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Evaluating the Surrounding Physical Habitat for *Thynnichthys thynnoides*'s Spawning Areas using a Visual-Based Habitat Assessment at Rui River, Perak

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ABSTRACT

This study was conducted to evaluate the physical habitat of spawning areas for *Thynnicthys thynnoides* (*T. thynnoides)* in the Rui River, Gerik, Perak. Five sampling sites of Rui River's floodplain were chosen. Sampling was conducted between May and October 2015 by using a visual-based habitat assessment developed for Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish. This study showed that *T. thynnoides* still migrated to the upper stream of Rui River during spawning season mainly in August. Habitat assessment scoring indicated that the physical habitat structure of Rui River fell into a suboptimal category, which was most likely able to support fish populations and thus providing a suitable habitat for *T. thynnoides* during the spawning season. Conclusively, it was observed that the *T. thynnoides* population was dependent on environmental conditions.

Keywords: Fisheries, habitat, riverine, Rui River, spawning, *Thynnichthys thynnoides*

INTRODUCTION

Thynnichthys thynnoides (Bleeker 1852) or Lomah (Malay common name) was categorized on the IUCN Red List as a species of least concern (Ambak et al., 2010; Vidthayanon, 2012). However, Chong et al. (2010) classified *T. thynnoides* as being under medium threat due to several factors such as overfishing, habitat degradation

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and pollution (Dolasoh, 2014). It is anticipated that fishing pressure on *T. thynnoides* will increase as this species is selectively targeted during the spawning season ("Loam fish threatened", 2015). Although there are no high threats recorded at present, habitat degradation and overexploitation could be a concern in the future (Casazza et al., 2016). Alteration of the river habitat is becoming an alarmingly serious threat to fish populations, especially to *T. thynnoides* in the Rui River. Turbidity and sedimentation caused by tin mining, which is operated at the upper stream of the Rui River, may worsen the situation. In a recent study, the mean seston value in the Rui River was 9.97 ± 12.59 mg/L; this was significantly greater compared to before (0.25 ± 0.05 mg/L) and after (1.40 ± 0.52 mg/L) its convergence with the main stem of the Perak River (Zarul, 2013). Survival of *T. thynnoides* is mostly influenced by movement from one habitat to another. During flood inundation, *T. thynnoides* use floodplain habitats for various purposes such as shelter, breeding, nursery and feeding. The timing and duration of flooding are highly variable, and greatly affect the growth and survival of fish populations. *T. thynnoides* has been subject to special consideration as they are particularly vulnerable to changes in river ecology that is induced by human activities. This vulnerability shows that this fish is inter-connected with its habitat and surrounding land use. Consequently, the establishment and maintenance of suitable spawning habitats, and the recruitment and maturation of fish stocks, are crucial in sustaining and protecting these riverine fisheries.

Therefore, this study aims to assess physical structures of riverine habitat that influence *T. thynnoides*'s spawning activity. This study contributes to the body of knowledge regarding freshwater fish species in Malaysia. Information on the surrounding environment of *T. thynnoides* from this study benefits a conservation-conscious society and researchers generally. The research outcome from this study is expected to inform various governmental agencies, namely, the Department of Fisheries (DOF), Department of Environment (DOE), district councils, and other stakeholders regarding *T. thynnoides* species and its environmental status in the Rui River. This study provides relevant information in assisting the stakeholders' decision-making process while they constitute regulation or governance matter on the Rui River, especially for *T. thynnoides*. Inevitably, decisions made by these stakeholders directly or indirectly affect local communities that depend on fisheries as their source of income. Besides that, future generations would benefit from sustainable fisheries with a continuous effort to protect the environment, maintain source of income, and conserve life quality in the sense of the economic and aesthetic value of the Rui River. Sustainable fisheries could provide improved and sustained of the local communities' quality life.

MATERIALS AND METHODS

Site Description

This study was conducted in the Rui River, which is one of the Perak River tributaries in Hulu Perak District (Figure 1). The Rui River is about 38.48 km long, with a catchment area of 868 km^2 (Figure 1). It flows from the Banjaran Bintang watershed and heads north towards Intan before flowing southeast to Kampung Lalang (Lalang village) and finally merges with the main stem of the Perak River. The mouth of the Rui River is located about 4-km below Bersia Dam. The flow then heads to Kenering Reservoir, which is about 40 km further downstream.

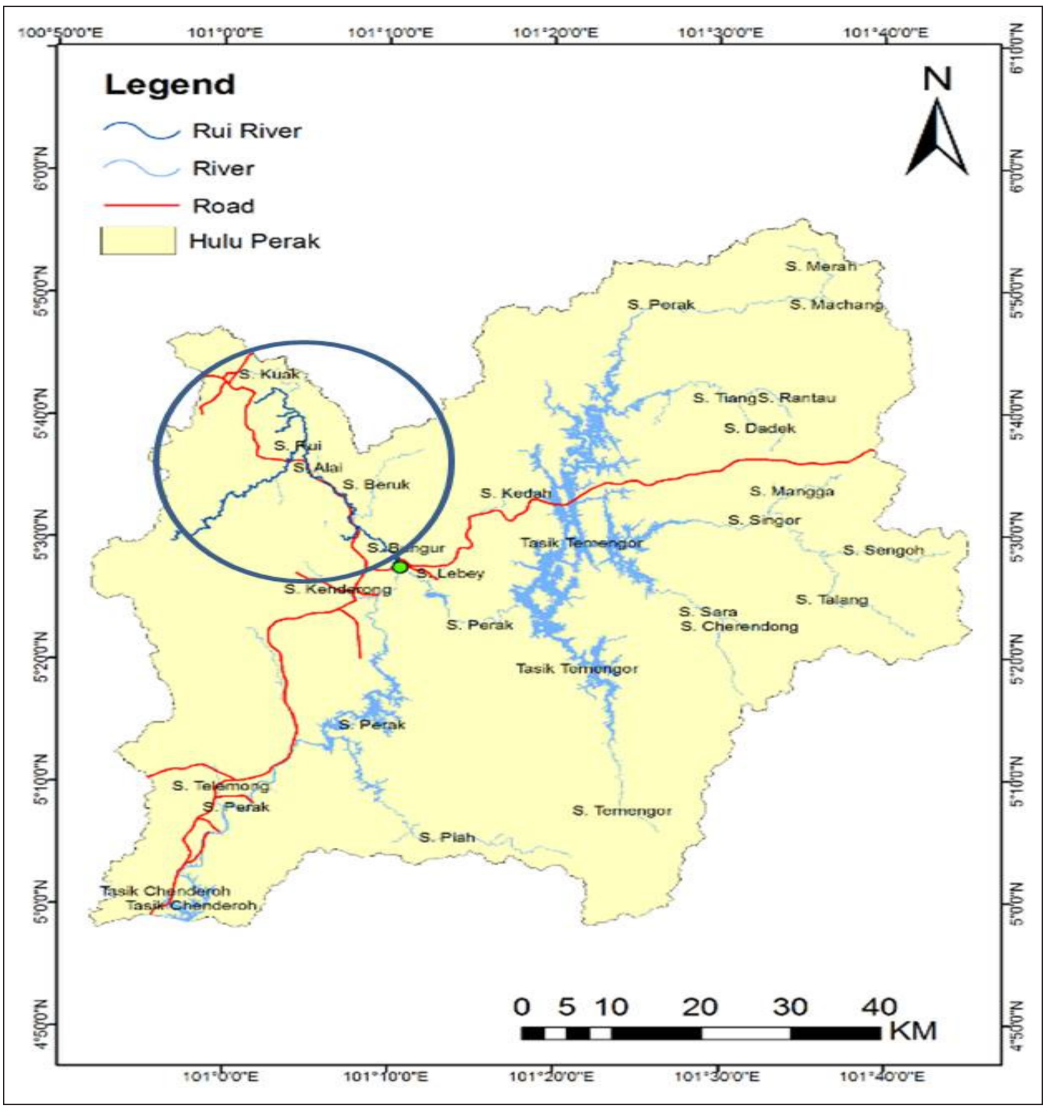

Figure 1. Location of the Rui River in Perak, Malaysia, shown in circle

The Rui River is surrounded by several forests of unknown status and certain compartments of the respective forest have been cleared for oil palm plantation. In the upstream area, a small impoundment of unknown size and status exists. The Rui River is used extensively for small scale fishing, agricultural irrigation, and recreational uses (Table 1). Some of the local villagers still use 'Lei', which is a traditional method to catch migrating fishes, such as *T. thynnoides* and *Osteochilus hasselti*, at the Rui River. A summary of each sampling point is described in Table 1.

Table 1
Summary of descriptions and coordinates of sampling points on the Rui and Perak rivers

Sites	Descriptions
S1 Kampung Alai	• Coordinate: N 05.62 1394° E 101.08 3572° • River bank substrates are mainly sand, rock, mud and silt. • Sand bar visible during low water level. • Rubber tree plantations along both sites of the river. • Locals use the river for small scale fishing and agriculture.
S2 Kampung Bharu	• Coordinate: N 05.586 96° E 101.08 48° • River bank substrates are mainly sand, rock, mud and silt. • Secondary forest along both sites of the river. • Locals use the river for small scale fishing during rainy season. • S2 was approximately 5.3 km from S1.
S3 Kampung Plang	• Coordinate: N 05.57 987° E 101.09 438° • River bank substrates are mainly sand, rock and mud. • Big boulders reduced the water path and increas the water flow. • Secondary forest along both sites of the river. • Locals used the river for small scale fishing during rainy season. • S3 was approximately 1.7 km from S2.
S4 Kampung Kerunai	• Coordinate: N 05.51 4777° E 101.13 0459° • River bank substrates are mainly sand, mud and silt. • Oil palm tree plantation along both sites of the river. • S4 was approximately 12.5 km from S3.
S5 Kuala Rui	• Coordinate: N 05.45 468° E 101.18 043° • River bank substrates are mainly sand, mud and silt. • Oil palm and rubber tree plantations along both sites of the river. • Dataran loma with concrete river bank located here. • Locals used the river for fishing during rainy season. • S5 was approximately 13.5 km from S4.
S6 Kampung Perah	• Coordinate: N 05.44435° E 101.17 500° • River bank substrates are mainly sand, mud and silt. • Rubber tree plantation along both sites of the river. • Locals used the river for fishing during rainy season. • Two small jetties used by local fisherman to land fish. • Hectic boat transportation from dawn to dusk. • S6 was approximately 2.55 km from S5.
S7 Air Ganda	• Coordinate: N 05.44 966° E101.19 086° • River bank substrates are mainly sand and mud. • Oil palm and rubber tree plantations along both sites of the river.

Table 1 *(continue)*

Sites	Descriptions
S7 Air Ganda	• Temenggor Reservoir formed here as the catchment area became extensive. Locals used the river for fishing. • S7 was approximately 16.45 km from S6.
S8 Bersia	• Coordinate: N 05.449332° E 101.189682° • River bank substrates are mainly sand and mud. • Secondary forest along both sites of the river. • Locals used the river for fishing. • S5 was approximately 1.5 km from S5. • This station was use as a reference station.

Habitat Assessment

For this study, a visual-based habitat assessment was used based on the modified parameter checklist from the Rapid Biological Assessment Protocol (Barbour et al., 1999). For streams, an encompassing approach to assessing the structure of the habitat, which includes an evaluation of the variety and quality of the substrate, channel morphology, bank structure, and riparian vegetation. Habitat parameters pertinent to the assessment of habitat quality cover those that characterize the stream in to a "micro scale" habitat (e.g., estimation of embeddedness), the "macro scale" features (e.g., channel morphology), and the riparian and bank structure features that are most often influential in affecting the other parameters. Measurements of these parameters or characteristics serve to stratify and place streams into distinct classifications.

The primary data collection was conducted from May 2015 to October 2015. The selection of five sampling points (from S1 to S5) for this assessment was based on the spawning areas of *T. thynnoides* (N = 5 sampling points × 3 replicates × 3 observers = 45 samples/river). The location of this fish in May 2015 was believed to be further downstream of Perak River, and the fish were spotted moving upstream from S7 and S8 to S5 in August (Mohamad Radhi, 2017). In September and October 2015, *T. thynnoides* started to migrate further to the upper stream of the Rui River at S2 and S3 (Figure 2).

Based on the Rapid Biological Assessment Protocol guideline (Barbour et al., 1999), this habitat assessment consists of 10 parameters, which are (1) substrate, (2) habitat complexity, (3) velocity-depth combination, (4) bank stability, (5) bank conservation, (6) vegetation cover, (7) vegetation diversity, (8) intensity of human activities, (9) water cognition, and (10) riverside land use. For parameters one to seven (as previously listed), each parameter was evaluated at four different levels of condition: optimal (score of 16-20), sub-optimal (score of 11-15), marginal (score 6-10), and poor (score of 1-5), according to the guideline. For parameters eight to ten, each bank was evaluated separately from 0 to 10, and the scores for both right and left banks were then cumulated (refer Barbour et. al., 1999). Scores increase as habitat quality increases (refer to Appendix A). The sum of

10 parameter scores was calculated then the habitat assessment scores were obtained by using the formula for Physical Characterisation score (Barbour et al., 1999):

$$\text{Total Physical Characterisation Score} = \frac{\text{(Sum score of ten parametes)}}{10} \quad (1)$$

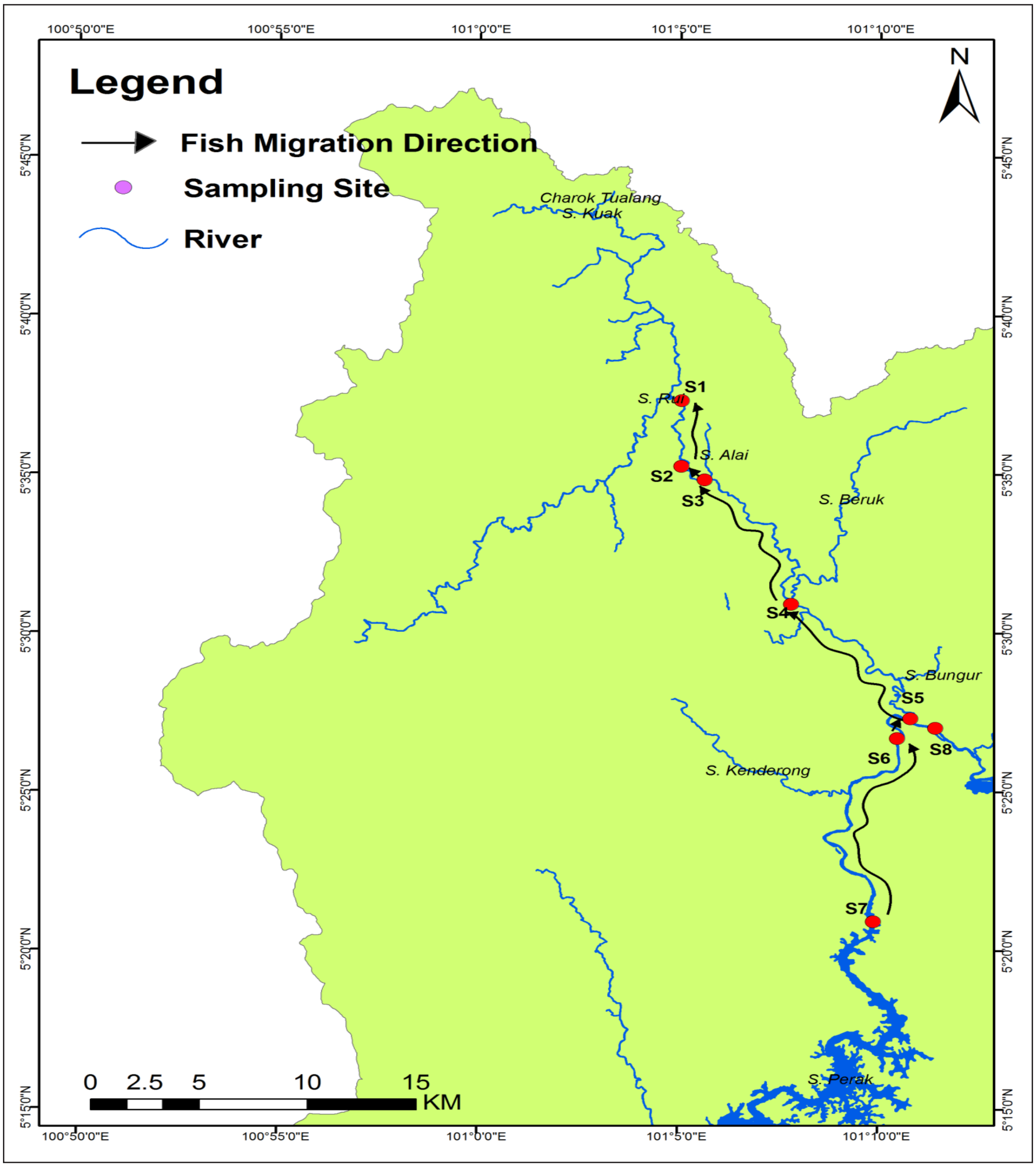

Figure 2. Migration movement of *Thynnicthys thynnoides* towards spawning areas during spawning season (May to October 2015). Spawning areas are predicted at S2 and S3 as no migration was observed at S1 during spawning season

The total scores were then totaled and compared to a reference condition to provide a final habitat total scoring. A brief set of decision criteria is given for each parameter corresponding to each of the four categories reflecting a continuum of conditions (optimal, suboptimal, marginal, and poor) (Table 2). All calculation and procedures for habitat assessment followed Rapid Bioassessment Protocols (Barbour et al., 1999).

Table 2
Integrated scores for habitat suitability conditions

Condition Categories	Total Scoring
Optimal	16-20
Suboptimal	11-15
Marginal	6-10
Poor	0–5

RESULTS AND DISCUSSION

This study revealed that the habitat along the Rui River was in good condition. The habitat score ranged from 11.6 to 18.8. Sampling sites of S2, S3, and S4 were categorized as optimal while S1 and S5 were considered as suboptimal (Table 3).

Station 2 had the highest average scores for condition category (18.8) as compared to other sampling sites (Table 3). Station 2 supported favorable substrate for epifaunal colonization and fish cover because S2 was located upstream of the Rui River and there were only local housing areas established nearby, especially at the riparian zones. The intact forest of the river habitat protects the river from exposure to direct light and shades the stream (Rohasliney & Jackson, 2008; Rohasliney & Jackson, 2009; Rohasliney, 2010). This is because riparian forests provide a wide range of key ecosystem function and services (da Silva et al., 2017) that can serve the needs of *T. thynnoides* during spawning season and its juvenile at the nursery grounds. The stream channel consists of a mixture of substrate materials, gravel and sand, root mats, and submerged vegetation. This area was also full of deep pools with a distinctive stream. Station 3 was categorized as optimal, which had similar habitat characteristics with S2. Both sites had deeper pools and strong water flow after the stream section. There were minor sediment depositions in the area. An optimized river has little or no enlargement of islands or point bars, and less than 5% of the bottom is affected by the river. Water channel flow status at S2 and S3 districts were considered good, where water reached the base of both lower banks, and only a minimal amount of channel substrates were exposed. The mixture of four different velocities (slow-deep, slow-shallow, fast-deep and fast-shallow) were observed at the sampling sites. Channel alterations were observed at S2 and S3 with normal pattern streams and the bends in the area were stable. The surrounding areas were still protected by more than 90% of the stream bank surfaces, and an immediate riparian zone was covered by native vegetation;

including trees, understory shrubs, or woody macrophytes. Thus, S2 and S3 theoretically were considered to be the most attainable habitat for fish spawning areas and nursery grounds for the juveniles.

S1 and S5 were categorized as suboptimal (11-15) (Table 3). The average habitat condition in S1 and S5 areas scored 12.0 and 11.6, respectively. The area for S1 was mainly dominated by agricultural activity, and S5 was located near a small-town area where schools, shops, and oil palm plantations were. The substrate was either disturbed or removed. Mud or sand could be observed in the bottom of the river with no root mat submerged vegetation attached. The shallow pools and deep pools were found in similar numbers. A previous channelization was present in the areas of bridge abutments. The most obvious establishment built at S5 was the Dataran Loma (Loma Square). This area was built to facilitate the locals and outsiders capture *T. thynnoides*. The pickled fish (ikan pekasam) traders were found at S5 and bought captured *T. thynnoides* in bulk during spawning season. S5 may not be the spawning areas for the fish, but S5 is the path for migration towards its spawning areas. Conservation and preservation of this stream channel from habitat degradation are crucial.

Urbanization in this area had caused river bank erosion and the accumulation of sediment in the stream. A major flood in 2014 was also one factor that caused significant erosion at S5. The fast-current flow from the upper stream of the Rui River and overflowed water from the main stem (Perak River) entered S5 and caused erosion. Sediment deposition of both sampling points showed that the river bottom was affected by a mixture of gravel, sand, and fine sediment form bars. The local fishermen stated that they had difficulty maneuvering their boats to S5 during intermediate season, as the sediment deposition lowers the water level. Only a few tracks remained accessible to S5 from the main stem (Perak River). Similar issues occured in Morobe, Papua New Guinea, as there were discernible changes in water quality at Nauti due to a mining operation upstream of the Watut River. Suspended solids were reported to have increased about 100-fold in Watut River throughout the 16 years of observation (Roche & Mudd, 2014).

S4 revealed an optimal condition with a score of 15.3 (Table 3).

Table 3
Condition category of habitat assessment in the Rui River

Sampling points	Total score of habitat parameter	Condition score	Condition category	Average condition category for Rui River
S1	120	12.0	Suboptimal	Suboptimal (15.3)
S2	188	18.8	Optimal	
S3	186	18.6	Optimal	
S4	153	15.3	Optimal	
S5	116	11.6	Suboptimal	

This sampling point was an area of local housing and oil palm plantation within the riparian zone (Figure 3).

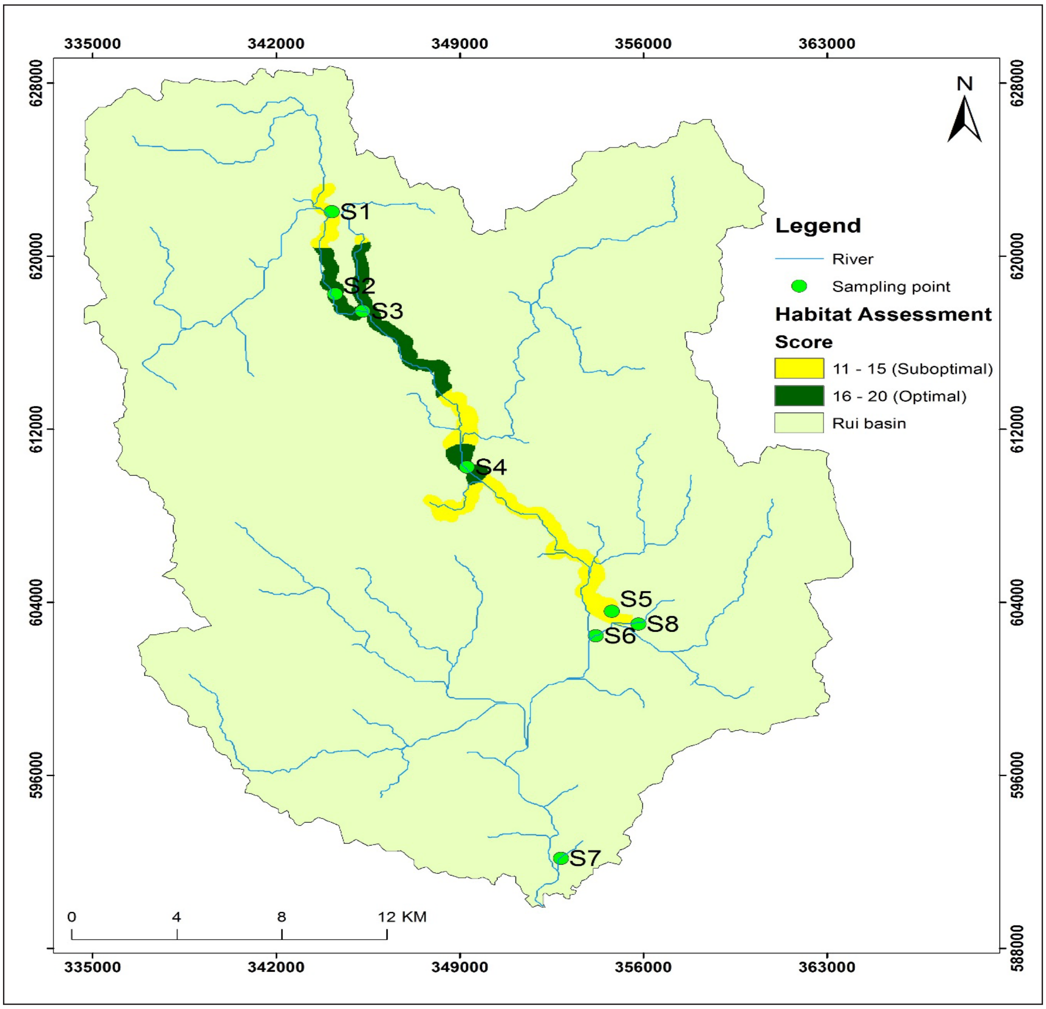

Figure 3. Digitized habitat assessment classification at the Rui River, Gerik, Perak

Deposits of fine materials increased the bar development and less than 5% of the bottom changed frequently. As for the channel flow status, there were different velocities with small streams. The channel stream had been routed to build a bridge, but the bank seemed to be stable with vegetation cover and trees. For vegetative protection, 90% of the stream bank surfaces were estimated to be covered by vegetation, and it was obvious that disruption occurred. The width of the riparian zone was observed to be more than 18 meters, and human activities had little impact on the zone. Statistically, the habitat condition scores of S2 and S3 (upper stream) differed from the score of S5 (downstream of the Rui River). Results of Kruskal-Wallis analysis showed that the score differed among sampling sites [r2/n (4, N = 273 = 538,7236, $P < 0.05$]. S4 had the highest mean rank of 11,051, as compared to other sampling points. The lowest mean ranks with a significant difference value of U = 305.5, $P < 0.05$, was S3 (rank sum = 1995.5) and S1 (rank sum = 1085.5). The highest mean rank with a significant difference value of U = 3879.5, $P < 0.05$, was between S5 (rank sum = 5285.5) and S4 (rank sum = 6960.5).

The habitat result for this study is supported by Chong et al. (2010) in their evaluation on habitat status for *T. thynnoides*. The conservation status provided in their study included habitat degradation, overharvesting, and pollution. From this study, the habitat in the Rui River is potentially at threat from the existing sources of pollution, namely tin mining and sand mining, at the upper stream of the river. Based on observations, the tailings were spotted along the Rui River, deposited on river banks and sand banks. The impact from tin mining, such as heavy sedimentation, sand bank formation, and changes in water quality, also occur at other metal mining sites such as Selangor River, Selangor (Nurhidayu & Azhar, 2015), Chini Lake, Pahang (Ahmad et al., 2008), Natchez Trace Parkway, Mississippi, USA (Rohasliney & Jackson, 2007), Morobe, Papua New Guinea (Roche & Mudd, 2014), and Tanshui River, Taiwan (Young et al., 2014). This situation, if not mitigated well by stakeholders, could greatly affect the population and spawning area of *T. thynnoides* species at the Rui River. Based on the assessment of this study, S2 and S3 are the most suitable spawning sites for *T. thynnoides*, as they have high habitat scores (Figure 3). The existing cover from trees, and natural channels with abundant river bank vegetation, may promote spawning activity for the species.

CONCLUSION

In conclusion, it is apparent that habitat degradation due to land use and water pollution inhibit replenishment of the fish species that inhabit the Rui River. Being a unique fish species, which migrates from downstream to upper stream to locate a suitable spawning area, *T. thynnoides* needs the best attainable habitat in order to survive, grow and reproduce. This study revealed that the habitat along the Rui River is in good condition with overall suboptimal status from the physical habitat assessment score. Thus, the Rui River provides suitable habitat for a spawning site for *T. thynnoides*.

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