

Technical Report

Hand-Rearing and Rehabilitation of Orphaned Wild Giant Otters, *Pteronura brasiliensis*, on the Rupununi River, Guyana, South America

Diane McTurk¹ and Lucy Spelman^{2*}

¹Karanambu Trust, Guyana, South America

²National Zoological Park, Smithsonian Institution, Washington, DC

From 1985–2003, 34 orphaned giant otters, *Pteronura brasiliensis*, (22 males, 12 females) were hand raised for eventual return to the wild at The Karanambu Cattle Company Limited Ranch (Karanambu), on the Rupununi River, Guyana, South America. The orphans ranged in age from 2 weeks to 9 months old; most were 8–10-week-old cubs. Feeding, housing, exercising, veterinary care, and rehabilitation protocols for young giant otters were developed during this period. Six cubs died during hand-rearing; of these, four died from illness or injury, and two were killed, one by a caiman and one by another orphaned otter. Of 34 giant otters brought to Karanambu, 28 (82%) were reared successfully to an age and condition suitable for rehabilitation, and 18 (53%) returned to the wild. Ten otters survived hand-rearing but died either before or during the process of rehabilitation. These hand-reared giant otters were killed by people (3 known, 2 presumed) or other giant otters (5), including one male otter that remained at Karanambu for several years. During rehabilitation, young giant otters chose to spend increasing amounts of time on the Rupununi River away from human care, often interacting with wild giant otters. Although long-term monitoring was not possible, Karanambu staff observed most (15 of 18) of the rehabilitated otters repeatedly, for as long as 4 years after their return to the river. The giant otter rehabilitation program at Karanambu generated new knowledge about this species, and offered visitors the opportunity to observe them. Zoo Biol 24:153–167, 2005. © 2005 Wiley-Liss, Inc.

*Correspondence to: Dr. Lucy Spelman, 3620 39th St., Apt F540, Washington, DC 20016.
E-mail: lucy.spelman@gmail.com

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INTRODUCTION

In 2000, the giant otter (*Pteronura brasiliensis*) was moved from vulnerable to endangered on the species list maintained by the World Conservation Union (IUCN) [Foster-Turley et al., 1990]. Giant otters are endangered throughout most of their range [Duplaix, 1980; Melquist, 1984; Mason and Macdonald, 1986; Foster-Turley et al., 1990; Carter and Rosas, 1997; Schenck and Staib, 1998; Olson et al., 2001]. There are no current population estimates for giant otters in Guyana, where they are known to range along river and lake systems. They are most numerous in uninhabited areas [Groenendijk, 1998]. Along the Rupununi River and its tributaries, where they are known as “water dogs” or ‘turara’ in Macusi language, giant otters are often observed (G. Watkins, N. Duplaix, D. DeFreitas, A. Holland, personal communication).

Human activity is the main threat to the giant otter along the Rupununi River. In the absence of alluvial gold mining, the greatest disturbance is caused by fire used to clear paths along the high river banks. Burning and clearing of vegetation disturbs the areas where giant otters excavate their hidden dens. A family group of giant otters can consume large amounts of fish at a single feeding. They are often perceived as competitors by human populations who rely on river fish as a source of food and income [Gomez and Jorgenson, 1999]. Large, vocal, bold, and gregarious, giant otters are easily captured or killed.

The Karanambu Cattle Company Limited Ranch (Karanambu) located on the Rupununi River in southwestern Guyana, was established in 1927. Well known for its relative abundance of wildlife, the ranch became a rehabilitation center for orphaned wild giant otters in 1985. The Karanambu Trust, a nonprofit organization, was established in 1996 to promote environmental and wildlife research, conservation and education, with a focus on the giant otter. One of the organization’s initial objectives was to develop protocols for hand-rearing young giant otters, with the ultimate goal of returning them successfully to the wild on the Rupununi River. The ranch property is ideally situated for this purpose because it includes and is surrounded by giant otter habitat. Residents and visitors to Karanambu, local, national and international, have a unique opportunity to observe and study wild giant otters in their natural habitat.

MATERIALS AND METHODS

A retrospective survey of the records available for individual orphaned giant otters brought to The Karanambu Cattle Company Limited Ranch (Karanambu) during the years 1985–2002 formed the basis of this study.

The giant otters were cared for by the staff at Karanambu ranch, which covers a total of 32,375 hectares (125 sq miles) including Kwaimatta village and approximately 40 km (25 miles) of river frontage stretching along the left bank of the Rupununi River between Massara and Yupukari villages. Approximately 100 people live on Karanambu, along with 600 cattle (longhorn-Brahman cross), and 30 working horses. More than 1,100 people live in two nearby Amerindian villages (Yupukari and Massara). A narrow band of low gallery forest, followed by scrub and savannah, borders each side of the river in this region and there are numerous

creeks, ponds, and oxbow lakes that vary in size between wet and dry seasons. Many of the small creeks and ponds dry completely.

Between 1985–2002, 34 young, orphaned, wild, giant otters were brought to Karanambu for hand-rearing and eventual rehabilitation to the wild. From the start, the aim was to rear the cubs to independence and return them to the Rupununi River (rehabilitation). Informal notes including details of husbandry (feeding, housing, exercising, health problems) and rehabilitation were maintained on each giant otter beginning in 1985; formal veterinary records were maintained beginning in 1996. All notes were reviewed retrospectively, and organized into three stages: arrival, hand-rearing, and rehabilitation.

Information was gathered and summarized for each stage. Arrival information included date, location found, age, sex, weight, and health status upon arrival. Hand-rearing information included survival, details of feeding, housing, exercise, management of social interactions with other orphaned otters, and medical care for injury or illness. Rehabilitation information included timing and duration of interactions with other wild otters, sightings of orphaned otters interacting with or joining packs of wild giant otters, evidence of reproductive activity, and survival.

RESULTS

Arrival

Thirty-four young giant otters (22 males, 12 females) were brought to Karanambu over an 18-year period (Table 1; note arrival dates include 1985–2002, rehabilitation dates include 2003). The otters ranged in age from 2 weeks to 9 months old. The youngest otters (2–5 weeks) arrived during the first few years of the program. Since 1994, all of the orphaned cubs were estimated to be at least 5 weeks old. The number of otters arriving each year decreased during the period: 25 otters arrived during the first 9 years, compared to nine during the second 9 years of the program. There were 6 years in which no otters arrived (1986, 1990, 1994, 1995, 2000, and 2001).

In the wild, giant otters give birth once a year from early September to mid October, at the end of the wet season. Most of the otters arrived at Karanambu between October and January. Details of where the otters were found were often incomplete, but most came from the North Rupununi area (Massara, Yupukari, Simuni, Katoka, Rewa, Annai) and were found by local Amerindian villagers, captured either for trade or pets.

There were four distinct age groups of orphaned giant otters: neonates (1–3 weeks), cubs (4–10 weeks), juveniles (11–20 weeks), and sub-adults (5–12 months) (Table 2). Age groups were based upon size, estimated age, estimated or actual weights, dental development, and feeding behavior. Weights were obtained in some cases by acclimating the otters to being lifted and held by D. McTurk, standing on a scale. Others would not tolerate this procedure, nor would they tolerate being placed in a box for weighing. Their weights were estimated using the known weights of companions or data obtained from other otters of similar age.

Table 1. Orphaned giant otter cubs (*Pteronura brasiliensis*) hand-reared and rehabilitated at Karanambu, Guyana^a

Otter no.	Year	Sex	Age	Origin	Time observed in wild after return	Status ^b
1	1985	♂	2 weeks?	Simuni	2 year	KP
2	1987	♀	8 weeks	Kotoka	7 year	RR
3		♀	10 weeks	Massara	7 year	RR
4	1988	♀	14–16 weeks	Simuni	3.5 year	RR
5		♂	5 weeks	Yupukari	1 year	RU
6		♀	5 weeks	Yupukari	1 year	RU
7		♂	2 weeks?	Simuni	14 day	DC
9		♂	8 weeks	Yupukari	14 day	DC
8		♀	4 weeks	Yupukari	2.5	DP-KP
10	1989	♀	5–6 weeks	Yupukari	2 year	RR
11		♂	5–6 weeks	Yupukari	2.5 month	DC
12	1991	♂	3 weeks	Simuni	4 year	RR
13		♂	10 weeks	Yupukari	4 year	RR
14		♂	10 weeks	Kotoka	4 year	RR
15	1992	♂	8 weeks	Massara	1.5 year	DC-KC
16		♂	8 weeks	Massara	4 year	RR
17		♀	8 weeks	Annai	4 year	RR
18		♂	8 weeks	Maraswatta	2.5 year	RR
19		♂	8–10 weeks	Yupukari	2 year	RR
20		♂	8–10 weeks	Massara	2 year	RR
21	1993	♀	3 weeks	Massara	3 year	KP
22		♂	9 weeks	Katoka	1 month	KO
23		♂	9 weeks	Katoka	1 month	KO
24		♀	9 weeks	Katoka	1 month	KO
25		♀	9 weeks	Katoka	3 day	DC
26	1996	♂	10 weeks	Simuni	1 year	RU
27		♂	10 weeks	Simuni	3 month	KP
28		♂	9 monthnths	Quebana	4.5 year	KO
29	1997	♂	5 weeks	Yupukari	1 week	DC-KO
30	1998	♀	9 weeks	Yakarinta	8 month	DP-KP
31	1999	♂	8 weeks	Yupukari	4 year	RR-DP
32		♀	8 weeks	Yupukari	4 year	RR-DP
33	2002	♂	12–14 weeks	Rewa	Alive	RR
34		♂	8–10 weeks	Kurupung	6 month	KO

^aNo otters were brought to Karanambu in 1986, 1990, 1994, 1995, 2000, 2001.

^bKP, killed by people; KO, killed by other giant otters; KC, killed by caiman; RR, rehabilitated and recorded in wild; RU, rehabilitated and unrecorded in wild; DC, dead as cubs; DP, presumed dead.

Hand-Rearing

Housing.

Housing for new arrivals was identical for all otters: they spent their first few days in the bathroom of D. McTurk to ensure a regular feeding schedule, and to begin the process of bonding with a human caretaker. Their transport crate (wooden box with slats or sky kennel plastic domestic animal crate) served as their “den” and remained with them. On their first day of arrival, the cubs were first placed in a small plastic tub with water to encourage defecation. Fresh scat, their own or that from other otters on the premises, was used to mark a suitable “sprainting” site and to

Table 2. Four age groups and estimated weights for young male and female giant otters (34 total), *Pteronura brasiliensis*, presented to Karanambu for hand rearing and rehabilitation between 1985 and 2002

Age group	Estimated weight range (kg)	Estimated age range	Males	Females	Total (34)
Neonate	0.5–2.0	1–3 week	3	1	4
Cub	2.1–5.4	4–10 week	18	9	27
Juvenile	5.5–12.4	11–20 week	1	1	2
Sub adult	12.5–22.0	5–12 month	1	0	1

teach the otter the proper location. The cubs soon used this site exclusively. Once the newly arrived cubs developed a bond with the caretaker, they could be picked up and handled as needed. This was particularly important in the event of aggression from another otter.

Giant otter cubs that were very small remained in the bathroom until the small tub was no longer large enough for swimming. Between 1985–1998, the cubs were moved from the bathroom to an adjacent enclosed building, the “giant otter house.” This building included a cement floored sprainting area, a raised brick grooming area with layers of towels to simulate clay or sandy soil, room for the caretaker to dry the otter after its swim, a “den” fashioned out of a metal drum laid on its side and covered with heavy towels or curtains, and a much larger tub (7–10 gallons) for swimming, made from a large truck tire. Simple floating toys such as plastic cups or puppy toys were used for enrichment.

After 1999, older cubs were transferred to a specially built facility, known as the “giant otter pens.” This open-sided building consisted of three adjacent pens, located near the main ranch house. For construction, the Philadelphia Zoo donated building materials and Youth Challenge International provided labor. The pens were covered with a thatched roof, separated by brick walls, and each contained a medium-sized tub (bathtub), large pool (approximately 100 gallons), metal drum “dens,” and a grooming and drying area.

Howdy panels of metal mesh were included between adjoining pens, set within the dividing walls; these panels permitted otters of varied ages and acquired at different times, to meet and interact safely. Draped towels were placed over mesh panels to gradually introduce new arrivals to resident otters. Otter introductions were made at mealtimes; eventually, compatible otters were housed together.

Feeding.

Twelve young otters required bottle-feeding for 1–5 weeks after arrival. Bottle feedings were also often given as a “comfort” to older cubs to encourage them to sleep when they first arrived, even if they were old enough to eat fish. The amount and frequency of bottle-feeding was empirical and driven in part by the requirements of each individual otter. A human baby bottle, with a cross cut to widen the hole in the nipple, was used routinely. Most otters were fed 0.5–1.0 full bottle of milk (120–240 ml) three to four times a day. Optimal positioning for bottle feeding was with the otter sternal, head up, neck extended.

Of 12 cubs that were bottle fed for several weeks, 10 were given infant human milk replacer only; two also received a veterinary formula. The composition of the human milk replacer varied depending upon the availability of this product in Guyana, but a powder mixed with water was used. The veterinary milk replacer product (Zoologic Milk Matrix 30/55, PetAg, Inc., Hampshire, IL) became available initially in 1997 (courtesy of Karl Kranz and the Philadelphia Zoological Society). The Karanambu Trust subsequently purchased milk formula as needed and shipped it to Guyana.

Diarrhea developed in three otter cubs fed with human milk formula. The first otter to develop this problem was the first cub brought to Karanambu. This was a very young otter (estimated 2–3 weeks) with its eyes barely open; trial and error was used to develop a feeding strategy. Human powdered milk mixed with water at a standard dilution was used initially, but the otter developed persistent, severe diarrhea. The formula was substituted with a mixture of electrolyte solution and chicken eggs until the otter's stools improved. The egg was gradually replaced by milk powder and the concentration was adjusted to a 1:3 dilution. As this cub grew, it remained very small. It also developed premature dental wear involving its canines, and was never rehabilitated.

For subsequent cubs, the concentration of the milk formula was increased to increase the calories provided. Cubs were started on a dilute mixture (1:4) that was gradually increased, in some cases as high as 1:1 dilution depending on the individual otter. Milk concentration was adjusted on a daily basis to maintain normal stool consistency (loose, curd-like, light colored). Stool color darkened gradually as more fish was eaten. If diarrhea occurred, otters were given an egg/electrolyte mixture for several feedings until stools improved, and then transitioned back onto milk formula. One other otter grew to a relatively small size for an adult, developed fractured canines, and was never rehabilitated. This was a young male that arrived at the approximate age of 8–9 months in poor physical condition; its diet as a cub was unknown.

Young otters learned to suckle from the bottle quickly. They also tended to hold onto the nipple and attempted to nurse even when the milk was gone, taking in air and small amounts of fluid. In 1986, one cub died of presumptive aspiration pneumonia, which was associated with this behavior and bottle-feeding. With experience, bottle-feeding techniques were modified so that the bottle was pulled away from the otter before it was emptied to minimize the risk of aspiration. Giant otters were not encouraged to drink milk out of a dish because they tended to submerge their noses, blow bubbles, and sneeze rather than drink.

The cubs were weaned by daily offers of freshly killed fish, either in small strips or small whole fish. In the case of very young cubs, fish was not offered until after their eyes were open and teeth were evident. Most cubs started to eat fish by 3 months of age. Species offered were usually red piranha, *Serrasalmus nereteri*, lukunani (also known as peacock bass), *Cichla ocellaris*, and huri, *Hoplias malabaricus*.

The transition onto fish was abrupt in every case. From the first time it tasted fish, each otter quickly developed a ravenous appetite. Fish feeding volumes were increased concomitant with the cub's appetite, whereas milk volumes were decreased accordingly. As the cubs matured, they developed a preference for the more bony species (e.g., red piranha and huri). Dark colored, semi-formed stools with tiny fish bones and scales were considered normal for young giant otters eating fish. If fish

was scarce (wet season or very beginning of dry season), beef was offered to orphaned otters. Although the otters would eat the beef and seem satisfied, they did not seem to digest it well. Stool quality with this diet was poor, with a strong smell, and pieces of undigested meat.

Older cubs and juveniles were offered two to four small whole fish at each feeding, three to four times a day. As the otters matured and returned to the river, they were encouraged to forage on their own. During their return to the river and transition back to the wild, juveniles and young adults were offered freshly killed fish intermittently (1–2 times/day) as a supplement to their diet.

Swimming, grooming, and sleeping.

The daily routine for all otters, regardless of age, was similar. They were offered three to five meals per day. After meals, they were given the opportunity to swim, dry off (with towels), and sleep. Feeding times were usually early morning, mid-morning, early afternoon (two to three daytime feedings depending on demand) and late afternoon. Depending on their stage of development, the cubs were carried or led down to the Karanambu landing to swim. Depending upon water levels, the river in this area formed a small pond and sand bank. The otters were coaxed into the river by feeding them pieces of fish at the water's edge. Once the otters were swimming and foraging for live fish on their own, they were given the option to remain at the river during the day or to return to the pens between feeds.

The swimming and grooming/drying sessions for older otters often lasted an hour or more and were monitored closely by staff. Typically, once the otters finished swimming, they would seek out a suitable grooming and drying area; these included the sand banks along the river and the layers of dry towels provided in their pens. Every evening, Karanambu staff would help dry the otters and groom them quietly until they fell asleep in their "dens."

Each otter was provided with a soft "chewing cloth" on which they would suck or gnaw, engaging in nursing behavior until they fell asleep. This was considered particularly important as it supplied an alternative outlet for their urge to suckle; otters housed together otherwise showed a tendency to damage each other's ear and tail tips. It was also essential that the cubs' wet towels be replaced with dry bedding, given the importance to this species of a dry and well-groomed coat, and the fact that they no longer had access to the body heat of their family group throughout the night.

Survival and health problems.

Twenty-eight of 34 otters (82%) survived to an age and size suitable to start the process of rehabilitation (Table 1). Six cubs died during hand-rearing. Of these, four died from illness or injury within days of arrival and before they could be fully evaluated. Two were killed; one by a caiman and one by another orphaned otter.

Overall, health problems were minor among otter cubs during hand-rearing. Most new arrivals were thin and judged to be mildly dehydrated, based upon reduced skin turgor and tacky mucous membranes. Frequent feedings and access to water, as well as a suitable drying and sleeping areas, corrected these problems within a few days. Two otters had deep wounds around their neck (from being tied) such that the top layer of brown fur was not renewed and their pelts remained scarred by cream-colored fur; others had superficial abrasions around their necks. All of these wounds healed. One cub arrived infested with fleas, and several others

Table 3. Antibiotics and anti-inflammatory drugs and dosages administered, orally in fish for minor wounds and lacerations to giant otters, *Pteronura brasiliensis*, during hand rearing and rehabilitation

Drug	Dosage	Typical dose for young adult (15–22 kg)
Amoxicillin (250 mg chewable tab or capsule)	15–20 mg/kg two or three times a day	250 mg
Enrofloxacin (136 mg tabs)	5–7.5 mg/kg once a day	120 mg
Aspirin (325 mg)	15 mg/kg once or twice a day	325 mg

with ticks; these infestations were assumed to be the result of their environment after their capture and before arrival at the ranch.

Two giant otters housed together as cubs (in the 3-pen system) developed excessive allogrooming behavior that resulted in lacerated tail and ear tips. In this instance, the behavior abated as the animals grew to young adults (16-week-old male and a 12-week-old female) but the wounds persisted once they were rehabilitated, presumably due to interactions with other giant otters (wild and rehabilitated) and possibly piranhas.

During the early stages of rehabilitation, giant otters often returned to Karanambu with digit, foot, head, and neck wounds, especially during the wet season. On occasion, rehabilitated otters returned to Karanambu with fishing arrows or hooks embedded in their head, neck, or shoulder area. Severe wounds were treated accordingly (including removal of arrows or hooks) if the otter could be coaxed back to the pens, and treatment initiated with antibiotic and anti-inflammatory therapy (Table 3).

Anesthesia was required on one occasion in a sub-adult rehabilitated female requiring surgery with an arrow point embedded in her neck. The otter was given intramuscular injections by hand of xylazine (estimated dosage = 2.5 mg/kg) for sedation, followed by ketamine hydrochloride (estimated dosage = 2.5 mg/kg) for anesthesia; after the surgery was completed, the anesthesia was reversed with yohimbine (estimated dosage = 0.125 mg/kg).

Because injured rehabilitated otters often returned to the ranch landing at least once each day to rest, oral antibiotic treatment was possible. The otters would, however, avoid tablets in fish or refuse fish containing liquid antibiotics. The most successful antibiotic over the years was amoxicillin (various manufacturers), given two or three times a day. Enrofloxacin (Baytril, 60 mg; Bayer Corporation, Shawnee Mission, KS) was also successful when once a day dosing was required, as in the case of the female otter that survived surgical removal of an arrow point. Cephalosporin antibiotics were unpalatable and refused after the first dose. In cases where severe swelling or cellulitis associated with injuries was present, low dose aspirin therapy was administered.

Beginning in 1999, giant otter cubs and Karanambu ranch domestic dogs were dewormed regularly. For the cubs, one of three standard anthelmintics was given on a rotating basis every 4–8 weeks (various manufacturers): ivermectin paste 2%,

Table 4. Anthelmintics and dosages administered orally in fish to giant otters, *Pteronura brasiliensis*

Drug	Dosage ^a	Typical dose for young adult (15–22 kg)	Indication
Pyrantel pamoate (paste, 180 mg/ml)	10 mg/kg	1.0 ml (180 mg)	Nematodes; routine
Ivermectin (paste, 20 mg/ml)	0.2 mg/kg	0.2 ml (4.0 mg)	All parasites, including ectoparasites
Praziquantel (34 mg tablets)	5 mg/kg	3 tabs (102 mg)	Cestodes

^aPyrantel, Ivermectin, and Praziquantel were given monthly on a rotating basis.

pyrantel pamoate paste 18%, and Praziquantel tablets. Dosages were extrapolated from other otter species (Table 4). The domestic dogs were dewormed twice a year with ivermectin or pyrantel at the same dosages.

Karanambu ranch dogs were also vaccinated annually with canary-pox vectored canine distemper vaccine 2 weeks apart, followed by annual boosters (Purevax Ferret Distemper, Live Canarypox vector; Merial Inc., Athens, GA). The juvenile male giant otter that became resident at Karanambu and was never rehabilitated was vaccinated in his third and fourth years at the ranch for canine distemper, again using the canary pox vectored vaccine.

Rehabilitation

Twenty-eight giant otters survived hand-rearing and began the transition back to the wild. The hand-raised otters would first spend hours during the day, and then nights, away from Karanambu and from human care. Eventually, they would spend days, weeks, and months away from the ranch.

Eighteen otters (53%) survived to make this transition complete, moving permanently away from the ranch. Although long-term monitoring was not possible, Karanambu staff observed most of these (15) rehabilitated otters repeatedly, for as long as 4 years after their return to the river. Ten otters were never successfully rehabilitated (Table 1). Eight of these were killed, including three by people and five by other giant otters. Of those killed by other otters, one was the male that remained at Karanambu for 4 years. The two other otters left the ranch but were never seen again; these were presumed dead, probably also killed by people.

For the 18 giant otters that did return to the wild, the age at which they left the ranch was variable, with most leaving after the wet season. Most of the otters spent <12 months at Karanambu and left at the end of their first wet season (September), when they were approximately 1 year old. Others spent 2 or more years at Karanambu.

All 18 otters joined nearby groups of wild giant otters, several found mates, and most were observed again in the area surrounding Karanambu. The rehabilitated otters would recognize and approach the people who raised them. They also often visited Karanambu and interacted with other giant otter cubs in the

process of being-hand raised. The frequency of such sightings varied with the wet and dry season cycle. Otters were found most often at the end of the dry season (January to mid-May) when they congregated to fish in the main Rupununi River, Simuni creek, or larger ponds. Karanambu staff and their guests encountered giant otters on nearly every river visit (average length = 1–2 hr) during this time of low water because the daily movements of the otters in and out of ponds became known.

In the wet season (mid-May to August), river sightings of giant otters required 4–10 river visits. Rehabilitated otters and wild otters intermittently visited the landing during wet season to fish sometimes on a daily basis for stretches of 3 or 4 days at a time. If noted by Karanambu staff or guests, the otters were often fed fish to supplement their diet, as fishing was more difficult in the wet season. Rehabilitated otters occasionally appeared at the landing alone in the wet season to rest and fish away from wild otters.

Beginning in 1999, a mixed group of wild and rehabilitated otters established their territory along a 3-km stretch of river front that included the Karanambu ranch landing. The group was initially formed when a wild male otter (a transient) began to visit the landing at Karanambu regularly in the beginning of the wet season 1999 in search of a mate. Within a few weeks, the wild male returned with an adult female and this pair then began to interact with the four orphans that were just beginning the process of rehabilitation at Karanambu. The wild and orphaned otters would often go off together to the river during the day, with the orphans returning to Karanambu for the night. Eventually, several of the hand-reared otters were rehabilitated and joined this adult pair. When the wild pair gave birth to 5 cubs in 2001, the Karanambu family group numbered 9 otters.

The following year, two rehabilitated otters were driven out of the group. Both returned to Karanambu at the end of the 2002 wet season, interacting with a new male orphan being hand raised. The pair of rehabilitated otters then moved on, while the young male joined the Karanambu pack. As of the 2003 wet season, the Karanambu pack again numbered seven: the adult pair and their three sub-adult offspring (two cubs did not survive), one new cub, and one rehabilitated otter.

DISCUSSION

This study is the first to document a long-term rehabilitation program for giant otters in South America. Along the Rupununi River in Guyana, most (28 of 34) of the orphaned giant otters brought to Karanambu ranch were hand-reared to the age and size suitable for return to the river. Over half (18) were successfully rehabilitated back to the wild. In the only other published account of giant otter rehabilitation, two young otters were raised and returned to the wild in Columbia [Gomez et al., 1999].

The overall success of this program is attributed in part to the unique location of the Karanambu ranch, with access to the Rupununi River that includes prime giant otter habitat and a relatively low human population. As a result, it was possible to monitor the young otters closely as they returned to the river, and track their encounters with wild otters. The dedicated staff of Karanambu was also critical to the program's success. Each orphaned giant otter required constant care and attention for months to years. Once the otters returned to the Rupununi River,

however, it was impossible to track them reliably, particularly during the wet season. The long-term survival of these rehabilitated otters was unknown.

The location of Karanambu was also a factor in the initiation of the rehabilitation program. The first otter cubs brought to Karanambu were very young, several with their eyes just open. These orphans most likely were the result of the localized pelt trade along the Guyana-Brazil border at that time. Eventually, fewer neonates and very young cubs arrived each year, presumably because the pelt trade had all but ceased. However, otter cubs continued to be captured and kept as pets by Amerindian villagers. Eventually, their captors gave up these otters, presumably because of their huge appetite for fish. Juvenile otters can also be aggressive and become unmanageable. Because the interest and expertise of the Karanambu staff was known, these otters were brought to the ranch rather than be abandoned or killed.

Techniques for hand-rearing and rehabilitating orphaned giant otters cubs at Karanambu changed gradually over the years, reflecting successful trial and error. Published reports were not available for developing protocols for many years. Recently, protocols have been established for mother reared giant otter cubs in captivity [Sykes-Gatz, 2001]. In addition, there is one report of the rehabilitation of two giant otters in Columbia, Central America [Gomez et al., 1999].

Although specific data is lacking for giant otters, otter milk is known to be very high in fat (up to 65%) and relatively high in protein (up to 30%) [Shaul, 1962]. The availability of milk formula in the interior of Guyana limited nutritional options for otter cubs and it was impossible to reproduce this ratio using the available supplies. In addition, even with the development of specialized veterinary milk replacers, such as Zoologic (30% protein, 55% fat), it was difficult to deliver the desired fat content. This product tends to be thick and lumpy at full strength, and had to be diluted. In addition, it seems to be less palatable (based upon recent additional experience with two orphaned otters at Karanambu in 2004) than human milk replacer. Regardless of the milk formula, young giant otters should be introduced to fresh fish as soon as they express an interest, to ensure optimal nutrition and minimize the risks associated with bottle-feeding.

All new arrivals learned their new routines quickly, adapting to specific defecating sites in a few days. Most of the giant otters bonded to D. McTurk within 3 days. Over time, it was evident that larger pools were required. In addition, the opportunity to properly introduce new arrivals to otters already on site was advantageous.

The giant otter pens constructed in 1999 provided several benefits. Although the giant otters were farther away from the main house, they were able to swim freely in their pools. The metal mesh howdy panel between adjacent pens also allowed gradual introductions. Young otters were often found taking a daytime nap on either side of the mesh, fur to fur, in the shadows of the draped towels. Otter introductions took place at mealtimes, when each otter was hand fed their share of fish. Resident otters would investigate the new cubs, provoking demonstrations of submission. When these interactions became too rough, staff separated the otters. Eventually, the otters refused to be separated and were then housed together.

Introducing the youngest cubs to the river was a gradual process, as many were fearful of the deep water. Initially, the cubs were led or carried down to the river; most were at least 12–16 weeks for their first visit. This process was continued for

weeks to months until they adapted to this routine on their own. All young giant otters were resistant, even fearful, of entering the river on their first occasion, some more so than others. If there was an older and more experienced otter present, the young ones would follow them and the process went more quickly. When the otters finally submerged, they learned to swim and dive quickly. Of interest, all of the otters exhibited a similar behavior once they learned to swim in the river: they would dive under water and ingest mud and plant material from the river bottom. This behavior has also been observed in the wild [Duplaix, 1980].

Teaching young otters, particularly if they were solitary, to fish on their own in the river was also a challenge. For example, the very first orphaned giant otter cub showed no interest in live fish even after it learned to eat fish pieces. A number of strategies were used, including putting small live fish in small ponds excavated in sand banks. The next stage was to release freshly caught fish in the river (live fish were not fed in the otter pens to keep the pools clean), and encourage the otter to go and find them. Subsequently, most of the orphaned otters were fed this way once they began to swim in the river regularly, and most learned to catch wild fish quickly.

Four cubs died early on in the hand-rearing process as a result of injuries or illness; one of these presumably died of aspiration pneumonia. Aside from these cases, relatively few health problems occurred in the giant otters reared at Karanambu. Antibiotic therapy (orally in fish) was used effectively for minor and major injuries. Injured rehabilitated giant otters often returned to the Karanambu landing to rest and feed. These return visits allowed close examination of wounds and lacerations, and treatment if needed.

Anesthesia has been rarely reported in giant otters and is challenging given the size of this species and general tendency for anesthetized otters to show respiratory depression [Spelman, 1999]. Published reports include ketamine alone (10 mg/kg) or ketamine (10 mg/kg) and xylazine (1–2 mg/kg), without yohimbine [Marsicano et al., 1986; Colares and Best, 1991]. Based upon limited experience by the authors with giant otters at Karanambu and at the Georgetown Zoo, Guyana, the following protocol was developed: xylazine (2–3 mg/kg) given intramuscularly as a sedative first, followed 10–20 min later by ketamine (2–3 mg/g), and subsequently reversed with yohimbine (0.125 mg/kg). An alternative was ketamine (5 mg/kg) mixed with medetomidine (0.050 mg/kg), followed by atipamezole (0.25 mg/kg) for reversal. Neither xylazine nor medetomidine should be used at these dosages without the reversal agent on hand. Ketamine (10 mg/kg) combined with midazolam (0.25 mg/kg) was ineffective in two trials.

Regular deworming for internal parasites was initiated in 1999 as a result of increased contact between domestic dogs, starting with the resident juvenile male giant otter (that was never rehabilitated), and two new cubs being hand-reared. Parasite screening in both otters and dogs showed a mixture of similar cestodes and nematodes. As a result, routine anthelmintic therapy was given to Karanambu ranch domestic dogs and the giant otters. This program was continued in subsequent years: cubs being hand-reared were regularly dewormed to limit potential ill effects of increase parasite loads while at the ranch.

Also in 1999, vaccination of ranch dogs for canine distemper was initiated to protect against a potential outbreak that could endanger otter cubs. Only the newly available recombinant canary pox vaccine from Merial was used for this purpose; the number of vaccinated ranch dogs varied from one to six (1999–2003). This

vaccination program followed a serosurvey of Karanambu ranch dogs that showed many dogs with non-protective titers to distemper (RA Weiss, personal communication).

Domestic animal diseases such as canine distemper and parvovirus have been identified previously as potential disease risks for wild giant otters in Peru [Schenck et al., 1997]. The only otter vaccinated for canine distemper was the resident juvenile male giant otter that remained at Karanambu. Given that this otter showed no inclination to return to the river, it was considered to be at risk of contracting distemper in the case that the disease became active in the area. For giant otters returning to the river system, vaccination was not considered, given the absence of an active disease outbreak and the impracticality of booster vaccinations.

Among the 10 giant otters that were never rehabilitated, most were known killed either by people or other otters. Aggression by wild otters led to the death of five otters in three separate incidents. On one occasion, three young cubs were killed by wild otters in the river, each with a single crushing bite to the skull. One cub was killed immediately upon arrival by the non-rehabilitated male otter that had made Karanambu his territory. Inversely, this otter was killed by wild otters that had accepted two sub-adult otters into their group; the wild otter group turned on the 4-year-old and killed him as he started to range further, possibly looking for a mate of his own. This male presumably presented a threat to the wild adult male's group. These observations confirm that giant otters are capable of fatal aggression, similar to males of other large carnivores (e.g., lions). Although not observed at Karanambu, cannibalism has also been documented among wild otters in Brazil [Mourao and Carvalho, 2001].

People killed three (and probably two others for a total of five) orphaned giant otters during the early stages of their rehabilitation. Two of these were otters that had developed a taste for poultry (both had received eggs in their milk formula); people who were attempting to prevent the otters from stealing their chickens killed them. A third otter, a sub-adult female, was killed after it seriously injured a young woman.

For the 18 giant otters that were eventually rehabilitated, the process was gradual. Most otters initially elected to remain at the river after a mid-day feeding rather than return to the house or pens. They would find an existing den or create their own natural den in the river banks nearby. Next, they would spend a night or more on the river, and then return for a feeding or a rest up at the ranch. At this stage, the giant otters were free to come and go, and were contained at the house or in the pens only if a conflict with rival wild otters was anticipated.

Eventually, the juvenile or sub-adult otters began to travel far from Karanambu, spending days to weeks away from the ranch feeding in the river or ponds. Often, otters first began to leave the landing and spend time on the river only after they encountered wild otters. Although these first interactions were not always positive, they also seemed key to a successful return to the river. Female orphans generally stayed at Karanambu longer than males, with one exception, and seemed to attract young males (transients) seeking a mate.

In general, single orphaned otters seemed to have a difficult time interacting with wild otters. Giant otters reared in groups of two or more and rehabilitated at Karanambu adapted more readily to life on the river. These young otters formed their own, non-breeding groups. This situation occurred with three different sets of

giant otters (different years) over the 18-year period. The 1999–2003 Karanambu group is the most recent example of successful integration of wild and rehabilitated giant otters. The movements and social dynamics of this group are currently under study [Duplaix, 2003]. Of interest, male and female giant otters reared together at Karanambu were never observed to form breeding pairs, although this remains a possibility. At least one adult rehabilitated female paired with a wild male and another rehabilitated female was observed lactating.

Mixed groups of rehabilitated and wild otters would often return to Karanambu, or to the boats moving through the area, looking for fish. In all cases, the rehabilitated otters, and often the wild otters, recognized the voice and calls of D. McTurk and swam to the boat or landing to be fed. Because of this, it was possible to record the movements and behavior of several different otter groups on the Rupununi River, and to gather detailed information about wild giant otters. For example, over 3 consecutive years, the otter group that adopted Karanambu as its territory had two litters. Rehabilitated otters that joined the group were observed actively participating in cub rearing (moving, feeding, guarding, grooming, playing), even though they were not related to the juvenile wild otters.

Studies of wild giant otters along the upper Rupununi River have expanded [Duplaix, 2003]. These include long-term observations of giant otter ecology, social and feeding behavior, scat sites and scat analysis, causes of cub mortality, interspecies aggression among family members as well as rival groups, and infectious disease susceptibility. Studies of giant otters and their interactions with people include preference for fish species and the pattern and frequency of encounters between otters and local villagers [Shackley, 1996, 1998].

CONCLUSION

The Karanambu giant otter rehabilitation program generated substantial information on hand-rearing of orphaned otters and returned 18 young otters to the wild on the Rupununi River. At least one rehabilitated female has reared a litter. At the same time, the program has served to increase conservation awareness among local, national and international visitors. Much remains to be learned about this species in Guyana. Field studies are underway to observe wild and rehabilitated giant otters in and around Karanambu. Efforts must also be expanded to engage the local Amerindian community in the protection of the giant otter in the Rupununi watershed region.

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