A MONITORING PROGRAM FOR THE AMUR TIGER

THIRD-YEAR REPORT: 1999-2000

A cooperative project conducted as a component of the Federal Target Program for Conservation of Amur Tigers by representatives of:

Wildlife Conservation Society
All Russia Research Institute of Wildlife Management, Hunting, and Farming
Institute of Geography, Far Eastern Branch of the Russian Academy of Sciences
Institute of Biology and Soils, Far Eastern Branch of the Russian Academy of Sciences
WorldWide Fund for Nature
Sikhote-Alin State Biosphere Zapovednik
Lazovski State Zapovednik
Ussuriski Zapovednik
Botchinski Zapovednik
Bolshe-Khekhtsirski Zapovednik
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Executive Summary. In the 1999-2000 winter 16 monitoring units, totaling 23,555 km^2 (approximately 15-18% of suitable tiger habitat) were surveyed to assess changes in tiger numbers using three indicators (presence/absence ratios on survey routes, track density estimators, and expert assessments of number of independent tigers on monitoring sites), cub production, and relative ungulate densities. A total of 246 survey routes were sampled twice (492 samplings), representing 3057 km of routes (with double sampling, a total of 6114 km traversed). Results of the first three years (1997-1998 winter through 1999-2000 winter) of monitoring Amur tigers in the Russian Far East suggest that the tiger population may have experienced a slight increase between the first and second years, followed by a slight decrease between the second and third years. These changes were not statistically significant, and not consistent across all three indices. A decrease in cub production, and localized depressions in ungulate numbers, are also causes for concern. Future monitoring will be important to determine whether these trends continue.

I. INTRODUCTION

At the international level, the Amur tiger (*Panthera tigris altaica*) is considered in danger of extinction. With only a few individuals remaining in China, and an unknown number in North Korea, preservation of this animal has become primarily the responsibility of the Russian government and the Russian people. Accordingly, Russia has taken many steps to conserve this animal, starting with a ban of hunting in 1947. The Russian Federal government has since listed the animal as endangered (Russian Red Data Book), and has recently developed a National Strategy for Conservation of the Amur Tiger in Russia, as well as a Federal Program to implement the national strategy.

The recovery of the tiger after near extinction in the first half of this century (following the 1947 ban) has been fairly well documented through a series of surveys (Kaplanov 1947, Abramov 1962, Kudzin 1966, Yudakov and Nikolaev 1970, Kucherenko, 1977, Pikunov et al. 1983, Kazarinov 1979, and Pikunov 1990). Most recently, a range-wide survey provided a great deal of information on the distribution and status of tigers in the past decade (Matyushkin et al. 1996). Nonetheless, there remains a long standing need for a reliable and efficient means for monitoring changes in the tiger population.

The tiger is a rare, sparsely distributed, and secretive animal that is distributed across at least 180,000 km^2 of Primorski and Khabarovski Krais in southern Russian Far East. This combination of attributes make it a particularly difficult animal to count reliably, and the financial burden and logistical problems associated with range-wide surveys make it practically impossible to conduct full-range surveys with sufficient frequency to track changes in tiger abundance.

Nonetheless, there exists a need to monitor the tiger population on a regular (preferably yearly) basis. Such a monitoring program should serve a number of functions, including:

1. A monitoring program should act as a "early warning system" that can indicate dramatic changes in tiger abundance. Range-wide surveys, usually conducted with long intervals with no information, may come too late to allow a rapid response to a decline in numbers. Yearly surveys should serve to provide notice so that immediate conservation actions can be initiated.

2. Ultimately, tiger numbers, or at least trends in the tiger population, should be used as a basis to determine the effectiveness of conservation/management programs. In Russia, there have been tremendous efforts and significant support from regional, Krai-wide, federal, and international levels for implementation of tiger conservation efforts that range from anti-poaching programs to conservation education. All these efforts are aimed at protecting the existing Amur tiger population in Russia, yet without an accurate monitoring program that can determine trends in tiger numbers with statistical accuracy, the ultimate effectiveness of these conservation programs will remain unknown.

3. Among other indicators, a monitoring program should provide information on reproductive rate of the population, which may act most effectively as an indication of trends in the populations.

4. Changes in ungulate populations, as primary prey for tigers, may also provide important clues to potential impacts on tiger numbers.

In an attempt to address these needs, nearly all coordinators of the 1996 tiger survey have worked together to develop a reliable and effective monitoring program for Amur tigers. The task is a huge one, given the area involved and the logistics of working in a northern environment. The results, and the effectiveness of this program are continually being evaluated, but we are hopeful that the results will demonstrate the value and the need for investing in such a program.

II. GOALS AND OBJECTIVES

The ultimate goal of this program is the yearly implementation of a standardized system to monitor changes in tiger abundance, and factors potentially affecting tiger abundance, across their present range in the Russian Far East. The intent is to provide a mechanism that will assess changes in the density of tigers, as well as other potential indicators of population status, within their current range over long periods of time. This methodology should provide a means of assessing the effectiveness of current management programs, provide a means of assessing new programs, and provide an "early warning system" in the event of rapid decreases in tiger numbers.

Objectives

Specifically, the objectives of this monitoring program are to:

1. Develop a standardized, statistically rigorous system based on track counts that will provide estimates of relative density as a mechanism for monitoring trends in relative numbers of tigers in representative "count units" throughout tiger range in the Russian Far East.

2. Determine presence/absence of tigers on survey routes as a second indicator of trends in tiger numbers, and differences in tiger abundance among survey units in the Russian Far East.

3. Combine the track counts with "expert assessments" of tiger numbers as a means to provide a second indicator of population trends.

4. Monitor reproduction across the range of tigers to identify areas of high/low productivity, and changes in reproduction over time.

5. Monitor changes in the prey base (large ungulates) of tigers within count units.

6. Record and monitor instances of tiger mortality within and in close proximity to count units.

7. Monitor changes in habitat quality.

III. METHODOLOGY

We emphasize that the design of any monitoring program has limitations. We decided to focus on developing a method that would, with statistical rigor, monitor changes in the tiger population that occur due to changes in density within the existing range of tigers (i.e., monitor changes in indicators of tiger density) instead of monitoring changes in tiger numbers due to increases/decreases in tiger distribution (i.e., fluctuations in range of tiger).

Extensive work has been conducted in developing a survey methodology that can provide a statistically rigorous mechanism for detecting trends in tiger numbers. The rationale for this methodology has been provided elsewhere (Hayward et al, in review, 1st Year Report). An abbreviated summary and rationale of methodologies is provided here.

Project Design

Given the logistical and financial constraints of implementing a full range census, a more efficient estimate of changes in relative abundance of tigers is required. To insure acceptance of methodologies at the local level, and to provide linkages with existing databases, it is to our advantage to attempt to develop a rigorous methodology that relies on the extensive experience of regional biologists and their understanding of tiger ecology.

An index of tiger abundance, based on track counts measured on sampling units well dispersed across the total range of tigers, may provide an efficient approach to monitor trends. Changes in count estimates over time within each count unit should provide an indication of changes across the entire range. Furthermore, by distributing count units across the entire range of conditions that tigers exist in the Russian Far East, it may be possible to detect changes that may be regional or localized.

While an approach based on sampling provides the benefits of lower cost, more frequent implementation, and measures of precision, there are problems. Counts of rare objects generally result in estimates with large variances. This leads to the potential for estimates that lack the level of precision necessary to make critical management decisions.

We have attempted to define a set of count units based on criteria outlined below, and then develop a sampling scheme within each count unit that will provide an estimate of relative tiger abundance based on track abundance, as well as derive counts of actual tiger numbers based on expert assessments derived from track data. The sampling scheme was primarily designed to reduce variance in tiger track counts within each monitoring unit (which acts as a sampling unit), but the efficiency of sampling prey species was also considered. Below we delineate how the system was developed and what criteria were used for selecting this sampling scheme.

Location of count units. The set of count units selected should be dispersed across tiger range to represent the full range of conditions in which tigers occur. Both high quality and marginal areas should be monitored. It is also important that protected areas be monitoring using the same methodology as in unprotected areas to provide a comparison of the impacts of human activities on tiger populations. We also sought to create monitoring units within and adjacent to the larger protected areas (Sikhote-Alin, Lazo, and Ussuri) to act as paired comparisons of protected and unprotected area that share nearly all features except protected status. Unprotected count units adjacent to protected areas should theoretically demonstrate higher densities of tigers and prey than most unprotected areas because they lay immediately adjacent to source populations, but not so high as the zapovedniks themselves. They may be sensitive indicators of the effect of human impacts.

We determined that the range of environmental factors that should be represented include:

protected/unprotected areas;
north/south gradient; and,
inland/coastal (in most cases this represents the west and east sides of the Sikhote-Alin Mountains, respectively).

Number of count units. The number and location of count units should be determined by a number of factors: 1) there should be an adequate representation of the environmental variables as defined above; and 2) the sample size should be sufficient to allow statistical analyses for overall trends in population and differences due to environmental variables (e.g., protected/unprotected); 3) there should be personnel and an infrastructure that will insure long-term monitoring will be consistently carried out; 4) financial constraints will largely limit the upper allowable number of sites.

Given these constraints, 16 permanent monitoring units have been created to be representative of the range of conditions across the present distribution of tigers (Table 1).

Table 1. Monitoring sites selected for the Amur tiger monitoring program in the Russian Far East.

#	Name	Size of unit (km^2)	Krai	Status	Geographic location	Coastal/ inland
1	Lazovski Zapovednik	1192.1	Primorye	Zapovednik	southern	coastal
2	Lazovski Raion	987.5	Primorye	unprotected	southern	coastal
3	Ussuriski Zapovednik	408.7	Primorye	Zapovednik	southern	inland
13	Ussuriski Raion	1414.3	Primorye	unprotected	southern	inland
6	Borisovkoe Plateau	1472.9	Primorye	Zakaznik (partially)	southern	coastal
7	Sandagoy (Olginski Raion)	975.8	Primorye	unprotected	southern	coastal
4	Vaksee (Iman)	1394.3	Primorye	unprotected	central	inland
5	Bikin River	1027.1	Primorye	unprotected	central	inland
14	Sikhote-Alin Zapovednik	2372.9	Primorye	Zapovednik	central	coastal
15	Sineya (Chuguevski Raion)	1165.4	Primorye	unprotected	central	inland
16	Terney Hunting lease	1716.5	Primorye	unprotected	central	coastal
8	Khor	1343.8	Khabarovsk	unprotected	northern	inland
9	Botchinski Zapovednik	3051	Khabarovsk	Zapovednik	northern	coastal
10	Bolshe Khekhtsirski Zapovednik	475.6	Khabarovsk	Zapovednik	northern	inland
11	Tigrini Dom	2069.6	Khabarovsk	unprotected	northern	inland
12	Matai River Basin (Zakaznik)	2487.6	Khabarovsk	new zakaznik	northern	inland

Summarizing the count units on the basis of the environmental variables outlined above shows that the resulting distribution of sites is well dispersed in a north-south gradient (6 southern, 5 central, and 5 northern) and the inland versus coastal gradient (9 inland, 7 coastal). Included as monitoring units are all 5 zapovedniks that include potential tiger habitat. Obviously, location, size, and number of protected areas was not a variable we could determine or randomize, limiting the extent to which we could develop a balanced design (Table 2).

Table 2. Characteristics of monitoring units for tiger monintoring program.

	Protected (zapovednik)		Unprotected		
	Inland	Coastal	Inland	Coastal	Total
Southern	1	1	1	3	6
Central	0	1	3	1	5
Northern	1	1	3	0	5
Total	2	3	7	4	16

An imbalance of this design exists in the distribution of unprotected sites in inland versus coastal areas (7 versus 4), but we were constrained here by personnel and infrastructure capacities in selecting sites. In Khabarovsk (northern section), there is little coastal habitat for tigers, and access is very difficult. Hence, except for Botchinski Zapovednik, no effort has been made to monitor the northern coastal region.

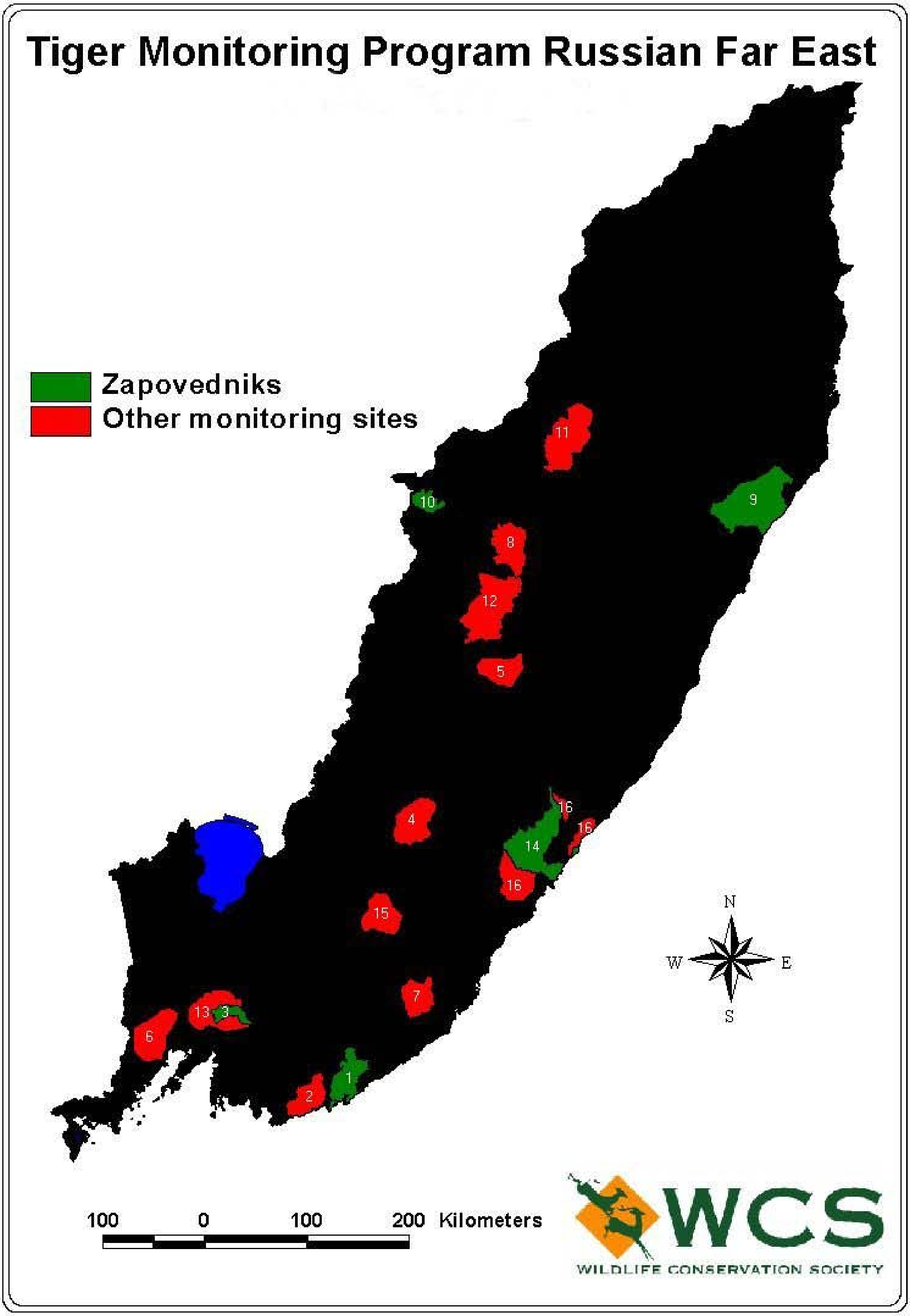


Figure 1. Location of the 16 sites used for monitoring Amur tigers in the Russian Far East. Numbers referenced in Table 1 and most other tables throughout text.

Size of count units. Our criteria for determining size of count units were as follows:

i) to detect changes in tiger density, a count unit must be sufficiently large to potentially contain tiger numbers that could fluctuate over time, hopefully reflecting the conditions for tigers in the representative region. In other words, count units should be large enough to have a low probability of tigers being completely absent from the area during the survey period (if tigers are perennially absent from a count area, it is impossible to detect changes in population density), and large enough so that several or more tigers might be present. Hence, ideally a monitoring unit would contain an area large enough for 2-3 female territories.

ii) given that units must be large enough to contain several potential female home ranges, count units should be as small as possible to minimize the expenses of monitoring; and

iv) count units should have natural boundaries reflecting either boundaries of protected areas, or natural geographic boundaries (ridgetops, or large rivers);

In good tiger habitat, assuming that female home ranges average 400-500 km^2 (Miquelle et al. 1999) 100,000 - 150,000 ha should contain 2-3 adult resident females, at least 1 adult male, transients, dispersers, and cubs. Therefore, we sought to create count units of approximately this size. Some exceptions were inevitable - the size of existing protected areas are obviously fixed (although with larger protected areas we sought to sample only a portion of the region). In general, we sought to keep count units with the range of 1000 - 1500 km^2.

Use of survey routes). Forty years of experience surveying tigers in the Russian Far East has demonstrated that counting tracks encountered while snow is on the ground along well-placed routes can be an effective means of describing the distribution and numbers of tigers in a region. Unlike other regions where tigers occur, the snow cover afforded in the winter season in the Russian Far East provides a “clean pallet” which reveals presence of tigers, and usually retains that evidence for an extended period, often until the next significant snowfall.

Location of survey routes. Two potential approaches exist for positioning routes: either distribute them randomly throughout a given count unit as a non-biased indicator of the presence of tigers within the region, or place them along routes that have the highest probability of encountering tiger tracks. Because our interests lay in the ability to detect changes over time, it is more important that there be a high probability of tiger tracks being encountered along routes. If a large percentage of routes are devoid of tracks, there is no means of detecting changes in tiger numbers. Therefore, we sought to locate routes along those routes that have the greatest chance of intersecting tiger tracks, and to minimize the number of zero counts. Maximum efficiency of encountering tracks can be achieved by positioning routes along trails, ridgetops, roads, or natural travel corridors where tigers are most likely to travel (Matyushkin 1990).

Route length. Routes should be sufficiently long so as to have a high probability of encountering tracks, and should be of a length sufficient to reduce the variability of tracks encountered per route. However, determination of appropriate length is always a trade-off between the appropriate length for statistical rigor, the financial cost of conducting surveys with different route lengths, and the amount of time (money) that can be invested in covering routes. Ideally, we should select the shortest route length that will result in only a small percentage of routes without tiger tracks, and that is sufficiently long enough to reduce the variability of number of tiger tracks. When variability in track density among routes is high, our ability to statistically detect changes in tiger abundance decreases.

Using data we developed in the initial experimental stage of this program (Hayward et al. in review) we determined that routes longer than 10 km have a much greater chance of detecting tracks than shorter routes, and that longer routes were always better, the savings (as measured in change in standard deviation) diminished greatly with routes over 20 km. Based on these preliminary data, therefore, we strove to create routes that ranged in length from 10 to 20 kilometers.

Number of routes/site. The number of routes per site should be based on the following considerations: 1) there should be sufficient number of routes to have a high probability of encountering tracks of all tigers within the count unit (see below); 2) there should be sufficient number of routes to provide a statistical basis for comparisons among count units; and, 3) there should be a fairly standard density of route kilometers/km^2 across count units.

We examined the statistical power of a monitoring program with different numbers of routes, and determined that with 10 routes per count unit there is a 90% chance of statistically detecting a 10% decrease in population size (density of tiger tracks), and a 94% chance of detecting a 10% increase in population size. Chances of detecting a 5% change are decidedly less (61-64%). With 20 routes, a 10% change in population size will almost certainly be detected (greater than 99%) and 5% changes also have a high probability of being statistically detectable (82%). Based on this analysis, it would be ideal to create 20 routes/count unit, but our ability to do so would likely be prohibitively expensive and create logistical problems. Therefore, we decided that our goal would be to establish 10-20 routes/count unit.

Secondarily, we attempted to maintain route density to be greater than 1 kilometer of route/10 km^2 count unit.

Reducing variability in simultaneous counts by using repeated counts. It is well known that counts of rare, secretive animals that occur in low numbers across a large area result in great variability because there are many parameters that affect the probability of encountering any one animal. Given these constraints, it is nearly impossible to count the entire population with a single simultaneous survey of all routes. An analysis of repeated surveys in Sikhote-Alin Zapovednik, where it is possible to check if radio-collared animals were included in a count, indicated that in a single, simultaneous count, as few as 20%, and up to 100%, of the tracks of known animals were encountered along routes. This variability in simultaneous counts makes it particularly difficult to monitor changes in tiger numbers between years, because it is impossible to determine whether differences in survey results reflect real changes in tiger numbers or simply fluctuations due to variation in ability to detect presence of animals.

Two ways to reduce the amount of variation between years are: 1) to saturate a count unit with greater numbers of routes in the hope that there will be more consistent detection of tigers. This approach may be helpful, but there are at least two reasons why a saturation approach may prove ineffective in reducing variability. First, because tigers are so mobile, part of the variation is due to the fact that some percentage of tigers are simply not present on the count unit during any single survey. Secondly, because tigers can stay on kill sites for up to a week, moving less than 100 meters, even with a saturation approach some tigers could be missed.

The second possible approach is to repeatedly survey a count unit within a given year. This process greatly increases the cost of the survey, but should also greatly increase the probability of encountering all tigers that use a count unit in the course of a winter, and should therefore greatly decrease inter-year variation in count accuracy. We have selected to conduct two surveys of each count unit each winter – once early in winter (December-January) and once closer to the end of winter (mid-February).

Method of transportation. Initial analysis of data from Sikhote-Alin (Miquelle and Smirnov 1995) indicated that there may be differences in detection rate of tiger tracks dependent on the mode of transportation. Because we are primarily interested in monitoring changes in track density along each route for each year, variation in detection rate is acceptable between routes, but not in one route over years. Therefore, it is preferable that for each route the same mode of transportation (on foot, snowmobile, or vehicle) be used every year, for each survey, under all conditions.

Continuity of Personnel. People selected for the monitoring program should be selected on the basis of their experience in the region, their knowledge of tigers, and the probability of their continuing to participate in the monitoring program in the future. Stability in track counts will depend on retaining the same personnel over many years. Therefore, every effort has been made to retain the same coordinators and fieldworkers in each monitoring unit.

Data Collection

Details of data collection are outlined in the Instructions to Coordinators and the Field Diary that is provided to all field workers (Appendix II). Very briefly, the data that is collected includes:

Basic information recorded on each field "diary":

Name of field worker
Name of count unit
Name/number of route
Length of route
Date route was covered
Mode of travel: on foot, snowmobile, or vehicle
Date of last snowfall
Snow depth measured at three places along each route (beginning, middle, end)

Tiger tracks:

a unique number is assigned to each track
location of a track is pinpointed onto a map (usually 1:100,000 scale)
track size of front pad (or measurement of overlap track of rear and front)
track size of rear pad (not mandatory, but included as a reference for field counters to be aware of which foot they are measuring)
estimated date track was created

Tracks found off routes are also reported to coordinators. These "non-survey" tracks are used by coordinators in developing "expert assessments" of the number of tigers in a count unit. These data are not used in developing an estimate of track density (which relies only on tracks recorded along permanent survey routes) and therefore insures that there is some independence in how track counts and expert assessments are derived. This independence is desirable when we assess the relationship of track counts and estimates of tiger numbers based on expert assessments

Ungulate tracks. For each route, the following information is recorded:

number of fresh tracks (less than 24 hours old) that bisect the route, by species, include the following species:

red deer
wild boar
roe deer
sika deer
musk deer
moose (so far not recorded on survey routes)

Tiger Reproduction. Information should be recorded by each fieldworker on evidence of cubs in or near the count unit, including:

Tracks of female with cubs
Location of tracks
Date tracks observed
Estimated age of tracks
Number of tracks (# cubs)
Measurement of tracks (each set)

Tiger Mortality.

Was there any evidence of tiger deaths in the past year in or near the count unit?
Description of event (poaching, legal human killing, natural death, etc.)
Location (on map of 1:100,000 scale).

Creation of a Spatially Explicit Data Base

A key component of creating a reliable, long-term monitoring program is the development of a means of storing and analyzing data. We have invested a considerable amount of energy in developing a spatially explicit database in a standardized format that will provide relatively easy access for analysis. We have developed a database in Microsoft ACCESS that linked to an ARCINFO GIS (Geographic Information System) that contains all data collected by fieldworkers on every tiger track and individual, tiger deaths, route information (ungulate densities are reported by route), and count unit. The first two years of the program were spent in developing the database, and creating the spatial data that coincides with the attribute data. Each count unit is defined by a series of “coverages” that includes: boundaries of count unit (and boundaries of protected areas), the river system, for most count units a forest cover map, location of survey routes, tiger tracks (coded by sex and age when possible) location of females with cubs, and sites of mortality. The database now exists in a specially designed format so that data entry is possible without technical expertise in ARCINFO, or the need for digitizing data.

Analyses

We sought to determine trends in tiger populations and their key prey resources by assessing spatial and temporal variation in the following parameters:

1. Zero counts. Presence/absence of tiger tracks on survey routes (expressed as the percentage of routes with no tiger tracks recorded) may be an indicator of relative abundance of tigers. We record zero counts on routes when tracks were not reported on routes in either the early or later winter survey (as noted above, each survey route is sampled twice/year). Monitoring units can then be ranked on the basis of percentage routes with (without) tiger tracks.

2. Variation in tiger track densities across:

i. all monitoring sites (assuming a uniform response across the entire range of tigers in the Russian Far East);

ii. within regions (assuming the population may be changing differently among regions, by looking for differences in:

-northern, middle, and southern monitoring sites;
-coastal versus inland monitoring sites;

-protected versus unprotected monitoring sites;

iii. over time.

Tiger track densities are expressed as a function of number of tracks recorded along each survey route adjusted by the length of the survey route, and the time since last snow (the greater the interval since the last snow, the more time for tiger tracks to accumulate). The number of tracks is first divided by the length of each route for each survey (2 conducted per winter), providing an estimate of tracks/km for each survey separately. Tracks/km is then divided by the number of days since the last snowfall, providing an estimate of tracks/day/km, which is arbitrarily multiplied by 100 to provide an estimate of tracks/day/100 km.

There are two problems using days since last snow to adjust the track density estimator. First, in some cases, the date of last snow is unknown, or not reported. Secondly, degradation/elimination of tracks can occur prior to previous snowfall, so that, when snowfalls are widely separated, track densities will be underestimated if time between snows is used. Based on a preliminary assessment in Sikhote-Alin, nearly all tracks become unmeasureable after 7-8 days. However, many of these can still be identified as tiger tracks. By approximately 14 days, however, most tiger tracks are fairly well obliterated.

Based on these considerations, we used the following values as standards for adjusting for days since snow:

1. number of days since last snow, when the last snowfall was less than or equal to 14 days;
2. 14 days, if the last snow was greater than 14 days ago (assuming that tiger tracks will deteriorate beyond recognition by that time);
3. 14 days, if either date of last snow or date route covered is unreported.

This value (tracks/days since snow/km *100) is then averaged for each route (for the two surveys per route per year), and becomes the test statistic to be used for trend analyses and comparisons among sites. Because this test statistic was not normally distributed (due primarily to the large number of zero counts), we used the rank value of track density to test for differences among sites using an unbalanced GLM (SAS 1998), the mean of those ranks as an indictor of relative abundance on each monitoring sites, and used Fisher's LSD test to determine which sites were different from each other.

3. Changes in the numbers of tigers on each site, based on expert assessments. Coordinators for each site develop an estimate of the number of tigers present on each monitoring site during the winter period (December-February). Their source of data for these expert assessments are threefold: 1) track data from the survey routes; 2) additional records of tracks on monitoring sites that are not part of our 2-stage survey; 3) interview information that is collected from local informants. Based on these sources, by comparing track sizes, distances of tracks from each other, dates tracks were created, and the coordinator's understanding of tiger social structure and behavior in relationship to the local physical environment, each coordinator derives an estimate of the likely number of tigers on the study site, and provides an estimate of age (adult, subadult, cub, unknown) and sex (male, female, unknown). If evidence of a particular tiger is recorded in only one of the survey periods (i.e., it may have been a transient, or may have died), that animal is nonetheless included in the count for the study period. These expert assessments, conducted by the same coordinators on the same sites over extended periods of time, provide a valuable indicator of changes in tiger numbers.

For analyses, we combined all age classes except cubs (adults, subadults, and unknown) to form an estimate of number of independent tigers (i.e., independent of their mother) existing on a monitoring site during the survey periods. The number of independent tigers was used to estimate tiger density, and as a basis for comparison among sites.

We compared how well these three abundance estimators (presence/absence, track densities, tiger densities) correlated with each by ranking each site by its relative value for each of the estimators, and estimating Spearmans rho (Conover 1980) on those ranks.

Trends in population status were assessed graphically, and by comparing means and confidence intervals for each of the abundance estimators derived as the mean for all 16 monitoring sites (mean percent of routes without tracks, mean track density estimator, and mean independent tiger density).

4. Changes in the productivity. Data on number of litters, number of cubs, and litter size are reported for each site as part of the estimate of tiger numbers by coordinators. We summarize this data across all sites to develop an estimate of productivity for the year. However, because sites varied greatly in size, we could not use number of cubs or litters as an parameter for comparison across years and sites. We instead used cub density (number of cubs divided by area of the monitoring site) as a measure of productivity to compare among sites and as a constant that could be used for analyses of trends across years.

5. Prey populations. Relative abundance of the 4 primary prey species of tigers (red deer, wild boar, roe deer, and sika deer) is estimated on the basis of number of fresh (< 2 hours old) tracks intersecting survey routes. Freshness is a subjective estimate whose accuracy is yet to be defined, but which hopefully retains a consistent error across sites and years. Estimates from both surveys in each winter (early and later winter surveys) are averaged to derive an estimate of mean number of tracks, for each species, that intersect each route for the winter. Each route acts as a sampling unit. Exploratory analyses indicated that distributions of these ungulate track density estimators were in most cases non-normal. Therefore, while we report means and standard deviations, tests for changes over time use general linear models (SAS 1990) conducted on the ranks of track density estimators across all years and sites.

IV. RESULTS OF THE 1999-2000 WINTER MONITORING PROGRAM

Summary Data on Count Units and Routes

In the 1999-2000 winter the total area included in monitoring units was 23,555 km^2, or approximately 15-18% of the total area considered suitable tiger habitat, assuming either 156,571 (Matyushkin et al. Table 4) or 127,693 km^2 (Miquelle et al. 1999, Table 19.3) of suitable habitat.

A total of 246 survey routes were sampled twice (492 samplings), representing 3057 km of routes (with double sampling, a total of 6114 km traversed) (Table 1). On average, route length was 12.8 km. Route length was fairly consistent across monitoring units (Table 1), with the exception of the Khor and Ussuriski Zapovednik units, where routes are unusually short.

Table 3. Characteristics of units surveyed for Amur tiger monitoring program, 1999-2000.

	Monitoring Unit	Coordinator	Size of unit (km2)	# survey routes	Total length of survey routes (km)	Average length of survey routes (km)	Survey route density (km/10 km2)
1	Lasovski Zapovednik	Salkina, G. P.	1192.1	12	121.4	10.1	1.02
2	Laso Raion	Salkina, G. P.	987.5	11	138.9	12.6	1.41
3	Ussuriski. Zapovednik	Abramov, V. K.	408.7	11	104.4	9.5	2.55
4	Iman	Nikolaev. I. G.	1394.3	12	176.9	14.7	1.27
5	Bikin	Pikunov, D. G.	1027.1	15	188.4	12.6	1.83
6	Borisovkoe Plateau	Pikunov, D. G.	1472.9	14	216.8	15.5	1.47
7	Sandago	Aramilev, V. V.	975.8	16	218.5	13.7	2.24
8	Khor	Dunishenko, Yu. M.	1343.8	19	190.3	10	1.42
9	Botchinski Zapovednik	Dunishenko, Yu. M.	3051	14	164.7	11.8	0.54
10	BolsheKhekhtsir Zapovednik	Dunishenko, Yu. M.	475.6	7	82.9	11.8	1.74
11	Tigrini Dom	Dunishenko, Yu. M.	2069.6	14	181.8	12	0.88
12	Matai	Dunishenko, Yu. M.	2487.6	24	372	15.5	1.50
13	Ussuriski Raion	Abramov, V. K.	1414.3	12	178.2	14.9	1.26
14	Sikhote Alin Zapovednik	Smirnov, E. N.	2372.9	26	277.7	10.7	1.17
15	Sineya	Fomenko, P. V.	1165.4	15	207.2	13.8	1.78
16	Terney Hunting Society	Smirnov, E. N.	1716.5	24	247.2	10.3	1.44
	Totals		23555.1	246	3057.3	12.42805	1.30

Overall, goals for size and coverage of monitoring units were met: the average size of monitoring units was 1472 km^2 (goal: 1000-1500 km^2); all units except Bolshe-Khekhtsirski Zapovednik (which is exceptionally small) had 11 or more survey routes (goal: minimum of 10), average survey route distance was at least 10 km in all but Ussuriski Zapovednik (goal: 10-20 km), and average density of survey routes exceeding 1 km/10 km^2 in all but two units (Botchinski and Tigrini Dom) (goal 1 km/10 km^2).

Measures Of Tiger Abundance

Zero Counts on Survey Routes

Reporting on zero counts on survey routes serves two purposes.

1) as noted in the Introduction, from a methodological perspective large numbers of zero counts are not desirable because they reduce our capacity to detect changes in tiger numbers, i.e., if a survey route never has an occurrence of tiger tracks reported, it does not provide information on changes in tiger numbers. Therefore, understanding the distribution of zero counts is important component of understanding the effectiveness of the sampling design.

2) Presence/absence is used as one of three indicators used to assess abundance (in this case, relative abundance) of tigers in each monitoring unit by ranking monitoring sites based on the percentage of routes without tiger tracks.

We report zero counts on survey routes when no tracks were recorded on both the early and late winter surveys. In the 1999-2000 winter, 28.5% of routes did not intersect tiger tracks. If routes were sampled a single time, there would be zero counts on nearly half (49.1%) of the routes. This result indicates that the double sampling regime (early and late winter) dramatically increases the amount of information each route provides (nearly doubling it).

The percentage of routes without tracks varied greatly among monitoring units (Figure 2). Five of the top 8 units with fewest zero counts were protected areas. Of the three

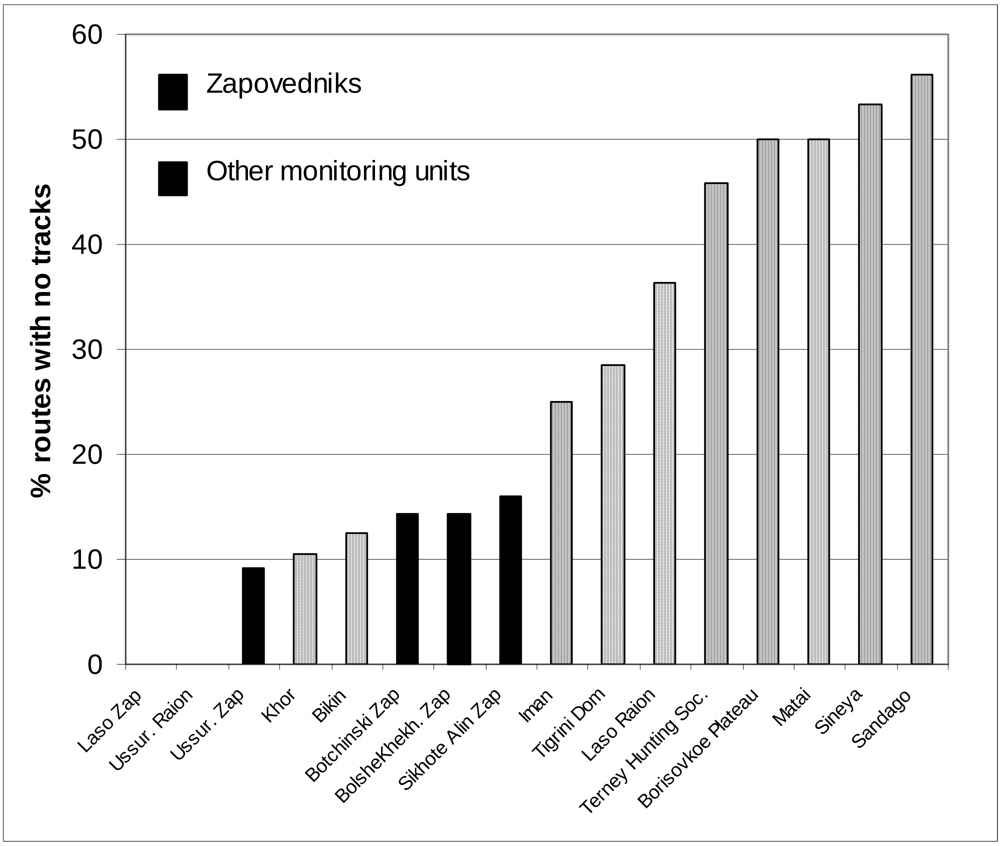


Figure 2. Percentage of survey routes with no tiger tracks within each of the 16 monitoring units of the Amur Tiger Monitoring Program, winter 1999-2000.

zapovedniks with a paired unprotected site adjacent to it, differences between Ussuriski Zapovednik and Ussuriski Raion were small (0 vs. 9.1% of routes with no tracks, with the Raion, not the zapovednik having 0%), but differences between Sikhote-Alin Zapovednik and Terney Hunting Society (16 vs. 45.8%) and Lazovski Zapovednik and Raion (0 and 36.4%) were much greater, indicating greater relative abundance of tigers in the protected areas.

There was no clear relationship between zero counts and latitude, as those four units with the highest percentage of zero counts (Borisovkoe Plateau, Sandagoy, Sineya, and Matai) include the full spectrum of southern, central, and northern sites. Similarly, there was no clear relationship between zero counts and inland versus coastal sites (Figure 2).

Track Counts on Survey Routes

The track density estimator varied significantly among monitoring sites (GLM based on ranks of track density estimator, F = 6.04, df =15,230, P = 0.0001). Mean track density provides an indication of relative abundance of tigers on monitoring sites (Table 4), but the population of track density estimators was non-normal, making the mean value somewhat biased. Using

Table 4. Summary of sample size (number of routes), track density (tracks/days since snow/100 km survey routes), standard deviation of track density, relative track density of monitoring sites using ranking of survey routes (see text), and results of Fishers Least Significant Difference range test for differences in track density among monitoring sites, based on the results of the 1999-2000 winter Amur tiger monitoring program.

Site #	Site	# routes	Mean track density	SD	Nonpara-metric ranking	LSD range test*
3	Ussuriski Zapovednik	11	6.45	4.30	1	A
1	Lasovski Zapovednik	12	3.18	1.62	2	A
13	Ussuriski Raion	12	1.90	1.29	3	A B
8	Khor	19	1.58	1.24	4	B C
9	Botchinski Zapovednik	14	1.22	1.05	5	B C D
14	Sikhote-Alin Zapovednik	25	1.29	1.58	6	B C D E
5	Bikin	16	0.95	0.83	7	B C D E
11	Tigrini Dom	14	1.13	1.26	8	C D E
6	Borisovkoe Plateau	14	2.03	3.11	9	C D E
4	Iman	12	0.86	0.78	10	C D E F
10	BolsheKhekhtsir Zapovednik	7	0.84	0.98	11	B C D E F
2	Laso Raion	11	0.99	1.23	12	C D E F
16	Terney Hunting Society	24	0.71	1.09	13	D E F
15	Sineya	15	0.47	0.59	14	E F
12	Matai	24	0.73	2.03	15	F
7	Sandagoy	16	0.34	0.58	16	F

*Sites with different letters are significantly different from each other.

ranked track density estimators indicates a somewhat different relationship among monitoring sites (comparing columns of mean track density and non-parametric ranking, Table 4). For instance, although Borisovkoe Plateau had the third highest mean track density estimator (Table 4), tracks were located on a small number of routes (i.e., many zero counts - Figure 2), resulting in a high standard deviation (Table 4) and a lower estimate of relative abundance using ranked estimators.

Four of the top six ranked monitoring sites were zapovedniks.

Expert Assessment of Tiger Numbers on Monitoring Sites

Tiger densities, based on expert assessments, varied nearly tenfold, from nearly 1 animal/100 km^2 in Ussuriski Zapovednik, to 0.13 /100 km^2 in Botchinski Zapovednik (Table 5). Explanations for this variation probably include a number of environmental factors as well as biases in the estimate. Zapovedniks (Ussuriski, Sikhote-Alin, and Lazovski) had the highest concentrations of tigers (all greater than 0.8/100 km^2), indicating that protected status is an important indicator of density (a conclusion supported by both the presence/absence and track density data). However, latitude appeared to also be an important factor: the two northernmost zapovedniks (Bolshe-Khekhtsirski and Botchinski) despite their status, reported low tiger density, as did generally the monitoring sites to the north in Khabarovski Krai (Matai, Khor, Tigrini Dom).

Table 5. Number of independent tigers (those classified as adults, subadults, and unknown) based on expert assessments of tiger tracks on 16 sites in the Russian Far East, during the first 3 years of monitoring.

		Area	Number of independent tigers			Tiger density (independents/100 km^2)		
#	Site	(km^2)	97-98	98-99	99-00	97-98	98-99	99-00
1	Lasovski Zapovednik	1192.1	6	8	10	0.503	0.671	0.839
2	Laso Raion	987.5	8	4	5	0.810	0.405	0.506
3	Ussuriski. Zapovednik	408.7	7	10	4	1.713	2.447	0.979
4	Iman	1394.3	8	6	5	0.574	0.430	0.359
5	Bikin	1027.1	3	10	7	0.292	0.974	0.682
6	Borisovkoe Plateau	1472.9	4	5	4	0.272	0.339	0.272
7	Sandago	975.8	6	6	5	0.615	0.615	0.512
8	Khor	1343.8	3	4	4	0.223	0.298	0.298
9	Botchinski Zapovednik	3051	3	3	4	0.098	0.098	0.131
10	BolsheKhekhtsir Zap.	475.6	2	1	2	0.421	0.210	0.421
11	Tigrini Dom	2069.6	4	6	4	0.193	0.290	0.193
12	Matai	2487.6	3	5	4	0.121	0.201	0.161
13	Ussuriski Raion	1414.3	5	5	2	0.354	0.354	0.141
14	Sikhote Alin Zapovednik	2372.9	24	21	23	1.011	0.885	0.969
15	Sineya	1165.4	5	6	5	0.429	0.515	0.429
16	Terney Hunting Society	1716.5	11	11	13	0.641	0.641	0.757
	Sum/Average*	23555.1	102	111	101	0.517	0.586	0.478

*Sum for numbers of independent tigers, average for densities of tigers.

There are also, however, a number of biases that may be influencing these results. The size of the monitoring site, in relation to coverage by survey routes, can inflate or depress density estimates. For instance, Botchinski Zapovednik has the lowest coverage (km survey routes/km^2) by far of any monitoring site (Table 3), so that the low density estimator may simply reflect a low search effort.

In assessing other potential biases of expert assessments, two questions are of interest: 1) how much do expert assessments vary among coordinators?, and, 2) how well do the expert assessments correlate with the other two measures of relative tiger abundance? The second issue is covered in the next section.

In an attempt to determine how much expert assessments varied among coordinators, we compared the ratio of all tracks reported for a monitoring site (only those reported on survey routes, as well as those both on and off survey routes) and the number of tigers based on expert assessments, to determine if there are large variations among coordinators (Figure 3). The results suggest that the track data are interpreted quite differently by different coordinators. The pattern demonstrated in Figure 3 suggests, for instance, that for a given number of tracks, it is likely that Dunishenko would report far fewer tigers that Smirnov. The results seem fairly stable whether only tracks on routes are used as a basis for comparison, or whether all tracks reported on a site are used (although the data also suggest this supplemental data off survey routes are an important source of information for some coordinators). The ratio appears to remain fairly constant across different monitoring sites by an individual coordinator (e.g., Dunishenko is always low, Smirnov is always high). These results suggest that these expert assessments may not be extremely valuable in comparing density estimates across monitoring sites, and that their main value will be in evaluating trends within each give site, assuming that the same coordinator does the evaluation of data for an extended time period.

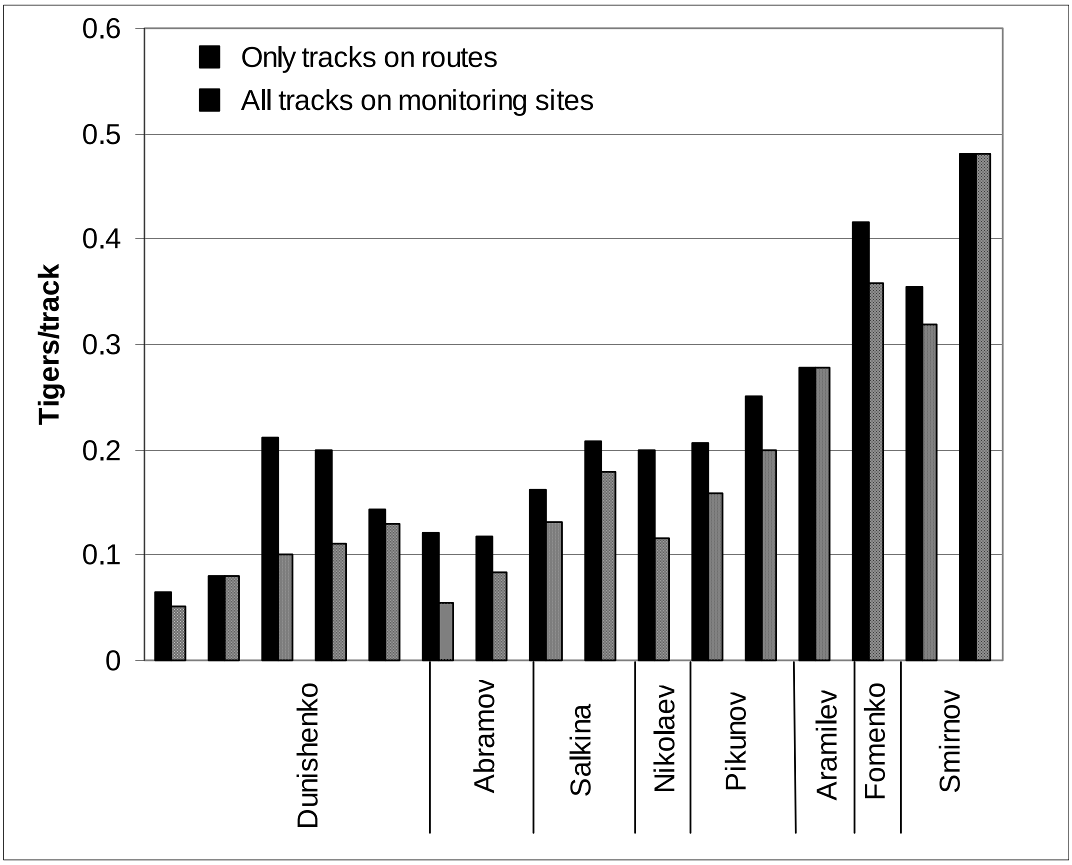


Figure 3. Variation in interpretation of track data for expert assessments by coordinators of the Amur tiger monitoring program, estimated from only tracks found along survey routes, and from total number of tracks throughout monitoring site (i.e., including tracks reported off survey routes). For any given number of tracks, a smaller tigers/track ratio indicates that fewer tigers would be reported.

Correlations Among 3 Tiger Abundance Indices

To assess the relationship of presence/absence, track densities, and expert assessments of tiger numbers, we ranked each site for each separate index in terms of relative abundance of tigers, and then estimated Spearman's rho for the three, 2-way comparisons to determine correlations among the three indicators (Table 6).

Table 6. Correlations (using Spearman's rho) of three indicators of tiger abundance, based on the ranks of each monitoring site for each indicator, for data from the 1999-2000 Amur tiger monitoring program

	Presence/ absence	Track indicator	Expert assessment
Presence/absence	1		
Track indicator	0.901	1	
Expert assessment	0.101	0.094	1

The results suggest that while the correlation between presence/absence and track density estimators is very high and significant (Spearmans $\rho = 0.9007$, n=16, $P = 0.0001$), there were non-significant and very poor correlates with the expert assessments (Table 6).

The correlation between presence/absence counts and track density is perhaps not

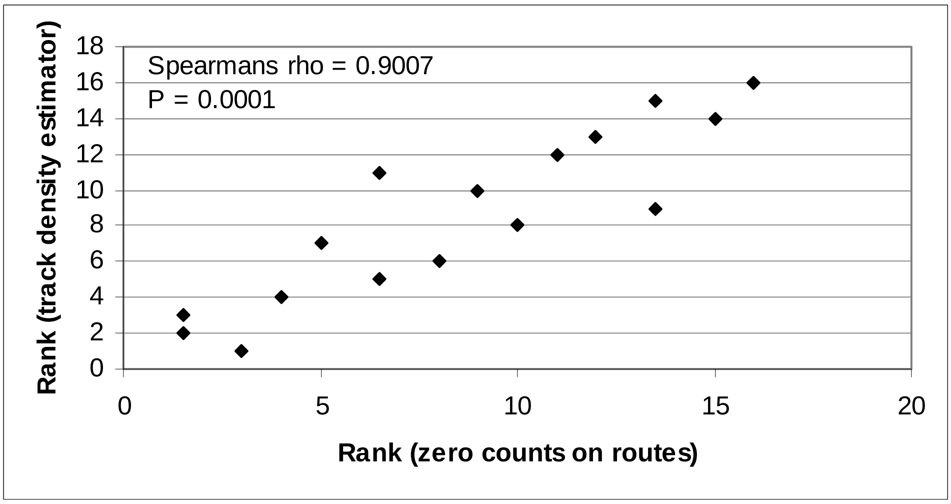


Figure 4. Relationship of two indicators of relative abundance on monitoring sites, based on: 1) ranking of sites based on percentage of survey routes with tigers (presence/absence); and, 2) ranking of sites based on mean of ranked track density estimators.

surprising, given that the information is coming from the same source (tracks on survey routes), but the strength of the relationship (Figure 4) is reassuring in that both indicators demonstrate the same pattern in terms of tiger abundance. There are a number of potential explanations for the lack of correlation between the expert assessments and other abundance estimators. While the presence/absence and track indicators both rely solely on data from survey routes, expert assessments include track data from other sources, and interview information. The fact that coordinators apparently interpret track data differently (Figure 3) also makes it unlikely that track densities and expert assessments will show a strong correlation.

Measures of Reproduction, Sex-age Structure, and Mortality

Reproduction on Monitoring Sites

Expert assessment of tiger numbers and sex-age structure provide an opportunity to track changes in reproduction and population structure over time. Reproduction appeared to drop off slightly for the 1999-2000 season (Table 10, Figure 5). On all 16 sites combined, only 12 litters produced 15 cubs, with both number of litters and number of cubs decreasing from previous years. However, and analysis of cub density (see below) demonstrated no significant change.

Litter size has remained fairly stable, with litters of one making up over 83% of the total number of litters (88, 78, and 83% for the 3 years) (Table 11). The first litter of 3 reported in the

Table 7. Number of litters, and number of cubs produced on each monitoring unit for 3 winters, based on expert assessments of tiger tracks.

		Year							
		97-98		98-99		99-00		Total	
	Monitoring site	# litters	# cubs	# litters	# cubs	# litters	# cubs	# litters	# cubs
1	Lasovski Zapovednik	1	1	1	2	0	0	2	3
2	Laso Raion	2	2	1	2	0	0	3	4
3	Ussuriski. Zapovednik	2	2	3	3	1	3	6	8
4	Iman	0	0	0	0	1	1	1	1
5	Bikin	1	1	0	0	2	2	3	3
6	Borisovkoe Plateau	0	0	1	1	1	1	2	2
7	Sandago	2	3	1	1	0	0	3	4
8	Khor	0	0	0	0	0	0	0	0
9	Botchinski Zapovednik	1	1	1	1	2	2	4	4
10	BolsheKhekhtsir Zapovednik	0	0	1	1	0	0	1	1
11	Tigrini Dom	0	0	1	1	1	1	2	2
12	Matai	2	3	2	2	1	2	5	7
13	Ussuriski Raion	-	-	1	2	0	0	1	2
14	Sikhote Alin Zapovednik	5	5	3	4	1	1	9	10
15	Sineya	1	1	0	0	1	1	2	2
16	Terney Hunting Society	-	-	2	2	1	1	3	3
	Total	17	19	18	22	12	15	47	56

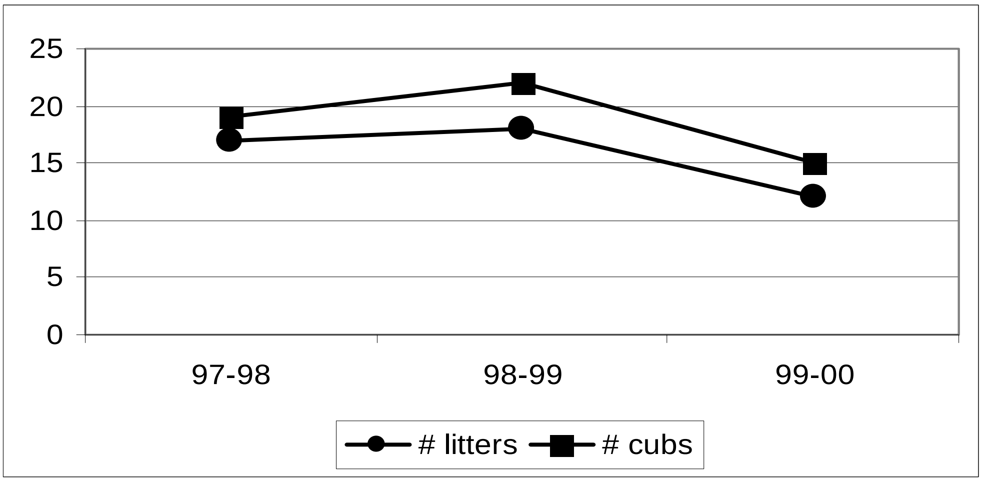


Figure 5. Total number of litters and total cub production summed across all 16 monitoring sites in the Russian Far East, for the first 3 years of monitoring.

monitoring program was recorded in Ussuriski Zapovednik this winter. Because litter size is recorded for cubs of all ages that are still in association with their mothers, this value in no way reflects litter size at birth, which is no doubt significantly higher. Because litter size has not varied across years, number of cubs and number of litters has retained a tight association (Figure 5).

Table 8. Size of all litters recorded in 4 winter surveys in 16 monitoring sites for Amur tigers in the Russian Far East.

Litter size	97-98	98-99	99-00	Total
1	15	14	10	39
2	2	4	1	7
3	0	0	1	1
Total	17	18	12	47

We used cub density to compare productivity across areas and years, ranking all estimates for all sites across all years, and employing an unbalanced GLM analysis (estimates for two sites were not available for the first year). We included two variables, year, and protected status into this model. The analysis indicated that there has been no significant change in cub density among the three years (F = 0.41, df = 2, 45, P = 0.6633), but that zapovedniks had much higher cub densities than unprotected areas (F = 6.27, df = 1, 45, P = 0.0165) (Figure 6). The 1998-1999 winter was particularly productive in zapovedniks (Table 10, Figure 5). Although we are not able to compare recruitment in various monitoring sites, these results suggest that protected areas are acting as source populations for the Sikhote-Alin tiger population, and may be critical to maintaining stability in the overall population.

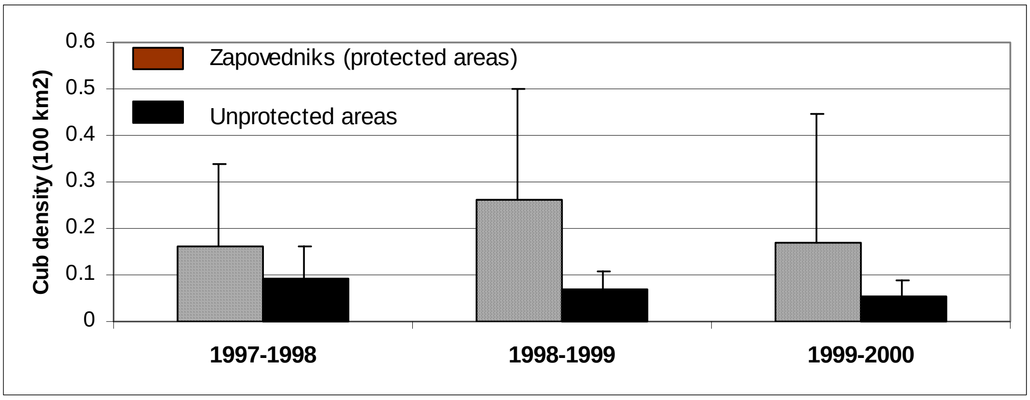


Figure 6. Cub density in zapovedniks and unprotected areas for the first 3 years of monitoring Amur tigers in the Russian Far East.

Sex-age Structure on Monitoring Sites

Although there are numerous sources of potential error in using expert assessments of track data to derive sex-age structure of tiger populations, two factors suggest this information can be useful: 1) a high percentage of unknowns (Table 9) suggest that project coordinators are fairly conservative in attributing sex-age attributes to animals where information is insufficient; 2) assuming the same coordinators develop these data for extended periods, the data will show trends if there are any changes in population structure.

Table 9. Number of tigers, by age class, and sex (for adults only) on 16 monitoring sites in winter 1999-2000, based on expert assessments.

		Age						Totals		
		Adults								
#	Site	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independents*	Total (all tigers)
1	Lasovski Zapovednik	3	4				3	7	10	10
2	Laso Raion	3	1				1	4	5	5
3	Ussuriski Zapovednik	1	2			3	1	3	4	7
4	Iman	2	1		1	2	1	3	5	7
5	Bikin	2	2	1	1	1	1	5	7	8
6	Borisovkoe Plateau	1	2	1		1		4	4	5
7	Sandago	1	1				3	2	5	5
8	Khor	2	2					4	4	4
9	Botchinski Zap.	2	2			2		4	4	6
10	BolsheKhekhtsir Zap.	1	1					2	2	2
11	Tigrini Dom	3	1			1		4	4	5
12	Matai	1	1		2	2		2	4	6
13	Ussuriski Raion	1	1					2	2	2
14	Sikhote-Alin Zap.	7	7		4	1	5	14	23	24
15	Sineya	2	2		1	1		4	5	6
16	Terney Hunting Soc.	5	5			1	3	10	13	14
	Total	37	35	2	9	15	18	74	101	116

*Independent = adults, subadults, and unknown.

The tiger population in all monitoring sites combined is dominated by adults (63%), with subadults representing 8%, and animals of unknown age (which probably all represent adults and subadults) representing 15% of the population (Table 9). Cubs represent 13% of the total animals recorded. The male:female ratio of adults was nearly equal this year (Table 9). We combined adults, subadults, and animals of unknown age to develop a sex ratio statistic for independent animals across all years (Table 10). This sex ratio estimator demonstrates a consistent trend of females being a slightly larger percentage of the population than males (1.2:1). However, about one-third of the animals are reported of unknown age. Radiotelemetry studies suggest that the majority of these are likely females, in which case the actual sex ratio of the population is likely to be much more skewed than these data suggest.

Table 10. Sex ratio of independent tigers on 16 monitoring site based on expert assessments of track data during 4 winter surveys.

	Males	Females	Unknown	Ratio (Females:Males)
1997-1998	35	39	28	1.1 : 1
1998-1999	26	41	44	1.6 : 1
1999-2000	38	39	24	1 : 1
2000-2001	34	47	15	1.4 : 1
Total	133	166	111	1.2 : 1

Reports of Tiger Mortalities

Only 2 reports of tiger mortalities were recorded by project coordinators for the 1999-2000 winter, bringing a total 21 mortalities reported across the first three years of the monitoring program. These results contrast sharply with 1998-1999, when 14 deaths were reported in Primorski Krai (Table 11). This database is presently maintained only for Primorski Krai, and therefore represents only a portion of the total tiger range in Russia. At present there are likely too many biases in how this data is collected to derive any estimates of mortality rates (human-caused or otherwise) or spatial distribution of mortalities. Results from these first three years demonstrate that most reports come from the vicinity of zapovedniks, where a cadre of forest guards, scientists, and interested field technicians are more likely to report tiger mortalities than elsewhere across tiger range (Figure 7).

Adults make up a smaller percentage of the mortalities than of the reported population in the monitoring sites (38 versus 63%), and subadults slightly more (19 versus 8%), but the number of animals of either unknown age or sex makes all comparisons questionable (Tables 9 and 11). Reports of cubs, both in the living population and in mortality data, may be slightly more reliable because they are such a distinctive class. Their representation in the monitoring sites and in the mortality database are approximately equal (13 versus 19%, respectively).

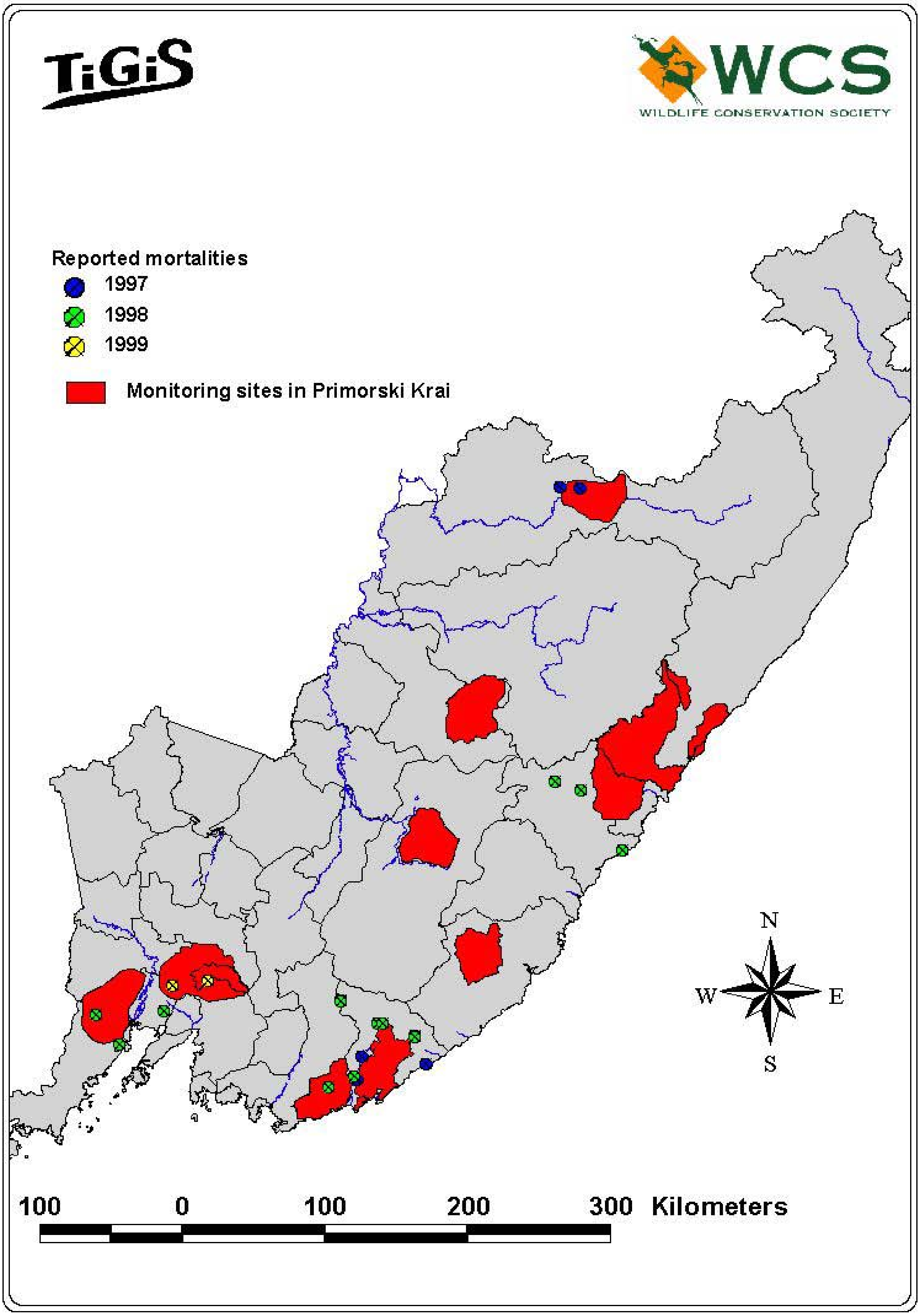


Figure 7. Locations of reported tiger mortalities from coordinators of the Amur tiger monitoring program (Primorski Krai only), for 1997-1998 through 1999-2000.

Table 11. Reports of tiger mortalities from coordinators of the Amur tiger monitoring program in Primorski Krai, 1997-1998 through 1999-2000.

Age	Sex	1997-1998	1998-1999	1999-2000	Total
Adults	Males	1	2		3
	Females		2	2	4
	Unknown	1			1
Subadults	Males	1	1		2
	Females		1		1
	Unknown	1			1
Unknown	Unknown		5		5
Cubs		1	3		4
Totals		5	14	2	21

Ungulate populations on Monitoring Sites

As expected, prey numbers varied greatly among sites (Table 11). Sika deer populations, which only occur in southern and central monitoring sites, can occur at very high densities (e.g., Lazovski Zapovednik and Borisovskoe Plateau), which greatly increases the total prey biomass potentially available in those regions. Red deer populations tend to be inversely related to sika deer populations, but red deer never attain the densities reported for sika deer. Highest densities of red deer, based on track density estimators, are in Sikhote-Alin Zapovednik, and secondly, in Bolshe-Khekhtsirski Zapovednik.

Wild boar and sika deer tend to occur in larger aggregations than roe and red deer, and this clumped distribution results in larger errors associated with means. This clumped distribution may also account for what appears to be more dramatic variation in yearly averages across all sites (Figure 10) – averages vary dramatically dependent on whether our sampling design “hits” upon a few large groups. Based on track densities, wild boar tend to be the least common of the prey species on 14 of 16 sites (excluding sika deer where they do not occur or rarely occur).

Using mean values of these indicators to test for variation among sites or across years is inappropriate because exploratory analyses demonstrated that many were non-normally distributed. To test for differences among years for each species, we ranked estimators for each route for each site, plotted median track densities across all sites, (Figure 8), and compared ranks of track density estimators across years using a GLM model (SAS 1998). These analyses suggested that there were significant changes in red deer ($F= 7.03$, $df = 3, 980$, $P = 0.0001$) and roe deer ($F= 5.40$, $df = 980, 3$, $P = 0.0011$) numbers, but not wild boar ($F= 0.72$, $df = 980, 3$, $P = 0.5378$) or sika deer ($F= 1.1$, $df = 980, 3$, $P = 0.3485$) (sika deer tested only for those 7 sites where they normally occur). For both red deer and roe deer, the only year that was significantly different from others was the 1997-1998 winter. Given that this year represented the first year of the monitoring program, it is not clear whether these differences reflect real changes in population densities, or simply methodological problems associated with initiation of the program. Estimates of ungulate densities were initially given a lower priority in establishing the monitoring program, and because there was less discussion of the methodologies to be used, it is highly likely that these statistically significant variations may simply be methodological anomalies. Despite the apparent upward trend in sika deer numbers, because of their clumped distribution, variation was too great across the range to detect a significant trend.

Table 12. Track count estimates for 4 prey species of tigers on 16 monitoring sites for the 1999-2000 winter period.

		# routes	Red deer		Wild boar		Roe deer		Sika deer	
#	Monitoring site	n	mean	std	mean	std	mean	std	mean	std
1	Lasovski Zapovednik	12	6.94	15.66	5.24	10.45	3.90	4.89	108.28	158.11
2	Laso Raion	11	1.18	3.76	0.30	0.49	0.67	1.41	41.79	65.13
3	Ussuriski. Zapovednik	11	6.98	6.98	4.13	3.31	10.33	10.65	30.72	45.74
4	Iman	12	5.34	7.23	0.19	0.40	2.98	3.94	-	-
5	Bikin	16	8.01	6.62	0.30	0.65	1.74	2.85	0.00	0.00
6	Borisovkoe Plateau	14	0.00	0.00	5.53	5.95	4.58	6.46	65.74	87.40
7	Sandago	16	9.90	10.78	2.68	4.04	6.70	5.69	4.06	3.98
8	Khor	19	3.98	4.46	0.37	0.74	2.73	3.38	0.00	0.00
9	Botchinski Zapovednik	14	4.33	2.50	0.00	0.00	2.69	2.85	-	-
10	BolsheKhekhtsir Zapovednik	7	13.65	12.75	0.61	1.09	0.16	0.42	-	-
11	Tigrini Dom	14	1.38	1.39	1.00	0.90	0.36	0.74	-	-
12	Matai	24	3.76	3.97	2.05	2.03	2.10	1.22	-	-
13	Ussuriski Raion	12	4.28	3.67	2.07	2.68	12.05	7.70	2.69	3.56
14	Sikhote Alin Zapovednik	25	27.02	22.64	3.25	5.09	20.05	21.05	4.68	12.59
15	Sineya	15	2.77	3.74	0.61	1.07	2.37	1.83	0.00	0.00
16	Terney Hunting Society	24	10.75	11.62	1.33	2.02	5.52	8.19	1.73	5.29
	Totals	16*	6.89	6.52	1.85	1.83	4.93	5.25	32.46	38.46

*sample size for sika deer =8 sites where sika deer normally occur.

Aside from the first year differences, there do not appear to be any clear trends in any of the prey populations, when viewed as an average, across all 16 sites (Figure 8). These data, suggesting stable, or potentially slightly increasing populations, do not reflect the opinions of may regional biologists and local hunters, who often express concern of decreasing numbers of ungulate species. This issue is of critical concern to tiger conservation, and deserves a more thorough treatment than is possible using our tiger monitoring methodologies, which are designed with a priority to detect changes in the tiger population, and not ungulate numbers.

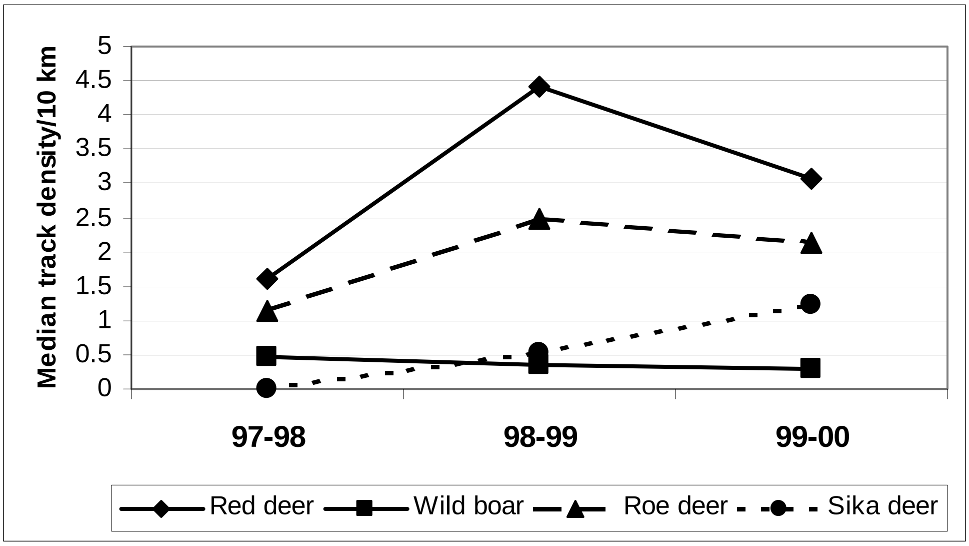


Figure 8. Changes in relative abundance of prey numbers, 1997-98 through 1999-2000, based on track density estimators derived from survey routes on 16 monitoring sites across Amur tiger habitat in the Russian Far East (estimates for sika deer are derived only from those sites where they regularly occur, n=7).

Trends in the Amur Tiger Population

Normally, trend analyses combine a graphical assessment with regression analyses (Thompson et al. 1998). With only three years of data, it is still early to conduct intensive regression analyses, but it is still possible to plot out yearly averages and begin to look for patterns in all three tiger abundance indices. Additionally, we can conduct non-parametric analysis of yearly abundance indices to determine if significant differences exist between any years. Assessments of tiger reproduction, population structure, and information on trends in ungulate numbers can help to assess present status, and provide a basis for making prognoses for the future. Finally, reviews provided by individual coordinators (see Section II) help provide clues to trends in individual monitoring sites. Cumulatively, the assessments of these coordinators provide a valuable resource for tracking changes at each site, and ultimately, over the entire range of tigers.

Two of the three indicators of tiger abundance showed similar trends – track densities and densities of independent tigers showed a slight increase in the second year of monitoring, followed by a slight decrease in the 1999-2000 season (Figures 10-11). In contrast, the presence/absence index showed a slight decrease in the number of routes with tigers present in 1998-1999, followed by a subsequent increase. Overall, none of these changes were large, and none were statistically significant. Overall, the results suggest that the tiger population was fairly stable as a whole over the previous three years, at least within these monitoring sites.

To test for yearly variation in track densities, we used the non-parametric "Quades" test (Conover 1980, which uses the ranks of the observations (mean track densities within each site) within each block (site) across treatments (years). This 2-way analysis of variance on ranks essentially tests whether certain years were higher/lower than others, on average. The results (Quades test $T = 1.02$, df = 2, 30, $P > 0.25$) appear to conclusively rule out changes in population numbers between years, based on track density estimators.

It may be more valuable to look at the pattern of changes for each of the units to determine if any regional and local shifts may have been occurring. Comparing changes in both track densities and tiger densities between the first and second years, and second and third years of monitoring, there do not appear any obvious trends that carry across all sites (Figures 12, 13, Table 13). Changes in track density estimates between the first two years suggest that there were more negative changes (10) than positive (5), but just the opposite trend is suggested in looking at tiger densities (Table 13). Changes between the second and third year appear to be more balanced, with approximately equal numbers of sites showing decreases and increases (Table 13).

Table 13. Number of monitoring sites that showed increases (+), decreases (-) or no change (0) in track and tiger density estimators, based on comparisons of each pair of consecutive years (see Figures 12 and 13) of the Amur tiger monitoring program.

		Direction of change		
Winters under comparison	Density estimator	+	-	0
(1997-1998) - (1998-1999)				
	Track densities	5	10	1
	Tiger densities	8	4	4
(1998-1999) - (1999-2000)				
	Track densities	8	7	1
	Tiger densities	6	9	1

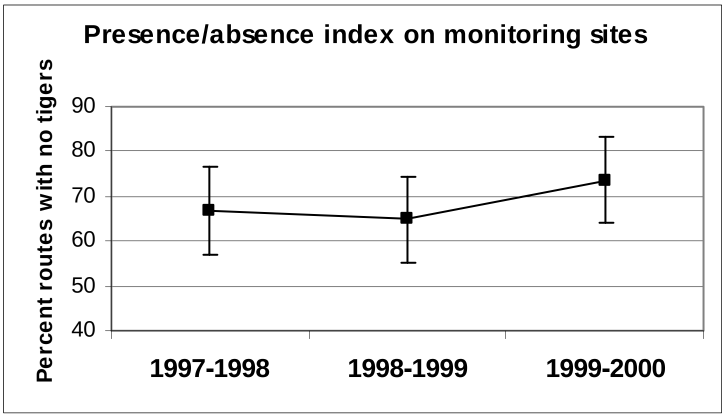


Figure 9. Presence/absence index (mean percentage of routes with tigers) for 16 monitoring sites for Amur tigers, Russian Far East over three years.

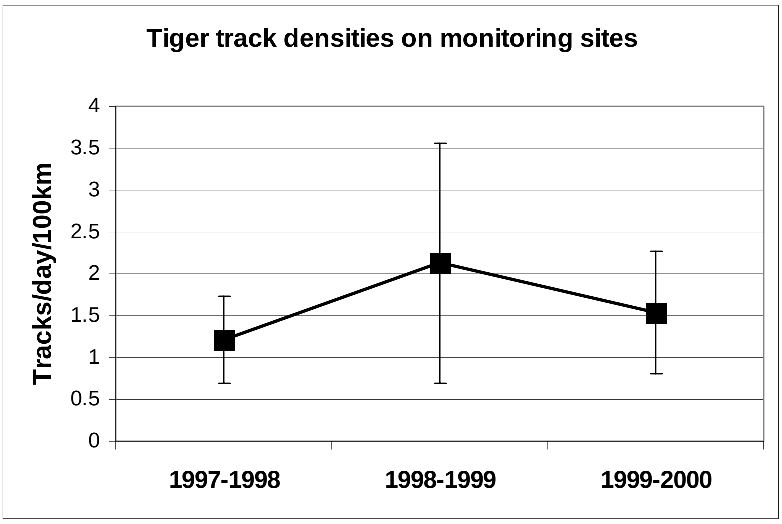


Figure 10. Mean track density estimator for 16 monitoring sites for Amur tigers, Russian Far East over three years.

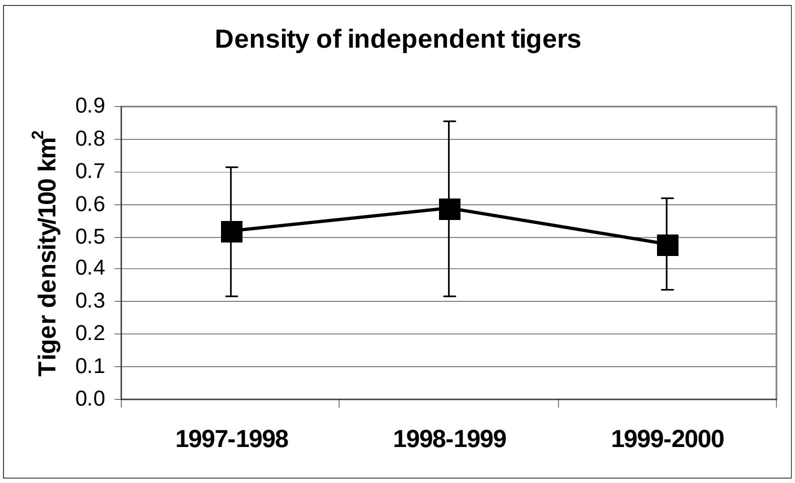


Figure11. Mean tiger density (independent animals/100 km^2), based on expert assessments, 16 monitoring sites for Amur tigers, Russian Far East over three years.

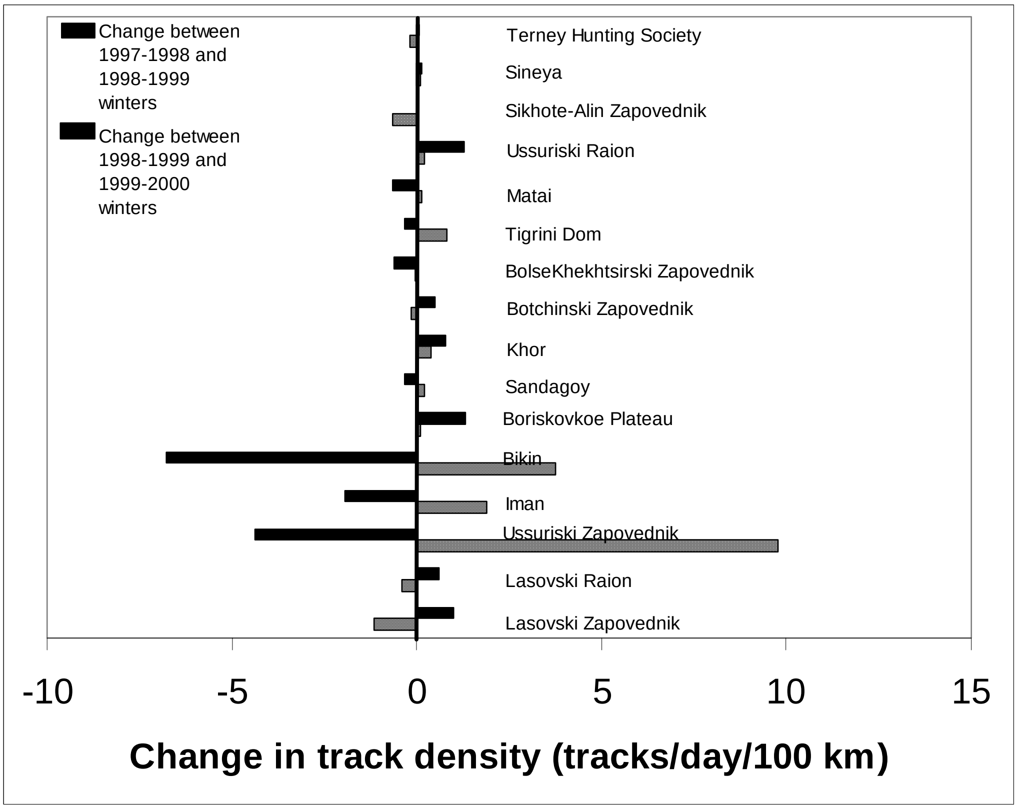


Figure 12. Changes in track density estimators for Amur tiger monitoring sites from the 1997-1998 winter to the 1998-1999 winter, and from the 1998-1999 to the 1999-2000 winter.

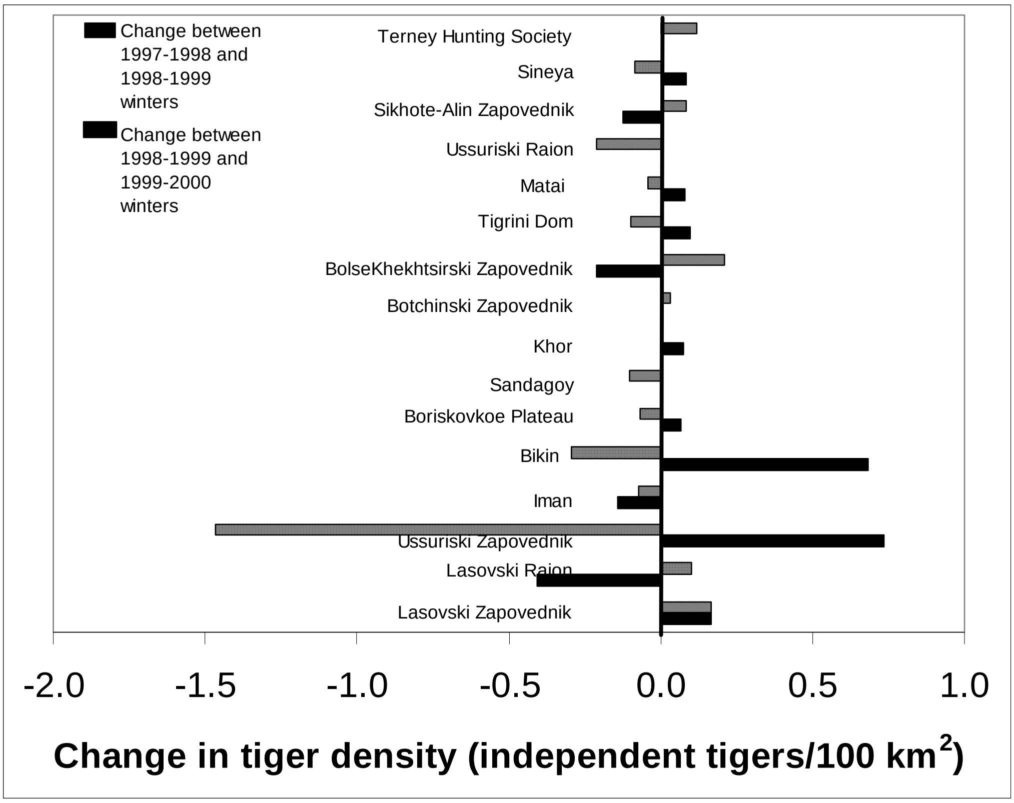


Figure 13. Changes in tiger density estimates based on expert assessments for Amur tiger monitoring sites from the 1997-1998 winter to the 1998-1999 winter, and from the 1998-1999 to the 1999-2000 winter.

Two sites, Ussuriski Zapovednik and the Bikin, showed dramatic increases between the first two years, and subsequently nearly as dramatic decreases between the next two years, whether track or tiger density estimators are compared (Figures 12, 13). These sites should be monitored closely in the future to determine if these fluctuations were temporary abnormalities, whether instability is a feature of these particular systems, or perhaps whether there are methodological issues that need to be addressed.

Aside from first year variations, the ungulate data, when viewed in summary, does not suggest that there are dramatic changes occurring in any of the prey species populations. However, lumping all sites together may result in a smoothing effect that is not truly indicative of local conditions. A review of individual sites (see Section II) suggests that there are localized regions of concern. Project coordinators for the Bikin, Ussuriski Zapovednik and Ussuriski Raion sites suggest that ungulate numbers are decreasing in those areas. In contrast, for the 5 sites in Khabarovsk, the ungulate population appears to be relatively stable (Section II). Coordinators for 7 of the 16 sites commented that habitat conditions or populations themselves of either ungulates or tigers were worsening, but others considered the situation relatively stable for the short term. No one indicated that conditions are improving, although localized increases in some prey populations were noted (e.g. wild boar in Borisovskoe Plateau).

A drop in number of litters and number of cubs in the 1999-2000 is a point of concern, and this indicator should be tracked closely in the coming years. This dip, in connection with the indications of slight declines in two of the three tiger density estimators, is sufficient cause for concern, but by themselves are insufficient to indicate conclusively that the population had declined over the past year. Next years results, particularly in relation to cub production and ungulate densities, will be particularly interesting.

In summary, results of the first three years of monitoring Amur tigers in the Russian Far East suggest that the population may have experienced a slight increase between the first and second years, followed by a slight decrease between the second and third years, but this trend is not consistent across all three trend indices for tigers, and is not statistically significant A decrease in cub production, and localized depressions in ungulate numbers, are also causes for concern. Future monitoring will be important to determine whether these trends continue.

V. LITERATURE CITED

Conover, W. J. 1980. Practical nonparmetric statistics, 2nd Edition. John Wiley & Sons.
Thompson, W. L., G. C. White, C. Gowan. 1998. Monitoring vertebrate populations. Academic Press.
SAS 1998. SAS Release 6.12 TS Level 025. SAS Institute Inc. Cary, N.C.

VI. REPORTS ON INDIVIDUAL MONITORING SITES 1999-2000

INTRODUCTION

Following are brief summaries of each monitoring site. For each site, a summary of the highlights and results of the year are provided by the coordinator for that site. Additionally, a map of the area, including location of survey routes, location of tiger tracks reported on survey routes during both surveys (early and late winter) and location of tiger tracks reported off survey routes (or reported at another time than the actually survey) is also provided. These track data provide the basis for the three estimators of tiger abundance (presence/absence, track density, and number of independent tigers) (see Section I), each of which is summarized in a graph for the first three years of the monitoring program for each site. A summary table of the sex-age distribution of tigers in each site, based on expert assessments is also provided, which includes information on reproduction. Ungulate track density estimators are summarized in a table, and for comparative purposes, in a bar graph as well.

Some sites, such as Ussuriski Zapovednik and Ussuriski Raion, or Sikhote-Alin Zapovednik and Terney Hunting Society, are reported on together by the single coordinator responsible for them. All 5 sites in Khabarovsk are reported on together by Yu. M. Dunishenko, who provides an excellent assessment of conditions there.

In summary, results of this year's monitoring program at each of these sites represent a "snap-shot" of conditions existing across tiger range in the Russian Far East. By reviewing the sum of these data it is possible to derive a better understanding of the variation in conditions across this vast area for tigers, and to better appreciate local variations, trends, and conditions for tigers and their prey base.

LAZOVSKI ZAPOVEDNIK

Southeast Primorski Krai

Report on results of Amur tiger monitoring program in Lazovsky Zapovednik monitoring unit in winter 1999-2000

Coordinator - G. P. Salkina

1. Name of monitoring unit: Lazovsky zapovednik
2. Coordinator: G. P. Salkina
3. Time of simultaneous counts: the first count - December 27 - January 10. Count on 10 routes was conducted from December 27 to December 30 (i.e. during 4 days). The count on route # 11 was conducted on January 10 because there was no snow earlier. The second count was conducted from February 23 to March 3. Ten routes were traveled during four days (February 23-26), and one route was traveled on 3rd of March.
4. Routes ##: 1-12
5. Total length of routes: 117 km and all routes were traveled on foot.
6. Conditions:

First count. The first snow did not fall on the coast, and the second snowfall was on 24th of December. On the 4th day after snowfall 10 routes out of 12 were traveled. Route # 10 (on the coast) was traveled on the third day after snowfall because snow was melting fast. After the first count, which was conducted on 24th of December, there was no snow on the route # 11. During the first week of January, snow fell almost nonstop and we were able to conduct the count only on 19th of January. In inland part of the reserve snow depth was: in valleys - 7-22 cm, on northern slopes - 8-20 cm, on southern slopes - 5-10 cm, on passes - 14.5-17.5 cm. On the coast snow was 2-3 cm deep in valleys, 4 cm - on northern slope, and 2-2.5 cm - on ridges. After second snowfall snow depth on 11th routes was: in valleys - 11-20 cm, on northern slope - 20.5-27 cm and 4.5 cm - on ridge.
Second count. In inland part of the reserve snow depth was: in valleys - from 9 up to 57.5 cm, on northern slopes - 44.5-65 cm, on southern slopes - from 14 to 57.5 cm, on ridges - 32.5-65 cm. On the coast snow was 3-25 cm deep in valleys, 20.5 cm - on northern slope, 13-19.5 cm on southern slopes and 6-23 cm - on passes. There were no snowfalls after 6th of January and the count was conducted on routes with numerous tracks («mnogosleditsa») except route # 5 that was traveled on the fourth day after snowfall. It was more difficult to conduct the second count than the first one because of deep snow. It was impossible to walk along the routes located inland without skies.

7. Assessment of efficiency: In December, there was no snow on the coast. One route was traveled 11 days later than others in the reserve. But most likely, it did not influence the results because indirect data suggest that tigers visit Preobrazhenski forest district very rarely, as was confirmed during the count. During the second count, snow was everywhere. Routes situated inland were impassable without skies. Two fieldworkers tried to do this but they had to spend a night in a forest. Due to this fact, the route # 5 was not traveled in time. Then snow fell and the route was traveled 5 days later than all other routes. The count was conducted in the end of February because many people at this time had influenza.

In sika deer habitat it was difficult to count individual tracks because of grouping behavior (large aggregations of deer moving together) and territorial conservatism is typical for this species. At a spot it was difficult to determine where feeding ("zhirovka") begins and ends. That is why all crossings are counted in zapovednik. In order to include an adjustment coefficient it is necessary to process existing data and to conduct special investigations.

8. Summary of results:

Habitat conditions and status of ungulate populations

Such prey species of tiger as wild boar, elk, sika deer, roe deer and musk deer inhabit the monitoring unit. An average acorns crop in autumn of 1999 and average winter were favorable for ungulate populations. Based on December and February survey data (mean number is taken) total ungulate density increased by 13% in comparison with winter season 1995-1996. If we compare only counts made in February (in winter 1995-1996 counts were made in February only) then total ungulate density is on the same level. Counts made on "white trail" show different results.
A high level of illegal hunting on ungulates continues. Illegal hunting takes place especially in zapovednik buffer zones, where there are convenient access roads. During past years (from March to March) only two cases of illegal hunting on ungulates were reported in the zapovednik. It is absurd (i.e., unrealistic) estimate.

Habitat conditions and status of tiger population in comparison with previous information (for example with data of Tiger census 1996)

Survey results showed that the number of adult tigers remains the same as in winter season 1995-1996. However, numerous tracks ("mnogosleditsa") probably have influenced this survey results. Before the count in February there was no snowfall for about month and a half and this fact could result in overestimation. Old tracks of the same tiger enlarged, and fresh tracks left on a trail have partly printed pad. On the other hand, it was difficult to determine how many times the same tiger came off the trail and returned (for old tracks).

In the zapovednik tigers has become rare on the coast. No tracks were found on two routes in December and January although they were traveled at 11 days interval. No tiger signs were found on route # 12 although they were common here before. Tigers have changed their travel patterns here.

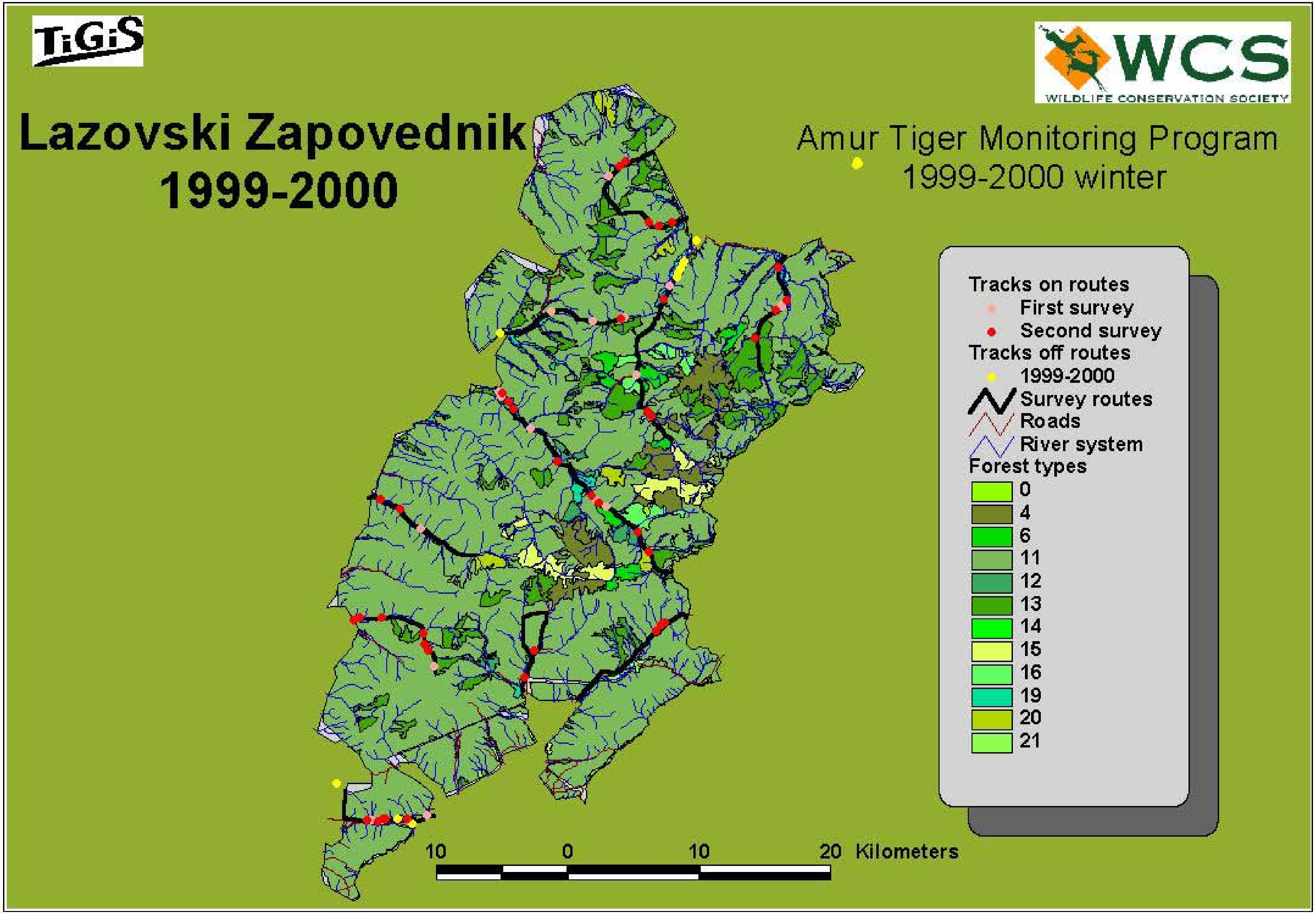
No litters were found in zapovednik from March 1999 until March 2000. During this period 3 reports about cubs' tracks on the coast were made by forest guards and local people. We have thoroughly examined this information on the ground but it was not confirmed. In 1996 three litters of 8 cubs were found in zapovednik. The absence of tiger cubs in the zapovednik could be explained by direct persecution of tigers by poachers. It is known that "new" tigers in a "new" place do not immediately begin to reproduce. Indirect evidence of the fact that tigers are "newcomers" lies in the fact that tigers have changed their travel patterns along the coast.

Therefore, tiger population in Lazovsky Zapovednik is enduring difficult times. For the first time since 1960s no tiger litters were found. But effective reproduction is the evidence of good population status. Therefore, we can conclude that existing tiger protection today is not effective.

Habitat conditions

Spring and fall of 1999 were rainy otherwise there will be much more fires in the area.
High level of illegal hunting for ungulates still remains, and the number of discovered illegal kills is low - less than 10%. Moreover, there is no such term in zapovednik as unrevealed law violations. Violations (poaching) are not being registered, except poached ungulates - because this information is necessary for scientific researchers.

Zapovednik's territory (especially the coast) is under intensive recreational pressure. Moreover, there are many people searching for ginseng during visits to the zapovednik in summer.


TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Lazovski Zapovednik
1999-2000
Amur Tiger Monitoring Program
1999-2000 winter
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2000
Survey routes
Roads
River system
Forest types
0
4
6
11
12
13
14
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16
19
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21
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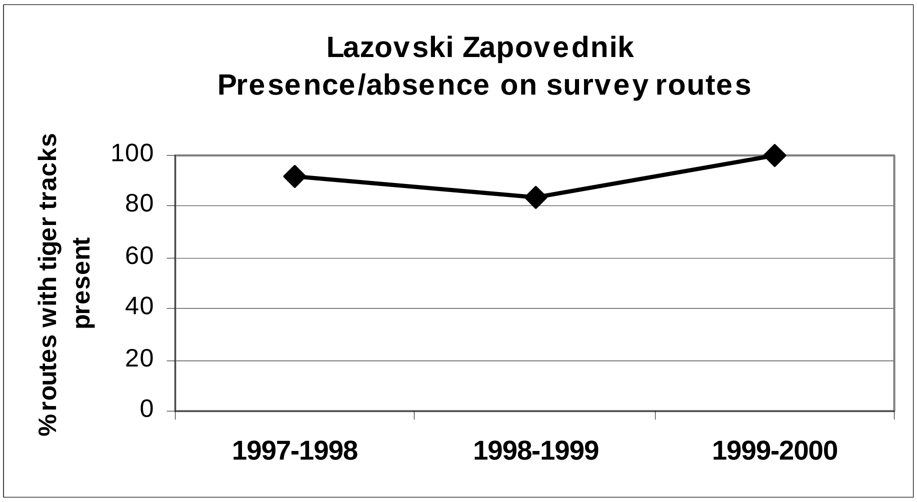
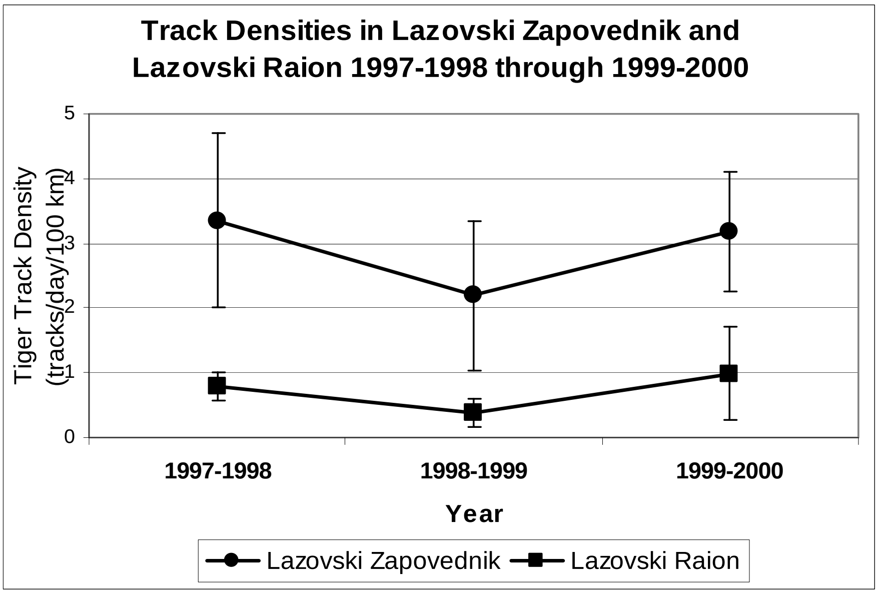
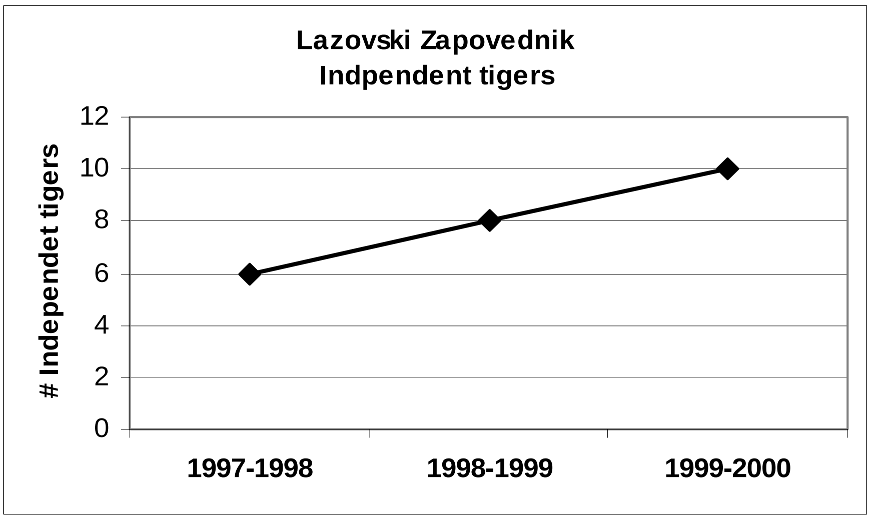
10
20 Kilometers



Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in Lazovski Zapovednik and adjacent unprotected site in Lazovski Raion



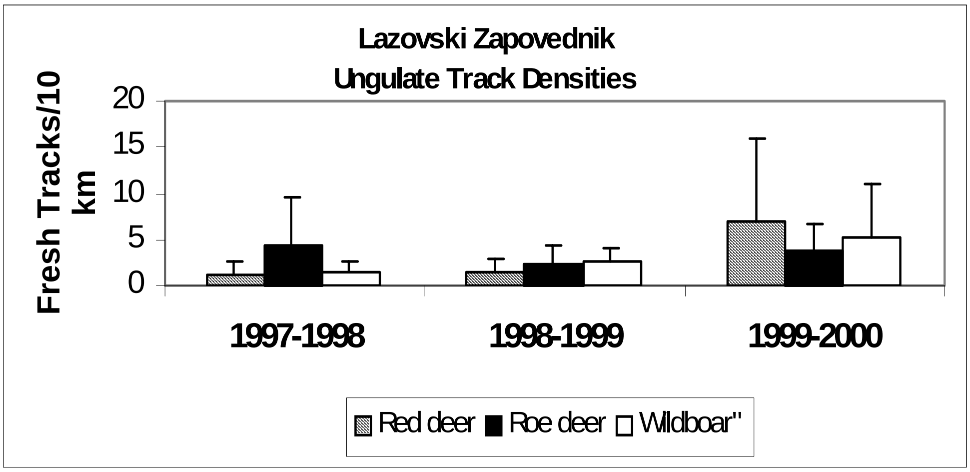
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

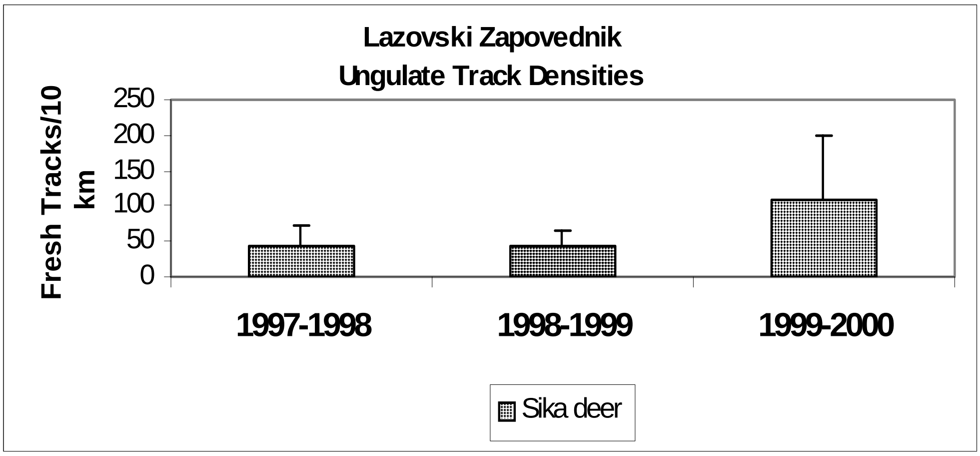
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independ ents*	Total (all tigers)
1	Lasovski Zapovednik	1997-1998	0	0	0	0	0	6	0	6	6
1	Lasovski Zapovednik	1998-1999	0	1	0	0	2	7	1	8	10
1	Lasovski Zapovednik	1999-2000	3	4	0	0	0	3	7	10	10

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997		1998		1999		Total
				mean	std	mean	std	mean	std	mean
1	Lasovski Zapovednik	Red deer	12	1.234	2.392	1.490	2.640	6.945	15.659	3.223
1	Lasovski Zapovednik	Roe deer	12	4.301	9.258	2.401	3.602	3.901	4.891	3.334
1	Lasovski Zapovednik	Sika deer	12	45.178	50.585	43.850	39.937	108.282	158.110	80.174
1	Lasovski Zapovednik	Wild boar	12	1.451	2.163	2.523	2.728	5.242	10.453	3.574





LAZOVSKI RAION
Southeast Primorski Krai

Report on results of Amur tiger monitoring program in Lazovsky Raion monitoring unit in winter 1999-2000 Coordinator - G. P. Salkina

1. Name of monitoring unit: Lazovsky raion
2. Coordinator: G. P. Salkina
3. Time of simultaneous counts: January 10-16 and February 16-21
4. Routes ##: 1-11
5. Total length of routes: 9 routes (115 km) were traveled on foot, 2 routes were partly (20 km) traveled on foot and partly - by vehicle.
6. Conditions: There were two snowfalls in December but on the coast snow had melted. At the beginning of January, it had been snowing for a week. The survey began on the fourth day after snowfall. In Krivaya basin the snow cover was: in valleys - 14-28.5 cm, on northern slopes - 26-47 cm, on southern slopes - 11-24 cm, and on ridges facing sea - 11.5-24 cm. At this time on the shore snow cover was: in valleys - 6.5-16.5 cm, on southern slopes - 11.5-24 cm. The second count was conducted from 15 to 21 of February. There were no snowfalls for about month and a half. The whole area was covered with snow except southern slopes that had patchy snow cover (were partly covered with snow). In Krivaya river basin the snow cover was 18-39 cm, on northern slopes - 18-31.5 cm, on ridges facing sea - 12-29.5 cm. On the shore snow cover was: in valleys - 10 cm, on ridges - 12-29.5 cm. On southern slopes, on places with snow, it was up to 24.5 cm deep.
7. Assessment of efficiency: During the first count snow was everywhere, people had time to establish roads and to make trails. During the second count, there was no snow cover in some places on the slopes facing sea. But it was possible to count tigers there. The possibility of missing a tiger can be considered low. As for ungulates - they were counted on such parts of routes (see table 3b). The survey was complicated by the absence of snowfall and tiger tracks on the roads were quickly destroyed by vehicles. But there were only three such routes. Numerous crossings ("mnogosleditsa") also made tracks identification difficult.
In sika deer habitat it was difficult to identify tracks due to multiple crossings of aggregations of deer,. At a spot it was difficult to determine where feeding ("zhirovka") begins and ends. That is why all crossings are counted in zapovednik. In order to include an adjustment coefficient it is necessary to process existing data and to conduct special investigations.

8. Summarizing of results:

Habitat conditions and status of ungulate populations

Prey species of tiger such as wild boar, elk, sika deer, roe deer and musk deer inhabit the monitoring unit. The average acorn crop in autumn of 1999 and average winter were favorable for ungulate populations. Total ungulate density (number of crossing per 10 km of route) in February was reduced twice in comparison with data obtained in December. If to compare data on ungulate density obtained in February 1996 and in February 2000 - this index has slightly decreased. Most likely ungulate density has decreased significantly. First, the last count was conducted by more experienced fieldworkers who registered all crossings. Second, on six routes very few crossings were registered.

A high level of poaching remains. During the survey 30 skins of sika deer were found despite the fact that hunting for sika deer is prohibited in Lazovsky Raion. In state hunting inspection there is no such term as "undisclosed infringement" - illegal kills are not registered.

Habitat conditions and status of tiger population in comparison with previous information (for example with data of Tiger census 1996)

Survey results showed that the number of adult tigers had been reduced to half of what occurred here in the 1995-1996winter season. Numerous tracks ("mnogosleditsa") probably influenced this survey results. Before the survey in February there was no snowfall for about month and a half and this fact could result in overestimation. Old tracks of the same tiger enlarged, and fresh tracks left on a trail have partly printed pad. On the other hand, it was difficult to determine how many times the same tiger came off the trail and returned (for old tracks).

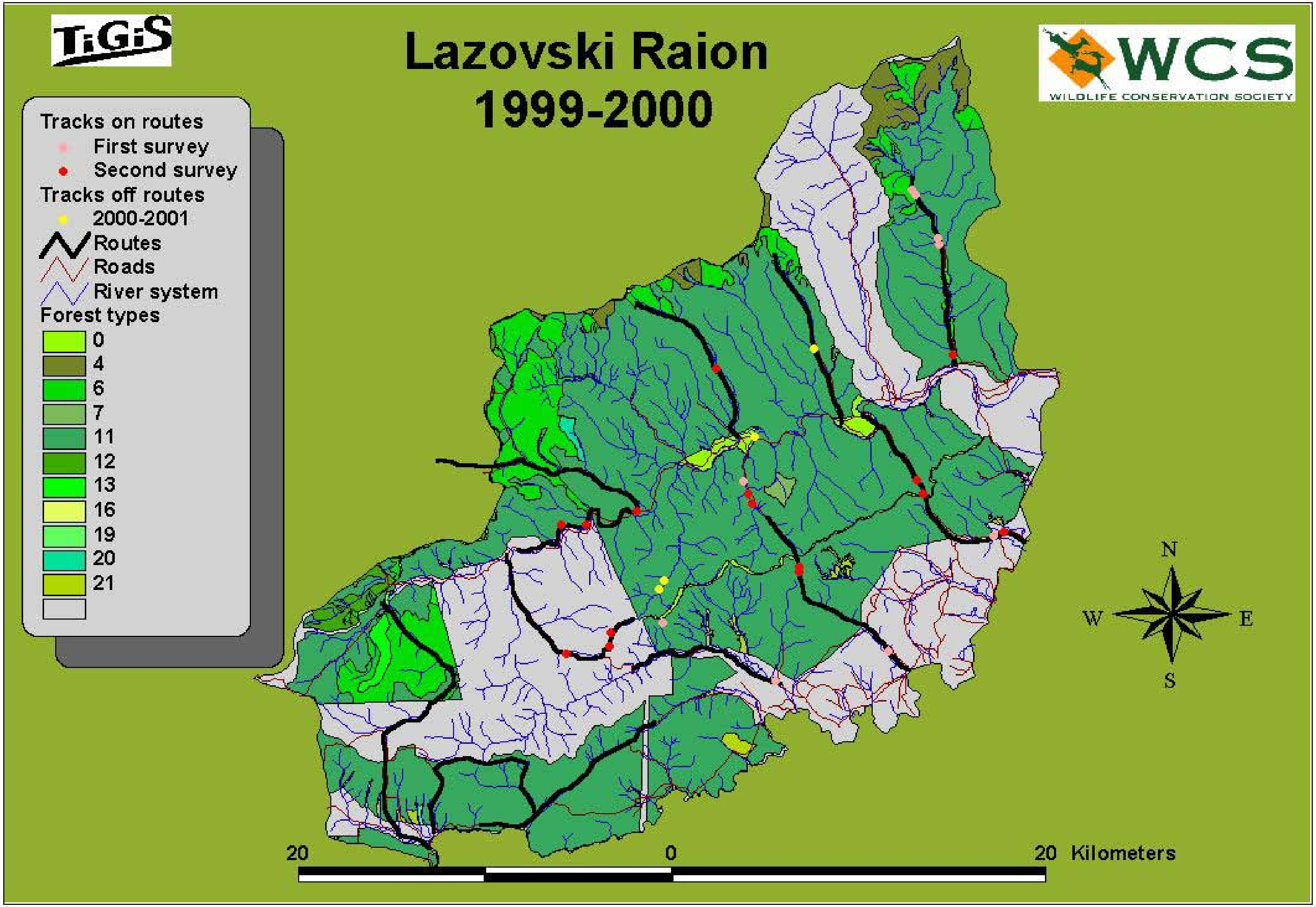
During the first count, tiger tracks were not found on seven routes of 11, in the second count - on five routes, despite the fact that there was no snowfall for about month and a half. No tracks were found on four routes both during the first and the second count. The following tendency is tracked. Last year tigers were rarely found in adjacent areas of Partizansky Raion, which borders monitoring unit. This year tracks were not found in the southeastern part of unit from the direction of Nakhodka and Partizansk towns, which is an area often visited by people.

No tiger litters were found. Hunters say that there were no litters last year. In 1995 until February 1996 four litters including five cubs were registered in this territory. It looks like tigers are hanging around the settlements. During the first count on Sinegornaya river tigers (male and female) left numerous tracks near logger's trail, where they were attracted by dogs. During the second count, the male was also registered here. Both in the first and in the second counts tiger tracks were found near Kievka village. In Komyndov creek area a tiger walked around a cabin, examined a rubbish heap and had been lying for a long time near this place. Above Sinegornaya river there was an accident when tiger demonstrated aggression when a man attempted to confiscate its prey. Tiger was not killed only because the hunter had unsafe rifle and was afraid to shoot.

Therefore, the status of tiger population in Lazovsky Raion monitoring unit became worse in comparison with 1995-96 winter season. For the first time for many years, litters were not found. But effective reproduction is the evidence of good population status. Therefore, we can conclude that existing tiger protection today is not effective.

Habitat conditions

Spring and fall of 1999 were rainy otherwise there would be much more fires in the area.
High level of illegal hunting for ungulates still remains, and the number of discovered illegal kills is low - less than 15%. Everyday during the second count (when hunting season had already been closed) fieldworkers heard the shots or saw poachers. Heavy recreational pressure in the territory takes place. Krivaya river valley is being occupied, new khutors are being built (many of which are poachers' bases). Logging has increased.
In Polozov creek valley 3 km of road were destroyed by flood and this fact can be considered as positive event.


TiGiS
Lazovski Raion
1999-2000
WCS
WILDLIFE CONSERVATION SOCIETY
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Routes
Roads
River system
Forest types
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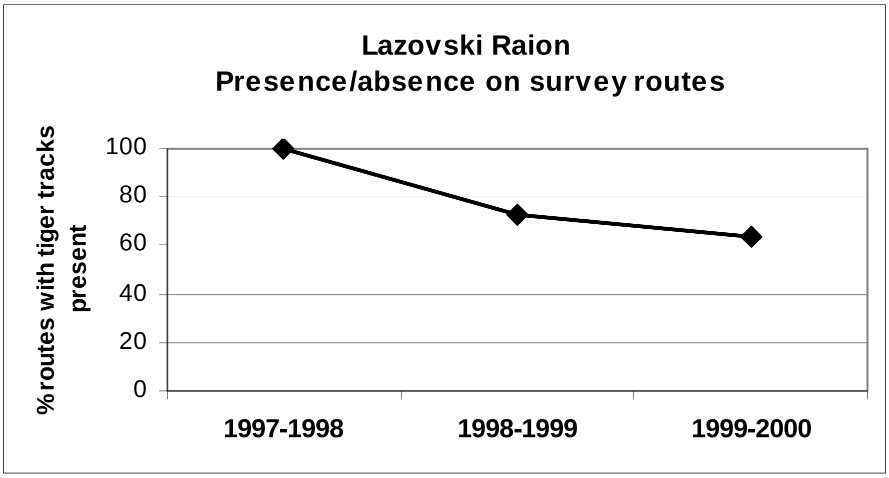
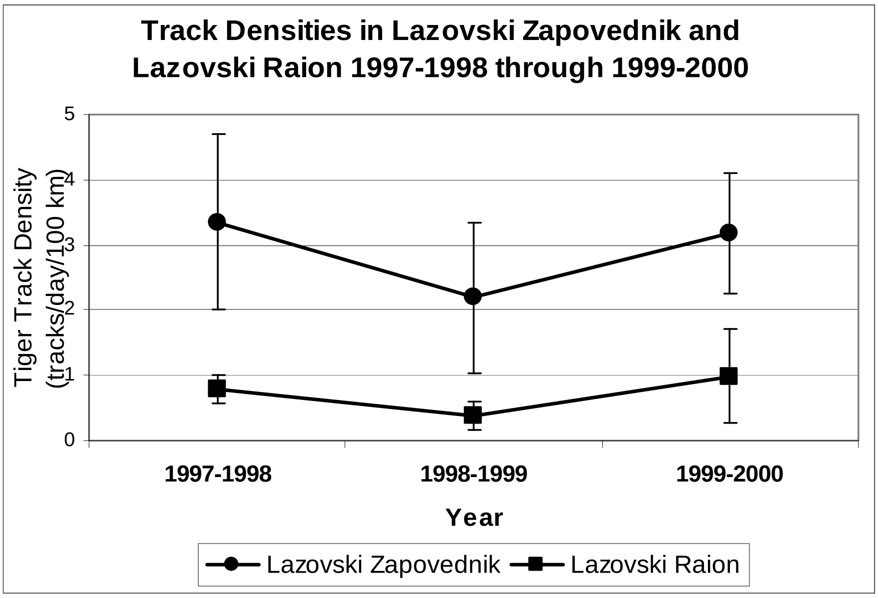
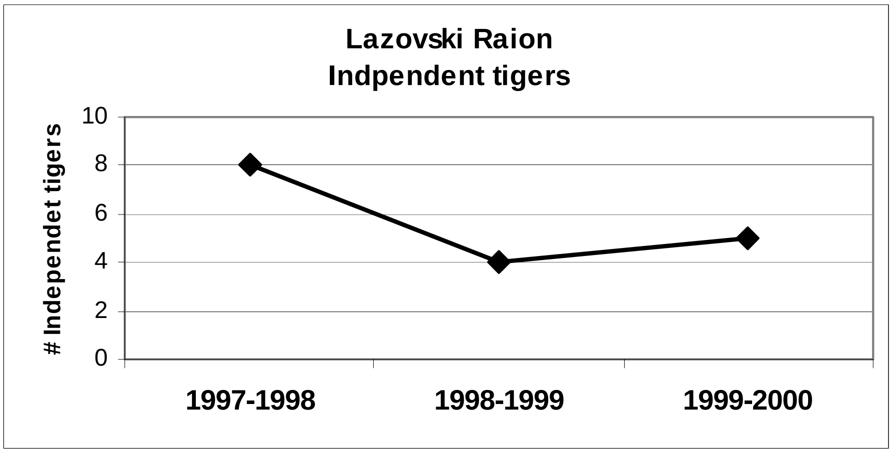


Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in Lazovski Zapovednik and adjacent unprotected site in Lazovski Raion



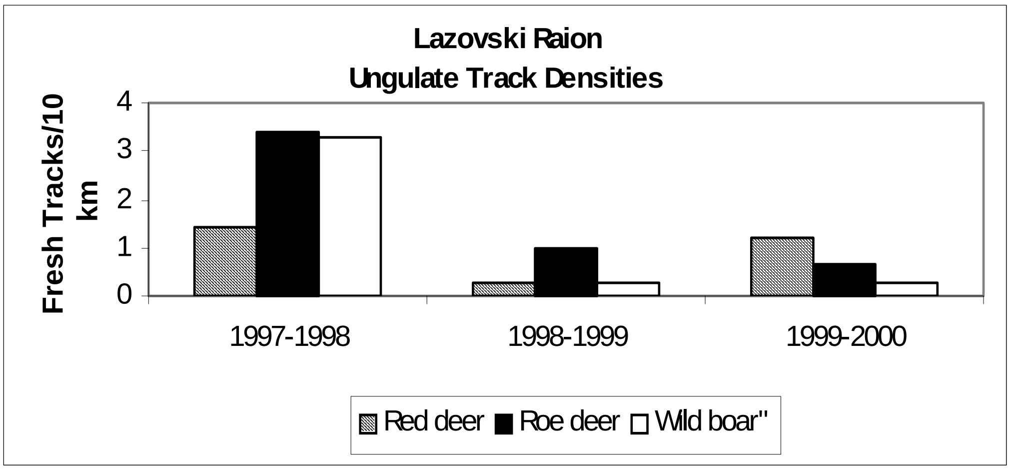
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

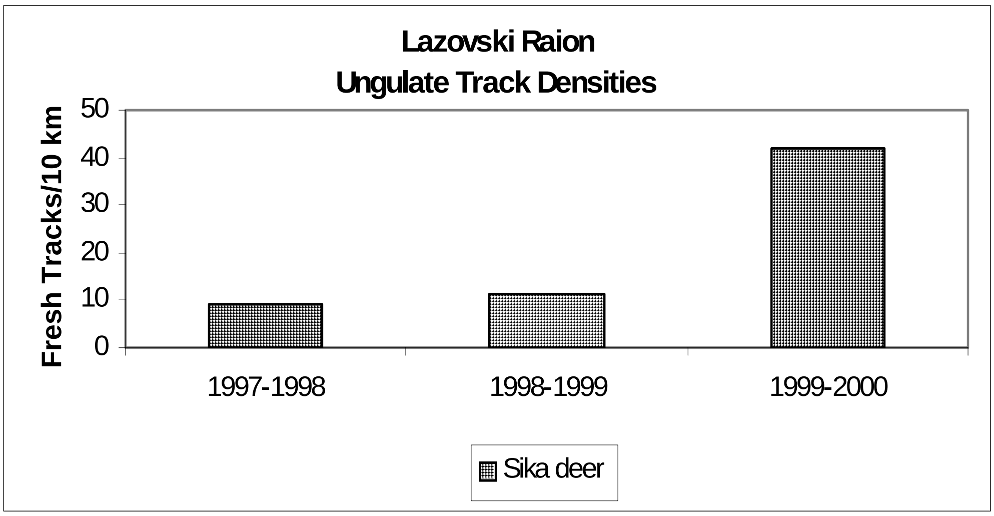
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

#	Site	Year	Age: Adults: Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Totals: Total adults	Total independents*	Total (all tigers)
2	Lazovski Raion	1997-1998	0	2	0	0	0	6	2	8	8
2	Lazovski Raion	1998-1999	0	1	0	0	2	3	1	4	6
2	Lazovski Raion	1999-2000	3	1	0	0	0	1	4	5	5

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	Total mean
2	Lazovski Raion	Red deer	11	1.414	3.683	0.254	0.564	1.182	3.757	0.758
2	Lazovski Raion	Roe deer	11	3.424	5.466	1.012	0.969	0.667	1.411	1.303
2	Lazovski Raion	Sika deer	11	9.314	6.993	11.435	12.098	41.785	65.131	28.544
2	Lazovski Raion	Wild boar	11	3.283	2.027	0.299	0.606	0.298	0.493	1.037





USSURISKI ZAPOVEDNIK AND USSURISKI RAION
Southcentral Primorski Krai
1999-2000

Report on results of Amur tiger monitoring program in Ussuriisky Zapovednik and Ussuriiski Raion monitoring units in winter 1999-2000

Coordinator - V.K. Abramov

Tiger and ungulate survey was conducted in December 21-23, 1999 and in February 18-19, 2000. The territory as in previous winter season was divided into two units: zapovednik and raion.

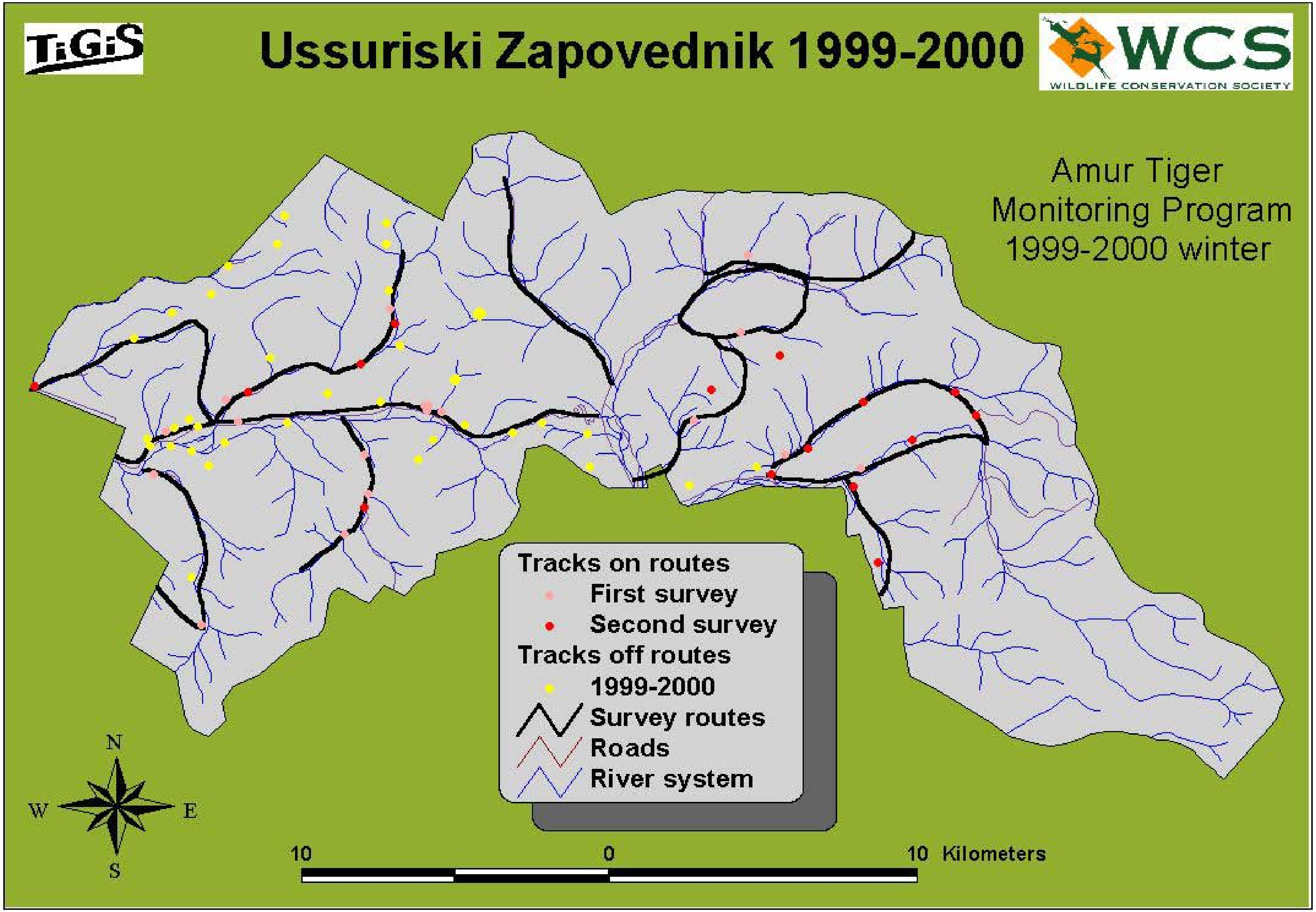
Routes ## 1, 5, 6, 7, 8, 12, 14, 15, 17, 22, 23, 23 are located in Zapovednik monitoring unit and routes ## 4, 9, 10, 11, 13, 16, 18, 19, 20, 21, 24 are located in Raion monitoring unit. Total length of survey routes is 302.4 km including routes traveled on foot -209.9 km and by vehicle - 92.5 km. In zapovednik steady snow cover formed after snowfall that took place on December 20, 1999. During the first phase of survey, snow cover height varied (depending on relief and vegetation) from 5 to 16 cm. Before the beginning of the second phase of survey snowfall took place on February 15 and during the field work snow cover height varied (depending on relief and vegetation) from 4 to 40 cm, and on most routes snow cover was 22-23 cm.

In December one male and one individual of unknown sex and age (probably subadult, independent tiger) were not registered during the survey. In February, tracks of cubs and one individual of unknown sex and age were not found. But these gaps in December and February counts were supplemented with information obtained between and after these counts. Based on monitoring data we can estimate the total number of tigers in the monitoring units as: two males, two females, and one female with cub, three cubs and one individual of unknown sex and age.

During the last year, the number of tigers in monitoring unit has decreased. First of all, it concerns two litters. The litter, which lived in Perevoznaya and Kamenushka river valleys (route # 3), disappeared entirely - female and two cubs. Most likely, they were poached in summer or autumn 1999. The second litter that lived in Levaya Komarovka river valley in Zapovednik (route # 7) also disappeared. It is suggested that female died or was killed, but one cub survived. Probably tracks # 20, 21, 73, 74 in zapovednik and track # 6 in the Raion belong to him.

The status of ungulate populations (elk, wild boar, roe deer and musk deer) became worse. The number of ungulates is decreasing both in the zapovednik territory and adjacent areas. Sika deer numbers in the zapovednik are stable or even potentially increasing s their range extends.

In comparison with past winter season human disturbance has decreased - people visited the forest seldom because of bad pine nuts crops.


Ussuriski Zapovednik 1999-2000
TiGIS
WCS
WILDLIFE CONSERVATION SOCIETY
Amur Tiger
Monitoring Program
1999-2000 winter
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2000
Survey routes
Roads
River system
N
W
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10
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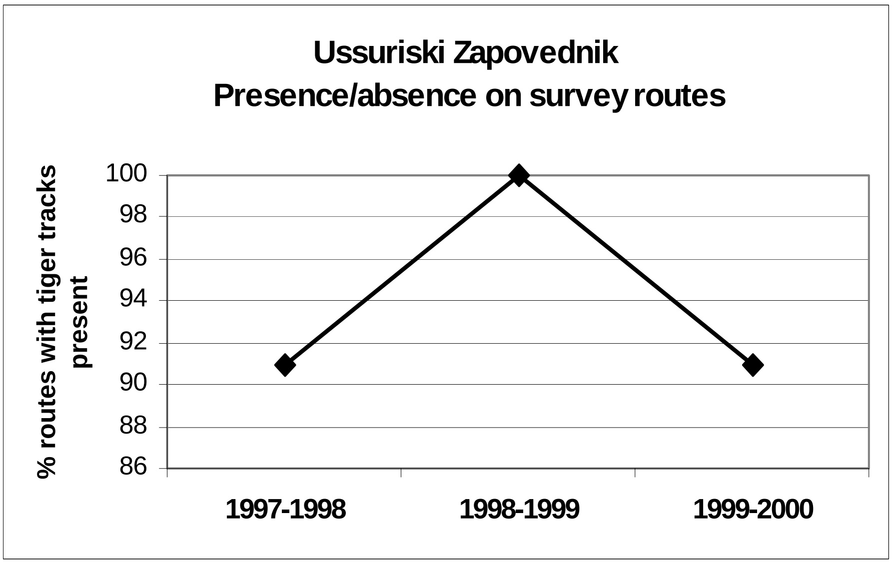
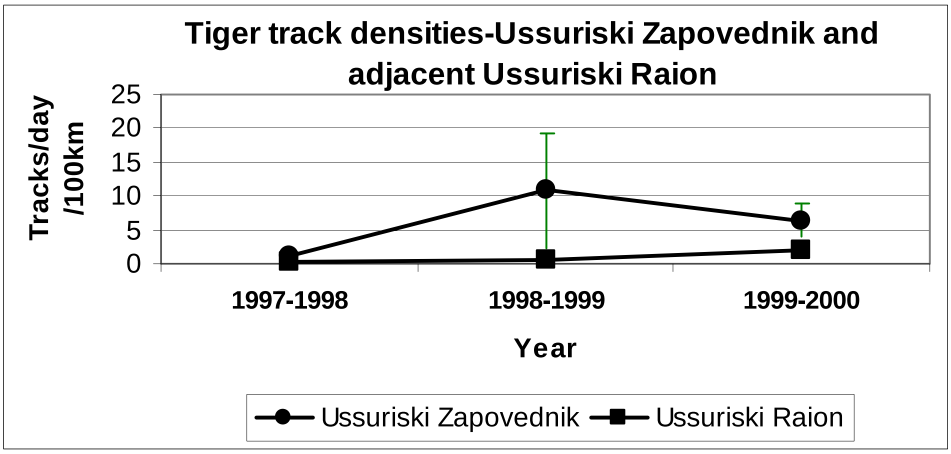
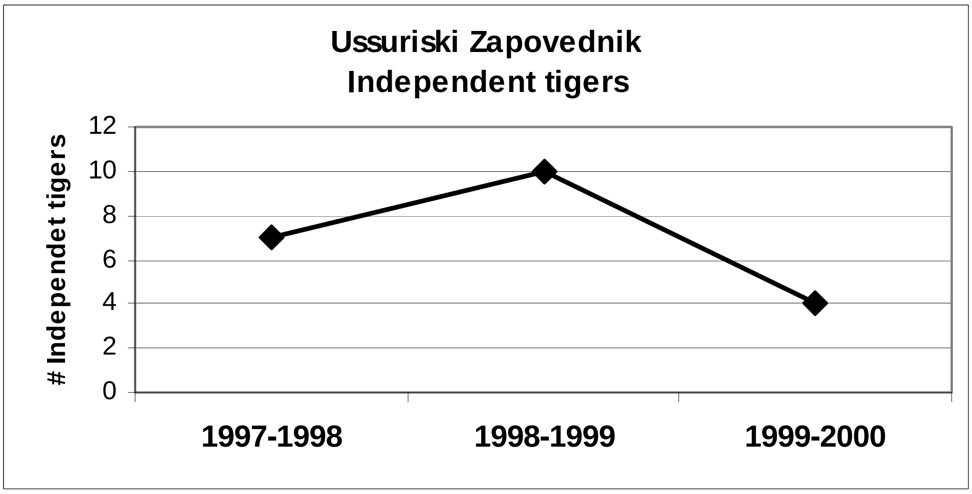


Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in Ussuriski Zapovednik and adjacent unprotected site in Ussuriski Raion



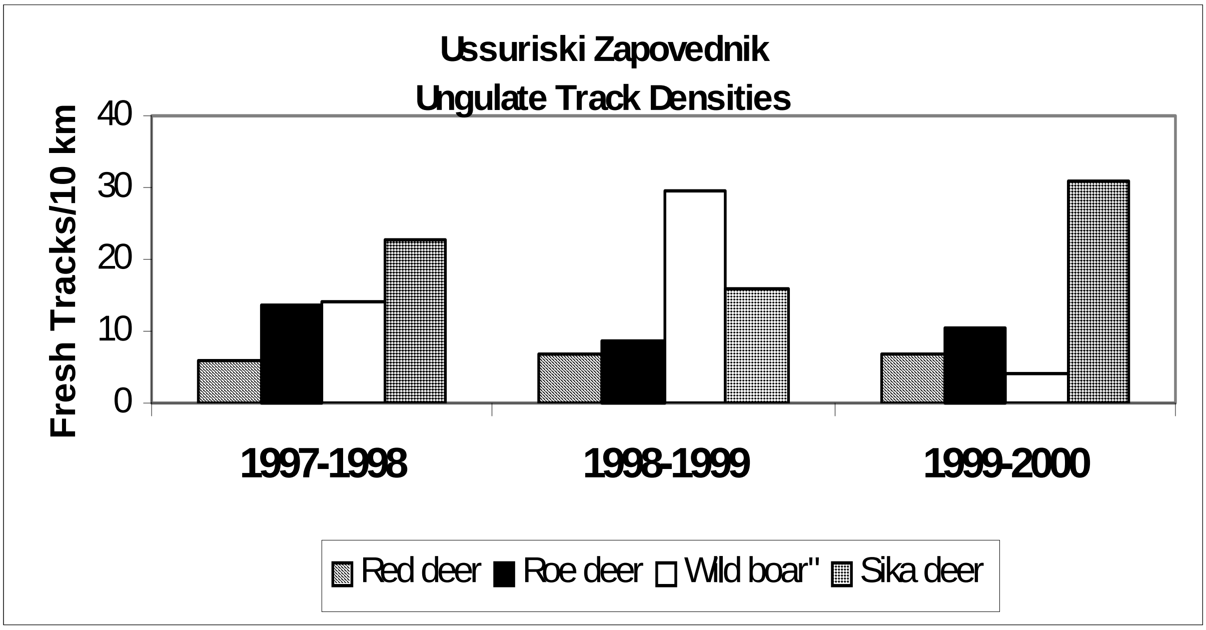
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

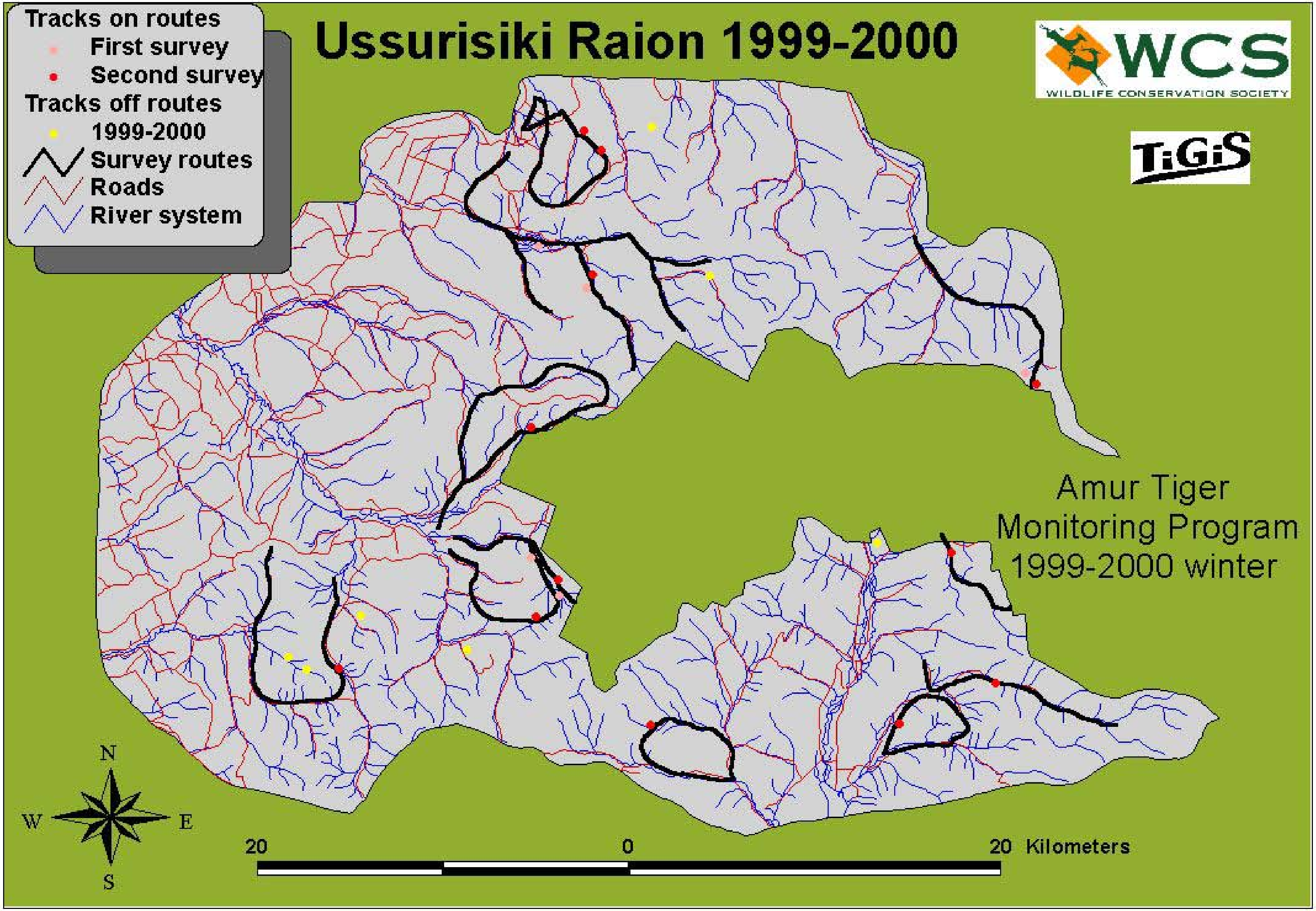
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

#	Site	Year	Age: Adults: Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Totals: Total adults	Total independ ents*	Total (all tigers)
3	Ussuriski Zapovednik	1997-1998	0	0	0	1	0	6	0	7	7
3	Ussuriski Zapovednik	1998-1999	0	1	0	2	0	7	1	10	10
3	Ussuriski Zapovednik	1999-2000	1	2	0	0	3	1	3	4	7

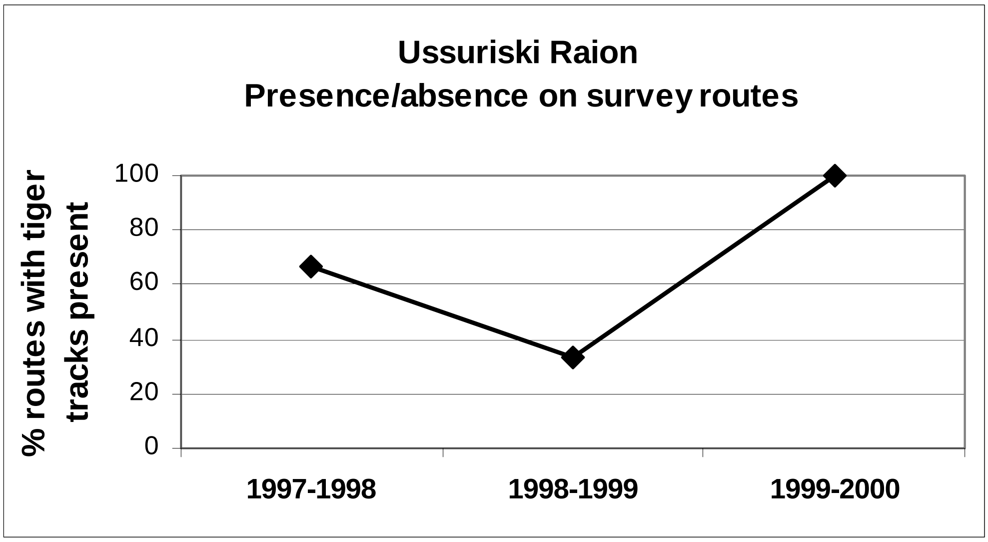
Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	Total mean
3	Ussuriski. Zapovednik	Red deer	11	6.059	6.250	7.026	5.713	6.975	6.984	6.274
3	Ussuriski. Zapovednik	Roe deer	11	13.815	16.105	8.608	10.446	10.333	10.651	9.812
3	Ussuriski. Zapovednik	Sika deer	11	22.555	25.163	16.115	17.815	30.715	45.737	24.010
3	Ussuriski. Zapovednik	Wild boar	11	14.092	17.653	29.555	32.903	4.129	3.308	18.247

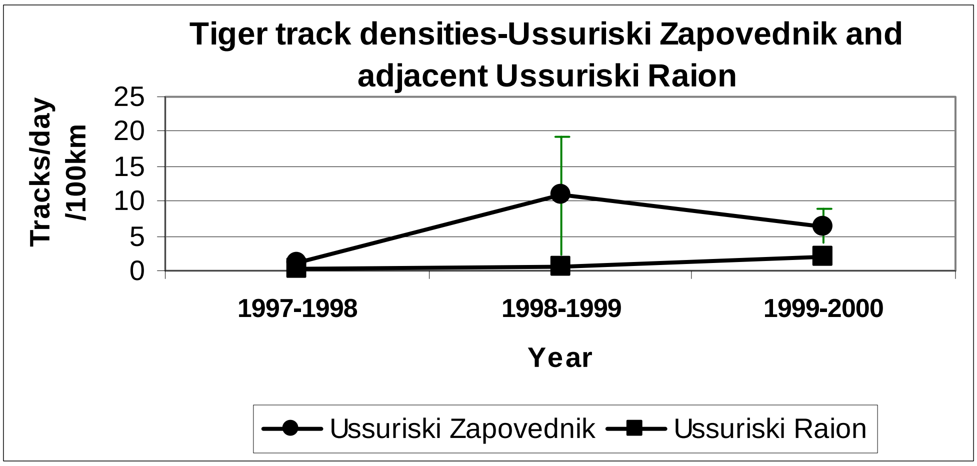




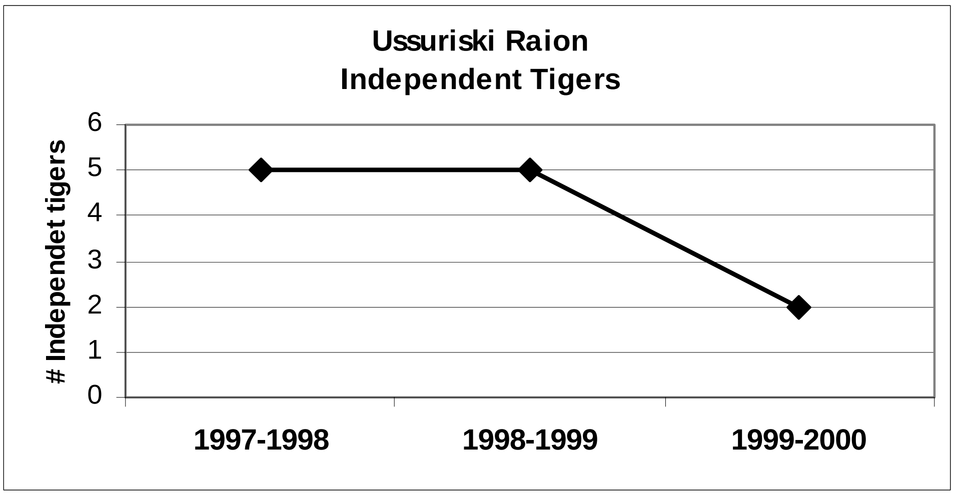
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2000
Survey routes
Roads
River system
Ussurisiki Raion 1999-2000
WCS
WILDLIFE CONSERVATION SOCIETY
TiGiS
Amur Tiger
Monitoring Program
1999-2000 winter
N
W
E
S
20
0
20 Kilometers



Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in Ussuriski Zapovednik and adjacent unprotected site in Ussuriski Raion



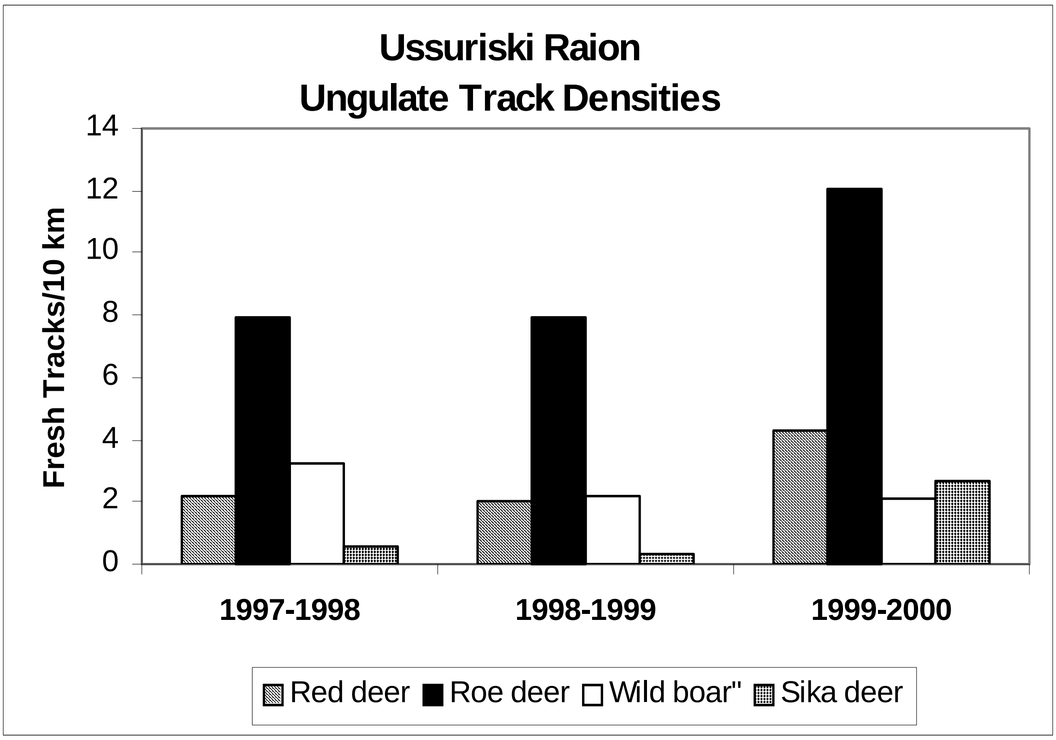
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

#	Site	Year	Age: Adults: Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Totals: Total adults	Total independents*	Total (all tigers)
13	Ussuriski Raion	1997-1998	0	0	0	3	0	2	0	5	5
13	Ussuriski Raion	1998-1999	0	2	0	0	2	3	2	5	7
13	Ussuriski Raion	1999-2000	1	1	0	0	0	0	2	2	2

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	Total mean
13	Ussuriski Raion	Red deer	12	2.162	2.960	2.017	2.044	4.276	3.669	2.562
13	Ussuriski Raion	Roe deer	12	7.935	9.007	7.921	8.239	12.052	7.696	8.941
13	Ussuriski Raion	Sika deer	12	0.587	1.275	0.342	0.743	2.694	3.557	1.401
13	Ussuriski Raion	Wild boar	12	3.242	3.978	2.189	3.034	2.072	2.676	2.303



BORISOVKOE PLATEAU
Southwest Primorski Krai
1999-2000

Report on results of Amur tiger monitoring program in Borisovskoe Plateau monitoring unit in winter 1999-2000 Coordinator - D.G. Pikunov

Borisovskoe Plateau monitoring unit is situated in southwestern part of Primorski Krai. After a "complete count" survey of Amur tigers was conducted in winter 1995-1996, the monitoring program of tiger and ungulate populations was implemented here three years ago.

Time of surveys. The first count was divided into two phases: from 23 to 29 of December 1999 - all routes except 3 were traveled (we could not investigate these 3 routes because snow cover was less than 5 cm), and on January 11-12, 2000 routes ## 1, 2, 3 were traveled soon after heavy snowfalls. The second count was conducted from 12 to 21 of February, 2000.

Monitoring unit was covered with 14 routes evenly located over the whole territory. Most routes were set along beds of medium and large rivers, where (based on our long-term field studies) the typical tiger and ungulate habitat is situated. Most survey routes run along valleys, cross or go into divides and plateaus (routes ## 1, 2, 3, 9, 10, 13, 14). Routes set up in valleys and especially in lower reaches were not chosen at random. Southwest Primorye is the least snowy area in the region. Minimum snow usually falls in lower river basins and therefore snow cover in valleys is more or less stable. Snow is small or absent on slopes and "warm" expositions even in average winters. Tigers residing at divides and plateaus necessarily cross or come down to valley with time. About 50% of monitoring unit area is covered with hunting grounds, other territory is free of hunting (hunting is prohibited). 14 routes include six routes traveled on foot (total length is 96-98 km), 6 - traveled by vehicle (total length - 100-102 km), 2 - traveled both by vehicle (20 km) and on foot (15 km). The total length of all survey routes is 230-240 km.

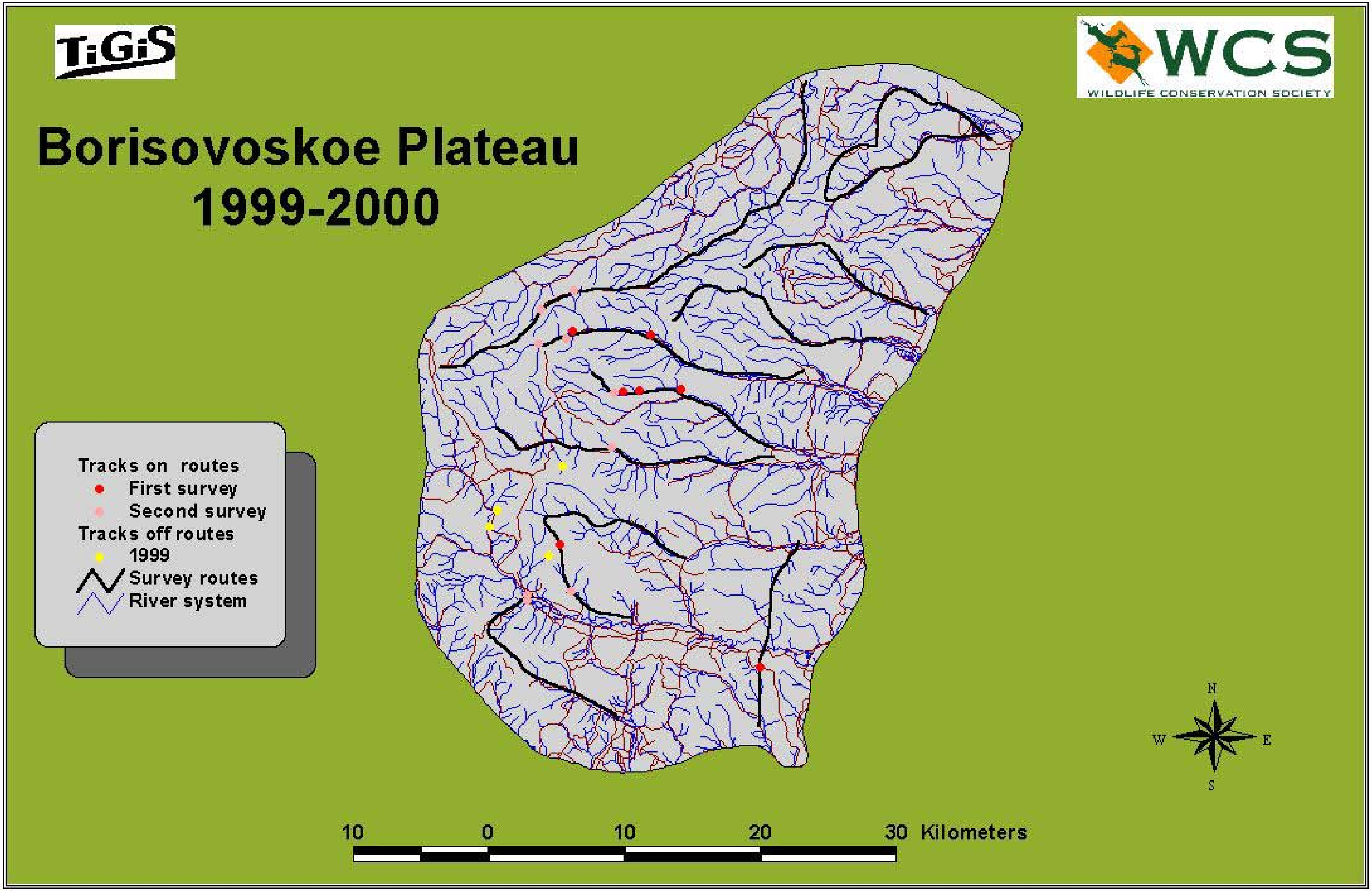
It was somewhat difficult to organize the first count in December because of low snow cover. Virtually there were no tigers there because of maximum human disturbance, associated with intensive hunting on ungulates. In February the field work was done on a deep snow cover (30-40 cm) therefore, survey results are beyond any doubt.

Organizational problems are associated with intensive movements of ungulates and predators: brief and heavy snowfalls forced ungulates down to lower reaches, where snow cover is low and there is an abundant harvest of acorns - the favorite food of all wild ungulates.

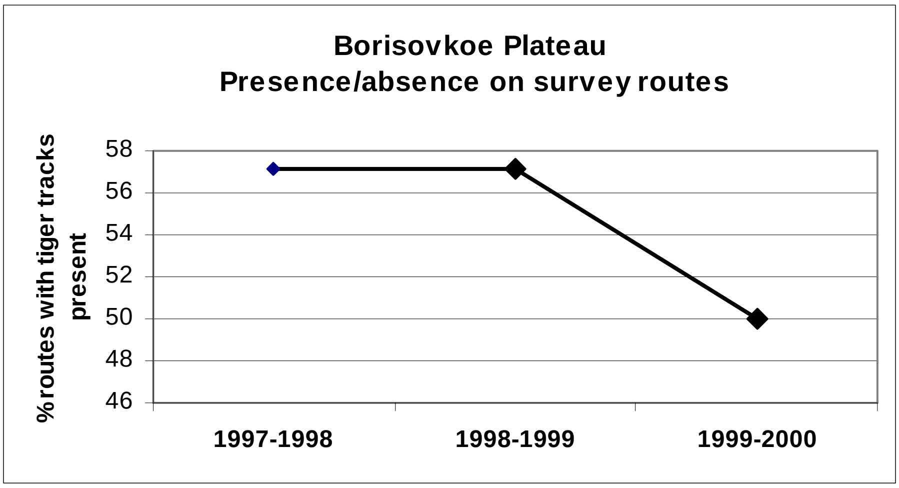
It was very difficult to count numerous crossings of wild ungulates especially sika deer. In some places it is impossible to count tracks even approximately. Therefore the number of crossings (of sika deer in particular) on some routes is not precise. On the whole, the information got during the winter survey 1999-2000 raises no doubts. The number of wild boars is increasing gradually in Borisovskoe plateau area: herds consisted of 10 and more individuals are not so rare there. It is unclear whether the local population of wild boars is growing or this increase represents a migration of wild boars from northern areas, or even from Sikhote-Alin Range. From this point of view tiger habitat is improving. But this territory began to be used for logging. Logging rates in the area continue to increase. The road along Ananievka river was prepared for driving by any trucks and passenger cars in winter season. Borisovskoe plateau territory is easy to access and many people visit the area intensively. This leads to poaching and total absence of tigers and wild ungulates in vast areas. Logging of oak continues. Therefore in future there will be a significant deterioration of forage resources of wild ungulates. Today logging and both legal and illegal hunting become more and more intensive every year not only in the territory between Chinese and Russian border (behind KSP) but almost on the whole territory of Borisovskoe Plateau.

The situation with habitat conditions of ungulates and predators becomes more and more difficult every year. This winter all identified tigers were found within the region, which is very difficult to access, where hunting is banned. Probably because of this tigers visit the eastern part of monitoring unit (where biggest sports hunting leases are situated) more and more rarely. Intensive hunting for ungulates and the low density of ungulates are probably the main reasons why tigers left this territory. The only tiger found in the eastern part of Borisovskoe Plateau (Penyazhinskiy route) was probably poached. During previous surveys, tigers and leopards were always found here.

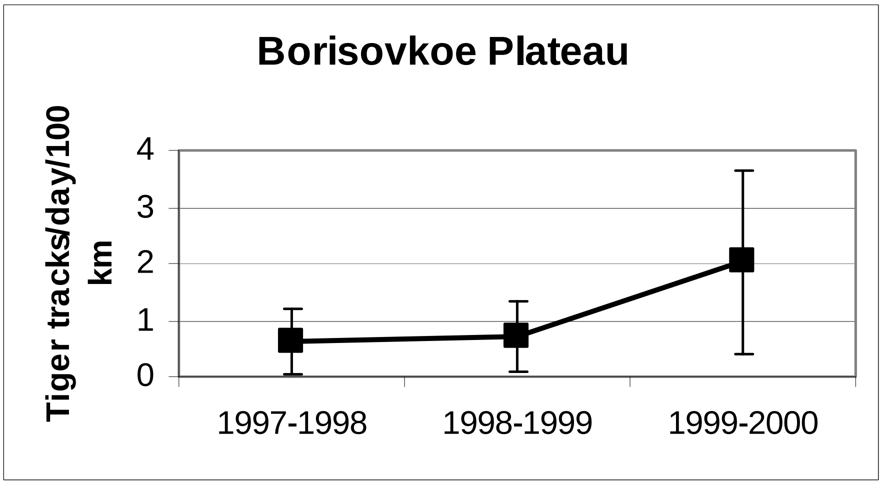
It is urgent to establish special protected area in the territory of Borisovskoe Plateau monitoring unit.



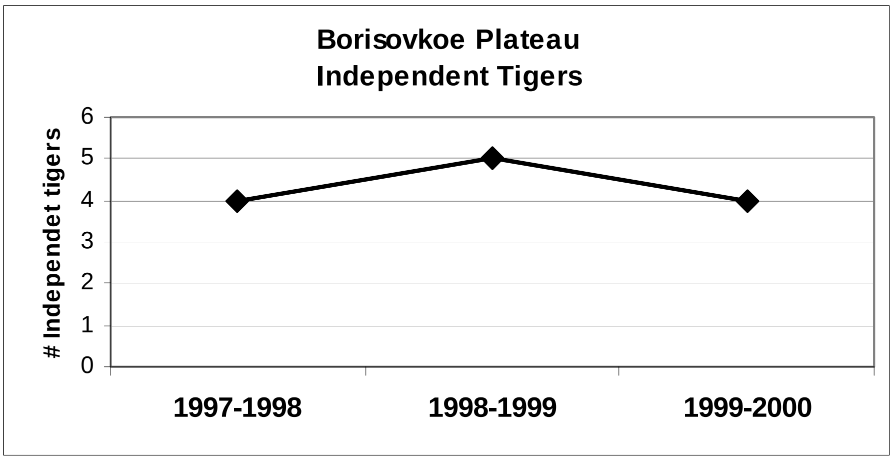
Borisovoskoe Plateau
1999-2000
Tracks on routes
First survey
Second survey
Tracks off routes
1999
Survey routes
River system
10
0
10
20
30 Kilometers
N
S
W
E



Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



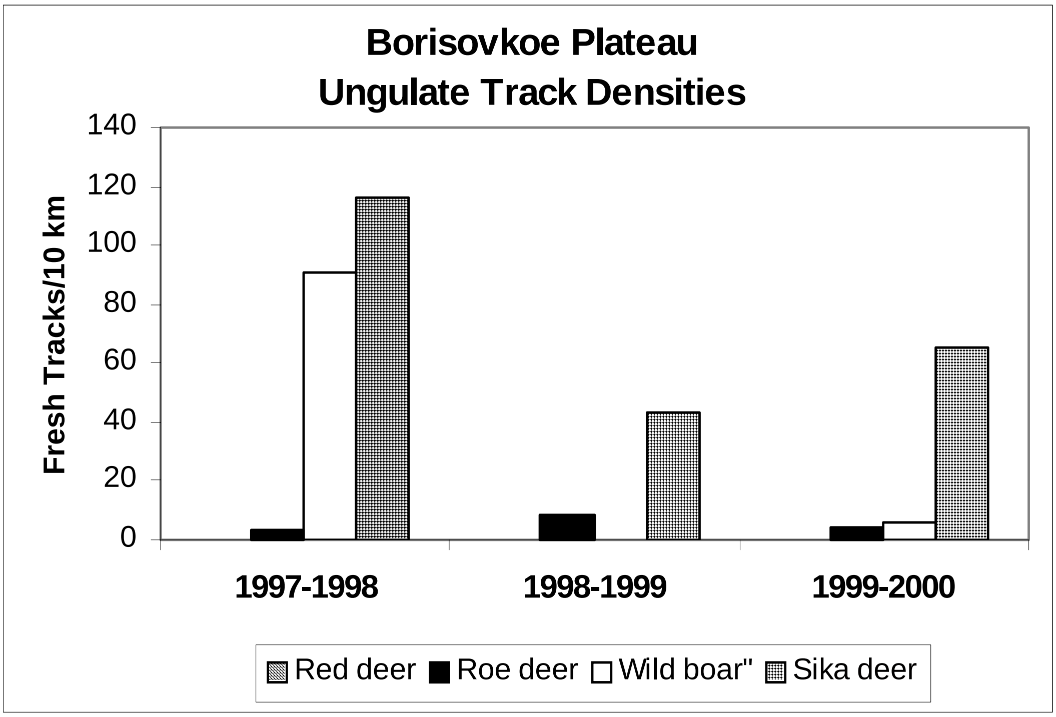
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

#	Site	Year	Age: Adults: Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Totals: Total adults	Total independ ents*	Total (all tigers)
6	Borisovkoe Plateau	1997-1998	1	2	0	1	1	0	3	4	5
6	Borisovkoe Plateau	1998-1999	1	1	0	2	1	1	2	5	6
6	Borisovkoe Plateau	1999-2000	1	2	1	0	1	0	4	4	5

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	Total mean
6	Borisovkoe Plateau	Red deer	14	0.019	0.069	0.000	0.000	0.000	0.000	0.005
6	Borisovkoe Plateau	Roe deer	14	3.376	5.286	8.479	15.224	4.583	6.456	5.664
6	Borisovkoe Plateau	Sika deer	14	116.288	183.222	42.867	56.987	65.738	87.396	61.425
6	Borisovkoe Plateau	Wild boar	14	91.094	122.255	0.261	0.842	5.526	5.947	26.087



SANDAGOY
Olginski Raion
Southeast Primorski Krai

Report on results of Amur tiger monitoring program
in Sandagou monitoring unit in winter 1999-2000
Coordinator - V. V. Aramilev

Weather conditions: in contrast to past years this winter was characterized by deep snow cover. In November snow lay for 1-2 days and then melted quickly on southern slopes. By the middle of December snow cover of about 10 cm deep with crust of ice had formed. On most of the monitoring unit it was impossible to find ungulate tracks and sometimes tiger tracks on snow cover. Therefore, we had to postpone the first count to January. As it was 16 years ago (in 1984-1985) heavy snowfalls happened on New Year holidays: 80 cm of snow fell during 24 hours. As a result by the 10th of January snow cover in the southern part of monitoring unit (in valley) had reached 70-80 cm, on ridges and northern slopes - up to 1 m. Less snow was in the central part of monitoring unit: 35-40 cm in valley, up to 50-60 cm - on slopes and ridges. In northern part of monitoring unit snow cover increased with elevation. Mean temperatures of December, January and February did not differ significantly from ones in previous counts. Snow has settled and covered with icy crust.

Organization details: because of deep snow cover local people refused to take part in the survey, so the field work was done only by employees of Institute of Sustainable Nature Use. All routes could be traveled only on skies - therefore the time of travel increased, as did the required level of exertion. A spacious winter cabin built in October 1999 helped a lot in field work and saving of funds.

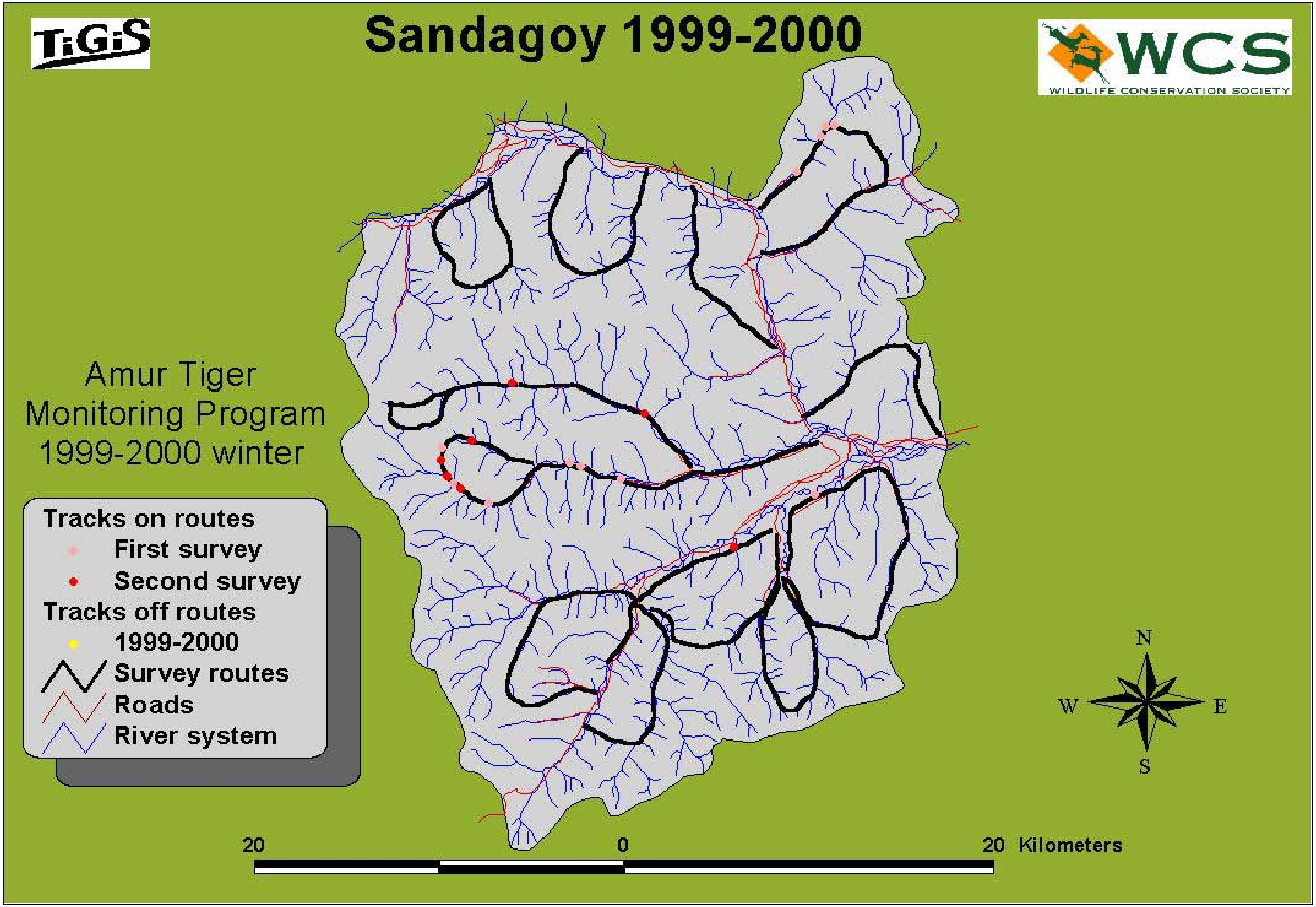
Ungulates and predators allocation: allocation of ungulates and predators was influenced by two factors: height and distribution of snow cover and local acorn crop (having a bad harvest of pine nuts). During 2-3 weeks ungulates (elks, roe deer, wild boars and sika deer) moved to the central part of the monitoring unit due to the low snow cover there. Some roe deer were not able or had no time to move to the sites with low snow cover, and consequently three dead roe deer (young individuals) were registered in the southern part of monitoring unit. Probably more dead animals will be registered in the spring. Some elk and sika deer did not move to the sites with low snow cover. Based on March observations in monitoring unit, it appears that the elk population survived the winter without losses. A sika deer, which had apparently died from starvation, was found. This year a characteristic feature of ungulate movements was their propensity to avoid deep snow, not by going into river valleys and then downstream but by moving to ridges to the north and then to sites with low snow cover. During bear surveys the ungulate density in southern part of monitoring unit was (individuals/1,000 ha): roe deer - 0, elk - 1-2, sika deer - 0, wild boar - 0.5-1.

Local acorn crops were registered in the eastern part of monitoring unit. Wild boars moved there and stayed for the whole winter. Rare herds left the territory and then returned in a short time.

Ungulates allocation and snow cover influenced the tiger distribution. In January tigers were not found in the southern part of the monitoring unit, in February tiger tracks were found on crumbly snow on the border of southern part on Mineralnaya river. Crumbly deep snow complicated tracks measurement, because print (track) crumbled and even after tracking it was difficult to find good track to measure. Due to deep snow tigers' movements were limited, they stayed on local sites with high ungulate density and did not move for long distances and did not leave tracks on routes. On the whole, it is difficult to say if all tigers still remain in the territory or not in comparison with past years.

To get reliable information in an anomalous and critical year for ungulates and tigers it is necessary to increase the volume of work and it requires additional funds. On the other hand, it is necessary to study such aspects thoroughly because such anomalies are "the bottle neck" of ungulate and tiger population. Based on my observations this situation with deep snow cover in Sandagou has twice in the past 16 years. Two times in this period snow cover was also high but not so high as in 2000. One more characteristic feature - deep snow cover was along the whole length of Japan Sea shore - from Olginsky Raion to Terney. Usually this region is characterized by small snow cover, ungulates use this territory for wintering, and this is the reason of high tiger density there.

The region where survey was conducted is characterized by absence of intensive human impact. Insignificant logging took place on local sites in northern part of monitoring unit. There is no agricultural and other industrial development.



Sandagoy 1999-2000
TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Amur Tiger
Monitoring Program
1999-2000 winter
Tracks on routes
First survey
Second survey
Tracks off routes
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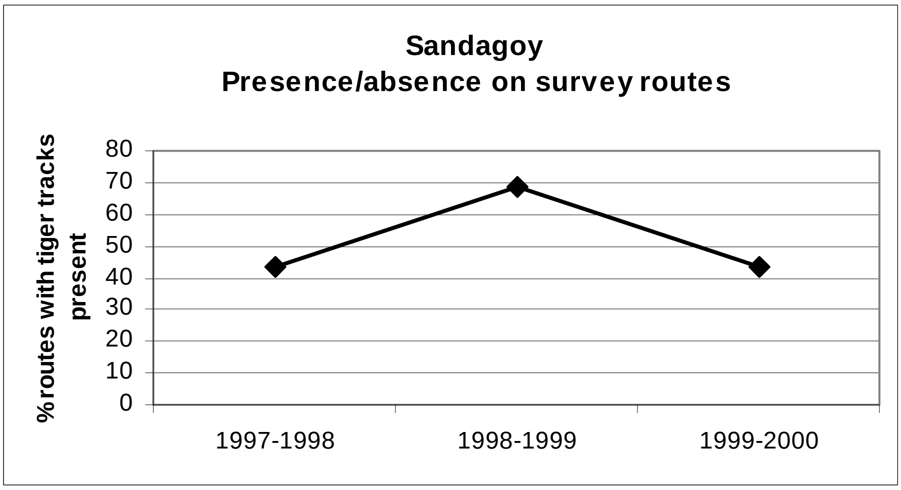
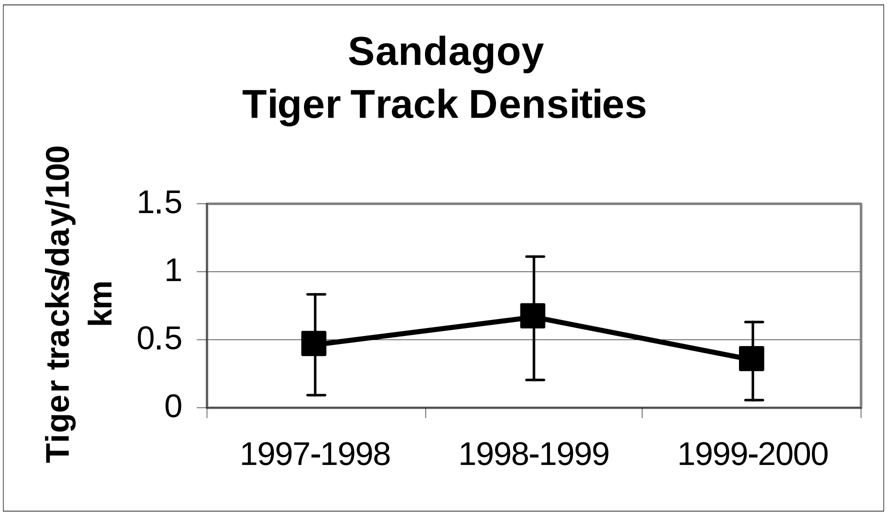
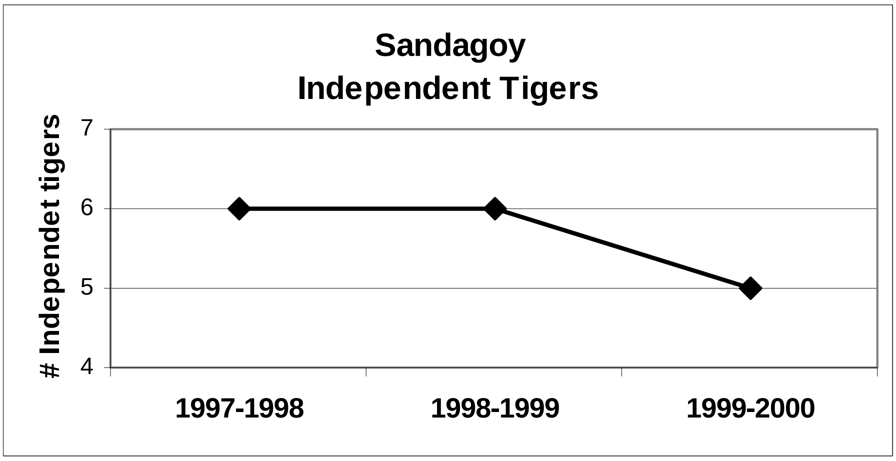


Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



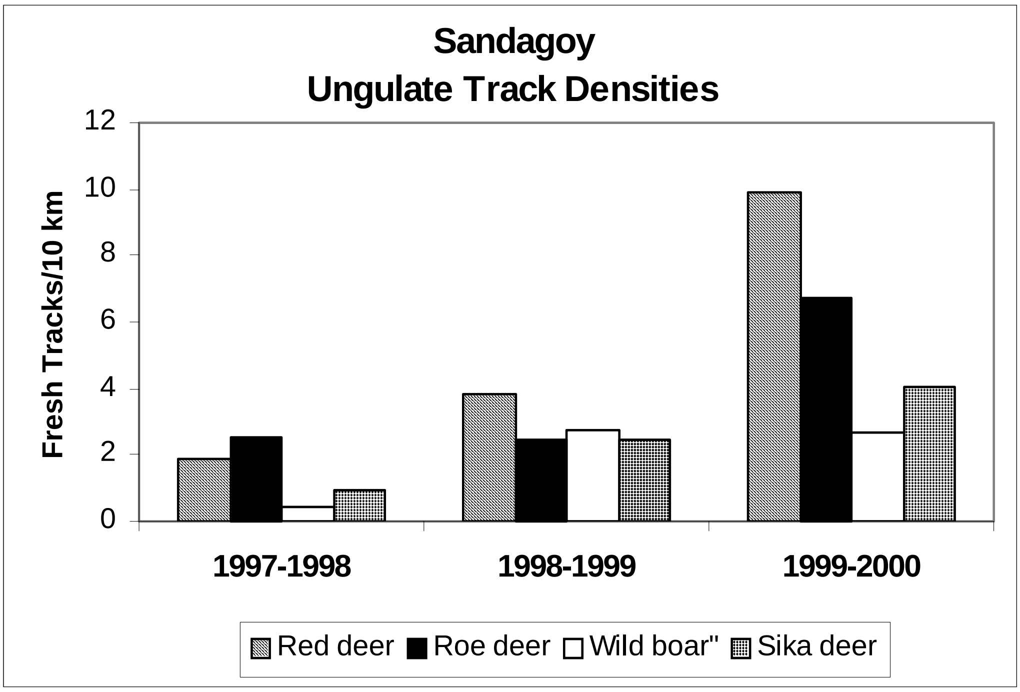
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

#	Site	Year	Age: Adults: Males	Adults: Females	Adults: Un-known	Sub-adults	Cubs	Age unknown	Totals: Total adults	Total independents*	Total (all tigers)
7	Sandagoy	1997-1998	1	1	3	0	1	1	5	6	7
7	Sandagoy	1998-1999	0	1	0	0	0	5	1	6	6
7	Sandagoy	1999-2000	1	1	0	0	0	3	2	5	5

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	Total mean
7	Sandagoy	Red deer	16	1.870	2.779	3.841	3.757	9.898	10.784	5.756
7	Sandagoy	Roe deer	16	2.502	2.666	2.437	2.248	6.698	5.692	5.155
7	Sandagoy	Sika deer	16	0.913	1.682	2.461	3.547	4.055	3.976	3.834
7	Sandagoy	Wild boar	16	0.417	0.678	2.763	4.070	2.683	4.036	1.600



SINEYA
Chuguevski Raion
Central Primorski Krai

Report on results of Amur tiger monitoring program
in Sinyaya monitoring unit in winter 1999-2000
Coordinator - P. V. Fomenko

Sinyaya monitoring unit is located in the central part of Chuguvski Raion, Primorski Krai. Organizer of field work in the unit is P.V. Fomenko - WWF RFE Program Coordinator.

Field work on the routes was conducted in December 27-30, and in March 2-5 (due to the illness of field co-coordinator).

Same as last winter season 15 routes were traveled. Total length and location of routes were the same. During the second phase of field survey, routes were mostly traveled by snowmobile because of deep snow cover.

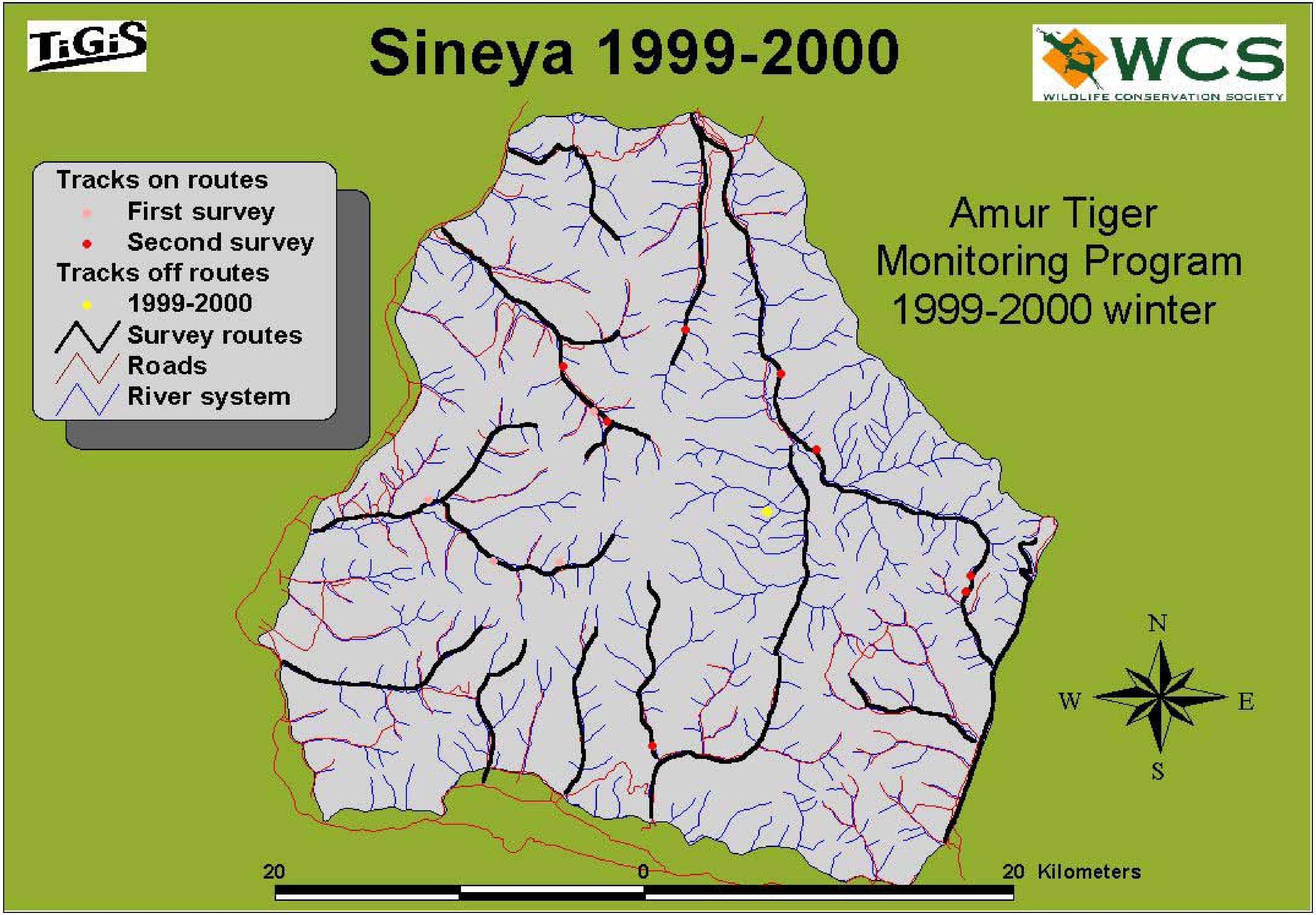
Snow cover height varies from 15 to 35 cm in December and from 20 to 60 cm in March. Time of latest snowfall in the first phase of survey just as in the second one was favorable for efficient track measurements.

Because field work in Sinyaya monitoring unit was conducted by the same specialists as last winter season there were no problems associated with survey.

Habitat conditions are virtually unchanged but roe deer and wild boar numbers have distinctly decreased. The changes are probably associated with absence of main ungulate forage - acorns and pine nuts. The number of elk in the monitoring unit is stable. On the whole, a decrease in ungulate numbers is probably associated with the significant impact of poaching.

During the past three monitoring seasons tiger numbers in the monitoring unit have remained stable. Based on interviews of professional trade hunters all tigers in 1999-2000 winter season were identified. One female with a cub was registered off the survey routes. Few tiger tracks were recorded during the first phase of the survey probably due to the fact that tigers followed wild boars, who had migrated in search of forage. In the second phase of survey when wild boars were feeding on horse-tail, tigers were more readily located.

On the whole habitat conditions in Sinyaya monitoring unit have undergone virtually no changes. Small sanitary logging has caused no significant damage to the habitat. There were no forest fires in the region this season. However, we are anxious about planned timber sale in a large area of Sinyaya Pavlovskaya river valley.



TiGIS
Sineya 1999-2000
WCS
WILDLIFE CONSERVATION SOCIETY
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2000
Survey routes
Roads
River system
Amur Tiger
Monitoring Program
1999-2000 winter
N
W
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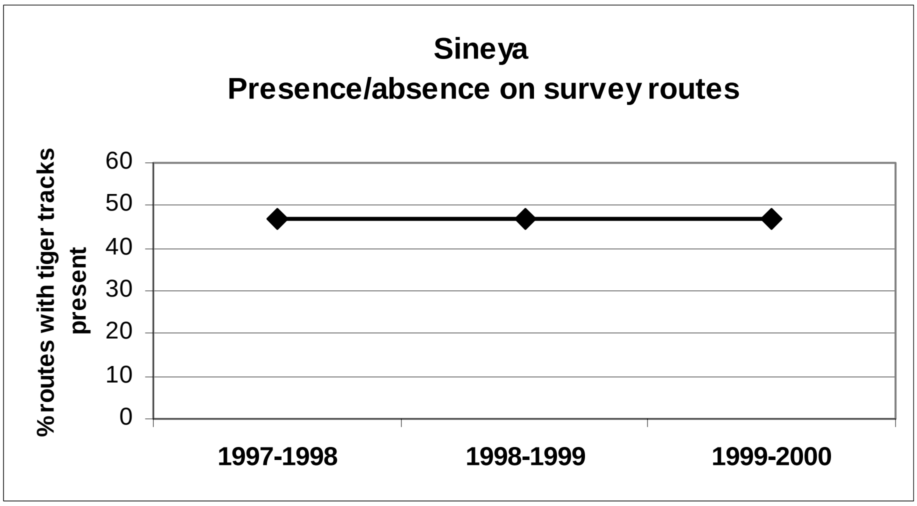
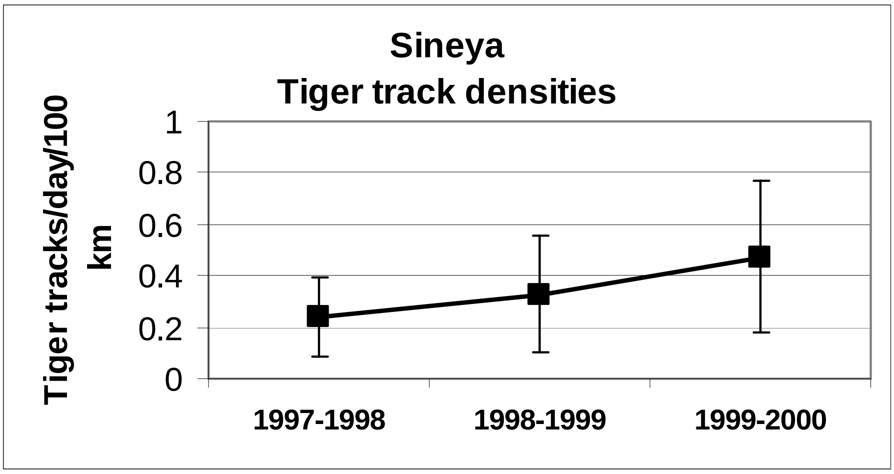
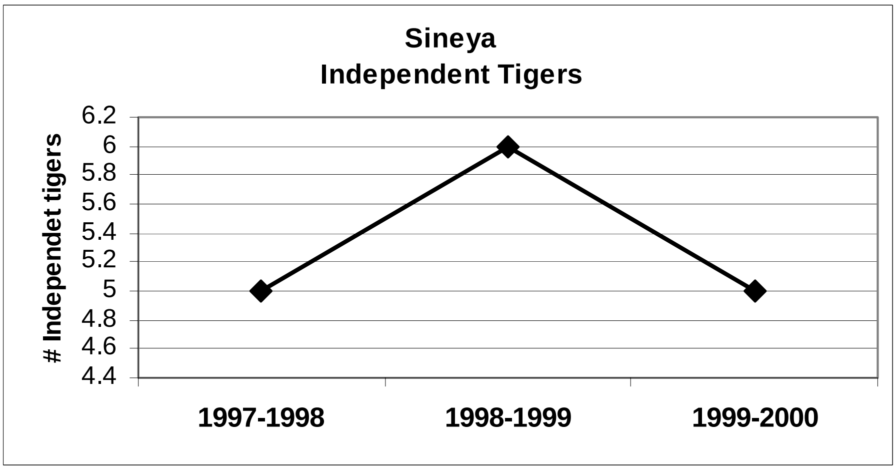
20 Kilometers



Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



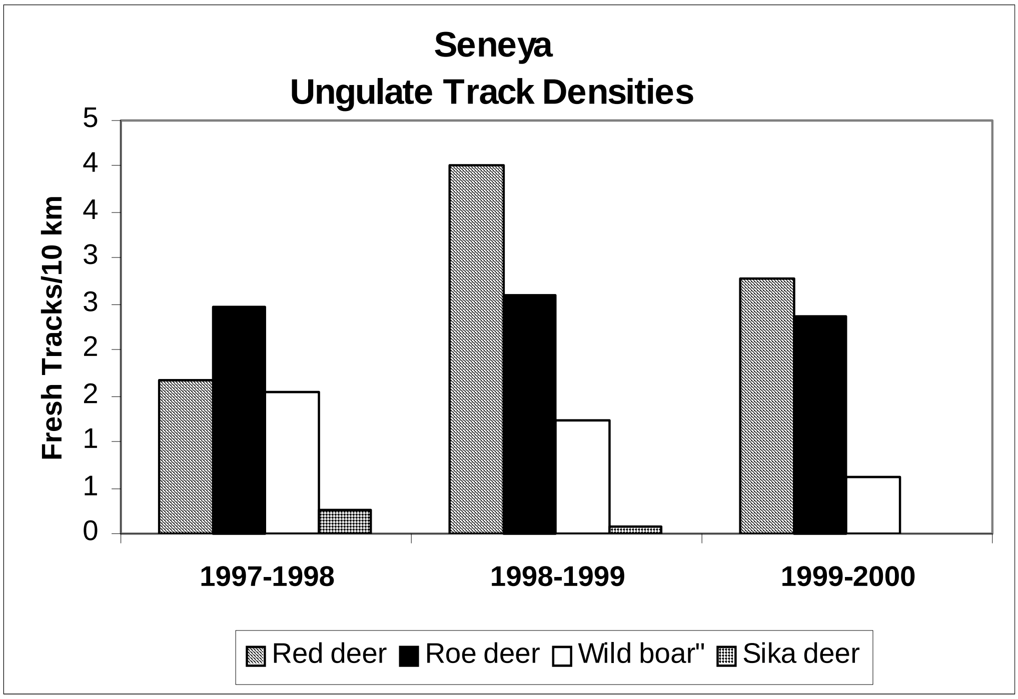
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

#	Site	Year	Age: Adults: Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Totals: Total adults	Total independents*	Total (all tigers)
15	Sineya	1997-1998	1	0	0	1	1	3	1	5	6
15	Sineya	1998-1999	1	2	0	0	0	3	3	6	6
15	Sineya	1999-2000	2	2	0	1	1	0	4	5	6

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	Total mean
15	Sineya	Red deer	15	1.677	1.600	3.999	2.602	2.765	3.744	2.947
15	Sineya	Roe deer	15	2.480	2.239	2.594	2.077	2.373	1.834	2.851
15	Sineya	Sika deer	15	0.266	0.780	0.075	0.213	0.000	0.000	0.085
15	Sineya	Wild boar	15	1.555	2.894	1.232	1.820	0.613	1.074	1.000



IMAN
Central Primorski Krai
1999-2000

Report on results of Amur tiger monitoring program in Iman monitoring unit in 1999-2000 winter
Coordinator - I.G. Nikolaev

The Iman monitoring unit is located in Malinovka river basin (Dalnerechensky Raion, Primorski Krai). The territory of the unit (140,000 ha) includes the upper basin of Orekhovka river and its tributary - Gornaya river. The border of the monitoring unit lies mostly on divides of these rivers basins and only in the west it runs through the valleys of Orekhovka and Gornaya rivers, crossing them near a rive crossing that leads to Polyana and Martynova Polyana villages.

The number of routes in monitoring unit, their numeration and location are the same as in past years.

Field work on the routes was conducted in December 19-21 and 26, in February 2-24 and in March 2-5. It was impossible to complete all the work in February due to the snowfall that started in the morning of February 27 and lasted more than 24 hours.

In December total length of routes traveled by vehicle is 132 km, on foot - 38, by snowmobile - 16 km. In March total length of routes traveled by vehicle is103 km, on foot - 66 km, by snowmobile - 16 km. Discrepancy between types of travel in December and February was caused (as in past years) by increased snow cover height during the second part of field survey: in December minimum and maximum snow cover heights in open site were 24 cm and 32 cm correspondingly; in February and first days of March these figures were 33 cm and 58 cm correspondingly. Due to this fact in February and March several routes, which were not passable for vehicle, were traveled on skies.

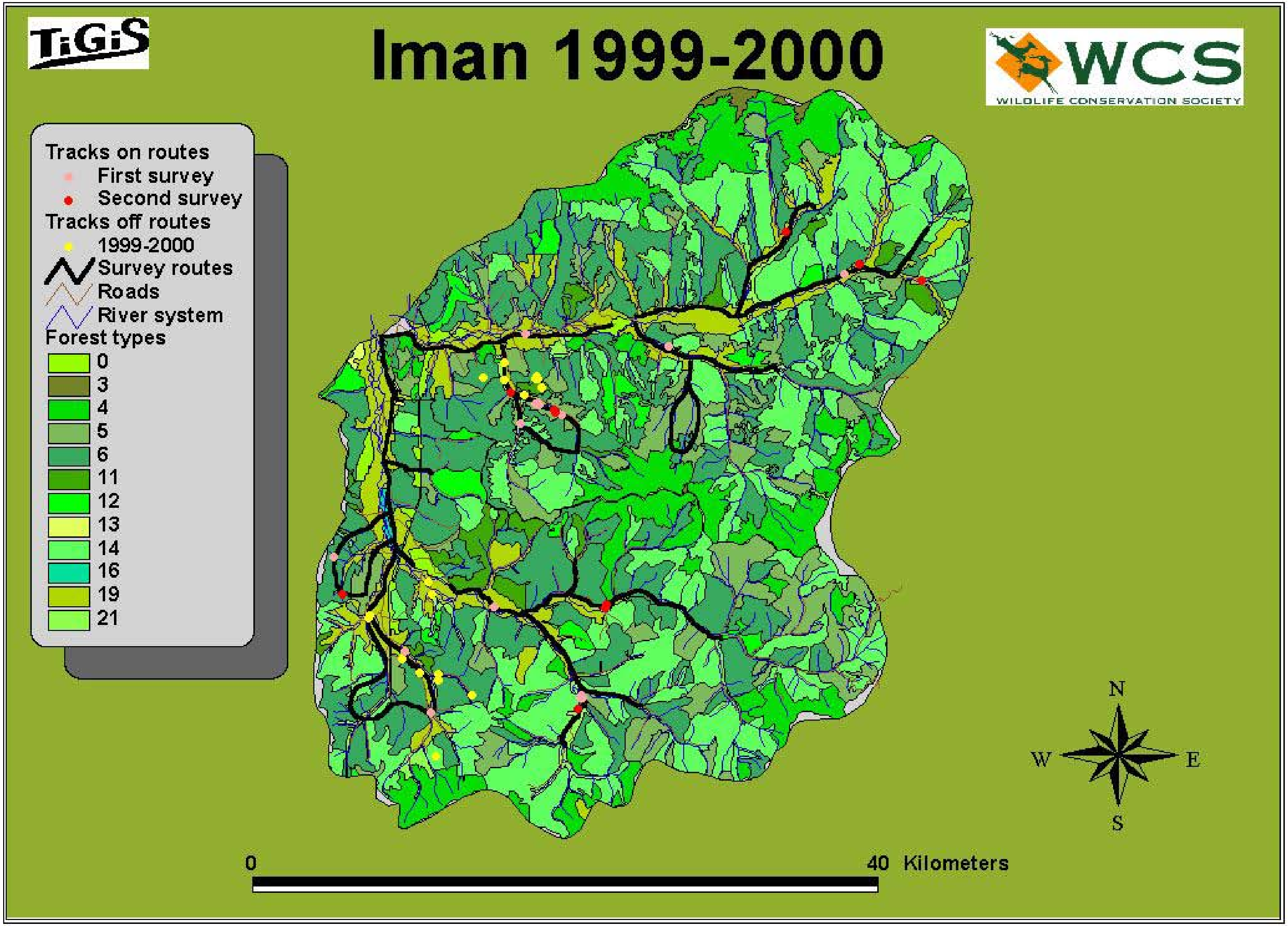
This season, in comparison with previous one, was characterized by more unfavorable conditions for the local tiger subpopulation. First, the number of wild boar (the main prey species for tiger in this territory) decreased dramatically in the beginning of December. Based on interviews with local people and my observations wild boar moved to oak forests and concentrated in areas 50 km northwest of the monitoring unit. Another indication of worsening conditions is the extensive movements of a female with 6 months cubs across the unit.

The status of the elk population is a little better (in comparison with wild boar), but nevertheless elk numbers are low. The status of the roe deer population is estimated as normal (satisfactory).

The second important negative factor is human disturbance. The role of this factor has increased due to the more intensive logging. The size of logging areas has risen mostly due to the activity of different industrialists and illegal logging. This factor affects females with cubs most of all. They usually leave a region where logging begins.

Although habitat conditions for tigers this winter season were considered unfavorable, nevertheless no significant changes except death of a tiger cub death have occurred in this tiger subpopulation. At the time of field work the status of this tiger subpopulation was estimated as normal.

Habitat conditions in monitoring unit still remain at the level suitable for tiger survival in the near future.


Iman 1999-2000
TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2000
Survey routes
Roads
River system
Forest types
0
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12
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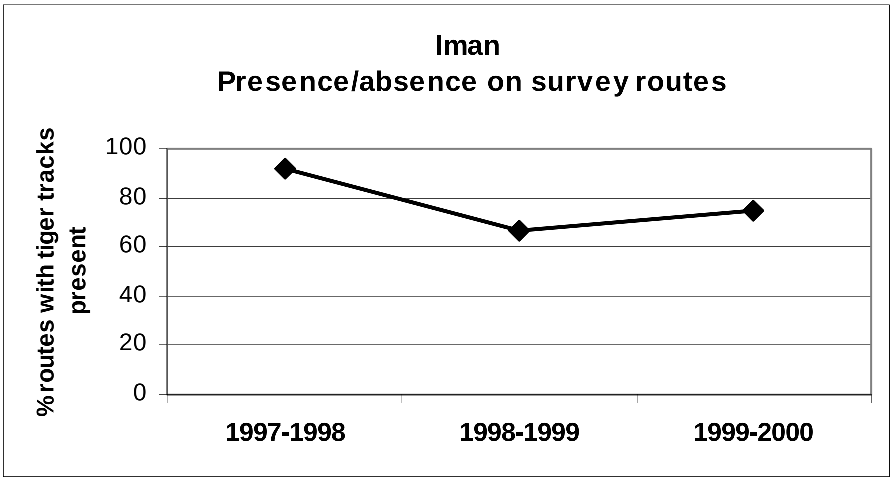
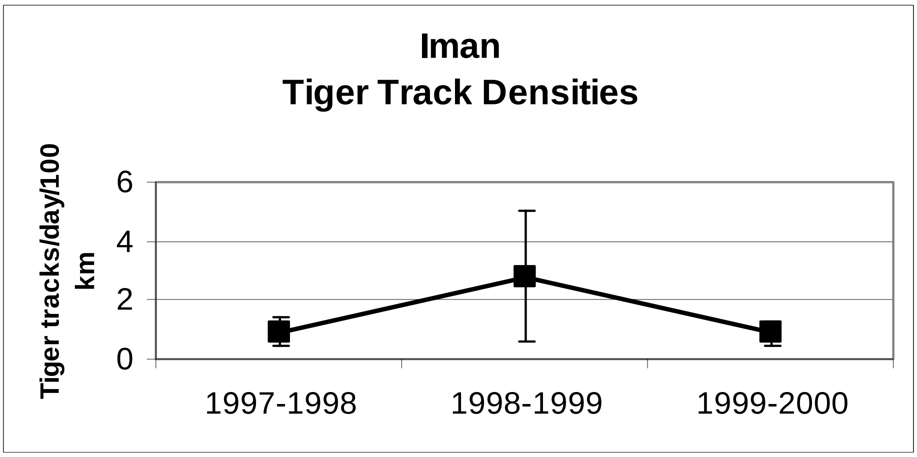
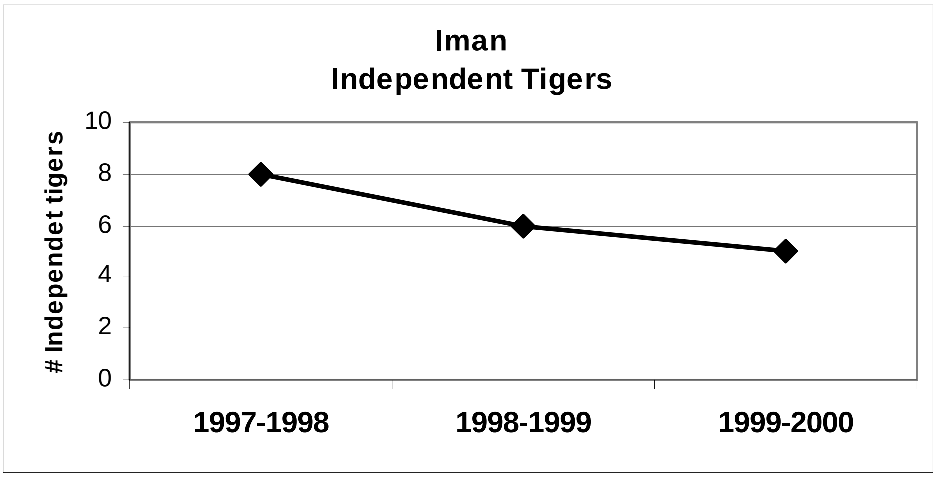
40 Kilometers



Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



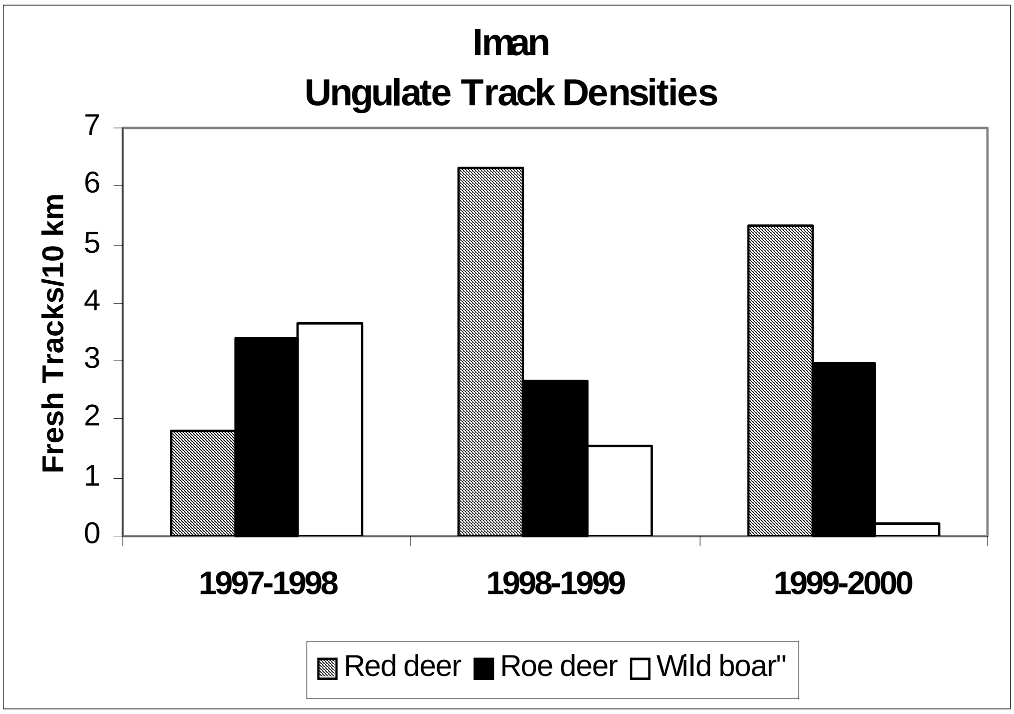
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

#	Site	Year	Age: Adults: Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Totals: Total adults	Total independents*	Total (all tigers)
4	Iman	1997-1998	3	1	0	2	0	2	4	8	8
4	Iman	1998-1999	3	2	0	1	2	0	5	6	8
4	Iman	1999-2000	2	1	0	1	2	1	3	5	7

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	Total mean
4	Iman	Red deer	12	1.793	2.881	6.331	5.273	5.343	7.232	4.758
4	Iman	Roe deer	12	3.383	5.326	2.681	2.278	2.982	3.944	3.373
4	Iman	Wild boar	12	3.632	5.070	1.546	2.368	0.193	0.401	1.508



BIKIN RIVER MONITORING SITE
Central Sikhote-Alin, Northern Primorski Krai

Report on results of Amur tiger monitoring program in Bikin monitoring unit in 1999-2000 winter
Coordinator - D.G. Pikunov

The first count (survey) was organized and conducted from 8 to 20 of January, 2000
The second count was organized and conducted from February 26 to March 4, 2000

During the survey 16 routes were established and traveled as in the two past years. Total length of routes is 210 km, including 150 km traveled on skies and 60 km traveled by snowmobile. A minimum of two snowmobiles "Buran" are necessary to bring fieldworkers and equipment to monitoring unit because roads are absent here.

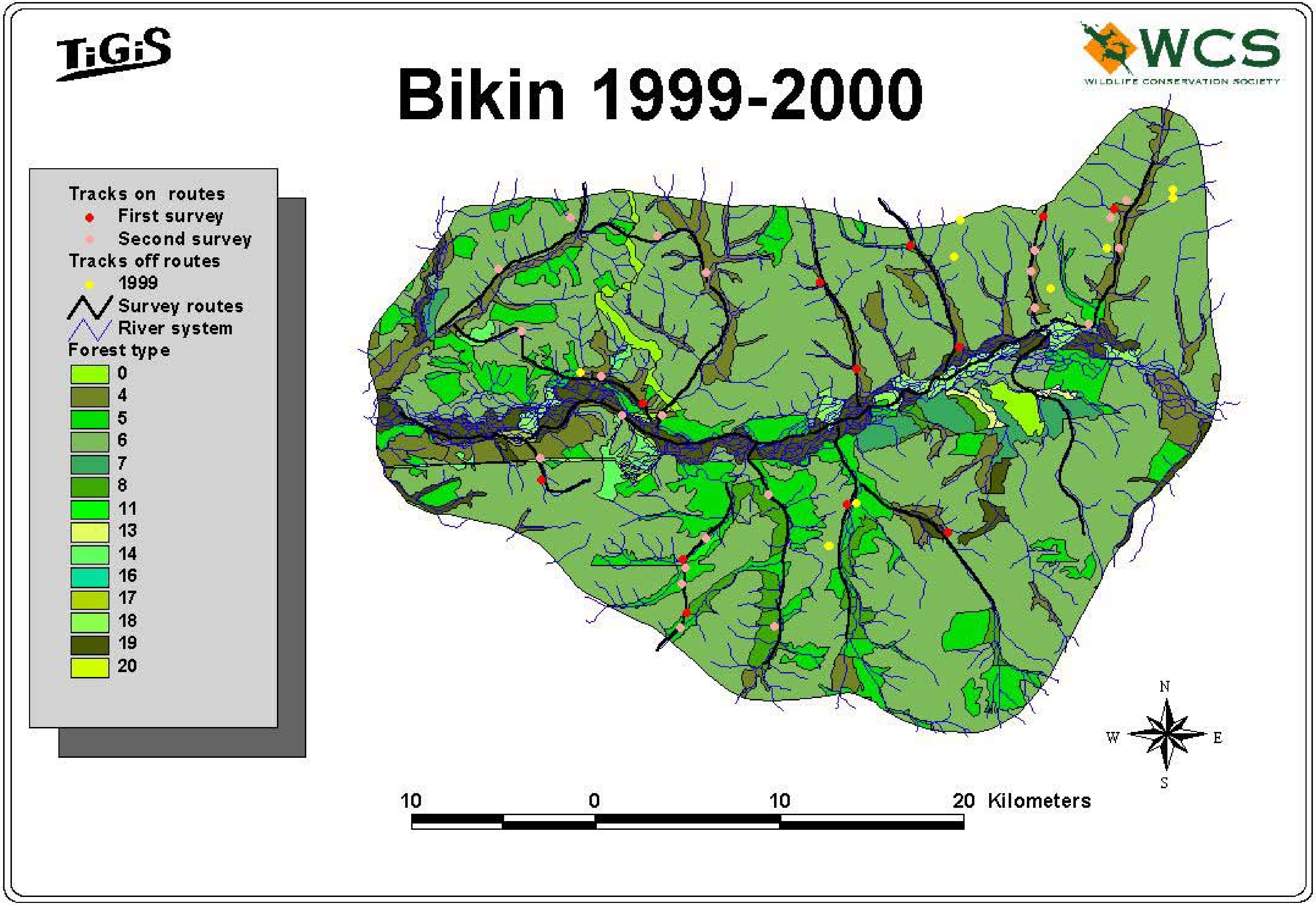
The first count in the monitoring unit was conducted by four fieldworkers, the second count - by six fieldworkers. Optimum number of fieldworkers is six specialists, including 2-3 local hunters (aboriginal), which have a good knowledge of territory and conditions of work. The count should be conducted by two teams, and each of them should have a snowmobile and other necessary equipment to work independently.

First visit to monitoring unit should be done immediately after New Year holidays, when firm ice cover has formed and it is safe to transport people and equipment on snowmobile along Bikin riverbed. The second count should be completed by the beginning of March before thaw and ice flow appear and it becomes difficult and dangerous to travel along the river.

This winter snow depth was high in comparison with the three past winters. This fact resulted in several peculiarities in animal behavior and therefore in summarizing of survey results. Particularly it looked like daily movements of tigers (even adult males) were reduced, the same can be said about size of home ranges. Tigers preferred to move along their old trails, ungulate trails, ice flows, snowmobile tracks and ski-tracks. It was difficult to measure tiger tracks on deep crumbly snow. It generally required more time to obtain measurements of most tiger tracks, and tracks varied in size even for the same individuals. Sometimes tigers remained in confined areas for extended periods because ungulates concentrated there. Under these conditions it was less likely to locate tracks of all tigers. All these facts resulted in some difficulties during final processing of the survey data. On the whole, a dramatic decline in ungulate numbers (especially wild boar) occurred in the monitoring unit. Tracks of wild boar were found only on one route. In this situation tiger litters were found in very poor conditions and it is possible that cubs will die or move to settlements. Habitat deterioration and most importantly, decrease in prey species, has become more evident every year. Today it is urgent to restrict hunting on ungulates immediately or to ban hunting on wild ungulates temporarily.

It is also very important to reduce uncontrolled access of fishermen, hunters and tourists to the Bikin river basin, which is a key tiger are for tiger conservation. Additionally, this is a territory of traditional use by indigenous people.

At present tiger habitat in Bikin river basin is deteriorating due to sharp decline in ungulate numbers, poorly regulated hunting, and increasing human disturbance.


Bikin 1999-2000
WCS
WILDLIFE CONSERVATION SOCIETY
TiGiS
Tracks on routes
First survey
Second survey
Tracks off routes
1999
Survey routes
River system
Forest type
0
4
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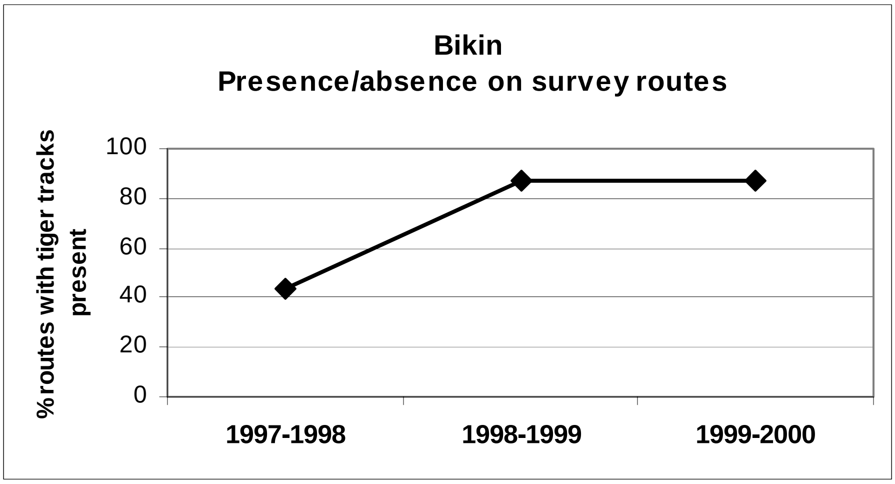
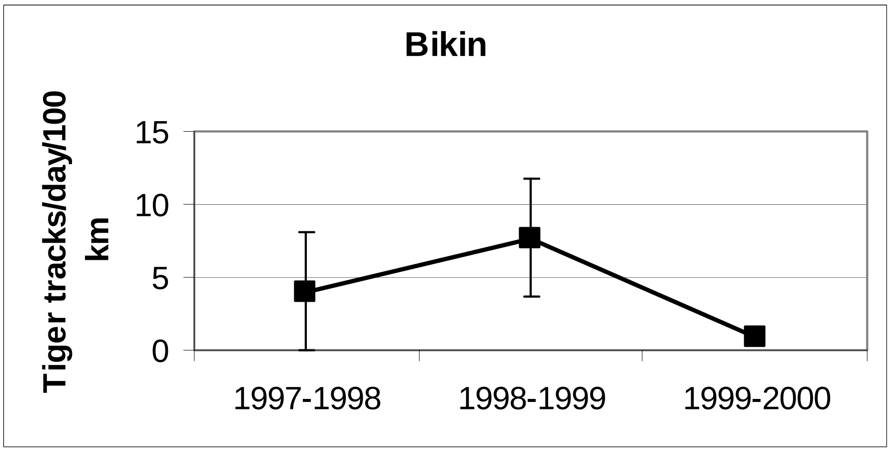
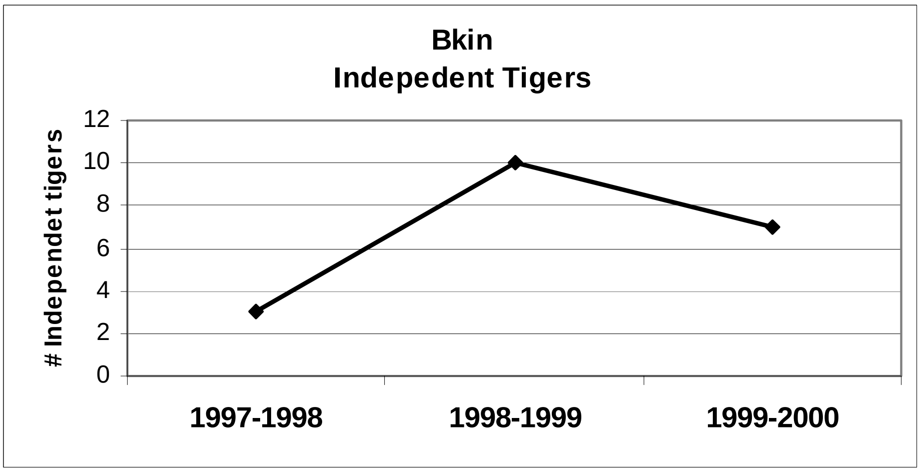


Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



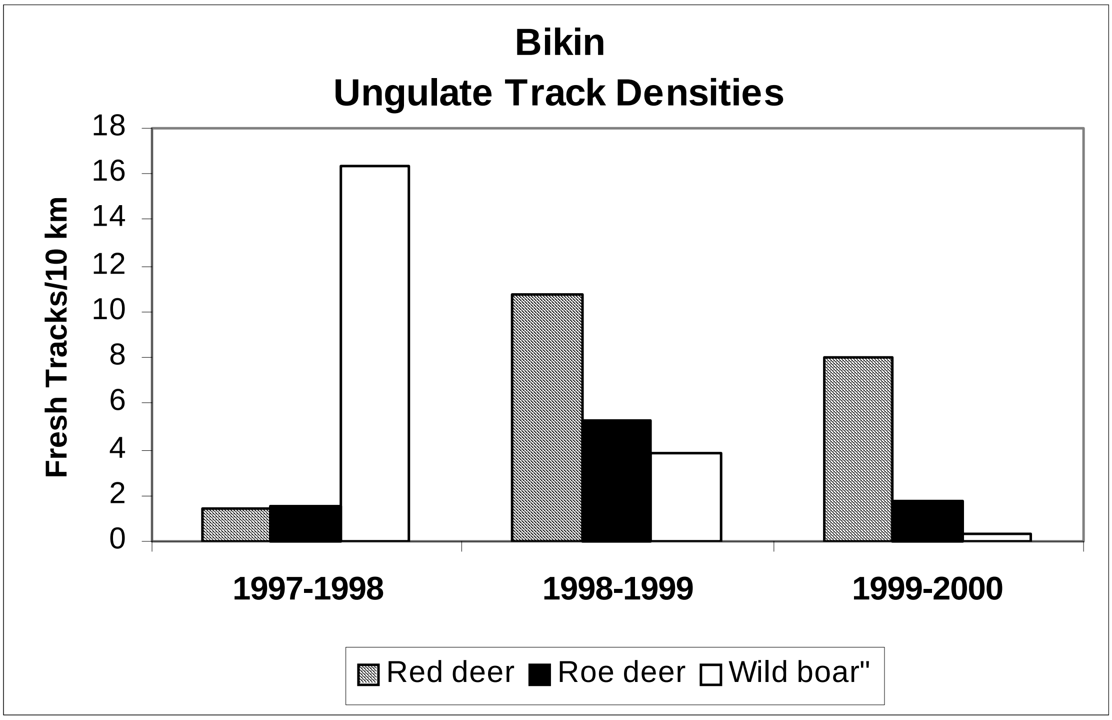
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independents*	Total (all tigers)
5	Bikin	1997-1998	0	3	0	0	3	0	3	3	6
5	Bikin	1998-1999	2	2	1	3	0	2	5	10	10
5	Bikin	1999-2000	2	2	1	1	1	1	5	7	8

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997		1998		1999		Total
				mean	std	mean	std	mean	std	mean
5	Bikin	Red deer	16	1.373	1.511	10.783	9.973	8.012	6.618	7.424
5	Bikin	Roe deer	16	1.490	1.912	5.303	3.030	1.735	2.847	2.852
5	Bikin	Sika deer	16	0.308	1.053	3.660	8.692	0.000	0.000	0.992
5	Bikin	Wild boar	16	16.324	61.206	3.795	4.556	0.299	0.654	6.096



SIKHOTE-ALIN STATE BIOSPHERE ZAPOVEDNIK AND TERNEY HUNTING SOCIETY

(Coastal, or “eastern macroslope” portion of zapovednik)
Terneiski Raion
Northeast Primorski Krai

Report on results of Amur tiger monitoring program in SABZ and Terney Hunting Lease monitoring units in winter 1999-2000
Coordinator - E. N. Smirnov

1. Monitoring units: Sikhote-Alin State Biosphere Reserve (SABZ)
Terney Hunting Lease

2. Coordinator: Smirnov E. N.

3. Time of counts: January 10-17, 2000
February 14-21, 2000

4. Numbers of routes: 1-52

5. Total length of routes:

Monitoring unit	Date	Length of routes, km		Total, km
		On foot	By vehicle	
SABZ	January 10-17, 2000	311.8	0	311.8
Terney Hunting Lease		83.5	116.9	200.4
				512.2
SABZ	February 14-21, 2000	296	0	296
Terney Hunting Lease		120	163.5	283.5
				579.5

6. Conditions: In December the count was not conducted because of absence of coordinator and funds. On 6th and 7th of January abundant snow fell down, in some places snow cover was up to 20-30 cm. Skies were necessary. In some places soggy snow made passability very difficult, snow stuck to skies and speed of travel did not exceed 1 km per hour. As we went to routes on fourth day after snowfall, we could not count many tigers.

We could not travel along several routes because of deep snow: 1.5 routes on foot and 4.5 routes by vehicle. On the whole, I think the survey went off satisfactorily.

There were no heavy snowfalls after January 7, 2000. The last newly-fallen snow (1-2 cm) before the survey fell on January 30-31. Everywhere snow settled, and melted, and during the survey snow cover did not exceed 30-40 cm. It was much easier to use skies than in January. Crust of ice was a hindrance but prevented only from counting little animals. On the whole, the conditions were favorable for survey. Only three routes were not traveled along Evlantievski Creek because they were not passable by vehicle.

7. Assessment of efficiency: I think that as the methodology itself has so many errors it is impossible to make absolute count and even close to it (identification of animals based on pad size, different fieldworkers, count by vehicle and count on foot, uncertainty in track age identification, insufficient territory, time after last snow, etc.).

But monitoring program has many advantages and we cannot argue about this fact. Such program is absolutely necessary for monitoring of significant changes in dynamics of ungulate and tiger numbers and for taking adequate measures. I think that the program was initiated opportunely and will give positive results.

As for results of monitoring in model units in 2000, we can say that conditions were favorable and data reflect the situation well enough.
What can be suggested to make gathered information more effective?

1. To introduce into practice "passport system" (sex, age, home range, individual characteristics, individual number) for all counted tigers in order to ensure that every survey is a continuation of the previous one. Sikhote-Alin Reserve has such experience.
2. It is necessary to make a computer program that allows for ranges of estimates, and not just absolute counts. We do not always know if there are 5, 6 or 7 males. There should be a mechanism for providing a range of values.
3. When summarizing monitoring results, both data on conflict tigers from Committee of Environmental protection and data on ungulate surveys from Hunting Department may be helpful.
4. Final results of surveys should be officially approved by all coordinators and should be sent to regional and federal authorities together with adequate recommendations.

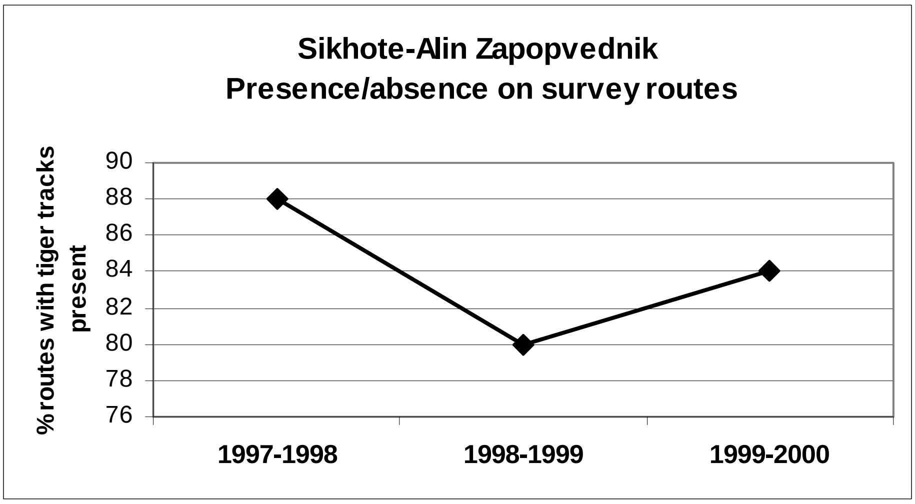
8. Conclusions:

1) Highways are the major contributor to intentional tiger and ungulate poaching. Many kilometers of roads can be closed without any damage to economy. This measure will save many animals and will not require great expenses.
2) Game inspectors, zoologists and specialists should educate trade hunters, including enlightenment through mass media. Seminars, trainings, meetings with hunters are not the attributes of stagnation but the continual forms of education. I propose to present books ("Amur tiger" by Dunishenko and Kulikov, "Encounters with tiger" by Smirnov and "Rules of people's behavior and cattle keeping in tiger habitat") to every hunter. "Rules.." also should be presented to farmers of southern part of Far East. Funds are necessary for all these activities.
3) The most difficult situation is with tigers near settlements. It is necessary to organize the team of specialists who are able to frighten, catch or kill such a tiger. Tragic encounters between tigers and people are registered mostly in such situations.

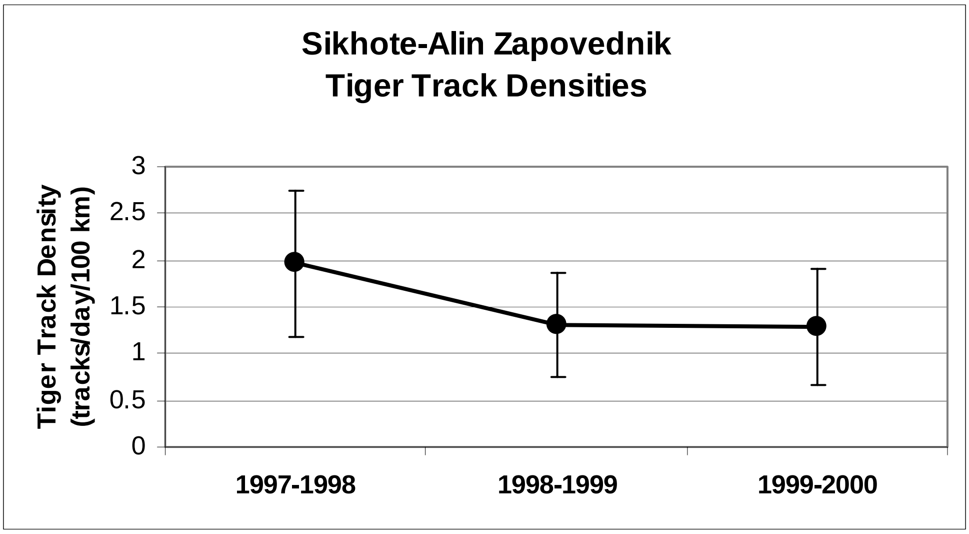
Further, it is necessary to read my previous report (1999). Nothing can be added to it, relative stability of situation remains.

It is important to mention all cases when tigers were saved from unnecessary killing. This experience differs fundamentally from previous practice.

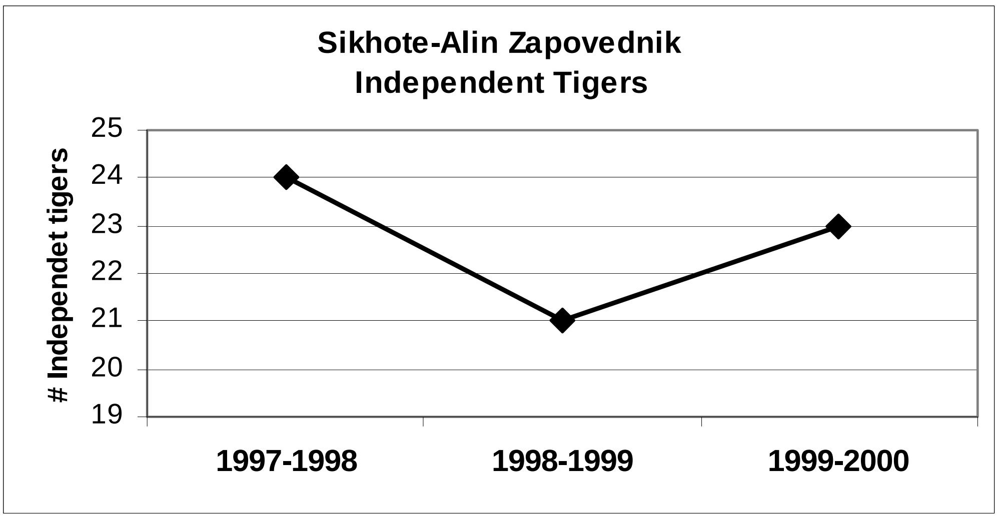

TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Sikhote-Alin Zapovednik
(coastal section)
1999-2000
Amur Tiger
Monitoring Program
1999-2000 winter
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2000
Survey routes
Roads
River system
N
W
E
S
0
40 Kilometers



Percentage of routes with tiger tracks reported (both surveys combined).



Tiger track densities in Sikhote-Alin Zapovednik



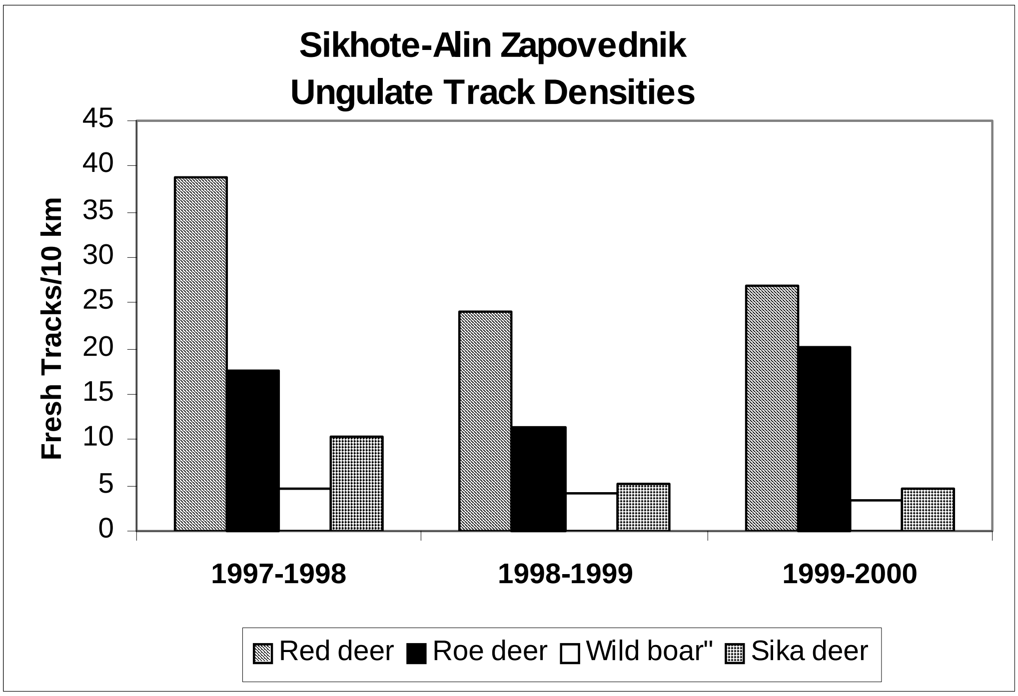
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

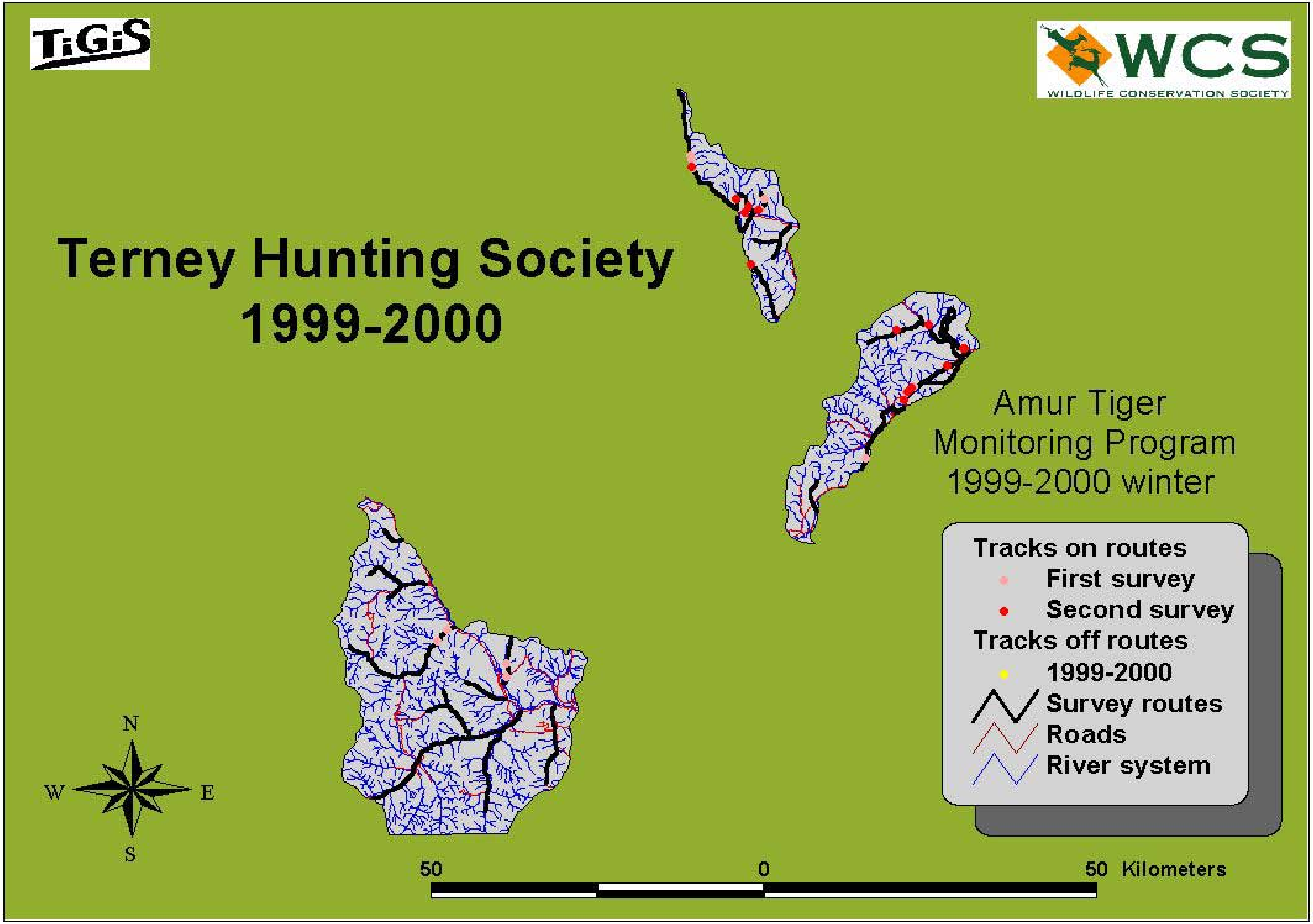
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independ ents*	Total (all tigers)
14	Sikhote-Alin Zap.	1997-1998	10	10	0	0	8	4	20	24	32
14	Sikhote-Alin Zap.	1998-1999	7	5	0	1	0	8	12	21	21
14	Sikhote-Alin Zap.	1999-2000	7	7	0	4	1	5	14	23	24

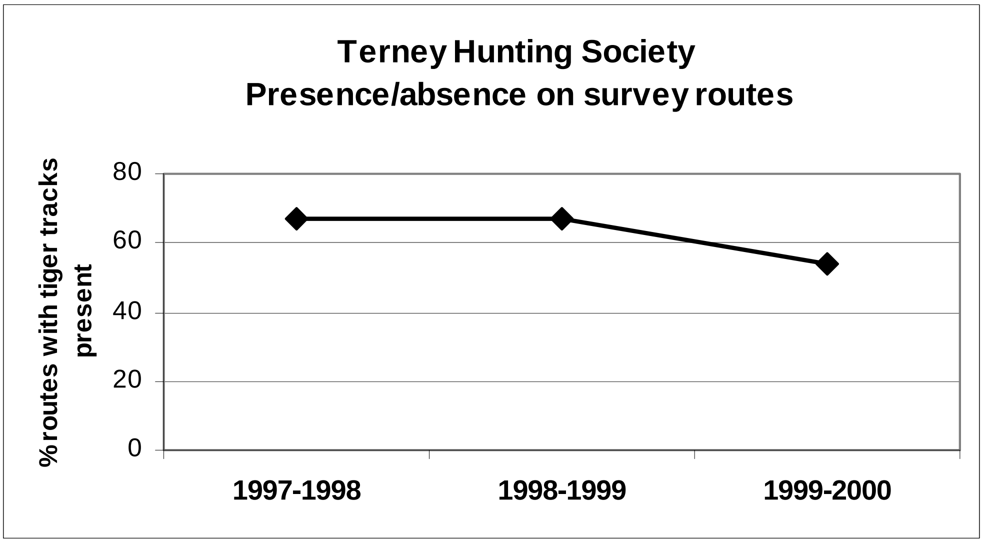
Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997		1998		1999		Total
				mean	std	mean	std	mean	std	mean
14	Sikhote Alin Zapovednik	Red deer	25	38.858	56.834	23.975	16.711	27.019	22.644	30.283
14	Sikhote Alin Zapovednik	Roe deer	25	17.595	39.802	11.501	17.618	20.050	21.050	16.480
14	Sikhote Alin Zapovednik	Sika deer	25	10.242	29.293	5.185	12.446	4.682	12.585	7.206
14	Sikhote Alin Zapovednik	Wild boar	25	4.595	4.910	4.207	4.780	3.249	5.086	3.905

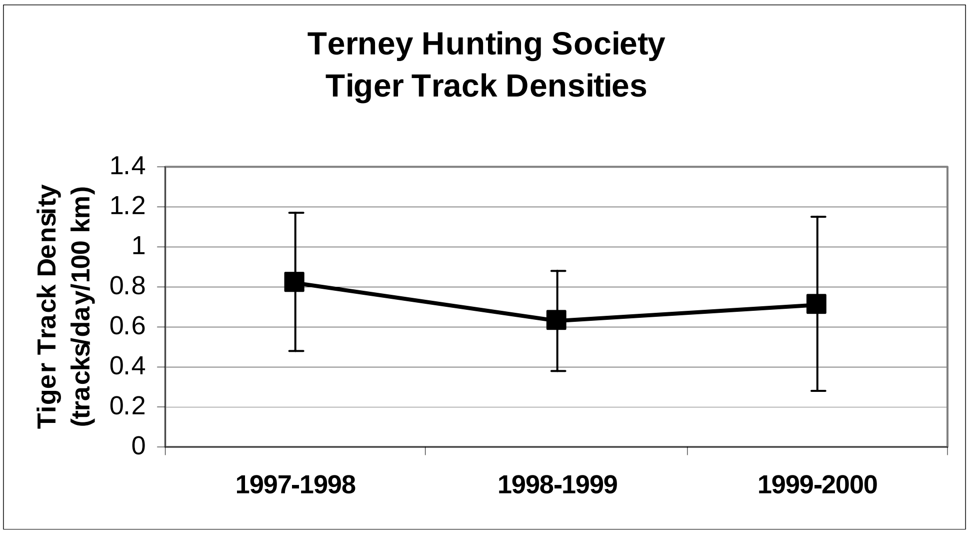




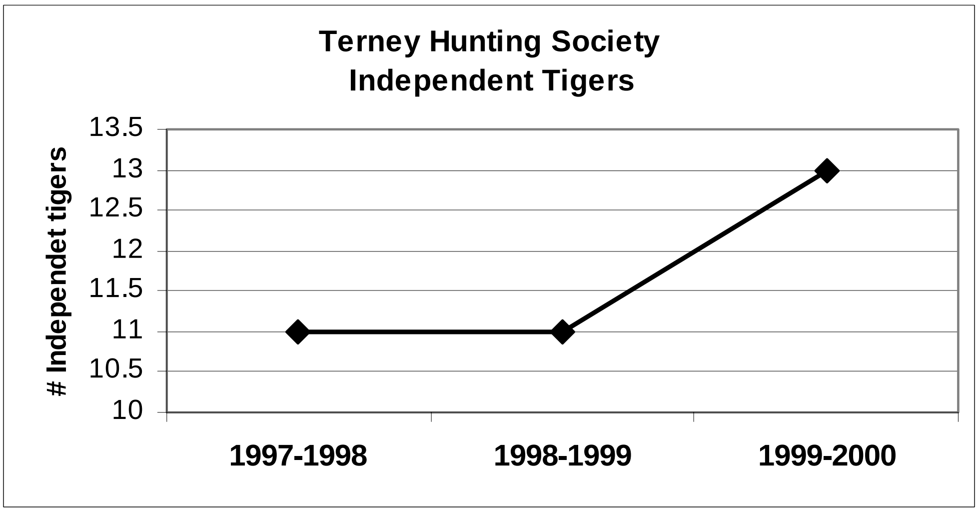
TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Terney Hunting Society
1999-2000
Amur Tiger
Monitoring Program
1999-2000 winter
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2000
Survey routes
Roads
River system
N
W
E
S
50
0
50 Kilometers



Percentage of routes with tiger tracks reported (both surveys combined).



Tiger track densities in Terney Hunting Society, Terneiski Raion



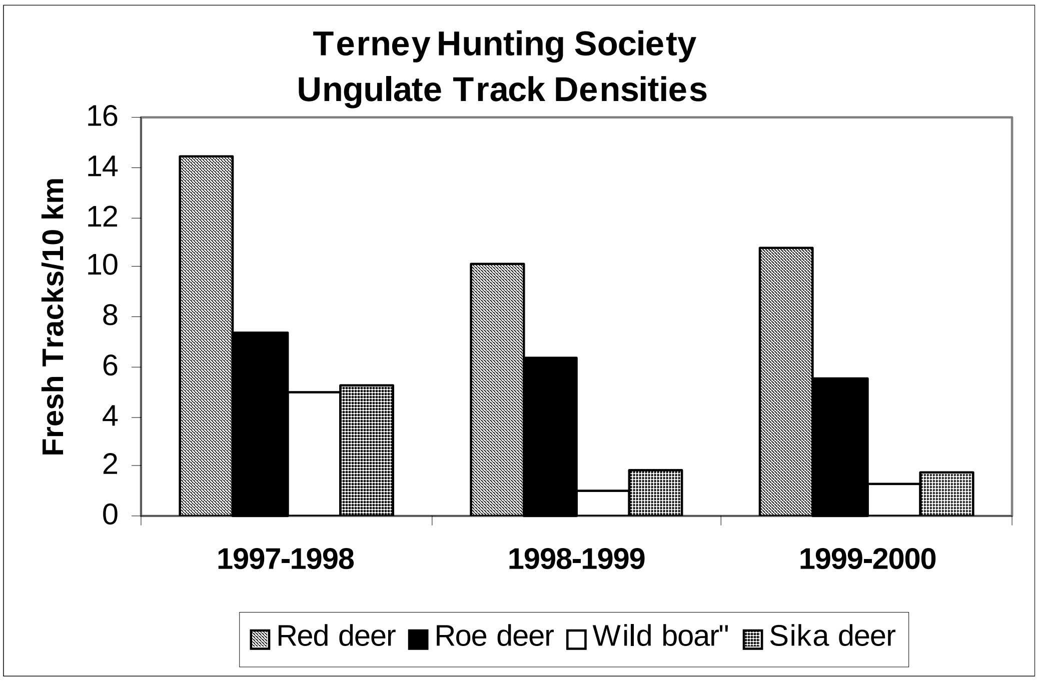
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

#	Site	Year	Age: Adults: Males	Adults: Females	Adults: Un-known	Sub-adults	Cubs	Age unknown	Totals: Total adults	Total independents*	Total (all tigers)
16	Terney Hunting Soc.	1997-1998	3	4	0	0	6	4	7	11	17
16	Terney Hunting Soc.	1998-1999	2	3	0	1	0	5	5	11	11
16	Terney Hunting Soc.	1999-2000	5	5	0	0	1	3	10	13	14

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	Total mean
16	Terney Hunting Society	Red deer	24	14.398	14.073	10.133	10.729	10.749	11.624	12.353
16	Terney Hunting Society	Roe deer	24	7.321	9.289	6.383	9.683	5.522	8.186	6.867
16	Terney Hunting Society	Sika deer	24	5.196	17.740	1.801	5.452	1.726	5.290	2.299
16	Terney Hunting Society	Wild boar	24	4.975	16.206	0.973	1.936	1.329	2.021	1.857



MATAI
KHOR
TIGRINI DOM
BOLSHE KHEKHTSIRSKI ZAPOVEDNIK
BOTCHINSKI ZAPOVEDNIK
Khabarovski Krai
1999-2000

Report on results of Amur tiger monitoring program in Khabarovski Krai in winter 1999-2000

Coordinator - Yu. M. Dunishenko

1. Work conditions and schedule

Monitoring counts were conducted as usual in five monitoring units according to the schedule. Only in Botchinsky monitoring unit the first count was conducted in January because of unstable ice conditions (according to S. V. Kostomarov). The lowest intensity of work (measured as routes per 1,000 ha) was done here; snow depth was not measured along with other deficiencies.

On the whole, all routes in monitoring units were traveled completely along their previously established locations without any changes, except in the Khor monitoring unit, where two routes were added by necessity. Next year it will be necessary to add two routes in Tigriny Dom monitoring unit.

Weather conditions were favorable but this season differed from others because there was no snowfall in January and February, resulting in accumulation of numerous tracks. Due to this fact it was almost impossible to measure old tracks - they had been destroyed by wind, trampled down by numerous tigers' crossings and covered with light, newly fallen snow (caused by condensation in cold conditions). Because of this problem, many recorded tracks could not be identified and the general situation is probably distorted. Perhaps it would be advantageous to conduct analyses only on those tracks less than 7 days old.

Table 1.1. Schedule and work conducted in monitoring units in Khabarovski Krai units.

Model unit	Period of counts		Number of fieldworkers	Total length of all routes traveled during both counts	Km per 1,000 ha		
	1st count	2nd count			1999/ 2000	1998/ 1999	1997/ 1998
Matai	Dec. 10-29	Feb. 10-22	15	754	2.95	2.81	2.9
Khor	Dec. 21-25	Feb. 16-24	9	446	3.39	2.96	2.42
Khekhtsir	Dec. 21-23	Feb. 22	14	140	3.1	3.1	3.0
Tigriny Dom	Dec. 9-22	Feb. 17-26	6	384	1.82	1.83	1.38
Botchinsky	Jan. 5-14	Feb. 13-20	6	320	1.04	0.95	1.13
Total			50	2044	2.15	2.02	1.93

Table 1.2. Work conducted on tiger monitoring program during first and second counts, winter 1999-2000 in Khabarovski Krai units.

Model unit	Area, 100,000 ha	Number of routes	Km traveled		Including					
					1st count			2nd count		
			1st count	2nd count	Vehicle	Snow-mobile	On foot	Vehicle	Snow-mobile	On foot
Matai	255.4	24	377	377	150	190	37	150	190	37
Khor	131.5	21	207	239	154	24	29	171	32	36
Khekhtsir	45.1	7	70	70	0	0	70	0	0	70
Tigrovy Dom	210.7	14	192	192	116	0	76	116	0	76
Botchinsky	307.0	14	160	160	0	160	0	0	139	21
Total	949.7	80	1006	1038	420	374	212	437	361	240

Notes: Route length is measured by curvimeter and may differ from computer variant.

As is seen from the information above, it is necessary to improve the quality of work done in Botchinski monitoring unit, where the number of routes should be doubled, and perhaps conduct the count only once in February. It is necessary to reassess the boundaries of this monitoring unit. It is probably reasonable to exclude the zapovednik's buffer zone from the area defined as the study area.

2. Ungulate populations status

The situation with prey species remains poor. Within tiger range in Khabarovski Krai there are only two prey species - wild boar and elk – which actually determine the status of tigers. Roe deer represent only a small part of the diet and are available only in southern part of the region. In northern part of the range, when snow depth increases, roe deer move into foothills, and consequently out of tiger habitat.

The status of the elk population can be considered stable at the presently low levels. In spite of the fact that population structure is optimal, recruitment rates are high and there are positive signs in terms of population status, the number of animals killed by hunters and predators equals the rate of reproduction.

The wild boar population appears to be increasing. According to our calculations, the population is increasing 15.4% per year, mostly in the southern part of the region. The ban on hunting of wild boar for the past three years has resulted in insignificant increases and cannot be considered much of a success. Addition, in the 1999-2000 winter wild boar numbers decreased dramatically to the north from right bank (as one faces downriver)of the Khor river, probably due to a combination of predation and poaching.

The comparative status of ungulate populations is demonstrated in monitoring data (Table 2.1).

Table 2.1. Encounter rate of wild ungulate tracks (individuals per 10 km of route) during monitoring counts, 1997-1998 through 1999-2000 (total numbers for two counts)

Model unit	Elk			Wild boar			Roe deer		
	1997-1998	1998-1999	1999-2000	1997-1998	1998-1999	1999-2000	1997-1998	1998-1999	1999-2000
Matai	2.78	4.68	3.63	1.04	1.07	2.07	2.10	2.51	2.08
Khor		5.82	3.18		0.77	0.22		6.56	2.20
Khekhtsir	15.0	16.64	14.57	1.40	3.21	0.78	0.73	1.36	0.14
Tigrovy Dom	2.63	4.69	1.20	0.48	0.83	0.96	0.59	0.91	0.31
Botchinsky	2.01	7.94	4.25	0.04	0	0	0.52	3.49	2.75
Total	3.91	6.28	3.92	0.70	0.95	1.05	1.18	3.07	1.74

Of course, these data do not reflect population status in full measure because most routes are located along valleys, and when the snow is low ungulates usually remain up above on the slopes. Nevertheless, these data can be generally relied on to indicate trends. These data suggest that roe deer numbers are increasing. Evidently population grows thanks to "tayozhnaya rasa", which is limited more by deep snow than by predators and humans.

The tiger population in Khabarovsk still has sufficient prey base. Total length of all routes traveled during past 3 years is 5,209 km, where 2,496 elk tracks were found as well as 485 wild boar tracks and 891 roe deer tracks. In other words, tiger can encounter (per 10 km of route) 7,43 ungulate tracks (24 hours old) including 4.79 elk tracks (2.83 individuals), 0.94 wild boar tracks (0.79 individuals), 1.71 roe deer tracks (1.18 individuals). At an encounter rate of one elk per 3.5 km of route, one wild boar per 12.6 km of route and one roe deer per 8.5 km of route, it is clear that tigers can find prey, but the energetic costs (to obtain prey) are significantly higher than in Primorye.

Conversion of tracks into individuals, as demonstrated above, is made with the help of coefficients, obtained during monitoring counts for the past 3 years. It was determined that along routes 2,319 elk tracks were created by 1,382 individuals (conversion coefficient = 1.69), 484 wild boar tracks deposited by 411 individuals (conversion coefficient = 1.18), 1,035 roe deer tracks were created by 716 individuals (conversion coefficient = 1.45) and 196 musk deer tracks were created by 153 individuals (conversion coefficient = 1.28).
These coefficients are based on an extensive amount of information and are likely close to reality, and can therefore be used to convert track counts along routes in a variety of different analyses.

It is important to note that ungulate densities are higher in protected areas than in unprotected areas (Table 2.2.).

Table 2.2. Data on ungulates based on monitoring counts, winter 1999-2000

Model unit	Number of fresh ungulate tracks per 10 km of route								Difference (± %) between counts
	1st count				2nd count				
	elk	wild boar	roe deer	Total	elk	wild boar	roe deer	total	
Matai	4.13	1.83	2.07	8.03	3.13	2.31	2.09	7.53	-6.22
Khor	4.15	0.29	2.90	7.34	2.34	0.17	1.59	4.1	-44.1
Khekhtsir	15.0	1.43	0.29	16.72	14.1	0.14	0	14.24	-14.83
Tigrovy Dom	0.78	1.93	0.52	3.23	1.61	0	0.10	1.71	-47.06
Botchinsky	4.0	0	1.94	5.94	4.5	0	3.56	8.06	+35.6
Total				8.25				7.13	-13.6

Despite the fact that in February ungulates usually move to valley bottoms, we can see in Table 2.2 that the number of ungulates decreases between first and second count for most species. These data are approximate, but when extensive information is gathered it may reflect reality.

People hunt for ungulates intensively, as is shown in the Table 2.3, where monitoring results are given (winter 1999-2000).

Table 2.3. Ranking of hunting and poaching intensity of ungulates along all surveyed routes (based on counts conducted in February 2000).

Model unit	Hunting intensity			Hunting intensity estimated in points	Poaching intensity			Poaching intensity estimated in points
	high	medium	low		high	medium	Low	
Matai	14	3	7	3.17	5	7	12	2.41
Khor	18	3	0	4.71	18	3	0	4.71
Khekhtsir	0	0	0	0	0	0	7	1.0
Tigrovy Dom	11	3	0	4.57	8	5	1	4.0
Botchinsky	0	0	0	0	0	0	14	1.0
Total	43	9	7	4.22	31	15	13?	3.61

From data obtained during 3 years we have noted that not only the number of ungulates changes but their distribution changes also. We suppose that tracks encountered on the routes reflects these changes (Table 2.4.)

Table 2.4. Ungulate tracks encountered on the routes during the counts conducted in February each year

Model unit	Number of routes (%) where ungulate tracks were found								
	elk			wild boar			roe deer		
	1998	1999	2000	1998	1999	2000	1998	1999	2000
Matai	90.0	91.7	75.0	60.0	37.5	66.7	90.0	83.3	79.2
Khor	82.3	82.3	47.6	17.6	17.6	9.5	52.9	52.9	38.1
Khekhtsir	85.7	100	85.7	0	14.3	14.3	28.6	28.6	0
Tigrovy Dom	90.0	92.8	64.3	20.0	21.4	0	40.0	21.4	7.1
Botchinsky	85.7	100	100	0	0	0	100	57.1	42.8
Total	86.2	92.1	71.2	18.9	21.0	23.7	65.5	55.2	52.5

From these data, we can see that only wild boar tracks encounter increased by 25.4% for three years. This fact confirms the trend mentioned above. In almost all sites the number of roe deer tracks decreases (by 8.1% per year), which is contrary to the above statement that the roe deer population is growing, if only this growth is not due to the increase of population density. The decrease in elk tracks by 7% per year it looks to be a real tendency.

We purposely analyzed track encounter rates only in February, when movement of animals has stopped and there is less confusion due to migrating animals.
Based on these data, it appears that prospects for the tiger do not look good if adequate measures to improve the prey base are not taken in the near future. Recovery of populations of prey species requires a long time and considerable funds.

3. Tiger count results

Twenty one tigers were identified in monitoring units in the 1999-2000 winter, one more than in the previous year. This change occurred in Botchinski Zapovednik, where according to V. S. Kostomarov, the number of tigers is consistently increasing (Table 3.1.).

Table 3.1. Tiger numbers and density in monitoring units in winter, 1997-1998 through 1999-2000.

Model unit	Number of tigers found			Tiger density per 100,000 ha		
	1998	1999	2000	1998	1999	2000
Matai	5	5	5	1.96	1.96	1.96
Khor	2	4	4	1.52	3.04	3.04
Khekhtsir	2	2	1	4.43	4.43	2.21
Tigrovy Dom	2	5	5	0.94	2.37	2.37
Botchinsky	3	4	6	0.98	1.3	1.95
Total	14	20	21	1.47	2.10	2.21

The number of tigers is stable in the Matai unit. Six tigers were registered here this winter, but one of them – a big male - was registered also in Khor monitoring unit, which he visited periodically. One tiger was illegally shot and two cubs appeared. Their fate is unknown because the last tracks that were located of them, they were traveling without their mother and were being followed by a male. One tiger, an adult male, was officially shot in Khekhtsir when, famished and sick, he went into house after a dog.

The stable number of tigers indicates that population itself is in a stable phase in which growth is sufficiently high enough to equal removal (mortality). The population structure according to monitoring data is as follows:

Table 3.2. Tiger population structure, winter 1999-2000

Model unit	Males	Females without cubs	Females with cubs	Cubs	Unknown sex	Total
Matai	0	0	1	2	2	5
Khor	3	1	0	0	0	4
Khekhtsir	0	1	0	0	0	1
Tigrovy Dom	3	0	1	1	0	5
Botchinsky	2	0	2	2	0	6
Total	8	2	4	5	2	21

Structure of the population also appears to be stable. Insignificant variations of some parameters are probably a result of errors in sex and age identification. Nonetheless, the number of cubs, which can be determined with minimum error, is on average 25% of the population from year to year (Table 3.3.).

Table 3.3. Changes of tiger population structure in monitoring units from 1996 to 2000

Population components	1996	1997-1998		1998-1999		1999-2000	
	%	individuals	%	individuals	%	individuals	%
Adult males	31.2	4	28.6	6	30.0	8	38.1
Adult females without cubs	17.2	3	21.4	1	5.0	2	9.5
Females with cubs	9.4	2	14.3	5	25.0	4	19.0
Cubs	25.0	4	28.6	5	25.0	5	23.9
Unknown sex	17.2	1	7.1	3	15.0	2	9.5
Total	100	14	100	20	1000	21	100

A balance in productivity was achieved by an increase in the number of reproducing females, which compensated for the decrease in litter size (Table 3.4.).

Table 3.4. Data on tiger litters in monitoring units, winter 1999-2000

Model unit	Adult females		Total number of cubs in litters	Average size of litter			
	with cubs	without cubs		1996	1998	1999	2000
Matai	1	0	2		2.0	1.0	2.0
Khor	0	1	0				
Khekhtsir	0	1	0		1.0	1.0	
Tigrovy Dom	1	0	1			1.0	1.0
Botchinsky	2	0	2			1.0	1.0
Total	4	2	5	1.67	1.5	1.0	1.25

The total number of cubs/litter remains low, despite a slight increase in 2000. At the same time since 1997, the index of cubs per mature female is actually stable - 0.83 cubs (the number of cubs per one adult female). These data indicate that tiger the population has a great reproductive potential, which could be efficiently realized if the prey base increases.

No significant changes in the number of tiger tracks found during counts were noted (Table 3.5.).

Table 3.5. The number of tiger tracks (less than 7 days old) found on the routes

Model unit	Number of tiger tracks on the routes					
	1st count			2nd count		
	1997	1998	1999	1998	1999	2000
Matai	7	5	6	4	20	9
Khor	8	14	15	3	3	16
Khekhtsir	8	3	1	4	1	0
Tigrovy Dom	6	7	6	13	8	5
Botchinsky	4	8	7	6	6	17
Total	33	37	35	30	38	47

Taking into consideration the fact that in 1997 and 1998 routes were not traveled completely, and in 2000 their length increased, the number of tracks has not significantly deviate from its basic value, although during February counts the number of tracks tends to increase.

4. Monitoring of tiger habitat

Information about new roads construction, number of logging sites and logging areas only partly reflects changes of tiger habitat, because this information is generally incomplete. To get all the information is impossible due to enormous trips and expenses. In 1999-2000 these changes were noted:

Table 4.1. Changes of tiger habitat, winter 1999-2000

Model unit	New roads, km	Number of logging sites	Area of logging sites, ha
Matai	275	27	2002
Khor	16	10	850
Khekhtsir	0	0	
Tigrovy Dom		7	520
Botchinski	0	0	
Total	291	44	3372

It is evident that small forest fires play an important role (but it is difficult to find information about them in reports) as well as human activity in forests.

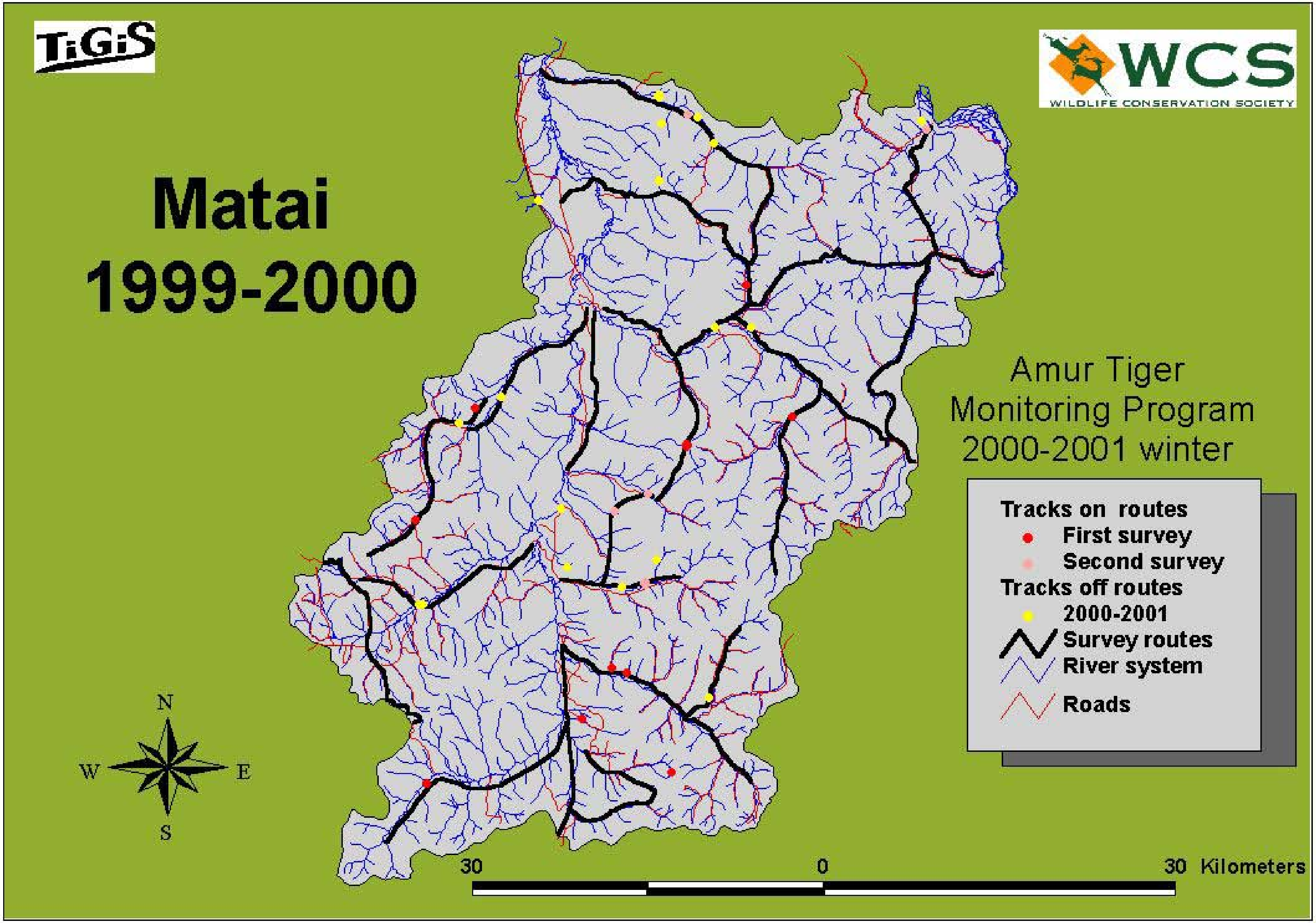
In spite of the fact that annual size of logging activities in monitoring units is less than 1% of their total area, the negative impacts are profound. Roads associated with logging increase accessibility of forests, leading to deterioration of their protective qualities due to cutting of coniferous trees, destruction of remnant pine and oak forests, and destruction of horse-tail (*Equisetum* spp. - an important winter forage) by heavy machinery. All these events have a negative influence on the tiger prey base. Continuing logging of forests has resulted in a complex patchwork that consists of different forest types (different in species composition and age). Mature forests, where ungulate densities could be high, represent less than 20% of monitoring units. For red deer and musk deer, areas logged 3-20 years ago, depending on their location, still can provide quality habitat, but for wild boar such areas are essentially lost as habitats for 50-70 years, if not forever.

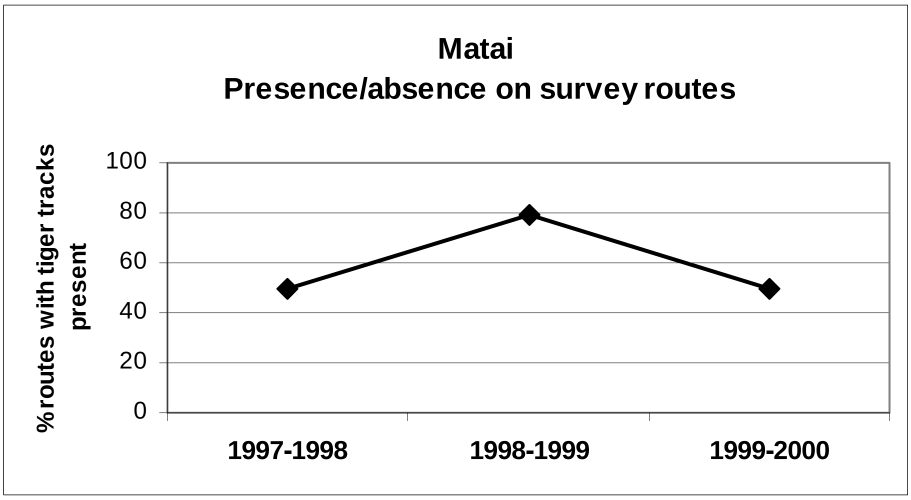
In this connection within all tiger range all areas proposed for logging activities should undergo an obligatory environmental assessment that demonstrates that the advantages of logging, outweigh the disadvantages. Presently, such assessments are not done.

The same situation exists with forest roads. Numerous roads have been constructed up through the present. Some of them are in poor condition and overgrown, others are used only in winter, but in general roads are disasters for wild animals. Year-round roads reduce wildlife habitat forever, and seasonal roads also result in human disturbance. Animal numbers sharply decreases areas bisected by roads, as well in adjacent zones that incur indirect influences.

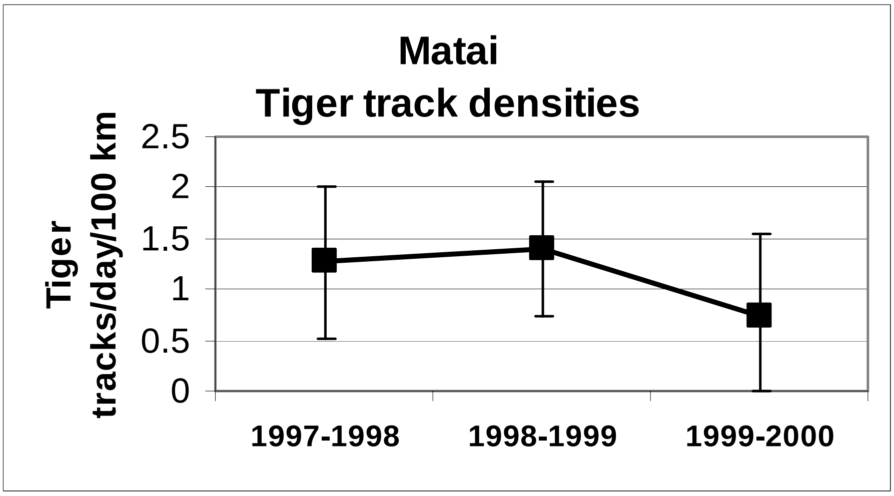
Therefore, the following measures are necessary:

1. Obligatory environmental examination and assessment of damage from new road construction and use.
2. Inventory of all roads, their classification according to the extent of use and effect on fauna. Destruction of roads, which will not be used for economical activity in near future.
3. To improve control and protection along roads.

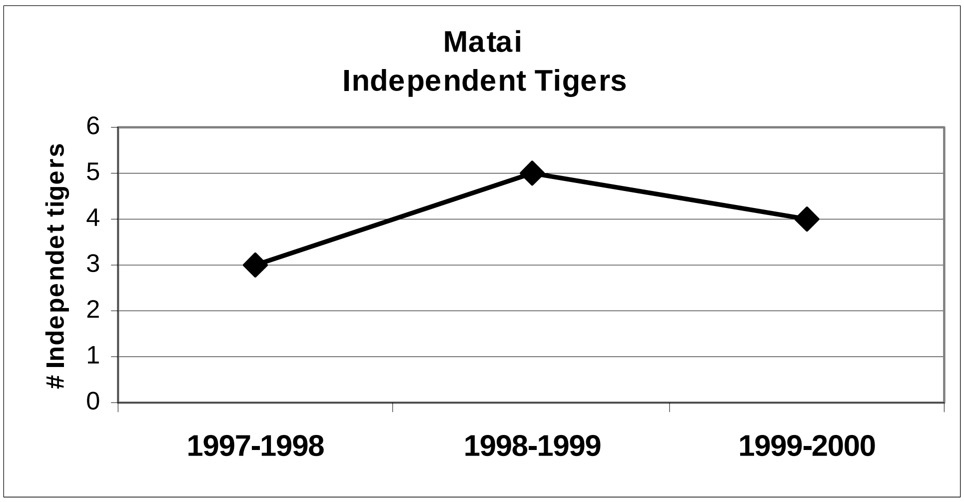

Matai
1999-2000
Amur Tiger
Monitoring Program
2000-2001 winter
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
River system
Roads
N
W
E
S
30
0
30 Kilometers



Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



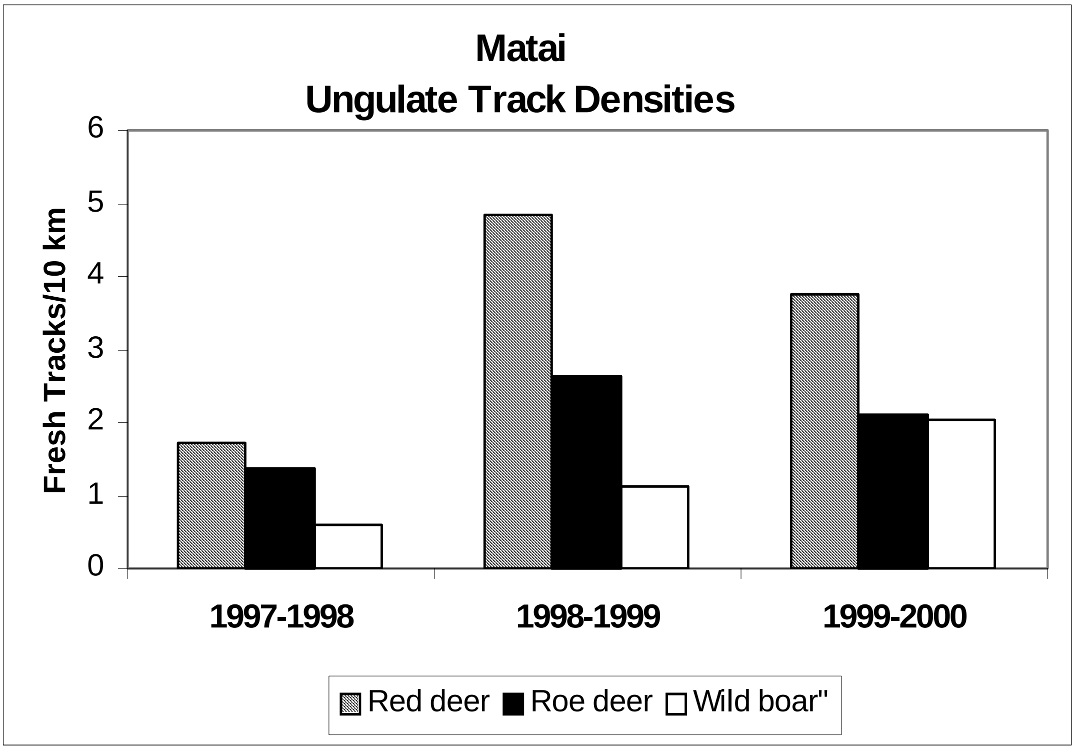
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

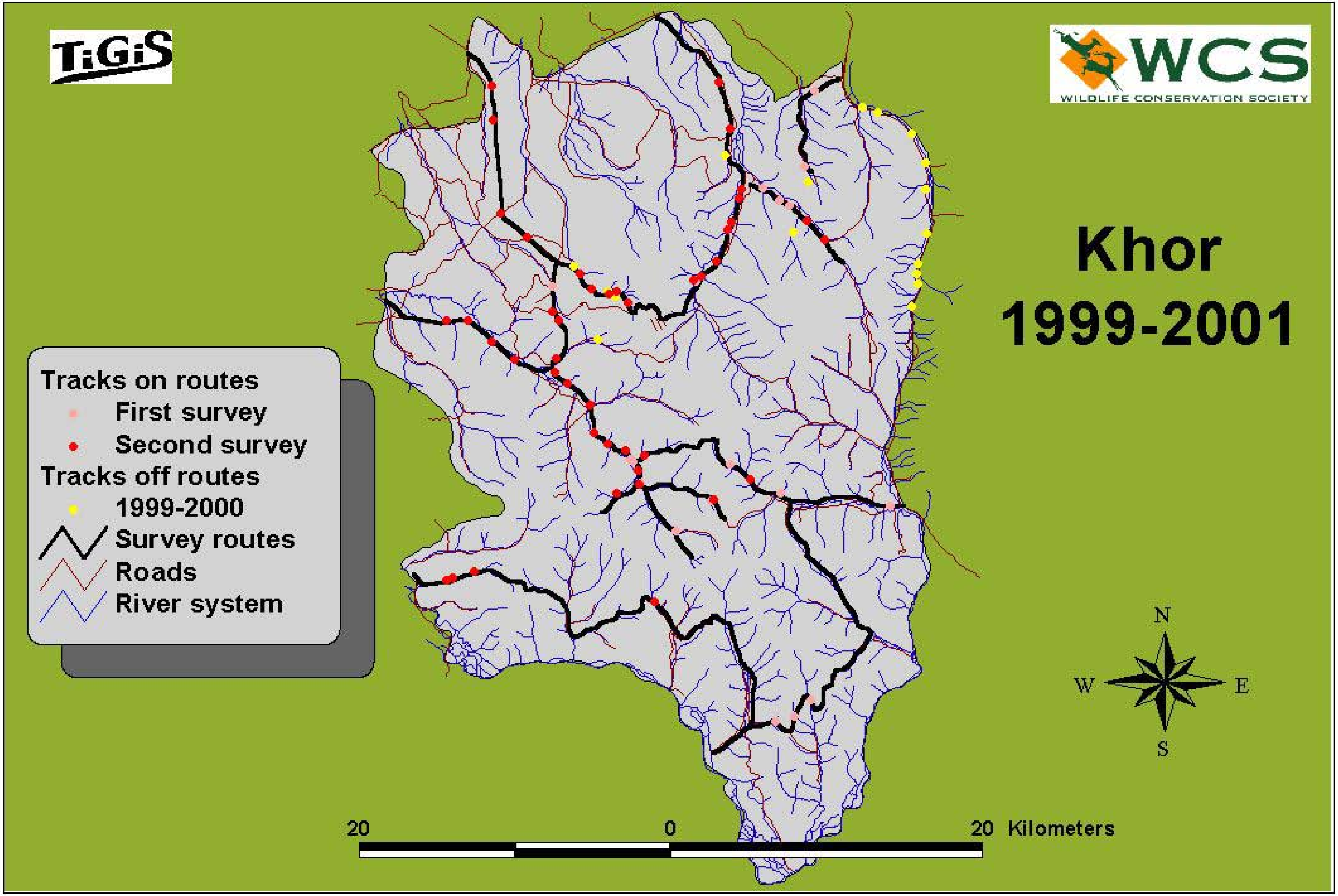
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independ ents*	Total (all tigers)
12	Matai	1997-1998	1	2	0	0	0	0	3	3	3
12	Matai	1998-1999	0	2	0	2	0	1	2	5	5
12	Matai	1999-2000	1	1	0	2	2	0	2	4	6

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997		1998		1999		Total
				mean	std	mean	std	mean	std	mean
12	Matai	Red deer	24	1.714	1.768	4.852	4.043	3.764	3.974	3.134
12	Matai	Roe deer	24	1.371	1.761	2.618	2.119	2.102	1.221	1.905
12	Matai	Wild boar	24	0.591	0.939	1.111	1.093	2.052	2.026	1.424




Khor
1999-2001
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2000
Survey routes
Roads
River system
20
0
20 Kilometers
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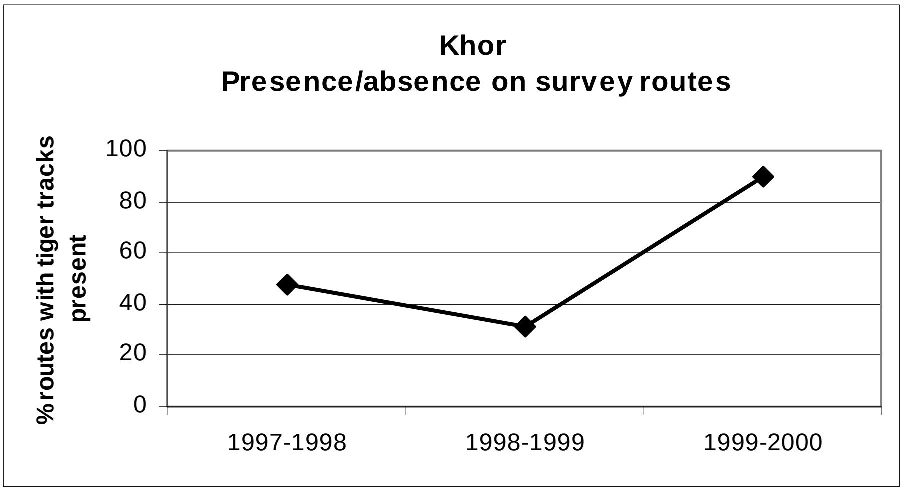
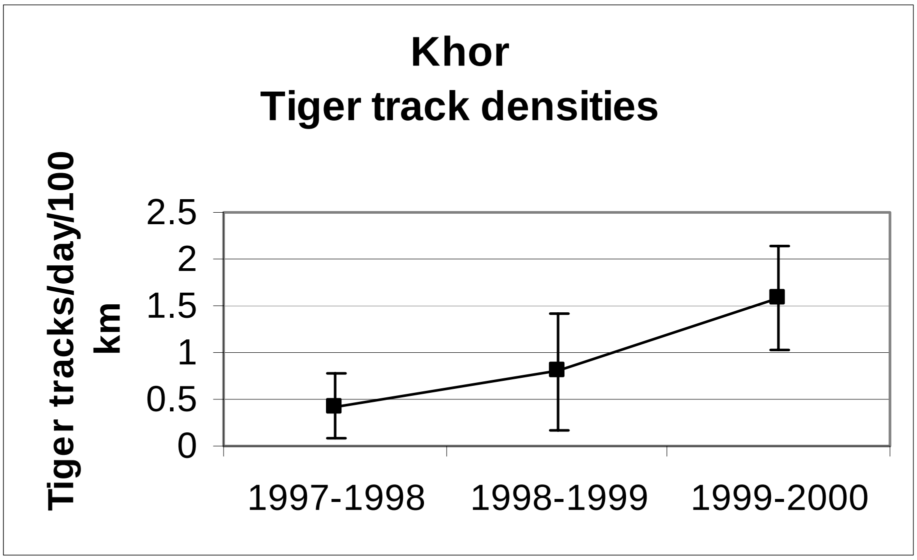
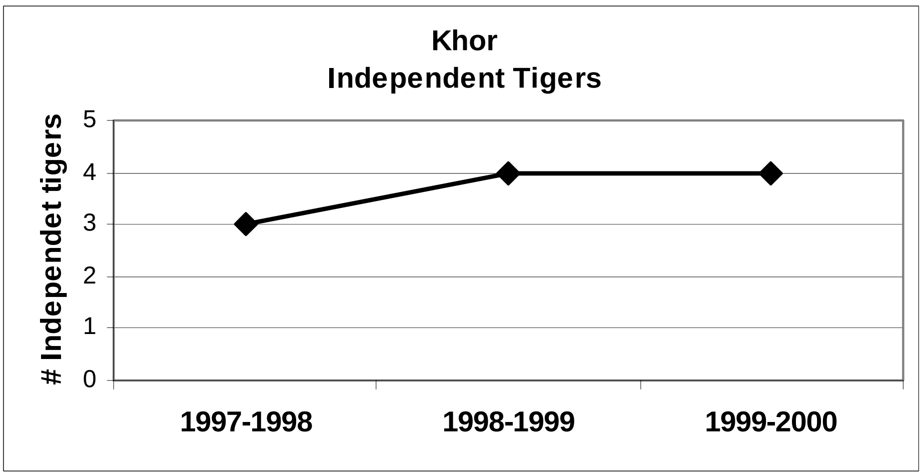


Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



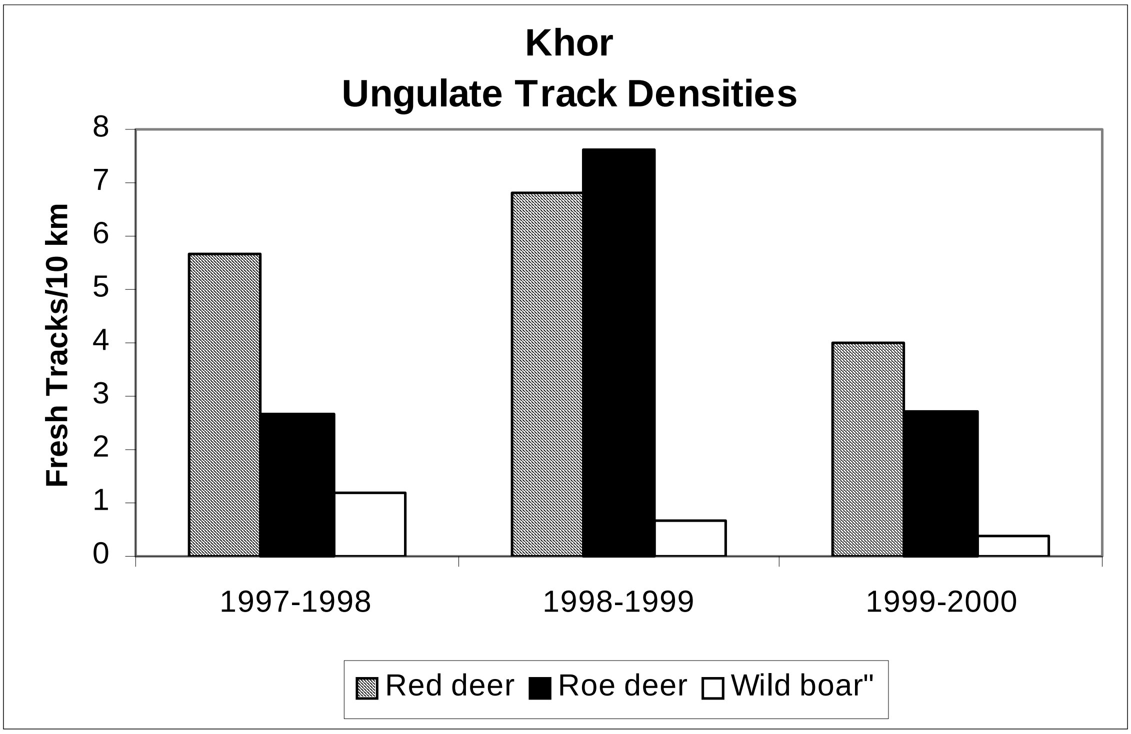
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

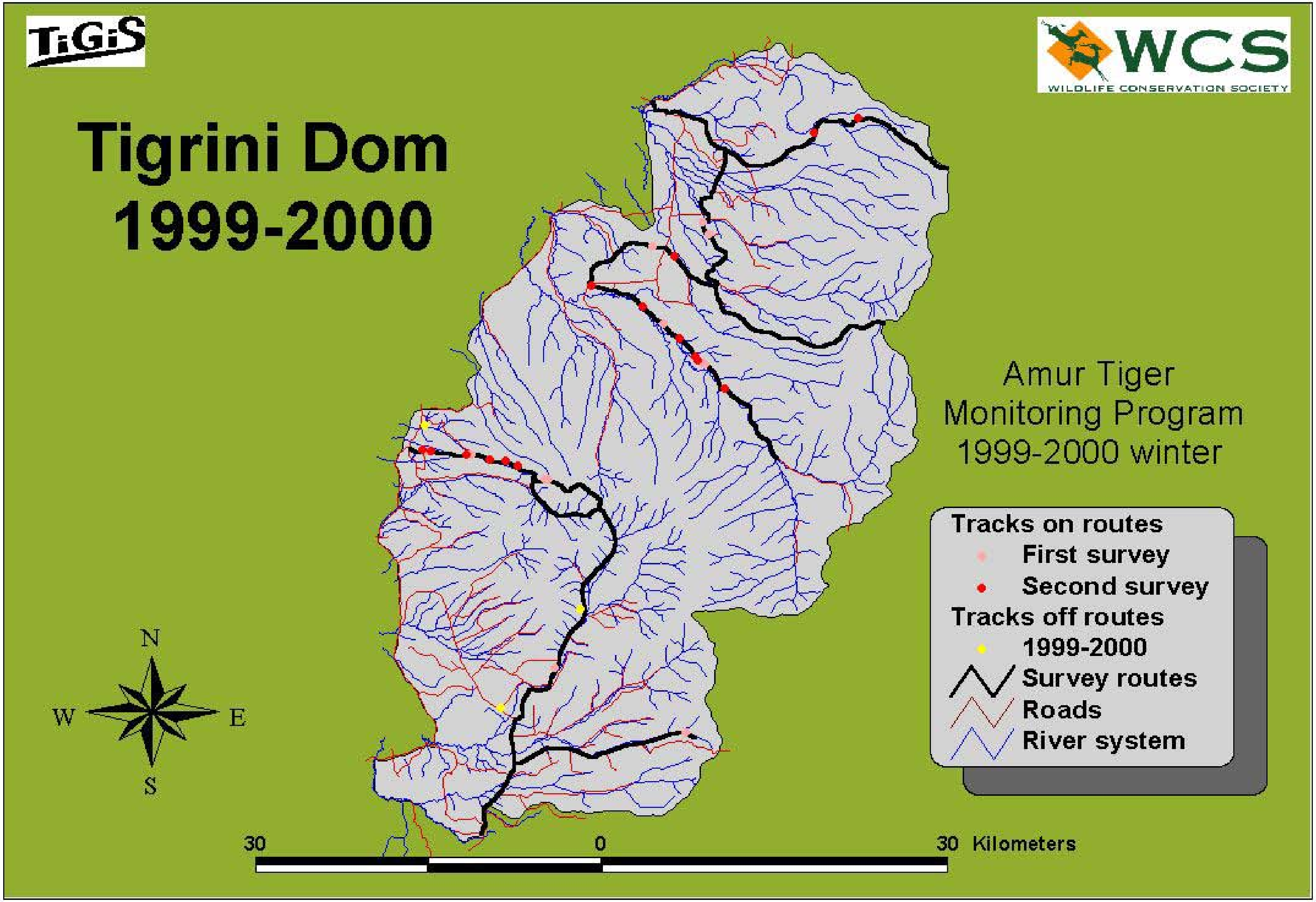
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independ ents*	Total (all tigers)
8	Khor	1997-1998	2	1	0	0	1	0	3	3	4
8	Khor	1998-1999	2	2	0	0	2	0	4	4	6
8	Khor	1999-2000	2	2	0	0	0	0	4	4	4

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997		1998		1999		Total
				mean	std	mean	std	mean	std	mean
8	Khor	Red deer	19	5.690	5.429	6.821	5.892	3.978	4.456	5.195
8	Khor	Roe deer	19	2.690	3.474	7.601	5.358	2.731	3.380	4.094
8	Khor	Sika deer	19	0.058	0.252	0.000	0.000	0.000	0.000	0.014
8	Khor	Wild boar	19	1.181	2.330	0.658	0.980	0.373	0.736	1.237




TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Tigrini Dom
1999-2000
Amur Tiger
Monitoring Program
1999-2000 winter
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2000
Survey routes
Roads
River system
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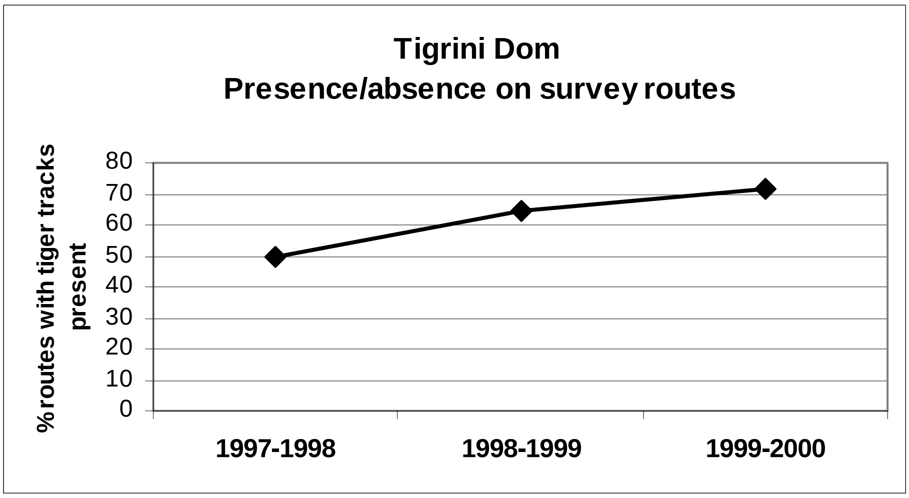
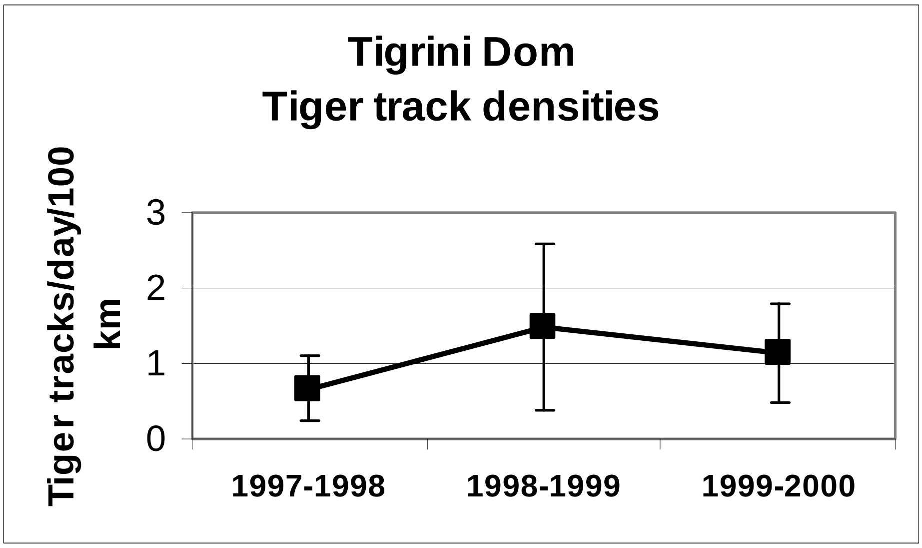
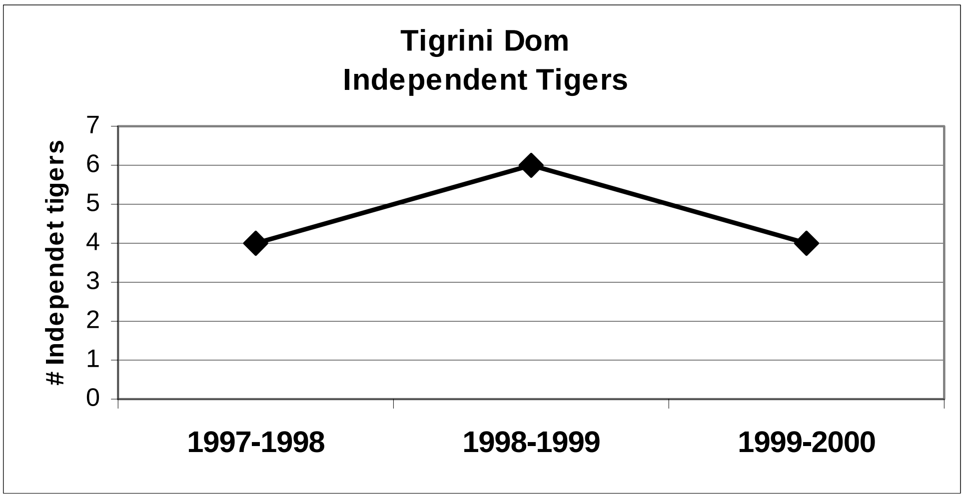
30 Kilometers



Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



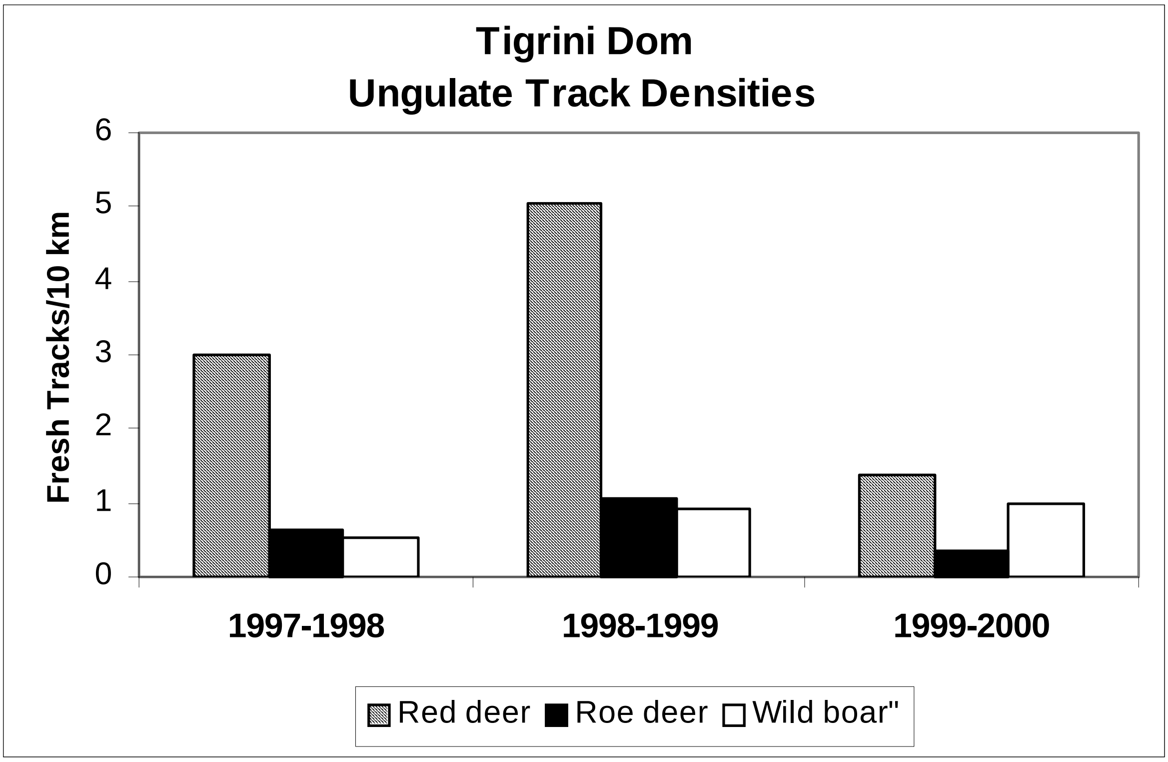
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

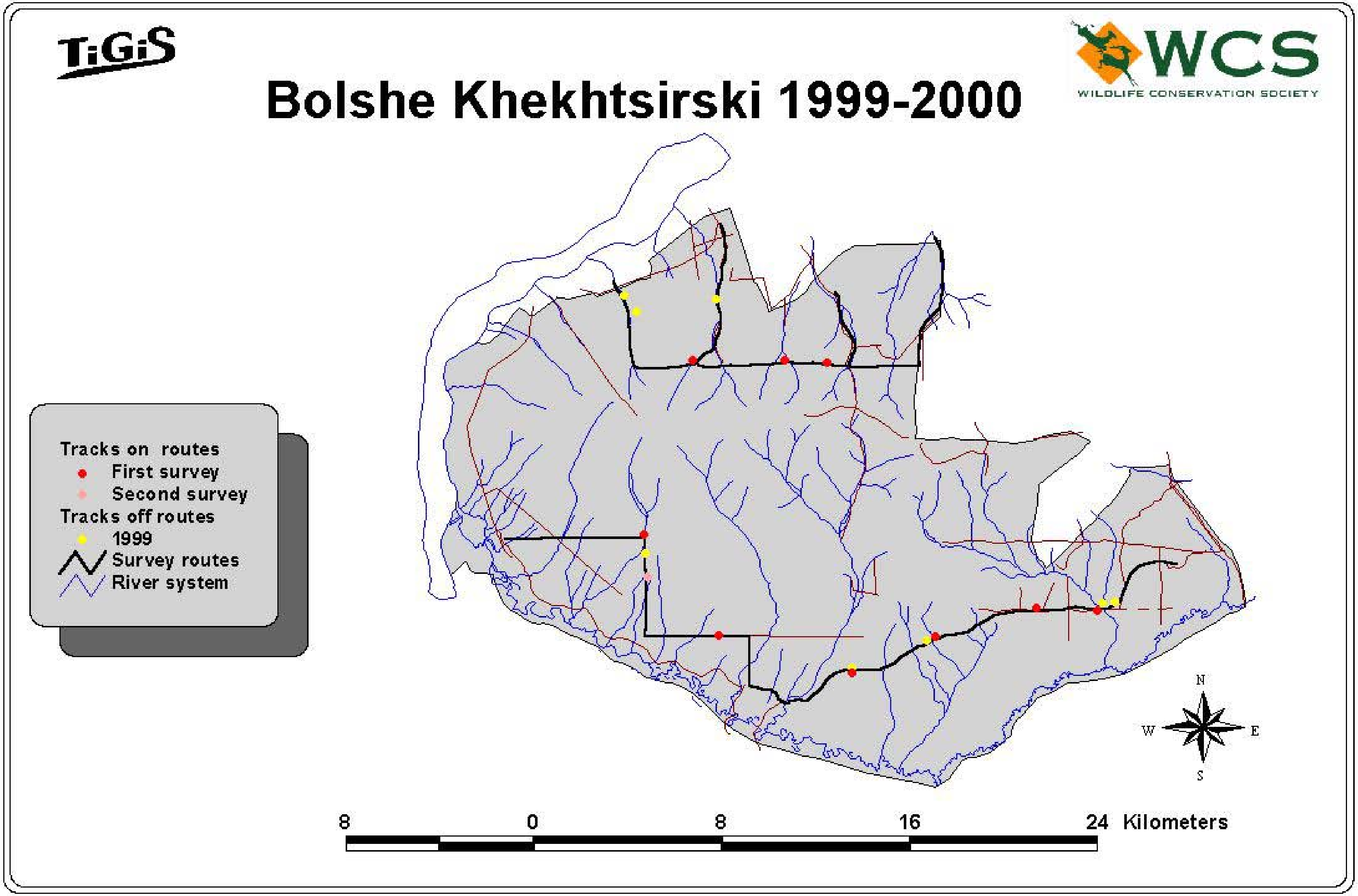
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

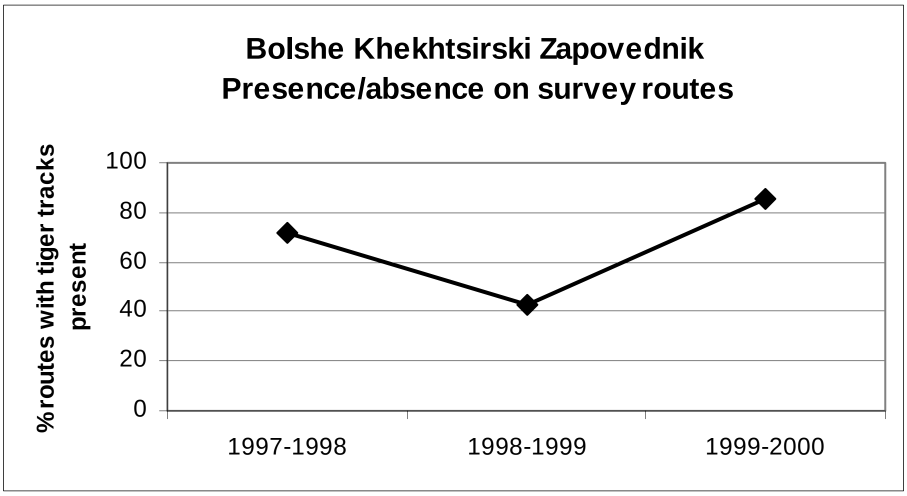
#	Site	Year	Age: Adults: Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Totals: Total adults	Total independents*	Total (all tigers)
11	Tigrini Dom	1997-1998	2	0	1	1	0	0	3	4	4
11	Tigrini Dom	1998-1999	2	0	2	2	0	0	4	6	6
11	Tigrini Dom	1999-2000	3	1	0	0	1	0	4	4	5

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

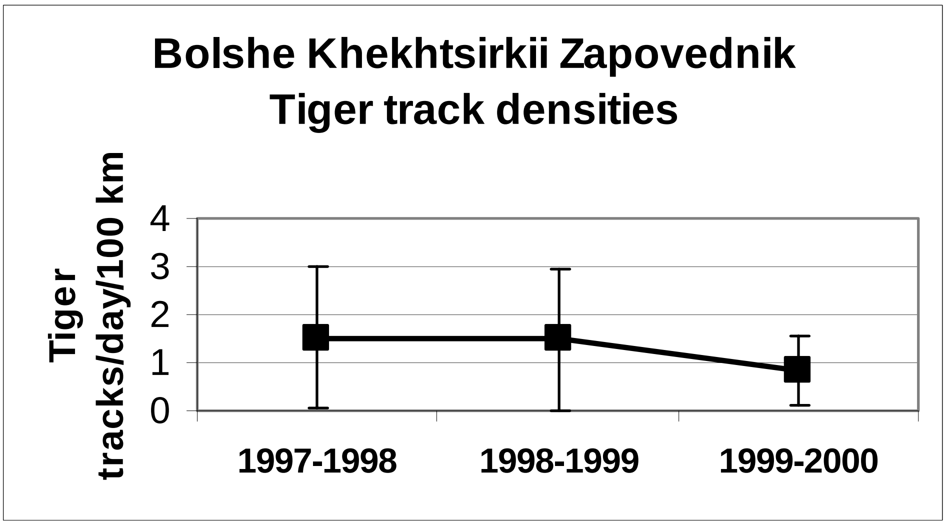
#	Monitoring Site		n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	Total mean
11	Tigrini Dom	Red deer	14	3.003	3.916	5.060	3.404	1.377	1.386	2.760
11	Tigrini Dom	Roe deer	14	0.647	0.817	1.044	2.602	0.362	0.739	0.593
11	Tigrini Dom	Wild boar	14	0.537	1.203	0.935	1.572	0.997	0.896	0.749



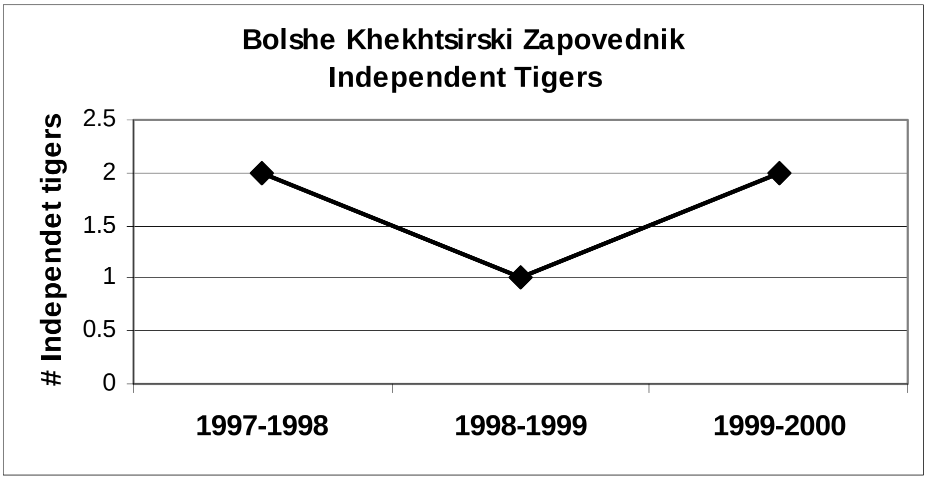

Bolshe Khekhtsirski 1999-2000
WILDLIFE CONSERVATION SOCIETY
Tracks on routes
First survey
Second survey
Tracks off routes
1999
Survey routes
River system
N
W
E
S
8
0
8
16
24 Kilometers



Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



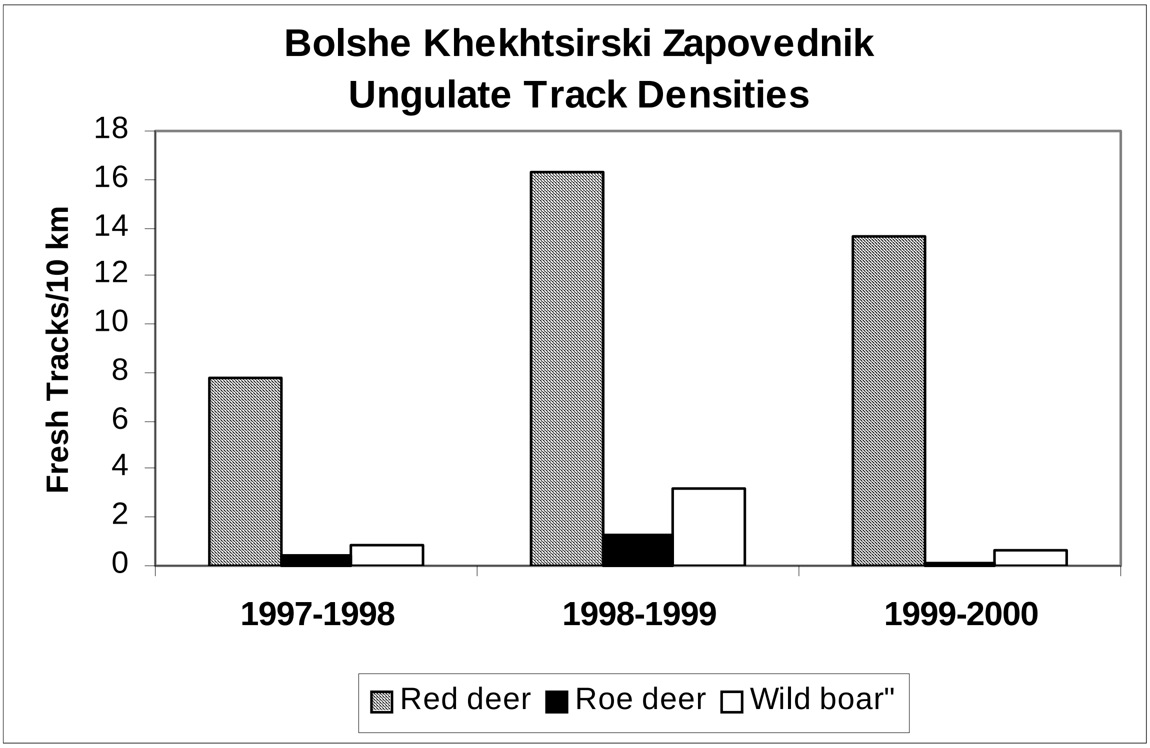
Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

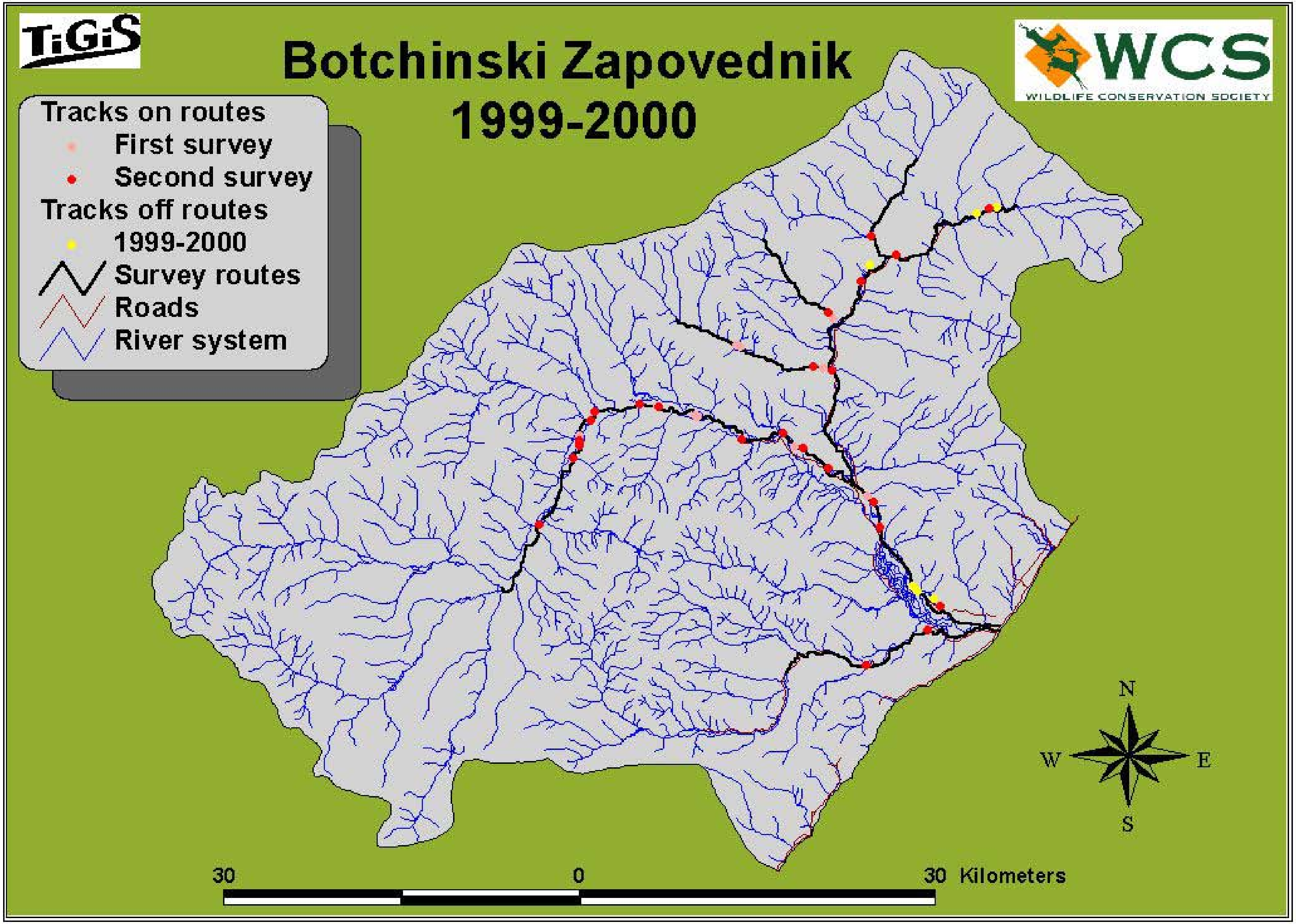
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

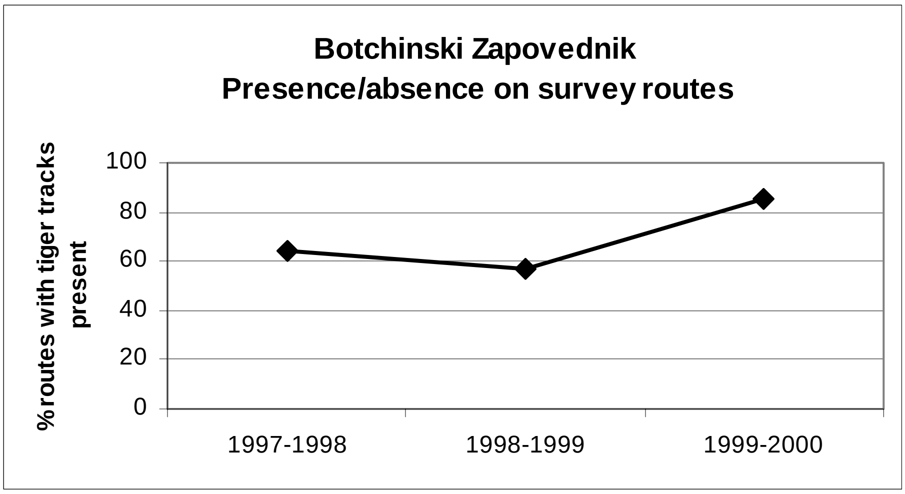
			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independents*	Total (all tigers)
10	BolsheKhekhtsir Zap.	1997-1998	1	1	0	0	0	0	2	2	2
10	BolsheKhekhtsir Zap.	1998-1999	0	1	0	0	1	0	1	1	2
10	BolsheKhekhtsir Zap.	1999-2000	1	1	0	0	0	0	2	2	2

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

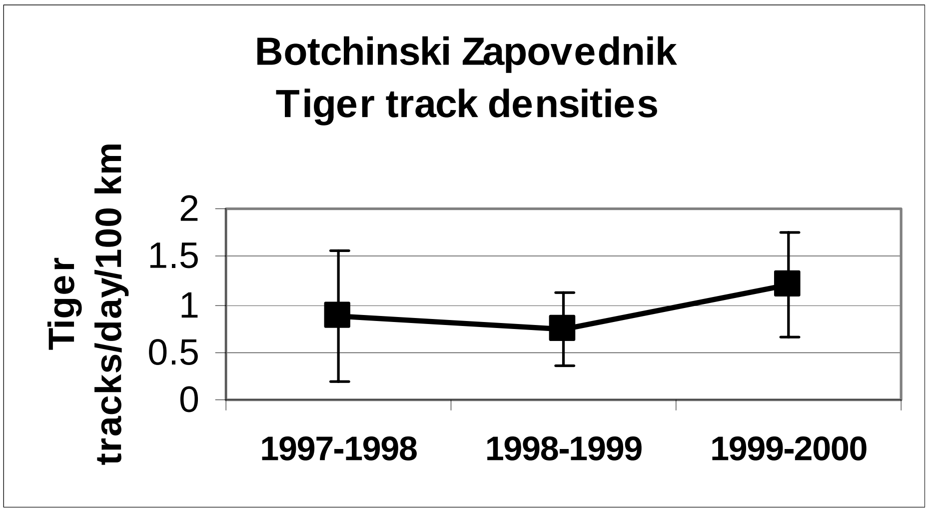
#	Monitoring Site		n	1997		1998		1999		Total
				mean	std	mean	std	mean	std	mean
10	BolsheKhekhtsir Zapovednik	Red deer	7	7.801	7.713	16.294	14.121	13.652	12.746	19.680
10	BolsheKhekhtsir Zapovednik	Roe deer	7	0.452	0.370	1.272	1.546	0.157	0.416	0.699
10	BolsheKhekhtsir Zapovednik	Wild boar	7	0.800	1.049	3.160	3.450	0.611	1.095	2.022



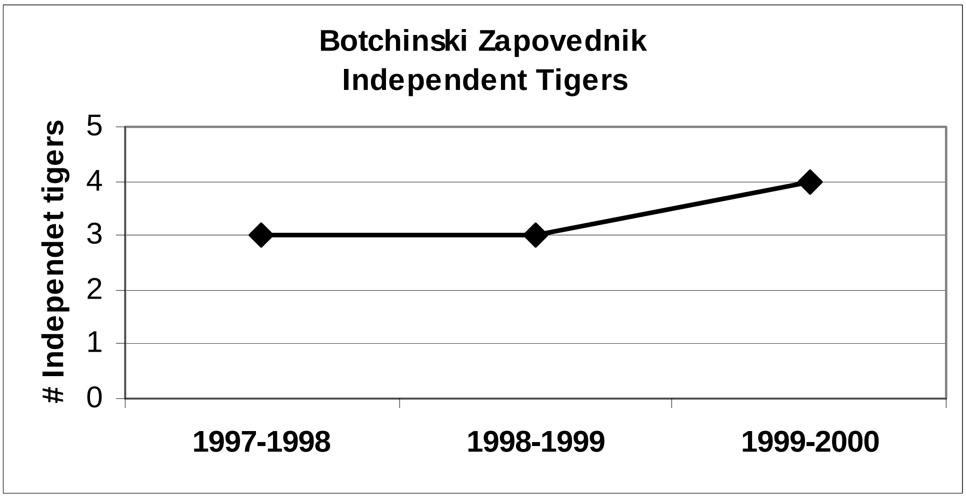

Botchinski Zapovednik
1999-2000
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2000
Survey routes
Roads
River system
WCS
WILDLIFE CONSERVATION SOCIETY
N
W
E
S
30
0
30 Kilometers



Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



Number of Independent tigers (adults, subadults, unknown) on monitoring sites, 1999-2000

Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independents*	Total (all tigers)
9	Botchinski Zap.	1997-1998	1	2	0	0	0	0	3	3	3
9	Botchinski Zap.	1998-1999	1	0	1	1	1	0	2	3	4
9	Botchinski Zap.	1999-2000	2	2	0	0	2	0	4	4	6

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 3 years.

#	Monitoring Site		n	1997		1998		1999		Total
				mean	std	mean	std	mean	std	mean
9	Botchinski Zapovednik	Red deer	14	1.753	1.192	6.866	5.062	4.328	2.501	3.968
9	Botchinski Zapovednik	Roe deer	14	0.421	0.628	2.995	3.158	2.688	2.846	2.585
9	Botchinski Zapovednik	Wild boar	14	0.027	0.102	0.000	0.000	0.000	0.000	0.007