Capture and Immobilization of Free-living Baird’s Tapirs (Tapirus bairdii) for an Ecological Study in Corcovado National Park, Costa Rica  ( 21-Dec-2001 )

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Introduction

The Baird’s tapir is currently listed as Vulnerable as established by the 1996 IUCN Red List of Threatened Animals. Despite its general category of vulnerable, this species of tapir is likely to be considered endangered with extinction in most countries [1]. Historically, this species ranged from southeastern Mexico, from the northern portion of Colombia to the Gulf of Guayaquil in Ecuador [2]. Today this species occurs west of the Andes in Colombia and Ecuador [3]. Its confirmed current range in Central America is limited to areas sparsely populated by humans and isolated populations in protected areas of Mexico, Belize, Honduras, Costa Rica, Panama and possibly Nicaragua. It is considered extinct in El Salvador [1]. Figure 1 shows the current distribution of the Baird’s tapir.

As with most large, solitary mammals, tapir populations are normally found in low densities. The primary pressures on their numbers are habitat loss and excessive hunting. Due to the tapir’s low reproductive potential and slow growth, even minimal hunting has proven to significantly decrease their populations [4]. Consequentially, these smaller populations become even more susceptible to extinction from natural disasters and disease epidemics. In Costa Rica, the primary threat to the Baird’s tapir is deforestation due to logging and farming practices. It is estimated that 80% of Costa Rica has been deforested [1]. In Corcovado National Park, gold mining also poses an important threat to their habitat [1,5].

Without reliable information on the basic ecological requirements of tapirs (habitat use, home range, demographics, etc), it will be impossible to develop an effective strategy for sustaining free-ranging populations. Until recently, researchers have relied on indirect methods such as track counts, fecal examination and transect counts to estimate population densities, habitat use and diet. These methods, though useful, are limited in the scope of data they can provide. Until 1995, only two previous studies had utilized direct methods to gather such data in tapirs [6-9]. During the last few years, more tapir researchers have elected to employ radio telemetry to monitor the movements of their study animals. As a result, there has arisen a need for an effective protocol for the immobilization of free-ranging tapirs that is safe for the animals as well as the researchers.

Since 1994, the authors have studied the ecology and health of a small population of Baird’s tapirs in Corcovado National Park, Costa Rica. The project aimed to define basic ecological details such as home range, habitat use, activity patterns, diet, disease susceptibility and reproduction. In this article we describe the basic capture and immobilization method utilized from March 1996 to February 2000 to radiocollar the study animals.
Materials and Methods

Location - This project took place in Corcovado National Park (8°27′ - 8°39′ N and 83°25′ - 83°45′ W) located on the southwest coast of Costa Rica on the Osa Peninsula. Measuring 424 square kilometers Corcovado conserves the largest remaining lowland tropical rainforest forest on the Pacific coast of Central America [1]. This study was based out of the Sirena Biological Station, which is located on the southwest corner of the park. The forest in this area consists of a mixture of primary and secondary growth lowland rain forest and premontane forest. Other landmarks include an 800 m long grass strip (airstrip) in front of the research buildings, two large river habitats, and a lagoon. Figure 2 illustrates the different habitats included in the research area. Based on track counts, Naranjo (1995) estimated a tapir population of between 254 - 300 individuals lived in the park.

Prior to this study, no telemetry studies of tapirs had been conducted in this area, but previous studies [5] and explorations confirmed the presence of tapirs based on tracks, browsing signs and direct observations.

Capture Site - Evidence of tapirs’ presence in a forest is relatively easy to detect due to their unique three-toes tracks, browsing behavior, their use of wallowing holes and distinctive fecal excrement. An area of 10 square kilometers was inspected for evidence of heavy tapir activity in which to establish a capture site. Such evidence included tracks, fecal excrement, waterholes surrounded by tapir tracks and plants that had been browsed at a level corresponding to the height of a tapir, such as the Monstera sp vine browsed by a tapir shown on Fig. 3.

Once an area of high tapir activity was identified, a bait station near such area was created. A potential capture site had to fulfill certain criteria:

1. It could not be situated within 100 m of a major body of water,
2. It could not be located on uneven ground, or within 100 m of an embankment,
3. There must be at least one tree upon which a platform could be built and
4. There could not be extensive undergrowth which would obscure visibility from a tree platform.

A suitable capture area was defined as a circular area measuring approximately 50 square meters. In the center of the capture area, a 2 m² area was cleared of leaf litter to expose the underlying soil and facilitate the identification of tapir tracks. Figure 4 is a view of a bait station as seen from a tree platform.
Approximately 20 - 30 mature bananas (*Musa acuminata*) were placed in the center of this bait station. Additional bananas were thrown from the bait station into the forest and hung from nearby trees to disperse the odor of bananas. Bananas were placed in the bait stations at dusk to avoid consumption by diurnal animals. The bait stations were inspected for tapir tracks in the mornings. Care was taken not to disturb bait stations unnecessarily as tapirs are known to avoid areas where human frequent. A bait station was considered successful if tapir tracks were identified on at least two consecutive days or four non-consecutive days in a 7 day period.

Once a bait station proved successful, a wooden platform was built 10 - 15 meters high in a tree(s) overlooking the bait station. The platform consisted of wooden planks on support beams. Fig. 5a and Fig. 5b depicts a typical tree platform. The platforms were typically built early in the morning and care was taken to remove all man-made materials from the area. Bananas were placed on the bait station the same evening. The site was not utilized for a capture until tapir tracks were identified at least an additional time.

*Figure 5a. Typical wooden tree platform from which tapirs were darted. - To view this image in full size go to the IVIS website at www.ivis.org. -*

*Figure 5b. Sometimes wooden platforms were built onto existing structures. This platform was built on the roots of a fallen tree. - To view this image in full size go to the IVIS website at www.ivis.org. -*

**Capture Method 1** - The project veterinarian and the biologist sat quietly on the tree platform of a proven bait station on a daily basis starting one hour prior to sunset. Typically a tapir’s movements were not detected until the animal was within 20 meters of the platform. Once an animal’s footsteps were heard, a low-power flashlight or a night-vision telescope was utilized to scan the area and confirm that the animal was a tapir. Tapirs were first inspected to verify if it already had a radiocollar. If the animal did not have a radiocollar, the veterinarian would prepare the immobilization drugs while the biologist dropped bananas from the platform every 10 - 20 seconds to bring the animal closer to the platform. This feeding technique was used to keep the animal distracted while the dart was being loaded and entice the tapir to move to an area where the veterinarian could have an open shot. The tapir’s reaction to thrown bananas was also used to evaluate its demeanor and level of nervousness. When the dart was loaded and the tapir was in an acceptable spot for darting, the veterinarian and biologist would confer one last time as to whether or not it should be darted based on its behavior and predicted reaction to the impact of the dart. A low-power flashlight was used to illuminate the tapir and the veterinarian darted the animal from the platform.

**Capture Method 2** - The radiocollars (MOD 550, Telonics Inc., Mesa, AR, USA) utilized in this project have a reported life span of 30 months. Since this project was designed as a long-term study, radiocollars were replaced every 2 years. Twelve of the individuals captured in the above method were recaptured from March 1999 to February 2000 to change their radiocollars and collect additional biological samples. In those cases, the animals were located during the day using a radio receiver (TR-4, Telonics Inc, Mesa, AR, USA). If the tapir was located in a safe area and remained calm, it was immobilized via dart. A safe area is defined as an area at least 100 m from a major waterway (river, lagoon, ocean), on level ground and at least 100 m from an embankment. Given a tapir’s keen senses of hearing and smell, it was difficult for the veterinarian and primary investigator to approach a tapir during the day on foot without being undetected. In fact, tapirs appear to be more wary while resting during the day than when active at night. Whenever possible, the animals were approached from downwind and researchers concealed themselves behind trees or other objects to remain out of sight. Again, researchers used their judgment to determine if the animal was calm enough for the capture procedure to continue. Bananas were thrown towards the animal to get it standing and eating. If the tapirs appeared preoccupied with bananas, the veterinarian would then proceed to dart the tapir.

**Immobilization and Reversal** - The tapirs in this study were not weighed consistently. They were estimated to weigh between 200 - 300 kg. Actual weights were obtained for three animals and these fell within the estimated range. The tapirs
were immobilized with an initial mixture of 40 - 50 mg (mean dose of 47.46 mg) of butorphanol (i.e., Torbugesic) and 50 - 100 mg of xylazine (i.e., Rompun; mean dose of 96.65 mg) per tapir as previously described by Foerster [10]. A 6 ml dart (“P” type, Pneu-Dart Inc., Williamsport, Philadelphia, Pennsylvania, USA) was filled with the drug mixture and delivered with a CO2 powered pistol (DanInject, Wildlife Pharmaceuticals, Fort Collins, Colorado, USA).

Bananas were thrown from the platform to keep the tapir preoccupied during the darting process. More bananas were offered after the animal was darted but this was discontinued once the animal showed the first effects of the drugs. A tapir showing initial effects of the anesthetics is depicted in Fig. 6.

Once the animal fell in sternal recumbency, the veterinarian would climb down from the platform, and approach the animal to apply a blindfold, insert gauze in the ears and begin anesthesia monitoring. Fig. 7 illustrates the gauze in the ears and the blindfold in place. While immobilized, the tapirs were fitted with radiocollars. In addition, morphometric measurements, and biological samples (blood, feces, hair, skin biopsies and urogenital swabs) were collected. Biological parameters (heart rate, respiratory rate, direct and indirect blood pressure, body temperature, blood gases, ECG) were monitored and recorded as previously described by Foerster [10].

Some of the aforementioned procedures required that the tapir be manipulated requiring further sedation to avoid premature arousal. Ketamine (i.e., Ketaset) was utilized in 19 of the 33 immobilizations as a means to either achieve deeper sedation or extend the anesthetic period. Of the animals that received ketamine, 13 received it intravenously, while 6 received it as an intramuscular injection. An intravenous catheter was placed in the ear vein to administer ketamine as shown in Fig. 8.

Ketamine was administered in increments of 25 mg (range 25 - 200 mg) and the mean total dose used was 123.50 mg per animal. Propofol (i.e., Rapinovet) was used to provide further sedation in 5 animals. This was administered as a constant rate infusion at a range of 50 - 200 micrograms/kg/minute based on the estimated weights of each individual. Table 1 illustrates the different doses of propofol used on five tapirs.

<table>
<thead>
<tr>
<th>Tapir</th>
<th>Estimated Body wt (kg)</th>
<th>Dose of Propofol (mg/kg/mt)</th>
<th>Total Propofol Administated (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rio</td>
<td>300</td>
<td>0.33</td>
<td>1.8</td>
</tr>
<tr>
<td>Leftie</td>
<td>300</td>
<td>0.10</td>
<td>5.7</td>
</tr>
<tr>
<td>Roberta</td>
<td>300</td>
<td>0.10</td>
<td>6.8</td>
</tr>
<tr>
<td>Flash</td>
<td>300</td>
<td>0.23</td>
<td>10.4</td>
</tr>
</tbody>
</table>
Naltrexone (i.e., Trexonil) was injected intramuscularly in all immobilized tapirs to reverse the butorphanol. The mean dose of naltrexone utilized was 153.50 mg/animal (range 50 - 300 mg). Either yohimbine (i.e., Yobine) or tolazoline (i.e., Tolazine) was administered intramuscularly to reverse the alpha-2 agonist effects of xylazine. Yohimbine was used at a mean dose of 34 mg/animal while tolazoline was used at a mean dose of 961.33 mg/animal (range of 400 - 1200 mg). The reversal agents were administered no sooner than 15 minutes from the last administration of ketamine. After the reversal drugs were administered, the cotton gauze was removed from the ears, but the blindfold was left in place. The veterinarian recorded all time-related events such as time of dart impact, time of first effects, time of sternal recumbency, time of reversal administration, time to return to sternal position and time to return to standing and total time immobilized.

Results
Captures - Twenty animals (11 males, 9 females) were captured using either of the aforementioned methods. Of the 20 animals, 3 were juveniles and 17 were considered adults. Some animals were captured more than once. A total of 35 immobilizations took place during March of 1996 and February of 2000. Approximately 30 bait stations were created throughout the 4 year period. Sixteen immobilizations were achieved from tree platforms. All of these captures occurred before midnight. The majority of the captures utilizing the tree platform method occurred between the hours of 6:00 - 10:00 pm. The most successful bait stations were located within secondary growth rainforest located either

1. near fruiting trees (*Ficus*, *Spondias*, etc),
2. near heavily used tapir trails, or
3. near rainforest "gaps" formed by a natural tree fall.

Three animals walked away after being darted, prior to showing the effects of the immobilization drugs. Of those, only one belonged to the group captured from a tree platform. The other two animals were approached on foot during the day. The first animal walked away a few meters before it started to show first effects and stopped. The second animal, a female, walked away slowly until it fell onto lateral recumbency 50 meters from the area where it was darted. The remaining animal was darted from a tree platform and within 2 minutes began to walk away while shaking its head. Leaf cutter ants (*Atta* sp.) that were also attracted to the bananas were biting this animal on its face and lips. The animal was found in sternal recumbency within 30 m of the bait station.

Immobilization - First effects of sedation were observed an average of 4 minutes from dart impact. The first sign associated with sedation was an inability to prehend bananas with their proboscis. Other signs observed consistent with first effects were ataxia, wide base stance, a head down posture, penile prolapse in males and hypersalivation. Animals achieved sternal recumbency in an average of approximately 11 minutes. Animals went down by first lowering their hindquarters and then extending their forelimbs in front of them. The head was the last to be lowered to the ground. During two different immobilizations of the same tapir, the animal assumed a wide base stance but did not lie down until manually pushed over. The animals were anesthetized an average of 45 minutes. Three animals experienced premature arousal. This was defined as an animal assuming a sternal position or standing prior to the administration of reversal agents. Two of these animals did not receive ketamine. The remaining animal had received ketamine intramuscularly.

The average time from reversal administration to return to sternal recumbency was approximately 4 minutes. The average time it took for tapirs to stand was approximately 12 minutes from reversal administration. Animals that received propofol took an average of approximately 8 minutes to return to sternal recumbency after reversal administration. It took them an average of approximately 12 minutes to return to standing. Often, tapirs returned to eating bananas soon after recovery. The results to the physiologic parameters such as heart rate, respiratory rate, body temperature, SP02, blood gases, and ECG were previously reported by Foerster [19].

Discussion
Bait Stations - Prior to 1995, few telemetry studies of any of the four tapir species had been undertaken. The primary obstacles to placing radiocollars on these highly elusive and nocturnal animals are the capture and immobilization procedures. Other methods currently employed to capture members of the *Tapirus genus* include utilizing trackers and hunting dogs to corner an animal, box traps or pit traps [S. Deem, personal communication;11]. The stress associated with chasing an animal whose physiology approximates that of a horse might lead to anesthetic complications. In addition,
although capture myopathy has not been reported in tapirs before, the potential for this complication exists as it does occur in horses. Pitt traps appear to be a successful method to capture tapirs; however, the inherent danger of a large animal falling into a pit trap must be taken into account.

The success of the methods described here depends on several factors. The researchers must be able to identify signs that indicate areas regularly visited by tapirs. The bait only serves as extra incentive to return to that area on a repeated basis. Therefore, the bait stations must be placed in areas where tapirs would be expected to be traveling regardless of the bait (Fig. 9). Depending on the density of the population to be studied this first step is not necessarily an easy one. Prior knowledge of tapir behavior and the study area will help the researcher focus in on areas with higher potential of heavy tapir traffic.

Figure 9. Tapirs are elusive animals that rarely come into plain view. - To view this image in full size go to the IVIS website at www.ivis.org . -

Baird’s tapirs in Corcovado National Park spend their days sleeping in thickets or wallowing holes and forage at night. They forage plants to a level of 1 m. With experience, plants browsed by tapirs can be distinguished from browse sign of any other animals [8]. In addition, they often forage in tree-fall gaps, where colonizing plants abound [12]. Tapirs will also return night after night to fruiting trees, especially those that produce fleshy fruits such as Ficus sp., Spondias sp., and Licania sp., offering a great opportunity for capture. Their natural behavior is tied to waterways. They defecate in water, consume aquatic vegetation, rest in streams and rivers for extended periods of time as illustrated in Fig. 10a and Fig. 10b. Additionally, they often submerge themselves completely to walk along the river-bottom [1]. Well-traveled trails can be found along riverbeds where tapirs enter and exit on a regular basis [5,13]. This requires that those wishing to capture these animals spend several weeks to months studying tapir tracks and understanding their habitat preferences, foraging predilections and movement patterns to and from key areas such as rivers, waterholes and lagoons.

Figure 10a. Tapirs routinely defecate in waterways. - To view this image in full size go to the IVIS website at www.ivis.org . -

Figure 10b. Tapirs spend a great deal of time in the water to keep cool. - To view this image in full size go to the IVIS website at www.ivis.org . -

Foerster [14] found that tapirs sleep most of the day and become active at sundown. They actively forage between sundown and midnight, sleep for 1 - 2 hours and resume foraging until sunrise. It follows that the best time to attempt a capture would be during the tapir’s most active foraging hours. Finally, it appears that the key to the success of this method is the bait.

Bait - Unquestionably, tapirs' craving for bananas maximized the capture success. During the explorations undertaken prior to the start of the project, a variety of fruits and vegetables were tested as bait: apples (Malus sylvestris), pineapples (Ananas comosus), potatoes (Solanum tuberosum), sweet potatoes (Ipomoea batatas), palm nuts (Raphia sp.) and watermelon (Citrullus lanata). Other items known to be part of the Baird’s tapir natural diet such as wild figs (Ficus sp.) and Spondias sp. fruits were also used as bait. Mineral salt blocks, which had been used successfully by other researchers, were also tested. However, only bananas proved to be consistently successful at attracting tapirs to specific areas and maintaining their attention during the darting process. In some instances when bananas were not readily available, bait stations were loaded with natural foraging items and a few bananas. Tapirs visited these stations, but often left prematurely prior to having had an opportunity to dart them.
The tapir’s highly developed sense of smell and the odorous nature of mature bananas both play a significant role in this phenomenon. This is evidenced by the fact that tapirs, whose home range included the area immediately surrounding the research station, occasionally left the forest and visited the station when bananas were hung on a line to mature. If allowed, they would approach clotheslines utilized to hang bananas and begin eating them like the female depicted in Fig. 11.

On several occasions, a tapir repeatedly attempted to enter a building containing hundreds of mature bananas. Tapirs normally avoided the open areas of the research station if bananas were not present.

Other behaviors further prove that tapirs prefer bananas. In one case, a tapir was found inside a metal box trap, shown in Fig 11, which was utilized by researchers to capture collared peccaries (*Tayassu pecari*) and baited with bananas. This box measured 1.5 x 0.75 x 1.0 m and it is the opinion of the authors that a tapir would typically avoid entering such a small confined space unless enticed by bananas. These aberrant behaviors suggest that bananas maximized the success of the captures in this project. Barongi [15] recommends offering bananas to captive tapirs only as treats, as the animals may not accept other food items. This suggests that a tapir’s predilection for bananas may be common to all tapirs and not specific to the animals of this study. Nevertheless, bananas may not be the best choice for all locations and researchers may have to experiment with other bait choices to find what works best for their situation.

There are some inherent dangers in darting an animal that is not confined. If the animal becomes frightened from the dart impact, it could easily run, covering a lot of ground prior to the effect of the anesthetic drugs. In addition, the physiologic effect of excitement and the endogenous release of catecholamines may delay anesthetic induction or even prevent an animal from becoming sedated enough to stop moving. Since many of the captures in this study took place at night, the possibility that an animal may run after dart impact could prove disastrous. Therefore, it was paramount that the animals be as calm as possible at time of dart impact. The researchers sitting on the tree platform or approaching an animal took care not to make unnecessary noise or use bright lights. The sound of bananas falling from the platform mimicked the normal sound of other fruiting rainforest trees and may have actually made these tapirs less nervous. Fig. 12 depicts a tapir eating bananas as seen from a tree platform. In those cases in which bananas were not thrown from the platform, the tapirs would finish the bait on the ground and leave the bait station soon thereafter. If they heard noise, they disappeared into the forest quickly. With some experience, the authors learned to evaluate the attitude of the tapirs and judge when the animals were sufficiently distracted with the bait to be darted without danger.

### Immobilization Protocol

Several protocols have been utilized to immobilized captive tapirs [17-19]. Immobilization protocols that have been reported for free-ranging tapirs include etorphine/acepromazine combinations [19], butorphanol/xylazine/ketamine combinations [10] and tiletamine-zolazepam and medetomidine combinations [21].

Anesthetic protocols to be used to immobilize tapirs in the field must satisfy the following criteria:

1. they must provide a rapid induction to avoid predation, trauma or accidental drowning,
2. they should be fully reversible to ensure a rapid recovery,
3. they should have a relatively wide margin of safety since pre-capture weights are difficult to obtain in the field,
4. they should provide adequate immobilization to ensure sedation as long as it is needed to accomplish the desired procedures,
5. they should be relatively inexpensive.
Etorphine/acepromazine combinations provide a rapid induction but have a low margin of safety and pose a human health hazard. Tiletamine-zolazepam and medetomidine produces prolonged recoveries, which can be dangerous in animals that are not confined. Butorphanol, xylazine, ketamine combinations have been utilized to anesthetize horses routinely [20]. This protocol provided a rapid induction, rapid recovery after reversal administration, adequate immobilization with the addition of ketamine and a wide safety margin. Tapirs are phylogenetically related to horses and appear to share similar physiology. Furthermore, the protocol described fulfilled the aforementioned requirements. Typical of alpha-2 agonist and agonist/antagonist narcotic combinations, one problem that could be encountered with this protocol is premature arousal [20]. Loud noises or excessive manual manipulation can cause premature arousal. Placing cotton gauze in their ears minimized noise detected by the animals. The addition of ketamine or propofol to the protocol eliminated this problem by allowing further sedation to manipulate the animals and extend the anesthetic period. In a previous study that looked at the anesthetic effects of this protocol, the most consistent anesthetic effects without premature arousal were obtained with 50 mg of butorphanol, 100 mg of xylazine and 100 - 250 mg of ketamine/animal [10]. The lower ranges of ketamine were utilized for procedures, which required minor manipulation (rolling to lateral recumbency), whereas the higher ranges were utilized while pushing or pulling the animal. The main disadvantage encountered with the administration of propofol was a prolonged reversal administration-sternal recumbency period when compared with animals in which ketamine alone was used. This could be due to the different metabolic pathways utilized to break down these two agents. Subjectively, we observed that animals that received propofol took longer to recover and were more likely to be ataxic upon standing than those that did not. The administration of propofol for extending the anesthetic protocol is not recommended unless the tapir can be confined after recovery.

This capture and immobilization protocol proved to be useful to radiocollar and collect biological samples from free-ranging Baird’s tapirs in Costa Rica. We believe other tapir researchers in other countries can successfully implement the methods presented here. Considering the threatened status of the Tapiridae family and the increase in studies requiring the capture of tapirs, it is vital that extreme care be taken to ensure the safety of the animals during these procedures. Table 2 summarizes the recommended anesthetic protocol for immobilization of Baird’s tapirs. These dosages are based on the authors’ experience with the protocol discussed throughout the years.

Table 2. Recommended Anesthetic Protocol for Immobilization of Baird’s Tapirs.

<table>
<thead>
<tr>
<th>Estimated Body wt (kg)</th>
<th>Induction Anesthetic</th>
<th>Supplemental Drugs</th>
<th>Reversal Drugs</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 kg</td>
<td>50 mg Butorphanol</td>
<td>25 - 150 mg Ketamine</td>
<td>50 mg Naltrexone</td>
</tr>
<tr>
<td></td>
<td>100 mg Xylazine</td>
<td></td>
<td>1200 mg Tolazoline</td>
</tr>
</tbody>
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