April 13, 2023

LORMELYN E. CLAUDIO, CESO IV
Regional Executive Director
Department of Environment and Natural Resources (Region 4B)
1515 L&S Building, Roxas Boulevard, Ermita, Manila

Subject: **Endorsement for the acquisition of Wildlife Gratuitous permit for the project: "Multidisciplinary Approaches for TAmaraw Protection Against Threats (MATAPAT) in Mt. Calavite Wildlife Sanctuary, Occidental Mindoro"**

Dear Dir.Claudio:

Good day!

I am hereby endorsing the request of **NIKKI HEHERSON A. DAGAMAC, DR.RER.NAT,** an Assistant Professor of the Department of Biological Sciences, College of Science at the University of Santo Tomas, to secure a Wildlife Gratuitous Permit for the collection of leaf litter and woody substrates for his DOST-GIA-funded project, **"Multidisciplinary Approaches for TAmaraw Protection Against Threats (MATAPAT) in Mt. Calavite Wildlife Sanctuary, Occidental Mindoro".** Mainly, this project aims to establish a comprehensive inventory of Tamaraw in Mt. Calavite Wildlife Sanctuary, Occidental Mindoro using enhanced protocol for sampling and analysis of habitat suitability. Moreover, this project also wanted explore the protist (Myxomycetes) diversity through the collection of 50 ground leaf litters, 50 aerial leaf litters, 50 twig samples, and 50 bark samples, hence this recommendation for their application for Wildlife Gratuitous Permit.

We look forward to your favorable response and I hope you can provide assistance in facilitating the acquisition of the necessary permits.

Thank you very much.

Respectfully,

Sittie Aisha B. Macabago, Ph.D.
Assistant Professor
Department of Biological Sciences, CAS
University of Santo Tomas

April 14, 2023

Authorization letter

To whom it may concern,

This is to authorize the bearer of this letter, Mr. John Carlo R. Santos, my project assistant to submit to your good office my application for Wildlife Gratuitous Permit (GP).

I am not able to submit the application personally due to my tight and strict schedule in my university. Please consider this submission on my behalf. Together with this letter is a copy of my Philippine passport and my institution's ID.

I hope for your kind consideration and thank you very much.

Sincerely yours,

Nikki Heherson A. Dagamac, Dr.rer.nat
Assistant Professor
Department of Biological Sciences, College of Science
University of Santo Tomas

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Maka-Tao,
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at Makabansa.
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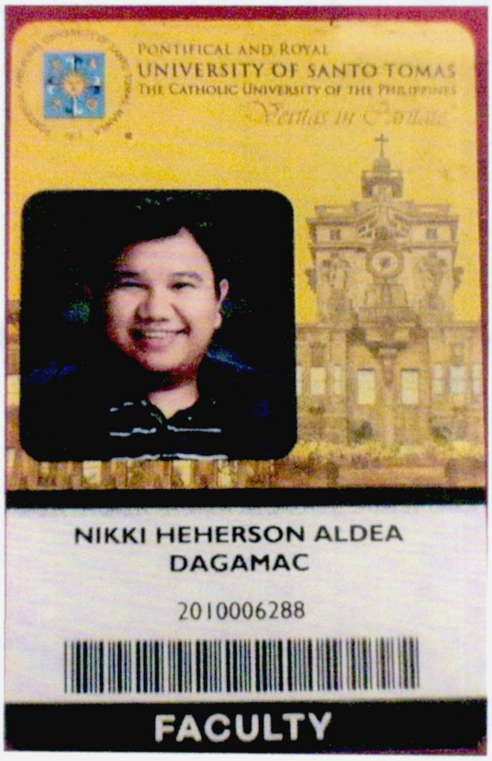

PONTIFICAL AND ROYAL
UNIVERSITY OF SANTO TOMAS
THE CATHOLIC UNIVERSITY OF THE PHILIPPINES
Veritas in Caritate
NIKKI HEHERSON ALDEA
DAGAMAC
2010006288
FACULTY

Republic of the Philippines
Department of Environment and Natural Resources
Region 4B (MIMAROPA)
L&S Bldg, 1515 Roxas Boulevard, Malate, Manila
E-mail: denrncr@hotmail.com

APPLICATION FOR: **PERMIT FOR OTHER USES OF WILDLIFE**
(Subject in Duplicate)

A. COMMERCIAL

☐ EXHIBITION/SHOWS

_____Animal _____Plant

☐ EDUCATIONAL/DOCUMENTATION

_____Animal _____Plant

B. RESEARCH

_____Animal ✔ Plant

C. ☐ CLEARANCE TO OPERATE

_____Animal _____Plant

April 15, 2023
(Date)

The Regional Director
DENR – Region 4B
L&S Bldg, 1515 Roxas Boulevard,
Malate, Manila

Thru: The ARD, Technical Services

Sir/Madam:

In accordance with R.A. 9147 otherwise known as the Wildlife Resource Conservation and Protection Act and other pertinent wildlife rules and regulations with which I shall familiarize myself and to which strict compliance of same is hereby promised,

1. I, Nikki Heherson A. Dagamac have the honor to apply for the above permit.
2. I am 35 years of age, citizen of the Republic of the Philippines, by birth
   (if by naturalization, submit papers for verification)
   Date of birth: May 16, 1987 Place: Quezon City, Metro Manila
   Residence: 1249 Dos Castillas, Sampaloc, Manila Tel No.: 0976 033 7369
   Business Address: Espana St., Sampaloc, Manila Tel No.: ________
3. My occupation/profession is an/a Assistant Professor
4. I am single/married and the name of my spouse/wife is ________
5. I am member/not a member of a sportsmen and/or game club and/or scientific or conservation society. State name/s of organization/s, if a member Research Center for the Natural and Applied Sciences, University of Santo Tomas.
6. I intend to use the following wildlife for exhibition/education/research:

Kind/Species	No.	Kind/Species	No.
Aerial leaf litter	50	Bark samples	50
Ground leaf litter	50		
Twig samples	50		

8. I understand that the information stated in this application are true and correct andany omission of facts herein shall cause the disapproval of this application and/or cancellation of the permit that may be issued to me.
9. I understand that the filing of this application conveys no right to take, collect or possess any wildlife until a permit is issued to me by the Regional Director of DENR- R4B.
10. The Application fee of Php____________in____________made payable to the Regional Director, DENR-R4B with Official Receipt No.__________________is herewith enclosed. Non-approval or non-issuance of the permit does not entitle me to refund the fee.

(Signature of Applicant)

TIN: 249-123-206-0000

1249 Dos Castillas, Sampaloc, Manila
(Address)

REPUBLIC OF THE PHILIPPINES)
QUEZON CITY:

SUBSCRIBE AND SWORN to before me this ______________________
Day of__________________, 20_. Applicant exhibited to me his/her Community TaxNo. ______________________________, issued at ______________________________
on__________________________20_____.

____
(Officer authorized to Administer Oath)
Print Name Clearly and Sign

____
(Official Designation)

Republic of the Philippines
Department of Environment and Natural Resources
MIMAROPA Region
COMMUNITY ENVIRONMENT AND NATURAL RESOURCES OFFICE
MT. CALAVITE WILDLIFE SANCTUARY
PROTECTED AREA MANAGEMENT OFFICE

HALAW MULA SA KATITIKAN NG 3rd REGULAR NA PAGPUPULONG NG PROTECTED AREA MANAGEMENT BOARD NG MT. CALAVITE WILDLIFE SANCTUARY NA GINANAP NUONG IKA-8 NG SETYEMBRE TAONG 2022, SA NAPS-EMERALD RESTO BAR, PAG-ASA, BARANGAY PAYOMPON, BAYAN NG MAMBURAO, KANLURANG MINDORO.

KAPASIYAHAN BLG. 2022-017, SERYE NG 2022

(RESOLUTION NO. 2022-017, SERIES OF 2022)

KAPASYAHANG NAGHAHAYAG NG PAHINTULOT NA MABIGYAN NG GRATUITOUS PERMIT ANG PROYEKTONG "MULTI-DISCIPLINARY APPROACHES FOR TAMARAW PROTECTION AGAINST THREATS (MATAPAT) UPANG MAKAPANGOLEKTA NG "LEAF AND WOODY SUBSTRATES" SA LOOB NG MT. CALAVITE WILDLIFE SANCTUARY (MCWS)

SAPAGKAT, ang project MATAPAT sa pamamagitan ni Ginoong Nikki Heherson A. Dagamac, ay nagpahayag ng intensyon na makakakuha o makakolekta ng "leaf and woody substrates sa loob ng MCWS, upang makapagsagawa ng pagaaral patungkol sa "myxomycetes" na maaaring makita o madiskubre sa nasabing pinangangalagaang pook;

SAPAGKAT, ang project MATAPAT ay naglalayong makakolekta ng limampung (50) "aerial leaf litter", limampung (50) "ground leaf litter", limampung (50) "pieces of twigs", at limampung (50) "small bark samples".

SAPAGKAT, ang nasabing pag-aaral ay maaring makapagbigay ng makabuluhan at makabagong impormasyon patungkol sa distribusyon at pagkakaiba-iba ng myxomycetes na matatagpuan sa MCWS;

SAPAGKAT, ang pag-aaral ay isasagawa sa buwan ng Nobyembre hanggang Disyembre taong 2022;

CERTIFIED PHOTOCOPY
FROM ORIGINAL COPY
HELEN M. ALCOBER
In-Charge, Records Office
CENRO Sablayan Coordinating

Republic of the Philippines
Department of Environment and Natural Resources
MIMAROPA Region
COMMUNITY ENVIRONMENT AND NATURAL RESOURCES OFFICE
MT. CALAVITE WILDLIFE SANCTUARY
PROTECTED AREA MANAGEMENT OFFICE

KUNG KAYA'T DAHIL DITO, pagkaraang mapagnilay-nilayan sa pamamagitan ng deliberasyon at sa mosyon ni PAMB Member Elorde A. Marasigan, na pinangalawahan ni PAMB Member Josue C. Delfin, PINAGTIBAY, AT SA NGAYON NGA'Y PINAGTITIBAY, ng Mt. Calavite Wildlife Sanctuary Protected Area Management Board, ang kapasiyahan na naghahayag ng pahintulot na mabigyan ng "Gratuitous Permit" sa isasagawang pagkolekta ang Project MATAPAT sa loob ng pinangangalagaang pook o ang Mt. Calavite Wildlife Sanctuary.

KARAGDAGANG PINAGTIBAY, na ang resulta ng pag-aaral, larawan at ibang dokumento ay ibabahagi sa MCWS-PAMB, PAMO at sa lahat ng angkop na ahensya ng pamahalaan para sa kanilang nararapat na pagkilos at dokumentasyon.

PINAGTIBAY, ngayong ika-8 ng Setyembre, 2022 na ginanap sa NAPS-Emerald Resto Bar, Pag-asa, Barangay Payompon, Mamburao, Occidental Mindoro.

Inihanda ni:

JOSIE R. CORDUZ
ECOMS I/Technical Support Staff
Member, PAMB Secretariat

Sinuri at pinatutunayang wasto:

ARLENE V. FRANCISCO
Protected Area Superintendent
Head, PAMB Secretariat

Pinatotohanang pinagtibay:

MENARDO A. TORIANA
Punong Tagapangulo
PAMB Member

Pinatotohanan:

LORMELYN E. CLAUDIO,CESO IV
Ang Punong-Konseho ng PAMB
Regional Executive Director
DENR-MIMAROPA Region

CERTIFIED PHOTOCOPY
FROM ORIGINAL COPY
HELEN M. ALCOBER
In-charge, Records Officer
CENRO Sablayan Coordinating

(1) PROJECT PROFILE
Program Title:---
Project Title: Multidisciplinary Approaches for TAmaraw Protection Against Threats (MATAPAT) in Mt. Calavite Wildlife Sanctuary, Occidental Mindoro, Philippines
Project Leader/Sex: Nikki Heherson A. Dagamac / Male
Agency: Department of Biological Sciences, University of Santo Tomas
Address/Telephone/Fax/Email: College of Science, España 1008 Manila/nhadagamac@gmail.com

(2) COOPERATING AGENCY/IES: D'ABOUVILLE FOUNDATION

(3) SITE(S) OF IMPLEMENTATION (Municipality / District / Province / Region)
Base Station: Mt. Calavite Wildlife Sanctuary, Municipalities of Paluan and Mamburao/Lone District/Occidental Mindoro/Region IV-B
Other Site(s) of Implementation: N/A

(4) TYPE OF RESEARCH	(5) R&D PRIORITY AREA & PROGRAM (based on HNRDA 2017-2022)
__X__ Basic _____ Applied	__X__ Agriculture, Aquatic and Natural Resources Sector: _Biodiversity (Tamaraw Program)__ _____ Health Sector: _______________ _____ Industry, Energy and Emerging Technology Sector: _______________ _____ Disaster Risk Reduction and Climate Change Adaptation Sector: _______________ _____ Basic Research Sector: _______________

A. IDENTITY OF RESEARCHER

B. RATIONALE

Bubalus mindorensis or Tamaraw is a critically endangered wildlife known to be endemic in Mindoro, Philippines. Historically, tamaraws were known to be endemic on the islands of Mindoro with suspicion that it was once widely distributed in the whole archipelago since related species was accounted in Cebu and other areas in Luzon during prehistoric time. Tamaraws are believed to be living together with indigenous ethnic group of people known as the Mangyans. However, the population size of this national wildlife emblem starts to decline due to many factors. For instance, the increased anthropogenic activities such as landscape fragmentation, wildlife poaching or slash and burn farming contribute to the rapid decrease of their population size. Biological invasions of non-native plants, such as weeds or grasses, have been suspected to alter the natural diet of the tamaraws making such factor to be considered a density dependent factor that affected their drastic shifts in population size over the last decades. Although such speculation remains since this supposition continued to be an ecological gap for many decades until now.

Currently, only four Tamaraw sub-populations are known to survive on the island. Based on the most recent surveys and animal counts, the bulk population is in Mts. Iglit-Baco National Park (MIBNP) with an estimated number of more or less 500 individuals. However, space for further growth for the species in MIBNP is now limited and may decline in the future due to impact of fires, invasive plants and uncontrolled hunting from residing indigenous communities. Thus, identification of areas for possible translocation is urgent (DENR 20219). Meanwhile, Tamaraw sub-populations in Mt. Calavite Wildlife Sanctuary, Mt. Aruyan-Malati, Upper Amnay Watershed and Mt. Gimparay varies from 15 to 70 individuals only. However, according to DENR (2019), sub-populations in the latter three areas may not survive if no supplementation is conducted. Moreover, the present status, distribution and niche ranges of the Tamaraw in these areas are still a major challenge, hindering translocation strategies. Such knowledge is considered to be important especially in developing the right conservation effort and wildlife management that the local environmental units needed for their protection.

Hence, to further fill the missing gaps of the distribution and remaining suitable habitats of the Tamaraw that would help address the R&D priority programs of DOST-PCAARRD and to gather information on bio-sociological impacts of Tamaraws on ethnic minorities of the areas to answer in the call of UN Sustainable Development Goals (SDG 15, Life on Land), PROJECT MATAPAT was conceptualized. The idea is that this project will run for several project phases that will run for the next three years focusing on collecting data around the selected protected landscapes in Mindoro. For the first 2 years, PROJECT MATAPAT is planned to be implemented in MCWS to investigate the distribution and present status of Tamaraw in the protected area. This is due to the fact that most of the accounted record of wildlife and terrestrial flora in the area is considered to be relatively scarce. Case in point, the population of Tamaraws and other wildlife and biological organism in Mt. Calavite is confirmed but have never been intensely monitored. Moreover, PROJECT MATAPAT also aims to conduct habitat suitability analysis using ecological niche modelling to identify areas of high conservation priority for the critically endangered Tamaraw across the island of Mindoro under the current and future climatic scenarios.

C. OBJECTIVES

SPECIFIC GOAL: To establish the comprehensive inventory of Tamaraw in Mt. Calavite Wildlife Sanctuary using enhance protocol for sampling and analysis of habitat suitability.

To address this specific goal this projects is packaged into three subprojects that would be conducted in parallel during the whole two year duration of the research study. Listed below are the projects and their corresponding objectives:

Component A. Tamaraw Inventory and Movement using Approaches for Wildlife Analysis

- Collect photographic evidence using camera traps and record indirect signs of Tamaraw across the Strict Protection Zone (SPZ) of MCWS.
- Assess the present status and distribution of Tamaraws in the SPZ.
- Provide a Relative Abundance Index for the Tamaraw and other photographed wildlife in the SPZ.
- Understand the local hunting systems and patterns, resiliency to climate change, and indigenous practices and knowledge of the Mangyan tribe in Mt. Calavite Wildlife Sanctuary

Component B. Habitat Suitability modeling of landscapes

- Identify and visualize the suitable habitats and potential distribution of Tamaraw under current and future climatic scenarios.
- Explain how environmental variables affect the distribution of the Tamaraw.
- Understand the vulnerability of the Tamaraw's habitat to future climate change by estimating the amount and distribution of potential suitable habitat for the species both under current climate and future climate change scenarios.
- Provide suggestion to identify areas with high conservation priority for existing sub-populations of Tamaraw.

Component C. Protist Assessment on Niches Associated with Tamaraw

- Collect plant litter and dung samples to establish the first inventory of myxoymcete flora in Mt. Calavite Wildlife Sanctuary
- Measure the diversity of protist associated on different elevational belts (vegetations) where Tamaraw populations maybe thriving using myxomycetes as models

D. REVIEW OF LITERATURES

Methods in wildlife monitoring for medium to large-sized mammals

For the past decades, different techniques on biodiversity assessment have been developed to survey mammals of different sizes (see Hoffman et al. 2010). Traditional methods that are commonly employed for mammal inventories and research include direct counts (Silveira et al. 2003), line transects (Plumptre 2000), trapping (Kasangaki et al. 2003), interview with the locals (da Silva Neto 2017), and indirect evidence through nests, tracks, and signs (Plumptre & Reynolds 1997). There are also techniques that use more advanced technology and are more cost-effective for monitoring mammals. As an example, camera traps (McCleery et al. 2014, McDonald et al. 2015), and radio-telemetry (Collins & Kays 2014, Clement et al. 2015) are used as a tool to conduct surveys or record general observations as it is an efficient, non-labour intensive and easily replicable tool to study and monitor both ground-dwelling (O'Connel & Bailey 2011, Rovero et al. 2013a) and arboreal wildlife populations (Méndez-Carvajal 2014, Olson et al. 2012). Moreover, use of hair samples from hair tubes is also now a technique to record species occurrence wherein animals can freely enter and leave the tube leaving behind a hair sample on an affixedd sticky tape and identify the species through hair morphological examination (Bertolino et al. 2009). For medium to large-sized mammals, however, distance sampling, radio telemetry and camera trapping are commonly employed (Dirzo & Miranda 1990, Peres 1996, Voss & Emmons 1996, Tobler et al. 2008).

The use of distance sampling technique has become increasingly popular to estimate animal population densities since the production of the computer package transect (Laake et al. 1979) and distance (Buckland et al. 1993, Laake et al. 1994). Surveyors of this technique can utilize both direct and indirect observations such as nests (Hashimoto 1995, Ihobe 1995) and dung (Barnes 2008) to record the occurrence or estimate density of the animals through observing in transects. Basically, the idea of distance sampling is to establish transects in a random design. Transects can be either line or point transects, which correspond to rectangular and circle shaped survey plots, respectively. These transects are then surveyed by having an observer either moving along the line, in the case of line transects, or standing at the point for a short period of time, in the case of point transects, and recording the distances to all the detected animals. More specifically, it is the perpendicular distance from the line in the case of lines and the radial or animal-to-observer distance in the case of points that is being measured.

Meanwhile, radio-telemetry technology and tracking methods for studying the behaviour and ecology of wild animals have also advanced significantly since its first appearance in 1960s (Cochran & Lord 1963). Here, a species of focus is caught initially to attach the radio tracking device in order for the researcher to get radio signals from the animal. Hence, improving the ability of wildlife ecologists to locate animals which increases their chances of examining detailed ecological questions relating to movement (Ramazin et al. 2007), animal behaviour (Lodé 2011), habitat use and activity (Martin et al. 2010). However, although the technique provides a lot of scientific data, radio-tracking can be considered as intrusive since it requires live-capturing of animals and attaching a collar to them (Cohen et al. 2001). The only study in the Philippines which utilizes radio tracking is by Fernandez et al. (2018) which investigated the spatial ecology of Palawan leopard cats (Prionailurus bengalensis) in Arborlan, Palawan. By attaching radio-trackers on the animals, the authors provided information on the species' habitat use and home range size.

Further, methods for capturing animals on film have also become popular with the advent of commercial wildlife camera traps in the early 1990s (Kucera & Barrett 1993). A camera trap is a remotely activated camera that is equipped with a motion sensor or an infrared sensor which serves as its trigger whenever an animal pass through the equipment. With this remote trigger, camera traps serve as a method for capturing wild animals on film without the need of the researchers being on the field (Swan et al. 2010). Camera trapping has also provided researchers opportunities to collect photographs of even the rarely seen and often globally endangered species since the method is non-intrusive and non-invasive (Griffiths 1993, Karanth 1995). A study by van Schaik & Griffiths (1996) also proved that camera traps can greatly help in observing cryptic or elusive animals that live in inaccessible habitats such as dense tropical forests in Southeast Asia. With the promising potential of the method, camera trapping has become a widely used tool to estimate population sizes, monitor threatened populations and communities, and observe cryptic, elusive and nocturnal species (Moruzzi et al. 2002).

In the Philippines, most of the mammal studies are concentrated on small-sized mammals such as bats and rodents. Hence, available literatures on the techniques employed in the country are limited to using mist-netting (Quibod et al. 2019), cage trapping or snap trapping (de Guia et al. 2011), and use of bat detectors (Sedlock 2001, Sedlock et al. 2019). Meanwhile, studies which employ monitoring techniques that commonly target medium to large-sized mammals are very limited in the country (Marler et al. 2016, Fernandez et al. 2019). Nonetheless, with the advancement of technology and cost-effectiveness of modern tools in assessing and monitoring mammals, applications of these equipment on future mammalian studies in the Philippines is at arm's reach in the next few years.

Challenges in Tamaraw population

Originally widespread across Mindoro, only four sub-populations of tamaraw are currently known to survive on the island; Mt. Calavite Wildlife Sanctuary, Aruyan-Malati Tamaraw Reservation, Upper Amnay Watershed Region and Mts.Iglit-Baco Natural Park sub-populations. Harrisson (1969) reported that the population of tamaraw dropped from a high of 10,000 individuals in 1900 to just 300 heads in 1969. As a result, the tamaraw was categorized as endangered in 1986. Unfortunately, their numbers in the wild continued to dwindle and was categorized as critically endangered since 2000 (IUCN, 2006).

Among the primary threats to the remaining tamaraw populations are the continuous destruction of their habitat due to farming and cattle ranching by resettled and local people for the past centuries (Boyles et al. 2016). Conversion of natural habitats into agricultural lands was likely the primary cause of decline in the Tamaraw's range throughout the 20th century. In 1988, around 70% of the forest cover had been lost to commercial logging and subsequent conversion to agriculture such as slash and burn agriculture (Gonzalez et al. 2000) and an additional 30,000 ha of forest cover was lost between 1988 and 2015 (Long et al. 2018). Moreover, activities of cattle ranching have also resulted to the destruction of large portion of the tamaraw's remaining habitat. Cox and Woodford (1990) have reported that about 14 pasture permits covering approximately 6,616 ha have been issued by the Philippine government for commercial cattle ranching where burning, a common practice by the cattle ranchers especially during summer resulted in the appearance of less suitable and palatable botanical growth. With this intense deforestation, it has allowed grasslands dominated by invasive plant species particularly the cogon (Imperata cylindrica), hagonoy (Chromolaena odorata), makmak basong (Ageratum conyzoides) and common bracken (Lantana camara) to develop and persist, forcing tamaraw to seek shelter to more mountainous and forested terrain (Long et al. 2018) where the amplitude of their natural diet and preferred habitats remain still unkknown. Moreover, with only few remaining suitable habitats combined with shortage of undisturbed natural corriders, the tamaraw's ability to disperse and increase their range has been made more difficult (Schütz 2015).

Along with habitat loss, illegal hunting has greatly affected the distribution and population of Tamaraw (Cebrian et al. 2014). Historically, Tamaraw were hunted for sports and subsistence, which led to a period of drastic decline in the number of individuals and populations (Rabor 1977). It is reported that hunting intensified in the late 1960s, and trophy hunting was occurring until the 1980s. Prior to World War II, local hunting was carefully regulated but with the growing population and availability of high-powered rifles and automatic weapons alongside traditional hunting using spears and pit-traps, dramatic decline of Tamaraw's numbers became more evident (Talbot & Talbot 1966). According to Long et al. (2018), there were also reports that insurgent groups in the mountainous region hunt Tamaraw for food, while the inhabitants of lowland Mindoreños occasionally kill Tamaraw when poaching pigs or deer. Meanwhile, the species was also a 'by-catch' from the Mangyan indigenous communities who practices traditional hunting such as snare and pit-trapping for wild deer and pigs which also contribute a major impact on the survival of remnant Tamaraw sub-populations (de Leon et al. 1996).

Small population size and increased fragmentation of the Tamaraw population could have also posed a serious threat for the species' long term survival (Long et al. 2018). Sub-populations of Tamaraw greatly vary on the 4 sites where the species currently occurs; Mt. Calavite having the lowest number with maximum of five individuals to 500 tamaraws in Mts. Iglit-Baco Natural Park (MIBNP), where the bulk population is located. However, one thing common from all the sub-populations are the very limited portion where they inhabit due to hunting pressures and degrading suitable habitats, making random-mating a challenge which results to a higher chance of inbreeding. According to Frankham et al. (2010), population inbreeding may reduce fitness of a population and could negatively affect its ability to adapt to any environmental changes. Although inbreeding is poorly documented for the Tamaraw, inbreeding is highly possible since around 80% of the estimated 500 remaining individuals are presumed to be in only on sub-population (MIBNP sub-population) with a restricted area of less than 3,000 ha (Long et al. 2018).

Despite the attention that the Philippine national government and non-government organizations is giving to conserve and protect the Tamaraw and its habitat, survival of the sub-populations still remains at the brink of extinction if these threats and challenges on the Tamaraw's populations are not successfully addressed.

Philippine indigenous ethno-biological knowledge

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), 'Local and indigenous knowledge' refers to the cumulative and complex information, know-how, practices and representations that are maintained and developed by communities with extended histories of interactions with the natural environment. Indigenous and local knowledge spans several important areas such as ethnoscience, ethnobotany, and traditional ecological knowledge among others. From the vast majority of rural and indigenous peoples, each and every ethnic group has their own sophisticated understandings, interpretations and meanings on different entities on their environment.

The Philippines has more than 110 ethnic tribes and cultural communities whose cultures and traditions, unfortunately, are on the state of being forgotten. The Filipino indigenous cultural communities or 'tribal Filipinos' constitute about 10% of the Philippine population (Molinyawe 1999) making them the most impoverished and marginalized sectors in the country. Most of which are living in the upland forests, retaining many of their attitudes, beliefs, practices and way of life despite the influences of modern living. For the past decades, there have been growing focus in preserving Philippine indigenous knowledge and practices such as the implementation of RA 8317 Indigenous People Rights Act (IPRA) which aims to give recognition of the full ownership and protection of their cultural and intellectual rights and EO 247 which prescribes a regulatory framework for the prospecting of all biological resources in the public and private ancestral domains.

Despite the growing trend to preserve indigenous knowledge in the Philippines, limited researches have been done to learn and document the dynamic relationships between indigenous peoples, biota, and environments or the so-called 'ethno-biological' knowledge. Currently, most of the ethno-biological studies in the country focused on the use of plants as traditional foods, herbal medicine and shelter material by different tribal groups. In the study of Abe & Ohtani (2013), the authors described a total of 112 plant species used as medicines against 13 categories of ailments by the Ivatan communities in Batan Island, Batanes. In addition, they found that 96.6% of the inhabitants actually use medicinal plants while 87.1% used them occasionally. The frequent and wide use of the Ivatans on plants as herbal medicines can also be seen to other ethnic groups in the country. Balangcod & Balangcod (2015) recorded 75 plants which are traditionally used by the Ibaloi tribe in Benguet province which are also shared with other cultures such as guava (Psidium guava), sambong (Blumea balsamifera), lawed (Piper beetle), tanglad (Cymbopogan citratus), lagundi (Vitex negundo) and banaba (Lagerstroemia speciosa). To mention some examples, lawed is used by almost all tribes in the Cordillera as treatment for cough, aside from its use as an ingredient for betel nut chewing (Balangcod & Balangcod 2011). Banaba has also been known traditionally as a cure for many aliments such as kidney problems, stomach ache, urinary tract infections, diarreha, and hypertension, among others (Laruan et al. 2013). Aside from plants as traditional medicines, there are also ethnic tribes who use animals and animal-derived product as a healing ingredient. Estrada et al. (2015) reported that the

Tagbanuas in Palawan used 13 species, i.e. the Philippine monkey (Macaca fascicularis), Palawan stink badger (Mydaus marchei), and Reticulated python (Malayopython reticulatus), in different specific ways for therapeutic uses and some diseases (malaria, cough, rabies, ulcer, etc.). Meanwhile, Ybanag tribes in northern Isabela, Cagayan Valley used 38 species of animals for food, medicine, shelter and other tribal customs (Cabauatan 2014). Although the World Health Organization (WHO) emphasizes that inappropriate use of traditional medicines or practices can have negative or dangerous effects, it is without no doubt that use of traditional medicine systems has become a part of the cultures and traditions by different ethnic groups.

Moreover, studies have also been done to elucidate the beliefs and rituals of different indigenous tribes to various biotic and abiotic resources. Example of which is the report of Sampang (2007) in Calamian Tagbanwa Ancestral Domain in Coron, Palawan. According to her findings, Calamian Tagbanwa indigenous communities have cultural and spiritual beliefs in the form of food and habitat taboos. Some fish species are avoided for consumption, rooted from a cultural belief that they may pose a health risk, especially for women after childbirth. Restricted areas like fish sanctuaries and sacred areas around the island are also believed to have giant, human-like octopus or pugita dwell on the deeps. Meanwhile, there are also ethnic groups who have superstitious convictions towards different life forms such as in the case of the Yapayao-Isneg tribes in Ilocos Norte (Gonzales & Briones 2018). From their study, the Yapayao-Isneg tribes follow different beliefs and rituals for hunting, farming, and even death. For example, when the men of the tribe are hunting, they bring shells along with them to serve as lucky charms for a bountiful hunt. Though before organizing the hunt, the Yapayao hunters also observe the movement and flight behavior of the labag wherein if the omen bird is observed to take flight from the right going to the left, the action of the bird is interpreted to be bad luck and if it flies from the left going to the right, the bird signifies good luck or good fortune. In terms of farming, the tribe solemnly prays to god-creator named "Marsua" to bless them with an abundant harvest. Aside from praying, they also offer chicken before planting of crops and rice. After a plentiful harvest, they sacrifice and offer wild boars to show their appreciation to the gods. There is also an ethno-zoological belief among the Yapayao-Isnegs that when an owl makes a sound other than hooting, it means that in the succeeding hours, someone is bound to die or if a dog howls in an eerie and hair-raising manner then a person in the house where the dog focuses its attention is deemed to eventually die in a few hours or days. Nonetheless, this just proves that Philippine indigenous groups such as the Yapayao-Isneg tribes have a long-standing rich culture and tradition from hunting to farming, in omens and even in death rites.

It is evident that indigenous or traditional knowledge is part of a community's belief systems and collective values, and preserves national identity as well as cultural diversity. However, although studies carried out to date have proved the importance of these beliefs on the way of life by different ethnic groups, ongoing erosion of culture and tradition is becoming more and more apparent as these knowledge is slowly disintegrating as new generations are born into a world that places modernizations at its priority (Gonzales & Briones 2018), while most of the indigenous knowledge has not really been explored since they are only transferred though verbal means. Hence, a need for documentations to preserve these cultures and traditions.

E. METHODOLOGY

STUDY SITE

Covering a total of ~16,334 hectares, Mt. Calavite Wildlife Sanctuary (MCWS) is a protected area located in the municipality of Paluan, Occidental Mindoro. The highest peak in the mountain is almost 1,500 m a.s.l. with the majority of land area characterized as steep to very steep slope. The geology of MCWS comprised mostly of Pre-Jurassic (97% of land area) that belongs to sedimentary and metamorphic rock groups, while the rest are Cretaceous-Palogene and Oligecene with some being recent rock formations. MCWS is characterized to have climate type I where dry season starts from November and end with April while wet season occurs during the rest of the year.

MCWS encompasses three barangays and home to the Iraya indigenous peoples.. The significant portion of the protected area lies within Barangays Harrison and Alipaoy, while some are also within the boundaries of Barangay Mananao. Among the three barangays, Barangay Harrison has the most number of residents with 652 households and a total population of 3,302, while Alipaoy with 276 households and Mananao with 329 households comprise 1,478 and 1,641 in terms of total population, respectively (CBMS, 2012).

The Strict Protection Zone (SPZ) is designated mainly for the conservation of biodiversity, protection of unique habitats, conservation of soil and water, vegetation, geologic formation and landscape, and minimization of climate-related and other disaster risks. The strict protection zone in the entire MCWS covers a total of 9,552 hectares. This zone is characterized by old growth forest lands above 50% slope and with 1,000 meters above sea level (masl) elevation. Based from the mapping exercise, there are 3,805 hectares of land within the wildlife sanctuary with above 50% slope. The remaining natural forests or closed forest in MCWS should be protected at all costs. Based on Balete et al. (2013), the peak of Mt. Calavite (1,100 m) covers extensive riparian vegetation along a dried up river which is surrounded by steep slopes below the exposed grassy ridges. Climbing bamboos were also found to be abundant at both edges of the grassland surrounding the remnant forest fragments, forming defense cover over the canopy of the trees closest to edges of the grassland.

COMPONENT A: TIMAWA (Tamaraw Inventory and Movement using Approaches in Wildlife Analysis)

A.1. Camera Trapping

Twenty (20) infrared camera traps will be deployed in the SPZ of MCWS for five runs of 14 days, totalling to 100 camera trap locations and 1400 camera trapping days. In setting trap locations, an initial survey of 14 days will be conducted on the SPZ to select possible routes and locations for the camera trapping. Afterwards, "MBHdesign" (https://cran.r-project.org/package=MBHdesign) in R software (R Core Team 2013) will be utilized to allow us randomly choose the positions of our camera trap locations. To elaborate, MBHdesign is a package useful for creating spatially balanced designs by maintaining the representativeness of the study area in terms of habitat types and species abundance while at the same time accounting for the difficulties of the terrain, and the spatial context with the sites which are sometimes not accessible for researchers (i.e. sacred sites, indigenous people settlements, very steep locations). Hence, we can generate statistically equivalent designs and choose the one we will consider the most feasible in terms of field implementation. More so, to prevent spatial autocorrelation, camera trap locations will be placed at least 300 meters apart (Rode-Margono et al. 2019). The cameras will be set to record 30-seconds video, with a 1-minute interval until the next trigger.

To supplement the data that will be obtained from the camera traps, indirect signs of Tamaraw presence such as footprints, foraging prints, and fresh feces will also be recorded through a foot census. More importantly, both camera trapping and route census may also record other wildlife such as the Endangered Oliver's warty pig (Sus oliveri) and the Vulnerable Philippine Brown Deer (Rusa marianna), which just like the Tamaraw, needs to be intensely assessed and monitored for their conservation.

A.2. Data Analysis for Camera trapping

All retrieved photographs from the camera traps will be compiled. Important information of the photographed animals will also be identified such as their sex and age. Afterwards, relative abundance will be reported for all species encountered, with the Relative Abundance Index (RAI) defined as all independent detections of a given species summed for all camera traps over all days, multiplied by 100, and divided by the total number of camera trap nights (O'Brien et al. 2003). A 1-hour interval will be employed to define independent events to reduce the bias from multiple detections of the same individual (Rovero et al. 2013b, Rademaker et al. 2016).

A.3 Ethnoecological surveys

A convenient-random interview using a semi-structured questionnaire with the aid of a local assistant will be used for the ethnoecological survey for the three barangays in MCWS namely Barangay Harrison, Alipaoy and Mananao.

To validate the data that will be gathered, a Focus Group Discussion (FGD) will be conducted in each barangay to enhance and gather additional information regarding hunting and trade on their locality. The survey questionnaire for the FGD will also mirror the questions indicated for the one on one interview but with open-ended questions.

COMPONENT B: HASULA (HAbitat SUitability modelling of LAndscapes)

B.1.1. Data collection

Initially, species occurrence points of B. mindorensis will be collated from our camera traps, published sources, field surveys, and online database that annotated valid species occurrence points. We will utilize the original 19 bioclimatic variables for the current climate including 11 temperature matrices and eight precipitation matrices obtained from the WorldClim v2.1 database (https://www.worldclim.org) (Fisk & Hijmans 2017), gridded to 30 arc-second (1 pixel = ~1 km2). These climatic variables will then be checked for correlation to prevent unreliable results. This will be done by calculating Pearson's correlation coefficient ($|r| < 0.70$) and the variance inflation factors (VIFs) correlation using R (package usdm, Naimi 2013). Predictor variables with VIFs > 5 will be removed from the analysis since even mildly correlated layers are known to influence the accuracy of species distribution models (Veloz 2009). In addition, three topographical variables such as elevation, vegetation index, and land cover will also be included in the final set of predictor variables. For future habitat prediction, the same environmental layers of 30 arc-seconds resolution will be downloaded from the Consultative Group on International Agricultural Research's (CGIAR) Research Program on Climate Change, Agriculture and Food Security (CCAFS) climate data archive (data available from http:// www.ccafs-climate.org/data/). The future climate projections are based on representative concentration pathways or RCPs (IPCC, 2014), which assume different greenhouse gas concentration trajectories based on a range of radiative forcing. The RCP 4.5 represents an optimistic emission scenario, where emissions will peak around 2040 and then decline, and RCP 8.5 assumes increased greenhouse gas emission throughout the 21st century. We will generate habitat suitability models for three future time periods 2030s (2021–2050), 2050s (2040–2069) and 2080s (2070–2099) for both the RCPs. Meanwhile, the 3 topographical variables will be treated as static during the future projections.

B.1.2. Model building and validation

To reduce the effects of spatial autocorrelation among the occurrence points, climatic heterogeneity of the study site will be calculated using principal component analysis (PCA) of all the climatic variables. A climate heterogeneity map will then be developed by combining the principal components axes using SDMToolBox (Brown 2014). Afterwards, the spatial aggregation among occurrence records within an area will be subsequently reduced by spatially filtering the occurrence points (Boria et al. 2014).To develop habitat suitability maps, the input variables will be processed through MaxEnt algorithm (Phillips et al. 2006), a grid-based machine learning algorithm that follows the principle of maximum entropy (Jaynes 1957). To estimate variable importance, response curves and jack-knife tests will be run while the output will be set to logistics in order to evaluate the importance of each biophysical variable. R package ENMeval (Muscarella et al. 2014) will be used to tune the best current model while the model with the lowest omission rates will be chosen for the future projections. Further, area under curve (AUC) of the receiving operating curve (ROC) will also be generated to evaluate the accuracy of the model. AUC values range from 0 to 1 where the AUC value >0.5 show the model to be better than one constructed at random, while a value of 1 indicates a perfect fit of the model (Pearce & Ferrier 2000, Newbold et al. 2009). Categorically, this study will interpret the AUC values based on Swets (1988) recommendation wherein 0.5-0.6 = fail, 0.61-0.7 = poor; 0.71-0.8 = fair, 0.81-0.9 = good, and 0.91-1.0 = excellent. The output file generated from MaxEnt will be exported as an ASCII file format to ArcMap software to get a visualization of the suitable habitats for the species, which will then be categorized into four major classes (Threshold, low suitability, moderate suitability and high suitability). To quantify the suitable areas (km2) predicted by models for all climatic scenarios, the number of pixels belonging to each classifification will be counted and multiplied by the pixel resolution.

COMPONENT C: PANATA (Protist Assessment on Niches Associated with TAmaraw)

C.1. Field work sampling and laboratory preparations

Five randomly chosen elevational belts will be chosen to establish 10 plots (approx. 10m × 10m) in Mt. Calavite, Wildlife Sanctuary. For each plot, 10 of each of four types of decaying litters (ground leaf litter, aerial leaf litter, drifting twigs, barks) will be collected. All of this samples will then be air dried and will be subjected to moist chambers in a period of 12 weeks. These cultures will be maintained under ambient light conditions at room temperature. All fruiting bodies of myxomycetes that shall develop will then be morphologically characterized and identify using taxonomic guides (Poulain et al., 2011) or interactive keys (eumycetozoan project)

C.2. Data Evaluation

Initially, a moist chamber that exhibited either plasmodial and/or fruiting body growth will be considered as a positive collection for myxomycetes, and thus, will be noted as one positive record. The number of positive collections will be counted and be divided by the total number of MCs prepared, and shall be express as moist chamber productivity (Macabago et al. 2012). Species composition and occurrence will also be determined as relative abundance of each species. An abundance index was then translated from the computed values as described by Stephenson et al. (1993): < 0.5% - rare (R); > 0.5% but < 1.5% - occasional (O); > 1.5% but < 3% - common (C); > 3% - abundant (A). To estimate the extent how the survey will be exhaustive in terms of species obtained from the moist chambers, the software program EstimateS (Version 9.1, 200 randomizations) will be used to construct a species accumulation curve (SAC). The Chao 1 estimator results (an estimator for target richness for individual based data as such that one record of a species in a certain culture is considered as one individual) will then be utilized in accordance with the protocols of Macabago et al. (2017) and Novozhilov et al. (2017). Coleman rarefaction curves will be constructed between collecting period and among substrates.To calculate the taxonomic diversity, the quotient of the number of species with the number of genera will be calculated. Intuitively, a lower value indicates the more diverse biota since in principle a biota with species distributed among many genera is more diverse than a biota with species belonging to only few genera (Stephenson et al. 1993). Using the vegan package in R environment, species abundance distribution (SAD) model will also be constructed following the concept of Wilson (1991) that suggested the following five models: Null (fits the broken stick model), Preemption (fits the geometric series or Motomura model), log-Normal, Zipf and Mandelbrot. To evaluate which of the five models would be the "best" fit for the data, corrected AIC (Akaike Information Criterion) will be also selected. Community analysis will also be performed using (i) hierarchical cluster analysis based on Bray Curtis similarity (Bray and Curtis 1957) and (ii) Venn diagram. Furthermore, two similarity indices from Stephenson et al. (1993) will be computed: Coefficient of Community (CC) which considers the presence or absence of a species and Percentage of Similarity (PS) index that accounts for both presence and absence of a species and its relative abundance. The CC values range from 0 (no species are present in both communities) to 1 (all species are present in both communities) while the PS values range also from 0 to 1 and are interpreted that if the value is closer to 1 then the two municipalities being compared are highly similar in terms of species composition and abundance

F. MATERIALS TO BE USED AND DATA GATHERING INSTRUMENTS

The main instrument to be used in the study are the camera traps. Camera traps is a camera, that is automatically triggered by a change in some activity in its vicinity, like presence of an animal. It is typically equipped with a motion sensor – usually a passive infrared (PIR) sensor or an active infrared (AIR) sensor. Camera traps, also known as trail cameras, are used to capture images of wildlife with as little human interference as possible. In this study, cameras will be attached to trees or any solid materials to photograph as many wildlife as possible.

Fig. 1: Example of camera trap usage

The rest of the materials that will be used for gathering data are via human observations, survey interviews, online sourcing and litter collections (leaf litter, bark, twigs).

G. SCOPE AND LIMITATION OF THE STUDY

This two year project will serve as a baseline to properly document Tamaraw population in Mt. Calavite Wildlife Sanctuary since most of the documentation so far is not clearly communicated for the area. The methodologies that are proposed to properly survey Tamaraw on the highlands of the said locale shall also be used to acquire data on other wildlife that is poorly documented in the area. Moreover, the protist survey in the natural environment where Tamaraw are suspected also to thrive will give possible glimpse on the ecological role of endemic fauna on terms of local dispersal of such protist groups. In spite of these projections, this two year project will only focus first on the areas that will be allowed by the local Mangyan tribe and conservation authorities to be access by the researchers.

H. SOURCE OF FUND

The main source of funding for this project will be coming from the Department of Science and Technology – Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST-PCCAARD). Moreover, the University of Sto. Tomas would also serve as a counterpart funder for the project.

I. PERIOD OF RESEARCH AND TIMELINE OF ACTIVITIES INVOLVED

The entire project will start from January 2021 and will end in August 2023 but data collections will be conducted for a certain period of time within these years. To be specific, the table below shows the timeline of activities involved in this project.

Table 1. Timeline of research activities for the entire project

Objectives	Target activities	2021				2022				2023			
COMPONENT TIMAWA		Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
Investigate and monitor the Tamaraw sub-population in Mt. Calavite Wildlife Sanctuary	Camera trapping and route foot census in MCWS												
Conduct ethnoecological surveys with regards to local hunting systems and patterns, climate change resiliency, indigenous knowledge and practices	Survey interviews and key informant interviews in Barangay Harrison, Mananao, and Alipaoy												
COMPONENT HASULA													
Conduct Habitat suitability analysis on the Tamaraw using ecological niche models	Habitat suitability modelling for Tamaraw across Mindoro												
COMPONENT PANATA													
Establish a protist inventory on niches associated with Tamaraw	A. Collection of decaying litters in Mt. Calavite Wildlife Sanctuary												
	B. Identification and compilation of protists (myxomycetes) on niche associated with Tamaraw												

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