PROJECT: POPULATION ASSESSMENT, HABITAT SUITABILITY AND CONSERVATION OF NORTHERN WHITE-CHEEKED GIBBON (*Nomascus leucogenys*) IN VU QUANG NATIONAL PARK, VIETNAM

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I. INTRODUCTION

Nowadays, biodiversity is increasingly declining, and especially primate species due to habitat loss, hunting, climate change, and other threats (Estrada et al. 2017). The size of the wildlife population most directly illustrates the degree of species endangerment and the effectiveness of conservation policies and practices (McComb et al. 2010). Therefore, knowledge on the population status of species can contribute to conservation efforts and help to address the biodiversity crisis (Hassel-Finnegan et al. 2008; Vu et al. 2018). Understanding the population status of a species is of high importance for monitoring, and also is a top priority for conservation programs and action plans (Buckland et al. 2001). However, we are seriously lacking data on the population status of many species (Sodhi et al. 2009; Tordoff et al. 2012; Coudrat et al. 2013), especially rare species.

Of the 19 gibbon species are considered threatened with extinction means that the information on their population status is crucial and very necessary to monitor and implementing conservation plans. The accurate estimated population for species enables managers and conservationists to determine the threat level and population prioritize for conservation intervention. However, methods used for estimating the gibbon population are still limited with a large number of bias resulting in inaccurate results.

The previous study estimated the density and abundance of gibbon based on the suitable habitat area as the rich and medium forest area (Vu et al., 2016; Ha et al., 2011; Channa and Gray, 2009; Hoang et al., 2010; Vu et al., 2018). The suitable habitat of gibbon depends on the quality of the forest (Geissmann et al., 2000; Pham 2002; Cheyne et al., 2014). However, there are many factors that may influence the distribution of a species, such as elevation, anthropogenic impacts. According to Geissmann et al. (2000), gibbon rarely distributes in the elevation ranging from 1500 to 2000 m a.s.l. Furthermore, Gibbon is a species very sensitive to the presence of humans (Geissmann et al., 2000; Pham Nhat 2002; Treaholt 2005). Therefore, if we only used the type forest in estimating the gibbon population would be higher. It might lead to the overestimation of the gibbon population size. Using MaxEnt modeling is the one way to predict suitable habitat for species from existing information (Phillips et al., 2006). The method has been used for several primate species, for example Sarma et al., 2015; Thorn et al., (2009), Bett et al., (2012), Coudrat et al., (2013), Hansen et al. (2019). Estimating the suitable habitat will not

only allow to increase the accuracy in estimating population size but also enable management broads to determine the higher conservation prioritize.

Northern white cheeked gibbon (*Nomascus leucogenys*) (NWCG) is a crested gibbon, which distributes in northwestern Vietnam, northern Laos and southern China. In Vietnam, the species occurs from the southwest of the Black river (Dien Bien province) to north of Rao Nay river (Ha Tinh province) (Rawson et al. 2011). NWCG was assessed that its population has decreased by at least 80% over the past 45 years (Bleisch et al. 2008), so the species is listed as Critically Endangered in IUCN red list (IUCN 2019). The main threats to the species are illegal hunting and habitat loss because of illegal logging and expanding cultivation areas (Rawson et al 2011, Nguyen et al. 2011). Therefore, the gibbon is a species of special conservation concern in Vietnam as well as Southeast Asia. The total population size of *N. leucogenys* in Vietnam remains unclear. Only a few rapid surveys focused on the status and distribution of the species have been conducted. According to the recent rapid surveys, 84 gibbon groups were detected in 10 isolated protected areas in northern Vietnam (Nguyen et al. 2011). A rapid survey in 13 days in 2011 confirmed 10 groups in northwest of Vu Quang NP, while the majority of the protected area has not been surveyed. Therefore, Vu Quang national park needs to have an additional survey to determine the population size, and conducting the conservation activities in the area (Rawson et al. 2011).

In the study, to provide baseline data for managers and conservationists implementing conservation actions for species, we will use the audio point count method (Brockelman & Ali, 1987), and autonomous recorders to gather field data. We, then, combined Distance Sampling (Buckland et al., 2001, Vu et al. 2018), and Ecological Niche Modeling (MaxEnt model, Phillips et al., 2006) to estimate the population abundance of *N. leucogenys* in Vu Quang NP. The result of population size for the gibbon in the protected area can be used for implementing long-term monitoring and conservation actions.

II. GOAL AND OBJECTIVES

2.1. Goal

The goal of the project was provided and updated information on the population, distribution, and threats of NWCG in Vu Quang NP. The project will also implement activities to enhance the conservation capacity of forest rangers in Vu Quang NP and the awareness on conservation of local communities.

2.2. Objectives

1. To assess the population status of NWCG in Vu Quang NP
2. To identify the threats to the gibbon population and its habitat.
3. To implement gibbon conservation activities in the study area.
4. To provide appropriate recommendations for species management and conservation in Vu Quang NP.

III. METHOD

3.1. Study area

Vu Quang national park (NP) was established in 2002 (Degree 102/2002/QD-TTg of Prime Minister), covering an area with 55.273,6 ha. Currently, Vu Quang NP is located in three districts in Ha Tinh province, including Vu Quang, Huong Khe, Huong Son district. The protected area lies on the Annamite mountain, which is the highest biodiversity area in Vietnam as well as Indochina. Vu Quang National park connects with Huong Son forest to the north and Nakai-Nam Theun National protected area (353,200ha) to the south-west Laos PDR, which is one of the largest primary forest areas for conservation in Indochina (BirdLife International (2019). Until now, 94 mammals, 315 birds, 58 reptiles, and 31 amphibian have been confirmed in Vu Quang NP (Vu Quang NP, 2014). Two new species mammals were discovered from the national park in the 1990s, including Sao La (Sao La - *Pseudoryx nghetinhensis*), and Giant Muntjac (*Muntiacus vuquangensis*) (Vu Quang NP, 2014). The fauna of Vu Quang NP is not only diverse in the number of species but also contains high endemic level in Indochina, such as North white-cheek gibbon (*Nomascus leucogenys*), Edwards's pheasant (*Lophura edwardsi*). Therefore, Vu Quang NP was assessed as an important site in conserving wild animals, especially large mammals (Eve 2000). Furthermore, the protected area is also determined as an important bird area in Vietnam (Tordoff 2002; BirdLife International, 2019), and lies Annamese Lowlands Endemic Bird Area (BirdLife International, 2019). In addition, the protected area reported that 1678 flora species with 191 families have been confirmed (Vu Quang NP, 2014). In which, 94 species were listed in the Vietnam Red List Book (2007). Therefore, Vu Quang NP is considered as an important regional conservation priority in Vietnam. However, the ecosystem in Vu Quang NP is facing the degradation due to anthropogenic impacts such as deforestation, illegal wildlife hunting, fragmented habitat (Eve, 2000; Birdlife International, 2019).
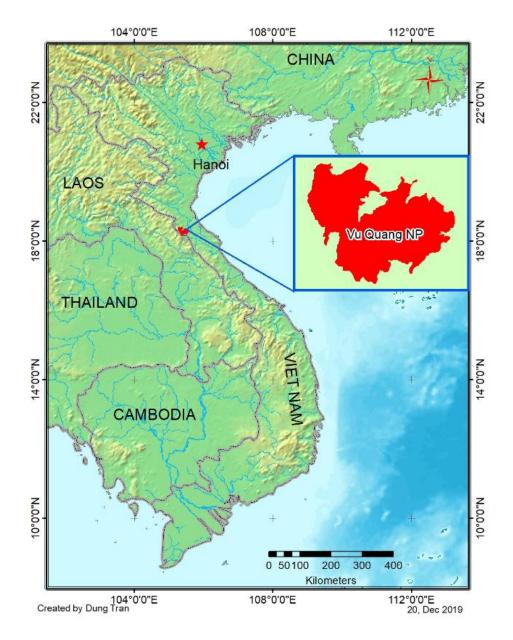
Figure 1. Location of Vu Quang NP in Vietnam

3.2. Interview method

An open questionnaire method will be used. Interviewees are local hunters, forest rangers and nature reserve's staffs, who have historically interacted with the forests about the distribution of the species in the areas. They will be asked about the presence, locations, group structure as well as main threats of gibbon population by surveyors. An assessment form will be created to assess the level of awareness on the gibbon of interviewees. Information acquired via the interviews will also be used to aid the field survey results and evaluating the threats the endangered species are facing.

3.3. Survey method

In the project, we will use the auditory point count method to assess gibbon population size and density during the survey (Brockelman & Ali, 1987). Group and

individuals will be recorded using combine information from angles, distances, and song characteristics. The sampling points will be defined by topographic and habitat in the survey areas. At least 20 sites and 60 listening points in the study area will be surveyed. Each sampling point will be recorded for at least 3 days. Surveyors will listen from 04:00 to 11:00. During the surveys, the surveyors will record compass bearing, distance to the calling gibbon, start and end time of all song bouts and type of songs. The distance from listening posts to the gibbon call location was estimated using a rangefinder. GPS devices were used to record the location of the listening posts in the field. Information about wildlife trapping and habitat disturbances will also be gathered.
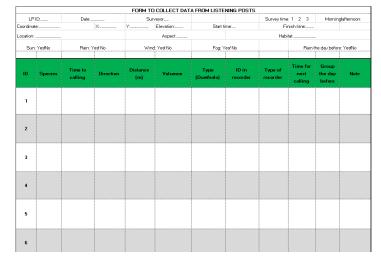
Table 1: Form for collecting data from listening posts

FORM TO COLLECT DATA FROM LISTENING POSTS										

During the same sampling time period, at each site, three full spectrum recorders synchronized with satellite clock (SM3, Wildlife Acoustics Inc.) will be set up to record the songs of gibbon. The recorders will be set to record from 04:00 to 20:00. The data from recorders will be used to aid the auditory point count method.

In each listening post, surveyors will also collect habitat characteristic with 6 covariates including: Tree density, Average tree height, Canopy density, Human disturbance, Habitat type, Distance to settlements (km). The data will be applied to assess habitat quality of the area. We will use the data as an input data for ecological niche modelling in projecting the suitable habitat for gibbon.

3.4. Data analysis

Locations of gibbon groups will be determined through the triangulation using the angle and distance from surveyors because there is overlap among listening posts in MapInfo 10.5 (Pitney Bowes Business Insight). Different groups will be differentiated by their locations. If detected groups are >500m apart (Brockelman & Ali, 1987) they will be considered separate groups.

Moreover, we will use vocalization software to analyze and determine the total number of gibbon individuals in each group base on the structure of the songs. RAVEN software (Cornell Lab of Ornithology) will be used to generate spectrograms and count individuals. The sonograms could help to distinguish between the songs of male, female or juvenile gibbons. Crested gibbon songs consist of phrases from both sexes. The great call is produced by adult females, is the most easily identifiable phrase of the gibbon song. A duet is a song bout in which both sexes produce their loud vocalizations and exhibit vigorous movements in an interactive manner. Young gibbons normally give calls with their parents at the same time and thus can easily be counted in sonograms (Konrad & Geissmann, 2006).

We will use the distance sampling method (Buckland et al., 2001) to estimate the population density in the study area by Distance program (Thomas et al., 2010). The distance sampling method allows for reduced detection probability of animals as distance increases. Statistic models including Uniform, Half normal, Hazard rate, and Negative exponential will be used to model the relation between detection probability and distance. The best models will be selected using Aikaike information criteria (AIC) (Buckland et al., 2001). One main assumption of distance sampling is detection on the line or at the listening station will equal to one. If not, an estimated detection probability on the line or at the listening/observing station is needed to correct density estimates. This estimate is necessary for gibbon surveys because gibbons do not call every day (Brockelman & Ali, 1987).

Species distribution modelling uses species occurrence data, along with environmental predictor variables to project a model of suitable habitat for species from existing information (Phillips et al. 2006). We will use the MaxEnt (v. 3.3.3k; Phillips et al. 2006) with the user-defined parameters to model the suitable habitat of gibbon in Vu Quang NP. Forty-two models with combinations of the "feature class" and "regularization multiplier", and a default auto – feature were used to compare and select the best model. In the study, we used six types and combinations of restriction ("feature class") including linear (L), quadratic (Q), threshold (T), hinge (H), linear+ quadratic (L+Q), and liner + quadratic + hinge (L+Q+H) (Morales et al. 2017). Each of feature class was combined with regularization multiplier values: 0.5; 0.75; 1; 1.25; 1.5; 1.75, and 2. To select the best model, we will apply ENMTOOLS software version 1.4.4 (Warren et al. 2011) to calculate the Akaike information criterion (AICc). MaxEnt software can generate a map layer with pixels representing suitable level with values ranging from 0 to 1. Outputs of the model will be analyzed by using ArcMap software version 10.2 (ESRI, Redlands, USA). The area of suitable habitat was used to calculate the density of gibbon in the study area.

The conservation activities will be implemented with the collaboration of Vietnam National University and Vu Quang NP. Community meeting in order to talk

about protecting wildlife will be conducted in six communes in the buffer zone of Vu Quang NP. The posters, and T-shirts will be printed gibbon's photo as a tool to encourage people to protect gibbon. It will be supplied for trainers, some students, and local people. The material for conservation activities will be prepared by team leader.

Preparing the documents of appropriate recommendations for gibbon conservation will be proposed base on the population status, distribution, threats on the gibbon. Importantly, the level of awareness of local communities and staffs of NR will be considered in the recommendation for gibbon.

IV.PROJECT ACTIVITIES

4.1. Fieldwork

Time for fieldwork will be implemented from May 2020 to July 2020.

+ Interview activities will be conducted in 12 communes including staffs of Vu Quang NP (2 days), Vu Quang District (4 days); Huong Son District (2 days) and Huong Khe District (4 days). These communes are located in the core zone and the buffer zone of Vu Quang NP.

+ Field surveys will be conducted in core zone of Vu Quang, in 60 days including Vu Quang District (28 days); Huong Son District, 12 days, and Huong Khe District (20 days).

4.2. Activities and Timescale

Phase 1: Pre-project (In Vietnam National University of Forestry) (from April/2020)

In this phase, the team will make sure that the project aims to achieve. Therefore, the project leader and the team will review all of the aims, objectives, methods, and plans of the project. In addition, the project leader will ensure that the project has sufficient fund secured before starting other conservation activities. Finishing the phase, the final project plan will be complete, which is the blueprint for the project from other activities. The final project plan cannot be changed. Now, the project is funded by Vietnam National University for the survey activities for surveyors, and equipment, including 4 team members, 01 office room, 03 autonomous recorders, 03 cameras.

Phase 2: Project Initiate (In Vietnam National University of Forestry) from 1st May 2020 to 10th May 2020.

The purpose of this phase is to prepare for a successful implementation of the project. Main activities are:

- Preparing for interviewing local communities and staffs of NP (semi-open questions, the photos of gibbon, the songs of gibbon) (3 days)

- Preparing for the survey: document, maps, food, equipment (GPS, Camera, recorder (SM3 song meter)… (3 days).

- Preparing materials to train team members (document, notebook) (1 days)
- Training team members (3 days).

Phase 3: Project Implementation

Field survey (Vu Quang NP, Ha Tinh province) from 15th May 2020 to 15th September 2020.

The purpose of this phase is to deliver the project results. Main activities are:

- Interviewing local people and staff members of Vu Quang NP. The team will divide into two groups for interviewing 12 communes (10 days) from 15th May 2020 to 25th May 2020.

- Surveying in Vu Quang NP (Field survey 60 days) from 26th May 2020 to 25th July 2020.

Data analyzing (in Vietnam National University of Forestry).

- Analyzing data (20 days) from 1st August 2020 to 20th August 2020.

- Preparing for conservation activities in Vu Quang NP (5 days): Photos, Posters, T-shirt, plans (August 2020)

- Writing mid-project report (September 2020).

- Implementing conservation activities in Vu Quang NP (We will chose 6 commune to implement conservation activities) (15 days). From 1st September 2020 to 15th Sep 2020.

- Writing project report, receiving the comment from reviewers (40 days) from 20th Sep 2020 to 30th Oct 2020.

- Writing manuscript and submitting to an international scientific journal from November 2020 to December 2020.

- Creating a poster from the information and the picture which are collected from the field survey of the project in January 2021.

- Reporting to the Vu Quang's director and deliver the poster to Vu Quang NP in February 2021.

Phase 4: Project close (Vietnam National University of Forestry and Vu Quang NP).

The purpose of project close is to evaluate the project, hand over project documents, and to stop any further expenditure of funds and staff time on project activities.

Submitting the final project report to the grant in March 2021

The leader of the project will hold a project-end meeting to close the project in March/2021.

The schedule of project is showed in table 2.

Table 2. The schedule of the project

No	Phase	Activities	Duration	2020									2021		
				4	5	6	7	8	9	10	11	12	1	2	3
1	Phase 1: Pre-project	The team will make sure that the project aims to achieve	10 days	■											
2	Phase 2: Project initiate	Preparing for interviewing	3 days		■										
3		Preparing for the survey: document, maps, food, equipment (GPS, Camera, recorder (SM3 song meter)	3 days		■										
4		Preparing materials to train team members (document, notebook).	1 day		■										
5		Training team members.	3 days		■										
6	Phase 3: Project Implementation	Interviewing local people and staff members of Vu Quang NP.	10 days		■										
7		Surveying in Vu Quang NP	60 days		■	■	■								
8		Data analyzing	20 days					■							
9		Preparing for conservation activities in Vu Quang NP	5 days					■							
10		Writing mid-project report							■						
11		Implementing conservation activities in Vu Quang NP	15 days							■					
12		Writing project report	4 weeks								■				
13		Writing manuscript and submitting to an international scientific journal	12 months								■	■			
14		Creating a poster	2 days										■		
15		Reporting to the Vu Quang's director and deliver the poster to Vu Quang NP	1 day											■	
16	Phase 4: Finishing project	Submitting the final project report to the grant													■
17		The leader of the project will hold a project-end meeting to close the project	1 day												■

4.3. Monitoring

The project leader is responsible for the success of the project. Therefore, the project leader will monitor the through the objectives.

Objective 1 and 2: The success of this objective is data about the status, distribution of, and threats to NYCG. The result of this objective includes data tables, audio files, pictures, and GPS data. At least 01 article of this objective will be accepted to a scientific journal.

Objective 3: The success of the objective is the number of meeting (and the number of local people) to encourage local people participating in conservation activities. The quick interviews will be conducted before and after each meeting, and the awareness of local people will be assessed when compared the results of quick interviews.

Objective 4: This objective will be considered successful if an appropriate recommendation for gibbon conservation is completed after receiving comments from experts and Vu Quang NP's director.

Furthermore, we also analyze the threats of the project.

Threats:

Vu Quang is a large, complex topography area. The climate in Ha Tinh province is harsh, especially in the rainy season so the schedule might be subjected to change slightly. The field survey should be conducted in the dry season, later field survey might lead to many difficulties for surveyors. Vu Quang NP has many ethnic

minorities which lead to difficult in communicating between our team and local communities.

Solutions to address the threats: We will select the fieldwork area and schedule of survey based on the support of the Vu Quang NP and local people. Working plan will be made well-advanced before the implementation of the project. Right after the proposal is approved, we will start arranging for the project. We will seek the support from local forest rangers in organizing and preparing, communicating with local people for the project.

V. CONSERVATION OUTPUTS

Products of the project:

+ A project report: The report will contain all information related to the project, including population status, population size, distribution, main threats to gibbon population, recommendation for species management and conservation in Vu Quang NP. We expect that one of the largest population of NWCG will be explored.

+ Project results will be published in a journal article (at least 01 from the result of this project will be published in an international journal (Asian Primates Journal or International Journal of Primatology).

+ At least one news of field work will be published on the website of Vietnam National University of Forestry.

+ The results of this project will be updated on the lectures of Department of Wildlife, Vietnam National University of Forestry.

The results of the project will provide important information for:

Decision makers including Ministry of Agriculture and Rural Development and Ministry of Natural resources and Environment (Vietnam): The study results will provide information for conservation planning within the country and national action plan for conservation endangered primates species.

National Park: The project will benefit the nature reserve by providing information on the status, distribution and key threats to the targeted species and enhance their capacity in biodiversity monitoring and conservation. They will have an overview to prepare next step support to protect wildlife.

Vietnam National University of Forestry: The knowledge and experiences from this project will also be used as teaching materials.

NGO: NGO can use project results as referential information to develop conservation programs.

Team members: Through the project, the team members will improve their skills and experiences in implementing conservation program, including biodiversity monitoring, data analysis, writing reports, working with nature reserve and working with local people.

VI.TEAM MEMBER

1. **Principal investigator: Tran Van Dung;** lecturer at Wildlife Department (Vietnam National University of Forestry)

As a lecturer at Wildlife Department, I focus on conserving primates, especially gibbon species. Throughout various research projects, I have been gaining profound skills and experiences in fieldwork, data analysis, and working with local people. Some of those subjects are: Research on gibbons in Chu Yang Sin NP, Ngoc Linh NR, Cat Tien NP, Song Thanh NR. Especially, I received the grant for Early Career Grant from National Geographic, and Rufford Small Grant in 2018. I also participated in the IPS Pre-Congress Training Program about primate conservation, in Kenya, 2018. I have the ability to apply the bioacoustics method. Furthermore, I also studying on ecological niche modelling to predict the potential distribution of wildlife species, as well as the impacts of climate change on their distribution. With my knowledge and experience, I believe that I will implement successfully the project in conserving Northern white-cheeked gibbon in Vu Quang NP.

In this project, I will work with my supervisor (Dr. Thinh Vu) and two colleagues who have collaborated with me in several projects

2. **Assoc. Prof. Dr. Thinh Vu (co-principal investigator)**

Head of the Department of Wildlife
Faculty of Natural Resource and Environmental Management,
Deputy Head, Division of Post-Graduate Study
The Forestry University of Vietnam
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Dr. Thinh Vu is one of the experts in gibbon survey. He has managed successfully several gibbon survey such as in Chu Yang Sin NP, Cat Tien NP, Ngoc Linh NR. He is also co-author of computer package "calculating gibbon population density from auditory surveys" funded by Conservation International. Furthermore, he has published a lot of articles relevant to gibbon surveys. With his experience, Dr. Thinh Vu promised to support in training, designing the field survey, data analysis and revising the reports and publications for this project.

3. **Mr. Giang Trong Toan**, lecturer at Wildlife Department (Vietnam National University of Forestry) Email: giangtoan51a@gmail.com
4. **Mr. Nguyen Van Manh,** Forest ranger at Vu Quang NP, Ha Tinh province.

Mr. Giang Toan, Mr. Manh Nguyen also have experience in gibbon surveys. They will support Dung Tran in fieldwork. Especially, Mr. Manh Nguyen works as a forest ranger in Vu Quang NP. Thus, he will not only participate in collecting field data and implement conservation activities but also help Dung Tran to easily contact with local authorities.

VII. BUDGET DETAILS

+ Total budget requested from Gibbon Conservation Alliance (GCA): 5,000 USD

+ Total budget requested from Department of Wildlife, Vietnam National University of Forestry (VNUF): 1,484 USD

+ Total budget of the project: 6,484 USD.

In addition, the VNUF will provide officer and allow its staff to take part in the project (room 310, A1). Dept. of Wildlife agreed for our team to borrow some equipment including: three recorders (SM3, Wildlife acoustic), three cameras, binocular, and compass.

No	Description	Amount from GCA ($)	From others ($)	Note
1	Vehicle Rental: 2 motorbikes x 50 days x $8 (travel during interview (5 days) and fieldwork (40 days) by motorbike (2 people/1 motorbikes), and conservation activities (5 days)	800		
2	Vehicle Gas and Maintenance: Gas for motorbikes during interview, fieldwork, and conservation activities (2 x 50 days x $3)	300		
3	Travel: 4 team members x $50 (Travel from Hanoi to study sites and vice versa by coach (Hanoi - Vu Quang NP) for field survey.	200		
4	Travel: 2 team members x $50 (Travel from Hanoi to study sites and vice versa by coach (Hanoi - Vu Quang NP) for implementing conservation activities	100		
6	Lodging: 15 days (5 days interview and 10 days fieldwork)x $10x 2 rooms (2 people/room) (other days in fieldwork will stay in camp in the forest)	300		
7	Lodging for conservation activities (1 room x 5 days x $10)	50		
8	Food in interview process: 6 people (4 team members + 2 local guides) x 5 days interview x $5)	150		
9	Food for field survey: (7 people (4 team members + 1 forest ranger + 2 local guide) x 40 days fieldwork x $5))	1400		

10	Food for conservation activities: (3 people (2team members + 1 forest ranger) x 5 days x $5))	75		
11	Wage for assistants (local guides) $7/ person/day (2 people x5 interview days) + (4 people x 40 fieldwork days)	910		
12	T-shirt ($8 x 50)	400		
13	Printing poster ($3 x 5 posters)	15		
14	Batteries for digital camera, GPS, recorders and other field equipment (20 package of 4 Energizer AAA x $2 + 80 package of 2 Energizer D x $2)	200		
15	First aid kits: 3 kits x $10 + $20 medical supplies.	50		
16	Communications (telephone/internet/postage)	50		
17	Camping equipment: Hammocks (8 kits x $12) tents (8 kits x $20), sleeping bags (8 kits x $20), candles (40 boxes x $2), cooking utensils (1 kits x $30) +Garmin GPSMAP 78 (3 GPS x $169.93)		956	VNUF
18	Individual field equipment: 6 surveyors and 2 local guides: Field clothes and shoes (8 kits x $20); backpacks (8 x $20); notebooks (6 kits x $2); stationery (6 kits x $2); rain jackets (8 kits x $3); headlamps (8 kits x $20)		528	VNUF
Total		**5,000**	**1,484**	**6,484**

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