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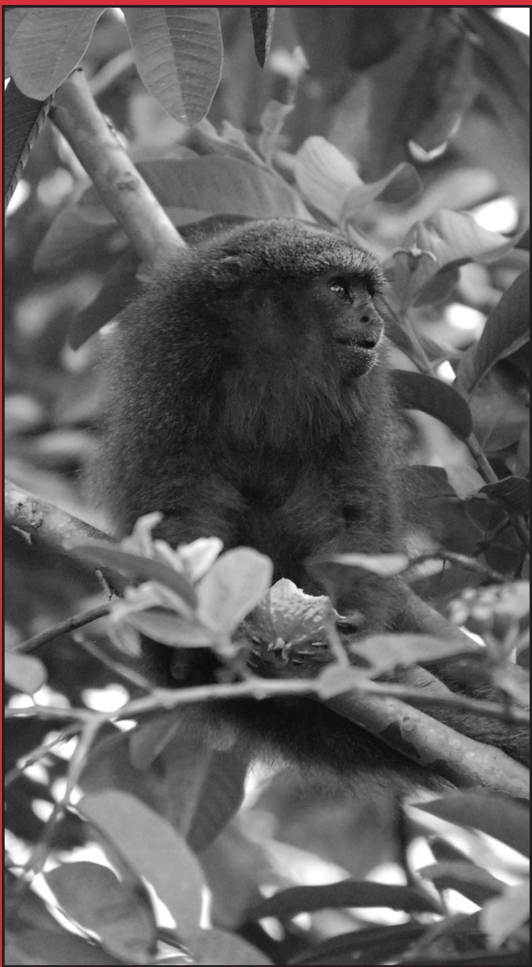

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Front cover: Adult male of Caquetá titi monkey (*Plecturocebus caquetensis*) at vereda La Leona, municipality of Valparaiso, Caquetá department, Colombia. Photo by Javier García.

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Articles

A FIELD PROTOCOL FOR THE CAPTURE AND RELEASE OF CALLITRICHIDS

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Abstract

While primate trapping is a widely used field methodology, there are substantial health, safety and social risks to handling wild primates, necessitating sharing of best-practice methods to minimize such risks. Yet, comprehensive capture-and-release protocols are rarely published, and updated even less frequently, despite advances that significantly elevate animal safety. Here, we propose a modified capture and release protocol for small primates and demonstrate its effectiveness on free-ranging populations of *Saguinus weddelli* (the saddleback tamarin) and *Saguinus imperator* (the emperor tamarin) in southeastern Peru. This study was conducted over seven years, from 2009 to 2015, and resulted in 346 capture instances with recaptures of the same individuals over years. We present a modified trap design that is lighter, locally produced, easy to set up and maintain, and is safer for animals. We provide data on how a 'caller animal' may dramatically increase the success of a new trapping program, but is not necessary on an ongoing basis. We also propose a conversion from previously used single-step anesthetization methods, which are more likely to result in loss of habituation or potential injury, to a novel dual-phase anesthetization process with no delays in processing times or increases in the amount of anesthetic administered. We discuss modifications to traditional trapping strategies that decrease distress to the animals before, during and after trapping. This method ensures high recapture rates and sustained animal habituation to trap sites and observers while also prioritizing animal safety.

Keywords: Trapping, Callitrichidae, capture, Peru

Resumen

Aunque la captura de primates es una metodología de campo ampliamente utilizada, hay sustanciales riesgos de salud, seguridad y sociales al manipular primates silvestres, necesitándose compartir las mejores prácticas de metodologías para minimizar tales riesgos. Sin embargo, protocolos completos de captura y liberación son raramente publicados, y aún menos frecuentemente actualizados, a pesar de los avances que significativamente incrementan la seguridad de los animales. Aquí proponemos un protocolo modificado de captura y liberación para primates pequeños y demostramos su efectividad en poblaciones silvestres de *Saguinus weddelli* (tamarin de Weddell) y *Saguinus imperator* (tamarin emperador) en el suroriente de Perú. Este estudio fue llevado a cabo durante siete años, de 2009 a 2015, lográndose 346 eventos de capturas con recapturas de los mismos individuos a lo largo de los años. Presentamos un modelo de trampa modificada que es más liviana, producida localmente, fácil de armar y mantener y, es más segura para los animales. Proveemos datos sobre cómo un 'animal llamador' puede incrementar dramáticamente el éxito de un programa nuevo de trampeo, pero no es necesario regularmente. También proponemos una conversion de los métodos previamente utilizados de anestesiamiento en un solo paso, que son más propensos en resultar en pérdida de la habituación o potencial daño, a un novedoso proceso de anestesiamiento de dos fases, sin demoras en los tiempos de procesameinto o incrementos en la cantidad de anestésico administrado. Discutimos modificaciones a las estrategias tradicionales de trampeo que disminuyen la angustia a los animales antes, durante y después de ser atrapados. Este métodos asegura altas tasas de recaptura y habituación sostenida de los animales a los sitios de trampeo y a los observadores a la vez que se prioriza la seguridad de los animales.

Palabras Clave: Trampeo, Callitrichidae, captura, Perú

Introduction

When studying wild nonhuman primates, establishing individual identities can be illuminating but difficult, especially in the case of arboreal primates that are often obscured by vegetation, low light levels, and high canopy heights. These difficulties are further exacerbated when the primates are small to medium-sized and lack obvious indicators of maturity or reproductive state (Glander et al., 1991; Fernandez-Duque, 2003). In such cases, observers often struggle to become proficient at instantaneously identifying study subjects, even when the population is well habituated.

Capture-and-release programs that allow for the placement of unique identification tags on individuals provide a solution to this problem. In addition to facilitating identification of individual subjects, such programs also enable monitoring of dental condition, health, development, and reproductive states. Tissue samples collected post-capture may be used for genetic, endocrine, and parasite analyses, and radio-collars can also be placed on individuals, resulting in valuable data that cannot be acquired via observation alone (Sapolsky and Share, 1998; Jolly et al., 2011). Despite these benefits, animal capture gives rise to a number of potential complications and risks to animal safety. Captures can cause elevated stress hormones (Rodas-Martínez et al., 2012), potentiate a negative response to human observers from bad capture experiences, and partial group captures may alter the social standing of animals in groups (Brett et al., 1982; Sapolsky and Share, 1998).

Even though callitrichids have often been captured (Garber and Teaford, 1986; Santee and Arruda, 1994; Dietz et al., 1994; Goldizen et al., 1996; Windfelder, 1997; Suárez, 2007; Porter et al., 2007; Aragón, 2007; Díaz-Muñoz, 2010), there are only two comprehensive published protocols for capture-and-release. The first is a record of capture strategies (Encarnación et al., 1990) created by Peruvian biologists, and used for the export of some 30,000 primates per annum between 1961 and 1971 (Grimwood, 1968). The second is a 1993-description of trapping procedures of *Saguinus oedipus* in Colombia—the only detailed capture protocol of wild callitrichids intended for a subsequent behavioral study (Savage et al., 1993). Select protocols, with limited applicability to callitrichids, have been published for other primate species (Glander et al., 1991; Lemos de Sá and Glander, 1993; Agoramoorthy and Rudran, 1994; Sapolsky and Share, 1998; Karesh et al., 1998; Fernandez-Duque, 2003; Aguiar et al., 2007; Jolly et al., 2011; Stone et al., 2015), and general guidelines for primate trapping are available (Powell and Proulx, 2003; Fedigan, 2010; Sikes and Gannon, 2011; Jolly et al., 2011). However, due to variation in primate habitat, body mass, social organization, and feeding ecology, a capture-protocol used for one species can be largely unsuitable for another. Unfortunately, the majority of trapping protocols remain unpublished or are published in minimal detail, despite their obvious importance to safe and successful field research by decreasing the repetition of avoidable capture mistakes and reducing mortalities (Fedigan, 2010).

Here, we present a modified capture protocol based on Encarnación et al. (1990), also known as "the Peruvian method", with improvements in trap design and animal handling methods that preserve habituation and minimize capture-related injuries. We compared published protocols with our modified protocol and demonstrate the success of our methods on free-ranging populations of sympatric *S. weddelli* and *S. imperator*. While past long-term monitoring of *S. weddelli* (formerly *S. f. weddelli* cf. Matauschek et al. 2010) has involved capture-and-release programs (e.g., Goldizen et al., 1996), *S. imperator* has rarely been captured (Terborgh, 1983; Calegaro-Marques and Bicca-Marques, 1994; Windfelder, 1997; Aragón, 2007) and never before in complete groups for population-level monitoring.

Methods

Study site and subjects

Our protocol was used in 346 capture instances of *S. weddelli* and *S. imperator* over a seven-year period (2009-2015) (Watsa, 2013) at the Estación Biológica Los Amigos (EBLA) in southeastern Peru. The small size (300–650 g), arboreal lifestyle, sexual monomorphism and morphological homogeneity of both target species (Hershkovitz, 1977) served as natural obstacles to reliable identification of the individuals in 21 study groups. After careful review of capture recommendations and guidelines (Sikes and Gannon, 2011), a capture and release program, as opposed to darting, was deemed justifiable for the collection of samples and placement of visible identification markings on each animal. Since emperor tamarins were not incorporated into the study until Season 2, our baiting strategy and processing protocol were largely crafted on *S. weddelli* during Season 1 (October 2009 – July 2010), and then applied to both species from Season 2 onwards.

Caller animal

All populations were completely naïve to non-native bananas, with the exception of one social group whose home range centered around the research station where Aragón (2007) had previously captured a group of *S. imperator*. We initiated the capture program in Season 1 by placing 79 feeding platforms in forested areas frequented by *S. weddelli*. After 4 months of little progress (only capturing the one previously habituated group near camp while all others ignored the bait), we acquired a *c.* 3-month-old saddleback tamarin from the Taricaya Rehabilitation Center in Puerto Maldonado, Peru, as a caller animal to inspire bait and trap habituation, an approach suggested by previous studies (Encarnación et al., 1990; Suárez, 2007). The animal was quarantined for several weeks before transportation to the study site, and for about four months accompanied researchers to new trapsites for approximately six hours each day. The results were remarkable, with unhabituated groups beginning to eat bananas within 3 days in some cases. For field seasons 2–6 (2010–2015), a caller animal was not required. Instead, naïve groups learned to eat bananas from habituated groups in areas of home range overlap.

Brief protocol description

We used multi-compartment traps similar in design to those used in the "Peruvian method" (Encarnación et al., 1990), with 6–10 compartments that are controlled manually by an operator located 10–15 m away (Fig. 1). Each trap was provisioned according to a baiting protocol consisting of 5 stages (Table 1) designed to entice animals to

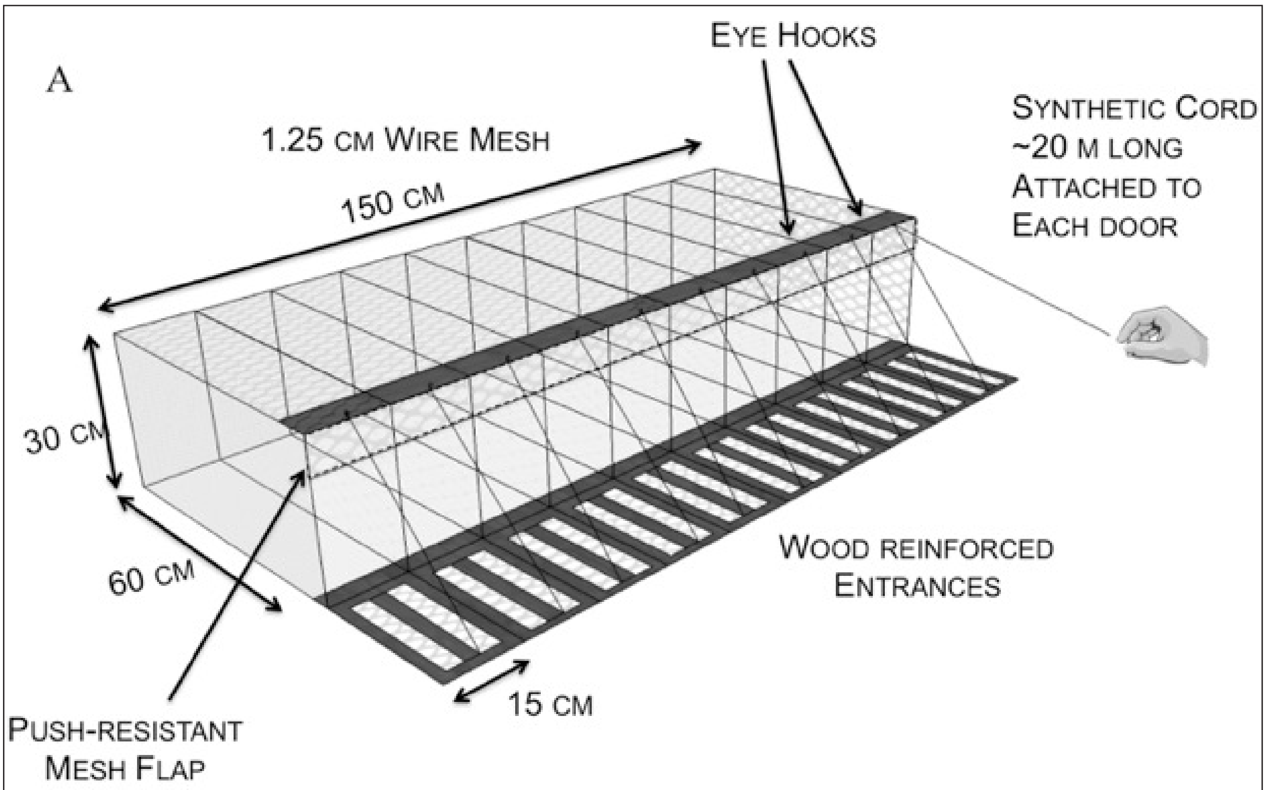

Figure 1. Tamarin trap design indicating materials used as well as the dimensions for a 10-compartment trap. The door-string is only shown for a single compartment.

Table 1. The five stages of baiting a trap.

Stage	Setup	Fruit Size	Fruit Placement	Minimum Conditions to Upgrade to the Next Stage
I	Platform	Whole fruit	Elevated above the platform (*c.* 4 m) using bamboo poles	Animals must try the bananas and/or venture onto the platform.
II	Trap	Whole fruit & small pieces	Whole fruit remain elevated, but small fruit are placed on the trap roof and doors	Animals must pick up pieces off the trap, and be spending time feeding at the whole fruit.
III	Trap	Small pieces	On trap doors and roof	Animals must descend to feed from the trap, and venture onto the doors.
IV	Trap	Small pieces	On doors and inside the trap, but not on the roof	Animals must venture inside the trap compartments, even if they only grab the fruit and leave to eat it in the trees.
V	Trap	Large pieces	Inside the trap only	Animals must remain within the compartments eating the fruit without removing it from the trap itself. At this stage, if all animals in the group are entering the trap, the group is ready for capture.

Table 2. Study population demographics at EBLA involved in the capture process.

	S. imperator	*S. weddelli*	**Program Overall**
Trapping years	Five: 2011–2015	Seven: 2009–2015	Seven: 2009–2015
Total # distinct individuals processed	60	106	166
Total # of group processing instances i. e. successful processing days	31	56	87
Total # distinct groups processed	7	14	21
Mean group size (range)	5.17 (3–8)	4.85 (3–8)	4.97 (3–8)
Total # of capture instances	126	220	346
Average # animals processed per year	25.2 ± SD 3.5	36.7 ± SD 12.6	31.5 ± SD 11.0
Total # of males processed	58	115	173
Total # of females processed	68	105	173
% of captures that were juveniles (*c.* 4 mo old)	17.5%	21.8%	20.2%
***% capture success 2009-2015**	94.9%	97.3%	97.2%
**** % re-capture success 2009-2015**	89.4%	95.8%	93.8%

* % capture success = (number of individuals present) / (all individuals present)

** % re-capture success = (number of known individuals recaptured) / (number of known individuals present)

taste a previously unknown fruit bait, banana, and then gradually enter traps to feed. A stakeout was conducted at each trap location for about 6 hours each day to record animal behavior at the trap. During stakeouts, except for Season 1 when a caller animal was present, we used playbacks of contact-call vocalizations of adults and juveniles every 15 minutes to attract groups to the area. Durations for each baiting stage depended on the level of habituation of the entire group to the observer and the trap. Except for the first season that spanned nearly a full year, the trapping program was carried out annually during the dry season (May–August), when natural sources of fruit are scarce and banana bait is most appealing.

Once all the individuals in a group had consistently fed within the trap compartments, we captured entire groups together to avoid disruption of social dynamics. All captures were initiated as early in the morning as possible in order to provide sufficient processing time for same-day release. No animal was released without spending a minimum of 1.5 h in a recovery chamber after its last dose of anesthetic. All animals received bleached tail rings and a novel twin-set beaded collar for field identification (Fig. 2).

The proposed protocol, although similar in terms of capture methodology to the Peruvian (Encarnación et al. ,1990) and the Colombian protocols (Savage et al., 1993), has several significant modifications, particularly with regards to processing methodology. For a detailed, step-by-step description of our protocol please visit: <https://goo.gl/wfnLGM>.

Evaluating the dual-step anesthetization protocol

Savage et al. (1993) recommended that a whole group be captured in a single event, and that only a single animal should be anesthetized and processed at a time (hereafter referred to as *single-step anesthetization*). We found that this method resulted in the majority of animals spending long periods of time in trap compartments awaiting their turn to be processed. A capture event in Season 1 using single-step anesthetization also resulted in high stress to the tamarins, evidenced by self-inflicted injuries including fresh scrapes and bruising on faces and muzzles and the loss of habituation to observers.

To minimize stress to tamarins, we used a novel *dual-step anesthetization* process on a subset of groups in Season 1. After all animals had entered the trap, each was given a single low dose of anesthetic and rapidly transferred into a padded recovery chamber for holding (Step 1). Then, each animal was in turn removed from the recovery chamber, given a second dose of anesthetic, and processed for sample and data collection (Step 2). Upon completion of Step 2, each animal was returned to its recovery chamber until release. By providing an immediate, small dose of anesthetic to each animal and transferring it to a dark recovery chamber we dramatically reduced the amount of time animals spent fully awake and aware in traps. To evaluate this capture method, we compared mean processing times and total anesthetic doses relative to body weight for single and dual-step methods, and we documented the severity and number of self-inflicted injuries on all animals tested. For all habituated groups, we noted any changes in habituation post-capture (i.e. the inability to follow them for a minimum of 5 hours continuously), and for all groups, we recorded recapture rates as an assessment of maintenance of trap-habituation.

All research was conducted with annual authorization from the Institutional Animal Care and Use Committees (IACUC) of Washington University in St. Louis and the University of Missouri-St. Louis, as well as the General Directorate of Forestry and Wildlife in Peru. This research adhered to the American Society of Primatologists' Principals for the Ethical Treatment of Non-Human Primates. The caller animal was returned to the Rehabilitation Center unharmed and later rehabilitated to a local tamarin group.

Results

From 2009–2015, we used the modified capture protocol on 166 animals from 21 study groups of both species, including 70 juveniles, defined as individuals captured in the same season they were born (about 4 to 7 months of age) (Table 2). In each trapping season, we spent about 21 days attempting to capture groups or lone individuals, and we were successful 67.5% of the time. Overall trapping success was highest in the dry season with groups that were being newly introduced to the fruit, with visitations occurring most frequently in the early morning and just before dusk.

Comparison with previous protocols

We compared the Peruvian (Encarnación et al., 1990) and Colombian (Savage et al., 1993) protocols to our modified protocol across a variety of factors relevant to behavioral habituation and animal well-being (Table 3). The modified protocol used a lighter version of the multi-compartment trap and was manually operated by researchers fully visible to the animals. Animals were processed at the trapsite, comprehensively sampled, and released on the same day (Table 4). We averaged a capture success (ratio of animals captured to animals present) of over 97% (Table 2).

Habituation to observation

In all cases, groups were released from capture and followed briefly to ensure that all animals were reunited with the group. In most cases, animals ran out of the recovery cages upon release and immediately re-entered the re-baited trap, spending about 20 min feeding inside of it. Of all individuals that remained in the study population, i.e. that did not disappear due to natural death, predation or dispersal from our study site, we recaptured 93.8% across the study period. All 21 groups captured over the three years were habituated to the presence of the observer at the baited sites before being trapped, and all groups returned to trapsites, with observers present, post capture. The only exception was a single *S. weddelli* group in Season 1 (recaptured in Season 2), which avoided researchers for several months after being captured. We attribute this to the use of single-step anesthetization that resulted in prolonged and stressful waiting periods in the trap and consequently a loss of habituation during that season.

Evaluating the two-step method

There was no significant difference (Mann-Whitney U, p >0.05) between total anesthetic dose relative to body weight for the 35 individuals that underwent single-step processing (mean = 21.7 ± SD 10.4 mg/kg) or the 9 individuals who underwent dual-step processing (mean = 26.4 ± SD 8.4 mg/kg) in Season 1. For dual-step processing, the average step 1 dose was 8.87 ± SD 4 mg/kg. There was also no significant difference (Mann-Whitney U, p >0.05) between processing times for 31 individuals (time not recorded on four individuals) that underwent single-step processing (mean = 72.3 ± SD 43.6 min) or the nine individuals who underwent dual-step processing (mean = 73.8 ± SD 21.7 min) in Season 1. Dual-step processing had no added effect on anesthetic doses or processing time, and it completely prevented the incidence of self-injury due to extended waiting periods in the trap (between 1.3 h and 4.7 h for groups of three and eight individuals, respectively).

Overall, adult *S. weddelli* received lower doses of anesthetic than adult *S. imperator*, which weigh 100–250 g more on average (Table 4). Relative to body weight, juveniles of both species received slightly higher doses of anesthetic on average than adults, though this was not significant (Mann-Whitney U, p >0.05) (Table 4). More than 95% of the time, groups were captured before 9 am in the day. Average processing time for groups ranged from 3.97 ± SD 0.8 h for groups of 3 animals to 8.03 ± SD 0.6 h for groups of 8. All groups were released no later than 4 pm in the day, after

Table 3. Comparison of prior capture protocols for *Saguinus* spp. to this protocol.

Item	Encarnación et al (1990)	Savage et al. (1993)	This Protocol
Purpose	Export of animals.	Behavioral study without biological sampling.	Behavioral study with biological sampling.
Trap dimensions (cm)	L: 120–150, W: 40, H:36	L: 160, W: 45, H: 30	L: 90–150, W: 60, H: 30
Compartment width (cm)	12–15	16	15
# of compartments	10	10	6–10
Trap weight	Heavy - wooden frame used.	Heavy - wood frame and wire mesh.	Light - mesh and zipties. Wood only around door frames
Construction materials	Wood, nails, hinges, galvanized mesh, nylon thread, staples, wire, and rubber strips.	Wood, wire mesh, steel hinges and eye-screws.	Galvanized wire mesh, staples, zipties, and eye-screws.
Holding cages	Large structures for multiple animals housed together for export.	Not mentioned in protocol.	Two 4-compartment structures with padding and a cover sheet.
Tail protection during trapping	Not mentioned.	1 cm gap to prevent tail being injured.	None found to be necessary, but a modified top mesh flap reduced escape rate.
Caller animal	Yes, for faster habituation to bait.	Not used at all.	Yes, first trapping season only.
Caller animal source and fate	Captured; fate uncertain, probably exported.	Not applicable.	Borrowed from and returned to a Rehabilitation Center.
Trapping platform	Made of bamboo or wooden sticks.	Eight 0.3 m - rope extensions.	Temporary, small sheet of galvanized mesh with rope tied to all four corners.
Bait placement	Secured in cages to force animals to remain.	Unsecured bait.	Unsecured. Capture attempts aborted if animals do not voluntarily eat inside trap.
Trapper visibility	Hidden by blind	Hidden by blind	Visible within mosquito net.
Operator to trap distance	6–12 m	4–6 m	10–15 m
Blind construction	Involved structure of palm leaves and sticks.	Wood and burlap.	No cover required for blind: operators visible.
Strings	Grooved rod, fixed to ground with sticks involved.	Not specified in protocol	Simple braided string tied in trapdoor-order to a larger rope between trees.
Trapping duration	Trapping can extend to many hours, depending on skill of trapper.	On average, 2 to 6 h.	Animals only trapped if entire group enters - trapping duration minimal.
Trigger to end group capture attempt	Full group captured, or not enough compartments.	Complete group captured. Waited up to 24 hours until all animals in a group entered the trap; provisioning after 6 hours.	Pre-allotted time of 25 minutes, or animals released and capture attempted another day.
Partial group captures	Permitted - behavior unimportant for exported animals.	Avoided, but at cost to remaining group members via extended capture times.	Strongly avoided, capture typically abandoned if entire group does not enter.
Relocation for animal processing	Canoes or motorized boats used to move animals to camp.	Hand-carried to research station - distance unknown.	None - animals processed immediately at trapsite.
Animal identification	Not mentioned in protocol.	Tattoos, colored hair dye, and radio collars.	Microchips, 3-bead collars, one radio collar per group, and bleached tail-rings.
Morphometric measurements	Some measures recorded on some individuals.	Only body weight reported.	About 80 morphological measurements per animal
Provisioning during/after capture	Bananas and milk powder fed to animals for a week, minimum.	Two banana slices per animal, with additional slices for extended trapping (>24 h).	During recovery period 1–2 bananas are split between all individuals in a group.
Time to release	Purpose of capture not for release.	Within 24 hours of capture.	Same day, < 7 hours of capture.

Table 4. Anesthetization doses and processing times for each species across the study.

Trapping Evaluator	*S. imperator*	*S. weddelli*	Both species
Mean adult weight (g)	515.4 ± SD 66	386 ± 54 SD	435.5 ± SD 86
Mean infant weight (g)	264.1 ± SD 40	223.6 ± SD 35	236.8 ± SD 41
Mean total anesthetic for adults (mg/kg)	20.1 ± SD 6.4	18.2 ± SD 10.2	18.9 ± SD 9.4
Mean total anesthetic for juveniles (*c.* age 4 mo) (mg/Kg)	23.8 ± SD 4.7	18.9 ± SD 6	20.3 ± SD 6.1
Anesthetic dose 1 for adults (mg/kg)	7.4 ± SD 1.6	5.7 ± SD 2.1	6.4 ± SD 2.1
Anesthetic dose 1 for juveniles (mg/kg)	8.7 ± SD 3.2	9.5 ± SD 3.0	9.2 ± SD 3.0
Mean processing time for Step 1 per animal (min)	10.7 ± SD 4.0	13.7 ± SD 7.0	12.1 ± SD 5.0
Mean processing time for Step 2 per animal (min)	37.2 ± SD 10	37.6 ± SD 8	37.5 ± SD 9
Average processing time per group (h)	5.6 ± SD 1.5	5.4 ± SD 1.6	5.5 ± SD 1.6

the last individual given an anesthetic dose had recovered for about 90 min.

Caller animal

In Season 1 (from October 2009 – February 2010), *S. weddelli* did not eat bananas at any baiting site save one, where a group was successfully captured. Subsequent to encountering a caller animal, animals that had resisted eating bananas for five months consumed the bait in a matter of days. In Season 2 and beyond, we used only 7–10 baited trapsites placed strategically in areas of home range overlap between bait-habituated and bait-unhabituated groups, and trapping success was high at all sites. We conclude that a caller animal was essential to increase the effectiveness of our baiting strategy in Season 1, but was unnecessary during additional field seasons as bait habituation transferred between and within groups.

Discussion

Modifications to improve trapping safety

Although rifles and blowpipes have been used to anesthetize other free-ranging primates (Glander et al., 1991; Fernandez-Duque, 2003), darting is not recommended for tamarins due to their small size (Jolly et al., 2011). In addition, we recommend the use of manually controlled traps that eliminate non-target captures, which is a major disadvantage of Sherman/Tomahawk traps that have automatic doors. Across our study period we have documented *Cebus*, *Callicebus*, *Callimico*, tayras (*Eira barbara*), coatis (*Nasua nasua*), nocturnal marsupials and rodents exploring our traps. Furthermore, automatic traps have only a single compartment, which often precludes the possibility of capturing entire groups together. They are also typically positioned on large grid systems or transects (Pacheco et al., 2007; Blanco, 2008) that must be checked periodically, which creates longer awake and aware waiting times for trapped animals (hours) than this protocol (about 25 min), which can result in significant injuries.

Post-capture, we avoided transporting animals to a field laboratory in favor of processing all animals in a tent near the trap site, which resulted in a total processing time that was much lower than previous protocols (a maximum of eight hours in this study, compared to as much as 24 hours in other studies). We also captured entire groups within 25 min and infrequently captured partial groups (about 14% of all instances) when a single animal was reluctant to enter the trap. In the two instances (of 346) that a juvenile would not enter the trap, an adult was released to remain with it while the rest of the group was processed (an option precluded by automatic traps). When possible, a trapsite would be revisited for a second attempt to capture individuals that did not enter previously. Since only trap-habituated groups were captured, we minimized the frequency with which missed captures occurred. Our trapping method, in concert with dual-step processing, not only reduced injuries and preserved animal habituation, but also avoided disturbance and distress to social groups. No mortalities associated directly with the trapping protocol were observed in this study. However, we observed that one young female who was captured and released successfully in Season 2 did not survive two hours after recovering from the first small dose of anesthetic when trapped in Season 3. Poor body condition, established during post-mortem examination, indicated a history of disease.

Figure 2. Marked individuals of both tamarin species post-capture. **A:** Bleached tails and beaded collars on *Saguinus weddelli*. **B**: Beaded collar on *Saguinus imperator*.

Modifications to marking individuals
A modified, double-beaded collar increased visibility of beads from multiple angles (Fig. 2). Collars have been known to cause injury to *Callicebus* in other trapping programs (Müller and Schildger 1994) and collars must be large enough to accommodate weight increase in the wet season but not so big that the collar can slip over the jaw and chip a canine. We strongly recommend collar sizing presented in the detailed protocol online, and do not recommend radio-collaring animals younger than one year of age. We also confirm that correctly sized radio collars around the necks of wild tamarins cause no observable negative health effects, but we do not recommend backpack radio transmitters, as this could affect infant-carrying behaviors in these cooperatively breeding primates.

We used hair bleach to successfully create a selection of 11 ringed patterns on the animals' tails, with better success on the darker saddleback tamarins than the emperor tamarins (Fig. 2). Infant tamarins were bleached very lightly in different patterns on their bodies, as their tails were too thin to be easily visible. The bleached sections routinely molted along with the rest of the pelage within 3–4 months of application, fading rapidly in the last month. No adverse effects on hair growth were observed in any recaptured individual, unlike freeze-banding of tails that may cause loss of a portion of the tail (Fernandez-Duque, 2003). Microchips used to permanently identify individuals were reliably detected during recaptures in all but two individuals. The beveled needle tips form an effective delivery system and cause no bleeding, and animals were not observed attempting to remove chips.

Modifications to improve trapping efficiency and outcomes
We suggest three major mechanical improvements to the multi-compartment traps. First, the use of galvanized mesh and zipties reduces trap weight from construction materials like wood used by both Savage et al. (1993) and Encarnación et al. (1990). We found no need for a 1-cm gap at the top of the door (Savage et al., 1993) to prevent injuring the tail of the animal. We installed a push-resistant mesh flap at the top of each entrance which eliminated escapes during capture caused by animals bending doors open by pushing on them. Finally, by using a mesh layer attached by rope to four trees as a trap platform, we avoided bulky and complicated systems used in the past and made trap setup and take down efficient and adaptable to varying forest conditions. We observed that for a team of 4–5 handlers, the processing of two animals simultaneously increased the number of variables that needed to be recorded at a given time and data omissions became increasingly common. Thus, we reaffirm that processing one animal at a time improves trapping efficiency.

The average anesthetic doses (excluding minimal dose during initial processing, which can be separated by hours from complete processing) received by both tamarin species are generally lower or in some cases on a par with those used in other studies (about 25 mg/kg by Savage et al., 1993) (Table 3). The processing of each animal, including Steps 1 and 2, occurred in just under 49 min on average, but ranged from 47.5 to 50.5 min for the collection of 80 or more measurements and a variety of biological samples (see supplemental data for list). If collection of samples and data were minimized, as in the case of the Colombian protocol, we would be able to reduce processing times to between 20 and 30 minutes. The assignment of specific roles for handlers and improved data management methods (such as voice recorder backups) also contributed to streamlining processing.

Modifications to improve trapping success and habituation post-capture
Once a primate has undergone a negative experience associated with a foraging endeavor, it can be expected to form a negative association with that particular stimulus or setting, which jeopardizes the feasibility of capture-and-release programs conducted in conjunction with behavioral sampling. A survey of 120 studies involving trapping of about 65 species of free-ranging primates revealed that a well-planned study does not cause habituated animals to change their behavior towards observers (Jolly and Phillips-Conroy, 1993). There are several ways to measure the extent to which primates are habituated to an observer, such as the distance between the observer and the primate or the extent of contact time with the animals. However, we used qualitative behavioral indicators of familiarity to an observer instead, such as vocalization cues and lack of acknowledgement of the observer's presence, to describe habituation post-trapping. All habituated groups processed using the dual-step anesthetization protocol retained habituation to the observer and the trap. Groups unhabituated to the observer, but habituated to the traps, showed no fear of researchers at the trapsite, were observed feeding at the trap in the same season, and were able to be captured the following year in all cases. In a single case of the single-step anesthetization process, one group experienced long wait times and displayed significant loss of habituation to observers in that season; however, they were recaptured and became habituated to observers in all subsequent years.

We can also confirm that the number of new immigrants in a group negatively impacted the ease with which a previously habituated group could be followed by an observer, and increased the time it took for the group to be habituated to a bait site. Habituation is thus a dynamic representation of a primate group's tolerance to observation, and seven years of behavioral research with this tagged population demonstrates that it is indeed possible to conduct a capture program without diminishing habituation or affecting overall behavior.

General recommendations on the trapping of small mammals
The capture of animals in live traps with no more invasive methodology than a peripheral blood draw is supported by care guidelines specified by the American Society of

Mammalogists (Sikes and Gannon, 2011). These guidelines specify justifications for capture, including "livetrapping to tag (with radiotransmitters, necklaces, ear tags, or passive integrated transponder tags), mark (number, band, hair color, freeze brand, ear tag, or toe clip), or collect tissue" (Sikes and Gannon, 2011). Trained individuals should conduct the necessary chemical immobilization, with experience in the administration of anesthetics, tranquilizers, sedatives, and antidotes in the appropriate doses (West et al., 2007; Kreeger, 2007; Fowler, 2008). Finally, sedated animals should be monitored closely and released only when they have regained full consciousness and locomotion (Sikes and Gannon, 2011).

The data on health and physiology accumulated from capture-and-release programs has revolutionized our perspectives of both captive and wild animals, but the acquisition of data from wild populations should not be given higher priority than the health and safety of the animals themselves. As times change, we should continually re-assess trapping strategies and make use of new technology that alleviates stress to study subjects. If behavioral monitoring were required for all capture-and-release programs, the likely result would be the further improvement of trapping protocols.

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