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Sustainable Conservation Management System for The Critically Endangered *Betta Persephone* in Ayer Hitam Peat Swamp Forest Reserve Muar Johor

Mohd Rafiq Mujilan[1], Nazirah Mohamad Abdullah[1,2*], Izyan Hakimah Kamar Supardi[2], Saifullizan Mohd Bukari[2]

[1]Faculty of Applied Sciences and Technology,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, MALAYSIA

[2]Centre of Applied Geomatics and Disaster Prevention, Faculty of Civil Engineering and Built Environment,
Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, 86400, MALAYSIA

*Corresponding Author

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Abstract: In recent years, there has been a lot of interest in protecting and conserving wildlife on a wide range of scales. *Betta Persephone*'s habitat life may be affected by urbanization in Ayer Hitam Peat Swamp Forest Reserve (AHPSFR). This species is endangered due to the widespread conversion of peat swamp forests to industrial forestry and monoculture plant. The evaluation of fish habitat always has been a research priority for individuals in the domains of environmental protection and sustainable development, to improve habitat conservation. Results of the study through sample water collection shows the result of pH water. Based on these environmental factors, the factors that under dry leaves and branches and blackwater are the main factors that affect *Betta Persephone* choose AHPSFR as its own natural habitat. The satellite data and to analyze the catchment area results and construct the maps. U.S Geological System (USGS) and Geographic Information System (GIS) used to generate the maps. Geographic Information System (GIS) is a computer system that analyses and displays information that is geographically referenced. This study is carried out to predict the hydrologic analyze of the study area. The location of *Betta* is at one of the small sub catchments at the study area. The sub catchment that are found of the habitat are at the nearly the low stream links and at the watershed area that are found using the software.

Keywords: *Betta Persephone,* catchment area, hydrologic analysis

1. Introduction

The wildlife habitats and regions of the world's wilderness are diminishing in both time and space as a result of the enormous pressures of human-centered economic growth. Modern civilization has severely harmed the natural system by removing forests for settlements, agriculture, and communication, and by constructing massive hydroelectric projects and industry. In recent years, there has been a vast of interest in protecting and conserving wildlife on a wide range of scales [1]. In particular, the habitat life of *Betta Persephone* may be affected by urbanization in Ayer Hitam Peat Swamp Forest Reserve (AHPSFR), which is a peat swamp forest reserve in Malaysia and the research center for *Betta Persephone*. This species is endangered due to the widespread conversion of peat swamp forests to industrial forestry and monoculture plants [2].

Urban expansion has resulted in a steady flow of heat generated by factories, automobile exhaust emissions, air conditioner use, and other human activities. Environmental issues, land use disputes, hazards to agricultural operations

*Corresponding author: nazirah@uthm.edu.my

and land market speculation are merely some of the downsides of urbanization at its maximum [3]. The evaluation of fish habitat always has been a research priority for individuals in the domains of environmental protection and sustainable development as part of conservation authorities effort to improve habitat conservation [4], [5]. Changes in habitat induced by human activities, together with alterations in water characteristics and flow patterns, may result in a continuing fall in aquatic organism populations [6]. Therefore, in order for biodiversity protection efforts to result in sustainable development, it is vital to obtain a deeper comprehension of how anthropogenic risks affect aquatic species [7]. Experimentation has provided information regarding crucial environmental elements and biological processes, enabling the planning of appropriate mitigation and protection measures.

2. Study Area and *Betta Persephone* Habitat Factor

2.1 Ayer Hitam Peat Swamp Forest Reserve (AHPSFR)

In Muar, Johor a reserved forest named Ayer Hitam Peat Swamp Forest Reserve (AHPSFR) was established as a National Park. On February 28, 2004, it was designated as a State Park under the control of the Johor Government. The AHPSFR are protected areas which not accessible to the public. With an average yearly rainfall of 2215mm, the AHPSFR is reliant on rain for peat production [8]. According to Wetland International Malaysia [9] evaluation, this region has great biodiversity and a diverse range of animal species. There were 91 bird species, 21 fish species, and seven animal species spotted.

In 2012, Wetlands International Malaysia undertook a survey to investigate the variety of peat fish in the AHPSFR. The project's goal is to investigate the variety of fish species found in the AHPSFR and its adjacent water bodies. The initial survey expedition yielded 21 species, including the severely endangered *Betta Persephone*. The second survey had a reduced species count of only 15, with three new species discovered that were not discovered on the first expedition. According to Low [10], this location is presently the only natural habitat of the endangered species *Betta Persephone*. Forests developed into habitats for plants and wildlife. The diversity of plants and wildlife species in the forest helps to manage the ecology. For example, AHPSFR, Muar is Peninsular Malaysia's only peat swamp forest reserve with *Betta* fish life. The conservation of this species permits researchers and environmentalists to investigate the forest and all its inhabitants.

2.2 Type of *Betta* Fish in Malaysia

The taxonomy of fighting fishes of the genus *Betta* from Singapore, Malaysia, and Brunei has been reviewed, and 23 new species have been identified [11]. Table 1 shows the *Betta* species found in Malaysia.

Table 1 - *Betta* species found in Malaysia

Betta	Year discovered	Localities
Pugnax	1850	Johor, Kedah, Pahang, Penang, Selangor, and Terengganu
Bellica	1884	Johor, Selangor, Pahang, and Perak
Akarensis	1910	Sarawak
Taeniata	1910	Sarawak
Macrostoma	1910	Sarawak
Ocellata	1933	Sabah
Balunga	1940	Sabah
Imbellis	1975	Johor, Kedah, Penang, Perak, Selangor, and Terengganu
Coccina	1979	Johor
Tussyae	1985	Pahang
Waseri	1986	Pahang and Terengganu
Persephone	1986	Johor
Chini	1993	Sabah
Hipposideros	1994	Selangor
Pulchra	1996	Johor
Ibanorum	2004	Sarawak
Lehi	2005	Sarawak
Gladiator	2005	Sabah
Omega	2018	Selangor

According to Low [10], *Betta Persephone* is one of endangered species of *Betta* species. As AHPSFR was built at *Betta Persephone*'s natural habitat, studies by researchers from within and outside the country are focused on this research center.

2.3 *Betta Persephone*

Schaller, an aquarist, gave the binomial name *Betta Persephone* in 1986. *Betta Persephone* is a tiny species that may grow to be 2.6 cm long. *Persephone*'s name derived from the nickname of the Greek Goddess, the Queen of the Underworld. The Osphronemidae family classified as one of the labyrinth fishes, which have a unique supplementary respiratory apparatus called a labyrinth [12]. Members of this family may be found in a wide range of biological niches and settings, from stagnant water ditches to moving hill streams with high acidic pH, such as in peat swamp woods [13].

2.4 Satellite Data and ArcGIS Software

A satellite is a space object that orbits or circles around a larger object. Nowadays, a growing number of satellite sensor systems are used to observe and monitor the Earth and neighboring celestial bodies [14]. Thus, the satellite can be used to collect and generate data for use in the Geographic Information System (GIS). The U.S Geological Survey (USGS) is a system that provides numerous products, including data on current conditions and earth observations in real-time or near real-time. The data information provided includes data from satellite, which is Digital Elevation Model (DEM); basically, USGS is the primary source of GIS.

A DEM is a raster representation of a continuous region, often the earth's surface. The resolution is the primary determinant of this data's correctness (the distance between sample points). Other elements influencing accuracy include data type (integer or floating point) and surface sampling while constructing the initial DEM [15]. DEM are typically created using remotely sensed data from satellites, drones, and planes. The function of the DEM datasets that are collected is to discover and obtain the hydrologic analyses of the study area based on the study research that relates to catchment area. The basins, stream connectivity, flow accumulation, and flow direction are all part of the hydraulic analysis. All these analyses are utilized to create catchment area maps. The data collected from satellite data can subsequently be used to generate maps with GIS. GIS helps answer questions and solve problems by storing data in an easily understood and shared format. GIS-based maps and visualizations significantly aid in situational knowledge, resulting in better decision making and improved communication.

3. Methodology

The pH water can be detected by taking the sample water in the peat swamp water. Then, the steps for obtaining the catchment area and maps of the study region begin with collecting the DEM dataset, progressing the data, and producing the final output. The DEM dataset was obtained from USGS sources, and ArcGIS software was used to process the data.

3.1 Data Collection

Water samples were collected at each of the five locations namely A, B, C, D and E to determine the pH value. In geomorphological mapping, data are fundamental to the process of constructing topographic maps. Spatial data types, also known as geometric data types, provide a basic abstraction for describing the geometric structure of things in space, as well as their connections, characteristics, and actions [16]. The coordinates of the entrance of the study area are obtain from the site visit and receive from EXIF application which on mobile phone. The list of DEM dataset will appear during data finding tasks, and data that lie within the study area location are chosen.

3.2 Data Processing

The data that is received will be processed using ArcGIS software. The data that is process involving the feature that is provided in the software.

Start the process data by opening the ArcMap 10.8.3 software. The few start steps were *ArcMap > New Maps > Blank Map*. After choosing the DEM data, which is generally at Johor, few steps need to be done, to focus and specific for the maps to crop at the study location. Few shapefiles need to be inserted to process the catchment area. Shapefile is used for this process of producing the catchment area. Shapefile is used as a storage of geometric location and attribute information of geometric. To insert shapefile, click on *Catalog > Folder Connections > Create New Folder > Choose Shapefile*. To insert the coordinates of the study area, the steps start with click *Shapefile > Right Click on Data > Start Editing > Click on Absolute X, Y > Insert The Longitude and Latitude > Stop Editing.*

Analyzing the DEM data of the mapping will be done by using the features of ArcToolbox. For producing the catchment area of the study, the features that used is Hydrology features. The steps of using ArcToolbox are, search *ArcToolbox > Spatial Analysis Tool > Hydrology*. In the Hydrology section, the tools are used to fill accumulation,

stream link, etc. Fig. 1 and Fig. 2 show some of the displays of the ArcMap during the feature steps. Subsequent steps involve choosing the tools and creating the features to fill in the features box. The features box that have been filled will be at the top, which is on input raster line, then, choose the DEM files. In the output raster, rename the file to make it easy for the researcher to find and search for it later, for example, saving it as, "Fill." Flow accumulation, flow direction, stream link, snap pour point and watershed are tools used in progressing the data. For input raster of flow accumulation, the input raster is flow direction, which is relate to one another.

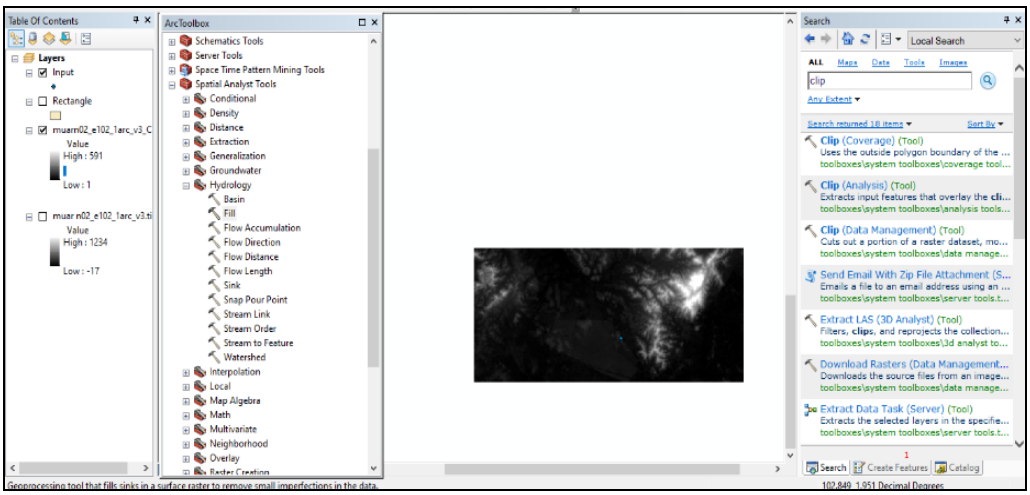

Fig. 1 - Display of the ArcMap with ArcToolbox

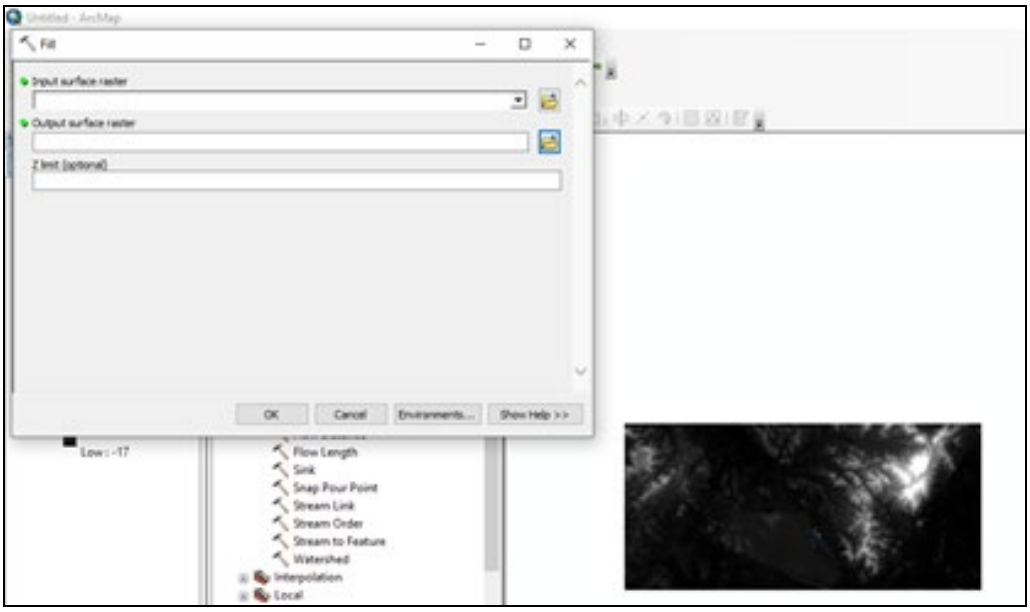

Fig. 2 - Example of create features of "Fill"

4. Result and Analysis

The results and analysis of the study are based on method(s) used. This section shows the outcome of the study based on the methodology of the research. The sample result and site visit has revealed that there is only one natural *Betta Persephone* habitat area in AHPSFR. All scenarios, causes, and methods may also be discovered using this technique.

4.1 pH Result

The results of pH tests on five water samples, namely A, B, C, D, and E that were taken in the black water peat swamp forest are shown in Table 2.

These *Betta Persephone* are very sensitive to their environment, which prefers dark environments in contrast to other *Betta* species. Studies also show that *Betta* lives in areas covered by trees. Based on Schaller [17], the habitat of *Betta Persephone* only lives at a water pH between four to six.

Fig. 3 shows the maps from google satellite that are produced by QGIS software. The map displayed the entire Ayer Hitam Utara area including forest and road. As stated in Table 2, *Betta Persephone* exists in location A, B and C but not in location D and E. The water characteristic disturbed in Points D and E, which are near to the major visitor route.

Table 2 - Value of pH in sample location

Location	Latitude	Longitude	pH	Existence of Habitat
A	2.31801	102.4945042	5.60	Exist
B	2.31815	102.4944880	5.70	Exist
C	2.31717	102.4944598	6.00	Exist
D	2.31853	102.4944460	8.48	Not exist
E	2.31928	102.4944898	8.34	Not exist

Fig. 3 - Sample location from QGIS

4.2 Data Collection

The USGS, which is frequently utilized by users conducting research on land use, land cover change, and other topics, provided the data for this study. The DEM data was gathered, and these data were located using the longitude and latitude of the research area. Based on the coordinates of the research area, a small number of DEM data were listed, including an entity ID of SRTM1NO2E102V3. The DEM data needed for data processing are shown in Fig. 4.

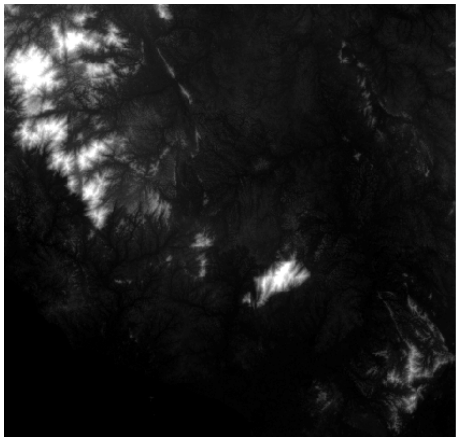

Fig. 4 - DEM dataset chosen for the study

4.3 Data Analysis

In this study, the DEM that was collected is based on the coordinates of the study area and process of ArcGIS using ArcMap. The data explored will be collected for further data analysis. The shapefile created is used to store the coordinates of the study area.

Features and tools that are used from ArcGIS include Fill, Flow Direction, Flow Accumulation, Stream Link, Snap Pour Point, and Watershed Tools. All these tools were used to construct the catchment area and map the study area. The

Fill feature will generate a focus area of the map. The Fill feature can be used to fill any defect that exists on the surface raster, where in this study, the total number of all fillings is 262. The location of the study area had eight (8) different slopes of flow direction. The flow direction raster function takes a surface as data and generates a flow direction raster from each pixel to its steepest downslope neighbor. The highest count of pixel 28252, where the value is 16. This shows that the highest downslope value is 16. Meanwhile, flow accumulation is related to stream links. Cells with numerous flow accumulations are regions with multiple flows, which can be used to find stream channels. The flow accumulation is the flow from the low value in ArcGIS of 0 to a high value of ArcGIS of 26136. Stream links are based on flow direction and flow accumulation that were processed before. The stream links are categorized into five classifications, which are from the values of 1 to 24, 24 to 49, 49 to 77, 77 to 104, and 104 to 132. The value is categorized following an ascending value, which is from the lowest to the highest stream. On the other hand, a watershed is an area of land that drains rainfall and snowmelt into streams and rivers [14].

Based on the flow accumulation and stream links, the watershed obtained is almost at the center of the study area. *Betta Persephone* lives in downstream areas, and based on the DEM, the habitat does not need a high area. This species is typically found in peat swamp forest, streams beneath deep canopy, and branches above, with just a few lights penetrating the surface of its natural habitats.

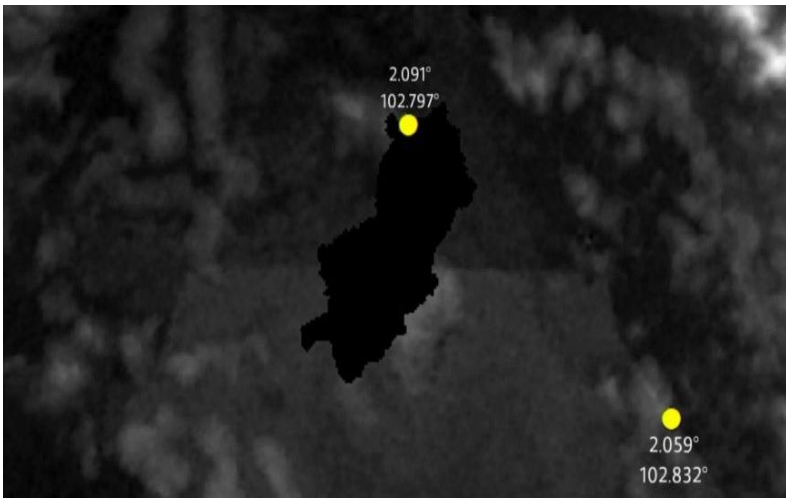

Fig. 5 - The coordinates of *Betta Persephone* location

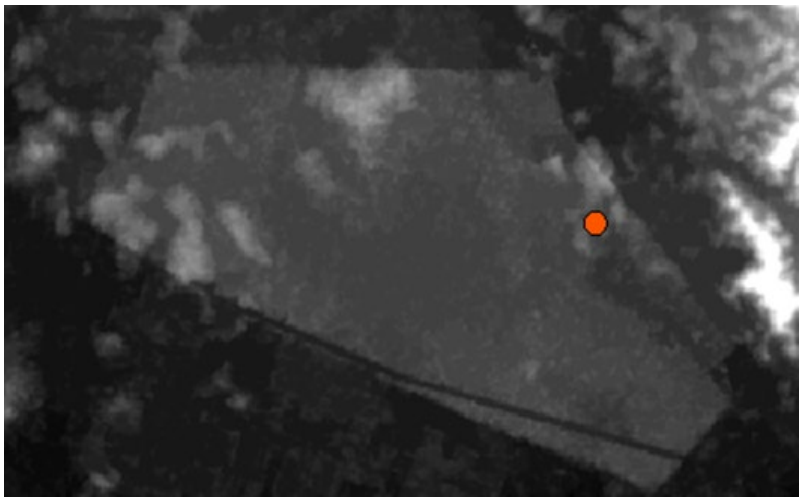

Fig. 6 - Pointed the location of *Betta* fish habitat at study area

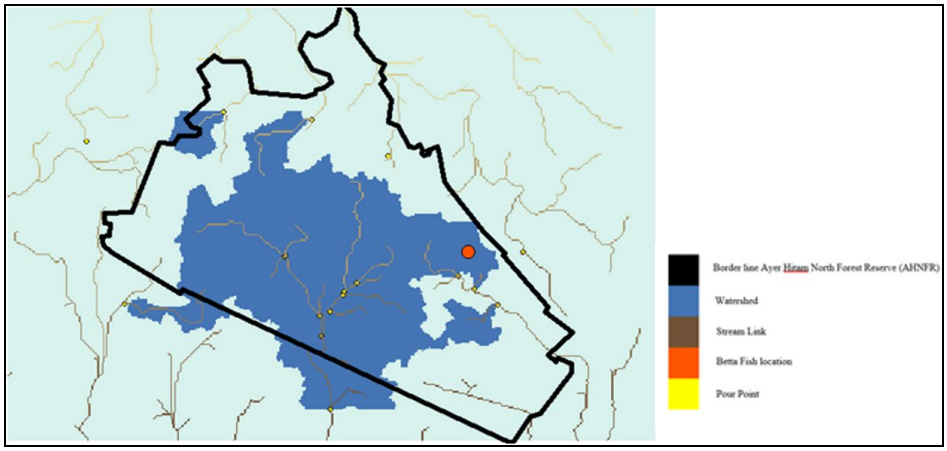

Fig. 7 - Mapping of catchment area

5. Conclusion

The findings of the study found in general, Betta life prefers stagnant water areas. Betta Persephone shows this characteristic by preferring blackwater environments associated with peat swamp forest, where it often lives in stagnant water, hiding under dry leaves and living in areas that receive less sunlight [12]. This is evidenced by visiting an area that is rumored to be the natural habitat of *Betta Persephone*. The analysis used are related to hydrology analysis, including Fills, Flow Direction, Flow Accumulation, Stream Link, Snap Pour Point, and Watershed. All these features are correlated to one another. Meanwhile, Fig. 6 demonstrates the habitat of *Betta Persephone* that is pointed on the maps. The *Betta* is located at one of the small sub catchments at the study area. Sub catchments that are found in the habitat are nearly at the low-stream links and at the watershed area, which are found using the ArcGIS software. As a conclusion, satellite data help to detect the catchment area in Ayer Hitam peat swamp forest.

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