1999 SURVEY OF AMUR TIGERS AND FAR EASTERN LEOPARDS IN EASTERN HEILONGJIANG PROVINCE, CHINA AND RECOMMENDATIONS FOR THEIR CONSERVATION

Cooperators:

Heilongjiang Wildlife Institute, Harbin, Heilongjiang, People's Republic of China
Heilongjiang Provincial Department of Forestry, People's Republic of China
Hornocker Wildlife Institute, USA
Wildlife Conservation Society, USA

Sponsor:

Wildlife Conservation Society, USA

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Authors:

Sun Baogang, Heilongjiang Wildlife Institute
Dale G. Miquelle, Wildlife Conservation Society/Hornocker Wildlife Institute
Yu Xiaochen, Heilongjiang Wildlife Institute
Endi Zhang, Wildlife Conservation Society
Sun Hiyai, Heilongjiang Wildlife Institute
Guan Goshen, Heilongjiang Wildlife Institute
Dimitry G. Pikunov, Head Laboratory of Ecology and Protection of Wild Animals, Far Eastern Branch of the Russian Academy of Sciences, Institute of Geography
Yuri M. Dunishenko, Senior Researcher, All-Russia Research Institute of Wildlife Management, Hunting and Farming
Igor G. Nikolaev, Research Scientist, Institute of Biology and Soils, Laboratory of Vertebrate Zoology, Far Eastern Branch of the Russian Academy of Sciences
Lu Daming, Heilongjiang Wildlife Institute

Cooperators:

Heilongjiang Institute of Wildlife, Harbin, Heilongjiang, People's Republic of China
Heilongjiang Provincial Department of Forestry, People's Republic of China
Hornocker Wildlife Institute, USA
Wildlife Conservation Society, USA

Sponsor:

Wildlife Conservation Society, Bronx, USA

This report can be cited as:

Sun B., D. G. Miquelle, Y. Xiaochen, E. Zhang, S. Hiyai. G. Goshen, D. G. Pikunov, Y. M. Dunishenko, and I. G. Nikolaev, and L. Daming. 1999. 1999 Survey of Amur tigers and Far Eastern leopards in eastern Heilongjiang Province, China, and recommendations for their conservation. A final report to The Wildlife Conservation Society. 56 pages.

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PREFACE

Natural ecosystems, and the species which depend on those ecosystems, are being lost at a rapid rate throughout the world due to development, high human densities, and extraction of natural resources. Large mammalian carnivores are particularly vulnerable to large-scale impacts to ecosystems because of their large land requirements and their position at the top of the trophic chain - any impact can have a "ripple" effect that can seriously affect predator populations. Therefore, surveys such as the one described here, are important not only because they provide an indicator of the status of large carnivores, but are also a reflection of the integrity of natural ecosystems in a region.

Northeast China was originally a vast forest complex, rich in its variety of animal and plant life. More than 70% of Northeast China was originally forested, and one hundred years ago it was described as "verdant and luxurious. The entirety of the forest looks like a cloud covering the entire sky….Huge branches [of ancient trees] seem as old dragons rushing into the sky" (The Fortune of Manchuria 1909). Such is no longer the case. Most of these forests have been exploited to varying degrees, and are a remnant of what was once a nearly continuous forest tract. Nonetheless, forests still cover a large portion of eastern Heilongjiang, and the opportunity for retaining a diversity of forest ecosystems still exists.

This report represents a final stage in a series of surveys that have been conducted across the Sino-Russian transboundary region to better define the status and distribution of the Amur tiger and the Far Eastern leopard at the end of the 20th century. There has been a long tradition of surveying wildlife in the Russian Far East, beginning with Kaplanov's (1948) now classic work to estimate the number of tigers in "Ussuriland." A series of surveys in both Jilin and Heilongjiang (reviewed below) have also attempted to track changes in tiger and leopard numbers on the Chinese side of the border. But starting in 1996, when a full-range survey of tigers took place in the Russian Far East, there has been an international effort to define the status of leopards and tigers across their entire range, irrespective of international boundaries. These efforts began in China in 1998, with the UNDP and WCS-sponsored survey of leopards and tigers in eastern Jilin Province. At the same time, a series of surveys have monitored the status of leopards and tigers along the border regions on the Russian side.

The results of this Heilongjiang survey are the culmination of this process. In the final section, we have outlined a bold action plan to save tigers and leopards that is entirely dependent on cooperative efforts between Russia and China. It is clear that if the Amur tiger is to survive in China, and if the Far Eastern leopard is to survive at all, cooperative management of these two species will be essential. It is our hope that these surveys, conducted by multi-national parties, will act as the catalyst for such cooperative management of the rich natural ecosystems of these international boundary regions. 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. With these surveys, we now have the necessary knowledge. Hopefully, we will also have the wisdom to make the right decisions.

ACKNOWLEDGMENTS

Financial support for this survey was provided by the Wildlife Conservation Society. We thank Josh Ginsberg, Asia Program Coordinator, for continuing support of this work. The Hornocker Wildlife Institute invested substantial logistical support, and we are indebted to Howard Quigley and Maurice Hornocker for their support.

The State Forestry Administration, Heilongjiang Forest Industry Bureau, Heilongjiang Provincial Department of Forestry, and the Forest Bureaus of Suiyang, Muling, Yingchun, Dongfanghong, Dongjingcheng and Dahailin all provided key support. Supervisors of each Forest Bureau provided supplies and support, and put their personnel at our disposal. We thank each of them for their assistance - our project would have been virtually impossible without their support. In addition, we thank Dr. Chen Huapeng, Jin Kun and Li Diqiang for their assistance in field work.

Executive Summary.

An international team of specialists conducted a survey of leopards and tigers in eastern Heilongjiang Province, between January 19 and March 19, 1999. Mailed questionnaires and an extensive process of questioning local villagers and Forest Service employees about recent observations of tigers and leopards provided a basis for identifying areas of interest and delineating field routes to be surveyed. Over 600 km were covered on 67 routes by 4 teams of investigators.

Responses to questionnaires and interviews, and results of field surveys suggested that 5-7 tigers occurred in eastern Heilongjiang in the 1999 winter. However, the data suggest that there no longer exists a resident, stable population anywhere in Northeast China, and that, with the possible exception of the Eastern Wandashan Mountains, no reproduction of young is occurring. These results, in concert with results from Jilin (Yang et al. 1998), indicate that Amur tigers in Northeast China exist largely as nomadic, isolated individuals, and that there is no breeding nucleus to sustain this population. We therefore conclude that the Amur tiger is on the verge of extinction in Northeast China, and that it is presently sustained by emigration of individuals from Russia. The extinction of tigers in Northeast China can only be averted if an immediate and long-term commitment is made to conservation of this subspecies in the wild.

Perhaps 3-5 Far Eastern leopards still occur in eastern Heilongjiang Province. With the exception of the Laoyeling region, leopards were probably historically rare in Heilongjiang. As with the tiger, there is no evidence of a stable, resident population anywhere in Northeast China. More than the tiger, survival of this leopard subspecies is dependent on securing habitat in China. Protection of habitat in Laoyeling region of Heilongjiang can play a vital role in protecting the last population of Far Eastern leopards.

Prey populations seem to be critically low in most areas surveyed. Intensive poaching appears to be the primary cause of prey depletion, and tiger recovery will be largely dependent on recovery of prey populations (red deer, wild boar, and roe deer). Removal of snares, and control of illegal hunting activities will be key for increasing prey populations.

Based on surveys in Russia, Jilin, and Heilongjiang, it is assumed that two spatially separated populations of Amur tigers exist: the Tumen River Population, which occurs in southwest Primorskii Krai Russia, Jilin Province, southern Heilongjiang (Laoyeling and Zhangguangcailing), and possibly North Korea; and the Sikhote-Alin Population (of which the Wandashan tigers represent a sub-population). Conservation plans should seek to protect both populations and retain connectivity of all subpopulations within each of these populations, irrespective of provincial or international boundaries. A land-use plan is proposed to conserve these two populations of tigers in Northeast China by connecting protected areas across provincial and international boundaries with three levels of land use: strictly protected areas, tiger management zones, and ecological corridors linking management areas. If implemented, recovery of prey populations will lead to natural emigration and establishment of resident, breeding populations of tigers in Jilin and Heilongjiang Provinces. It is estimated that the Tumen River Tiger Population could consist of as many as 42 tigers (including 21 resident, breeding females) across Russia, Jilin, and Heilongjiang, and that 17 tigers could exist in the Wandashan-Strelnikov subpopulation. Tigers in northern Laoyeling and Pogranichny Raion Russia can only be conserved if they are linked to Southwest Primorye via an ecological corridor and tiger management lands in Northern and Southern Laoyeling. This same complex of managed lands in Laoyeling will be critical to long-term survival of the Far Eastern leopard population. Specific management guidelines are proposed for tiger management zones. The proposed land-use plan is compatible with the Project for Protection of Natural Forests enacted by the Chinese government. Immediate actions are necessary to insure the recovery of tigers in Northeast China.

1. INTRODUCTION

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. The tiger (*Panthera tigris*) is threatened across its entire range throughout Asia by a combination of poaching, habitat loss, and loss of prey (Karanth et al. 1999). Because of its large area requirements (Miquelle et al. 1999) the Amur tiger is particularly susceptible to habitat fragmentation and consequent loss of genetic diversity. The fact that this subspecies presently is distributed across three countries (Russia, China, and possible North Korea) makes development of a comprehensive management plan that will prevent habitat loss and fragmentation particularly problematic.

The Far Eastern leopard is even more endangered than the Amur tiger. Surviving only in a relatively small tract of forests along the Sino-Russian border, their habitat is bounded to the east by the Sea of Japan, to the west by development in Hunchun County (Jilin Province), to the north by agricultural development in Pogranichny and Ussuriski Raions of Russia and adjacent lands in Heilongjiang. To the south, their status in North Korea is simply unknown. In total, their numbers have been consistently pegged at less than 40 individuals over the past 20 years.

Accurate information on the status of these species is a critical first step towards conservation planning that may mitigate the potential impact of development and loss of habitat. Russia conducted a range-wide survey of tigers in 1996 (Matyushkin et al. 1996) and has since conducted several leopard surveys (Pikunov et al. 1997, Aramilev et al. 1998). With support of the UNDP, Jilin Province conducted a survey on tigers and leopards in 1998 (Yang et al. 1998). A final component necessary to have a complete picture of tiger and leopard distribution at the end of the 20th century is this survey of eastern Heilongjiang Province, China.

In March 1993, during an international conference on Amur tiger conservation in Khabarovsk, Russia, the Heilongjiang Wildlife Institute, Hornocker Wildlife Institute and the Russian Academy of Sciences Far Eastern Branch Pacific Institute of Geography agreed to cooperate in development of an Amur tiger and Far Eastern leopard survey in the Ussuri River basin. Between 1993 and 1996 exchanges and visits were made, during which time it was agreed that international cooperation and international protected areas would be essential to secure potential habitat for both species and their prey.

Based on a series of meetings between representatives of the Wildlife Conservation Society, the Hornocker Wildlife Institute, the Russian Academy of Sciences, and the Heilongjiang Wildlife Institute, financial support was committed and plans were formulated for a survey to be conducted in the winter of 1998-1999.

2. BACKGROUND INFORMATION

2.1 Status of tigers

2.1.1 Previous surveys in Heilongjiang.

Recent information on tiger distribution in Heilongjiang Province is based on three previous surveys.

1) 1974-1976. A wildlife survey during this period employed 964 fieldworkers to cover 51,956 km of survey routes. Survey results indicated that 81 tigers (including young) were present in eastern Heilongjiang (east of 127^{o} E longitude). No evidence of tigers was found in the Greater Khingan Mountains. A total of 8 tigers were reported in the Lesser Khingan Mountains, 28 in the Wandashan Mountains, 28 in Zhangguangcailing, and 17 in the Laoyeling region (Figure 1).

2) 1984-1986. Between 1984 and1986, a tiger survey was conducted in Northeast China. Survey methods included interviews, field surveys and an attempted aerial survey. The survey region included the eastern mountainous areas in Heilongjiang Province and Changbai Mountain region in Jilin Province. The results suggested that there were approximately 20-30 tigers in Northeast China, that the quality of the tiger habitat was degraded, and that ungulate densities were low.

3) 1988-1991. Between 1988-1991, a wildlife census, primarily focused on tigers and other endangered species, was conducted across 40 Forest Bureaus of Heilongjiang Forest Industry Bureau. Over 900 people covered a total of 3,368 survey routes. The results suggested that 10-14 tigers lived in Laoyeling, Zhangguangcailing and Wandashan regions of Heilongjiang Province (Figure 1). No evidence of tigers was found in the Lesser Khingan Mountains. At that time, 2-4 tigers were reported in Dongfanghong and Yingchun Forest Bureaus (Wandashan); 4 in Huanan Forest Bureau (Western Wandashan); 1-3 in Suiyang (Southern Laoyeling); 1 in Muling and eastern Dongjingcheng (Southern Laoyeling); 1 in Fangzheng, Caihe and Yabuli (Northern Zhangguangcailing); and 1 in Dahailin, Shanhetun and western Dongjingcheng (Southern Zhangguangcailing) (Figures 1 and 4).

Prey densities within the survey areas were generally low (Table 1). With low densities of red deer and wild boar (generally considered key prey species where sika deer do not occur), it is clear that there were insufficient prey to support tigers in many areas. Low prey densities were reported for Western Wandashan and Southern Laoyeling, as well as both Northern and Southern Zhangguangcailing. The Eastern Wandashan Mountains retained the highest prey densities at the time of the survey, and probably represented the best chances for survival of tigers in eastern Heilongjiang.

Since this survey, there have been no reports of tigers in the Western Wandashan Mountains. It is likely that a combination of habitat destruction, habitat fragmentation, and low prey densities, with the additional potential burden of human-induced mortality, resulted in the loss of tigers from this region. Fragmentation of forest habitat has resulted in isolation of this habitat patch, making recolonization highly unlikely.

2.1.2 Jilin Province

Information from Jilin Province, China are based on a series of surveys. In 1976, four tigers were found in Shanhe of Chunhua; in 1982 six tigers were reported in Chunhua, Madida, Yangpao and Liangshui (North Eastern Forestry University); in 1983, four animals were identified by the Hunchun Forestry Bureau; and in 1992 three to five tigers were reported by the Jilin Provincial Wildlife Survey Team based on interviews of local

citizens. In 1996, based on an expert assessment, it was estimated that perhaps 12 tigers lived in Northeast China (Ma and Li 1996).

In winter 1998, a questionnaire and field-based survey conducted by a international team of specialists determined that four to six tigers occurred in eastern Jilin Province at the time of the survey (Yang et al. 1998). With a few exceptions, most of the evidence demonstrating presence of tigers was found close to the Russian border, opposite Southwest Primorye, Russia. Additionally, evidence suggested that all animals were nomadic, i.e., not permanent residents. Just as significant, there was no evidence of reproduction (i.e., no cubs) in the areas surveyed.

Table 1. Prey densities in tiger range surveyed in eastern Heilongjiang Province, 1988-1991.

		Animals/10 km^2						
Region	Forest Bureau	Wild boar	Red deer	Roe deer	Musk deer	Bears	Hares	Squirrel
Eastern Wandashan	Dongfanghong	3.72	9.76	22.56		0.54	8.96	0.99
Eastern Wandashan	Yingchun	3.35	9.20	15.80		0.33	0.58	2.91
Western Wandashan	Huanan	1.57	3.05	3.41		0.27	1.09	
Southern Laoyeling	Suiyang	0.36	3.65	4.66	0.05	0.22	0.50	
Southern Laoyeling	Muling	1.99	1.88	6.54	0.13	0.24	0.51	6.26
S. Zhangguangcailing & S. Laoyeling	Dongjingcheng	1.92	0.99	9.55	0.29	0.28	0.79	2.92
N. Zhangguangcailing	Fangzheng	3.30	1.84	5.47	0.15	0.38	1.35	7.84
N. Zhangguangcailing	Caihe	1.02	0.51	1.71	0.08	0.19	0.33	4.74
N. Zhangguangcailing	Yabuli	1.04	0.62	3.19	0.16	0.27	0.80	6.97
S. Zhangguangcailing	Dahailin	3.55	2.66	11.34	0.25	0.66	1.66	5.58
S. Zhangguangcailing	Shanhetun	0.40	1.00	15.80		0.12	0.68	
Average		2.02	3.19	9.09	0.16	0.32	1.57	4.77

2.1.3 Russia

The status of the Amur tiger in Russia is relatively well known due to a series of surveys in the past 30 years (Yudakov and Nikolaev 1970, Pikunov 1985, Matyushkin et al. 1996). The most recent, in 1996, reported 330-371 adult Amur tigers in Primorskii and Khabarovskii Krais in the Far East Russia (Matyushkin et al. 1996). While the majority of this population survives in an intact continuous habitat of the Sikhote-Alin Mountains, there exist several fragmented populations, including four that border China (Figure 2) and are of direct relevance to conservation efforts in China, including:

1) Southwest Primorye. A small population of tigers survives in approximately 350,000-400,000 ha of habitat southwest Primorye. Amur tigers have always inhabited southwest Primorye, but numbers have never been high. This fragmented habitat has been virtually cut off from the main block of habitat in the Sikhote-Alin Mountain Range of Russia by development. In 1970, 3 individuals were recorded (Yudakov and Nikolaev 1973), in 1984-85 8 individuals occurred there, (Pikunov 1990), in 1995-1996, 6 individuals were

reported (Matyushkin et al. 1996), and in 1998 it was estimated that 14-18 tigers existed in the region (Aramilev et al. 1998). Three protected areas in Russia - Kedrovya Pad Zapovednik (18,000 ha), Barsovy Zakaznik (97,400 ha), and the newly gazetted Borisovkoe Plateau Zakaznik (61,300 ha) - provide good protection to habitat and prey populations over a portion of this habitat patch.

On the Chinese side, opposite Southwest Primorye, although there is intensive development surrounding the city of 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 this side of the border are precariously low and in endanger of extinction.

2) Pogranichny Raion. A second, ephemeral population of tigers occurs in this region. Suitable tiger habitat in Pogranichny Raion is comprised of an isolated patch of no more than 250,000 ha. This tiger population appears to be ephemeral, with individuals appearing and disappearing periodically. No more than 4 tigers were reported by Yudakov and Nikolaev (1970), while no evidence of tigers was found in 1978-1979 (Pikunov et al. 1983). Tigers reappeared in the early 1990's, and in the 1996 survey 4 individuals (2 adults and 2 cubs) were reported. However, a 1998 survey, simultaneous with the one conducted in Heilongjiang, failed to find evidence of tigers (Pikunov unpubl.).

3) Strelnikov Range. The Strelnikov Mountains border China's Wandashan Range, and are connected to the Sikhote-Alin Range via a narrow forested corridor that is bisected by the Vladivostok-Khabarovsk road between the city of Luchegorsk, in Primorskii Krai, and the village of Bikin, in Khabarovskii Krai. This patch of habitat includes land in both Primorskii and Khabarovskii Krais. In the 1996 survey, tigers were reported in this region. However, in 1998, coincident with work in the Wandashan, a survey failed to detect presence of tigers in this region (Dunishenko unpubl. data).

4) BolsheKhekhtsirskii Range. A very small island of habitat is included in Bolshe-Khekhtsirskii Zapovednik, just south of the city of Khabarovsk. Two adults plus young appeared in this area during the 1996 survey after a 50-year absence. No suitable habitat exists close to this habitat patch on the Chinese side of the border. As with the Pogranichny situation, this presence of tigers in this range is also ephemeral, as it is fragmented from suitable habitat both in China and the Sikhote-Alin.

2.2 Status of Far Eastern leopards

The Far Eastern leopard is yet more threatened than the Amur tiger. While leopards were once distributed across much of Jilin, southern Heilongjiang and southern Primorskii Krai, a single remaining population appears to be centered in southwest Primorye (Figure 2). Recent surveys in this region suggest that 24-40 leopards remain (Korkisko and Pikunov 1994, Pikunov et al. 1997, Aramilev et al. 1998). Yang and Jiang (1996) reported that the leopard population in Jilin Province has been decreasing from 45 in 1976-77 to 15 in 1991-92. The 1996 survey (Yang et al. 1998) reported evidence of 4-7 leopards in eastern Jilin Province.

In Heilongjiang Province there are no historic records of distribution or numbers of leopards due to a lack of surveys. In the more recent past (1974-1976; 1988-1991), surveys did not reveal the presence of leopards.

2.3 Regional Conservation Planning and Environmental Impacts.

A Sustainable Land-Use and Allocation Program for the Ussuri/Wusuli Watershed. In 1996 an international planning team consisting of Chinese, Russian, and Americans developed a land-use plan for the Ussuri Basin (Anonymous 1996). Recommendations arising from this plan 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 in southwest Primorye Krai on the Russian side, and 487,100 ha in Southern Laoyeling of Heilongjiang Province. Parts of Jilin Province were considered suitable for inclusion as well, and were tentatively included in the plan. Russia has, on its part, initiated the plan in 1996 by converting 613 km^2 into a Krai-level (Provincial) protected area, Borisovkoe Plateau Zakaznik (wildlife refuge). The second proposed international protected area, tentatively called the "Wandashan National Park and International Tiger Refuge", identified 324,700 ha in China, which are linked through a series of wildlife protection areas (zakazniks and ecological corridors) to the Sikhote-Alin ecosystem via the Bikin watershed.

The UNDP Tumen River Development Program. To the south of the Ussuri Basin, 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. The realm of influence this development program is expected to influence coincides directly with the remaining leopard habitat and the distribution of tigers in southwest Primorye, eastern Jilin, and southeastern Heilongjiang (Shibao et al. 1998, Figure 3). 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 patches. Individuals animals remaining in those isolated habitat units are extremely susceptible to extinction due to the effects of genetic deterioration, inbreeding, and random effects on small populations. Localized, gradual loss of individuals from each patch leads eventually to extinction of the species.

Natural Forests Conservation Project. Due to nation-wide concern of the loss and degradation of forest lands, loss of ecosystem integrity and reduction of wildlife resources due to high human populations and unsustainable exploitation, the "Natural Forests Conservation Project" was enacted in 1997 by the State Council of China. This project is a long-term attempt (1998-2050) to prevent further deterioration of the forest ecosystems, protect forest biodiversity, reduce logging intensity, enhance reforestation efforts, and develop more comprehensive plans for forest management. Its short –term goal (1998-2000) is to eliminate or greatly reduce logging levels to provide a recovery period for natural forests. At the same time, attempts will be made to focus develop of timber output on forest plantations with the goal of shifting 70% of timber output to plantation lands, thereby further protecting natural forests. Implementation has commenced on 135 Forest Bureaus, including those in Jilin and Heilongjiang Provinces. Timber production has decreased in 40 Forest Bureaus in Heilongjiang (with an initial focus on the Greater Khingan region). Most of the Forest Bureaus in the study region were in the process of decreasing timber output during the 1999 winter.

3. GOALS AND OBJECTIVES

This survey was designed to assess the status and distribution of large cats in eastern Heilongjiang Province, one phase in a series of surveys to better understand the distribution and status of Amur tigers and Far Eastern leopards throughout their respective ranges (Matyushkin et al. 1996, Pikunov et al. 1997, Aramilev et al. 1998, Yang et al. 1998). Effective efforts to conserve 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 both China and Russia. Remaining leopard habitat is extremely limited, and conservation of Far Eastern leopards will require efforts on both sides of the Russian-Chinese border. Tiger populations are fragmented in southwest Primorye and western Primorye (Pogranichny Raion) and localized extinctions of these sub-populations are highly probable without a united effort to increase the amount of suitable habitat and create ecological corridors between countries and amongst habitat patches. Thus the two primary goals of our survey were to: 1) provide an accurate assessment of tigers and leopards, their habitat, and potential prey existing in eastern Heilongjiang Province, China; and, 2) use survey information as a basis for making management recommendations. Ultimately, the survey will hopefully act as a catalyst to bring interested parties from Russia and China together to begin the process of developing cooperative management plans.

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

1) Describe the distribution of tigers and leopards in eastern Heilongjiang Province.
2) Estimate the minimum number of tigers and leopards in eastern Heilongjiang Province.
3) Assess the status of prey for tigers and leopards in eastern Heilongjiang Province.
4) Assess the status and amount of suitable habitat for tigers and leopards in eastern Heilongjiang Province.
5) Determine the potential for development of protected areas both along the international borders, and within Heilongjiang Province.
6) Determine where ecological corridors could effectively connect habitat patches across international and provincial boundaries, as well as within the Province itself.
7) Provide management recommendations to improve conditions, increase the population size, and secure a resident, breeding population of wild tigers and leopards in Heilongjiang Province.

4. STUDY AREA

4.1 Description of Study Area

4.1.1 Geographic location

The survey was focused in the eastern mountainous area of Heilongjiang Province, China, near the borders of Russia and Jilin Province, including Laoyeling, Zhangguangcailing, and Wandashan forested regions (Figures 1and 4). This area is geographically bounded by between 128°24’ and 134°05’E longitude, and 43°08’ and 47°15’N latitude. This region is bounded to the south by the provincial border with Jilin, and to the east by the international border with Russia.

4.1.2 Subdivision of study area into survey regions

There exists natural geographical divisions between the mountainous regions of eastern Heilongjiang Province, that is reflected not only by topography, but by forest cover as well. We defined 5 subdivisions within which we organized the survey and summarized results and recommendations (Figures 1 and 4).

1. Southern Laoyeling represents the southeastern border of Heilongjiang, bordered to the east by Russia, and to the south by Jilin Province. This region extends across Dongning, Muling and Ning'an counties. Forested areas are managed by the Muling Forest Bureau, the southernmost portion of Suiyang Forest Bureau, and the southeastern portion of Dongjingcheng Forest Bureau (Figure 4). The total area is approximately 9000 km². Forest types are primarily mixed conifer - broad-leafed forests, and secondary broad-leaved forests. Opposite Southern Laoyeling, on the Russian side of the border lies the Borisovkoe Plateau region, one of the best preserved and most diverse regions in the Russian Far East.

2. Northern Laoyeling is separated from Southern Laoyeling by a development corridor that includes a major road, and a number of cities, starting at the Russian border with Suifenhe. To the east, this region is bordered by good forested habitat in Pogranichny Raion in Primorskii Krai, Russia. Northern Laoyeling extends across Dongning, Jidong and Muling Counties, and includes Bamiantong Forest District in the northern part of Suiyang Forest Bureau (Figure 4). The total forested area includes about 1000 km², covered mainly by mixed conifer - broad-leaved forests, and secondary broad-leaved forests.

3. Southern Zhangguangcailing represents the southwestern edge of our survey area. This region borders Jilin Province to the south for 100 km, and includes the western part of Dongjingcheng Forest District, Dahailin Forest District (Figure 4) and Xiaobeihu Nature Reserve (60,000 ha). The forested area, approximately 5,000 km², is mainly covered by mixed conifer - broad-leaved forests, and secondary broad-leaved forests.

4. Northern Zhangguangcailing represents the northwestern corner of the survey area, and includes Fangzheng, Caihe, Yabuli, Lingkou and northern Hailin Forest Bureaus (Figure 4). The total area is roughly 10,000 km². Mountains are high and precipitous in this region, with the highest peak (Laotuding Mountain) at 1687 m. The predominant forest types are mixed conifer - broad-leaved forests, mixed broad-leaved forests, and secondary oak forests.

5. Eastern Wandashan is located in the northeast corner of the survey area, and bordered to the east by the Strelnikov Range in Russia, and to the north and west by the Naoli River. This region extends across Raohe, Hulin, Baoqing and Mishan County or City lands. Total forested area is approximately 14,000 km². Forests are mainly centered in Dongfanghong and Yingchun Forest Bureaus. Forest types found in the region are primarily mixed conifer - broad-leaved forests, secondary mixed broad-leaved forests, and secondary oak forests. There still remain a few stands of primary Korean pine forests at higher elevation around Shendingfeng Mountain.

4.1.3 Topography

The survey area is part of the middle and lower regions of Changbaishan Mountain Region, and consists of three small mountain ranges, the Laoyeling, Zhangguangcailing, and Wandashan. Topography is for the most part hilly with few large mountain massifs (Figure 4). Zhangguangcailing is the highest of the regions, with an average elevation between 500 and 1,000 m, while Wandashan is the lowest, with average elevation about 400 m. Average elevation of Laoyeling region is about 600m. Mountain slopes generally lie at 15-45 degrees.

4.1.4 Climate

This region is characterized by a temperate, oceanic climate that is the warmest and wettest of Heilongjiang Province. The annual mean temperature is 2.3º C, with the mean temperature in January -18.6º C, and mean temperature in July 21.6º C. Yearly average rainfall is 500-700 mm. The frost-free season lasts 122-151 days. In winter, the mean snow depth is 30-50 cm, but snow depth may reach 60-70 cm or more in the higher mountainous areas.

4.1.5 River System

In the Zhangguangcailing region, the largest river is the Mudan, arising in the Mudan peaks of Jilin Province, passing through Jingpo Lake, and joining the Songhua River in Yilan County (Figure 1). This river flows for 382 km within the survey area. The Hailang River is the longest tributary of the Mudan River (about 110 km), and is located in Dahailin Forest Bureau in Hailin County.

In the Laoyeling region the Suifen and Muling Rivers are the primary drainages of the region (Figure 1). The Suifen River arises near the border with Jilin Province, joins the Lesser Suifen River at Dongning County, and then flows into Russian territory. The Muling River arises in the southern mountains of Muling Forest Bureau, passes through Muling, Jixi, Mishan and Hulin county and city lands, and then joins the Song'acha River, which eventually flows into the Ussuri River.

In the Wandashan region, the Ussuri River, which forms the boundary with Russia, flows along the east edge of survey area (Figure 1). The Naoli, Abuqin, Dumu, and Dadai Rivers are the main tributaries of the Ussuri in the region.

4.1.6 Soils

The soils of the mountainous areas in east Heilongjiang are mainly dark brown forest soils. The middle plains and surrounding hills are composed primarily of "Baijiang", meadow, bog, and alluvial soils. Dark brown forest soils cover over 75% of survey area and are distributed over the mountainous areas between 600-1,200 m.

4.1.7 Vegetation

Vegetation within the survey area belongs to the Changbai Mountain floristic zone. The main vegetation types are mixed conifer forests, mixed conifer - broad-leaved forests, secondary broad-leaved forests, shrublands, and marsh meadows. Mixed conifer - broad-leaved forests are predominantly in the upper mountains, while at lower elevations secondary broad-leaved forests are dominant. The dominant conifer species in high elevation mountains are Korean pine (*Pinus koraiensis*), Jeddo spruce (*Picea ajanensis*), Khingan fir (*Abies*

nephrolepis), and larch (*Larix spp.)*. The main broad-leaved trees are Mongolian oak (*Quercus mongolica*), Manchurian ash (*Fraxinus mandshurica*), Manchurian walnut (*Juglans mandshurica*), Japanese elm (*Ulmus propingua*), aspen (*Populus davidiana*), three species of birch (*Betula platyphylla, B. dahurica and B. costata*) and two species of basswood (*Tilia amurensis and T. mandshurica*). The most common shrubs are hazel (*Corylus spp.*), willow (*Salix spp.*), Xing'an azalea (*Rhododendren dhuricum*) and lespedeza (*Lespedeza bicolor*). The most common herbaceous species include sedges (*Carex spp.*), horsetails (*Equisetum hiemale*), and ferns (*Pteridium spp.*).

4.1.8 Wildlife

Fifty-nine species of mammals belonging to 17 families and 6 orders have been reported within the region. Besides the Amur tiger and Far Eastern leopard, two other felids occur, the lynx (*Lynx lynx*), and leopard cat (*Felis euptilura*). Other carnivores include the brown bear (*Ursus arctos*), Himalayan black bear (*Ursus thibetanus*), sable (*Martes zebellina*), yellow-throated marten (*Martes flavigula*), Siberian weasel (*Mustela sibilica*), badger (*Meles meles*), common otter (*Lutra lutra*), raccoon dog (*Nyctereutes procyonoides*), and red fox (*Vulpes vulpes*). Ungulates occurring in the area include wild boar (*Sus scrofa*), sika deer (*Cervus nippon*), red deer (*C. elaphus*), roe deer (*Capreolus capreolus*), musk deer (*Moschus moschiferus*), and goral (*Naemorhedus goral*). Also present are common squirrels (*Sciurus vulgaris*), Manchurian hare (*Lepus mandschuricus*) and arctic hare (*L. timidus*). A total of 210 species of birds representing 43 families and 16 orders have been reported in the survey area, as well as 15 species of reptiles and 12 species of amphibians.

4.2 Social and Economic Conditions

4.2.1 Historical Changes and Development

In the mid-19th century, eastern Heilongjiang Province was covered by expansive tracts of primary forest, a sparse human population, and abundant wildlife resources. Near the end of 19th century, the Qing government initiated a policy of emigration to strengthen the boundary areas, resulting in many Chinese citizens from interior China moving into and developing this region. During the Japanese occupation (starting in 1937), intensive harvest of forest lands began, resulting in a gradually changing forest composition from large stands of primary conifer and mixed conifer-broad-leafed forests to secondary broad-leaved forests. Beginning in 1945, the Chinese government established 16 forest bureaus in eastern Heilongjiang Province, developed a forest management plan that combined logging with reforestation, and passed the "Forest Management Law" and "Wildlife Conservation Law." Nonetheless, ecosystem integrity and wildlife resources continued to deteriorate due to high

human populations and unsustainable exploitation. To counteract this trend, the "Natural Forests Conservation Project" enacted in 1997 by the State Council of China was enacted as a long-term attempt (1998-2050) to prevent further deterioration of the forest ecosystems, protect forest biodiversity, reduce logging intensity, enhance reforestation efforts, and develop more comprehensive plans for forest management.

4.2.2 Industry and agriculture

Fourteen industries in the region (with mining and chemical most important) are represented by over 200 industrial enterprises that employ over 50,000 workers. The main industries include coal, gold, iron, granite, paper, machinery, cement, chemical, cigarette, timber, ceramics, furniture, liquors and food products.

There are over 200 villages belonging to 14 cities or counties and 3 prefectures. The total area of farmlands covers about 6740 km². The main crops are corn, rice, wheat and soybean. Most villages scattered throughout the region are along river bottoms.

4.2.3 Wildlife management

Since 1949, the Chinese government has been attached great importance to wildlife conservation and management, and has published a series of wildlife conservation regulations and management guidelines, conducted environmental education programs, and conducted wildlife censuses and scientific research. A federal law regulating control of firearms was initiated in 1981. Since 1992, the province has outlawed possession of firearms and has actively confiscated weapons. At the same time (1992), a provincial law prohibited hunting of wildlife, by any means, was enacted. Due to these measures, wildlife resources have recovered to some degree in some areas. But traditional hunting methods, including muskets, neck and foot snares, are still in use.

4.2.4 Human Population

Over 570,000 people live within the survey area. Han nationalities are the dominant ethnic group.

5. METHODS

Despite the expected low numbers of tigers and leopards in Heilongjiang, the potential range of distribution is large (Figure 1). As recently as 1991 tigers were reported in Laoyeling, Zhangguangcailing and Wandashan. Given logistical and financial restrictions it was impossible to physically survey all potential habitat. Therefore, a three-stage process was used to attempt to collect information from the widest range of areas and identify those regions where there was a higher probability of encountering sign of tigers or leopards. As a first step questionnaires were sent out to those areas that historically harbored tigers and/or leopards to determine whether recent evidence existed. Based on results of questionnaires, in-person interviews of local people were conducted in likely areas to gather first-hand

accounts of 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 the greatest number of reports occurred, or where information appeared more reliable. Field survey routes were then focused in those regions where there was a higher probability of encountering signs of tiger or leopards.

5.1 Questionnaires and Interviews of Local Citizens

Collecting information from local people is an important first step in attempting to narrow the area of focus for field-based surveys. We used both mailed questionnaires and interviews of local citizens to gather data on potential distribution of tigers and leopards.

Questionnaires were distributed to local forest administrators, farmers, hunters and other potentially knowledgeable people (partially based on lists developed from previous surveys) within potential ranges of tigers and leopards to gather recent, but usually more generalized information on reports of tigers or leopards. This process provided a means of focusing interviews in those areas where higher response rates indicated greater probability of tiger or leopard presence. In those areas identified from the mail questionnaire, a large number of local people were visited to gather recent information on tiger and leopard distribution. Interviewees included wildlife management officials in the local government, forestry policy personnel, hunters, guides, archivists, border police and local citizens who use forest resources.

Recent information (1995-1999) on tigers and leopards were of primary interest. Six categories of information were collected during interviews:

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

5.2 Field Survey Routes

5.2.1 Field survey team and equipment

The field survey team was divided into four groups, each consisting of 4 people, including one Chinese specialist, one Russian or America specialist, one interpreter and one guide. Each group was equipped with a 4 wheel-drive vehicle that was used to cover survey routes, or provide transportation to survey routes. Each group was supplied with a topographic map (scale 1:100,000) with the proposed route laid out, a GPS (geographic positioning system), and a radio to maintain contact with the driver or nearby groups. The GPS was used to record beginning and end points as wall as locations along the route (usually about every 30 minutes or forest type change), to estimate route length, and to record geographic coordinates of tiger, leopard and other animal sign.

5.2.2 Route selection and adjustments in the field

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 (1997-1999), two or more survey routes were placed. Location of routes was based on

topography, administrative boundaries, landscape patterns, ease of access, and habitat characteristics. Survey routes often followed river bottoms or frozen rivers and creeks (where tracks would still be present), old logging roads or paths (human and animal), or ridges or divides that are natural animal travel corridors. In the Wandashan, areas with snow exceeding 50 cm were usually avoided.

Planned routes were mapped (scale 1:100,000) prior to initiation of fieldwork. Once in the field, routes were adjusted dependent on relief, distribution of snow, and landscape features to increase the probability of encountering tiger, leopard, and ungulate tracks.

Route length was generally planned to provide a full day of walking, adjusted for travel time to and from starting points. Survey route length was generally recorded 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. Where speed of travel was slow enough, and all tracks adequately counted, these sections were included in our estimate of route length.

5.2.3 Data collection on tigers and leopards

Where tracks or sign of tigers or leopards were found the following data were collected:

1) location (coordinates recorded with GPS);
2) width of the pad on the front paw;
3) length and width of the entire paw;
4) stride length;
5) direction of travel;
6) type of scent-marking (scrapes, scent-marking on trees, etc.)
7) estimated age of track (data of passage);
8) description of habitat; and,
9) photographs of evidence were taken.

Other signs of predators were also searched for, including scrapes, scent- marks, remains of kills, beds, or excrement.

The number of tigers and leopards in the survey region was estimated primarily on the basis of information collected during the field survey, and secondarily on information from reliable interviews. Tracks of similar size or other sign in close proximity to each other were considered to be representative of a single individual unless evidence indicated otherwise. 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 information from interviews used in estimated presence of tigers that was uncorroborated from other sources 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 and sign data of varying ages and conditions.

Distribution of tigers and leopards 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 or leopard sign is most frequently reported, and can provide an indication of which areas deserve more detailed assessment in the future.

5.2.4 Habitat Suitability

Assessing habitat quality is important component of evaluating conditions for tigers and leopards. Although we attempted no formal, quantitative assessment, we considered a variety of features that define quality habitat 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. The following habitat characteristics were also included in the assessment: forest types, forest condition, and extent of human disturbances. Human disturbances on potential tiger and leopard habitat were evaluated with the following criteria: human population density in the immediate vicinity, the extent of commercial forest use (logging) and personal use (hunting, plant collection, etc.), intensity, extent, and types 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 the five regions were determined on the basis of information collected from questionnaires, interviews, field survey routes, estimates of prey densities, and habitat assessment.

5.2.5 Prey assessment

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

1. General estimate of relative abundance along survey routes. This indicator was the most generalized form of reported ungulate abundance along survey routes. Signs indicating the presence of prey species - tracks, bed sites, feeding sites, excrement, and den sites provided positive evidence of a species presence in the area. All tracks (both old and fresh) were included in this estimate. Information from guides and employees of local forest districts provided additional information. We summarized information for all survey routes over each region, and reported results as:

1) **Absent** - no evidence of species;
2) **Low** – sign and tracks rare (1-3 tracks found along survey route);
3) **Moderate** – tracks and other sign in moderate amounts (4-10 tracks/km along route); and,
4) **High** – tracks (>10 tracks/km) and other evidence found in large numbers.

2. Tracks per kilometer of survey route. For every survey route walked, the number of fresh tracks, by species, were recorded for the entire length of the route. This information provide an estimate of tracks/km, which could be averaged over routes to provide an indication of relative abundance of ungulates. By reporting only those tracks estimated to be fresh (less than 24 hours) it is possible to compare relative abundance of ungulate species among study regions.

3. Animals along survey routes. Oftentimes, estimates of tracks along survey routes can give false estimates of relative abundance if individual animals repeatedly cross survey routes. To balance this potential error, we also reported an estimate of the number of animals that crossed survey routes. This indicator, although dependent on observer interpretation, can

in some situations provide a better estimate of relative abundance along survey routes than tracks alone.

6. RESULTS

6.1 Questionnaires and Interviews

6.1.1 Questionnaires

A total of 230 questionnaires on tigers, leopards and other species was distributed to the survey areas prior to the field survey. There were 66 responses, which included 27 reports of tigers, 9 reports of leopards and 30 reports of other species (Table 2). The majority

Table 2. Results of questionnaires mailed to gather evidence of tigers and leopards in Heilongjiang Province, 1998-1999.

	Forest Bureau/	# questionnaires		Information provided on		
Study region	County	sent	returned	tigers	leopards	other species
Southern Laoyeling	Muling	30	9	4	1	4
Southern Laoyeling	Suiyang	40	9	7	2	0
S. Zhangguangcailing S. Laoyeling	Dongjingcheng	35	17	2	1	14
S. Zhangguangcailing	Dahailin	30	7	0	2	5
N. Zhangguangcailing	Linkou	30	5	0	3	2
N. Zhangguangcailing	Fangzheng	10	1	1	0	0
Eastern Wandashan	Dongfanghong	35	12	9	0	3
Eastern Wandashan	Yingchun	10	2	2	0	0
Eastern Wandashan	Raohe	10	4	2	0	2
Totals		230	66	27	9	30

	% postive responses for		
Summary	Tigers	Leopards	Other species
Southern Laoyeling	15.7%	4.3%	5.7%
S Zhangguangcailing*	3.1%	4.6%	29.2%
N Zhangguangcailing	2.5%	7.5%	5.0%
Eastern Wandashan	23.6%	0.0%	9.1%
Total	11.7%	3.9%	13.0%

*For purposes of this summary, included all of Dongjingcheng as part of Southern Zhangguangcailing.

of responses came from Suiyang, Dongfanghong, Muling and Yingchun Forest Bureaus within the last five years. The overall positive response rate was nearly 17% for tigers, and 5.6% for leopards, but response rate varied by area. The majority of reports on tigers were from Southern Laoyeling (nearly 16% positive responses) and Eastern Wandashan (23.6% positive responses) (Table 2). Reports of leopards were much rarer than tigers, and were scattered across Southern Laoyeling and Southern and Northern Zhangguangcailing (Table 2). There were no positive responses of leopards in Eastern Wandashan.

6.1.2 Interviews of local citizens

More than 120 people were interviewed in the survey study area. However, most negative reports were not recorded, resulting in 77 accounts that includes 73 reports on the presence of tigers (Table 3, Figure 6) and 18 accounts of leopards (Table 4). One third of the reports on tigers were from 1998 or 1999, and the large majority (90%) were within the last five years. Eight reports of leopards (44%) were from 1997 or 1998, and 11 (61%) from the past five years.

6.2 Field Survey Routes

A total of 67 routes covered over 600 km in 25 forest districts within Suiyang, Muling, Dongfanghong, Yingchun, Dongjingcheng and Dahailin Forest Bureaus of Heilongjiang Province (Table 5, Figure 5). Length of survey routes varied from 2.2 to 25 km, and averaged 9 km long. Routes were distributed amongst the Forest Bureaus as follows: 16 survey routes were situated in Suiyang Forest Bureau (Southern and Northern Laoyeling), 12 routes in Muling (Southern Laoyeling), 4 routes in Yingchun (Eastern Wandashan), 27 routes in Dongfanghong (Eastern Wandashan), 4 routes in Dongjingcheng (Southern Laoyeling and Southern Zhangguangcailing), and 4 routes in Dahailin Forest Bureau (Southern Zhangguangcailing) (Table 5, Figure 5). Distribution of survey routes within survey regions was as follows: 28 routes in the Laoyeling Mountains (24 in Southern Laoyeling, 4 in Northern Laoyeling), 31 in the Eastern Wandashans and 8 in the Southern Zhangguangcailing Mountains.

A total of 15 species of mammals in 7 families and 4 orders were recorded (Tables 6 and 9). Ten species of carnivores were identified, including 3 felids, 5 mustelids and 2 bears. Siberian weasels were the most abundant carnivore (found on 72% of survey routes), followed by yellow-throated martens (45% of survey routes), Himalayan black bears (16% of routes had evidence usually in form of broken branches of mast or fruit-producing trees), and lynx (tracks on 12% of routes) (Table 6). Four species of ungulates were identified, including roe deer, sika deer, red deer, and wild boar (Table 9). Both Manchurian and snowshoe hares were reported. Other potential prey species that were noted included squirrels, chipmunks, pheasants, and hazel grouse.

Evidence of tigers was found on 3 survey routes (Table 6). Tracks were found on two routes in Suiyang Forest Bureau, and white hairs found on a birch tree in Muling Forest Bureau (all in Southern Laoyeling) could have been from a tiger rubbing at a scent-marking station. However, confirmation of this last report was not possible. No evidence of leopards was found on any routes. The survey team found no evidence of tigers in Dongjingcheng Forest Bureau of Southern Zhangguangcailing, but three reliable interviews (Table 3, interviews 64-66) and photographs indicated that a tiger was present for at least part of the winter.

Table 3. Evidence of tigers gathered in winter 1999 from interviews of local citizens in Heilongjiang Province, China.

	Informant		Date of observation		Study	Location of Observation			
#	Name	Occupation	Month/ season	Year	area	Forest bureau/ county	Forest district	Specific location	Type of information
1		Truck driver	winter	1998	Jilin	Jilin	Wangqing	Wangqing	Heard that tiger tracks were seen.
2	Dong Ku	Forest worker	mid-Jan.	1999	Wandashan	Dongfanghong	Hekou	Liuzhixiang	Saw tiger tracks (2 tigers, one bigger and one smaller).
3	Li Jianchen	Forest worker	March	1998	Wandashan	Dongfanghong	Qiyuan	unit 23	Saw tiger tracks.
4	Lu Defu	Truck driver	Dec.	1998	Wandashan	Dongfanghong	Qiyuan	unit 41	Heard that tiger tracks were seen.
5	Lu Defu	Truck driver	winter	1996	Wandashan	Dongfanghong	Qiyuan	unit 26	Saw a live tiger; local wild boars in group (5-6 boars in group).
6	Wang Haiyang	Headman of forest workers			Wandashan	Dongfanghong	Shichang		With a 20 years experience in local forest, he has never seen a tiger track.
7	Ren Deyue	Forest worker	winters	97-98	Wandashan	Dongfanghong	Qiyuan	unit 39	Heard that tiger tracks were seen.
8	Liu Rujin	Headman of forest workers	autumn	1998	Wandashan	Dongfanghong	Qiyuan	Dalin	Heard that tiger tracks were seen; He has over 10 years forest life but never seen tiger tracks.
9		Forest worker	winter	1998	Wandashan	Dongfanghong	Qiyuan	unit 46	Heard that tiger tracks were seen.
10	Mr. Guo	Forest worker	Dec.	1998	Wandashan	Dongfanghong	Qiyuan	unit 60	Heard that tiger tracks were seen.
11	Li Aimin	Truck loader	winter	1997	Wandashan	Dongfanghong	Qiyuan	Shizhixian	Heard that tiger tracks were seen.
12	Li Aimin	Truck loader	winter	1996	Wandashan	Dongfanghong	Qiyuan	unit 41	Heard that tiger tracks were seen.
13	Zhang Aixue	Forest worker	December	1990	Wandashan	Dongfanghong	Shichang	unit 6	Saw tiger tracks.
14	Mr.Qing	Chief Forest Resources			Wandashan	Dongfanghong	Dayake		Never heard reports on tiger or tiger tracks locally.
15		Forest worker	December	1997	Wandashan	Dongfanghong	Qiyuan	units 31, 32	Heard that tiger tracks were seen.
16		Forest worker	spring	1998	Wandashan	Dongfanghong	Qingshan	Dumohe	Heard that tiger tracks were seen.
17		Forest worker	winter	1997	Wandashan	Dongfanghong	Qingshan	unit 29	Heard that tiger tracks were seen.
18	W. Mingsheng	Forestry official	December	1994	Wandashan	Dongfanghong	Qiyuan	unit 10	Heard that a man called Zhang Cunyuan saw a tiger on the road.
19	W. Mingsheng	Forestry official	January	1995	Wandashan	Dongfanghong	Qiyuan	unit 47, near Shendingfeng	Heard a local called Yu Hongwei saw a tiger.
20	W. Mingsheng	Forestry official	February	1995	Wandashan	Dongfanghong	Dadai	unit 94	Tiger tracks reported.
21	W. Mingsheng	Forestry official	October	1995	Wandashan	Dongfanghong	Qiyuan	Qiyuan	Heard 4 tigers seen (one adult three young).
22	W. Mingsheng	Forestry official	December	1997	Wandashan	Dongfanghong	Qiyuan	unit 4	Heard one local forester saw a tiger track.
23	Mo Baoguo	Former Forestry official	February	1999	Wandashan	Dongfanghong	Qiyuan	Shizhixian	Heard a tiger track was found.

Table 3 cont.

			Date of observation		Study	Location of Observation			
	Name	Occupation	month/ season	year	area	Forest Bureau/ County	Forest District	Specific location	Type of Information
24		guide	November	1998	Southern Laoyeling	Suiyang	Sanchahe	Sanjielazi (village Syotoon)	Tracks of tiger seen and unsuccessful attempt by a tiger to kill a horse .
25		forest worker	January	1994	Wandashan	Dongfanghong	Qingshan		Found young boar killed by tiger.
26		guide	November	1998	Southern Laoyeling	Suiyang	Sanchahe	Rte 1, near border	Tiger track reported.
27		guide	Nov.-Jan.	94-95	Southern Laoyeling	Suiyang	Sanchahe	Rte 1, near border	Tiger tracks commonly reported.
28	Pikunov		June	1994	Southern Laoyeling	Suiyang	Sanchahe	near border	Pikunov found track of male (11.0 cm) .
29					Southern Laoyeling	Muling	Daimagou	Rte 18	Man > 60 yrs reported tracks present only through early 1960's.
30		guide	November	1997	Wandashan	Yingchun	Wupao	Rte. 30	Tiger tracks reported.
31		forester	winter	1995	Wandashan	Yingchun	Wupao	Rte. 30	Tiger reported in snare, died in Qiyuan.
32		guide	November	1993	Wandashan	Dongfanghong	Dumuhe	Rte 46	Reported tiger track on route in Nov. 1993.
33		forest worker	winter	93-94	Wandashan	Dongfanghong	Dumuhe	Rte 46	Reported tiger track along route.
34					Wandashan			Rtes 6, 10, 14, 22, 26, 34, 38, 42	No reports of recent tiger tracks by guides or local people interviewed.
35	Mrs. Liu	timber checker	June	1997	Wandashan	Dongfanghong	Hekou	Hekou	Saw a tiger.
36	Wang Aiguo	taxman	November	1995	Wandashan	Dongfanghong	Dadai	Xiaomoying	Saw fresh tiger tracks and a partial eaten wild boar (they were hunting).
37		forest worker	November	1987	Wandashan	Dongfanghong	Daiyake	Daiyake Forest District	Saw a half eaten boar and brought back. Then saw a tiger sat near their lodge.
38	Mr. Liu	Forest officer/guide	Summer	1998	Wandashan	Dongfanghong	Qiyuan	unit 56	Saw a tiger on the road.
39	Bi Endchen	Dep. Director	winters	97-98	Southern Laoyeling	Suiyang	Sanchahe	units 28, 29	Heard that tiger tracks were seen.
40		forest worker	December	1998	Northern Laoyeling	Bamiantong	Laoheishan	Near Suiyang	Heard that tiger tracks were seen.
41	Xiang Guisheng	forest worker	Nov.-Dec.	1998	Wandashan	Dongfanghong	Dadai	unit 99-100	Saw tiger tracks.
42	Luo Shoulong	hunter	December	1997	Wandashan	Dongfanghong	Shichang	Northern part of the district	Saw tiger tracks.
43		retired forest worker	winter	1998	Wandashan	Dongfanghong	Hekou	unit 50	Heard that tiger tracks were seen.

Table 3 cont.

	Name	Occupation	Date of observation: month/ season	Date of observation: year	Study area	Location of Observation: Forest Bureau/ County	Location of Observation: Forest District	Location of Observation: Specific location	Type of Information
44	Gao Kejiang	technician	January	1993	Wandashan	Dongfanghong	Wulindong	Subdivsion 82, and 76	Saw tiger tracks.
45	Zhang Cuibao	forestry official	November	1998	Southern Laoyeling	Suiyang	Zhongguliu	Sanjilazhi Village	Heard from local villagers that a horse was injured by two tigers. Heard that someone in the village saw the tiger.
46	Zhang Cuibao	forestry official	November	1997	Southern Laoyeling	Suiyang	Nuanqianhe	Subdivsion 22	Heard that a tiger track was found.
47	Peng Xuewen	forestry official	winter	1997	Southern Laoyeling	Muling	Laodaogou		Heard that forest worker saw a tiger track.
48	Dong Hongyu	forestry official	November	1997	Wandashan	Yingchun	Wupao	units 28, 29, 30	Heard that a tiger track was found (size small).
49	Dong Hongyu	forestry official	October	1998	Wandashan	Yingchun	Wupao	units 21, 23, Zhongguo	Heard local forest worker saw a tiger.
50	Dong Hongyu	forestry official	winter	1995	Wandashan	Yingchun	Wupao	unit 28	Heard a young tiger was snared and then heard the tiger run to Dongfanghong.
51	Dong Hongyu	forestry official	winter	1997	Wandashan	Yingchun	Wupao	units 21-23	Heard that Mr. Guo, a forest worker saw a tiger track.
52	Dong Hongyu	forestry official	Jan.-Feb.	1998	Wandashan	Yingchun	Wupao	unit 44	Heard that tiger tracks were seen.
53	Gao Kejiang	technician	winter	1997	Wandashan	Dongfanghong	Wulindong	unit 15	Heard that a tiger track was found.
54	Gao Kejiang	technician	winter	1996	Wandashan	Dongfanghong	Wulindong	units 26, 27, 28	Heard that a tiger track was found.
55	Gao Kejiang	technician	winter	1997	Wandashan	Dongfanghong	Yongxing	units 3, 4, 5	Heard that a tiger track was found.
56	Zhang Jiyao	forestry official	winter	1996	Wandashan	Dongfanghong	Qingshan	units 17-18	Heard that a tiger track was found.
57	Zhang Jiyao	forestry official	winter	1997	Wandashan	Dongfanghong	Qingshan	units 2-3	Heard that a tiger track was found.
58	Mr. Liu	local officer	December	1995	Wandashan	Dongfanghong	Chuangyie Village, Wulindong	Shengding-shan on Wu-lindong side	Saw an elk was half eaten. Then saw a fresh tiger tracks. And saw lying site of tiger and tracks of tiger.
59	Yan Xiangyen	Police chief	October	1997	Wandashan	Dongfanghong	Shichang	Near Sheng-dingshan	All four people traveled saw one tiger with two youngs.
60	Ma Guoqing	engineer	Jun-Jul	1995	Southern Laoyeling	Suiyang	Nuanquanhe	on the road	Heard that a tiger track was found; Pad width 8.3 cm, length 6.1 cm.
61	Zhang Yenong & Yang Yujiang	worker	December	1995	Wandashan	Dongfanghong	Qingshan	units 1-4	Saw tiger tracks twice. First time was two tracks with one large and one small. Second time was a track of an adult.

Table 3 cont.

	Name	Occupation	Date of observation: month/ season	Date of observation: year	Study area	Location of Observation: Forest Bureau/ County	Location of Observation: Forest District	Location of Observation: Specific location	Type of Information
62	Xu Rongzheng and his brother	worker	May	1995	Wandashan	Raohe	Majiazi	Dadingzhi-shan	Saw a tiger about 180cm in length and the should height about 80cm.
63	Sun Haiyi & D. Pikunov	biologist	July	1995	Southern Laoyeling	Suiyang	Nuanquanhe	unit 29	Saw a tiger track about 15 days old.
64	Shi Baoshan	worker	Jan.	1999	Wandashan	Dongjingcheng	Erzhansan	unit 15 (44 02'71" N,128 17'16"E)	Saw a live tiger (distance is about 20-30 m).
65	Chen Dengyi	Worker	Jan.	1999	Wandashan	Dongjingcheng	Erzhansan	units 11, 15, 51, 52	Saw a live tiger (distance about 100 m away) and tracks.
66	Mr. Huang	Forestry official	Jan.	1999	Wandashan	Dongjingcheng	Beigou	unit 36	Saw a tiger track and took photo.
67	Fu Chaosun	Worker	Feb.	1999	Southern Zhangguangcailing	Dahailin	Qifeng	unit 119	Saw tiger tracks in 1994 and 1996.
68	Yang Chenbin	Worker	Jan.	1999	Southern Zhangguangcailing	Dahailin	Qianjin	unit 44	Saw a tiger track.
69	Mr.Feng	Forestry official	June	1989	Northern Laoyeling	Mishan	Heping	unit 3, near river	Saw a tiger track.
70	Lu Qingxing	Worker	Mar. 11	1993	Northern Zhangguangcailing	Fangzheng	Shuguang	unit 45	He was injured by a tiger.
71	Cao Guanghua	worker	July 14	1997	Northern Zhangguangcailing	Fangzheng	Shuguang	unit 6	Saw a tiger track.
72	Mr. Chen	Forestry official		1994	Northern Zhangguangcailing	Caihe	Hongguang	near river	Saw a tiger track.
73	Zheng Qingfa	Forestry official		1994	Northern Zhangguangcailing	Caihe	Linjiang	unit 14	Saw that a horse was killed by a tiger.
74	Gao Yi	Forestry official		1990	Northern Zhangguangcailing	Yabuli	Yuejin		Three oxes were killed by a tiger.
75	Li Yushan etc.	worker	Apr.	1991	Western Wandashan	Huanan	Shengli	near Qingshan	Saw two tigers with two youngs.
76	Du Zhaoming	Forestry official	Dec.	1991	Western Wandashan	Huanan	Shengli	units 10, 11	Saw four tigers fresh tracks (two adults and two youngs).
77		Guide (same as #30)	March	1998	Wandashan	Yingchun	Wupao	Rte 30	Tiger tracks reported.

Table 4. Evidence of leopards gathered in winter 1999 from interviews of local citizens in eastern Heilongjiang Province, China.

	Name	Occupation	Date of observation	Region	Location of Observation			Type of Information
					Forest Bureau	Forest District	Location	
1	Li Cunshan	Forestry official	апр.98	Northern Laoyeling	Suiyang	Shuangqiao	Subdivision 55	Heard that a local forest worker saw a leopard at the watchtower.
2	Peng Xuewen	Forestry official	1997	Southern Laoyeling	Muling	Laodagou	Subdivision 41	Heard local forester worker saw leopard track.
3	Peng Xuewen	Forestry official	янв.97	Southern Laoyeling	Muling	Gonghe	Subdivision 51	Heard a leopard track was seen.
4	Peng Xuewen	Forestry official	12.ноя.98	Southern Laoyeling	Muling	Gonghe	Subdivision 49-51	Heard a leopard track was found.
5	Xu Zhengmin	Guide	Winter 1996	Northern Laoyeling	Suiyang	Shuangiao	Subdivision 62, 63, 73, 75	Saw leopard tracks twice.
6	Fu Weiwo	Forestry official	ноя.97	Northern Zhangguangcailing	Lingkou	Shidao	Subdivision 57	Heard that a dog was killed by a leopard.
7	Fu Weiwo	Forestry official	Winter 1996	Northern Zhangguangcailing	Lingkou	Fenduo		Heard a leopard track was found.
8	Yuan Fengqin	Forestry official	Dec.-98	Northern Laoyeling	Bamiantong	Laoheishan	Subdivision 16	Heard that a local worker saw a leopard track.
9	Wang Jingwen	Forestry official	Spr.-98	Southern Zhangguangcailing	Dahailin	Changting	Subdivision 138	Heard that a local worker saw a leopard track.
10	Duan Xiangkun	Guide	Winter-98	Northern Zhangguangcailing	Lingkou	Chaoyang	near the village	Saw a leopard track, and livestock was injured by leopard.
11	Li Cunshan	Forestry official	Winter 1993	Southern Laoyeling	Suiyang	Sanchahe		Saw a leopard.
12	Zhang Chuanfa	Worker	Jan.-1994	Southern Laoyeling	Suiyang	Sanchahe	Subdivision 34	Saw a leopard track; after a few days, one person was injured by leopard.
13	Liu Xingjiang	Forestry official	июл.95	Southern Laoyeling	Suiyang	Hanconghe		Saw one leopard with two youngs.
14	Li Ming	Worker	1985	Southern Laoyeling	Dongjingcheng	Dongfanghong	Subdivision 75	Saw a leopard.
15	Local people	Worker	1989	Southern Zhangguangcailing	Dongjingcheng	Fuyu	Subdivision 103-104	Saw a leopard track.
16	Li shiyou	Worker	1989	Southern Laoyeling	Dongjingcheng	Honhqi	Subdivision 35-36	Saw a leopard.
17	Local people	Worker	1988	Southern Laoyeling	Dongjingcheng	Huashu	Subdivision 38	Saw one leopard with two youngs.
18	Yu Tonghai	Forestry official	1990	Southern Laoyeling	Dongjingcheng	Huashu		Heard one person was injured by leopard.

6.3 Distribution and Number of Tigers

6.3.1 Number of tigers

Based on the information gained from interviews and field surveys, we estimated that 5-7 tigers were present in eastern mountain areas of Heilongjiang Province in winter of 1998-1999. Details justifying this estimate are provided below, in Table 7, and Figure 6.

Tiger #1. Jan. 19, 1999: One tiger track was identified on survey route 2 (Tables 6 and 7, Figure 6) in Suiyang Forest Bureau. The front pad width averaged 10.0-11.0 cm, total width of track was measured as 14.5 cm, total length of track was 17 cm. Stride length averaged 75cm (based on 5 measurements). It was estimated that the track was more than a week old. Also on Jan. 19, 1999, one tiger track was identified on survey route s 3 in Nuanquanhe forest district of Suiyang (Tables 6 and 7). The front pad width was 10.5-11.5 cm. The animal was likely a male. Although melt-out of tracks made precise measurements difficult, it appeared that tracks on routes 2 and 3 represented one individual on the basis of the front pad width, direction of travel, age of tracks, and distance between these two tracks (less than 10 km). It is likely the animal came from Jilin Province (as route 2 was on the border, and the animal was moving north), passed units 14, 12, 11, and 18 of Sanchahe forest sub-district, and likely traveled to unit 53 of Nuanquanhe Forest Subdistrict. This animal was likely a male.

Tiger #2. Jan. 24, 1999. A few white hairs which appeared to be those of a large cat were found on a tree that had characteristics of a "marking tree" (leaning birch tree positioned at an junction of trails) in Daimagou Forest District of Muling Forest Bureau (route 17). This sign possibly represented a sight where a tiger had rubbed on a tree, but it was not possible to verify observation.

Tiger #3. No any evidence of tigers was found on survey routes in the Zhangguangcailing region, but interviewees reported one tiger in Dongjingcheng and Dahailin Forest Bureaus of Southern Zhangguangcailing Mountains (Table 3, interviews 64-68). Photographs of tracks were also taken. According to evidence provided by eyewitnesses, we believe this animal was likely a male.

From January 16 to Feb. 4, 1999, one tiger and multiple tracks were found in the Erzhansan (units 15, 11 and 52) and Beigou (unit 36) Districts of Dongjingcheng Forest Bureau and Qifeng (unit 119), Qianjin (unit 44) districts of Dahailin Forest Bureau. The tiger stayed in Erzhansan District for about 7 days, and stayed in Qifeng District for about 4 days, frightening local people and loggers, who refused to go into the forest. Local people drove the tiger away with firecrackers, after permission was received from appropriate authorities. Photographs of tiger tracks were taken.

Based on timing, geographic locations, and general reports, we believe all these reports represent one animal, a male, that traveled through this region between 1998 and 1999.

Tigers #4-7. No evidence of tigers was found on the survey routes in Yingchun and Dongfanghong Forest Bureaus of Wandashan. However, a large snowfall just prior to initiation of surveys may have covered much potential evidence. Based on the information gained from interviews in Qiyuan, Qingshan, Hekou, Shichang, Wupao, Wulindong, Dumuhe and Yongxing Forest Districts, it appeared that repeated observations

Table 5. Location and description of field routes to survey tigers and leopards in eastern Heilongjiang Province, China, in winter 1999.

Route #	Date dd.mm.yy	Location			Route length (km)	Geographic Coordinates at Starting Point		Altitude (m)	Snow depth (cm)	Dominant Forest Types
		Region	Forest Bureau	Forest District		Latitude	Longitude			
1	19.01.99	Southern Laoyeling	Suiyang	Sanchahe	11	43° 29' 118" N	131° 13' 800" E	550-745	15-20	Mixed riverine/Spruce-fir
2	19.01.99	Southern Laoyeling	Suiyang	Sanchahe	9.8	43° 27' 860" N	131° 07' 00.0" E	580-670	15-30	Mixed Conifer/Deciduous
3	19.01.99	Southern Laoyeling	Suiyang	Sanchahe	7.3	43° 35' 320" N	131° 07' 548" E	220-550	10	Oak/Deciduous
4	19.01.99	Southern Laoyeling	Suiyang	Sanchahe	12			800-920	24	Larch
5	20.01.99	Southern Laoyeling	Suiyang	Sanjielazi	7.8	43° 29' 736" N	130° 58' 702" E	800-875	30	Larch
6	20.01.99	Southern Laoyeling	Suiyang	Sanjielazi	5.5	43° 32' 523" N	130° 56' 370" E	735-810	10-15	Birch
7	20.01.99	Southern Laoyeling	Suiyang	Zhongguliu	4.6	43° 27' 692" N	130° 52' 158" E	500-700	10-25	Larch/Birch
8	20.01.99	Southern Laoyeling	Suiyang	Zhongguliu	7.1	43° 31' 560" N	130° 48' 590" E	665-850	18	Mixed forest(birch-larch)
9	21.01.99	Southern Laoyeling	Suiyang	Liuqiaogou	2.2	43° 40' 004" N	130° 36' 117" E	600-750	12	Oak
10	21.01.99	Southern Laoyeling	Suiyang	Liuqiaogou	5	43° 40' 693" N	130° 33' 050" E	600-750	12-15	Oak
11	21.01.99	Southern Laoyeling	Suiyang	Hanchonghe	8.2	43° 53' 770" N	130° 36' 774" E	600-700	5-20	Oak
12	21.01.99	Southern Laoyeling	Suiyang	Hanchonghe	5	43° 52' 390" N	130° 37' 010" E	460	12	Oak/Mixed forest
13	22.01.99	Northern Laoyeling	Suiyang	Shuangqiao	6.3	44° 41' 104" N	130° 54' 495" E	800-950	35-40	Mixed conifer
14	22.01.99	Northern Laoyeling	Suiyang	Shuangqiao	15	44° 41' 154" N	130° 54' 515" E	800-960	45-50	Mixed conifer
15	22.01.99	Northern Laoyeling	Suiyang	Shuangqiao	11	43° 23' 56.8" N	131° 08' 44.3" E	775-850	40-55	Oak/Deciduous
16	22.01.99	Northern Laoyeling	Suiyang	Shuangqiao	8	43° 23' 15.0" N	131° 03' 17.5" E	715-820	20	Oak/Deciduous
17	24.01.99	Southern Laoyeling	Muling	Daimaguo	14	44° 28' 255" N	130° 03' 302" E	520-730	20	Birch
18	24.01.99	Southern Laoyeling	Muling	Daimaguo	11.5			550-765	17-20	Birch/Spruce-fir
19	24.01.99	Southern Laoyeling	Muling	Daimaguo	4.5	44° 26' 248" N	129° 55' 337" E	700-800	23	Spruce-fir/Birch
20	24.01.99	Southern Laoyeling	Muling	Daimaguo	10			885-965	25	Mixed
21	26.01.99	Southern Laoyeling	Muling	Laodaoguo	7	44° 21' 187" N	130° 05' 151" E	550-735	25-30	Birch./Mixed forest
22	26.01.99	Southern Laoyeling	Muling	Laodaoguo	10.5			500-750	35-40	Oak/Spruce-fir
23	26.01.99	Southern Laoyeling	Muling	Laodaoguo	7			400-500	35	Birch/Mixed-Korean pine
24	26.01.99	Southern Laoyeling	Muling	Laodaogou	5.8			660-720	39	Mixed (birch-spruce)
25	27.01.99	Southern Laoyeling	Muling	Gonghe	8.3	43° 57' 238" N	130° 12' 873" E	580-930	20-30	Mixed/Mixed riverine
26	27.01.99	Southern Laoyeling	Muling	Gonghe	8.5			650-775	20-25	Deciduous/Mixed riverine
27	27.01.99	Southern Laoyeling	Muling	Gonghe	10			685	23-27	Korean pine-broadleaved/Conifer
28	27.01.99	Southern Laoyeling	Muling	Gonghe	7			590-840	22	Mixed (spruce-birch)
29	29.01.99	Eastern Wandashan	Yingchun	Wupao	6.7	46° 30' 004" N	133° 09' 985" E	185-340	50	Korean pine-broadleaved
30	29.01.99	Eastern Wandashan	Yingchun	Wupao	7.5			200-352	45-50	Korean pine-broadleaved
31	29.01.99	Eastern Wandashan	Yingchun	Wupao	7			110-270	45-50	Oak
32	29.01.99	Eastern Wandashan	Yingchun	Wupao	5.5			185-370	58	Deciduous riverine/Oak
33.1	31.01.99	Eastern Wandashan	Dongfanghong	Qiyuan	11.3	46° 39' 674" N	133° 26' 449" E	350-370	50	Deciduous riverine/Mixed riverine
33.2	31.01.99	Eastern Wandashan	Dongfanghong	Qiyuan	11.1	46° 41' 433" N	133° 29' 762" E	130-200	50	Deciduous riverine/Mixed riverine
34	31.01.99	Eastern Wandashan	Dongfanghong	Wulindong	20	46° 28' 580" N	133° 50' 110" E	20-50	20-30	Deciduous riverine/Oak
35	31.01.99	Eastern Wandashan	Dongfanghong	Qiyuan	13.2			85-360	54	Deciduous (logged Korean pine)
37	01.02.99	Eastern Wandashan	Dongfanghong	Qiyuan	9.3	46° 36' 740" N	133° 24' 573" E	80-220	45-55	Deciduous riverine/Korean pine

Table 5 cont.

Route #	Date dd.mm.yy	Location			Route length (km)	Geographic Coordinates at Starting Point		Altitude (m)	Snow depth (cm)	Dominant Forest Types
		Region	Forest Bureau	Forest District		Latitude	Longitude			
38	01.02.99	Eastern Wandashan	Dongfanghong	Wulindong	15	46° 32' 953" N	133° 35' 235" E	50-475	40-70	Deciduous riverine/Korean pine
39	01.02.99	Eastern Wandashan	Dongfanghong	Qiyuan	14			160-860	50-70	Korean pine
40	01.02.99	Eastern Wandashan	Dongfanghong	Wulindong	10.4	46° 36' 080" N	133° 35' 180" E	150-270	55	Mixed forest
41.1	02.02.99	Eastern Wandashan	Dongfanghong	Qiyuan	6.1	46° 43' 554" N	133° 31' 709" E	175-350	40-50	Shrubland/Oak
41.2	02.02.99	Eastern Wandashan	Dongfanghong	Qiyuan	4.6	46° 39' 822" N	133° 32' 623" E	220-275	45-50	Korean pine-broadleaved
42	02.02.99	Eastern Wandashan	Dongfanghong	Wulindong	21	46° 34' 715" N	133° 45' 622" E	105-385	35-50	Oak /Conifer
43.1	02.02.99	Eastern Wandashan	Dongfanghong	Qiyuan	6.5			170-325	40-50	Korean pine/Oak
43.2	02.02.99	Eastern Wandashan	Dongfanghong	Qiyuan	3.5			140-260	40-50	Korean pine/Oak
44	02.02.99	Eastern Wandashan	Dongfanghong	Wulindong	25	46° 30' 290" N	133° 41' 480" E	90-410	30	Deciduous (birch-oak)
45	03.02.99	Eastern Wandashan	Dongfanghong	Dadai	3.6	46° 41' 598" N	133° 37' 143" E	250-350	55-65	Deciduous riverine/logged Korean pine
46	03.02.99	Eastern Wandashan	Dongfanghong	Dumuhe	25	46° 32' 641" N	133° 33' 402" E	85-475	50-60	Riverine/Deciduous/Korean pine
47.1	03.02.99	Eastern Wandashan	Dongfanghong	Shichang	7			130-300	25-40	Oak/Mixed riverine
47.2	03.02.99	Eastern Wandashan	Dongfanghong	Shichang	7			240-340	43	Oak/Mixed riverine
48	03.02.99	Eastern Wandashan	Dongfanghong	Yongxing	5			220-305	46	Korean pine-broadleaved
49	04.02.99	Eastern Wandashan	Dongfanghong	Hekou	17.3	46° 42' 814" N	133° 20' 691" E	200-350	50	Deciduous & Mixed riverine
50	04.02.99	Eastern Wandashan	Dongfanghong	Qingshan	7	46° 28' 052" N	133° 16' 579" E	285-320	50-60	Mixed riverine/Korean pine
51	04.02.99	Eastern Wandashan	Dongfanghong	Hekou	5			250-300	45	Deciduous forest
52	04.02.99	Eastern Wandashan	Dongfanghong	Qingshan	5	46° 34' 410" N	133° 19' 450" E	315	30-52	Deciduous/Mixed forest
54	05.02.98	Eastern Wandashan	Dongfanghong	Qingshan	10	46° 31' 718" N	133° 21' 581" E	210-420	60-70	Mixed riverine/Conifer
56	05.02.98	Eastern Wandashan	Dongfanghong	Qingshan	8.3	46° 25' 050" N	133° 24' 090" E	110-225	50	Deciduous riverine
57	02.02.99	Eastern Wandashan	Dongfanghong	Dadai	16	46° 45'240" N	133° 37' 450" E	160-315	54	Mixed
58	04.02.99	Eastern Wandashan	Dongfanghong	Hekou	6	46° 37' 250" N	133° 17' 270" E	160-255	45	Mixed riverine
59	10.03.99	S. Zhangguangcailing	Dongjingcheng	Erzhansan	6	44 02'63"N	128 17'95"E	685-827	50-65	Mixed Forest
60	10.03.99	S. Zhangguangcailing	Dongjingcheng	Erzhansan	6.5	44 01'71"N	128 27'16"E	574-1059	50-70	Mixed forest/spruce-fir
61	12.03.99	S. Zhangguangcailing	Dongjingcheng	Beigou	7.6	44 07'44"N	128 37'95"E	565-738	40-70	Broadleaved/Mixed
62	12.03.99	S. Zhangguangcailing	Dongjingcheng	Beigou	7.5	44 10'45"N	128 29'74"E	595-816	40-50	Mixed forest
63	18.03.99	S. Zhangguangcailing	Dahailin	Qifeng	7	44 22'19"N	128 31'18"E	582-846	45-60	Mixed forest/Broadleaved
64	18.03.99	S. Zhangguangcailing	Dahailin	Qifeng	8.5	44 21'16"N	128 30'07"E	590-886	40-55	Mixed forest/oak
65	19.03.99	S. Zhangguangcailing	Dahailin	Qianjin	6.5	44 17'15"N	128 24'35"E	625-928	50-80	Mixed forest
66	19.03.99	S. Zhangguangcailing	Dahailin	Qianjin	7	44 13'03"N	128 20'59"E	605-894	60-90	Broadleaved/mixed forest

Table 6. Summary of observations of mammals along census routes during tiger/leopard survey in eastern Heilongjiang Province, January 19 - March 19, 1999

		Felids									Mustelids					Ursids		
		Tiger				Leopard												
		Track	Scat	Scrape	Other	Track	Scat	Scrape	Other	Lynx	Yellow-throated marten	Siberian weasel	Mink	Sable	Short-tailed weasel	Black bear*	Brown bear	Hares
1	Southern Laoyeling	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
2	Southern Laoyeling	10.0-11.0	-	-	-	-	-	-	-	-	X	-	-	-	-	tracks	-	X
3	Southern Laoyeling	10.5-11.5	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X
4	Southern Laoyeling	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
5	Southern Laoyeling	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X
6	Southern Laoyeling	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X
7	Southern Laoyeling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
8	Southern Laoyeling	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X
9	Southern Laoyeling	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X
10	Southern Laoyeling	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
11	Southern Laoyeling	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X
12	Southern Laoyeling	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X
13	Northern Laoyeling	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
14	Northern Laoyeling	-	-	-	-	-	-	-	-	-	-	-	-	X	-	tree	track	X
15	Northern Laoyeling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	tracks	-	-
16	Northern Laoyeling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	Southern Laoyeling	-	-	-	hair?	-	-	-	-	-	X	X	-	-	-	-	-	-
18	Southern Laoyeling	-	-	-	-	-	-	-	-	-	X	X	-	-	-	tree	-	X
19	Southern Laoyeling	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
20	Southern Laoyeling	-	-	-	-	-	-	-	-	-	X	X	-	-	-	3 tracks	-	-
21	Southern Laoyeling	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
22	Southern Laoyeling	-	-	-	-	-	-	-	-	-	-	X	-	-	-	tree	-	X
23	Southern Laoyeling	-	-	-	-	-	-	-	-	-	X	-	-	-	-	tracks	-	-
24	Southern Laoyeling	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
25	Southern Laoyeling	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
26	Southern Laoyeling	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
27	Southern Laoyeling	-	-	-	-	-	-	-	-	2	X	X	-	-	-	-	-	-
28	Southern Laoyeling	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
29	Eastern Wandashan	-	-	-	-	-	-	-	-	1	X	X	-	-	-	-	-	X
30	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	X	-	-	-	tree	-	X
31	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
32	Eastern Wandashan	-	-	-	-	-	-	-	-	2	-	X	-	-	-	-	-	-
33.1	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X

Table 6 cont.

		Felids									Mustelids					Ursids		
		Tiger				Leopard												
		Track	Scat	Scrape	Other	Track	Scat	Scrape	Other	Lynx	Yellow-throated marten	Siberian weasel	Mink	Sable	Short-tailed weasel	Black bear*	Brown bear	Hares
33.2	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	X
34	Eastern Wandashan	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
35	Eastern Wandashan	-	-	-	-	-	-	-	-	-	X	X	-	-	X	-	-	X
37	Eastern Wandashan	-	-	-	-	-	-	-	-	-	X	X	-	-	-	tree	-	X
38	Eastern Wandashan	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X
39	Eastern Wandashan	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X
40	Eastern Wandashan	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X
41.1	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
41.2	Eastern Wandashan	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X
42	Eastern Wandashan	-	-	-	-	-	-	-	-	2	-	X	-	-	-	-	-	X
43.1	Eastern Wandashan	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X
43.2	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
44	Eastern Wandashan	-	-	-	-	-	-	-	-	1	-	X	-	-	-	-	-	X
45	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
46	Eastern Wandashan	-	-	-	-	-	-	-	-	1	-	X	-	-	-	-	-	X
47.1	Eastern Wandashan	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X
47.2	Eastern Wandashan	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X
48	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
49	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	X	-	-	-	tree	-	X
50	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X
51	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
52	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X
54	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	X	-	-	-	tree	-	X
56	Eastern Wandashan	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	X
57	Eastern Wandashan	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X
58	Eastern Wandashan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
59	S. Zhangguangcailing	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X
60	S. Zhangguangcailing	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	
61	S. Zhangguangcailing	-	-	-	-	-	-	-	-	1		X	-	-	-	-	-	X
62	S. Zhangguangcailing	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X
63	S. Zhangguangcailing	-	-	-	-	-	-	-	-	-	X	X	-	X	-	-	-	
64	S. Zhangguangcailing	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	
65	S. Zhangguangcailing	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	
66	S. Zhangguangcailing	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X
	% occurrence	3%	0%	0%	2%	0%	0%	0%	0%	12%	45%	72%	2%	6%	2%	16%	2%	60%

were made around Shendingfeng Mountain in the Eastern Wandashan Mountains. There were 12 reports of tigers in the area from 1998 to February 1999. Since 1995, there have been repeated reports of a single individual and a family group in the fall of 1998, situated around Shendingfeng (Figure 6 and Table 3, interviews 2, 21, 35, 38, 49, 59, 61 and 62). Based on the information gained from interviews (Table 3, No. 2-4, 7-10, 16, 38, 41, 43 and 49), we estimated that 2-4 tigers were present in this region between 1998 and 1999. Two animals observed together (Interview 53) could be a male-female pair, but track measurements suggest that it was a female with a relatively large cub. No evidence of male tigers was reported in the Eastern Wandashans in the past year, even though evidence from interviews suggests that there may be up to two females in the region.

Information from other interviews (particularly 40, 47, 62, 70 and 71, Table 3) suggested additional tigers may exist in Northern Laoyeling, Muling Forest Bureau and Raohe County, but were not included in this estimate because sources were of unknown quality and unverifiable.

6.3.2 Distribution and status of tigers within study regions

Based on interviews and field surveys, the distribution of tigers in Heilongjiang Province has obviously shrunk since the 1980's. There has been no evidence for many years of tigers in the Lesser Khingan Mountains, Western Wandashan or Northern Zhangguangcailing. We review evidence of tiger distribution within the other 4 regions defined in our survey.

1. Southern Laoyeling. Since 1994, 9 reports on about tiger activity in this region on were obtained via interviews, five of which were within the last two years (1997-1998). Two tracks and one potential rubbing on a tree were identified on the field survey routes (Route 2, 3 and 17). We estimate that at least 1 tiger were present in this region in the winter of 1998-1999 (Table 7).

This region is contiguous with tiger range Jilin Province and Southwest Primorye, Russia. Although high fencing on the Russian side of the border inhibits movements of animals, it is highly likely that tigers, leopards, and perhaps even ungulates, find crossover points that provide linkages for animal populations on both sides of the border. Southern Laoyeling was one of first regions developed by the forest industry (starting in 1948), and the most common forest types now are secondary broadleaf forests, but there still exist a few mixed Korean pine forests (conifer- broadleaf) in southern Suiyang. This region represents one of the best habitat patches for tigers in Heilongjiang Province because it abuts the Russian and Jilin borders, where tigers also occur (Matyushkin et al. 1996, Yang et al. 1998), has low levels of human activity, and relatively higher prey densities (see section 6.5.1). There were an estimated 24 tigers recorded in this area during the 1974 survey, but only 3 tigers in 1991. Evidence of tigers still exist here, but a reduction in human disturbance, and protection of ungulates and habitat will be essential for recovery of the tiger population in Southern Laoyeling. Nonetheless, this region represents one of two key areas for tiger conservation in Heilongjiang.

2. Northern Laoyeling. Recent evidence of tigers in this region came only from one interview (# 40, Table 3) from December 1998. Although no evidence was found on the survey routes, heavy snowfall the day of the survey would have hidden potential sign. Prior to 1997, there had been repeated reports of tiger activity. Evidence of tigers was

Table 7. Evidence used for estimating number of tigers in eastern Heilongjiang Province, China, winter 1999.

Tiger No.	Region	Forest District	Date of information	Tracks: Front Pad width (cm)	Tracks: Total width x length (cm)	Tracks: Stride length (cm)	Scent-mark	Age of evidence	Interview #	Key information	Quality of information	Sex	Estimated # tigers
1	Southern Laoyeling	Suiyang	19.01.99	10.0-11.5	14.5	75 (n=5)		> 7 days		tracks on 2 routes	good	male	1
2	Southern Laoyeling	Muling	19.01.99				hair on tree	?		marginal evidence on route 17	unconfirmed		0-1
3	Southern Zhangghangcailing	Dongjingcheng							64-68	photos of tracks	good	male	1
4	Eastern Wandashan	Dongfanghong	20.10.99	9.5-10.0	14.6x17.0	70 (n=3)		1 day	3-4, 7-10, 23, 38	maybe same as 5	good	female	0-1
5	Eastern Wandashan	Dongfanghong	22.10 99	9.8		80 (n=3)		visual	53	a driver saw tigers #5 & #6 together on road	good	female	1
6	Eastern Wandashan	Dongfanghong	22.10.99	8		65 (n=2)		visual	53	a driver saw tigers 5 & 6 together on road	good	young with # 5	1
7	Eastern Wandashan	Dongfanghong	05.11.99 07.11.99	9.5-9.8	15x17 16.5x17.5	68 (n=8) 67.7 (n=11)	hair on tree	3-5 days	16, 48, 49		good	female	1
	Total												5-7

reported in adjacent Pogranichny Raion in Russian in 1996 (Matyushkin 1996), and although no evidence was found in a survey simultaneously conducted with this Heilongjiang survey in 1999 (Pikunov unpubl.), there was a report from a reliable source that a tiger had been poached from the Pogranichny area in the 1998-1999 winter. Tigers may still exist in this transboundary area, and it is a region that should be monitored for additional evidence.

3. Southern Zhangguangcailing. Although no evidence was found along 8 survey routes, five interviewees (interviews 64-68) reported sightings in January and February, 1999, and photographs of tracks confirmed the presence of a large felid. We believe these reports represent a single tiger that was present in the region during the 1998-1999 winter.

This region is bounded on the south by Jilin Province, where reports of tiger activity occur infrequently (approximately every 2-3 years). Southern Zhangguangcailing apparently represents a region still accessible to dispersing tigers, but is not suitable for retaining a resident population. The higher elevation region has deeper snows, more intensive development, and more human disturbance, leading to lower ungulate densities and overall poorer habitat for large carnivores.

4.*Eastern Wandashan*. Seventy-four percent of all interviews that indicated presence of tigers came from the Eastern Wandashan area. Although no evidence was found on any of the 31 survey routes, deep snows and the general problem of locating animals that exist at low density in large habitat patches may have resulted in the negative findings. Based on the number of relatively reliable interviews, we estimated that 2-4 tigers were distributed over Eastern Wandashan in winter of 1998-1999.

Although the total area of the Eastern Wandashan exceeds 19,000 km^2, the most suitable habitat is exists in about 2,000 km^2 of the central core of the range. Shendingfeng Peak appears to be the center of tiger activity, with tigers potentially using Qingshan, Qiyuan, Hekou, Shichang, Wulindong, Dumuhe, Yongxing, Dadai and Wupao Forest Districts, which surround Shendingfeng. The Naoli River represents the northern boundary of the region, and the Ussuri River is the eastern boundary. Northeastern Mishan County, a region of wetlands and croplands, appears to be a barrier separating the Eastern and Western Wandashan Mountains. The Chinese-Russian border is divided by the Ussuri River, but the river is frozen in winter and could be swum in summer by tigers. On the Russian side, the Strelnikov Range, connected to the Sikhote-Alin Range, could act as a movement corridor, and as a source for animals emigrating into eastern Wandashan from Russia. On the Chinese side, the regions from Zhenjiang to Yongxing and from Xinancha to Dadai could also possibly act as ecological corridors for tigers.

At present, prey resources and forest habitats are in better condition here than elsewhere in eastern Heilongjiang, but high road densities, intensive logging, high hunting pressure and serious human disturbance all threaten this region. Despite these threats, the Wandashan represents the best potential tiger habitat in eastern Heilongjiang, and with Southern Laoyeling, has the greatest potential to act as a reserve for tigers in Heilongjiang Province. Most importantly, this is the only region in all of northern China (Jilin and Heilongjiang) where there appears to be any evidence of a female tiger reproducing. Since 1995, family groups have been reported 4 times (Table 3, No. 2, 21, 59, and 61). Reproduction is obviously critical if a population is to survive and increase, and the Wandashan appears to be the single area where it may be occurring. Protection of tiger habitat should be a priority for this region.

Besides the 4 regions discussed above, Western Wandashan and Northern Zhangguangcailing also represent potential tiger habitat in Heilongjiang Province. Five reports of tigers exist in Fangzheng, Yabuli and Caihe of northern Zhangguangcailing (Table 3), but 4 of those 5 were prior to 1995. Historically, Huanan and Shangyashan districts of Western Wandashan were important tiger habitat, and the Chinese government even established a reserve (Qixinglazi Reserve) in 1981 to protect tigers in the Huanan forest area. However, since the mid-1980's, almost no reports of tiger exist for this area. Monitoring will be important in the future to confirm that tigers have entirely disappeared from this region.

6.4 Distribution and Number of Leopards

6.4.1 Number of leopards

Leopards appear to be sparsely distributed and quite rare in Heilongjiang Province. Existing information makes it difficult to attempt an estimate of the number of leopards that may be left. Field surveys failed to reveal any evidence of leopards, but a number of interviews strongly suggested that leopards may still occur in Southern Laoyeling. Although there were reports of leopards in the Dongjingcheng Forest District of the Eastern Wandashans (interviews 14-18, Table 4), this region was probably never part of their historical range, and reports are likely unreliable.

Based on the information gained from interviews (Table 4), we estimated that 3-5 leopards may have been present within the survey area in eastern Heilongjiang during the 1998-1999 winter based on the information summarized here and in Table 8.

Leopard #1. Based on interviews 11, 12 and 13 (Table 4), we estimated that one leopard was possibly present in the southern part of Suiyang Forest Bureau of Southern Laoyeling. There exists suitable habitat for leopards in Sanjielazi, Liumaogou, Hanconghe, Sanchahe and Nuanqianhe districts of southern Suiyang Forest Bureau, which is contiguous to leopard habitat in Southwest Primorye, Russia.

Leopard #2. Based on interviews 2, 3 and 4 (Table 4), it is possible that at least one leopard was present in Muling Forest District of Southern Laoyeling in the 1998-1999 winter.

Table 8. Evidence used for estimating number of leopards, based interviews of local people in eastern Heilongjiang Province, China, winter 1999.

No.	Location		Interview #	Quality of information	Estimated # leopards
	Region	Forest district			
1	Southern Laoyeling	Sanchahe, Hanconghe, Suiyang	11, 12, 13	unconfirmed	0--1
2	Southern Laoyeling	Muling	2, 3, 4	good	1
3	Northern Laoyeling	Shaungqiaozi, Laoheishan	1, 5, 8	good	1
4	Southern Zhangguangcailing	Changting, Dahailin	9	unconfirmed	0--1
5	Northern Zhangguangcailing	Shidao, Fendou, Chaoyang Lingkou	6, 7, 10	good	1
	Total				3--5

Leopard #3. According to interviews 1, 5 and 8 (Table 4), it is likely that that at least one leopard was present in Shuangqiao and Laoheishan districts of Northern Laoyeling (northern Suiyang Forest Bureau) in the 1998-1999 winter.

Leopard #4. Based on interview 9 (Table 4), it is possible that one leopard was present in Dahailin Forest Bureau of Southern Zhangguangcailing.

Leopard #5. One leopard may have been present in Lingkou Forest Bureau of Northern Zhangguangcailing in 1998-1999 winter, based on interviews 6, 7 and 10 (Table 4).

6.4.2 Distribution and status of leopards within study regions

Based on field surveys and interviews, we review the status of 4 of the study regions as potential leopard habitat. We do not include Eastern Wandashan, which likely has never had a leopard population in the past 100 years, and is not considered suitable habitat for leopards.

1. Southern Laoyeling. A total of 10 interviews (56% of total) suggest that this region may be the most important for leopards. Southern Suiyang has the most suitable habitat for leopards, and is immediately adjacent to Borisovkoe Plateau Zakaznik (wildlife refuge) in southwest Primorye Krai, Russia, which is considered prime leopard habitat, and has been one of the key areas in Russia protecting leopards. Southern Suiyang Forest Bureau, in combination with potentially good habitat in Hunchun County in Jilin Province (which also borders leopard habitat in Russia), must be considered vital habitat for the Far Eastern leopard. It will be critical to protect prey resources and habitat in this region, and to insure connectivity exists between suitable habitat in Southern Laoyeling, Heilongjiang, Hunchun, Jilin, and southwest Primorye Krai.

2. Northern Laoyeling. Three interviews (17% of total), including what appears to be a visual observation, suggested that leopards still occur in Northern Laoyeling close to the Russian border. In the past five years, a number of tracks have been reported. A simultaneous survey in Pogranichny Raion, Primorye (opposite Northern Laoyeling) failed to provide evidence of leopards this winter, although leopards have been reported here in the 1990's. There is relatively little suitable habitat (even including Pogranichny Raion in Russia). Survival of leopards (and tigers) will depend on providing corridors to other habitat patches in the region.

3. Southern Zhangguangcailing. Only 2 interviews (11% of total) suggest that leopards may be present in this region. There are some secluded areas in Southern Zhangguangcailing that could harbor leopards, but anthropogenic disturbances, including intensive logging, heavy snaring, and lower prey densities make this region relatively poor habitat for leopards.

4. Northern Zhangguangcailing. Although no survey routes were covered here, there were 3 reports of leopards in the region. However, no evidence of leopards was found on 36 routes during a wildlife resource census (March to April 1999). In general, probably neither interview nor survey data is reliable because survey personnel (and interviewees) had no training and little experience identifying large carnivore tracks.

6.5 Distribution and Abundance of Prey Species

6.5.1 Ungulate prey species

As part of our effort to assess the potential of survey areas to support tigers and leopards, we reported sign of large ungulate species along survey routes (Table 9). Roe deer were the most common large ungulate in eastern Heilongjiang, but wild boar and red deer were encountered in all regions. Evidence of sika deer was found only in Southern Laoyeling (Table 9).

The three measures of ungulate abundance we employed did not always support each other in defining relative densities of ungulates in the four study regions (Table 10). Because the estimate of relative abundance included expert assessment of old tracks (tracks greater than 24-hours old were not included in the other measures) it provides a more general description of presence and relative abundance. The estimate of mean number of animals showed less variation between areas because repeated crossings of individual animals were not included. A brief description of the distribution and status of the 4 most common ungulate species is provided below.

Roe deer. Roe deer was the most common ungulate species in all study regions in eastern Heilongjiang, with tracks present on 80% of the survey routes (Table 9). We estimated that approximately 456 animals crossed survey routes, leaving 879 tracks. All measures of abundance indicated that roe deer were the most common ungulate in all areas (Table 10). Greatest abundance appeared to be in the Eastern Wandashan, and lowest abundance in Northern Laoyeling (Table 10). Relative abundance of roe deer in the Southern Laoyeling and Southern Zhangguangcailing were similar (Table 10).

Despite the fact that numbers of roe deer were higher than other ungulates, densities still appeared lower than the potential of the habitat to support this species. The roe deer population could likely increase substantially across much of the area surveyed if better protection were provided. As with other ungulate species, human harvest is likely the key limiting factor (see Section 6.6).

Although tigers prey on roe deer, they are usually a secondary component of the tigers' diet. It is unlikely that a tiger population could survive and reproduce in an area where only roe deer occurred. However, roe deer can be an important component of the diet of leopards and a supplemental component of the diet of tigers. Although important to both carnivore species, increased populations of wild boar and red deer are likely more important for tigers.

Wild boar. Wild boar were found in all regions where survey routes were covered (Southern and Northern Laoyeling, Southern Zhangguangcailing, and Eastern Wandashan) (Table 10). As is typical of this species, distribution was sporadic: tracks were found on only 26 of the 67 routes (39%). We estimated there were about 158 animals on the survey routes, based on the 207 tracks recorded (Table 10). Overall abundance of wild boar was low, but highest in Southern Zhangguangcailing (Table 10). Local experts believe that the wild boar populations are increasing due to the newly enforced ban on hunting, but nonetheless, illegal hunting is still common (see Section 6.6) and likely the primary cause of wild boar mortality.

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. Red deer were uncommon across all survey regions. No evidence of red deer was found in Northern Laoyeling, but only 4 survey routes were covered there, and fresh snow reduced the potential to assess abundance of ungulates in general in this region. This species was found on only 28.4% (19 routes) of routes surveyed (Table 8). Highest densities of red deer tracks were found in the Eastern Wandashan region (Table 10), and in general this region appeared to be better habitat for red deer. Evidence of red deer was rare in Southern Zhangguangcailing and Southern Laoyeling (Table 10), which concurs with the fact that this species is also rare in neighboring regions of Jilin Province and Russia..

Although sign of red deer was more common in eastern Heilongjiang than Jilin (Yang et al 1998), densities appeared to be extremely low. In combination with wild boar, red deer should be one of the key prey species for tigers in eastern Heilongjiang. Successful recovery of the tiger population will be dependent on an increase in red deer numbers.

Sika deer. Evidence of sika deer were found in a very small sliver of habitat in the most southern part of Southern Laoyeling in the Sanchahe and Nuanquanhe Districts of Suiyang Forest Bureau. Tracks were found on only 2 routes (3% of total routes). Sika deer often have a localized and clumped distribution, as was demonstrated here: on one route 43 tracks were recorded.

Historically, southern Heilongjiang probably represents the northernmost distribution of sika deer in northeast China. Therefore, their absence over most of the area surveyed is not unexpected. Sika deer were more common in Jilin Province, but almost exclusively in Hunchun County close to the Russian border. While there exists potential to bolster populations of sika deer in Jilin with adequate protection, this species will likely never be common in Heilongjiang, and may increase only in Southern Laoyeling.

6.5.2 Secondary prey species

In addition to ungulates, a number of other animal species are preyed upon by tigers and leopards. Leopards especially rely on a variety of smaller mammals and birds; tigers also take small items, and sometimes prey on bears as well. When ungulate densities are low, as is the case in Heilongjiang, the importance of secondary species becomes magnified. Therefore, the status of some of these potential prey is reviewed here.

Hares *(Lepus spp.)*. Two species of hares, the Manchurian and arctic, occur in the eastern mountains of Heilongjiang Province. However, we could not distinguish between the two species based on tracks and scats. In general, Manchurian hare are more widely distributed, and arctic hare are found only in the Wandashan Mountains. Sign of hares (either scat or tracks), was found on 60% of the survey routes (Table 6). In the Eastern Wandashan, hares were especially abundance, being found on 81% of survey routes. Nonetheless hare number were generally low throughout the survey region. Although hare numbers fluctuate widely naturally, intensive snaring no doubt is depressing numbers in at least some regions. At present, hare numbers are so low that they do not contribute significantly to the available prey biomass.

Bears *(Ursidae)*. Both brown bears and Himalayan black bears occur in eastern Heilongjiang Province. Bears can form a small, but significant part of the diet of tigers. Although most bears should have been hibernating at the time of the survey, tracks were nonetheless found on 5 routes (4 appeared to be black bears, and one a brown bear), and evidence of tree breakage by black bears (to harvest mast and berries) was found on 7 routes

Table 9. Number of fresh tracks, number of individual animals, tracks/km of survey route, and relative abundance (0, low, moderate, high) of ungulate species on survey routes in Heilongjiang Province, January 19-March 19, 1999.

Route #	Region	Total distance of route (km)	Ungulate Species															
			Roe deer				Wild boar				Red deer				Sika deer			
			# tracks	# ind.	Tracks/ km	Rel. abund.	# tracks	# ind.	Tracks/ km	Rel. abund.	# tracks	# ind.	Tracks/ km	Rel. abund.	# tracks	# ind.	Tracks/ km	Rel. abund.
1	S. Laoyeling	11.0	19	10	1.73	mod	4	2	0.36	low	0	0	0	0	41	19	3.73	mod
2	S. Laoyeling	9.8	33	22	3.37	high	0	0	0	0	0	0	0	0	0	0	0	0
3	S. Laoyeling	7.3	8	2	1.10	low	17	11	2.33	mod	0	0	0	0	3	3	0.41	low
4	S. Laoyeling	12.0	55	13	4.58	high	0	0	0	0	0	0	0	0	0	0	0	0
5	S. Laoyeling	7.8	3	3	0.38	mod	0	0	0	mod	0	0	0	0	0	0	0	0
6	S. Laoyeling	5.5	3	2	0.55	low	0	0	0	0	0	0	0	0	0	0	0	0
7	S. Laoyeling	4.6	7	7	1.52	mod	2	2	0.43	low	0	0	0	0	0	0	0	0
8	S. Laoyeling	7.1	1	1	0.14	low	6	2	0.85	low	0	0	0	0	0	0	0	0
9	S. Laoyeling	2.2	2	2	0.91	mod	0	0	0	low	0	0	0	low	0	0	0	0
10	S. Laoyeling	5.0	0	0	0	mod	7	7	1.40	high	0	0	0	0	0	0	0	0
11	S. Laoyeling	8.2	39	13	4.76	high	14	7	1.71	mod	0	0	0	0	0	0	0	0
12	S. Laoyeling	5.0	0	0	0	low	0	0	0	low	0	0	0	0	0	0	0	0
13	N. Laoyeling	6.3	0	0	0	low	0	0	0	mod	0	0	0	low	0	0	0	0
14	N. Laoyeling	15.0	9	3	0.60	mod	13	9	0.87	mod	0	0	0	mod	0	0	0	0
15	N. Laoyeling	11.0	1	1	0.09	mod	0	0	0	mod	0	0	0	low	0	0	0	0
16	N. Laoyeling	8.0	0	0	0	mod	0	0	0	mod	0	0	0	low	0	0	0	0
17	S. Laoyeling	14.0	8	8	0.57	mod	0	0	0	mod	1	1	0.07	low	0	0	0	0
18	S. Laoyeling	11.0	17	13	1.55	mod	3	3	0.27	mod	0	0	0	low	0	0	0	0
19	S. Laoyeling	4.5	2	2	0.44	low	0	0	0	high	0	0	0	low	0	0	0	0
20	S. Laoyeling	10.0	7	3	0.70	mod	0	0	0	low	4	4	0.40	mod	0	0	0	0
21	S. Laoyeling	7.0	2	2	0.29	low	0	0	0	0	0	0	0	low	0	0	0	0
22	S. Laoyeling	10.5	4	2	0.38	low	0	0	0	low	0	0	0	0	0	0	0	0
23	S. Laoyeling	7.0	7	5	1.00	low	1	1	0.14	low	1	1	0.14	low	0	0	0	0
24	S. Laoyeling	5.8	0	0	0	low	0	0	0	low	0	0	0	low	0	0	0	0
25	S. Laoyeling	8.3	0	0	0	0	0	0	0	low	0	0	0	0	0	0	0	0
26	S. Laoyeling	8.5	12	8	1.41	mod	6	6	0.71	mod	0	0	0	0	0	0	0	0
27	S. Laoyeling	10.0	14	12	1.40	mod	12	6	1.20	mod	0	0	0	0	0	0	0	0
28	S. Laoyeling	7.0	0	0	0	low	0	0	0	low	0	0	0	0	0	0	0	0
29	E. Wandashan	6.7	5	5	0.75	mod	0	0	0	mod	3	3	0.45	mod	0	0	0	0
30	E. Wandashan	7.5	13	8	1.73	high	0	0	0	low	13	7	1.73	mod	0	0	0	0
31	E. Wandashan	7.0	4	4	0.57	mod	0	0	0	low	6	2	0.86	mod	0	0	0	0
32	E. Wandashan	5.5	0	0	0	low	0	0	0	low	0	0	0	low	0	0	0	0
33.1	E. Wandashan	11.3	5	5	0.44	high	0	0	0	0	0	0	0	low	0	0	0	0
33.2	E. Wandashan	11.1	3	3	0.27	mod	4	4	0.36	low	0	0	0	0	0	0	0	0
34	E. Wandashan	20.0	52	32	2.60	high	0	0	0	0	0	0	0	0	0	0	0	0

Table 9. cont.

Route #	Region	Total distance of route (km)	Ungulate Species															
			Roe deer				Wild boar				Red deer				Sika deer			
			# tracks	# ind.	Tracks/ km	Rel. abund.	# tracks	# ind.	Tracks/ km	Rel. abund.	# tracks	# ind.	Tracks/ km	Rel. abund.	# tracks	# ind.	Tracks/ km	Rel. abund.
35	E. Wandashan	13.2	11	9	0.83	mod	3	3	0.23	low	0	0	0	0	0	0	0	0
37	E. Wandashan	9.3	27	22	2.90	high	0	0	0	0	13	8	1.40	high	0	0	0	0
38	E. Wandashan	15.0	47	23	3.13	mod	0	0	0	low	1	1	0.07	low	0	0	0	0
39	E. Wandashan	14.0	48	26	3.43	mod	0	0	0	low	0	0	0	0	0	0	0	0
40	E. Wandashan	10.4	18	7	1.73	mod	0	0	0	0	0	0	0	0	0	0	0	0
41.1	E. Wandashan	6.1	2	2	0.33	mod	20	6	3.28	high	0	0	0	0	0	0	0	0
41.2	E. Wandashan	4.6	0	0	0	low	0	0	0	0	0	0	0	0	0	0	0	0
42	E. Wandashan	21.0	59	29	2.81	high	4	4	0.19	mod	0	0	0	0	0	0	0	0
43.1	E. Wandashan	6.5	50	13	7.69	mod	10	10	1.54	mod	0	0	0	0	0	0	0	0
43.2	E. Wandashan	3.5	32	7	9.14	mod	0	0	0	low	0	0	0	0	0	0	0	0
44	E. Wandashan	25.0	44	14	1.76	high	0	0	0	low	0	0	0	0	0	0	0	0
45	E. Wandashan	3.6	0	0	0	low	0	0	0	0	0	0	0	0	0	0	0	0
46	E. Wandashan	25.0	38	21	1.52	mod	0	0	0	low	1	1	0.04	low	0	0	0	0
47.1	E. Wandashan	7.0	22	10	3.14	high	21	15	3.00	high	3	3	0.43	low	0	0	0	0
47.2	E. Wandashan	7.0	2	2	0.29	mod	0	0	0	mod	8	5	1.14	mod	0	0	0	0
48	E. Wandashan	5.0	6	6	1.20	mod	0	0	0	low	0	0	0	0	0	0	0	0
49	E. Wandashan	17.3	14	7	0.81	high	2	2	0.12	mod	10	4	0.58	mod	0	0	0	0
50	E. Wandashan	7.0	0	0	0	low	7	7	1.00	mod	0	0	0	low	0	0	0	0
51	E. Wandashan	5.0	4	4	0.80	mod	6	6	1.20	mod	26	4	5.20	low	0	0	0	0
52	E. Wandashan	5.0	0	0	0	mod	0	0	0	0	1	1	0.20	low	0	0	0	0
54	E. Wandashan	10.0	22	12	3.14	mod	0	0	0	0	1	1	0.14	low	0	0	0	0
56	E. Wandashan	8.3	8	4	1.60	mod	4	4	0.80	low	6	3	1.20	low	0	0	0	0
57	E. Wandashan	16.0	7	7	1.40	high	3	3	0.60	high	0	0	0	0	0	0	0	0
58	E. Wandashan	6.0	4	4	0.40	high	0	0	0	high	0	0	0	mod	0	0	0	0
59	Zhangguangcailing	6.0	3	3	0.50	low	5	5	0.83	low	0	0	0	0	0	0	0	0
60	Zhangguangcailing	6.5	5	4	0.77	low	0	0	0	0	1	1	0.15	low	0	0	0	0
61	Zhangguangcailing	7.6	2	1	0.26	low	0	0	0	0	2	2	0.26	low	0	0	0	0
62	Zhangguangcailing	7.5	0	0	0	0	10	10	1.33	mod	0	0	0	0	0	0	0	0
63	Zhangguangcailing	7.0	2	2	0.29	low	0	0	0	0	0	0	0	0	0	0	0	0
64	Zhangguangcailing	8.5	24	16	2.82	high	6	6	0.71	low	0	0	0	0	0	0	0	0
65	Zhangguangcailing	6.5	11	8	1.69	mod	0	0	0	0	2	2	0.31	low	0	0	0	0
66	Zhangguangcailing	7.0	3	2	0.43	low	17	17	2.43	high	0	0	0	0	0	0	0	0
TOTALS		605.9	850	456	1.40		207	158	0.34		103	54	0.17		44	22	0.07	

(16%) (Table 6). Evidence of Himalayan black bears was found in all regions except Southern Zhangguangcailing. Although data is inadequate, available evidence suggested that bears were 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, but hazel grouse were 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. No evidence of pheasant was encountered along survey routes.

6.6 Factors Influencing Prey Populations

Because survey routes were located to maximize probability of encountering sign of tiger and leopard, data concurrently collected on ungulates is no doubt biased, and cannot adequately reflect the real distribution and number of prey species. Additionally, heavy snow in some areas influenced the quality and reliability of ungulate survey data. All these factors, plus the limited time in each region, introduced many errors in deriving estimates of abundance. Nonetheless, these measures provide a reasonable index of the status of prey resources for tigers and leopards in eastern mountains of Heilongjiang Province.

Survey results demonstrated that prey densities were, in general, low throughout most of the areas surveyed. The government has increased efforts to protect wildlife in recent years, including outlawing and confiscating firearms, increased public outreach and education programs, and strictly limiting hunting seasons for game species. In some regions, local people reported increases in wildlife populations as a result of these measures. However, present densities of potential prey species are still well below that which the available habitat could support, and are insufficient to support leopards and tigers in all survey regions.

The sporadic distribution and low abundance of many prey species in survey areas was likely attributable to two factors – excessive human harvest and reduction of suitable habitat.

6.6.1 Reduction of suitable habitat

Every wildlife species requires a set of habitat parameters that provide forage, cover, and other critical needs. The amount of suitable habitat for many wildlife species has decreased in Eastern Heilongjiang due to continuous, long-term logging activities. This activity, along with conversion of forests into grazing and agricultural lands, has resulted in a gradual, but overall dramatic reduction in wildlife abundance. Reduction in forest wildlife habitat in Heilongjiang is clearly evident in comparing the amount of forested lands in 1898 and 1986 (Figures 8a and 8b). Total forested area has decreased dramatically, and most importantly, some of the key habitat types, such as Korean pine forests, have been eliminated or nearly eliminated from many areas.

Of the key prey species for tigers, wild boar are probably most dependent on Korean pine forests. Because Korean pine nuts are an important winter forage, loss of this habitat type can have a dramatic impact on the potential of an area to support wild boar. While red deer can survive in second-growth forests, such forest are often of marginal value for wild boar unless adequate mast crops exist – the most important of which, in addition to Korean pine, are Mongolian oak and hazelnut (*Corylus* spp.). Mongolian oak is a common component of second growth forests of this region, but in recent years the cultivation of an

Table 10. Mean track density (per 10 km along survey routes), mean number of animals/10 km, and relative abundance of four ungulate species in four study areas of eastern Heilongjiang Province, based on data collected along survey routes between January 19 and March 19, 1999.

		Roe deer			Wild boar			Red deer			Sika deer		
Region	# survey routes	Mean tracks/ 10 km	Mean animals/ 10 km	Relative abundance*	Mean tracks/ 10 km	Mean animals/ 10 km	Relative abundance*	Mean tracks/ 10 km	Mean animals/ 10 km	Relative abundance*	Mean tracks/ 10 km	Mean animals/ 10 km	Relative abundance*
Southern Laoyeling	24	11.2	6.9	moderate	3.9	2.5	low	0.3	0.3	low	1.7	1.2	low
Northern Laoyeling	4	1.7	1.0	low	2.2	2.2	low	0.0	0.0	absent	0.0	0.0	absent
Eastern Wandashan	31	17.6	8.9	moderate	4.0	2.0	low	4.3	1.3	low	0.0	0.0	absent
S. Zhangguangcailing	8	8.5	6.4	moderate	6.6	6.7	low	0.9	0.9	low	0.0	0.0	absent
Total	67	14.491		moderate	3.2641		moderate	1.1705		low	0.7254		mostly absent

*based on relative abundance of tracks on survey routes.

edible fungus (*Auricularia auricula-judae*) has resulted in the loss of large areas of oak forests. Any further increases in these economic developments will have serious impacts on the distribution and numbers of wild boar distribution.

The Project for Protection of Natural Forests, which was initiated by the Federal government, should protect vast forest tracts of Heilongjiang Province. This project could greatly benefit wildlife by protecting habitat and reducing human activity (especially illegal hunting) on forest lands. This project also has important implications for creation of protected areas (see below).

6.6.2 Excessive human harvest

Although possession of hunting firearms is illegal, it is clear that some hunters are still in possession of rifles, and make use of them. For instance, we encountered 6 hunters with one gun and 3 dogs (useful for hunting wild boar, squirrels and other species) in Shichang District of Dongfanghong Forest Bureau, Eastern Wandashan (route 47.2).

While hunting by rifle still occurs in the region, snares no doubt have a greater impact in the region. A total of 78 wire neck snares, apparently set primarily for capture of ungulates, were found along the 566 km of survey routes that were covered on foot (Table 11). We found 10 instances where evidence suggested that ungulates had been killed (dead animals in snares, remains at snare site, tracks in snow where animals had been dragged off, etc.) (Table 11); including 3 instances where the remains of an ungulate was found in a snare. Assuming that all 10 mortalities were associated with a snare capture (a few drag marks could not be associated with a specific snare site) approximately 13% of snares successfully captured ungulates. This estimate is not doubt an exaggerated estimate of capture success, because snares were much more obvious when dead animals (or remains) were at snare sites, and drag marks were often not associated with a specific snare. Using the minimum number (3 snares sites where remains were found) snare success rates is a minimum of 4%.

Snares appeared to be of varying ages – some appeared to have been set many years ago, but most were probably set this winter. Old snares, though no longer maintained or checked by trappers, continued to function, killing ungulates.

Snares not only kill ungulates, but also have the capacity to kill large predators such as leopards and tigers. Information from two interviews (Table 3, Interviews 31 and 50) indicate that at least two tigers were snared since 1995, and at least one of those was killed in a snare set for wild boar in Wupao District of the Eastern Wandashan. Our ability to collect such information was limited, and it is likely that other incidences went unreported.

Information in Table 11 does not adequately demonstrate the potentially catastrophic impact of snaring. To demonstrate the potential of snares to impact ungulate populations, it is worthwhile to estimate the potential impact of snaring over a large area. We provide such an example for a typical Forest Bureau of 5000 km^2 (e.g. Suiyang or Dongfanghong Forest Bureaus are both approximately this size) (Table 12). Using a conservative estimate of snare density, and a conservative estimate of the number of snares that successfully capture ungulates (Table 12), we estimate that a minimum of 550 ungulates are being killed each year over a 5000 km^2 area (1 animal/9 km^2). Using the maximum estimate for capture rate of snares (13%), the impact is much greater: nearly 1,800 ungulates per year (1 animal/2.8 km^2). These figures provide only a crude estimate of the impact of snares, as our data is limited, and may not be directly applicable to any specific Forest Bureau, since our data is generalized for all survey areas. Nonetheless, these data are sufficient to indicate that snares are killing an extremely large number of ungulates in the eastern mountains of Heilongjiang Province.

Table 11. Number of snares found, and evidence of ungulates killed along survey routes of the tiger/leopard survey of eastern Heilongjiang Province, winter 1999. Routes not traveled on foot were excluded from this summary.

Route #	Total km	# Snares located	Snares/ km walked	# animals killed in snares or other means	Species Killed
1	11	2	0.18	0	
2	9.8		0.00	0	
3	7.3	16	2.19	drag mark when animal was removed	boar or sika deer
4	12	1	0.08	0	
5	7.8	3	0.38	drag mark	probably roe deer
6	5.5	2	0.36	caught in snare & dragged off	roe deer
7	4.6		0.00	0	
8	7.1		0.00	0	
9	2.2		0.00	0	
10	5		0.00	0	
11	8.2		0.00	0	
12	5		0.00	0	
13	6.3		0.00	0	
14	15		0.00	0	
15	11		0.00	0	
16	8		0.00	0	
17	14		0.00	0	
18	11	1	0.09	wild boar found in snare	wild boar
19	4.5		0.00	wild boar dragged off	wild boar
20	10		0.00	0	
21	7	3	0.43	0	
22	10.5		0.00	0	
23	7	4	0.57	0	
24	5.8		0.00	0	
25	8.3		0.00	0	
26	8.5	2	0.24	0	
27	10		0.00	0	
28	7		0.00	0	
29	6.7		0.00	0	
30	7.5	2	0.27	0	
31	7		0.00	0	
32	5.5		0.00	0	
33.1	11.3		0.00	0	
33.2	11.1		0.00	0	
34	20	5	0.25	0	
35	13.2		0.00	0	
37	9.3		0.00	0	
38	15	4	0.27	0	
39	14		0.00	0	
40	10.4		0.00	0	
42	21	4	0.19	0	
43.1	6.5		0.00	0	
43.2	3.5		0.00	hunting with dogs and probably gun	
44	25		0.00	0	
45	3.6		0.00	0	
46	25	2	0.08	0	

Table 11. cont.

Route #	Total km	# Snares located	Snares/ km walked	# animals killed in snares or other means	Species Killed
47.1	7		0.00	0	
47.2	7		0.00	0	
48	5		0.00	0	
49	4.3 on foot		0.00	0	
50	7	7	1.00	found remains at one snare site	wild boar
51	5		0.00	0	
52	5		0.00	0	
54	10	0	0.00	0	
56	8.3		0.00	0	
58	6		0.00	0	
59	6	3	0.50	one	roe deer
60	6.5		0.00	0	
61	7.6	1	0.13	one	wild boar
62	7.5	5	0.67	0	
63	7		0.00	0	
64	8.5	9	1.06	one	roe deer
65	6.5	2	0.31	one	roe deer
66	7		0.00	0	
Totals	566.2	78	0.14		10

Table 12. An estimate of the potential impact of snares on prey populations in Heilongjiang Province, using Suiyang Forest Bureau as an example, based on data collected during the 1998 winter tiger/leopard survey.

Assumptions and bases for estimate	Value	Unit
1. With 78 snares found in 566 km of all survey routes, the encounter rate of snares was:	0.14	snares/km walked
2. If we assume that snares can be sighted up to 25 meters on either side of the walking route, then for every kilometer walked, approximately:	5	ha were searched/km
3. The density of snares can then be estimated to be:	2.8	snares/km^2
4. The total area of Forest Bureau (Suiyang or Dongfangchong) is	5,000	km^2
5. Therefore, given the estimated snare density, there are:	13,781	snares in Suiyang
6. Our data suggests that capture rate in snares may be as high as 13%. However, we use a conservative estimate:	4%	of snares capture ungulates
7. Given the conservative capture rate, and the estimated number of snares, the estimated annual mortality in Suiyang is:	551	prey/year killed by snares
8. If the capture rate is snares is 13%, (the maximum estimate from our data) then the estimated annual mortality of ungulates in Suiyang Forest Bureau would be:	1792	prey/year killed by snares

These data strongly suggest that the widespread prevalence of snares is the most likely explanation for the paucity of prey over the survey area. The scarcity of tigers, leopards, and lynx, and the absence of wolves or other large predators suggests that predators are not depressing prey populations. Good habitat and adequate forage exists for roe deer, red deer and wild boar. These species can recover naturally in most areas if snares are eliminated, and the intense harvest pressure by humans is reduced.

7. CONSERVATION STRATEGY AND MANAGEMENT RECOMMENDATIONS

To develop meaningful recommendations for the conservation of tigers and leopards in Heilongjiang Province and northeast China, it is first necessary to understand the status of tigers and leopards, as well as to define the major causes for their decline in this region. Finally, it is impossible to consider a conservation strategy for Heilongjiang Province independent of neighboring provinces and countries. Therefore, the conservation strategy we outline below takes into account our knowledge of tigers and leopards in both Jilin and Heilongjiang, and Russia as well as China. North Korea represents the last potential location where the status of tigers is still unknown, but opportunities to include North Korea should be preserved if there exists an interest on their part to participate in international conservation efforts.

7.1 Status of Tigers and Leopards in Heilongjiang Province and northeast China

The Amur tiger has become extremely endangered in northeast China. In fact, in combination with survey results in eastern Jilin Province (Yang 1998), **we conclude that the tiger is on the verge of extinction in northeast China**. The animals that do occur across this region appear to be for the most part, isolated, nomadic individuals. While in the Eastern Wandashans numerous reports exist over an extended period, suggesting the presence of permanent, resident tigers, in other regions a single or small set of reports occur for short periods of time, after which animals seem to disappear, suggesting that tigers are simply wandering through these regions, never taking up permanent residence, or are killed before they have a chance to do so. With the possible exception of the Eastern Wandashan, there is no evidence that tigers are reproducing anywhere in northeastern China. Given the fact that reproduction is not occurring, it appears that those animals that do occur in Jilin Province, and in Laoyeling and Zhangguangcailing of Heilongjiang, are probably dispersing nomads that have crossed the border from Russia. The existing situation suggests that, again with the possible exception of the Wandashan region (although exchange occurs there as well), the presence of tigers in northeast China is completely dependent on the fact that dispersal of tigers from Russia is still possible. Therefore, those populations of tigers that still exist on the Russian side of the border are critical to survival and recovery of tigers in both Jilin and Heilongjiang. Without reproduction, and without any localized concentration of tigers where reproduction could occur, tigers in northeast China would likely already be extinct if emigration from Russia were not occurring.

Based on the results of this survey, plus work that has been conducted in Jilin (Yang et al. 1998) and Russia (Matyushkin et al. 1996), it appears that Amur tigers presently exist in two isolated populations in Heilongjiang. **1) The Tumen River Tiger Population**, which consists of tigers in southwest Primorye Krai, Russia, Hunchun and Wangqing Counties of Jilin Province,

Southern and Northern Laoyeling Region, and the Zhangguangcailing Region of Heilongjiang (it is yet unknown whether tigers in North Korea may be connected to this population; if so, they may later be added to this tiger conservation unit). Tigers in Northern Laoyeling and Pogranichny Raion, Russia (if any still exist) may already be isolated from this population, in which case we recommend that efforts be made to reconnect this region by restoring habitat in a proposed ecological corridor between Southern and Northern Laoyeling (see 7.3.4). **2) The Wandashan Tiger Sub-population**, which is connected to the Sikhote-Alin metapopulation via the Strelnikov Range in Russia, is the second population of tigers in Heilongjiang. As it is highly unlikely that these two populations of tigers will ever be reconnected, we propose that it is important to acknowledge this fact and manage the existent tigers and potential tiger habitat in Heilongjiang (and the adjacent regions) as two separate populations. Conservation plans should insure long-term viability of each of these populations assuming isolation will continue in the future.

Leopards are probably even rarer than tigers in Heilongjiang. Leopards were probably historically found only in southeast Heilongjiang in Laoyeling and possibly Zhangguangcailing regions. Most of Heilongjiang probably represents marginal leopard habitat, and leopards were probably always rare. Nonetheless, there likely existed a few pockets of good leopard habitat where they were not uncommon in both southern and northern Laoyeling, and perhaps in the southern Zhangguangcailing region.

7.2 Primary Threats to Tigers and Leopards in Heilongjiang Province

Although the Chinese government has taken steps to protect wild tigers and leopards, these steps do not appear to have improved the status of either species in Heilongjiang. To determine why these steps were insufficient, and how to develop a strategy that could lead to recovery of tigers and leopards in Heilongjiang, it is first necessary to identify the primary threats to these populations so that actions can be taken to mitigate those threats. Below we outline what we believe to be the primary causes for their decline and the present dangerously low numbers of tigers and leopards.

7.2.1. Habitat loss and fragmentation.

Amur tigers are associated primarily with large, forested tracts of land. As demonstrated in Figures 8a and 8b, the total forested area of Heilongjiang has decreased dramatically from its original size. Conversion of forest lands continues today, and continued logging changes the composition and types of forests that remain. The continuing conversion of forest lands results in overall reduction, degradation, and fragmentation of forest patches. Originally, many forest tracts that are presently considered potential tiger habitat – Western and Eastern Wandashan, Northern and Southern Laoyeling, and Northern and Southern Zhangguangcailing - were connected as a continuous forest tract. Now, each of these forests exist as parcels of land separated from each other by human-dominated landscapes that do not permit movement of tigers or leopards (Figure 8b). Two forest tracts where tigers are no longer found – Western Wandashan and Lesser Khingan – are totally isolated from other forest tracts in China, and from tiger habitat in Russia. This isolation, associated with other factors listed here, is likely a primary reason why tigers no longer exist in these regions.

The Eastern Wandashan Mountains are separated from Western Wandashan, as well as all other forest tracts in China. However, a small corridor of habitat remains linking Eastern Wandashan with the Strelnikov Range of Primorskii and Khabarovskii Krais, Russia, which is further connected to the Sikhote-Alin Range, where the majority of Amur tigers exist today.

This corridor may provide a continuous source of tigers for Eastern Wandashan. Evidence exists that tigers do move back and forth across the Ussuri River (Xiaochen Yu, unpubl. data), which marks the international boundary in this region.

Northern Laoyeling is still connected to forest habitat in Pogranichny Raion, Russia, via a forested boundary in this region. However, Northern and Southern Laoyeling, although connected by lands managed by the Suiyang Forest Bureau, are actually separated by a large expanse of degraded shrub lands with intense human use that likely prevents passage of tigers or other wildlife between the two components of what was once a continuous forest tract. Therefore, Northern Laoyeling, at present, represents a very small tract of habitat for tigers, which, even in combination with forested areas of Pogranichny Raion, is insufficient to retain a viable population of tigers by itself.

Southern Laoyeling, although marginally connected to Northern Laoyeling, is still connected to the Zhangguangcailing Range due to the existence of forested habitat along the Jilin-Heilongjiang provincial border both in Dongjingcheng Forest Bureau in Heilongjiang and Wangqing Forest Bureau in Jilin. It is still possible for a tiger that crosses the Russian-Chinese border from Southwest Primorye, to travel via either Southern Laoyeling in Heilongjiang Province, or the Dalongling Region of Jilin Province to either Southern or Northern Zhangguangcailing.

"Classic" processes of extinction for large carnivores often begin with fragmentation of habitat into numerous small parcels, followed by localized extinction of animals in each of these habitat parcels. Fragmentation has already extended across much of Heilongjiang Province, and localized extinction has already occurred in two of those parcels – the Western Wandashan and Lesser Khingan Mountains. To avoid further extinctions, it is critical that connectivity amongst habitat patches be maintained.

7.2.2 Low prey densities

No matter how well forests are protected from further degradation and fragmentation, there must be an adequate prey resource for tigers and leopards if they are to survive in those remaining forest tracts. Tigers require high densities of large ungulates – red deer, wild boar, sika deer, and to a lesser extent, roe deer. In Heilongjiang Province, red deer and wild boar were probably historically the most important prey species for tigers. Unfortunately, these two prey species are sparsely distributed at exceedingly low densities in many of the areas we surveyed in eastern Heilongjiang. Although it is impossible from our data to accurately estimate ungulate density, it is clear that present densities are insufficient to support a population of healthy, reproducing tigers. An increase in numbers of sika deer in southern Laoyeling could help to recover both tiger and leopard numbers there, but elsewhere, an increase in numbers of roe deer, red deer, and wild boar will be essential.

As long as ungulate numbers are low, tigers dispersing through good forest habitat will be forced to adopt a nomadic existence. Where adequate prey densities exist, and where good forest habitats occur, tigers will "settle down" to establish home ranges and maintain permanent residency. If female tigresses find areas with sufficient prey densities to raise young, they will establish permanent home ranges, and male tigers will shortly establish residency there as well. Hence, management and protection to increase prey densities will be an essential component of any plan to recover tiger and leopard populations.

7.2.3 Direct human-caused mortality of tigers and leopards

We have very little information to estimate the extent to which poaching is a mortality factor for tigers in Heilongjiang Province. Of the 76 interviews reported (Table 3), there were

two accounts of tigers being snared (2.6%). However, this information is likely a poor indication of the extent to which poaching of tigers or leopards may occur. In nearby Russia, illegal hunting and trapping is the primary cause of death for tigers. The situation is likely similar in China. In both countries, tiger carcasses are very valuable, and local hunters can earn substantial amounts of money by killing a tiger. Historically, hunting of tigers in northeast China was fairly common (Baikov 1925) and it is likely that the tradition has continued up to the present.

Elimination of human-caused mortality will be essential for recovery of the tiger population in Heilongjiang.

7.3 Recommendations for Conservation of Tigers and Leopards in Eastern Heilongjiang Province

Despite the dangerously low populations of tigers, leopards, and their prey, there are at least six reasons for optimism that these populations can recover in Heilongjiang Province. 1) There remain extensive tracts of forested lands in Dongfanghong, Yingchun, Suiyang, Muling, Dongjingcheng and Dahailin Forest Bureaus, and although prey populations are low, these regions retain the capacity to harbor good populations of prey, as well as tigers and leopards, if they are adequately protected. 2) There exist sizable populations of tigers, leopards, and their prey in adjacent habitat in Russia that could act as a source for animals emigrating into Laoyeling and eastern Wandashan of Heilongjiang Province, thus speeding the recovery process. 3) 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 tigers and leopards. 4) Evidence of reproduction by at least one female was found in the vicinity of Shendingfeng Mountain in Eastern Wandashan in recent years, indicating that breeding and natural reproduction (and hence, the potential for population increase) can still occur. 5) Enactment of the Project for Protection of Natural Forests in 1997 can assist in protecting large tracts of habitat necessary for conservation of tigers and leopards. 6) Finally, there appears to be a sincere desire on the part of the Wildlife Conservation Association and the State Forestry Administration, as well as other branches of the government, to assist in recovery of tiger and leopard populations. The State Forestry Administration is presently developing "The Tiger Conservation Action Plan for China," and the Russian and Chinese federal governments have initiated dialogue for establishment of transboundary reserves to protect Amur tigers.

If the forests are properly protected, illegal hunting and snaring is controlled, and ungulate populations are allowed to increase, resident populations of tigers and leopards will naturally become established in Heilongjiang Province. We recommend that the goal of a recovery process of tigers and leopards in Heilongjiang should be the establishment of a viable, resident breeding population of wild tigers and leopards. We present 9 recommendations concerning land use practices and recovery of ungulate population in Heilongjiang Province that we believe would lead to the recovery of tigers and leopards.

7.3.1 Develop a tiger and leopard recovery plan for Heilongjiang Province.

Because tigers and leopards are highly threatened by habitat fragmentation and degradation, inadequate prey resources, and illegal hunting, it is necessary to develop a comprehensive and feasible recovery plan for tigers and leopards as quickly as possible in Heilongjiang Province. As stated above, the goal of this plan is the development of stable, reproducing populations of tigers and leopards that are linked to suitable habitat in Russia and Jilin. **We cannot overemphasize the urgent need to develop and implement a recovery plan immediately: while tigers still exist in Wandashan, and are scattered across Laoyeling and**

Zhangguangcailing, it is important to implement plans that can save the remaining tigers. Attempts to recreate a population after tigers become extinct in northeast China will be more difficult by several orders of magnitude. Therefore, it is essential to create and implement a recovery plan immediately.

The recovery plan should act as a guiding document to be used in managing specified Forest Bureaus. In addition to the suggestions outlined below, the plan should include the following points:

- there should be complete endorsement and support from of the Federal and provincial governments;
- there should exist a bureaucratic structure to insure that the recovery plan is implemented, i.e., specific organizations and individuals within those organizations should be charged with primary responsibility for implementation of the recovery plan;
- a land-use plan should be developed that specifically designates which lands are strictly protected for tigers and leopards(7.3.2-7.3.3);
- training is essential for those managers of Forest Bureaus responsible for implementing management guidelines of the recovery plan, and for all Forest Bureau staff in regions where tiger and leopard conservation is a priority, to insure guidelines are understood and implemented;

The key component of this recovery plan will be the development of a habitat protection plan for tigers and leopards in Heilongjiang and adjacent territories in Jilin and Russia. We propose a three-stage process for creating a system of protected areas and tiger management units: 1) create protected areas designed specially for tiger and leopard conservation; 2) create tiger management zones where other uses are allowed as long as they are compatible with tiger and leopard conservation; and, 3) create ecological corridors where necessary to insure connectivity between habitat patches. We provide plans for both the Tumen River Population of tigers, the Wandashan sub-population of tigers, and the lone remaining leopard population (sections 7.3.2-7.3.3, Figure 9, Table 13) and then provide concrete recommendations for management regimes within these areas (section 7.3.5).

Often, creation of strictly protected areas is seen as a liability and loss of potential resources, because economic activities must be prohibited if protected areas are to achieve their intended goals. However, with the enactment of the Project for Protection of Natural Forests by the Chinese government, tiger and leopard conservation, creation of protected areas, and goals established for this project can be attained simultaneously. Creation of protected areas on Forest Bureau lands will protect natural forests and ecosystem integrity, increase wildlife populations, and provide key habitat for tigers. Thus, tiger conservation is compatible with existing legislature to protect forests in Heilongjiang and Jilin Provinces.

Our proposals for a land-use plan are based on the following assumptions.

1. First, as stated above, tigers in Heilongjiang should be managed as two populations, and conservation plans should insure long-term viability of each of these populations assuming complete isolation from each other.

2. The best chance for recovery of wild populations of tigers and leopards in both Heilongjiang and Jilin will be to insure connectivity with existing populations in Russia. Under present conditions, the scattered individuals in Jilin and Heilongjiang do not represent viable populations of tigers, and will surely go extinct without emigration from Russia. If a recovery plan is to be implemented, the quickest, cheapest and most effective means for insuring recovery is to protect transboundary habitat to provide a mechanism for exchange of tigers between the two countries. Existing protected areas in northern China created for tigers (Changbaishan in Jilin and Qixinglazi in Western Wandashan) no longer harbor

tigers because these regions are isolated fragments of habitat with no means for tigers to emigrate into these areas. If habitat is protected in China along the Russian border, and ungulate populations increase, emigrating tigers will establish permanent residence in China, and, as protection increases and prey populations reach sufficient densities, tigers will begin reproducing. Long-term viability of tigers on both the Russian and Chinese side will be greatly enhanced if tigers and leopards are managed jointly as single transboundary units. Therefore, we focus our proposals for protected areas along the Russian border for both the Tumen River Tiger Population and the Wandashan sub-population because these areas have the greatest potential for protecting tigers, as evidenced by the fact that some tigers still occur there.

3. We attempt to project the potential of the habitat proposed for protection to harbor tigers by estimating the number of tigers that could be contained in each protected unit. Based on data collected in Russia (Miquelle et al. 1999), we assume that in high quality, well-protected habitats, each adult resident female requires 470 km^2 to live and raise young. In areas that are not as well protected, or contain lower quality habitat, we apply a habitat value rating that adjusts adult female density to lower levels by 25% increments. This habitat value rating is a crude attempt to evaluate the near-term potential of areas to harbor tigers. Based on 20 years of survey data in Sikhote-Alin Zapovednik (1973-1993) we further assume that, in calculating the number of tigers, the ratio of adult females to adult male tigers is approximately 2.2:1, and that the ratio of adult females to subadult tigers is approximately 1.9:1(Smirnov and Miquelle 1999).

7.3.2 Southern and Northern Laoyeling Regions: Create specially protected areas (national and international), define tiger management zones, and delineate ecological corridors.

Southern Laoyeling represents critical habitat for both leopards and tigers in the Tumen River Population. If this region can be connected to Pogranichny Raion in Russia via Northern Laoyeling, there exists the opportunity to save these small habitat patches in the northernmost part of this tiger conservation unit and northernmost leopard habitat.

7.3.2.1 Southern Laoyeling-Suiyang Protected Area. The southernmost portion of Suiyang Forest Bureau is the only place where tiger tracks were located over the entire survey. This region borders Jilin Province, where evidence of tigers was found in 1998, and Southwest Primorye, where tigers are regularly reported. This region has great potential as a tiger and leopard reserve because it lies adjacent to a system of protected areas in Russia where both species are common.

The proposed "Big Cat (*Panthera*) International Park and Wildlife Refuge" (Anonymous 1996) would link protected areas in Jilin, Russia, and Heilongjiang. We endorse this proposal and recommend that a strictly protected area of approximately 1,200 km^2 be created in southern Suiyang Forest Bureau (Figure 9). Forests of this region are mainly mixed conifer and broad-leaved forests, and hold great potential as both tiger and leopard habitat. This proposed protected area would abut similarly proposed protected areas in the Dalongling Region of Hunchun (2000 km^2), which has already been proposed for protection (Yang et al. 1998) and be linked to proposed protected areas in the Russian Border Region of Hunchun (500 km^2) (Table 13, Figure 9). On the Russian side, three protected areas - Borisovkoe Plateau Zakaznik (613 km^2), Barsovy Zakaznik (974 km^2), and Kedrovya Pad Zapovednik (180 km^2) – already exist and form a connected network of protected areas (Table 13). Together, these protected areas would represent a complex of protected habitat encompassing nearly 5,500 km^2. In Heilongjiang

the proposed Southern Suiyang protected area should be created with federal level protection, while efforts are made to raise its status to the international level, to be managed in conjunction with the Russian side.

7.3.2.2. Tiger management zones. In both Southern Laoyeling and Northern Laoyeling there exists potential tiger habitat in Suiyang and Muling Forest Bureaus, and possibly also in Bamiantong Forest Bureau in the north. These regions should come under a special management regime (see below) that minimizes human impact to tigers, leopards, and potential prey. International cooperation should be developed to manage Pogranichny Raion of Primorskii Krai Russia in connection with Northern Laoyeling. If populations of prey species start to recover in these management areas, and if tigers recolonize the proposed protected area in Suiyang, dispersal and settlement into these management areas of China and Russia can be expected.

7.3.2.3. Ecological Corridors. Presently Northern Laoyeling is probably isolated from Southern Laoyeling by degraded, heavily used habitat and a major highway that crosses this region. On the Russian side, Pogranichny habitat represents an island of habitat connected only to Northern Laoyeling. We propose creation of an ecological corridor that links Northern and Southern Laoyeling (Figure 9). Restoration of this region, and strict protection, could provide a linkage for tigers, leopards, and other wildlife to move between these two segments of Laoyeling. Without creation of an effective corridor, Northern Laoyeling cannot support tiger or leopard populations because it is simply too small an area, even in conjunction with habitat in Pogranichny Raion.

A second ecological corridor via Dongjingcheng Forest Bureau could link Southern Laoyeling with Southern Zhangguangcailing Region. We consider this process a long-term plan, and do not develop the concept further here because we believe that conservation efforts in Heilongjiang should focus on quality habitat patches close to the Russian border.

7.3.2.4. Potential Number of Tigers in Tumen River Population. Based on our projections, we estimate that 2-3 breeding females could establish home ranges in the proposed protected area of Southern Suiyang, and that collectively across both provinces and countries, this population could have as many as 21 adult females and a total population of approximately 42 individuals (Table 13). The existent Tumen River population that exists in southwest Primorye, which numbers less than 15 individuals, is not viable in the long-term. Linking this primarily Russian population to protected areas in China that harbored reproducing populations of tigers would greatly increase the probability of survival.

7.3.2.5. Impact of conservation plans in Southern Laoyeling on leopards. By expanding leopard habitat with new protected areas in Jilin and Heilongjiang, it is possible to greatly increase the size of the existent population, which presently resides primarily in southwest Primorye. This small population, at less than 40 individuals, would have a much greater chance of survival if its numbers could be increased. Creating the proposed protected areas in China would essentially double the amount of habitat, greatly increasing the potential for this leopard population to increase.

7.3.3 Eastern Wandashan Mountains: create a specially protected area (national and international), define tiger management zones, and delineate ecological corridor to nearby Russian tiger habitat.

7.3.3.1 Eastern Wandashan Shendingfeng Protected Area. Total potential habitat for tigers in the Eastern Wandashan Mountains exceeds 5,000 km^2. However, the majority of recent locations, and the most secure habitat, exists in a region surrounding Shendingfeng Mountain. We propose creating a specially protected area of approximately 2,000 km^2 in the central core of the Eastern Wandashan, with linkages to the Russian border (Figure 9). This protected area would safeguard what appears to be the best remaining habitat for tigers in northeast China, and protect the last region where evidence of reproduction still exists. Forests of this region are

mainly mixed Korean pine and broad-leaved forests, and broad-leaved forests. A protected area of 2,000 km^2 could contain at least 4 resident females, and perhaps 8 or more tigers in total (Table 13).

7.3.3.2. Eastern Wandashan tiger management zones. The remaining forested habitat in Dongfanghong Forest Bureau, north and south of the specially protected areas, and perhaps parts of Yingchun Forest Bureau would be managed as tiger management zones (Figure 9, Table 13). In total, tiger management zones would encompass approximately 3,000 km^2. These lands would be critical habitat for what we hope would be an expanding tiger population in the Wandashan with appropriate management strategies.

7.3.3.3. Develop an ecological corridor between Eastern Wandashan and Sikhote-Alin Mountains via the Strelnikov Range in Russia. The key to survival of the Wandashan tigers will be an ecological corridor that links the Wandashan tigers to the Sikhote-Alin population in Russia. Evidence that tigers presently cross the Ussuri River (international boundary) exists (Xiaochen Yu, unpublished data), and emphasize the need to secure this natural corridor. Only one place exists where such a corridor is possible – linking the central part of the Wandashan with the Strelnikov Range on the Russian side. Agencies on the Chinese side will be responsible to insure that key habitat is protected on their side of the border to insure that exchange of tigers is possible. Meetings between the appropriate Russian and Chinese Ministries should be initiated in the near future to secure this key corridor. The patch of habitat represented by the Strelnikov Range is bisected by the primary road linking Vladivostok and Khabarovsk, and parts of this range occur in both Khabarovskii and Primorskii Krais. Forest tracts exist on both sides of the road, making exchange possible, but there exists a relatively narrow band of forest habitat left that could provide a travel corridor from the Bikin River Basin into the Strelnikov Range, and ultimately, to the Wandashans. On the Russian side of the border, discussions must be initiated to secure this parcel of habitat.

7.3.3.4. Potential Number of Tigers in Wandashan Sub-population. The combination of Shendingfeng Protected area, tiger management zones in the Wandashan, and the Strelnikov Ecological Corridor have the potential to contain as many as 9 resident adult tigresses, and perhaps a total population of approximately 17 individuals (Table 13). Such a small population is probably not viable if isolated, but if plans are properly implemented, there will be continuous exchange with tigers from the largest existent tiger habitat patch for Amur tigers - the Sikhote-Alin Range, where approximately 90% of all Amur tigers reside. As long as the potential for exchange is secured, the probability of long-term survival of tigers in Wandashan would be high.

7.3.4. Extension of the protected areas network

It is possible to extend the proposed protected areas network for the Tumen River tiger population to the west by incorporating forested lands in Wangqing County in Jilin, and connecting forested habitat in Southern Zhangguangcailing to Southern Laoyeling via Dongjingcheng Forest Bureau. Good potential tiger habitat exists in these regions, but restoration of prey populations will be essential. However, we recommend that conservation efforts should initially focus on recovery of tiger populations close to the Russian border, where the probability of success is greatest. If these efforts are successful, later attempts can be made to expand the network.

7.3.5 Define management guidelines for proposed protected areas and tiger management zones

Within areas designated for conservation, strict management regimes must be enforced if recovery of tigers and leopards is to be successful. All potential tiger and leopard habitat in

Table 13. Proposed system of transboundary protected areas and tiger management areas in Heilongjiang Province, and adjacent territories of Jilin Province and Russia.

Tiger population	Name	Country	Province	Forest Bureau	Status	Area (km^2)	Habitat value rating	Projected potential number of tigers			
								Adult females	Adult males	Sub-adults	Total
Tumen River Tiger Population											
I. Big Cat (Panthera) International Protected Area											
	1	China	Heilongjiang	Southern Suiyang	proposed	1200	1	2.6	1.2	1.3	5.1
	2	China	Jilin	Dalongling-Hunchun	proposed	2000	1	4.3	1.9	2.2	8.4
	3	China	Jilin	Border Region-Hunchun	proposed	500	1	1.1	0.5	0.6	2.1
	4	Russia	Primorye	Borisovkoe Plateau Zakaznik	created 1996	613	1	1.3	0.6	0.7	2.6
	5	Russia	Primorye	Barsovy Zakaznik	created	974	1	2.1	0.9	1.1	4.1
	6	Russia	Primorye	Kedrovya Pad Zapovednik	created 1916	180	1	0.4	0.2	0.2	0.8
	7	Russia	Primorye	Khasan-Nadeshdenski-Ussurisk Forest Districts	existent	1605	0.75	2.6	1.2	1.3	5.1
II. Southern Laoyeling Tiger Management Zone											
	8	China	Heilongjiang	Suiyang Forest Bureau	proposed	5000	0.25	2.7	1.2	1.4	5.3
	9	China	Jilin	Dajuaoggou District-Wangqing	proposed	5000	0.25	2.7	1.2	1.4	5.3
III. Northern Laoyeling-Pograninchny Tiger Management Zone											
	10	China	Heilongjiang	Suiyang Forest Bureau	proposed	300	0.5	0.3	0.1	0.2	0.6
	11	Russia	Primorye	Pogranichny Raion	proposed	1000	0.5	1.1	0.5	0.6	2.1
IV. Ecological Corridor between Northern and Southern Laoyeling											
	12	China	Heilongjiang	Suiyang Forest Bureau	proposed	1000	0.25	0.5	0.2	0.3	1.1
V. Tumen River Ecological Corridor between Khasan Russian and North Korea											
	13	China	Jilin	Hunchun Province	proposed	75	0.25	0.0	0.0	0.0	0.0
Total potential size of Tumen River Tiger Population based on projections:								21	10	11	42
Wandashan Tiger Sub-population (part of the Sikhote-Alin metapopulation)											
VI. Eastern Wandashan Shengdingfeng specially protected area											
	14	China	Heilongjiang	Dongfonghong	proposed	2000	1	4.3	1.9	2.2	8.4
VII. Eastern Wandashan Tiger Management Area											
	15	China	Heilongjiang	Dongfonghong-Yingchun	proposed	3000	0.5	3.2	1.5	1.7	6.3
VIII. Strelnikov Range Corridor											
	16	Russia	Primorye-Khabarovsk		proposed	1200	0.5	1.3	0.6	0.7	2.5
Total potential size of the Wandashan Tiger Sub-population based on projections:								9	4	5	17

Heilongjiang Province is managed by the local forest bureaus. Therefore, it will be largely the task of the local forest districts to manage forest lands in a way that will be compatible with tiger and leopard conservation. The present human density in southern Suiyang and Dongfanghong Forest Bureaus is similar to areas in the Russia Far East where tigers and leopards thrive, and is not necessarily an impediment to recovery, but access and use of forests must be controlled. Changes in forest management and logging activities will also be necessary. We recommend that the following recommendations be adopted by Suiyang, Dongfanghong, Yingchun, Muling, Dongjingcheng and Dahailin Forest Bureaus.

7.3.5.1 No human activities in areas specially protected for tigers. In specially protected areas, no logging should be permitted, and no human access should be allowed except by forest guards to patrol the area. When these areas are secured, snares are eliminated (see below), and prey populations have recovered, it may be possible to develop recreational activities in these areas, but initially it is essential to create areas with no human disturbances.

7.3.5.2 Removal/elimination of snares, and elimination of illegal hunting, with highest priority in proposed protected areas. Wire snares, set by local people primarily to capture ungulates, are everywhere in the forests of eastern Heilongjiang. 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. Although there is a moratorium on hunting, snares likely have an even greater impact on prey populations than hunting. Prey populations are not recovering, or doing so extremely slowly, yet recovery of prey populations is the first and most important step in recovering leopard and tiger populations. Preventing further setting of snares, and instigating a program to remove those already present in the forests, should be one of the highest priority activities in both proposed protected areas and tiger management zones. Successful elimination of snares will be key for recovery of tigers and leopards. We strongly urge the Provincial government, the State Forestry Administration, and appropriate local authorities to implement actions that will lead to the removal of snares from forest lands.

7.3.5.3 No logging or road construction in protected areas. We recommend that in protected areas created for tiger and leopard conservation, no logging should be allowed. Logging brings not only habitat destruction and alteration, but also creation of roads, and human disturbance that greatly reduces the suitability of habitat for tigers. It has been well demonstrated that roads provide access for illegal hunting, and poaching. While some areas must be harvested to provide for the economic welfare of local people, we recommend that in protected areas, no logging or road construction should occur.

7.3.5.4 Close all roads possible in protected areas and tiger management zones. Roads pose serious threats to tigers, leopards, and their prey. It has been shown repeatedly in many countries that higher road densities lead to decreased prey densities, increased poaching of large carnivores, and increased human disturbance that can cause animals to abandon otherwise suitable habitat. Therefore, especially in protected areas, but also in designated tiger management zones, all efforts should be made to close existing roads that are not essential.

7.3.5.5 Logging regulations in tiger management zones. Some logging can be conducted in tiger management zones if it is limited in scope, and well-controlled. The following restrictions on logging should be implemented:

1. Protect Korean pine: Korean pine nuts 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 the eastern mountain forests areas of Heilongjiang Province suggests that there is very little Korean pine left, yet logging of this species continues. Because of its importance as a winter food supply to key prey species, we recommend that logging of Korean pine in potential tiger habitat should be discontinued.

2. Use a selective cutting regime, and avoid clearcutting: 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 used (with restrictions), and that clearcutting be avoided.

3. Limit total area logged per year and limit areas where logging activity is allowed. Logging and all the associated human activities associated with it brings a high level of human disturbance to an area. These areas become at least temporarily unsuitable habitat for large carnivores and their prey. Therefore, logging activity effectively diminishes the amount of available habitat at any give time. If logging activities are spread out across Forest Districts, the network of vehicle and human activity has the potential to greatly impact the quality of habitat, and diminish recovery efforts. Therefore, we recommend that in tiger management zones, logging activities be planned so as to focus on specific areas, allowing at least 75% of forest lands to be left free of human disturbance during any logging season. This guideline refers not just to the total area logged, but includes the areas impacted due to vehicle traffic and other forms of human disturbance. Areas where there is sign of tiger or leopard activity should ideally be closed while animals are present in an area to avoid disturbance.

4. 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 the higher prey densities and easier travel conditions, riverine forests are often used by tigers. Although it is necessary to haul harvested timber through riverine forests, protection of these forests is critical not only for wildlife conservation, but also for protection of water quality in the region. Elimination of harvests on riverine forests, and minimization of human impact should be an important component of tiger and leopard conservation.

5. Retain use of oxen to extract timber in tiger management zone: Over many areas surveyed, timber was extracted primarily with the use of oxen. This type of logging activity reduces impact on soils and had only slight impact on the river bottoms though 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.

6. Avoid monoculture plantations, especially of larch. Heilongjiang Provincial Forestry Administration 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 tree-planting is planned in natural forests on tiger management zones, 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.

7.3.6 Develop a monitoring program for tigers, leopards, and their prey, and develop cooperative cross-border surveys.

If a recovery plan is put into effect in Heilongjiang 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 reported here, are prohibitively expensive to be conducted on a yearly basis. We recommend that a corps of individuals be recruited and trained from local forest districts to provide yearly reports on evidence of tigers (tracks, scrapes, etc.), tiger depredations, and human encounters with large carnivores. People recruited should 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, and changes in the frequency of tiger and leopard reports will be detectable. 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 wild boar, roe deer, red deer, sika deer and hare should all respond to the removal of snares, and a continued moratorium on hunting. To verify that these management actions are having the desired effect, it will be critical to monitor changes in prey populations 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 limited 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.

7.3.7 Develop an environmental education program for villages close to tiger and leopard management areas.

A local environmental education program aimed at people in the small villages close to tiger and leopard 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. Ideally, an environmental education program should be developed in the local schools. In general, a program is needed to increase public awareness of the need to protect natural resources.

7.3.8 Develop a state-sponsored compensation program for tiger or leopard depredations on 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 northeast China). 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 by the state. 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 reduce their losses.

Depredations by tigers do occur in northeast China. However, given the presently small population of tigers, 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 either a state-sponsored compensation program, or a program that is developed cooperatively by an non-governmental organization and the State Forestry Administration be developed. Such a programs should include a mechanism to verify depredation events. It is highly recommended that local inhabitants 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, 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 and leopards, can reduce the chances of illegal killing of these carnivores, and will provide a framework for monitoring the presence of tigers and leopards through the records maintained on depredations.

7.3.9 Do not engage in attempts to reintroduce captive tigers into the wild in northeast China.

We are strongly opposed to the idea of attempting to reintroduce captive tigers back into the wild. Although this concept has been proposed widely in China and elsewhere, there are numerous problems with such an approach that make this alternative unacceptable. Some of the major obstacles include:

1. The problem in northeast China is not lack of tigers, but lack of adequate tiger habitat. A fundamental misunderstanding that is associated with this approach is that simple reintroduction of tigers will solve the problem of tiger conservation in northeast China. In fact, simple reintroduction will have virtually no impact, by itself, in saving wild tigers in northeast China. The problem in this region is not lack of tigers, but lack of adequate habitat where tigers can survive and reproduce. For tigers to survive in the wild, dramatic changes must be made in forestry and hunting management to increase prey populations, and better protect existing forests. These changes have been outlined above. Failure to implement these changes will result in extinction of tigers in northeast China, no matter how many tigers are reintroduced.

2. Captive tigers in China are mostly of unknown genetic origin. The genetic composition of tigers kept at many of the facilities in China are of mixed genetic heritage, including animals that are not Amur tigers. Release of these animals into the wild would potentially introduce genes that are not representative of the existing wild population.

3. Russian cooperators and international donors would be opposed. Any efforts to develop cross-boundary programs with Russia, or seek international financial support for tiger conservation would be nullified by such a reintroduction program. Russian and other international specialists would likely be strongly opposed to introducing captive animals of unknown genetic make-up into the wild, because of the possibility of "contamination" of the existing Russian population. Therefore any attempts to conduct cooperative programs with Russia would be thwarted by these efforts.

4. Reintroduction of captive animals acclimatized to humans could have catastrophic consequences. Tigers that are accustomed to receiving food from humans, and living in close association with human sounds and smells, will likely associate human activity

with the potential to obtain food. This means that such tigers, released into the wild, will likely seek out human settlements as a source of food. This will not doubt result in loss of livestock and dogs, and ultimately, could easily lead to the loss of human life. Such an outcome would be a catastrophic set-back for attempts at tiger conservation in China.

5. Proper implementation of reintroduction guidelines is difficult and expensive. Proper implementation of such a program must follow internationally approved procedures, such as the IUCN Guidelines for Reintroductions. Such procedures are demanding, exacting, and expensive. Finding the financial support for such a program would be difficult.

6. There is no need for reintroduction. Ultimately, it is far more efficient and cost-effective to rely on natural emigration of tigers from Russia for recolonization of northeast China. If the key steps are taken to protect habitat and increase prey populations (as outline above), tigers will settle in Laoyeling and Eastern Wandashan. It is well confirmed that a few tigers consistently cross the international borders. What is required is an environment in which they will want to stay. If appropriate management changes are made, tigers will settle in northeast China naturally, without any need for reintroduction.

7.3.10 Foster international cooperation.

The survey results in Heilongjiang and Jilin Provinces show that most Amur tigers in China occur along the boundary zones with Russia and North Korea. Therefore, it is critical to foster international cooperation amongst these three countries. We propose that joint efforts are critical to saving the tiger in northeast China.

We propose that joint efforts at developing management strategies for transboundary populations of tigers and leopards can take the following forms.

1) An international workshop should be hosted in China to exchange information and develop concrete recommendations for tiger conservation. This workshop should have, as first priority, development of a conservation action plan for tigers in northeast China, and secondly, a transboundary conservation action plan with Russia.

2) A mechanism should be developing for creating transboundary protected areas and implementing an international conservation plan.

3) A working group should be established to foster exchange of information, implement transboundary management plans, and seek international support for conservation efforts.

4) A sub-component of the working group should consist of a scientific advisory panel that provides information to the working group, and conducts transboundary surveys of large carnivores and their prey.

8. CONCLUSIONS

Results of international surveys in Jilin and Heilongjiang suggest that the Amur tiger and Far Eastern leopard are both on the verge of extinction in northeast China. Although we recorded the presence of 5-7 tigers and 3-5 leopards in Heilongjiang, the majority of these animals appear to be wandering nomads. There does not appear to be any population nucleus where a healthy group of reproducing animals exists. Interview data from the Eastern Wandashans suggest that this may be the last site where reproduction of tigers is occurring in northeast China.

Despite the critical situation of these large carnivores, recovery of both tigers and leopards is possible if local, provincial, federal, and international efforts are made aggressively and quickly. The sooner these efforts are implemented, the greater is the probability of success. Therefore, we urge the Chinese federal government, Heilongjiang Government officials and the State Forestry Administration to consider the recommendations offered here, and quickly implement a plan to protect remaining forest tracts for tigers and leopards.

Recovery of leopards and tigers in Heilongjiang will be difficult, and perhaps impossible without a cooperative effort between Russia and China. Russian officials have signaled their readiness to engage in discussions that could lead to the development of international protected areas and a transboundary management plan. Hopefully, this process can be expedited through workshops and meetings that will provide an easy means of communication and discussion.

The forests of Heilongjiang, although heavily logged and subject to intensive use, are nonetheless a rich natural resource that still retains the potential to protect sizeable numbers of tigers, leopards, and their prey. To realize this goal, a strong commitment must be made in China to change land-use practices, establish protected areas, and secure those areas from logging and other human disturbances. The enactment of the Project for Protection of Natural Forests in 1997 is a potentially valuable program that can work in conjunction with these recommendations to achieve the joint goals of large carnivore and forest conservation. There is very little time left to save tigers and leopards in Heilongjiang Province. Yet, given prompt initiation of a strong management regime, there is no reason why tigers and leopards populations cannot increase in size to become important components of the world-wide populations, and a common feature of the forests of Heilongjiang Province.

We hope that recovery of tigers and leopards in Heilongjiang Province will be become a high priority for Heilongjiang Government officials and the State Forestry Administration, and that land management practices will be implemented that will result in the successful recovery of these two magnificent, yet highly endangered wild cat species.

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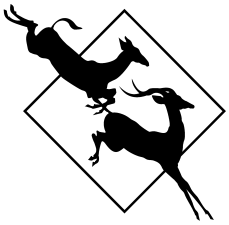

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