Fish biomass in relation to water quality index as an indication of fisheries productivity of four selected fish species along the Galas River, Kelantan, Malaysia

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Abstract

This study aimed to assess the relationship between river water quality and fish biomass along the Galas River, Kelantan. Fish were collected using gill nets set along the Galas River from 2008 to 2009. Water Quality Index (WQI) data were obtained from the Department of Environment (DOE), Malaysia. A two-way ANOVA repeated-measures test, simple linear regression, and Spearman correlation were used to analyse the data. There was a significant difference in fish biomass in relation to water quality along the Galas River among stations and years. There was a weak correlation between WQI and fish biomass of four selected fish species in the Galas River from 2008 to 2009 ($r = 0.22; p > 0.05$).

1. Introduction

Rivers support a significant proportion of the earth’s aquatic biodiversity. Species richness within some tropical systems surpasses that of marine ecosystems, including coral reefs [1, 2]. Additionally, associated semi-aquatic/terrestrial habitats, such as seasonally flooded forests, are an integral part of river ecosystems, and sustaining
the water resources is a pre-requisite for their viability. Biologists have identified about 1.7 million species, the majority of which are insects followed by others including freshwater fishes. Worldwide, freshwater fishes are the most diverse of all vertebrate groups, but are also the most highly threatened [3]. Fish are important ecologically, economically and as a source of animal protein. The demand for fish protein has fuelled extraordinary growth of the fishing industry on the east coast of Peninsular Malaysia which includes Kelantan, Terengganu and Pahang. It is estimated that 20% of the world’s freshwater fishes are in danger of extinction or in need of urgent conservation efforts. Requirements for sustaining biodiversity and fisheries in rivers are integrally linked through a mutual need for improved management of both habitats and exploitation [2]. In some cases, fish biomass can be an indicator of fisheries productivity. Their size, community composition and structure often reflect the status of a water body. Fish biomass normally decreases in a degraded environment (i.e. where there is water pollution, sedimentation and habitat degradation). Fish biomass can be expressed as the catch-per-unit effort (CPUE). Higher fish biomass suggests that conditions in the river environment are suitable for fish growth. Galas River has been commonly used for transport, irrigation, recreation, and industry for years. To a lesser extent, it has been used as a source of water for human consumption in some remote areas. The Galas River (GR) also serves as a very important natural fishery resource for the local people living around that area. Many local people fish to supplement the family diet. Therefore, this study aimed to determine the relationship between the WQI and fish biomass. This study also provided baseline information about fish health and fisheries management status.

2. Materials and method

2.1 Study location

The GR is the main tributary of the Kelantan River (KR). The length of the river is 178 km and its catchment area is about 7,770 km² with main geological features of shale, mudstone, and limestone. The GR flows northward passing through Ulu Galas Forest Reserve to villages and towns, such as Ulu Pulai, Limau Kasturi, Dabong, Gua Musang and Kuala Krai, before joining other rivers (i.e. the Nenggiri and Pergau rivers) to form the KR. Out of three rivers sampled and monitored, the GR tended to reflect the most natural state, especially the upstream part of the river. However, downstream, palm and rubber plantations can be found nearby. Fig. 1 shows the locations of sampling sites. Three sampling stations were selected along the the GR: station 1 (Ulu Pulai, 04° 47.338’ 101° 56.429’), station 2 (Limau Kasturi, 05° 04.849’ 102° 04.303’), and station 3 (Dabong, 05° 22.875’ 102° 00.669’).

2.2 Water Quality Index (WQI)

Water Quality Index (WQI) data were obtained from the Department of Environment (DOE), Malaysia from 2008 until 2009. Water quality data were collected by the DOE from three water quality stations which were Ulu Pulai, Limau Kasturi and Dabong stations. Water quality was measured five times per year, namely during February, April, June, August and November. WQI was calculated using data obtained from the DOE in accordance with the formula prescribed by the National Water Quality Standards (NWQS).

2.3 Fish biomass

Sampling for fish was carried out during the dry and wet seasons. Five experimental gill nets (measuring 30 m in length, 1.5 m in depth, with a stretch mesh size of 3 and 4 inches) were set up and left overnight for five consecutive days at each sampling station (N = 2 seasons x 5 days x 5 gill nets = 50 samples/river). Each net was inspected every day for five days from morning until the afternoon. Nets were set up along parts of the river that covered the most river pools. Four fish species were selected for this study, namely Barbonymus schwanenfeldii (Lampam Sungai), Cyclocheilichthys apogon (Temperas), Labiobarbus lineatus (Kawan) and Mystacoleucus marginatus (Sia) due to their high distribution and abundance, as well as their importance as major food source for local populations. Catch-per-unit effort (CPUE) was estimated as catches of the fish (g) per day.
3. Results and discussion

3.1 Fish

There were 143 individual fish caught in 2008, and 207 caught in 2009 (Fig. 2). *Mystacoleucus marginatus* showed the highest number in both 2008 and 2009 with 60 and 77 individuals, respectively. While in 2008, *Labiobarbus lineatus* showed the lowest number of fish with only 6 individuals compared to *Barbonymus schwanenfeldii* (38 individuals) and *Cyclocheilichthys apogon* (39 individuals). However, in 2009, the number of *L. lineatus* increased dramatically.
Meanwhile, the total biomass of fishes (CPUE, g/day) was calculated from all of the species, collectively. In 2008, the highest total fish biomass was collected at station 3 with 4668 and the lowest was 1706 g at station 1 (Fig. 3). The highest total biomass was obtained from station 2 (13,420 g) during 2009. The total biomass of the four fishes caught was rather relatively small as shown in Fig. 3. Stations 1 and 3 had a total fish biomass of less than 10 kg (10,000 g), while station 2 had a total of 17 kg (± 1700 g).

3.2 Water Quality Index

The water quality of the GR ranged from 61.66 to 72.09 (Fig. 4). Therefore, GR can be classified as a Class III river which categorizes it as slightly polluted. Morrow and Fischenich (2000) stated that typically degraded water and habitat quality support a large fish biomass due to high levels of nutrients present in many polluted rivers but the reverse impact is observed in this study. This is because the selected fish species in this study can be considered to be intolerant fish species. These species will not be able to thrive under extreme conditions, including water and habitats that have been drastically degraded by anthropogenic causes. Sedimentation was observed in the GR which results in turbid water and thus prevents these fishes from foraging effectively.
3.2 Relationship between fish biomass and WQI

Fig. 5 shows there was a straight line of WQI plotted against fish biomass in both years. There was a weak correlation between WQI and fish biomass in the GR during 2008 and 2009 ($r = 0.22; p > 0.05$). This shows that fish biomass is still influenced by the quality of the river water. The higher the water quality index (which indicates excellent water quality), the healthier the fishes are.

4. Conclusion

In conclusion, the quality of river water is significant in order to increase fishery resources as well as boost subsistence and artisanal fishing catches in the GR. The study indicated that water quality play a significant role in fish growth. In addition, high CPUE was observed in a good habitat and water quality areas. The human demand for fish has been met historically through fishing, although lately the demand has become unsustainable due to anthropogenic activities especially over the past 10 years. Therefore, intensive conservation efforts need to be conducted in the GR in order to preserve river quality for sustainable fisheries productivity. It is recommended that a
A series of comprehensive studies should be undertaken to ensure the CPUE is improved and habitat quality is maintained.

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**References**