The Baram Heritage Survey

Community-collected socio-ecological data

The Borneo Project, SAVE Rivers, Bruno Manser Fund and KERUAN Organisation

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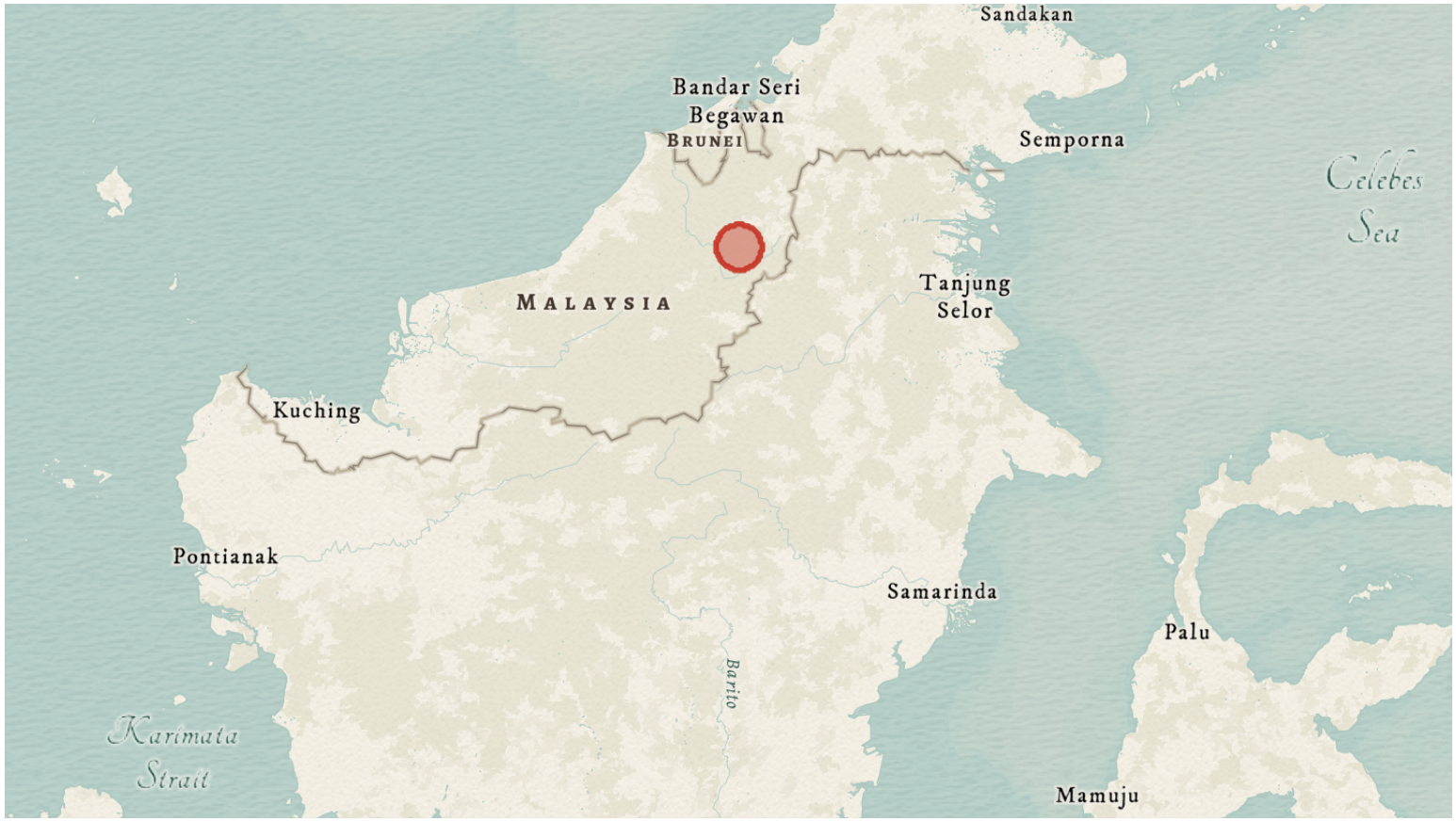
The Baram Heritage Survey trained and employed local field technicians to collect social, ecological, and economic data throughout 2020 and 2021 across three sites in the Baram River Basin. Field technicians walked forest transects twice every month, once looking for animal sightings and again looking for animal signs. They also conducted fishing and hunting surveys and interviewed community members.

Despite movement and travel restrictions imposed by the Covid-19 pandemic, the technicians successfully collected data over two years. Apart from Christmas and the paddy harvest, our technicians worked throughout the year, through challenging weather and landscapes.

The Baram Heritage Survey relied on the expertise of local communities rather than sending in external researchers. This participatory process was designed to empower communities with information and strengthen landscape management. This project design underscores the importance of Indigenous Knowledge in understanding forest-dwelling communities, and in developing forest protection projects and policy.

Project area

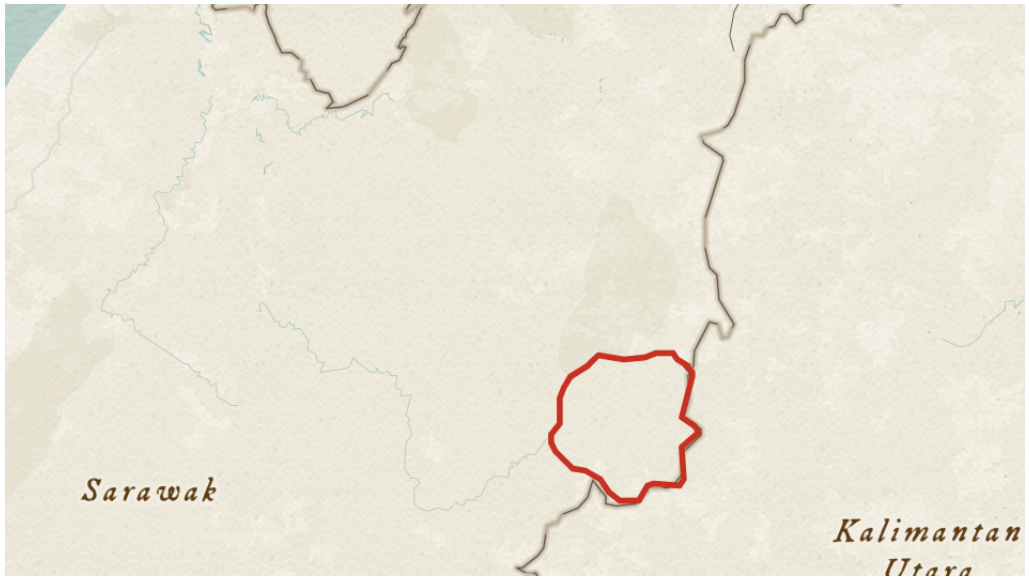
The communities involved in the survey are located in the middle and upper stretches of the Baram River in Northern Sarawak. The Baram is a major tributary of Sarawak that starts in the mountainous highlands near the border with Indonesia and winds its way north to the small city of Miri on the South China Sea.



Project Area Map

The area was densely covered in tropical rainforest until the last few decades, when first logging and then massive oil palm expansion moved in. Despite the striking impact extractive industries have made on the landscape, a significant amount of forest cover remains. The project worked with six communities in three different sites.

Upper Baram Forest Area



UBFA map

Five of the participating villages are located in what is known as the Upper Baram Forest Area (UBFA), sometimes referred to as the Baram Peace Park. The UBFA is an initiative designed to increase forest protection and build regenerative livelihoods in the upper Baram area. The idea came from local communities who want to protect their heritage and forests.

Transect methodology

Each site had four transects (walking paths) measuring four kilometers long each, for a total of twelve transects that were monitored and reported on in the project. Two of the transects were placed in community reserve forests. One of the transects was placed in a very remote area beyond the normal hunting territory of any village. All the other transects were randomly generated.

The transects that were placed in the community forests and beyond the normal hunting territory provided information specifically about these areas that have experienced less human activity, less logging, and more protection. Randomly generated transects provided information about the animal populations in the area in general, without targeting a specific land use designation or habitat. Using both ways of generating transects also provided a method of comparing forests that have been less impacted by logging and other human activities with the general area. The randomly generated transects traversed agricultural land, logged forests, roads, unlogged forest, and communal forest.

Results overview

- 5,347 transect data entries
- 111 social interviews
- 298 hunting surveys
- 166 fishing return surveys

The results show that these communities have an exceptional knowledge of local wildlife, with the ability to identify animals and birds through sight, sound, tree markings, footprints, feathers, scat, nests, and food.

A woman prepares smoked wild boar for the group

The data collected by the field technicians confirms the presence of a huge diversity of wildlife, including many endangered and protected species. They have shown that their villages rely heavily on healthy forests and rivers for their nutritional, cultural,

and livelihood needs. The social interviews confirm that people from the communities of the middle and upper Baram River have far-reaching connections to the land and a strong desire to celebrate their way of life and protect their resources for generations to come.

Social Survey

> *"We want to defend our land."*

Field technicians at training

The Baram Heritage Survey extensively interviewed people living in the village about their lives. The survey questions included socio-economics, livelihoods, land use, nutrition, resource use, and views about the future. Field technicians asked questions

about household income, jobs, hunting and fishing, farming and livestock, planting of fruit trees and foraging of wild plants. Participants were asked questions about how forest resources can and should be used by the village, by outsiders, or by companies. They were asked what they want for the future of their communities, and how they would like to see the land managed in generations to come.

These questions were intended to examine how traditional livelihoods are still practiced at the village level, how communities use and manage their resources, how people envision the future of their communities, and how existing land management practices might feed into future land use plans. Field technicians interviewed everyone over the age of 18 who was willing to participate.

Livelihood and nutrition

> *"We are very concerned about sustainable areas of forests, land, plants, and animals for future generations."*

Fish prepared by riverside BBQ

Across all three village groups, people listed agriculture, including gardening, farming and paddy, as their most important source of income. The majority of people participated in hunting and almost everyone regularly went fishing.

Monthly income varied between the village groups. In the village closest to the coast and cities, more than half of participants earnt

between 250-500 MYR per month. In the more remote villages, 75-80% of participants earnt less than 250 MYR per month. The most remote village group had the lowest average monthly income.

Everyone kept some livestock, mostly chickens, pigs, and ducks and most people sold their livestock. Everyone participated in forest-dependent livelihoods, and no one listed logging or oil palm company jobs.

While everyone consumed hunted meat and local fish as a regular part of their diet, most people also supplemented their diets with farmed meat. Most people also picked and consumed wild fruit, and almost everyone interviewed had planted their own fruit trees. In the two village sites that shared an ethnic background, more than 75% of people sold part of the produce. In the remaining village group, which is also more remote, only a small number of people sold their produce from fruit trees.

More than 90% of people across the village groups planted paddy. Everyone ate the rice they grew, and only five people sold the rice they grew.

The majority of people interviewed cut timber trees for their personal use, primarily as a building material. Some also planted

timber for personal use, and only five people sold the timber. The primary type of wood harvested was yellow meranti, in addition to red meranti, ironwood, kapur, and others.

Land use

> *“Land is the source of life. Without land, life is meaningless. Land is very useful for us. Land is everything for us.”*

Women embrace as logging truck passes by

All the sites in the survey had similar views regarding land use and forest management. There were mixed opinions between the sites about whether community members should be allowed to cut down big trees. In the two communities with a designated

communal forest area the majority of people believed that community members should not log in that area. A vast majority of people across all sites agreed that community members should not be allowed to log in the water catchment area.

Only one person across all the village sites thought that logging companies should be allowed to extract timber from Orang Ulu land. This is emphatic evidence that these communities do not want logging companies operating on their land. No one thought that logging companies should be allowed to log in the communal forest or water catchment areas. All but one person thought that it was not OK for outsiders to hunt on their land.

A significant majority of people thought that loggers regularly encroach on Orang Ulu land, and more than half said that there has been logging on their land that they did not want. Most people thought that logging concessions should be cancelled in the Baram region, although 11 people (10% of all those interviewed) were unsure.

A minority of people thought it was OK for outside companies to establish plantations on Orang Ulu land. No one believed that outside companies should be able to decide how their land is used, and most people did not agree that the government should be able to decide how the land is used.

In one site, no one was sure whether the government recognized their Native Customary Rights (NCR), in another only two people thought they did recognize their NCR, and in the remaining site the answers were split between people who thought the government recognized their NCR and those who were unsure.

> *"I will ban the logging company from entering my village land area and build up blockades to prevent them from entering our land."*

Everyone across two village sites representing one specific ethnic group were aligned in their forest management and land use goals. Everyone from this group said they would be interested in making laws that allow forests to grow back, and that allow animal numbers to increase.

All but one person said they would be interested in making laws that allow fish populations to recover. In the other ethnic group, three-quarters of people said they were interested in making laws that allow forests to grow back, and two-thirds of people were interested in making rules to allow fish and animal numbers to increase.

Apart from one person, nobody across any of the village sites

was interested in selling their land, and everyone wanted future generations to inherit the land. Over half of people surveyed thought it was “very important” to set up rules to ensure there is enough wildlife for their children and grandchildren to be able to hunt.

There is no interest in any commercial gain that hinges on a loss of native customary ownership. As one interviewee put it “the earth is life and breath, for us to live”.

Hunting and fishing

A hunter stops on the road to offer his catch

Hunting and fishing are a major part of rural livelihoods. Twenty-one percent of people interviewed listed hunting as one of their main sources of income and 12% listed fishing. The hunting data demonstrated that wild game is an extremely important protein

for village communities in the Baram. Fishing is also an important source of food and income: 94% of people interviewed participated in fishing from time to time and ate what they caught. All community members regularly ate hunted meat and locally caught fish.

The Baram Heritage Survey collected 298 hunting return surveys over two years. Field technicians interviewed hunters when they returned from a hunting trip, regardless of whether the hunt was successful or not.

Hunters in these communities were highly skilled, with 78% of hunting trips returning a kill. A successful hunt brought an average of 46 kilograms of meat back to the village. Almost all hunts were intended to feed the hunter's household, however the vast majority of kills were also shared with neighbors and guests, intended for a festival or celebration, or sold and traded.

The most common animals that hunters searched for were bearded pig, deer, macaque and civet – although a much greater variety of wildlife was caught, including sun bear, otter and porcupine. The most used weapons to kill an animal were shotgun, spear and parang, with hunters often using multiple weapons at a time.

Hunters used a variety of modern and traditional methods, including hunting from a boat, trapping, spotlighting, sitting and waiting, using flushing dogs, poison blowpipe and dart, or walking an established hunting trail. Forty percent of hunters went in a group and 60% worked alone. Eighty-eight percent of hunters went on foot, by boat or by a combination of the two, while a handful drove or went by motorbike.

Field technicians also collected 166 fishing return surveys over two years. The primary purpose of fishing was to collect food for households, to share with the community, or to trade and sell. People used a variety of methods including cast nets, long lines, pole and line, multi-hook line, and spearfishing – although by far the most common method was nets.

Key Species

> *"We hope that laws for animals and plants, conservation and restoration will be established."*

Rhinoceros hornbill courtesy Chien C Lee Photography

The Baram Heritage Survey used transects to monitor the species richness, density, and abundance of animals in the target area. A smartphone app was developed and subsequently used to collect data entries. The app was co-designed by a field

coordinator who grew up in the Baram region, with input from the field technicians who would be walking the transects surrounding their own communities. Species that are regularly seen or hunted by the communities, as well as important rare, threatened, and endangered species were listed in the app.

The survey monitored 120 bird species, 67 mammal species and 24 reptile and amphibian species. Examining all animal data is beyond the scope of this analysis. The key species in this analysis have been considered based on their sheer numbers, their importance to the community, or their status as rare, threatened, or endangered.

Rare, threatened, and endangered species

The survey identified the presence of 39 RTE species in the project sites. This includes 3 critically endangered species, 9 endangered species, and 27 vulnerable species. Transect walks identified 5,368 individual animals that fall into these categories.

Bearded pig (Sus barbatus)

Bearded pig courtesy Chien C Lee Photography

The survey recorded at least 734 reports of bearded pigs across all transects, with 69 visual sightings and 567 signs. This makes it the most numerous mammal species recorded in the survey. More than 60% of signs were hoof tracks. Other common signs for tracking bearded pigs were ground ruts, muddy plants, and mud baths. Most visual sightings identified between 2 and 6 animals, although solitary animals were also commonly found. Bearded pigs were recorded in all transects and across all landscape types.

> *The most important animal in terms of caloric contribution is the bearded pig.*

Bearded pig catches made up more than 60% of successful hunts. This figure illustrates the devastating impact diseases such as African Swine Fever can have on Indigenous communities when wild populations are impacted, as was seen in the widespread die-off following the December 2020 outbreak in Sabah. Collapse of bearded pig populations due to disease also places increased pressure on other species, as communities are forced to hunt alternative species with lower reproduction rates for their protein.

Bearded pigs were caught using shotguns, spears, parang, and occasionally traps. Bearded pig catches ranged up to 130 kilograms, meaning one hunt could feed many families for multiple days. With their ordinarily high numbers and high reproduction rate, a healthy bearded pig population is an important element of food security in the research area.

Deer (Family Cervidae)

Lesser mouse deer courtesy Chien C Lee Photography

The survey recorded 582 deer sightings and signs, with 288 sambar deer, 311 yellow muntjac, 16 lesser mouse-deer and 11 greater mouse-deer. Sambar deer were mostly found by their hoof tracks, with 75% of recordings as tracks, 13% visual sightings and 3% scent. Yellow muntjac are also known as barking deer because of the bark-like sound they make. Eighteen percent of yellow muntjac recordings were of sound, 53% tracks, 25% visual and 1.4% scent. Seventy-eight percent of muntjac recordings were in intact and communal forest.

Deer were the second most significant animal reported on in the

Sambar deer tracks, photographed by field technicians on transect walk

hunting surveys, with 14% of successful hunts returning deer species.

Communities hunted all deer species. The larger species such as sambar and muntjac were reported as sometimes returning more than 80 kilograms of meat for one animal. This indicated that deer were a very valuable source of protein for communities in the Baram. Most deer were caught using shotgun and parang, although two mouse-deer were caught using the traditional blowpipe method.

Hornbills (Family Bucerotidae)

Wreathed hornbill courtesy Chien C Lee Photography

The survey identified 6 hornbill species through transect sightings and signs, with more than 2,000 individuals found. No hornbills were recorded in the hunting return surveys.

All hornbills are totally protected in Sarawak. The wreathed and rhinoceros hornbill are listed as vulnerable by the IUCN and the white-crowned hornbill is endangered. The helmeted hornbill was upgraded to critically endangered by the IUCN in 2020, signifying that it is on the verge of extinction due to poaching and habitat loss.

> *Hornbills are especially important in the regeneration of fragmented tropical forests, since they can disperse the seeds of large canopy trees across landscapes.*

Other frugivore species such as primates and rodents are less inclined to travel across human-disturbed landscapes – hornbills simply fly over the top. This is why some researchers call hornbills the farmers of the forest.

The majority of observations were visual sightings, with many birds flying in pairs and some in flocks. Apart from visual sightings, around one third of all hornbill entries were identified by sound, except for the wreathed hornbill, which only had 13% sound. A small number of hornbills were identified by dropped feathers. Black, bushy-crested and white-crowned hornbills were spread across all landscapes, and wreathed, rhinoceros and helmeted hornbills were found predominantly in intact and communal forests (more than 70%).

Primates (Family Cercopithecidae and Hylobatidae)

Pig tailed macaque courtesy Chien C Lee Photography

The survey identified 6 primate species and 2,274 individuals. North-Borneo gibbons, Hose's langurs, pig-tailed macaques, long-tailed macaques, red langurs, and western tarsiers were identified through transect sightings and signs. No slow loris were found, although this is unsurprising because technicians walked transects during the day and the slow loris is nocturnal.

While all primates are protected in Sarawak, langurs and gibbons are totally protected species. Pig- tailed macaques, long-tailed macaques and North-Borneo gibbons are listed as endangered species by the IUCN, signifying that their populations are facing a very high risk of extinction in the wild.

> *Primates play an important role in forest health because of the large diversity of fruit they eat and disperse.*

While some animals focus on particular plants, primates eat a huge variety; they have knowledge about which plants are fruiting at what times and will move around the forest

accordingly.

Most primate entries were visual sightings, although red langurs were mostly identified by sound. Hose's langur was identified more frequently in the more remote areas, and red langurs were found exclusively the most remote areas. No langurs were recorded in the hunting return surveys.

Sixty-one percent of gibbons were identified by their sound and 39% were found by visual sightings. Seventy-nine percent of gibbons were found in intact and communal forest. No gibbons were recorded in the hunting return survey. Macaques were identified across all sites and across all landscapes.

Great Argus (Argusianus argus)

Great Argus courtesy Chien C Lee Photography

The survey identified 249 great argus, with 59% visual sightings, 38% sound and a few feathers. Most were solitary animals, with a minority recorded in groups or pairs. Great argus entries were recorded in all landscapes and across all clusters. No great argus were caught in the hunting return survey. The great argus is listed as vulnerable on the IUCN red list of threatened species due to habitat loss and is a totally protected species in Sarawak.

Felines (Family Felidae)

Sunda Leopard Cat courtesy Chien C Lee Photography

The survey identified 9 cats, all individuals, all identified by their signs, and all found in the more remote areas.The elusive nature of carnivores such as felines leads to very few encounters of such species and identifying them by sign is difficult. As such, these results would best be verified using camera traps. Low encounter rates of this group of species are also likely due to its nocturnal behavior, since transect walks were done during the day. No felines were found in the hunting return survey.

The bay cat and flat-headed cat are both endangered, signifying that they are facing a very high risk of extinction in the wild. The

IUCN also lists the marbled cat and clouded leopard as vulnerable.

> *Very little is known about Borneo's key carnivore species, except that their numbers are dwindling due to habitat loss and poaching.*

Sun bear (Helarctos malayanus)

Sun bear courtesy Chien C Lee Photography

Sun bear scratchings photographed by field technicians during transect walk

The vast majority of sun bears were identified through signs: 57% tree clawing, 13% paw prints, 6.6% digging, and 5 visual sightings. Seventy-one percent of sun bear entries were in intact or communal forests, although tree clawing was also seen in cleared land and agricultural areas.

Sun bears are protected in Sarawak and are listed as vulnerable to extinction by the IUCN. Although very little is known about their numbers in the wild, sun bears have a large territory and low reproduction rate. Because they have low numbers in any given area, they are very sensitive to hunting, poaching, and habitat loss. Even occasional hunting can have a large and lasting impact on sun bear populations and on the surrounding environment.

> *Sun bears are a keystone species, meaning they have a disproportionately significant effect on their*

> *environment relative to their abundance.*

When hunting for ants and bees they create tree cavities, which are then used by other vulnerable tree-dwelling species. Sun bears are important pest controllers due to their appetite for termites and other insects. Their extinction could cause significant unknown damage to the forest ecosystem.

Pangolin (Manis javanica)

Sunda pangolin courtesy Chien C Lee Photography

Sunda pangolin hold/burrow photographed by filed technicians during transect walk

The survey identified all pangolins through signs: 43% digging, 31% animal holes, 14% scent, 5% prints, and other signs that were not listed on the smartphone app used to record data. Many of the digging signs showed where a pangolin had been hunting for ants. The animal holes, or burrows, are easily identifiable by the smooth entrance created by the pangolin's scales. Eighty-four percent of pangolin recordings were made in intact or primary forest. No pangolins were recorded in the hunting return survey.

Sunda pangolins are protected in Sarawak and are listed as critically endangered by the IUCN, signifying that they are on the verge of extinction in the wild. This is due to the illegal trade for pangolin meat and scales.

> *Pangolins are believed to be the most trafficked mammal in the world.*

Almost a quarter of pangolins in the survey were found in one communal forest where hunting is banned, suggesting their populations can potentially recover within small, protected zones. With a diet exclusively of ants and termites, a single pangolin eats millions of pests every year. There would be a cascading impact on the environment if pangolins were to go extinct.

Applications

> *"The land was passed down by my ancestors from generation to generation thus I have to preserve it for my future grandchildren."*

Copies of BHS atlases distributed to communities

High Conservation Value benchmarks (HCV)

A High Conservation Value (HCV) is a biological, ecological, social, or cultural value of outstanding significance or critical importance. In the context of Malaysia, companies undertaking

activities such as logging, oil palm plantations, and mining may be required to produce an HCV assessment prior to the start of their project to determine the potential impacts of the project on communities, wildlife, and ecosystems. There is a total of six HCVs. In the context of the Baram Heritage Survey, we can consider HCV 1, 5 and 6.

HCV 1, Species Diversity:

Concentrations of biological diversity, including endemic species, and RTE species, that are significant at global, regional, or national levels. This includes any area that contains significant concentrations of certain species, or an area that has a significant mix of these species. Traditional Ecological Knowledge, the method used by the Baram Heritage Survey, is one method used to evaluate this HCV.

The survey found a high level of species diversity. Our technicians found the presence of at least 39 different RTE species. They also found significant concentrations of many of these species.

HCV 5, Community Needs:

Sites and resources fundamental for satisfying the basic necessities of local communities or Indigenous peoples (for

livelihoods, health, nutrition, water) identified through engagement with these communities. This includes food, freshwater, wood, fiber, fuel, medicine, and fodder for livestock. A site or resource is fundamental for satisfying the basic necessities if the services it provides are irreplaceable (if alternatives are not readily accessible/affordable), and if its loss or damage would cause suffering or prejudice to affected stakeholders.

The survey substantiates the common knowledge that communities rely heavily on forest resources to meet their basic needs, including food, water, building material, and medicine. Through the survey findings, we can see the following evidence of HCV 5 Community Needs:

- Most houses are built from local materials. Eighty-three percent of people interviewed either harvested timber or collected timber for personal building purposes.
- People have limited opportunity to generate cash income. Only 1 person in the survey had a job that was not dependent on natural resources. Everyone else listed their most important source of income as agriculture, fishing, or hunting. One person listed handicraft, which is also reliant on natural resources. Sixty-six percent of people reported earning less than 250 MYR per month.

- Farming and livestock raising are done on a small or subsistence scale or crucial for generating income for acquiring basic necessities. Eighty-three percent of people listed agriculture as their most important source of income. Ninety-seven percent of people grew rice for personal consumption, and only 3 people out of the 108 people who grew rice sold part of their harvest. Everyone raised at least some livestock, and 40% of people sometimes sold their livestock. Ninety-six percent of people planted and harvested fruit, and 44% of those people sold part of the fruit harvest.
- Hunting and fishing are an important source of protein and income. Everyone in the survey ate hunted meat and locally caught fish as an important part of their diet. Several people did not eat any farmed meat at all.
- Wild food resources constitute part of the diet. In addition to wild animals and fish, 90% of people collected wild fruits, and 96% of people regularly ate wild fruits.

HCV 6, Cultural Values:

Sites, resources, habitats, and landscapes of global or national cultural, archaeological or historical significance and/or of critical cultural, ecological, economic or religious/sacred importance for the traditional cultures of local communities or Indigenous peoples.

In the context of Malaysia, HCV 6 encompasses traditional cultures of local communities or Indigenous peoples as identified through engagement with these communities. Indicators of a potential HCV 6 include megaliths, religious or sacred sites, burial grounds, sacred trees, sites where ceremonies and traditions take place, and resources for making traditional tools and culture items. The presence of shifting cultivation, tagang systems, and strong traditional practice also indicate the presence of HCV 6.

While the Baram Heritage Survey did not collect data about sacred sites, many comments from the interviewees clearly indicated the importance of traditional practice and cultural ties to the land:

> *"The land and old forest that I inherited from generation to generation is everything. The whole forest is a habitat for the animals that are my food source. Preserved and clean rivers promise beauty and the necessities of life continuously. The air will be preserved with the beauty of nature as a whole."*

> *"My land was preserved and protected by my ancestors long before me so I would want the same for the future generations. Most importantly, I want the future generations to be able to enjoy and*

> *gain the resources from the land that was once protected and maintained by their own ancestors and grandparents."*

Another indicator of HCV6 (as well as HCV 5, Community Needs) is the recognition or claim of customary rights. Although most people interviewed in the survey were not sure whether the government officially recognized their land as NCR, everyone who answered the question “Are Native Customary Rights something you want to establish here?” replied “Yes”. Furthermore, many people commented that they wanted their claim to the land to be recognized.

Building on the Baram Heritage Survey

> *A successful model that can be replicated*

Women in the Baram share a laugh

The Baram Heritage Survey was the largest survey of its kind ever conducted in the Baram region. The area is a biodiversity hotspot, yet the upper Baram in particular has attracted little research due to its inaccessibility. Most ecological studies in

Sarawak have concentrated on protected areas where logistics make research more achievable. Despite the need for species inventories to be conducted in inaccessible areas — especially those areas subject to logging concessions — our researchers could not find any existing research describing the diversity of species in the study area.

The survey was also unique in that it was co-designed with Indigenous communities. This bottom-up approach represents a new model of research that marries Indigenous Knowledge with elements of citizen science using smartphone technology. The methodology recognizes the fact that people from local communities are the true experts when it comes to understanding and recognizing local fauna and flora and evaluating their environments. The Baram Heritage Survey app was custom designed to be accessible with no scientific language and minimal technical training. Animals were categorized not by their taxonomy but by how the local people think of them — for example hoofed mammals, padded mammals, clawed mammals, and tree mammals. Knowing the Bahasa Melayu or English name for an animal or bird was not required as the app contained pictures of every species and many different footprints.

Field technicians' understanding of the distinct song and call of

various species was invaluable, with 638 data entries based on sound. While designing the app, technicians demonstrated they could easily mimic the sound of gibbons, great argus, and muntjac, as well as multiple distinct hornbill species. Technicians' comfort in the challenging terrain was another skill that cannot be overstated. Local communities are the best placed to conduct this type of research, and this is especially true in extreme remote settings such as the Baram. This model could be replicated in other places in Sarawak and Malaysia.

Other potential applications

Field team for one cluster of villages

There are several areas of the survey that could attract further research by using or expanding on the collected data.

The survey collected data on 120 different bird species, and 14 of

the 39 RTE species identified were birds. Further analysis of the bird data could assess their diversity and status and inform protection measures. The presence of endangered birds could be grounds for strengthening forest protection in the Baram.

Currently, there is no inventory of species diversity in the Baram, nor an official population count, locally or globally, for many of the species. This is true for sun bears, gibbons, and Hose's langur, to name just a few. The method used by our research team required a certain minimum number of sightings to run an abundance analysis, and many species fell short of this number. To complete a population count for all mammals, for example, more transects would need to be created across the landscape and many more months of data would need to be collected.

Additional species-specific research could be conducted. Comparing wildlife numbers inside protected areas against unprotected areas like the Baram could demonstrate the positive impact of Indigenous-led forest management, as it has in many other places around the world. There are several other avenues that could be explored if local communities would like to work on wildlife conservation or research with other international organizations. In Sabah, sun bear conservationists use a slightly different transect method that could be replicated in the Baram, so that sun bear numbers for both states could be counted and

compared. For gibbons, a project has been done in Indonesia using a triangulation method to count gibbon sounds.

There are pangolin crisis initiatives, and programs aimed at targeted population recovery for helmeted hornbills. As the Baram Heritage Survey data was collected before the outbreak of African Swine Fever in Sarawak, bearded pig numbers from the survey could be used to evaluate the impact of the disease in future studies. This is by no means an exhaustive list.

Birding enthusiasts are keen ecotourists all around the world, even in the most remote locations. This is an angle that could be explored for generating alternative livelihoods for Indigenous communities. The same could be said for wildlife photographers looking to capture photographs of specific species. While wildlife should remain undisturbed by outsiders as much as possible, tours to the region could take visitors to places where they are likely to see hornbills flying above, or hear gibbons in the trees, for example.

The survey collected data that could be used to verify or counter the claims of logging companies when they conduct assessments for their projects. These assessments tend to downgrade the degree to which communities rely on forest resources for their survival. They may also skim over the ecological value of wildlife,

the abundance and diversity of RTE and keystone species, and minimize the value of ecosystem services. The results of this atlas sit in direct contravention to such misrepresentations.

The Baram Heritage Survey was designed and implemented within the context of the Upper Baram Forest Area. The methodology itself was intended to build community capacity and strengthen Indigenous-led forest protection and land rights. The data outcomes from the survey demonstrate its success and offer a model of Indigenous-led research that can be replicated in other difficult to access areas of ecological significance.

Acknowledgments

The Baram Heritage Survey and Community Atlases were only possible through the hard work and collaboration of many people. We are very grateful to the collaborating communities. Special thanks to our field manager, and to the field technicians, who spent many hours – on foot, by boat, and motorbike – walking transects on difficult terrain and interviewing community members for many months.

Thank you to the community leaders of these villages for helping to organize the project. We are also grateful to our collaborating

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Glossary

- Bahasa Melayu: a Malaysian language.
- Citizen science: scientific research conducted by ordinary people without formal qualifications.
- Communal Forest: an area of forest designated by the community with certain use restrictions and protection measures.
- Customary Rights: rights to land that is owned, claimed, or jointly managed by a community based on the customs of that group.
- Ecosystem services: the benefits provided to humans by a healthy natural environment such as clean air, potable water, food security and natural medicines.
- Field technician: a community member trained to collect social and ecological data.

- High Conservation Value (HCV): a biological, ecological, social, or cultural value of outstanding significance or critical importance.
- Intact forest: forest without a history of clearing or logging.
  IUCN: The International Union for Conservation of Nature, the world's most comprehensive information source on the global extinction risk status of animal species.
- Native Customary Rights (NCR): the legal term for Indigenous customary land rights in Sarawak.
- Parang: a type of knife used across the Malay Archipelago.
  Protected species: the Wildlife Protection Ordinance, 1998 protects rare animals in Sarawak from habitat destruction and hunting. A license is required to hunt, capture, kill, sell, import, export, possess any recognizable part of these animals, or keep them as pets.
- RTE species: rare, threatened, or endangered species.
- Shifting cultivation: an agricultural system in which plots of land are cultivated temporarily, and then abandoned so that fallow vegetation is allowed to grow naturally while the cultivator moves on to another plot.
- Tagang: a traditional method of wildlife management, usually involving fisheries, in which certain use and fishing restrictions are agreed on by the community to promote healthy wildlife populations.
- Traditional Ecological Knowledge (TEK): also called

Indigenous Knowledge or Native Science, TEK refers to the evolving knowledge acquired by Indigenous and local peoples over hundreds or thousands of years through direct contact with the environment. This knowledge is specific to a location and includes the relationships between plants, animals, natural phenomena, landscapes, and timing of events that are used for lifeways, which are including but not limited to hunting, fishing, trapping, agriculture, and forestry.

- Totally protected species: the Wildlife Protection Ordinance, 1998 protects extremely rare animals from habitat destruction and hunting. It is illegal to hunt, capture, kill, sell, import, export, possess any recognizable part of these animals, or keep them as pets without written permission from the Controller of Wildlife.
- Transect: a walking path cleared in the forest.
- Upper Baram Forest Area (UBFA): The UBFA is an initiative designed to increase forest protection, reduce, or eliminate industrial logging, and build regenerative livelihoods in the upper Baram area. The idea came from local communities who want to protect their heritage and forests. It is also referred to as the Baram Peace Park.

About the author

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