

Searching for the coexistence recipe: a case study of conflicts between people and tigers in the Russian Far East

DALE MIQUELLE, IGOR NIKOLAEV, JOHN GOODRICH,
BORIS LITVINOV, EVGENY SMIRNOV
AND EVGENY SUVOROV

INTRODUCTION

Large carnivores provide the ultimate test of society's willingness to conserve wildlife. They present a unique conservation challenge because first, large carnivores generally require large tracts of land, and second, they can and do kill people and domestic animals. Governments throughout the world are creating protected areas, suggesting that society seems willing to apportion some land for conservation, but whether it is willing to dedicate sufficiently large tracts, and whether it is willing to accept the risk of living in close proximity to large carnivores, are questions yet to be answered. Because human-induced mortality is one of the greatest threats to persistence of carnivore populations worldwide (Woodroffe and Ginsberg 1998), resolving human–carnivore conflicts is key to their survival. Whether a future exists for these most charismatic components of wild ecosystems will largely depend on networks of suitable habitat and intervention programmes that minimize risks to both carnivores and people.

In 1941 Kaplanov (1948) estimated that there were 20–30 Amur tigers (*Panthera tigris altaica*) remaining in the Russian Far East. Harvest of tigers was outlawed in Russia in 1947, and collection of cubs for the world's zoos was sharply curtailed by 1957. Thereafter a slow but apparently steady growth in tiger numbers led to what many believe was a peak population of as many as 600 tigers at the end of the 1980s (Kucherenko 2001). A sharp increase in poaching in the first half of the 1990s (Galster and Vaud Eliot 1999) probably rapidly depressed tiger numbers. In 1996 there were an estimated 330–371 adult (and approximately 100 young) Amur tigers distributed across 156 000 km² of habitat in the Russian Far East (Matyushkin *et al.* 1996, 1999).

Presently, only 7% of the remaining tiger habitat is protected as *zapovedniks* (IUCN Category I) or *zakazniks* (IUCN Category IV), and even

best-case scenarios suggest no more than 16% of tiger habitat will come under a protective regime (Miquelle *et al.* 1999a). A conservation strategy dependent solely on protected areas would result in small fragmented subpopulations of tigers scattered across the landscape, a scenario with high extinction risk. A more viable alternative relies on a protected areas network interlaced with multiple-use forest lands (some 84–93% of tiger habitat today), shared between tigers and the approximately 4 million people who live in the region (Miquelle *et al.* 1999a). Survival of Amur tigers will therefore depend largely on whether local people tolerate their presence. Mitigating conflicts, reducing risk to both tigers and people and increasing tolerance of people living with tigers will be fundamental to a successful conservation effort (Miquelle and Smirnov 1999).

In this case study of tigers and people in the Russian Far East, we identify six motives, or situations, that result in human-caused tiger mortality, based on reviews of existing information, as well as new analysis of data from the past 50 years. We focus this discussion on those four motives that represent direct conflicts of interest between tigers and local people. We do not consider those impacts that indirectly influence survivorship of tigers (e.g. habitat loss, road construction, development) or welfare of people (e.g. development restrictions), which are no less important, but require a separate suite of conservation actions beyond the scope of this chapter (Miquelle *et al.* 1999a; Kerley *et al.* 2002). We describe the context in which direct conflicts occur, impacts of each on both tigers and people, and mitigation actions that have been taken to resolve these conflicts. Where possible, we assess effectiveness of these actions.

STUDY AREA

The distribution of Amur tigers in Russia is restricted to Primorski Krai (Province), a region of 165 900 km², and the southern portion of Khabarovski Krai (100 450 km²) (Fig. 19.1). Due to human development elsewhere, approximately 95% of the Amur tigers in Russia remain in the Sikhote-Alin Mountains, a coastal range that parallels the Sea of Japan, from Vladivostok 1000 km north. The remaining 5% of tigers occur in the East Manchurian Mountains in southwest Primorski Krai (Matyushkin *et al.* 1996), and adjacent territories of Jilin and Heilongjiang Provinces, China (Miquelle and Pikunov 2003). These regions also support brown bears (*Ursus arctos*), Himalayan black bears (*U. thibetanus*) and wolves (*Canis lupus*), and ungulate species such as red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), sika deer (*Cervus nippon*), musk deer (*Moschus moschiferus*) and wild boar (*Sus scrofa*) (Miquelle *et al.* 1996, 1999b). Tiger habitat in the

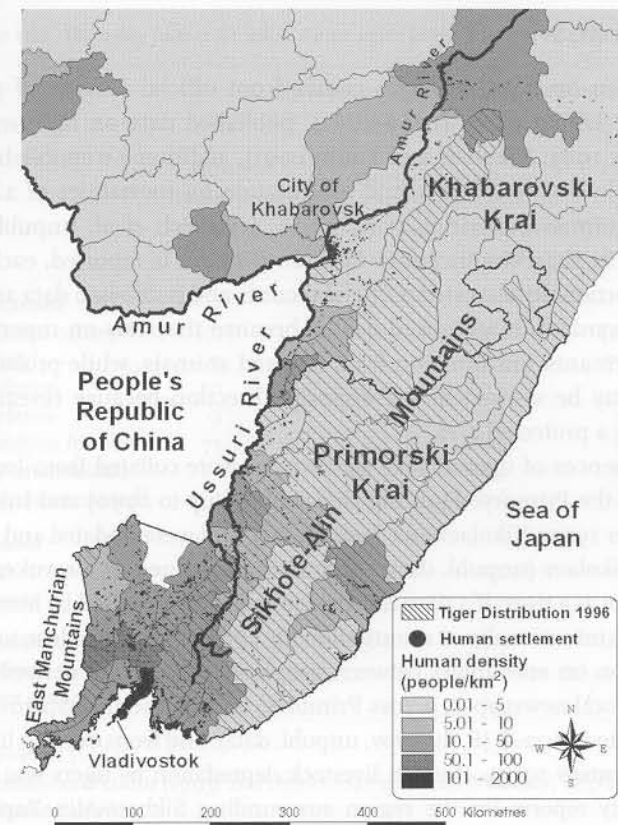


Figure 19.1. Major topographic features, human density (by raion, or county) and distribution of tigers in the Russian Far East. (From Matyushkin *et al.* 1996.)

Sikhote-Alin and East Manchurian Mountains is nearly completely forested. The mountains are relatively low (the highest peak is 2004 m), and are covered with a combination of conifer and broad-leaved species. Research on radio-collared tigers is conducted by the Siberian Tiger Project (Goodrich *et al.* 2001), which is centred in Sikhote-Alin State Biosphere Zapovednik, a large (4000-km²) reserve situated in northeast Primorski Krai, straddling the Sikhote-Alin divide. Human settlements are concentrated around the capital cities of Vladivostok and Khabarovsk, and along the fertile lowlands associated with the Ussuri and Amur Rivers (Fig. 19.1). Nonetheless, small communities are dispersed across the entirety of tiger habitat. People in these small forest communities rely on the fish, wildlife, timber and other natural resources in tiger habitat to provide a means of subsistence and income.

METHODS

Information on tiger mortality comes from official records of permits issued for killing tigers (1985–2001), published data on tiger mortality (Gorokhov 1983; Nikolaev and Yudin 1993), additional unpublished data (collected by I. G. Nikolaev), and information on mortalities of 22 radio-collared animals (Goodrich *et al.* 2000; Goodrich *et al.* unpubl. data). Where more than one incentive for killing a tiger is reported, each death was proportionally allocated. Official records and published data are likely biased towards human-caused deaths because they rely on reports from local informants. Information from collared animals, while probably less biased, may be skewed in the opposite direction because research was centred in a protected area.

Occurrences of tiger attacks on humans were collated from long-term records of the Primorye Hunting Department (up to 1990) and Inspection Tiger (after 1990: Nikolaev and Yudin 1993), and were updated and verified by I. G. Nikolaev (unpubl. data). Attacks were defined as 'provoked' if the person shot at a tiger, if a tiger had been previously wounded by humans, or if a person intentionally or unintentionally approached very close to a tiger. Information on encounters between people and tigers was derived from a survey of local newspapers across Primorski and southern Khabarovsk Krai for the period 1992–8 (E. Suvorov, unpubl. data), and from existing literature (e.g. Khramtsov 1995). Data on livestock depredation by tigers was derived from yearly reports for the region surrounding Sikhote-Alin Zapovednik (compiled by E. N. Smirnov), and in Khabarovsk on the basis of responses to a questionnaire (Sukhomirov 2002).

HUMAN-CAUSED MORTALITY OF AMUR TIGERS

Information summarized over the past 50 years (Table 19.1) indicates that human-caused mortality of Amur tigers in the Russian Far East can be categorized as:

- (1) Poaching (defined here as intentional killing with intent to profit)
- (2) Lethal control with official permit
- (3) Self-defence in response to perceived or real threat (including killing of animals that have attacked people and legal and illegal lethal control of animals considered dangerous)
- (4) Retaliation for depredation of livestock or other domestic animals
- (5) Elimination of 'competitor' by hunters
- (6) Accidental killings (mostly vehicle collisions).

Table 19.1. Mortality factors for adult Amur tigers in the Russian Far East, 1951–2001

Reason	Percentage of total mortalities			
	Survey of local people ^a	Onsite examinations ^b		Radio- collared tigers ^c
	1951–73 (n = 49)	1970–90 (n = 56)	1991–2001 (n = 78)	1992–2001 (n = 22)
Human-caused				
Legal lethal control ^d	(0)	(23.2)	(24.4)	(0)
Poaching ^e	0	0.0	57.7	72.7
Depredation	20	29.5	10.3	4.5
Self-defence	9	20.5	23.1	0.0
Competition for prey	71	1.8	0.0	0.0
Motive unidentified		30.4	1.3	0
Other human-caused ^f		1.8	2.6	4.5
Other causes				
Natural	0	14.3	0.0	18.2
Unknown	0	1.8	5.1	
Total human-caused mortalities	100	83.9	94.9	81.7
Total other causes			5.1	18.2

^a Gorokhov (1983).

^b Nikolaev and Yudin (1993) and recent material from Nikolaev, unpubl.; includes confiscated skins.

^c Goodrich *et al.* unpubl. data.

^d Permits for legal control (in parentheses) are usually a response to livestock depredations or a potentially dangerous tiger (self-defence). Because this category overlaps with others, it is not included as part of column totals, but only as a percent of total deaths reported.

^e Includes radio-collared animals who death was categorized as 'suspected poaching'.

^f Includes accidental killings (vehicular collisions).

Lethal control is initiated almost entirely in response to attacks on humans or livestock and since it overlaps with these two categories, is reported separately (Table 19.1). While accidental killings occur (for example, Nikolaev and Yudin (1993) reported three tigers killed by automobiles) they are rare, probably unimportant to tiger population dynamics, and are not considered further.

Although variation in reporting procedures exists, available data indicate two important trends. First, despite biases in data collection procedures that vary among studies, all evidence indicates that human-caused mortality is responsible for at least 80% of all tiger deaths (Table 19.1). Second,

beginning in the 1990s, there was a dramatic shift in the reasons that humans killed tigers. Prior to 1990, tigers were killed for a combination of reasons; hunters killed tigers as competitors, and farmers for livestock depredation, and tigers were not uncommonly killed in self-defence. Based on a survey of local hunters, Gorokhov (1983) reported that the majority of tigers (71%) were killed because they were considered competitors for prey. Nikolaev and Yudin (1993) could not always determine motive for killing, but their examinations of tigers shot and left in the forest (often roadside killings) suggest that tigers were generally viewed as 'bad', probably because of some combination of the fact that they are dangerous and kill prey. Thus, results of Gorokhov (1983) and Nikolaev and Yudin (1993) are probably more similar than the data, as presented, suggest.

From 1972 to 1992 poaching for commercial gain was not reported (Table 19.1): borders were closed during the Soviet era and access to the Asian demand for tiger products was virtually non-existent. Dissolution of the Soviet Union brought an easing in border restrictions and gun laws, and a new, urgent need for village inhabitants to earn income in a collapsed economy with spiralling inflation. Almost instantly tigers turned into a valuable cash crop at a time when there was high demand for tiger parts for traditional Chinese medicines (Mills and Jackson 1994). Data from field examinations and skin confiscations (column 3 in Table 19.1) and from radio-collared animals support the conclusion that the vast majority (58–73%) of deaths were associated with poaching. Those motives that existed prior to the 1990s (self-defence, retaliation for depredations, and elimination of competitors) probably continued, but are masked by the additional commercial value of tiger parts in the black market.

Effect of human-caused mortality on the Amur tiger population

The tiger is considered by some to be a 'resilient' species capable of recovering rapidly from intensive human harvest (Sunquist *et al.* 1999). However, recent analyses suggest that at least some populations may not be so resilient. Smirnov and Miquelle (1999) indicated that recovery of the adult segment of a colonizing Amur tiger subpopulation to 10–15 animals took 20 years, with a modest growth rate of 6%. Reproductive parameters of Amur tigers are not dramatically different from other subspecies (Kerley *et al.* 2002), suggesting that growth rates of other populations may also be slow. Recent modelling suggests that the Amur tiger population can be seriously threatened with extinction if poaching rates exceed 10% of the total population (G. Chapron *et al.* unpubl. data), and available evidence suggests that poaching rates exceeded that level during the 1990s (World Wildlife Fund 2002).

Although poaching for commercial gain has become the primary reason for humans killing tigers over the past decade, this is not a result of 'conflict' between humans and tigers, is not a primary focus of this analysis, and probably masks other continuing conflicts. Since tigers are most often opportunistically shot (e.g. tigers are usually shot during an encounter in the forest, and are not specifically targeted), the incentive for killing probably represents not only the prospect of commercial gain, but a complex mixture of emotions by a poacher, including fear and a sense that tigers are 'bad' because they are dangerous and kill livestock (see below). The long-term data presented here (Table 19.1) suggest that even when commercial gain was not an option, humans were responsible for the majority of tiger deaths. The cumulative impact of these other motives may be critical in determining the fate of small tiger populations. Therefore, efforts to reduce incentives for human-caused tiger mortality other than poaching seem well justified.

LETHAL CONTROL

Hunting of tigers as a game species has been illegal since 1947 in Russia. Permission for lethal control is issued from the appropriate Ministry in Moscow only for animals considered a danger to human life or welfare. Despite the difficulties inherent in obtaining a permit from a governmental agency 8000 km and seven time-zones away, over the 17-year period beginning in 1985, 55 animals have been killed under permit. Nearly all cases are associated with livestock depredation or in defence of human welfare. Aside from the 1986 winter, when 15 tigers were legally killed as a result of severe winter conditions that forced tigers into settlements seeking domestic prey (Nikolaev 1985), yearly kill rates have been consistently low, averaging 2.3 animals per year (3.2 if 1986 is included).

Attempts to reduce lethal control

In 1999, Inspection Tiger created a special Tiger Response Team to address 'problem situations' between tigers and people. The goals of this team are: first, to reduce or eliminate threats and perceived threats caused by tigers to humans (see below), and second, to reduce tiger mortality associated with conflicts with people. While the first priority is to provide safety for local people, many actions are intended to increase survivorship of tigers. The Tiger Response Team was responsible for killing five 'problem tigers' over the four-year period of its existence, resulting in a death rate slightly less than the long-term average (1.75 versus 2.3). However, this analysis does not include the team's impact in reducing tiger mortality due to killing in retaliation and in

self-defence (see below). By providing a mechanism by which local citizens can expect a rapid and official response to problem situations, there should be fewer incidents where local people resolve problems 'unofficially.'

SELF-DEFENCE FROM REAL/PERCEIVED THREAT TO HUMAN LIFE

Impact on humans

Of the large predators, tigers are considered the most consistently dangerous species (McDougal 1987; Sillero-Zubiri and Laurenson 2001). Although reports of man-eating Amur tigers were not uncommon across its range in the nineteenth century and the first part of the twentieth century (Prezhewalski 1870, 1923; Baikov 1925), there were no reports of man-eating tigers in the Russian Far East from the 1930s until 1976 (Abramov 1962; Zhivotchenko 1977). Over the most recent 32-year period (1970–2001) there were 51 official reported tiger attacks, with 14 people killed (Fig. 19.2). In eight instances a person escaped an attack uninjured. The probability of being killed by a tiger was identical (27%) for provoked and unprovoked attacks. This attack rate (1.4 attacks per year) and mortality rate (0.4 human deaths per year) is low in comparison to historical rates in Russia and elsewhere (McDougal 1987). In the Sundarbans, where man-killing tigers are most common, Hendrichs (1975) reported 24.3 deaths per year over a 15-year period. Adjusted for area (kills per 1000 km² tiger habitat per year) the kill rate in the Sundarbans (6 kills per 1000 km² per year) is two orders of magnitude greater than in the Russian Far East (0.01).

While elsewhere repeated attacks on humans by individual tigers are common (Corbett 1944; Hendrichs 1975; McDougal 1987), in the Russian

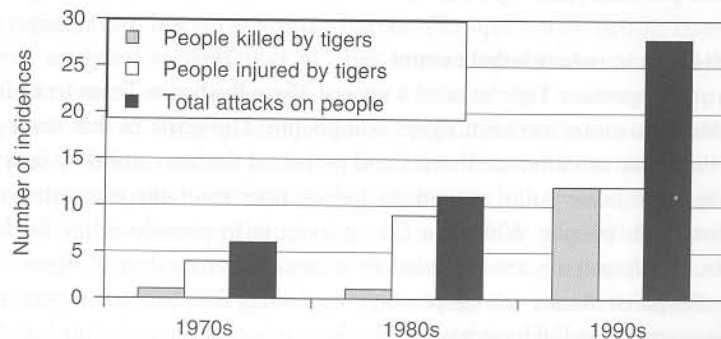


Figure 19.2. Number of attacks and people killed or injured by tigers in the Russian Far East, 1970 to 1999.

Far East there have been only two reported cases in the past 30 years of an individual tiger killing more than one person (in both cases two people were killed). Confirmed man-eaters appear to be rare in the Russian Far East because man-eating tigers are often quickly hunted down and killed and because, with low human densities, man-eaters (often sick or lame) have relatively few opportunities to kill people before succumbing to a natural death in severe winters.

The rate of encounters (as opposed to attacks) between tigers and people provides an indication of the potential and perceived risk to local people. A survey of local newspapers from 1992 to 1998 uncovered 397 articles (66 per year) reporting direct encounters with tigers. The majority of encounters (68%) occurred in tiger habitat (forested areas), but tigers do stray into human-dominated areas where chance of encounter is greater: 15% of encounters were along roads, 11% in transition zones between forest and human settlements (e.g. orchards, dumps, bee-keeping camps), and occasionally (6%) close to or within villages.

The largest percent of encounters (42%) occurred in winter (December–February), and autumn (September – November) (24%), when large numbers of hunters are in the forests. Cumulatively these data indicate that the majority of encounters are between human forest-users (primarily hunters and loggers) and tigers in natural tiger habitat, but excursions by tigers into settled areas do occur.

Low human density within tiger habitat (lower than any other tiger range country) in the Russian Far East is probably an important factor explaining the low attack rate (Fig. 19.1). Nonetheless, villages are scattered throughout the entire range of tigers in the Russian Far East, and the logging, hunting and trapping systems are structured to ensure that nearly all lands with potential yields of timber, game and furs are exploited. Therefore, even in areas with extremely low human densities, hunters and loggers will be scattered across the entirety of tiger habitat, with the result that encounter rates will be relatively high relative to the low densities of both humans and tigers.

Although attacks are rare, the perceived threat by local citizens is considerable, due partially to this high encounter rate. When asked to provide a reason against conserving tigers, respondents in two separate surveys most often cited danger to humans as the primary reason (Zabanova *et al.* 2001; Sukhomirov 2002). The rare but well-publicized appearances of tigers near villages reinforce the perception of danger.

The threat of tigers as perceived by local inhabitants has been reinforced by a significant increase in tiger attacks and human deaths in the early 1990s ($\chi^2 = 17.7$, $df = 2$, $p = 0.0001$) (Fig. 19.2), including all but two of 14

reported deaths since 1970. This increase is coincident with one ecological and two political/economic trends. First, tiger numbers increased consistently through the 1970s and 1980s, probably peaking in the late 1980s (Matyushkin *et al.* 1996; Kucherenko 2001). Political and economic turmoil which brought about the collapse of the Soviet Union in the early 1990s led to an increase in both gun ownership and illegal hunting as greater numbers of villagers entered forests to extract resources for subsistence, resulting in more encounters with tigers. Finally, poaching of tigers apparently reached a peak in the early 1990s (Galster and Vaud Eliot 1999; World Wildlife Fund 2002). The number of provoked attacks consequently increased (18 events in the 1990s compared to 11 from 1970 to 1989) as failed poaching attempts resulted in tiger attacks and human deaths. Thus, an increase in numbers of tigers, an increase in number of people in the forest, and an increase in poaching attempts collectively resulted in an increase in attacks and deaths of humans.

Impacts on tigers

Although some tigers are killed when entering villages, the majority are killed by people with guns in the forest. Fear of attack and a sense of threat no doubt play a role in a hunter's decision to shoot a tiger (Gorokhov 1983). Khramtsov (1995) reported that tigers demonstrated 'exploratory' behaviour (defined as standing motionless, often with tail twitching, and intently watching the person for some time before moving away) in 80% of 120 encounters with people. A motionless tiger staring intently, with tail twitching, could be sufficiently intimidating to elicit a reaction to shoot by any armed person. Although few have attempted to measure the importance of fear and self-defensive reactions as a contributing factor to human-caused mortality, Gorokhov (1983) reported it as one of the three primary motives for killing tigers between 1951 and 1973. It is clear that this sense of fear continues today (Zabanova *et al.* 2001; Sukhomirov 2002), and may be an even more common explanation for killing tigers as more inexperienced recreational and subsistence hunters are entering the forest (V. Solkin pers. comm.).

Attempts to reduce loss of/threat to human life

Given the bureaucratic constraints of obtaining a permit, it is not surprising that local people often prefer to resolve problems without official intervention. As already noted, in 1999 a federally mandated Tiger Response Team was created to address problem situations. To date the team has responded to 73 conflicts in nine different ways (Table 19.2). The most common response (50%) is to investigate and provide 'security' to local people who

Table 19.2. Responses of the Tiger Response Team to conflicts between Amur tigers and people in the Russian Far East, 1999–2002

Action	1999	2000	2001	2002	Total
Not investigated	2	3	5	3	13
Surveillance	3	5	14	17	39
Scare tactics	1	4	2		7
Capture and release		1			1
Capture and relocation		1		1	2
Capture, rehabilitation and release			2		2
Removal to captive population			2 (cubs)		2
Killed/died after capture and assessment		2	2	1	5
Killed		2			2
Total	6	18	27	22	73

feel threatened. These situations most often represent a single encounter in which a person or community felt threatened by the presence of a tiger. In these situations the perceived risk is clearly greater than the actual risk, yet, by responding, the team provides an official acknowledgement of the concerns of local people, and helps alleviate the antagonistic relationship between local people and tigers. A steady increase in 'surveillance' responses over four years is indicative of an increasing awareness of the team's existence by local people, and an increasing interest in requesting an official response (Table 19.2). Although difficult to measure, the ability of the Tiger Response Team to reduce the perceived risk may be its most important contribution in lowering human-caused tiger mortality.

Education programmes have attempted to reduce human fear and change local attitudes towards tigers, and publications such as 'Amur tiger: recommendations for human behaviour and domestic animal husbandry in tiger habitat' (produced by Inspection Tiger) attempt to reduce conflicts. Unfortunately, the effectiveness of these outreach programmes in changing local perceptions has not been measured.

RETALIATION KILLING FOR DEPREDAATION OF DOMESTIC ANIMALS

Impact on humans

Livestock depredation is the most common source of conflict between large carnivores and humans (Sillero-Zubiri and Laurenson 2001; Rabinowitz, Chapter 17, Frank *et al.*, Chapter 18, Swenson and Andren, Chapter 20). However, in the Russian Far East livestock depredation may not be as

important as in other parts of the world. Many villagers retain one to three cows (and to a lesser extent goats and sheep) as a source of milk and meat, but these animals are seldom targeted by tigers because they are normally brought into sheds every night. Larger farms retain sizeable herds of cattle, often close to tiger habitat, but few such enterprises have survived perestroika. Horses are not uncommon, and in winter often range independently, making them a potential target. Nonetheless, the relatively low numbers of livestock and the attentive management of small herds results in relatively few depredation incidents when compared to other parts of the world where depredation by carnivores occurs.

Comprehensive data on livestock depredations across the region are scarce, but E. N. Smirnov has kept records in a 5000-km² boundary area surrounding Sikhote-Alin Zapovednik since 1983 (Fig. 19.3). Depredation rates of livestock in this region averaged 3.2 animals per year \pm 1.4 (95% confidence interval), ranging from 0 to 10. Extrapolating depredation rates from this study area (which are probably at the high end of the spectrum) across the entire tiger range in the Russian Far East would indicate that approximately 100 livestock per year are killed.

Dogs are the most common domestic animals taken as prey by tigers in the Russian Far East. Dogs are an easy target of tigers entering villages since they are usually chained outside, but most dogs are killed while accompanying hunters in the forest. Hunting dogs are a valuable asset, and loss of a dog can disrupt an entire hunting/trapping season, substantially impacting income. Of the 588 survey respondents in Khabarovsk Krai who knew of a depredation event, 55% involved killing of dogs (Sukhomirov 2002). Data from Sikhote-Alin suggest that depredation on dogs is at least as common as on livestock (Fig. 19.3). Unfortunately, there is little that can be done to

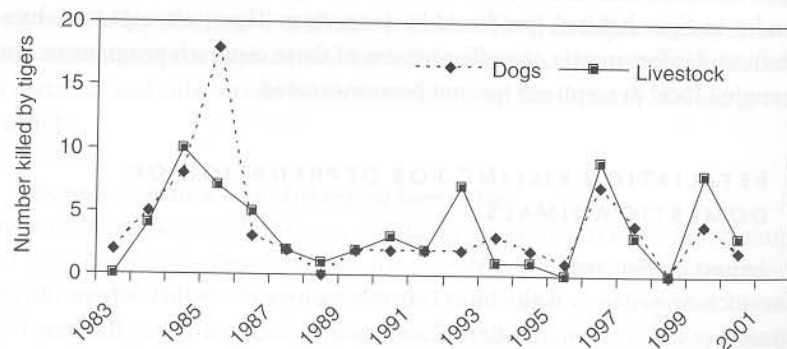


Figure 19.3. Number of dogs and livestock killed by tigers in the 5000-km² boundary area of Sikhote-Alin Zapovednik, Russian Far East, 1983–2001.

reduce such losses as long as hunters encourage their dogs to roam freely in tiger habitat.

Impact on tigers

Depredation retaliation accounted for 20–30% of reported tiger mortalities from 1951 to the early 1990s (Table 19.2). Since then depredation retaliation represents a smaller percentage of the total number of tigers killed (Table 19.2), probably reflecting both the increase in poaching rates, and a reduction in depredations as livestock numbers decreased. Gorokhov (1983) cites ‘revenge’ for loss of dogs as a primary motive for killing tigers. Dogs that run to their owner when pursued by tigers can precipitate encounters between tigers and humans, resulting in either an ‘incidental’ tiger attack or killing of a tiger in self-defence. Although such events do occur (Nikolaev and Yudin 1993), they are relatively rare, and a relatively unimportant factor affecting tiger population dynamics, but they help fuel the antagonistic attitude of hunters towards tigers (see next section).

Attempts to resolve the depredation problem

Historically, livestock depredations by tigers were covered by state-sponsored insurance. This system evaporated with the political turmoil of the early 1990s. Commercial insurance programmes are available, but premiums are relatively high, and are seldom, if ever, used by local farmers. In 1993 we began an experimental compensation programme in the area surrounding Sikhote-Alin Zapovednik. Compensation payments for tiger depredations were made at a few key farms within the range of radio-collared tigers. Our goals were to increase survivorship of study animals, and reduce antagonistic relationships between farmers and tigers. Antagonism of local farmers towards members of the Siberian Tiger Project appeared to decrease afterwards, and more significantly, we never recorded a loss of a radio-collared tiger that appeared linked to livestock depredation.

Despite the apparent success of this approach, it worked only at the local level, and was dependent largely on personal relationships between research staff and a handful of farmers. More importantly, the system was not sustainable in the long term, requiring continuous international sponsorship, and it provided no incentive for local farmers suffering depredations to improve animal husbandry techniques to reduce losses. While reducing retaliation killing locally, the rate of depredation was not changed, and the approach could not be extended to a larger area.

In an attempt to address these deficiencies, in 1999 the ‘Farmers’ Fund’ was created as a legally registered non-governmental insurance and loan

programme for farmers. Farmers paid membership dues that acted as insurance, but could also apply for low-interest loans to improve animal husbandry techniques. Membership fees were dependent on number of animals insured, but ranged from 500 to 4000 rubles (US\$16 to 133), while the average value of cattle was approximately US\$300 when rates were set. Using the long-term average depredation rate for the model area (4.0 animals per year), we needed to generate a minimum US\$1200 per year in membership fees to establish a sustainable programme. Membership fees above this amount could go into a loans programme. A membership base of 20 farmers in the model area would generate sufficient funds to insure sustainability.

In 2000 we publicized in local newspapers and billboards and by word of mouth to recruit members. In 2000 five members joined, in 2001 only four, and in 2002 the number decreased to only three farmers. In total, nine farmers joined for one or more years. Over its first three years the fund collected a total of 34 500 rubles (about US\$1150) in membership dues, and paid out US\$1182 in compensation for five depredation events (one horse and four cows). Whereas in previous years we knew farmers had killed depredating tigers (including farmers who later joined the fund) we had no records of tigers being killed in retaliation for depredations in the model area.

Due to a lower than average depredation rate, compensation costs only slightly exceeded membership dues, providing a false sense of sustainability. However, running costs and projected increases in depredation rates (to the 20-year average) would run the programme into bankruptcy. Most discouraging was the lack of interest in the programme from local farmers. Despite the fact that all nine members applied for and received low-interest loans, interest in the programme was weak.

We believe there were three interacting reasons for the poor results: (1) there is no cultural tradition of buying insurance in Russia, where formerly the state paid everything, thus the concept is new and unfamiliar to local people; (2) management/advertising of the fund was inadequate; and (3) the risk of depredation loss is too low. Even if cultural and educational barriers were overcome, it appears that for most farmers the risk of depredation is simply too low to justify the cost of insurance. Most farmers joined for one season and abandoned the programme when they incurred no immediate losses. While evidence suggests that a compensation programme does reduce retaliation killings, it appears ineffective to run a privatized insurance programme. Expenses to run such a programme are not high, and could theoretically be absorbed by the government under the auspices of the Federal Program for Conservation of the Amur Tiger.

COMPETITION BETWEEN HUNTERS AND TIGERS FOR UNGULATES

A key parameter of tiger habitat is prey density (Karanth and Stith 1999; Miquelle *et al.* 1999b), and therefore a key component of tiger conservation should be management of ungulate populations. There are over 40 000 registered hunters in Primorski Krai, making them potentially the largest stakeholder group coexisting with tigers. Virtually all unprotected tiger habitat is hunted, so hunter perception of and interaction with tigers is a fundamental component of tiger conservation. Nearly all tigers intentionally killed are shot by hunters, and therefore changing the traditional view of tigers as competitors for ungulates is critically important.

Impact of humans on tigers

Hunters impact tiger populations via prey depletion and direct killing of tigers. An average 8624 licences were issued per year (1998–2000) for all ungulates in Primorski and southern Khabarovski Krai, but actual kill rates were an estimated 250% higher (21 560 animals) than the legal limit (World Wildlife Fund 2002). Although hunting quotas are established conservatively, an estimated 97% of hunters kill more than allowed: an average 1.7–3.5 ungulates on licences issued for single animals. Hunting without a license is even more common (World Wildlife Fund 2002). Therefore illegal harvest has probably been a primary factor depressing ungulate numbers over the past decade, thereby increasing tensions over scarce game between tigers and hunters.

Gorokhov (1983) listed competition for prey as one of the three most important reasons for illegally shooting tigers. Gorokhov (1977) reported that hunters often leave dead tigers in the forest, not even attempting to profit from the killing. Available evidence suggests that the incentive to kill tigers as competitors continues, but now with greater access to Asian black markets, there is the added incentive of economic returns. While it is difficult to separate out these motives clearly, the strong sentiments regularly expressed by many hunters indicate that control of tiger numbers is considered an acceptable and even necessary action.

Impact of tigers on humans

Beginning in the early 1970s there has been concern about the impact of increasing tiger numbers on ungulate populations (Kucherenko 1970, 1993; Gorokhov 1983; Dunishenko 1985). In two recent surveys respondents indicated that the impact of tigers on wild ungulate populations ranked second only to concerns about personal safety as reasons not to protect tigers

(Zabanova *et al.* 2001; Sukhomirov 2002). Although the argument as to whether tigers actually do limit prey population densities is debatable, there is sufficient evidence to suggest that at least in some situations limitation by tigers can occur (Miquelle *et al.* 2005). Uninterested in the scientific debate, hunters view every ungulate killed by tigers as one less ungulate they are able to harvest. The annual offtake of ungulates by tigers (an estimated 20 000–25 000 animals: World Wildlife Fund 2002) is often cited as evidence of the severe impact of tiger predation on ungulate populations. Thus a perception has developed that competition between hunters and tigers is direct and serious, with some suggesting that coexistence is possible only with regulation of the tiger population through controlled harvest (Bragin and Gaponov 1989; Kucherenko 1993).

Responses to the problem

Increasing prey populations, better hunter management, and education are key elements in resolving the hunter–tiger conflict in Russia. Beginning in 1995, new legislature provided opportunities for local people to create non-governmental hunting ‘societies’ that could obtain and manage hunting lands. Today, in place of a small number of state-controlled operations, there are 102 registered hunting leases in Primorye. For the first time ever, local people have been given responsibility for managing wildlife populations, acquiring in the process some responsibilities for non-game and endangered species as well. While this new arrangement only provides rights to use and manage wildlife, it nonetheless represents a revolutionary change in resource management in Russia. Under the former system, most people believed in maximizing personal consumption of communal (state) properties, including wildlife resources, without concern about sustainability. Now, local people have a vested interest in properly managing a resource that is theirs, and that they depend upon for recreation, income and food.

In 2000, the Wildlife Conservation Society initiated a programme to improve wildlife management through support and education to hunting groups of the region. The intention is to support newly established hunting leases, to increase capacity for self-management and financial independence, to increase ungulate populations, and to improve the relationship between hunters and tigers. Activities within the scope of this project include legal assistance to private leases, increasing stakeholder capacity, increasing financial stability, education programmes, and management initiatives to increase ungulate densities (including improvements in anti-poaching, population management and habitat improvements). It is too early to judge the results of this programme, but in a few experimental leases, increases in ungulate populations have been reported. It remains to

be determined whether a grassroots approach to wildlife management will result in higher ungulate densities and improved relations between tigers and hunters.

CONCLUSIONS

Given that densities of both human and tiger populations in the Russian Far East are as low or lower than any other tiger range country, the success or failure of humans and tigers to coexist there may be considered a benchmark case for carnivore conservation. If coexistence is impossible in this setting, prospects for success in other countries, where human densities and their demands on the landscape are magnitudes greater, are dim. The fact that the Russian Far East retains the single largest unfragmented habitat for tigers, and that the Amur tiger population probably represents the largest contiguous population of tigers in the world, provides hope for the future. Intensive investments of time, energy and money on the part of the international conservation community, along with commitment from some key governmental agencies, have apparently secured a stable population of Amur tigers, at least temporarily. While intensive harvest of prey remains problematic, the creation of special anti-poaching teams and tiger response teams have had some success in reducing direct impacts of tigers and people on each other. The success of programmes aimed at increasing prey numbers and reducing the antipathy of hunters towards tigers is yet to be determined. In the absence of adequate government financial support a comprehensive compensation programme for livestock depredation is difficult.

We believe that tigers and people can coexist in the Russian Far East, but active conflict-resolution programmes must be an integral part of the coexistence recipe. Government-sponsored tiger conflict teams, educational programmes and hunter support programmes are important steps towards reducing conflicts to manageable levels. At the same time, it must be recognized that while conflicts can be reduced with proper management and education, it is unlikely that they can be totally eliminated as long as people and tigers are using the same land base. Impacts on people must be reduced to a level that is acceptable, not to the global society as whole, but to the people of the forest communities that incur the cost of living with tigers. At the same time, it is imperative to reduce human-caused mortality to levels that do not threaten viability of the tiger population. Increasing ungulate densities, and improving attitudes of local hunters towards tigers, as well as effective depredation compensation programmes, remain challenges for the future.

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