SNOW LEOPARDS

CONFLICT AND CONSERVATION

A REVIEW ON CAPTIVE SNOW LEOPARD MANAGEMENT

AT

PADMAJA NAIDU HIMALAYAN ZOOLOGICAL PARK, DARJEELING

BY

SUPRIYO DALUI
ACKNOWLEDGEMENT

I pay my sincere regards to Miss Upashna Rai, Scientific Officer of Padmaja Naidu Himalayan Zoological Park, for her guidance and critical evaluation of this dissertation work.

I express my heartfelt thanks and deepest gratitude to The Director of the PNHZ Park for giving me the permission to work in the restricted areas of the zoo and for providing me all possible help from his side.

I am also grateful to the Keepers of the animals, Mr. Nipan Tamang and Rudhen Lepcha for their support and help and also the Animal Supervisor and The veterinarian Doctor for their valuable opinions.

Last but not the least I would like to thank my friends, family and group members for their constant support and co-operation.

Date: 02.06.2016

Place: Kolkata

Supriyo Dalui
## CONTENTS

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>TOPIC</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ABSTRACT</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>OBJECTIVE OF THE STUDY</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>INTRODUCTION</td>
<td>4-5</td>
</tr>
<tr>
<td>4.</td>
<td>TAXONOMY OF THE SPECIES</td>
<td>5</td>
</tr>
<tr>
<td>5.</td>
<td>CONSERVATION STATUS</td>
<td>5</td>
</tr>
<tr>
<td>6.</td>
<td>DISTRIBUTION OF SNOW LEOPARD: WORLDWIDE DISTRIBUTION</td>
<td>6</td>
</tr>
<tr>
<td>7.</td>
<td>SNOW LEOPARD’S HABITAT AND DISTRIBUTION IN INDIA</td>
<td>7</td>
</tr>
<tr>
<td>8.</td>
<td>WILD POPULATION OF SNOW LEOPARDS IN THE WORLD</td>
<td>8</td>
</tr>
<tr>
<td>9.</td>
<td>CAPTIVE POPULATION OF SNOW LEOPARDS IN THE WORLD</td>
<td>8</td>
</tr>
<tr>
<td>10.</td>
<td>BIOLOGY OF THE SPECIES</td>
<td>9</td>
</tr>
<tr>
<td>11.</td>
<td>ECOLGY OF THE SPECIES</td>
<td>9-10</td>
</tr>
<tr>
<td>12.</td>
<td>HUNTING BEHAVIOUR AND WILD PREY SPECIES</td>
<td>10-11</td>
</tr>
<tr>
<td>13.</td>
<td>PRINCIPAL THREATS TO SNOW LEOPARDS</td>
<td>12-13</td>
</tr>
<tr>
<td>14.</td>
<td>ROLE OF SNOW LEOPARD IN THE ECOSYSTEM</td>
<td>14</td>
</tr>
<tr>
<td>15.</td>
<td>PROJECT SNOW LEOPARD</td>
<td>14-15</td>
</tr>
<tr>
<td>16.</td>
<td>SNOW LEOPARD RECOVERY PLAN AND PNHZ PARK</td>
<td>16</td>
</tr>
<tr>
<td>17.</td>
<td>OBJECTIVE OF A SNOW LEOPARD CONSERVATION BREEDING CENTRE</td>
<td>17</td>
</tr>
<tr>
<td>18.</td>
<td>CAPTIVE HUSBANDRY AND CARE FOR SNOW LEOPARDS AT PNHZ PARK</td>
<td>18-24</td>
</tr>
<tr>
<td>19.</td>
<td>CAPTIVE DIET FOR SNOW LEOPARDS</td>
<td>25-26</td>
</tr>
<tr>
<td>20.</td>
<td>HEALTH ISSUES IN EX-SITU POPULATION</td>
<td>27-28</td>
</tr>
<tr>
<td>21.</td>
<td>CAPTIVE BEHAVIOURAL PROBLEMS</td>
<td>28-29</td>
</tr>
<tr>
<td>22.</td>
<td>REPRODUCTION AND DEVELOPMENT</td>
<td>29-33</td>
</tr>
<tr>
<td>23.</td>
<td>BEHAVIOURAL STUDY OF THREE FEMALE SNOW LEOPARDS AT PNHZ PARK</td>
<td>33-34</td>
</tr>
<tr>
<td>24.</td>
<td>POPULATION MANAGEMENT AND GENETIC PROFILING OF SNOW LEOPARD (Uncia uncia) IN CAPTIVITY</td>
<td>34-35</td>
</tr>
<tr>
<td></td>
<td>REINTRODUCTION PLAN OF THE SNOW LEOPARD</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>CONCLUSION</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>REFERENCE</td>
<td>37-38</td>
</tr>
</tbody>
</table>
Abstract

For my M.Sc. dissertation work on Wildlife and Conservation Biology, I have decided to work on behavioural aspect of one of the most endangered species of the World i.e. the Snow leopard.

It is worth remembering that behaviour is what animals do to interact with, respond to, and control their environment. Behaviour is generally the animal’s “first line of defence” in response to environmental change. As such, careful observations of behaviour can provide us with a great deal of information about animals’ requirements, preferences and dislikes, and internal states (Mench and Mason 1997), provided that our interpretation of those observations is firmly grounded in knowledge of species-typical behaviour patterns. As behavioural study of Snow leopard is very difficult in the wild so this kind of behaviour study in captivity give us first-hand information about their behaviour and help us to understand how their behaviour can be affected due to environmental changes in the wild.

My work consisted of studying the captive behaviour of Snow Leopards (Uncia uncia) at Padmaja Naidu Himalayan Zoological Park and also to make a review on Conservation Breeding Programme of Snow leopard focusing on the aspects like the breeding biology, how breeding is done in the park and thereafter including type of diet, captive husbandry methods, captive health issues etc.

Objective of my work

The aim of my work is to understand the need and the basis of the conservation breeding for the endangered Snow Leopard in the PNHZ Park. For this, I did a literature survey on the present status of Snow leopard in Indian Himalaya and the need of its conservation breeding and then make a review on the captive breeding programme of PNHZ Park. I also did behavioural study of three individual female Snow leopards to understand their behaviour pattern in captivity.

For this above said objective, I worked in the park first for a period of 2 weeks from 4th to 18th October 2015 then for a period of 10 days from 20th to 30th March 2016.
The Snow leopards, in a genus of their own, are endangered big cats and inhabits the rugged, remote mountainous terrain, in 12 or 13 range countries of South and Central Asia, namely Afghanistan, Bhutan, China, India, Kyrgyzstan, Kazakhstan, Nepal, Mongolia, Pakistan, Russia, Tajikistan, Uzbekistan, and possibly also Myanmar (Fox 1994; Nowell and Jackson 1996) and has been listed in the Red data book as an endangered species throughout its range since 1972 (Goodwin and Holloway). The Snow leopard meets criteria for endangered status under newly proposed criteria (IUCN 1994). The Snow leopard is primarily an inhabitant of the alpine and sub alpine zone. They inhabit mountainous rangelands at elevations of 3000 to over 5000 m in the Himalaya and Tibetan Plateau, but as low as 600m in Russia and Mongolia (Sunquist and Sunquist 2002). Snow leopard habitat is among the least productive of the world’s rangelands due to low temperatures, high aridity, and harsh climatic conditions, with an average peak graminoid biomass of 170 kg/ha (asymmetric 95% CI 128–228 kg/ha; Mishra 2001). Consequently, prey populations are also relatively low, ranging from 6.6–10.2 blue sheep (Pseudois nayaur) per sq. km in productive habitat in Nepal (Oli 1994) to 0.9 ibex (Capra ibex) per sq. km in marginal habitat of Mongolia (McCarthy et al. 2005). In Pakistan, Russia and parts of India they are reported to migrate to lower elevations during winter, following prey (Roberts 1977; Dang 1967).

The Snow leopards are endangered due to habitat loss, naturally low densities, extensive home ranges, dependence upon prey species whose populations are low and or mostly declining, high vulnerability to poaching and conflict with livestock herders (Jackson, Mishra and M. McCarthy 2009). Traditional pastoralism and agro-pastoralism are the predominant land uses and sources of local livelihood in snow leopard habitat, with seven range countries having over 25% of land area under permanent pasture, >50% of their human population involved in agro-pastoralism, >40% living below national poverty levels, and average per capita annual incomes of US $250–400 (Mishra et al. 2003). Although relatively few humans live in snow leopard habitat, their use of the land is pervasive, resulting in ever-increasing human–wildlife conflict, even within protected areas.

This beautiful and shy species is a striking symbol of world’s highest places and good indicator of the mountainous ecosystem (Shrestha 1997, Shrestha 2003,
Jackson 1996). It is considered and ranked as a top level species of the food chain in the Himalayan range. Because of its rarity and extremely harsh and often impassable terrain where it is found, little is known of its behaviour in the wild state (Yaksha 1999). Much of the Snow leopard’s distribution is located along contentious international borders, adding to the difficulty of reliably establishing the species current status and distribution. In addition many surveys were conducted over a decade ago so that the existing database may be seriously outdated. There is now a general agreement that population estimates of around 2,000 made in the early 1970’s when the endangered species regulation were enacted, are too low. (Fox 1989) placed the total snow leopard range at 1.23 million sq. km with a world population of 3,350-4,050 animals. These figures were updated to between 4,510-7,350 snow leopards with a total potential habitat of 1,835,000 sq. km (Fox 1994).

**TAXONOMY OF SPECIES:**

**Common name:** Snow leopard  
**Scientific name:** *Uncia uncia*

**Classification of Snow leopard (Toriello 2002)**

- **Kingdom** - Animalia  
- **Phylum** - Chordata  
- **Subphylum** - Vertebrata  
- **Class** – Mammalia  
- **Order** - Carnivora  
- **Family** - Felidae  
- **Sub Family** – Pantherine  
- **Genus** - Uncia  
- **Species** - *Uncia uncia*

**CONSERVATION STATUS:**

- Endangered IUCN (International Union for Conservation of Nature and Natural Resources)  
- Appendix I CITES (Convention on International Trade of Endangered Species of Wild Flora and Fauna)  
- Schedule I according to WPA (Indian Wildlife Protection Act 1972).
**DISTRIBUTION OF SNOW LEOPARDS:**

**WORLD WIDE DISTRIBUTION AND HABITAT:**

The Snow leopards range crosses several central and South Asian countries including Afghanistan, Bhutan, China, India, Mongolia, Nepal, Pakistan, Russia, Kazakhstan, Kyrgyz Republic, Tajikistan, and Uzbekistan. Total population estimated between 3,920 and 6,390 individuals World-wide (WWF Report 2015).

Map of Snow leopard distribution Worldwide

<table>
<thead>
<tr>
<th>Range Country</th>
<th>Area Covered (km²)</th>
<th>Total snow leopard habitat</th>
<th>% of habitat covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nepal</td>
<td>21,077</td>
<td>30,000</td>
<td>70.26</td>
</tr>
<tr>
<td>India</td>
<td>22,606</td>
<td>75,000</td>
<td>30.14</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>2,354</td>
<td>10,000</td>
<td>23.54</td>
</tr>
<tr>
<td>Russia</td>
<td>13,000</td>
<td>60,000</td>
<td>21.67</td>
</tr>
<tr>
<td>Mongolia</td>
<td>13,996</td>
<td>101,000</td>
<td>13.86</td>
</tr>
<tr>
<td>China</td>
<td>137,846</td>
<td>1,100,000</td>
<td>12.53</td>
</tr>
<tr>
<td>Pakistan</td>
<td>10,009</td>
<td>80,000</td>
<td>12.51</td>
</tr>
<tr>
<td>Bhutan</td>
<td>1,730</td>
<td>15,000</td>
<td>11.53</td>
</tr>
<tr>
<td>Afghanistan</td>
<td>5,000</td>
<td>50,000</td>
<td>10.00</td>
</tr>
<tr>
<td>Kyrgyz Republic</td>
<td>7,110</td>
<td>105,000</td>
<td>6.77</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>717</td>
<td>50,000</td>
<td>1.43</td>
</tr>
<tr>
<td>Tajikistan</td>
<td>875</td>
<td>100,000</td>
<td>0.88</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>236,320</strong></td>
<td><strong>1,776,000</strong></td>
<td><strong>13.30</strong></td>
</tr>
</tbody>
</table>

Snow leopard Range Countries and Total Area Covered.
SNOW LEOPARD’S DISTRIBUTION AND HABITAT IN INDIA:

Wildlife, especially snow leopard and prey species are pervasive in the snow leopard range in India. Local communities also use the region almost pervasively, resulting in a large people-wildlife interface. The region has over 30 wildlife protected areas (PA) but the wildlife values are spread way beyond their boundary. Considering these unique features the Ministry of Environment & Forests (MoEF) have initiated a national flagship species programme called the Project Snow Leopard to streamline efforts for the conservation of this unique landscape.

PROJECT AREAS:

<table>
<thead>
<tr>
<th>State</th>
<th>Potential Area Under PSL (km²)</th>
<th>Approximate percentage of each State’s area falling under the Project</th>
<th>Approximate percentage of total Project Area covered by each State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jammu &amp; Kashmir</td>
<td>77,833</td>
<td>61</td>
<td>60</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>27,846</td>
<td>50</td>
<td>22</td>
</tr>
<tr>
<td>Uttarakhand</td>
<td>13,885</td>
<td>23</td>
<td>11</td>
</tr>
<tr>
<td>Sikkim</td>
<td>3,031</td>
<td>36</td>
<td>2</td>
</tr>
<tr>
<td>Arunachal Pradesh</td>
<td>6,162</td>
<td>08</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>1,28,757</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Geographical scope of the Project Snow Leopard in the five Himalayan states. The figures for the Western Himalaya include areas above 3000 m and those for the Eastern Himalaya are above 4,000 m. Estimates are based on Digital Elevation Model from Shuttle Radar Topography Mission (SRTM).

Map of northern India showing the important mountain ranges, including the Himalaya and the Tibetan Plateau, which form the project area for the Project Snow Leopard.
WILD POPULATION OF SNOW LEOPARD IN THE WORLD:

<table>
<thead>
<tr>
<th>Range Country</th>
<th>Habitat Area (km²)</th>
<th>Estimated Population¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>50,000</td>
<td>100—200?</td>
</tr>
<tr>
<td>Bhutan</td>
<td>15,000</td>
<td>100—200?</td>
</tr>
<tr>
<td>China</td>
<td>1,100,000</td>
<td>2,000—2,500</td>
</tr>
<tr>
<td>India</td>
<td>75,000</td>
<td>200—600</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>50,000</td>
<td>180—200</td>
</tr>
<tr>
<td>Kyrgyzstan</td>
<td>105,000</td>
<td>150—500</td>
</tr>
<tr>
<td>Mongolia</td>
<td>101,000</td>
<td>500—1,000</td>
</tr>
<tr>
<td>Nepal</td>
<td>30,000</td>
<td>300—500</td>
</tr>
<tr>
<td>Pakistan</td>
<td>80,000</td>
<td>200—420</td>
</tr>
<tr>
<td>Tajikistan</td>
<td>100,000</td>
<td>180—220</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>10,000</td>
<td>20—50</td>
</tr>
</tbody>
</table>

CAPTIVE POPULATION OF SNOW LEOPARD:

INTERNATIONAL CAPTIVE POPULATION:

As per the record of International Studbook of Snow leopard volume 9, globally 205 institutions are housing Snow leopard with a total population of 445 individuals in 206:239 ratios. Analysis done on the number of individuals housing in different captive facilities of Snow leopard shows that a total of 212 individuals were housing in 100 European institutions, 164 individuals were housing in 84 American institutions, 46 individuals were housing in 16 Asian institutions, 15 individuals were housing in 4 Australian institutions and 2 individuals were housing in 1 African institution.

NATIONAL CAPTIVE POPULATION:

Currently there are total of 10 individuals, housing in 2 zoological park of India, of which 9 individuals are housing at Padmaja Naidu Himalayan Zoological Park, Darjeeling, West Bengal and only 1 at Gangtok Zoo, Sikkim.
BIOLOGY OF THE SPECIES:

**Morphology:**

- The males weighing 45–55 kg and females 35–40 kg. Head-body length of 1.8–2.3 m (Hemmer 1972).
- Smoky-grey pelage tinged with yellow and patterned with dark grey, open rosettes and black spots, the snow leopard is well camouflaged.
- Well-developed chest, short forelimbs with sizable paws, long hind-limbs, and a noticeably long tail.
- Adaptations for cold include an enlarged nasal cavity, long body hair and a thick tail.

Adaptations for cold: long body hair and a thick tail

ECOLOGY OF THE SPECIES:

**HABITAT:**

- Snow leopard serves as an indicator species of Asia’s high mountain ecosystem.
- In India Snow leopard has been identified as a flagship species for the high altitude Himalayas.
- Snow leopards favour steep, rugged terrain, arid and semi-arid shrub land. (Jackson and Ahlborn 1989; Sunquist and Sunquist 2002).
- Generally found in elevations between 3000-4500m, occasionally go above 5500m in the Himalayas.

- Home range size varies from 12 to 39 sq. km in productive habitat in Nepal (Jackson and Ahlborn 1989) to 500 sq. km or more in Mongolia with its open terrain and lower ungulate density (McCarthy et al. 2005).

**HUNTING BEHAVIOUR:**

- Snow leopards are opportunistic predators capable of killing prey 3 times their own weight.

- Hunting is done mainly in the early morning or late evening.

- They kill large animals twice monthly. In summer months they also use to eat small animals like marmots, pikas, small rodents, hares, etc.

- Their main wild prey species are: Blue Sheep, Asiatic Ibex, Markhor, Argali sheep, Himalayan Tahr, Goral, Wild Yak, Wild Ass, Tibetan Gazelle, Antelope, etc.
WILD PREY SPECIES:

Blue Sheep

Markhor

Asiatic ibex

Himalayan Tahr

Marmot

Pikas
The threats can be divided in the following categories

**Category 1: Habitat and Prey Related**
- Habitat Degradation and Fragmentation
- Reduction of Natural Prey due to Illegal or Unregulated Hunting
- Reduction of Natural Prey due to Legal Hunting
- Reduction of Natural Prey due to Competition with Livestock
- Reduction of Natural Prey due to Disease or Transmission of Disease
- Fencing that Disrupts Natural Animal Movements and Migration

**Category 2: Direct Killing of Snow Leopards**
- Killing of Snow Leopards in Retribution for Livestock Depredation Loss
- Poaching Snow Leopards for Trade in Hides or Bones
- Zoo and Museum Collection of Live Animals
- Traditional Hunting of Snow Leopards
- Secondary Poisoning and Trapping of Snow Leopards
- Diseases of Snow Leopards

**Category 3: Policy and Awareness**
- Lack of Appropriate Policy
- Lack of Effective Enforcement
- Lack of Trans-boundary Cooperation
- Lack of Institutional Capacity
- Lack of Awareness among Local People
- Lack of Awareness among Policy Makers
- War and Related Military Activities
- Human Population Growth and Poverty (indirect threat)
- Climate Change

1. Poaching Snow Leopards for Trade in Hides or Bones or fur
2. Killing of Snow Leopards in Retribution for Livestock Depredation Loss
3. Traditional Hunting of Snow Leopards
4. Zoo and Museum Collection of Live Animals
ROLE OF SNOW LEOPARD IN THE ECOSYSTEM:

THE SNOW LEOPARD AS AN INDICATOR SPECIES

1. The Snow leopard serves as an indicator species for Asia’s high mountain ecosystems, as it resides at the top of the food chain, requires large home ranges, moves over vast areas and flourishes under pristine conditions.
2. It is also a “flagship” species around which people rally support for far-reaching conservation initiatives.
3. The snow leopard’s endangerment has made it a symbol for international cooperation.
4. As an Umbrella species, the ecological and behavioural aspect of snow leopard will also help to conserve the other facets of biodiversity in the alpine eco regions. By protecting snow leopards, one also protects habitat for a host of other plant and animal species.
5. The Snow leopard can be a focal species for landscape conservation planning in the montane areas of the Himalayas, as elephants, rhinos, and tigers have done for other landscapes.

PROJECT SNOW LEOPARD

Objective of PSL: The goal of Project Snow Leopard is to safeguard and conserve India’s unique natural heritage of high altitude wildlife populations and their habitats by promoting conservation through participatory policies and actions.

The high altitude Himalayan landscape in India is spread over c. 130,000 km² including c. 35 existing protected areas (c. 31,000 km²). Given that this high altitude landscape is unique as the wildlife populations, though threatened, occur across the landscape and are not restricted to protected areas, an alternative, landscape-level conservation approach is needed. At the same time, this landscape continues to undergo traditional resource use in the form of livestock grazing and associated activities, and a participatory approach to conservation, that fully involves local communities, is urgently required. Keeping this broad philosophy in mind,

The following are the objectives of the Project Snow Leopard:

1. FACILITATE A LANDSCAPE- LEVEL APPROACH TO WILDLIFE CONSERVATION
2. RATIONALIZE THE EXISTING PROTECTED AREA NETWORK AND IMPROVE PROTECTED AREA MANAGEMENT WITHIN THE LARGER LANDSCAPE

3. DEVELOPE A FRAMEWORK FOR WILDLIFE CONSERVATION OUTSIDE PROTECTED AREAS AND PROMOTE ECOLOGICALLY RESPONSIBLE DEVELOPMENT

4. SUPPORT FOCUSED CONSERVATION AND RECOVERY PROGRAMMES FOR ENDANGERED SPECIES SUCH AS THE SNOW LEOPARD AND ITS PREY SPECIES

5. PROMOTE STRONGER MEASURES FOR WILDLIFE PROTECTION AND LAW ENFORCEMENT

6. PROMOTE BETTER UNDERSTANDING AND MANAGEMENT OF HUMAN WILDLIFE CONFLICT

7. RESTORE DEGRADED LANDSCAPES IN THE HIGH ALTITUDE HIMALAYAN AND TRANS-HIMALAYAN BIOGEOGRAPHIC REGIONS

8. PROMOTE KNOWLEDGE-BASED APPROACH TO CONSERVATION AND AN ADAPTIVE FRAMEWORK FOR WILDLIFE MANAGEMENT

9. REDUCE EXISTING ANTHROPOGENIC PRESSURES ON NATURAL RESOURCES

10. PROMOTE LOCAL CAPACITY, CONSERVATION EDUCATION AND AWARENESS

<table>
<thead>
<tr>
<th>State</th>
<th>Potential Area Under PSL (km²)</th>
<th>Approximate percentage of each State’s area falling under the Project</th>
<th>Approximate percentage of total Project Area covered by each State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jammu &amp; Kashmir</td>
<td>77,833</td>
<td>61</td>
<td>60</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>27,846</td>
<td>50</td>
<td>22</td>
</tr>
<tr>
<td>Uttarakhand</td>
<td>13,885</td>
<td>23</td>
<td>11</td>
</tr>
<tr>
<td>Sikkim</td>
<td>3,031</td>
<td>36</td>
<td>2</td>
</tr>
<tr>
<td>Arunachal Pradesh</td>
<td>6,162</td>
<td>08</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>1,28,757</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Project Areas**
The Central Zoo Authority has prioritized the Snow leopard as a species to be taken up for conservation breeding based on the distribution of the species in India and globally, status of the species as per the IUCN and Wildlife (Protection) Act, 1972, availability of founders in wild and in captivity including availability of information on breeding biology and husbandry protocol and threat to the population.

**The Need for Conservation Breeding of Snow Leopards:**

The endangered snow leopard continues to decline across nearly all of the 12 Central Asian Countries it inhabits due to poaching for its valuable pelts and bones, from retributive killings and from widespread depletion of its natural prey base. Hence Conservation Breeding of Snow leopards is a “need based activity”.

Padmaja Naidu Himalayan Zoological Park started a captive breeding programme of Snow leopard, with an objective of establishing and maintaining a breeding centre at a suitable location in the park and to acclimatize, rear, breed and multiply the endangered species and then make an effort to establish subsidiary breeding centres in suitable locations in Himalayas.

**Padmaja Naidu Himalayan Zoological Park**

Padmaja Naidu Himalayan Zoological Park, popularly known as Darjeeling Zoo is a high altitude zoo situated at an altitude of 2137m (6500 ft). PNHZ Park is categorised as a small zoo (Anon 2001). Located at 27° 03’ 32” N and 88°15’47”E it covers an area of 67 acres. PNHZP presently holds 44 species that includes mammals, herbivores, pheasants, birds and an amphibian. The Park currently has three off display Conservation Breeding Centres. The Park is currently working towards the Conservation Breeding of ten species- Red Panda (*Ailurus fulgens fulgens*), Snow leopard (*Uncia uncia*), Himalayan Wolf (*Canis lupus himalayensis*), Blue Sheep (*Pseudois nayaur*), Himalayan Thar (*Hemitragus jemlahicus*), Satyr tragopan (*Tragopan satyra*), Blood Pheasant (*Ithaginis cruentus*), Grey Peacock Pheasant (*Polypectron bicalcaratum*), Himalayan Monal (*Lophura impejanus*) and Red Jungle Fowl (*Gallus gallus*).
OBJECTIVES:

- Conservation breeding of Snow leopards is an insurance against possible early extinction of species in wild.
- To study breeding behaviour of the Snow leopards.
- Re-introduce viable number of animals for their long term survival in wild.
- To donate stock to other zoos which are not considered for re-introduction.
- Monitoring and modifying management practice to provide survival of Snow leopards in captivity as well as in wild.
- Research and education.

Targets for Captive Breeding Programme:

- Sufficient number of founders.
- Carefully managed pair combinations.
- Not merely produce larger numbers of individuals but also aim to maintain a high proportion of the gene diversity that is present in the wild population. A 90% gene diversity retained can be expected to correspond to an average level of inbreeding of 10% in the next generation if the current generation were to randomly breed and if no new founders are added.
- Large captive populations.
CAPTIVE HUSBANDRY AND CARE FOR SNOW LEOPARD AT PNHZ PARK

Housing requirements:

EXHIBIT DESIGN

- The terrain used by Snow leopards is typically extremely rugged (Schaller 1977, Koshkarev 1984, Mallon 1984b, Fox et al. 1988, Jackson and Ahlborn 1988). They show a high preference for cliff, areas with slopes in excess of 40 m and areas with 25m of edges with cliff.
- Preferred bedding sites are situated on or near ridges, cliffs and other sites with good views.
- Thus Animals should be displayed, in exhibits replicating their wild habitat.

Details of the Enclosures at PNHZ:

Snow Leopard Enclosure I at CBC

This is a good off display enclosure in the Conservation breeding of Snow leopard. There are basically two enclosures with night shelters in the same building. There are eight number of night cells (four on each side) with kraal (one on each side) with a long passage in-between. Each enclosure is provided with a den. Furnishing has been provided using logs; ropes etc.

CBC Snow Leopard Enclosure II

This is a newly constructed enclosure at the Conservation breeding Centre. The enclosure is provided with two night shelters of 1.90m X 2.00m each with a corridor of 3.87 m long. Each night cell is provided with skylight for adequate sunlight and ventilation for proper aeration.

CBC Snow Leopard Enclosure III

This is a newly constructed enclosure at the Conservation breeding Centre.
NEW OFF DISPLAY BREEDING CENTER AT TOPKEY DARA

A new off display breeding and release facility has been established in an area of 5 hectares at Topkey Dara near 3rd mile under Darjeeling Forest division with the purpose of investigating and study on behaviour, breeding cycle, food adaptation of Snow leopard when kept in near natural condition. The off display breeding centre hold two open enclosures with an area of 45×30 mt. attached with six numbers of night shelters and two kraal areas. Each night cell is provided with skylight for adequate sunlight and ventilation for proper aeration.

Layout plan for off-display conservation breeding centre for Snow Leopard at Topkeydara.

TOPOGRAPHY

- Exhibits are terraced, sloped and contain high and low spots.
- Exhibits are provided with climbing structures to enable the snow leopards to utilize all areas of the enclosures to hide or find shelter.
Topography of the Snow leopard’s exhibit.

OFF-EXHIBIT DENs

- Off-exhibit dens are provided to snow leopards to allow them privacy and shelter from the elements.

Substrate

- Rocky substrate is present inside the enclosure.

Enclosure Furnishing

- Snow leopards are amazing climbers so natural substrate such as soil with a grass cover a layer of limestone, gravel or similar substrate like Platforms or raised rock points are provided inside the exhibit.
Plantation of trees and bushes in the exhibit of Conservation Breeding Centre of Snow leopard at PNHZ Park to provide shade for Snow leopard’s.

**NIGHT QUARTERS & BREEDING ENCLOSURE**

- Internal measurements are 3x2.5 meters with a ceiling height of 2.1 meters.
- The night shelters are connected to the main display by vertical or horizontal sliding doors operable from the keeper’s area. Doors into the den are constructed of steel/iron/Aluminium.
- Wooden platforms are provided to allow animals to lie off the concrete floor.
- Humidity is maintained at appropriate levels for the species by using dehumidifier.
- Floor requires a slope to the drainage area situated on the outside of the night quarters to prevent the pooling of water.
- Insect flashers are used to relief the animals from insects.
- Relative humidity is maintained within the range of 30%-70%.
- UV-light is installed to sterilize the room and make it free from micro-organism.
- CCTVs are installed inside the breeding room to monitor and record each and every event without disturbing the animal.
- Bedding of room with dry leaves and dry wood shavings which aid in absorbing the urine and faecal matters keeping the room clean and dry.
- Installation of thermometer and hygrometer to keep the record.
- Turmeric burning and sprinkling are often done as anti-bacterial precaution.
GENERAL HUSBANDRY:

ROUTINE OBSERVATION AND ROUTINE DATA COLLECTION

- Each individual animal is observed for any changes or problems daily twice a day. If any notable events have been observed then that is recorded.
**HYGIENE AND CLEANING**

- The wooden platforms are taken out, cleaned and dried every day.
- Faecal deposits and uneaten food are removed daily.
- Water troughs and feeding trays need are cleaned daily.
- Water sources including storage facilities and distribution channels are checked periodically.
- Disinfecting agents like phenyl, common salt (NaCl), lime powder, bleaching powder, tincture iodine, formalin, potassium permanganate (KMnO4), Copper sulphate (CuSO4), Khrosolin (virbac) are used sometime.
- The walls of the room are white washed with lime every three months.

![Cleaning of the wooden platform]

**RECORD KEEPING**

- Keeper's dairy are maintained with information's on animal's behaviour, feed, enrichment, health etc.
- Feed chart are maintained regularly about the animal's feed, type of feed, feed timings and feed rejection (quantity).
- Separate registers are maintained for recording temperature, humidity and amount of water obtained from the dehumidifier.
CAPTIVE DIET REQUIREMENTS

FEED:

- 2.5 kg per individual of Beef, Chicken and Mutton are offered to the animal alternatively.
- Live and healthy animals are slaughtered and given to the animals along with the blood and other organs (except intestine and stomach).

PRESENTATION OF FEED:

- Meat is presented at room temperature, as it is more palatable and digested easily.

WATER:

- Filtered water is provided to the animal both in the enclosure and off-exhibit area.

SUPPLIMENTS:

Supplements are provided for seven days every month and the supplements recommended for the Snow leopards are

- Cod liver oil - 1 cap daily
- Calcium tabs - 2 tabs daily
- Revital cabs - 1 cap daily
- Astymin - 1 cap daily
- Evion 400 - 1 cap daily
- Liv 52 - 2 cap daily for seven days

ANIMALS KEPT OFF-FED ONCE A WEEK:

Many institutions fast their cats once each week. Theory behind this is that wild cats do not necessarily eat every day. Thursday is off-feed day at PNHZ park.
1. PREPARATION OF THE FEED
2. CHICKEN
3. MUTTON
4. WEIGHT MACHINE TO MEASURE THE FEED
5-6. FEEDING EVENT OF SNOW LEOPARD
FREQUENTLY OCCURRING DISEASES IN SNOW LEOPARD AT PNHZ Park

PNEUMONIA:

- Pneumonia is common mostly in new born cubs and sometimes in adults.
- The causative agent of Pneumonia is bacteria *streptococcus pneumonia*.
- It is characterized by fever with chills (rapidly rising) cough characterized
  by rusty sputum, chest pain – stabbing aggravated by respiration &
  coughing, sniffing, runny nose.

PLEURSIY:

- Pleurisy (also known as pleuritis) is an inflammation of the pleura, the
  lining surrounding the lungs.
- There are many possible causes of pleurisy but viral infections spreading
  from the lungs to pleural cavity are the most common.

A pleural effusion is an abnormal collection of fluid in the pleural space resulting
from excess fluid production or decreased absorption.

Accumulation of pleural fluid
CAPTIVE BEHAVIOURAL PROBLEMS

In captivity, the “normal” behaviours are often replaced by abnormal or “stereotypic” behaviours such as pacing (Carlstead, 1996). Stereotypy which is defined as the repetitive behavioural pattern without any apparent goal or function.

Abnormal behaviours exhibited by wild animals in captive condition are as follows:

a. **Pacing**: Repetitive ambulatory movement, transversing the same pathway at least twice (Shepherdson, 1998).

b. **Head toss**: So-called “weavers” swing their heads rhythmically. At the same time pawing alternately with their feet.
c. **Auto-mutilation:** Some individuals turn a normal grooming behaviour into an excessive cleaning behaviour. This behaviour, an exaggerated licking, gnawing and scratching at parts of the body, which may cause serious wounds.

d. **Abnormal aggressiveness:** Explosion of aggressive behaviour that can be directed to a conspecific or other another animal, including humans.

e. **Apathy:** Separation from a mate or companion to which an animal is strongly attached can evoke a state of apathy comparable to depression and mourning of man.

**ENVIRONMENTAL ENRICHMENT:**

- Environmental enrichment is probably the most common means of tackling Captive Behavioural Problems.

**Aim of Environmental enrichment**

1) Increase the number and range of normal behaviours shown by the animals;
2) Prevent the development of abnormal behaviours.
3) Increase the positive utilization of the environment (e.g., the use of space)

---

**REPRODUCTION AND DEVELOPMENT**

**Reproductive Biology:**

**Breeding:** Breeding is most seasonal in felids in the higher latitudes and this is of particular importance in the reproductive pattern of Snow Leopard. The mating season for ♂ snow leopards are generally the end of the winter (December through February) (Freeman et al. 1977).

The female Snow Leopard reaches sexual maturity in captivity at around 2-3 years while males take around 4 years. The age of specific fertility rate for captive snow leopards increases with age until six years for females and eight years for males. After these peaks, fertility decreases until the end of the life span. As per the record of PNHZ Park, the age of sexual maturity ranges from
forty four months of age to hundred and ten months with an average of seventy three months (six years).

MATING BEHAVIOR OF SNOW LEOPARD

OESTRUS PERIOD:
- The time of oestrus is not always the same. This is probably the effect of captivity.

Oestrus Detection:
- Oestrus usually lasts for five to eight days.
- Females in oestrus have a significant increase in rolling behaviour. Head rubbing at specific spots like wooden logs, dens, tree trunk and grass field.
- Flehmen behaviour is also often seen.
- Very often the Female presents herself to the Male by walking in front of him with her tail raised in the air so that her anal region is clearly visible.

Copulation:
- Copulations take place over a period of three to six days.
- The male usually grips the fur on the female’s neck when he mounts. After the last thrust and with the occurrence of full immissio penis, the male gives a loud piercing yowl.
- Sometimes aggressiveness is observed when the Male dismounts the Female. The Female might swear at the male, paw him and even chase him. After copulation, the female rolls on the ground.

1. Flehmen behaviour in Male Snow leopard, 2. Copulation in ventral/ventral position
1. Mating frequency between Karan (male) and Neeta (female) (2003)

2. Mating frequency between Prabhat (male) and Ritu (female) (2012)

**BEHAVIOURS TO CONFIRM PREGNANCY IN SNOW LEOPARD:**
- Increase in genital grooming.
- Less active.
- Resting in one particular place for a maximum time.
- Moderate weight gain which may not be physically visible till the third month.
- Change in the body shape, slight bulge in the hind quarters.
- Two days prior to birth the female will start rejecting her feed.

**Gestation period:**
- The gestation period has been reported to last 90-120 days.

**BIRTH AND LITTER SIZE:**
- Birth usually last two or three hours and in most cases takes place in the morning.
- The new born snow leopard weighs from 300 to 380g.
- They are weak at birth and their eyes are closed. The eyes open in seventh and ninth day.
- The litter size has been reported to be one to five cubs per litter, though most litters comprise one to three cubs.
OBSERVATION ON THE NURSING BEHAVIOUR OF SNOW LEOPARD AT PNHZ Park

Behavioural study of three female Snow leopards (Zima, Morning and Rare) at PNHZ Park:

Duration: Observation of the Snow leopards were conducted from 4.10.2015–18.10.2015 for a period of 2 weeks and then again from 20.03.2016-30.03.2016 for 10 days.

Study Area: Captive breeding centre at PNHZ Park.

Total Hours: 96 hours (10:00 a.m.-4:00 p.m. for 15 days)

Methodology: Continuous Focal Sampling.

Among the three leopards Zima is older than the other two and is fully adult, her age is 5 year. Morning is Zima’s daughter and is a juvenile of 1 year and 5 months. Rear is a sub-adult female of 3 year and 5 months.

Inferences drawn:

1. Snow leopards are diurnal in wild and in captivity also they show this behaviour and are most active at the morning time from 9 a.m. to 11 a.m. when they are released in the enclosure from night shelter and at the evening from 4 p.m. to 5 p.m...They usually rest during the afternoon session.
2. Among the three individual Morning is most active and playful and shows all signs of natural behaviour.
3. Zima spend her most of the day time in resting or sleeping and it seems she is ok with the captive condition.
Unlike the other two Rear spend most of its time in pacing, which is a stereotypic behaviour and a sign of stress. This is most probably because of changing its enclosure few days ago before the study started.

All animals show normal sign of feeding and accept their given feed totally.

One single day (Wednesday 14^{th} October' 15) behaviour observation pattern of Morning and Rear

**POPULATION MANAGEMENT AND GENETIC PROFILING OF SNOW LEOPARD (Uncia uncia) IN CAPTIVITY**

The ultimate goal of ex situ conservation is to provide support for the survival of species in the natural environment. Moreover every ex-situ breeding programme is to manage the captive population in such a way that after 100 years, there will be a viable population of the species with a minimum of 90% of the original genetic diversity retained.

**OBJECTIVE OF POPULATION MANAGEMENT:**

- Increase the population to a sufficient size to avoid extinction due to accidental or chance events, and then to maintain that population with an age and sex structure that promotes reliable reproduction when needed.
- The genetic goal for these populations is to retain the founders' genetic diversity, as unchanged as possible over time, so that the population can serve as a genetic reservoir for the species.
DATA FOR POPULATION MANAGEMENT
The most important task in the development of a captive breeding plan is compiling the basic data required for population analysis and management. The best source of compiled data is a studbook.

“Studbooks are primarily a compilation and source of genealogical data of individual animals which make up a particular zoo population. Studbooks can, however, also assist with recommendations on which animals should breed, with whom, how often and where.”

REINTRODUCTION PLAN OF THE SNOW LEOPARD

Reintroduction projects using wild-caught animals are more successful than those using captive-born animals. Wild caught carnivores are more likely to survive than captive born carnivores and that this trend appears to remain consistent across species and families.

Taking the above review result, a new conservation breeding facility for snow leopard have been developed in a 5 hectare area at Topkey Dara, Darjeeling. The site is as close to the natural habitat of the snow leopard on sunny aspect and will experience snowfall at an altitude of 6800-6900 feet.

The facility aims towards the following goals:

- Less human interference: the facility itself is isolated and away from human habitation, one of the major factors towards preparing the species for reintroduction.
- Large enclosure and undulating slopes allowing the animal to exhibit normal activities.
- Live feeding practices to sharpen their hunting instinct and slowly getting rid of the habit of eating prepared feed in tray.
- No manipulation for management practices with the environmental factors in the breeding centre. Animal to be made accustomed accordingly.
- The facility of Darjeeling Zoo at Topkey dara can be used for housing wild/rescued animals with an objective of releasing back to the wild.
CONCLUSION:

The Snow leopard (*Uncia uncia*) formerly known as *Panthera uncia* is a carnivore of the high mountains of Central Asia, noted for its rarity as an indicator of the ecological health of high altitude ecosystem. The Snow leopard is classified as an endangered species by the IUCN (International Union for Conservation of Nature and Natural resources), Appendix I of the Convention on International Trade in Endangered species of Flora and Fauna (CITES) and schedule I as per WPA (Indian Wildlife Protection Act).

The Snow leopard has been extensively studied in the ranging countries, the study majorly confining to its ecology, habitat, food habit, and estimation of home range with limited studies on its behaviour in the wild perhaps because of its illusive and shy nature. Studying the behaviour of the Snow leopards in captivity thus provides a wide array of opportunities essential for not only knowing the species better but also for the best management interventions as Snow leopard in captivity is a priority species in the Global Conservation Breeding Programme of Endangered species.

The review titled "Study of Snow leopard (*Uncia uncia*) at PNHZ Park" was done at the Park to study the behaviour of the species in captivity and to understand the existing management practices according to the behavioural needs of the animal and also to understand the Conservation Breeding management plan for the species in Indian scenario.
REFERENCE

Snow leopard Conservation in Uttarakhand and Himachal Pradesh. WWF, India. PP. 35-46.


