Final Evaluation Report

Your Details	
Full Name	Woo Chee Yoong
Project Title	Spatial distribution of three sympatric species of globally threatened otters in a coastal ecosystem in Selangor, Peninsular Malaysia
Application ID	36718-2
Date of this Report	11th June 2025

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To map the spatial distribution of smooth-coated otter, Asian small-clawed otter and hairy-nosed otter along the North-central Selangor coastline (NCSC) and sub-coastal landscapes			/	This activity was completed in December 2024. The PCR-RFLP method that we developed during the 1st Rufford Small Grant (28938-1) was used to identify a total of 151 otter spraint samples. Out of 151 samples, 77 samples were identified as smooth-coated otter, 49 samples of Asian small-clawed otter and one sample of hairy-nosed. We calculated the occupancy and detection probability estimations for both smooth-coated otter and Asian small-clawed otter through PRESENCE software. The spatial distribution maps were shown in Figures 1, 2 and 3 in Section 2.
To evaluate the relationships between smooth-coated otters and Asian small-clawed otters, and the distribution of land uses along the North-central Selangor coastline (NCSC) and sub-coastal landscapes			/	This activity was completed in December 2024. We incorporated the layers of different land use by ESRI, road network, distance to the coastline and water body width as site covariates, and water tide levels and herbaceous cover as detection covariates into QGIS to calculate the proportion of each covariate in each surveyed grid. The habitat relationships were then assessed using boxplot analysis which dividing the proportions of each covariate

				into two categories which were grids where each otter species is present and grids where without presence of both species. The boxplot analyses were shown in Figure 4, 5, 6 and 7 in Section 2.
To assess the existence and nature of human-otter conflict along the North-central Selangor coastline (NCSC) and sub-coastal landscapes			/	This activity was completed in June 2023. We conducted the semi-structured interview survey with a total of 64 aquaculture farmers across the three districts in Selangor.

2. Describe the three most important outcomes of your project.

a) Two spatial distribution maps of both smooth-coated otter and Asian small-clawed otter were produced as shown in Figures 1 and 2, respectively. With detection probability, it affects the occupancy of the species even in the grids where the species were not found during our survey. Based on the spatial distribution maps, smooth-coated otter had an evenly distribution along the coastline and subcoastal especially along the peat swamp forest fringe. Whereas the Asian small-clawed otter's occupancy was concentrated in the fragmented and small patch of mangrove habitats. Spatial distribution analysis for the hairy-nosed otter is not being conducted due to insufficient samples. But the discovery of one hairy-nosed otter's spraint sample in the NCSC and subcoastal areas, was still an important finding for future studies and conservation purposes (Figure 3). Additionally, four holt locations were discovered in two out of the three districts' coastline and subcoastal areas that we surveyed. All four holts belonged to the smooth-coated otter. We monitored the breeding of the smooth-otter groups in these holts using camera traps. The footage of the pups was captured at all four locations. This showed the smooth-coated otter populations in these two districts are possibly increasing and healthy. Most importantly, three holts are located inside mangrove forests, which is rare evidence but highlighted the utmost importance to protect this coastal habitat. Our camera trap also captured the footage of the rare hairy-nosed otter including one image where a mother and a pup,

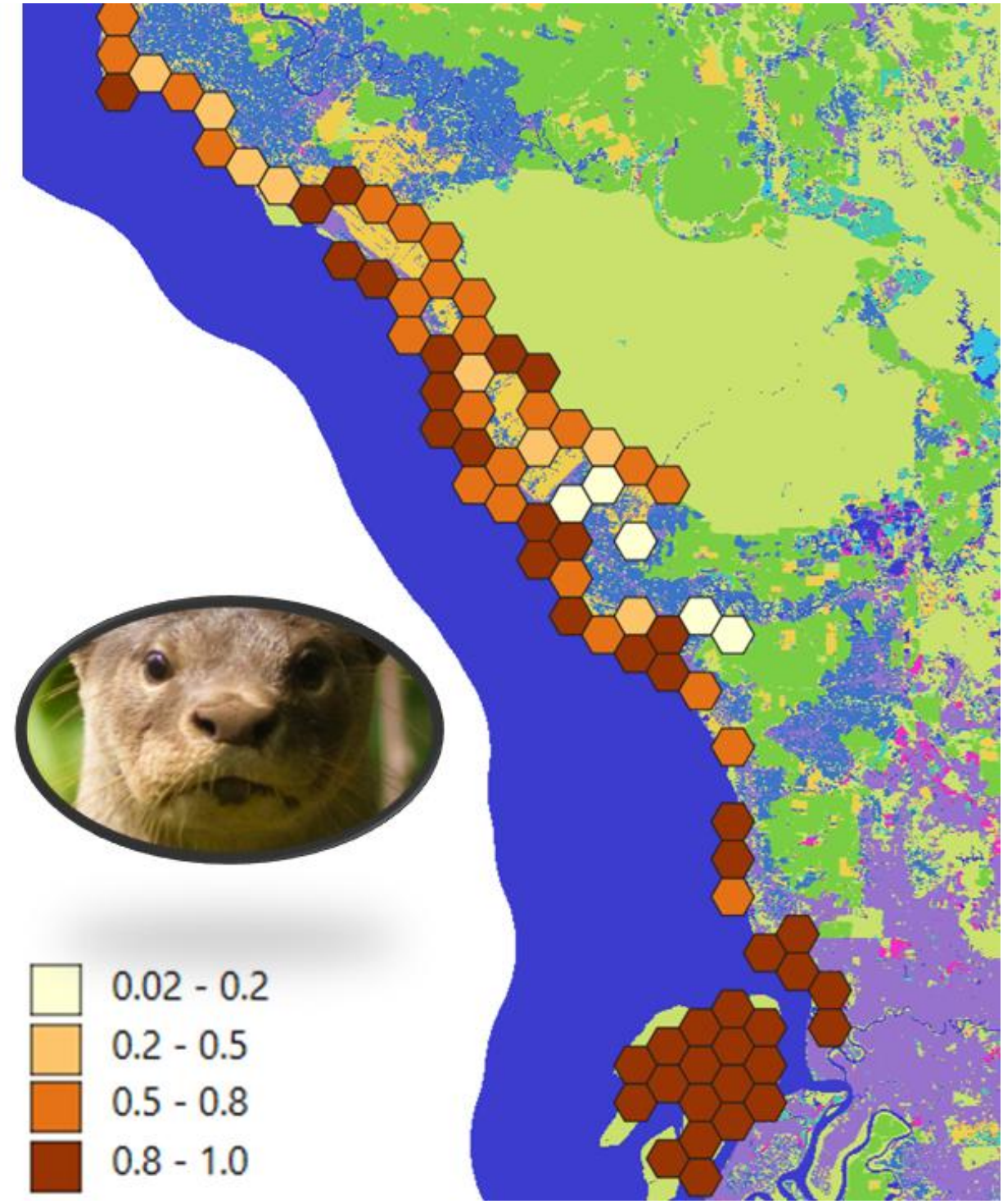

Figure 1. Spatial distribution of smooth-coated otter in the North-Central Selangor Coast and subcoastal areas, Selangor.

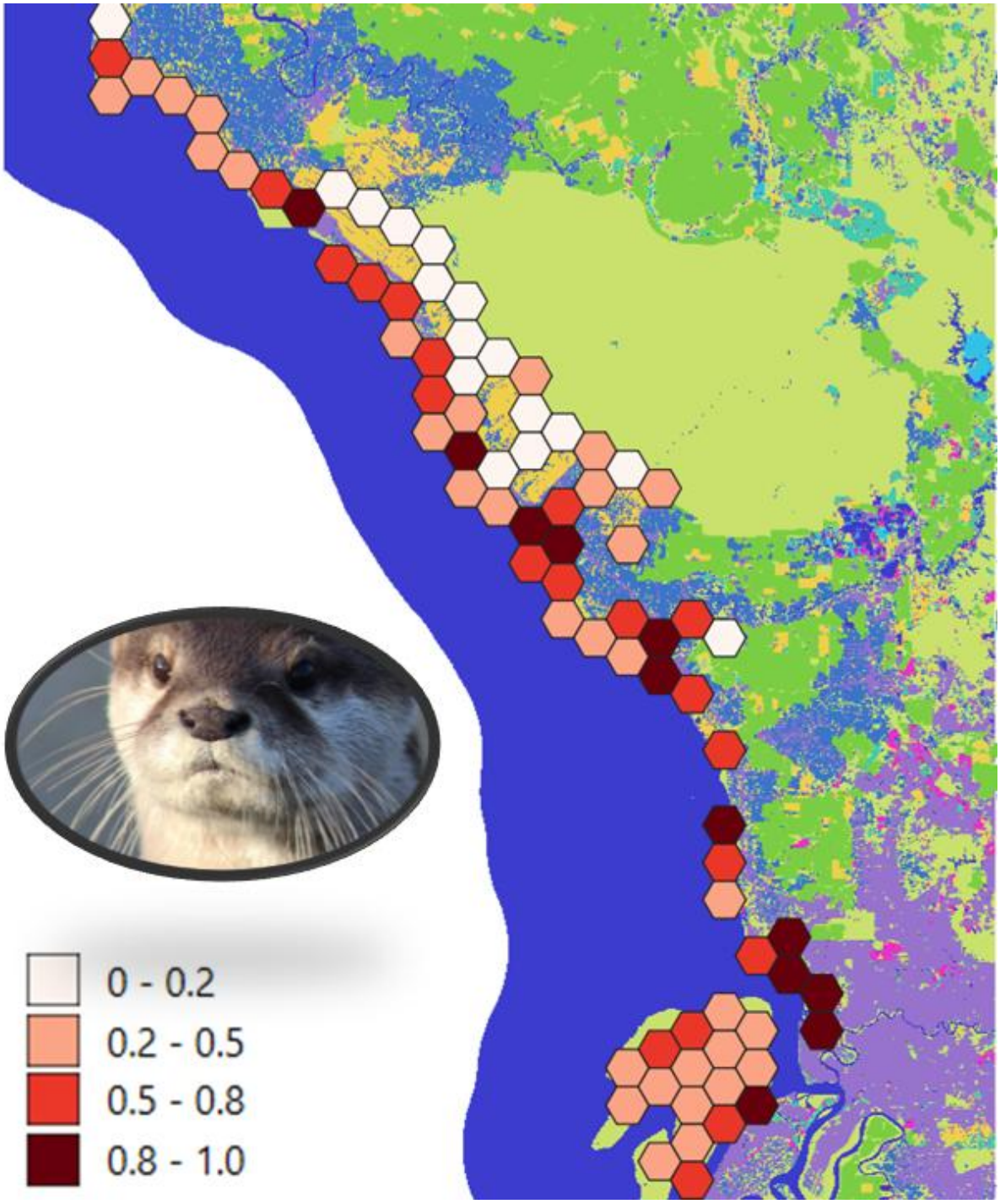

Figure 2. Spatial distribution of Asian small-clawed otter in the North-Central Selangor Coast and subcoastal areas, Selangor.

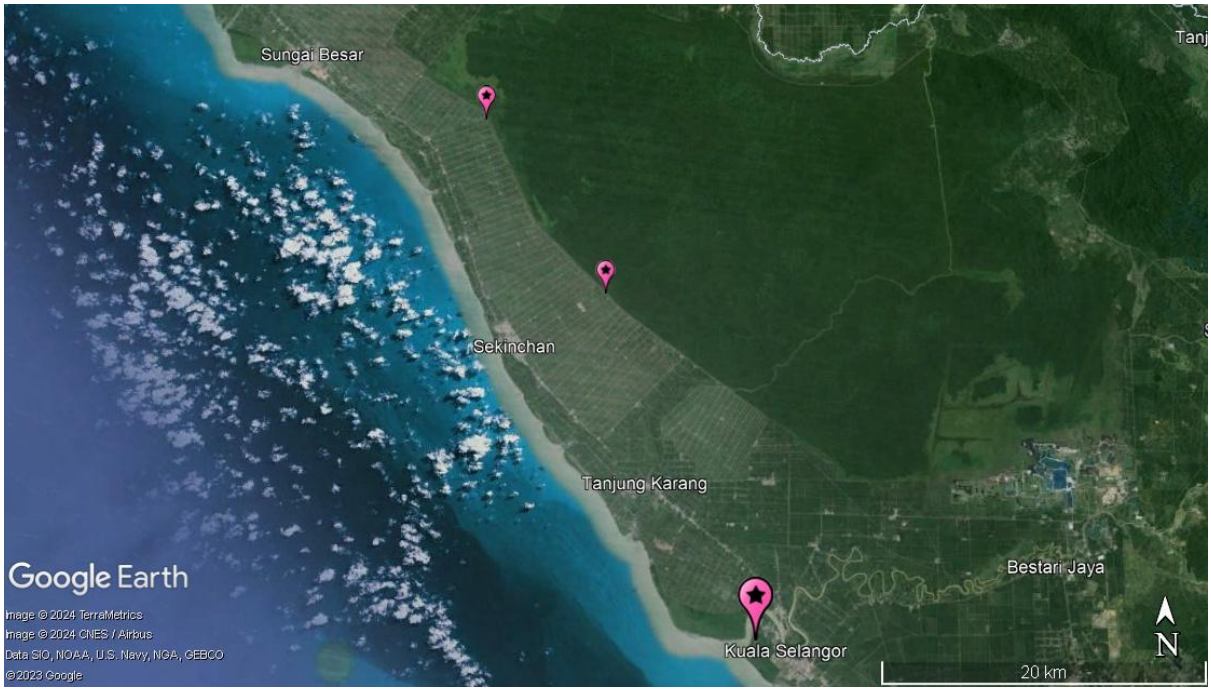

Figure 3. The only location where the hairy-nosed otter's spraint was found during our survey in the North-Central Selangor Coast and subcoastal areas, Selangor.

b). The modelled occupancy of smooth-coated otter was 0.70 (Standard error: ±0.0314) and Asian small-clawed otter was 0.48 (Standard error: ±0.0263). The modelled detection probability of smooth-coated otter was 0.38 (Standard error: ±0) and Asian small-clawed otter was 0.15 (Standard error: ±0.0074). Both smooth-coated otter and Asian small-clawed otter displayed different habitat relationships. Although the spatial distribution maps of both species showed that their occupancy rates were higher along the coastline with mangrove forests, but each species had different predictors of occupancy. Oil palm, built areas and water body width were the most important predictors of occupancy for smooth-coated otters. Crop and built area were the most important predictors of occupancy for Asian small-clawed otters. However, all predictors were not statistically significant except oil palm. Based on our habitat relationship box plot analysis (Figure 4, 5, 6 and 7), both the smooth-coated otter and Asian small-clawed otter shared similar where the median of presence in forest was the highest across all five different land uses which aligned with the spatial distribution maps, showing their occupancy rates were higher in both mangrove and peat swamp forests. In the converted land uses like oil palm, paddy field and built area, both species had different associations, but these land uses could be potential secondary habitats for them. Food availability might be an important factor influencing their occupancies.

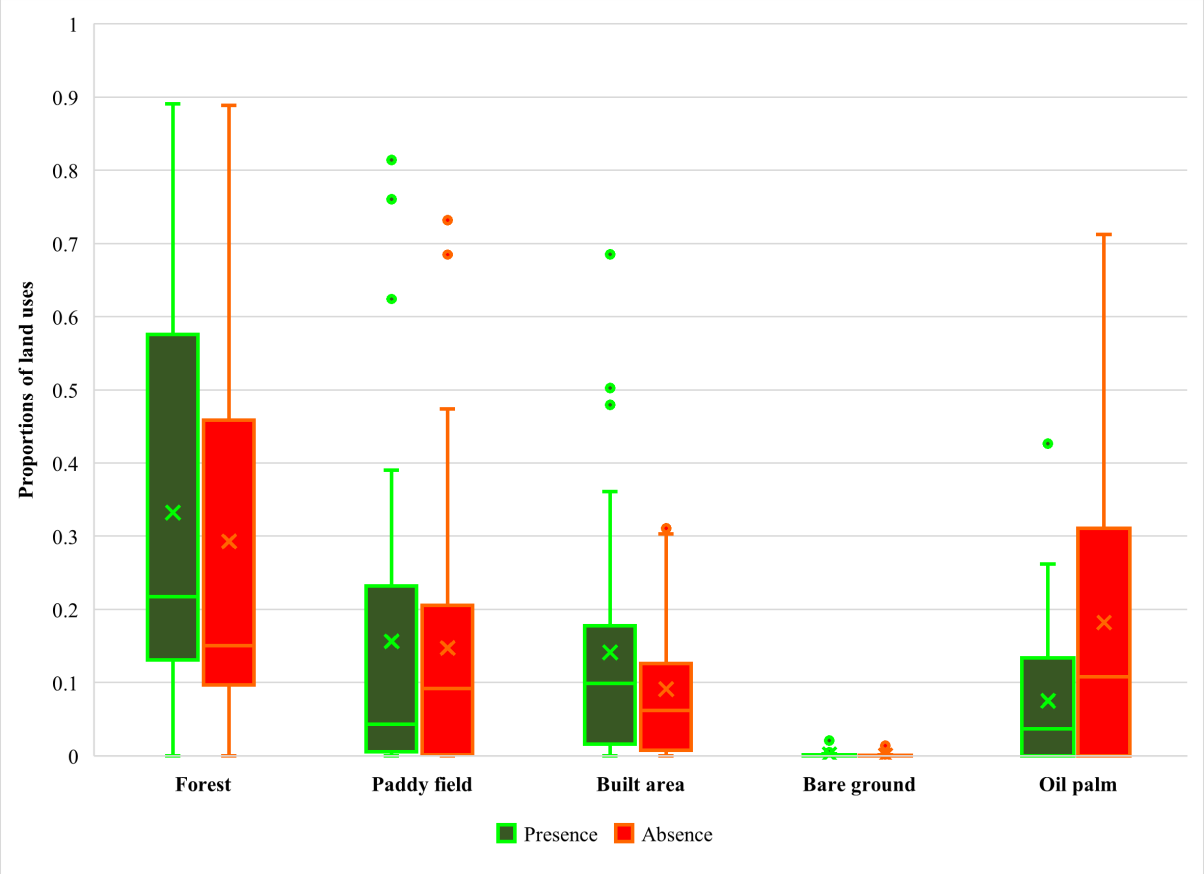

Figure 4. Habitat relationships between five different land uses and occupancy of smooth-coated otter in North-Central Selangor Coast and subcoastal areas.

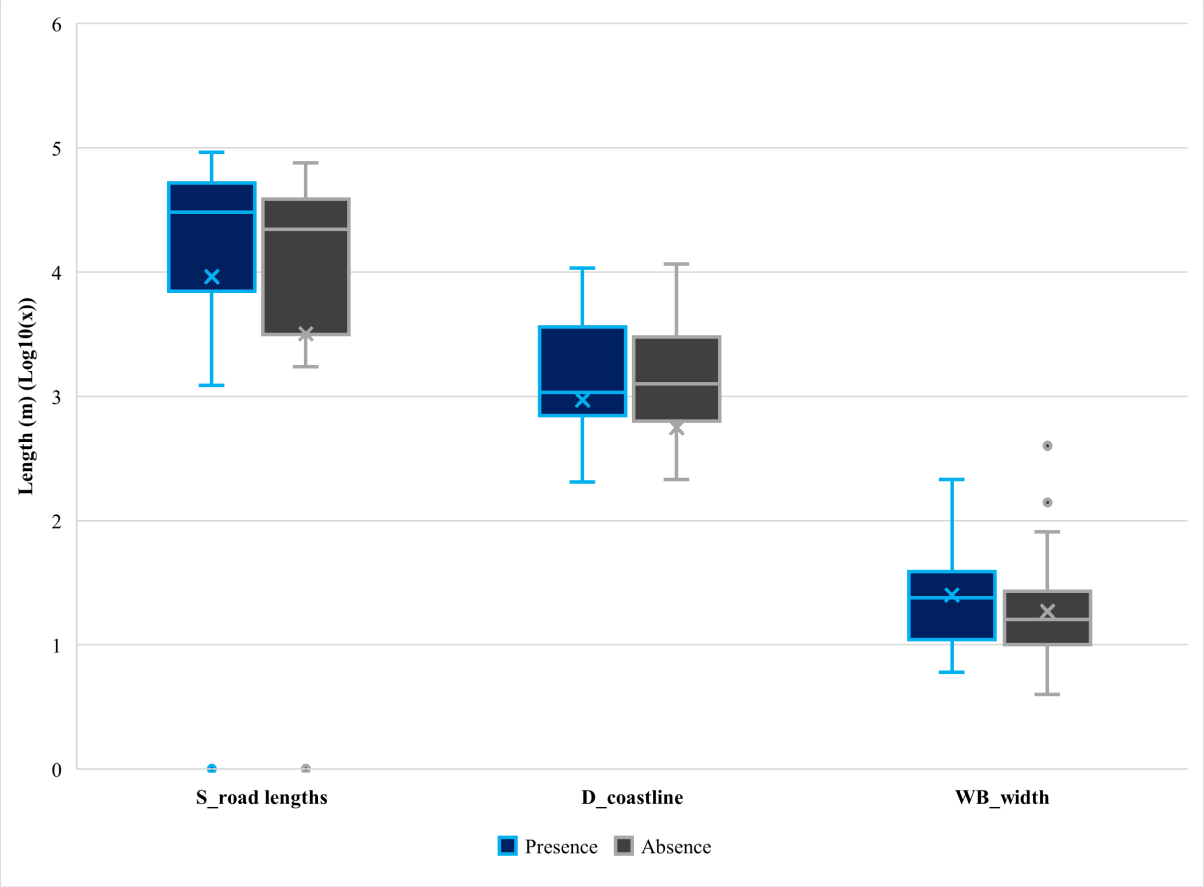

Figure 5. Habitat relationships between three different habitat covariates and occupancy of smooth-coated otter in North-Central Selangor Coast and subcoastal areas.

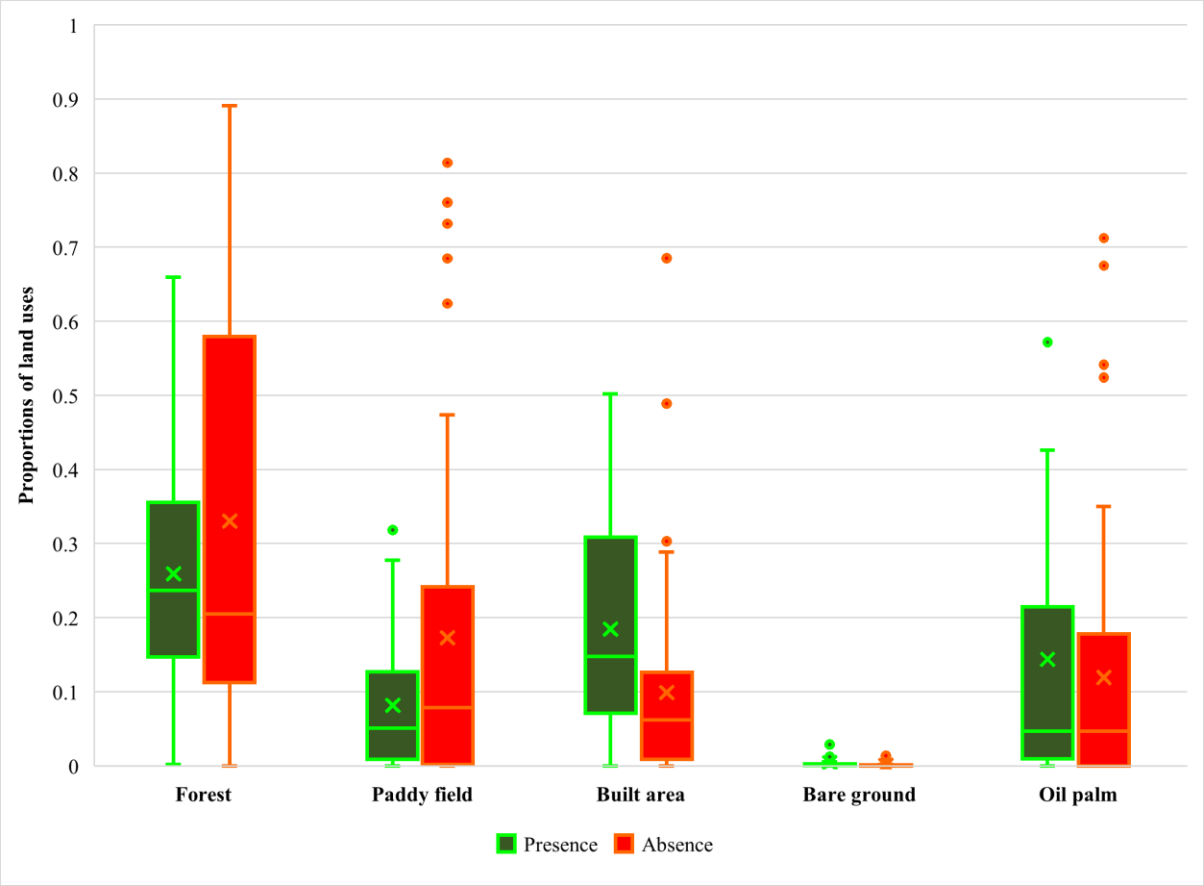

Figure 6. Habitat relationships between five different land uses and occupancy of Asian small-clawed otter in North-Central Selangor Coast and subcoastal areas.

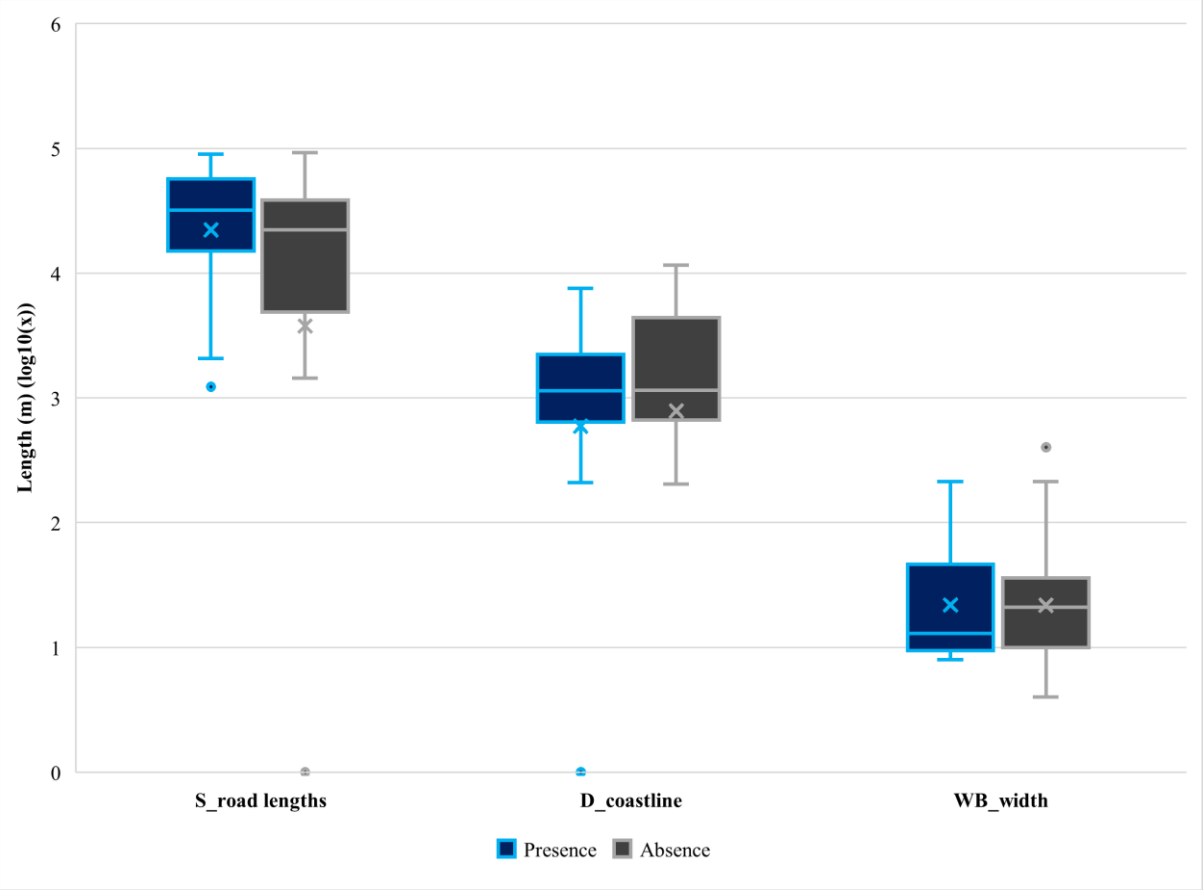

Figure 7. Habitat relationships between three different habitat covariates and occupancy of Asian small-clawed otter in North-Central Selangor Coast and subcoastal areas.

c) Based on our interview surveys, we found that 43 out of 64 aquaculture farmers faced conflict issues with the otters. Hence the assessment proved the seriousness of the human-otter conflict issue in this region and the urgency for conservation intervention. A minority of them (9 farmers) used extreme measures like snaring, trapping, poisoning, hitting and shooting to eliminate the otters. The others had demonstrated the potential of coexistence by implementing various mitigation measures such as fencing using zinc sheets and electrical wire, building concrete ponds, chain-linked floating cages, human and dog patrolling.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

During our survey, we often faced the challenge of extreme weather. Due to safety precautions, we only survey when the weather was good and safe for the survey. Another challenge that we faced was the difficulty to survey Klang mangrove islands. The muddy banks and lack of trails were the obstacles that did not allow foot survey. We used a fiberglass boat to search for otter footprints along the banks as the signs of otters' spraint presence. In addition, we faced the difficulties in obtaining the cooperation from the local aquaculture farmers to participate in the human-otter conflict interview. Thus, we approached the Department of Fisheries Malaysia for the list of aquaculture farmers who registered with the Department and situated

along the Selangor coast. The Department also found that our survey will be beneficial to the aquaculture farmers, therefore, they helped to facilitate among the farmers to participate in the interview survey.

4. Describe the involvement of local communities and how they have benefitted from the project.

Three local indigenous people (Mah Meri tribe) and one local school student were trained as local field assistants and assisted the principal investigator during the field surveys. They were trained by the principal investigator to understand otter ecology, survey for otter signs, set up camera traps, collect otter spraint and interview aquaculture farmers for human-otter conflict documentation as methods of monitoring otter populations.

The staff of the Kuala Selangor Nature Park (KSNP) was equipped with knowledge of otters. Staff will patrol the lake daily and provide monthly updates on otter signs and/or observations to the principal investigator.

Thus far, 64 aquaculture farmers who are the local communities staying around the areas were interviewed to obtain preliminary data on the human-otter conflict. At the same time, they were educated about the otters' protection status, laws and the importance of otters in coastal ecosystems and for surrounding local communities.

5. Are there any plans to continue this work?

Yes. Since we have developed a novel non-invasive method to identify all three Asian otter species accurately through the 1st Rufford Small Grant Project (28938-1) and the results helped to determine the spatial distribution and habitat relationships for the otters along the North-Central Selangor Coast and subcoastal landscapes. We aimed to continue with further analysis using the collected spraint samples and DNA information that we had extracted to answer some important ecological questions of these otter species and for future conservation management. The next research study that we are aiming to conduct will be improve the understanding on the population genetic and specific diet of the otters along the North-central Selangor coastline and sub-coastal landscapes.

6. How do you plan to share the results of your work with others?

We submitted an article that showcased our project's findings to the IUCN SSC Otter Specialist. The link to the article is shown below:
https://shorturl.at/DGTU5

The results of developing a novel non-invasive method to identify the three Asian otter species under the 1st Rufford granted project were published in Ecology and Evolution on 12th December 2022. The link to the paper is shown below:
https://onlinelibrary.wiley.com/doi/10.1002/ece3.9585

A press release on the publication was published by the German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, the link to the press release is shown below:

https://www.idiv.de/en/news/media-releases/article/5041.html.

The findings of this research project were presented in my Master's thesis, which was submitted on May 16, 2025. We are in the process of drafting a paper for publication in Biological Conservation and an article on public awareness which to be published either in Malaysian Naturalist or International Otter Survival Fund. The abstract of my thesis is shown below, for more information can contact my supervisor, Associate Professor Dr Yow Yoon Yen from Sunway University at yoonyeny@sunway.edu.my.

SPATIAL DISTRIBUTION AND HABITAT RELATIONSHIPS OF THREE SYMPATRIC SPECIES OF OTTER IN A COASTAL ECOSYSTEM IN PENINSULAR MALAYSIA

ABSTRACT

Spatial overlapping and partitioning are important ecological mechanism permitting coexistence among sympatric species. The study of species interactions and relationships with different land uses are often overlooked in the context of the conservation of these species, especially otter which is not well-studied in Southeast Asia. The most important factor that is influencing the species response to these land us changes might be the anthropogenic disturbances. Otters in Malaysia are confined to inland and coastal wetland habitats that are vulnerable to a variety of anthropogenic disturbances. Three globally threatened species of otters, the smooth-coated otter (*Lutrogale perspicillata*), the Asian small-clawed otter (*Aonyx cinereus*), and the hairy-nosed otter (*Lutra sumatrana*) occur at the North-central Selangor Coast in Peninsular Malaysia. I assessed the spatial distribution and habitat relationships among these three species using an occupancy modelling approach to identify critical habitats and spatial partitioning among these species. A systematic sign survey of the study area was conducted for latrine sites, footprints, and holts. The study area was overlaid with 9 km2 grid cells covering a range of different land use types such as mangrove forests, peat swamp forests, oil palm plantations, paddy fields, aquaculture farms, towns, roads and rivers. Within 80 randomly selected grid cells, two to five transects (500 m each) were surveyed for otter signs or direct observations of individuals and groups. Spraint samples were collected for PCR-RFLP procedure for species identification. Species location data were overlaid with GIS layers of land use to map spatial distribution and assess habitat relationships. I used single-season occupancy models with information-theoretic methods to assess important habitat and site covariates that influenced occupancy and patterns of species co-occurrence of otters. We collected 151 fresh and old spraint samples, of which 77 samples were identified as those of smooth-coated otters, 49 as Asian small-clawed otters, one as hairy-nosed otters and one unidentified. Both signs and direct observations confirmed that smooth-coated otters occurred in 48 grids, Asian small-clawed otters in 21 grids, and hairy-nosed otters occurred in two grids. Sympatry among two or more species of otter was evident in 16 grids. The modelled occupancy of smooth-coated otter was 0.70

(Standard error: ±0.0314) and Asian small-clawed otter was 0.48 (Standard error: ±0.0263). The modelled detection probability of smooth-coated otter was 0.38 (Standard error: ±0) and Asian small-clawed otter was 0.15 (Standard error: ±0.0074). Our habitat relationships results showed that oil palm, built areas and water body width were the most important predictors of occupancy for smooth-coated otters. Crop and built area were the most important predictors of occupancy for Asian small-clawed otters. However, confidence intervals for both covariates overlapped zero. The overall spatial distribution results and habitat relationships indicated a strong association between otters and natural habitats like the mangrove forest and peat swamp forests where the only spraint of a hairy-nosed otter was found. Altered land use such as aquaculture farms and agriculture may serve as secondary habitats and corridors, and protected areas may be vital for their persistence. The results of this study provided natural resource agencies with specific knowledge of otter distribution and habitat use, and ecological information crucial for the development of effective conservation policies for otter populations in Malaysia.

During the granted period, I delivered seven public presentations about the project at the following events as mentioned below:

a) 15th IUCN/SSC OSG International Otter Congress from 19th to 23rd September 2022 at Sospel, France, poster presentation.
b) 4th International Workshop for Mangrove Biodiversity Studies by eDNA Metabarcoding organised by the University of Nottingham on the 12th March 2023 at Kuala Selangor Nature Park, oral presentation.
c) EGS Environmental Research Seminar Series organised by the University of Nottingham on the 12th April 2023 at the University of Nottingham Malaysia, oral presentation.
d) Industry in the Classroom organised by the Universiti Malaysia Terengganu on the 22nd May 2023 virtually, oral presentation.
e) Water World: the Way to Go seminar organised by the Xiamen University Malaysia Campus on the 15th June 2023 at the Xiamen University Malaysia Campus, oral presentation.
f) Sunda Talk organised by Sunda Shelves on the 25th May 2024 at Sunda Shelves, Selangor, Malaysia, oral presentation.
g) 16th IUCN/SSC OSG International Otter Congress from 24th and 28th February 2025 at Lima, Peru. My presentation had won the best oral presentation award as shown in the report below. https://www.otterspecialistgroup.org/osg-newsite/wp-content/uploads/2025/03/16th-IOC-Report.pdf

The results on spatial distribution and human-otter conflict will be used as an important engagement tool with multi-stakeholders and decision-makers within the Malaysia Otter Network, a local professional team established to promote otter research and conservation in Malaysia.

7. Looking ahead, what do you feel are the important next steps?

As mentioned in report, the possible driver that influence the otter's occupancy and movement will be food resources. Their main food resources are the aquatic prey such as fish, crustacean, mollusc, etc which are even more challenging to study and more limited information about these aquatic prey species. The depletion of aquatic prey species due to wetland degradation and pollution, and decrease of native species due to invasive alien species will be an emerging threat to the otters. In addition, prey species study will be important in the conservation of otter in another two major aspects. The identification of major prey species in the otter's diet might help to provide clarity on whether the otters consume mostly aquaculture products. This is because otters are always perceived as pest among the aquaculture farmers. The other aspect will be the issue of invasive fish species in the freshwater ecosystem. In Malaysia, this issue has been increasing, and lack of awareness causes more people to release invasive fish species into our river ecosystem. If we can prove that the diet of otters consume mostly invasive fish species, we might be able to improve the perception about otters as biological control of invasive fish species. Furthermore, continuing with the spatial distribution results from this research study, we would think of exploring further on the population genetic will help to inform on the diversity of different groups of otter along the approximately 100 km long stretch of coastal habitats which were heavily fragmented. Hence, I would strongly suggest that the important next steps would be the research on diet and population genetic. These studies will be important in providing useful data and information for our upcoming plan in producing the National Otter Action Plan in 2026 that will be spearheaded by the Malaysia Otter Network which I am one of the members and the coordinators.

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

Yes, we submitted an article that showcased our project's findings to the IUCN SSC Otter Specialist with the mention of The Rufford Foundation with its logo. The link to the article is shown below:
https://shorturl.at/DGTU5

The results of developing a novel non-invasive method to identify the three Asian otter species under the 1st Rufford granted project were published in Ecology and Evolution on 12th December 2022. The Rufford Foundation was acknowledged and mentioned in the paper. The link to the paper is shown below:
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https://www.idiv.de/en/news/media-releases/article/5041.html.

In my submitted Master study thesis, The Rufford Foundation was acknowledged and mentioned in the manuscript as shown below:

ACKNOWLEDGEMENT

Last but not least, this research study will not be able to start without funding support from Sunway University, Rufford Foundation, MSIG Holdings (Asia) Pte Ltd., Conservation International Asia-Pacific Ltd., The Conservation, Food & Health Foundation, Keidanren Nature Conservation Fund and Rolex Explorers Club.

During the granted period, I delivered seven public presentations about the project at the following events as mentioned below, with the mentions of The Rufford Foundation with its logo:

a) 15th IUCN/SSC OSG International Otter Congress from 19th to 23rd September 2022 at Sospel, France.
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g) 16th IUCN/SSC OSG International Otter Congress from 24th and 28th February 2025 at Lima, Peru.

9. Provide a full list of all the members of your team and their role in the project.

1. Mr. Woo Chee Yoong, Malaysia Otter Network and Sunway University, Malaysia: Principal investigator of this project who led the field research and laboratory activities and training the local field team;
2. Dr. Shyamala Ratnayeke, Allegany College of Maryland, US: Main supervisor of Woo Chee Yoong's MSc study in this project who supervised Woo Chee Yoong in methodology and data analysis;
3. Dr. Sandeep Sharma, German Centre for Integrative Biodiversity Conservation (iDiv), Germany: Co-supervisor of Woo Chee Yoong's MSc study in this project who supervised Woo Chee Yoong and the research assistants in PCR-RFLP;
4. Associate Professor Dr. Yow Yoon Yen, Sunway University, Malaysia: Co-supervisor of Woo Chee Yoong's MSc study in this project who supervised Woo Chee Yoong and the research assistants in laboratory activities;
5. Associate Professor Dr. Chew Jactty, Sunway University, Malaysia: Co-supervisor of Woo Chee Yoong's MSc study in this project who supervised Woo Chee Yoong;
6. Late Mr. Balu Perumal, Malaysian Nature Society, Malaysia: Former supervisor/advisor of Woo Chee Yoong's MNS Otter Conservation Project who

supervised Woo Chee Yoong in local community works and overseeing the operation of the project;

7. Mr. Yeap Chin Aik, Malaysian Nature Society, Malaysia: Supervisor/advisor of Woo Chee Yoong's MNS Otter Conservation Project who supervised Woo Chee Yoong in local community works and overseeing the operation of the project;
8. Dr. Pazil Abdul Patah, Department of Wildlife and National Parks Peninsular Malaysia, Malaysia: Local collaborator in this project who is the local otter expert and conducted PhD study on otter ecology in Malaysia, guided Woo Chee Yoong on otter ecology and permission matters from the government authority;
9. Ms. Teoh Wan Yi, Sunway University: Former laboratory research assistant who assisted in the laboratory analysis of the spraint samples;
10. Mr. Kahar bin Buntal, Malaysian Nature Society: Local boatman who assisted Woo Chee Yoong during the field research survey;
11. Mr. Kamarul bin Abdullah, Malaysian Nature Society: Local field assistant and boatman who assisted Woo Chee Yoong during the field research survey;
12. Mohd Helmi bin Mohd Agus, Malaysian Nature Society: Local field assistant and boatman who assisted Woo Chee Yoong during the field research survey;
13. Mr. Abu Bakar bin Moin, Malaysian Nature Society: Local field assistant and boatman who assisted Woo Chee Yoong during the field research survey;
14. Mr. Haizan anak Kamarul Zaman, Malaysian Nature Society: Local field assistant who assisted Woo Chee Yoong during the field research survey;
15. Mrs. Norsyila binti Ali, Malaysian Nature Society: Local field assistant who assisted Woo Chee Yoong during the field research survey;
16. Mr. Lim Wei Hang, Malaysian Nature Society: Local field assistant who assisted Woo Chee Yoong during the field research survey;
17. Atan anak Kamarul Zaman, Malaysian Nature Society: Local field assistant who assisted Woo Chee Yoong during the field research survey.

10. Any other comments?

We hope the Rufford Foundation is happy with our results. We intend to apply for the Booster Grant to support the 3rd phase of this research project.