ECOLOGICAL STUDIES ON GREY PEACOCK PHEASANT *Polyplectron bicalcaratum* (Linn, 1758) IN THE TROPICAL FOREST OF MIZORAM, INDIA

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By

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SUBMITTED IN PARTIAL FULLFILLMENT OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN ZOOLOGY OF MIZORAM UNIVERSITY, AIZAWL.

Dedicated to

my wife

Lalhluzuali,

my brother

Zarzotlinga Sailo, and

my parents

Lalneihkimi & David Sailo

DECLARATION

I, Mr. Lalawmawia Sailo, hereby declare that the subject matter of this thesis entitled "**Ecological Studies on Grey Peacock Pheasant *Polyplectron bicalcaratum* (Linn, 1758) in the Tropical Forest of Mizoram, India**" is the record of work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University/Institute.

This is being submitted to the Mizoram University for the award of the degree of Doctor of Philosophy in the Department of Zoology.

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CERTIFICATE

This is to certify that the thesis entitled "**Ecological Studies on Grey Peacock Pheasant *Polyplectron bicalcaratum* (Linn, 1758) in the Tropical Forest of Mizoram, India**" submitted to Mizoram University for the award of the degree of Doctor of Philosophy by **Lalawmawia Sailo**, research scholar in the Department of Zoology, is a record of his original research work under our guidance and supervision.

Mr. Lalawmawia Sailo has put more than eight term of research work in the Department of Zoology. He was admitted for Ph.D. degree and the thesis is submitted as per new UGC Regulations, 2009.

This work has not been submitted elsewhere for any degree.

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(LALAWMAWIA SAILO)

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LIST OF ABBREVIATIONS

LWS	:	Lengteng wildlife sanctuary
TWS	:	Tawi wildlife sanctuary
km	:	Kilometre
sq.km	:	Square Kilometre
m	:	Metre
mm	:	Millimetre
>	:	greater than
<	:	less than
NTFP	:	Non timber forest produces
℃	:	degree Celsius
IUCN	:	International Union for Conservation of Nature
IBA	:	Important Bird Area
PCA	:	Principal Component Analysis
NGO	:	Non-governmental Organisation
EF&CC	:	Environment, Forest and Climate Change
WLS	:	Wildlife Sanctuary
IWPA	:	Indian Wildlife Protection Act

CHAPTER 1

INTRODUCTION

1.1 General Introduction

Galliformes are considered one of the most diverse groups of birds (Keane et al., 2005) which are often considered to be among the most threatened avian orders with 300 species being red listed globally (McGowan, 2002; Brickle et al., 2008). Galliformes have a distinct, bright and colourful plumage. They are considered to be a very useful biological indicator of the habitat quality of a particular area (Bhattacharya et al., 2009). Galliformes is a large and varied group of birds in the world comprising of 70 genera and 284 species (Keane et al., 2005). Five families come under the order Galliformes *viz.* Megapodidae (Scrub Fowls, Bush Turkeys, Mallee Fowl), Cracidae (Guans, Chachalacas, Curassows), Numididae (Guineafowl), Odontophoridae (New World quails) and Phasianidae (Grouse, Turkeys, Pheasants and Partridges) (Dickinson, 2003).

The Indian Himalaya is home to 16 species of pheasant out of the total 17 species recorded for India with the only exception being the endemic Grey Junglefowl *Gallus sonneratii*, which is confined to the Peninsular India. There are seven endemic and eight restricted-range species of Galliformes within India (Sathyakumar et al., 2007). Five species of pheasant are among the 12 avian species to be listed as threatened (Sathyakumar and Sivakumar, 2007). The Indian Himalayan region is home to 80% of pheasants found in India thus indicating its

richness (Kaul, 2007). The Eastern Himalayan forests are known to be rich in species diversity than the western Himalayas, with 11 species of the 17 pheasant species in India are found in the eastern Himalayas. Heavy depletion in pheasant population is taking place in their whole geographical range which can be attributed to excessive hunting for coloured plumage and meat (Ramesh et al., 1999).

Pheasants are Asian in their origin, except the Congo Peafowl which is endemic to the Democratic Republic of Congo in central Africa (Crowe et al., 1986). Humans introduced several species of pheasant into various parts of Europe and North America for sport-hunting and for other purposes (Bump 1941, Pokorny and Pikula, 1987; Hill and Robertson 1988). Within Asia, pheasants occupy a vast geographical area in the continent from Flores, east of Java at about 8ºS (Green Junglefowl), through the equatorial forests of the Thai-Malay Peninsula, to north-eastern China at about 50ºN (Koklass, Ring-necked Pheasant, Reeves's Pheasant, Blue-eared Pheasant). Caucasus is regarded as the western limit of the pheasant group at about 45ºE (Ring-necked Pheasant) with the exception of Congo Peafowl. Pheasants are recorded all along the Himalayan chain, to the extent of far east Taiwan at 121ºE (Mikado Pheasant, Swinhoe's Pheasant) and Japan at 145ºE (Copper Pheasant, Ring-necked Pheasant). Most pheasant species are found to be dependent on heavily wooded habitats which range from lowland tropical rainforest (e.g., Crested Fireback) and montane tropical forest (e.g., Mountain Peacock Pheasant) to temperate coniferous forests (e.g., Western Tragopan). Some species are found to inhabit more open habitats, such as subalpine scrub (e.g., Blood Pheasant), alpine meadows (e.g., Chinese Monal), and grassland (e.g., Cheer Pheasant). Pheasants and humans have long history of close association (Fuller and Garson, 2000).

Pheasants are large bodied and predominantly terrestrial birds, they are easy to trap or shoot, and their meat and eggs are rich sources of protein and are thus preferred by the hunters. Sixteen species are so far introduced to different places outside their natural range for various purposes such as enhancing collection of ornamental feathers, trophy, sport, and the production of eggs and meat (Long, 1981). The Ring-necked Pheasant is the most widely introduced pheasant species outside its native range where they are brought to Europe from Asia Minor, later from China and Japan about one thousand years ago (Long, 1981). Today they are found throughout Europe and most states of the United States of America where they strive well and reproduce successfully. Although they are originally subjected mainly for food, they now became one of the most important game birds. In Europe, annual harvest of this pheasant species is over 22 million birds, while approximately 9.5 million birds are harvested annually in North America. Sport hunting of this pheasant is of great significance in terms of revenue to landowners because huge number of employments is also generated for the local people (Aebischer, 1997a). The scale of this exploitation ranges from low intensity, level to support the local economy through sustainable harvesting ensuring the survival of the species and may be up to levels leading to local extinction of the species (Simiyu, 1998). The species most affected by hunting in its native range is the Copper Pheasant in Japan, which is reared in captivity to provide birds for sport (Brazil, 1991). Pheasants are therefore a very significant material with benefits to human populations, both locally and internationally, and this increases the possibility of harnessing these benefits for conservation purposes. If sufficient economic incentives can be gained through harvesting and managing pheasant populations in a sustainable manner, hunted populations of these species may be safeguarded in the long term. Apart from the economic benefits derived from pheasants, they have been absorbed into human

cultural traditions over the centuries. Several species feature prominently in the art, religion, social customs, and folklore of different ethnic groups in Asia. The Red Junglefowl (*G. gallus*) has been associated with humans for centuries, and has (possibly) been in domestication as the progenitor of the domestic fowl for nearly 5000 years (Wood-Gush, 1959).

The man-pheasant association has now come to such extent that it has great economic importance and has influenced language, literature, religion, and medicine. The magnificent Indian Peafowl is especially well-known in ornamental bird collections and trade all around the world and, since it enjoys holy status under the Hindu religion, it remains common and abundant in the wild throughout the plains of South Asia. Many myths are associated with this species, including its capability to hypnotise a snake and muddled its eggs. The feathers of the Brown-eared Pheasant decked the Chinese military uniforms since the period of the Warring States to the last part of the Qing Dynasty (475BC – 1911AD). Their relationship with military valour arises from the fight fought by the males during the mating season. It was believed that there may be great scope for utilizing this relationship to strengthen the conservation of these mesmerizing and beautiful birds, without which all our lives would be very much the poorer (Fuller and Garson, 2000).

The cultural and economic interest of human beings resulted in habitat loss, habitat degradation and habitat fragmentation of most pheasant species (McGowan et al., 1998; Ramesh, 2003). Habitat loss and alterations in its many forms, is suspected to be the main contributor for the decline of most threatened pheasant species. Many forests which are habitat of the pheasant may be permanently or temporarily destroyed as a result of timber collection or through deforestation for other purposes

such as agricultural activities and urban encroachment, including road building. Habitats are often totally lost or become much less useful to wild species by means of degradation resulting from surplus activities such as livestock foraging, or fodder and firewood collection.

1.2 Threats

Habitat destruction is characterised by complete removal of the existing vegetation structure or alteration of the available habitat to an extent which renders it unsuitable to the inhabitant. For forest dependent wildlife, like most pheasants, the complete removal of all trees in an area (deforestation) will inevitably cause a tragic decline. Harvesting timber by means of logging operations is the primary reason for deforestation. Timber collection by means of large-scale logging is particularly common in areas with tropical forest on plains, where desired trees can easily be extracted on a large scale. Logging can be of great concern when accompanied by human settlements in the cleared or deforested area (van Balen and Holmes, 1993). Approximately 1.3 million hectares of land were deforested in Sumatra and Kalimantan between 1985 and 1997, representing 26% of the total forest cover. Illegal logging is prevalent, even within protected areas. Therefore, it is clear that all the pheasant species that inhabit lowland tropical rainforests in Sumatra and Borneo will be under serious threat from habitat destruction. On Hainan Island in China, destructive logging is putting pressure on the two distinct pheasant subspecies endemic to the island (Silver Pheasant *Lophura nycthemera whiteheadi* and Hainan Peacock Pheasant *Polyplectron katsumatae*). As a result of a ban on logging primary forest in January 1994, habitat loss has not been a serious threat as earlier (Yu-ren, 1998).

Forests are cut down for agricultural purposes, such as plantations of coffee, rubber, and tobacco, or for grazing by domestic livestock. This is a particular problem where intensive farming methods are used following habitat clearance, as vast tracts of land may become permanently inhospitable to many species of forest-dwelling animals. For example, the practice of *jhuming* (shifting cultivation) in northeast India has detrimental effect on the habitats of Blyth's Tragopan (*Tragopan blythii*) and Grey Peacock Pheasant (*P. bicalcaratum*) (Kaul et al., 1995). The clearing the forests and such unsustainable farming practice may be attributed to the local extinction of Green Peafowl from the Northeast riverside plains and adjacent forest (Kumar, 1999). Infrastructure developments which encroach or degrade forest has caused natural habitat to be unsuitable land mass for pheasants (Khaling et al., 1998). The road project connecting Genting Highlands with Fraser's Hill and Cameron Highlands if allowed to proceed will disturb the restricted range of resident and endemic pheasant of Malaysia (Anon, 1998). Although with utmost significance, the habitat destruction leads to habitat fragmentation of the remaining habitat and bitter consequences to the wildlife inhabiting it. In the long run, this resulted to the vanishing of all but small patch of suitable habitat, which becomes separated from each other by vast unsuitable ground. These fragmented habitats contain populations that are often both diminutive and secluded, making them particularly susceptible to extinction through the amalgamation of genetic, demographic, and environmental effects usually called the 'extinction vortex' (Primack, 1998). Thus, the extinction of a number of such populations over a small time may yield in major range reduction and population depletion or may even complete loss of the entire species.

Habitat degradation resulted to a drop-in value without the loss of all the original floral components or composition. It can happen by over exploitation of non-timber forest produces (e.g. medicinal herbs, fungi) or excessive grazing by domestic

animals. Selective logging, where only a few amounts of some trees (usually species of high value) are collected from the forest in a given area, may also be unfavourable. The term 'selective logging' is often used to refer that trees are harvested according to sustainable principles and alterations to forest composition are minimal. But, usually, the remaining forest is severely degraded and exhibits an aberrantly patchy and lopsided canopy. Related problems like damage to residual trunks and soil compaction are studied by Whitmore (1984), while Marshall and Swaine (1992) offer a more comprehensive re-evaluation of the consequences of selective logging on tropical forests.

Studies in the Singhalila National Park in India clearly showed that birds were avoiding areas near human settlement, apparently due to anthropogenic activities leading to habitat disturbance or degradation with the area being heavily grazed by domestic animals, collection of firewood, and bamboo being removed for daily use (Khaling et al., 1998).

Although habitat degradation is thought to be stripping the habitat from some of its composition thus rendering it unsuitable, but, in some case minimal disturbances make the habitat suitable for species that particularly thrive in such temporary or managed situations. For example, the Cheer Pheasant inhabit places in the western Himalayan foothills that are dominated by grassland and scrub habitats barred from being transformed into pine and oak forests by a number of factors including grazing by domestic animals, hay harvesting, and stubble burning (Kaul, 1989 and Kalsi, 1998). Another good example is the Margalla Hills National Park in Pakistan, which harbours Cheer Pheasants naturally until 1976 (Severinghaus et al., 1979), the desertion of a management establishment to produce grass has yield in the

invasion of the previously open slopes by a dense thorn scrub forest. This has rendered the site suitable to support a large population of White-crested Kalij Pheasant thus driving out the Cheer Pheasant and rendered the place unsuitable for their re-introduction (Garson et al., 1992).

Although, the consequences of anthropogenic activities like hunting and snaring are considered being minimal for some species, pheasants are usually exploited in large amounts with almost all known wild galliformes are being exploited for consumption, wild bird trade and even sports (Aebischer, 1997a). In reality, differentiating the effect of hunting or overexploitation from those of habitat destruction and degradation is nearly impossible although the latter being considered as a major threat in some places (Aebischer, 1997b). The real consequences of hunting are also difficult to determine as it is illegal in most countries and, therefore, are done with secrecy. But direct exploitation is thought to be having serious and harmful effects on populations of several pheasant species. Direct exploitation from local hunters is thought to exert great threat to the three pheasant species listed as Endangered in the Pheasant Action Plan 2000-2004 (Fuller and Garson, 2005). O'Brien et al. (1998) found that trapping of the endangered Bornean Peacock Pheasant for food in Kalimantan (Indonesia) is to such extent that it exerts great threat to this species survival. The recent discovery of the local extirpation of Green Peafowl (*Pavo muticus* Linn. 1766) from its former range in Vietnam (Brickle et al. 1998), Java (van Balen et al., 1995) and Laos (Evans and Timmins, 1996) was attributed to the rapid decline of suitable habitat and over exploitation for meat, feathers and egg. The species local extinction from Peninsular Malaysia was eventually the result of hunting and, in most places; *P. muticus* keep on avoiding areas near human settlements (McGowan et al., 1998).

Apart from hunting and snaring, collection of non-timber forest produces like mushroom and other edible forest products and medicinal herbs are thought to effect

pheasants more than any other wild life as pheasants are solely depending on the ground for foraging and nesting. The presence of Western Tragopan (*T. melanocephalus*) in the adjacent forest near the protected areas which lack the species in Himachal Pradesh is attributed to the anthropogenic disturbances in the protected area by means of collection of NTFP (Katoch et al., 1997). The solitude of protected areas and the lofty value of their habitats catch the attention of a large level of morel fungus collection by local residents and highly organised teams with more modern equipment from abroad, mostly accompanied by dogs (Ramesh, 2003). Wandering flocks of goats and sheep, followed by shepherds and dogs, change their grazing altitude thus entering deeply in the protected areas with the onset of spring which coincides with the breeding season (Gaston and Garson, 1992). Recent studies in China depicted that where Morel collection flourish the failure rates of Brown-eared Pheasant nests is thus elevated (Zheng-wang, 1998). The large-scale growth of the ecotourism industry may pose serious threat to pheasant and their survival. For example, the Crested Argus is known to be intolerant of anthropogenic interruption (Wells, 1999). The opportunity of trekkers to climb the thickets of the pristine highland habitat, following the improvement of several access routes to the remote habitat is also exerting serious threats to the pheasants (Mamat and Yasak, 1998).

1.3 Grey Peacock Pheasant *Polyplectron bicalcaratum*

Grey Peacock Pheasant *Polyplectron bicalcaratum* (Linnaeus, 1758) belongs to a group of birds commonly referred as ‘game birds’ or ‘pheasants’. Pheasants are large-bodied, brightly coloured, ground-dwelling birds, which belong to the family Phasianidae in the order Galliformes. The male *P. bicalcaratum* are recognized by

their larger size, dark grey with paler bars forward pointing bushy crest, long train feathers with prominent bluish green ocelli and the whitish throat and cheeks. The other plumage is more or less uniformly vermiculated and barred grey-brown with numerous mainly bluish green ocelli with buff or white colour that surrounds the eye spots. The females are smaller and have darker plumage with fewer ocelli. The tail of the female *P. bicalcaratum* is literally without ocelli or eye spots which are prominently present in males. The ocelli or eye spots are usually restricted to the wings and tail coverts of the female (Srivastav and Nigam, 2010).

The *P. bicalcaratum* reach sexual maturity within the first year and breeding season is in between the months of March and June mainly during April and May. The nest is usually built in a superficial depression often beneath the clump of a bamboo or in thickets of bushes. Most of the time, the nest is well concealed by dry leaves and surrounding thick vegetation. It is often located near good source of water. The clutch size is mostly reported to be two. The eggs have cream coloured shell with an average size of 46.5 x 35.9 mm. The duration of incubation is 21 days and it is taken up by female alone. The hatchlings are fed by the female by regurgitating the food; the chicks learn to take food from ground only after first the few days. The chicks are seen moving under the cover of their mother wherever they go; this is thought to be of a protective behaviour (Srivastav and Nigam, 2010).

P. bicalcaratum are known to have an omnivorous diet that include grains, berries, seeds, wild figs, insects, grubs, snails and other small animals. They particularly like termites and are also feeding upon bamboo seeds and young shoots of green vegetation depending on their availability. They do not appear to have a specific roosting site and it is reported that the male perches on a branch to call in the morning or late afternoon. The *P. bicalcaratum* remain concealed in the dense

undergrowth and are exceptionally fast moving on their legs. *P. bicalcaratum* moves very slowly, scratching for food in a methodical, secretive and restrained manner during foraging. Their movement in the undergrowth is stealthy; they skulk under obstructions instead of jumping or flying over them (Srivastav and Nigam, 2010).

Traditional taxonomy placed the Grey Peacock Pheasant *P. bicalcaratum* in the subfamily phasianinae in the family phasianidae however recent molecular genetic evidence suggests that they are more closely related to peafowl and partridges than to other pheasants (Srivastav and Nigam, 2010).

P. bicalcaratum being categorised as 'Least Concern' by the IUCN (2018) is a relatively common species as compared to the other peacock pheasant (Johnsgard, 1999). *P. bicalcaratum* are loud calling ground birds which inhabit the dense evergreen forest of the hilly terrain (Johnsgard, 1999). During the breeding season, the male call throughout the day predominantly from the display scrapes to defend their territory (Baker, 1930) and to attract eligible mate (pers. obs). Display scrapes are patch(es) of ground cleaned by the male by clearing off all leaf litter thus making the ground bare (Johnsgard, 1999).

The breeding season is from late February to mid-May with prime season being the month of March and April (pers. obs). The female does not call but responds to the calling male by visiting the display scrapes (Thunhikorn et al., 2016) and also by a soft chuckling low tone call (pers. obs). *P. bicalcaratum* is a lesser known species due to its elusiveness and stealthy behaviour (Srivastav and Nigam, 2010).

P. bicalcaratum is reported to be present in Bhutan, Bangladesh, Myanmar, South China, Thailand, South Laos and Central Vietnam with its western limit being Sikkim of India (Madge and McGowan, 2002). In India, this species is found throughout the north east states *viz.* Sikkim, Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland and Tripura (Srivastav and Nigam, 2010).

Lalthanzara et al. (2014) are in the opinion that *P. bicalcaratum* sighting is related to the presence of pristine evergreen forest with very few or no human disturbances including collection of NTFPs. They also reported that *P. bicalcaratum* were encountered mostly in virgin evergreen forest with a small number of *P. bicalcaratum* sighting in the secondary forest and the total absence of *P. bicalcaratum* from the fallow land adjacent to the evergreen forest. This finding clearly depicts the specific needs of *P. bicalcaratum* for its survival thus playing an important role as indicator to habitat disturbances or change in the ecosystem.

Majority of the rural populations are tribal who engaged in shifting cultivation where the forest is slashed, dried and burned, cultivated for a year and the cycle goes on by shifting to different area. Apart from shifting cultivation, the people also indulge in monoculture farming of orange, oil palm, betel nut, tea, coffee and other agricultural produces. Being a hillock state, development shuns many villages in the periphery of the political boundary of the state and people are deprived of daily basic needs like the Liquefied Petroleum Gas (LPG). The local's resort to the use of firewood for cooking and collection of firewood from the adjacent forest is a yearlong daily chore of the villagers. The expansion of human habitation, the destruction of habitats by agriculture (slash-and-burn shifting cultivation, known as *jhum*), timber logging and hunting have resulted in a sharp decline in Galliformes

abundance as well as causing habitat fragmentation. Although many pheasant occur within Protected Areas (PA), the enforcement of wildlife laws is inadequate at many places (Choudhury et al., 2007). Within the north-eastern states, Dohling and Sathyakumar (2011) and Sathyakumar et al. (2007) works on pheasant were notable. Despite the state bird of Mizoram being a pheasant (Mrs. Humes' Pheasant), few works were done on pheasant of Mizoram (Ghose, 1999 and 2000; Ghose and Thanga, 1998; Ghose et al., *2003*; Choudhury 2005, 2006 and 2009; and Lalthanzara et al., 2011, 2014 (a,b) and Sailo et al., 2013) and are mainly focused on spatial distribution of Pheasants.

Even though the state is rich in pheasant diversity, till date there have been few systematic survey or population studies of pheasant in the state. Knowing the details of biology and ecology is an essential component in the conservation strategy for this ecologically important ground birds. Moreover, there is a paucity in ecological data and information of this important bird, particularly from the hilly tropical evergreen forest of Indo-Myanmar biodiversity hotspot. Therefore, this study is taken up to add reliable information on the ecology of the *P. bicalcaratum* of Mizoram with the following objectives to fill the knowledge gap about this species.

CHAPTER 2

OBJECTIVES

The general objective of this study is to provide knowledge on the ecology of *P. bicalcaratum* in the tropical forest of Mizoram, India.

The gap in knowledge about the *P. bicalcaratum* population demography, distribution in relation to season and the pattern of habitat use, habitat association and factors playing significant role in their habitat selection will be answered by studying the following specific objectives:

1. To study the population status and demography of *P. bicalcaratum*
2. To assess spatio-temporal distribution of *P. bicalcaratum*
3. To determine habitat composition of *P. bicalcaratum*
4. To study habitat selection by *P. bicalcaratum*

CHAPTER 3

LITERATURE REVIEW

Pheasants are large-bodied, brightly coloured, ground-dwelling birds, which belong to the family Phasianidae in the order Galliformes and are predominantly adapted to ground scratching and are non-migratory (Dohling and Sathyakumar, 2011). Since they are mainly ground-feeding and ground nesting species, they are very sensitive to understory clearance and habitat fragmentation from timber harvesting and hunting (Garson and Zheng, 2006). Pheasants are known to be among the most endangered avian groups in the world (McGowan, 2002; Brickle et al., 2008). 27 species of pheasants are included on the most recent Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) list, with 17 species being classified as CITIES I (Appendix A species are either rare or endangered; CITES 2011). Pheasants (Family-Phasianidae) generally comprised of three sub-families: Tragopaninae (Tragopans), Argusianinae (Argus pheasants), and Phasianinae (Pheasants) (Amador 1999). Pheasants are the most fascinating of all the avian species found in the Himalayan region (Sathyakumar et al.). The high endemism and brilliantly decorated feathers of the pheasants makes them the most unique bird family of the Himalaya (Ali 1981). Of the 51 species of pheasants recorded globally, 20 (39%) are endemic to the Himalayan region, which include the genera of *Ithaginis* (Blood pheasant), *Tragopan* (Tragopans or horned pheasants), *Lophophorus* (Monal pheasants), *Lophura* (Kalij pheasant), *Pucrasia* (Koklass pheasant), *Catreus* (Cheer pheasant), *Crossoptilon* (Eared pheasant) and *Polypectron* (Peacock pheasant). Out of the 17 species found in the Indian Subcontinent, 16 are found in the Indian Himalayan region. Five species of pheasants found in the Indian

Himalaya are threatened with extinction (Sathyakumar & Sivakumar 2007). They play an important role as prey-base for terrestrial carnivorous fauna, thus providing a significant characteristics and role in the functioning of the high altitude ecosystem (Johnsgard 1987). Pheasants are found to occupy habitat with various vegetation types and altitudinal gradients. In majority of their range, pheasant population had undergone intense decline due to over hunting for colored feathers and meat (Ramesh et al., 1999). Habitat fragmentation, habitat degradation, habitat loss and over exploitation through hunting both for cultural and economic interest of humans are major threats to pheasants. (McGowan et al., 1998; Ramesh, 2003).

Traditional taxonomy positioned the *P. bicalcaratum* in the subfamily phaisininae in the family phasianidae however latest molecular genetic evidence suggests that they are more closely related to peafowl and partridges than to other pheasants. However, our understanding of this group is still very limited (Bush and Strobeck, 2003).

Genus *Polyplectron* which constitutes the peacock-pheasants is a unique group of small, usually having dark-brown-grey colour tone, inhabiting the forest of tropical Asia and its adjacent larger islands. They are mostly shy and very elusive-frequenting habitat with dense undergrowth which aid in the difficulty of sighting them. They are mostly vocal and their distinguishing calls help in their detection and identification even up to species level (Madge and McGowan, 2002).

The genus is usually characterised by a slender legs with multiple short sharp spurs (2-3 or may be more in some species) in males where they resembles spurfowls

of India. Some species have an elaborate crown feathers or crest and pronounced neck ruffles. The crest is mostly forward pointing, bushy and usually displayed when provoked. The contour feathers and the tail feathers usually have peacock-like ocelli at the tip. Most species has a spectacular display postures and usually produce a clutch of not more than 2 eggs which appears to be the distinguishing character among the phasianids (Madge and McGowan, 2002).

IUCN Red Data Book (2018) listed *P. bicalcaratum* under a Least Concern category as the population estimate does not reach the threshold for threatened category. While the other Peacock Pheasant *viz.* Hainan Peacock Pheasant *P. katsumatae* and Bornean Peacock Pheasant *P. schleiermacheri* are under IUCN Endangered list (IUCN, 2018), Malayan Peacock Pheasant *P. malacense*, Palawan Peacock Pheasant *P. emphanum* and Mountain Peacock Pheasant *P. inopinatum* are under Vulnerable category (IUCN, 2018). Germaine's Peacock Pheasant *P. germaini* is a Near Threatened species while Sumatran Peacock Pheasant *P. chalcurum* and Grey Peacock Pheasant *P. bicalcaratum* are the only two species under the genus *Polyplectron* to fall under the Least Concern category (IUCN, 2018). As compared to other Peacock Pheasant, the *P. bicalcaratum* is a relatively common species (Johnsgard, 1999). The species falling under the genus *Polyplectron* are mostly habitat specialists and are facing number of similar threats in their respective range. The threat faced by the species under the genus *Polyplectron* can be summarised as habitat loss and habitat degradation due to anthropogenic pressure, hunting for commercial and local trade, and most importantly the lack of reliable knowledge and information about each and every species (Madge and McGowan, 2002).

P. bicalcaratum are often mentioned in literatures and articles of ornithology but detailed discussion is often lacking. Habits and habitat of *P. bicalcaratum* is virtually unknown due to lack of studies and observations (Madge and McGowan, 2002).

Madge and Mc Gowan (2002) considered this species to be fairly common in the protected areas of Thailand. They also mention that the overall population of *P. bicalcaratum* in Laos appears to be healthy whereas no recent report of *P. bicalcaratum* from Myanmar which is believed to be a former range of the species. In China the species is found to be much localised and perhaps expanding its range (this may be just due to intensive search result in Yunnan). It is considered locally not uncommon in the undisturbed forest of northeast India and Bhutan (Madge and Mc Gowan, 2002). Thompson and Johnson (2003) confirm the presence of *P. bicalcaratum* in Chittagong Hill Tracts.

The species is represented by four subspecies, *viz.* i) *P. b. Bakeri* (Lowe, 1925), a Bhutan Grey Pheasant more widely known as Himalayan Grey Peacock Pheasant, is the palest and greyest form; ii) *P. b. bailyi* (Rothschild, 1906), a Hainan Grey Peacock; iii) *P. b. bicalcaratum* (Linnaeus, 1758), a Burmese Grey Peacock Pheasant is dark brown and buff coloured specimens; and iv) *P. b. Ghigii* (Delacour and Jabouille, 1924), a Ghigi's Grey Peacock Pheasant, browner than *P.b. bicalcaratum* with buff coloured surrounds on the tail ocelli. *P. bicalcaratum* is a lesser known species due to its elusiveness and stealthy behaviour. This species occurs in Bhutan, Bangladesh, Myanmar, South China, Thailand, South Laos and Central Vietnam with its western limit being Sikkim of India (Madge and McGowan, 2002). In India, this species is found throughout the north east states *viz.* Sikkim,

Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland and Tripura (Srivastav and Nigam, 2010). Grimmettet al. (2013) mentioned that *P. bicalcaratum* is a resident of East Himalayas with North East India and Bangladesh as its distribution range in the Indian sub-continent. Furthermore, Bikram et al. (2016) highlight the distribution range of *P. bicalcaratum* in the Indian sub-continent to be from Sikkim to Arunachal Pradesh without mentioning other North Eastern states.

Thunhikorn et al. (2018) studied the spatial distribution of display sites in relation to micro-habitat and predators during the breeding season in Thailand. *P. bicalcaratum* is reported up to an elevation of 1800m in Thailand whereas in Yunnan of China they are reported to reach the height of 2000m by Madge and Mc Gowan (2002), but the lower elevations were not mentioned. Sathyakumar and Kaul, (2007) also did not mention the lower limit for this species whereas the upper altitudinal limit is mentioned to be 1200m.

P. bicalcaratum is fairly abundant in thick cover along banks of rivers. Even found in tangled scrub and secondary growth or mixed bamboo and thick scrub (Srivastav and Nigam, 2010). Usually not seen near human land use forms like cultivations near forest and wooded tea gardens (Srivastav and Nigam, 2010). *P. bicalcaratum* was however reported to inhabit a dry shorea forest ecosystem of Phibsoo Wildlife Sanctuary in Bhutan from south western Bhutan bordering India (Singh, 2012). Goriup (2006) reported the presence of *P. bicalcaratum* in various community reserve forest of Nagaland. Meanwhile, Kaul et al. (1995) mentioned that shifting cultivation in NE India is affecting the habitat of *P. bicalcaratum*. Selvan et al. (2013) observed that *P. bicalcaratum* was rigid to human disturbance and occurs mainly in primary forest of Pakke Tiger Reserve.

Detailed population assessment of *P. bicalcaratum* was done in the pristine sub-montane forest of Huai Kha Khaeng wildlife sanctuary, Western Thailand by Thunhikorn et al. (2016). Madge and MacGowan (2002) mentioned the difficulties of an overall population assessment due to lack of proper studies in its range compounded by the geographical and political differences. They are of the opinion that *P. bicalcaratum* are at risk from habitat loss in most of its known range while hunting is also a serious threat in some area of its distribution range.

The habits of *P. bicalcaratum* is virtually unknown which can be attributed to lack of observation. They are thought to skulk away to the undergrowth with minimal disturbances. Usually forage the well wooded forest floor singly or in pairs searching for seeds, berries, fruits, and invertebrates principally the termites. Foraging is known to be slow and deliberate with little noise from the ground scratching. Their presence is mostly detected by the call of the male pheasant which is known to be carried far away. The males are known to call throughout the day during the breeding season which may vary across its range but usually between March to June with peak breeding season between April and May (Madge and McGowan, 2002).

Although the north-eastern region of India is rich in pheasant diversity with 13 species (out of the 17 species of Pheasants present in India) occur in the North East (Sathyakumar and Kaul, 2007). Works on pheasants in the region is scanty and are usually sighting report other than the work of Ghose et al. (2003) where a status survey of Blyths Tragopan was done in the Phawngpui National Park (Blue Mountain National Park) of Mizoram. Selvan et al. (2013) also conducted a detailed

assessment on the abundance, habitat use and activity patterns of Kalij Pheasant, Red Jungle Fowl and Grey Peacock Pheasant at Pakke Tiger Reserve of Arunachal Pradesh. Relative abundance of galliformes in Nongkhyllem Wildlife Sanctuary of Meghalaya was also assessed by Dohling and Sathyakumar (2011). A Questionnaire Survey for Pheasants, describing the distribution of Kalij Pheasant *Lophura leucomelanos* and Peacock Pheasants *Polyplectron bicalcaratum* in Meghalaya was done by Mukhim and Micheal (1992). Ramesh et al. (2012) conducted a questionnaire survey on people's perception on the Blyths Tragopan in Nagaland. Other literature available from the region concerning pheasants are usually sighting report like the record of four species of pheasants from Mizoram by Choudhury (2006), sightings of three Tragopan species (Blyths Tragopan, Temminck's Tragopan and Satyr Tragopan) in Arunachal Pradesh by Suresh Kumar (Tragopan 19), sighting report of Mrs Humes Pheasant from Mizoram by Choudhury (2000) and the presence report of blyths Tragopan from Eaglenest Wildlife Sanctuary of Arunachal Pradesh by Suresh Kumar and Pratap Singh (Tragopan 17). Lalthanzara et al. (2011) furnished a detailed status of pheasants in the contemporary Mizoram; while, Sailo et al. (2013) provided a distribution pattern of the six pheasant species in Mizoram.

Aiyadurai (2011) clearly highlight the threats faced by many pheasant species including the Grey Peacock Pheasant of Northeast India due to the practice of hunting by the tribal community of the region. Kaul et al., (1995) also highlighted that the practice of *jhuming* (shifting cultivation) in northeast India has detrimental effect on the habitats of Blyth's Tragopan (*Tragopan blythii*) and Grey Peacock Pheasant (*P. bicalcaratum*).

Reports about presence or absence of *P. bicalcaratum* from north east India is given by Choudhury (2006), Choudhury et al. (2007), Ghose et al. (2007), Lachungpa and Bhutia (2007), Sathyakumar and Dohling (2009) and Selvan et al.(2013). The *P. bicalcaratum* is one amongst the six species of pheasants found in Mizoram (Lalthanzara et al., 2011). No ecological studies being done on this bird from Mizoram other than a reconnaissance survey of Lalthanzara et al. (2011, 2013, and 2014).

CHAPTER 4

MATERIALS AND METHODS

4.1 Materials- Study sites

Mizoram (21,087 sq. km., 21°58'N to 24° 35'N latitude and 92°15 to 93°29'E longitude) is a hilly state, located in northeast India. It is sandwiched by international borders with Bangladesh from the west (318 km) and Myanmar from the east and south (404 km). It has a state boundary in the north with Manipur, Assam and Tripura. It lies in the Indo-Myanmar Biodiversity Hotspot area; therefore, Mizoram is rich in wild flora and fauna, both in variety and abundance. There are six Important Bird Areas (IBAs) in Mizoram viz, Phawngpui National Park (A1 & A3), Dampa Tiger Reserve (A2), Lengteng Wildlife Sanctuary (A1 & A2), Murlen national Park (A1 & A2), Ngengpui Wildlife Sanctuary (A3) and Palak Lake (A3) which fall under IBA criteria A1- A3. Mizoram experience four seasons *viz.* winter, autumn, summer/rainy season and spring, with a moderate climate. The average temperature usually ranges from 12.4^{o}C to 27.3^{o}C. The pre-monsoon winds and thunderstorms, the fore runner of the rainy season start from mid-April usually accompanied by hailstones and thunder showers. The rainy season is long and wet, with very heavy downpour between May and mid-October. From the month of November to mid-February is mostly cold and dry with little rain and a warmer month of March and April follows. The state has an average annual rainfall of 2500 mm. Mizoram is a land of rolling hills with average height of roughly 1000 m, deep valleys, rivers/streams and few small lakes. The southward appearance of the hills leads to difference in various climatic conditions as compared to other Himalayan ranges.

The total forest cover of the State of Mizoram is 18186 sq. km. *i.e.* 86.27% of the total geographical area. Very dense natural forest covers 131 sq. km. (*i.e.* 0.62%), moderately dense forest cover is 5861 sq.km. *i.e.* 27.80% and the open forest covers an area of 12184 sq.km. *i.e.* 57.84% of the forest cover (FSI, 2017).

4.1.1 Sampling

Extensive field survey was done by visiting 255 villages of Mizoram covering the entire eight districts by randomly selecting the village to represent the whole state covering all types of vegetation during September to October 2014.

This field survey was taken up to collect secondary information from local people, particularly hunters, elders, knowledgeable persons including the local NGO leaders (particularly Young Mizo Association) who took up conservation steps in the villages and also staffs of Environment Forest and Climate Change (EF&CC) department if any are present. The oral information was confirmed by making the people to identify the *P. bicalcaratum* from coloured plates and also by identifying the trophies viz, tail feathers and leg of the species kept by the hunters (shown in Photo 4 and 5). Wherever possible, the doubtful information was verified by visiting the forest for confirmation of *P. bicalcaratum* call and locating the display scrapes.

Based on the information collated during the preliminary study and collection of secondary data, two intensive study sites *viz,* Lengteng Wildlife Sanctuary (LWS), Champhai district and Ţawi Wildlife Sanctuary (TWS), Aizawl district were selected (Map 1).

4.1.1a Lengteng Wildlife Sanctuary (LWS)

Lengteng Wildlife Sanctuary (LWS) is located in the north eastern part of the state (23°50'31.99"N 93°12'35.39"E). The forests comprise of Tropical Evergreen and Sub-tropical Broad-leaf types which is still fairly undisturbed. The elevation ranges from 800 m to 2141 m. The second highest peak of Mizoram (2141 m) is in this Sanctuary. The Sanctuary lies close to the Indo-Myanmar border and is significant because of its proximity to the Chin Hills. The nearest town is Ngopa. Map of Lengteng Wildlife Sanctuary is given in Map 2. LWS has a total area of 60 km^2 with 7 fringe villages viz, Lamzawl, Ngopa, Kawlbem, Selam, Lungphunlian, Tualcheng and Pamchung. LWS is home for Mrs. Humes Pheasant, Great Indian Hornbill, Wreathed Hornbill, Pied Hornbill and White-cheeked Partridge, Tiger, Himalayan black bear, and Hoolock Gibbon etc. (https://forest.mizoram.gov.in/page/lengteng-wildlife-sanctuary).

The sanctuary is maintained by the Department of Environment, Forest and Climate Change, Government of Mizoram. The Forest Range Officer (Wildlife division) was the officer in charge of the sanctuary and was based at Lamzawl village. The nodal department has various check posts on the roads connecting the sanctuary to other places of the state, Beat Officers and few Wildlife Guards are manning the various stations which are based on the fringe village from where they occasionally carried out patrol inside the sanctuary.

The possible habitat for *P. bicalcaratum* was identified by preliminary field survey inside the LWS. The habitat area of *P. bicalcaratum* comprise of small steep hills with deep gorges and small streams, thick undergrowth of climbers, bamboo, and shrubs. All these lead to a very poor visibility even during the day and also the

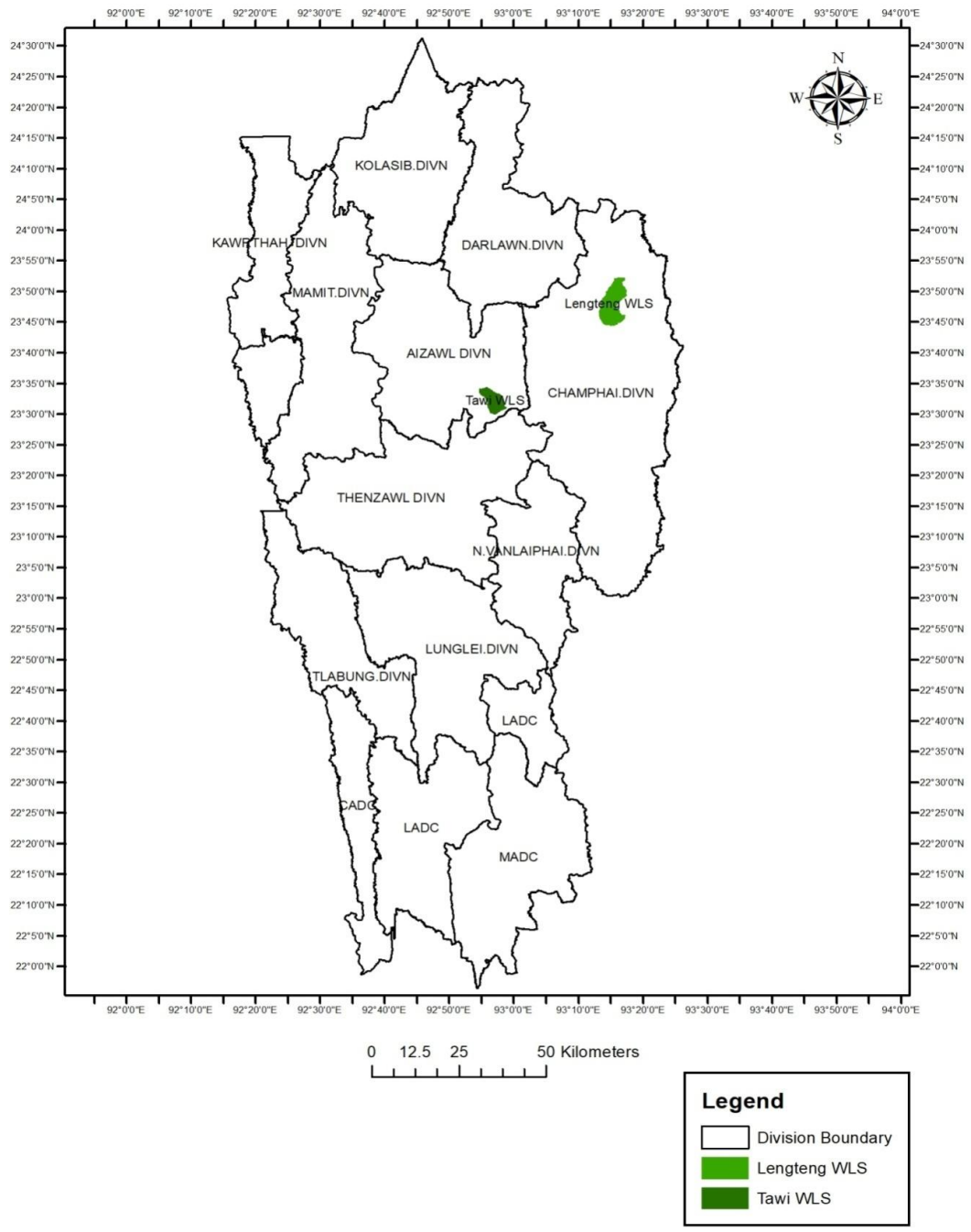
place cannot be access easily due to the unfriendly terrain. The temperature in the area ranges from 2.4°C - 22.3°C. Rainfall is experienced from the month of April and continues till October and sometimes till mid-November.

4.1.1b Tawi Wildlife Sanctuary (TWS)

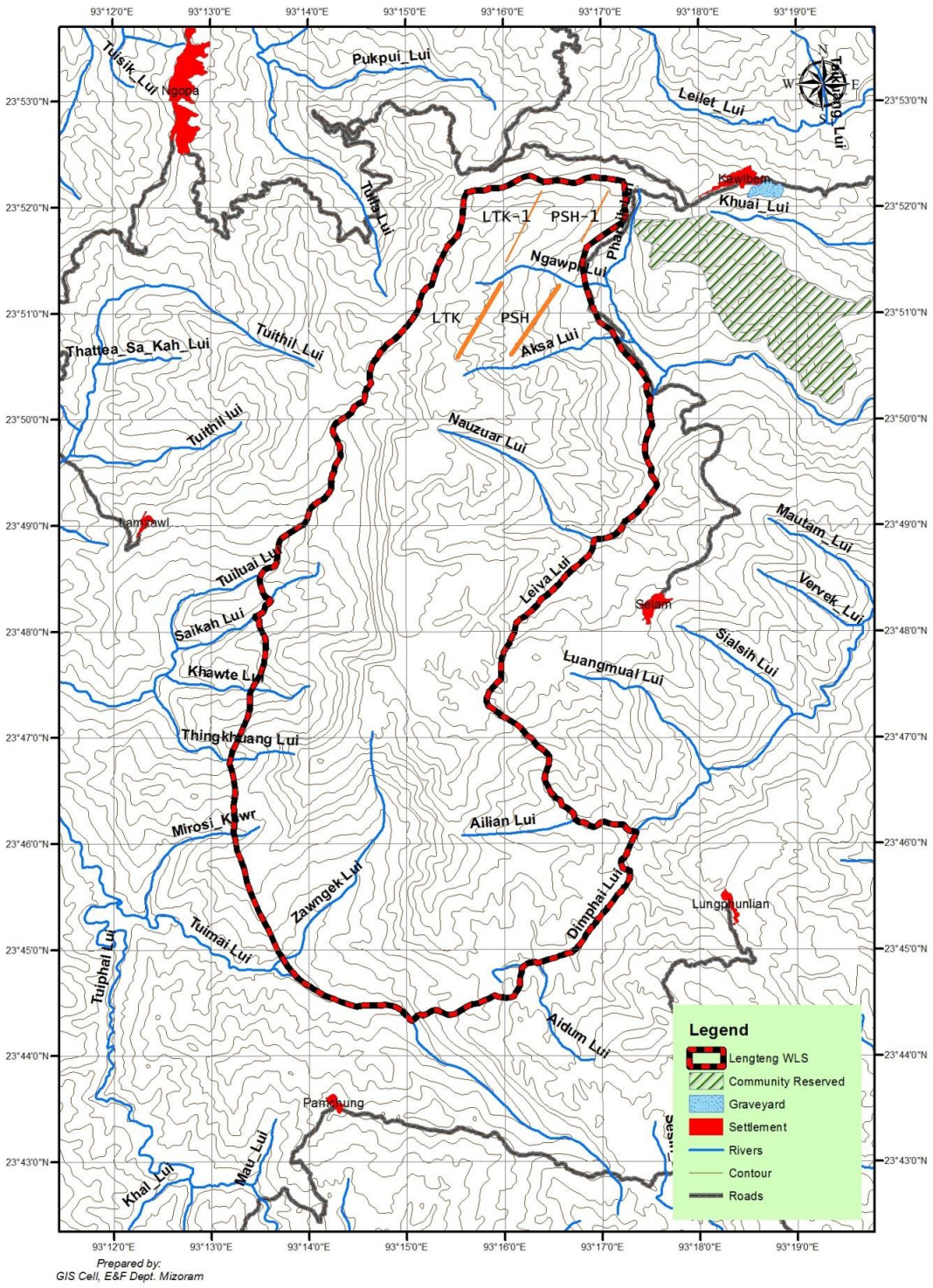
Tawi Wildlife Sanctuary (TWS) (23° 31.52'71'' N 92°57'483" E) lying in the extreme periphery of Aizawl district is credited amongst the first sanctuaries of Mizoram being constituted in the year 1978. It is located roughly 100 km to the south-eastern side from the capital city Aizawl. The total area covers 36 km^2 and the vegetation is dominated by tropical evergreen forest. The elevation ranges from 400 m – 1705 m and temperature drop to as low as 2°C in the winter and may soar to 25.3°C in the summer. Rainfall is experienced from the month of May to October and sometimes may extend up till mid-November.

The hilly terrain is compounded by small deep gorges which separate small hillocks. The deep gorges turned to small strong rivulets during the rainy season but usually dry up with the onset of the dry season. The cliff surrounding the wildlife sanctuary in the east-south-west face forms nearly a vertical wall preventing easy access. The northern and north-western side of the sanctuary is the only easily accessible openings as the hills steadily gradient downward towards the sanctuary border. The fringe village surrounding the sanctuary are Ţawizo, Maite, Hmunţha and Hualtu. The jeep-able roads connecting these villages are very poorly maintained and are not easily accessible during the rainy seasons.

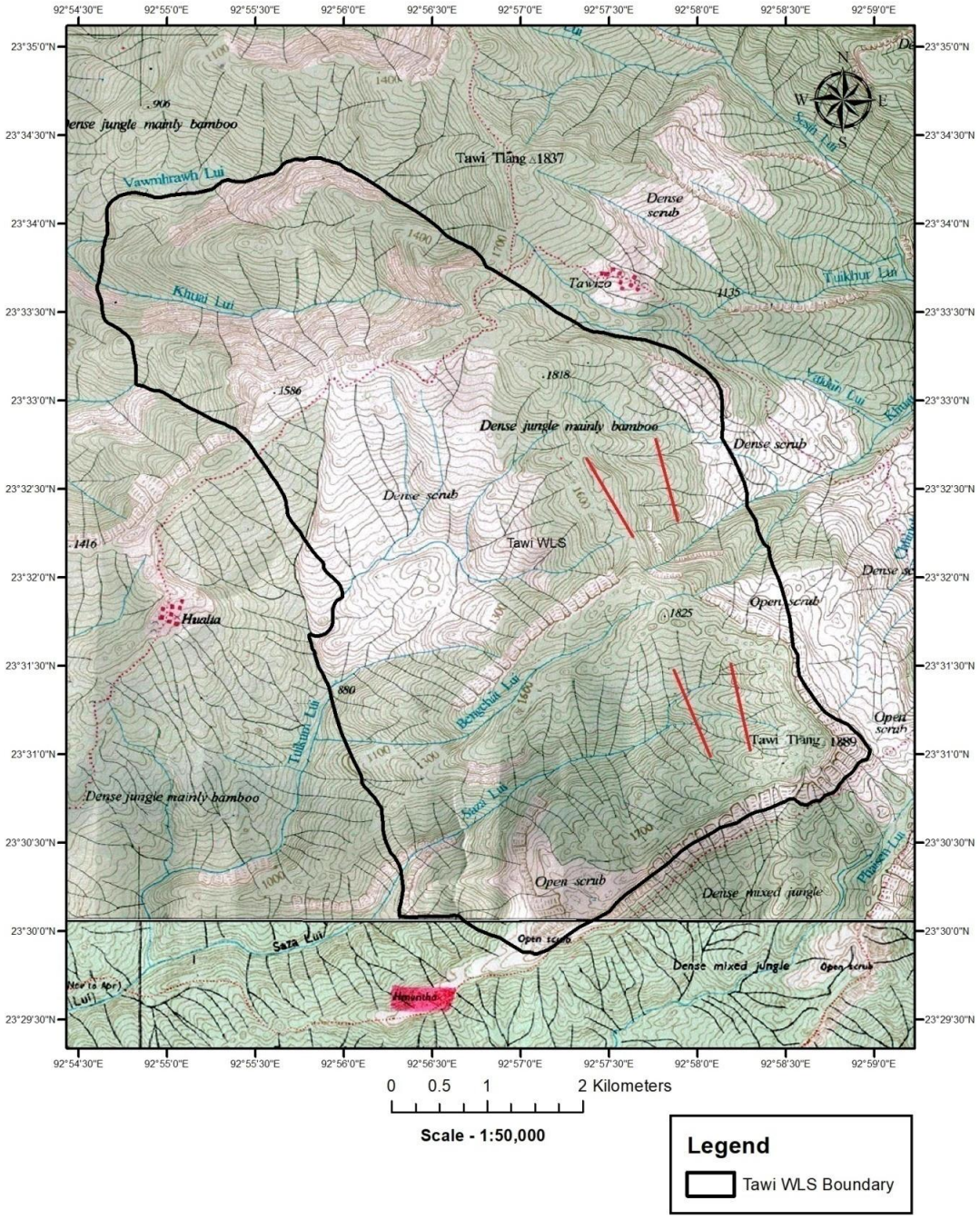
The sanctuary is governed and maintained by the Environment, Forest and Climate Change Department under the Government of Mizoram. The Forest Range Office for this sanctuary is located at Hualtu village with few Wildlife Guards scattered in the fringe village. The roads leading to the sanctuary have no check posts, entry and exit to and fro the sanctuary was not either restricted. The nodal department claimed the presence of many wild life species including threatened and rare White-cheeked Hill Partridge, Great Indian Hornbill, Tiger, Golden cat, Marbled cat, Malayan Sun Bear, Hoolock Gibbon and Phayre's Leaf Monkey (https://forest.mizoram.gov.in/page/tawi-wildlife-sanctuary). Map of TWS is depicted in map 3.



Map 1. Location of the two study sites- Lengteng Wildlife Sanctuary (LWS) and Tawi Wildlife Sanctuary (TWS) in Mizoram



Map 2. LWS showing Line transects in orrange coloured line



Map 3. TWS showing Line transects in red coloured line

4.2 Study animal

Grey Peacock Pheasant *Polyplectron bicalcaratum* (Linnaeus, 1758) belongs to a group of birds commonly referred as ‘game birds’ or ‘pheasants’. Pheasants are large-bodied, brightly coloured, ground-dwelling birds, which belong to the family Phasianidae in the order Galliformes.

Phylum:	Chordata
Class :	Aves
Order :	Galliformes
Family:	Phasianidae
Genus:	*Polyplectron*
Species:	*bicalcaratum*

Pheasants serve as useful indicator for environmental quality as a major prey base for predatory birds and mammals and indicators of adverse human impact on high altitude ecosystem (Ramesh et al., 1999; Fuller and Garson, 2000; Kaul, 1989 and Lalthanzara et al., 2014). They are predominantly adapted to ground scratching and are non-migratory.

Of the 17 species of Pheasants present in India, 13 species occur in the North East (Sathyakumar and Kaul, 2007) and 6 species are reported from Mizoram (Lalthanzara et al., 2011). Traditional taxonomy placed the *P. bicalcaratum* in the subfamily phaisininae in the family phasianidae however recent molecular genetic evidence suggests that they are more closely related to peafowl and partridges than to other pheasants. The *P. bicalcaratum* is one amongst the six species of pheasants found in Mizoram. The species is represented by four subspecies, *viz.* i) *P. b. bakeri*

(Lowe, 1925), a Bhutan Grey Pheasant more widely known as Himalayan Grey Peacock Pheasant, is the palest and greyest form; ii) *P. b. bailyi* (Rothschild, 1906), a Hainan Grey Peacock; iii) *P. b. bicalcaratum* (Linnaeus, 1758), a Burmese Grey Peacock Pheasant is dark brown and buff coloured specimens; and iv) *P. b. Ghigii* (Delacour and Jabouille, 1924), a Ghigi's Grey Peacock Pheasant, browner than *P. b. bicalcaratum* with buff coloured surrounds on the tail ocelli. *P.b. bicalcaratum* is a lesser known species due to its elusiveness and stealthy behaviour. In the present study sites, the nominate sub species *P. b. bicalcaratum* is known to be present and inhabit the hill forest of Mizoram.

P. bicalcaratum being categorised as Least concern by the IUCN (2018) is a relatively common species as compared with other peacock pheasant (Johnsgard, 1999). *P. bicalcaratum* are loud calling ground birds which inhabit the dense evergreen forest of the hilly terrain (Johnsgard, 1999). During their breeding season, the male *P. bicalcaratum* call throughout the day predominantly from the display scrapes to defend their territory (Baker, 1930). Display scrapes are patch (es) of ground cleaned by the male by clearing off all leaf litter thus making the ground bare (Johnsgard, 1999).

The breeding season starts from late February to mid-May with prime season being the month of March and April (pers. obs). The female does not call but responds to the calling male by visiting the display scrapes (Thunhikorn et al., 2016) and also by a soft chuckling low tone call (pers. obs).

This species occurs in Bhutan, Bangladesh, Myanmar, South China, Thailand, South Laos and Central Vietnam with its western limit being Sikkim of

India (Madge and McGowan, 2002). In India, this species is found throughout the north east states *viz.* Sikkim, Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland and Tripura (Srivastav and Nigam, 2010).

Photo 1: Study animal- Grey Peacock Pheasant *P. bicalcaratum* (Male), Photo- Awmawia Sailo

4.3 Methods

In order to achieve my objectives, secondary information on the spatial distribution of *P. bicalcaratum* was collected from local hunters, environment and forest department staff and from feathers in and around the study area. Preliminary survey was conducted using existing test path or footpath to determine the presence/absence and distribution of the *P. bicalcaratum* in the field investigation areas. After identifying the probable habitat of the bird, 4 line transects (Burnham et al., 1981) were laid in each of the study sites. Details of each transect at LWS are Lengteng Kawng-1, 0.84 km, 1686m, 23˚52.026'N 93˚15.571'E; Lengteng Kawng-2, 0.71 km, 1693m, 23˚52.022'N 93˚15.544'E; Lengteng Kawng-3, 0.6 km, 1679m, 23˚52.036'N 93˚15.539'E and Lengteng Kawng-4, 0.73 km, 1701m, 23˚52.027'N 93˚15.563'E. The transect details of TWS are Kham chung, 0.56 km, 1777m, 23˚51.763'N 92˚97.349'E; Kham chung-1, 0.64 km, 1705m, 23˚51.841'N 92˚97.533'E; Tui lakna, 0.47 km, 1507m, 23˚51.662'N 92˚97.731'E and Maite kawng, 0.72 km, 1325m, 23˚51.641'N 92˚97.436'E.

All environmental variables *viz.* rainfall, temperature, relative humidity, slope, wind velocity, cloud cover, tree species, litter cover, canopy cover and distance from water source are properly recorded. The rainfall of the study area was measured by installing one Noah's rain gauge (250 mm) in each study sites. The rainfall was measured twice a month along walking the transect. The wind velocity was measured by MASTECH MS6252B digital anemometer while sampling the transect. The relative humidity (RH) of the study sites were measured by HTC AL-7010. Slope percentage of the study area was calculated by dividing the rise by the run multiplied by 100 following Michael Noll (2018) [downloaded from:

www.archtoolbox.com]. The temperature of the study sites was measured by using the inbuilt thermometer of HTC AL-7010. The cloud cover over the study sites during the transect walk was estimated by grading the cloud cover as clear sky (0-30%), moderate (31% -60%) and over cast (>60%). The canopy and litter cover are also quantified into thin (0 -30%), moderate (31% – 60%) and thick (>60%). The equipment used in the field was depicted in photo 2.

The collected data was then analysed using Principal Component Analysis (PCA). For population status, demographic studies, spatio-temporal distribution and determination of habitat selection of *P. bicalcaratum*, a was collected by Line Transects and Call count method.

4.3.1 Line Transects

Line transects (Burnham et al., 1981) method was employed to obtain density estimate for *P. bicalcaratum*. In this method, a straight line was walked and birds on both sides of the line were counted. Four variable length (200m-600m) Line transects of fixed width (50 m) was laid in each study site and are walked (Map 2 & 3, Photo 3) at least 2 times a month during the early morning hours (0500 hrs to 0930 Hrs) for 36 months (November 2014 – October 2017). For every sighting, number, age and sex, and sighting distance as well as other environmental variables were recorded.

4.3.2 Call count-technique

Since the study sites are compounded by steep slope and dense vegetation, the call-count technique is one of the most feasible methods for counting the species of interest (Duke, 1990). As *P. bicalcaratum* calls most of the time during the breeding season and also at dawn and in the evening during other season (Madge and

McGowan, 2002). Call of *P. bicalcaratum* was listened from the transect line itself after every 10 minutes' walk without designating a specific vantage point. The calling male in the breeding season were considered to be paired and data was merged to the Line transect data. Call count method was employed to detect *P. bicalcaratum* in the transect itself by its call as they are difficult to detect by direct sighting in the thick undergrowth.

Environmental variables of the study site *viz.* rainfall, temperature, humidity, cloud cover, wind velocity, litter cover, canopy cover, slope, vegetation types, vegetation category and distance from water source were recorded to determine the habitat selection.

4.3.3 Vegetation sampling

Quadrate method was employed to study the vegetation composition of the study area. In order to assess the habitat composition of *P. bicalcaratum*, systematic sampling (Bill et al. 1985) of vegetation along the transects was carried out by placing 10 random quadrates with fixed size of 10m x 10m as prescribed by Baxter (2014). The quadrates were randomly laid in the study area, mainly within the width of the transects. The quadrates were laid in such a way that it will cover and represent maximum part of the study area to thoroughly determine the habitat composition of the *P. bicalcaratum*. The plant species in the quadrates were then identified with the help of The Book of Mizoram Plants by Sawmliana (2013).

4.3.4 Equipment

The equipment employed for the study was presented in Photo 2.

a. Camera- For photographing the study area and the study animal and other evidence during the study period, Nikon DSLR camera model D5100 with 55-300mm lens was used.

b. GPS- During the study period, to determine the altitude and co-ordinates of particular areas of the study sites and place of interests, Garmin eTrex 30 was used.

c. Barometer- For the determination of the Relative Humidity of the study sites, HTC AL-7010 was used.

d. Anemometer- The wind velocity of the study sites during the transect sampling was recorded by the help of MASTECH MS6252B digital anemometer.

e. Rain gauge- 2 Noah's Rain gauge with 250mm capacity each were installed in each study sites.

f. Temperature- The temperature of the study sites was measured all through the study period by HTC AL-7010.

g. Binocular- Nikon A211 (15x50) and Nikon Sporter EX (15x50) was used.

4.4 Data analysis:

The data collected by the above-mentioned methods was analysed by the following methods:

4.4.1 Relative abundance (for population studies)

Relative abundance was calculated using encounter rate *i.e.* number of birds seen/km walk or number of calling stations/Sampling plot (Rodgers, 1991) i.e,

$$ER = n/L,$$

where n = number of sightings or birds detected and L= distance involved.

4.4.2 Density

The density of the *P. bicalcaratum* in the study area was calculated following Rodgers (1991) using the formula,

$$D=n/2xrxl$$

Where, n=no. of birds detected; r=sighting distance; l=total distance walked.

4.4.3 Principal Component Analysis (PCA) for habitat selection studies

Data collected from line transects were analysed using Principal Component Analysis (PCA) and Logistic Regression to determine the habitat preference of *P. bicalcaratum* by employing SPSS 16.

4.4.4 Spatio-temporal distribution

One way ANOVA and Spearman's co-relation test were employed to check the influence of seasonal change in the population status and altitudinal distribution of *P. bicalcaratum* in the study area.

4.4.4 Density and abundance estimation of vegetation

Calculation of density and abundance of each species present in each quadrate was done by following Curtis and McIntosh (1950) using the following formula.

(a) Density

Density is an expression of the numerical strength of a species where the total number of individuals of each species in all the quadrats is divided by the total number of quadrats studied.

Density is calculated by the equation:

$$\text{Density} = \frac{\text{Total No of indiv. of a species in all quadrats}}{\textit{Total No of quadrats studied}}$$

(b) Frequency (%)

This term refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage occurrence. It was studied by sampling the study area at several places at random and recorded the name of the species that occurred in each sampling units. It is calculated by the equation:

$$\text{Frequency (\%)} = \frac{\text{No of quadrats in which the species occured}}{\textit{Total No of quadrats studied}} \text{x100}$$

(c) Abundance

It is the study of the number of individuals of different species in the community per unit area. By quadrats method, samplings are made at random at several places and the number of individuals of each species was summed up for all the quadrats divided by the total number of quadrats in which the species occurred. It is represented by the equation:

$$\text{Abundance} = \frac{\text{Total No of indiv. of a species in all quadrats}}{\textit{Total No of quadrats in which the species occured}}$$

a. GPS (Garmin etrex 30), Anemometer and Barometer

b. Noah's rain gauge installed at the study site

c. Binocular and camera

Photo 2. Equipment used in the field work (a, b and c)

a. One of the Line transects

b. Walking the Line transect

c. Recording the field data

Photo 3. Process of Data collection from the study sites

CHAPTER 5

RESULT

5.1 Preliminary Survey

Secondary information was collected from 255 villages of Mizoram covering the entire eight district and villages are selected randomly to represent the whole state covering all vegetation types. Out of 255 villages covered, 103 villages show the presence of *P. bicalcaratum* in the area. It was observed that *P. bicalcaratum* was more or less uniformly distributed in the state of Mizoram. The *P. bicalcaratum* were found to be present in not only in government designated Protected Areas but, also at various community reserve forest with pristine evergreen forest although fragmented by habitat loss and habitat degradation.

Collection of secondary information was done by interview of local people, particularly hunters, elders, knowledgeable persons including the local NGO leaders (particularly Young Mizo Association) who took up conservation steps in the village and also staffs of Environment, Forest and Climate Change (EF&CC) department if any are present. The verbal information was confirmed by making the people to identify the *P. bicalcaratum* from coloured plates and also by identifying the trophies viz, tail feathers and leg of the species kept by the hunters (shown in Photo 4 and 5). The presence of *P. bicalcaratum* in some areas (when doubtful from the secondary information) was also confirmed by visiting the forest, locating the calling sites and identification of display scrapes.

5.2 Field Data

Based on a very extensive field work covering large number of villages of the state, reliable distribution map of *P. bicalcaratum* in Mizoram is prepared and is given in Map 4. The preliminary survey result and the distribution map clearly depict the more or less uniform distribution of *P. bicalcaratum* in the state of Mizoram which contradict the map provided by Srivastav and Nigam (2010). The collected information from this preliminary survey helps in selecting the intensive study sites.

From the two intensive study sites *i.e.* LWS and TWS, the detail records of *P. bicalcaratum* and their environmental variables during November 2014 to October 2017 (36 months) were presented in table 1 and 2. A total of 306 birds have been detected at LWS comprising of 218 males and 88 females (Table 1). From TWS as many as 497 birds have been detected during the course of study (Table 2). This includes 280 males and 217 females. In both study site, there is no record of chicken. And there are no nesting sites found in both study sites, except one abandoned at LWS.

Table 1: Monthly data of bird detection and environmental variables of LWS (Nov. 2014 – October 2017).

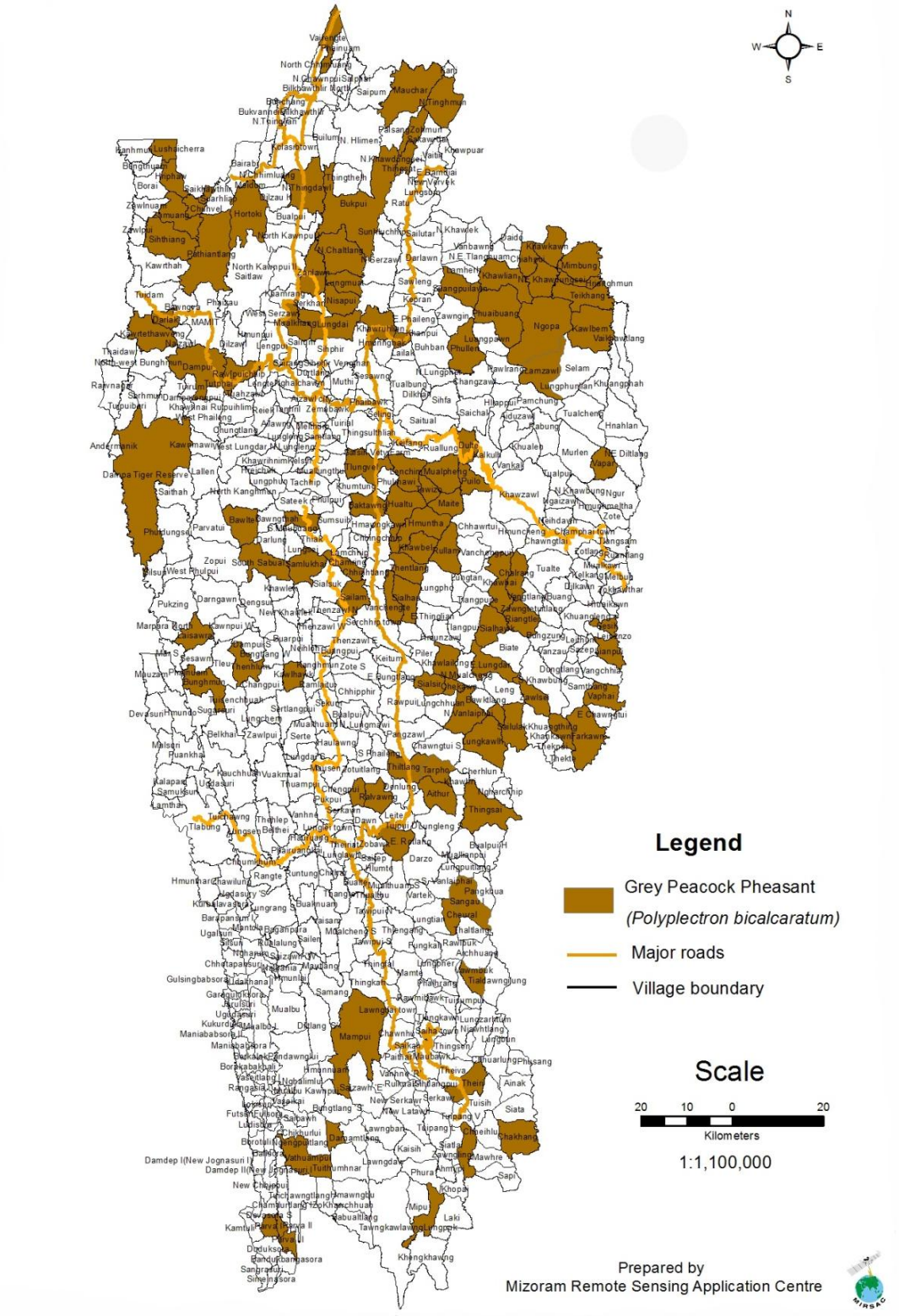
Month & year	No of indivi-duals	Male	Female	Temp (ºC)	Rainfall (mm)	RH (%)	Wind (m/s)	Altitude (m)	Distance from water source (m)
Nov 2014	11	7	4	15.9	23.1	61.5	0.8	1691	17.5
Dec 2014	9	6	3	12.4	2	51	0.8	1664.8	29
Jan 2015	7	6	1	10	1.5	52.3	1	1686	20.5
Feb 2015	8	5	3	12.7	5.7	57.6	1.1	1691	12.7
Mar 2015	9	7	2	14.6	61.2	54.5	0.5	1684.7	11.8
Apr 2015	8	7	1	17.8	111.3	58.5	0.7	1693	14.2
May 2015	10	8	2	17	245.3	50.1	1.8	1692.7	16.2
Jun 2015	7	7	0	19.2	219.7	53.2	1.5	1686.7	16.8
Jul 2015	8	7	1	21.5	247.1	62.8	0.8	1689.8	23.8
Aug 2015	7	7	0	20.8	221.9	64.5	1	1692.7	12.5
Sep 2015	10	6	4	20.5	205.4	56.5	1	1664.8	20.2
Oct 2015	9	5	4	17.2	127.3	72.1	0.6	1686	28.1
Nov 2015	10	7	3	15.9	17.9	66.1	0.7	1691	18.4
Dec 2015	8	6	2	12.4	2.7	51.3	1.8	1665.7	29.3
Jan 2016	9	7	2	9.6	1.4	60.1	1.3	1664.8	19.5
Feb 2016	9	5	4	11.1	32.7	51.7	0.7	1686	12.7
Mar 2016	9	4	4	15.7	86.3	59.1	0.6	1691	11.3
Apr 2016	9	6	3	15.7	108.3	50.5	1.1	1690.5	14.6
May 2016	7	5	2	18.1	265.2	52.1	0.6	1479.8	15
Jun 2016	8	6	2	17.8	266.7	67.1	1	1690.5	20.2
Jul 2016	9	8	1	20.1	229.1	62.7	0.9	1660	23
Aug 2016	7	4	3	20.2	201.6	63.3	0.8	1686.7	12.5
Sep 2016	8	5	3	18.7	179.5	50	0.8	1689.8	25.8
Oct 2016	10	8	2	17.3	183.2	53.8	0.9	1692.7	25.8

Nov 2016	10	7	3	15.6	32.1	52.2	1.3	1670.6	20.6
Dec 2016	8	7	1	12.3	3.6	60.4	1.3	1689.7	22.7
Jan 2017	9	5	4	9.7	3.1	55.3	0.9	1690.5	16.8
Feb 2017	9	5	4	10.9	18.4	58.2	0.5	1876.8	22.6
Mar 2017	9	6	2	14.4	75.6	55.1	1.1	1665.7	16.5
Apr 2017	8	5	3	16.1	192.5	59.9	0.6	1664.8	12.7
May 2017	8	4	4	17	279.1	52	2.1	1686	11.8
Jun 2017	7	4	3	16	283.5	70.1	1	1691	12
Jul 2017	9	8	1	17.7	227.8	79.4	1.2	1693.3	18.7
Aug 2017	7	4	3	17.6	264.2	89.6	0.4	1685.8	16.8
Sep 2017	7	5	2	16.7	210.7	75.6	1.2	1688.8	22.6
Oct 2017	9	7	2	15.1	221.3	68.2	1.1	1671.5	11.8

Table 2: Monthly data of bird detection and environmental variables of TWS (Nov. 2014 – October 2017).

Month & year	No of indivi-duals	Male	Female	Temp (ºC)	Rainfall (mm)	RH (%)	Wind (m/s)	Altitude (m)	Distance from water source (m)
Nov 14	15	9	6	10.5	32.3	56.7	0.7	1575.8	31.6
Dec 14	17	10	7	13.7	5.4	63.1	1.5	1577.7	30.5
Jan 2015	12	6	6	14.2	1.8	53.3	0.5	1547.4	27.2
Feb 2015	18	12	6	14.6	19.8	65.1	4.7	1558.4	29.1
Mar 2015	12	7	5	11.5	72.3	66.4	2.4	1571.2	24.5
Apr 2015	16	8	8	14.9	189.9	71.1	1.7	1570.3	25.7
May 2015	9	5	4	17.2	176.5	75.5	3.7	1574.1	28.2
Jun 2015	7	5	2	18.5	259.2	71.9	1.9	1573	30.1
Jul 2015	10	6	4	19.3	235.6	77.3	5.2	1555.9	22.6
Aug 2015	9	6	3	16.7	267.4	88.2	3.5	1569.5	29.7
Sep 2015	11	7	4	17.4	212.3	79.3	6.2	1571.4	28.7
Oct 2015	7	4	3	19.5	276.2	89.1	0.7	1572.1	32.4
Nov 2015	11	8	3	11.1	31.6	56.4	2.1	1572.5	28.7
Dec 2015	12	9	3	12.3	3.7	54.2	1.1	1573.2	30.6
Jan 2016	16	7	9	6.8	3.1	50.9	0.9	1573.7	29.4
Feb 2016	18	9	9	9.3	31.3	52.2	1.1	1574.3	31.3
Mar 2016	20	10	10	12.2	87.2	51.2	0.8	1573.1	30.6
Apr 2016	20	10	10	13.8	108.3	65.1	0.7	1575.2	31.2
May 2016	16	8	8	14.5	264.1	69.6	1.8	1573.7	33.1
Jun 2016	20	10	10	15.2	267.3	70.8	3.2	1565	28.7
Jul 2016	15	8	7	13.9	228.8	66.9	2.7	1571.4	29.4
Aug 2016	20	11	9	12.6	202.3	69.6	3.3	1578	30
Sep 2016	13	8	5	14.3	181.2	72.2	1.2	1570.3	30.6

Oct 2016	16	7	9	14.1	184.7	71.8	2.5	1565.8	32.5
Nov 2016	18	11	7	12.8	30.2	67.7	1.2	1573.7	28.7
Dec 2016	15	8	7	13.5	4.1	69.5	0.9	1573.7	30.6
Jan 2017	20	13	7	15.2	2.9	69.1	0.6	1545.3	28.7
Feb 2017	13	7	6	14.7	17.7	70.3	1.2	1560.4	31.2
Mar 2017	14	7	7	12.6	78.1	69.4	2.5	1573.7	30.6
Apr 2017	13	8	5	13.8	193.2	69.2	2.4	1575.7	31.2
May 2017	10	6	4	14.7	168.7	70.3	1.6	1574.4	33.1
Jun 2017	13	6	7	14.5	285.1	69.9	3.4	1575	28.7
Jul 2017	11	9	2	15.6	224.6	71.5	0.6	1556.3	30
Aug 2017	11	5	6	14.7	258.9	72.3	2.3	1573.9	30.6
Sep 2017	14	7	7	14.5	205.4	74.1	1.2	1575.1	30
Oct 2017	5	3	2	14.3	222.1	66.3	1.1	1570	31.2



Map 4. Distribution map of Grey Peacock Pheasant *P. bicalcaratum* in Mizoram

5.3 Population status

The population status of *P. bicalcaratum* was given in table 3. During the study period, we encountered 306 individuals at LWS which comprise of 218 male and 88 female. The encounter rate in LWS is 2.9 (±0.05 S.E) individuals per kilometre walk. LWS has a very thin population of *P. bicalcaratum* with density of 0.34 individuals per kilometre square. In TWS, 497 individuals were encountered with 280 male and 217 female respectively. Here the encounter rate is 2.9 (±0.07 S.E) individuals with every kilometre walk. The population density in TWS is 0.19 individuals per square kilometre. The sex ratio (male: female) is found to be 2.5:1 and 1.3:1 at LWS and TWS respectively (Table 3). The density of P. bicalcaratum in the study area was found to be 0.34/sq.km at LWS while at TWS, the density was found to be 0.19/sq.km.

Table 3: Population status of *P. bicalcaratum* at LWS and TWS

Study sites	No. encountered ♂	No. encountered ♀	Total No. of individuals encountered	Sex ratio (male:female)	Density (No/km^2)	Encounter Rate ±SE
LWS	218	88	306	2.5 : 1	0.34	2.9±0.05
TWS	280	217	497	1.3 : 1	0.19	2.9±0.07

5.4 Spatio-temporal distribution

The study area has a wide range of elevation ranging from 800 m – 2141 m at LWS (table 1) and 400 m – 1705 m at TWS (table 2). The *P. bicalcaratum* are usually detected in between the altitude range of 1390 m – 1813 m at both study sites. Therefore, the study on spatio-temporal distribution of *P. bicalcaratum* is also limited only within their known range of altitudinal distribution, although the lower elevation areas are visited occasionally to determine the presence of the bird. The lowest point of detection is 1390 m and 1621 m at TWS and LWS respectively. The highest elevations of detection at TWS and LWS are 1705 m and 1813 m respectively. In both the study sites, the highest elevation recorded for detection of species is with a temperature of 20.1°C and 14.1°C at LWS and TWS respectively. While the lowest elevation of detection corresponds to temperature of 20.1°C and 12.6°C at LWS and TWS respectively. The recorded temperature in the study area ranges from 6°C to 22°C during the study period (Table 4).

Pearson's Correlation Co-efficient test was performed to check the co-relation between the elevation of detection and the corresponding temperature. The result shows no significant correlation between them (Table 5) and therefore, no significant spatio-temporal change observed in the distribution of *P. bicalcaratum*. No changes in spatio-temporal distribution were seen in the study area but *P. bicalcaratum* are known to forage a wide range of their habitat throughout the day. They are not showing any significant altitudinal migration *i.e.* shifting from a particular place to another all through the season. *P. bicalcaratum* are observed to be strictly non-migratory, defending their habitat and occupying the same for life.

One way ANOVA was also performed to test the effect of seasonal change in the population status of *P. bicalcaratum* in the study area. The analysis of variance (Table 6 and 7) showed that in both the study sites seasonal change does not affect (p=0.5 and p=0.06 at LWS and TWS respectively) the population of *P. bicalcaratum*.

Table 4: Elevation of detection and temperature of both study sites

Study sites	Altitude (m)	Highest elevation of detection (m)	Temp (°C)	Lowest elevation of detection (m)	Temp (°C)	Temperature range (°C)
LWS	1500m-2000m	1813m	20.1	1621m	20.1	6° - 22°
TWS	1350m-1705m	1705m	14.1	1390m	12.6	

Table 5: Pearson's correlation test between number of birds detected and temperature of monthly data

Study sites	Pearson's test	Significance level
LWS	F(3,18) = 0.814, p =0.492	P<0.05
TWS	F(3,18) = 2.159, p = 0.128	

Table 6. Analysis of variance (one way) for LWS

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*Sig level*
Between Groups	238.1667	2	119.0833	4.85504	0.067132	0.05
Within Groups	220.75	9	24.52778			
Total	458.9167	11				

Table 7. Analysis of variance (one way) for TWS

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*Sig level*
Between Groups	11.16667	2	5.583333	0.72043	0.512599	0.05
Within Groups	69.75	9	7.75			
Total	80.91667	11				

5.5 Habitat composition

The habitat composition of the *P. bicalcaratum* was studied by laying 10 random quadrates (10 x 10 m) in each of the study area. The study area comprises of tropical evergreen forest with 23 different species of trees and bamboo at LWS and 28 species of vegetation including trees, bamboos and rattan at TWS.

The vegetation composition of the two study sites are presented in table 6 and table 7. The most abundant and most dense vegetation in both the study sites is *Schizostachyum fashianum* (local name, Rawnghal), a bamboo species forming clump of nearly climbing stems that form a thick under storey or secondary layer of the forest canopy.

The large trees usually grow to a height of approximately 20 m – 30 m and form the top canopy of the forest. The secondary canopy or undergrowth was formed by mixture of smaller trees and some species of bamboo and rattan. The forest has a well blend composition of various tree species and few bamboo species. *Alseodaphne petiolaris* (Bul), *Castanopsis indica* (Se-hawr), *Macaranga indica* (Hnahkhar), *Phoebe hainesiana* (Bul-eng), *Phoebe lanceolata* (Bulfek), *Macropanax undulates* (Phuanberh), *Sapium baccatum* (Thing vawkpui), *Randia wallichi* (Saphut)

and *Vitex quinata* (Thleng-reng) are the common fruiting trees found in the study sites.

The study area comprises mainly of small deep gorges compounded by steep slope with an average of 63% slope at LWS and 45% slope at TWS. LWS was much steep and undulating as compared to the moderate average slope of TWS. The habitat area of *P. bicalcaratum* at TWS was located mainly at a plateau like cliff top and near plain like small streams which are on top of a hilly terrain.

Table 8: Vegetation composition of *P. bicalcaratum* habitat at LWS

Species	Abundance	Density (/km^2)	Frequency (%)
Quercus polystachya (Thil)	67.2	67.2	100
Lithocarpusdealbata (Fah)	56.1	56.1	100
Quercus helferiana (Hlai)	73.5	73.5	100
Engelhardtia spicata (Hnûm)	59.7	59.7	100
Castanopsis tribuloides (Thingsia)	66.7	66.7	100
Alseodaphne petiolaris (Bul)	73.7	73.7	100
Betula alnoides (Hriang)	78.4	78.4	100
Castanopsis indica (Se-hawr)	57.6	57.6	100
Macaranga indica (Hnahkhar)	23.7	23.7	100
Schizostachyum fushsianum (Rawnghal)	284.2	284.2	100
Diospyros racemosa (Zo-thing-hang)	7	0.7	10
Protium serratum (Bil)	5.66	1.7	30
Phoebe hainesiana (Bul-eng)	19.5	3.9	20
Phoebe lanceolata (Bulfek)	20.75	8.3	40

Quercus oblongata (Then)	25.3	15.2	60
Garcinia xanthochymus (Tuai ha bet)	4	0.8	20
Chimonocalamus griffithianus (Phar)	155	62	40
Calamus flagellum (Hruipui)	12	1.2	10
Magnolia baillonii (Ngiau-hnahsin)	65	13	20
Macropanax undulates (Phuanberh)	7	0.7	10
Syzygium cumini (Lenhmui)	9	0.9	10
Olea dioica (Se vuak)	23	2.3	10
Taxus wallichiana (Tufar)	1	0.1	10

Table 9: Vegetation composition of *P. bicalcaratum* habitat at TWS

Species	Abundance	Density (/km^2)	Frequency (%)
Quercus polystachya (Thil)	173.4	173.4	100
Ficus semicordata (Theipui)	7	0.7	10
Quercus helferiana (Hlai)	63.1	63.1	100
Engelhardtia spicata (Hnûm)	51.3	30.8	60
Castanopsis tribuloides (Thingsia)	70	70	100
Alseodaphnepetiolaris (Bul)	56.6	56.6	100
Betula alnoides (Hriang)	72.6	72.6	100
Castanopsis indica (Se-hawr)	52.9	52.9	100
Macaranga indica (Hnahkhar)	18.7	18.7	100
Schizostachyum fushsianum (Rawnghal)	219.3	197.4	90
Diospyros racemosa (Zo-thing-	11	1.1	10

hang)			
Magnifera sylvatica (Hai-favang)	7	0.7	10
Phoebe hainesiana (Bul-eng)	25	5	20
Phoebe lanceolata (Bulfek)	11	4.4	40
Quercus oblongata (Then)	36.1	21.7	60
Olea dioica (Se vuak)	19	5.7	30
Musa sylvestris (Changel)	39.5	7.9	20
Calamus flagellum (Hruipui)	23	2.3	10
Magnolia baillonii (Ngiau-hnahsin)	44	8.8	20
Garcinia xanthochymus (Tuai ha bet)	5	1	20
Persea villosa (Bulbawr)	26	2.6	10
Sapium baccatum (Thing vawkpui)	17.5	7	40
Magnolia oblongata (Ngiau)	38	7.6	20
Chimonocalamus griffithianus (Phar)	127	76.2	60
Randia wallichi (Saphut)	18.7	7.5	40
Vitex quinata (Thleng-reng)	15.2	3.1	20
Protium serratum (Bil)	14.6	4.4	30
Syzygium cumini (Lenhmui)	14	2.8	20

5.6 Habitat selection

The habitat selection of *P. bicalcaratum* in the study areas was quantified by Principal Component Analysis (PCA) using the data collected from the transects by taking the environmental variables *viz*, rain, temperature, relative humidity, slope, altitude, distance from water source, litter cover, canopy cover, wind, cloud cover and vegetation into considerations. We employ SPSS version 16 for the analysis. The analytical steps of PCA were shown in table 11 and 13.

5.6.1 Habitat selection analysis at LWS

The analysis shows that there are varieties of important factors which have impact on the habitat selection by *P. bicalcaratum* in the study area. The component 1 to 4 having Eigen value >1 (Fig. 1) are considered to have great impact on the habitat selection by the *P. bicalcaratum*. The environmental factor that plays important role for *P. bicalcaratum* in selecting this particular habitat are wind, temperature, slope, cloud cover, relative humidity, distance from water source, litter cover and canopy cover. Further analysis shows that among the eight important factors that govern the habitat selection, it was found that *P. bicalcaratum* prefers habitat with good water source ($p<0.002$ at 95% CI).

Table 10: Factor analysis using PCA and Logistic regression (LWS)

	B	SE	Wald	df	sig	Exp (B)	95% C.I for Exp (B)	
							Lower	Upper
Canopy Cover, Litter Cover, Slope	.003	.020	.024	1	.878	1.003	.964	1.044
Cloud Cover, Temp	-.003	.049	.003	1	.956	.997	.907	1.097
Distance from water source	.000	.000	9.704	1	**.002**	1.000	1.000	1.000
Wind	.291	.342	.727	1	.394	1.338	.685	2.613
Constant	1.91	.617	9.667	1	.002	6.812		

Variable(s): Canopy Cover, Litter Cover, Slope, Cloud Cover, Temp., Dist from water source and Wind

Table 11: Steps of PCA and Logistic regression for LWS

Table 11.1: KMO and Bartlett's test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.540
Bartlett's Test of Sphericity	Approx. Chi-Square	109.701
	df	45
	Sig.	.000

Table 11.1 shows the values of Kaiser-Meyer-Olkin of sampling Adequacy (MSA) and Bartlett's Test of sphericity. The value of Kaiser-Meyer-Olkin for MSA is found as 0.540 and indicating that patterns of correlations are relatively compact and so factor should yield distinct and reliable factors. Bartlett's test is highly significant ($p<0.0001$) and therefore factor analysis is appropriate as there are some relationships between the variables included in the factor analysis model.

Table 11.2: Correlation matrix of variables

Correlation Matrix[a]

Correlation	Sp	Wind	Temp.	Time	Slope	CLC	RH	DFWS	L C	CC
Species	1.00									
Wind	.036	1.000								
Temp.	-.049	-.015	1.000							
Exact Time	-.085	.013	-.057	1.000						
Slope	-.033	-.082	.040	-.012	1.000					
Cloud cover	.011	.039	.155	.005	.027	1.000				
R H	-.052	-.069	.069	.013	.041	.089	1.000			
DFWS	-.123	.003	-.092	.106	.087	-.108	-.033	1.000		
Litter Cover	.000	.012	.023	-.102	.125	-.008	.007	-.055	1.000	
Canopy cover (%)	.013	-.035	.039	.032	.232	.018	-.001	.016	.179	1.000

Table 11.3: Communities of variables

Communalities

	Initial	Extraction
Species	1.000	.384
Wind(m/s)	1.000	.697
Temp.(˚C)	1.000	.429
Exact Time(Hrs)	1.000	.480
Slope (%)	1.000	.505
Cloud cover (%)	1.000	.561
Relative Humidity (%)	1.000	.413
Distance from water source (m)	1.000	.493
Litter Cover (%)	1.000	.439
Canopy cover (%)	1.000	.549

Extraction Method: Principal Component Analysis.

Table 11.3 shows the value of communalities of the variables before and after extraction. The principal component analysis applies on the initial assumption that all variances are common and therefore, the communalities before extraction are found to be 1. The communalities of the variables after extraction are shown in the last column of the above table. It is known that the communalities of variable are the total amount of variance shared with the other.

The communality of Wind is 0.697 and it infers that 69.7% of the variance associated with.

Wind is shared with other variables. Similarly, 42.9%, 48%, 50.5%… 54.9% of the variances associated with temperature, time and slope… Canopy Cover respectively are shared with other variables.

Table 11.4: Total variance explained

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.408	14.080	14.080	1.408	14.080	14.080	1.370	13.695	13.695
2	1.309	13.088	27.168	1.309	13.088	27.168	1.252	12.525	26.220
3	1.194	11.936	39.104	1.194	11.936	39.104	1.237	12.366	38.586
4	1.039	10.393	49.497	1.039	10.393	49.497	1.091	10.911	49.497
5	.968	9.681	59.178						
6	.917	9.172	68.350						
7	.876	8.760	77.110						
8	.809	8.093	85.203						
9	.756	7.558	92.761						
10	.724	7.239	100.000						

Extraction Method: Principal Component Analysis.

Lists the eigen values associated with each linear factor before extraction and after extraction. Before extraction, as same as number of original variables, *i.e.* 10

factors are identified within the data set. The eigen value associated with each factor represents the total variance explained by that particular factor and it is also expressed in terms of percentage of variance explained and cumulative percentage. The factor *i.e.* wind explains 13.080% of the total variance and similarly 11.936% of variance explained by next factors and so on. It is clear that the first few factors, that is up to 4^{th} factor, explain relatively large amounts of variance whereas subsequent factors explain only small amounts of variance. Nearly 50.289% of total variance is explained by first 4 factors.

By latent root (or eigen value) criterion, only the factors having eigen values greater than 1 are considered as significant and corresponding factors are extracted. The eigen values associated with these factors are again displayed in the column labelled "Extraction Sums of squared loadings". The values in this part of the table are same as the values before extraction, except that the values for the deleted factors (loadings less than 1) are ignored. Altogether 4 factors after extraction explain nearly 50% of the total variance and they are statistically significant factors extracted by the model.

Both latent root, percentage of variance and scree test criteria are used to extract the adequate number of factors to be extract. From table 11.4, it is confirmed that the 4 factors are having eigen values greater than one and hence they are statistically significant factors for extraction and again, the cumulative percentage of variance for these six factors are also more than 50%. Further, the scree test curve is depicted in the following figure for number of factors eligible for extraction.

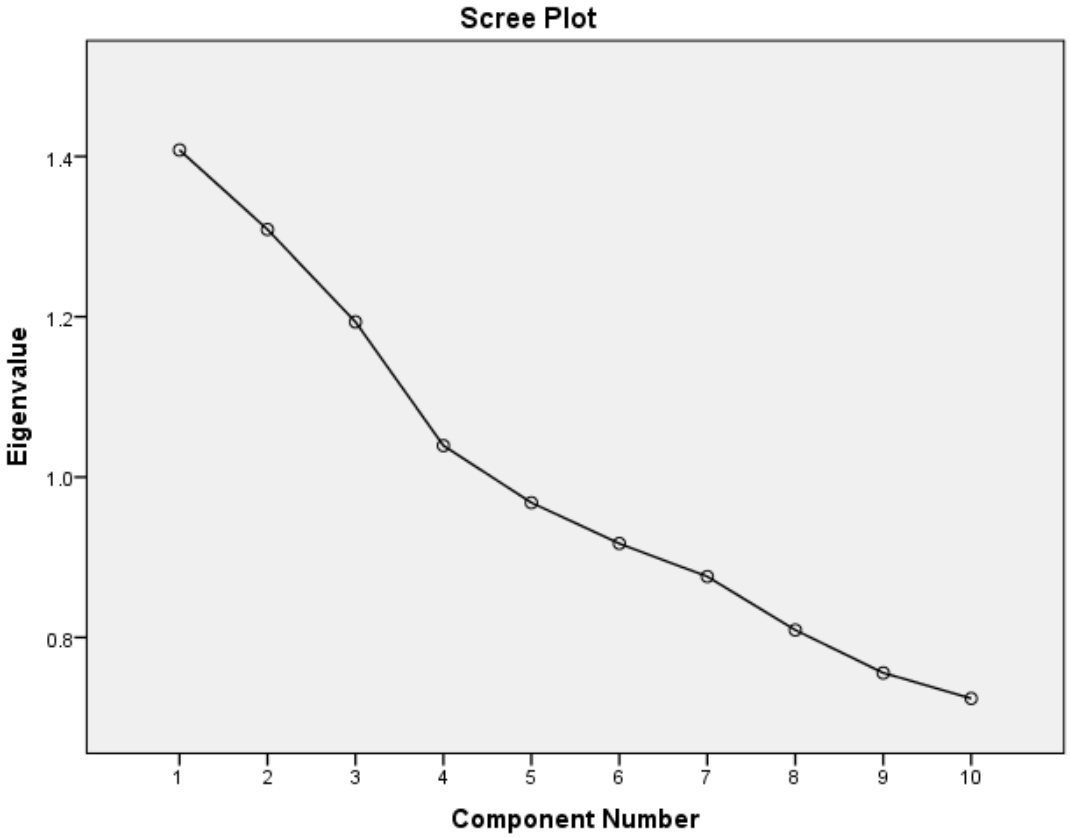


Figure 1: Scree plot (LWS)

Factors 1, 2, 3 and 4 have Eigen value >1 and are therefore considered statistically significant factors for extraction and again, the cumulative percentage of variance for these six factors are also more than 50%. Further, the scree test curve (Fig. 1) is depicted in the above figure which shows number of factors eligible for extraction.

Table 11.5: Component Matrix (Un-rotated)

Component Matrix[a]

	Component			
	1	2	3	4
Species	-.047	-.345	-.513	-.004
Wind (m/s)	-.204	-.139	-.187	.775
Temp.(°C)	.344	-.399	.373	.107
Slope (%)	.629	.330	-.007	.008
Cloud cover	.245	-.459	.393	.370
Relative Humidity (%)	.226	-.146	.504	-.293
Distance from water source	-.104	.672	.141	.103
Litter Cover (%)	.542	.005	-.378	.051
Canopy cover (%)	.638	.254	-.175	.218

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

The initial un rotated factor matrix is computed to assist in obtaining a preliminary indication of the number of factors to be extracted. This factor matrix contains factors loading for each variable on each factor. Here, the factor loading greater than 0.40 are considered as significant. However, some variables like distance from water source, litter cover and canopy cover have several moderate sizes loading, all of which are significant and job of interpreting is much more difficult. The difficulty arises because a variable with several significant loadings must be considered in interpreting or labelling all the factors on which it has a significant loading. To interpret the factors meaningfully, the varimax rotation is applied to identify all variables which have significant loading on one factor. The following

table 11.6 shows the factor loading matrix after varimax rotation.

Table 11.6: Rotated Component Matrix

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Species	-.008	-.108	-.559	.244
Wind (m/s)	-.051	.154	.058	.817
Temp. (°C)	.078	.638	-.049	-.115
Slope (%)	.669	.028	.157	-.180
Cloud cover (%)	.006	.736	.017	.137
Relative Humidity (%)	-.043	.380	.095	-.507
Distance from water source (m)	.108	-.343	.603	.005
Litter Cover (%)	.598	-.008	-.279	.057
Canopy cover (%)	.733	.048	.065	.075

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

With this varimax rotation, a factor solution has been obtained in which all variables have a significant loading on a particular factor. The factor-1 has three variables *viz.* slope, litter cover and Canopy cover. The factor-2 has two variables *viz.* temperature and cloud cover. The factor-3 has two variables *viz.* time and distance from water source. The factor-4 has one variable *i.e.* wind.

Table 11.7: Component Transformation Matrix

Component Transformation Matrix

Component	1	2	3	4
1	.882	.377	-.114	-.259
2	.335	-.627	.699	-.081
3	-.292	.596	.628	-.405
4	.157	.330	.322	.873

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Table 11.8: Component Score Coefficient Matrix

Component Score Coefficient Matrix

	Component			
	1	2	3	4
Species	.007	-.105	-.451	.201
Wind(m/s)	-.001	.165	.084	.761

Temp.(°C)	.038	.504	-.012	-.075
Slope (%)	.482	.009	.124	-.127
Cloud cover (%)	-.004	.599	.057	.161
Relative Humidity (%)	-.063	.289	.078	-.450
Distance from water source (m)	.088	-.247	.473	.016
Litter Cover (%)	.441	-.030	-.225	.071
Canopy cover (%)	.540	.030	.059	.109

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with KaiserNormalization. Component Scores.

The objective of factor analysis in the present study is to create a smaller set of variables of factors to replace the original set of large variables for subsequent analysis of the effects of these variables. Thus, factor scores are computed as shown in table 11.8 and logistic regression is carried out to identify the effect of the newly extracted factors.

Identification of effect of derived variables on species found through logistic regression analysis.

Table 11.9: Saturated logistic model

	B	S.E.	Wald	df	Sig.	Exp(B)
Step 0 Constant	1.762	.131	180.157	1	.000	5.824

Table 11.10: Omnibus Tests of Model Coefficients

Omnibus Tests of Model Coefficients

	Chi-square	df	Sig.

Step 1	Step	9.848	4	.043
	Block	9.848	4	.043
	Model	9.848	4	.043

Table 11.11: Goodness of fit

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	376.832[a]	.021	.037

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 11.12: Hosmer – Lemeshow test

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	5.388	8	.715

The overall significance of the model in logistic regression analysis is tested by likelihood ratio test and it is also known as Omnibus test for model coefficients as shown in (Table 11.10). It is found statistically not significant, indicating that the predictors do not have a significant effect and create essentially no different model from the null model or saturated model as shown in (Table 11.9). The model

summary shown in (Table 11.11) gives the values of Cox and Snell R^2 and Nagelkerke R^2. The value of Cox and Snell R^2 is 0.21 and it indicates that 2.1% of the variation in the response variable (species found) is explained by the logistic regression model and the value of Nagelkerke's R^2 is 0.37 indicates a relationship of 3.7% between the predictors and the prediction. Hosmer and Lemeshow test is found statistically insignificant implying that there is no difference between observed and model predicted values and hence the model fits the data well.

Table 11.13: Logistic regression using derived variables from factor analysis.

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Canopy Cover, Litter Cover and Slope	.003	.020	.024	1	.878	1.003	.964	1.044
	Cloud Cover and Temp	-.003	.049	.003	1	.956	.997	.907	1.097
	Distance from water source	.000	.000	9.704	1	.002	1.000	1.000	1.000
	Wind	.291	.342	.727	1	.394	1.338	.685	2.613
	Constant	1.919	.617	9.667	1	.002	6.812		

a. Variable(s) entered on step 1: Canopy Cover * Litter Cover * Slope, Cloud Cover * Temp, Dist from water source & Wind.

The Wald test for the co-efficient of factor-3 (i.e, distance from water source) is statistically significant and that distance from water source plays an important role in predicting the species. The odds ratio of 1 is held constant at 5% level of significance.

The Wald test for factor-2 (Cloud cover and temperature) contributes insignificantly in prediction of species found. The odds ratio for Factor-2 is 0.997 with 95% confidence interval.

Although other factors, *viz.* Factor-1 (cloud cover, litter cover & slope) and factor-4 (wind) have positive relation with the prediction of species, their effects on species found are not significant.

5.6.2. Habitat selection analysis at Tawi Wildlife Sanctuary

The factors which determine the habitat selection by *P. bicalcaratum* at TWS was analysed by Principal Component Analysis and Logistic regression (given in table 12).

Seven environmental variables or factors are found to play very important role in the habitat selection of *P. bicalcaratum* inside TWS. The important environmental variables are canopy cover, litter cover, distance from water source, slope, temperature, relative humidity and cloud cover. These environmental variables have Eigen value >1 (Fig. 2) and the total Eigen value contribution of the seven variables is more than 65%.

Table 12: Factor analysis using PCA and Logistic regression (TWS)

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Canopy Cover, Dist Fr Water, LitterCover	.013	.020	.403	1	.525	1.013	.973	1.055
Cloud Cover, Relative Humidity, Slope, Temp	.013	.018	.528	1	.467	1.013	.978	1.049
Constant	1.699	.695	5.987	1	.014	5.471		

a. Variable(s) entered on step 1: Canopy Cover * Dist Fr Water * Litter Cover, Cloud Cover * Relative Humidity * Slope * Temp.

Table 13: Steps of PCA and Logistic regression (TWS)

Table 13.1: KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.735
Bartlett's Test of Sphericity	Approx. Chi-Square	569.905
	df	21
	Sig.	.000

Table 13.1 shows the values of Kaiser-Meyer-Olkin of sampling Adequacy (MSA) and Bartlett's Test of sphericity. The value of Kaiser-meyer-Olkin for MSA is found as 0.735 and indicating that patterns of correlations are relatively compact and so factor should yield distinct and reliable factors. Bartlett's test is highly significant ($p<0.0001$) and therefore factor analysis is appropriate as there are some relationships between the variables included in the factor analysis model.

Table 13.2: Correlation matrix of variables

Correlation Matrix[a]

		Distance from water source	Temp. (˚C)	Slope (%)	Cloud cover (%)	Relative Humidity (%)	Litter Cover (%)	Canopy Cover (%)
Correlation	Distance from water source (m)	1.000						
	Temp.(°C)	.053	1.000					
	Slope (%)	-.256	.269	1.000				
	Cloud cover (%)	-.075	.173	.158	1.000			
	Relative Humidity (%)	-.078	.462	.263	.216	1.000		
	Litter Cover (%)	.772	-.031	-.291	-.178	-.137	1.000	
	Canopy Cover (%)	-.816	.021	.308	.144	.159	-.905	1.000

Table 13.3: Communities of variables

Communalities

	Initial	Extraction
Distance from water	1.000	.834

source		
Temp.(°C)	1.000	.655
Slope (%)	1.000	.400
Cloud cover (%)	1.000	.240
Relative Humidity (%)	1.000	.618
Litter Cover (%)	1.000	.888
Canopy Cover (%)	1.000	.919

Extraction Method: Principal Component Analysis.

Table 13.3 shows the value of communalities of the variables before and after extraction. The principal component analysis applies on the initial assumption that all variances are common and therefore, the communalities before extraction are found to be 1. The communalities of the variables after extraction are shown in the last column of the above table. It is known that the communalities of variable are the total amount of variance shared with the other.

The communality of distance from water source is 0.834 and it infers that 83.4% of the variance associated with

Distance from water source is shared with other variables. Similarly, 65.5%, 40%, 24%,…., 91.9% of the variances associated with temperature, slope, cloud cover, …., Canopy Cover respectively are shared with other variables.

Table 13.4: Total variance explained

Total Variance Explained

Compo	Initial Eigen values	Extraction Sums of	Rotation Sums of Squared

nent				Squared Loadings			Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.907	41.526	41.526	2.907	41.526	41.526	2.742	39.169	39.169
2	1.647	23.533	65.059	1.647	23.533	65.059	1.812	25.890	65.059
3	.876	12.513	77.572						
4	.722	10.312	87.883						
5	.522	7.455	95.339						
6	.237	3.381	98.719						
7	.090	1.281	100.000						

Lists the eigen values associated with each linear factor before extraction and after extraction. Before extraction, as same as number of original variables, *i.e.* 7 factors are identified within the data set. The eigen value associated with each factor represents the total variance explained by that particular factor and it is also expressed in terms of percentage of variance explained and cumulative percentage. The factor 1 explains 41.526% of the total variance and similarly 23.533% of variance explained by second factors and so on. It is clear that the first two factors explain relatively large amounts of variance whereas subsequent factors explain only small amounts of variance. Nearly 65.06% of total variance is explained by first 2 factors.

By latent root (or eigen value) criterion, only the factors having eigen values greater than 1 are considered as significant and corresponding factors are extracted. The eigen values associated with these factors are again displayed in the column

labelled “Extraction Sums of squared loadings”. The values in this part of the table are same as the values before extraction, except that the values for the deleted factors (loadings less than 1) are ignored. Here, 2 factors after extraction explain nearly 65% of the total variance and they are statistically significant factors extracted by the model.

Both latent root, percentage of variance and scree test criteria are used to extract the adequate number of factors to be extract. From table 13.4, it is confirmed that the 2 factors are having eigen values greater than one and hence they are statistically significant factors for extraction and again, the cumulative percentage of variance for these six factors are also more than 65%. Further, the scree test curve is depicted in the following figure for number of factors eligible for extraction.

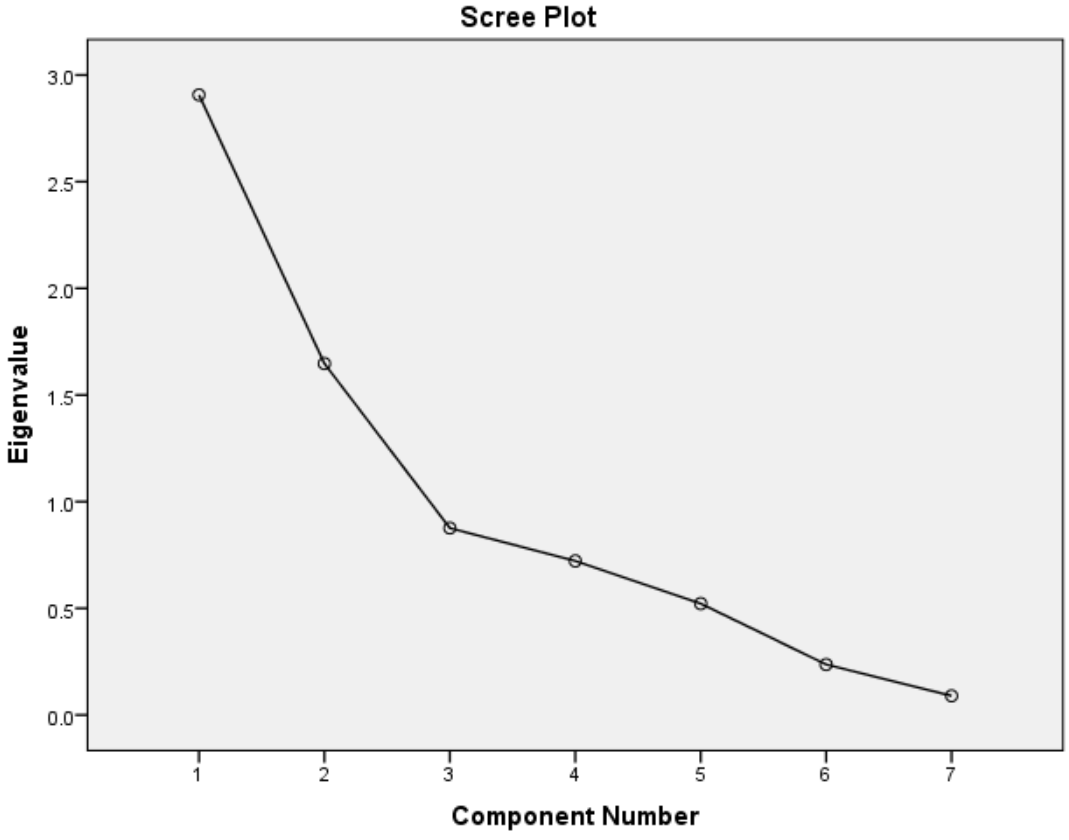


Figure 2: Scree plot (TWS)

The Scree plot (Fig. 2) confirmed that 2 factors are having Eigen values greater than one (Eigen value >1) and hence they are statistically significant factors for extraction and again, the cumulative percentage of variance for these six factors are also more than 65%. Further, the scree test curve is depicted in the above figure for number of factors eligible for extraction.

Table 13.5: Component Matrix (Un-rotated)

Component Matrix[a]

	Component	
	1	2
Canopy Cover (%)	.932	-.224
Litter Cover (%)	-.917	.215
Distance from water source (m)	-.857	.316
Slope (%)	.498	.390
Temp.(°C)	.175	.790
Relative Humidity (%)	.322	.717
Cloud cover (%)	.283	.400

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

The initial unrotated factor matrix is computed to assist in obtaining a preliminary indication of the number of factors to be extracted. This factor matrix

contains factors loading for each variable on each factor. Here, the factor loading greater than 0.40 are considered as significant.

Table 13.6: Rotated Component Matrix

Rotated Component Matrix[a]

	Component	
	1	2
Canopy Cover (%)	-.950	.129
Litter Cover (%)	.933	-.132
Distance from water source (m)	.913	-.015
Temp.(°C)	.123	.800
Relative Humidity (%)	-.040	.785
Slope (%)	-.323	.544
Cloud cover (%)	-.119	.476

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

With this varimax rotation, a factor solution has been obtained in which all variables have a significant loading on a particular factor. The factor-1 has two variables *viz.* litter cover and distance from water source; The factor-2 has four variables *viz.* temperature, relative humidity, slope and cloud cover.

Table 13.7: Component Transformation Matrix

Component Transformation Matrix

Component	1	2
1	-.932	.362
2	.362	.932

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

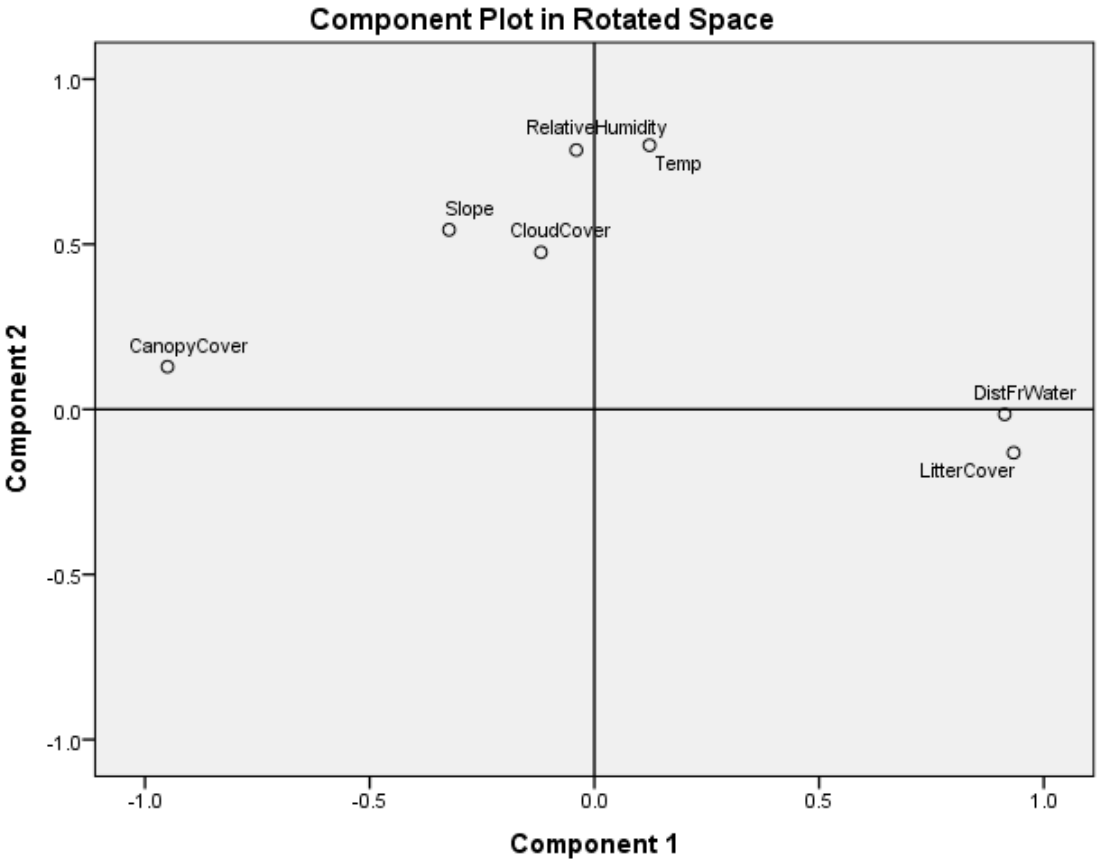


Figure 3: Component plot in rotated space (TWS)

Table 13.8: Component Score Coefficient Matrix

Component Score Coefficient Matrix

	Component	
	1	2
Distance from water source	.344	.072
Temp.(°C)	.117	.469
Slope (%)	-.074	.283
Cloud cover (%)	-.003	.262
Relative Humidity (%)	.054	.446
Litter Cover (%)	.341	.007
Canopy Cover (%)	-.348	-.010

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization. Component Scores.

The objective of factor analysis in the present study is to create a smaller set of variables of factors to replace the original set of large variables for subsequent analysis of the effects of these variables. Thus, factor scores are computed as shown in table 13.8 and logistic regression is carried out to identify the effect of the newly extracted factors species found.

Identification of effect of derived variables on species found through logistic regression analysis.

Table 13.9: Saturated logistic model

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	2.277	.263	75.257	1	.000	9.750

Table 13.10: Omnibus Tests of Model Coefficients

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	.816	2	.665
	Block	.816	2	.665
	Model	.816	2	.665

Table 13.11: Goodness of fit

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	105.644[a]	.005	.010

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 13.12: Hosmer – Lemeshow test

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	9.074	8	.336

The model summary shown in table 13.11 gives the values of Cox and Snell R^2 and Nagelkerke R^2. The value of Cox and Snell R^2 is 0.005 and it indicates that 5% of the variation in the response variable (species found) is explained by the logistic regression model and the value of Nagelkerke's R^2 is 0.010 indicates a relationship of 10% between the predictors and the prediction. Hosmer and Lemeshow test is found statistically insignificant implying that there is no difference between observed and model predicted values and hence the model fits the data well.

Table 13.13: Logistic regression on species found using derived variables from factor analysis (TWS).

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	CanopyCover by DistFrWater by LitterCover	.013	.020	.403	1	.525	1.013	.973	1.055
	CloudCover by RelativeHumidity by Slope by Temp	.013	.018	.528	1	.467	1.013	.978	1.049
	Constant	1.699	.695	5.987	1	.014	5.471		

a. Variable(s) entered on step 1: Canopy Cover * Dist Fr Water * Litter Cover, Cloud Cover * Relative Humidity * Slope * Temp.

The Wald test for the co-efficient of factor-1 (*i.e.* canopy cover, litter cover and distance from water source) is statistically not significant. The odds ratio of 1 is held constant at 5% level of significance.

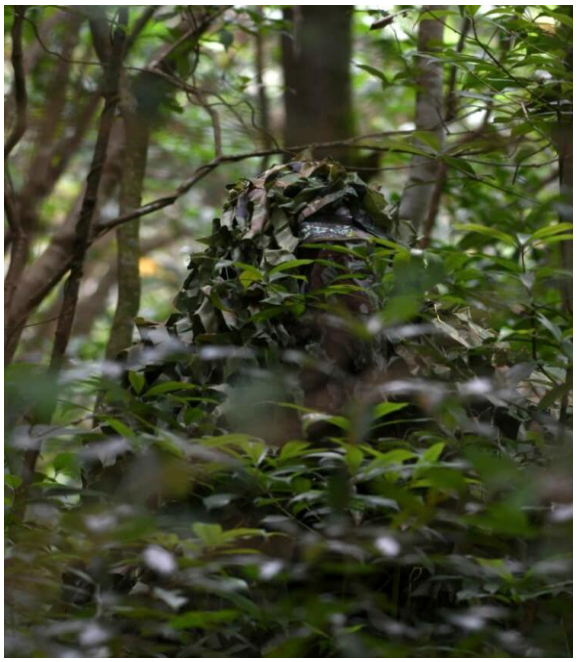
Other factors, *viz.* cloud cover, relative humidity, temperature & slope have positive relation with the prediction of species, and their effects on species found are not significant.

(a)

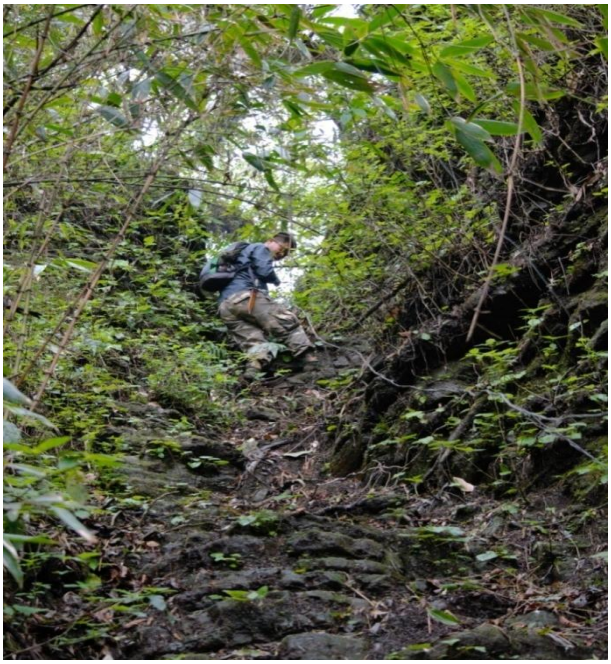
(b)

(c)

(d)



(e)



(f)

Photo 4. Some photos from the study sites: a, b & c- Camping sites; d-measuring rainfall; e- observing the pheasants; f- scalling the terrain at the study site

A

B

C

D

Photo 5. Photos of *P. bicalcaratum* from the study sites A: Male *P. bicalcaratum* at display scrapes; B: Foraging male *P. bicalcaratum* at Lengteng WLS; C: Foraging male *P. bicalcaratum* at Tawi WLS; D: Display scrapes of *P. bicalcaratum* at Tawi WLS

Photo 6. The road connecting the study sites

CHAPTER 6

DISCUSSION

P. bicalcaratum is one of the most widely distributed Peacock Pheasant occurring over most of mainland South East Asia (Srivastav and Nigam, 2010). They further demarcate the distribution of *P. bicalcaratum* in the Indian Territory to be Central and Eastern Himalayas from Sikkim to Arunachal Pradesh and North-eastern states of Mizoram, Meghalaya, Assam, Nagaland and Tripura. The distribution map prepared by Srivastav and Nigam (2010) demarcate only few northern patches of Mizoram as the known distribution range of *P. bicalcaratum*. But the present study recorded *P. bicalcaratum* from 103 village area of Mizoram which are more or less uniformly distributed throughout the entire state. The present study confirms the presence of *P. bicalcaratum* in the community forest and the remaining pristine evergreen forest of many villages across Mizoram which is in line with the findings of Goriup (2006) who reported the presence of *P. bicalcaratum* in many of the village's community reserve forest of Nagaland.

6.1 Population status

The encounter of 306 and 497 individuals of *P. bicalcaratum* at LWS and TWS from eight line transects during the study yield 0.34/km^2 and 0.19/km^2 density at LWS and TWS respectively thus indicate low population density of this species in Mizoram. Selvan et al. (2013) calculated the density *P. bicalcaratum* at Pakke Tiger reserve of Arunachal Pradesh to be 4.2/ km^2 while Yu-Ren (1999) indicates the *P. bicalcaratum* of Hainan Island, China has 3.75/km^2 density. The lower density estimates at LWS and ŢWS during the present study may be attributed to the steep

and rugged terrain which hinders the movement of the observer and a thick litter cover and ground cover which imposes problem for stealthy movement of the observer while providing cover for the ground birds. It could also be due to the high anthropogenic activities and disturbances from some livestock. BirdLife International (2018) mentioned that forest dependent bird species are less tolerant to any form of habitat alterations and are usually affected to a great extent by selective logging, shifting agriculture, livestock grazing and even by subsistence collection of timber and firewood. Selvan et al. (2013) also concluded that anthropogenic disturbances like grass cutting, logging and fire wood collection has a negative impact on pheasant including the Grey Peacock Pheasant. The study areas, though a protected area, are subjected to anthropogenic activities like bamboo shoot collection for local consumption, rattan collection both for consumption and daily use, mushroom collection during the wet season and illegal timber collection by means of selective felling of large trees, hunting/poaching by poachers and also collection of fire woods by the fringe village dwellers. These anthropogenic activities can have a negative impact on the population of this ground dwelling secretive bird thus threatening the existence of the species in the hill forest of Mizoram. The low population density and encounter rate of the present study is supported by Srivastav and Nigam (2010) who mentioned that *P. bicalcaratum* are not present in the probable habitat with minimal human disturbances. The presence of *P. bicalcaratum* in 103 village area of Mizoram with very low population in the primary forest of LWS and TWS clearly depicts the ill-fated status of the *P. bicalcaratum*. Although they are distributed more or less uniformly throughout the state, their population is very scattered and thin thus elevating the chance of being wiped out from the area.

The observed male-female sex ratio of *P. bicalcaratum* reported by Selvan et al. (2013) at Pakke Tiger Reserve of Arunachal Pradesh is 1:1.3 while the present study observed sex ratio to be 2.5:1 at LWS and 1.3:1 at TWS. The sex ratio (male :

female) observed also contradicts the prescription of Javed and Rahmani (2000) with more male than female in both the study sites *i.e.* 2.5:1 at LWS and 1.3:1 at TWS. Field data collection was conducted all through the season of the study period. The rainy season of the year provide hindrance in detection by direct sighting as the ground is crowded with thick under growth. The rainy season in Mizoram lasted for more than 6 months starting from April to October. The visibility in this tropical broadleaved evergreen forest is very low accompanied by the unfriendly steep terrain which also hinders the direct sighting of a female bird that never calls out aloud. The females are quiet and skulky thus very difficult to detect except during the dry season. The males often give alarm calls when disturb even during the non-breeding season and during rainy season direct sighting is virtually near impossible. Therefore, the unusual sex ratio of the present study may be the outcome of the above-mentioned condition.

6.2 Spatio-temporal distribution

The present study confirms the specificity of *P. bicalcaratum* in their habitat need. They are observed to remain in their habitat for the whole study area with no specific altitudinal movement with change of season (table 5). The *P. bicalcaratum* are at first assumed to change their habitat from lower elevation to higher elevation and vice versa with change in season. The present study observed and confirmed that there is no such altitudinal migration corresponding to season or temperature changes. The result of the present study can be attributed to the mild climatic conditions with moderate temperature which prevails in the study area. The absence

of thick frost at higher elevation even during the winter and moderate summer is tolerable and does not affect the food availability of the *P. bicalcaratum*. The physiology of the *P. bicalcaratum* suits well with the prevailing conditions in the given altitude in the study area, therefore, does not undertake any form of migration even altitudinal movement corresponding to time and temperature. So far, literature on spatio-temporal distribution pattern of *P. bicalcaratum* is not available at present and the present study is thought to be the first of its kind.

6.3 Habitat composition

Northeast India is broadly classified into Tropical moist deciduous forest, Tropical semi-evergreen forest, Tropical wet evergreen forest, Sub-tropical forest, temperate forest and Alpine forest (Hedge, 2000 and FSI, 2003). The study area is an interspersed between Tropical semi-evergreen forest and Tropical wet evergreen forest. The study area experienced rainfall every month of the year with an average rainfall of 132.5mm/month and 147.6mm/month at LWS and TWS respectively. The lowest rainfall recorded at LWS is in the month of December 2013 where only 1.2 mm of rain was received corresponding to 283.5 mm recorded during the month of June 2017 which is being the maximum rainfall recorded during the study. TWS received a little more amount of rain as compared to LWS during the study period with a record low of 1.7 mm on January 2016 and a maximum of 285.1 mm during the month of June 2017.

The average range of temperature in the study area is 6.8°C - 22°C in the transects but the temperature in the camping site sometimes drop to a near freezing point of just 2°C in the winter months. The dry season is short but the small streams and rivulets dried up with few waterholes which are still wet providing water to all life forms of the forest.

In the intensive study area, the *P. bicalcaratum* was mostly detected in the site with evergreen forest dominated by *Quercus polystachya* (Ṭhil), *Lithocarpus dealbata* (Fah), *Quercus helferiana* (Hlai), *Engelhardtia spicata* (Hnûm) and *Castanopsis tribuloides* (Thingsia). The other vegetation comprises of *Alseodaphne petiolaris* (Bul), *Betula alnoides* (Hriang), *Castanopsis indica* (Se-hawr), *Macaranga indica* (Hnahkhar) with thick undergrowth of *Schizostachyum fushsianum* (Fam. Gramineae-Rawnghal) and small herbs. The irritating herb of *Girardinia diversifolia* (Kangṭhai) is prevalent in the dried and wet stream belt. Whereas Selvan et al. (2013) found that *P. bicalcaratum* detection is associated with *Dillenia indica, Dysoxylum fraserianum, Pterospermum acerifoliumm, Melia azedarach* and *Mucuna impricata.* The observation by Singh (2012) of *P. bicalcaratum* inhabiting the dry shorea forest of Bhutan is contradicting the findings of the present study that *P. bicalcaratum* habitat was dominated by the evergreen vegetation with good water source nearby the vicinity. Although the shorea forests are tropical forest trees which can be the emergent species of the rain forest, the present study encountered the *P. bicalcaratum* only in the moist evergreen broadleaf forest of Mizoram.

The altitude where the *P. bicalcaratum* was sighted ranges from 1684 m – 1836 m above mean sea level. The two study sites *viz.* LWS and TWS have an elevation range of 800 m - 2,141 m and 400 m – 1705 m respectively. *P. bicalcaratum* is being reported up to an elevation of 1800 m in Thailand whereas in Yunnan of China they are reported to reach the height of 2000 m by Madge and Mc Gowan (2002), but they did not mention the lower elevation limit. Sathyakumar and Kaul (2007) also did not mention the lower limit for this species whereas the upper altitudinal limit is mentioned to be 1200 m in the Indian Territory which is lower than the findings of the present study.

P. bicalcaratum sighting were very low as the bird was too shy to be detected, *P. bicalcaratum* was detected mostly based on their calls. The calls of *P. bicalcaratum* were used to confirm their presence in the thick impenetrable and steep slope which is similar to the findings of Selvan et al. (2013). Dohling and Sathyakumar (2011) also confirmed the presence of *P. bicalcaratum* in Nongkhyllem Reserve of Meghalaya based on its call. *P. bicalcaratum* was found to be intolerable to human disturbance and it occurs mainly in primary forest which is in line with Selvan et al. (2013). Bhattacharya et al. (2007) also mentioned that human and livestock present in the forest can have negative impact on galliformes which is true in the present study sites. Minimal disturbances like selective felling of trees outside the sanctuary and anthropogenic activities like collection of forest produces other than timber, making a forested footpath also push away the *P. bicalcaratum* from the area. The presence of '*mithun*' in the fringe area of the sanctuary which occasionally roam the sanctuary is also known to be disturbing the *P. bicalcaratum*.

6.4 Habitat selection

The habitat selection of *P. bicalcaratum* was observed to be governed by various environmental factors (Eigen value > 1) *viz.* wind velocity, temperature, slope, relative humidity, cloud cover, distance from water source, litter cover and canopy cover. The habitat area of *P. bicalcaratum* was found to have a variety of Relative Humidity (RH) with different season of the year. The RH ranges from 50.3% in the month of March to 90.2% in the month of September. The mild and moderate temperature of the study area usually ranging from 6°C to 24°C gives an optimum temperature for *P. bicalcaratum* to forage and breed in success. The temperature is also believed to be suitable for the prey/food items to thrive in the forest floor as the *P. bicalcaratum* are observed to feed mainly on leafy shoots,

seeds, roots of young germinating seeds, soil invertebrates, insects and even smaller snails. The habitat of the *P. bicalcaratum* was observed to be mainly the steep hill slope (average slope of at LWS and TWS are 65% and 50% respectively) of the tropical forest in the study area. The habitat areas are mostly steep with deep gorges and seasonal streams which restrict movement of larger mammals and are believed to provide safe haven for *P. bicalcaratum* against its predators. The detection of *P. bicalcaratum* was always in the region with thick canopy cover and thick undergrowth of bamboo *S. fushsianum* which is locally called 'Rawnghal' and other small shrubs and herbs. This bamboo species when present formed thick undergrowth usually at the height of 3 m – 5 m above the ground and thus prevent the direct entry of sun rays to the forest floor. The cryptic pattern of the *P. bicalcaratum* suits well in the dark brown shades thus providing it with better camouflage. The thick undergrowth of the *S. fushsianum* is also believed to provide *P. bicalcaratum* with better cover from its predators thus frequenting the shaded habitat. Also, the *P. bicalcaratum* are encountered mostly in the area with good water source. Further statistical test also confirms the significance of water source ($p = 0.002$) for the habitat selection of *P. bicalcaratum*. The habitat with good water source being preferred by the *P. bicalcaratum* is attributed to the availability of food source. The deep gorges filled with water in the rainy season forming small streams which usually dry up with the onset of dry season provide more suitable conditions for the invertebrate population to thrive even in the dry cold season. The plenty availability of food items near the water source is assumed to be the driving force of *P. bicalcaratum* to prefer habitat with good water source. Cloud cover and velocity of wind are also believed to play some important role in the habitat selection by *P. bicalcaratum*.

The least known and very rare Hainan Peacock Pheasant *P. katsumatae* and Bornean Peacock Pheasant *P. schleiermacheri* are under IUCN Endangered list (IUCN, 2018). These two endangered species are faced with threats from logging and hunting wich result in their habitat loss and rapid population decline (Madge and McGowan, 2002). Malayan Peacock Pheasant *P. malacense*, Palawan Peacock Pheasant *P. emphanum* and Mountain Peacock Pheasant *P. inopinatum* are restricted to narrow suitable habitat range and highly fragmented habitat which can result in tragic outcome when combined with development works such as road construction. Madge and McGowan, (2002) mentioned that the three species are confined to a small suitable habitat which is gradually shrinking with illegal logging coupled by hunting which resulted in population decline, thus, were categorised as Vulnerable till date by IUCN (2018). Germaine's Peacock Pheasant *P. germaini* is a Near Threatened species as the population is known to decline due to expanding agricultural and commercial crop cultivation. The habitat loss and fragmentation is also due to commercial logging, and are known to be hunted even within the Protected Areas due to shortage of personnel and resources (Madge and McGowan, 2002) while Sumatran Peacock Pheasant *P. chalcurum* and Grey Peacock Pheasant *P. bicalcaratum* are the only two species under the genus *Polyplectron* that are categorised under the IUCN Least Concern category (IUCN, 2018). All the threatened species are known to be 'habitat specialist' having specific requirements for survival.

This study shows that *P. bicalcaratum* depends wholly on evergreen forest with good water source and particular sets of environmental factors; hence it qualified to be called 'habitat specialist'. Therefore, the *P. bicalcaratum* is observed

to have a bleak fate with the extent of destruction to the evergreen forest in its known range of distribution.

CHAPTER 7

CONCLUSION

The *P. bicalcaratum* were more or less uniformly distributed all through the state of Mizoram. *P. bicalcaratum* was recorded from 103 villages of Mizoram encompassing all the eight districts of the state. The *P. bicalcaratum* are found in places where pristine forests are present with minimal anthropogenic disturbances. The distribution pattern of *P. bicalcaratum* in Mizoram is found to be patchy with small population scattered in a fragmented habitat separated by vast expanse of unsuitable habitat which is directly or indirectly the aftermath of human activities like building roads, logging, agricultural cultivation, human settlements, dependency on forests and its produces etc.

The two intensive study sites *viz.* Lengteng Wildlife Sanctuary and Tawi Wildlife sanctuary were selected based on their location, altitude, and vegetation conditions through information collected from the preliminary survey. They are assumed to house an abundant and stable population of *P. bicalcaratum* owing to their remoteness and vegetation conditions. But, the population of *P. bicalcaratum* in the two study sites were found to be small and thinly distributed. The encounter rate in Lengteng Wildlife Sanctuary is 2.9 (±0.05 SE) individuals per kilometre walk. Lengteng Wildlife Sanctuary has a very thin population of *P. bicalcaratum* with density of 0.34 individuals per kilometre square.

The encounter rate at TWS is 2.9 (±0.07 SE) individuals with every kilometre walk with population density of 0.19 individuals per square kilometre. The sex ratio (male: female) is found to be 2.5:1 and 1.3:1 at Lengteng Wildlife Sanctuary and

Tawi Wildlife Sanctuary respectively which is lopsided and indicative of an unstable population.

The present study concluded that *P. bicalcaratum* are strictly non-migratory and are not undertaking any change in foraging altitude with respect to season and temperature. This confirms the *P. bicalcaratum* as a habitat specialist which survives at a particular elevation with few sets of given environmental variables for their survival.

The habitat analysis of the present study clearly shows that *P. bicalcaratum* depends solely on the evergreen broadleaf forest dominated by *Quercus polystachya* (Ṭhil), *Lithocarpus dealbata* (Fah), *Quercus helferiana* (Hlai), *Engelhardtia spicata* (Hnûm), *Castanopsis tribuloides* (Thingsia), *Alseodaphne petiolaris* (Bul), *Betula alnoides* (Hriang) and *Castanopsis indica* (Se-hawr) with thick undergrowth of *Schizostachyum fushsianum*(Rawnghal).

The habitat selection of *P. bicalcaratum* was found to be affected by numbers of environmental factors viz, temperature, slope, cloud cover, canopy cover, wind, litter cover, relative humidity and distance from water source. The present study concluded that *P. bicalcaratum* preferred habitat with good water source, compounded by steep slope, thick canopy cover and litter cover; with relatively humid climate and moderate temperature of the tropical broadleaved forest of Mizoram.

The feeble maintenance of Protected Areas in the study sites with poor enforcement of The Indian Wildlife Protection Act all around the state is fuelling the rapid deforestation and habitat destruction which can lead to local extinction of small

populations of *P. bicalcaratum* from various isolated habitat. The field staffs of Environment, Forest and Climate Change department need motivation, better equipment, training and regular salary as they play a key role in preservation of the forest and its inhabitant. The deeper participation of the public and NGOs in conservation effort along with implementation of alternate mode of rural livelihoods and poverty alleviation will help save the many precious wild flora and fauna which need a particular set of habitats for survival like the *P. bicalcaratum* in this hill state.

Recommendations

1. Alternate mode of livelihood needs to be implemented to check rapid deforestation:

Tropical forests are known to be home for rich diversity of flora and fauna but are also the most vulnerable to deforestation (LaFrankie et al., 2006). The problem arising out of increasing human population and its dependency wholly or partly in forest produces leads to rapid deforestation in rural areas. The forest in the study area bore the torment of deforestation in various forms *viz.* Logging, shifting cultivation and its worse sister-the uncontrolled forest fire, agricultural plantation, and collection of fire woods by the villagers. The villages around the study area are poorly developed and lack basic amenities (for e.g. Liquefied Petroleum Gas (L.P.G). Collection of fire woods from the forest is a yearlong daily chore of the villagers, irrespective of age and sex. The collected fire woods are stock pile in and beneath every house, with collection being soaring high during the dry season. The loss of forest is also rapid with larger trees being the target of local loggers and timber dealers. The deforestation is also fuelled by expansion of monoculture plantation due to agricultural practices and also shifting cultivation being practiced in the tribal areas is an important factor for rapid loss of forest. As Meyers (1988) suggests that 140,000 sq. km. of tropical forests are lost annually, the above-mentioned problems need to be rightly addressed urgently so as to save the remaining forest and natural habitat of various rare and precious wildlife.

2. Stringent enforcement of The Indian Wildlife (Protection) Act (1972):

The tribal habit of hunting, snaring and collection of bush meat in various forms is prevalent in the study area. The local population although partially depend on bush meat for consumption, the culture of hunting and snaring still persists in the lifestyle and mindset of the people. Unlicensed fire arms, local made guns are common in every village with most of them being used for hunting. Even the licensed fire arms are also being misused and are contributing to many undocumented killings of the wildlife. The hunters roam the villages and the forest freely sometimes even with the killed wildlife being carried openly without any hesitation. Not only this, the parts and whole body of the killed wildlife (mainly ground birds, deer and wild pig) are sold by many roadside vegetable vendors. BirdLife (2018) emphasize on the problem of wild bird trade accompanied by commercial hunting being a great threat to many bird species of Asia. Aiyadurai (2011) studied on the hunted animals of NE India and mentioned that pheasants and mammals of any species are hunted irrespective of season and sex. The same condition prevails in hunting the birds and wildlife of Mizoram; thus, more efficient and stringent enforcement of The Indian Wildlife (Protection) Act 1972 is the need of the hour in this hilly state.

3. Field staffs of EF&CC department needs to be motivated, properly trained, well paid and well equipped:

The wildlife guard manning and patrolling the harsh of hilly terrain compounded by steep slope, heavy and long rainy season of this rain forest are mostly the poor local man employed on contract basis by the government. The village itself lack basic infrastructure or development with scarcity of daily needs. The roads leading to the sanctuary (our study sites) have no check posts and entry and exit to and fro the sanctuary was not either restricted.

The guard sacrifice their life facing all the hardships of this unforgiving jungle in exchange with little amount of money. Their salary often comes with great irregularity from the sanctioning authority which hampers the moral and activity of the guards who need to feed the family as many of them are the sole bread earner in the family. Their equipment's are old, hardly in working condition so as their 'khaki' uniform which is worn out of its colour and pride. The field staffs are the key to the success of conservation in these remote areas, but, are lacking proper training, salary is irregular; equipment and motivation which they really need to perform their protection duty efficiently are not received.

4. People's participation in conservation:

Apart from the stringent enforcement of IWPA, the much needed steps to be taken for successful conservation is to include the general mass, the native people in the conservation process. Chatterjee et al. (2006) states that 'there has been practically no success in declaring community forests areas as community reserves' which contradicts the on-going age-old practice of the Mizo community in the study area. According to Lalnunmawia (2014), conservation and management of forests is a long-standing practice under the unwritten traditional laws of the Mizo community who has the knowledge to demarcate a large patch of land as 'Village safety reserve' and 'Supply reserve'. The safety reserve is more or less preserved from any anthropogenic activity while the supply reserve serves the need of the villagers in many forms. Lalnuntluanga et al. (2014) also mentioned the active role of NGO's of Mizoram in afforestation of lands degraded by shifting cultivation and uncontrolled forest fire. The NGO also taken up roadside plantation to recover the cleared patch of forest for road constructions and other activities. Although the NGO are active in afforestation programmes; every individuals of the local population need to be aware about the value of the rich biodiversity they hold in their area and the utilization of

such treasure. In the present scenario, many of the local people are unaware of the deforestation, climate change and other ecological crisis happening in the world abroad and in their surroundings. They did not imagine the consequences and impact of such act and their importance in saving the pristine forest and its dwellers.

Recent successful step in conservation of the natural forest and its inhabitants at Sâilàm village of Mizoram is a good example which we are reluctant to conceal. The local people established an NGO named Sâilàm Ecological Conservation Society (SECS) back in the year 2013 which actively take part in giving awareness to the school going children and local hunters. With little help from wildlife enthusiasts, nature lovers and local birdwatchers, the SECS along with NGO co-ordination committee of the village set up a bird sanctuary in the year 2017. Birder's Cottage was set up and utilised by birdwatchers, researchers, wildlife photographers, students and nature lovers both from the country and abroad. The revenue collected from the cottage and sanctuary directly enters the hand of local NGOs which then utilizes the money for the village developmental needs. This encourages the local population to protect the wild flora and fauna along with their habitat more and more and is hopeful of inspiring the neighbouring villages as well.

In many parts of its distribution range in Mizoram, *P. bicalcaratum* were found in community reserve forests which fall under the jurisdiction of the village council. Most Village council did not enact or enforce rules and regulation to curb hunting/poaching, logging and collection of fire woods and other forest products from the reserve forest which keep this pheasant more vulnerable to local extinction. Therefore, the Government along with the NGOs of the area involving most of the local people should take initiative in preserving the habitat and wildlife of their respective area.

a. Rescued Female *P. bicalcaratum* at Chamring village, Aizawl district.

a. Abandoned nest with egg at Lengteng Wildlife sanctuary

b. Female *P. bicalcaratum* kept as pet

Photo 7. *P. bicalcaratum* and eggs during the study (a, b and c)

a. Hunter's trophy: leg of pheasant species

b. Tail feathers of male *P. bicalcaratum*

c. Tail feathers of male *P. bicalcaratum*

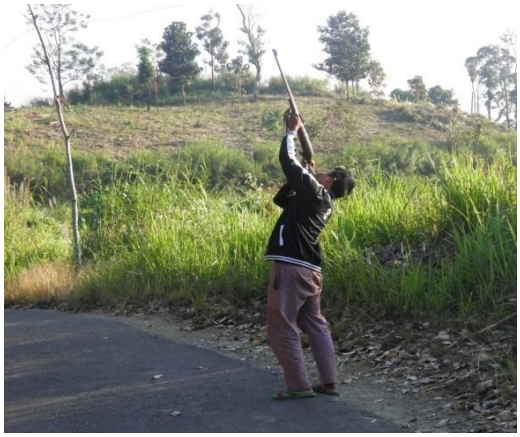
Photo 8: Evidence collected during collection of secondary information

a. Forest fire

b. Burnt ‘jhum’ for shifting cultivation

Photo 9 (a & b). Threats by habitat loss and habitat degradation near the study sites

A



B

C

D

E

F

Photo 10. Threats in the study sites: - A: A village boy with catapult; B: An opportunistic hunter often enters the protected areas; C: Trap for ground birds inside Tawi WLS; D: Hunters entering the protected area; E: Selective logging: F: Feathers of killed Grey peacock pheasant near the illegal loggers abandoned camp.

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LIST OF PUBLICATIONS

Lalawmawia Sailo, G.S.Solanki, S.N.Ramanujam, and H.Lalthanzara (2013) Survey on distribution of pheasants (Galliformes) in Mizoram, India [*Science Vision 13(2)* April-June 2013]

Lalawmawia Sailo, G.S.Solanki, S.N.Ramanujam, and H.Lalthanzara (2014) Galliformes and their conservation issues in Mizoram, North East India [*Cibtech Journal of Zoology* Vol. 3 (1) January-April, 2014]

Lalawmawia Sailo, G.S.Solanki, S.N.Ramanujam, and H.Lalthanzara (2014) Grey Peacock Pheasant, *Polyplectron bicalcaratum*, as a probable candidate for Ecological Indicator in Tropical Montane Forest of Mizoram, Northeast India [*Issues and Trends of Wildlife Conservation in Northeast India* 2014]

Lalawmawia Sailo, G.S.Solanki, S.N.Ramanujam, and H.Lalthanzara (2015) Density and Relative Abundance of Grey Peacock-Pheasant (*Polyplectron bicalcaratum*, Linnaeus, 1758) in Montane Broadleaved Evergreen Forest of Mizoram, North East India [*IJISET - International*

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Lalawmawia Sailo and H. Lalthanzara (2015). Bird diversity of Lengteng Wildlife Sanctuary, Mizoram. [*Science Vision* 15(2), 87-96 (2015)]

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Lalawmawia Sailo, G.S.Solanki, S.N.Ramanujam, and H.Lalthanzara (2018). Distribution mapping of Grey Peacock Pheasant *Polyplectron bicalcaratum* (Linn.1875) in Mizoram: a potential indicator of climate change. In :G.S.Solanki (Eds) Biodiversity Conservation: Strategies and Application. Pages 75-81. Scientific Book Centre, Guwahati. Pp 461. ISBN 978-81-287-0035-4.

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Examinations	School/College	Subject/	Year	Division	Percentage

	(Board/University)	Specialization			of Marks
H.S.L.C	T.B.S.E		2003	II	58.75 %
H.S.S.L.C	M.B.S.E	Science	2005	II	52.4%
B.Sc	N.E.H.U	Zoology	2009	I	63.75 %
M.Sc	N.E.H.U	Zoology (Insect Physiology)	2011	I	63.75 %
Ph.D	MZU	Zoology (Conservation Biology & Ecology)	2016-2019	R/A	

Additional information:

a. Ph.D title: Ecological studies on Grey Peacock Pheasant *Polyplectron bicalcaratum* (Linn, 1758) in the tropical forest of Mizoram, India.
b. Work experience: Completed 3 years as Project Assistant under DST(SERB) project entitled, "Diversity, distribution and habitat selection by pheasants in Mizoram, India"
c. Hobby: Bird watching, reading books, nature camping, trekking and conservation work.
d. Current activities:
    i. Visit schools in remote villages to enlighten the future generation for conservation.
    ii. Plays an active role in setting up of Community Bird Sanctuary (named Sailam Bird Sanctuary) at Sailam village of Mizoram.
    iii. Held talks and interview on various ecological issues and ornithological topics at All India Radio (AIR) Aizawl.

e. Paper published: Published a total of 10 scientific papers which are as follows-

Lalawmawia Sailo, G.S.Solanki, S.N.Ramanujam, and H.Lalthanzara (2013) Survey on distribution of pheasants (Galliformes) in Mizoram, India [*Science Vision 13(2)* April-June 2013]

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Lalawmawia Sailo, G.S.Solanki, S.N.Ramanujam, and H.Lalthanzara (2015) Density and Relative Abundance of Grey Peacock-Pheasant

(*Polyplectron bicalcaratum*, Linnaeus, 1758) in Montane Broadleaved Evergreen Forest of Mizoram, North East India [*IJISET - International Journal of Innovative Science, Engineering & Technology*, Vol. 2 Issue 7, July 2015]

Lalawmawia Sailo and H. Lalthanzara (2015). Bird diversity of Lengteng Wildlife Sanctuary, Mizoram. [*Science Vision* 15(2), 87-96 (2015)]

Lalawmawia Sailo, Raju Kasambe and H. Lalthanzara. (2015). Himalayan Vulture: Sighting report and people's perception in Mizoram. [*Mistnet* Vol. 16 No. 2 April-June 2015]

Lalawmawia Sailo, Raju Kasambe and H. Lalthanzara. (2015). Bird survey in Lengteng Wildlife Sanctuary and Blue Mountain (Phawngpui) National Park, Mizoram. [*Buceros* Vol. 18, No. 3, 2013]

Lalawmawia Sailo, G.S.Solanki, S.N.Ramanujam, and H.Lalthanzara (2016) Factors affecting habitat selection by Mrs Hume's Pheasant *Syrmaticus humiae* (Hume, 1881) in Mizoram, Northeast India [*Science Vision* 16 (1) January-March 2016]

Lalawmawia Sailo, G.S.Solanki, S.N.Ramanujam, and H.Lalthanzara (2018). Distribution mapping of Grey Peacock Pheasant *Polyplectron bicalcaratum* (Linn.1875) in Mizoram: a potential indicator of climate change. In :G.S.Solanki (Eds) Biodiversity Conservation: Strategies and Application. Pages 75-81. Scientific Book Centre, Guwahati. Pp 461. ISBN 978-81-287-0035-4.

Lalawmawia Sailo, C. Lawmsangzuala, A. Rochamliana and H. Lalthanzara (2018). Sightings of Chestnut-flanked White-eye *Zosterops erythropleurus*: First report from Mizoram, India. [*Science Vision* 18(2), 78-80(2018)]

PARTICULARS OF THE CANDIDATE

NAME OF CANDIDATE	:	LALAWMAWIA SAILO
DEGREE	:	Ph.D
DEPARTMENT	:	ZOOLOGY
TITLE OF THESIS	:	ECOLOGICAL STUDIES ON GREY PEACOCK PHEASANT *Polyplectron bicalcaratum* (Linn, 1758) IN THE TROPICAL FOREST OF MIZORAM, INDIA
DATE OF ADMISSION	:	10.8.2016

B.O.S : 15.4.2016

REGISTRATION No. & DATE : MZU/Ph.D/930 of 22.04.2016

Head of Department

Tlanga sava zawng zawng ka hre vek a:
Ram sate pawh hi ka ta a ni.
SAM 50:11

I know all the fowls of the mountains
And the wild beasts of the field are mine.
PSALM 50:11