has become evident that natural recovery of this population is impossible without taking urgent measures. The situation is becoming worse due to growing chaotic situation connected with social and economic problems in Russia. The taiga is the only place where many local people can earn a living after they have lost their jobs. This situation leads to the development of different forms of poaching: from illegal logging and hunting for ungulates to tigers and leopards. Under these conditions, suitable habitat and numbers of this rare animal will decrease rapidly. It has become evident that it is impossible to stop the fragmentation of leopard range and loss of its habitats without considerably improving (optimizing) the network of specially protected territories. In other words, it is necessary to designate the whole of leopard range in Southwest Primorye with a special environmental status. An environmental regime within this territory has to take into consideration the present level of economic activity but leopard conservation must be the highest priority. We propose that all existent leopard habitat must be assigned one of three different management regimes dependent on importance of the area for this endangered species, the level of economic activity that occurs there, and the existing land use system.

The territory we suggest for leopard conservation is divided into the following components with different regimes:

Zone 1. Experience has demonstrated that the most effective measure in protecting habitat is the establishment of zapovedniks. It is very difficult to establish a zapovednik for large cats because it is necessary to include a sufficiently take large territory that will ensure conservation of the entire population. In consideration of this fact, it is absolutely necessary to establish a zapovednik that includes the following regions: Borisovskoe Plateau Zakaznik, the western part of the Federal Barsovy Zakaznik, Nezhinskoe Hunting Lease and Kedrovya Pad Reserve (see Figure 3). It should be noted that there exist no comparable landscapes or regions of such biological diversity, not only in the Far East, but in the whole of Russia. Due to the unique complex of natural features, this territory should be included as a potential zapovednik in the "Long-term program for nature protection and sustainable use of nature resources in Primorsky Krai till 2005". In essence, it is the single most reliable form of protection for the best remaining leopard habitat. Today two-thirds of present leopard population, including breeding females, inhabit this region. Establishing a zapovednik on Russian territory located opposite the remaining leopard habitat in China should serve as an stimulus for further development of international protected area.

Zone 2. A second zone must act as a buffer zone around the zapovednik. This zone must have the status of a federal zakaznik. Hunting and commercial logging should be excluded but firewood collection and use of the forest for the needs of local people should be allowed. Some forms of agriculture and livestock maintenance, including deer farms, should be allowed. Management of ungulate populations should be conducted to increase the numbers of sika deer, roe deer and wild boar. This second zone must include all territories located between the KSP border fence and the international Russian-Chinese border (except the territory recommended for inclusion into the zapovednik – see Figure 3). This zone should also include the territory located west of the main Ussuriisk-Khasan road from Terekhovka village to the border of Kedrovya Pad Zapovednik.

Kedrovy, Penezhinsky, Peschany, Bezverkhovsky deer farms, Gamov peninsula with its deer farm, and adjacent areas should also be included in this zone.

Zone 3. The third zone, allocated as a recreation and resort zone, should be located along the shore of the Sea of Japan. Limited economic activity, which has no negative impact on leopard habitats, should be allowed. Controlled hunting on ungulates, pheasant and waterfowl should be allowed to an extent that can be sustained by wild ungulate densities. This territory is largely located to the south of existent Barsovy Zakaznik and Kedrovaya Pad Reserve up to border control fence, where hunting should be totally banned.

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Figure 1. Survey routes for the sweep survey conducted in winter 2000 in Southwest Primorski Krai.

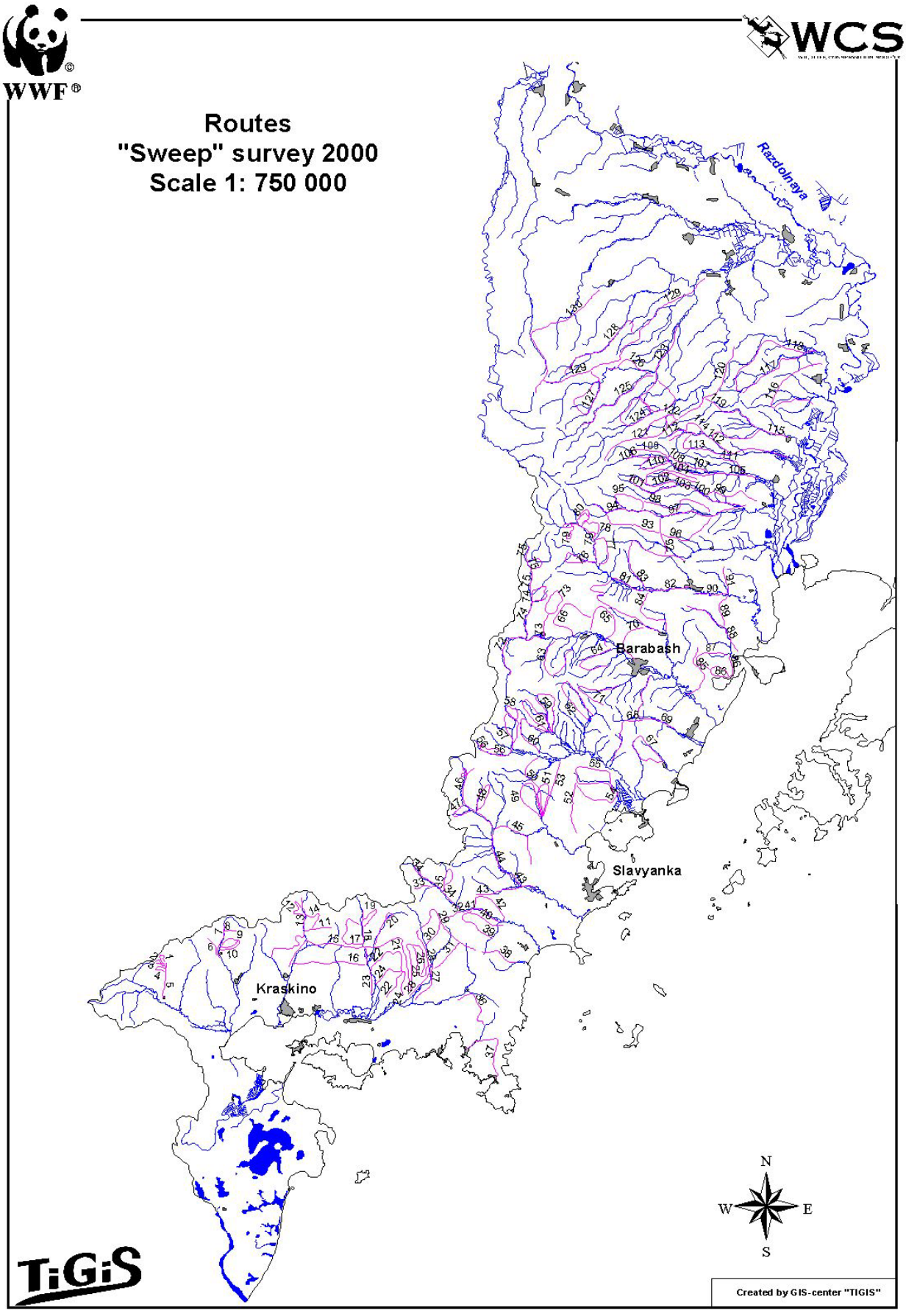


Figure 2. Tracks of leopards and tigers reported during the sweep survey conducted in Southwest Primorski Krai, winter 2000.

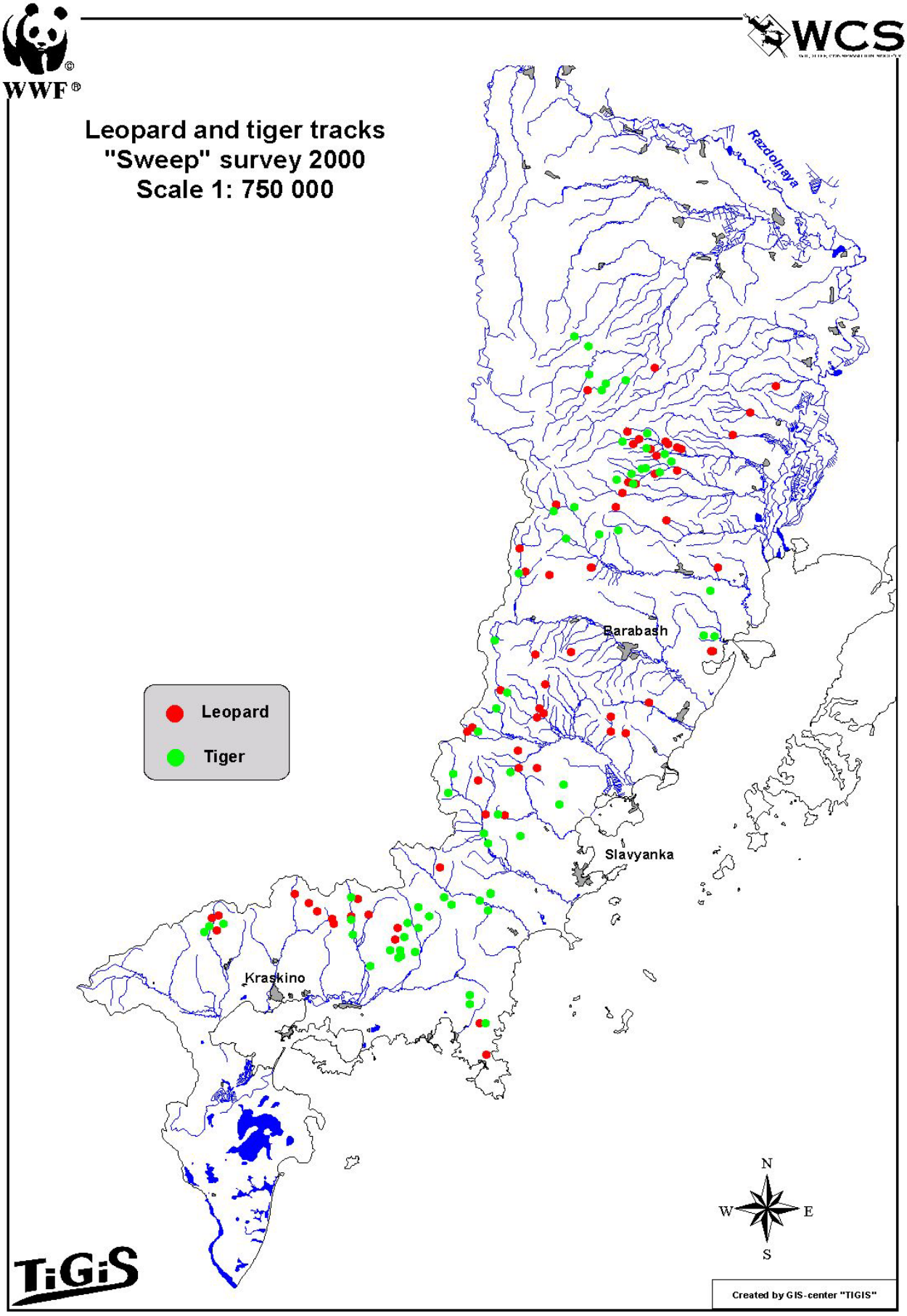
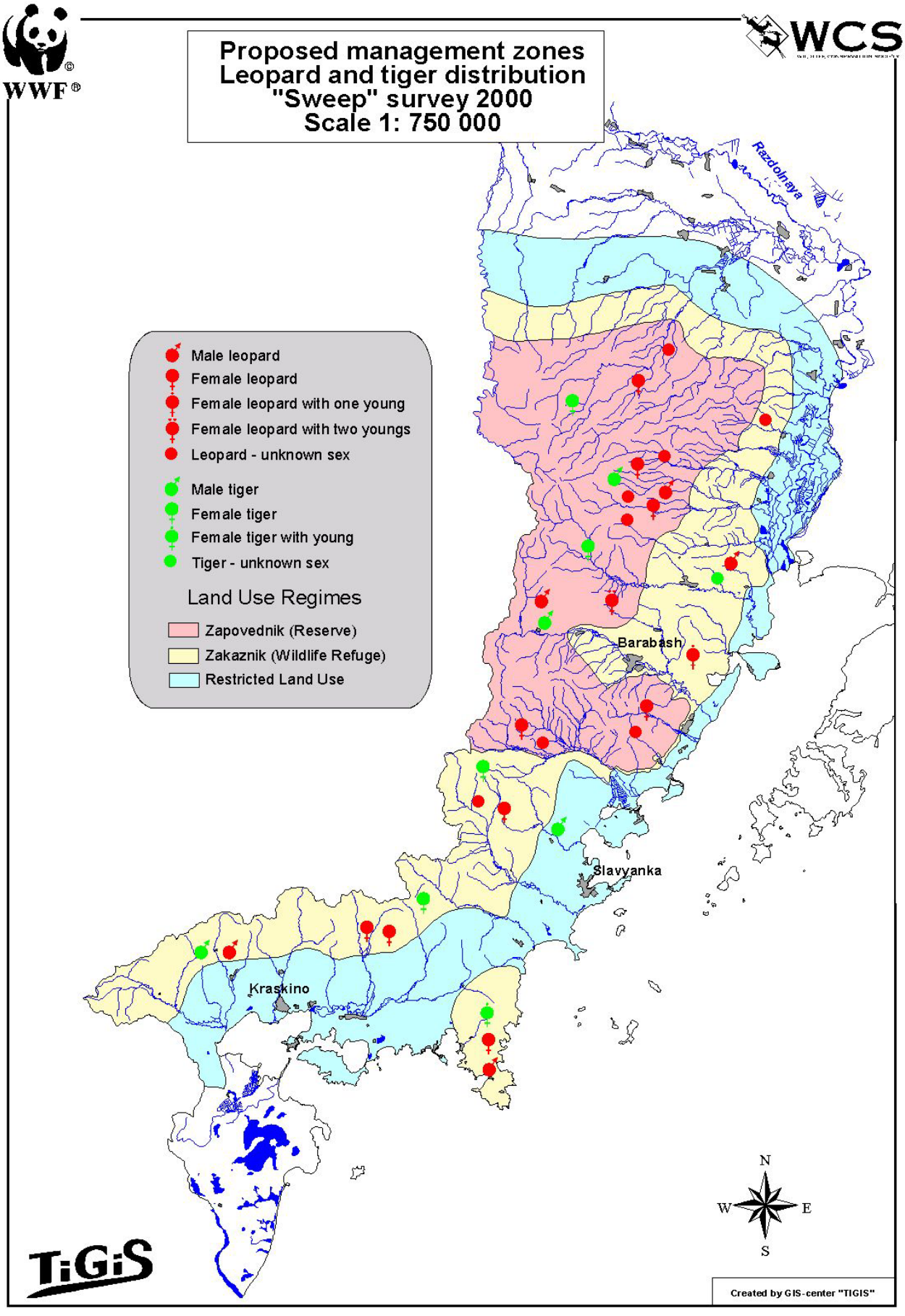


Figure 3. Proposed management zones for leopard and tiger conservation in Southwest Primorski Krai.



SIMULTANEOUS SURVEY OF FAR EASTERN LEOPARDS AND AMUR TIGERS IN SOUTHWEST PRIMORSKI KRAI, WINTER 2000

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According to methods employed for a simultaneous count, approximately 50 fieldworkers should cover routes (in strict compliance with a map) that were evenly distributed throughout the typical leopard habitat. Given these constraints, unusual phenomena such as deep snow or low temperature make implementation of a simultaneous count difficult. The most reliable results occur when snow covers all leopard habitats completely and crusting of snow (resulting from large variations between day and nighttime temperatures) does not occur.

The simultaneous count in 1998 demonstrated that this method provides data qualitatively similar to the sweep survey, but is less expensive and takes less time. However, it was deemed desirable to conduct both types of survey simultaneously to compare results of the two types of survey. Despite unfavorable weather conditions in the 1999-2000 winter, the simultaneous count was implemented.

1. Conditions for survey

As there was no opportunity to assess potential presence of leopards in northwestern Primorye or the Sikhote-Alin, surveys in 2000 were limited to southwest Primorye. The simultaneous count was focused in Khasanski Raion, western parts of Nadezhdinski and Ussuriiski Raions.

The 1999-2000 winter was quite different from previous winters, and was characterized by deep snow cover. By mid-December snow depth had accumulated to 30-40 cm in the foothills and 50-60 cm on plateaus and the middle part of mountains. In January 2000, heavy snowfalls occurred along Sikhote-Alin shore as well as in the southwestern regions. In southwest Primorye snow depth reached 50-60 cm in the valleys and to 80-90 in the mountains. By February snow depth had decreased to 50-70 cm, but a crust of ice on top of snow did not allow fieldworkers to walk the usual 12-15 km a day. A physically fit fieldworker was capable of walking only 4-5 km a day. All forest roads, which usually provide access to survey routes, were not passable for UAZ vehicles, and and sometimes even for GAZ-66. Local people are not accustomed to using skis in these mountains, and most do not even have skis. Locating and providing skis for all fieldworkers in such short time was an impossibility.

In deep snow conditions, ungulates usually localize on steep southern slopes, and therefore carnivores also tend to concentrate there. Such conditions introduce errors to the simultaneous count method. Because two surveys were being conducted this winter, and because Pikunov's team began implementing the sweep survey in February, the only possible time for implementing the simultaneous count was later in the season. Based on trial routes covered in the beginning of March, we ascertained that snow depth and conditions in the central part of southwest Primorye were suitable for survey implementation. Snow depth was 20-30 cm in the valleys and 40-50 cm in the mountains, but at the same time steep southern slopes were snow-free, and southwestern and southeastern slopes were crusted with ice at night. In the northern part of southwest Primorye snow depth was 10-20 cm more, and some roads were passable for jeeps and cross-country vehicles. It was decided to initiate the survey in 7-10 days. However, 2 days after that decision, temperatures in southwest Primorye increased considerably for 3 days. After that, above zero mid-day temperatures were standard. Due to the dramatic change in weather, initiation dates were urgently pushed forward, and the survey conducted on 11-12 of March.

At the time survey routes were covered, snow depth was 5-7 cm under forest canopy in river valleys in the southern part of the range and snow crusted over sufficiently to in the morning support a man's weight. Southern slopes were free of snow, western and eastern slopes were partially covered with snow, and only northern slopes were covered with sufficiently deep snow (15-20 cm) to provide a substratum for leopard tracks to be printed. In central part of range, southern slopes were also free of snow, crumbly snow partially covered western and eastern slopes and entirely covered northern slopes (where it was 20-30 cm deep). In the northern part of the range, southern slopes were partially free of snow, western and eastern slopes were snow covered with a thin crust of ice, and northern slopes were covered with friable snow 25-35 cm deep.

During the survey nighttime temperatures dropped to 5-8^{o} below zero at night, and rose to 3-5 ^{o} above zero in midday hours. Temperatures above zero occurred for 6-7 hours a day. Cloud cover was low, and accompanied by weak southeastern winds. The most recent snow occurred 5 days prior to the survey, but by the time the survey began nothing remained of that snowfall.

Weather conditions which existed in the beginning of March 2000 occur approximately every two years in southwest Primorye. Conditions similar to spring 2000, without snow or with minimal snow cover during most of the winter, usually develop in southwest Primorye by the first ten days of February, which is the most convenient time for implementing a simultaneous count. Ungulate hunting season ends on February 15th and by that time ungulates naturally disperse throughout the territory during the first ten days of February.

If monitoring of the Far Eastern leopard population is to be conducted, we recommend that surveys on numbers and distribution of leopards should be implemented within a strictly defined time period so that the results of a simultaneous count provide an opportunity not only improve the methods used but also to estimate actual leopard numbers in spite of unfavorable weather conditions.

2. Survey methods

In 1987, methods for surveying Amur tigers were published (Pikunov, Bragin, 1987). The method consists of two parts: 1) collect information about movement patterns and presence of tigers from Field Diaries of local people; and, 2) implementation of a simultaneous count. Tiger counts in 1985-1986 and 1995-1996 were largely implemented using these methods.

According to Pikunov and Korkishko (1992) in 1972 the State Hunting Service implemented a simultaneous count of Far Eastern leopards. Thirty-five fieldworkers took part in this work, covering a total 670 km. Survey methods were not described in this source.

The Far Eastern leopard survey implemented in the southwestern part of its range in 1997 (Pikunov et al. 1999) (including coordinators Aramilev and Fomenko) was, in essence, a simultaneous count, but without collection of information using Diaries and without individual meetings with fieldworkers. In 1998, a simultaneous count was also conducted in southwest Primorye. It consisted of two parts, and 52 fieldworkers implemented the main part (field survey) during two days: 103 routes covering 1041 km were traveled (Aramilev, Fomenko and Miquelle, 1998).

Because of weather conditions in winter 2000, it was necessary to change survey methods. Nevertheless, the main principles and methods for implementing the survey remained the same. The presence of cubs with female can be considered an exact criterion to determine sex of an adult (Pikunov and Korkishko, 1992). These authors reported that felid tracks with a pad width from 7.0 to 8.0 cm belong to male leopards. Tracks of females and subadults have pad widths from 4.5 to

6.5 cm (Pikunov et al. 1987). Tracks of cubs still in association with females have pad widths from 3.5 to 5.5 cm.

With rare exceptions, tracks of Amur tigers with pad width of 10.5 cm or more belong to males. Adult females and subadult males have pad widths from 8 to 10.5 cm. Tiger cubs followed by females in winter have pad widths from 6.5 to 10.5 cm (Matyushkin et al.)

Male lynx have pad widths from 5 to 6 cm, female lynx – from 4 to 5 cm (Pikunov et al. 1987, our data).

Tracks of tiger and leopard can always be differentiated by size, because subadult tigers do not begin to travel independently until their pad width is at least 8.5-9.0 cm. Fresh leopard tracks of such size were not found.

Lynx tracks are smaller in general than tracks of leopards traveling independently. Additionally, a lynx's paw is hairy, and it is therefore difficult to mistake a lynx track for a leopard track. Moreover, lynx occur very rarely in leopard habitat.

We developed the following approach for implementation of the 2000 simultaneous count, including improvements over the methods of 1997-1998 survey:

1. Preliminary data collection using field diaries was excluded, because these data were not used in the actual counting process and served only as additional information to establish survey routes.
2. With the elimination of the preliminary surveys, there was no longer a need for two types of field diaries. Only one format (diary) for field data was prepared and used for all data on daily encounters of carnivore and ungulates tracks, snow cover and human impacts. The format of the diary was developed for registering data with a single purpose.
3. The fieldworker has the following tasks: to walk exactly along the established route, to determine the species of animal that left a track, to estimate the freshness of track, to make exact measurement of the size of carnivore tracks, and to register all ungulate tracks that are no more than 24-hours old.
4. A fieldworker should measure pad width of carnivore tracks at least 5 times, noting which pad he is measuring: front pad, rear pad or an overlapping pad.
5. Species and sex of felids should be determined based on the following criteria: tracks with a pad width of 10.5 cm and more were considered male tigers; tracks of single leopard with a pad width of 7.0-8.0 cm belong to a male leopard. The tracks of an adult with cubs belong to females. The criteria used to determine the sex of adult tigers and leopards (female tracks are more oval shaped) (Pikunov and Korkishko, 1992) is subjective to a great extent, and cannot be expressed with concrete figures. Therefore we did not use this criteria in assessing sex of animals.
6. It is the project coordinator's responsibility to provide instructions to all field coordinators, who in their turn have responsibility for instructing fieldworkers, including a demonstration of how to measure tracks and how to determine animal species using plaster casts or real tracks.
7. When gathering field diaries at the end of the count each coordinator should meet with all fieldworkers individually to insure correct data entry in the diary.

According to J. Augustine et al. (1996) the maximum home range diameter of a Far Eastern leopard female is 11 km, making the radius 5.5 km. The diameter of male leopard home range is 23.6 km, making the radius 12 km. The maximum distance between beginning and ending points of a 24-hour movement for adult females was estimated at 1.2 km and 1.6 km. Maximum distances actually traveled during a 24-hour period by females was estimated as 3.5 km and 4.3 km. Average

distance between beginning and ending points for a 24-hour movement by males was 3.8 km, and the maximum overall 24-hour travel distance was 10 km and 18 km (Miquelle, unpubl.). Thus, if there is over 5 km distance between two tracks of female leopards of the same size and freshness, then we can, with some certainty, consider these tracks as belonging to different females. If there is over 15 km distance between two males tracks of the same size and freshness, then we can consider these tracks as belonging to different individuals.

According to Pikunov and Korkishko (1992), female leopard home ranges average 80 km^2, while male home ranges average 300 km^2. These data are close to radiotracking data, but apparently less exact; therefore, we used the parameters of leopard home range developed from radiotracking data.

According to Yudakov and Nikolaev (1987) in the Central Sikhote-Alin the average distance of 24-hour movements for male tigers was 9.6 km, for females 7 km, and the maximum 24-hour movement for males was 41 km, while for females it was 22 km. The average home range of a male tiger occupies 600-700 km^2, while that of a female tiger occupies 300-400 km^2.

Based on radiocollared tigers in Sikhote-Alin Zapovednik and adjacent areas, the average home range diameter of female tigers is 29 km, while that of males is 42 km. The maximum straight-line distance traveled between beginning and ending points during a 24 hour period is 5 km for females and 7 km for males (Miquelle et al., unpubl.).

Daily measurements of tiger tracks in Sikhote-Alin Reserve demonstrated that track size increases by 3.5 mm after 3 days, by 11 mm after 5 days, by 16 mm after 7 days (Smirnov et al., unpubl.).

Based on the above information and the authors' field data, the following criteria were used to estimate numbers of tigers and leopards based on tracks in Southwest Primorye:

1. The main data used for identifying individuals should be tracks no more than 24 hours old.
2. The main parameter used for identifying an individual is the size of front pad. Depending on conditions, measurements of front pad, rear pad, and joint pads (overlap of front and rear pads) should be compared.
3. The allowable variation in track size for one individual is 0.5 cm.
4. Based on the information on home range diameter and 24-hour travel distances, leopards tracks are considered as belonging to different males if the distance between tracks of equal freshness is over 15 km, and over 5 km for females. The analogous parameters for tigers are 20 km for males and 11 km for females.
5. Data on tracks greater than 24-hours old and supplemental data from fieldworkers' diaries provide additional information for individual identification.
6. Weather conditions during the survey are additional criteria used for individual identification.

3. Survey results

During the first stage of the count two project coordinators met with employees of Pavlinovskoe, Borisovskoe, Nezhinskoe, Slavyanskoe and Fauna hunting leases, as well as raion hunting managers of Ussuriisky and Khasansky Raions and rangers and hunting managers of Barsovy and Borisovskoe Plateau Zakazniks. During these meetings information on general snow cover were

Table 1. Leopard tracks registered during simultaneous count of leopard and tiger in Southwest Primorye, winter 2000.

Track #	Route #	Pad width, cm			Track age
		Joint	Front	Rear	
1	4	5.7	0	0	2-4 days
2	7	5.5	0	0	2-4 days
3	8	6	0	0	2-4 days
4	8	4.5	0	0	2-4 days
5	10	0	0	6.3	2-4 days
6	90	5.5	0	0	1-2 days
7	15	5.7	0	0	2-4 days
8	23	7.1	0	0	2-4 days
9	23	4.4	0	0	4-7 days
10	24	5.5	0	0	1-2 days
11	25	7	0	0	4-7 days
12	27	6	0	0	1-2 days
13	30	0	0	0	4-7 days
14	31	0	6.8	6.4	2-4 days
15	35	6.5	0	0	4-7 days
16	36	0	5.4	4.3	24 hours or less
17	37	6.5	0	0	24 hours or less
18	37	6.1	0	0	24 hours or less
19	39	5.4	0	0	4-7 days
20	40	5.5	0	0	2-4 days
21	40	5	0	0	1-2 days
22	42	4.1	0	0	4-7 days
23	43	5.5	0	0	1-2 days
24	43	4.3	0	0	1-2 days
43	46	5.9	0	0	2-4 days
25	60	8	0	0	4-7 days
26	63	6.9	0	0	1-2 days
27	63	6.4	0	0	1-2 days
28	63	6.2	0	0	1-2 days
29	63	5.7	0	0	1-2 days
30	64	5.7	0	0	1-2 days
31	64	6.3	0	0	1-2 days
32	65	7.8	0	0	1-2 days
33	65	7.9	0	0	1-2 days
34	66	5.3	0	0	1-2 days
35	66	5.6	0	0	1-2 days
36	66	4.5	0	0	1-2 days
37	67	6.3	0	0	1-2 days
38	67	4.4	0	0	1-2 days
39	67	6.4	0	0	1-2 days
40	68	4.7	0	0	24 hours or less
41	68	6.1	0	0	1-2 days
42	74	5.9	0	0	4-7 days

clarified, and in concert with general information on leopard, tiger and ungulate distribution and movements, this information formed the basis for establishing survey routes. A total of 92 routes were established, of which 90 were covered, totaling 1225 km (200 km more than in the previous count). The average route length was 13.6 km. The majority of routes were traveled on foot, 3 routes were traveled by “Buran” snowmobile, and 4 routes on horseback. Fieldworkers were

transferred to and from starting and ending points of a route by car. Information gathered along the route of the vehicle was recorded as additional data. On some survey routes high ungulate densities and an absence of fresh snow resulted in numerous tracks, making it difficult to identify or determine freshness of both carnivore and ungulate tracks. "Control routes" along roads demonstrated that some percentage of both carnivore and ungulate tracks were not reported on routes traveled by car.

According to tracks encounters in the period from November 1999 to February 2000, the area inhabited by leopards during the survey totaled nearly 370 000 ha in southwest Primorye. Excluded from this estimate were areas surveyed in 1997 and 1998 counts where leopards were not reported during counts in 1997 and in 1998. Two years ago the simultaneous count was conducted not only on the territories of reserves, zakazniks, sports hunting leases and deer farms, but also behind technical border construction line (KSP border fence).

Table 2. Tiger tracks registered during simultaneous count of leopard and tiger in Southwest Primorye, winter 2000.

Track #	Route #	Pad width, cm			Track age
		Joint	Front	Rear	
1	3	10.5	0	0	4-7 days
2	5	9.5	0	0	4-7 days
3	5	0	9.3	8.4	24 hours or less
4	8	10	0	0	2-4 days
5	9	10	0	0	2-4 days
6	12	11.3	0	0	2-4 days
7	12	8.7	0	0	4-7 days
8	16	0	9.4	8.7	2-4 days
9	36	0	9.5	8.5	2-4 days
10	36	9.3	0	0	24 hours or less
11	36	9.5	0	0	4-7 days
12	37	11.3	0	0	4-7 days
13	37	0	11.2	10.5	24 hours or less
14	37	11.2	0	0	4-7 days
15	39	9.4	0	0	2-4 days
16	52	0	0	8.9	4-7 days
17	50	0	10.7	0	2-4 days
18	75	9.9	0	0	4-7 days
19	45	10.6	0	0	4-7 days
20	64	9.2	0	0	1-2 days
21	63	9.4	0	0	1-2 days
22	74	9.7	0	0	2-4 days
23	80	0	9	0	4-7 days
24	80	8.9	0	0	4-7 days
25	78	16.5	0	0	4-7 days
26	77	10.5	0	0	24 hours or less
27	79	9.1	0	0	4-7 days
28	79	0	0	10	4-7 days
29	79	0	9.2	0	4-7 days
30	79	0	0	9.8	1-2 days
31	82	9.6	0	0	1-2 days
32	82	9.7	0	0	1-2 days

All carnivore tracks were recorded on a 1:100 000 scale map. During the simultaneous count, implemented on March 11th and12th, 42 leopards tracks (more than twice less than the 86 tracks reported two years ago) and 32 tigers tracks (35 tracks recorded in 1998) were reported. Of the 42 leopard tracks, 37 were considered fresh (less than or equal to 24-hours old) (compared to 59 in previous count), and 8 out of 32 tigers tracks were considered fresh (16 in previous count). Applying the "soft" and "hard" criteria 24-26 leopards and 13-14 tigers were identified on the territory of southwest Primorye. Lynx and wolf tracks were not found. During the count there were records of both black and brown bears emerging from dens.

Sex-age structure of leopard population

Sex and age structure of tiger and leopard populations are presented in Table 3.

Table 3. Sex-age structure of leopard and tiger populations in southwest Primorye in 2000

#	Species, %	Males	Females	Subadults	Unknown	Total
1.	Leopard	2	3	5	14	24
	%	8	13	21	58	100
2.	Tiger	4	0	0	10	14
	%	29	0	0	71	100

Review of mapped data revealed, as did the survey from two years ago, spatial separation of tigers and leopards. In some areas where a few tigers tracks were reported, no leopards tracks were found. In other areas where tigers were present, the situation was the same: a few tiger tracks of varying freshness, and presence of leopard tracks only several km distant. These data support the idea that competition between these two predators is occurring, or at a minimum, indicates that leopards use territories where tigers usually do not occur.

Ungulate count

Winter weather conditions during the count had an impact on ungulate distribution and the probability of encountering fresh tracks. In general, the data on ungulates indicated a high ungulate density. Throughout most of territory, the relative index for sika deer was 5-15 fresh tracks per 10 km of route, 2-3 tracks/10 km for roe deer, and 2-3 tracks/10 km for wild boar.

Ungulate track indices in protected areas and hunting leases are provided in Table 4.

Table 4. Relative abundance of ungulates

#	Territory	Number of fresh ungulates tracks per 10 km survey route				
		Sika deer	Roe deer	Wild boar	Elk	Musk deer
1.	Pavlinovka	3.4	2.4	3.2	0	0
2.	Borisovskoe Plateau Zakaznik	8.1	1.8	2.7	0.2	0.1
3.	Northern part behind wire-net	4.1	0.4	2.2	0	0.1
4.	Borisovskoe Hunting Lease	10.6	1.6	2.3	0	0
5.	Nezhinskoe Hunting Lease	14.3	1.64	4.0	0.3	0.2
6.	Barsovy Zakaznik	4.2	3.9	0.8	0	0
7.	Kedrovaya Pad Reserve	16.7	21.8	18.1	0	0
8.	Slavyanskoe Hunting Lease and Fauna Hunting Lease	5.4	3.7	1.3	0	0.1
9.	Within KSP Border fence - Southern region	5.9	1.9	1.3	0	0.1

Table 5. Data on survey routes traveled, snow depth and ungulate abundance during simultaneous count in winter 2000

Route #	Date	Field worker	Snow depth, cm						Elk		Sika deer		Wild boar		Roe deer		Musk deer	
			Valley	Divide	Slope				Tracks	Indiv.	Tracks	Indiv.	Tracks	Indiv.	Tracks	Indiv.	Tracks	Indiv.
					N	W	S	E										
1	03/11/00	Zherdev S.A.			8		0		-	-	-	-	-	-	11	-	-	-
2	03/12/00	Kovrov N.E.							-	-	-	1	-	-	-	3	-	-
3	03/11/00	Vashurin A.I.	20		20	15			-	-	21	6	3	-	2	-	-	-
4	03/11/00	Baturin A.S.	0	20	20			15	-	-	15	15	3	8	-	-	-	-
5	03/11/00	Sysik A.I.	9		20		0		-	-	28	-	-	-	-	-	-	-
6	03/11/00	Shevchenko N.G.	17	5	22		6		-	-	4	-	-	-	12	2	-	-
7	03/11/00	Panfilov V.A.	18	20	20		0		-	-	1	-	-	-	-	-	-	-
8	03/11/00	Vinogradov A.I.	20	15		25	0		-	-	1	-	-	-	1	-	-	-
9	03/11/00	Yurchenko I.V.	20	18		25		20	-	-	3	-	-	-	-	-	-	-
10	03/12/00	Panfilov V.A.	20	25	20		0		-	-	7	1	-	-	-	-	-	-
11	03/11/00	Lenkov I.A.	18	50	0	0	13	15	1	-	18	-	-	-	5	-	-	-
12	03/11/00	Golobokov A.N., Starikov N.N.	13	9	7		4		-	-	-	-	-	-	-	-	-	-
13	03/12/00	Shevchenko M.G.	21	25		7		6	-	-	4	-	-	-	7	1	-	-
14	03/12/00	Lenkov I.A.	16	45	30		7		-	-	17	-	-	-	6	-	-	-
15	03/11/00	Goncharov V.V.	8	35					-	-	11	-	-	-	4	-	1	-
16	03/11/00	Goncharov V.V.	8	25					-	-	7	-	4	-	6	-	-	-
17	03/12/00	Sysik A.I.	10	20	30		0		-	-	-	58	-	2	-	2	-	-
18	03/12/00	Yurchenko A.B.	20	8	10		3		-	-	-	-	-	-	-	-	-	-
19	03/12/00	Pasyuk A.N.	15						-	-	11	-	-	-	4	-	-	-
20	03/12/00	Gapko, Potilitsin V.	13	10	15		0		-	-	5	-	1	-	9	-	-	-
21	03/12/00	Goncharov V.V.	10	30					-	-	23	-	-	-	6	-	-	-
22	03/11/00	Pasyuk A.M.	11	15			0		-	-	5	-	-	-	2	-	-	-
23	03/11/00	Stoma E.O.	10	5	10		0		-	-	-	-	-	-	-	-	-	-
24	03/11/00	Guly A.A.	15	10	15		0		-	-	4	-	5	-	9	-	-	-
25	03/11/00	Savin V.S.							-	-	2	-	4	-	8	-	-	-
26	03/12/00	Blech V.E.	10	3	10		3		-	-	12	-	-	-	6	-	-	-
27	03/12/00	Savin V.S.	15	15	15		15		-	-	7	-	2	-	7	-	-	-
28	03/12/00	Ivanov E.V.	13	5	18			13	-	-	19	-	20	-	25	-	-	-
29	03/11/00	Zaev A.P.	18	14	17		3		-	-	20	-	29	-	33	-	-	-
30	03/12/00	Zaev A.P.	15	18	18		2		-	-	16	-	12	-	15	-	-	-

Table 5 (cont.)

Route #	Date	Field worker	Snow depth, cm						Elk		Sika deer		Wild boar		Roe deer		Musk deer	
			Valley	Divide	Slope				Tracks	Indiv.	Tracks	Indiv.	Tracks	Indiv.	Tracks	Indiv.	Tracks	Indiv.
					N	W	S	E										
31	03/11/00	Ivanov E.V.	13	5	13		8		-	-	16	-	16	-	20	-	-	-
32	03/11/00	Maramchin N.V.	10	10	15		0		-	-	2	-	-	-	13	-	-	-
33	03/11/00	Romanov S.N.	10	10	15		15		-	-	-	-	-	-	3	1	-	-
34	03/11/00	Chernyshev V.V.	17	6	2		0		-	-	-	-	-	-	10	-	-	-
35	03/12/00	Rybalko K.N.	11	6	11		5		-	-	-	-	3	-	9	-	-	-
36	03/11/00	Kulikov P.B.	20	3	25		2		-	-	9	-	5	-	2	-	1	-
37	03/12/00	Kulikov P.B.	22	3	31		2		-	-	19	-	-	-	2	-	-	-
38	03/11/00	Zakharov A.S.	6	4	10		0		-	-	-	-	1	-	7	-	-	-
39	03/11/00	Blech V.E.	20	5	20		0		-	-	1	-	-	-	15	-	-	-
40	03/11/00	Schukin M.A.	25	20	25		10		-	-	-	-	8	-	3	-	-	-
41	03/11/00	Gavrishev V.A.	19	17	14		11		-	-	-	-	1	-	3	-	-	-
42	03/12/00	Gavrishev V.A.	18	43	23		15		-	-	-	-	-	-	2	-	-	-
43	03/12/00	Schukin M.A.	20	10	20	20	0	25	-	-	-	-	19	-	-	-	-	-
44	03/12/00	Skvorchinski S.V.	5	10	10		0		-	-	2	-	18	-	6	-	-	-
45	03/11/00	Skvorchinski S.V.	20	20	25	10	0	10	-	-	39	-	-	-	3	-	1	-
46	03/12/00	Voropaev E.R.	20	15	20		0		-	-	-	-	-	-	-	-	-	-
47	03/12/00	Shevchenko A.V.	20	15	20		0		-	-	-	-	-	-	-	-	-	-
48	03/11/00	Kaveshnikov A.V.	25	19	30		10		-	-	5	-	4	-	-	-	1	-
49	03/12/00	Fedyakin G.A.	14	21	21	12	3	10	-	-	47	17	-	-	-	-	1	-
50	03/12/00	Bazaliy R.V.	17	15	15		0		-	-	73	3	2	-	-	-	-	-
51	03/12/00	Teplyakov A.V.	0	16	18		5		6	-	19	-	16	-	-	-	1	-
52	03/12/00	Berezhan M.M.	21	2	25		0		-	-	21	-	8	6	-	-	-	-
53	03/11/00	Pankov V.R.	19	20	23		13		-	-	7	-	-	-	-	-	-	-
54	03/11/00	Belozor A.A.	25	22	25			8	-	-	8	-	-	-	13	-	-	-
55	03/11/00	Skorodelov A.S.	8	0	20		5		-	-	-	-	1	-	5	-	-	-
56	03/12/00	Pokotilo A.V.	14	12	15		8		-	-	8	-	1	-	4	-	-	-
57	03/12/00	Skorodelov A.S.	8	2	14		0		-	-	-	-	9	-	17	-	-	-
58	03/11/00	Bazaliy R.V.	16	21	30		8		-	-	16	-	2	-	2	-	-	-
59	03/11/00	Berezhan M.M.	0	22	22	12	3	11	-	-	9	12	-	-	-	-	-	-
60	03/11/00	Teplyakov A.V.	0	16	21	10	10	15	-	-	22	-	8	-	-	-	-	-
61	03/11/00	Fedyakin G.A.	15	22	22	12	3	11	-	-	29	37	-	-	-	-	2	1
62	03/11/00	Pokotilo A.V.	15	12	30		7		1	-	18	-	-	-	-	-	-	-
63	03/12/00	Melnikov A.M.	25	15	28		7		-	-	31	-	16	-	-	-	-	-

Table 5 (cont.)

Route #	Date	Field worker	Snow depth, cm						Elk		Sika deer		Wild boar		Roe deer		Musk deer	
			Valley	Divide	Slope				Tracks	Indiv.	Tracks	Indiv.	Tracks	Indiv.	Tracks	Indiv.	Tracks	Indiv.
					N	W	S	E										
64	03/12/00	Potapov S.F.	25	15	28		5		-	-	20	-	1	-	-	-	-	-
65	03/11/00	Simushkin S.V.	28	15	28		5		-	-	39	-	7	-	-	-	-	-
66	03/12/00	Simushkin S.V.	28	17	28		7		-	-	15	-	26	-	2	-	-	-
67	03/11/00	Mannikov A.M.	25	15	28		7		-	-	-	-	-	-	-	-	-	-
68	03/11/00	Potapov S.F.	28	18	28		5		-	-	19	-	12	-	2	-	-	-
69	03/11/00	Bogachov A.S.	25	28	36		32		-	-	3	-	2	-	2	-	-	-
70	03/11/00	Shiroki P.P.	20	30		28		32	-	-	-	-	-	-	5	-	-	-
71	03/11/00	Umanets O.A.	25	15	25		0		-	-	24	-	2	-	-	-	-	-
72	03/12/00	Umanets O.A.	25	15	25		0		-	-	-	-	-	-	1	-	-	-
73	03/11/00	Parmilov P.A.	25	15	25		0		-	-	14	-	-	-	3	-	-	-
74	03/11/00	Sumerkin Yu.N.	20	30	30		10		-	-	19	34	5	-	2	-	-	-
75	03/11/00	Agapov N.A.			46				-	-	7	-	-	-	1	-	-	-
76	03/12/00	Orel A.A.	0	30	30		6		-	-	6	-	-	-	-	-	-	-
77	03/11/00	Ryborenko A.A.	30	18	26		12		-	-	11	-	11	-	-	-	-	-
78	03/11/00	Orel A.A.	24	19	30		5		-	-	10	-	1	-	-	-	-	-
79	03/12/00	Agapov N.A.	26	31					-	-	4	-	4	-	-	-	-	-
80	03/11/00	Agapov N.A.	46	45					2	-	23	-	3	12	-	-	-	-
81	03/11/00	Timanov M.V.	22	25	26		10		-	-	32	-	-	-	3	-	-	-
82	03/11/00	Burikov V.M.	22	25	27		15		-	-	33	3	17	3	3	-	-	-
83	03/11/00	Shmakov I.I.	18						-	-	6	-	6	-	-	-	-	-
84	03/11/00	Sivarisha V.N.	15						-	-	10	-	-	-	2	-	-	-
85	03/11/00	Orlov S.	14	15	15		0		-	-	5	-	4	-	4	-	-	-
86	03/11/00	Shevchenko Yu.S.	13	10	12		0		-	-	2	-	-	-	5	-	-	-
87	03/12/00	Shevchenko Yu.S.	14	20	12		0		-	-	2	-	1	-	7	-	-	-
88	03/11/00	Degtyarev S.V.	22	24	29		0		-	-	-	-	-	-	-	-	-	-
89	03/11/00	Khokhlov Yu.N.	20						-	-	-	-	10	-	2	-	-	-
90	03/12/00	Onischenko A.G., Simonov M.M.	15	10	5		0		-	-	-	-	-	-	-	-	-	-

In comparison with previous counts, there appeared to be an increase in wild boar numbers in southwest Primorye, perhaps due to an abundance of acorns and improved ungulate management in the hunting leases.

Data on relative abundance of ungulates in Kedrovya Pad Zapovednik, obtained during this simultaneous count for the first time, were surprisingly high, possibly due to acorn abundance or inaccuracies in recording fresh tracks.

In some areas and some routes it was impossible to count the number of tracks crossing routes when group numbers of ungulates were high, or there were repeated crossings in one small area. Data on visual counts of ungulates in hunting leases also provide an indication of relative abundance (Table 6).

Table 6. Visual ungulates counts on routes

#	Territory	Sika deer	Roe deer	Wild boar	Elk	Musk deer
1.	Pavlinovka					
2.	Borisovskoe Plateau Zakaznik			12		
3.	Northern part behind wire-net					
4.	Borisovskoe Hunting Lease	37		6		
5.	Nezhinskoe Hunting Lease	69		6		1
6.	Barsovy Zakaznik					
7.	Kedrovaya Pad Reserve					
8.	Slavyanskoe Hunting Lease and Fauna Hunting Lease	1	7			
9.	Southern part behind wire-net	25		8		

It is important to note that visual encounters of ungulates were registered on the territories of hunting leases but only one wild boar herd was reported in Borisovskoe Plateau Zakaznik.

Large felids and deer farms

Antipoaching activities in recent years has decreased the level of poaching on deer farms. Efforts of the "Tiger" Department (Krai Committee for Nature Protection) and of an antipoaching group (of the Hunting Department) along with a 5-year sentence for a poacher who had shot leopard, sent a strong message to local people that the state will enforce nature protection laws and punish those who violate the laws. In addition, deer farm employees do not have the right to carry arms in the context of their work.

In the last two years, deer farms have changed their form of ownership, all having been privatized. Because new owners are not profited as much as anticipated, threats to leopards (killing to protect deer herds) have appeared again. As in the past, high leopard densities were registered in Kedrovski deer farm area, and leopards were present in Gamovski, Bezverkhovski, Peschany and Provalovski deer farms. The absence of leopards in former Slavyanski deer farm is suspicious: two years ago a cage for capture of large cats was found on this deer farm.

Results of the survey, as well as additional data gathered around farms, indicate that leopard densities have increased around deer farms. Two leopards – a female with kitten – were found in Kedrovski deer farm; 5-6 km from this farm another female with two cubs was reported; a female and kitten were reported near Peschany deer farm; and, what was probably a female and subadult were present near Bezverkhovski deer farm.

At present time deer farms that have retained high deer numbers act as a feeding area for leopards, and some individuals apparently prefer to stay and hunt on deer farm lands or in close proximity to them. Due to this fact, the importance of deer farms to leopard conservation cannot be overestimated. Development of cooperative associations with farm owners is necessary, but it is also important for some nature protection organizations to actually buy these farms to manage them as a forage base for leopards and to provide the suitable territory for leopard reproduction.

4. Basis for optimizing the protected territories system in Southwest Primorye

The main problem in establishing an optimal protected territories system in southwest Primorye resolves around the strategic interests of Russia in this territory. At present a large portion of tiger and leopard habitat is located behind the "KSP" border patrol fence. Local people have limited access to this territory, but opportunities for protection of natural resources is also limited by the Department of Defense and its representatives at the local level. Nevertheless, this territory has great potential as a reserve with a high level of protection (zapovednik or federal zakaznik). The potential of this region would be even greater with the creation of a protected territory in adjacent areas of China (as has been proposed). In addition, parts of southwest Primorye are intensively used as military firing range.

The second serious problem is the fact that a large portion of southwest Primorye, especially in Khasansky Raion is already protected. Today economic activity is restricted on more than 30% of the raion. There is a shortage of land where local people can hunt, fish, collect eatable plants and berries, and recreate.

Our proposed "optimization plan" is based on investigations conducted here since 1996 (Aramilev and Fomenko 1999), on historic information in this region, and our experiences with similar problems in other regions. Acknowledging that the total territory available for leopard conservation is limited, it is necessary to increase numbers of those ungulate species that are primary prey for tigers and leopards. At present tigers number in Sikhote-Alin are sufficient for its survival in the wild. Because there is overlap in use of prey species by these two large cats, the Far Eastern leopard and Amur tiger, competition is apparently occurring. Therefore, assuming leopard conservation has a higher priority, it may be necessary to move tigers to Sikhote-Alin, China or Korea.

A number of researchers have suggested that ungulate numbers within protected territories fluctuate in 40-50 year cycles. As ungulate numbers increase, the forage base becomes depleted and in response ungulate numbers drop to a minimum value. Predator numbers (in this case, the leopard) will also decrease correspondingly. Therefore, a strictly protected reserve (zapovednik) is not the best form of protected territory for large predator conservation. To maintain high densities of ungulates it is necessary to provide not only protection, but conditions for high levels of reproduction. Such management practices are in accordance with current legislation/regulations for zakazniks and nature parks, making the federal zakaznik designation (with lands expropriated), the most acceptable from of protected territory for leopard conservation. Nevertheless, according to our investigations, ungulates numbers in hunting leases of southwest Primorye are no less than in existing zakazniks and the zapovednik. Therefore, allocation of lands for hunting leases in southwest Primorye is necessary to appease the attitude or local people to endangered species conservation.

In our proposed plan, the needs of all interested parties are taken into consideration. The territory between the international border and zones of economic activity can act as a reserve for leopard conservation. The status of Kedrovya Pad Zapovednik must be retained and its lands must retain

connectivity with the leopard conservation zone, with all these lands allocated as a zapovednik. Federal zakaznik lands must protect leopards and retain highly productive populations of ungulates in quality habitats. Within zones of limited economic activity, use of forests and mineral resources must be rational, and there must be stable use of lands for construction and and agricultural needs. Deer farms represent a separate problem. Territories that are presently fenced off are shown on map. In fact, owners of these farms retain even larger territories as community or private property, and can, at any moment, extend fencing to include these areas, creating even greater problems for leopard conservation. Due to the fact that deer farms were initially allocated lands from the land "fund," it would be very difficult to convert them into protected territories. At present time, it is necessary to prevent enlargement of deer farms and to start the process of their converting them back into state property.

5. Discussion of Results and Conclusions

Results of the simultaneous survey demonstrate that with modern communication and travel facilities, in concert with other conditions, it is possible to train the necessary number of fieldworkers, to guide them before and during counts, and adjust timing of the count. In contrast to the "sweep" method, in which fieldworkers travel throughout leopard habitats in the course of a month, the simultaneous count gives a instantaneous "picture" of the existent situation. In two days, leopards and tigers are capable of moving great distances, and cannot move towards or away from fieldworkers (as is possible in the sweep method). Recent investigations of leopard ecology indicate that leopards follow migrating ungulates; males move in search of females and prey, subadults search for unoccupied habitats. Therefore, the sweep method provides results that are intuitive estimates of professional researchers that are beyond any mathematical treatment. Moreover, the simultaneous count is cheaper than the sweep method. It should be remembered that simultaneous counts of large cats always underestimate actual numbers (Miquelle and Smirnov, unpubl. data), so there is no risk of overestimated population size, even with a high estimate.

Results obtained from the simultaneous count raise no doubts because the work was conducted in full compliance with the proposed methodology. However, the results obtained in this survey do not reflect actual leopard numbers, because 50-70% of study area was free of snow or was covered with icy crust, upon which leopard tracks would not be visible. Based on our estimates, the resulting number of leopards could easily be multiplied by two. Thus, 48-50 individuals is a realistic number of leopards in southwest Primorye at the present time.

6. Conclusions

Both types of surveys indicate that at the present time there are less than 50 Far Eastern leopards in southwest Primorye. This number is extremely inadequate for long-term survival of the species.

Leopard habitats in southwest Primorye are limited and the potential for expansion of habitat is unlikely in the near future. According to Augustine et al. (1996), 56-67 leopards could inhabit southwest Primorye. Therefore, if poaching and forest fires are prevented and ungulate densities increase, this potential number of leopards could be obtained 4-5 years. Therefore, it becomes extremely important to organize and initiate the process of expanding potential leopard habitat in China and North Korea, and for reintroduction within defined territories in Sikhote-Alin.

Protected areas play a special role in leopard conservation. The authors of the project suggest two different approaches for optimizing the protected areas network for leopard conservation. The differences in approach are based on two fundamental principles. One group of authors believe that coexistence of people and leopards in southwest Primorye is possible, and that humans must retain

the right to use some portion of the natural resources, and secondly, that the optimal form of protected area for conservation is that one that allows management of ungulates and the land. The second group of authors suggests it is necessary to expropriate the majority of leopard habitat from economic use, and considers zapovedniks to be the best form of protected area. Despite this difference in approach, it is evident that in southwest Primorye optimization of protected areas is needed and immediate efforts are required.

Today all specialists have no doubts about the importance of deer farms for leopard conservation. Initial, insufficient attempts to get deer farms to partake in leopard conservation have not been successful, but we now understand that a serious program is needed to make a progress in this arena. We must not to be afraid to try new approaches. At the present time new private and community owners of deer farms are disappointed and surprised by the lack of profit from this kind of economic enterprise, making it a favorable time to purchase these farms to establish appropriate nature protection and economic structures. Such an action provides, in one stroke, to exclude lands from inappropriate economic activity and to obtain the structural and technical basis for feeding and breeding leopards.

Finally, results of this project demonstrate that the problem of Far Eastern leopard conservation is no less critical. Regardless of state policy and unavailability of funds, it is necessary to continue to study leopard ecology and to take immediate measures for conservation of the Far Eastern leopard.

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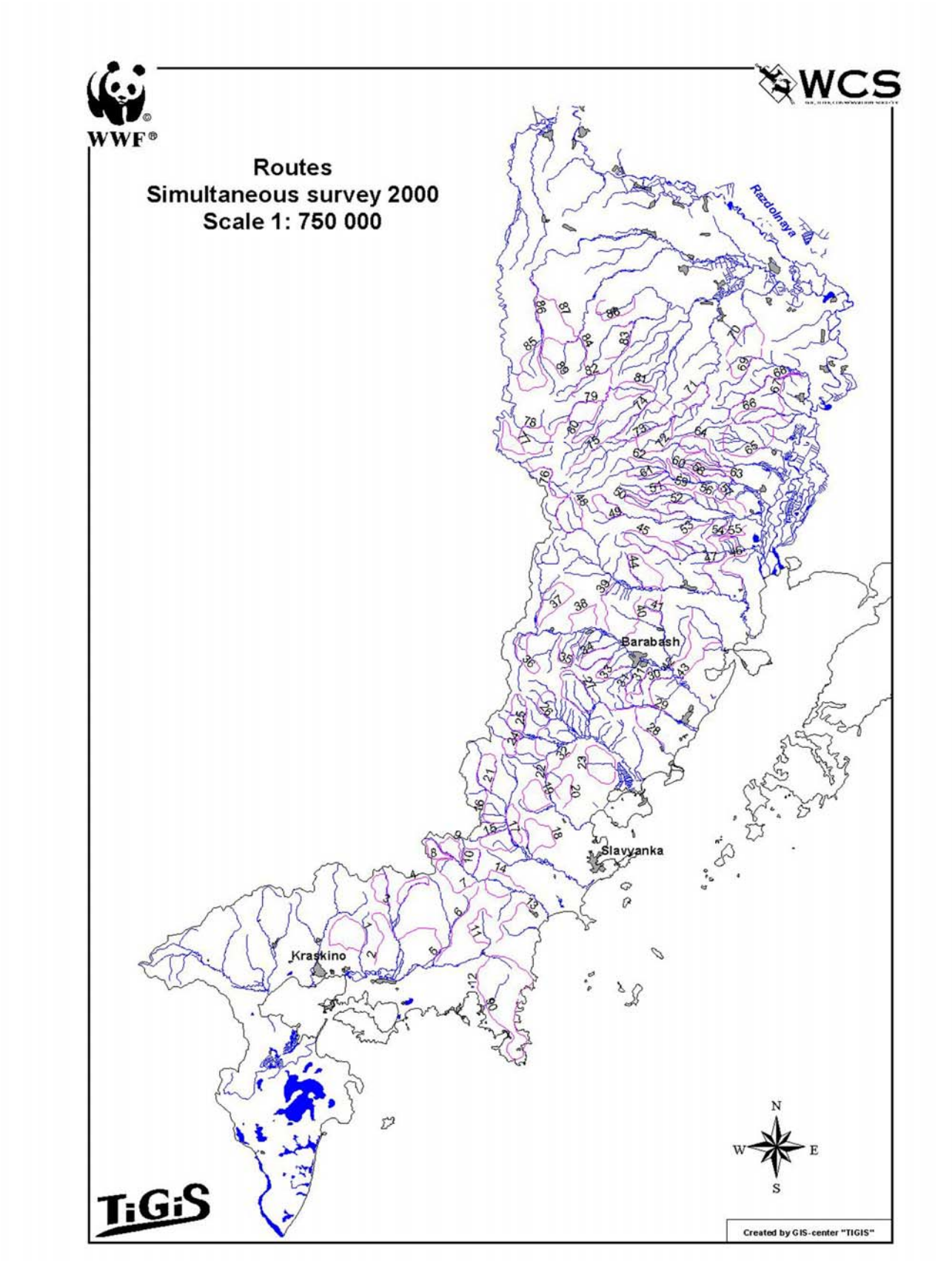

Figure 1. Survey routes for the simultaneous count conducted in winter 2000 in Southwest Primorski Krai.

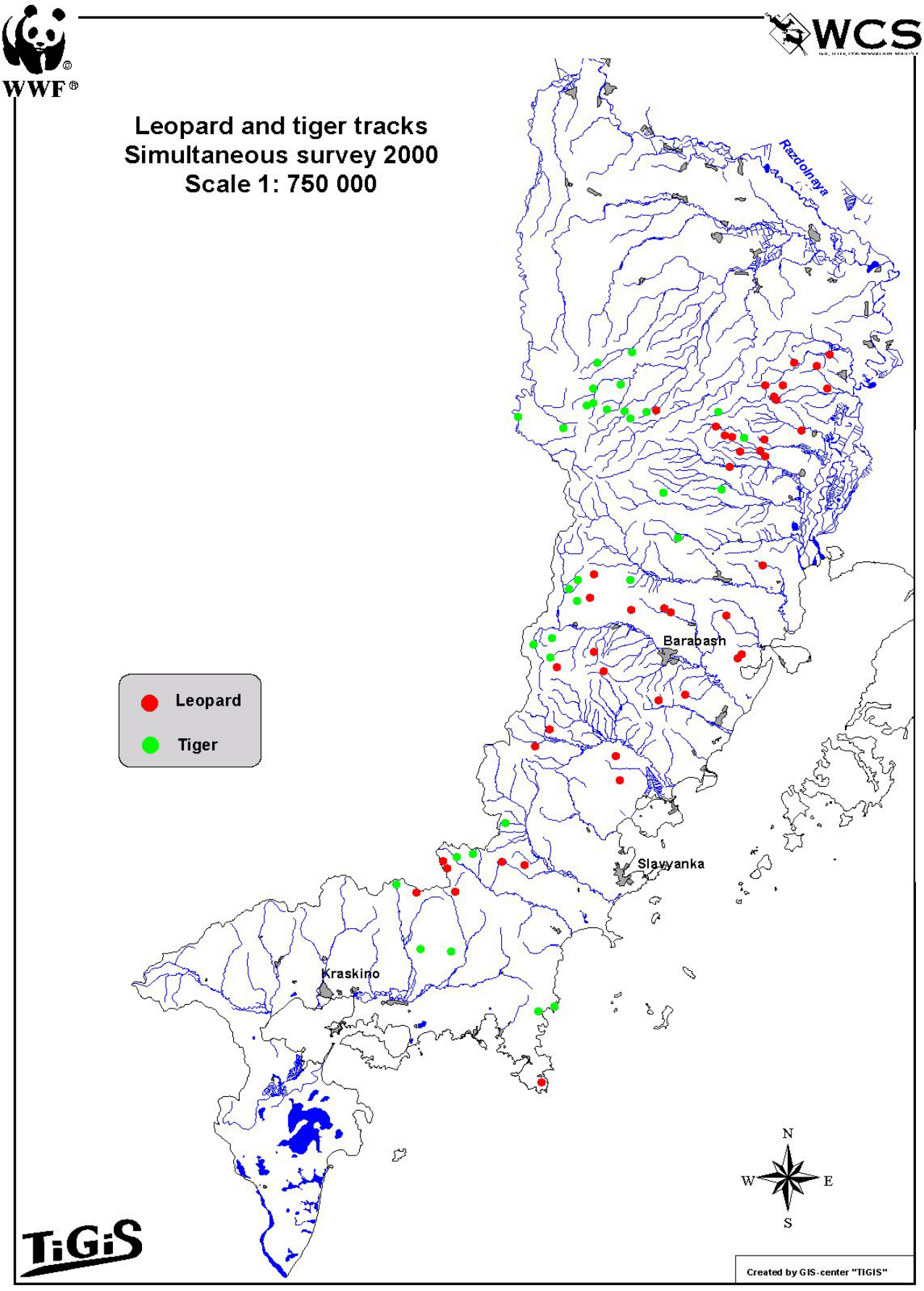

Figure 2. Tracks of leopards and tigers reported during the simultaneous count conducted in Southwest Primorski Krai, winter 2000.

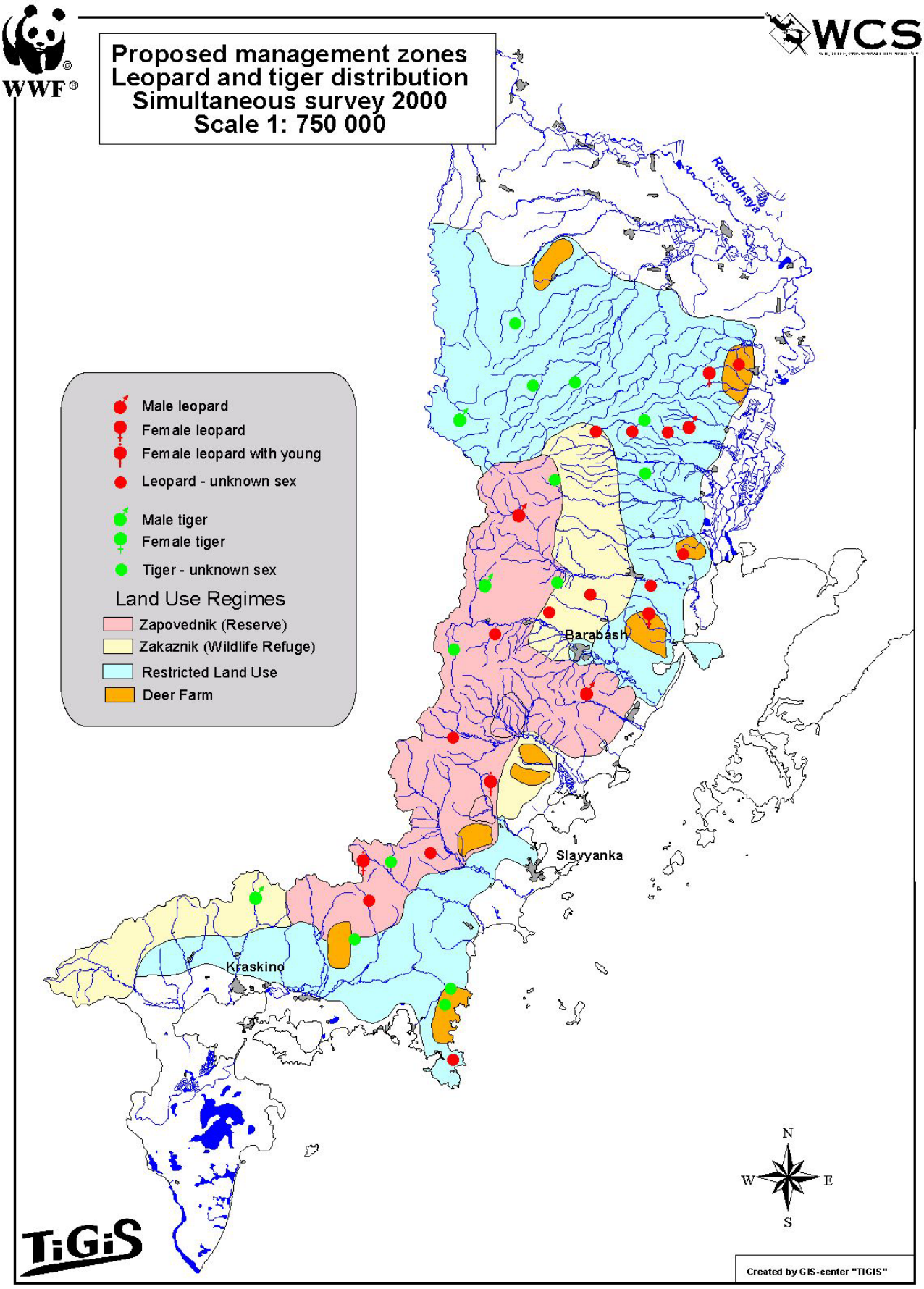

Figure 3. Proposed management zones for leopard and tiger conservation in Southwest Primorski Krai.