NATIONAL STUDBOOK

Himalayan Serow *(Capricornis thar)*

Published as a part of the Central Zoo Authority sponsored project titled "Development and Maintenance of Studbooks for Selected Endangered Species in Indian Zoos" awarded to the Wildlife Institute of India vide sanction order: Central Zoo Authority letter no. 9-2/2012-CZA(NA)/418 dated 7th March 2012]

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Central Zoo Authority

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Foreword

Habitat loss, fragmentation and degradation coupled with poaching are limiting the sustained survival of wild populations of several species; increasingly rendering them vulnerable to extinction. For species threatened with extinction in their natural habitats *ex-situ* conservation offers an opportunity for ensuring their long-term survival. This can be ensured by scientific management to ensure their long term genetic viability and demographic stability. Pedigree information contained in studbooks forms the basis for this management.

The Central Zoo Authority (CZA) in collaboration with zoos in India has initiated a conservation breeding program for threatened species in Indian zoos. As a part of this endeavour a Memorandum of Understanding has been signed with the Wildlife Institute of India for compilation and update of studbooks of identified species in Indian zoos.

As part of the project outcomes the WII has compiled the II edition of the National Studbook of Himalayan Serow (*Capricornis thar*) in Indian zoos. The recommendations contained in the studbook will form the basis for the long term management of the species in captivity. It is hoped that the holding institutions will adopt the recommendations and keep the WII informed of changes in their populations on a regular basis to enable the timely update of the studbook.

(Dr. D.N. Singh, I.F.S.)
Member Secretary
Central Zoo Authority

Acknowledgement

The National Studbook of Himalayan Serow (*Capricornis thar*) is a part of the assignment to the Wildlife Institute of India, Dehradun by the Central Zoo Authority, New Delhi on the development and maintenance of studbooks of selected endangered species in Indian zoos.

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The team sincerely acknowledges the support and help extended by holding zoos listed below towards facilitating the successful development of the studbook.

1. Aizawl Zoo, Aizawl
2. Assam State Zoo cum Botanical Garden, Guwahati
3. Lady Hydari Park Animal Land, Shillong
4. Nagaland Zoological Park, Dimapur

We also thank Mr. Mukesh Arora for layout and design of this document.

Project team

CONTENTS

Species Biology

The Himalayan serow (*Capricornis thar*) is a medium-sized goat like antelope, native to the montane forests of the Himalayas. It is considered a flagship species due to its specialized habitat requirements of dense and undisturbed forests. Decline in overall population has been attributed to poaching and habitat loss in recent times.

Taxonomy

Phylum- Chordata
Subphylum- Vertebrata
Class- Mammalia
Order- Artiodactyla
Family- Bovidae
Subfamily- Caprinae
Genus- *Capricornis* (Ogilby, 1837)
Species- *Capricornis thar* (Hodgson, 1831)

Based on its geographical distribution and limited morphological evidence, the Himalayan serow was originally treated as a subspecies of *Capricornis sumatraensis*. The taxonomic level and phylogenetic position of the Himalayan serow remained unclear for a long time (Shackleton, 1997; Wilson and Reeder, 2005). Later, increased morphological data led to a review of the genus *Capricornis*, and the elevation of Himalayan Serow to a full species status with delineation of the monotypic genera into six species (Wilson and Reeder, 2005) listed below:

- *Capricornis crispus* (Japanese Serow, restricted to Japan)
- *Capricornis milneedwardsii* (Chinese Serow, but also occurring in southeast Asian countries)
- *Capricornis rubidus* (Red Serow, restricted to Myanmar)
- *Capricornis sumatraensis* (Sumatran Serow, in Indonesia, Malaysia and southern Thailand)
- *Capricornis swinhoei* (Formosan Serow, restricted to Taiwan, Province of China)
- *Capricornis thar* (Himalayan Serow, along the Himalayan range)

The same was further validated by the work of and Groves and Grubb, (2011). The molecular phylogenetic position of the species was resolved with analysis using mitochondrial Cytb and D loop sequences by Liu *et al*., (2013) who suggested its closest affinity to *Capricornis milneedwardsii.* Work by Dou *et al*. (2016) revealed *C. Crispus* to be the basal species and *C. thar* clustered in the clade of *C. milneedwardsii*, a sister clade to *C. crispus*. They; however, cautioned on using the outcomes of their study due to limitations in sample size and recommended using a larger number of samples and markers for confirming the phylogenetic relationships.

Morphology

Table 1: Morphometrics of Serow (Prater 1993)

Body weight	90 kg
Shoulder height	100-110 cm
Body length	140-180 cm
Horns	**Length: 23-25 cm** **Girth: 13-15 cm**

The species is characterised by its large head, long mule-like ears, thick neck and short limbs. They have a coarse coat which varies in colour from grizzled black, blackish grey-roan to red. The limbs of the Himalayan serow are reddish-brown above the knee and dirty white beneath. They show limited sexual dimorphism. The pre-orbital glands are enlarged and used for scent marking and indicating the estrus status of females (Jass and Mead 2004).

Limited information on the species exists in literature, the information from a closely related species, Japanese Serow (*Capricornis crispus*) has been used as a surrogate. Characters of the horns, including size, curvature, thickness of transverse horn rings, and number of transverse rings are indicative of age. Horns begin to develop at approximately 4 months of age in both males and females (Miura 1985). The horn sheath of yearlings contain 1–3 thick, transverse rings and retain a visible swelling in the distal part of the sheath (Kishimoto 1988). Subadults (2 years old) have more thickened transverse rings that are longer (Kishimoto 1988). As adulthood is reached, the distal swelling is lost and the thicker transverse rings are displaced upward by development of thinner horn rings at the base (Kishimoto 1988).

Distribution

The species is oriental in origin (Schaller 1977) and is known to occur in east and southeast Bangladesh, Himalayas (Bhutan, northern India including Sikkim and Nepal), China (Tibet only), northeast India (provinces east of Bangladesh), and have uncertain presence in Myanmar (Grubb 2005).

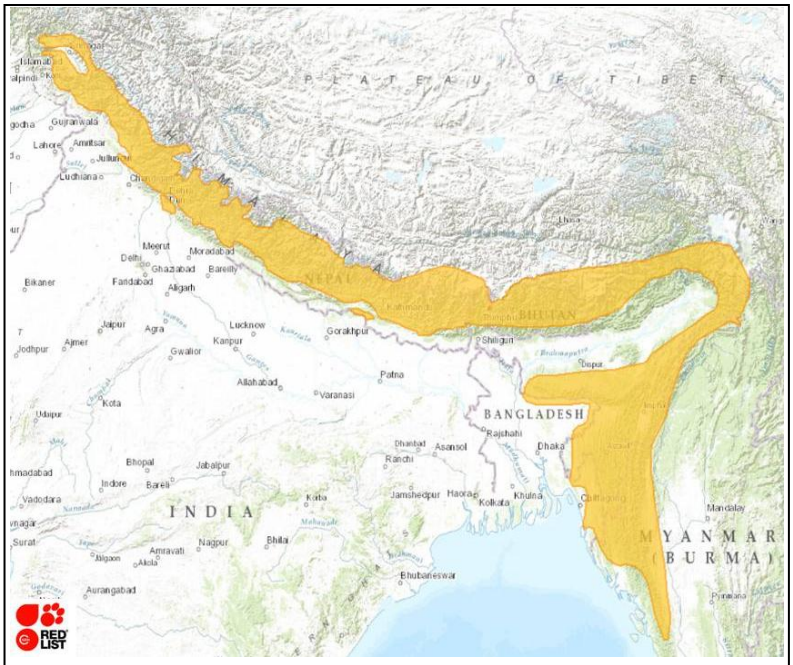


Figure 1: Distribution of Himalayan Serow (Duckworth, and MacKinnon 2008)

Habitat

They inhabit steep hills with rocky slopes, especially limestone regions up to 3,000 m above sea level, and also in hill and mountain forest areas with gentler terrain. Serows prefer damp and thickly wooded gorges and typically occur at altitudes between 1,500-4,000 m (Prater 1993; Schaller 1977). Aryal (2008) showed that serow preferred 2,500–3,500 m altitude range in central Himalaya of Nepal, while in Sikkim, India, Himalayan serow were most frequently detected in the subalpine habitats and temperate habitats within the low and mid-elevation range of 1,200–3,700 m with a preference for higher elevation > 2100 m (Bhattacharya *et al.* 2012). In Nepal, altitudes of 2500 to 4000 m were mostly

used for feeding and shelters; while higher altitudes were used to escape from predators. Habitats above 4000 m altitude, were totally avoided (Aryal 2008).

They generally prefer areas with gentle to steep slopes while plains are generally avoided (Aryal 2008). Steeper areas are used as resting places, while gentler sloped areas are used for grazing. They make use of the different cover (both vegetation and rocks) in their habitat to shelter from inclement weather, predation, and human hunting (Aryal 2008).

Food and Feeding Ecology

Microhistological fecal analyses has established that the Himalayan serow is a generalist herbivore (Giri *et al*. 2011). It feeds on a variety of food items, including oak leaves, shrubs, grasses, shoots, montane bamboo, ferns, moss and lichen (Nowak and Paradiso 1983, Sathyakumar 1997). A total of thirty four plant species have been identified to be consumed by them, with *Arundinaria spp* being the principal component *(*9.4%) followed by *Urtica spp* (7.4%), *Strobilanthes spp* (7.1%), *Oplismlaus composites* (6.1%), *Leontopodium jacotianum* (6.1%), *Rhododendron spp* (6.1%), *Eqmesetum debile* (4.0%), *Reinwardtia indica* (4.0%), *Rubus spp* (3.0%) and *Themada triandra* (2.0%) (Giri *et al*. 2011). They show a preference for nutrient rich palatable plants (Aryal 2009).

Behaviour and Social Organization

They are solitary, shy and nocturnal animals and poorly studied. Their elusive nature, preference for rugged terrain, occurrence in low densities has contributed to the lack of information on them (Schaller 1977; Green 1985). They are crepuscular with activity peaks during mornings (0600 – 0800 h), and evenings (1600 – 2200 h) (Sathyakumar 1997; Bhattacharya *et al.* 2012). On being disturbed, they flee away with a hissing snort; their call is a whistling scream (Prater 1993).

They are usually solitary; however, occasionally male-female pair units or family groups of up to three to four individuals are seen together (Sathyakumar 1997, Kishimoto 1987). Adult serows of both sexes exhibit strict intrasexual territoriality in which males and females defend separate territories against same-sex rivals (Kishimoto 1987, Ochiai and Susaki 2002). Adult serows also show a high degree of site fidelity (Ochiai and Susaki 2002). Despite solitary ranging; an adult male range may almost completely overlap with an adult female range; or the range of an adult polygynous male may overlap two adult female ranges (Kishimoto 1987, Ochiai and Susaki 2002).

Reproduction

Females are sexually mature by 2.5 years while males mature at 3 years. The breeding season is between October-November and the young are born in May-June (Sathyakumar 1997, Prater 1993). The litter size is 1 with rare twinnings (Prater 1993). Further details on the mating system and reproduction of the species are yet to be described. Details of a closely related species *C. crispus* are presented here.

Young usually follow mothers. Yearlings begin to become independent, but they still remain within the mothers' territories. When they reach 2–4 years old, both sexes leave the natal area to establish their own territories elsewhere (Kishimoto 1987; Ochiai 1983). In the process of territory establishment of offspring, female offspring tend to remain within their mothers' ranges. This is attributable to the different interactions of the adult pair towards the offspring (above 1 year); the adult male is usually aggressive and chases out male offspring but is tolerant towards female offspring. The mother is usually tolerant to offspring of both sexes, and the tight mother-young bond continues until next kids are born (Kishimoto 1987).

Table 2: Life-history traits of the Serow

Age at sexual maturity	2-3 years (Sathyakumar 1997)
Breeding season	October-November (Prater 1993)
Gestation period (*C. crispus*)	215 days (Kita *et al.* 1987, Sugimura *et al.* 1981); 210–220 (captive populations) (Ito 1971).
Birth season	May-June (Prater 1993)
No. of off spring	Single offspring is most common; twins are rare (Prater 1993)
Sex ratio at birth (*C. crispus*)	1.03:1.00 (Kita et al. 1987)
Weaning age	6 months (Sathyakumar 1997)
Reproductive tenure (*C. crispus*)	2.5 to 19.5 years (Kita *et al.* 1987)
Maximum longevity (*C. crispus*)	21–22 years (females); 20–21 years (males) (Tokida and Miura 1988)

Threats and Conservation Status

The major threats to the species include habitat fragmentation, land use changes, conflicts predators and villagers, livestock grazing in serow habitat, and poaching (Aryal, 2009; Giri *et al.*, 2011). Himalayan serow based on the threats it faces is categorised as Near Threatened in the IUCN Red List and listed in Appendix I of CITES and listed in Schedule I (revised March 1987) of the Wildlife Protection act (1972).

Status in Captivity

Available records indicate a total of 28 captive individuals housed in Indian zoos during 1979-2016, with a median of 3 individuals per year. The species has been identified as one of the endangered animal species taken up for the Conservation Breeding Program by the Central Zoo Authority, India. The Co-ordinating Zoo for the Conservation breeding of the species is Assam State Zoo cum Botanical Garden with Manipur Zoological Garden as the Participating institution. The total historical population housed in different Indian zoos is presented in Table 3.

Table 3: Status of Serow in Indian zoos

Location	Total no. of individuals (M.F.U)	Living Individuals (M.F.U)	Time span in captivity (years)	Births (M.F.U)	Deaths (M.F.U)
Aizawl	1.1.0	1.0.0	2006-2016 (11)	0.0.0	0.1.0
Assam	16.6.0	3.2.0	1979-2016 (38)	14.3.0	12.2.0
Dimapur	2.1.0	2.1.0	2013-2016 (4)	0.0.0	0.0.0
Shillong	1.0.0	1.0.0	2009-2016 (8)	0.0.0	0.0.0

Three individuals were lost to follow up at Assam State Zoo cum Botanical Garden

Scope of the Studbook and Data Quality

The species has been referred by different species names by the holding institutions: Himalayan serow (Aizawl zoo), Sumatran serow (Assam and Shillong zoos) and Red serow (Nagaland zoo); however, a perusal of literature indicates the presence of Himalayan serow (*C. thar*) in India (Wilson and Reeder 2005). Accordingly all captive specimens in Indian institutions were treated as Himalayan serow.

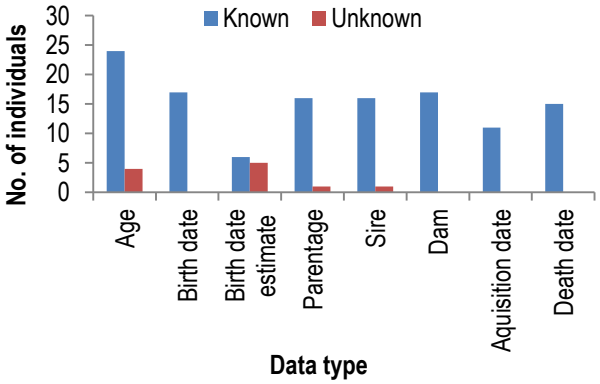


Figure 2: Data quality of captive population

The National Studbook includes pedigree records of all living and historic specimens, housed in Indian institutions. The availability of data with reference to the captive population in Indian zoos is summarized in Figure 2. Records of both parents were available for 16 out of the 17 births in captivity. For captive-births identification of dam was known for 17 individuals while sires were known for 16 individuals. Birth dates were available for all the captive-born individuals, while birth date estimates were known for 6 of the 11 wild-born individuals. Dates of acquisition were known for all the wild-born individuals and death dates were available for all the 15 mortalities recorded. In addition to these, 3 individuals have also been recorded to have escaped from captivity.

Methods

Data on individual history was collected by means of questionnaires, zoo visits and from the websites of CZA and ZIMS (Zoological Information Management System). Questionnaires were sent to the institutions housing Serow in India, requesting information for each captive specimen. Data was entered in the Single Population Analysis and Records Keeping System (SPARKS *v* 1.66) (ISIS, 2004) and subsequently exported to population management programme PMx *v* 1.2 (Ballou, *et al.,* 2011) for further analysis.

Analysis

Demographic Analysis

Historical population

Census trends

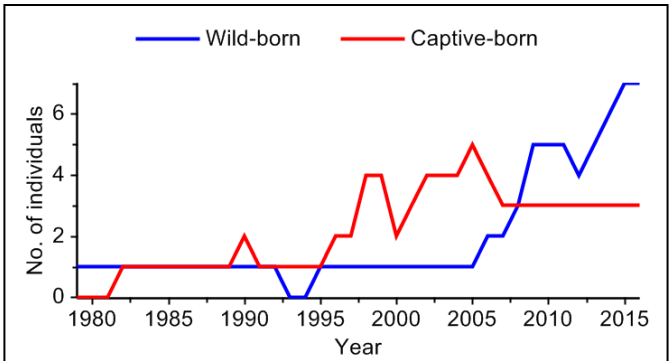


Figure 3: Origin-based census trends

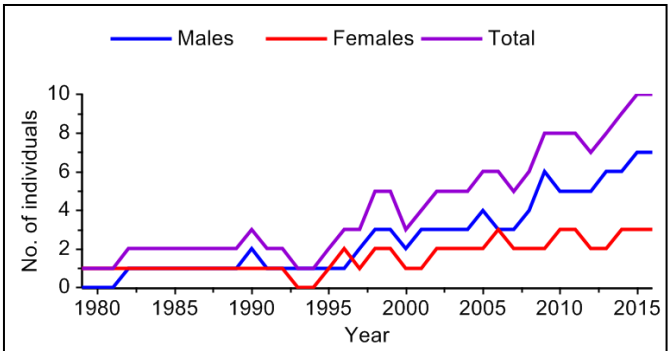


Figure 4: Sex-based census trends

The historical population includes 28 animals (20.8.0), of this 11 (6.5.0) were wild-born and 17 (14.3.0) were captive-born individuals. The census trends for the captive Indian population of Serow are represented in the figures 3 and 4. The details of the historical population is summarized in table 4 and information concerning events for each specimen is presented in Appendix I. The species was first housed in captivity in India in 1979 with one wild-born individual (0.1.0) housed at Assam State Zoo cum Botanical Garden. The first documented captive birth occurred in 1982; since then, the contribution of captive-births to the population has been very small (Figure 3). The population has remained consistently small with occasional incorporation from wild and sporadic births in captivity. The sex-based census trend (Figure 4) is suggestive of a male bias post 1998 due to the birth of more male kids (n=10) in comparison to females (n=2); leading to the present male-biased sex-ratio in the population (2.3:1).

Table 4: Summary of the historical population

	Males	Females	Unknown	Total
Total studbook size	20	8	0	28
Total number of acquisitions from wild	6	5	0	11
Total number of births	14	3	0	17
Total number of deaths	12	3	0	15
Total number of escaped individuals	1	2	0	3
Total number of breeding individuals	4	3	0	7
Wild-born that have bred	0	2	0	2
Captive-born that have bred	4	1	0	5

Living population

The living population consists of 10 (7.3.0) individuals held at four institutions, and includes 7 (4.3.0) wild-born and 3 (3.0.0) captive-born specimens. The sex ratio is strongly biased towards males, contrary

to that observed in the free ranging population. Coupled with the small population size of the population it acts as major limiting factor to the growth of the captive population. The living population is summarized in table 5 and details are presented in Appendix II.

Table 5: Summary of the living captive population

	Males	Females	Unknown	Total
Total no. of living individuals	7	3	0	10
Total number of wild-born individuals	4	3	0	7
Total number of captive-born individuals	3	0	0	3
Total number of breeding individuals	3	1	0	4
Wild-born that have bred	0	1	0	1
Captive-born that have bred	3	0	0	3

Age structure

The current age–sex structure (6 (4.2) known age individuals) of the population is represented by an irregular structure. The structure has large gaps between different age-classes and reflects the male-bias of the population (Figure 7). As shown in Figure 5, there are 2 (1.1) animals in the post reproductive age-class and 4 (3.1) animals in the breeding age class (3-15 years of age), of which 2 (2.0) are about to reach reproductive senescence. The absence of reproduction in the population is reflected by the absence of individuals in the lower age classes. The absence of reproductive activity in the population is also reflected by the predominance of wild origin specimens in the living population (Figure 3).

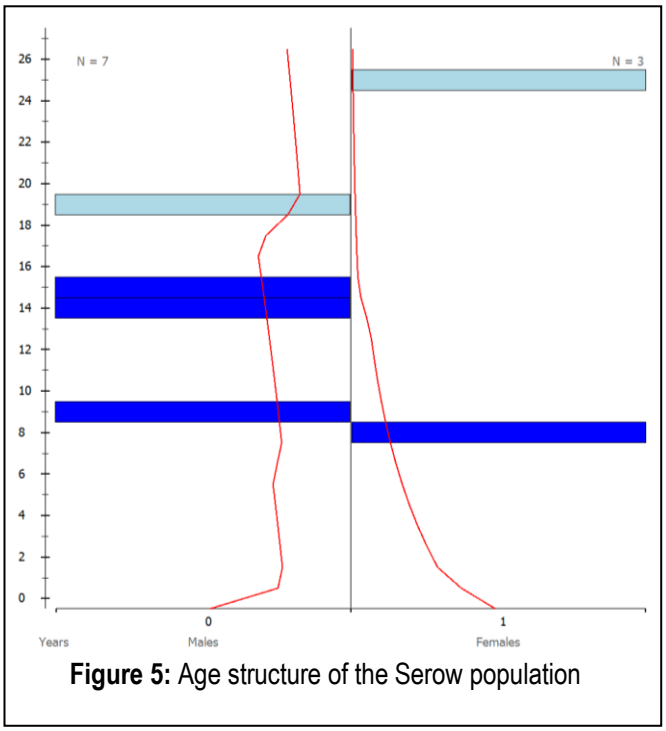


Figure 5: Age structure of the Serow population

Population growth rates

Table 6: Life-table summary

	Male	Female	Total
Population growth rate (λ)	0.968	1.140	1.051
Mean generation time (T)	10.8	6.9	8.9

The Serow data set contains small sample sizes for life-table analysis (total known age specimens 23), limiting the accuracy of results. The results of the analysis are only indicative in nature and do not represent the demographic characteristics of the species in captivity; and hence have been excluded from the Studbook. Table 6 summarizes the growth rates obtained from the life-table and indicate a long mean generation time of 8.9 years and the predicted number of 37 (25.12.0) individuals after 20 years.

Genetic Analysis

The Indian captive population of Serow received 11 wild-origin individuals of which only two (0.2) bred and have living descendants in the population. One of these founders is currently alive; however, it has reached reproductive senescence (25 years; housed at Assam). The population additionally includes 6 (4.2) potential founders of these the age of four (3.1) are unknown while the remaining two (1.1) are in reproductively active age-span though held separately at Assam and Nagaland.

Table 7: Genetic summary

	Current	Potential
Founders	2	6
Gene Diversity	0.5540	0.9323
% Known	94	
Founder Genome Equivalents	1.12	7.38
Population Mean Kinship	0.4460	
Mean Inbreeding	0.1228	

Table 7 summarizes the current genetic status of the population. It indicates that the population retains only 55.4% of the genetic diversity entering the captive population from the two founders that contributed to the captive population. The small population size of the captive population has resulted in reproduction between closely related individuals resulting in a mean inbreeding of 0.1228 and population mean kinship of 0.4460 (*i.e.* they are related at the level of full siblings). This has also resulted in the population retaining only 1.1.2 Founder Genome Equivalents. The various measures for assessing genetic diversity of the population indicate that the population has retained limited genetic diversity of the two contributing wild origin individuals. It also indicates that the population is likely to become extinct in captivity if measures to augment the genetic diversity of the population are not initiated urgently.

Breeding Recommendations

The selection of breeding pairs in a conservation breeding program is aimed at reducing the rate at which gene diversity is lost and inbreeding is accumulated within the population. Optimal breeding pairs should be selected based on their low mean kinship values relative to the population. Breeding recommendations based on the "Mate Suitability Index" (MSI) scores for each individual (details in Box 1.), are provided in Table 8.

Table 8: Pairing options for the captive Serow population

Dams	Possible Sire	MSI
00025	00022, 00024, 00026, 00028	1
00027	00022, 00024, 00026, 00028	1

Mate Suitability Index (MSI)

It is a numerical genetic assessment of a male-female pair that incorporates several variables into one ranking (MSI range is 1 to 7, with 1 being the most genetically beneficial).

The default value in the table is the *MSI* (Mate Suitability Index) value for each male –female pair. *MSI* is a composite score that integrates four genetic components into a single index:

Delta GD (dGD): Change in gene diversity (GD) of the population if one offspring is produced by the pair. Positive dGD increases the GD of the population, while negative dGD decreases GD.

Differences in MK values (MKDiff): Difference in the genetic value (mean kinship value) of the male and female. Breeding a pair with a large MKDiff is detrimental because it combines under-represented and over-represented genetic lines.

Inbreeding coefficient (F): Inbreeding coefficient of any offspring resulting from the pair (i.e., the kinship value for the pair). Inbreeding is considered to be detrimental to the fitness of the resulting offspring.

Unknown ancestry: The amount of unknown ancestry in the male and female. Incomplete pedigree information means that the genetic value and relatedness of a pair cannot be accurately calculated.

1 = very beneficial (genetically) to the population;
2 = moderately beneficial,
3 = slightly beneficial;
4 = slightly detrimental,
5 = detrimental, should only be used if demographically necessary
6 = very detrimental (should be considered only if demographic considerations override preservation of genetic diversity)
"-"= very highly detrimental (should not be paired, due to high level of kinship of pair)

Using Pairwise Info

The default table of *MSI* values for pairs can be used to quickly assess the relative genetic value of a pair, subset of pairs, potential mates for one individual, and many other valuable data when making breeding recommendations. This can be especially helpful to quickly explore options for pairing individuals at one facility that houses numerous individuals of each sex or to quickly identify an alternative suitable mate if a recommended breeding fails.

Source: Traylor-Holzer, K. (ed.). 2011.

Targets for Population Management

The long-term survival of the species is threatened by various anthropogenic factors that include habitat fragmentation and poaching across its distribution range. Maintenance of *ex-situ* insurance populations is therefore a viable option for ensuring its long-term persistence that entails ensuring demographic stability and genetic viability of the captive population. The same is dependent on arriving at an understanding of the number of specimens to be maintained in captivity and the periodicity and number of wild origin animals to be used for supplementation. PMx Software (Ballou et. al. 2011) provides a tool for establishing these targets.

Multiple simulations were run using the software; the first simulation was run based on the demographic and genetic status of the existing population and the results are presented as figure 6. It indicate that the population would continue to lose genetic diversity with each generation and at the end of 100 years would contain only 34.7% of the genetic diversity of the two effective founders.

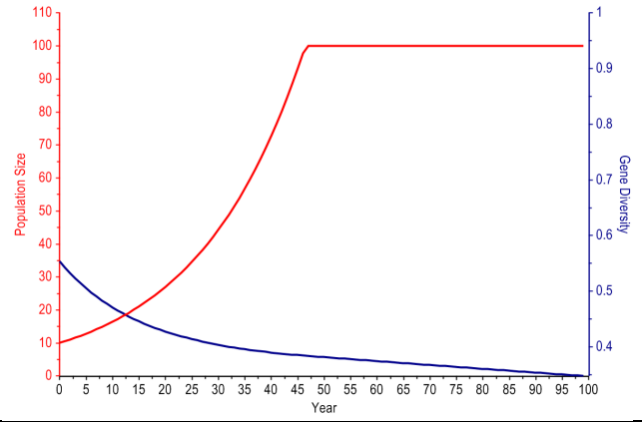
Simulation Output	Input variables
	**Population Variables:** Generation Length; 8.9 Maximum potential lambda; 1.0507 Current N; 10 Current Ne; 3.0 Ne/N; 0.30 Current Gene Diversity; 0.5540 Maximum N; 100 No founders added **Results:** Can maintain only 34.7% GD

Figure 6: Simulation outcomes without supplementation

The scenario that best supported the achievement of conservation goals for the species is presented in Figure 7. It suggests that supplementing the population with three effective wild origin founders every 10 years will ensure meeting the goals of establishing a captive population of the species.

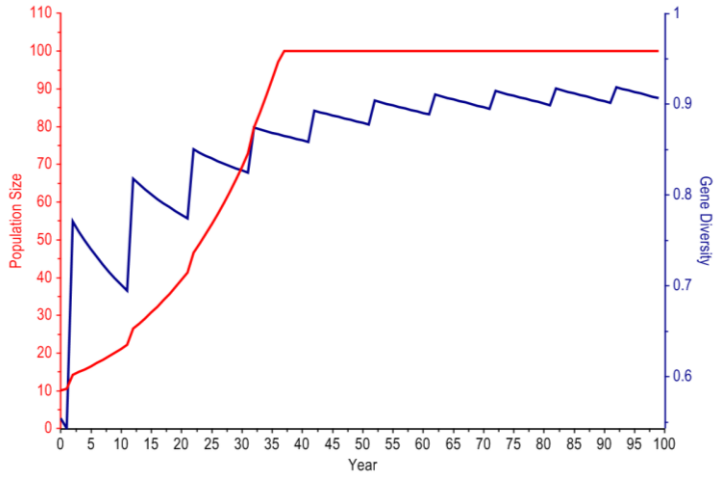
Simulation Output	Input variables
	**Population Variables:** Generation Length; 8.9 Maximum potential lambda; 1.0508 Current N; 10 Current Ne; 3.0 Ne/N; 0.30 Current Gene Diversity; 0.5540 Maximum N; 100 **Founder Related Variables** New founders per Addition event; 3 Year to start adding founders; 1 Years between events; 10 Year to stop adding founders; 100 FGE per Founder; 0.40 N per Founder; 1 **Results:** Can exceed goals and maintain 90.5% Can maintain over 90.0% for up to 102 years

Figure 7: Simulation outcomes without supplementation

Conclusions and Recommendations

Himalayan Serow is listed as a threatened species in the IUCN Redlist of threatened species due to increasing fragmentation and degradation of habitats and anthropogenic pressures. Maintenance of *ex-situ* population is an effective means for ensuring the long-term persistence of the species. The current population is characterized by:

The population of the species is small and Indian zoos currently house 10 (7.3.0) specimens maintained at four locations.

Based on the outcomes of the demographic analyses the population has a poor recruitment rate.

The population retains a limited amount of genetic diversity compared to the free ranging population. It retains only 55.4% of the genetic diversity introduced into the population by two effective founders.

Specimens in the population are closely related to each other as is indicated by the levels of inbreeding (0.1228) and population mean kinship (0.4460).

Appropriate actions aimed at maintaining self-sustaining captive population of the species include:

The paring of compatible animals should be carried out to ensure optimal reproductive performance and acquisition of additional wild origin specimens for improving the reproductive output of the population.

The housing and husbandry practices for the species need to be revised based on the natural history traits of the species.

The inclusion and appropriate pairing choices for wild origin specimens can ensure the maintenance of genetic viability.

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Appendix I

Historical Population of Himalayan Serow *(Capricornis thar)*

Sl. No.	National Studbook No.	House name/ Local ID/ Transponder No.	Sex	Birth Date	Sire	Dam	Location	Date	Event
1.	00001	Unnamed 400001	F	~ Mar 1979	Wild	Wild	India Assam	23-May-79 23-May-79 27-Dec-93	Capture Transfer Death
2.	00002	Chaimon 400002	M	31-Aug-82	Unk	00001	Assam	31-Aug-82 26-Jul-01	Birth Death
3.	00003	Unnamed 400003	M	20-Oct-90	00002	00001	Assam	20-Oct-90 10-Jun-91	Birth Death
4.	00004	Unnamed 400004	M	28-Jun-91	00002	00001	Assam	28-Jun-91 19-Aug-91	Birth Death
5.	00005	Chaimona 400005 CB/07CZAINDIA094	F	~ 1991	Wild	Wild	India Assam	28-Feb-95 28-Feb-95	Capture Transfer
6.	00006	Unnamed 400006	F	12-Sep-96	00002	00005	Assam	12-Sep-96 06-Jul-97	Birth Death
7.	00007	Champak 400007	M	21-May-97	00002	00005	Assam	21-May-97	Birth
8.	00008	Unnamed 400008	M	01-Feb-98	00002	00005	Assam India	01-Feb-98 12-Aug-00	Birth Release
9.	00009	Unnamed 400009	F	18-Oct-98	00002	00005	Assam India	18-Oct-98 12-Aug-00	Birth Release
10.	00010	Unnamed 400010	M	11-Jul-99	00002	00005	Assam	11-Jul-99 03-Oct-99	Birth Death
11.	00011	Unnamed 400011	M	~ May 1999	Wild	Wild	India Assam	26-Nov-99 26-Nov-99 01-Dec-99	Capture Transfer Death
12.	00012	Unnamed 400012	M	22-May-00	00007	00005	Assam	22-May-00 05-Aug-00	Birth Death
13.	00013	Unnamed 400013	M	26-Mar-01	00002	00005	Assam	26-Mar-01	Birth
14.	00014	Mantu 400014	M	11-Dec-01	00007	00005	Assam	11-Dec-01	Birth
15.	00015	Unnamed 400015	F	22-Aug-02	00007	00005	Assam India	22-Aug-02 12-Oct-07	Birth Release
16.	00016	Unnamed 400016	M	13-May-03	00014	00005	Assam	13-May-03 02-Jul-03	Birth Death
17.	00017	Unnamed 400017	M	08-Oct-04	00013	00005	Assam	08-Oct-04 14-Oct-04	Birth Death

Sl. No.	National Studbook No.	House name/ Local ID/ Transponder No.	Sex	Birth Date	Sire	Dam	Location	Date	Event
18.	00018	Unnamed 400018	M	17-Oct-04	00013	00015	Assam	17-Oct-04 05-Dec-04	Birth Death
19.	00019	Unnamed 400019	M	26-Jun-05	00013	00005	Assam	26-Jun-05 28-Nov-06	Birth Death
20.	00020	Zatei Cb022	F	????	Wild	Wild	India Aizawl	10-Feb-06 13-Feb-06 14-Jun-12	Capture Transfer Death
21.	00021	Unnamed Cb-432 400020	M	26-Mar-06	00014	00015	Assam	26-Mar-06 05-May-06	Birth Death
22.	00022	Tea Cb0221	M	????	Wild	Wild	India Aizawl	12-Mar-08 15-Mar-08	Capture Transfer
23.	00023	Thoi Cb-432 400021	M	~ 2003	Wild	Wild	India Assam	06-Mar-09 06-Mar-09 29-Apr-10	Capture Transfer Death
24.	00024	Unnamed 146	M	????	Wild	Wild	India Shillong	10-Sep-09 10-Sep-09	Capture Transfer
25.	00025	Gita 400022	F	~ 2008	Wild	Wild	India Assam	23-Dec-10 23-Dec-10	Capture Transfer
26.	00026	Ram	M	~ 2007	Wild	Wild	India Dimapur	24-Aug-13 24-Aug-13	Capture Transfer
27.	00027	Unnamed	F	????	Wild	Wild	India Dimapur	31-Jan-14 31-Jan-14	Capture Transfer
28.	00028	Lali RS03	M	????	Wild	Wild	India Dimapur	02-Jan-15 02-Jan-15	Capture Transfer
TOTALS: 20.8. 0 (28)									

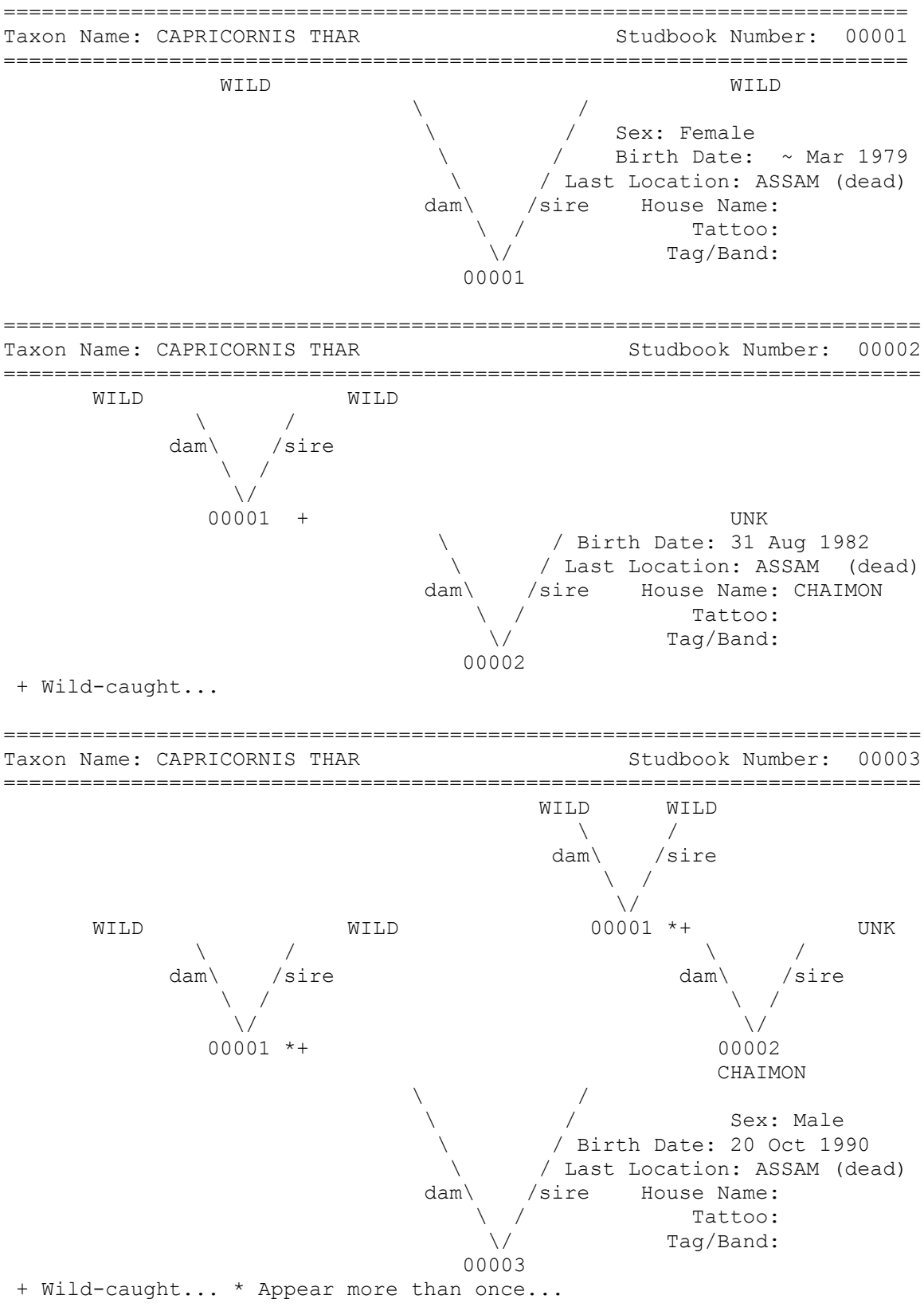
Appendix II

Living population of Himalayan Serow *(Capricornis thar)*

Sl. No.	National Studbook	House name/ Local ID/ Transponder No.	Sex	Birth Date	Sire	Dam	Location	Date	Event
Aizawl Zoo, Aizawl									
1.	00022	Tea CB0221	M	????	Wild	Wild	India Aizawl	12-Mar-08 15-Mar-08	Capture Transfer
Totals: 1.0.0 -1									
Assam State Zoo Cum Botanical Garden, Guwahati									
2.	00005	Chaimona 400005 CB/07CZAIN DIA094	F	~ 1991	Wild	Wild	India Assam	28-Feb-95 28-Feb-95	Capture Transfer
3.	00007	Champak 400007	M	21-May-97	00002	00005	Assam	21-May-97	Birth
4.	00013	Unnamed 400013	M	26-Mar-01	00002	00005	Assam	26-Mar-01	Birth
5.	00014	Mantu 400014	M	11-Dec-01	00007	00005	Assam	11-Dec-01	Birth
6.	00025	Gita 400022	F	~ 2008	Wild	Wild	India Assam	23-Dec-10 23-Dec-10	Capture Transfer
Totals: 3.2.0 -5									
Nagaland Zoological Park, Dimapur									
7.	00026	Ram	M	~ 2007	Wild	Wild	India Dimapur	24-Aug-13 24-Aug-13	Capture Transfer
8.	00027	Sita	F	????	Wild	Wild	India Dimapur	31-Jan-14 31-Jan-14	Capture Transfer
9.	00028	Lali RS03	M	02-Jan-15	Wild	Wild	India Dimapur	02-Jan-15 02-Jan-15	Capture Transfer
Totals: 2.1.0-3									
Lady Hydari Park Animal Land, Shillong									
10.	00024	Unnamed 146	M	????	Wild	Wild	India Shillong	10-Sep-09 10-Sep-09	Capture Transfer
Totals: 1.0.0 -1									
Totals: 7.3.0 -10									
4 Institutions									

Appendix III

Pedigree Chart Report of Himalayan Serow



```
==========================================================================
Taxon Name: CAPRICORNIS THAR                      Studbook Number:  00004
==========================================================================
                                          WILD      WILD
                                            \      /
                                             dam\    /sire
                                                \/
       WILD                WILD                 00001 *+             UNK
              \      /                                  \      /
             dam\    /sire                              dam\    /sire
                 \/                                        \/
              00001 *+                                   00002
                                                         CHAIMON
                                  \          /     Sex: Male
                                   \        /   Birth Date: 28 Jun 1991
                                    \      /  Last Location: ASSAM (dead)
                                  dam\    /sire    House Name:
                                      \  /            Tattoo:
                                       \/           Tag/Band:
                                    00004

+ Wild-caught... * Appear more than once...

==========================================================================
Taxon Name: CAPRICORNIS THAR                      Studbook Number:  00005
==========================================================================
                WILD                                    WILD
                                  \          /   Sex: Female
                                   \        /    Birth Date:      ~ 1991
                                    \      /     Last Location: ASSAM
                                  dam\    /sire    House Name: CHAIMONA
                                      \  /            Tattoo:
                                       \/           Tag/Band:
                                    00005

==========================================================================
Taxon Name: CAPRICORNIS THAR                      Studbook Number:  00006
==========================================================================
                                          WILD      WILD
                                            \      /
                                             dam\    /sire
                                                \/
       WILD                WILD                 00001  +             UNK
              \      /                                  \      /
             dam\    /sire                              dam\    /sire
                 \  /                                      \  /
                  \/                                        \/
              00005  +                                   00002
              CHAIMONA                                   CHAIMON
                                  \          /            Sex: Female
                                   \        /  Birth Date: 12 Sep 1996
                                    \      / Last Location: ASSAM (dead)
                                  dam\    /sire    House Name:
                                      \  /            Tattoo:
                                       \/           Tag/Band:
                                    00006

+ Wild-caught...
```

```
==========================================================================
Taxon Name: CAPRICORNIS THAR                    Studbook Number:  00007
==========================================================================
                                          WILD      WILD
                                            \      /
                                             dam\    /sire
                                                \  /
                                                 \/
       WILD                WILD                00001  +             UNK
                \      /                                  \      /
              dam\    /sire                              dam\    /sire
                  \  /                                       \  /
                   \/                                         \/
                00005  +                                   00002
                CHAIMONA                                   CHAIMON
                                  \            /
                                   \          /    Sex: Male
                                    \        /     Birth Date: 21 May 1997
                                     \      /    Last Location: ASSAM
                                   dam\    /sire    House Name: CHAMPAK
                                       \  /             Tattoo:
                                        \/            Tag/Band:
                                     00007

+ Wild-caught...

==========================================================================
Taxon Name: CAPRICORNIS THAR                    Studbook Number:  00008
==========================================================================
                                          WILD      WILD
                                            \      /
                                             dam\    /sire
                                                \  /
                                                 \/
       WILD                WILD                00001  +             UNK
                \      /                                  \      /
              dam\    /sire                              dam\    /sire
                  \  /                                       \  /
                   \/                                         \/
                00005  +                                   00002
                CHAIMONA                                   CHAIMON
                                  \            /
                                   \          /            Sex: Male
                                    \        /      Birth Date:  1 Feb 1998
                                     \      /    Last Location: INDIA
                                   dam\    /sire    House Name:
                                       \  /             Tattoo:
                                        \/            Tag/Band:
                                     00008

+ Wild-caught...
```

```
=========================================================================
Taxon Name: CAPRICORNIS THAR                      Studbook Number:  00009
=========================================================================
                                        WILD      WILD
                                           \      /
                                            dam\    /sire
                                                \  /
                                                 \/
       WILD                 WILD                00001  +             UNK
                \      /                                    \      /
              dam\    /sire                                 dam\    /sire
                  \  /                                         \  /
                   \/                                           \/
                  00005  +                                     00002
                  CHAIMONA                                     CHAIMON
                                  \          /   Sex: Female
                                   \        /   Birth Date: 18 Oct 1998
                                    \      /    Last Location: INDIA
                                  dam\    /sire    House Name:
                                      \  /             Tattoo:
                                       \/            Tag/Band:
                                     00009

+ Wild-caught...

=========================================================================
Taxon Name: CAPRICORNIS THAR                      Studbook Number:  00010
=========================================================================
                                        WILD      WILD
                                           \      /
                                            dam\    /sire
                                                \  /
                                                 \/
       WILD                 WILD                00001  +             UNK
                \      /                                    \      /
              dam\    /sire                                 dam\    /sire
                  \  /                                         \  /
                   \/                                           \/
                  00005  +                                     00002
                  CHAIMONA                                     CHAIMON
                                 \           /
                                  \          /            Sex: Male
                                   \        / Birth Date: 11 Jul 1999
                                    \      /  Last Location: ASSAM (dead)
                                  dam\    /sire    House Name:
                                      \  /             Tattoo:
                                       \/            Tag/Band:
                                     00010

+ Wild-caught...
```

```
==========================================================================
Taxon Name: CAPRICORNIS THAR                      Studbook Number:  00011
==========================================================================
                 WILD                                      WILD
                                  \          /  Sex: Male
                                   \        /  Birth Date:  ~ May 1999
                                    \      / Last Location: ASSAM (dead)
                                  dam\    /sire    House Name:
                                      \  /             Tattoo:
                                       \/            Tag/Band:
                                     00011

==========================================================================
Taxon Name: CAPRICORNIS THAR                      Studbook Number:  00012
==========================================================================
                                          WILD      WILD     00001  +  UNK
                                             \      /           \     /
                                              dam\    /sire       dam\   /sire
                                                  \/                  \/
       WILD                WILD                 00005 *+              00002
                                                CHAIMONA             CHAIMON
              \      /                                    \      /
            dam\    /sire                                dam\    /sire
                \  /                                        \  /
                 \/                                          \/
              00005 *+                                     00007
              CHAIMONA                                     CHAMPAK
                                  \          /    Sex: Male
                                   \        /   Birth Date: 22 May 2000
                                    \      /  Last Location: ASSAM (dead)
                                  dam\    /sire    House Name:
                                      \  /             Tattoo:
                                       \/            Tag/Band:
                                     00012

+ Wild-caught... * Appear more than once...
^ Pedigree continues beyond top of page...


==========================================================================
Taxon Name: CAPRICORNIS THAR                      Studbook Number:  00013
==========================================================================
                                        WILD      WILD
                                           \      /
                                            dam\    /sire
                                                \/
       WILD                WILD                 00001  +              UNK
              \      /                                    \      /
            dam\    /sire                                dam\    /sire
                 \/                                          \/
              00005  +                                     00002
              CHAIMONA                                     CHAIMON
                                  \          /            Sex: Male
                                   \        / Birth Date: 26 Mar 2001
                                    \      / Last Location: ASSAM
                                  dam\    /sire    House Name:
                                      \  /             Tattoo:
                                       \/            Tag/Band:
                                     00013
+ Wild-caught...
```

```
==========================================================================
Taxon Name: CAPRICORNIS THAR                      Studbook Number:  00014
==========================================================================
                                                                    |
                                          WILD      WILD     00001  +   UNK
                                             \      /           \      /
                                          dam\    /sire       dam\    /sire
                                              \  /                \  /
                                               \/                  \/
       WILD                WILD                00005 *+             00002
                                               CHAIMONA             CHAIMON
              \      /                                  \      /
            dam\    /sire                           dam\    /sire
                \  /                                    \  /
                 \/                                      \/
              00005 *+                                 00007
              CHAIMONA                                 CHAMPAK
                                \            /
                                 \          /            Sex: Male
                                  \        /   Birth Date: 11 Dec 2001
                                   \      /    Last Location: ASSAM
                                 dam\    /sire    House Name: MANTU
                                     \  /             Tattoo:
                                      \/            Tag/Band:
                                   00014

+ Wild-caught... * Appear more than once...
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==========================================================================
Taxon Name: CAPRICORNIS                           Studbook Number:  00015
==========================================================================
                                          WILD      WILD     00001  +   UNK
                                             \      /           \      /
                                          dam\    /sire       dam\    /sire
                                              \  /                \  /
                                               \/                  \/
       WILD                WILD                00005 *+             00002
                                               CHAIMONA             CHAIMON
              \      /                                  \      /
            dam\    /sire                           dam\    /sire
                \  /                                    \  /
                 \/                                      \/
              00005 *+                                 00007
              CHAIMONA                                 CHAMPAK
                                \            /
                                 \          /    Sex: Female
                                  \        /   Birth Date: 22 Aug 2002
                                   \      /    Last Location: INDIA
                                 dam\    /sire    House Name:
                                     \  /             Tattoo:
                                      \/            Tag/Band:
                                   00015

+ Wild-caught... * Appear more than once...
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```

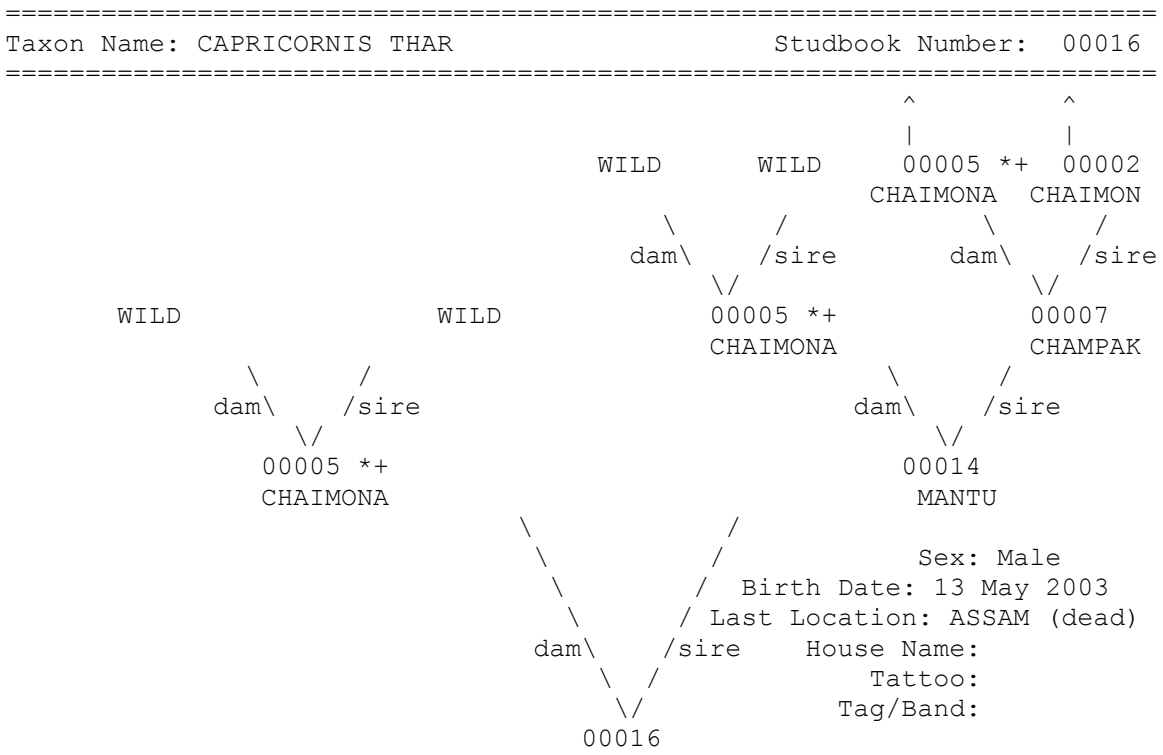

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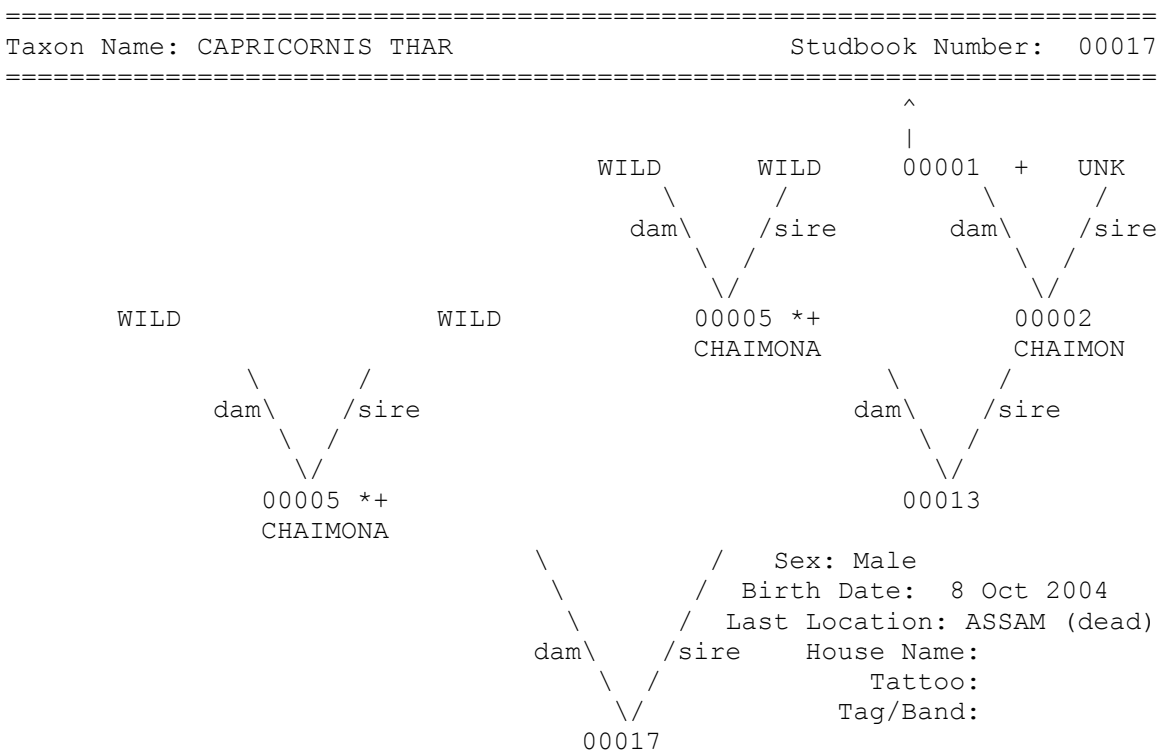

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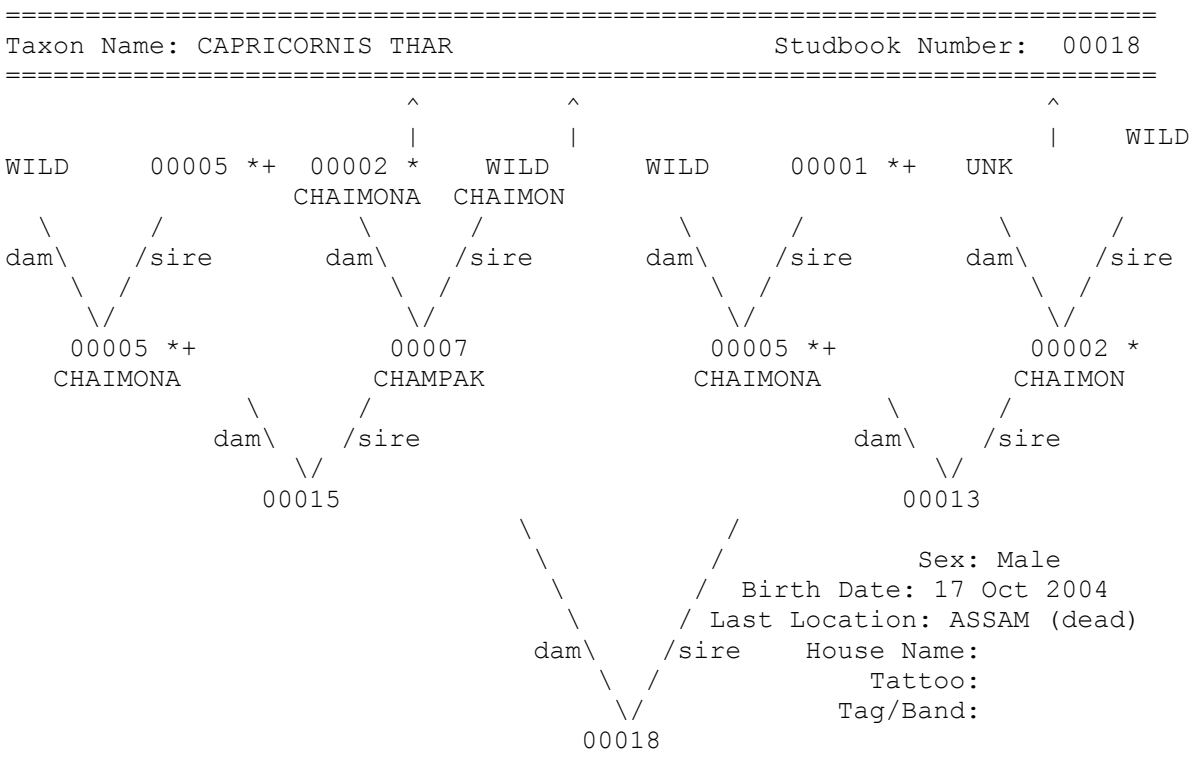

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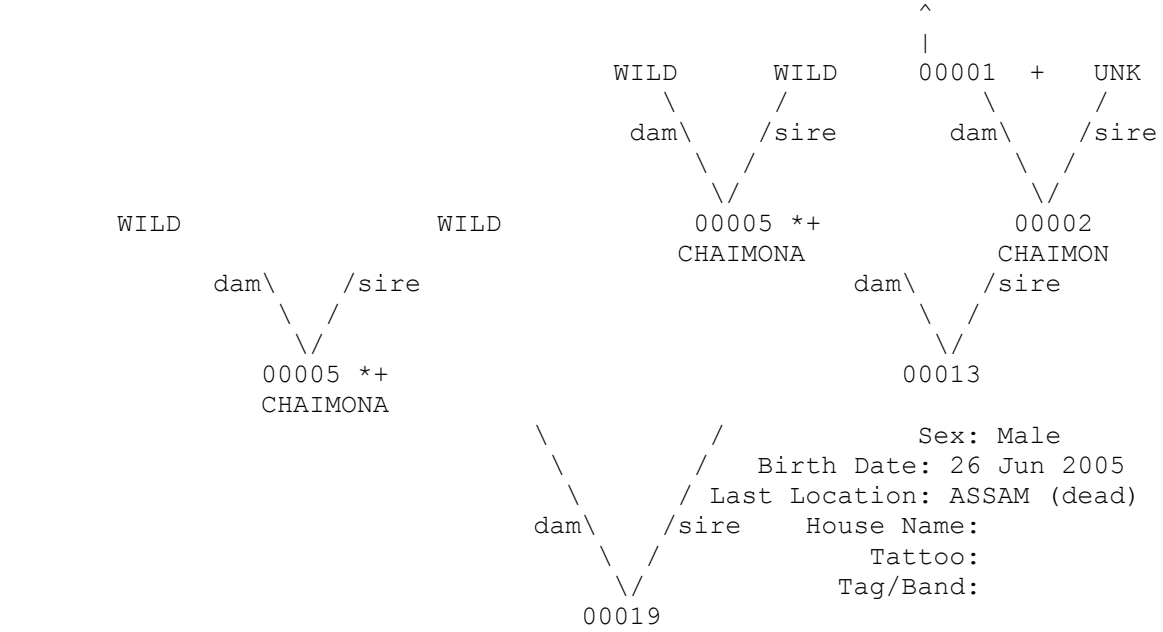

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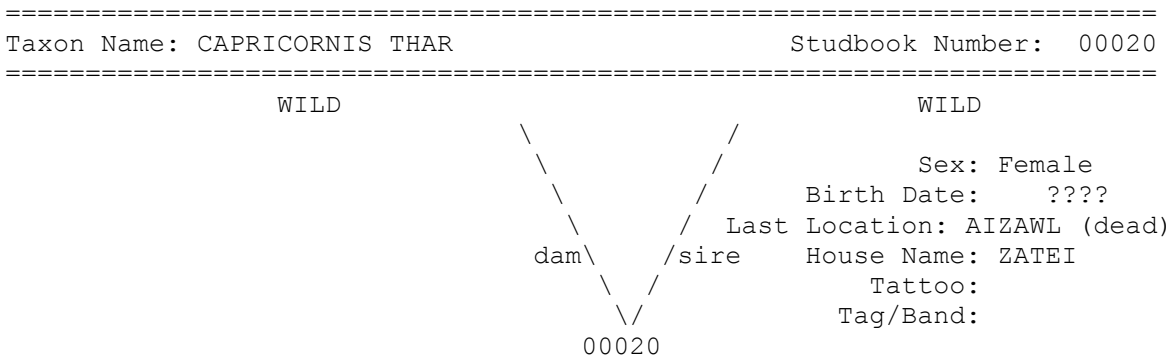

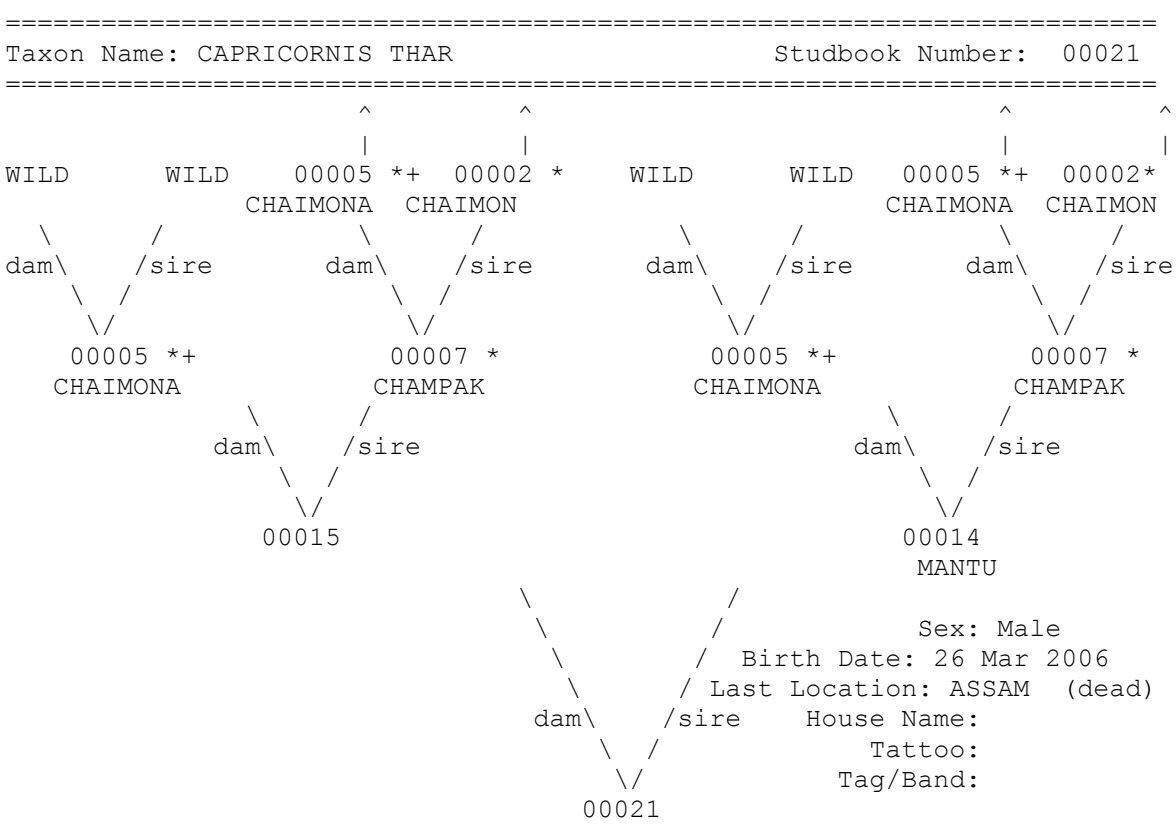

+ Wild-caught... * Appear more than once...
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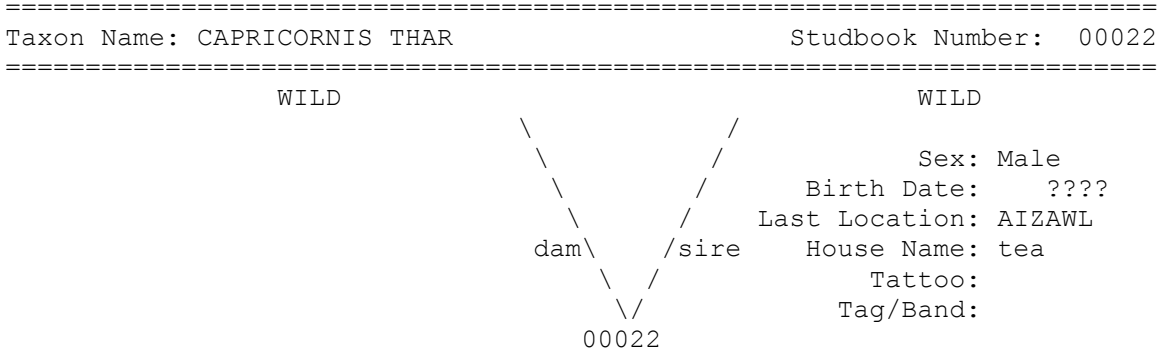

```
==========================================================================
Taxon Name: CAPRICORNIS THAR                    Studbook Number:  00023
==========================================================================
                WILD                                      WILD
                                \           /
                                 \         /            Sex: Male
                                  \       /    Birth Date:      ~ 2003
                                   \     /  Last Location: ASSAM (dead)
                                 dam\   /sire    House Name: THOI
                                     \ /             Tattoo:
                                      \/           Tag/Band:
                                   00023
```

```
==========================================================================
Taxon Name: CAPRICORNIS THAR                    Studbook Number:  00024
==========================================================================
                WILD                                      WILD
                                 \         /            Sex: Male
                                  \       /      Birth Date:    ????
                                   \     /    Last Location: SHILLONG
                                 dam\   /sire    House Name:
                                     \ /             Tattoo:
                                      \/           Tag/Band:
                                   00024
```

```
==========================================================================
Taxon Name: CAPRICORNIS THAR                    Studbook Number:  00025
==========================================================================
                WILD                                      WILD
                                \           /
                                 \         /            Sex: Female
                                  \       /     Birth Date:      ~ 2008
                                   \     /    Last Location: ASSAM
                                 dam\   /sire    House Name: GITA
                                     \ /             Tattoo:
                                      \/           Tag/Band:
                                   00025
```

```
==========================================================================
Taxon Name: CAPRICORNIS THAR                    Studbook Number:  00026
==========================================================================
                WILD                                      WILD
                                 \         /            Sex: Male
                                  \       /     Birth Date:      ~ 2007
                                   \     /    Last Location: DIMAPUR
                                 dam\   /sire    House Name: Ram
                                     \ /             Tattoo:
                                      \/           Tag/Band:
                                   00026
```

```
==========================================================================
Taxon Name: CAPRICORNIS THAR                    Studbook Number:  00027
==========================================================================
                 WILD                                    WILD
                                \          /             Sex: Female
                                 \        /      Birth Date:    ????
                                  \      /    Last Location: DIMAPUR
                                dam\    /sire    House Name: SITA
                                    \  /             Tattoo:
                                     \/            Tag/Band:
                                   00027


==========================================================================
Taxon Name: CAPRICORNIS THAR                    Studbook Number:  00028
==========================================================================
                 WILD                                    WILD
                               \            /
                                \          /             Sex: Male
                                 \        /      Birth Date:    ????
                                  \      /    Last Location: DIMAPUR
                                dam\    /sire    House Name: lali
                                    \  /             Tattoo:
                                     \/            Tag/Band:
                                   00028
```