

Final Evaluation Report

Your Details	
Full Name	Caleb D Gnanaolivu
Project Title	Understanding tourism impacts on biodiversity towards the conservation of critical habitats in the Andaman Islands.
Application ID	28155-2
Date of this Report	28/5/2023

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 document biodiversity across a disturbance gradient				Due to non- consistent field access, this objective could not be fully achieved. However, we did conduct a brief biodiversity survey across the South and Middle Andamans in littoral and evergreen forests.
To document various tourism activities and highlight associated biodiversity loss.				Substantial data was collected for this objective, but the lack of replicates makes it hard to provide empirical evidence to support the conclusions of the study. Hence partially achieved.
Communicate results and discuss sustainable tourism practices with stakeholders.				The communication of results was done by means of nature walks, school programmes and wildlife-oriented retreats, which are different from what was originally proposed in the beginning of the study. Hence a significant part of this objective was achieved.

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

a). The two most commonly encountered species across habitat types and the tourism gradient were the Bay Island forest lizard (*Coryphophylax subcristatus*) and the Andaman Islands grass skink (*Eutropis andamanensis*). They seem to be the species most tolerant to tourism disturbances.

b). Both the diversity and total number of individuals recorded in the case of evergreen forests decreased as tourism foot traffic increased.

c). The average distance of the species of reptiles from the path increased with greater levels of physical anthropogenic disturbance.

d). In littoral forest patches, the total number of individuals recorded decreased as tourism levels increased.

e). The diversity in littoral forests however was the highest at sites which witnessed moderate levels of tourism (8 species), followed by high tourism (6 species) and low

tourism sites (5 species). This discrepancy can be attributed to the presence of the two invasives, i.e., the oriental garden lizard and the Indian bullfrog, at highly and moderately disturbed sites, as well as the site-specific availability of microhabitats for certain littoral forest species.

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

Multiple issues arose during the study period. These are detailed below:

- Procuring research permits in protected areas in the Andaman Islands were particularly challenging during this time. The researcher had to go through two independent rounds of application to procure research permits.
- The Andaman Islands are going through a complicated political scenario while racing towards rapid tourism development. Due to bureaucratic roadblocks, the researcher was denied access to sampling in Little Andamans.
- A week after research permits were received, the Government of India announced restrictions due to the Covid 19 pandemic. The researcher was forced to leave the field, and the study was put on hold for more than a year. Even after that, the Island restricted access to outsiders and made it difficult to access the study sites for 6 more months. The research permit lapsed by the time the islands were accessible.
- After the Covid pandemic, the primary investigator had to take on other employment to support himself.
- In late 2022, another new team member (Mr Sumer Rao) was brought on board to collect biodiversity data in varied tourism disturbance sites in order to obtain basic data required to successfully close the study.

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

The two field assistants employed for the study were from local communities settled in the Andaman Islands. They were remunerated for their work and were educated about the purpose and results of the study. They also learnt crucial skills such as species identification, tree climbing training and safety protocols.

5. Are there any plans to continue this work?

The chief investigator now works as a naturalist in the Andaman Islands. He continues to document the changes in biodiversity assemblages across various seasons while also educating tourists about the results of the study and the role we can play as landscape stakeholders in minimising the impacts of intense trail-use on biodiversity assemblages.

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

As an outdoor educator and naturalist, the primary investigator (Mr Caleb Daniel) continues to educate tourists and school programmes about the effect of tourism on

biodiversity assemblages. From the study, there is some evidence of a direct effect of footfall on loss of herpetofauna biodiversity. He intends to utilise this information to diversify the access of trails over a season in order to allow the landscape to recover and minimise the intensity of impact on said areas in tourism-oriented islands. He regularly engages with tourism companies and local communities and educates them in eco-sensitive practices towards access to wild spaces.

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

The chief investigator of the study is now an outdoor facilitator and naturalist working in the tourism intensive Island in Andaman and Nicobar Island (Swaraj dweep/Havelock Island). We believe a greater impact on supporting and educating sustainable tourism practices can be made by directly engaging with tourists and people working in the tourism sector and educating them about the impacts of tourism while engaging them in island conservation issues.

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 utilised the logo in forest department reports, Dakshin Foundation yearly reports and in internal progress reports.

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

Mr Caleb Daniel G - lead investigator/researcher.

Mr James - field assistant. Assisted in primary data collection trip.

Mr Jeevan - Field assistant. Assisted in primary data collection trip.

Mr Sumer Rao - Team member. Carried out the second stage of data collection and photographic documentation for the project.

10. Any other comments?

APPENDIX 1

Scoping study to assess the impacts of tourism on the diversity and abundance of herpetofauna in the Andaman Islands

The objective of this project is to assess the impact of tourism on the abundance and diversity of herpetofauna, in evergreen and littoral forests in the Andaman Islands. Field work and surveys were conducted between the June and July 26, 2022, across 12 sites in Middle and South Andaman Islands.

Methods

Forested sites in South Andaman witness substantial tourism footfall, when compared to ecologically similar sites in the more remote Middle Andaman. Some of the popular tourist trails which include Chidiyatapu and Mundapahad were visited by over 300 tourists during the week of the 23rd to the 30th of June 2022 (data courtesy, Forest Department visitor logs) despite it being the 'tourism off-season'. Through conversation with FD staff, we found that the number of visitors per week sometimes exceed 3,000, during peak-tourism months, which are typically from November to March each year.

Ninety-minute Visual Encounter Surveys (VES) were conducted at each site, during morning hours (~ between 6:30 AM and 8:00 AM) to estimate herpetofaunal diversity and abundance. Each site was surveyed twice (one survey per day), for a total of 3 hours of sampling. Night-time surveys were initially carried out in evergreen forested sites in Middle Andaman; however, owing to the lack of permits we were unable to undertake them across all our sites, especially those in South Andaman which fall under protected areas and have fixed visiting hours. As such, data collected from the night surveys in Middle Andaman have not been included in the analysis but have instead been used alongside the morning VES data to prepare a species checklist for evergreen forests in Middle Andaman.

During the VES, an observer walked along a demarcated forest trail (both tourist trails and community-use trails), in the case of evergreen forests, and along the coast in littoral forests (in the absence of an existing trail), recording all individual reptiles and amphibians encountered. Additional information noted for each recorded individual includes the substratum on which found, perch height, perch width and distance from trail. Commonly occurring microhabitat types which were examined included leaf litter, tree trunks, tree hollows, perennial, intermittent and temporary streams, beaches, fallen logs and rocks. The number of hours of sampling (total of 36 hours, 18 across evergreen forests and 18 across littoral forests) have been used to derive Encounter Rates for different species, across forest types and a tourism gradient.

Since the VES data only includes daytime (morning) surveys, many nocturnal and crepuscular species have not been recorded, or recorded infrequently, which explains the relatively lower levels of diversity and abundance reported when compared with similar herpetofaunal documentation studies undertaken in the islands.

Table 1: Sites selected for the surveys, the level of tourism footfall and their locations. Tourism footfall is not the only source of physical anthropogenic disturbance, as some of the low tourism sites surveyed are also utilized by local communities, for multiple purposes. This frequency of use however is not comparable to sites which witness moderate to high levels of tourism foot-traffic.

Forest Type	Tourism Level	Site Name	Location	Coordinates
Evergreen	High	Mundapahad Forest Trail	South Andaman	N 11°29'5.81" E 92°42'33.55"
Evergreen	High	Chidiyatapu Trail	South Andaman	N 11°29'43.05" E 92°42'19.33"
Evergreen	Medium	Manjery Trail	South Andaman	N 11°31'6.58" E 92°39'48.29"
Evergreen	Medium	Karmatang 11 Forest Trail	Middle Andaman	N 12°49'4.55" E 92°56'31.87"
Evergreen	Low/None	Webi RF – Trail 1	Middle Andaman	N 12°50'6.10" E 92°52'36.31"
Evergreen	Low/None	Webi RF – Trail 2	Middle Andaman	N 12°50'9.03" E 92°52'51.78"
Littoral	High	New Wandoor	South Andaman	N 11°36'22.65" E 92°36'23.84"
Littoral	High	Karmatang 9 – Turtle Beach	Middle Andaman	N 12°50'45.55" E 92°56'20.20"
Littoral	Medium	Bada Balu	South Andaman	N 11°30'16.50" E 92°40'18.44"
Littoral	Medium	Safed Balu	Middle Andaman	N 12°49'38.16" E 92°56'37.11"
Littoral	Low/None	Karmatang 11	Middle Andaman	N 12°47'54.09" E 92°56'57.03"
Littoral	Low/None	Gwiji	Middle Andaman	N 12°47'18.40" E 92°56'30.21"

Results:

Table 2: Species encountered during VES surveys, the total number of individuals recorded (N) and the forest-type in which each species was recorded. Species marked with * are endemic, whereas species that are underlined were introduced to the Andaman Islands. **Key: E – Evergreen and L – Littoral.**

Sr. No.	Common Name	Scientific Name	N	Forest Type
1	Bay-Island Forest lizard*	<i>Coryphophylax subcristatus</i>	396	E, L
2	Andaman Islands Grass Skink*	<i>Eutropis andamanensis</i>	152	E, L
3	<u>Oriental Garden Lizard</u>	<i>Calotes versicolor</i>	10	E, L
4	Andaman Keelback*	<i>Xenochrophis tytleri</i>	10	E, L
5	Tytler's Litter Skink*	<i>Eutropis tytleri</i>	9	E, L
6	<u>Indian Bullfrog</u>	<i>Hoplobatrachus tigerinus</i>	6	E, L
7	Andaman Bronzeback*	<i>Dendrelaphis andamanensis</i>	6	E, L
8	Short-Tailed Forest Lizard*	<i>Coryphophylax brevicaudus</i>	5	E, L
9	Andaman Day Gecko*	<i>Phelsuma andamanensis</i>	4	E
10	Water Monitor	<i>Varanus salvator</i>	3	E, L
11	Mangrove Frog	<i>Fejervarya cancrivora</i>	3	L
12	Yellow-Lipped Sea Krait	<i>Laticauda colubrina</i>	3	L
13	Andaman Giant Gecko*	<i>Gekko verreauxi</i>	1	E
14	Andaman Bent-Toed Gecko*	<i>Cyrtodactylus rubidus</i>	1	L
15	Andaman Pit Viper*	<i>Trimeresurus andersoni</i>	1	E

Table 3: Total number of individuals (N) and number of species encountered across sites, for a total of 6 person-hours each. Since high levels of foot traffic is one of the leading, direct impacts of tourism on habitats, the average distance from path for species recorded in evergreen forests has also been calculated and presented.

Sr. No.	Forest Type	Tourism Level	N	Number of species	Average distance from path (m)
1	Evergreen	High	116	6	1.75
2	Evergreen	Medium	133	9	1.49
3	Evergreen	Low	142	10	1.41
4	Littoral	High	52	6	NA
5	Littoral	Medium	78	8	NA
6	Littoral	Low	89	5	NA

Table 4: Encounter Rate/Hour for all species recorded in High, Moderate and Low tourism evergreen forests, for a total of 6 in-person hours each.

Sr. No.	Species	ER – High Tourism	ER – Moderate Tourism	ER – Low Tourism
1	Bay-Island Forest lizard*	14.2	15.7	16.50
2	Andaman Islands Grass Skink*	3.5	5.0	4.3
3	<u>Oriental Garden Lizard</u>	0.7	0.5	0
4	Andaman Keelback*	0	0.2	1
5	Short-Tailed Forest Lizard*	0	0	0.7
6	Andaman Bronzeback*	0.2	0.2	0.2
7	Andaman Day Gecko*	0.2	0.2	0.2
8	Tytler's Litter Skink*	0	0.3	0.2
9	<u>Indian Bullfrog</u>	0.5	0	0
10	Water Monitor	0	0.2	0.2
11	Andaman Giant Gecko*	0	0	0.2

Table 5: Encounter Rate/Hour for all species recorded in High, Moderate and Low tourism littoral forests, for a total of 6 in-person hours each.

Sr. No.	Species	ER – High Tourism	ER – Moderate Tourism	ER – Low Tourism
1	Bay-Island Forest lizard*	4.67	6.33	8.67
2	Andaman Islands Grass Skink*	2.83	4.83	4.83
3	Tytler's Litter Skink*	0	0.17	0.83
4	Indian Bullfrog	0.17	0.33	0
5	Yellow-Lipped Sea Krait	0.50	0	0
6	Mangrove Frog	0	0.50	0
7	Andaman Keelback*	0	0.50	0
8	Andaman Bronzeback*	0	0.17	0.33
9	<u>Oriental Garden Lizard</u>	0.17	0.17	0
10	Water Monitor	0	0	0.17
11	Andaman Bent-Toed Gecko*	0.17	0	0

Discussion

A total of 15 species were recorded during the VES, which included 9 species of lizards, 4 species of snakes and 2 species of frogs. From the recorded species, 2 are known to be invasive in the Andaman Islands, namely the Oriental Garden lizard (*Calotes versicolor*) and the Indian bullfrog (*Hoplobatrachus tigerinus*). The 2 most commonly encountered species across habitat types and the tourism gradient were the Bay Island Forest lizard (*Coryphophylax subcristatus*) and the Andaman Islands grass skink (*Eutropis andamanensis*), with 396 and 152 individuals sighted over the course of 36 person hours, respectively.

Signs of tourism-related disturbance observed during the study included heavy foot traffic through popular forest trails, clearing of leaf litter and understory vegetation for path demarcation and plastic waste (largely from picnics). Trail marker boards along the Mundapahad trail and Karmatang 9 beach were common but were often seen being utilised as perches by arboreal species such as the Bay Island Forest lizard.

Based on our findings, both the diversity and total number of individuals (N) recorded in the case of evergreen forests decreased as tourism foot traffic increased. The two high-tourism sites surveyed include Mundapahad and Chidiyatapu, which are frequented by an average of 1000 visitors per week (conservative estimate based upon Forest Department logs). A total of 6 different

species and 116 individuals were recorded at these sites over 6 person-hours (Table 3). Of the 6 recorded species, 2 invasives, namely the Oriental Garden lizard and the Indian bullfrog, were both recorded at these sites with encounter rates of 0.7/hour and 0.5/hour, respectively (Table 4). The Oriental Garden lizard was also recorded in sites with moderate-tourism levels (Manjery forest trail and Karmatang 11 trail), with a lower encounter rate of 0.5/hour, but was not recorded in undisturbed sites. The Indian bullfrog was not recorded in moderate to low-tourism sites. Both these species are known to be found more abundantly at sites in close proximity to human settlements with high-levels of disturbance, and as such the higher encounter rates at sites which witness high-tourism influx are consistent with our understanding of these species and their invasions.

Lower encounter rates of 14.2/hour for the Bay Island Forest lizard and 3.5/hour for the Andaman Islands grass skink, were reported from the high-tourism evergreen forest sites relative to the undisturbed sites (Table 4). For this study, the average distance from path was also noted (albeit a visual estimation by the observer) to assess whether herpetofaunal species moved further away from trails, in high tourism sites – the result of physical disturbance from heavy foot traffic and the clearing of leaf litter and understory vegetation to ensure clear path demarcation. Based on our findings, the average distance from path increased with greater levels of physical anthropogenic disturbance. An average distance of 1.75 m was reported from sites with high-tourism levels, followed by 1.49 m and 1.41 m at medium and low-tourism sites respectively (Table 4). A larger number of surveys, including additional sites, would need to be undertaken to explore this relationship further.

A total of 11 different species, including two invasives, were recorded at the 6 littoral forest sites surveyed. Similar to our findings from evergreen forests, the total number of individuals recorded decreased as tourism levels increased, with an abundance of 52, 78 and 89, at high, medium and low-tourism sites. The trend in encounter rates for the Bay Island Forest lizard and the Andaman Islands grass skink in littoral forests remained consistent with those seen in evergreen forests, with rates decreasing as tourism levels increased. The diversity in littoral forests however was the highest at sites which witnessed moderate levels of tourism (8 species), then followed by high tourism (6 species) and low tourism sites (5 species). This discrepancy can be attributed to the presence of the two invasives, i.e., the Oriental Garden lizard and the Indian bullfrog, at highly and moderately disturbed sites, as well as the site-specific availability of microhabitats for certain littoral forest species. Yellow-Lipped Sea kraits (*Laticauda colubrina*) were only recorded at New Wandoor – a site which witnesses high levels of tourism – owing to the presence of fallen Andaman Bulletwood trees, the root systems of which are used by the species to rest and slough. Similarly, the mangrove frog (*Fejervarya cancrivora*) was only recorded from Bada Balu, a moderate tourism site, due to the presence of patches of mangrove forests along the coast.

This study has provided a preliminary documentation of the impacts of tourism on the diversity and abundance of herpetofaunal species in the islands. Future work however should include more robust sampling over seasons, including night-time surveys, to further explore the impacts of tourism related activities on species of

herpetofauna. The fact that this work was conducted during peak monsoon months might have impacted our findings, as most species will seek shelter during heavy rain. More rigorous sampling will uncover the impacts of tourism on herpetofauna. However, this study does provide evidence of the potential negative impacts of tourism, and the need to undertake some basic measures to mitigate these impacts and promote herpetofauna diversity in the islands.

Table 6: Checklist of species encountered both diurnally and nocturnally in the evergreen forests of Webi, Middle Andaman. This checklist includes records from the morning VES surveys as well as the initially carried out night-time VES surveys. Opportunistic sightings of herpetofauna during the study period, when returning from field sites and at the field base (which is adjacent to a disturbed evergreen forest) have also been included in this list.

1	<i>Coryphophylax subcristatus</i>	Day & Night
2	<i>Coryphophylax brevicaudus</i>	Day
3	<i>Eutropis andamanensis</i>	Day
4	<i>Eutropis tytleri</i>	Day
5	<i>Gekko verreauxi</i>	Day & Night
6	<i>Phelsuma andamanensis</i>	Day
7	<i>Cyrtodactylus rubidus</i>	Night
8	<i>Hemidactylus frenatus</i>	Night
9	<i>Gehrya mutilata</i>	Night
10	Unidentified gekko sp.	Night
11	<i>Varanus salvator</i>	Day
12	<i>Dendrelaphis andamanensis</i>	Day
13	<i>Xenochrophis tytleri</i>	Day & Night
14	<i>Boiga andamanensis</i>	Night
15	<i>Bungarus andamanensis</i>	Night
16	<i>Trimeresurus andersoni</i>	Day & Night
17	<i>Cerberus rynchops</i>	Night
18	<i>Lycodon capucinus</i>	Night
19	<i>Kaloula ghoshi</i>	Night
20	<i>Microhyla chakrapani</i>	Night
21	<i>Duttaphrynus melanostictus</i>	Night
22	<i>Fejervarya andamanensis</i>	Night

23	<i>Rohanixalus</i> sp.	Night
24	<i>Hoplobatrachus tigerinus</i>	Day & Night

IMAGES OF HERPETOFAUNA FROM SURVEYS



Andaman Bent-Toed Gecko (*Cyrtodactylus rubidus*) on the trunk of a fallen tree at New Wandoor, South Andaman.



Andaman Day Gecko (*Phelsuma andamanensis*) at Manjery forest trail, South Andaman.



A sleeping Bay Island Forest Lizard (*Coryphophylax subcristatus*) seen in Webi RF.



Littoral forest trail at Safed Balu, Middle Andaman.



Evergreen forest trail at Karmatang 11, Middle Andaman.



Andaman Keelback (*Xenochrophis tytleri*) in a temporary water body in littoral forest at Bada Balu, South Andaman.



Mangrove Frog (*Fejervarya cancrivora*) at Bada Balu beach, South Andaman.



Yellow-Lipped Sea Krait (*Laticauda colubrina*) nestled in the root system of a fallen Andaman Bulletwood tree at New Wandoor beach, South Andaman.



The coastline and littoral forests at Bada Balu, South Andaman.



A Pandanus dominated littoral forest trail at Karmatang 11, Middle Andaman.



An Andaman Pit viper (*Trimeresurus andersoni*) seen amongst the leaf litter in the evergreen forests of Webi RF, Middle Andaman.



Evergreen forests of Manjery, South Andaman.



A fallen Andaman Bulletwood Tree at Bada Balu, South Andaman. These extensive root systems form a microhabitat which are utilised by Yellow-Lipped and Blue-Lipped Sea Kraits to rest and slough.



An endemic Andaman Bullfrog (*Kaloula ghoshi*) from Webi RF, Middle Andaman.



Evergreen forest trail, Webi RF, Middle Andaman.



Littoral forests at Gwiji, Middle Andaman.