# **HOOLOCK GIBBON** SURVEY AND MONITORING IN **HTAMANTHI** WILDLIFE SANCTUARY, SAGAING REGION, MYANMAR

WILDLIFE CONSERVATION SOCIETY, MYANMAR PROGRAM

**HOOLOCK GIBBON CONSERVATION IN HTAMANTHI WILDLIFE SANCTUARY, SAGAING REGION, MYANMAR**



**Author**
WCS Myanmar

**Major Contributors**
Min Hein Htike, Hla Naing, Robert Tizard and Gibbon team members

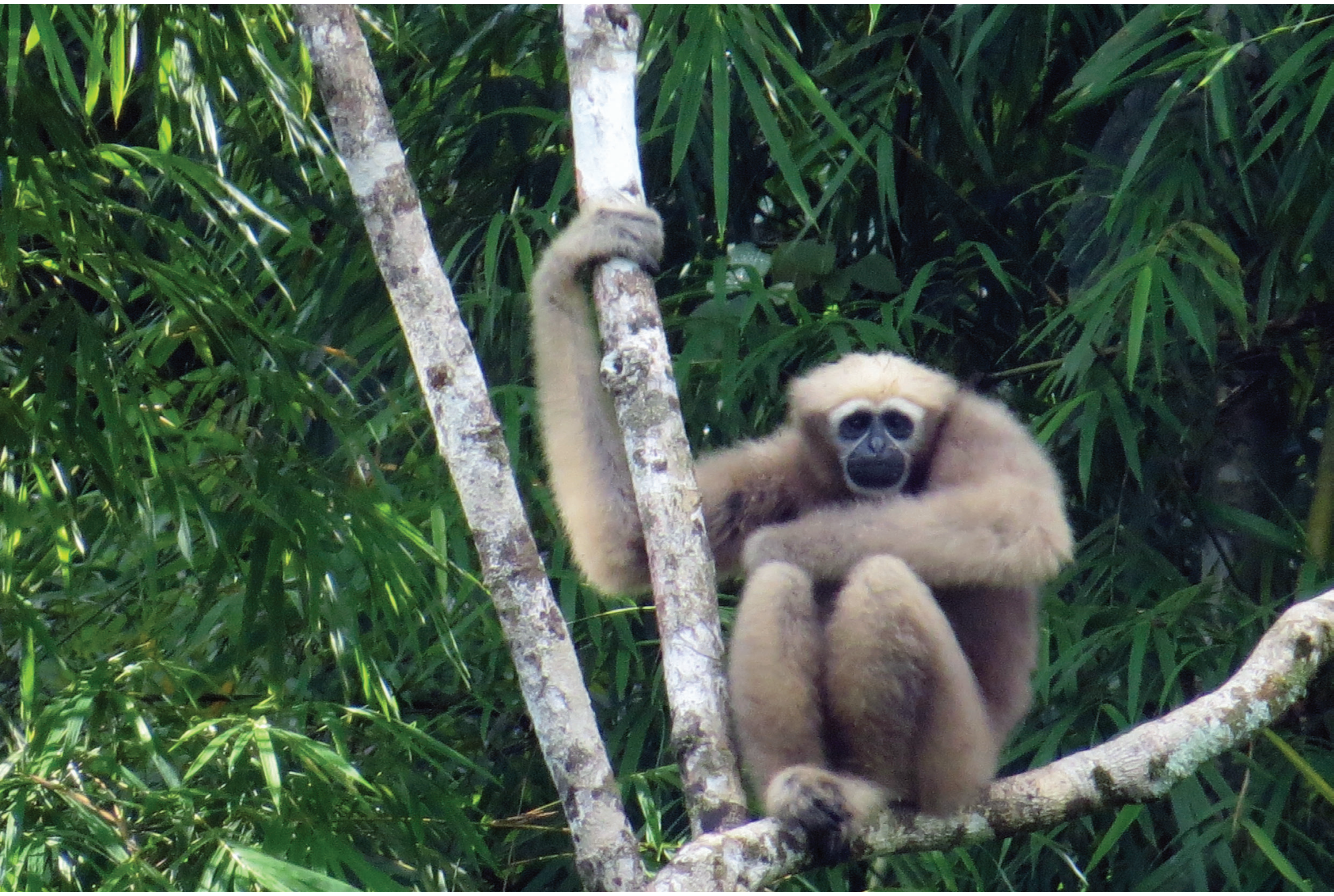
**Printed copies are available upon request to:**
WCS Myanmar
No. 12 (B – 21, 22), Narnattaw Road, Kamayut Township 11041
Yangon Myanmar

Email: wcsmyanmar@wcs.org
Phone: +95 1 535711
Web: http://myanmar.wcs.org
Facebook: WCSMyanmar
Twitter: @WCSMyanmar



**Citation:** WCS Myanmar. Hoolock Gibbon survey and Monitoring in Htamanthi Wildlife Sanctuary, Sagaing Region. . 2019. Yangon, Myanmar. WCS and Forest Department.

# Contents



# FOREWORD

This document reports "Hoolock Gibbon Surveys in Htamanthi Wildlife Sanctuary" with generous funding from Arcus Foundation and jointly implemented by the Forest Department (Nature and Wildlife Conservation Division in particular) and WCS Myanmar Program. As the Country Program Director of Wildlife Conservation Society Myanmar Program, I deeply appreciate and am proud of their effort to fill a gap in nature and wildlife conservation knowledge in Myanmar.

Geologically, Eastern Hoolock Gibbon Hoolock leconedys and Western Hoolock Gibbon Hoolock hoolock are divided by the Chindwin River. However, in the upper Chindwin watershed area like Hukaung Valley, it is assumed that a hybrid zone of both species occurs. These gibbons are listed as Vulnerable and Endangered Species in the global IUCN red list. Gibbons can only live in deep forest with high canopy coverage. Being frugivores, they play a critical role in ecosystem functioning and sustaining natural forest by dispersing seeds for natural regeneration. Therefore, we monitor the presence of Hoolock gibbons, which are an indicator of healthy natural forest ecosystems.

In Myanmar, there is a great challenge to obtain accurate and reliable information on gibbons because of the long imposed economic sanctions which impacted funding for biodiversity conservation projects. Consequently, only three surveys have been conducted (Mahamyaing Wildlife Sanctuary, Hukaung Valley Wildlife Sanctuary, and Rakhine State) before the Arcus Foundation provided support for Htamanthi Wildlife Sanctuary. Comprehensive or scientific data on Eastern and Western Hoolock gibbons are still limited as additional support to scientific reporting and population estimates are needed. This is the reason why WCS Myanmar is dedicated to supporting Hoolock Gibbon conservation in Myanmar and regarding it as an integral part of our conservation activities within Htamanthi Wildlife Sanctuary.

I do hope this report will strengthen our knowledge in achieving effective conservation of Hoolock Gibbons in Myanmar's natural forests. In addition, the resulting scientific information of these species will inform management for better conservation planning by mainstreaming these results and suggestions.

Saw Htun
Country Director
Wildlife Conservation Society
Myanmar Program

# EXECUTIVE SUMMARY

The Hoolock Gibbon survey conducted in Htamanthi Wildlife Sanctuary was generously funded by the Arcus Foundation. The WCS Myanmar conducted this research from 2013 to 2017 in close collaboration with the Forest Department, Nature and Wildlife Conservation Division in particular, as a long-term monitoring program of Eastern and Western Hoolock gibbons. In Myanmar, deforestation, habitat loss and hunting have caused Hoolock gibbons to be a threatened species and extirpated them from much of their historical range. Along with a few surveys for gibbon conservation, scientific information and overall conservation status of gibbon species are still poorly understood in Myanmar.

WCS Myanmar working in close collaboration with the Forest Department has carried out other conservation activities in Htamanthi Wildlife Sanctuary concurrently with this research. Those activities include SMART patrolling, law enforcement monitoring, community led natural resource management initiatives including village consultations and land use zoning, infrastructure development for effective conservation interventions, and monitoring of land cover changes. This report thoroughly explains all these project activities over five chapters.

According to these four years of research, it is learnt that, year by year, the gibbon population trend is steadily increasing while threats to gibbons have significantly decreased. This is undoubtedly a result from effective patrolling using SMART, the development of infrastructure and facilities such as ranger stations and mini training-cum-meeting hall, and empowering community members in natural resource management around the edges of the sanctuary. Another indicator of conservation success was, strongly indicated by spatial analysis of Landsat images, the significant increase of forest cover in both core area and buffer area of the sanctuary.

This report explains how this long-term intervention for Hoolock Gibbon conservation within Htamanthi Wildlife Sanctuary has been achieved by the close collaboration between Forest Department and WCS Myanmar together with the Arcus Foundation.

# ACKNOWLEDGEMENTS

This project is an illuminating moment of research and dedication to conservation. It would be impossible without the huge support from Arcus Foundation, Forest Department, WCS, and every single individual of the project team.

Therefore, we would like to extend our sincere gratitude to all of them. First of all, we would like to thank Arcus Foundation for their generous financial support that makes it possible to save Myanmar's gibbons, and Myanmar Forest Department, and Nature and Wildlife Conservation Division for their tireless technical and administrative support.

We would like to express our deepest gratitude to Dr. Nyi Nyi Kyaw (Director General of Forest Department), U Win Naing Taw (Director of Nature and Wildlife Conservation Division), U Than Myint (Senior Program Coordinator, WCS Myanmar Program), and U Saw Htun (Country Program Director, WCS Myanmar Program) for their guidance, supervision, encouragement and support during the project period to meet our qualified outcomes.

Another official to be acknowledged is U Than Lin, Park Warden of Htamanthi Wildlife Sanctuary, for his contribution to the project and his extensive experiences. We would like to extend our thanks to U Maung Win and U Khin Maung Hla, former park wardens who have successfully supported the project.

We would like to express our sincere appreciation to the strong and dedicated staff from Htamanthi Wildlife Sanctuary, WCS and local community guards that form this survey team and who have devoted their time, effort and sweat for the project. We also would like to thank our logistics team from Htamanthi Wildlife Sanctuary Foreword Station and WCS Country Office who have ensured smooth implementation.

Last but not the least, we would like to give special thanks to Robert Tizard and other contributors from WCS Myanmar.

# CHAPTER – 1

## HOOLOCK GIBBON SURVEYS AND MONITORING IN HTAMANTHI WILDLIFE SANCTUARY

# Introduction

Myanmar is one of the most biologically diverse countries in mainland Southeast Asia. In comparison with its neighbors, approximately 30% of Myanmar is still forested, providing unique opportunities to conserve biodiversity within protected areas (Rao et al., 2002). Gibbon species are only found in Southeast Asia and many are listed in the International Union for Conservation of Nature (IUCN) red list as threatened species. Myanmar forests support three species of gibbon: White-handed Gibbon (Hylobates lar), Eastern Hoolock Gibbon (Hoolock leucondys) and Western Hoolock Gibbon (Hoolock hoolock). Although there are several recent publications for Eastern and Western Hoolock gibbons of Myanmar, little information is available about White-handed Gibbon which are found east of the Salween River and southern parts of Myanmar.

Evidence has shown that deforestation, habitat loss and hunting have exterminated Hoolock gibbons from much of their historical range. But due to very few field surveys of gibbons in Myanmar, scientific information and conservation status of gibbon species are limited. This is clearly visible because conservation and census projects have been performed in only three locations which are (1) Proposed Mahamyaing Wildlife Sanctuary (MWS), (2) Hukaung Valley Wildlife Sanctuary (HVWS) and (3) some areas within Rakhine State. According to IUCN Red List, there is no exact population estimate and in the western parts of HVWS, a large area of forest (>1,000 $km^2$) has not been surveyed yet, but it is likely to hold these species. There are several thousand square kilometers of forest habitat that still need to be surveyed in the Central West and Northwest of the country, with a particular need to survey the Western areas, west of the Chindwin/ Ayeyarwady River (Brockelman, W., Molur, S. & Geissmann, T. 2008).

Therefore, Nature and Wildlife Conservation Division (NWCD) and Wildlife Conservation Society Myanmar Program (WCS Myanmar) have conducted field surveys for Hoolock gibbons, focusing on Eastern Hoolock Gibbon in HWS located in the east of the Chindwin River and west of the Uru River, with generous support of the Arcus Foundation. This report explores the current conservation status focusing on Hoolock gibbon census in HWS from 2013 to 2017, and will provide effective support for management of the sanctuary and national conservation strategies.

# Objectives

**The objectives of this report are:**

I. To update scientific information regarding Myanmar Gibbon conservation status, context and future trends,

II. To determine the group density of Eastern Hoolock Gibbon in HWS, To support management plan of HWS and in developing conservation strategies for wildlife,

III. To evaluate effectiveness of park management by monitoring gibbons as an indicator.

# Background

At present, Myanmar Forest Complex is the largest area of remaining populations of three Gibbon species: Hoolock hoolock (Western Hoolock Gibbon), H. leconedys (Eastern Hoolock Gibbon), and Hylobates lar (White-handed Gibbon). However, gibbons in Myanmar remain largely unstudied. For H. leconedys, a population census had been done in Mahamyaing Wildlife Sanctuary, Hukaung Valley Wildlife Sanctuary and Htamanthi Wildlife Sanctuary. These surveys were carried out by vocal survey methods and it is found that there is approximately 2 groups/km$^2$ in MWS. Based on that result, the total population may be 50,000 individuals (Brockelman, pers. Comm., cited in Geissmann, 2007).

For Western Hoolock Gibbon, it was censused during 2008 in Rakhine State by Myanmar Primate Conservation Program, BANCA, and FFI in coordination with Yangon University. It is estimated that population density in the study area is 0.37 groups/km$^2$.

For White-handed Gibbon no reliable population estimate is available yet in Myanmar. Beyond the three surveys mentioned above and some presence/ absence data from a few basic biodiversity surveys in protected areas, no additional data on the status of Hoolock gibbons in Myanmar exist.

J.T Marshell Jr. reported hearing Eastern Hoolock Gibbons along Salween River from Thailand in 1974 and 1981 (W.Y Brockelman et.al, 2009), but it was not clear if any viable population still exists there. There appear to be no conservation areas along the Salween River in the Eastern part of Myanmar. According to "Myanmar Protected Area: Context; Current Status and Challenges" published by Instituto Oikos and BANCA in 2011, Eastern Hoolock Gibbon can be found in Hponkanrazi Wildlife Sanctuary (HPWS), HWS, HKWS, Indawgyi Lake Wildlife Sanctuary (IWS), MWS, and Pidaung Wildlife Sanctuary (PWS). Western Hoolock Gibbon is found in Rakhine Yoma Elephant Range (RYER). There are no records of Lar Gibbons found in Myanmar's Protected Areas and this is due to the fact that most of gibbon conservation project.

Until present day, Hoolock Gibbon's surveys can only be found in MWS, HVWS and Rakhine State. The initial work in Mahamyaing WS was funded by the U.S. Fish and Wildlife Service (USFWS) and consisted primarily of gibbon census work conducted in 2004-2005. In the field, the survey team chose eleven sample plots in the sanctuary and it was found that there were an average group of 2.2 breeding groups, or 8 - 9 individuals per $km^2$ It was also showed that the density of Hoolock gibbons appears to be below carrying capacity in most listening areas, but it is close to the maximum in some areas (i.e. 1 - 4 individual). For most gibbon species, a density of approximately (4) breeding groups per $km^2$ appears to be the maximum a forest can support (Warren Y. Brockelman, 2009). In 2006, NWCD and WCS Myanmar co-organized a workshop on census methods for gibbons in HVWS, and then a gibbon census was carried out in the valley.

In Rakhine State, gibbon survey was jointly conducted by the People Resources and Conservation Foundation (PRCF), Fauna and Flora International (FFI), the Myanmar Biodiversity and Nature Conservation Association (BANCA) and Zoological Department Yangon University to assess conservation status of Myanmar in 2008. This survey was carried out in the southern Rakhine Mountain Range (Rakhine Yoma), adjacent to Taing Kyo village and Chaung Tha village in Thandwe District. The methodology was also the auditory survey method as in MWS. Survey finding showed the group density of 0.37 and 0.13 breeding groups per $km^2$ in Rakhine Yoma. In addition, participatory rural appraisal (PRA) methods were used to obtain local reports on Hoolock Gibbon status (Geissmann, T., et al., 2008).

As for WCS Myanmar, the first gibbon population census and habitat assessment survey was conducted during 2002-2003 at Babu Lonhtan area between Machanbaw and Naung Mong, Kachin Sate. The MWS gibbon survey had been conducted in 2004- 2005. During 2005-2006, a gibbon survey was carried out in HVWS. In addition, WCS has accomplished a gibbon population census and habitat assessment at HWS and Naga Hill area in 2013. After that, Eastern Hoolock Gibbon monitoring and law enforcement activities have been conducted in HWS consecutively for 6 years (2013-2018). Since 2016, Eastern Hoolock Gibbon surveys were started in HPWS by WCS Myanmar.
In HWS, the gibbon monitoring was conducted using fixed listening posts from

2013 to 2018. There are ten sample plots in the sanctuary and we survey five sample plots each year alternatively. In HPWS, northern Myanmar, Eastern Hoolock Gibbon were monitored since 2016 and use the same sampling as mentioned above and we monitor five sample plots in each year.

WCS Myanmar is conducting Eastern Hoolock Gibbon surveys and monitoring in support of Arcus Foundation, USFWS, and GEF/UNDP. However, we jointly implement with Myanmar FD, NWCD and park staff.

Except RYER, WCS Myanmar has done surveys and monitoring in four PAs: Mahamyaing, Htamanthi, Hukaung Valley, and Hponkanrazi WSs and Hkakaborazi Southern Extension – Proposed (Figure 1). Hoolock gibbon surveys and monitoring in RYER have been conducted by other conservation agencies.

Another research project relating to Hoolock Gibbon was "Scientific verification and conservation planning for Western and Eastern Hoolock gibbons in Northern Myanmar". The proposed project area is located on the border of HVWS and HPWS. The project was aimed to verify the existence of interaction between Eastern and Western Hoolock Gibbons populations. The project was funded by USFWS and started in 2014. The above map shows the location of Western and Eastern Hoolock gibbons' presence in protected areas.

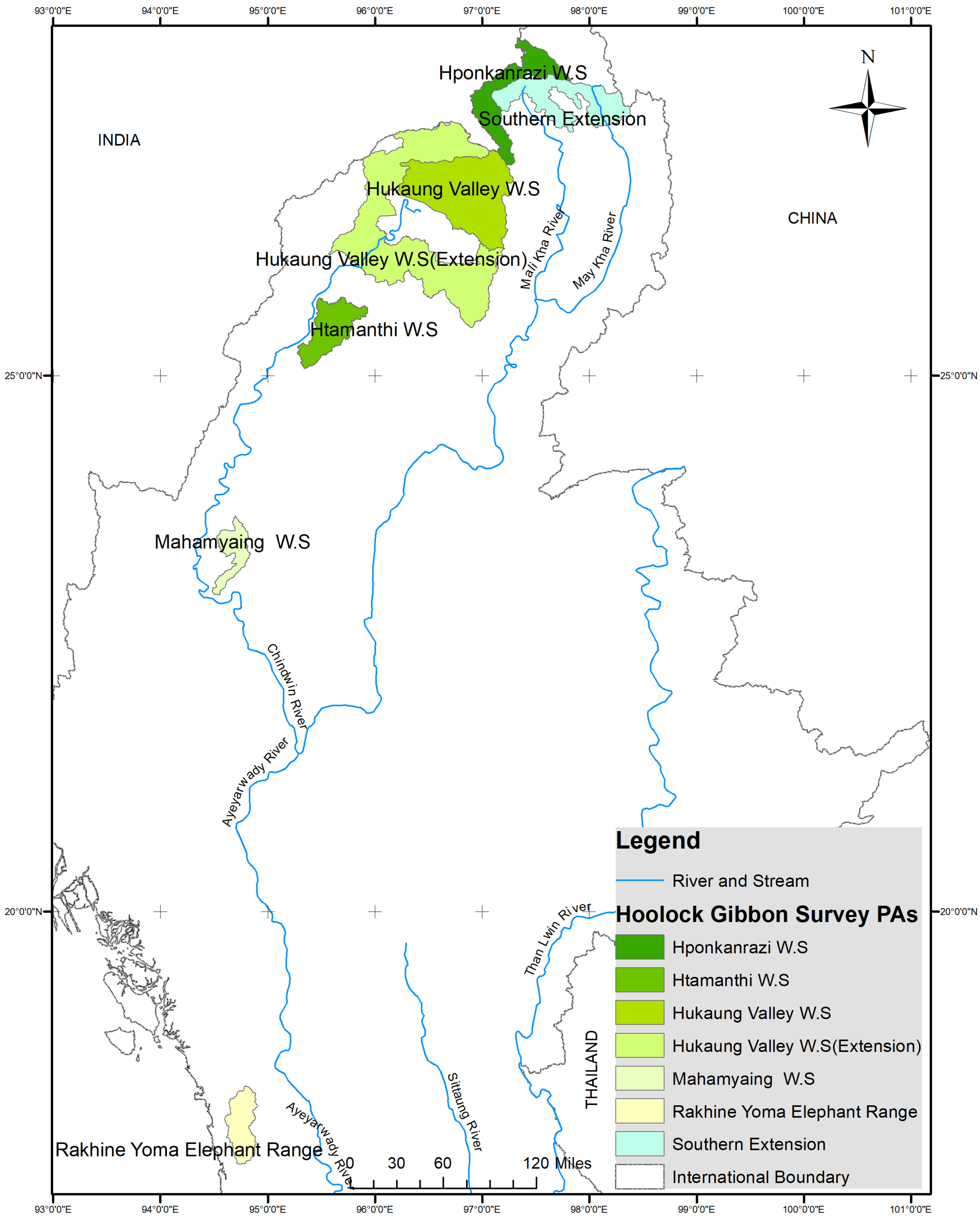



**Figure 1: Past Hoolock Gibbon Survey Area in Myanmar**

# General Description for Hoolock Gibbons

Gibbon species differ most notably in fur coloration and territorial songs. Some species are highly variable in their fur coloration (polychromatism), with some showing pronounced sex differences (Geissmann T., 20014). In addition, some other gibbon species change multiple colors throughout the phases of their life. They hardly differ in body size but differ in color.

Gibbons are distributed across tropical rainforests of Southeast Asia. Bodies of water like the Ayeyarwady (Irrawaddy) and the Mekong often form insuperable obstacles for the gibbons and become barriers to distribution of many gibbon species and genera (Geissmann T., 2014). In Myanmar, Eastern and Western Hoolock gibbons are separated by Chindwin River.

The scientific names of Eastern and Western Hoolock gibbons are Hoolock leconedys and Hoolock hoolock respectively. This taxon is considered monotypic but it was formerly considered conspecific with Hoolock leconedys. The previous generic name, Bunopithecus, was changed by Mootnick and Groves (2005) to Hoolock (Haimoff et al. 1984). They are listed as Endangered in IUCN red list because this species has been declined by at least 50 % over the past 40 years. Hunting and habitat loss are the main drivers of population decline. Chindwin River flows as the common boundary of these two species Western Hoolock Gibbon is found in North- western Myanmar, i.e., West of Chindwin River. According to recent publications, it is also found in Rakhine State. The population of Western Hoolock Gibbon in southern most of Myanmar has been surveyed by Geissmann et al. confirming the presence and identification of Western Hoolock Gibbon in Southern Rakhine Yoma, Myanmar, albeit a very small number. Reports of several other surveys in Southern Myanmar are pending (Geissmann et al. 2008). It can also be found in other countries such as Bangladesh, and India (Assam). However, the population status of Western Hoolock Gibbon in Myanmar Northwest Forest Complex (west of Chindwin River) is not clearly understood yet.

In Northwestern Myanmar (East of the Chindwin River), H. leuconedys can be found. The boundary between the two species of Hoolock Gibbon is uncertain in the Chindwin headwaters in the north, and possibly includes a zone of intermediates or variable population (T. Geissmann pers. comm.). More fieldwork is required to investigate populations on both sides of the river and in the headwaters of the Chindwin River (Brockelman pers. comm.).

# Habitat and Ecological Factors of Gibbons

Gibbons are forest-dwelling species that inhabit tropical evergreen rainforests, tropical evergreen and semi-evergreen forests, tropical mixed deciduous forests, sub-tropical broadleaf hill forests, primary evergreen, scrub and semi-deciduous hill forest, as well as mountainous broadleaf and pine-dominated forest, and are known to utilize regenerating secondary forest and selectively logged forest (Johns 1985). They are a frugivorous species and eat ripe fruits as a majority of their diet. Individuals also eat a large proportion of figs and some amount of leaves, shoots, and petioles. This diet contributes to a relatively large home range of some populations. No intensive studies have been carried out on the behavior or ecology of H. leuconedys but it may be assumed to be similar to that of H. hoolock, with diet varying somewhat by habitat (W. Brockelman pers. comm.).

Home ranges in most populations range from 8-63 ha (20 – 156 acres), but unusually large home ranges of 200-400 ha (494 – 988 acres) were reported from Tripura and Arunachal Pradesh, Northeast India.

Gibbons, unlike most macaques and leaf monkeys, are the engineers of natural forests. They often share their habitats and swallow nearly all the seeds that they ingest, making them potentially important as seed dispersers. Certain species of fruits that require the consumer to remove a tough outer cover appear to rely almost entirely on gibbons for seed dispersal (Bartlett 1999; Ellefson 1974; Gittins and Raemaekers 1980; MacKinnon and MacKinnon 1980; Palombit 1992, 1997; Ungar 1995).

# Gibbon Conservation Project in HWS

The aim of our project is to conduct survey and monitoring of the population, and to eliminate threats to gibbon in the HWS by increasing the effectiveness of patrols and law enforcement in the area and by supporting a buffer of suitable forest habitats for community use around the protected area.

For gibbon survey and monitoring we present the past five years of activities, outcomes and indicators. In year one, to get an effective law enforcement and patrolling, to enhance systematic planning, implementation, monitoring, reporting, adaptive management, and to build capacity for all levels of PA staff, regular patrols were conducted through systematic planning, monitoring and assessment of effectiveness. The capacities of patrol staff, SMART operators, and the PA manager were strengthened based on training needs assessment. From year two, the outcome was set to stabilize the population of Hoolock gibbons in HWS and to eliminate threats to the population by means of an effective patrolling and community participation in protected area management. The population density estimation of Hoolock Gibbons is reported using the scientifically accepted auditory method.

During the project, we maintained a stable population of Hoolock gibbons in HWS. This has been achieved through decreases in threats resulting from more effective patrolling and continued community participation in protected area management. Land use and natural resource use in the buffer zone are managed through Community Based Natural Resource Management (CBNRM) approach. Some villages have developed natural resource management plans based on results of village use zoning.

# Introduction to Census on Eastern Hoolock Gibbon in HWS

In collaboration with FD, NWCD, WCS Myanmar has conducted the Western and Eastern Hoolock gibbon surveys, and Eastern Hoolock Gibbons are monitored since 2013.

The Hoolock gibbons are the second largest of the gibbon species from the family of the gibbon (Hylobatidae). Gibbons are apes. They are more loosely related to human than to macaques, baboons or langurs. Yet these small apes are far less known and researched than their larger relatives: chimpanzees, gorillas, or orangutans (Geissmann T., 2014). The historical range of Hoolock gibbon's distribution is from Northeast India to Northeast Myanmar with a small population of Hoolock gibbons also found in Bangladesh, and Southwest China. The Western and Eastern Hoolock Gibbon are naturally divided by Chindwin River. Some literature suggests there may be a hybrid zone where Eastern and Western Hoolock Gibbons can occur together along or at the head waters of the Chindwin River. However, scientific field researches are still needed for confirmation.

In Myanmar, Hoolock gibbon's population is being rapidly declined by several kinds of threats such as poaching, hunting and habitat loss. Eastern Hoolock gibbon is currently vulnerable and is doing relatively well in Myanmar, but there is no guarantee of continued protection in the next few decades (W. Brockelman pers. comm., 2009). Therefore, it is urgently needed to realize the real status of Western and Eastern Hoolock gibbons, their related habitats and threats they are facing. Because of its high-canopy forest dwelling nature, it is critically important to understand the population trend by doing surveys and follow up monitoring program annually or biannually and this will help to understand the success of conservation interventions and to keep track of the status of current forest cover to enable preparing for potential climate change impacts in the near future.

# Study Area

HWS is selected for survey and monitoring of Eastern Hoolock Gibbons. Among many protected areas established in Myanmar since 1918, HWS was established on 1st May 1974 with an area of 2,151 $km^2$. It is one of the largest protected areas conserved especially for Asian mega-fauna such as Sumatran rhino Rhinoceros sumatransis (sadly extirpated from HWS), Asian elephant Elephax maximus, Tiger Panthera tigris, Gaur Bos gaurus, bear species and forest dwelling primates like Hoolock gibbons and langur species. Geographically, the sanctuary is located between Chindwin and Uru rivers and shared administration by Homalin and Hkamti Townships in Sagaing Region. The 10 sample plots were randomly selected for Hoolock gibbon survey and monitoring for the four-year period (**Figure 2**).

In HWS, the gibbon monitoring was conducted using fixed listening posts annually from 2013 to 2017 (**Table 1**). The survey period in each sample plot varied due to logistical and scheduling constraints. However, in 2015 and 2016 gibbon monitoring period was only described in net survey days, i.e. 4 days.

| Sample plot ID | 2013 | | 2015 | | 2016 | | 2017 | |
|---|---|---|---|---|---|---|---|---|
| | Start Date | End Date | Start Date | End Date | Start Date | End Date | Start Date | End Date |
| HMT-01 | 26/02/2013 | 05/03/2013 | No Monitoring | | 03/01/2016 | 09/01/2016 | No Monitoring | |
| HMT-02 | 18/02/2013 | 25/02/2013 | 12/02/2015 | 15/02/2015 | No Monitoring | | 16/05/2017 | 19/05/2017 |
| HMT-03 | 19/03/2013 | 26/03/2013 | No Monitoring | | 01/05/2016 | 10/05/2016 | No Monitoring | |
| HMT-04 | 11/03/2013 | 18/03/2013 | 06/02/2015 | 09/02/2015 | No Monitoring | | 29/05/2017 | 01/06/2017 |
| HMT-05 | 10/02/2013 | 15/02/2013 | 16/03/2015 | 19/03/2015 | No Monitoring | | 14/11/2016 | 17/11/2017 |
| HMT-06 | 19/01/2013 | 04/02/2013 | No Monitoring | | 17/02/2016 | 24/02/2016 | No Monitoring | |
| HMT-07 | 23/01/2013 | 28/01/2013 | 23/02/2015 | 26/02/2015 | No Monitoring | | 26/11/2016 | 29/11/2017 |
| HMT-08 | 27/05/2013 | 31/05/2013 | 04/05/2015 | 07/05/2015 | No Monitoring | | 05/02/2017 | 08/02/2107 |
| HMT-09 | 4/06/2013 | 12/06/2013 | No Monitoring | | 16/05/2016 | 26/05/2016 | No Monitoring | |
| HMT-10 | 18/05/2013 | 26/05/2013 | No Monitoring | | 14/05/2016 | 23/05/2016 | No Monitoring | |

▲ **Table 1: Survey and Monitoring Period for 4 years**

# Methodologies

## Training Exercises

Before surveying, from 7th-10th January 2013, comprehensive survey training was provided to twenty dedicated trainees; ten from WCS Myanmar and ten from FD. Trainers were U Saw Htun (Deputy Country Director of WCS Myanmar), and U Saw Htoo Tha Po (Senior Technical Coordinator of WCS Myanmar) and U Maung Win (Park Warden). Training agenda emphasized on the "Auditory Method" to estimate gibbon groups and "Points Intercept Method" to assess habitat quality. After the training, survey work plan for the 2013 was developed using a participatory approach.

## Sample Plots

Ten sampling plots were generated using Arc View 3.2 by applying two conditions – 10 km as the minimum interval between sampling plots to increase habitat representativeness and 2 km away from boundary to avoid edge effects as demonstrated in Figure 2. Sampling plots are spread across the sanctuary with one in the Nam Pi Lin Management Sector, four in Nam E Zu Management Sector, three in Nam Pa Gon Management Sector and two in Nam Yan Yin Management Sector, respectively. Although these 10 sample plots are permanent sample plots for each management sector for long-term monitoring of hoolock gibbons, the topography of HWS makes movement difficult and therefore, logistics arrangement are challenging especially in the rainy season. For flexibility, the survey teams used the matrix for substitution of sample plots (Figure 3).

When the survey team has difficulty to access a particular sample plot, the team has 12 alternative sample plots for substitution. Sequentially, starting from the north, the team firstly consider No. 1 sample plot which is located 4 $km^2$ plot away from the original sample plot, then right to No. 2 and left to No. 3, then to the east (right or left), to the South (right or left), and to the West (right or left).the east (right or left), to the South (right or left), and to the West (right or left).

# Location of Sample Plots for Eastern Hoolock Gibbon Survey and Monitoring in Htamanthi Wildlife Sanctuary

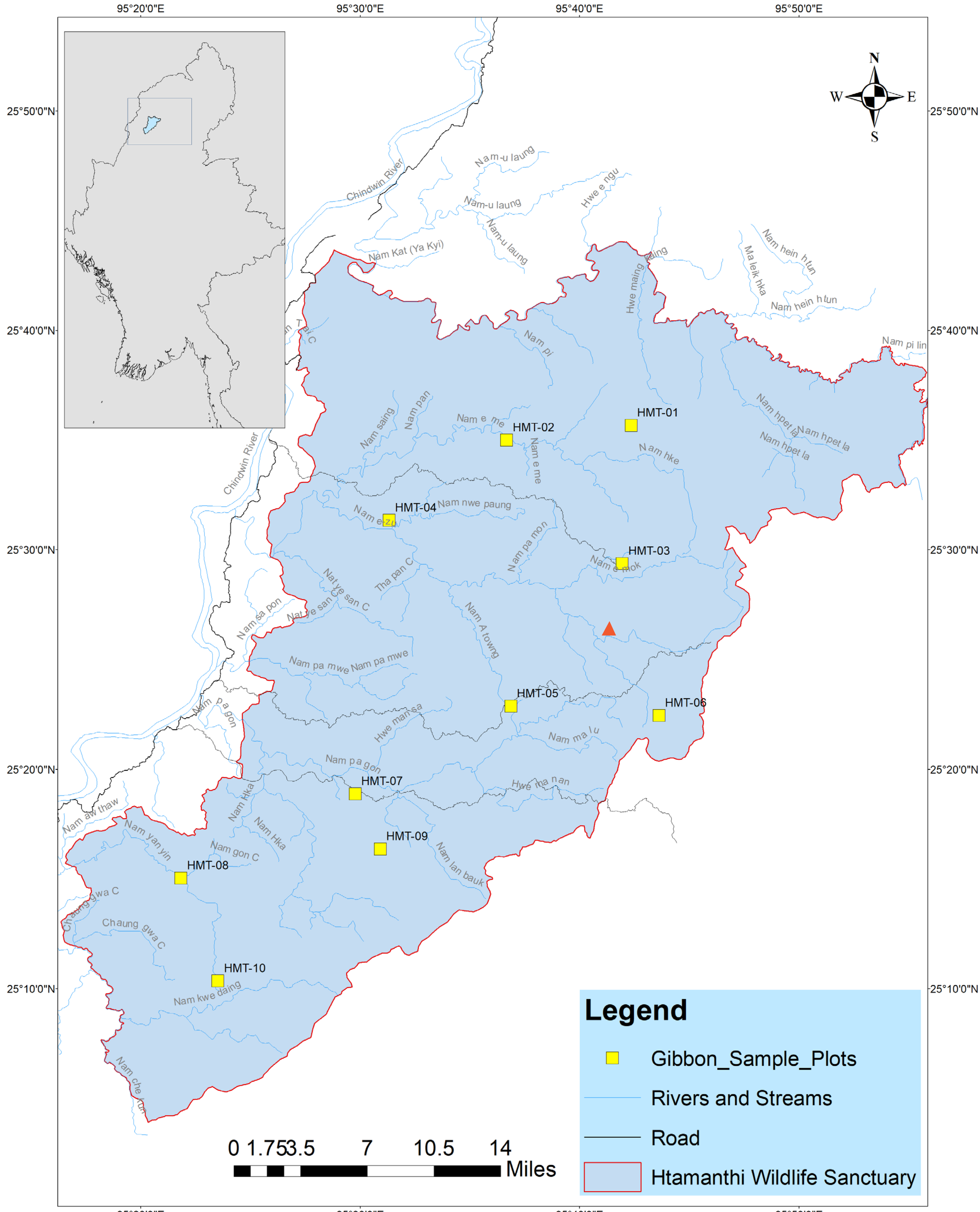



**Figure 2: Sample Plots of Hoolock Gibbon Survey and Monitoring in Htamanthi Wildlife Sanctuary**

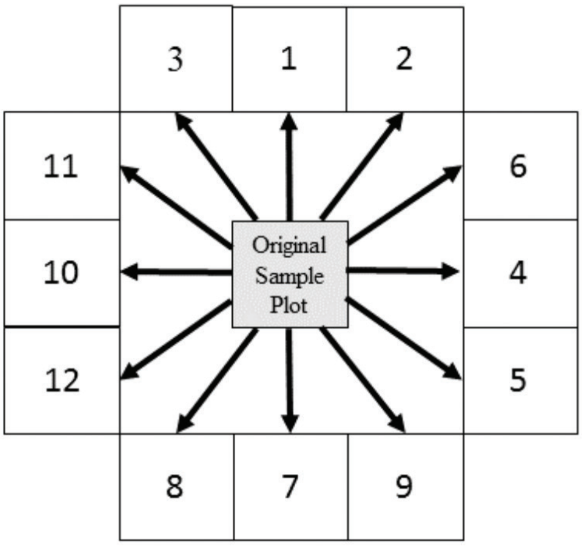


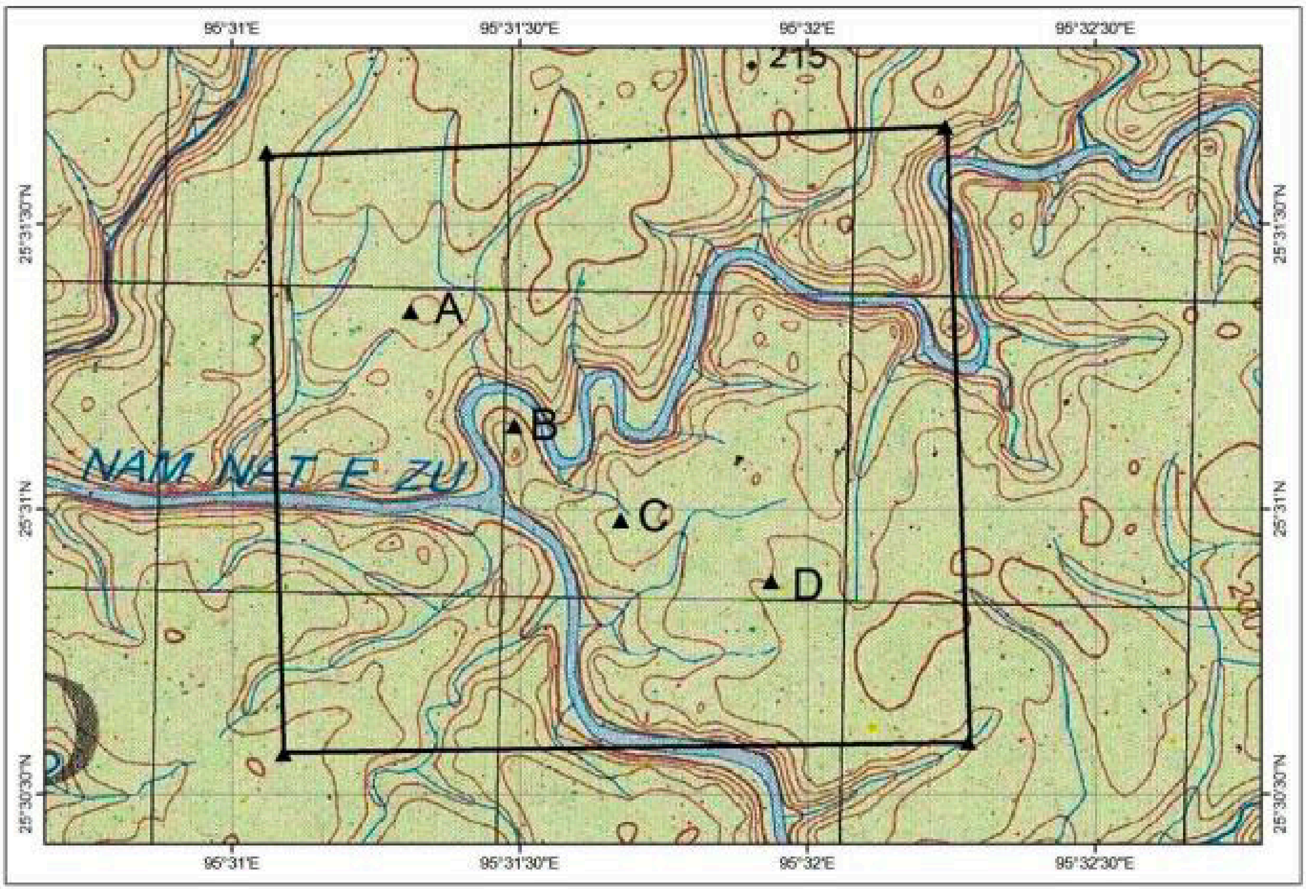

Figure 3: Original sample plot and alternative sample plots for substitution due to difficult access

# Auditory Method for Gibbon Group Estimation

Since direct observation of gibbons is difficult in natural habitat, an auditory method is seen as a suitable method to estimate group density and population (Brockelman 2008). Also, in Mahamyaing, auditory method was used to estimate gibbon density. The auditory census method requires some knowledge of the duetting behavior of the species (Brockelman and Srikosomatara 1993 cited by Warren Brockelman et al., 2009). Gibbons "mark" their territory with loud and long morning songs that usually last 10 to 20 minutes, depending on the species (Geissmann, 2014). Most songs occur in the early morning hours, but depending on species or even sex, time preference varies. Given these facts, we realized that, although duet could probably be used to determine the number of breeding groups, the number of groups could be assumed to equal number of duet bouts heard, and we might have difficulty in distinguishing the group singing around us (Warren Brockelman et al., 2009).

At each sample plot, four listening posts were established about 500 m apart, often along old logging tracks, on ridges or hill top in order to avoid sound barriers of gibbon sounds. Listening posts (LPs) are not required to be straight line. But the position of four posts should not be a triangle or rectangular

**Figure 4: Four Listening posts in one sample plot**



shape because those shape of LPs can reduce the number of gibbon calls recorded when triangulation method is used.

We conducted survey from 2013 to 2017 in these sample plots to compare the breeding gibbon group density and to understand population trend, i.e. increase, steady or decline. Once we have known the population trend, the conservation success or failure becomes visible. Then the resulted conservation status shall be applied to formulate the necessary adaptation strategy for patrolling and law enforcement intervention.

▲ **Figure 5: Recording Gibbon calls by taking bearing using compass and taking duration of duet bouts using digital watch**

To record gibbon calls, we used the necessary field equipment, comprising magnetic compasses, digital watches, GPS Units, thermometers, data sheets and pencils. Before survey activity, all digital watches were daily synchronized with the GMT provided by the GPS unit. The survey teams must get LPs exactly at 6:00 hour as gibbons start their calls mostly in the very early morning. As soon as the first calls from any group were heard, the time was quickly recorded in the data sheet. Then, directions to the call were identified and recorded. More than one surveyor checked the direction from the calls repeatedly. As gibbon calls can be conveniently heard within one-kilometer distance, the distances between LPs and gibbon groups were estimated and recorded. If gibbon calls are too far to identify in term of direction and distance, they were not counted.

▲ **Figure 6: Marking Listening Post by using GPS to record gibbon calls for four days in a post**

These data were recorded on the back of the data sheet so that gibbon calls of each LP were recorded for four to five days. Then, three variables – calling time, direction, and estimated distance of each day for four listening posts were plotted and triangulated on graph paper.

Density of breeding gibbon groups was estimated based on triangulating these results. During gibbon surveys, we also used point intercept methods to access the habitat quality for Hoolock gibbon. But during 2016 gibbon monitoring season, we did not conduct vegetation survey and the main reasons is of there is zero timber extraction in 2016 compared with the previous survey season i.e., we assume that habitat quality had not been degraded anymore.

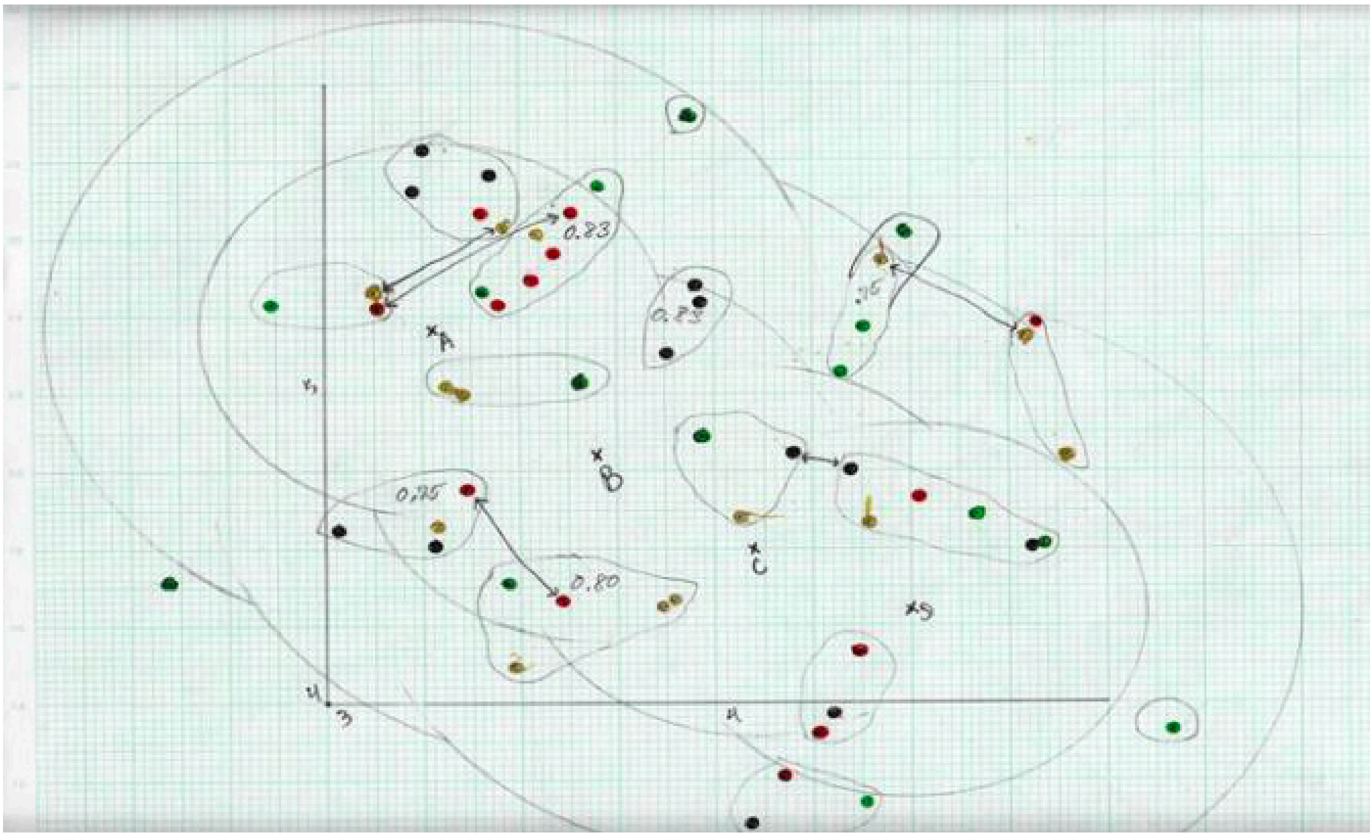


**Figure 7: Demonstrates a composite map for gibbon group estimation based on 600 m and 1,000 m radii respectively**

To assess the quality of habitat, a one-hectare plot (100 m x 100 m) representing the general habitat quality of the whole 4 $km^2$ sample plot (2 km x 2 km) was established for each plot. Then the point intercept method was applied to assess the quality of habitat. In the point intercept method, two variables of canopy cover height and diameter of trees at breast height were measured. To assess two variables for the vegetation survey mentioned above, we used field equipment such as Clinometers, Range Finders, Compass, GPS Units, diameter tapes, 50 meter tapes, water proof note books, flagging tape, pencils and data sheets.

To establish a one-hectare plot, 100-meter base line was established following the direction of the main terrain and ridges. On the base line, stakes with flagging tape were set at 10 meter intervals. Then, 50-meter side lines were established from each stake along the base line to the right and left.

Stakes marking with flagging tape were also set at 10-meter intervals on all side lines. Then, canopy cover height was measured at every point marked with a stake at 10 meter intervals. To measure the height of canopy, cover directly overhead at each point, a surveyor had to measure the zenith point (90 degrees) overhead by using a clinometer. The highest canopy cover point by a direct overhead was identified.

Figure 8: Measuring Canopy High and Diameter at Brest Height

The nearest height was measured in meter by using a rangefinder. To achieve the actual height of canopy cover, it was necessary to add the surveyor's height into the canopy cover height measuring. Measurements of canopy cover heights were tallied in a designated data sheet carefully. Diameters at breast height-DBH (10 centimeter and above) of all trees were measured in the plot. Two 50-meter tapes were placed along the first two sidelines to avoid missing trees to measure DBH. All DBH measurements for all trees in the plot must be found in this way. Measurement of tree DBH is recorded in the relevant data sheet. Tree species were also identified and recorded with the help of local people who were skillful in tree identification. Then the quality of habitat for each sample plot was assessed using canopy height, DBH and species composition.

We did habitat assessment only in 2013 and did not continue in the next years because timber extraction in HWS has been completely ceased with restricted public access to the sanctuary by Government of Myanmar. Therefore, we made assumption that the habitat quality won't be degraded with its opportunities to improve.

By regularly recording audio signals, groups of gibbons can be tracked to determine whether gibbon population is stable or increasing and gibbon population can be correlated with regular effective patrolling and law enforcement. During survey, track and signs of Asia mega fauna such as Asian Elephant, Tiger, Gaur and bear species, and other associated primate species were also recorded, together with direct and indirect threats in the same sample plots.

# Gibbon Group Estimation

After complete data have been collected by survey teams, the initial phase of data analysis was started in which the data were placed on the graph using graph paper, color pen and drawing tools. Four LPs of each plot was drawn on the graph as four scale-points (on ground, these LPs were 400 to 500 m apart) by using GPS point of each LP.

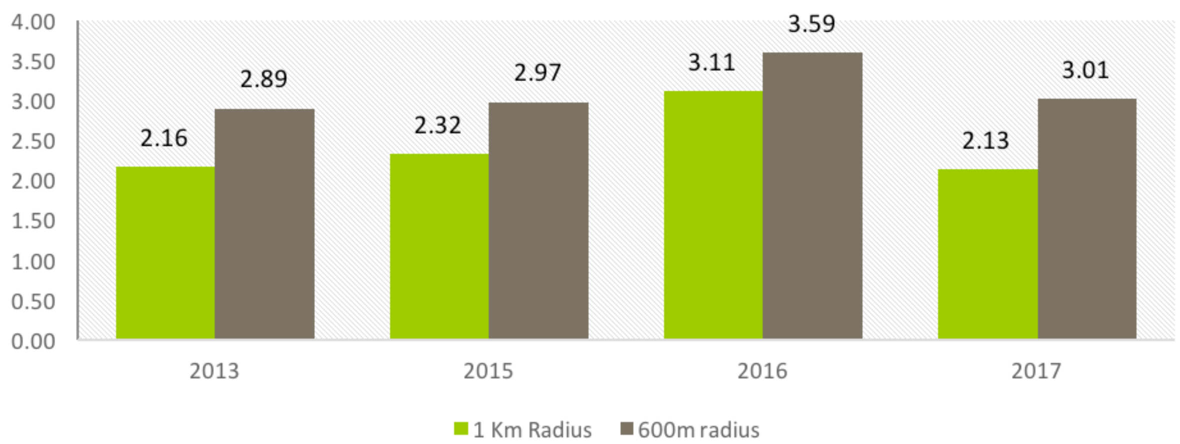



**Figure 9: Group Density of Eastern Hoolock Gibbon in Htamanthi Wildlife Sanctuary for four years.**

Drawing four scaled-points (on ground, listening posts, that are 400 – 500 m apart) on the graph representing the GPS point of each listening post. After that, we plotted three variables - time (of which the first gibbon bout recorded using synchronized watches), direction (as indicated by compass bearing) and estimated distance (recorded as by the surveyor's guess over the distance between LP and gibbon sound, if the surveyor has a direct sighting to the nearest gibbon's call, range finder was used to measure the distance. For each day, the surveyor went to LPs and carried out data collection of assigned plots for four days. The gibbon calls on a single day were merged to a map and the resulted maps for four days were then combined so that five maps per census area were obtained. Groups heard from more than one listening post were plotted on each map by triangulation (Figure 8). All four days data were compiled in the composite map and the group estimation was outlined in 600 m and 1000 m radii.

Each four-day drawing data were compiled and ready for the composite map for the gibbon group estimation. In the composite map, all the four-day data were combined and the group estimation was outlined on 600 m and 1000 m radii.

# Results

According to 2013 gibbon survey, population density of Eastern Hoolock Gibbon in the study area was 2.16 gibbon groups per km$^2$ using 1,000 m radius and 2.89 groups per km$^2$ using 600 m radius, presented in **Table 2**. The average size of gibbon groups in HWS was found to be 3.8 ± 0.3 individuals per group. In 2015, the population density

| | 2013 | | 2015 | | 1016 | | 2017 | |
|---|---|---|---|---|---|---|---|---|
| Gibbon Plot ID | 1000 m radius | 600 m radius | 1000 m radius | 600 m radius | 1000 m radius | 600 m radius | 1000 m radius | 600 m radius |
| HMT01 | 2.43 | 3.55 | No Monitoring | | 2.92 | 2.85 | No Monitoring | |
| HMT02 | 2.36 | 2.52 | 1.52 | 2.11 | No Monitoring | | 1.58 | 1.59 |
| HMT03 | 2.01 | 1.77 | No Monitoring | | 3.86 | 4.31 | No Monitoring | |
| HMT04 | 2.52 | 3.58 | 2.39 | 2.82 | No Monitoring | | 2.52 | 3.47 |
| HMT05 | 2.62 | 3.63 | 2.33 | 2.97 | No Monitoring | | 1.36 | 1.40 |
| HMT06 | 1.92 | 2.67 | No Monitoring | | 3.98 | 4.53 | No Monitoring | |
| HMT07 | 1.92 | 2.64 | 3.24 | 4.25 | No Monitoring | | 2.84 | 4.16 |
| HMT08 | 1.52 | 2.44 | 2.11 | 2.72 | No Monitoring | | 2.35 | 4.43 |
| HMT09 | 1.86 | 2.37 | No Monitoring | | 1.78 | 2.10 | No Monitoring | |
| HMT10 | 2.68 | 4.27 | No Monitoring | | 3.01 | 4.13 | No Monitoring | |
| *Average* | 2.16 ± 0.12 | 2.89 ± 0.23 | 2.32 ± 0.28 | 2.97 ± 0.35 | 3.11 ± 0.40 | 3.59 ± 0.47 | 2.13 ± 0.64 | 3.01 ± 0.28 |

**Table 2: Group Density of Eastern Hoolock Gibbon in HWS**

was 2.32 groups per km$^2$ with 1000 m radius and 2.97 groups per km$^2$ with 600 m radius. In 2016, the gibbon group density has increased dramatically. The population density was 3.11 groups per km$^2$ in 1,000 m radius and 3.59 group per km$^2$ in 600m radius. Therefore, it is concluded that this population is steadily increasing that indicates the effective conservation intervention in HWS.

## Density of Gibbon Groups

Gibbon group densities were based on 1000 m radius and 600 m radius. The smaller 600 m listening radius yields a mean density of 24% higher than 1000 m listening radius. This was because some of the groups beyond 600 m from the LPs were not heard well enough to record while different groups closer to LPs could be distinguished more easily than groups farther away. Nearby groups can be more easily located through triangulation than distant groups. Group calls behind hills sound more distant and such groups from 0.6 – 1 km away may have been considered to be farther than 1 km away. For these reasons, the densities derived from the 0.6 km listening radius data are regarded as more reliable than those derived from the 1.0 km radius data.

## Gibbon Group Density Comparison for 4 years

As shown in Figure 10, Eastern Hoolock Gibbon population trend in HWS is gradually increasing in calculations within 1 km radius as well as within 600 m radius. We did data collection in all sample plots during 2013 (all plots) and but in later years, data were collected in five plots alternatively per year. It was because 2013 was for our first initial assessment and the next three years were conducted for monitoring. This data collection pattern shift was correlated with the facts of '2013 being the first initial assessment', 'the next three years being for monitoring' and 'the assumption that the population trend in an area would be relatively significant at least one year after'. In 2013, gibbon breeding group density was 2.16 with the standard error of 0.12 in 1 km radius and in 600 m radius; there was group density of 2.89 groups/ $km^2$ with the SE of 0.23. In 2015, 2016, and 2017, group densities of 1 km radius were 2.32 ± 0.28, 3.11 ± 0.40 and 2.13 ± 0.64 respectively. Figure 10 is showing gibbon group density comparison for four years.

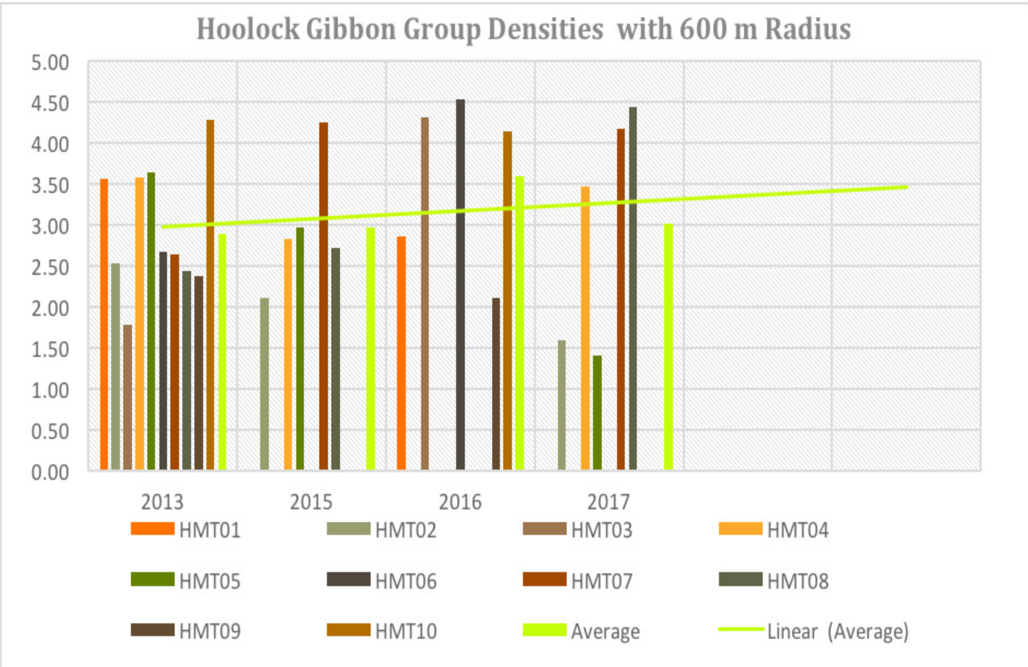



**Figure 10: Gibbon Group Density Trend with 600m radius**

In above Figures the gibbon group density of 2015 and 2017 are nearly the same but 2016 was higher than all others. This is because the 2015 survey plots and 2017 survey plots are the same: HMT02, HMT04, HMT05, HMT07 and HMT08. Anyhow, general concept is that the population trend of Hoolock Gibbon in HWS is progressively increasing.

## Mean Group Size

It is important to have knowledge of mean social group size to estimate gibbon population sizes from (range 2-4) but most were seen while fleeing, which can sometimes lead to some individuals being missed (Warren Y. Brockelman et al., 2009). The average Eastern Hoolock Gibbon group size is three individuals.

# Habitat Quality for Hoolock Gibbon in HWS

Generally, gibbon habitats in HWS had been disturbed by logging since 2005. The concession was given by the government to extract timber within an inundation area of a proposed hydro power project. However, logging was ceased in July 2013 when the government decided that the proposed dam project was not technically feasible. This eight year of logging inside the sanctuary had put a pressure on the quality of habitat to some extent. Although the logging was extensive but selective so that degradation is not so severe.

Tall Dipterocarp species were especially logged and fortunately, the canopy height of the remaining stand above 15 m is still good enough to support gibbons. Our surveyor observed that seven gibbon groups counted during the censuses had a mean size of 3.0 individuals. However, the effective conservation intervention by the coordination of WCS Myanmar and Forest Department has brought a stable state of habitat recovery within HWS.

# Threat Analysis for Hoolocks Gibbons

Different threats observed by the survey team in each sample plot are tabulated in 3, particularly, extensive logging across the wildlife sanctuary. Survey teams experienced the sound of chainsaws and logging trucks.

No timber extraction was encountered in the sanctuary since after 2013. On the other hand, sign of few poaching, such as knife marks and gun fire sound, encroachment like occurring and three families collecting Non-timber Forest Products were recorded in 2015. Significantly, threats encountered are decreasing in terms of types and level.

**Table 3: Threats occurred during Hoolock gibbon surveys in Htamanthi Wildlife Sanctuary**

| Sample Plot ID | Threats observed |
|---|---|
| HMT-01 | Two active gold mine areas, one guar was trapped and killed in an old gold mining trench |
| HMT-02 | Three mechanized gold mines and one manual gold panning |
| HMT-03 | Noise of chainsaw and logging trucks from nearby logging; presence of workers and staff of logging companies; |
| HMT -04 | Elephant poaching gang; old evidence of gold mining; feathers of white-winged duck |
| HMT-05 | Logging roads and logging trucks |
| HMT-06 | One manual gold panning site; one hunter with a muzzle loader; noise from logging; pile of 125 old logs |
| HMT-07 | Illegal NTFP collection, two gibbon poachers, Logging roads |
| HMT-08 | Illegal NTFP collection, one hunting hut (12-volt battery, accessories for making muzzle loader; one Shortridge's langur carcass |
| HMT-09 | Electric fishing; Illegal NTFP collection |
| HMT-10 | Old turtle collector's hut |

Threats are defined as follows - A threat is any activity or process (both natural and anthropogenic) that has caused, is causing, or may cause harm, death or behavioral changes to a species at risk, or the destruction, degradation, and/or impairment of its habitat, to the extent that population level effect occurs. The next chapter shows threats comparison from 2013 to 2017.

According to threats comparison, over the four years, threats have significantly decreased in number of occurrence and kind. This shows that law enforcement and patrolling activities have a significant impact to the sanctuary. But human encroachment could not be completely eradicated. They still occur throughout 2017. This might be related with livelihood insecurity and socio-economic constraint of local community. No strong social economic improvements have taken into action for local community residing around the sanctuary and the community still depends on natural resources.

# Discussion

Htamanthi Wildlife Sanctuary is covered by tropical and sub-tropical evergreen forest with some hilly ranges along the eastern portion of the sanctuary. The Eastern Hoolock Gibbon is widely dispersed through HWS. According to our 2013 gibbon survey, the wild population of this vulnerable species and their habitat were seriously affected from gold mining, legal and illegal logging, heavy poaching, habitat loss and fragmentation leading to dramatic population decline.

Comparison between gibbon group density from 2013, 2015, 2016 and 2017 surveys reveal that the number of gibbon groups are steadily growing in the sanctuary. This increase in gibbon population is an indicator of conservation success, increase of patrol coverage and resulted in reduced direct threats like direct hunting and habitat loss.

We recognize this increase in gibbon population as an indicator of conservation success as well as the success of our cooperation between FD and WCS Myanmar which is essential to an effective biological monitoring and patrolling activities for Eastern Hoolock Gibbons in HWS. This cooperation in is necessary in maintaining our current conservation success in Eastern Hoolock Gibbon conservation. It is still needed to raise the community awareness and to strengthen their participation through environmental education and respecting customary rights of indigenous people. Natural forest (bordered to HWS) management should be encouraged to empower communities in conservation and management activities. More research and conservation actions are still demanded for saving Eastern Hoolock Gibbon along the eastern bank of Chindwin River. We recommend to increase patrol frequency and coverage, and to strengthen law enforcement activities for monitoring and conservation of gibbons. Together with this Eastern Hoolock Gibbon study, Western Hoolock Gibbon study was also conducted by our team in 2013 as in appendix.

# CHAPTER – 2

## LAW ENFORCEMENT AND SMART PATROLLING



**Confiscated hunting weapons during SMART patrol in HWS(2013-17)**

# Introduction

Over a decade, law enforcement activities have been performed in HWS. Following support of Arcus Foundation, patrols tasks were carried out in systematic planning and monitoring. At the beginning of project, existing threats were assessed, existing law enforcement system was reviewed, a systematic law enforcement monitoring training was provided to patrol staff and Spatial Monitoring and Reporting Tool (SMART) application training for potential SMART operators was provided. With a range of these new skills, patrol tasks are now being planned in a participatory approach.

# Objectives

- To implement law enforcement monitoring using SMART best practices for a better monitoring, evaluation and an adaptive management of patrolling

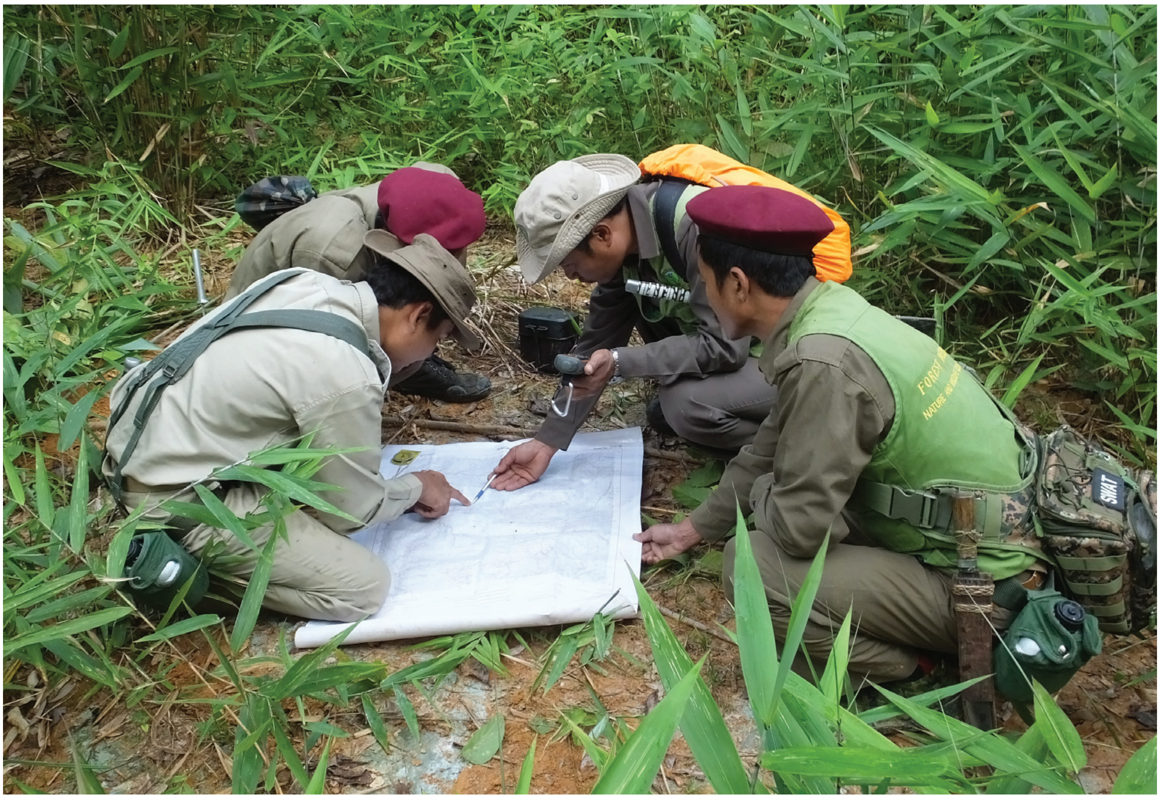
# Capacity Building of Staff for Law Enforcement Monitoring

In establishing a sustainable and an effective law enforcement monitoring (LEM) system, it is important to build the capacity of all relevant law enforcement staff. Since 2013, staffs of NWCD, FD and WCS have been trained in several basic and advanced training of SMART by WCS Myanmar. In addition, a systematic basic LEM training to patrol staff and SMART application training to potential SMART operators of HWS was provided from 2-6 January 2013. During 2014-15 grant periods, from 17 to 21 January 2015, we organized a five-day revisit training for SMART application together with basic law enforcement and monitoring training. Participants included forest staff, community guards and WCS staff at Htamanthi Forward Station. Capacity building trainings provided by WCS are summarized below.

Basic Law Enforcement Monitoring Training: this five-day long training was for law enforcement rangers scheduled from 2-6 January 2013 in HWS. Seventeen trainees from FD and four trainees from WCS were joined the training instructed by Saw Htun (Country Director) and Saw Htoo Tha Po (Senior Technical Coordinator) and Maung Win (Former Park Warden of HWS). The training covered in 1) identification of existing threats, 2) reviewing existing patrol and law enforcement system, 3) identification of data to be collected by patrol teams, 4) ranger-based data collection system, 5) application of a LEM database for planning, monitoring, and reporting of LEM activities, 6) field practical for patrolling and reviewing the results, 7) adaptive patrol planning and management concepts, 8) assessing the existing operational resources such as field equipment and 9) developing an actual patrol plan.

SMART Training on database application in planning, monitoring and reporting for LEM activities was for those who have a great potential to be SMART managers/ operators. Five trainees from FD were trained in March 2013. The training focused on how a protected area could be managed more effectively by applying SMART for planning, monitoring, and reporting of LEM activities.

**Defining Management Sectors:** Although there were five guard posts, management sectors had not been explicitly defined. Therefore, in parallel with patrol planning, the boundary of each management sector was defined with the participation of patrol rangers. Four management sectors namely Nan Phi Lin, Nam Ei Zu, Nam Pa Gon and Nam Yan Yin, were defined as shown in Figure 14. The explicitly defined boundary for each management sector enhances accountability and lays clear responsibilities between patrol teams. These management sectors are now in use by both NWCD and WCS including these in SMART Conservation tools for improved law enforcement and patrolling.



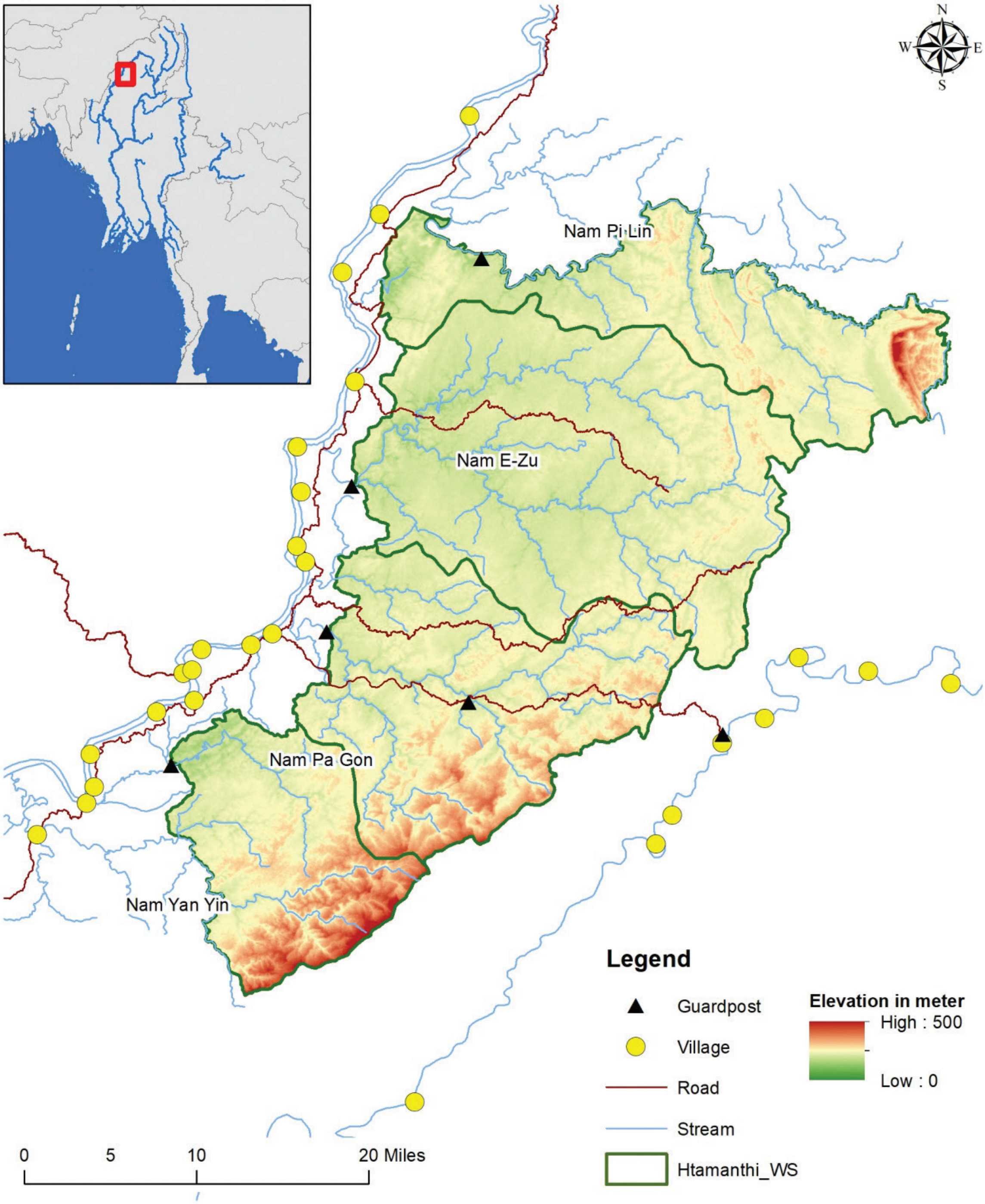



**Figure 11: The Management Sectors of Htamanthi Wildlife Sanctuary.**

# Why SMART Patrol?

A loose protection will not sustain the vulnerable natural resources of protected areas. Therefore, patrolling is brought into play. Patrolling has been globally accepted and proved as an essential protection of valuable resources within protected areas, especially for rare and endangered species such as tigers, pangolins and bear species. Unfortunately, many of these species have been heavily extracted from Myanmar's natural forests. Therefore, FD and WCS are improving the patrol system in which the Spatial Monitoring and Reporting Tool (SMART) is used as a conservation equipment for park rangers and frontline staff so that information technology is applied for a better protection of PAs in Myanmar.

# Implementation of Law Enforcement Activities

Patrol summary data for four years (2013-16) are shown in the following table.

| No. of Patrols | No. of Days | Distance (km) | No. of Patrols | No. of Days | Distance (km) | No. of Patrols | No. of Days | Distance (km) |
|---|---|---|---|---|---|---|---|---|
| Nam E Zu | 12 | 87 | 1362.24 | 2 | 16 | 313.818 | 9 | 31786.414 |
| Nam Pagon | 5 | 42 | 638.84 | 2 | 54 | 265.496 | 13 | 1727.206 |
| Nam E Zu | 30 | 119 | 2032.06 | 12 | 230 | 2717.042 | 13 | 2953.229 |
| Nam E Zu | 2 | 17 | 279.96 | 1 | 20 | 334.502 | 7 | 717.816 |

▲
**Table 4: Summary for (2013-16) SMART patrol**

# Patrol Coverage

This report compares patrol coverage in three years the following maps, extracted using SMART software, and shows an increase in patrol coverage.

The patrol coverage is normally focused along the creek stream and river, with its easy access by boat or walking routes along waterways. Patrol team rarely moved away from the accessible waterways but the exception was in the eastern part of Nam Ei Zu patrol area. This area was the study site in support of Wildlife Conservation Research Unit-WildCRU, Oxford University, to undertake research into clouded leopard by camera trap. WCS Myanmar arranged law enforcement and monitoring team to follow with biological monitoring team as a joint patrol for the purpose of increasing patrol coverage and enhancing camera trapping knowledge for patrol teams.

## Spatial Distribution of Key Threats

The patrol teams encountered a number of threats such as hunting, Non-Timber Forest Product (NTFP) collection, logging, fishing, gold mining, grazing, intrusion and trespassing. Although these threat occurrences were spread out across the whole sanctuary, generally, it was most regularly encountered along the boundary. The northern boundary, along Nam Pi Lin creek, was at stake by most of these threats.

During 2015 and 2016, the numbers of threats encountered were much more than 2013 and 2014. This increase in visibility of threats was due to extensive patrol coverage in 2015. This indicated that threats already existed and patrol teams could not reach to these areas before. Another fact to be considered is that patrol teams did not encounter poachers in these areas as poachers avoided the patrol team. However, threats were distributed across the areas covered by patrols along the creeks and streams.

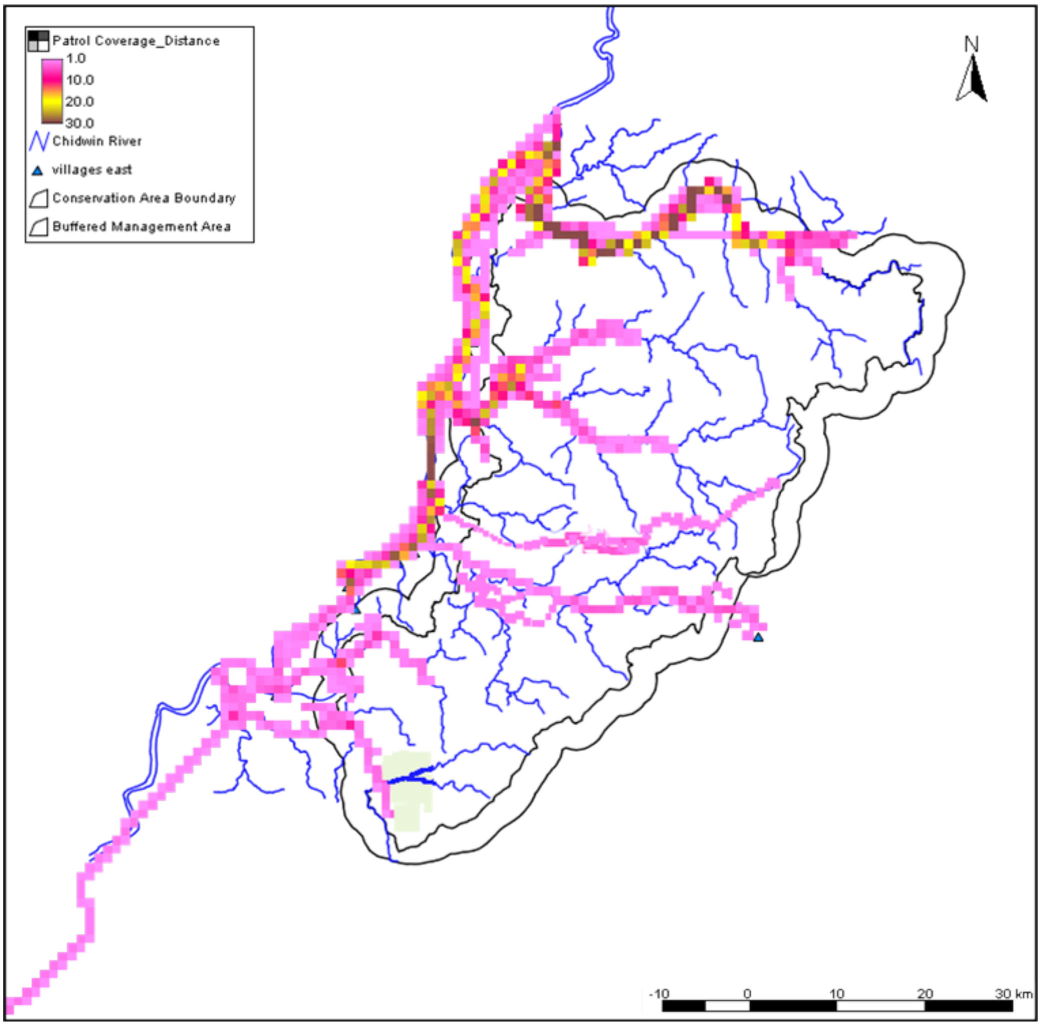



**Figure 12: Patrol Coverage for 2013**

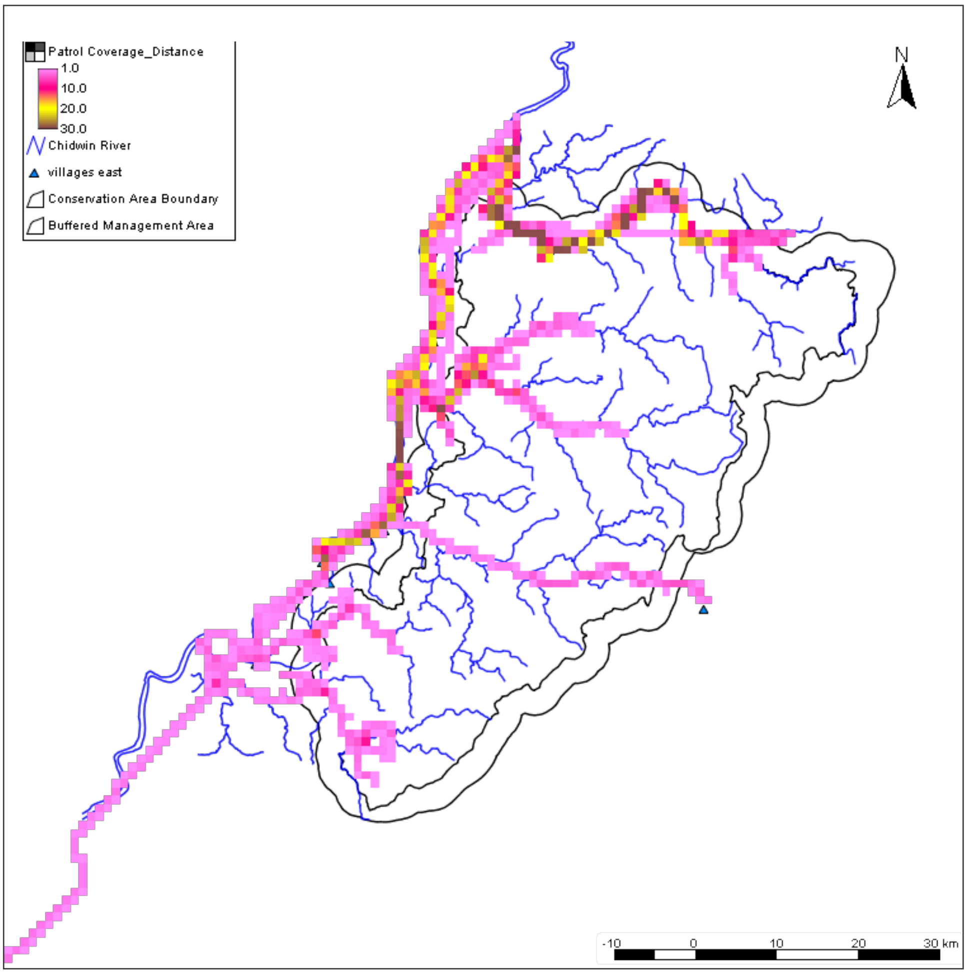



Figure 13: Patrol Coverage for 2014

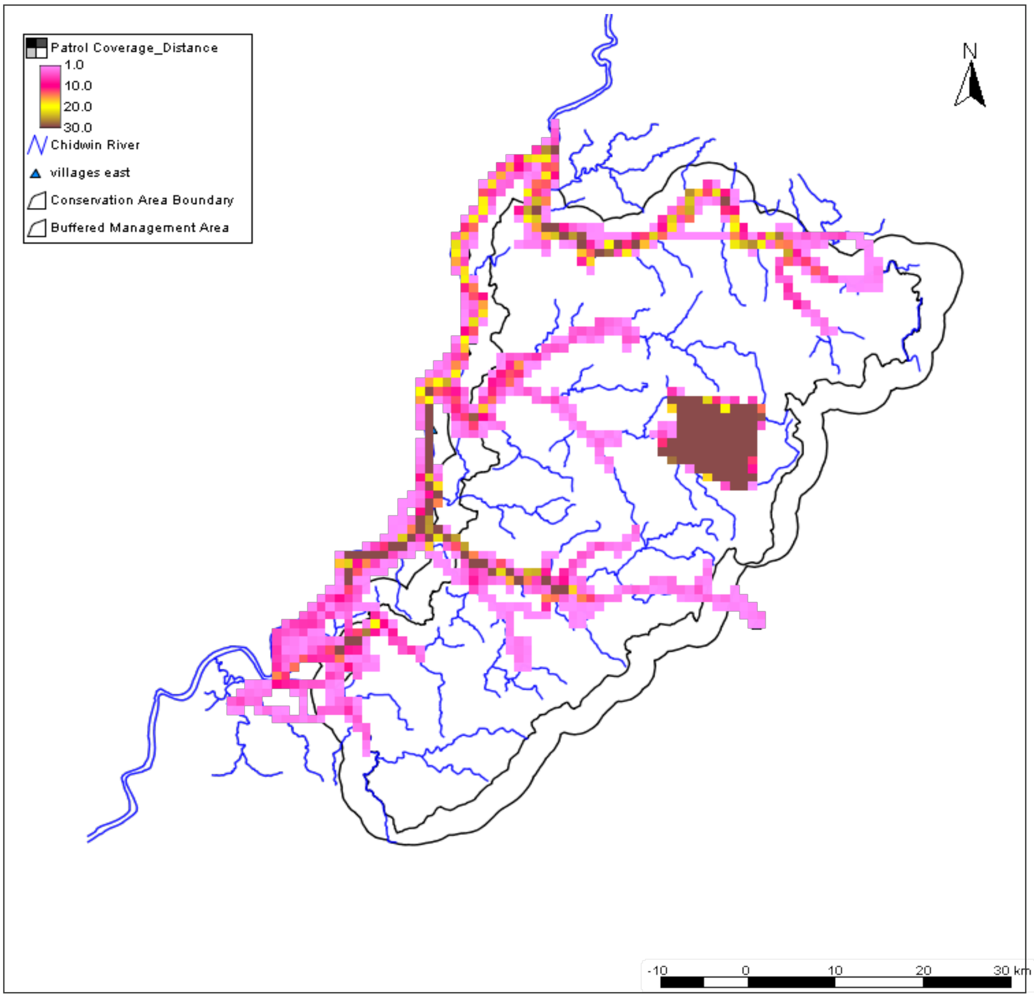



Figure 14: Patrol Coverage for 2015

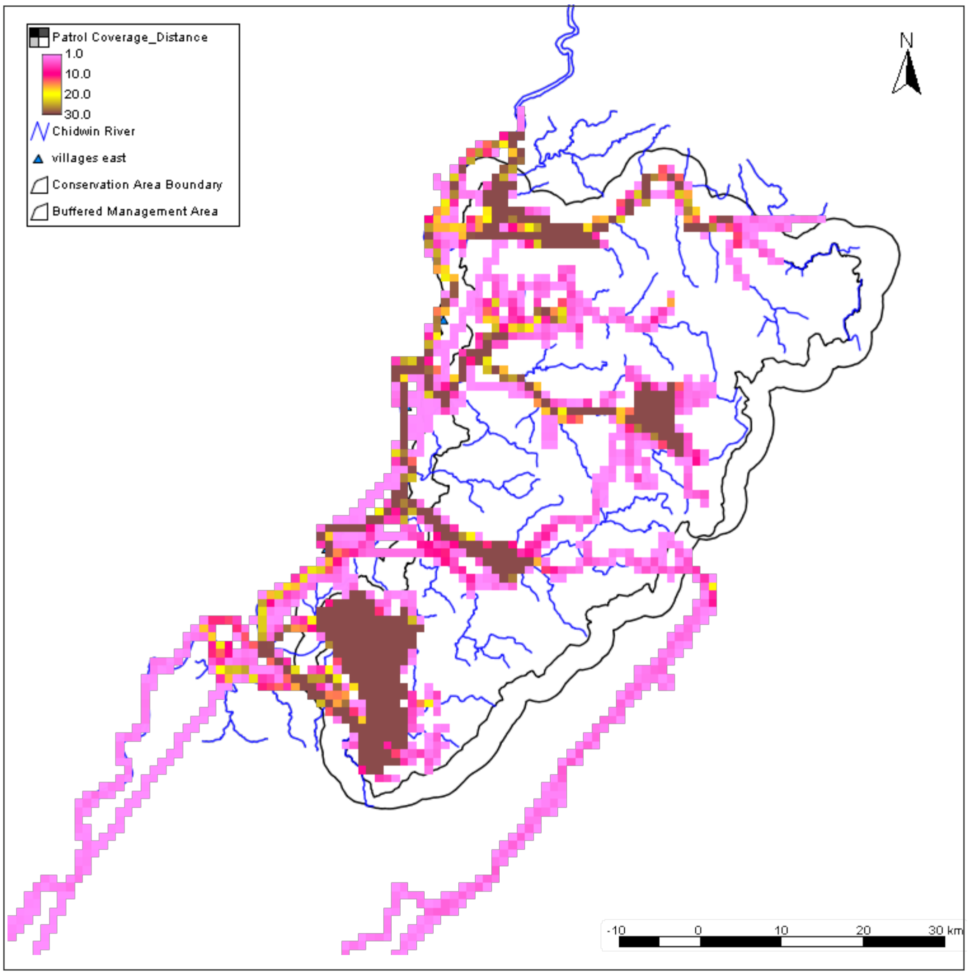



**Figure 15: Patrol Coverage for 2016**

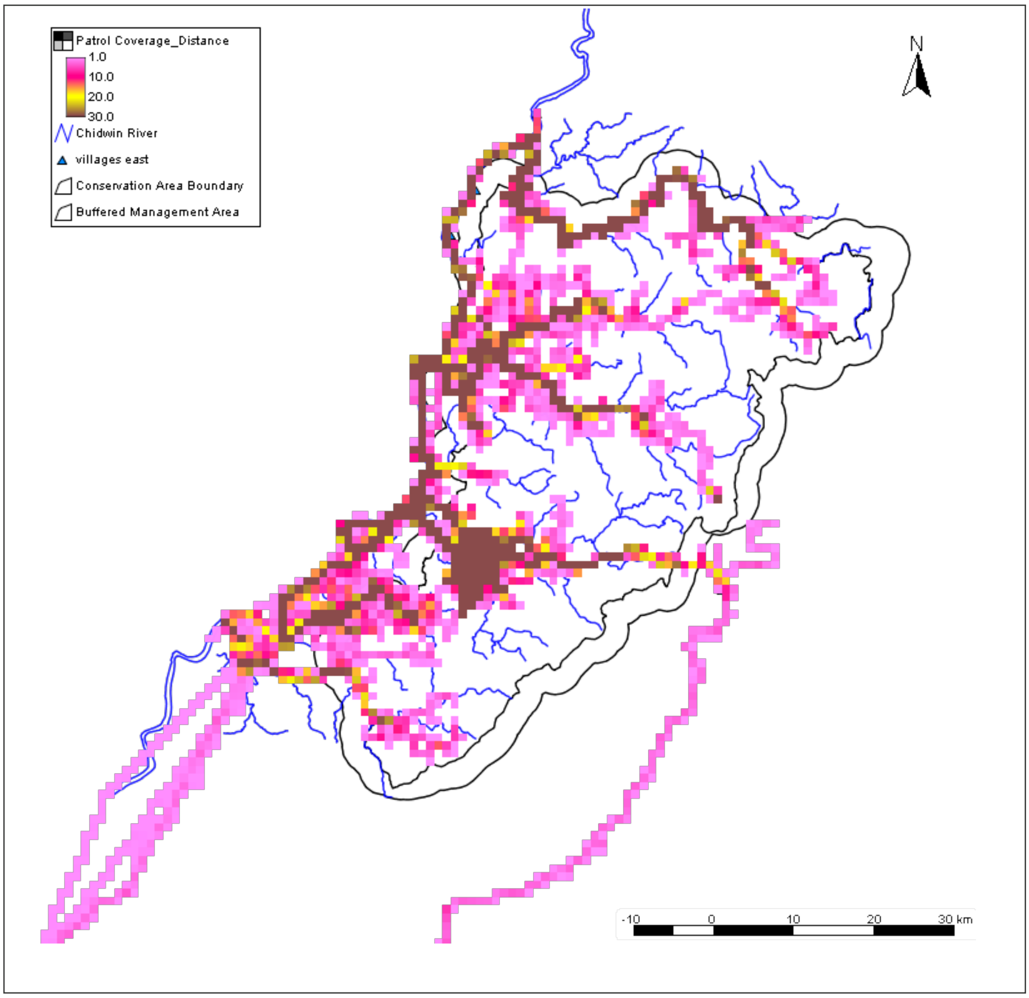



**Figure 16: Patrol Coverage for 2017**

## Relative Abundance of Key Threats

The following graph shows relative abundance of key threats in HWS. In the graph, the level of gold mining is higher than other threats but its numbers decrease during subsequent years. Unfortunately, number of logging is increased in 2015. Nam Phi Lin sector along the northern boundary of the sanctuary was an area under high risk of threats particularly with a higher degree of gold mining. The reason was due to both small and commercial scale gold mining outside of the sanctuary is easily accessed along Nam Phi Lin stream.

Poaching related threats was high in Nam Ei Zu sector. According to the reports of WildCRU and other camera trap surveys, Nam Ei Zu has a great record of wildlife species such as sun bear, tiger, elephant, pangolins and other rare species. Therefore, the wide spread nature of various threats demands for law enforcement patrolling across all management sectors.

In reducing those threats, the patrol teams took a broad spectrum of actions like confiscating weapons, destroying weapons, confiscating transportation materials, destroying temporary hunters' camps, educating, and verbal warning, written warning and arresting people. For a consistent comparison in year, only action taken against violators were analyzed. Confiscated weapons and tools for poaching were muzzle loader, steel cable snare, Nylon rope snare, knife, axe, iron rod and hoe. Those for logging were chainsaws and those for transportation included engines over 22 HP, engines under 22 HP, gasoline, diesel and engine oil. Various types of batteries were used for electrofishing. Wooden pan and neck pipe were related for gold mining. Most poachers used boats with engine over 13 HP.

## Relative Abundance of Key Threats

The following graph shows relative abundance of key threats in HWS. In the graph, the level of gold mining is higher than other threats but its numbers decrease during subsequent years. Unfortunately, number of logging is increased in 2015. Nam Phi Lin sector along the northern boundary of the sanctuary was an area under high risk of threats particularly with a higher degree of gold mining. The reason was due to both small and commercial scale gold mining outside of the sanctuary is easily accessed along Nam Phi Lin stream.

Poaching related threats was high in Nam Ei Zu sector. According to the reports of WildCRU and other camera trap surveys, Nam Ei Zu has a great record of wildlife species such as sun bear, tiger, elephant, pangolins and other rare species. Therefore, the wide spread nature of various threats demands for law enforcement patrolling across all management sectors.

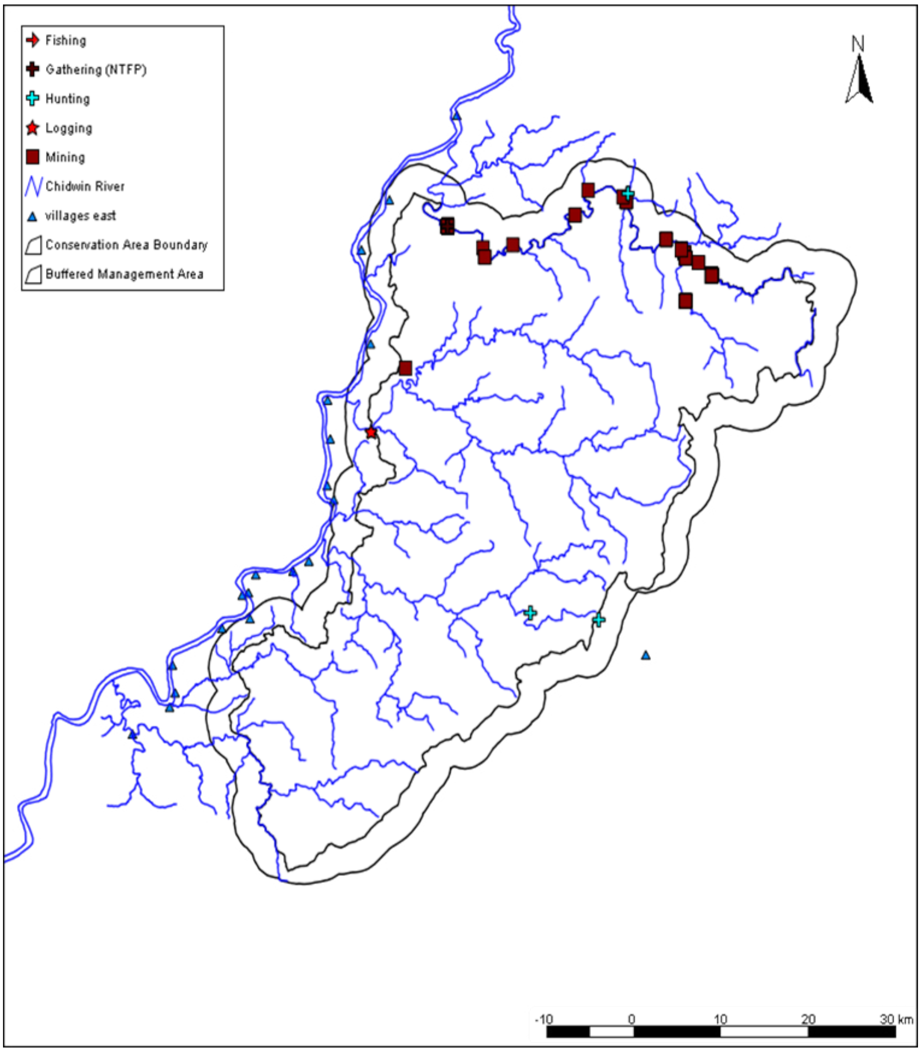



**Figure 17: Spatial Distribution of key threat in 2013**

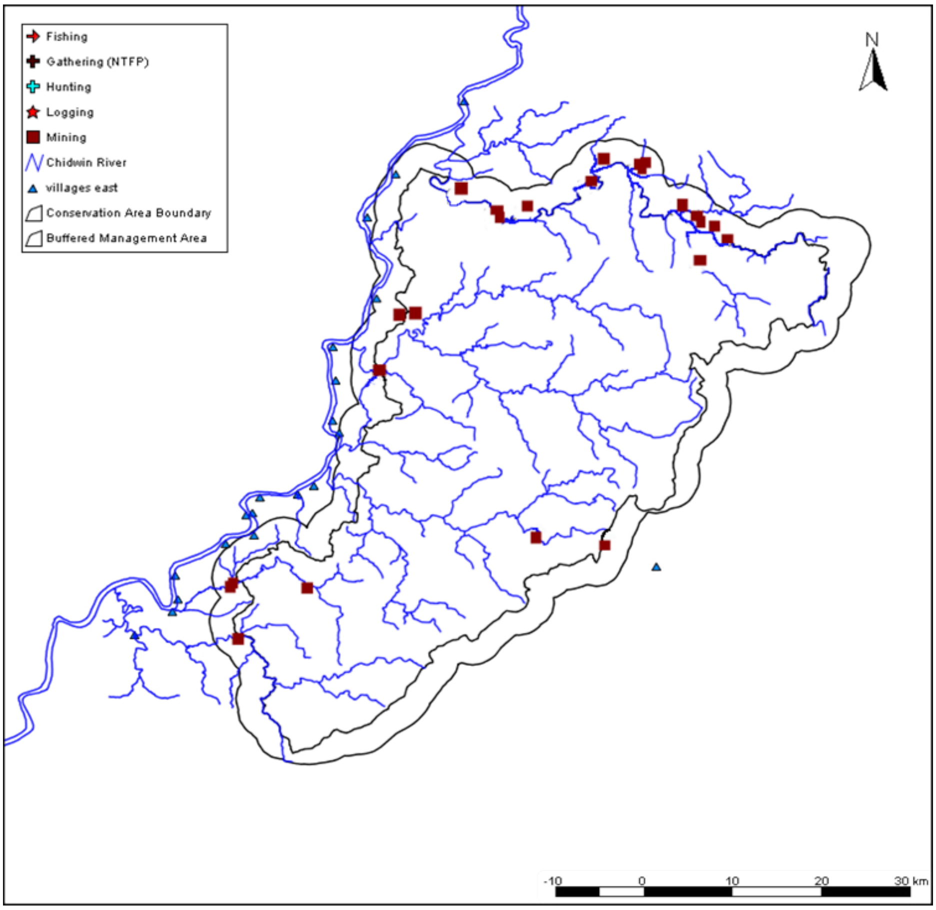
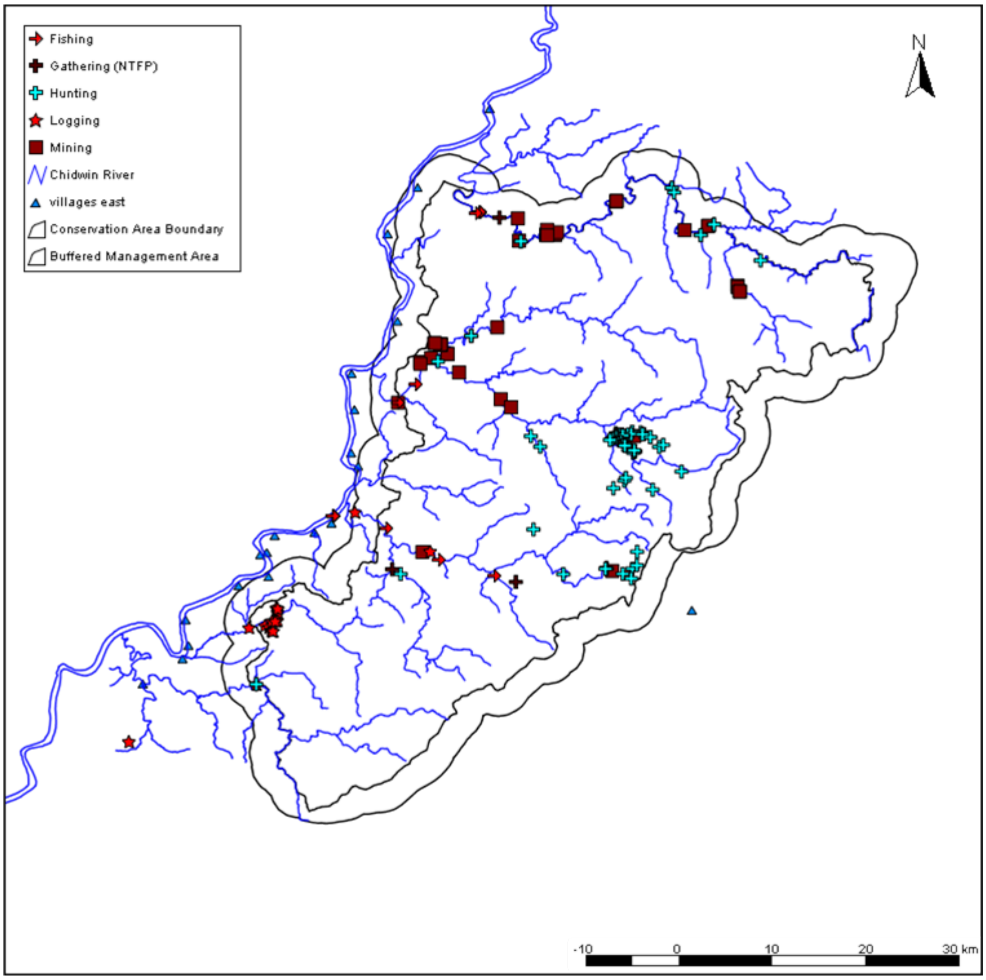
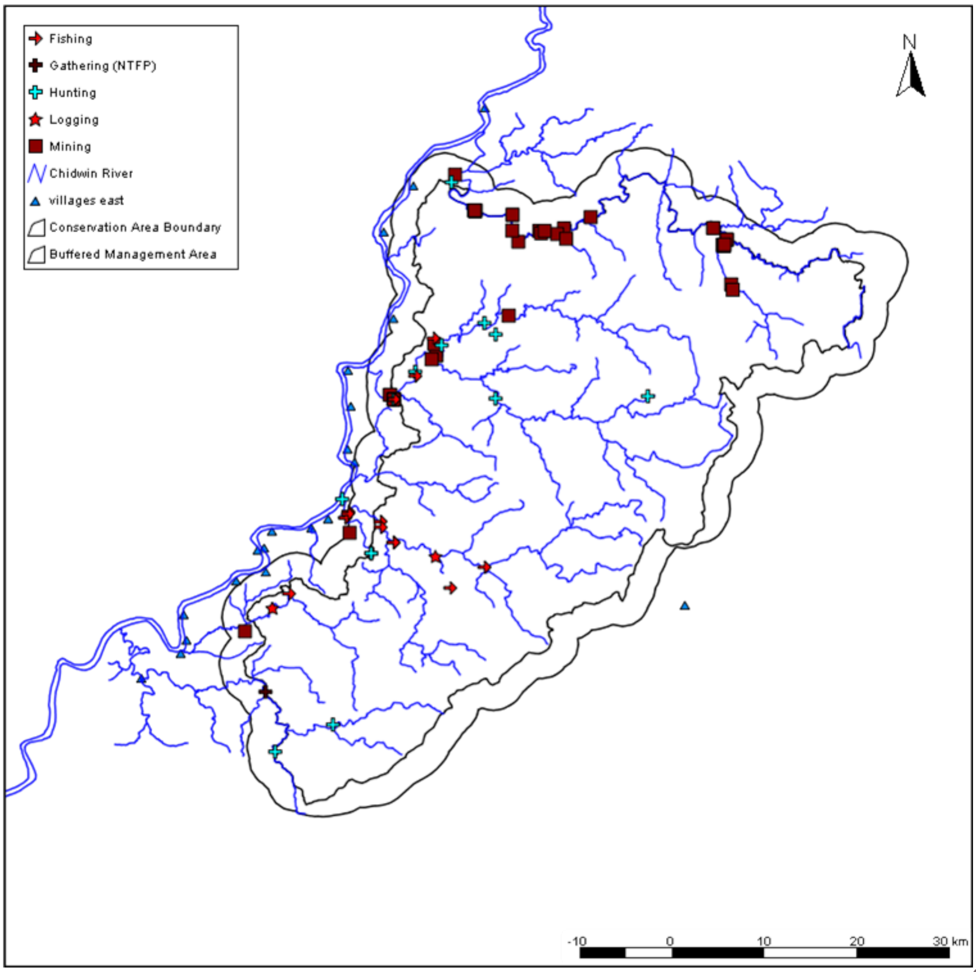



**Figure 18: Spatial Distribution of key threats in 2014**




▶ **Figure 19: Spatial Distribution of key threats in 2015**




▶ **Figure 20: Spatial Distribution of key threats in 2016**

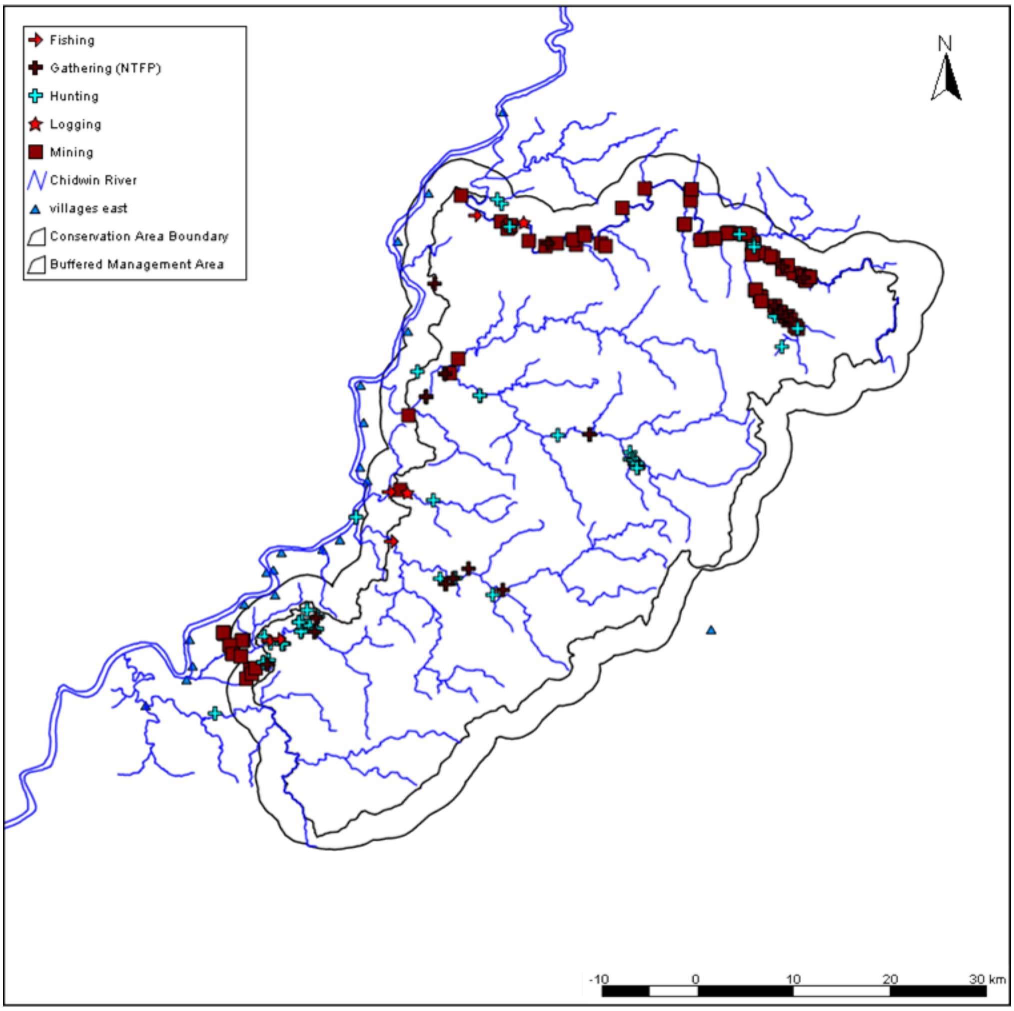



**Figure 21: Spatial Distribution of key threats in 2017**

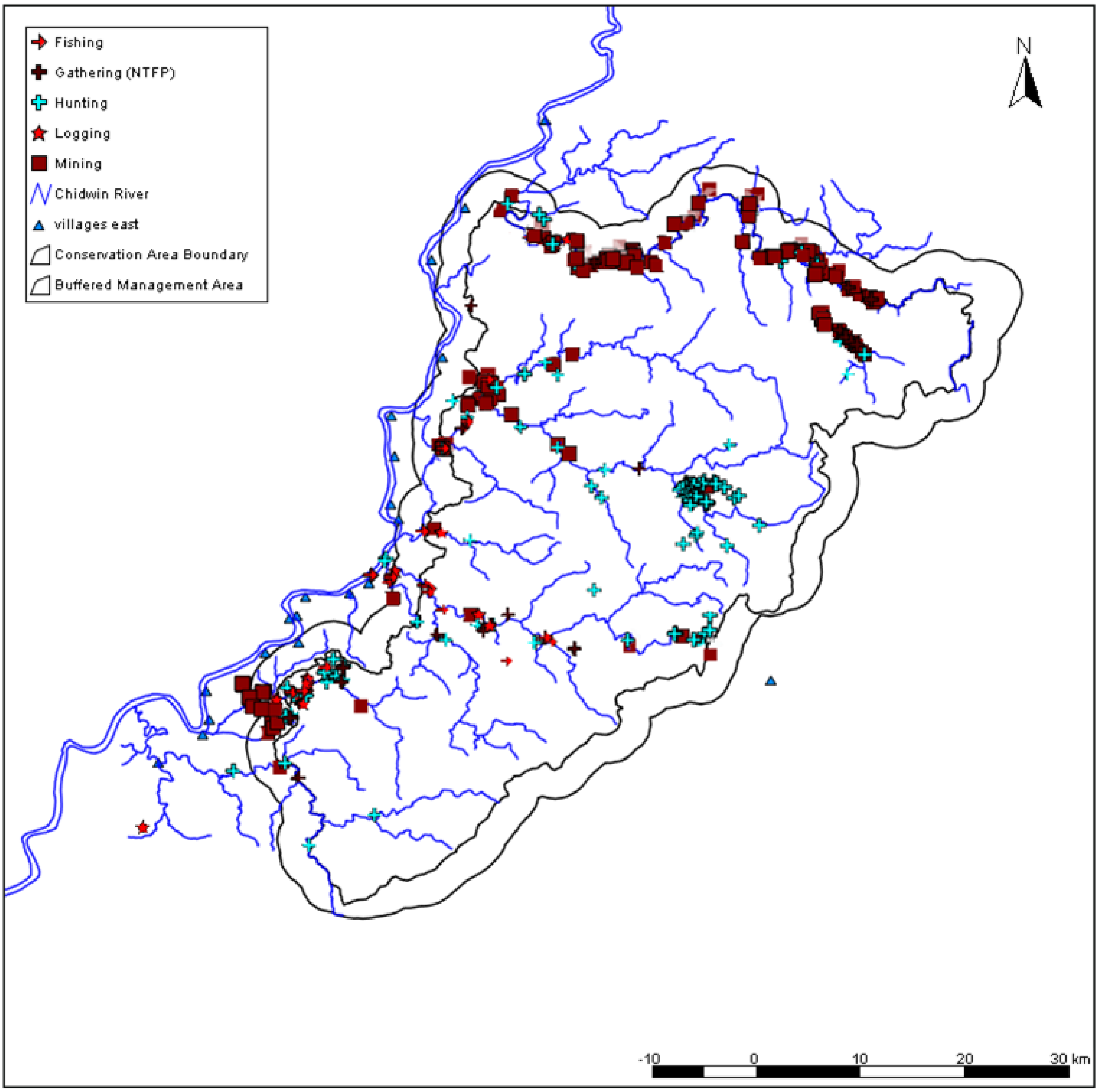



Figure 22: Spatial Distribution of key threats in 2013-2017

# Conclusion

HWS has a high value of biodiversity and natural resources with its important and intact ecosystems. These values are very attractive to those who, in greed, extract solely for their own interest.

The northern parts of the sanctuary are very close to Myanmar Treasure Land being famous for gold and amber mining and this area is in continuation with the world-famous jade land in Kachin State. People searching these resources gradually encroach into the sanctuary through this northern boundary to do gold mining business.

Concerning the eastern side of the sanctuary, only a few data of threats have been collected in this remote area, as the accessibility was challenging for law enforcement patrol teams even though a patrol station has been established there. The intelligence collected by patrol team highly indicated that poachers were entering into the sanctuary through this eastern boundary. Therefore, be suggested that NWCD and WCS Myanmar should exert more effort in improving the facilities to overcome the inaccessibility for the sake of a better patrol coverage and stronger law enforcement and monitoring in the eastern area of the sanctuary.

If NWCD and WCS could improve HWS facilities to support patrol teams, it will create more patrol coverage and stronger law enforcement and monitoring on the eastern side of the sanctuary.

In current context, it is not in a favorable condition to establish a sanctuary with a zero tolerance to poaching. The security risk to patrol and frontline staff is still remaining to act against any direct or indirect observations. Still, it is not feasible to arrest a poacher because the patrol staff are not armed. Despite of concern and challenges mentioned above, the patrol teams could achieve a solid result of effective patrol coverage within the sanctuary and threat occurrence has been dramatically decreased, especially for gold mining.

To be summarized, milestones have been satisfied as stated in the project document and the patrol teams are taking actions to threats.

# CHAPTER – 3

## INFRASTRUCTURE DEVELOPEMNT



# Introduction

For conservation activities and effective law enforcement, the strategic establishment of infrastructure was a must. NWCD and WCS Myanmar considered this in developing infrastructure with support from the Arcus Foundation.
The management office of the sanctuary is located in Homalin city which is 70 km away from the sanctuary. It usually takes over half a day to get to the sanctuary using boat travel along the Chindwin River. The distance between the office and the sanctuary makes a challenge for efficient management in the long run.

Following the development of the forward station close to the sanctuary in Htamanthi village to very support conservation interventions. The forward station is 10 km away from the nearest management sector, Nam Pa Gon. The newly established infrastructure within the forward station, consists of management office, training-cum-meeting hall, staff house, sanitation unit and patrol stations within the sanctuary. This had a great impact on effective management for time and resources leading to faster action.

# Infrastructure Newly Established

Dating back to 2013, the Sanctuary's Forward Station was only an old staff house and a log cabin. Then the funding of Arcus Foundation made it possible to establish the necessary buildings.

## Office

The management office is the main building of the forward station for effective park management. The range officer, ranger, community guard, site office manager and site coordinator are based here to support their responsibilities of logistics and administration. The building is attached with four bed rooms for guests and a mezzanine for the staff. This concrete design helped to reduce cost with an expanded space.

## Training Hall

The training cum meeting hall, is designed to have good ventilation and natural light. It was built at the river view side of the compound and is used for various trainings and meetings. More than 15 trainings and meetings were provided using this training hall. Three sides are open with hand rail and bamboo curtain and one wall is for using projector and other visual displays.

## Ranger House and Store Room

This wooden two storied building serves as a residence as well as a warehouse. The upstairs is with rooms for government wildlife rangers and community rangers while the ground floor is used as a store room for keeping field equipment.

## Sanitation Unit and Kitchen

These buildings of Htamanthi Forward Station are small but essential for the best hygienic practices. The kitchen is primarily for cooking and food preparation but also for socializing of staff. Staff and training participants together prepare food in the kitchen, the place maintains a social bond among staff.

# Infrastructure Maintenance

### Special Guest House

This ecofriendly building was designed with logs and as old as the Forward Station, needing serious maintenance. It has been renovated and designed to serve the special guest such as senior government officials, ambassadors, project donors, visiting researchers, and local government members.

# Supplied Field Gear

Limited field gear was functional at the start of project. Then during the project, motor boats, engines, and motor cycles were supported for the biological monitoring team, law enforcement team, and community engagement team. These field gear deteriorate over time. Limited funding is still a challenge to overcome and very important for effectively managing the sanctuary.


# Conclusion

Before the project, limited operational resources reduced the staff capabilities to carry out conservation activities including law enforcement patrols. Therefore, the funding of Arcus Foundation was a strategic and timely input for improving management of the sanctuary in moving forward to save gibbons and other wildlife and wild places. Following the support of the Arcus Foundation, patrol activities and monitoring could be planned and executed in a systematic way, law enforcement was performed strongly following infrastructure establishment, and trainings were feasible at the training hall. These newly established infrastructure are now accepted as an integral part of the sanctuary management.

# CHAPTER – 4

## VILLAGE CONSULTATION PROCESS ANDVILLAGE USE ZONING



# Introduction

The Forest Department (FD) and the Wildlife Conservation Society (WCS Myanmar) have been working collaboratively for over 25 years. Now with generous financial support from the Arcus Foundation, part of the work focused on Community Based Natural Resource Management (CBNRM) as a tool to enhance community participation in protected area management and sustainable use of natural resources by local communities residing around the sanctuary. This CBNRM activities were in line with the existing Law of the Protection of Wildlife, Wild Plants and Conservation of Natural Areas (1994). The process went well with its interconnected activities – Village Consultation Process (VCP), Village Use Zoning (VUZ) and CBNRM. These VCP, VUZ and CBNRM activities were later integrated into village participatory land use planning.

During VCP a socio-economic profile was assessed using villages' timeline, natural resources listing and ranking, trends of keys resources, household income vs. expenditure, and population growth projection. The village profile was then developed for each village and the data collected to be used as a base line data to monitor socio-economic changes.

During VUZ process, customary land uses and village's boundary were identified using participatory sketch mapping. Major landmarks along the village boundary and land use types were verified by participatory ground truthing using Global Positioning System (GPS) unit.

For sustainable natural resource management, participatory resource inventory was collected by each village community and a natural resource management area was identified. The village community then developed a management plan for this natural resource area of the village after calculating supply and demand for their uses. VCP and VUZ processes have been conducted since 2013 in support of conservation actions. This chapter summarizes the outputs of VCP and VUZ processes within 19 villages along the western side of the Htamanthi Wildlife Sanctuary

# Objectives

- To identify utilization of natural resources, and land use by local people,
- To explore the status of natural resources and pressure on these resources around these .
- To explore the livelihood practices, religious beliefs, socio-economic status including health and education etc.

# VCP and VUZ implemented villages

The process covered 19 villages comprising 15 Ethnic Shan villages, 3 Ethnic Chin villages and 1 Ethnic Naga village. These villages are adjacent to the sanctuary along the Chindwin River (Figure 28) namely, Authaw, East Kauk Taung, Hmaw Yone Myaing, Htonmalut, Hweina, Kaung Hein, Linn Phar, Malin, Male, Manthe, Maukgalaul, Minsin, Naga Ywar Thit, Nanspi, Naung Taw Ngoe, Pinmar, Swekaung Ngow, Thayetkone, and Yetpha.

# Methods

The methods used in VCP and VUZ processes were:

- Introduction and village timeline,
- Natural resource listing,
- Natural resource voting,
- Trend lines for priority resources,
- Wealth Ranking, and
- Income and expenditure analysis.

Both male and female aspects were included in VCP-VUZ process. The age of participants ranged from 16 to 70. During the process, in respect of their dignity, culture, ethnicity and gender identity, the teams took the consent of respondents before interviews and the interviews were taken in a secured place to maintain confidentiality and comfort.

Villages around the Htamanthi Wildlife Sanctuary

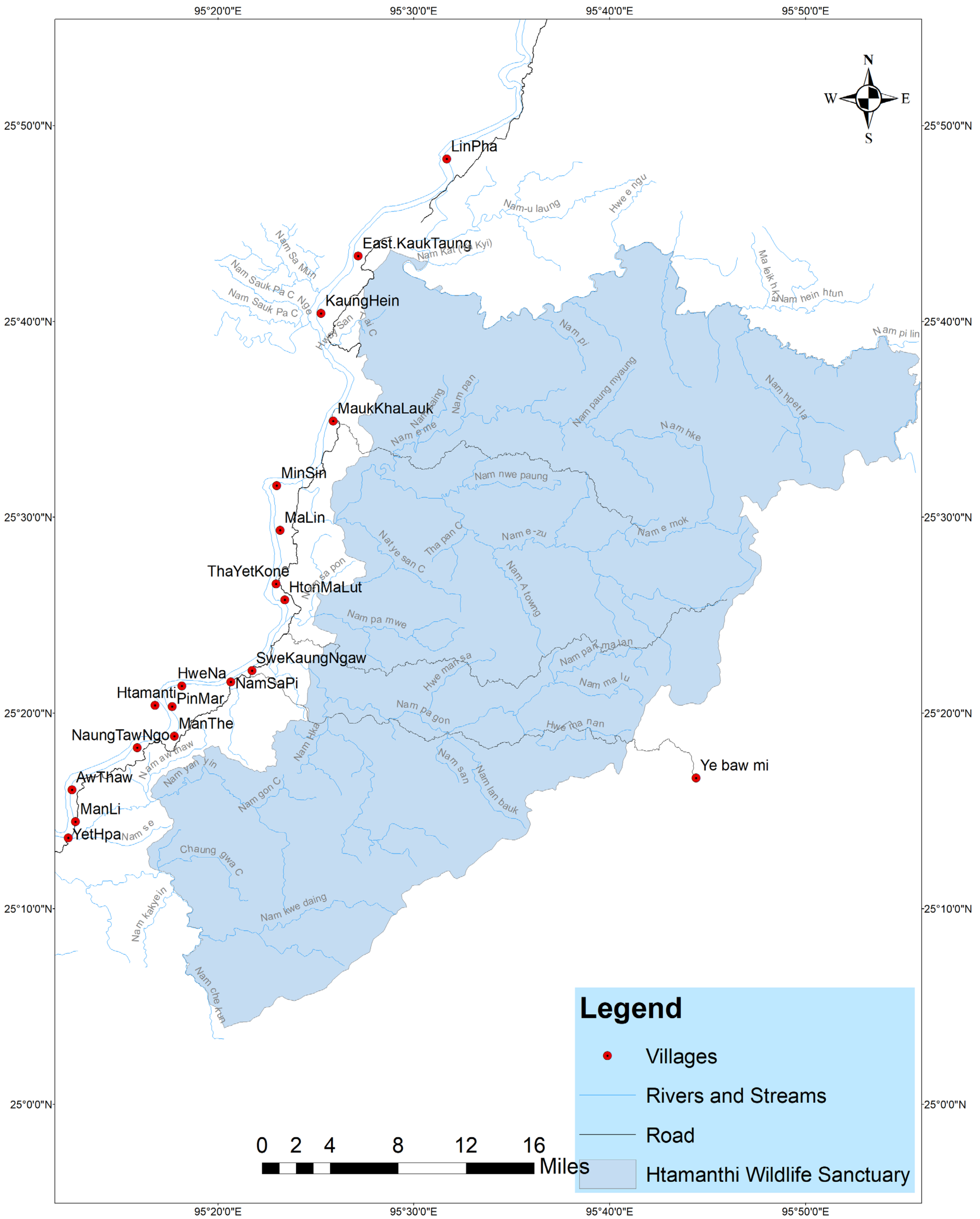



Figure 23: Villages around HWS

## Historical Time Line

In summary, the historical timeline revealed that in 1994, a plague of rats destroyed paddy fields and transmitted infectious diseases to human and domestic animals. During the last decade of the 20th century, this area has frequently suffered from natural disasters such as heavy rain, floods, early rains and emerging infectious diseases creating stresses and shocks for livelihood assets.

After 1992, logging and mining became the major businesses in the area. In particular, the number of logging and mining companies expanded between 2008 and 2012. In 2012-2013 open seasons, the government increased further restrictions on the mining industry. In return, these restrictions lead to more natural forest resource exploitation and poaching from the sanctuary as their alternative income for local communities.

## Livelihood and Dependency on Natural Resource

Communities around HWS live with a land-based economy system. Therefore, for their livelihood, local people solely depend on mining, farming, logging, NTFP collection, and fishing for their major income sources. This is clearly seen in the outputs of the VCP and VUZ process that shows two-thirds of the village households are depending on farming, while the remaining households rely on fishing, seasonal jobs, small-scale NTFP collection and hunting.

The wealth ranking category ‘C’ has more households than ‘A’ and ‘B’. According to the above table, category ‘C’ represents a lower wealth rank than ‘A’ and ‘B’. This indicates that (a) local people still rely on natural resources for their primary and additional incomes and (b) for subsistence, income of farmers and casual labors are insufficient. These facts should be considered and integrated into conservation activities so that communities receive additional benefits from community based natural resource management.

## FINDINGS OF VCP AND VUZ

needs for natural resources were explored by using participatory processes. It is found that all of the villages needed natural resources for their livelihoods. Important natural resources were identified as timber like teak, Dipterocarp species, and NTFPs like rattan species, wild forest palms, bamboo species, firewood, and traditional medicinal plants, and other wildlife species like bears, tiger, gaur, pangolins, and fish species. The wildlife resources were rarely found around the villages. However, natural resources in the most demand are NTFPs such as rattan and bamboo species.

**Figure 24: Focused Group Discussion With Local Community**

| PROSPERITY LEVEL | HH | MEN'S GROUP | HH | WOMEN'S GROUP |
|---|---|---|---|---|
| A | 0 | | 4 | Elephant (1) |
| | | | | Cows (6) |
| | | | | Buffalo (1) |
| | | | | Pigs (4) |
| | | | | Rice mill (2) |
| | | | | Shop (1) selling dried goods, snacks, salt, fish, past, onion |
| | | | | Home video (1) |
| | | | | Generator (1) |
| B | 1 | Medium house (1) | 3 | Farmland 6 acres |
| | | Farmland | | Buffalo (1) |
| | | Shifting cultivation | | Pigs (2) |
| | | Cows | | Sewing machine (1) |
| | | Buffalos | | Restaurant and lodging (1) |
| | | Elephant (1) | | Tea shops (2) |
| | | Pig | | |
| | | Bullock cart | | |
| C | 19 | Farm | 13 | Farm (12) acres |
| | | Shifting cultivation | | Cows (6) |
| | | Small boats (3) Honda engine | | Buffalos (6) |
| | | Cow | | Fishing |
| | | Buffalo | | Daily labor (1000 k/day) farming and shifting cultivation |
| | | Pig | | |
| | | Bullock cart | | |

**Table 5: Wealth ranking of 19 villages in the west of HWS**

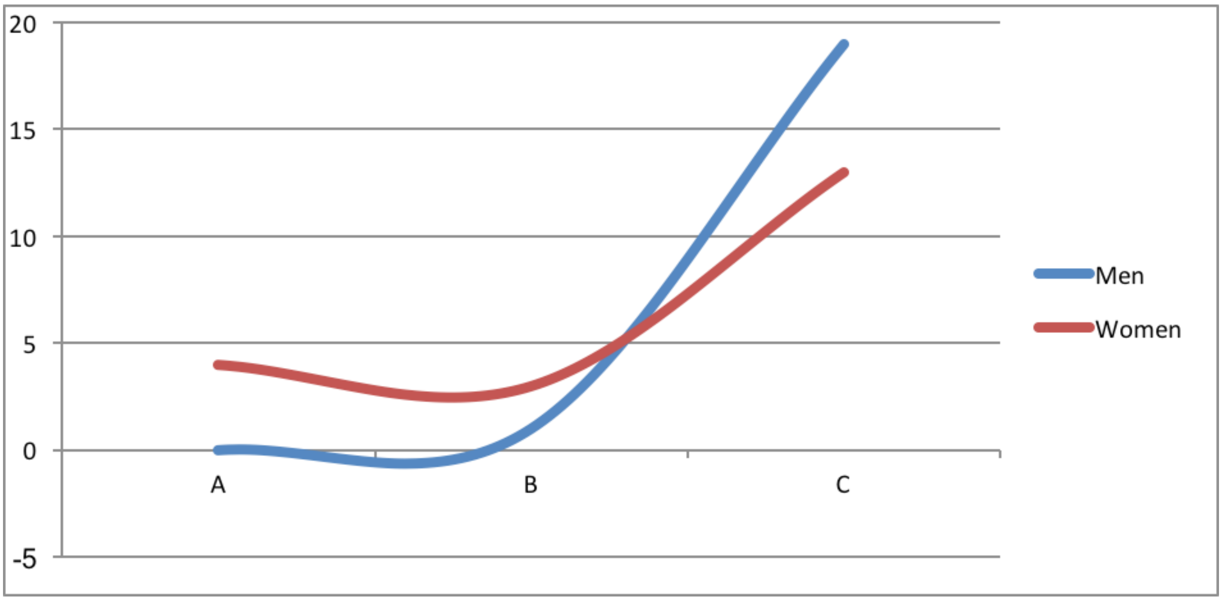



Figure25: Wealth distribution graph of 19 villages in the western sides of HWS


Figure 26: Field trip and discussion with new set up village

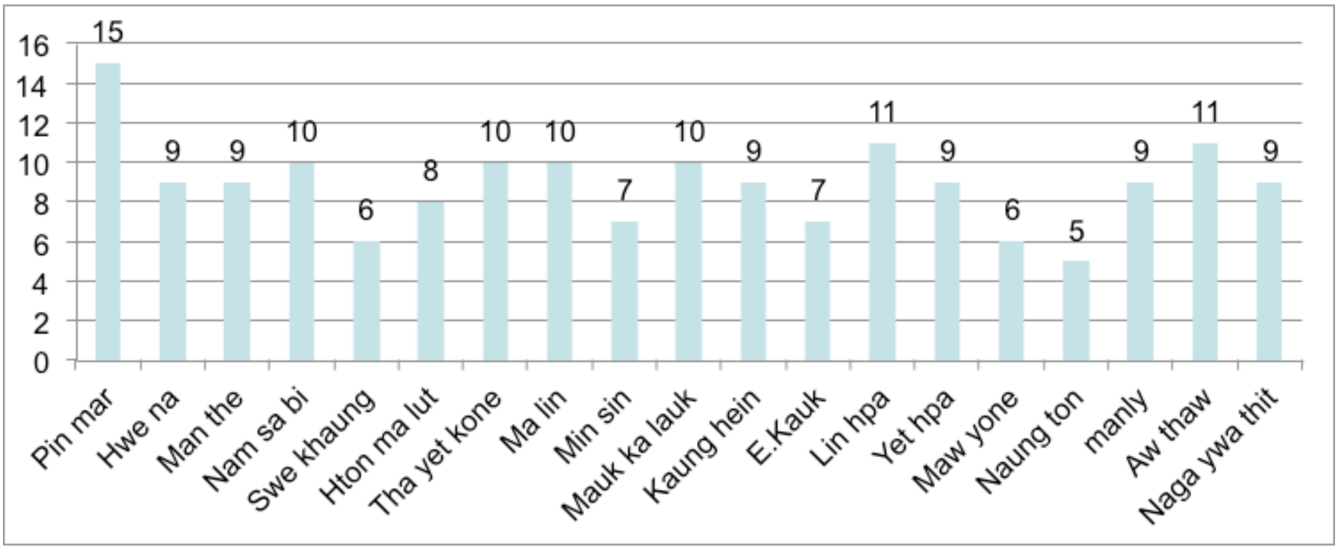



**Figure 27: Total number of natural resources needed by each village**

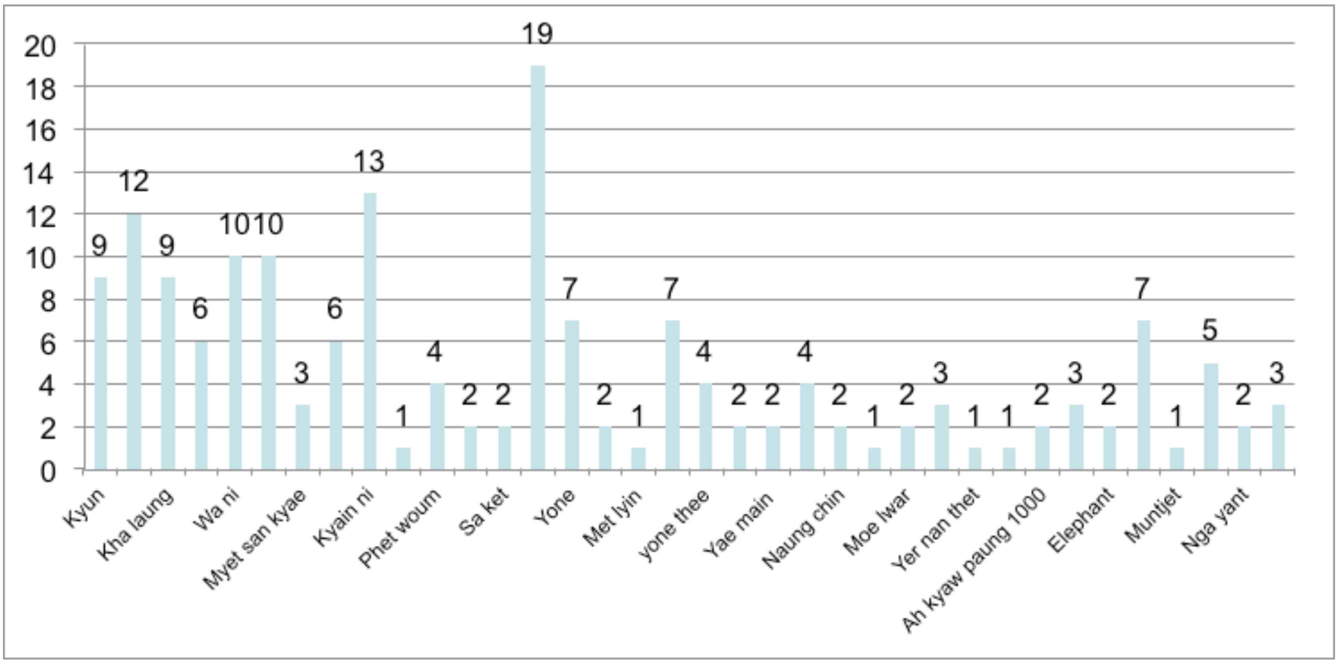



**Figure 28: List and ranking of important natural resources for each village**

# Discussion

In 2014, WCS community engagement team revisited communities around the sanctuary and mini-talks were made to inform the communities about CBNRM.

Then the team initiated a CBNRM program in Authaw and its neighboring villages. These villages have existed for over a century. In these days, the land use patterns are not stable for their customary practices of agriculture and gardening, because gold mining has put pressure on these practices. The mining business has resulted in decreased quality and quantity of natural resources, increased forest degradation, deforestation, and a clean water crisis. According to our findings, the local residents in this area are considering to move to other areas because they predict that their livelihoods will not be secured and the expect uncertainty over the next 5 to 10 years while all-natural resources are being extracted.

Therefore, local governments, local communities and the international community should coordinate and collaborate to combat deforestation and degradation of natural resources.

HWS is a protected area with high potential for conservation success as it is one of the last genetic banks of natural resources in Myanmar. To enhance participation among local communities, government and the international community, it is suggested to increase transparency and accountability. To earn mutual trust with local communities, solid community engagement must be maintained for all future conservation activities.

# CHAPTER –5

## FOREST COVER CHANGES



Law Enforcement and Patrolling in HWS (2013)

# Introduction

Gaining a better understanding of the ways that land cover and land use practices evolve is a primary concern for the global change research community (J. Southworth, 2003). Myanmar natural forest cover is decreasing year by year. Forest cover is a vital and important indicator of sustainable forest management and conservation. However, due to high regional diversity of forest types and the range of causes of forest change, it is not easy to map and to evaluate forest cover for the whole landscape of the northern forest complex of Myanmar. But satellite remote sensing provides objective and consistent observations suitable for mapping tropical forest cover dynamics at a fine scale (Tucker & Townshend 2000).

The sanctuary does not have any base line survey for forest cover since 2013. But at the national scale, FD has conducted a land cover change assessment in 2003. Landsat satellite imagery from the 1990s and 2000s were used to develop a country-wide forest map and to estimate deforestation. Although the country has retained much of its forest cover, it is declining by 0.3% annually. HWS is widely known for being rich in biodiversity, but a range of threats still remain causing degradation in environmental quality. Therefore, FD and WCS have decided to conduct conservation research activities within the sanctuary. Then they jointly implemented the research and monitoring project for Eastern Hoolock Gibbon. This land cover change analysis was taken as a component of the Eastern Hoolock Gibbon conservation activities.

# Objectives

- To measure baseline area of forest and non-forest (ha) within PA,
- To assess forest cover change percentages inside the PA and buffer zone,
- To compare changes of forest cover over a 4-year period (2013-2017) and use this data as an indicator to measure conservation success

# Forest Cover Changes Analysis in the Past in Sagaing (2002-14)

The main reason for decreasing forest cover changes in Sagaing Region is due to its tremendous mining areas. This has led to the loss of forest cover. Although Sagaing Region still has 63% forest cover (intact and degraded combined), forest is being lost at an annual rate of 0.25% (Tejas Bhagwat. et.al. 2016). Intact forest cover is 34% of Sagaing Region and it is being lost at an average annual rate of 0.67%. Especially, northern Sagaing has very large unfragmented areas of intact forest where HWS is situated. On the other hand, mining areas have increased from about 7,000 ha to over 59,000 ha with an average increase of 743%. Over 52,600 ha of forest have been converted to mining areas. Many new patches of non-forest are scattered throughout the northwestern part of the region in the Naga Hills. This project focused on analyzing the Htamanthi Wildlife Sanctuary including the proposed buffer to understand changes in forest cover.

# Methodology

## Study area

Htamanthi Wildlife Sanctuary is situated in the northern part of Sagaing Region and in the east of the Chindwin River. The sanctuary is under the administration of Hkamti Township and Homalin Township. In this study, forest cover of the sanctuary and the proposed buffer were included to describe the impacts of conservation interventions not only inside of the sanctuary but also the area around the sanctuary.

## Materials Used and Sources

Detection of land cover changes from mid-resolution, multi-temporal satellite images such as Landsat is one of the most valuable contributions of satellite remote sensing to natural resource management and biodiversity assessments (Turner et al. 2003; Leimgruber et al. 2005). Landsat imagery has been the most heavily used source of satellite data for monitoring forest change. These images provide encoded radiance data in the visible near- and middle-infrared spectra, in which most mature tropical forest can be spectrally distinguished from farm, fallow land and other non-forest vegetation (for example Sader et al. 1991; Moran et al. 1994; Steininger 1996, 2000). The 30 m spatial resolution provided by Landsat images enables detection of forest clearings as small as one hectare. Analysis of multi-temporal satellite images has been used to accurately estimate forest cover and deforestation rates (for example Tucker & Townshend 2000; Steininger et al. 2001).

WCS Myanmar team analyzed two wall to wall Landsat data sets for HWS acquired in 2013 to early 2017 based on the image availability and quality. The main source of the Landsat data set is USGS website (http:// glovis.usgs.gov). All of the Landsat images used in this project were taken based on the same months over all five years from Landsat 8, to analyze 30 m resolution for HWS forest cover.

| Path & Role Year | 134/42 | 134/43 |
|---|---|---|
| 2013 | LC81340422013353LGN00 | LC81340432013353LGN00 |
| 2014 | LC81340422014356LGN00 | LC81340432014356LGN00 |
| 2015 | LC81340422015359LGN00 | LC81340432015359LGN00 |
| 2016 | LC81340422016330LGN00 | LC81340432016330LGN00 |
| 2017 | LC81340422017044LGN00 | LC81340432017044LGN00 |

**Table 7: List of landset 8 images used in land cover analysis for HWS.**

Almost all images were taken in the open season (December-February), a time period when forest vegetation tends to be lush and cloud cover is low. Therefore, in this analysis, cloud cover among images was limited (>2% of cloud). Selection of images near anniversary date timing for acquiring the next image was done to reduce confounding effects of seasonal changes in leaf cover in the mixed deciduous and dry forest in and around the sanctuary. Although most of the forest type in the sanctuary is evergreen forest, a small part of dry deciduous forest (teak bearing forest) is observed in the southwestern part of the sanctuary.

After building a mosaic with these two raster datasets, HWS raster data was classified. This classification of raster dataset was for selecting categories of real-world objects or land cover; for example, water, forest, and bare soil. We classified four clusters of data into water bodies, open forest, closed forest, and non-forest, using ISO UNSUPERVISED CLASSIFICATION TOOL in ARGIS 10.2.
This tool combines the functionalities of the ISO Cluster and Maximum Likelihood Classification tools. It outputs a classified raster, and it optionally outputs a signature file. Unsupervised classification has been used extensively in rangelands for a wide range of applications, including:

- Land cover classes,
- Major vegetation types,
- Distinguishing native vs. invasive species cover,
- Vegetation condition, and
- Disturbed areas (e.g. fire)

Land use change exploration of image datasets is getting a sense of clustering in

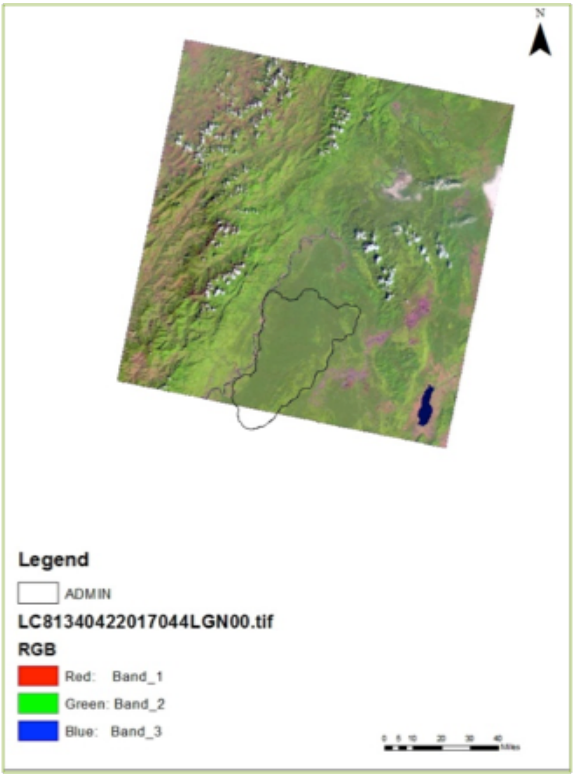



Figure 29: Landsat 8 Image of 134/42

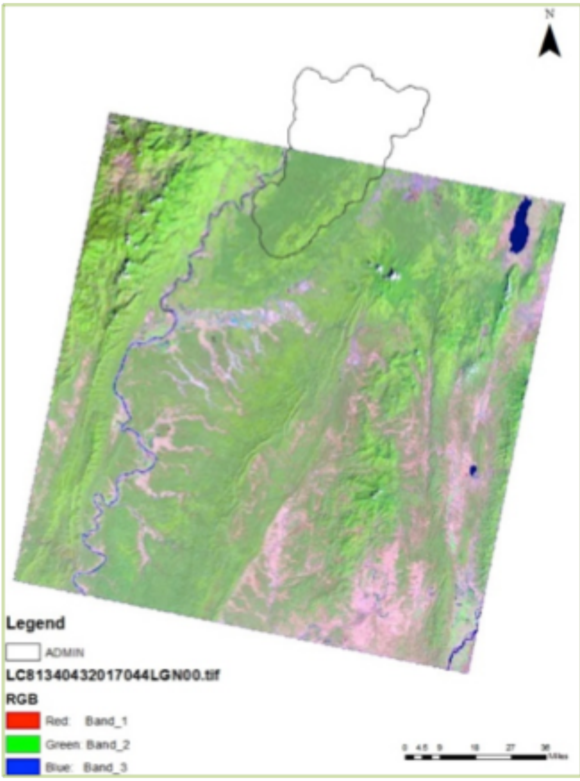
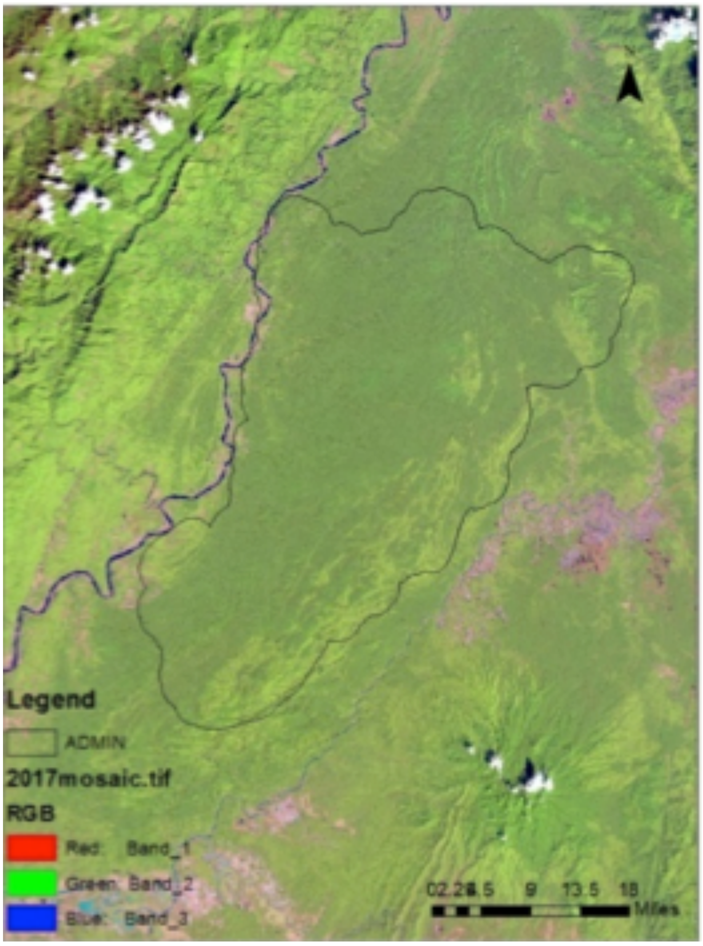



Figure 30: Land set 8image of 134/43




the data of features. The results are often general or mixed for a thematic map, but sometimes a lack of other observational data exists for the image, this leaves unsupervised classification as the best option (F.F. Sabins, Jr., 1987). After classification, we calculate change detection by using an attribute table and geometry calculator from ARGIS10.2.

Figure 31: Land set image mosaic of HWS

# Results

In 2013, HWS had a total forest cover of 2126.81 km$^2$ (including 582 km$^2$ of open forest and 1598.54 km$^2$ closed forest). In 2016, the closed forest area had increased to 1840.20 km$^2$ and in 2017 it had again increased to 2080.64 km$^2$. This must be due to the stopped timber extraction within the sanctuary by FD and Myanmar Timber Enterprise since early 2013. Forest cannot regenerate rapidly during a single year, but general forest cover has increased. Although non-forest cover has not significantly decreased, the amount of open forest cover has significantly decreased from 26.67% to 5.35% during 2013-2017.

| | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| Water Bodies (km$^2$) | 1.12 | 1.51 | 1.80 | 2.37 | 1.66 |
| Open Forest (km$^2$) | 582.27 | 453.97 | 304.16 | 99.10 | 116.76 |
| Closed Forest (km$^2$) | 1598.54 | 1587.25 | 1840.20 | 2080.64 | 2059.10 |
| Non-Forest (km$^2$) | 1.50 | 110.70 | 37.26 | 1.31 | 8.90 |
| | 2013 | 2014 | 2015 | 2016 | 2017 |
| Water Bodies (%) | 0.05 | 0.07 | 0.08 | 0.11 | 0.08 |
| Open Forest (%) | 26.67 | 22.17 | 13.93 | 4.54 | 5.35 |
| VNon-Forest (%) | 0.07 | 5.07 | 1.71 | 0.06 | 0.41 |
| Total (%) | 100 | 100 | 100 | 100 | 100 |

▲ **Table 8: Amount of Forest Cover Changes in sq. km and percentage**

Most of the buffer and the area along the eastern boundary could be difficult for regenerating forest. Along the northern boundary, Nam Phi Lin stream has extensive bare soil by mining and the bare soil did not disappear until 2017. This area had been an old gold mining area and regenerating will take several years.

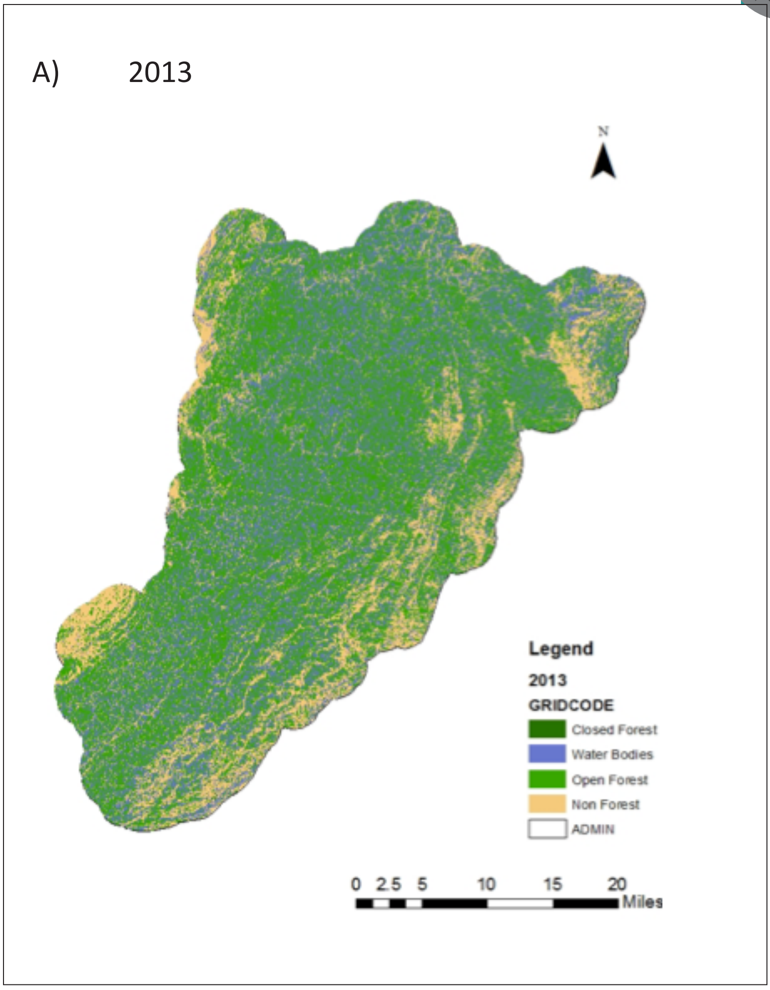



Figure 32: 2013 HWS land cover

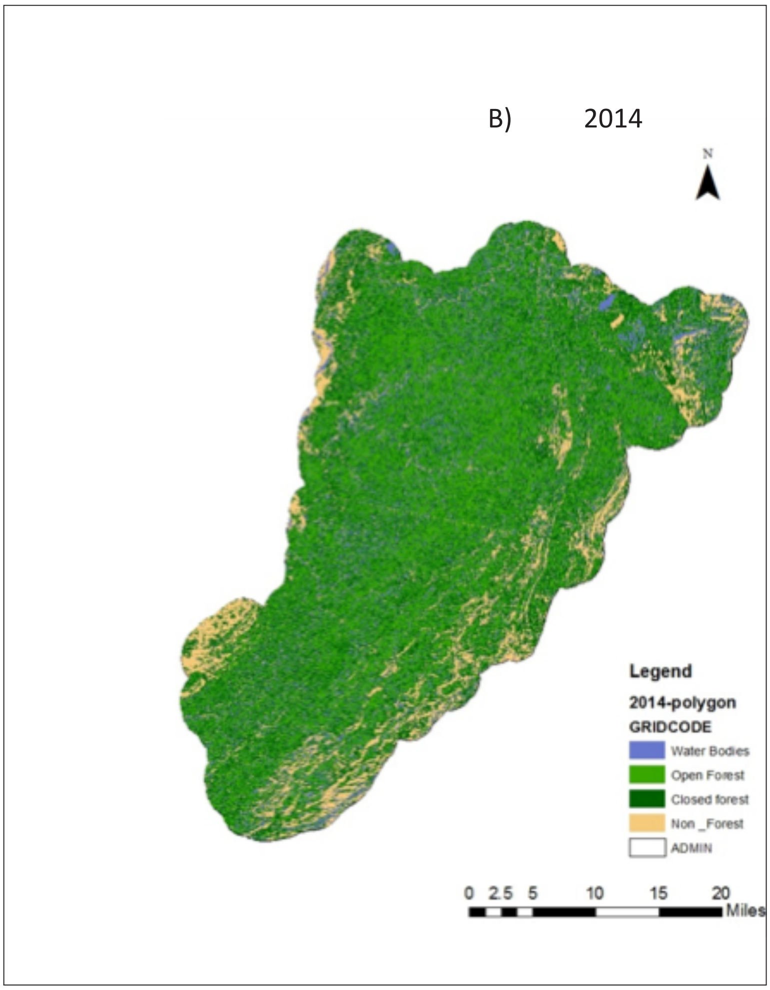



Figure 33: 2014 HWS land cover

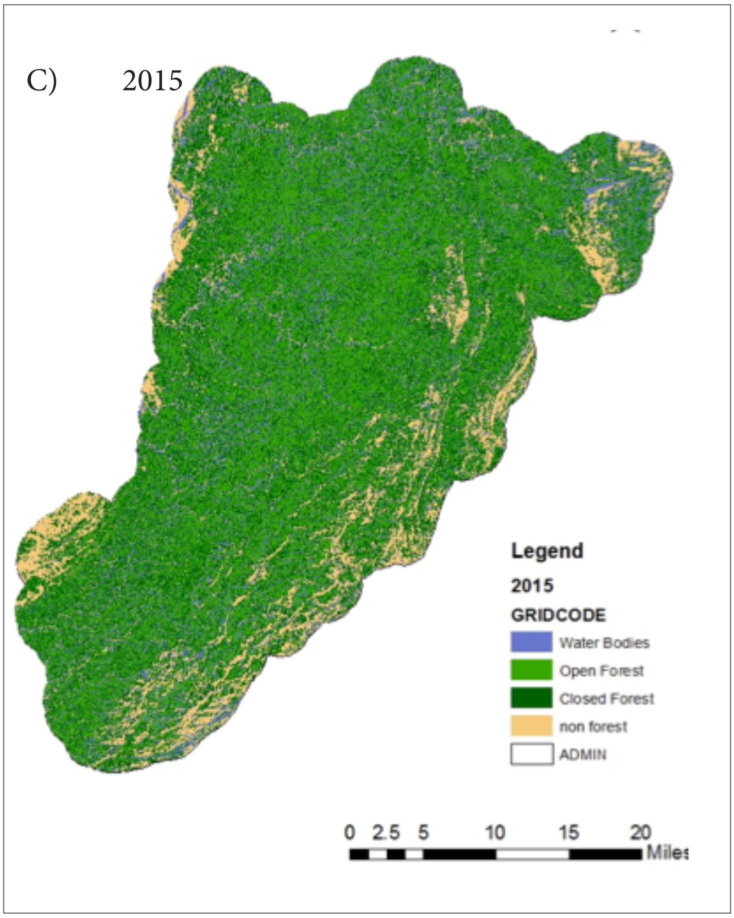



**Figure 34: 2015 HWS land cover**

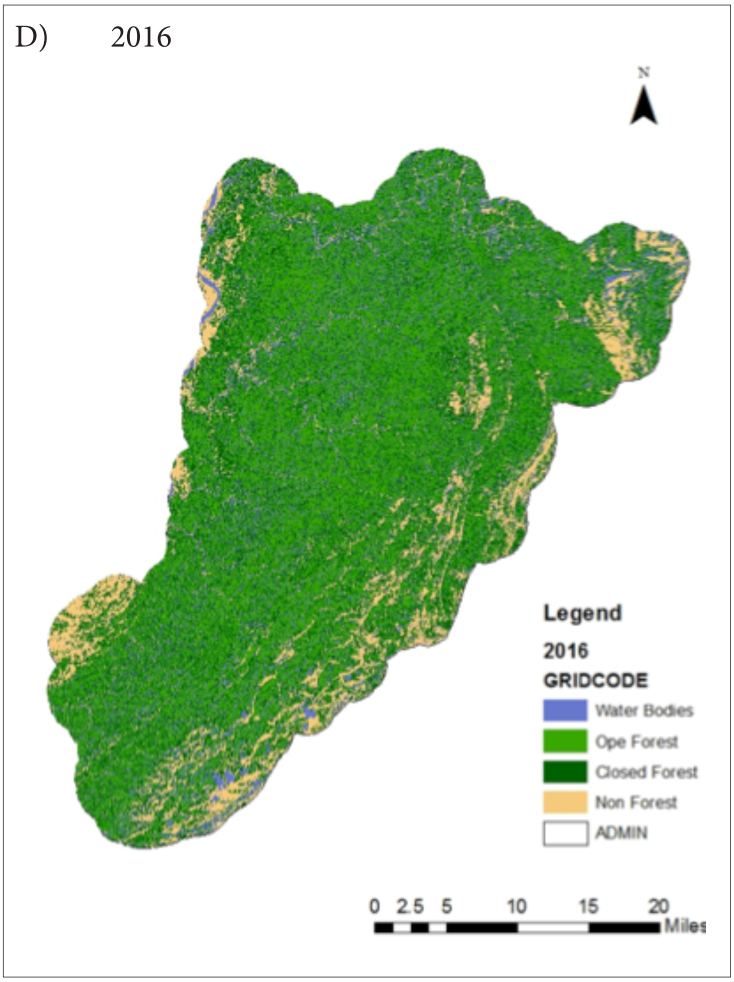



**Figure 35: 2016 HWS land cover**

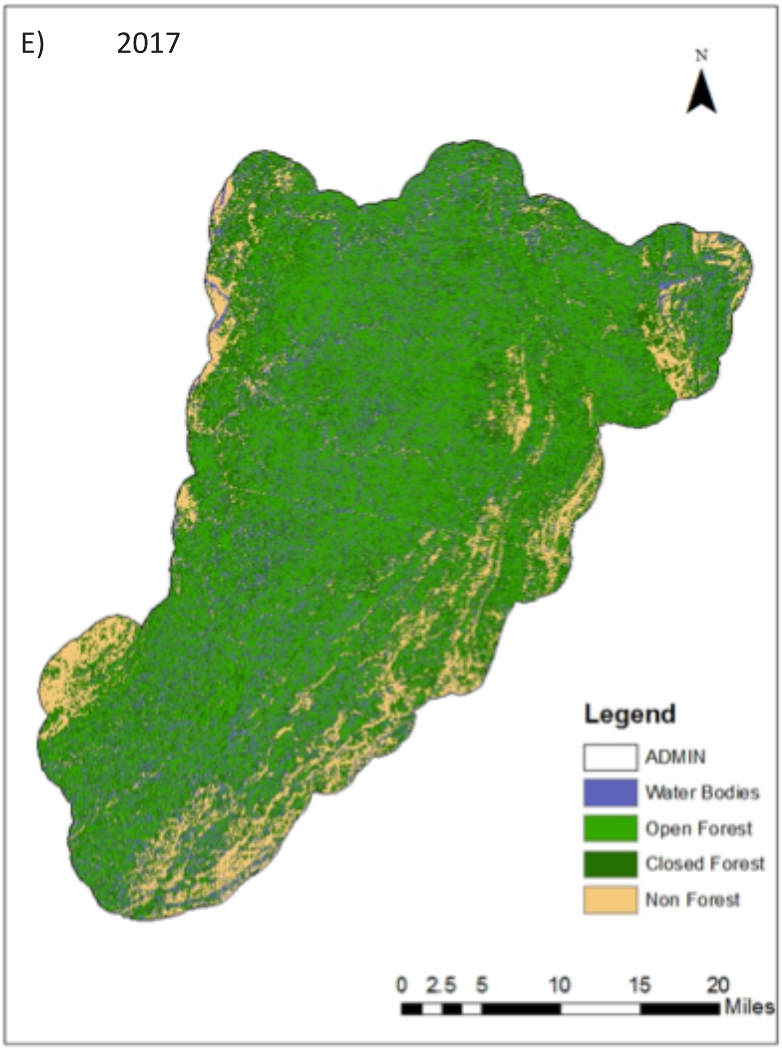



**Figure 36: 2017 HWS land cover**

# Image Classification and Accuracy Assessments

ISO Unsupervised classification was used for quantitative analysis of Landsat 8 datasets. The annual land cover maps of the HWS were evaluated with the traditional error matrix that consists of producer and user accuracies developed by comparing ground truth points and satellite image pixels. A tool that is used to present the accuracy statistics is called a contingency table. The following table is a contingency table for a map that delineates water, open forest, closed forest, and non-forest for the year 2013. Like 2013, each year (2014, 2015, 2016, and 2017) data were also generated using ArcGIS 10.2 and MS excel 2010. This table can calculate producer and consumer accuracy as well as some other common accuracy indicators

**Table 9: Contingency Table: A pixel by pixel comparison of ground reference class to satellite-based map class**

| Classification | Water | Open Forest | Closed Forest | Non-Forest | Ground Truth |
|---|---|---|---|---|---|
| Water | 9 | 0 | 0 | 3 | 12 |
| Open Forest | 4 | 131 | 4 | 4 | 143 |
| Closed Forest | 1 | 3 | 115 | 2 | 121 |
| Non-Forest | 0 | 1 | 0 | 18 | 19 |
| | 14 | 135 | 119 | 27 | |

**Table 10: Land Cover Change Accuracy Assessment for 2013 only**

| 2013 Land Cover Accuracy Assessment | | | | |
|---|---|---|---|---|
| Water | | Open Forest | Closed Forest | Non-Forest |
| Omission Error(%) | 35.70 | 3.00 | 3.40 | 33.30 |
| Omission Error(%) | 25.00 | 8.40 | 5.00 | 5.30 |
| User Accuracy(%) | 64.29 | 97.04 | 96.64 | 66.67 |
| Producer Accuracy(%) | 75.00 | 91.60 | 95.00 | 94.00 |

Sample accuracy assessment table for 2013 and overall accuracy for five consecutive years can be seen in tables.

**Table 11: Image Classification Accuracy Assessment For five years**

| Image Classification Accuracy Assessment | | |
|---|---|---|
| | Overall Accuracy(%) | Kappa Coefficient |
| 2013 | 92.54 | 0.97 |
| 2014 | 96.35 | 0.96 |
| 2015 | 76.24 | 0.73 |
| 2016 | 98.12 | 0.95 |
| 2017 | 93.33 | 0.93 |

# Discussion

According to the results and findings of the land cover change analysis, the conservation interventions in the sanctuary are being regarded as a success over the past five years. The forest cover has increased in HWS, while other regions of the Northern Forest Complex within Sagaing Region experienced rapid deforestation. The most growing forest cover is only found in and around HWS. This strongly indicates that law enforcement patrolling using SMART, the monitoring program together with community engagement programs are effective and efficient in conserving Eastern Hoolock Gibbons and increasing forest cover. This dedication and hard work from FD and WCS have successfully strengthened the conservation management of Htamanthi Wildlife Sanctuary.

Law enforcement monitoring and patrolling using SMART together with community engagement programs have significantly shown that forest cover has increased and Eastern Hoolock Gibbons are being protected in Htamanthi Wildlife Sanctuary through effective conservation action.

| Land Cover | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| Water Bodies (%) | 37.14 | 26.12 | 26.97 | 28.21 | 30.48 |
| Forest Cover (%) | 34.90 | 63.86 | 63.27 | 62.96 | 62.08 |
| Non-Forest Cover (%) | 27.96 | 10.02 | 9.76 | 8.83 | 7.44 |
| | 100 | 100 | 100 | 100 | 100 |

Table 10: Percentage difference of land cover in HWS

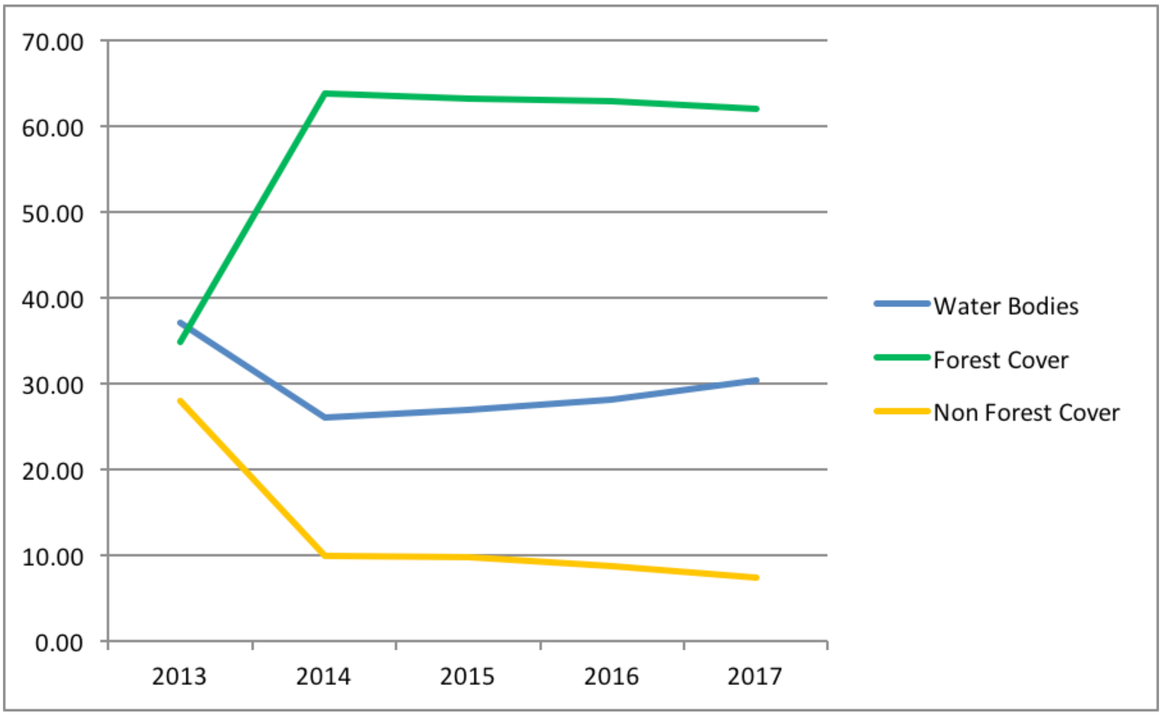



Figure 37: Land Cover Cahnges In Percentages Of HWS

# References

Brockelman, W, Naming H, Saw C, & et al, (2005) Census of Eastern Hoolock Gibbons (Hoolock leuconedys) in Mahamyaing Wildlife Sanctuary, Sagaing Division, Myanmar

Brockelman, W. & Geissmann, T. 2008. Hoolock leuconedys. The IUCN Red List of Threatened Species 2008: e.T39877A10278832. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T39877A10278832.en

Brockelman, W. & Geissmann, T. (2008). Hylobates lar. The IUCN Red List of Threatened species 2008: e. T10548A3199623 http://dx.doi.org/IUCN.UK.2008.RLTS.T10548A3199623.en

Brockelman, W., Molur, S. & Geissmann, T. (2008). Hoolock hoolock. The IUCN Red List of Threatened Species 2008: e.T39876A10278553. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T39876A10278553.en

Everitt, J. H., C. Yang, D. E. Escobar, R. I. Lonard, M. R. Davis. (2002). Reflectance Characteristics and Remote Sensing of a Riparian Zone in South Texas. The Southwestern Naturalist 47: 433-439 – used unsupervised classification to map dominant vegetation types

Fernando J. Aguilar (2015) A Quantitative Assessment of Forest Cover Change in the Moulouya River Watershed (Morocco) by the Integration of a Subpixel-Based and Object-Based Analysis of Landsat Data

From F.F. Sabins, Jr. (1987) Remote Sensing: Principles and Interpretation. 2nd Ed.,1987. Reproduced by permission of W.H. Freeman & Co., New York City.

Geissmann, T., Grindley, M. E., Ngwe Lwin, Saw Soe Aung, Thet Naing Aung, Saw Blaw Htoo, and Momberg, F. (2013). The conservation status of hoolock gibbons in Myanmar.

Geissmann, T., Grindley, M., Momberg, F., Ngwe Lwin, and Saw Moses (2008).

Hoolock gibbon and biodiversity survey and training in southern Rakhine Yoma, Myanmar: Preliminary report.

Gissmann, T., Ngwae Lwin, Saw Soe Aung, Thet Naing Aung, Zin Myo Aung, Tony Htin Hla, (2011) The Myanmar Hoolock Gibbon Conservation Status Review: First results

Peter leimgruber, (2005). Forest cover change patterns in Myanmar (Burma) 1990–2000, Environmental Conservation: Foundation for Environmental Conservation

Rao, M., Myint, T., Zaw, T., and Htun, S. (2005). Hunting patterns in tropical forests adjoining the Hkakaborazi National Park, north Myanmar.

Ravinder Virk and Doug King (2006) Comparison of Techniques for Forest Change Mapping Using Landsat Data in Karnataka, India, Geocarto International, Vol. 21, No. 4, December

Thomas Geissmann (2014). Gibbons – Die singenden Menschenaffen / Gibbons – The singing apes. Anthropologischesurrent Status and Challenges

# APPENDIX

## Gibbon Group Estimation in Western Sides of Chindwin River

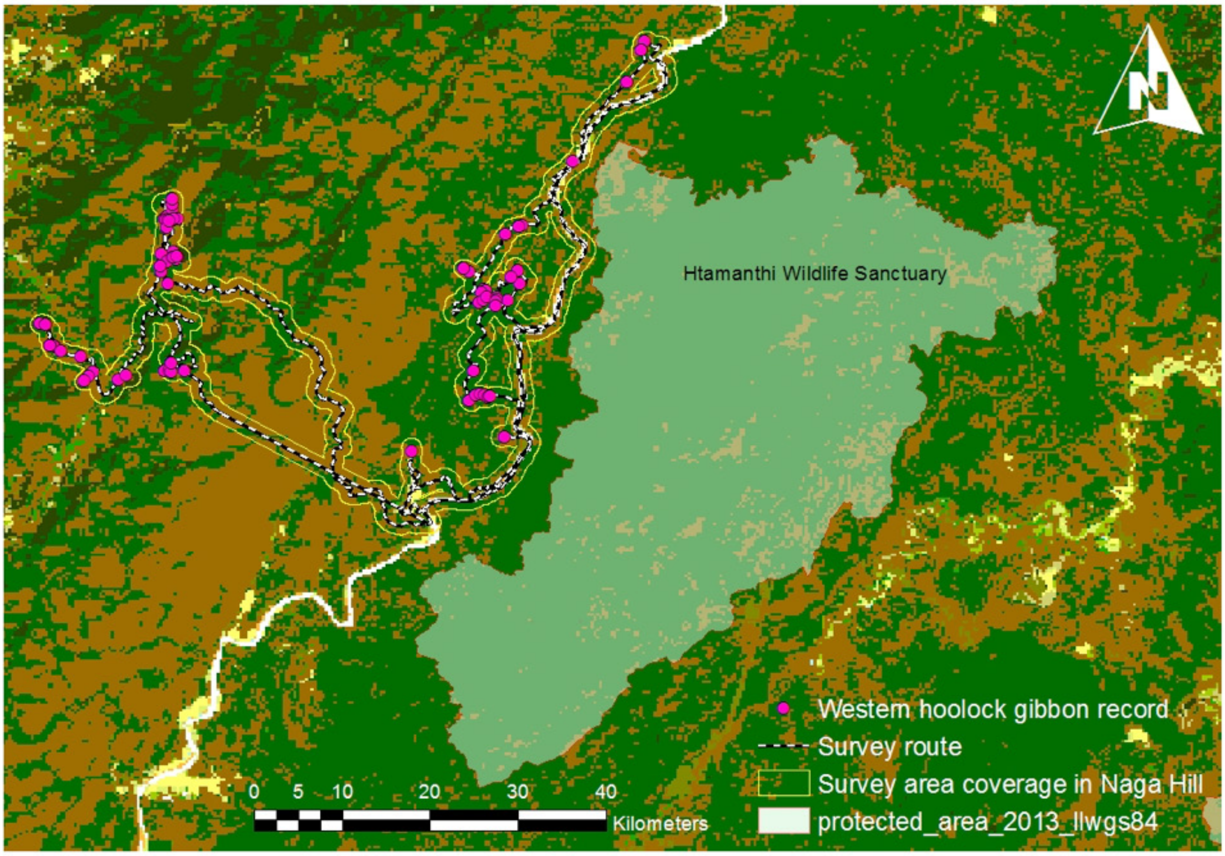



**Figure 38: Map of Area Coverage by Western Hoolock Gibbon Survey Team in Naga Hill Area**

The Chindwin River might be the natural divide between western and eastern hoolock gibbons. On the map in Figure #, the pink spots are the recording surveys in the survey, where the team measured the estimated distance and bearing of gibbon bouts; the balck and white dashed line shows the survey route; and the white and transparent protected area on the eastern side of the river is Htamanthi Wildlife Sanctuary. The survey team travelled about 730 km covering 714 km2 in Naga Hills and the western bank of the Chindwin river. The background on the map is land cover from 2009 extracted from globecover 2009, ArcGIS online.

# Hoolock Gibbon Survey in Naga Hills

We also conducted Western Hoolock gibbon survey in Naga Hills region. In the western species survey, there were four survey sites: two in the higher elevation area and the other two in areas
adjacent to western banks Chindwin River (i.e., lower elevation ranges). The survey sites are as follows_

1) Layshi-Satpya-Chalra-Painekone-Kyekaw-Tikon-25 Miles Area,
2) 25 Miles-Tikon-Kyekaw-Yawpami-Latte-Yawhaw-Balbal-Modom Ywama-Yannway Area,
3) Malanpaing-West Kauk Taung- Lite Tite- Molun Area and
4) Molun-Tone Lone-Nathalatt Area.

The location of the study area is shown in the following figure. Western Hoolock gibbon survey was carried out in October to November, 2013 as shown in the following table.

# Gibbon Group Estimation on The Western Side

Survey team used the complete data for gibbon group estimation. However, survey results could not be estimated as done in the HMTWS due to different method used on the Western hoolock gibbon survey. Graph paper, color pen and protractor were used for the gibbon group estimation. Survey results could not put and draw a group map on graphic paper for all of the data at once. So, the gibbon group maps were drawn for estimation in the small and fragmented patches nearby the villages. Sometime, survey teams spent two or three days at one area, and gibbon groups were estimated by triangulation. The following are the gibbon group estimation results for each site.

(1) Layshi-Chalra-PeinneKone- Tikon trip: 11 groups
(2) 25miles-Tikon-Yawpami-Latte-Yawhaw-Yannwe trip: 25 groups
(3) Malanpai-Molun trip: 22 groups
(4) Molun-Nanthalatt trip: 20 groups

**Table 11: Arcus: Myanmar Gibbon Three Years Outcomes and Activities**

| No. | Context | Activities | EXPECTED OUTPUTS |
|---|---|---|---|
| Year-1 | The effectiveness of law enforcement and patrolling will be enhanced through systematic planning, implementation, monitoring, reporting, adaptive management, and building the capacity of all levels of PA staff. | Regular patrols will be conducted through systematic planning, monitoring and assessment of effectiveness. | Patrol effectiveness indicators – the effectiveness of patrolling will be assessed using the following indicators. These indicators are complementary to each other, serving as the check and balance mechanism to the performance of patrol team. |
| | | | (1) Patrol days |
| | | | (2) Patrol distance (km) |
| | | | (3) Patrol coverage ($km^2$) |
| | | | (4) Patrol effectiveness (catch - illegal activity events recorded - per unit effort) |
| | | The capacity of patrol staff, SMART operators, and the PA manager will be developed based on the training needs assessment. | Numbers of trainings and post training evaluation – At least two basic patrol trainings for rangers, one training for SMART application, and one training for planning, evaluation, and monitoring of patrolling will be conducted using complementary funds. Each training will be associated with post-training evaluation to assess the understanding of trainees. |
| | Stable population of Hoolock gibbons in Htamanthi WS – Elimination of threats to the population of Hoolock gibbons is expected as a result of more effective patrolling and community participation in PA management. | Assess population density of Hoolock gibbons using scientifically accepted auditory methods. | Estimated population of gibbons – the estimated population of Hoolock gibbons should be at a baseline group density of 2.184 ± 0.123 groups per $km^2$. |

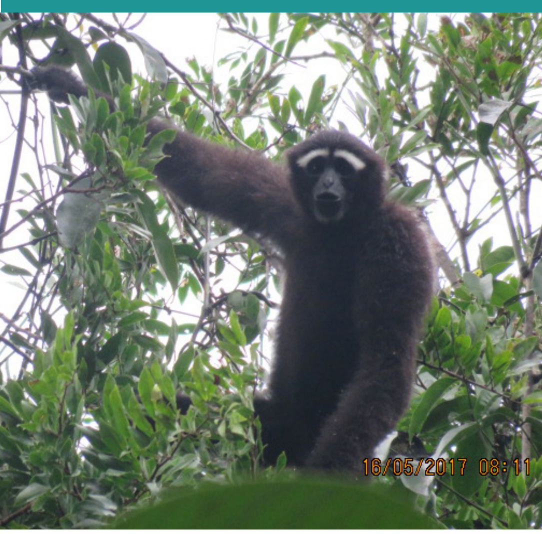
| No. | Context | Activities | EXPECTED OUTPUTS |
|---|---|---|---|
| Year-1 | | Assess direct threats to Hoolock gibbons and plan for maximally effective patrols through the collection of SMART data. | Intensity, urgency, and area of main threats to Hoolock gibbon will be assessed from the SMART data and compared year by year. |
| | Land use and natural resource use in the proposed buffer zone of the PA are defined and established. A buffer zone for local community use will be defined and established using CBNRM tools. | Conduct Village Consultation Process (VCP) and Village Use Zonation (VUZ) activities in the remaining 4-6 villages where this has not yet been carried out around the PA. | # Development of village profile and list of important natural resources within the remaining 4-6 villages around the PA. This will be completed through VCP. |
| | | | # Drafting of village land use and land category maps. This will be completed through VUZ. |
| | | Conduct natural a resource needs assessment and forest inventory in at least one pilot model village around the PA. | |
| | | | # Results of natural resource needs assessment and forest inventory in selected pilot villages. This will include data on size distribution of important timbers in the forest and volume and sustainability of important natural resources needed by communities. |
| | Baseline forest cover of the PA and proposed buffer zone is established. This will be assessed using Landsat 8 satellite image analysis. | Analysis of satellite images with outcome of established baseline data on forest cover in Year 1. For this, we will acquire and analyze Landsat 8 satellite images for the PA and proposed buffer zone. | Baseline area of forest and non-forest ($km^2$) inside PA and proposed buffer zone is established. This will be generated from satellite image analysis. |

| No. | Context | Activities | EXPECTED OUTPUTS |
|---|---|---|---|
| Year-2 | The effectiveness of law enforcement and patrolling will continue to be enhanced through ongoing systematic planning, implementation, monitoring, reporting, adaptive management, and building the capacity of all levels of PA staff. | Regular patrols continued based on systematic planning, monitoring, and effectiveness assessment. | The capacity of patrol staff, SMART operators, and the PA manager will continue to be enhanced through trainings (funded by GEF) on SMART application and patrolling based on earlier training needs assessments. |
| | | | Numbers of trainings and results from associated post training evaluation that assesses understanding of trainees. |
| | | | Patrol effectiveness indicators – the effectiveness of patrolling will continue to be assessed using indicators from Year 1: |
| | | | (1) Patrol days |
| | | | (2) Patrol distance (km) |
| | | | (3) Patrol coverage ($km^2$) |
| | | | (4) Patrol effectiveness (catch - illegal activity events recorded - per unit effort) |
| | A continued stable population of Hoolock gibbons. This is expected because of a decrease in threats resulting from more effective patrolling and community participation in PA management. | Continue to assess population densities of Hoolock gibbon using scientifically accepted auditory methods. | Estimated population of gibbons – The estimated population of Hoolock gibbon should remain stable around the baseline group density (2.184 ± 0.123 groups per $km^2$). |
| | | Continue to assess direct threats to Hoolock gibbons through the collection of SMART data. | Intensity, urgency and area of main threats to Hoolock gibbons will continue to be assessed and be compared to Year 1. |
| | Land use and natural resource use in the buffer zone are well managed through CBNRM. | Develop village natural resource management plans based on results of VCP and VUZ processes. | The number of Community Based Organizations (CBO), such as Natural Resource Management Committees (NRMC) and CF User Groups, formed to manage their natural resources. |

| No. | Context | Activities | EXPECTED OUTPUTS |
|---|---|---|---|
| Year-2 | | Develop village natural resource management plans based on results of VCP and VUZ processes. | Development of draft village natural resource management plans integrating CF and individual agroforestry plans. |
| | | Identify potential community forest areas in village use area of pilot villages and initiate Community Forestry (CF) processes with the participation of communities. | Development of draft domestic rules and regulations associated with village natural resource management plans. |
| | | Identify potential individual entrepreneurs for local conservation enterprises and agroforestry in the pilot villages. | |
| | Baseline forest cover in PA and buffer zone maintained. | Acquire and analyze Landsat 8 satellite images for PA and buffer zone area for Year 2. | # Change in area of forest and non-forest ($km^2$) inside the PA and buffer zone is measured in Year 2 and compared to Year 1. |
| | | | # Forest cover change percentages inside the PA and buffer zone is measured in Year 2 and compared to Year 1. |

| No. | Context | Activities | EXPECTED OUTPUTS |
|---|---|---|---|
| Year-3 | Continued enhanced effectiveness of law enforcement and patrolling through ongoing systematic planning, implementation, monitoring, reporting, adaptive management and capacity building. | Continued regular patrolling based as before on systematic planning, monitoring, and assessment of effectiveness. | Number of on the job trainings and associated regular evaluation to assess understanding of trainees. |
| | | Continued capacity building of law enforcement staff, SMART operators, and PA manager based on the training needs assessments conducted in Years 1 and 2 of the project. | The effectiveness of patrolling will continue to be assessed throughout the project using the following indicators:<br>(1) Patrol days<br>(2) Patrol distance (km)<br>(3) Patrol coverage ($km^2$)<br>(4) Patrol effectiveness (catch - illegal activity events recorded - per unit effort) |
| | A continued stable population of Hoolock gibbon as a result of targeted threat reduction through effective patrolling and community participation in PA management. | Continued assessment of population density of Hoolock gibbons using scientifically accepted auditory methods. | The estimated population of Hoolock gibbon should continue to be stable around the baseline group density of 2.184 ± 0.123 groups per $km^2$. |
| | | Continued assessment of direct threats to Hoolock gibbon through the collection of SMART data. | Intensity, urgency, and area of main threats to Hoolock gibbon will continue to be assessed and be compared to Years 1 and 2 of the project. |
| | Land use and natural resource use in the buffer zone continue to be well managed and improved through CBNRM. | Village natural resource management plans will implemented based on results of VCP and VUZ processes. | Capacity of CBOs such as NRMCs and CF User Groups will continue to be built. |

| No. | Context | Activities | EXPECTED OUTPUTS |
|---|---|---|---|
| Year-2 | | CF will continue to be implemented in village use areas with the participation of communities. | Village natural resource management plans are approved and implemented (integrating CF and individual agroforestry plans). |
| | | Individual entrepreneurs will be implementing local conservation enterprises and agroforestry in pilot villages. | Finalized domestic rules and regulations associated with village natural resource management plans. |
| | Baseline forest cover in the PA and buffer zone is maintained. | Acquire and analyze Landsat 8 satellite images for PA and buffer zone area for Year 3. | Changed area of forest and non-forest in the PA and buffer zone will be compared between Years 1 and 2 and Year 3. |
| | | | Forest cover change percentages inside the PA and buffer zone is measured in Year 3, and compared to Years 1 and 2. |


16/05/2017 08:11