A MONITORING PROGRAM FOR THE AMUR TIGER

FOURTH-YEAR REPORT: 2000-2001

In accordance with the Russian National Strategy for Tiger Conservation

A cooperative project conducted 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
Sikhote-Alin State Biosphere Zapovednik
Lazovski State Zapovednik
Ussuriski Zapovednik
Botchinski Zapovednik
Bolshe-Khekhtsirski Zapovednik
Institute for Sustainable Use of Renewable Resources
World Wide Fund for Nature

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Executive Summary. In the 2000-2001 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 relative and absolute indicators), cub production, mortality, 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 four years (1997-1998 winter through 2000-2001 winter) of monitoring Amur tigers in the Russian Far East suggest that the tiger population appears to be stable. Although some sites, such as Lazovski Raion, appear to be experiencing a decline in tiger numbers, others, like Botchinski Zapovednik, appear to have increasing tiger numbers. Red deer and roe deer appear to be experiencing small increases in population size overall, but local conditions vary greatly. Prey numbers and cub production outside protected areas (zapovedniks) is extremely low, and it is unlikely that cub production in zapovedniks will be sufficient to maintain the present population level. Recovery of ungulate populations on privately managed hunting leases should be a priority for tiger conservation efforts in the Russian Far East.

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 between 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 third 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 press, 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 3 primary variables:

Protected status: protected (as zapovednik)/unprotected areas;
Latitude: northern, central, or southern; and,
Geographic location: inland or coastal.

We defined protected areas only as those area with zapovednik status. Although some sites have partially or wholly protected as zakazniks (Borisovkoe Plateau, Matai), these designations are relatively new, and do not provide the same level of protection afforded to zapovedniks. It is commonly assumed that latitude is an important factor affecting tiger density, and that density decreases at the northern limits of its range. Therefore sites in Khabarovski Krai should theoretically retain lower tiger densities than sites to the south. Finally, there are important differences forest types and presumably ungulate densities, between coastal areas (i.e., those sites on the coastal side of the Sikhote-Alin Divide) and inland sites. In all cases except for Borisovkoe Plateau, this designation 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 (Figure 1, 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	Latitude	Geographic location
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).

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

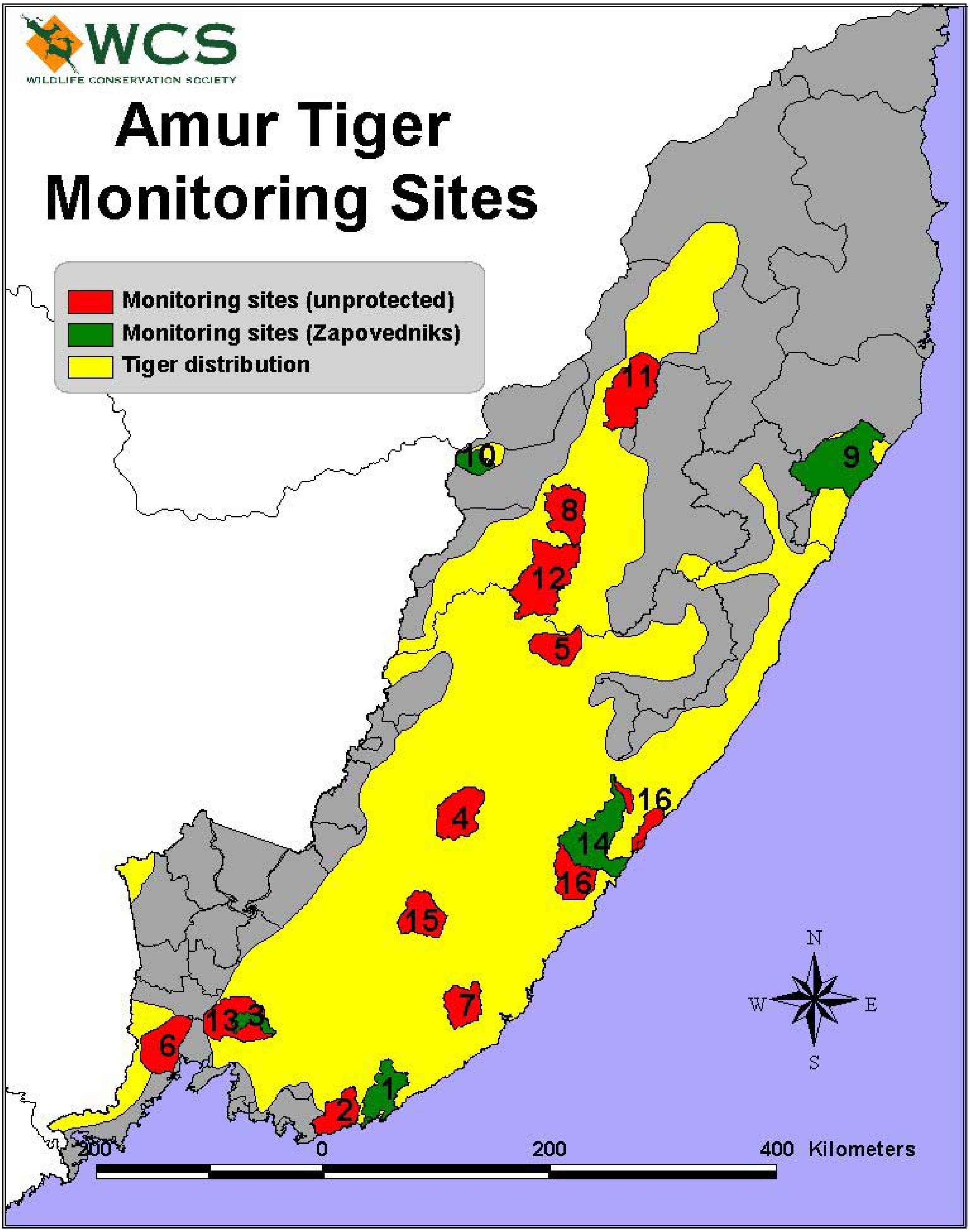


Figure 1. Location of the 16 sites used for monitoring Amur tigers in the Russian Far East. Numbers referenced in Table 1 and most other tables throughout text.

Included as monitoring units are all 5 zapovedniks that have 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). 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.

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 boundaries defined as boundaries of protected areas, or natural boundaries reflecting geographic constraints on tiger movements (e.g., high ridgetops, large rivers);

iii) In good tiger habitat, assuming that female home ranges average 400-500 km^2 (Miquelle et al. 1999) 100,000 - 150,000 ha may 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 tiger range, in the Russian Far East the snow cover afforded in the winter season provides a “clean pallet” which reveals presence of tigers, and usually retains that evidence for an extended period, usually 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 to 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 in 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 bisecting tiger tracks than shorter routes, and that while 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 (to allow for expert assessments of number of tigers); 2) there should be sufficient number of routes to provide a statistical basis for comparisons among count units and within a count unit over years; 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). Chances of detecting a 5% change are decidedly less with 10 routes(55-56%). Increasing the number of routes to 20 increases the chance detecting a 10% decrease to 98%, but would represent a doubling of effort for a relatively modest gain. 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 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 and ungulate 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)

We generally report only on the 4 key prey species: red deer, wild boar, roe deer, and sika deer. Musk deer and moose are very rarely preyed upon by tigers, and form an insignificant portion of their diet.

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 on each monitoring unit 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 per winter season). Monitoring units can then be ranked on the basis of percentage routes with (without) tiger tracks as an indicator of relative abundance, which can also be compared among years within each unit..

We compared relative abundance of tigers, based on presence/absence data, used ranks of the percentage of routes where tigers were reported for each site as a basis for comparison (presence/absence data is highly non-parametric). We assessed environmental parameters of sites that may explain presence/absence data by conducting a 3-way factorial ANOVA (SAS GLM), with protected status, latitude, and proximity to coast as independent variables (Tables 1 and 2)

For all three indicators of tiger abundance, to look for trends in the population we conducted linear regression analyses. For presence absence data, we used the average percentage of routes with tigers present for all sites combine, and then conducted separate analyses for each individual site. The same types of analyses were conducted for tiger track data, tiger density estimated from expert assessments, and track data for ungulates (see below). The intent of the regression analyses is to identify trends in the population across the whole region, and in each of the monitoring sites. We have defined sites as "areas for concern" if the trend analyses demonstrate a negative slope for which the statistical probability was greater than 80% (i.e. $P < 0.2$) that the population was decreasing (i.e. that the slope of the line did not equal zero). We have used the same criteria for defining sites as "areas with positive growth indicators" if the slope is positive.

This is a very conservative approach, as most statisticians use a P value of 0.05. By increasing the P-value to 0.2, we dramatically increase the probability of defining a site as an "area of concern" or an "area of positive growth indicators" when in fact such may not be the case. This rationale is that we must have a mechanism for identifying areas early, so that remedial action can take place: a more liberal approach (with a smaller P value) would result in fewer "false alarms" but may not identify all areas in time to respond on an appropriate time scale.

By assessing a host of variables, we believe the approach provides a balance between being overly alarmist and overly complacent.

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. The mean derived from this value for both surveys in each winter is taken as the track density estimator

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 between snowfalls when the interval is large, resulting in an underestimation of track densities. 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 the track density estimator for days since last snowfall:

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) averaged for each route (for the two surveys per route per year), is the track density estimator 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 the track density estimator 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.

To look for trends across time, we combined visual graphic assessments with regression analyses. For each route, we tested whether there existed a significant slope (i.e., β not equal to 0), and then compared years (as above) for all sites combined, and separately for each.

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, sub-adult, 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, sub-adults, 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 Spearman's rho (Conover 1980) on those ranks.

Trends in population status, converted to density, were conducted as with the other two indicators of tiger abundance.

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 simply the total 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 to develop a mean for the monitoring site. For each species, we conducted a separate a 3-way factorial model to assess environmental parameters (latitude, protected status, and proximity to coast) and conducted trend analyses using linear regression for each site separately and for all combined.

IV. RESULTS OF THE 2000-2001 WINTER MONITORING PROGRAM

Summary Data on Count Units and Routes

In the 2000-2001 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 (in nearly all units they were sampled twice), representing 3057 km of routes (with double sampling, a total of 6114 km traversed) (Table 3).

In the southern part of Primorski Krai, and in some central areas, snow depth was unusually high this winter (Figure 2). In Borisovkoe Plateau (usually one of the warmest, and most snow-free areas), a heavy snowfall occurred on November 27th, and by the February count snow depth had reached 50-60 cm in some areas. In Lazovski Raion, snow depth reached 80 cm in some areas. In both the Iman and Sikhote-Alin units, some routes were not passable in February due to deep snow, and therefore were not surveyed a second time.

This winter was also exceptional cold in the Russian Far East, and for that matter, across much of Russia. In Khabarovsk, it was estimated that mean daily temperatures were 7-8^o C colder than normal. Cold temperatures may be a significant factor affecting tiger hunting success (see Dunishenko report in section on individual sites), and deep snow is often a contributing factor to winter mortality of ungulates. Overall, winter conditions were harsh this year, and likely affected wildlife populations in a number of ways.

Table 3. Characteristics of units surveyed for Amur tiger monitoring program, 2000-2001.

	Monitoring Unit	Coordinator	Size of unit (km^2)	# 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 exceeded 1 km/10 km^2 in all but two units (Botchinski and Tigrini Dom) (goal 1 km/10 km^2). The only problems encountered, as mentioned above, was the inability to cover some routes a second time in the Iman and Sikhote-Alin sites due to excessive snow.

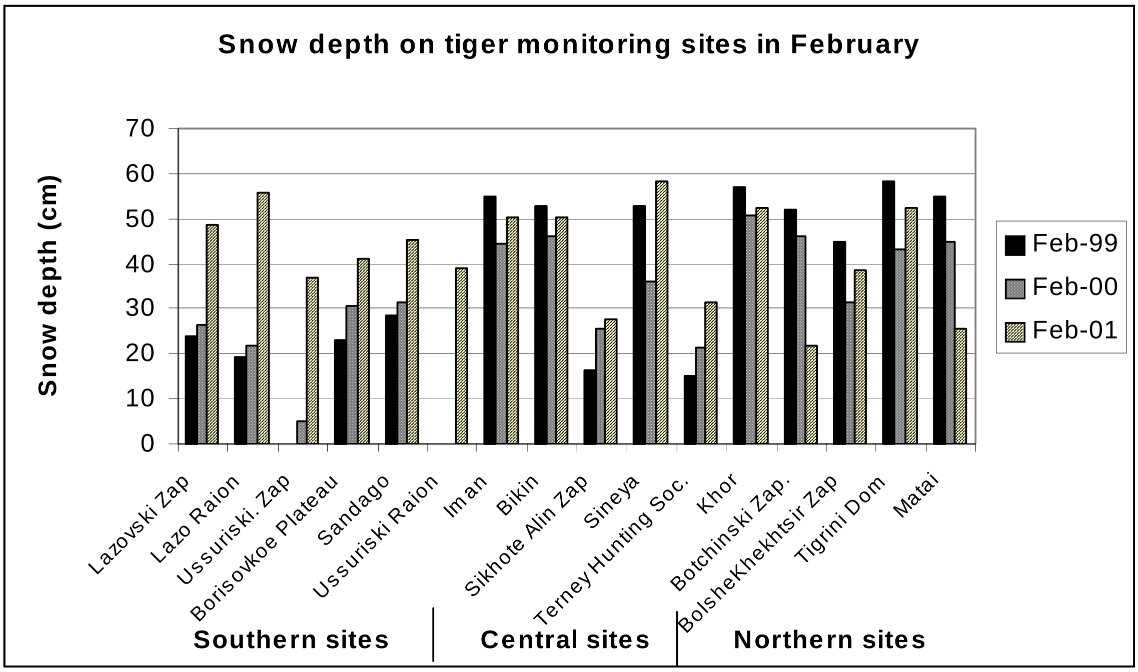


Figure 2. Average snow depth on routes within monitoring sites of the Amur Tiger Monitoring Program, for February, 1999-2001 (snow data was not collected in the 1997-1998 season).

Measures Of Tiger Abundance

Zero Counts on Survey Routes (Presence/Absence)

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 an 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 2000-2001 winter, 32.9% of routes did not intersect tiger tracks, a slight increase from 1999-2000. when 28.5% of routes were without tracks.

The percentage of routes without tiger tracks varied from 0 to 67% among monitoring units (Table 4) in the 2000-2001 winter. In general, presence/absence indices for 2000-2001 followed patterns of previous years (Table 4, Figure 3), but there were some important changes. In Ussuriski Raion, Lazovski Raion, and Bolshe-Khekhtsirski Zapovednik the percentage of routes without tiger tracks increased dramatically from the 4-year average (Figure 3). As in the past, the 3 zapovedniks in the southern and central portions of tiger range in the Russian Far East (Lazovski, Ussuriski, and Sikhote-Alinski) had some of the lowest incidences of absence on routes, and over the past 4 years these sites stand out as those with the overall lowest percentage of routes without tiger tracks (Table 4). The northern zapovedniks, Botchinski and Bolshe-Khekhtsirski, do not seem to consistently demonstrate this same pattern. Bolshe-Khekhtsirski is very small, and therefore subject to dramatic fluctuations in tiger activity, and Botchinski, on the northern range of tigers along the coast, is likely also subject to fluctuations, as well as inherently low tiger numbers.

Table 4. Percentage of routes with tiger tracks absent on 16 sites during the first four years of the Amur Tiger Monitoring Program, and results of least signficance difference range test after a nonparametric. analysis of variance.

#	Monitoring site	Year				Overall	LSD Range test*
		1997-1998	1998-1999	1999-2000	2000-2001		
3	Ussuriski. Zapovednik	9.1%	0.0%	9.1%	0.0%	4.5%	A
1	Lazovski Zapovednik	8.3%	16.7%	0.0%	0.0%	6.3%	A B
4	Iman	8.3%	33.3%	25.0%	8.3%	18.8%	A B C
14	Sikhote Alin Zapovednik	12.0%	20.0%	16.0%	24.0%	18.0%	A B C D
5	Bikin	56.3%	12.5%	12.5%	6.3%	21.9%	A B C D E
9	Botchinski Zapovednik	35.7%	42.9%	14.3%	0.0%	23.2%	A B C D E
2	Lazo Raion	0.0%	27.3%	36.4%	54.5%	29.5%	F B C D E
11	Tigrini Dom	50.0%	35.7%	28.6%	21.4%	33.9%	F G C D E
16	Terney Hunting Society	33.3%	33.3%	45.8%	41.7%	38.5%	F G C D E
13	Ussuriski Raion	33.3%	66.7%	0.0%	66.7%	41.7%	F G C D E
12	Matai	50.0%	20.8%	50.0%	45.8%	41.7%	F G D E
8	Khor	52.6%	68.4%	10.5%	42.1%	43.4%	F G D E
10	BolsheKhekhtsir Zapovednik	28.6%	57.1%	14.3%	85.7%	46.4%	F G E
6	Borisovkoe Plateau	42.9%	42.9%	50.0%	42.9%	44.6%	F G E
7	Sandago	56.3%	31.3%	56.3%	43.8%	46.9%	F G
15	Sineya	53.3%	53.3%	53.3%	53.3%	53.3%	G

*Sites with no letters in common are significantly different from each other.

To assess whether variation among sites existed in presence/absence indices, we used all four years of data and ranked all percentage presence indices from 1 to 64, and then conducted a nonparametric ANOVA (Kruskal-Wallis) test using SAS GLM. This analysis demonstrated significant differences among sites ($F = 3.07$, $df = 15, 48$, $P = 0.0016$), even with a sample size of only 4 (i.e., 4 years) for each site (Table 4). The least significant difference range test tends to confirm that zapovedniks stand out as somewhat separate, but other sites, such as the Iman, also appear to have consistently higher presence indices than other sites.

Differences in presence/absence indices may be due to variation in detection rates among monitoring sites (i.e., on some sites routes may be better positioned to increase the probability of encountering tiger tracks). For instance, zapovedniks and the Iman have been the sites of extensive research, and coordinators there may have more information on tiger movement corridors, resulting in placement of survey routes that are more likely to “capture” tiger tracks. Alternatively, there may be some inherent characteristics of some sites that result in higher presence indices (e.g., latitude, protected status, or geographic location).

To determine whether some inherent characteristics help explain the variation in presence indices among sites, we conducted a second nonparametric analysis of variance using a full factorial model for the following parameters: status (protected/unprotected), latitude (northern/central/southern), and geographic location (inland/coastal). A significant difference was found ($F = 3.0$, df = 3, 54, $P = 0.0057$), but the only significant parameters were protected status ($F = 13.75$ $P = 0.0005$), and the interaction of protected status and latitude ($F = 3.36$, $P = 0.0422$). The interaction factor is not surprising, as both northern zapovedniks (Bolshe-Khekhtsirski and Botchinski) have characteristics that might lead to lower densities and greater variance of tiger density estimates (see above). The other parameters, latitude and geographic location, did not appear to be important in explaining variation in presence/absence indices. This statistical result confirms a visual assessment of Figure 3, where there is a mixture of central, southern and northern sites in the lower echelons of the ranking of presence/absence indices. Similarly, there is no clear relationship between coastal and inland sites.

Paired comparisons of the 3 zapovedniks with adjacent monitoring sites (i.e., Ussuriski Zapovednik versus Ussuriski Raion, Lazovski Zapovednik versus Lazovski Raion, and Sikhote-Alin Zapovednik versus Terney Hunting Society) demonstrate that there are clear differences in presence/absence indices within and adjacent to protected areas (Figure 3)

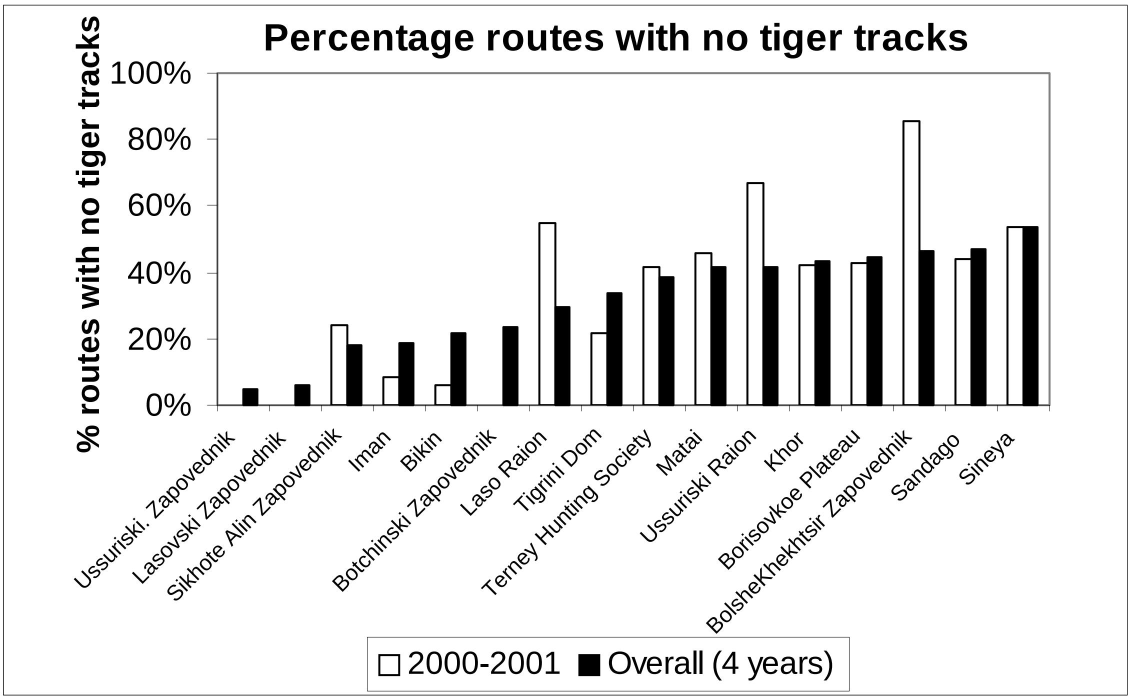
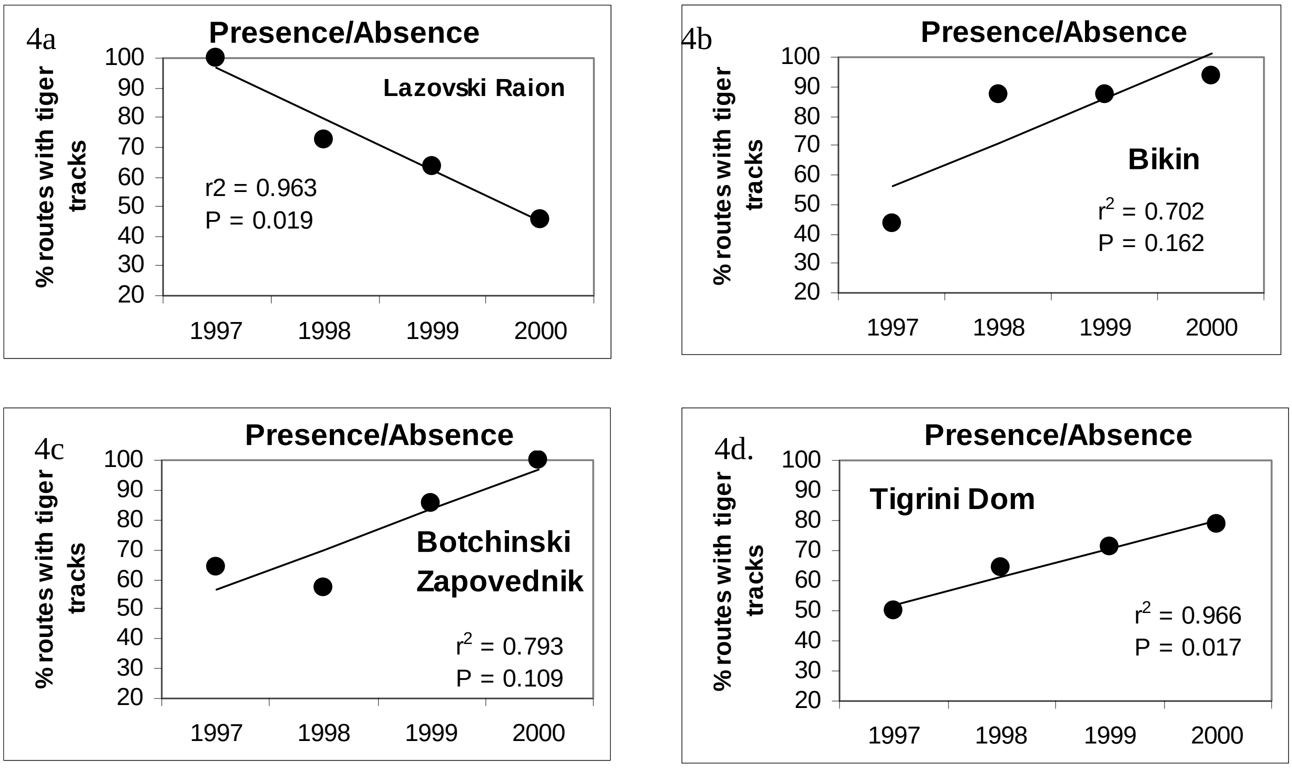


Figure 3. Percentage of survey routes with no tiger tracks within each of the 16 monitoring units, winter 2000-2001, and averaged across all 4 years of the Amur Tiger Monitoring Program.

We looked for trends in the tiger population using presence/absence data by applying a regression analysis to individual sites, and all 16 monitoring sites combined. Overall, there was no change in relative abundance of track presence on routes within all monitoring sites combined ($F = 0.759$, $P = 0.475$, $r^2 = 0.275$). However, when regression analyses were conducted for individual sites, there were significant trends ($P < 0.05$) found at Lazovski and Tigrini Dom



Figures 4a-d. Trends in presence of tiger tracks on routes on 4 monitoring sites where P < 0.2 for the regression over 4 years.

(Figures 4a, 4d), and non-significant, but potentially meaningful trends ($P < 0.2$) for the Bikin and Botchinski Zapovednik sites. Since presence/absence data is perhaps the least sensitive indicator of tiger abundance, the important of these findings should be weighed in combination with the other two indicators.

Track Counts on Survey Routes

Mean track density, adjusted for the number of days since the last snowfall (see Methods), should provide an indication of relative abundance of tigers on monitoring sites (Table 4). As in previous years, estimates of track density varied significantly among monitoring sites (GLM $F = 5.21$, df =15, 48, $P = 0.0001$), with Ussuriski Zapovednik reporting the highest track density. Three of the four sites with the highest track density estimators were zapovedniks (Ussuriski, Lazovski, and Sikhote-Alinski Zapovedniks), but track density in the Bikin monitoring site was also high (Table 5). Three northern sites (Matai, Khor, and Tigrini Dom) also reported unusually high track densities.

As with presence/absence data, we conducted an analysis of variance to determine if protected status, latitude, or proximity to coast were important factors explaining variation in the average track density (averaged for 4 years) among sites. Because proximity to coast was not a significant factor ($F = 0.86$, $P > 0.358$), we conducted a full factorial model for the remaining two parameters. This analysis demonstrated that both protected status and latitude, as well as their interactions, explained some of the variability in track density among monitoring sites (for overall

Table 5. Track density (tracks/days since snow/100 km survey routes) of tigers reported on 16 sites during the first four years of the Amur Tiger Monitoring Program, and results of at least significance range test after an analysis of variance.

#	Monitoring site	Year				Overall	LSD Range		
		1997-1998	1998-1999	1999-2000	2000-2001		Range test*		
3	Ussuriski. Zapovednik	1.027	10.808	6.448	5.916	6.050	A		
5	Bikin	3.941	7.710	0.950	3.704	4.076	B		
1	Lazovski Zapovednik	3.355	2.191	3.181	3.443	3.043	B	C	
14	Sikhote Alin Zapovednik	1.961	1.316	1.294	1.675	1.561		C	D
4	Iman	0.930	2.810	0.865	0.761	1.342		C	D
12	Matai	1.262	1.396	0.733	1.884	1.319		C	D
8	Khor	0.424	0.798	1.581	1.996	1.200		C	D
11	Tigrini Dom	0.671	1.471	1.127	1.454	1.181			D
10	BolsheKhekhtsir Zapovednik	1.508	1.474	0.842	0.714	1.135			D
13	Ussuriski Raion	0.388	0.611	1.896	1.438	1.083			D
9	Botchinski Zapovednik	0.876	0.736	1.216	1.295	1.031			D
6	Borisovkoe Plateau	0.620	0.711	2.025	0.601	0.989			D
16	Terney Hunting Society	0.822	0.633	0.711	1.316	0.870			D
2	Lazo Raion	0.791	0.384	0.990	1.018	0.796			D
7	Sandago	0.466	0.661	0.344	0.385	0.464			D
15	Sineya	0.242	0.329	0.472	0.580	0.406			D

*Sites with no letters in common are significantly different from each other.

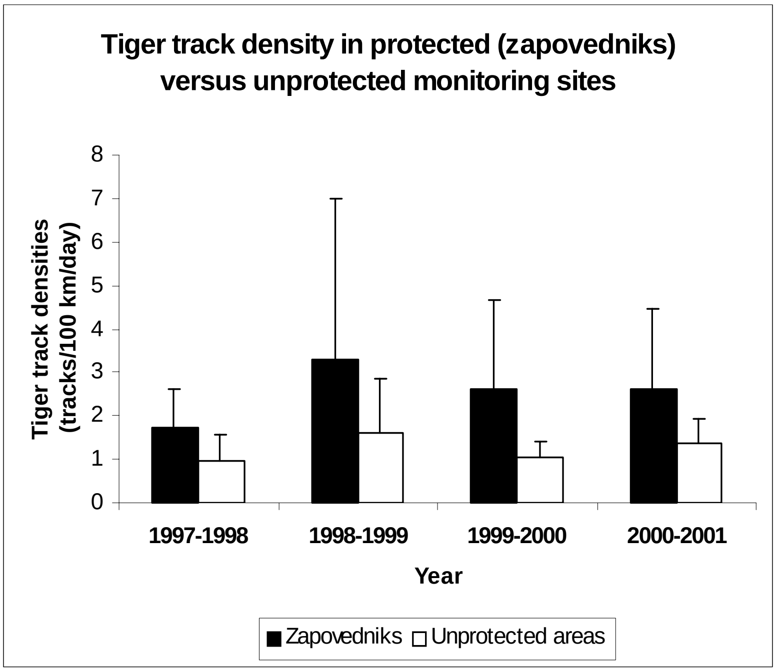


Figure 5. Track density estimators for protected (zapovedniks) and unprotected sites included in the Amur Tiger Monitoring Program, 1997-1998 through 2000-2001.

model, F= 5.24, P < 0.001). Protected areas had significantly higher track densities than unprotected areas (F = 10.42, P < 0.004) (Figure 5), and southern sites had higher track densities than central sites (F = 4.44, P < 0.016), but not northern sites (Figure 6). Oddly, central sites had non-significant, but nonetheless lower overall track densities than northern sites. High variability in track density, as reflected in the large confidence intervals, reduce the power of this comparison. However, the low track densities in central sites may be related to greater human impact than in the northern sites.

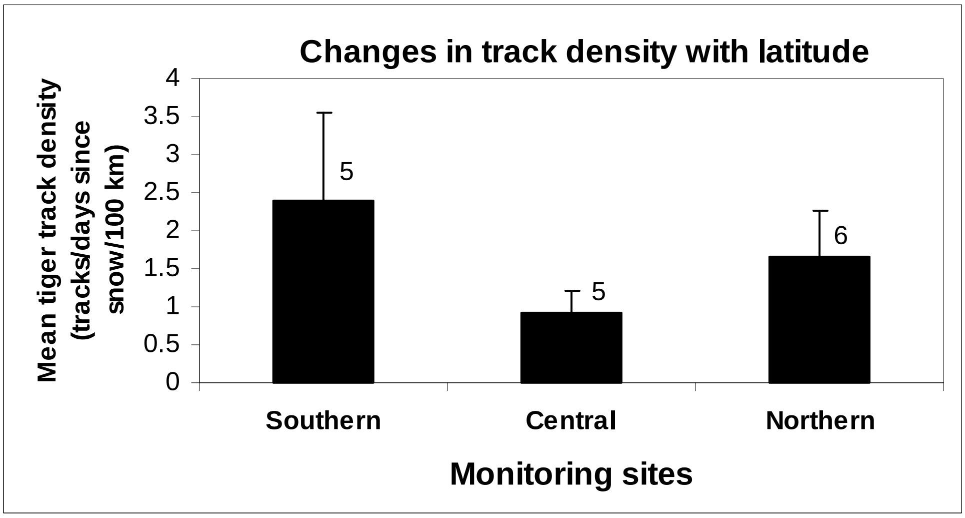
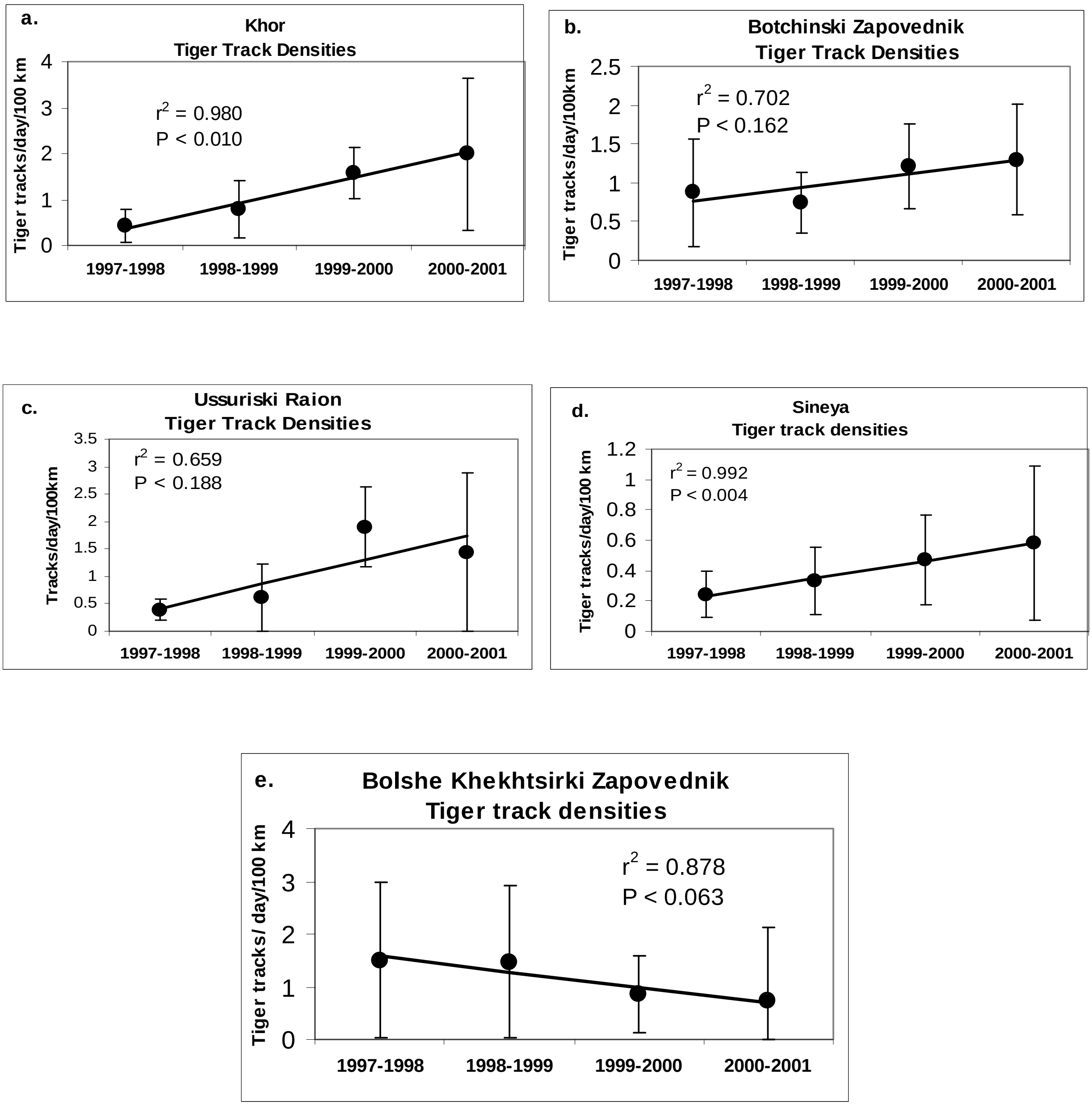


Figure 6. Changes in track density of Amur tigers with latitude, based on averages over 4 years for 16 sites (number of sites in each category listed beside error bar) in the Amur Tiger Monitoring Program, 1997-1998 through 2000-2001.

As with presence/absence data, we looked for trends in the tiger population using track data by applying a regression analysis to individual sites, and all 16 monitoring sites combined. This regression analysis suggested that there was no trend in relative abundance of track density across all monitoring sites combined (F = 0.300, P = 0.639, r^2 = 0.130). However, when regression analyses were conducted for individual sites, five sites had trends for which their P value (for the test that the slope of the line did not equal zero) was less than 0.20 (Figure 7). Four of these sites indicated positive trends in track densities, including two, Khor and Ussuriski Raion, that demonstrated strongly significant, positive trends (r^2 = 0.98 and 0.99, respectively, with $P \leq 0.01$). The trends for Botchinski Zapovednik and Ussuriski Raion were weaker and non-significant (Figure 7), but should be considered in light of other indicators. Only track density data from Bolshe-Khekhtsirski Zapovednik suggested a negative trend that was nearly significant (r^2 = 0.878, P = 0.063).

Of these five sites, only Botchinski Zapovednik demonstrated a similar response in both presence/absence and track density data.



Figures 7a-e. Trends in track density estimators (calculated as the number of tiger tracks/days since last snow x100 km of transects covered) for 4 years on 5 sites {a) Khor, b) Botchinski Zapovednik, c) Ussuriski Raion, d) Sineya, and e) Bolshe- Khekhtsirski Zapovednik} of the Amur Tiger Monitoring Program, for which P-values of the regression analysis (test that B, or slope of the line, does not equal 0) were less than 0.20.

Expert Assessment of Tiger Numbers on Monitoring Sites

Tiger densities, based on expert assessments, varied nearly tenfold, from over 1.2 animal/100 km^2 in Ussuriski Zapovednik, to 0.13 /100 km^2 in Botchinski Zapovednik (Table 6). As with the other indicators (presence/absence and track density data), the three southern and central zapovedniks (Ussuriski, Lazovski, and Sikhote-Alin) contained some of the highest densities of tigers (all greater than 0.7/100 km^2), indicating once again that protected status is an important parameter determining tiger density.

Table 6. Number and density of independent tigers (those classified as adults, subadults, and unknown), based on expert assesments of tiger tracks on 16 sites in the Russian Far East Amur Tiger Monitoring Program, during the first four years of monitoring, 1997-1998 through 2000-2001.

		Area	Number of independent tigers				Density of independent tigers (animals/100 km^2)			
#	Site	(km2)	97-98	98-99	99-00	00-01	97-98	98-99	99-00	00-01
3	Ussuriski. Zapovednik	408.7	7	10	4	5	1.71	2.45	0.98	1.22
1	Lasovski Zapovednik	1192.1	6	8	10	11	0.50	0.67	0.84	0.92
7	Sandago	975.8	6	6	5	7	0.61	0.61	0.51	0.72
14	Sikhote Alin Zapovednik	2372.9	24	21	23	17	1.01	0.88	0.97	0.72
16	Terney Hunting Society	1716.5	11	11	13	11	0.64	0.64	0.76	0.64
15	Sineya	1165.4	5	6	5	7	0.43	0.51	0.43	0.60
5	Bikin	1027.1	3	10	7	6	0.29	0.97	0.68	0.58
4	Iman	1394.3	8	6	5	6	0.57	0.43	0.36	0.43
2	Laso Raion	987.5	8	4	5	4	0.81	0.41	0.51	0.41
8	Khor	1343.8	3	4	4	4	0.22	0.30	0.30	0.30
10	BolsheKhekhtsir Zapovednik	475.6	2	1	2	1	0.42	0.21	0.42	0.21
6	Borisovkoe Plateau	1472.9	4	5	4	3	0.27	0.34	0.27	0.20
11	Tigrini Dom	2069.6	4	6	4	4	0.19	0.29	0.19	0.19
12	Matai	2487.6	3	5	4	4	0.12	0.20	0.16	0.16
13	Ussuriski Raion	1414.3	5	5	2	2	0.35	0.35	0.14	0.14
9	Botchinski Zapovednik	3051	3	3	4	4	0.10	0.10	0.13	0.13
	Totals		102	111	101	96	0.52	0.59	0.48	0.47

The importance of protected status and latitude was supported with the factorial model (conducted for the other indicators as well) (F = 16.26, df = 9,54, P = 0.0001) for all 4 years combined. Although proximity to coast explained a significant amount of the variability in the overall 3-way model (F = 4.41, P =0.040), the least significant difference test failed to demonstrate a significant differences between inland and coastal sites in terms of tiger densities. This variable was therefore dropped from the model. Subsequently, protected area status (F =

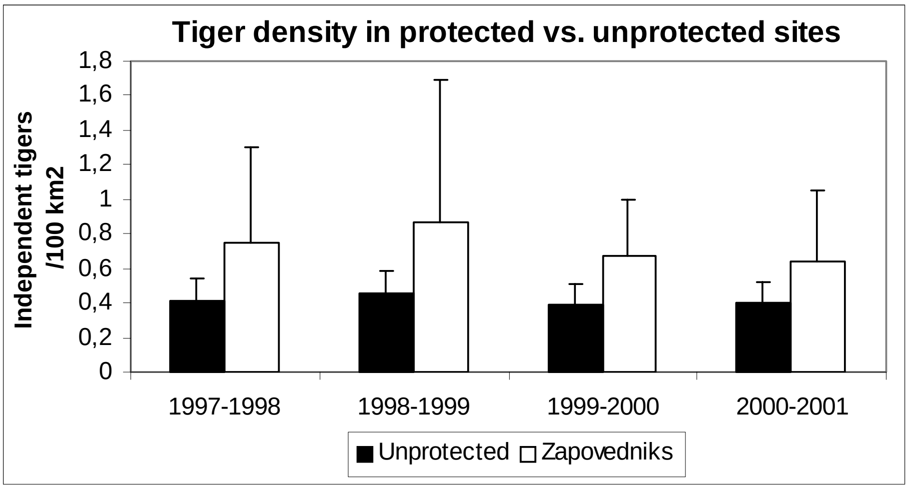


Figure 8. Density of independent tigers (/100 km^2) in protected (zapovedniks) versus unprotected areas included in the Amur tiger monitoring program 1997-1998 through 2000-2001.

20.42, df = 1, 58, P = 0.0001), latitude (F = 19.26, df = 2, 58, P = 0.001) and their interaction (F = 14.19, df = 2, 58, P = 0.001) were significant factors. The difference between protected areas and unprotected areas is very consistent across all years (Figure 8). Southern areas had significantly higher tiger densities than northern areas (but not central), and central areas also had significantly higher estimates of tiger densities than northern areas (Figure 9). This pattern of decreasing density with increasing latitude is expected since more northern latitudes are less productive, and is likely a more realistic pattern than that depicted with the track density data (Figure 6).

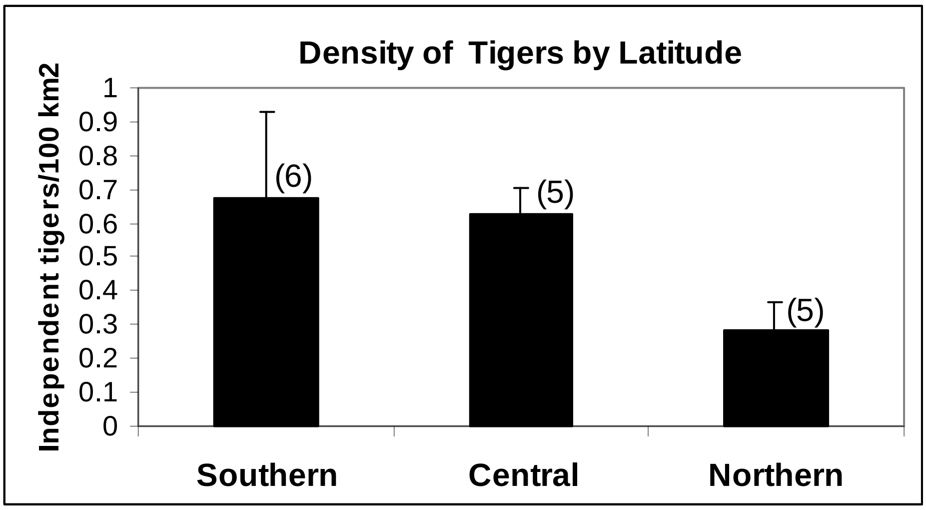


Figure 9. Density of independent tigers (/100 km^2) in southern, central and northern areas included in the Amur tiger monitoring program 1997-1998 through 2000-2001. Numbers in parentheses refer to number of sites in each region.

Biases associated with density estimates have been reported previously (1999-2000 report) and will not be repeated here.

We conducted the same trend analysis with tiger density data as with presence/absence and track density data. As with the others, we found no significant trend in overall changes with all 16 sites combined (F = 1.068, df = 1,3, P = 0.410), but there were three sites where the regression analysis demonstrated significant or near significant trends (Figure 10). The trend in Lazovski Zapovednik is likely a result in changes in how sex-age data were recorded over the years, and may not reflect a real change in numbers. As with other indicators, Botchinski demonstrated a strong positive trend, suggesting that the population of tigers there is increasing.

For Ussuriski Raion, contrary to the track density indicator, which showed a positive trend, independent tiger densities show a negative trend. Neither is statistically significant (i.e. P > 0.05), but this is one of the few cases where there are relatively strong relationships for individual sites that contradict each other.

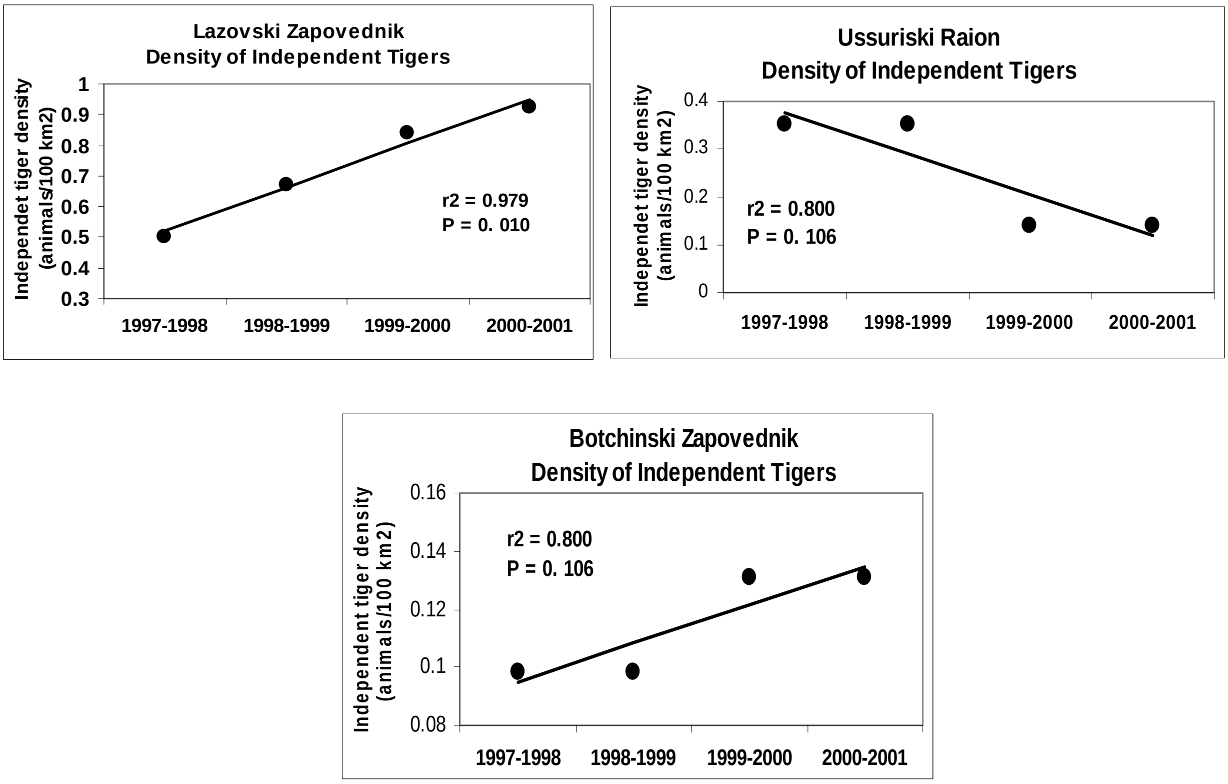


Figure 10. Regression analyses for individual monitoring sites with P-values < 0.20 for changes in density of independent tigers across the four years of the monitoring program, 1997-1998 through 1999-2000.

Correlations Among 3 Tiger Abundance Indices

To assess the relationship of presence/absence, track densities, and expert assessments of tiger numbers, we averaged indices across all four years for each site, then ranked each site for each separate index, and then estimated Spearman’s rho for the three, 2-way comparisons to determine correlations among the three indicators (Table 7).

Table 7. Correlations (using Spearman's rho) of three indicators of tiger abundance, based on the ranks of each monitoring site for each indicator, for data averaged for the first four years of the Amur tiger monitoring program, 1997-1998 through 2000-2001.

	Presence/ absence	Track indicator	Expert assessment
Presence/absence	1		
Track indicator	0.744	1	
Expert assessment	0.432	0.306	1

The results suggest a similar pattern to that conducted previously for specific years. While the correlation between presence/absence and track density estimators is high and significant

(Spearman's ρ = 0.744, n=16, 0.05 < P < 0.1) (Figure 11a), these two estimators showed relatively poor correlates with the expert assessments (Table 7, Figures 11b, 11c).

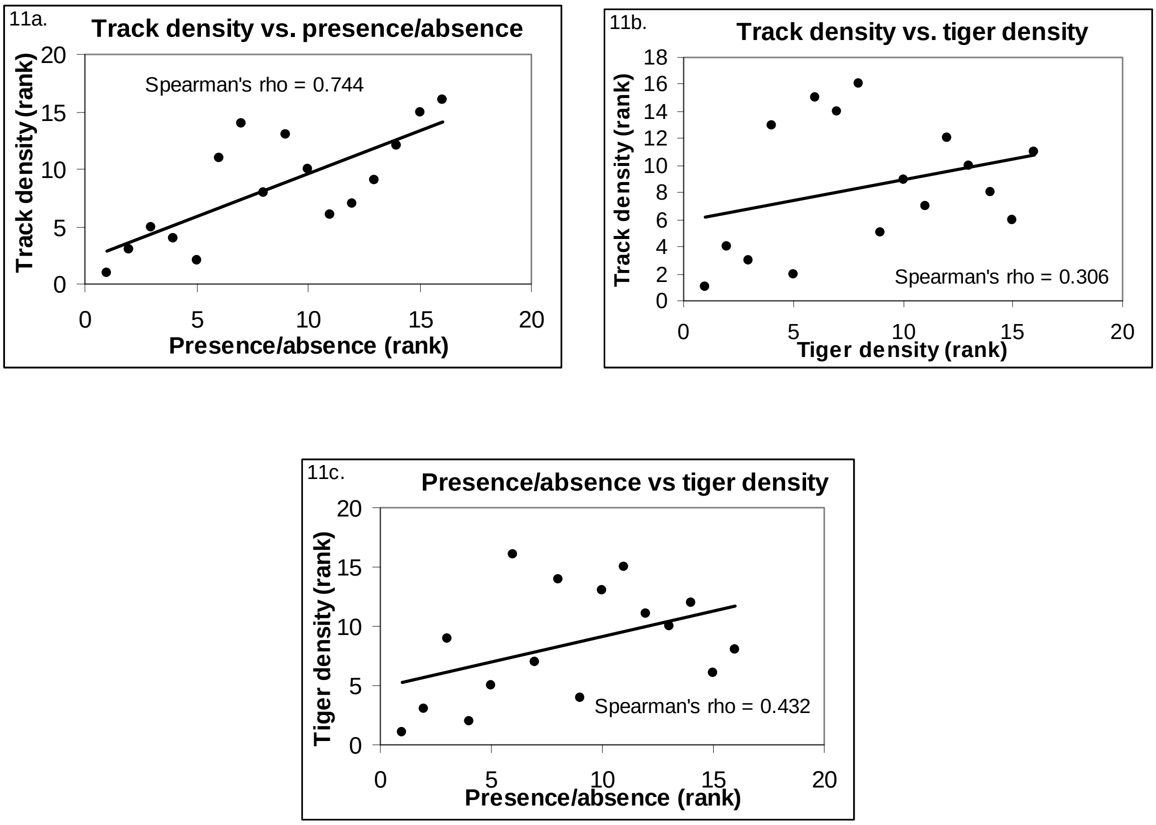


Figure 11a-c. Relationship of three indicators of tiger abundance on monitoring sites, based on: a) ranking of sites based on percentage of survey routes with tigers (presence/absence) versus ranking of sites based on track density estimators; b) track density estimator versus expert assessment of tiger density; c) presence/absence estimator versus expert assessment of tiger density.

The correlation between presence/absence counts and track density is perhaps not 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 (see 1999-2000 report) 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. In the 200-2001, there were 20 cubs from 11 litters reported for all 16 monitoring sites; only 9 of the 16 sites reported tracks of cubs during the winter survey periods.

Over the course of the first four years of monitoring, cub production has been recorded in each of the 16 monitoring sites (Table 8). However, there is considerable yearly variation, both within and between sites. In only 4 sites (Ussuriski Zapovednik, Botchinski Zapovednik, Sikhote-Alin Zapovednik, and Matai) were tracks of cubs reported for all 4 years.

Cub production appears to have remained fairly stable across the 4 years of monitoring (Figure 12). However, the number of litters appears to be decreasing over time (Figure 13). Whereas in previous years cub production and litter production appeared to be fairly tightly

Table 8. Number of litters, and number of cubs produced on each monitoring unit for 4 winters, based on expert assessments of tiger tracks.

		Year									
		97-98		98-99		99-00		00-01		Total	
		# litters	# cubs	# litters	# cubs	# litters	# cubs	# litters	# cubs	# litters	# cubs
1	Lasovski Zapovednik	1	1	1	2	0	0	2	5	4	8
2	Lazovski Raion	2	2	1	2	0	0	1	3	4	7
3	Ussuriski. Zapovednik	2	2	3	3	1	3	1	2	7	10
4	Iman	0	0	0	0	1	1	1	1	2	2
5	Bikin	1	1	0	0	2	2	0	0	3	3
6	Borisovkoe Plateau	0	0	1	1	1	1	0	0	2	2
7	Sandago	2	3	1	1	0	0	0	0	3	4
8	Khor	0	0	0	0	0	0	1	1	1	1
9	Botchinski Zapovednik	1	1	1	1	2	2	1	2	5	6
10	BolsheKhekhtsir Zapovednik	0	0	1	1	0	0	0	0	1	1
11	Tigrini Dom	0	0	1	1	1	1	1	1	3	3
12	Matai	2	3	2	2	1	2	0	0	5	7
13	Ussuriski Raion	-	-	1	2	0	0	0	0	1	2
14	Sikhote Alin Zapovednik	5	5	3	4	1	1	2	2	11	12
15	Sineya	1	1	0	0	1	1	1	3	3	5
16	Terney Hunting Society	-	-	2	2	1	1	0	0	3	3
	Total	17	19	18	22	12	15	11	20	58	76

associated, this is the first year where a clear divergence appears to have emerged. Cub production has retained stability, in the face of decreasing litter production, due to an increase in litter size (Table 9). Whereas in the first two years of monitoring, no litters of three were recorded, there were three sets of triplets recorded this past winter. Although the decrease in litter production should be considered as a potential warning signal of decreasing productivity, as long as it is balanced by an increase in litter size, it should not pose a threat to overall productivity. However, this shift in how total cub production is being attained may indicate that cub production is becoming concentrated in only a few of the monitoring sites.

We examined whether cub production is becoming concentrated in fewer sites by looking at productivity, measured as cub density, in zapovedniks versus other monitoring sites. Because

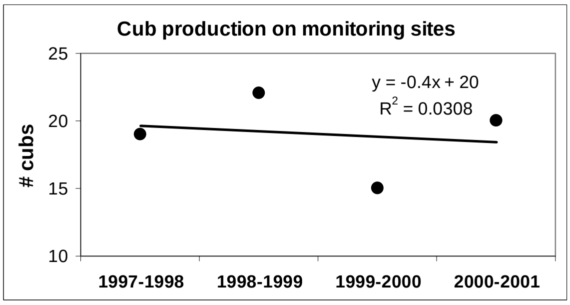


Figure 12. Total number of tiger cubs produced on 16 monitoring sites in the Russian Far East, during the first 4 years of the program.

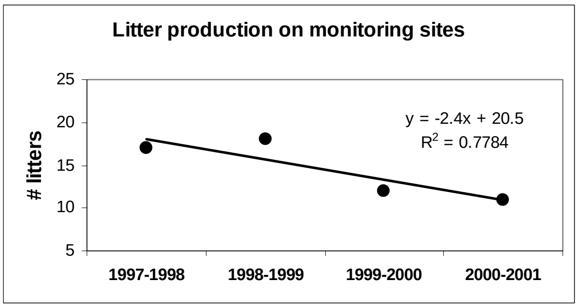


Figure 13. Total number of litters produced on 16 monitoring sites in the Russian Far East, during the first 4 years of the program.

all other indicators (presence/absence, track density, and tiger density) suggest that tiger densities are higher in zapovedniks, we predict that conditions are better there (e.g. prey densities higher, see below) and therefore productivity is higher. In fact, when we compared cub density across years and protected area status (zapovedniks versus others), ranking all estimates for all sites across all years, there was no significant change in cub density among the four years ($F = 0.68$, df = 3, 54, $P = 0.5669$), but zapovedniks had much higher cub densities than unprotected areas ($F = 4.13$, df = 1, 54, $P = 0.0471$). From these analyses, it is clear that zapovedniks are responsible for the majority of cub production.

Table 9. Litter size of all litters recorded in 4 winters of the Amur Tiger Monitoring Program, based on expert assessments of tracks.

Litter size	97-98	98-99	99-00	00-01	Total
1	15	14	10	5	44
2	2	4	1	3	10
3	0	0	1	3	4
Total	17	18	12	11	58

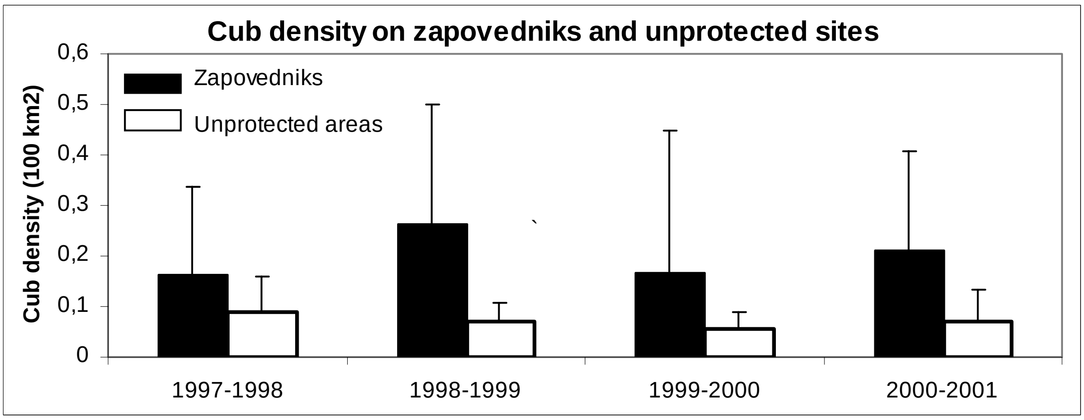


Figure 14. Cub density in zapovedniks and unprotected areas during the first 4 years of monitoring Amur tigers in the Russian Far East.

This process requires careful study incoming years. In the meantime, it is clear that protected areas are acting as source populations for the entire Russian Amur tiger population, and may be critical to maintaining stability in the overall population.

Sex-age Structure on Monitoring Sites

Although there are numerous sources of potential error in using expert assessments to derive sex-age structure of tiger populations, two factors suggest this information can be useful: 1) a high percentage of unknowns (Table 10) 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

Table 10. Number of tigers, by age class, and sex (for adults only) on 16 monitoring sites in winter 2000-2001, 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	1	2			5	8	3	11	16
2	Laso Raion		2			3	2	2	4	7
3	Ussuriski Zapovednik	2	2	1		2		5	5	7
4	Iman	2	3		1	2		5	6	8
5	Bikin	2	4					6	6	6
6	Borisovkoe Plateau	1	2			1		3	3	4
7	Sandago	2	1		1		3	3	7	7
8	Khor	2	2			1		4	4	5
9	Botchinski Zap.	2	1		1	2		3	4	6
10	BolsheKhekhtsir Zap.		1			3		1	1	4
11	Tigrini Dom	2	1		1	1		3	4	5
12	Matai	1	2	1		2		4	4	6
13	Ussuriski Raion	1	1					2	2	2
14	Sikhote-Alin Zap.	3	7		2	4	5	10	17	21
15	Sineya	2	3		1	3	1	5	7	10
16	Terney Hunting Soc.	3	3			1	5	6	11	12
	Total	26	37	2	7	30**	24	65	96	126

*Independent = adults, subadults, and unknown.

**Sum number of cubs does not equal value in Table 8, which was adjusted for inconsistencies in cub identification.

trends if there are any changes in population structure.

The tiger population in all monitoring sites combined is dominated by adults (52%), with sub-adults representing 5%, and animals of unknown age (which probably all represent adults and sub-adults) representing 19% of the population (Table 10). Cubs represent 23% of the total animals recorded, according to Table 9, but this value likely represents an error (either in the database, or in track interpretation) that must be resolved. The female:male ratio of adults was 1.4:1 (Table 9). We combined adults, sub-adults, and animals of unknown age to develop a sex ratio statistic for independent animals across all years (Table 11). This sex ratio estimator demonstrates a consistent trend of greater numbers of females in the population, but that ratio varies from 1.6:1 to 1:1 (Table

11). Because radiotelemetry studies suggest that that the ratio of females and males is higher than 1:1, we suspect that the true ratio in the population is at the higher end of this spectrum of values.

Table 11. Sex ratio of independent tigers on 16 monitoring sites 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

Sixteen instances of tiger mortalities were recorded by project coordinators for the 1999-2000 winter, bringing a total 37 mortalities reported across the first four years of the monitoring program (Table 12). This is the first year that data has been received from Khabarovski Krai, and therefore the database is not fully representative of the distribution of mortalities across 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 four 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 15).

Adults make up a smaller percentage of the mortalities than of the reported population in the monitoring sites (51 versus 63%), and the proportion of sub-adults is about the same as in the populations (10 versus 8%), but the number of animals of either unknown age or sex makes all comparisons questionable (Tables 10 and 12).

Table 12. 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	2000-2001	Total
Adults	Males	1	2		4	7
	Females		2	2	3	7
	Unknown	1				1
Subadults	Males	1	1			2
	Females		1			1
	Unknown	1				1
Unknown	Unknown		5		6	11
Cubs		1	3		3	7
Totals		5	14	2	16	37

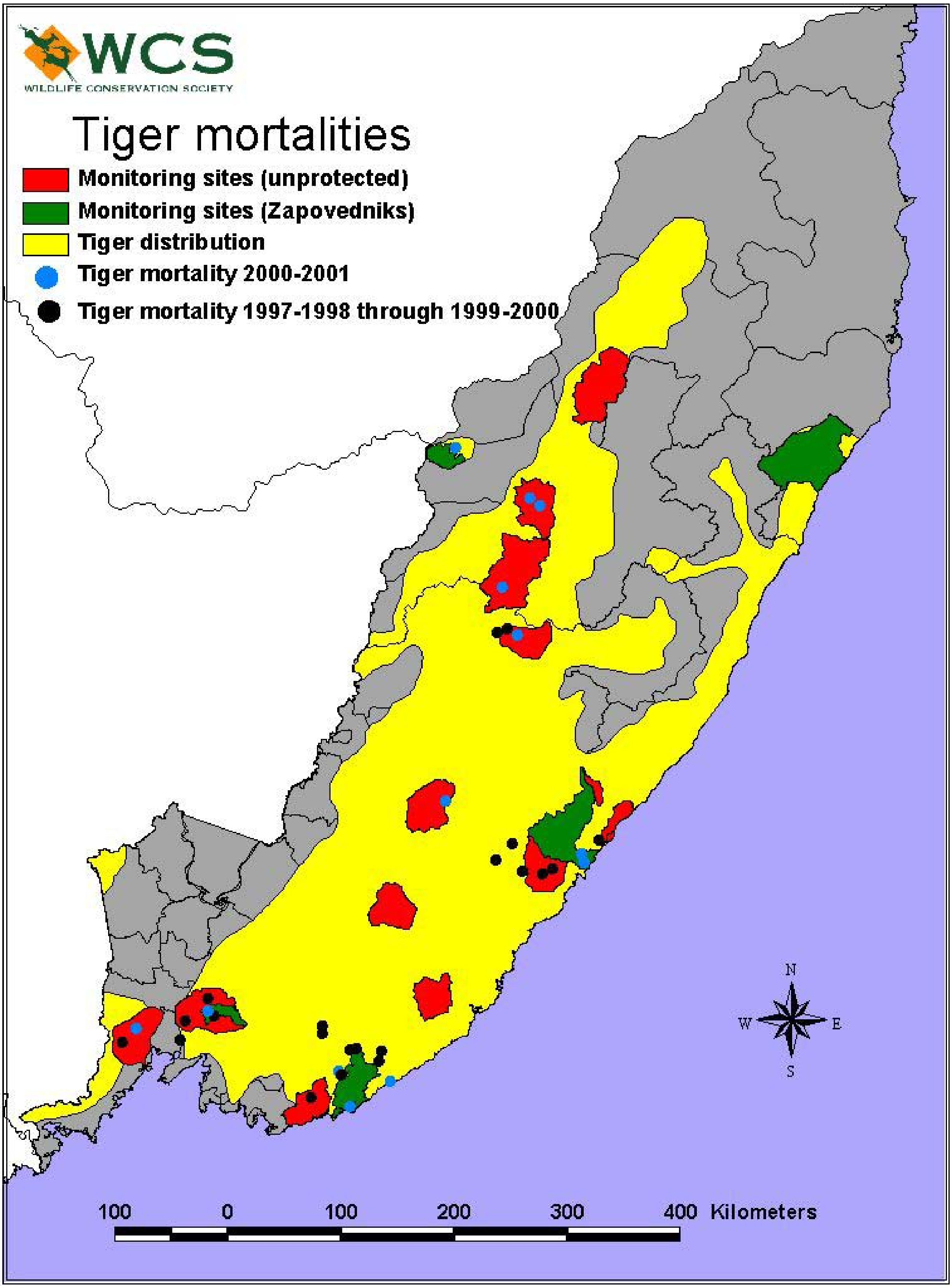


Figure 15. Locations of reported tiger mortalities from coordinators of the Amur tiger monitoring program (Primorski Krai only), for 1997-1998 through 1999-2000.

Ungulate Populations on Monitoring Sites

As in previous years, prey numbers varied greatly among sites (Table 12). To attempt to understand how density estimates varied across monitoring sites and time, we conducted two separate analysis. First, we used the average track density estimates for each of the monitoring sites for each of the past 4 years, and assessed how those density estimates were affected by protected status, latitude, and proximity to coast in a 3-way factorial analysis to assess potential variables affecting track density estimators for each species (using SAS GLM). Secondly, we conducted a regression analysis to look for trends across time (4 years of monitoring), looking first at trends for all sites combined, and then separately for each site and each species. We report all sites where the probability is less than 0.2 that the slope is not zero, under the understanding that firstly, sample sizes are small (4 years) and that we are looking for general trends and potential early warning signs across the region and within each monitoring site. Many of the details of ungulate densities are provided in the individual accounts of each site (Part II). We report results separately for each species.

Table 12. Track count estimates for 4 prey species of tigers on 16 monitoring sites for the 2000-2001 winter period, for the Amur Tiger Monitoring Program.

		# routes	Red deer		Wild boar		Roe deer		Sika deer	
#	Monitoring site	n	mean	std	mean	std	mean	std	mean	std
1	Lasovski Zapovednik	12	9.16	12.57	5.08	6.45	2.73	3.05	123.38	155.86
2	Laso Raion	11	0.18	0.46	0.27	0.59	0.11	0.36	51.64	105.40
3	Ussuriski. Zapovednik	11	5.03	4.78	25.21	27.41	6.49	4.81	26.65	30.41
4	Iman	12	5.56	3.71	0.66	2.03	4.45	7.10	-	-
5	Bikin	16	9.53	9.05	3.97	5.83	2.88	3.15	-	-
6	Borisovkoe Plateau	14	0.00	0.00	7.47	12.02	6.22	5.57	20.81	16.99
7	Sandago	16	7.41	8.55	0.54	0.99	8.98	8.57	7.91	13.77
8	Khor	19	4.29	4.92	2.73	3.15	3.35	3.51	0.00	0.00
9	Botchinski Zapovednik	14	2.92	2.98	0.00	0.00	4.24	3.66	-	-
10	BolsheKhekhtsir Zapovednik	7	40.97	47.01	3.52	3.93	0.92	1.44	-	-
11	Tigrini Dom	14	1.60	1.70	0.53	0.89	0.32	0.50	-	-
12	Matai	24	2.21	1.73	1.94	3.03	1.53	0.98	-	-
13	Ussuriski Raion	12	1.79	2.02	1.71	3.63	7.86	5.19	1.98	3.33
14	Sikhote Alin Zapovednik	25	31.28	16.80	3.57	4.63	16.77	19.66	8.71	22.33
15	Sineya	15	3.35	2.27	0.60	1.23	3.96	2.49	0.00	0.00
16	Terney Hunting Society	24	14.13	11.43	0.15	0.47	8.24	11.56	0.47	1.43
	Total	246	8.8729	14.944	3.1656	8.6094	5.5976	9.242	17.22	57.90

Red deer. Track count estimates of red deer were highest in Bolshe-Khekhtsirski Zapovednik, and secondly, in Sikhote-Alin Zapovednik (Table 12). In general, red deer densities were higher in protected areas, but this relationship was not straightforward. The overall 3-way factorial model was highly significant (F = 19.02, df = 9,54, P = 0.0001) with protected status (F = 58.56, P = 0.0001) and latitude (F = 45.1, P = 0.0001) being highly significant, and proximity to coast being marginally non-significant (F = 3.08, P = 0.0563). Interactions between protected status and latitude (F = 11.3 , P = 0.0001) and latitude and coast (F = 7.03, P = 0.002) were also significant, again indicating that these relationships were rather complicated. While one might expect red deer density to decrease with increasing latitude, in fact this was not the cast (Figure 16). Red deer reach their highest densities in the central portion of their range in the Russian Far East, and their lowest densities in the south (Figure 16), and paired LSD comparisons of each category demonstrate that those differences are statistically significant (P < 0.05).

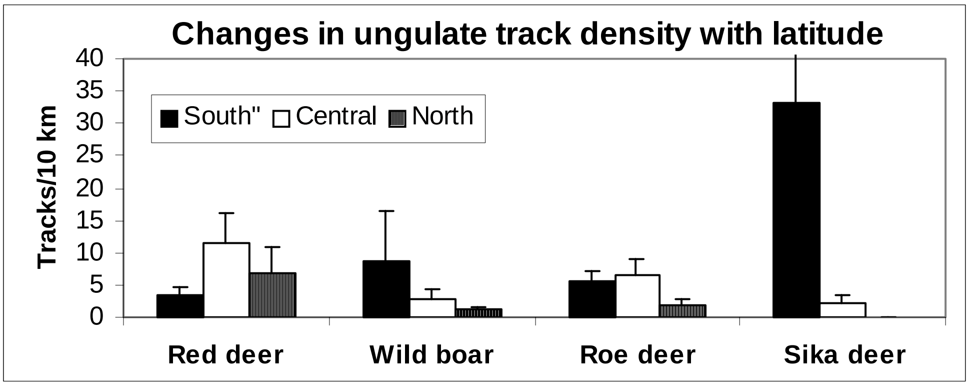


Figure 16. Changes in ungulate track density (fresh tracks/10 km of routes) with changes in latitude, with each monitoring site categorized as southern, central, or northern (see Table 1). The average track density for each site for each year considered a sampling unit (n = 64).

It has been commonly assumed that the decrease in red deer density in the south is attributed to competition with sika deer numbers. Our data, however, does not substantiate that assumption. We conducted a regression analysis of red deer and sika deer densities for the southern and central monitoring sites (Figure 17) and did not find a clear relationship between sika and red deer numbers (r^2 = 0.0794, P = 0.401). Thus, there may be other factors explaining the low numbers of red deer in the south.

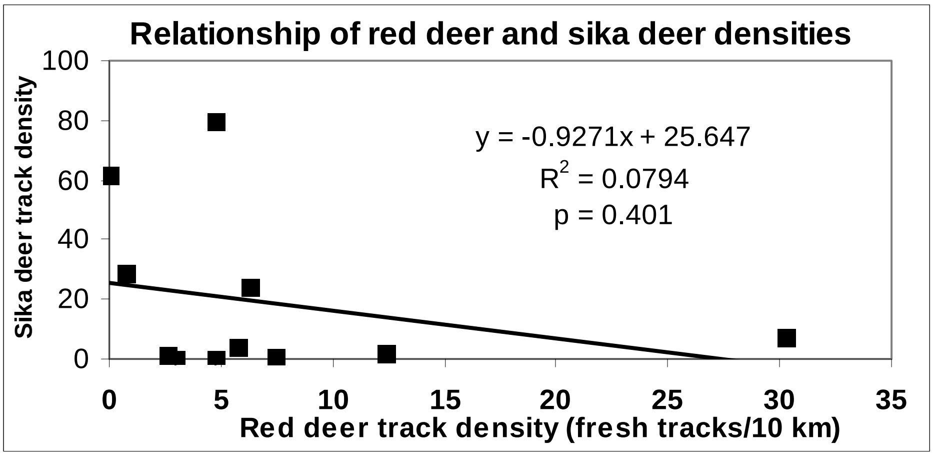


Figure 17. Track densities (fresh tracks/10 km route) of sika deer and red deer in southern and central monitoring sites of the Amur Tiger Monitoring Program, averaging across all four years for each site.

The relationship between protected area status and red deer density is more clear cut (Figure 18). Red deer track densities are, on average, three times higher in protected areas than in unprotected areas.

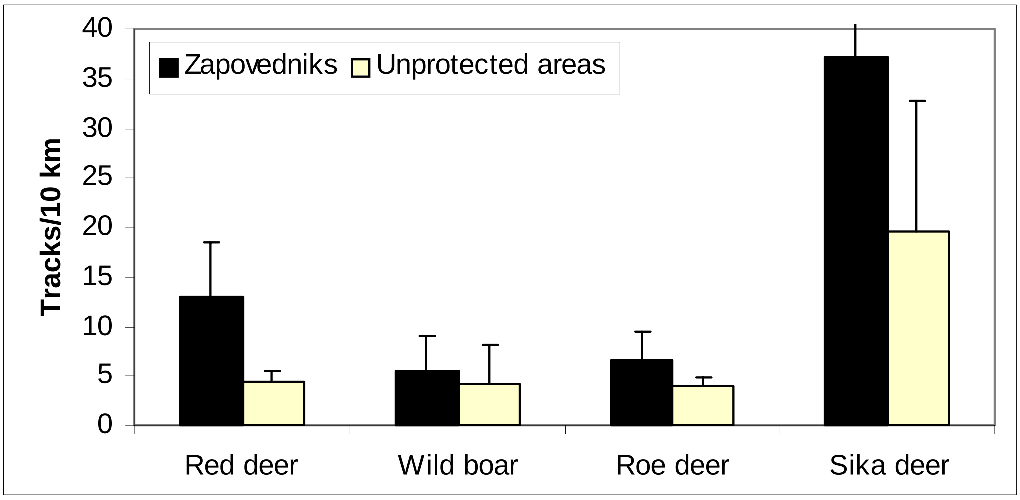


Figure 18. Track densities (fresh tracks/10 km route) for red deer, wild boar, roe deer, and sika deer in zapovedniks (protected areas) versus unprotected areas, with each yearly average for each monitoring site used as a sample (sample size = 64), for the Amur Tiger Monitoring Program, 1997-1998 through 2000-2001.

There was a significant positive trend in red deer numbers over the four years for all sites combined ($r^2 = 0.887$, $P = 0.05$) (Figure 19). Given the large amount of error associated with each estimate, it is as yet unclear whether this trend is significant, biologically, but this evidence suggests that red deer numbers appear to be slightly increasing.

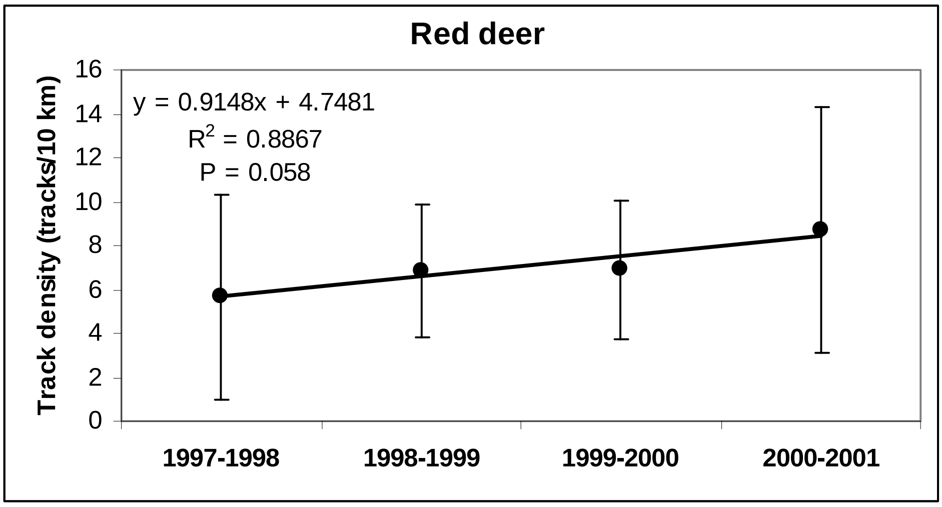


Figure 19. Average red deer track density for all sites for each of the first four years of the Amur Tiger Monitoring Program, 1997-1998 though 2000-2001.

There were three monitoring sites (Lazovski Zapovednik, Sandagoy, and Bolshe-Khekhtsirski Zapovednik) where red deer numbers may be increasing (Figure 20) , but that trend was statistically significant only for Lazovski Zapovednik ($r^2 = 0.904$, $P = 0.049$).

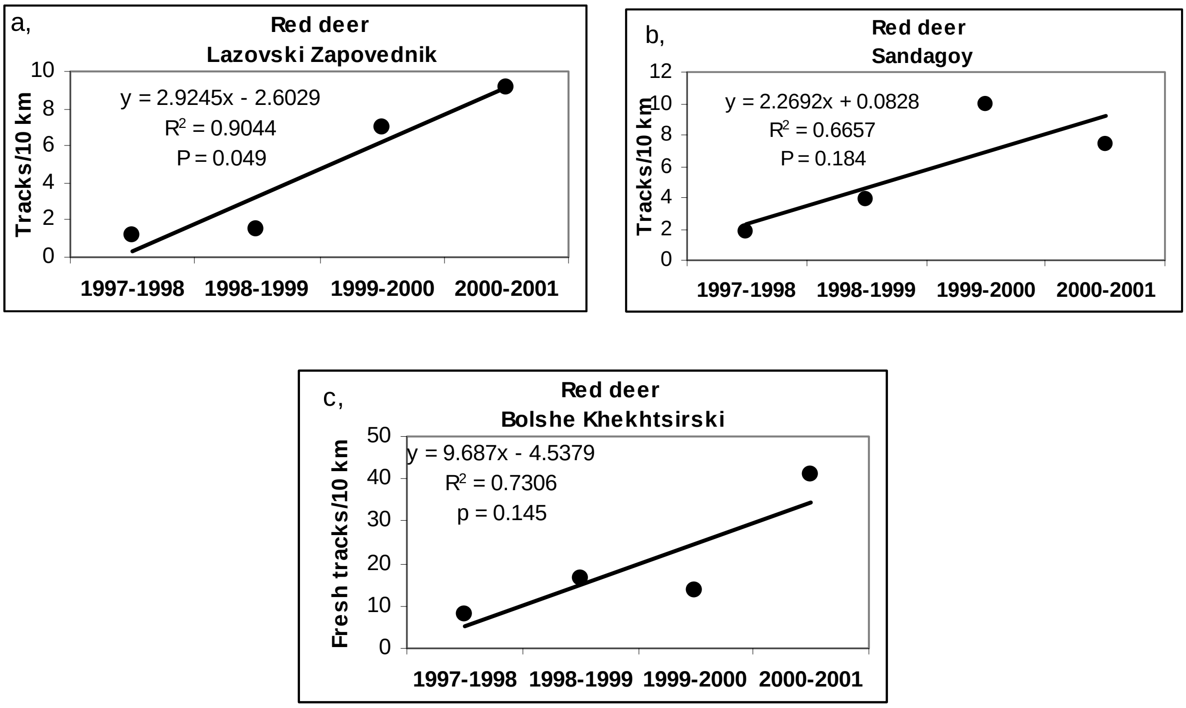


Figure 20a-c. Changes in red deer densities, as measured by fresh tracks/10 km along routes in 3 of the 16 monitoring sites of the Amur Tiger Monitoring Program: a) Lazovski Zapovednik; b) Sandagoy; c) Bolshe-Khekhtsirski Zapovednik.

Wild boar. Wild boar populations tend to fluctuate more dramatically than deer populations, and because they are commonly found in groups, are more problematic to accurately estimate density. Track density in Ussuriski Zapovednik was dramatically higher than any other site (Table 12), suggesting a large concentration of boar in this region, or replicate counting of a few groups. Boar track densities in Borisovkoe Plateau were also high (Table 12). In comparison to Ussuriski Zapovednik (where track density was 25 tracks/10 km), seven sites had boar track

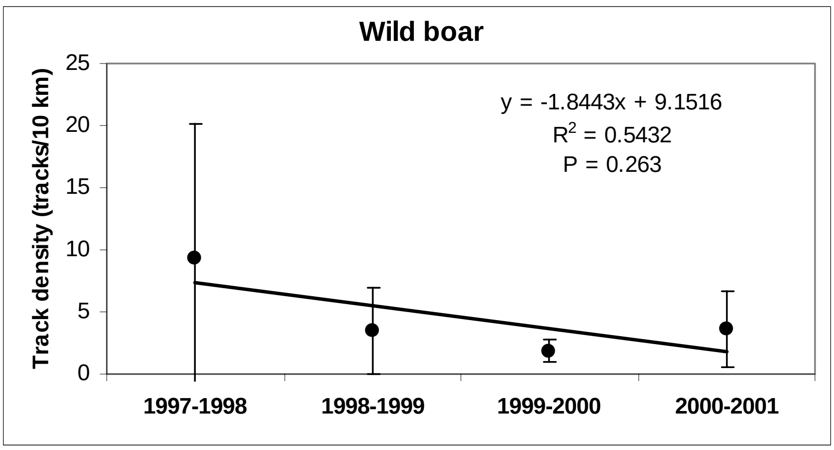


Figure 21. Average wild boar track density for all sites, for each of the first four years of the Amur Tiger Monitoring Program, 1997-1998 though 2000-2001.

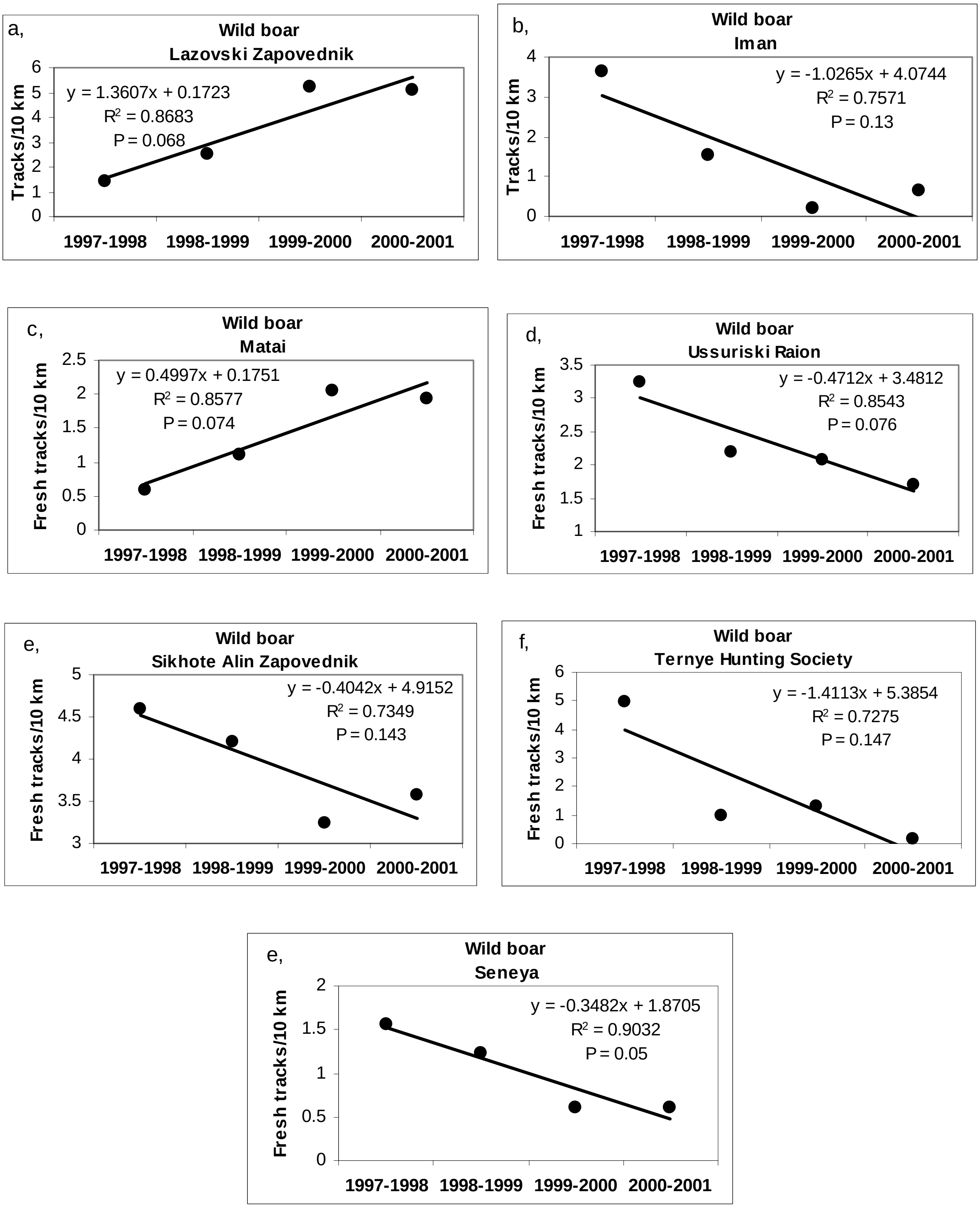


Figure 22a-c. Changes in wild boar densities, as measured by fresh tracks/10 km along routes in 7 of the 16 monitoring sites of the Amur Tiger Monitoring Program where the probability is less than 0.2 that the slope of the line does not equal zero.

densities less than 1 track/10 km (Table 12). Unlike red deer, there was no relationship between track density of wild boar with protected status, latitude, or proximity to coast (for overall model, F = 1.05, df = 9, 54, P = 0.416).

Although there was a negative slope to the trend analysis (Figure 21), there was no statistically significant evidence ($r^2 = 0.543$, P = 0.263) that wild boar numbers are decreasing across the region. Boar populations show great variation both spatially and temporally (as evidenced by large confidence intervals in some years), and it is probably exceedingly difficult to get good indications of trends in the boar population. This overall pattern should be compared with analyses of individual sites (see below and Part II), and should be monitored closely in coming years to assess changes.

Analyses at individual sites reinforce the hypothesis that the wild boar population is decreasing across a large portion of tiger habitat (Figure 22a-g). Five sites demonstrated a negative trend (where the probability is less than 0.2 that the slope does not equal zero), with only one statistically significant site (Sineya), but only two sites, Lazovski Zapovednik and Matai, had indications of a positive trend (both nearly significant, P = 0.068 and 0.074, respectively). Negative trends were concentrated in the central portion of tiger range (Iman, Sineya, Sikhote-Alin Zapovednik, Terney Hunting Society), although boar appear to be decreasing around Ussuriski Raion as well. Perhaps the most clear evidence of a decline in boar numbers (even though non-significant) exists for Sikhote-Alin and Terney Hunting Society, which are adjacent to each other, and which demonstrate nearly identical trends (Figures 22 d and f).

Sika deer. Sika deer occur regularly in only nine of the monitoring units, including all 6 in the south, and 3 of the central monitoring sites (Table 12). The 3-way factorial analysis for just these sites demonstrated that, even while excluding the northern sites, latitude was an important factor affecting track density (F = 14.72, P = 0.0005), with the majority of sika deer concentrated in the southern part of tiger range (Figure 16). Protected areas also retained higher concentrations of sika deer (F = 4.46, P = 0.042) (Figure 18). Unlike red deer, proximity to coast was also an important factor affecting sika deer densities (F = 10.04, P = 0.003), with greater densities of sika deer in coastal areas (Figure 23)

There was no significant trend in sika deer numbers when averaged across all nine sites where sika deer are commonly found ($r^2 = 0.241$, P = 0.509) (Figure 24), but there were interesting trends in many of the sites (Figure 25 a – f). In three of these sites, sika deer populations appear to be increasing (Lazovski Zapovednik, Lazovski raion, and Sandagoy) (25a,

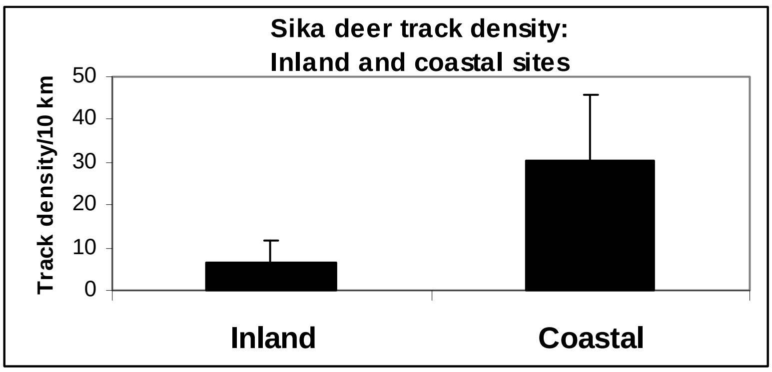


Figure 23. Variation in sika deer track densities between inland and coastal monitoring sites, based on 4 years of the Amur Tiger Monitoring Program, 1997-1998 through 2000-2001.

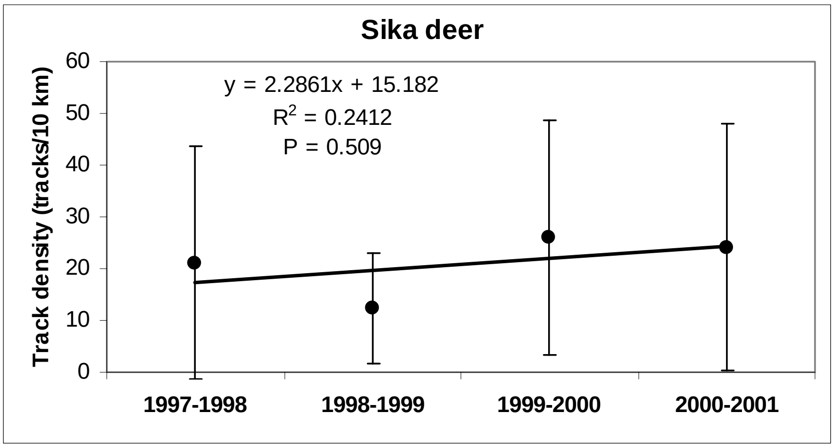


Figure 24. Average sika deer track density for all sites, for each of the first four years of the Amur Tiger Monitoring Program, 1997-1998 though 2000-2001.

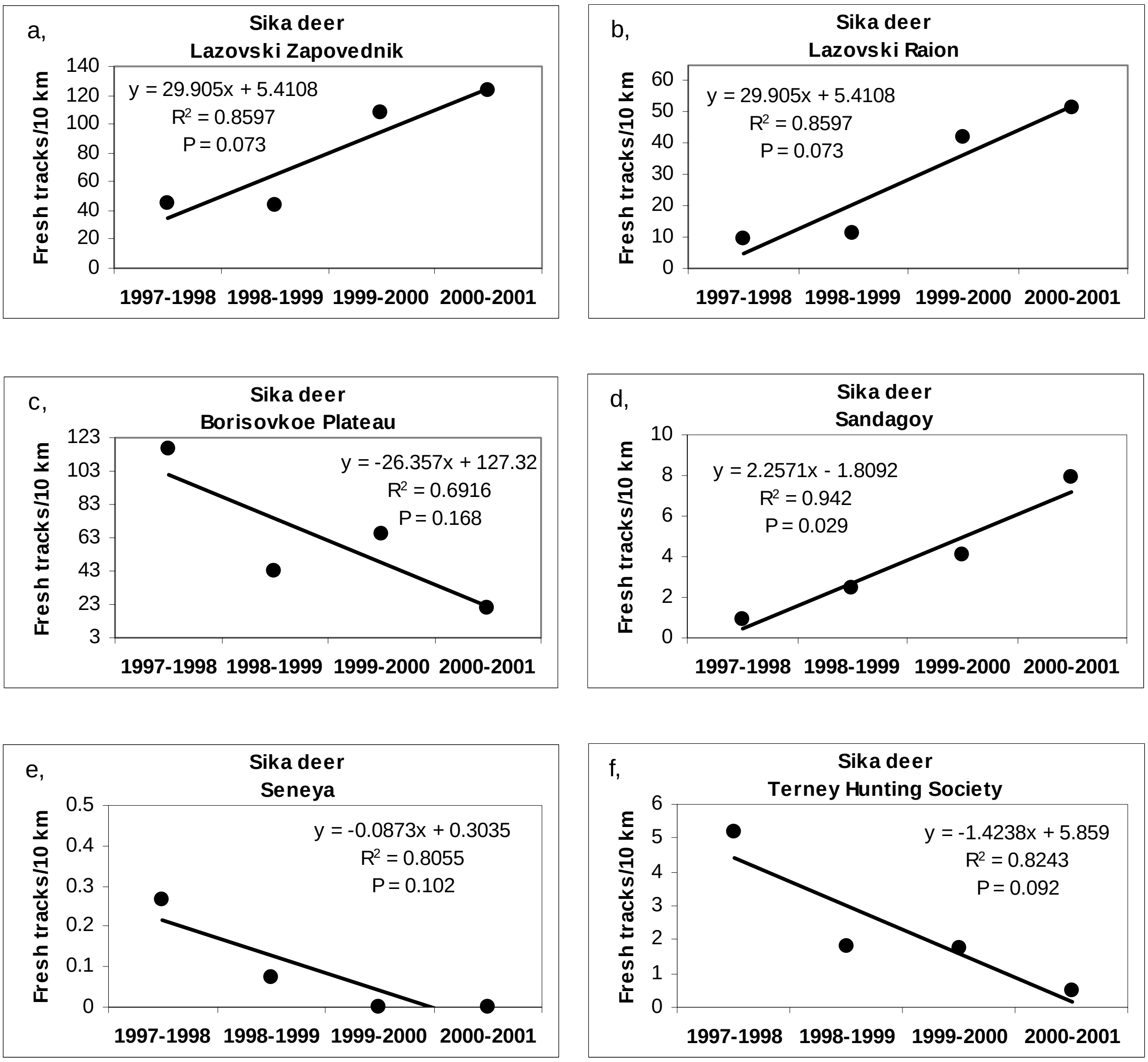


Figure 25a-f. Changes in sika deer densities, as measured by tracks/10 km along routes in 6 of the 9 monitoring sites where this species occurs in the Amur Tiger Monitoring Program.

25b, 25d) while in the other three sites (Borisovkoe Plateau, Sineya, and Terney Hunting Society) sika deer populations appear to be decreasing (Figures 25c, 25e, 25f). In all but one of these sites, the P-value is less than 0.1, suggesting that trends are significant and real. These results suggest that the southern coastal populations of sika deer may be expanding, while others are going through a contraction phase. Of particular concern is the Borisovkoe Plateau region, which is important for both tigers and leopards, and where red deer populations are very low. If sika deer numbers continue to show declines, it may be necessary to take remedial actions in this region.

Roe deer. Track densities of roe deer vary with protected status (F = 12.15, P = 0.001) and latitude (F = 46.23, P = 0.0001) but not with proximity to coast ((F = 0.62, P = 0.434). Roe deer showed the same pattern as do red deer, with densities in the central monitoring sites highest (Figure 16), but there were significant differences only between the northern areas and the other latitudes. Roe deer densities are nearly two times higher in zapovedniks than unprotected areas (Figure 18).

Roe deer numbers showed the greatest stability of all 4 prey species reviewed, but there was nonetheless a very slight and nearly significant increasing trend to the population estimates (Figure 26). The increase is very slight, considering the wide confidence intervals, but in a regression analysis this tendency is nonetheless very clear (Figure 26).

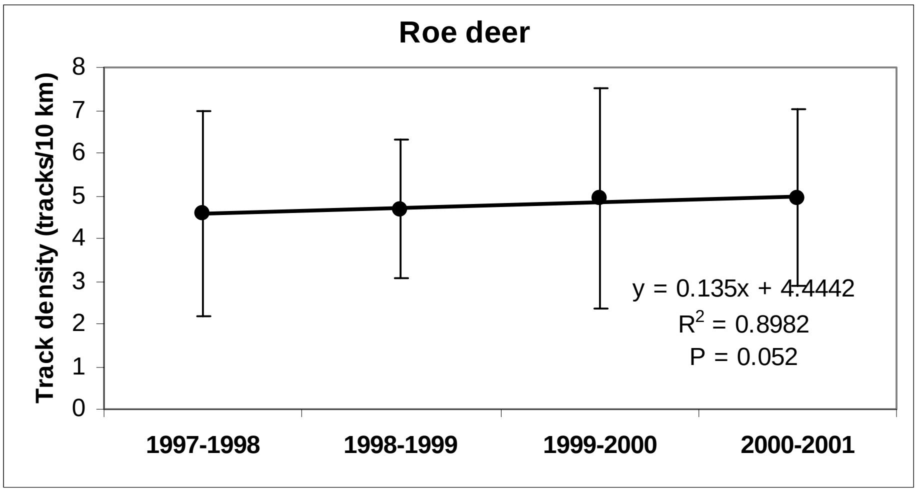


Figure 26. Average roe deer track density for all sites, for each of the first four years of the Amur Tiger Monitoring Program, 1997-1998 though 2000-2001.

Despite the overall positive trend, only two sites, Sandagoy and Botchinski Zapovednik, demonstrated positive trends (with $P \leq 0.2$), but two sites, Lazovski Raion and Ussuriski Zapovednik, also demonstrated negative trends. The majority of sites appear to have stability roe deer populations.

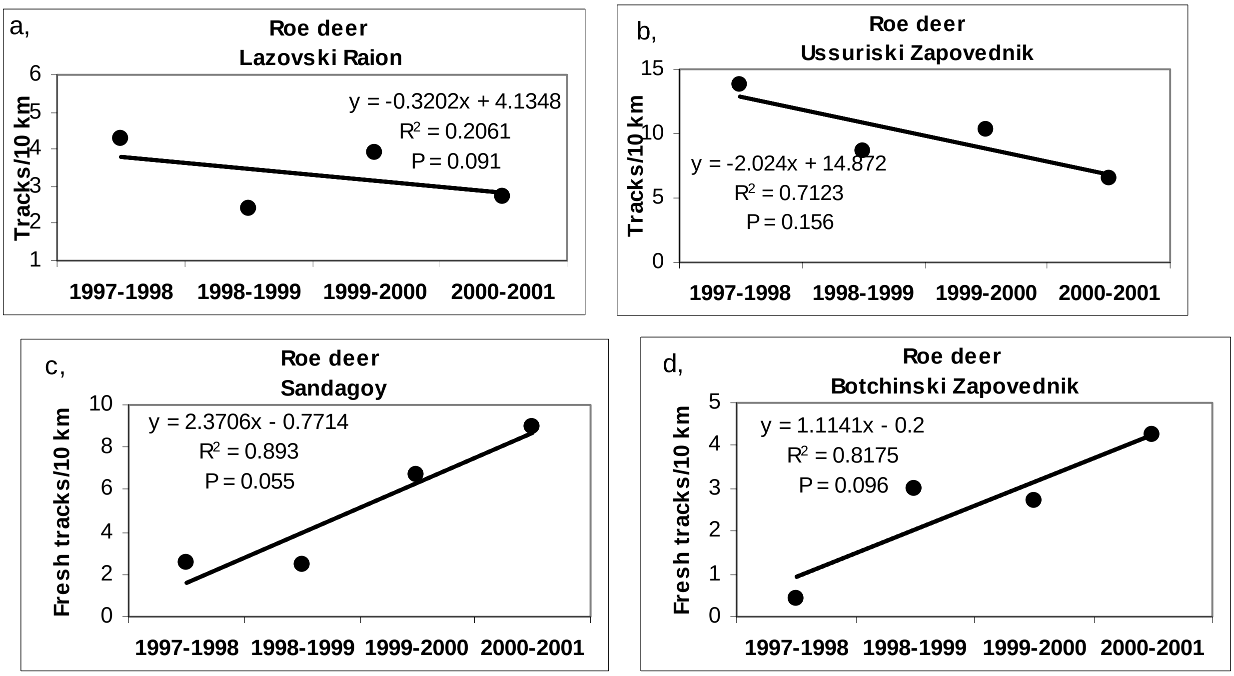


Figure 27a-d. Trends in roe deer densities, 1997-1998 through 2000-2001, as measured by fresh tracks/10 km along routes in 4 monitoring sites (where P < 0.2 that the slope of the line does not equal zero) of the Amur Tiger Monitoring Program.

Ungulate and Tiger Densities Inside and Outside Protected Areas.

Numerous analyses conducted above have demonstrated the importance of zapovedniks as reservoirs, or core areas, for tigers and their prey. Perhaps the most convincing evidence, however, comes from comparisons of zapovedniks (strictly protected areas) and the monitoring sites immediately adjacent to zapovedniks. These paired comparisons are particularly valuable because habitat types, climate, and a host of environmental parameters that may affect ungulate

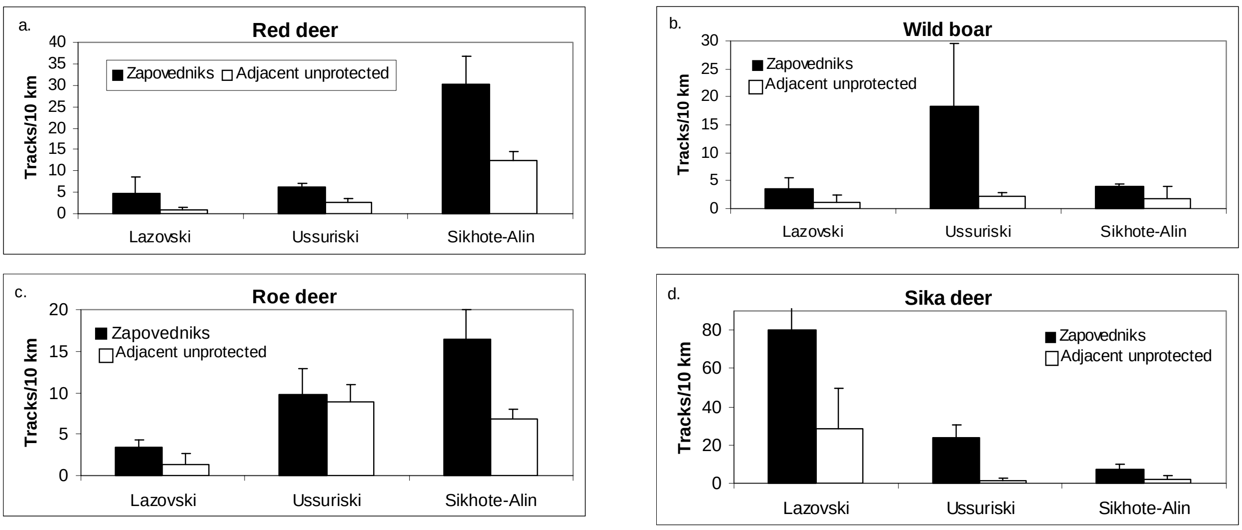


Figure 28a-d. Comparison of ungulate densities, based on fresh tracks/10 km in protected areas (zapovedniks) and adjacent territories included in the Amur Tiger Monitoring Program.

and tiger densities should be constant for each pair, with the primary difference being the influence of anthropogenic impacts. The paired comparisons for all 4 prey species demonstrate a very consistent pattern: track densities are almost without exception at least two times higher in zapovedniks than in adjacent territories (Figures 28a-d). Given this pattern, it would be expected that tiger densities are also higher, and this is indeed the case (Figure 29a-b), whether looking at track density estimators (Figure 29a) or expert assessments of tiger density (Figure 29b), indices of tiger numbers are consistently higher in zapovedniks than adjacent territories. Given that a disproportionate share of cub production also occurs on zapovedniks, these regions must be considered core areas, and security to these areas is key to long-term survival of the Amur tiger population.

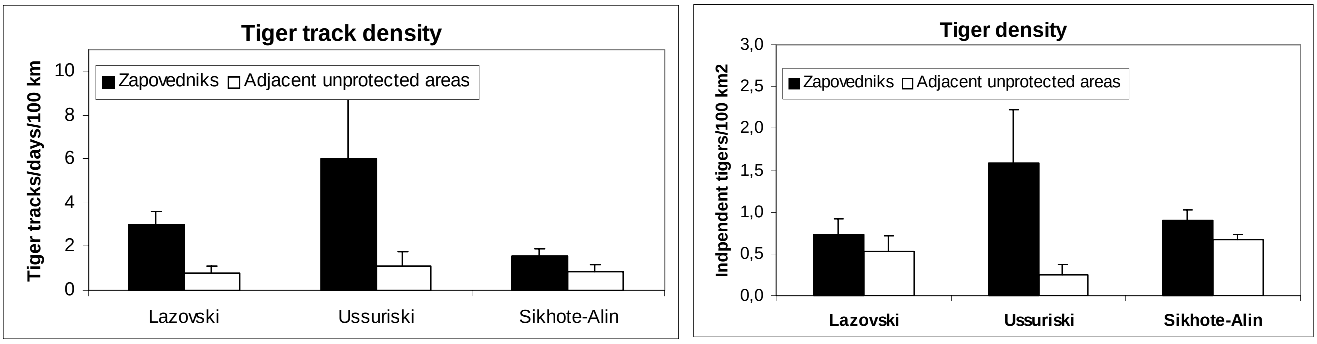


Figure 29a-b. Comparison of indices of tiger abundance in zapovedniks (protected areas) and adjacent monitoring sites, based on a 4-year average for the Amur Tiger Monitoring Program, 1997-1998 through 2000-2001.

Trends in the Amur Tiger Population and a Scorecard for Monitoring Sites

We used a linear regression trend analysis for the three indicators of tiger abundance: % routes with tigers present, mean track density, and an expert assessment of independent tiger density. The intent of these regression analyses is to identify trends in the tiger population across the whole region, and in each of the monitoring sites. We have defined sites as “areas for concern” if the trend analyses demonstrates a negative slope for which the statistical probability was greater than 80% (i.e. $P < 0.2$) that the population was not stable (i.e. that the slope of the line did not equal zero). We have used the same criteria for defining sites as “areas with positive growth indicators” if the slope is positive.

This is a very conservative approach, as most statisticians use a P value of 0.05. By increasing the P value to 0.2, we dramatically increase the probability of defining a site as an “area of concern” or an “area of positive growth indicators” when in fact such may not be the case. Our rationale for taking this approach is that we must have a mechanism for identifying areas early, so that remedial action can take place: a more liberal approach (with a smaller P value) would result in fewer “false alarms” but may not identify all areas in time to respond on an appropriate time scale.

To balance this conservative approach, we have used three indicators of tiger abundance that could signal changes in the population. We consider changes to be important if two of the three indicators indicate a similar pattern.

Overall, the population of Amur tigers, based on average estimates derived from the 16 monitoring sites, appears to be stable (Figures 30a-c). All three of the indicators suggest a stable population (no significant positive or negative slopes), and in fact, all three P values are greater

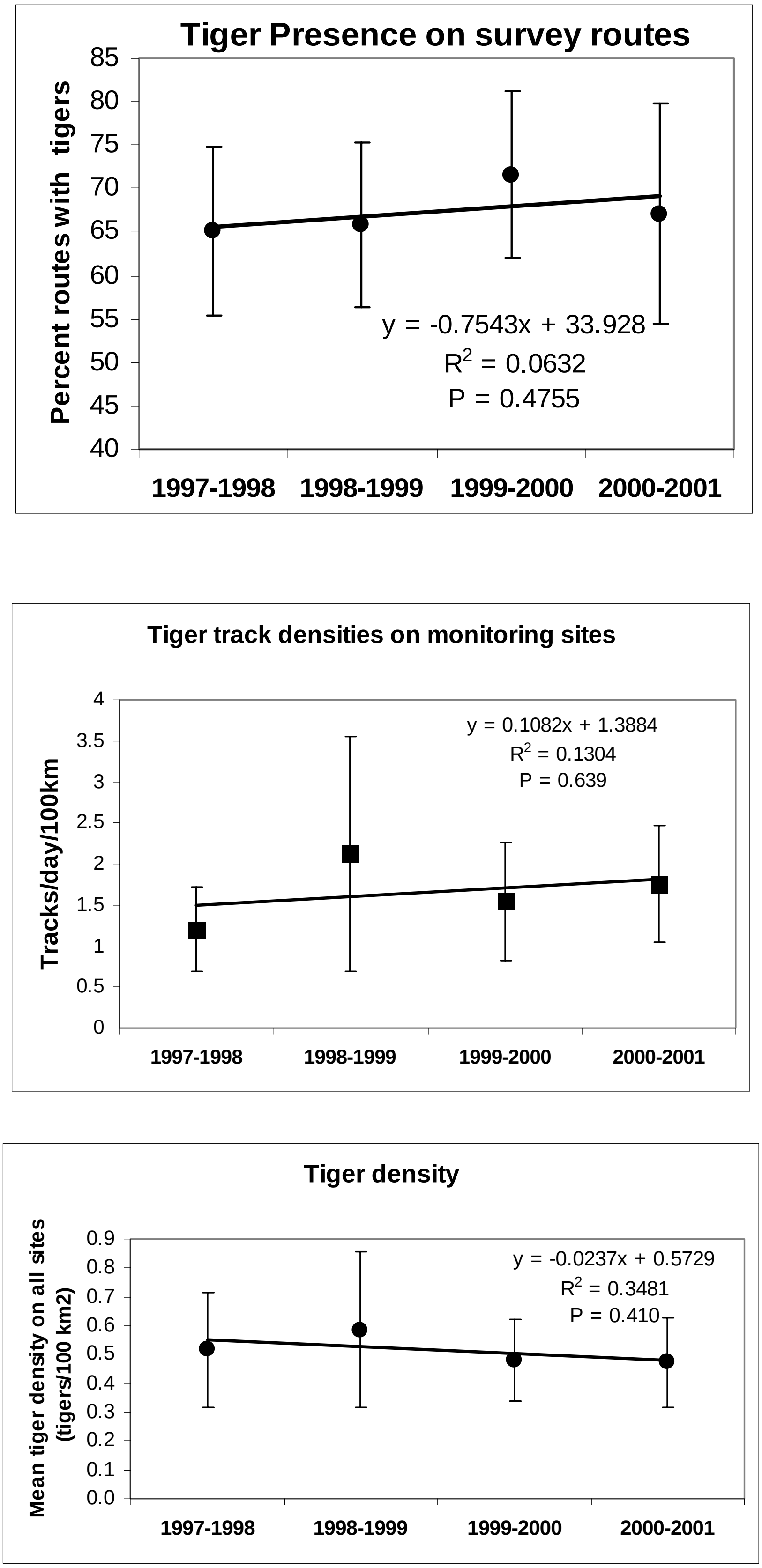


Figure 30a-c. Trend analyses for three indicators of tiger abundance: a. % routes with tiger tracks present; 2) mean track density; 3) density of independent tigers, based on expert assessment. Results are averaged for each year from 16 monitoring sites across tiger range in the Russian Far East.

than 0.4. Thus, if we can assume that the monitoring sites are a good representation of the entire population, Amur tigers appear to be holding steady in the Russian Far East.

Despite this overall stability, there are a number of areas for concern. Only two sites – Lazovski Raion and Bolshe-Khekhtsirski Zapovednik, demonstrated negative trends for at least one of the three indicators, and of those, only Lazovski Raion had negative trends for two of the tiger abundance indicators (% presence on routes, and tiger density). Thus, the results suggest that tiger numbers have decreased in only one of the 16 sites. We label Lazovski Raion as an “area of concern.”

On the other hand, seven sites had at least one positive indicator of tiger abundance. Of those, however, only Botchinski Zapovednik had two positive indicators (track and tiger density). Thus, it appears likely that tiger numbers have been increasing in Botchinski Zapovednik over the past 4 years.

Along with measures of tiger abundance, reproduction is a second important indicator of population status. Nine of the 16 monitoring sites reported cubs from the past winter season. If we consider only the past 3 winters (in 1997-1998 we only had 14 sites, making comparisons difficult), there has been a decline in the number of sites producing cubs over each of the past three winters (Figure 31). Although total cub production has remained stable, a smaller percentage of the monitoring sites are responsible for maintaining the current level of productivity. Unfortunately, it appears that zapovedniks are becoming, more and more, islands of high prey density, higher tiger densities, and higher productivity. Thus, zapovedniks play a major role in producing dispersers that move out of the zapovedniks and into adjacent habitat. Since there are now records of tigers dispersing more than 120 km, the few scattered zapovedniks can potentially provide dispersers over a wide area. However, it is unlikely that productivity within zapovedniks is sufficient to retain present numbers of tigers across their entire range. The low densities of prey in unprotected areas (e.g. Figure 28) may explain reduced productivity of tigers in these areas. Increasing prey numbers will be critical to retaining tigers and increasing productivity in these unprotected areas over the long term.

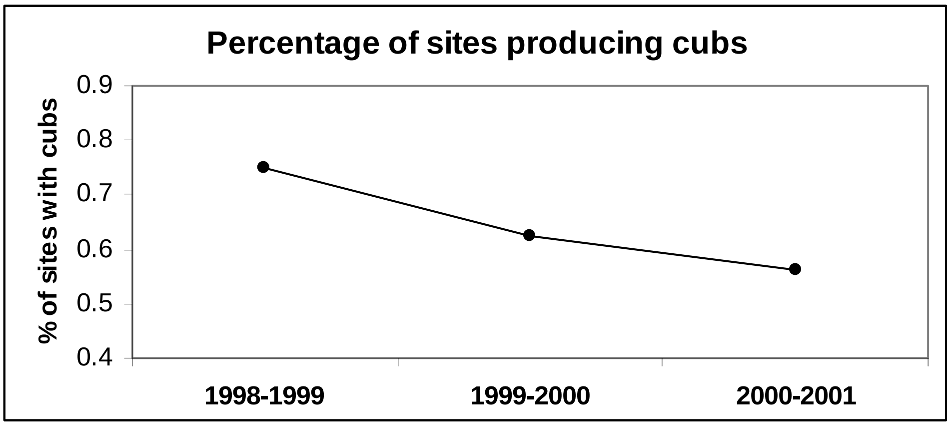


Figure 31. Percentage of monitoring sites that produced cubs in each of the past 3 winter seasons, for all 16 monitoring sites of the Amur Tiger Monitoring Program (1997-1998 not included, when only 14 sites were monitored, confusing comparisons)

A monitoring site scorecard. We are in the process of developing a “scorecard” for each of the monitoring sites, based on tendencies derived from trend analyses (Table 13). By identifying the sum of negative and positive trends simultaneously within any one site, it may be possible to derive an estimate of its status, at least in relation to other monitoring sites. We believe that the key characteristics that should be included in this scorecard are:

- All three indicators of trends in tiger abundance
- Indicators of trends in prey numbers
- Whether recruitment was reported in the previous winter.
- Reports of tiger mortalities (especially human-caused)
- Human impacts .

Presently, we have only included the first three indicators in this scorecard system (Table 13). Mortality data is not consistently reported across all sites, and in fact tends to be recorded only in those sites where a coordinator is permanently stationed (e.g. zapovedniks). Therefore, evidence of mortality is more closely related to knowledge of the area than real mortality trends across the region, at this point. Similarly, we have not yet derived indicators of human impacts, but we are working on these.

Table 13. A "scorecard" for monitoring sites: a summary of trend analyses and population status of tigers and their prey on the 16 monitoring sites of the Amur Tiger Monitoring Program for the 2000-2001 season.

		Trend analyses									Human	
		Tiger abundance			Ungulate abundance				Reproduction	Mortality	impacts	
#	Name	% tiger presence on rtes	Tiger track density	Tiger density	Red deer track density	Wild boar track density	Sika deer track density	Roe deer track density	Reproduction this year	Mortalities reported	Human impacts	Total
1	Lazovski Zapovednik			+	+	+	+		+	-2		5
9	Botchinski Zapovednik		+	+				+	+	0		4
7	Sandagoy (Olginski Raion)				+		+	+	0	0		3
8	Khor		+						+	-2		2
11	Tigrini Dom	+							+	0		2
5	Bikin River	+							0	-1		1
12	Matai River Basin (Zakaznik)					+			0	-1		1
15	Sineya (Chuguevski Raion)		+			-	-		+	0		1
3	Ussuriski Zapovednik							-	+	-1		0
4	Vaksee (Iman)					-			+	-1		0
10	Bolshe Khekhtsirski Zapovednik		-		+				0	-1		0
14	Sikhote-Alin Zapovednik					-			+	-2		0
2	Lazovski Raion	-		-			+	-	+	-2		-1
6	Borisovkoe Plateau						-		0	-1		-1
13	Ussuriski Raion		+	-		-			0	-1		-1
16	Terney Hunting lease					-	-		0	0		-2

By simply summing the pluses and minuses derived from trend analyses of tiger and ungulate populations, along with tiger recruitment, we have a mechanism for comparing relative status of the 16 monitoring sites. Based on these parameters, Lazovski and Botchinski Zapovedniks appear to have the most positive signs, in terms of increasing trends in either tigers or prey, and good recruitment. Five of the 16 sites are considered to be stable (i.e. sum=0), and only three have a total negative sum: Lazovski Raion, Borisovkoe Plateau, and Terney Hunting Lease. These regions represent areas of concern, where conservation efforts may need to be focused.

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VI. REPORTS ON INDIVIDUAL MONITORING SITES 2000-2001

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 four 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 inhabited by 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 2000-2001
Coordinator - G. P. Salkina

1. Name of monitoring unit: Lazovsky Zapovednik
2. Coordinator: G. P. Salkina
3. Time of simultaneous counts: the first count was conducted on December 14-27. The count on 10 routes out of 12 was conducted on 14-15th of December. Seven routes were traveled on the 14th of December, three routes were traveled on the 15th of December, and the remaining two routes were traveled on 17th and 27th of December. The second count was conducted on 10 routes out of 12 on 10-11th of February and two routes were traveled on 12th and 25-26th of February.
4. Routes ##: 1-12
5. Total length of routes: all routes (total length is about 130 km) were traveled on foot.

6. Conditions: the first snow fell early this winter - on 20th of November. The last snow before counts fell on the 9th of December, but then there was a strong wind that could destroy some tracks. The count on 10 routes out of 12 was conducted in 5-6 days after snowfall. During the count snow depth varied from 13 cm on the coast to 50 cm inland (count on 27th of December). During the main survey (December 14-17) maximum snow depth inland was up to 38 cm in the upper reaches and on passes. On northeastern slopes along the coast snow depth was as much as 34 cm.

Before the count in February the last snowfall took place on the 1st of February. Routes were traveled 9-10 days after last snowfall (10 routes out of 12), one route 11 days after snow, and the last route 24-25 days after snow. In February snow depth varied from 0 cm in some places on passes to 80 cm in creek heads. At this time snow depth on the coast was 17 cm in coniferous forests, up to 50 cm on passes, up to 54 cm in glades and up to 74 cm in fir forests. The weather was rather cold on the 10th and 11th of February. During this count snow was crumbly, icy crust over snow occurred only in a scattering of areas. On 25th and 26th of February count was conducted on route # 4 because this route was not traveled earlier (see below). At this time snow was crumbly and was melting extensively, making it difficult to walk (that is why the route was traveled during two days) and to identify age of tracks.

7. Assessment of efficiency: In December snow depth did not obstruct our survey work along the routes. However rivers were not frozen completely and it was difficult to travel, especially on skies. In February snow was much more abundant and it was impossible to walk along the routes without wide skies in inland regions. Fieldworkers had to use only their own skies and not all people have them. Route # 4 had to be traveled on 10th and 11th of February, when the survey was being conducted. A fieldworker was brought to the route in morning on 10th of February, and he later gave the information about tiger tracks, ungulate tracks and snow depth to coordinator, who recorded all data in a Field diary. But later we received information that the route had not been traveled. A check on the work confirmed this information. There were no human tracks neither in creek valleys nor on trails where the route is situated. Therefore this route was surveyed on 25th and 26th of February, i.e. 16 days after the beginning of the survey in the zapovednik. Our visit to the cabin in Shirokiy Log creek confirmed that this fieldworker was here during survey in December, i.e. he traveled only one-third of the route. The rest of the survey route probably was not traveled.

During the count in February an incident occurred. Because of deep snow a fieldworker who was travelling along route # 5 reached the pass (that is situated in the middle of the route) only in the evening despite the fact that he drove out of Lazo at 8 a.m. He had skies 15 cm wide. On the pass he was not able to take off his boots to dry his feet. Here the fieldworker had to wait until the moon rose (about 10:30 p.m.) and then went down to the cabin, which he reached only in the evening of the next day. As a result he incurred severe frostbite on his feet. Search for fieldworker began immediately and he was immediately provided with medical care. This person was a highly experienced and conscientious fieldworker and he gathered all the necessary data. According to zapovednik's safety code routes should be traveled by two people. To minimize such incidents coordinators of monitoring program should develop a safety code and insert it into Field diary. It is necessary to buy 24 (12?) pairs of skies of adequate width.

It is difficult to write the data on snow depth in the Table # 8. The following points are placed in the table - snow depth at the starting point of route, in the middle and at the end of the route. Instruction for coordinators says that snow depth should be measured in valley, on slopes and on the pass. Many routes pass river valleys through slopes of different aspects. Here is the question - what measurements should be done in this case? For example - if route passes through river valley, through divide, southern and northern slopes - it is clear that it is necessary to measure snow depth in valley, on different slopes and on pass in order to obtain adequate information about snow conditions of this winter. Table columns concerning snow depth should have subsections: snow depth in valley, on slopes (separately southern slopes, including southeastern and southwestern parts, and northern slopes, including northeastern and northwestern parts), on divides. Field diary should contain instructions how and where to measure snow depth, how many measurements should be done at one place or to give mean value. There is also a question - what to do with snow-wreaths and places without snow - to measure them separately or to give mean value?

8. Summarizing of results:

Habitat conditions and status of ungulate populations
Tiger prey species that occur in this unit include wild boar, elk, sika deer, roe deer, musk deer and ghoral. Zapovednik should provide optimal conditions for these species, and there are all types of habitat here - from oak forests to coniferous taiga. This fall there was an abundant crop of pine cones. The 2000-2001 winter was difficult for ungulates. Snow cover formed early with the first snowfall on 20th of November, which did not melt (except on southern slopes). The border of the Zapovednik is indented; valleys jut out deep into its territory. Ungulates came down to valleys beyond borders of the zapovednik, to fields and roads where they were poached. In January snow cover increased (see above), and the winter was quite cold. The weather station in Preobrazhenie registered - 22^{o} C for only the second time in the past 15 years. Snow insolation (?) was inadequate and winter conditions ungulates were difficult, especially for sika deer, which have a hard time with snow depths greater than 50-60 cm for 2-3 months. A great number of sika deer were poached on the road between Benevskoe and Kievka village. From November to March 219 poached ungulates were registered by Zapovednik employees (most of them sika deer). Part of the population died from starvation, caused by deep snow (20 sika deer were found). The situation was aggravated by a 40-50 cm snowfall that took place between 3rd and 4th of March, followed by sleet on the coast, resulting in an icy crust. Dead deer (which were dissected) had full stomach but filled with low-calorie food.

Average number of sika deer in a herd was six individuals. It was taking into consideration during tracks counting on feeding sites. To count tracks of other ungulates was not difficult for fieldworkers.

In comparison with the past year total ungulate density increased by 8% (approximately, if to take average values for December and February). The elk and wild boar populations remain more stable than sika deer, but it is likely that ungulate populations (especially sika deer) will decline further before green-up begins.

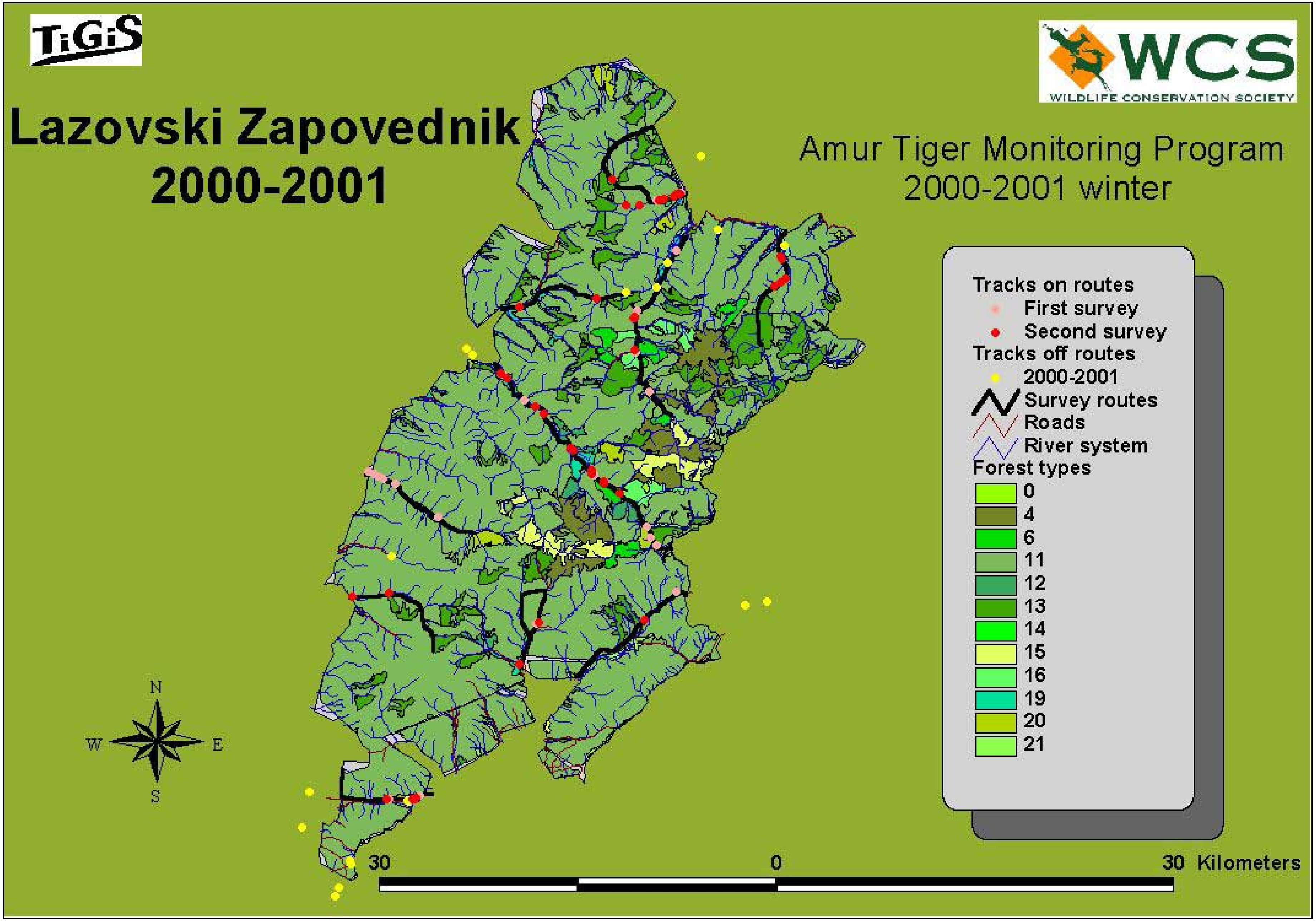
Habitat conditions and status of tiger population in comparison with previous information (with data of Tiger census 1996)

In comparison with data obtained last year and during the 1996 tiger census the number of tigers has increased by one individual. Two litters consisting of five cubs appeared. Information about litters appears valid because in one case it was checked by coordinator, in another case the cub tracks were photographed. Tiger numbers can be overestimated due to inaccurate measurements of pad width and errors in identifying age of tracks. But there is no doubt that six tigers were present in the reserve during the survey. But following facts raise some doubts. During the past years visible tiger signs have become rare in the zapovednik, including the number of communicative signs (scratches, urine marks, etc.). On some routes no tigers have been found for a long time: during one survey tigers left numerous tracks, during another survey there were neither fresh nor old tiger tracks. It is indicative that only three tigers were found during the count "on white trails" (three tracks during the first day and one track - during the second day), although in past years at least six tigers were identified during such survey. That is why the number of tiger tracks per route unit does not directly reflect tiger numbers and density.

Appearance of cubs indicates that population status is improving to some extent in comparison with past two years. However, illegal hunting for deer and their death from starvation probably will destabilize the current situation.

Habitat conditions

In past fire season (spring and fall 2000) there was one forest fire in the territory of the reserve, where 2.5 ha were burnt. One road (about 6-7 km long) was being reconstructed in northeastern part of coast. High recreational pressure still remains on southeastern coastal part of the reserve. In the warm season many people cross the reserve territory in order to get to the bay that is situated in an adjacent area. As far back as in 1998 the drying of Jeddo spruce in the area of 100 ha was registered. Probably this process began in 1992. The number of ungulates in the reserve is influenced by poaching that takes place near the reserve's borders and in its buffer zone, which are visited by ungulates from time to time.



TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Lazovski Zapovednik
2000-2001
Amur Tiger Monitoring Program
2000-2001 winter
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
Roads
River system
Forest types
0
4
6
11
12
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14
15
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19
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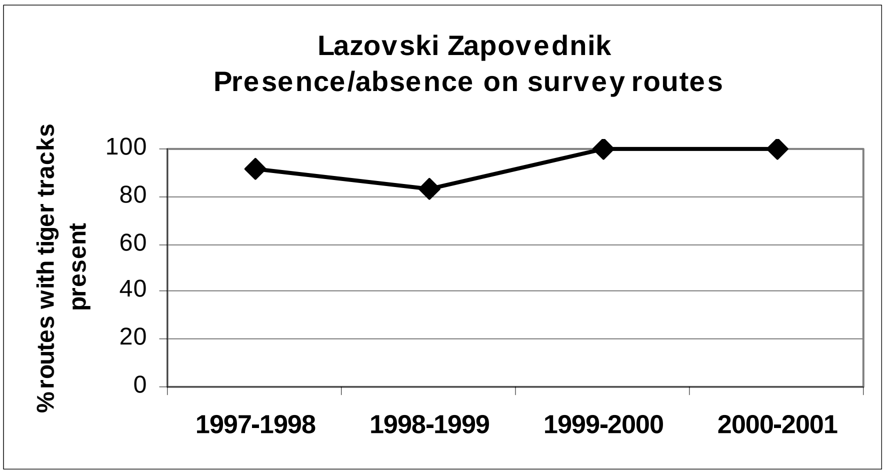
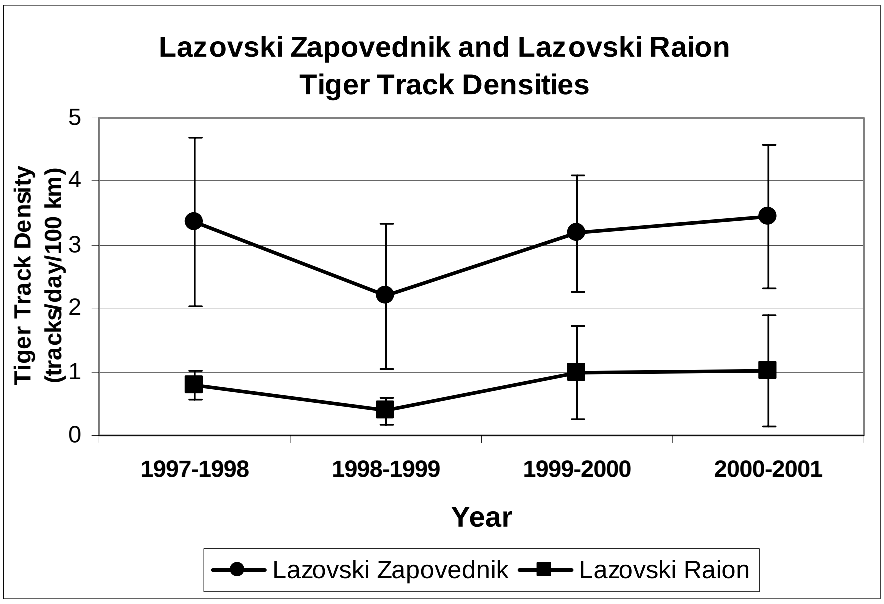
30 Kilometers



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



Comparison of track densities in Lazovski Zapovednik and adjacent Lazovski Raion

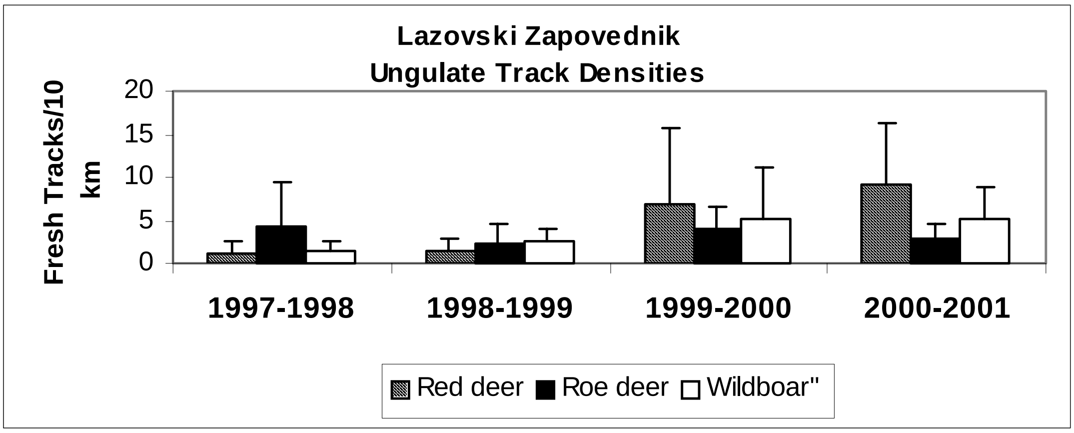
Number of Independent tigers (adults, subadults, unknown) on monitoring site

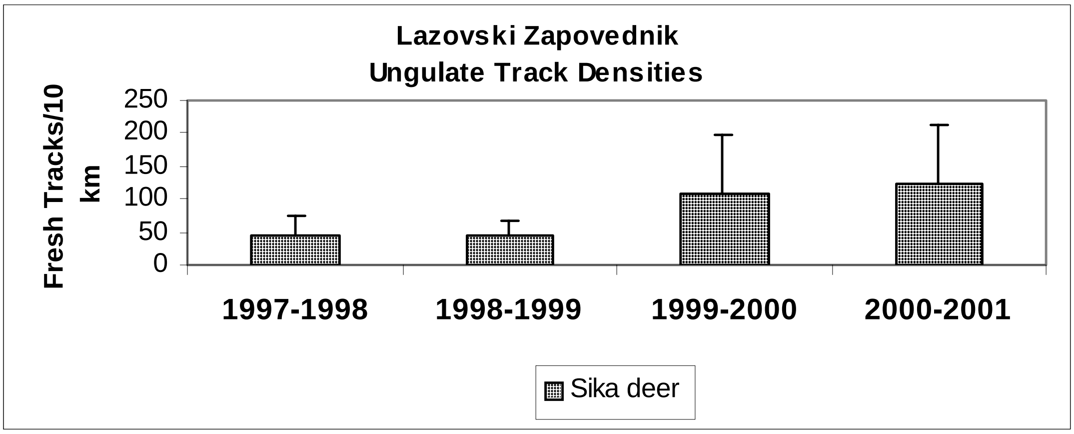
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

			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
1	Lasovski Zapovednik	2000-2001	1	2	0	0	5	8	3	11	16

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

		Prey		1997		1998		1999		2000		Grand Total	
#	Monitoring Site	species	n	mean	std	mean	std	mean	std	mean	std	mean	std
1	Lasovski Zapovednik	Red deer	12	1.23	2.39	1.49	2.64	6.94	15.66	9.16	12.57	4.71	10.46
1	Lasovski Zapovednik	Roe deer	12	4.30	9.26	2.40	3.60	3.90	4.89	2.73	3.05	3.33	5.61
1	Lasovski Zapovednik	Sika deer	12	45.18	50.58	43.85	39.94	108.28	158.11	123.38	155.86	80.17	117.63
1	Lasovski Zapovednik	Wild boar	12	1.45	2.16	2.52	2.73	5.24	10.45	5.08	6.45	3.57	6.39





LAZOVSKI RAION
Southeast Primorski Krai

Report on results of Amur tiger monitoring program
in Lazovsky Raion model unit in winter 2000-2001
Coordinator - G. P. Salkina

1. Name of model unit: Lazovsky raion - Krivaya river basin and coast
2. Coordinator: G. P. Salkina
3. Time of simultaneous counts: December 27-30 and February 16-22 (survey on 10.5 routes out of 11 was conducted on February 16-21, 2001)
4. Routes ##: 1-11
5. Total length of routes: nine routes were traveled on foot, two routes were partly traveled on foot and partly by vehicle. Total length of routes is about 145 km.
6. Conditions: the first snow fell early this winter - on 20^{th} of November. The last snow before counts fell on 23^{rd} of December; then there was a strong wind that could eliminate some tracks. The count was conducted 4-7 days after snowfall. During the count snow depth varied from 10 cm on the coast to 100 cm on the divide in the upper reaches of Krivaya river. In Krivaya valley snow depth was 29-48 cm. Snow depth on northern slopes was up to 45 cm, on southern slopes - up to 37 cm, on passes - 40-100 cm.

Before the count in February the last snowfall took place on the 1^{st} of February. Routes were traveled 15-20 days after the last snowfall (10 routes out of 11), the second part of the last route was traveled on the 21^{st} day after snowfall. During the count snowmelt was extensive, and the temperature was above zero. It was difficult to travel along routes because snow stuck to skies, and one route was traveled during two days, including a night spent in the forest. In February snow depth varied from 37 cm in valley bottoms to 68 cm on northern slopes in Krivaya river basin. Snow depth in this river valley was 48-57 cm. At this time snow depth on the coast was 0-70 cm. Here on northern slopes snow was 67-70 cm deep, on southern slopes - 0-70 cm deep and in river and creek valleys - 0-70 cm deep.

7. Assessment of efficiency: Two routes were partly traveled on foot and partly by vehicle because it was necessary to travel routes ## 4 and 5 completely in one day because there were no cabins to stay overnight (cabins were burnt). That is why we tried to drive fieldworker as far as possible along the road and then finish the route on foot. Route # 6 was also traveled by a combination of vehicle and on foot. This route is situated in river valley where there are many crossings, i.e. this area was difficult to travel by vehicle. That is why we should not leave the driver (who brought fieldworkers to the place) alone. It was impossible to use more fieldworkers or assistants because the vehicle was small.

In February the count was delayed due to incident which occurred during the survey in the Zapovednik (see report on Lazovsky Zapovednik).

On the whole surveys were conducted by experienced people in an appropriate timeframe.

8. Summarizing of results:

Habitat conditions and status of ungulate populations
Tiger prey species that inhabit the monitoring unit include wild boar, elk, sika deer and roe deer. Abundant pine nut crop was available in fall of 2000, but much of it was gathered by people. The 2000-2001 winter was difficult for ungulates. First snow fell on 20th of November and it did not melt (except on southern slopes). Ungulates came down to the valleys, fields and roads where they were easily poached. In January snow depth increased substantially, and the winter was quite cold. The weather station in Preobrazhenie registered 22^o C, only the second such record in the past 15 years. Snow insolation was inadequate and winter conditions were difficult for ungulates. The sika deer population especially was hard hit. It is generally accepted that this species copes poorly with snow depths greater than 50-60 cm for 2-3 months. At the beginning of March, because of greater snow depths (about 60 cm more), the conditions for ungulates in this model unit were more difficult than in Lazovsky Zapovednik. By the 8-12th of March snow cover was up to 1 m, and an icy crust formed, strong enough to support a man, and leave no human tracks. During the count 28 poached deer were found, and 13 deer died from starvation (including the beginning of March).

The number of ungulate tracks found this year was on average less than past year. The number of elk tracks decreased by 5-6 times; the number of wild boar tracks remains at the same low level.

Habitat conditions and status of tiger population in comparison with previous information (for example with data of Tiger census 1996)
In this model unit the tiger population density (adult tigers) has reduced (even taking into consideration a possible underestimation) twice in comparison with the winter season 1995-1996. This winter one litter which consisted of three cubs was registered. In 1995-1996 (up to February 1996) four litters totalling five cubs were present in this territory. Therefore, the number of tiger cubs has been reduced in half. Tigers were not found in the southwestern part of the unit, where no tracks were observed on five routes during the count. No tiger tracks were also found on one route situated in the northeastern part. Last year there were no tiger tracks here as well, but a tiger walked within the valley where the route is situated. Last year tiger signs (marked trees) were found on two routes. This year no tiger tracks or signs were found on another route (neither during the counts nor during the whole season). Tiger habitat is being eliminated by the densely populated valley of adjacent Partizansk Raion. Tigers can be still found in remote areas, which are difficult for hunters to access or to develop.

Illegal hunting for ungulates and death due to starvation will probably have a negative impact on this tiger subpopulation in the future.

Habitat conditions

During this year, no considerable movements of human population occurred in this model unit. In Krakovka Bay the owner of one of recreation departments is constructing a smoking-shed. We suppose it will be used for smoking of meat of wild ungulates, sika deer in particular, which are widely distributed here, even though this population of sika deer in Lazovsky Raion is listed in the Red Book of the Russian Federation.

Industrial development did not increase. According to the information of Lazo Forestry District, the area of logging activity in this model unit was less than past years. Data obtained from Tikhookeanski Forestry (military forestry that includes Medonos creek basin) indicated that there was no logging here. But information we have does not confirm this statement. Logging took place both in this and past years.

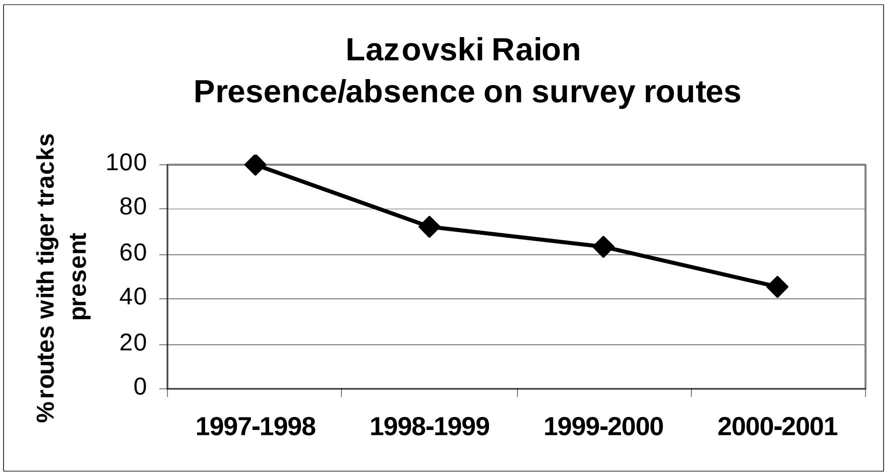
According to the information obtained from local forestries and local people, no fires happened burned last year in this model unit.

Recreational pressure from citizens of the adjacent densely populated Partizanski raion remains high. In summer many people are looking for ginseng here. In the upper reaches of Krivaya river in Maly Port hunting lease there is a reproduction area, where hunting is limited. But ungulate density remains very low there. It is especially evident in Medonos creek area, where route # 4 is situated. No fresh tracks of ungulates were found there and old tracks are also very rare. Many more ungulate tracks were found on the next route that is situated on the other side of divide along the river valley, which flows into the sea. Probably deep snow made access to this area very difficult.

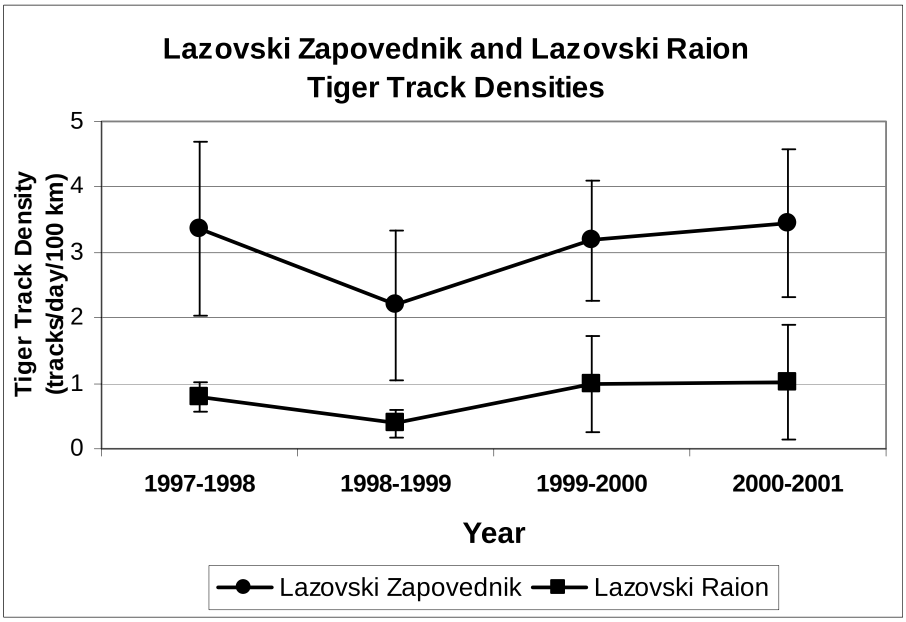
Hunting pressure on ungulate populations increased in comparison with the past year. The number of licenses distributed for hunting elk and wild boar is more than ungulate populations' density can bear. Hunters with license have a right to stay in the territory, but they kill sika deer instead of elk, wild boar or roe deer.

On the whole, it is our opinion that tiger habitat and living conditions in this model unit continue to deteriorate.

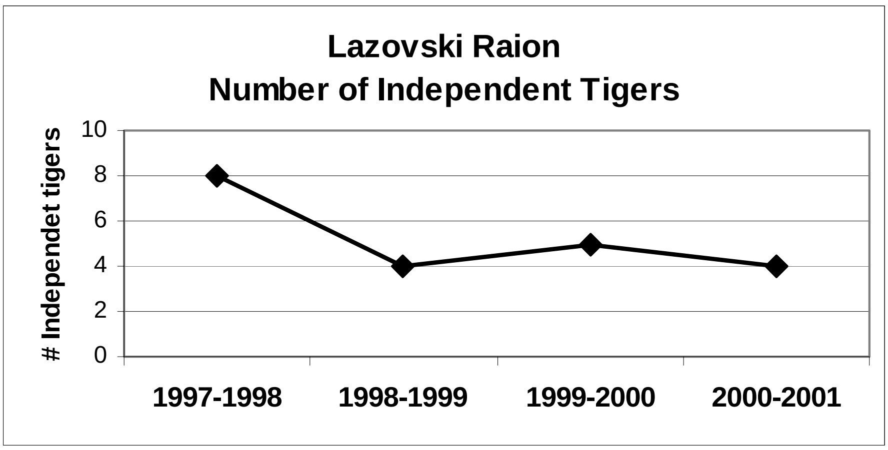

Lazovski Raion
2000-2001
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Routes
Roads
River system
Forest types
0
4
6
7
11
12
13
16
19
20
21
N
W
E
S
10
0
10
20 Kilometers



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



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



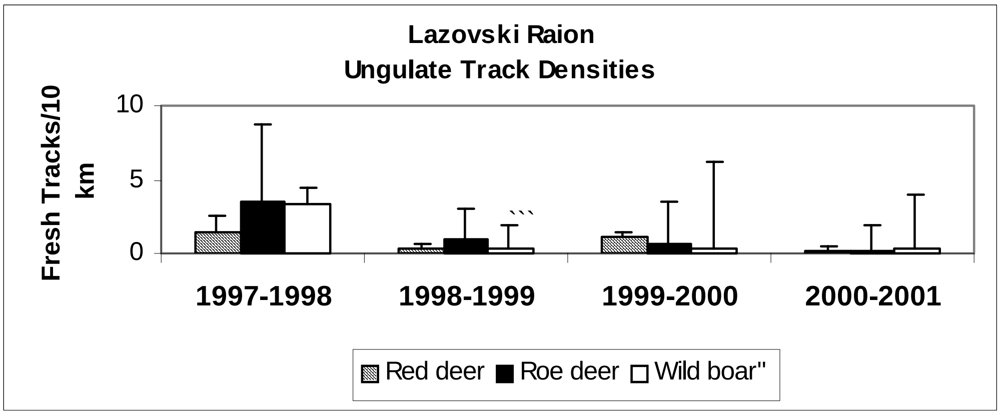
Number of Independent tigers (adults, subadults, unknown) on monitoring site

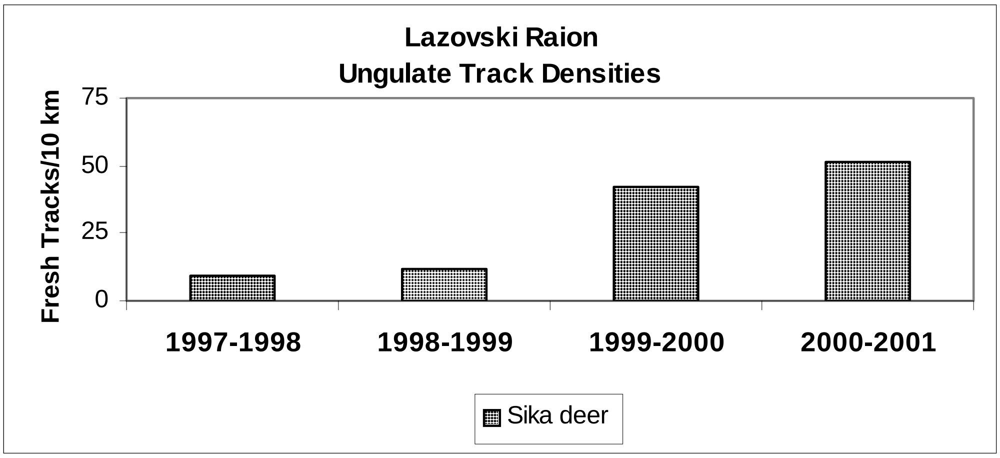
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independents*	Total (all tigers)
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
2	Lazovski Raion	2000-2001	0	2	0	0	3	2	2	4	7

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

		Prey		1997		1998		1999		2000		Grand Total	
#	Monitoring Site	species	n	mean	std	mean	std	mean	std	mean	std	mean	std
2	Lazovski Raion	Red deer	11	1.41	3.68	0.25	0.56	1.18	3.76	0.18	0.46	0.76	2.62
2	Lazovski Raion	Roe deer	11	3.42	5.47	1.01	0.97	0.67	1.41	0.11	0.36	1.30	3.05
2	Lazovski Raion	Sika deer	11	9.31	6.99	11.43	12.10	41.79	65.13	51.64	105.40	28.54	62.98
2	Lazovski Raion	Wild boar	11	3.28	2.03	0.30	0.61	0.30	0.49	0.27	0.59	1.04	1.70





USSURISKI ZAPOVEDNIK AND USSURSIKI RAION
Southcentral Primorski Krai

Report on results of Amur tiger monitoring program
in Ussuriisky Zapovednik and Ussuriiski Raion model units in winter 2000-2001
Coordinator - V.K. Abramov

Organizer: Abramov V. K.
Coordinators: Kovalev V.A. – Ussuriiski, Nadezhdinski, Mikhailovsky raions
Kosach S. P. – Shkotovsky, Mikhailovsky raions

The territory consists of two parts: central (the territory of Zapovednik – 40,432 ha) and outlying (areas adjacent to zapovednik – 141,926 ha).

Central part (Ussuriiski Zapovednik)
Number of routes – 11 (## 1, 5-8, 12, 14, 15, 17, 22, 23), total length of routes – 100.8 km, including 1 route traveled by vehicle (16.6 km) and 10 routes traveled on foot (84.2 km). The survey was conducted on 22-24 of December and on 15-17 of February.

Outlying part (Ussuriiski Raion)
Number of routes – 13 (## 2-4, 9-11, 13, 16, 18-21, 24), total length of routes – 198.1 km, including 75.9 km traveled by vehicle and 122.2 km traveled on foot. The survey was conducted on 21-23 of December and on 15-18 of February.

Survey conditions. In December 2000 snow depth depended on route location. Snow was 2-3 cm deep along the roads, where tracks were measured, and in the forest snow was 20-29 cm (up to 35 and 42 cm) deep. In February snow depth had not changed significantly despite previous snowfalls, but snow condition had changed greatly. Snow became dense and in some places it was covered with a thin crust of ice. Along roads snow was 2-7 cm deep, and 20-30 cm deep (in some places up to 35-48 cm) under forest canopy.

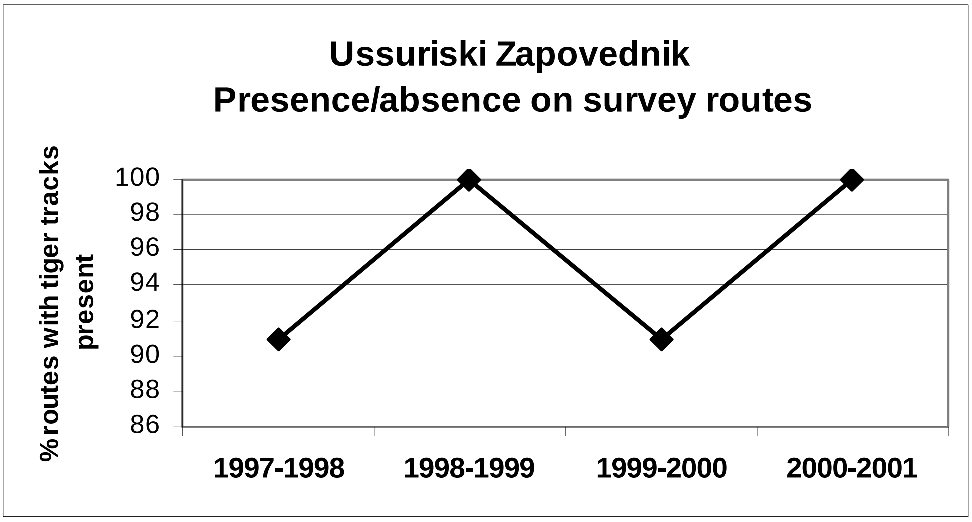
Survey efficiency – encounters of ungulate and tiger tracks encounter was low. The main reason for this was the absence of animals. The absence of animals is caused firstly by a decrease in ungulate numbers and secondly by a high level of human disturbance (every day people visited the forest to gather pine cones).

Sometimes it was very difficult to travel along the route by vehicle because the roads were not passable. As those road sections are situated in lowlands, they were not frozen and it was necessary to rent a bulldozer or tractor to travel along such routes. It is necessary to provide additional funds for tractor rental and fuel to conduct the survey in the future.

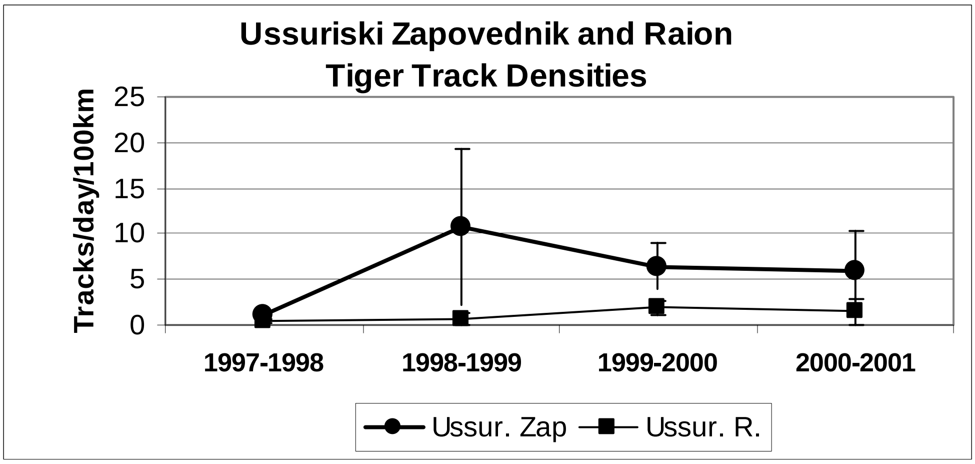
Habitat conditions for tigers and ungulates became significantly worse in Ussuriisky Raion due to the increase in human disturbance, a worsening management regime, and an increase in poaching, resulting in a decrease in ungulate numbers. During the past year the number of ungulates (roe deer, elk, and wild boar) was reduced by half in the outlying part (Ussuriisky Raion). The number of tigers was reduced by six individuals from last year (in 2000 – 12 individuals, 2001- 7 individuals). It is likely that most of them were poached in summer in Ussuriisky Raion. A litter disappeared (a female with two cubs) in the hunting lease along Kamenushka and Perevoznaya rivers (Aramilev’s hunting lease).

Eight tigers were wintering in monitoring unit in the 2000-2001 winter season: one female with two cubs, one female without cubs, two males and two individuals of unknown sex and age.

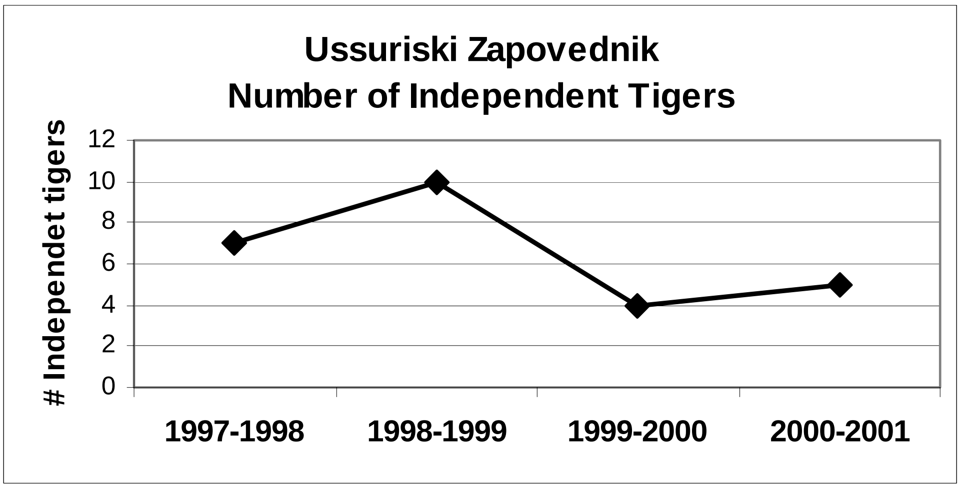

Ussuriski Zapovednik 2000-2001
TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Amur Tiger
Monitoring Program
2000-2001 winter
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
River system
Roads
N
W
E
S
5
0
5
10 Kilometers



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



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



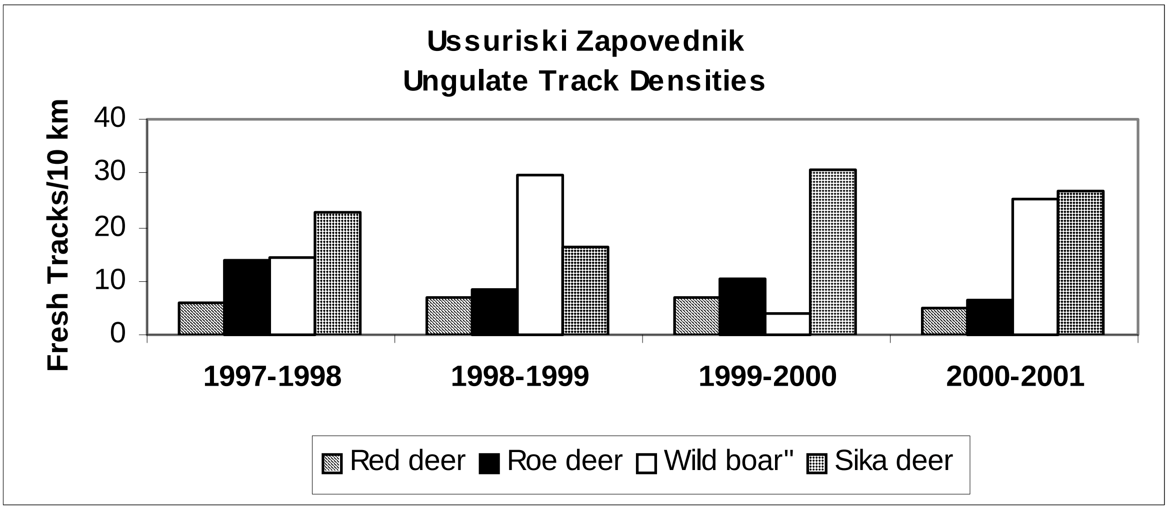
Number of Independent tigers (adults, subadults, unknown) on monitoring site

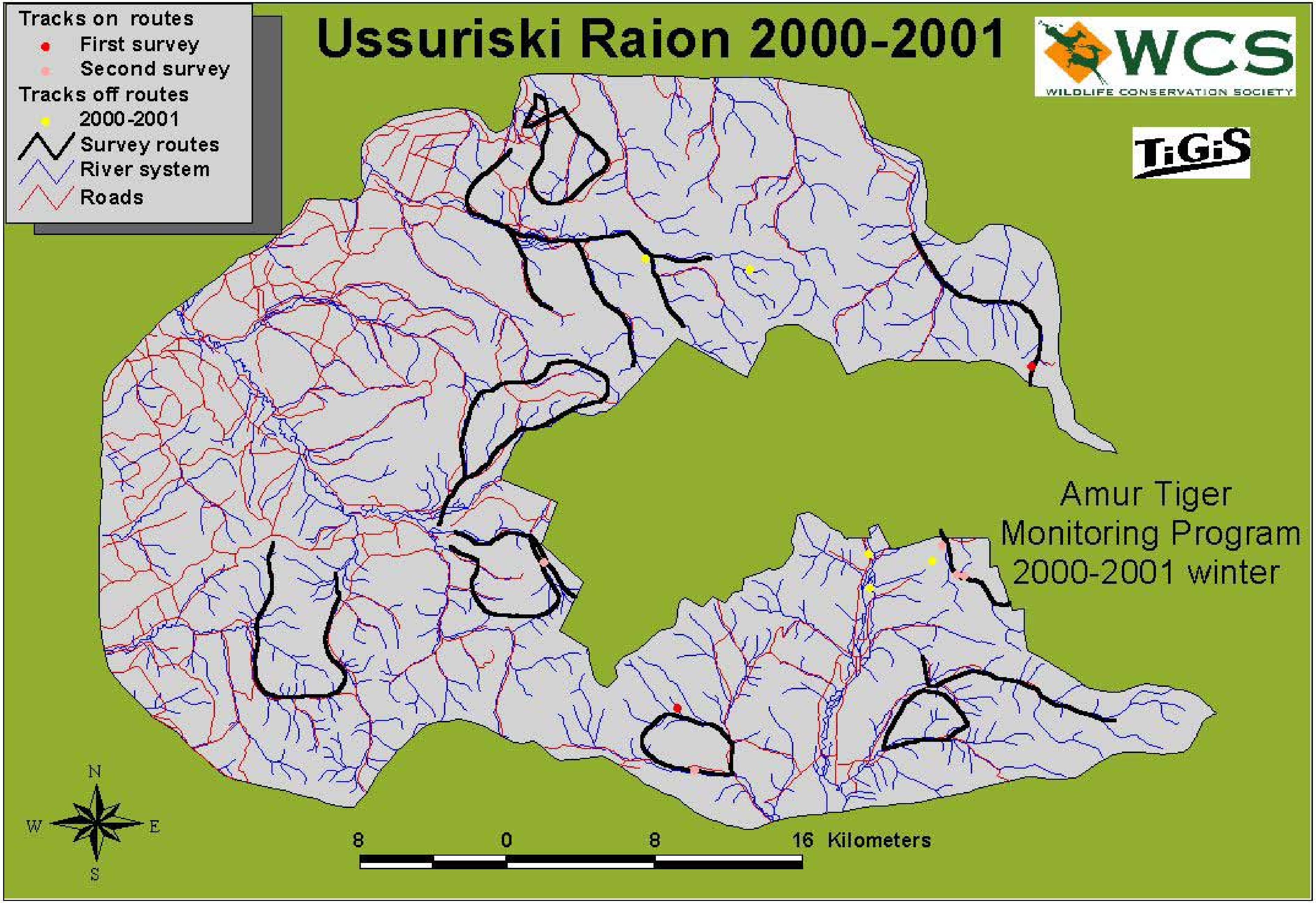
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

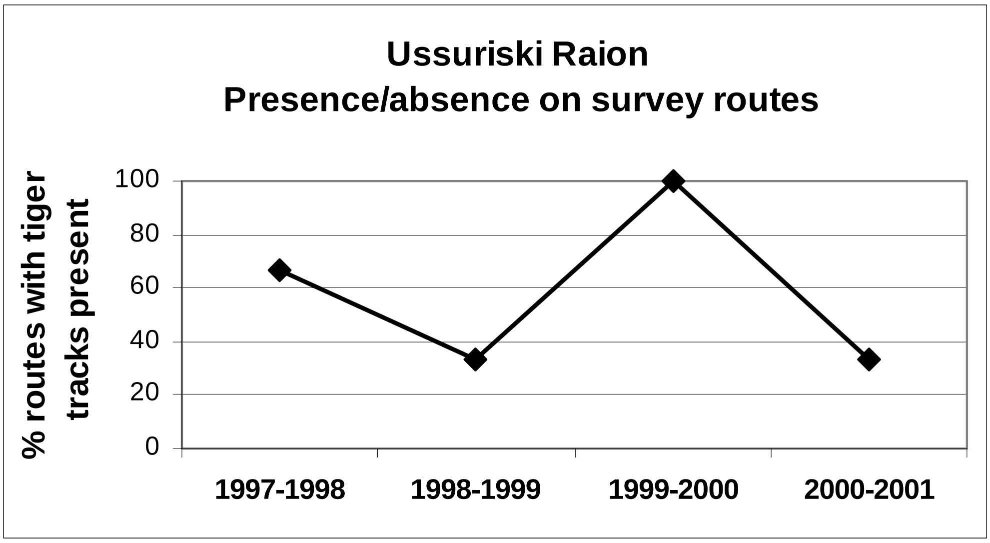
			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independents*	Total (all tigers)
3	Ussuriski Zapovednik	1997-1998	0	0	0	1	0	6	0	7	7
3	Ussuriski Zapovednik	1998-1999	0	1	0	2	0	7	1	10	10
3	Ussuriski Zapovednik	1999-2000	1	2	0	0	3	1	3	4	7
3	Ussuriski Zapovednik	2000-2001	2	2	1	0	2	0	5	5	7

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

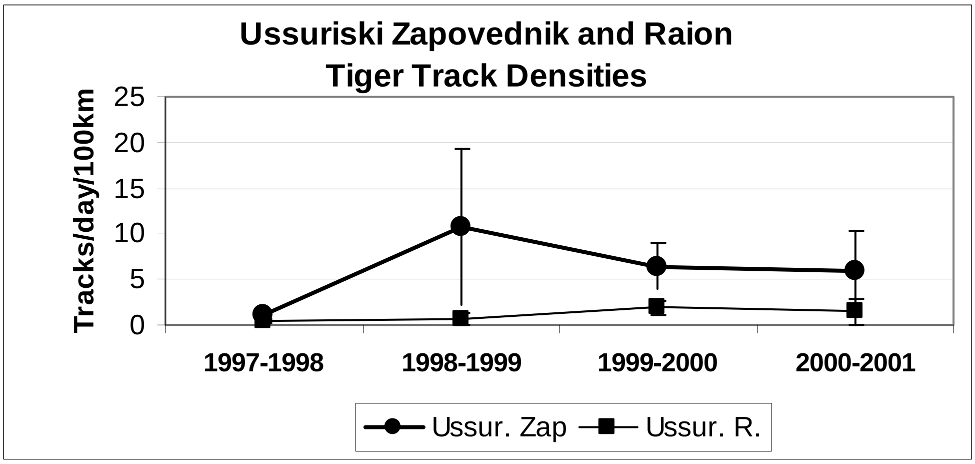
		Prey		1997		1998		1999		2000		Grand Total	
#	Monitoring Site	species	n	mean	std	mean	std	mean	std	mean	std	mean	std
3	Ussuriski. Zap.	Red deer	11	6.06	6.25	7.03	5.71	6.98	6.98	5.03	4.78	6.27	5.83
3	Ussuriski. Zap.	Roe deer	11	13.81	16.11	8.61	10.45	10.33	10.65	6.49	4.81	9.81	11.17
3	Ussuriski. Zap.	Sika deer	11	22.56	25.16	16.12	17.82	30.72	45.74	26.65	30.41	24.01	30.86
3	Ussuriski. Zap.	Wild boar	11	14.09	17.65	29.56	32.90	4.13	3.31	25.21	27.41	18.25	24.54



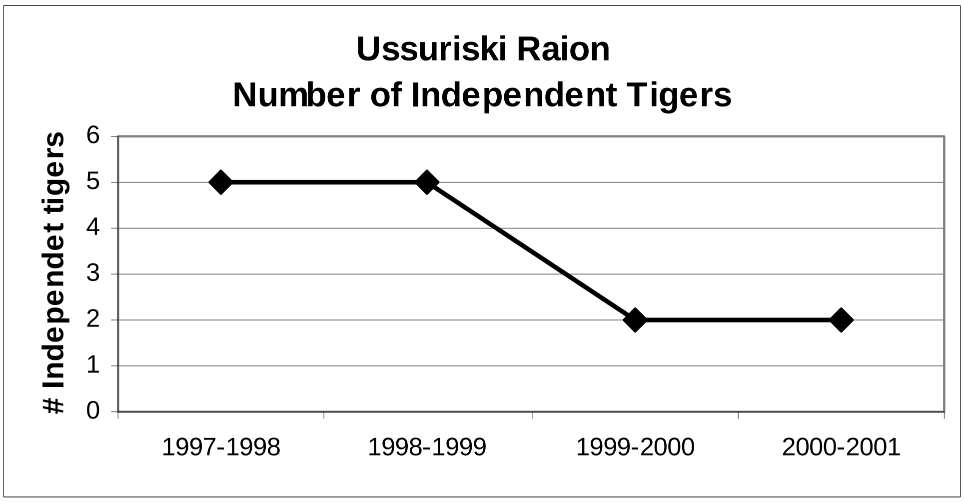

Ussuriski Raion 2000-2001
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
River system
Roads
WCS
WILDLIFE CONSERVATION SOCIETY
TiGiS
Amur Tiger
Monitoring Program
2000-2001 winter
N
W
E
S
8
0
8
16 Kilometers



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



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



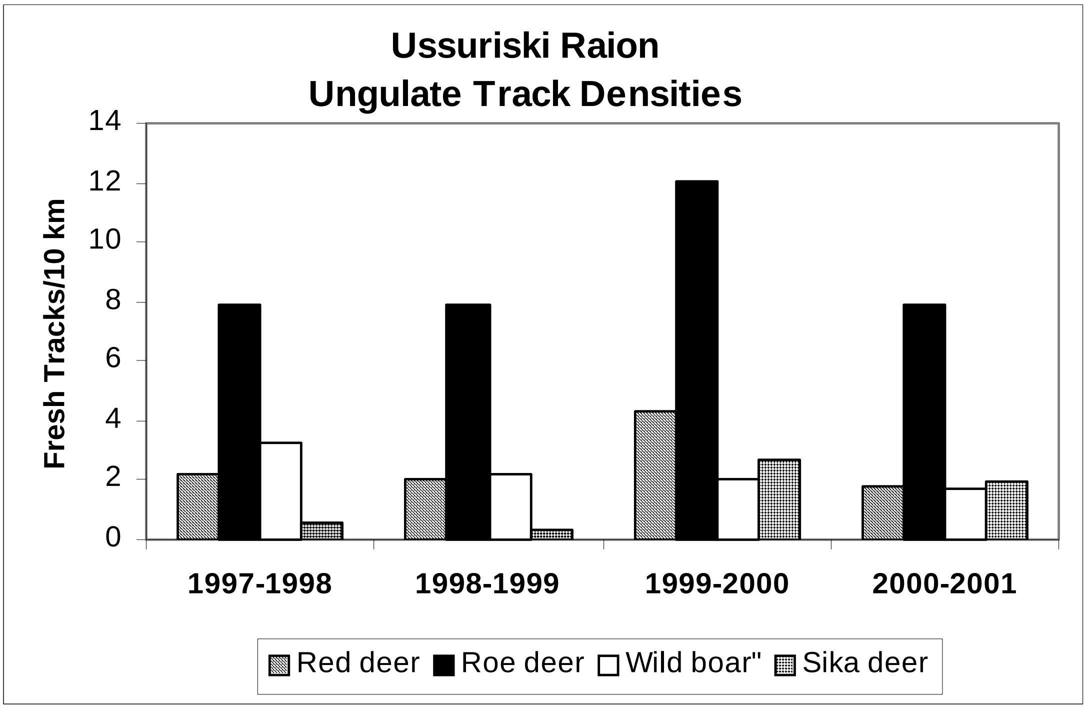
Number of Independent tigers (adults, subadults, unknown) on monitoring site

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)
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
13	Ussuriski Raion	2000-2001	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 4 years.

		Prey		1997		1998		1999		2000		Grand Total	
#	Monitoring Site	species	n	mean	std	mean	std	mean	std	mean	std	mean	std
13	Ussuriski Raion	Red deer	12	2.16	2.96	2.02	2.04	4.28	3.67	1.79	2.02	2.56	2.86
13	Ussuriski Raion	Roe deer	12	7.93	9.01	7.92	8.24	12.05	7.70	7.86	5.19	8.94	7.64
13	Ussuriski Raion	Sika deer	12	0.59	1.27	0.34	0.74	2.69	3.56	1.98	3.33	1.40	2.65
13	Ussuriski Raion	Wild boar	12	3.24	3.98	2.19	3.03	2.07	2.68	1.71	3.63	2.30	3.31



BORISOVSKOE PLATEAU
Southwest Primorski Krai

Report on results of Amur tiger monitoring program in Borisovskoe Plateau monitoring unit in winter 2000-2001 Coordinator - D.G. Pikunov, Pacific Institute of Geography

Counts were conducted on December 1-9, 2000 and on February 27 - March 11, 2001.

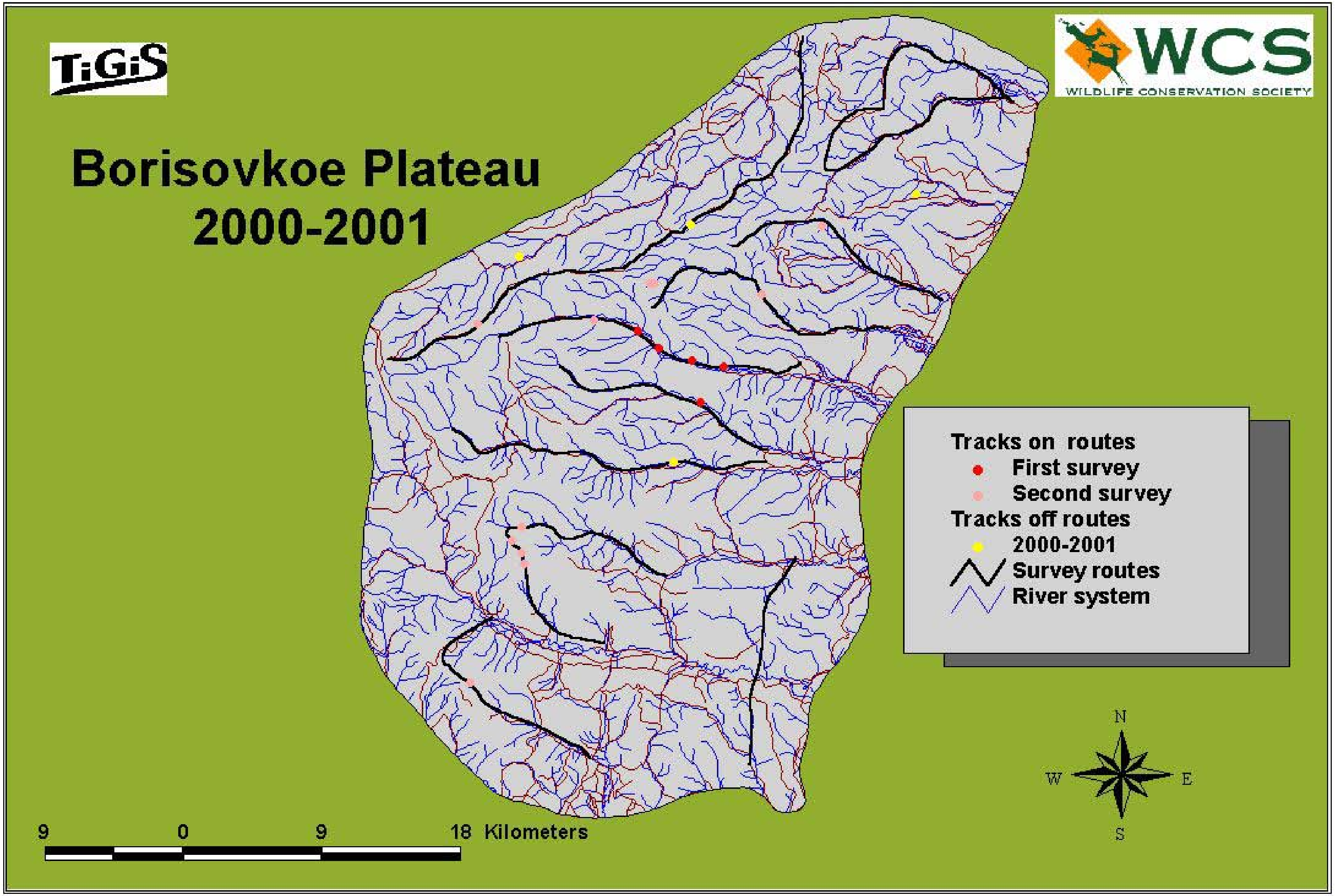
As in past years 14 routes that evenly covered the whole territory of the monitoring unit were traveled. The total length of routes was 217 km.

Routes # 1, 2, 3, 5 and 8 were traveled on foot (total length is 73 km). Routes # 4, 7, 11, 12, 13 and 14 were traveled by vehicle (total length is 94 km). Routes # 6, 9, 10 were traveled both by vehicle and on foot (total length - 50 km). Route # 10 was traveled only during the first count, during the second count the route was not traveled due to technical reasons. Heavy atypical snowfall took place in southwest Primorye on 27th of November. Most of routes were traveled 4-7 days after heavy snowfalls, when average snow depth was 15-25 cm. So the snow conditions were favorable for efficient count of tigers and ungulates. Snow conditions were also favorable for tracking individuals, as necessary, to measure their tracks accurately.

A more difficult situation existed in the second count, in association with snow depth and distribution of tigers and ungulates. Snow depths occurred up to 50-60 cm, and periodical thaws created a thin crust of ice on top of the snow that made travel difficulty for all large animals. Ungulates and predators had to gather on southern slopes, where snow was melting after thaws. There was a lack of food for ungulates on the slopes in comparison with valley bottoms, where there exist a variety of shrubs - important food for deer. Ungulates very rarely came down to valley bottoms, even if in the absence of a navigable road along the valley. Such ungulate behavior is not typical and it is associated with uncharacteristic snow conditions. Usually when ungulate hunting for ungulates is closed in the second part of winter, most ungulates stay in valley bottoms, where monitoring routes were set up. The same situation occurred on mountain plateaus. Even on the most remote plateaus (e.g., plateau between Borisovka river and Nezhinka river, where maximum ungulate densities were observed during the first count) ungulates left the territory after development of an icy crust had formed. Ungulates gathered on southern slopes. Animals had to leave the territory, even wild boars, despite the abundance of pine nuts - their favorite food. Permanent survey routes and atypical snow conditions were the reason why the second count gave slightly distorted information about ungulates and large predators distribution. Nevertheless, integrated results of both counts reflected the whole situation correctly enough. It has become more evidently that definition of the time frame for both counts should be more flexible and dependent on heavy snowfalls.

The first survey on Borisovskoe Plateau coincides with the height of hunting season for ungulates and results in a great deal of disturbance, which influences the distribution of both ungulates and predators. During the first count on part of monitoring unit, where hunting grounds of Nezhinskoe Hunting Lease are situated, the number of ungulates and tigers was minimal. It is possible that existing hunting methods including battue with unlimited number of participants make it possible that not only ungulates but also tigers can be shot. In the 2000-2001 winter season a female with one cub (T-7 and T-8), which were registered in upper basin of Vtoraya Rechka in December 2000, disappeared without leaving a trace. In addition, an adult female disappeared from southern part of monitoring unit, where her tracks (#1, 2, 3, 4, and 5) were registered on the 1st and 2nd routes. This was confirmed by the absence of her tracks on Penyazhinskiy (# 3) route, which was a part of her home range in past years.

Mass battues (legal and illegal), industrial logging (including mature oak forests) and a decreasing number of ungulates are undoubtedly the reasons of tiger habitat deterioration. The monitoring survey results indicate that in the 2000-2001 winter season in Borisovskoe Plateau monitoring unit only two tigers were present – a resident male and adult female. Only the total prohibition of hunting and industrial logging in the whole territory of Borisovskoe Plateau, Barsovy Zakaznik and Khasan Raion up to Kraskino settlement (to the west from highway between Ussuriisk and Kraskino) will help to protect small populations of ungulates and large predators. Otherwise, there will be no chance for natural dispersal of ungulates and predators into northern provinces of China and North Korea from Russia.


TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Borisovkoe Plateau
2000-2001
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
River system
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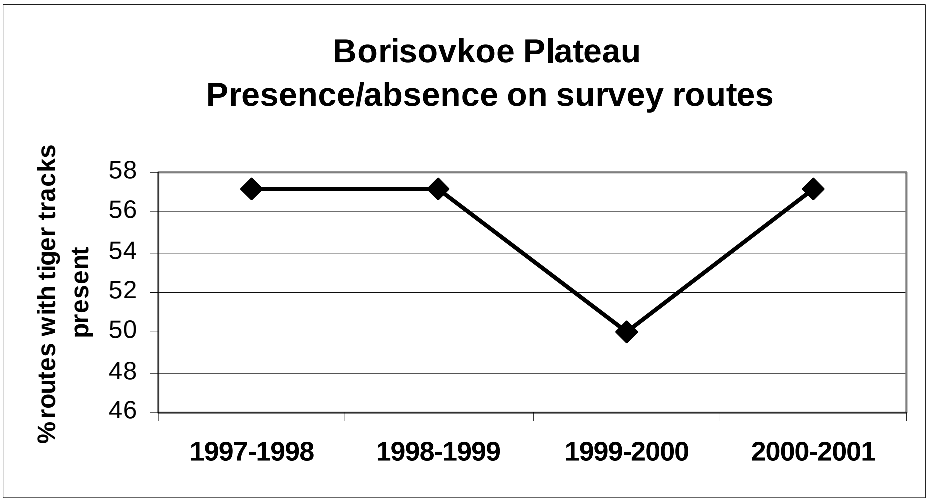
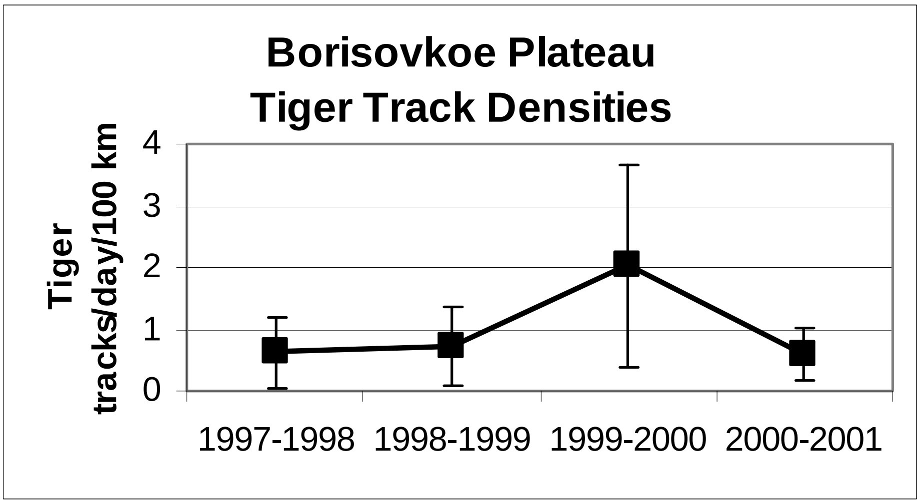
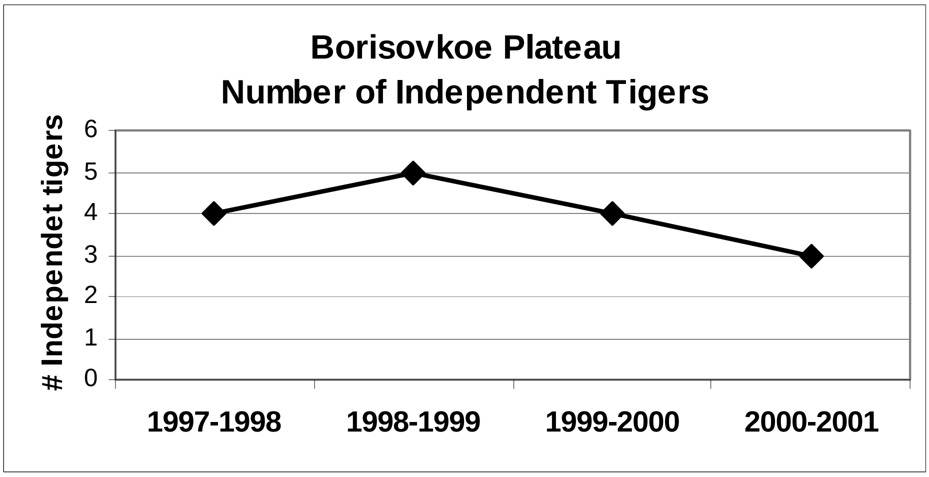


Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



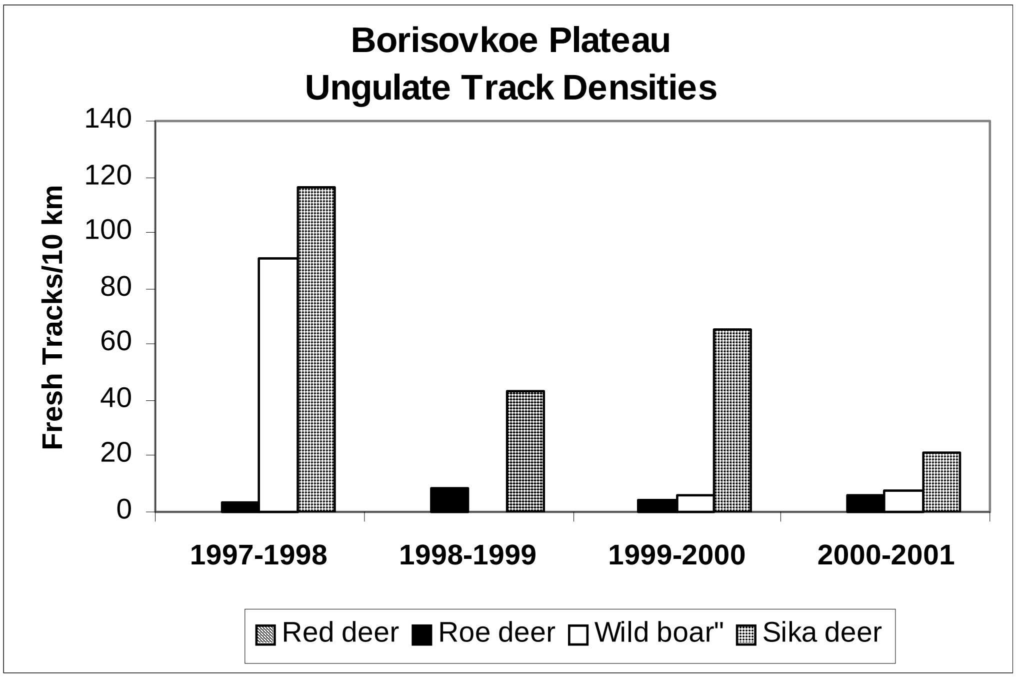
Number of Independent tigers (adults, subadults, unknown) on monitoring site

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)
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
6	Borisovkoe Plateau	2000-2001	1	2	0	0	1	0	3	3	4

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

		Prey		1997		1998		1999		2000		Grand Total	
#	Monitoring Site	species	n	mean	std	mean	std	mean	std	mean	std	mean	std
6	Borisovkoe Plateau	Red deer	14	0.02	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
6	Borisovkoe Plateau	Roe deer	14	3.38	5.29	8.48	15.22	4.58	6.46	6.22	5.57	5.66	9.07
6	Borisovkoe Plateau	Sika deer	14	116.29	183.22	42.87	56.99	65.74	87.40	20.81	16.99	61.43	108.88
6	Borisovkoe Plateau	Wild boar	14	91.09	122.25	0.26	0.84	5.53	5.95	7.47	12.02	26.09	70.83



SANDAGOY
Olginski Raion, Southeast Primorski Krai

Report on results of Amur tiger monitoring program in Sandagou monitoring unit in winter 2000-2001

Coordinator - V.V. Aramilev, Institute for Sustainable Use of Natural Resources

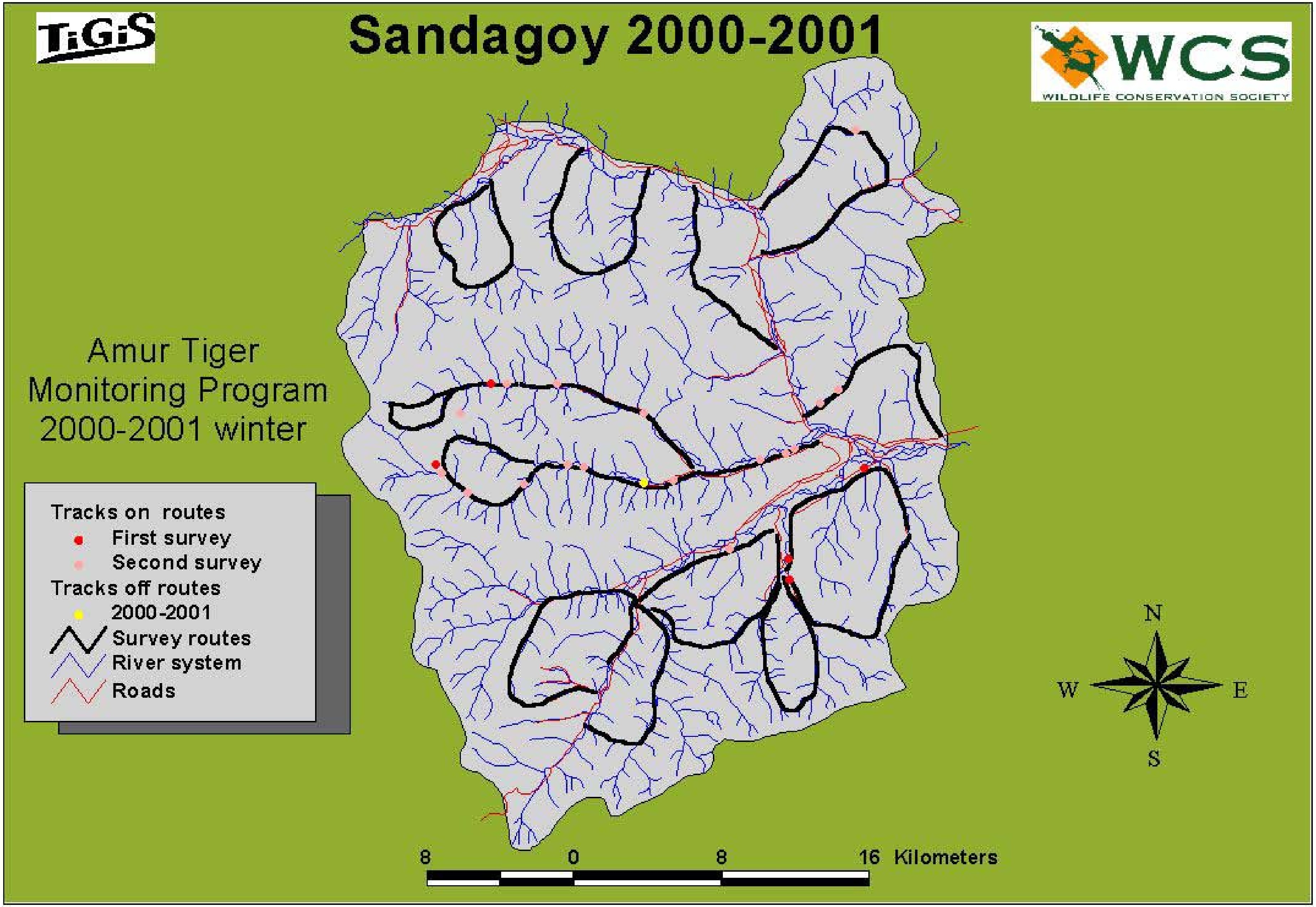
This winter survey in the monitoring unit was conducted on December 17-18, 2000 and on February 10-11, 2001. By the beginning of December stable snow cover had formed in the monitoring unit and we were able to conduct the first count in December. In the second part of winter snow cover increased but all routes were passable on skies and the second count was conducted according to the schedule. All 16 routes were traveled twice during this winter survey. All routes in our monitoring unit are traveled on foot. When snow is deep fieldworkers use skies. Routes are traveled according to existing scheme and have not varied between years. The actual number of kilometers traveled on routes can be accurately determined with the help of GPS and route length marked on the map can be determined more accurately with the help of computer program.

During the first count, average snow depth was 15-30 cm depending on height above the sea level and snow was evenly spread across the territory. Three weeks passed since the last snowfall and convenient conditions had formed for counting tiger tracks. In February snow cover increased up to 40-50 cm and routes could be traveled only on skies. Only ten days passed after the last snowfall and that is why fewer tiger tracks were registered. Cold weather had an influence on activity of tigers, at nights temperature went down to 30-35^{o} C below zero and in daytime it did not exceed 15-18^{o} C below zero. Usually in daytime wind rose up to 10-15 m/sec. Tiger distribution and their track activity (movements) were determined by the distribution of ungulates and their physiological condition. After deep snow cover had formed in December some ungulates went along creeks down to river valleys. After sunny weather had set in and snow depth on steep slopes decreased ungulates went up from river valleys to slopes again. But because of deep snow and low temperatures ungulates did not move widely and stayed on local sites: wild boars - in areas with good harvest of pine cones, deer - on steep slopes with herbaceous food, elks and roe deer - in areas with adequate food and minimally acceptable snow cover. Tigers correspondingly stayed not far from areas where ungulates concentrated and went out to roads, trails and river valleys more rarely.

In comparison with the past year ungulate numbers increased despite a difficult 1999-2000 winter season with deep snow. As in the past minimum ungulate densities were observed in areas adjacent to Mikhailovka and Furmanovka villages. But this year "Chin San" hunting lease was established here with our assistance, and local hunters obtained rights for long-term use. Now they are owners of the territory, and should organize the hunting season and protection of hunting resources.

The number of tigers in the monitoring unit has been stable for the two past years. The sex-age composition of tigers in the monitoring unit seems appropriate and does not provide any indicators that would cause anxiety. The particular feature of this year is the absence of litters. A young tiger with a pad width of 7.5 cm should walk with his mother but this one individual did not. It is worth mentioning that last year an animal with the same pad width was also registered in this monitoring unit.

Logging in monitoring unit territory takes place within confined areas. Hardwooded, broadleaved species are mainly logged, but coniferous trees are also logged near Furmanovka village. Logging here is not large-scale and comprises only about 150 ha for the past year. There were no crown fires in monitoring unit, but ground fires were found in localized parts of the northeastern section of the unit.


Sandagoy 2000-2001
TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
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
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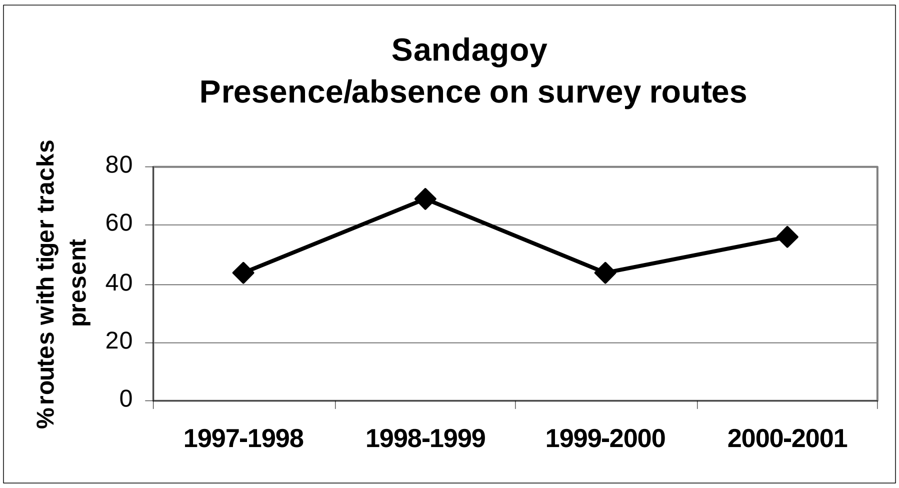
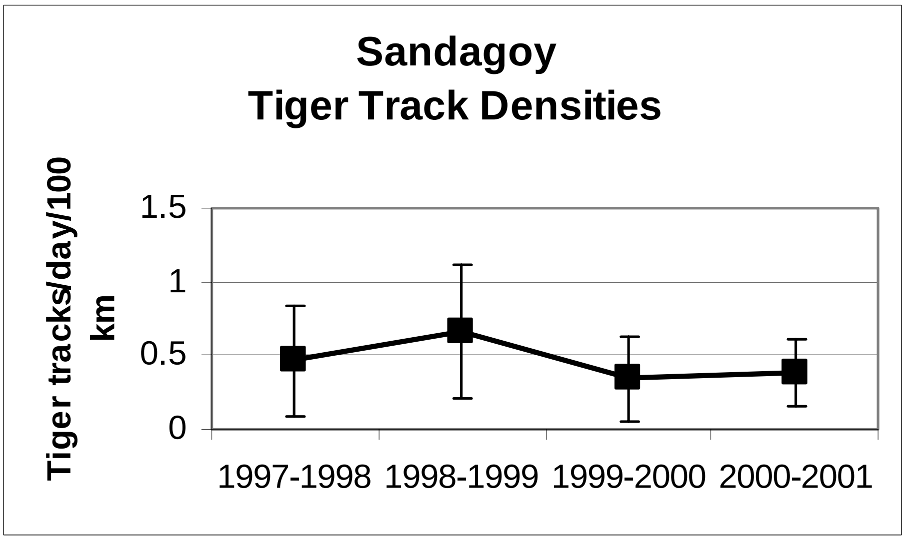
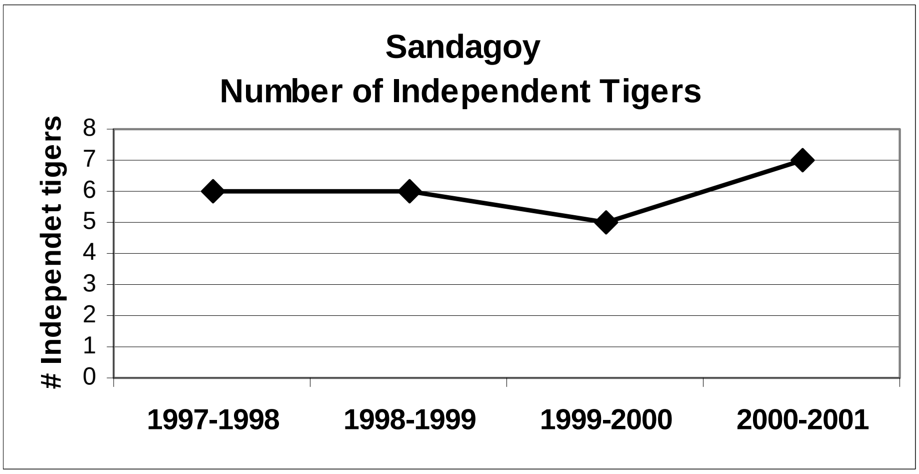
S
8
0
8
16 Kilometers



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



Comparison of track densities in monitoring site across years



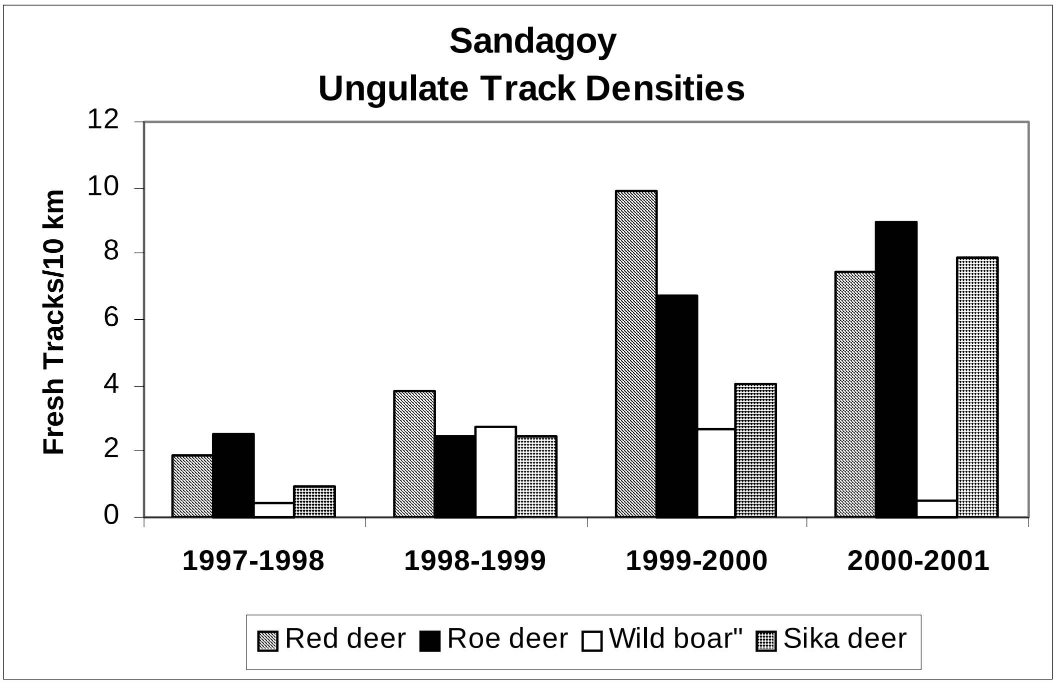
Number of Independent tigers (adults, subadults, unknown) on monitoring site

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)
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
7	Sandagoy	2000-2001	2	1	0	1	0	3	3	7	7

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

		Prey		1997		1998		1999		2000		Grand Total	
#	Monitoring Site	species	n	mean	std	mean	std	mean	std	mean	std	mean	std
7	Sandagoy	Red deer	16	1.87	2.78	3.84	3.76	9.90	10.78	7.41	8.55	5.76	7.75
7	Sandagoy	Roe deer	16	2.50	2.67	2.44	2.25	6.70	5.69	8.98	8.57	5.16	6.01
7	Sandagoy	Sika deer	16	0.91	1.68	2.46	3.55	4.06	3.98	7.91	13.77	3.83	7.71
7	Sandagoy	Wild boar	16	0.42	0.68	2.76	4.07	2.68	4.04	0.54	0.99	1.60	3.07



SINEYA
Chugevski Raion
Central Primorski Krai

Results of monitoring program in Sinyaya monitoring unit in winter 2000-2001
Pavel Fomenko, WWF-RFE Program Coordinator

Sinyaya monitoring unit is situated in the central part of Chuguevsky Raion (Primorski Krai). Coordinator of survey is P. V. Fomenko – WWF RFE Program Coordinator.

Both counts were conducted in accordance with the schedule.

15 routes were traveled. Total length of the routes and their location were the same as last winter. Deep snow cover made it necessary to use snowmobiles during both counts.

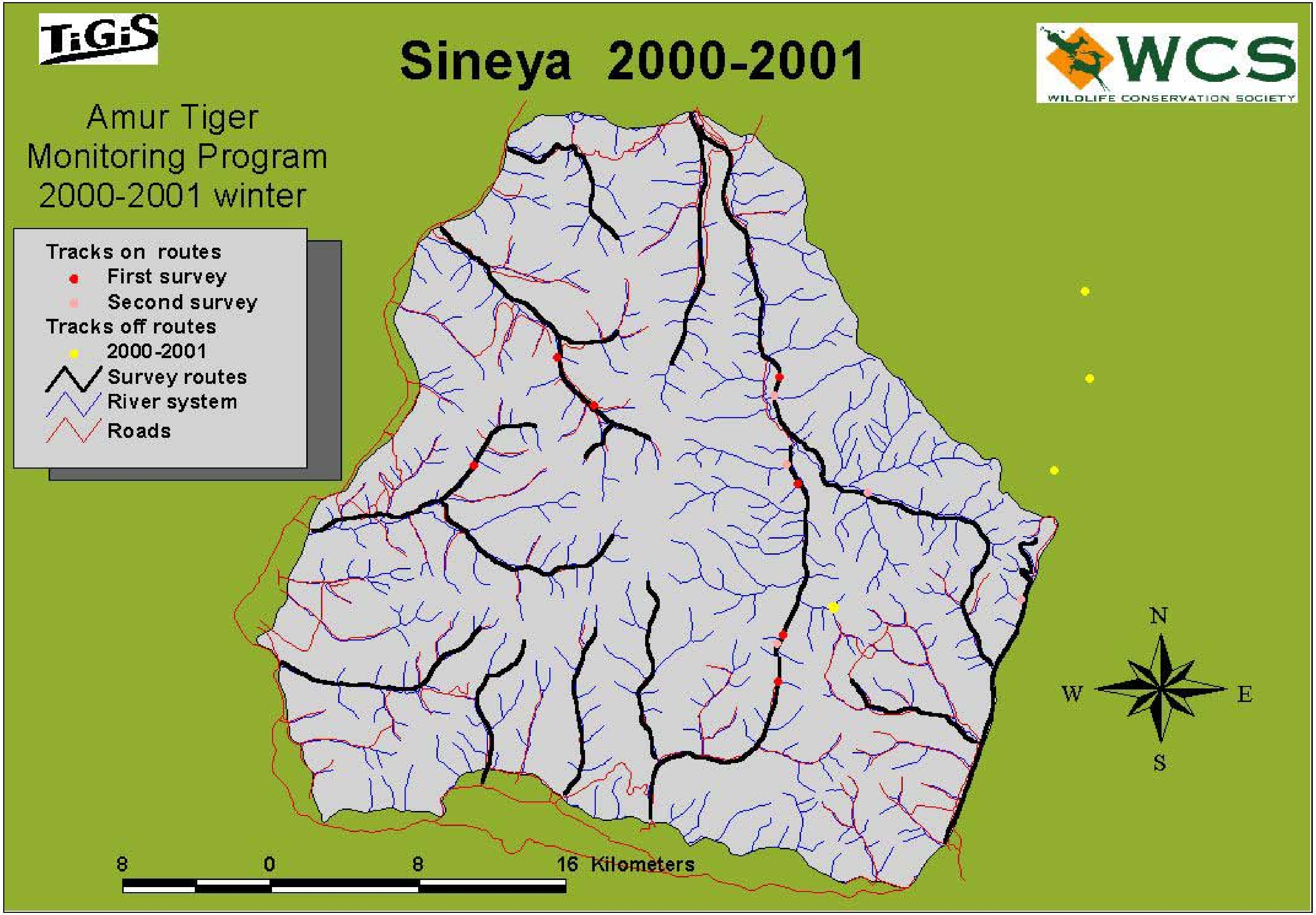
Weather conditions were extreme, both in relation to snow depth and average winter temperatures. Snow depth was 15-20 cm more than last year.

There were no any organizational problems because the survey was conducted by the same fieldworkers as the last year. Weather conditions also did not influence the work efficiency.

Despite the very difficult conditions for wintering ungulates, there were not reports of mortality (winter kill). In comparison with past years, the numbers of roe deer and wild boar (insignificantly) have increased. The elk population in study area is stable.

The number of tigers in the monitoring unit is stable. Almost all animals are identified excluding one big male tiger. In addition two females with cubs were found (one of them was registered outside of the monitoring unit). The death on one cub was reported (probably he was killed by a male). There was no information about poached tigers.

Habitat conditions have not changed significantly. Small ground fires in spring and fall did not impact the habitat significantly. There were no crown fires. Selective logging did not damage the habitat. As usual hunting pressure on ungulates is considerable but it is compensated for by recruitment.


Sineya 2000-2001
Amur Tiger
Monitoring Program
2000-2001 winter
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
River system
Roads
WCS
WILDLIFE CONSERVATION SOCIETY
TiGiS
N
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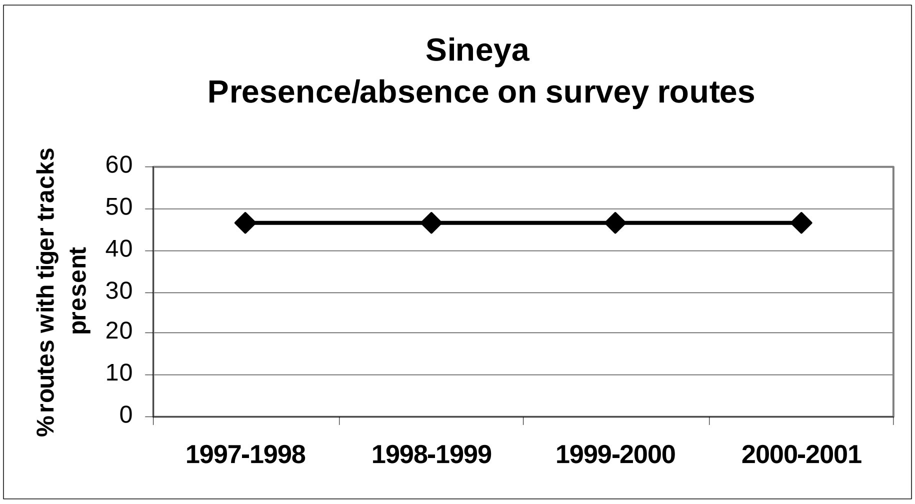
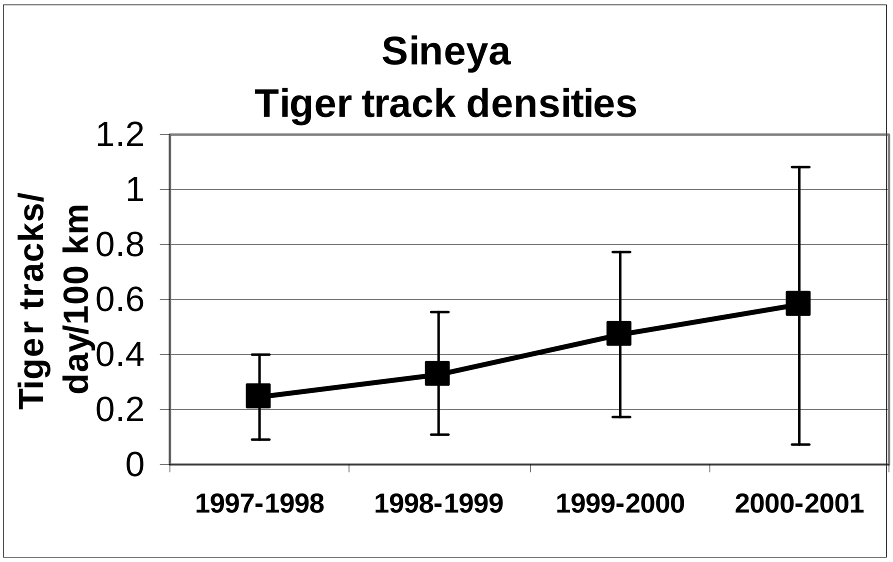
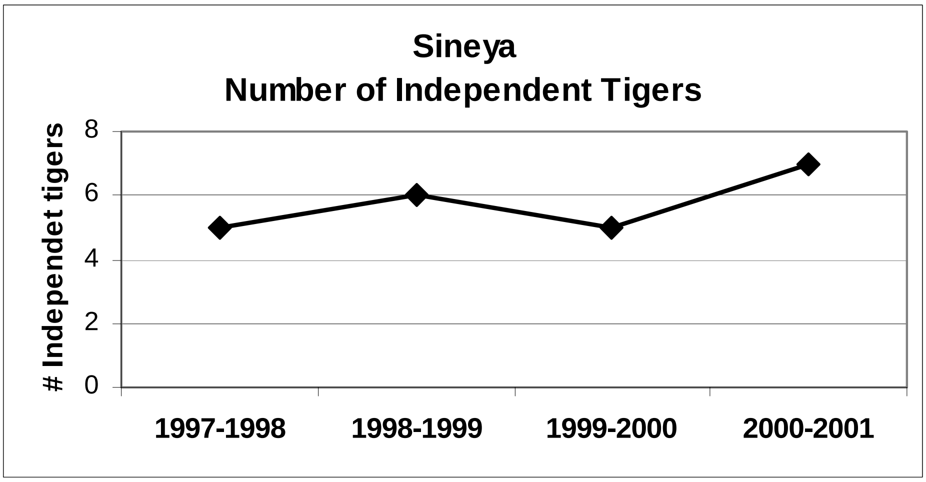
16 Kilometers



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



Comparison of track densities in monitoring site across years



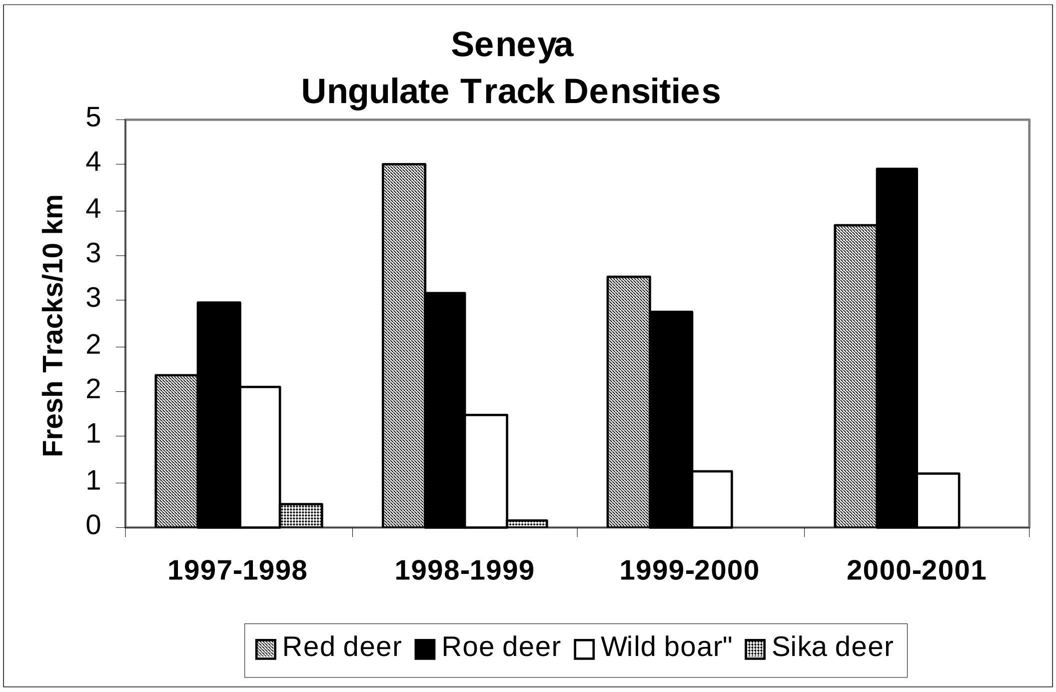
Number of Independent tigers (adults, subadults, unknown) on monitoring site

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
15	Sineya	2000-2001	2	3	0	1	3	1	5	7	10

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

#	Monitoring Site	Prey species	n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	2000 mean	2000 std	Grand Total mean	Grand Total std
15	Sineya	Red deer	15	1.68	1.60	4.00	2.60	2.77	3.74	3.35	2.27	2.95	2.74
15	Sineya	Roe deer	15	2.48	2.24	2.59	2.08	2.37	1.83	3.96	2.49	2.85	2.21
15	Sineya	Sika deer	15	0.27	0.78	0.08	0.21	0.00	0.00	0.00	0.00	0.09	0.41
15	Sineya	Wild boar	15	1.56	2.89	1.23	1.82	0.61	1.07	0.60	1.23	1.00	1.89



IMAN
Central Primorski Krai
1999-2000

Report on results of Amur tiger monitoring program in Iman monitoring unit in 2000-2001 winter Coordinator

I.G. Nikolaev
Institute of Biology and Soils, Far Eastern Branch Russian Academy of Sciences

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

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

Field work on the routes was conducted in December 6-8 and in February 19-22.

In December the total length of routes traveled by vehicle was 131 km, on foot – 68 km. In February the total length of routes traveled by vehicle was120 km, on foot - 78 km. Routes were not traveled by snowmobile, which was used only to bring fieldworkers to the routes. A discrepancy in modes of travel during the first and the second counts was caused (as in past years) by a big difference in snow depth in December and February. In December the minimum and maximum snow depth in open sites were 19 cm and 35 cm respectively; in February these figures were 41 cm and 60 cm. Due to snow depth in the second half of the winter several routes which were not passable by vehicle were traveled on skies.

The date of last snow (for the count in December) was November 26 and the February count - January 31. Therefore, before first count there had been an interval of 10 days since the last snow, and before the second count,19 days.

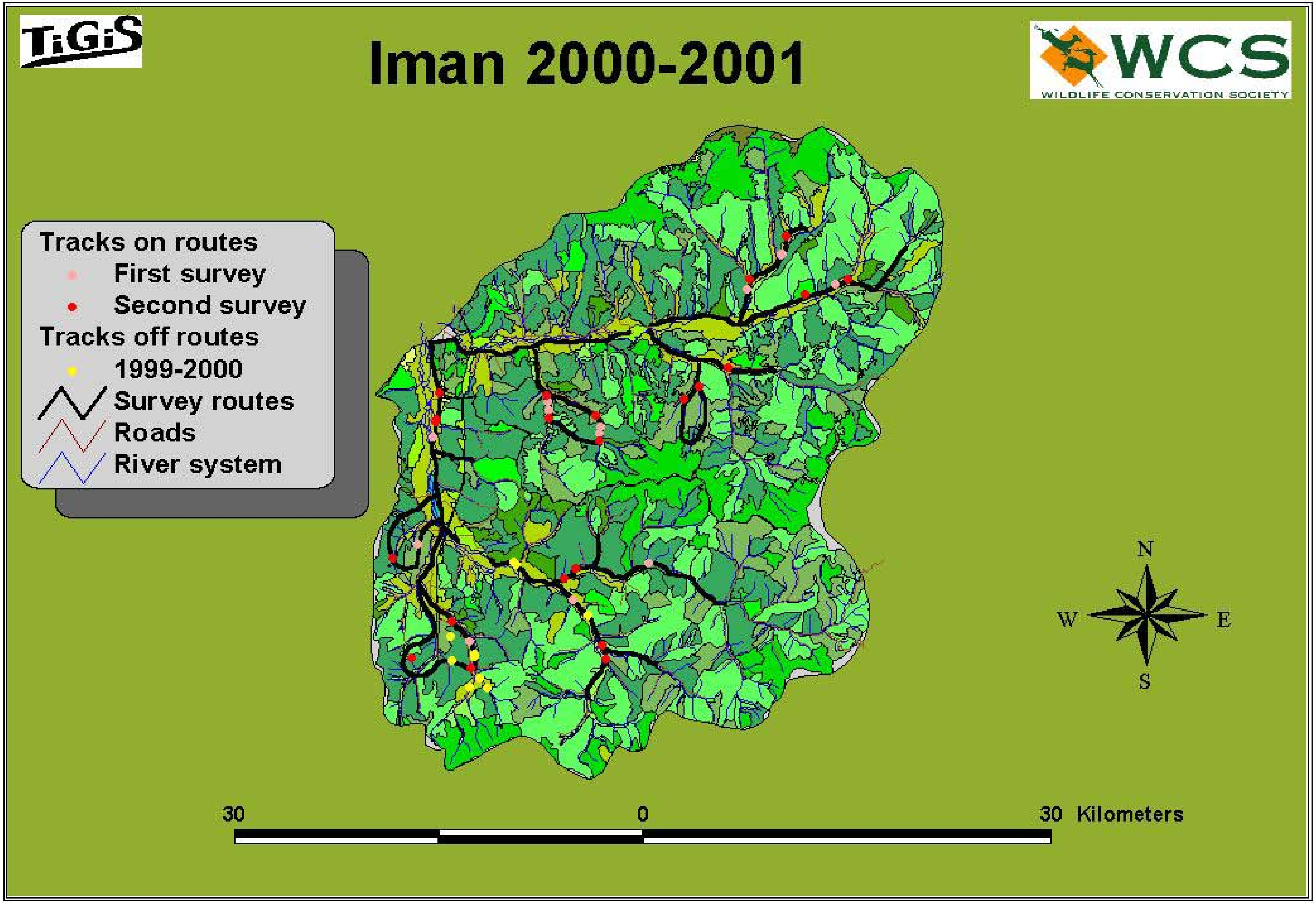
This season as well as the past winter were both unfavorable for local tigers. This situation has developed due to an imbalance in predator-prey numbers. Among tiger prey species, or primary concern is the wild boar population, whose density has remained at very low levels for the past six years. In February no fresh tracks of wild boars were found on routes.

Elk and roe deer populations appear to be in satisfactory condition. There were considerable differences in the number of elk tracks reported in February in comparison with December (81 tracks in December versus 126 in February), which can probably be explained by the difference of snow depth in the first and second surveys. Deep snow (which accumulated in the second part of winter) forced elk to go downslope into river valleys and to concentrate in their middle and lower reaches of river basins as snow depth increased.

The second important negative factor is human disturbance. The importance of this factor has increased due to more intensive logging. The area being logged has risen mostly due to the activity of a variety of commercial and illegal logging groups. This factor affects females with cubs most of all. They usually leave areas where logging activity is occurring.

Although the condition of tiger habitat for this winter season was considered not particularly favorable, nevertheless population density here remains at the same high level as before.

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


TiGiS
Iman 2000-2001
WCS
WILDLIFE CONSERVATION SOCIETY
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2000
Survey routes
Roads
River system
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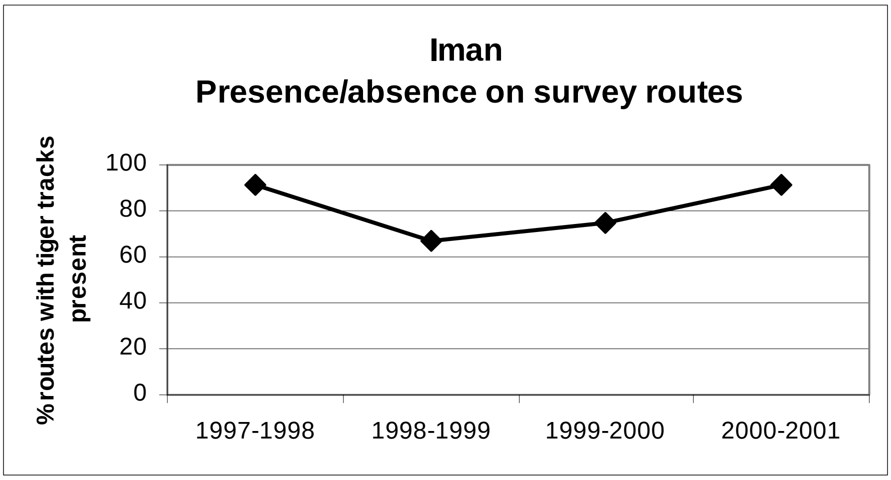
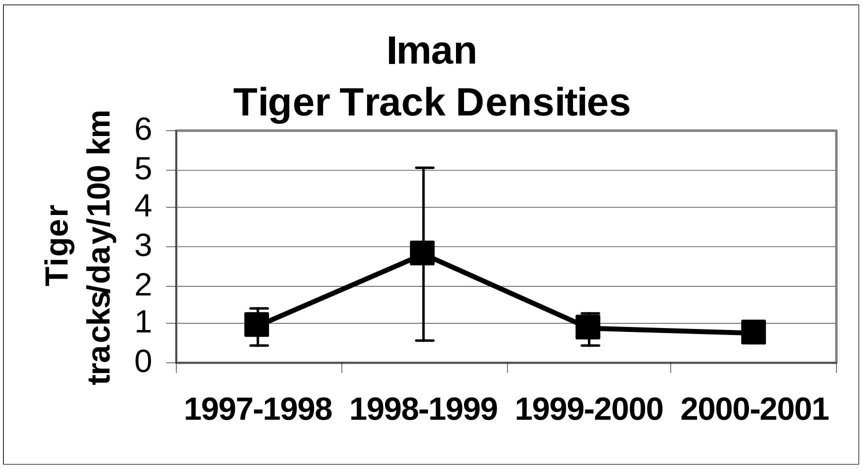
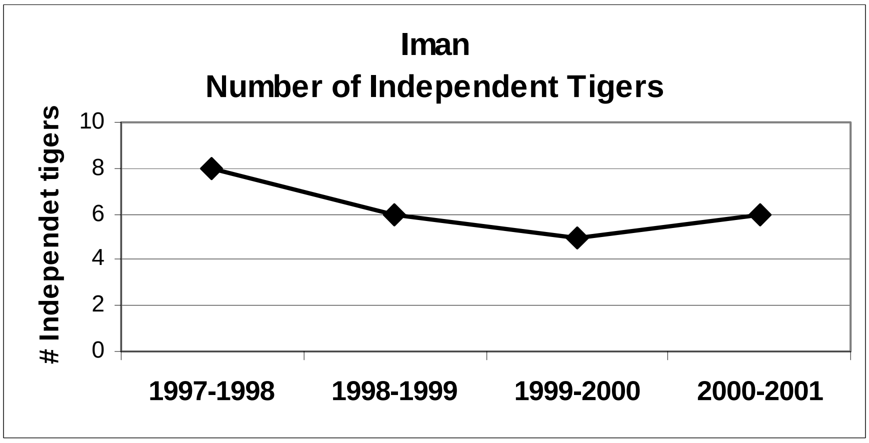


Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



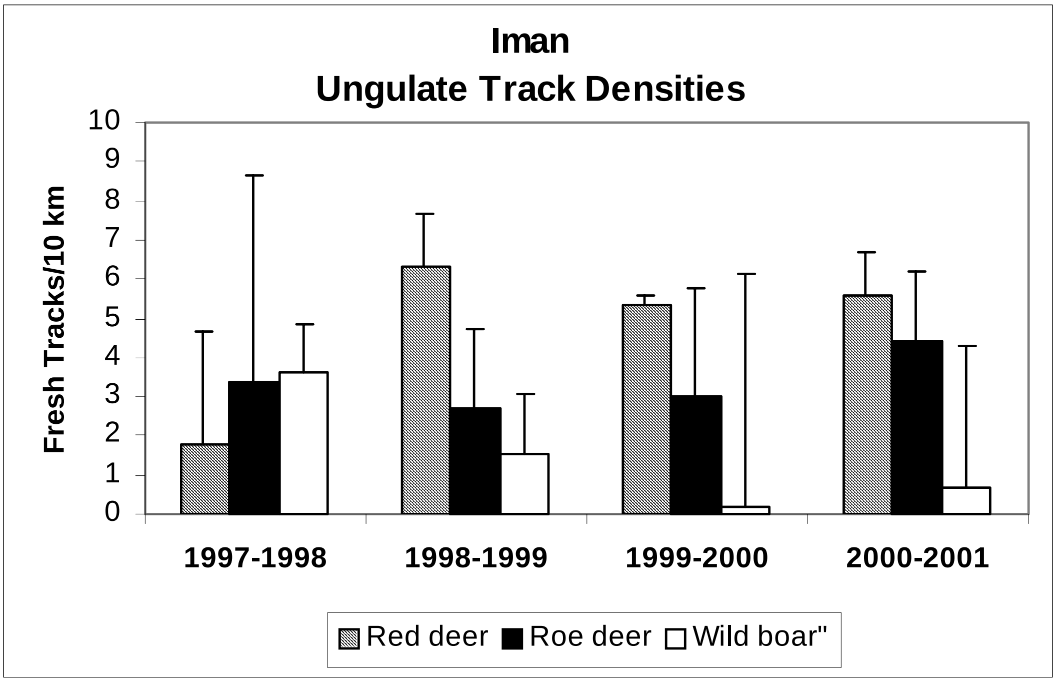
Number of Independent tigers (adults, subadults, unknown) on monitoring site

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
4	Iman	2000-2001	2	3	0	1	2	0	5	6	8

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

#	Monitoring Site	Prey species	n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	2000 mean	2000 std	Grand Total mean	Grand Total std
4	Iman	Red deer	12	1.79	2.88	6.33	5.27	5.34	7.23	5.56	3.71	4.76	5.20
4	Iman	Roe deer	12	3.38	5.33	2.68	2.28	2.98	3.94	4.45	7.10	3.37	4.87
4	Iman	Wild boar	12	3.63	5.07	1.55	2.37	0.19	0.40	0.66	2.03	1.51	3.18



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

Report on results of Amur tiger monitoring program in Bikin monitoring unit in winter 2000-2001 Coordinator

D.G. Pikunov
Pacific Institute of Geography, Far Eastern Branch Russian Academy of Sciences

Simultaneous monitoring counts were conducted on January 5-14, 2001 and on February 22-28, 2001. As in past years 16 routes (total length 191 km) were traveled in Bikin monitoring unit. Routes # 1, 2, 5, 10, 11 - total 68 km - were traveled by snowmobile. Routes # 3, 4, 6, 7, 12, 13, 14, 15, 16 - total 101 km - were traveled on skies. Routes # 8 and 9 were traveled both on snowmobile and on skies - total 22 km.

By the first count, snow cover had developed without an icy crust. Snow was 28-40 cm deep, making it favorable for an efficient count. The first and second counts began 7-10 days after heavy snowfalls. From time to time light snow fell that helped to identify the age of tiger tracks correctly. Some difficulties were associated with snow cover: movements of ungulates were extremely limited in associated with short heavy snowfalls. As with ungulates, tigers also moved mostly within limited portions of their home ranges. Tiger tracks persisted for a long time because snowfalls were heavy but rare enough so there were many tiger tracks, increasing the ability to identify individual tigers.

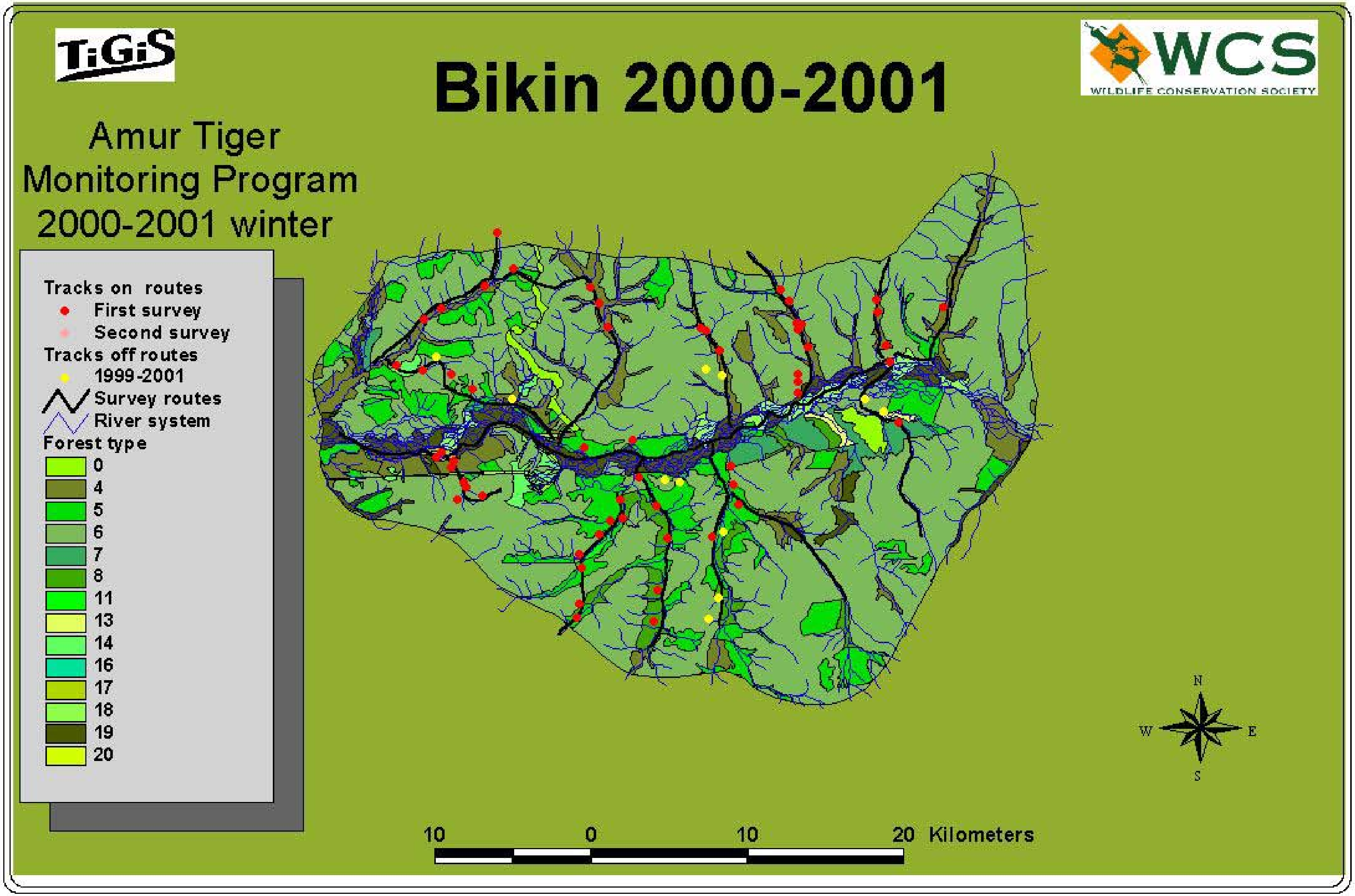
During the second count most of professional hunters had already left the forest because low sable densities made trapping efforts mostly ineffectiveness. Their absence prevented us from obtaining additional information via personal interviews on tiger distribution over the territory, and, additionally, as there were no snowmobile trails, ski trails and hunter trails several routes that we previously counted from snowmobile had to covered on skies (a deviation from our normal monitoring protocol). Low winter temperatures (- 30-40^{o}) made our work on routes more difficult, especially travel on snowmobiles.

Nevertheless, both counts provided sufficient information to define tiger numbers and distribution over the monitoring unit. The yearly trend of decreasing of ungulate numbers was clearly discernable along the main bed of Bikin river, where a primary snowmobile road is situated. The presence of several wild boar herds and a slight increase of in numbers of this species in western part of monitoring unit improved the quality of tiger habitat there. The large pine cone crop that developed in most areas of Primorski Krai did not occur in the Bikin basin. However, there was an abundant acorn crop in localized sites of mature oak forests that concentrated wild boar (and correspondingly tigers) in these territories. On the whole a great number of tracks on some routes and the complete absence of track on other routes, as well as an absence of tiger litters, confirmed that population status has became worse and tiger numbers have decreased. We were able to confirm a considerable number of poaching incidents of tigers in previous years, but people still appear unwilling to provide recent information.

The status of the ungulate populations is poor and in most regions of monitoring unit ungulate densities do not exceed 1-3 elk and 2-3 wild boar per 1,000 ha. Given this situation, survival for tigers is difficult. Low ungulate densities have influenced hunting behavior of tigers, which has become atypical, with isolated wild boar herds being followed by 1-2 tigers. Low ungulate numbers are probably the main reason for the absence of tiger litters. Under such conditions females are simply unable to raise viable cubs. This was confirmed by the report of hunters that dead cubs were found, and that a female had apparently abandoned cubs 7-8 months old. In winter, such cubs left by female will usually die.

As an recommendation for monitoring methods, it should be noted that on the relatively flat western slopes of Sikhote-Alin range snow depth does not depend on aspect and topography very much. Snow depth depends more on canopy density. Probably in the future it will be reasonable to note canopy density in the places where snow depth is measured (and to write down this information into the diary). This is important because availability of food for ungulates (and as a result ungulate and tiger distribution over the territory) directly depends on snow distribution.

Survey results confirmed the presence of two or three resident males and three adult females in the monitoring unit. As we mentioned above no females with cubs as well as subadults were found.


TiGiS
Bikin 2000-2001
WCS
WILDLIFE CONSERVATION SOCIETY
Amur Tiger
Monitoring Program
2000-2001 winter
Tracks on routes
First survey
Second survey
Tracks off routes
1999-2001
Survey routes
River system
Forest type
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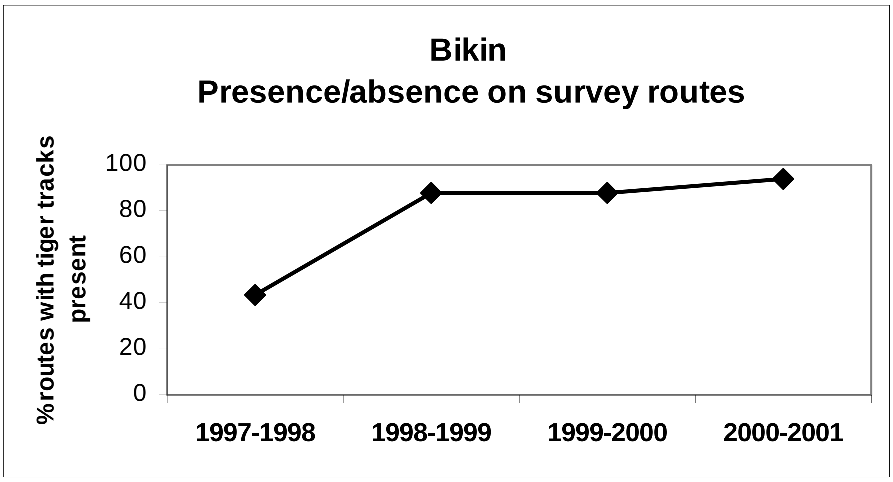
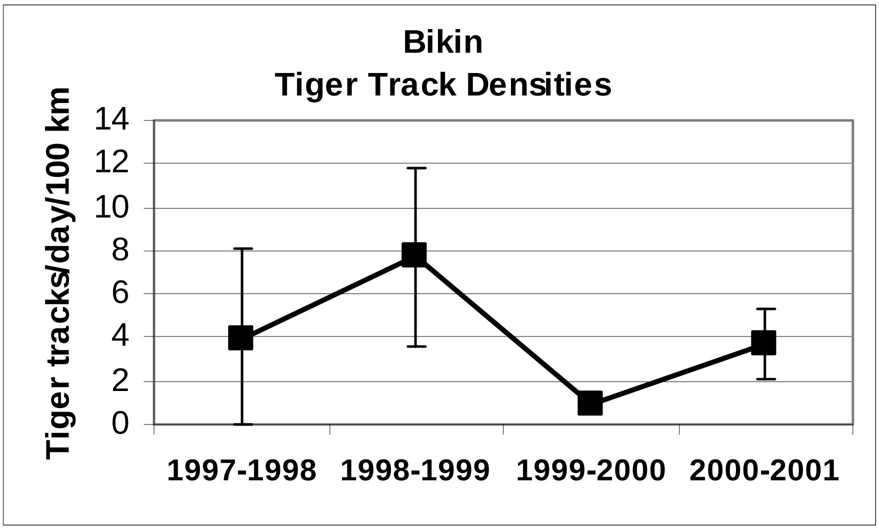
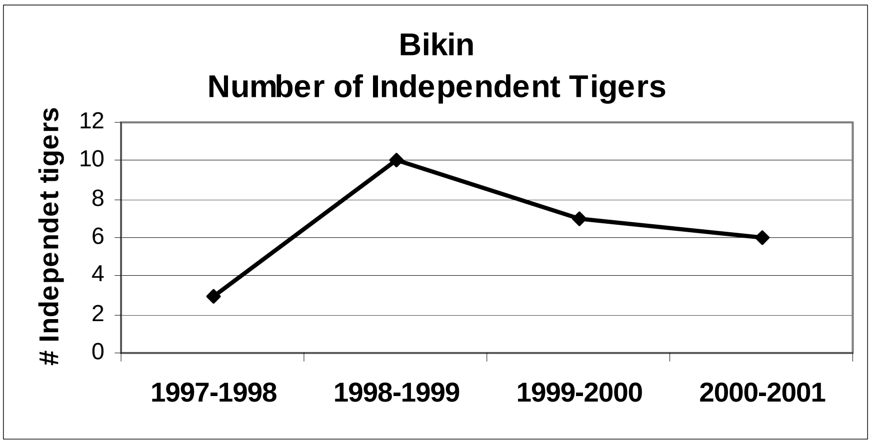


Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in monitoring site across years



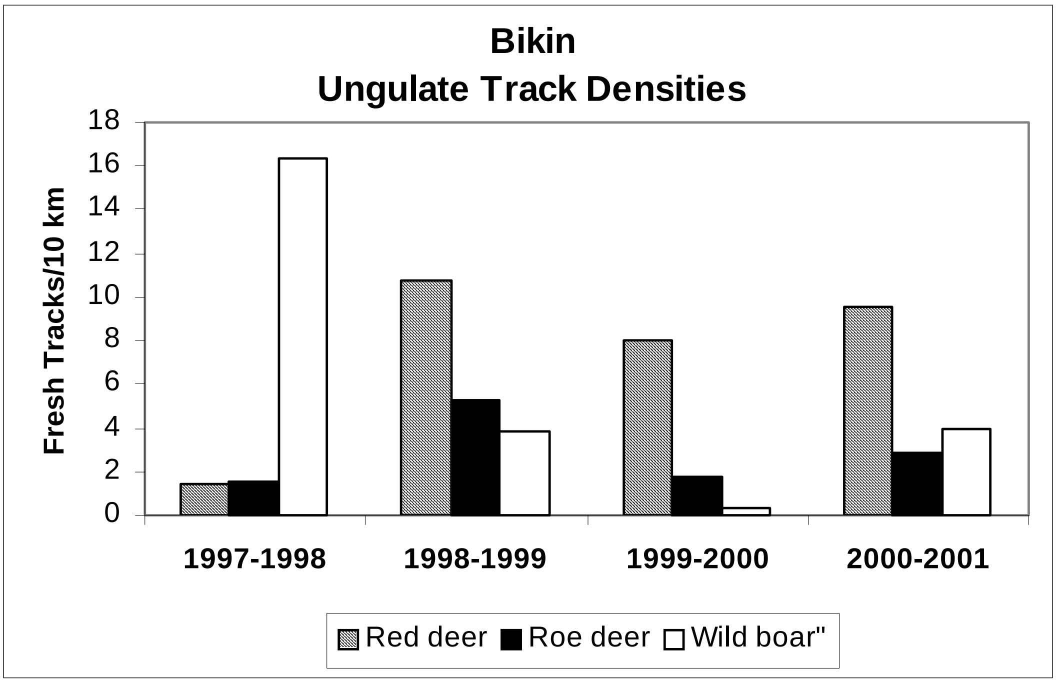
Number of Independent tigers (adults, subadults, unknown) on monitoring site

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
5	Bikin	2000-2001	2	4	0	0	0	0	6	6	6

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

		Prey		1997		1998		1999		2000		Grand Total	
#	Monitoring Site	species	n	mean	std	mean	std	mean	std	mean	std	mean	std
5	Bikin	Red deer	16	1.37	1.51	10.78	9.97	8.01	6.62	9.53	9.05	7.42	8.22
5	Bikin	Roe deer	16	1.49	1.91	5.30	3.03	1.74	2.85	2.88	3.15	2.85	3.11
5	Bikin	Sika deer	16	0.31	1.05	3.66	8.69	0.00	0.00	0.00	0.00	0.99	4.55
5	Bikin	Wild boar	16	16.32	61.21	3.80	4.56	0.30	0.65	3.97	5.83	6.10	30.70



SIKHOTE-ALIN STATE BIOSPHERE ZAPOVEDNIK AND TERNEY HUNTING SOCIETY

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

2000-2001

Report on results of Amur tiger monitoring program in SABZ and Terney Hunting Lease model units in winter 2001
Coordinator - E. N. Smirnov, Sikhote-Alin State Biosphere Zapovednik

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

2. Coordinator: Smirnov E. N.

3. Time of surveys: January 14-20, 2001
February 14-20, 2001

4. Numbers of routes: 1-52

5. Total length of routes: In January 556 km of routes were traveled on foot and 181 km - by vehicle.
In February – 342 km were traveled on foot and 198 km – by vehicle.

6. Conditions: Snow fell on the 10th of January and the count began on 14th of January. Snow cover did not exceed 30-40 cm. Conditions for the survey were favorable. In February the last snowfall was on the 2nd of February and the survey was conducted on February 14-20 in the presence of numerous tracks left on snow (mnogosleditsa). Snow cover, as in January, did not exceed 30-40 cm. Conditions for survey were favorable.

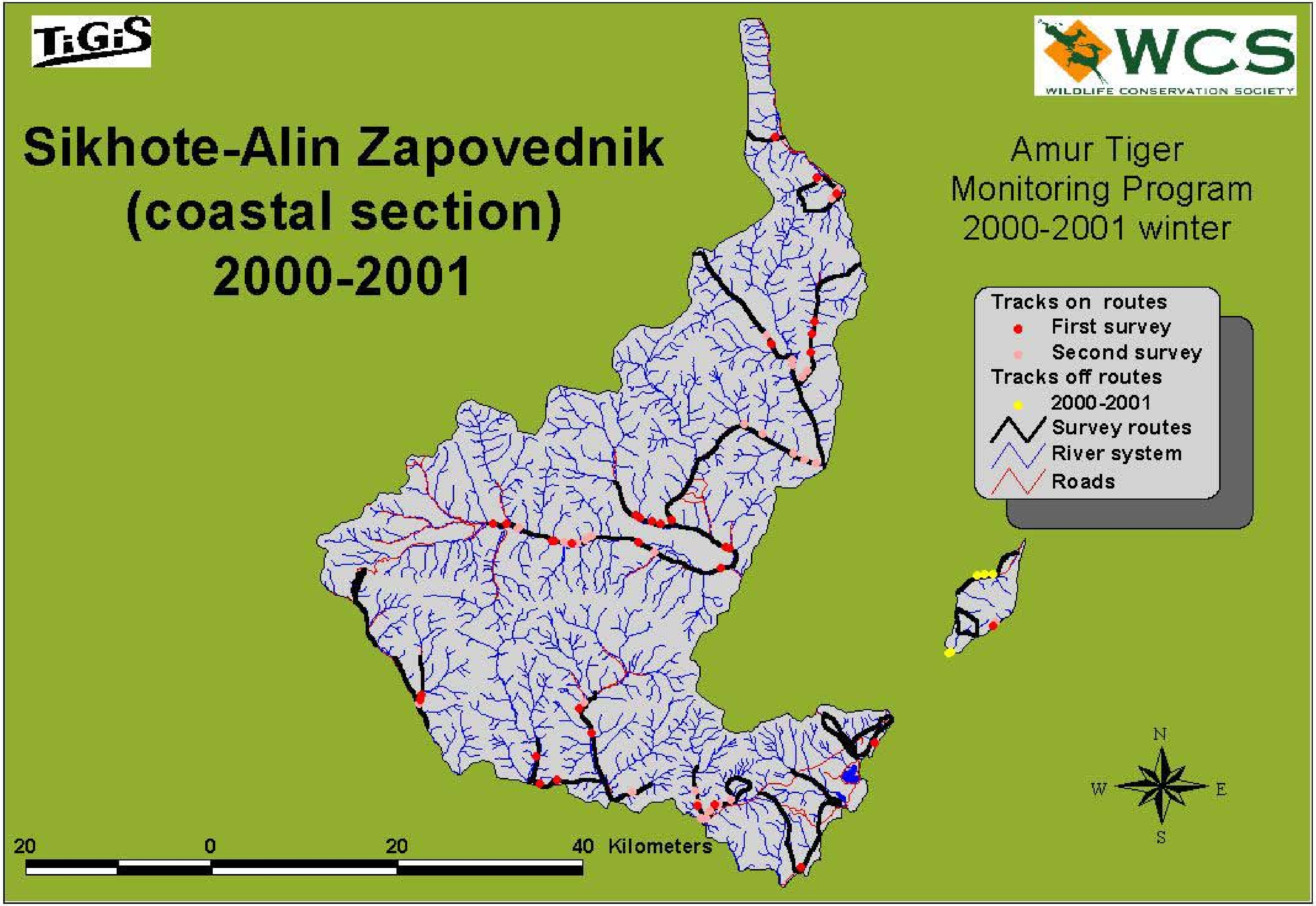
7. Assessment of efficiency: Both counts - in January and February - were successful. Not all forest roads were traveled completely because some of them were in poor condition or not plowed. And I hope they will never be cleaned out. Two routes (18 and 19) were not traveled because a trade hunter (the usual field worker) was absent there. But on the whole these changes did not influence picture of tiger and ungulate densities.

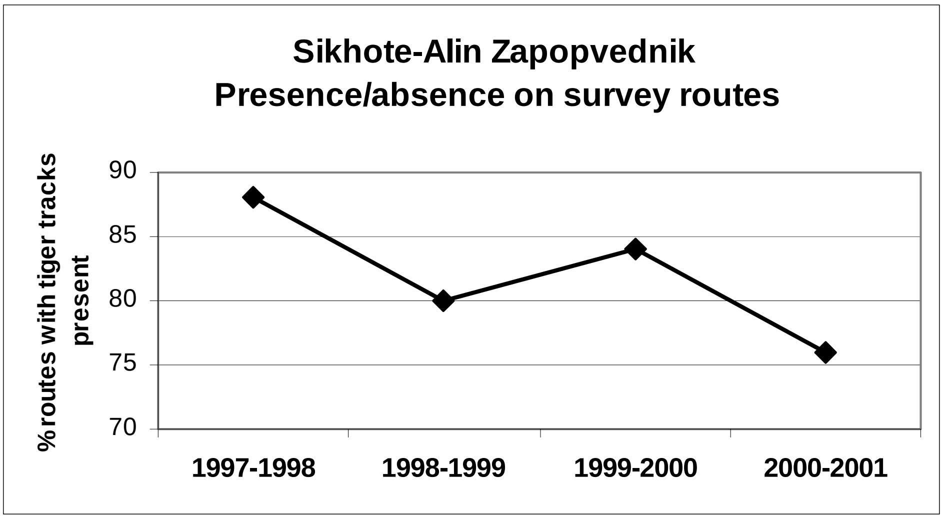
How to assess the efficiency of conducted survey? What are the criteria? Who is the judge? I wrote about it in my previous report. I do not want to repeat.

To my mind, no dramatic changes associated with habitat or wild animals have occurred in our model units (SABZ and Terney Hunting lease). I think that situation has been stable for all the years of monitoring (for wild animals). And what about Man - the situation becomes worse and worse. People grow poor, have no job and belief in the future, there is no social support. And to put it mildly - local people have became brutal. They are looking for ways to survive and find them in Nature. Whether we want to or not, we have to draw attention to people in small villages, situated in taiga – eventually the tigers' fate depends on them.

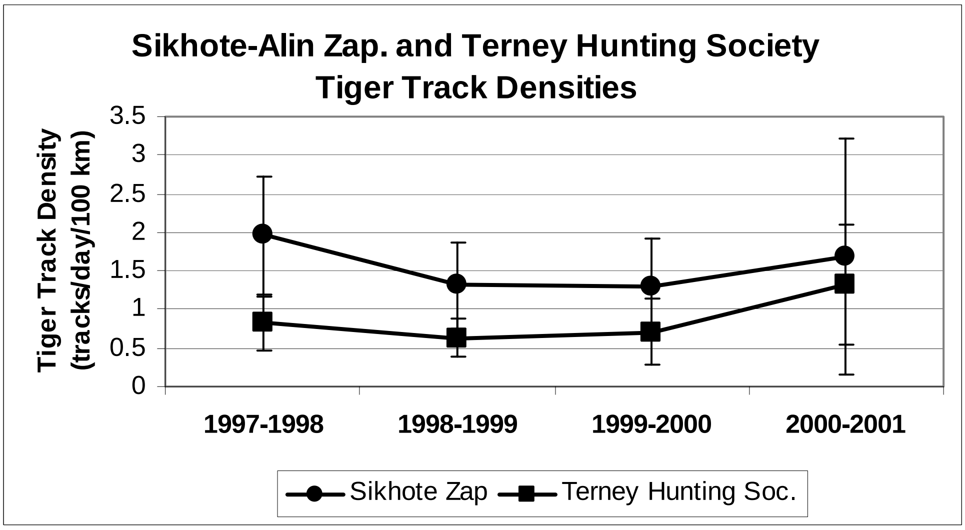
8. Conclusions:

In comparison with previous counts, no drastic changes were found. Status of habitat actually has not changed. Wild animals' density is at the same level. The results of our counts are far from absolute and depending on many factors can differ by order of magnitude. The most difficult situation is with local people. We can do little for them but we must. But this is the theme for separate conversation.

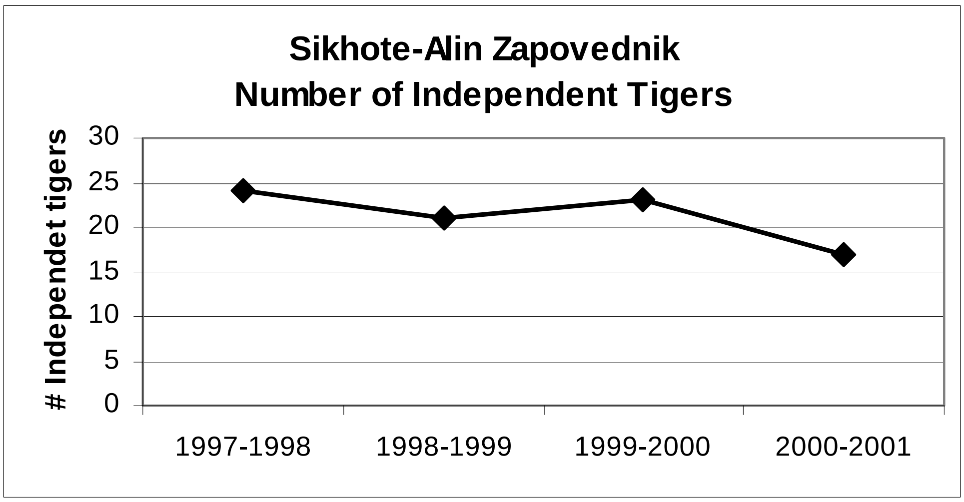

TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Sikhote-Alin Zapovednik
(coastal section)
2000-2001
Amur Tiger
Monitoring Program
2000-2001 winter
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
River system
Roads
N
W
E
S
20
0
20
40 Kilometers



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



Comparison of track densities in Sikhote-Alin Zapovednik and Terney Hunting Society, Terneiski Raion



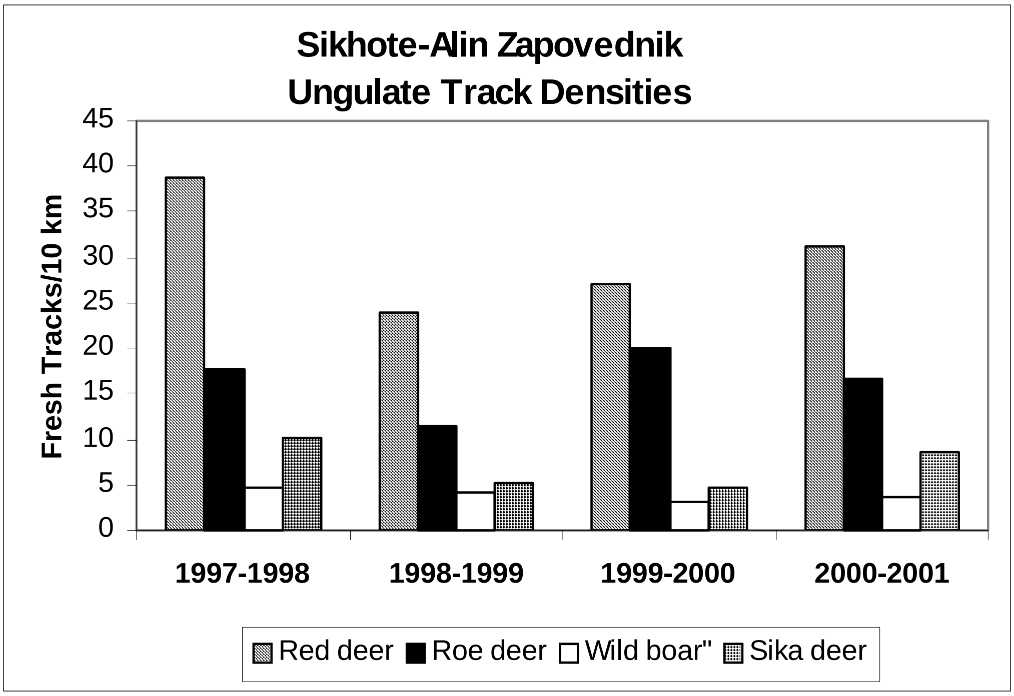
Number of Independent tigers (adults, subadults, unknown) on monitoring site

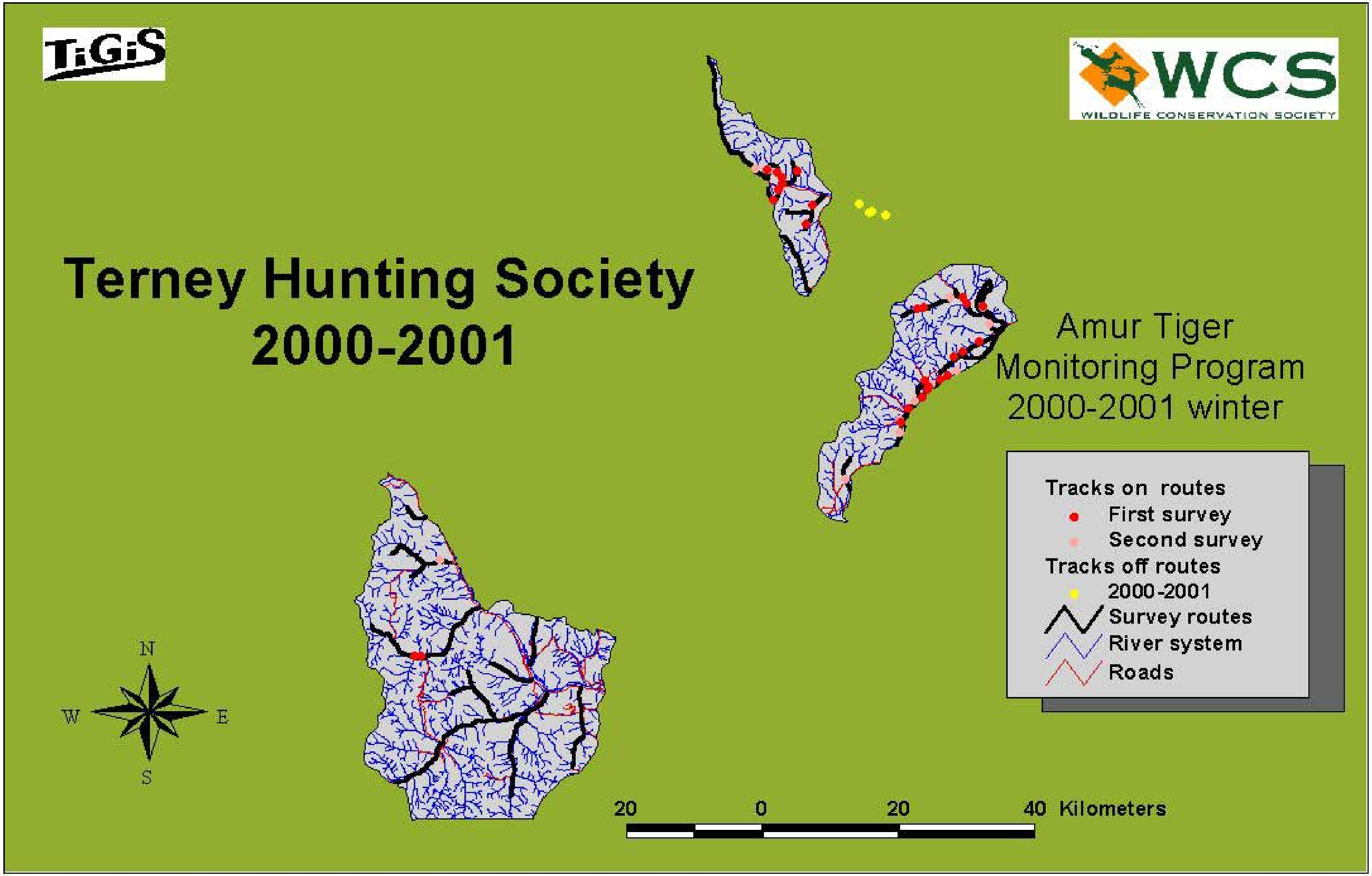
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independents*	Total (all tigers)
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
14	Sikhote-Alin Zap.	2000-2001	3	7	0	2	4	5	10	17	21

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

		Prey		1997		1998		1999		2000		Grand Total	
#	Monitoring Site	species	n	mean	std	mean	std	mean	std	mean	std	mean	std
14	Sikhote Alin Zapovednik	Red deer	25	38.86	56.83	23.98	16.71	27.02	22.64	31.28	16.80	30.28	32.79
14	Sikhote Alin Zapovednik	Roe deer	25	17.60	39.80	11.50	17.62	20.05	21.05	16.77	19.66	16.48	25.89
14	Sikhote Alin Zapovednik	Sika deer	25	10.24	29.29	5.18	12.45	4.68	12.59	8.71	22.33	7.21	20.26
14	Sikhote Alin Zapovednik	Wild boar	25	4.60	4.91	4.21	4.78	3.25	5.09	3.57	4.63	3.90	4.81




TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Terney Hunting Society
2000-2001
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River system
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N
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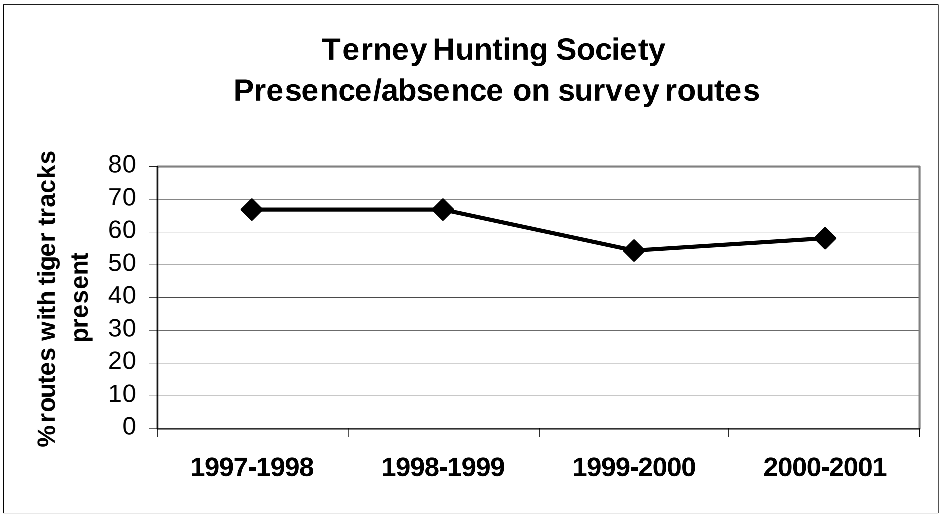
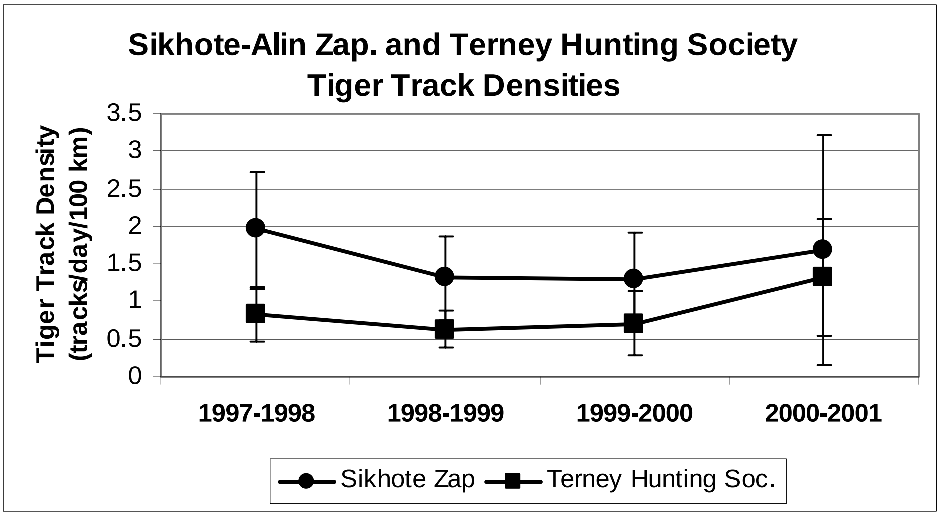
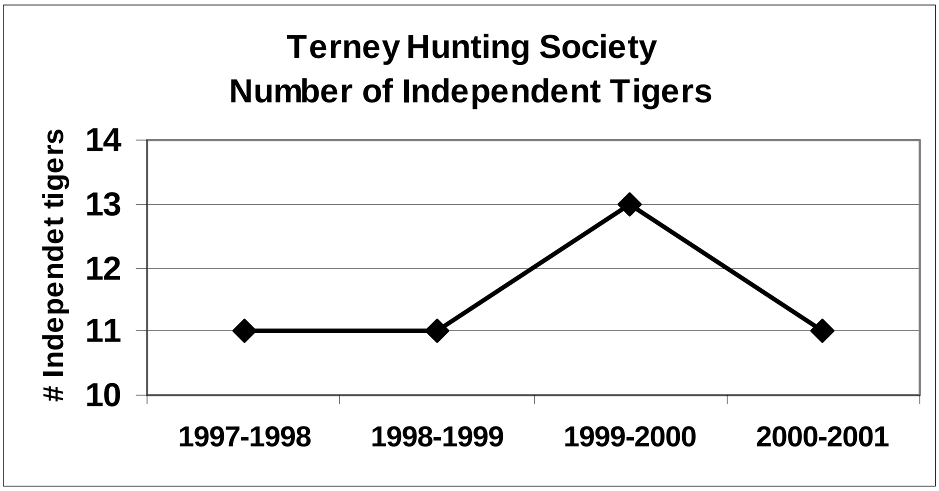


Percentage of routes with tiger tracks reported (both surveys combined).



Comparison of track densities in Sikhote-Alin Zapovednik and adjacent unprotected site in Terney Hunting Society, Terneiski Raion



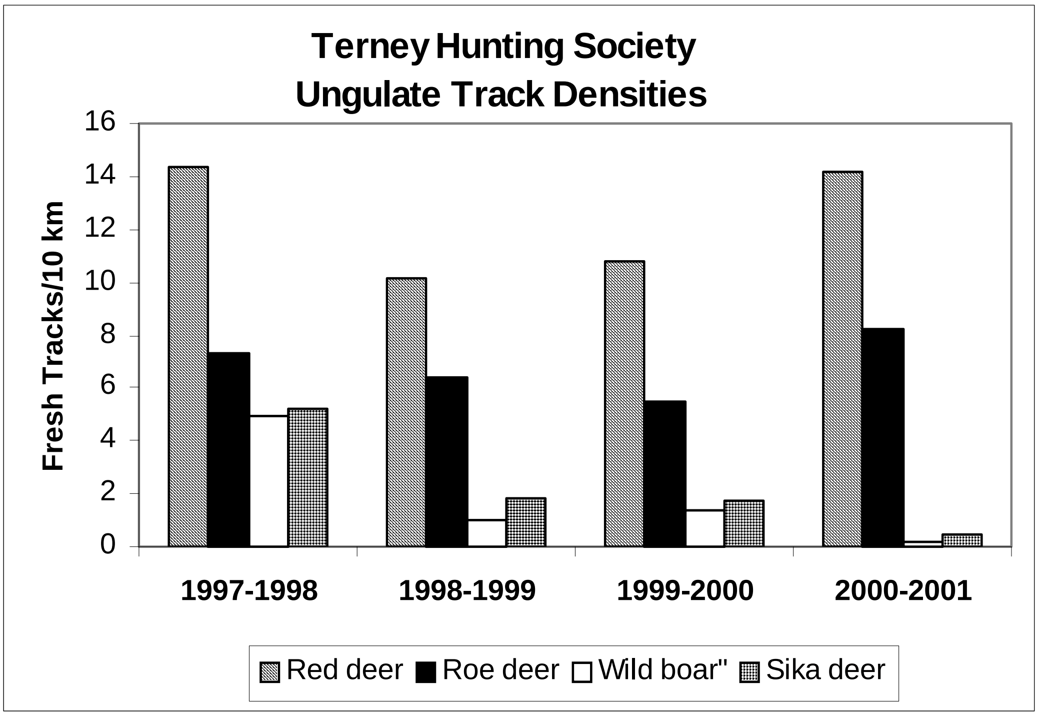
Number of Independent tigers (adults, subadults, unknown) on monitoring site

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)
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
16	Terney Hunting Soc.	2000-2001	3	3	0	0	1	5	6	11	12

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

#	Monitoring Site	Prey species	n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	2000 mean	2000 std	Grand Total mean	Grand Total std
16	Terney Hunting Society	Red deer	24	14.40	14.07	10.13	10.73	10.75	11.62	14.13	11.43	12.35	12.00
16	Terney Hunting Society	Roe deer	24	7.32	9.29	6.38	9.68	5.52	8.19	8.24	11.56	6.87	9.66
16	Terney Hunting Society	Sika deer	24	5.20	17.74	1.80	5.45	1.73	5.29	0.47	1.43	2.30	9.68
16	Terney Hunting Society	Wild boar	24	4.98	16.21	0.97	1.94	1.33	2.02	0.15	0.47	1.86	8.31



MATAI
KHOR
TIGRINI DOM
BOLSHE KHEKHTSIRSKI ZAPOVEDNIK
BOTCHINSKI ZAPOVEDNIK
Khabarovski Krai
2000-2001

Report on results of Amur tiger monitoring program in Khabarovski Krai in winter 2000-2001

Coordinator - Yu. M. Dunishenko
All Russia Research Institute of Wildlife Management, Hunting, and Farming

1. Introduction

The Amur tiger population monitoring survey in the 2000-2001 winter season in Khabarovski Krai was conducted without any methodology changes from previous years. The survey was done according to the schedule, except in Botchinski Zapovednik, where every year the first count is conducted in the second half of January, because it is impossible to do so earlier due to ice conditions on rivers, along which all routes are situated.

Survey conditions were favorable everywhere due to the depth of snow that accumulated later than usually. The absence of wind and snowfall in the first part of winter as well as good acorn crops changed ungulate distribution among habitat types, resulting in greater tiger activity in November, when all roads were littered with tigers tracks. By December this activity abruptly decreased as wild boar movements ceased and intense cold weather had set in.

The second part of winter was abnormally cold. Mean daily temperatures were lower than mean annual (average long-term) temperatures by 7-8^{o} and snow depth was insignificant up to the end of February. Snow was frozen hard, crunching at every step, and there was not muffling of the rustle of frozen leaves. While walking the "crunch" could be heard in frozen dense air over hundreds of meters. Consequently, the ability of predators to stalk prey was dramatically decreased, making it almost impossible to kill elk, while wild boar were distributed in oak habitat mostly outside of tiger range. Even for human hunters it was difficult to find herds that stayed in confined areas. Therefore, these were very difficult conditions for tigers, especially for young and females, which lactated in spring and summer. They had difficulty acquiring sufficient energy to make it through the difficult winter periods. Therefore, predators often traveled along the roads and into settlements in search of food.

Among other characteristics, we should mention that snow cover was uneven in February in Botchinski monitoring unit. Maximum snow depths occurred along the seashore and in the middle basin of the Botchi River, contrary to the norms when upper basins accumulate the most snow.
On the whole all routes were traveled completely and the survey was done as usual (Tables 1.1. and 1.2.)

Table 1.1. Survey schedule and workload in monitoring units, 2000-2001 winter season

Monitoring unit	Time of survey		Number of field-workers	Total length of all routes traveled during 2 counts	Kilometers traveled per 1,000 ha			
	1st count	2nd count			2000-2001	1999-2000	1998-1999	1997-1996
Matai	Dec. 10-30	Feb. 14-Mar. 7	5	754	2.95	2.95	2.81	2.9
Khor	Dec. 18-23	Feb. 17-25	5	478	3.63	3.39	2.96	2.42
Khekhtsir	Dec. 20-22	Feb. 20-21	18	140	3.1	3.1	3.1	3.0
Tigrovy Dom	Dec. 18-27	Feb. 11-25	3	384	1.82	1.82	1.83	1.38
Botchinski	Jan. 14-16	Jan. 21-25	7	320	1.04	1.04	0.95	1.13
			38	**2076**	**2.19**	**2.15**	**2.02**	**1.93**

Table 1.2. Work conducted during tiger monitoring program, winter 2000-2001

Monitoring unit	Area, thousand ha	Number of routes	Total length of routes, km		1st count			2nd count		
			1st count	2nd count	vehicle	snow-mobile	on foot	vehicle	snow-mobile	on foot
Matai	255.4	24	377	377	163	73	141	148	167	62
Khor	131.5	21	239	239	175	12	52	146	29	64
Khekhtsir	45.1	7	70	70	0	0	70	0	0	70
Tigrovy Dom	210.7	14	192	192	116	-	76	105	-	87
Botchinski	307.0	14	160	160	20	89	51	0	109	51
Total	949.7	80	1038	1038	474	174	390	399	305	334

Note: route length was measured with curvimeter and may differ from computer variant

Suggestions for improving organization of work are the same:

1. To reduce the area of Botchinski monitoring unit. To increase the number of routes and not to conduct the count in January.
2. To correct mistakes in Field diary that were repeatedly discussed: point 11 - to replace "Snow depth after last new-fallen snow" with "Depth of last new-fallen snow". Table 1, column 10 - to replace "Snow depth where track was left" with "Depth of track". To make corrections on the picture: front paw is behind.

All these defects cause alternative versions and mistakes.

2. Tiger prey base

In Khabarovski Krai three ungulate species are the main tiger prey in winter: elk, wild boar and roe deer. We have no recent reports of tigers hunting on musk deer or moose, which both occur mostly outside of tiger range.

Elk. Data obtained from hunting leases in tiger range would lead us to believe that the elk population is stable or increasing. However, the following pattern has been observed - the more hunting leases that are created, the more elk number are registered in reports. This relationship is apparently an attempt to inflate elk numbers in order to obtain more hunting licenses (which are based on percentage yield of the existing population). And unfortunately, it is impossible to check the reliability of this count data, because we have no primary data and no funds to conduct control counts.

Therefore the information annually obtained from 80 monitoring routes is the most reliable available, because these data are collected by qualified and unprejudiced specialists. If we assume that, for the most part, the number of animals encountered on monitoring routes reflects population dynamics, then it can be seen that elk numbers are dramatically decreasing over the entire territory (Table 2.1.). Within past three years elk population decreased by 48% (i.e. 16% per year) in zapovedniks and by 64.4% (21.1% per year) on trade hunting territories. Such widespread decreases are unlikely, but nonetheless are confirmed by other information. Table 2.2. shows that the difference in elk encounters on the routes between the first and second counts (separated by two months) in 2000-2001 was 12.5%, while between the two counts in 2000 the difference was 8.5%. In other words 4.25 - 6.25% for one winter month or 21.5 - 31.2% for 5 winter months. These figures are similar to our calculations above. Reduction in elk numbers can occur not only due to a decrease in population density, but also due to a reduction in range, which also appears to be occurring, based on data on elk encounters (Table 2.3.). In 1998, elk occupied 86.2% of the area of monitoring units, while in 2001 its distribution had decreased by 10%.

We are not inclined to think that the status of the elk population is so disastrous because we do not have enough information to be absolutely sure about our conclusions. Nevertheless, we have other information that confirms that a yearly decline in elk numbers by 4-8% is occurring. The situation is different in different regions, as we can see from Tables 2.1, 2.2. and 2.3., but it is evident that the status of a primary tiger prey species is far from good. The reason of this tendency appears to be that winter mortality is not adequately compensated for by growth.

Table 2.1. Wild ungulates encountered (individuals per 10 km of route) in total of two counts during different years

Monitoring unit	Elk			Wild boar			Roe deer		
	1998-1999	1999-2000	2000-2001	1998-1999	1999-2000	2000-2001	1998-1999	1999-2000	2000-2001
Matai	4.68	3.63	1.64	1.07	2.07	1.31	2.51	2.08	1.24
Khor	5.82	3.18	2.99	0.77	0.22	1.56	6.56	2.20	1.78
Khekhtsir	16.64	14.57	10.57	3.21	0.78	1.28	1.36	0.14	1.0
Tigrovy Dom	4.69	1.20	0.94	0.83	0.96	0.34	0.91	0.31	0.23
Botchinski	7.94	4.25	2.21	0	0	0	3.49	2.75	3.34
Total	6.28	3.52	3.67	0.95	1.05	0.9	3.07	1.74	1.51

Table 2.2. Wild ungulates encountered on routes during winter season 2000-2001

Monitoring unit	Number of individuals 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	1.06	1.06	0.93	3.05	2.23	1.56	1.56	5.35	+75.4
Khor	2.63	3.01	2.26	7.9	3.35	0.12	1.30	4.77	-39.6
Khekhtsir	12.14	2.43	0.86	15.43	9.0	0.14	1.14	10.28	-33.3
Tigrovy Dom	1.2	0.47	0.21	1.88	0.68	0.21	0.26	1.15	-38.8
Botchinski	2.56	0	4.06	6.62	1.87	0	2.62	4.49	-32.2
Total	3.92	1.39	1.66	6.81	3.43	0.41	1.37	5.21	-23.5

Table 2.3. Wild ungulates encountered on routes during February of each year

Monitoring unit	Number of routes (%) with ungulate tracks											
	elk				wild boar				roe deer			
	1998	1999	2000	2001	1998	1999	2000	2001	1998	1999	2000	2001
Matai	90.0	91.7	75.0	83.3	60.0	37.5	66.7	54.2	90.0	83.3	79.2	83.3
Khor	82.3	82.3	47.6	66.7	17.6	17.6	9.5	14.3	52.9	52.9	38.1	42.8
Khekhtsir	85.7	100	85.7	100	0	14.3	14.3	14.3	28.6	28.6	0	42.8
Tigrovy Dom	90.0	92.8	64.3	57.1	20.0	21.4	0	21.4	40.0	21.4	7.1	21.4
Botchinski	85.7	100	100	85.7	0	0	0	0	100	57.1	42.8	71.4
Total	86.2	92.1	71.2	76.2	18.9	21.0	23.7	25.0	65.5	55.2	52.5	55.0

Wild boar. The same data indicate that the wild population appears to be stable or increasing. The area occupied by wild boar increased by 32.2% since 1998 (on average by 8% each year, see Table 2.3.), and the number of tracks increased each year (in 1997-1998 it averaged 0.7 tracks per 10 km of route). However, the reduction (loss) between winter months (from first to second count) varied from 52.3 % to 75.5% (based on number of animals found on routes). Such considerable mortality can not be compensated for by effective growth rates, which are mostly consumed by predators. Hunting is also a significant impact, since there are distinct preferences for killing females. Tigers act more wisely - they usually prey on piglets and young boar first.

In November wild boar were more abundant than the past winter, but its numbers were reduced very quickly because, in addition to predation, limited hunting was allowed (actually it was hunting was essentially unlimited due to poor protection capacity). Nevertheless, we think that population is increasing because food was abundant and the winter was favorable for animals.

Winter roe deer numbers probably were more or less stable at their low levels (see Tables 2.1, 2.2, 2.3). Our prognosis is that that abundant food and favorable winter conditions will change this trend and result in an increase in numbers, if there is not severe mortality associated with heavy snowfalls that took place all over the territory in March.

Thus according to the estimates of total encounter rates of ungulates on routes in December and February a tiger could find 10.3 tracks (per 10 km of route) of potential prey in 1998-1999, 6.71 tracks in 1999-2000, and 6.08 tracks in 2000-2001. This translates into an overall decrease of 41% during 3 years, 13.6% per year. If these figures are converted into available biomass this change decreases in amount, but is still significant – no less than 8% a year.

We conclude that it is necessary to conduct an inventory of tiger prey resources and, based on the results, develop specific recommendations for recovery of ungulate populations, in coordination with the interests of hunting industry. If such measures are not taken, we believe the tiger population will begin a progressive decline.

3. Changes in habitat

Monitoring changes in habitat is a supplemental part of the monitoring that cannot be obtained during data collection on routes. To get this information requires a great amount of additional work to visit logging areas and forest districts, and (in view of intensive illegal logging trade), to make a field inventory because official data on habitat changes are largely unreliable. Moreover, the Forest Service districts do not provide official data for a variety of reasons. Consequently, we cannot guarantee the accuracy of information we give in this report (Table 3.1.).

Table 3.1. Changes of tiger habitat in winter 2000-2001

Monitoring unit	Human impacts					
	New roads construction, km		Number of logging areas		Logging area, ha	
	2000	2001	2000	2001	2000	2001
Matai	24	52	27	65	2,002	2,500
Khor	16	-	10	7	850	260
Khekhtsir	0	0	0	0	0	0
Tigrovy Dom	0	0	7	13	520	50
Botchinski	0	0	0	0	0	0
Total	40	52	44	85	3,372	2,810

The most serious changes in tiger habitat have occur due to an increased demand for oak wood, and consequent increasing in logging of oak forests. Ash and lime (basswood) are also logged, as well as pine (whenever it is possible).

All these species grow in quality tiger habitat, which were further damaged by logging of pine. Therefore, the best habitats, i.e., those areas where good tiger reproduction could occur, are being destructed. Despite its status as a zakaznik, much of the forest in the Matai river basin is being logged. Habitat tracts situated along the newly created Khabarovsk-Nakhodka highway is deteriorating quickly, and may likely result in fragmentation of the existing tiger range.

Logging goes on in other areas as well, with the primary targets being the most valuable tree species. Of most concern is logging of oak trees. A decrease in the number of mature oak trees will surely lead to negative changes for wild boar, elk and roe deer populations for whom acorns represent a key forage for fat accumulation and successful overwintering.

Forest roads are in a constant state of flux, and it is nearly impossible to monitor them because loggers are constantly moving.

On the whole, forests have been logged for a 100 years in all monitoring units except zapovedniks and their appearance is far from that of the primeval virgin Ussuri taiga. Productive habitat, where potential tiger prey is abundant, represents is less than 20% of all forests. And even in this habitat "abundance" is relative and by an order of magnitude less than it was 50-70 years ago.

Recovery measures are necessary equivalent to deterioration size.

4. Results of tiger numbers monitoring

According to the information received from different parts of tiger range it appears that tiger numbers have decreased greatly in comparison to last year. Tigers were not observed in upper reaches of Katen, 10 km up from the mouth of the Chuken, nor in the mouth of the Sukpay area, and only single individuals were found along the right bank of Khor above Kutuzovka village. It appears that the range has been reduced in the east as well, and an expected growth of the population in primary habitat did not occur.

Within the monitoring units, the number of tigers is virtually unchanged (Table 4.1), except in the Matai, where tiger numbers are reduced. In the beginning of March, there were five tigers here, but between March 15-18 one tiger, which attacked dogs in Dolmi village, was shot.

Table 4.1. Tiger numbers and density in monitoring units in different years

Monitoring unit	Number of registered tigers				Population density per 100,000 ha			
	1998	1999	2000	2001	1998	1999	2000	2001
Matai	5	5	5	4	1.96	1.96	1.96	1.57
Khor	2	4	4	4	1.52	3.04	3.04	3.04
Khekhtsir	2	2	1	1	4.43	4.43	2.21	2.21
Tigrovy Dom	2	5	5	5	0.94	2.37	2.37	2.37
Botchinski	3	4	6	6	0.98	1.3	1.95	1.95
Total	14	20	21	20	1.47	2.10	2.21	2.10

It is necessary to mention that data obtained during survey in monitoring units are supplemented by additional information and appear to be quite accurate. So the annual increase of number of tiger tracks found on routes cannot be explained by a growth in tiger numbers but by their extensive movements (due to the lack of prey) and favorable conditions of the survey.

Table 4.2. The number of tiger tracks less than 7 days old

Monitoring unit	1st count				2nd count			
	1997	1998	1999	2000	1998	1999	2000	2001
Matai	7	5	6	13	6	4	20	19
Khor	8	14	15	5	15	3	3	10
Khekhtsir	8	3	1	0	1	4	1	2
Tigrovy Dom	6	7	6	16	6	13	8	11
Botchinski	4	8	7	7	7	6	6	13
Total	33	37	35	41	30	38	47	55

Insignificant changes in tiger numbers within monitoring units (despite the repeated reports of population decreases in other parts of its range) are probably explained by the specific location of monitoring units, which occupy the best tiger habitat. But on the whole, we will be able to better assess the population status after our survey next year, because this year the conditions were very poor and the animal mortality rate was extremely high.

A unique situation has developed on the eastern macroslopes of the Sikhote-Alin, where elk and roe deer numbers have risen for the past 8 years due to the absence of deep snow (which usually causes ungulate mortality). Stable prey resources support a stable tiger population, which disperses from year to year.

5. Tiger population structure

At the beginning of the winter season an increase in litter size had been observed all over the range. Females with 2-3 cubs were found often, and there were more females with cubs. However, by the end of the season virtually all of them had died. Therefore, population structure at the end of February 2001 was as follows:

Table 5.1. Tiger population structure in winter season 2000-2001

Monitoring unit	Males	Females without cubs	Females with cubs	Cubs	Unknown sex and age	Total
Matai	2	1	0	0	1	4
Khor	1	1	1	1	0	4
Khekhtsir	0	1	0	0	0	1
Tigrovy Dom	2	0	1	1	1	5
Botchinski	3	0	1	2	0	6
Total	8	3	3	4	2	20

But according to the information obtained during 4 years of the monitoring program there has been a significant reduction of the percentage of cubs in the population (Table 5.2).

Table 5.2. General changes of tiger population structure in monitoring units during different years

Monitoring unit	1997-1998		1998-1999		1999-2000		2000-2001	
	Ind.	%	Ind.	%	Ind.	%	Ind.	%
Matai	4	28.6	6	30.0	8	38.1	8	40.0
Khor	3	21.4	1	5.0	2	9.5	3	15.0
Khekhtsir	2	14.3	5	25.0	4	19.0	3	15.0
Tigrovy Dom	4	28.6	5	25.0	5	23.9	4	20.0
Botchinski	1	7.1	3	15.0	2	9.5	2	10.0
Total	14	100	20	100	21	100	20	100

From these data it can be seen that in the past 4 years the percentage of cubs in the population has decreased by 30.1%, on average by 7.5% annually. It is reasonable to believe that not only cub numbers are decreasing, but the entire tiger subpopulation in Khabarovsky Krai. If the situation does not change then rate decrease will reach the same level in 2-3 years because population growth during the past years has hardly compensated for animal mortality. In any case, population growth was not observed.

As we said above, an insignificant growth of litter size has been observed during the past two years. Information obtained from the monitoring units also provides evidence for this fact despite the small amount of data (Table 5.3).

Table 5.3. Data on tiger litters in monitoring units, winter 2000-2001

Monitoring unit	Number of adult females		Total number of cubs in litters	Mean litter size				
	With cubs	Without cubs		1996	1998	1999	2000	2001
Matai	0	1	0	-	2.0	1.0	2.0	0
Khor	1	1	1	-	-	-	-	1.0
Khekhtsir	0	1	0	-	1.0	1.0	-	0
Tigrovy Dom	1	0	1	-	-	1.0	1.0	1.0
Botchinski	1	0	2	-	-	1.0	1.0	2.0
Total	3	3	4	1.67	1.5	1.0	1.25	1.33

We are concerned that since 1999 the number of females with cubs has been steadily decreased (on average by 13.5% annually). The number of females without cubs has increased proportionally (from 5% to 15% for 3 years!). At present 50% of females either do not reproduce or had lost their cubs by the beginning of February. At the same time, the percentage of adult males is increasing in the population. Since 1998, their contribution to the population has increased from 28.6% to 40% and now the sex ratio between mature (adult) tigers is not conducive to high productivity. Population reproductive potential has decreased distinctly. This is either a sign of the beginning of a long-term trend towards population decrease or the result of a temporary reduction in prey resources. But the cause may have more serious reasons which could threaten survival of the species, including progressive habitat deterioration. In any case low productivity is an extreme alarm signal, which is more reliable than data on tiger numbers and which warns us about a possible population collapse. In connection with this, it is necessary to conduct a full survey of the entire tiger range, and to develop specific conservation recommendations, which will be able to reduce the rate of decline, even if it will be impossible to prevent it. At this stage, primary attention should be paid not on control of poaching.

6. Monitoring of tiger range

Based on inventory of the entirety of tiger range at the end of 2000, total area was 3,815,300 ha, which was an increase of 452,000 ha in comparison with the 1996 tiger census. Expansion of tiger range occurred mostly due to dispersal of tigers to the north on the eastern macroslopes of Sikhote-Alin and in the Gur River basin. All existing semi-isolated tiger groups still remain.

7. Monitoring of tiger mortality

Within the Khabarovsk part of tiger range during 2000-2002 winter season the following cases of tiger deaths and removal from the wild were recorded:

1. Three cubs 8-9 months old (two males and one female) died from starvation and cold in Bolshe Khekhtsir Range. The adult female could not feed them despite the high elk density. She often killed dogs in adjacent settlements but could not save her cubs. At last, she left the male cubs that could walk yet near the cabin of game inspector V. Koval and brought the dying female cub to a dog she had killed. The female cub died while the tigress was carrying her. One male cub was

taken by a game inspector and transported to the Khabarovsk rehabilitation center, where he died in 24 hours. The second male cub died near the cabin.
2. A young male was caught in Svyatogorie village in kennel, where he was killing and eating dogs and refused to leave the area. He was moved to the Khabarovsk rehabilitation center.
3. A tiger cub 7-9 months old was picked up near Lermontovka village, in an extremely emaciated condition. He is now in the Khabarovsk rehabilitation center.
4. A young tiger was poached in Dolmi village. The place of death was found but it was completely inundated by an overflow on the ice, eliminating any investigation.
5. A tiger cub of approximately the same age was brought to the rehabilitation center from Nanaisky raion at the end of March 2001.
6. Last year's monitoring report did not contain information about a tiger cub that was caught in summer 2000 in Troitskoe village. She was emaciated and came to the bank of the Amur river. This female cub is also in "Utyos" rehabilitation center now.

Thus, we know for sure about eight tigers withdrawn from the wild. Moreover, it was reported (but not verified) that two more cubs died in Vyazemsky raion and one cub in Lazo raion.

Probably several tigers were poached in other areas because in there was snowfall in March and snow depth was from 40 cm in the southern part of range to 87 cm the northern part of range. Such deep snow could force tigers out onto roads and into settlements. Probably other cubs (especially very young) also died. Such a significant loss/mortality will have a considerable impact on the status of this population , especially because most reproductive females sustained a loss.

It is necessary to mention that this is the first time such an unfavorable combination of winter conditions was observed during the 4-year monitoring program. And we arrive at rather unexpected conclusions: that extremely cold weather with low snow cover has a greater impact on tigers than high snow cover with normal temperatures. Probably tiger mortality would have been much less if wild boar was more abundant.

8. Conclusions and recommendations

The work on monitoring the tiger population in Khabarovski Krai was conducted according to the established methods and schedule. The available information indicates that prey resources continue to decline. Elk numbers are decreasing by 21.5-31.2% each winter, and this decline is not completely compensated by population growth, resulting in an overall negative balance. The area occupied by tigers is shrinking except on the eastern macroslopes (coastal areas) of the Sikhote-Alin.

The same situation exists with roe deer population, which has been consistently decreasing within tiger range during four past years. We hypothesize that beginning in 2001 population trend will change for the better.

Stable growth of wild boar numbers (on average 8% annually), which has been occurring since 1998, is constrained by high mortality during the winter season (from 52.3% to 75.5% based on the difference in track encounters) and cannot compensate for the lack of prey resources. An overall reduction of tracks found on routes is averaging 13.6% annually and, converting to biomass, the total reduction of animals is about 8%.

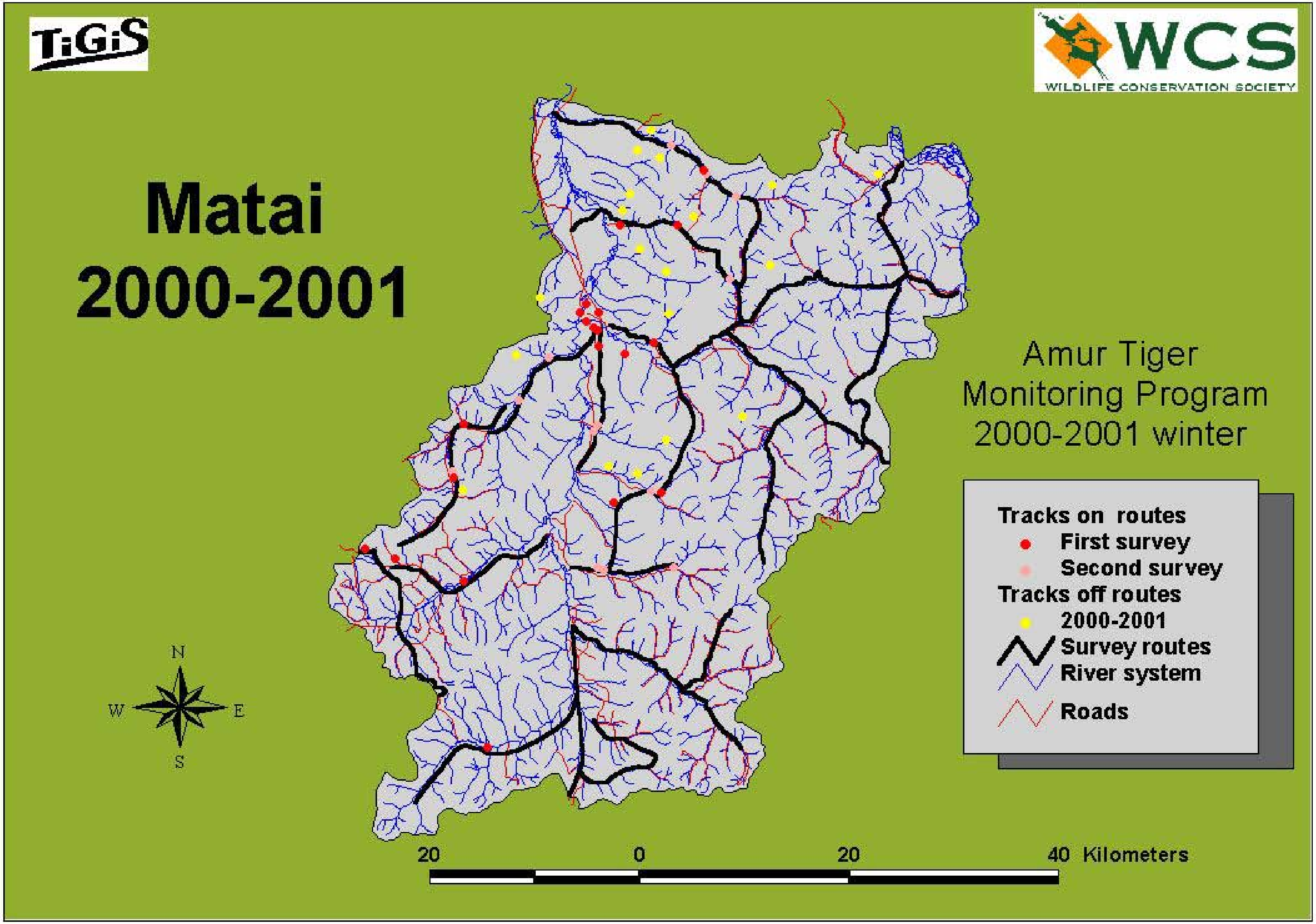
Habitat deterioration continues and is aggravated due to intensive logging of oak forests, which provide food for wild boar, elk and roe deer.

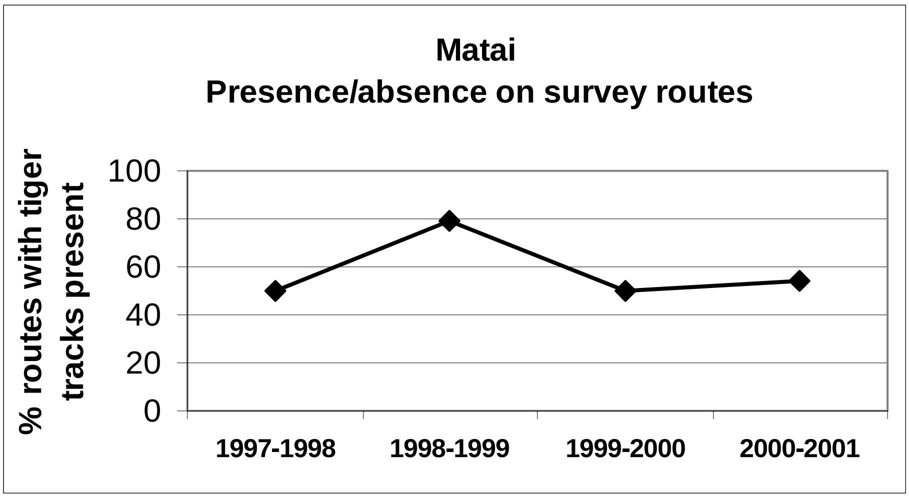
Habitat deterioration may also be responsible for a reduction in the tiger population, which is confirmed by negative changes in its population structure. During the past four years the percentage of cubs in the population has been constantly decreasing (on average by 7.5% annually), which approximates an equal reduction in prey resources. The percentage of females with cubs which survive through February, has been decreasing for three years from 25% to 15%. The sex ratio of adult tigers is not skewed in favor of males, reducing the potential for reproduction, but such changes are consistent across the range. Range expansion to the north continues on the eastern macroslopes of Sikhote-Alin, resulting in an increase of the total area populated by tigers up to 9,815,300 ha. However, this increase in area will not help the tiger population because the potential prey are under the constant threat of overwinter mortality associated with deep snow.

In addition these the general negative trends, the number of tigers has significantly decreased due to extremely cold weather, and a great number of cubs and young animals have died. Death of eight tigers has been officially recorded.

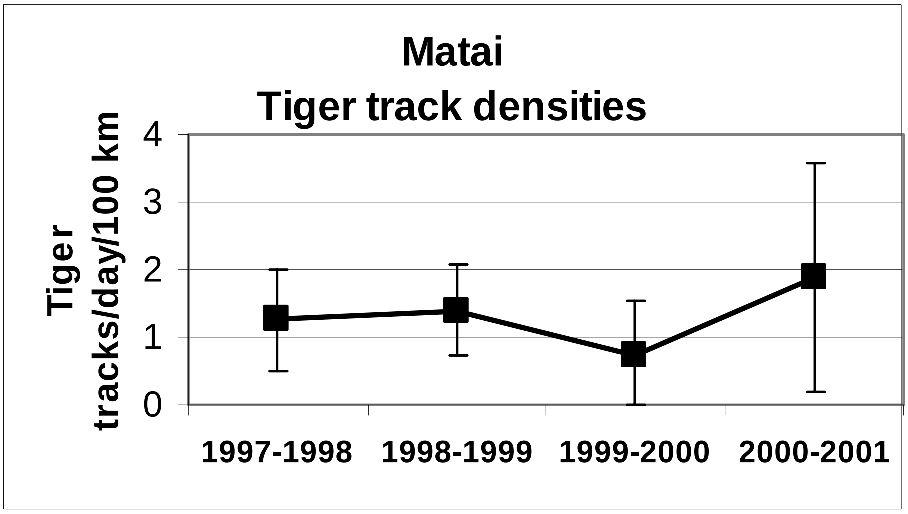
To improve the situation it is necessary:

1. to begin preparations and search for funds for a complete survey of tigers and ungulates;
2. to develop a long-term recovery program for elk, wild boar and roe deer populations and to initiate it immediately;
3. to redistribute the allocation of funds for Amur tiger conservation. Prey base recovery actions should be financed first of all, in the second place habitat conservation should be financed and poaching patrol should be considered third;
4. to remind the Government of Russian Federation about National Strategy of Amur tiger conservation and to request funds for realization of its most important sections;
5. to prohibit hunting for wild boar in Khabarovski and Primorski Krais for 2-3 years;
6. to draw attention of non-governmental nature protection organizations and mass-media to intensive logging of oak forests and to provide adequate control of its export to adjacent countries;
7. to establish the regulations for obligatory environmental assessments (expertisa) of nature use in tiger range and to use funds (obtained as compensation for damage) for realization of the national strategy of tiger conservation.

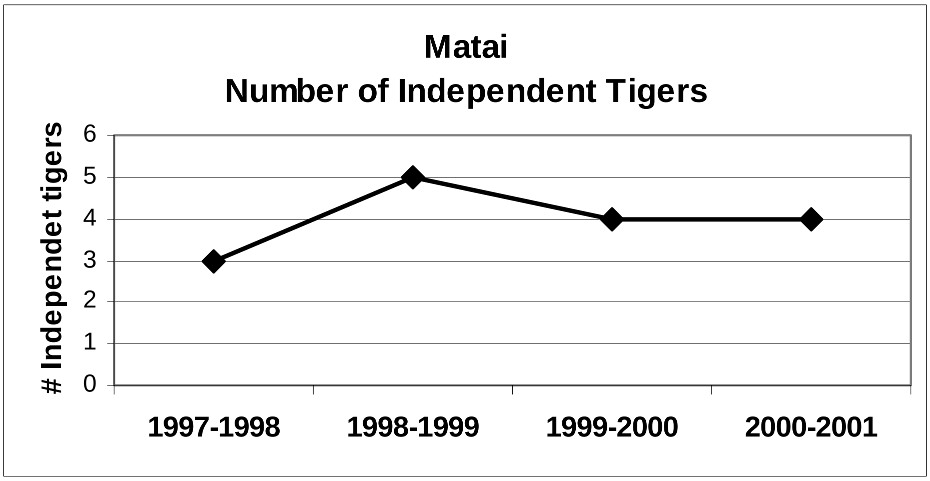

TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Matai
2000-2001
Amur Tiger
Monitoring Program
2000-2001 winter
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
River system
Roads
N
W
E
S
20
0
20
40 Kilometers



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



Comparison of track densities in monitoring site across years



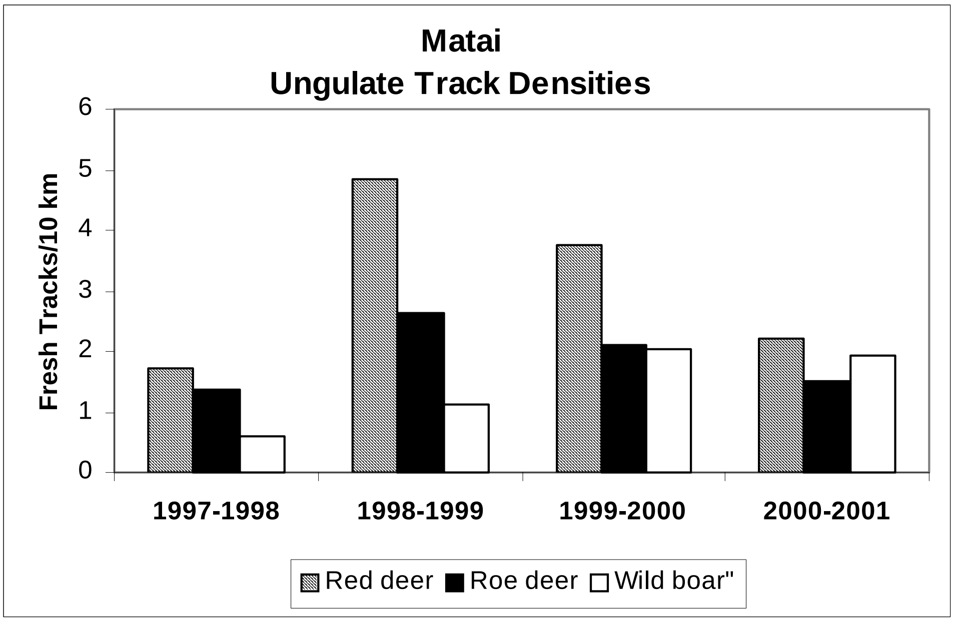
Number of Independent tigers (adults, subadults, unknown) on monitoring site

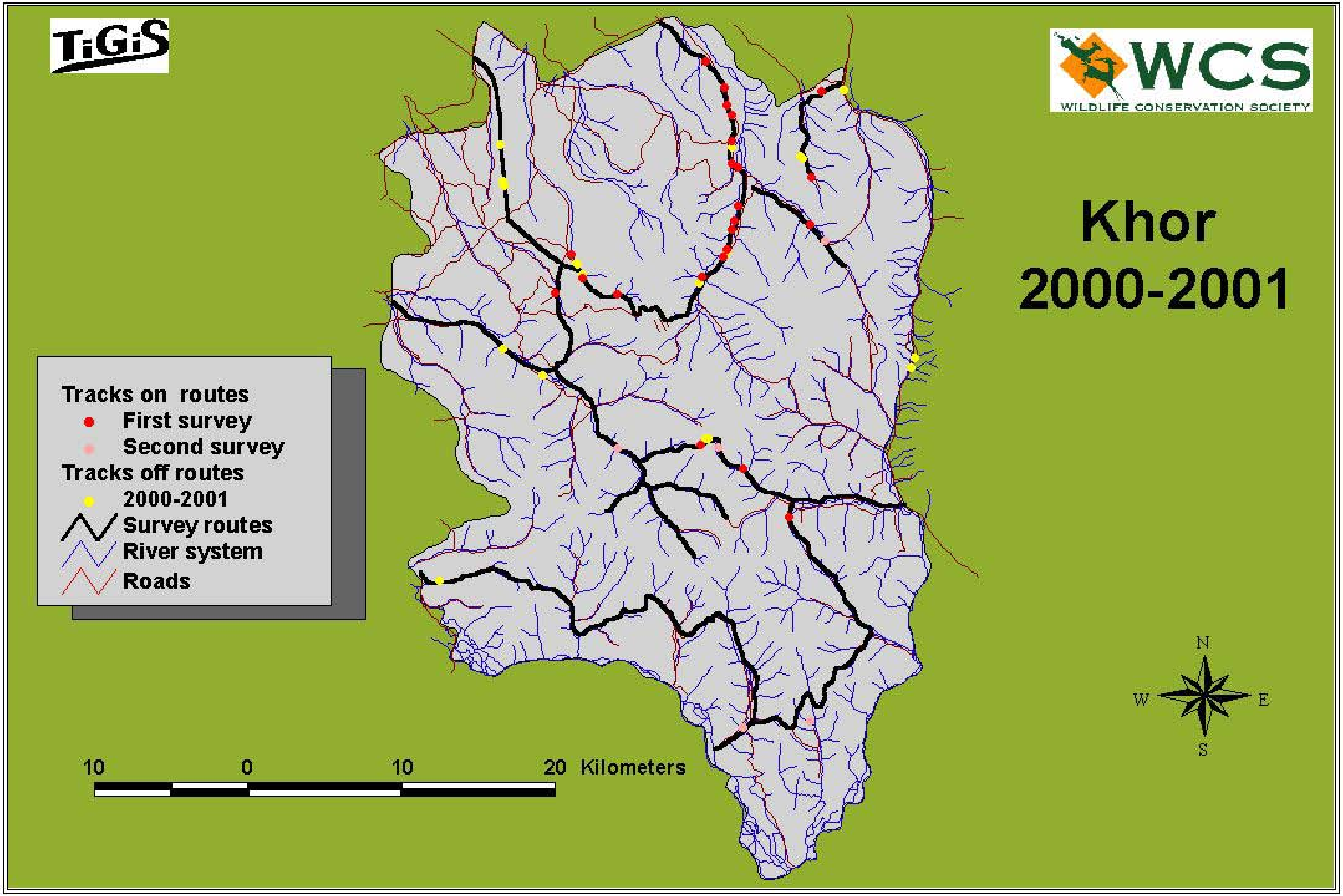
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independents*	Total (all tigers)
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
12	Matai	2000-2001	1	2	1	0	2	0	4	4	6

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

#	Monitoring Site	Prey species	n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	2000 mean	2000 std	Grand Total mean	Grand Total std
12	Matai	Red deer	24	1,714	1,768	4,852	4,043	3,764	3,974	2,208	1,730	3,134	3,291
12	Matai	Roe deer	24	1,371	1,761	2,618	2,119	2,102	1,221	1,526	0,980	1,905	1,637
12	Matai	Wild boar	24	0,591	0,939	1,111	1,093	2,052	2,026	1,943	3,029	1,424	2,021




TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Khor
2000-2001
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
River system
Roads
10
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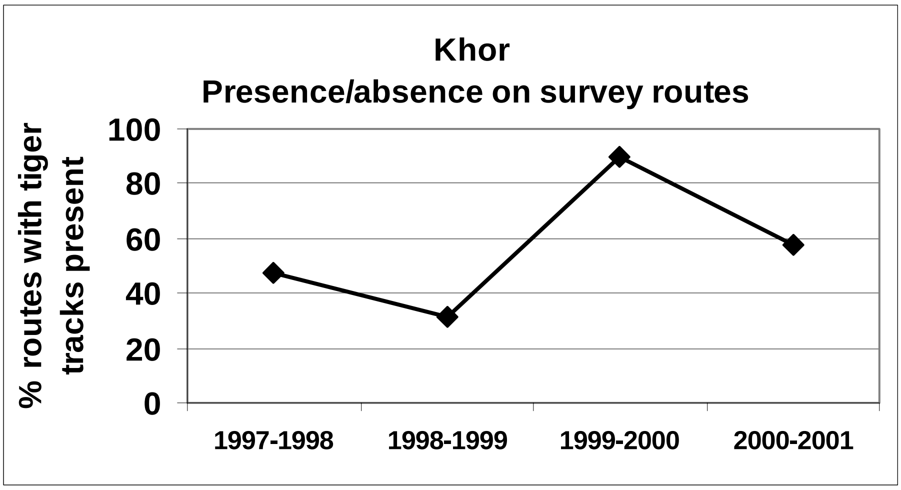
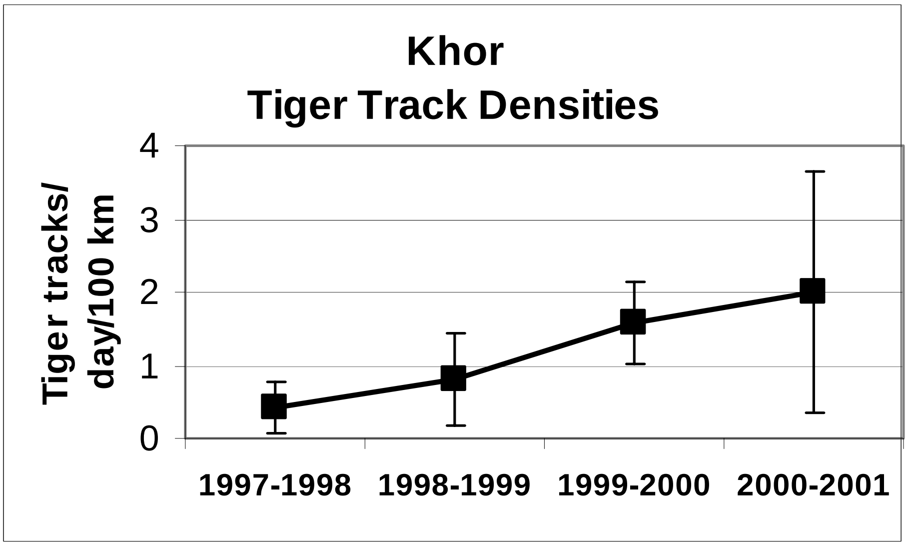
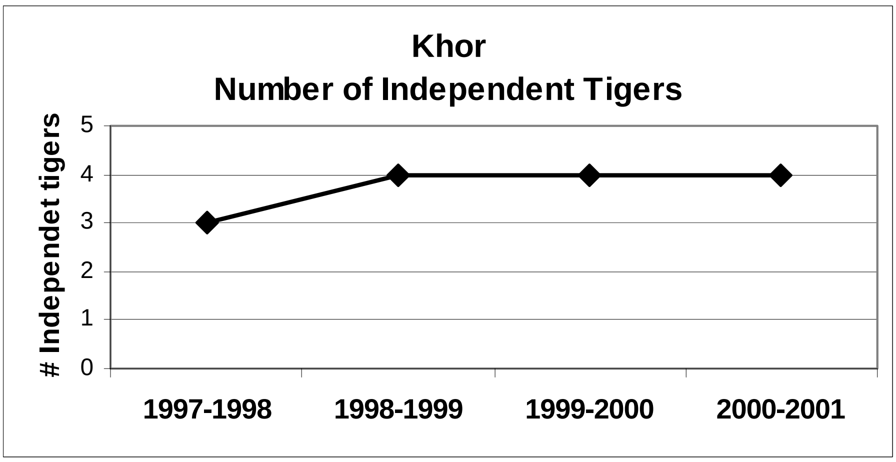
20 Kilometers
N
W
E
S



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



Comparison of track densities in monitoring site across years



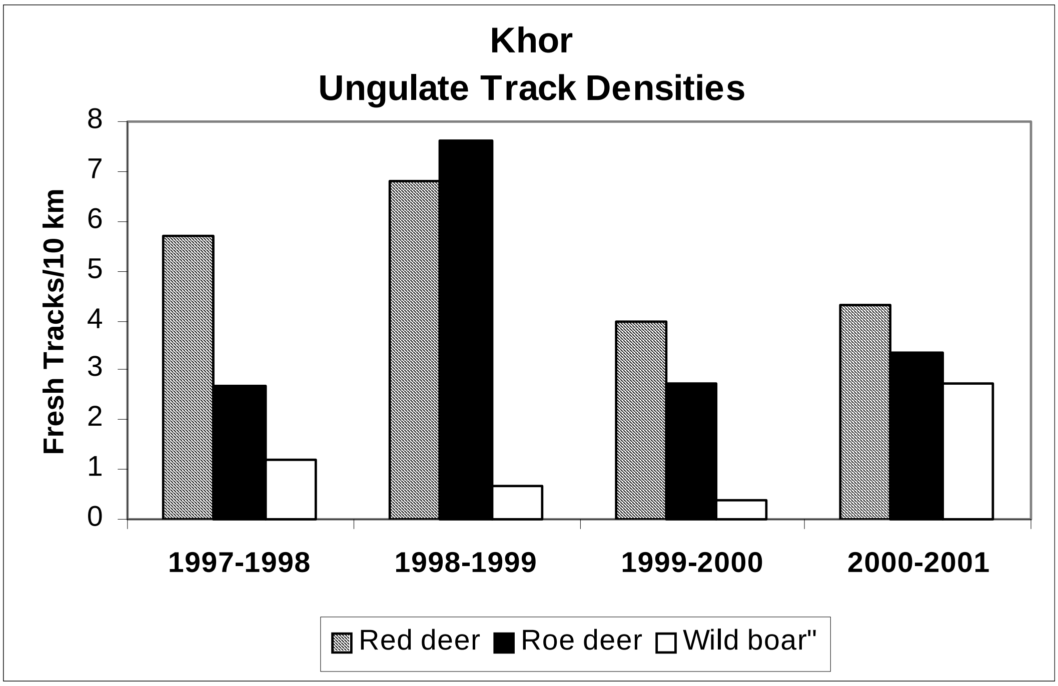
Number of Independent tigers (adults, subadults, unknown) on monitoring site

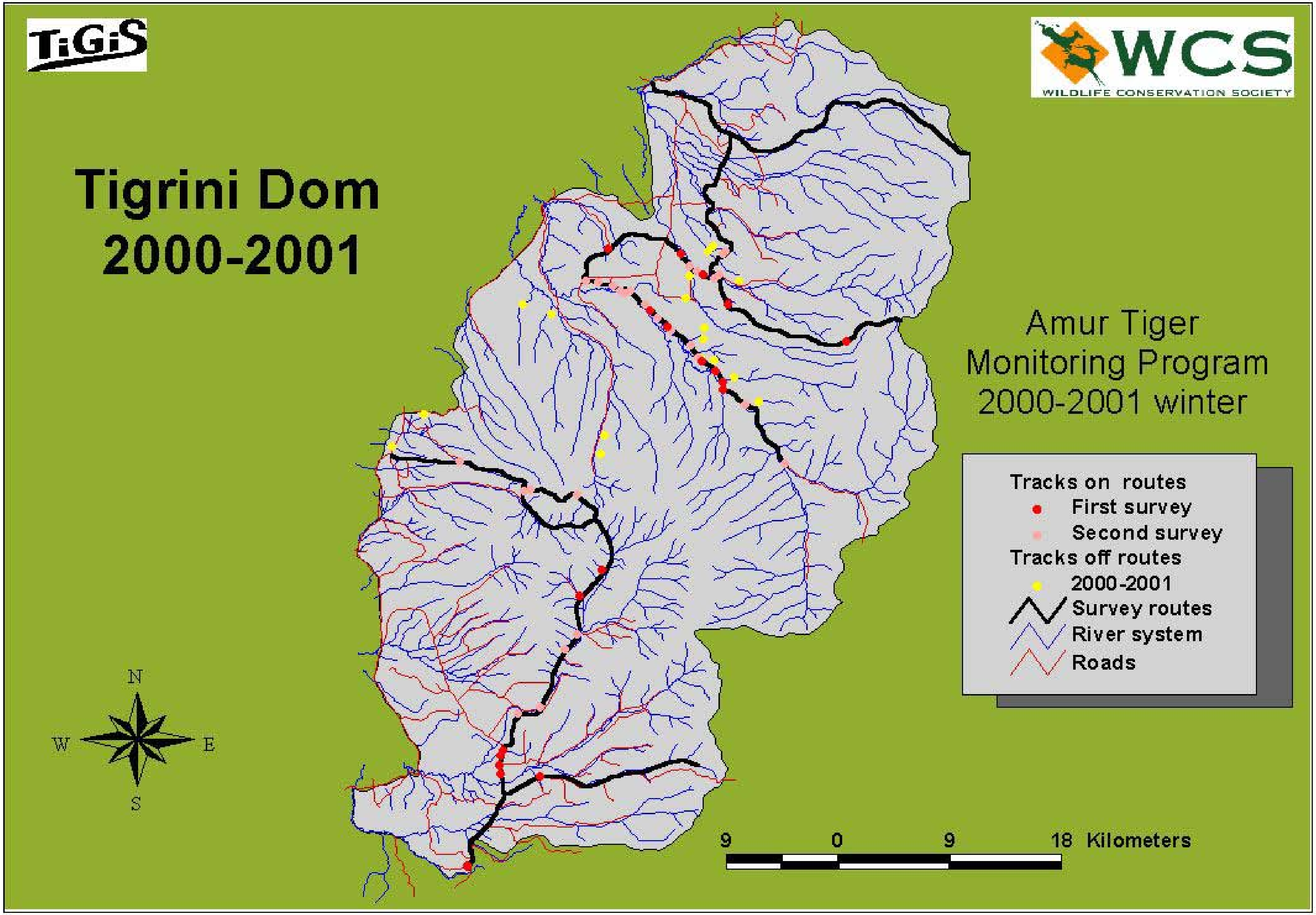
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

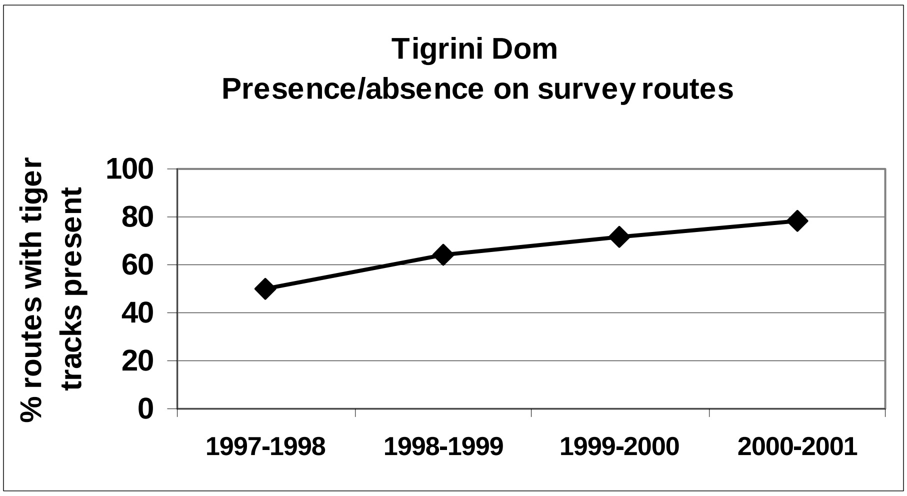
#	Site	Year	Age: Adults: Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Totals: Total adults	Total independents*	Total (all tigers)
8	Khor	1997-1998	2	1	0	0	1	0	3	3	4
8	Khor	1998-1999	2	2	0	0	2	0	4	4	6
8	Khor	1999-2000	2	2	0	0	0	0	4	4	4
8	Khor	2000-2001	2	2	0	0	1	0	4	4	5

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

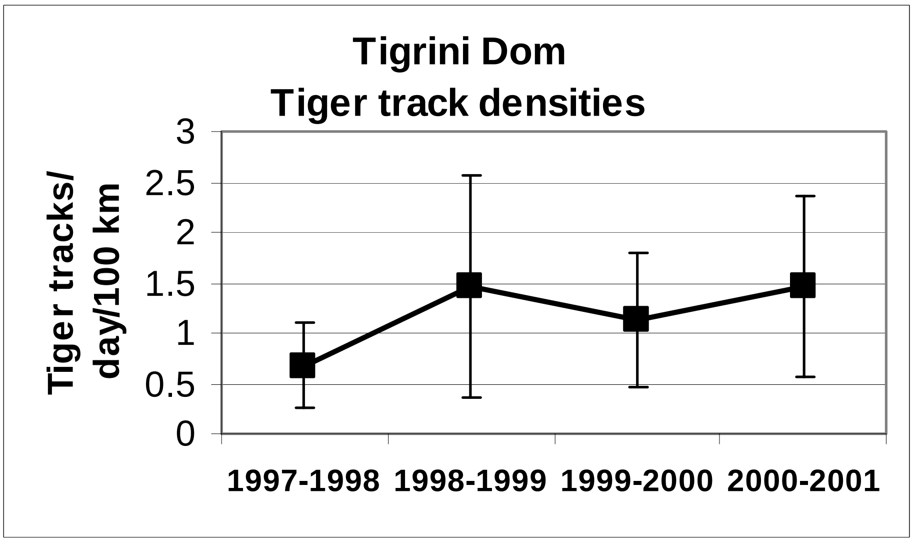
#	Monitoring Site	Prey species	n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	2000 mean	2000 std	Grand Total mean	Grand Total std
8	Khor	Red deer	19	5,69	5,43	6,82	5,89	3,98	4,46	4,29	4,92	5,20	5,22
8	Khor	Roe deer	19	2,69	3,47	7,60	5,36	2,73	3,38	3,35	3,51	4,09	4,44
8	Khor	Sika deer	19	0,06	0,25	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,13
8	Khor	Wild boar	19	1,18	2,33	0,66	0,98	0,37	0,74	2,73	3,15	1,24	2,21



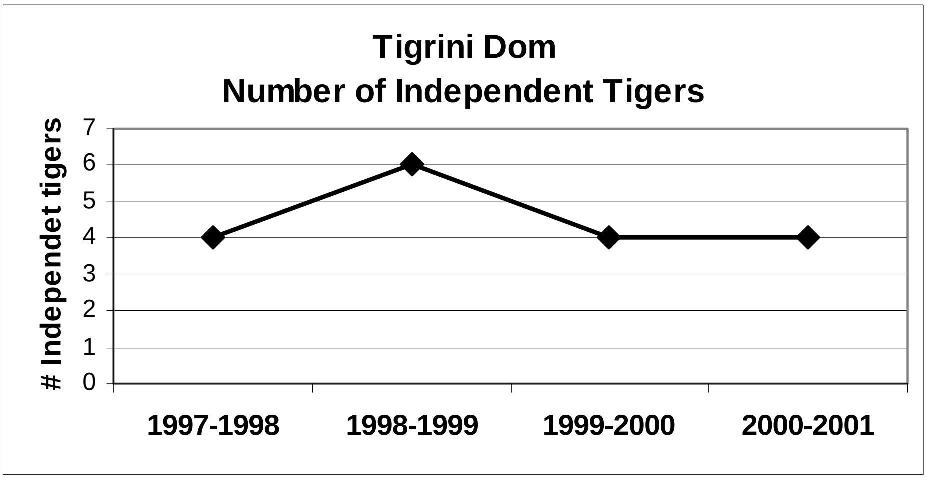

TiGiS
WCS
WILDLIFE CONSERVATION SOCIETY
Tigrini Dom
2000-2001
Amur Tiger
Monitoring Program
2000-2001 winter
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
River system
Roads
N
W
E
S
9
0
9
18 Kilometers



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



Comparison of track densities in monitoring site across years



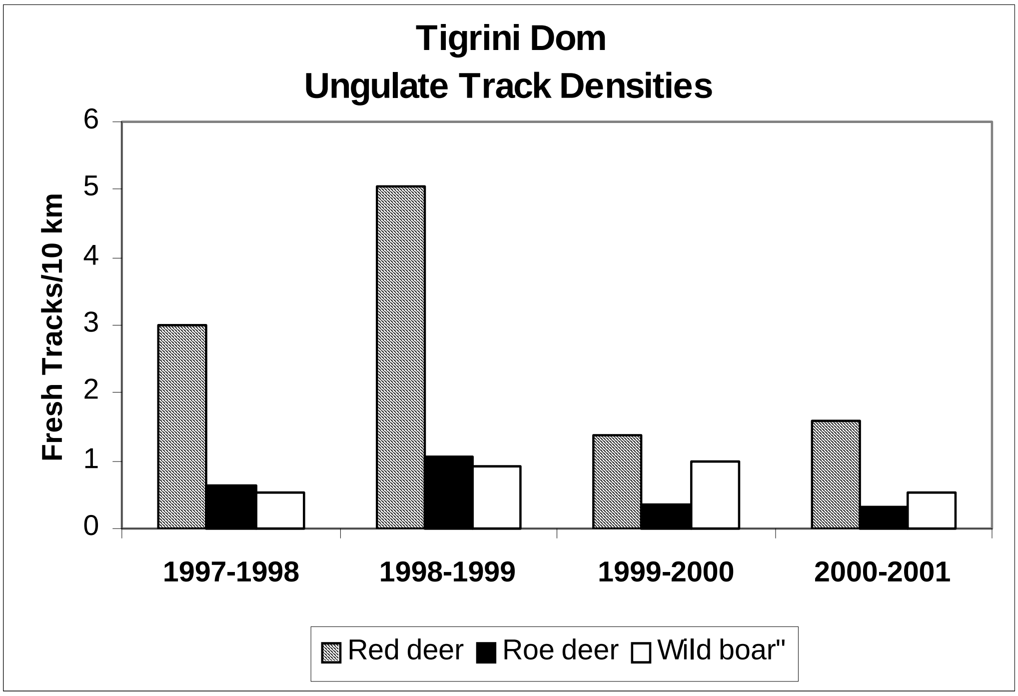
Number of Independent tigers (adults, subadults, unknown) on monitoring site

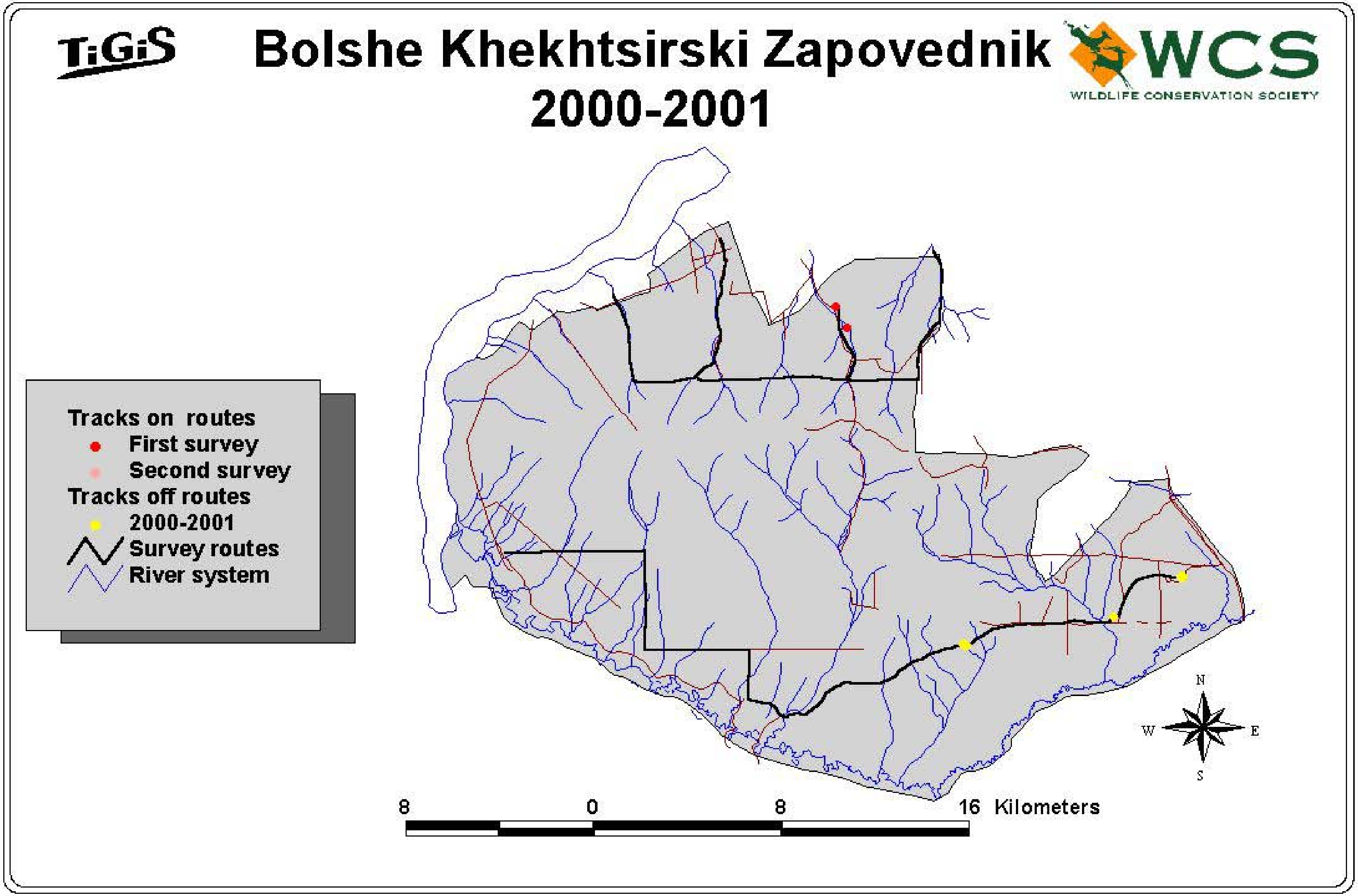
Number of tigers, by age class, and sex (for adults only) on Amur tiger monitoring sites in winter

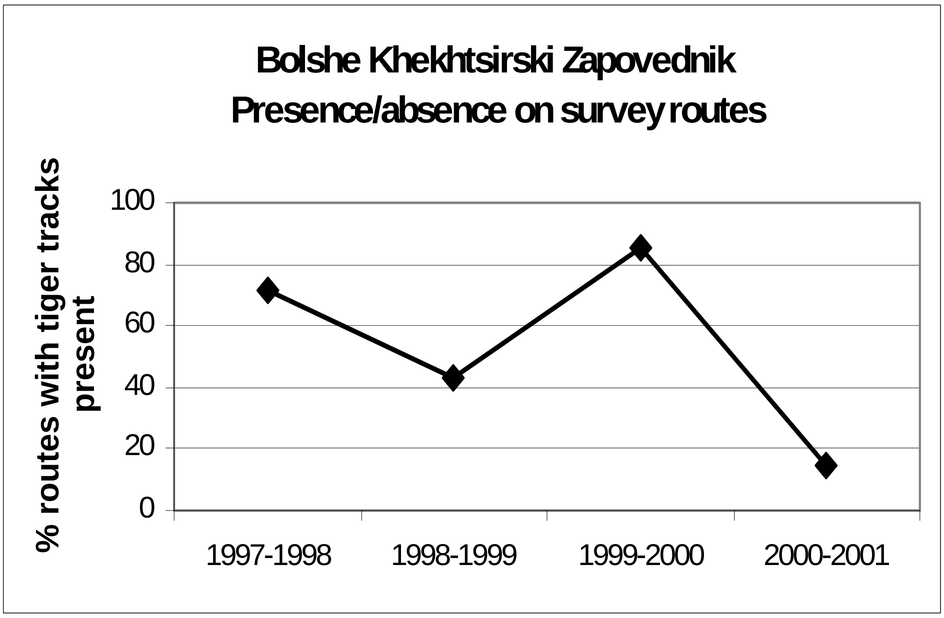
			Age						Totals		
			Adults								
#	Site	Year	Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Total adults	Total independents*	Total (all tigers)
11	Tigrini Dom	1997-1998	2	0	1	1	0	0	3	4	4
11	Tigrini Dom	1998-1999	2	0	2	2	0	0	4	6	6
11	Tigrini Dom	1999-2000	3	1	0	0	1	0	4	4	5
11	Tigrini Dom	2000-2001	2	1	0	1	1	0	3	4	5

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

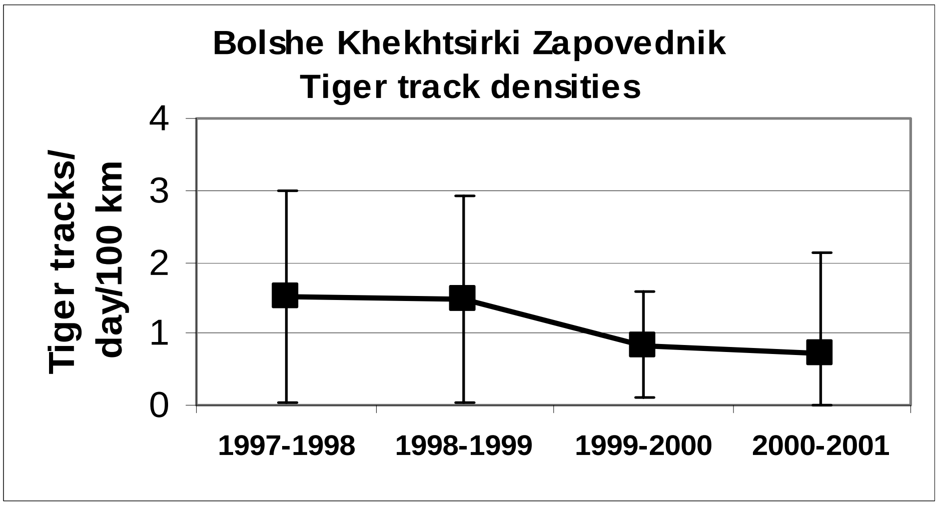
#	Monitoring Site	Prey species	n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	2000 mean	2000 std	Grand Total mean	Grand Total std
11	Tigrini Dom	Red deer	14	3,00	3,92	5,06	3,40	1,38	1,39	1,60	1,70	2,76	3,11
11	Tigrini Dom	Roe deer	14	0,65	0,82	1,04	2,60	0,36	0,74	0,32	0,50	0,59	1,43
11	Tigrini Dom	Wild boar	14	0,54	1,20	0,93	1,57	1,00	0,90	0,53	0,89	0,75	1,16



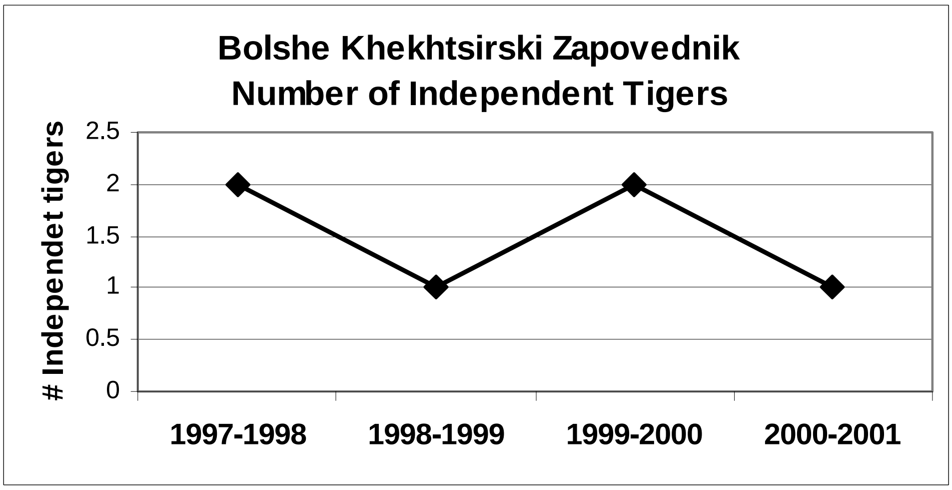

TiGiS
Bolshe Khekhtsirski Zapovednik
2000-2001
WCS
WILDLIFE CONSERVATION SOCIETY
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
River system
8
0
8
16 Kilometers
N
W
E
S



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



Comparison of track densities in monitoring site across years



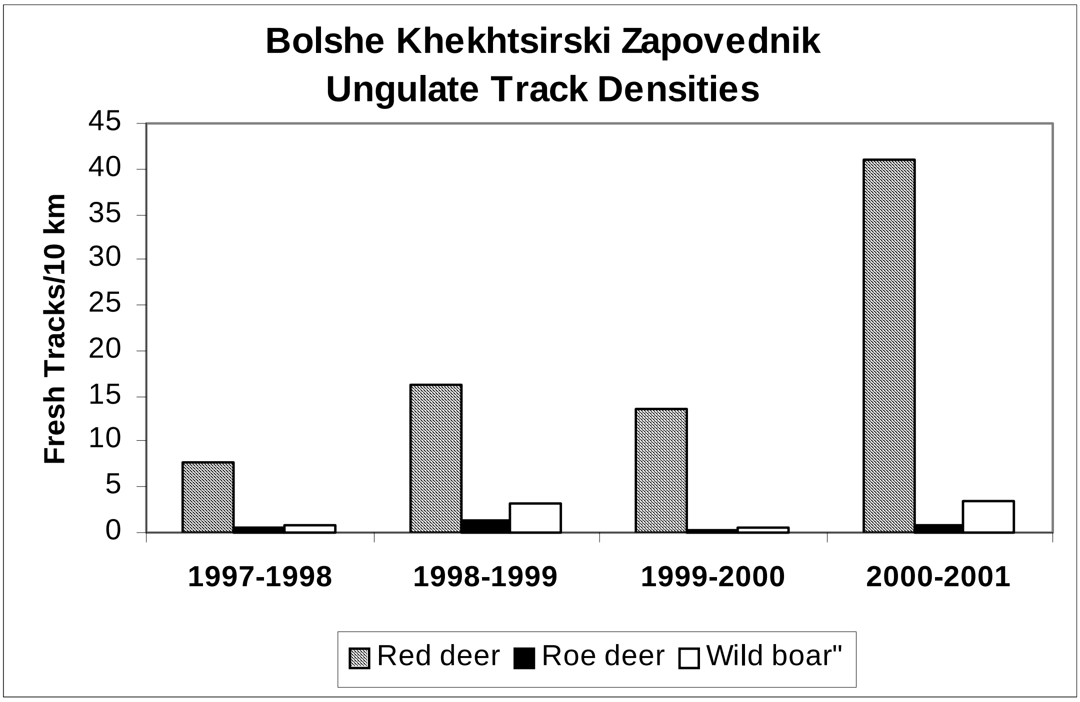
Number of Independent tigers (adults, subadults, unknown) on monitoring site

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

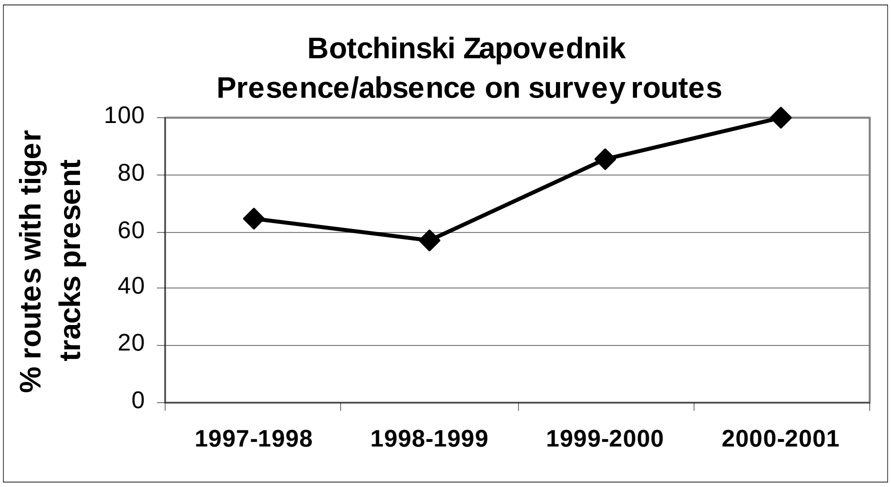
#	Site	Year	Age: Adults: Males	Females	Un-known	Sub-adults	Cubs	Age unknown	Totals: Total adults	Total independents*	Total (all tigers)
10	BolsheKhekhtsir Zap.	1997-1998	1	1	0	0	0	0	2	2	2
10	BolsheKhekhtsir Zap.	1998-1999	0	1	0	0	1	0	1	1	2
10	BolsheKhekhtsir Zap.	1999-2000	1	1	0	0	0	0	2	2	2
10	BolsheKhekhtsir Zap.	2000-2001	0	1	0	0	3	0	1	1	4

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years.

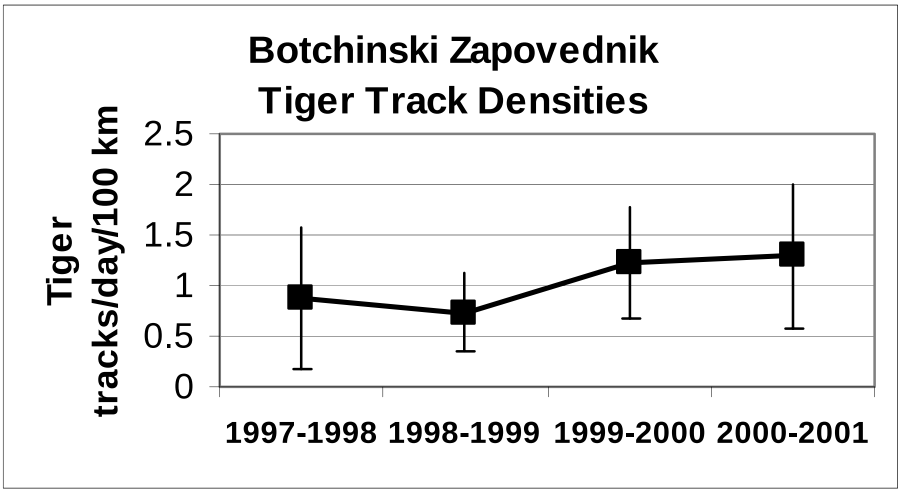
#	Monitoring Site	Prey species	n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	2000 mean	2000 std	Grand Total mean	Grand Total std
10	BolsheKhekhtsir Zapovednik	Red deer	7	7,80	7,71	16,29	14,12	13,65	12,75	40,97	47,01	19,68	27,41
10	BolsheKhekhtsir Zapovednik	Roe deer	7	0,45	0,37	1,27	1,55	0,16	0,42	0,92	1,44	0,70	1,12
10	BolsheKhekhtsir Zapovednik	Wild boar	7	0,80	1,05	3,16	3,45	0,61	1,09	3,52	3,93	2,02	2,90



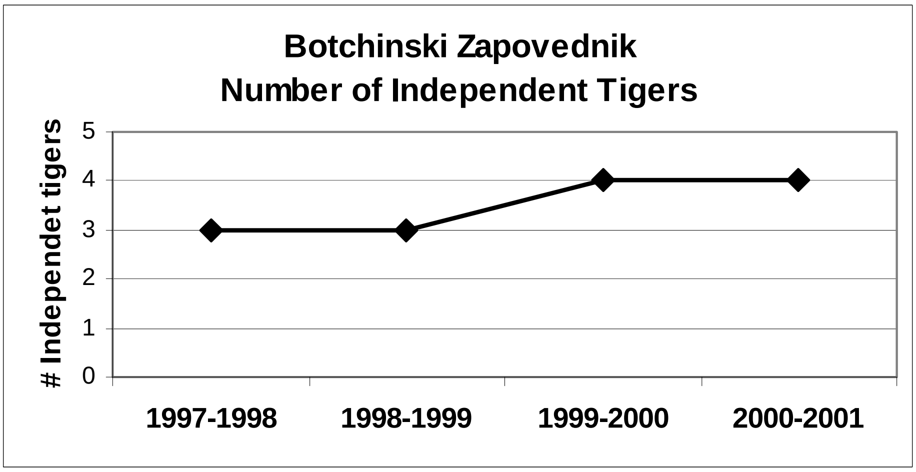
Botchinski Zapovednik
2000-2001
WCS
WILDLIFE CONSERVATION SOCIETY
Tracks on routes
First survey
Second survey
Tracks off routes
2000-2001
Survey routes
River system
N
W
E
S
20
0
20
40 Kilometers



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 site

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

#	Site	Year	Age: Adults: Males	Age: Adults: Females	Age: Adults: Un-known	Age: Sub-adults	Age: Cubs	Age: Age unknown	Totals: Total adults	Totals: Total independents*	Totals: 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
9	Botchinski Zap.	2000-2001	2	1	0	1	2	0	3	4	6

Mean track density (tracks less than 24 hours) of ungulates in Amur tiger monitoring sites for first 4 years

#	Monitoring Site	Prey species	n	1997 mean	1997 std	1998 mean	1998 std	1999 mean	1999 std	2000 mean	2000 std	Grand Total mean	Grand Total std
9	Botchinski Zapovednik	Red deer	14	1,75	1,19	6,87	5,06	4,33	2,50	2,92	2,98	3,97	3,70
9	Botchinski Zapovednik	Roe deer	14	0,42	0,63	3,00	3,16	2,69	2,85	4,24	3,66	2,59	3,08
9	Botchinski Zapovednik	Wild boar	14	0,03	0,10	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,05