Recreation Resource Impacts of Pantai Kerachut Trail in Penang National Park

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Abstract. Recreation resources often referred to as the combination of natural resources essential to carry on a variety of recreational activities for humankind. Being one of the most-visited destinations among visitors who are seeking outdoor experience, Penang National Park (PNP) faces a substantial impact on its recreation resources. Among the common issue arises are the impacts on the quality of the routing system, particularly on sites like Pantai Kerachut Trail. The impacts cause undesirable change and degrade the components of recreation resources such as soil, vegetation, wildlife and water resources of the natural area. This issue threatens its integrity to maintain the benefits of recreation function and raises conflict between the visitors and the management of this area to reach its sustainability. Thus, an assessment has been conducted to evaluate the current status of recreation resource impacts in Pantai Kerachut Trail. A total of 75 sampling points were collected along Pantai Kerachut Trail. The methods of Rapid Survey Technique, Census Sampling Technique, and Cross-sectional measurement were used to determine the major factors influencing the impact. This investigation also identifies the relationship between impact and inventory parameters caused by recreational activities on the trail. Findings reveal that the current status of soil (soil erosion and soil drainage); and vegetation (root exposure, loss of vegetation, decrease in the percentage of canopy cover and vegetation density) along Pantai Kerachut Trail are at the moderate level of impact. Meanwhile, water and wildlife are confirmed at a minimal level of impact. The outcomes as such could be advantageous for the management to ensure the sustainability of the trail system in accommodating visitation while enhancing protection towards recreation resources along Pantai Kerachut Trail.

Keywords: Recreation ecology, recreation resource impacts, trail impact assessment

1. Introduction

The national park is considered as one of the national icons in protecting the natural, ecological and cultural assets.[1, 2] According to the Union for Conservation of Nature (IUCN) national park categorized under Category II of protected areas with the main objective to protect natural biodiversity along with its underlying ecological structure and supporting environmental processes, and to promote education and recreation.[3] Meanwhile, the combination of these natural resources often referred to as recreation resources offer essential recreational opportunities beneficial for visitors’ participation. The Outdoor Recreation Resource Review
Commission (ORRRC) described recreation resources as “any available land, water resources and management of wildlife which compatible for outdoor recreation.”[4, 5] In 2012, Penang National Park (PNP) and ten other protected areas under the management of the Department of Wildlife and National Parks (DWNP) attracted 1.3 million tourists which represents a 22.5% increase compared to 2011 and evidenced by 108,276 visits to PNP [6]. However, such visitation has contributed impacts to all recreation resource components within the natural setting and this credit directed the establishment of recreation ecology field which connected outdoor recreation and ecological impacts.[7, 8, 9, 10]

Realizing the importance of linkages between recreation and resources, quality and well-managed trail system is crucial.[11] Significantly, there are three major functions of trails: protecting the resource by concentrating traffic on a hardened track, providing recreational opportunities along aesthetically trail routes and facilitate recreational use by providing a transportation network.[12, 13] For visitors, they used trails to reach the attractive spot in the park and also provide safe access for the visitor to pursue recreational activities such as jungle trekking, appreciation to the natural and scenic environment as well as to observe wildlife.[7] Hence, trail settings in nature areas are capable to improve both ecological conservation efforts and the quality and visitor experiences.[14, 15] But the situation faced by most of the managers when they provide accessibilities for visitors, trails degradation is widespread and the conflict to conserve flora, fauna, and natural ecological systems are arising especially for future generations. It worsens when the visitation contributed to adverse recreation resource impacts namely as impacts on soil, vegetation, wildlife and water. Resulted in developing systems to monitor visitor impacts and strategies to alleviate them when they are considered unacceptable.[16, 17]

Recreation activities that cause undesirable change to the ecosystem is called recreation resource impacts and these impacts include vegetation loss and compositional changes, soil compaction, erosion, muddiness, exposure of tree roots, trail widening, and the proliferation of visitor-created side trails.[18, 12, 19, 20] However, soil erosion is the only impact indicator that does not recover naturally over time compared to disturbed vegetation and compacted soil whereby requires costly management actions.[22, 23] All these issues need to be addressed to ensure the fulfilment of dual responsibilities in managing natural areas such as national park compromise the resources sustainability and opportunities for visitors to gain high quality of experiences.[7, 24]

To understand this situation, exploring recreation resource impacts mainly vital because trail-related recreation activities such as hiking and wildlife viewing are popular ecotourism activities, and because trails receive some of the most intensive visitor use within national parks.[25] The outcome of this research contributes to determining the causes and consequences of recreation resource impacts which are challenging and highly site-specific, with the relative balance of many factors depending on environmental, management and use-based characteristics. Thus, recreation resource impacts are a concern for managers because the trail may become difficult or unsafe, aesthetic aspects of protected areas may be diminished, and because substantial funding or staffing may be required to repair or maintain trails.

2. Purpose of Study
The objectives of this study are (1) to identify the condition of Pantai Kerachut Trail and (2) to assess recreation resource impacts on soil, vegetation, wildlife and water along the most popular trail in a national park.
3. Penang National Park

Penang National Park (PNP) is the smallest national park in Peninsular Malaysia with a total coverage area of 2,563 hectares and the only considerable natural setting left which makes up 0.04% of the Penang Island size.[6, 26] Located at the very northwest of the island (coordinates 5° 27’U, 100°12’T) (Figure 1), this is the only national park with five natural habitats found within a single location namely lowland dipterocarp forest, hill dipterocarp forest, mangrove forest, sandy beaches and meromictic lake (only in Penang, Malaysia and Victoria, Australia). The highest peak is the 464-meter high Bukit Batu Hitam. Further, there are recorded more than 1000 species of plants which dominated by the Family Dipterocarpaceae, Leguminaceae, Apocynaceae, Anacardiaceae and Moraceae; 271 species of wildlife, with some nearly driven to extinction.[27]

![Figure 1 Peninsular Malaysia, Penang and Penang National Park](image)

Formerly, PNP was known as Acheh Beach Forest Reserve which gazetted in 1928 and used for logging up until 1996. Due to overwhelm concerns from the Federal and State governments, NGOs and the local community on the importance of preserving biodiversity in a metropolitan area, Penang National Park was declared a National Park on 10th April 2003 under the National Park’s Act 1980 virgin forest.[28, 29] The main objective of its establishment is to preserve and protect wildlife, plants and interests in terms of geology. Ancient history, history, ethnicity and other interests of science and legislation.[30] Besides, the early establishment of PNP triggered by the consent in preserving and protecting “flora and fauna, geological, archaeological, historical, ethnological features, scientific values and scenic interest”.

Due to its status as a national park and the vicinity is considered one of the most developed state in Peninsular Malaysia, the Penang National Park is one of the prominent ecotourism destinations in Malaysia managed to attract significant number of visitors every year with various attractions such as jungle trekking, camping, swimming, sightseeing, etc. Thus, the recognition of the trail conditions and their level of degradation significantly valuable for PNP management in the context of proper management of visitor traffic and preventing further trail degradation.[9]
4. Methodology

Penang National Park currently has two main nature trails which starting from the main entrance which are Pantai Kerachut Trail (±3.4km) (Figure 2) and Pantai Teluk Kampi Trail (±4.9km). There are also other trails interconnected with the main trails namely Bukit Batu Hitam Trail (±6km), Muka Head Light House Trail (±4.7km), Monkey Beach Trail (±3.4km), Teluk Aling Trail (±2km), Sungai Tukun Trail (±940m) and Pasir Pandak Trail (±490m). Unfortunately, the trail to Monkey Beach is closed for maintenance due to landslide. For this study, only Pantai Kerachut Trail has been selected for the assessment on top of suggested by the PNP management as the existing of important biodiversity hotspot throughout the trail.

Figure 2 Pantai Kerachut Trail

Primarily, this study involves three methods. Rapid Survey Technique was conducted to collect data with 50 meters [13, 31] distance from one sample point to another, Census Sampling Technique involved census problem areas at the entire trail system and Cross-Sectional Measurement was used to understand the changes in trail depth, width and the relationship between both.[32] The data collection is based on the researcher’s visibility and confirmed by the PNP Park Ranger. It started at sample point number one located at the main entrance of Pantai Kerachut Trail, then rapidly continuous similar technique until the last sample point at the Pantai Kerachut Guard Post.

The content of inventory form has been sought by an expert judgement before the data collected on-site. The inventory form comprised of ecological aspect parameter that were divided into some sections focusing on impacts on soil, vegetation, wildlife and water; trail width, transect line depth, types of forest, soil profile slope and overall trail condition [19, 7, 33, 9]. Each of the chosen parameters rated into four classes respectively and later were analysed statistically using adapted interpret mean score in Table 1 to firm the classification.
5. Results and Discussion

5.1. The trail condition based on trail width and trail depth

A total of 75 points has been sampled from the whole length (3.734km) of the Pantai Kerachut Trail. Trail width and depth has been described as a part of the trail corridor which directly support the majority of recreation traffic in natural settings. But it is not applicable when the sample point not situated on the trail surface.[34] Commonly trail surface problems are excessive tread incision or soil erosion, excessive wet or muddy soil, excessive tread widths, the excessive occurrence of exposed roots, occurrence of running water, and occurrence of multiple or secondary treads.[35]

The result shows that readings for trail width are ranging from 37cm to 182cm throughout the trail (Table 2). Based on the record, 14.7% (11 points) of trail surface are paved by interlocking materials and only 1.3% (1 point) stated reading at 37cm which is below than assuming a conservative average trail width of two feet (60cm).[7] Significantly, 60% (45 points) marked the reading more than 90cm of width (excluded reading for pavement area) and this represented as excessive trail width because the trail exhibits a greater than 3 foot (90cm) expansion in width that is clearly attributable to recreational uses, such as walking around tree falls, wet or muddy areas, eroded areas, multiple treads, etc. [36, 37]. This result then supported by a reading of trail depth which calculated from data collected in three different sections of the trail which are the middle trail depth (D), the right side of trail depth (D1) and left side of trail depth (D2).

| Mean score | Level |
|------------|-------|
| 1.00 – 2.00 | High |
| 2.01 – 3.00 | Medium |
| 3.01 – 4.00 | Low |

**D** – middle trail depth reading
**D1** – right side of trail depth reading
**D2** – left side of trail depth reading

It is proven that the mean depth at the middle of the trail is considered severe (6cm) and almost equal with the right (4cm) and left (5cm) readings. All sections have minimum trail depth measurement which 1cm (excluded readings for 0cm pavement surface), while all sections are not much different in the maximum measurement of trail depth but the middle section still records the highest trail depth (37cm). None of these readings exceeded 100cm because once the trail reaches such depth it is considered highly eroded.[37]
5.2. The overall assessment of recreation resource impacts
The recreation resource impacts on vegetation (ten parameters), soil (four parameters), wildlife (four parameters) and water (four parameters) were assessed (Table 3). In terms of vegetation, the results indicated that impact classified at “Medium Level” is root exposure (Mean 2.56), canopy coverage (Mean 2.97) and vegetation composition (Mean 3.00). Meanwhile, the remaining seven parameters maintained at “Low Level” of impact. Based on the assessment, root exposure condition along Pantai Kerachut Trail rated “severe” (73.3%) because three-quarters or more of major roots are exposed more than 30cm from the base of the tree and soil erosion obvious.[38, 37] This followed by moderate level of canopy coverage (97.3%) since light intensity ranging from 26% to 50% and vegetation composition also moderate level generally because the trampling not so intense where most of the plants are not shifted to the adjacent of the trail.[39, 33, 40]

Table 3. The parameter for recreation resource impacts of Pantai Kerachut Trail

| Impact                        | Parameter                          | Scale                  | Mean | Level  |
|-------------------------------|------------------------------------|------------------------|------|--------|
| Vegetation                    | Root exposure                      | Total expose (%):     |      |        |
|                               |                                    | Severe (21.3%)         | 2.56 | Medium |
|                               |                                    | Moderate (73.3%)       |      |        |
|                               |                                    | No/Slight (5.3%)       |      |        |
| Loss of vegetation            | Clear (0%)                         | Severe (1.3%)          | 3.01 | Low    |
|                               |                                    | Moderate (96%)         |      |        |
| Canopy coverage               | Total uncovered (%)                | Severe (2.7%)          | 2.97 | Medium |
|                               |                                    | Moderate (97.3%)       |      |        |
|                               | Dark (0%)                          |                        |      |        |
| Damages to vegetation         | High (0%)                          | Severe (0%)            | 3.79 | Low    |
|                               |                                    | Moderate (21.3%)       |      |        |
|                               |                                    | Minimal (78.7%)        |      |        |
| Tree stumps, fallen trees and | High (0%)                          | Severe (1.3%)          | 3.84 | Low    |
| lean trees                    |                                    | Moderate (13.3%)       |      |        |
|                               |                                    | Minimal (85.3%)        |      |        |
| Vegetation density            | Clear (0%)                         | Severe (0%)            | 3.09 | Low    |
|                               |                                    | Moderate (90.7%)       |      |        |
|                               |                                    | Compact (9.3%)         |      |        |
| Vegetation composition        | High (0%)                          | Severe (0%)            | 3.00 | Medium |
|                               |                                    | Moderate (100%)        |      |        |
|                               |                                    | Minimal (0%)           |      |        |
| Unique and endangered species | Clear (0%)                         | Severe (0%)            | 3.99 | Low    |
|                               |                                    | Moderate (1.3%)        |      |        |
| Impact          | Parameter                          | Scale                        | Mean | Level |
|-----------------|------------------------------------|------------------------------|------|-------|
| Impact          | Compact (98.7%)                    |                              |      |       |
| Mechanical damage | High (0%)                          |                              | 3.95 | Low   |
|                 | Severe (0%)                        |                              |      |       |
|                 | Moderate (5.3%)                    |                              |      |       |
|                 | Minimal (94.7%)                    |                              |      |       |
| Exotic species and weeds | High (0%)                          |                              | 4.00 | Low   |
|                 | Severe (0%)                        |                              |      |       |
|                 | Moderate (0%)                      |                              |      |       |
|                 | Minimal (100%)                     |                              |      |       |
| Soil Problem areas | Totally exposed (4%)               |                              | 3.71 | Low   |
|                 | Trail widening (2.7%)              |                              |      |       |
|                 | Gully (12%)                        |                              |      |       |
|                 | Muddy (81.3%)                      |                              |      |       |
| Soil erosion    | High (2.7%)                        |                              | 2.83 | Medium|
|                 | Severe (21.3%)                     |                              |      |       |
|                 | Moderate (66.7%)                   |                              |      |       |
|                 | Negligible (9.3%)                  |                              |      |       |
| Soil drainage   | Bad (1.3%)                         |                              | 2.83 | Medium|
|                 | Average (24%)                      |                              |      |       |
|                 | Moderate (65.3%)                   |                              |      |       |
|                 | Good (9.4%)                        |                              |      |       |
| Soil exposure   | Mineral soil (26.7%)               |                              | 2.56 | Medium|
|                 | Organic soil (25.3%)               |                              |      |       |
|                 | Organic litter (13.3%)             |                              |      |       |
|                 | Forest litter (34.7%)              |                              |      |       |
| Wildlife        | Wildife disturbance                |                              | 4.00 | Low   |
|                 | High (0%)                          |                              |      |       |
|                 | Severe (0%)                        |                              |      |       |
|                 | Moderate (0%)                      |                              |      |       |
|                 | None/Minimal (100%)                |                              |      |       |
| Wildlife        | Harvesting                         |                              | 4.00 | Low   |
|                 | High (0%)                          |                              |      |       |
|                 | Severe (0%)                        |                              |      |       |
|                 | Moderate (0%)                      |                              |      |       |
|                 | None/Minimal (100%)                |                              |      |       |
| Loss or modification of wildlife habitats | High (0%) | 4.00 | Low | None/Minimal (100%) |
| Wildlife dependency on food | High (0%) | 4.00 | Low | None/Minimal (100%) |
### Impact and Parameter Analysis

| Impact | Parameter | Scale | Mean | Level |
|--------|-----------|-------|------|-------|
| Water  | Contamination of useable water resources | High (0%) | 3.96 | Low   |
|        |          | Severe (0%) |       |       |
|        |          | Moderate (4%) |     |       |
|        |          | None/Minimal (96%) |   |       |
|        | The presence of bacteria | High (0%) | 4.00 | Low   |
|        |          | Severe (0%) |     |       |
|        |          | Moderate (0%) |     |       |
|        |          | None/Minimal (100%) | |       |
|        | Water quality | High (0%) | 4.00 | Low   |
|        |          | Severe (0%) |     |       |
|        |          | Moderate (0%) |     |       |
|        |          | None/Minimal (100%) | |       |
|        | Solid suspended matter | High (0%) | 4.00 | Low   |
|        |          | Severe (0%) |     |       |
|        |          | Moderate (0%) |     |       |

Impacts on soils occurred when there are changes in soil compaction, chemical and microbiological properties and soil loss.[41] Majority of the parameters for soil reached “Medium Level” classification with soil exposure (Mean 2.56), soil erosion (Mean 2.83) and soil drainage (2.83). Soil exposure clearly understood as the ground condition with very little or no organic litter (partially decomposed leaf, needle, or twig litter) or vegetation cover within the site boundaries.[37] Mineral soil surface (26.7%) and dark organic soil (25.3%) represented mostly along the trail. It is supported with soil drainage parameter also moderate (65.3%) due to the existence of multi-coloured horizons, at least with one that is blue or grey, as a result of poor drainage. Thus, the soil erosion completed the link when rated as moderate (66.7%) because of some deepening about 30cm and widening from the range 25 to 75cm of trail soil may scatter along trail edge.

Nonetheless, the impact on wildlife which resulted in “Low Level” on wildlife disturbance, wildlife harvesting, loss or modification of wildlife habitats and wildlife dependency on food. Similarly, impact on water shows “Low Level” of all parameters such as contamination of useable water resources in natural areas due to erosion of riverbanks and camping activities, the presence of bacteria from food leftover and domestic animal waste, water quality changes and the presence solid suspended matter. However, a constant assessment should be done by the management (DWNP) to ensure the sustainability of these recreation resources and strategies on minimizing unacceptable impacts. The results show that the current condition of recreation resources along Pantai Kerachut for impacts on soil was moderately damaged and lightly damaged with minimal disturbance for impacts on vegetation. No substantial impacts collected for wildlife and water resource. Therefore, the integrated current efforts by the management with the support of responsible visitors will lead to the improvement of healthy recreation resources and high-quality recreational experiences.

### 6. Conclusion

As a conclusion, since PNP is one of the most-visited destinations among who are seeking outdoor experience, it has the potentials to face many threats and challenges especially from
its precious clients – the visitor. Hence, this kind of assessment specifically to comprehend the range of recreation resource impacts derived from common activities that visitors did when they visited a national park. Further studies such as this are important in maintaining the standards of quality to ensure the sustainability of the trail in accommodating visitation to meet the user’s expectation as this will reflect their memories and experience while enhancing natural resource protection along Pantai Kerachut Trail.

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