THE SIBERIAN TIGER PROJECT™
ECOLOGY AND CONSERVATION OF THE SIBERIAN TIGER

Final Report To
Save The Tiger Fund/National Fish and Wildlife Foundation
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Maurice G. Hornocker and Howard B. Quigley
Co-Directors, Siberian Tiger Project™
Hornocker Wildlife Institute, Inc.
Moscow, Idaho

EXECUTIVE SUMMARY

The Siberian Tiger Project™ has now completed more than five years of field work, along with almost two years of preliminary planning. During this reporting period, we continued to focus on the creation of the best possible data base for understanding Siberian tiger ecology, which is being used in the creation of plans for the future conservation of the animal in the wild. In addition to the fieldwork, our programs in conservation planning and environmental education continue to develop.

The field program in the Sikhote-Alin Reserve added one study animal, Tiger 23, to the previous nine that were being radio-tracked. This animal is especially important since it was still travelling with its mother, Tiger 04; documenting dispersal is a primary focus of our efforts now. More than one-hundred seventy locations were obtained on these animals, along with more than fifty kills, and the documentation of one additional litter; four litters were tracked providing essential, hard-to-get information for conservation planning. In addition, digitizing of the cover map for habitat analysis within the Sikhote-Alin Reserve has been completed, allowing us to begin analysis for habitat types critical for tiger survival in the Russian Far East.

The conservation-planning portion of the Project continues to promote and modify the document, A Habitat Protection Plan for the Conservation of the Amur Tiger, a preliminary attempt to integrate field information on the tiger with range-wide land-use planning for the species. The environmental education program produced its annual tiger calendar and a poster appeal by the actor Bruce Willis, both of which are distributed in the Russian Far East. In addition, through supplementary funding, a community conservation project was begun in the town of Melnichnoye on the west side of the Sikhote-Alin Reserve.

INTRODUCTION

This report updates the activities and accomplishments of the Siberian Tiger Project™ through May, 1997. Since this document may be distributed to various readers, some of whom may have limited knowledge of our activities, we include information on the overall background and objectives of the Siberian Tiger Project™. We hope this allows readers a greater appreciation of the scope of work the Siberian Tiger Project™ has undertaken, how the activities of the past few months fit into the bigger picture, and a vision of where we are going with our Russian colleagues, not only in the conservation of the Siberian tiger, but natural resource conservation overall in the Russian Far East.

As we assess our achievements in our sixth year of the project, we feel much has been accomplished, and much is yet to be done. We have captured and released 16 tigers, six leopards, and nearly 20 bears for study and have accumulated a sizable body of data on these animals' activities. Our accomplishments have been not only in the realm of scientific field research. Due in great part to the attention focused on the Project, information concerning the plight of the Siberian tiger and the ecological crisis in the Russian Far East has reached worldwide. With the data gathered to date, along with our in-depth knowledge of the area and the unique problems that exist there, we are in a unique position to develop and carry out conservation strategies for the tiger and the forest community upon which it depends. Our collaboration with the Wildlife Conservation Society, World Wildlife Fund-Germany and WWF-U.S., the U.S. Agency for International Development's EPT Project, along with close associations with the Russian Ministry of Ecology and the Far Eastern Branches of the Academy of Sciences, provide a solid foundation from which to continue a myriad of science and conservation activities.

The Hornocker Wildlife Institute's Far East Russian Program was born in 1988 around a campfire in the Idaho wilderness. The idea of a collaborative investigation of the Siberian tiger was proposed to some visiting Russian scientists. Though the idea had been intriguing to many scientists previously, few had attempted to begin such an activity. The objectives of the project were straightforward: to apply scientifically gathered information to the conservation of the subspecies. The goal from the beginning of the Project has been to provide the best possible information on the ecology and dynamics of the tiger population. This database would provide the foundation for conservation planning.

At the time of the initial contact with our Russian counterparts, the number of Siberian tigers in the wild was estimated to be between 400 and 500; more than ninety-percent of the population occurs inside the borders of Russia, in the Provinces of Primorye and Khabarovsk (see Attachment 1). This number was critically low, and conservation efforts were not underway. But conservation planning is only as good as the base of information from which it is developed. Although Russian scientists had gathered immensely important data on tiger ecology in the previous 20 years, it was limited by the fact that they relied on the traditional form of snow tracking (that is, following tiger tracks during the snow-bound months of the year). This meant that much of the annual cycle of life for the Siberian tiger was unknown. Moreover, specific individuals could not be tracked over long periods of time, an important element in describing the life history of a long-lived species such as a tiger. We proposed to bring Western technology and techniques to Russia, meld them with ongoing Russian work, and put the entire picture together through a joint effort.

With encouragement from their Soviet guests in 1988, the Hornocker Wildlife Institute moved ahead with planning and fundraising. Despite the dissolution of the Soviet Union and a 1991 failed coup attempt in Moscow (among many other major obstacles), the Hornocker Wildlife Institute's Siberian Tiger Project™ survived. In 1992, field work commenced with a collaborative team consisting of representatives from Hornocker Wildlife Institute, the Sikhote-Alin State Biosphere Reserve, the Far Eastern Institute of Geography, and the Far Eastern Institute of Biology and Soils. These collaborations continue to be at the core of Project activities and successes.

As one of the very first American "ventures" in the Russian Far East, the Siberian Tiger Project™ was historic in demonstrating the feasibility of successful, cooperative work in the region. Later, a host of non-government organizations, the Peace Corps, the U.S. Agency for International Development, and even an American consulate became established in the Russian Far East. But the Hornocker Wildlife Institute led the way in establishing a presence in the region.

The scope of Hornocker Wildlife Institute involvement in the Russian Far East has expanded beyond the initial biological field investigations of the Siberian Tiger Project™. It was obvious from the start that to conserve the tiger, a wide-ranging conservation program would be essential. And, from our first contacts, our mission has been to seek collaborative associations for program development, because, ultimately, it is the Russian scientists, agencies, resource managers, and local people who will decide the fate of their own natural resources. One of the goals of the Hornocker Wildlife Institute has been, and will continue to be, to provide leadership in initiating activities, relying heavily on Russian colleagues, transferring as much responsibility as possible to nationals, and providing training where appropriate and when requested. While the heart of our program continues to be scientific investigation, we have supported, directly and indirectly, a variety of programs aimed at conservation of the natural resources of the Russian Far East.

The Hornocker Wildlife Institute has finished more than five years of field study in the Russian Far East. Given the chaotic economic and political realities of working in Russia, we feel our achievements are substantial. We have fostered important ties with colleagues, institutions, and communities, and provided an important framework for conservation activities. Below is a summary of accomplishments and activities.

RESEARCH ACTIVITIES

When examining the potential for research on solitary carnivores, one of their most important characteristics to consider is their secretive behavior. Although this is a behavioral adaptation to its predatory lifestyle, it makes scientific observations of many of their activities difficult, if not impossible, to document with reliability. Thus, one of the most useful tools for the study of carnivores is the radio-transmitter. In the case of carnivores, the transmitter is attached by means of a collar. With this radio-collar in place, study animals can be followed for two years or more, until the batteries no longer produce energy. To attach the radio-collar, researchers must temporarily capture animals and immobilize them with anesthetizing drugs so they can be handled safely. While the animal is immobilized, measurements are taken, the animal is generally examined, and the radio-collar attached before the animal is again released back to the wild. In addition, a small about of blood and tissue are taken from each captured animal. These samples are analyzed for genetic characteristics important to our understanding of how individuals are related to each other, and the diversity of the genetic stock as it relates to conservation issues.

Once captured animals are released, to determine aspects of their ecology and biology, their movements are followed by tracking the signals from their radio-collars. In the Russian Far East, given the rugged landscape and the extensive movements of tigers, radio-telemetry tracking is performed most reliably through the use of aircraft. Whenever possible, however, closer tracking is performed to produce more specific information on tiger activities and behaviors. Below are descriptions of the activities and results of the field investigation, as well as our activities in the application of the information to issues important in the conservation of the Siberian tiger and the natural resources of the Russian Far East.

The primary study site for the Siberian Tiger Project™ has been, and continues to be, the Sikhote-Alin Biosphere Reserve. However, the Project also operates a smaller field research undertaking in and around Kedrovia Pad Reserve in the southern part of the Primorye Province (see Attachment 1). This southern project was originally designed to focus on tigers, with additional, peripheral information to be generated on the endangered Amur leopard. However, early in 1995, this was reversed so that activities could emphasize Amur leopard ecology and conservation, with additional, peripheral information collected on tigers. This project is currently operated as the Amur Leopard Project, centered in the Kedrovia Pad Reserve (see Attachment 1), also under the direction of the Hornocker Wildlife Institute.

Capture Activities

Helicopter captures. We recaptured Tiger 01 and Tiger 16 (Tables 1 and 2) by helicopter in March, 1996, to change their radio collars because the batteries were due to fail. Both tigers were captured on the first attempt; however, we attempted to capture both tigers once in December, 1995, as well. In March of 1997, we also made a recapture attempt on Tiger 03; success was also obtained on our first attempt in this instance. Since March, 1995, we have recaptured eight tigers in ten attempts; a success rate of 80% for the helicopter recapture method. There were several instances when we were unable to pursue an individual animal because the animal was in dense cover where it could not be seen from the air. Hence, this success rate reflects the probability of recapturing an animal given suitable cover.

Ground trapping. We trapped in the Nevedeemka area from 1 May through 18 June, 1996; our objective was to capture Tiger 18 and Tiger 19's mother; tracks believed to be hers were observed in the area during winter and spring 1996. Scat and fresh scent marks indicated that both a male and a female tiger were using the area within two weeks before we set traps and boar and elk were using the area heavily. However, there was no evidence of tigers using the area during trapping, except when Tiger 20 entered the area on 18 June. During Nevedeemka operations, we equipped one new adult male Himalayan black bear

(Ut22) with a radio collar (Table 1). Hence, six black bears currently have functioning collars. These bears will provide important ecological data for this rare animal and will allow us to make comparisons between black bears and brown bears.

We also trapped in the Sheptoon drainage from 3 May to 18 June, 1996, with the objective of capturing an adult male tiger who had been heavily using the area during winter and spring, 1996. In Sheptoon, we radio-collared a large adult male brown bear (Ua17), an adult female brown bear (Ua21) with at least one yearling cub, and a young adult male tiger (Tiger 22; Tables 1 and 2). In addition, we recaptured Tiger 21.

From October through December, we trapped for the cubs of Tiger 01, Tiger 04, and Tiger 15, primarily by setting traps on kills. We captured Tiger 04 and her cub (Tiger 22) on 18 October in snares set on a kill. Because Tiger 04 has been tracked since the first year of the project – and this is her third documented litter – this was an important capture. We set snares on kills of Tiger 15 on three occasions, but she and her cub never returned to a kill with a snare. We flew to capture the cubs of Tigers 01, 03, and 15 from the helicopter as well, but the cubs were not with their mothers during three attempts on Tiger 01, two on Tiger 15, and one on Tiger 03.

We trapped in the Haunta-mi area for approximately one month in May with the hope of capturing Tiger 15's cub and in the Koorima area for three weeks in June for Tiger 03's cubs. We captured no tigers but caught a young adult female brown bear in Blogadatna and an adult male Himilayan bear in Koorima. We fitted the brown bear with a radio collar. We will continue to closely monitor Tiger 03 with the hope of finding a kill close enough to a road to set traps on it.

Radio-tracking and Status of Radio-collared Tigers

Our goal in data collection on study animals has always been to obtain at least one location every two weeks on each animal. To accomplish this goal, we are highly dependent on aerial support for radio tracking; this is the backbone of our radio-tracking system. Ground radio tracking is performed as a follow-up to aerial radio tracking to obtain specific information on behavior, reproduction, and survival. Ground radio tracking is also used to provide more intensive information on movements and provide fill-in locations when it is not possible to fly for locations.

Overall, our ability to obtain locations on study animals is dependent on multiple factors, including availability of aircraft, fuel, and funds. Due to the ruggedness of the study area, the distances covered by these large carnivores, and the remoteness of some tiger habitat, the field team is constantly confronted with the problem of compensating for biases toward the most accessible study animals. Conversely, however, these most accessible animals are providing our best picture of tiger behavior and tiger ecological requirements. During this reporting period, we were hampered many times by lack of fuel for aircraft or availability of vehicles. However, these problems were not insurmountable or uncommon, and were dealt with rapidly to assure consistency of data collection. We have heard rumors, however, that the regional flying authority, Vladivostok Air, may raise the price of flights by as much as two times the present cost (about $600/hr). We are examining alternatives to this very high cost of locating our study animals. In the meantime, all is function and the following is a summary of movements for radio-collared study animals.

Tiger 01. Several hunters and forest guards observed the tracks of a tiger with young cubs within Tiger 01's home range throughout winter 1995-1996. Snow tracking and radio-tracking information on 4-8 March confirmed that Tiger 01 had three cubs. However, we saw only two cubs from the helicopter on 24 and 28 March, 1996; and only two cubs were seen when we observed Tiger 01 and her cubs on the road 2 September. We assume one cub died between 8 and 24 March. Based on cub track size and observations of cub tracks as early as 1 December, 1995, we estimate these cubs were born in late October, 1995 (Table 2). When we observed the cubs on 2 September, both appeared in good condition. One cub was nearly twice the size of the other, indicating one is likely a male and the other a female. Tiger 01 was still with her cubs in late December.

The fate of Tiger 01's previous litter of one cub is unknown. It would have been approximately 14 months old when the new litter was born in October, 1995 and only 11 months old at the time that Tiger 01 mated; at 11 to 14 months, it should have still been with her mother; hence, either the cub died, or was still with her mother at the time of breeding and reproduction. Although inconclusive, evidence suggests the latter may be true. Tracks indicated that the cub was still alive in July, 1995, and a forest guard observed three tigers together in an area where Tiger 01 had been recently located in August, 1995, when Tiger 01 would have bred to produce a litter in October. Lastly, we observed 8.5 and 9.0 cm wide tiger tracks associated with Tiger 01's cubs in December, 1995; the 8.5 cm track could have been the cub. That Tiger 15 and Tiger 16 probably copulated in August, provides further evidence that Siberian tigers may breed well before cubs reach dispersal age. However, it is also possible that both tracks belonged to Tiger 01, with measurement variation resulting from substrate differences.

Tiger 01 was in very good physical condition when captured in March (Table 1). She spent most of January, February, and March in a small area well north of the Reserve where wintering elk had congregated. An intensive search of this area produced seven elk killed by Tiger 01 and several scats.

Tiger 01 was observed with her cubs in January and again in February. When we attempted to capture her cubs from the helicopter on three occasions in March, Tiger 01 was alone. However, snowtracking during the same period indicated that both cubs were travelling within Tiger 01's home range. Hence, family breakup may have been occurring in March when the cubs were 16-months-old, but the cubs had not yet dispersed.

On 13 May, 1997, two cows were killed and one mortally wounded at the south edge of Tiger 01's home range. Tracks at the kill site measured 10.5 cm, indicating that the tiger was a young male, possibly Tiger 01's dispersing male offspring. The tiger was sighted several times near and in Terney during May and June and killed one more cow and probably two horses in June. Also, one cow and three pigs have been reported missing. The tiger was last seen on 21 June in Terney by local police who reported firing shots into the air to scare the tiger.

Tiger 03. Snow tracking data indicated Tiger 03's cubs (Table 2) traveled with Tiger 03, but also traveled considerable distances on their own in December, 1995. On 19 December, and in late January, 1996, Tiger 03 was with Tiger 16, indicating that she may have been in estrus and that her cubs were in the process of dispersing.

We believe that Tiger 03 and Tiger 16 were together for mating; this is supported by the fact that their meetings were separated by about one month, the estrus interval for female tigers. Further, the two were first located together in Tiger 16's home range and outside of Tiger 03's home range, indicating that Tiger 03 sought out Tiger 16. The home ranges of Tiger 03 and Tiger 16 overlap very little, while the home ranges of Tiger 03 and Tiger 20 overlap completely. Hence, Tiger 16 probably "usurped" a mating (with Tiger 03) from Tiger 20. This indicates that even small amounts of male-male and male-female home range overlap are biologically significant.

On 28 December, 1996, from the helicopter, we observed Tiger 03 with one cub. The cub was large and we estimated it was probably three to six months old. A priority for January, 1997, was to determine by snow tracking the number and age of Tiger 03's most recent litter.

Tiger 03 was in good physical condition when recaptured in March. On two occasions in March, we observed Tiger 03 with three cubs. We estimated the cubs weight between 55 and 80 kg, indicating that the cubs may have been as old as ten months. If ten months old, the cubs would have been born in May, 1996, three months after Tiger 03 and Tiger 16 were together in January 1996. Hence, Tiger 16 may be the father, again adding evidence that he usurped a mating with Tiger 03 from Tiger 20.

Tiger 04. In 1996, Tiger 04 limited her movements to a small area in the northern portion of her original home range since the birth of her cub in July, 1995. We believe she gave up most of her home range to a daughter from a previous litter. Her cub, born in late July, 1995, was captured and radio collared along with Tiger 04 in October, 1996 (Table 2).

When captured in October, Tiger 04 was in good physical condition, but her teeth displayed heavy wear and three canines were broken, two at the gum line and one about two centimeters above the gum; the breaks were not the result of capture.

During 1997, Tiger 04 still traveled exclusively in a small area in the northern portion of her original home range. Her current home range is considerably smaller than her original home range and its boundaries include some new areas that were not part of her original home range.

Her cub, Tiger 23, born in late July, 1995, was captured and radio collared along with Tiger 04 in October, 1996. Since November, 1996, the two were rarely located together, indicating that family breakup occurred when Tiger 23 was 15-months-old. However, as of 30 June 1997, Tiger 23 was still travelling within her natal home range.

Tiger 15. Tiger 15 continues to use the same area within the southeastern portion of the Reserve. Her cub, born in late November, 1995, and sired by Tiger 16, was last confirmed as traveling with her when their tracks were observed together in the snow on 25

December, 1996. We observed Tiger 15 from the helicopter four times and her tracks several times during January through March, 1997, and she was never with her cub. This indicates family breakup occurred in early January, when her cub was 14-months-old. Observations of tracks indicated that her cub was travelling alone within Tiger 15's home range in April and May.

Tiger 15 and Tiger 16 were located together on four occasions during the summer of 1996. On 24 August, the two were together and we heard them vocalizing in the same manner as when they copulated in August, 1995. Hence, we believe the two mated while Tiger 15 had a 9 month old cub. However, this mating was not successful.

Tiger 16. Tiger 16 continues to move within the southeastern portion of the Reserve and his home range boundaries are still nearly identical to those of Tiger 15. Although he probably mated with Tiger 03, he has not expanded his home range into her home range. He is frequently together with Tiger 15. He was in excellent physical condition when recaptured in March (Tables 1 and 2).

Tigers 18 and 19. Tiger 18 and Tiger 19 dispersed south and are currently missing. Tiger 19 left his natal home range and was last located on 11 May 1995, near Dal'negorsk, well south of his natal home range. His male sibling, Tiger 18, has also dispersed to the south and moved over a large area from the southern boundary of the Reserve south to Dal'negorsk. He was last located on 4 August 1995.

Tiger 20. Tiger 20, captured in November, 1995, has a home range that overlaps with at least three adult females: Tiger 03, Tiger 21, and Tigers 18 and 19's mother. At 1182 km^2, his home range is 2.7 times larger than that of male Tiger 16 (432 km^2), his smaller and younger neighbor. The adjacent home ranges of Tigers 20, 22, and 16 are providing valuable data on social structure of the male portion of the population. So far, data indicate the home ranges of these three tigers overlap very little.

Tiger 21. Tiger 21's (Table 2) home range centers around the Sheptoon River drainage south of the Reserve. Although data are inconclusive, it appears that her home range borders that of Tiger 03, except that their home ranges are separated by the Djigitofki River basin, an area of high human disturbance that neither tiger crosses. Because her home range is entirely off the Reserve, it is subject to high levels of human activity, including logging, poaching, hunting, some cattle grazing, and recreational activities such as fishing and picnicking. Her home range is overlapped by those of Tiger 20 and Tiger 22.

On several occasions this year, we observed poachers with dogs and heard gunshots in the Sheptoon River and Seenansha River drainages. Also, we discovered a body snare, probably set for elk, but that could have caught a tiger as well. Tiger 21 killed and partially ate one of the poacher's dogs in April. We have reported this to the World Wildlife Fund poaching patrol, but they have no authority in the area except during hunting season. Also, we drive through the Sheptoon River drainage often and have made it widely known that there are two tigers and at least four bears with radio collars in the area. We hope our presence will discourage poachers from shooting tigers and bears. A similar tactic has worked successfully on the Reserve.

When recaptured on 17 June, 1996 (Table 1) Tiger 21 was in good condition, thin, but with a healthy hair coat. At 113 kg, she had lost 14 kg since we first caught her in December, 1995, although her stomach was very full at the time of capture.

Tiger 22. Captured on 18 June, 1996 in the Sheptoon area, Tiger 22 is our newest adult tiger (Tables 1 and 2). He weighed an estimated 160 kg and was in fair to good condition. Based on track observations before his capture, we believe he is the resident adult male in the Sheptoon drainage. However, at an estimated three to four years old, he may be a dispersing tiger. Because of his young age, we equipped him with a break-away radio collar that should last one to two years.

We recaptured Tiger 22 in March, 1997, and he was in good physical condition with a healthy hair coat. His leg appeared healed, but the area of the break was enlarged by about 50% and the leg was slightly twisted outward. Tiger 22's 4th toe on his right rear leg was cut off at the joint between the distal and middle phalanges in an unknown injury. The second phalange protruded from the injury by about 1 cm. The cut was very straight and had healed very little even though the injury was about 6-weeks-old (track observations indicated that he sustained this injury in January). Because the protruding bone seemed to prevent healing, we amputated the toe at the joint between the middle and proximal pelages. Tiger 22's movements appear normal since his recapture, and when observed from the helicopter he appeared to walk normally. The source of his cut is unclear, but the very straight clean nature of the cut indicate that it was sliced off; perhaps by glass, sharp metal, or a thin wire snare.

Tiger 23. Captured on 18 October, 1996, on a kill with her mother (Tiger 14), Tiger 23 was 14 months old and weighed 80 kg (Table 2). She spent very little time with her mother following their capture and was last located with her mother in early December. Hence, family break-up occurred when Tiger 23 was about 15 months old, earlier than expected from previous data on family break-up. Since late November, Tiger 23 has limited her movements to a small area in the northeast edge of Tiger 04's home range. Since her capture, Tiger 23 has moved throughout Tiger 04's home range and had not dispersed as of late June.

Home Range

We made preliminary calculations of estimated home range size and overlap for all adult tigers and presented this information as a poster at the conference, "Large Carnivores and Man" in Japan, November, 1996 (Attachment 2). An unexpected result is that adult male Tiger 16's home range was smaller than the average female home range size and that his home range appears to overlap with that of only one adult female. However, his home range is bordered on the west by that of Tiger 20, an older and larger adult male who may prevent Tiger 16 from moving west. Tiger 16's movements to the east are prevented by the Sea of Japan and movements to the north and south are probably inhibited by towns and unforested areas with high human activity in the Cerebrianka and Djigitofki River basins. Hence, his home range size is probably limited by social constraints and human activity.

Food Habits

To date, through June 30, 1997, we have located more than 200 tiger kills made by eight marked, and an unknown number of unmarked, tigers. Elk were the predominant prey species (50%), followed by wild boar (30%). The remaining 20% of the kills included badgers, roe deer, sika deer, brown bears, and a red fox. We have also collected well over 100 scats that have not yet been analyzed, but will provide a useful comparison to kill data. Domestic stock are not included in the above analysis.

We also analyzed kill data to estimate tiger utilization of meat on kills because many people, especially hunters, believe that tigers kill much more than they need and often abandon kills after eating only a small amount. We found that when tigers were not disturbed by humans while on a kill, they consumed an average of 97% of the available meat (Table 4). However, preliminary analysis showed that when tigers on kills were disturbed by humans, they returned significantly less often than expected (Chi-square = 7.4, d.f. =1, $P<0.05$) and ate significantly less meat (Wilcoxon Rank Sum Z=4.05, $P<0.05$, n spooked=11, n unspooked=40) than undisturbed tigers (Table 4).

Thus, in this preliminary analysis we conclude that: 1) tigers usually finish their kills; 2) tigers often do not return to kills after being disturbed or dislocated; 3) the amount of meat eaten by dislocated tigers depends on how much they have eaten before they leave; and 4) frequent harassment of individual tigers by people may increase a tiger's energetic demands because they are forced to make more kills while eating less from each kill. Thus, they may spend more time hunting and less time resting than tigers that are left undisturbed. These energetic hardships may result in reduced reproductive success and survival rates of both adults and cubs whose mothers are frequently disturbed.

CONSERVATION PLANNING

The Conservation Planning component of the Siberian Tiger Project™ continues to focus on range-wide issues. The center focus is our Habitat Protection Plan that outlines a program for tiger habitat planning. This plan applies some general principals of conservation biology, population biology, and land-use planning in an attempt to formulate a north-south backbone of priority tiger areas through present tiger range. This first step in range-wide planning has garnished high-level attention and provided a legitimate basis for conservation planning efforts. We developed this plan based on preliminary analyses of available biological data. Further analyses are being performed with additional information.

Our field site is now able to provide for a more detailed analysis for range-wide conservation planning. In 1996, the cover map and all physical features were finalized within our geographic information system (GIS) database for the main study site at Sikhote-Alin Reserve. In the coming year, we will complete the analysis of habitat selection by our radio-collared study animals. In itself, this analysis is an important step in describing the natural history of Siberian tigers, and their habitat requirements, specifically. But, subsequently, these data will be used to develop a range-wide habitat suitability model to identify, describe, and predict the distribution of critical components of tiger habitat. This will provide further support for tiger conservation planning and our Habitat Protection Plan.

Lastly, two activities are currently underway within the Conservation Planning component that are operating on specific funding. First, the Reserve Extension Project is in its final months, after enduring several delays. This Project is designed to support the legal and infrastructure building activities for the 250 mi^2 addition to the west side of the Sikhote-Alin Reserve. In June, the final two activities of the operation will be completed, the fuel depot at the forest service compound in Melnichnoye and the guard houses at the edge of the Reserve.

The second separate activity is a community development project in the town of Melnichnoye on the west side of the Reserve. This project began in January and will focus on three areas, environmental education, forest service enforcement and general functions, and the development of a locally run and operated hunting society.

ENVIRONMENTAL EDUCATION

Although our educational activities for the Siberian Tiger Project™ run a far-reaching gamete of activities – from community presentations to national magazine publications – here we focus only on those activities in the Russian Far East which were directly related to our main goal, securing the future of Siberian tigers in native range. We are currently focusing on two areas with our environmental education component, the general public and local programs for school children. The breadth of the focus is mainly dependent on funding.

First, one of the most effective approaches toward the general public in the Russian Far East has been the use of wall hangings with pictures. Thus, two years ago, we produced our first Russian calendar for distribution in tiger range. These calendars have been widely accepted and in much demand. Thus, this year we produced our third calendar and transported them to Russia for distribution. Again, they have been widely accepted and distribution went quickly. In addition, a poster was produced with the cooperation of Mr. Bruce Willis, the actor. Mr. Willis is well known in Russia for his movies and the series "Moonlighting", which is broadcast in the Russian Far East. Thus, we were very fortunate to get the help of Mr. Willis for the production of a poster appeal to save the Siberian tiger. It has also been well received.

Secondly, with our small amount of funds, we have tried where possible to implement environmental education in schools. With a small grant to local Peace Corps workers in the town of Terney (our base of operations), we were able to help in a county-wide summer camp for school children and the establishment of a local resource room (complete with computer) for students interested in nature and natural resources. The programs have been very well received and we are considering further support if funds can be obtained.

PERSONNEL

Dale Miquelle, based in Vladivostok, continues to serve as the regional coordinator of all Hornocker Wildlife Institute activities in the Russian Far East. Dr. Miquelle presented two papers at the Tigers 2000 Conference in London (Attachment 4). Kathy Quigley serves as Project veterinarian and coordinates immobilization and biological collections and protocols. In addition, she oversees newsletter development and environmental education. John Goodrich and Linda Kerley continue to coordinate field operations in the Sikhote-Alin Reserve, based in Terney. Bart Schleyer is in his fourth year as capture and immobilization specialist for the field project. Losha Kastera and Kola Reebin continue working as the principal Russians conducting field work on the Project. Their primary responsibilities are radio tracking from the ground and assisting with trap lines. Kola is also the main mechanic and Losha does about 50% of the aerial radio tracking. We have continued training Kola in capture and handling techniques and he has become proficient at administering drugs and collecting all samples and data. Although Losha has received some capture and handling training, we hope to train him more intensively during future trapping seasons. Losha has continued his biology studies as a correspondent student with the university in Vladivostok. He was in Vladivostok for five weeks in March and April to take annual exams.

Moscow University had no students available to study bears this past summer. However, Alexei Zborovsky, one of the students who worked for the Project the previous summer, worked with the Project October-December to collect data on Himilayan bears for his Ph.D. dissertation. He returned to Terney in early April. He will be in Terney for about four-months and will collect data on den sites, home range, movements, and habitat use of Himilayan black bears.

Evgenny Smirnov, leader of the Russian side, continues to coordinate Project planning in the Reserve. Much of his time in the past year was spent on the Siberian Tiger Census. He traveled to Moscow in early April to present papers on tiger home ranges and tiger reproduction (Attachment 3) at a conference on endangered species in Russia.

Table 1. Notes about animals captured and collared in 1996 and 1997.

Date	ID[1]	Capture Method	Est. Age	Sex	Physical condition[2]	Notes
3/97	*Pt*03	Helicopter	1	F	good	
3/97	*Pt*22	Helicopter	3-4	M	good	Leg healed from initial capture; new, unrelated foot injury.
3/24	*Pt*01	Helicopter	5	F	very good	
3/28	*Pt*16	Helicopter	6	M	excellent	
5/15	*Ua*17	Snare	>15	M	very good	Remained within 100 m of trap for 4.5 days
5/17	*Ut*22	Snare	5	M	very good	Break-away collar.
6/13	*Ua*21	Snare	8-10	F	very good	Lactating.
6/17	*Pt*21	Snare	5-7	F	good	
6/18	*Pt*22	Snare	3-4	M	good	Rear leg injury; fully healed on subsequent capture.
10/18	*Pt*04	Snare	9-12	F	good	Caught on kill.
10/18	*Pt*23	Snare	1.17	F	very good	Tiger 04's cub, caught on kill.

[1]Pt=Panthera tigris, Ua=Ursus arctos, Ut=U. thibetanus.
[2]Rated as poor, fair, good, very good, or excellent based on body weight, estimated body fat, i.e., observer ability to see and feel bones, and hair coat condition.

Table 2. Current status of radio-collared tigers in and near the Sikhote-Alin Reserve.

ID	Tiger Name	Sex	Age	Capture Date	Known reproductive history	Current Status
01	Olga	F	Ad	02/92	Litter born 8/94. Litter born 10/95	One cub, undocumented status. Three cubs; one undocumented, two dispersed 3/97.
03	Natasha	F	Ad	10/92	1st litter, birth date unknown. 2nd litter, born Spring 1996.	Two cubs. Dispursed. Three cubs confirmed 3/27/97.
04	Mary Ivanna	F	Ad	11/92	Litter born 1991. Litter born 8/93. Litter born 7/95.	Two cubs (Tiger 05 and 06); dispersed. Two cubs; dispersed 11/95, 94/95. One cub (Tiger 23)
15	Katerina	F	Ad	10/93	Litter born late 11/95.	One cub; family break-up 1/97.
16	Zheny	M	Ad	11/93	Fathered Tiger 08's cub. Probably bred Tiger 03, 1/96.	Alive.
18	Kouza	M	3 y	04/94		Missing. Dispersed to south.
19	Bart	M	3 y	10/94		Missing. Dispersed to south.
20	Dale	M	Ad	11/95		Alive.
21	Nadia Ivanna	F	Ad	12/95	Currently not with cubs, but has had cubs.	Alive.
22	Alexei	M	3-4 y	06/96		Alive.
23	Tonya	F	16m	10/96	Juvenile, has not reproduced.	Alive; offspring of Tiger 04.

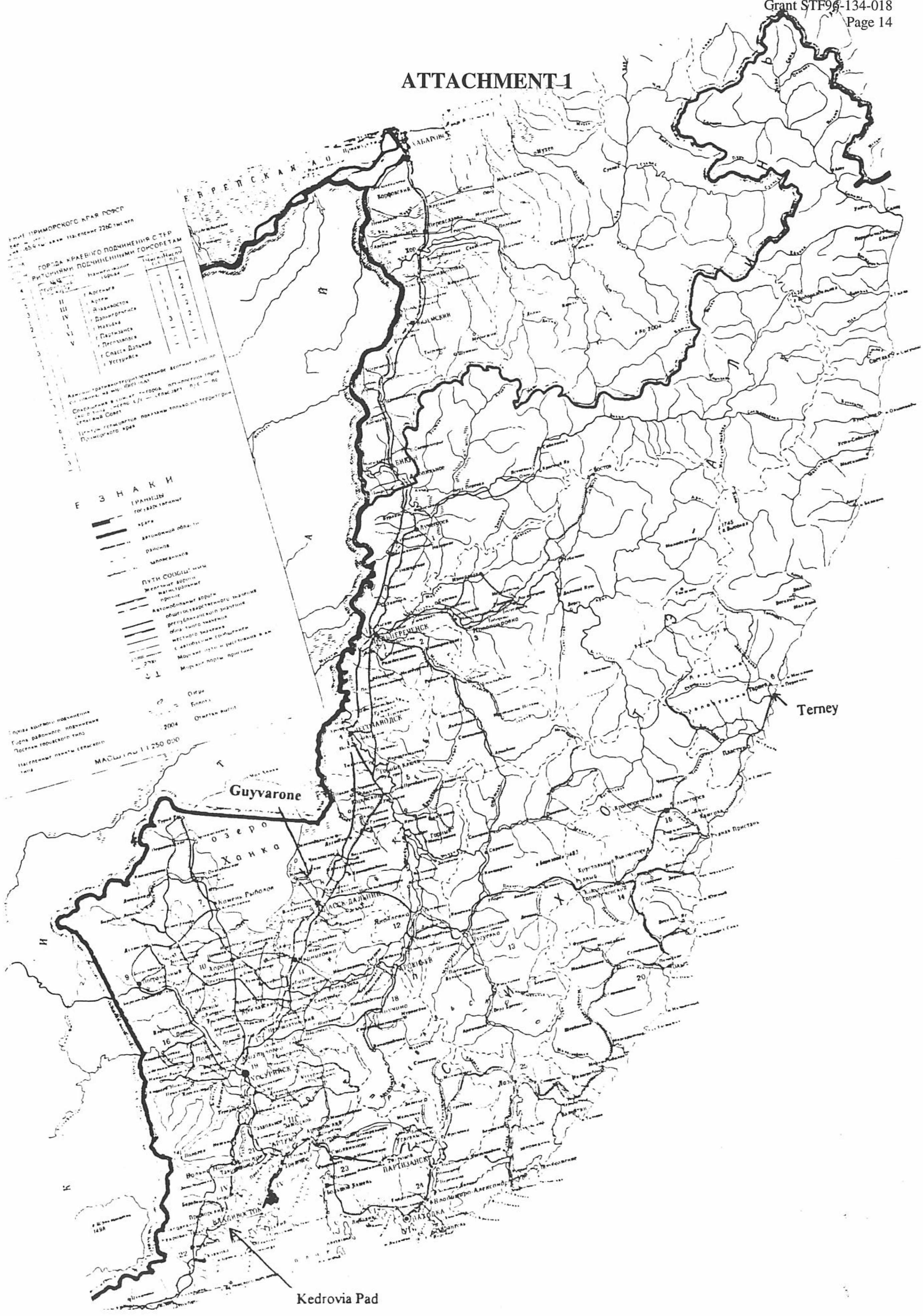
Table 3. Summary of locations and home range size of radio collared tigers on the Sikhote-Alin Reserve, 11 March 1995 - 31 December 1996.

ID	Number of Locations	Dates tracked		Total days tracked
		From	To	
01	89	95/03/11	96/12/31	661
03	66	95/03/11	96/12/31	661
04	89	95/03/11	96/12/31	661
08	220	95/03/11	96/12/31	661
09	148	95/03/11	96/12/31	661
10	15	95/03/11	65/08/04	146
11	10	95/03/11	95/05/06	56
20	40	95/11/01	96/12/31	426
21	44	95/12/08	96/12/31	389
22	41	96/06/18	96/12/31	196
23	19	96/10/18	96/12/31	74

Table 4. A comparison of the average percent of meat eaten on kills by tigers that were disturbed off of their kills by humans and tigers that were left undisturbed.

Category	Sample size	Number of tigers	Percent Meat Eaten		
			Average	Maximum	Minimum
Undisturbed	40	7	97%	100%	60%
Disturbed but returned to kill	2	2	97%	100%	95%
Disturbed and did not return	9	3	52%	90%	0%

ATTACHMENT 1



Attachment 2. Text of poster presented at the conference "Large Carnivores and Man," Japan, November 1996.

A Preliminary Analysis of Land Tenure Systems of Amur Tigers on the Sikhote-Alin Biosphere Zapovednik, Russia.

John M. Goodrich[1], Linda L. Kerley[1], Dale G. Miquelle[1], Evgeny N. Smirnov[1,2], I.G. Nikolaev[1,3], Howard B. Quigley[1], and Maurice G. Hornocker[1].

[1] Hornocker Wildlife Institute, University of Idaho, Moscow, Idaho, USA.
[2] Sikhote-Alin Biosphere Reserve, Terney, Primorye Krai, Russia.
[3] Institute of Biology and Soils, Vladivostok, Russia.

Introduction

The tiger (*Panthera tigris*) is threatened with extinction throughout its geographic range. While the ecology of the Bengal subspecies (*P. t. tigris*) has been well studied (Sunquist 1981, Smith et al. 1987), little is known about other tiger subspecies (review in Nowell and Jackson 1996). We are currently studying the Amur, or Siberian tiger (*P. t. altaica*), as part of a joint Russian-American project between the Hornocker Wildlife Institute and the Sikhote-Alin Biosphere Reserve.

Understanding home range sizes and spatial distributions of large carnivore species is important for conservation planning because these life history attributes can influence effective population size, population demography, and disease spread within a population (Berger 1996, Goodrich and Buskirk 1995, Hornocker and Bailey 1986). Here we present preliminary results of home range sizes and overlap for Amur tigers. We tested the hypotheses that land tenure systems of Amur tigers was similar to that of other tiger subspecies; i.e., intrasexual territoriality (low home range overlap) and male home ranges that overlap with two or more female home ranges.

Study Area and Methods

We collected data from 10 radio-collared tigers on and near the 4,000 km^2 Sikhote-Alin Biosphere Zapovednik, Primorye Krai, Russia, February 1992 – September 1996. The area is dominated by the Sikhote-Alin Mountains, with elevations ranging from 0 m at the coast of the Sea of Japan to 1430 m above sea level. Dominant forest types include oak (*Quercus mongolica*) and mixed conifer-broadleafed forests (Miquelle et al. 1996).

We located radio-collared tigers from the ground or by aircraft and estimated 95% and 50% adaptive kernel home ranges (Worton 1989) using program CALHOME (Kie et al. 1994) for 9 tigers: 3 adult males and 6 adult females. Adult female 007 was not radio-collared, so we estimated her home range with location data from her two radio-collared male cubs. Because we report data collected as part of a continuing study, results reported here are preliminary.

We examined the occurrence of intra- and intersexual home range overlap for neighboring tigers for both 50% and 95% adaptive kernel home range isopleths. We calculated percent overlap for each occurrence of overlap (x_o) and calculated total percent overlap, $x_{to}=4x_o$, which assumes that, on average, every tiger would have 4 neighbors. Hence, total overlap is that proportion of a tigers home range that overlaps with other tigers, i.e., that proportion which is nonexclusive. As a measure of territoriality our estimates of overlap are conservative, i.e., we probably overestimated overlap between females. Tiger 03 was very young with an unstable home range when first collared, and Tiger 007's home range may be overestimated because of increased movements by her cubs as they approached dispersal age.

Results

Home range size. Average home range size for 6 adult females was 480 ± 112 km^2, while the home range sizes of 2 adult males were 432 km^2 and 1182 km^2 (Table 1). Tiger 22 was tracked for only 3 months and hence his home range is probably grossly underestimated.

Female-female overlap. The 95% isopleths of 5 neighboring female tigers (007, 01, 03, 15, and 21) overlapped 3 times (Fig. 1). Where overlap did not occur between adjacent females (Tigers 01 and 15, and Tigers 03 and 21) home ranges were separated by unsuitable habitat: towns and open river bottoms with high human disturbance. Fifty percent isopleths never overlapped. Average percent overlap (x_o) was 10% (range 0-23%) and total percent overlap (x_{to}) was 40%.

Male-male overlap. The 95% isopleths of 3 males (16, 20, and 22) overlapped 2 times (Fig. 2). Fifty percent isopleths did not overlap among males. Average percent overlap (x_o) was 9% (range 9-13%, Tiger 22 excluded) and total percent overlap (x_{to}) was 36%.

Male-female overlap. Male 16 overlapped with 2 females: 15 and 03, but overlap with female 03 was minimal (Fig. 3). Male 20 overlapped with 3 females: 03, 007, and 21. Male 22 overlapped with female 21.

Tigers of the same sex were never located in an area of overlap at the same time while tigers of opposite sex were frequently located together.

Table 1. Adaptive kernel home range sizes (95%) for 10 radio collared Amur tigers on and near the Sikhote-Alin Biosphere Reserve, Russia, 1992-1996.

Id	Sex	Home range size (km^2)	Number of locations	Dates (mm/yy) tracked	
				from	to
01	F	559	381	01/92	09/96
03	F	483	198	10/92	09/96
04	F	493	239	11/92	09/96
15	F	363	435	10/93	09/96
21	F	344	33	12/95	09/96
007[1]	F	636	59	04/94	11/94
16	M	432	335	11/93	09/96
20	M	1182	33	11/95	09/96
22	M	(265)[2]	27	06/96	09/96

[1]Home range estimate based on data collected from tiger 00's two male cubs before dispersal.
[2]Tracking duration too short for an accurate home range estimate.

Discussion

Our tigers had home ranges that were an order of magnitude larger than those reported for other tiger subspecies (12-65 km^2 for females and 30-105 km^2 for males; review in Sunquist 1981). Home ranges reported here are also larger than reported previously for Amur tigers (100-400 km^2 for females and 800-1000 km^2 for males, Matyushkin 1979).

Despite such large home ranges, large portions (60%) were still exclusive and core areas (50% isopleths) never overlapped. Thus, the land tenure system of our tigers was similar to that reported for Bengal tigers (Smith et al. 1987); intrasexual territoriality and males overlapping with one or more females. However, intrasexual overlap among our tigers was greater than reported in Nepal for Bengal tigers (*P. t. tigris*, 7.1% for females, Sunquist 1981, Smith et al. 1987). This may be due to differences in data analysis techniques, for example, Sunquist (1981) deleted "outliers", which may reduce estimates of overlap while we probably overestimated overlap (see above). It may also be a biological difference because the large home ranges of our tigers are probably more difficult to defend against intruders.

Even small areas of overlap were biologically important. For example male tiger 16 and female tiger 03 were located together and probably mated within the area of overlap between the home ranges of male 16 and male 20. Thus, male 16 usurped a mating with female 03 from male 20, whose home range overlaps almost completely with that female, while male 16's home range overlapped very little with hers.

Conservation Implications

The primary long term threat to Amur tigers is habitat loss through logging, mining, and development. Because Amur tigers occur at lower densities and have larger home ranges, protected areas must be an order of magnitude larger than those required by other tiger subspecies. Also, the social system of Amur tigers may reduce effective population size, as it does in Bengal tigers (Smith et al. 1987), further increasing the required size of protected areas. It will be impossible to set aside single reserves large enough to sustain a viable population of Amur tigers. Thus, protection of Amur tiger habitat requires careful land use planning at a scale that include their entire geographic range and a system of protected areas that are well connected by travel corridors (e.g., Miquelle et al. 1995).

The primary short term threat to Amur tigers is poaching, which effects the population both directly, by removing large numbers of tigers, and indirectly by creating an unstable social structure. By causing instability in the social structure of other solitary carnivores, high human induced mortality may cause reduced reproductive rates, further increased cub and adult mortality from aggressive interactions, and increased disease transmission (Goodrich and Buskirk 1995, Hornocker and Bailey 1986, Smith and McDougal 1991). For example, reproductive rates may decrease because it takes time for a young emigrating tiger to establish territory boundaries and relationships with resident tigers of the opposite sex (Sunquist 1981). This may be why tiger 15 in our study did not produce a litter for 2.5 years after emigrating to fill the vacancy created when another radio-collared female tiger was poached, even though tiger 15 was of reproductive age.

Literature Cited

Berger, J. 1996. Animal behaviour and plundered mammals: is the study of mating systems a scientific luxury or a conservation necessity? Oikos 77: in press.

Goodrich, J. M. and S. W. Buskirk. 1995. Control of abundant native vertebrates for endangered species conservation. Conservation Biology 9:1357-1364.

Hornocker, M. and T. Bailey. 1986. Natural regulation in three species of felids. Pages 211-220 in S. D. Miller and D. D. Evererr, eds. Cats of the World: Biology, Conservation, and Management. National Wildlife Federation, Washington, D.C., USA.

Kie, J. G., J. A. Baldwin, and C. J. Evans. 1994. CALHOME home range analysis program electronic user's manual. U.S. Forest Service, Pacific Southwest Research Station, Fresno, CA, USA, 20 pp.

Matyushkin, E. N., V. I. Zhivotchenko, and E. N. Smirnov. 1977. The Amur Tiger in the U.S.S.R. Unpublished report to the International Union for the Conservation of Nature and Natural Resources, Morges, Switzerland. 80 pp.

Miquelle, D. H., E. N. Smirnov, H. B. Quigley, M. G. Hornocker, I. G. Nikolaev, E. N. Matyushkin. 1996. Food habits of Amur tigers in Sikhote-Alin Zapovednik and the Russian Far East, and implications for conservation. Journal of Wildlife Research 1:138-147.

Miquelle, D., H. Quigley, and M. Hornocker. 1995. A habitat protection plan for Amur tiger conservation. Hornocker Wildlife Institute, Moscow, Idaho, USA. 33 pp. (In English and Russian).

Nowell, K. and P. Jackson. 1996. Wild cats: status survey and conservation actin plan. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland, 382 pp.

Smith, J. L. D., C. W. McDougal, and M. E. Sunquist. 1987. Female land tenure system in tigers. Pages 97-109 in R. L. Tilson and U. S. Seal, eds., Tigers of the World: the Biology, Biopolitics, Management, and Conservation of an Endangered Species. Noyes Publications, Park Ridge, New Jersey, USA.

Smith, J. L. D. and C. McDougal. 1991. The contribution of variance in lifetime reproduction to effective population size in tigers. Conservation Biology 5:484-490.

Sunquist, M. E. 1981. The social organization of tigers (Panthera tigris) in Royal Chitwan National Park. Smithsonian Contributions to Zoology 336:1-98.

Worton, B. J. 1989. Kernel methods for estimating the utilization distribution in home-range studies. Ecology, 70:164-168.

Attachment 3. Text of poster presented by E.N. Smirnov in Moscow at a conference on Russian endangered species.

New Data on Amur Tiger Reproduction

E.N. Smirnov, I.G. Nikolaev, D.G. Miquelle, J.M. Goodrich, L.L. Kerley, H.B. Quigley, and M.G. Hornocker, B. Schleyer, N.N. Reebin, A.V. Kostirya

Introduction

We studied reproductive activity of 15 Amur tigers (9 females and 6 males) equipped with radio-collars in Sikhote-Alin Reserve, 1992-1996, as part of the joint Russian-American Siberian Tiger Project. Besides radiotracking (Miquelle et al. 1993), we used the traditional method of snow tracking (Kaplanov 1947, Yudakov and Nikolaev 1987). Our data provide more detailed information on Amur tiger reproductive activity than has previously been available.

Results

Four marked females provided information for 4-5 years each (Figure 1). One of them gave birth to three litters, while the others had two litters each. We recorded 13 litters, including 9 litters that were monitored until family breakup and dispersal of young. The earliest date at which Amur tiger cubs began to live independently was 15 months; the latest date was 20-21 months.

The first recorded family break-up occurred in July 1992, when a young female began to hunt independently of her mother for roe deer. Absence of her mother's tracks at kill sites indicated that the cub, which was estimated at 18-20 months, was hunting on her own. A second break-up occurred when a young male dispersed from his mother's home range when he was 18-19 months. During the next two years (while the radiocollar still functioned) he traveled throughout much of the Reserve and beyond Reserve boundaries (total area used equaled 4085 km2 for 100% minimum convex polygon, or 1808 km2 for 95% minimum convex polygon) apparently in search of a vacant territory. In a third case of family break-up, a radio-collared female cub was rarely with her mother after 15-months. In all other cases we could not determine the exact time of family break-up, but it appeared to range within 15-21 months.

Usually adult female tigers gave birth to cubs approximately once every two years (Fig. 1), which is important information for determining population reproductive potential (Smirnov 1986, Smirnov and Miquelle 1996).

In the Russian scientific literature it has been stated repeatedly that tiger cubs stay with their mother until three years of age, although some authors have questioned this statement (Matyushkin et al. 1981, Kuchereneko 1985, Smirnov 1986). Baikov's (1925) belief that family break-up occurs at 1.5 years, and at two years a new litter is born is not cited in the Russian literature. Some authors have relied on data from zoos or other subspecies of tigers.

We determined time of birth usually by localized movements of the female in a very small area for one month or more. Such inductive evidence was then checked by searching for cub tracks or cubs themselves in the vicinity. Some females lost litters and came into estrus again in 1-2 months. The adult female "Lena" lost three cubs (the last was hit by a car in April 1992). In September she gave birth to a litter of four. The tigress "Katia" who apparently gave birth to a stillborn cub in April 1995, gave birth to a new litter at the end of November or beginning of December 1995. In seven cases we discovered new litters within one month of their birth and twice in 3-5 months after their birth. Numbers of cubs were determined by their snow tracks, but often not until several months after their birth. Thus, it was often impossible to determine cub mortality until snowfall.

In the Russian literature there is considerable discussion of cub weight and size (Abramov 1961, Kucherenko 1985), but to date there had been no measurements of Amur tiger cubs from the wild. Our data indicate the weight of a young male at one year was 100 kg, a young female also at 1 year was 70-80 kg. At this time the width of the pad of a male's front paw than that of his mothers, while 1-year old females have a pad size a little less than their mothers (Table 1). By two years of age, young females are comparable in size and weight to their mother, whereas males are already considerably larger.

First age of breeding for females appears to be between 3.5-4 years. The tigress "Olga" first gave birth when she was approximately 3.5 years old, and "Natasha" when she was about 4. Although our sample size is small, evidence suggests that there is some seasonality to birthing (Table 3). Most litters were born between April and November and we recorded only one litter in winter. These findings correspond with observations in Northern Hemisphere zoos, which report the largest number of births in captivity during the same period (Seal et al. 1987). Based on these observations, most of the breeding occurred between December and August, assuming a 105-day gestation period.

Size of first litters for three females averaged 1.3 cubs (1, 1, and 2 cubs/litter). These cubs were not marked, but based on snow tracking, it appeared that only one died within the first 6 months of life. The size of second litters was larger: 2.3 cubs/litter (1, 3, and 3 cubs/litter). These cubs were also not marked, but observations of the cubs and their tracks indicate that only one cub die prior to family breakup. However, family breakup has not yet occurred for one of the litters of three. Older females gave birth to larger litter sizes: on average 0.7 cubs/litter (1, 2, 3, 3, 3, and 4 cubs/litter); although some of these litters could have been second litters because the tigers were not collared at the time of their first litters. Approximately 1.6 cubs per litter survived until family break-up.

Based on family units with at least one member radio collared, we collected information on 13 litters (Table 2) comprised of 29 cubs; although for "Lena's" first litter, neither she nor her cubs were collared. Twenty of the 30 survived (65.5% survival). This calculation includes young females (less than 3.5 years), nonresident females, and possibly some young males misclassified as females. Four cubs were removed from the wild at three months of age when poachers killed their mother "Lena": two of these survived and were exported.

Four marked females were monitored during five years, two females with marked cubs were monitored for only 1-2 years. This is necessary to take into account when we calculate reproduction rate, which may be calculated in three ways. The more correct is to use data only from the four females marked for five years, so that the monitoring period is identical for all females. This index may be compared to the index in our previous study. The reproductive rate calculated for these four marked females (1.1) is higher than for all tigers in the Reserve (0.8-0.9).

The estimate presented here, based on mature, resident females, and reflects the reproductive potential of only the breeding component of the female tiger population in Sikhote-Alin Reserve. If we calculate reproduction rate for 1992-1996 following Smirnov and Miquelle (1986), the reproductive rate for all females was 0.46, lower than the average rate for 1966-1993. Radiotracking allows us to estimate population reproduction population more accurately than traditional snow tracking. The tiger study in the Reserve continues and we hope to continue to collect reliable information about Amur tiger biology.

Attachment 3/Table 1. Short description of marked tigers.

N	Capture Date	Sex	Age	Weight Length (kg)	Body size (cm)	Pad Size
1	11/02/92	F	13 months	75	141	8
	02/04/92	F	3 years	120	167	8.7
	28/03/96	F	5 years	126	169	9
2	22/06/92	F	5-6 years	114	169	9
3	17/10/92	F	2-3	102	164	8
	26/04/95	F	5.5-6.5	119	168	9
	20/03/97	F	7.5-8.5	119	169	9.3
4	08/11/92	F	5-7	129	182	9.5
	13/03/95	F	7-9			
	18/11/96	F	9-11	124	182	9.4
5	08/11/92	M	13 months	100	187	10
6	08/11/92	F	13 months	70	155	8.5
7	25/04/93	F	2 years	99	162	8
8	29/10/93	F	2-3	104	177	8
	21/12/95	F	4-5	112	177	9.5
9	10/11/93	M	4-5	175	195	10.7
	28/03/96	M	6.5-7.5	189	199	11.5
10	27/04/94	M	11 months	91	151	9
	05/02/95	M	21	151	180	11
11	13/10/94	M	1.5 years	120	174	10.5
12	01/11/95	M	6-7	200		12.5
13	07/12/95	F	3-4	126	168	9.5
	17/06/96	F	3.5-4.5	112	180	9.5
14	18/06/96	M	3-4		189	11.2
	15/03/97	M	3.5-4.5		195	11.2
15	18/11/96	F	14 months	79	141	9

Attachment 3/Table 2. Reproductive rate of marked female Amur tigers in Sikhote-Alin Reserve.

Name	Year, month of birthing	Age	No. of Cubs	No. of cubs/ year	No. of cub deaths	Survival (cubs/year)
Olga	1992	1	0			
	1993	2	0			
	1994,07	3	1			
	1995,10	4	3	1.3	1	1.0
	1996	5	0			
Olga's mother	1991,01	3				
	1992	0		1.5	0	0.5
Lena	1991	4-5	3		3	
	1992	5-6	4	3.5	2	1.0
Natasha	1992	2-3	0			
	1993	3-4	0			
	1994,10	4-5	2			
	1995	5-6	0			
	1996,05	6-7	3	1.7		
Mary Ivanna	1991,09	5-6	3		1	
	1992	6-7	0			
	1993,08	7-8	2			
	1994	8-9	0	1.0		0.8
	1995,08	9-10	1			
	1996	10-11	0			
Katia	1993	3-4	0			
	1994	4-5	0			
	1995,04	5-6	1*		1	
	1995,11	5-6	1	0.5		0.25
	1996	6-7	0			
Kuzia's mother	1992		3			
	1993		0	1.5		
Nadia	1996	3-4	0			

(*) - the first litter (one cub) died

Attachment 3/Table 3. Cub birthing time in 1991-1996 in Sikhote-Alin Reserve (number of litters).

	Month												
Time	01	02	03	04	05	06	07	08	09	10	11	12	SUM
Marked females	1			1	2		1	2	1	4	1		13
Unmarked females							1	1	1	1			4
SUM	1			1	2		2	3	2	5	1		17

Attachment 4: MOLECULAR GENETIC ASCERTAINMENT OF SUBSPECIES AFFILIATION IN TIGERS

Tiger 2000 Symposium
February 1997

Joelle Wentzel*, J. Claiborne Stephens, Warren Johnson,
Marilyn Menotti-Raymond, Jill Pecon Slattery, Naoya Yuhki, Mary Carrington
Howard Quigley, Dale Miquelle, Ron Tilson, Jansen Manansang,
Gerald Brady, Lu Zhi, Pan Wenshi, Huang Shi-Qiang, Leslie Johnston,
Mel Sunquist, Ullas Karanth and Stephen J. O'Brien

- J. Wentzel*, M. Carrington, SAIC Frederick, National Cancer Institute, Frederick,
- MD 21702-1202
- J.C. Stephens, W. Johnson, M. Menotti-Raymond, J.P. Slattery, N. Yuhki, S.J. O'Brien, Laboratory of Genomic Diversity, National Cancer Institute, Frederick, MD 21702-1201
- H. Quigley, D. Miquelle, Hornocker Wildlife Research Institute, Inc., PO Box 3246, University Station, Moscow, ID 83843
- R. Tilson, Tiger SSP Coordinator, Minnesota Zoo, 13000 Zoo Boulevard, Apple Valley, MN 55124
- J. Manansang, Tamaan Safari, Indonesia
- G. Brady, Potter Park Zoological Gardens, 1301 S. Pennsylvania Avenue, Lansing, MI 48912
- Lu Zhi, Pan Wenshi, Department of Environmental Biology and Ecology, College of Life Science, Peking University, Beijing 100871, China
- H. Shi-Qiang, Beijing Zoo, Beijing, People's Republic of China
- L. Johnston, 1946 Clavart St., N.W. #1, Washington, DC 20009
- M. Sunquist, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611
- U. Karanth, Wildlife Conservation Society, Bangalore 560 042, India

*Present address: University of Pretoria, Department of Zoology and Entymology, Pretoria, South Africa 00002

Abstract

Isolated populations of *Panthera tigris* have been assigned subspecific taxonomic designation according to geographic distribution and morphological descriptions. Eight tiger subspecies are recognized traditionally; however, three have gone extinct (P.t. *virgata,* P.t. *sondaicus*, and P.t. *balica*) during this century largely due to increasing human demand for tiger parts (bones, skins, organs) and habitat. The five remaining subspecies (P.t. *tigris*, P.t. *corbetti*, P.t. *sumatrae*, P.t. *altaica*, and P.t. *amoyensis*) survive in small, fragmented populations with restricted gene flow. Mitochondrial DNA markers (RFLP, 16s RNA and control region sequence) revealed a paucity of genetic variation among 28 "voucher" specimens representative of the five living subspecies, a result reaffirmed by low variation of the DRB gene loci of the tiger major histocompatibility complex (MHC). A survey of 20 short tandem repeat (STR) polymorphism loci (also called microsatellites) revealed significant phylogeographic differentiations between the five living subspecies Using a

parametric maximum likelihood approach to analyze composite STR genotypes, a robust test for individual subspecies affiliation was developed. The STR affiliation test was used to identify the subspecies origin of 17 captive tigers whose origins were uncertain. The results suggest that geographically isolated tiger subspecies have undergone gene flow until relatively recently, but that subsequently developed population genetic substructure is sufficient to determine population origin for tigers whose ancestry is in question.

Attachment 5: A HABITAT PROTECTION PLAN FOR THE AMUR TIGER: DEVELOPING POLITICAL AND ECOLOGICAL CRITERIA FOR A VIABLE LAND-USE PLAN

Miquelle[1], D. G., W. T. Merrill[3], Y. M. Dunishenko[5], E. N. Smirnov[2], H. B. Quigley[1], D. G. Pikunov[4], and M. G. Hornocker[1]

[1]Hornocker Wildlife Institute, Moscow, Idaho
[2]Sikhote-Alin Biosphere Reserve, Terney, Primorski Krai, Russia
[3]Landscape Dynamics Laboratory, Dept. of Fisheries and Wildlife, University of Idaho, Moscow, Idaho
[4]Institute of Geography, Far Eastern Brach Russian Academy of Sciences, Vladivostok, Russia
[5]All Russia Institute of Hunting Management, Khabarovsk, Russia

Abstract

We developed an incremental process for developing a habitat protection plan for the Amur, or Siberian tiger (Panthera tigris altaica) in the Russian Far East based on pre- established goals and pre-determined key components. A set of political and biological criteria were developed to guide the planning process: political criteria largely dictated priorities for allocating lands within the incremental planning process, and biological criteria assisted in identifying potential tiger habitat, defining ecological corridors, and employing parameters of tiger ecology to assess adequacy of the plan at each stage. We used high resolution data resulting from intensive radio- telemetry studies to determine key ecological parameters of tigers, combined with low resolution geographic information layers on land ownership and vegetative cover to determine potential tiger habitat. The goal of the proposed plan was no further loss of tiger habitat. Because Amur tigers require expansive tracts of land, a viable habitat protection plan must include non-protected areas. Thus, we propose a mechanism for identifying all potential tiger habitat, and a zoning process to guide land-use planning in non-protected areas. Assessment of the protected areas network was based on the distribution of tiger tracks recorded during a range-wide survey. A proposed protected areas network of 65,000 km2 would protect approximately 70 resident female tigers, and provide an unbroken chain of protected habitat throughout the existing range of tigers in Russia. Although the challenge of creating such a protected areas system is enormous in the political and economic instability of present-day Russia, there are many reasons for optimism and persistence. However, even with such a massive protected areas network, ultimately the fate of the Amur tiger will be dependent on how non-protected lands are managed. Therefore, efforts to seek resolution between economic interests (especially logging and hunting) and habitat conservation will be critical to survival of the tiger in the Russian Far East.