INNOVATIVE ECOLOGICAL RESEARCH FOR HIGH-PRIORITY AQUATIC REPTILES IN SARAWAK, MALAYSIA

A CONSERVATION PROJECT FUNDED BY CONSERVATION LEADERSHIP PROGRAMME
Innovative Ecological Research for High-Priority Aquatic Reptiles in Sarawak, Malaysia

CLP – 03288716

Sarawak, Malaysia
17 June 2016 — 1 May 2018

Final Report

CLP 03288716 project team members (Pui, Siti, Anthony) Photo Credit: Prof. Indraneil Das

Report Completed
15/05/2018
Final Report

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<tr>
<td>Report Authors</td>
<td>Siti Nor Baizurah Binti Abdul Malik and Anthony Pine</td>
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<tr>
<td>Contact Address</td>
<td>Institute of Biodiversity and Environmental Conservation – c/o Siti Nor Baizurah Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak</td>
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<tr>
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<td><a href="mailto:sitinorbaizurahabdulmalik@gmail.com">sitinorbaizurahabdulmalik@gmail.com</a> and <a href="mailto:anthonykpine@gmail.com">anthonykpine@gmail.com</a></td>
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Project Partners & Collaborators

- Institute of Biodiversity and Environmental Conservation (IBEC) at Universiti Malaysia Sarawak (UNIMAS)
  - Project supervision and institutional support
  - Additional equipment and project needs
  - Seminar rooms and outdoor space for training workshops
  - Undergraduate and postgraduate research assistants and volunteers
  - Animal ethics regulation and permissions

- UNIMAS Publisher
  - Publication and printing of *A Crocodile Named Tom*
  - Promotion of book and CLP team conservation efforts within Malaysia

- Sarawak Forestry Department (SFD)
  - Facilitated permits required to conduct research at all field sites
  - Partner and enforcement agency for Crocodilian Management Program
  - Provided CITES export permits for laboratory analysis of genetic samples

- Sarawak Forestry Corporation (SFC)
  - Handling of accommodation and entrance permits within National Parks
  - Partner during public outreach events
  - Partner in handling large crocodile captures and releases

- Jabatan Pendidikan Negeri Sarawak (JPN)
  - Facilitated permits for educational efforts in schools

- Telenax Wildlife Tracking Equipment
  - Transmitter and receiver purchase and assistance in configuration and use
Project Summary

The aim of this CLP conservation project was to investigate and improve understanding for the conservation and management concerns affecting five species of reptiles including the Spiny hill turtle (*Heosemys spinosa*), Asiatic softshell turtle (*Amyda cartilaginea*), Malaysian giant river turtle (*Orlitia borneensis*), Saltwater crocodile (*Crocodylus porosus*), and Tomistoma crocodile (*Tomistoma schlegelii*). Objectives of this project were to conduct some of the first, focused research and conservation efforts for our targeted species. Our research efforts aimed to increase understanding for our targeted species ecology, a foundation needed to make sound and worthwhile management decisions. Our conservation efforts and assessments aimed to understand and prioritize practical and effective management options to ensure our species and their habitat were protected into the future.

Our CLP team conducted over 30 field trips at five different field sites. We were able to use innovative approaches and technology to capture and survey our species, map river habitat, assess environmental conditions and track tagged animals. Our project has conducted some of the first ecological studies for our species in Sarawak and our team has created interest and awareness for our species through community outreach, hands-on training workshops and children’s literature. Our team has also discovered new and ongoing conservation threats to our targeted species, threats that we are actively working to address and report to management officials to ensure that are species populations are sustainable.
Introduction

In the Malaysian state of Sarawak, on the island of Borneo, there are characteristic species of reptiles that are highly dependent on aquatic ecosystems. The largest of such semiaquatic reptiles include the crocodilians, of which two species are known to exist in Sarawak, including the Saltwater crocodile (*Crocodylus porosus*) and the False gharial (*Tomistoma schlegelii*). These crocodilian species offer unique importance to regional biodiversity, play an important role in ecosystem health and have added much to the vibrant culture, traditions and folklore found within local communities. River turtles represent another interesting and important order of reptiles that are present within many of the same rivers and aquatic environments as crocodiles. In Malaysia, there are two notable and potentially large species of river turtles that are under conservation concern that include the Malaysian giant river turtle (*Orlitia borneensis*) and the Asiatic softshell turtle (*Amyda cartilaginea*). A third turtle species is the Spiny hill turtle (*Heosemys spinosa*), an enigmatic and elusive species that is found outside of aquatic environments but is another high-priority species to better understand and conserve.

This project focused on conducting research and conservation efforts to better understand and address conservation threats and management concerns for these unique species of reptiles. In many areas, these reptiles are under immense pressure from habitat loss, illegal trade and hunting, poor management and other causes of exploitation. Equally concerning is a serious lack of understanding for the intensity of these threats and their potential impact for long-term conservation and management effort. This project focused on taking the first steps to building a foundation for realizing these conservation concerns and for initializing management recommendations to best benefit long-term conservation.

Beyond the problem of threats to species conservation, this project also addressed the serious lack of understanding for the ecology of our targeted species, which plays a key role in better assessing and understanding the impact of habitat change and other detriments to our targeted species. Issues addressed include presence and abundance of species at targeted sites, movement patterns, habitat use and habitat mapping. We also addressed the serious lack of proper management of crocodilians by helping to develop a management and tagging problem alongside Sarawak Forestry Department for their recent allocation of licensed crocodile hunters.

Our field sites included three main river systems in southwest Sarawak (Sungai Samarahan, Sungai Tuang and Sungai Simunjan) and mountainous forest regions in south-west Sarawak. These sites are notable for the current conservation and management concerns related to our targeted species. These sites were chosen as they offered significant opportunities for public outreach and education to bolster local interest and awareness for our targeted species which occurred within the same localities. We could also better assess direct conservation concerns through local interviews and field research efforts.
Project Members

- Siti Nor Baizurah Binti Abdul Malik
  Siti is a PhD student with the Institute of Biodiversity and Environmental Conservation (IBEC) at Universiti Malaysia Sarawak (UNIMAS) and has specialization in herpetofaunal research related to thermoregulation, habitat use and movement patterns. Her current project focuses on the range and movement patterns of the Spiny hill turtle in south-west Sarawak. Her role in this project is team leader and helps plan and organize research and conservation efforts focused on the targeted species of turtles.

- Anthony Pine
  Anthony is a MSc student with IBEC at UNIMAS and has specialization in crocodilian research and conservation. His current project is looking at habitat use and species presence within rivers of south-west Sarawak, genetic analyses of scute samples, and management protocol for wild crocodilian populations. His role in this project is team co-leader and helped to organize research and conservation efforts for the targeted species of crocodiles.

- Pui Yong Min
  Pui is a PhD student with IBEC at UNIMAS and has specialization in identification and classification of reptiles, field survey techniques and data analysis. Pui also brought skills to our team related to outreach and educational program development, important for our community outreach initiatives. His role in this project was as research assistant and helped to plan and fulfill research and conservation goals throughout the project.

- Professor Indraneil Das
  Indraneil is a Professor with IBEC at UNIMAS and is specialized in all matters of herpetofaunal research and field techniques. His role in this project was to provide project supervision and advice, including aspects of the project related to project planning, reporting, field work, and lab analyses. He also helped broaden connections necessary to collaborate with relevant forestry officials, local stakeholders and management officials for research and conservation efforts.
Aim and Objectives

The main aim of this project is to obtain ecological baseline data and threat assessments for our targeted reptile species to better understand conservation concerns and management priorities. Through this aim, we hope to better our ability to conserve, educate and promote awareness for our targeted species and gain necessary knowledge to substantiate our research findings through recommendations and reports to decision-makers, environmental management officials and local stakeholders.

- Objective 1: Increase scientific understanding on the targeted species ecology in Sarawak.
- Objective 2: The degree of exploitations and conservation threats to species are ranked and assessed, including new threats and management concerns.
- Objective 3: Increase knowledge and understanding of targeted species within local communities and improve conservation interest and support.
- Objective 4: Improve management strategies by providing useful research reports and recommendations to authorities.
- Objective 5: Improve training and increase interest in conservation projects to Sarawakian wildlife officials, local fishermen and hunters and to students at Universiti Malaysia Sarawak.

Changes to Original Project Plan

Throughout our trapping efforts and using our CLP hoop traps, our team did not have success in capturing *A. cartilaginea* or *O. borneensis* in the wild, although we were able to observe and record illegal trade of the species at local markets and villages. Our team felt that it was necessary and important to include these species into our project and reporting due to the amount of data we’ve obtained from local reports and interviews, direct observations from illegal trade and from the need to emphasize the species importance in awareness efforts.

Our project did not achieve attaching all purchased vhf transmitters to suitably-sized crocodiles for tracking purposes. This has been due to not having the number of trained individuals to take part in capture efforts of medium to large crocodiles. Of the 48 crocodiles that we have caught during this project, only one adult Tomistoma was large enough to support our radiotransmitter package. We expect to address this problem with a new crocodile capture collaboration between our CLP team and Sarawak Forestry Department, whom have agreed to loan crocodile cage traps, and with potential collaboration alongside licensed crocodile hunters to focus and capture large adult crocodiles.

After CLP approval, our project also included the Spiny hill turtle (*Heosemys spinosa*), an endangered species, into our project list of targeted species as our team was able to secure a field site and permits to conduct a research and conservation project. Our team is currently tracking multiple turtles and have conducted necessary habitat assessments to better understand the potential threats and management requirements for this species.

After our preliminary report, we also made some necessary changes to better utilize our remaining budget, including adding field trips for the Spiny hill turtle and to include a crocodile management and tagging project in cooperation with the Sarawak Forestry Department.
Methodology

Research on the Spiny hill turtle (*Heosemys spinosa*) occurred within high elevation forest areas in Sarawak. Finding turtles required intense effort through visual encounter surveys and pitfall trapping using 20 litre pales. Pitfall traps were checked regularly during field trips and were removed after field trips to avoid accidental capture or mortality of animals. Captured turtles were measured and were immediately taken to a veterinarian for x-ray, transmitter attachment and implantation of temperature-sensitive ibuttons. Captured individuals were released and full-day tracking occurred for 8-10 days per month throughout the duration of this CLP project. Captured turtles will have ibuttons removed in the future to better understand thermoregulatory patterns for the species.

Research focused on crocodilians required the use of side-scan sonar mapping, eyeshine surveys, and capture trips. Side-scan sonar surveys were performed using a bow-mounted Humminbird ONIX 10cxi device (international model) at a constant boat speed of 8km/hour during ideal weather and tidal periods. Sonar recordings were processed using SonarTRX software (http://www.sonartrx.com) and the result mosaics were imported and analysed in ArcGIS Pro (https://pro.arcgis.com). Crocodile eyeshine surveys occurred on nights of suitable weather and tidal conditions (i.e. low tide) using the IBEC research boat modified for crocodilian research. Crocodile eyeshine surveys followed standard techniques outlined in Fukuda *et al*, 2013 and categorized crocodiles based on size, species and location within the river. Water quality tests were conducted at 1km intervals at survey sites using necessary equipment and probes. A large scoop net was used for capture efforts of hatchling and juvenile crocodiles. Captured crocodiles were measured in detail and small scute clippings were taken for further genetic research. Eyeshine surveys, interviews, water quality assessments and capture efforts were aided with our custom-designed cybertracker app (http://www.cybertracker.org), allowing the survey recorder to enter data on an android tablet (Samsung Galaxy Tab A7).

Education and outreach occurred at public places and local schools at field survey sites and elsewhere in Sarawak. School presentations utilized age-appropriate presentations focused on the importance of biodiversity, conservation and our targeted reptile species. A hands-on portion of educational programs took students outside to observe and use our field equipment, get into the crocodile boat and understand field survey techniques. Various media were distributed after events, including outreach flyers, children’s books and informational packets. Our various professional training workshops were conducted at IBEC and utilized presentations and hands-on training to educate participants in field survey techniques, management and conservation for our targeted species.

A crocodile tagging project was developed in collaboration with Sarawak Forestry Department to ensure proper procedures and recordkeeping was in place for the recently-initiated Saltwater crocodile culling program in Sarawak. Before our project, licensed crocodile hunters did not and were not required to collect any data related to crocodiles that were killed (i.e. species, size, sex, location, place of sell, etc). Our CLP team noticed that a poorly-managed culling program could cause negative impact towards future crocodilian management and reached out to Sarawak Forestry Department to initiate development of this tagging project in which our CLP team will train licensed hunters on proper methods to humanely trap and
kill a crocodile, how to record vital data relative for each kill and how to collect genetic samples and necessary data.

Although our CLP team does not fully believe a Saltwater crocodile culling programs was necessary, we do feel there is a need to ensure accountability, recordkeeping and humane killing. From this soon-to-be mandatory tagging project for licensed hunters, we can help understand the effects of the crocodile cull on both *Crocodylus porosus* and *Tomistoma schlegelii*, identify crocodiles that were not hunted legally in meat markets, obtain genetic and other useful data for program monitoring, ensure crocodiles are humanely trapped, handles and killed, and ensure that standardized hunting and management practices are used to validate such a program towards international standards. In terms of methodology, this tagging project consists of a training workshop for licensed hunters, provision of necessary equipment via a licensed hunter kit, followed by communication and long-term monitoring of results with project collaborators. Hunter kits include a project t-shirt, measurement tape, stainless steel tweezers and scissors, a set of 5ml labelled sampling vials with alcohol, custom-printed Tyvek tags, marker pen and a waterproof box.
Outputs and Results

Objective 1: Increase scientific understanding on the targeted species ecology in Sarawak.

A total of four river systems were mapped using side-scan sonar, totalling approximately 70km worth of new, usable maps for research and management – essentially a bold, first look into these lotic ecosystems. These sonar maps provide a clear visualization of many parameters previously unknown within the environment, including depth, habitat type, habitat complexity, anthropogenic disturbance and even habitat change. Further analysis will be needed over the coming months to categorize subaerial habitat composition and sediment types to examine any significance these features have on the presence or distribution of crocodiles within the area. As for now, these maps provide a basemap for future studies and for long-term monitoring of habitat change at our field sites.

There were also repeated crocodile eyeshine surveys at mapped areas. A total of 627 crocodiles were surveyed over the course of 11 dedicated eyeshine surveys. On separate nights, we also focused on crocodile captures for morphometric research and genetic sampling. Over the course of 18 capture trips, our team sampled and released 48 crocodiles, mostly hatchlings. Data collected related to the morphometrics of captured hatchling crocodiles offer new insight into the growth rates and morphology of our targeted crocodiles. In the future, this will be compared to growth rates of captive crocodiles at the local crocodile farms in Sarawak.

Water quality sampling was conducted at each river system, covering the range of our other research surveys (i.e. sonar, eyeshine and captures). Water quality tests were conducted at equally-spaced intervals at survey sites with a combined total of 52 sampling sites across all sites.
Objective 2: The degree of exploitations and conservation threats to species are ranked and assessed, including new threats and management concerns.

Conservation Threat Assessments for Crocodilians

Field sites were assessed for conservation concerns and conservation threat rankings based on local interviews and an overall assessment summary form for each field site completed at the culmination of field work. Advantages for conservation were also evaluated at each field site.
The Most Dangerous Conservation Threats for the Spiny Hill Turtle in Sarawak

- Likelihood of increase in threat levels
- Inefficiency of enforcement
- Inefficiency of management
- Unattended animal or research traps
- Illegal hunting activities
- Illegal specimen collection by foreigners
- Disturbances caused by trespassing hunters
- Illegal selling / Traditional Chinese Medicine
- Habitat loss, fragmentation or alteration
- Illegal use for cultural purposes
- Pollution level (within river)
- Logging and logging trails/huts
- Agricultural or plantation land use

Advantages to Conservation for the Spiny Hill Turtle in Sarawak

- Absence of cultural taboos
- Absence of agricultural land use
- Absence of scientific collection or hunting
- Local site protection from government
- Willingness to help in research efforts
- Outlook towards conservation
- Community interest in activities
- Enforcement power available within area
- Ability of locals to influence management efforts
- Interest in long-term habitat protection/management
- Interest in species long-term survival/management
- Appreciation of H. spinosa as important to ecosystem
- Understanding of presence by locals and stakeholders
**Objective 3: Increase knowledge and understanding of targeted species within local communities and improve conservation interest and support.**

A total of seven outreach events were conducted to promote awareness and interest for our targeted species. There are plans to culminate our educational efforts with 2-3 more educational presentations at schools and within local communities in the coming months.

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<td>School Students</td>
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**Objective 4: Improve management strategies by providing useful research reports and recommendations to authorities.**

A total of 27 field trip reports were completed for field trips associated with our CLP project. Short trip reports summarized the activities and outcomes from each field trip and were provided to project supervisors, management officials and kept for internal record.

An official management recommendation report for *Heosemys spinosa* is planned at the culmination of CLP team’s research. Similarly, this report is expected to be submitted once full confidence is achieved in our assessments and our radiotelemetry efforts are fully analysed.

An official management recommendation report for *Tomistoma schlegelii* is planned to be submitted to management officials. This report requires additional time due to ongoing research and data analysis that will improve confidence in our management recommendations.

These management reports will focus on recommendations for habitat protection and protection zones, alongside initiatives that could bolster interest and awareness for species conservation.

**Objective 5: Improve training and increase interest in conservation projects to Sarawakian wildlife officials, local fishermen and hunters and to students at Universiti Malaysia Sarawak.**

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<th>Location</th>
<th>Presentation-type</th>
<th>Audience type</th>
<th>Estimated attendance</th>
<th>Resulting volunteers during CLP field trips</th>
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<td>UNIMAS</td>
<td>Outdoor training</td>
<td>University Students</td>
<td>30</td>
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Beyond training workshops, on-site training and collaboration with forestry officials and local stakeholders occurred at our field sites. Management officials and forestry officers assisted during radiotelemetry efforts and were able to gain hands-on experience with animal tracking in densely-vegetated, hilly forests. Sarawak Forestry officers also attended multiple crocodile field trips, including one occasion where we jointly restrained and released an adult crocodile – an important feat for research and conservation. Local peoples also helped immensely throughout our efforts and have aided in reporting sightings, captures and protection of our species even when our CLP team was not present. We hope to build upon these relationships to promote local-led species conservation.
Communication and Application of results

Our project results have been communicated to project supervisors and to management officials through regular field trip reports following each of our field trips. These include trips to field sites for research, veterinarian visits and for our educational outreach events. As our conservation project has just completed field work, we are now at the stage of organizing and analysing our research to make accurate and substantiated recommendations to management authorities and local stakeholders.

There are still aspects of our field work which are still ongoing, including radiotelemetry and genetic research, which we are hoping to analyse soon to ensure our management recommendations are accurate and provide the most beneficial options and outcomes for long-term conservation of our species. For example, our CLP team is very close to understanding the movement patterns of an adult crocodile and also the movement patterns of different Spiny hill turtles. With this data, we can better understand habitat use, range sizes and movement boundaries that will be necessary in predicting and assigning conservation zones that would best benefit protection by environmental managers and local stakeholders.

Monitoring and Evaluation

Research
- Field surveys can be evaluated by our ability to detect our species in the wild. Over time, we were able to better detect our species and better understand the safest and most practical environmental conditions that allowed effective population surveys.
- Radiotelemetry success was assessed by our ability to detect our species after release. In all cases, we have been able to relocate our released animals.
- Side-scan sonar mapping was evaluated based on the quality and range of our mapped river areas. We could easily evaluate our sonar mosaics and made necessary adjustments over time to improve overall quality of our river maps.

Conservation Threats
- Local interviews and field observations were evaluated based on the number of interviews conducted and our ability to determine habitat threats (via habitat assessment forms) for our survey areas.

Outreach and Workshops
- The effectiveness of our outreach efforts were evaluated by participant attendance. We monitored effectiveness of our training workshops by recording how many people participated and from what participant category (i.e. students, local stakeholders, forestry officials). School presentations were assessed by the number of students who participated, and the number of books or materials provided at the end of events.

Management Recommendations (not yet complete)
- Our ability to improve management strategies can be evaluated by the number of potential recommendations we are able to provide to management authorities.
Achievements and Impacts

This CLP project had many important achievements and impacts relative to the conservation objectives for our targeted species and the overall conservation aim of our team project. These achievements can be separated into categories related to research, conservation and community involvement, with the most important achievements being listed below.

Research
Established base-line research for our targeted species.

- There have been little to no research conducted for the majority of our targeted reptile species. By conducting some of the first surveys and intensive research, we can provide a foundation for future research and long-term conservation planning. Areas of new research include studies into ecology, morphometrics, genetics, and population distribution for our targeted species in Sarawak.

- Used innovative technology and approaches to create new understandings necessary at our field sites.

Conservation
Public awareness and educational presentations in Sarawak.

- By providing access and opportunities for local people to learn about our activities and conservation goals, we were able to instil interest and support for our conservation efforts, improve awareness for our goals and enable children an opportunity to understand the importance of biodiversity, conservation and the survival of our targeted species.

- Training workshops allowed practical and intensive learning opportunities that otherwise would not have been possible for students and local participants.

- Workshops related to crocodile research methods and techniques have help spread awareness for our conservation project and get future students interested in continuing research related to our conservation goals and our targeted species. One future workshop for licensed hunters is also expected to improvement management capabilities of the Sarawak Forestry Department and also educate hunters on the humane hunting and tagging procedures for saltwater crocodiles.

Publication of a children’s book related to our project goals for youth awareness.

- By producing and publishing a children’s book with UNIMAS Publisher, we hope to have a sustainable outlet to promote conservation for school students throughout Sarawak.

Ranking conservation threats for our field sites has improved our understanding for future conservation.

- By establishing threat rankings for each of our field sites, we better our ability to provide accurate and practical approaches to improving conservation and management plans at our field sites.

Community Involvement
Partnership and collaboration of efforts with Sarawak Forestry and local stakeholders have improved project efforts and contributed towards collective accomplishments and interests in conservation.

- Through many collaborative field trips and field trips requiring local support and assistance, we have improved understandings for our project conservation goals and helped create interest and awareness within the community for our field work.

Public awareness initiatives at local villages at high-priority sites have helped reduce illegal trade of our targeted species.

- Although not definitive, there have been cases where our team has created good relationships with local people at field sites that have changed their earlier habits of selling aquatic reptiles and instead helped conservation by informing our team of captures and helped to facilitate releases.
Capacity Development and Leadership Capabilities

Our CLP team has acquired many new skills and improvements in our abilities to be project team members and conservationists. Our research project was highly-complex, often requiring learning new techniques or approaches to evaluate conservation concerns or for studying our animals in the field. Through our CLP grant, we had access to funds necessary to purchase and gain skills in using various research equipment, including radiotransmitters, trapping materials and a side-scan sonar device. As a team, we had regular meetings and capacity building activities throughout our CLP project, which enabled our team to obtain new perspectives into approaching conservation.

Siti has greatly improved her understanding and ability to conduct technical research on the Spiny hill turtle (*Heosemys spinosa*), a species where little information was provided for guidance or review. She has helped train, interview and hire research assistants, improving her leadership skills and her ability to build a team around the purpose of her research and conservation. She collaborated with Sarawak Forestry officials and has established protocol for trapping and transporting turtles and for specialized veterinarian work. As a conservationist, she has trained our CLP team with the necessary resources provided by her training in Canada to better our team’s planning and project implementation. Through her hard work, she has greatly improved the ability to conserve a poorly-understood species of turtle in Sarawak, which can lead to incredible opportunities for understanding how to protect the Spiny hill turtle into the future.

Anthony has gained new skills in project management and implementation, including various areas that were new to him including operating a boat, training research assistants, leading field surveys and interacting with local community members and stakeholders. He was required to apply for both CITES and Sarawak research permits, which has improved his understanding of procedures necessary to conduct research and conservation of protected species in Sarawak. He was able to initiate and develop and crocodile tagging program to ensure management criteria was included into Sarawak’s crocodilian management program. He was able to plan educational efforts in local schools and help assist in implementing fun and educational school presentations. Based on progress made throughout our CLP project, he also was accepted into the IUCN - Crocodile Specialist Group, which he hopes to help provide accurate information regarding the populations of crocodiles in Sarawak. As a conservationist, Anthony was able to improve his understanding and ability to properly conduct conservation and management projects for crocodiles in Sarawak.

Pui has gained new skills in advising co-leaders Siti and Anthony throughout this project. He has been an important leader for our team and has helped immensely in providing insight into our project plans, how to conduct effective research and how to reach out to public for educational efforts and activities. He has gained knowledge in professional collaboration with local stakeholders and governmental agencies and has further his pursuits in conservation leadership for his own interests in amphibians and biodiversity. As a conservationist, Pui has been a role model for our team and has motivated our CLP team to pursue our goals for conservation.
Conclusion

This CLP conservation project has shed new light on the understanding and future conservation potential for our targeted species in Sarawak, Malaysia. By evaluating conservation threats, conducting research on poorly-understood facets of the species ecology and distribution and by interacting and incorporating local and governmental collaboration, this project has provided a greater foundation for progressive conservation efforts focused on primary factors that negatively affect the targeted species in the wild. Over the course of over 30 field trips, this CLP project acquired data related to conservation threats and benefits at each field site, which can be analysed alongside our data to produce useful, practical and effective recommendations to environmental managers. We hope our past and future efforts will instil a long-lasting appreciation for our targeted species within local communities and for the stakeholders that can also help to protect the species and the habitat where they are found.
Problems encountered and lessons learnt

Activities that went well
This project had many successful activities that produced worthwhile outcomes for the effort and funding required. Some of the most interesting, novel and successful activities include capturing and tracking our endangered targeted species, species that often require immense effort, time and experience to find and conduct research. The Spiny hill turtle was exceptionally difficult and rare to find, yet our project was successful in finding and tracking 4 individuals from different life stages, sexes and locations. This data is incredibly useful for understanding the ecology of the species and relating this to practical and substantiated methods for future management and habitat protection. We can now confer with managers that this species is present, is reproductive and has a population requiring protection from conservation threats. Similarly, finding an accessible population of Tomistoma was an incredibly rare feat that has taken Anthony roughly 2½ years to find. We have identified one of the only known and likely one of the most important populations of Tomistoma in Sarawak, a reproductive population found at a site with extreme conservation concerns. With the knowledge we were able to obtain, we can provide governmental managers the information and opportunity to protect our species in the wild.

All field work went relatively well and training students and other stakeholders provided useful and unexpected opportunities for our CLP team to build its team leadership skills whilst also helping to shed our interest and passions for conservation to others. Lastly, we had much success in interacting with local communities and stakeholders and we felt extremely privileged to have had the funding and opportunities available to pursue collaborations with locals to support our conservation project.

Problematic and unexpected activities
There were a few minor activities and outcomes that did not go as expected or that was problematic during our CLP project. At all of our field sites, we did encounter illegal activities that affected our targeted species. Usually it was hunting or illegal trade, activities that we have no power to enforce or defend against. Our sites had a few instances of illegal or remnant capture buckets placed within the park and camera trap photographs showed hunters utilizing the park for hunting wildlife. Although these illegal activities might not be focused on the Spiny hill turtle, it does show potential for illegal captures or at the least could provide potential for negative impacts to affect the ecosystem that the species relies upon. We also noticed anthropogenic land use and alteration at our field sites, mostly from illegal logging that goes uncontrolled. Local communities often use the forests for their livelihoods, so although this is difficult to comprehend in terms of conservation, it does pose problems that can impact our sites and the habitat used by our species. Alongside illegal trade, these conservation threats did create minor problems that we needed to understand and work alongside throughout our CLP activities.

More direct problems related to the accessibility to capture our targeted species. The Spiny hill turtle was extremely difficult to find and radiotelemetry required much effort to feasibly track the multiple individuals we had tagged. As for crocodiles, it was problematic to find the necessary team-members and equipment that were necessary to do capture efforts of large individuals that were capable of supporting transmitters. In this way, radiotelemetry for crocodiles did not go as expected. Instead we still did our best to capture hatchling and juvenile crocodiles that were more feasible to capture during our boat surveys and that could still provide useful training for research assistants and useful data related to crocodilian morphometrics and genetics. We also had a minor problem initially with our side-scan sonar device, which was problematic in operation from purchase and didn’t work correctly until the manufacturer repaired the device under warranty after many boat trips of trial and error.
Assessment of methodology used

The methodology used during our activities and efforts often went well and as planned. Minor aspects that were not originally accounted for included changes in weather, which did impact and even cancelled a few of our field trips. It would be important to better take into account weather and environmental conditions, such as tide and lunar phase, when conducting boat surveys and planning field work within Sarawak. Also, for any implantation or transmitter attachment procedures, it was important that a veterinarian was used as we did. Our conservation approaches used for threat assessments, training and for community awareness went well as did the necessary methods used. Overall, our methodology was suitable and went well during our efforts.

Lessons learnt and recommendations for enhancements to project

1. Perseverance and hard work pays off
2. Sparking interest in children and local people for our cause is beneficial and rewarding
3. Managing people can often relate to managing threats towards species conservation
4. Objectives need to target specific, achievable goals and not necessarily ambitious goals
5. Partnering and forming connections with local conservation agencies is incredibly important
6. Identifying and ranking conservation threats is a pivotal step in management planning
7. Teamwork and regular team discussions can help our team stay informed and motivated
8. Including and providing opportunities for local people and stakeholders to take part and have responsibility in our efforts provides collective and enduring results that everyone can be proud of.

In the future

Our project will continue to monitor and conduct follow-up research and conservation efforts at our field sites and within local communities where we have made contact and promoted conservation and awareness for our targeted species. This will be in-part due to our graduate studies, training of undergraduate students and our institute’s commitment to our field work and to better realize long-term research, conservation and management needs for our targeted species.

As our study was one of the first to better evaluate and understand conservation threats to our targeted species in Sarawak, our project members will remain vigilant in providing accurate and practical management recommendations for our species as more ecological baseline data is obtained and we have a better understanding of the habitat and areas most important to our targeted species survival. Management recommendations will be based on our research activities and will target protecting habitat that is crucial to our species.

Based on the foundation that our project has created for the understanding of our species and important conservation areas in Sarawak, it would be important for future work to focus on our recommended field sites (to be announced after more data review) and to prioritize areas that have the highest potential for governmental protection. For endangered and poorly-understood species, such as the False gharial (Tomistoma schlegelii) or the Spiny hill turtle (Heosemys spinosa), it will be important to attract undergraduate students to follow-up on our projects related to these species and our CLP objectives.

Our CLP team also looks forward to assisting Sarawak Forestry in implementing a tagging program for their crocodile management program. We also plan compare our research related to crocodile morphometrics with crocodiles found in captivity at the local crocodile park. Our CLP also aims to promote our children’s book to ensure our conservation message reaches a wider audience in Sarawak and abroad. There are also a few upcoming collaborative projects for turtle and crocodile releases that our CLP team hopes to take part in alongside Sarawak Forestry Department.
## Financial Report

<table>
<thead>
<tr>
<th>Itemized expenses</th>
<th>Total CLP Requested (USD)</th>
<th>Total CLP Spent (USD)</th>
<th>% Difference</th>
<th>Details &amp; Justification (Justification must be provided if figure in column D is +/- 25%)</th>
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<tbody>
<tr>
<td><strong>PHASE I - PROJECT PREPARATION</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Communications (telephone/internet/postage)</td>
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<tr>
<td>Field guide books, maps, journal articles and other printed materials</td>
<td></td>
<td></td>
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<tr>
<td>Insurance</td>
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<tr>
<td>Visas and permits</td>
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<tr>
<td>Team training</td>
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<td></td>
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<tr>
<td>Reconnaissance</td>
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<td></td>
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<tr>
<td>Other (Phase 1)</td>
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<tr>
<td><strong>EQUIPMENT</strong></td>
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<tr>
<td>Scientific/field equipment and supplies</td>
<td>5,400.00</td>
<td>4,329.23</td>
<td>-20%</td>
<td>We were able to utilize funding from our project supervisor (Prof. Indraneil Das) to help cover some equipment costs</td>
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<tr>
<td>Photographic equipment</td>
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<td>Camping equipment</td>
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<tr>
<td>Boat/engine/truck (including car hire)</td>
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<tr>
<td>Other (Equipment)</td>
<td></td>
<td></td>
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<td><strong>PHASE II - IMPLEMENTATION</strong></td>
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<tr>
<td>Accommodation for team members and local guides</td>
<td>1,440.00</td>
<td>30.20</td>
<td>-98%</td>
<td>Our project didn’t have expected accommodation costs and these funds were utilized elsewhere as described and approved in our preliminary report</td>
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<td>Food for team members and local guides</td>
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<td>Travel and local transportation (including fuel)</td>
<td>3,700.00</td>
<td>4,872.37</td>
<td>32%</td>
<td>Increase in costs from additional field trips</td>
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<td>Customs and/or port duties</td>
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<td>Workshops</td>
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<td>1,031.36</td>
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<td>This budget change was requested/approved by CLP for the development of a crocodile tagging management project</td>
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<td>Outreach/Education activities and materials (brochures, posters, video, t-shirts, etc.)</td>
<td>1,800.00</td>
<td>1,933.05</td>
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<td>Books were slightly more expensive than anticipated</td>
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<td>Other (Phase 2)</td>
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<td><strong>PHASE III - POST-PROJECT EXPENSES</strong></td>
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<tr>
<td>Administration</td>
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<td>Report production and results dissemination</td>
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<tr>
<td>Other (Phase 3)</td>
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<td><strong>TOTAL</strong></td>
<td>12,340.00</td>
<td>12,196.21</td>
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### Appendices

<table>
<thead>
<tr>
<th>Output</th>
<th>Number</th>
<th>Additional Information</th>
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<tr>
<td>Number of CLP Partner Staff involved in mentoring the Project</td>
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<td></td>
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<tr>
<td>Number of species assessments contributed to (E.g. IUCN assessments)</td>
<td>0</td>
<td>Plans to submit IUCN assessment for T. schlegelii</td>
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<tr>
<td>Number of site assessments contributed to (E.g. IBA assessments)</td>
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<td>Number of NGOs established</td>
<td>0</td>
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<tr>
<td>Amount of extra funding leveraged ($)</td>
<td>1200</td>
<td>NRGS Grant Scheme – Indraneil Das</td>
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<td>Number of species discovered/rediscovered</td>
<td>3</td>
<td>H. spinosa, C. porosus, T. schlegelii</td>
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<tr>
<td>Number of sites designated as important for biodiversity (e.g. IBA/Ramsar designation)</td>
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<td>Number of species/sites legally protected for biodiversity</td>
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<tr>
<td>Number of stakeholders actively engaged in species/site conservation management</td>
<td>2+</td>
<td>Sarawak forestry, Local villages</td>
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<tr>
<td>Number of species/site management plans/strategies developed</td>
<td>0</td>
<td>Management reports and recommendations expected soon</td>
</tr>
<tr>
<td>Number of stakeholders reached</td>
<td>3+</td>
<td>Sarawak Forestry, Local Villagers</td>
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<tr>
<td>Examples of stakeholder behaviour change brought about by the project.</td>
<td>3</td>
<td>Increase interest in conservation participation</td>
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<tr>
<td>Examples of policy change brought about by the project</td>
<td>0</td>
<td>None yet, but hopefully added sites for protection</td>
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<tr>
<td>Number of jobs created</td>
<td>0</td>
<td>Temporary jobs only for research assistants</td>
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<tr>
<td>Number of academic papers published</td>
<td>0</td>
<td>Expected soon after culmination of radiotelemetry efforts</td>
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<tr>
<td>Number of conferences where project results have been presented</td>
<td>0</td>
<td>To be expected in future!</td>
</tr>
</tbody>
</table>

Appendix 4.1 CLP M&E measures
Bibliography


Address list and web links

Universiti Malaysia Sarawak (IBEC) – [http://www.ibec.unimas.my/](http://www.ibec.unimas.my/)
IUCN Redlist – Heosemys spinosa: [http://www.iucnredlist.org/details/9942/0](http://www.iucnredlist.org/details/9942/0)
  – Crocodylus porosus: [http://www.iucnredlist.org/details/5668/0](http://www.iucnredlist.org/details/5668/0)
Photo and Video

Videos
To view the videos, please click on the hyperlinks below.
1. Research assistant Sally helps to release a hatchling saltwater crocodile
2. River Debris during a neap tide
3. Mapping small tributary in Samarahan river
4. Mapping another small river in Samarahan river

Photos
Sandra Wong Jye Wen and Veronica Martin help assist in mapping a portion of Sungai Samarahan
Hunter packages for licensed hunters including t-shirt, hunter tags, measurement tape, scute sampling vials and equipment.

Perhaps the most symbolic photo, a yearling Tomistoma overlooking a small village child reading *A Crocodile Named Tom*. 
T-shirt design for tagging program to ensure licensed hunters are recognizeable by managers and buyers
Jason Hong silhouetted as he conducts his eyeshine training at Sungai Samarahan

Ahmad Fitri and Sandra Wong Jye Wen helping to map a remote portion of Sungai Sarawak
Ahmad Fitri and Zahran Mansor holding a hatchling saltwater crocodile during croc eyeshine surveys
Anis Musfirah and Batrisyia Teepol showing off their first captured crocodile during their training.

Veronica Martin, a long-term research assistant, doing her first scute samples from a hatchling croc.
Cheoh Chuan Ong holding a saltwater he caught during training at Sungai Sarawak
Cybertracker Water Quality page in our survey application
Example of survey app in use to record morphometrics for a captured Tomistoma
IBEC Workshop for Crocodilian Research

What: 1.5 hour presentation about research methods for Crocodiles
Where: IBEC Meeting Room, IBEC Office
When: March 2nd 2018, 3-5PM
About:

Boat Safety

Equipment and survey skills
Field work and Research Experience

Come and learn about the skills required for conducting research and conservation of Crocodiles in Sarawak. The powerpoint presentation will discuss the different types of crocodiles in our world, why they are important and the methods/techniques employed for surveying and conducting research on crocodiles in the wild. After dark on the same day, there will be an outdoor eyeshine workshop in the FSTS parking lot which will help you learn about and test your skills at detecting crocodile eyeshines. There’s also options to volunteer during crocodile eyeshine boat surveys after attending this course.

If you are interested in Crocodiles or just want to learn something new, feel free to attend this workshop. It’s free to join too!

RSVP by contacting Tony
tonykg89@gmail.com

Flyers used to promote crocodile training workshops at UNIMAS
The type of vegetation preferred by the Spiny hill turtle. We tracked tagged individuals actively throughout the area during field trips (8-10 days per month).

Intense fieldwork required finding and catching turtles. This picture shows the latest individual caught in March, 2018.
Looking for the best spot to attach radiotransmitter without hurting the turtle and to avoid breakage of scutes.

Proper husbandry care given to all individuals prior to release. Picture shows a female given antibiotic for speedy recovery and minimize risk of infection.
Some of the locals that willing to join out of genuine interest to the conservation of local species especially the endangered Spiny Hill Turtle
Anthony Pine holding a subadult Tomistoma with village children

CLP shirt and a Tomistoma
Siti holding a Tomistoma during a capture and release project with local villagers

Conducting radiotelemetry for crocodiles
Attached radiotransmitter to crocodile