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# Fish index for classifying riverine ecosystem of Peninsular Malaysia

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**ABSTRACT** Tolerance levels of common freshwater fishes found in the various freshwater ecosystems of Peninsular Malaysia are presented to enable calculation of the fish index (FI) in the field for river classification purpose. These tolerance levels range from 0.5 to 4.5. Smaller values are for sensitive fishes that cannot tolerate even a small change in the surrounding environment, while larger values are for fishes that can withstand a wide range of environmental changes. From the study, *Channa gachua* (family Channidae), *Clarias teijsmanni* (family Clariidae), *Glyptothorax major* and *Glyptothorax platypogonoides* (both from family Sisoridae) are considered to be the most sensitive species with tolerance value of 1 or smaller. On the other hand, *Liposarcus pardalis* (family Loricariidae) is the most tolerant fish with a tolerance level of 4.5. This species is the dominant fish in the heavily polluted riverine ecosystem. The present river classification based on fish index is similar with the river classification system based on water quality index (WQI) widely used by the Department of Environment, Malaysia. However, the FI is a much easier and cheaper index to use as compared to WQI in the classification of rivers in Peninsular Malaysia.

**ABSTRAK** Tahap toleransi ikan-ikan air tawar yang biasa ditemui di ekosistem air tawar di Semenanjung Malaysia dibentangkan untuk membolehkan pengiraan indeks ikan (FI) di lapangan bagi tujuan pengelasan sungai. Tahap toleransi ini bernilai di antara 0.5 dan 4.5. Nilai toleransi yang kecil adalah bagi spesies ikan yang sensitif terhadap pertukaran persekitaran di dalam sungai, manakala nilai toleransi yang besar adalah bagi ikan-ikan tidak sensitif terhadap pertukaran ini. Dari kajian yang dijalankan, spesies ikan seperti *Channa gachua* (famili Channidae), *Clarias teijsmanni* (famili Clariidae), *Glyptothorax major* dan *Glyptothorax platypogonoides* (kedua-duanya daripada famili Sisoridae) tergolong sebagai ikan-ikan yang sensitif dengan mempunyai paras toleransi 1 ataupun lebih kecil. Sebaliknya, *Liposarcus pardalis* (famili Loricariidae) adalah spesies ikan yang paling tahan terhadap pencemaran dengan mempunyai nilai toleransi 4.5. Pengelasan sungai dengan menggunakan indeks ikan (FI) yang dicadangkan dalam kertas ini menyerupai dengan pengelasan sungai menggunakan indeks kualiti air (WQI) yang digunakan oleh Jabatan Alam Sekitar, Malaysia. Walau bagaimanapun, penggunaan FI adalah lebih mudah dan murah jika dibandingkan dengan penggunaan WQI bagi pengelasan sungai-sungai di Semenanjung Malaysia.

(fish index, tolerance level, river classification)

## INTRODUCTION

The river classification exercise initiated by the Department of Environment (DOE), Ministry of Science, Technology and the Environment, Malaysia for the last 10 years stressed the need for rapid field-based assessment approaches to classify our river ecosystems [1]. It was recognized that in saving time and money, a degree of accuracy would be sacrificed. However, the index must provide information to inform the Malaysian public of the state of our rivers on a regular basis. Also, the index must be usable within the limits of the available information, labour, expertise and financial resources. Therefore, indicators based on biological organisms seem to be the most appropriate approach.

Throughout the classification exercise of our Malaysian rivers such as Sungai Melaka [2], Selangor [3], Sungai Kesang [4] and Sungai Langat [5], several bio-indicator indices such as Shannon-Wiener index and family biotic index, were used. Unfortunately, these indices were developed in western countries for organisms in

temperate environment [6, 7]. Local rivers such as Sungai Bernam, Sungai Melaka, Sungai Rompin and Sungai Selangor have been classified on the basis of the composition of algae, fish and other aquatic organisms [1, 8]. Unfortunately, the classification proposed was qualitative in nature. Besides, for a biological organism to be used as bio-indicator in river classification system, identification of the organism to species level is necessary. Therefore, the objective of this paper is to provide a fish bio-indicator index that is quantitative in nature, usable within the limits of available information, and flexible enough to be useful in all riverine ecosystems in Peninsular Malaysia.

## MATERIALS AND METHODS

The fish index (FI) is based on the tolerance level of fishes found in a particular area. The value is set arbitrarily on the basis of the presence of the species in a particular class of river throughout the river system studied during the river classification programme [2, 3, 4, 5]. If the species is rare and prevalent only in class I river, a value of 0.5 is selected. If the species is normally found only in class I rivers but they are common, then the tolerance level of the species is 1. Fishes occupying two classes of river will be given average values of the classes, which is 1.5, 2.5 or 3.5. Fishes mainly found in class IV river but are relatively rare, their tolerance value is 4. The most common and abundant fish in class IV river is set at 4.5. The formula used to calculate the index is as follows:

$$FI = \frac{\sum_{i=1}^{s} TL_i}{s}$$

Where: FI = Fish Index; TL = Tolerance level; s = number of species

The proposed classification system of the river is similar in values with the water quality index (WQI) used by the Department of Environment, Ministry of Science, Technology and the Environment, Malaysia. Class I is used for the cleanest water body inhabited by very sensitive fish species. It is so clean that there is no need for special treatment for the water to be used as domestic water supply. A river inhabited by less sensitive fish species that requires a conventional treatment for the water to be used in water supply is classified as Class IIA. A Class IIB water body is similar with the class IIA, except that fishes present are those capable of tolerating minor disturbance. A moderately polluted river is classified as class III. An extensive treatment is required for the water to be used domestically. The fish community is dominated by groups of fishes capable of tolerating a high degree of pollution. Class IV is water body with high level of pollution. The water is suitable only for irrigation, and it is inhabited by a handful of highly pollutant-tolerant fishes.

At a selected site, fish sampling must be carried out extensively to ensure as many species are caught. In large, lowland sections of the river, fishing tools such as gill net, cast net, dip net, trap, hook-and-line with live bait and electroshocker are normally used, and fish sampling may go on for at least 24 hours. In the upper reaches of the stream, it suffices to use electroshocker for about 30-minute sampling during the day followed by dip-netting at night.

## RESULTS AND DISCUSSION

Table 1 indicates the tolerance level (TL) of the fishes normally found in the major river systems in Peninsular Malaysia. The value ranged from 0.5, being the most sensitive, to 4.5, being the most tolerant species. The most sensitive fish are *Amblyceps foratum* and *Glyptothorax platypogonoides* found mainly in the unpolluted stretch of mountain stream and *Chaca bankanensis* found in the undisturbed lowland, forested stream. *Glyptothorax platypogonoides* was once very common in the upper reaches of the Gombak River but has since become locally extinct due to the construction of the Karak highway [9]. The most tolerant fish is *Liposarcus pardalis*, known as *ikan bandaraya* or *ikan majlis daerah*, commonly found in heavily polluted rivers. The species is native to the aquatic ecosystem of South America, introduced into Malaysian waters through aquarium trade.

On the basis of the present TL, the FI should have a value from 0.5 to 4.5. Table 2 shows the various ranges of FI for the five classification systems. Examples of how the FI is calculated, based on hypothetical species composition, are shown in Table 3. In the event that no fish is collected in a sampling area, the water body cannot be classified based on FI. Perhaps, the river is so polluted that no fish can survive in it. On the other hand, if the section of the river is

close to sea, many marine fishes will frequently invade the area. As such, many fish species might be caught from the area but it cannot be classified by the present method.

The drawback of the index is that some freshwater fishes caught may not be identified to any of the fish species listed in Table 1. In this situation, the species should be omitted from the calculation or if the genus is known, a researcher might use the lowest tolerance level for the genus. As an example, if the genus of the specimen is identified as *Hemibagrus*, then the tolerance level of 1.5 should be used because it is the lowest among the three species listed in Table 1.

In a man-made aquatic ecosystem in which the fishery is mainly for recreational activities, its fish community is always controlled by regularly restocking the water body with suitable fishes to provide satisfaction to anglers. Results of FI in such an ecosystem can be misleading, and it must be used with great caution.

**Table 1**. Tolerance level of the freshwater fishes normally found in the riverine ecosystems of Peninsular Malaysia.

| Species | Family | Tolerance Level |
|---|---|---|
| *Acantopsis dialuzona* | Cobitidae | 1.0 |
| *Amblycep foratum* | Amblycipitidae | 0.5 |
| *Anabas testudineus* | Anabantidae | 4.0 |
| *Aplocheilus panchax* | Aplocheilidae | 2.5 |
| *Bagarius yarrelli* | Sisoridae | 2.0 |
| *Barbichthys laevis* | Cyprinidae | 2.0 |
| *Belodontichthys dinema* | Siluridae | 2.0 |
| *Belontia hasselti* | Belontiidae | 2.0 |
| *Betta imbellis* | Belontiidae | 2.5 |
| *Betta pugnax* | Belontiidae | 2.0 |
| *Betta waseri* | Belontiidae | 2.0 |
| *Botia beauforti* | Cobitidae | 1.5 |
| *Botia hymenophysa* | Cobitidae | 2.0 |
| *Botia morleti* | Cobitidae | 1.0 |
| *Chaca bankanensis* | Chacidae | 0.5 |
| *Channa gachua* | Channidae | 1.0 |
| *Channa lucius* | Channidae | 2.0 |
| *Channa melasoma* | Channidae | 2.0 |
| *Channa micropeltes* | Channidae | 2.0 |
| *Channa striata* | Channidae | 3.5 |
| *Chela laubuca* | Cyprinidae | 2.0 |
| *Chela maasii* | Cyprinidae | 1.5 |
| *Chitala lopis* | Notopteridae | 1.5 |
| *Clarias batrachus* | Clariidae | 3.5 |
| *Clarias gariepinus* | Clariidae | 3.5 |
| *Clarias nieuhoffi* | Clariidae | 2.0 |
| *Clarias teijsmanni* | Clariidae | 1.0 |
| *Crossocheilus oblongos* | Cyprinidae | 2.0 |
| *Cyclocheilichthys apogon* | Cyprinidae | 2.0 |
| *Cyclocheilichthys heteronema* | Cyprinidae | 1.5 |
| *Cyclocheilichthys repasson* | Cyprinidae | 2.0 |
| *Danio regina* | Cyprinidae | 1.0 |
| *Doryichthys deokhatoides* | Syngnathidae | 2.0 |
| *Doryichthys martensii* | Syngnathidae | 2.0 |
| *Epalzeorhynchos kalopterum* | Cyprinidae | 1.5 |
| *Esomus siamensis* | Cyprinidae | 3.5 |
| *Garra cambodgiensis* | Cyprinidae | 0.5 |
| *Glyptothorax major* | Sisoridae | 1.0 |
| *Glyptothorax plathypogonoides* | Sisoridae | 0.5 |

**Table 1.** (Continued)

| Species | Family | Tolerance Level |
|---|---|---|
| *Hampala macrolepidota* | Cyprinidae | 2.5 |
| *Helicophagus waandersii* | Pangasiidae | 2.0 |
| *Helostoma temminckii* | Helostomatidae | 2.0 |
| *Hemibagrus gracilis* | Bagridae | 1.5 |
| *Hemibagrus hoevenii* | Bagridae | 4.0 |
| *Hemibagrus nemurus* | Bagridae | 3.5 |
| *Hemirhamphodon pogonognathus* | Hemirhamphidae | 2.5 |
| *Homaloptera leonardi* | Balitoridae | 1.0 |
| *Homaloptera nebulosa* | Balitoridae | 1.0 |
| *Homaloptera orthogoniata* | Balitoridae | 1.0 |
| *Homaloptera zollingeri* | Balitoridae | 1.0 |
| *Kryptopterus apogon* | Siluridae | 2.0 |
| *Kryptopterus bicirrhis* | Siluridae | 1.5 |
| *Labeo chrysophekadion* | Cyprinidae | 1.5 |
| *Labiobarbus fasciatus* | Cyprinidae | 1.0 |
| *Labiobarbus festivus* | Cyprinidae | 1.0 |
| *Labiobarbus leptocheilus* | Cyprinidae | 1.5 |
| *Labiobarbus ocellatus* | Cyprinidae | 1.5 |
| *Laides hexanema* | Schilbeidae | 2.0 |
| *Laides sinensis* | Schilbeidae | 1.5 |
| *Leiocassis leiacanthus* | Bagridae | 1.0 |
| *Leiocassis micropogon* | Bagridae | 1.0 |
| *Leiocassis poecilopterus* | Bagridae | 1.0 |
| *Leptobarbus hoevenii* | Cyprinidae | 2.0 |
| *Liposarcus pardalis* | Loricariidae | 4.5 |
| *Luciocephalus pulcher* | Luciocephalidae | 1.5 |
| *Luciosoma setigerum* | Cyprinidae | 2.0 |
| *Luciosoma trinema* | Cyprinidae | 1.5 |
| *Macrochirichthys macrochirus* | Cyprinidae | 1.5 |
| *Macrognathus maculatus* | Mastacembelidae | 1.5 |
| *Mastacembelus favus* | Mastacembelidae | 2.0 |
| *Mastacembelus notophthalmus* | Mastacembelidae | 1.5 |
| *Mastacembelus unicolor* | Mastacembelidae | 1.5 |
| *Monopterus albus* | Synbranchidae | 4.0 |
| *Mystacoleucus marginatus* | Cyprinidae | 2.5 |
| *Mystus gulio* | Bagridae | 4.0 |
| *Mystus nigriceps* | Bagridae | 2.5 |
| *Mystus singaringan* | Bagridae | 2.5 |
| *Mystus wolffii* | Bagridae | 4.0 |
| *Nandus nebulosus* | Nandidae | 2.0 |
| *Nemachilus masyae* | Balitoridae | 1.5 |
| *Nemachilus selangoricus* | Balitoridae | 1.5 |
| *Neolissochilus soroides* | Cyprinidae | 1.5 |
| *Notopterus notopterus* | Notopteridae | 2.5 |
| *Ompok bimaculatus* | Siluridae | 1.5 |
| *Oreochromis mossambicus* | Cichlidae | 3.5 |
| *Osphronemus goramy* | Osphronemidae | 2.5 |
| *Osteochilus enneaporos* | Cyprinidae | 1.5 |
| *Osteochilus hasseltii* | Cyprinidae | 3.0 |
| *Osteochilus melanopleurus* | Cyprinidae | 2.0 |
| *Osteochilus spilurus* | Cyprinidae | 2.0 |
| *Osteochilus waandersii* | Cyprinidae | 1.5 |
| *Oxyeleotris marmorata* | Eleotridae | 3.0 |
| *Oxygaster anumalura* | Cyprinidae | 2.0 |
| *Pangasius micronemus* | Pangasiidae | 2.0 |
| *Pangasius nasutus* | Pangasiidae | 2.0 |

Table 1 (continued)

| Species | Family | Tolerance Level |
|---|---|---|
| *Pangio cuneovirgata* | Cobitidae | 2.0 |
| *Pangio kuhlii* | Cobitidae | 2.0 |
| *Pangio malayana* | Cobitidae | 2.0 |
| *Pangio piperata* | Cobitidae | 2.0 |
| *Parachela maculicauda* | Cyprinidae | 1.5 |
| *Parachela oxygastroides* | Cyprinidae | 2.0 |
| *Parambassis apogonoides* | Ambassidae | 1.5 |
| *Parambassis siamensis* | Ambassidae | 2.0 |
| *Poecilia reticulata* | Poeciliidae | 4.0 |
| *Poropuntius deauratus* | Cyprinidae | 2.0 |
| *Pristolepis fasciata* | Nandidae | 2.5 |
| *Probarbus jullieni* | Cyprinidae | 1.0 |
| *Pseudogobiopsis oligactis* | Gobiidae | 1.5 |
| *Puntioplites bulu* | Cyprinidae | 2.0 |
| *Puntius binotatus* | Cyprinidae | 2.5 |
| *Puntius gonionotus* | Cyprinidae | 3.0 |
| *Puntius lateristriga* | Cyprinidae | 1.5 |
| *Puntius partipentazona* | Cyprinidae | 2.0 |
| *Puntius schwanenfeldii* | Cyprinidae | 2.5 |
| *Rasbora argyrotaenia* | Cyprinidae | 2.0 |
| *Rasbora bankanensis* | Cyprinidae | 2.0 |
| *Rasbora einthovenii* | Cyprinidae | 2.0 |
| *Rasbora elegans* | Cyprinidae | 1.5 |
| *Rasbora heteromorpha* | Cyprninidae | 1.5 |
| *Rasbora sumatrana* | Cyprinidae | 2.5 |
| *Scleropages formosus* | Osteoglossidae | 1.5 |
| *Silurichthys hasseltii* | Siluridae | 1.5 |
| *Sphaerichthys osphromenoides* | Belontiidae | 1.5 |
| *Tetraodon leiurus* | Tetraodontidae | 2.0 |
| *Tetraodon palembangensis* | Tetraodontidae | 1.5 |
| *Thynnichthys thynnoides* | Cyprinidae | 2.0 |
| *Tor tambra* | Cyprinidae | 1.0 |
| *Trichogaster leerii* | Belontiidae | 2.0 |
| *Trichogaster pectoralis* | Belontiidae | 3.5 |
| *Trichogaster trichopterus* | Belontiidae | 2.5 |
| *Trichopsis vittata* | Belontiidae | 2.0 |
| *Tuberoschistura baenzigeri* | Balitoridae | 2.0 |
| *Vaillantella euepipterus* | Balitoridae | 1.0 |
| *Vaillantella maassi* | Balitoridae | 1.0 |
| *Wallago leerii* | Siluridae | 2.0 |
| *Xenentodon canciloides* | Belonidae | 2.5 |

**Table 2.** Fish index for the five categories of river classification

| Fish Index | River Classification |
|---|---|
| 0.5 – <2.0 | Class I |
| 2.0 – <2.5 | Class IIA |
| 2.5 – <3.0 | Class IIB |
| 3.0 – <4.0 | Class III |
| 4.0 – 4.5 | Class IV |

**Table 3**. Examples of fish index based on hypothetical fish species composition.

| Site | Fish Species Caught | Tolerance Level | Fish Index | River Classification |
|---|---|---|---|---|
| 1 | *Channa gachua* | 1.0 | 3.5 ÷ 4 = 0.88 | Class I |
| | *Glytothorax major* | 1.0 | | |
| | *Glyptothorax platypogonoides* | 0.5 | | |
| | *Tor tambra* | 1.0 | | |
| 2 | *Channa gachua* | 1.0 | 8 ÷ 5 = 1.60 | Class I |
| | *Cyclocheilichthys apogon* | 2.0 | | |
| | *Hemibagrus gracilis* | 1.5 | | |
| | *Mastacembelus notophthalmus* | 1.5 | | |
| | *Poropuntius deauratus* | 2.0 | | |
| 3 | *Channa lucius* | 2.5 | 16 ÷ 7 = 2.29 | Class IIA |
| | *Clarias batrachus* | 3.5 | | |
| | *Glyptothorax major* | 1.0 | | |
| | *Hampala macrolepidota* | 2.5 | | |
| | *Hemibagrus nemurus* | 3.5 | | |
| | *Macrognathus maculatus* | 1.5 | | |
| | *Mastacembelus notophthalmus* | 1.5 | | |
| 4 | *Channa lucius* | 2.5 | 20.5 ÷ 8 = 2.56 | Class IIB |
| | *Channa striata* | 3.5 | | |
| | *Clarias batrachus* | 3.5 | | |
| | *Hemibagrus gracilis* | 1.5 | | |
| | *Mastacembelus notophthalmus* | 1.5 | | |
| | *Osteochilus hasseltii* | 3.0 | | |
| | *Rasbora sumatrana* | 2.5 | | |
| | *Trichogaster trichopterus* | 2.5 | | |
| 5 | *Channa striata* | 3.5 | 21.5 ÷ 7 = 3.07 | Class III |
| | *Hemirhamphodon pogonognathus* | 2.5 | | |
| | *Liposarcus pardalis* | 4.5 | | |
| | *Oreochromis mossambicus* | 3.5 | | |
| | *Oxyeleotris marmorata* | 3.0 | | |
| | *Oxygaster anomalura* | 2.0 | | |
| | *Rasbora sumatrana* | 2.5 | | |
| 6 | *Liposarcus pardalis* | 4.5 | 12.5 ÷ 3 = 4.17 | Class IV |
| | *Monopterus albus* | 4.0 | | |
| | *Poecilia reticulata* | 4.0 | | |

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