



**The Amur Tiger  
in the USSR**

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THE AMUR TIGER IN THE USSR

by

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## CONTENTS

	Page
1. Introduction	1
2. CHANGES IN RANGE AND POPULATION OF THE AMUR TIGER SINCE THE MIDDLE OF THE 19TH CENTURY	5
2.1. Natural Range	5
2.2. Reduction in range and population during the second half of the 19th and the first half of the 20th Centuries	7
2.3. The growth in tiger numbers since the 1940s	9
2.4. The present structure of the range	10
3. DYNAMICS OF THE TIGER POPULATION IN THE PRIMORJE RESERVES	11
3.1. Frequency of tracks	11
3.2. Methods of counting in the reserves	13
3.3. Results of the counts; density of the population	14
4. TIGER HABITAT	17
4.1. Peculiarities of the tiger in winter; the snow cover	17
4.2. Relief	18
4.3. Vegetation	18
5. THE NETWORK OF THE ROUTES; HOME RANGES AND THE STRUCTURE OF THE POPULATION	21
5.1. Selectivity in the construction of the system of crossings; constant trails	21
5.2. Lairs	22
5.3. Use of territory; night and day motion; home range	23
5.4. Marking behaviour	24
5.5. Sex and age ratios	25
6. HUNTING, FEEDING AND RELATIONS WITH OTHER PREDATORS	27
6.1. Hunting - where and how	27
6.2. Feeding habits	28
6.3. Composition of prey	31
6.4. Prey preferences	32
6.5. Attacks on domestic animals	33
6.6. Competitors and scavengers	33
7. THE TIGER AND MAN: CONSERVATION PERSPECTIVES	35
7.1. Man-made changes in the habitat and their effect on the tigers	35
7.2. The tiger's reaction to direct contact with man	36
7.3. The conservation outlook	37

	Page	
8.	TABLES	
8.1.	Table I - Annual occurrence of tiger tracks on the territory of Sikhote-Alin and Lazovski reserves	41
8.2.	Table II - Diet of the Amur tiger	42
8.3.	Table III - Seasonal kill of ungulates by tigers in Lazovski reserve and contiguous territories 1973-75	43
8.4.	Table IV - Deaths of sika deer caused by predators in Lazovski reserve	44
9.	SCIENTIFIC NAMES OF ANIMALS IN TEXT	45
10.	BIBLIOGRAPHY	47

## ILLUSTRATIONS

1.	Amur tiger ( <u>Panthera tigris altaica</u> ).	3
2.	Distribution of the Amur tiger.	4
3.	Mountain ranges covered with conifer and broad-leaf forest - tiger habitat in the north of Primorje. Sikhote-Alin reserve, February 1968.	16
4.	A profile diagram illustrating the selectivity of tigers with regard to their movement in the river valleys of Sikhote-Alin. (The thickness of the black arrows is proportional to the probability of choosing a particular route - see text, page 21.)	20
5.	Movement pattern of a tiger watching people (see text, page 36) Sikhote-Alin reserve, February 1971.	20
6.	Shelter "box" of the tigress at the foot of a big fallen poplar. Sikhote-Alin reserve, December 1971.	26
7.	The tigers regularly hunt on the animal salt licks. A male Isubra deer on the Boshoi kaplanovski salt lick in Sikhote-Alin reserve, May 1966.	29
8.	The remains of a cow killed by a tiger. Lazovski region, September 1976.	30
9.	The night tracks of a tigress in the thin layer of snow covering the ice of stream. Sikhote-Alin reserve, December 1970.	39
10.	Amur tiger ( <u>Panthera tigris altaica</u> ).	40

Illustrations 2 - 9 are by the authors. Photographs 1 and 10 are by Peter Jackson.

In memory of Lev Georgievitch Kaplanov (1910-1943)  
and Anatoli Grigorievitch Yudakov (1937-1974),  
selfless field researchers who contributed greatly to  
the study of the Amur tiger.

# T H E   A M U R   T I G E R   I N   T H E   U S S R

1

## INTRODUCTION

Within the geographical range of the tiger Panthera tigris - and its many (up to 10) forms - the Amur subspecies (Panthera tigris altaica Temm, 1884) is of particular interest. The animals inhabiting the Amur basin and the contiguous coast of the Sea of Japan are very big (most probably maximum size) with long and very thick winter fur which is relatively light in colour. The range of the Amur tiger was semi-isolated in the past and is entirely isolated now; it is the most northern form of the species and has adapted to very specific conditions of life.

In eastern and (even more so) central and western Siberia tigers do not live and have never lived except spasmodically; they fully inhabit only the area of broad-leaved and mixed broad-leaved/coniferous forests in the Far East - an area on the same latitude as France and Italy.

Not less than one-third of the natural range of the Amur tiger is in the USSR. Russian and Soviet zoologists have for a long time paid particular attention to the study of this remarkable animal. It was in the Soviet Far East that the pioneer "bloodless" research on the tiger in the wild was carried out (Kaplanov, 1948). Ecological data received in Priamurje and Primorje and other parts of the range are unique - being based as a rule on winter tracking. Here and only here is it possible to record in the snow the posture and movements of tigers.

During the 19th - 20th century the Amur tiger population fluctuated, sometimes sharply, but for the most part unevenly. In this century, postwar measures for the conservation of the species in the Soviet Far East have achieved rapid results. In the process valuable experience has been accumulated. The tiger in the USSR is protected in all areas, but of primary importance are the Far East

reserves, especially the biggest ones - Sikhote-Alin and Lazovski situated in the central and southern parts of Sikhote-Alin. Though today there are no grounds for regarding the Amur tiger as being directly endangered, its future prospects are causing concern. During recent years research on the tiger's ecology and conservation has been vigorously pursued in our country and this paper should be considered as the first step towards the publicizing of accumulated data. The authors have mainly relied on their lengthy investigations in Sikhote-Alin (1964-77) and Lazovski (1973-77) reserves.

#### Acknowledgements

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Illustration 1: Amur tiger (Panthera tigris altaica).

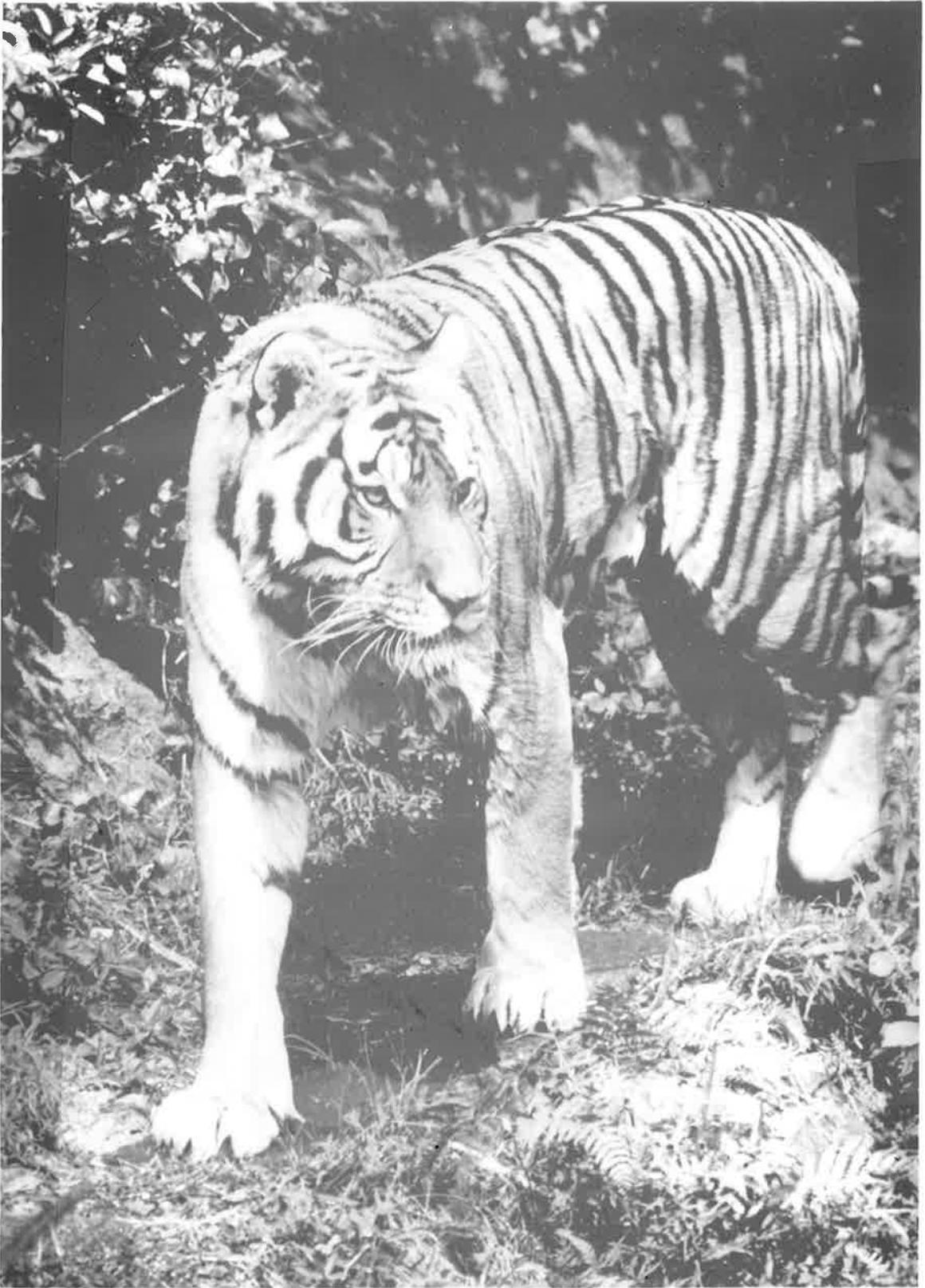
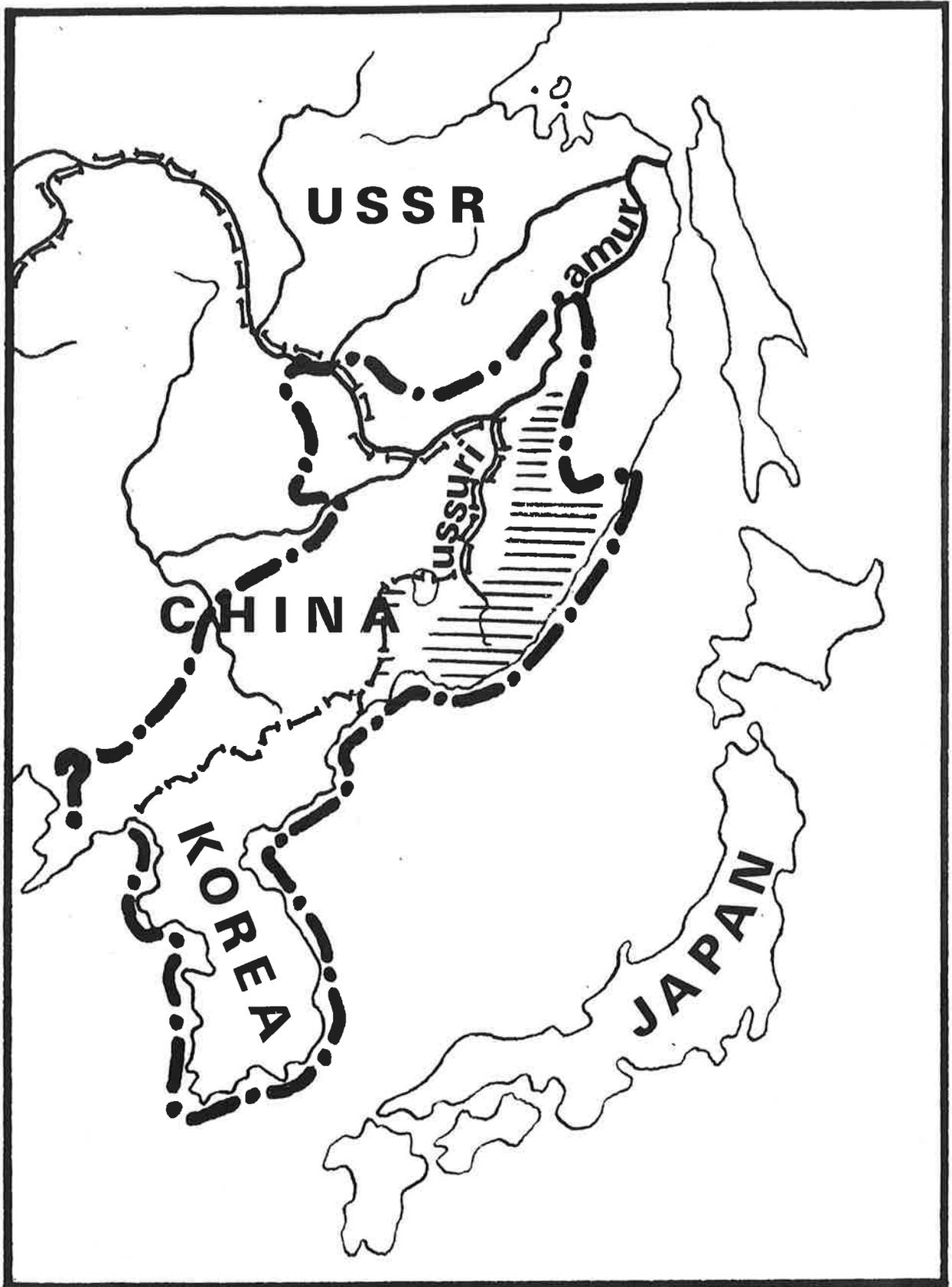


Illustration 2: Distribution of the Amur tiger.



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==== 2

CHANGES IN RANGE AND POPULATION OF THE AMUR TIGER  
SINCE THE MIDDLE OF THE 19TH CENTURY

1. Natural range

The first detailed information on the distribution of the tiger in Primorje and Priamurje dates back to the middle of the last century. At that time the animals inhabited the whole region both in the mountains and on the plain as far north as about 50°N. Precision as to the limits of northern penetration is rather difficult, both for the past and the present, because the northern boundary of the range is bordered by terrain where the tigers appear periodically (Heptner and Sludski, 1972). It is evident that the analysis of the factors determining the distribution of the species, and the evaluation of conservation perspectives, must be based upon correct understanding of the limits of the areas permanently inhabited by the animals. The reports of zoologists and travellers of the last century are approached from this point of view.

Even R.K. Maak (1859) stated definitely that the tigers which occasionally appeared near the Argun river and areas of Transbaikalie "should be considered accidental ones" coming from next-door Manchuria. On the Amur river the animals occurred most often on the line between the western foothills of the Mali Hingan and the plain further down from the Ussuri mouth. G.I. Radde, 1862, who did more detailed research on the fauna of the central region of the Amur river came to similar conclusions. All reliable indications confirmed for Radde the presence of tigers gravitating towards Mali Hingan. He emphasized that tigers do not live permanently, but appear only periodically on the plains to the west of the above-mentioned mountains. Accordingly the border of the range was marked "beständig" (constant) on the map; it approached the Amur river only somewhat to the north of the mouth of the Bureya river. These data are well-grounded despite a later tendency to push the north-eastern projection of the former range of the Amur tiger to the upper stream of the Amur river, Bolshoi Hingan and Argun (Abramov, 1970, Heptner and Sludski, 1972). According to Radde and Maak, the natural western limit of the distribution of the settled tiger population on the left bank of the Amur river is 129°-130°E.

Along the right bank of the Amur river and the spurs of the Mali Hingan on the Chinese side, the tigers probably went as far west as 127°-128°E. No animals inhabited Bolshoi Hingan permanently. According to N.A. Baikov's data (1925), acquired in the first decades of the 20th century, only solitary tigers penetrated through the upper reaches of the Humaerha river into the eastern part of Bolshoi Hingan where they occurred sometimes in the area of the sources of the Nonni river.

Maak (1859) was inclined to consider the mouth of the Gorin river (138° E) to be the north-eastern boundary of the distribution of the tiger in the Amur valley. L. Schrenk (1859) also noted that the tigers were more uncommon in the middle stream than in the lower stream of the Amur river, but concluded (from data obtained from questionnaires) that they inhabit the territory up to the Yaj river and Lake Kizi throughout the year (about 140°E). The area of periodical penetrations of the tigers, according to L. Schrenk, extended even to the north of the Amur mouth. The area inhabited by the animals to the east of the boundary pointed out by R.K. Maak was not confirmed by other investigations. N.M. Przhevalski (1870) spoke only of the penetrations of separate specimens "further than the mouth of the Gorin river". Later Arsenjev, whose data are tabulated by S.I. Ognev (1935), considered the middle stream of the Gur river flowing somewhat to the south of the Gorin river to be the north-eastern boundary of the distribution of the tiger on the right bank of the Amur river. All these data and also the fact that the Gur-Gorin area is an important biogeographical boundary (it marks the penetration to the north of conifer/broad-leaved forests of the "Manchurian" type) speak in favour of Maak's conclusion. Probably the most northern point of the tiger's main habitat in the Amur basin was on the Gorin river (51°N). As regards penetration by individual specimens they were similar here to those in the upper Amur - relatively frequent and far-reaching. Rare occurrences of the animals around the basin of the Yaj river happen even nowadays (Schtilmark, 1973).

On the left bank of the Amur river between the Gorin and Bureya river the northern boundary of the restored tiger range probably took the shape of a sharp arc curving to the south and embracing the last conifer/broad-leaved forests on the Kur, Urmi and Arhara rivers. The boundary curved almost symmetrically to the south on the right bank of the Amur river, in Sikhote-Alin. V.K. Arsenjev (1957), in recounting his travels of 1908-10, noted that there were then no tigers whatsoever in the area of the main Sikhote-Alin watershed below the latitude of the Anyuy and Gur rivers. It is evident that this deflection of the boundary reached in the south the basin of the Bikin river (approximately 46°N) as it does today (Kucherenko, 1974). Along the seashore the northern boundary of the area permanently inhabited by the tiger moved again somewhat to the north, but not so far as in the Amur valley. It probably reached the seashore near the Samarga river (47-47°30'N). There are exact data (Arsenjev,

1949) regarding tigers in the basin of the Samarga river, but it is now difficult to say if they lived there permanently. Judging by their distribution in Sikhote-Alin today, and also by the general biogeographical interrelations, the previous northern boundary of permanent tiger terrain reached probably to about 46°30' (the coastal region of the Sobolevka and Svetlaya rivers).

From here and up to the southern limit of the Korean peninsula the range reached everywhere to the shores of the Sea of Japan. In the epoch preceding the intensive economic development of northern China the Amur tiger in all probability inhabited the mountains of Liaotung peninsula that are a direct continuation of the East Manchurian mountains. The flora of Liaotung peninsula still have a conspicuous "Manchurian" character (Kazakova, 1964). But animals disappeared from this area a long time ago.

N.A. Baikov (1914) laid special emphasis on the fact that there were no tigers in "Mukden province" (Manchuria); the south-western boundary of the natural distribution of the Amur tiger was most probably connected with the grassland and grassland-steppe spaces in the lower stream of the Liao ho river. From here along the foothills of the wooded East Manchurian mountains, the boundary of the range went to the north and north-east, crossed the Sungari river near the southern border of Mali Hingan and, bordering this mountain mass, continued north-west (Baikov, 1925). Only individuals, as mentioned above, visited the upper Nonni. The existence in the past of settled groupings of animals in the north-western part of Mali Hingan in China (49°-51°N) is doubtful because conifer/broad-leaved forests inhabited by the Amur tigers are concentrated in the south-east of the mountain mass, near the valley of the Sungari river. The north-western boundary of the distribution of the Korean cedar (*Pinus koraiensis*) which is the typical representative of the Manchurian floristic complex may serve in this respect as a clear indicator.

These are, according to existing data, the natural contours of the Amur tiger range (Figure 2). The territory occupied by the Amur tiger in the USSR extended for about 1000 km from north to south, and 600-700 km (at most) from west to east.

## 2. Reduction in range and population during the second half of the 19th and first half of the 20th centuries

As regards the former number of tigers it is possible to make only suppositions. However, it was obviously much higher than now because at the turn of the century the annual kill amounted to 120-150 animals (Silantjev, 1898). The rapid growth of the population and the economic development of the area in the second half of the last century stimulated the tiger hunt. The change probably took place in the 1870s and 1880s as only a short time earlier (1861) Maak had noted that

tigers were seldom taken. It was only in cases of emergency that hunters from the local tribes shot the mighty predator; they did not even like to speak of the tiger.

Within the limits of the natural (restored) range the tigers lived everywhere including the lowlands of the hollow of Lake Khanka and the valleys of the Ussuri river. Indeed Maak (1861) stressed that these damp low grounds were the animals' main habitat. Some tiger kills on islands in the Ussuri river were later noted by N.M. Przhevalski (1870) who stated that tigers were more common in southern parts of the Ussurijski region than in northern parts. The same conclusion probably holds good for the contiguous portions of China.

Human impact can hardly have been the chief cause of the large number of tigers gravitating towards the Changbaishan plateau bordering Korea (Baikov, 1925). At the beginning of the 20th century tigers seldom reached the left bank of the Sungari river, Heilongjiang province, though solitary individuals occurred up to the Amur river (Baikov, 1914). Possibly a peculiar "nucleus" of the Amur tiger range was located in the southern and central section of the territory enclosed within the above boundaries.

By the beginning of this century the structure of the tiger range underwent considerable changes. Agricultural development of Priamurje and Primorje brought about sharp disturbances in the habitat of the animals on the plains where human density was highest. In the 1920s the tiger was forced out from the eastern and southern parts of the Prihankajski plains, also from the environs of the cities of Ussurijsk and Vladivostok (Baikov, 1925). It is obvious that the same happened to the animals inhabiting the Ussuri valley along which a railroad was built.

These changes violated the integrity of the range bringing about full or almost full isolation of the Sikhote-Alin territory inhabited by the tiger from the Mali Hingan and Changbaishan-Liaoning centres. The following two decades saw the population and range of the Amur tiger reduced. It was hunted by all possible methods and special teams undertook the capture of live cubs. In the 1930s and 1940s the number of tiger cubs taken exceeded the number of tigers killed (Kaplanov, 1949). Damage done to the population each year was undoubtedly greater than it could sustain. At the same time the results of the practice can be seen in the enormous number of Amur tigers now in zoos (Seifert, Müller, 1976).

Although the general outline of the range had not changed much by the 1940s (the animals occurred still in Mali Hingan, and on the right bank of the Amur reached 49°N) the area had been reduced and split up. The tiger's distribution now consisted of several isolated foci of different size. At that time the first attempt was made to estimate the total tiger population in the Soviet Far East (Kaplanov, 1948).

The result, 20-30 individuals, testified to the fact that the Amur tiger in Sikhote-Alin was under threat because it was now totally (or almost totally) isolated from the Manchurian population. The animals had disappeared from many of the oldest "tiger" areas, such as the basins of the Bikin and Hor rivers. In the south of the area the tiger persisted in only three previous centres whose size did not exceed 50-70 km in diameter (Yudakov, Nikolaev, 1973). The biggest and most stable centre was preserved on the main western slope of central Sikhote-Alin; it became part of the Sikhote-Alin State reserve set up in 1936.

### 3. The growth in tiger numbers since the 1940s

The setting up of the nature reserve and the ecological research initiated there (Kaplanov, 1948) marked a turning point in the fortunes of the Amur tiger. For the first time a well-grounded call for the conservation of the animal had been voiced. This viewpoint was not immediately shared by everyone. The tiger hunt was reduced to some extent because of the war, but not till 1947 was there an official ban on tiger shooting. The capture of tiger cubs continued (it still does to a greater or lesser extent) but since 1956 it has been under strict control and requires a special permit.

The beneficial effect of these conservation measures was demonstrated by the tiger count in 1959. It showed a considerable growth in numbers since the time of Kaplanov's research (1948). About 60 animals were counted in Primorje - with 90-100 estimated for the whole of the Soviet Far East (Abramov, 1962). Unevenness in the distribution of the tigers had decreased, as had the isolation of separate population centres. In Sikhote-Alin part of the range that was common to different populations was restored. The number of Amur tigers in North-East China at the end of the 1950s amounted to 200-250 animals (Sludski, 1966); thus about one-third of the total population of this subspecies inhabited the Soviet Far East.

Ten years later, in 1969-70, the tiger count in Primorje was repeated, but this time the research was more detailed (Yudakov, Nikolaev, 1973). It showed that after 1960 the population grew faster than previously. By 1970 the number of tigers in Primorje was at least 130, with the total for the whole of the Soviet Far East amounting to about 150. When in doubt the researchers "erred" on the side of caution, so the figures obtained are a minimum. Available data suggest that these figures also reflect the present-day population. The conservation of the Amur tiger in Sikhote-Alin would thus seem to have been effective; the animal's existence is no longer threatened - at least not in the immediate future. The importance of this becomes clear if we take into account that in North-East China and North Korea there were by the early 1970s some few dozen tigers left (Sludski, 1973).

#### 4. The present structure of the range

At present tigers in the middle and southern part of Sikhote-Alin are distributed almost everywhere, though not quite uniformly. To judge by the map reflecting the results of the count (Yudakov, Nikolaev, 1973), the chief population density is on the eastern slopes of the mountain country, latitude 43°-44°N, and on both sides of the main watershed between 45°-46°N. These two focal points are divided by a relatively narrow strip. Here tigers occur only sporadically; nevertheless the integrity of the Sikhote-Alin population is maintained - as was confirmed by our reconnaissance counts in January-February 1977 which showed that on the eastern slopes of southern Sikhote-Alin (where the Lazovski reserve is situated) the tiger population underwent no radical changes in the years 1970-77.

Two small areas inhabited by tigers remain isolated in the spurs of the East Manchurian mountains - in the frontier area to the south-west of Lake Khanka and to the west of Amur Bay. These two areas are close to the other main part of the range in the adjacent territories of China and Korea. Here tigers often cross the State frontier, but penetration into Sikhote-Alin is hardly possible because of land development along the railroad. Furthermore the railroad now crosses the recently re-opened "corridor" connecting the East Manchurian and Sikhote-Alin populations, so making contact between these populations almost impossible.

The local "islands" inhabited by tigers in the frontier area are not independent and are vulnerable. To maintain stable populations here requires international cooperation. Unilateral measures do not bring results; this was shown by the changes that took place on the left bank of the Amur river, in Mali Hingan. In 1958-62 tiger tracks were to be found here, but a decade later these had become very rare (Kucherenko, 1970). The sharp reduction in the number of tigers in this area of Priamurje coincided with the growth of Sikhote-Alin populations - the dynamics of the various groups being different.

In evaluating changes brought about by the activity of man in the distribution and number of the Amur tiger, one must stress that its range within the USSR has not been reduced by more than one-third (Figure 2); throughout the continent, on the other hand, it is estimated that the tiger has quit about 60% of the territory it formerly occupied (Sludski, 1973).

DYNAMICS OF THE TIGER POPULATION IN THE  
PRIMORJE RESERVES

Because the population covers vast regions we have only very approximate data as to its size. Long-term observations on the limited protected areas enable us to make a more detailed analysis and may serve as a sensitive indicator of general tendencies. From these data we can evaluate the degree of stability of the local tiger groupings and the possibility of their restoration on former territories which are now outside their range.

1. Frequency of tracks

The most significant data refer to the two biggest tiger nature reserves in the Far East - Sikhote-Alin (347,000 ha) and Lazovski (116,000 ha) reserves. The former is in mountain country, partly on the western slope but chiefly on the eastern seaside slope. Access to the seashore means the impact of man is stronger here than in the depths of Sikhote-Alin. At the beginning of the century tigers in the area of Ternei Bay were numerous, but by the early 1940s they had practically disappeared (Kaplanov, 1948).

Sikhote-Alin reserve was set up in 1936 and included a bigger part of the "tiger centre" in the basins of the large tributaries of the Ussuri river on the western slope. With the establishment of the conservation regime the animals began to penetrate through the mountain passes of the main watershed. As far back as 1940-42 they were living here permanently. But in the course of the next 20 years the population remained thin. The number did not increase.

Data on the frequency of tiger tracks since 1961-62 have been recorded every year by the staff of the Sikhote-Alin and Lazovski reserves and are presented in Table I. The number of observations per year depends not only on the number of animals but also on the number of human visits to the reserves, the durability of the snow cover, etc. Thus slight differences may not be connected with population changes; only big fluctuations are reliable.

In 1962, as in several previous years, about 10 tiger tracks were recorded in Sikhote-Alin reserve. This figure corresponds to the "observed" population level for the whole of the postwar period. During 1963-65, however, only single occurrences were recorded and these were of a transitory character; the animals no longer lived in the reserve permanently. The reasons for this have not been clarified, but the capture of tiger cubs on territory adjacent to the reserve in the preceding years was certainly a factor. It became necessary to introduce more strict conservation measures, in particular a temporary ban on the capture of cubs (Matjushkin, 1966).

By 1966 the number of tigers had already increased, but by 1967 the "index" was seven times the 1966 figure. It was clear that tigers again populated the reserve, their tracks showing the direction of their movement (Gromov, Matjuschkin, 1974). While almost all the occurrences in 1966 took place in the southern seaside area, the 1967 tracks were recorded throughout the reserve. This time, in contrast to the 1940s, the animals did not come to the coastal portion of the reserve from the west, but from the south, from the areas that had been lived in and were economically more developed - so confirming the already-noted increase of tigers in the south of Primorje.

According to data obtained by A.G. Yudakov and I.G. Nikolaev (1973) tigers occurred very seldom between 1910 and 1945 on the seaward slope of the mountain country to the south of the reserve. Their increase there began after 1960 and accelerated in 1964-65 when tigers appeared even in places where they had not been seen since the end of the last century. The second "settling" of the reserve was 1-2 years later. It is clear that under favourable conditions tigers can quickly settle free territories, passing over to new areas and settling there. The difference between the routes used to penetrate the reserves in the 1940s and in the second half of the 1960s reflects the reorganization of the range and consequent changes in the position of population centres.

The tigers now in the main southern nature reserve - Lazovski reserve - were introduced in a somewhat different way. From 1936 to 1947 on the territory where the reserve was set up there were no tigers at all - though they had been common there at the turn of the century. The settling of Lazovski reserve occurred in three stages and was completed by 1970 when distribution and population became stable (Zhivotchenko, 1977). From 1947 to 1957 only periodical penetrations of tigers into the north-eastern part of the reserve were observed. In 1958-62 they were seen more often and in a larger area, but they did not penetrate deep into the territory. In 1963-70 they settled throughout the reserve including its remote parts. The changes here occurred more steadily than in Sikhote-Alin reserve - see Table I. In the two nature reserves separated from each other by about 300 km the fluctuations in number were not in harmony. During the great decline of 1963-65 in Sikhote-Alin reserve there was a steady increase of tigers in Lazovski reserve.

## 2. Methods of counting in the reserves

Since 1971 in Sikhote-Alin reserve, and since 1974 in Lazovski reserve, special tiger counts based on snow tracks have been made annually. A common method of parallel transects employs the principle suggested by L.G. Kaplanov (1948): simultaneous passage of the routes along the main river valleys, the meeting places, the direction and size of each track, and the depth and state of the snow. The count is based on scrupulous analysis of the tracks of the animals of different sex and age in the context of all other relevant variables (Matjushkin, Yudakov, 1974).

For the most important parameter - the breadth of the hind pads - we followed the method of K.G. Abramov (1961). Measurements for each individual are repeated several times on different imprints. In order to find the scrapes and the resting places and to define more precisely the direction of the animal a track is studied by the researchers for a distance of several hundred metres.

The drawing of a network of transects provides for a uniform and thorough territory survey, each transect being coordinated with the two neighbouring ones. The transects along the river valleys often link up through the mountain passes, but along the seashore the record-keepers move mainly on the slopes and ridges of the hills. In Sikhote-Alin reserve the work is carried out by 12-14 census groups, in Lazovski reserve by 15-16 groups. Each group covers 20-50 km over a period of 2-3 days.

In the smaller and more accessible Lazovski reserve the routes lie not only within the protected area, but also along its boundaries, so enabling us to check all of the tigers' "entries" and "exits". How many tigers inhabit this reserve? The question cannot be answered in this form because we are speaking of very mobile animals ranging over a large territory. The question must be split into three parts.

- 1) How many tigers may be on the territory of the reserve simultaneously?
- 2) How many tigers penetrate into the territory of the reserve at present?
- 3) How many tigers live primarily within the protected territory?

Strictly speaking an annual count made by the agreed method may answer only the first question. It is a "snapshot" of the distribution of tigers. To answer the second and the very important third question, the regular observations of the forest control service and of all the researchers, the special long-term tracking work of the zoologists and repeated counts (for example at the beginning and end of winter) are used.

### 3. Results of the counts; density of the population

Details of counts made in Sikhote-Alin reserve in the winter of 1971-72 may help to illustrate the method - and the difficulties. In the first half of that winter, 13-17 December, the minimum number of tigers recorded on the routes was 6, but the tracks could have belonged to 8 individuals. The spring count made from 30 March to 1 April showed that there were 6-7 tigers in the reserve.

But some individuals, moving within the space cut by the routes, might have been omitted. Also other tigers may come to the territory at another time. Adult males - easily identified by the size of their tracks - are a case in point. The December count revealed one, in March there were 2, but in the first half of December, even before the count began, 3 adult males had been found in different parts of the reserve.

In November 1970, on the Tajezhnaya river, tracks of a female tiger with 2 cubs were noticed. The counts failed to record these animals.

It is clear that the total number of tigers appearing periodically in the reserve exceeds the minimum result of the count and amounts to at least 10. As regards the individuals living mainly in the territory of the reserve (i.e. those animals whose home ranges - more than half of the area - are within the protected territory), these number probably only 4 or 5, and certainly not more than 6. A group of this size, though scarcely independent, is important as a "gravitation centre".

It can hardly be hoped that the number of tigers within the reserve will grow. Its present level is probably a maximum for the conifer/broad-leaved forests of central Sikhote-Alin. It is noteworthy that the number of tigers recorded during the counts has stabilized in the course of the last 5 years. On 25-29 January 1977 the minimum number of tigers counted by researchers on the routes amounted again to 6 or 7.

From these data (and taking into account the home ranges of the animals with regard to the reserve boundaries) the density of the tiger population is equivalent to 0.13 - 0.32 individuals per 100 km<sup>2</sup>. This corresponds to the number suggested by S.P. Kutcherenko (1973) for the "optimum biotopes". But the tigers inhabit Sikhote-Alin reserve unevenly because about one-third of the territory has types of vegetation which the animals virtually do not use. After making appropriate corrections, a higher density should be accepted - about 0.3 - 0.4 individuals per 100 km<sup>2</sup>. These last figures in all probability reflect the natural level near the northern limits of the tiger's range.

Lazovsky reserve is approximately one-third the size of Sikhote-Alin reserve. Results of the counts made in three

successive winters, starting in 1974-75, are similar - although different individuals were recorded - but their distribution had changed considerably. The minimum number of animals recorded each season was not less than 7, but observations made during the whole winter plus special tracking enable us to increase this figure to 10. The total number of tigers visiting the reserve is about twice that - 18-23 in the winter of 1975-76. Individuals are not limited by the boundaries of the reserve: from time to time they leave, but return with consistent regularity. Because the area of Lazovsky reserve is small, it is more difficult to determine the number of tigers closely connected with this protected territory. But even for those animals which leave it for a long time, it is very important that at least a part of their home range is in the nature reserve because the further they are from its boundaries the lower the density of wild ungulates.

The density of the tiger population in Lazovsky reserve is equivalent to 0.6 - 0.9 individuals per 100 km<sup>2</sup>. Detailed research shows that in the coastal part of the reserve - where the animals were distinguished individually - this number may rise to 1 individual per 100 km<sup>2</sup>. Either way the density of the population here is 2-3 times higher than in Sikhote-Alin reserve.

On the territory surrounding the reserve the tigers gravitate towards its boundaries. At the same time, with regard to the whole southern half of the Primorski area, the region of Lazovski reserve does not stand out as an isolated tiger habitat. Nor should it become so; there are sufficient tigers in the adjoining area. And there has been no sign of decline in their numbers in the period 1970-77.

Illustration 3: Mountain ranges covered with conifer and broad-leaf forest - tiger habitat in the north of Primorje. Sikhote-Alin reserve, February 1968.



## TIGER HABITAT

1. Peculiarities of the tiger in winter; the snow cover

The ecology of the Amur tiger over the larger part of its range is very peculiar. First of all, winters are very severe. From November to March clear frosty weather is the norm in Primorje. On the western slopes of Sikhote-Alin, in the Ussuri and Amur valleys, the temperature is  $-20^{\circ}$  for long periods; and every year it drops at times to  $-35^{\circ}$  or  $-40^{\circ}\text{C}$ . It is much warmer on the coast. For instance, in Olga Bay the average temperature in January is  $10^{\circ}$  higher than on the banks of Lake Khanka (Vitvitski, 1969).

The severity of winter is intensified by the strong, often stormy, north-western winds. However the Sikhote-Alin winters do have an abundance of sun. In January, February and March it shines for more than 70% of the daylight hours.

The depth of the snow varies from none at all to about one metre - particularly in February and March. On the southern slopes, especially near the coast, the snow, under the influence of sun and wind, quickly melts. The further from the shore and the higher up the mountains, the deeper and more even the snow cover. Snow 35-50 cm deep and lying for 2-4 months a year is characteristic of the tiger habitat. Under such conditions - the more so in years when there is no snow - the tigers spend the winter quite safely, though from time to time difficult or even critical situations may develop. For example, in Lazovski reserve in January 1977, when there was about 70 cm of snow throughout most of the territory, a distinct redistribution of the tigers took place: the animals were concentrated on the narrow coastal stretch where there was relatively little snow and where ungulates were concentrated as well. In the central part of Sikhote-Alin such movements were not observed, but on the whole the importance of the snow as one of the factors limiting the dispersal of the tigers to the north is obvious.

The Sikhote-Alin winter is characterized by infrequent but heavy snow-falls. The tiger then finds it hard to move and creates a kind of trench when doing so. Even a thin layer of snow causes difficulties. Lumps of ice frozen on the soles

produce bleeding of the toes: drops of blood can often be found in tracks. (N.M. Przhevalski wrote about these injuries in 1870.)

## 2. Relief

Sikhote-Alin is mountain country. It contains a dense network of rivers and streams. The main watershed is not a distinct unit, and the mountain ranges and spurs extending from it point in different directions. The topography of the seaward slope is more sharply divided than is the western slope that is part of the Ussuri basin. The ridges of the mountain chains are 500-800 m above sea level and some summits are higher than 1000 m. The valleys of the rivers and streams have flat bottoms of up to a kilometre and more in breadth. The ridges of the mountain spurs are smooth but steep slopes predominate. There are not many exposed rocks - except on the coast where jagged cliffs run almost uninterruptedly.

N.A. Baikov (1925) laid special emphasis on the tiger's preference for rocky mountain ranges with cliffs, fissures and caves. Observations made in Sikhote-Alin partly support this viewpoint. It is no mere chance, for example, that one of the few areas inhabited by the tiger in southern Sikhote-Alin during its steep population decline was the basin of the Milogradovka river, the valley of which goes through big rocky massifs.

## 3. Vegetation

The mountains in the Far East were covered with unbroken forests before the intensive impact of man upon them. Only certain summits are above the tree level. The vast forest belt of the mountains had almost no natural openings. At present the Sikhote-Alin mountain ranges are forested almost everywhere, with secondary growth where logging and fire have destroyed the primary forests.

In northern and southern parts of Sikhote-Alin the high-altitude zones of vegetation take different forms - as too does man's impact on the forests. In Sikhote-Alin reserve on the eastern slope of the mountains, cedar forests predominate; the nearer the sea, the more they are replaced by secondary birch and broad-leaved forests, oak-woods and meadows.

The tigers gravitate mainly towards the middle of the river basins. It is an area of cedar forests but they do not deliberately avoid the secondary vegetation. We happened to track their movements in the thinned-out birch woods and open meadows; on the southern slopes of Podnebesni ridge the home ranges of several tigers are mostly in the secondary forests.

Above 700-800 m are the coniferous (Abies, Picea) mountain forests with vegetation of a subalpine type on several summits. These areas, occupying up to 30% of the territory of the reserve, are scarcely ever visited by tigers. The upper part of the basin of the Kolumbe river in the north of the reserve, where the Abies, Picea taiga is the dominant vegetation, has no tigers. These facts show the error of the point of view, sometimes propagated, which states that the exploitation of the forests of Sikhote-Alin made the Amur tiger move over to the dark conifer taiga (Abramov, 1970).

In Lazovski reserve, where conifers are markedly fewer and where the vegetation is more southern in character the tigers occur almost everywhere. Long-standing human impact upon the forests of the southern part of Sikhote-Alin has left very few communities undamaged. More than half of Lazovski reserve is covered by (usually) secondary forests where the Mongolian oak (Quercus mongolica) predominates. These areas in the south of Sikhote-Alin are a "normal" habitat of the Amur tiger. Moreover the density of the population in Lazovski reserve in contrast to Sikhote-Alin reserve is highest in the coastal area - an area where the vegetation has changed most.

The above holds good for the unprotected territories also. Thus, according to data obtained in 1977, the density of tigers in the Olginski administrative region was much higher than in the Chuguevski region. But 60% of the former is secondary forest with cedar and broad-leaved trees not exceeding 10%, while in the latter region cedar and broad-leaved trees occupy 45% and oaks only about 9%. The number of tigers mainly depends on food resources and effective protection.

There are therefore no grounds for believing that the Amur tiger can only exist where there are vast areas of "virgin" taiga. These native forests are of course very valuable - but that is a different matter. The tiger will tolerate considerable interference with the composition and structure of the vegetation communities. It is appropriate here to refer to R.K. Maak's (1861) observations. He often came across tiger tracks in the leaf-bearing groves of the meadows around Lake Khanka - land which later came under the plough causing the tiger to disappear.

Illustration 4: A profile diagram illustrating the selectivity of tigers with regard to their movement in the river valleys of Sikhote-Alin. (The thickness of the black arrows is proportional to the probability of choosing a particular route - see text, page 21.)

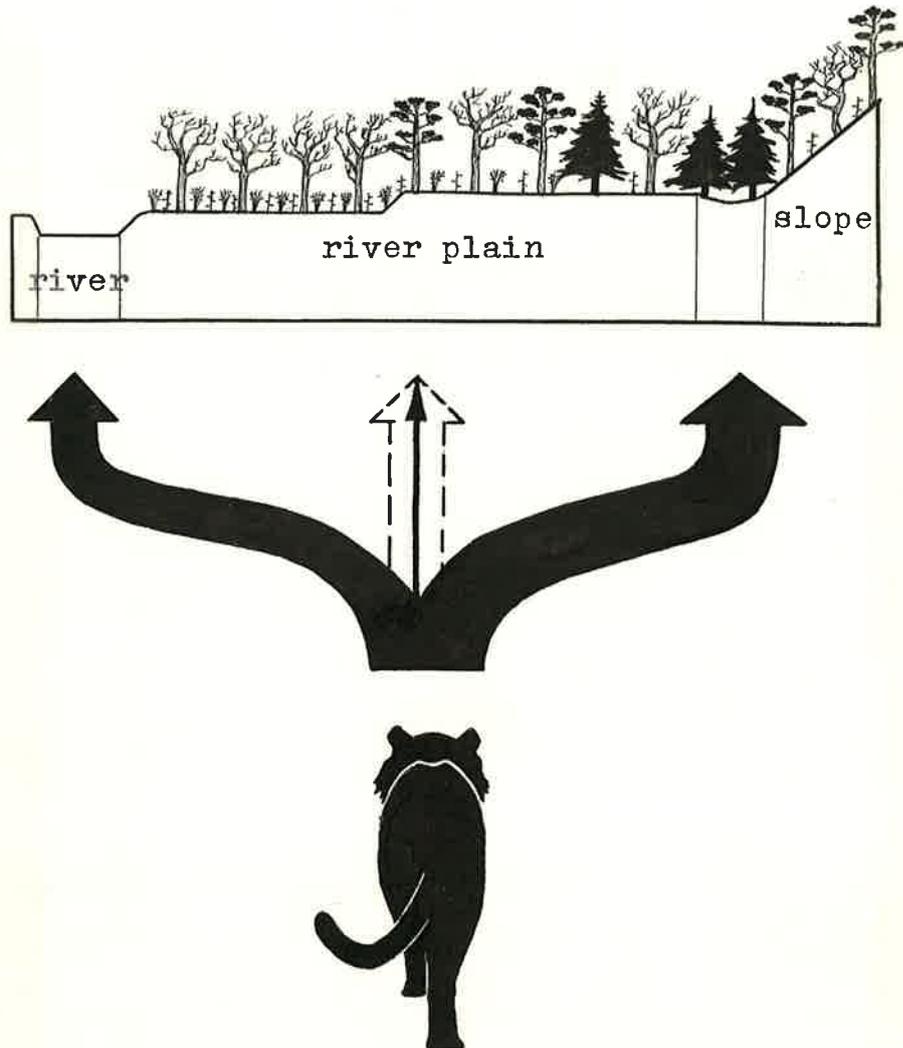
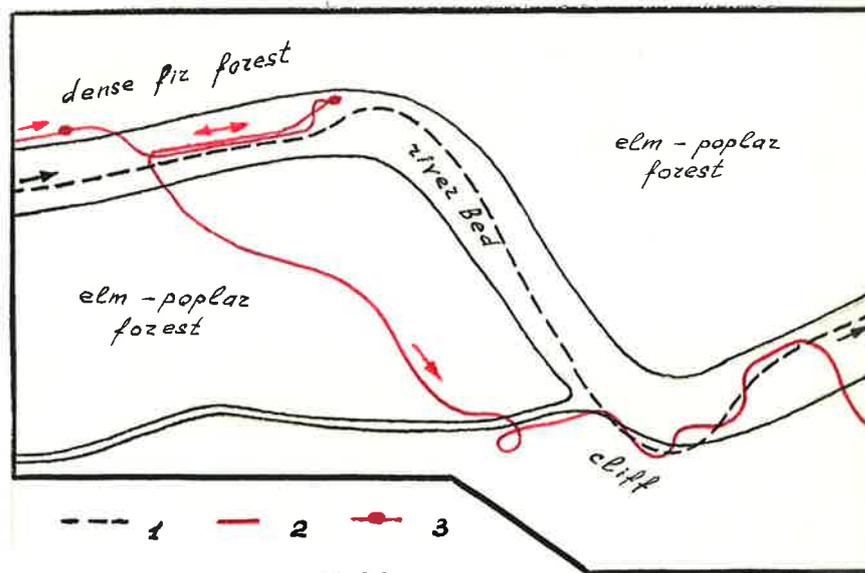


Illustration 5: Movement pattern of a tiger watching people (see text, page 36). Sikhote-Alin reserve, February 1971.



THE NETWORK OF THE ROUTES; HOME RANGES AND THE  
STRUCTURE OF THE POPULATION

1. Selectivity in the construction of the system of  
crossings; constant trails

From tracking tigers in the snow and mapping their routes we have discovered an undoubted regularity in their movements when not hunting or seeking shelter; the animals will often move for up to ten kilometres at a stretch in a more or less straight line - any turns seldom exceeding 30°. Tiger "crossings" are clearly based on the mountain/river pattern of the territory. They usually follow one or another leading line: the general extension of the river valley, the beds of the frozen river, the foot of the slope, the ridge of the mountain chain, the trail.

The river valleys of central Sikhote-Alin contain an example of the animals' preference for certain routes. In 140 km of tiger tracks in these valleys 43% were along the foot of the slopes, 35% in flood-land forests and 22% on the frozen riverbeds. The tigers covered two-thirds of the distance along leading lines - as shown in the diagram (figure 4 - see page 20), where the thickness of the arrows represents this relation (Matjushkin, 1977).

But these tentative calculations do not properly reflect the tigers' real preferences. The point is that the forests of the flood-lands and terraces occupy almost the whole valley while the river and the line of the foot of the slopes are outlined against this background as narrow ribbons. The average breadth of the valleys of this territory is about 400 m - the riverbeds being just 20 m. If the tigers' route were random - not selected - then they would travel 18 times as far in the flood-land forests as on the ice of the rivers or along the foot of the slopes. Quantitative evaluation of tiger preferences means taking this factor into account - which means dividing by 18 the distance covered by the animals in the flood-land forests. (The three black arrows in the diagram, figure 4, reflect the results of this recalculation.)

Similar analysis made for tiger habitat in the mountain

ridges and spurs shows a preference for the routes along the lines of the watersheds. Sometimes the animals do not merely prefer to travel along the foot of a slope or the ridge of a mountain range in a general sense, but opt for a particular slope or ridge amongst many which are very similar.

Retracing its own tracks is a peculiarity typical of the tiger. One may quite often observe double tracks (one track laid upon the other) which in many cases are due to defensive reactions. Tigers happening upon a dangerous place retreat along their own trail; it is in this manner that they almost always leave their prey or their daytime lairs. Double tracks may stem from hunting manoeuvres. When tigers are in a confined area for a long time (for example near large prey) they form a system of trails which resemble in miniature the pattern of the network throughout the animals' home range.

The fact that the tigers possess a system of constant trails is confirmed by the data of many researchers (Kaplanov, 1948; Yudakov, 1974; Zhivotchenko, 1976; Matjushkin, 1977). In winter when the snow is very deep the animals use these trails so frequently that it becomes difficult to spot fresh tracks. If there is no snow for several weeks the animals may still use the trails, but in these conditions they will tend to break new ground over most of the route. The less snow there is, the more they are likely to deviate from the regular trails.

Research over several successive years shows that the network is under perpetual reconstruction, although sections of the regular routes - and the "tigerless" spaces between them - remain unaltered for years. The network junctions are the favourite hunting areas and daytime lairs.

## 2. Lairs

When near their prey the tigers do not look for special cover: they simply lie close to the trunks of cedars and firs - trees through which the sun can penetrate. Their real lairs are well protected resting places which they usually approach with a sharp change of direction - sometimes making complicated manoeuvres known as "loops".

We observed three such lairs in Sikhote-Alin reserve. The first was on a stone ledge near the foot of a steep stone wall. This wall was a part of the massif of rocks on the narrow ridge of a spur approachable only from the side. The lair was about 150 m above the bank of the river. The tiger would lie on the ledge covered with a thin layer of soil, dry cedar needles and rotting leaves. The ledge faces south-west, is well heated by the sun and protected from the northern winds. Snow is unlikely to penetrate and in summer the overhanging rock keeps off the rain. The big male occupant of this lair visited it twice during two winters, each time by a different route. The animal would have to have curled up to make use of the bed which measured just 140 x 100 cm.

A very different lair, regularly visited by a tigress, was composed of three fallen trees, a cedar and two firs. Tracks showed that the tigress wriggled into the dip near the foot of the upturned trunks, two sides of which acted as walls of the lair and the third as its roof. In winter the trunks would be covered with snow but the bed remained dry. The floor covering was composed of wood shavings and dry conifer needles. The entrance faced south-east.

A fallen poplar with split trunk and a box-like shape made a third lair. The "box" - 170 cm long, 130 cm broad and 60 cm high - contained the bed of another tigress. Lairs similar to these are very numerous in Sikhote-Alin where the supply of fallen trees is practically unlimited. The fact that the tigers use some of them repeatedly is due primarily to the stable pattern of movement on the home ranges.

### 3. Use of territory; night and day motion; home range

The value of an organized network of routes on the home ranges is obvious. For the animal can then travel with minimum expenditure of energy (especially important in winter), and quickly find the mountain passes or hunting areas or likely places for meeting other individuals. A.G. Yudakov has shown (1974) that the route the tiger actually takes involves less fluctuation of altitude and snow depth than a line drawn in conformity with the general direction of the animal.

Cyclic movement within the vast territory ensures uniform taking of prey, but it is hard to quantify this movement because tigers can be active in broad daylight as well as at all other times. The task is not made easier by their habit of lying down some 6-8 times in every 10 km (Matjushkin, Yudakov, 1974). The duration of their stay in different lairs is also a problem - especially as that useful aid, fresh snow, is very rare in Primorje.

While the data available are not sufficient to solve these various matters, enough is now known to be able to assert that the Amur tiger's mobility is exaggerated in much of the literature. Although scarcity of food may compel some animals to cover 80-100 km in 24 hours (Baikov, 1925), under normal conditions the distance will not be more than 15-20 km.

According to observations made in 1970-72 in Sikhote-Alin reserve the tigresses moved within an area of about 200-400 km<sup>2</sup> and the male tigers within an area of 800-1000 km<sup>2</sup>. These are maximum figures, but yet those given by L.G. Kaplanov (1946) are 3-4 times as large. The differences are accounted for by changes in the density of the population: fewer tigers (as at the time of the earlier research) mean a larger home range. This fact is confirmed by contemporary observations made in Lazovski reserve. Here, the tigers being more numerous, the size of the females' home range is

only about 100 km<sup>2</sup> (Zhivotchenko, 1976). When the cubs are little, movement is minimal. L.G. Kaplanov (1948) noticed that a tigress with two cubs stayed within an area of 5 x 3 km for three weeks.

The home ranges of tiger with tiger - or tigress with tigress - are clearly separated or overlap only slightly. At the same time the males cover to a considerable extent the home ranges of the females, including females with cubs. A.G. Yudakov (1974) put forward the idea of "family territoriality" of the Amur tiger when demonstrating that tigresses with young move along male tracks and even use the remains of their prey. According to him monogamy is characteristic of the Amur tiger, but the data gathered by V.I. Zhivotchenko (1976) and E.N. Matjushkin (1977) prove that the males visit the home ranges of different tigresses. Characteristic "play" speaks in favour of tiger mating - plots of beaten snow carrying the imprints of the bodies of the animals surrounded by many tracks. During the mating period the animals willingly move on the snow-covered river ice. Here within the space of about a hundred metres one may count more than 10 crossings.

On the "family plot" of 50,000 hectares where V.I. Zhivotchenko (1976) did field research one male and two adult females lived in the winter of 1973-74. One of the tigresses had two grown-up cubs, while a young but independent animal periodically joined the second female. In the winter of 1974-75 the young tigers left the home range of their parents but three little cubs appeared in two new litters (one cub in one litter, two in the other).

#### 4. Marking behaviour

Marking is an important factor in retaining the spacing of a population. The Amur tiger, like the other geographical forms of the species (Schaller, 1967), displays it in two ways. Usually the animals mark the vertical surfaces (the trunks of the trees, the cliffs) with small portions of urine and probably also with a secretion of the anal glands. On the soil or in the snow the tigers leave distinctive stripes of the loosened substrate, the so-called "scrapes". This behaviour has nothing to do with the covering of excrement; the urinary spots and faeces are left on the surface (Matjushkin, Yudakov, 1974).

When approaching the marked trees and cliffs the animals always change direction. The trees which attract the tiger's attention have something special about them - their size, or their placing (for example, the single fir tree in a group of leaf-bearing trees), or some specific features (the form of the trunk, excrescences, etc). The scrapes and scent marks on the vertical surfaces are the main ways of marking territory. The scratches on the trunks usually remain near the prey and are seldom renewed.

The sexes differ in their marking behaviour. According to A.G. Yudakov (1974) the scrapes are generally made only by the males. While there are many observations confirming this view, the data obtained in different parts of Sikhote-Alin show that "scraping" is characteristic also of the females. The marking intervals are fairly regular but become more frequent on the smoothest parts of the trails which are close to fresh prey and to day lairs. The marks are put mainly where other tigers are most likely to appear (Yudakov, 1974), i.e. on the shared crossings. The belief that their sole function is to delineate the borders of the home ranges is not yet confirmed. It may be that for the Amur tiger they also serve a broad communicative purpose.

#### 5. Sex and age ratios

According to the data obtained in Sikhote-Alin and Lazovski reserves tigresses form slightly more than one-third of the total population. The count made in 1958-59 showed that cubs then formed somewhat more than 40% of the population (Abramov, 1970). Lately in Lazovski reserve this figure has been around 38% (Zhivotchenko, 1977).

Every year a certain number of the females have no young. L.G. Kaplanov (1948) wrote of meetings with un-mated tigresses; in recent years their tracks have been regularly observed in Sikhote-Alin reserve. It should be emphasized that the pattern of reproduction and social relations in the family groups of the Amur tiger have been little studied; future research may discover much more. In particular, the settled notion of a three-year breeding cycle should be thoroughly checked.

Illustration 6: Shelter "box" of the tigress at the foot of a big fallen poplar. Sikhote-Alin reserve, December 1971.



## HUNTING, FEEDING AND RELATIONS WITH OTHER PREDATORS

1. Hunting - where and how

The diverse nature of Sikhote-Alin makes for an uneven distribution of ungulates - whose seasonal movements are conditioned by the food supply and snow cover. For example, in winter the sika deer Cervus nippon in Lazovski reserve are concentrated in the areas with little snow on the seaward slopes, but in spring and in the first half of summer they - like the Isubra deer Cervus elaphus xanthopygus - keep to the bays suitable for drinking seawater.

The places where ungulates foregather - salt licks, for example - are well known to the tigers and are periodically visited by them, even in those seasons when there is not much chance of finding prey there (Zhivotchenko, 1977). There are several favoured hunting areas of this kind within the home range of each individual. After a kill the tigers do not return to the site for some 7-10 days - or even longer. If repeated visits prove unsuccessful the areas in question are gradually "dropped". While constant change of hunting area deflects the tigers from their "standard" routes, successful hunts consolidate these deviations. If the distribution of the prey turns out to be uniform on a vast territory - which is the case for the Isubra deer in the central part of Sikhote-Alin - then the hunting areas will also be uniformly distributed.

The tigers hunt both in the river valleys and in the mountain taiga of the watersheds. The movement of the attacking predators varies greatly. As mentioned already, in the valleys they prefer to move along the foot of the slopes while the Isubra deer browse in the river-bed forests. In Sikhote-Alin reserve, out of 10 hunting incidents observed in this kind of forest, only once did the tiger approach the prey from the frozen river bed. In the valleys the tigers cunningly use the contours of the land as camouflage. Isubra deer often lie down in the hollows on the sides of small slopes; the predators approach imperceptibly from behind the upper rim of these dips. In the watershed the hunting trails are mostly on the ridges, but the animals also hunt on the slopes with the prey both above and below them.

Stalking begins only with the discovery of the prey itself; the prey's tracks do not spark this reaction. Approaches to

the victim pursue a zigzag course but without complex loops. Then comes the charge.- a sharp change of pace and a series of bounds. Attacks are seldom launched from behind a thick tree, cliff or other shelter; nor from the lairs. Real ambushes in which the predator predetermines the movement of the prey and manoeuvres accordingly have been noted only occasionally.

As a rule the tiger does not attack its prey until less than 30 m from it - more often 10-15 m. The length of the bounds when the snow is not deep is 2.5 - 3.5 m - maybe up to 5 m down hill. Longer bounds claimed in the literature are clearly an exaggeration.

Where the attacks are not successful the tiger will make 40-60 bounds but seldom carries on the pursuit for more than 150 m. (And there is only one record in Sikhote-Alin reserve of Isubra deer being caught after being chased for 100 m). Thereafter it will often immediately lie down, but attacks may sometimes be repeated at intervals of about 1 km or less.

Around 30% of attacks on Isubra deer in Sikhote-Alin reserve were successful - in Lazovski reserve 20%. In other words the predators succeed only once in every 3-5 attacks. They catch prey with their paws in the region of the hind quarters but are sometimes pulled along by it - as shown by distinctive tracks. In cattle attacked but not killed by young tigers one may often see deep scars on the hind quarters.

The prey is killed by the tigers' fangs, striking at the big blood-vessels in the back of the head and neck. The jugular vertebrae are often splintered, the trachea is usually broken. The prey is seldom eaten where it is killed. The tiger drags it to a more secluded spot - the shelter of a fallen tree or of conifers or the lair of a wild pig Sus scrofa. The slain prey usually leaves a broad and almost bloodless furrow, running next to the track of the tiger - which returns to the carcass many days later and drags it to a new place. In all the tiger will drag its prey for some 40 m, but occasionally for more than half a kilometre (Matjushkin, Yudakov, 1974).

## 2. Feeding habits

The muscles of the hind part of the trunk and legs, and a portion of the intestines are eaten first. Tigers spend anything from several hours to 5-7 days or even longer near the carcass (Yudakov, 1973; our data) and are able to eat a great deal of meat at one "sitting" (A.G. Yudakov 1973) described how a male tiger, without changing its position, ate up every morsel of a slain roe-deer Capreolus capreolus. According to some observations a large tiger may eat up to 50 kg of meat per night; but these data should be checked.

Tigers hardly ever stay near their prey till the latter is fully consumed; they leave behind 20% - 70% of the weight of

Illustration 7: The tigers regularly hunt on the animal salt licks. A male Isubra deer on the Boshoi kaplanovski salt lick in Sikhote-Alin reserve, May 1966.



Illustration 8: The remains of a cow killed by a tiger. Lazovski region, September 1976.



the carcass. The remains are sometimes returned to and eaten by the "owners", but are usually devoured by scavengers. In Lazovski reserve 28 cases of a male tiger eating its prey were observed; in 15 cases it spent a day and a night near the prey, in 9 cases two days and nights, and in 4 cases 3-4 days and nights. In 75% of the cases the remains of the male's prey were consumed by tigresses, including those with cubs. In 3 out of 28 cases the remains of the male's prey were eaten only by a cub. It is known that males do visit the prey of tigresses but this is uncommon. Tigresses and young will spend 3-7 days and nights near their slain prey. Intervals between killings fluctuate from several hours to 11 days. A solitary tigress in 12 days killed 4 wild pigs (a female and 3 young), one young Isubra deer and one roe-deer; a male in 40 days killed 3 Isubra deer (a stag, a hind, and a calf), one wild pig and three young (Yudakov, 1973). From these data this author concluded that an adult tiger catches at least 70-75 individual prey each year. On the other hand L.G. Kaplanov (1948) was of the opinion that an adult tiger annually eats about 30 animals weighing 100 kg each. The fact that young ungulates often form a high portion of the catch may account for the discrepancy.

### 3. Composition of prey

In the southern Soviet Far East where many species of ungulates are found - and sometimes in great quantity - the tiger is well provided for (Table II - see page 42). In central Sikhote-Alin tigers sometimes hunt the moose Alces alces and the musk deer Moschus moschiferus; the sika deer is intensively hunted only in the south of the area (where it has been preserved). Wild pig and Isubra deer form the tiger's main diet. Contrary to the widely held view that the number of tigers is closely related to the number of wild pigs, the available data testify to the fact that the hunting "interests" of the tiger may easily switch to Isubra deer or, if possible, to the sika deer. Isubra deer is mainly responsible for the stable grouping of tigers in Sikhote-Alin reserve during the last decades. When wild pigs left this region during a scarcity of cedar and pine cones the tigers did not follow - indeed they often preferred to pursue Isubra deer even in the places inhabited by wild pigs (Gromov, Matjuschkin, 1974).

The tigers may become habituated to rarer food. For example, in Lazovski reserve some persistently hunt goral Nemorhaedus goral which inhabit a narrow strip of the rocky seaside (Zhivotchenko, 1976). The animals that once lived in the low-lying land around Lake Khanka hunted mainly sika deer and (especially) roe deer (Maak, 1861).

The fact that Amur tigers are very tolerant in their choice of prey is of great importance when deciding on conservation measures for the species. Man-made changes in the cedar/broad-leaved forests greatly affect populations of the wild pig (Bromley, 1964) which is also very sensitive to excessive hunting. The "cedar-wild pig-tiger" chain is very

vulnerable. However the populations of Isubra deer and roe deer in these secondary forests are not reduced - and even increase where hunting is properly managed.

Bears are also regularly taken by the tigers. The black bear Ursus thibetanus is less often a victim because it can climb trees. That is probably why in the southern part of the area - where the brown bear Ursus arctos is very rare - bears form scarcely any part of the tiger's diet. Nevertheless 2 of the 5 cases mentioned in Table II (Sikhote-Alin reserve) refer to black bears.

Brown bears may be taken in their dens in winter. In the period 1952-59 more than 15 cases were recorded in central Sikhote-Alin (Bromley, 1965). L.G. Kaplanov (1948) observed one such incident: "Coming to the mountain range the tigress turned 90° left and in short stalking steps approached the cedar 50 m away that had a den beneath it. The den was small, the entrance facing north. Probably the tigress then dug a hole on the southern side of the den to frighten the female bear, jumping in turns at the entrance or at the newly dug hole until with a strike of its paw it caught the bear by the foreleg, pulled it outside and severed the jugular vertebrae near the back of the head. The skin on the sole and toes of one of the forelegs was ripped back. The yearling cubs weighing 30 kg each were strangled in the den, splashing the walls and the roof with blood..." (pp. 26-27). The interrelations between the tiger and the brown bear are not simply those of "predator-prey". The bears often consume the tigers' left-overs - and even deliberately track the animals. Authentic cases of young tigers perishing in fights with the large brown bears are known (Heptner, Sludski, 1972).

The type of prey taken by the tigers varies not only with the region but also with the season. In Lazovski reserve most of the sika deer are taken in winter and early spring when they are concentrated on the less snowy slopes, and then again in the first half of summer (Table III - see page 43) when they feed on the salt near the bays. The tigers persistently chase Isubra deer in spring and early summer on the salt licks. Wild pigs predominate in the tigers' winter and autumn catch when there are seasonal concentrations of these animals in the areas abundant in food. One might expect that the autumn "bellowing" of both species of deer would alert hungry tigers and lead to a seasonal increase in their killing of deer - especially in view of the belief that bellowing stags attract tigers (Arsenjeva, 1949 et al.). The data available give no grounds for such a conclusion.

#### 4. Prey preferences

In those areas of Lazovski reserve where there are no (or very few) sika deer but equal numbers of Isubra deer and wild pig, the tiger feeds chiefly on the former in spring and summer and chiefly on the latter (when "supplies" are sufficient) in autumn and winter. It appears that

availability governs the frequency with which different prey species are taken. The belief that tigers hunt "selectively" remains unproved.

Further research should be done on the differences in sex and age of prey. According to A.G. Yudakov (1973) young pigs make up 80% of the wild pigs killed. In Lazovski reserve less than 18% of the sika deer killed are adult bulls - slightly below their 20% share of the total population (Bromley, 1956); females and young are the chief victims. Recent research in Sikhote-Alin reserve showed that 10 out of 32 Isubra deer taken were adult stags - slightly more than their share in the population according to L.G. Kaplanov (1948).

#### 5. Attacks on domestic animals

The secondary settling of tigers in almost all the forested territory of Primorje and simultaneous reduction of the ungulate population by human impact in a number of regions, caused a sharp increase in attacks on domestic animals as the following figures show: 1920-60, 162 attacks recorded in the area; 1961-65, 100 attacks recorded; 1966-70 386 attacks recorded (Yudakov, Nikolaev, 1973). The number of such attacks is directly related to the degree of economic development of the area. In the surroundings of Sikhote-Alin reserve they are rare; on the borders of Lazovski reserve they happen constantly. In the latter region some tigers even specialize in this form of prey (Zhivotchenko, 1976) because the density of the domestic animals is comparable here with that of the wild ungulates.

Cows are the principal victims but horses are also quite often taken. Some observations suggest that when they have a choice the tigers prefer horses. Dogs are also chased persistently. For example, in 1970 in Lazovski reserve 3 dogs were killed in the forest posts and 7 in the village of Kievka (Zhivotchenko, 1977).

#### 6. Competitors and scavengers

In Sikhote-Alin only the wolf Canis lupus is - or may be - a serious competitor of the tiger. It is often said in the literature that as soon as the tiger appears in an area the wolf disappears. The tiger's persistent pursuit of dogs suggest that it would also chase wolves but there is scant evidence to support the view that tigers exterminate wolves. In Lazovski reserve in the winter of 1974-75 only one case was recorded of a tiger killing a wolf - and that one had been wounded by a hunter. Furthermore the tiger did not eat it.

In recent decades in Sikhote-Alin reserve the wolves, like the tigers, have mainly hunted Isubra deer - a real overlap of hunting "interests". The growth of the tiger population

since 1966 has not caused a reduction in wolf tracks. But the wolf distribution has changed: the main wolf centre has moved over from the basins of the rivers of the eastern slopes - which are now inhabited by the tigers - to the western slopes and the basin of the Kolumbe river where tigers are almost non-existent. Nevertheless the routes of these predators often overlap and there is sometimes a very close "interlacing" of the hunting areas. Wolves may even appear near the remains of a tiger's prey (Gromov, Matjushkin, 1974).

In Lazovski reserve the wolf, which hardly occurred there before 1905, became common around 1926 when the tiger was practically exterminated. Wolves were especially numerous there during the war and immediately afterwards. At that time and up to the beginning of the 1960s leopards were also more common (Zhivotchenko, 1977).

When the tigers settled again within the reserve the wolves became appreciably fewer, concentrating in areas seldom visited by tigers. The tigers now replaced wolves as the main influence on the populations of sika deer (Table IV - see page 44). One predator was replaced by another. At the same time cases of tiger/wolf propinquity were recorded in the south of Primorje as elsewhere.

During the 7-10 days and more which it takes tigers to devour their prey, different scavengers have access to the remains. Among the birds it is the raven Corvus corax and the jungle crow Corvus macrorhynchos that are most important, among mammals the Siberian weasel Mustela sibirica and the fox (Vulpes vulpes). The "secondary consumers" are very diverse - consisting, where opportunity offers, of almost all meat-eating predators. Apart from the species just mentioned, wolf, brown bear, black bear, yellow-throated marten Martes flavigula, lynx, and many birds including jay Garrulus glandarius and nutcracker Nucifraga caryocatactes will feed on the tiger's left-overs (Matjushkin, 1974). In February 1977 in Sikhote-Alin reserve wild pigs were observed eating the remains of a male Isubra deer which a tiger had killed and which the pigs had to dig out of the snow.

## THE TIGER AND MAN: CONSERVATION PERSPECTIVES

1. Man-made changes in the habitat and their effect on the tigers

The reaction of the tiger to man-made changes in the habitat has been partly reviewed already. The animal's adaptability is great, but surely not boundless. The intensification of felling, the development of agriculture in the valleys of Sikhote-Alin, the extraction of minerals in the mountains - all these things mean a considerable shrinkage of the areas suitable for tigers. And when the number of ungulates is also reduced, tigers will attack cattle more frequently - an added problem for the conservationist. Paradoxically it is the tiger's ability to adapt to the impact of man which aggravates the situation.

The trails in the taiga regularly used by people serve as routes for the tiger. But along and close to the highways going through the taiga there are fewer ungulates, so discouraging the presence of tigers. Nevertheless tigers often approach and cross the highways, and will sometimes even move along them for hundreds of metres. There have been many meetings with tigers on the highways when the observers were in cars or on tractors or motorcycles. The animals appear undisturbed by the construction of these narrow highways or by the noise of engines; where they have left their habitual places the reason is shortage of ungulates.

Tigers calmly pass quite close to the huts periodically visited by people in the taiga, and approach solitary dwellings in the forest. The settlements and the agricultural areas surrounding them cause different reactions in the tiger depending on the degree of development. For example, in the region of Sikhote-Alin reserve where the populated areas are fairly distant from each other tigers seldom visit this habitat while in the more populous region of Lazovski reserve they are quite common. In 1973-74 a young tiger regularly hunted dogs in the outskirts of the village of Kievka - even moving between the different houses.

## 2. The tiger's reaction to direct contact with man

Direct contact with people usually causes the tigers to retreat, even if this means leaving a freshly killed prey; afterwards they sometimes track the man (Kutcherenko, 1970; Matjushkin, 1974). The animals are seldom visible, even if they are very close. In the period 1973-76 the tracks of tigers in Sikhote-Alin reserve were observed 545 times, but the animals themselves only 21 times - and in 19 of these cases they disclosed their presence by roaring. With the growth in the number of tigers, especially in the south of Primorski, more and more people have seen the animals. In such situations the tigers pretend not to see the people - remaining where they are or retreating only slowly. Even shooting into the air does not panic them.

The way tigers behave when tracking people unnoticed may be illustrated by an example. On a February evening in Sikhote-Alin reserve one of the authors of this paper and a fellow traveller were walking back to their isolated hut. In the morning we found the tracks of a big male tiger imprinted upon our own. A close study of the tiger's tracks revealed the following sequence of events. The tiger entered "our" valley at a point two kilometres from the hut and moved along the bank of a narrow mountain river - an old trail through a thick fir forest. There, well hidden but with a good view of the river, it lay down. Not for long though; the bed was hardly melted. The front paws of the animal were stretched towards the river, its attention drawn by something going on there, probably people were walking on the ice.

Leaving its bed the tiger descended on to the ice of the river and came to our trail. It followed us for about 300 m, then turned aside and lay down. But almost immediately it rose (the snow under the tiger was not melted at all) and retraced its (and our) tracks before crossing the river to the elm and poplar forest on the opposite bank. (The movements of the tiger are shown in Figure 5.)

Even in critical situations tigers do not attack man. In the winter of 1974-75 a forester from Lazovski reserve, V.I. Schevchenko, was walking along the seashore when, after turning into a small bay, he suddenly came across a tiger which was devouring the remains of a sika deer frozen into the ice. The animal had two possible escape routes: along the shore, but the forester was standing there - or up a narrow ravine, but a steep, 6 m high icy ledge blocked the way. The forester fired a pistol into the air, and the tiger jumped on to the ledge but slipped off. He fired again - with the same result. Only at the third attempt did the animal manage to overcome the obstacle. It turned out that it was a big male tiger and that in jumping on the icy ledge it had wounded its paw.

Tigers seldom charge people: we know of only one such case. In Lazovski reserve a tiger charged a group of three adult men and a child but before reaching them it turned sharply

and disappeared. Single instances of tigers openly and persistently pursuing a man are recorded but there were no attacks. In the evening of 29 May 1977 a forester from Sikhote-Alin reserve, V.A. Solomatin, came upon a tiger while walking on the trail. He left the trail to let the tiger pass. But the animal, instead of staying on the trail, hid behind the trees and shrubs and continued to come towards him. Slowly he retreated, the tiger following, the distance between them being 7-9 m. In desperation he climbed a tree, but the tiger came close up to it and lay down. When shouting failed to frighten the animal he threw down a burning paper and the forest began to smoulder. Only then did the tiger, though still not immediately, rise and slowly disappear into the shrubbery. The man climbed down and went quickly towards a house that was not far away. The tiger, however, still pursued him - from time to time coming into view but not again approaching so closely.

For people in the south of the Soviet Far East meeting tigers has become quite a common experience - especially in recent years. It would be no exaggeration to say that on average, each animal finds itself close to people at least 10 times a year (the people of course, are usually unaware of the tiger's presence). Probably this figure is too low, because in the south of the area some tigers run into people constantly.

But while this means that for people living in Primorje potentially dangerous meetings occur thousands of times a year, for more than half a century there have been no recorded cases of tigers attacking people there - except when provoked. All the same there is always the remote chance of tragedy - as confirmed by an incident on 18 February 1976. On the road near the village of Lazo a tiger killed a tractor-driver, who was near his tractor, and ate part of the body (Zhivotchenko, 1977).

### 3. The conservation outlook

This incident along with the increase in attacks by tigers on domestic animals points to the fact that in southern Primorje the situation is now similar to that of the early period of settlement in the Ussuri area - as we can tell from the descriptions of N.M. Przhevalski (1870). N.A. Baikov (1925) reported a number of incidents of tigers attacking people in the adjacent parts of China where it became necessary to eliminate those which preyed on man or on domestic animals. Such action is important not just because it removes dangerous animals, but also because the animals do ill-service to the cause of tiger conservation.

Poaching still presents a problem. Many tigers have perished in the taiga through accidentally encountering armed people. (Furthermore these encounters are quite likely to result in dangerous, wounded animals. The poachers often do not even try to establish the results of their shots.) According to

the data published by A.G. Yudakov and I.G. Nikolaev (1973) 70 tiger killings were recorded in the period 1965-70. Though the present population is sufficient to withstand this, poaching needs to be brought under control. An effective measure may be periodic bans on the capture of cubs - fully controlled by the official hunting bodies. It is noteworthy that in the 40-year period 1920-60 the number of cubs taken was almost equal to the number of tigers killed; only in recent decades has the "cub-catch" declined (Yudakov, Nikolaev, 1973). The enlargement of the main tiger reserves so as to ensure that the local populations of tigers stay within these boundaries remains a burning issue.

To sum up, we conclude that the present status of the Amur tiger gives grounds for optimism - though this certainly does not mean that all difficulties have been surmounted or that the tiger is wholly secure. There is always the possibility of a sudden and sharp drop in numbers as occurred in Sikhote-Alin reserve in 1963-65. And though economic development of the mountain and forest landscapes of Sikhote-Alin may not in itself be harmful to the tiger, it must be of a kind which does not reduce the wild ungulate population. This will not be easy.

Regional differences in the status of the tiger are important too. There has been no appreciable growth in numbers near the northern boundaries of its range, while in some places irreversible reductions of the range have occurred. In the northern part of the region attention should be fully directed towards the strengthening of conservation measures, but in the southern part these measures will have to go hand in hand with regulating the population - eliminating individuals in certain places. Obviously any measures taken must be scientifically based.



Illustration 9: The night tracks of a tigress in the thin layer of snow covering the ice of a stream. Sikhote-Alin Reserve, December 1970.



Illustration 10: Amur tiger (Panthera tigris altaica)

## TABLES

TABLE I

ANNUAL OCCURRENCE OF TIGER TRACKS ON THE TERRITORY OF  
SIKHOTE-ALIN AND LAZOVSKI RESERVES

<u>Reserve</u>	<u>1961</u>	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Sikhote-Alin	-	13	1	1	3	13	92
Lazovski	4	4	26	24	33	36	56

<u>Reserve</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>
Sikhote-Alin	60	95	66	82	114	100	141	172
Lazovski	45	130	170	71	127	98	125	180

TABLE II

## DIET OF THE AMUR TIGER

COMPOSITION	The whole of Primorje, 1957-59 (Abramov, 1962)		Lazovski reserve 1973-77 (Zhivotchenko)		Central Sikhote- Alin; western slopes 1970-72 (Yudakov, 1973)		Sikhote-Alin reserve 1936-48 (Schamikin, Abramov's data, 1962)		Sikhote-Alin reserve 1962-62 (Gromov, Matjushkin, 1974)	
	Number	%	Number	%	Number	%	Number	%	Number	%
<i>Sus scrofa</i>	12	30	90 (29)	31.4	18 (18)	48.7	21	35.7	11 ( 4)	27.5
<i>Cervus elaphus xanthopygus</i>	20	50	92 (39)	32.1	10 (10)	27	13	22.1	23 (20)	57.5
<i>Cervus nippon</i>	2	5	51 (22)	17.9						
<i>Capreolus capreolus</i>	1	2.5	16 ( 7)	5.6	4 ( 4)	10.8	2	3.4	2 ( 2)	5
<i>Moschus moschiferus</i>	1	2.5			1 ( 1)	2.7	8	13.6		
<i>Alces alces</i>	1	2.5					6	10.1	1 ( 1)	2.5
<i>Nemorhaedus caudatus</i>			6 ( 1)	3						
<i>Ursus thibetanus</i>									2	5
<i>Ursus arctos</i>	2	5					5	8.4		
Bears of undetermined species			1	0.3	2 ( 2)	5.4			1	2.5
<i>Canis domesticus</i>			19 (12)	6.6	2 ( 2)	5.4				
<i>Nyctereutes procyonoides</i>			2 ( 2)	0.6						
<i>Meles meles</i>	1	2.5	2 ( 1)	0.6						
<i>Lynx lynx</i>							1	1.7		
<i>Lepus brachyurus</i>			2 ( 1)	0.6						
<i>Erinaceus europaeus</i>			2 ( 2)	0.6						
<i>Tetrastes bonasia</i>			3 ( 3)	1			3	5.1		
Total	40	100	286(119)	100	37 (37)	100	59	100	40 (27)	100

Note: the number of actual remains of prey found out of the total data is in brackets; the difference represents occurrence of the prey species in droppings.

TABLE III

SEASONAL KILL OF UNGULATES BY TIGERS IN LAZOVSKI RESERVE AND CONTIGUOUS TERRITORIES (1973 - 1975)

<u>UNGULATES</u>	<u>Spring</u>		<u>Summer</u>		<u>Autumn</u>		<u>Winter</u>		<u>TOTAL</u>
	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	
Cervus nippon	6	26	3	25	1	5.8	8	27.6	18
Cervus elaphus xanthopygus	13	56.5	6	50	4	23.3	7	24.2	30
Sus scrofa	4	17.5	1	8.3	9	52.3	13	44.8	27
Capreolus capreolus	-	-	2	16.7	3	17.6	1	3.4	6
TOTAL	23	100	12	100	17	100	29	100	81

TABLE IV

DEATHS OF SIKA DEER CAUSED BY PREDATORS IN LAZOVSKI RESERVE

PERIOD	WOLVES	TIGERS	LYNX	DOGS	SPECIES NOT DETERMINED	OTHER REASONS	TOTAL	SOURCE
1936-38	15 (60%)	-	-	4 (16%)	-	6 (24%)	25	Vendland, 1938; Bromley, 1956
1944-48	39 (86.5%)	-	2 (4.5%)	2 (4.5%)	-	2 (4.5%)	45	Bromley, 1956
1958-69	42 (20.6%)	20 (9.8%)	20 (9.8%)	5 (2.4%)	49 (24.2%)	67 (33.2%)	203	Prisjazhnjuk, 1970
1973-75	2 (8%)	17 (68%)	-	-	-	6 (24%)	25	Authors' data

SCIENTIFIC NAMES OF THE ANIMALS

<i>Alces alces cameloides</i> Milne-Edwards, 1867	moose
<i>Canis lupus tschiliensis</i> Matschie, 1907	wolf
<i>Capreolus capreolus bedfordi</i> Thomas, 1908	roe deer
<i>Cervus elaphus xanthopygus</i> Milne-Edwards, 1867	Isabra deer or Manchurian wapiti
<i>Cervus nippon hortulorum</i> Swinhoe, 1864	sika deer
<i>Corvus corax kamtschaticus</i> Dybowski, 1882	raven
<i>Corvus levaillantii mandschuricus</i> Buturlin, 1913	jungle crow
<i>Lynx lynx stroganovi</i> Heptner, 1969	lynx
<i>Garrulus glandarius brandtii</i> Eversmann, 1842	jay
<i>Martes flavigula aterrima</i> Pallas, 1811	yellow- throated marten
<i>Moschus moschiferus parvipes</i> Holl, 1911	musk-deer
<i>Mustela sibirica mandschurica</i> Brass, 1911	Siberian weasel
<i>Nemorhaedus goral caudatus</i> Milne-Edwards, 1867	goral
<i>Nucifraga caryocatactes macrorhynchos</i> Brehm, 1823	nutcracker
<i>Panthera pardus orientalis</i> Schlegel, 1857	leopard
<i>Sus scrofa ussuricus</i> Heude, 1888	wild pig
<i>Ursus arctos lasiotus</i> Gray, 1867	brown bear
<i>Ursus thibetanus ussuricus</i> Heude, 1901	Asiatic black bear
<i>Vulpes vulpes daurica</i> Ognev, 1931	red fox



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