Human-Wildlife Conflicts in the Nanda Devi Biosphere Reserve, Uttarakhand, India

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Introduction

In 1977 UNESCO initiated its Man and Biosphere Program (UNESCO "Man and Biosphere" Programme FAQs) in an effort to protect ecosystems that are valued for their natural and aesthetic qualities. The Nanda Devi Biosphere Reserve became one of the first Biosphere Reserves in India in 1988, and remains one of the best known. The Reserve is comprised of two core zones: the Nanda Devi National Park and the Valley of Flowers National Park. Both of these are surrounded by a Buffer Zone where people live. The two parks were later proclaimed a UNESCO World Heritage site.

UNESCO outlines three primary functions of a biosphere. These are: (1) conserving ecosystems, (2) promoting economic and human development that does not interfere with the well being of the ecosystems, and (3) providing opportunities to conduct research related to conservation and development (UNESCO "Man and Biosphere" Programme FAQs). Problems often arise when these functions, particularly the first and second, conflict with each other. This is currently the case in the Nanda Devi Biosphere Reserve, where conserving the natural landscape and promoting economic growth often collide in the form of Human-Wildlife Conflict, hereafter referred to as HWC.

HWC occurs in several ways in the Nanda Devi Biosphere Reserve. From the perspective of humans, conflict ensues when animals damage crops and property, prey on livestock, and attack people (Ogra and Badola 2008). Many animals

contribute to HWC in the Reserve, including bears, boars, porcupines, leopards, and the subjects of this thesis, non-human primates.

Primates are a major contributor to HWC in the Reserve. Primates do not prey on people or livestock, but instead cause significant problems because they raid crops and orchards of the residents living in the Reserve. The damage they cause to orchards is particularly acute, although they destroy and uproot crops as well.

In this thesis, my primary objective is to provide an account of the research that I conducted in conjunction with the Wildlife Institute of India at the Nanda Devi Biosphere Reserve in July of 2010. In this study, we assessed people's attitudes toward HWC, with special reference to conflict created by primates. Crop raiding by primates emerged as the primary source of HWC in the Nanda Devi Biosphere Reserve. A second goal of this thesis is to furnish suggestions about how to resolve this form of HWC in the Reserve.

Methods

Study Area and Subjects

The Nanda Devi Biosphere Reserve (79°40'E – 80°5'E and 30°17'N – 30°41N) is located in the Chamoli district of the northern Indian state of Uttarakhand and is part of the Garhwal Himalaya mountain range (Appendix 1). The Biosphere occupies

an area of 2,237 km^2, of which 625 km^2 forms a core zone and the remaining 1,612 km^2 constitutes a buffer zone (Maikhuri *et al.* 2001), where the people of the Reserve live. The most notable feature of the area is the mountain for which the Biosphere derives its name. At 7,817 meters Nanda Devi is the second highest mountain of the Indian Himalaya. The glacial basin that is formed by its twinned peak supplies the Rishi Ganga and the surrounding rivers. The altitude of the Biosphere varies from 1,900 to 7,817 meters (6,234 to 25,646 feet). This altitudinal variation leads to an immense plant and animal biodiversity that makes up the ecological landscape of the region.

According to the 2001 report of the Nanda Devi Expedition conducted by the Wildlife Institute of India, the Biosphere supports over 1,000 species of plants and approximately 520 species of animals, including mammals, birds, reptiles, amphibians, fishes, and insects (Uniyal 2004). There are 14 known species of mammals living in the Biosphere, six of which are currently listed as endangered (Nanda Devi & Valley of Flowers National Parks 2005). Among these are the Bharal (*Pseudois nayaur*), the snow leopard (*Panthera uncia*), and the musk deer (*Moschus leucogaster*). Villagers from the 45 surrounding villages in the buffer zone report frequent sighting of these animals, but nonhuman primates are the most frequently encountered animals in the reserve.

The farmers of this region are called Tolchas and generally farm terraced fields that provide them with two harvests per year: a wheat, barley, and millet harvest in May and a variety of lentils, kidney beans, and potatoes in the late summer to early fall (Bosak 2008). Summer and fall crops are generally sold for

cash. There are also several fruits and nuts grown, including apples, pears, apricots, walnuts and almonds. Although primates are thought to mostly raid orchards, they have been known to cause considerable damage to crops as well.

The Primates

Two endemic species of primates to India are also a part of the ecological diversity of the Nanda Devi Biosphere Reserve. These include rhesus macaques (*Macaca mulatta*) and common or Hanuman langurs (*Semnopithecus entellus*).

Although they often inhabit the same area, these two species differ in many ways. Common langurs and rhesus macaques are easily distinguished by their overall appearance. Common langurs are gray and white and have black faces. Rhesus macaques, on the other hand, possess light brown coats with reddened faces and perineal regions. Langurs are larger than macaques. The average head to body length of common langurs is approximately 63.9 cm (25.16 inches) (Gron 2008). In contrast, the average length of rhesus macaques is 53.18 cm (20.94 inches) and 46.88 cm (18.48 inches) for males and females, respectively (Cawthon 2005). There is also a marked disparity in weight between the two species with common langurs averaging 12.5 kg (27.6 lbs.), while rhesus macaques males average 7.7 kg (17 lbs.) and females average 5.34 kg (11.8 lbs.).

Common langurs and rhesus macaques differ behaviorally as well as morphologically. Because this study examines crop raiding, here I focus primarily on ecological and dietary differences between the two species. Rhesus macaques are

well adapted to co-existing with humans, and thrive near urban and agricultural human settlements (Cawthon 2005). The ability of rhesus macaques to reside in close proximity to humans is likely tied to their dietary preferences. Macaques have a non-specialized and very flexible diet, which allows them to live commensally with humans, even in degraded habitats or urbanized areas where they feed on whatever humans eat (Campbell 2011). It is not uncommon to see macaques rummaging through trash left by humans in many urban areas. For instance, I witnessed such behavior frequently during my five-week stay in India. In rural areas where there is a plentiful supply of food from crops and orchards, rhesus macaques do not typically forage in human trash pits.

Common langurs, on the other hand, like most other colobines are largely folivorous. They are known as "leaf-eating monkeys" because they have physiological adaptations, such as a multi-chambered stomach that facilitates the digestion of leaves (Campbell 2011). However, their diet is not exclusively folivorous. Depending on the season, langurs also incorporate varied amounts of fruits, flowers, and insects into their diet (Gron 2008). And while they have preferences for certain young leaves and fruits, in times of food scarcity they are able to adapt to a wide variety of foods, including bark and the cones of conifers. While their diets are not as flexible as those of macaques, langurs still raid crops, especially orchards.

Another important behavioral distinction between these two species is their temperament: rhesus macaques are more inclined to aggression than the common

langurs. Most attacks by monkeys on humans are committed by rhesus macaques (Malik 2001).

Interviews and Questionnaire

My research was conducted by means of interviews with local residents from three villages in the buffer zone of the Nanda Devi Biosphere Reserve. The three villages are all within close proximity of each other southeast of the city Joshimath. They include: Barhgaon, Tapovan, sometimes called Topoban, and Pursari. The villages varied in terms of their size and population. One village, Pursari is considerably smaller than the others (Table 1) (Demographics: Barghaon; Demographics: Pursari; Demographics: Tapoban).

Table 1. Number of Households and Population by Village

Village	**Number of Households**	**Population**
Barhgaon	176	825
Tapoban	173	793
Pursari	31	157

The interviews were conducted via a questionnaire prepared ahead of time by the Wildlife Institute of India. The questionnaire is provided in Appendix 2. Briefly, the questionnaire asked individuals about their attitudes towards non-

human primates as they relate to (1) their crops and orchards; (2) their own personal well-being; and (3) the well-being of their family members. Some of the questions permitted only “yes” and “no” answers, while others were open ended and allowed respondents to give as many answers as they would like. Each individual was asked twelve questions.

The questionnaire that was used to conduct interviews was created by members of the Wildlife Institute of India. Interviews adhered to the laws and regulations of the Republic of India. All interviews were conducted with consenting adults, whose ages ranged between 18 and 73. I accompanied one of the two members from the Wildlife Institute of India, who administered the questionnaires. Interviews were conducted in and around town centers or in the respondents’ homes. We completed 54 interviews. Table 2 shows the distribution of respondents by villages.

Table 2. Number of people interviewed in each village

Village	**Number of people interviewed**
Barhgaon	27
Tapoban	8
Pursari	19

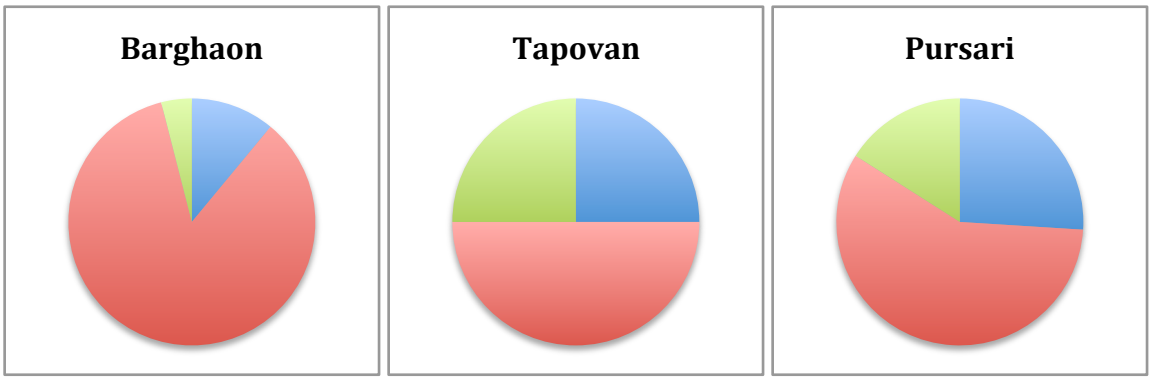
Results

Of the 54 respondents, virtually all of them (93%) said they frequently came into contact with monkeys. When asked if they consider primates pests, 96% said yes with little variation between the three villages. The next question, however, yielded diverse responses. In question 4, we asked: "Relative to other animals, are primates more or less of a problem?" Responses from people in Barghaon differed greatly from those given by villagers in Tapovan and Pursari. Eighty five percent of the respondents in Barghaon (23/27) said primates were less of a problem than were other animals. In contrast, 50% of the respondents from Tapovan (4/8) said primates were less of a problem. Figures were similar for Pursari, where 58% (11/19) of all individuals replied that primates were less of a problem than were other animals (Table 3 and Figure 1).

Table 3 and Figure 1. Responses to Question 4 "Relative to other animals, are primates more or less of a problem?"

	Barghaon	**Tapovan**	**Pursari**
More (blue)	11%	25%	26%
Less (red)	85%	50%	58%
Equal (green)	4%	25%	16%

Figure 1.



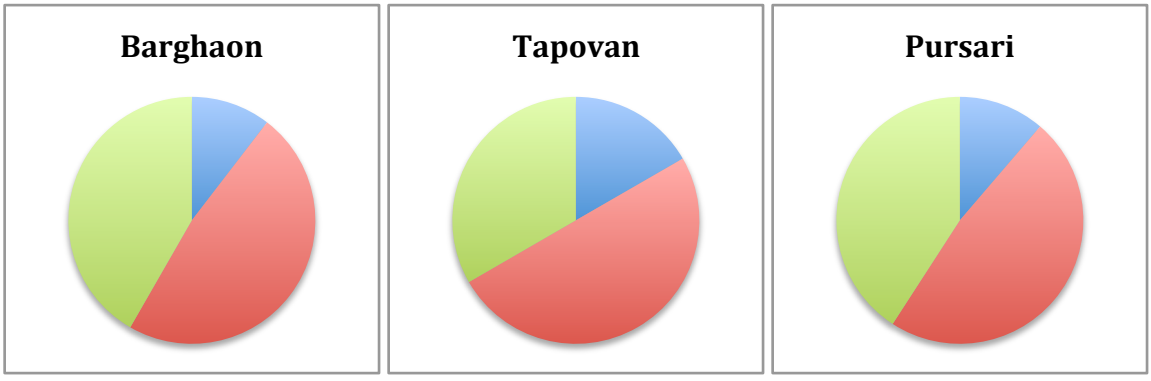
Unlike questions 1 - 4, Question 5 was open ended, and therefore, allowed for a variety of answers. In it we asked: "What sort of problems do primates pose for you?" Despite the open nature of the question, many of the responses we received were similar. I classified the responses into 3 major categories: damage to crops, damage to orchards, and "crop guarding". Each of these were cited enough by respondents to have them qualify as separate categories. Damage to crops and orchards includes several things, including eating crops and in some cases only uprooting them. Damage to orchards is similarly defined. I defined "crop guarding" as posting someone near the crops and orchards to keep the monkeys away. Crop-guarding was inconvenient and time consuming, according to the respondents, because the fields were typically far away from residences. We received fairly uniform responses to this question. Damage to crops was cited as the most

important problem by a majority of the respondents and varied from 68% (13/19 respondents from Pursari) to 85% (23/27 respondents from Barghaon). Half or more of all respondents cited damage to orchards as a problem (Table 4 and Figure 2).

Table 4 and Figure 2. Responses to Question 5 "What sort of problems do primates pose for you?"

	Barghaon	**Tapovan**	**Pursari**
Damage to Crops	85%	75%	68%
Damage to Orchards	74%	50%	58%
"Crop Guarding"	18.5%	25%	16%

Figure 2.

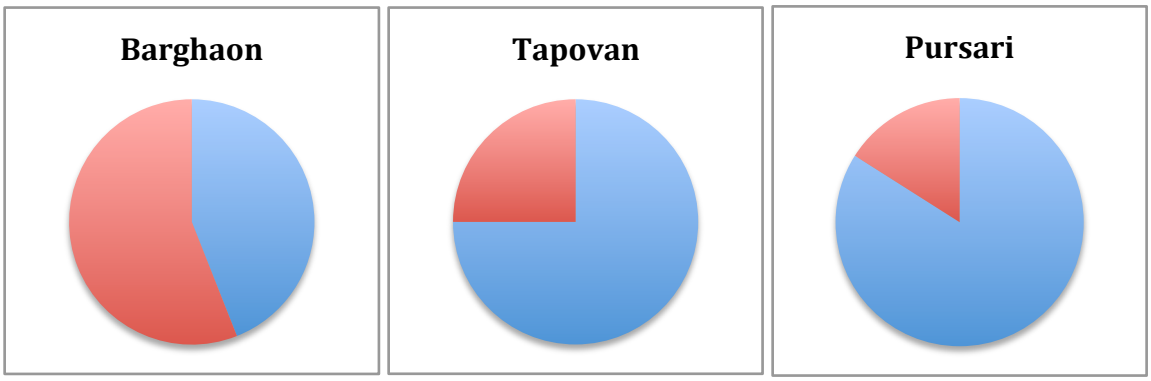


Leaving the issue of crop raiding aside, one set of questions we asked concerned the individuals' well being, as well as the well being of their family members. While 87.5% (7/8 respondents from Tapovan) to 100% (19/19 respondents from Pursari) of individuals from the villages said they have never been attacked or injured by a monkey, the following question elicited an interesting difference in responses by villagers. In question 10 we asked: "Do you ever fear that you or anyone in your family will be attacked or injured by a monkey?" In Barghaon only 44% of the respondents said they were afraid of future attacks. In contrast, 75% and 84% of the respondents from Tapovan and Pursari, respectively, said they were afraid of such attacks (Table 5 and Figure 3).

Table 5 and Figure 3. Responses to Question 10 "Do you ever fear that you or anyone in your family will be attacked or injured by a monkey?"

	Barghaon	**Tapovan**	**Pursari**
Yes (blue)	44%	75%	84%
No (red)	56%	25%	16%

Figure 3.



What could account for this disparity? One possibility is that the individuals from Barghaon have less frequent encounters with primates on a daily basis. Or perhaps these individuals are less likely to encounter primates when alone. This could influence one's vulnerability to an attack. Another important factor to consider is that primates are more likely to attack children than adults, and when adults are attacked they are frequently women (Malik 2001). Of the twelve individuals from Barghaon who responded yes to this question, seven were women. In Tapovan, all three of the women we interviewed responded yes to this question. And in Pursari, of the 16 who responded yes, 8 were women. In other words, a disproportionate number of women answered yes to this question. In fact, when considering the aggregate data, 82% of women responded yes to Question 10, as opposed to 50% of men. Responses given to this question might also factor in the possibility of attacks on other family members. Women might be more sensitive to

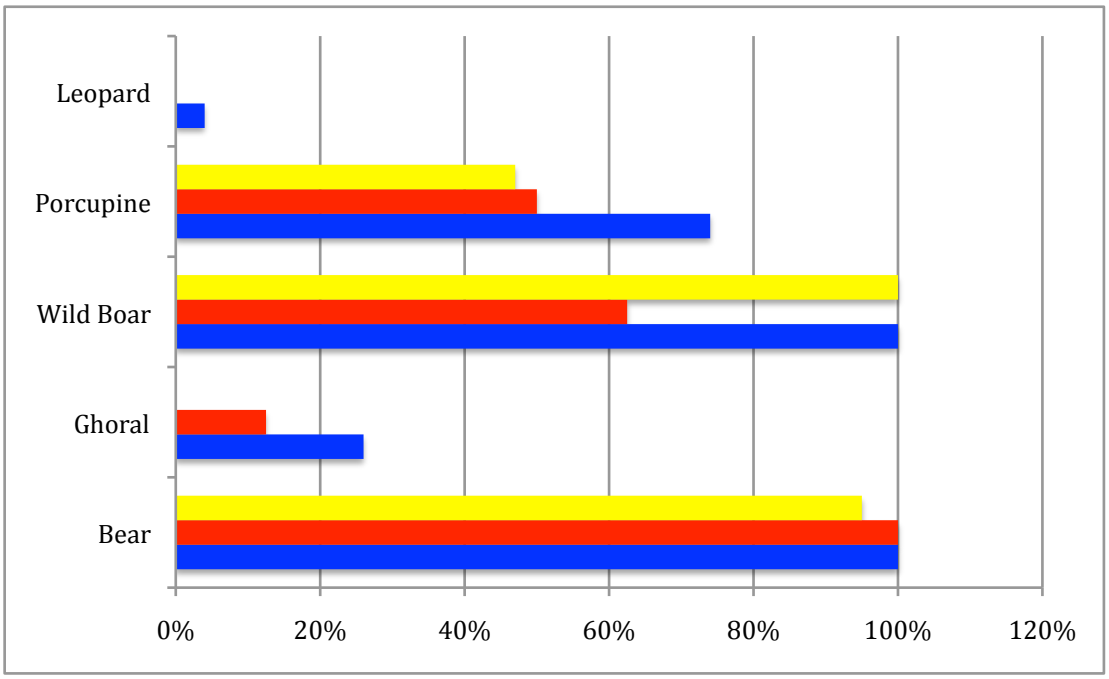
this because they are the primary caretakers. As a consequence, women may be more fearful of future attacks than are men for both themselves and their children.

Responses to questions revealed that primates are not the only source of HWC. We thus asked what kinds of other animals posed problems. Common responses to this question included bears, boars, porcupines, and ghorals. Bears received the most responses with nearly every individual (53/54) citing them. Boars received a similar number of responses from those living in Barghaon and Pursari, but a much smaller percentage of residents from Tapovan (62.5% or 5/8) mentioned them. A similar number of respondents from Tapovan and Pursari (4/8 = 50% and 9/19 = 47%, respectively) cited porcupines as a problem, while a slightly larger number of individuals from Barghaon (20/27 = 74%) claimed that porcupines represented pests (Table 6 and Figure 4). Respondents from Barghaon cited more animals on average than those from the remaining two villages.

Table 6. Responses to Question 12 "Other than monkeys what are the other animals cause damage to your property and how?"

Animals:	**Barghaon (Blue)**	**Tapovan (Red)**	**Pursari (Yellow)**
Bear	100%	100%	95%
Ghoral	26%	12.5%	0%
Wild Boar	100%	62.5%	100%
Porcupine	74%	50%	47%
Leopard	4%	0%	0%

Figure 4.



Taken together these results indicate that several animals contribute to HWC in the Reserve. Different animals pose problems in different villages. Likewise, the role that primates play in creating HWC varies between villages. But while they may contribute a disproportionate amount to the problem, we found that peoples' attitude towards primates were fairly similar across villages. In the second question we asked: "Would you describe your interaction with monkeys as pleasant, unpleasant, or neither?" An average of 79% of the total respondents said unpleasant

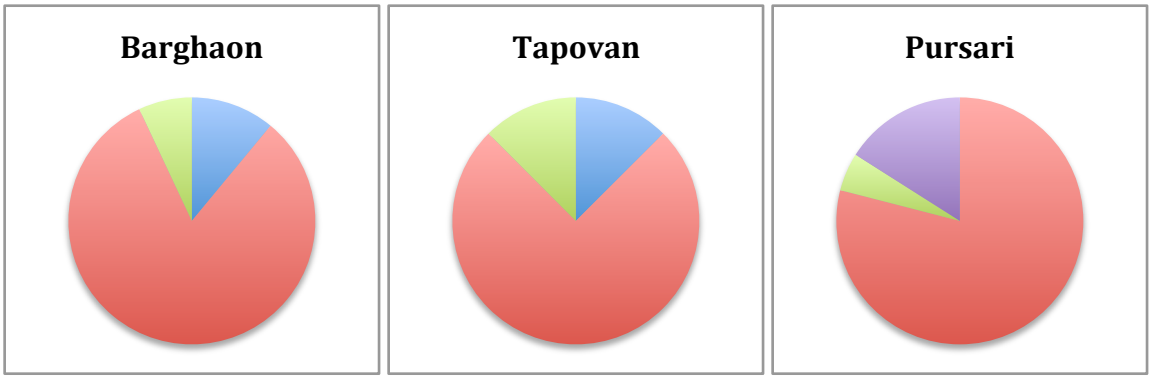
(ranging from 82% or 22/27 from Barghaon to 75% or 6/8 from Tapovan). A similar number of people responded “pleasant” and “neither” (Table 7 and Figure 5).

Table 7. Responses to Question 2 “Would you describe your interaction with monkeys as pleasant, unpleasant, or neither?”

	Barghaon	**Tapovan**	**Pursari**
Pleasant (blue)	11%	12.5%	0%
Unpleasant (red)	82%	75%	79%
Neither (green)	7%	12.5%	5%
*Both (purple)	0%	0%	16%

* see limitations section.

Figure 5.



Even though we offered respondents only three options: pleasant, unpleasant, and neither, some people in the last village said "both [pleasant and unpleasant]". I discuss the probably reason why the respondents gave this answer in the following section.

To summarize these results:

1. Most villagers have contact with monkeys regardless of village.
2. Most consider primates pests.
3. Primates seem to be considered less problematic in Barghaon than the other two villages.
4. Across all three villages the most common problem primates tend to cause (in order of most to least prevalent) are damage to crops, damage to orchards, and crop guarding.
5. Most people said they have never been attacked by a monkey before.
6. There is much less fear of future attack by monkeys in Barghaon than the other two villages.
7. Across all three villages the most frequently cited animals causing HWC besides primates (in order of most to least cited) were bears, wild boars, porcupines, ghorals, and leopards.

Discussion

While there has been considerable research on HWC in the Nanda Devi Biosphere Reserve, we know little about how primates contribute to the problem. In this study my goal was to address this issue through an investigation of three villages in the buffer zone. While most villagers reported having frequent contact with monkeys and most considered them pests, some differences emerged between the villages. First, primates seem to be less problematic in Barghaon than the other two villages. One reason for this could be that other animals pose a larger threat to people and their crops in Barghaon. Random sampling error could furnish another reason for the disparity between villages, as sample sizes were not very large in any of the three villages. Responses to question 12 lead me to believe the first possibility, rather than sampling error, accounts for why people in Barghaon consider primates less problematic than do people in the other two villages. The respondents from Barghaon were more likely to cite other animals than the respondents from the remaining two villages. From this I conclude that primates, while still a problem, are less so compared to other animals in Barghaon.

Another disparity in the results was that there is much less fear of future attacks by monkeys in Barghaon than the other two villages. There are also various reasons for this. As noted in the results, it is possible that villagers from Barghaon were typically accompanied by one or more individuals when going to the fields, where the monkeys tend to be frequently encountered. Another possibility is that the sample of villagers differed in their gender composition and that this affected

their responses. For example, if there were fewer female respondents from Barghaon, this may have affected the results. This was not the case, however, as 37% of the respondents in Barghaon were female (10/27). This did not differ from the number of females questioned from Tapovan (37.5% = 3/8), but was less than those responding from Pursari (53% = 10/19). So while it is true that females were more likely to say that they were afraid of future attacks, this does not explain why there was so much variation between the villages. This raises the possibility that respondents from Barghaon are more likely to travel in groups when encountering monkeys. I was unable to test this hypothesis, though, because we did not pose this question in our interviews.

Despite these differences between the villages, there was little disparity in terms of the problems that primates cause. The most frequently cited issue was damage to crops, followed by damage to orchards, and also crop-guarding. Although none of our questions addressed this, there seemed to be a distinction in the way in which villagers think about rhesus macaques and common langurs. Most consider rhesus macaques to represent a greater threat than do the langurs.

Limitations of this Study

Although we were able to gather a reasonable amount of data through the interviews, there were some obstacles in the interview process that need to be taken into account. The first, and most obvious limitation is that we were only able

to interview a small number of individuals in all three villages. The relatively small samples of individuals questioned may have resulted in answers that are not entirely representative of the villages as a whole.

Another factor to take into consideration, although it does not necessarily limit the study itself, is that I chose to eliminate two of the questions from the original questionnaire, questions 7 and 8. These questions concern compensation for crop loss due to primates. As it turns out, the government does not compensate for this sort of loss, although they do compensate for loss due to other animals, such as bears and leopards. Question 7 asked: "Have you ever received any sort of compensation for your loss [of crops]?" Every respondent said no. Question 8 was a continuation of question 7, and was, therefore, also eliminated from this report. The fact that farmers are not compensated for their losses caused by primates could lead to more negative feelings towards the monkeys and the damage they cause.

An unexpected limitation that occurred in the course of the interviews was the use of the word "monkey" in Hindi, which corresponds to *bandar*. During the first interviews we conducted, my colleagues only used the word *bandar* when posing the questions about monkeys. Our intention was to include both rhesus macaques and common langurs, but it became apparent later that the respondents associated the word *bandar* with rhesus macaques alone. Common langurs are simply referred to as *langur*. We were not aware of this distinction initially, but my colleagues later altered the questions to include langurs. This could have led to some difference in responses, since only one species was considered early on.

In relation to this limitation, some respondents gave us unexpected answers to question two, which asked: "Would you describe your interaction with monkeys as pleasant, unpleasant, or neither?" I did not take into consideration that some respondents would respond "both". For instance, a few of the respondents remarked that in general it was pleasant to see monkeys because they are interesting animals, but unpleasant feelings arose when they damaged their crops and orchards. I believe that this is due to our incorporation of the langurs into the questions during the course of the interviews. It is possible that respondents have a different relationship with langurs since they are behaviorally less antagonistic (Chauhan and Pirta 2010). As mentioned earlier, langurs are behaviorally quite different from macaques, especially since they are folivorous their diet is much more restricted and are, therefore, not as likely to raid crops. This could explain why the people we interviewed had more positive associations with langurs, but not with macaques. However, there was nothing in the questionnaire that addressed this specifically, so this is only speculation.

Summary and Implications

Human-wildlife conflicts can take many forms. For the Nanda Devi Biosphere Reserve, crop raiding seems to be the most costly and severe. As in many wildlife-protected areas around the world, the farmers in this region are particularly susceptible to crop raiding because they are surrounded by wildlife habitat, which increases the likelihood of encountering wildlife on a daily basis, and for ensuing

conflict to arise. Primates are particularly pertinent in this respect for several reasons. For one, primates are highly intelligent creatures that are able to adapt to new situations and learn to overcome obstacles such as fences and scarecrows (Sillero-Zubiri and Switzer 2001; Chhangani and Mohnot 2004). These features are able to keep some wildlife away from crops, but they pose almost no concern for primates. Second, most primates are omnivorous and able to eat almost anything that humans eat. This is particularly true for rhesus macaques and less so for langurs, but both find the crops and orchards that humans grow highly desirable foodstuffs.

For these reasons, and many more, primates are the most frequently identified crop raiding animals around the world (Sillero-Zubiri and Switzer 2001). Yet, very little research is devoted to primates and crop raiding. Primates receive little attention in this regard because they are often perceived as having low conservation value by government agencies and the public alike. Whereas high-profile crop raiders such as elephants, because of their conservation status, have much more research devoted to reducing crop raiding without hurting the animals. Leopards, and other large felines, receive similar treatment with predation of livestock, which is why governments like India provide compensation to farmers who lose livestock to predation and discourage poaching and other violent ways of reducing conflict. Primates, on the other hand are often simply treated as pests; governments often prescribe the lethal removal of primates (as was the case with the farmers that we interviewed).

It is likely that crop raiding has been around since the beginning of agriculture. However, with a continuously growing population and an increasing need for food supply, it is likely that these problems will only continue to escalate in the future. This is especially true in a country like India, where economic and population growth is exponential. That is why it is important to address these issues now, and find viable solutions to help mitigate crop raiding in the future. In light of these circumstances, I have come up with a couple of recommendations.

The first recommendation, as follows from the results of this data, is that more research is needed on primate crop raiders. The Nanda Devi Biosphere is one such place where research should be conducted in hopes of finding reliable methods to remedy the crop raiding situation with primates, especially since many techniques that are used (i.e. fences) are unreliable for them. Traditional techniques, as described to us by the farmers, are burdensome and inefficient. A method that is often relied on, such as crop-guarding involves spending hours in the fields chasing away monkeys. This is time consuming, but also ineffective in the long run.

Researchers Claudio Sillero-Zubiri and David Switzer compiled a report on crop raiding and outlined several traditional and modern methods of preventing crop raiding. Since many of these traditional techniques are ineffective, or simply do not work for primates (i.e. scarecrows), it seems that only hunting, trapping, and poisoning are effective. These methods obviously have negative consequences on the primate population of the area, as well as the overall biodiversity. They also do not provide a long-term solution, as – inevitably – other primates will continue crop raiding. On the other hand, more modern techniques such as electric fencing are

expensive and, not to mention, cruel. While this method is often employed in more industrialized countries, for a developing country like India it does not seem like a viable solution.

When coming up with a solution, two things should be kept in mind. First, the farmers themselves know crop raiding the best because they deal with it on a daily basis. Thus, any solution needs to be developed with their help and guidance. Second, and this applies specifically on primates, it is important not to underestimate the crop raiders' intelligence. Whatever solution is proposed needs to be more sophisticated than what is currently used because they are able to surpass many obstacles with ease. For instance, monkeys are smart enough to know if they see someone guarding a field that they should return later when there is no one there.

There is by no means an easy solution to the problem of crop raiding, but through the study of animals, such as primates, it will be easier to know what they are capable of and what is beyond their abilities. This can bring us one step closer to finding a remedy to this issue that plagues farmers, not only in the Nanda Devi Biosphere Reserve, but throughout the world.

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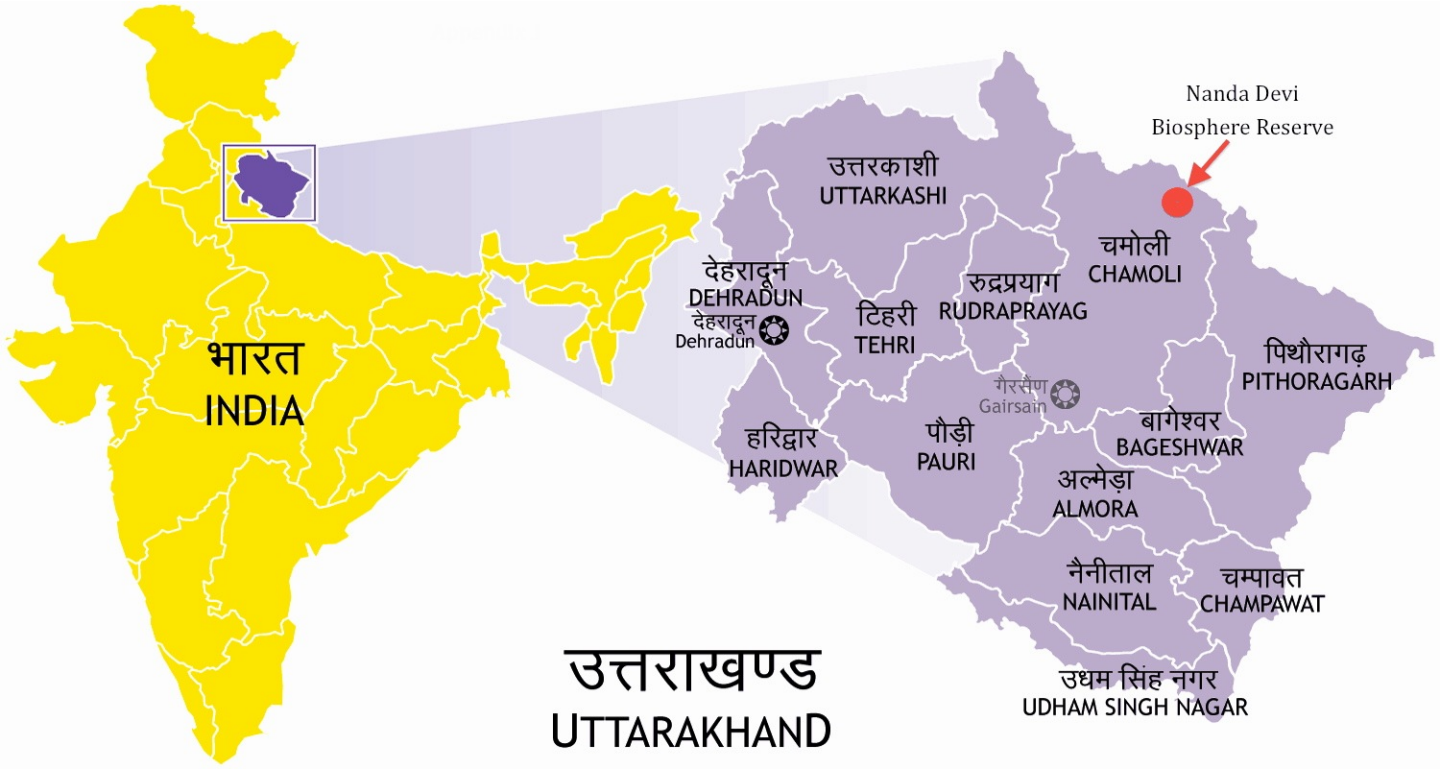
APPENDIX 1


Nanda Devi
Biosphere Reserve
उत्तरकाशी
UTTARKASHI
चमोली
CHAMOLI
देहरादून
DEHRADUN
देहरादून
Dehradun
टिहरी
TEHRI
रुद्रप्रयाग
RUDRAPRAYAG
पिथौरागढ़
PITHORAGARH
गैरसैंण
Gairsain
भारत
INDIA
हरिद्वार
HARIDWAR
पौड़ी
PAURI
बागेश्वर
BAGESHWAR
अल्मेड़ा
ALMORA
नैनीताल
NAINITAL
चम्पावत
CHAMPAWAT
उधम सिंह नगर
UDHAM SINGH NAGAR
उत्तराखण्ड
UTTARAKHAND

APPENDIX 2

Name of the Village: Name of the respondents:

Age: Sex : M/F Education level:

Questionnaire

1. Do you frequently come into contact with monkeys?	
2. Would you describe your interaction with the monkeys as pleasant, unpleasant, or neither?	
3. Do you consider primates pests?	
4. Relative to other animals, are primates more or less of a problem?	
5. What sort of problems do primates pose for you?	
6. How much of your crop/orchard damage is due to primates?	
7. Have you ever received any sort of compensation for your loss?	
8. If yes, were you satisfied with the compensation you received?	
9. Have you or anyone in your family ever been attacked or in some way injured by a monkey?	
10. Do you ever fear that you or anyone in your family will be attacked or injured by a monkey?	
11. Do you know the biting of a monkey may cause some diseases? If yes, what are they? Have you taken any precaution?	
12. Other than monkeys what are the other animals causing damage to your property and how?	