REPORT ON THE SINO-RUSSIAN JOINT SURVEY OF FAR EASTERN LEOPARDS AND SIBERIAN TIGERS AND THEIR HABITAT IN THE SINO-RUSSIAN BOUNDARY AREA, EASTERN JILIN PROVINCE, CHINA WINTER 1998

Cooperators:

Jilin Provincial Wildlife Conservation Association, People's Republic of China
Jilin Provincial Department of Forestry, People's Republic of China
Russian Academy of Sciences Far Eastern Branch Institute of Geography, Russia
Hornocker Wildlife Institute, USA

Sponsors:

United Nations Development Project,
Tumen River Area Development Programme
Wildlife Conservation Society, USA

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PREFACE

The Tumen River region is a fascinating mixture of flora, fauna, and cultures. Three countries - China, Russia, and North Korea - share their borders along the river. Across the landscape, there are rich coastal, wetland, and upland ecosystems, abundant with life of an astonishing diversity. The upland forests have attracted particular attention, for everything from their unique assemblage of butterflies to the beautiful black fir forests. But it has been the large cats of this region that have attracted the most attention. Four species of wild cats can be found here: the diminutive Far Eastern wild cat (*Felis euptilura*), the lynx (*Lynx lynx*), the Far Eastern leopard (*Felis pardus orientalis*), and the Amur (also known as the North Chinese or Siberian) tiger (*Felis tigris altaica*). But while the wild cat and lynx are distributed widely elsewhere and secure in numbers, both the Far Eastern leopard and Amur tiger are threatened with extinction.

Russian biologists have been tracking the status of the Amur tiger in the Russian Far East for over 30 years. While the population has recovered from the threat of extinction in the 1940's, renewed poaching and dramatic losses of habitat have again threatened this species in the 1990's. Nowhere is this threat greater than in southwest Primorye Krai, in the Tumen River region.

At the same time that Russian biologists have worried about the fate of tigers and leopards on their side of the border, Chinese specialists had been independently tracking changes in the distribution of leopards and tigers in Jilin Province through a series of surveys starting in the 1970's. Even though specialists on both sides recognized that animals were traveling back and forth across the international boundary, what was happening on "the other side" was a mystery. Both Chinese and Russian biologists separately recognized two facts: a cooperative effort would be necessary to get a clear understanding of the distribution and status of these large cats, and that joint management would be essential if the species were to survive in this region.

The tiger is threatened across its entire range throughout Asia, and this northernmost subspecies, the Amur tiger, is at risk because its requirements for vast tracts of land make it particularly susceptible to habitat fragmentation and consequent loss of genetic diversity. The fact that this subspecies presently is distributed across three countries (Russia, China, North Korea) makes development of a comprehensive management plan particularly problematic.

The Far Eastern leopard is yet more threatened than the Amur tiger. With perhaps no more than 40 individuals in the wild, and poorly represented within the world's captive population, this subspecies must be considered one of the most endangered of all the great cats. More so than the tiger, remaining habitat for this cat resides in the tri-country region surrounding the Tumen River.

Opportunities for cooperation arose in the mid-1990's with a warming of relationships between the two countries. By the time Yeltsin had signed an agreement with Peking to work cooperatively in conservation of the Amur tiger (1997), a series of exchanges had already occurred between Russian and Chinese specialists (most of whom participated in this survey), and a memorandum of agreement had already been drawn up by D. G. Pikunov and S. Yang.

The Tumen River Development Programme, a UNDP-sponsored project, has provided both a threat and opportunity for the large cats of this tri-country region. While the planned development corridor could split the region permanently into separate, fragmented parcels of habitat, permanently rupturing linkages amongst animals across the three countries, early planning and a better understanding of the distribution of these animals may prevent such a loss. Fortunately, the Tumen Secretariat was well aware of the potential impacts of the development program, and has eagerly sought means to assess existing status of the environment in hopes of minimizing the long-term impacts of development.

This survey is a first step in what we hope will be a series of surveys across the tri-country region, leading ultimately to cooperative management of the rich natural ecosystems of the Tumen River Region. Our goals are lofty but necessary: the fate of the Amur tiger and Far Eastern leopard are dependent on decisions that will be made by us in the near future. Hopefully, we will have the vision to make the right decisions.

ACKNOWLEDGMENTS

We wish to thank the United Nations Development Programme, and UNOPS for the support to conduct this survey. In particular the Tumen Secretariat, Ian Davies, has been the pivotal person who made this survey possible by providing an information link between the two countries, securing funding, and guiding us through the labyrinth of bureaucratic procedures necessary to conduct this kind of work. Without his full support, this project would have never happened.

The Wildlife Conservation Society provided additional support, and was ready at key moments to provide necessary assistance to insure that the project moved forward. In particular, Alan Rabinowitz and Josh Ginsberg have been strongly supportive of the effort.

Anatoly Kachur and Petr Baklanov of the Russian Academy of Science's Far Eastern Branch Institute of Geography in Vladivostok provided the necessary administrative support on the Russian side to insure success of the project, and additionally provided advice and insight in working on international efforts.

The Hornocker Wildlife Institute invested substantial amounts of time and effort in seeing this project through, and we are indebted to Howard Quigley, President of that Institute, for the unfailing support.

In China, the list of organizations that provided support is enormous. Jilin Provincial Wildlife Conservation Association, Jilin Provincial Department of Forestry, Hunchun Forestry Bureau, Hunchun City Forestry Bearua, and Yanbian Prefecture Forestry Bureau all provided key support. Supervisors of each Forest District put supplies, support, and their personnel at our disposal, and we thank each of them for their assistance. Our project would have been virtually impossible without their support. The staff of Changbaishan National Reserve provided accommodations and support at the end of our field work, when we summarized the results of our findings.

Executive Summary. An international team of specialists conducted a survey of leopards and tigers in eastern Jilin Province, between February 27 and March 18, 1998. Prior to initiation of field work, an extensive process of questioning local villagers and Forest Service employees about recent observations of tigers and leopards (including depredations, tracks, or visual observations) provided the basis for delineating field routes to be surveyed. A total of 250 km was walked along 32 routes by 3 teams of investigators. Results suggested that at least 4, and as many as 6 tigers may have been present in Jilin Province during the 1997-1998 winter. We found evidence for 4-7 leopards as well. Other reports of tigers and leopards from questionnaires either could not be corroborated, or were from previous years. Results indicated that the majority of tigers and leopards were recorded close to the Russian border, and that nearly all confirmed reports were within Hunchun County, although there were some scattered reports to the west in Wangqing and Antu Counties as well. Resident animals likely occur only along the Russian border. We were unable to confirm that reproduction is occurring in either species, suggesting that neither population is self-sustaining.

The primary obstacle to an increase in populations of tigers and leopards appears to be low densities of prey populations. Tracks of red deer were found on only a few occasions, wild boar densities were higher to the west in Antu County, and sika deer were common only along the Russian border. Roe deer densities were low but occurred across all areas surveyed. Evidence of hares and badgers, suitable prey for leopards, was also scarce. Therefore the highest priority for recovery of tiger and leopard populations is the recovery of prey populations. Hunting has already been banned by the Provincial government, which is an important first step that should be applauded, but by itself is probably insufficient for recovery of prey populations. Wire neck snares, scattered throughout the survey area, are likely depressing prey populations, as well as potentially killing both tigers and leopards.

Despite the dangerously low populations of tigers, leopards, and their prey, there are at least four reasons for optimism. First, there remain extensive tracts of forest lands in northern Hunchun, Wangqing, and Antu Counties that are well managed by the Ministry of Forests, and retain the capacity to harbor good populations of prey species, tigers and leopards. Secondly, although China has a very large human population to care for, human densities adjacent to potential tiger and leopard habitat are not high, and in fact are comparable to regions in nearby Russia that harbor healthy populations of both large cats. Thirdly, there exists sizable populations of tigers, leopards, and their prey in adjacent Russian habitat which could act as a source for animals emigrating into Jilin, thus speeding the recovery process. Finally, there appears to be a sincere desire on the part of the Wildlife Animal Protection Society and the Ministry of Forestry, as well as other branches of the government, to assist in recovery of tiger and leopard populations.

Therefore, we recommend the development of a recovery plan for tigers and leopards that focuses on Hunchun County as a critical first step, and has, as its goal, the re-establishment of a breeding population of leopards and tigers in Jilin Province. As part of the recovery effort it is critical to establish new protected areas for tigers and leopards in Hunchun County. In particular, we recommend that a potential ecological corridor may exist between the three countries (China, Russia, North Korea) along the Tumen River where Russia and North Korea are separated by approximately 10 km. In northern Hunchun there is excellent leopard and tiger habitat along the Russian and Heilongjiang borders, and some portion of this region be included in the proposed Panthera Big Cat international park. If Dalongling, the Russian Border Region, and Panling-Laoyeling can maintain ecological connectivity, and receive adequate protection from hunting and other human pressures, the cumulative amount of suitable habitat for leopards and tigers in this Chinese-southwest Primorye (Russian) region can be essentially doubled, greatly increasing the probability of survival of both populations.

1. INTRODUCTION

Natural ecosystems, and the species which depend on those ecosystems, are being lost at a rapid rate due to development, high human densities, and extraction of natural resources. Large mammalian carnivores are particularly vulnerable to loss of large, intact ecosystems because of their large land requirements and their position at the top of the trophic chain - any impact in an ecosystem can have "ripple" effects that can seriously impact predator species.

The forests of Northeast China and Far East Russia hold two of the most magnificent mammalian carnivores on earth: the Amur (Siberian, or North China) tiger (*Panthera tigris altaica*) and the Far Eastern leopard (*Panthera pardus orientalis*). Once dominant figures across the landscape, both species are now threatened with extinction. While there are approximately 330-371 adult Amur tigers in Far East Russia (Matyushkin et al. 1996), in 1996 it was estimated that perhaps 12 tigers lived in Northeast China (Ma and Li 1996). More detailed information across different regions of Jilin Province China are based on a series of surveys: in 1976, 4 tigers were found in Shanhe of Chunhua; in 1982 6 tigers were reported in Chunhua, Madida, Yangpao and Liangshui (North Eastern Forestry University); in 1983, 4 animals were identified by the Hunchun Forestry Bureau; and in 1992 3-5 tigers were reported by the Jilin Provincial Wildlife Survey Team based on a survey of local citizens. No tigers have been reported in Changbaishan Reserve, perhaps the best known protected area in Jilin Province, since 1991. With the exception of a few animals that may remain in North Korea, the combined populations in China and Russia represent the last stronghold for this unique subspecies of tiger.

The Far Eastern leopard is even more endangered than the tiger. There are an estimated 25-30 remaining in the southwest corner of the Russian Province Primorye, and this population appears to have been fairly stable since the 1980's (Korkisko and Pikunov 1994). In Jilin Province, numbers of leopards have decreased over the past 25 years: in a 1976-1977 survey 45 leopards were reported; in 1982-1983, 30 were identified, and in 1991, there were an estimated 15 (Xingjia Yang and Jinsong Jiang 1996). Their range has also decreased, with leopards largely eliminated from southwest Jilin, and remaining individuals are found mostly in the north and eastern regions bordering Russia and Heilongjiang Province. There may also be leopards in Heilongjiang Province, China, and in North Korea, but numbers are unknown.

Presently, some of the best remaining habitat for both leopards and tigers occurs along the international border between China and Russia (Figure 1). The entire range of the remaining Far Eastern leopard population in Russia is located here in southwest Primorye opposite Hunchun County in Jilin. Amur tigers have always inhabited southwest Primorye, but numbers have never been high. In 1970, 3 individuals were recorded (Yudakov and Nikolaev 1973); in 1979, 2 individuals; in 1984-85, 8 individuals (Pikunov 1990); and in 1995-1996, 6 individuals (Matyushkin et al. 1996). Three protected areas in Russia (Kedrovya Pad Zapovednik, Barsovy Zakaznik, and the newly gazetted Borisovkoe Plateau Zakaznik) provide good protection to habitat and prey populations. On the Chinese side, although there is intensive development surrounding Hunchun and within the Hunchun river valley (including the Xiaoxi'nancha gold mines), there are relatively few villages on the eastern side of Hunchun River along the tributaries draining the Russian border. However, populations of both tigers and leopards on both sides of this border are precariously low and in endanger of extinction. This fragmented habitat has been virtually cut off from the main block of habitat in the Sikhote-Alin Mountain Range of Russia by development over the past 50 years.

Effective efforts at conserving these two large cat species will be dependent on accurate information on their status and distribution, as well as cooperative, visionary international conservation plans that include China and Russia, as well as North Korea. Thus the two primary objectives of our survey were to provide an accurate assessment of tigers and leopards, their habitat, and potential prey existing in Jilin Province, China, as a basis for making management recommendations. Secondarily, the survey will hopefully act as a catalyst in bringing interested

parties from Russia and China together to begin the process of developing cooperative management plans.

2. PROJECT BACKGROUND

A recently developed international recovery plan for Far Eastern leopards identified the need for cooperative efforts between China and Russia (Miquelle, Arzhanova, and Solkin 1996). A separate international planning team consisting of Chinese, Russian, and Americans recently developed a land-use plan for the Ussuri Basin (Anonymous 1996). One of the recommendations included the creation of two international protected areas for large carnivores. One of these proposed protected areas: “The Big Cat (Panthera) International Park and Wildlife Refuge,” includes 485,600 ha on the Russian side, and 487,100 ha in Heilongjiang Province on the Chinese side. Parts of Jilin Province may be suitable for inclusion as well, and were tentatively included in the plan. Russia has, on its part, initiated the plan by creating, in 1996, a Krai-level (Provincial) protected area, Borisovkoe Plateau Zakaznik (wildlife refuge).

At the tri-national boundaries of China, North Korea, and Russia, there is intense interest in the Tumen River Development Program, which is a UNDP-sponsored program to further international economic interests and ties in the region. While economic development of this region is likely to benefit the welfare of the local citizens of all countries, its potential impact on coastal, wetland, and upland environments is of great concern. Tigers and leopards are dependent on intact, upland ecosystems that are linked to form extensive tracts of suitable habitat. Viable populations of both species require not only vast tracts of land, but the capacity for individuals and genetic material to be exchanged between sub-populations. Development programs such as that proposed for the Tumen River Region have the capacity to destroy large segments of habitat, or fragment the remaining habitat into isolated units. Individuals animals remaining in those isolated habitat units are extremely susceptible to extinction due to the effects of genetic loss, inbreeding, and random effects on small populations. Localized, gradual loss of individuals from each patch leads eventually to extinction of the species.

Accurate information on status of these species is a critical first step towards conservation planning that may mitigate the potential impact of development. Momentum for initiation of this survey was the result of a number of interactions between Russian and Chinese specialists, equally concerned about the status of tigers and leopards on adjacent territories. In February of 1996, Chinese specialists were invited to visit Russia and assist in an investigation of tigers. At this time, both sides agreed informally to initiate a cooperative survey of tigers and leopards in China. A more thorough discussion on potential collaborative efforts came during the International Conference for developing a recovery plan for Far Eastern Leopards, held in Vladivostok in October 1996. In August 1997, a proposal compiled by Russian and Chinese scientists was supported by UNDP/TRADP, leading to the signing of a "Memorandum of Agreement" for survey work in Jilin between Jilin Provincial Wildlife Conservation Association and the UNDP/TRADP, and an analogous agreement between UNDP/TRADP and the Russian Academy of Sciences Far Eastern Branch Institute of Geography. Planning continued through the winter of 1998 until the Russian/American component of the field team crossed the border into Jilin on February 27, 1998.

3. GOALS AND OBJECTIVES

A survey of tigers and leopards in the eastern portion of Jilin Province was initiated with the goal of determining numbers and distribution of each species, as a first step in developing conservation programs. The ultimate goal is the conservation of tigers and leopards in Jilin Province, which will likely require an international cooperative effort. Remaining leopard habitat is extremely limited, and conservation of Far Eastern leopards will require efforts that span the tri-country, Tumen River Region. Tiger numbers are extremely low in southwest Primorye, and localized extinction of this sub-population is highly probable in this habitat fragment without a united effort to increase the amount of suitable habitat and create ecological corridors amongst the three countries.

The objectives of this survey, therefore, were the following:

1. Describe the distribution of tigers and leopards in eastern Jilin Province.
2. Estimate the minimum number of tigers and leopards in eastern Jilin Province.
3. Assess the status of prey for tigers and leopards in eastern Jilin Province.
4. Assess the status and amount of suitable habitat for tigers and leopards in eastern Jilin Province.
5. Define the potential for ecological corridors both among countries (Russia, China, and North Korea) and within Jilin Province to insure the long-term survival of tigers and leopards in eastern Jilin Province and the tri-country area.
6. Determine the potential for development of protected areas both along the international borders, and within Jilin Province.
7. Make recommendations to improve conditions, increase the population size, and develop a breeding nucleus of tigers and leopards in Jilin Province.

4. SURVEY AREA

4.1 Natural Environment

4.1.1 Geographic Location. The survey focused on the eastern portion of Jilin Province, China, near the borders of Russia and North Korea (Figure 1). Within Jilin, focus was primarily on Hunchun County (Figure 4), Yanbian Korean Autonomous Prefecture, within the geographical coordinates of 129^{o} 52'E - 131^{o} 18'E and 42^{o} 25' N - 43^{o} 29' N (Figure 4). This region represents the merger point of 3 nations: North Korea borders Jilin Province for 139 km to the southeast, and Russia shares a border with Jilin for 233 km. Heilongjiang Province borders the study area to the north (Figure 1).

A second survey site, Haerbaling, was located further to the west, at the merger points of Antu County, Dunhua County, Wangqing County, and Yanji City township (Figure 4). This region, over 100 kilometers west of Hunchun city, also contained suitable tiger and leopard habitat, as well as reports of large cat activity. Our survey routes were confined to two Forest Districts (Antu Forest Bureau, and Jingheyuan Forest District) that were adjacent to each other. This region was centered within the geographic coordinates of 129^{o} 00'E - 129^{o} 20'E and 43^{o} 19' N - 43^{o} 30' N.

4.1.2 Subdivision of study area into distribution regions. To better define distribution of leopards and tigers, as well as densities of prey species, the survey area was subdivided into 5 distribution regions. This main study area, centered in Hunchun County, was divided into 4 regions, based on geographic parameters and political boundaries to provide a more refined assessment of tiger, leopard, and prey across the entire area (Figure 4). Haerbaling represented the fifth geographic region (Figure 3). All five regions combined totaled 5,162 km^{2}.

I. The Dalongling Region includes the northernmost, upper portions of the Hunchun River Basin, bordered to the north by Heilongjiang Province, to the west by the Dalongling ridge, and to the east by the Russian border (Figure 4). Total area is roughly 940 km^2. Forest types within Dalongling are primarily mixed conifer and broad-leaved forests. There still remain primary fir and spruce forests at high elevations (1,000 m) along the border of Jilin and Heilongjiang.

II. The Russian Border Region is a narrow band of habitat stretching from the east side of the Hunchun River to the Russian border, an area covering approximately 1,000 km^2 (Figures 2 and 3). Mixed broad-leaved forests and secondary oak forests are the main habitat types in this region.

III. The Tumen River Lower Basin Region includes the area from the confluence of the Hunchun and Tumen Rivers in the west to the Chinese-Russian-North Korean border near the mouth of the Tumen River (Figure 4). This narrow band of habitat, approximately 500 km^2, is generally less than 10 km wide, with Russia marking the northern border, and North Korea the southern border. The basin is mainly composed of wetlands, swamps, and farmlands, but towards its northwestern end (near Dapanling) there is mountainous terrain that provides a continuous forest cover from the Russian to North Korean borders. Where forests occur, they are predominantly oak.

IV. The Panling-Laoyeling Region includes the Panling and Laoyeling massifs, a large range of mountains due north of Hunchun city (Figure 4). The total area includes about 1974 km^2. The area is predominately mixed conifer, broad-leaved forest, and secondary oak-forests. In 1981, the Jilin Department of Forestry gazetted the Laoyeling Rare and Endangered Wildlife Protection Zone, which protects all wildlife from hunting.

V. The Haerbaling Region is located at intersection area of Dunhua, Antu, and Wangqing Counties and Yanji city (Figure 4). Total area of this region is 748 km^2. Forested habitat is relatively high, averaging approximately 1000 m, and includes fir, spruce, mixed conifer, and broad-leaved forests.

4.1.3 Topography. The survey area is part of the middle and lower regions of Changbaishan Mountainous Region. The area is more mountainous with higher elevations to the north, while in the south there is a more undulating topography. Laoyeling Peak within the Laoyeling Range is the highest mountain in the region at 1,477 m, while the lowest point (5 m) is Fangchuan village in Jingxin township, in the southeastern corner of Hunchun County along the Tumen River.

4.1.4 Climate. This region is characterized as having a temperate, oceanic, monsoon climate. Annual mean temperature is 5.6^o C, mean temperature in January is 11.8^o C, mean temperature in July is 20.2^o C. The yearly mean precipitation is 607 mm. The frost-free season averages 145.6 days.

4.1.5 River System. The survey region is located within the lower reaches of the Tumen River. The river flows for a total of 140 km within Hunchun County. There are 370 tributaries within the Tumen River System within Hunchun County. Hunchun River, at 187 km, is the longest of the 5 main tributaries within the region.

4.1.6 Soils. The soils of the mountainous area in northeast Jilin are mainly dark brown forest soil. In the middle plains and surrounded hill areas there are primarily bog soils, Baijiang soils and alluvial soils.

4.1.7 Vegetation. Vegetation within the study area is considered representative of Changbaishan flora. The main conifer species in mountainous, high elevation

Figure 1. Location of study area (enclosed in box) in eastern Jilin Province, China

Fig. 2.1. View of oak forests (with clearcut) in Russian Border Region

Fig. 2.2. Field investigation in the snow

Fig. 2.3. Setting up transect route on map

Fig. 2.4. Chinese and Russian specialists measuring foot tracks of tiger

areas are Korean pine (*Pinus koraiensis*), Jeddo spruce (*Picea jezoensis*), and fir (*Abies nephrolepis*). The main broad-leaved trees are Manchurian ash (*Fraxinus mandshurica*), walnut (*Juglans regia*), Mongolian oak (*Quercus mongolica*), Japanese elm (*Ulmus propingua*), two birch species (*Betula platyphylla* and *B. costata*) and Cathay poplar (*Populus cathayana*). The predominant forests are either broad-leaved, or mixed conifer- broadleaved forests. In the lower hill areas, secondary oak-forests are dominant (Figure 2). Undergrowth species include hazelnut (*Corylus mandshurica*), and Japanese honeysuckle (*Lonicera japonica*), while the most common herbs are horsetails (*Equisetum hiemale*), sedges (*Carex* spp.) and ferns (*Pteridium revolutum*).

4.1.8 Wildlife. Fifty-one species of mammals belonging to 17 families and 7 orders have been identified within the region. Some of the large mammalian species include, in addition to the Amur tiger and Far Eastern leopard, the Far Eastern wild cat (*Felis euptilera*), lynx (*Lynx lynx*), Himalayan black bear (*Ursus thibetanus*), sika deer (*Cervus nippon*), roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*), wild boar (*Sus scrofa*), Manchurian hare (*Lepus mandshuricus*), and a variety of mustelids, including badgers (*Meles meles*), yellow-throated martins (*Martes flavigula*), Siberian weasel (*Mustela sibirica*), and mink (*Mustela vison*). A total of 227 species of birds representing 42 families and 16 orders have been reported in the study area, as well as 8 species of reptiles and 4 species of amphibians.

4.2 Social and Economic Conditions

4.2.1 Historical Changes and Development. In 1881 the Qing government initiated a policy of emigration to strengthen boundary areas, resulting in many Chinese citizens from interior China and of Korean nationality moving into and developing the region. During the Japanese occupation (starting in 1937), intensive harvest of forest lands resulted in development of secondary oak forests on many northern exposures, and secondary mixed broad-leaved forests on southern exposures. Currently, forest lands cover 76.5% of the region, and the standing biomass amounts to 51,280,000 m^3.

4.2.2 Industry and Agriculture. Nine types of industries in the region (with mining and chemistry most important) are represented by 149 industrial enterprises that employ 19,000 workers. The total gross value production in 1991 was 35.5 million Yuan (RMB). The mining industry focuses on coal, gold and granite. The main manufactured products are ceramics, furniture, liquors, paper, and cement.

Currently farmlands (246,000 ha) are cultivated by 82,000 agricultural workers. The main crops are rice, corn and soybean. Total agriculture gross value production was 12 million Yuan (RMB) in 1991.

4.2.3 Hunting. Hunting has historically been restricted by the government. Traditional hunting methods, including muskets, neck and foot snares, are still in use, although there some changes. After enactment of China's wildlife conservation law (March 1, 1989), the Standing Committee of the People's Congress of Jilin Province initiated a "Resolution for a five-year ban on hunting in Jilin". Hunting is presently illegal throughout Jilin Province until 2000.

4.2.4 Human population. Over 175,000 people live within the survey area, with people of Korean origin representing the dominant ethnic group (50.1%), following by Han nationalities. Most of these people live in the city of Hunchun and nearby vicinities, but small villages are scattered throughout the region along river bottoms.

5. METHODS

Because it was impossible to survey all potential habitat of tigers and leopards during the field portion of this study, a two-stage process was developed to identify those regions where there was a high probability of encountering sign of tigers or leopards. During the first stage large numbers of local people were interviewed to gather general information on tiger and leopard distribution. While not all information collected from interviews can be corroborated, information on encounters or sign of large carnivores served to focus attention of those regions where indications of carnivore activity were greater, or where information appeared more reliable. Field survey routes were then focused in those regions where there was a high probability of encountering signs of tiger or leopards.

5.1 Interviews of local citizens

Local people were selected for interviews based on their knowledge of wildlife or forest resources. Interviewees included wildlife management officials in the local government, forestry policy personnel, archivists, forest guards, hunters and local citizens who use the forest resources.

Information on tigers or leopards during or after 1995 were of primary interest during interviews. Five categories of information were collected during interviews:

1. Background information on interviewees: name, gender, age, occupation, education, and address;
2. Information on occurrence of tigers or leopards: type of information (visual sighting, tracks, other evidence), time, location, events associated with sighting;
3. Livestock depredation: type of livestock, number, sex, mortality (or wounding), and type of wounds incurred by livestock.
4. Encounters with people: name of person in encounter, age of person, explanation of incident, extent of wounds (if any).
5. Description of tiger and leopard habitat where sightings occurred: geographic coordinates, altitude, gradient, aspect; tree species, forest age, canopy density; prey resources, including roe deer, red deer, sika deer, and wild boar;

5.2 Field Survey Routes

5.2.1 Route selection, adjustments in the field, and route length. Survey areas were identified on the basis of information collected from interviews across the study area. In regions where tiger or leopard sign had recently been recorded (1997-1998), one or more survey routes were placed. Location of routes was based on topography, administrative boundaries, landscape patterns, ease of access, and habitat characteristics. Twenty-three survey routes were situated in Hunchun County, 3 survey routes in Wangqing, 3 survey routes in Antu, and 3 survey routes in Dunhua (Figure 4, Table 1). Distribution of survey routes within distribution regions for leopards and tigers was as follows: 9 routes in Dalongling Region, 8 in Russian border Region, 6 in Panling-Laoyeling Region, 3 in Tumen River Region, and 6 in Haerbaling Region (Table 1).

Three groups worked simultaneously in the field, each being assigned a separate route each day. Each group was equipped with a 4 wheel-drive vehicle, an interpreter, and a local, experienced guide who had specific knowledge of the region. Usually each group consisted of 4 people: at least one Chinese specialist, one Russian (or American) specialist, an interpreter, and a guide. Each group was supplied with topographic maps (scale 1:100,000), with the proposed route laid out, a GPS (Geographic Positioning System), and a radio to maintain

Table 1. Location and description of field routes for survey of leopards and tigers in eastern Jilin Province, China, in the 1998 winter.

	Route #	Date dd.mm.yy	Location (Nearby villages, townships or Forest Districts)	County	Distribution Region	Route Length (km)	Geographic Coordinates of Starting Points Y	Geographic Coordinates of Starting Points X	Altitude (m)	Dominant Forest Types
1	4-1	28.02.98	Naozhi, Madida	Hunchun	Border	6	42° 53' 41.8" N	130° 54' 12.7" E	200-300	Oak
2	4-2	28.02.98	Shanhe, Hadamen Forest District	Hunchun	Panling	2	43° 03' 26.4" N	130° 32' 55.4" E	155-300	Mixed
3	2-1	01.03.98	Yantonglazi, Yangpao	Hunchun	Border	10	42° 51' 48.0" N	130° 39' 58.7" E	220-550	Mature oak
4	2-2	01.03.98	Songlin, Yangpao	Hunchun	Border	7	42° 51' 20.6" N	130° 35' 58.5" E	255-485	Mature oak
5	2-3	01.03.98	Yantonglazi, Yangpao	Hunchun	Border	8	42° 54' 44.8" N	130° 39' 12.5" E	155-225	Secondary broad-leaved
6	3-1	02.03.98	Hulubienangou, Madida	Hunchun	Border	6	42° 52' 23.2" N	130° 46' 06.9" E	350-700	Oak
7	3-2	02.03.98	Xiboicha, Sando Forest District	Hunchun	Panling	8	43° 06' 17" N	130° 44' 25.4" E	300-980	Mixed conifer/broadleaved
8	3-3	02.03.98	Huangbaishudonggou, Haidong	Hunchun	Border	9	43° 02' 09.6" N	130° 59' 39.6" E	115-400	Secondary forest
9	1-1	03.03.98	Zhanggugeng, Fangchuan Jingxin	Hunchun	Tumen	3	42° 26' 28.1" N	130° 35' 37.4" E	20-80	Oak
10	1-2	03.03.98	Shuilinfeng, Fangchuan, Jingxin	Hunchun	Tumen	8	42° 33' 18.4" N	130° 33' 52.7" E	65-415	Oak
11	1-3	03.03.98	Xiaopanling, Daduchuan	Hunchun	Tumen	10	42° 41' 12.1" N	130° 24' 27.1" E	110-670	Natural Oak, lowland
12	8-1	05.03.98	Sicha, Qinglongtai, Chunhua	Hunchun	Dalongling	9	43° 25' 01.3" N	131° 13' 48.9" E	570-580	Mixed conifer/broadleaved
13	8-2	05.03.98	Banfang, Qinglongrai, Chunhua	Hunchun	Dalongling	7	43° 22' 12.9" N	131° 15' 21.5" E	485-745	Mature broadleaved
14	8-3	05.03.98	Xiacaomaodongou, Chunhua	Hunchun	Dalongling	14	43° 15' 20.2" N	131° 13' 38.6" E	340-750	Mixed mature conifer
15	9-1	06.03.98	Lanjiantangzi, Chunhua	Hunchun	Dalongling	7	43° 23' 56.8" N	131° 08' 44.3" E	550-680	Mixed mature conifer
16	9-2	06.03.98	Lanjiantangzi, Chunhua	Hunchun	Dalongling	5	43° 23' 15.0" N	131° 03' 17.5" E	465-570	Mixed mature conifer
17	9-3	06.03.98	Liuguisonggou, Lanjia, Chunhua	Hunchun	Dalongling	12.5	43° 23' 12.1" N	131° 03' 31.3" E	330-780	Mature broadleaved
18	7-1	07.03.98	Lishugou, Chunhua	Hunchun	Border	10	43° 05' 01.4" N	131° 06' 52.7" E	370-615	Broadleaved
19	7-2	07.03.98	Dadonggou, Chunhua	Hunchun	Border	7	43° 07' 12.1" N	131° 04' 25.3" E	125-755	Mixed conifer/broadleaved
20	7-3	07.03.98	Houtunzigou, Beimenzi, Chunhua	Hunchun	Dalongling	15	43° 16' 56.1" N	131° 03' 06.8" E	340-825	Mixed conifer/broadleaved
21	10-1	08.03.98	Taipinggou, Chunhua	Hunchun	Dalongling	8	43° 15' 48.5" N	131° 0' 12.1" E	240-725	Oak
22	10-2	08.03.98	Chaoyaggou, Chunhua	Hunchun	Dalongling	6		130° 56' 57.4" E	300-505	Broad-leaved
23	10-3	08.03.98	Taipingchuan, Chunhua	Hunchun	Panling	10	43° 18' 25.9" N	131° 57' 50.6" E	170-795	Mixed conifer/broadleaved
24	13-1	10.03.98	Qingniwa, Lanxi Forest District	Wangqing	Panling	6	43° 27' 11.5" N	130° 58' 18.7" E	615-780	Mature mixed
25	6-2	10.03.98	Dongbeigou, Dahuang	Wangqing	Panling	5	43° 09' 38.6" N	130° 27' 41.3" E	495-800	Mixed conifer/broadleaved
26	12-1	10.03.98	Duhuangzi	Wangqing	Panling	6	43° 15' 18.3" N	130° 35' 46.8" E	650-890	Mixed conifer/broadleaved
27	15-3	12.03.98	Qinggouzi, Sandao Forest District	Antu	Haerbaling	10	43° 11' 10.2" N	129° 13' 42.7" E	400-605	Mixed, oak
28	15-2	12.03.98	Huangbatougon, Tuntian, Antu Forest Bur.	Antu	Haerbaling	7	43° 21' 58.0" N	129° 12' 28.6" E	580-1080	Mixed conifer/broadleaved
29	15-1	12.03.98	Wangtanggou, Tunian, Antu For.	Antu	Haerbaling	12	43° 23' 20.0" N	129° 14' 42.0" E	610-865	Broad-leaved
30	16-1	13.03.98	Xioqinggou, Jiangheyuan, Dashitou Forest Bureau	Dunhua	Haerbaling	6	43° 23' 53.6" N	129° 08' 36.8" E	910	Mixed conifers
31	16-2	13.03.98	Beigou, Jiangheyuan Forest Dist.	Dunhua	Haerbaling	5	43° 30' 46.2" N	129° 01' 25.2" E	495-940	Mixed conifer/broadleaved
32	16-3	13.03.98	Dongnancha, Jiangheyuan Forest Dist.	Dunhua	Haerbaling	6	43° 24' 16.2" N	129° 10' 01.8" E	800-990	Mixed conifer/broadleaved

contact with the driver or nearby groups. The GPS was used to record beginning and endpoints as well as locations along the route (usually about every 30 minutes), to estimate route length, and to record position of tiger/leopard sign.

Planned routes were mapped (1:100,000 scale) prior to initiation of fieldwork. Once in the field, planned routes were adjusted dependent on relief, distribution of snow, and landscape features to increase the probability of encountering tiger, leopard, and ungulate tracks. Survey routes were often taken along bottomlands or frozen rivers and creeks (where tracks would still be present), on old logging roads or paths (human and animal), on ridges or divides that are natural animal pathways, along edges of snowfields, and more rarely on northern exposed slopes (where the most snow still laid, but frozen, crusty conditions hindered animal movement). Southern exposures, where snow was generally absent, were usually avoided.

Route length was generally planned to provide a full day of walking, adjusted for travel time to and from starting points. We recorded route length as the actual distance walked, which provided a basis for estimating encounter rates with tiger and leopard sign, as well as prey. However, during travel time in vehicles we also attempted to search for sign (especially where rough roads demanded slow speeds) and to assess habitat characteristics. Estimates of these travel distances are more difficult, but nonetheless were valuable in assessing habitat status.

5.2.2 Data collection for tigers and leopards. Where tracks or sign of tigers or leopards were found, the following data were collected: location (recorded from GPS), width of the pad on the front paw; length and width of the entire paw; direction of travel, estimated age of track (data of passage), and a photo was taken of tracks. Other signs of predators were also recorded, including scrapes, scentmarks, remains of kills (usually depredation kills), beds, or excrement. Width and length of scrapes were recorded to aid in determining species identification. Excrement was collected as reference material, and a small portion was preserved for potential future genetic analyses (Figure 3).

The minimum number of tigers and leopards in the survey region was estimated primarily on the basis of information collected during the field survey. Tracks or other sign in close proximity to each other were considered to be representative of a single individual. During field surveys we attempted to verify information collected during interviews, and, where this information was found to be reliable, it was included in assessing distribution and numbers of tigers or leopards. However, with one exception, information from interviews that were considered highly reliable, but where either a survey team did not work or where a survey team could find no evidence, was reported as “unverifiable”. Estimates of tigers and leopards are presented as a range of values that reflects the inherent uncertainty of trying to discern number of individuals based on track/sign data of varying ages and conditions.

Distribution of leopards and tigers was based on information provided from both interviews and the field survey. Interview information, though less reliable, can provide a general indication of where tiger/leopard sign is being most frequently reported, and can provide an indication of which areas deserve more detailed assessments in the future.

5.2.3 Habitat Suitability. Assessment of habitat quality is important for evaluating conditions for tigers and leopards. Quality habitat should contain characteristics for both prey species and predators. The existence of an adequate prey base was the primary criteria for defining habitat quality for predators, and ultimately, defines the number of predators that can occur in a region. Also included in the assessment were the following habitat characteristics: forest type, forest condition, and extent of anthropogenic disturbances. Anthropogenic impact

on potential tiger and leopard habitat were evaluated with the following criteria: human density in the region, the extent of forest use for commercial (logging) and personal use (hunting, plant collection, etc.), intensity, extent, and type of logging, density of roads and location and number of snares set by poachers to catch wild ungulates and large predators. An assessment of tiger and leopard distribution in five defined regions (section 4.1.8) was determined on the basis of information collected from questionnaires, field survey routes, estimates of prey densities, and habitat assessment.

5.2.4 Prey Assessment. The assessment of prey resources for tigers and leopards along survey routes included all wild ungulate species (sika deer, roe deer, wild boar, red deer, musk deer), hare, badgers, and bears. Three indicators were used to assess prey:

1. Estimate of presence/absence along survey routes. Signs indicating the presence of prey species - tracks, scats, remains of kills, trails and dens of badgers and bears - provided positive evidence of a species presence in the area. Information from guides and employees of local Forest Districts provided additional information. We reported results as: *absent* - no evidence of species; *rare* - tracks or evidence found, but usually only one or a few over an entire region; *present* - tracks and other evidence found in larger numbers. This estimate was applied over entire distribution regions (see section 4.1.2, but not to specific survey routes).

2. Relative abundance of tracks. Number of tracks encountered along a route were recorded for each species, and presented as number of tracks/km. This data provides only a crude estimate of relative abundance because many tracks were very old, and varying portions of each route were devoid of snow. Therefore, this information was summarized into five categories: 1) 0 - no tracks found; 2) very low - 1-3 tracks found within entire distribution region (used only for distribution regions); 3) <3 tracks/km (low abundance); 4) 4-10 tracks/km (moderate abundance); 5) >10 tracks/km (high abundance). A medium value was derived for each distribution region.

3. Expert estimate of density. An estimate of prey density was derived from three estimates: the number of individuals of each species that crossed the survey route (estimated from the number of track crossings), an estimate of the area surveyed along a route, and an extrapolation to the number of individuals within the survey area. The estimate of area surveyed was based on an assessment of local conditions (relief, anthropogenic influences, status of snow, especially crusted snow, quantity of forage, etc.) and knowledge of each species ecology (size of home range, daily travel distance, and food habits). We present the average value across all survey routes within each distribution region.

Results were divided into 5 geographic regions, as defined in section 4.1.8.

6. RESULTS

6.1 Interviews

More than 80 people were interviewed in the survey study area, resulting in 40 accounts of tigers (Table 2) and 15 accounts of leopards (Table 3). Half of the reports on tigers were from 1997 or 1998, and the large majority (80%) were within the last five years (1994-1998). For leopards, 8 interviews (53%) recorded evidence from 1997 or 1998, and 10 (67%) from the past five years. Though there were considerably more records of tigers than leopards, the difference may reflect a difference nor of relative abundance, but rather

Table 2. Information gathered from interviews of local citizens on tigers in eastern Jilin Province, and associated survey routes traveled for verification.

	Person Interviewed				Information on tigers			
			Location of home					
No.	Name	Occupation	Village	County	Date of Observation	Location of Observation	Type of Information	Survey route
1	Huang Wuzhan	farmer	Fangchun, Jingxin	Hunchun	mid Dec. 1996	Fangian	tracks and hair	1-1
2	Jin Yungao	farmer	Fangchun, Jingxin	Hunchun	end Dec. 1996	Jingxin	wounded by tiger 10 days after #1	1-1
3	Jin Yonglong	farmer	Quanhe, Jingxin	Hunchun	end May 1995	Judaopao livestock farm	wounded cow	1-2
4	Jin Zhongfu	farmer	Quanhe, Jingxin	Hunchun	May 1994	Douggou, Qianhe	6 cattle killed; 3 visual sightings	1-2
5	Piao Fongi	head farmer	Dadachun, Jingxin	Hunchun	Oct. 26, 1997	in village	killed cow, tracks to and from shed	
6	Jiang Honglin	wildlife manager	Huchun Forest Bureau	Hunchun	1995	10th boundary stone, Maozigou	tiger found dead in trap trapped tiger also reported in 1989	2-1
7	Taiguotian	farmer	Songlin, Yangpao	Hunchun	early Feb. 1998	Hounan, Maozigou	tracks reported every year	2-2
8	Yan Changji	head farmer	Yaofonglazi, Yangpao	Hunchun	Oct. 97, Jan 98	Liushugou	tracks, depredation reported before 1990's	2-3
9	Jin Chengiun	resource manager	Sandaogou Forest Dist.	Hunchun	Nov. 1997	Xibeigou, Madida	tracks, reportedly hunts cattle	3-1
10	Cai Chenyu	head farmer	Hedong, Madida	Hunchun	summer 1997	Huangbaishugou	bloody track, reportedly hunts cattle	3-3
11	Cui Chenghi	farmer	Naozigou, Madida	Hunchun	Jan. 15, 1998	Naozigou, Madida	visual sighting in fall 1997	4-1
12	Mr. Jin	farmer	Naozigou, Madida	Hunchun	Feb. 24, 1998	Naozigou, Madida	tracks, larger than #11	4-1
13	Jin Chengiun	resource manager	Sandaogou Forest Dist.	Hunchun	summer 1997	Tazigou, Madida	wounded 2 cows	4-1
14	Jin Yingquan	director	Hunchun Forest Bureau	Hunchun	Jan. 27, 1998	Duanmugou, Heshaon	tracks, bed, remains of cow	4-2, 4-3
15	Oui Jinghao	farmer	Dajuaoggou forest Dist.	Wangqing	end Jan. 1998	Dahuanggou Forest Dist.	saw tracks 3 times in 10 days	6-2
16a	Liu Ruguo	farmer	Chunhua	Hunchun	fall 1995	Husixingdong, Chunhua	tracks	7-1
16b	Liu Ruguo	farmer	Chunhua	Hunchun	spring 1996	Laohudeng, Lishugou	heard roar and saw tracks in morning	7-1
17	Liu Quanjun	farmer	Xiasaomao, Chunhua	Hunchun	1995-1996	Nanshao, Qinguwagou	killed a cow	8-1, 8-2
18	Xiao Xuehun	worker	Bangang, Chunhua	Hunchun	Feb 15-17, 1998	Qinglongwadonggou	tracks	8-1, 8-2
19	Wang Shiyou	farmer	Shangsaomao, Chunhua	Hunchun	May 1994	Qinglongwadonggou	tracks common, person wounded by tiger	8-1, 8-2
20	Sun Yuonghui	farmer	Xiasaomao, Chunhua	Hunchun	fal 1997	Xiaodenggou	tracks, cow killed in March 1994	8-3
21	Mr. Yang	farmer	Xiasaomao, Chunhua	Hunchun	1996-1997	300 m east of village	tracks, cattle killed before 1994	8-3
22	Liu Quanjun	farmer	Xiasaomao, Chunhua	Hunchun	June 1997	5 km from village	sister saw tiger when gathering herbs	8-3
23	Xiao Xuehun	farmer	Lanjiastangzi, Chunhua	Hunchun	Nov. 1997	Guchenghan	tracks and bed, pig wounded in 1994	9-1
24	An Tailog	head farmer	Chunhua Forest Dist.	Hunchun	Nov. 11 1998	Shuanglazi	tracks	
25	Liang Songji	farmer	Taiping, Chunhua	Hunchun	May-Jun 1997	Sifunglingzi	cow killed, beds of adult and two cubs	10-1
26	Guan Peisong	driver	Wangqing Forest Bureau	Wangqing	Feb 1994	Quxianqiao	visual sighting, horse killed in 1994	13-1
27	Wang Jiangao	technican	Tuntian Forest Dist.	Antu	Nov. 1991	Wangtangzigou, Yuangou	tracks	15-1
28	Wang Jiangao	technican	Tuntian Forest Dist.	Antu	winter 1991	Zhangbatogou	"light eyes" seen every night	15-2

Table 2 continued.

	Person Interviewed				Information on tigers			
			Location of home		Date of	Location of	Type of	Survey
No.	Name	Occupation	Village	County	Observation	Observation	Information	route
29	Kang Shiquan	farmer	Dongbeisun, Changing	Antu	Oct. 1994	Xiaolishugou, Dalazigou	visual sighting and collected scat	
30	Di Qiang	forest officer	Dashitou Forest Dist.	Dunhua	Oct. 1996	Yizhila, Shaheyuan For.	track	16-1
31	Huang Shufang	forest officer	Dashitou Forest Dist.	Dunhua	Feb. 1997	Dashitou Forest Bureau	track	16-1
32	Wu Zhigang	specialist	Changchun	Chungchun	April 1991	Huilongfeng	2 tracks from North Korea	
33	Jin Yonzhe	farmer	Chaoyang, Jingxin	Hunchun	Oct. 1994	Hanshinangou	1 cow wounded	
34	Yan Changji	head farmer	Yantonglazi, Yangpao	Hunchun	Aug 1989	Yantonglazixigou	2 cattle wounded	
35	Jin Yongjun	forest officer	Sandaogou Forest Dist.	Hunchun	Aug. 1997	Guandagou, Xiaojiebeigou	9 cattle wounded	
36	Liu Ruguo	farmer	Chunhua	Hunchun	Nov. 1993	Heixiuzibei, Lishugou	interviewee wounded by tiger	
37	An Tailog	head farmer	Chunhua Forest Dist.	Hunchun	1997	Sichadonggou	tracks common	
38	Chen Baoqing	forest officer	Chunhua Forest Dist.	Hunchun	1991	Sarengou	visual sighting	
39	Jio Longhe	forest officer	Chunhua Forest Dist.	Hunchun	1990	Dafangzi, Tuymozi	visual sighting	
40	Chen Baoqing	forest officer	Chunhua Forest Dist.	Hunchun	1991	Niaxindongzi	tiger present	

Table 3. Information gathered from interviews of local citizens on leopards in eastern Jilin Province, and associated survey routes traveled for verification.

	Person Interviewed				Information on leopards			
			Location of home					
No.	Name	Occupation	Village	County	Date of Observation	Location of Observation	Type of Information	Survey route
1	Cai Chenyu	Head farmer	Helong, Madida	Hunchun	summer 1997	Huanghaishugon	track, 12-14 mm width	3-3
2	Jin Chengiun	Forest officer	Sandougou Forest Dist.	Hunchun	1990	Xibeichagou	abundant tracks	3-2
3	Jin Longhe Liu Ruguo	Farmers	Quanhe, Jingxin	Hunchun	Oct. 1992	Lishagou	visual sighting of 2 animals	7-1
4	Jin Longhe Liu Ruguo	Farmers	Quanhe, Jingxin	Hunchun	Feb. 20, 1998	Yinguilazi	tracks of female + cub	7-2
5	Mr. Yang	Farmer	Xiacaonao	Hunchun	1996-1997		1 individual	
6	Wang Shiyon	Farmer	Chunhua	Hunchun	May 1997	Qinglongwadonggou	occaisonal tracks	8-1, 8-2
7	Mr. liu	worker	Chunhua	Hunchun	1993	Qinglongwadonggou	person wounded, and later died	8-1, 8-2
8	Xuan Xnelian	worker	Chunhua	Hunchun	June 1998	Qinglongwadonggou	track near house	8-1, 8-2
9	Xuan Xnelian	worker	Chunhua	Hunchun	Nov. 1997	Taojiatongzi	visual sighting of 2 animals	8-1, 8-2
10	Jin Lonazhe	farmer	Chunhua Forest Dist.	Hunchun	1990	Dulangzi	track	9-1
11	Xuan Xuechun	farmer	Chunhua	Hunchun	Nov 1997	guochenghan	tracks common	9-1
12	Hong Chunli	farmer	Dahunggou Forest Dist.	Wangqing	winter 1996	Naozigou, Madida	leopard present twice	6-2
13	Han Nailin	worker	Daxchancha Forest Dist.	Wangqing	1997	Mopanshan	2-3 leopards ate dog	
14	Liu Yuchgiun	forest officer	Antu Forest Bureau	Antu	Dec. 1996	Qinggouzi,	leopard killed dogs in village 3 times	15-3
15	Mr. Wang	farmer	Yushutun	Yanji City	Feb. 1998	Sandaogou Forest Dist. Yuangou	track	15-1

familiarity of local people with the two species, and/or a smaller probability of encountering sign of the more secretive leopard.

6.2 Field Survey Routes

The field survey covered 4,280 km^2 in 11 townships within Hunchun, Wangqing, Antu and Dunhua Counties, Jilin Province. Over the course of 20 days approximately 600 km weretraveled, including 250.5 km along survey routes. Survey route length varied from 2 to 15 km, and averaged 7.8 km.

Along 32 routes, 23 species of mammals in 8 families and 4 orders were recorded (Tables 4 and 7). Fifteen species of carnivores were identified, including 4 felids (cat family), 7 mustelids (weasels), 3 canids (dog family) and 1 bear. Within the order Artiodactyl (even-toed ungulates), four Cervidae (deer family) and one suid (wild boar) were identified (Table 7). Other potential prey species noted were hare, 2 species of rodents (squirrels and chipmunks), as well as pheasants and grouse.

Evidence of tigers was found on 7 survey routes, and on 5 routes evidence of varying quality indicating presence of leopards was identified (Table 4).

6.3 Distribution and Numbers of Tiger

6.3.1 Number of tigers. Based on the information gained from interviews (Table 2) and field survey routes (Table 4, Figure 5), we estimated that 4-6 tigers were present in eastern Jilin Province in the 1997-1998 winter. Of the four animals verified, two were likely males, one a female, and one of undetermined sex. Of the two unverified reports, one was possibly a male, and the other of undetermined sex. Of the two unverified reports, one was possibly a male, and one of undetermined sex. The information that served as a basis for this estimate is summarized in Table 5, and reported below for each animal.

- 1. March 1, 1998: tiger tracks were identified on survey routes 2-1 and 2-2 (Table 5), approximately 8 km apart in the Russian Border Region (Figure 5). Although melt-out of tracks made precise measurements difficult, it appeared that these two sets of tracks likely represented one individual.

- 2. Three bulls were recorded killed in the same drainage during the winter; two of these were less than 100 m apart, and the last was less than 5 km away. At both sites, tiger excrement was found. Local people reported tiger tracks (interview 14, Table 2), which were largely melted out by the time of our inspection. Tracks patterned like tiger were present at the kill sites. One tiger was likely responsible for all three depredation events. The size of the excrement at the kill sites (Table 5) suggested that this tiger was likely a male.

- 3. March 5, 1998: on survey routes 8-1 and 8-2 in the Dalongling Region, located approximately 5 km from each other, tiger tracks of similar size (pad width of 9.2 and 9.6 cm respectively) were reported. These measurements are sufficiently similar to be considered a single individual given their close proximity, and likely were made by an adult female tiger.

Table 4. Summary of predator data from census routes of tiger/leopard survey in eastern Jilin Province, February 28 - March 13, 1998

		Route	Total	Tiger				Leopard				Yellow throated	Red	Siberian			Wild	Himal. black		Raccoon
	Date	#	km	Track	Scat	Scrape	Other	Track	Scat	Scrape	Other	marten	fox	weasel	Mink	Lynx	cat	bear	Badger	dog
1	28.02.98	4-1	6	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
2	28.02.98	4-2	2	-	2	-	-	-	1?	-	-	1	-	-	-	-	-	-	-	-
3	01.03.98	2-1	10	1	-	1	-	1	-	1	-	-	-	-	-	-	-	1	1	-
4	01.03.98	2-2	7	1	1	2	M.tree	-	-	-	-	-	-	1	-	-	1	-	-	-
5	01.03.98	2-3	8	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-
6	02.03.98	3-1	6	1	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
7	02.03.98	3-2	8	-	-	-	-	1	-	1	-	-	-	-	-	1	1	-	1	-
8	02.03.98	3-3	9	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-
9	03.03.98	1-1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	03.03.98	1-2	8	-	-	-	-	-	-	-	-	-	-	-	-	-	4-5	-	-	-
11	03.03.98	1-3	10	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
12	05.03.98	8-1	9	1	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-
13	05.03.98	8-2	7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	05.03.98	8-3	14	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
15	06.03.98	9-1	7	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
16	06.03.98	9-2	5	-	-	-	-	-	-	-	-	2	-	-	2	-	-	-	-	-
17	06.03.98	9-3	12.5	-	-	-	-	1??	-	-	-	-	-	-	1	-	-	-	-	-
18	07.03.98	7-1	10	-	-	-	-	-	-	-	-	2	1	-	-	-	1	-	1-3	1
19	07.03.98	7-2	7	-	-	-	-	-	-	-	-	1	-	2	1	1	-	-	-	-
20	07.03.98	7-3	15	-	-	-	-	1??	-	-	-	>10tr(4)*	1	3tr (2)	1	1	-	-	-	-
21	08.03.98	10-1	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	08.03.98	10-2	6	-	-	-	-	-	-	-	-	1	-	-	2-3	-	-	-	-	-
23	08.03.98	10-3	10	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
24	10.03.98	13-1	6	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
25	10.03.98	6-2	5	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
26	10.03.98	12-1	6	-	-	-	-	-	-	-	-	2	-	2	1	-	-	1	-	-
27	12.03.98	15-3	10	-	-	-	-	-	-	-	-	2	1	-	-	-	-	1	-	-
28	12.03.98	15-2	7	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	2-3	-
29	12.03.98	15-1	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	13.03.98	16-1	6	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-	-
31	13.03.98	16-2	5	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
32	13.03.98	16-3	6	-	-	-	-	-	-	-	-	3	-	6tr(2)	-	-	-	-	-	-
Summary			251	5	4	3	1	3(2?)	1?	2	0	30	4	9	9	4	4	4	2-4	1

* recorded number of tracks (tr) and in parentheses, estimated number of individuals along route.

Table 5. Evidence used for estimating number of tigers, based on sign observed in eastern Jilin Province, China.

No.	Distribution Region	Survey Route		Measurements of sign									Related interview No.	Quality of information	
				Tracks											
		No.	Date Surveyed	Front Pad width (cm)	Total width x length (cm)	Stride length (cm)	Scat present (diameter) (cm)	Scrape width x length (cm)	Scent mark	Depredation	Age of evidence	Est. Sex		good	un-verified
1	Russian border	2-1	Mar 1, 1998	old	old			25 x 40			> 1 week	male	7	1	
		2-2	Mar 1, 1998	old	16 (width)	142 uphill	X*	24 x 46	on tree				7		
2	Panling	4-2	Feb 28, 1998	old	old		3.5-4.0			3 cattle killed		male	14	1	
3	Dalongling	8-1	Mar 5, 1998	9,2	13x14	124 uphill					2 days	female	17-22	1	
		8-2		9,6	15x16		3,3				2-4 days				
4	Tumen	1-3	Mar 3, 1998				3			cow wounded	> 3 weeks	unk.	5	1	
5	Haerbaling											unk.	27-31		1
6	Russian border	3-1	Mar 2, 1998	old							3-4 days	male?	9,11,12,13		1

* X indicates item was present but not neasured

- 4. March 3, 1998: we confirmed reports (interview # 5, Table 5) that a tiger had killed a bullock some weeks earlier in a stall adjacent to a house in a small village in the Sanjiaoshan-Dapanling area of the Tumen River Region close to the Russian border. The tiger was apparently frightened away before he had time to eat the bullock. Villagers reported that tracks in the snow came out of, and returned back to the drainage coming off the Russian border. One local villager also claimed that a wild boar, killed by a tiger, was also found. Less than 1 km from the village, on survey route 1-3, we identified a tiger scat with wild boar hair (Tables 4, 5), apparently corroborating the report of the villagers. This location is less than 5 km from the Russian border, and less than 10 km from the North Korean border.

- 5. Although no evidence was found along survey routes, repeated sightings of tigers and tiger tracks (interviews 27-31, Table 2) suggest that at least one tiger was residing in the Haerbaling Region. The region contains suitable habitat where tigers could occur.

- 6. March 2, 1998: old tracks, perhaps of an adult male, were identified on survey route 3-1 in the Russian Border Region, but tracks were too old and melted out to be measurable. It is possible that this was the same animal as identified in survey routes 2-1 and 2-2, but information from interviews (1, 2, 12, and 13, Table 2) suggest that it may represent a separate individual. This observation was considered unverifiable, but could potentially represent a sixth individual within the survey region.

Information from other interviews (particularly 3, 4, 5, 32, 33) suggested additional tigers may exist in the area, but were not included in this estimate because sources were of unknown quality and unverifiable. Of particular interest was a report of an adult female with 2 cubs in the Dalongling Region (interview #25, Table 2). This report is the only evidence that there may be resident female tigers reproducing within the survey region. However, this information could not be verified.

6.3.2 Tiger Distribution. Based on interviews and field surveys, highest density of tiger sign appeared to be in Hunchun County (Figure 5). Except in areas of high human density, primarily Hunchun city and surrounding agricultural areas, and the Xiaoxi'nancha gold mining area (in the Hunchun River Valley), sign of tiger was discovered over many of the regions within Hunchun County, an area totaling 3,900 km^2. We review evidence of tiger distribution within the 5 defined regions of our survey.

1. The Dalongling Region. Thirty-five percent (14 of 40 interviews) of all observations of tigers collected from interviews were reported here, and sign of tigers was found along 2 of the 8 survey routes (tiger #2) within the region. Evidence of one tiger near the Russian border was based on both interviews and field survey data (Table 5). In general, the region appears to contain much suitable habitat for tigers, and should be considered one of the key components of a conservation strategy for both leopards and tigers in Jilin.

2. The Russian Border Region. This region contained the greatest amount of tiger activity. Reports of tiger sign in this region comes from 12 interviews (30% of all tiger reports from interviews) and 3 of 8 survey routes. One tiger was confirmed to have been present, and a second was suspected but unconfirmed (Table 5). With adequate forest cover, relatively abundant ungulate resources (see Status of Prey section), and tigers immediately

adjacent in Russian with easy emigration routes, proper management of this region, in conjunction with Dalongling, is critical for conservation of tigers in Jilin Province.

3. The Tumen River Lower Basin Region. Although much of this region does not appear suitable for tigers, there have been consistent reports of tigers here since 1990, including 7 reports from interviews. We confirmed the presence of one tiger which killed a cow in the mountainous northwestern portion of the region (Table 5, Figure 5). It appears possible that tigers using this region can easily travel between Russia and China, and, by crossing the Tumen River, could cross over into North Korea as well. Suitable habitat exists on the Russian side, but status of habitat on the North Korean side is presently unknown. This narrow band of habitat may represent the last remaining potential ecological corridor amongst the three countries, and therefore demands particular attention.

4. The Panling-Laoyeling Region. One tiger killed three bullocks during the 1997-1998 winter on the south side of the Panling Ridge (Table 5, Figure 5). Evidence of tigers in this region also came from 2 interviews. Tigers were reported in the Heshan Forest District in a 1976 wildlife survey. On January 27, 1998, tiger tracks and a bed were photographed by local wildlife managers in this region.

5. The Haerbaling Region. Time constraints limited the number of field survey routes in this region (6 routes), but 5 reports of tiger sign came from interviews of local people. Suitable habitat exists in this region, although prey abundance may be a problem (see below).

6.4 Distribution and Number of Leopards

Estimates of presence, distribution, and numbers of leopards along survey routes were difficult to define due to a variety of factors. Small track size in comparison to tigers (similar to lynx), preference for exposures free of snow, and relatively small home ranges (in comparison to tigers) all act in concert to decrease the probability of finding leopard sign. Nonetheless, evidence of leopards was found.

6.4.1 Number of leopards. We accumulated sufficient evidence to verify that at least four individual leopards were present in the study area during the 1997-1998 winter (Table 6, Figure 6). One animal was of undetermined sex, two were believed to be males, and one a female. Evidence for as many as 3 more individuals was collected, but was considered unverifiable. Information for a total count of 4-7 animals is presented below (and summarized in Table 6).

- 1. March 1, 1998: on route 2-1 in the Russian Border Region tracks with a pad width of 7.5 cm, and two scrapes (measuring 14x27 and 12x22 cm) suggested that a female leopard had passed along this route within the previous week (Table 6).

- 2. March 2, 1998: on route 3-2, in the Panling-Laoyeling Region, tracks (pad width approximately 8 cm in diameter), probably of a male leopard, were identified, and distinguished from what appeared to be lynx (or possibly young leopard) tracks in the same vicinity (Table 4). Tracks appeared to be approximately 2 days old (Table 6).

Table 6. Evidence used for estimating number of leopards, based on sign observed in Jilin Province, China.

No.	Distribution Region	Survey Route		Measurements of sign									Related inter-view No.	Quality of information	
				Tracks											
		No.	Date Surveyed	Front Pad width (cm)	Total width x length (cm)	Stride length (cm)	Scat present (diameter) (cm)	Scrape width x length (cm)	Scent mark	Depredation	Age of evidence	Est. Sex		good	un-verified
1	Russian border	2-1	Mar 1, 1998	7.5	12.5x16			7x27 12x22			2-3 days	female ?		1	
2	Panling	3-2	Mar 2, 1998	8	9x9						2 days	male?		1	
3	Dalongling	8-3	Mar 5, 1998	7.8	10.8x11.5						1 days	male	6-9	1	
4	Haerbaling	15-3	Mar 12, 1998					?**		dog (1996)		unk.	12, 14	1	
5	Panling	4-2	Feb. 28, 1998				X								1
6	Dalongling	9-3	Mar 6, 1998	?**									10-11		1
7	Dalongling	7-3	Mar 7, 1998	?**											1

* X indicates item was present but not neasured.
** ? indicates uncertainty about presence of item.

- 3. March 5, 1998: on transect 8-3 in the Dalongling Region tracks of a large leopard (pad width 7.8 cm, total track width 10.8 cm, total track length 11.5 cm), probably a male, were found crossing the border from China into Russia (Table 6, Figure 6). Tracks were likely made the previous morning.

- 4. March 12, 1998: in the Haerbaling Region on route 15-3, old marks on the ground may have been scrapes created by a leopard (Table 6). Additional reports (interview 14, Table 3) of a leopard depredation on a dog in the village of Qinggouzi in December 1996, suggested that a leopard may have been residing in this region. Although no fresh tracks were found, there was relatively little time to survey the area, which contained suitable habitat. Specialists agreed to include this animal in the count (reported as unknown sex), bringing the total number of positively identified individuals to four.

In addition to the 4 animals positively identified, there exists unverifiable information of leopards on three other routes.

- 5. February 28, 1998: on route 4-2 in the Panling-Laoyeling Region excrement was collected on a ridgeline 1 km away from a tiger depredation that was smaller and did not match tiger excrement found at the site (Table 4, Figure 6). The size and shape suggested that of a leopard, but could not be confirmed. This observation was considered unverifiable, but later genetic analyses could be used to identify species (Table 6).

- 6. March 6, 1998: on route 9-3, old tracks were observed (with fresh snow in them) in suitable leopard habitat on the Lantsyatantsakha branch of the Hunchun River in the Dalongling Region (Figure 6). Tracks were badly melted and were impossible to measure, but the pattern and behavior greatly resembled that of a leopard. This observation was not verifiable (Table 6).

- 7. March 7, 1998: on route 7-3 very old tracks resembling those of a leopard were found near Sifangdingzi Mountain, near the village of Taipinggou in the Dalongling Region (Figure 6). Nearby routes did not confirm presence of leopard tracks, but habitat was considered suitable. This observation was included as unverifiable (Table 6).

Other information from interviews of local people could not be verified. On route 15-1 a man working in a logging camp reported seeing leopard tracks 10-14 days prior to the date of the survey. Under questioning, the man seemed knowledgeable about animals and tracks, but refused to show the tracks to the field team. The team went to the area where he claimed to have seen tracks, but could not verify the existence of tracks. As with other interview data, because no concrete evidence was found, this report was excluded.

Results of the survey confirmed the presence of 4 leopards: 2 along the border with Khasanski Raion Primorye (one in Dalongling and one in the Russian Border Region), 1 in the Panling-Laoyeling Region, and one in the Haerbaling Region. Unverifiable evidence existed for 3 other individuals, one in the Panling-Laoyeling Region and two in the Dalongling Region. Therefore, in our survey area, evidence for 4-7 leopards were found during the field survey between February 28 and March 13, 1998.

6.4.2 Leopard distribution. Evidence of leopards from both interviews and field surveys is more sparse for leopards than tigers. Whether this difference is due to the greater difficulty of finding and identifying leopard sign, or to a real difference in relative abundance, cannot be determined with existing information. We review information on leopards for each of the distribution regions, and briefly discuss the value of each region to leopard conservation.

1. The Dalongling Region. A total of 6 reports from interviews (43% of total) and sign along 3 survey routes (7-3, 8-3, and 9-3, Table 2) suggest that this region may be the most important for leopards. Some of the best remaining habitat on the Russian side adjoins the Dalongling Region, including the newly created Borisovkoe Plateau Zakaznik (wildlife refuge). Dalongling has suitable habitat for leopards, and in combination with the Russian Border Region, must be considered vital to survival of the leopard.

2. The Russian Border Region. Four interviews reporting leopards in this region (Table 3) were concentrated in the middle and northern parts, but the only tracks identified were in the southern portion (Figure 6). The entire region borders good leopard habitat on the Russian side of the border, and it is likely that leopards cross back and forth along the entire length of this boundary. As with the Dalongling Region, protection of this habitat will be critical if leopards are to survive in Jilin.

3. The Tumen River Lower Basin Region. No leopards were found in this region. However, leopards have been reported on the Russian side of the border, and it is likely that leopards frequent this area. As with tigers, this region is likely the only area that could act an ecological corridor connecting North Korea, China, and Russia.

4. The Panling-Laoyeling Region. Sign of leopards was found on two survey routes (3-2, 4-2, Table 4) and reports of leopards came from two interviews of local people (Table 3). This region includes good habitat for leopards, an abundance of cliffs (favorite haunts of Far Eastern leopards), and a variety of forest types. More intensive survey work is needed to better understand the distribution of both leopards and tigers in this region.

5. The Haerbaling Region. Sign of leopard was found on one transect, and two reports of leopards came from interviews. Most of the suitable habitat in this region occurs between 800 and 1000 m altitude. The borders of potential leopard distribution are from Wudao to Lianhua to Sifangtai, then to Dashi and Zhangbatougoudi, then to Tuntian Nanzhangzhi and then turn bake to Wudao, an area of some 250 km^2.

6.5 Distribution, Population Densities and Status of Prey Species

The survey of eastern Jilin Province demonstrated that prey resources for tigers was primarily wild boar and sika deer, and for leopard, primarily roe deer and sika deer. Musk deer were practically absent, do not contribute significantly to the estimates of available prey, and consequently, are not considered further (tracks of only one individual were identified). A brief description of distribution and population status, based on information gathered during the survey, is provided for each prey species below.

6.5.1 Ungulate Prey Species. Ungulates make up the majority of the diet of tigers, and to a lesser extent, leopards as well. Therefore, the status of four key ungulate species is reviewed in detail.

Table 7. Summary observations on number of tracks, tracks/km of survey route, and relative abundance (0, low, moderate, high) of prey species for tigers and leopards on census routes in Yanbian Prefecture, Jilin Province, February 28 - March 13, 1998.

	Date	Route #	Region	Total distance of route (km)	Track abundance														
					Sika deer			Roe deer			Wild boar			Red deer			Manchurian hare**		
					# tracks	Tracks/ km	Rel. abund.*	# tracks	Tracks/ km	Rel. abund.	# tracks	Tracks/ km	Rel. abund.	# tracks	Tracks/ km	Rel. abund.	# tracks	Tracks/ km	Rel. abund.
1	28.02.98	4-1	Border	6	10	1.67	Low	7	1.17	Low	0	0.00	0	0	0	0	0	0.00	0
2	28.02.98	4-2	Panling	2	2	1.00	Low	0	0.00	0	0	0.00	0	1?		?	0	0.00	0
3	01.03.98	2-1	Border	10	15	1.50	Low	0	0.00	0	0	0.00	0	0	0	0	-	-	Low
4	01.03.98	2-2	Border	7	12	1.71	Low	4	0.57	Low	many		Mod	0	0	0	0	0.00	0
5	01.03.98	2-3	Border	8	0	0.00	0	4	0.50	Low	0	0.00	0	0	0	0	10	1.25	Low
6	02.03.98	3-1	Border	6	28	4.67	Mod	24	4.00	Mod	2-3	0.42	Low	0	0	0	-	-	2
7	02.03.98	3-2	Panling	8	0	0.00	0	many		High	>20		Mod	0	0	0	0	0.00	0
8	02.03.98	3-3	Border	9	5	0.56	Low	22	2.44	Low	1	0.11	Low	0	0	0	4-5	0.50	Low
9	03.03.98	1-1	Tumen	3	0	0.00	0	12	4.00	Mod	0	0.00	0	0	0	0	-		High
10	03.03.98	1-2	Tumen	8	>20		Mod	7	0.88	Low	0	0.00	0	0	0	0	0	0.00	0
11	03.03.98	1-3	Tumen	10	33	3.30	Mod	1	0.10	Low	2	0.20	Low	0	0	0	>10		Low
12	05.03.98	8-1	Dalongling	9	>20		Mod	>20		Mod	-		Low	-		Low	-		Low
13	05.03.98	8-2	Dalongling	7	>20		Mod	6	0.86	Low	0	0.00	0	2	0.286	Low	0	0.00	0
14	05.03.98	8-3	Dalongling	14	>10		Low	>20		Mod	10	0.71	Low	5	0.357	Low	5	0.36	Low
15	06.03.98	9-1	Dalongling	7	2?	0.29	Low	>20		Mod	-		Low	0	0	0	-	-	Low
16	06.03.98	9-2	Dalongling	5	0	0.00	0	0	0.00	0	>20		Mod	0	0	0	0	0.00	0
17	06.03.98	9-3	Dalongling	12,5	0	0.00	0	>40		Mod	14	1.12	Low	0	0	0	1	0.08	Low
18	07.03.98	7-1	Border	10	10-12	1.10	Low	0	0.00	0	-		Low	0	0	0	0	0.00	0
19	07.03.98	7-2	Border	7	2	0.29	Low	1	0.14	Low	0	0.00	0	0	0	0	>3		Low
20	07.03.98	7-3	Dalongling	15	0	0.00	0	10	0.67	Low	1	0.07	Low	0	0	0	>20		Low
21	08.03.98	10-1	Dalongling	8	0	0.00	0	3	0.38	Low	1	0.13	Low	0	0	0	1	0.13	Low
22	08.03.98	10-2	Dalongling	6	0	0.00	0	0	0.00	0	0	0.00	0	0	0	0	0	0.00	0
23	08.03.98	10-3	Panling	10	0	0.00	0	0	0.00	0	0	0.00	0	0	0	0	2	0.20	Low
24	10.03.98	13-1	Panling	6	0	0.00	0	3-4	0.58	Low	0	0.00	0	0	0	0	-		Low
25	10.03.98	6-2	Panling	5	0	0.00	0	4	0.80	Low	0	0.00	0	0	0	0	0	0.00	0
26	10.03.98	12-1	Panling	6	0	0.00	0	2	0.33	Low	>20		Mod	0	0	0	1	0.17	Low
27	12.03.98	15-3	Haerbaling	10	0	0.00	0	16-21	1.85	Low	24	2.40	Low	0	0	0	0	0.00	0
28	12.03.98	15-2	Haerbaling	7	-	-	Low	>20		Mod	0	0.00	0	0	0	0	0	0.00	0
29	12.03.98	15-1	Haerbaling	12	0	0.00	0	22	1.83	Low	9	0.75	Low	0	0	0	0	0.00	0
30	13.03.98	16-1	Haerbaling	6	0	0.00	0	11-14	2.08	Low	>20		Mod	0	0	0	-	-	Low
31	13.03.98	16-2	Haerbaling	5	0	0.00	0	>20		Mod	>20		Mod	0	0	0	1	0.20	Low
32	13.03.98	16-3	Haerbaling	6	0	0.00	0	>30		High	4	0.67	Low	??		0	2	0.33	Low
Summary				250,5	190	0.76	Low	321	1.28	Low	195	0.78	Low	7	0.028	Low	83	0.33	Low

* Relative abundance reported as: 0 - absent; low - > 0 < 3 tracks/km; moderate - 4-10 tracks/km; high -= > 10 tracks/km.

**Estimates for Lepus mandschuricus based on presence of both tracks and scats

Table 8. Estimates of presence, relative abundance and density of 4 ungulate prey species in eastern Jilin Province, based on data collected along survey routes in 5 regions.

		Prey Density											
	Number	Sika deer			Roe deer			Wild boar			Red deer			Total Ungulate*
Area	of routes	presence/ absence	Relative abund.	Density #/km^2	presence/ absence	Relative abund.	Density #/km^2	presence/ absence	Relative abund.	Density #/km^2	presence/ absence	Relative abund.	Density #/km^2	Density #/km^2
Russian border	8	present	low	0.544	present	low	0.235	present	low	0.071	absent	0	0	0.850
Dalongling	9	rare	low	0.360	present	low	0.303	present	low	0.111	present	low	0.030	0.804
Tumen	3	present	moderate	0.535	present	low	0.707	present	low	0.069	absent	0	0	1.311
Panling	6	rare	very low	0.042	present	low	0.329	rare	low	0.118	present?	very low	0	0.489
Haerbaling	6	rare	very low	0.063	present	moderate	0.576	present	low	0.341	absent	0	0	0.980
Summary	32			0.307			0.380			0.142			0.008	0.837

*does not include Lepus mandshurica

Sika deer (*Cervus nippon*). Results of the survey revealed that sika deer are primarily found along the Russian border in Dalongling, Russian Border Region, and the Lower Basin of the Tumen River (Table 7). In the Russian Border and Tumen River regions evidence of sika deer were found on 9 of 11 routes, and in Dalongling Region, evidence of sika deer was only found on routes close to the Russian border (Table 7). Densities of sika deer were high only on routes close to Russia (Table 8); further to the west, in Panling-Laoyeling and Antu, sika were virtually absent (Tables 7), and densities were exceedingly low (Table 8). On the southern slopes of the Panling-Laoyeling Ranges, suitable habitat exists, and local people indicated that some sika deer are still found, but they probably occur in isolated pockets of habitat. Distribution of sika deer in Jilin appears patchy and fragmented, which is at least partially a result of anthropogenic impacts. Exchange of animals between Russia and China is likely, which may help to bolster populations on the Chinese side. Sika deer populations could likely increase in many regions, in particular the Panling-Laoyeling area, is adequate protection is provided. An increased abundance of this species would be one of the key components of improving habitat conditions for both tigers and leopards.

Roe deer (*Capreolus capreolus*). Roe deer were distributed throughout the areas surveyed, with evidence of this species on over 80% of all routes (Table 7). Highest densities were found in the oak woodlands in the Tumen River Region, but roe deer were also relatively common in Antu (Tables 7 and 8). Along the border, where densities of sika deer were higher, roe deer were less common. Densities of roe deer in the Border Region and Panling-Laoyeling were similar (Table 8). Despite the fact that distribution of roe deer is wider than sika deer, this species was generally found at lower densities than the capacity of the habitat. Roe deer densities could likely increased substantially across much of the area surveyed if better protection is provided. As with other prey, human harvest is likely the key limiting factor (see next section).

Although tigers do take roe deer, in most areas, roe deer are a secondary component of their diet. However, they can form an important component of the diet of leopards. Although important to both species, increased densities of sika deer, red deer, and wild boar are likely more important for tigers.

Wild boar (*Sus scrofa*). Wild boar were sporadically distributed, being found on only 60% of routes surveyed (Table 7). Overall densities of wild boar were low: 0.084/km^2 along the border, 0.069/km^2 in the Tumen River Region, and 0.115/km^2 in the Panling-Laoyeling area (Table 8). Only in the Antu Region were boar populations in better condition, where 5 of 6 routes reported boar tracks (Table 7), and overall density in this region appeared to be higher (Table 8). The distribution of wild boar cannot be accurately mapped based on the data collected from our survey, but it can be predicted that winter distribution will be related to distribution of mast crops - acorns and Korean pine nuts - and therefore adequate protection for these two mast-producing trees is important. There is an abundance of good habitat for wild boar in Jilin, but much appears to be uninhabited.

This species, where present, forms a key component of the diet of tigers. Therefore, any plan for tiger conservation must include an adequate plan for increasing wild boar in recovery zones.

Red deer (*Cervus elahpus*). Although many local people presence of red deer across many regions, tracks of only 3 or 4 individuals were encountered along survey routes, all in Dalongling Region, except tracks of one animal that could not be positively identified in

Haerbaling (Table 7). Red deer are apparently extremely rare in Jilin, as is the case in the adjacent territory of southwest Primorye, Russia, where sika deer are dominate. In the Panling and Laoyeling Ranges, local villagers reported that red deer still occur, but such information could not be verified. If this species still exists in some of these regions, it would require intensive efforts to increase population size. The best habitat for red deer appeared to be in the Antu region, where there is an abundance of horsetail (Equisetum spp.), and a forage base that would support larger numbers.

Although red deer form an important component of the diet of tigers across much of their range in Russia, in the more southern regions, sika deer replace red deer to a large extent. If conditions in southwest Primorye are any indication, it may be more feasible in many regions of Jilin to focus efforts on increasing sika deer populations as a prey base for both leopards and tigers.

6.5.2 Secondary Prey Species. In addition to ungulates, a number of other mammals fall prey to tigers and leopards. Leopards especially rely on a variety of smaller mammals and birds, but tigers also take small items. When ungulate densities are low, as is the case in Jilin, the importance of secondary species is magnified. Therefore, the status of some of these potential prey species is reviewed here.

Manchurian hare (*Lepus mandshuricus*). Hare can be an important prey item for leopards, but population densities of Manchurian hare were much lower in regions surveyed than their potential carrying capacity. Sign of hares, either scat or tracks, was found on only half of the survey routes (Table 7). In the Tumen River Region high densities of hare were found on one route (Table 7). Elsewhere, hare densities appeared to be severely depressed. Hares can be an important component of leopard diets if population densities are greater than 1/km^2. Although hares were found patchily distributed throughout the 5 regions surveyed, with the possible exception of the Tumen River Region, this species does not contribute significantly to the available prey biomass for leopards. Hare populations fluctuate widely naturally, and it is therefore difficult to determine the cause for depressed populations.

Badger (*Meles meles*). Within tiger and leopard range in the Russian Far East, the badger is an important prey object, especially for leopards in the warm seasons. At the time of the survey badger activity should have commenced, especially in lower elevation, warmer habitats, and signs of their activity - tracks, diggings, scats - should have been apparent. Despite the fact that much of the region appeared to be suitable habitat for badgers, only 12.5% of routes reported evidence (Table 4). It is likely that badger populations have been depressed for an extended period, as temporary holes, dens, trails, and excrement were rarely seen.

Himalayan black bear (*Ursus thibetanus*). Himalayan black bears can form a small, but significant part of the diet of tigers. No tracks of Himalayan black bears were found, but most animals were likely still hibernating at the time of the survey. Nonetheless, where Himalayan bears are common, evidence in the form of broken tree tops of mast and berry-producing trees should be common. Such evidence was found on only 4 (12%) of the survey routes, across 3 of the 5 regions (Russian Border, Panling-Laoyeling, and Haerbaling). Although data is inadequate, available evidence suggests that this species was widely distributed but relatively rare in the areas surveyed.

In addition to the species discussed above, 2 species of gallinacious birds can act as a forage resource, especially for leopards. The hazel grouse and pheasant were distributed across many parts of the survey area, with hazel grouse by far more common. Evidence of hazel grouse was observed on over half of the survey routes, and it was broadly distributed across the region.

6.6 Factors Influencing Prey Populations

Conditions for surveying prey were very poor. Survey routes were located to identify tiger and leopard sign (not count prey) and were therefore biased. Scattered snow cover, with southern exposures (probably preferred by many prey) were mostly snow-free, and crusty snow in many areas (which ungulates would avoid), made estimates of the number of tracks and individuals very difficult. All these factors, plus the limited time to conduct the survey, introduced many errors in deriving estimates of relative and absolute abundance. Nonetheless, the three measures of abundance (presence/absence, relative track abundance, density estimate) provide an index of the relative abundance amongst the survey routes, and a general indication of the status of prey resources for tigers and leopards in eastern Jilin Province.

Prey densities appeared to be low. In nearby southwest Primorye Krai, where habitat conditions are very similar, populations of sika deer, roe deer, wild boar, hare, badger, and bear are considerably greater.

The sporadic distribution and low densities of many prey species in this region are likely attributable to a single factor - excessive human harvest. While hunting can be an important mortality factor (and the moratorium on hunting instituted in Jilin Province is an important step), snares no doubt have a greater impact.

A total of 51 wire neck snares were found along the 250 km walked (Table 9). These snares appeared to be primarily set for capture of ungulates. In approximately 10% of all snares located, dead ungulates (4 sika deer, 1 roe deer) were found. All ungulates had been killed this year. Snares appeared to be of varying ages - some appeared to have been set many years ago, while others were set this past season. The fact that dead ungulates were found in snares indicates that many of these snares had been abandoned by the person who set them. Yet such snares continued to function, killing ungulates.

We attempted to estimate the potential impact of snares on ungulate populations using Hunchun County as an example. By assuming that on routes walked, we could locate snares up to 15 m on each side of the route, we searched approximately 3 ha/km walked. With an encounter rate of 0.204 snares/km walked, there were approximately 0.068 snares/ha on all routes. Focusing only on Hunchun County, which has approximately 330,000 ha of forest land, with a density of 0.068 snares/ha, there could be approximately 22,440 snares set and active within Hunchun County alone. Given the observed capture and mortality rate of snares located on routes (9.8% of snares had killed an ungulate), these estimates imply that snares may kill nearly 2,200 ungulates per year.

These figures provide only a crude estimate of the impact of snares, as our data is limited. Nonetheless, even if the impact of snares is only half that predicted, snares are killing an extremely large number of ungulates within eastern Jilin Province, and the widespread prevalence of snares is the most likely explanation for the paucity of prey found during the survey. The paucity of tigers, leopards, and lynx, and the absence of wolves or other large predators suggests that predation is not depressing prey populations. Good habitat and adequate forage exists for sika and roe deer, as well as wild boar. These species can recover

Table 9. Number of snares found along routes traveled during the tiger/leopard survey of Yanbian Prefecture, Jilin Province, February 28 - 13 March, 1998.

	Date	Route #	Total km	# Snares located	Snares/ km walked	# animals killed in snares	Species Killed
1	28.02.98	4-1	6	3	0.50	0	
2	28.02.98	4-2	2	0	0.00	0	
3	01.03.98	2-1	10	2	0.20	1	sika deer
4	01.03.98	2-2	7	0	0.00	0	
5	01.03.98	2-3	8	0	0.00	0	
6	02.03.98	3-1	6	3	0.50	0	
7	02.03.98	3-2	8	4	0.50	1	sika deer
8	02.03.98	3-3	9	2	0.22	0	
9	03.03.98	1-1	3	1	0.33	0	
10	03.03.98	1-2	8	0	0.00	0	
11	03.03.98	1-3	10	1	0.10	0	
12	05.03.98	8-1	9	3	0.33	1	sika deer
13	05.03.98	8-2	7	7	1.00	1	sika deer
14	05.03.98	8-3	14	0	0.00	0	
15	06.03.98	9-1	7	2	0.29	0	
16	06.03.98	9-2	5	0	0.00	0	
17	06.03.98	9-3	12.5	1	0.08	0	
18	07.03.98	7-1	10	6	0.60	0	
19	07.03.98	7-2	7	0	0.00	0	
20	07.03.98	7-3	15	0	0.00	0	
21	08.03.98	10-1	8	0	0.00	0	
22	08.03.98	10-2	6	1	0.17	0	
23	08.03.98	10-3	10	1	0.10	0	
24	10.03.98	13-1	6	0	0.00	0	
25	10.03.98	6-2	5	0	0.00	0	
26	10.03.98	12-1	6	0	0.00	0	
27	12.03.98	15-3	10	0	0.00	0	
28	12.03.98	15-2	7	3	0.43	1	roe deer
29	12.03.98	15-1	12	0	0.00	0	
30	13.03.98	16-1	6	0	0.00	0	
31	13.03.98	16-2	5	11	2.20	0	
32	13.03.98	16-3	6	0	0.00	0	
Summary			250,5	51	0.204	5	

naturally in most areas if snares are eliminated, and the intense harvest pressure by humans is reduced.

Although we found no evidence that snares killed tigers or leopards, there is sufficient evidence from Russia and elsewhere that snares can effectively capture and kill both large predators. Therefore, snares negatively impact the potential of Jilin to retain tiger and leopard populations in two ways: first, through direct mortality of tigers and leopards; and, secondly, by greatly depressing prey populations.

6.7 Habitat Characteristics of Tiger and Leopard Locations

There were some patterns in habitat characteristics of the 24 locations where tiger or leopard sign was found. Elevation of tiger and leopard locations ranged from 120-885 m. The 17 locations of tiger sign varied from 120-700 m, with 47% of them lower than 300 m, 29% between 301-500 m, and 24% greater than 500 m. The 7 locations of leopard sign ranged in elevation from 423-885 m.

Tiger and leopard sign was primarily found in mixed broad-leaved forest (75%) or mixed conifer and broad-leaved forests (25%). Both species appeared to prefer more dense overstories: 38% of locations were in high density canopies, 58% in mid-density canopies, and only 4% in sparsely covered forests. Older forests were also selected: 54% of location were in mature forests, 42 in middle-aged forests, and only 4% were in young forests.

In summary, both carnivores were more commonly found in broad-leaved forests with high or medium canopy densities in middle and low elevation mountainous areas. These regions, in general, were also places where prey densities were higher.

6.8 Distribution and Status of Tigers and Leopards Within 5 Regions

An absence of suitable densities of prey species likely explains the rarity of tiger and leopard sign on survey routes. Nonetheless, we attempt to assess the potential of each of the 5 regions (Figure 4) to support tigers and leopards if appropriate management actions are taken.

1. The Dalongling Region. Both tigers and leopards readily cross the international boundary between Russia and China, and prey densities are some of the highest in Jilin close to the border. Further to the west in this region, potential habitat exists, but prey densities are extremely low, no sign of tigers existed (except from interviews), and only one melted out track was identified as potentially that of a leopard (Table 6). On the Russian side of the border, the newly created Borisovkoe Plateau Zakaznik provides good protection, which could be of great assistance in recovering ungulate populations in this region, and is a natural source for dispersing leopards and tigers. The forests of this region are well-managed, and human impact is not severe. This area has great potential as part of an international protected area, and has been proposed for inclusion in the “The Big Cat (Panthera) International Park and Wildlife Refuge”. Dalongling has suitable habitat for both leopards and tigers, and along with the Chinese-Russian Border Region, must be considered vital to survival of the leopard.

2. The Russian Border Region. From Chunhua south along the Chinese-Russian border there is excellent habitat for both tigers and leopards. Sufficient prey exists in this region, but human pressures from both the Russian and Chinese side threaten to degrade this finger of habitat. This region, along with Dalongling, is in critical need of protection if the Far Eastern leopard is to survive in the wild. Conservation of tigers will be slightly more

problematic here because it is a thin finger of habitat, but this region, in combination with Dalongling, is critical if the Jilin tiger population is to expand and complement the population of tigers in southwest Primorye that is precariously small. In the future it will be essential to manage both sides of the border as a single, conservation unit. Dispersal/migration corridors will need to be re-established.

3. The Tumen River Lower Basin Region. A relatively small percentage of the Tumen River Region retains potential habitat for tigers or leopards, but this fact does not reduce the importance of this region as an ecological corridor between Russia, China, and North Korea. This region holds the highest densities of prey, and could provide a critical link between the Russian Border Region to the north, and North Korea, and should be given high priority for protection. This narrow band of habitat may represent the last remaining potential ecological corridor amongst the three countries, and therefore demands particular attention.

4. The Panling-Laoyeling Region has good potential habitat for both leopards and tigers, but suffers from low prey densities. Only roe deer reside in reasonable densities. Sika deer are virtually absent, and boar rare. The north sides of these mountain massifs appear to have particularly low prey densities. The proposed Laoyeling Protected Area would provide an ecological corridor from the Russian border to this mountain range, and should be considered high priority. If Dalongling, the Russian Border Region, and Panling-Laoyeling can maintain ecological connectivity, and receive adequate protection from hunting and other human pressures, the cumulative amount of suitable habitat for leopards and tigers in this Chinese-southwest Primorye (Russian) region can be essentially doubled. Such an increase in available habitat would greatly increase the probability of survival of both populations.

5. The Haerbaling Region. In Antu, in the upper reaches rivers draining this mountain range potentially good habitat exists for red deer, wild boar, and tiger. Protected status, or elimination of snares and illegal hunting, would assist in recovering these species. There are suitable tracts of habitat that could provide opportunities for supporting a reproducing population of tigers, but ecological corridors will be necessary to insure a linkage with habitat to the east.

7. CONSERVATION STRATEGY AND MANAGEMENT RECOMMENDATIONS

Despite the dangerously low populations of tigers, leopards, and their prey, there are at least four reasons for optimism that these populations can recover in Jilin Province. First, there remain extensive tracts of forest lands in northern Hunchun, Wangqing, and Antu Counties that are well managed by the Ministry of Forests, and retain the capacity to harbor good populations of prey, as well as tigers and leopards. Secondly, although China has a very large human population to care for, human densities adjacent to potential tiger and leopard habitat are not high, and in fact are comparable to regions in nearby Russia that harbor healthy populations of both tigers and leopards. Thirdly, there exists sizable populations of tigers, leopards, and their prey in adjacent habitat in Russia that could act as a source for animals emigrating into Jilin, thus speeding the recovery process. Finally, there appears to be a sincere desire on the part of the Wildlife Animal Protection Society and the Ministry of Forestry, as well as other branches of the government, to assist in recovery of tiger and leopard populations.

7.1 Recommendations for Conservation of Tigers and Leopards in Eastern Jilin Province, China.

For establishment of a resident, breeding population of tigers and leopards, we present 9 recommendations that relate to land-use practices and recovery of ungulate populations. If the forests are properly protected, and ungulate populations are allowed to increase, resident populations of leopards and tigers will naturally become established in Jilin. We provide the following recommendations as key components of a successful effort to increase populations of these two large carnivores in Jilin Province.

7.1.1 Develop a tiger/leopard recovery plan for Jilin Province, and specifically for Hunchun County, which has, as its primary basis, a land use plan that delineates potential tiger and leopard habitat in Hunchun. A tiger/leopard recovery plan should be created for Jilin Province that will act as a guiding management document whose goal is the development of stable, reproducing populations of tigers and leopards that are linked to the Russian, and hopefully North Korean populations. A first step in developing such a recovery plan for tigers and leopards in Jilin is to focus on creation of a land-use plan for Hunchun that will delineate potential habitat. A series of maps should be developed that delineate key parameters needed to guide the land-planning process, including maps of existing Forest Service lands, other forested lands (if such exist), forest types (in a generalized format, for example, 10-15 forest types), all villages and settlements, the road network, river systems, and relief (elevation). This information can be used to assess potential tiger habitat, and would provide a framework for identifying key areas for tiger management and potential corridors to insure connectivity of a tiger population within Jilin Province and the tri-country region. Once potential tiger habitat has been delineated, key areas can be identified for protection, and specific management regimes can be established across potential tiger habitat to increase the probability of establishing resident populations of tigers and leopards. Some components of a proposed management regime are included in the recommendations below.

At least 4 development programs pose serious threats to recovery of tigers and leopards in Jilin Province:

1. In Jingxin, from Quanhe to Jingxin, there is a major highway under construction, which runs right through the proposed ecological corridor in the Lower Tumen River Basin. This new road, and the increased flow and speed of traffic, could severely reduce the capacity of the region to act as a biological linkage point amongst the three countries. Ways to mitigate this serious impact should be sought immediately.
2. Secondly, a new cross-border international railway between Hunchun and Kraskino, Russia, will open to commercial traffic in September of 1998. This rail line will cross at the existing inner border guard fence in Russia, and will cut across the region that, on the Russian side, would be the critical link between the proposed ecological corridor in the Lower Tumen River Basin, and existing habitat in Khasanski Raion, Primorski Krai. An assessment of the railway's potential impact is of vital importance.
3. A new railway, planned for construction in the years 2002-2005 at Dongning on the Chinese-Russian border, will link to a line along the Russian and North Korean borders through Chunghua and the Laoyeling Rare and Endangered Wildlife Protection Zone. The activity associated with construction, and the new development associated with this rail line in key areas proposed for tiger and leopard conservation in Dalongling and the Chinese-Russian Border Regions threaten the capacity of these regions to act as key

components of a habitat protection plan. This railroad construction plan, if implemented, could eliminate any possibility of recovering leopard and tigers in Hunchun County.

4. Authorities are promoting construction of a water reservoir on the Hunchun River that would be known as the Laolongkou Reservoir. Its backwaters would reach the Laoyeling Rare and Endangered Wildlife Protection Zone, and may become a barrier to movement of tigers and leopards across the Hunchun river valley, thus isolating the Panling-Laoyeling Region to the Russian Border Region (Figure 4). If fragmentation of this sort occurs, it would dramatically reduce the value of the Panling-Laoyeling Region for tiger and leopard conservation, and severely reduce the potential of the Hunchun to support viable populations of tigers or leopards.

Each of these proposed development projects poses serious threats to long-term prospects of tigers and leopards in eastern Jilin. Therefore, one of the primary tasks and challenges of a recovery plan will be to seek ways to resolve the potential conflict between the needs of people and wildlife. Cooperative efforts that include wildlife conservation as a component of each of these projects, and foresight in the planning processes can go a long ways towards mitigating the potential impact of each of these projects.

7.1.2 Develop a protected area in the Dalongling Region. There exists a proposal for the creation of a "Big Cat (Panthera) International Park and Wildlife Refuge" which would protect 487,000 ha in Heilongjiang and 485,600 ha in Russia for tigers and leopards (Anonymous 1996). This proposed protected area borders the northeast corner of Jilin, and the map associated with this plan suggests enlarging the protected area to include a portion of Jilin Province. It is highly recommended that in the northeast corner of Jilin, special status be given to the region beginning in the south from Nanbieligou in Madida of Hunchun County (42^{o} 52' N) north to the border of Heilongjiang and Jilin (43^{o} 30' N), west from the Panling Range (130o 30.1' E, east to the Russian border This region, about 420,000 ha in size, includes land from both the Dalonglilng and Panling-Laoyeling distribution regions, and specifically includes: the mountain massifs Taipingling, Dalongling, Laoyeling, Panling and Laosongling of the Changbaishan Area, and the upper basins of the Hunchun and Suifenhe Rivers. Forests of this region are mainly mixed conifer and broad-leaved forests, and hold great potential as both tiger and leopard habitat. Creation of a protected status in Jilin would provide protection for leopards and tigers crossing into Jilin, and a haven where a resident population of both could become established in Jilin. The survey routes covering this region had good habitat, and if the region were properly protected, could become breeding habitat for leopards, as well as tigers. Because this region offers some of the best potential habitat for leopards, we consider providing these lands with special protected status of utmost importance.

We recommend that UNDP provide assistance in completing the necessary studies needed for creation of such a protected area, including development of a funding strategy for the protected region.

7.1.3 Secure an ecological corridor that will link Russia, China and North Korea in the Tumen River region, and impose a management regime to protect prey populations and habitat for tigers and leopards. If tigers and leopards of the tri-country region surrounding the Tumen River are to exist in the future as a single metapopulation, it is essential to secure lands that will act as an ecological corridor between these countries. Such a corridor would provide a gateway through which an exchange of individuals and genetic material would be possible.

The border between Jilin and Russia extends for over 175 km, and there exists opportunities for tigers and leopards to cross that boundary (despite the "KSP" or barrier erected on the Russian side) along its entirety. However, the opportunity for movement of animals between North Korea, China, and Russia occurs only in one locale in Jingxin along the Tumen River. There exists a small mountainous zone that extends across the entire Chinese portion of this region between North Korea and Russia centered around N 42 ^{o} 42' and E 130^{o} 23'. This region has suitable habitat for both tigers and leopards (the presence of a tiger was confirmed in this region during the survey - Table 5), and if properly managed, could develop a sufficient prey base for predators to persist.

We propose strict protection of this region, and the necessary legislature for creation of a protected area that would act not only as a travel corridor for tigers and leopards, but as an ecological linkage for all components of the mountainous ecosystems of this tri-country region. At its narrowest point, North Korea and Russia are separated by approximately 10-15 km, a distance that could be easily traveled by a tiger in a single day, if there are no barriers to movement. Presently, we do not know if suitable habitat exists on the North Korean side of the Tumen River, and it is therefore of the highest priority to survey this region. In the meantime, it is recommended that China consider protecting a region across the entire width of this narrow finger of territory from the Russian border to North Korea.

Presently, the road linking Hunchun to the North Korean port is the primary threat that may act as a barrier to dispersal. Development along this road within the proposed ecological corridor could do irreparable damage and eliminate the potential for an ecological corridor by creating a barrier to dispersal among the three countries. Therefore, it is highly recommended that no development occur along this road in the region proposed as an ecological corridor. On the Russian and North Korean sides, efforts will also have to be made to manage adjacent lands in a manner consistent with tiger and leopard conservation efforts.

We consider development of an ecological corridor that will mitigate the effects of intensive development in this region of utmost importance, and that UNDP could play a major role of development of ecological corridors.

7.1.4. Develop a monitoring program for tigers, leopards, and prey, and organize cooperative cross-border surveys. If a recovery plan is put into effect in Jilin Province, it will be necessary to develop a means of monitoring changes in the tiger, leopard, and prey populations to assess the success of the recovery efforts. Intensive surveys, such as the one just conducted, are prohibitively expensive to be conducted on a yearly basis. We recommend that a corps of individuals be recruited from local Forest Districts, and even knowledgeable people from local villages, to provide yearly reports on tiger depredations, human contact with these predators, and identification of tracks. Ideally, people selected would be experienced, trustworthy individuals who spend significant time in the forest every year and can mostly rely on their own observations. These people should receive some training in identification of tracks, and a format for collecting information from local citizens about tigers and leopards. If the same individuals are used every year, errors in reporting will be minimized and standardized, changes in the frequency of tiger and leopard reports should become evident, and the information obtained will act as a gauge to assess relative changes in the actual population of tigers and leopards.

Because availability of prey appears to be the primary factor limiting tiger and leopard distribution, a monitoring program should also determine changes in status of key prey species. Populations of sika deer, roe deer, wild boar, and hare should all respond to the removal of snares (Recommendation 7.5), and to a continued moratorium on hunting (Recommendation 7.8). To verify that these management actions are having the desired

effect, it will be critical to monitor changes in prey population size over time. If no changes are noted, then it will be evident that either the above recommendations have not been adequately implemented, or there are still other factors regulating prey populations.

A monitoring program should sample prey populations across the range of territories that have been identified as potential tiger habitat. Details will not be delineated here, but a statistically rigorous field survey method can be developed at relatively low cost by employing local Forest Service workers to collect field data with guidance from scientists.

To foster better cooperative efforts, and exchange of information between China, Russia, and North Korea, it is suggested that an international working group be established. This working group could organize cooperative surveys, and work to develop a single, conservation strategy and management regime for tiger and leopards.

7.1.5 Removal/elimination of snares, with highest priority in Hunchun. Wire snares, set by local people primarily to capture ungulates, are everywhere in the forests of eastern Jilin. Once set, they have the capacity to kill for many years. And although these neck snares are primarily set to capture ungulates, they can and probably do kill both tigers and leopards.

The density of ungulates is extremely low in many of the areas surveyed. Jilin Province has instigated a 5-year moratorium on hunting through the year 2000, which is an important step forward in recovering prey populations. However, snares likely have an even greater impact on prey populations than hunting. Based on the preliminary findings of our survey, the Hunchun Forest Bureau has already instigated a program for removal of all snares from all Forest Districts. Continuation of this program, and successful elimination of snares will be a key for recovery of tigers and leopards. We strongly urge the Provincial government, the Ministry of Forestry, and appropriate local authorities to continue to implement actions that will lead to the removal of snares from forest lands.

7.1.6 Coordinate Timber Harvest Regimes and Tiger/Leopard Conservation Efforts on Ministry of Forestry lands. Nearly all potential tiger habitat in Jilin is managed by the Ministry of Forestry. Therefore, it will be largely the task of the local Forest Districts to manage use of these lands in a way that will be compatible with tiger and leopard conservation efforts. The human density that now exists in northern Hunchun County is similar to areas in the Russian Far East where tigers and leopards thrive - therefore, the existent human density is not necessarily an impediment to recovery. However, it will be important to consider some changes in management of forest lands. We recommend that the following issues be considered by the Hunchun Forest Service.

1 Retain the use of oxen to extract timber in tiger management zones. Over most of the areas surveyed, timber was extracted primarily with the use of oxen. This type of logging activity reduced impact on the soils and had only slight impacts on the river bottoms through which timber was hauled. Such logging activity has far less impact than other types of mechanized extraction process, (e.g., use of skidders, or tractors). Therefore, we strongly recommend that this extraction process be continued in tiger management zones, and that mechanized extraction be prohibited, except to haul timber from collection sites.

2 Employ a selective cutting regime. Throughout the areas surveyed, clearcutting of forests was observed in some areas, but selective cutting of specific species was more generally practiced. Although selective cutting can also have negative impacts on forest health, and ultimately, on the animals dependent on those forests, a selective cutting regime is strongly preferable to clearcutting in preserving tiger and leopard habitat.

Therefore, we recommend that, where logging is to occur, a selective logging regime should be employed (with restrictions), and that clearcutting be avoided.

3 Protect Korean pine. Nuts from Korean pine (*Pinus koraiensis*) provide a critical fall and winter food supply for wild boars, red deer, and sika deer, the primary prey of tigers, and therefore are of critical value as a component of tiger habitat. Our observations in eastern Jilin Province suggest that there is very little Korean pine left, but that extraction of this species is continuing. Because of its importance in providing a winter food supply to key prey species, we recommend that logging of Korean pine in potential tiger habitat be discontinued.

4 Avoid monoculture plantations, especially of larch (*Larix spp.*). Jilin Province Ministry of Forestry should be applauded for engaging in an aggressive replanting program following logging activities. However, monoculture plantations provide relatively poor habitat for ungulates, and therefore, for leopards and tigers as well. This fact is especially true for monotypic stands of larch, which was one of the more common types of plantations that we saw. Trees within these stands are usually closely aggregated, and provide little light penetration, and therefore little forage for ungulates. Additionally, in some places understory is removed. Such practices may enhance growth rates and health of trees, but greatly reduce the value of the land for ungulates. Therefore, where plantations are planned in the future on potential tiger habitat, we recommend that monocultures in general be avoided, that plantings of larch be interspersed with other species to provide a greater diversity of tree species, and that thinning of understory be avoided.

5 Avoid logging activities in riverine forests. Riverine forests are particularly important habitat for ungulates. In general, riverine forests are more productive, more diverse, provide more forage, and provide better cover for many of the key prey species of tigers and leopards. These forests are particularly important in winter, when deep snows can limit travel of ungulates. Because of higher prey densities and easier travel conditions, riverine forests are often used by tigers, and to a lesser extent leopards. Although it is necessary to haul harvested timber through riverine forests, protection of these forests is critical not only for wildlife conservation, but for protection of water quality in the region. Elimination of harvests on riverine forests, and minimization of human impact will be an important component of tiger and leopard conservation.

6 Extract timber on a sustainable basis. Jilin Province is dependent on its forest lands for production of timber for its economic well-being. However, it is also clear that local people rely on forest lands for extraction of a great variety on non-timber products as well. Therefore, it is critical that timber extraction be balanced with the needs of local citizens to insure that they are provided with sufficient employment, timber products (firewood, building supplies) and non-timber products (eatable plants, medicinal plants, mushrooms, berries, etc.). It is the responsibility of the Forest Service to insure that timber is extracted in an appropriate manner and at a rate that insures that a continuous, balanced production will be possible on a long-term basis.

7.1.7 Develop an environmental education program for villages close to tiger management zones. A local environmental education program aimed at people in the small villages close to tiger habitat should be focused on explaining the need for tiger and leopard protection, and increasing local knowledge of existing laws on wildlife conservation in China. Such a campaign can be developed through newspapers, TV broadcasts, billboards, information leaflets, and advertisements. It would also be desirable to develop an environmental education program in local schools. In general, the program should be initiated to increase public awareness of the need to protect natural resources.

7.1.8 Retain the moratorium on hunting, and develop a reward system for wildlife protection. The Jilin Provincial Government should be applauded for its efforts to protect ungulate populations through implementation of a 5-year ban on hunting. Although there has been no rigorous monitoring program, it is evident that, half-way through the program, ungulate populations are still extremely low in many regions. Therefore, to assist in recovering prey populations, it is recommended that the moratorium on hunting should be extended, and strict implementation of the law is essential.

An incentive program could develop by the Wildlife Conservation Association to provide rewards for successful conservation efforts, and oversee implementation of all work associated with leopard and tiger management.

7.1.9 Develop a state-sponsored compensation program for tiger/leopard depredations on cattle and all livestock. **A** recurring problem throughout the world-wide range of tigers is depredation on domestic livestock. In areas where tigers are in close contact with humans and their livestock, depredation will inevitably occur, especially where prey populations are low (as is the case in Jilin). There have been a variety of methods employed to address this issue, ranging from no response (owners of livestock incur the loss) to local insurance programs (in which local livestock owners pay a premium for insuring against loss), to full compensation. In general, it is clear that where there is no compensation, and repeated losses to tigers occur, local people take matters into their own hands, and shoot, trap, or poison tigers to mitigate their losses. Depredations by tigers are occurring in Jilin, and were recorded during our survey. However, given the presently small population of tigers in Jilin, livestock depredation occurs at most, only a few times per year. At this low level of occurrence, a very small amount of money is required for full compensation of local people.

It is recommended, therefore, that a state-sponsored compensation program that includes verification of depredation events be initiated and administered by the Ministry of Forestry. It is highly recommended that inhabitants of Hunchun County be notified that full compensation will be provided only under the following conditions: 1) a depredation loss is immediately reported to the local Forest Service; 2) a trained representative of the Forest Service or other appropriate organization visits the site, and confirms that a tiger (or leopard) was present, based on tracks, scat, or other sign. Full records of all depredations, including location, type of animal killed, owner of animal, and information surrounding the incident, should be maintained and summarized for each year by each Forest District.

If recovery of tigers and leopards is successful in Jilin, and depredations become more prevalent, it may be necessary in the future to modify this compensation program. However, for the immediate future, a depredation compensation program can be initiated at low cost, will reduce local animosity towards tigers, can reduce the chances of illegal killing of tigers, and will provide a framework for monitoring the presence of tigers through the records maintained on depredations.

8. CONCLUSIONS

Results indicated that the majority of tigers and leopards were recorded close to the Russian border, and that nearly all confirmed reports of both predators were within Hunchun County. There are also a few infrequent reports of tigers and leopards to the west in Wangqing and Antu. Permanent resident animals likely occur only along the Russian border, where there may be a few individuals of both tigers and leopards that maintain territories that include both countries. Of critical importance is the fact that we were not able to confirm the presence of reproduction by either species anywhere in Jilin. Although there was one interview (#25) in which cubs were potentially reported, we were not able to verify this observation. A lack of reproduction would indicate that Jilin is dependent on immigration of tigers and leopards into the Province, and that the existent population here is not self-sustaining. Therefore, one of the primary goals of a conservation program should be the establishment of reproducing females within Jilin. Reports of female tigers or leopards with cubs should be thoroughly investigated and reported.

Based on historical data, it is clear the tigers and leopards ranged throughout eastern Jilin in the past. Gradual clearing of lowlands for agricultural development, dramatic increases in logging activity, and severe reduction in prey numbers through intensive human harvest led to fragmentation of habitat, and elimination of tigers and leopards from large portions of its former range. Although tigers and leopards appear to be infrequent visitors to Wangqing and Antu Counties, it appears that there exists potential habitat in which both species could exist. However, it will be necessary to provide dispersal corridors to connect these habitat patches with Hunchun County habitat.

The primary obstacle to an increase in populations of tigers and leopards appears to be low densities of prey populations. Tracks of red deer were found on only a few occasions, wild boar densities were higher to the west in Antu County, and sika deer were common only along the Russian border. Roe deer densities were low but occurred across all areas surveyed. While roe deer are suitable prey for leopards, it is unlikely that tiger populations can thrive where only roe deer occur. Evidence of hares and badgers, suitable prey for leopards, were also scarce. Therefore the highest priority for recovery of tiger and leopard populations is the recovery of prey populations. Hunting has already been banned by the Provincial government, which is an important first step that should be applauded, but by itself is probably insufficient for recovery of prey populations. Wire neck snares are scattered throughout the survey area and are likely depressing prey populations, as well as potentially killing both tigers and leopards. It should be a high priority to reduce this impact by intensive efforts to eliminate snares from Forest Service lands.

Despite the dangerously low populations of tigers, leopards, and their prey, there are at least four reasons for optimism. First, there remain extensive tracts of forest lands in northern Hunchun, Wangqing, and Antu Counties that are well managed by the Ministry of Forests, and retain the capacity to harbor good populations of prey, as well as tigers and leopards. Secondly, although China has a very large human population to care for, human densities adjacent to potential tiger and leopard habitat are not high, and in fact are comparable to regions in nearby Russia that harbor healthy populations of both tigers and leopards. Thirdly, there exists sizable populations of tigers, leopards, and their prey in adjacent habitat in Russia which could act as a source for animals emigrating into Jilin, thus speeding the recovery process. Finally, there appears to be a sincere desire on the part of the Wildlife Animal Protection Society and the Ministry of Forestry, as well as other branches of the government, to assist in recovery of tiger and leopard populations.

Therefore, we recommend the development of a recovery plan for tigers and leopards that focuses on Hunchun County as a critical first step, and has, as its goal, the re-establishment of a breeding population of leopards and tigers in Jilin Province. If successful, the initial step - recovery of breeding populations in Hunchun County- would provide the nucleus for dispersal of tigers and leopards into Wangqing and Antu. We do not believe that reintroduction of either species is necessary at this time. There exists small but adequate populations of both leopards and tigers in Russia that could act as a source for Hunchun County, if prey populations are restored. Information obtained during the survey confirmed that both tigers and leopards cross the international boundary. As part of the recovery effort it is critical to establish new protected areas for tigers and leopards in Hunchun County. In particular, we recommend that the potential ecological corridor between the three countries (China, Russia, North Korea) in Jingxin, southern Hunchun County, along the Tumen River, be immediately protected from further development, pending a complete investigation of this region. This mountainous region is the only place that could provide a linkage amongst all three countries, and should therefore receive immediate attention. Creation of a protected status for lands in Dalongling as part of the proposed Panthera Big Cat international park, and development of the Laoyeling Rare and Endangered Wildlife Protection Zone will also be critical first steps.

There exists 20-30 leopards in southwest Primorye, Russia, and these animals, along with the few remaining in Jilin, represent the last viable population of wild Far Eastern leopards in the world. There also exist 6-8 tigers in southwest Primorye, which are separated from the main Sikhote-Alin population in Russia by a development corridor. The status of both species to the north in Heilongjiang, and to the south, in North Korea, is unknown, but likely no better than in Jilin. Therefore, the existent populations of both tigers and leopards in southwest Primorye and Jilin are in extreme danger of extinction, and will not survive without a cooperative management program between the two countries that increases the amount of suitable habitat within which these predators can live. If conditions in Jilin are improved (primarily through an increase in prey populations), the existent breeding population of both tigers and leopards in Southwest Primorye will expand into northern and eastern Hunchun County, and hopefully, in the future, into Wangqing and Antu Counties.

Both Siberian tigers and Far Eastern leopards require a large land base, much of which can only be found in the Forest Service lands of Jilin Province. For these Forest Service lands of Hunchun County to act effectively as tiger and leopard habitat, they must be connected to provide for movement of animals amongst the 4 distribution regions (Dalongling, Russian Border, Tumen, and Panling-Laoyeling) (Figure 4). The opportunities for improving conditions in Jilin are excellent, and essential to securing viable populations of Far Eastern leopards and Amur tigers in the wild, but development programs are a serious threat. It is our hope that recovery of tigers and leopards in Jilin Province will become a high priority for Jilin Government officials, and for the Ministry of Forestry, and that land management practices will be implemented that will increase the quality of habitat, and increase the potential for successful recovery of these two magnificent, yet highly endangered wild cat species.

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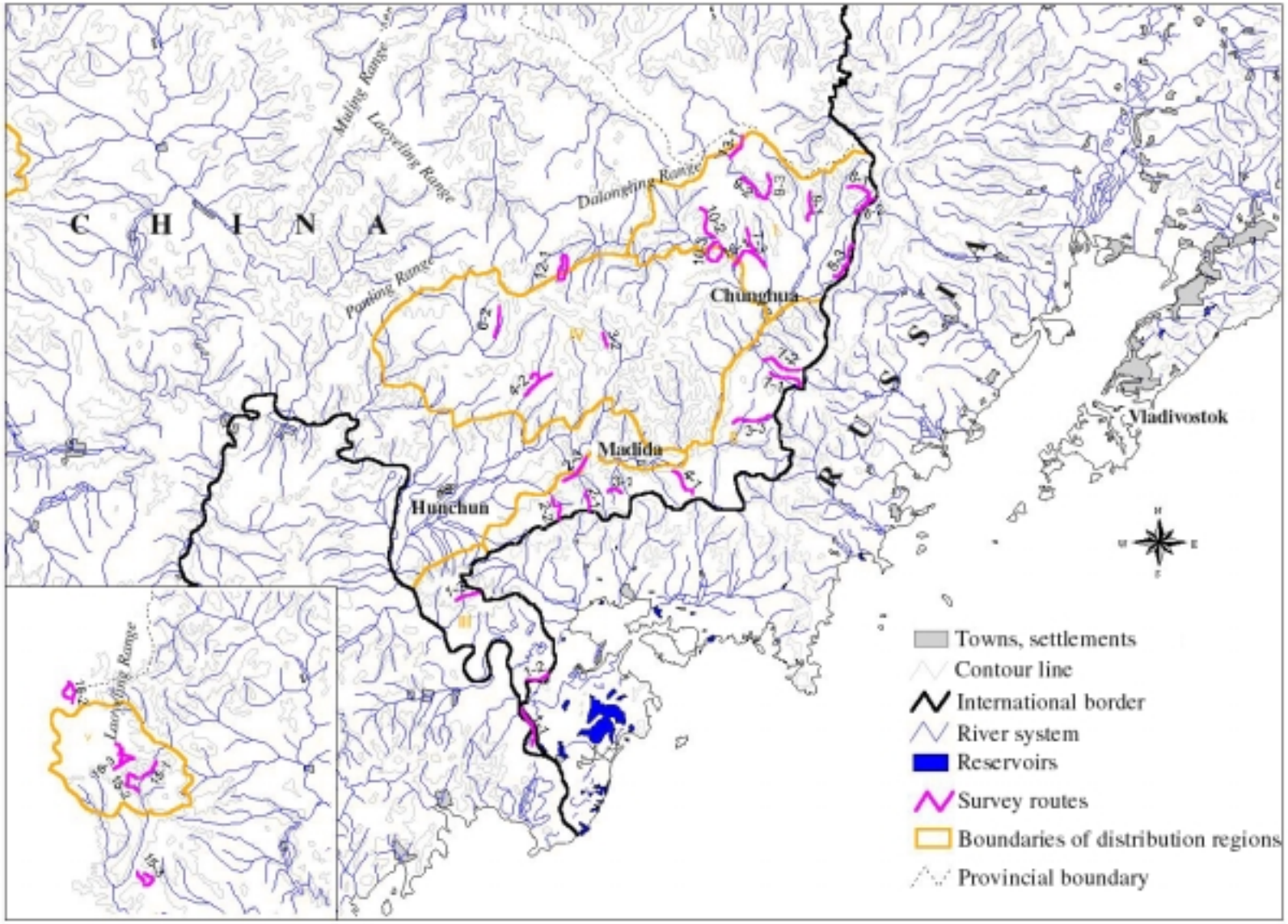
Figure 3. Location of study areas, boundaries of distribution regions, and location of survey routes for the 1998 survey of tigers and leopards in eastern Jilin Province, China



ИАЦ "ТИГИС"

Figure 4. Location of tiger sign based on interviews of local people and survey routes walked during February and March 1998 in eastern Jilin Province, China

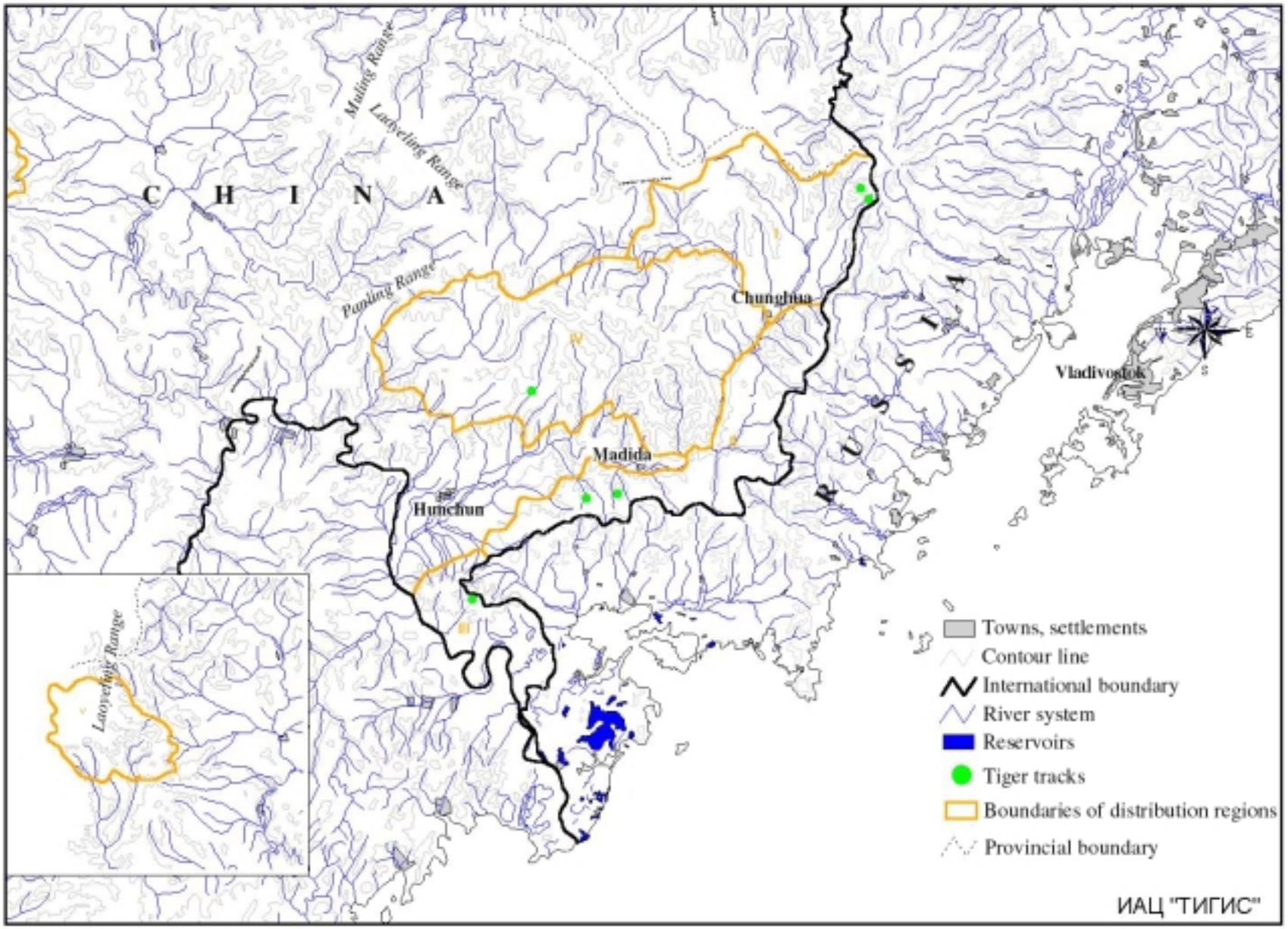


Figure 5. Location of leopard sign based on interviews of local people and survey routes walked during February and March 1998 in eastern Jilin Province, China