DRAFT DOCUMENT

ESTABLISHING A MONITORING PROGRAM FOR THE AMUR TIGER

FIRST-YEAR REPORT: 1997-1998

A cooperative project conducted by representatives of:

Hornocker Wildlife Institute/Wildlife Conservation Society
All Russia Research Institute of Wildlife Management, Hunting, and Farming
Institute of Geography, Far Eastern Branch, Russian Academy of Sciences
Institute of Biology and Soils, Far Eastern Branch, Russian Academy of Sciences
Sikhote-Alinski State Biosphere Zapovednik
Lazovski State Zapovednik
Ussuriski Zapovednik
Botchinski Zapovednik
Bolshe-Khekhtsirski Zapovednik
WWF-Russia
Institute for Sustainable Use of Renewable Resources

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I. Introduction

On 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 present decade (Matyushkin et al. 1996). Nonetheless, the need for a reliable and efficient means for monitoring changes in the tiger population remains.

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 financial burden and logistical constraints make range-wide surveys practically impossible to conduct with sufficient frequency to monitor changes in tiger abundance.

There have been great efforts and significant support from regional, Krai-wide, federal, and international levels for implementation of 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 at present there exists no way to assess the effectiveness of these programs. **Without an accurate monitoring program that can determine trends in tiger numbers with statistical accuracy, the ultimate effect of tiger conservation programs will remain unknown.**

All authors of the 1996 survey agreed that a more regular, though less intensive survey could provide information on trends of the tiger population if a comprehensive monitoring program were to be developed. Concurrently, the National Strategy calls for implementation of a monitoring program. In response, the Hornocker Wildlife Institute submitted a 2-phase proposal that called for an assessment of survey methodology coupled with development of a statistically reliable survey protocol. Support was provided by WWF-Germany and WWF-US (with funds provided by USAID). This program has been implemented in consultation and conjunction with Federal and Krai governmental representatives as well as several Institutes of the Russian Academy of Sciences (Table 1). Statistical advice has been provided from the Department of Zoology, University of Wyoming.

II Goals and Objectives

The ultimate goal of this program is the development of a standardized system to monitor changes in tiger abundance across the existent range in the Russian Far East. The intent is to provide a mechanism that will assess changes in the density of tigers within their current range over long periods of time. This methodology should provide a means of assessing the

Table 1. List of Individuals who have been consulted, participating in planning, or assisted in implementation of the Amur tiger monitoring program.

Name	Representative Agency	Location
Kolonin, G.V.	State Committee for Environmental Protection	Moscow
Dunishenko, Yu.M.	Institute of Hunting, Hunting Management	Khabarovsk
Kostomarov, S.V.	Botchinski Zapovednik	Khabarovsk
Kryukov, V.G.	Department of Natural Resources	Khabarovsk
Spiridonov, S.V.	Bolshe-Khekhtsirski Zapovednik	Khabarovsk
Abramov, V.K.	Ussuri Zapovednik	Primorye
Aramilev, V.V.	Institute of Sustainable Resource Use	Primorye
Astafiev, A.A.	Sikhote-Alin State Biosphere Zapovednik	Primorye
Fomenko, P.V.	WWF	Primorye
Gaponov, V.V.	Department of Natural Resources	Primorye
Laptev, A.A.	Lazo State Zapovednik	Primorye
Nikolaev, I.G.	Institute of Biology and Soils, RFE Branch Academy of Sciences	Primorye
Pikunov, D.G.	Institute of Geography, RFE Branch Academy of Sciences	Primorye
Salkina, G.P.	Lazo State Zapovednik	Primorye
Schetinin, V.I.	State Committee for Environmental Protection	Primorye
Smirnov, E.N.	Sikhote-Alin State Biosphere Zapovednik	Primorye
Murzin, A.	Institute of Geography, RFE Branch Academy of Sciences	Primorye
Hayward, G.	Department of Zoology, University of Wyoming	USA
Miquelle, D.G.	Hornocker Wildlife Institute/Wildlife Conservation Society	USA

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.

We emphasize that the design of any monitoring program has limitations. Tiger numbers can, in a broad sense, change in two ways: either by changes in density in areas already occupied, or by expansion/contraction of range with resultant changes in tiger numbers. Our primary focus is on developing a method that would, with statistical rigor, monitor changes in the tiger population that occur due to changes in density in existing tiger range (monitoring density) instead of monitoring changes in tiger numbers due to increases/decreases in tiger distribution. Although we are also attempting to develop methodologies that monitor changes in distribution (only briefly noted in this report), the most effective use of the methodology we have developed is the monitoring of tigers in existent range. Because some of the monitoring sites occur at the edge of tiger range this program does have the capacity of track some changes, but its primary focus is tracking changes in tiger density in key areas of their existent range.

Objectives

Specifically, the objectives of this monitoring program are:

1. to develop a standardized, statistically rigorous system based on track counts for monitoring trends in relative numbers of tigers in representative "count units" throughout tiger range in the Russian Far East;
2. to determine the presence/absence of tigers in count units and elsewhere across tiger range to monitor changes in distribution of tigers in the Russian Far East;
3. to develop a monitoring system that may provide a basis for relating relative track abundance to absolute abundance of tigers;
4. to monitor the prey base (large ungulates) of tigers within count units;

5. to monitor reproduction across the range of tigers to identify areas of high/low productivity;

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

7. to monitor changes in habitat quality.

Certification of methodology. Ultimately, it is our hope that the monitoring program developed here will be accepted as a component of the Federal Program, and that the methodology be reviewed and certified at both the regional and federal level. Although it is typical for reviews to occur prior to initiation of programs, we believe there are still many unknowns in developing a statistically rigorous system for tiger monitoring, and therefore feel it is important to experimentally develop the methodology prior to submitting it for review.

III. Methodology

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. Past estimates of tiger numbers, however, provide a sound foundation for assessing tiger trends if a revised approach can link with the old methods.

An index of tiger abundance, based on track counts measured on a portion of the count units examined in the 1996 census may provide an efficient approach to monitor trend. By choosing a sample of count units based on an appropriate sampling procedure, estimates could be calculated with associated measures of precision. Data collected on a portion of the count units would not require as great financial or logistical investments and could be collected at more frequent intervals than the complete census data.

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 variance. 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 two estimates of tiger abundance: 1) an estimate of relative tiger abundance based on track abundance; and, 2)an estimate of actual tiger numbers based expert assessment of track data. Design of the sampling scheme was primarily based on an analysis of existing data on tiger tracks, 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 the 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 have created monitoring units within and adjacent to the larger protected areas (Sikhote-Alin, Lazo, and Ussuri) to have a background comparison for areas immediately adjacent to protected areas. Such unprotected count units 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.

The range of environmental factors that should be represented include:

protected/unprotected areas;
north/south gradient;
east/west macroslopes of the Sikhote-Alin Mountains; and,
peripheral areas where tiger presence is transitory, as well as quality habitat where tigers should be present.

Number of count units. The number of count units should be determined by two factors: 1) there should be an adequate representation of the environmental variables as defined above; and 2) adequate sample size to allow statistical analyses for overall trends in population.

Given these constraints, 16 permanent sites were selected to be representative of the range of conditions across the present distribution of tigers (Figure 1, Table 2).

Table 2. Count units selected for the Amur tiger monitoring program in the Russian Far East.

	#	Name	Status	Geographic location	Coastal/ inland
Primorye Krai					
	1	Southwest Primorye	protected	southern	SW Primorye
	2	Ussuriski Zapovednik	protected	southern	inland
	3	Ussuriski Raion	unprotected	southern	inland
	4	Lazovski Zapovednik	protected	southern	coastal
	5	Lazovski Raion	unprotected	southern	coastal
	6	Sandagoy (Olginski Raion)	unprotected	southern	coastal
	7	Vaksee (Iman)	unprotected	central	inland
	8	Chuguevski Raion	unprotected	central	inland
	9	Sikhote-Alin Zapovednik**	protected	central	coastal
	10	Terney Hunting lease**	unprotected	central	coastal
	11	Bikin River*	proposed	central	inland
Khabarovski Krai					
	12	Botchinski Zapovednik	protected	northern	coastal
	13	Bolshe Khekhtsirski Zapovednik	protected	northern	inland
	14	Matai River*	proposed	northern	inland
	15	Khor	unprotected	northern	inland
	16	Tigrini Dom*	proposed	northern	inland

* Have been proposed as protected areas.
** In 1998, these two count units were surveyed as a single unit. In all future surveys they will be considered as separate units.

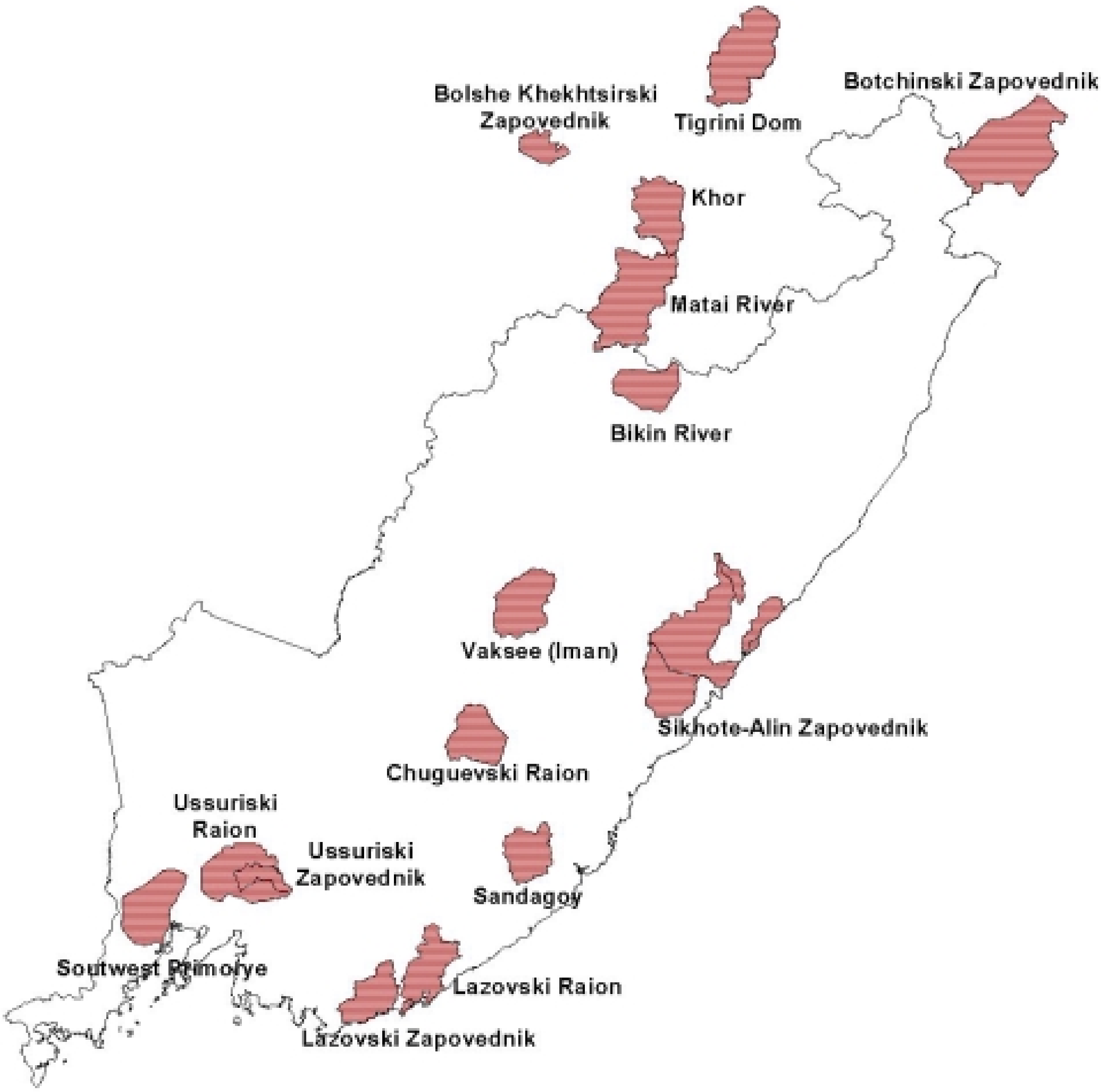


Figure 1. Locations of sites selected for a monitoring program of tigers in the Russian Far East (See Table 3 for key to numbers).

Summarizing the count units on the basis of the environmental variables outlined above shows the following distribution:

Count units in:					
protected:	7	unprotected	6	proposed	3
south	6	central	5	north	5
east macroslope	6	west macroslope	8	other	2
main Sikhote-Alin	14	peripheral	2		

In addition to these proposed areas, in the future we will attempt to monitor changes in distribution by studying key peripheral areas with a different, less intensive methodology, designed simply to detect tiger presence over time. Areas considered for inclusion are:

Pogranichny Raion - peripheral, isolated habitat on the Chinese border in Primorski Krai;
Spassk-Chernogovka - partially isolated region that has just recently become fragmented from Sikhote-Alin;
Samarga River Basin - unprotected area in northern east macroslope, marginal habitat;
Maksimovka River Basin - unprotected area in northern east macroslope, marginal habitat;

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

i) to detect changes in tiger density, a count unit must be large enough to potentially contain a number of individuals that could fluctuate over time, hopefully reflecting the conditions for tiger survival 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);

ii) given the constraint above, count units should be as small as possible to minimize the expenses of monitoring; and,

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

In good tiger habitat, 100,000 - 150,000 ha should contain 2-3 adult resident females and associated cubs, at least 1 adult male, and dispersing animals, or non-resident animals. Therefore, we sought to create count units of approximately this size. Some exceptions were inevitable - the size of existing protected areas are obviously fixed yet did not meet the size criteria (although with larger protected areas we sought to sample only a portion of the region). In general, we sought to keep count units within the range of 1000 - 1500 km^2.

Use of transects in winter. 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 transects can be an effective means of describing the distribution and numbers of tigers in a region. Unlike other regions where tigers occur, the snow cover afforded in the winter season in the Russian Far East provides a “clean pallet” upon which all tiger tracks are identifiable.

Location of transects. Two potential approaches exist for positioning transects: 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 interest lays in the ability to detect changes over time, it is important that there be a high probability of tiger tracks being encountered along transects. If a large percentage of transects are devoid of tracks, there is no means of detecting changes in tiger numbers. Therefore, we sought to locate transects along those routes that have the highest probability of finding tracks. Maximize efficiency of encountering tracks can be achieved by positioning transects along trails, ridgetops, roads, or natural travel corridors where tigers are most likely to travel (Matyushkin 1990).

Transect length. Transects 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 transect lengths, and the amount of time (money) that can be invested in covering transects. Ideally, we should select the shortest transect length that will result in only a small percentage of transects without tiger tracks, and that is sufficiently long enough to reduce the variability of number of tiger tracks. When variability in track density among transects is high, our ability to statistically detect changes in tiger abundance decreases.

To determine appropriate transect length, we collected data along a series of transects in Sikhote-Alin Zapovednik to address two questions:

1. How does the proportion of zero counts (no tracks encountered) change with transect length?; and,
2. Does the variability in rate of tiger tracks encountered per km of transect change with increasing transect length? If variability does change, does the pattern suggest a transect length that will be most efficient for a monitoring program?

A series of transects of various lengths in Sikhote-Alin Zapovednik (Smirnov and Miquelle, unpubl.) were repeatedly sampled from 1995-1998 to estimate the frequency of tiger tracks on different length transects. We divided transects into 5 categories based on length, and compared the percentage of transects in each category that had no tiger tracks reported (Figure 2). For this analysis we reported only those transects that were covered on foot (533 repeated counts of transects). These data suggest that transects longer than 10 km have a much greater chance of detecting tracks than shorter transects. Therefore, these data provide an indication of what the

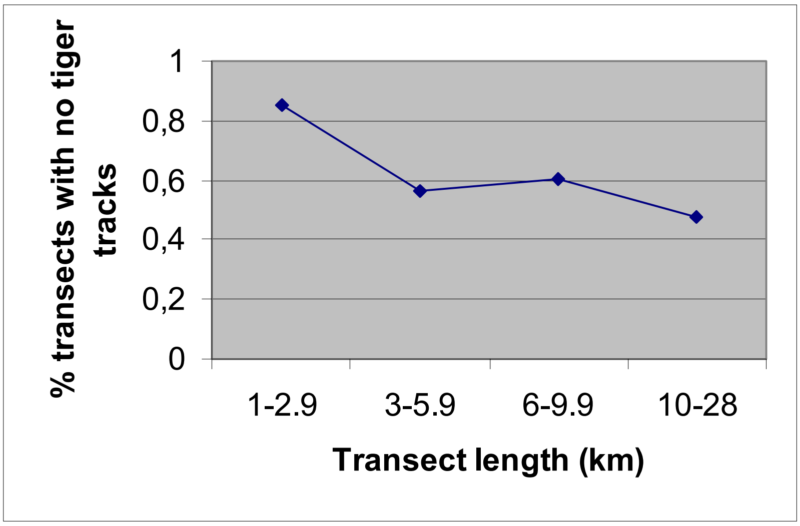


Figure 2. Variation in the percentage of transects of different lengths in Sikhote-Alin Zapovednik on which no tiger tracks were reported.

minimum length of a transect should be, but there are not sufficient longer transects to compare the trade-offs of fewer, longer transects versus more, shorter transects.

We therefore also analyzed how variation (measured as standard deviation of mean number of tigers/km of transect covered) varied with transects of different lengths. These results (Figure 3) indicate that transects of 10-20 kilometers have the lowest standard deviation, and the slope of the curve suggests that longer transects would probably result in relatively small benefits in terms of statistical variation. Based on these preliminary data, therefore, we recommend that transects range in value from 10 to 20 kilometers.

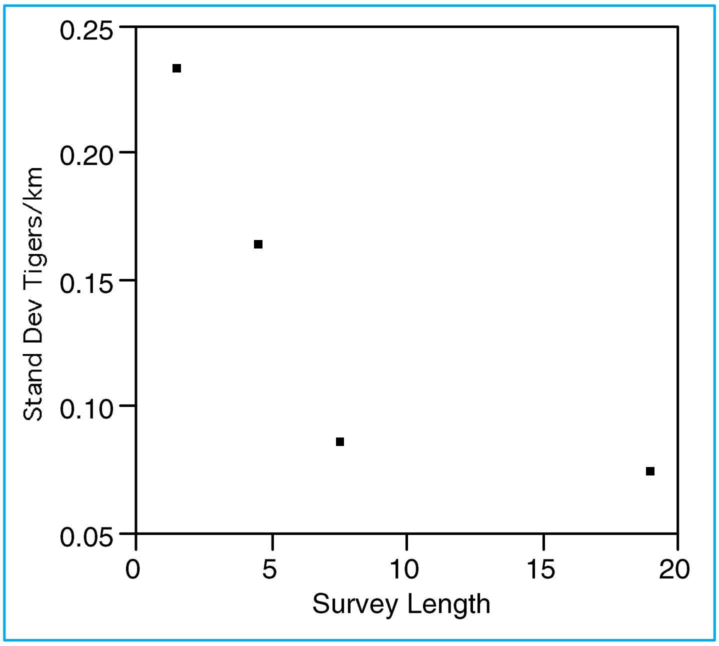


Figure 3. Standard deviation of relative tiger abundance (number of tigers crossings/km transect) obtained from 490 foot surveys from 1995-1998 in Sikhote-Alin Zapovednik. For this analysis transects are broken into four categories based on length (0-2.9, 3-5.9, 6-9.9 and >10 km). Standard deviation in tiger crossings per km are: 0.2345 (n = 52), 0.1656 (n = 147), 0.0878 (n = 145), and 0.0757 (n = 146).

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

To examine the statistical power of a monitoring program with different numbers of transects, we constructed a set of hypothetical transects based on data collected in Sikhote-Alin Zapovednik. We examined the statistical power of a monitoring system within a count unit to detect a trend (10% change in population size, 5% change, or no change) based on 3, 5, 10, and 20 transects. For this analysis we assume:

- alpha = 0.20
- a one-tailed test
- trend variation equaled 0.01 (1%)
- each transect is surveyed twice in each of 5 years.

For the analysis one must provide a mean and standard deviation for track counts on each transect being monitored. We calculated these values based on counts from 10 river basins within Sikhote-Alin Zapovednik monitored from 1995-1998. Values employed were:

First 5 Initial Values:	Mean initial Value	0.086	0.16551	0.0999	0.13529	0.0967
	Standard Deviation	0.045	0.1656	0.0864	0.090221	0.1110
Other Initial Values:	Mean initial Value	0.09795	0.08333	0.0264	0.02845	0.0499
	Standard Deviation	0.11244	0.11785	0.0298	0.01968	0.0589

Table 3. Relationship between number of transects monitored and probability of detecting a trend (percent change in tiger track abundance). Analysis is based on mean tiger crossings of transects and standard deviation calculated from 493 foot surveys from 1995-1998 in Sikhote-Alin Zapovednik. This analysis assumes a exponential regression analysis. Mean and standard deviation refer to the mean count per km for each transect length and the standard deviation of that count.

Change in population	Number of Transects			
	3	5	10	20
- 1%	0.6723	0.797	0.9097	0.9956
- 5%	0.4354	0.5145	0.6172	0.8191
0%	0.1904	0.1974	0.2014	0.1916
+ 5	0.4437	0.531	0.6482	0.8244
+10	0.7161	0.8343	0.9456	0.9979

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

In addition to estimating a minimum number of transects, we sought to maintain a transect density of approximately 1 transect kilometer/10 km^2 of count unit. At present, we have no good theoretical basis for any given density: it is our hope that data developed during the monitoring program can be used to assess appropriate transect densities, which can be later be adjusted accordingly.

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 (such as tigers) 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 simultaneous survey. An analysis of repeated surveys in Sikhote-Alin Zapovednik, where it is possible to check if radio-collared animals were included, indicated that in a single, simultaneous count, as few as 20%, and up to 100%, of the tracks of known animals were encountered along transects. 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 transects 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 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 possibility 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 Sikhote-Alin data indicated that there may be differences in detection rate of tiger tracks dependent on the mode of transportation (Smirnov and Miquelle, unpubl.). Because we are primarily interested in monitoring changes in track density along each transect for each year, variation in detection rate is acceptable between transects, but not in one transect over years. Therefore, it is preferable that for each transect the same mode of transportation be used every year, for each survey, under all conditions.

Continuity of personnel. People selected for the first monitoring program should be selected on the basis of their experience in the region, their knowledge of tigers, and the probability of them continuing to participate in the monitoring program in the future. Stability in track counts will depend on retaining the same people over many years. Therefore, counters should be asked if they are willing to participate over a long-term project.

Data Collection

Identification of coordinators for each count unit. A core team of biologists with extensive field experience in tiger survey methodology were identified as coordinators for their respective count units (Table 4). These individuals took on responsibility for helping develop methodology, and for implementing data collection on their count units. Each coordinator has experience in data collection, survey methodology, and in interpretation of tiger track data. Continuity in use of these individuals will be critical to long-term success of the program.

Details of data collection are outlined in the Instructions to Coordinators (Appendix I) 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 transect
Length of transect
Date route was covered
Mode of travel: on foot, snowmobile, or vehicle
Date of last snowfall
Snow depth measured at three places along each transect (beginning, middle, end)

Tiger tracks:

a unique number is assigned to each track
location of a track is drawn onto a map
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

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

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

elk
wild boar
roe deer
sika deer
moose

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

Have tracks of female with cubs been reported
Location of tracks
Date tracks observed
Estimated age of tracks
Number of tracks
Measurement of tracks (each set)

Tiger mortality.

Was there any evidence of tiger deaths in the past year in or near the count unit?
Describe event (poaching, legal human killing, natural death, etc.)
Location

Depredation events reported in or near count units.

Location of depredation
Date of depredation
Species of domestic animal killed

Habitat Changes.

Have any new roads been built in the count unit for the specific year?
Have any roads been closed in the count unit for the specific year?
Intensity of hunting activity on count unit in past year
Intensity of poaching activity on count unit in past year
Logging activity on count unit in past year
Fires on count unit in past year

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 that will provide a long-term data storage in a standardized form that will provide relatively easy access for analysis. We have developed a GIS (Geographic Information System) that contains all data collected by fieldworkers on every tiger track, transect, and count unit. The first two years of the program have been spent in developing the database and creating the spatial data that coincides with the attribute data. Each count unit is defined a series of "coverages" that includes: boundaries of count unit (and boundaries of protected areas), the river system, and, for most count units, a forest cover map. The database is being designed so that in future years data entry will be possible directly into a computer, and will not require technical expertise of a computer specialist well-versed in the process of digitizing data or structuring the database. The entire database will be available on a single compact disk, thus making the data available to a wide realm of people, institutions, and organizations.

An example of the data collected for each count unit, including map layers, and tables, is provided (in Russian) in Appendix III.

IV. RESULTS OF THE 1997-1998 WINTER MONITORING PROGRAM

Count Units and Transects

In the 1997-1998 winter the total area included in monitoring units was 27,193.4 km^2, or approximately 17% of the total area considered suitable tiger habitat (based on Matyushkin et al. Table 4). This percentage represents an excellent sampling of suitable tiger habitat, and in fact, may be more than is necessary to be cost-effective. We plan to reduce the size of the Sikhote-Alin Zapovednik count unit (Figure 1), and divide it into two units (protected and unprotected), which will increase the number of sampling units by one, and reduce the percentage of suitable habitat sampled to approximately 15%.

A total of 252 transects were sampled twice (504 samplings), representing 3,105 km of transects (with double sampling 6300 km) (Table 1). On average, transect length was 12.8 km. Transect length was fairly consistent across monitoring units (Table 1), with the exception of the Khor and Ussuriski Zapovednik units, where transects seem unusually short. This variable should be adjusted in the future.

Table 4. Summary of information on monitoring units for Amur tigers in the Russian Far East, 1998.

#	Name	Coordinator	Size (km^2)	Transects: Number (n)	Transects: Total length (km)	Transects: Average length (km)	Transects: Density (km/10 km^2)
Primorye							
1	Southwest Primorye	Pikunov	1472.9	14	216.8	15.5	1.47
2	Ussuriski Zapovednik	Abramov	406.7	11	100.9	9.2	2.48
3	Ussuriski Raion	Abramov	1414.3	12	181.9	15.2	1.29
4	Lazovski Zapovednik	Salkina	1192.1	12	121.4	10.1	1.02
5	Lazovski Raion	Salkina	967.5	11	136.7	12.4	1.41
6	Sandagoy (Olginski Raion)	Aramilev	975.8	15	184.5	12.3	1.89
7	Chuguevski Raion	Fomenko	1165.4	14	197.3	14.1	1.69
8	Vaksee (Iman)	Nikolaev	1394.3	12	200.3	16.7	1.44
9	Sikhote-Alin Zapovednik	Smirnov	7749.7	62	652.3	10.5	0.84
10	Terney Hunting lease*	Smirnov					
11	Bikin River	Pikunov	1027.1	11	166	15.1	1.62
Khabarovsk							
12	Botchinski Zapovednik	Kostomarov	3051	14	169	12.1	0.55
13	Bolshe Khekhtsirski Zapovednik	Spirodonov	475.6	8	83	10.4	1.75
14	Mataiski	Dunishenko	2487.6	24	362.2	15.1	1.46
15	Khor	Dunishenko	1343.8	18	151.2	8.4	1.13
16	Tigrini Dom	Dunishenko	2069.6	14	181.8	13.0	0.88
Average**			1388.8	13.6	175.2	12.8	1.4
Total			27193.4	252	3105.3		

*Included with Sikhote-Alin Zapovednik for 1997-1998.

**Averages do not include Sikhote-Alin, which was an exceptionally large count unit, and will be divided into two units in future counts.

The density of transects (kilometers of transects per km^2 of the monitoring unit) was also fairly consistent, averaging nearly 1.4 km per 10 km^2., and provides an indication where greater densities of transects may be required (Botchinski Zapovednik and Tigrini Dom). Part of this difference may simply reflect a need to alter the boundaries of the count unit (decreasing size of the count unit will increase density of transects). We will use this data to assess the effect of transect density on our monitoring efforts.

In summary, although the average transect length and number of transects used per count unit was at the lower end of the ideal range of values, implementation of our sampling design was successfully executed (Table 5).

Table 5. Summary of proposed goals (based on analysis of pre-existing data) and actual values for count unit size, number of transects/count unit, and transect length for design of the Amur tiger monitoring program from 1998.

Variable	Proposed	Actual
Count unit size:	100,000-150,000 ha	1388,800 ha
Number of transects	10-20	13.6
Transect length	10-20 km	13.6 km

Because we are also concerned that large numbers of transects with zero counts will impede our ability to detect differences between count units, and across years, we also have assessed the percentage of transects in each count unit with no tiger tracks reported (Figure 4).

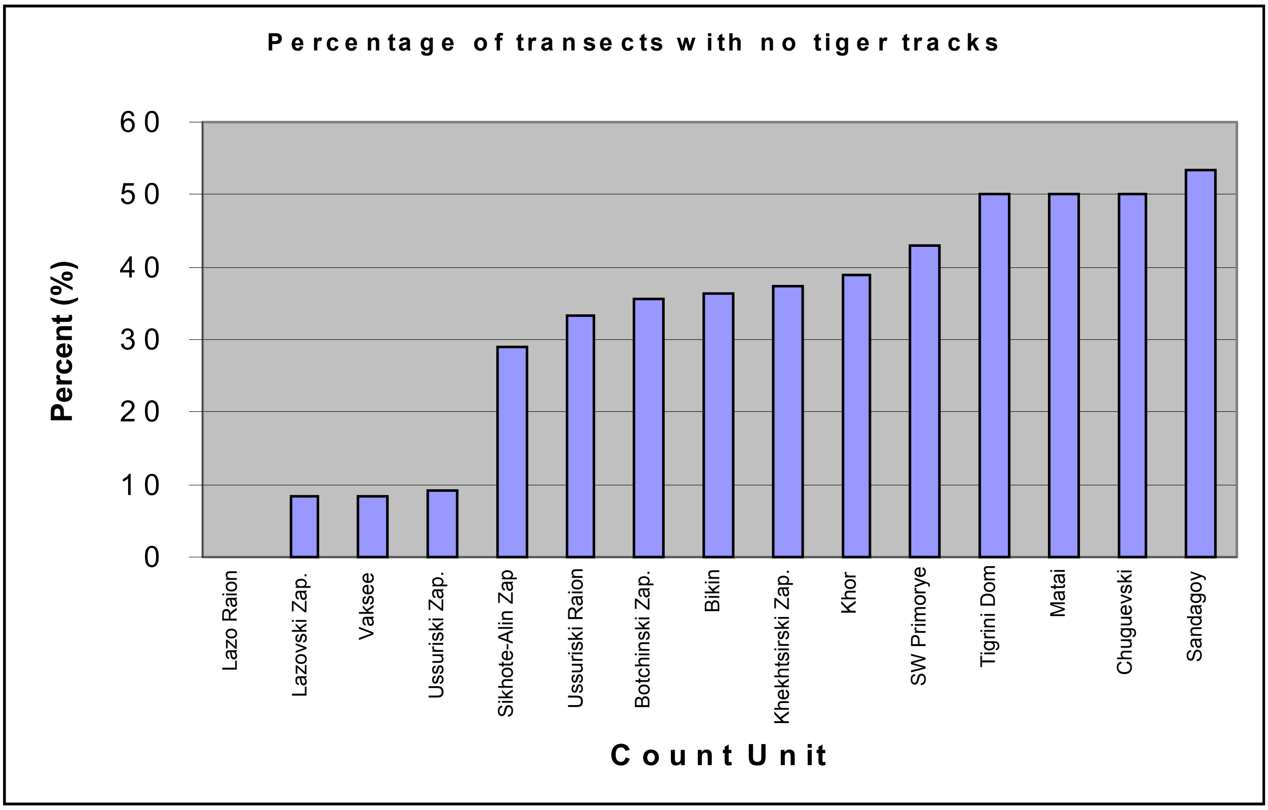


Figure 4. Percentage of transects with no tiger tracks in each of the 15 count units of the Amur tiger monitoring program for winter 1998.

One-third of the count units had zero counts on more than 40% of their transects, which may be at the higher end of the spectrum needed to detect trends. However, this value (number of zero count transects) should be a general indicator of the relative abundance of tigers in a count unit, and in fact, there is a relationship between the number of tracks reported per count unit and the number of transects with zero track counts (compare to Table 6, below).

Sampling Peripheral Areas for Changes in Tiger Distribution

As yet we have not completely developed a methodology or the infrastructure for monitoring periphery regions - i.e., regions where tiger occurrence is transitory. These areas provide important information on the status of the tiger population in general, and may provided a type of "early warning system". To date financial and logistic constraints have prevented implementation of this phase of monitoring. We hope to initiate this work in the future.

Measures of Tiger Abundance

We will rely on two measures of tiger abundance as we monitor the population across the 16 count units: relative density of tiger tracks on transects within each count unit, and an estimate of actual tiger numbers. The first value provides a statistically reliable way to assess changes in abundance independent of human bias (assuming data is collected in the same manner each year), while the second estimate provides a expert opinion of the actual number of tigers using a count unit in the course of a winter, and may also be useful for detecting trends.

Table 6. Summary of tiger track counts, mean track density, and statistical comparison of track densities on 15 count units for the first year of the Amur tiger monitoring program, winter 1997-1998.

#	Count unit	Total number of tracks	Number of transects (n)	Track density: mean # tracks/10 km (x)	Track density: standard deviation (sd)	Tukey's range test*
4	Lazovski Zapovednik	51	12	2.25	1.40	A
9	Sikhote-Alin Zap.**	205	62	1.65	1.72	A B
2	Ussuriski Zapovednik	27	11	1.43	1.01	A B C
5	Lazovski Raion	31	11	1.13	0.56	A B C
13	Bolshe Khekhtsirski Zap.	13	8	1.02	1.27	A B C D
16	Tigrini Dom	30	14	0.80	1.09	B C D
7	Vaksee (Iman)	28	12	0.77	0.57	A B C D
11	Bikin River	17	11	0.58	0.62	B C D
6	Sandagoy	21	15	0.52	0.73	B C D
3	Ussuriski Raion	18	12	0.51	0.47	B C D
15	Khor	14	18	0.50	0.50	B C D
12	Botchinski Zapovednik	14	14	0.39	0.36	B C D
1	Southwest Primorye	17	14	0.38	0.50	C D
8	Chuguevski Raion	15	14	0.31	0.37	C D
14	Matai River	19	24	0.25	0.29	D
Totals		520	252	0.94	1.20	

*Count units with the same letters are not significantly different.

The results of the track density data (Table 6) indicate that the highest density of tiger tracks is generally found in protected areas: four of the five count units with the highest track densities were zapovedniks. The value of zapovedniks as secure, core areas for tiger conservation is clearly demonstrated by these results.

Because the track count data is skewed by many zero counts and a few large counts, we performed an Analysis of Variance (ANOVA) on the ranks of the track density counts to determine if there were statistical differences in tiger track density among count units. Using the estimate of track density on each transect as the sampling unit, we found highly significant differences in track density among different count units ($df=14$, $F=5.67$, $P<0.001$). We conducted Tukey's studentized range test to determine which count units differed from each other. The results indicated that Lazovski Zapovednik stood out most significantly, differing from 10 of the 15 count units (Table 5). In contrast, Sikhote-Alin Zapovednik, which had the second highest track density, statistically differed from only three other count units (Table 5). The Matai River Basin, which had the lowest track density, was significantly different from the 5 count units with the highest track density (Table 5).

A second measure of tiger abundance was derived from "expert assessment" of the track data by each coordinator. This process is essentially identical to the "intuitive method" used in the 1996 survey (Matyushkin et al. 1996), and was conducted largely by the same individuals who participated in that survey. Therefore, these values can be compared to the results of that survey two years prior.

Tiger density estimated from the results of the expert assessment of tiger numbers shows a slightly different pattern than track density (Table 7). Two zapovedniks and Lazo Raion again reported highest tiger densities, but a number of other unprotected areas (Sandagoy, Bikin, and Vaksee) reportedly had higher densities of tigers than Sikhote-Alin and Bolshe-Khekhtsirski Zapovedniks, both of which ranked in the top five in terms of track density (Table 6). These differences probably relate to two factors: 1) in 1998, the Sikhote-Alin count unit included large

Table 7. Summary of tiger numbers and estimated tiger density in monitoring units for Amur tigers in the Russian Far East, winter 1997-1998.

Name	Area of count unit (km^2)	Tigers						Estimated Tiger Density (per 100 km^2)
		Male	Female	Female w/ 1 cub	Female w/ 2 cubs	Unknown	Total*	
Ussuriski Zapovednik	406.7	1	0	2		4	7	1.72
Lazovski Zapovednik	1192.1	4	3		1	2	10	0.84
Lazovski Raion	967.5	4	1	2		1	8	0.83
Sandagoy (Olginski Raion)	975.8	2	2	0		3	7	0.72
Bikin River	1027.1	0	3	0		3	6	0.58
Vaksee (Iman	1394.3	4	3	0		1	8	0.57
Sikhote-Alin Zap.	7749.7	11	8	5		19	43	0.55
Chuguevski Raion (Seneya)	1165.4	1	4	0		1	6	0.51
Ussuriski Raion	1414.3	2	3	0		1	6	0.42
Bolshe Khetsirski Zapovednik	475.6	1	1	0		0	2	0.42
Borisovkoe Plateau	1472.9	1	2	0		2	5	0.34
Tigrini Dom	2069.6	1	0	0		3	4	0.19
Khor	1343.8	1	1				2	0.15
Mataiski	2487.6	1	0	1	1	0	3	0.12
Botchinski Zapovednik	3051	1	1	1		0	3	0.10
Average	1812.9	2.3	2.1	0.8		2.9	8.0	0.54

tracts of land that were not part of the zapovednik (this will be changed in 1999); 2) definition of boundaries of count units have a large impact on estimates of tiger densities (unlike estimates of track density). For instance, one of the reasons that Botchinski Zapovednik may have the lowest estimate of tiger density is because there is a low number of transects for the large area (see transect density, Table 4), resulting in a lower probability of encountering tigers. Increasing the number of transects in Botchinski Zapovednik to a density similar to others (1.4 km transect/km^2 count unit), or decreasing the area of the count unit would likely change these results.

Ideally, these two indicators of tiger abundance – track density and expert assessment of tiger density – should be correlated if they are both good indicators of true tiger density. To assess this relationship, we ranked the indicators of abundance (Table 8), and conducted a regression analysis on these two factors (Figure 5).

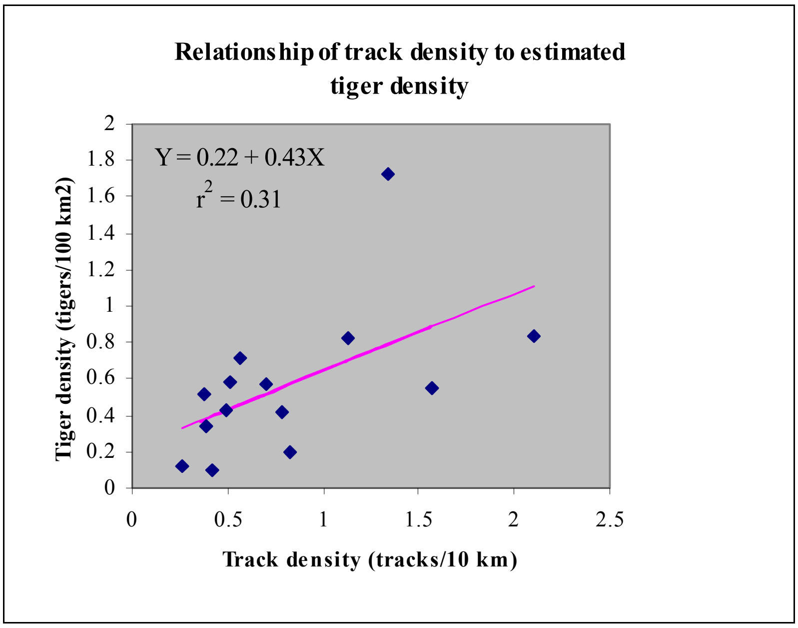


Figure 5. Relationship of tiger track density (measured as the number of tracks/transect averaged over both early and late surveys) and tiger density (estimated from expert assessment of tiger numbers) for 15 count units in the 1997-1998 Amur tiger winter monitoring program.

Although this relationship appears to be significant (df = 1,2, F = 5.5, $P < 0.04$), the relationship is very weak ($r^2 = 0.31$). The reason for a weak relationship may be simply a relatively small sample size, but it may be also reflect differences in how experts use track data to determine numbers of tigers. We looked at the relationship between the number of tracks counted in a count unit, and the number of tigers reported (Table 8). These data suggest that there is a large amount of variation in how different experts interpret track data. Data from northern count units (in Khabarovsk) were interpreted more conservatively (more tracks being attributed to fewer tigers) than in Primorye. In the most "liberal" interpretation of tracks, in Seneya (2.5 tracks/tiger), 3 times fewer tracks were considered representative of one animal than in the most conservative interpretation in Tigrini Dom (7.5 tracks/tiger). These differences may reflect real differences in frequency of tracks (related to date of last snow or movement of tigers in the area) or it may reflect real differences in how experts interpret track data. This problem will receive greater attention as more data is accumulated.

Table 8. Comparison of the ratio of tiger tracks reported and number of tigers estimated by expert assessment on count units for the 1997-1998 winter Amur tiger monitoring program.

#	Count unit	Total number of tracks	Total number of tigers estimated	Tracks/tiger
11	Tigrini Dom	30	4	7.50
8	Khor	14	2	7.00
10	Bolshe Khetsirski Zapovednik	13	2	6.50
12	Mataiski	19	3	6.33
1	Lazovski Zapovednik	51	10	5.10
14	Sikhote-Alin Zap. and adjacent	205	43	4.77
9	Botchinski Zapovednik	14	3	4.67
2	Lazovski Raion	31	8	3.88
3	Ussuriski Zapovednik	27	7	3.86
4	Vaksee (Iman	28	8	3.50
6	Borisovkoe Plateau	17	5	3.40
13	Ussuriski Raion	18	6	3.00
7	Sandagoy (Olginski Raion)	21	7	3.00
5	Bikin River	17	6	2.83
15	Chuguevski Raion (Seneya)	15	6	2.50
	Average	34.7	8.0	4.5

*Includes both Ussurriski Zapovednik and Raion

Tiger Reproduction

One of the important advantages of reporting numbers of tigers (versus only numbers of tracks) is that it provides an opportunity to monitor reproductive activity (i.e., the number of breeding females) on the monitoring units. This variable is particularly important in determining the quality of habitat, and the reproductive fitness of various segments of the Amur tiger population.

Of the thirteen litters reported within count units in 1997-1998, 9 (69%) were located in zapovedniks (Table 7), even though zapovedniks represented only 33% of the count units (5 of 15). We hope to build a spatial database of reproductive activity both on and outside count units to develop a better picture of areas of high reproductive output across tiger habitat, and areas of low output (population sinks). This information may be critical to identifying lands that are important to the reproductive success of the overall population.

Ungulate Densities

Because availability of prey is a key determinate of habitat quality for tigers, monitoring prey populations is essential to understanding the status of tigers in any given area. For maximum efficiency, we sought to incorporate ungulate surveys within the context of the monitoring program by collecting data on ungulates along transects designed for tiger monitoring. Such an approach may not be as accurate as if a survey were designed specifically for ungulates, but it is the most efficient and cost-effective method of collecting data on ungulate populations within the context of the monitoring program.

We collected data on 5 primary prey species: elk, wild boar, sika deer, roe deer, and moose. Sika deer are restricted to the southern and central regions of Primorye, and moose are restricted to

Khabarovsk and northern portions of Primorye: only elk, wild boar, and roe deer extend throughout tiger range. Results here exclude moose, which are rare, and contribute relatively little to the diet of tigers in most regions.

While we have collected data on both track density, and actual animal density, here we report only the former: number of ungulate tracks encountered/10 km along transects. A comparison of the total number of tracks (all 4 species combined) indicates that there is a general trend of lower ungulate track densities in the north, very high track densities in some of the southern areas, and medium track densities in the central count units (Table 9). As demonstrated with tiger track densities, higher track densities of ungulates are especially notable in zapovedniks, with the exception of Botchinski, which is a newly designated protected area.

Table 9. Ungulate track densities, and results of statistical comparison of track densities on count units of Amur tiger monitoring program, based on average track density from two counts (December-February) for each transect sampled in the 1997-1998 Amur tiger monitoring program.

	Number of transects (n)	Mean track density (tracks/10 km)	Standard deviation SD	Tukey's Range test				
Ussuriski Zapovednik	9	69,08	28,32	A				
Lazovski Zapovednik	12	52,38	47,69	A	B			
Sikhote-Alin Zapovednik**	62	44,16	75,72	A		C		
Southwest Primorye	14	41,01	29,00	A				
Ussuriski Raion	8	20,89	14,34	A			D	
Lazovski Raion	11	17,43	13,68	A			D	
Khor	18	14,06	14,28		B	C	D	E
Bolshe Khekhtsirski Zapovednik	7	13,97	5,65	A			D	
Vaksee (Iman)	12	8,81	11,26				D	E
Bikin River	11	8,31	5,43			C	D	E
Tigrini Dom	14	6,59	10,88				D	E
Chuguevski Raion	14	6,41	3,71				D	E
Sandagoy (Olginski Raion)	15	6,08	5,18				D	E
Matai River	20	5,38	3,22				D	E
Botchinski Zapovednik	14	2,83	1,82					E

Probably due to inherent patchy distribution of ungulates, and their tendency to group (especially sika deer and wild boar), distributions have a clumped pattern, resulting in high variances associated with track densities (as reflected in standard deviation estimates). To provide a more powerful testing of differences among count units, we conducted an Analysis of Variance (ANOVA) based on the ranks of ungulate track densities for each transect and a Tukey's studentized range test on those ranks to distinguish which count units are significantly different from others. This analysis confirmed that there are statistically significant differences among count units (df = 1,14, 240, F = 11.64, P = 0.0001). As already noted, two factors appeared responsible for differences in ungulate track densities: 1) as with tiger track densities, ungulate track densities tended to be higher in zapovedniks; and, 2) sika deer, which occur only in southern half of Primorye Krai, occur in high densities in some of the count units, greatly increasing track count estimates (Table 10). Sika deer occur in 6 of the count units, and in three of them (protected areas), densities are very high, resulting in high overall track densities. Elk and wild boar densities are generally considerably lower than sika deer track densities (Table 10).

Table 10. Summary of ungulate track densities, by species, in count units of the Amur tiger monitoring program, winter 1997-1998

#	Monitoring Unit	Tracks per 10 km along transects				Total track
		Red deer	Wild boar	Roe deer	Sika deer	density
1	Lazovski Zapovednik	1,29	1,49	4,30	45,30	52,38
2	Lazovski Raion	1,41	3,28	3,42	9,32	17,44
3	Ussuriski Zapovednik	7,41	17,22	16,88	27,57	69,08
4	Vakskee (Iman)	1,79	3,63	3,38	0,00	8,81
5	Bikin River	2,25	2,79	2,81	0,00	7,85
6	Boriskovkoe Plateau	0,02	6,42	4,76	29,81	41,01
7	Sandagoy (Olginski Raion)	2,00	0,45	2,67	0,97	6,08
8	Khor	8,02	1,93	3,90	0,22	14,06
9	Botchinski	2,30	0,03	0,51	0,00	2,84
10	Khekhtsir	12,71	0,82	0,45	0,00	13,98
11	Tigrini Dom	4,78	0,97	0,84	0,00	6,59
12	Mataiski	2,61	0,75	2,01	0,00	5,37
13	Ussuriski Raion	3,24	4,86	11,90	0,88	20,89
14	Sikhote-Alin Zapovednik	23,04	4,29	10,69	6,14	44,16
15	Seneya (Chuguevka)	1,80	4,67	2,66	0,29	6,41
	Average	8,68	9,55	5,72	12,83	36,77

The two most widely distributed, and most important prey species of tigers – red deer and wild boar – show different patterns of distribution. (Figures 6 and 7). Red deer densities exceeded 5 tracks/10 km only in 4 count units, and reached their highest densities in Sikhote-Alin Zapovednik. Wild boar track densities were consistently low across most of the count units, with the exception of Ussuriski Zapovednik.

Over time we will be able to monitor changes in track abundance of ungulates within these count units, which should provide an important indicator of changes in habitat quality for tigers.

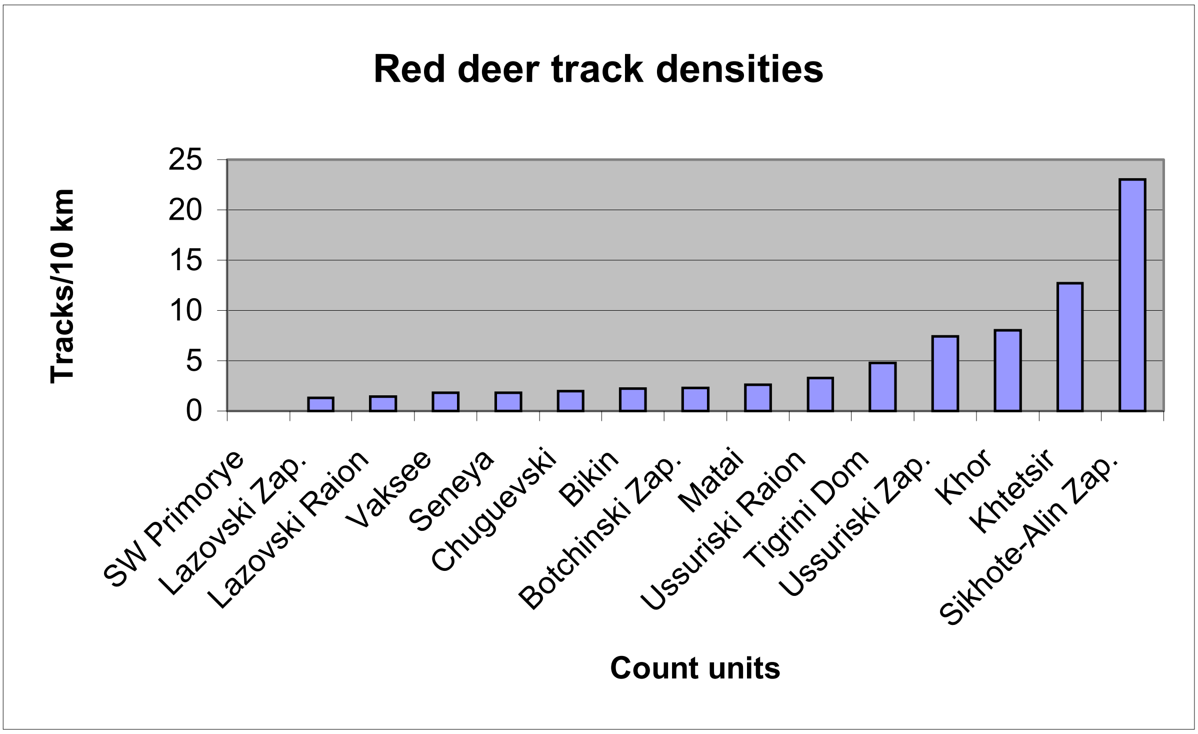


Figure 6. Red deer track densities on 15 count units of the Amur tiger monitoring program, based on the average track density for each transect from two winter counts (December and February), 1997-1998.

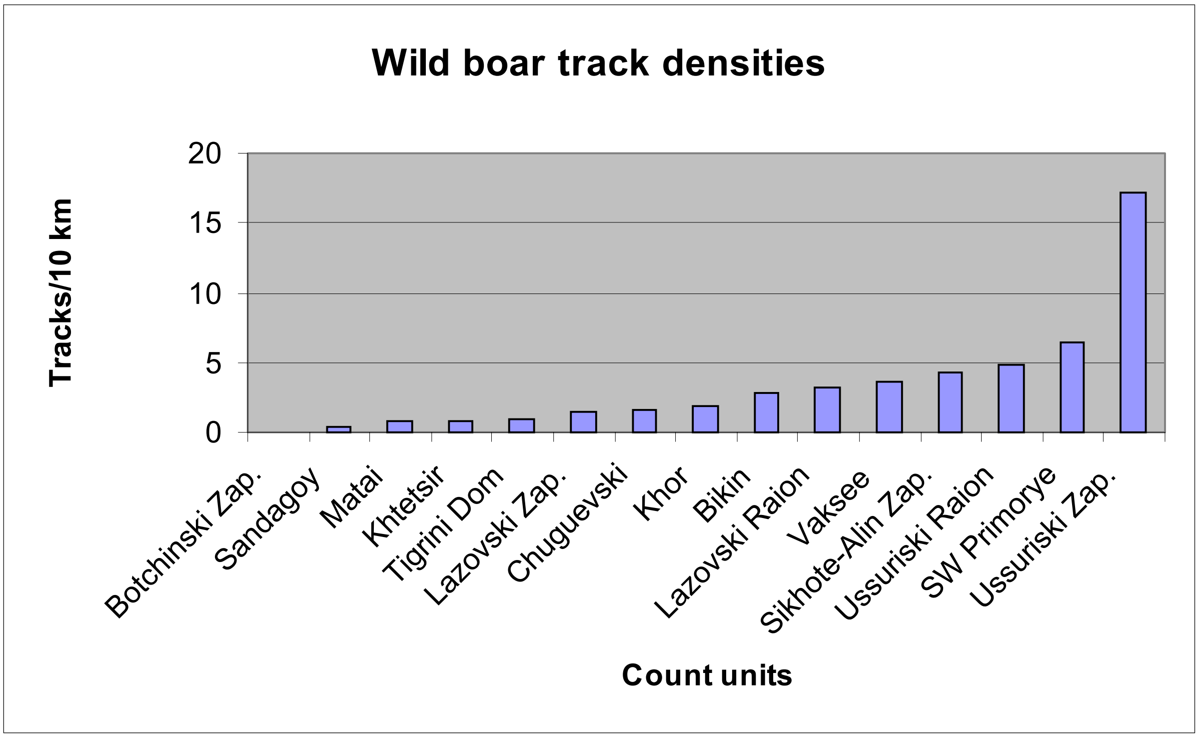


Figure 7. Wild boar track densities on 15 count units of the Amur tiger monitoring program, based on the average track density for each transect from two winter counts (December and February), 1997-1998

Tiger numbers should be largely dependent on the density of prey species in any given area. Our data on track densities of ungulates and tigers provides an opportunity to assess this relationship over the 15 count units. A regression analysis demonstrated a significant relationship (P = 0.02) between tiger track numbers and ungulate track numbers (Figure 8). In the future we hope that we will be better able to define this relationship, because it has an important bearing on understanding tiger numbers and survival in any given area. Once this value is well defined, large deviations from this pattern in any given area may suggest that other factors are impacting tiger survival (e.g. poaching or other human sources of mortality).

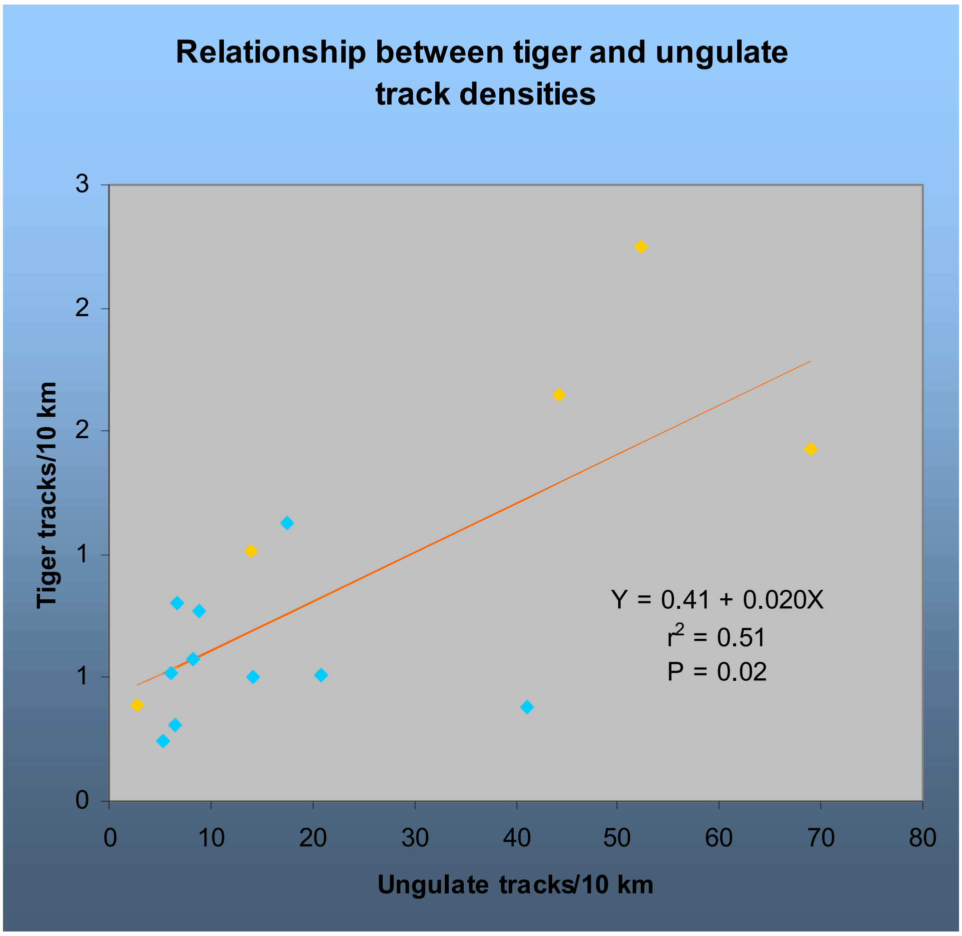


Figure 8. Relationship between track densities of tigers and ungulate species in 15 count units of the Amur tiger monitoring program, 1997-1998, where densities are estimated as the mean density of tracks (averaged over two count periods) on each transect within count units.

Human Impacts

Base line data on the extent of human impacts on count units is presented in Table 11. These impacts will be monitored on a yearly basis, which we hope will provide indications of changes in the quality of habitat across count units. By themselves, these data may not represent the entire range of impacts on tiger habitat, but they may provide important information on trends of impacts, and in what portions of tiger range those impacts are being most severely felt.

Table 11. Summary of human impacts on monitoring units for Amur tigers in the Russian Far East, 1998.

			Human Impacts on Monitoring Unit						
			Roads		Logging			Commercial	#
			general	forest	Total area	Number of areas	Burns	Enterprises	settlements
#	Krai	Name	(km)	(km)	(ha)		(ha)	n	
1	Primorye	Lazovski Zapovednik	4	30	0	0	310.4	0	0
2		Lazovski Raion	25	145	109	14	58	5	13
3		Ussuriski Zapovednik*							
4		Ussuriski Raion*	162*	450*	377.6*	41*	5178*	0*	14*
5		Vakskee (Iman)	33	230	450	8	0	0	2
6		Bikin River	15	30	35	3	0	0	0
7		Borisovkoe Plateau	51	155	175	8	15	2	12
8		Sandagoy (Olginski Raion)	72	132	12	2	0	0	4
9		Chuguevski Raion (Seneya)	80	180	15	3	6	0	6
10		Sikhote-Alin Zapovednik**	270	320	680	25	1228	0	3
11	Khabarovsk	Khor	50	97	200	18	0	0	0
12		Botchinski Zapovednik	0	70	0	0	0	0	0
13		Bolshe Khetsirski Zapovednik	105	160	1000	5	0	0	0
14		Tigrini Dom	0	0	0	0	0	0	0
15		Mataiski	110	160	0	17	70	0	2
	Totals (average)								

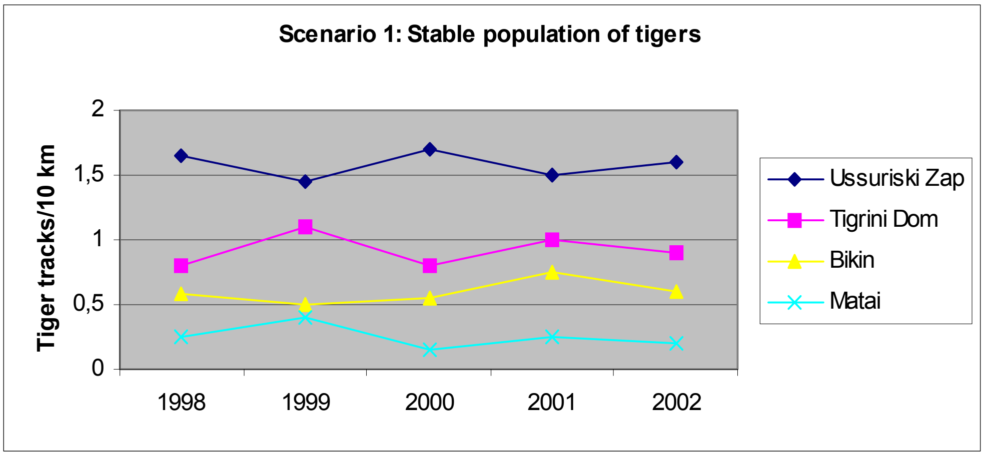
*Includes both Ussurriski Zapovednik and adjacent Ussuriiski Raion count units
** Includes both Sikhote-Alin Zapovednik and adjacent, unprotected lands

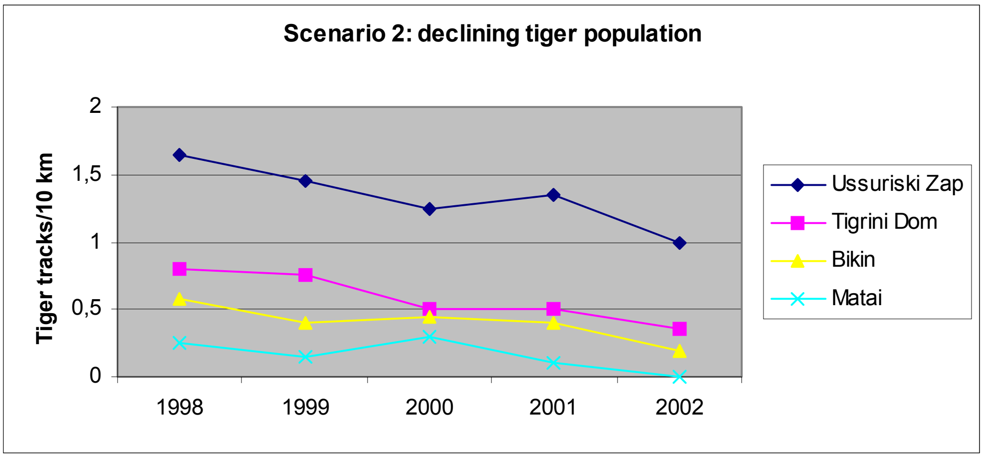
How this data will be used in the future: trend analysis.

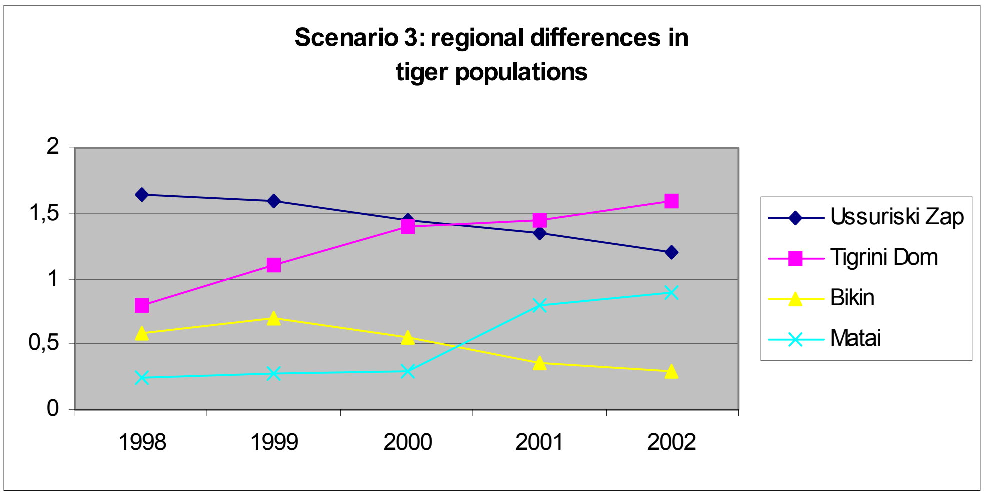
The most valuable aspect of this work lies in its power to detect long-term trends in the status of Amur tigers across their entire range. As yet we have only begun this program, so it is impossible to demonstrate exactly how this data will be analyzed. However, for illustrative purposes, we present 3 scenarios, using just 4 protected areas, to demonstrate some aspects of how the data will be useful in the future (Figure 9). By looking at overall trends between the 16 count units, we should be able to detect if there are significant changes in tiger numbers over time. Such changes may reflect a general stability in tiger numbers (Scenario 1), an overall downward trend in tiger numbers (Scenario 2), or there may be regional differences (Scenario 3), in which tiger numbers in different parts of their range are responding to different pressures. Use of a battery of statistical tests will help us to determine the significance of changes in track densities, and use of the expert assessments on actual tiger numbers will act as an important second means of assessing trends.

In short, the value of this work will lie in a long-term commitment to collection of data on a yearly basis. The foundation has been established for an effective monitoring program that will reflect the changes in tiger numbers brought about by negative impacts or appropriate management actions. Support of this program will be essential to assessing the fate of the Amur tiger in Russia.

Figure 9. An example of different trends that might be expected from long-term monitoring of the Amur tiger population, here demonstrated with only 3 scenarios from 4 of the 15 count units.







Appendix III. An example of the GIS database developed for each count unit, here represented by a set of maps and tables from the Bikin River count unit.

1. Boundaries, river system, and eleven transects developed in Bikin River count unit for 1997-1998 winter monitoring program.

2. Location of tiger tracks reported for the Bikin River count unit in December 1997 (in red) and February 1998 (in green) along transects for the Amur tiger monitoring program.

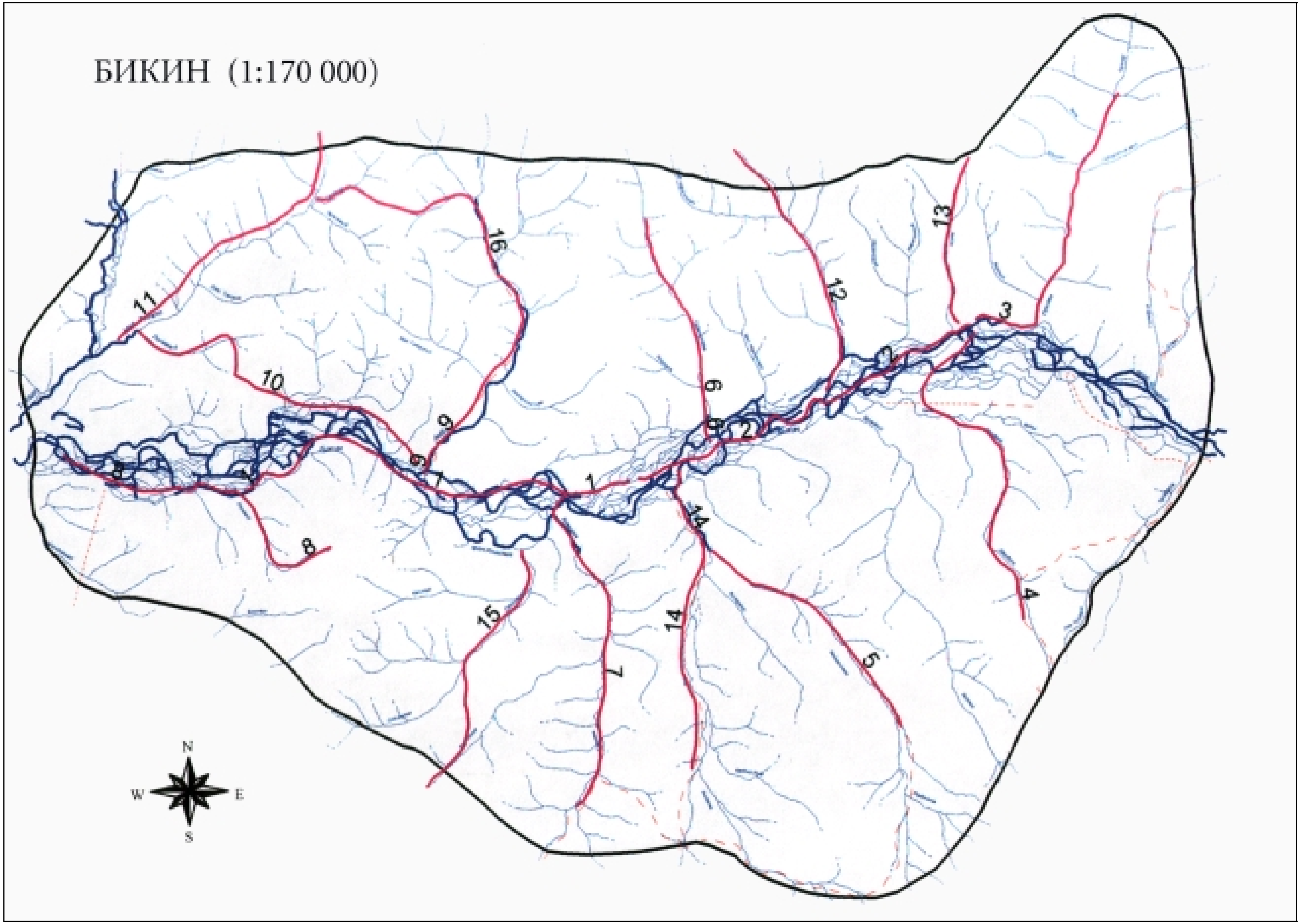
3. Number, name, date surveyed, date surveyed, length, and type of transportion on all 11 transects surveyed on the Bikin River count unit for the 1997-1998 Amur tiger monitoring program.

4. Location of tigers, by transect in the Bikin River count unit, 1997-1998, for the Amur tiger monitoring program.

5. Summary of number of tigers on the Bikin River count unit during winter, 1997-1998, based on expert assessment of tiger track data.

6. Record of every tiger track reported on transects in the Bikin River count unit, with information on track size, estimated sex and age of animal that made track, age of track, and name of fieldworker who reported data for the 1997-1998 Amur tiger monitoring program.

7. Ungulate data from the Bikin River count unit for the 1997-1998, for the Amur tiger monitoring program.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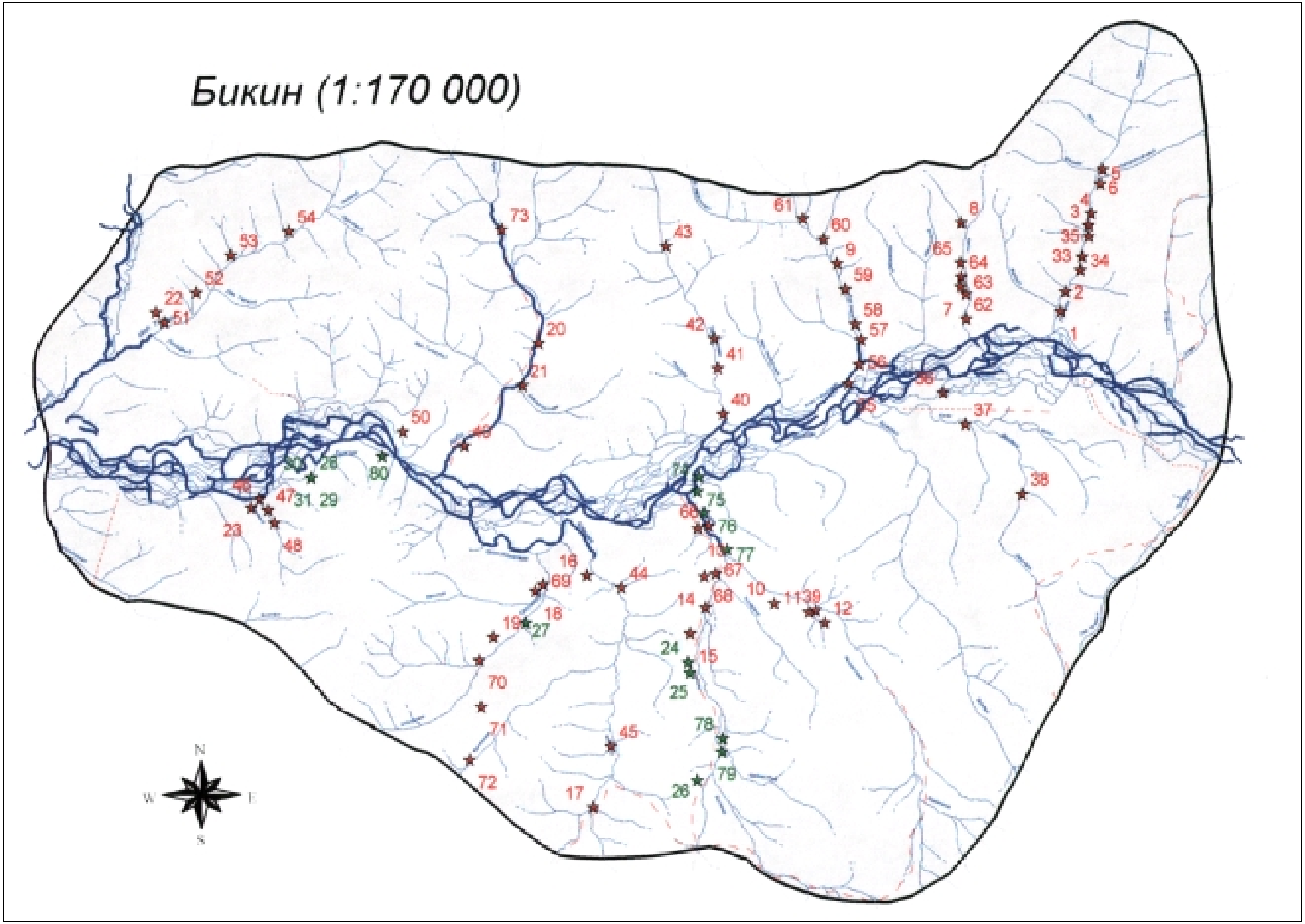
Бикин (1:170 000)

Сведения о маршрутах

Маршр	Описание	Дата	Учет	Длина	Тип
1	Бикин, низовья	04.01.99	Декабрь98	19	М
2	Бикин, верховья	04.01.99	Декабрь98	20	М
3	р. Пушная	05.01.99	Декабрь98	12	П
4	Джубяса	05.01.99	Декабрь98	11	П
5	Леснуха	06.01.99	Декабрь98	13	П
6	Таймень	08.01.99	Декабрь98	10	П
7	Кленовка	09.01.99	Декабрь98	14	П
8	Корневой	10.01.99	Декабрь98	14	П
9	Амба	10.01.99	Декабрь98	22	П
10	Линейный - Амба	10.01.99	Декабрь98	14	М
11	М. Тахоло	09.01.99	Декабрь98	17	М

Сведения о тиграх на маршрутах

Учет	Маршрут	Самцы	Самки	Самки с тигрятами	Тигрята без самок	Неизвестно
Декабрь98	3	1	1	0	1	0
Декабрь98	5	0	1	0	0	0
Декабрь98	7	0	0	0	1	0
Декабрь98	8	0	1	0	0	0
Декабрь98	9	0	1	0	0	0
Декабрь98	11	0	1	0	0	0
Декабрь98	14	0	0	0	2	0
Декабрь98	15	0	1	0	0	0

Сведения о тиграх

Номер тигра	Пол	Возраст
1	С	В
2	НО	Т
3	С	В
4	НО	Т
5	С	В
6	НО	Т

Регистрация следов тигров на модельном участке «Бикин»

Учет	Маршрут №	След №	Передняя пятка	Задняя пятка	Совмещенный след	Давность	Пол	Возраст	Дата снегопада	Глубина снега	Примечание	Учетчик
Декабрь97	3	7	9	0	0	Сутки или менее	НО	В	18.12.97	10	Живет постоянно	Порхало
Декабрь97	6	1	8,7	0	0	Более 7 суток	НО	НО	18.12.97	10		Пикунов
Декабрь97	8	2	8	0	0	Сутки или менее	НО	В	27.12.97	20	Две лежки на льду	Смирнов
Декабрь97	8	3	8	0	0	Сутки или менее	С1	В	27.12.97	20	Самка шла в паре с тигренком	Смирнов
Декабрь97	8	4	7	0	0	Сутки или менее	НО	Т	27.12.97	20		Смирнов
Декабрь97	9	5	9	8,0	0	4-7 суток	С1	В	27.12.97	22,5	Возможно те же	Пикунов
Декабрь97	9	6	9	8,0	0	4-7 суток	С1	В	27.12.97	22,5	Те же, что и у Смирнова. Шли вверх по Амбе	Пикунов
Февраль98	3	11	8	0	0	Более 7 суток	С1	В	03.02.98	42,5		Шереметьев
Февраль98	3	12	0	0	0	Более 7 суток	НО	Т	03.02.98	42,5	Ходят в паре	Шереметьев
Февраль98	5	8	7	0	0	2-4 суток	НО	Т	03.02.98	42,5		Шибнев
Февраль98	5	9	10	0	0	Более 7 суток	С	В	03.02.98	42,5	Одна и та же самка	Шибнев

Информация по копытным на модельном участке «Бикин»

Учет	Маршрут	Изюбрь		Плотность на 10 км	Кабан		Плотность на 10 км	Косуля		Плотность на 10 км	Олень		Плотность на 10 км
		Следы	Особи		Следы	Особи		Следы	Особи		Следы	Особи	
Декабрь97	1	8	5	4,21	0	0	0	19	12	10,01	0	0	0
Декабрь97	2	0	0	0,0	0	0	0	0	0	0	0	0	0
Декабрь97	3	5	2	3,10	4	2	2,48	2	2	1,24	0	0	0
Декабрь97	4	5	3	3,61	15	8	10,82	0	0	0	0	0	0
Декабрь97	5	3	1	1,68	2	1	1,12	0	0	0	0	0	0
Декабрь97	6	1	1	1,15	13	8	14,95	2	2	2,30	0	0	0
Декабрь97	7	0	0	0,0	0	0	0	0	0	0	0	0	0
Декабрь97	8	2	2	1,43	11	6	7,84	6	4	4,28	0	0	0
Декабрь97	9	2	2	1,42	4	2	2,83	9	7	6,37	0	0	0
Декабрь97	10	4	2	4,44	1	1	1,11	4	3	4,44	0	0	0
Декабрь97	11	2	2	1,16	1	1	0,58	1	1	0,58	0	0	0
Февраль98	3	4	3	2,48	0	0	0	0	4	0	0	0	0
Февраль98	4	6	3	4,33	0	3	0	1	1	0,72	2	2	1,44
Февраль98	5	0	1	0,00	0	0	0	4	2	2,24	15	10	8,40
Февраль98	6	1	6	1,15	0	0	0	7	4	8,05	0	0	0
Февраль98	7	10	0	7,52	0	0	0	4	2	3,01	0	0	0
Февраль98	9	0	2	0,00	0	2	0	0	2	0	0	0	0
Февраль98	10	3	2	3,33	0	0	0	4	2	4,44	0	0	0
Февраль98	11	5	2	2,91	0	0	0	0	4	0	0	0	0