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Assessing the Sustainability of Baird's Tapir Hunting in the Bosawas Reserve, Nicaragua

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Abstract

In many locales throughout its range, the Baird's tapir is a preferred game species for subsistence hunters. I review research on Baird's tapirs and use the methods of Robinson and Redford's (1991) production model to present MSY estimates based on three diverse density estimates. These estimates are used to assess the sustainability of tapir hunting in Nicaragua's Bosawas Reserve. The assessment indicates that tapirs are harvested unsustainably in the core hunting zone around two indigenous communities. The immigration of tapirs from unexploited areas upstream of the communities appears to explain their continued existence in the hunting zone. I discuss efforts to protect this species, and I describe some of the challenges to the conservation of tapirs in the reserve.

Introduction

Tapirs are hunted throughout much of their range in the Neotropics. Despite the infrequency of kills, their large size ensures that they comprise a large percentage of the hunted biomass in many settings. In general, tapirs trail only peccaries in their contribution of hunted biomass to Neotropical diets (Vickers 1984). Among other factors, the increased influx of firearms into once isolated settlements poses a threat to tapir populations, as Yost and Kelley (1983:215) report that Waorani hunters prefer shotguns to traditional weapons when hunting tapirs.

Because of their endangered status and vulnerability to habitat loss and over-hunting, tapirs have received considerable attention from conservationists. Interestingly, whereas the production model of Robinson and Redford (1991) allows Amazonian researchers to assess the sustainability of lowland tapir (*Tapirus terrestris)* harvests, similar figures are lacking for Baird's tapir (*Tapirus bairdii*). Given that Baird's tapirs are hunted in many of the locations where they survive in Central America and Mexico (Fragoso 1991; Naranjo and Cruz 1998; Smith 2005; cf. Jorgenson 2000), an estimate of the maximum sustainable yield (MSY) might prove useful for management decisions related to this species. Using the methods of Robinson and Redford's production model (1991), I surveyed the literature to find estimates of Baird's tapir reproduction and densities, with which I generated MSY estimates. I then compare these estimates to the harvest of tapirs that I observed during a yearlong project in Nicaragua's Bosawas Biosphere Reserve.

The Maximum Sustainable Yield (MSY) Estimate

Researchers have used the production model of Robinson and Redford (1991) to assess the sustainability of hunting in a number of Neotropical settings (Alvard et al. 1997; Leeuwenberg and Robinson 2000;

Townsend 2000). Although it is widely applicable, the model is not without its weaknesses, many of which were noted by the authors themselves (Robinson and Redford 1994). The model has the advantage of generality, but given its limitations, the authors emphasize that the model can be used only to demonstrate that a harvest is unsustainable; the opposite is not true, as the model cannot demonstrate that an observed harvest *is* sustainable (Robinson and Redford 1994:255).

Like Robinson and Redford (1986*a*), I reviewed the literature for reproductive data. There are relatively few publications on Baird's tapir reproduction, however, and Brown et al. (1994) provide some of the only data available on captive Baird's tapirs. Fortunately, these data suggest that the reproductive characteristics of Baird's tapir are comparable to those of the lowland tapir. For the lowland tapir, Robinson and Redford (1986*a*) list 3.7 and 23.5 as the ages of first and last reproduction and 0.38 as the annual birth rate of female offspring. These figures differ little from estimates drawn from observations of captive Baird's tapirs (Janine Brown, personal communication, June 23, 2006). The maximum finite rate of natural increase (λ_{max} in the Robinson and Redford model) would therefore be identical for the two species: 1.22.

Calculation of the maximum sustainable yield also requires a density estimate for the population. Because density estimates from observational studies are often unreliable, Robinson and Redford (1991:418) typically use predicted densities from their review of the allometric relationship between population density, body size, and diet (Robinson and Redford 1986*b*). The body mass that the authors cite for Baird's tapir is 300 kg, more than twice the value cited for the lowland tapir (Robinson and Redford 1986*b*). Assuming a body mass of 300 kg for Baird's tapir, the regression equation used by Robinson and Redford (1986*b*) for frugivore-herbivores yields a predicted density of 0.66 individuals/km^2. However, a body mass of 300 kg typically represents the highest mass in the range of estimates for this species, with some authors giving a range of estimates that includes values below 200 kg (Emmons 1990; Reid 1997). Substituting a body mass estimate of 200 kg in the same regression equation gives a predicted density of 0.94 individuals/km^2.

To some extent, the former estimate of 0.66 individuals/km^2 is comparable to estimates based on observational studies, many of which are cited by Brooks et al. (1997). In particular, this estimate is similar to the density estimate of 0.6 individuals/km^2 cited by Naranjo (1995) for Corcovado National Park in Costa Rica. However, many density estimates for Baird's tapir are much lower. For example, Naranjo and Bodmer (2002) cite estimates of 0.24 individuals/km^2 in slightly hunted areas and only 0.05 individuals/km^2 in persistently hunted areas in Mexico. By contrast, one of the highest estimates in the literature also comes from Corcovado National Park, as Foerster (2002) reports an average density of 1.6 adult individuals/km^2 during his multi-year study. It is important to note that Foerster's methods, which include direct measurements of radio-collared animals, represent the most rigorous attempt to document the density of a Baird's tapir population.

Given this variability in density estimates for Baird's tapir populations, it is difficult to advocate a single value as the basis for the MSY estimate. By using predicted values or an average of density estimates, it is possible to generate an MSY estimate that would not be sustainable in settings where the density is unexpectedly low (Peres 2000). This problem highlights the need for long-term studies to determine population density and dynamics for proper estimation of the MSY for this endangered species in settings throughout Central America. Because such long-term research is not always possible, however, an alternative approach would be to generate a range of MSY estimates, which should be applied conservatively when the actual density of tapirs remains in doubt. Accordingly, I present separate MSY estimates for three of the density estimates cited above.

The Study Area

First created in 1991 as a "natural reserve," the Bosawas Biosphere Reserve is located in north-central Nicaragua. Part of the largest tract of tropical rain forest north of Amazonia (Stocks 1996), the reserve is inhabited by a number of generally endangered species, including jaguars (*Panthera onca*), spider monkeys (*Ateles geoffroyi*), giant anteaters (*Myrmecophaga tridactyla*), and white-lipped peccaries (*Tayassu pecari*). The reserve is also inhabited by the Mayangna and Miskito, the two most populous indigenous groups in Nicaragua. In 2005, after a decade of cooperative work with The Nature Conservancy (TNC), the indigenous communities in the reserve were granted legal land title by the Nicaraguan government. The reserve is divided into six territories, which were delineated and mapped as part of the TNC effort to document the indigenous land claims (Stocks 2003). My research was based in two communities along the Lakus River in the territory of Kipla Sait Tasbaika (Figure 1). Specifically, I worked in Arang Dak and Suma Pipi, two communities with a combined population of about 260-265 individuals. Elevations within five kilometers of the communities range from about 150 to 400 meters. There are no permanent settlements upstream of Arang Dak, and the headwaters of the Lakus River watershed are largely unexploited by residents of the reserve.

Like most Neotropical horticulturalists, the Mayangna and Miskito rely on agricultural products for the bulk of their diet. Staple crops include bananas, manioc, rice, corn, and beans. Along with meat from domestic animals, especially pigs, fish and hunted game provide much of their dietary protein. Rifles and dogs are the principal hunting technologies, and adult men do most of the hunting. Although men sometimes leave on intentional hunting trips into the forest, many of the animals in the harvest are acquired opportunistically in the course of other subsistence activities. In the reserve, tapirs are notorious for raiding bean fields, and a farmer who notices signs of tapirs in his beans might visit the field at night with a rifle in an attempt to encounter and kill the animal. On intentional hunting trips, hunters simultaneously search for a broad suite of prey types, but they sometimes make a point of visiting boggy sites where tapirs are known to rest on occasion during the day.

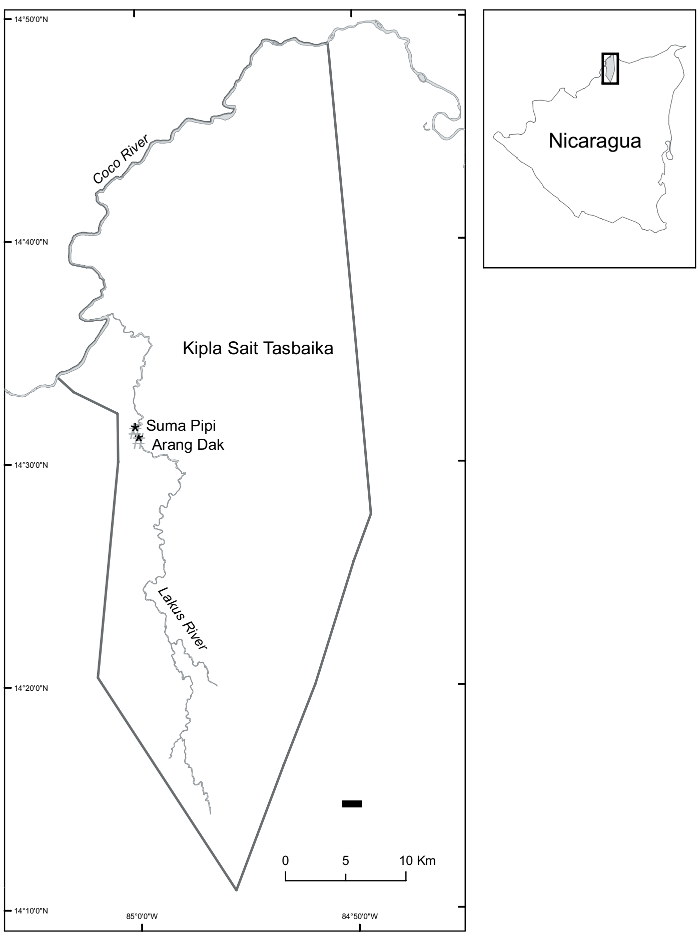

Figure 1. The location of Kipla Sait Tasbaika within Nicaragua and the location of Arang Dak and Suma Pipi within the territory.

Methods

Fieldwork in Bosawas lasted approximately 13 months, from August 2004 to September 2005. As part of a project on subsistence strategies, I employed indigenous research assistants to document the acquisition of game animals. An assistant remained in the community during daylight hours to administer questionnaires to hunters as they returned with game. The assistants also carried scales and weighed the animals whenever possible. The hunting questionnaire included data on time expenditure, participants, the technologies brought by each participant, the names of dogs on the outing, and other factors. Following Smith's (2003) methodology, the assistants also drew sketch maps of the kill sites in relation to known landmarks such as fields, trails, and streams. These kill sites were later entered into a Geographic Information System (GIS), as were landmarks that research assistants and I collected with a Global Positioning System (GPS) receiver. Household food consumption forms, which were completed daily, revealed game animals that were not initially reported to the assistants. Kills of tapirs attract considerable attention upon the hunter's return to the community, however, and I am confident that no tapir kills went undocumented during the yearlong study period.

An important component in sustainability estimates is the size of the hunting zone (Alvard et al. 1997: 979). Although men sometimes hunt while far from the community on multi-day excursions, most of the hunting on daylong expeditions occurs within a few kilometers of Arang Dak and Suma Pipi. I estimated the size of this core hunting zone by creating a polygon that included all kill sites from daylong hunting trips, with a 500 meter buffer on all sides to account for possible inaccuracies in the sketch mapping process. The result is a hunting zone of 77.6 km^2 (Figure 2).

In light of evidence that tapirs often frequent anthropogenic habitats, especially secondary forest (Foerster and Vaughan 2002; Reyna-Hurtado and Tanner 2005), I also include actively cultivated fields in Figure 2. These are fields cleared during the dry season (January-May) for planting in May and June, 2005. The map does not include fields planted at the beginning of the dry season, which are usually bean or corn fields in the alluvial floodplains alongside the river. The map also does not include fallows, although the Mayangna and Miskito preference for starting new fields next to fields from the previous season ensures that the fallows exhibit a distribution similar to the fields depicted in Figure 2. Throughout the hunting zone, the areas within one kilometer of the river are generally characterized by a mosaic of active fields, fallows, secondary forest, and relatively mature forest. All of the tapir kills in the hunting zone were located within two kilometers of an actively-cultivated field, and most were much closer.

To produce MSY estimates, I hold λ_{max} constant, using the aforementioned value of 1.22. Production is calculated with the following equation (where *D* is the density estimate):

$$P_{max} = (0.6\ D \times \lambda_{max}) - 0.6\ D$$

Like Robinson and Redford (1991), I note that Baird's tapir is a long-lived species, and I therefore assume that hunters can sustainably harvest only 20% of production. Using these figures, if the density is 0.24 individuals/km^2, then the MSY is 0.006 individuals/km^2. If the density is 0.66 individuals/km^2, then the MSY is 0.017 individuals/km^2. Finally, if the density is 1.6 individuals/km^2, then the MSY is 0.042 individuals/km^2. These MSY estimates can be multiplied by the average body mass of the species to calculate the potential harvest of biomass (kg/km^2).

Results

Fourteen tapirs were killed during the study period. Informants also reported that they injured two other tapirs with rifles, but the animals subsequently managed to escape. Although hunters returned the following day to track these injured tapirs, they could not locate them, and the extent of the injuries is not known. Of the fourteen tapirs that were killed and brought back to the community, ten were males and four were females, and all were adults. We were able to weigh two of the animals in their entirety, both times in December. An adult female weighed 166.5 kg while an adult male weighed 186.5 kg. Dogs played a role in eleven of the kills, usually by pursuing the tapir to a site where the hunter or others could catch up and attack it. Hunters with rifles made two of the remaining three kills. The last tapir was killed when a hunter spotted a tapir in the shallows of the river, and he and his companions were able to maneuver their boat close enough to stab the animal with a lance.

Thirteen of the kills occurred in the core hunting zone. Six of these kills were made in the river itself, usually because the dogs had chased the tapir into the water. Six other kills occurred in stream beds, where the tapirs turned to face the dogs, thus giving the hunter time to catch up and initiate an attack (cf. Smith 1976:456). The final kill site (the westernmost point in Figure 2) was a boggy location visited by a rifle hunter who suspected that he might find a tapir there.

Including only the thirteen tapirs killed in the hunting zone, the annual harvest of tapirs is 0.168 individuals/km^2. This harvest easily exceeds all of the MSY estimates calculated above. The harvest of tapirs in the hunting zone would therefore exceed sustainable limits even if the density of tapirs around the communities were equal to the highest population density ever recorded, that of Corcovado National Park in Costa Rica (Foerster 2002).

Discussion

Native informants in Arang Dak and Suma Pipi report that the annual harvest of tapirs has been fairly consistent since they returned to the area from Honduran refugee camps in 1991. It is probable that the harvest of tapirs in the hunting zone has exceeded sustainable limits for about 15 years, although there are no data to confirm this supposition. Therefore, an interesting question is how the tapir population has avoided localized extirpation in the hunting zone.

There are essentially two possible explanations, which are not necessarily mutually exclusive. The first possibility is that tapirs exist at higher densities than the estimate used to calculate the MSY. Germane to this hypothesis is the observation that tapirs seem to thrive in anthropogenic habitats, where they browse on fast-growing secondary vegetation. Theoretically, the enhanced foraging opportunities in anthropogenic habitats could allow tapirs to breed more prolifically and exist at abnormally high densities. This relationship has not been demonstrated empirically, however.

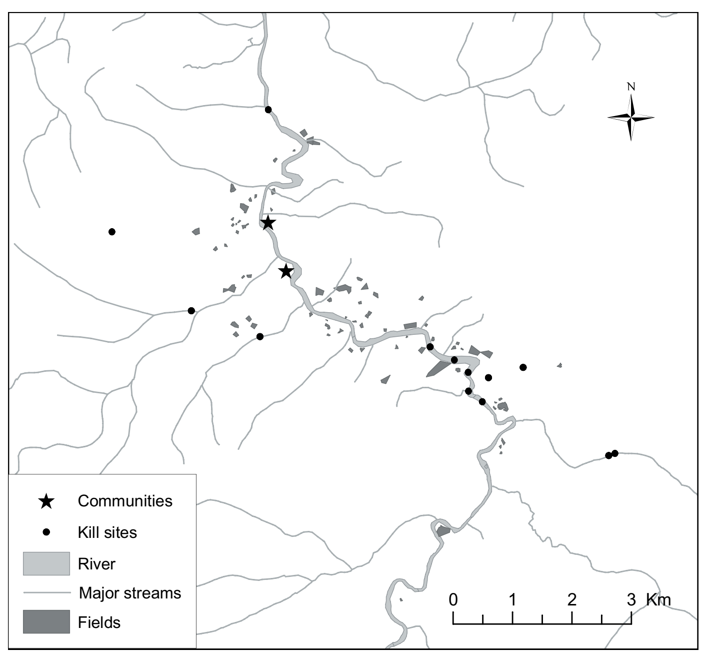

Figure 2. The location of the 13 tapir kills in the hunting zone.

The second explanation is that the unsustainable harvest of tapirs in the hunting zone is balanced by the immigration of tapirs from lightly hunted areas. In a review of source-sink hunting dynamics in the Neotropics, Novaro et al. (2000) note that hunted tapir populations generally survive only where there are large unexploited areas adjacent to the hunting zone. Similarly, the undeveloped areas upstream of Arang Dak probably serve as a source of dispersing tapirs. As part of the TNC project, the indigenous territories were divided into use zones, including areas of infrequent use and conservation (Stocks 2003). In Kipla Sait Tasbaika, the size of these two zones exceeds 500 km^2, and most of this area is located in the headwaters of the Lakus River upstream of Arang Dak. Neighboring territories have similar zones, which combine with the unexploited area in Kipla Sait Tasbaika to form the Waula Conservation Area (Stocks 2003). Given the extent to which tapir populations can be depleted near communities, maintaining the integrity of this conservation area might be the key to the survival of this species in the reserve. Because source-sink dynamics seem vital to the long-term sustainability of tapir populations throughout the Neotropics, conservationists should give more attention to sustainability models that specifically address the spatial characteristics of source areas (Salas and Kim 2002).

Reducing the harvest of tapirs would also help to sustain the population. Employees of the Saint Louis Zoo's *Proyecto Biodiversidad*, which has been working in the Bosawas Reserve since 2000, recently met with territorial leaders in Kipla Sait Tasbaika to present results of the project's research (Williams-Guillen et al. 2006). During that meeting, territorial leaders informally agreed (pending ratification) to implement limits on the harvest of three species: white-lipped peccaries, spider monkeys, and tapirs. This agreement limits the number of tapirs that individual hunters can kill each year, and the hunting of tapirs is forbidden in November and December. Geographically, the hunting of tapirs is restricted to the agricultural and frequent use zones. Additional stipulations include a prohibition on kills of females with accompanying offspring, and hunting should be directed only at those tapirs which damage crops. Employees of the zoo's project are currently cooperating with leaders to explain and present these norms to communities throughout Kipla Sait Tasbaika.

This conservation initiative is not without challenges, however. Tapir meat is highly-valued, and a hunter who sells most of the meat from a full-sized tapir can earn almost US$100. In a setting where the standard pay for a day of agricultural labor is about US$4, a tapir kill can be a relatively lucrative economic opportunity for hunters. As long as this opportunity exists, hunters might be inclined to disregard the newly-established norms. Similarly, foregoing chances to kill tapirs might seem risky to local farmers, who are understandably concerned about the possibility that the animals could soon consume their staple crops. Hunters generally hunt in patches of forest near their fields, and tapirs that they encounter are considered a potential threat even if there has been no recent damage to crops.

Hunting with dogs also complicates the situation somewhat. On hunting trips, the dogs typically fan out into the forest to search for game. When the dogs encounter and pursue animals, the hunters are often uncertain what species is being pursued, and they are effectively powerless to interrupt the pursuit until they catch up to the dogs, at which point the tapir and the dogs might be in active combat. Although tapirs are usually considered less dangerous to dogs than jaguars, giant anteaters, and white-lipped peccaries, hunters say that bites from a tapir can severely wound a dog. Good hunting dogs can be sold for more than US$30, and hunters attempt to protect their dogs as much as possible. When a tapir poses an immediate threat to a valued dog, it is difficult to imagine a hunter refraining from an attack.

Not all dogs are capable of matching the tapir's pace on a high-speed pursuit, and escapes are common. Also, unless the tapir is chased into the river, hunters without rifles are often unable to get close enough to attack the animal. Dogs and rifles are a potent combination, as the use of dogs increases the rate at which hunters encounter tapirs, and rifles allow hunters to attack tapirs once they catch up to the pursuit. Although forbidding the use of rifles when hunting with dogs might reduce the harvest of tapirs, hunters would be reluctant to relinquish their guns, as they are sometimes needed to fend off jaguars that prey on the dogs (perhaps the leading cause of death for adult dogs in the reserve).

It is important for conservationists to understand and appreciate the economic context in which hunting decisions are made. When management plans account for local concerns and perspectives, they stand a better chance of lasting success. By promoting a management plan that does not prohibit the hunting of tapirs which damage crops, the Saint Louis Zoo's project has increased the likelihood that the residents of the territory will abide by the new regulations. Overall, the prospects for the conservation of tapirs in the Kipla Sait Tasbaika are reasonably promising, in large part because the indigenous leadership has repeatedly emphasized its commitment to wildlife management. The Mayangna and Miskito residents of the Bosawas Reserve recognize the value of the forest to their livelihood and subsistence, and their willingness to cooperate with external scientists and organizations bodes well for the immediate future of the tapir population.

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