



CONSERVATION MANAGEMENT PLAN (July 2021 – June 2031)

JIGME KHESAR STRICT NATURE RESERVE
Department of Forests and Park Services
Ministry of Agriculture & Forests
Haa, Bhutan



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DEDICATION



**The Conservation Management Plan is dedicated to
His Majesty The 5th Druk Gyalpo of Bhutan**

དཔལ་ལྷན་འབྲུག་གཞུང་། སོ་ནམ་དང་ནགས་ཚལ་ལྷན་ཁག། ནགས་ཚལ་དང་གླིང་ཀ་ཞབས་ཏྲིག་ལས་ཁུངས།
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**ENDORSEMENT AND APPROVAL OF ROYAL
GOVERNMENT OF BHUTAN**



**Conservation Management Plan of Jigme Khesar Strict Nature
Reserve (2021-2031)**

*“In accordance with the provisions under Section 21 subsection (b) of the Forest and Nature
Conservation Act of Bhutan, 1995”*

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MINISTER

Royal Government of Bhutan
Ministry of Agriculture and Forests
Tashichhodzong
Thimphu: Bhutan



FOREWORD

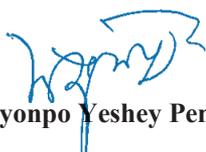
Jigme Khesar Strict Nature Reserve, the only Strict Nature Reserve in the country is truly a conservation jewel in the Eastern Himalayas, featured with astonishing biodiversity of many globally endangered, rare, and endemic species of flora and fauna, amazing sceneries and landscapes and a unique yak-herding culture since times immemorial. Additionally, the nature reserve harbors the only endemic poppy, the *Meconopsis superba* (White poppy), with the most pristine temperate and alpine ecosystems in the country. It is the only protected area in Bhutan that is part of the trans-boundary conservation landscape making its connection with the Kangchenjunga Landscape.



Grounded on the extensive biodiversity surveys and field data analysis, the current conservation management plan (2021-2031) aims to balance conservation landscapes and build resilient yak-herding communities. The plan focuses on five key areas; 1. Ensure species persistence; 2. Zonation and habitat management; 3. Build climate resilience of herding communities in and around the nature reserve; 4. Human-wildlife conflict mitigation measures; and 5. Institutional strengthening.

A key salient feature of the plan is the prerequisite to develop an Annual Operational Work Plan aimed at addressing the existing, emerging challenges and threats more effectively and effectually. I am hopeful that the Conservation Management Plan will contribute significantly towards balancing the conservation landscapes and social livelihood needs within and around Jigme Khesar Strict Nature Reserve.

Tashi Delek !


(Lyonpo Yeshey Penjor)

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SECRETARY

**Royal Government of Bhutan
Ministry of Agriculture and Forests
Tashichhodzong
Thimphu: Bhutan**



PREFACE

It gives me enormous pleasure to applaud the management of Jigme Khesar Strict Nature Reserve in coming with its Second Conservation Management Plan for a period of ten years (2021-2031). JKSNR, the only Strict Nature Reserve in the country has made remarkable achievements in terms of conservation of floral and faunal diversity, infrastructure and human resource development, awareness and advocacies to the local communities. Such success is mainly attributed to efficient implementation of the First Conservation Management Plan (2012-2017) which provided guidance for the execution of conservation programs and activities. It is heartening to notice that the new plan has a clear vision, mission, goals with realistic, reckonable, and time-bound objectives that are all geared towards accomplishing the goals of preserving the rich biodiversity and providing the ecosystem services to the nation.



I extend my appreciation to the management of JKSNR for coming up with yet another holistic conservation management plan. I am also optimistic that it will serve as a guide to ensure effective and efficient implementation of planned activities for conservation of most pristine temperate and alpine ecosystems in the country.

Lastly, certainly not the least, I would like to congratulate and express my appreciation to the entire team of JKSNR who were involved in the intensive field surveys and plan writing.

Tashi Delek!

(Rinzin Dorji)



DIRECTOR

ནགས་ཚལ་དང་སྐྱིད་ཀ་ཞབས་ཉིག་ལས་ཁུངས།
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ACKNOWLEDGEMENT

On behalf of the Department of Forests and Park Services and the conservation fraternity, I would like to take this opportunity to offer our cordial thanks and congratulations to all our field colleagues of Jigme Khesar Strict Nature Reserve (JKSNR) for performing the creditable work towards the preparation of the 2nd conservation management plan for the period of 10 years (2021-2031).

The Department highly values their contributions and appreciates every one for demonstrating and signifying unwavering commitment, dedication, and support in this momentous endeavor.

The Department also attaches great importance to the continued support and assistance provided by the Bhutan for Life (BFL), and the Royal Government of Bhutan (RGoB) for providing funding to carry out major portions of the plan revision expenses like Rapid Biodiversity Survey, socio-economic surveys, stakeholder consultations and printing for which we are immensely grateful for their support.

Finally, I congratulate the management of JKSNR for dedicating this second edition of the conservation management plan of JKSNR to His Majesty, the King Jigme Khesar Namgyal Wangchuck.



With best wishes and Tashi Delek!

(Lobzang Dorji)

ACRONYMS

JKSNR	Jigme Khesar Strict Nature Reserve
BFL	Bhutan for Life
RGoB	Royal Government of Bhutan
MoAF	Ministry of Agriculture and Forests
NCD	Nature Conservation Division
RBS	Rapid Biodiversity Survey
Km	Kilometer
M	Meter
Ha	Hectare
IUCN	International Union for the Conservation of Nature
CITES	Convention on International Trade in Endangered Species
FNCRR	Forest and Nature Conservation Rules and Regulations 2017
FNCA	Forest and Nature Conservation Act of Bhutan 1995
GIS	Geographic Information System
GPS	Global Positioning System
SPSS	Statistical Package for Social Science
DBH	Diameter at Breast Height
BA	Basal Area
NWFPs	Non-wood Forest Products
RBA	Relative Basal Area
Cm ²	Centimeter square
H'	Species Diversity
SES	Socio-economic Survey
HH	Household
UWICER	Ugyen Wangchuk Institute for Conservation and Environmental Research

GLOSSARY OF BHUTANESE TERMS

Chiwog	Lowest administrative unit formed by group of villages
Dzongkhag	District
Dasho Dzongdag	Governor of District
Dungkhag	Sub District
Gewog	Block
Gup	An elected head of the Gewog
Tshogpa	Elected representative of the Chiwog
Kamshing	Dry land
Chhuzhing	Wet land
Tshesa	Kitchen Garden
Lanor	High altitude cattle
Thanor	Low altitude cattle
Yuelnor	Local breed cattle

Executive Summary

Operationalized in the year 2010, Jigme Khesar Strict Nature Reserve (JKSNR), erstwhile known as Toorsa Strict Nature Reserve is the only Strict Nature Reserve amongst the 10 (ten) protected areas in Bhutan, encompassing parts of Haa and Samtse dzongkhags with an area of 784.225 km².

The first ever conservation management plan which was prepared for a period of 05 years (2012-2017) exclusively emphasized on species conservation, enhancement of livelihoods, minimization of human-wildlife conflicts, capacity building, research and infrastructure development. The achievements made in the implementation of the thematic conservation areas resulted in the scoring of 62.22% evaluated through Bhutan Management Effectiveness Tracking Tool Plus (Bhutan METT Plus).

The current conservation management plan which is prepared for a period of 10 years (2021-2031) is based on the findings of robust assessment of the biodiversity and socio-economic surveys of the resident local communities. Based on the potentiality and accessibility within the nature reserve area, a total of 250 plots (20 x 20m) for tree layer and 399 plots (2 x 2m) for herb layer from 48 grids of 4x4 km were sampled for the biodiversity assessments. Social information of individual Household (HH) were collected from 119 representatives HHs of yak-herding communities and resident local communities of the buffer areas using a structured questionnaire. In addition, a strategic framework analysis and several participatory appraisals (PRA), stakeholder consultations at local, dzongkhag and national level have also attributed in shaping this document.

A total of 754 species of plants belonging to 129 families, 100 species of fungi, 40 mammals, 235 birds, 68 butterflies, 7 fishes, 16 reptiles and 7 amphibians were recorded through the biodiversity assessments conducted in 48 grids covering the entire area of the nature reserve. Macro-invertebrates belonging to 7 class/order under 9 families were recorded from the 29 sampling sites from alpine lakes and streams.

This Plan consisting of seven chapters describes in detail the aspects of conservation strategy, challenges and threats, achievements from the past conservation management plan and strategic actions for the next ten years. The plan aims to address the issues pertaining to species conservation and protection such as habitat management, zonation, research, human-wildlife conflicts, building climate resilience of the yak-herding communities and strengthening institutional efficiency with the inclusion of implementation of conservation programs with budget outlay, monitoring and evaluation.

The costs incurred for the several biodiversity and socio-economic surveys, stakeholder consultation meetings, printing and publication were all funded with fund support from the Bhutan for Life.

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CHAPTER 1:

Background

The Jigme Khesar Strict Nature Reserve (JKSNR), the only Strict Nature Reserve in the country, was declared in the year 1993 and operationalized in 2010 spans across an area of 784.225 km². JKSNR is located to the north-west of the country, south-east of the Chumbi valley approximately between latitude 27°12' to 27°32' & longitude 88°53' to 89°09' in the Eastern Himalayas. JKSNR is renamed from Toorsa Strict Nature Reserve in October 2014 in reverence to the extraordinary contribution of our beloved 5th King His Majesty Jigme Khesar Namgyal Wangchuck towards ensuring the conservation and protection of our pristine environment.

It spreads across two Dzongkhags of Haa and Samtse in western and south-western Bhutan. Its highest area coverage is under Bjee gewog with about 62.07% followed by Sangbay gewog with an area coverage of 31.56% under Haa Dzongkhag. In addition, 3.67% area of Norgaygang and 2.65% of Tendruk gewogs under Samtse Dzongkhag falls under JKSNR area (Figure 1). This is the only protected area in Bhutan without any permanent human settlements, except for a few migratory yak-herding communities from Bjee, Katsho and Eusu gewogs under Haa dzongkhag.

The nature reserve protects the eastern most variant of the central temperate forests in the country ranging from broadleaf forests to alpine meadows in the north. Being virtually uninhabited, the nature reserve has one of the most pristine temperate and alpine ecosystems. Considered to be the conservation jewel in the Eastern Himalayas featured with astounding biodiversity composed of many globally endangered, rare and endemic species of fauna and flora including high value medicinal plants, spectacular sceneries and a unique culture endowed with many critical watersheds for two major rivers of Bhutan Amo Chhu and Haa Chhu-Wang Chhu.

It shares international borders with the Indian state of Sikkim to its west (Pangolakha Wildlife Sanctuary) and forms a contiguous natural habitat of pristine alpine meadows with the Tibetan Autonomous Region of China to its north. It is connected to Jigme Dorji National Park (JDNP) to its north-east part of the JKSNR-JDNP Biological Corridor 1. The nature reserve is almost entirely inside Haa dzongkhag and slightly within Samtse dzongkhag; and is home to a good number of important flora and fauna including the elusive *Panthera uncia*, *Panthera tigris tigris*, *Budorcas taxicolor whitei*, *Ailurus fulgens*, *Moschus chrysogaster*, *Bos gaurus*, etc.

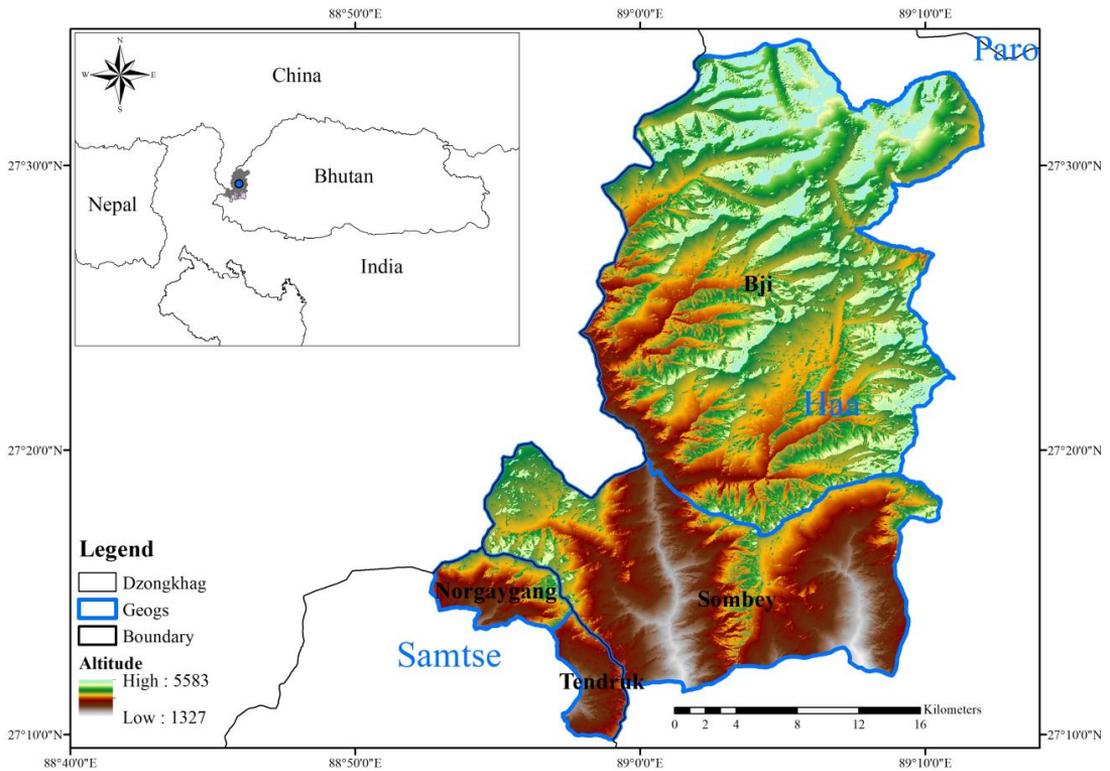


Figure 1: Map of JKSNR (location map)

1.1 History and Significance of JKSNR in Bhutan

The history of protected areas in Bhutan dates back to the 1960s, when the country’s first protected area, the Manas Wildlife Sanctuary (now known as Royal Manas National Park) was designated. After Manas Wildlife Sanctuary in 1974, six other protected areas were created and further revisions to the national protected areas system resulted in the current network of protected areas. The JKSNR, then the Toorsa Strict Nature Reserve was gazetted in 1993 is in operation since 2010 as the lone protected areas without permanent human settlements other than the seasonal yak-herding communities of Bjee, Katscho and Eusu gewogs in Haa dzongkhag.

The operation of the nature reserve began with the preparation of its first 5 (five) year period Conservation Management Plan (2012-2017) with an area coverage of about 609.52 km². However, with the new boundary demarcation and area extension, JKSNR now has a total area of 784.225 km².

The significance of JKSNR is not only for Bhutan, but also for the entire Hindu-Kush Himalayan region (HKH), which is a significant reservoir of biodiversity, composed of extraordinarily varied eco-systems, assemblage of species of global importance, rich genetic diversity; and the only protected area in Bhutan making its connectivity with the Kanchenjunga trans-boundary conservation landscape. It is also linked to a part of the Sacred Himalayan Landscape (SHL) of Eastern Himalayas, also known as Snow leopard Landscape, which covers a conservation area of 39,021 square kilometers, of which about 73.5% falls in Nepal, 24.4% in Sikkim and Darjeeling of India, and the remaining 2.1% in Bhutan (Figure 2).

The SHL builds links with the three major trans-boundary conservation areas in China, India and Bhutan. The landscape is contiguous with one of the largest protected areas in Asia, the vast Quomolongma Nature Preserve in Tibet (China) to the north. In the east, the SHL-Nepal maintains continuity with Kanchenjunga Landscape in India, linking further to the Bhutan Biological Conservation Complex that has natural connectivity to JKSNR in western Bhutan in the country.

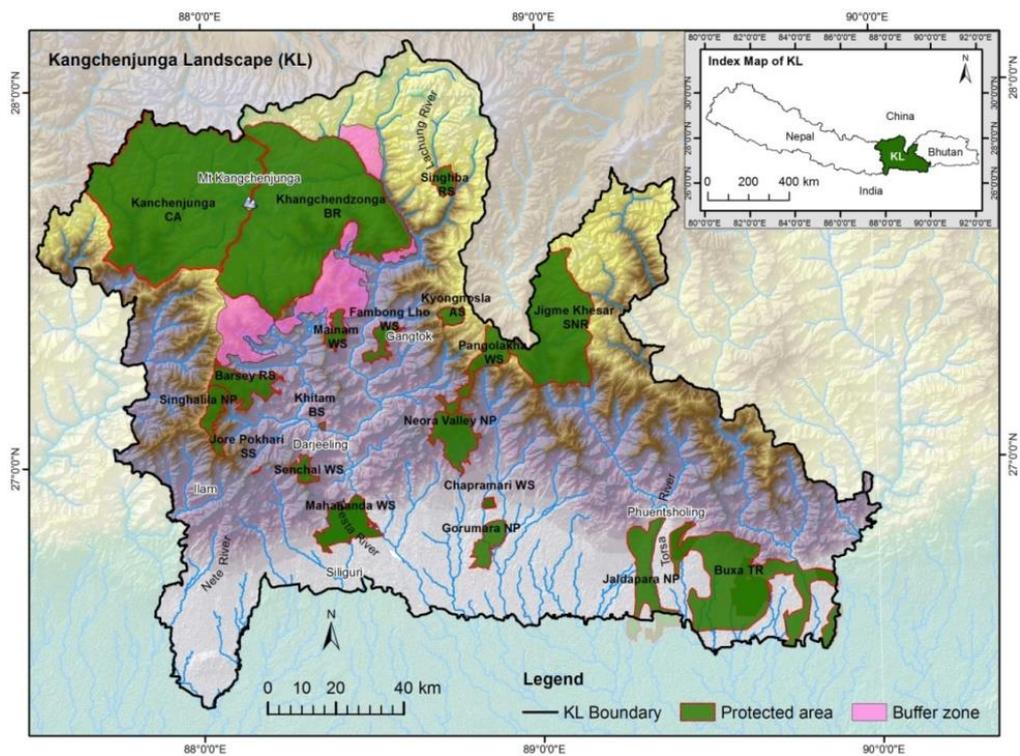


Figure 2: Linkage of Kangchenjunga Landscape (KL) & JKSNR (Source: ICIMOD, Nepal)

A recent review and research in Kanchenjunga Landscape revealed that the landscape is rich in biodiversity and a high proportion of these species are threatened or endemic to the region. Species such as Bengal tiger (*Panthera tigris tigris*), Snow leopard (*Panthera uncia*), Asiatic black bear (*Ursus thibetanus*), Himalayan red panda (*Ailurus fulgens*), Alpine musk deer (*Moschus chrysogaster*), and Bhutan takin (*Budorcas taxicolor whitei*) are the flagship species of the landscape.

The main habitat type in JKSNR consists of pristine mixed-conifer forests interspersed with grasslands and alpine meadows and has the strongest representation of the pristine temperate and alpine ecosystems in the country. It is also known to have the highest endemism in the country.



Figure 3: White Poppy (*Meconopsis superba*)

1.2 Vision, Mission, Goals and Objectives

Vision: An exemplary natural landscape for scientific studies and nature education in its geo-cultural environment.

Mission:

- 1. Maintain ecological integrity and species persistence of the pristine temperate and alpine ecosystems in the country.**
- 2. Enhance ecosystem services and human well-being through biodiversity conservation.**

Goals:

- 1. To conserve habitats, ecosystems and its integrity for species persistence in the landscape.**
- 2. To promote harmonious co-existence between nature and transhumance communities.**

Conservation objectives:

- 1. To protect, conserve and monitor the wildlife species.**
- 2. To protect, conserve and manage habitat from degradation.**
- 3. To strengthen conservation practices through capacity development.**
- 4. To promote harmonious co-existence between wildlife and transhumance communities.**
- 5. To prevent and address the spread of communicable diseases.**
- 6. To monitor and ensure adaptive measures on climate related impact on wildlife, habitats, water and local communities.**
- 7. Strengthening institutional capacity for effective services delivery and implementation of conservation programs.**

1.3 Salient features of the plan

The plan was prepared using rapid biodiversity assessments and socio-economic survey data collected from the households having traditional rights. Both these assessments have enabled the compilation of relevant and measurable indicators to judge the success of the plan at the end of ten years period.

The plan has provisioned room for monitoring and stipulates the requirement of an annual assessment of the programs and activities based on the Bhutan METT+. This should enable replication and up-scaling of successful models. The BFL project will fund JKSNR for the 10 years plan period. However, it also calls upon management to proactively pursue fund mobilization with interested and committed partners or donors.

The first chapter describes the background and administrative jurisdictions, history, conservation significance, vision, mission and goals/conservation objectives, salient features of the conservation management plan and zonation of the reserve based on zonation guidelines for safeguarding the existing biodiversity and maintaining the integrity of JKSNR's pristine temperate and alpine ecosystems.

The second chapter of plan pronounces the current status of nature reserve describing the landscape characteristics including climate and topography, hydrology and drainages and different vegetation zones with detail descriptions on floral, faunal diversity, local yak-herding communities and their livelihoods through socio-economic surveys of resident communities within the nature reserve and along its buffer. Since, this is the only protected area in Bhutan without permanent human settlements, except for a few migratory yak-herding communities from Bjee, Katsho and Eusu gewog under Haa dzongkhag. However, natural resources like firewood, medicinal plants and grazing land have been traditionally used by the yak-herding communities. Therefore, the plan aims to mitigate and/or reduce issues and challenges/threats related to human-wildlife conflicts, grazing, explore and promote alternative sustainable livelihoods, indigenous and traditional knowledge and systems; and nature and research/eco-tourism prospects to conserve the biodiversity inside JKSNR. In addition to its description on the institutional and administrative arrangements, infrastructural development including the nature reserve head office and range office field out-posts is also aimed for effective service delivery and implementation of conservation management programs.

The third chapter of the plans deals with the summary review of the past conservation management plan programs and activities implemented in the field by the management of JKSNR for the five years (2012-2017) including the Assessment report of Bhutan METT+ and lesson learnt through implementation of the programs.

The conservation issues, threats and challenges is well described in chapter four of the plan, while chapter five outlines the management strategic premise and actions of the plan. The sixth chapter describes how to implement the conservation management plan and outlines the financial aspects of the plan for the 10 years plan period. Chapter seven, which is the last chapter describes monitoring and evaluation framework of the conservation management plan, which intends to streamline the shortfalls or insufficiencies in management activities to ensure full implementation of the conservation management plan.

1.4 Zones of the JKSNR

According to principles and criteria prescribed in Protected Area (PA) zonation guidelines of Bhutan 2019, JKSNR has three main functional zones viz. Core, Transition and Buffer zone. Such zonation helps in managing the areas through enforcement of different sets of rules and regulations for respective zones.

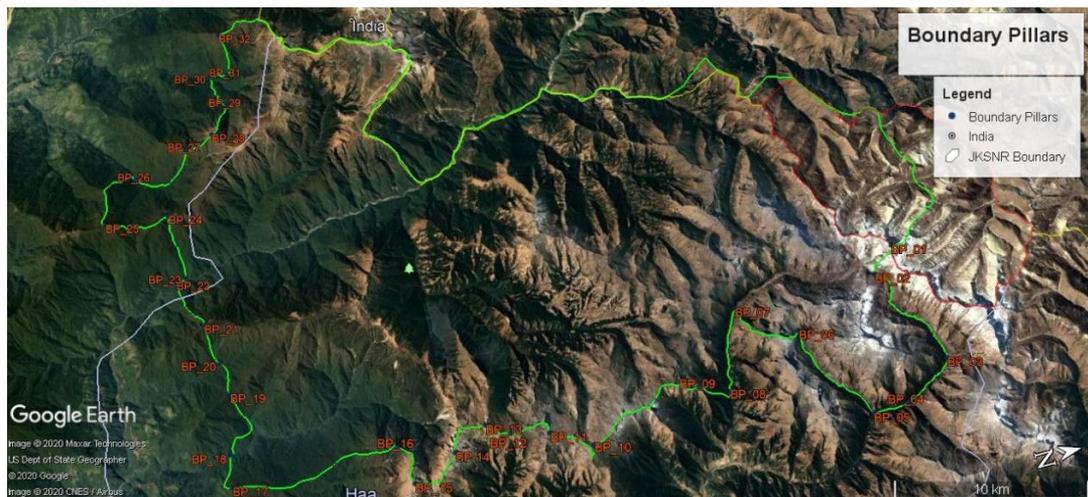


Figure 4: Boundary Pillars (Google Earth View)

1.4.1 Description of JKSNR boundary

After realignment of boundary along the permanent features, the management have identified and placed 32 permanent boundary pillars (BP) numbering as BP-01 to BP-32 along its boundary.

In the North, the boundary starts at Shaktoe and follows Chundugang ridge (BP-01: 89.11615, 27.54333), Jatshothen Pass (BP-02), Jatshoten Tsho to Chuzomsa (BP-03: 89.18193, 27.55402), follows Takha Chhu, Takha Chhu & stream confluence (BP-04) until Takha Chhu & Chala trail confluence (BP-05: 89.20014, 27.51194). The boundary ascends along Chala trail till Lake (BP-06) and follows Lamtsha Tsho ridge until Chala Dopu & Lamtsha Chhu confluence (BP-07: 89.12617, 27.46254). It runs along with Chala Chhu till Haa la Chhu & Chala Chhu confluence (Pangkochimchu-BP-08:89.16942, 27.44876). Then it rises from Pakochim Chhu following the stream (left of Haa La trail) until it meets Chuzomstsee top (BP-09); and follows the Chuzomstsee ridge until Bjara Pass (BP-10: 89.17848, 27.37794). Ensuing Bjara ridge, it passes through Yakto La (BP-11), Yakto La ridge, Gongchen La (BP-12), Tshonapata La (BP-13), Tshona top, Tshona ridge until Jatha Tsho (BP-14: 89.16369, 27.31431).

Hereafter, it follows Jatha Tsho ridge till Shebji & Tergola ridge confluence (BP-15: 89.17373, 27.29296) and it descend along Shebji ridge (BP-16) until Shebji top (BP-17: 89.14945, 27.2051); and turns right above Shaba village till Shaba Chhu (BP-18: 89.13089, 27.20464). Boundary rises uphill till Nakha top: BP-19 (approximately 2 km from Nakha village) and then descend towards Nakekha Chhu (BP-20). Hereafter, it follows a ridge till Army outpost (BP-21: 89.0591, 27.20662) and run down until Amo Chhu basin (BP-22). It follows Amo Chhu basin until a right turn at Amo Chhu & stream confluence (BP-23: 89.0241, 27.19716). It then takes a stream up to Batashey top (BP-24) and run down towards Batashey following Batashey ridge until Batashey-Kachin junction (BP-25). Following Kachin ridge, it descends till D-Bindu Khola (BP-26) and takes a right of D-Bindu Khola and follows an uphill stream until D-Bindu top (BP-27 & BP-28). Then it follows along Passang Goenpa ridge, Assamsa Khola following Mejo La ridge (Captain Japhu) via BP-29, BP-30, BP-31 until Norgaygang ridge top (BP-32: 88.8827, 27.23948) and finally joins the international border (Indo-Bhutan) at Doklam. Thereafter, it follows the Indo-Bhutan international border in the south-west and China-Bhutan border in north-west part of the country.

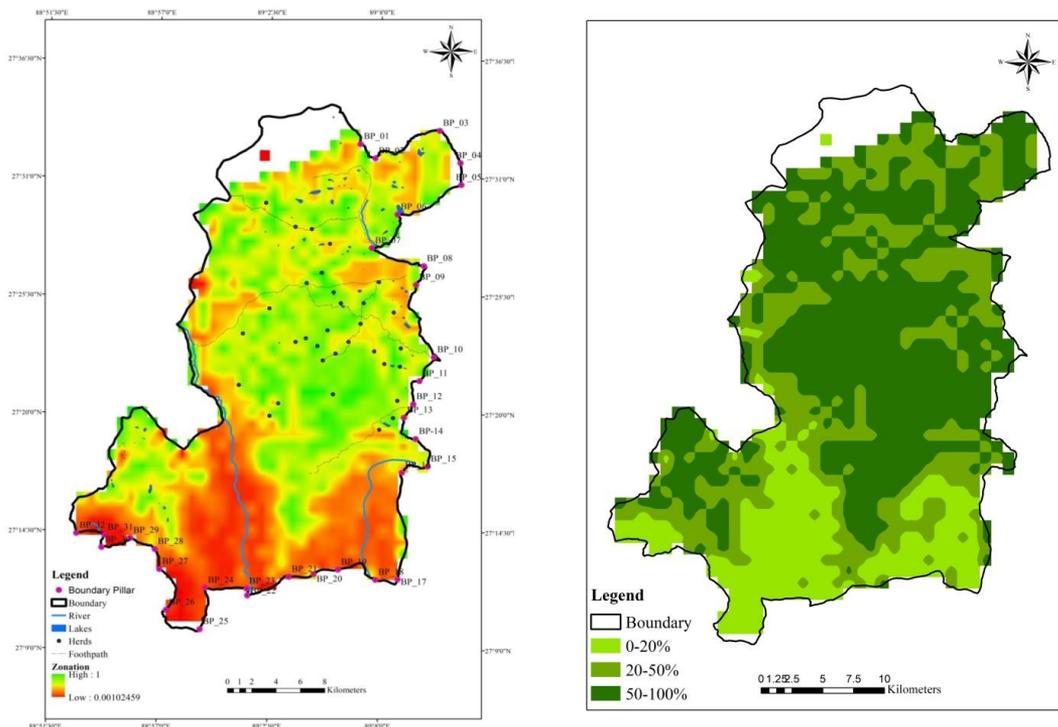


Figure 5: Boundary Pillar & predicted zones

1.4.2 Designation and description of Zones

Protected Area Zonation guidelines of Bhutan, 2019 prescribes four (4) zones viz. Core, Buffer, Transition and Multiple use zones. However, three (3) zones namely Core zone, Transition zone and Buffer zone were identified and delineated based on the local needs.

Table 1: Type of Zones, area and % of total JKSNR area

Type of Zone	Area (Sq. km)	% Of Total JKSNR area
Core Zone	293.6	37.4
Transition Zone	453.6	57.8
Buffer Zone	37.5	4.8

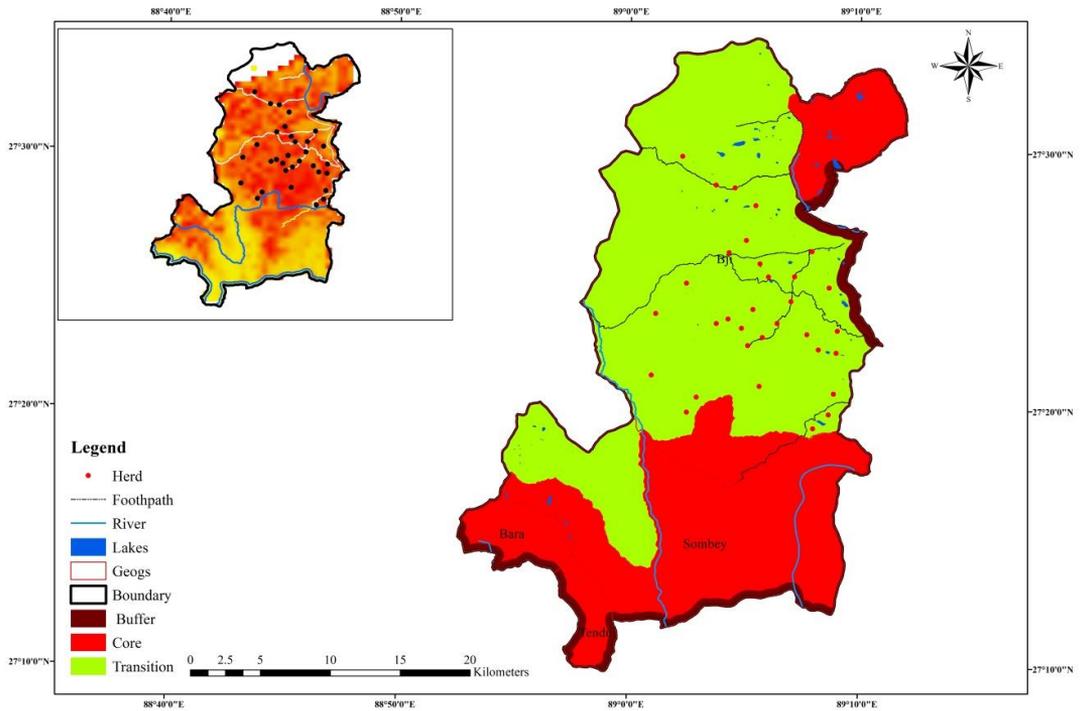


Figure 6: Type of Zones: Core, Transition & Buffer Zone

1.4.2.1 Core Zone: Protection Zone

Zonation software output has shown the top priority areas for delineating the core and transition zones (Figure 3 & 4). Top 50% of the nature reserve covering an area of 293.6 square kilometers was delineated as a core zone (Table 1). Core zone is a zone where no anthropogenic activities is allowed except research of national and management importance. Accordingly, two core blocks were identified and delineated across the nature reserve, which encompasses diverse habitats viz. alpine, temperate, cool broadleaved, and warm broadleaved forests. The core zone is designated as a zone of protection. In the context to JKSNR, minimal human interference is allowed inside this zone. This zone is specially meant to keep the natural state with least management prescription and interventions. Nevertheless, with formal approval from the higher authority, the concerned management and other relevant individual/stakeholders can conduct research for betterment of the site/species ecology. Furthermore, the local yak-herding communities having traditional user rights can access the inherent benefits with proper written by-laws.

Table 2: Core zone blocks, area and their significances

Name of Block	Area (Sq.km)	Gewog covered	Significance
Takha	46.0	Bjee	Snow leopard, Bhutan takin, Blue sheep, Alpine musk deer, Asiatic golden cat, Dhole, Himalayan marmot, Red fox, Asiatic black bear, White poppy, Rhododendrons.
Amo-Chhu	247.5	Bjee, Norgaygang, Sangbaykha, Tendruk	Snow leopard, Bengal tiger, Blue sheep, Alpine musk deer, White poppy, Red fox, Himalayan marmot, Asiatic black bear, Dhole, Red fox, Himalayan red panda, Common leopard, Asiatic golden cat, Spotted linsang, Marbled cat.

Takha Block (*Boundary description*)

The Takha block covers an area of 46.0 square kilometres in the north-eastern part of the nature reserve under Bjee gewog. The block boundary starts at Jatshothen Pass (BP-02), Jatshoten Tsho to Chuzomsa (BP-03: 89.18193, 27.55402), follows Takha Chhu, Takha Chhu & stream confluence (BP-04) until Takha Chhu & Chala trail confluence (BP-05: 89.20014, 27.51194). The boundary ascends along Chala trail till Lake (BP-06) and follows Lamtsha Tsho ridge until Chala Dophu & Lamtsha Chhu confluence (BP-07: 89.12617, 27.46254). Thereafter, boundary follows Chala Dophu Chhu and joins at Jatshothen pass via Chala Dophu.

Conservation significance

Takha block is an area left without any management as of now. Primarily shrub, rocky outcrops, alpine scree and mixed conifers are the main habitat types in the zone. The zone was designated to conserve diverse habitats for wild fauna and flora, particularly important fauna such as the Snow leopard and its prey, Alpine musk deer (*Moschus chrysogaster*), Dhole (*Cuon alpinus*), Red fox (*Vulpes vulpes*), Bhutan takin (*Budorcas taxicolor whitei*), Common leopard (*Panthera pardus*), Asiatic black bear (*Ursus thibetanus*), Himalayan monal (*Lophophorus impejanus*),

Tibetan snowcock (*Tetraogallus tibetanus*), Himalayan griffon (*Gyps himalayensis*), Blood pheasant (*Ithaginis cruentus*) and many cat species. Moreover, it provides suitable and have potentiality in conserving the only endemic *Meconopsis* species, the *Meconopsis superba*, *Viola bhutanica*, *Rhododendron kesangiae*, *R. bhutanense* and *Fritillaria bhutanica*. It is also home to many more important flora and fauna species.

There are almost 10-15 alpine lakes in this zone. This zone acts as a watershed for Takha Chhu and other critical freshwater streams. These lakes are important catchment for downstream rivers viz. Haa Chhu, Takha Chhu, which are pivotal for livelihoods of Haa, Paro, Samtse, and Chukha dzongkhags.



Figure 7: Different zone boundary (Google Earth View)

Amo-Chhu Block (*Boundary description*)

The Amochhu block falls in the southern part of the nature reserve covering an area of 247.5 square kilometers. The block covers Bjee, Sangbaykha, Tendruk and Norgaygang gewogs. The boundary follows Jatha Tsho ridge till Shebji & Tergola ridge confluence (BP-15: 89.17373, 27.29296) and it descend along Shebji ridge until Shebji top (BP-17: 89.14945, 27.2051); and turns right above Shaba village till Shaba Chhu (BP-18: 89.13089, 27.20464). The boundary rises uphill till Nakha top: BP-19 (approximately 2 km from Nakha village) and descend towards Nakekha Chhu (BP-20). Hereafter, it follows a ridge till Army outpost (BP-21: 89.0591, 27.20662) and run down until Amo Chhu basin (BP-22). It follows Amo-Chhu basin until a right

turn at BP-23: 89.0241, 27.19716. It takes stream up to Batashey top (BP-24) and run down towards Batashey following Batashey ridge until Batashey-Kachin junction (BP-25). Following Kachin ridge, it descends till D-Bindu Khola (BP-26) and takes a right of D-Bindu Khola and follow an uphill stream until D-Bindu top (BP- 27 & BP-28). Then it takes Passsang Goenpa ridge, Assamsa Khola following Mejo La ridge (Captain Japhu), via BP-29, BP-30, BP-31 until Norgaygang ridge top (BP-32: 88.8827, 27.23948); and it joins international border (Indo-Bhutan) at Doklam. Thereafter, it follows the Indo-Bhutan international border in south-west till Doklam pass and it declines down following the stream until Amochhu basin.

The boundary takes Amochhu basin till Himbuna Chhu confluence and follows Himbuna Chhu until it joins with Baena stream. It ascends from Baena stream to Baena ridge and run down to Himbuna Chhu – Tshona Damto Chhu via Himbuna stream and Himbuna Chhu. Thereafter, the boundary follows Tshona Damto Chhu and joins Tshona ridge (JKSNR boundary).

Conservation significance

This zone stretches in southern part of the nature reserve and covers an array of habitats from lower foothills to alpine ecosystems. Pristine temperate forests along with cool and warm broadleaved forests provides suitable habitat for numerous wild flora, avifauna and fauna species. Comparatively this zone was least explored than Takha block and has higher chances of discovering new species in the future.

Important species such as Bengal tiger (*Panthera tigris tigris*), Snow leopard (*Panthera uncia*), Alpine musk deer (*Moschus chrysogaster*), Dhole (*Cuon alpinus*), Red fox (*Vulpes vulpes*), Bhutan takin (*Budorcas taxicolor whitei*), Asiatic black bear (*Ursus thibetanus*), Himalayan red panda (*Ailurus fulgens*), Common leopard (*Panthera pardus*), Himalayan gaur (*Bos gaurus*), Blue sheep (*Pseudois nayaur*), Spotted linsang (*Prionodon pardicolor*), Marble cat (*Pardofelis marmorta*), and Asiatic golden cat (*Catopuma temminckii*) reside in the zone. As per the National Tiger Survey Report, this zone showed suitable habitat for Bengal tiger and recently during Rapid Biodiversity Survey (RBS) camera trapping, we have captured Bengal tiger images from four grids (G30, G31, G32 and G33). This area also provide niche for Himalayan monal (*Lophophorus impejanus*), Tibetan snowcock (*Tetraogallus tibetanus*), Himalayan griffon (*Gyps himalayensis*), Little owl (*Athene noctua*), Blood pheasant (*Ithaginis cruentus*), Rufous-necked hornbill (*Aceros nipalensis*), Satyr tragopan (*tragopan satyra*), Indian peafowl (*Pavo cristatus*),

and many others. Moreover, it provides suitable habitat to only endemic *Meconopsis* species, the White poppy, and other many poppy species and medicinal plants.

There are 20-40 alpine lakes and numerous drainage systems which are main tributaries for Amo Chhu. These lakes are important catchment for downstream rivers which are pivotal for livelihoods of Haa, Samtse, and Chukha dzongkhags.

1.4.2.2 Transition zone: Traditional User Right Zone

Fifty seven percent (57%) of JKSNR (453.6 square kilometers) is delineated as a Transition zone (Table 3). Almost 70% of the Snow leopard, Blue sheep, Alpine musk deer and White poppy habitats fall in this zone. According to the Protected Area Zonation Guidelines of Bhutan, 2019, Transition zone takes same legal status with Core zone and act as a cushion layer to its adjacent Core zones. Traditional grazing and regulated eco/research tourism activities are allowed with minimal destruction to the surrounding vegetation/habitat. This zone was traditionally grazed by 53 herders of Bjee, Katsho, and Eusu gewogs under Haa dzongkhag. About 3672 yak and 294 horses reside in this zone (Socio-economic Survey Report, 2020). The zone shall function as Core zone when the temporary migratory yak-herder migrates to other grazing grounds within and outside JKSNR. Therefore, DO's and DONT's and sustainable management prescriptions are prescribed in this zone. Moreover, Nub-Tshonapata trekking route fall in this zone and attract numbers of foreign and local tourists. Diverse number of Poppies including White poppy is seen in this zone, which attracts larger number of Japanese tourists to visit the area. Waste from yak-herders and eco-tourism possesses threat on wild flora and fauna inside the zone.

1.4.2.3 Buffer Zone

About 37.5 square kilometers of JKSNR is under Buffer zone (Figure 6). Unlike the concept of buffer zone in the past, PA Zonation Guidelines of Bhutan, 2019 prescribes the Buffer zones around the Core zones, which are important ecosystems and habitats to provide cushioning effect to minimize the adverse impact from threats from other zones. This zone is also delineated along the boundary where pressure from nearby local community is emergent. Buffer zone will provide a cushioning or supportive layer outside the Core zone which shares a boundary with Traditional use/Transition zone. Minimum or less disturbance activities or interventions shall be allowed in the zone.

CHAPTER 2: Current Status of JKSNR

2.1 Landscape Characteristics

2.1.1 Climate and Topography

Geographically, the northern parts of JKSNR consists mostly of rugged mountain terrain, rocky peaks, and screes, harboring numerous sacred alpine lakes and few plains. The southern parts are scoured steeply by streams and rivers forming narrow valleys. Alluvial and colluvial formation are apparent in the narrow valleys of the nature reserve, which consist of soil, silt, clay, sand and gravels brought down by the action of the soil and water erosion.

The climate data is essential in understanding the relation between the forest ecosystems and climate. Climate influences the structure and function of forest ecosystems and plays an essential role in forest health. A changing climate may worsen many of the threats to forests, such as pest and diseases outbreaks, fire and drought. Therefore, it is important to carry out experimental plots in different ecological zones to study the changes on forest ecosystems. Like other alpine and arctic zones of the globe, the climate of this alpine zone is cold, with intense irradiance and low partial gas pressure. Heavy frost, blizzards and snow prevail throughout the year except for few months. Meteorological data recorded at the alpine experimental station are shown in Figure 8. Mean minimum and maximum temperature was recorded as -11.09°C and 08°C and mean temperature was 0.67°C , respectively. Precipitation was observed in the form of heavy rains, hail, snow and showers during the year. Snowfall occurs from November to April. Snowmelt occurs during April and July providing an abundance of soil water prior to the monsoon period. Maximum rainfall was recorded as 1577.5mm in June-August. Maximum Relative Humidity recorded was 98%, minimum 39% and mean RH was 77%.

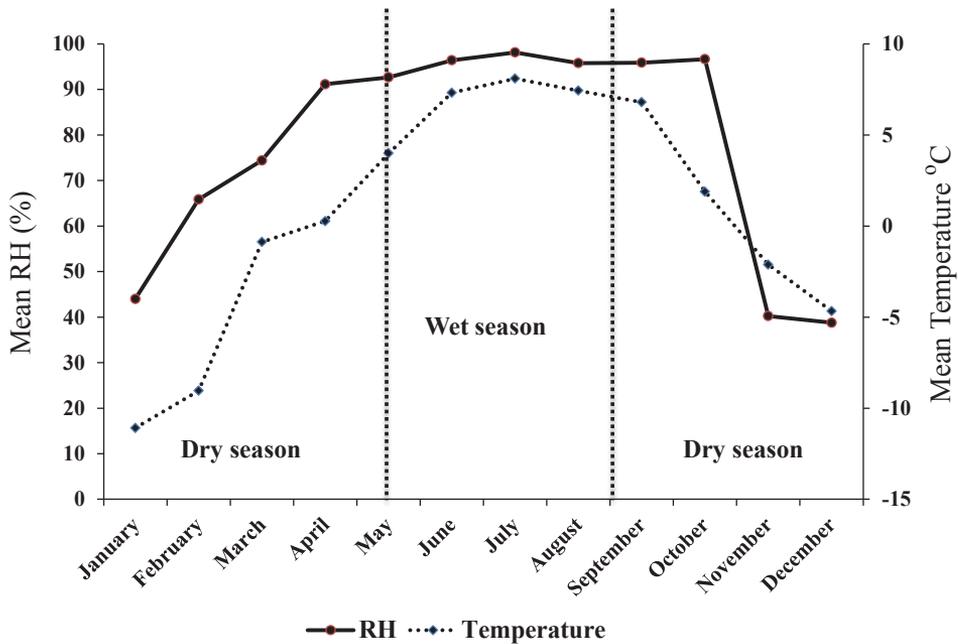


Figure 8: Pluviothermic diagram showing wet and dry months at study sites. Based on mean relative humidity and temperature recorded for 3 years (2015-2017).

2.1.2 Hydrology and Drainage

The high-altitude wetlands (alpine lakes) also represent the fresh water and wetland ecosystems of JKSNR which are integral components of river basin system to the downstream. Culturally, high altitude wetlands (alpine lakes) are considered and revered as sacred sites and their conservation is important for the myths and traditional beliefs of the local people of Haa dzongkhag.

Based on the preliminary study, 39 lakes of different sizes were recorded and found scattered along the nature reserve forming the catchment of several tributaries for Amo-Chhu and Haa-Chhu-Wang-Chhu. There are no permanent snow-capped mountains in JKSNR. Alpine lakes and its tributaries serve as water heads for river systems which are critical for the livelihoods of residents within and along the basin covering Haa, Paro, Chukha and Samtse dzongkhags. Amongst the lakes, Nub-Tshonapata, Rigona, Ngatsho, Dungtsho, Ngetotsho, Chundulhatsho, Hala and Jula lakes are considered the most sacred; and are also important sources for many down streams under Haa dzongkhag.

Wetland: The Abode of Deities

The lakes located in the high-altitude areas in JKSNR represent one of the most pristine types of ecosystems in the country. Unlike lower elevation lakes and streams which are seldom affected by pollution, habitat alteration or unnatural water level fluctuations. Since it is far away from settlements, the alpine lakes under JKSNR are pristine with presence of littoral macro-invertebrates and other zoo-plankton community which are the indicators of good aquatic ecosystem. Nub-Tshonapata is a legendary lake profound with special historical significance and is one of the most revered and renowned lake in Bhutan; and is located at an altitude of 4100 m.a.s.l. surrounded by Rhododendron scrubs. This is the lake that connects the significant history, rich in myths and legends of Terton Sherab Mebar, the Paro Rinpung Dzong, App Chundhu and “Nublang”. A cymbal as a treasure from the lake was discovered by Terton Sherab Mebar and this cymbal is used during first day of Paro Tshechu annually in the present day. The first breeding bull Nublang (*Bos indicus*) was gifted to a local cow herder in return for providing food and shelter to the mermaid of the lake. The lake is named in line with the origin of mythical Ox “Nublang”. The Nublang breed is highly valued and the Department of Livestock is taking up conservation programs to conserve this native species of Ox. This sacred Lake in Haa is a pilgrim site visited by many locals and the tourists considering its significance and beautiful alpine landscape.

2.1.3 Vegetation Zone

The country has a wide range of eco-floristic zone divided into three major distinct zones with different forest types namely: Alpine zone (4000+ m.a.s.l) mainly composed of meadows, Juniper Rhododendron scrub and Dry alpine scrub. Temperate zone (2000-4000 m.a.s.l) comprises of Fir forest, Hemlock forest, Spruce forest, Bluepine forest, Evergreen oak forest and Cool broad-leaved forest. Sub-Tropical zone (75-2000 m.a.s.l) mainly comprised of Chirpine forest, Warm broad-leaved forest and Sub-tropical forest. The altitude of the nature reserve ranges from about 1361 to 5597 m.a.s.l, broadly falling under the two major zones of Alpine and Temperate zones. Among the different forest types, the nature reserve is dominated by Alpine meadow grassland ecosystem (37.70%), followed by Cool-broadleaved ecosystem (26.49%), Temperate moist conifer ecosystem (26.18%); and least covered by Warm broadleaved ecosystem (9.63%).

i). Dry Alpine scrub (>4000m)

This zone consists of loose rocks with very sparse vegetation of grasses, herbs and stunted shrubs. Many of the rocks are covered by mosses and lichens. The rocky terrain provides good habitat for Snow leopard and its prey, the Blue sheep. Rugged nature proves to be a suitable hunting ground for Snow leopard; while providing even good refuge for its prey from its predators. Alpine scrub and meadows are also used by Alpine musk deer (*Moschus chrysogaster*), Red fox (*Vulpes vulpes*) and various bird species, like Tibetan snowcock (*Tetraogallus tibetanus*), Snow partridge (*lerwa lerwa*) as a major habitat. Encroachment by unpalatable shrubs like Rhododendrons and Junipers is observed in the zone.

Alpine meadows

Depending on the soil types and the moisture content, different types of alpine grasslands occur. In many of the alpine meadows, diverse high value-medicinal plants can be found. Chinese caterpillar (*Ophiocordyceps sinensis*), *Neopicrorhiza kurroa* and *Nardostachys grandiflora* are grown in such areas. The important alpine grazing areas like Kampula, Tshona, Chuzomtse, Hala-Jula, Chala and Jasoten are primarily being grazed by yaks in summer.

ii). Fir Forest (3500-3900m)

Fir forests are abundant in the nature reserve and precious old growth Fir forests is found from 3000-3900m altitude. The Fir Forest is characterized with *Picea spinolasa*, *Larix griffithiana*, *Juniperus* spp., bamboo and Rhododendron undergrowth. Common species of plants include *Rhododendron campanulatum*, *R. hodgsonii*, *R. kesangiae*, *R. falconeri* and *Betula utilis*. Red panda can be found mostly in the stands of bamboo undergrowth.

iii). Cool Broadleaved Forest (2500-3500m)

This forest is wetter than the evergreen oak forest. This forest is dominated by *Acer* spp., *Betula* spp., *Rhododendron* spp., *Quercus* spp., *Sorbus* spp., *Castanopsis* spp., *Lithocarpus* spp., *Exbucklandia* sp., *Salix* spp., *Viburnum* spp., *Lyonia* sp., *Michelia* sp., *Magnolia* spp., and with profuse growth of *Symplocos* spp., and bamboo species. This forest are important and integral part of the Tiger, Red panda and other cat species habitat in the nature reserve.

iv). Warm Broadleaved Forest (1300-2500m)

These mixed evergreen and deciduous forests are found in the southern part and are also an important habitat of Bengal tiger and Rufous-necked hornbill in the nature reserve. *Alnus nepalensis*, *Albizia* spp., *Duabanga grandiflora*, *Schima wallichii*, *Juglans regia*, *Castanopsis hystrix*, *Cinnamomum* spp., *Termenalia* spp., *Syzygium* spp., *Macaranga* spp., and understory of *Maesa* spp., *Mallatus* spp., *Melastoma* spp., *Ficus* spp., and *Eurya* spp., are dominant species in this forest.

However, for our purpose, the classification and definition is made on four major habitat types based on the elevation range with area coverage (Table 3).

Table 3: Four major habitat types and Area and Altitude range in JKSNR

Habitat Type	Area (Sq.km)	Altitude (m)
Alpine meadow	295.68	> 3900
Fir Forest	205.36	3500-3900
Cool Broad-leaved Forest	207.74	2500-3500
Warm Broad-leaved Forest	75.56	1361-2500
Total Area	784.225	

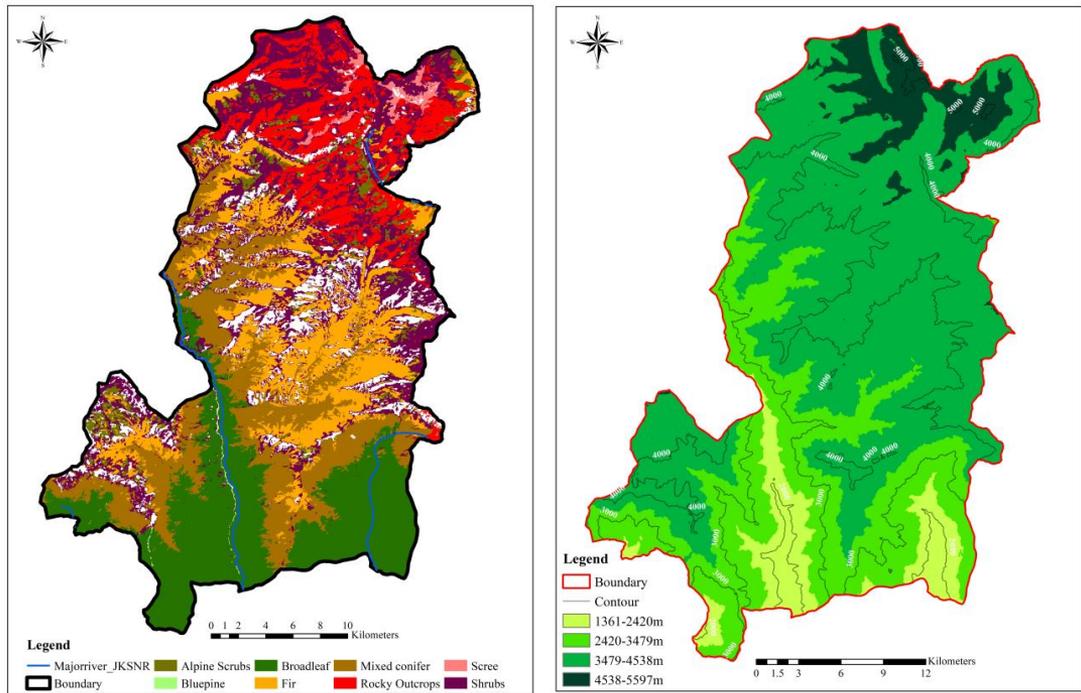


Figure 9: Forest type and elevation class distribution

2.2 Vegetation survey design and methodology

A quantitative vegetation analysis of natural forests was done in 48 grids measuring 4 x 4 km within the altitude range of 1361– 5597 m.a.s.l covering different forest types in the nature reserve. A total of 250 plots were surveyed with plot size of 20 x 20 m for tree layer and a total of 399 herb plots were surveyed with a plot size of 2 x 2 m ground layer (herb) nested inside the tree plots (Ohsawa, 1999; Swamy, 2000; Wangda and Ohsawa, 2006b; LingPing *et al.*, 2011) and Biodiversity Monitoring Protocol, 2020.

Vegetation survey was conducted at two levels, (1) tree layer survey and (2) seedling/ground (herb) layer survey. In the tree layer, the height of all the trees (>1.3 m) using the hypsometer and diameter at breast height (DBH) was measured using DBH tape. In the ground layer, tallest height and the cover (%) of each species; and the regeneration was also recorded inside the 2 x 2 m plot.

2.2.1 Floral Diversity

Vegetation survey in the 48 grids covering an area of 102,404 m² has recorded a total of 754 species of plants belonging to 129 families (129 tree, 135 shrub, 373 herb, 82 orchids, 14 grasses, 10 ferns, 6 bamboo and 5 weed species). Out of the 754 species, four species fall in Schedule I of FNCA-1995 namely, *Ophiocordyceps sinensis*, *Lyodia yunnanensis*, *Panax-pseudogensing* and *Taxus baccata*. Other notable floral species of significant importance are *Viola bhutanica*, *Bhutanthera himalayana*, *Nardostachys jatamansi* and *Bryocarpum himalaicum* which are protected under CITES Appendix II species group. The nature reserve is also home to the globally endemic and endangered White poppy (*Meconopsis superba*).

Tree Layer

Trees and Shrub life-form

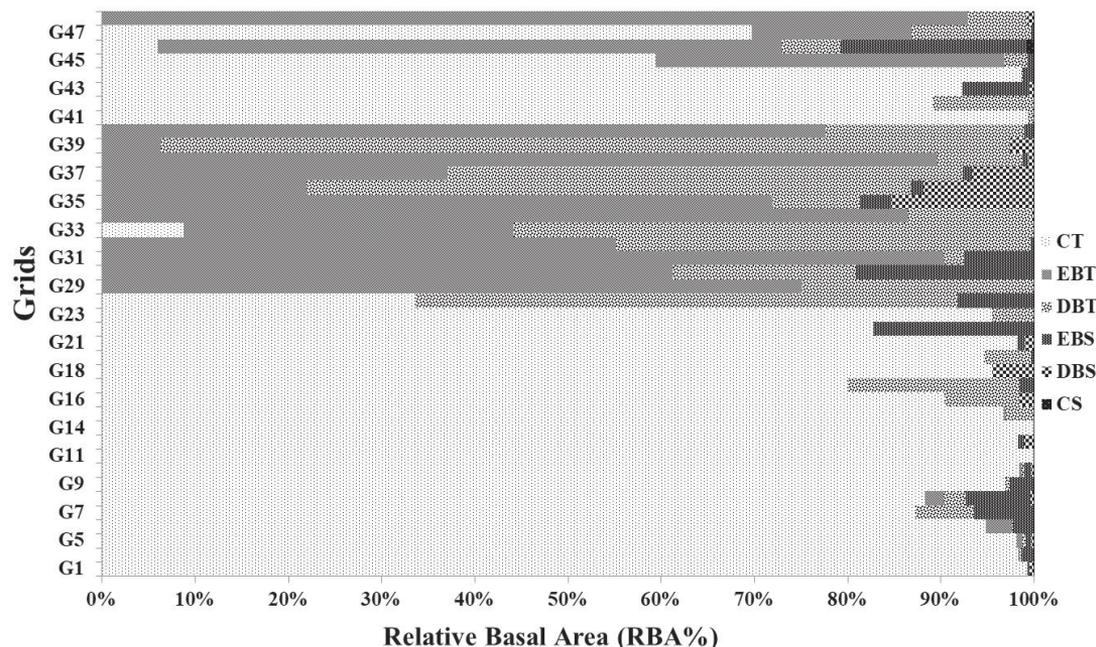


Figure 10: Distribution of major life-forms of trees (1500-4000 m)

A total of 264 species belonging to 73 families were recorded from 250 plots of 100,000 m² area. Of the total species recorded, the tree layer comprises of 129 species with 44 families and shrub layer of 135 species with 46 families. Species recorded was classified into four major life-forms consisting of Evergreen broad-leaved forest (159 species, 60%), Deciduous broad-leaved forests

(66 species, 25%), Conifer tree and shrub (10 species, 4%) and Sub-shrub and climbing shrub (29 species, 11%). This was represented by 31% Evergreen broad-leaved trees, 16% Deciduous broad-leaved trees, 30% Evergreen broad-leaved shrubs, 9% Deciduous broad-leaved shrub, 4% Conifer tree & shrub, and 11% Sub-shrub & Climbing shrub (Figure 10).

Based on the calculated RBA%, the Evergreen-forest was mainly dominated by Fagaceae (*Castanopsis* spp., *Lithocarpus* spp., *Quercus* sp.), Ericaceae (*Rhododendron grande*, *R. arboreum*, *R. barbatum* and *R. campylocarpum*), Theaceae (*Schima wallichii*), Symplocaceae (*Symplocos* sp.), Juglandaceae (*Engelhardia spicata*), and Betulaceae (*Alnus nepalensis*, *Betula alnoides*).

The Deciduous broad-leaved forest was dominated by Aceraceae (*Acer* spp.), Rosaceae (*Sorbus cuspidate*, *Prunus* spp.), Juglandaceae (*Juglans regia*), Lythraceae (*Lagerstroemia parviflora*), Leguminosae (*Albizia procera*, *Erythrina stricta*), Bombacaceae (*Bombax ceiba*), Magnoliaceae (*Magnolia campbellii*), Rutaceae (*Tetradium* sp.) and Anacardiaceae (*Rhus* sp.)

The Conifer-forest was significantly covered by Pinaceae (*Abies densa*, *Picea spinulosa*, *Larix griffithiana*, *Tsuga dumosa*), Cupressaceae (*Juniperus recurva*, *J. communis*, *J. pседosabina*, *J. squamata*) and Taxaceae (*Taxus baccata*).

In the sampling plots or forest community dominated by single species, the corresponding value represents 100% relative dominance. Similarly, if two species share the dominance, the value represents 50% relative dominance and with relative dominance value of 33.33% if three species dominates the community. Number of dominance ranged from 1 to 8 species per grid. *Juniperus squamata*, *J. recurva* and *Rhododendron* scrub followed by *Abies densa*, *Picea spinulosa*, *Larix griffithiana*, *Rhododendron kesangiae* and *Rhododendron barbatum* (<3700m) dominates the high-altitude zones. *Sorbus cuspidate*, *Quercus lamellosa*, *Castanopsis* spp., *Betula utilis*, *Acer* spp., *Magnolia campbellii*, *Quercus glauca*, and *Lithocarpus* spp., shared the dominance along the mid-altitudes (<3000m); and *Ailanthus grandis*, *Alnus nepalensis*, *Hobenia* sp., *Engelhardia spicata*, *Schima wallichii*, *Macaranga denticulata*, *Lagerstroemia parviflora*, *Castanopsis tribuloides* and *Toona ciliate* shared dominance at the lower altitudes (<2500m).

The diversity varied from 0.035 at 3700 m (Grid 41) to 2.293 at 2100 m (Grid 29), thus comparatively higher species diversity (H') was observed in lower foothills than alpine

ecosystems. Generally, species diversity is one of the most important indices used to evaluate an ecosystem. A rich ecosystem with high species diversity has a large value (H') while an ecosystem with low value (H') will have low species diversity (Sobuj and Rahman, 2011; Deka *et al.*, 2012).

The most dominant families were Ericaceae (30 species), followed by Lauraceae (21 species), Rosaceae (19 species), Fagaceae (14 species), Leguminosae (11 species), Araliaceae and Euphorbiaceae (10 species each), and the least were 33 families with single species (Figure 11). The dominance of this family could be as a result of habitat adaptation on favorable environmental conditions which encourage pollination, dispersal and eventual establishment of species. A similar study on tree structure and biomass in the temperate forest of Mamlay watershed in Sikkim revealed the same dominance (Sundriyal and Sharma (1996). Egbe *et al.* (2012) mentioned similar report in a disturbed and natural regeneration forest in Kourp National Park.

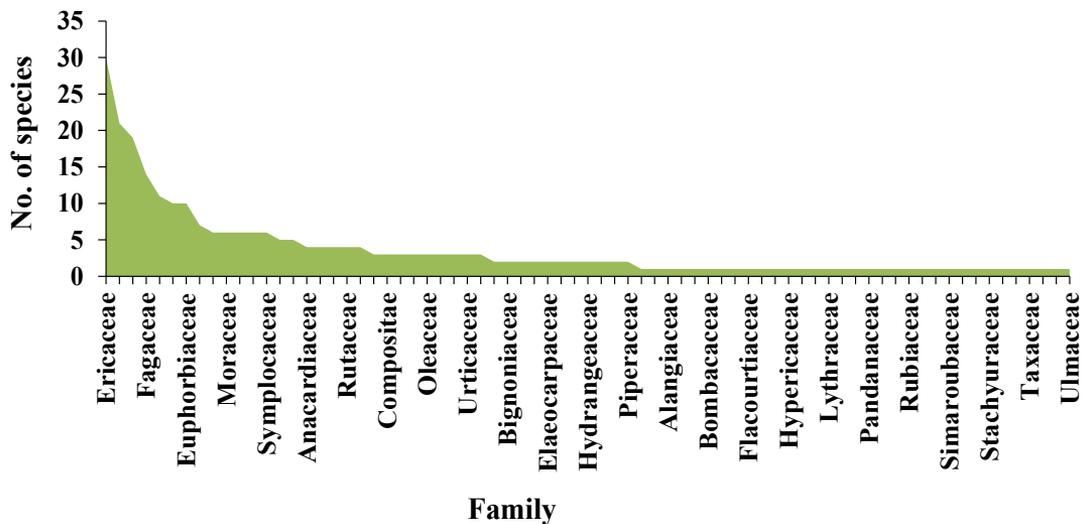


Figure 11: Family distribution of tree vegetation

A total of 168,5746.76 cm² BA was recorded in 40 grids (4km x 4km). The highest total BA recorded was 21,7330.67 cm² at Grid 45 in Cool broadleaved forest while least was at Grid 14 with 92.68 cm² in Fir forest at 3700 m. A total of 1392 stem > 1.3 cm diameter were enumerated in an area of 100,000 m² area. The highest density was recorded at an elevation of 3500 m (Grid 8) with 121 stems per plot while the lowest was at Grid 41 with 02 stems per plot. The structure

shows inverse-J regeneration pattern with maximum density at lower DBH class indicating continuous regeneration (Figure 12).

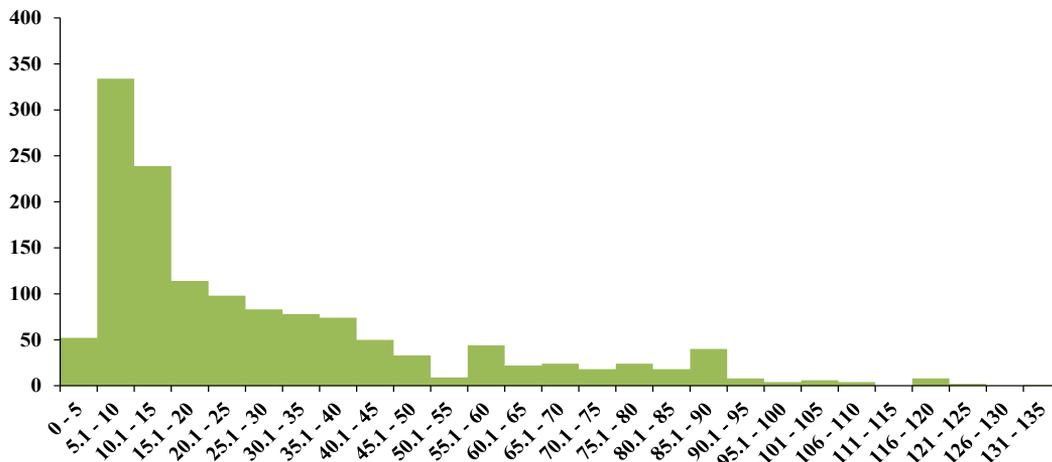


Figure 12: Stem density class distribution

The stem density of tree species decreased with increase in DBH class distribution in the reserve area which indicates inverse-J in lower DBH class distribution and Uni-modal pattern type of distribution at higher DBH class. This finding was in accordance with the work of Deka *et al.* (2012) with tree species having high stem densities at lower DBH classes. The study by Sahoo *et al.* (2009) also reported that stem density can be affected by natural and anthropogenic disturbance. Similar observation was also made by Swamy (2000); Sagar (2005); Echeverria (2007); Kharkwal and Rawat (2010). The DBH and height class of tree species in each plot were used to investigate the population structure and regeneration patterns. In conifer forest of 25 grids (>3400 m) *Abies densa* species exhibited dominance. The regeneration pattern distributed within the stem diameter class range of 1.3 – 135 cm within the altitudinal gradient from 1500-3900m. However, there is no pressure on tree utilization and harvesting since there is no permanent settlement inside reserve.

Forest Zone Classification

The reserve forest was classified and analyzed based on RBA of individual species in each plot within the grids. Cluster analysis grouped the homogenous plant communities to cluster of forest zones by species similarity index in dendrogram. The similarity index of 35% was performed using the distance measure of Relative Sorensen and Group Linkage Method using group average to determine the forest type in the reserve. There are six forest types namely, Type I: Cold conifer forest with *Abies densa*-*Rhododendron*-*Juniperus*, Type II: *Betula*-*Juniperus*, Type III: *Acer*-*Quercus*, Type IV: *Quercus*-*Juglans*, Type V: *Lithocarpus*-*Sorbus* and Type VI: *Alnus*-*Schima*. These six forest types were named based on the dominant species occurring in the cluster groups (Figure 13).

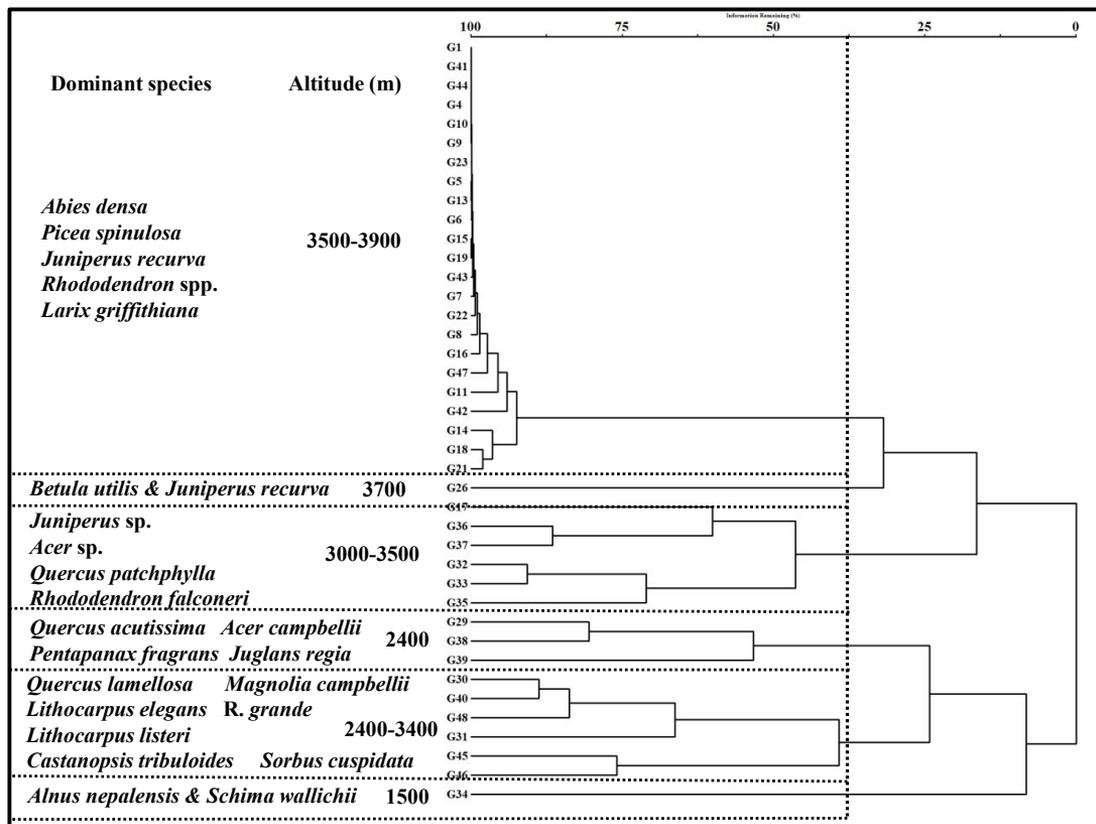


Figure 13: A dendrogram showing similarity of forest tree & shrub species based on 35% similarity index.

Ground layer

A total of 490 species belonging to 69 families were recorded from 399 plots within the 1,596 m² area of which composed of 373 herbs, 82 orchids, 14 grass, 10 ferns, 6 bamboo and 5 weed species. Ground vegetation is composed of annual herb (41%), perennial herb (33%), orchid (17%), climber (4%), grass (3%), fern and bamboo (1%). The dominant families recorded were Orchidaceae (82 species), Compositae (74 species), Primulaceae (31 species), Scrophulariaceae (21 species), Gentianaceae (20 species), Polygonaceae and Umbelliferae (19 species), Ranunculaceae (17 species), Cyperaceae, Labiatae and Rosaceae (12 species), Papaveraceae and Urticaceae (11 species) and rest are with single species (Figure 14).

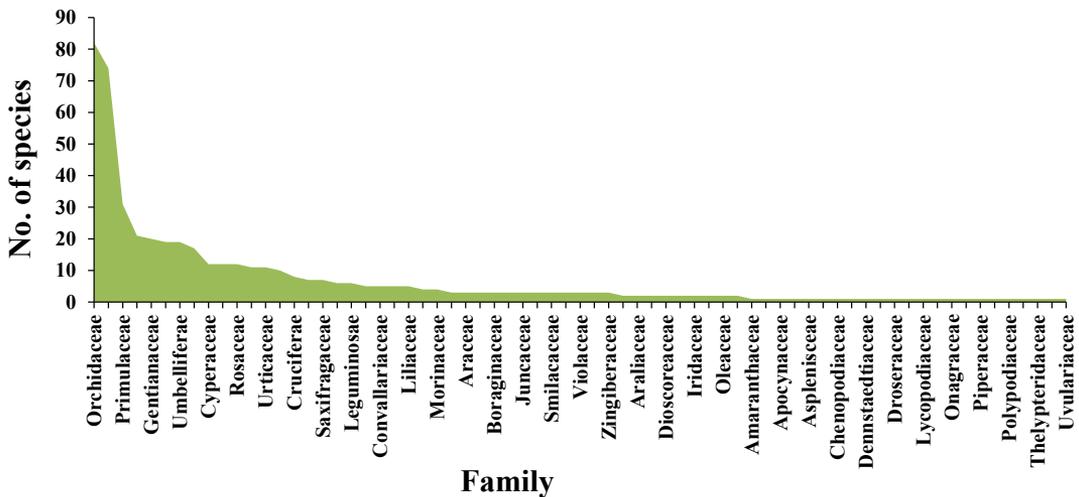


Figure 14: Family distribution of ground layer vegetation

The lowest diversity was 0.339 at 2400m (G30) and 3.299 was highest at 3700m (G9). With 82 species in the G9 share the highest species richness followed by 65 species in G19, 58 species in G21, 53 species in G3, and 48 species in G10, G11 and G43, and the lowest was 2 species at 2600m (G 30).

Based on dominance analysis, *Rhododendron anthopogon*, *R. lepidotum*, *R. setosum*, *Potentilla microphylla*, *P. peduncularis*, *P. arbuscula*, *Rhodiola* sp., *Carex* sp., *Rheum nobile*, *Fragaria nubicola*, *Fimbristylis* sp., *Meconopsis superba*, *Rheum australe*, *Bistorta affins*, *Aconogonon*

molle, *persicaria* sp., *Plantago erosa*, *Koenigia molle*, *Aconitum ferox* are dominant species recorded in the ground layer community.

Alpine meadows

Alpine meadows are a major vegetation component of this nature reserve and it occupies about 40% of the area. Vegetation in the alpine zone exhibits a characteristic adaptation to the environment. Alpine meadow vegetation communities inside the nature reserve are predominantly being dominated by cold-tolerant species belonging to the families of Graminae, Gentianaceae, Saxifragaceae, Ranunculaceae, Ericaceae and Polygonaceae. These plant communities have short growing period, a simple plant community structure and low biomass production. These are used exclusively for livestock grazing by domestic animals chiefly by Yaks (*Bos grunniens*). These plant communities support many highland yak-herders who have a long tradition of semi-nomadic pastoralism. Together with alpine shrubland, alpine meadows are the favored habitat for Alpine musk deer (*Moschus chrysogaster*), Himalayan marmot (*Marmota himalayana*), Himalayan serow (*Capricornis thar*), Sambar (*Rusa unicorn*) and Blue sheep (*Pseudois nayaur*) forming the main prey base for Snow leopard (*Panthera uncia*) inside the nature reserve. The nature reserve is truly a conservation jewel in the Eastern Himalayas, featured with astounding biodiversity composed of many high-value alpine medicinal plants, many globally threatened, endangered, rare, and endemic species of plants (TSNR, 2011). However, rampant illegal collection of alpine medicinal plants by local communities is another threat in the field of alpine medicinal plant conservation inside the nature reserve. Shifting of tree line and colonization (encroachment) by Rhododendron and Juniper scrub in the alpine habitat is another threat in the nature reserve.

The disturbance data revealed 30% landslides, 20% erosion and grazing, and least was 12% for NWFPs collection like alpine medicinal plants. In the alpine meadows, signs of erosion and rill formations on mountain sides were frequently observed in the nature reserve area. Limiting grazing in heavily grazed sites and avoiding burning in erosion prone areas might help to stabilize the fragile mountain ecosystem. Natural and anthropogenic disturbances were further classified into four intensities: no intensity (nil), low (10-20%), intermediate (30-40%) and high (>50%) in order to study the disturbance intensities of the alpine meadows. In the grids, both natural and anthropogenic disturbances recorded the disturbances intensity of 46% and 54% each

and had low intensity disturbances of 27%, intermediate intensity level of disturbances of 73% and there is no record of high intensity disturbances in the survey plots (Figure 15). This is in line with the findings of Ohsawa (2002) and Wangda and Ohsawa (2006), that such intermediate level of disturbance is important for the diversity of species.

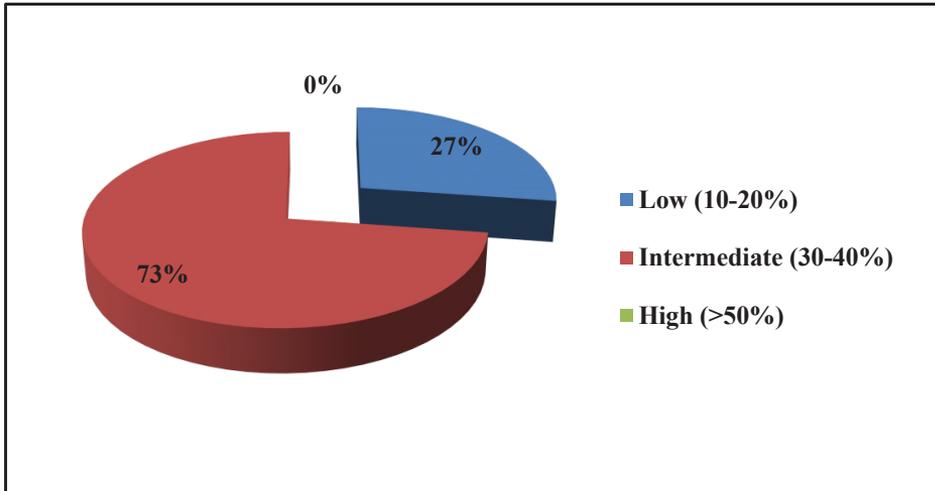


Figure 15: Disturbance Intensity

Several sites have been identified that require controlled burning especially for those sites which have been colonized by unpalatable shrubs including the Rhododendron and Juniper species (Figure 16).



Figure 16: Encroachment (colonization) of alpine meadows by *Juniperus squamata*

2.3 Faunal description

With huge variation in altitude from 1361-5597 m.a.s.l and existence of complex vegetation zones, JKSNR harbors outstanding numbers of faunal diversity. It provides home to many threatened faunal species. For the survey, the Biodiversity Monitoring Grids of 4x4 km which corresponds to the 4x4 km grid around the National Forest Inventory Cluster Plots were used to record all the mammals, birds and other wildlife species with different data collection methods.

A total of 40 species of mammals, 235 species of birds, 68 species of butterflies, 7 species of fishes, 16 reptiles and 7 amphibians were recorded from the rapid biodiversity survey conducted in the 48 grids covering the entire nature reserve area. Macro-invertebrates belonging to 7 class/order under 9 families were recorded from the 29 sampling sites from alpine lakes and streams. The biodiversity assessment revealed record of terrestrial, avian, herpetofauna and aquatic species that added to the existing lists in JKSNR.

2.3.1 Mammal Diversity

Mammals often leave behind signs that indicate their presence such as tracks, scats, dung piles, pellets, hairs, scent marks, scrapes etc. that can be easily seen during the survey. Therefore, trail transects survey for mammals were used to record evidence/signs in every 500 m transect walk covering major habitat types within the grids to calculate the evidence encounter rate per kilometer walk of a species (Biodiversity Monitoring Protocol, 2020). A total of 786 animal signs were observed along the 118 transect walk covering 59 km. The total sign encounter rate in 118 transect walk (59km) was 13.32/km (mean \pm SE = 10.42 \pm 3.33). The sign encounter rate was significantly higher in the alpine areas with 20.26/km walk (mean \pm SE = 0.38 \pm 0.05), and gradually decreased in cool broadleaved forest with 8.50/km (mean \pm SE = 0.31 \pm 0.02), fir forest with 7.08 (mean \pm SE = 0.29 \pm 0.04); and then to warm broadleaved forest with 5.83/km (mean \pm SE = 0.48 \pm 0.03).

Camera traps are used to survey terrestrial mammals, especially those known to use trails as travel paths. Surveys using infrared camera traps along the actively used paths, or any wildlife signs were used for camera installation within the grids. Out of the 69 grids of 4x4 km, 24 grids were sampled in all surveys, covering a total area of 384 km² for camera trap installation. Based on the potential areas and accessibility, a total of 24 camera traps were stationed in 24 grids with camera traps that yielded 4797 trap nights. Based on the number of independent images of 862

and 4797 trap nights, a photographic capture success of 0.18 images (detection rate) per period was achieved. The mammal density recorded based on image detection rate was 2.24/km² (mean \pm SE = 35.92 \pm 6.24).

JKSNR is home to 40 mammal species represented by 17 families including (Figure 17) one species of flying mammals from the family Hipposideridae. By way of order, the nature reserve has species belonging to at least six orders of animal kingdom; primates, even toed ungulates, carnivore, rodentia, lagomorpha and chiroptera. The species of bat recorded belongs to the order insectivore. Families Sciuridae and Felidae has the highest number of species represented by seven and six species each followed by Bovidae with five species, Mustelidae with three; while Canidae, Cervidae, Ochotonidae and Cercopitheciidae has two species each. Other families have one species each. Of all the species, the Clouded leopard are said to be present as per the verbal communication with yak-herders and even based on habitat suitability model. However, it needs further validation and extensive research for confirmation of this species in the nature reserve.

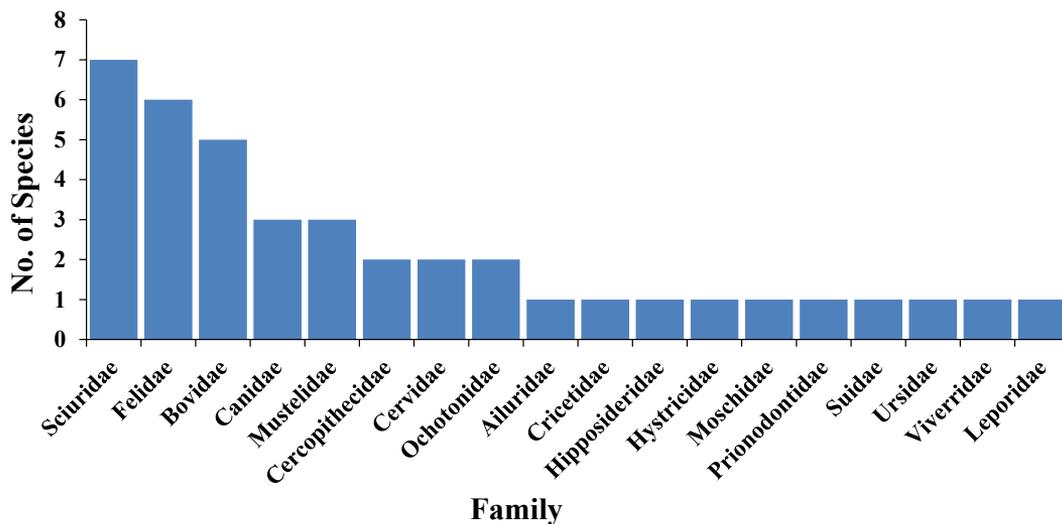


Figure 17: Number of species in each family

Many of these species can be considered “flagship” species for JKSNR, such as Snow leopard in the pristine alpine ecosystem, Bengal tiger in the pristine temperate ecosystem, and Himalayan red panda in the bamboo forests. Though the southern part of the nature reserve is found to be excellent habitat for Bengal tiger, evidence of Tiger’s presence in JKSNR was initially based on

anecdotal reports and few pug marks. Camera trapping exercise of 2014, 2016, 2018, has failed to capture a single image in any camera station despite a good distribution of its prey species. However, during the RBS in 2019-2020, several camera traps has captured Bengal tiger thereby confirming the presence of Bengal tiger in JKSNR. Confirmation of its presence validated its presence with camera images at three location which is a great win for conservation; and gives all reason to monitor and ensure that these species are protected. The nature reserve serves as an important and promising area for global conservation of not only the Snow leopards, but also the Tigers too.

By way of protection status, out of the total 40 mammal species in JKSNR, 19 species are listed in the IUCN Red List as globally threatened; 4 species are endangered, 6 species are vulnerable, 9 species are near threatened and 21 species are of least concern. 10 species are strictly protected under Schedule I of Forest and Nature Conservation Act of Bhutan (FNCA) 1995 (Table 4).

Table 4: JKSNR mammals of conservation importance

Common Name	Scientific Name	IUCN Status	FNCA 1995 Schedule
Bengal tiger	<i>Panthera tigris</i>	EN	SC I
Snow leopard	<i>Panthera uncia</i>	VU	SC I
Alpine musk deer	<i>Moschus chrysogaster</i>	EN	SC I
Himalayan red panda	<i>Ailurus fulgens</i>	EN	SC I
Common leopard	<i>Panthera pardus</i>	VU	SC I
Dhole (Wild dog)	<i>Cuon alpinus</i>	EN	
Asiatic black bear	<i>Ursus thibetanus</i>	VU	SC I
Himalayan gaur	<i>Bos gaurus</i>	VU	SC I
Bhutan takin	<i>Budorcas taxicolor whitei</i>	VU	SC I
Sambar	<i>Rusa unicolor</i>	VU	
Asiatic golden cat (4 morphs)	<i>Catopuma temminckii</i>	NT	
Marbled cat	<i>Pardofelis marmorata</i>	NT	
Eurasian otter	<i>Lutra</i>	NT	
Mountain weasel	<i>Mustela altaica</i>	NT	
Himalayan serow	<i>Capricornis thar</i>	NT	SC I
Himalayan goral	<i>Naemorhedus goral</i>	NT	
Assamese macaque	<i>Macaca assamensis</i>	NT	
Malayan giant squirrel	<i>Ratufa bicolor</i>	NT	
Leopard cat	<i>Prionailurus bengalensis</i>	LC	SC I

EN- Endangered; VU-Vulnerable; NT- Near Threatened; LC-Least Concerned; SC I- Schedule I

Avifaunal Diversity

Within the grids of 4x4 km, MacKinnon Listing methods were adopted to investigate the abundance and diversity of birds with respect to the forest habitat types. A trail transect involves walking, observing and enumerating all sightings along an existing trail. Along a trail at each habitat site, different listing (5-5, 10-10, 20-20) was done for different habitats and a total of 104 lists (alpine 41, fir 18, cool broadleaved 11 and warm broadleaved 6) were recorded. The nature reserve thus far recorded 235 bird species belonging to 62 families which constitute 32% of the total bird species found in Bhutan (Figure 18). The nature reserve recorded 74 new species as additional list including 2 new records to Bhutan. Among the list, five species namely Himalayan monal, Satyr tragopan, Indian peafowl, Black-necked crane and Rufous-necked hornbill are listed in Schedule I of the FNCA 1995. Six species are listed as Appendix I/III species of CITES, endangered Steppe eagle is listed as Endangered in the IUCN Red List of Threatened Species and two species viz., Rufous-necked hornbill and Black-necked crane as vulnerable. Satyr tragopan, Himalayan griffon, Bearded vulture and River lapwing fall under the near threatened category of the IUCN Red List. Significant rare species like Tibetan snowcock and Tufted duck, one restricted range species called Hoary-throated barwing; and long-distance migrant bird like Eurasian hobby are also recorded in the nature reserve.

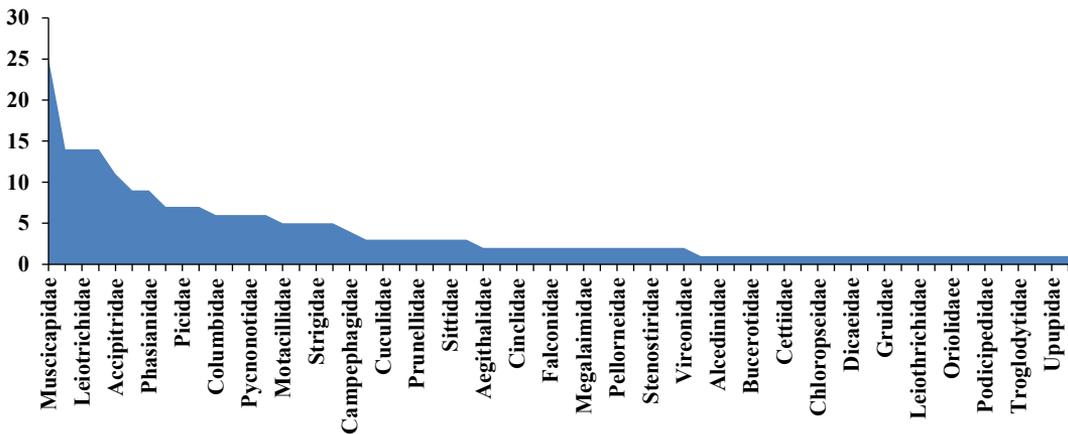


Figure 18: Record of species in each family

Table 5: Avi-faunal diversity based on detection rate

Habitat	Detection	Species Richness	Species Diversity H'	Evenness (J')
Alpine	205	45	2.873	0.77
Conifer/Fir	180	54	3.555	0.90
Cool Broadleaved	220	79	4.051	0.90
Warm Broadleaved	120	76	3.77	0.88

From the record, the diversity index (H') indicate that Cool broadleaved forest had higher species diversity with 4.051 followed by Warm broadleaved forest with 3.77, Fir and Rhododendron forest with 3.56 and least diversity in Alpine meadows (Figure 19). Based on the relative abundance computation, Snow pigeon (199) was the highest recorded, followed by Himalayan monal (68), Blood pheasant (56) and White-throated laughingthrush (51). When each habitat type was considered separately, Snow pigeon (30%, n=179) was recorded in Alpine habitat, Himalayan monal (9%, n=32) in Conifer forest-Fir, Scarlet finch (7%, n=29) in Cool broadleaved forest and White-throated laughing thrush (14%, n=44) at Warm broadleaved forest.

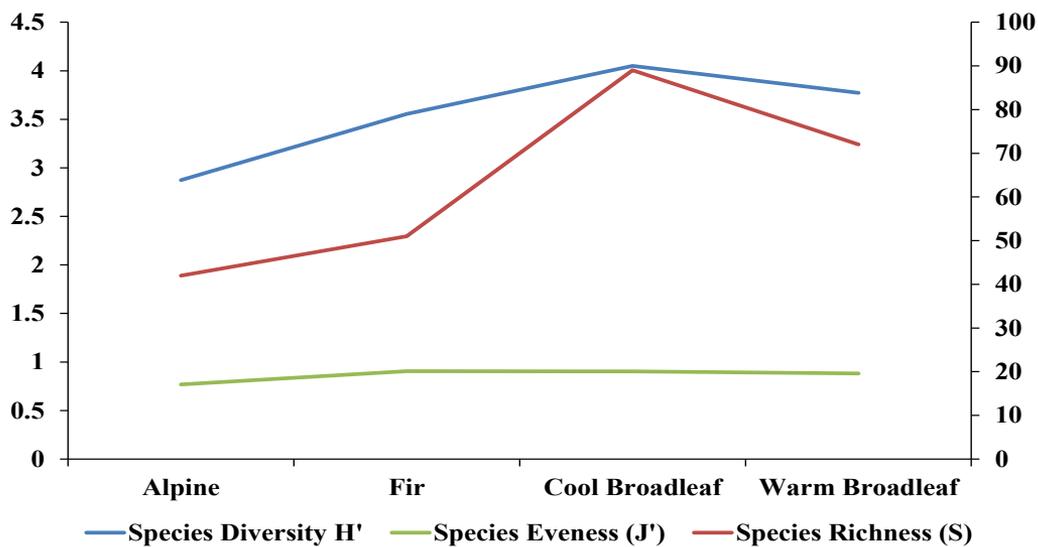


Figure 19: Birds diversity in different habitat zone

Species richness is the total bird species diversity reached where/when no new species are recorded in a new succeeding list or when the species richness curve runs parallel to the x-axis (Figure 20). It is thus assumed as the total number of bird species found at any habitat at that particular time of survey. A particular habitat will show different species richness during different seasons mainly due to the altitudinal migratory patterns of the birds.

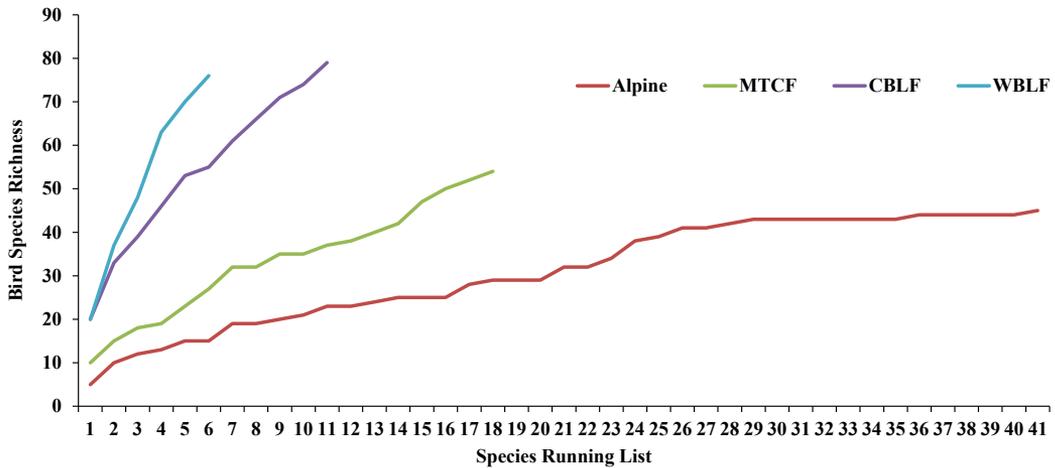


Figure 20: Species Richness Accumulation Curve for four major habitat types

Cool broad-leaved habitat has the highest bird density with a total count of 79 bird species recorded in 11 running lists, while Alpine habitat recorded the least with the count of 45 birds in 41 lists (Table 6). In all the habitat types, the addition of new species in all succeeding list with new additions even in the last lists suggests that we have not been able to determine the complete species richness or in other words given the time and resources, more birds will be recorded in all the habitat types. We can infer from the species richness curve that not many species will be recorded in the Alpine habitat after a list or two as the curve has started to flatten after the 26th-27th lists, whereas in the Conifer and Broadleaf forest it indicates that the survey is incomplete.

Table 6: Species Richness in Different Habitat Types

Habitat Type	Species Richness	No. of List	Total Count
Alpine Meadows (Alpine)	45	41	205
Conifer Forest (MTCF)	54	18	180
Cool Broadleaved Forest (CBLF)	79	11	220
Warm Broadleaved Forest (WBLF)	76	6	120

Butterfly Diversity

The nature reserve has added four additional butterflies to the earlier list of butterflies, thus taking the total count to 68 species belonging to 19 families (Figure 21). Several rare species are found in the nature reserve including *Lethe scandal*, *Prosotas nora airdates*, *Pontia daplidice moorei*, *Tirimala septentrionis*, *Euploea midamus rogenhoferi*, *Melitaea arcesia sikki-mensis*, *Kuekenthaliella gemmate*, *Parnassius hardwickei*, *Albulina lehana*, *Choaspens benjaminii*, *Lethe sinorix* and *Appias lalage*. The most common species of butterflies found in the nature reserve are Common peacock (*Achillides polyctor*), Paris peacock (*Achillides paris*), Blue peacock (*Achillides arcturus*), and Spangle (*Sainia protenor*). Butterflies are not only important for pollination but also perform manifold functions such as providing ecological, economic, educational and social values.

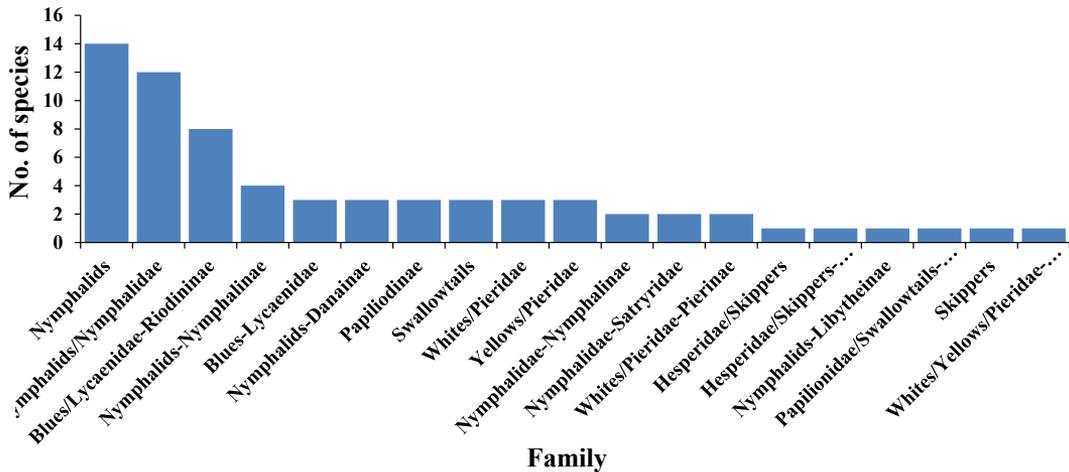


Figure 21: List of butterflies in JKSNR

Fungal Diversity

JKSNR is not only home to plants with decent uses that also beautify the landscape, but is also home to 100 species of mushroom species including a CITES Appendix II species *Ophiocordyceps sinensis* (Yartsa Guenboop) and others like *Tricholoma mantsutaki* (Sangay sham), *Dacromyces* sp. (Orange jelly), *Ramaria botrytis* (Pink tipped coral fungus – Jichu Kangru), *Trametes versicolor* (used for medicinal tea), *Humaria hemisphaerica* (Harry fairy cup), *Sparassis spathulata* (Cauliflower mushroom), *Amanita hemibapha* (Gongsa sham), *Spathularia flavida* (Yellow earth tongue) and an inedible *Amanita pantherima* species like

Boletos frosti (unknown and new record for Bhutan), *Clavaria* cf. *delphus* (Horned group), *Peziza vesiculosa*, *Xyloria* sp. (Antler fungi), *Cantherellus* cf. *civariusfries* (Yellow chanterelle, Sisi sham), *Hydnum rependum* (Hedgehog, Cheshamu), *Origularis* sp. (Bjili namcho), *Calocybe scarnia*, *Inocybe griseolilacina*, *Clitocybe geotropa* (cousin of Sisi-shamu), *Laetiporus* cf. *cincinnatus* (Tashamu), *Russula emetica* (Grey – the sickener, Om sham), *Russula sanguinaria*, *Amanita* sp. (not the one mentioned above), *Trichoglossum hirsutum*, *Lactarius piperatus* (peppery milk cap), *Mycena* sp. *Hericium* cf. *erinaceum*, *Aleuria aurantia*, *Auricularia auricula*, *Lycoperdon perlatum* (dusty powder when dried), *Gomphus floccosus* (Scaly chanterelle), *Crucibulum* sp. leave (Konpu sham or Ting sham), *Hygrophorosis aurantiaca* (Paxillaceae), *Clabulimnopsis helvola*, *Strobilomyces strobilaceus*, *Calocera viscosa* (Yellow stag horned fungus) are some fungus seen inside the nature reserve. Even *Exidia* sp. an economically important species is found in the nature reserve are picked occasionally by porters who travel with researchers, surveyors and pilgrims.

Herpetofauna Diversity

16 reptiles and 7 amphibians were recorded from the biodiversity assessments conducted in 48 grids covering the entire area of the nature reserve. The nature reserve is home to a good number of Wolf snakes, Kukri snakes, Kraits, Vipers and Keel-backs. *Oligodon albocinctus*, *Sibynophis collaris*, *Trachiuschium* sp., and a number of other species which we could not identify. The nature reserve is also home to anurans such as *Duttaphrynus melanostictus*, *Duttaphrynus himalayanus*, *Polypedates* sp. *Amolops* species. The high-altitude lakes inside the nature reserve also has record of *Scutigera* species, *Nanorana parkeri* and also *Nanorana lebiegii*. We do have records of *Amphiesma platyceps*, *Hebius cerasogaster* (although further confirmation is necessary).

Freshwater Macro-invertebrates and Fishes

The freshwater has always been home to diverse macro-invertebrates which play important role for both aquatic and terrestrial ecosystems. The assessment of macro-invertebrate communities is one of the best ways to monitor the health of a stream. Physical, chemical and biological assessment of stream/river/lake can provide a complete spectrum of water quality. Such a study entails huge investment, technical expertise and is time consuming, therefore the freshwater macro-invertebrates still remain the least explored study area in JKSNR. Many aquatic insects

play important roles in the aquatic and riparian food web; and are good indicators of water quality because they live in environments that are cold and well-oxygenated. Freshwater diversity as an indicator for water quality and health of the ecosystem; and there is need to understand their status for future planning, decision making and maintaining sustainable freshwater ecosystem services. Thus, the preliminary surveys recorded 7 class or order belonging to 9 families of freshwater macro-invertebrates (Table 7) from the 29 sampling sites from the alpine lakes and streams and 7 species of fishes (Table 8). Macroinvertebrates within the order Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies) all play a vital role in ecological function because they provide an important food source for fishes and other aquatic animals.

Table 7: Macro-invertebrates taxa, abundance and composition for whole survey area

Order	Family	Common Name	Abundance	%
Ephemeroptera	Heptageniidae	Mayflies	17	22.08
Ephemeroptera	Baetidae	Mayflies	16	20.78
Trichoptera	Leptoceridae	Caddisflies	6	7.79
Trichoptera	Hydropsychidae	Caddisflies	10	12.99
Diptera	Chironomidae	Midges	7	9.09
Heteroptera	Corixidae	Water boatman	2	2.60
Plecoptera	Nemouridae	Stoneflies	4	5.19
Coleoptera	Dytiscidae	Water beetle	8	10.39
Haplotaxida	Tubificidae	Worms	1	1.30
		Shell	6	7.79

Table 8: List of fish species in JKSNR

Sl/No.	Common Name	Scientific Name	Family
1	Chocolate mahseer/Copper	<i>Neolissochilus hexagonnalepis</i>	Cyprinidae
2	Snow trout	<i>Schizothorax richardsonii</i>	Cyprinidae
3	Brown trout	<i>Salmo trutta</i>	Salmonidae
4	Sucker throat catfish	<i>Pseudochenesis sulcate</i>	Sisoridae
5	Sucker head/Stone roller	<i>Garra gotyla</i>	Cyprinidae
6	Torrent minnow	<i>Psilorhynchus</i> sp.	Psilorhynchidae
7	Stone catfish	<i>Exostoma</i> sp.	Sisoridae

All life forms prefer in water having favorable physico-chemical properties. The maximum temperature recorded was 13.70 °C and minimum was 2.60 °C with the mean temperature recorded at 7.66 °C (mean \pm SD = 7.66 \pm 2.75). The mean Dissolved Oxygen recorded was 6.58 mg/L (mean \pm SD = 6.58 \pm 2.26) with the maximum recorded as 17.70 mg/L and the minimum as 4.30 mg/L; and the water pH record was 7.55 (mean \pm SD = 7.05 \pm 1.52).

2.4 Local people and livelihoods

Administratively, JKSNR spreads across two dzongkhags; Haa with 93.67% of the area (two gewogs) and with a very small area spreading south into Samtse with 6.32% (two gewogs) (Table 9). The nature reserve has its primary communities as a migratory yak-herding community from Bjee, Katsho and Eusu gewogs under Haa; and those communities at the enclave of the nature reserve particularly Sangbaykha as a secondary community user. Collection of socio-economic data on the local communities residing inside and outside the nature reserve was an integral part of the plan which has resulted in a considerable amount of information becoming available. The report provides a comprehensive analysis of the available socio-economic data and information for better and effective planning of integrated conservation and development programs.

The data are collected through various techniques like Participatory Rapid Appraisal (PRA) and Rapid Rural Appraisal (RRA) tools and approaches. The interviews were conducted for both village and individual households through structured interview using a set of developed questionnaires. A sufficient sample size was used to ensure that the survey results will be statistically relevant. Random sampling is used to ensure that the sample is representative of the survey areas so as to avoid biasness in the result analysis and to ensure that all elements of the population have an equal chance of being interviewed. The Yamane's (1967) method is used to determine the sample size while a lucky dip system was used to determine which households are to be selected for interview primarily to sidestep biasness. In total, 118 households were selected from four gewogs, respectively 100% of the yak-herding communities and 25% from outside the nature reserve.

Table 9: Gewogs falling within JKSNR

Sl/No.	Gewog	Dzongkhag	Area (Sq.km)	% Cover
1	Bjee	Haa	486.796	62.07
2	Sangbaykha	Haa	247.848	31.60
3	Norgaygang	Samtse	28.819	3.67
4	Tendruk	Samtse	20.762	2.65
Total Area			784.225	

2.4.1 General description

There are two distinct groups of communities: yak-herding (primary users) and non-yak herding/farming (secondary users) residing within and at the enclave of the nature reserve as shown in Table 10. Unlike the other yak-herding communities of Bhutan, they do possess some agricultural land and have been cultivating different cereal crops back in the villages. These yak-herders (gewogs of Bjee, Katsho and Eusu) from 53 households with 217 residents have traditional customary grazing rights over the area and depends on the income earned from yak-herding supplemented by agriculture farms. The socio-economic report substantiates that there is decrease in yak-herding households by 15%, 53 hhs (217 resident population) in comparison to previous plan data of 71 hhs (315 residents). In contrast, the farming communities of Sangbaykha gewog depend upon subsistence production from agricultural farming supplemented by livestock (local and improved breeds), while Tendruk and Norgaygang under Samtse dzongkhag were not surveyed since they do not have direct stake on JKSNR for resources as these communities reside more than 3-4 days walk from JKSNR in addition to the restrictions made due to border sensitivity.

Table 10: Yak herders (HHs) and population falling within JKSNR (past and present status)

Sl/No.	Gewogs	Old HHs	Old Pop	New HHs	New Pop	Total HHs	Total Pop
1	Bjee	25	113	35	141	60	254
2	Katsho	35	151	12	46	47	197
3	Eusu	11	51	6	30	17	81
Total		71	315	53	217	124	532
%		57	59	43	41	-15%	-18%

Based on the use and importance of the area to the inhabitants, the populace are categorized into three groups based on their use of natural resources.

i). Primary Users/Inside JKSNR: 2% of the yak-herding communities of Bjee (N=35 HH), Katsho (N=12 HH) and Eusu (N=6 HH) gewogs under Haa having traditional grazing rights in the area and use the area exclusively for grazing fall within this category. This group is considered as the primary users of the nature reserve which showed an overall decrease by 15% (18hhs) on the actual yak-herding households (Figure 22).

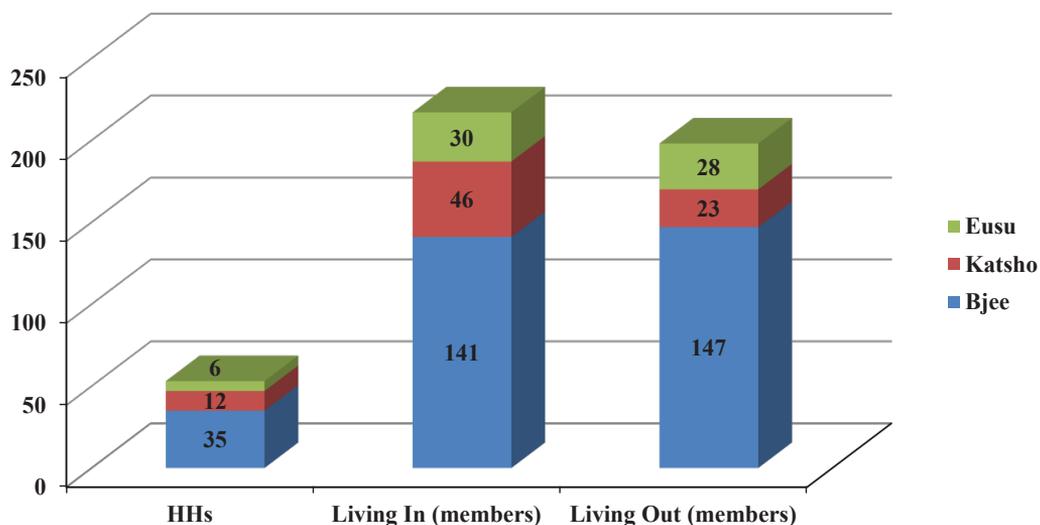


Figure 22: Herding communities (HHs & Households' members)

ii). Secondary Users/Outside JKSNR: 98% of the agricultural community of Sangbaykha, Tendruk and Norgaygang gewogs falls within this category and depend upon subsistence farming, mainly agriculture complemented by livestock farming and residing at the outskirts of the nature reserve having lesser interaction with JKSNR when compared with the primary users (Table 11).

iii). Other Users: Besides the above users, there are other user groups outside the nature reserve known to use the nature reserve's resources such as army outposts, tourists, government agencies, etc., particularly while travelling.

Table 11: Households falling within JKSNR (primary and secondary users)

Sl/No.	Gewogs	Dzongkha	Yak Herders (HHs)	Outside JKSNR (HHs)	Total HHs
1	Bjee	Haa	35	243	278
2	Katsho	Haa	12	259	271
3	Eusu	Haa	6	259	265
4	Sangbaykha	Haa		244	244
5	Tendruk	Samtse		789	789
6	Norgaygang	Samtse		803	803
	Total		53	2597	2650
	%		2	98	

2.4.2 Demography and Social Structure

It is found inevitable to know the demographic profile of the households prior to the scrutiny of the socio-economic details (Kumar, *et al.* 2002). This study tried to involve equal number of male and female in order to get proportionate representation and explore the information from both sexes as shown in Figure 23. From a total percentage of male and female respondents, 58% (n=68) of the respondents were men and 42% (n=50) were women, showing a little higher involvement of male respondents during the survey (Figure 23). The survey was not only inclusive to the HHs members residing in the HHs during the time of actual survey exercise, but inclusion were also made to the family members staying away in other places, either as government employees, students, armed forces, monks, businesspersons and employees in corporate organizations and private firms.

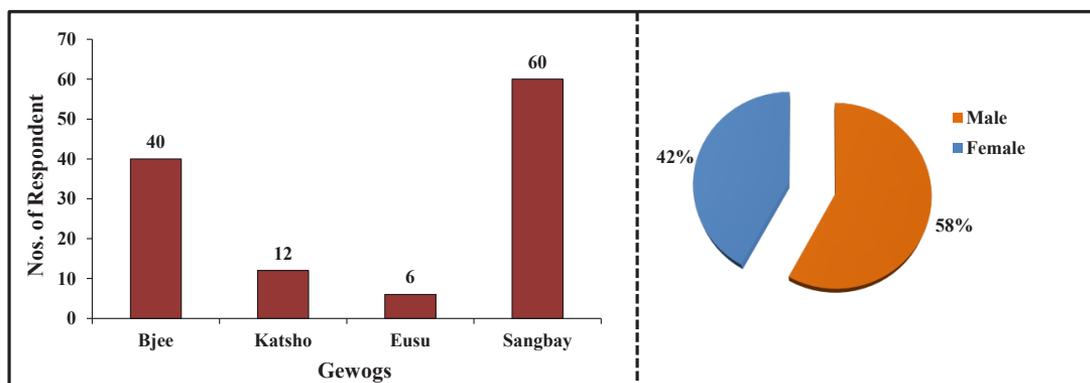


Figure 23: i). Respondents per gewog

ii). Respondents by gender

2.4.3 Livelihood and Income

The socio-economic data generated from the survey revealed that the agriculture farming like cereals, potatoes and vegetables remains the most important source of livelihood for the majority of the households. Majority of the communities in JKSNR depends upon agricultural farming (35%), livestock rearing (30%), horticulture farming (19%) and supplemented by non-farm activities such as businesses, government services, portering, casual labor, and other sources through rituals by lay monks/Gomchen (14%) and non-wood forest products (NWFPs) contributed (2%) (Figure 24).

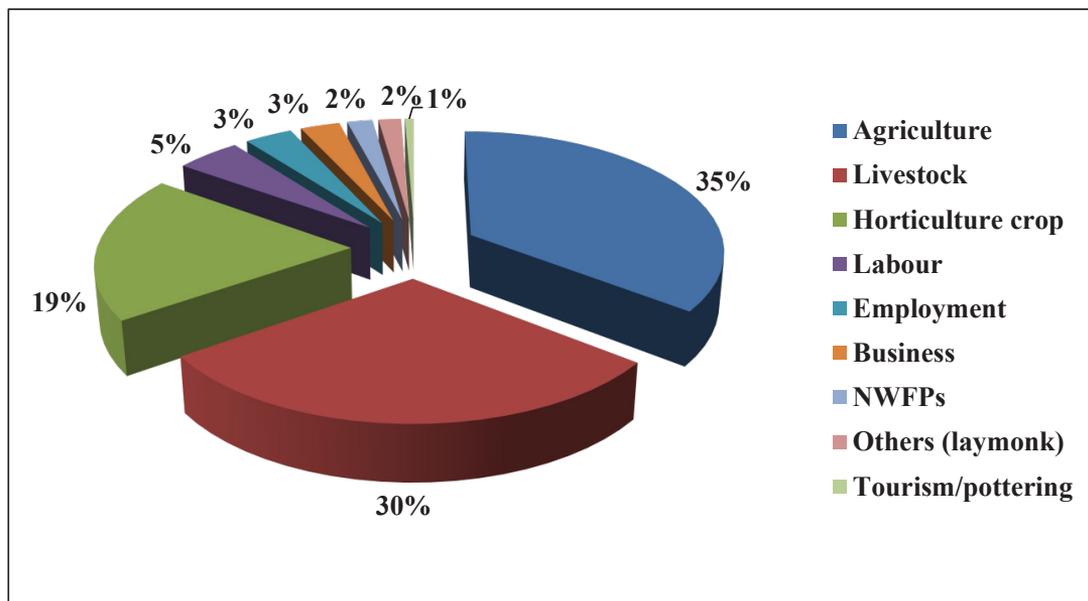


Figure 24: Source of Livelihood and income

The sources of cash from livestock mainly through the sale of meat, butter and cheese are reported highest from yak-herders from Bjee, Katsho and Eusu gewogs as it is their main source of income. A fresh meat of yak cost Nu. 450 – 750 per kg, Chugo (a string of hard cheese) cost Nu. 600 – 800 per shey, yak butter cost Nu. 500 - 800 per kg, Jaa (yak hair tent) Nu. 120,000 per tent, Nu. 1200 per rope made of yak hairs and a live yak cost Nu. 40,000 – 130,000 per yak (based on age). In addition, the male yaks are also sold live to other highlanders, as their yak breeds are considered superior. However, yak-herding as a profession is dwindling and vanishing due to labor shortage and other alternative easier and economical activities. The yak-herding communities in their permanent villages bank on potato as cash crop for their livelihoods. Potato

farming is almost exclusive in these gewogs since its harvest is taken down to Phuntsholing and in return essential food items are brought back. On an average, the community harvest around 15 to 100 bags (1 bag=50kgs) of potatoes annually.

On the other hand, wheat, turnip, buckwheat is also grown by these gewogs in addition to apples which is grown as a cash crop. Horticulture crops such as cardamom and oranges are also main source of cash income for the communities of Sangbaykha, Tendruk and Norgaygang gewogs. From cardamom, the community fetches around Nu. 20,000 – 500,000 averaging 5 to 40 gunny bag (bora) for each household (1 bora=50 kgs). They also grow maize, paddy, millet, barley and buckwheat for their livelihoods and self-consumption. The non-wood forest products (NWFPs) such as cane shoot, mushroom, *Elastostema* sp., fern top, bamboo, incense, cordyceps and medicinal plants also contribute and supplement the livelihood of these farmers. Sangay shamu (*Matsutake mushroom*) fetches Nu. 800 - 1500 per kg whereas Cordyceps earns Nu. 100-200 per piece making an earning of Nu. 30,000 - 90,000 per household. However, the income source differs from gewog to gewog and household to household depending on their landholding, work force, inherited traditional farming system and lifestyle. Other income source like portering, casual labor and ritual performance by lay monks also plays a critical role in supplementing the income of these local communities.

2.4.4 Livestock Holding

Other than agriculture, livestock is also an important component of farming. It is practiced by most of the farmers for supplementing their diet and income. Livestock reared by farmers include cattle (local & jersey cross), yaks, poultry, pig, goat, sheep, horses and dog for guarding. Among the livestock population in the gewogs, yaks dominates with highest number per household with 55.64 (mean \pm *SD* = 55.64 \pm 41.12) per household with maximum household rearing (205, n=3672) followed by poultry 19.06 (mean \pm *SD* = 19.06 \pm 45.28) per household with maximum (100, n=1032). The average cattle holding was 5.61 (mean \pm *SD* = 5.61 \pm 7.51) with maximum (55, n=887) per household. Since all the gewogs are well connected with the farm roads, the population of horses has drastically declined with an average holding of 3.80 (mean \pm *SD* = 3.80 \pm 0.70) with maximum (15, n=294) per household compared to the past 5 years (n=582). The dogs owned by the families from Bjee, Katsho and Eusu gewogs are mostly

Tibetan mastiff breed mainly kept in yak-herd camps to guard the camp and protect livestock from predators.

On an average, Katsho gewog has the highest number of yaks per household followed by Bjee and Eusu (Figure 25). The three types of cattle categorically termed as *Lanor* (meaning cattle kept at the mountains), *Thanor* (cattle reared at the lower valleys) and *Yuelnor* (cattle raised in and around the houses) are being raised by the local communities of Bjee, Katsho and Eusu gewogs in addition to improved breeds like Jersey and Brown swiss.

However, Sangbaykha gewog still practice the rearing of the native *Nublang* breed and continue preserving the bloodline and genes of the *Nublang* breed in Bhutan.

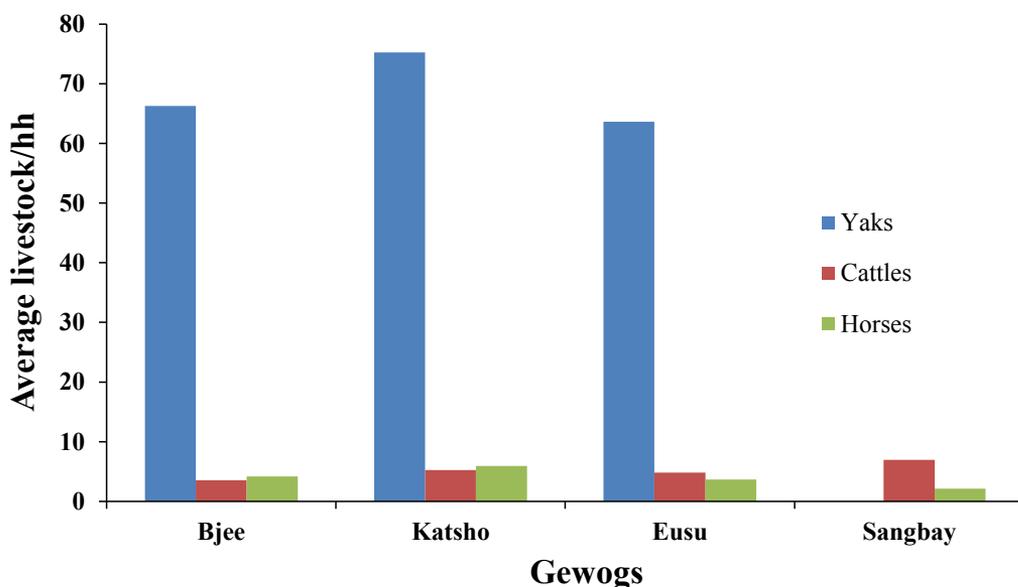


Figure 25: Average livestock holding per household

The yaks are kept inside JKSNR (as shown in Table 12) unlike horses and cattle. The cattle from Sangbaykha gewog are kept at the periphery of JKSNR. The horses only move seasonally and are kept inside the nature reserve and mainly used for transportation by yak-herders, armed forces and the other travelers like tourists (local and international).

Table 12: Number of Livestock inside JKSNR

Gewog	Total yaks inside JKSNR	Total horses	Cattle outside JKSNR
Bjee	2387	167	142
Katsho	903	71	63
Eusu	382	11	24
Sangbaykha	-	34	396
Total	3672	283	625

The livestock are mostly reared as a source of food for the family 31.7% followed by backyard manure 30.7% for organic agriculture farming; and livestock rearing as a source of subsidiary income through sale of dairy products 24.8%. Means of transportation was recorded as least important with 6.5% considering the connectivity of the gewogs by farm roads. Even though the agriculture fields are mostly located in the valley floor with gentle slope, farm mechanization has not been popular in the gewogs, people still keep oxen for draught purpose 5% (Figure 26).

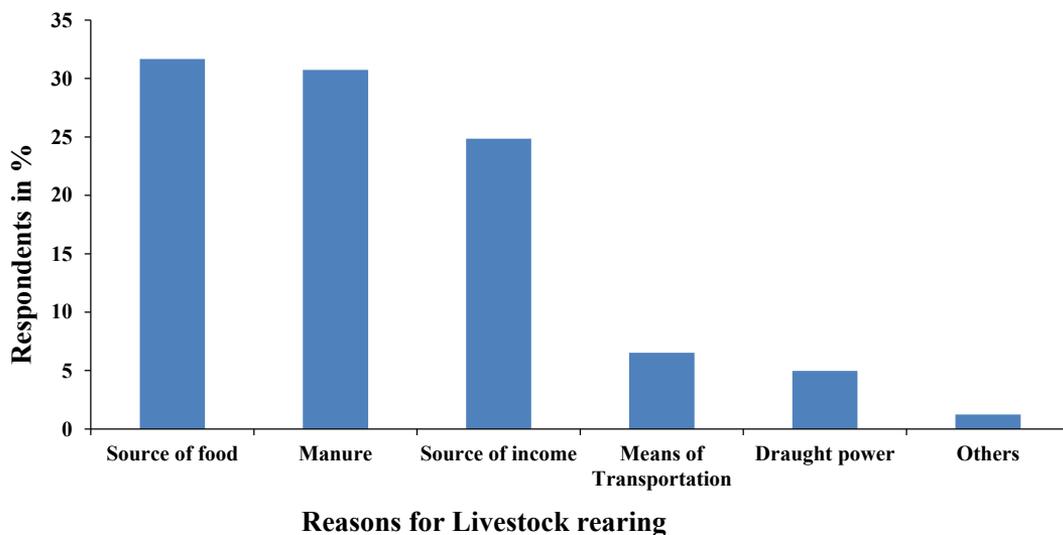


Figure 26: Primary importance of livestock rearing

Problem for rearing livestock

As depicted in Figure 27, the livestock depredation (loss of livestock to the wild predators) is the most reported case from every gewog with 22.47% (n=80). There is a strong correlation between free range grazing and livestock loss as 61.78% (n=118) of the households grazed their livestock in the open forest land where most of the livestock were attacked by wild predators. Low milk yield, poor quality breed, insufficient grazing land, insufficient fodder, few extension visits, poor quality grazing area, diseases and exceptional case of conflict with the Tibetan herders for grazing ground in the northern part of nature reserve are also featured as a problem for the local communities.

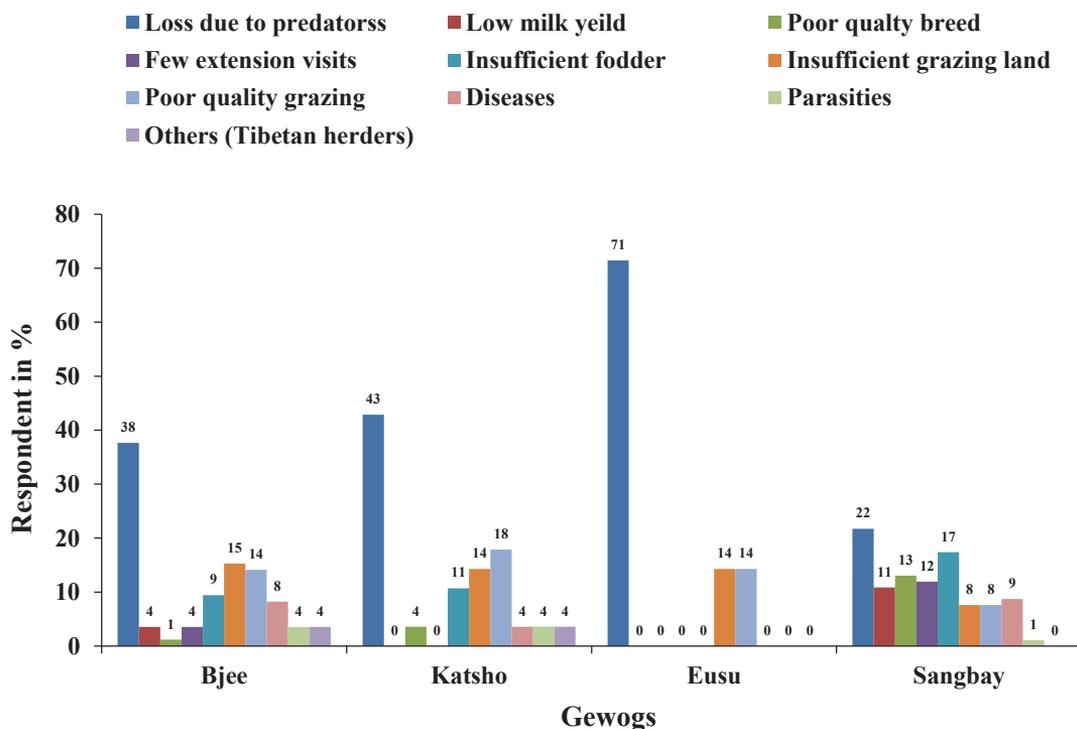


Figure 27: Problems and Constraints to livestock rearing

2.4.5 Agriculture Holding

JKSNR is the only protected area in Bhutan where there is no agricultural cultivation inside the nature reserve and all the agricultural land falls way beyond its boundary. Since the livelihood of the community is interdependent on the farming system, agriculture is also being dealt in brief with relation to the residents of JKSNR. They are mostly subsistence farmers who are dependent on agriculture for their livelihood and practice agriculture farming in different types of land use. As shown in Figure 28, average land holding per household varies from gewog to gewog. The common forms of land use in the five gewogs are *Kamzhing* (dryland), *Chhuzhing* (wetland), orchard and kitchen garden.

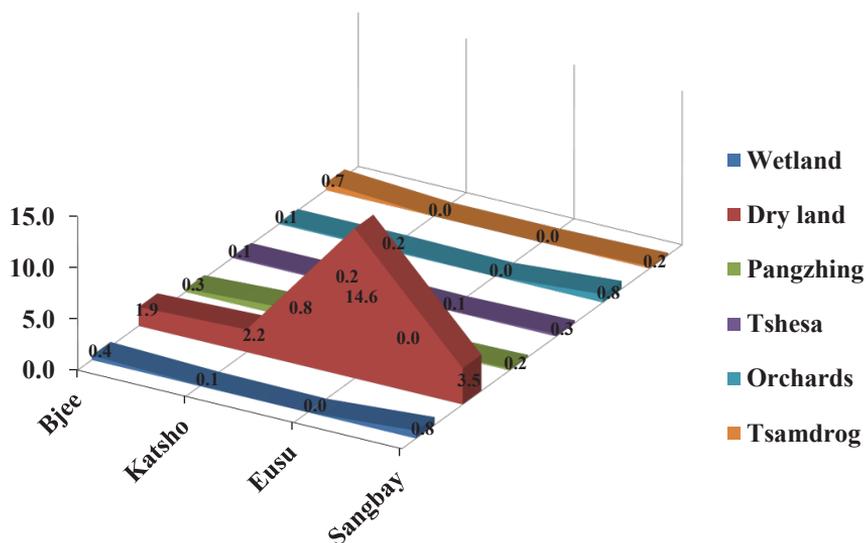


Figure 28: Average landholdings per household

Unlike the other yak-herding communities of Bhutan, the yak herders of Haa have fairly good amount of land. Major land type was *Kamzhing* (dryland) with an average of 14.63 (mean \pm SD = 14.63 \pm 29.70) acres per household followed by Orchard with 0.82 acres (mean \pm SD = 0.82 \pm 1.45), *Chhuzhing* (wetland) with 0.76 acres (mean \pm SD = 0.76 \pm 1.03). Upper Haa gewogs of Bjee, Katsho and Eusu are mostly dominated by *Kamzhing* (dryland) while *Chhuzhing* (wetland) are owned by the local communities of Sangbay gewog in lower Haa.

Problems with agriculture farming

The degree and severity of the problems and constraints related to agriculture are not even and differ. As illustrated in Figure 29 below, the major problem among the households in all the gewogs is crop depredation by wild animals (34.52%). This is followed by labor shortages (18.15%) and marketing problems (13.88%) specific to Bjee, Katsho and Eusu gewogs; and poor accessibility (4.27%) prevalent for Sangbay gewog. Another significant problem with agricultural production is insufficient irrigation, among others (9.25%).

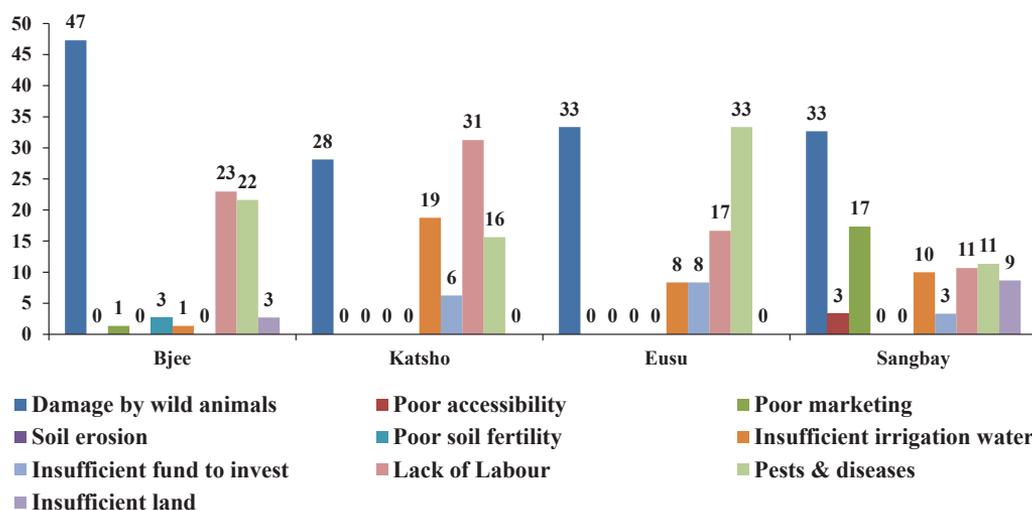


Figure 29: Agriculture problem and constraints

2.4.6 Community perception on Climate change

Climate change is a global challenge, but the degree of impacts varies and impacts are already being felt irrespective of places or gewogs. The survey report on the subject revealed that 72% of the respondents reported that it is changing yearly and changes are experienced in the form of unusual storm, erratic rainfall, snowfall and flash floods (Figure 30); and additionally, changes like extreme weather events in the form of drought, flooding, fire, pest and diseases, etc has also impacted on the livelihood through losses incurred especially on production of agriculture crops. The deforestation and over exploitation of natural resources, forest fires, pollution from vehicles, factories, wastes, developmental activities are felt and seen as the causes of climate changes. However, the respondents have also suggested for an effective adaptation strategy to overcome with the climate related impacts through awareness and advocacy programs, conservation and

protection of environment, control or minimize pollution, climate resilient crops, organic farming, plantation in degraded areas, climate smart infrastructures, diversifying the farming systems etc.

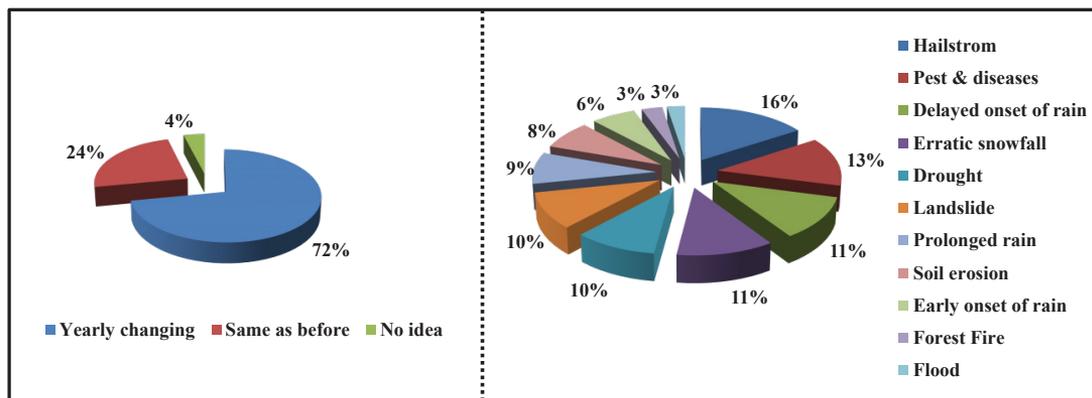


Figure 30: Respondent views on climate change and its variables

2.4.7 Human-wildlife Conflicts

The data authenticate that the major challenge to the local communities of four gewogs is with the presence of mega-fauna living in close proximity to the rural communities/herding communities. Sharing the same landscape and shrinkage of the natural habitats has resulted in people and animal conflicts over living space and food.

One major impediment to livelihoods is the plight where households suffer due to persistent and widespread wildlife damage to both livestock and crops. Taking into consideration the importance of knowing the human-wildlife conflict dimension, a brief assessment was included in this survey, where almost 90% (n=106) of the respondents reported that they have conflict with wildlife and 10% (n=12) reported no conflict with wildlife as they have no livestock holding and did not venture into cultivation over the years.

2.4.7.1 Livestock depredation

Livestock rearing is the main source of livelihood of the local communities living inside and at the fringes of JKSNR. As authenticated through the survey, almost 65.08% (n=82) of the households practice free range grazing system resulting in displacement of the wild herbivores as natural prey for the carnivores (Figure 31). As a consequence of low food resources in the

forests, natural prey species clustered around human settlements and entered into direct conflict with human through crop damage and livestock depredation (Wang, 2008). Similarly, a study on livestock depredation case in four gewogs revealed that almost 62% of the respondents perceived livestock depredation case which revealed 34.75% severity, 27.97% of the respondents considered it as minor and 37.29% as maximum reported no loss of livestock.

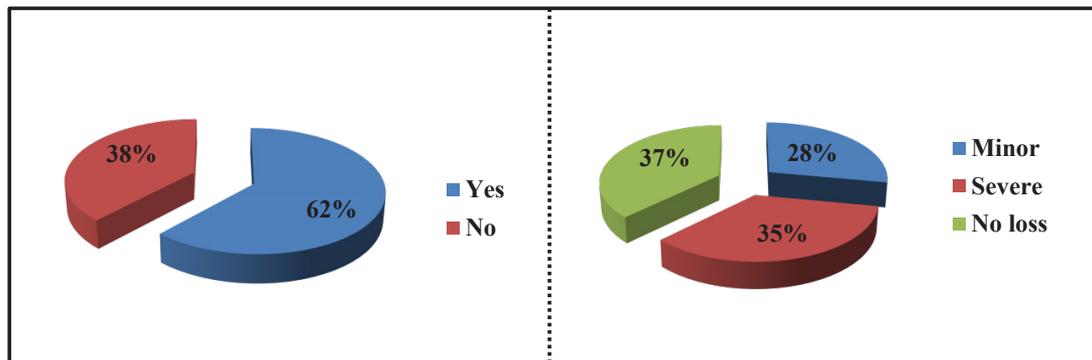


Figure 31: Respondent views on livestock depredation and severity

Based on the survey, it is ascertained that there are livestock depredation by different predators. As shown in Figure 32 of the past three years (2017-2019), the predation by Dhole seems to be taking place in almost all the gewogs, followed by Leopard. Snow leopard alone has killed 159 yaks (89%) and 3 horse (2%) under Bjee, Katsho and Eusu gewogs, while Dhole has killed 11 yaks, 40 cattle and 1 horse. The most vulnerable age class was between 1 to 4 years old yak killed by Snow leopard and a similar study by Wangchuk, 2018 in buffer areas of JKSNR revealed the same findings. The depredation pattern was comparable to the study done in Nepal where most of the yak kills were in yearling stage, killed during the daytime when livestock are released in the wilderness to graze without supervision (Jackson *et al.*, 1996; Wangchuk, 2018). Leopard has killed 3 yaks, 2 cattle and 1 horse, and a report of 4 cattle killed by Bear. There is also a report of Tiger kill in the year 2019-2020, 1 horse and 3 cattle under Sangbaykha gewog. Interestingly, there is a report of two yak calf killed by Stray dog and Small cats; and Yellow-throated marten and Eagles predating upon poultry are also reported.

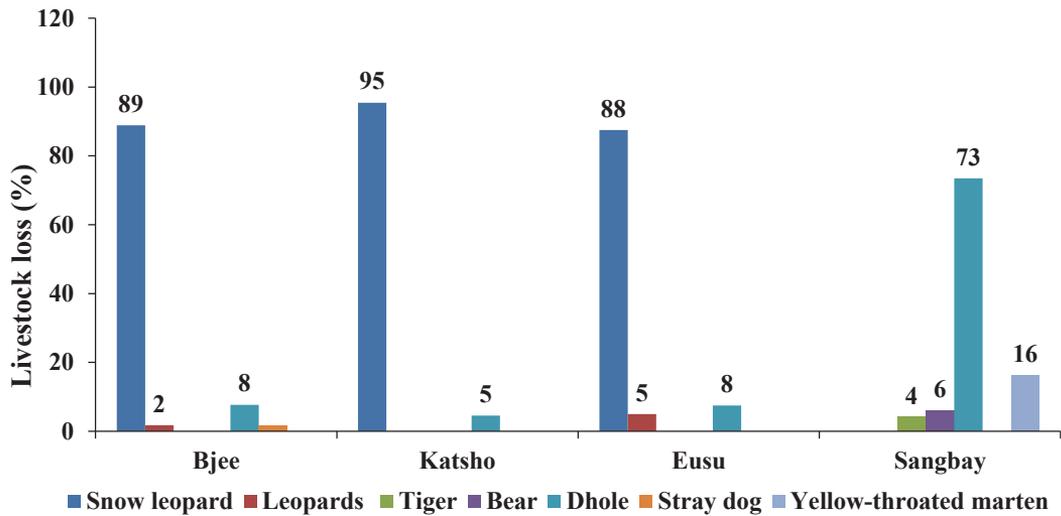


Figure 32: Livestock depredation by wild predators

The predation has happened exclusively due to negligent herding, inadequate guarding practices, open grazing in the forest areas, lax herding practices and let-loose in forest. However, past studies in Bhutan (Wang & Macdonald, 2006; Sangay & Vernes, 2008; Thinley *et al.*, 2011) also reported that livestock predation is mainly caused by lax herding in deep forests. A study by Wangchuk, 2018 in buffer areas of JKSNR revealed that most depredation case was recorded in the forest without supervision, lax herding practice which also overlaps with the habitat of the predators such as Wild dog, Tiger, Snow leopard, Leopard and Asiatic black bear which indicates negligence of the livestock owner.

HWC can be minimized through good management practices and approaches involving low-cost technologies. Most of the studies recommended intensifying livestock, including pasture development, financial compensation, incentives as a short-term and immediate relief to the losses. As a long-term measure, an insurance scheme, the possibility of relaxing the resources use restrictions, improvement in herding and guarding practices; and building proper corralling facilities (Wang & Macdonald, 2006; NCD, 2008; Sangay & Vernes, 2008; Thinley *et al.*, 2011; Wangchuk, 2008).

At the same time other traditional and/or innovative modern strategies, measures and solutions should be explored and tried on pilot basis and then up scaled if the interventions prove to be successful in the pilot sites.

2.4.7.2 Crop depredation

Securing enough food to sustain their families round the year is the primary goal of a large majority of farmers in Bhutan. Crop damage is the most prevalent form of human-wildlife conflict across the country. The occurrence of crop-raiding was also reported by most of the respondents from the four gewogs during survey, wherein almost 85% of the respondents have reported loss of agriculture crop as a reality, with 64% as severe and 22% of the respondents considering it as minor while 14% revealed as no loss to severity of loss (Figure 33).

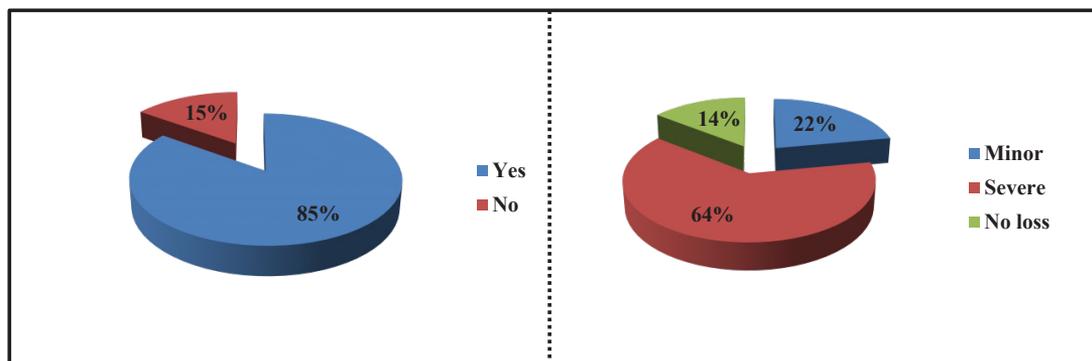


Figure 33: Respondent views on crop damage and severity

The crop loss is more rampant at the periphery and near the forests. Wild pig remains the number one crop predator as reported with 52%, followed by Asiatic black bear 23%, Monkey 10%, Barking deer 7%, Sambar 4% and least with Porcupine, Rodents and Birds (Figure 34) mostly concentrated in lower gewog of Sangbaykha. Respondents perceived that HWC was caused due to habitat destruction and habitat quality deterioration since people collect forest resources such as timber and NWFPs from the habitat. They also highlighted that wild animal raid agriculture crops as the easy food source and being habituated fast.

As preventive and protective measures, manual guarding, scarecrows and local fencing have been tried and used, but found to be ineffective.

Overall, Wild pig and Bear are the two biggest threats to food security in all the four gewogs.

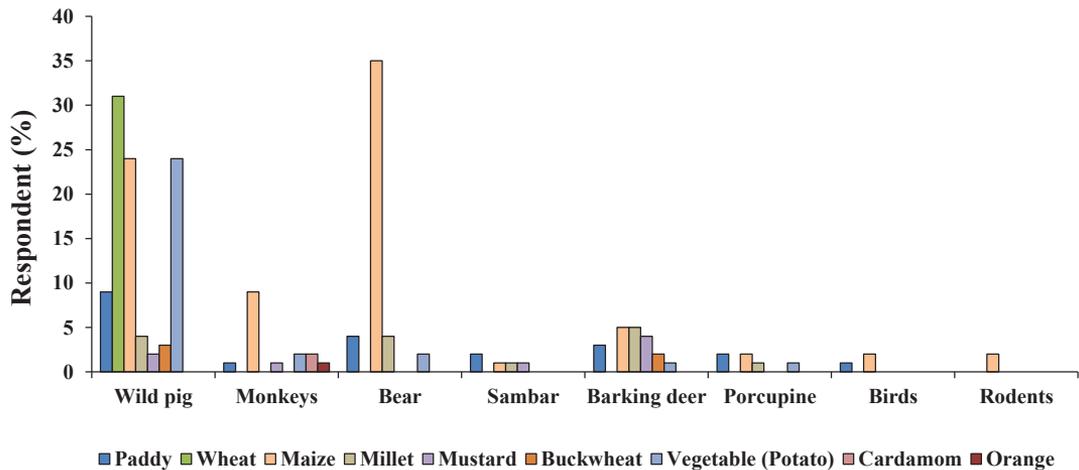


Figure 34: Wild animals responsible for crop damage

As illustrated in above Figure 34, maize, wheat, millet, buckwheat, potatoes are the crops most vulnerable to wildlife attacks. The preference of different crops by different animals are also observed with Wild pig depredated almost all the crops with high preference to wheat, maize, potatoes, and paddy. Overall, maize is preferred by every wild animal and depredated in abundance. The grievances are shown by the local communities on crop damage by wild animals considering it as complex, as the damages are being done at different cropping stages.

A number of innovative strategies, such as electric/solar fencing, natural resource use compensation systems, community-based natural resources management schemes, incentives and insurance programs also seems to be sustainable and should be up scaled in the conflict areas (Wang & Macdonald, 2006; Wangchuk, 2018).

2.5 Nature Resource Area

Globally, forest resources and products are fundamental for the livelihoods of a large part of the world’s population (FAO, 1999). The communities of Bjee, Katsho, Eusu, and Sangbaykha gewogs are mostly dependent on forest for grazing, NWFPs like medicinal plants, mushrooms, fuel wood, fodder etc. for self-consumption purposes. While most of the forest resources are collected by the resident local communities outside of the JKSNR boundary, the yak-herders

residing in the northern part of the nature reserve are mostly dependent for grazing, collection of firewood and medicinal plants.

2.5.1 Grazing (Traditional User)

There is no forest resource allocation within the nature reserve, but the yak-herders which constitute 2% of the resident population (53 households with 217 resident populations) have traditional customary grazing rights over the alpine rangeland areas. They are considered to be the primary users of the nature reserve mainly managed through settled transhumance system. Few of the family members of the yak-herders look after their yak herds and migrate from pasture to pasture while the remaining family members stay back in villages, supporting their children in attending school and engaging in other income generating activities including farming. More emphasis on their children’s education has resulted in labor shortage which also played a major role for the yak-herders to give up their nomadic lifestyle. In the past five years, yak herds have decreased by 15% (18hhs), however, interestingly there is an increase of yak population by 14% as shown in Table 13. The reasons for the decline in yak-herders includes development activities, insufficient labor since yak-herding is labor intensive, and the younger educated generations are not interested to take up yak-herding and harsh climatic conditions. Similar findings by Wangchuk, 2017 indicate that that yak-based pastoralism is declining in Bhutan as younger generations pursue alternate lifestyles and livelihoods, and his survey shows that over the past decade, there has been a 31% decrease in the number of yak-herding households in Bhutan. In JKSNR, similar trend was also observed as there is 15% decrease in yak-herding households.

Table 13: Trends in yak rearing

Gewog	Present (53 hhs)	5 years back (71 hhs)	Difference	%
Bjee	2387	1168	1219	2.14
Katsho	903	1092	-189	-9.47
Eusu	382	495	-113	-12.88
Total	3672	2755	917	14.26

The yak-herders follow seasonal migration from higher elevations to lower elevations and vice-versa depending on the weather conditions to utilize the grazing land and also to avoid harsh winter conditions in the higher altitudes. Management of grazing land varies from area to area. As per the survey report, two herders from Bjee and one herder from Katsho gewogs have permanent rotational grazing land. However, six herders of Eusu, eleven herders of Katsho and thirty-three herders from Bjee gewogs utilize their grazing land on a rotational basis every five years. There has been a lot of conflicts among the yak-herders for the winter and summer grazing grounds for yaks. Conflict has been severe in the summer grazing ground especially, where Bhutanese herders share grazing land (Shakhtey-4hh, Jamana-3hh, Sinchuloom-2hhs) with Tibetan herders. However, there is no conflict in grazing with *Thanor* as reported in 1st management plan since there is drastic decline of *Thanor* population (n=887) comparing to past data (n=4700). The decrease is due to the government policy of reduction of unproductive cattle and supply of improved breeds of cattle like Jersey and Brown swiss called *Yuelnor* (cattle kept in and around the house). The shift between the different grazing grounds has also been reduced to two shifts in a year. In summer, the Eusu gewog use grazing ground of Tshonapata, Tsang, Tshabjola and shift their grazing ground in winter towards Tergola, Chelela and Dawakhatop. For Katsho gewog, summer grazing grounds are Kampula, Chuzomtse, Regona, Jadatoen, Lolithang, Jichela, Shamey, Sinchuloom and in winter they shift towards Chungayna, Charithang, Baina, Ningula and Kalela. The Bjee gewog herders use Chaladopu, Tshonathangka, Shaktoey, Gebla as summer grazing areas and Jaza, Chelela and Damthang as winter grazing grounds.

In Sangbaykha gewog, the highest population of *Thanor* was reported (n=396). However, majority of the local communities are now resorting to raise the cattle near the village rather than in far flung pastures. *Thanor*- includes traditional breeds of cattle such as: *Jatsha*, *Jatshsm*, *Thrabam*, *Yangkum*. Far away pastures are now being used for keeping only the non-milking cattle and ox. Batasey grazing ground above Yaba is used by sheep herding communities from Tendruk and Namgaycholing gewog under Samtse dzongkhag during summer.

In terms of grazing resources for livestock by the herders, survey data revealed that open forest/free ranging {65.08% (n=82)} is widely practiced, followed by tethering/stall feeding

{15.08% (n=19)}, improved pasture in fallow land {11.90% (n=15)}, and least was abandoned agriculture field {3.17% (n=04)} for those cattle kept in and around the house (Figure 35).

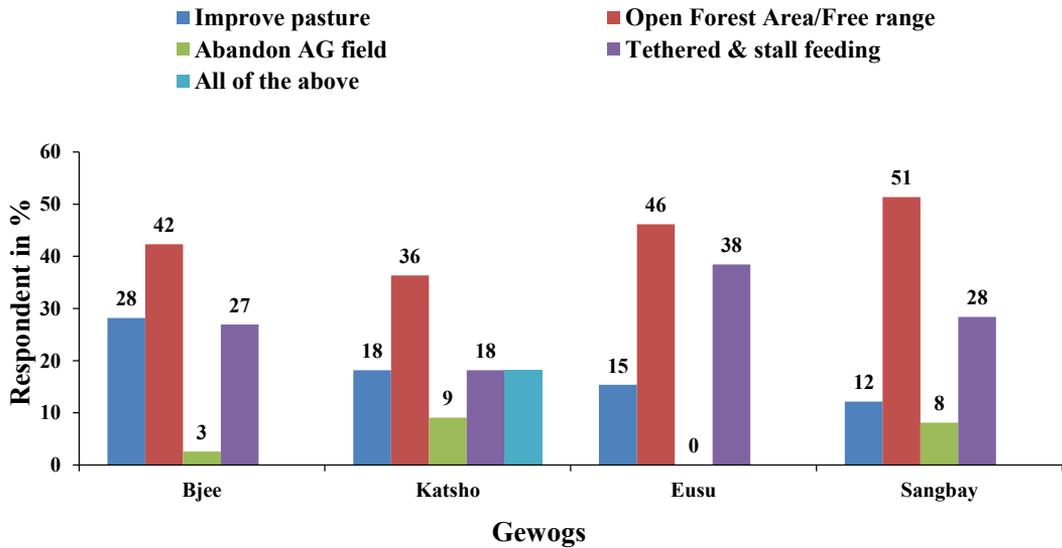


Figure 35: Livestock grazing areas/pattern in four gewogs

2.5.2 Firewood

Yak-herders living in alpine areas of the nature reserve use firewood for cooking and heating purposes, and they collect and use alpine shrubs like Rhododendron and Juniper species. The average use of firewood by herders in a month was 11 back-load (mean \pm SD = 11 \pm 2.18), and within 6 months of their stay at the alpine areas, the average use of firewood was 66 back-load (mean \pm SD = 66 \pm 13.06). The invasion of alpine meadows by these shrubs will significantly reduce forage production, posing a serious threat to the yak-herders' livelihood and Blue sheep for grazing. The nature reserve management will have to encourage the herders to cut and use these scrub species as firewood for management of alpine grasslands. A study by Wangchuk *et al.*, (2013) highlights that prescribed burning at specific intervals is an effective tool to restore shrub-infested high-altitude grasslands.

2.5.3 NWFPs collection

Non-Wood Forest Products (NWFPs) are considered to be an important resource for sustaining rural livelihood, reducing rural poverty, biodiversity conservation and facilitating rural economic

growth as it plays a vital role in livelihood of people in and around the forests (Tejaswi & Basavarajappa, 2008).

JKSNR harbours high medicinal value plants both in lower elevation and alpine areas. However, these plants are not allowed to be collected for commercial purpose other than self-consumptions by the herders. Mushrooms such as Rangpai kam (*Ganoderma lucidum*), Sangay shamu (*Tricholoma matsutake*), Black brain fungus (*Exidia glandulosa*) and Sisi shamu (*Cantharellus cf. cibarius*) found in the nature reserve area are collected by the communities of Bjee, Katsho and Eusu gewogs. Individual herders collect around 5-10 kgs of *Sangay shamu* for period of 1 month (July) which are sold at Haa market at Nu. 800-1500 per kg. *Sangay shamu* fetches more money than *Sisi shamu*. Cordyceps (*Ophiocordyceps sinensis*) also grows in few and scattered areas of Lana, Shatey and Jasoten. The herders from Bjee gewog also collect Cordyceps from this growing area. They collect around 100-600 pieces per year which fetches Nu. 100-200 per piece. Incense/medicinal plants like *Rhododendron* spp., *Nardostachys jatamansi*, *Panax pseudoginseng*, *Neopicrorhiza kurroa*, *Juniperus* spp., etc are collected for self-consumption or local use only. However, illegal collection and trading of above species were also recorded in the past years. The nature reserve management should implement effective and sustainable solutions to deal with illegal collection of the resources like formation of NWFPs group, awareness and advocacy, training on scientific methods of collection, resource assessment and research.

People from Sangbaykha gewog collect Cane, Bamboo, Mushroom, Fern, Dambro (*Elastostema* sp.), Piper, Chirata (*Swertia* sp.), both for self-consumption and commercial purposes. The management should come up with resource assessment, group formation, product diversification, value addition and marketing for the improvement of livelihood of these communities in the fringes of the nature reserve.

2.5.4 Community perception on Biodiversity/natural resources trends

The response on the outlook of the biodiversity status in the past shows 11% of the respondents were not able to say anything on the topic, while 52% reported that biodiversity status was good in the past, 31% rated excellent and 6% rated bad (Figure 36). Responders highlighted that in the past, biodiversity was at the risk from forest fire, poaching and while current threats includes irrational and over exploitation of resources for commercial purposes and lack of awareness on forestry rules and regulations.

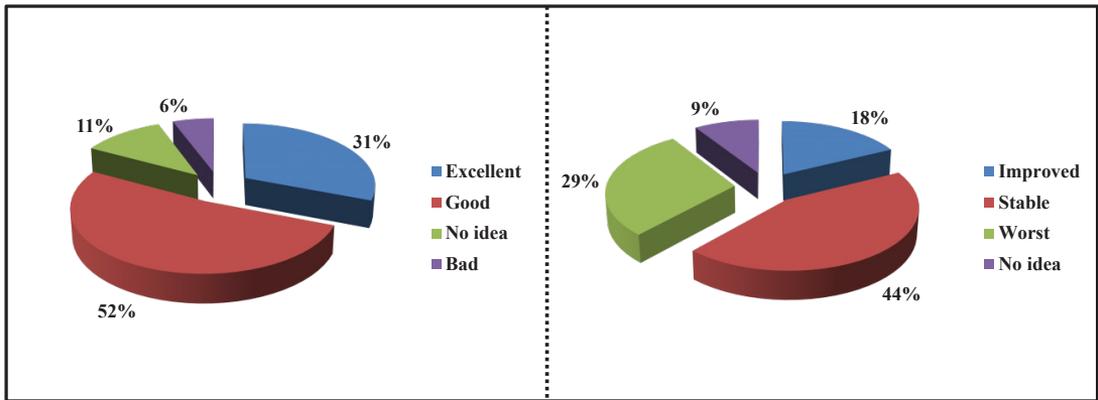


Figure 36: Respondents views on past & present biodiversity status

The report on current status of biodiversity shows that 44% reported it has remained the same as before, 18% reported that it has improved and 9% failed to give views or they were not aware of the status. Interestingly, 29% reported it has gone worst and the reason mentioned were due to increase in population, rapid developmental activities, establishment of more sawmill and wood-based industry and illegal trade.

2.6 Administration, service delivery and reserve infrastructure

Majority of the nature reserve area falls under Haa dzongkhag (93.67%). The nature reserve head office has been set up at Chonaphu under Bjee gewog in Haa dzongkhag in the year July 2020. Headed by the Chief Forestry Officer (CFO), the management of JKSNR is administered through four functional sections and two Range offices viz. Sangbaykha Range in the south and Bjee Range in the north. In addition, the nature reserve has four guard/outposts/research stations at Chaladophu, Tshona, Lolithang and Yaba to extend the coverage for the conservation programs and activities, increase efficiency in public service delivery and to minimize the incidences of wildlife poaching and illegal trade under the management jurisdiction of the nature reserve (Figure 36). At present JKSNR is manned with 27 technical staff, 2 administrative and finance staff, 1 driver and 3 Elementary Service Personal (ESP) staff.

JKSNR is now fully established with basic infrastructures like a full-fledged nature reserve head office at Chonaphu and two range offices at Sangbayama and Chonaphu for efficient and effective service delivery. The head office and Sangbaykha range office was constructed with funding support from BTF-EC and BFL project. The nature reserve has one 4WD Toyota hilux

and two motorbikes which were procured with funding support from BFL Project which ensures timely and efficient public service delivery. However, the existing single pool vehicle and bikes are not enough to perform the mandates and duties of the nature reserve efficiently and smoothly at the optimum desired level. Therefore, there is a need for an additional pool vehicle for the range offices. The management also feels that three guard/outpost/research stations in the northern part of nature reserve is found to be indispensable for effective research, monitoring and patrolling programs.

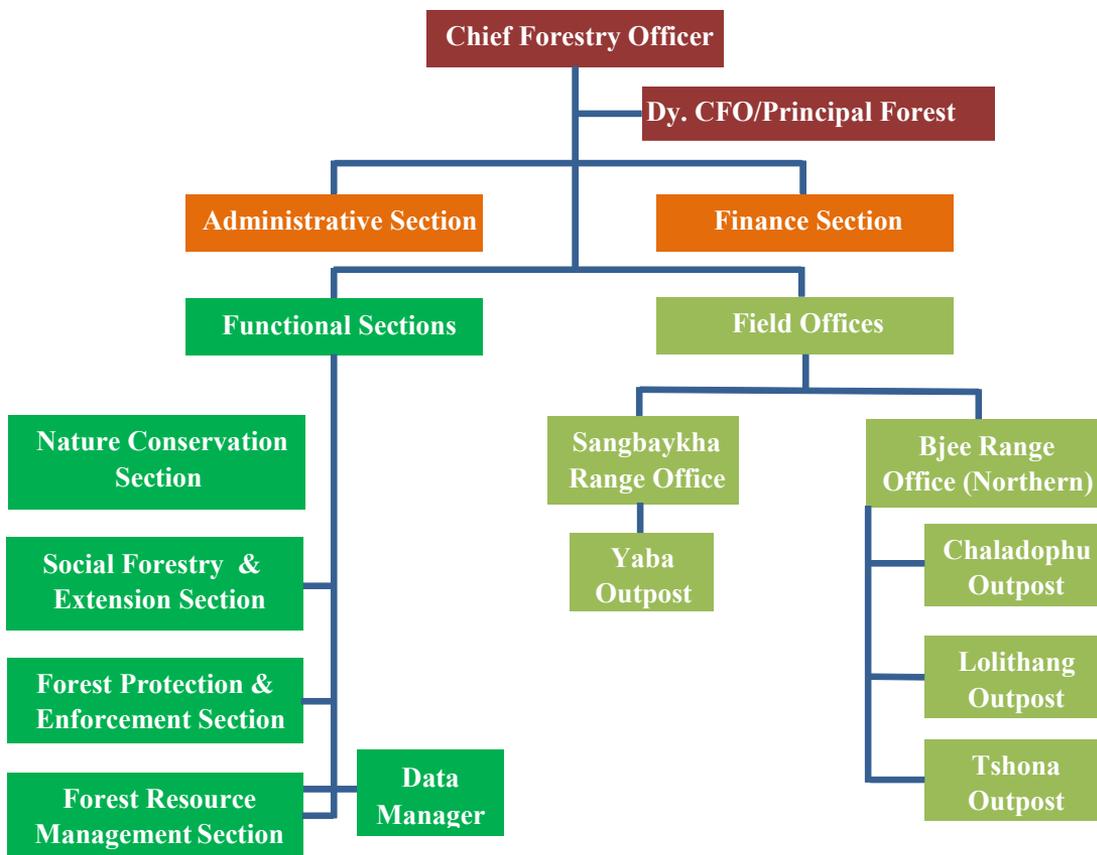


Figure 37: Organogram of Jigme Khesar Strict Nature Reserve

In addition, Jigme Khesar Strict Nature Reserve management upon the directives of the Department of Forests & Park Services has been tasked with additional management responsibilities pertaining to forestry activities under Gakiling and Sangbaykha gewogs from Haa Range jurisdiction considering the acute shortages of field staff with the Haa range under Paro Forest Division in October 2018 to be managed as Areas outside Protected Areas Management Regime. Approximately, more than 50% of the area previously under Haa range i.e., 600.11 sq.km is being currently managed by JKSNR as management of areas outside PAs similar to the Territorial Divisions.

In summary, approximately 70% of Haa dzongkhag's total area is currently managed by JKSNR including part of Sangbaykha and entire Gakiling gewog as an additional mandate. The management has permanently placed 14 staff, 07 staff each under Sangbaykha and Gakiling Range so as to cater to the public services pertaining to Nature Conservation, Social Forestry, Forest Resources Management and Forest Protection and Enforcement programs.

Further, basic local government institutional settings at the gewog level such as the gewog administration offices, hospitals, BHUs, RNR centers, and schools are centrally located in the context of JKSNRs headquarters and field range offices in terms of their location, which will eventually enhance the service delivery of the management to the resident local communities/farmers.

CHAPTER 3:

Summary review of the past plan

The first conservation management plan of Jigme Khesar Strict Nature Reserve, then the Toorsa Strict Nature Reserve was prepared for a 5-year period from 2012-2017 with a vision of maintaining ecological integrity and species of the pristine temperate and alpine ecosystems. The plan was steered by six guiding principles as follow:

- Adaptive learning & management
- Participation and partnership
- Balancing Conservation with community development needs
- Recognizing and reconciling conflicting interests
- Dynamism
- Ensuring continuity

In keeping with the assessment using the Bhutan Management Effectiveness Tracking Tool Plus (METT Plus), the management achieved 62.60% in the direction of managing the nature reserve habitats effectively contributing to the commitment and implementation of the activities in the conservation management plan. On the contrary, some of the activities as alluded in the management plan could not be achieved mainly due to lack of funds and technical know-how.

3.1 Assessment of previous plan

The 1st conservation management plan was prepared based on three objectives (Short, Mid and Long term) unambiguously to ensure conservation of the pristine and alpine ecosystems (Biodiversity and Socio-economic). The management plan interventions was primarily emphasized on.

- ✓ Landscape & Species Research & Monitoring
- ✓ Zone management
- ✓ Human wildlife management
- ✓ Institutional strengthening (Infrastructure development & Human Resource development) and service delivery.

1. Landscape & Species Research & Monitoring

Sl#	Activities	Achieved	Not achieved	Remarks
1.	Comprehensive surveys of Biodiversity (RBS).	✓		Inclusive and wide range of Rapid Biodiversity surveys was carried out on floral, faunal, avifaunal and mushrooms within JKSNR and its buffer areas. The preliminary baseline surveys are also carried out on fish species. The survey results were also systematically analyzed and documented with the publications of 2 volumes of technical reports and through the revision of the conservation management plan (2021-2031).
2.	Enable proper zonation of the nature reserve to understand pristine temperate and alpine landscapes, ecosystems, habitats, species and associated threats to conservation and priority for management.	✓		Zonation plan for the nature reserve is prepared dividing the nature reserve into three management zones of Core, Transition and Buffer. The zonation plan is endorsed by all the stakeholders of JKSNR.
3.	Robust research programs pertaining to Issues related to grazing.		✓	Though the survey and report writing on the alpine meadow assessment is done. However, it still requires more depth and comprehensive study to ascertain the crux of issues related to grazing (under grazing Vs. over grazing). This activity will be carried over in this new conservation management plan as a priority activity.

4.	Ecology of key species such as White poppy and other endemic floral species.	✓		Mapping and delineation completed for the habitats of White poppy.
5.	Distribution, population estimates and habitat status 1. Snow leopard 2. Red panda 3. Wild dog/Dhole 4. Wholly hare 5. Rufous-necked hornbill 6. Tibetan wolf 7. Musk deer 8. Blue sheep	✓ ✓ ✓ ✓	✓ ✓ ✓	The population estimates, ecology and associated threats of the key species generated, documented, identified for better management. However, the management could not conduct any study on Wild dog, Rufous necked hornbill and Tibetan wolf due to lack of funds and time constraint; and it will be done in detail within the revised management plan.
6.	Interaction of Blue sheep and livestock in the pristine alpine ecosystems and monitor usage of habitat by wild ungulates in the absence of yaks and their symbiosis.		✓	The study on the mentioned thematic area could not be carried out due to budget constraint and lack of expertise. It will be carried forward as an important activity in the current management plan.
7.	Potential/feasibility for community-based ecotourism in the buffer and multiple use zone of JKSNR.		✓	The feasibility report on the development of infrastructures along Haa to Nub-Tshonapata trekking route is complete; and the management has also initiated construction of several structures.

2. Zone management

Sl#	Activities	Achieved	Not achieved	Remarks
1.	Enable proper zonation of the nature reserve.	✓		Zonation plan for the nature reserve is completed, adopted and endorsed by all stakeholders for implementation.

3. Human Wildlife Management

Sl#	Activities	Achieved	Not achieved	Remarks
1	Initiate crop and livestock loss mitigation strategies in pilot villages.	✓		The management has supported in supplying electric fencing materials to the highly affected villages of Shari and Dorikha under Samar gewog, Kibree village under Eusu gewog, Bali and Mobmechoko villages of Katsho gewog; and Sangbayama and Nakha villages of Sangbay gewog. A total of 25 kms of electric fencing was installed in helping farmers from losing crops and livestock to wild animals.
2	Initiate and pilot strategies to mitigate livestock depredation.	✓		A pilot activity was initiated in 3 Snow leopard conflict sites by providing materials and training for building an electric fence corral to guard juvenile yaks

				from depredation very recently. The budgetary constraints were the key problem which has deterred in the implementation of the activity earlier.
3	Source funding to provide seed money for such insurance schemes through the HWC endowment fund.		✓	No funding could be sourced to initiate the program till date.
4	Establish a “Wildlife Rescue and Rehabilitation Unit” within the Nature Reserve’s head office. Fund for training, manpower and procuring essential wildlife drugs.		✓	The unit is currently being established with funding support from the EU-RDCRRP and will be completed within the year 2021. However, funding for training, manpower and procuring essential wildlife drugs will be sourced from the BFL in the current plan.
5	Improve herding practices to reduce livestock depredation.	✓		Awareness, advocacy and education programs initiated in all the gewogs. Regular consultation and collaboration with the livestock officials at the local level.

4. Institutional Strengthening (infrastructure development & Human Resource Development) and Service delivery

SI#	Activities	Achieved	Not achieved	Remarks
1.	Construct nature reserve headquarters at Bjee gewog and Reserve field Range offices.	✓		
2.	Construct a field research station in Lolithang/Nub-Tshonapata area.		✓	
3.	Equip JKSNR staff with all necessary office equipment (computers, fax, telephone, photocopier, internet) surveillance equipment (binoculars), survey equipment (GPS, compass, altimeter, maps etc), extension kits (tents, sleeping bags, ruck sacks, radio communication equipment (wireless radio sets, repeaters and walkie-talkie) and transportation (four-wheel, motor bikes etc), audio-visual equipment (LCD projector, digital camera) for research, education and awareness building.	✓		
4.	Propose a comprehensive HRD plan depending on the expertise required for JKSNR to carry-out the research work needed to meet the main objectives of JKSNR.	✓		
5.	Undertake proactive consultative donor engagements to ensure planned HRD programs.	✓		

3.2 Lessons learnt

Results/Achievements (Based on Bhutan Management Effectiveness Tracking Tool Plus, Bhutan METT Plus).

Evaluation of Nature Reserve's Management Plan Activities/Indicators				
Sl#	Success Indicators/Criteria	Score	Comments	Remarks
1	JKSNR management authority in place with all the required infrastructure and equipment.	3	Office well equipped in terms of equipment, well-built infrastructure for the Nature Reserve head-office and two field Range offices.	BTFEC/BFL/ EU-RDCRRP funding support for office construction.
2	The population estimates, ecology and associated threats of the following key species generated, documented, identified and better understood.	2	Snow leopard, Red panda and White poppy	Inadequate fund to carry out for all the species. However, remaining of the species will be taken care within the current conservation management plan.
	i		Snow leopard	✓
	ii		Red panda	✓
	iii		Rufous-necked hornbill	x
	iv		Common leopard	x
	v		Wild dog	x
	vi		White poppy	✓
3	Monitoring protocols developed and implemented for five key species.	2	Snow leopard, Red panda and White poppy.	Constant patrolling and research being carried out with publication of technical reports.
	i		Snow leopard	✓
	ii		Red panda	✓
	iii		Rufous-necked hornbill	x
	iv		White poppy	✓
	v		Pheasant	x
4	Research undertaken and completed on the impact of climate change on invasive species inside JKSNR.	0	No baseline data collected.	Inadequate funding to carry out for all species. However, it will be ventured in the current CMP.
5	Research undertaken and completed on the impact of climate change on the pristine temperate eco-system.	0	No baseline data collected.	Inadequate funding to carry out for all the species.

6	Research undertaken and completed on the impact of climate change on the pristine alpine ecosystem.	3	Alpine medicinal plants & rangeland survey done.	Further detailed study is needed in the current plan period.
7	Research undertaken and completed on the interaction of Snow leopard and Blue sheep and their habitat associations.	2	Survey done for the Snow leopard and its prey species.	Further detailed study is needed in the current plan period.
8	Research undertaken and completed on the interaction of Blue sheep and Yaks.	0	Inadequate fund to carry out the research.	Need to carry out this important activity in the current plan period.
9	Mapping and delineation completed of the habitats of White poppy, Viola spp. and other endemic plant species within JKSNR.	2	Survey carried out for White poppy and alpine medicinal plants.	
10	Greater understanding of the threats to the key species and their habitats and investigation of possible mitigation measures.	2	Snow leopard, Red Panda and Musk deer completed.	The study is also proposed for the other key species viz-a-viz HBB and ungulates in the current plan period.
11	Hot-spot poaching areas in JKSNR identified and mapped.	3	Hot-spots mapping completed.	Need to identify and map hot-spot areas on a continued basis.
12	Research conducted is used to aid and assist in the implementation of informed and effective management measures.	3	Evaluated through Bhutan METT+	Report produced
13	Practical zoning for the park completed, adopted and endorsed by all stakeholders.	3	Zonation plan finalised and report produced.	Currently under implementation and will be continued in the current plan period.
14	Fire-wood use minimized through the adoption of alternative energy sources.	0	Inadequate fund to carry out the activity.	To be carried out in the current plan with the adoption of bio-gas and other innovative alternatives.
15	Timely monitoring of activities translated to reports which aids in making informed conservation policy decisions (Technical reports)	3	27 Technical Reports produced till date on the various studies and surveys undertaken by the management.	Need regular monitoring and technical reports produced in the current plan period for all the surveys, studies and research on various topics being undertaken in JKSNR.

The nature reserve management has room for the improvement in terms of planning, inputs, process and outputs/outcome. The current scores of 62.60% of the 1st conservation management plan implementation would be the benchmark score for JKSNR. The previous conservation management plan was prepared for a five-year period (2012-2017). The management plan success indicators have 15 questions making the total score of 45. The final assessment of the plan activities within 5 years (plan period) + 2 years (2018-2019) scores was 28 with overall score percent of **62.22%** which indicates more than 60% of the planned activities were achieved within the 7 years plan period.

Challenges/Issues

1. Lack of Infrastructure and Field communication equipment/gears

The management of JKSNR is mandated to protect floral and faunal diversity in a holistic manner through different management and protection strategies. However, lack of reliable infrastructure such as transit camps and guard/outposts especially in the northern part of the nature reserve has hampered in efficiently implementing protection and conservation activities. Additionally, patrolling and monitoring activities have always remained as the greatest challenge for the management due to rugged terrain with mostly inaccessible areas, poor communication facilities and mobility for surveillance. The remote porous border in the north with security risk was another obstacle for the staff during highland patrolling. Therefore, there is a need to adequately develop infrastructures like transit camps, especially in higher altitude and border areas where there is record of illegal activities. Poor communication facilities can be improved by purchasing best walkie-talkie sets for every individual staff and installation of repeater stations in the highlands. The patrolling routes must be developed properly to effectively carry out patrolling and monitoring activities. At the same time, field staff must be equipped with all the required necessary field gears on regular basis to tackle any sort of field related issues and problems.

2. Illegal Wildlife Trade

The poachers target several species of wild animals such as Musk deer for its pod, Tiger and other big cats for their skin, bones, meat and body parts, Asiatic black bear for its bile; and plants like *Nardostachys jatamansi*, *Picorrhiza kurroa*, *Paris pollyphilla*, *Panax pseudogingseng* and

Ophiocordyceps sinensis which are of great commercial value in the international market for their high medicinal value. Since JKSNR shares porous international borders with India and China, the illegal wildlife poaching and trade remains as one of the main challenges for the management.

3. Human-wildlife Conflict

Yak/cattle depredation and crop damage by wild animals are common and widespread in JKSNR, particularly with Snow leopard in the highlands, Asiatic black bear and Wild pigs in the south and valleys within the nature reserve and its buffer areas.

4. Knowledge and Information Gap on Climate change

Climate change is one of the extreme challenge's humankind is ever facing, and on top of that there is lack of information base on the effects of climate change to the local communities and the natural environment. The change of species compositions such as appearance of invasive plant species, change in phenological seasons, shifting of tree line and erratic rainfall/snow are already being detected and noticed by the local communities. This clearly sends an urgent need to conduct studies on how the climate change affects the livelihoods of the local migratory yak-herding communities in the highlands and resident communities in the lower valleys, document and understand the traditional adaptive measures taken up by the local communities. At the same time, different innovative intervention measures to mitigate and adapt to the adverse impacts of climate change could be explored from the best practices elsewhere and taken up in the near future by the JKSNR management.

5. Ineffective Waste Management (wetlands and water resources, highlands and mountains)

With the upsurge in population, there is proportionately the indiscriminate littering of waste. Despite the repeated sensitization, advocacy and awareness campaigns to all walks of life; huge amount of garbage is found recklessly thrown along the trekking routes and public places in the alpine meadows, pilgrimages sites, roadside and in the water bodies. Highland mountains are littered especially by the trekkers/pilgrims, collectors involved in the medicinal plants and NWFPs etc. Such poor waste management practices would not only threaten public health and the natural environment; but also pollute water sources of the pristine mountain landscape.

6. Lack of Wild Animal Rescue and Handling facilities

The management was confronted with the intimidating task to rescue wild animals notably Ungulates like Sambar and Barking deer that are injured due to attacks by stray dogs and some other accidents. On an average, the nature reserve staff released at least one wild animal per week in the wild after treatment during the peak season from November-March. Besides ungulates, JKSNR has also rescued a couple of Bears and Avi-faunal species. However, lack of a rescue shelter had hampered to provide sufficient shelter and avenue to the rescued animals for which requirement of a proper animal rescue shelter is a must and found to be inevitable.

3.3 Challenges and Carry-over Actions from the Previous Conservation Management Plan

The 1st Conservation Management Plan for JKSNR was prepared for a five-year period (July 2012-June 2017). In the process of implementing the conservation activities, the management encountered challenges due to lack of financial support from the donors resulting in the non-execution of some of the planned activities. The lack of technical know-how by the staff on varied research works (field surveys, data compilation, analysis and reporting etc.) at the beginning of the first two years had also impeded in the implementation and timely completion of the planned activities.

The Bhutan Trust Fund for Environmental Conservation was very instrumental in financially supporting JKSNR for two phases (2014-2015 and 2016-2019) in the initial years of establishment which helped the management towards improving the human resource capacity of the front-line staffs, infrastructure development and mobility enhancement; and conducting several species-based survey/research works. However, several important conservation activities of the previous conservation management plan that needs to be carried over and implemented in the new plan are:

- Study on the impacts of grazing, interaction of Blue sheep and Livestock in the alpine ecosystem, ecosystem services and impacts of Climate change,
- Study on key species of flora and fauna not conducted earlier,
- HWC mitigation program activities,
- Nature-based eco/research tourism programs and
- Implementation the of Zonation plan.

CHAPTER 4:

Threat Analysis

The threat analysis in conservation planning and management forms an integral part of conservation planning and management. Once threats are identified, threat ranking is done to prioritize different strategic interventions as given below:

4.1 Conservation threats

4.1.1 Degradation of Alpine Habitats (Meadows)

4.1.1.1 *Illegal collection of NWFPs*

In addition to grazing and climate change, there are several drivers that contribute to habitat degradation. Alpine habitat is continuously disturbed from rampant and unsustainable collection of high valued medicinal and incense plant like *Nardostachys jatamansi*, *Panax pseudoginseng*, *Neopicrorhiza kurroa*, *Ophiocordyceps sinensis*, *Rhododendron* spp., *Juniperus* spp. The temptation to easy money has led to unsustainable harvesting of resources and such method impedes regeneration of the meadow community, facilitates soil erosion and continues to degrade the ecology of this alpine ecosystem. In 2019, JKSNR staff apprehended illegal collectors of *Nardostachys* from Tsang and Chuthana area and imposed fines as per FNCRR 2017. Alpine habitats serve as pasture for many prey species like Blue sheep, but increasing number of collectors deteriorate the quality of these pastures.

4.1.1.2 *Solid Waste Disposal*

Intruders (collectors and traders) strew large quantities of non-degradable waste (mostly plastic wraps, cloth, plastic bottles and used batteries) in the alpine meadows which accumulate throughout the years. Subsequently, the trekkers, pilgrims, armed forces and even local people also discard garbage along the trails, camp sites and water bodies which serves as water reservoirs. Yearly increase of visitors to Nub-Tshonapata Lake is one of the concerns in terms of waste, sound pollution and the carrying capacity of the area. They are responsible for the poor waste management leaving behind lots of non-degradable waste which pose threat to flora and fauna in the area. These irresponsible practices have to be prevented and visitors need to be sensitized and educated to ensure that they bring back all the solid waste that is taken into the alpine areas, and strict Garbage In-Garbage Out (GIGO) policy should be adopted, backed by

enforcement of rules and regulations along with other innovative measures to ensure strict implementation of the policy.

4.1.1.3 Encroachment of Alpine Meadows

The invasion or colonization of alpine meadows by unpalatable shrubs mainly *Juniperus* and *Rhododendron* spp., significantly reduces forage production, posing a serious threat to the herders' livelihood and Blue sheep for grazing. As the extent of alpine habitats shrink, there will be fewer grazing areas for domestic livestock, potentially increasing competition with wild ungulates. Several sites have to be identified that requires controlled burning of those unpalatable shrubs and to encourage growth of alpine grass. Moreover, under-grazing of alpine meadows because of a decline in yak herds could cause the alpine meadows to be encroached by trees and shrubs, which could result in loss of alpine grazing areas for Blue sheep and associated ungulate species resulting in declining populations of Blue sheep which could further escalate the livestock depredation by Snow leopards. The immediate absence of large grazers like yaks can change the alpine grassland ecosystem as well. A conventional seasonal rotation or transhumance system has been considered an effective way of avoiding the rangeland degradation. However, there are limited scientific studies to provide evidence of such impacts. Therefore, research is found necessary to determine the ecological dynamics of grazing by livestock, wild ungulates, grassland communities and regeneration capacities of the alpine meadows.

4.1.1.4 Livestock Grazing

Yaks form an integral part of the pastoral system and yak-husbandry is therefore a major part of the livelihoods and economy of pastoral groups in JKSNR. Recent social surveys showed that, there is a 15% decrease in yak-herding households under Bjee, Eusu and Katsho gewogs. Despite the decrease in number of yak-herding communities, there is interestingly a 14% increase in yak populations (N=3762) comparing to past data (N=2755). An increasing trend in livestock populations could degrade the ecologically sensitive and fragile alpine meadows resulting in degradation of the ecosystem. Free range grazing of livestock in alpine meadows is another indirect threat to the alpine ecosystem, whereby livestock poses direct competition to important prey ungulates in the wild. A conventional seasonal rotation or transhumance system has been considered an effective way of avoiding the rangeland degradation. In some abandoned herds, it

was colonized by *Rumex nepalensis*, *Anisodus luridus*, *Aconitum ferox*, *Artemisia thellungiana*. Moreover, unmanaged grazing practices could change the species richness in the alpine grassland ecosystem (Wangchuk, 2010). However, Wangda 2016, suggest that intermediate grazing is essential for grassland ecosystem management and is a management tool too. These opposing views require urgent attention and need to be studied on a case-by-case basis in the area because both over-grazing and under-grazing of alpine meadows can result in degradation of this ecosystem that is essential habitat for Snow leopard conservation in JKSNR.

4.1.2 Poaching and Illegal Trade

One major concern for the nature reserve management is the far-flung ness and remoteness of the area which increases the probability of poaching activities. Poaching of wildlife species inside the nature reserve is evident from the traps, snares and poacher caves encountered during survey and patrolling. In the year 2018, almost 100 traps were dismantled by the patrolling team during anti-poaching patrolling. The management has encountered and handled frequent cases of illegal wildlife trade of Red sanders (1 case) and wildlife parts (2 cases). The nature reserve harbors a good number of species highly valued for their parts or products. A porous international border and proximity to/or falling in the regional wildlife trafficking routes; and a lucrative market for wildlife parts and products in the region coupled by remoteness makes JKSNR highly vulnerable to poaching and illegal wildlife trafficking. Since JKSNR shares an international boundary with both the Tibetan Autonomous Region of China and Sikkim in India, the trans-boundary populations of both predators and prey are vulnerable to poaching. The close proximity to the international border in the north allows poachers to transport wildlife parts with relatively little probability of being detected. Although, there was no evidence of bird poaching, the large number of Musk deer traps collected from the area clearly indicates that birds especially the bigger sized pheasants like Himalayan monal, Tibetan snowcock, Blood pheasant and Snow partridge could be under threat due to these unintended traps. Absence of sufficient field camps/infrastructures has also led to increased cases of illegal resource collection by both the residents and people outside the nature reserve. Therefore, better information and intelligence must be gathered by forming a network consisting of local communities, herders and border security forces. This information and intelligence, together with the adoption of latest technology in the nearest future will help to build a better database with a predictive capability to address poaching.

4.1.3 Retaliatory Killing

Yaks are mostly kept inside the nature reserve area whereby depredation of yaks, especially the juveniles and calves are occasionally reported (Snow leopard alone has killed 159 yaks (89%) and 3 horses (2%) under Bjee, Katsho and Eusu gewogs; while Dhole has killed 11 yaks, 40 cattle and 1 horse). There is also a report on Tiger, Leopard and Bear kill in lower part of the nature reserve. However, considerable tolerance of the yak-herders is evident wherein there are no official reports of retaliatory killing cases in JKSNR, although few incidences of retaliatory killing cannot be completely ruled out.

Nevertheless, the management should not be complacent as retaliatory killing can happen at any time once the tolerance level of the yak-herders crosses the optimum threshold, and if those affected herders are not compensated on the loss of their yak to the Snow leopard through an innovative compensation mechanism at the earliest possible. At the same time, alternative income generating sources need to be explored for the yak-herders through community-based nature and/or research tourism programs; and other viable solutions should be made available to avoid retaliatory killing like construction of “predator proof corrals” to prevent or at-least minimize yak depredation by Snow leopards. The threat of retaliatory killing is perceived; however, it cannot be undermined; therefore, necessary preventive and precautionary measures, and possible incentives should be explored and implemented at the earliest possible by the management.

4.1.4 Transmission of Diseases

Seasonal migration of yaks from lower to higher elevation may lead to transmission of diseases like Foot and Mouth Disease (FMD) from domestic to wild ungulates particularly Blue sheep, Musk deer, Bhutan Takin and Sambar. If ever, there are cases of disease spread or occurrences, there is probability of complete wipe out of the existing prey species population. Livestock officials has also warned on the possibility of spread of the disease known as ‘Black Quarter’ which is caused by a bacterium (*Clostridium chauvoei*) from yaks and horses to wild ungulates. Another agent of transmission of diseases like canine distemper and rabies to wildlife would be from the feral dogs. Of late, the management encountered cases of viral infection outbreak specifically in *Capripox*, which was evidenced through the mass dying of Goral, Serow and Wild pigs. This issue has come up as a new threat and concern for Jigme Khesar Strict Nature

Reserve. As a mitigation measure, the samples were collected and carcasses were buried and the surrounding areas were disinfected. The management will need to create advocacy programs to the communities on such deaths and effective means of communication for information flow for effective management of such outbreaks in future. A quick response team (QRT) comprising team members from JKSNR, NCD, Livestock, Local Governments and Community volunteer rangers will need to be formed in responding to such cases in the future.

4.1.5 Stray/Feral dogs

There are increasing numbers of stray/feral dogs in the forests and alpine areas (personal observation at Lolithang, Tshabjola on dated September, 2019) which compete with other predators for the prey species. A pack of feral dogs can even take down an adult Blue sheep (observation at Tshabjola on dated November, 2020) and even Snow leopard cubs which will ultimately lead to a decrease in the population of these species. These dogs have already started to attack yaks as reported above (two yak calves killed by a stray dog in the year October, 2019), and there is even a high possibility of disease transmission (canine distemper, gid and rabies) to Dhole, Red fox and other wildlife. Most of the dogs are brought from the lowlands by yak-herders, traders, trekkers, pilgrims, armed force personnel and local intruders. During the socio-economic survey, a respondent shared that the problem of feral dogs was not only with wildlife, but also with killing of yak calf and threat to human life too. The inter-specific competition may lead to a significant reduction in the occurrence or even local extinction of the species.

4.1.6 Climate change

Broad trends in global climatic patterns including a rise in mean temperatures and changes in the level of precipitation are clear. The mountains of Asia are likely to be subject to more extreme and more variable weather as a result of a changing climate according to the assessment by the Intergovernmental Panel on Climate Change (IPCC, 2007). Mountain ecosystems and their biodiversity are especially vulnerable to climate change impacts. Climate projection indicates that the tree line in Bhutan will shift northward and upwards along the mountains, intruding into alpine scrubs and meadows (Lhendup *et al.*, 2012). Similar observations were also made by our field staff that few trees (Fir) are growing in the alpine habitat above 4000m. So, there are chances that the entire vegetation type may change and the highland vegetation may be forced to extinction. The social survey report on the subject revealed that 72% of the respondents reported

that it is changing yearly and changes are experienced in the form of unusual storm, erratic rainfall and snowfall. Yearly, there is decrease in thickness of snowfall in the mountains as reported by yak-herding communities of Bjee, Katsho and Eusu gewogs.

In JKSNR mountains, some alpine grasslands are seen to be replaced with few perennial trees, though the effect is not that prominent in the current scenario. The invasive species will slowly colonize the alpine plant communities as we can see few invasive species like *Rumex nepalensis*, *Anisodus luridus* are overtaking abandoned herds, contributing to an overall change and degradation of the ecosystem community structure and function. Overall, the climate change impact will cascade on the biodiversity and human communities in the alpine mountains which will lead to local species extinction. However, there is lack of scientific information on the effect of climate change to the natural environment and the local communities. The people's perception on climate variables stated that there is change in weather patterns like erratic rainfall, snowfall, pest and diseases. Therefore, it is necessary to build resilience against these changes through proactive measures and appropriate adaptation strategies, and conservation actions to safeguard the vulnerable mountain yak-herding communities of the nature reserve.

4.1.7 Uncontrolled fires

Unlike in the past, cases of incendiary forest fires in the nature reserve's highlands have reduced drastically due to the efforts put in by the management on educating the resident yak-herders and trekkers/pilgrims on the environmental aspects including forest fires. The timely monitoring by field staff has also contributed in bringing down the cases of forest fires. However, for alpine habitat management, prescribed or controlled burning is recommended as it helps in managing the weeds and encroachment by scrub species, restore nutrients and lead to a more desirable plant growth for ungulates and yaks.

4.2 Management Challenges

4.2.1 Porous International Boundary

Since the international boundary demarcation in the northern part of Haa dzongkhag has not yet been finalized with China, it is of grave disadvantage for the management with regard to wildlife and its habitat management. The limitations posed in the movement of the frontline staff in our own area has impeded the effective monitoring and anti-poaching programs considering the

inaccessibility of some areas in the northern part of JKSNR. A porous international border and proximity to wildlife trafficking routes make JKSNR highly vulnerable to poaching and illegal wildlife trade. For instance, the Royal Bhutan Army (RBA) at Damthang apprehended illegal traders possessing Leopard skin, Bear paws and Python skin who was trying to cross border for illegal trade. The nature reserve staffs too apprehended NWFP illegal traders who was trying to cross the borders for illegal trade.

4.2.2 Inadequate Data and Information Gaps

Inadequate and reliable field data on target species has impeded science-based conservation and management of natural resources in JKSNR. Knowledge of species dispersal and persistence is the primary goal for the nature reserve without which or lack of it will seriously hamper the management in implementing successful species conservation programs in the future. The nature reserve has conducted studies on only Snow leopard distribution and population survey and monitoring. The management needs to address the concerns on the lack of knowledge of other target species populations like Musk deer, Red panda, Leopard, Asiatic black bear, prey population and their habitats. Inadequate data on climate variables has also hampered the study on climate change and its impact on vegetation and species dispersal. The nature reserve also lacks real time climate data for long term study on climate change impacts although the area has high potential as a field research station for climate studies. Therefore, the information gaps mentioned has to be addressed for better implementation of conservation programs to manage the habitats at the larger landscape level.

4.2.3 Capacity Development, Advocacy and Awareness

Protected area capacity is the cornerstone of effective protected area management. The capacity needs for incorporating climate change cuts across each of the conservation goals. If protected area staffs are to be able to address emerging issues in climate change, they will require new skills and knowledge on a wide range of topics. Capacity building opportunities of the field staff and low literacy rate of the local communities still remain as a significant challenge for the management of JKSNR in the field of conservation. Conservation of charismatic and flagship species needs strong and comprehensive policies guided by participatory principles through education outreach, public meetings and door to door awareness campaigns. However, the modalities of conservation policies are impaired by limited knowledge, skills and capacity of the

frontline staff in developing good climate-based and gender sensitive conservation management plans, and implementation of the strategies and activities in the nature reserve.

Therefore, lack of significant knowledge and skills by the frontline staff in the field of conservation constrained by limited funding for capacity building from the government as well as both internal and external conservation donors has decreased the intensity of professionalism and technical expertise required for optimum functioning in the nature reserve; and this had somehow accelerated the rate of retribution by local communities on wild carnivores for killing their livestock.

4.2.4 Remoteness & Inaccessibility of the area

Remoteness of the entire area and inaccessibility of some areas makes JKSNR highly vulnerable to poaching and illegal trade. Some areas under the nature reserve are inaccessible which makes it difficult to carry out anti-poaching patrolling and survey work. This has also hampered in timely and regular reach of the frontline staff in maintaining the ecological integrity of the nature reserve. The lack of communication facilities has also impacted in effective patrolling and survey works. The only option that the management foresee is to have outposts built in strategic locations to provide shelter to the patrolling staffs in the far-flung areas in the nature reserve. The construction of communication towers for communication handsets are also critical areas that need to be looked into by the management.

4.2.5 Pandemic (COVID-19)

The operational capacity of most protected and conserved areas like JKSNR has been affected to some extent by COVID-19. Bhutan too is feeling the impacts as the virus continue to spread around the world. Often, the immediate response has been to reduce staff activity and vital management services, including ranger patrols. Travel restrictions have made it difficult for some rangers to get to work, for example in JKSNR too, its rangers are affected. The management activities are operating at a lower intensity because of newly imposed expenditure constraints and cuts in staff numbers. In JKSNR, rangers have been diverted to tasks that are part of the COVID-19 response, such as helping in manning checkpoints and outposts at various locations.

There are reports of increased poaching (both subsistence and commercial), and illegal resource extraction in several different countries which is encouraged by a reduced management presence; and Bhutan too will not be an exception. There may well be differences among types of illegal exploitation. For example, high value transnational trafficking may be temporarily declining because of the lockdown and travel restrictions, whilst poaching for timber, bushmeat, encroachment for grazing or illegal fishing may be increasing. Lockdowns and travel restrictions along with reduced employment and livelihood opportunities mean local communities are increasingly depending on subsistence harvesting and foraging, which could potentially lead to overharvesting. This can be exacerbated when people return to their home communities from urban areas.

Many activities, while important for conservation, are not deemed essential under some governments guidelines which aim to discourage the movement of people over long distances. As a result, authorities may be less able to respond quickly to forest fires or incidents of human–wildlife conflict, potentially resulting in increased hardship to local communities and reduced tolerance to wildlife. This includes some types of scientific research and resource management which may be time-critical for effective conservation (Corlett *et al.*, 2020). For example, research and enforcement patrol programs have been temporarily shut down because of travel restrictions affecting researchers and rangers and also due to lack of funds.

Local communities living in and around protected and conserved areas like JKSNR are extremely vulnerable to pandemics. They often live far from urban centres and have communal and sometimes nomadic lifestyles. This can lead to limited access to information and medical services, which are important in the context of novel viruses.

4.3 Threat Ranking

The overall threat assessment for JKSNR was **medium** (Table 14). The threat which was ranked to illegal poaching and trade due to lack of infrastructure at strategic locations and remoteness for monitoring of species was ranked as High. Habitat degradation through NWFPs collection, free range grazing, encroachment by scrub forest, erosion, retaliatory killing and transmission of diseases were also ranked as Medium. The listed threats required actions to stimulate towards conservation. Among the individual threats, illegal collection of NWFPs, poaching and illegal trade was given the highest threat ranking, being ranked High for its impact on population

decline and impact on habitats. Degradation of alpine habitats/meadows scored Medium for its impact on Snow leopard and its prey species, the Blue sheep population, and shrinking of grazing areas. The retaliatory killing due to livestock depredation scored as medium threat. However, if there are no innovative preventive solutions/measures, incentives and/or alternative income generating opportunity/schemes implemented to make up for the loss, there is a risk for the increase of threat level to very High severity. Therefore, it is very important to implement the innovative preventive measures and/or solutions to ensure population stability and growth. Transmission of diseases is also another threat which was listed as Medium based on the recent case where most of the Goral and Serow species were infected by the goat virus. Thus, the priority actions should be to address the impacts from several threats and challenges listed to ensure species population stability and growth. The feral dog population in the wild is also listed as threat with Low ranking, however, with increase in its population, it has major impact on predation on Blue sheep, yak calf and as a disease transporter. Climate change impact threat was ranked as Low threat compared to others; nevertheless, it requires further investigation to understand the impact of climate change on ecosystem and the species presence.

Table 14: Miradi table of threats for each target ranked based on scope, severity, and irreplaceability.

Threats \ Targets	Promote harmoni...	To manage habit...	To protect, cons...	Fill knowledge/ i...	Prevent & addre...	Monitor & ensure ...	Summary Threat Rating
Poaching & Illegal trade			High				Medium
Habitat degradation		Medium	Medium				Medium
Climate change		Low		Medium		Low	Low
HWC: Retaliatory killing	Medium		Medium				Medium
Stray dog/Feral dog			Low		Medium		Low
Transmission of diseases			Medium	Medium	High		Medium
Summary Target Ratings:	Low	Low	Medium	Medium	Medium	Low	Overall Project Rating Medium

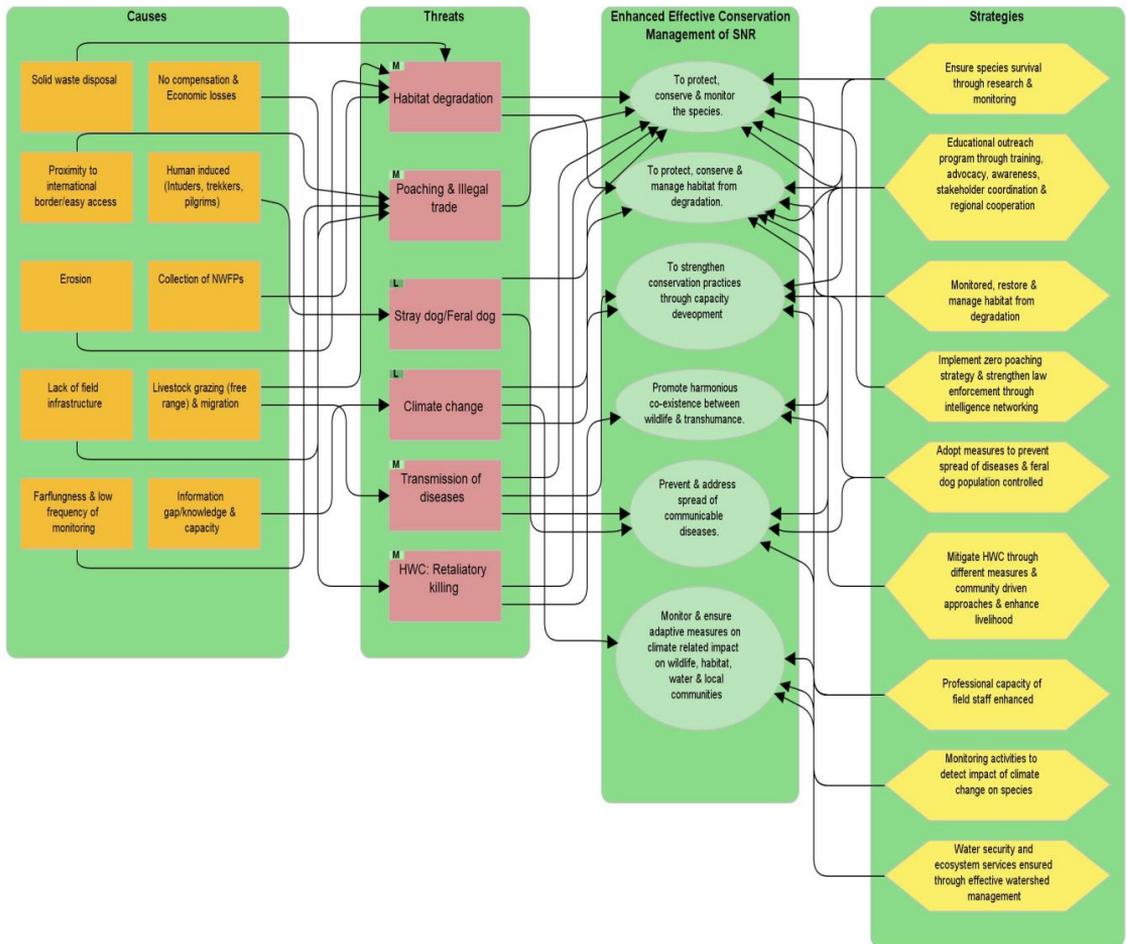


Figure 38: Conceptual model for JKSNR conservation management to achieve Targets

Opportunities: A post Covid-19 new focus on protected areas

The COVID-19 pandemic has highlighted the urgent need to change the relationship between people and the natural environment, especially in the case of protected areas like JKSNR. While economic recovery will still be a national priority, however, it will have to be a green economic recovery. As Bhutan and other nations seek to reboot the economy afterwards, vast sums of money will be invested and they must decide to use this as a once-in-a-generation opportunity to correct the course of economic development towards more sustainable outcomes. Economists,

central bankers and finance ministry staff from around the world have already identified natural climate solutions and rural support for ecosystem restoration as policies that will generate both economic multiplier effects and climate benefits (Hepburn *et al.*, 2020). There is significant policy opportunity to ‘mainstream’ and integrate conservation into economic planning as well as human health priorities. Most importantly, it could spur the global community to a determination to address the other global crises of climate change and biodiversity loss through a heightened focus on protected and conserved areas. There is an extensive and robust body of scientific knowledge to help target investment on the most valuable ecosystems for the simultaneous pursuit of carbon sequestration, biodiversity and economic goals. Nature and biodiversity conservation should be seen as critical to sustainable economic growth and human health – two priority issues that will dominate the global recovery agenda (IUCN, 2020).

New and Transformative relationship with Nature: The pandemic will result in significant changes in humanity’s perception of our planet and our relationship to nature. Nations now share a dramatic pandemic experience together, resulting in a shared bond with the planet and with each other. There is a new appreciation that the global pandemic is a result of the way consumer-driven societies are degrading and misusing nature. The pandemic raises global understanding of the two intertwined major crises: climate change and biodiversity loss. Science and its role in helping solve human problems have risen to the fore. The pandemic promotes a collective understanding of the immensity of the biodiversity and climate challenge, showing that transformative change is possible.

Natural or nature-based solutions involving protected and conserved areas; and ecological restoration are seen as the preferred response to a range of human challenges, from biodiversity loss to carbon storage and sequestration, and from disaster risk reduction to improving human physical and mental well-being. Human populations get better at living with wildlife and reducing conflict. Healthy nature, stewarded by local communities in protected and conserved areas is the backbone of a recovering planet, with diversified funding sources, including but not limited to sustainable tourism. Encouragingly, leaders from many parts of the planet have already signaled their intention to embrace this opportunity in their recovery plans; and Bhutan too should be no exception to join the league of extraordinary and visionary nations.

CHAPTER 5:

Management Strategies (Prescription)

Strategies and actions (*management prescriptions*) are defined based on the overall conservation goal of the plan to protect and conserve species, maintain habitats, and enhance social livelihoods. These strategic actions will be able to address the issues, threats, challenges and/or problems or overcome the barriers that prevent from achieving the conservation objectives, and subsequently the conservation goals to ensure sustainable development in and around the nature reserve.

In this section, we outline the strategic plan prescriptions to address issues, threats and challenges discussed in chapter IV of this plan to contribute towards achieving the overall conservation goals of JKSNR. These will be achieved through the strategic actions grouped under 7 objectives, 15 strategies; and 82 actions which are detailed out in the logical framework.

Objective 1: To protect, conserve and monitor the wildlife species.

Strategy 1.1: Ensure species persistence/survival through research and monitoring of species ecology.

Action 1.1.1: Conduct surveys/research on stable and thriving populations of the following key/flagship species:

- i). Tiger population survey through camera trapping.
- ii). Monitoring of Snow leopard population through camera trapping.
- iii). Assessment of Blue sheep count/population and monitoring.

Action 1.1.2: Documentation, distribution and mapping of the following species will be carried out:

- i). Dhole
- ii). Alpine musk deer
- iii). Himalayan red panda
- iv). Asiatic black bear and Sloth bear survey
- v). Rufous-necked hornbill
- vi). Felidae (cats) species
- vii). Small mammals/lesser-known species, herpetofauna, butterfly and fresh water macro-invertebrates
- viii). Avi-faunal diversity and distribution in different habitats

Action 1.1.3: Conduct field surveys on the following plant species:

- i). Ecology of key species such as White poppy and other endemic floral species.
- ii). Mushroom diversity and distribution.
- iii). Rhododendron diversity and distribution.
- iv). Plant communities and composition of alpine meadows.
- v). Vegetation population structure and composition in JKSNR.
- vi). Orchid diversity and distribution.
- vii). Invasive species distribution and documentation.

Action 1.1.4: Conduct periodic Biodiversity monitoring using structured, grid-based methods.

Action 1.1.5: Conduct camera-trap surveys for wildlife to monitor population and its distribution.

Strategy 1.2: Educational outreach programs enhanced through training, advocacy, awareness, stakeholder coordination and regional cooperation.

Action 1.2.1: Coordinate stakeholder coordination workshops/meetings to strengthen collaboration with other law enforcement agencies to enhance partnership in conservation efforts.

Action 1.2.2: Initiate educational outreach programs to promote conservation education advocacy and training to gain support for conservation; and engage youth or volunteer groups as a conservation partners & promote local stewardship.

Action 1.2.3: Coordination meetings/workshops for trans-boundary cooperation.

Action 1.2.4: Organize trainings and exposure trips for the PA staffs on PA management and conservation.

Strategy 1.3: Implementation of Zero Poaching Strategy and strengthen law enforcement through intelligence networking.

Action 1.3.1: Conduct regular anti-poaching or *ad hoc* patrolling to curb illegal poaching.

Action 1.3.2: Equip frontline staff with basic field equipment and gears like tents, sleeping bags, mats, torch, field boots, and SMART phones etc. for effective SMART patrolling.

Action 1.3.3: Develop community-based monitoring and intelligence networking system by active engagement of the local communities through partnership and local stewardship.

Action 1.3.4: Conduct basic first aid, arms handling, uniform discipline and field safety training to the frontline staff.

Action 1.3.5: Strengthen capacity of frontline staff on identifying and mapping of patrolling routes and surveillance sites in the landscape.

Action 1.3.6: Adopt Zero Poaching Strategies (SMART); Zero Poaching will be driven forward through implementation of the six pillars of Zero Poaching; **Assessment-** conduct regular effectiveness assessment, **Technology-** use the best available tools & technology, **Capacity-** increase field staff's ability to protect wildlife, **Community-** engage with local communities, **Prosecution-** improve approaches for prosecution, and **Cooperation-** share information and data.

Objective 2: To protect, conserve and manage habitat from degradation

Strategy 2.1: Habitats monitored, restored and managed to prevent from degradation.

Action 2.1.1: Carry out improvement of alpine habitats through clearing of scrub and bio-engineering work in erosion and landslide areas for restoration.

Action 2.1.2: Periodic prescribed burning on identified sites to restore shrub-infested high-altitude grasslands.

Action 2.1.3: A detailed research study on the burnt and un-burnt scrub areas for the effectiveness of the management prescription needs to be conducted.

Action 2.1.4: Development and improvement of water holes, and plantation of fruit trees for habitat enrichment.

Action 2.1.5: Support development of pastures to the yak-herding communities.

Action 2.1.6: Conduct study on the Interaction of Blue sheep and livestock in the pristine alpine ecosystem to document changes in grassland vegetation.

Action 2.1.7: A scientific research study on Grazing impacts (over grazing and under grazing impact) on plant composition needs to be conducted.

Action 2.1.8: Conduct scientific research for developing a management plan for sustainable NWFP collection and initiate group formation within yak-herding and local communities.

Strategy 2.2: Management of solid waste disposal to prevent habitat degradation.

Action 2.2.1: Strict Garbage In-Garbage Out (GIGO) policy should be adopted, backed by legislations (policies, acts, rules and regulations) along with legal enforcement of the legislations.

Action 2.2.2: Install signages and information boards at strategic locations along the eco-trails and campsites; and research sites and plots.

Action 2.2.3: Enhance advocacy and awareness education programs on waste management to school children and other key stakeholders.

Action 2.2.4: Organize regular cleaning campaigns and other environmental education (EE) programs by engaging the school groups and local communities as leaders and local stewards.

Action 2.2.5: Institutionalize waste collection among the yak-herding communities and conduct regular advocacy and awareness programs on proper waste management.

Objective 3: To strengthen conservation practices through capacity development.

Strategy 3.1: Professional capacity enhanced for frontline staff through capacity building.

Action 3.1.1: Conduct refresher courses and training for the field staff.

Action 3.1.2: Basic training on Biodiversity assessment for monitoring.

Action 3.1.3: Training on wildlife study design, data analysis, reporting and statistic for ecology and conservation biology.

Action 3.1.4: Training on PA management and Governance of protected areas.

Action 3.1.5: Training on leadership in protected area management.

Action 3.1.6: Training on Species and Landscape Management

Action 3.1.7: Field learning and exposure trips (in-country & ex-country) to the field staff on flora & fauna conservation, and PA management.

Action 3.1.8: Capacity building on sustainable financing, disaster preparedness, and integrated wildlife and human health approaches.

Action 3.1.9: Conduct hands on training on survey designing, data collection and analysis; and technical and scientific report writing.

Action 3.1.10: Purchase of field equipment (camera traps and accessories) for instant environmental data collection and data-loggers for environmental variable studies.

Action 3.1.11: Develop a database of camera-trap data on wildlife with network access in every field office, and with the central data repository at the JKSNR head office.

Objective 4: To promote harmonious co-existence between wildlife and transhumance communities.

Strategy 4.1: Mitigate Human-wildlife Conflict through different innovative measures/solutions and community driven approaches.

Action 4.1.1: Carry out periodic update of the hotspot map, distribution, and to highlight spatial-temporal characteristic of the conflict to understand patterns and trends.

Action 4.1.2: Pilot and/or test protective measures such as enclosures, predator-proof corrals and portable solar fencing to protect juvenile yaks against predators.

Action 4.1.3: Initiate incentive programs to compensate for the loss from depredation.

Action 4.1.4: Establish a “Wildlife Rescue and Rehabilitation Enclosure” within the head office compound.

Strategy 4.2: SNR dependent communities aware of the conservation significance of flagship species.

Action 4.2.1: Field survey to assess people’s perception towards the conservation of Snow leopard and other wildlife species.

Action 4.2.2: Select and train few local communities, armed force personnel, and community volunteers to encourage to become local stewards and citizen scientists.

Action 4.2.3: Formation of local herding communities as Snow leopard Conservation Volunteers.

Action 4.2.4: Organize exposure visits for conservation volunteers to learn about conservation efforts of Snow leopard and other wildlife species.

Strategy 4.3: Ensure important habitats using sustainable climate-integrated approaches.

Action 4.3.1: Improvised herder’s huts/tents through innovative and smart infrastructure development.

Action 4.3.2: Harnessing solar energy and supply of improvised stoves to reduce dependence on firewood.

Action 4.3.3: Initiate & implement safe drinking water schemes in the highlands.

Strategy 4.4: Promote nature-based research/educational tourism programs to enhance livelihoods of transhumance communities.

Action 4.4.1: Encourage and promote nature-based research/eco-tourism through awareness and nature education.

Action 4.4.2: Enhance capacity for local nature guides in Haa.

Action 4.4.3: Development of climate smart eco-trail and camp sites, and improvised migration trails/bridges to be constructed to support the program.

Action 4.4.4: Installation of information boards and signage in the strategic locations.

Action 4.4.5: Conduct study on the Economic Valuation and visitor carrying capacity of the Nub-Tshonapata Lake.

Action 4.4.6: Enhance livelihood options with special focus on migratory yak-herders through exploration, and adoption of alternative innovative and sustainable income generation activities.

Objective 5: To prevent and address the spread of communicable diseases.

Strategy 5.1: Adopt measures to prevent the spread of diseases and control feral dog population.

Action 5.1.1: Coordinate and collaborate closely, and regularly with livestock sector to monitor the prevalence of diseases.

Action 5.1.2: Train patrol teams to monitor, collect samples and report on wildlife disease.

Action 5.1.3: Identify strategic locations of feral dog prevalence, and adopt population control measures.

Action 5.1.4: Establish a Quick Response Team (QRT) to investigate, control spread of diseases, treat, monitor and report.

Objective 6: To monitor and ensure adaptive measures on climate related impacts on wildlife, habitats, water and local communities.

Strategy 6.1: Monitoring program to detect impacts of climate change on species.

Action 6.1.1: Establish and monitor permanent vegetation plots in different ecological zones to detect altitudinal shift in tree line, and change in plant composition over time.

Action 6.1.2: Setting up of weather monitoring stations (data-logger) to gather periodic data for analysis.

Action 6.1.3: Periodic data collection on climate indicator species for the climate vulnerability study.

Action 6.1.4: Purchase of weather station (data loggers) and environment data collection equipment's for climate study.

Action 6.1.5: Training on specific tools to assess wildlife species vulnerability to climate change.

Strategy 6.2: Water security and ecosystem services ensured through effective watershed management.

Action 6.2.1: Conduct lotic and lentic biodiversity assessment and mapping; and periodic monitoring.

Action 6.2.2: Assessment of spring-shed, critical watershed, water source areas for management and intervention.

Action 6.2.3: Assessment of the status of high-altitude wetlands for conservation.

Action 6.2.4: Conduct community consultation, awareness and trainings on watershed management.

Action 6.2.5: Initiate various forest fire management programs to reduce fire incidences.

Action 6.2.6: Purchase of forest firefighting tools and equipment.

Strategy 6.3: Ensuring a Climate Resilient Community-“Vulnerability of local communities to climate change variability reduced”.

Action 6.3.1: Conduct Climate Vulnerability and Capacity Analysis (CVCA) and propose sustainable adaptive actions to reduce vulnerabilities of the transhumance communities.

Action 6.3.2: Organize awareness and advocacy programs to sensitize local communities on the impacts of climate change based on CVCA results.

Action 6.3.3: Periodic surveys on people's perception on change in biodiversity and water due to climate change.

Action 6.3.4: Organize exposure tours for local communities to understand the impacts of climate change and local community vulnerabilities.

Objective 7: Strengthening institutional capacity for effective services delivery and implementation of conservation programs.

Strategy 7.1: To ensure effective service delivery through basic infrastructure, appropriate technology and communication facilities.

Action 7.1.1: Construct field outpost or research stations in four locations (Lolithang, Tshonapata Chala and Yaba) for effective implementation of conservation activities.

Action 7.1.2: Procure and equip field staff with all necessary communication, office and field equipment and field gears.

Action 7.1.3: Provide field staff with adequate facilities in terms of housing and capacity development opportunities.

Action 7.1.4: Procurement of additional pool vehicles and bikes for range offices for effective public service delivery; and conducting effective patrolling.

Action 7.1.5: Construct a Rangers Club House to serve as a research information/visitor center including a library, laboratory, and to provide services and facilities to rangers.

Action 7.1.6: Provide operational/directional support for effective and smooth functioning of the offices.

Action 7.1.7: Payment of staff salary and allowances for effective and efficient services delivery.

CHAPTER 6:

Implementation plan and financial outlay

Although the establishment of protected areas (PAs) is considered the main strategy adopted by countries to conserve natural ecosystems, the resources available for PA establishment and adequate management fall short of their needs (Emerton *et al.*, 2006; Bovarnick *et al.*, 2010). In this context, the reality is no different for JKSNR in Bhutan too. The significant efforts to expand the National Protected Areas System (PAs) were not accompanied by a sufficient increase in the budget allocated to these protected areas, and JKSNR is no exception and a significant funding gap still exist.

This underfunding compromises the allocation of human resources, infrastructure development and equipment, and the realization of basic activities for effective biodiversity protection, since the provision of sufficient, stable, long-term funding is essential for PAs to function effectively and to achieve conservation outcomes (Bonham *et al.*, 2014; WWF-Brazil & Funbio, 2017).

In this context, JKSNR management had been moderately successful in conserving and maintaining the ecological integrity of the pristine and temperate ecosystems in its area; and contributed to the country's rich biodiversity. This was solely because of the continued fund support from the RGoB and committed national conservation donors like BTFEC during the initial establishment period; and recently by the BFL project. Till date, the direction and operation budgets are being met from funding by the RGoB, whereas major capital and recurrent budget to implement key conservation programs was funded by BTFEC and by the BFL project. The present plan has incorporated more conservation and sustainable development programs in comparison to the past plan. Therefore, in pursuit of implementing various conservation programs for the next 10 years; and to achieve the conservation goals and objectives, there must be a secured and sustainable funding mechanism, which is expected to be achieved through major fund support from the Bhutan for Life project (14-year period). However, a funding gap still exists apart from secured BFL and RGoB funding. Therefore, it is imperative for the management to strive and explore new funding opportunities from other conservation donors like the WWF-Bhutan Program, UNDP-GEF, UNODC, Helvetas-Bhutan and Bhutan Foundation, RSPN, etc. to fund the conservation programs which are either, not included or not adequately funded by the BFL project; and strive to collaborate and strengthen partnerships with the various donor organizations, both national and international within the country and outside.

The total budget outlay for 10-year conservation management plan period (2021-2031) is estimated at **Nu. 330.8 million**. Despite the approved funding support under Bhutan for Life project estimated at **Nu. 172.754m** and from RGoB with **120.37m**; a funding gap of **Nu. 37.63m** is still estimated, for which the management needs to explore funding from other conservation donors and/or RGoB for implementation of planned conservation programs. The recurrent expenses like pay & allowances and management services will be met from RGoB funding based on the number of approved staff strength by RCSC and yearly budget allocation endorsed by the RGoB with 10% inflation consideration. In addition, an annual conservation operational plan should be developed based on the broad 10-year implementation plan period (annexure II).

6.1 Implementation Framework

The implementation plan for the period of 10 years (2021-2031) was developed as per the *implementation framework/format/Logical Framework* (Table 15) with details of when the specific program activity would be carried out mentioning the actual amount of fund required for successful implementation. With the emergence of new issues and threats; and mitigation and/or addressal of the existing or perceived issues and threats, the program activities should be re-aligned accordingly. An *Annual Operational Work Plan* will be prepared and linked with *Annual Performance Appraisal* (APA) and *Monitoring Framework* to help achieve this dynamism and evaluate/scored based on APA criteria annually.

Table 15: Logical Framework

Objectives	Strategies	Actions	Year along with budget (in Nu. Million)										Total					
			Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10						
1. To protect, conserve and monitor the wildlife species.	1.1: Ensure species persistence/survival through research and monitoring of species.	1.1.1: Conduct research on stable and thriving populations of key/flagship species like Tiger, Snow leopard and Blue sheep count and monitoring through camera trapping.	1.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	5.00	
		1.1.2: Documentation, distribution and mapping of following species will be carried out; species like Dhole, Alpine musk deer, Himalayan red panda, Asiatic black bear, Sloth bear, Rufous-necked hornbill, Cat species in JKSNR, lesser-known species, Herpeto-fauna, Butterfly, Freshwater macro-invertebrates and Avi-faunal diversity and distribution.	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	4.30
		1.1.3: Further, field survey on the following plant species will be conducted:	0.00															
		i). Ecology of key species such as White poppy and other endemic floral species.	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00
		ii). Mushroom diversity and distribution.	0.50	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.50	2.00
		iii). Rhododendron diversity and distribution.	0.00	0.60	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	1.80
		iv). Plant communities and composition of alpine meadows.	0.00	0.00	0.90	0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	2.70
		v). Vegetation structure and composition of JKSNR.	0.00	0.70	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	2.10
		vi). Orchid diversity and distribution	0.00	0.49	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	1.28
		vii). Invasive species and impact of climate change on such ecosystem.	0.60	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.40	2.00
1.1.4: Conduct periodic Biodiversity monitoring using structured, grid-based methods.	0.00	0.00	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00	2.30		

	1.1.5: Conduct camera-trap survey for wildlife to monitor population and distribution.	0.00	0.80	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.80	2.40
	1.2.1: Coordinate stakeholder coordination and collaboration workshops/meetings/trainings.	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	1.00
1.2: Educational outreach programs enhanced through training, advocacy, awareness, stakeholder coordination and regional cooperation.	1.2.2: Initiate educational outreach programs to promote conservation education, advocacy and training to gain support for conservation; and engage youth or volunteer groups as conservation partners & promote local stewardship.	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	1.57
	1.2.3: Coordination meetings/workshops for trans-boundary cooperation.	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.80
	1.2.4: Organize trainings and exposure trips for the PA staff on PA management & conservation.	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90
	1.3.1: Conduct regular anti-poaching or <i>ad hoc</i> patrolling to curb illegal poaching.	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	30.00
	1.3.2: Equip frontline staff with basic field equipment and gears like tents, sleeping bags, mats, torch, field boots, and SMART mobile phones for effective SMART patrolling.	0.00	8.96	0.00	0.00	0.00	8.96	0.00	0.00	0.00	0.00	0.00	17.92
1.3: Implementation of Zero Poaching Strategy and strengthen law enforcement through intelligence networking.	1.3.3: Develop community-based monitoring and intelligence networking system by active engagement of the local communities through partnership and local stewardship.	0.14	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	1.56
	1.3.4: Conduct trainings on first aid, arms handling, discipline and field safety for JKSNR staff.	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	1.00
	1.3.5: Strengthen capacity of frontline staff on identifying and mapping of patrolling routes and surveillance sites.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	10.00

	<p>2.2.1: Strict Garbage In-Garbage Out (GI-GO) policy should be adopted backed by legislations (policies, acts, rules and regulations) along with legal enforcement of the legislations.</p> <p>2.2.2: Install signages and information boards at strategic locations along the eco-trails and campsites; and research sites and plots.</p> <p>2.2.3: Enhance advocacy and awareness education programs on waste management to school children and other stakeholders.</p> <p>2.2.4: Organize regular cleaning campaigns and other environmental education programs by engaging the school groups and local communities as leaders and stewards.</p> <p>2.2.5: Institutionalize waste collection among the yak herding communities and conduct regular advocacy and awareness program on proper waste management.</p>	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.40
<p>3: To strengthen conservation practices through capacity development.</p>	<p>2.1: Habitat monitored, restored and managed to prevent from degradation.</p>	0.10	0.00	0.10	0.00	0.10	0.00	0.10	0.00	0.40
	<p>3.1: Professional capacity enhanced for staff through capacity building.</p>	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.45
	<p>3.1.1: Conduct refresher courses and training for field staff.</p> <p>3.1.2: Basic training on Biodiversity assessment for monitoring.</p> <p>3.1.3: Training on wildlife study design, data analysis and statistic for ecology and conservation biology.</p> <p>3.1.4: Training on management and Governance of protected areas.</p> <p>3.1.5: Training on Leadership in protected areas management.</p> <p>3.1.6: Training on Species and Landscape Management</p>	0.11	0.15	0.00	0.00	0.00	0.00	0.15	0.15	0.54
		0.20	0.00	0.20	0.00	0.20	0.00	0.00	0.20	0.80
		0.00	0.00	0.20	0.20	0.00	0.00	0.00	0.00	0.60
		0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.50
		0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.50
		0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.50

		4.2.1: Field survey to assess people's perception towards the conservation of Snow leopard and other wildlife species.	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.60
	4.2: SNR dependent communities aware of conservation significance of flagship species.	4.2.2: Select and train few local communities, armed forces, volunteer group to encourage them to become stewards and citizen scientists.	0.30	0.30	0.00	0.30	0.00	0.30	0.00	0.30	0.00	0.30	0.00	0.30	0.00	1.80
		4.2.3: Formation of local herding communities as Snow leopard Conservation Volunteers.	0.16	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.36
		4.2.4: Organize exposure visits for conservation volunteers to learn about conservation efforts of Snow leopard and other wildlife species.	0.00	0.78	0.00	0.30	0.00	0.30	0.00	0.30	0.00	0.30	0.00	0.30	0.00	1.68
	4.3: Ensure important habitats using climate-integrated approaches.	4.3.1: Improvised herders hut/tent through innovative and smart infrastructure development.	0.00	1.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
		4.3.2: Harnessing solar energy and supply of improvised stove to reduce dependence on firewood.	0.00	0.20	0.00	0.20	0.00	0.20	0.00	0.20	0.00	0.20	0.00	0.20	0.00	0.60
		4.3.3: Initiate & Implement safe drinking water scheme.	0.00	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40
	4.4: Promote nature-based research/educational tourism programs to enhance livelihoods of transhumance communities.	4.4.1: Encourage and promote nature-based research/eco-tourism programs.	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33
		4.4.2: Enhance capacity for local nature guides in Haa.	0.10	0.10	0.00	0.00	0.00	0.10	0.00	0.10	0.10	0.00	0.00	0.00	0.00	0.40
		4.4.3: Development of climate smart eco-trail and camp sites, and improvised migration trails/bridge to be constructed to support the program.	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
		4.4.4: Installation of information boards and signage placed in strategic locations.	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.40
		4.4.5: Conduct study on the Economic Valuation and visitor carrying capacity of the Nub-Tshonapata lake.	0.00	0.50	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70

		4.4.6: Enhance livelihood options with special focus to migratory yak herders through exploration and adoption of alternative innovative and sustainable income generation activities.	0.00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	1.80	
5. To prevent and address the spread of communicable diseases.	5.1: Adopt measures to prevent the spread of diseases and feral dog population controlled.	5.1.1: Coordinate and collaborate closely, and regularly with livestock sector to monitor the prevalence of diseases.	0.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	2.25	
		5.1.2: Train patrol teams to monitor, collect samples and report on wildlife disease.	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	
		5.1.3: Identify strategic locations of feral dogs prevalence, and adopt population control measures.	0.00	0.30	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.90	
		5.1.4: Establish Quick Response Team (QRT) to investigate, control spread of diseases, treat, monitor and report.	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00	1.17
		6.1.1: Establish and monitor permanent vegetation plots in different ecological zones to detect altitudinal shift in tree-line, and change in plant composition over time.	0.00	0.40	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70
6. To monitor and ensure adaptive measures on climate related impact on wildlife, habitats, water and local communities.	6.1: Monitoring program to detect impacts of climate change on species.	6.1.2: Setting up of weather monitoring stations (data-logger) to gather periodic data for analysis.	0.00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	1.80	
		6.1.3: Periodic data collection on climate indicator species for the climate vulnerability study.	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	
		6.1.4: Purchase of weather station (data loggers) and environment data collection equipment for climate study.	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
		6.1.5: Training on specific tools to assess wildlife species vulnerability to climate change.	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10

conservation programs.	communication facilities.	0.00	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	3.84
	7.1.2: Procure and equip field staff with all necessary communication, office & field equipment and field gears.	0.00	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	7.35
	7.1.3: Provide field staff with adequate facilities in terms of housing and capacity development opportunities.	2.24	2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.44
	7.1.4: Procurement of additional pool vehicle and motor bikes for range offices for effective public services delivery and conduct patrolling.	0.00	6.80	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	11.80
	7.1.5: Construct a Rangers Club House to serve as research information center including a library, laboratory, and services and facilities.	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	8.65
	7.1.6: Provide operational/directional support for effective and smooth functioning of office.	11.56	11.69	11.79	11.89	11.99	12.09	12.19	12.29	12.39	12.49	12.59	120.37
	7.1.7: Payment of staff salary and allowances for effective and efficient services delivery.	31.0	62.2	30.4	26.6	32.1	38.6	25.3	25.8	28.9	29.7	330.6	
Total Nu. in million													

CHAPTER 7:

Monitoring and Evaluation

Additionally, timely monitoring and evaluation of conservation programs is essential to ensure proper delivery of outputs. The DoFPS in general will be the parent organization of the JKSNR management authority, and therefore the overall monitoring and supervising agency for monitoring the implementation of the management plan activities through periodic field visits and a regular system of technical and financial progress reports. The monitoring and evaluation plan would be part of the conservation management plan and based on the plan, the activities will be monitored and reported as per the PA monitoring framework (which would be developed/derived from the implementation plan/schedule).

7.1 Monitoring:

Monitoring is a continuous assessment that aims at providing all stakeholders, with early detailed information on the progress or delay of the ongoing assessed activity giving an oversight of the implementation stage of the activity. Its purpose is to determine if the outputs, deliverables and schedules planned have been reached so that action can be taken to correct the deficiencies as quickly as possible.

The monitoring at the field/implementer level will be done by the implementers continuously and throughout the implementation phase using PA Monitoring Framework (*Annexure III*) Table 16. The monitoring aims to:

- ❖ ensure coordination and build partnerships amongst stakeholders to ensure effective implementation of nature reserve activities, and thereby secure and consolidate conservation landscapes,
- ❖ Ensure exchange of information and experiences amongst stakeholders and partner organizations to help make implementation of conservation strategies more effective, and
- ❖ Ensure monitoring and evaluation to effectively address emerging challenges and changing issues.

7.2 Evaluation:

The assessment will be an initiative to understand the state of the nature reserve and to determine interventions that could be recommended to further enhance the management effectiveness. Bhutan METT Plus is a self-assessment tool designed to measure how effective a protected area is being managed. It is a self-reflection of the protected area management boards on how well they are doing with their management of the protected areas. In doing so, this activity also addresses the need to measure how much of the nature reserve's habitats are effectively protected and managed to contribute to the commitment in the management plan of the nature reserve. The final assessment of nature reserve will be based on 35 questions of Bhutan METT Plus. The results of this assessment shall be used as a benchmark in monitoring the progress of the achievement of this goal.

Final evaluation of the nature reserve status would be carried out using the “Bhutan METT+ (Bhutan Management Effectiveness Tracking Tool)” (*Annexure IV*) to evaluate the management effectiveness of JKSNR two times within the 10 year-plan period (once in 5 years).

Table 16: M&E: Assessment of the Output indicators for JKSNR 10 years conservation management plan period.

Objectives	Actions	Output indicator	Baseline	Unit	Yearly Target														
					Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10					
1. To protect, conserve and monitor the wildlife species.	1.1.1: Conduct research on stable and thriving populations of key/flagship species like Tiger, Snow leopard and Blue sheep count and monitoring through camera trapping.	Survey undertaken and completed to understand its distribution to ensure and maintain its population.	2	Report	1	1					1	1							
	1.1.2: Documentation, distribution and mapping of following species will be carried out; species like Dhole, Alpine musk deer, Himalayan red panda, Asiatic black bear, Sloth bear, Rufous-necked hornbill, cat species in JKSNR, lesser-known species, Herpeto-fauna, Butterfly, Freshwater macroinvertebrates and Avi-faunal diversity and distribution.	Survey/Research report on faunal species prepared, documented, mapped for species survival.	4	Report	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	1.1.3: Further, field survey on the following plant species will be conducted;	Survey/Research report for other floral species to ensure species survival within reserve conducted.		Report															
	i). Ecology of key species such as White poppy and other endemic floral species.	Survey Report	1	Report	1														1
	ii). Mushroom diversity and distribution.	Survey Report	0	Report	1			1											1
	iii). Rhododendron diversity and distribution.	Survey Report	0	Report	1				1										1
	iv). Plant communities and composition of alpine meadows.	Survey Report	0	Report			1				1								1
	v). Vegetation structure and composition of JKSNR.	Survey Report	1	Report		1					1								1
	vi). Orchid diversity and distribution	Survey Report	0	Report		1					1								1
	vii). Invasive species and impact of climate change on such ecosystem.	Survey Report	0	Report		1					1								1
	1.1.4: Conduct periodic Biodiversity monitoring using structured, grid-based methods.	Monitoring Report	0	Report								1							1
	1.1.5: Conduct camera-trap surveys for wildlife to monitor population and distribution.	Survey Report	1	Report		1					1								1
	1.2.1: Coordinate stakeholder coordination and collaboration	Stakeholder coordination workshops conducted & report prepared.	3	Times	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

1.2.2: Initiate educational outreach programs to promote conservation education advocacy and training to gain support for conservation, and engage youth or volunteer groups as a conservation partners & promote local stewardship.	Organized Educational Outreach Program and Report prepared (Nos. of head trained)	1300 (6 gewogs)	Heads/Nos.	250	250	250	250	250	250	250	250	250	250
1.2.3: Coordination meetings/workshops for trans-boundary cooperation.	Organized and attend workshop and meeting for stakeholders.	0	Heads/Nos.					5					5
1.2.4: Organize trainings and exposure trips for the PA staff on PA management & conservation.	Organized exposure trips to neighbouring state of India & other country.	0	Heads/Nos.						10				
1.3.1: Conduct regular anti-poaching or <i>ad hoc</i> patrolling to curb illegal poaching.	Regular/ <i>ad hoc</i> patrolling conducted	12	Report	12	12	12	12	12	12	12	12	12	12
1.3.2: Equip frontline staff with basic field equipment and gears like tents, sleeping bags, mats, torch, field boots, and SMART mobile phones for effective SMART patrolling.	Equipped frontline staff with basic field amenities/kits and equipment for effective SMART patrolling.	1	Nos.				34			34			
1.3.3: Develop community-based monitoring and intelligence networking system by active engagement of the local communities through partnership and local stewardship.	Enhanced intelligence sharing/networking system/informants to deter, minimize and reduce poaching.	0	Nos.	5	5	5	5	5	5	5	5	5	5
1.3.4: Conduct training on first aid, arms handling, and discipline and field safety for JKSNR staff.	Trained all staff on uniform discipline and arms handling.	3	Times	1	1	1	1	1	1	1	1	1	1
1.3.5: Strengthen capacity of frontline staff on identifying and mapping of patrolling routes and surveillance sites.	Field staff trained on GIS mapping (hotspots) and crime prevention.	0	Times	1	1	1	1	1	1	1	1	1	1
1.3.6: Adopt Zero Poaching Strategies (SMART); Zero Poaching will be driven forward through implementation of the six pillars of Zero Poaching (Assessment, Technology, Capacity, Community, Prosecution & Cooperation).	Officials trained on SMART and adopt Zero poaching strategy (SMART patrolling) to curb illegal poaching and wildlife trading.	4	Report	6	6	6	6	6	6	6	6	6	6
2.1.1: Carry out improvement of alpine habitats through clearing scrub forest and bio-engineering work in erosion/landslide areas for restoration.	Initiate alpine habitat management through bio-engineering work in landslide areas, planting grasses, improvement of waterholes.	0	Ha	1	1								
2.1.2: Periodic prescribed burning on identified sites to restore shrub-infested high-altitude grasslands.	Initiate prescribed burning in shrub infested plot for monitoring.	0	Ha	3	3								
2.1.3: A detailed research study on the burnt and un-burnt scrub areas for the effectiveness of the management prescription needs to be conducted.	Study conducted on alpine habitat management on burnt and un-burnt scrub area for management prescription.	0	Report	1					1				1
2: To protect, conserve and manage habitat from degradation.													

4: To promote harmonious co-existence of wildlife and transhumance communities.	3.1.3: Training on wildlife study design, data analysis and statistic for ecology and conservation biology.	Staff trained on wildlife study design and analysis.	1	Heads/Nos.	10	10	14		
	3.1.4: Training on management and Governance of protected areas.	Trained heads on governance and protected area management.	0	Heads/Nos.		10			
	3.1.5: Training on Leadership in protected areas management.	Trained on conservation leadership	1	Heads/Nos.	2				
	3.1.6: Training on Species and Landscape Management	Trained on species and landscape management	0	Heads/Nos.	2				
	3.1.7: Field learning and exposure trips to field staff on flora & fauna, conservation, and PA management within and outside country.	Organized exposure visits to staff on conservation program and PA management.	20	Heads/Nos.	29			34	
	3.1.8: Capacity building on sustainable financing, disaster preparedness, and integrated wildlife and human health approaches.	Trained staff on disaster management and financing	0	Heads/Nos.		5			
	3.1.9: Conduct hands on training on survey designing, data collection and analysis; and technical and scientific report writing.	Trained field staff on survey designing (GIS) and data collection methods & analysis.	1	Heads/Nos.	28		32		
	3.1.10: Purchase of field equipment (camera trap) for instant environmental data collection and data-logger for environmental variable studies.	Equipped research work through purchase of research equipment like, data-logger, camera trap, and instant environmental data collectors (HydroSense, Vaisala, Water testing kit).	0	Nos.	25	25			
	3.1.11: Develop a database of camera-trap data or any wildlife data with network access in each field office, and with the central data repository at the JKSNR head office.	Develop and establish a central data repository system in JKSNR head office	0	No.	1				
	4.1.1: Carry out periodic update of the hotspot maps, distribution, to highlight spatial-temporal characteristic of the conflict to understand patterns and trends.	Conflict hotspot areas identified and mapped for intervention to understand patterns and trends.	0	Report	1	1		1	1
	4.1.2: Pilot-test protective measures such as enclosures, predator-proof corrals & portable solar fencing to protect juvenile yaks against predators.	HWC incidences reduced in areas/village where different mitigation measures are put in place (pilot predator-proof corral/enclosures/fencing).	0	HHS	3	3		3	3
	4.1.3: Initiate different incentive programs to compensate for the loss from depredation.	Initiate incentive program for depredation case to reduce conflict.	0	HHS	5	5	5	5	5
	4.1.4: Establish a "Wildlife Rescue and Rehabilitation Enclosure" within the head office compound.	Established wildlife rescue centre/enclosure	0	No.	1				

5. To prevent and address the spread of communicable diseases.	5.1.1: Coordinate and collaborate closely, and regularly with livestock sector to monitor the prevalence of diseases.	Coordinate with livestock sector and trained patrol team to monitor the prevalence of diseases and set forth control program.	0	Event	1	1	1	1	1	1	1	1	1	1
	5.1.2: Train patrol teams to monitor, collect samples and report on wildlife disease.	Trained patrol team to monitor and submit patrol report	0	Report	1									
	5.1.3: Identify strategic locations of feral dogs prevalence, and adopt population control measures.	Coordinate with livestock sector for feral dog sterilization program.	0	Event	1	1								
	5.1.4: Establish Quick Response Team (QRT) to investigate, control spread of diseases, treat, monitor and report.	Established Quick Response Team and trained them annually.	0	Team	1	1	1	1	1	1	1	1	1	1
	6.1.1: Establish and monitor permanent vegetation plots in different ecological zone to detect altitudinal shift in tree-line, and change in plant composition over time.	Established permanent vegetation plots in 4 different ecological zones for monitoring and periodic data collection.	0	Plots	4									
6. To monitor and ensure adaptive measures on climate related impact on wildlife, habitats, water and local communities.	6.1.2: Setting up of weather monitoring stations (data-logger) to gather periodic data for analysis.	Installed data loggers and periodic data collected.	4	Nos.	1	1	1	1	1	1	1	1	1	
	6.1.3: Periodic data collection on climate indicator species for the climate vulnerability study.	Data collected on climate indicator species for the climate vulnerability study (invasive species, herpeto-fauna, and freshwater macro-invertebrate).	1	Report	1					1				
	6.1.4: Purchase of weather station (data loggers) and environment data collection equipment for climate study.	Purchased data loggers for water and climate study.	4	Nos.	5									
	6.1.5: Training on specific tools to assess wildlife species vulnerability to climate change.	Trained field staff on wildlife vulnerability to climate change data collection and analysis.	0	Heads/Nos.	29									
	6.2.1: Conduct lotic and lentic biodiversity assessment and mapping; and periodic monitoring.	Research undertaken and assessed lotic and lentic biodiversity for monitoring.	0	Report	1					1				
	6.2.2: Assessment of spring-shed, critical watershed and water source areas for management and intervention.	Watershed/spring shed/water source assessed for management of watershed area.	0	Report	1									
	6.2.3: Assessment of the status of high-altitude wetlands for conservation.	Assessed the status of high-altitude wetlands for conservation.	1	Report					1					
	6.2.4: Conduct community consultation, awareness and trainings on watershed management.	Trained communities on watershed management.	0	Heads/Nos.	100					100				
	6.2.5: Initiate various forest fire management programs to reduce fire incidences.	Conduct awareness, poster development, formation of Forest fire management group (FFMP), and firefighting.	4	Report	1					1				

	6.2.6: Purchase of forest fire fighting tools and equipment.	Purchased of forest firefighting equipment (water bag, flapper, rack, power chain, spade, knife, safety helmets, masks, hand gloves, etc).	0	Items	50				50				
	6.3.1: Conduct Climate Vulnerability and Capacity Analysis (CVCA) of local sustainable and adaptive actions to reduce vulnerabilities of the transhumance communities.	Conduct survey on climate vulnerability (CVCA) of local communities for adaptation strategies and actions.	0	Report	1				1				1
	6.3.2: Organize awareness and advocacy programs to sensitize local communities on the impacts of climate change based on CVCA results.	Conduct awareness and training on climate change and adaptation.	0	Herds/hhs	53								53
	6.3.3: Periodic survey on people's perception on change in biodiversity and water due to climate change.	Social survey on climate change and biodiversity.	0	Herds/hhs	53								53
	6.3.4: Organize exposure tours for local communities to understand the impacts of climate change and local community vulnerabilities.	Organized exposure trips for local communities.	0	Herds/hhs				53					53
	7.1.1: Construct field outposts/research stations in four locations (Lolithang, Tshonapata, Chala & Yaba) for effective implementation of activities.	Field outpost/research station constructed for effective implementation of activities.	0	Nos.	1	1	1	1					
	7.1.2: Procure and equip field staff with all necessary communication, office & field equipment and field gears.	Equip staff/office with all necessary communication facilities, office and field equipment, and computer, furniture and field gears to ensure motivation.	27	Staff	28	29	30	31	32	33	34	34	34
	7.1.3: Provide field staff with adequate facilities in terms of housing and capacity development opportunities.	Conduct adequate capacity building of field staff on conservation.	20	Nos.	10	10	10	10	10	10	10	10	10
	7.1.4: Procurement of additional pool vehicles and motor bikes for range offices for effective public services delivery and conduct patrolling.	2 4WD Hilux and 3 motor bikes purchased.	1 (4WD Hilux) and 1 bike.	Nos.	1	2					1	1	
	7.1.5: Construct a Rangers Club House to serve as a research information centre including a library, laboratory, and provide services and facilities.	Construct/developed facilities within reserve head office.	0	No.	1								
	7.1.6: Provide operational/directional support for effective and smooth functioning of office.	Timely released and utilized the operation and direction services fund.	33	Staff	34	34	34	34	34	34	34	34	34
	7.1.7: Payment of staff salary and allowances for effective and efficient services delivery.	Timely released and disbursement of fund.	33	Staff	34	34	34	34	34	34	34	34	34
7: Strengthening institutional capacity for effective service delivery and implementation of conservation programs.													

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Annexures:

Annexure I: Zonation Guideline

Annexure II: Conservation Operational Planning format

Annexure III: PA Monitoring Framework format

Annexure IV: Bhutan METT+ format