CONSERVATION MANAGEMENT PLAN
BIOLOGICAL CORRIDOR 01

(Connecting JDNP and JKSNR)

(July 2023 to June 2032)

Divisional Forest Office, Paro

Department of Forests and Park Services

Ministry of Energy and Natural Resources

CONSERVATION MANAGEMENT PLAN FOR BIOLOGICAL CORRIDOR 01

(Connecting JDNP and JKSNR)

(July 2023 to June 2033)

Divisional Forest Office, Paro

Department of Forests and Park Services

Ministry of Energy and Natural Resources

Plan prepared by:

1. Thinley Tshering, Dy. Chief Forestry Officer
2. Pema Rinzin, Sr. Forestry Officer.
3. Sherab Jamtsho, Sr. Forestry Officer
4. Sonam Phuntsho, Sr. Forestry Officer.
5. Karma Choden, Sr. Forestry Officer.
6. Namgay Dechen, Forest Officer
7. Gyeltshen Dorji, Forest Ranger I
8. Ngawang Gyeltshen, Sr. Forest Ranger, NCD

Contributors:

1. Phub Thinley, Sr. Forest Ranger
2. Dorji Gyeltshen, Sr. Forest Ranger
3. Pema Dorji, Sr. Forest Ranger
4. Lobzang, Forest Ranger I
5. Tshewang Nidup, Sr. Forest Ranger III
6. Tenzin Zangpo, Forest Ranger I
7. Pemba Tshering, Forest Ranger I
8. Jigme Lhuendup, Forest Ranger I

Input and edited by:

1. Nature Conservation Division team

Suggested Citation:

Divisional Forest Office (2023), conservation management plan of biological corridor 01(July 2023 to June 2033), Department of Forests and Park Services, Ministry of Energy and Natural Resources, Royal Government of Bhutan, Paro.

Contact:

Divisional Forest Office, Department of Forests and Park Services, Ministry of Energy and Natural Resources. Paro.
Post box no: 1208
Telephone: +975272163

དཔལ་ལྡན་འབྲུག་གཞུང་། རྒྱལ་ཤྲཱིས་དང་རང་བཞིན་སྐྱོང་ལྡན་ཁག།
ནགས་ཚལ་དང་གྲིང་ཀ་ཞབས་ཏོག་ལས་ཁུངས།
སྤུ་རོ་ མངའ་སྡེ་ནགས་ཚལ་ཡིག་ཚང་།

ENDORSEMENT AND APPROVAL OF ROYAL GOVERNMENT OF BHUTAN

Conservation management plan of Biological Corridor-01 connecting Jigme Dorji National Park and Jigme Khesar Strict Nature Reserve (Amendment 2022)

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

Submitted for approval:

Offtg. Chief Forestry Officer,
Divisional Forest Office, Paro.

Forwarded for approval:

Chief Forestry Officer,
Nature Conservation Division

Recommended for Approval:

DIRECTOR
Department of Forests and Park Services

Approved By:

SECRETARY
Ministry of Energy and Natural Resources

ACKNOWLEDGEMENT

In Bhutan, the biological corridors came into existence in 1999 as a cost-effective and reliable strategy to conserve meta-populations of wide-ranging species, promote gene flow of all species, and allow species to adapt to climate change.

The management plan of BC-01 is deemed necessary for its protection and enhancement could fulfill the objectives of species conservation and gene low promotion of the wide-ranging animals. It could also help individuals mitigate and adapt to climate change and its consequences.

On behalf of the management of the Divisional Forest Office Paro, I would like to thank all the staff for working tirelessly for data collection, data analysis, and management plan drafting for Biological Corridor 01.

As a whole, Divisional Forest Office, Paro acknowledge Bhutan for Life Project and GEF LDCF for financial support and Nature Conservation Division for technical backstopping rendered during plan preparation.

Offtg. Chief Forestry Officer
Divisional Forest Office, Paro.

ACRONYMS

BC	Biological Corridor.
B2C2	Bhutan Biological Corridor Complex
BFL	Bhutan for Life
CFO	Chief Forestry Officer
CITES	Convention on International Trade in Endangered Species
DBH	Diameter at Breast Height
DoFPS	Department of Forests and Park Services
FMD	Foot and Mouth Diseases
FNCRR	Forest and Nature Conservation Rules and Regulations
FNCA	Forest and Nature Conservation Act of Bhutan
HWC	Human Wildlife Conflict
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JKSNR	Jigme Khesar Strict Nature Reserve
JDNP	Jigme Dorji National Park
Km^2	Square Kilometer
LC	Least Concern
N	Number
NCD	Nature Conservation Division
NTS	National Tiger Survey
NWFP	Non-Wood Forest Product
QRT	Quick Response Team
RBA	Rapid Biodiversity Survey
RD	Relative Density
SD	Standard Deviation
SMART	Spatial Monitoring and Reporting Tools
WWF	World Wildlife Fund

Landscape in BC 1

Executive Summary

The Biological Corridor-01 (BC-01) connecting Jigme Dorji National Park and Jigme Khesar Strict Nature Reserve is a part of the Bhutan Biological Corridor Complex (B2C2). The BC-01 has an area of 255.55 sq.km. In the process of preparing this plan, comprehensive surveys on flora were carried out in the 90 sample plots in monitoring grid of 4km x 4km and fauna survey were carried out through transect walk along the trail. Socio-economic survey was also conducted for the people living in the vicinity of the BC-01.

For the avifauna, 20-20 MacKinnon Listing method was adapted to study the abundance and diversity of birds based on forest type. Socio-economic survey and public consultations were conducted under two gewogs. The survey covered 90% households (HH numbers) of Tsento gewog and Bjee gewog under Paro and Haa Dzongkhags respectively.

The survey recorded the evidence of 21 mammal species including Tiger, Snow leopard, Musk deer and Wild dogs.

The photographic evidence from the camera traps showed that the biological corridor is not only home for key species like Tigers, Snow Leopard and Takins, but also inhabited by other cat species like Asiatic golden cat, Leopard cat and common Leopard. Through the survey, it was also confirmed that the corridor is being used by Takin as it's summer habitat.

Avian fauna survey recorded a total of 49 species belonging to 30 genera and 16 families. However, records from both the present and past surveys showed that the corridor is home to around 183 bird species. The corridor is found as an important habitat for vulnerable bird species like *Gallinago nemoricola* (Woodsnipe) and totally protected bird species under FNCA, 2006 the *Lophophorus impejanus* (Himalayan Monal). Globally Near Threatened bird species like *Tragopan satyra* (Satyr Tragopan) was also recorded during the survey. The presence of restricted range bird species like *Actinodura nipalensis* (Hoary-throated Barwing) and significant and rare birds like *Lerwa lerwa* (Snow Partridge) was also recorded in the BC-01.

A total of 51 trees and shrubs belonging to 17 families were identified from 91 sample plots randomly distributed inside the corridor. Quadrate plots sized 20 X 20 m for trees and shrubs and 2 X 2 m for ground vegetations were established and enumerated for analysis. The results from the analysis showed 46 trees and shrubs classified to the species level, while others were identified to the genera and family level only. Besides 93 herb spp., 4 climber spp., 6 fern spp. and 8 orchid spp. were recorded from BC-01. From the recorded floral listings, 73 medicinal plants were identified. Cluster analysis of tree species with an arbitrary similarity index at 25% threshold generated 5 different forest types, namely Juniper Forest, Fir Forest, Spruce Forest, Hemlock Forest and Bluepine forest.

The overall life-form composition recorded considerable proportion of evergreen conifer trees with 71 % followed by Deciduous trees with 15%, evergreen trees with 5 %, evergreen shrub with 4.45 %, and deciduous shrub with 4.3% compositions covering two Gewogs.

Tsento Gewog under Paro dzongkhag is constituted by 5 Chiwogs and 18 villages with 905 households with a population of 5,946 (PHCB, 2017). Bjee gewog under Haa dzongkhag is comprised of 9 chiwogs and 25 villages with a total of 279 households with a population of 3230 (PHCB, 2017). The main occupation of the people in both the gewogs is agriculture followed by livestock rearing.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

Landscape in BC 1

Chapter 1: Background

1.1. Biological corridors in Bhutan

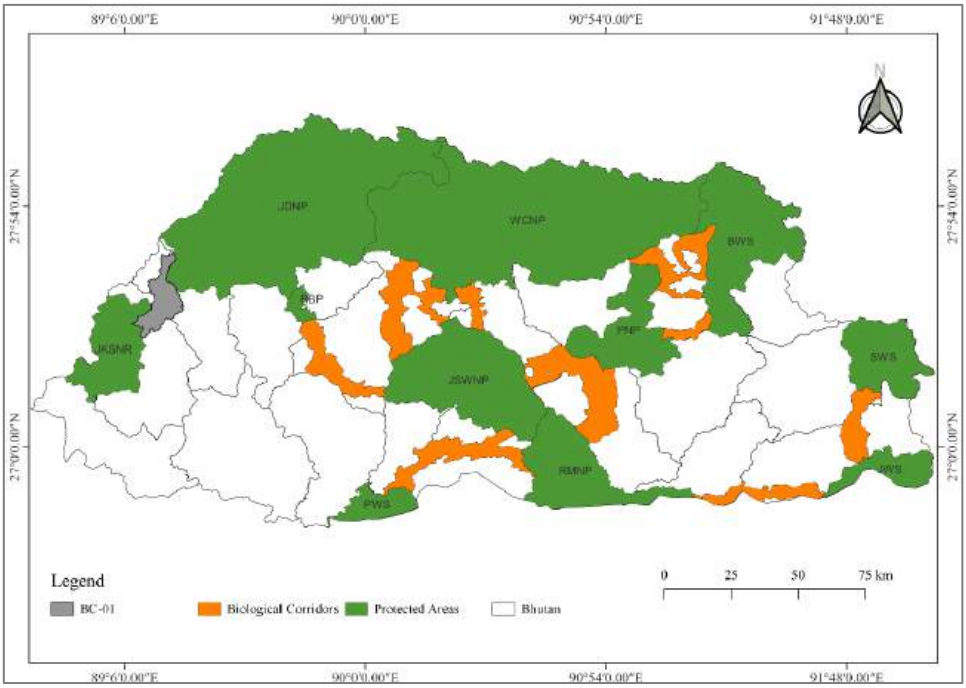

Figure 1. Overall map showing protected areas and Biological Corridors in Bhutan

Bhutan recognized the significance of habitat connectivity between the protected areas and have committed to its' maintenance and was first declared as "Gift to the Earth from the people of Bhutan" by Her Majesty Ashi Dorji Wangmo Wangchuck in the year 1999. Biological corridors make 7.73 % of the protected areas covering an area of 2966.54 km^2 in the country. This connectivity ensures continuous gene flow through uninterrupted wildlife movements and succession of habitats which greatly increase the conservation values of the protected areas as well as in buffering the impacts of climate change.

Initially, the status of Biological Corridors was set above State Reserved Forests Land (SRFL), but below that of Protected Areas. However, recognizing

the importance of Biological Corridors, the Forest and Nature Conservation Rules and Regulations of Bhutan (2017) now provides the Biological Corridors with equivalent legal protection status as is with the other protected areas.

There are 8 BCs in the country which connect the national parks, wildlife sanctuaries and strict nature reserve, forming the important Bhutan Biodiversity Conservation Complex. The management of biological corridors is vested within the Divisional Forest Offices (DFO).

1.2. Functions of Biological Corridors

Large-scale landscape connections maintained for movement, migration, and dispersal of ranging animals are referred to as biological corridors. The main purpose of the biological corridors is to provide connectivity to the different habitats while;

- Providing a secured migratory habitat to facilitate movement (dispersal or migration) of species.
- Preventing inbreeding of species which may otherwise lead to local extinction and,
- Providing a supplementary feeding habitat for animals.

1.3. Biological Corridor 01

The Biological Corridor 01 (BC-01) which lies in the north western part of the country connecting the Jigme Dorji National Park and Jigme Khesar Strict Nature Reserve is part of the Bhutan Biological Corridor Complex (B2C2) with an area of 255.55 sq.km.

The Membulung tsho ridge (89°15′9.535″E, 27°42′47.521″N), Soe Makhang (89°17′1.044″E, 27°43′28.980″N), Thangthangka (89°17′20.534″E, 27°42′27.695″N) and Tshundu zam (89°17′26.846″E, 27°41′57.188″N) marks the northern boundary for BC-01.

In the East, Pachhu separates BC-01 from JDNP. Boundary for BC-01 in the East runs along the Paachu, Nuberi Soe junction (89°15′37.931″E, 27°39′18.548″N), Shingkharab (89°15′27.304″E, 27°38′36.635″N), Shana (89°16′10.840″E, 27°36′50.223″N), Chuyul (89°17′36.249″E, 27°34′51.171″N) and along Mesi Zam ridge (89°18′57.440″E, 27°32′11.471″N), Chungey ridge (89°18′41.654″E, 27°31′26.627″N) and the top of Chudiphu (89°17′20.660″E, 27°29′49.210″N) located above Balakha village.

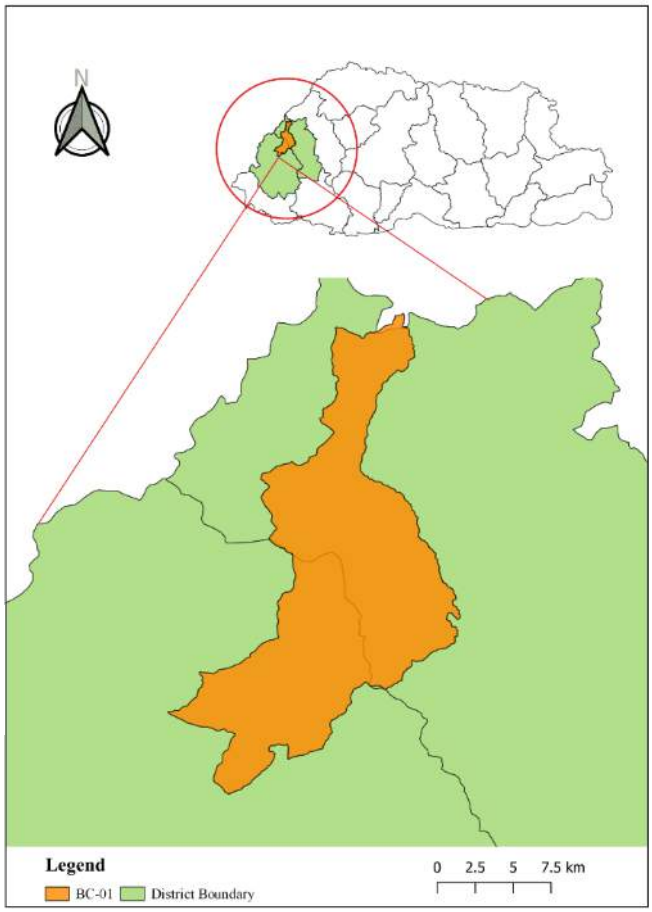

Figure 2. Map showing the location of BC-01

In the South, the boundary for the corridor extends towards the boundary of Tsento and Bji gewog (89°15′30.330″E, 27°28′56.740″N), Takha ridge (89°14′28.840″E, 27°27′38.460″N), and towards Damthang river (89°11′46.110″E, 27°26′23.050″N) and Halila (89°9′59.665″E, 27°24′27.591″N). In the West, the boundary spreads upward towards Pangkala (89°9′24.291″E, 27°29′18.068″N), the top of Haa chu (89°11′59.968″E,

27°30′43.039″N), Chuzomsa (89°11′59.600″E, 27°31′46.785″N) and Gongzola (89°12′32.408″E, 27°32′38.639″N). From Gongzola, it runs towards Pinchuna (89°12′11.518″E, 27°37′38.196″N), Garello (89°14′12.303″E, 27°38′54.077″N), the junction of Chekha and Nubri (89°13′45.991″E, 27°39′47.941″N), and then uphill towards Gaytsha Ringu (89°14′19.030″E, 27°40′36.407″N) till Chungla (89°14′6.028″E, 27°42′18.819″N)

1.4. Area Statement

BC-01 encompasses an area of 255.55 sq.km of which 44.63% is covered by forests, and 36.63% is covered by shrubs. Forests and shrubs occupy the maximum area in BC-01 with a combined area coverage of more than 80%. Area covered by built up structures and cultivated agriculture is the lowest with built up structures covering only 0.01% and 0.07% of the total area in BC-01.

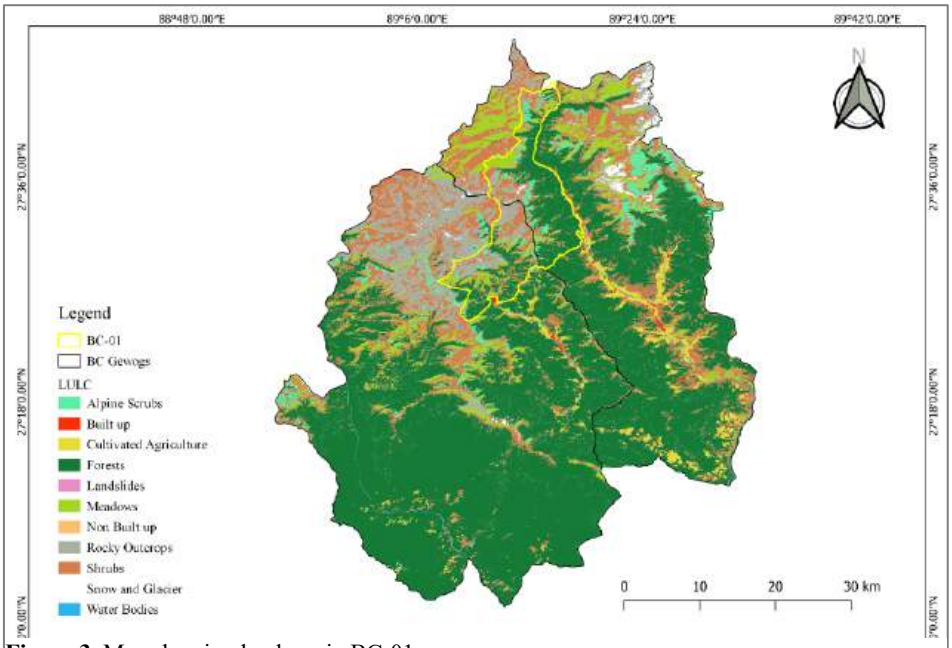

Figure 3. Map showing land use in BC-01

Table 1. Land use of BC-01

Land Use	Area (Ha)	Percentage Area
Alpine Scrubs	2024.42	4.13
Built up	3.31	0.01
Cultivated Agriculture	34.12	0.07
Forests	21874.3	44.63
Meadows	3589.36	7.32
Rocky Outcrops	3313.01	6.76
Shrubs	17952.1	36.63
Snow and Glacier	87.97	0.18
Water Bodies	128.97	0.26
Grand Total	**49007.56**	**100**

1.5. Vision, mission, and objectives of the plan

Vision: A structurally functional corridor for wildlife movement and genetic dispersal between the protected areas of Bhutan

Mission: To secure functional habitat contiguity between the two protected areas of JDNP and JKSNR through enhanced climate smart management of biodiversity and engagement of communities

Goal: Enhance conservation management for ecosystem goods and services and to strengthen the livelihood of the community

Objectives:

1. Conservation and sustainable management of natural resources
2. Adaptation and mitigation to impacts of climate change
3. Enhancement of livelihood of local people residing within and near BC-01

***Rheum nobile* in BC 1 Landscape**

Chapter 2: Current Status of BC-01

2.1. Landscape Characteristics

2.1.1 Topography

The consideration of the physical and biological characteristics is an essential element of land use planning. The physical and biological base is defined and identified by physiographic, geologic, vegetative, hydrologic and cultural characteristics. The general terrain of the biological corridor is moderate to very steep ranging from zero degree to 77 degrees. Steep areas mostly occur along the ridges and at many parts are inaccessible to people.

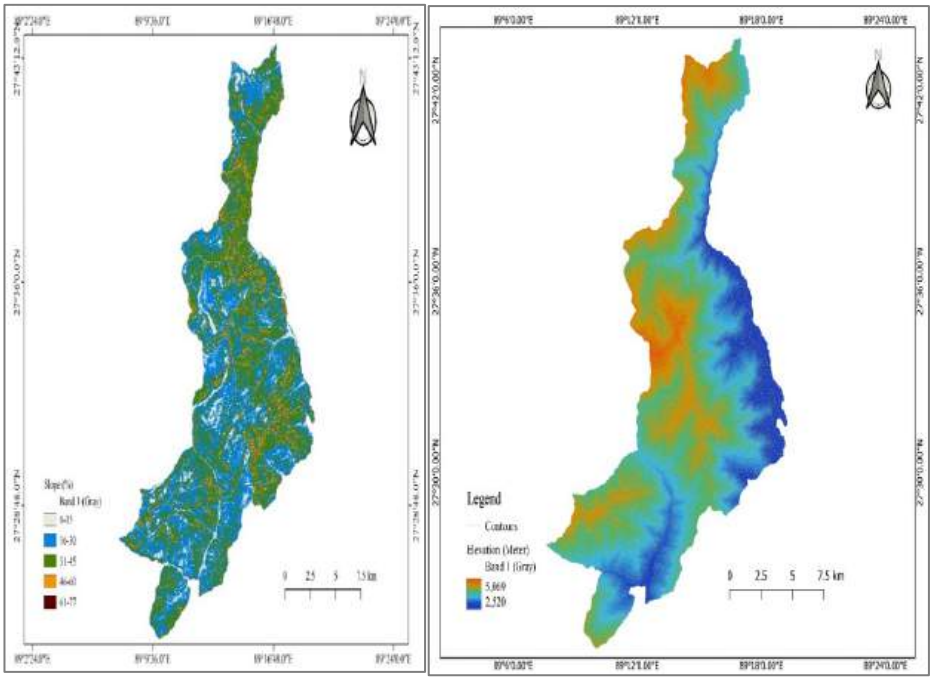

Figure 4. Map showing topography in BC-01

Around 23% of the Corridor area falls within the slope class of 35 to 45 degree making some parts of the corridor inaccessible to human (Figure 4). The steeper parts of the corridor are mostly located in the area falling under Paro Dzongkhag. A total of 1988.23 Ha equivalent to 8% of BC area falls above 45

degrees. The Haa portion of the corridor is mostly moderate in slope and mostly accessible. Almost 92% of the corridor falls within the slope range between 0-45 degree and are accessible. The lowest elevation starts from 2520 meters from Tsento Geog and goes up to 5000 meters in alpine areas. The major chunk of BC areas falls within the elevation range of 4000 – 5000 meters. This information can be used as baseline information during any future field survey designing and field work planning. Slope classification was done using 3 m resolution ASTER DEM of Bhutan.

Slope (degree)	Area (ha)	Area cover (%)
0-35	17663.73	69
35-45	5949.75	23
45 above	1988.23	8
Grand Total	25601.713	100

Table 2. Slop classification in BC-01

2.1.2. Climate

The climate data is important to understand the relation between the forest ecosystems and climate. Climate influences the structure and function of forest ecosystems and plays a vital role in forest health. The rapid change in climate may pose threats to forests, such as pest and diseases outbreaks, fire and drought. Therefore, it would be imperative to conduct experimental plots in different ecological zones within the BC-01 area to study the changes on forest ecosystems. Similar to other alpine and arctic zones of the globe, the climate condition in alpine zone remains cold, with intense irradiance and low partial

gas pressure. Heavy frost, blizzards and snow prevail throughout the year except for few months.

Meteorological data derived from station records of (Paro-DHHS, Class A & Haa Namgayling, Class A), from the Meteorology Section, Department of Hydromet Services, Ministry of Economic Affairs, Thimphu, shows that the weather data for the past 20 years recorded highest average maximum temperature of 23.08°C and lowest average minimum temperature of -3.96°C in 2009 at Paro Drugyal Dzong in the month of August and December respectively. Similarly, highest average temperature of 18.15°C was recorded in 2009 in the month of August and lowest average minimum temperature of 3.42°C was recorded in January 2007 at Haa Namgayling Dzong.

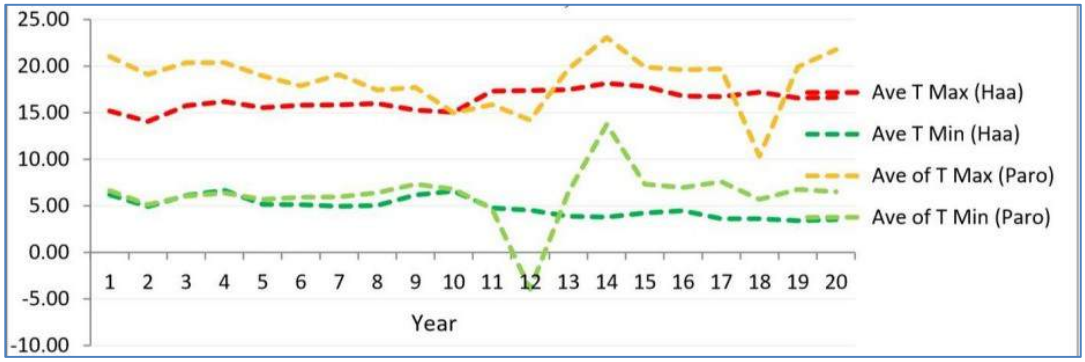

Figure 5. Average maximum and minimum temperatures for 20-year period of Paro and Haa.

Paro Drugyal Dzong station received the highest average annual precipitation of 6.89 mm in and Haa Namgayling station received the highest average annual precipitation of 3.41 mm (Figure 6).

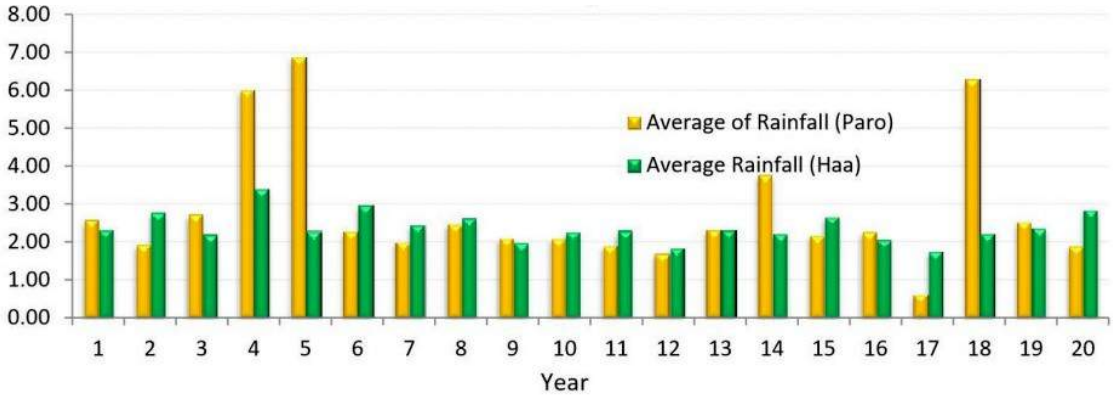

Figure 6. Average precipitation for Paro and Haa

2.1.3 Hydrology and Drainage

The fresh water and wetland ecosystems of BC-01 are also represented by high-altitude wetlands (alpine lakes), which are key components of the river basin system to the downstream. High altitude wetlands (alpine lakes) are treasured as sacred spots both in Haa and Paro dzongkhag's culture, and their preservation is crucial for the local people's myths and traditional beliefs. According to preliminary research, a total of 21 lakes of various sizes were found spread around the BC-01 area, serving as the watershed for tributaries of the Haa-Chhu and Pa chu rivers. Many marshy areas are also found scattered all along the alpine areas making this corridor an important watershed for both Haa and Paro Dzongkhags. The mapping of wetland and marshey areas must updated in near future for proper management.

2.1.4. Geology and Soil

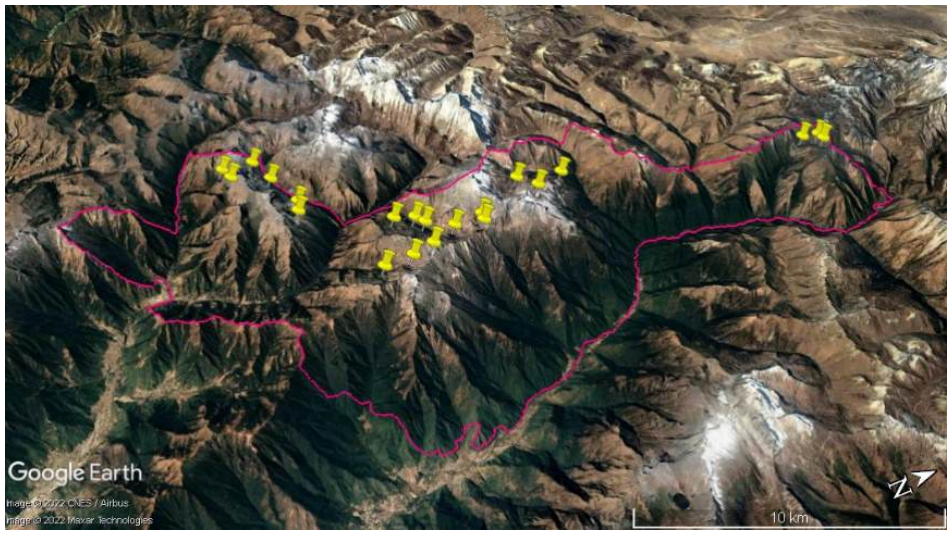

Figure 7. Google map showing location of lakes inside BC-01 area

The Corridor is located in the Central Crystalline Zone in the inner reaches of the lesser Himalaya. The rocks are of Gneiss Complex. The formation is characterized by migmatites and biotite-gneisses with thin bed of quartzite, quartz-mica schists, calc-silicate rocks, marbles etc. (UNDP 1991). Big rocks covering huge area are in many places especially in the northern and central parts of the corridor. Along the upper regions of the corridor beyond 4000 m elevation are mostly covered with rocky outcrops. The soils below 4000 m elevation tend to be fairly stable and are not prone to large scale or frequent surface erosion or landslides with moderate risk of erosion and gullying. However, meadows above 4000 m on steep slopes with sparse vegetation cover are at higher risk of degradation due to soil erosion and small-scale landslides.

2.2. Vegetation zones, land use and habitat types

The corridor has two major eco-floristic zones encompassing different vegetation; 1) Temperate zone and 2) Alpine zone (NBSAP, 2014). The corridor supports a wide range of forests and habitats on different land use types. Forest constitutes the dominant ecosystem with 85% of coverage. A total of 9 land use types are identified within the corridor (LULC, 2016) and within the different land use types identified, presence of 5 forest types (Shrub 34.59%, mixed conifer 30.63%, fir 24.10%, Bluepine 10.63% and broadleaf 0.04%) is reported which signifies faunal and floral diversity of the corridor.

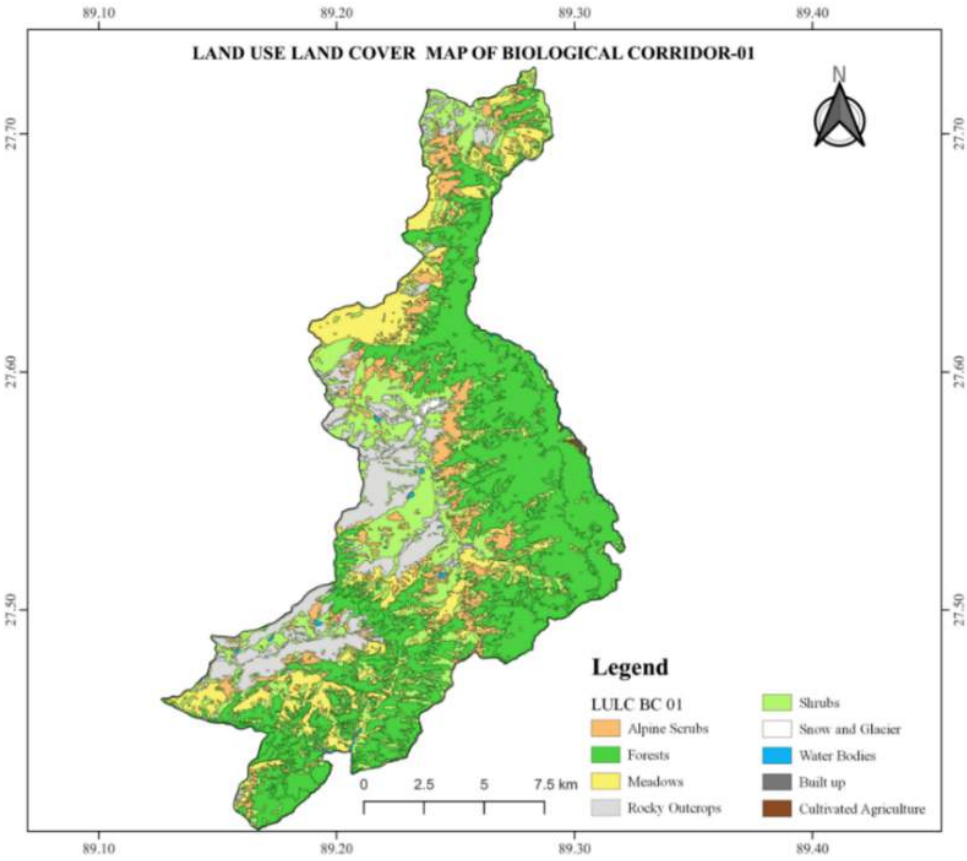

Figure 8. Land use map showing nine land use type classified inside the Bc-01

Table 3. Land use and Land cover map of BC-01

Land use	Area (ha)	Percentage (%)
Alpine Scrubs	1976.72	7.736
Blue pine	1851.88	7.248
Broadleaf	6.42	0.025
Built up	3.31	0.013
Fir	4200.38	16.439
Kamzhing	18.03	0.071
Lake	41.78	0.164
Meadows	2889.96	11.310
Mixed conifer	5340.27	20.900
Rivers	45.19	0.177
Rocky Outcrops	2882.06	11.280
Scree	190.73	0.746
Shrubs	6018.72	23.555
Snow and Glacier	85.81	0.336
Grand Total	25551.26	100

2.3. Important areas in BC-01

Besides playing significant role in conservation and protection of the natural flora and fauna species, the BC-01 also has identified major important sites due to its presence of endangered and vulnerable fauna species such as *Panthera tigris*, *Panthera uncia, Budorcas taxicolor whitei* and *Ursus thibetanus.* These animals were recorded during the national tiger survey 2021-2022 and national snow leopard survey 2022-2023 and majority of area falls towards western part of the BC. Moreover, the BC-01 has other management regimes such as Community Forest and watershed areas. One of the CFs fall under the jurisdiction of BC-01 at Lemdo under Tsento Gewog and the identified watershed is at Chuteyphu. These areas are monitored through SMART patrolling to enhance improvement and conservation of habitats.

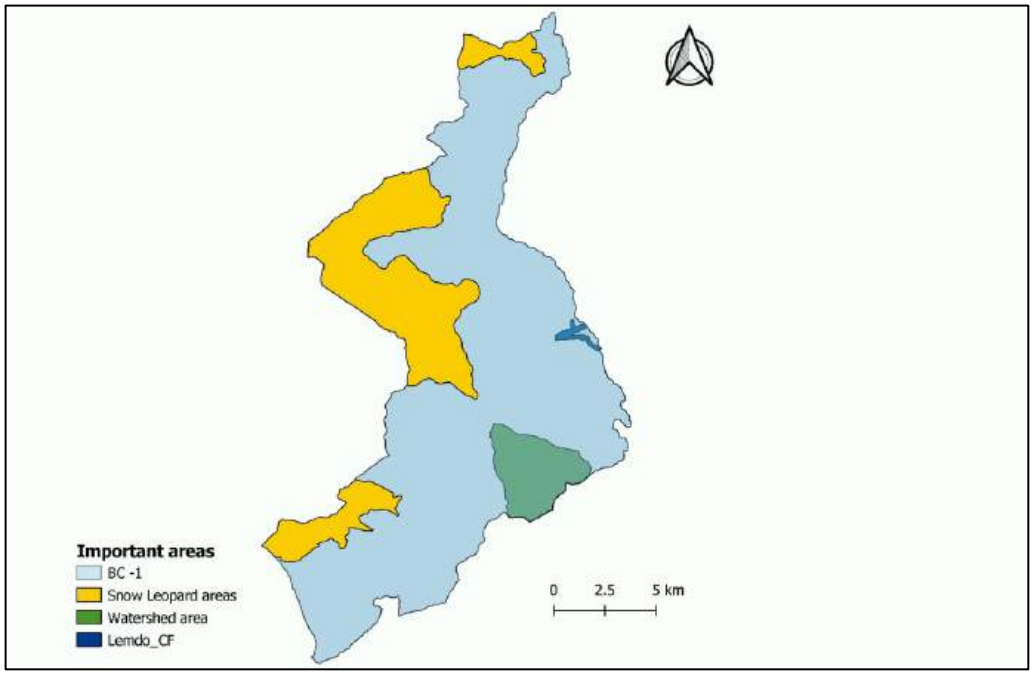

Figure 9. Map showing important areas in BC

2.3. Floristic composition of the major life-form distribution under each Gewog & the Forest type

2.3.1. *Floristic composition*

A total of 51 trees and shrubs belonging to 17 families were identified from 91 sample plots randomly distributed inside the corridor. Quadrate plots sized 20 X 20 m for trees and shrubs and 2 X 2 m for ground vegetation were established and enumerated for analysis. The results from the analysis showed 46 trees and shrubs classified to the species level, while others were identified to the genera and family level only. Two trees remained unidentified; it is yet to be identified. Of the total seventeen families (figure 10) identified, *Ericaceae* family dominated the composition with 11 species, followed by *Rosaceae* family with six species. 6 families (*Aceraceae, Araliaceae, Buddlejaceae*, *Grossulariaceae, Oleaceae* and *Theaceae*) were represented by single species each.

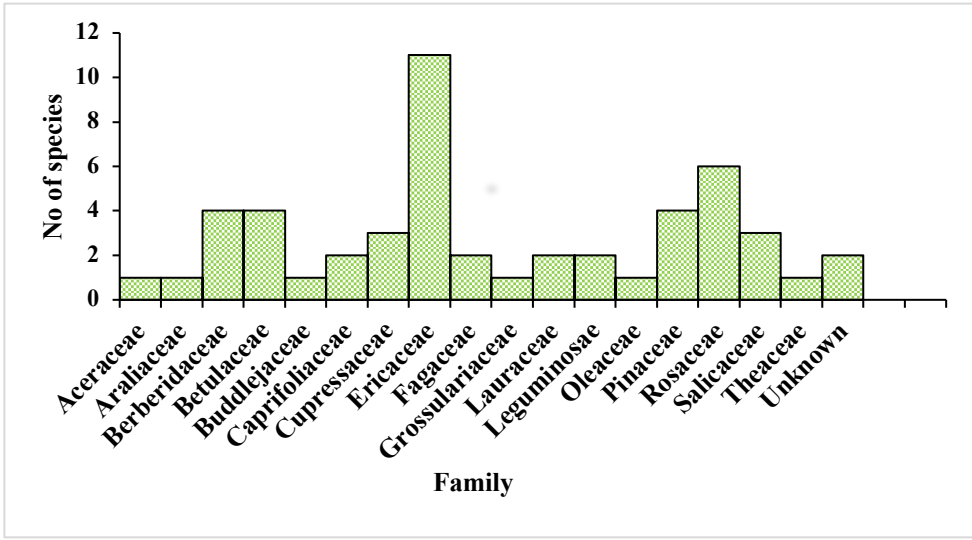

Figure 10. Family wise composition with total species

2.3. 2. Forest types

Cluster analysis was performed on PCORD (Version 5.1) and the graph distinctly depicted 5 forest types as explained below.

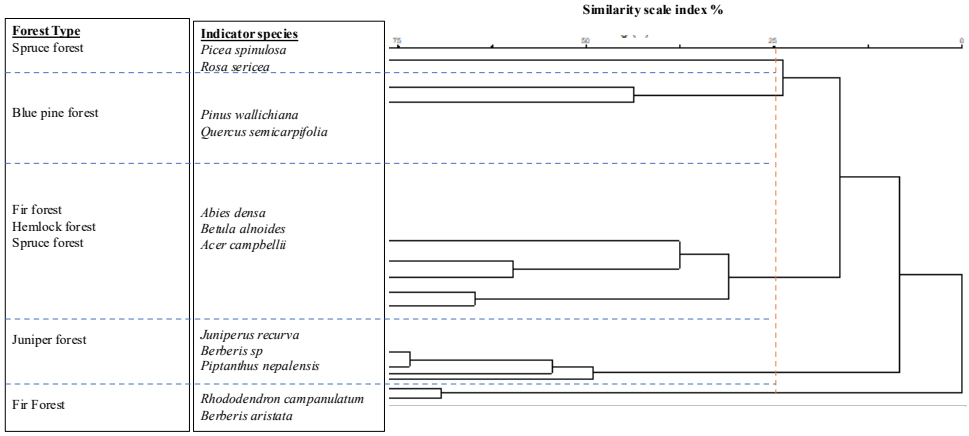

Figure 11. Cluster dendrogram

Cluster dendrogram showing sequential clustering of trees and shrubs using Relative Basal Area in % (RBA). Also depicts the data on 56 plots and the similarity index scale (%) arbitrarily marked at 25% portraying 5 cluster solution with red dotted lines. The cluster analysis was performed using distance measure of relative Sorensen (Bray-Curtis) and group average as linkage method.

2.3.2.1. Juniper Forest

Juniper Forest type was found at Chushola, Jigmeding, above Cheykha and Thangthangka within the altitudinal range of 4000-4600 masl and the dominant species recorded were *Juniperus recurve (M=25.4 SD=11.49 P*0.0002)* and *Berberis* sp. *(M=18.3 SD=10.76 P*0.0754).*

2.3.2.2 Fir Forest

This type of forest was found at Shingkharab , below Chushola, above Damthang, below Jigmeding, above Lamdo and below Thangthangka within the altitudinal range of 3079-4000 masl and the indicator species were *Abies densa (M=25.2*

*SD=7.61 P*0.0002), Rhododendron campanulatum (M=14.4 SD=9.4 P*0.0002), Berberis ristate (M= 11.1 SD=9.8 P*0.0980).*

2.3.2.3. Spruce forest

This forest types were found above lamdo, above Talung, above Shana and above Damthang within the elevation range from 2400-3070 masl and the most significant indicator species recorded were *Picea spinulosa (M=21.4 SD=11.7 P* 0.0004)* and *Rosa sericea (M=14.8 SD=10.5 P*0.0060).*

2.3.2.4. Hemlock forest

This type of forest was found above Lamdo, above Talung, Shingkharab, Damthang and blow Thangthangka within the elevation of 2500-4000 masl. The indicator species recorded was *Betula alnoides (M=21.3 SD=11.8 P*0.2342)*

2.3.2.5. Blue pine forest

This forest types were found mostly along the Pa Chhu valley, Tsento Zamsa and Drugyal Dzong area. The indicator species recorded were *Pinus wallichiana (M=18.2 SD=10.7 P*0.0010)* and *Quercus semicarpifolia (M=19.1 SD=11.2 P*0.0002).* Blue pine tree is the most preferred timber for construction.

2.4.3. Gewog wise life-form composition of trees & shrubs, and also ground vegetation

2.4.3.1. Trees & shrubs

The overall life-form composition recorded considerable proportion of evergreen conifer trees with 71% followed by Deciduous trees with 15%, evergreen trees with 5%, evergreen shrub with 4.45%, and deciduous shrub with 4.3% compositions covering two Gewogs (refer figure 12 for clarity).

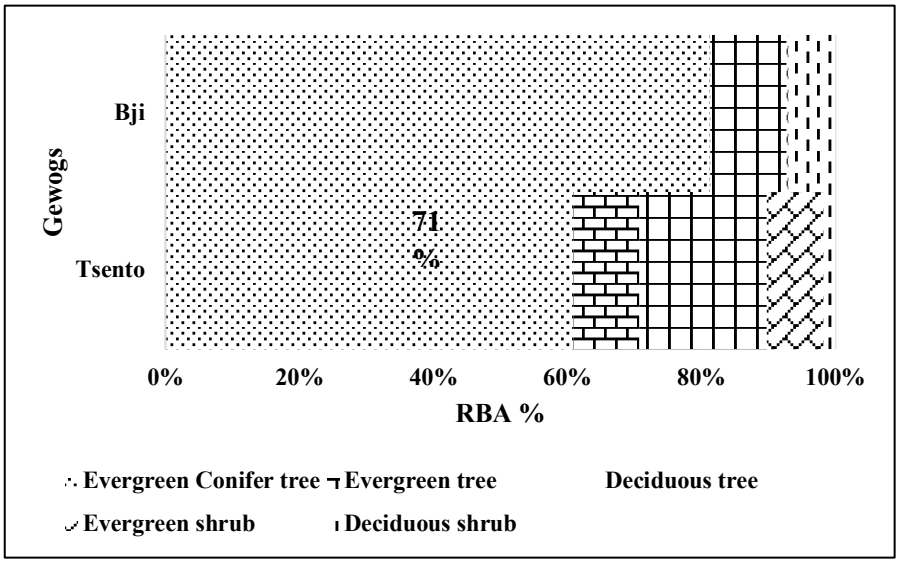

Figure 12.Gewog wise distribution pattern of five life form group of trees and shrubs

2.4.3.2. Ground vegetation

The life-form composition of the ground vegetation has considerable proportion of perennial herb with 51% followed by Graminoid with 24%, Annual herb with 9%, Climbers with 10%, Subshrub with 8%, spore bearing plants with 8% and undetermined plants with 0.3% compositions respectively (Refer figure 13 for clarity).

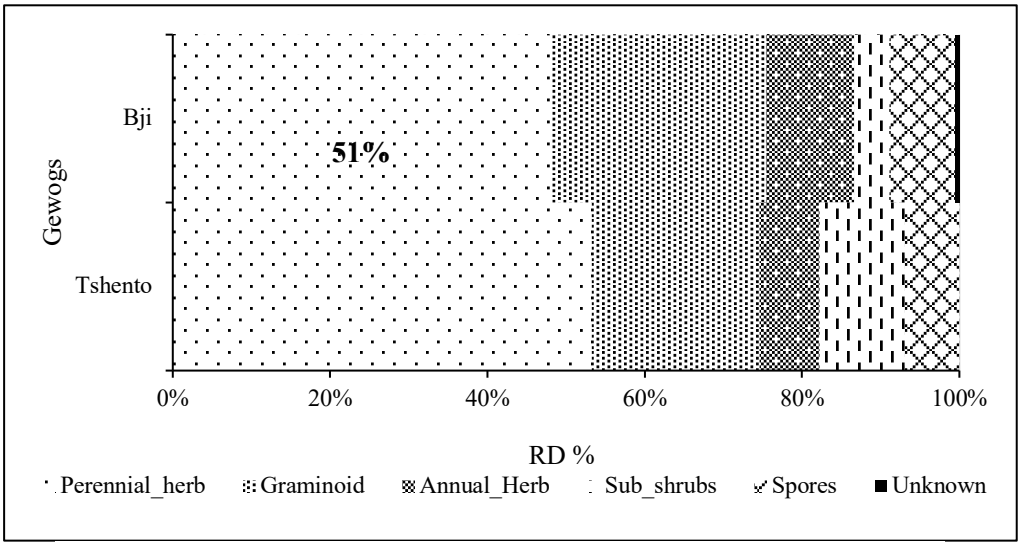

Figure 13. Gewog wise distribution pattern of five lifeform groups of herbaceous plants

2.4.3.3. Forest structural features under each Gewog

A total of four forests structural feature namely: maximum DBH, stem density, basal area, DBH, diversity, class distribution is shown in table 4.

	Tsento Gewog	Bji Gewog
Plot size (Tree)	20 X 20m^2	20 X 20m^2
Plot size (Herb)	2 X 2m^2	2X m^2
No. of Plots (Tree)	31	25
No. of Plots (Herb)	57	32
Species richness (count)	36	33
Bam^2/Ha	31	25
Highest DBH (cm)	120	130
Altitude Range (m)	2906-4666	3091-4281
Diversity (H')	2.38	1.74

Table 4. Summary of the plots surveyed under each Gewog with mention of plot size and forest structural features

2.4.3.4. DBH class

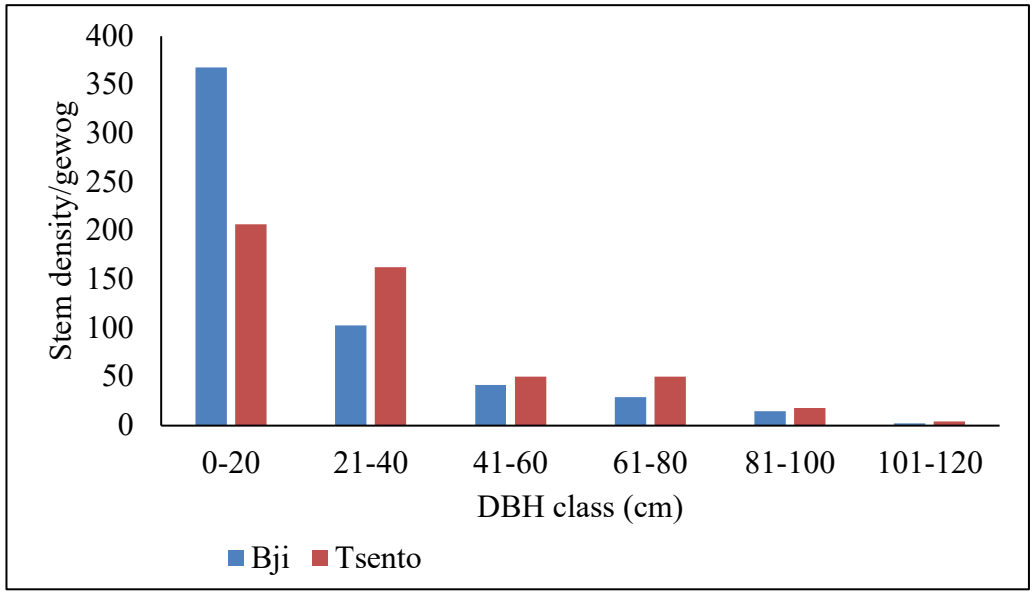

Figure 14.DBH class distribution of trees and shrubs under Bji and Tsento Gewog

The forest stand structural feature of the corridor is illustrated by DBH class distribution arranged at an interval of 20 cm with 6 classes as shown above.

2.4.3.5. Species dominance curve

The dominance curve showing the pattern of trees and shrubs ranked by abundance based on RBA% from highest to lowest inside the corridor as shown below.

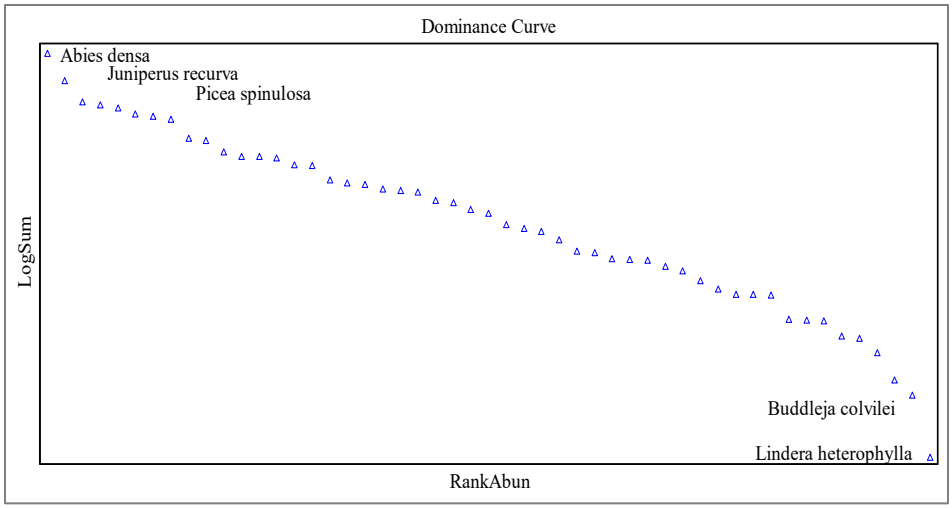

Figure 15. Species dominance curve of trees and shrubs

2.5. Threatened floral species (Description)

The corridor is home to some of the threatened flora species and conservation of these species will be of outmost importance to provide ecosystems' goods and services to the communities residing within and in the periphery of the park. The *Meconopsis superba* or White Poppy was recorded at Chala Dophu and Nubri but assessment on the population status, habitat characteristics and threat level of the species is fairly understood for the management of the species. The other threatened floral species recorded inside the corridor were *Cypripedium himalaicum*, *Nardostachys jatamansi, Paris polyphylla, Panax pseudo-ginseng, Taxus baccata* etc. And some of these species require further assessment for the conservation and sustainable management. There are as

many as 73 species of medicinal plants recorded during the survey. the direct and indirect threat observed were habitat loss, forest fire, human disturbances, browsing and climate change.

2.6. Faunal description

2.5.1. Mammal Diversity

The camera trap data from the National Tiger Survey (NTS) conducted in 2021-2022 was used for recording the mammalian diversity. A total of seven camera stations from the NTS fall inside the corridor. In addition, sign surveys were conducted both along the transects and within the 20m x 20m vegetation plots.

Figure 16.*Meconopsis superba* in its natural habitat at Chala Dophu and Nubree

A total of 13 mammals were recorded from the camera traps and seven other mammals were recorded from sign surveys along the transects. Together, a total of 21 mammals were recorded from BC-01. The observation frequency for Himalayan Serow was the highest while the observation frequency for blue sheep was the lowest (figure 18). The observation frequency of mammals was observed highest (n=16) in mix conifer forest and lowest (n=8) in alpine forest.

Figure 17.Schedule I Mammals found in BC-01 as per and act, 1995 and FNCR, 2017

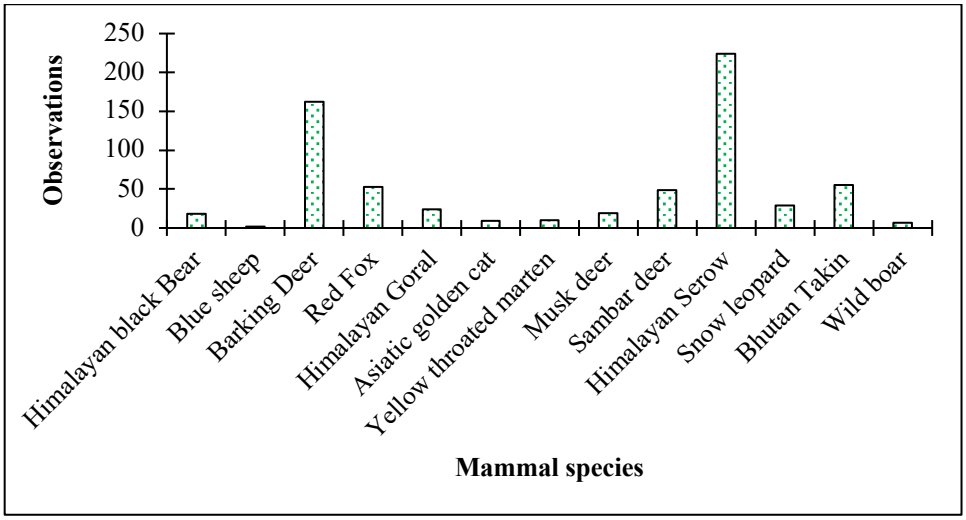

Figure 18.Graph showing the observation of mammals in BC-01

A total of five families of mammals were recorded. Bovidae (n=5) and Felidae (n=5) family was dominant in terms of frequency while Suidae (n=1), Mustelidae (n=1) and Ailuridae (n=1) families were the least dominant.

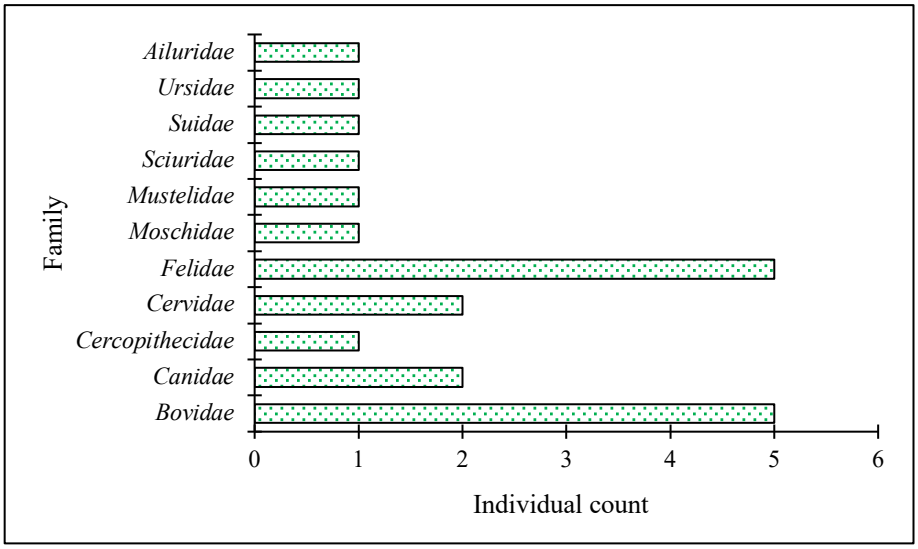

Figure 19. Graph showing family wise composition of mammals in BC-01

A total of 21 mammal species were recorded, of which four species fall under endangered category, six species under vulnerable and three species near threatened as per IUCN Red List (figure 20). The endangered mammals include

tiger, red panda, musk deer, and dhole while takin, gaur, sambhar deer, snow leopard, common leopard, and Himalayan beer are the vulnerable mammals.

Among 21 species found in BC-01. tiger, snow leopard, musk deer, takin, gaur, serow, red panda and Himalayan bear are listed in schedule I of Forest and Nature Conservation Act of Bhutan (FNCA) 1995.

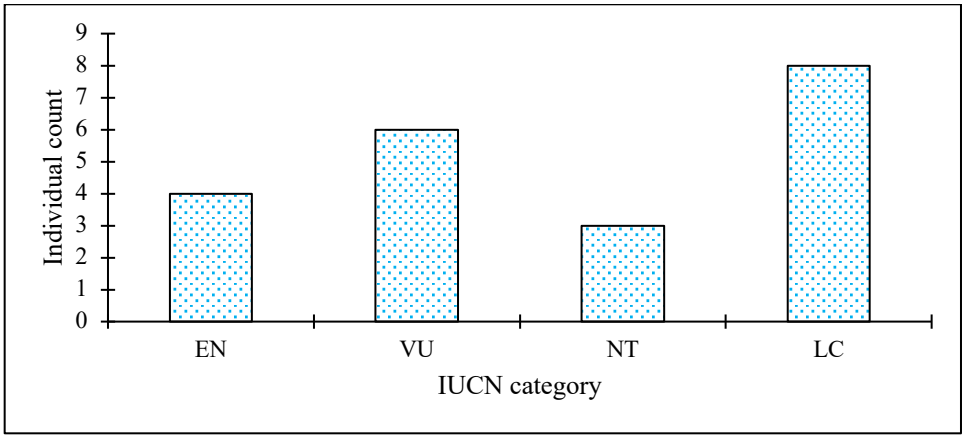

Figure 20. Graph showing IUCN list mammal found in BC-01

The capture of Bhutan takin (*Budorcas taxicolor whitei*) in BC-01 during national snow leopard survey-I in the year 2015-2016 is a conservation milestone of the biological corridor which recorded movement of takin from JDNP to JKSNR using BC-01 as a route. In December 2019, 07 individuals were sighted inside JKSNR which is possible through connectivity of BC-01.

Figure 21. Bhutan takin (*Budorcas taxicolor whitei*) in BC01

2.6.2. Avifauna Diversity

The BC-01 has a vibrant bird diversity and supports number of bird species of conservation concern. A total of 183 species of birds have been documented within the BC-01 and the adjoining areas of Paro Forest Division. The survey was conducted from August to November, 2021 for birds in 11 transects employing MacKinnon Listing method. The Rapid Biodiversity Assessment (RBA) survey recorded 49 species belonging to 30 genera and 16 families. According to the Red List, two species (Himalayan Griffon *Gyps himalayensis* and Satyr Tragopan *Tragopan satyra*) are Near Threatened (NT) and 47 species Least Concerned (LC). From the recent survey, five species of birds were recorded as additional list to the existing list. The recent RBA survey listing in BC-01 constituted 26% of the total bird species recorded in the BC-01 and adjoining areas of the Division.

Figure 22. Male Himalayan Monal (*Lophophorus impejanus*)

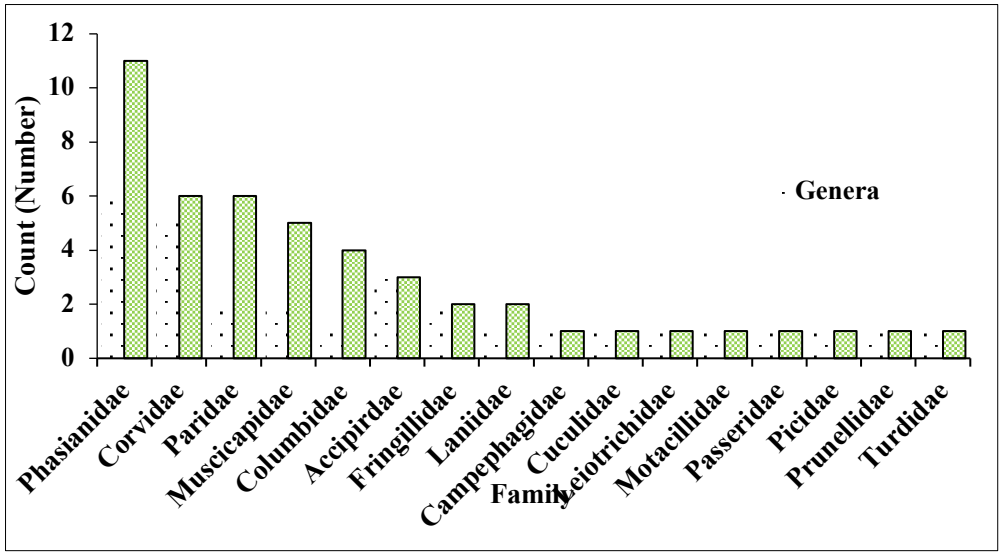

Figure 23. Showing the genera and number of individual bird species recorded in the BC-01

Phasianidae was reported to be the dominant family amongst sixteen families of birds in the BC-01 area. These group of bird species were mostly observed in the higher elevations from 2000 m asl to above 4000 m asl except for Kalij Pheasant.

2.7. Social and Demographic

Bjee Gewog is one of the largest among six Gewogs under Haa dzongkhag and has 9 chewogs with 279 households populated by 3230 people. The total area of the Gewog is 748.83 Sq Kms and is bordered in the north and north-east by Paro dzongkhag, northwest by China (Tibet), South by Sombey Gewog and East by Katsho and Sama Gewogs. The elevation of the gewog ranges from 2300 to 5525 m above sea level. Since the corridor area falling in the gewog falls within the alpine zone, climate is characterized by cold and dry winter and wet and cool summer.

Tsento Gewog is one of the 10 gewogs falling under Paro dzongkhag and the largest of them in terms of size with an area of 579.744 sq. km. It is in the north-western part of Paro Dzongkhag and is bordered by Lamgong gewog towards the south, Doteng, Naro and Lingzhi gewog in the east, Soe gewog in the north, Bjee gewog in the south-west and China in the north-west. The gewog is divided into 5 chiwogs with 905 households with a population of 5946 people. The elevation of the gewog ranges from 2400 to 5320 meters above sea level.

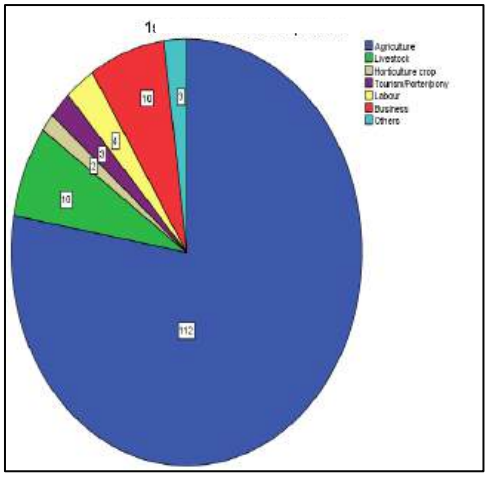

Figure 25. Income source

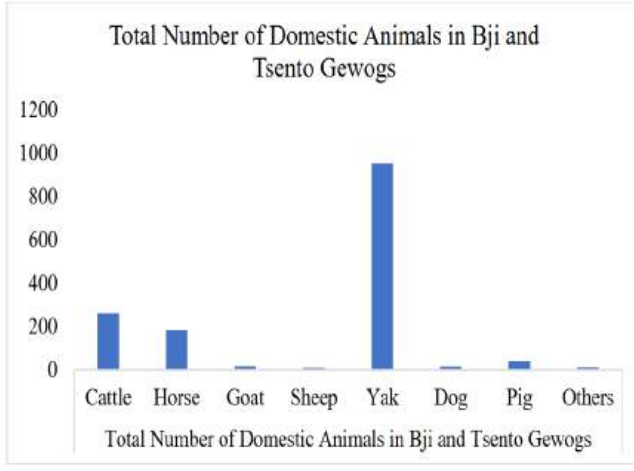

Figure 24. Livestock holding

The majority of the respondent (n = 112) in BC-01 depend on Agriculture as their main source of income followed by livestock and business (n = 10 each). The main crop grown are wheat, mustard, buckwheat, maize, and vegetables in both gewogs. Apple, potatoes and vegetables are the main source of income besides livestock and business.

People of Bji and Tsento domesticate a wide range of animals. The most common being yak followed by cattle and horse. Since the population of yak and cattle are high in the 2 Gewogs, considerable pressure on the grassland and forests of the biological corridor is foreseen if the animals are not monitored.

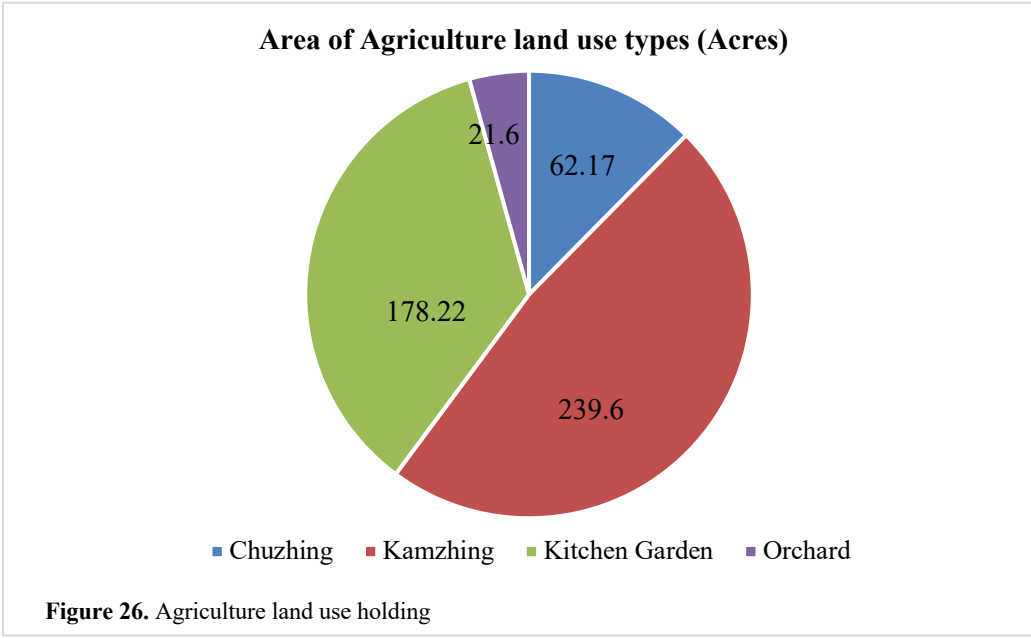

Figure 26. Agriculture land use holding

The chart depicts the total area of the different agriculture land use types in both Bji and Tsento Gewogs. A total of 239.6 acres of agriculture land is Kamzhing making it the largest agriculture land use type owned in terms of area. Kitchen gardens covering an area of 178.22 acres and chuzhing covering

an area of 62.17 acres are the second and third largest owned agriculture land use type in Bji and Tsento Gewogs.

2.8. Human Wildlife Conflict

The social survey resulted that, wildlife threat to agricultural produces and livestock is a major concern for the residents of Tsento and Bji Gewogs. During survey, many of the individuals depict negative attitude towards the conservation of wildlife in their locality especially for cases where local people are not incentivized or compensated for the losses.

Of the total 144 respondents, 55.6% (n=80) of the total respondents agree on damages caused by wild animals to their agricultural products and livestock to are frequent and intense compared to other problems. As a result, 62.5% (n=90) of them are against the idea of conserving wildlife in their locality because of the severity of the damages caused by the wild animals especially to their agricultural crops.

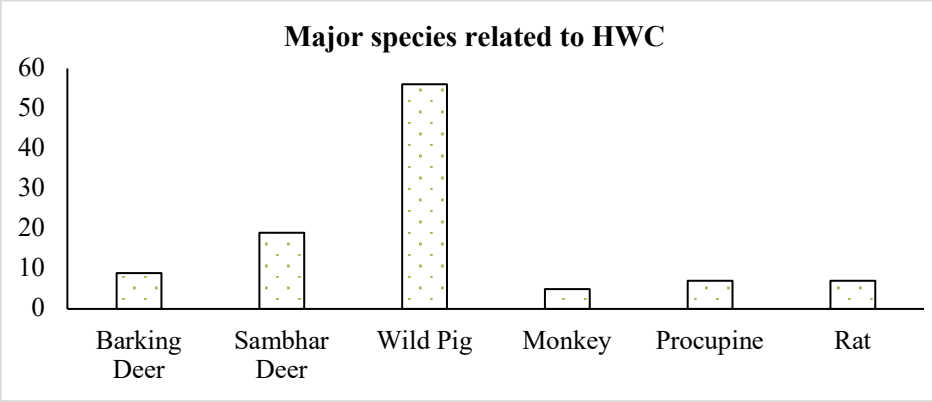

Figure 26: Conflicting wild animals' species which causes HWC

Among the list of wild animals, which are believed to be the main cause human-wildlife conflicts in Bji and Tsento Gewogs, most of the respondent reported wild pigs as the most problematic animal followed by Sambhar deer and Barking deer as per the graph above

Table 5: Incentives (ICDP)

	Frequency	Percent
Yes	33	22.9
No	111	77.1
Total	**144**	**100**

On the topic of incentives provided to the farmers in BC area, 77.1% (n=111) of local people have not been compensated in most of the cases. Only 22.9% (*n*=33) of the total respondents received incentives and compensations for their losses

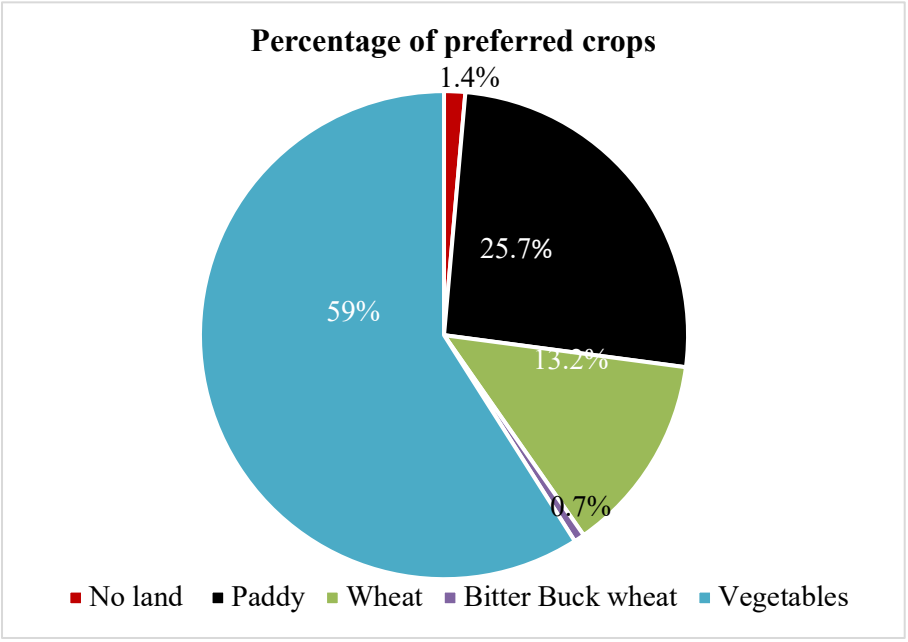

Figure 27. Crop preference graph

Vegetables are the most grown crop of the respondents from Bji and Tsento Gewogs. Paddy and wheat follow vegetables in the preference rating of crops by the respondents.

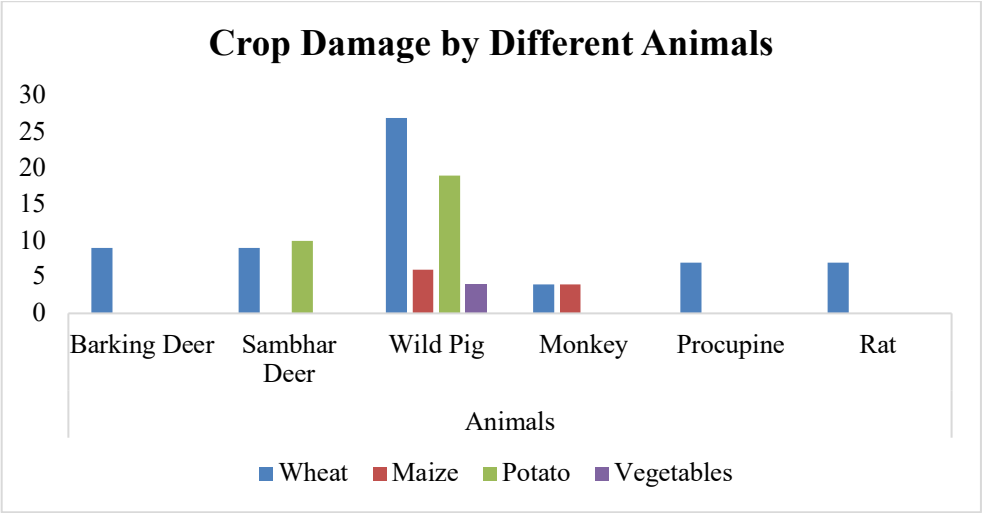

Figure 28. Graph showing crop damage by different wild animals

The people of Bji and Tsento reported damage of crops such as wheat, maize, potato, and vegetables by the wild animals. Among which the most affected is the wheat followed by potatoes and then maize and vegetables.

Table 6. Problems faced by respondents related to agriculture farming

Problems	**Frequency**	**Percent**
Poor accessibility to Market	7	4.9
Shortage of labour	15	10.4
Insufficient land	40	27.8
Damage by wild animals	80	55.6
Lack of irrigation water	2	1.4
Total	**144**	**100**

Among the various problem listed above, 55.6% (n=80) of the total 144 respondents stated damage to agriculture crops by wild animals was recorded to be the major problem faced by the farmers in the Biological Corridor. 27.8% (n=40) of the respondent listed insufficient land as the 2nd major problem faced by the farmers followed by a shortage of labour as per the table shown above.

Table 7. Severity of Crop Damage by wild animals

	Frequency	Percent
Severe	55	38.2
Moderate	43	29.9
Minor	46	31.9
Total	**144**	**100**

Regarding the severity of crop damage, 55 respondents making 38.2% (n=55) of the total respondents believe crop damages caused by wildlife to be severe while 46 respondents making 31.9% (n=46) of the total respondents believe the damages are minor as shown in table above.

Table 8. Livestock depredation

	Frequency	Percent
Yes	28	19.4
No	116	80.6
Total	**144**	**100**

On the topic of livestock depredation, only 19.4% (n=28) of the total respondents have experienced livestock depredation by wild animals while 80.6% (n=116) of the respondent has not experienced any loss of cattle to wild animals.

Table 9. Severity of livestock depredation

	Frequency	Percent
Severe	24	16.7
Moderate	21	14.6

Minor	99	68.8
Total	**144**	**100**

While questioning about the severity of livestock depredation, 16.7% (n=24) of the total respondents considered livestock depredation by wild animals as severe, while 68.8% (n=99) of the total respondents reported it to be minor. While the remaining of the 14.6% of the respondents considered livestock depredation by the wild animal to be of moderate severity.

2.9. Perception on conservation of BC

Table 10. Awareness on BC

	Frequency	**Percent**
Yes	83	57.6
No	61	42.4
Total	**144**	**100**

Regarding awareness on BC, 57.6% of the total respondents (n=83) were aware of biological corridors that passes through their area and they were also aware about of the importance of having Biological Corridor and its function.

Table 11. Poaching activities in the area

	Frequency	**Percent**
No	132	91.7
Don't know	12	8.3
Total	**144**	**100**

On the topic of awareness on poaching, 91.7% (n=132) of the total respondents believe there are no poaching activities in Bji and Tsento Gewogs and 12 of the respondents were not aware of whether poaching is occurring or not.

Table 12. Need for conservation of wildlife

	Frequency	Percent
Agree	33	22.9
Do not Agree	90	62.5
No idea	21	14.6
Total	**144**	**100**

A total of 90 respondents (making 62.5%) of the total respondents do not support conservation of wildlife while 33 respondents making (22.9%) of the total respondent support conservation of wildlife. This shows that there needs to be a concentrated effort from DoFPS to create more awareness and educate people on the need and importance of wildlife conservation and the Biological Corridor.

2.10. Forest Resource area

2.10.1. Bjee gewog

The use of forest for grazing, collection of firewood and timber for construction was traditionally sanctioned as part of customary rights (RGoB, 1979). The right and the privileges of the local inhabitants, concerning the forest use is as per the Forest and Nature Conservation Act of 1995 and the National Forest Policy of Bhutan, 2011. According to the Forest and Nature Conservation Act, grazing, collection of firewood, fodder and leaf mold for domestic uses were allowed either free or on royalty basis. Collection of firewood is permitted from only dead and fallen trees. Timber trees are issued for bona fide domestic use, after they have been marked by a Forest Officer and royalty has been paid. Hunting wild animals is completely prohibited in the forest (DoFS, 2004).

Forest in case of Bjee gewog is the main source of their daily livelihood. They depend on forest and its resources on daily basis for timber, firewood, none wood forest products like leaf mold and mushrooms. Further, forests serve as the main grazing ground for cattle and yaks. As per the Local Forest

Management Plan, Annual Allowable Cut for the Bjee was fixed at 723 m^3 for the plan period of July 2014 to June 2024.

From year 2018 to 2019 people of Bjee gewog availed 178000 Cft for new construction and 7000 cft for renovation of houses. In year 2020 to 2022, 729 numbers of drashing size timber for new construction and 36 numbers of drashing size timber for renovation of houses on rural concessional royalty. The people availed these number of trees mainly for construction of new houses, renovation of old houses, cowshed construction and flag poles from vicinity of Talung and Damthang areas.

2.10.2. Tsento gewog

Tsento gewog has a large tract of land under forest cover dominated by mixed conifer followed by conifer and broadleaf forests types. People depend on forests for timber, fuel wood, leaf litter, fodder, incense and collect NTFPs like mushrooms and ferns. Blue pine is the most favorable timber species while spruce and hemlock are also used. Fir is usually used for producing roofing shingles. As per the Local Forest Management Plan, Annual Allowable Cut for the Tsento was fixed at 843 m^3 for the plan period of July, 2018 to June 2028.

From year 2018 to 2019 people of Tsento gewog availed 86000 cft for new construction and 5500 cft for renovation of houses. In year 2020 to 2022, 1247 numbers of drashing size timber for new construction and 44 numbers of drashing size timber for renovation of houses. The people availed these number of trees mainly for construction of new houses, renovation of old houses, cowshed construction and flag poles from the vicinity of Chuteyphu, Chuyuel, Lamdo and shana areas.

Table 13. Timber allotment in four years

Gewog	Year 2018-2019		Year 2020-2022	
	New construction (Cft)	Renovation (cft)	New construction (numbers)	Renovation (numbers)
Tsento	86000	5500	1247	44
Bjee	178000	7000	729	36

Chapter 3: Threat Analysis

3.1. Conservation threats

The threat analysis in conservation planning and management forms an integral part of conservation planning and in the management of protected areas. The threats are identified and threat ranking is done to prioritize different strategic interventions as given below as per the Miradi rankings.

The overall threat assessment for Paro Forest Division was **Medium** (Table 18). The threat habitat fragmentation and degradation through NWFP collection, forest fire, illegal timber harvesting, infrastructure development, erosion and landslides was ranked **Medium** and probably will have high impact on conservation and sustainable management of wildlife and forest resources. The listed threats required management actions to stimulate efforts towards conservation. Beside habitat fragmentation and degradation, all other threats including wildlife crime, pest and diseases, climate change and human wildlife conflicts were ranked **Low**.

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

Threats \ Targets	Conservation and sustainable management...	Adaptation and Mitigation of clima...	Enhancement of livelihood of lo...	Summary Threat Rating
Wildlife Crime: Poaching & Illegal Trade	Medium			Low
Habitat fragmentation and degradation	High			Medium
Pests and transmission of diseases	Medium			Low
Climate Change		Medium		Low
HWC: Retaliatory killing (crop & livestock depredation)			Medium	Low
Summary Target Ratings:	Medium	Low	Low	Overall Project Rating: Medium

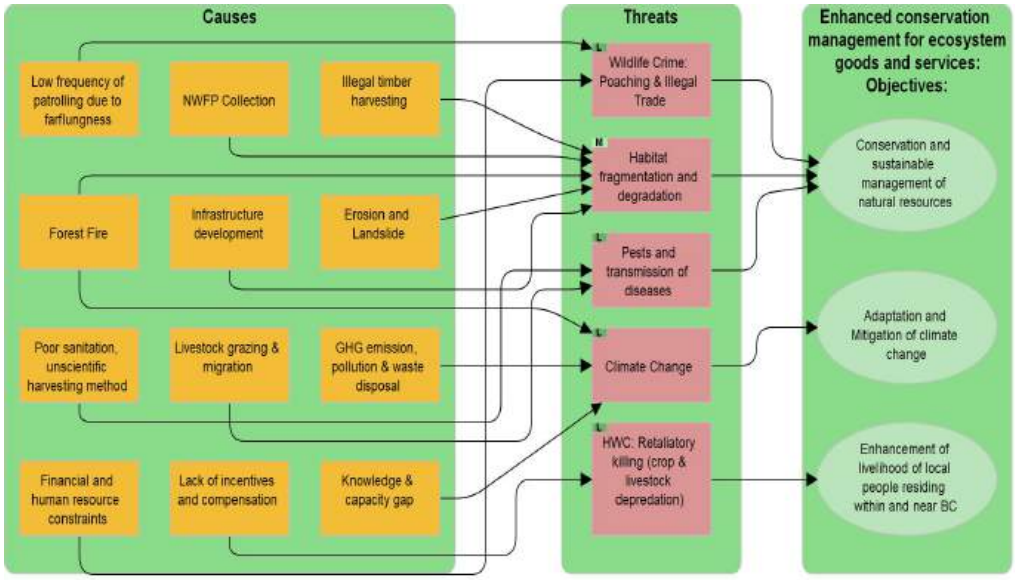

Figure 29.Schematic representation of threat and its causes for BC-01

3.1.1. Habitat fragmentation and degradation

3.1.1.1. NWFP collection

In addition to grazing and illegal felling of the trees, NWFP collection is one of the drivers that contribute to habitat degradation. Alpine habitat is continuously disturbed from rampant and unsustainable collection of high valued medicinal and incense plants like *Nardostachys jatamansi*, *Panax pseudoginseng*,

Neopicrorhiza kurroa, *Ophiocordyceps sinensis*, *Rhododendron* spp*., Juniperus* spp. The demands and value possessed by such species have led to unsustainable harvesting and such method impedes regeneration of the meadow, causes soil erosion, and continues to degrade the ecology of this alpine ecosystem. The alpine meadows served as pasture land for prey species such as blue sheep and domesticated yaks however, uncontrolled collection of NWFP leads to land degradation in alpine meadow areas. The Division Office has recorded 468 kg *Picrorhiza* species and 361.55 kg *Nardos* species and 400 kg of *Paris* species illegal in past years.

3.1.1.2. Illegal timber felling

The BC-01 harbors a good amount of timber resources as per resource assessment and the most of accessible areas of BC-01 were recorded high illegal extraction of timber by the people from Bjee, Tsento and other adjacent gewogs. The illegal extraction of timber from conservation areas may lead to wildlife habitat degradation and fragmentation. From 2018 to 2021, the Division has overall record of 49207.5 cft of illegal timber from Haa and Paro.

3.1.1.3. Forest fire

Although there were no major incidents of forest fire being reported inside BC-01, however considering the unparallel affects it brings to biodiversity and the aesthetic view of an area, it is important to ensure that there are all time preventive measures are in place and the area is monitored to protect the area from fire. Since majority of BC area is under mixed-conifer forest which is moderately susceptible to the forest fire during dry and windy season, it is necessary to equip field staffs with firefighting equipment and train them on firefighting techniques. The timely monitoring by field staff so far has contributed in reducing the number of forest fire incidences. 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.

From 2015-2020, we have recorded 14 incidences (1189.87 acres) at different location of forest fire in the Division.

3.1.1. 4. Infrastructure development

Across the globe, developmental activities are considered as one of the major threats on wild flora and fauna and its habitat. Shana to Nuberee transmission line runs through the BC-01 and the Bhutan Power Corporation Limited (BPCL) clears bushes and trees falling within the 12 meters corridor which leads to fragmentation and degradation of wildlife habitat. In addition to the existing transmission line, there are settlements within the periphery of BC-01 boundary and creating possibility of encroachment in the future. Overall, the Division has recorded more than 30 incidences of illegal road construction in the state reserved forest land from 2018 to 2021. In this regard, a constant SMART (Spatial Monitoring and Reporting Tool) patrolling and implementation of strict rules as per the land act is found extremely important as part of conservation of BC in collaboration with Dzongkhag Administration and Local Government.

3.1.1.5. Erosion and landsides

During the resource assessment and SMART patrolling in the BC areas, it was observed that there were several erosion and landslides areas especially in the alpine meadows. During the rapid biodiversity survey, physical evidences of overgrazing were observed in the alpine meadows causing landslide and erosion. Soil compaction and trampling of vegetations by the animals including domesticated yaks and wild mountain ungulates causing soil erosion and gully formations in various sites. As per the social survey response, the intense grazing competition by Blue sheep to the domesticated Yak was indicated as one of the major threat to the highland herders as the population trend of Blue sheep was observed in an increasing trend. Further, the competiton is aggravated by the summer visiting population of takin and around 25 to 30 individuals of takin was recorded. These are the factors leading to soil erosion

and landslide that contribute towards degradation and wildlife habitat fragmentation in the BC.

Figure 30. Erosion and landslide at Nuberee

3.1.2. Pest and diseases

Small patches of forest adjacent to BC were observed with incidences of dieback and bark-beetle infestations, thus the possibility of spreading to the forest inside the BC area is extremely high. Therefore, proper sanitation and scientific management is prerequisite to prevent from pest infestation and diseases infection to the flora inside BC areas.

In the year 2021, there was a record of 13 numbers of takin dead cases in Nuberee areas. Livestock officials also cautioned about the possibility of the spread of the disease known as “Black Quarter” which is caused by a bacterium (*Clostridum chauyoei*) from yaks and horse to wild ungulates. Feral dogs were observed as carrier for another agent in transmission of diseases like canine distemper and rabies to the wildlife and these possess high risk to the wildlife in the BC.

Yak is a major part of livestock for peoples’ livelihood of Bjee and Tsento highlander. The recent social survey showed that, a total of 3147 and 1831 yaks

in Bji and Tsento Gewogs respectively. They migrate their yaks from one place to another in alpine meadows due to shortage of winter fodders and freely graze their yaks in alpine meadows. The free-range grazing of livestock may lead to transmission of Gid diseases (a pathological condition in young yaks) to other wild animals such as blue sheep, sambar, musk deer and takin. As per information provided by the Livestock Officer, yearly five to six cases of Gid (Coenurosis) diseases were reported from Nuberee and Bjee under Haa Dzongkhag.

3.1.3. Climate change

3.1.3.1. Forest Fire

There were 14 incidences (1189.87 acres) of forest fire recorded in the Division from 2015-2020. There was no record of forest fire cases in BC but majority (20.90 %) of BC area is under mixed-conifer forest which is moderately susceptible to the forest fire during dry and windy season. Therefore, it is necessary to equip field staffs with firefighting equipment and train them on firefighting techniques. The increasing trends of forest fire will lead to one of the factors that contribute towards the climate change.

3.1.3.2. GHG emission and Waste problem

According to Intergovernmental Panel on Climate Change (IPCC, 2007), the Himalayas are more vulnerable to rapid climate change and its associated erratic weather patterns. Especially, mountain ecosystems and their biodiversity are 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). The social survey shows that the communities of the two gewogs are already becoming victims of global climate change. Either delayed or early onset of precipitation immensely impacts their cropping system. The rapid drying of local water sources is seen as a prominent challenge. The increase in temperature and erratic precipitation could pose a great threat to the overall habitat of the wildlife.

Unmanaged waste in the SRF is yet another concerned to the conservation and protection of BC-01. Waste from grocery including other goods such as plastics, clothes, bottles, and batteries were observed along Sagala trek and Shana to Nuberee track route. Besides, cordyceps collector in Nuberee areas, trekkers produce large amount of waste in alpine meadows due to non-availability of waste collection point and poor waste management system in place. Therefore, these irresponsible practices must be prevented through sensitization and education to the commuters to ensure that they bring back all the solid waste that is taken into the alpine areas backed up by enforcement of rules and regulations along with other innovative measures to ensure strict implementation of the policy.

3.1.2.3. Knowledge and capacity gap

The capacity and knowledge on climate change is key to the frontline staffs for effective management of BC. 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 advance skills and knowledge on a wide range of topics. Capacity building opportunities of the field staff and low literacy rate of the local communities remain as a significant challenge for the management of BC in the field of conservation.

The advancement of knowledge and improving skills in the field of conservation for managing the area at best is found to be genuine. Therefore, the government and the doner agencies from around the globe needs to intensify and support in building capacity of the frontline staff for smooth functioning and management of the BC.

3.1.4. Human Wildlife Conflict: Retaliatory killing

3.1.4.1. Lack of incentives and compensation

The yaks/cattle depredation, crop damage and property raids by the wild animals are common and widespread within the vicinity BC. The Himalayan bear was reported to be one of the main wildlife species coming in conflict with

the people, livestock and often threatening the lives of school going children. Besides this, the snow leopards have been reported to be causing menace to the highlander who depends their livelihood solely on yaks herding in Bjee and Nuberi. With no proper compensation scheme in place, the highlander often resorts to retaliation out of anger. Therefore, an innovative compensation mechanism needs to be put in place to compensate the people for loss of their animals' wild predators such as tiger, snow leopard and himalayan bear to avoid retaliatory killing of such species. Among the various initiatives taken by the people to reduce crop depredation, the most preferred mitigation measure is fencing followed by guarding their field at night.

An alternative income generating opportunities can to be explored for the yak-herders through community-based nature and/or research tourism programs. Other viable solutions like construction of "predator proof corrals" to prevent or at-least minimize yak depredation by Snow leopards and search light to chase away the snow leopards were provided to 18 households in Nuberi.

3.2. Management threat

3.2.1. Porous International Boundary

Closeness of the corridor to the porous international boundary on northern part of BC-01 acts as illegal international trade route, and is difficult to monitor due to security reason, weather, and rugged terrain. This area has limited access for normal and regular patrol. Records of seizure of illegal timber and trophies have been made in the past years by patrolling team along the BC.

3.2.2. Lack of Infrastructure and shortage of staff

The lack of reliable infrastructure such as transit camps and guard/outposts especially in the northern part of the BC area has hampered in efficiently implementing protection and conservation activities. Additionally, patrolling and monitoring of activities have always remained as the greatest challenge for the management due to rugged terrain, weak/poor communication network and

mobility for surveillance. The remote and porous international border in the north is 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. Communication can be improved through the usage of modern and efficient. Poor communication facilities can be improved by purchasing best walkie-talkie sets for every individual staff and handset 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 necessary gears on regular basis to tackle any sort of field related issues. Moreover, there is no separate staffs designated to manage particularly for BC and it was managed from the Division office which hamper in regular patrolling and carrying out research work in BC.

Chapter 4: Management Interventions (Prescription)

The strategies and actions in this management plan are based on the overall goals and objectives to achieve the vision and mission of protecting and to conserve the biodiversity while continuing to improve the livelihood of the local people living in and around BC. These strategic actions will try to address the issues, threats, and challenges to overcome the barriers of the conservation objectives set herein.

17 actions which are detailed below, under seven strategies and three objectives have been identified for implementation in the next 10 years.

Objective 1: Conservation and sustainable management of natural resources

Strategy 1.1. Strengthen the wildlife crime prevention: Poaching and illegal trade.

Action 1.1.1. Set up central command center for managing law enforcement monitoring data at Tsento Beat Office.

Action 1.1.2. SMART data model and reporting requirement training to smart focal

Action 1.1.3. Equip BC range office with law enforcement equipment and office furniture

Action 1.1.4. Conduct long range SMART patrolling to rule out any wildlife poaching and illegal harvesting

Strategy 1.2. Ensure species persistence through monitoring and research.

Action 1.2.1: Conduct research or study on following key species

- Tiger population survey through camera trap and sign survey
- Snow leopard survey and monitoring through camera trap
- Musk deer occupancy study through camera trap and sign survey.
- Red panda occupancy study through camera trap and sign survey

Action 1.2.2. Conduct research/study on medicinal plants

Objective 2: Adaptation and mitigation of climate change

Strategy 2.1. Prevent habitat degradation through monitoring, restoration and managing.

Action 2.1.1. Alpine meadow management as a part of habitat management

Action 2.1.2. Hotspot mapping of land degraded areas in BC-01 to detect the scale of degradation.

Action 2.1.3. Improvement of water holes, salt lick and habitat management in degraded areas.

Strategy 2.2. Support and build technical capacity of the staffs

Action 2.2.1. Train on survey methodologies to monitor the flora and fauna diversity.

Action 2.2.2. Refresher course on SMART and law enforcement.

Action 2.2.3. Train on silviculture system like thinning and habitat management.

Objective 3: Enhancement of livelihood of local people residing within and near BC.

Strategy 3.1. Support and mitigate the HWC through different measures

Action 3.1.1. Provide support on solar/ electric fencing materials to the community in and around BC-01

Action 3.1.2. Outreach program to herding communities as Snow leopard Conservation women Volunteers.

Strategy 3.2. Built and promote conservation awareness to the local communities

Action 3.2. Conduct awareness campaign on Forest and Nature Conservation Acts and Rule to the villages in and around BC-01

Action 3.2.1. Initiate educational outreach programs to promote conservation education advocacy and training to gain support for conservation

- Forest fire awareness
- Waste management awareness.

Strategy 3.3. Improve livelihood of the community through engagement of youth in conservation.

Action 3.3.1. Engage youth or volunteer groups as a conservation partners & promote local stewardship.

- In conservation activities like SMART patrolling, data collection of mammal, bird and reporting.

Chapter 5: Implementation plan and financial outlay

5.1. Implementation Agency

The Divisional Forest Office under the Department of Forests and Park Services (DoFPS) will be responsible for the implementation of this conservation management plan.

5.2. Implementation schedule and budget

Following activities are proposed to be carried out during the ten years plan period. These activities are derived based on the current information and knowledge gaps, infrastructure deficits and lack of staff capacity to implement the management plan of the biological corridor (table 19). A total of Nu. **18.60 million** has been proposed for a period of 10 years.

Objectives	Strategies	Actions	Year along with budget (in Nu. m)									
			Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
1. Conservation and sustainable management of natural resources	*Strengthen the wildlife crime prevention: Poaching and illegal trade.*	1.1. Set up central command center for managing law enforcement monitoring data at Tsento Beat Office.	0.20	0.20								
		1.2. SMART data model and reporting requirement training to smart focal	0.15	0.15								
		1.3. Equip BC range office with law enforcement equipment and office furniture		0.25				0.25			0.25	
		1.4. Conduct long range patrolling to rule out any wildlife poaching and illegal harvesting	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	Ensure species persistence through monitoring and research.	1.5. Conduct research/study on keystone species (tiger, snow leopard, red panda and musk deer)		0.50		0.50		0.50			0.50	
		1.6. Carry out study on medicinal plant in BC		0.30	0.20							
2. Adaptation and mitigation of climate change	*Prevent habitat degradation through monitoring,*	2.1. Alpine meadow management as a part of habitat management		0.50		0.50	0.50					
		2.2. Hotspot mapping for land degraded areas in BC-01 to detect the scale of degradation	0.05		0.05		0.05		0.05		0.05	

	restoration and managing.	2.3. Development and improvement of water holes and salt lick in BC-01		0.30				0.30				
	Support and build technical capacity of the staffs	2.4. Train on survey methodologies to monitor the flora and fauna diversity to the frontline staffs		0.15		0.15			0.15		0.15	
		2.5. Refresher course on SMART and law enforcement	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
		2.7. Train on silviculture system like thinning and habitat management.		0.30			0.30			0.30		0.30
3. Enhancement of livelihood of local people residing within and near BC-01	*Support and mitigate the HWC through different measures*	3.1. Provide support on solar/ electric fencing materials to the community in and around BC-01	0.80		0.80		0.80			0.80		0.80
		3.2. Outreach program to herding communities as Snow leopard Conservation women Volunteers.	0.50									
	Built and promote conservation awareness to the local	3.3. Initiate educational outreach programs to promote conservation education advocacy and training to gain support for conservation	0.35		0.35		0.35		0.35		0.35	

	communities	3.4. Conduct awareness campaign on Forest and Nature Conservation Acts and Rule to the villages in and around BC-01	0.25		0.25		0.25			0.25		
	Improve livelihood of the community through engagement of youth in conservation.	3.5. Engage youth or volunteer groups as a conservation partners & promote local stewardship.	0.05		0.05		0.05			0.05		0.05
		Total budget in Nu. (million)	**2.65**	**2.95**	**2.00**	**1.45**	**2.6**	**1.35**	**0.85**	**1.7**	**1.6**	**1.45**

Table 15. Implementation Schedule and budget for BC-01

Chapter 6: Monitoring and Evaluation

6.1 Monitoring and evaluation

Monitoring and evaluation are a tool that allows results, processes, and experiences to be documented and used as a basis to steer decision-making and learning process. Monitoring will be carried out annually and evaluation will be done after 5 years to check the progress against the planned activities. The monitoring and evaluation plan would be part of the biological corridor management plan and based on the plan, the activities will be monitored and reported as per the PA monitoring framework. Overall supervising and evaluation will be done by Department of Forest and Park Services, since they are the parent agency. And the monitoring at the field level will be done annually by the implementing agency based on the protected are monitoring framework (annexure attached). The monitoring of the BC-01 will be done mainly to:

- If all activities are in line with the objectives and as per the plan
- Effectively identify and address challenges and issues and take action in going forward.
- Ensure transparency and exchange of information and experiences between stakeholders including local community
- Ensure the implementing agency to stay organized, and use the limited resources effectively and timely.

Evaluation is the examination off if the set objectives are being achieved at the end of the plan period. The evaluation of the implementation of the biological corridor management plan will be two phase evaluation. The mid-term evaluation will be carried out the end of five year from the implementation date. And the final evaluation will be done at the end of the plan period. The evaluation process will involve analysis of the information collected during the

annual monitoring. Department of Forest and Park Services along with the Nature Conservation Division shall form a separate independent evaluation team to ensure that evaluation is carried out on time.

Table 16. Monitoring and Evaluation for BC-01 for 10 years conservation management plan period.

Objectives	**Actions**	**Output indicator**	**Baseline**	**Unit**	**Yearly Target**									
					Y1	**Y2**	**Y3**	**Y4**	**Y5**	**Y6**	**Y7**	**Y8**	**Y9**	**Y10**
1. Conservation and sustainable management of natural resources	1.1. Set up central command center for managing law enforcement monitoring data at Tsento Beat Office.	Central command center developed	0	Nos	1	1								
	1.2. SMART data model and reporting requirement training to smart focal.	SMART data module established	8	Nos	8	8					8	8		
	1.3. Equip BC range office with law enforcement equipment and office furniture	BC-01 range offices equipped with all necessary furniture and equipment	50	Percent		60				80			100	
	1.4. Conduct long range patrolling to rule out any wildlife poaching and illegal harvesting	Conducted and report generated for any long-range patrolling for further action.	2	Nos	1	1	1	1	1	1	1	1	1	1
	1.5. Conduct research on keystone species like Tiger, Snow leopard, Red Panda and	Research conducted and report generated	2	Nos		1		1		1			1	

	Musk deer.													
	1.6. Conduct research on medicinal plant	Research conducted and report generated	0	Nos		1	1							
2. Adaptation and mitigation of climate change	2.1. Alpine meadow management as a part of habitat management	Area of alpine meadow managed under BC-01	0	Nos		1		1	1					
	2.2 Hotspot mapping for land degraded areas in BC-01 to detect the scale of degradation	Hotspot map mapped	0	Nos	1		1		1		1		1	
	2.3. Development and improvement of water holes and salt lick in BC-01	Number of water hole and salt lick developed	16	Nos		10				10				
	2.4. Train on survey methodologies to monitor the flora and fauna diversity to the frontline staffs	Nos of frontline staff trained	0	Nos		50		50			50		50	
	2.5. Refresher course on SMART and law enforcement	Nos of frontline staff trained	60	Nos	30	30	30	30	30	30	30	30	30	30
	26. Train on silviculture system like thinning and habitat management.	Nos of frontline staff trained	0	Nos		50			50			50		50
3. Enhancement of livelihood of local people residing within and near BC-01	3.1. Conduct awareness campaign on Forest and Nature Conservation Acts and Rule to the villages in and around BC-01	Number of people involved in conservation	120	Heads	100		100		100			100		
	3.2. Provide support on solar/ electric fencing materials to the	Communities supported in kind of establishment of	2	Nos	1		1		1			1		1

	community in and around BC-01	new or maintenance of electric/solar fencing												
	3.3. Initiate educational outreach programs to promote conservation education advocacy and training to gain support for conservation	Organized Educational Outreach Program and Report prepared (Nos. of head trained)	0	Nos	50		50		50		50		50	
	3.4. And engage youth or volunteer groups as a conservation partners & promote local stewardship.	Number of youths engaged or volunteer group formed.	0	Nos	10		10		10			10		10
	3.5. Outreach program to local herding communities as Snow leopard Conservation women Volunteers.	Snow leopard conservation volunteer formed & trained.	0	Nos	1									

REFERENCES

1. Feuerbacher, A., Lippert, C., Kuenzang, J., & Subedi, K. (2021). Low-cost electric fencing for peaceful coexistence: An analysis of human-wildlife conflict mitigation strategies in smallholder agriculture. Biological Conservation, 255. https://doi.org/10.1016/j.biocon.2020.108919

2. Lham, D., Wangchuk, S., Stolton, S., & Dudley, N. (2018). Assessing the effectiveness of a protected area network: a case study of Bhutan. *Parks, Wildlife Sanctuaries, Strict Nature Reserves and Biological Corridors*.

3. Sharma, P., Chettri, N., Uddin, K., Wangchuk, K., Joshi, R., Tandin, T., Panday, A., Gaira, K. S., Basnet, K., Wangdi, S., Dorji, T., Wangchuk, N., Chitale, V. S., Uprety, Y., & Sharma, E. (2020). Mapping human–wildlife conflict hotspots in a transboundary landscape, Eastern Himalaya. *Global Ecology and Conservation*.

4. Sharma, P., Chettri, N., & Wangchuk, K. (2021). Human–wildlife conflict in the roof of the world: Understanding multidimensional perspectives through a systematic review. Ecology and Evolution. https://doi.org/10.1002/ece3.7980

5. Thinley, P. (2010). Technical Comments on the Design and Designation of Biological Corridors in Bhutan: Global to National Perspectives. *Journal of Renewable Natural Resources*.

ANNEXURES

Annexure 1. Conservation operational plan

Framework for Conservation Operational Plan for Protected Areas of Bhutan			
* The Conservation Operational plan for the protected areas shall be prepared only after the budget for the FY is approved.			
Name of the office:	Divisional Forest Office, Paro. BC 01		
Plan Period:			
Prepared by and date:			
Verified by and date:			
Recommended by and date			
Approved by and date:			
I. REVIEW OF THE PREVIOUS YEARS' PLAN			
I.a. SUMMARY OF THE PLAN			
No. of Planned activities	Status of the activities (in Nos.)		
	Achieved	On-going	Not Implemented

I.b. DETAILED REVIEW OF THE PLANNED ACTIVITIES						
Activities	Target with unit	Budget utilization status (in %age)	Remarks (Justification/reasoning if not completed or not implemented)		Remarks (Justification/reasoning if not completed or not implemented)	
II. ANNUAL CONSERVATION OPERATIONAL PLAN SCHEDULE						
II.a. DETAILS OF THE PLANNED ACTIVITIES						
Output Indicator as per the management plan/APA	Activities	Target with Unit	Timeline	Budget (in Nu. (m))	Fund Source	Specify location, if relevant

Program 1: Nature Conservation[1]						
Program II: Forest Resources Management[2]						
Program III: Social Forestry and Extension[3]						

Program IV: Forest Protection and Enforcement[4]						
Program IV: Administration and Direction[5]						
[1.] Program I shall include but not limited to; Surveys, research, HWC management, habitat management, watershed wetland protection, ecotourism nature recreation, waste management, wildlife rescue & rehabilitation.						
[2.] Program II shall include but not limited to; LFMA plan preparation, timber allocation and monitoring.						

3. Program III shall include but not limited to; CF management, NWFP management, plantation, livelihood improvement initiatives.
4. Program IV shall include but not limited to; patrolling, forest offence compounding/prosecution, forestry clearances, pest & diseases surveillance, forest fire management.
5. Program V shall include but not limited to; Park management plan preparation, work planning, coordination meetings, administrative and accounting activities, monitoring and evaluation, data management.
*Note: Activities such as Awareness, capacity building, etc to be tagged with respective program activities.

Annexure 2: Species composition table of the corridor

Lifeform	Family	RBA%	RBA%
Evergreen Conifer tree		**Tsento**	**Bji**
Abies densa	Pinaceae	26.097	48.906
Juniperus recurva	Cupressaceae	11.898	17.985
Tsuga dumosa	Pinaceae	10.576	0.204
Pinus wallichiana	Pinaceae	7.430	0.915
Picea spinulosa	Pinaceae	2.671	13.255
Juniperus communis	Juniperaceae	2.217	
sub total		**60.890**	**81.266**
Evergreen tree			
Quercus semecarpifolia	Fagaceae	8.880	
Rhododendron arboreum	Ericaceae	0.488	0.028
Rhododendron hodgsonii	Ericaceae	0.475	
Osmanthus suavis	Oleaceae	0.051	
Rhododendron kesangiae	Ericaceae		0.073
Litsea sericea	Lauraceae		0.028
Sub total		**9.894**	**0.130**
Deciduous tree			
Betula alnoides	Betulaceae	11.557	0.545
Acer campbellii	Aceraceae	2.977	1.259

Quercus griffithii	Fagaceae	2.211	
Gamblea ciliata	Araliaceae	0.925	0.000
Betula utilis	Betulaceae	0.532	0.179
Lyonia ovalifolia	Ericaceae	0.335	0.824
Larix griffithiana	Pinaceae	0.300	4.269
Corylus sp	Betulaceae	0.072	
Populus sp	Salicaceae	0.036	
Alnus nepalensis	Betulaceae		3.172
Salix wallichiana	Salicaceae		1.092
sub total		**18.946**	**11.341**
Evergreen shrub			
Rhododendron campanulatum	Ericaceae	7.388	
Rhododendron cinnabarinum	Ericaceae	0.682	0.082
Rhododendron sp	Ericaceae	0.193	0.233
Rhododendron lanatum	Ericaceae	0.142	
Rhododendron aeruginosum	Ericaceae	0.097	
Pieris formosa	Ericaceae	0.091	
Eurya cerasifolia	Theaceae	0.006	
Sub total		**8.599**	**0.315**
Deciduous shrub			
Sorbus sp	Rosaceae	1.214	0.544
Ribes sp	Grossulariaceae	0.185	
Salix sp	Salicaceae	0.097	0.171
Rosa macrophylla	Rosaceae	0.075	
Enkianthus deflexus	Ericaceae	0.025	0.059
Berberis aristata	Berberidaceae	0.024	
Berberis sp	Berberidaceae	0.020	0.393
Piptanthus nepalensis	Leguminosae	0.010	
Viburnum erubescens	Caprifoliaceae	0.010	
Viburnum nervosum	Caprifoliaceae	0.010	
Rosa sericea	Rosaceae	0.001	0.003
Berberis angulosa	Berberidaceae		2.571
Berberis asiatica	Berberidaceae		2.000
Prunus sp	Rosaceae		0.878
Liptodermis sp	Rubiaceae		0.253
Sorbus microphylla	Rosaceae		0.034

Rosa sp	Rosaceae		0.029
Desmodium sp	Leguminosae		0.007
unknown			0.002
Buddleja colvilei	Buddlejaceae		0.001
Lindera heterophylla	Lauraceae		0.000
Sub total		**1.670**	**6.948**

Annexure 3: List of bird species

Sl. no	**Common name**	**Scientific name**
1	Alpine Accentor	*Prunella collaris*
2	Amur Falcon	*Falco amurensis*
3	Ashy Drongo	*Dicrurus leucophaeus*
4	Ashy wood pegion	*Columbia pulchricollis*
5	Ashy-throated Warbler	*Phylloscopus maculipennis*
6	Asian brown flycatcher	*Muscicapa dauurica*
7	Asian House Martin	*Delichon dasypus*
8	Bhutan laughing thrush	*Trochalopteron imbricatum*
9	Black Bulbul	*Hypsipetes leucocephalus*
10	Black Drongo	*Dicrurus macrocercus*
11	Black Eagle	*Ictinaetus malayensis*
12	Black Kite	*Milvus migrans*
13	Black Redstart	*Milvus migrans*
14	Black-faced Laughingthrush	*Garrulax affinis*
15	Blanford's Rosefinch	*Carpodacus rubescens*
16	Blood Pheasant	*Ithaginis cruentus*
17	Blue Whistling Thrush	*Myophonus caeruleus*
18	Blue-fronted Redstart	*Phoenicurus frontalis*
19	Blyth's Leaf Warbler	*Phylloscopus reguloides*
20	Brown Bullfinch	*Pyrrhula nipalensis*
21	Brown Dipper	*Cinclus pallasii*
22	Brown Shrike	*Lanius cristatus*
23	Buff-barred Warbler	*Phylloscopus pulcher*
24	Bush Shrike	*Malaconotidae spp*

25	Bush warbler	*Horornis diphone*
26	Chestnut-bellied Rock Thrush	*Monticola rufiventris*
27	Chestnut-crowned Laughingthrush	*Garrulax erythrocephalus*
28	Chestnut-headed Tesia	*Tesia castaneocoronata*
29	*Chestnut-tailed Minla*	*Minla strigula*
30	Coal Tit	*Parus ater*
31	Collared Grossbeak	*Mycerobas affinis*
32	Common Buzzard	*Buteo buteo*
33	Common Hoopoe	*Upupa epops*
34	Common Kestrel	*Falco tinnunculus*
35	Common Quail	*Coturnix coturnix*
36	Common Stonechat	*Saxicola torquata*
37	Crested Goshawk	*Accipiter trivirgatus*
38	Crested Kingfisher	*Megaceryle lugubris*
39	Crimson-breasted Woodpecker	*Dendrocopos cathpharius*
40	Crimson-browed Finch	*Propyrrhula subhimachala*
41	Crossbills	*Loxia spp*
42	Darjeeling Woodpecker	*Dendrocopos darjellensis*
43	Dark-breasted Rosefinch	*Carpodacus nipalensis*
44	Dark-rumped Rosefinch	*Carpodacus edwardsii*
45	Dark-sided Flycatcher	*Muscicapa sibirica*
46	Eurasian Cuckoo	*Cuculus canorus*
47	Eurasian Hobby	*Falco subbuteo*
48	Eurasian Jay	*Garrulus glandarius*
49	Eurasian Sparrowhawk	*Accipiter nisus*
50	Eurasian Tree Sparrow	*Passer montanus*
51	Eurasian Treecreeper	*Certhia familiaris*
52	Eurasian Woodcock	*Scolopax rusticola*
53	Fire-tailed Sunbird	*Aethopyga ignicauda*
54	Forest Wagtail	*Dendronanthus indicus*
55	Gold Crest	*Regulus regulus*
56	Golden Bush Robin	*Tarsiger chrysaeus*
57	Golden-spectacled Warbler	*Seicercus burkii*
58	Gold-naped Finch	*Pyrrhoplectes epauletta*
59	Green-backed Tit	*Parus monticolus*

60	Greenish Warbler	*Phylloscopus trochiloides*
61	Grey Bushchat	*Saxicola ferrea*
62	Grey crested tit	*Lophophanes dichrous*
63	Grey Nightjar	*Caprimulgus indicus*
64	Grey-backed Shrike	*Lanius tephronotus*
65	Grey-cheeked Warbler	*Seicercus poliogenys*
66	Grey-chinned Minivet	*Pericrocotus solaris*
67	Grey-crested Tit	*Parus dichrous*
68	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*
69	Grey-sided Bush Warbler	*Cettia brunnifrons*
70	Grey-winged Blackbird	*Turdus boulboul*
71	Hill Partridge	*Arborophila torqueola*
72	Himalayan Griffon/Himalayan vulture	*Gyps himalayensis*
73	Himalayan Monal	*Lophophorus impejanus*
74	Himalayan white-browed rose finch	*Carpodacus thura*
75	Hoary-throated Barwing	*Actinodura nipalensis*
76	Hodgson's Redstart	*Phoenicurus hodgsoni*
77	House sparrow	*Passer domesticus*
78	Hume's Warbler	*Phylloscopus humei*
79	Ibisbill	*Ibidorhyncha struthersii*
80	Indian Blue Robin	*Luscinia brunea*
81	Indian Roller	*Coracias benghalensis*
82	Kalij Pheasant	*Lophura leucomelanos melanota*
83	Lammergeier	*Gypaetus barbatus*
84	Large Hawk Cuckoo	*Hierococcyx sparverioides*
85	Large-billed Crow	*Corvus macrorhynchos*
86	Large-billed Warbler	*Phylloscopus magnirostris*
87	Lemon-rumped Warbler	*Phylloscopus chloronotus*
88	Lesser Cuckoo	*Cuculus poliocephalus*
89	Little Forktail	*Enicurus scouleri*
90	Long-billed Thrush	*Zoothera monticola*
91	Long-tailed Minivet	*Pericrocotus ethologus*
92	Long-tailed Shrike/Rufus-backed shrike	*Lanius schach*
93	Long-tailed Thrush	*Zoothera dixoni*

94	Long-tailed tit/Long-tailed bushtit	*Aegithalos caudatus*
95	Merlin	*Falco columbarius*
96	Mountain Hawk Eagle	*Spizaetus nipalensis*
97	Mrs Gould's Sunbird	*Aethopyga gouldiae*
98	Nepal House Martin	*Delichon nipalensis*
99	Olive-backed Pipit	*Anthus hodgsoni*
100	Orange-flanked Bush Robin	*Tarsiger cyanurus*
101	Oriental cukoo	*Cuculus optatus*
102	Oriental magpie-robin	Copsychus saularis
103	Oriental Turtle Dove	*Streptopelia orientalis*
104	Oriental White Eye	*Zosterops palpebrosus*
105	Parrotbill	*Paradoxornis sp.*
106	Plain Mountain Finch	*Leucosticte nemoricola*
107	Plain Prinia	*Prinia inornata*
108	Plain-backed Thrush	*Zoothera mollissima*
109	Plumbeous Water Redstart	*Rhyacornis fuliginosus*
110	Red Crossbill	*Loxia curvirostra*
111	Red-billed Chough	*Pyrrhocorax pyrrhocorax*
112	Red-billed Leiothrix	*Leiothrix lutea*
113	Red-headed Bullfinch	*Pyrrhula erythrocephala*
114	Red-vented bulbul	*Pycnonotus cafer*
115	Richards pipit	*Anthus richardi*
116	River lapwing	*Vanellus duvaucelii*
117	Rock Pigeon	*Columbia livia*
118	Rosy pipit	*Anthus roseatus*
119	Ruddy shelduck	*Tadorna ferruginea*
120	Rufous Sibia	*Heterophasia capistrata*
121	Rufous-bellied Niltava	*Niltava sundara*
122	Rufous-bellied Woodpecker	*Dendrocopos hyperythrus*
123	Rufous-breasted Accentor	*Prunella strophiata*
124	Rufous-fronted Tit	*Aegithalos iouschistos*
125	Rufous-gorgetted Flycatcher	*Ficedula strophiata*
126	Rufous-vented Tit	*Parus rubidiventris*
127	Rufous-vented Yuhina	*Yuhina occipitalis*
128	Rufous-winged Fulvetta	*Alcippe castaneceps*

129	Russet Sparrow	*Passer rutilans*
130	Rusty-flanked Treecreeper	*Certhia nipalensis*
131	Satyr tragopan	*Tragopan satyra*
132	Scaly Thrush	*Zoothera dauma*
133	Scaly-breasted Wren Babbler	*Pnoepyga albiventer*
134	Short-billed Minivet	*Pericrocotus brevirostris*
135	Slaty Blue Flycatcher	*Ficedula t. tricolor*
136	Snow Partridge	*Lerwa lerwa*
137	Snow Pigeon	*Columba leuconata*
138	Solitary Snipe	*Gallinago solitaria*
139	Speckled Wood Pigeon	*Columba hodgsonii*
140	Spoted dove	*Spilopelia chinensis*
141	Spoted forktail	*Enicurus malculatus*
142	Spotted Forktail	*Enicurus maculatus*
143	Spotted Laughingthrush	*Garrulax ocellatus*
144	Spotted Nutcracker	*Nucifraga caryocatactes*
145	Spot-winged grosbeak	*Mycerobas melanozanthos*
146	Streak breasted schimitar Babler	*Pomatorhinus ruficollis*
147	Streaked laughingthrush	*Trochalopteron lineatum*
148	Striated prinia	Prinia criniger
149	Stripe-throated Yuhina	*Yuhina gularis*
150	Tickell's Leaf Warbler	*Phylloscopus affinis*
151	Titetan Snowcock	*Tetraogallus tibetanus*
152	Ultramarine Flycatcher	*Ficedula superciliaris*
153	Upland buzzard	*Buteo hemilasius*
154	Verditor flycatcher	*Eumyias thalassinus*
155	Wall Creeper	*Tichodroma murarua*
156	Whiskered yuhina	*Yuhina flavicollis*
157	Whistler's Warbler	*Seicercus whistleri*
158	White Wagtail	*Motacilla alba*
159	White-bellied Redstart	*Hodgsonius phaenicuroides*
160	White-browed Bush Robin	*Tarsiger indicus*
161	White-browed Fulvetta	*Alcippe vinipectus*
162	White-browed shortwing	*Brachypterix montana*
163	White-capped Water Redstart	*Chaimarrornis leucocephalus*

164	White-collared Blackbird	*Turdus albocinctus*
165	White-tailed Nuthatch	*Sitta himalayensis*
166	White-throated Dipper	*Cinclus cinclus*
167	White-throated Laughingthrush	*Garrulax albogularis*
168	White-throated Redstart	*Phoenicurus schisticeps*
169	White-throated Wren Babbler	*Pnoepyga pusilla*
170	White-winged Grossbeak	*Mycerobas carnipes*
171	Winter Wren	*Troglodytes troglodytes*
172	Wood Snipe	*Gallinago nemoricola*
173	Yellow Billed Cough	*Corvus graculus*
174	Yellow-bellied bush warbler	*Horornis acanthizoides*
175	Yellow-bellied fairy-faintail	*Chelidorhynx hypoxanthus*
176	Yellow-bellied Fantail	*Rhipidura hypoxantha*
177	Yellow-billed Blue Magpie	*Urocissa flavirostris*
178	Yellow-breasted Greenfinch	*Carduelis spinoides*

Annexure 4. List of medicinal plants

Sl. no	Botanical name	Dzongkha name	Medicinal uses
1	*Abis densa*	ཐང་ནག།།	Cures swelling and diarrhea, dries fluids
2	*Anemone griffithii*	སྒྲབ་ཀཱ།།	Anti-coagulant, anti-dropsy and increases body temperature
3	*Arenaria kansuensis*	རྡ་ཚ་ཙོང་།	Cures lung disorders and abscess
4	*Aster flaccidus*	ཨེ་ཏོག་ཡུག་མིག།	Treating affliction by evil sprits
5	*Bergenia stracheyii*	ཀ་དུར།	Cure vomiting, diarrhoea and dysentery
6	*Bergenia ciliata*	ཀ་དུར།	Cure vomiting, diarrhoea, dysentery, bile and liver disorder
7	*Carum Carvi*	ཞོ་སྐོད།	Allays giddiness, hypertension and poisonings
8	*Cautleya spicata*	ཐ་སྐམ།	Anti-coagulant, febrifuge and cures bad-rlung (breath)

9	*Chrysanthemum coccineum*	འཁན་ས།	Act as an insect repellent, cures skin disease and used as incense
10	*Clematis acutangula*	དབྱི་མོང་ཏཱར་ཡོ།	Used as an anti-tumor and aperitive
11	*Ophiocordyceps sinensis*	དབྱར་ཆ་དགུན་བྱད།	Improves immune systems, builds body and used as an aphrodisiac
12	*Corydalis crispa*	བ་ཤ་ཀཱ།	Allays blood, liver and bile disorders
13	*Cotoneaster microphyllus*	NA	Astringent property, Leaves are used for Dermatitis
14	*Ephedra gerardiana*	མཚོ་ཕྲན།	Used for treating wounds, injuries and fever
15	*Dracocephalum tanguiticum*	ཏི་ཡང་ཀྱ།	Used as diuretic and anti-dropsy and stomach disorders
16	*Euphorbia griffithii*	དུར་ཁྲིད།	Used as a purgative and anti-inflammatory of nerves, blood arteries and veins.
17	*Eriophyton wallichi*	ཁང་ཚན་སྨུ་ར།	Heals wounds in lungs, joins, nerves, blood arteries and veins.
18	*Fragaria nubicola*	འཇི་རུ་ས་འཛོན།	Used as an anthelmintic, cures neurological disorders and chest infections
19	*Euphorbia wallichii*	ཐར་ཀྱ།	Used as a laxative, diuretic and anti-inflammatory
20	*Gentiana urnula*	གང་གཱ་ཆུང།	Used for curing fever, hysteria, diabetes, high blood pressure, prevent muscle spasms, treat parasitic worms, start menstrual periods, as a germ killer, treating wounds and cancer.
21	*Gentiania robusta*	ཀྱི་ཚི་དཀར་ཡོ།	Heals wounds, swelling and inflammation of stomach and liver
22	*Helina eliptica*	ཚ་གས་ཏེག་རང་མགོ་མ།	Heals wounds, allays common cold and cough, headache.
23	*Heracleum obtusifolium*	སྨུ་དཀར།	Relieves headache, cures leprosy and stops bleeding.
24	*Panax pseudoginseng*	རྒྱིང་གི་ར་ཙ།	Provides nourishment, enhances body growth and improves body immunity
25	*Hippophae salicifolia*	སྐར་ཅ།	Anti-coagulant for tuberculosis and liver diseases
26	*Inula racemosa*	མ་ཀྱ།	Anti-hypertensive for inflammation of stomach

27	*Iris goniocarpoa*	ཨོ་ཆ།	Used for curing jaundice and used as an antidote
28	*Juniperus indica*	ཤུག་ར།	Cures kidney disorders and infections
29	*Lancea tibetica*	ར་ཡག།	Used for curing lung and heart disorders and dries wounds
30	*Megacordon stylophorus*	ཀྱེ་ཚེ་རོ་ཟེག།	Uses to cure wounds and dries watery fluids
31	*Leontopodium himalayanum*	ཟླ་བ།	Ingredient for moxibustion
32	*Iris kemaonensis*	དེས་མ་ཐོ།	Used as anthelmentic and anti-pyretic
33	*Maconopsis peniculata*	ཨུཏྤལ་སེར་དོ།	Used for curing lung and liver disease and for curing swelling of limbs
34	*Nardostachys jatamansi*	རྨ་སྤོས།	Used for curing altitude sickness, tumours and intestinal parasites.
35	*Nardostachys grandiflora*	ཁང་སྤོས།	Anthelmintic, vermifuge and detoxifier
36	*Neopicrorhiza scrophulariiflora*		
37	*Onosma hookeri*	འབྲི་ཚོག།	Allays asthma, hypertension and pneumonia
38	*Oxytropis lapponica*	ཁང་དཀར།	Useful in dropsy and sudden swellings of the body
39	*Pedicularis integrifolia*	མེ་ཏོག་སྨད་སྐ།	Used as an anti-dropsy and as an anti-diuretic for asthma
40	*Pedencularis megalantha*	ལག་རྩ་དམར་དོ།	Used as an antidote and cures intestinal disorders
41	*Pedicularis siphonantha*	འདྲེ་སྨད།	Antidote, anti-diarrhoeal and febrifuge
42	*Phytolacca acinosa Roxb*	དཔའ་བོ་ཏུག་རོ།	Analgesic, antidote and cough and cold
43	*Phlomis rotata Benth*	རྐ་ཐགས།	Strengthen broken bones and improves stiffness
44	*Plantago depressa*	ཐ་རམ།	Cures diarrhoea
45	*Polygonum macrophylla*	ཁང་རམ།	Allays diarrhoea, stomach pain and dysentery
46	*Potentila anserina*	ཕྱོ་མ།	Allays dysentery

47	*Podophyllum hexandrum*	བོལ་མོ་ཐེ།	Cures gynocological problems, paralysis, and kidney disorders
48	*Potentila spp*	ས་ལས་ཐྲོན་ནམ།	Curing diarrhoea, cholera, arthritis and diabetes
49	*Potentila arbuscula*	སྐེན་མ་ནག་ཡོ།	Cures cough and cold
50	*Quercus grifithii*	མོན་ཚར།	Anti-diarrheal
51	*Rheum moorcroftianum*	ཇུམ་ཙ།	Laxative, diuretic and antiemetic
52	*Ranunculus brotherusi*	སྤ་ཚེ།	Antiseptic, anti-pyretic and heals wounds
53	*Rheum australe*	ཆུ་ཙ།	Carminative, purgative and indigestion
54	*Rhodiola dumulosa*	ཚན་ཆུངས་ར།	Cures liver disorders, fever and asthma
55	*Rheum nobile*	ཆུ་བར་ཨེ་ཇོག།	Laxative, diuretic and retain body fluids
56	*Rhododendron anthopogon*	བ་ཡུ་དཀར་ཡོ།	Used as a febrifuge, it heals body and face swelling and used for regaining body health
57	*Rhododendron setosum*	བ་ཡུ་ནག་ཡོ།	Allays grang-ba and gag-lhog. Used in incense, perfumery, aromatic oils and cosmetics
58	*Salvia castanea*	འཇིབ་རྩི་ཆེན་ཡོ།	Cures mouth ulcer, toothache and liver disorders
59	*Sambucus nigr*	ཤུ་རིགས།	Cures flu and bacterial infections
60	*Rosa sericea*	སེ་བའི་ཨེ་ཇོག།	Cures bile and air disorders
61	*Sassurea pachyneura*	ཀོན་པ་གཅ་སྐྱེས།	Curing blood diseases
62	*Saussurea lappa*	ཏ་ཀྱ།	Anti-hypertensive, anti-flatulence and anti-tussive
63	*Swertia angustifoli*	ཆུ་ཀིག།	Used as febrifuge and anti-malaria
64	*Swertia chirata*	ཆུ་ཀིག།	Used as febrifuge and anti-malaria
65	*Selinum wallichianum*	འབམ་ཡོ།	Anti-inflammatory and anti-tumour
66	*Taraxacum eriopodum*	ཁུར་ཨོང།	Used as a detoxifier and febrifuge and cures stomach disorders

67	*Thypha elephantia*	ཨ་དག་དཀར་དོ།	Progresses flesh growth, builds body and improves intelligence
68	*Thalictrum chelidonii*	ཁམ་ཀྱིལ།	Antidote, anti-malarial, analgesic
69	*Taxus bacata*	ཀི་རང་ཤིང།	Anti-cancer
70	*Thermopsis barbata*	ཐ་བ་ཐང་མ།	Cures stomach disorders and sore throat. Used as diuretic
71	*Valeriana wallichii*	ཀུ་ཚོས།	Cures sore throat, wounds, indigestion and headache.
72	*Veronica cephaloides*	ཕྱམ་དག་དོན་མཁྲིས།	Used as hemostatic. Helps in healing wounds and regenerating cells
73	*Meconopsis simplicifol*	ཕྱུག་པ་ཐོན་དོ།	Used as an anti-pyretic against fever, inflammation of lung and liver.

Published by:

Divisional Forest Office, Paro

Department of Forests and Park Services

Ministry of Energy and Natural Resources

BHUTAN FOR LIFE

GREEN CLIMATE FUND

WWF

BTFEC

Bhutan Trust Fund for Environmental Conservation