Insights to Wildlife Health



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INSIGHTS TO WILDLIFE HEALTH

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PREFACE



The purpose of compiling the book entitled 'Insights to Wildlife Health' is to provide a comprehensive understanding of wild animal health, focusing on diverse range of factors that influence well being of animals in the wild. This book on wildlife health monitoring has touched most of important topics pertaining to wildlife health with special emphasis on wild animal anaesthesia, dentistry, ultrasonography, haematology, blood biochemistry, role of Wildlife veterinarians, wild animal dentistry, ophthalmology, wild rhodent surgery, wildlife resurgence, stress in wild animals, important aspects of post mortem of wild animals, challenges and ecology of flagship animal Hangul, DNA extraction, blood collection, rescue operations, and wildlife forensics etc to protect wildlife health, by which we can safeguard biodiversity and invest in a healthier & more sustainable future. This book on wildlife health brings together existing knowledge and research on the subject making it easily accessible to readers. By compiling a book on wildlife health, awareness can be raised about the importance of wildlife health, the impact of human activities on wildlife, and the need for conservation efforts. This book can serve as a valuable resource for students, researchers, and professionals in the field of wildlife conservation, ecology, and veterinary medicine. The literature in the book is presented in such a way that is easily understood and accessible to readers. The motive of the book is to give practitioners and researchers a concise and clearly arranged ideas on techniques employed in the most usual types and procedures in wild animal management and health care. The technical staff and veterinarians, wildlife researchers, professionals, who are involved in the work pertaining to wildlife and wild animals, may forget the details and data required for managing day to day work related to wild animals, but I am sure that this book would surely serve as memory bank to recall various things pertaining to wildlife management. By highlighting the challenges facing wildlife populations and the importance of conservation efforts, a book on wildlife health can inspire readers to take action and support conservation initiatives. Additionally this book on wildlife health can provide a foundation for further research, helping scientists and researchers to identify knowledge gaps and develop new studies. This book especially on account of its explanations and numerous illustrations should prove of considerable assistance to the wild life professionals who are affiliated with the job in forests and wildlife departments. The recommendations made herein have roots from scientific principals, and experiences gained during practical work, published researches and textbooks.

ACKNOWLEDGEMENT

Words seem inadequate to thank the Creator of all things, whose love and grace are beyond measure. I am deeply grateful for the divine guidance and endless support that have been with me throughout this journey. From the smallest moments to the greatest challenges, it is by God's mercy and wisdom that I have been able to complete this work. Apart from my efforts, the success of compiling this book 'Insights to Wildlife Health' depended largely on the encouragement and guidance of my parents. I take this opportunity to express my gratitude to so many people who have been instrumental in the successful completion of my book on Wilidfe health. I would like to show my greatest appreciation to Sh. Omar Abdullah sahib Hon'ble chief Minister of Jammu and Kashmir, Sh. Javed Ahmed Rana sahib Hon'ble Minister for Jal Shakti, Forest, Ecology & Environment and Tribal Affairs, Sh. Javed Ahmed Dar sahib Hon'ble Minister for Agriculture Production, Rural Development & Pancayat Raj Cooperative and Election, Sh. Atal Dulloo IAS Chief Secretary J & K, Sh. Dheeraj Gupta IAS Deputy Chief Secretary J & K, Sh.Suresh kumar Gupta IFS Principal secretary school and higher education and Culture, Sh. Sarvesh Rai IFS Principal chief conservator of forests PCCF / Chief Wildlife Warden, J&K, Sh.Tawheeed Ahmed Deva Regional wildlife warden Kashmir, Sh.Rashid Yahya Naqash Regional wildlife warden headquarter j and K, and all wildlife wardens of Kashmir region, I thank you all for valuable guidance, generous help, affectionate encouragement, deep indulgence throughout. None of my work would be possible without the love and support of my family members. Endless thanks are not enough for my family for always believing in and loving me and all my eccentricities. Growing up, my dad Mr.Akhter Ali Gazi (former Sr.Administrative officer) who taught me to pay attention to the world around me, I thank him for his quiet love and for being the scientist with whom I can only dream to compare. I thank my mom (Mrs.Hashmat Aga) for her incredible friendship, strong love, and limitless prayers and for being an angel for me. Bundle of thanks to Mr.Syed Yaqoob Dilkash (Former principal) and Mrs.Qudsiya Dilkash for all their affections, love and understanding. The cooperation and help extended by Dr.Syed Huma Dilkash deserve reverential thanks for her unflinching affections and valuable suggestions during the compiling of this book. I feel privilege to thank my brother Mr.Hakim Yasir Abbas (Faculty of law Kashmir University) and Sister Sumaiya Gazi, for being great friends and for their pep talks and all time support. My silent friend Mr. Syed Yasoob Dilkash needs special thanks for always being supportive and caring. I would like to thank Mr Hakim Mohd Afzal (educationist and scholar) for all the technical guidance and help during the course of compilation of this book. Lastly the five pillars of my life Master. Asad Ali Gazi, Master. Hakeem Ammar Hussain and baby

Mahira, baby Yumna and Mater Mohammad Arham Gazi you deserve all love and care for always being calm and sprinkling love throughout (god bless u all). My Staff Mr. Bashir Ahmed, Jabeena madam, firdousa madam, Choudhary lalli and Hilal Ahmed bhat deserve special appreciation for their dedication towards duties.

Messages

Principal Secretary,
Department of Culture &
School Education Department
Jammu and Kashmir



Suresh Kumar Gupta

This book titled "Insights to Wildlife Health encompasses the importance of wildlife health monitoring with special emphasis to wild animal anesthesia, dentistry, ultrasonography in Wildlife, hematology and blood biochemistry, role of Wildlife veterinarians, wild rodent surgery, wildlife resurgence, stress in wild animals, important aspects of post mortem of wild animals, challenges and ecology of flagship animal Hangul, DNA extraction, blood collection in wild animals, rescue operations, man animal conflict and wildlife forensics etc. and thus shall be helpful to protect wildlife health, by which we can safeguard biodiversity and invest in a healthier, more sustainable future. A comprehensive book on wildlife health brings together existing knowledge and research on the subject, making it easily accessible to readers. By compiling a book on wildlife health, authors can raise awareness about the importance of wildlife health, the impact of human activities on wildlife, and the need for conservation efforts. This book can serve as a valuable resource for students, researchers, and professionals in the field of wildlife conservation, ecology, and veterinary medicine. The literature in the book is presented in such a way that is easily understood and accessible to readers. The motive of the book is to give practitioners and researchers a concise and clearly arranged ideas on techniques employed in the most usual types and procedures of wild animals. The technical staff and veterinarians, wildlife researchers, professionals, who are involved in the work pertaining to wild animals may easily forget the details, for them this book is intended to serve as "memory and in constructing this memory it has been tried to follow the advice of an old Chinese proverb which asserts that a picture says more than a thousand words. By highlighting the challenges facing wildlife populations and the importance of conservation efforts, a book on wildlife health can inspire readers to take action and support conservation initiatives. Additionally this book on wildlife health can provide a foundation for further research, helping scientists and researchers to identify knowledge

gaps and develop new studies. This book especially on account of its explanations and numerous illustrations should prove of considerable assistance to the wild life professionals who are affiliated with the job in forests and wildlife departments. The recommendations made herein have roots from scientific principals, and experiences gained during practical work, published researches and textbooks.

I compliment the Authors of the Book for taking the wonderful initiative for the benefit of Wildlife experts, Health workers, Researchers and Enthusiasts.

07/12/2024

(Suresh Kumar Gupta) IFS

GOVERNMENT OF JAMMU & KASHMIR
OFFICE OF THE PR. CHIEF CONSERVATOR OF FORESTS (WILDLIFE)/
CHIEF WILDLIFE WARDEN



Dr. Mohsin Gazi, a Wildlife Veterinary Officer, has gained immense experience in wildlife rescue and health management in Kashmir during his posting with Jammu & Kashmir Wildlife Protection Department. His pivotal contributions include establishing a state-of-the-art Wild Animal Health and Diagnostic Center at Dachigam National Park, advancing diagnostic and therapeutic care for wildlife. He has successfully carried out rescue, treatment and rehabilitation of several wild animals including Snow Leopard, Musk Deer, Himalayan Black Bear and Brown Bear. His expertise underpins Insights to Wildlife Health, a comprehensive resource on wildlife health monitoring and conservation.

The book covers critical topics such as wild animal anaesthesia, haematology, wildlife forensics, and conservation challenges of species like the Hangul (Cervus hanglu hanglu). By combining innovative practices with practical applications, it serves as a valuable guide for students, researchers, and professionals, fostering a deeper connection between wildlife health, ecosystem balance, and sustainable conservation efforts.

I extend my sincere appreciation to the author of this book for his significant contribution. His expertise and dedication are evident throughout this work. I am confident that Insights to Wildlife Health will become a cornerstone reference in advancing wildlife healthcare and promoting informed conservation across the country.

Date: 04-01-2025

(Sarvesh Rai) IFS
PCCF (Wildlife)/Chief Wildlife Warden
Jammu & Kashmir

Government of Jammu and Kashmir
Department of Wildlife Protection
Office of Regional Wildlife Warden Kashmir



Wildlife health monitoring is an essential pillar of conservation science, linking veterinary medicine, ecology, and biodiversity preservation. It plays a critical role in maintaining ecological equilibrium, safeguarding our planet's natural heritage, and supporting sustainable coexistence between humans and wildlife. This book, Insights to Wildlife Health, is a significant step forward in addressing the complex and multifaceted challenges faced in wildlife health care and management.

The text offers a comprehensive exploration of practical approaches and advanced techniques vital to wildlife health monitoring. It also delves into critical conservation issues such as human-wildlife conflict, rescue operations, and the management of endangered species like the Hangul (Cervus hanglu hanglu). The inclusion of topics like rodent surgery and wildlife resurgence reflects the breadth and depth of this publication.

This resource is particularly valuable for students, researchers, field veterinarians, and professionals working in wildlife conservation. It bridges theoretical concepts with practical applications, ensuring its relevance in field conditions where rapid and informed decision-making is often required. The illustrative content enhances its accessibility, making it a vital tool for veterinarians, conservationists, ecologists, and forest managers who navigate the challenging and dynamic field of wildlife health.

By addressing the interplay between wildlife health and ecological sustainability, this book underscores the need for a proactive approach to conservation. The knowledge it provides is not only a guide for addressing current challenges but also a foundation for future research and innovation. It

highlights critical knowledge gaps, inviting professionals to pioneer solutions that ensure the long-term survival of wildlife populations.

I commend Dr. Mohsin Gazi for his dedication and expertise in producing such a detailed and practical work. His commitment to advancing wildlife health and conservation is evident throughout this publication. Insights to Wildlife Health is a testament to his efforts and a significant contribution to the field.

As the Regional Wildlife Warden of Kashmir, I am optimistic that this book will inspire professionals and enthusiasts alike to deepen their engagement with wildlife conservation. May it serve as a catalyst for innovative practices and meaningful contributions to preserving our natural world for generations to come. Together, we can build a future where wildlife thrives in harmony with human development.

Tawheed Ahmad Dev, IFS
Conservator of Forests
Regional Wildlife Warden, Kashmir

Government of Jammu and Kashmir
Department of Wildlife Protection
Office of Regional Wildlife Warden Headquarter J&K



The book, "Insights to Wildlife Health", has been meticulously compiled to address the critical need for monitoring and maintaining the health of wildlife a cornerstone of biodiversity conservation and a healthier, more sustainable future. This comprehensive volume delves into various aspects of wildlife health, including anesthesia, dentistry, ultrasonography, haematology, blood biochemistry, and post-mortem procedures. It also explores niche topics like wild rodent surgery, wildlife resurgence, stress management in wild animals, DNA extraction, blood collection, rescue operations, man-animal conflict, and wildlife forensics, with a special focus on the conservation challenges of the Hangul, a flagship species.

The primary aim of this book is to provide a consolidated resource that integrates current knowledge and research in the field of wildlife health, making it easily accessible to students, researchers, veterinarians, ecologists, and conservationists. By offering a clear and concise overview of techniques and procedures commonly employed in wildlife health management, this book serves as a practical guide for professionals working in forest and wildlife departments.

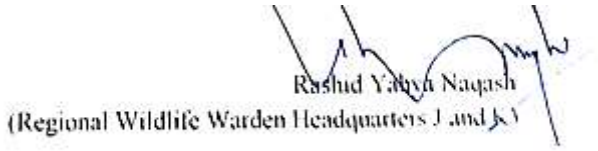
Wildlife health is an often-overlooked but critically important aspect of conservation and ecological management. As human activity increasingly encroaches on natural habitats, wildlife species are facing unprecedented challenges from habitat loss, climate change, and emerging diseases. Understanding the health of wild animals is essential not only for their survival but also for the stability of ecosystems that depend on them. The content is thoughtfully presented with straightforward explanations and numerous illustrations, ensuring clarity and ease of understanding.

The recommendations presented here are grounded in scientific principles, enriched by practical experiences, and supported by published research and

authoritative texts. This book will help to serve as a comprehensive resource on the health of wild animals, covering a wide array of topics including disease prevention, management strategies, the impact of human interaction, and the intricate relationships between wildlife, ecosystems, and human health.

I would like to extend my heartfelt appreciation to Dr. Mohsin Gazi, Wildlife Veterinarian, whose unwavering dedication and expertise have been instrumental in compiling of this book. His contributions have significantly enriched the content, making it an invaluable resource for the UT of J&K and beyond.

It is my sincere hope that "Insights to Wildlife Health" will empower its readers to contribute meaningfully to the preservation and well-being of our planet's wildlife.



Rashid Yahya Naqash
(Regional Wildlife Warden Headquarters J and K)

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CHAPTER 1

History of Wild Life

The term 'wildlife' not only refers to wild animals but also takes into account all undomesticated life forms including birds, insects, plants, fungi and even microscopic organisms. For maintaining a healthy ecological balance on this earth, animals, plants and marine species are as important as humans. Each organism on this earth has a unique place in food chain that helps contribute to the ecosystem in its own special way (*Mondal et.al 2012*). In present time many of the animals and birds are getting endangered as a result of destruction of natural habitats for land developments and farming and other activities by humans. Additionally poaching and hunting of animals for fur, jewellery, meat and leather are other great factors contributing to wildlife extinction. There is a dire need of incorporating stringent steps to save our precious wildlife. India is one of the most biodiverse regions and is home to a large variety of wildlife (*Stephen et.al 2015*). About 24.6% of the total land area is covered by forests. It has various ecosystems ranging from the high altitude Himalayas, tropical evergreen forests along the Western Ghats, desertin the north-west, coastal plains and mangroves along the peninsular region (*Bhat et.al 2020*). India lies within the Indomalayan realm and is home to about 7.6% of mammal, 14.7% of amphibian, 6% of bird, 6.2% of reptilian, and 6.2% of flowering plant species. India has an estimated 92,873 species of fauna, roughly about 7.5% of the species available worldwide (*Parmar et.al 2020*). Insects form the major category with 63423 recorded species. India is home to 423 mammals, 1233 birds, 526 reptiles, 342 amphibians, 3022 fish, apart from other species which form 7.6% of mammal, 14.7% of amphibian, 6% of bird, 6.2% of reptilian species worldwide. Among Indian species, only 12.6% of mammals and 4.5% of birds are endemic, contrasting with 45.8% of reptiles and 55.8% of amphibians (*Thomas*, 2017; Saravanan 2022). Wildlife in India has been surviving since the Vedic period ranging from 1500 BC to 500 BC a record of the existence of nearly 250 species of birds at the time have been obtained. Information about wildlife belonging to this period is present in the medical treatises of Sushruta and Charaka. The blackbuck was quite common in `Aryavarta` or the land of the Aryans, who were present in the northern part of the Vindhya Mountains and even those which extended till the south. The house crow and Indian koel were commonly noticed at that time (*Polissar et.al 2021*). The 2000-year-old `Gajashastra`, which was written in Pali script, contains references to the training of captured elephants. Several animal bones, which existed prior to 1700 BC, have been discovered at the sites of Indus Valley Civilization. More specifically, the bones of elephants, chital, jackal, hare and rhinoceros have been discovered at the site (*Baskaran & Desai1996; Stephen*

et.al 2017). Clay tablets of this period depict species of elephant and rhinoceros, which have presently been labeled as "extinct". Elephants are the earliest known Indian animals, which were employed to be mounted upon during battles. They acted as raised platforms during hunting and also as a status symbol during Harappan Civilization (*Choudhury, 1985;* Nandan, 1995). When we go through medieval history of Indian wildlife we find Jahangir and Babur were amongst the mughal emperors who made regular observations of wildlife in their journals. Some of the literature suggests that lesser rhinoceros survived during the time, especially near Mahanadi river and Sunderbans, close to Bengal and also near Rajmahal Hills, close to Ganges River. Babur and Jahangir were fond of hunting and many animals were hunted near Kolkata as per the old literature (Prasanna 1996; Smith 1991).

During Mughal period, a significant contribution from the point of view of environment conservation has been the establishment of magnificent gardens, fruit orchards and green parks, round about the emperor's palace, central and provincial headquarters etc. In addition, the religious policy of Akbar based on principle of complete tolerance also reflects concern for protection for birds and beasts in so much so as endeavors were taken during his reign to stop their unnecessary killing. The Mugal court patronised the use of birds and animals as essential elements in the composition of landscapes and portraiture. 'The Mugal Emperor exhibited deep interest in wild life of India during medieval period (Divan, 2001). They have created hunting reserves called 'shikargaha' for protection and preservation of game animals (Singh, 1989).

As far as Jammu and Kashmir is concerned it comprises of India's most scenically beautiful wildlife reserves. Due to the vast variation in geographical structure, climate and altitude, these parks are demarcated into two regions. The upper region faces extremely harsh winter, therefore the best time for visiting it is between the months of April and August (*Lawrence, 1895*). For the lower region, the ideal time is between October and February but it is also equally rewarding in summer. Apart from the unspoiled natural beauty, the wildlife sanctuaries of J&K are known for some of the rarest and endangered species of wild animals. Hangul (Kashmiri stag; an endangered species of red deer), leopard, wild cats, Himalayan black bear, musk deer, Himalayan marmot and species of wild goats like the markhor can be seen (Singh, 1989; *Groombridge, 1993;* Nandan, 1995;Brown and Sleeman 2002; Chitty and Lierz 2008; Grogan and Kelly 2013). Various Himalayan birds, colorful pheasants like the monal pheasant, blood pheasant and koklass pheasant, golden eagles and bearded vultures are also seen encircling the majestic mountains (*Hamadani et.al 2022*). Several other fascinating and exquisite forms of life can be seen in the national parks and sanctuaries in Jammu and Kashmir.

The history of wildlife conservation in Jammu and Kashmir is intertwined with the region's rich biodiversity and cultural heritage (Prasanna, 19996). Some important events which mark add to history of wildlife in j and k includes, early Conservation Efforts: Pre-Colonial Era: Indigenous communities in the region had traditional practices that helped maintain ecological balance. There are 867 vertebrate species living in Jammu and Kashmir out of the 6122 species in all of India. Of these 867, 120 are fish, 17 are amphibians, 63 are reptiles, 555 are birds, and 112 are mammals. Fish make up about 14%, 2% are amphibians, 7% are reptiles, 64% are birds, and mammals make up 13%. In Jammu and Kashmir, there are 1485 species of invertebrates, out of the 83,479 species in all of India. There 121 species of rotifers 22 species of annelids 1315 species of arthropods and 27 species of mollusks Additionally, rotifers make up 8% of the 1485 species of invertebrates, 1% are annelids, 89% are arthropods, and mollusks make up less than 2% (Dar *et.al* 2020).

After independence, in the year 1950s-1960s, the Indian government recognized the need for comprehensive wildlife conservation. The Wildlife Protection Act of 1972 was a significant milestone, providing a legal framework for protecting wildlife and their habitats. This Act provides for the protection of the country's wild animals, birds, and plant species, in order to ensure environmental and ecological security. Among other things, the Act lays down restrictions on hunting many animal species (*Tritsch, 2001; Sanjay, 2022*). In the year 1970s-1980s: Several national parks and wildlife sanctuaries were established in Jammu and Kashmir, including Dachigam National Park, Hemis National Park, and Kishtwar National Park. These protected areas played a crucial role in safeguarding the region's unique wildlife. Jammu and Kashmir is home to five remarkable national parks, each offering a unique blend of breathtaking landscapes and rich biodiversity. The State Government has notified about 4861.28 sq km as Protected Area Network comprising of various National Parks, 14 Wildlife Sanctuaries and 30 Conservation / Wetland Reserves (Bhat *et.al* 2020). There are many management activities being undertaken in the areas include habitat improvement, plantation, soil and water conservation, protection from fire, anti poaching activities, development of infrastructure for front line staff, providing supplemental feed to rescued and captive wild animals etc

CHAPTER 2

Introduction to wild life health

Dr. Mohsin Ali Gazi (Veterinary officer Department of Wildlife Protection Kashmir)

I. INTRODUCTION

Wildlife health is the state of well-being of wild animals, encompassing their physical, mental, and ecological health. It embraces the study and management of diseases, injuries, and other health-related issues affecting wildlife species. It also includes understanding how factors such as habitat loss, environmental changes, human activities, and interactions with domesticated animals can influence the health of wildlife populations. Modern definition of wildlife health should emphasize that 1) health is the result of interacting biologic, social, and environmental determinants that interact to affect capacity to cope with change; 2) health cannot be measured solely by what is absent but rather by characteristics of the animals and their ecosystem that affect their vulnerability and resilience; and 3) wildlife health is not a biologic state but rather a dynamic social construct based on human expectations and knowledge. The wildlife health framework aims to identify and promote solutions for more effective monitoring and early detection systems through the integration of wildlife components. By protecting wildlife health, we safeguard biodiversity and invest in a healthier, more sustainable future. Humans and animals including both domestic and wild, share their ecosystems with numerous micro-organisms (*Thomas. 2017*). Among those micro-organisms many provide essential life-sustaining support, but some are harmful and may cause diseases in humans or animals.

During recent years, the increasing number of emerging disease has been linked, or even blamed on wildlife. However, human activity, along with factors such as climate change, wildlife trade, deforestation, and certain farming practices are also major forces behind disease emergence. Animals and biodiversity can often be the forgotten victims of disease outbreaks. For decades, the World organization for Animal Health has strived to improve animal health, including protecting wildlife health. It is recognized fact that the health of humans, animals (both wild and domestic) and ecosystems are interdependent. To protect one, we need to value them equally (*Turvey et.al 2021*). Diseases in wildlife can influence reproduction, survival, fitness, and abundance of wildlife populations and can affect biodiversity within ecosystems and present an additional threat to many populations, especially those with limited abundance (i.e. threatened and

endangered species) (Pascual*et.al*2022). Some pathogens can also be transmitted among conspecifics, other wildlife species, domestic animals, and humans, posing risks to human and animal health and resulting in significant economic impacts (Cupertino *et.al*2020). A few examples of important diseases occurring in various countries that may have significant ecological, economic, and health impacts include: chronic wasting disease of North American Cervids, Rabies and Bovine tuberculosis in wild terrestrial mammals, avian malaria and pox, and multi-species ecological impacts of avian influenza, avian cholera, and avian botulism. In addition, many exotic diseases have emerged or re-emerged in wildlife populations as threats throughout the world including foot and mouth disease, Rift Valley fever, and Ebola hemorrhagic fever (Cunningham *et.al* 2018). Emerging zoonotic (transmitted between animals and humans) diseases (e.g., AIDS, SARS, rabies, Ebola) have increased concern for public health and stimulated importance of collaborative approaches that integrate human, domestic animal, and wildlife health (Syed *et.al* 2024).

Wildlife health is a crucial aspect of conservation biology, focusing on the health and well-being of wild animals in their natural habitats. It focuses on the physical and ecological well-being of wild animals, ensuring they thrive in their natural habitats. It encompasses the diagnosis, treatment, and prevention of diseases affecting wildlife populations, as well as the monitoring of environmental health and its impact on wildlife. Maintaining healthy wildlife populations is essential for preserving ecosystem balance, biodiversity, and ecological integrity. Wildlife health is closely linked to human health, as many diseases can be transmitted between humans and animals (Booth, 2003). Various factors affecting wildlife health incorporate habitat destruction and fragmentation, climate change, pollution, overexploitation of resources and disease transmission. Understanding wildlife health is critical for developing effective conservation strategies, managing wildlife populations, and mitigating the impacts of human activities on wildlife. Key aspects of wildlife health include: disease ecology and epidemiology, wildlife pathology and diagnostics, conservation medicine, wildlife-human interface and zoonotic diseases, ecosystem health and biodiversity conservation.

Table: Showing Physiological Parameters of Various Wild Animal Species, Including Heart Rate, Respiratory Rate, Body Temperature, and Other Key Metrics. These Values can Vary Depending on the Species, Age and Environmental Conditions.

Physiological Parameter	Deer	Big Cats (Lions, Tigers, leopards)	Bears (Grizzly, Black Bear)
Body Temperature	38-39°C (100-102.5°F)	38-39°C (100-102.5°F)	37.5-38.5°C (99.5-101.3°F)
Heart Rate (Resting)	60-80 beats per minute	40-70, 60-100 (leopard) beats per minute	40-70 beats per minute
Respiratory Rate	20-30 breaths per minute	20-30 breaths per minute	10-25 breaths per minute
Blood Pressure	120/80 mmHg (approx.)	100-120/60-80 mmHg (approx.)	100-120/60-80 mmHg (approx.)
Lifespan	10-20 years (depends on species)	12-15 years up to 20 (in the wild)	20-30 years (in the wild)
Body Mass	50-200 kg (depends on species)	100-250 kg (depends on species)	50-700 kg (depends on species)
Metabolic Rate	Moderate to high	High	Moderate to high
Food Consumption	Herbivore, 2-4% of body weight daily	Carnivore, 2-5% of body weight daily	Omnivore, 3-5% of body weight daily
Oxygen Consumption	Moderate	High	High
Reproductive Cycle	Seasonal, Rut (Mating) in fall	Year-round, estrus in females	Seasonal, estrus in spring-summer

***Note that values can vary somewhat based on species and environmental conditions. (References have been taken from published research work, well known studies and field guides on animal biology, behavior and conservation)**

1. **Heart Rate (bpm):** Beats per minute. Generally, larger animals have slower heart rates, while smaller animals (like birds) have faster heart rates.
2. **Respiratory Rate:** The number of breaths per minute. Predators often have a lower rate, while herbivores tend to have higher rates due to energy demands.

3. **Body Temperature:** Most wild mammals are endothermic (warm-blooded), maintaining a steady body temperature, though reptiles like crocodiles and sharks are ectothermic.
4. **Blood Pressure:** Varies widely among species and provides insight into cardiovascular health.
5. **Body Mass:** Body weight can range significantly across species, with larger animals like elephants and whales weighing several tons, while smaller animals like koalas are much lighter.
6. **Lifespan:** The number of years an animal typically lives in the wild.

2.1 BLOOD BIOCHEMISTRY AND URINALYSIS

Blood hematology and biochemical parameters are essential to diagnose disease pertaining to the health of both wild and captive animals. The use of hematological parameters is essential in assessing the condition of animals, and serum biochemistry is used as a tool for the clinical assessment of health wild animals. The use of animal blood as an indicator for disease pathology is critical in the management of wildlife. Blood samples shall be taken from rescued animals and wild animals in captivity shall be put to assessment of various tests like KFT and Blood glucose levels.

Urinalysis is one of the underrated, yet remarkable tools in health diagnostics of animals. The initial stages of development of several diseases such as diabetes mellitus, urinary tract infection and glomerulonephritis can be easily traced by using urinalysis as an aid. Observing the physical, chemical and microscopic aspects accompanied by microbial culture and sensitivity test reveals majority of the lower tract infection and also determines the overall health status of a animal. Proper sampling and storage are a prerequisite for any accurate prognosis of an ailment. Sterility while collecting the necessarily to be maintained at all conditions and a fresh collection container is always to be preferred. Collection of urine samples shall be done by cystocentesis the most preferred and accurate method. A sterile needle shall be inserted into the urinary bladder via the abdominal wall and with the help of a syringe, and urine collection can be done.

Evaluation of Kidney health: Kidney function tests, such as measuring blood urea nitrogen (BUN) and serum creatinine levels are very helpful in assessment of the overall kidney health of wild animals. Changes in kidney function can be indicative of an animal's hydration status. Abnormal kidney values may suggest dehydration, a common issue in wildlife, especially during droughts or in arid environments. Elevated values or raised kidney levels may indicate kidney disease or dysfunction and can be a sign of stress and other nephrological disorders in animals. Wildlife Veterinarians use these tests to monitor how

animals are adapting to new environments, captivity, or other stressors. Monitoring kidney function in wildlife can help assess the impacts of environmental pollutants or toxins on a population. Understanding the kidney health of endangered or threatened species is crucial for conservation efforts. Long-Term monitoring of kidney values can help researchers understand changes in animal populations over time. In cases where kidney dysfunction is detected, Wildlife Veterinarians can use kidney function tests to guide treatment plans, such as fluid therapy, dietary adjustments, or medication. When capturing and handing wild animals for research or relocation, kidney function tests are part of the health assessment to ensure animals are fit for release.

Overall, kidney function tests are valuable tools in wildlife veterinary medicine and provide essential information about an animal's health, stress levels, and exposure to environmental factors, contributing to the conservation and well-being of wild species. Introduction of urinalysis in the field of wildlife sciences for study and examination of urine of wild animals can augment the research work in detecting wide range of urinary tract infections, kidney diseases and diabetes studies in field conditions.

Regarding estimation of Glucose levels in wild animals, it is a crucial part of a comprehensive health assessment for wild animals. Abnormal glucose levels can indicate underlying health issues such as diabetes, metabolic disorder, or stress. Elevated glucose levels can be a sign of stress and other endocrine disorders in wild animals. Monitoring glucose levels can help assess how animals are responding to capture, handing, or other stressors, which is vital for minimizing the impact of research or conservation efforts. Glucose levels can provide insights into an animal's nutritional status. Low glucose levels may indicate malnutrition or inadequate food availability in the animal's habitat. In some cases, diabetes can occur in wildlife population. Blood glucose measurement is vital to enable meaningful health and physiological assessments in captive and wild animals. When wild animals are rescued and brought to rehabilitation centres, monitoring their glucose levels can help to ensure about proper animal nutrition and medical care during the rehabilitation process. Monitoring glucose levels in endangered or threatened species can provide valuable information about their overall health and the impact of environmental changes on their well-being

2.2 HEART HEALTH / MONITORING OF CARDIAC HEALTH IN WILD ANIMALS

Electrocardiography (ECG) is a valuable diagnostic tool when used by veterinarians for monitoring and assessing the cardiac health of wild animals. Electrocardiography is the process of producing an electrocardiogram (ECG) a

recording of the heart's electrical activity through repeated cardiac cycles. It is an electrogram of the heart of animal which is a graph of voltage versus time of the electrical activity of the heart using electrodes placed on the skin of animal. One of the most common and simplest methods is to place these electrodes on the limbs of animals referred to as a body surface limb ECG recording. Electrodes can also be placed on the chest (precordial chest ECG recording commonly used in humans) to have an idea about heart rhythms and cardiac activity. This main aim of conducting and recording ECG in animals is to evaluate the cardiac health and to rule out cardiac ailments or disorders. It is the method most commonly used in veterinary medicine for clinical diagnosis of arrhythmias and heart attacks. Changes in the normal ECG pattern occur in numerous cardiac abnormalities, including cardiac rhythm disturbances (such as atrial fibrillation and ventricular tachycardia, inadequate coronary artery blood flow (such as myocardial is chemia and myocardial infarction), and electrolyte disturbances (such as hypokalaemia and hyperkalaemia). Rescued animals and sick wild animals in captivity need to be put to electrocardiography and assessment of cardiac health is necessary so that the clinical findings are correlated with the signs and symptoms of animal presented and accordingly treatment regimens can be planned. ECG is especially important when animals are captured or sedated and are in stress, for research or medical purposes and health monitoring of wild animals. ECG can provide essential data for research on wild animal's populations. It helps researchers understand the cardiac physiology and stress responses of these animals. ECG helps evaluate the stress levels of wild animals in response to various environmental factors or human interactions, which can be crucial for conservation efforts. When performing medical procedures on wild animals, veterinarians can use ECG to monitor the animal's heart rate and rhythm to ensure their safety under anesthesia and operative procedures. For injured or orphaned wild animals undergoing rehabilitation, ECG can assist in tracking their cardiac progress and ensuring their readiness for releasing animals back into the wild. In summary, ECGs are essential non-invasive tools in wildlife health assessment, offering insights into cardiac function that can guide conservation efforts, enhance animal welfare, and further scientific understanding of wildlife physiology.



Fig: Health monitorring of wild animals and wild birds, images taken from wild animal healthcare centre Dachigam.







Fig: Health examination in different wild animals, images taken from wild animal healthcare centre hospital Dachigam.

CHAPTER 3

Health monitoring of wild animals

Dr. Mohsin Ali Gazi (Veterinary officer Department of Wildlife Protection Kashmir)

I. INTRODUCTION

Health monitoring in wild animals is an important component of the conservation of wild species. These wild animals like other domestic animals, birds and humans are susceptible to various infectious diseases that can cause morbidity and mortality resulting in significant impact on the dynamics and conservation status of these precious species. The health of wildlife is deeply interlinked with the health of other animals, the environment and even humans. Pathogens in wild animals may affect human health and can be direct sources of infection for people with pathogens that can cause disease in humans. According to research and recent studies there are hundreds of human diseases derived from pathogens in wild animals that became important to human health in the past so many years. The survival of humans, animals, and plants depends on the health of their ecosystems so by protecting wildlife health, we safeguard biodiversity and invest in a healthier, more sustainable future. Wildlife is a valuable asset for many communities across the world, supporting livelihoods through the provision of income, whether it is through tourism or as a source of food. Importantly wildlife has a positive effect on human well-being, contributing to education, physical and mental health, social values, culture and spirituality (Bexton& Robinson 2003). Wild animal health care aims to identify and promote solutions for more effective monitoring and early detection of diseases through animal regular heath check control programs which is a key component of animal welfare.

Nowadays we find a need of introducing wildlife dentistry as it plays a crucial role in wildlife conservation and management. It is the art and science of prevention, diagnosis, and treatment diseases of conditions, and disorders of the oral cavity, the maxillofacial region, and its associated structures related to wild animals. Dental instruments and dentistry equipment's are mainly used to examine, manipulate, treat, restore, remove teeth and surrounding oral structures and provide dental treatment. Examination of the oral cavity should form basic part of every physical examination of all rescued wild animals requiring oral health check-up and correction of any disease conditions and disorders of the oral cavity. Prior to initiation or planning of any treatment for disorders of oral cavity, radiographs(x-rays) may be needed to evaluate the health of the jaw and

the tooth roots below the gum line as most dental disease occurs below the gum line and require radiograph for accurate visibility and correct diagnosis. Dental examination of the wild animals can help determine the age of animals, which is essential for population management and can provide valuable insights into the overall health of wildlife dental broader health issues, such as malnutrition or infection. Dentistry can also aid in distinguishing between different species based on dental features, helping in the accurate classification of animals. Further Injured or rescued wild animal may also require dental health check-up to enable their mastication mechanisms, dental caries or oral infections and overall dental health before release. Another aspect of introducing wild animal dentistry can be that it can contribute to our understanding of wildlife behavior, diet, and ecology, which can inform conservation strategies and habitat management and research.

Apart from dentistry, there is a need of establishment of comprehensive diagnostics and imaging techniques in the form of ultrasonography (USG) and digital X-ray as a valuable tool to study about pregnancy state of any rescued female wild animal in Kashmir and to evaluate and monitor the reproductive health of wildlife species for providing better care and management to pregnant animals and its young one. USG can guide to detect tumours, injuries, or infections in internal organs, allowing for timely intervention and treatment. It can help us to diagnose injuries or illnesses, guiding treatment and rehabilitation efforts. Simultaneously digital X-rays (a non-invasive diagnostic tool) can also be used to monitor the health of populations, identifying diseases or conditions that may impact the overall well-being of a species. It can be used to diagnose injuries or illnesses in wildlife, helping in making informed decisions about treatment and rehabilitation. X-rays can reveal information about the age, growth, and reproductive status of individuals within a population, aiding in population management and conservation efforts.

Another aspect of upgrading health care of wild animals can be with the evaluation of Kidney health using kidney function tests, such as measuring blood urea nitrogen (BUN) and serum creatinine levels shall be helpful in assessment of the overall health of wild animals. Changes in kidney function can be indicative of an animal's hydration status, stress and body mechanics. Monitoring kidney function in wildlife can help assess the impacts of environmental pollutants or toxins on a population. In cases where kidney dysfunction is detected, (KFT) can guide in treatment plans, such as fluid therapy, dietary adjustments, or medication. Further estimation of Glucose levels in wild animals can also be a crucial part of health monitoring and can indicate underlying health issues such as diabetes, metabolic disorder, or stress. Monitoring glucose levels can help assess how animals are responding to capture, handing, or other stressors, which is vital for minimizing the impact of

research or conservation efforts. Glucose levels can provide insights into an animal's nutritional status. Low glucose levels may indicate malnutrition or inadequate food availability in the animal's habitat. One more aspect of advances in diagnostics can be use of ECG to assess the overall cardiac health of wild animals. This is especially important when animals are captured or sedated for research or medical purposes and health monitoring of wild animals. It helps researchers understand the cardiac physiology and stress responses of these animals. ECG helps evaluate the stress levels of wild animals in response to various environmental factors or human interactions, which can be crucial for conservation efforts. Precisely, up gradation of wild animal healthcare can be a valuable thing in wildlife management and conservation, helping to ensure the well- being and preservation of various species in their natural habitats and can have a positive impact on overall management of wild animals.



Fig: Medication and followups in wild birds and captive wild animals at rescue and rehabilitation centre dachigam.



Fig: Health monitoring and follow-up in wild birds and wild animals in Kashmir

CHAPTER 4

Role of Wildlife veterinarians

Dr. Mohsin Ali Gazi (Veterinary officer Department of Wildlife Protection Kashmir)



Dr. Mohsin Ali Gazi



I. INTRODUCTION

The survival of humans, animals, and plants depends on the health of their ecosystems so by protecting wildlife health, we safeguard biodiversity and invest in a healthier, more sustainable future. Wild animal health care aims to identify and promote solutions for more effective monitoring and early detection of diseases through animal regular heath check control programs which is a key component of animal welfare. Wildlife veterinarian has not only a broad education in comparative medicine but also are also highly trained in recognizing, diagnosing and understanding disease impact on public health as well as on individuals, populations and whole ecosystems. Their skills and expertise turn them into valuable key players in planning, implementing and effectively assisting rescue and rehabilitation, both in-situ and ex-situ conservation methods and rescue of animals in distress and conservation of worldwide fauna flora, and protection of animal welfare in whole. Wildlife veterinarians play a vital role in both conservation efforts and mitigating human-wildlife conflict throughout world. They are managing health and well-being of wild animals, both in the wild and captivity. They also work to mitigate the negative impacts of human-wildlife conflict on both humans and wildlife. Wildlife veterinarians play a vital role in the capture of menace-causing wild animals. They are responsible for ensuring that the capture process is safe and humane for both for the animal and the capture team. Wildlife veterinarians typically work with other professionals, such as forest rangers, wildlife biologists, and capture experts, to develop and implement a capture plan. The capture plan is tailored to the specific species of animal being captured, and it

takes into account the animal's age, sex, health condition, and the environment in which it is being captured. Before attempting capture, veterinarians consider the biological aspects of the targeted species, the immobilization techniques required, and the transport methods for captured animals. Chemical restraint employed by the wildlife veterinarians has to been successfully conducted to relocate or treat animals in the captivity as well as in the wild resulting in the rescue of many rare and critically endangered species in order to minimize risks of anesthesia to the subject animals. Wildlife Veterinarians also need to be able to react appropriately using the correct equipment with sufficient skill to deal with anything that may go wrong during the capture. Use of anesthetics, dose of medicine, route of administration, type of needle, size of gauge, dart pressure, site of traquilization, position of restraining, and use of appropriate antidotes is all the domain of a wildlife veterinarian (Vogelnest, 2008). The fate of rescued animals in terms of stress management during rescue and rehabilitation is all together a technical part that can be best judged by a veterinarian who can understand animal pain, discomfort, stress level, and other symptom-based ailments of rescued animals. Once a capture plan has been developed, wildlife veterinarians are responsible for selecting the appropriate capture drugs and dosages. They are also managing monitoring of the animal's health during the capture process and providing veterinary care as needed. After the animal has been captured, wildlife veterinarians are assessing its health and fitness for release. Wildlife veterinarian has a mandate for providing immediate medical/health care to injured or sick wildlife with necessary medications, control of immobilization equipment, and first aid provisions. Wildlife veterinarians ensure the availability of emergency medicines, transport containers, and other essential resources to effectively manage wildlife health emergencies. The specialized equipment's, darts, cages, and other operative gears used during mitigating of human-wildlife conflict are also animal specific and can be best be decided by a veterinarian as far as the technicality of the issue is concerned.

All the rescue operations in valley are being augmented with the training programmes and practical demonstrations to frontline warriors throughout year and that too is being conducted by a wildlife veterinarian. The role of wildlife veterinarians in conservation and human-wildlife conflict mitigation in India is of utmost importance. Their expertise in understanding wildlife, managing disease outbreaks, and implementing conservation strategies is instrumental in maintaining the delicate balance between human settlements and wildlife habitats. By collaborating with various stakeholders and utilizing scientific knowledge, wildlife veterinarians contribute significantly to the preservation of overall unique biodiversity. Furthermore the sensitivity of involvement of scheduled wild animals, technicality of the process and professionalism in managing MAC (Man animal Conflict), and overall animal welfare the

monitoring rescue operations w.r.t MAC strictly a domain of a wildlife veterinarian. Although a strong support of respective wildlife wardens, foresters, range officers, frontline workers, health institutions, police, disaster management teams has to be a part of any rescue operation but SOP's for planning and mitigation has to be strictly followed as per directions and guidelines conveyed by CZA (central zoo authority) and can be best undertaken under the supervision of a wildlife veterinarian only.



Fig: pictures taken during trainings and rescue operations in Kashmir

CHAPTER 5

Advances of Ultrasonography in healthcare of wild animals





Dr. Mohsin Ali Gazi (Veterinary officer Department of Wildlife Protection Kashmir)

I. INTRODUCTION

Ultrasonography in veterinary field is a diagnostic imaging technique used to visualize internal structures and organs of animals. This non-invasive procedure utilizes high-frequency sound waves, which are emitted by a transducer, to create real-time images of the tissues inside the body. The sound waves bounce off tissues and organs, and the resulting echoes are then processed into images, which can help veterinarians diagnose various medical conditions. Nowadays we are familiarised with a number of imaging techniques & diagnostic modalities that help us in diseases diagnosis & many of these have been adapted for use in animals. Ultrasound is among the most rapidly advancing imaging techniques that is becoming increasingly important in veterinary practices for precise diagnosis of a disease. It is a safe diagnostic technique that provides information about insights of internal structures of organs and carries information about any deformity in the form of images. This chapter briefs about the importance and uses of ultrasonography in animals especially wild.

II. ULTRASONOGRAPHY AT GLANCE

Ultrasonography (USG) is a well-established, non-invasive, diagnostic imaging technique that provides unique information about the structure of soft tissues & enables the evaluation of the motion pattern of certain organs & structures. Principle of USG involve use of ultrasonic sound waves to create images of

body structures based on the pattern of echoes reflected from the tissues and organs being imaged. Transducer sends out a beam of sound waves/echo's into the body, these sound waves get reflected back to the transducer by boundaries between tissues. When these echos hit the tranducer they generate electric signals which are send to USG scanner. Using the speed of sound and time of each echo returned, scanner calculates the distance from the transducer to tissues, and these distances are used to generate two dimensional images of tissues and organs.

A wide range of animal species from large to small and from domestic animals, to wild are being put to USG examination for proper disease diagnostics and planning better treatment regimens. The profitability of an ultrasound can be maximized through the scanning of various organs like liver, bladder, mammary gland, lungs, & kidneys, musculoskeletal & viscera for various infections & deformities. It is nowadays possible that even eye examination with ultrasound for staphylomas, retinal detachments, foreign objects, cataracts, tumours, glaucoma, anterior chamber pathology such as hypopion, & many other vision-related problems can be taken care with USG. Ultrasonography has a wide range of utility related to reproduction assessment and assisted reproduction technologies, physiologic, anatomic, and morphologic studies. Primarily use of USG for safer pregnancy diagnosis is because of the fact that there is no exposure to ionizing radiation as has been observed with X-ray imaging techniques. Ultrasonography is an excellent tool for safely & accurately guiding a needle into a nodule or mass to ensure proper sampling & an accurate diagnosis. In addition, the use of USG in abdominocentesis, thoracocentesis, pericardiocentesis, cystocentesis, and biliary centesis with increased safety of each procedure when small volumes of fluid are sampled is reported (Nyland*et.al* 2020). More over ultrasound can be used to gain valuable information about the urogenital system. The bladder, ureters, & urethra can be examined for stones, thickening of the lumen walls, or mural lesions of the bladder (Mohsin, 2018). In our routine veterinary clinical practice, cases of ingestion of foreign materials like polythene, nails, pins, balls, metal, glass, wood pieces & other materials by animals come up leading to foreign body syndrome followed by congestive heart failures & finally death if not treated on time. Radiopaque objects can be located by conventional radiographs but radiolucent bodies like wooden splinters are difficult to detect & are usually missed, USG is a highly sensitive & accurate modality in detecting radiolucent foreign bodies that are difficult to be visualized on standard radiographs so it is helpful in identifying the dimensions and depth of the foreign body and recognise the site of the foreign body as part of pre operative surgical planning. It has also been observed that the healing benefits of therapeutic ultrasound could help animals heal better. Therapeutic ultrasound has also been found effective in treatment of uterine fibroids, to alleviate pain from spread

of cancer into the bones (bone metastases), and for various surgical procedures. Major constrains with USG in wildlife is physical restraint, sedation, or anaesthesia of wild animal which is necessarily required to perform and to facilitate safe examination of animal. Some species or individuals like mammals, primates, elephants, and rhinoceroses may be trained to allow ultrasonographic examination (Julie *et.al* 2020) but most of the wild animals like cheetah, leopard, jackals, bears, civets, and other wild species require restraint and sedation.

III. CONCLUSION

Ultrasonography examinations have been shown to have no harmful biological effects and is considered a safe procedure for the animal, operator and nearby personnel, without the need for specific safety precautions but effective methods of physical restraint that minimize the possibility of physical injury and physiological and psychological stress to animal should be chosen and least amount of restraint in the shortest possible time is necessary for the procedures being undertaken. Conclusively ultrasonography is a powerful diagnostic tool for veterinary care, research, and conservation of wild animals, offering the potential for more effective management of wildlife health and species protection.







Fig 1: Abdominal ultrasonography in various wild animal species being performed at wild animal health care centre hospital Dachigam.

CHAPTER 6

Wildlife Dentistry-Ensuring oral health of wild animal



Fig: Dental examination in wild animals.

Dr. Mohsin Ali Gazi (Veterinary officer Department of Wildlife Protection Kashmir)

I. INTRODUCTION

The branch of medicine focused on the teeth, gums, and mouth is dental medicine and oral medicine or dentistry. It consists of the study, diagnosis, prevention, management, and treatment of diseases, disorders, and conditions of the mouth, most commonly focused on dentition, as well as the oral mucosa. Veterinary dentistry involves the application of dental care to animals, encompassing not only the prevention of diseases and maladies of the mouth, but also considers treatment. Dentistry in wild animals involves the study and treatment of dental issues in non-domesticated species. Wild animals, like their domestic counterparts, can experience dental problems, though these are often different due to their natural diet, habitat, and survival behaviors. Wild animals' teeth undergo significant wear due to their diet, which may include hard materials like bones, tough vegetation, or prey (Konjevic *et.al* 2004). This natural wear can sometimes result in tooth damage or loss. Animals in the wild

can also suffer from abscesses due to injuries, infections, or poor oral hygiene, which can lead to more severe health problems. Some wild animals may experience misalignment of teeth (malocclusion), leading to difficulty in eating or causing injury to the mouth. The diverse dental findings as to endodontic morphology, occlusal, and radicular forms, tooth sizes, and numbers of teeth all complicate exotic animal dentistry (Arzi *et.al* 2015). Difficulty in obtaining routine oral examination to intercept developing problems and provide routine dental maintenance is a large factor in maintaining or regaining oral health. Additionally, poor financial rewards, lack of exotic animal dental knowledge and education, all contribute to the challenges of providing successful oral care for these animals. All the dental disciplines practiced in human and small animal dentistry can be practiced in exotic animal or zoo dentistry. By addressing dental issues, zoo dentists ensure that animals can consume the appropriate diet for their survival, promoting overall health and vitality (Crossley 2003). There are many specialties within the field of animal dentistry, including endodontics which incorporates treatment of dental pulp (the tissue in the center of the tooth). Common ailments include pulpitis (inflammation of the dental pulp), tooth abscesses, and structural fractures). Then comes Periodontics which involve the treatment of periodontal (gum) disease and treatments regimens include tooth scaling and polishing, root planning, gum surgery, guided tissue, and bone regeneration). Then we have another specialty associated with dentistry that is Orthodontics meaning the correction of jaw misalignment and the common procedures include the application of orthodontic appliances and bite evaluations). Dental restoration is another modality which encapsulates applying metal crowns, fillings, bridges, and implants etc. Again we have dental radiology which is a diagnostic modality for tooth assessment; examination for dental disease, oral tumors, or fractures for making accurate diagnosis of the dental and ocular ailments for promoting better treatment and oral health care of animals. After diagnosing a disease some serious dental conditions require dental surgeries (oral surgery and maxofacial surgery) which involves extractions; correction of jaw fractures and palate defects; removal of oronasal fistulas, oral tumors, and dislocated teeth oral disease: oral manifestations of systemic disease (disease that affects other parts of the body) (Berkovitz and Shellis 2016). Dental problems can be multiple, complex, and often unseen in domestic small animal dentistry. Therapy can be complicated by limited oral access in some species. Most zookeepers are untrained in recognition of developing dental problems. This results in advanced dental pathology before the condition becomes clinically evident. Because of advanced levels of pathology, therapy is often more difficult and with uncertain prognosis for success. Zoo dentistry includes many and varied species. New technologies are now beginning to be seen, or at least contemplated, in the treatment of some of the large species. Now regarding dental instruments and dentistry equipment's which are used to examine,

manipulate, treat, restore, remove teeth and surrounding oral structures and provide dental treatment is another important thing in dentistry of wild animals. Examination of the oral cavity should form basic part of every physical examination of all rescued wild animals requiring oral health check-up and correction of any disease conditions and disorders of the oral cavity. Prior to initiation or planning of any treatment for disorders of oral cavity, radiographs (x-rays) may be needed to evaluate the health of the jaw and the tooth roots below the gum line as most dental disease occurs below the gum line and require radiograph for accurate visibility and correct diagnosis (Sullivan *et.al* 2019). Dental health is crucial for the overall well-being and survival of wild animals. Dental problems can lead to malnutrition, pain and discomfort, infection and disease and can even reduce reproductive success. Some common dental issues in wildlife include tooth wear and tear of teeth, abrasion and attrition of teeth, tooth fractures, gingivitis and periodontitis and tooth resorption (Miles *et.al* 1990). Wildlife dentistry poses unique challenges, including handling and restraint, anesthesia and pain management, limited access to dental care and species-specific dental anatomy. As far as the importance of wildlife dentistry is concerned, dental examination of the wild animals is very important as it can help to determine the age of animals, which is essential for population management and can provide valuable insights into the overall health of wildlife dental broader health issues, such as malnutrition or infection. Dentistry can also aids in distinguishing between different species based on dental features, helping in the accurate classification of animals (Steenkamp *et.al* 2016). Further Injured or rescued wild animal may also require dental health check-up to enable their proper mastication mechanisms, manage dental caries or oral infections and assessment of overall dental health before release. Another aspect of introducing wild animal dentistry can be that it can contribute to our understanding of wildlife behavior, diet, and ecology, which can tell us about conservation strategies and habitat management. Dental care is especially critical for endangered species where every individual is vital to maintaining the population. Dental treatments can improve the life expectancy of many animals, contributing to conservation programs aimed at preserving species. By studying dental conditions in wildlife, researchers can gain insights into the overall health of ecosystems and species. Some dental problems may be linked to environmental factors, diseases, or pollutants, helping to monitor ecosystem health. Precisely, wildlife dentistry is a valuable tool in wildlife management and conservation, helping to ensure the well- being and preservation of various species in their natural habitats and can have a positive impact on overall health management of wild animals.

II. CONCLUSION

Wildlife dentistry plays a critical role in the overall health and conservation of wild animals. Proper dental care can prevent pain, infections, and other health complications that may interfere with an animal's ability to forage, hunt, and thrive in the wild. Wildlife dentistry often involves unique challenges due to the diverse species, environments, and behavioral traits of animals. Dental problems, if untreated, can significantly impact an animal's ability to eat, forage, and thrive. While wildlife dentistry is still an evolving discipline, advancements in techniques, tools, and knowledge have greatly enhanced the care provided. By advancing knowledge and techniques in this specialized field, veterinarians and conservationists can better address the oral health needs of wildlife, contributing to their survival and overall well-being. Management of dental issues such as malocclusion, wear, and infection, wildlife dentistry helps prevent pain, improve nutrition, and enhance overall quality of life.

CHAPTER 7

Guidelines for Wild Rodent Surgery

Dr. Sukhbir Singh (Former Senior Scientist, Department of Veterinary Surgery and Radiology, LUVAS, Hisar)

These guidelines apply to all surgical procedures performed on rodents nam ely mouse, rat, hamster, beaver and guinea pig.

- **Aseptic Technique:** It is used to reduce microbial contamination to the lowest possible practical level.
- **Disinfection**: The chemical or physical process that involves the destruction of pathogenic organisms. All disinfectants are effective against vegetative forms of organisms, but not necessarily spores.
- **Sterilization**: The process whereby all microorganisms including spores are eliminated or destroyed. The criterion of sterilization is the failure of organisms to grow if a growth supporting medium is supplied.
- **Minor Surgery**: Minor survival surgery does not expose a body cavity and causes little or no physical impairment (e.g.,wound suturing, peripheral vessel cannulation percutaneous biopsy, and most procedures routinely done on an "outpatient" basis in veterinary clinical practice).An imals recovering from these minor procedures donot show significant sig ns of post operative pain, have minimal complications, and return to nor mal function in a relatively short time.
- **Major Surgery**: Major survival surgery penetrates and exposes a body cavity, produces substantial impairment of physical or physiologic functions, or involves extensive tissue dissection ortran section (e.g., laparotomy, thoracotomy, joint replacement, craniotomy, sciatic nerve cuff, and limb amputation).

1. General

- Rodent's donot vomit, so it is not necessary to fast the prior to surgery.
- Appropriate pre-operative and post-operative care of animals are required.
- A designated animal procedure space for rodent surgeries is requird; for example, a location within a procedure room or laboratory space free f rom clutter and easily disinfected prior to the surgical procedure. During the surgery period, the area should be dedicated to rodent surgery such that cleanliness is ensured; andcontamination is minimized at the time of use.
- A "tips-only" technique restricts you to using only the sterile working

ends of the surgical instruments to manipulate the surgical field. The gloved hand must never touch the working end of the instruments, the suture, suture needle, or any part of the surgical field.

All survival surgery will be performed by using aseptic procedures, including masks, sterile gloves, sterile instruments, and aseptic technique. Good technique includes; aseptic technique, gentle tissue handling, minimal dissection of tissue, maintain tissue hydration, appropriate use of instruments, effective hemostasis and use of suture materials and patterns or other wound closure techniques that minimize trauma & remain intact. In addition to clinically sound techniques, a surgical plan should also consider the availability of personnel to provide anaesthetic induction, aseptic preparation of the surgical site, and post-operative care appropriate to the surgical procedure. A surgical plan should include; analgesia, preservation of corneal integrity/hydration, nutritional support, maintenance of body temperature and hydration.

2. Procedures

- **Personal Protective Equipment**
  - Clean covering such as a labcoat worn over work clothes
  - Mask and Hair cover
  - Gloves: Using sterile surgical gloves allows you to touch all areas of the sterile surgical field and surgical instruments with your gloved hand.
  - Pre-Operative:
  - Surgery should be conducted in a disinfected, uncluttered area that promotes
    asepsis during surgery. Hard surfaces such as tablet ops and non-surgical equipment should be disinfected prior to setting up surgical area.
  - Protect eyes from corneal desiccation by applying sterile ophthalmic ointment since anaesthesia abolishes the blink reflex.
  - After anesthetizing the animal, remove the hair from the surgical site by clipping, plucking, or using a depilatory. This procedure must be done at a separate area and not at the designated animal surgical space. If a depilatory is used, thoroughly rinse the chemical from the rodent's skin or apply a neutralizing agent.
  - Administer analgesics (pre emptive analgesia).
  - Take measures to minimize hypothermia by providing heat.
  - Prepare the surgical site(s) with an appropriate kind disinfectant. If us ing as tereo taxic frame, the rodent should be placed in the frame before the skin disinfectant is applied.
  - A surgical scrub agent can be alternated three times with 70% alcohol

or sterile saline, followed by a final soaking with a disinfectant solution. Alcohol, by itself, is not an adequate skin disinfectant.

- Aseptic scrub skin preparation may contribute to hypothermia. Alternating with alcohol reduces body temperature but results in a rebound phase in which body temperature returns to baseline within a few minutes after application.
- Surgeons should wash and dry their hands before aseptically donning sterile gloves.
- Nitrile examination gloves can be either autoclaved or gas sterilized as an economical alternative to pre-packaged sterile surgical gloves. Multiple pairs of nitrile gloves can be autoclaved in the same pack, but care must be used to avoid contamination of the gloves during donning.
- When feasible, the surgical site should be draped aseptically with sterile material prior to making an incision to create a sterile surgical field. Draping is important when suture material will be used.
- Instruments, suture material, suture needle, etc. must never touch outside of the sterile surgical field.
- When working alone and manipulation of non-sterile objects (e.g., anaesthesia machines, microscopes, lighting, etc.) is required, it may be helpful to use sterile aluminium foil or sterile plastic covers to manipulate the objects.

- **Operative:** The animal must be maintained in a surgical plane of anesthesia throughout the procedure.If using the pedal with drawal reflex totest depth of anesthesia, there are paw has been shown to be more reliable than the forepaw. If neuromuscular blocking agents (e.g., pancuronium, succinyl choline) are administered then alternative indicators of anesthetic depth must be monitored. Animals on neuromuscular blockers must be mechanically ventilated.

  - Provide an external heat source (preferably a feedback-controlled, infrared, warm water, or air- circulating heating device) throughout anaesthesia and surgery. Hypothermia is a common cause of mortality in rodents undergoing a surgical procedure due to their high surface area to body massration. Electric heating pads and heat lamps are not recommended because of their potential to cause burns.
  - Begin surgery with sterile instruments and devices (e.g., implants and catheters). Handle instruments and devices aseptically.
  - Whenusing“tips-only”technique, the sterility of the instrument tips must be maintained throughout the procedure.

- Consider monitoring the animal's vital signs (e.g., respiratory rate, heart rate, body temperature) and tissue hydration.
- Ensure homeostasis and minimize blood loss.
- Close surgical wounds using appropriate techniques and materials.
- Suture gauge selection: Use the smallest gauge suture material that will perform adequately. Cutting and reverse cutting needles: Provide edges that will cut through dense, difficult to penetrate tissue, such as skin.

- **Post-Operative**
  - Move the animal to a warm, clean, dry area and continue to monitor during recovery.
  - Return the animal to its routine housing only after it has exhibitedright ing reflex.
  - Continue to provide analgesics as appropriate and approved in your A SP.
  - If appropriate, consider giving warm fluids and/or nutritional support.
  - Animals must be monitored and evaluated post-operatively.
  - Generally, remove skin closures 7 to 14 days post-operatively after verifying that the wound has healed.
  - Surgical Record:
  - Creating and maintaining a surgical record with important operative and post-operative information (e.g., annotate cage card with procedure and date, bodyweight on the day of surgery, analgesic administration, wound closure removal, etc.) is required.
  - Continue frequent monitoring of the animal post-surgery until stable (e.g., body weight, body condition, etc)



Fig: Surgical dressings and post operative care being provided to wild animals.

CHAPTER 8

Anaesthesia, sedation and chemical restraint of wild animals

Dr. Sukhbir Singh (Former Senior Scientist, Department of Veterinary Surgery and Radiology, LUVAS, Hissar)

I. INTRODUCTION

In wildlife medicine, it is often necessary to chemically restrain animals to perform even the most basic procedures. This is particularly true when working with large animals, particularly large carnivores. Therefore, it is important for veterinarians, wildlife researchers and their support personnel to be familiar with the variety of immobilizing agents and equipment used in this field, as well as to understand when to use each of them. Because there is some overlap in the situations in which the various drugs and equipment may be used, personal preference and familiarity play a large role in determining which types of immobilization agents and equipment are used. Other factors involved in this decision include: facility design, the species involved, the attitude and behavioural characteristics of the animal, and the physiologic or pathologic condition of the animal. Considerations for choice of restraint methods include human safety, animal safety, environmental factors, knowledge, preference and the preparation/planning involved (*Singh et.al 2007*).

II. PHYSICAL RESTRAINT OF WILDLIFE

Excepting cases in which an individual animal has been injured or rescued, more often than not, wild animals must be captured prior to any procedures being performed. Unless the animal has been sedated via remote delivery, this includes sedation. Thus, it becomes necessary for most wild animals to be physically restrained prior to sedation, regardless of size.Wild animals are far more susceptible to stress and injury than domestic species, particularly during capture, handling, restraint and transportation. Even straightforward procedures such as blood collection and clinical examination can be so distressing to a wild animal as to significantly jeopardize its health (Simpson and king, 2003). In addition, many wildlife species are potentially dangerous to handlers, so human safety must also be taken into consideration (*Kreeger and Arnemo, 2018*).Consequently, the aim of every capture and restraint procedure must be to minimize the stress on the animal, and at the same time maximize the safety of the handler. This means planning ahead and taking account of a number of important factors:

1. **Background.** A thorough knowledge of the species to be handled, including its behavior, reaction to stress, ability to defend it, and the appropriate physical and chemical restraint procedures is paramount to the success of the procedure and safety of all participants.
2. **Consideration.** Why does the animal needs to be handled? Precisely what is to be done to the animal? Is the procedure likely to be painful? How long will it take?
3. **Equipment and facilities.** All equipment and facilities should be checked and made ready before the animal is captured.
4. **Restraint procedures to be employed.** Is physical restraint sufficient or will chemical restraint also be required? This will depend upon the answer to the first two points.
5. **Timing.** When is the best time to undertake the procedure? Early morning or late afternoon might be cooler and therefore better for the animal.
6. **Recovery.** Animals which have been anesthetized will need to have appropriate recovery time, as well as a quiet, dark environment in which to recover, free from disturbance but where they can still be monitored.

Effective methods of physical restraint that minimize the possibility of physical injury and physiological and psychological stress should be chosen within the limits of human safety. The least amount of restraint and the shortest possible time necessary for the procedures being undertaken should be used. Personnel handling animals should be thoroughly trained in the planned procedures as well as in alternative methods of restraint that may be required.

III. CHEMICAL RESTRAINT OF WILDLIFE

Most wildlife, especially large (≥ 5 kg) or fractious individuals, or those requiring extensive procedures or surgical manipulation, require chemical restraint. In these cases, pre-immobilization planning is essential for successful chemical immobilization. This involves having trained personnel, appropriate equipment, an equipment checklist, a checklist to refer to during the procedure, emergency drug doses calculated, and a preanesthetic assessment of the patient. Human and animal safety issues must also be addressed prior to the chemical restraint of an animal.

Premedication (sedation) of animals may have value in some cases, but may be unnecessary in others. Some medications (i.e., diazepam) can be administered PO prior to a procedure, often with beneficial results; results, though can be highly variable. To administer premedication parenterally, though, requires that an animal be handled or darted twice to achieve anesthesia. In some cases, this can result in an excited animal at the wrong time, negating any potential benefit

from a sedative (Prater, 1993). Frequently, the anesthetic sparing effect of some sedatives can be retained by incorporating them with the anesthetic drugs (i.e., administering the drugs simultaneously). Following induction, maintenance of the animal using gaseous anesthetics is often indicated. Once anesthetized, it is important to monitor cardiopulmonary functions (i.e., pulse oximeter, Doppler blood flow monitor, ECG, etc.) and temperature of the patient. Administering supportive care such as supplemental heat and fluid therapy to anesthetized patients may be required. Recovery of an anesthetized patient should occur in an undisturbed, quiet, dimly lit, secure area that is free from physical hazards. Animals are generally placed in lateral recumbency for recovery. Chemical reversal of the anesthestic agent is generally desirable, although post anesthetic monitoring can present a great deal of difficulty in the case of native carnivores.



Fig: Tranquilization of a captive black bear and snow leopard for health examination and medication at mini zoo pahalgam.

CHAPTER 9

Wildlife Resurgence: Veterinary Approaches to Indigenous Species Rehabilitation

Urfeya Mirza *(Department of Large Animal Medicine and Surgery, School of Veterinary Medicine, St. George's University)*

Abstract: Veterinary surgeons in general practices are frequently presented with injured or orphaned animals by wildlife rescue centres, members of the public or police officers. Following treatment, many of these animals are released to the wild. Despite the large numbers of wildlife casualties rehabilitated in this way there are few published data detailing species, numbers treated, quality of care provided and outcome following release. There is also ongoing debate regarding the welfare and conservation benefits of such human intervention. This chapter reviews the available published evidence on wildlife rehabilitation and offers recommendations on future policy.

I. INTRODUCTION

1. **The rehabilitation of wildlife casualties:** The International Wildlife Rehabilitation Council (IWRC)defines wildlife rehabilitation as; the treatment and temporary care of injured, diseased, and displaced indigenous animals, and the subsequent release of healthy animals to appropriate habitats in the wild (Miller 2012). The process of rehabilitation varies according to the species involved and injuries sustained. A deer entangled in a wire fence without other injury may be released to the wild immediately (Green 2003), whilst an orphaned otter requires specialist care for over a year before release (Simpson &King 2003). People involved in the rehabilitation process have arrange of abilities and skills, varying from enthusiastic lay people with little training working with limited facilities, through to qualified professionals working in veterinary hospital standard premises (Kirkwood 2003; Miller, 2012).

2. **Rationale for Treatment and Rehabilitation of Wildlife Casualties:** Most people become involved in wildlife rehabilitation to provide care for individual casualty animals until released or euthanized (Dubois 2003). The need to avoid causing unnecessary suffering to animals brought into captivity through an inappropriate attempt to extend their natural life must, however, be balanced against such well-meaning altruism. One justification for the treatment of wildlife casualties is an attempt to counter the negative actions of man on species demographics and individual animal welfare

(Green, 2003). This moral and ethical responsibility is most powerfully illustrated in large man-made catastrophes such as oil spills that impact upon large numbers of seabirds and marine mammals. For the veterinary practitioner perhaps the greatest risks of dealing with wildlife casualties are related to health and safety of the practice work force. Many wildlife species will bite, kick or scratch, as well as being a potential source of zoonotic diseases (Robinson 2002; Best & Mullineaux 2003; *Adholeya et.al 2005*). The risk of disease transmission also extends to domestic species within the veterinary practice. Suitable standard operating procedures, training and risk assessments must be in place to mitigate these risks (Loftin, 1985: Cooper, 2003).

3. **Admissions to Wildlife Rescue Centres:** There are approximately 80 UK wildlife rescue centres (Mullineaux & Kidner 2011) dealing with an estimated 30to 40,000 animals per annum (Molony *et al.*2007), although true figures of admissions have been suggested to be double this (Grogan & Kelly 2013). Information relating to admissions to these centres is limited to surveys carried out by the BWRC in the late 1990s (Best 1999, Kirkwood 2003). From 16,000 admissions67·1% were birds, 32·5% mammals, with small numbers of reptiles and amphibians (Kirkwood 2003). Four common species accounted for over 40% of admissions; hedgehogs, feral pigeons (Columbidae), blackbirds (*Turdus merula*) and collared doves (*Streptopeliadecaocto*). Hedgehogs accounted for 16% of all admissions and 54% of mammals (Kirkwood 2003).Juvenile animals feature heavily in admissions to wildlife centres (Gonzalez *et.al* 2019).

4. **Triage of Casualties:** Key to ensuring the welfare of individual wildlife casualties is approved process that enables the rapid euthanasia of animals that are considered unlikely to be able to be released back to the wild, this process is referred to as "triage" (Best & Mullineaux 2003, Molony *et al.*2007, Vogelnest 2008). In medical terms, "triage" is usually used to differentiate between the most urgent and less medically concerning cases in an emergency room or at the site of an accident, in order to provide first aid and emergency care with priority where it is most needed. The limiting factors of medical triage are time and resources.

5. **Veterinary Care:** Review of the extensive published literature of wild animal diseases is beyond the scope of this chapter. However, the conditions presented to veterinary surgeons originate from areas of human–wildlife interactions around houses, gardens and roads and are consequently biased towards trauma rather than disease with only 9% of "casualties" presented for "natural causes" including disease (Kirkwood 2003). The prognosis for this category is poor and most are euthanized at first examination. Diseased

adult animals are often older individuals at the end of their natural life and typically emaciated (Mullineaux 2003).Specific disease in some species may become a significant rehabilitation issue, both as clinical cases and because of a need to screen some animals before release. Examples include tuberculosis in badgers (Mullineaux & Kidner 2011) and chlamydiosis in koalas

6. **Rehabilitation Care:** The possibility for disease transfer to and from wildlife casualties to domestic animals and the environmental conditions in most veterinary facilities (bio-containment risks) make them unsuitable for anything other than short-term care. Casualties' should be moved to a more suitable rehabilitation facility as soon as theyare clinically stable. The availability of facilities, suitably trained personnel and funding are limiting factors in rehabilitation (Best& Mullineaux 2003, Dubois 2003). Standards of care and facilities vary enormously, especially when regulatory standards are lacking.

7. **Release:** Release is broadly divided into two types, "soft" and "hard". Soft release involves initial provision of shelter and support feeding, usually in a temporary enclosure within the release site. Hard release, usually used only for adult short-term casualties, involves simply releasing the animal back into the wild as close as possible to its capture site (Llewellyn 2003). The time of year can influence the success of releases (Tribe *et al.*2005) and juvenile animals should be released when food is plentiful and territorial behavior reduced; special consideration must be given to the release of migratory species (Llewellyn 2003). Selection of release site areas is critical to the release process (Tribe *et al.*2005).

II. CONCLUSIONS

Wildlife rehabilitation fulfils a welfare, conservation and educational role, which varies around the world. The welfare of casualty and orphan animals would benefit from increased veterinary intervention especially in areas such as pre-release assessment (Gimenez*et.al* 2009).The true success of rehabilitation cannot be assessed without improved post-release monitoring. How animals survive, integrate and behave in the wild will determine the effectiveness of clinical triage, veterinary treatment and care received during rehabilitation. Such information can be used to educate veterinarians and wildlife rehabilitators, and ultimately benefit the welfare of the animals in their care.

CHAPTER 10

Blood collection in wild animals

Dr. Mohsin Ali Gazi (Veterinary officer Department of Wildlife Protection Kashmir)

I. INTRODUCTION

Blood sampling in wildlife involves the collection of blood from animals to analyze their physiological, biochemical, and health status. It is a vital procedure in veterinary medicine, wildlife research, and conservation biology. Blood analysis provides insights into disease diagnosis, nutritional status, stress levels, reproductive health, and overall fitness of the animal. Importance of Blood Sampling in Wildlife involves, its applicability in health monitoring wherein it helps in diagnose various diseases, infections, and metabolic disorders in individual animals or populations. Research and Conservation in which studies on genetic diversity, population dynamics, and adaptations to environmental changes are undertaken. Another important use is in drug and treatment Studies, where the effectiveness of drugs, vaccines, or treatments for various wildlife species can be studied. It can be useful in environmental assessment; it helps in/ as a bioindicator for exposure to toxins, pollutants, or environmental stressors (Noonan, 2000). There are some factors and challenges faced in wildlife during blood sampling of wild animals some of which are as under:-

1. **Animal restraint:** For blood sampling/collection from wild animals it requires expertise in physical or chemical restraint to minimize stress and ensure safety which is to be taken under guidance of a Veterinarian.

2. **Species differences and variability:** Different species have unique anatomical and physiological features that influence sampling techniques.

3. **Environmental and ethical concerns:** Sampling must minimize disturbance to animals and their habitats.

Blood collection in wild animals as already discussed is a challenging procedure requiring specialized techniques and equipment to ensure safety for both the animal and the collector. General approaches are here as under:

1. **Restraining of animal and selection of sites for collection**
   - **Animal Restraint:** Use physical or chemical restraint (e.g., sedatives like ketamine or medetomidine) to ensure safety.
   - **Site Selection:** Based on species, common sites include:
   - **Jugular vein:** Common in large mammals like deer and antelope.
   - **Tail vein (coccygeal):** usually preferred sites in reptiles and some larger mammals like kangaroos for collection of blood.
   - **Cephalic or saphenous vein:** preferred sites common in medium-sized mammals like primates.
   - **Wing vein (brachial):** preferred sites in birds.
   - **Cardiac puncture:** Sometimes used in small or deceased animals for collection of blood.

2. **Common Blood Collection Sites in Wild Animals**
   - **Mammals:** Jugular vein, cephalic vein, or saphenous vein.
   - **Birds:** Jugular vein or wing vein.
   - **Reptiles:** Caudal vein or cardiac puncture.

Blood collection in birds can be obtained from various body parts. Most common practice is to collect blood from brachial vein. Amount of blood drawn would depend on size of bird. In any case, not more than 1% of body weight should be collected.

3. **Requirements and equipments**
   - **Syringes and Needles:** Choose size based on the animal's size and blood vessel.
   - **Vacutainers:** Preferred for clean collection.
   - **Anticoagulants:** Use EDTA (for hematology) or heparin (for plasma samples).

4. **Procedure and method**
   - **Blood Collection Techniques**
     - Venipuncture: Collect blood from veins, such as the jugular, cephalic, or saphenous veins.
     - Arterial puncture: Collect blood from arteries, such as the femoral or carotid arteries (Clark *et.al* 2007).
     - Identify the site and clean the collection site.
     - Insert the needle at a shallow angle for superficial veins or perpendicular for deeper veins.
     - Collect the required volume (avoid exceeding 1% of body weight) (Clark and Duignan 2004).
     - Apply pressure post-collection to minimize hematomas.

5. Safety and precautions

- **Personal protective equipment (PPE):** Wear gloves, masks, and eye protection.
- **Animal restraint:** Use proper restraint methods to avoid injury to both humans and animals.
- **Disinfection:** Disinfect equipment and a collection site is important to prevent infection.
- Ensure proper handling to prevent injuries.
- Minimize stress by working efficiently.
- Monitor the animal post-procedure for signs of distress or complications.
- Report any reaction if observed in any wild animal specie

6. Post-Collection Procedures

- **Labeling and storage:** Label and store blood samples properly for transportation and laboratory analysis.
- **Animal release:** Release animals back into their natural habitat, ensuring their safety and well-being.

Assuring that blood flow has stopped (hemostasis) is of upmost importance after collecting a blood sample. To achieve hemostasis, place gentle pressure over the site of blood collection to stop the bleeding. A gloved hand and a piece of gauze are commonly used. Best practice involves re-inspecting animals approximately 5 minutes after return to their cage to assure blood flow has stopped.

II. CONCLUSION

Assessment of physiological status, diagnosis of diseases and ability of the animal to fight against the infections could be assessed by analysis of blood and their biochemical constituents. Blood collection is a sophisticated procedure in wild animal and wildlife research as well as in captive animal care. Refinement, as part of the 3Rs (replacement, reduction, and refinement of animal use), should be considered when selecting a blood collection site and how the blood will be collected. The most appropriate methods of blood collection will vary according to the species, individual animal characteristics (e.g. age, sex), the volume of blood that is required, and the requirements of the research. It is important to note that when we are collecting blood from animals, consideration is to be given to collection sites that are the least painful/distressful for them and ensure that the appropriate blood volume is collected. Care is to be taken when visiting outbreak areas for the purposes of sample collection, or even when samples are collected from apparently healthy animals for routine monitoring

purposes, strict biosecurity precautions should be taken by personnel involved to prevent any health hazard. Conclusively blood analyses have great potential in studies of ecology, ecotoxicology and veterinary science in wild vertebrates based on advances in human and domestic animal medicine. Hematology and blood chemistry reference values in wildlife animals are considered a key element to evaluate their health and welfare status.



Fig: Blood collection in wild animals

Table: Showing sites of blood collection in wild animals.

Type of animals	**Site of collection**	**Remarks**
Large Mammals	Jugular vein, Tail vein, Auricular vein	Use physical/chemical restraint; jugular is most common.
Primates	Femoral vein, Cephalic or saphenous veins, Tail vein	Sedation required for femoral vein; cephalic or saphenous in smaller species.
Carnivores	Jugular vein, Cephalic or lateral saphenous veins	Jugular preferred; lateral saphenous useful in small or sedated individuals.
Rodents	Tail vein, Submandibular vein, Retro-orbital sinus	Warm compress aids tail vein; retro-orbital requires anesthesia; cardiac puncture is terminal.
Birds	Jugular vein, Brachial vein, Medial metatarsal vein	Right jugular preferred; brachial and metatarsal veins suitable for different species.
Snakes	Caudal vein, Cardiac puncture	Tail vein at cloaca level; cardiac puncture requires caution and is used for critical samples.
Lizards	Caudal vein, Jugular	Caudal vein accessed ventrally or

	vein	laterally; jugular vein is challenging.
Turtles/Tortoises	Jugular vein, Subcarapacial sinus, Dorsal coccygeal vein	Subcarapacial sinus prone to lymph contamination; jugular best for larger volumes.
Amphibians	Ventral abdominal vein, Cardiac puncture	Ventral abdominal vein is common; cardiac puncture often terminal.
Fish	Caudal vein, Dorsal aorta	Sedation required; dorsal aorta accessed through the mouth.

CHAPTER 11

Stress management in wild animals

Dr. Mohsin Ali Gazi (Veterinary officer Department of Wildlife Protection Kashmir)

I. INTRODUCTION

Stress has often been described as the state of the animal when it has difficulties to adapt to environmental or physical constraints. Wild animals are frequently or constantly exposed to stressful stimuli, as they are all either predator or prey. Unlike domestic animals, wild animals are exposed to environmental stress, food deprivation, parasite infestation and numerous untreated diseases. In animals stress is a biological and physiological response to external or internal challenges. It can be a natural and necessary reaction of an individual to certain stimuli. This stress response is characterized by the activation of the animal's stress system, particularly the hypothalamic-pituitary-adrenal axis, which controls the release of stress hormones such as cortisol and adrenaline (Kagawa & Mugiya 2000). Stress in animals has a variety of causes some of which include environmental stressors like climate changes in temperature, rainfall patterns, seasonal cycles, extreme weather that can affect the availability of food, water, and shelter and other factors necessary for survival of an animal. Another factor that is mostly experienced in wild animals is acute stress due to presence of predators usually involves fight-or flight mechanism leading to adrenaline rush causing changes in animal physiology (Martin, 2011). One more factor that contribute to animal stress is pollution, including noise, light, chemical pollutants, and plastic waste etc, has become one of the leading causes of stress in wildlife. Noise pollution from traffic, aircraft, or construction, mining etc can disrupt communication, breeding, and feeding behaviors and mating behaviors in animals. Toxic pollutants in the water, air, and soil can also cause physical harm, altering reproductive success and survival rates and affect the overall health of wild animals. We have seen animals in free range or captivity due to scarcity or shortage of food and water or during periods of drought, seasonal changes, does experience stress due to competition for food with other individuals or species and produce stress. Additionally human activities such as deforestation, urbanization, or agricultural expansion lead to habitat Fragmentation which again becomes a serious cause of stress in wild animals. As far as animal physiology is concerned the spread of diseases among wildlife populations or sudden disease outbreak can lead to stress due to the potential for widespread illness and death. Pathogens entering animal body can weaken their immune systems, making them more vulnerable to other stressors

leading to serious health hazards. Orphaned, injured or sick, accidental wild animals that fear chance of predation or hunting easily fall into category of stressed animals through physical pain and impaired ability to find food for survival. One more commonly occurring factor is interaction of humans with wild animals viz man animal conflicts, hunting, poaching, and the destruction of habitats through urbanization also become a source of stress for wild animals. The presence of humans, especially in areas where animals are not accustomed to human interaction, can lead to altered behaviors, abandonment of animal shelters or territories, also causes overall increase in stress levels affecting animal health. So there is a need for regulating tourism with sustainable tourism practices that limit human-wildlife interaction can help reduce the stress on animals in popular wildlife reserves and parks. Now if we observe the impact of the stress on the wild animals it can range from immediate changes in behavior to long-term health problems that affect mental health, physical fitness and overall animal life (Love et.al 2012). Repeated exposure to stress factors can cause the continuous release of stress hormones such as cortisol and adrenaline and can impair the animal's immune systems, leaving them more vulnerable to infections and diseases, digestive problems, respiratory diseases and hormonal imbalances, affecting animal's health and well being (Ottenweller, 2007). In some species, it is observed that stress can suppress reproductive hormone production, leading to reduced fertility or even complete reproductive failure. Additionally, repeated mental stress alters the serotonin and dopamine levels in an animal's brain. This, in turn, can cause repetitive and frequently harmful animal behavior that result in a loss of energy. Stressed animals may show signs of excessive vocalization, decreased appetite, and changes in sleeping patterns, poor grooming habits, hiding away from people or other animals, and aggression (Huang et.al 2020).

II. CONCLUSION

Preserving and restoring natural habitats is one of the most effective ways to reduce stress in wildlife. By reducing habitat fragmentation and protecting ecosystems from human encroachment, deforestations, poaching and hunting, animals can live in environments that meet their physical and behavioral needs, reducing stressors and promoting healthy wildlife. Another thing is reducing or minimizing incidences of man-wildlife conflicts through effective conservation strategies like habitat restoration, proper waste management's, afforestration, creating buffer zones and thus reduce stress. Educating the public about the impacts of human activities on wildlife stress is an important thing for conservation and preservation of wildlife. Raising awareness about the effects of pollution, habitat destruction, proper waste disposal, creating buffer zones between forests and human habitats, explaining importance of wildlife, and nature can prevent stress and preserve our biodiversity (Huang *et.al* 2020). Thus

addressing these stressors through conservation efforts, habitat protection, and responsible human interaction with wildlife is essential for safeguarding the health and survival of wildlife species and ensuring the balance of ecosystems worldwide.



Fig: picture of Hangul in forest, treatment and rehabilitation of black bear, wild herbivore (musk deer) after surgical correction and another picture is showing physical examination of black bear after tranquilization.

CHAPTER 12
Postmortem Examination in Wildlife: A Gate Way to Conservation, Disease Surveillance, and One Health

Dr. Henna Wani (Research associate NLC Project)

I. INTRODUCTION

A postmortem examination, also known as a necropsy in animals, is an essential procedure that helps in the determination of the cause of death including wildlife. Necropsy is a useful tool for identifying diseases impacting wildlife populations, including zoonotic diseases such as rabies and avian influenza that can also potentially affect humans and other animals. Necropsy helps in exposing the cause of death, such as death from infectious diseases, poaching, habitat destruction, pollution, etc (Coles, 2007). This information leads to strategizing about saving endangered and vulnerable species.

Wild animal necropsies also provide information on ecosystem health through them. Wild animals are sensitive and can feel changes and imbalances in the environment. This knowledge leads to biodiversity conservation and ecological stability. At forensic levels, these necropsy findings can be used as the evidence base in cases involving illegal wildlife trade or for poaching and poisoning, thus making wildlife protection regulations enforcement more feasible. In addition to providing essential data on anatomy and physiology, these examinations enhance the comprehension of wildlife biology-the study of the natural history and, therefore, the better welfare and management of many species-and directly protect human and livestock populations by pointing to and allowing proactive responses to emerging diseases. Essentially, postmortem examinations are very important in understanding the complex relationship between wildlife and ecosystems and human health, which is the base of conservation efforts and public health.

II. PROCEDURE

NOTE: A veterinarian or trained wildlife pathologist should ideally perform the necropsy, especially in cases involving protected species or potential zoonotic diseases. A post-mortem examination of the wildlife is done step-by-step in terms of ensuring diagnostic specificity to a great extent as biosecurity could afford, starting off with the examination for the post-mortem exterior. Observations of the environment, such as the location of the carcass and the

surrounding evidence, can provide crucial insights into the circumstances of death (Brown and Sleeman, 2002). Postmortem examination starts with careful examination of the dead animals external body conditions, like looking for wounds, lacerations, bleeding, external orifices and stage of rigor mortis. After recording the external conditions the animal is cut open for internal assessment. The internal examination entails the careful opening of body cavities—thoracic, abdominal, and cranial—meticulously inspecting each in turn for any gross abnormalities and recording the same. The organs are examined for alterations in size, color, texture, as well as the presence of lesions, hemorrhages, or other pathological signs. The respiratory system is checked for any form of obstruction, fluid accumulation, or signs of pneumonia, and the digestive system is carefully checked for ulcers, perforations, or parasitic infestations. The liver, kidneys, and heart are carefully evaluated for signs of disease, degeneration, or toxic damage, and the musculoskeletal system is evaluated for fractures, dislocations, or tissue damage. In any post-mortem process, sample collection is essential as it gives the basis of the subsequent laboratory analyses (Clausen and Gudmundsson, 1981). Samples of tissues are handled with the highest care and preserved in 10% buffered formalin solution for histopathological examination. Sterile swabs are utilized for obtaining cultures aimed at finding bacterial, viral, or fungal pathogens. In cases suspected to harbor parasites, ethanol is utilized for preservation, while toxicological samples which may include liver, kidney, and stomach contents are taken for chemical analysis aimed at determining the presence of poisoning or contamination. Samples of genetics in the form of blood or tissue are also stored in ethanol or frozen for subsequent molecular analyses. Labeling, preservation, and storage should be appropriately done to preserve these samples in their integrity. All steps are well documented, from taking notes and measurements, to photographing any important finding (Vikas 1991). This serves not only in providing a basis for diagnosis but also helps to gather important data for epidemiological research, forensic research, and conservation efforts (Chitty and Lierz, 2008). However, the postmortem investigation provides much better understanding of wildlife, sheds light on the health dynamics in wild populations, strengthens disease surveillance, and plays a very important role in the effective implementation of those wider initiatives that encompass conservation and One Health efforts.

III. CONCLUSION

The post-mortem examination of wildlife is critical in establishing the causes of death, understanding the dynamics of disease, and assessing general health status, particularly in conservation and One Health (Chomel, 2007). Using a rigorous scientific approach from external and internal necropsies to careful collection of samples and detailed recording can be very helpful. The wildlife

necropsy yields information that supports surveillance for diseases, forensic analysis, and population management efforts.



Fig: postmortem examination of different wild animal species

CHAPTER 13

Conservation of Hangul (*Cervus hanglu hanglu*): Challenges, Ecology, and the Road Ahead

Dr.Khuban Buch, Range Officer (J&K Forest Department)

I. INTRODUCTION

The Kashmir Red Deer or Hangul (*Cervus hanglu hanglu*), belonging to the family Cervidae, is a critically endangered species and the state animal of Jammu and Kashmir. Previously considered one of the six easternmost subspecies of the European Red Deer (*Cervus elaphus*), the Hangul was earlier classified under the Least Concern category by the International Union for Conservation of Nature (IUCN). However, recent scientific research has provided sufficient evidence for its recognition as a distinct species. This reclassification, coupled with its dwindling population, has led to its status being upgraded to Critically Endangered by the IUCN, a crucial step in advocating its conservation.

1. **Historical and Current Distribution:** Endemic to Kashmir, the Hangul was once widely distributed across the mountains of Kashmir, including the Zanskar Mountain range. Historical records indicatxe its presence from Keran in the Kishanganga Valley to Dorus in Lolab Valley, Bandipora in the north, and Kishtwar High Altitude National Park and Ramnagar in the south. This distribution encompassed areas such as Baltal-Thajwas Wildlife Sanctuary, Tral Conservation Reserves (Shikargah, Panner, and Khiram), Overa-Aru Wildlife Sanctuary, and Rajparian Wildlife Sanctuary (Gee, 1965; Schaller, 1969;Schaller, 1969; Prater, 1993; Nowak, 1999). Currently, a genetically viable population of Hangul is largely confined to Dachigam National Park, with smaller, isolated populations in adjacent conservation reserves, including Bren-Nishat, Cheshmashahi Forest Reserve (southwest of Dachigam), Khrew, Khanagund, Shikargah, and Overa-Aru Wildlife Sanctuary.

2. **Habitat Preferences:** Hangul habitat selection is influenced by various ecological factors, including nutritional requirements, seasonal variations, altitude, aspect, and slope, which in turn determine vegetation availability, water resources, shelter, and escape cover (Clutton *et.al* 1989). Habitat use varies across sexes and seasons. While female habitat use remains relatively

stable throughout the year, males exhibit seasonal variations, particularly during the rutting period.

During winter, when forage availability is limited, Hangul are often restricted to mixed oak, mixed morus, and riverine forests, feeding on grasses and forbs available in ravines. In summer, they inhabit coniferous forests with rugged terrains or foothill ranges, which provide shelter and nutritious forage. They also frequent high-altitude meadows in alpine and sub-alpine zones or river bottoms like Daghwan. The species shows a marked preference for mid-altitudes between 1700–2300 meters, favoring south-facing slopes for their warmth and vegetation (Ahmad *et al.*, 2015).

3. **Feeding Ecology and Nutritional Requirements:** Hangul, as ruminant herbivores, exhibit mixed feeding behavior. While some populations primarily graze, others rely heavily on browse. Seasonal shifts in diet are evident, with a preference for grasses and forbs during spring and early summer, transitioning to woody browse in winter. During harsher conditions, Hangul have been observed debarking trees to meet their dietary needs.

   Supplementary feeding provided by the Department of Wildlife Protection during winters has proven beneficial for both males and females, reducing winter mortalities (Clausen and Gudmundsson 1981, Clutton-Brock & Albon, 1989; Smith,2001; Ahmad *et al.*, 2015). Hangul require nutrients from five broad categories: protein, energy, minerals, vitamins, and water. The seasonal variation in nutritional requirements aligns with physiological changes such as gestation, lactation, and antler growth. Research suggests caution when extrapolating nutritional data from domestic ruminants like sheep or goats, as deer exhibit unique physiological processes.

4. **Challenges in Conservation:** The Hangul's population has experienced severe declines in both numbers and range over the past few decades. Despite rigorous conservation efforts by the Wildlife Department of Jammu and Kashmir, factors such as habitat fragmentation, poaching, and human interference continue to threaten the species. Effective conservation strategies must prioritize habitat restoration, community involvement, and scientific research on the species' ecology and nutritional needs.

II. CONCLUSION

The Hangul, or Kashmir Red Deer (*Cervus hanglu hanglu*), symbolizes the ecological heritage of the Kashmir Valley and stands as a testament to the region's unique biodiversity. Its critically endangered status reflects the urgent need for concerted conservation efforts to prevent the loss of this irreplaceable

species. The Hangul's dependence on diverse habitats, seasonal variations in its nutritional needs, and vulnerability to anthropogenic pressures underscore the complexity of its conservation (Ahmad*et.al 2015; Jukar et.al 2021)*.

Ensuring the survival of the Hangul requires a multifaceted approach involving habitat restoration, scientific research, and community participation. Supplementary feeding, population monitoring, and mitigation of human-wildlife conflict must complement broader strategies addressing climate change and habitat fragmentation. As the only Asiatic survivor of the red deer lineage in the Indian subcontinent, the Hangul's preservation is not only an ecological imperative but also a cultural and moral responsibility.

Through collaborative efforts and innovative conservation measures, we can secure a future for the Hangul, transforming its story from one of decline to a beacon of hope for biodiversity conservation in the Himalayas. The survival of this iconic species will reflect the success of sustainable coexistence between humanity and nature.



Fig: Health monitoring of hangul (Cervus hanglu hanglu) at Munue hills Dachigam.

CHAPTER 14

Wild animal rescue and rehabilitation

Dr. Mohsin Ali Gazi (Veterinary officer Department of Wildlife Protection Kashmir)

I. INTRODUCTION

Wildlife rehabilitation is the process of caring for injured, sick, orphaned, or displaced wild animals with the goal of releasing them back into their natural habitat. It involves medical treatment, temporary housing, and specialized care for a variety of species, from birds and mammals to reptiles and amphibians. Rescue of wild animals in the current scenario requires coordination and cooperation between people from different backgrounds and different agencies. Different approaches and management techniques are required for different species of wild animals. It is one of the most challenging and a difficult task to rescue a wild animal and it is equally important to rehabilitate the rescued animals. Restraining wild animals is not an easy job and require highly technical inputs. Methods of restraining involve both physical and chemical restraining. Physical restraint is the use of manual of mechanical means to limit some or all of an animal's normal movement for the purpose of examination, collection of samples, drug administration, therapy or experimental manipulations. Chemical restraint includes any form of medication used not to treat illness, but to intentionally inhibit movement (*West et.al 2014*). This is often required in the veterinary practice to immobilize domestic animals for medical treatments (e.g., dentistry, surgery); it is also routinely required in zoo settings, and in wild animals in the field. Wild animals may be immobilized for relocation purposes, bio-measurement, ear-tagging, microchipping, vaccinations, radio collaring or medication, or performing various surgical corrections.

If we talk about Man animal conflict incidents, which are increasing every day due to several factors some of which include loss of habitat, fragmentation of habitat, loss of animal corridors, unavailability of feeds due to grazing pressure of domestic animals, old age etc. Additionally the changing climate, loss of natural habitats, and rapid urbanization are the primary factors driving these incidents on rise. Urbanization as per experts is leading to the destruction of wildlife habitats, thereby prompting wild animals to venture into human settlements in search of food, protection and shelter. The increasing trend of human populations has led to the destruction, fragmentation, or alteration of natural habitats, making it increasingly difficult for wild animals to find food

and refuge. Another reason for the rising incidents of man animal conflicts is low prey base in forests that has led leopards to move into villages and towns where they can easily catch soft prey such as dogs, which are present in abundance near garbage sites and other places. One more contributing factor is the introduction of invasive species to Kashmir. For instance, wild boars, which were originally introduced by the Maharaja for hunting purposes, have now become a menace for the people of valley. These wild boars are frequently spotted in orchards, gardens, and around human habitation, thereby heightening the likelihood of man-animal conflict.

Providing wild animals with secure living and feeding environments can deter them from venturing into inhabited areas. Therefore, the primary focus should be on restoring the natural habitats of wild animals by planting more fruit trees in forests, promoting installation of fencing between forests and orchard lands and creating of buffer zones etc. Additionally, increasing the population of herbivores, which serve as prey, can discourage leopards from leaving their natural habitats (*Kreeger and Arnemo 2018*). Furthermore, leopards require substantial territory for their habitat. Hence, expanding forested areas would provide ample space for leopards to live, feed, and breed. Further the risk of man-animal conflict can be minimized if people exercise caution is implemented to avoid disturbing wildlife habitats. Limiting activities in forests such as livestock grazing and the collection of non-timber forest products can aid in preserving critical habitats and reducing interactions between people and wildlife. There is a need for upgrading of dedicated routes and areas for Bakarwals who accompany their cattle for grazing in the forests. Community knowledge and raising awareness about man-animal conflict is another crucial requirement in reducing such conflicts. Educating people about the ecological significance of animals and providing them with specific tips on how to mitigate issues can foster a deeper appreciation for nature. Conducting workshops, seminars, and webinars and community events makes it easy to educate people about wildlife and the importance of preserving their habitats. Additionally, it is imperative to incorporate content about man-animal conflict into school textbooks, notice boards, to ensure that future generations are aware of these issues from a foundational level.

To begin with any rescue operations, it mainly includes use of tranquilizing equipments like the tranquilizing gun and its accessories. The dartguns must be examined at regular interval and testing should be carried out with practice darts to keep it in good conditions. Darts of different capacities (1 ml, 2 ml, 3 ml, 5 ml, 7ml and 10 ml) and material (plastic and metal) must be available along. Cartridge, syringe charger, cartridge holder, barrel cleaner, forceps must be available for inject guns along with pressure pumps and gas for darts etc should be regularly checked and kept available. Needle of different types (barbed,

plain) and different sizes (16 mm, 18 mm, 20mm, 22mm, 23mm, 24 mm and 25mm) must be there in store. A minimum of two guns must be available for carrying out rescue operation depending upon the use.

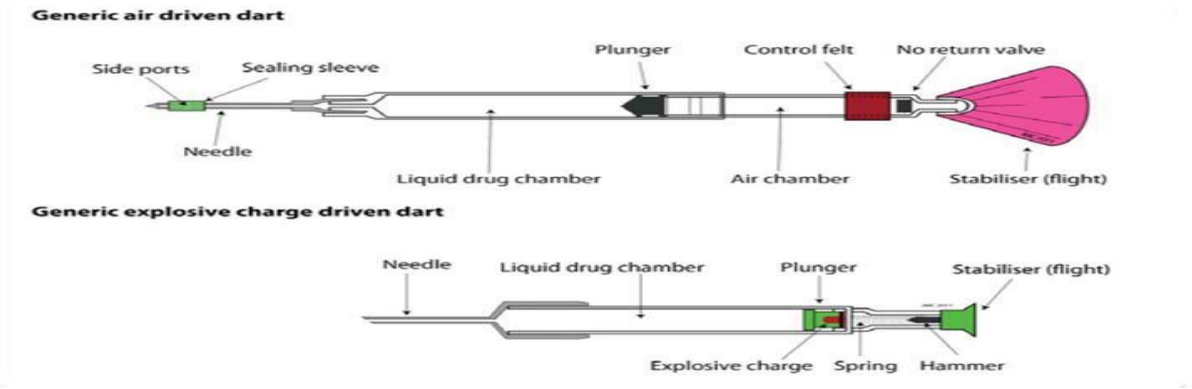


Fig: showing different components of dart syringe

Table: shows dosage of most commonly used anaesthetic drugs in some wild animals and birds (reference doses have been taken from published researches)

S.no	Species of wild animal/ birds	Drug	Dosage
1.	Leopards	Xylazine ketamine	1.5mg/kg 5 mg/kg
2.	Bears	Xylazine ketamine	2-4mg/kg 5-9 mg/kg
3.	Deer	Xylazine ketamine	1.5mg/kg 1.25 mg/kg
4.	Monkeys	Xylazine Ketamine	1 mg/kg 2.5mg/kg
5.	Wild birds	Xylazine Ketamine	2-3 mg/kg 20mg/kg

DIST-INJECT DART NEEDLE SIZE

Tab: shows dart needle size for different wild animals.

Animal	Size	Type
Monkey	16 mm./ 19 mm.	Collared
Langur	19 mm.	Barbed
Leopard	19 mm.	Barbed
Tiger	28 mm.	Barbed/Collared
Chitha	19 mm. 16 mm.	Barbed(Large Male) Collared (Small animal)
Sambar	28 mm.	Collared
Gaur	38 mm.	Collared
Rhino	45 mm./ 51 mm.	Collared
Elephant	51 mm./ 63mm.	Collared
Wild Boar	45 mm. To 63 mm.	Collared
Smaller cats & Civets	16 mm.	Collared

Now comes the role of rescue teams to deal with man animal conflict situations which is highly challenging task and a dedicated rescue team or rapid response teams whose primary work is to do rescue operations is required. There has to be more than one veterinarian, adequate animal keepers, driver and forest officials to conduct rescue operations successfully. During rescue operations and for dealing with wild animal immobilization, It is of utmost importance that adequate drugs and medicines are available which are fresh and good quality. Drug of choice is very important in terms of chemical immobilization as different drugs have different effect on different species of animals. Veterinarians and forest officials must make sure that all the drugs and medicines are available for emergency use along with its antidotes and life saving drugs.

1. **Things to remember and SOPs to be followed during wild animal rescue:** First important thing is safety of the rescuers, the public as well as the wild animal/bird. Avoid close contact with the animal unless necessary and use appropriate safety gear like gloves, masks, and nets and other operative gears are not available. Evaluate the animal's condition and environment to determine the best course of action without causing additional stress to the animal so condition assessment is must before planning a rescue operation. Another thing is to minimize animal stress by approaching the animal calmly and avoid loud noises, sudden movements, or bright lights that may cause distress or health hazards to animal. Further specialized tools and technique such as use capture nets, poles, or crates, darts and tranquilizers etc designed for the specific species and present

circumstances (Kelly *et.al* 2012). Understanding the behavior and biology of the species being rescued to handle them appropriately with appropriate tranquilizers and technique is very important to have a successful and safe rescue operation. Then we have to ensure proper containment and ventilation during transport of rescued animal to prevent injury or suffocation especially to sick, injured or pregnant rescued wild animals. We have to minimize direct handling to reduce the risk of zoonotic disease transmission and preserve the animal's natural behavior. In case of injuries or health concerns, veterinary care promptly for diagnosis and treatment is to be undertaken. Simultaneously record keeping of all the rescue operations, including details about the location, species, condition, and actions taken is to be routinely updated. Finally once the animal is rehabilitated and deemed fit, animal is to be released back into its natural habitat in compliance with local wildlife laws, animal ethics and welfare (Kirkwood, 1996; Kirkwood, 2003).

2. **Animal Handling:** Animal handling is defined as the technique and method of how we respond and interact with the animals within the environment of an animal. Proper handling techniques can reduce animal pain and distress and improve animal welfare. Wildlife capture and handling has the potential to result in serious injury to both the handler and the animal. It should only be undertaken if absolutely necessary. In all operations, handling of live wildlife should be minimized by confiscating the animal without handling it directly e.g., if it is already in a cage that can be moved, use this rather than moving the animal into another transport cage. So we have to use simple techniques and methods which can give least discomfort, stress or pain to a rescued wild animal.

   We have to maintain patience while rescuing a wild animal, avoid quick movements and loud noises, and never prod an animal when it has nowhere to go. If external expertise is not available on the day of the operation, maintain the animal on site (i.e., at the point of seizure) until assistance is available from experienced personnel. Avoid physical capture of animals by encouraging an animal to enter a transport crate using patience or food as enticement. Animal handling methods require training, skill, and behavioural knowledge of the species you are working with. Some animals usually responds by biting during handling so while rescuing small wild animals, it's a good to wear gloves and use animal muzzles for protection against bites, scratches, and other diseases. Raccoons, skunks, bats, and some foxes are more likely than other mammals to carry rabies, but any wild mammal can carry the disease. There are also several other serious or fatal diseases that can be transmitted to humans from wild animals, so utmost care is to be taken while rescuing a wild animal. Feeding or watering or medication of animals either in their mouth or in the container

with them is not allowed without professional trainer or animal keeper or wildlife rehabilitator. Water if placed wrongly in mouth can lead to aspiration pneumonia and even death and if not placed in the appropriate container properly will simply spill, causing the animal to be cold and wet.Always assess the animal's behaviour before approaching. Use slow, deliberate movements to avoid startling the animal. For small animals, use cloth or gloves to gently restrain them and for larger animals, use specialized equipment like capture nets, poles, or traps. For reptiles or amphibians, avoid handling with bare hands to prevent injury to the animal or handler as said above. Reduce direct physical handling to avoid causing stress. Strictly avoid holding animals by sensitive body parts (e.g., wings, tail) (Lombardi, 2018).Properly managing animals can lead to decreased pain and stress, ultimately benefiting their welfare.

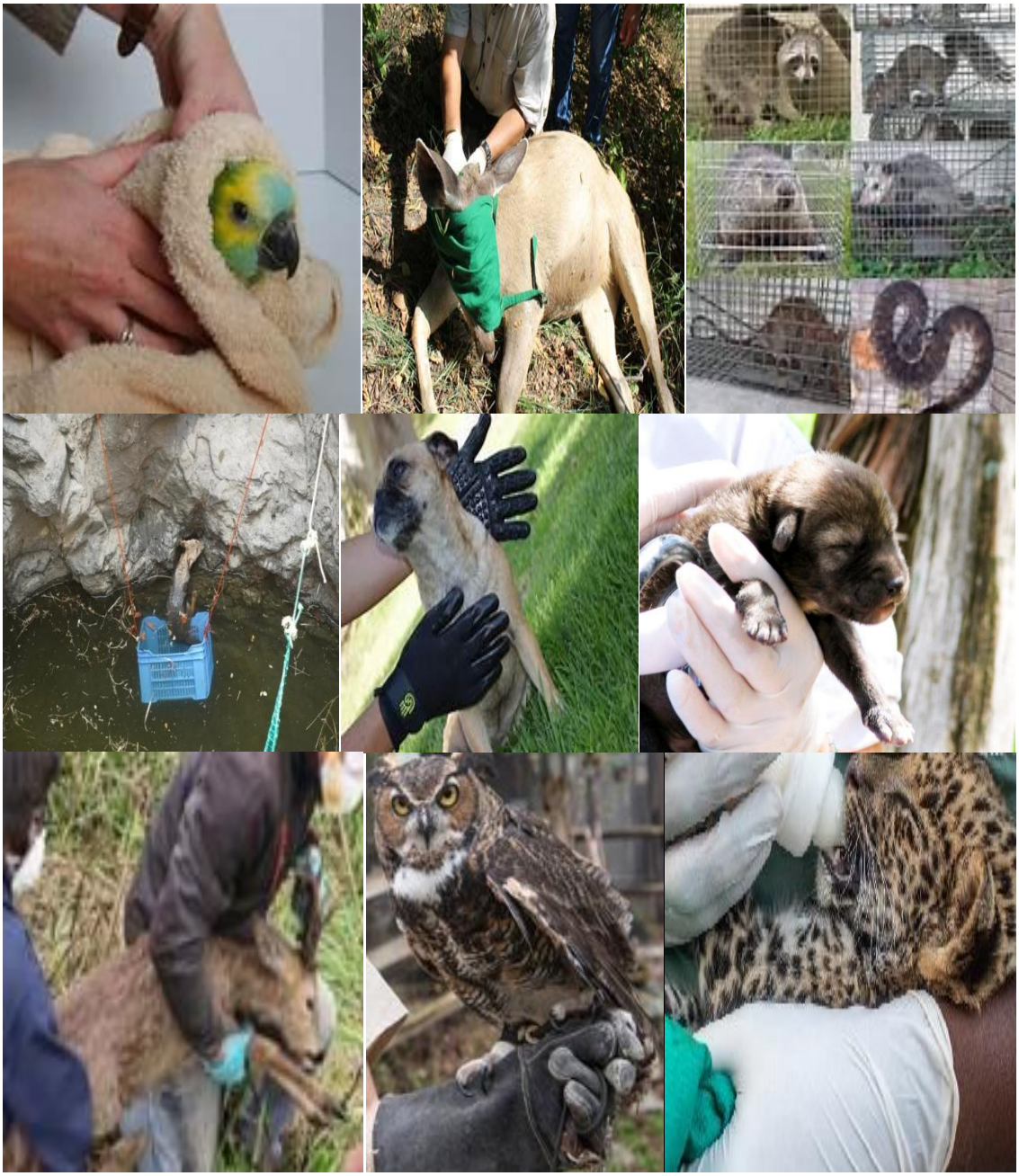


Fig: Restraining and handling of various wild animal/bird species.

3. Wild animal Care

- **Emergency Care and first aid:**
  - Address visible injuries (e.g., fractures, wounds) immediately using basic first aid.
  - Stabilize critical conditions like dehydration or shock before transport.
- **Animal feeding and Nutrition:**
  - Provide clean, species-appropriate water to dehydrated animals.
  - Avoid feeding immediately; consult a veterinarian or wildlife expert about the correct diet.

- **Environmental Comfort:**
  - Place the animal in a quiet, dark, and temperature-controlled environment to reduce stress.
  - Ensure adequate ventilation in containment areas.
- **Disease Management:**
  - Isolate animals showing signs of illness to prevent the spread of infections.
  - Follow strict hygiene practices to avoid cross-contamination.
- **Veterinary Care:**
  - Seek immediate veterinary evaluation for injuries, infections, or other health concerns.
  - Administer prescribed treatments under professional guidance.

4. **Animal Management**
   - **Species-Specific Requirements:**
     - Research and understand the natural history and behavior of the species to cater to its unique needs.
     - Provide species-appropriate enrichment to maintain natural behaviors during captivity.
   - **Quarantine Procedures:**
     - Quarantine rescued animals away from others to monitor for diseases or parasites.
   - **Behavioral Observations:**
     - Monitor the animal's behavior for signs of stress, aggression, or discomfort and document daily activity, feeding habits, and health status.
   - **Temporary Enclosures:**
     - Use secure enclosures that prevent escape and protect the animal from predators.
     - Ensure the enclosure mimics the animal's natural habitat to the extent possible.

5. **Transportation of animals:** The transportation of animals is the intentional movement of non-human animals by means of transport. The transportation of animals involves the safe and efficient movement of animals from one place to another, whether for agricultural, commercial, or personal purposes. This can include transporting livestock, pets, or exotic animals. Common categories of animals which are transported include livestock, destined for sale or slaughter, zoological specimens, laboratory animal race, horses, pets, and wild animals being rescued or relocated. As per guidelines of central zoo authority the transportation of animals must follow the below mentioned protocols as under:-

- The animal should be separated from the herd, if needed, sufficiently in advance before transport and complete health check up should be done before transport for assessing its health conditions.
- Animals in good health only should be transported. Sub-adult animals should be preferred for transportation.
- Pregnant or females which have recently given birth should be avoided for transport.
- Infants and too young, incapable of feeding themselves should also not be transported unless prior arrangements have been made for taking all due care for the same.
- The antlered animals in velvet should not be transported.
- The related papers like animal history cards, treatment cards, health certificate should accompany animal while transportation.
- Necessary arrangements for quarantine at the recipient station should be arranged in advance.
- The dimensions of the transportation containers for mammalian species should be such that the animal is not be able to turn around or to summer sault (Gimenez et.al 2009).
- It is important that all transportation containers should have inner surfaces which are completely free of any projecting nails, screws, ends of mesh or any other sharp material, which could cause injury to the animal.
- The transportation container should have adequate air circulation at all times. There should be additional ventilation by means of holes of suitable size in all walls of the container.
- Suitable lifting handles or gripers bars should be provided and when the containers will be heavily loaded, the hooks for crane slings and facilities for handling by fork-lift should also be fitted.
- On long journeys, the animals should be provided suitable bedding materials such as straw or hessian pad.
- Arrangements for feeding and watering as per the requirement of the species and duration of the journey should be provided.
- The animals which might have been sedated before their transportation should be transported only under the supervision of a qualified veterinarian
- The handling of animals during the transportation should be avoided to the possible extent. The animals should be disturbed as little as possible during the transportation.
- The transportation of animals should be avoided during extreme weather conditions like dry hot summer and very cold winter.

- The journey should preferably be performed during day time. The time between 11:00 A.M. to 4:00 P.M. may be avoided during hot summers and nights during winter
- While transporting the animals, due screening of the staff involved in transportation of animal should be made and it must be ensured that they do not infected of any such diseases that can infect the animal
- The accompanying Veterinarian should carry all necessary drugs, medicines, first aid kit, restraining equipments and drugs, which may be required during emergency.



Fig: Rescued wild herbivore being transported to its natural habitat after undergoing treatment at wild animal health care centre dachigam

CHAPTER 15

Wildlife Forensics

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I. INTRODUCTION

Wildlife forensics is a field of criminal investigation wherein science is used to identify and examine evidence from crime scenes where animals have been killed, particularly those that are protected by law. It can also be defined as a branch of forensic science that applies scientific techniques to investigate crimes against wildlife. It involves the identification of species, origin, and cause of death, as well as tracing illegal trade and poaching activities. Wildlife forensics plays a crucial role in curtailing the wildlife trade and human-wildlife conflict. Forensic examination can be undertaken by using different animal parts, including its blood, hair, teeth, tissue, claws, tusks, feathers or fur is collected. Sometimes, the weapon (if confiscated) or lethal material (poison, pesticide) is also analyzed in laboratory as per findings and chemical analysis (Khanet.al 2018).From these sources, DNA is extracted and amplified using PCR techniques and then sequenced for confirmatory results in forensic science.

1. **Importance of Wildlife Forensics:** Wildlife forensics is concerned with providing scientific evidence to inform investigations into crimes against wildlife focusing on determining the identity of poached or illegally traded wildlife products, and cruelty addressing questions relating to the species, geographic origin, relatedness, individual identity and age, combating illegal wildlife trade, mitigating human-wildlife conflicts, poisoning and animal torturing and hunting etc (Alacs, 2009). Some other key aspects include:

- **Crime Investigation:** Helps detect and solve wildlife crimes such as poaching, illegal trade, and habitat destruction.
- **Species Identification:** Determines the species of animals or plants involved in a case, even from minimal evidence like bones, fur, or feathers.
- **Legal Support:** Provides scientific evidence for prosecuting wildlife criminals.
- **Conservation Efforts:** Supports the protection of endangered species and ecosystems (*Prasad et.al 2002*).

2. Techniques in Wildlife Forensics

- **Morphological Analysis**
  - Examines physical characteristics of specimens like fur, feathers, bones, or scales to identify species.
- **DNA Analysis**
  - Uses genetic testing to identify species, trace geographic origin, or determine familial relationships in breeding programs.
  - Techniques include DNA barcoding and microsatellite analysis.
- **Toxicology Tests**
  - Identifies toxins or poisons in an animal's body to determine cause of death or poisoning incidents.
- **Ballistics**
  - Analyzes bullet fragments or gunshot wounds to link weapons to poaching incidents.
- **Stable Isotope Analysis**
  - Determines an animal's diet, migration patterns, or geographic origin using chemical signatures in tissues.
- **Microscopic Examination**
  - Analyzes hair, fibers, pollen, or soil particles for evidence linking a suspect to a crime scene.
- **Radiology and Imaging**
  - Uses X-rays or CT scans to identify internal injuries, foreign objects, or smuggling of wildlife in concealed containers. Studies of insect activity on carcasses to estimate the time of death or movement of remains.



Fig: Showing foot marks of various wild animal species, another picture is taken during seizure of wild animal skin for forensic testing.

3. Applications of Wildlife Forensics

- **Fighting and combating Poaching**
  - Identifies animals or products (e.g., ivory, tiger skins) involved in illegal trade.
- **Tracking Illegal Trade:**
  - Determines the origin and transit routes of trafficked wildlife.
- **Investigating Habitat Destruction**
  - Analyzes evidence related to deforestation, wetland draining, or pollution.
- **Supporting Endangered Species Laws**
  - Provides evidence to enforce regulations like CITES (Convention on International Trade in Endangered Species).
- **Human-Wildlife Conflict Resolution**
  - Assesses incidents where wildlife attacks humans or vice versa.

4. Challenges in Wildlife Forensics

- Limited availability of reference databases for species identification.
- Difficulty in collecting and preserving evidence from remote or harsh environments (Lombardi and Linda 2013).
- Lack of trained personnel and advanced equipment in some regions.

5. Role of Veterinarians in Wildlife Forensics

- Conducting necropsies to determine the cause of death.
- Identifying trauma or injuries caused by weapons or traps.
- Collecting biological samples (blood, tissue, hair) for analysis.
- Assisting in field investigations and documentation.



Fig: Sampling for laboratory analysis.

CHAPTER16

Impact of Wildlife on Emerging zoonosis

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I. INTRODUCTION

Wildlife offers several social and economic advantages to humans and is a crucial part of biodiversity. However, a resurgence of epidemics in the last 20 years has brought attention to wildlife's capacity to spread harmful infections to cattle and humans, with disastrous results on a global scale. Beyond the spread of infections and illnesses, there are significant connections between human and non-human animal health. The evolution of human cultures has been influenced by the numerous material and intangible connections that humans have with the animals that share their surroundings (Duff 2003; Pascual, *et al.* 2022).Zoonoses with a wildlife reservoir are a serious public health issue that affects every continent nowadays (Donnellan, 2007). The necessity for greater focus in this area is being addressed, and the significance of these zoonoses is becoming more widely acknowledged. Although the exact number of zoonoses is unclear, 62% of the 1415 known human infections that have been cataloged are zoonotic (Billinis., 2013). Wild animals appear to be implicated in the epidemiology of most zoonoses, and they serve as significant reservoirs for the transfer of zoonotic agents to domestic animals and humans (Gonzalez-Barrio et al., 2019). Emerging infectious diseases (EIDs) are those that have grown in incidence over the last 20 years and have the potential to spread further in the future. They can be caused by established etiological agents or newly discovered strains, and they account for at least 12% of all human infections. Examples include West Nile fever, influenza, Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome Coronavirus (MERS-CoV), and the ongoing outbreak of viral pneumonia caused by a novel coronavirus known as 2019 Novel Coronavirus (2019-nCoV) (Lumley *et,al* 2017). Also there-emerging illnesses, such as tuberculosis, which can be drug-resistant, cannot be ignored (Cupertino et al., 2020). Based on these basic epizootiological characteristics, wild animal EIDs can be divided into three groups: EIDs linked to the "overflow" of domestic animals to nearby wildlife populations; EIDs directly caused by human activity, such as the relocation of a parasite or host; and EIDs in which neither domestic animals nor people are clearly involve (Bernasconi *et.al* 2020). There are two significant biological ramifications to this circumstance. First of all, a number of diseases that endanger domestic animals and/or public health can be found in many wild

species. Second, animal EIDs pose a serious threat to the preservation of biodiversity worldwide (Allwright*et.al* 2005; Chomel *et,al* 2007;Cunningham *et al*., 2018).

In light of inadequate or nonexistent defences, the World Health Organization (WHO) has recently recognized the dangers posed by a number of viruses in the Bunyavirales order (Bernasconi et al., 2020). The Middle East, Africa, and Southern Europe are all endemic for the Crimean-Congo hemorrhagic fever virus (CCHFV) (Holbrook, 2017).

It is the most prevalent tick-borne virus that affects people in Western China and Southern Asia. Ixodid (hard) ticks and a range of wild and domesticated animals are involved in the virus's transmission cycle. The two-host tick, or "hunting tick," Hyalommamarginatum, is the species most frequently linked to the spread of CCHFV (Gargili et al., 2017). The Rift Valley Fever Virus (RVFV), a phlebovirus spread by mosquitoes, is the member of the Bunyavirales order that unquestionably has the biggest effect on the health of both humans and animals (Svensson 1998; Lumley et al., 2017). The main cause of sickness in humans, camelids, and wild and domesticated ruminants is hepatic necrosis that follows widespread replication of the virus in the liver . Large outbreaks of RVFV, which is native to Africa and the Arabian Peninsula, follow interepidemic intervals that can last for decades. Potential mosquito vectors' global distribution, globalization, and climate change all contribute to the likelihood of future incursions into presently unaffected areas. Due to their widespread distribution and high incidence of human infections (400 million cases annually), viruses belonging to the genus Flavivirus are among the most notable members of zoonotic arboviruses (Holbrook, 2017). Six of the nine viruses that make up the yellow fever complex have been shown to infect humans.

Direct transmitted wildlife diseases that affect the Human (Syed et al., 2024**):**

Disease	**Pathogen**	**Hosts**	**Geographical distribution**	**Impact on wildlife**	**Impact on Human health**
Rabies	*Lyssavirus* or rabies virus	Dogs, foxes, bats, Human	Asia, Africa, United States	Multiple populations in extinction danger	Inflammation of the brain in humans
Ebola Virus	*Ebolavirus*	Fruit bats or	Africa, Democratic	25% of chimpanzee	11,323 deaths

Disease		nonhuman primates (apes and monkeys)	Republic of the Congo, Uganda	s died in 1990s. Cause multiple infections in primates	and 28,646 illnesses in West Africa due to this disease.
Letospirosis	*Leptospira*	Rabbits, deer, opossums, dogs, sheep, hedgehogs	Southeast Asia, Africa, United States	Cause infection in horses, sheep, dogs, and hedgehogs	Every year, there are 500,000 cases of leptospirosis in humans globally.
Hanta Virus pulmonary syndrome	Hantavirus	Rodents	America, Canada, southern Florida, Canada, eastern United States	Cause the mild infections in wild animals	850 cases of hantavirus in US in 2021. In 2017, the mortality rate in the US due to HPS was 36%.
Rickketsial Pox	*Rickettsia akari*	Rodents like house mice	Boston, West Hartford, New York	Cause the infection in rodents.	Cause the serious infections and mild febrile illness in humans
Rat bite Fever	*Streptobacillus moniliformis, Spirillum minus*	Rats, gerbils	US, Europe, Australia, and Africa	Cause the infection in wild animals.	Zoonotic sickness and acute relapsing fever

In Africa, Aedes species spread it, while in South America, Haemagogus spp. do the same. Initially discovered from a lamb in South Africa in 1955, Wesselsbron virus (WESSV) is a significant virus that poses a hazard to ruminants (Weiss *et.al.,* 1956). Numerous cases of infections in other ruminants have been documented (Mushi *et.al.,* 1998), and ostriches have also been shown to be affected (Allwright *et.al.,* 1995). Crucially, Senegal's black rat virus isolation suggested that the virus was spreading throughout Africa (Diagne *et.al.,* 2017). More than 30 human cases of WESSV have been documented, resulting in fever, headache, and joint and muscular pain. According to Weyer et al. (2013), serological surveys in Southern African nations estimated seropositivity to be between 20 and 35 percent (Gales *et.al,* 2008; Gargili *et.al* 2017).

Despite the need to eliminate these pests, illness prevention and environmental and health education initiatives must take precedence. In order to assess the potential appearance of viral infections and develop appropriate preventive measures globally, a comprehensive study of the zoonotic epidemiology in high-risk animal-human interfaces is also required. High-risk interfaces likely increase the probability of a new human pandemic by encouraging the resurgence of old illnesses. Regarding viral infections, there are a number of viral species for which there is no trustworthy information on the conditions at the time of their spread. Due to erroneous global wild animal surveillance, comprehensive data on animal diseases is typically lacking (Cupertino *et.al.*, 2020).

CHAPTER 17

Housing of captive wild animals

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I. INTRODUCTION

Housing of wild animals in zoos and rescue centers is an important aspect of ensuring their well-being and providing appropriate care. It involves designing environments that meet the physical, psychological, and social needs of the animals, while also maintaining the safety of both the animals and visitors. There are certain key considerations for housing of wild animals and following facilities are essentially required for better management of captive wild animals. First of all animal enclosures should be large enough to allow animals to move freely and engage in natural behaviors. Overcrowding can lead to stress, aggression, and invite serious health related problems. The design of the enclosures should reflect the natural habitat of the species. For example, primates require climbing structures, while aquatic species need pools or water features which should be made available inside enclosures. The captive enclosures should provide environmental enrichments to the animals, such as hiding spots, toys, or challenges, encourages animals to exhibit natural behaviors, such as foraging, hunting, or climbing. Animals should have access to sheltered areas where they can retreat for rest, privacy, and protection from extreme weather conditions. The enclosures must be secure enough to prevent animals from escaping or harming visitors. This often involves strong barriers, fencing, and locked gates. The cages and enclosures of different species especially predators and prey, should be housed separately to prevent stress or potential harm (Kleiman *et.al* 2010). Animal care workers should have safe access to the enclosures for cleaning, feeding, and medical care, while maintaining the safety of both humans and animals and should be devised properly as per guidelines of central zoo authority (CZA). Zoos and rescue centers should have on-site veterinary clinics for regular health check-ups, medical treatments, and emergency care OF sick, injured and other animals. The Central Zoo Authority (CZA) of India provides comprehensive guidelines for the housing of captive wild animals to ensure their physical and psychological well-being. These guidelines cover aspects such as the minimum dimensions of enclosures, enrichment needs, and the environmental conditions for various species in captivity. As per Guidelines regarding housing of wild animals, enclosures should replicate the animal's natural habitat as closely as possible, providing opportunities for natural behavior and must be secure, durable, and

escape-proof. The fences must be escape-proof, with materials suited to the animal's size and strength. For larger predators, barriers should be at least 12 feet high. The enclosures should have proper drainage, shelter, and be free of hazards (Carrie, 2013).

1. **Specific Requirements for Enclosures:** For Carnivores (Big Cats, Bears, etc.): Enclosures should be designed to give the animals enough space for natural behaviors like hunting, roaming, and resting. Carnivores like tigers, lions and leopards require high fences (minimum 12 feet) to prevent escape. Pools and climbing structures (especially for tigers) should be incorporated for enrichment.

    - **For Primates:** Enclosures must provide ample vertical space for climbing, swinging, and exploring. Primates such as chimpanzees and gorillas need social interaction, so groups are often housed together, requiring larger spaces. Enrichment such as ropes, climbing platforms, and various toys should be provided to promote natural behaviors.

    - **For Herbivores (Zebras, Antelopes, deers etc.):** Grazing space should be abundant, and the enclosure should include natural vegetation or grass. These species need a shelter for shade, especially in hotter climates (Norton *et.al* 1995).

    - **For Aquatic Animals (Crocodiles, Seals, Dolphins, etc.):** Aquatic animals should have access to large water bodies for swimming and diving. Pools for these animals must be deep enough to allow for natural diving behavior, and they must include areas for basking.

    - **For Birds (Eagles, Parrots, etc.):** Large aviaries with trees, perches, and flight space are necessary, especially for birds like eagles and hawks. For smaller species like parrots, the enclosure should include perches and opportunities for flight and socialization.

    - **For Reptiles:** For reptiles like snakes and crocodiles, enclosures should provide temperature gradients, hiding spaces, and water access. The minimum dimensions for snakes depend on their species size, but large snakes require a spacious environment to move around.

2. **Housing wild herbivores:** Herbivores typically need ample space to graze, move, and display natural foraging behaviors. Herbivores generally prefer open spaces, they should still have access to shelter for protection from extreme weather. Enclosures should ideally have natural vegetation that resembles their native habitat, providing grazing opportunities and enriching

their environment. Herbivores require constant access to fresh water so adlib water availability is to be provided within enclosures for meeting animal demands round the clock. The minimum height of fencing for most herbivores ranges from 5-8 feet, depending on the species, to prevent escapes and ensure safety. The enclosure should ideally replicate natural terrain, with open grazing areas and some topographical variation, such as hills, rocks, or trees (Veasey *et.al* 1996). Enclosures should be secure and free from sharp objects or hazards that could harm the animals. Housing wild herbivores in captivity requires careful consideration of their natural behaviors, dietary needs, and habitat preferences to ensure their well-being and health. These animals, which often graze or browse for a large portion of the day, need spacious enclosures that replicate the variety of vegetation they would naturally encounter in the wild. Enclosures should include a diverse range of plants, shrubs, and trees to provide appropriate food sources and encourage natural foraging behaviors. Additionally, ample space is crucial to allow for movement, social interaction (for herd species), and territory establishment, as many herbivores are accustomed to wide-ranging habitats (Mellen *et al.* 1998). Environmental enrichment, such as varied terrain, hiding spots, and access to water, helps reduce stress and promotes natural behaviors. Special attention must also be given to maintaining proper nutrition through a well-balanced diet and ensuring regular access to clean water.

3. **Housing of wild birds:** Wild birds, being highly diverse in species, have specific requirements for housing. Generally, they require spacious enclosures that allow for flight, as flying is an essential part of their natural behavior. The enclosure should be large enough for birds to move freely and fly short distances. The structure should include varying heights, as many birds perch in trees, and provide a variety of perches with different diameters and textures to mimic natural habitats.

   Enclosures for wild birds should also replicate their natural environment, offering plant life, trees, and shrubs to promote foraging, nesting, and hiding behaviors. Environmental enrichment, such as swings, climbing structures, and food-dispensing toys, is essential to stimulate their physical and mental health. Birds are often social, so the enclosures must also cater to their social needs, especially for species that live in flocks or pairs.

   As we all know animal Safety is paramount so the enclosure should be escape-proof with secure fencing or mesh. The materials used should be smooth, avoiding sharp edges that could injure the birds. Additionally, clean water and a varied diet that suits the specific needs of each species are essential for keeping birds healthy. Housing wild birds and pheasants in

captivity requires careful attention to their specific behavioral and physical needs. Proper space for flight, varied perches, natural vegetation, and environmental enrichment are essential components of their enclosures. A well-designed habitat not only promotes physical and mental well-being but also supports conservation efforts as well. .

Table: Showing wild animal enclosure dimensions with additional remarks for captivity.

Species	**Dimensions**	**Remarks**
Bear **(**Ursus thibetanus)	*Enclosure size*: Minimum 2000 m² (0.5 acres) and *Height of the enclosure*: 3.5 m	Bears require large areas with both open spaces for roaming and areas with foliage for hiding and foraging.
Leopard (Panthera pardus)	*Enclosure size*: Minimum 1000 m² (0.25 acres) and *Height of the enclosure*: 3 m	Leopards are solitary animals and need large, secure enclosures for movement and territory. Height is important for climbing opportunities.
Rhesus Macaque (Macaca mulatta)	*Enclosure size*: Minimum 100 m² (per group) and *Height of the enclosure*: 3 m	Primates need both horizontal and vertical space for climbing and socializing. Fencing must be strong enough to prevent escape
Civet (*Viverra zibetha*)	*Enclosure size*: Minimum 50 m² per animal *Height of the enclosure*: 2.5 m	Civets are arboreal and terrestrial, requiring a mix of climbing structures and ground space. They are nocturnal and need a safe, secure enclosure with plenty of hiding places, trees, or branches for climbing.
Hangul (Cervus hanglu hanglu)	*Enclosure size*: Minimum 1000 m² (0.25 acres) *Height of the enclosure*: 2 m	Hanguls require open, grassy areas with vegetation for grazing. Their enclosures should allow them to move freely and have space for

		social interaction.
Porcupine (Hystrix indica)	*Enclosure size*: Minimum 25 m *Height of the enclosure*: 1.5–2 m	Porcupines need secure, enclosed areas with plenty of hiding spots and ground cover. They are nocturnal and burrowing, so their enclosures should mimic these behaviors.
Ibex (Capra ibex)	*Enclosure size*: Minimum 1000 m² (0.25 acres) *Height of the enclosure*: 2.5 m	Ibex require rocky, mountainous enclosures. They are good climbers and need vertical spaces to express natural climbing behavior.
Sambar (Cervus unicolor)	*Enclosure size*: Minimum 1500 m² (0.25 acres) *Height of the enclosure*: 3 m	Sambar deer need large areas for grazing and foraging. They should also have water bodies for bathing.
Chetal (Axis axis)	*Enclosure size*: Minimum 1000 m² (0.25 acres) *Height of the enclosure*: 1.5–2 m	Chetal deer require open grassy areas for grazing and foraging. Their enclosure should also have cover for hiding.
Markhor (Capra falconeri)	*Enclosure size*: Minimum 2000 m² (0.5 acres) *Height of the enclosure*: 2.5 m	Markhors need rocky and steep terrain in their enclosures to replicate their natural habitat. The height of the enclosure is essential for climbing opportunities.
Jungle Cats (Felis chaus)	*Enclosure size*: Minimum 100 m² per animal *Height of the enclosure*: 2.5 m	Jungle cats require space for roaming, hiding, and climbing. Their enclosure should provide vertical space for climbing, as they are arboreal to some extent. The height is required to prevent escape and allow for natural behaviors.

(Nilgai) (Boselaphus tragocamelus)	*Enclosure size*: Minimum 3000 m² (0.75 acres) *Height of the enclosure*: 1.8 m	Nilgai, being a large herbivore, require open, grassy enclosures for grazing and running. The height should ensure safety and prevent escape. The space should allow for movement and social interaction, as Nilgais are often seen in groups.
Musk deer (Moschus moschiferus)	*Enclosure size*: Minimum 500 m² *Height of the enclosure*: 2.5 m	Musk deer are shy and nocturnal. They need forested areas with ample ground cover and some elevation for climbing.
Pheasants	*Enclosure size*: Minimum 50 m² *Height of the enclosure*: 2.5–3 m (for flight space)	Pheasants need enough ground space for foraging and some vertical space for perching. Their enclosures should have natural foliage for cover and foraging.
Wild Birds (e.g., Peafowl, Crane, etc.)	*Enclosure size*: Minimum 200 m² for small species, 1000 m² for larger species *Height of the enclosure*: 3 m (for flight space)	Wild birds such as partridges and ducks require both **ground** and **water** areas. Enclosures should include natural vegetation, water bodies, and space for flying. For waterfowl, having a pond or lake is essential.

Animal enclosure dimensions according to CZA

S. NO.	NAME OF SPECIOES	SIZE OF FEEDING CUBICLE/NIGHT SHELTER PER ANIMAL(METERS)			OUTDOOR OPEN ENCLOUSER/ANIMAL (Sq.m)
		Length	Breadth	Height	
1	Leopard	2.00	1.80	2.50	250
2	Black Bear	2.50	1.80	2.50	500
3	Brown Bear	2.50	1.80	2.50	500

4	Civet	2.00	1.50	2.50	200
5	Hangul	3.00	2.00	2.50	750
6	Fawn	2.00-3.00	1.50-2.00	1.50-2.00	20-50
7	Goral	2.50	1.50	2.50	250
8	Spotted Deer	3.00	2.00	2.50	750

Tab: Showing wild animal enclosure dimensions, cubicle space, outdoor open enclosure space as per guidelines of Central Zoo Authority (CZA).

Animal Type	**Species Example**	**Minimum Enclosure Size**	**Minimum Height of Enclosure**
Large Carnivores	Lion, Leopard	1,000 m² (for a pair)	5 m
Medium Carnivores	Wild Dog (Dhole), Jackal	500 m² (for a pair)	4 m
Small Carnivores	Fox, Civet, Mongoose	100 m² (for a pair)	2.5 m
Primates	Gibbon, Langur, Bonobo	500 m² (for a pair)	4 m
Reptiles	Snake, pyhon,lizard	100–500 m² (based on species)	3 m
Birds of Prey	Eagle, Vulture	200 m² (for a pair)	5 m
Large Herbivores	Indian Elephant, Gaur,	3,000 m² (for a pair)	5 m
Medium Herbivores	Sambar, Nilgai, Wild Boar	1,000–1,500 m² (for a pair)	4 m
Browsers/Climbers	Bison, Deer	500 m² (for a pair)	4 m

These tabular format provides recommended enclosure sizes and height based on CZA guidelines, aimed at ensuring that wild animals are housed in environments that support their natural behaviors and welfare. (Dimensions have been taken from published researches online and may change with size and specie)

Note*

These dimensions can vary slightly depending on the specific needs of each species, as some animals may need larger enclosures due to territorial behaviors or more extensive exercise requirements. Also, there are specific guidelines for providing enrichment (e.g., natural features, trees, hiding spots) within the enclosures. The enclosure sizes mentioned are minimum requirements and may be adjusted based on specific species, zoo capacity, and behavioral needs. The height of enclosures is particularly relevant for ensuring the safety of both

animals and visitors. Higher enclosures prevent escape, especially for carnivores and large herbivores. Some species may require larger enclosures depending on their behavior, territorial needs, and space to roam or exhibit natural behaviors.

II. CONCLUSION

Housing wild animals in captivity is a complex issue that involves balancing the animals' natural needs with human-controlled environments. It is important to provide enclosures that simulate the animals' natural habitats as closely as possible, ensuring they have adequate space, appropriate shelter, and environmental conditions like temperature, humidity, and lighting. The housing of wild animals is a critical aspect of their care, well-being, and conservation. Properly designed enclosures must replicate natural habitats as closely as possible to support the animals' physical, mental, and behavioral needs. This includes providing sufficient space, appropriate environmental conditions, and enrichment activities to reduce stress and promote natural behaviors. Ethical considerations also play a vital role, with a focus on minimizing captivity's negative impact and prioritizing conservation efforts in the wild. By combining knowledge of animal behavior, habitat requirements, and sustainable practices, wildlife housing can contribute to both the welfare of the animals and the broader goals of wildlife preservation and education. To ensure the welfare of wild animals in captivity, it is crucial that the facilities comply with stringent standards set by animal welfare organizations and regulations.







Fig: showing captive wild animal species.

CHAPTER 18

Veterinary ophthalmology in wildlife

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I. INTRODUCTION

The word *ophthalmology* comes from the Greek roots *ophthalmos* meaning *eye* and *logos* meaning *word*, *thought* or *discourse*; ophthalmology literally means "The science of eyes." As a discipline it applies to animal eyes also, since the differences from human practice are surprisingly minor and are related mainly to differences in anatomy or prevalence, not differences in disease processes. The main organ of the vision is eye, the eye along with its various parts and generating vision in tandem with the brain. Eye is a unique and highly complex organ in terms of structure and function. It is a very sensitive organ, the function of which may be affected even with mild insult to its homeostasis (Riad *et.al* 2003). Eye Health is the state in which vision, ocular health, and functional ability is maximized, thereby contributing to overall health and. well- being, social inclusion, and quality of life. Animals spontaneously develop ocular diseases that closely mimic those in humans, especially dry eye disease, herpes virus infection (cats), fungal keratitis (horses), bacterial keratoconjunctivitis, uveitis, and glaucoma. Both uveitis and glaucoma are common in domestic animals and humans, and many similarities exist in pathogenesis, genetics, and response to therapy.

Veterinary ophthalmology is a specialized branch of veterinary medicine that focuses on the diagnosis, treatment, and management of eye diseases and conditions in animals. Veterinary ophthalmology is important for maintaining the health and quality of life of animals, particularly those who depend heavily on their vision, such as guide dogs or working animals. This field encompasses a wide range of disorders affecting the eyes and vision of pets, livestock, and other animals. The most common eye diseases and conditions associated with ophthalmology include cataracts, glaucoma, conjunctivitis, corneal ulcers, retinal diseases, uveitis, and eyelid disorders such as entropion or ectropion, trauma and other ocular disorders (Albert and Edwards 1996). Veterinary ophthalmologists perform surgeries to treat conditions like cataract removal, eye enucleation (removal of the eye), and repair of trauma-related injuries to the eyes and successfully treat ocular disorders in veterinary practice. Similar to human medicine various specialized tests and diagnostic tools, such as slit-lamp examination, tonometry (to measure intraocular pressure), ocular ultrasound, and fluorescein staining (to detect corneal ulcers), are used to

diagnose various conditions related to eyes in animals (Bartlett and Jaanus 2008). After proper physical examination of eyes of animals with the help of diagnostic tests and tools etc veterinary ophthalmologists accordingly plan treatment modules and use specific medications (e.g., eye drops, oral medications), laser therapy, or surgery to treat eye conditions in different animal species. Treatment of animals is followed up with regular eye examinations which are important for certain breeds that are prone togenetic eye diseases and veterinary ophthalmologists play a key role in providing guidance on preventive measure and overall health care of animals (Yoon et.al 2011).

In wild animals Ophthalmology involves the study and treatment of eye diseases and conditions affecting non-domestic species, including mammals, birds, reptiles, and amphibians and other wild animals (Tu *et.al* 2005). The field is similar to veterinary ophthalmology in companion animals but requires additional knowledge due to the unique biology, behaviors, and environmental factors affecting wild animals.

There are unique challenges in Wild animal ophthalmology due to the fact that wild animals come from various habitats and have highly specialized visual systems. For instance, raptors like eagles and owls have different eye structures and visual needs than nocturnal mammals or aquatic species like seals or dolphins. Many wild animals are difficult to handle for examination, requiring specific techniques, sometimes sedation or anesthesia, for proper evaluation. Rescue and restraining of wild animals is again a big challenge before undergoing examination of wild animals. Unlike domestic animals, wild animals may not have access to routine care, and diagnoses or treatments may be more challenging due to logistical constraints (Aguinaldo *et.al* 2018).

Some commonly occurring eye conditions in wild animals include trauma of eyes, wild animals are at risk of eye injuries from predation, hunting, collisions with vehicles, and environmental hazards (e.g., debris, branches, or fishing lines). These injuries may lead to corneal ulcers, retinal detachment, or other forms of trauma and as per the nature injury of eye and diagnosis of the condition the treatment plans are decided by veterinarians (Malstrom, and Kroger, 2006).

Similarly ocular infections caused by bacteria, viruses, fungi, or parasites in wild animals, may lead to conjunctivitis, uveitis, or other serious eye conditions. As wild animals grow with age, they may experience senile cataracts or degeneration of the retina, which can impair vision and overall survival. Again environmental factors like pollution, exposure to toxic substances, and habitat destruction can also contribute to eye conditions such as conjunctivitis, cataracts, or retinal diseases which need immediate treatment and care for safety

of animals. Subsequently there are certain parasites, like toxocara (roundworms), which can cause damage to the eyes of wild animals, leading to conditions like ocular larva migrans etc. For proper diagnosis of the condition or diseases, a thorough eye examination is essential and may include a slit-lamp exam, direct ophthalmoscopy, and specialized imaging like ocular ultrasound or fluorescein staining to detect ulcers and other ocular disease conditions. Given the nature of wild animals, sedation or anesthesia is often necessary to properly examine the eyes, particularly for species that are difficult to restrain. Techniques usually involved in ophthalmology studies in wild animals include such as tonometry (to measure intraocular pressure), corneal mapping, or PCR (for detecting pathogens) are used to assess eye health in animals (Leffler and Hogewind 2023).

As far as the medication of various eye affections is concerned, antibiotics, antifungals, and antiparasitic drugs are commonly used to treat infections or parasitic infestations in the eyes of wild animals. Steroid treatments may be sometimes used for treating inflammatory eye conditions in some cases but require caution and proper veterinary care (*Wincewicz et.al 2009*). In some cases, surgery may be necessary, such as for the removal of foreign bodies or the repair of traumatic injuries. For example, enucleation (removal of the eye) may be required if an eye is severely damaged or infected and is performed by veterinary surgeons only and require regular follow ups and post operative care for survival and better recovery. Some wild animals, such as endangered species, may be treated in rehabilitation centers, zoos, or wildlife sanctuaries under care and management of wildlife veterinarians. Protecting the vision of endangered species can be critical to their survival. Veterinary ophthalmologists working in conservation programs may treat animals in the wild or in captivity to prevent blindness or mitigate conditions that could further endanger the species. In wildlife sanctuaries and zoos, regular ophthalmologic exams are essential to detect and prevent eye conditions before they impact the animal's well-being. This is especially important in species known to be prone to hereditary eye diseases. Veterinarians and researchers in wildlife ophthalmology often educate the public, wildlife rehabilitators, and conservationists about preventing eye injuries in wild animals, particularly those in areas where human-wildlife interactions are common.

II. CONCLUSION

Wildlife ophthalmology plays a crucial role in maintaining the health of wild animal populations, both in captivity and in the wild. Eye health is crucial for the overall well-being of animals. Proper vision is essential for their survival, behaviour, and quality of life. Veterinary ophthalmology is a plays a key role and is a specialized field focused on diagnosing and treating eye disorders in

animals. Conclusively wildlife ophthalmology plays a crucial role in the diagnosis, treatment, and management of ocular diseases in animals. Given the unique physiology and ecological requirements of wild species, veterinary ophthalmologists must be well-versed in both general ophthalmic procedures and species-specific considerations. Early detection and treatment of ocular conditions are vital to the overall health and survival of wild animals, especially when considering conservation efforts.



Fig: Subconjunctival administration of medication and treatment of various occular disorders in wild animals at wild animal healthcare centre Dachigam

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