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Habitat Preference Assessment of *Capoeta razii* (Teleostei: Cyprinidae) in Klarood River, Mazandaran Province, Iran

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ABSTRACT

Habitat assessment is the most important step in environmental decisions. One of the ways to assess habitat quality is to use habitat suitability for fish species. So, this study was conducted in Klarood River, one of the important tributaries of Babolrood River in Mazandaran Province, north of Iran to evaluate the habitat quality for *Capoeta razii*. At first, a site with the least anthropogenic influences was selected on the river. Then the fish was caught by electrofishing device aggregate at 100 points. At each point where the fish was caught, environmental parameters such as depth, water velocity, type of biotic and abiotic substrate were also measured. The results showed that the species prefers water velocity of 16-30 cm s^{-1} and depth of 16-115 cm. Moreover, suitable abiotic and biotic substrates were Macrolithal, Mesolithal and Microlithal" as well as LPTP (Live parts of terrestrial plants) respectively. Generally, the results of this study showed the appropriate function of the model in assessing the habitat suitability of this species and it can be used as a guide for quantitative assessment of habitat as well as recognizing the behavioral characteristics of the studied species.

Keywords: Habitat preference, Freshwater management; Ecology, Biodiversity conservation, Fish.
Article type: Research Article.

INTRODUCTION

The hydrological and geomorphological conditions of rivers are constantly changing, providing a variety of habitats for fish and other aquatic life. These habitats provide the biological and non-biological conditions required for the survival of the species. Based on behavioral, physiological, and morphological adaptations, river-dwelling fish prefer specific habitats that are important for the survival and stability of individuals and populations. Nowadays, many fish species are under the stress of habitat change as well as human interventions (Tilman *et al.* 2001). Habitat quality assessment is one of the most important actions in environmental management (Vinagre *et al*. 2006). Various indicators can be used to manage and evaluate water bodies. In fact, the community of fishes and their presence can better describe the biological conditions (Oberdorff *et al.* 2001). Decreasing the quantity and quality of habitat is an important factor in reducing aquatic organisms and threatens their health. On the other hand, how fish populations respond to environmental alterations can change the frequency and distribution of the population (Gilpin & Soule 1986). Therefore, understanding the relationships between different physical, hydraulic, and chemical conditions of the habitat is essential for the reconstruction of altered river ecosystems (Lee *et al.* 2010). Each species and even each stage of species life prefer a particular habitat, and this habitat for fish is a place that meets needs such as adequate oxygen, optimal temperature, adequate food, and reduced prey

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(Thurow 1997; Fazli *et al.* 2018). In terms of habitat quality, the density of organisms indicates the potential and capacity of the habitat to maintain them. Habitat suitability for specific fish species is assessed using quantitative methods; one of them is the use of habitat suitability index models based on the concepts of use, availability and selection or preference (Johnston & Slaney 1996). Therefore, this study aimed to investigate habitat preferences of *Capoeta razii* in Klarood River in the southern Caspian Sea basin which has not been done so far.

MATERIALS AND METHODS

This study was done in Klarood River (Fig. 1), one of the important tributaries of Babolrood River in Mazandaran Province, north of Iran. At First, the ecological zone of rivers was identified using available information and documents (Mostafavi *et al.* 2015, 2019) as well as the experiences of authors by multiple sampling in previous. Then, we selected a section with low pressures and high diversity in micro and meso-habitats (Table 1).

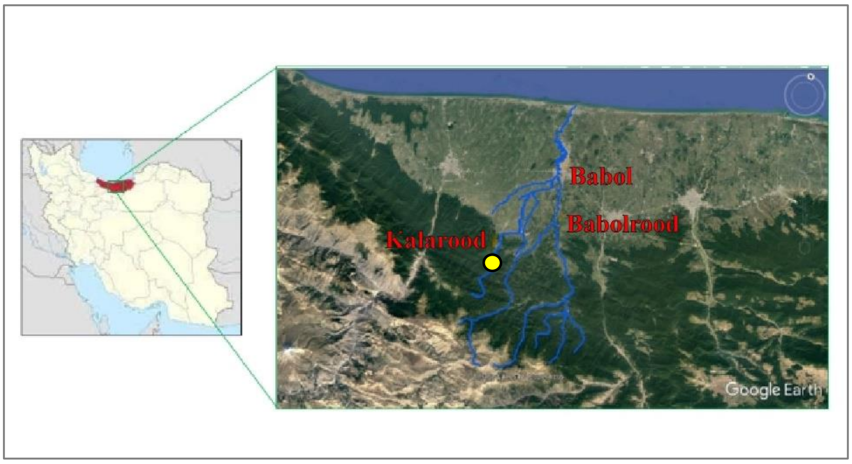


Fig. 1. Sampling site location (yellow circle) on Klarood River (a branch of Babolrood River in Mazandaran Province, Iran).

Table 1. Environmental characters of sampling site.

Station	Habitat type	Coordinate (x,y)	Elevation (m)	Slope (%)	Wetted width (m)	Maximum width (m)
Klarood	Pool-riffle-run	36°20'42.93"N 53°13'29.12"E	435	2.9	5.9	30

Abiotic and biotic data collection

Abiotic and biotic data were recorded based on the REFORM protocol and transect method (Poppe *et al.* 2012). All transects were selected at specific intervals in the sampling section. Then, in each transect, the features including flow velocity, depth, abiotic and biotic substrates were measured. Table 2 depicts the abiotic and biotic substrate classifications with explanation.

Fish data collection

Fish were sampled by electrofishing device aggregate in different random points according to Parasiewicz (2007) to cover all microhabitat types. Afterward, in each sampling point, the abundance of *C. razii* was counted separately. Moreover, in each point, all above-mentioned environmental variables (i.e. abiotic and biotic data) were measured similarly.

Data analysis

Available habitat and preference curves were developed for each microhabitat variable using frequency-of-use graphs, relevant to each age-class of each key species as follow (Melcher & Schmutz, 2010):

$$FUG_i = \frac{f_i}{f\left[\max\right]}$$

where f_i is class frequency and $f\left[\max\right]$ is maximum class frequency. For preference curves we used the Ivlev (1961) index as follow:

$$\text{Preference} = \frac{U}{A}$$

where U is class frequency of habitat used and A is the class frequency of habitat available.

Table 2. Abiotic and biotic Substrates classification according to Poppe *et al.* (2012).

Type	Platform name for the database	Floor Name	Abbreviation	Explanation	Grain size (mm)
Abiotic	Mega/ Macrolithal	Piece	Block	Dominated by large pieces of boulders, boulders	200>
	Mesolithal	Rubble	Cobble	Most with fist-sized rubble with a variable percentage of sand	200 -60>
	Microlithal	Coarse sand	Coarse-gravel	Predominantly with sandstones the size of a pigeon's egg to a fist with a variable percentage of fine sand	60 -20>
	Akal	Fine sand	Fine-gravel	Dominated by fine sand	20 -2>
	Psammal	Sand	Sand	Dominated by sand	2 -0.006>
	Argyllal	silty	Loam	Dominant with silt, loam, clay (inorganic)	200>
	Technolithal	artificial	Techno	Artificial blocks used to stabilize the channel in the damaged sections.	
Biotic	Xylal	Tree	Wood	Tree trunk, dead tree, branch, root	
	CPOM	Coarse organic particles	Coarse particulate organic matter	Sedimentation of particles of hard organic matter such as fallen leaves	
	FPOM	Fine organic particles	Fine particulate organic matter	Sedimentation of light organic matter particles such as mud and sludge (organic)	
	Algae	Algae	Algae	Stringy algae or prefixes	
	Sub_ macrophytes	Macrophytes immersed in water	Submerged macrophytes	Macrophytes immersed in water	
	Em_ macrophytes	Macrophytes outside in water	Emergent macrophytes	Extrinsic macrophytes in water, such as Louis (Typha), Carex, and Phragmites	
	LPTP	Live parts of terrestrial plants	Living parts of terrestrial plants	Living roots, floating coastal vegetation	

RESULTS

Table 3 depicts the diversity of environmental characteristics measured at sampled site.

Table 3. Environmental characteristics of the sampled points at Klarood site.

Site	Flow velocity (cm s^{-1})	Depth (cm)	Biotic substrate	Abiotic substrate
	Average	Average	Dominant substrate Amount(%)	Dominant substrate Amount(%)
Klarood	0-1.11 0.27	115-0 32	"Algae" 30.6	"Microlithal and Mesolithal" 64.9

According to Fig. 2, the maximum available river velocity is between 0 and 15 cm s^{-1} while *C. razii* prefers 16-30.

Fig. 3 exhibits that the maximum available river depth is between 0-115 cm. The species prefers depths of 16-60 and 75-115.

Fig. 4 illustrates that the most abiotic substrates were Microlithal and Mesolithal. In general, Macrolithal, Mesolithal and Microlithal are more preferred by species.

Fig. 5 reveals that the largest available biotic substrate was “Algae”, while the studied species preferred LPTP.

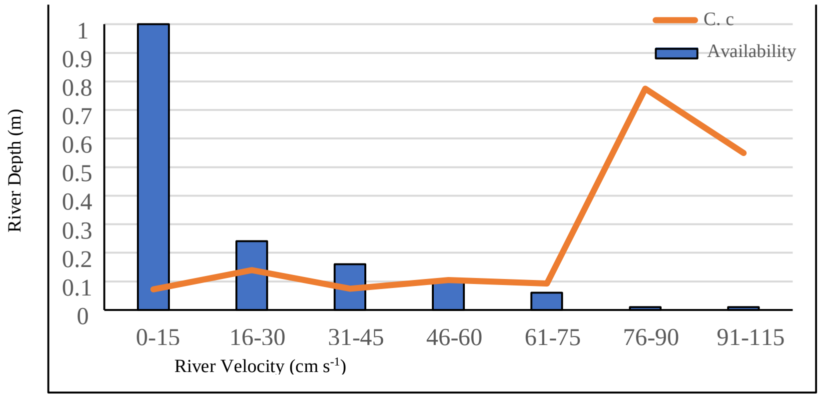


Fig. 2. Available habitat and species preference in relation to velocity variable (cm s^{-1}); C. c: *Capoetta capoetta.*

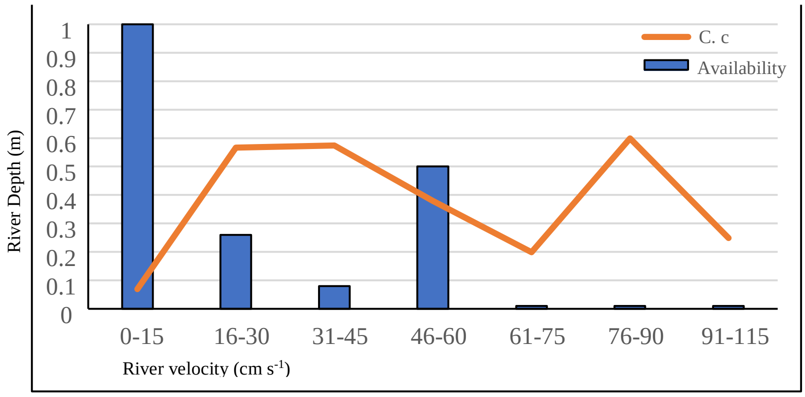


Fig. 3. Available and preferred species habitat in relation to depth variable (cm s^{-1}); C. c: *Capoetta capoetta.*

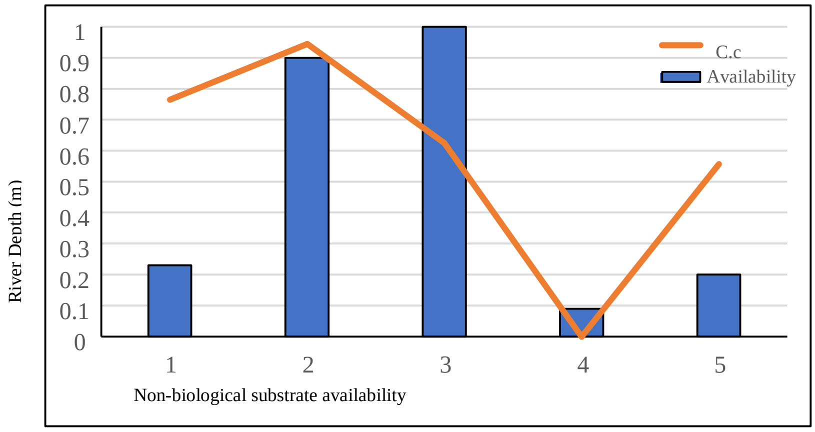


Fig. 4. Available and preferential habitat of black fish species in relation to non-biological substrate variables: (i) Macrolithal; (ii) Mesolithal; (iii) Microlithal; (iv) Akal; (v) Argyllal; C. c: *Capoetta capoetta.*

DISCUSSION

Habitat diversity in Klarood River

The complex structure of the habitat is provided by the close interaction between the river channel and the surrounding environment. In addition, due to the interaction between the ecosystem community and its surrounding landscape, they are highly integrated (Schmutz *et al.* 2000; Mostafavi *et al.* 2015). Some important factors in the formation of habitats and their function are as follows:

Coastal vegetation

Coastal plants perform many ecological processes in the river corridor. As a matter of fact, they balance habitat/cover for aquatic and terrestrial animals by influencing the temperature and light regime, producing organic debris (i.e. dead leaves and wood), routing sediment and water, constructing physical habitats on several scales and providing substrate for biological activities. Coastal plants are used as hard elements in drowning periods; thereby they influence hydrological and morphological processes that form the river landscape (Maridet *et al.* 1998; Growns *et al*. 2003). Such structure which can cause the above functions has been observed in the Klarood River (Fig. 6).

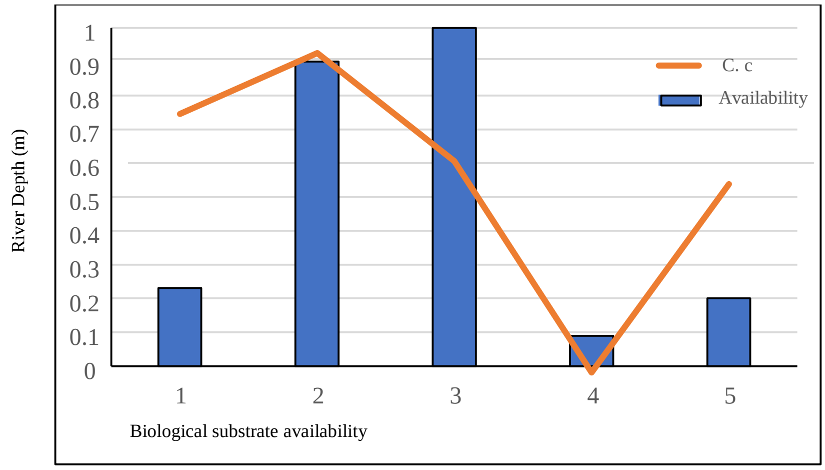


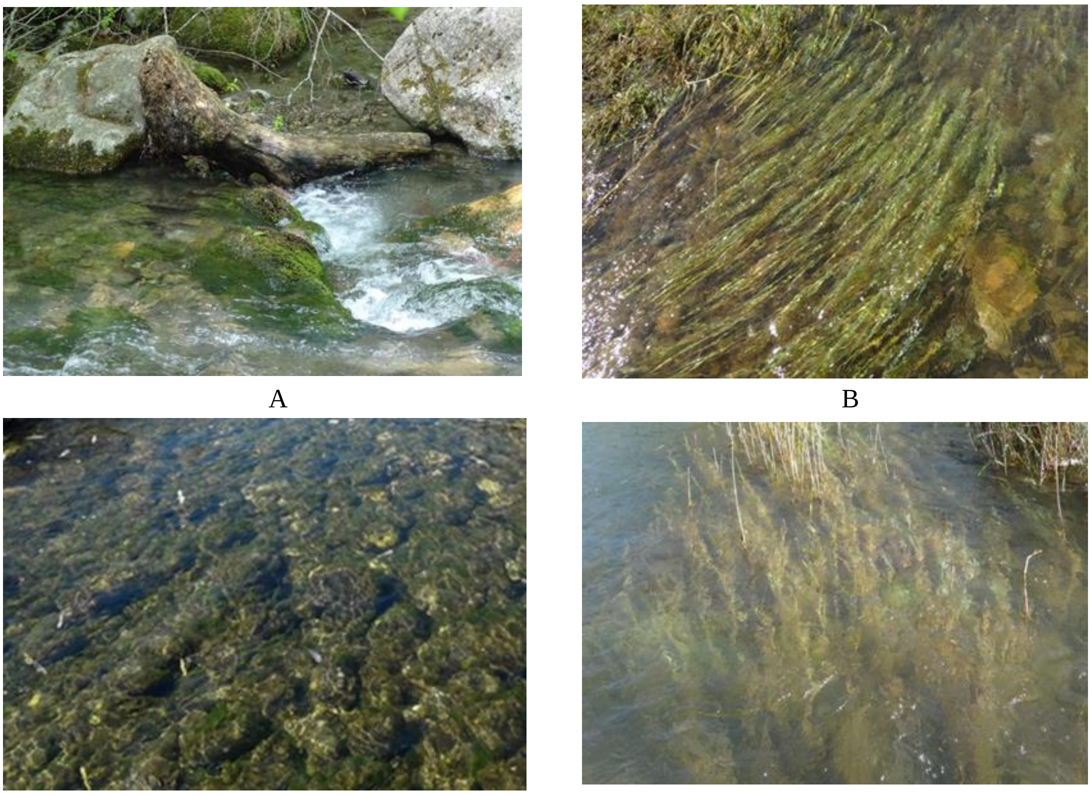
Fig. 5. Available habitat and species preference in relation to the substrate variable: (i) Algae; (ii) Sub_macrophytes; (iii) LPTP; (iv) Xylal; (v) CPOM; (vi) FPOM; C. c: *Capoetta capoetta.*

A B

Fig. 6. Coastal vegetation of the Klarood River at sampling site (A: Aerial photo; B: photo from location)

Aquatic vegetation

Aquatic plants, both macro and micro, with their organic and inorganic compositions, are considered as one of the components of the food chain of river ecosystems. Aquatic plants also provide the nutrients needed by other ecosystem organisms such as protozoa, rotifers, crustaceans, aquatic insects and fish by absorbing water nutrients. In addition, rooted macrophytes are able to absorb nutrients, especially phosphorus from sediments of water sources and affect the balance of aquatic ecosystems. They can also alter chemical water conditions such as acidity. Aquatic plants are also effective in eliminating water pollution like heavy metals (Hughes *et al.* 1998; Gebrekiros 2016). The plants are also capable of reducing the water velocity and elevating the diversity of habitats by depositing suspended matters, as well as providing the necessary shelter and environment for a wide range of aquatic animals. In addition, they can create a favorable environment for spawning and fish farming, and by producing oxygen in the aquatic environment. Furthermore, they play an effective role in river ecosystem life, especially for aquatic survival (Paraswiz 2007). Diverse cover of aquatic plants was observed in the Klarood River (Fig. 7).



A B

C D

Fig. 7. Aquatic vegetation (A, B, C and D) of the Klarood River at sampling sites (Algal coverage on the stony bed named to diameter).

Lateral or transverse continuity of the river

Lateral habitats or branches that generally include low-velocity water areas at the edge of the canal are very important for fish less than one-year-old (Bowee et *al.* 1994; Fig. 8).

Physical factors of habitat

Geomorphological parameters such as altitude, discharge, channel depth and water velocity have a greater impact than water physicochemical variables in predicting the increase in richness and diversity of native fish as well as alterations in the composition of the fish community along the downstream (Beecher *et al.* 2002; Bain & Jia 2012). The abiotic substrates (Fig. 9) are also the important variables in creating a living space in a habitat that provides the possibility of occupation, movement, reproduction, shelter and food supply for living organisms (Ahmadi-Nedushan *et al.* 2006). In addition, according to the diversity of substrate in the Klarood River, these services are expected for this ecosystem and is consistent with study of Mostafavi *et al.* (2015, 2019).

Fig. 8. Lateral or transverse continuity of the Klarood River at sampling site.

All of abovementioned factors are well observed in Klarood River, indicating that this river ecosystem can be highly functional and have the desired species diversity that was the case in this study. Therefore, habitats should be protected in rivers to preserve the biodiversity of species, because the habitat requirements of species at different stages of the life cycle are completely different. Fish move between three major habitats: feeding, overwintering, and spawning. Spawning, feeding and resting areas and self-preservation as functional units are connected to the environment in various ways and also the complex structure of the habitat is provided by the close interaction between the river channel and the surrounding environment.

A

B C D

Fig. 9. Abiotic substrates of the Klarood River at sampling site. Stones with different sizes in diameter (A, B, C and D).

Habitat Suitability of Studied Species

Habitat preference is a set of physiological and behavioral ecological functions of a species (Rosenfeld *et al.* 2000). Habitat preference curves for a species can be used as a management tool for a particular river or part of a catchment. Habitat requirements for fish are physical features of the environment that are essential for the sustainability of individuals and populations of a species (Rosenfeld *et al.* 2000). Physical factors such as water depth, water flow velocity, cover and bed composition have more important effects in comparison with chemical factors such as pH, dissolved oxygen, nutrients, along with organic and inorganic pollutants in determining the presence and composition of riverine species (Dalkiran *et al.* 2006). In other words, the more diverse habitats include the wider range of species than the simple habitats (Kramer 1983). According to the results, the studied species prefers specific habitats (i.e. studied variable) among all diverse habitats. However, it is essential to mention that in the selection of habitat by a species, of course, environmental factors are not considered separately, so that, all related environmental factors are considered. It can be claimed that the desirability of a factor, to some extent, can compensate for unfavorable factors associated with it and encourage the species to occupy such areas (Pont *et al.* 2005). Finally, as found out, Klarood River is one of the important tributaries of Babolrood River, which is less affected by human activities than other tributaries and the main canal. Therefore, it exhibits a favorable habitat diversity, which is well reflected in the habitat preferences of the studied species.

CONCLUSION

The results of this study represented an appropriate guide for quantitative assessment of habitat as well as identifying the behavioral characteristics of the studied species.

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