

ORIGINAL ARTICLE

Habitat suitability assessment of *Luciobarbus capito* (Güldenstädt, 1773) of ShahrBijar River, the South Caspian Sea basin, Iran

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Abstract

Knowledge of habitat requirements of aquatic animals plays an important role in fisheries and protection programs of aquatic ecosystems. Hence, this study was conducted to investigate the suitability indices of habitat use and habitat suitability index (HSI) of *Luciobarbus capito* in its distribution range in Shahr Bijar River. A number of environmental variables, including elevation, water depth, river width, river slope, velocity, substrate type, average diameter of bed stone, riparian vegetation type, and the relative abundance of *L. capito* at 13 stations and three replications from downstream to upstream, were examined during September 2013. The results showed that *L. capito* mostly preferred upper stretches of the river with higher velocity, middle depth, lower width, and bedrock substrate (i.e., beds with boulder cover and grasslands), and its residential area was riparian compared with the available ranges. Habitat selectivity index for *L. capito* showed that the elevation is 130-220m, water depth 55-89cm, channel width less than 12m, channel slope 0.5-2.3%, water velocity less than 2m.s⁻¹, bedrock substrate, average diameter of bed stone larger than 35-75cm. The presence of these conditions, with an HSI of 0.798, indicates that the ShahrBijar River is an excellent habitat for *L. capito*.

Keywords: Habitat selection, Suitability index, *Luciobarbus capito*, ShahrBijar River

INTRODUCTION

Changes in hydrological features of a riverine ecosystem due to anthropogenic activities, such as pollution and habitat destruction, can negatively affect the survival, reproductive success, and growth rates of aquatic organisms, particularly fish species (Rosenfeld 2003; Ahmadi-Nedushan et al. 2006; Hassan et al. 2025; Rudneva et al. 2025; Arkhi et al. 2026), thereby threatening their survival. Therefore, as a first step toward assessing the impact of human activity on riverine ecosystems and protecting their biodiversity, understanding the habitat requirements of their organisms is crucial (Vinagre et al. 2006; Valenzuela Gomez et al. 2026; Ouattara et al. 2026). Hence, Habitat Suitability Indices (HSI) of an aquatic species are one of the primary themes in river ecology to predict the effect of human manipulation due to the alteration of the riverine hydrological features (Guay et al. 2000). Hydrological characteristics of a river play an important role in fish distribution, affecting their metabolism rate, feeding, and behavior (Jowett et al. 2007). Habitat selection means that a fish species is more abundant in a specific suitable habitat (Rosenfeld 2003). Many environmental factors affect fish in selecting their preferred habitat (Bovee 1982).

Nevertheless, most models for studying the habitat suitability of a riverine species use hydrological parameters such as depth, current velocity, river width, riverbed type, river slope, elevation, and river vegetation as important factors (Orth 1988).

Eighteen species of *Barbus* fishes are found in Iran, and among them, the species of *Luciobarbus capito* is from the cyprinid family, native to the Caspian Sea basin, and has two forms: freshwater resident and migratory, which is a resident of the brackish water of the Caspian Sea and enters rivers for reproduction (Eagderi et al. 2013; Eagderi et al. 2022; Sayyadzadeh et al. 2024). This species has a fusiform body, relatively large scales, an inferior mouth, and two pairs of barbels (Fig. 1). Berg (1948-1949) refers to specimens from the Caspian Sea basin as *L. capito*, but Naseka & Bogutskaya (2009) recognize this subspecies as a valid species. Asadi et al. (2016) and Zamani-Faradonbeh et al. (2014) studied the habitat suitability of *Barbus lacerata* in the Sefid and Taleghan rivers in Guilan and Alborz provinces, respectively. A study predicted the impacts of climate change on the distribution of *L. capito* in rivers in the southern part of the Caspian Sea basin. The models indicated that this species is likely to experience a



Fig.1. *Luciobarbus capito* caught from ShahrBijar River.

decline in habitat suitability in the future under both optimistic and pessimistic scenarios for 2050 and 2080 (Farzi et al. 2023). In water resources management, assessing the occurrence and distribution of fish species is of considerable importance, as a high occurrence and widespread distribution at a given location indicate favorable habitat suitability for that species. This relationship has also been highlighted in numerous studies on inland freshwater fish populations (Eagderi et al. 2021; Mouludi-Saleh et al. 2022, 2024).

Little detailed information is available regarding the biology and ecology of *L. capito*, particularly its habitat use, and habitat suitability indices are unknown. Therefore, this study was conducted to assess the biological characteristics, habitat use, and habitat suitability indices of *L. capito* with respect to habitat availability in the ShahrBijar River, a branch of the Sefid River in the Southern Caspian Sea basin.

MATERIALS AND METHODS

Study area: ShahrBijar River is a branch of the Sefidrud River in the Southern Caspian Sea basin and originates from the Alborz Mountains. The approximate length of this river is 25km with an average slope of 6.1% (Fig. 2).

Sampling: For this study, we sampled fish and habitat variables in autumn 2014 under base-flow conditions. Thirteen sampling stations were located across the ShahrBijar River (Guilan Province, north of Iran) (Fig. 2). Elevation (m) and geographic coordinates were recorded for each station to ± 10 m using a GPS (Global Positioning System; Garmin) according to Torgersen & Close (2004). The river and the sampling point locations were mapped using ArcGIS 9.3 (Fig. 2). Fish were sampled in 10-15m stretches of the river using a backpack electrofishing device (Samus

Mp750, 45cm diameter, aluminum ring anode) in the downstream–upstream direction using upstream and downstream stop-nets of 0.2cm mesh. For sampling, a one-removal method with a similar catch-per-unit effort strategy was employed (Klaar et al. 2004). Fish specimens were collected from each station for 30min, anesthetized in clove powder solution (1g.l^{-1}), identified according to Coad (2015), counted, photographed, and finally placed in slow-moving water along the river bank to recover and return to the river. Since no comparable study on microhabitat use of this species was available, only the specimens larger than 40mm were selected and counted in each station for further analysis, because the habitat use of fishes in lotic systems can be strongly affected by ontogeny (Copp & Vilizzi 2004; Gillette et al. 2006).

Habitat data: Since there is limited or no knowledge available on the studied species, the environmental variables were selected according to the results of other studies conducted on other fishes (Chuang et al. 2006; Riffart et al. 2009; Tabatabaei et al. 2015). The habitat data were measured immediately after sampling (Yu & Lee 2002). The measured variables included water depth (cm), river width (m), Elevation (m), river slope (%), velocity (m.s^{-1}), substrate type (substrate index), average diameter of bed stone (cm), and riparian vegetation type.

Elevation of sampling sites was recorded by GPS (Garmin). The mean depth (cm) of each station was estimated by measuring depth at 20 random points across the sampling site using a measuring bar, considering their average as the river depth (Lotfi 2012). The mean width of the river (m) was measured using a tape measure by measuring the upper, middle, and lower sections of each sampling station, considering their average as the river width. Surface velocity (m.s^{-1}) was estimated using a simple float

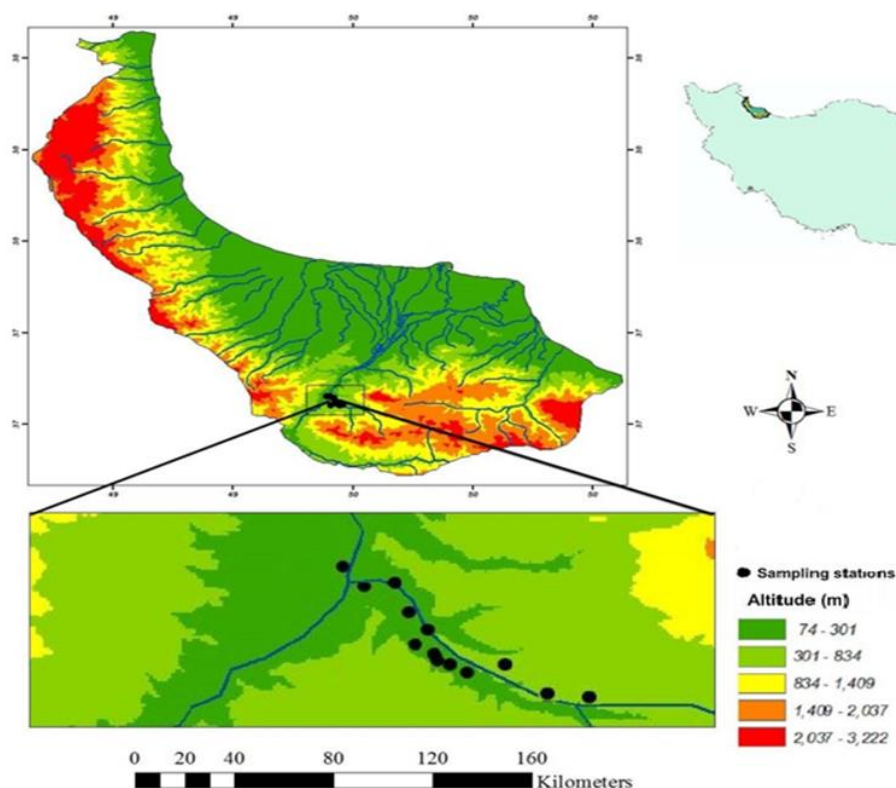


Fig.2. Location of Alborz Province, ShahrBijar River and sampling points.

Table 1. Explanation and abbreviation for each categorical habitat variable.

Substrate (mm)		Riparian vegetation type	
Bedrock	>4000	BV	Deciduous forest
Boulder	256-4000	BM	Deciduous forest and residential area
Cobble	64-265		
Pebble	16-64		
Gravel	2-16	A	Grasslands or herbs
Sand	<2	BA	Largely no vegetation

method based on Hassanlie (1999), repeated three times to minimize error. Dominant substrate type was determined both visually and randomly by measuring the diameter of the riverbed stones in 20 selected quadrats (50×50cm) based on Lotfi (2012), and then classified according to Johnston et al. (1996) and Tabatabaei et al. (2015). The bed stone diameter average was also calculated by measuring the diameter of bed stones in 20 selected quadrats (50×50cm) based on Lotfi (2012). Riparian vegetation type (based on the type of vegetation growing in the river's riparian zone or its absence) was classified according to our observations, photographs, and standard procedures, with some modifications (Johnston et al. 1996). The first six variables were continuous, and riparian vegetation type was nominal. The abbreviation and description for each discrete

variable are presented in Table 1.

Data analysis: Habitat use, availability, and selection were calculated over the range of each environmental variable. Each environmental variable was divided into intervals, and the mean relative abundance of fish in each interval was calculated using the habitat selection (Habsel) software 1.0 (Jowett 2014). The formula $S = (\%U_{c,i})/(\%A_{c,i})$, where i is the interval of a given environmental variable c , $\%U_{c,i}$ is the percentage of utilization of a specific interval of an environmental variable utilized by fish, and $\%A_{c,i}$ is the percentage of availability of this environmental variable (Guay et al. 2000; Waddle 2001; Tabatabaei et al. 2015), resulted in a selectivity value (S) at each interval. The selectivity values were then scaled, so that the maximum value was one. The mean selectivity values of each environmental variable

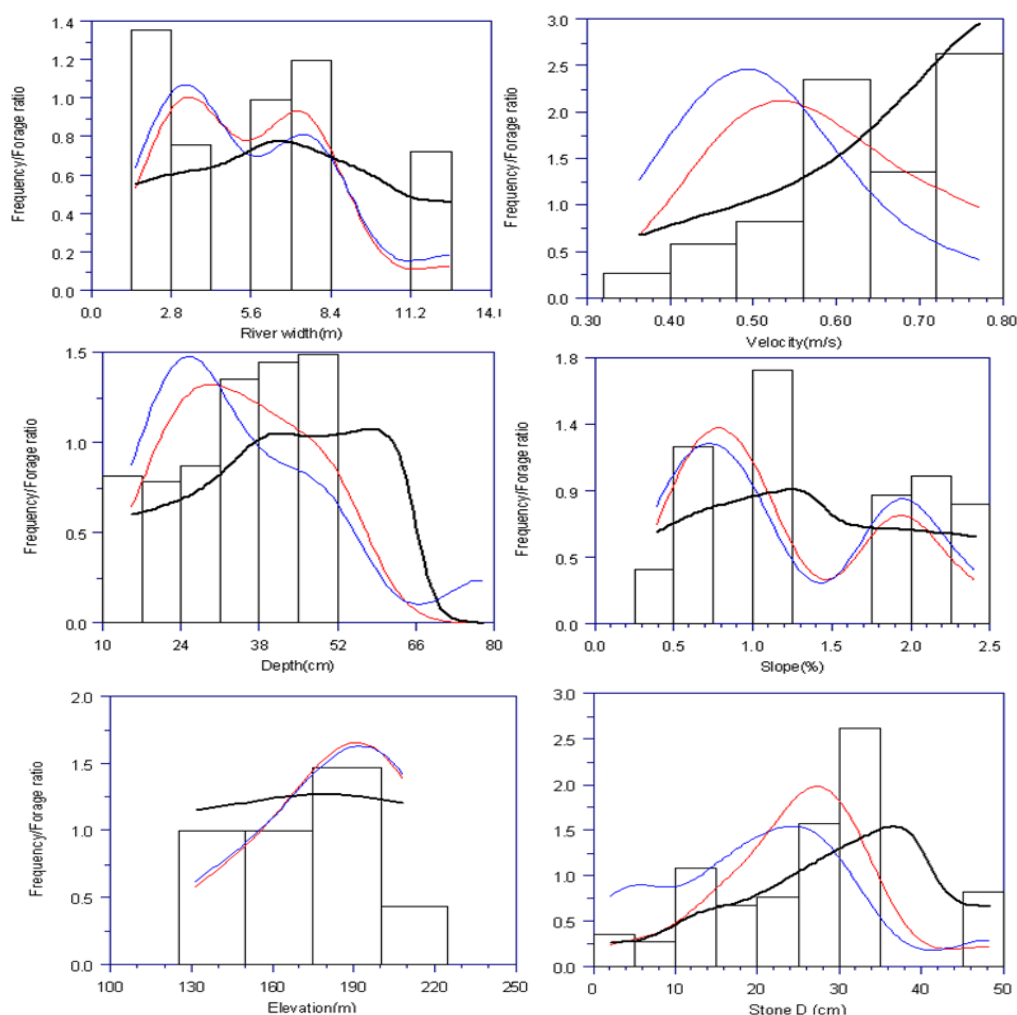


Fig.3. Habitat availability (blue line), used (red line) and selected (black line) by *L. capito* for environmental variables.

(scaled to the maximum value of one) were considered as the SI value of the variables at each station. Habitat Suitability Index (HIS) was calculated using the following formula (Guay et al. 2000):

$$HIS = \sqrt[n]{SI\ Width \times SI\ Depth \times \dots \times SI\ n}$$

In this formula, all variables of a habitat are considered essential, and the product equation yields zero suitability for any given unsuitable habitat variable. Since there is no data available regarding the value of each selected variable, in this research, the SI is multiplied to obtain HIS.

RESULTS

All collected fish during sampling belonged to 8 species, viz. *Luciobarbus capito*, *Barbus cyri*, *Capoeta razi*, *Alburnus filipi*, *Ponticola iranica*, *Ponticola cyrius*, *Alburnoides ssamiii*, and *Oxyinoemacheilus bergianus*, which were returned to the river after identification and counting. A total of

71 specimens of *L. capito* were collected. Habitat use, availability, and selection are presented in Figure 3. Table 2 summarizes the average data obtained from each sampling station, and environmental variables in the study area are shown.

The studied habitats in ShahrBijar River mostly occurred in an elevation range of 175-200m above sea level, with 0.55-0.89cm depth, 2.8-4.2m width, 0.76-1.95m.s⁻¹ water velocity, slope of 0.5-1.75% and stone diameter of 35-70cm, and cobble and then boulder substrate type, deciduous riparian forest, and with most available cover type of boulder (Fig. 2 and Table 3). The habitat-use pattern of *L. capito* generally followed habitat availability. Considering the availability of environmental variables and the selectivity, the habitat selection pattern of this species mainly had the following features: elevation 130-220 m, water depth 18-75cm, channel width less than 12m, channel slope 0.5-2.3%, water velocity less than

Table 2. Minimum, Maximum, Mean and Standard deviation of variables used.

Variable	Min	Max	Mean	SD
Depth (cm)	20	105	64.71	17.44
Slop (%)	0.37	2.4	1.21	0.68
Width(m)	2.7	5.57	91.31	2.815
Velocity (m.s ⁻¹)	0.56	2.2	0.91	0.123
Stone D (cm)	5	78.1	50.05	12.65
Elevation	129	208	180.6	25.133

Table 3. Mostly selected variables of *L. capito*.

Variable	Slop (%)	Velocity (m.s ⁻¹)	Stone D(cm)	Width(m)	Depth(cm)	Elevation (m)
Mostly selected	0.5-1.75	0.76-1.95	35-70	2.8-4.2	0.55-0.89	175-200

Table 4. Selected index for *L. capito* in different stations.

Variable	Slop (%)	Elevation(m)	Velocity (m.s ⁻¹)	Stone D(cm)	Width(m)	Depth(cm)	HSI _{total}
SI	0.803	0.57	1.95	0.81	0.82	0.69	0.798

Table 5. Habitat suitability for *L. capito* in different stations.

Station	1	2	3	4	5	6	7	8	9	10	11	12	13
HSI	0.29	0.65	0.84	9.67	0.63	0.7	0.97	0.81	0.56	0.45	0.41	0.64	0.34

0.8m.s⁻¹, bed rock substrate, average diameter of bed stone 15-50cm, and deciduous forest and residential area riparian type (Fig. 3).

Suitability index values of environmental variables for *L. capito* in ShahrBijar River are shown in Table 4. Among the variables studied, stone diameter had the highest value (0.81), and elevation had the lowest value (0.57). The calculation showed that the HSI river habitat suitability for *L. capito* in ShahrBijar River is 0.80. The results revealed that *L. capito* mostly selected upper stretches of the river with higher velocity and bedrock substrate (Table 3). Furthermore, this species selected lower depth and velocity, bedrock substrate (i.e., a bed with larger elements), deciduous forest and residential-area riparian types, and boulder cover compared to the available ranges. In some cases, the pattern of habitat use was different from the pattern of habitat selection, i.e., in water depth, river width, and velocity.

DISCUSSION

The present study has provided information on habitat use and the environmental factors affecting the distribution of *L. capito*, a native fish of Iranian inland waters, in ShahrBijar River. In recent years, industrial effluents in the ShahrBijar region have caused the

disposal of industrial effluents and chemical pollution of water resources (surface and groundwater), including ShahrBijar River. Therefore, the findings of the present study can show the importance of some factors for effective management and protection of this native species. The fish tend to be in water with higher velocity and a rocky bed. However, the preferred habitat of *L. capito* is middle-deep water with high velocity and medium- to large-sized substrates such as rock. The results of this study showed that the water flow rate is an effective factor in the presence and distribution of *L. capito* in ShahrBijar River. In the West Rivers of Taiwan, velocity rate was found to be an important variable influencing the populations of *Sinogastromyzon puliensis* (Shyi-Liang Yu et al. 2002), which is in line with our results. Water flow plays an important role directly on water and aquatic organisms and indirectly through food-supply transfers (Ahmadi-Nedushan et al. 2006).

The results revealed that *L. capito* mostly selects deeper reaches with the bedrock substrate and larger bed stones. In-stream habitat structures provide a variety of functions for stream fishes (Quist et al. 2005; Tabatabaei et al. 2015); cover features provide protection from predators or ameliorate adverse

conditions of stream flow or seasonal changes in metabolic costs and thereby influence fish survival and movement (MacKenzie & Greenberg 1998; Tabatabaei et al. 2015). In addition, the deep body shape of this species can help with rapid turning and maneuvering in tight quarters, as deeper reaches have substrate consisting of large rocks that provide dead spaces to establish proper habitat. Furthermore, substrate type can be important for fish spawning and feeding behavior (Quist et al. 2005; Tabatabaei et al. 2015). *Luciobarbus capito* mostly occupy areas with lower river width, i.e., less than 12m. Research showed that habitats with higher river width have little suitability for fishes such as *Varicorhinus barbatulus* (Littlejohn et al. 1985; Chuang et al. 2006). In addition, deeper reaches with lower current and narrower river width, along with larger bed stones, can provide transparent water that allows sunlight to penetrate, causing higher production of periphyton algae as the main food items of the *Barbus* species (Treer et al. 2006). The habitat of *L. capito* is an area with deciduous forest and a residential area of riparian type. This may be due to the organic matter it provides, which is considered the base of primary production in riverine ecosystems (Wootton 1999).

The results of the calculation of the HSI showed that almost all intermediate stations have a higher amount of (= 1) HSI index. It can be deduced that the habitat of choice in the area between the rivers for Kura barbel is ShahrBijar. The highest HIS index was at station 7 (0.97), while the lowest was at station 1 (0.29). These conditions, with an HSI of 0.798, indicate that the ShahrBijar River provides an excellent habitat for *L. capito*. The limitations of using an electrofishing device (Yu & Lee 2002; Mercado-Silva et al. 2008), considering the limited sampling period and the variability of the habitat features within each station, may affect the efficiency of the sampling procedure. Fish habitat-use patterns may vary with changing environmental conditions and be affected by seasonal patterns (Copp & Vilizzi 2004; Gillette et al. 2006). Seasonal patterns were not assessed here, but the habitat use and selection patterns of *L. capito* are indicative of autumn. Therefore, we recommend investigating habitat use and preference patterns in other seasons as well.

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مقاله کامل

ارزیابی شاخص مطلوبیت زیستگاه ماهی زردپر (*Luciobarbus capito*) در رودخانه

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انستیتو تحقیقات بین‌المللی ماهیان خاویاری، موسسه تحقیقات علوم شیلاتی کشور، سازمان تحقیقات، آموزش و ترویج کشاورزی، رشت، ایران، صندوق پستی: ۳۴۶۴-۴۱۶۳۵.

چکیده: در انجام طرح‌های حفاظت از اکوسیستم‌های آبی و بهره‌برداری‌های پایدار، وجود دانش لازم پیرامون نیارهای زیستگاهی گونه‌های آبی اهمیت فراوانی دارد. بنابراین، مطالعه حاضر با هدف شناخت ترجیح زیستگاهی و شاخص‌های مطلوبیت ویژگی‌های زیستگاهی گونه زردپر *Luciobarbus capito* و محدوده پراکنش آن در رودخانه شهربیجار انجام شد. برای بررسی متغیرهای زیستگاهی این گونه، فراوانی این ماهی و متغیرهای زیستی، شامل ارتفاع از سطح دریا، عمق، عرض، سرعت جریان، قطر متوسط سنگ و دما با نمونه‌برداری از ۱۳ ایستگاه و با سه تکرار از پایین‌دست به سمت بالادست رودخانه شهربیجار در مهرماه ۱۴۰۱ بررسی شد و محدوده زیستگاه انتخابی برای این گونه به دست آمد. با توجه به نتایج به دست آمده، شاخص‌های مطلوبیت زیستگاهی این گونه ارتفاع ۲۲۰-۱۳۰ متر، عمق در دامنه ۸۹-۵۵ سانتی‌متر، عرض از رودخانه کمتر از ۱۲ متر، شیب ۲/۳-۰/۵٪، سرعت کمتر از ۱/۹ متر بر ثانیه، بستر سنگلاخی و میانگین قطر سنگ بستر در دامنه ۷۰-۳۵ سانتی‌متر قرار داشت. وجود این شرایط با شاخص مطلوبیت ۰/۷۹۸ نشان می‌دهد که رودخانه شهربیجار برای زندگی ماهی زردپر زیستگاهی خوب تلقی می‌شود.

کلمات کلیدی: انتخاب زیستگاه، شاخص مطلوبیت، ماهی زردپر، رودخانه شهربیجار