

ON THE ENVIRONMENT-RELATED STABILITY OF SNOW LEOPARD (*Uncia uncia*)
POPULATIONS IN CONNECTION WITH THEIR DISTRIBUTION IN THE NATURAL
HABITATS AND CHANCES FOR SPREAD WITHIN THE USSR.

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The stability of animal populations in respect of the influence of the environment is well known to be conditioned by their location in the natural habitat and their ability to establish new territories (Geptner 1936, Panfilov 1960, Koli et al. 1979). In the peripheral regions of the natural habitat, however - in the zone that is ecologically least favourable - the situation of the animal is the most unstable. This is due to the increased pressure of environmental factors which favour neither a high frequency of contacts between individuals belonging to separate populations nor an increase in the number of such contacts and their stabilization. In our opinion, this describes the situation that has come about in certain regions inhabited by the snow leopard in the Soviet Union.

The area inhabited by the snow leopard (*Uncia uncia*) within the boundaries of the USSR forms the northern periphery of its geographical range and occupies about 17 % of the total area (2.2 million sq.km.). This sector spans nearly 2,000 km in the north-south direction and 3,000 km in overall latitude. Thus the conditions for the snow leopard's existence vary considerably between the extreme borders of this area. The region inhabited by the species covers the very highest mountain areas of the country, skirting the borders with Afghanistan, China and Mongolia. Indeed, the discontinuousness of the mountain ranges in this territory influences the stability of animal populations and creates the conditions for their integration or separation. The major hindrances to unimpeded contact between the snow leopards are apparently the huge water barriers, vast depressions between the mountains and areas of massive glacier formation. Thus, data concerning the distribution of the snow leopard in the past (Geptner 1972) and the present (Matyushkin 1984) indicate that the shrinking of the range occupied especially in the north-east (eastern Sayan) and north-west (Syrdarinsky Karatau) hinterlands and also in the Saur and Tarbagatai ranges, the snow leopard populations of these areas were apparently the most isolated orographically from the bulk of the population and sustained the

most severe impact of the environment. The rare encounters with snow leopards in these regions

(Grum-Grzhmailo 1914, Kumetsov 1948, Afanasev et al. 1953, Stroganov 1962, Geptner & Sludsky et al. 1972) reflect the general subdivision of the populations and their low potential for growth and migratory settlement. Starting from the assumption of the geographical differentiation of these highly mountainous countries themselves and the dissimilar situation of the populations, it is appropriate to delineate three main populations within the boundaries of the USSR having a different significance for the preservation of the snow leopard:

1. Central Asia (Pamir-Altai, Tien Shan),
2. Eastern Kazakhstan (Dzhungarian Alatau, Tarbagatai range, Saur),
3. Southern Siberia (Altai, Sayans; Figure 1)



Figure 1. The sub-populations of snow leopard in the territory of the USSR.

The greatest orographic segmentations between these sub-populations are observed in the regions of the Hi, Dzhungarian Alatau and Sayan depressions. This leads to the assumption that inter-group contacts take place more frequently between individuals from the same sub-populations than between animals from different ones. Principally, this kind of situation is probable for the sub-populations of Kazakhstan and Siberia which are separated from each other by a vast expanse of at least 200 km. The gap continues even farther to the east of the region indicated, where the Mongolian and Gobi Altai are separated from the eastern Tien Shan and the Dzhungar-Gobi-Basin. This leads us to ask whether the snow leopards are capable of

crossing the barriers that separate them and maintaining the integrity of the populations through migrations.

In order to answer this question and to assess the probability that the different populations are isolated, we shall examine the position of the snow leopard in each of its sub-populations, and cite data that characterize the animals' movements throughout the territory .

The Central Asian sub-population covers about 2/3 of the snow leopard's natural range in the Soviet Union (391,800,000 sq. kID). This, the largest sector, is situated at the juncture of southern Siberia and Central Asia, and it is characterized throughout its extent by considerable territorial uniformity. The shortest distance separating the Central Asian population from the eastern Kazakhstan population and the region of the Ili gorge totals about 150 kID. Within the sub-population, there is everywhere less isolation of the individual sectors where the animals live, and in the majority of cases, these do not exceed 50 km. In particular such dividing barriers are formed by the valleys of large rivers. In the western Tien Shan these are the Chatkal, Talas and Pskem; in the inner territory, they are the Naryn, Kyokyo-meren and Susamy; in the northern region they are the Chu, Tyup, Dzhergalan, Charyn and Tekes; and in the Pamir-Altai they are the Zeravshan, Surkhob, and Kyzyl-Su.

The most vulnerable populations are those in western and inner Tien Shan, where the snow leopard's sectors of habitation are like islands (Koshkarev 1988 a ; Figure 2). The frontier

position of these areas is unfavourable for the population. The main core apparently consists of the populations of the central and south-west Pamirs (Geptner, Siudsky 1972, Sokov 1990) and also the central and south-eastern part of inner Tien Shan (Koshkarev 1988 a). According to the above-mentioned authors, the snow leopard is common in the mountainous stretch consisting of the Turkestan, Zeravshansk and Gissarsk ranges (Figures 3, 4). In its southern part, the central Asian sub-population is connected orographically with the Hindu Kush, Karakorum and Kunlun.

As the studies referred to (Schaller et al. 1989) have shown, however, the density of the snow leopard population there is fairly low: 0.4 individuals/100 sq.km. This is only one-sixth

of the average in the Tien Shan region (Koshkarev 1988 a). In connection with this, it can not be excluded that contacts between the Central Asian populations and animals from the part of the habitat beyond the border do more to facilitate the "drain" of individuals than to attract new arrivals. For this reason the Central Asian sub-population may be one of the strongest links in the chain of populations surrounding it, not only in the USSR, but in China and Afghanistan as well.

In Tien Shan the greatest distance covered by a snow leopard during a 24-hour period in its normal home range - as ascertained by following the tracks in winter time - did not exceed 12 km (Koshkarev 1984). The roamings made by several individuals within the limits of the sector of habitation may reach a total of 50 kID, according to calculated data. The distance of attestably tracked movements along glaciers amounted to about 8.5 km (Koshkarev 1988 b).

Ratsek (1971) described the case of a snow leopard crossing the Zhalaysk range from the direction of the Alaysk Valley, and traversing the Lenin Peak (7,134 m). The distance travelled in the snow and icy terrain was probably not less than 20 kID. In the inner Tien Shan region, there have been instances when snow leopards crossed the Kokshaal-Too range into China and back again (personal report by Z. Shabdanov). In winter time migrations are known to have been made across the unforested river valleys, which are up to 3 kID wide (Koshkarev 1988 b), but they may be even longer. The longest migration was recorded in western Tien Shan in 1958, when a snow leopard was spotted and killed on a plateau 80 kID from the nearest high mountains (Gepter, Sludsky 1972).

Encounters with snow leopards have been recorded in 12 national reserves: the Zaminsk,

Kyzylsuysk, Mirakinsk, Tsatkalsk, Aksu-Dzhabagly, Alma-Atins, Besh-Aralsk, Issyk-Kul, Sary-Tseleks, Narinsk, Ramit, Dashditzhumsk (USSR national reserves, Sokov 1990). However, the reserves do not play an essential role in the preservation of the population, since as a rule they cover a fairly small area. Reserves such as the Tsatkalsky and Besh-Aralsky consist of non-contiguous sectors, which does not facilitate the preservation of integral populations of snow leopards. In spite of the fact that the reserves cited above, and also the Aksu-Dzhabagly reserve, are located near each other, there is no coordination of work between them (Matyushkin 1984).

The eastern Kazakhstan sub-population occupies 1/10 of the total area. This area is the smallest in extent and the most isolated in terms of its location. The shortest distances separating it from the neighbouring Central Asian and southern Siberian sub-populations (Figure 1) are about 200 km. Approximately the same distance separates the Dzhungarian Alatau and Tarbagatai ranges within the sub-population. On the face of it, this casts doubt on the correctness of regarding this as an independent sub-population. But here it is necessary to take account of the fact that the parts of the Dzhungarian Alatau and Tarbagatai habitats which lie beyond the border run into the Borokhoro range, across which the snow leopard can migrate. For this reason the 200 kID frontier which isolates the animal populations in the territory of the USSR narrows down by a factor of ten in areas where the mountain ranges run close together. In addition, the independent nature of the eastern Kazakhstan sub-population is supported by its natural conditions. It is characterized by its intermediate location between the mountains of southern Siberia and Central Asia (Gvozdetsky, Mihaylov 1970).

At the present time the likelihood of success in conserving settled snow leopard populations in the Saur and Tarbagatai ranges is doubtful. Snow leopards were last observed there in the mid 1950s (Sludsky 1973). When the Tarbagatai range was explored in 1962-1964 and in 1971-1972, not even tracks were encountered (Grachev, Fedosenko 1977). The number of snow leopards in the Dzhungarian Alatau has also decreased. In the period 1972-1978, for example, it was not possible to observe the presence of snow leopards in the valleys of the rivers Tokhta and Terekta, where they were common in the 1950s and 1960s. Nevertheless on rare occasions tracks have been discovered by shepherds in the winter (Fedosenko 1982).

In our opinion the extreme sparseness of the snow leopard population and its disappearance

from a number of areas in the eastern Kazakhstan sub-population should be viewed as a recurrent phenomenon. Here, as in no other sub-population, the snow leopards are hemmed in by "zonal death" (Severtsov 1951), which hinders effective contact with individuals of neighbouring populations and prevents dispersal. It is obvious that in the future there will be an increasing tendency for the population to become extinct, owing primarily to its isolated situation.

The farthest migration of a snow leopard was recorded in 1958 and is an isolated case. An animal was observed in hilly terrain on the northern shore of Lake Balkhash (Geptner, Sludsky 1972). To reach this site, the shortest distance that the animal must have traversed when descending from the high mountains was more than 600 km. Another case of an encounter with a snow leopard in the neighbourhood of Lake Balkhash occurred in the 1960s, and was cited by us (Koshkarev, Kuzminykh 1988) on the basis of questionnaires, and this seems to provide evidence that the animal can migrate over large areas. We do not, however, have data on the exact site where the animal was seen. Snow leopard migrations from the part of the habitat beyond the frontier are not known to occur.

There are no nature reserves in the eastern Kazakhstan centre, a fact which further worsens the position of the snow leopard. The question of whether such a reserve should be created was included in the Red Data Book for USSR (1984), but no decision has been made to date.

The southern Siberian sub-population occupies less than a third of the total area. In spite of the extensive territory, the population of this species is fragmented everywhere (Grum-Grzhimailo 1914, Stroganov 1962, Geptner, Sludsky 1972, Rare Terrestrial Vertebrates of Siberia 1988). The isolation of the centres of the animals is probably of little significance, since the regions they are known to inhabit are mostly not more than 30 km apart. Apparently the greatest cohesion is exhibited by the centre that occupies the transitional region from the Altai mountains to the western Sayan. Orographically speaking, this region has a monolithic character. Further to the east of the Sayan and western Tannu-Ola ranges, the orographic unity breaks down with greater isolation of the species. It is not to be excluded that relatively favourable conditions for the preservation of the snow leopard exist in the territory confined within the Topographers' Peak, the Sangilen range and the mountains of western Prikhubsugul. This conclusion is supported by the latest published data (Niki forov, Shurigin 1977, Sokolov, Orlov 1980, Shvedov et al. 1984, Sokolov 1988, Shurigin 1988) as well as the questionnaire surveys compiled by D. G. Medvedev. The last-mentioned source expands the notion regarding the boundaries of the area inhabited by the snow leopard in the central Sayan region, since they attest to encounters with the animals and their tracks in the 1950s and 1960s in the Ili Basin (area between the rivers Tissa and Debi). In the winter of 1985-1986 tracks were observed in the vicinity of the river Ili, which lies to the north of Topographers' Peak. Another surprising sighting is the report by Zavatsky concerning an encounter with a snow leopard in the Kumetsky Alatau (pers. comm.). The snow leopard was not previously known to inhabit this area.

The notion that snow leopard migrate long distances in the southern Altai region is

supported information we received in the summer of 1988 from A.I. Larnionov, a state hunter employed at the Markakolsky Procurement office. Beginning in 1974, snow leopard tracks were first noticed by him and other hunters in the stretch to the north-east of the village of Vladimirovka. At first the tracks of a single animal were recorded, but later there were tracks of a female with two cubs. Both of these came from the north-east. Snow leopard tracks have also been observed in the vicinity of the boundary of the Markakolsky Reserve in the region of Mount Turgauz. It is probable that all these animals are new arrivals. The distance which they can be assumed to have travelled is 60-70 km taking into consideration that the nearest settled population, judging from the most frequent encounters with the animals, is probably located in the upper reaches of the river Bukhtarma, (Kuznetsov 1948, Strogonov 1962, Geptner, Sludsky 1972, Sludsky 1973) Border Gaurds have reported that snow leopards have crossed over from China and Mongolia into the upper reaches of the Bukhtarma (pers. report).

The longest snow leopard migration that has been observed in the Khentey-Chikoysk Plateau (beyond lake Baikal) has been reported by Matyushkin (1981) and Shvetsov et al. (1984). The shortest distance that separates the snow leopards that were encountered from the populations in the Khentei - if we take into consideration the information given by D. Tsendzhav (1979 ; cited by Shvetsov et al. 1984) - are not less than 150 km. The distance from the nearest area of _on' ""itation of the ,..ow \"""""" in the w-ro prikhu""guI (Sokolov, Odov 19""), is nearly 600 kID. Matyushkin (1981) inclines to the view that it is most natural to assume that snow leopards migrate into the region beyond Lake Baikal from Mongolian Khentei.

Encounters with snoW leopards have been recorded in tWo reserves; in the Altai Reserve (Shilov, Baskakov 1973, Natural Reserves of the USSR 1983) and the Sayan Shushensk Reserve

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area of 3,895.7 sq. kID is the largest reserve of the snow leopard in the Soviet Union. The

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may roam from the contiguous territory, is not an area that it inhabits on a permanent basis

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that at present the stability of snow leopard populations is considerably higher in the Central

The minimum stability is exhibited by the eastern Kazakhstan sub-population, which is the smallest in territory and is the most isolated from the other sections of the habitat orographically. Apparently the trickle of animals into this area from nearby centres is extremely slow at present, and local conditions cannot _ the growth of the population.

The existence of the southern Siberian sub-population is supported, in all likelihood, by contacts with snow leopard populations from the Mongolian Altai, where the population density of the species is high - three individuals/100 sq. km (Bold, Dorzhunduy 1976). However, the wide occurrence of a taiga complex in the mountains of southern Siberia - an environment that is alien to the snow leopard - as well as the deep snow cover limit the animals' chances of spreading. The snow leopard originates from the high desert-like mountain plateaus in southern Siberia (Geptner 1936). For this reason the shrinking of the natural habitat in the eastern Sayan region (Geptner, Sludsky 1972) and the area beyond Lake Baikal, where drawings of snow leopards have been discovered on the mountain faces (Okladnikov, Zaporozhkaya 1970) indicate that precisely in now existing conditions, the ecological potential of the species has been exhausted. The populations which have survived in the southern Siberian sub-population inhabit refuges rather than areas which favour dense settlement (Figure 6).

This conclusion is further supported by the data on long migrations of the snow leopard. Panfilov (1960) is of the opinion that the longest ontogenetic migrations indicate a critical situation within the population, when owing to exacerbated conditions of existence, the few remaining individuals are forced to undertake migrations for distances of unaccustomed length. Migrations that do not exceed the optimal length, are taken to attest to the existence of normal conditions. We observe the former situation in the eastern Kazakhstan and southern Siberian sub-populations and the latter (or a near approximation to it) in the Central Asian sub-population.

The instances of snow leopards migrating over distances up to 600 km and more show that the species has a sufficiently high drive to overcome various natural boundaries. It can well be compared with the migrational drive of the puma, *Felis concolor*, (Bibikov, Karavaeva 1976), the Amur leopard, *Panthera pardus orientalis*, (Pikunov 1976) and the lynx, *Felis lynx*, (Azarov 1976, Matyushkin 1979, Zyryanov 1980, Zheltukhin 1984). Bearing in mind that the zones of the greatest territorial gap, which are formed by the Iliynsk, Dzhungarian and Sayansk depressions, do not exceed a distance of 200 km, the implication is that the snow leopard is potentially able to cross any of the distances separating its populations in the natural habitat. Grounds for this conclusion can be found in the fact that the snow leopard inhabits remote sectors of the In-Shan range and the upper reaches of the river Fenkhe in China (Przewalsky 1875, Pevtsov 1951, Dzhubayev, cited in Sludsky 1973). These sectors lie no less than 600 km from the nearest assumed sub-population, measured on a straight-line basis.

Furthermore, in evaluating, for example, whether migrational "bridges" really do exist between the separate sub-populations, we should take a level-headed view of the conditions that we have taken shape within them. In spite of the fact that the immigration of individuals from

one population into another is a phenomenon of immeasurably greater frequency than has been established through direct observations (Schwartz 1967), we must agree with the assertion that the likelihood of an effective flow of migrants is lower at the periphery of the range than in the central areas, even though individual animals are capable of undertaking super long-distance treks. Essentially, this is due to the lower density of the population, which is unable to trigger the necessary migrational impulse. In and of itself, the fact of a shrinking of the natural habitat in the regions of the eastern Sayan, Saur and Tarbagatai would assume precisely such a picture and we cannot refute it on the basis of the available information.

The large orographic gap between the southern Siberian and eastern Kazakhstan sub-populations and the low density of the populations in their periphery permit us to assume that the southern Siberian centre is today isolated from the main part of the range. Furthermore, the Dzhungarian basin extends even beyond the frontiers of the USSR all along the Mongolian and Gobi Altai, forming a barrier that isolates the Siberian-Mongolian sector of the habitat (Figure 7). What is involved here is a breakdown of the stability not only of separate populations, but of the entire species.

The process of extinction of individual populations can to some extent, be retarded but not in the form of the existing or newly organized reserves, but rather in the form of national parks. Given man's ubiquitous influence on the natural complexes, it is absurd to defend the reserves by according them the status of untouched standard systems. From this time forward, no such standards can exist and the reserves are simply places where all the suffering animals in the area aggregate after being chased into these remaining shreds of territory by the anthropogenic process. In addition, the prohibitions of various kinds that were intended to provide protection for the reserves have limited the possibilities of social control. Under the wing of the law, the local authorities sometimes transform the reserves into a hunting or farming estate, a situation that has been observed up to now in the Central Asian republics. Consequently a more acceptable form of preservation would be a national park. Its status would permit wide dissemination of information about the animal species requiring protection, and they would offer the local population the possibility of gaining first-hand acquaintance with them, thereby involving local people in control of the territory. What is more, the territory of a national park can be operated to a far greater extent on an institutional basis and generate proceeds for supporting the protective activities.

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