



WHITE BELLIED HERON RECOVERY PLAN
2017-2018



REPORT ON PROJECT ENTITLED

Occupancy Survey of White-bellied Heron (WBH)
and
Potential Habitat Assessment along Jomori River of
Jomotsangkha Wildlife Sanctuary (JWS)
Samdrup Jongkhar, Bhutan

Submitted by;

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ABSTRACT

This project is carried to understand WBH occupancy in Jomori river and habitat suitability. Transect walk of 7 km along the river was carried for 3 months. Occupancy data is also collected by questionnaire aided with photograph of WBH from 38 local inhabitants. Throughout the entire transect walk, no single individual of WBH is sighted. None of the respondents say WBH is present in the area. Questionnaire survey also says there is no history of WBH presence in the area. Thus, this study assumed WBH is not present in the Jomori river.

The Jomori river flows at the average speed of 1.51m/s, which is higher than the river speed of 0.93m/s, where WBH prefer to forage. Majority of river basin and bars are consist of stones and rocks covering 57.14% of the total surveyed river length. Mostly river runs in single channel. Sands, driftwoods and gravels are rarely present in the basin. Measuring 6-43m in width and 14cm -3.10m in depth, the Jomori river flows narrow and fast. Whereas WBH prefer site with slow to mild flowing current with clear shallow water, 12-30cm deep, puddles, braided and multi channels section for foraging. The basin characteristics shows the Jomori site is less likely to suit WBH to forage or roost. However this is one time data of post winter season.

The vegetation sampling from 14 plot shows mean tree density in the area is 16.14. While extrapolated, this shows 357 trees are present in a hectare. The tree density in the area is much higher than the mean tree density of 4.09 at Phochu site and 5.43 at Harachu site where WBH are present. WBH prefers open forest for roosting, nesting and foraging. WBH use chir pine and *Terminalia myriocarpa* for roosting and nesting. However, Chir pine tree is absent and *Terminalia myriocarpa* is recorded low density in the area. Thus dense forest and lack of species required for nesting and roosting shows the area is not likely to prefer by WBH.

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ACRONYMS

Bp – Basin sampling plot

CFO – Chief Forestry Officer

CR – Critically Endangered

EN – Endangered

FRI - Forest Research Institute

GBH or DBH – Girth at Breast Height or Diameter at Breast Height

HVTR – Hukaung Valley Tiger Reserve

IUCN – International Union for Conservation of Nature

JWS – Jomotsangkha Wildlife Sanctuary

NNP - Namdapha National Park

RSPN - Royal Society for Protection of Nature

Sp – Sampling plot

T – Threatened

WBH – White Bellied heron

WII – Wildlife Institute of India

WWF – World Wildlife Fund

1. INTRODUCTION

1.1 Background

The White Bellied Heron (WBH) *Ardea insignis* also known as Imperial Heron is a second largest and rarest heron in the world. It is distributed along the Himalayan foothills of Bhutan, north-eastern India to northern Myanmar. In 2014, a single individual is also recorded in China, Lushui County, Yunnan Province bordering with Myanmar (IUCN, 2018). The species is reported extinct from Nepal and possibly extinct from Bangladesh (Karma Wangdi, 2017). Although the species has large range of occurrence however no latest report of sighting WBH in some of the historical occurring sites in Myanmar. This possibly suggest decline in the species and its range. The WBH is restricted more towards certain sites within its range. For example, in Bhutan it is recorded mostly along Punatsangchu river and its tributaries, Assam and Namdapha National Park (NNP) in India and mostly in Hukaung Valley Tiger Reserve (HVTR) in Myanmar.

The estimated global population of the species is between 50-249 mature individuals. The population trend of the species is decreasing. The International Union for Conservation of Nature (IUCN) has classified WBH as Critically Endangered (CR) since 2007 in the red list of threatened species. The latest data shows there are 26 in Bhutan (RSPN, 2017), 23 and 7-8 individuals in Myanmar and India making up to 60 individuals at global level (Karma Wangdi, 2017). The species is usually found dwelling along the water bodies associated with sub-tropical or tropical broadleaved and Chir pine forest. It prefer both slow and fast flowing rivers and stream, lakes and wetlands. The species are usually found foraging in shallow side of water bodies, where it is braided into multi channels by sand bars, small and large stones and wooden logs. The WBH also forage fishes easily from backwater and puddles. The WBH forage by visual cues and it feeds on large fishes. Thus water clarity is also site attribute to suit for WBH.

The WBH roost at the river bank on sand, fine gravels, rocks and on trees. The heron is found roosting during daytime when the sun rays reached river sides and when it becomes warm. Towards evening, when the surrounding temperature turns cold, it fly towards river or stream and start foraging. The breeding season of WBH starts from February with the initiation of courtship by the end of January. It nest on Chir pine *Pinus roxburghii* and *Terminalia myriocarpa* usually on middle branch or crotches of the tree with >10cm diameter. In Bhutan, so far it is reported the species breeds only in chir pine forest.

The WBH in Bhutan was first sighted by the Fourth King at Mochu. Then more exploration was carried by RSPN researchers within country. At present, total of 26 individuals recorded in the country is the highest number recorded comparing with other countries of WBH habitat range. The maximum number was recorded along Punatsangchu and its tributaries including Phochu, Mochu, Sunkosh, Dagachu, and Ada lakes in west central with 17 individuals. WBH is considered more Bhutanese than Black Necked crane as the latter comes to Bhutan only seasonally (Bisht, 2008).

1.2 Problem statement

RSPN research teams has been surveying many rivers in Bhutan for the presence of WBH. Other than aforementioned rivers, the team explored Wangchu, Amochu, Pachu, and its tributaries in the west, Kishonachu, Hararongchu and its tributaries in the west central, Mangdechu, Chamkharchu and its tributaries in central and Tserichu, Kholongchu, Kurichu, Drangmechu, Nera Amachu and its tributaries in the east. From the survey, Kurichu and Drangmechu in the east was projected as suitable habitat for WBH. Correspondingly in 2016, a single heron was sighted in Jamkhardrang area of Drangmechu River.

From the survey carried so far by RSPN, the WBH are found occupying rivers and lake in west central and central Bhutan. But the sighting of WBH in Drangmechu in extreme east without comprehensive data became total vague. It was inspiring indication that the WBH can occupy suitable water bodies anywhere. There are many other rivers in the country which are yet to explore. Jomori River in south eastern Bhutan is one of the major river within Jomotsangkha Wildlife Sanctuary (JWS). So far no survey is carried for the presence-absence of WBH in the Jomori river. Also it is not sure if the particular river is suitable for WBH. In the flow of WBH research and exploration, the survey in Jomori river becomes significant. The data from this survey would count for the national importance.

1.3 Objectives

- 1) To study occupancy of White Bellied Heron along Jomori river system within Jomotsangkha Wildlife Sanctuary
- 2) To study the physical characteristics of the riverine stretches along with its floristic diversity along Jomori river system in the JWS.
- 3) To examine natural and anthropogenic threats and disturbances for the survival of the White Bellied Heron along Jomori river systems.

1.4 Research questions

- 1) Is there White Bellied Heron in the Jomori river in JWS? Was it there before?
- 2) Can Jomori river system provide suitable habitat for the survival of WBH?
- 3) What are the disturbances people pose to Jomori river and associated forest?

2. LITERATURE REVIEW

2.1 Distribution

One of the second largest heron of the family Ardeidae, the White Bellied Heron *Ardea insignis* is the rarest heron in the world (Karma Wangdi, 2017). It is classified as critically endangered in the IUCN Red list of threatened species. The species range covers three biodiversity hotspots: Eastern Himalayas, Indo-Burma, and South-West China; two Global 200 ecoregions: Terai-Duar savannah and grasslands and the Eastern Himalaya broadleaf and conifer forest (Goodman, 2015). The species is recorded from Himalayan foothills of Bhutan, north-eastern India to northern Myanmar and historically in west and central Myanmar. In 2014, the species is also recorded in China, Lushui County, Yunnan Province bordering with Myanmar (IUCN, 2018). However, in Myanmar, the species is reported to have abruptly declined in its range which was earlier said to have occur common. The species is reported extinct from Nepal and possibly extinct from Bangladesh (Karma Wangdi, 2017).

In India, most of the few recent record comes from the Assam and Namdapha National Park in Arunachal Pradesh. The latter is considered to be a breeding ground for the species (Murali Krishna, 2012). In Myanmar, the White Bellied Herons are reported from places such as Hukaung valley tiger reserve, Hpon Razi Wildlife Sanctuary, Hkakabo National Park and from Nam Sam Chaung of Kachin state. Hukaung Valley Tiger Reserve is considered to be most suitable habitat for the species. However very little is known about the status of White Bellied Heron in Nam Sam Chaung sites (International, 2018).

In Bhutan, the White bellied heron was first sighted and positively identified by His Majesty the Fourth Druk Gyalpo King Jigme Singye Wangchuck from the Mochu (RSPN, 2011). Later the more study about its occurrence was carried within the country in many of the major river system below 1,500m of altitude by RSPN research team. At present, the species is reported mostly along Punatsangchu and from other areas such as Phochu, Mochu, Hararongchu, Burichu, Ngagsina, Kamechu, Ada lake, Zawa and a single individual is sighted at Jamkhardrang area in Drangmechu in the east in April, 2016 by RSPN research team and nature guide trainees of Ugyen Wangchuck Institute for Conservation and Environmental Research (Karma Wangdi, 2017).

2.2 Population

The White-bellied Heron, is reported to be present only in three countries in the world namely Myanmar, India and Bhutan. The species is possibly extinct from Bangladesh and reported extinct from Nepal. The population size of the species is very small. It was classified as Threatened (T) in 1988. In 1994, the species is upgraded to Endangered (EN). Since from 2007, the IUCN has classified the white Bellied Heron as Critically Endangered due to rapid decline in its population. At present, the estimated population size of the species is between 50-249 mature individual (IUCN, 2018). By counts, it is believe the species has a small global population of 60 individuals (Karma Wangdi, 2017). Today, Bhutan with 26 individuals is having the highest number of species among the other countries of White Bellied Heron habitat range (RSPN, 2017). 23 and 7-8 individuals of species are reported from Myanmar and India respectively (Goodman, 2015). For

the conservation management of White Bellied Heron and to recover the population of the species, the RSPN in Bhutan has established a captive breeding. This is the first captive initiative of the species in the world (WWF, 2011).

The population study of white bellied heron in Bhutan is carried by research team of RSPN. The researchers adopted two methods; nest survey and synoptic winter population counts (RSPN, 2011). By nest survey methods, total of 5 active nest was discovered by 2010, which means only 10 breeding adults are present in the country. This is an extremely small population size from genetics and population viability viewpoints. However, the country has considerable area of appropriate habitat where the search is still not done intensively (RSPN, 2011). Winter synoptic population counts is adopted because by this time, birds usually stay associated with particular river reach or stream without large movement. By this methods, it indicates there are total of 30 individuals in Bhutan during winters (RSPN, 2011).

In 2014, one individual is sighted at Lushui County, Yunnan Province in china (International, 2018). This sighting was followed by large extend of survey in many regions. However the researchers couldn't sight any other individuals. The single individuals cannot be extrapolated a population size of national level, however can say the population in china is very low (Goodman, 2015). The current population trend of White bellied heron in the world is decreasing. A rapid decline is suspected due to habitat destruction and widespread of disturbances. Further it is expected to decline more rapidly in future (IUCN, 2018).

2.3 Habitat; Feeding, roosting and nesting ecology

The species is mostly recorded from small to large rivers, found foraging in wide variety of water bodies, including rivers and stream of both fast and slow moving, wetlands and lakes (RSPN, 2011). Water clarity is also important factor of site suitability as it forage by sight. In Myanmar observations of feeding have mainly been in clear, shallow waters, 12-30 cm deep, with some blue-green algae and with stone beds and sand bars (King B. F., 2001). While the consensus is that in India and Myanmar, WBH requires clear water for feeding. In Bhutan WBH has been seen feeding in turbid water made murky by hydropower construction (RSPN, 2011). It easily forage from shallows and backwaters, multiple channels, braided, puddles and depression.

The WBH often roost along river side during day when the sun reach river bar, after 8:30am. The roosting site of heron is usually characterized with presence of large rocks, logs, trees and often bare sandy patches. It lay down on sternum in sand or fine gravel. When the surrounding temperature rises, by February, the WBH start to roost on trees, chir pine (International, 2018) and *Terminalia myriocarpa*. Roosting behavior during night is poorly known (RSPN, 2011).

The WBH nest on Chir pine in Bhutan (RSPN, 2011) and *Terminalia myriocarpa* in India (Maheswaran, 2014). It is found nested on *Pinus roxburghii* measuring 27m-43m located at the slope of 42°-68°. The nesting height was 12.7m-22m usually on middle branch or crotches of the tree with >10cm diameter. The clutch size of WBH is usually 1-4. The adults incubate alternatively for 30-31 days. The mean chick fledging per nest varied between 0 and 3. Nestlings becomes capable to leave nest after 72-74 weeks (RSPN, 2011).

3. MATERIALS AND METHOD

3.1 Study area

Jomori river is located within Jomotsangkha Wildlife Sanctuary (JWS) in southeastern Bhutan under Samdrup Jongkhar district. The sanctuary covers area of 334.73 sq. km. The area is hilly with undulating terrain and altitude ranging from 170m to 2300m. Vegetation consists of sub-tropical, cool and warm broadleaved forest.

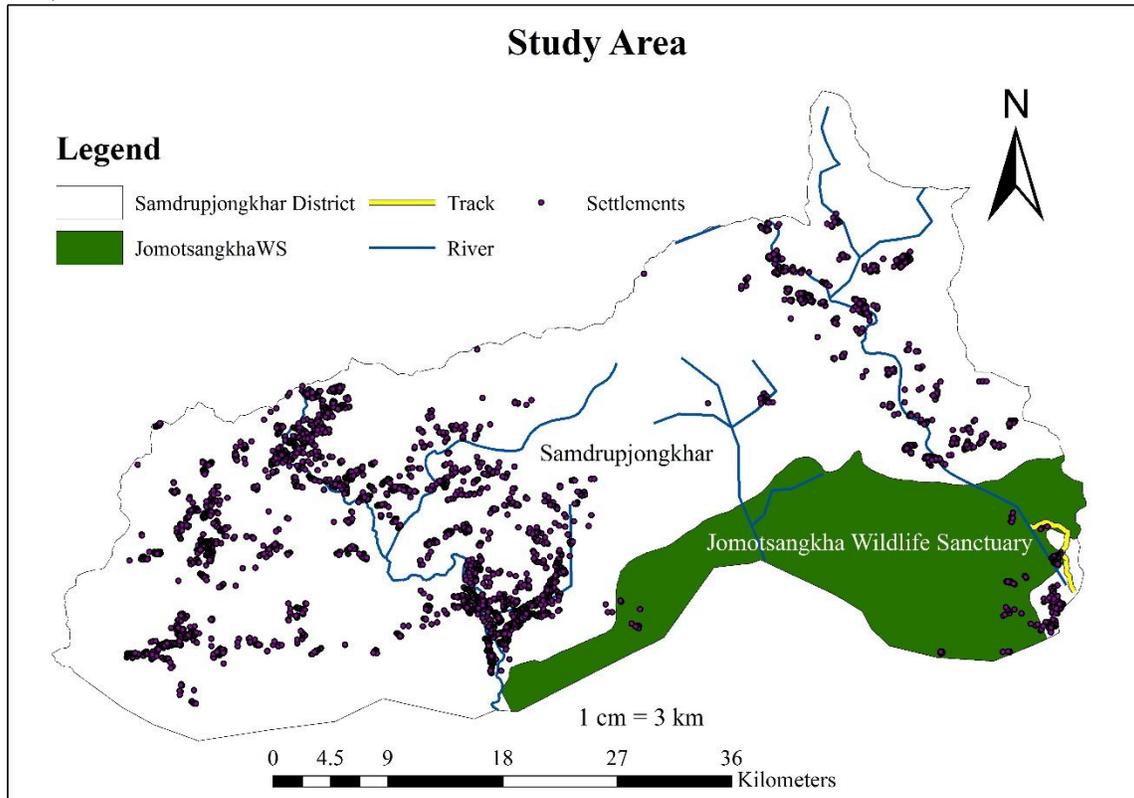


Figure 1: Study area showing surveyed site within Jomotsangkha Wildlife Sanctuary

The Jomori river earlier called Dhansari river flows through east of the Sanctuary. It flows from the Sakteng Wildlife Sanctuary into JWS and exits into Udalguri district of Assam state, India. The survey for WBH along the Jomori river was carried between Jomotsangkha (N26° 53.819', E92° 06.808' at the altitude of 696ft or 212masl and Tokaphu (N26° 56.584', E92° 06.963') at the altitude of 1,163ft or 355masl at the distance of 7km.

3.2 Methodology

3.2.1 Presence non-presence survey of WBH

A permanent transect walk of 7km is carried by three team members along the Jomori river. The team had surveyed the area for three months between February, March and April. In each month, the team carried transect walk for two times, in 2nd and 4th week but in April, 2nd and 3rd week. So the total of 42km is walked for entire duration. The team has walked at the rate of 2km/hr and the area surveyed is below the altitude of 1,500masl. During the transect walk, the team was equipped

with Digital DSLR camera and binocular. The team took transect walk silently and an opportunity survey was carried throughout the transect length. Based on encounter rate, the team aimed to note the species in the area if sighted.

To compensate the detection probability bias of WBH during transect walk, presence non-presence data is also collected by structured questionnaire from 38 household local people inhabiting nearby Jomori river. The data is collected during off day of transect walk both by going from house to another and from whoever meets on the way of survey team. The questionnaire is aided with photograph of WBH so the people do not misunderstand to other water birds. Questions asked are basically to understand presence non-presence of WBH at present, before 5 years and before 10 years.

3.2.2 Basin site characterization

Along transect, after every 1km, 50m of sampling plot (BP) is laid to characterized the river basin. Within the basin sampling plot, the team observed and noted river speed, depth, width and basin width. The team also noted presence of stones, rocks, gravels, sands, wood logs, bars, puddles, braid, channel and surrounding landscape including vegetation.

3.2.3 Vegetation sampling

After every 500m of transect length, the vegetation sampling plot is laid 50 m perpendicular from river towards right side and left side alternatively. Thus total of 14 circular quadrat plot of 12m radius is laid. All the trees within plot measuring GBH ≥ 30 cm is taken into account to understand vegetation structure of the area. Tree species, DBH, height and canopy % are noted.

4. RESULT AND DISCUSSION

4.1 Occupancy of WBH

The team carried presence non-presence survey of WBH in Jomori river by having transect walk for 6 times within 3 months. Throughout the duration of transect walk, the team couldn't sight any WBH in the area. The result of transect walk is shown in the table 1.

Table 1: The result of transect walk carried for six times in three months.

Si.no	Day	Date	Months	Sighted	Not sighted
1	Friday	09-02-18	February		√
2	Monday	26-02-18	February		√
3	Tuesday	13-03-18	March		√
4	Wednesday	28-03-18	March		√
5	Sunday	08-04-18	April		√
6	Wednesday	18-04-18	April		√

However, because of shy nature of WBH and some drawback factors associated with survey team, there is every chances the species detection probability will reduce. For the reason, the questionnaire survey was carried from local people inhabiting near to Jomiri river in order to compensate relative shortcomings. The total of 38 household has participated in the survey. Table

2 shows the result of questionnaire survey. Out of 38 respondents for the questionnaire survey, 23 are male and 15 were female as shown in figure 2.

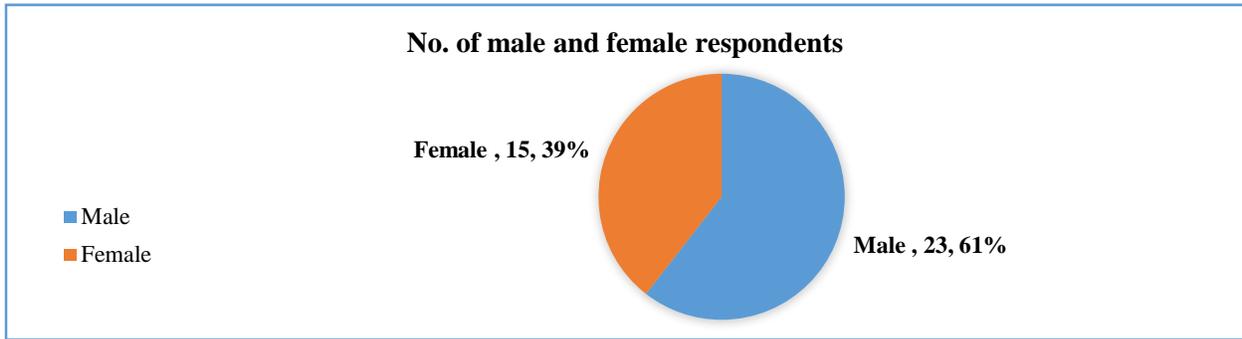


Figure 2: Ratio of male and female respondents

Majority of respondents (94.74%) were between the age 20 -50 years as shown in the figure 2. From the survey 31 respondents, which is 81.57% of the respondents answered the WBH is not present in Jomori river at present and 18.42% answered they don't know of its presence. None of the respondent says it is present.

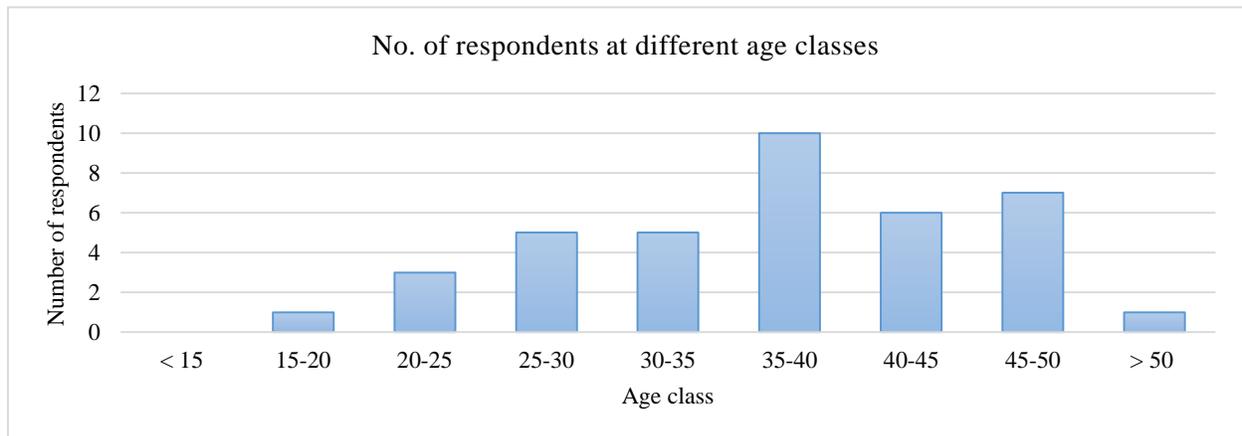


Figure 3: Number of respondents from different age classes.

In the second question, 30 respondents, which makes up 78.95% answered the WBH is not present in the area before 5 years. However, 21% of the respondent answered they don't know of it. The percent who responded the WBH was present in the area before 5 years is 0%.

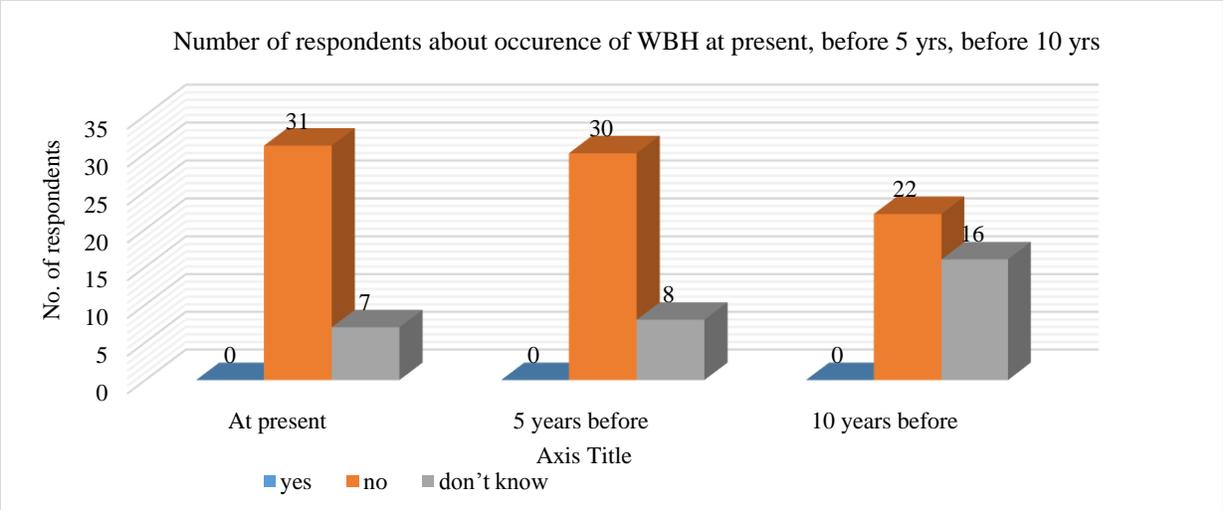


Figure 4: No. of respondents about occurrence of WBH at present, before 5 yrs and before 10 yrs

Also none of the respondents says WBH was present in Jomori river before 10 years. 22 respondents (57.89%) of the total says WBH was not there in the area before 10 years. However 16 respondent (42.11%) says they don't know about the presence of WBH in the area before 10 years. In the overall, 0% of the total says WBH is present in Jomori river at present, before 5 years and before 10 years. Correspondingly the 72.80% of the total says WBH is not present in the area at present, before 5 years and before 10 years and 27.19% of respondents says they don't know about its presence.

During the survey, no single individual of WBH is sighted in the area. From questionnaire survey, no single local people have respondent they have seen it in the area. Through questionnaire survey, we also came to know there is no history or record of WBH being sighted in the area before 5 years and before 10 years. Therefore, from this study, I assumed that the WBH is not present in the Jomori river of JWS. However, this study is carried during post-winter season (Feb-April) and questionnaire survey data is collected only from 38 household living between Jomotsangkha and Tokaphu. There are many other area in the Jomori river to carry survey in the future.

4.2 Basin characteristic

Basin characterization was carried to check the site suitability for WBH. Total of seven basin sampling plot was laid along the transect length. Table 3 shows the details of basin features. In each sampling plot, parameters such as river speed, width, depth, basin width, river edge features, presences of sand, gravels, stones, rocks and wood logs were noted.

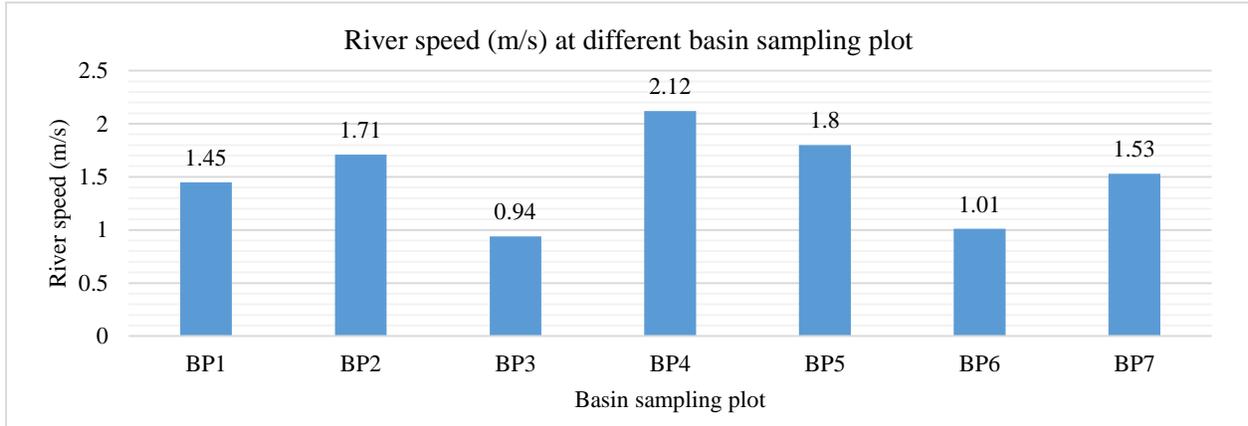


Figure 5: River speed at different basin sampling point.

In some point, the river width becomes very narrow until the width measure 6m and in some it is very wide measuring 35m in width. The depth of the river fluctuate from 14cm to 3.10m. The width of basin measures from 3m to 50m within which there lies rocks, gravels, sands, stones and wood logs. In majority the edge of river is bounded with stones towards inner side and rocks and large boulders towards periphery of the basin. Only in few case there lies sands or gravels and small stones.

Therefore, from the study, only 14.28% of the river basin is having sand in the basin. 57.14% of the river bank was lined with stones and rocks. 28.56% of river length is having deep slope and cliffy in the river bank. In 42.85% of river length, the basin is having patchy of sand along with small and large stones and other rocks.

Table 2: Basin characters at 7 basin sampling plot

Si no	Basin plot	River speed (m/s)	River width (m)	River depth (m)	Basin width (m)	River edge	Channel
1	BP1	1.45	9-15	0.4-2.90	12-23	Rocks	0
2	BP2	1.71	8-16	0.38-3.10	5-10	Stones, cliff	0
3	BP3	0.94	20-35	0.14-2.42	3-30	Sands, gravels, stones	2
4	BP4	2.12	6-20	0.16-3.05	7-25	Cliffy	0
5	BP5	1.8	12-28	0.22-2.7	15-50	Stones	0
6	BP6	1.01	14-30	0.43-3.0	10-32	Stones, rocks	0
7	BP7	1.53	22-43	0.15-1.2	18-38	Sand, stone, rocks	0

In 28.57% of the surveyed river length, driftwoods are present in the river basin as shown in the figure 6. River bank is usually having stones and rocks and rarely fined gravels. Only in plain area,

where the rivers runs shallow making 14.28 % of river length of the total surveyed, we could find gravels. In all the sampling plot, the rivers run in single channel except in sampling plot three (BP3), where the area was plain, the river runs slow and it was divided into two channels. Rocks and boulders are present throughout the length of river.

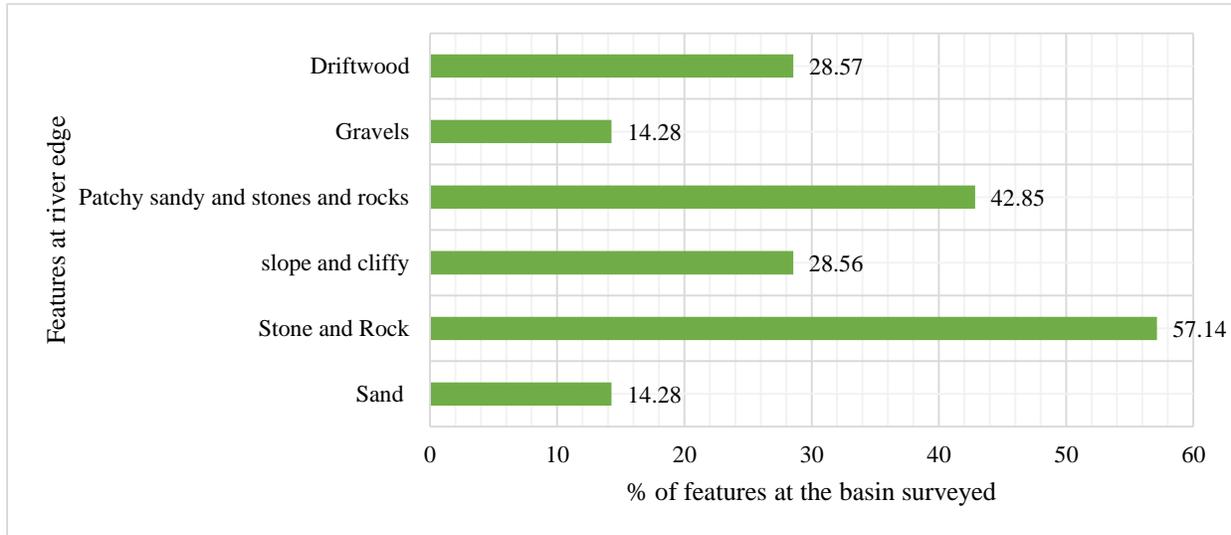


Figure 6: Different features at river edge and basin

The study in Myanmar found the WBH usually forage in clear shallow water with 12-30cm deep. Forage most commonly in shallow pond either within island or edge of island (Thet Zaw Naing, n.d). Both in Myanmar and in Bhutan, the study found WBH prefer cobbles, gravels, rocks and sandy river bars and multiple channels within the river for foraging. However, along Jomori river, the major part of river bar is consist of stones and rocks covering 57.14% of the surveyed site. The gravels and sand is very less making only 14.28% respectively. WBH commonly forage at braided sections and prefer multiple channels more than single channel. In most regions, the Jomori river runs in single channel and only in 1/7th of the surveyed area the river runs in two channels.

The study by RSPN in Bhutan found WBH usually foraging in the major river with 15-300m width (RSPN, 2011). River and stream of slow to mild flowing current are preferred feeding ground in Bhutan. The study by Chimi Dorji along Punatsangchu found WBH forage at the river site with mean width of 64.5m and mean depth of 42.70cm (Dorji C. , 2016). The Jomori river in the surveyed area runs at the mean speed of 1.51m/s. which is higher than the mean speed of 0.93m/s, at which the WBH prefer to forage (Dorji C. , 2016). Jomori river width range from 6-43m and depth from 14cm to 3.10m. In most of the region, the rivers becomes narrower and flows at high rate making site unlikely to prefer by WBH for foraging.

On comparative analysis of finding of the study with requirements of WBH, the Jomori river is not likely to prefer by WBH by keeping other factors (which are not studied) constant. However, the river basin characters are one time data collected during post winter or pre-monsoon season. Also there are many other regions of Jomori river, which needs to explore more.

4.3 Vegetation analysis

Jomori river runs through broadleaved forest within JWS. The tree species with GBH \geq 30cm is recorded within the sampling plot. The area from where vegetation sampling was carried was primary forest. Tree diversity and tree density is analyzed to understand the floristic characteristics of the area.

4.3.1 Tree diversity

From 14 vegetation sampling plots, 138 trees, under 66 species are recorded. Figure 6 shows the number of trees recorded in each sampling plots. The WBH use Chir pine tree and *Terminalia myriocarpa* for roosting and nesting (IUCN, 2018). However no single individual of chir pine tree is found within the surveyed area. Single individual of *Terminalia myriocarpa* is recorded in sampling plot 8 (Sp8) but its abundance in the area is very low. *Duabanga grandiflora* and *Talauma hodgsonii* are having the highest % frequency with 57.1%. *Alnus nepalensis* and *Schima wallichii* show the highest abundance with 6.

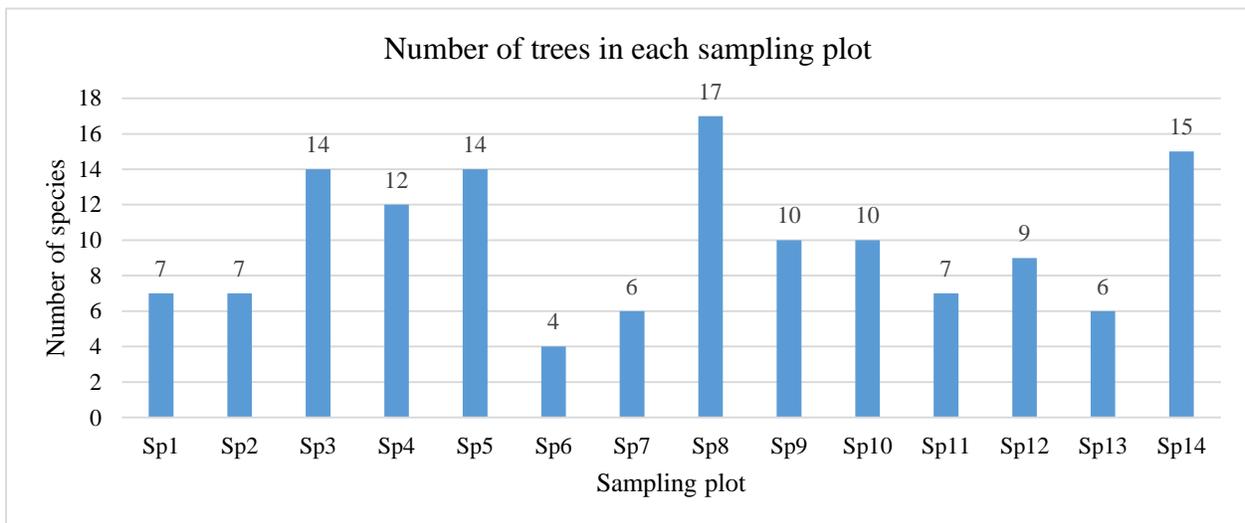


Figure 7: Number of Trees in each sampling plot

4.3.2 Tree density

The mean tree density of the broadleaved forest along the Jomori river side is 16.14. Therefore, the overall tree density extrapolated at the site is 357 trees/ha. The WBH usually prefers open forest. RSPN reported WBH roost on tall Chir pine tree with little or no mid story or understory vegetation. WBH are found to nest on sparsely dispersed large tall tree without understory or small vegetation layer (RSPN, 2011). Open canopy is needed for WBH to fly through without much danger. Study by Chimi Dorji along Phochu where WBH dwells reported mean tree density was 4.09 and mean tree density along Harachu was 5.43.

Therefore, the vegetation density at Jomori river site is much higher than that is preferred by WBH. The chir pine tree that is used by WBH for nesting and roosting in Bhutan are lacking in the area.

Terminalia myriocarpa which is used by WBH for roosting and nesting in Namdapha National Park is very low in density in the area. The *Schima wallichii* is having highest density among all with 1.23, followed by *Duabanga grandiflora* with density 1.07. Therefore, by vegetation composition and structure in the Jomori river site, the area is not likely to prefer by WBH for roosting or nesting.

5. GENERAL OBSERVATION OF DISTURBANCES IN THE JOMORI RIVER SITE

There are several human activities and natural disturbances that occurs in the area. The primary anthropogenic activities carrying in the area are grazing of cattle in the grassland along the river. For that reason the people seasonally burn the area for the regeneration of new palatable grasses. Secondly, fishing illegally by people from across the border is rampant. The fisherman and constant movement of monitoring team along the river is another disturbances in the site. Thirdly, illegal felling and logging of trees from the site is another disturbance.

On addition to anthropogenic threats, some natural disturbances such as degradation of river bank due to dry landslide and fall was observed happening constantly. Also the presence of other water birds and fish consuming birds in the area could be competitor to the WBH if it is present in the area. In one instance 33 flock size of Great Cormorant was found foraging along the river. They change the foraging site towards upper stream and downstream of the river and it is observed they lives foraging along the same river every day. The two to three numbers of Crested Serpent Eagle was found foraging in the area every time the team visit site.

CONCLUSION

The many river systems in Bhutan are surveyed for globally threatened WBH by RSPN expedition team. This study was carried to understand the presence of WBH in Jomori river and to see the river suitability as a habitat for WBH. From the transect walk carried, no single individual of WBH is sighted from the area. From the questionnaire survey, no single respondent answered the species is present in the area. Therefore, from this study it is assumed the WBH is not present in the area being surveyed. However there are many other sites along the river which are not covered and that has to be surveyed.

WBH primarily consume large fishes. For the foraging purposes, they prefer river site with shallow rivers, braided sites, rivers distributed into more channels. They roost along the rivers side in sand, rocks and gravels and sometimes on trees during warm season. From this study, it is found that the most of the Jomori river bank is lined with stones and rocks. Only few portion of the river length surveyed is having sands and gravels. The river runs at the speed of 1.51m/s which is higher than the WBH usually preferred for foraging (0.93m/s). The river at some site becomes narrow up to 6m and its depth measures between 14cm to 3.10m. Some basin of the river are sloppy and cliffy which makes the site unfavorable for foraging by the WBH. Thus from the findings of this study, I assumed the site will not be preferred by WBH for roosting or foraging. however this is one time data collected between February and April.

The type of vegetation along Jomori river is broadleaved forest. The vegetation analysis in the area shows the mean tree density in the area is 16.14. When extrapolated, the tree density of the area is 357 trees/ha. The WBH usually prefer open forest for foraging. The tree density at Jomori river site is higher than the WBH prefer for nesting for roosting near to its foraging site. Also the WBH prefer Chir pine *Pinus roxburghii* and *Terminalia myriocarpa* for nesting and roosting but the chir pine forest is not present in the area. The *Terminalia myriocarpa* is present in the area but its density is very low (0.07). Thus the vegetation of Jomori river site does not suit habitat for WBH as it is of higher density and absence of tree species required by WBH for nesting and roosting. The area shows high density of *Schima wallichii* and *Duabanga grandiflora*.

From the study, it shows the Jomori river does not suit to be used as a habitat for WBH. The Basin characteristics and vegetation structure in the area appears to be not as a suitable for the WBH. Therefore, this study shows Jomori river is not a suitable habitat for WBH. However there are many other site in the area which needs to explore more. Also the same study in the area at different season can be suggested.

RECOMMENDATION

The Jomori river neither appears too large nor small. The river width measuring 6m to 43m and basin width stretching from 3m to 50m, the Jomori river is apparently medium. The survey for WBH in the area accompanied by questionnaire survey from local people confirmed the species is not present in the area. Through structured questionnaire survey, it is also learnt there is no history of occurrence of WBH along the Jomori river. The basin characterization at the river site was carried to check the habitat suitability for the future occupancy of WBH. It was found the river depth fluctuate between 14cm and 310cm and in most of the case the river becomes narrower and flows fast. The mean speed of Jomori River with 1.51m /s is higher than the mean speed of river, 0.93m/s where WBH usually prefers to forage. 57.14% of river basin is only stones and rock with rare sands, driftwood and gravels. Majority of the river runs in single channel. Overall the river basin character shows deviate from the foraging and roosting site characters of WBH.

The vegetation sampling along Jomori river between Jomotsangkha and Tokaphu shows mean tree density of 16.14. The tree density in the area is found to be 357 trees/ha. The tree density in the area is much higher than the mean tree density of 4.09 at Phochu site and 5.43 at Harachu site where WBH are present. The WBH prefers open forest for roosting, nesting and foraging. WBH use Chir pine and *Terminalia myriocarpa* for roosting and nesting. However, Chir pine tree is absent and *Terminalia myriocarpa* is recorded low density along the Jomori river.

This study is carried for three months during post winter or pre-monsoon season (Feb–April). The basin character data are collected one time of the survey. With this study, I found the basin of Jomori river and Vegetation along the site may not be preferred by WBH or less likely to suit as a nesting or roosting habitat for WBH, by keeping other factors constant. Therefore I do not recommend Jomori river as a suitable habitat for WBH. However there is still more to understand about Jomori river other than surveyed area and also by carrying more research expedition in other seasons.

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ANNEXURES

1. Presence non-presence survey

Si. no.	Date	Sighted or sign	Not sighted	Flock size	Cue (activity)
1					
2					
3					
4					
5					

2. Questionnaire survey

Si. no.	date	Name	age (yr)	Male	Female	WBH present	WBH absent	WBH presnt bfr 5 yrs	WBH absent bfr 5yrs	WBH present bfr 10 yrs	WBH absent bfr 10 years	Don't know
1												
2												
3												
4												
5												

3. River basin characterization

si. no.	Basin plot	River speed	Shortest width	Longest width	Short depth	Long depth	basin width short	basin width long	river edge	Channels	Sand bars	Wood logs	Gravels	Rocks	Boulder
1															
2															
3															
4															
5															

4. Vegetation sampling

si no	plot no.	species	DBH	Height	% canopy
1					
2					
3					

5. Recorded tree species in 14 sampling plot and their % Frequency, Abundance and Density.

Si. no	Tree species	Number of individual in each quadrat														Total no. of individual	No. of quadrat in which the species occurs	Total quadrat studied	% Frequency	Abundance	Density
		Sp1	Sp2	Sp3	Sp4	Sp5	Sp6	Sp7	Sp8	Sp9	Sp10	Sp11	Sp12	Sp13	Sp14						
1	<i>Acronychia pedunculata</i>												1			1	1	14	7.14	1	0.07
2	<i>Aglaia spectabilis</i>													1		1	2	14	14.3	0.5	0.07
3	<i>Ailanthus grandis</i>		2	1												3	2	14	14.3	1.5	0.21
4	<i>Albizia lebbek</i>			1					1	1					1	4	4	14	28.6	1	0.28
5	<i>Alnus nepalensis</i>											1	11			12	2	14	14.3	6	0.85
6	<i>Altangia excelsa</i>							1					1			2	2	14	14.3	1	0.14
7	<i>Aphanamixis polystachya</i>					1									2	3	2	14	14.3	1.5	0.21
8	<i>Beilchmeidia gammieana</i>											1				1	1	14	7.14	1	0.07
9	<i>Callicarpa arborea</i>							2								2	1	14	7.14	2	0.14
10	<i>Castanopsis hystrix</i>				2	2			1							5	3	14	21.4	1.66	0.35
11	<i>Catunaregam longispina</i>											1				1	1	14	7.14	1	0.07
12	<i>Choerospondias axillaries</i>			1					3							4	2	14	14.3	2	0.28
13	<i>Cinnamomum bejolghota</i>	2	1													3	2	14	14.3	1.5	0.21
14	<i>Cinnamomum tamala</i>													1		1	1	14	7.14	1	0.07
15	<i>Cordia obliqua</i>					1					1					2	2	14	14.3	1	0.14
16	<i>Dendrocide sinuata</i>				2										1	3	2	14	14.3	1.5	0.21
17	<i>Diploknema butyracea</i>							1	1	1						3	3	14	21.4	1	0.21
18	<i>Duabanga grandiflora</i>			2			6	1	2	1	1		1	1		15	8	14	57.1	1.87	1.07
19	<i>Elaeocarpus lanceifolius</i>					2			1	1						4	3	14	21.4	1.33	0.28
20	<i>Erytherina indica</i>	1		1												2	2	14	14.3	1	0.14
21	<i>Eurya acuminata</i>								1							1	1	14	7.14	1	0.07
22	<i>Ficus elastica</i>							2								2	1	14	7.14	2	0.14
23	<i>Ficus sp.</i>								1				1			2	2	14	14.3	1	0.14
24	<i>Fuchsias magellanica</i>							1					1	1		3	2	14	14.3	1.5	0.21
25	<i>Gynocardia odorata</i>												1			1	1	14	7.14	1	0.07

26	<i>Hilecia nilligari</i>				1				1						2	2	14	14.3	1	0.14
27	<i>Jambosa formosa</i>		1										1		2	2	14	14.3	1	0.14
28	<i>Kydia calysina</i>			2											2	1	14	7.14	2	0.14
29	<i>Lagerstroemia</i>						3								3	1	14	7.14	3	0.21
30	<i>Litsea glutinosa</i>				1										1	1	14	7.14	1	0.07
31	<i>Litsea monopelata</i>				2	1									3	2	14	14.3	1.5	0.21
32	<i>Macaranga denticulata</i>			1											1	1	14	7.14	1	0.07
33	<i>Macaranga pustulata</i>							3		1			1		5	3	14	21.4	1.66	0.35
34	<i>Magnolia pterocarpa</i>				1										1	1	14	7.14	1	0.07
35	<i>Michelia spp.</i>	1													1	1	14	7.14	1	0.07
36	<i>Michelia champaca</i>				1										1	1	14	7.14	1	0.07
37	<i>Michelia doltsopa</i>				3										3	1	14	7.14	3	0.21
38	<i>Moliagera (N)</i>					1									1	1	14	7.14	1	0.07
39	<i>Morus spp.</i>				2										2	1	14	7.14	2	0.14
40	<i>Musa balbisiana</i>													2	2	1	14	7.14	2	0.14
41	<i>Oroxylum indicum</i>						1								1	1	14	7.14	1	0.07
42	<i>Ostodes paniculata</i>	1	5	3	1									2	12	5	14	35.7	2.4	0.85
43	<i>Persea bootanica</i>	2		1	1				1					1	6	4	14	28.6	1.5	0.43
44	<i>Persea fructifera</i>													1	1	1	14	7.14	1	0.07
45	<i>Persea odoratissima</i>								1			1	1		3	3	14	21.4	1	0.21
46	<i>Phalaris minor</i>													1	1	1	14	7.14	1	0.07
47	<i>Phoebe attenuate</i>							1							1	1	14	7.14	1	0.07
48	<i>Phoebe lanceolata</i>						2			2		4			8	3	14	21.4	2.66	0.57
49	<i>Phoebe spp.</i>			1		1		1							3	3	14	21.4	1	0.21
50	<i>Ptereospermum chelonoides</i>			2											2	1	14	7.14	2	0.14
51	<i>Pterospermum acerifolium</i>							1		1		1	1	1	5	5	14	35.7	1	0.35
52	<i>Schima wallichii</i>	2						4					12		18	3	14	21.4	6	1.23
53	<i>Sloanea tomentosa</i>		3			2									5	2	14	14.3	2.5	0.35
54	<i>Symplocos paniculata</i>					6									6	1	14	7.14	6	0.43
55	<i>Symplocos spp.</i>					2									2	1	14	7.14	2	0.14
56	<i>Symplocos tomentosa</i>							1	2						3	2	14	14.3	1.5	0.21
57	<i>Syzygium cumini</i>			1		1		2	1			3			8	5	14	35.7	1.6	0.57
58	<i>Talauma hodgsonii</i>	1	1	1	3	1			1	1				1	9	8	14	57.1	1.12	0.64

59	<i>Terminalia bellirica</i>					1			3						4	2	14	14.3	2	0.28	
60	<i>Terminalia alata</i>									1	1				2	2	14	14.3	1	0.14	
61	<i>Terminalia myriocarpa</i>								1						1	1	14	7.14	1	0.07	
62	<i>Tetrameles nudiflora</i>			3	1					1	1				2	8	5	14	35.7	1.6	0.57
63	<i>Tetratigma serrulatum</i>														1	1	1	14	7.14	1	0.07
64	<i>Toona ciliata</i>		1												1	1	14	7.14	1	0.07	
65	<i>Wrightia arborea</i>									3					3	1	14	7.14	3	0.21	
66	<i>Wrightia religiosa</i>									1					1	1	14	7.14	1	0.07	