PANTHERA TIGRIS ALTAICA (CARNIVORA, FELIDAE) IN THE LAZOVSKY STATE NATURE RESERVE AND IN THE ADJACENT NON-PROTECTED AREA (FAR EAST OF RUSSIA)

Galina P. Salkina[1,*], Nadezhda Ya. Poddubnaya[2], Vladimir S. Kolesnikov[3], Vera A. Nikandrova[2]

[1]*Joint Directorate of the Lazovsky State Nature Reserve and the National Park «Zov Tigra», Russia*
**e-mail: tpsrus@mail.ru*
[2]*Cherepovets State University, Russia*
[3]*Tiger Protection Society, Russia*

Received: 21.04.2022. Revised: 06.09.2022. Accepted: 09.09.2022.

To assess the state of the *Panthera tigris altaica* (hereinafter – tiger) population, its annual monitoring is being carried out on 16 sites within its range, as this subspecies is still considered threatened. These sites include state nature reserves and adjacent territories, which differ in their protection status. In this paper, a number of tiger individuals in groups and reproduction have been compared on these sites to identify factors that determine these parameters. The tiger population in the Lazovsky State Nature Reserve (area of 1210 km^2) was compared with the tiger population in an unprotected area (area of 988 km^2), which, similarly to the Protected Area, is located on the coast of the Sea of Japan. A description and comparison of these two sites is given. The study has been carried out in 1997–2021 in the Lazovsky State Nature Reserve, and in 1997–2012 in the unprotected site «Lazovsky District». During the winter, information was collected about tiger tracks in the study area, and data on predator tracks were collected out on stationary routes during two field counts. In the Lazovsky State Nature Reserve, the density of routes in various years was 1.0–1.5 km per 10 km^2, 1.2 km per 10 km^2 in the site «Lazovsky District». Tiger individuals were identified by the width of paw prints. Tracks differed by more than 2 cm were considered belonging to different individuals. Indicators of the tiger population was about twice higher in the Lazovsky State Nature Reserve than in the unprotected site «Lazovsky District». In 1997–2012, in both Lazovsky State Nature Reserve and unprotected site «Lazovsky District», the population density of both adult and subadult tigers was respectively 8.6 ± 0.7 individuals per 1000 km^2 and 5.3 ± 0.5 individuals per 1000 km^2, while this parameter was respectively 3.1 ± 1.0 individuals per 1000 km^2 and 1.7 ± 0.04 individuals per 1000 km^2 for tiger cubs younger than a year. The tiger track density in the Lazovsky State Nature Reserve was 3.03 ± 0.51 tracks per 100 km, taking into account the time passed after the snowfalls covering all tracks; on the site «Lazovsky District», this indicator was 1.33 ± 0.27 tracks per 100 km. In 1997–2012, the population density of adults and subadults was significantly ($F = 59.40$, $p < 0.001$) higher in the Lazovsky State Nature Reserve than on the site «Lazovsky District». The population density of tiger cubs ($F = 6.30$, $p < 0.018$) and the track density ($F = 4.86$, $p < 0.036$) were also significantly higher in the Protected Area than in the unprotected one. The survival rate of tiger cubs was also higher in the Lazovsky State Nature Reserve. Here, the proportion of tiger litters with one cub was 16% (n = 4), with two cubs 48% (n = 12), with three 32% (n = 8), and with four 4% (n = 1) of the total number. On the unprotected site «Lazovsky District», the proportion of litters with one cub was 53% (n = 8), with two 27% (n = 4), and with three 20% (n = 3) of the total number. A downward trend in the population density of tiger cubs was found on the site «Lazovsky District». In 2012–2021 in the Lazovsky State Nature Reserve, the average population density was 8.9 ± 1.8 individuals per 1000 km^2 for adult and subadult tigers, and 4.3 ± 1.1 individuals per 1000 km^2 for tiger cubs, while the average tiger track density was 2.39 ± 0.68 tracks per 100 km. During this period, the population density of tiger cubs decreased in the Protected Area, and there was also a tendency towards a decrease in the relative number of adults and subadults. The regular three-year cycle in the dynamics of the tiger track density in the Lazovsky State Nature Reserve indicates that environmental factors predominantly influence tiger groups here. No regular cycle was observed on the unprotected site «Lazovsky District». This finding and the lower number of tiger individuals in this area are associated with the negative impact of related anthropogenic factors, namely poaching, hunting, and logging. Recreational pressure also affects the tiger groups. In the last decade, the tiger group in the Lazovsky State Nature Reserve has been exposed to anthropogenic factors from the adjacent area. It is concluded that the further protection of the tiger and the increase in its number is possible if Protected Areas of various statuses are established, if extensive buffer zones are created around new and existing Protected Areas, if hunting is prohibited and logging is limited. The use of agricultural lands for other purposes around Protected Areas should be forbidden.

Key words: anthropogenic factor, population dynamics, population indicator, three-year cycle, tiger

Introduction

Panthera tigris (Linnaeus, 1758) is a threatened species. The fate of this predator, including *Panthera tigris altaica* Temmink, 1844 (hereinafter – tiger), recognised as a vulnerable subspecies in the 2nd edition of the Red Data Book of the Russian Federation (2021), is being discussed at the highest level. At the International Tiger Summit (Saint-Petersburg, Russia, 2010), leaders of the countries, inhabited by tigers, made a commitment to increase their populations (GTRP, 2010). The main tool for making decisions on threatened animals is monitoring their populations.

The state of the tiger population within the natural range in the Russian Far East is being determined using continuous counts of the number of individuals of this predator during the winter. However, such a large-scale study is being carried out approximately once a decade (e.g. Abramov, 1962; Yudakov & Nikolaev, 1973; Pikunov, 1990; Matyushkin et al., 1999; Miquelle et al., 2007). That is why it is necessary to have annual data for revealing trends in the tiger populations. For this purpose, a programme and methodology for annual observations was developed on 16 study sites in the Primorsky Krai and Khabarovsky Krai. In these regions, observations have been carried out since the winter of 1997–1998 to the present. The number and size of the accounting areas, their location, the count route density, the timing of surveys, accounting indicators, criteria for their determination have been determined (see Matyushkin et al., 1999; Miquelle et al., 2006a,b). In 2005, the mentioned methodology was approved by the Ministry of Natural Resources of the Russian Federation (Order, 2005).

Before 1997, annual censuses and year-round monitoring of tiger groups were mainly carried out in state nature reserves (e.g. Zhivotchenko, 1977; Matyushkin et al., 1981; Poddubnaya & Kovalev, 1993; Salkina, 1993, 2011; Smirnov, 1993; Tkachenko, 1996). Since 1997–1998, in order to determine anthropogenic factors affecting the tiger population size, the monitoring programme included also Sikhote-Alin State Nature Reserve, Lazovsky State Nature Reserve, and Ussuriyskii State Nature Reserve, as well as adjacent areas, which had no the protection regime, and called «unprotected» (Order, 2005).

The largest part of the current range of the tiger is located in unprotected area (Matyushkin et al., 1999). Protected Areas are mainly affected by natural factors, while anthropogenic influence is minimised. The comparison of the population characteristics of tiger groups in areas with different protection status makes it possible to determine the nature of the anthropogenic impact on tiger groups in (un)protected areas. On the other hand, this allows us to assess how feasible the task of increasing the number of tigers in the Russian Far East is, announced during the International Tiger Summit (GTRP, 2010).

The comparison of the state of tiger groups and their prey in areas with various protection status showed that population indicators in Protected Areas are significantly higher than in unprotected areas (Miquelle et al., 2005; Matyukhina et al., 2010; Salkina & Kolesnikov, 2010; Maslov, 2012; Lukarevskiy et al., 2021). Although the tiger population monitoring has been carried out since the winter of 1997–1998, there is a lack of publications devoted to this problem (e.g. Dunishenko, 2006; Miquelle et al., 2006a; Pikunov et al., 2009; Kostomarov, 2010).

This study was aimed to assess the state of tiger groups in the Lazovsky State Nature Reserve and in the adjacent unprotected site «Lazovsky District». For this purpose, the following tasks were established: determining the abundance indicators of tiger groups; studying the long-term dynamics of tiger groups; comparing results obtained in areas with different protection status.

Material and Methods

Study area

The study has been carried out in the southeastern part of the Sikhote-Alin mountain system. The Lazovsky State Nature Reserve was established in 1935. It is located in the Lazovsky district of the Primorsky Krai, in the interfluve of the River Kievka and River Chernaya (Fig. 1). The average altitude is 500–700 m a.s.l., with some peaks reaching 1200–1400 m a.s.l. The total length of the boundaries of the Protected Area is 240 km, of which 36 km along the coast of the Sea of Japan. The historically established boundaries of the Lazovsky State Nature Reserve are indented with valleys with agricultural lands protruding into this Protected Area. Only for a short area the border passes through the natural relief elements and watercourses, namely along a high mountain range to the north-east of the Lazovsky State Nature Reserve, and along the River Kievka to the southwest of its area.

For implementation of the tiger population monitoring programme, a site near the Lazovsky State Nature Reserve was chosen, which was similar to this Protected Area in terms of tiger habitat conditions. This site is also located in the Lazovsky district in the basin of the River Krivaya, a right tributary of the River Kievka, being located at 40 km of the coast of the Sea of Japan (Fig. 1). The area of the unprotected site «Lazovsky District» is 988 km^2; its borders pass along natural relief elements and watercourses, namely watersheds and the River Kievka. The River Kievka valley separates both study sites (Fig. 1), although it is not an obstacle to the tiger movements. Previous tracing of tiger tracks in winter showed that in the Lazovsky State Nature Reserve, adult males move over an area of 850 km^2, while adult females over an area of 300 km^2 (Salkina, 1993). The home range of a male includes home ranges of several females to some extent.

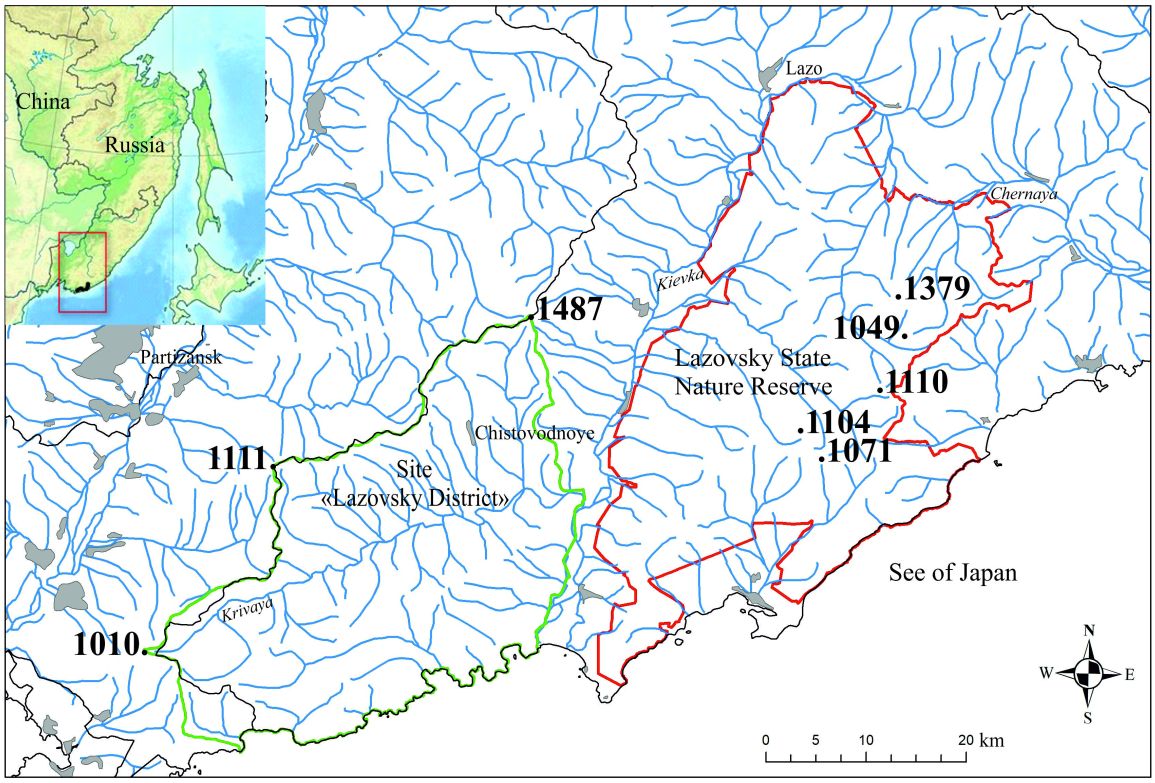

Fig. 1. The location of the study sites of the Lazovsky State Nature Reserve and the site «Lazovsky District», Far East of Russia.

The relief of the unprotected site «Lazovsky District» is generally flatter than of the Lazovsky State Nature Reserve; the average altitude is 400–500 m a.s.l., where peaks over 1000 m a.s.l. are located only on boundaries of this site (Fig. 1). Here, the length of the sea coast is not considerably longer than in the Lazovsky State Nature Reserve, but it is more indented by numerous coves. The site «Lazovsky District» stretches from west to east, while the Lazovsky State Nature Reserve in a north-south direction. Thus, the sea influence is more pronounced on the unprotected area. These factors affect the snow cover regime, since its thickness and duration of the snow period is less on marine slopes (Poddubnaya & Kolomiytsev, 2016). In addition, these factors form more favourable conditions for *Cervus nippon* Temminck, 1838, which go to the sea to lick salt and eat algae. In addition, *C. nippon* cannot tolerate deep snow (Bromley & Kucherenko, 1983), and during the winter, its population density is higher on the sea coast compared to continental areas (Salkina, 2011). *Cervus nippon* is one of the main prey items for tigers in the southeast of Sikhote-Alin (Salkina, 2011). Thus, a more favourable habitat for tigers is expected in the unprotected site «Lazovsky District».

However, the average total population density of ungulates is 2–3 times higher in the Lazovsky State Nature Reserve than in the unprotected site «Lazovsky District» (Salkina & Kolesnikov, 2010; Shvetsov et al., 2012). In the Lazovsky State Nature Reserve, the number of ungulate tracks of ≤ 1-day age, found on stationary routes, was 8.10 tracks per 10 km of the route for *Sus scrofa* Linnaeus, 1758, 3.50 tracks per 10 km of the route for *Cervus elaphus* Linnaeus, 1758, 2.02 tracks per 10 km of the route for *Capreolus capreolus* Linnaeus, 1758, and 98.64 tracks per 10 km of the route for *Cervus nippon*. On the site «Lazovsky District», this indicator was 1.42 tracks per 10 km of the route for *Sus scrofa*, 0.22 tracks per 10 km of the route for *Cervus elaphus*, 1.19 tracks per 10 km of the route for *Capreolus capreolus*, and 37.11 tracks per 10 km of the route for *Cervus nippon* (Shvetsov et al., 2012).

The logging had a significant impact on the vegetation on the unprotected site «Lazovsky District». It is dominated by young forests that have been cut down repeatedly and destroyed by fires, now being restored by pioneer species (Dyukarev et al., 2003). In the Lazovsky State Nature Reserve, such secondary forests are found along the periphery, where logging was carried out in 1951–1957, when the Lazovsky State Nature Reserve was temporarily closed. Conditionally-indigenous forests grow in the central part of the Lazovsky State Nature Reserve, which have also been influenced by old cuttings and fires, but they remain their species

richness and are being restored by trees of primary forests. There are separate areas of primary undisturbed forests (Dyukarev et al., 2003).

During the study, information has been collected on the population size around the study plots. We took into account only settlements located at a distance of up to 30 km from the study plots. There are 14 such settlements around the Lazovsky State Nature Reserve. In 1997, their population was 19 200 people. On the site «Lazovsky District», there were 17 settlements, where about 170 people lived, including 117 people in the Chistovodnoye village, and others on farms. At that time, around the site «Lazovsky District» at a 30-km radius, there were 34 settlements with a population of over 43 000 people lived mainly in the Partizansky district. Thus, in the unprotected site «Lazovsky District», the anthropogenic load from adjacent areas should be considerably higher than in the Lazovsky State Nature Reserve.

In 1997–2012, the site «Lazovsky District» was included in lands of three hunting societies. Since the 2000s, numerous hunting bases have been built around the Lazovsky State Nature Reserve, including those in its buffer zone. In the immediate neighbourhood of the Lazovsky State Nature Reserve, *Glycine max* (L.) Merr. and *Avena sativa* L. are being cultivated to lure animals out of the Protected Area, and numerous hunting towers have been built there (Salkina, 2013).

Data collection and analysis

For this paper, material has been obtained for tiger groups in the Lazovsky State Nature Reserve during 1997–2021 and on the unprotected site «Lazovsky District» during 1997–2012. Counts of the tiger have been carried out according to Matyushkin et al. (1999) supplemented by Miquelle et al. (2006b), and approved by the Ministry of Natural Resources of the Russian Federation (Order, 2005). During the winter, information on tiger tracks was collected on the study sites. Once or twice per winter, stationary routes were passed, on which all tiger tracks were recorded. The routes were laid out in places where tigers are most likely to pass, namely valleys, along roads, and paths (Salkina, 2011). As a result of the count, the following indicators were determined: the tiger track density (the number of tracks per 100 km of the route, divided by the number of days passed since the last snowfall covered all tracks), the number/density of the population of individual tigers and cubs younger than a year old (expert assessment). Since the Lazovsky State Nature Reserve is larger than the unprotected site «Lazovsky District», the comparison of the accounting indicators has been carried out according to the population density of independent adults and cubs of the tiger per 1000 km^2.

Individuals were identified by the width of the imprint of the forepaw pads. For tiger cubs of the first year old, this size is less than or equal to 7 cm. Their footprints are often being found next to the footprints of their mother. The group of independent tigers includes adult and subadult individuals. The size of their footprints ranges from 7 cm to 12–13 cm. Subadults are young individuals, which are older than one year old, often moving independently (Salkina, 2011), and which footprints do not differ in size from adult ones (Matyushkin et al., 1999).

Tracks that differ in the width of pads by more than 1 cm are considered to belong to different individuals (Order, 2005). However, in fact, such tracks may belong to the same tigers. Yudin (2010) concluded that when identifying the ownership of tracks, it is necessary to apply the criterion of individual differences of at least 2 cm. Our observations have confirmed this, guided by the recommendations of Yudin (2010). The size of tracks is highly influenced by such factors as the height and structure of the snow cover, the exposure and steepness of the slope, the amount of insolation, and daily temperature fluctuations. These factors usually lead to an increase in the size of tracks. We took into account all these data when determining the number of tigers in the study sites. In case of the strict adherence to recommendations of the Order (2005), i.e. when tracks differing in the size by more than 1 cm belong to different individuals, then the number of tigers will be strongly overestimated.

In the Lazovsky State Nature Reserve, the study has been carried out from the winter of 1997–1998 to the winter of 2020–2021. Until the winter of 2014–2015 and in the winter of 2015–2016, routes passed twice during the winter season, and once in the remaining study period (Electronic Supplement). Until the winter of 2014–2015, 11–12 routes were passed with a total length of 113 km to 126 km. The average route density was 1 km per 10 km^2. From the winter 2014–2015, 15 to 22 routes were passed, with a total length of 129 km to 204 km. The average route density was 1.5 km per 10 km^2. In 2005–2006, all stationary survey routes in the Lazovsky State Nature Reserve were measured with a 25-m non-stretching cable; every 200 m, the numbers of the corresponding pickets were painted on trees, and the exact length of routes was determined.

On the site «Lazovsky District», the study was carried out from the winter of 1997–1998 to the winter of 2011–2012, and 10–11 routes passed through this area with a total length of 101 km to 148 km (Electronic Supplement). Their average route density was 1.2 km per 10 km^2. Here, the length of the routes was measured using GPS-navigators.

When analysing the assessment results, the value of $p < 0.05$ was considered statistically significant. As a rule the distribution of accounting indicators differs from the normal distribution. The logarithm was used to normalise data. In the MS Excel 2010 programme, average values of accounting indicators, confidence intervals, and they limiting values were calculated. The standard deviation was calculated for logarithms of the indicators, since in this case, standard deviations are a natural measure of their variability (Williamson, 1972). Regression equations were built in MS Excel 2010. To study the linear trends of indicator abundance, natural logarithms of indicator values were used. In this case, the coefficients of arguments in regression equations reflect the rate of increase/decrease of the number. The determination/approximation confidence value (R^2) shows the value of the linear trend (0 – weak correlation, 1 – strong correlation).

The obtained indicators of the number of tiger groups in the Lazovsky State Nature Reserve and on the unprotected site «Lazovsky District» were also analysed using Statistica 10.0 (Statsoft, USA). The comparison of indicators was carried out using the F-test in the Anova module; the one-way ANOVA model was used. The regression analysis has been carried out in the multiple regression module; we used the linear regression model for the calculation of the Pearson correlation coefficient (r).

Results

The use of recommendations of the Ministry of Natural Resources of the Russian Federation (Order, 2005) makes it possible to obtain reliable information on the number of tigers even within one administrative region. No statistically confirmed relationships were found between the tiger track density and the number of independent tigers (adults and subadults), and between the number of cubs and the total number of individuals on both site (Lazovsky State Nature Reserve and site «Lazovsky District»). At the same time, based on combined data of both Lazovsky State Nature Reserve and the site «Lazovsky District», a positive significant ($r = 0.69$, $p = 0.001$) relationship was found between the tiger track density and the number of independent tiger individuals. Additionally, an average positive relationship was found between the tiger track density in the Lazovsky State Nature Reserve and site «Lazovsky District», although this relationship was not statistically significant ($r = 0.42$, $p = 0.116$). However, a positive significant relationship was found between the number of independent individuals on these study sites ($r = 0.52$, $p = 0.049$). Thus, the selected method is adequate to reach the task established in our study.

The comparison of the counted parameters on two study sites has been carried out over the period from the winter of 1997–1998 to the winter of 2011–2012. The average population density of independent tiger individuals and the tiger track density were significantly ($p < 0.05$) higher in the Lazovsky State Nature Reserve compared to the unprotected site «Lazovsky District» (Table). Annual values of these indicators were also higher in the Lazovsky State Nature Reserve (Fig. 2, Fig. 3). In 2012–2021, the average population density of adults and subadults in the Lazovsky State Nature Reserve slightly increased and amounted to 8.9 ± 1.8 individuals.

The average population density of tiger cubs in the Lasovsky State Nature Reserve was higher (Table), although in some years its value was higher on the unprotected site «Lazovsky District» (Fig. 4a). In the Lazovsky State Nature Reserve, this reproduction rate increased (2% per year), while in the site «Lazovsky District» it decreased (7% per year). However, low values of R-squared indicate a weak correlation of trends with the observed values, probably due to the large scatter of data. In the Lazovsky State Nature Reserve, litters with one cub were 16% (n = 4), with two cubs 48% (n = 12), with three cubs 32% (n = 8), and with four cubs 4% (n = 1) of the total number. On the site «Lazovsky District», litters with one cub counted 53% (n = 8), with two cubs 27% (n = 4), and with three cubs 20% (n = 3) of the total number.

From winter 2012–2013 to winter 2020–2021, the average population density of tiger cubs in the Lazovsky State Nature Reserve was 4.3 ± 1.1 individuals per 1000 km^2, a decrease of 12% per year. At the same time, we found a strong correlation ($R^2 = 0.7$; Fig. 4b) between its trend and observed values of this indicator.

Table. Indicators of tiger censuses in the Lazovsky State Nature Reserve and on the unprotected site «Lazovsky District» in 1997–2012

Indicator	Characteristics						
	Mean value		Limits (min–max)		Standard deviation of indicator's logarithm		F-criterion, p-value
	LR	LD	LR	LD	LR	LD	
Population density of independent tigers, individuals/1000 km²	8.6 ± 0.7	5.3 ± 0.5	6.7–11.7	4.0–8.1	0.07	0.08	F = 59.40, p < 0.001
Population density of tiger cubs, individuals/1000 km²	3.1 ± 1.0	1.7 ± 0.04	0.0–6.7	0.0–6.7	0.26	0.29	F = 6.30, p < 0.018
Tiger track density, tracks/100 km²	3.03 ± 0.51	1.33 ± 0.27	1.93–5.65	0.42–2.70	0.13	0.19	F = 4.86, p < 0.036

Note: LR – Lazovsky State Nature Reserve, LD – site «Lazovsky District».

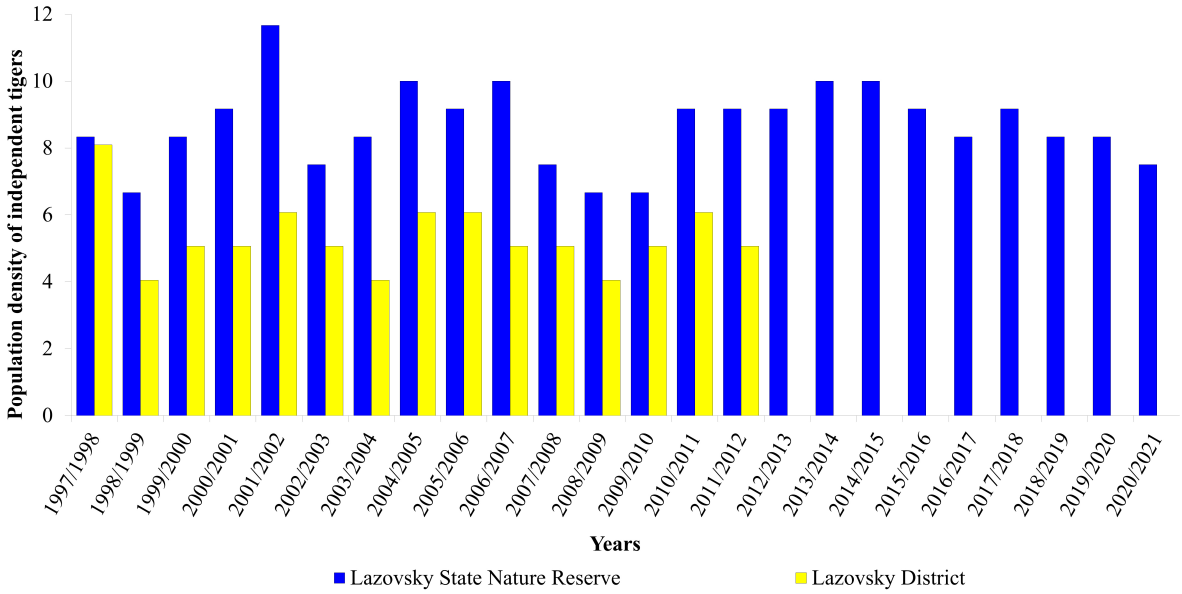

Fig. 2. Fluctuations in the population density of independent tigers (number of individuals per 1000 km²) in the Lazovsky State Nature Reserve (1997–2021) and on the unprotected site «Lazovsky District» (1997–2012).

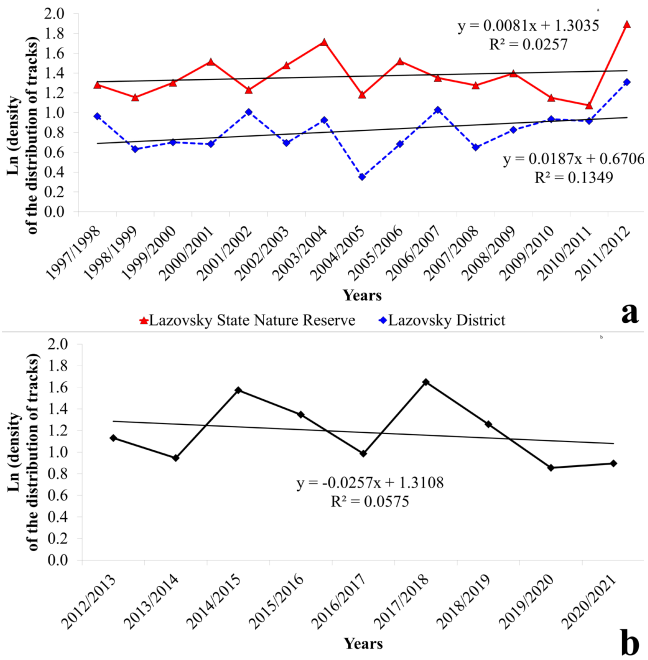

Fig. 3. Fluctuations in the relative number of tiger groups (number of tracks per 100 km of the route, taking into account days passed since the snowfall covered all tracks) and their linear trends (according to Salkina et al., 2018 with modification and additions). Designations: a – in the Lazovsky State Nature Reserve and on the unprotected site «Lazovsky District» in 1997–2012; b – in the Lazovsky State Nature Reserve in 2012–2021.

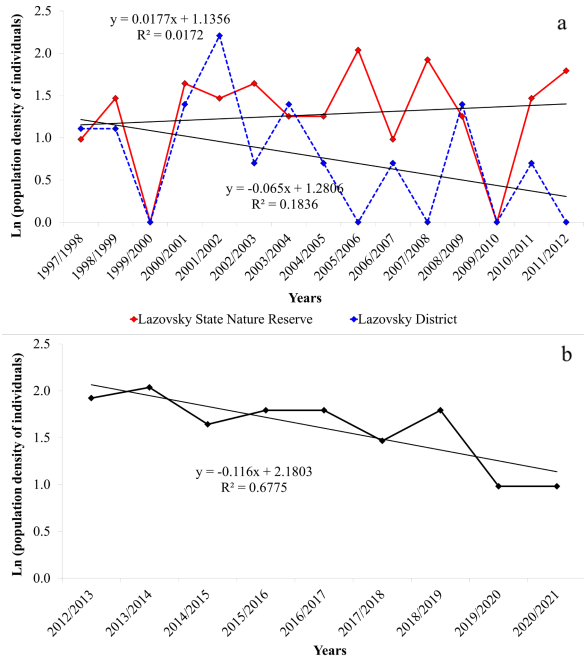

Fig. 4. Fluctuations in the population density of cubs younger than a year (number of individuals per 1000 km²): a) in the Lazovsky State Nature Reserve and on the unprotected site «Lazovsky District» in 1997–2012; b) in the Lazovsky State Nature Reserve in 2012–2021.

In the long-term dynamics of the tiger track density in the Lazovsky State Nature Reserve, a regular three-year cycle can be seen (Fig. 3). Until 2005–2006, values of this indicator increased during two years with its decrease in the third year. Then, an increase in tiger track density began to increase during one year, with its decrease during two years. On the unprotected site «Lazovsky District», the three-year cycle of the tiger track density was weakly expressed (Fig. 3a). There was a slight increase in the relative abundance index on two study sites in 1997–2012 (Fig. 3a). In subsequent years, this indicator decreased and amounted to 3% per year in the Lazovsky State Nature Reserve (Fig. 3b); its average value was 2.39 ± 0.68 tracks per 100 km. Insignificant R-squared values indicate that the degree of compliance of trend models with original data is weakly expressed. Judging by the insignificant value of the approximation reliability coefficients, other types of trend lines (exponential, logarithmic, polynomial and power) for all counted parameters also poorly correspond to original data.

Discussion

The direct relationship found between the expert assessment of the number of independent tigers and the tiger track density is evidence that this indicator of the relative abundance reflects the absolute (or real) abundance. A relationship between the track density of animals and their absolute population density has been found for many species, including the tiger (Chelintsev, 2000; Hayward et al., 2002). In some predator groups, such a relationship may not be revealed due to the small sample size.

In our study, no relationship was found between the total number of tigers (including cubs) and the tiger track density. This is because the tiger track density reflects the number of independent tigers that includes both adults and subadults, which often move independently during the second winter of their life (Salkina, 2011). In the first winter of their life, young individuals do not move far from the mother; the female periodically gives them its prey by leaving cubs there. Therefore, they are not registered frequently on the counting routes. This is confirmed by data obtained using camera traps, which are also installed in places where tigers are most likely to pass, i.e. in the same places where counting routes pass (Soutyrina et al., 2013). Therefore, for an unbiased study of the tiger population, it is important to conduct observations by collecting data on tiger tracks throughout the winter season for identifying the number of cubs and assess the reproduction level in tiger groups.

Indicators of tiger counts (tiger track density, population density of independent individuals and cubs) were approximately two times higher in the Lazovsky State Nature Reserve compared to the unprotected site «Lazovsky District» (Table), despite the fact that for *Cervus nippon*, one of the main food items of the tiger (Salkina, 2011), the unprotected site «Lazovsky District» has more favourable natural conditions than the Lazovsky State Nature Reserve. The unstable state of the tiger population on the unprotected site is also indicated by higher values of standard deviations of the logarithm of these census indicators compared to the ones in the Lazovsky State Nature Reserve (Table).

In the Lazovsky State Nature Reserve, litters with two or three cubs prevail (80% of the total number of litters in 1997–2012), while in the unprotected site, more than half of the litters consisted of one cub at the time of their count in the winter period, and the number of litters is lower on the site «Lazovsky District» than in the Protected Area. This indicates a higher survival rate of young individuals in the Lazovsky State Nature Reserve compared to the unprotected site. It also indicates a generally better state of the tiger group in the protected area that is obviously determined by its strict protection status.

In some years, the population density of tiger cubs was higher on the unprotected site «Lazovsky District» than in the Lazovsky State Nature Reserve (Fig. 4a). This may also be caused by the low survival rate of tiger cubs on the unprotected site. The female has offspring once every two years, if a previous litter has survived (e.g. Salkina, 1993; Yudin & Yudina, 2009). Otherwise, tiger cubs are being born more frequently. So, the high population density of young tigers may also indicate their low survival rate and more frequent changes of litters of the female.

In the Lazovsky State Nature Reserve, the regular three-year cycle in the dynamics of the tiger track density (see Fig. 3) confirms the dynamics of another indicator of the relative abundance of the tiger, namely the density of its scent marks (Salkina, 2011). The three-year cycle is associated with the population dynamics of *Sus scrofa*, one of the main food items for the tiger (Salkina et al., 2018). During the high abundance of *S. scrofa*, the survival rate of young individuals increases, and,

accordingly, the size of the tiger group. In comparison with other ungulates, *S. scrofa* is an easier object to hunt for tigers, especially when they start independent living (Salkina, 2011). A direct relationship between the number of independent individuals and the tiger track density in the Lazovsky State Nature Reserve and on the unprotected site «Lazovsky District» indicates that tiger groups are associated with the influence of a natural factor; obviously, it is the abundance dynamics of *S. scrofa*. However, on the unprotected site «Lazovsky District», the three-year cycle of the tiger track density is weakly expressed (Fig. 3a), apparently due to the instability of the tiger population.

Although the state of the tiger group was better in the Lazovsky State Nature Reserve than on the unprotected site «Lazovsky District», in 2012–2021, it is characterised by instability in the Protected Area. This is pronounced by an increase in fluctuation amplitude of the tiger track density during this period (Fig. 3b). In addition, there was a decrease in the average value of the tiger track density, which more reliably reflects processes occurring in the tiger group than the population density of individuals. This is caused by the subjective expert assessment of the number of recorded individuals, based on which the tiger population density is calculated.

Changes in the cycle of stages of the tiger long-term dynamics in the Lazovsky State Nature Reserve in 2005–2006 is associated with the stock effect, i.e. with a negative impact of anthropogenic factors from adjacent areas, mainly poaching (Salkina & Kolesnikov, 2005; Salkina, 2010, 2013; Salkina et al., 2018). As a result, the rapid turnover of adults and subadults in the tiger group of the Lazovsky State Nature Reserve is unnatural, i.e. 71% of such individuals were observed there for only 1–2 years. Tigers, individual areas of which do not include bait crop fields on areas adjacent to the Lazovsky State Nature Reserve, live much longer (Salkina et al., 2019).

A higher number of tigers and ungulates was noted not only in the Lazovsky, but also in the Ussuriyskii State Nature Reserve and Sikhote-Alin State Nature Reserve compared to adjacent unprotected areas (Miquelle et al., 2005; Matyukhina et al., 2010; Maslov, 2012). These differences are more pronounced in the Ussuriyskii State Nature Reserve and its adjacent area than in other pairs of protected (e.g. state nature reserves) and unprotected areas. This is caused by a greater anthropogenic load in the area adjacent to the Ussuriyskii State Nature Reserve, because the Ussuriyskii district is one of the most developed in the Primorsky Krai.

Within the tiger natural range, the poaching level is evidenced by the following. In Russia including the Lazovsky State Nature Reserve, the tiger population has increased during the early 1990s (Yudin & Yudina, 2009; Salkina, 2011). An increase in the number of individuals has occurred as a result of improved habitat conditions due to global warming (Kashkarov et al., 2008). However, already in the mid-1990s, the tiger population decreased again (Yudin & Yudina, 2009; Salkina, 2011) due to the increased poaching following the collapse of the USSR and later period. The poaching affects the tiger population both directly and indirectly. The poorly controlled hunting leads to the ungulate overexploitation (Gaponov, 2002). Gaponov (2012) noted that in the hunting farms of the Lazovsky district and Olginsky district of the Primorsky Krai, *Cervus nippon* became the main object of hunting in the first decade of the 2000s. Its native population was included in the 1st edition of the Red Data Book of the Russian Federation (2001) before its reissue.

The poaching flourishes where roads are built (Skidmore, 2021). Many roads were laid during the logging; roads increase the availability of lands for poachers in all seasons of the year. On the unprotected site «Lazovsky District», the logging has also negatively affected the local tiger group (Salkina et al., 2022). Road constructions also contribute to an increase in the wildfire frequency. Studies conducted in the southwest of Primorsky Krai showed that the higher proportion of fire-damaged areas is located closer to the roads. Tigers avoid such sites (Miquelle et al., 2004).

Tiger groups are also affected negatively by the recreational pressure on their habitats. The land availability leads to an increase in the disturbance factor. We found that during the summer the frequency of tiger visits to areas adjacent to the Protected Area is considerably reduced during the increase in the number of tourists on sea bays located near the Lazovsky State Nature Reserve (Salkina et al., 2021). Visits of tourists from densely populated Partizansky district to the unprotected site «Lazovsky District» should have a more considerably negative impact on the tiger population, especially on females with cubs. The behaviour of a tigress with cubs is accompanied by a stress response to the appearance of a human even in enclosure conditions (Yudin & Yudina, 2009). The ti-

gress is forced to leave its residence place that creates additional risks for cubs, especially in winter.

Conclusions

Being an indicator of relative abundance, the tiger track density corresponds to the absolute abundance of adult and subadult (independent) individuals. In small groups, such a correspondence may not be detected. It is important that, by assessing the number of tigers, experts take into account conditions for measuring track prints and apply the criterion of individual differences of at least 2 cm. Otherwise, an unreliable estimate of the tiger number is possible, which will lead to wrong conclusions on the state and dynamics of the tiger population. Consequently, this will reflect the conservation strategy of this threatened species.

In the Lazovsky State Nature Reserve, the main population characteristics of the tiger are higher than on the unprotected site «Lazovsky District», including the relative abundance, population density of adults, subadults, and cubs. In the Lazovsky State Nature Reserve, the survival rate of tiger cubs is higher than on the unprotected site. On the site «Lazovsky District», the population density of tiger cubs has been declining. In the Lazovsky State Nature Reserve this indicator decreased in 2012–2021. There has also been a trend towards a decrease in the relative abundance index.

The three-year cycle of the long-term dynamics of the relative abundance of tigers in the study area was clearer expressed in the Lazovsky State Nature Reserve. This parameter indicates a still leading role of natural factors in ecosystem processes (Poddubnaya et al., 2021). At the same time, a decrease in the population density of tiger cubs on both study sites, a decrease in the survival rate of tiger cubs and the index of the relative abundance of tigers in the Lazovsky State Nature Reserve suggest an increasing and possibly threatening impact on the tiger group by a complex of anthropogenic factors, namely poaching, uncontrolled hunting, logging, and recreational pressure on the adjacent area.

A creation of such Protected Areas, as state nature reserves and national parks, usually leads to an increase in the number of large predators and other animals. At present, such a Protected Area as the Lazovsky State Nature Reserve cannot fully serve as a breeding ground of tigers. An increase in the tiger population would be possible if a new state nature reserve would be established which is difficult to implement. A more realistic scenario seems to be the creation of extensive buffer zones around existing Protected Areas, the hunting prohibition, and the logging restriction. It is unacceptable to use agricultural fields for animal luring from Protected Areas instead of the intended purpose of these areas. In the Ecological Programme of the Primorsky Krai (Elyakov et al., 1993), a number of areas are recommended for creation of Protected Areas of various status, buffer zones around new and existing Protected Areas. The same areas must be created in the Khabarovsky Krai. Only by taking the recommended measures, it is possible to implement the Global Program to increase the number of tigers in the Russian Far East.

Acknowledgements

The organisation and implementation of the Amur Tiger Monitoring Program was co-ordinated by the Wildlife Conservation Society (WCS), the «Special Inspection "Tiger"». Funds for the programme were provided by the Tiger Rescue Fund, World Wildlife Fund, Rhinoceros and Tiger Conservation Fund, US Fish and Wildlife Service, Wildlife Conservation Society, Russian Geographical Society. The authors express their gratitude to all these organisations, and colleagues participated in the accounting work. We are grateful to A.A. Murzin for his help in preparation of the manuscript.

Supporting Information

Characteristics of accounting routes located in the Lazovsky State Nature Reserve and on the site «Lazovsky District» (Electronic Supplement. The number and length of the accounting routes in the Lazovsky State Nature Reserve (1997–2021) and on the unprotected site «Lazovsky District» (1997–2012)) may be found in the **Supporting Information**.

References

Abramov V.K. 1962. On the biology of the Amur tiger *Panthera tigris longipilis* Fitzinger, 1868. *Journal of the Czechoslovak Zoological Society* 26(2): 189–202.

Bromley G.F., Kucherenko S.P. 1983. *Ungulates of the southern area of the Far East of the USSR.* Moscow: Nauka. 305 p. [In Russian]

Chelintsev N.G. 2000. *Mathematical basis of animal surveys.* Moscow: Tsentrokhotcontrol. 431 p. [In Russian]

Dunishenko Y.M. 2006. Results of the monitoring of the Amur tiger population in the Khabarovsky Krai. In: *Proceedings of the International Conference on the Conservation of the Amur Tiger*. Vladivostok: Dalnauka. P. 191–201. [In Russian]

Dyukarev V.N., Ermoshin V.V., Murzin A.A. 2003. The state of forests. In: *Catalogue of electronic maps*. Vladi-

vostok: Information-Cartographic Analytical Centre (GIS-Centre «TIGIS»). [In Russian]

Elyakov G.B., Aladin V.I., Bogatov V.V., Zhuravlev Yu.N., Kachur A.N., Kusakin O.G., Lebedev B.I., Lehr P.A., Medvedev A.D., Rosenberg V.A., Stomatyuk E.S., Turetsky V.S. (Eds.). 1993. *Long-term program of nature protection and rational use of natural resources of Primorsky Krai until 2005 (Environmental Program)*. Part 1. Vladivostok: Far Eastern Branch of the RAS. 349 p. [In Russian]

Gaponov V.V. 2002. Ginseng, tiger and hunting. Double morality of the taiga nature management. *Russia and the Pacific* 4: 81–88. [In Russian]

Gaponov V.V. 2012. *The state and use of biological objects of coniferous-deciduous forests of the south of the Russian Far East.* PhD Thesis Abstract. Vladivostok: Pacific Institute of Bioorganic Chemistry of the FEB RAS. 41 p. [In Russian]

GTRP. 2010. *Global Tiger Recovery Program (2010–2022).* Saint-Petersburg. 89 p. [In Russian]

Hayward G.D., Miquelle D.G., Smirnov E.N., Nations C. 2002. Monitoring Amur tiger populations: characteristics of track surveys in snow. *Wildlife Society Bulletin* 30 (4): 1150–1159.

Kashkarov E., Baranov P., Pomortsev O., Ishchenko I. 2008. Global warming and the northern expansion of the big cats of Asia. *Cat News* 48: 24–27.

Kostomarov S.V. 2010. The Amur tiger on the Northern edge of its habitat. In: *The Amur Tiger in Northeast Asia: Planning for the 21st Century.* Vladivostok: Dalnauka. P. 233–239. [In Russian]

Lukarevskiy V.S., Lukarevskiy S.V., Kolchin S.A., Oleynikov A.Yu. 2021. Population structure and spatial distribution of the tiger (*Panthera tigris*, Felidae, Carnivora) in Southwestern Primorye (Russian Far East). *Ecologica Montenegrina* 43: 1–15. DOI: 10.37828/em.2021.43.1

Maslov M.V. 2012. Transformation of natural habitats and change of the populations condition of hoofed animals of the Ussuriysk Reserve and adjacent territories under the influence of the anthropogenic press. *Regional Geosystems* 21(140): 82–88. [In Russian]

Matyukhina D.S., Miquelle D.G., Salkina G.P., Abramov V.K., Litvinov M.N., Smirnov E.N., Zaumyslova O.Y., Gaponov V.V. 2010. Density of Amur tiger (*Panthera tigris altaica*) in Zapovedniks and adjacent territories of Primorski Krai, based of monitoring data, 1998–2009. In: *The Amur Tiger in Northeast Asia: Planning for the 21st Century.* Vladivostok: Dalnauka. P. 193–199. [In Russian]

Matyushkin E.N., Astafyev A.A., Zaitsev V.A., Kostoglod V.E., Palkin V.A., Smirnov E.N., Yudt R.G. 1981. The history, current state and prospects for tiger conservation in the Sikhote-Alin Nature Reserve. In: *Mammal Predators*. Moscow: TSNIL Glavokhoty RF. P. 76–118. [In Russian]

Matyushkin E.N., Pikunov D.G., Dunishenko U.M., Miquelle D.G., Nikolaev I.G., Smirnov E.N., Salkina G.P., Abramov V.K., Basylnikov V.I., Yudin V.G., Korkishko V.G. 1999. Distribution and numbers of the Amur tiger in the Russian Far East by the mid-1990s. In: *Rare species of mammals of Russia and adjacent territories.* Moscow: Theriological Society of the RAS. P. 242–271. [In Russian]

Miquelle D.G., Murzin A.A., Hotte M. 2004. *An analysis of fires and their impact on leopards in Southwestern Primorye*. Vladivostok: Dalnauka. 33 p. [In Russian]

Miquelle D.G., Smirnov E.N., Salkina G.P., Abramov V.K. 2005. The importance of protected areas in Amur tiger conservation: a comparison of tiger and prey abundance in protected areas versus unprotected areas. In: *Results of protection and research of the Sikhote-Alin natural landscape.* Vladivostok: Primpoligraphkombinat. P. 70–74. [In Russian]

Miquelle D.G., Dunishenko Y.M., Pikunov D.G., Aramilev V.V., Salkina G.P., Nikolaev I.G., Smirnov E.N., Fomenko P.V., Abramov V.K. 2006a. The state of the Amur tiger population in the Russian Far East. In: *Proceedings of the International Conference on the Conservation of the Amur Tiger (Khabarovsk, September 25–27, 2003)*. Vladivostok: Dalnauka. P. 179–191. [In Russian]

Miquelle D.G., Pikunov D.G., Dunishenko Y.M., Aramilev V.V., Abramov V.K., Smirnov E.N., Salkina G.P., Murzin A.A., Matyushkin E.N. 2006b. *Theoretical foundations of accounting for the Amur tiger and its forage resources in the Russian Far East.* Vladivostok: Dalnauka. 183 p. [In Russian]

Miquelle D.G., Pikunov D.G., Dunishenko Y.M., Aramilev V.V., Nikolaev I.G., Abramov V.K., Smirnov E.N., Salkina G.P., Seryodkin G.P, Gaponov V.V., Fomenko P.V., Litvinov M.N., Kostyria A.V., Yudin V.G., Korkishko V.G., Murzin A.A. 2007. 2005 Amur Tiger Census. *Cat News* 46: 14–16.

Order. 2005. *Order of the Ministry of Natural Resources of the Russian Federation №63 dated by 15.03.2005: Methodical recommendations on the conducting and organisation a census of the Amur tiger in the Russian Federation*. Available from https://studylib.ru/doc/4301687/metodicheskie-rekomendacii-po-provedeniyu-i-organizacii [In Russian]

Pikunov D.G. 1990. The number of tigers in the Far East of the USSR. In: *V Congress of the All-Union Theriological Society of the USSR Academy of Sciences*. Vol. 2. Moscow: WTO of the AS USSR. P. 102–103.

Pikunov D.G., Seredkin I.V., Mukhacheva A.S. 2009. State monitoring of large predatory mammals populations in the Southwest of Primorskyi Kray. *Proceedings of Samara Scientific Center of RAS* 11(2): 124–128. [In Russian]

Poddubnaya N.Ya., Kolomiytsev N.P. 2016. *The role of mammals in the forest ecosystems of Southeastern Sik-*

hote-Alin. Cherepovets: Cherepovets State University. 253 p. [In Russian]

Poddubnaya N.Ya., Kovalev V.A. 1993. State of Ussuri group of Amur tiger and its preservation perspective. *Bulletin of Moscow Society of Naturalists* 98(3): 54–62. [In Russian]

Poddubnaya N.Ya., Salkina G.P., Eltsova L.S., Ivanova E.S., Oleynikov A.Yu., Pavlov D.D., Kryukov V.Kh., Rumyantseva O.Yu. 2021. Mercury content in the Siberian tiger (*Panthera tigris altaica* Temminck, 1844) from the coastal and inland areas of the Russia. *Scientific Reports* 11(1): 6923. DOI: 10.1038/S41598-021-86411-Y

Red Data Book of the Russian Federation (Animals). Moscow: Astrel, 2001. 860 p. [In Russian]

Red Data Book of the Russian Federation (Animals). Moscow: VNII Ekologiya, 2021. 1128 p. [In Russian]

Salkina G.P. 1993. Tiger population present state in southeast of the Sikhote-Alin. *Bulletin of Moscow Society of Naturalists* 98(3): 45–53. [In Russian]

Salkina G.P. 2010. Poaching as a main factors of Amur tiger mortality. In: *The Amur Tiger in Northeast Asia: Planning for the 21st Century.* Vladivostok: Dalnauka. P. 143–146. [In Russian]

Salkina G. 2011. *The Tiger and it's relations with other species in South Sikhote-Alin: Materials on snow tracking and observations in snowless period*. Germany: Lambert Academic Publishing. 168 p.

Salkina G.P. 2013. Problems of tiger conservation in the Lazovsky State Nature Reserve. *Environmental protection and nature management* 1: 73–75. [In Russian]

Salkina G.P., Kolesnikov V.S. 2005. Mortality factors of Sika deer in the Lazovsky District of Primorye. In: *VII Far Eastern Conference on Conservation*. Birobidzhan: Institute for Complex Analysis of Regional Problems of the FEB RAS. P. 239–241. [In Russian]

Salkina G.P., Kolesnikov V.S. 2010. The number and reproduction of tiger groups in the Lazovsky State Nature Reserve and in the unprotected territory. In: *IX Far-Eastern Conference on Nature Conservation Problems.* Vladivostok: Dalnauka. P. 369–374. [In Russian]

Salkina G.P., Kolesnikov V.S., Eremin D.Yu. 2018. Population dynamics of the Amur tiger and the ungulates in Lazovsky Zapovednik. *Modern Science: actual problems of theory and practice. Natural and Technical Sciences* 7: 25–34. [In Russian]

Salkina G.P., Poddubnaya N.Ya., Kolesnikov V.S., Kolchin S.A. 2019. Change of tigers (*Panthera tigris* L., 1758) in the Lazovsky Nature Reserve and the National Park «Zov Tigra». *Ecology and evolution: New horizons*. Yekaterinburg: Yekaterinburg Humanities University. P. 91–94. [In Russian]

Salkina G.P., Poddubnaya N.Ya., Kolesnikov V.S. 2021. Influence of recreational load on the stay of the Amur tiger (*Panthera tigris altaica*) in its habitat. In: *Man and nature – interaction in Protected Areas*. Novokuznetsk: Kemerovo State University. P. 213–219. [In Russian]

Salkina G.P., Poddubnaya N.Ya., Kolesnikov V.S. 2022. The impact of logging on the state of the tiger grouping in the south-east of Sikhote-Alin. *Proceedings of the Mordovia State Nature Reserve* 30: 97–110. [In Russian]

Shvetsov E.P., Golishevsky A.V., Zaumyslova O.Yu., Konkov A.Yu., Litvinov M.N., Lukarevskiy S.V., Nikolaev I.G., Orlov A.G., Rybin A.N., Salkina G.P., Seredkin I.V., Bulgakov S.A., Kolchin S.A., Kostomarov S.V., Samarin A.E., Yanovsky E.G., Drozdov K.A. 2012. *Report on the implementation of selective surveys of the Amur tiger in the winter season 2011–2012.* Unpublished Report. [In Russian]

Skidmore A. 2021. Using crime script analysis to elucidate the details of Amur tiger poaching in the Russian Far East. *Crime Science* 10(1): 16. DOI: 10.1186/s40163-021-00150-z

Smirnov E.N. 1993. Tiger group in Sikhote-Alin State Nature Reserve and contiguous to its territory in the 80s. *Bulletin of Moscow Society of Naturalists* 98(3): 37–44. [In Russian]

Soutyrina S.V., Riley M.D., Goodrich J.M., Seryodkin I.V., Miquelle D.G. 2013. *A population estimate of Amur tigers using camera traps.* Vladivostok: Dalnauka. 156 p. [In Russian]

Tkachenko K.N. 1996. Tiger, *Panthera tigris (Carnivora, Felidae),* at the Bolshekhekhtsirsky Nature Reserve (Khabarovsk territory). *Zoologicheskii Zhurnal* 75(11): 1729–1736. [In Russian]

Williamson M.H. 1972. *Analysis of Biological Population (Special Topics in Biology Series)*. London: Edward Arnold. 180 p.

Yudakov A.G., Nikolaev I.G. 1973. State of the population of the Amur tiger (*Panthera tigris altaica*) in the Primorskiy Krai. *Zoologicheskii Zhurnal* 52(6): 909–919. [In Russian]

Yudin V.G. 2010. Tiger tracks in time and space. In: *The Amur Tiger in Northeast Asia: Planning for the 21st Century.* Vladivostok: Dalnauka. P. 151–159. [In Russian]

Yudin V.G., Yudina E.V. 2009. *The tiger of the Russian Far East.* Vladivostok: Dalnauka. 485 p. [In Russian]

Zhivotchenko V.I. 1977. Occupation of the Lazovsky Nature Reserve by the tiger (*Panthera tigris altaica*) and their relations with leopards and the wolves. *Zoologicheskii Zhurnal* 51(1): 131–139. [In Russian]

PANTHERA TIGRIS ALTAICA (CARNIVORA, FELIDAE) В ЛАЗОВСКОМ ЗАПОВЕДНИКЕ И НА СОСЕДНЕЙ НЕОХРАНЯЕМОЙ ТЕРРИТОРИИ (ДАЛЬНИЙ ВОСТОК РОССИИ)

Г. П. Салькина[1,*], Н. Я. Поддубная[2], В. С. Колесников[3], В. А. Никандрова[2]

[1]*Объединенная дирекция Лазовского государственного природного заповедника им. Л.Г. Капланова и национального парка «Зов тигра», Россия*
**e-mail: tpsrus@mail.ru*
[2]*Череповецкий государственный университет, Россия*
[3]*Общество защиты тигра, Россия*

Для оценки состояния популяции *Panthera tigris altaica* (далее – тигр), остающегося уязвимым подвидом, проводится ее ежегодный мониторинг на 16 участках его ареала. В эти участки входят заповедники и рядом расположенные территории, которые отличаются между собой охранным статусом. На этих участках сравниваются показатели численности группировок и воспроизводство для выявления определяющих их факторов. Население тигра в Лазовском заповеднике площадью 1210 км^2 сопоставляют с населением тигра неохраняемого участка (площадь 988 км^2), который, как и Лазовский заповедник, выходит к Японскому морю. В статье приводятся краткое описание и сравнение этих двух участков. Мониторинг проводился в Лазовском заповеднике в 1997–2021 гг. и на неохраняемом участке, названном «Лазовский район», в 1997–2012 г. В течение зимнего периода собирали информацию о следах тигра на всей территории участков: один или два раза проводили учеты следов хищника на постоянных маршрутах. Плотность распределения маршрутов в Лазовском заповеднике в разные годы составила 1.0–1.5 км на 10 км^2, на участке «Лазовский район» – 1.2 км на 10 км^2. Идентификацию особей проводили по ширине отпечатков подушечек лап. Следы, которые отличаются больше чем на 2 см, считали принадлежащими разным особям. Показатели численности группировки тигра в Лазовском заповеднике были примерно в два раза выше, чем на неохраняемом участке «Лазовский район». В 1997–2012 гг. в Лазовском заповеднике и на неохраняемой территории «Лазовский район» плотность популяции взрослых и полувзрослых тигров составила соответственно 8.6 ± 0.7 особей на 1000 км^2 и 5.3 ± 0.5 особей на 1000 км^2, тигрят младше 1 года – 3.1 ± 1.0 особей на 1000 км^2 и 1.7 ± 0.04 особей на 1000 км^2, соответственно. Плотность распределения следов тигра в Лазовском заповеднике составила 3.03 ± 0.51 следа на 100 км маршрута с учетом дней, прошедших после снегопада, засыпавшего все следы, и на участке «Лазовский район» – 1.33 ± 0.27 следа на 100 км маршрута. В 1997–2012 гг. плотность населения взрослых и полувзрослых особей в Лазовском заповеднике была статистически значимо ($F = 59.40$, $p < 0.001$) выше, чем в «Лазовском районе». Также достоверно выше здесь плотность населения тигрят ($F = 6.30$, $p < 0.018$) и плотность распределения следов ($F = 4.86$, $p < 0.036$). Выживаемость тигрят в Лазовском заповеднике была также выше. На особо охраняемой природной территории выводков с одним тигренком было 16% (n = 4), с двумя тигрятами – 48% (n = 12), с тремя – 32% (n = 8), с четырьмя – 4% (n = 1) от их общего количества. На неохраняемом участке «Лазовский район» выводков с одним тигренком было 53% (n = 8), с двумя тигрятами – 27% (n = 4), с тремя – 20% (n = 3) от их общего количества. Обнаружена тенденция снижения плотности населения тигрят на участке «Лазовский район». В 2012–2021 гг. в Лазовском заповеднике средняя плотность населения взрослых и полувзрослых тигров составила 8.9 ± 1.8 особей на 1000 км^2, тигрят 4.3 ± 1.1 особей на 1000 км^2; средняя плотность распределения следов – 2.39 ± 0.68 на 100 км маршрута. В этот период плотность населения тигрят в Лазовском заповеднике снижалась. Также наметилась тенденция к снижению относительной численности взрослых и полувзрослых особей. Регулярная трехлетняя цикличность в динамике плотности распределения следов тигра в Лазовском заповеднике указывает на преимущественное воздействие на группировку природных факторов. На неохраняемой территории «Лазовский район» регулярной цикличности не наблюдалось. Это и более низкие показатели численности тигров здесь связаны с негативным воздействием связанных между собой антропогенных факторов: браконьерства, охоты и лесозаготовок. Влияет на группировки тигров и рекреационная нагрузка на территории участков. В последнее десятилетие группировка тигров в Лазовском заповеднике подвергается воздействию антропогенных факторов с сопредельной территории. Дальнейшее сохранение тигра и увеличение его численности возможно, если будут создаваться особо охраняемые природные территории разного статуса, обширные буферные зоны вокруг них и вокруг уже существующих резерватов, будет запрещена охота и ограничены лесозаготовки. Использование сельскохозяйственных земель не по назначению вокруг особо охраняемых природных территорий недопустимо.

Ключевые слова: антропогенный фактор, динамика популяции, мониторинг, показатель численности, тигр, трехлетняя цикличность