Recommendations for the rehabilitation and release of wild-born, captive-raised cheetahs: the importance of pre- and post-release management for optimising survival

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SUPPLEMENTARY TABLE 1 Prey and carnivore species composition of each release site.

Release Site	Prey Species Composition	Carnivore Species Composition
Greater Waterberg Landscape	duiker, *Cephalophus grimmia* eland, *Tragelaphus oryx* giraffe, *Giraffe camelopardalis* impala *Aepyceros melampus* kudu *Tragelaphus strepsiceros* oryx *Oryx gazella* ostrich *Struthio camelus*, red hartebeest *Alcelaphus buselapus* springbok *Antidorcas marsupialis* steenbok *Raphicerus campestris* warthog *Phacochoerus africanus* plains zebra *Hippotigris quagga*	brown hyaena *Parahyaena brunnea* caracal *Caracal caracal* cheetah *Acinonyx jubatus* black-backed jackal *Canis mesomelas* leopard *Panthera pardus*
Erindi Private Game Reserve	duiker, *Cephalophus grimmia* eland, *Tragelaphus oryx* giraffe, *Giraffe camelopardalis* impala *Aepyceros melampus* kudu *Tragelaphus strepsiceros* oryx *Oryx gazella* ostrich *Struthio camelus* red hartebeest *Alcelaphus buselapus* springbok *Antidorcas marsupialis* steenbok *Raphicerus campestris* waterbuck *Kobus ellipsiprymnus* blue wildebeest *Connochaetes taurinus* black wildebeest *Connochaetes gnou* warthog *Phacochoerus africanus* plains zebra *Hippotigris quagga*	African wild dog *Lycaon pictus* brown hyaena *Parahyaena brunnea* caracal *Caracal caracal* cheetah *Acinonyx jubatus* black-backed jackal *Canis mesomelas* leopard *Panthera pardus* lion *Panthera leo* spotted hyaena *Crocuta crocuta*
NamibRand Nature Reserve	kudu *Tragelaphus strepsiceros* oryx *Oryx gazella* ostrich *Struthio camelus* springbok *Antidorcas marsupialis* steenbok *Raphicerus campestris* plains zebra *Hippotigris quagga*	brown hyaena *Parahyaena brunnea* caracal *Caracal caracal* black-backed jackal *Canis mesomelas* leopard *Panthera pardus* spotted hyaena *Crocuta crocuta*

SUPPLEMENTARY MATERIAL 1 General details on the husbandry procedure for animals in captivity undergoing rehabilitation for release purposes.

All release candidates were housed in enclosures at CCF's headquarters (-20.484172, 17.031612) built to Namibia's Ministry of Environment, Forestry and Tourism's (MEFT) regulation outlined in section 84(g) of the Nature Conservation Ordinance, 1975 (Ordinance No. 4 of 1975). Enclosures used for release candidates were located in an off exhibit rehabilitation facility and provided at least 1ha per individual. Release candidates only had exposure to human activity during daily husbandry routines (feeding, health check, management training, etc.).

All cheetahs were fed ~2 kg donkey/horse or wild game meat on the bone with added mineral supplements (™Predator Powder), once a day six times per week, with one fast day per week (Supplementary Table 2). All release candidates were in good physical and mental condition as they were exercised daily by chasing the feeding vehicle down the length of the enclosure.

SUPPLEMENTARY TABLE 2 Feeding schedule for captive cheetah undergoing rehabilitation, from the time of their arrival to the beginning of release preparations

Period	Day of Week	Feed	Exercise
Arrival to 1.5years	Day 1-6	500g-1,500g meat on the bone (horse/donkey/game) with ™Predator Powder (7g per kg meat)	Full lap chasing feeding vehicle around rehabilitation enclosure
	Day 7	Fasting	No exercise
1.5years to release prep	Day 1-6	1000g-2000g meat on the bone (horse/donkey/game) with ™Predator Powder (7g per kg meat)	Full lap chasing feeding vehicle around rehabilitation enclosure
	Day 7	Fasting	No exercise

SUPPLEMENTARY MATERIAL 2 Details on husbandry and collaring procedures for preparing candidates for release.

Feeding

One month prior to release, the feeding protocol of release candidates was adjusted to mimic a natural feeding regime. Cheetahs were fed intact carcasses of potential prey (oryx, kudu, warthog, eland, etc.) every few days depending upon the group size and the size of the carcass fed. Carcass feedings were done with two objectives: 1) to ensure release candidates were capable of 'opening' intact carcasses (i.e. tearing through the skin of the carcass to access meat), and 2) to start preparing their systems to handle larger quantities of food at less frequent intervals as is experienced in the wild. Carcass feeding frequency was adjusted as necessary to maintain the 'Ideal' body condition score established by Sengenberger et al. (2018) in their 'EAZA Best Practice Guidelines Cheetah (*Acinonyx jubatus*)'. During this period, cheetahs were still exercised daily if possible. If cheetahs were soft-released, this feeding regime was maintained throughout their soft-release holding period.

Pre-release Health Check and Collaring

In compliance with Namibian regulations, a full health examination under anaesthesia was conducted by a registered veterinarian on all candidates prior to release to ensure optimum condition and health. The health checks included routine blood-work and standard tests for Feline Immune Deficiency Virus (FIV), Feline Leukemia (FELV), and Feline Infectious Peritonitis (FIP) (IDEXX Laboratories, R.S.A.) (Marker et al., 2003, 2018).

During the health examination, the cheetahs were fitted with either VHF or GPS/satellite collars under permission from the Namibian Ministry of Environment, Forestry and Tourism (Marker et al., 2008, 2018). We used Advanced Telemetry Systems (ATS) (Minnesota, United States of America) VHF (very high frequency) radio-collars, Sirtrack (Havelock North, New Zealand) ARGOS collars, and Sirtrack Pinnacle Lite Iridium collars that all weighed below the 3% body mass recommendations by Kenward (2001). The Pinnacle Lite collars were all fitted with a Lotek (Newmarket, Ontario, Canada) timed-release dropoff (TRD).

GPS collars were set to record one fix per hour for the first month of release. Following the first month, we decreased the sampling frequency to record a point every three, four, or six hours depending on the conditions of the release. Data transmissions occurred once daily usually between 0600h-0800h local time to aid the post-release monitoring team in finding the animal at first light each day. Time and success of data uploads sometimes varied depending upon weather, topography, and solar flare activity. For a given collar, the life expectancy of the battery varied with its sampling protocol, but the batteries lasted on average two years. GPS collars were used in this study only from 2008 onwards. Released cheetahs were ground tracked with the VHF functionality of their collars using the R-1000 Telemetry receiver (Advanced Telemetry Systems, Minnesota, United States of America) and a three-element folding Yagi antenna.

SUPPLEMENTARY MATERIAL 3 Details on the post-release monitoring protocol, including monitoring schedule, supplemental feeding, and emergency situations

Monitoring Routine/Schedule

The monitoring schedule for a given day was dependent on the cheetahs' status in their post-release monitoring period in regard to behaviour, condition, activity, and location. The monitoring team attempted to locate each individual or group at least once in the morning and once in the afternoon, daily, during the monitoring period. The monitoring team used collar GPS data each morning to find the cheetahs or began tracking from the animal's last known location if it only had a VHF collar. This information informed the day's monitoring schedule as the team would determine and prioritise monitoring activity based upon the overnight developments captured by the GPS data or on the events of the previous day. For example, if a particular group needed to be fed or given water (decision based on observation during previous day) they would be prioritised and checked on first for the day. Or, if the collar data showed abnormal or concerning behaviour for a specific individual, that individual would be prioritised for the morning monitoring session.

Supplemental Feeding/Water

Released cheetahs were closely monitored following their release until they achieved independence or were deemed unsuccessful. The objective of supplemental feeding for the

first two weeks post-release is to allow the individual to focus on exploration of and adjustment to their new environment. During this period, individuals were fed along the same guidelines as the carcass feeding for release prep (see Supplementary Table 2) and the post-release monitoring team made feeding decisions to maintain the 'Ideal' body condition of Sengenberger et al. (2018). In addition, during this period water was offered to released cheetahs every other day if possible until there was evidence showing that the cheetahs had identified and visited available water points within the release site. This could be confirmed either by direct observation or by GPS collar data indicating that the cheetahs had visited a water point. Following the first two weeks, the post-release monitoring team began to reduce feeding frequency to prompt the released individual or group to hunt for themselves if they had not already begun to make successful kills. Feeding frequency never decreased to the point where an individual or group was at risk of starvation. The post-release monitoring team used the 'abdominal tuck' score of Sengenberger et al. (2018) guidelines to inform feeding frequency during this period of reduced supplemental feeding. The post-release monitoring team would only feed released cheetahs during this period once its 'abdominal tuck' score reached the 'prominent' rating, usually 5-7 days following a full meal. A planned supplemental feeding was cancelled if the monitoring team found that a released individual or group had made a successful kill on the day of a scheduled feeding.

Emergency Situations

During the post-release monitoring period a registered veterinarian was on standby at all times for any emergency situations. These could include significant injuries that require veterinary care or an escape from the designated release site. Our response varied depending on the emergency situation. For example, if a cheetah was severely injured, we brought that individual back into temporary captivity for recovery before being re-released. However, if the injury was only mild, we could treat the wound and release the cheetah immediately. If there was a situation in which a released cheetah was in danger from other animals, prey and predator alike, or from some other threat, we made the decision to always interfere with the situation wherever possible to ensure the safety of the released cheetahs, up until the released cheetah had acquired sufficient skills for survival.

References

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