RESEARCH AND REPORTS

Application of Spatial Monitoring and Reporting Tool (SMART) in tamaraw conservation

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Introduction

The tamaraw (*Bubalus mindorensis*) is a Critically Endangered species of dwarf buffalo found only on the island of Mindoro in the Philippines. The tamaraw population is currently estimated at less than 600 individuals, from an estimated population of 10,000 in 1900 (Harrison 1969 in Long et al, 2018). 80% of the current population is presumed to be in only one subpopulation in a restricted area of less than 3,000 hectares inside the Mts Iglit-Baco Natural Park (MIBNP), the largest protected area of the island. Traditional land-use practices from the residing Indigenous Communities and poaching incidents from lowlander Filipinos are currently the main threats to the viability of these subpopulations, limiting their chance to expand. In such a context, the capacity of rangers to conduct efficient patrols and collect relevant information is crucial to determine proper strategies for conservation and impede the killing of animals.

Since 2013, the D'Aboville Foundation and Demo Farm Inc. (DAF) have been supporting local authorities in their task to protect the species through its Mangyan-Tamaraw Driven Landscape Program. The urgent need to improve the monitoring capacity of the tamaraw rangers in the field was addressed through basic actions: provision of patrol gear, use of GPS devices and printed patrol maps with a coding system.

The formulation of two major plans in 2018 and 2019, the Tamaraw Conservation and Management Action Plan (TCMAP) 2019 - 2028 (DENR, 2019) and the MIBNP Protected Area Management Plan (PAMP) 2019 – 2028 (MIBNP-PAMO, 2020), called for the next step to upscale these initial attempts. SMART was already in use by the Philippines Department of Environment and Natural Resources (DENR), through their Lawin Forest and Biodiversity Protection System, led by the Forest Management Bureau (FMB). The DENR was eager to expand the use of this technology to protected areas. MIBNP therefore serves as a pilot site and the tamaraw as a focus species to test and establish SMART at a local scale. Global Wildlife Conservation (GWC), a DAF-supporting partner, took the lead in tackling this task through the provision of support and expertise. GWC is a SMART Partnership

member, supporting the development of the software and capacity building for SMART. Establishing SMART in tamaraw conservation is described in both major plans as a key activity to help improve the monitoring of the species across Mindoro and support the expansion of its range from its current distribution (baseline year: 2019). The implementation of SMART falls under Goal 8 (Strengthen Law Enforcement and Wildlife Crime Prevention of the TCMAP) and Program 4 (Wildlife Crime Prevention, Law Enforcement, and Compliance) of the MIBNP PAMP.

Baseline situation

Prior to the introduction of SMART, routine tamaraw-focused patrols in Mindoro were conducted by the rangers of the Tamaraw Conservation Program (TCP), a program established by the DENR in 1979 (Long et al, 2018). In MIBNP, DENR forest rangers were conducting patrols using CyberTracker and SMART, but these were focused on forest protection under Lawin (USAID/BWISER, 2018). There were 23 TCP rangers in 2018 and eight at the MIBNP Protected Area Management Office (PAMO). The TCP rangers conducted patrols in the Core Zone of Monitoring (CZM) for the tamaraw and the surrounding buffer area within the 106,655 hectare natural park. The CZM constitutes about 3% of the park. The rangers monitored and recorded the presence of wildlife as well as human activities. They recorded their observations and submitted these to the TCP headquarters. Records were written on paper and maps, using the rangers' knowledge and their navigation skills to position the events, as they lacked sufficient equipment, as well as structured data collection protocols and a system to record coordinates. This situation made it difficult to compile and track all the observed information, develop proper data management, and consequently visualize, conceptualize and analyze the data.

Inception and initial workshops

SMART was first discussed with stakeholders in Mindoro during the planning processes for both TCMAP and MIBNP PAMP during 2017 and 2018. This was followed by a series of meetings with staff of the Biodiversity Management Bureau and the Regional Office of DENR for Mindoro's Provinces in March 2019 to discuss the implementation of SMART for tamaraw conservation, and to get a copy of the existing SMART database from Lawin. Thereafter, a GWC and DAF-led team were invited by the Protected Area Management Board of MIBNP (PAMB-MIBNP) to propose and present a plan for implementing SMART in this Protected Area.

The first actions included a series of assessments, workshops, training and field-based activities conducted in April and May 2019 in order to introduce the SMART and its use to both the TCP and the MIBNP-PAMO. These activities included the creation of a data model suited specifically for both tamaraw conservation and management of the MIBNP, the testing of the data model and, at the same time, the coaching of the rangers in conducting patrols using sturdy mobile data collection devices to record patrol effort and observations. Data managers were selected among the staff and trained together with ranger team leaders and head officers. Training concluded with how to analyze and use data collected in the field to support information-based decision making and adaptive management in patrol planning.

Building capacity on the ground

Following this inception phase, both offices were provided with the necessary equipment to properly implement SMART through the support of GWC and DAF: One desktop computer placed at the TCP Office and another one at the PAMO, one laptop assigned for use at Station 2, where solar power is now available and 12 Blackview BV6000 rugged data collection devices, installed with CyberTracker software, for use by the rangers and DAF field team.

This enabled the rangers to collect field data, import it into the SMART database, store it first in the laptop at the Station, and later transfer it to the TCP and PAMO desktops through a USB stick. Capacity building involved two complementary layers: (a) training of the rangers assigned to the field to learn how to use CyberTracker to properly record observations and import the patrol data to the SMART database, but also how to prepare for patrols and how to react when confronted with certain situations during a patrol, and (b) office -based training focusing on data management (creating queries and reports) and using the results for adaptive management.

At a later stage, data managers were taught how to use the “independent incidents” feature of SMART. This feature allows the recording of data observed outside patrols. For example, when a ranger is off-duty and is doing extra work as a guide for trekkers. These were recorded as independent incidents, which explains why some observations of animals in the map (Fig. 5) do not fall within patrol routes.

The power of SMART progressively came to light as it encouraged stronger cooperation between the two offices and stimulated interaction between the field and office personnel. Joint meetings between TCP and PAMO are now organized on a regular basis to share data, visualize results of patrol efforts and discuss information collected. The results of analysis inform plans for the next patrol and help to assess actions needed.

Training and mentorship of TCP and PAMO staff is a constant, steady, and ongoing process, while rangers and officers are accumulating experience in using the devices and becoming familiar with computer-based systems.

Data Model and Metadata

The data model refers to the structure of the data that is collected during patrols; such as wildlife or human activities observed. Metadata, on the other hand, consists of information about the protected area; such as stations, patrol teams, mandates or patrol types. These data are not collected during patrols, but are instead necessary to better analyze patrol data specific to the efforts of MIBNP.

The data model in the SMART database of TCP and MIBNP PAMO was created based on the data model of DENR’s Lawin system already in use. Two categories needed to be added, as the Lawin data model was designed mainly for forest protection, not wildlife conservation or protected area management. One of these categories is “Human Activities”, which distinguishes between traditional and non-traditional practices. Traditional practices include the ancestral land uses of the Indigenous

People inhabiting the park, while non-traditional practices consist of the illegal practices which fall outside of the previous definition. The other category is “Biodiversity Monitoring” which includes wildlife that are not in the Lawin list of indicator species of forest health, such as the tamaraw.

The data model was created through an iterative process, via a series of meetings among the rangers and the TCP and MIBNP PAMO management. A configurable model, consisting of a representation of the data model to easily collect the data with the field devices, was designed and field tested. The rangers conducted scenario-driven patrols and recorded theoretical observations to determine if the configurable model was complete, appropriate, to identify areas of improvement, and get used to the process of exporting and importing patrol data between desktops and field devices.

Metadata included a list of all employees who would be using SMART in some capacity. This consisted of rangers, data managers, DAF field staff, and the trainers. Only the TCP Coordinator and the Protected Area Superintendent of MIBNP were given the full administrative permissions while data managers were given the access to analyse and enter data and patrol team leaders were given the ability to enter data collected from the field. Other rangers were not included as SMART users, but trained to collect data using CyberTracker using the field devices, with no need to access the database.

The metadata also included a list of ranger stations, patrol teams, patrol types, and patrol mandates (with patrolling and monitoring as the core objective). Maps, similar to those paper maps used in the field by rangers, were also designed for the database.

In the last quarter of 2019, the SMART database was upgraded from SMART 6.1 to SMART 6.2.3. For security, the mobile devices were locked, to ensure only the CyberTracker software would run, to avoid data loss or the misuse of DENR property. There are plans to upgrade the system in the future and shift to SMART Mobile for data collection, which is the latest version of CyberTracker.

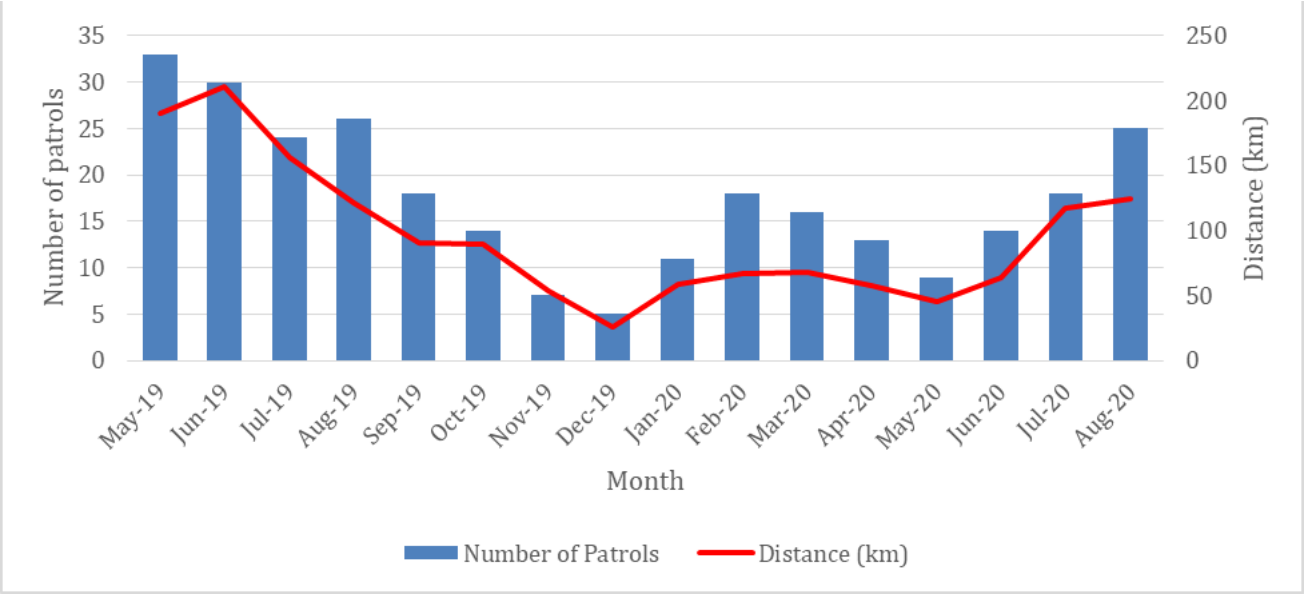

Figure 1. TCP patrol effort in MIBNP (May 2019 - August 2020)

Results

Patrol coverage and effort:

Patrols during the 16-month period from May 2019 to August 2020 covered the trails from Station 1 to Station 2, the area within and around the "Core Zone of Monitoring" where most of the tamaraws have been observed, and the area around the Tamaraw Gene Pool (see Patrol routes in Figs 3-5).

The area patrolled so far is confined to the elevations from 200 to 1400m and constitute approximately twice the area of the CZM or six percent of the total area of the park. Some higher elevation areas that have not been patrolled will be explored by TCP and DAF in the near future. Patrol efforts from May 2019 to August 2020 averaged 17 patrols, covering a distance of 96 kilometers for all the patrol teams of TCP and MIBNP per month, or four patrols and 24 kilometers per week for all the patrol teams (Fig. 1). Patrol effort, however, was not consistent. It decreased towards the end of 2019 due to rangers needing to prioritise other non-patrolling related tasks, then slightly increased in the beginning of 2020 before decreasing again during the start of the Covid-19 pandemic, when the Tau buid leadership prohibited rangers residing in towns with known Covid-19 cases from entering the park. Patrol effort has started to increase again in the last three months, focusing on areas where evidence of poaching collected with the SMART system were observed in previous patrols.

Recorded Observations:

Using CyberTracker installed on mobile devices, rangers record incidents and signs of activity that have an impact on tamaraw conservation. These include any of the illegal activities outlined in Section 20 (Prohibited Acts) of the Expanded National Integrated Protected Areas System Act of 2018; such as poaching, littering, illegal entry, or the traditional activities of the IPs, which are not regarded as illegal, but may affect tamaraw conservation if not carefully monitored. The rangers then record the actions that they carry out to address these activities. During patrols rangers also record the presence of three important mammals; tamaraw, Oliver's warty pig (*Sus oliveri*), and Philippine brown deer (*Rusa marianna*).

If the animals were seen outside patrols these were recorded as 'independent incidents' directly in the SMART database so that these can be included in the queries and reports. Signs of the presence of these animals (dung, tracks, etc.) were only recorded if these were found in areas outside of the 'Core Zone of Monitoring' and are therefore evidence of an increasing range.

Over a 16-month period, the rangers recorded evidence of 40 incidents of illegal activity in MIBNP, from eight of the 16 classifications of threat identified in the SMART data model (Fig. 2). The locations where these illegal activities were observed are shown in Fig. 3. Most of the illegal activities were observed outside the Core Zone of Monitoring. The identified locations of these illegal activities during patrols informed the design of the targeted areas for future patrol efforts.

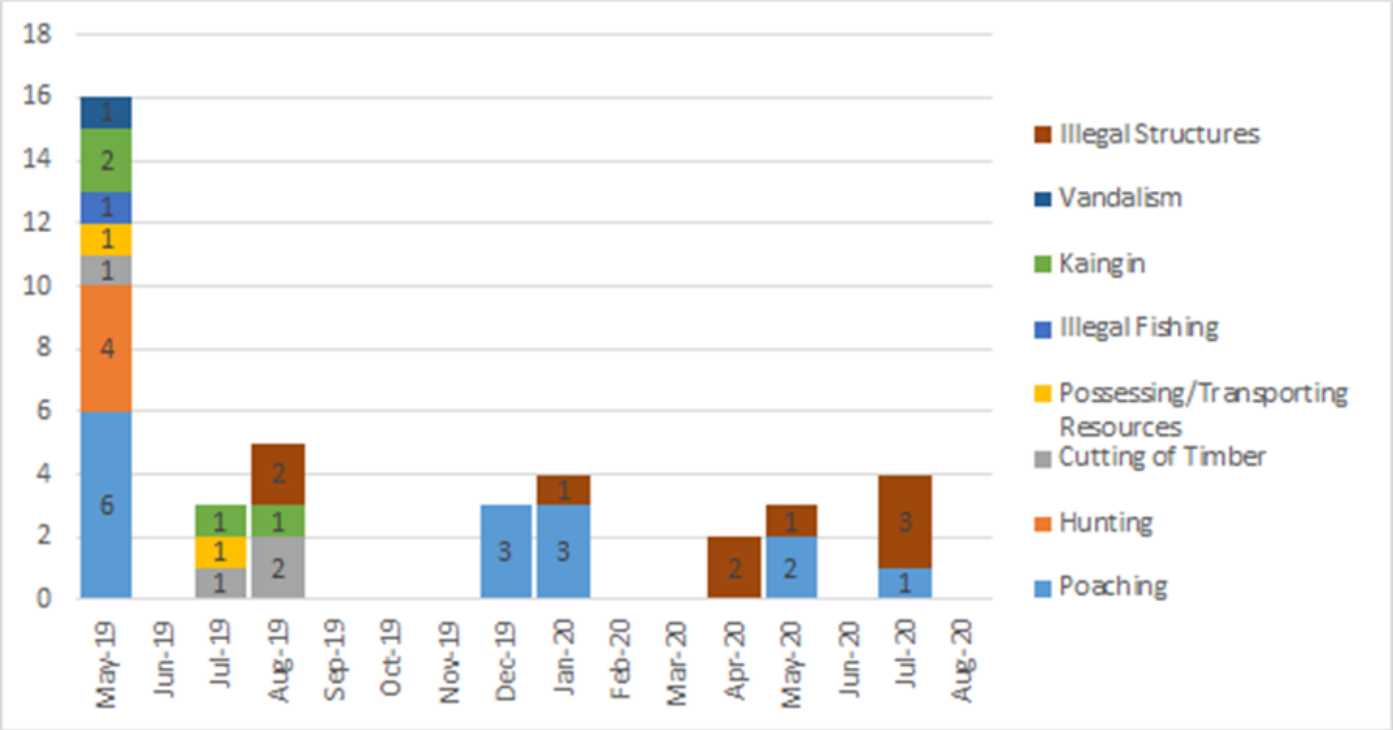

Figure 2. Illegal activities observed and recorded (May 2019 - August 2020)

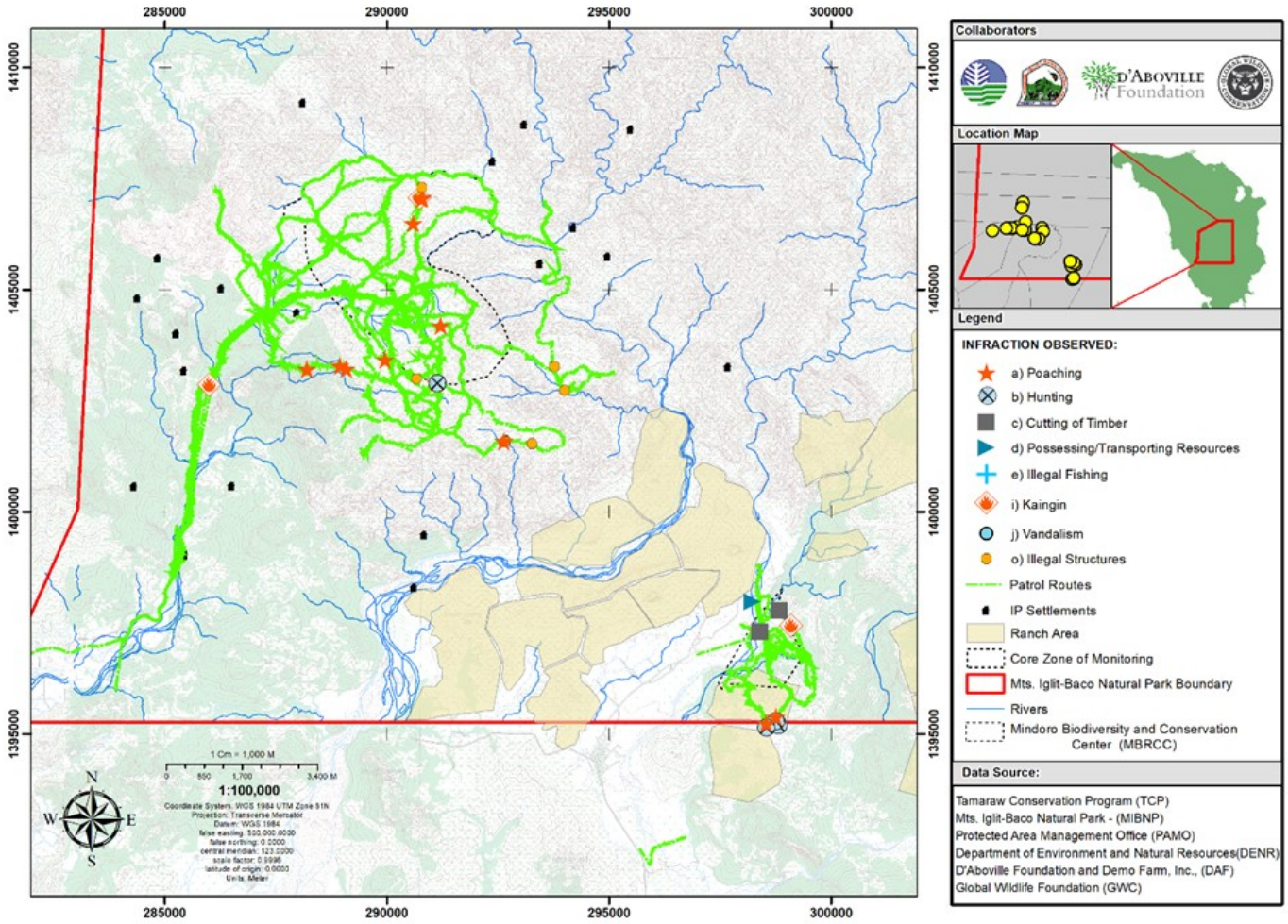

Figure 3. Locations of observed illegal activities (May 2019 - August 2020)

The rangers also recorded traditional practices of Indigenous Peoples (Tau buid) in the areas that they observed during patrols. During the 16-month period, they observed evidence of five types of traditional activities: kaingin (slash and burn agriculture), collection of non-timber forest products (NTFP), construction of temporary settlements, installation of traps and trap warning signs (Fig. 4). The majority of these activities were recorded outside the CZM. Those that were found inside were discussed with the Indigenous leaders in the area to determine the strategies for addressing and managing any activity which contravenes the agreements in place.

There were 290 tamaraw, 15 warty pig, and 18 Philippine brown deer encounters during patrols from May 2019 to August 2020 (Fig. 5)

The monthly tamaraw encounter rate averaged 0.07 individuals per kilometer (1 per 14.3 km) but this computation included 'patrols' conducted along the trails from Station 1 to Station 2 and Station 3.

Most of the observations of tamaraws were located in the CZM, although there were some observations outside the CZM. Warty pigs were observed mostly outside the CZM and around the Tamaraw Gene Pool Farm, while Philippine brown deers were observed inside and outside the CZM.

Recording and Monitoring Actions Taken

All the actions the rangers took were recorded and serious offences were communicated to local authorities. The rangers dismantled/ destroyed the traps located within the No

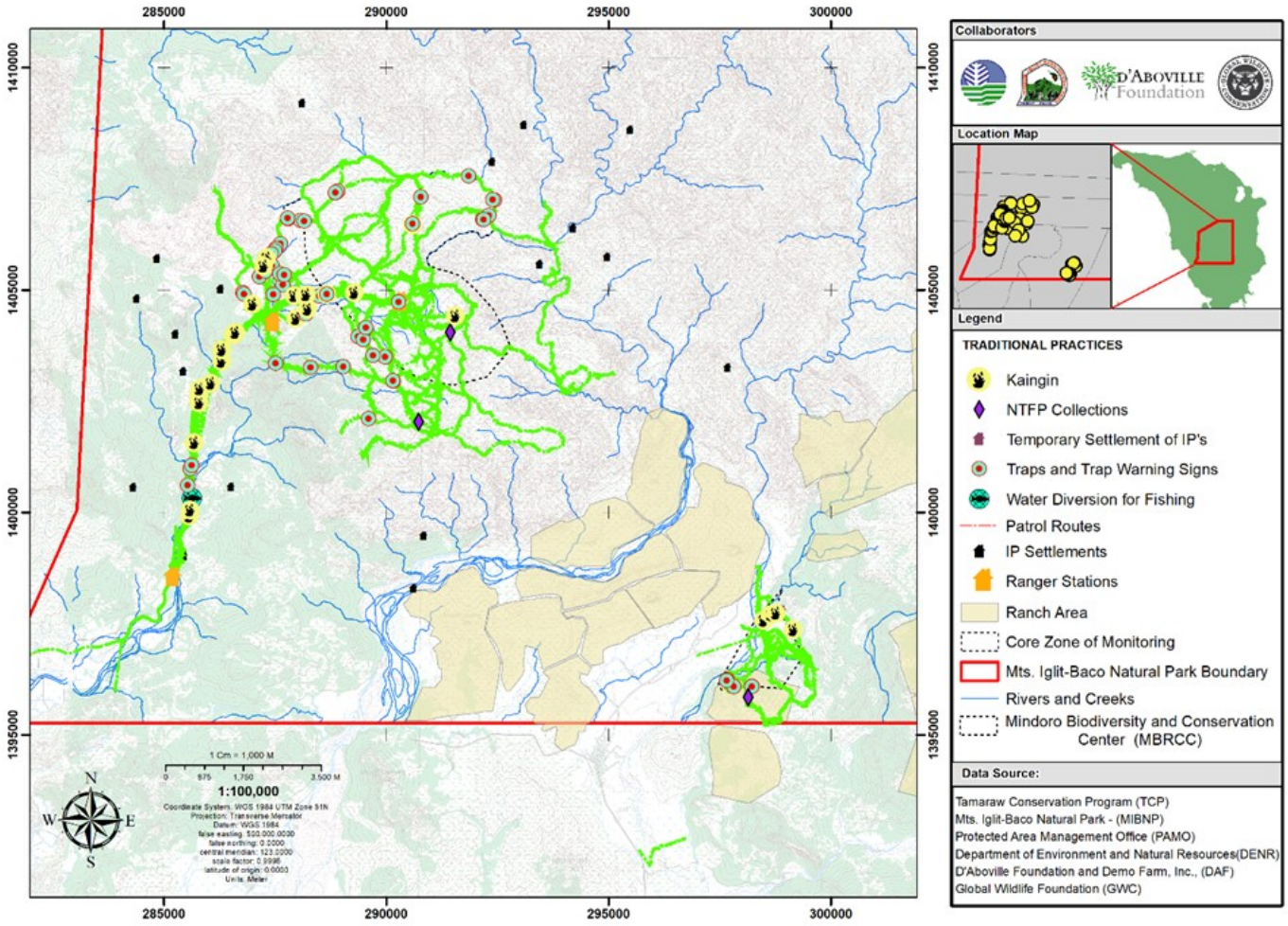

Figure 4. Observed traditional activities May 2019 - August 2020.

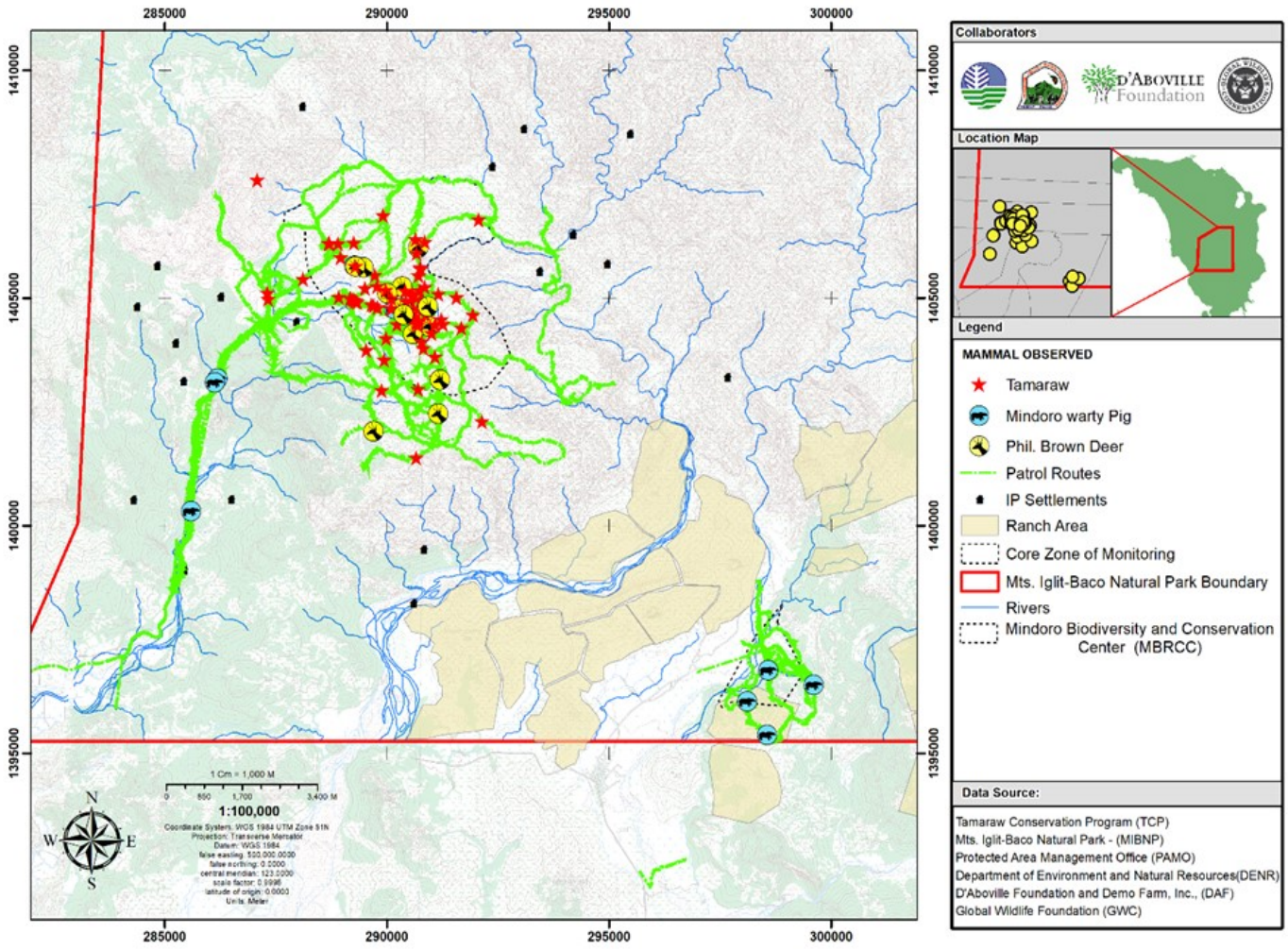

Figure 5. Mammals Direct Observation points (May 2019 - August 2020). Note: There is usually more than one tamaraw in an observation point.

Hunting Area and collected materials, such as nylons, that were used for the non-traditional practice of trapping animals (Table 1).

Table 1: Actions taken (May 2019 - August 2020)

Action taken	Number	%
Documented only	37	76%
Collected	7	14%
Dismantled/destroyed	5	10%
Total	49	

Summary after two years of experience

The implementation of SMART in tamaraw conservation resulted in two fundamental changes: 1) it enabled the geo-referenced recording of patrol effort, observations, and actions taken during and outside of patrols; and 2) allowed spatial and statistical analyses of the patrol data to inform further patrol planning and management decisions. Patrol data can now be queried, analyzed, and visualized in more ways than was shown in this article. SMART has so far only been used for patrolling and monitoring, but can also be used in ecological monitoring, visitor management, and in other aspects of protected area management. The way SMART is implemented in tamaraw conservation can still be improved in some aspects, such as ensuring better data quality assessment, better design of predetermined queries and reports used for monthly, quarterly, or annual reporting and on-

demand queries needed on a daily basis for quick decision-making.

However, the use of SMART for the past 16 months has provided a baseline that can be used in advancing patrol evaluations, impact monitoring and protected area management performance in the future.

The establishment of the SMART Technology for tamaraw conservation in Mindoro is coordinated by DAF and GWC with their local partners thanks to the financial support of the Mohamed Bin Zayed Conservation Fund, the National Geographic Society, Berlin Tierpark, ZGAP and the Association Française des Parc Zoologiques.

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