The conservation status of freshwater species and habitats in Key Biodiversity Areas at the Douro river basin

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Executive summary

This report presents the results of a broad assessment on freshwater diversity in 14 investigated sites within the Douro river basin in the Iberian Peninsula. These sites, either identified as Key Biodiversity Areas[1] (KBA) or potential KBA (Máiz-Tomé et al., 2017) were assessed on their effectiveness in containing important populations of KBA trigger species[2] and threatened species. For this, biodiversity surveys of the taxa used to identify freshwater KBA sites (fishes, molluscs, odonates, and aquatic plants) were undertaken in selected sampling sites. A total of 122 species were recorded in 43 sampling sites, including 82 aquatic plant species, 15 fish species, 12 dragonflies and damselflies species, 2 crayfish species, 5 bivalve species, and 6 gastropod species. Eleven of these species (8 fish, 1 bivalve, 1 odonate and 1 aquatic plant) are classified as threatened with extinction on the IUCN Red List of Threatened Species™. A total of 7 non-native species were also recorded.

Among the 14 investigated sites, the KBA sites Malcata and Montesinho e Nogueira were the sites with the highest total species richness (45 and 42 species, respectively). Taking out the aquatic plant species richness (observed only in a few KBA sites) the highest total species richness was still found in KBA sites Malcata and Serras de Montesinho e Nogueira, but also in the potential KBA Río Yeltes and the KBA Sierra de Gredos y Candelario. Five investigated sites sheltered the highest number of threatened species: potential KBA Río Yeltes and the 4 KBA sites Malcata, El Rebollar, Sierra de Gredos y Candelario and Sierra de la Cabrera. The highest number of non-native species were found in the KBA sites Fuentes Carrionas and Sierras de Peña Labra y del Cordel, with KBA Fuentes Carrionas having a higher number of non-native than native species.

Concerning Habitat Quality (HQA) from the River Habitat Survey (RHS), the KBA El Rebollar and the potential KBA Río Yeltes recorded the highest habitat quality. However, these investigated sites (El Rebollar and Río Yeltes) did also show high scores of Habitat Modification (HMI), only being outnumbered by the KBAs Malcata and Sierras de Peña Labra y del Cordel. Lowest Habitat Modification scores (HMI) were found in KBAs Sierras de Urbión, Cebollera y Neila and Cañón del Río Lobos.

The study shows worrying results on the status of freshwater biodiversity. No trigger species was found in 43% of all investigated sites surveyed in the Douro river basin. Recognizing that freshwater KBAs have high conservation importance, we identify the shortcomings, which mainly relate to either flawed or lack of distribution data for the trigger species.

Trigger species were found in all four investigated sites that were considered as potential KBA (Máiz-Tomé et al., 2017), but that are not included as such in the World Database of Key Biodiversity Areas. The results of this study support the need for the incorporation of these sites as KBA to help focus conservation efforts and promote management actions that allow the persistence of the biodiversity elements present. On the other hand, no trigger species were detected in several KBA sites, particularly in the northern part of the Douro river basin. In two KBAs (Sierra de Gredos y Candelario and Malcata), the trigger species were not recorded because the habitat where the species normally occurs was not sampled. In 5 KBA sites (Babia-Somiedo, Fuentes Carrionas, Sierras de Peña Labra y del Cordel, Sierras de Urbión, Cebollera y Neila and Cañón del Río Lobos) no trigger species was found even after intensive sampling. In 3 of these KBA sites (Babia-Somiedo, Fuentes Carrionas, Sierras de Peña Labra y del Cordel)

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1 Sites that contribute significantly to the global persistence of biodiversity. https://www.keybiodiversityareas.org/

2 Trigger species are the species that trigger the criteria for threatened, geographically restricted, biological processes or irreplaceability and thus identify a site as a KBA (IUCN, 2016).

other threatened species were detected, which should be added as biodiversity elements in the KBA profiles.

A total of 11 threatened species were found in the investigated sites, including 8 fish species: *Achondrostoma arcasii* (VU), *Achondrostoma salmantinum* (EN), *Anguilla anguilla* (CR), *Cobitis calderoni* (EN), *Cobitis paludica* (VU), *Cobitis vettonica* (EN), *Pseudochondrostoma duriense* (VU), *Squalius alburnoides* (VU), 1 bivalve species *Margaritifera Margaritifera* (EN), 1 odonate species *Macromia splendens* (VU) and 1 aquatic plant species *Eryngium viviparum* (EN). Besides the ones that were already identified as trigger species for the freshwater KBA sites, including the gastropod species *Iberhoratia aurorae* (DD), there were 3 threatened species that could qualify as trigger species: 2 fish species *Anguilla anguilla* (CR), *Squalius alburnoides* (VU) and 1 odonate species *Macromia splendens* (VU). The presence of the Critically Endangered european eel (*Anguilla anguilla*) is however puzzling since two specimens were detected in one of the KBA sites (Serras de Montesinho e Nogueira). Possible explanations are that it is either specimens introduced by man or some eels were able to pass all the dams in the Douro river basin and travel until the Sanabria lake. Further investigation is needed to better understand the current distribution of the european eel in the Douro river basin. The highest number of threatened species was found in the southwestern part of the Douro river basin, including in one potential KBA (Río Yeltes). At 2 KBA sites in the far northeastern part of the Douro river basin (Sierras de Urbión, Cebollera y Neila and Cañón del Río Lobos) no threatened species were recorded.

Non-native species were identified as an important threat for the native freshwater biodiversity. A total of 7 non-native species were found during this study in the Douro river basin: 2 crayfish species (*Pacifastacus leniusculus* and *Procambarus clarkii*), 1 bivalve species (*Corbicula fluminea*) and 4 fish species (*Barbatula barbatula*, *Gambusia holbrooki*, *Gobio lozanoi* and *Phoxinus bigerri*). Non-native species were found in all but 3 investigated sites (potential KBA Río Corneja, KBA Cañón del Río Lobos, KBA Sierra de Gredos y Candelario). These findings suggest that some of the endemic species remaining in sub-basins are being replaced by non-native species. The situation is especially alarming in the northern part of the Douro river basin.

Apart from non-native species negative impacts, the native freshwater biodiversity is also suffering from the presence of a large number of dams. Intensive agricultural practices are causing sedimentation, eutrophication, water shortage and droughts in several parts of the Douro river and its tributaries. The rivers and streams of the southern and eastern part of the Douro river basin suffer mostly from water shortage. In potential KBA Río Adaja, where a high number of the 2 trigger species was found, the rivers are completely dry in the summer. Since these potential KBAs form no part of other protective zones, incentives are necessary to safeguard the survival of the freshwater biodiversity that is crucial for the rest of the Douro river basin. On the other side, the western part of the Douro river basin suffers greatly from the large dams along the border between Spain and Portugal. Many of the populations of fish are isolated from the middle and lower sections of the Douro river basin, with an especially large impact on potamodromous migratory fish (species whose entire migration takes place in freshwater).

KBA sites have high conservation importance but additional measures are necessary in order to preserve the freshwater biodiversity. Steps should be taken for the inclusion of KBA trigger species in the management plans of existing protected areas (Ramsar Sites, Natura 2000 sites, other national or regional protection figures) and the inclusion of KBA sites in river basin management plans. This will ensure more appropriate planning and correct allocation of funds for nature conservation. Furthermore, management plans to control or even eradicate non-native species should be designed promplty and implemented. Finally, obsolete dams and barriers should be selected for decommissioning, and building fish passages on barriers impermeable to fish should be promoted.

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List of acronyms

BIOPOLIS	Program in Genomics, Biodiversity and Land Planning
CIBIO	Centro de Investigação em Biodiversidade e Recursos Genéticos (Research Centre in Biodiversity and Genetic Resources)
CIIMAR	Centro Interdisciplinar de Investigação Marinha e Ambiental (Interdisplinary Centre of Marine and Environmental Research)
CIMO	Centro de Investigação de Montanha (Mountain Research Centre)
CITAB	Centro de Investigação e Tecnologias Agroambientais e Biológicas (Centre for Research & Technology of Agro-Environmental & Biological Sciences)
InBIO	Research Network in Biodiversity and Evolutionary Biology

1

Introduction

The Douro is one of the major rivers of the Iberian Peninsula, flowing from its source near Duruelo de la Sierra in the province of Soria across northern-central Spain and northern Portugal to its outlet in Porto (Cortes et al., 2019). The river has a total length of 897 kilometers and passes through a very diverse landscape, from its source through the arid Castillian meseta and high mountains until it reaches the Atlantic Ocean. The microclimate allow for the cultivation of olives, almonds and grapes, the latter being used for the production of the famous Ribera del Duero and port wines (Lourenço-Gomes et al., 2015). The river also forms the natural border line between Spain and Portugal for 112 kilometers, and many important cities have been built along its river banks, including Valladolid, Zamora, Vila Nova de Gaia and Porto (Bordalo et al., 2006).

Once a wild river bursting with wildlife, the Douro has been undergoing quite a change due to human intervention. Fifteen hydrodams have been built to regulate the water flow, generate hydroelectric power, and allow navigation through locks. Consequently, river connectivity was highly impaired (Cortes et al., 2019). The lower part of the Portuguese drainage is influenced by the Atlantic climate. The upper-middle part of the Portuguese and Spanish section is used for agriculture (mainly vineyards) with some tributaries subject to a semi-arid (Mediterranean climate) while others in mountain areas have more water availability (Andresen et al., 2004). The main threats are posed by big urban areas and severe pollution.

Many of the developments in the Douro river basin had a negative impact on the biodiversity of the region (Nogueira et al., 2021). In order to protect the fragile wildlife of this river basin, 196 Natura 2000 zones have been designated. Several wetlands are designated as protected areas, including 4 wetlands under the Ramsar Convention. Finally, 64 Key Biodiversity Areas have been delineated in the Douro river basin, 9 are located in Portugal and 55 in Spain. Of these sites, only 2 have been identified as freshwater KBA with a focus on the conservation of freshwater biodiversity (BirdLife International, 2021).

During the years 2018 and 2019, a team of experts on freshwater biodiversity surveyed several sampling sites in the entire Douro river basin to assess the status of freshwater biodiversity (Figure 1). The aim was to understand the current situation of the freshwater biodiversity in 10 Key Biodiversity Areas and 4 sites identified as potential KBAs (Máiz-Tomé et al., 2017). These experts assessed the presence of freshwater trigger species, recorded the occurrence of fish, odonates, bivalves, crayfish and aquatic plants and determined the potential threats for these species (Table 1). Finally, they assessed the status of each site and gave recommendations on possible measures to better conserve freshwater biodiversity.

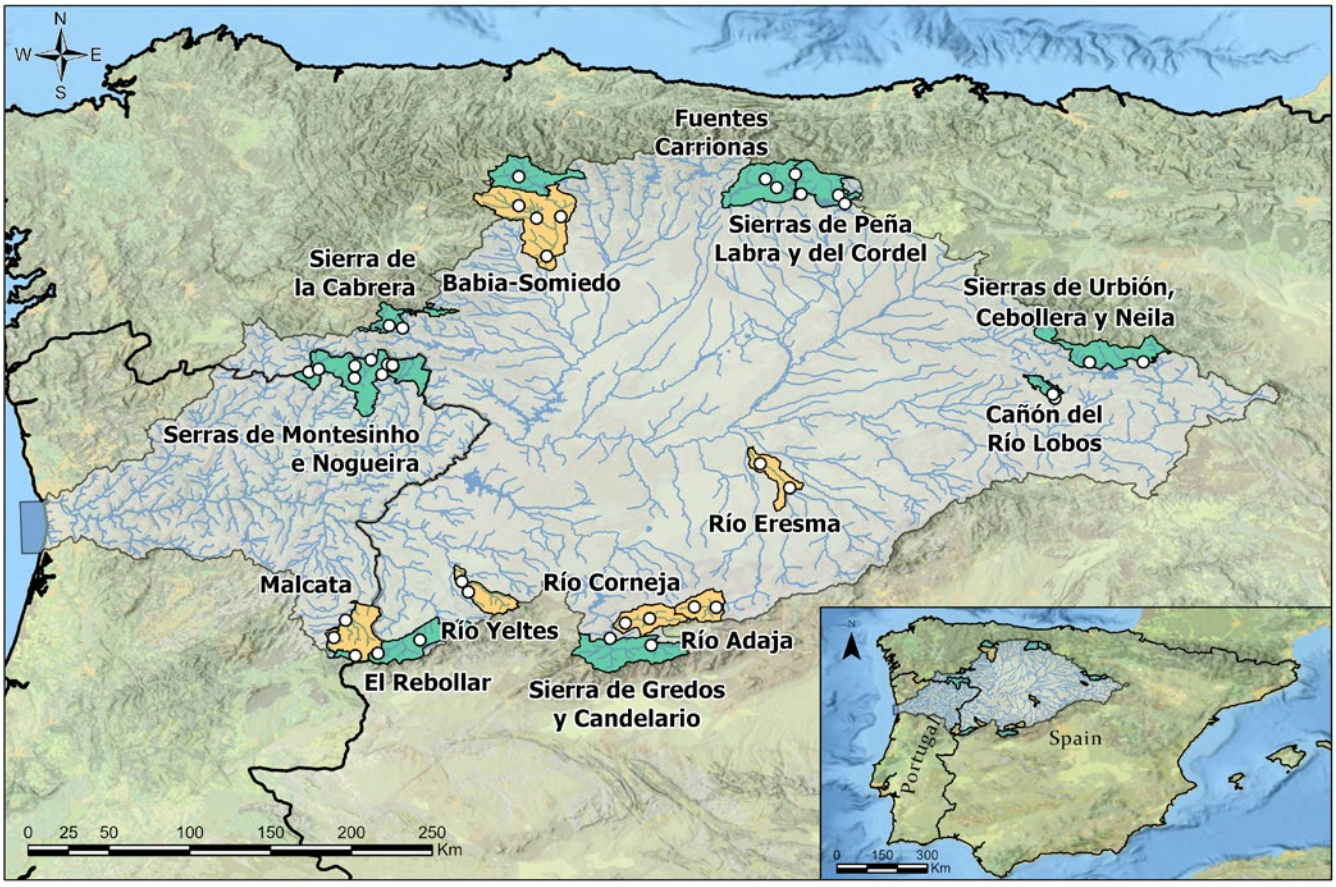

Figure 1. Map of the main Douro river network indicated in blue, the Key Biodiversity Areas in green, the sites identified as potential KBA (Máiz-Tomé et al., 2017) in orange and the sampling sites as white circles. Most of the sampling sites were assessed for macroinvertebrates, bivalves, gastropods, crayfish, odonates, RHS and physical chemical parameters. Both perennial and intermittent stretches illustrated without distinction. Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013) and World Database of KBA.

Table 1. Overview of freshwater trigger species surveyed in the KBA sites and potential KBA sites in the Douro river basin. (IUCN Red List Categories: CR Critically Endangered, EN Endangered, VU Vulnerable, NT Near Threatened, LC Least Concern, DD Data Deficient, NE Not Evaluated)

Name	Area type	Sampling sites	Taxa	Trigger Species	IUCN Red List Cat
Babia- Somiedo	KBA	5	Fish	*Cobitis calderoni*	EN
Fuentes Carrionas	KBA	3	Fish	*Pseudochondrostoma duriense*	VU
Sierra de Gredos y Candelario	KBA	2	Gastropods	*Iberhoratia aurorae*	DD
Sierras de Peña Labra y del Cordel	KBA	3	Fish	*Pseudochondrostoma duriense*	VU
Sierras de Urbión, Cebollera y Neila	KBA	2	Fish	*Cobitis calderoni*	EN
				Achondrostoma arcasii	VU
				Pseudochondrostoma duriense	VU
Cañón del Río Lobos	KBA	2	Fish	*Achondrostoma arcasii*	VU
				Pseudochondrostoma duriense	VU
Serras de Montesinho e Nogueira	KBA	9	Fish	*Cobitis calderoni*	EN
			Bivalves	*Margaritifera margaritifera*	EN
Sierra de la Cabrera	KBA	3	Fish	*Cobitis calderoni*	EN
				Achondrostoma arcasii	VU
El Rebollar	KBA	3	Fish	*Cobitis vettonica*	EN
Malcata	KBA	3	Aq. plants	*Eryngium viviparum*	EN
Río Corneja	Potential KBA	2	Fish	*Achondrostoma arcasii*	VU
Río Yeltes	Potential KBA	2	Fish	*Achondrostoma salmantinum*	EN
				Cobitis paludica	VU
Río Adaja	Potential KBA	2	Fish	*Cobitis paludica*	VU
				Achondrostoma arcasii	VU
Río Eresma	Potential KBA	2	Fish	*Cobitis calderoni*	EN
				Achondrostoma arcasii	VU

KBA = delineated KBA sites (World Database of KBA), Potential KBA = delineated KBA sites (Máiz-Tomé et al., 2017). Source: Darwall et al., 2014.

2
Methodology

SITE SELECTION

A total of 43 sampling sites were visited for sampling in three campaigns between June 2018 and September 2019. The sampling sites were surveyed for fish and all macroinvertebrates, in addition to River Habitat Surveys and standard water physical-chemical parameters (Figures 1; Appendix A). Aquatic plants were sampled in September 2019 in a few selected sampling sites with previously reported presence of rare species. Priority was given to sites where the species had previously been recorded or that were within the focal area of the designated or potential KBA sites.

SURVEYS

All selected sites were visited for potential surveys on aquatic plants, fish, and all macroinvertebrates including special surveys for crayfish, molluscs, and odonates (Appendix A). However, not all taxa were surveyed on all 43 sites but only those that could potentially be present in specific freshwater habitats (Appendix A). The surveys were then complemented with River Habitat Surveys, and standard water physical-chemical features to evaluate ecological integrity and anthropogenic modification of each site.

DATA COLLECTION

- Fish were assessed using electrofishing following INAG (2008)
- Freshwater molluscs were assessed using a Rapid Bioassessment for freshwater molluscs following Cummings et al. (2016) and complemented with macroinvertebrate sampling
- Crayfish were assessed by the combined effort of macroinvertebrate sampling and electrofishing
- Odonates were assessed based on the presence of larval stages identified through macroinvertebrate sampling
- Aquatic plants were assessed by walking surveys of selected river reaches and selected parts of the margins and water column of standing water bodies. The numbers employed indicate the percentage cover
- Macroinvertebrates were sampled following INAG (2008)
- Habitat Survey was accomplished using the River Habitat Survey Methodology (Raven et al., 1997; 1998)
- Water temperature, dissolved oxygen, conductivity, and pH were measured at each site using a YSI EXO 2 multi-parameter probe

3

Freshwater biodiversity in KBA sites

3.1 **Babia Somiedo** KBA site

			Sampling sites				
Trigger species presence and abundance		RED LIST	D515	D517	D518	D585	D590
Fish	*Cobitis calderoni*	EN	×	×	×	×	×

Source: data compiled by the authors with categories from IUCN Red List. - not sampled × no species found dried out river

Description

The KBA site is composed of mountain streams with a focal area in Órbigo River for the northern iberian spined-loach *Cobitis calderoni*. The Babia-Somiedo streams presented low fish diversity and diverse freshwater macroinvertebrate communities, but few odonates. Aquatic plants were not surveyed.

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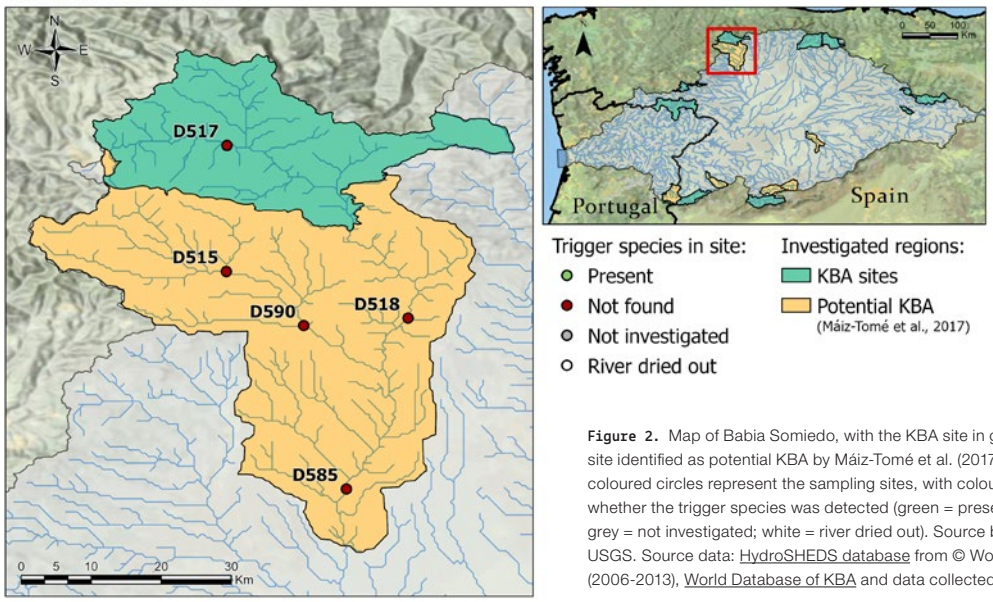

Figure 2. Map of Babia Somiedo, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

We failed to detect the trigger species, that is being replaced in the Esla river sub-basin by the introduced stone loach *Barbatula barbatula*. The fish community was also composed of *Achondrostoma arcasii* (VU) and *Salmo trutta fario*, common in headwater streams. No bivalves and only common freshwater gastropods were detected. Only a single species of odonates was detected in this site. The macroinvertebrate communities presented a high diversity score.

Trigger species: Northern iberian spined-loach (*Cobitis calderoni*) with Red List Category added © David Pérez (DPC), Wikimedia Commons, License cc-by-sa-3.0

Species richness (Non-native/Threatened)	**Sampling sites**				
Taxa	D515	D517	D518	D585	D590
Fish	1	1	2(1)	3(1/1)	3(1/1)
Bivalves	×	×	×	×	×
Gastropods	1	1	2	1	1
Odonates	1	×	×	×	×
Crayfish	×	×	1	×	×
Aquatic plants	-	-	-	-	-
TOTAL	**3**	**2**	**5(2)**	**4(1/1)**	**4(1/1)**
Macroinvertebrates					
Families	20	15	20	18	22
Shannon-Weiner Diversity	1.68	2.26	1.94	1.57	2.03

Source: data collected by the authors.

- not sampled × no species found dried out river

Habitat

The habitat quality of the streams was moderate to good but substantially modified by humans. The surrounding environment is mostly occupied by intense agriculture activities.

	Sampling sites				
River Habitat Survey (RHS)	D515	D517	D518	D585	D590
Habitat Quality Assessment (HQA)	33	38	55	41	48
Habitat Modification Score (HMS)	460	990	530	940	190

Source: data collected by the authors.

- not sampled dried out river

Threats

Non-native species followed by sedimentation and nutrient pollution from agriculture should be the main threats to the KBA's freshwater diversity.

Non-native species: Stone loach (*Barbatula barbatula*) © OpenCage, Wikimedia Commons, License cc-by-sa-2.5

Conservation guidance

The KBA site apparently lost its trigger species *Cobitis calderoni*. This is probably due to the introduction of a non-native loach, i.e. the stone loach *Barbatula barbatula*, that is quickly spreading throughout the whole Esla river basin. This introduction should be studied in more detail in order to design proper management plans devoted to the control or even eradication of this species and reintroduction of *C. calderoni*. If this is not viable, the status of the site should be re-evaluated.

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3.2 **Fuentes Carrionas** KBA site

			Sampling sites		
Trigger species presence and abundance			D0524b	D2018	D0553
Fish	*Pseudochondrostoma duriense*	VU	×	×	×

Source: data compiled by the authors with categories from IUCN Red List.

- not sampled × no species found dried out river

Description

The KBA site is composed of moderate quality headwater streams with a focal area in the upper river Pisuerga for *Pseudochondrostoma duriense*. We observed a low fish diversity, half of them non-native. The macroinvertebrate communities were diverse, but no threatened and rare species were found. Aquatic plants were not sampled.

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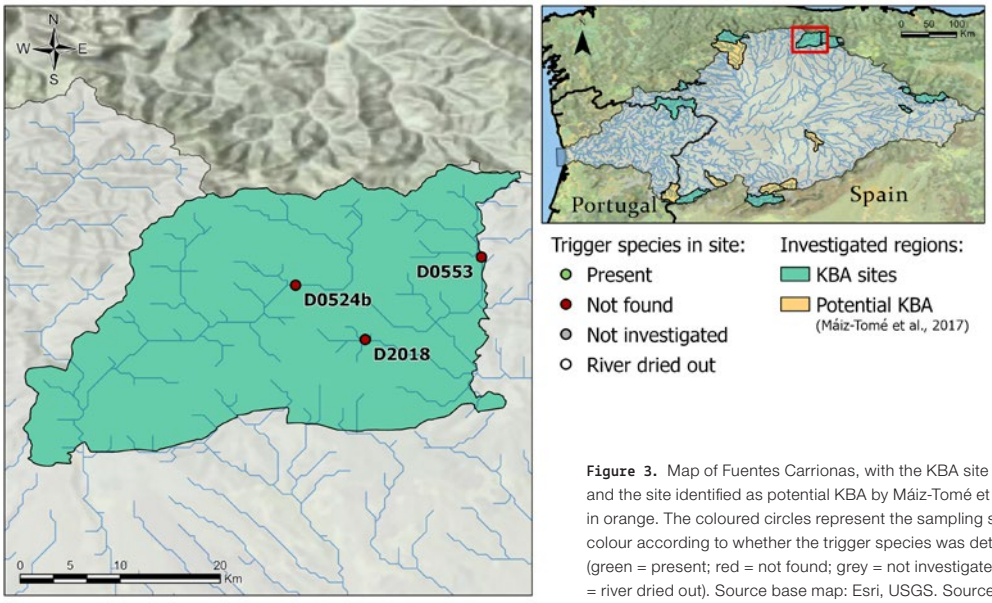

Figure 3. Map of Fuentes Carrionas, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

The KBA site is composed of good quality streams with low-density populations of the native *Salmo trutta fario* and *Achondrostoma arcasii* (VU). However, we failed to detect the trigger species. The fish communities are mainly composed of two non-native species *Phoxinus bigerri* and *Gobio lozanoi*. No bivalves, gastropods or odonates species were detected. Only a single non-native species of crayfish was detected. The macroinvertebrate communities exhibited reasonable diversity metrics.

River trout (*Salmo trutta fario*) © Gilles San Martin, Wikimedia Commons, License CC BY-SA 2.0

Species richness (Non-native/Threatened)	**Sampling sites**		
Taxa	D0524b	D2018	D0553
Fish	1	4(**2**/1)	2
Bivalves	✕	✕	✕
Gastropods	✕	✕	✕
Odonates	✕	✕	✕
Crayfish	✕	✕	1
Aquatic plants	-	-	-
TOTAL	**1**	**4(2/1)**	**3**
Macroinvertebrates			
Families	23	18	23
Shannon-Weiner Diversity	2,21	1,47	1,21

Source: data collected by the authors.

- not sampled ✕ no species found dried out river

Habitat

The habitat quality of the streams was moderate to good, but substantially modified by humans. Water quality is high as indicated by both biotic indices and the physical-chemical parameters of the water (Annex C).

	Sampling sites		
River Habitat Survey (RHS)	D0524b	D2018	D0553
Habitat Quality Assessment (HQA)	41	50	38
Habitat Modification Score (HMS)	100	260	560

Source: data collected by the authors.

- not sampled dried out river

Threats

Non-native species are very abundant and might be outcompeting the native *Achodrostoma arcasii.* As for the disappearance of the trigger species, the many dams and barriers that are hindering their migratory seasonal patterns and the many stresses on the middle and lower sections of the Río Pisuerga should be the main impacts. Sedimentation caused by agriculture activities is probably also one of the main threats to the freshwater diversity.

Non-native species: Signal crayfish (*Pacifastacus leniusculus*) © Astaicoides, Wikimedia Commons, License CC BY-SA 3.0

Conservation guidance

This KBA site needs to be revaluated and surveyed in more detail seasonally for the presence of *P. duriense*. Trigger species should include *A. arcasii,* another threatened fish detected here. The management of non-native species, such as the fish *Phoxinus bigerri* and *Gobio lozanoi*, and the crayfish *P. leniusculus*; as well as the increase of the riparian buffer to avoid sedimentation in streams should be pursued as the main conservation measures.

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3.3 **Sierra de Gredos y Candelario** KBA site

			Sampling sites	
Trigger species presence and abundance			IUNC10	IUCN11
Gastropods	*Iberhoratia aurorae*	DD	×	×

Source: data compiled by the authors with categories from IUCN Red List.

- not sampled × no species found dried out river

Description

The KBA site includes the Sierra de Gredos regional park, and is composed of mountain streams and springs. It contains an important population of the spring snail *Iberhoratia aurorae*. Several threatened fish species and diverse communities of macroinvertebrates were detected. A threatened odonate species and a near-threatened bivalve species were also found. Aquatic plants were not surveyed.

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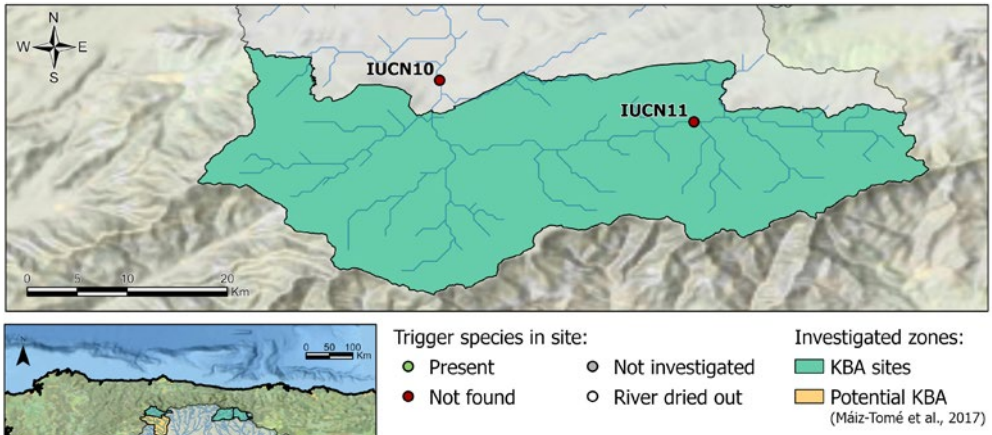

Figure 4. Map of Sierra de Gredos y Candelario, with the KBA site in green and the site identified as possible KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

The trigger species was not detected, given that no springs but only riverine sites were sampled in the current survey. A high abundance of native fish species was detected, especially in the most downstream site, including 3 threatened species. An extremely low diversity and abundance of freshwater molluscs was observed but a good stable population of the freshwater mussel *Unio delphinus* (NT) was found. Several common odonates species were detected, including a single individual of *Macromia splendens* (VU).

Splendid cruiser (*Macromia splendens*) © gailhampshire, Flickr, License CC BY-SA 2.0

Species richness (Non-native/Threatened)	**Sampling sites**	
Taxa	IUNC10	IUCN11
Fish	5(3)	3(1)
Bivalves	1	1
Gastropods	1	1
Odonates	5(1)	2
Crayfish	×	×
Aquatic plants	-	-
TOTAL	**12(2)**	**7(1)**
Macroinvertebrates		
Families	28	32
Shannon-Weiner Diversity	2.24	2,69

Source: data collected by the authors. - not sampled × no species found dried out river

Habitat

The habitat quality of the streams was very good but one of the sites was substantially modified by humans. Water quality was high by both biotic indices and physical-chemical parameters (Annex C).

	Sampling sites	
River Habitat Survey (RHS)	IUNC10	IUCN11
Habitat Quality Assessment (HQA)	65	72
Habitat Modification Score (HMS)	100	1280

Source: data collected by the authors. - not sampled dried out river

Threats

No major threats were observed in the Tormes river upper catchment but many of the populations are isolated from the middle and lower section due to the many dams and barriers built on the Tormes main channel. Most of the fish communities of the remaining river sub-basins are declining fast and being replaced by non-native species. Here, we did not find any non-native species, but prevention measures should be developed given the presence of non-native species in the lower section of the river Tormes and the Douro watershed.

Almendra dam, Spain © airpicimagen, Wikimedia Commons, License CC BY-SA 3.0

Conservation guidance

Although the site with the trigger species population was not visited, we contacted the authors that had described the species in 2007 and got confirmation about the population status. Therefore, the KBA site seems to be well evaluated but should include other fish trigger species such as *Pseudochondrostoma duriense* and *Squalius alburnoides*, both rarely found in other Douro KBA sites in Spain. Management plans for non-native crayfish and fish species should be implemented.

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3.4 **Sierras de Peña Labra y del Cordel** KBA site

			Sampling sites		
Trigger species presence and abundance			D0569	D0570	D0597
Fish	*Pseudochondrostoma duriense*	VU	×	×	×

Source: data compiled by the authors with categories from IUCN Red List.

- not sampled × no species found dried out river

Description

This KBA site was surveyed due to the previous presence of important populations of the Iberian nase *Pseudochondrostoma duriense*. It is composed of mountain streams and rivers belonging to the Pisuerga basin, one of the largest in the Douro watershed. The site presented a low diversity and abundance of all native species. The trigger species was not detected. Aquatic plants were not surveyed.

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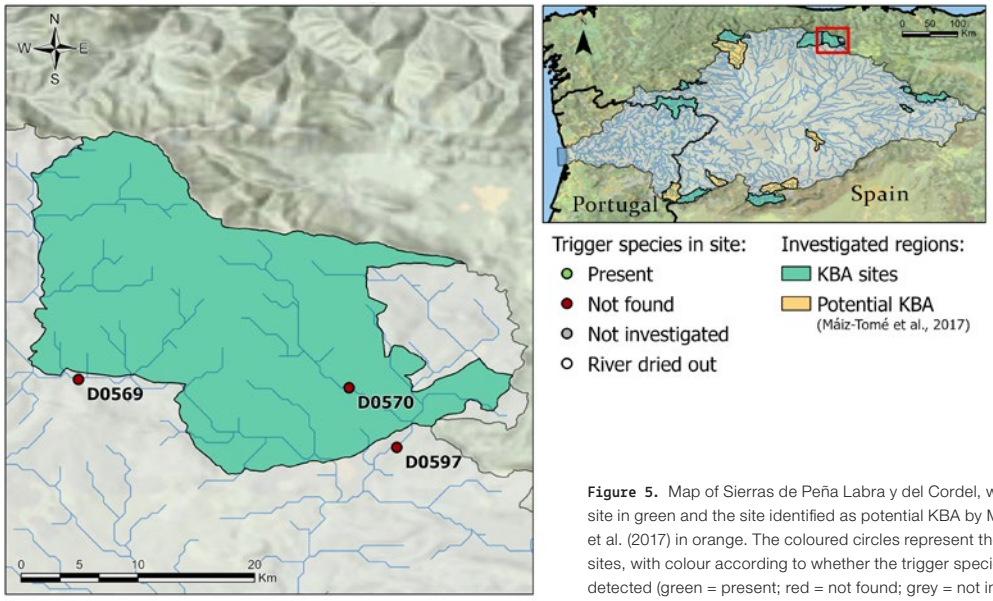

Figure 5. Map of Sierras de Peña Labra y del Cordel, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

A low diversity and abundance of native fish was detected, including the *Achondrostoma arcasii* (VU), but two non-native fish species were present in high abundances and seem to be replacing the native species. An extremely low diversity and abundance of common freshwater molluscs were observed and no odonates species were detected. One non-native species of crayfish was found. The macroinvertebrate communities exhibited low diversity metrics.

Radix balthica (previously: *Lymnaea peregra*) © Jamie McMillan, Flickr, License CC BY-SA 2.0

Species richness (Non-native/Threatened)	**Sampling sites**		
Taxa	D0569	D0570	D0597
Fish	2(1)	2(1/1)	3(2/1)
Bivalves	1	1	✕
Gastropods	3	✕	1
Odonates	✕	✕	✕
Crayfish	1	✕	1
Aquatic plants	-	-	-
TOTAL	**7(2)**	**3(1/1)**	**5(3/1)**
Macroinvertebrates			
Families	23	13	19
Shannon-Weiner Diversity	2,29	1,13	1,21

Source: data collected by the authors.

- not sampled ✕ no species found dried out river

Habitat

The habitat quality of the streams was good, but the sites were substantially modified by humans. Water quality was high by the IBMWP biotic index but with an unexpected low ratio of EPT taxa (Annex C). The conductivity was a bit higher than expected for headwater streams, indicating potential eutrophication.

	Sampling sites		
River Habitat Survey (RHS)	D0569	D0570	D0597
Habitat Quality Assessment (HQA)	54	62	49
Habitat Modification Score (HMS)	610	1890	1130

Source: data collected by the authors.

- not sampled dried out river

Threats

The many alterations and presence of barriers on the Pisuerga main channel might be disruptive for potamodromous migratory fish such as the trigger species *P. duriense*. Most of the fish communities of the remaining river sub-basins of the Douro watershed are declining fast and being replaced by non-native species. The increased siltation and conductivity caused by eutrophication due to nutrients and sediment loads from agriculture practices might be an additional threat.

Non-native species: Adour minnow (*Phoxinus bigerri*) © David Pérez (DPC), Wikimedia Commons, License cc-by-sa-3.0

Conservation guidance

Containment and eradication plans for the non-native species already present in the Douro watershed should be implemented. The increase of the riparian buffer in agricultural areas and the increase of riverine connectivity downstream are other suggested measures to improve the status of freshwater fish. A more detailed and comprehensive survey of the trigger species *P. duriense* and the vulnerable *A. arcasii* should be implemented to assess the abundance of both species and update the biodiversity elements of the KBA site.

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3.5 **Sierras de Urbión, Cebollera y Neila** KBA site

Trigger species presence and abundance			Sampling sites D0543	IUCN9
Fish	*Cobitis calderoni*	EN	×	×
Fish	*Achondrostoma arcasii*	VU	×	×
Fish	*Pseudochondrostoma duriense*	VU	×	×

Source: data compiled by the authors with categories from IUCN Red List. - not sampled × no species found dried out river

Description

The KBA site was surveyed due to the reported presence of important populations of fish, i.e. the Iberian nase *P. duriense*, the Lamprehuela *C. calderoni*, and the Bermejuela *A. arcasii*. It is composed of mountain oligotrophic streams and rivers. The diversity of all taxa was low, no trigger or threatened species were detected. Aquatic plants were not surveyed.

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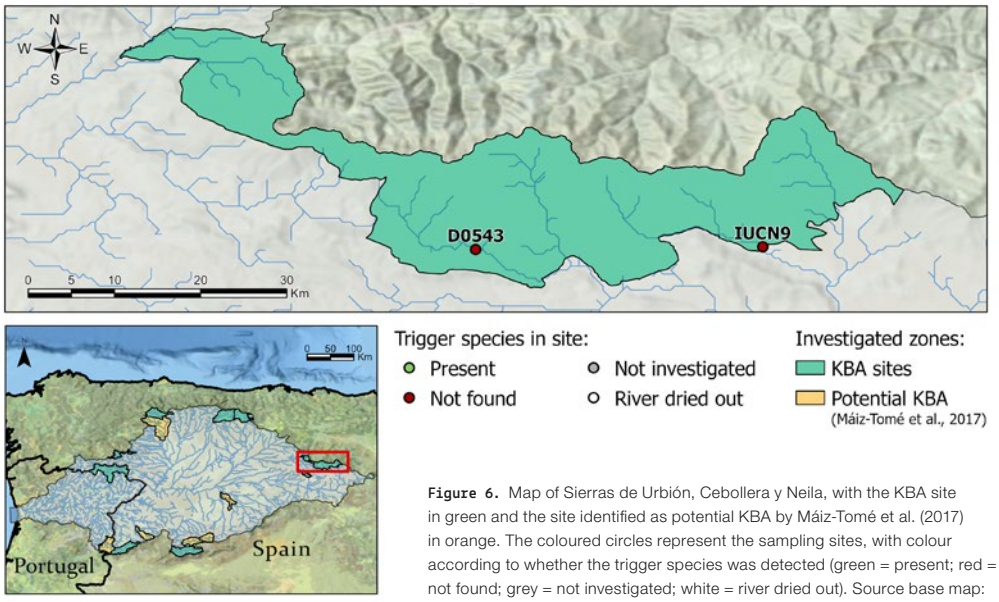

Figure 6. Map of Sierras de Urbión, Cebollera y Neila, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

The common brown trout was the only native fish detected and there were no signs of any of the three trigger species. Instead, a high abundance of the non-native fish species *Phoxinus bigerri* was detected in one of the sampling sites. Only a single pea-clam *Pisidium casertanum* was detected, and a single common odonate species, *Calopteryx virgo*. A non-native crayfish species was found in one of the sampling sites. The macroinvertebrate communities exhibited high values.

Beautiful demoiselle (*Calopteryx virgo*) © Michael Apel, Wikimedia Commons, License CC BY-SA 3.0

Species richness (Non-native/Threatened)	**Sampling sites**	
Taxa	D0543	IUCN9
Fish	2(1)	1
Bivalves	✕	1
Gastropods	✕	1
Odonates	1	✕
Crayfish	1	✕
Aquatic plants	-	-
TOTAL	**4(2)**	**2**
Macroinvertebrates		
Families	16	20
Shannon-Weiner Diversity	1,41	1,96

Source: data collected by the authors.

- not sampled ✕ no species found dried out river

Habitat

The habitat quality of the streams was very good. The water quality was high by the IBMWP biotic index but with an unexpected low ratio of EPT taxa (Annex C).

	Sampling sites	
River Habitat Survey (RHS)	D0543	IUCN9
Habitat Quality Assessment (HQA)	55	43
Habitat Modification Score (HMS)	0	270

Source: data collected by the authors.

- not sampled dried out river

Threats

Many of the populations are isolated from the middle and lower sections of the Douro river basin due to the barriers built on the Douro main channel, which might be disruptive for potamodromous migratory fish such as the trigger species *P. duriense*. Most of the fish communities of the remaining river sub-basins of the Douro watershed are declining fast and being replaced by non-native species. Here, we already found a high abundance of one non-native fish that could be displacing the native species.

Reservoir of the Cuerda del Pozo, Spain © JM, Wikimedia Commons, License CC BY-SA 4.0

Conservation guidance

Containment and eradication plans for the non-native species already present in the Douro watershed should be implemented. The increase of the riparian buffer in agricultural areas and the increase of riverine connectivity downstream are other suggested measures to improve the status of freshwater fish. A more detailed and comprehensive survey of the trigger species is needed to detect and assess the abundance of these species in this KBA site. If its absence or low abundance is confirmed, the status of the KBA site should be revaluated.

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3.6 **Cañón del Río Lobos** KBA site

Trigger species presence and abundance			Sampling sites IUCN5	IUCN6
Fish	*Achondrostoma arcasii*	VU	✕	⁄
Fish	*Pseudochondrostoma duriense*	VU	✕	⁄

Source: data compiled by the authors with categories from IUCN Red List. - not sampled ✕ no species found ⁄ dried out river

Description

The KBA site was proposed to be extended from the existing natural park limits due to the reported presence of important fish populations, i.e. *P. duriense* and *A. arcasii* in the River Ucero. The KBA site only covers a small portion of this river and the remaining freshwater habitats are dry most of the year. Two sampling sites were checked but only one was surveyed, because no water was found upstream of IUCN5. The diversity of all taxa was low, no trigger or threatened species were detected. Aquatic plants were not surveyed.

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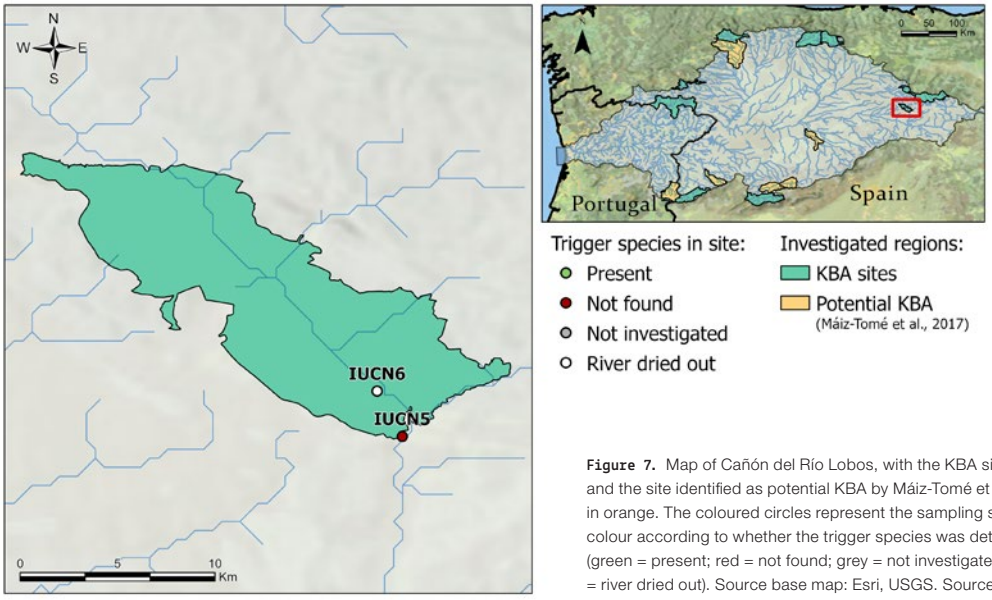

Figure 7. Map of Cañón del Río Lobos, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

Only the native fish species *Salmo trutta fario* was detected, and no signs were found of any of the trigger species. From conversations with the natural park workers, none of these cyprinids has been reported recently (>5 years) for this river section. Only the common gastropod *Ancylus fluviatilis* was found, and no odonate or crayfish species. The macroinvertebrate community exhibited high values.

River limpet *(Ancylus fluviatilis)* © Alexander Mrkvicka, Wikimedia Commons, License CC BY-SA 3.0

Species richness (Non-native/Threatened)	**Sampling sites**	
Taxa	IUCN5	IUCN6
Fish	1	/
Bivalves	×	/
Gastropods	1	/
Odonates	×	/
Crayfish	×	/
Aquatic plants	-	-
TOTAL	**2**	/
Macroinvertebrates		
Families	18	/
Shannon-Weiner Diversity	1,65	/

Source: data collected by the authors.

- not sampled × no species found / dried out river

Habitat

The habitat quality of the river was very good. Water quality was high by the IBMWP biotic index but with an unexpected low ratio of EPT taxa (Annex C).

	Sampling sites	
River Habitat Survey (RHS)	IUCN5	IUCN6
Habitat Quality Assessment (HQA)	53	/
Habitat Modification Score (HMS)	100	/

Source: data collected by the authors.

- not sampled / dried out river

Threats

Many of the populations are isolated from the middle and lower sections of the Douro river basin due to the many alterations and barriers built on the Douro main channel, which might be disruptive for potamodromous migratory fish such as the trigger species *P. duriense*.

Villacampo dam, Spain © Rodelar, Wikimedia Commons, License CC BY-SA 3.0

Conservation guidance

The portion of River Ucero within this KBA is extremely small and the other rivers and streams inside the KBA dry up during the summer. No signs of the trigger species or other rare species were found. Natural park officers said that the trigger species are generally not found in this area. Therefore, this KBA should be withdrawn as important site for freshwater biodiversity.

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3.7 **Serras de Montesinho e Nogueira** KBA site

Trigger species presence and abundance			Sampling sites								
			D19	D97	D98	IUCN1	IUCN2	IUCN3	IUCN4	MON1	MON2
Fish	*Cobitis calderoni*	EN	×	×	21	×	×	×	×	-	-
Bivalves	*Margaritifera margaritifera*	EN	51	×	188	×	×	×	×	-	-

Source: data compiled by the authors with categories from IUCN Red List.

- not sampled × no species found dried out river

Description

The Serras de Montesinho e Nogueira KBA site was adopted for the existing natural park of Montesinho in Portugal due to the reported presence of important populations of *C. calderoni* and *M. margaritifera*. It is composed of high-quality mountain rivers and streams of two of the main sub-basins of the Douro watershed. The diversity of all taxa was high and both trigger species were detected.

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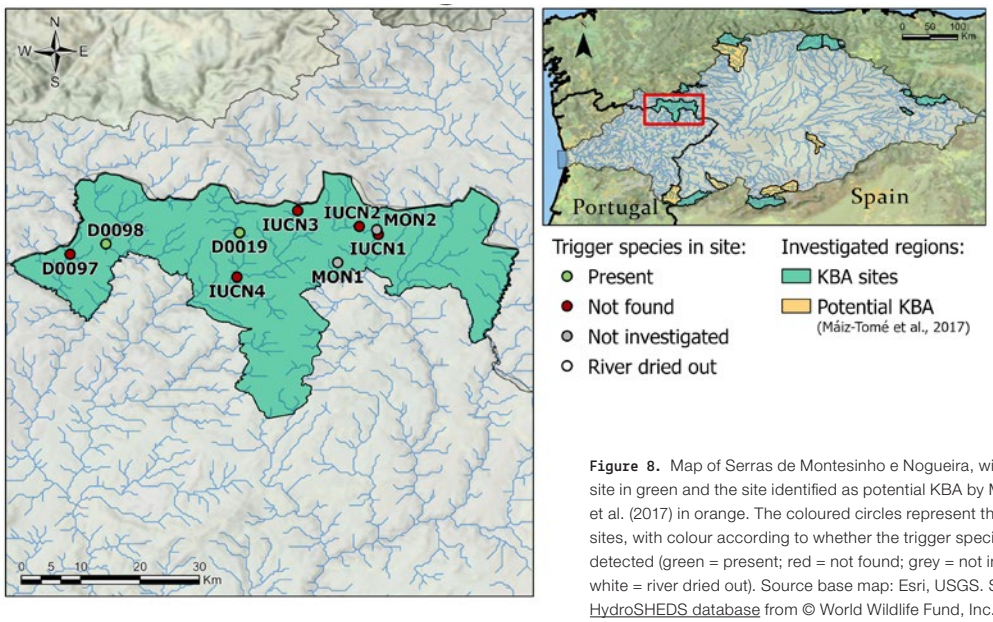

Figure 8. Map of Serras de Montesinho e Nogueira, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

The fish communities were composed of healthy populations of *C. calderoni* (EN), *P. duriense* (VU) and other native species. The most abundant population of *M. margaritifera* in the Iberian peninsula is located within this KBA site. Only common species of gastropods, odonates were detected and also one non-native crayfish species. Aquatic plants revealed a diverse composition of common species. The macroinvertebrate community exhibited high values.

Trigger species: Freshwater pearl mussel (*Margaritifera margaritifera*) © MrKimm, Wikimedia Commons, License CC BY-SA 3.0

Species richness (Non-native/Threatened)	**Sampling sites**								
Taxa	D19	D97	D98	IUCN1	IUCN2	IUCN3	IUCN4	MON1	MON2
Fish	4(1)	3(1)	4(2)	3(1)	2	1	2(1)	-	-
Bivalves	1	×	1	×	×	×	×	-	-
Gastropods	×	1	×	×	×	×	×	-	-
Odonates	2	3	3	×	×	×	×	-	-
Crayfish	×	1	1	×	×	×	×	-	-
Aquatic plants	-	-	-	-	-	-	-	18	15
TOTAL	**7(2)**	**8(1/1)**	**9(1/2)**	**3(1)**	**2**	**1**	**2(1)**	**18**	**15**
Macroinvertebrates									
Families	22	34	34	23	41	22	20	-	-
Shannon-Weiner Diversity	2,52	2,61	2,6	2,15	1,68	2,5	2,25	-	-

Source: data collected by the authors.

- not sampled × no species found dried out river

Habitat

The habitat quality of the streams was moderate to good but substantially modified by humans. The surrounding environment is mostly occupied by intense agricultural activities.

	Sampling sites								
River Habitat Survey (RHS)	D19	D97	D98	IUCN1	IUCN2	IUCN3	IUCN4	MON2	MON2
Habitat Quality Assessment (HQA)	59	59	60	-	-	-	-	-	-
Habitat Modification Score (HMS)	135	465	100	-	-	-	-	-	-

Source: data collected by the authors.

- not sampled dried out river

Threats

All freshwater species populations are now isolated from the Douro river basin due to two large dams, one in the lower Tua and another in the lower Sabor river. These dams might be disruptive for potamodromous migratory fish such as *P. duriense* or *L. bocagei*. The recent introduction of the signal crayfish might also have an important impact on the future of aquatic species in these basins.

Valeira dam, Portugal © Vitor Oliveira, Flickr, License CC BY-SA 2.0

Conservation guidance

The site is already protected. However a recent study mentions that the park should be extended downstream to include areas richer in diversity and abundance of threatened fish species. Therefore, ideally the KBA site should be extended 10-15 km downstream. The KBA should also include the Iberian Nase *P. duriense* as a trigger species, which has dramatically declined in the whole basin.

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3.8 **Sierra de la Cabrera** KBA site

Trigger species presence and abundance			Sampling sites		
			D0587	D0502	SAN001
Fish	*Cobitis calderoni*	EN	19	26	-
Fish	*Achondrostoma arcasii*	VU	42	×	-

Source: data compiled by the authors with categories from IUCN Red List.

- not sampled × no species found dried out river

Description

This KBA site was surveyed due to the reported presence of important populations of the fish *C. calderoni* and *A. arcasii*. It is composed of the Sanabria lake and the Tera river with its tributaries. Two sites were surveyed for riverine taxa in the river Tera main channel and an additional site was surveyed for aquatic plants. The diversity of all taxa was high in all sites, and we detected a high abundance of both trigger species.

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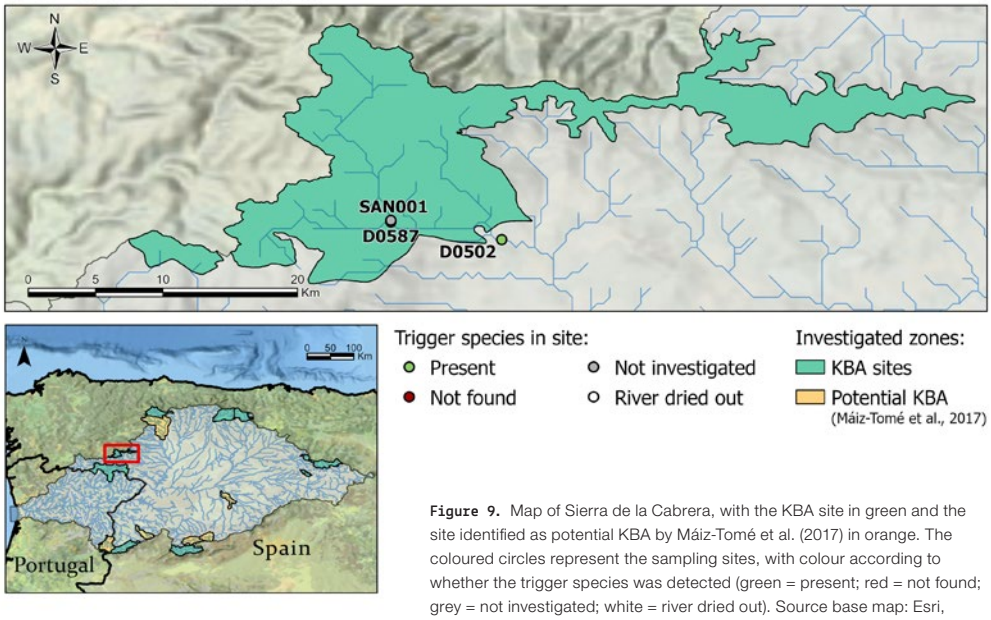

Figure 9. Map of Sierra de la Cabrera, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

Abundant populations of the trigger species and the non-native *G. lozanoi* were detected. Four other species were detected at lower quantities including the european *A. anguilla* (CR). The presence of the european eel is puzzling. Two explanations are likely: either specimens have been introduced by man or some eels were able to pass all the dams in the Douro river basin and travel from the sea to the Sanabria lake. The site surveyed for aquatic plants revealed a diverse composition of common species. The macroinvertebrate community showed high values.

European eel (*Anguilla anguilla*)

Species richness (Non-native/Threatened)	**Sampling sites**		
Taxa	D0587	D0502	SAN001
Fish	7(1/4)	4(1/2)	-
Bivalves	✕	✕	-
Gastropods	✕	✕	-
Odonates	2	2	-
Crayfish	✕	✕	-
Aquatic plants	-	-	19
TOTAL	**9(1/4)**	**6(1/2)**	**19**
Macroinvertebrates			
Families	24	22	-
Shannon-Weiner Diversity	2,14	1,43	-

Source: data collected by the authors. - not sampled ✕ no species found dried out river

Habitat

The habitat quality of the river was high.

	Sampling sites		
River Habitat Survey (RHS)	D0587	D0502	SAN001
Habitat Quality Assessment (HQA)	41	39	-
Habitat Modification Score (HMS)	360	10	-

Source: data collected by the authors. - not sampled dried out river

Threats

No major threats were detected in the KBA site. However, barriers in the lower Tera and Esla basin are now isolating freshwater species populations, making them more prone to genetic erosion and exposure to local extinction. Additionally, non-native species such as the signal crayfish *P. leniusculus* and the fish species *P. bigerri* and *B. barbatula* are already in other upper catchments of the Douro river basin and should arrive to this area shortly.

Non-native species: Iberian gudgeon (*Gobio lozanoi*) ©Javi Guerra Hernando, Wikimedia Commons, License CC BY-SA 4.0

Conservation guidance

Management plans for potential non-native crayfish and fish should be implemented. An effort should be made to increase the connectivity of the River Tera to the River Douro, by selecting obsolete dams and barriers for decommissioning and building fish passages on barriers impermeable to fish.

3.9 **El Rebollar** KBA site

			Sampling sites		
Trigger species presence and abundance			Dou218	Dou221	REB001
Fish	*Cobitis vettonica*	EN	×	14	-

Source: data compiled with the authors with categories from IUCN Red List.

- not sampled × no species found dried out river

Description

The KBA site is coincident with the protected natural area of El Rebollar and Los Agadones and is composed of good quality headwater mountain streams. It was designed to include populations of the trigger species *C. vettonica,* although no focal area was designated. A high diversity of fish, including rare and threatened species was observed. The macroinvertebrate communities were also highly diverse, but no threatened and rare species were found. Aquatic plants were well represented by common species.

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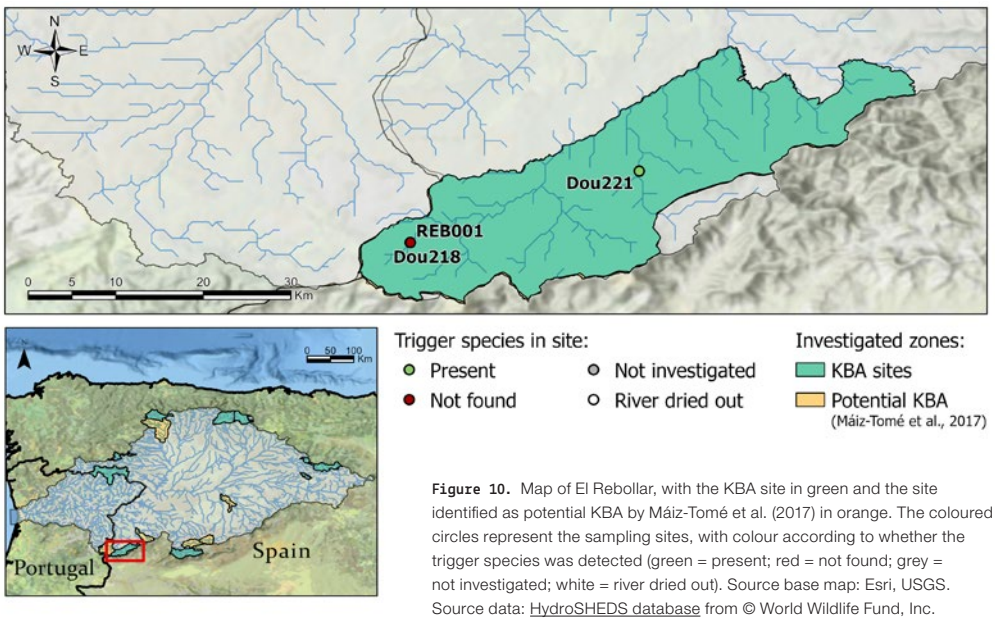

Figure 10. Map of El Rebollar, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

An abundant population of the trigger species *C. vettonica* was found in sympatry with another vulnerable loach, *C. paludica*. The fish community showed a good ecological condition being composed of vulnerable (*S. alburnoides* and *P. duriense*) and common species. Only a single odonate species and a non-native crayfish species were also found. No bivalves or gastropods were detected. The survey of aquatic plants revealed diverse common species of riverine habitats. The macroinvertebrate communities exhibited high diversity metrics, although not a high number of EPT taxa were detected.

Trigger species: Alagón spined loach (*Cobitis vettonica*)
© David Perez (DPC), Wikimedia Commons, License CC BY-SA 4.0

Species richness (Non-native/Threatened)	**Sampling sites**		
Taxa	Dou218	Dou221	REB001
Fish	1	6(4)	-
Bivalves	✕	✕	-
Gastropods	✕	✕	-
Odonates	1	✕	-
Crayfish	✕	✕	-
Aquatic plants	-	1	9
TOTAL	**2**	**7(1/4)**	**9**
Macroinvertebrates			
Families	33	41	-
Shannon-Weiner Diversity	2,07	2,47	-

Source: data collected by the authors.

- not sampled ✕ no species found dried out river

Habitat

The habitat quality of the streams was moderate to good but substantially modified by humans. The water quality is high as indicated by both the biotic indices and the physical-chemical parameters of the water (Annex C).

	Sampling sites		
River Habitat Survey (RHS)	Dou218	Dou221	REB001
Habitat Quality Assessment (HQA)	73	84	-
Habitat Modification Score (HMS)	1580	420	-

Source: data collected by the authors.

- not sampled dried out river

Threats

Non-native species followed by water shortage by increasing water use and climate change, and sedimentation caused by summer fires are the main threats to the KBA's freshwater diversity.

Non-native species: Red swamp crayfish (*Procambarus clarkii*)
© Luc Hoogenstein, Wikimedia Commons, License CC BY-SA 4.0

Conservation guidance

The KBA site includes a rare concentration of several threatened fish species. Given the dramatic decline of native freshwater fish in the Douro river basin, it emphasizes the need to preserve this area. The other threatened species that were detected in this study should be added as trigger species. Management of non-native species, such as the red swamp crayfish, and the control of water usage by avoiding agriculture practices with high water consumption should be pursued as the main conservation measures.

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3.10 **Malcata** KBA site

			Sampling sites		
Trigger species presence and abundance			D0038	D0576	IUCN7
Aquatic plant	*Eryngium viviparum*	EN	×	-	-

Source: data compiled by the authors with categories from IUCN Red List.

- not sampled × no species found dried out river

Description

The KBA site is composed by the River Coa upper catchment and associated good quality streams. The region is protected as a national reserve for Portugal and a Natura 2000 site. This KBA site was surveyed due to the potential presence of the aquatic plant *Eryngium viviparum*. Important populations of threatened fish and molluscs were observed. Aquatic plants also presented a high diversity, although the trigger species was not detected.

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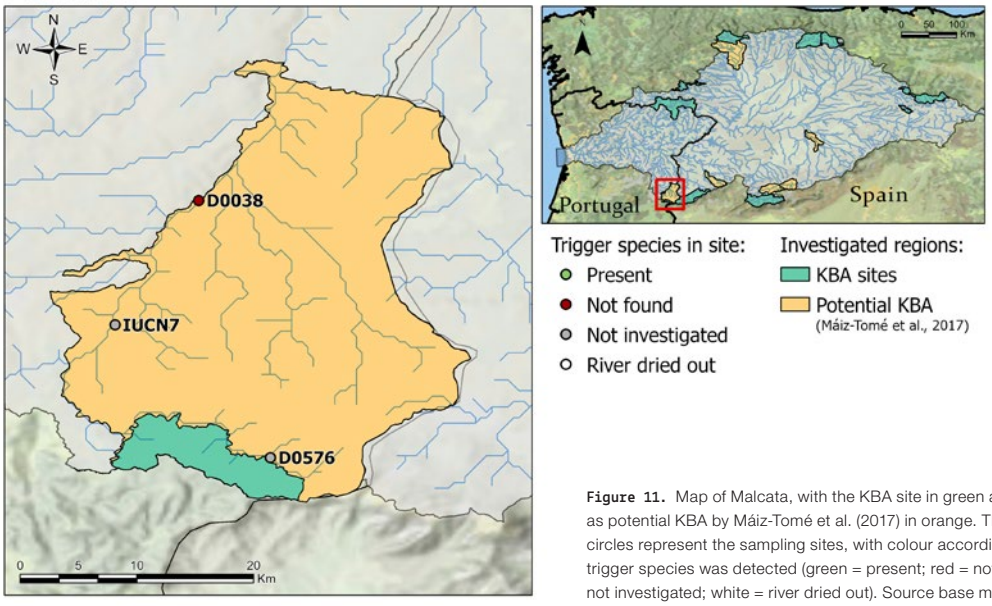

Figure 11. Map of Malcata, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

Only native fish species were detected with abundant populations of *C. paludica* (VU), *P. duriense* (VU), and *S. alburnoides* (VU). Also very abundant populations of freshwater mussels *A. anatina* (LC) and *U. delphinus* (NT) were detected, species that are becoming rarer in the whole Douro river basin. A high diversity of odonates was detected. A high diversity of aquatic plants was observed but not the trigger species *E. viviparum*. This could be due to the fact that only a single river site was sampled and the trigger species mainly occurs in temporary wetlands. The macroinvertebrate communities exhibited high diversity metrics, although not a high number of EPT taxa were detected.

Trigger species: Panicaut nain vivipare (*Eryngium viviparum*)
© ramses, Wikimedia Commons, License CC BY-SA 4.0

Species richness (Non-native/Threatened)	**Sampling sites**		
Taxa	D0038	D0576	IUCN7
Fish	5(3)	2(1)	4(2)
Bivalves	2	✕	✕
Gastropods	1	✕	✕
Odonates	5	4	✕
Crayfish	✕	✕	✕
Aquatic plants	28	-	-
TOTAL	**41(3)**	**6(1)**	**4(2)**
Macroinvertebrates			
Families	31	40	18
Shannon-Weiner Diversity	2,71	2,23	2,15

Source: data collected by the authors. - not sampled ✕ no species found dried out river

Habitat

The habitat quality of the streams was good but substantially modified by humans. Water quality is high as indicated by both biotic indices and the physical-chemical parameters of the water (Annex C).

	Sampling sites		
River Habitat Survey (RHS)	D0038	D0576	IUCN7
Habitat Quality Assessment (HQA)	60	63	-
Habitat Modification Score (HMS)	2200	1130	-

Source: data collected by the authors. - not sampled dried out river

Threats

The Coa river basin is threatened with water shortage and scenarios of global warming. The basin is also composed of many small dams and weirs that break the river connectivity.

© Mario Caruso on Unsplash

Conservation guidance

The presence of the trigger species could not be confirmed, but additional trigger species should include the threatened fish that were detected: *C. paludica*, *P. duriense*, and *S. alburnoides*. The water consumption by agricultural practices should be tightly controlled to maintain water levels in riverine and wetland systems. The many weirs and small dams should be analysed for their impact on river connectivity and obsolete barriers should be investigated for removal.

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4

Freshwater biodiversity in potential KBA sites

4.1 **Río Corneja** potential KBA site

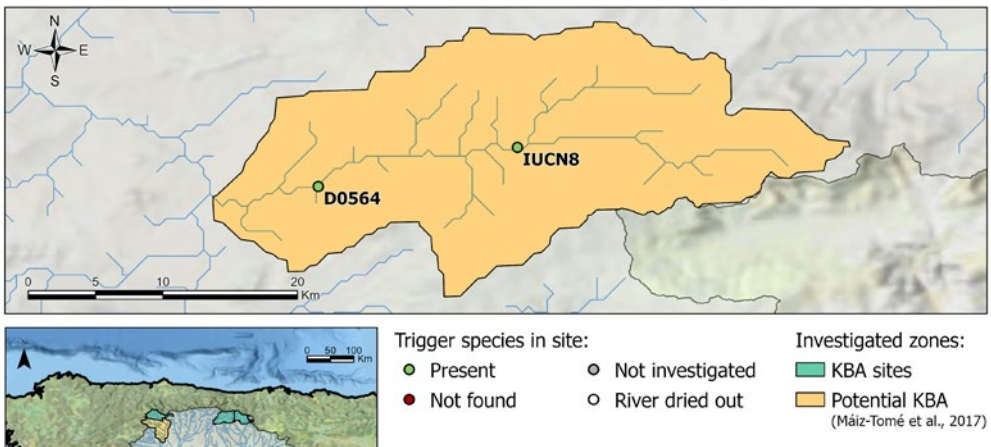
			Sampling sites	
Trigger species presence and abundance			IUCN8	D0564
Fish	*Achondrostoma arcasii*	VU	14	4

Source: data compiled by the authors with categories from IUCN Red List.

- not sampled × no species found dried out river

Description

The site includes the river Corneja, a tributary of the river Tormes basin, one of the largest in the Douro watershed. It was identified as potential KBA due to the reported abundant population of the fish species *Achondrostoma arcasii*. The site presented an overall low diversity of all groups surveyed. The possible trigger species *Achondrostoma arcasii* was detected, but not in high abundance and no other threatened species was detected for the surveyed groups.



Trigger species in site:
- Present
- Not found
- Not investigated
- River dried out

Investigated zones:
- KBA sites
- Potential KBA (Máiz-Tomé et al., 2017)

Figure 12. Map of Río Corneja, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

Only a single native fish, i.e. *Achondrostoma arcasii,* was detected at both sampled sites but not in high abundance. An extremely low diversity and abundance of molluscs was detected, since only a single *Planorbidae* sp. individual was collected at each site. No odonate or crayfish species were detected. A low diversity of common riverine aquatic plants was observed. The macroinvertebrates communities exhibited low diversity metrics.

Trigger species: Bermejula (*Achondrostoma arcasii*) © David Perez (DPC), Wikimedia Commons, License CC BY-SA 4.0

Species richness (Non-native/Threatened)	Sampling sites	
Taxa	IUCN8	D0564
Fish	1(1)	3(3)
Bivalves	✕	✕
Gastropods	✕	1
Odonates	✕	✕
Crayfish	✕	✕
Aquatic plants	10	-
TOTAL	**11(1)**	**4(3)**
Macroinvertebrates		
Families	11	19
Shannon-Weiner Diversity	0,99	1,89

Source: data collected by the authors.

- not sampled ✕ no species found dried out river

Habitat

The habitat quality of the streams was moderate to good, depending on the sampled site, but substantially modified by humans. Water quality was also site-dependent by both biotic indices and the physical-chemical parameters of the water, being better in site IUCN8 than D0564 (Annex C). The abundance of loose sands seems to suggest strong sedimentation/ siltation, probably derived from agricultural practices.

River Habitat Survey (RHS)	Sampling sites	
	IUCN8	D0564
Habitat Quality Assessment (HQA)	65	67
Habitat Modification Score (HMS)	340	1330

Source: data collected by the authors.

- not sampled dried out river

Threats

The river Corneja basin is threatened with water shortage. The basin is also highly threatened by high sedimentation that is probably affecting the benthic communities.

High sedementation in river Corneja basin

Conservation guidance

The region seems to be well evaluated as KBA site, although the abundance of the single possible trigger species is not high. Changes to agriculture practices that increase water consumption should be avoided to maintain water levels in riverine and wetland systems. Silt traps and the rehabilitation and increase of the riparian buffer could decrease the ongoing sedimentation/siltation problem.

4.2 **Río Yeltes**
potential KBA site

Trigger species presence and abundance			Sampling sites D0508	D0513
Fish	*Achondrostoma salmantinum*	EN	17	35
Fish	*Cobitis paludica*	VU	32	1

Source: data compiled by the authors with categories from IUCN Red List.

- not sampled × no species found dried out river

Description

The site only includes the Yeltes river basin which includes the Natura 2000 site Riberas de los Ríos Huebra Yeltes Uces y Afluentes. It is composed of Mediterranean climate rivers and was triggered by having abundant populations of the threatened fish *A. salmantinum* and *C. paludica*. The Río Yeltes region presented good populations of threatened fish species and diverse communities of macroinvertebrates.

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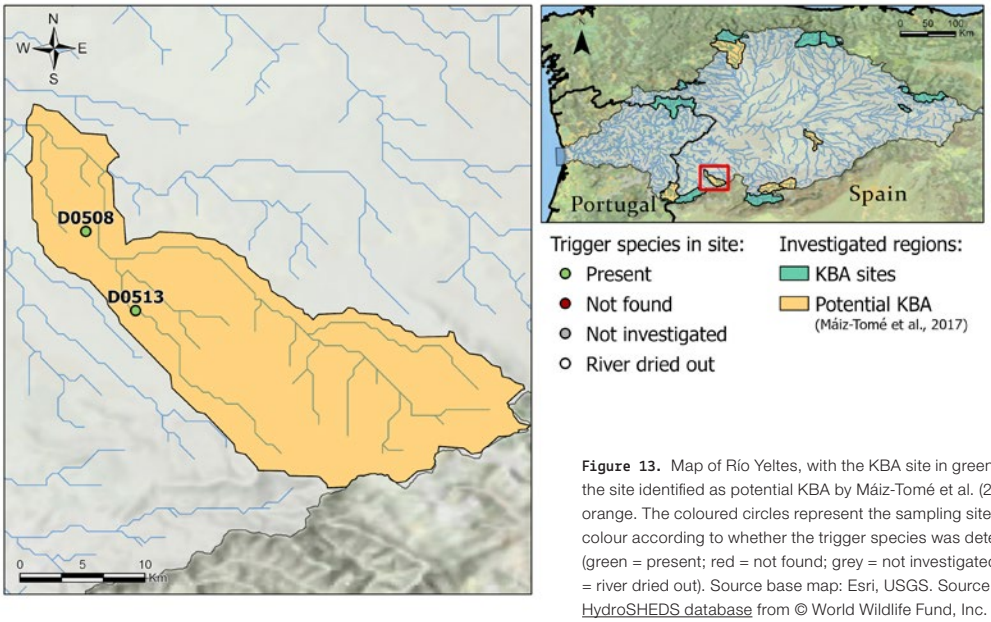

Figure 13. Map of Río Yeltes, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

A diverse native fish abundance was detected, especially in the most downstream site, including four threatened species. Only a single specimen of the non-native species *Gambusia holbrooki* was found. Only common species were found of bivalves and odonates. Abundant populations of the non-native crayfish species *Procambarus clarkii* were detected. Diverse common riverine aquatic plant community observed. The macroinvertebrate communities exhibited high diversity metrics.

Trigger species: Sarda (*Achondrostoma salmantinum*) © David Perez (DPC), Wikimedia Commons, License CC BY-SA 4.0

Species richness (Non-native/Threatened)	**Sampling sites**	
Taxa	D0508	D0513
Fish	8(1/4)	4(2)
Bivalves	✕	✕
Gastropods	1	1
Odonates	✕	2
Crayfish	1	✕
Aquatic plants	16	-
TOTAL	**26(2/4)**	**7(2)**
Macroinvertebrates		
Families	22	25
Shannon-Weiner Diversity	2,36	2,16

Source: data collected by the authors.

- not sampled ✕ no species found dried out river

Habitat

The habitat quality of the streams was good, but substantially modified by humans. Water quality was high by both biotic indices and the physical-chemical parameters of the water (Annex C).

	Sampling sites	
River Habitat Survey (RHS)	D0508	D0513
Habitat Quality Assessment (HQA)	78	81
Habitat Modification Score (HMS)	710	1400

Source: data collected by the authors.

- not sampled dried out river

Threats

The Yeltes river basin is threatened with water shortage. The basin is also highly threatened by sand extraction along the Huebra river. Most of the fish communities of the remaining river sub-basins of the Douro watershed are declining fast and being replaced by non-native species. Abundant populations of the non-native red swamp crayfish *P. clarkii* were found.

Non-native species: Eastern mosquitofish (*Gambusia holbrooki*) © Smithsonian Environmental Research Center, Flickr, License CC BY-SA 2.0

Conservation guidance

The region seems to be well evaluated as potential KBA but should include other fish trigger species such as *P. duriense* and *S. alburnoides* that were rarely found in other Douro KBA sites in Spain. Changes to agriculture practices that increase water consumption should be avoided to maintain water levels in riverine and wetland systems. Containment and eradication plans for the non-native red swamp crayfish *P. clarkii* and other non-native species already present in the Douro watershed should be implemented.

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4.3 **Río Adaja** potential KBA site

Trigger species presence and abundance			Sampling sites	
			IUCN12	IUCN13
Fish	*Cobitis paludica*	VU	dried out river	181
Fish	*Achondrostoma arcasii*	VU	dried out river	119

Source: data compiled by the authors with categories from IUCN Red List. - not sampled × no species found dried out river

Description

The upper Río Adaja site was identified as potential KBA site for the existing Natura 2000 site Encinares de los ríos Adaja y Voltoya and due to the reported presence of important populations of the fish *C. calderoni* and *A. arcasii*. It is composed of the intermittent Mediterranean climate river river Adaja and its tributaries. Two sites were visited for riverine taxa but only one had water. The diversity of all taxa was extremely low in the standing pool, but both possible trigger species were detected in high abundance. Aquatic plants were not surveyed.

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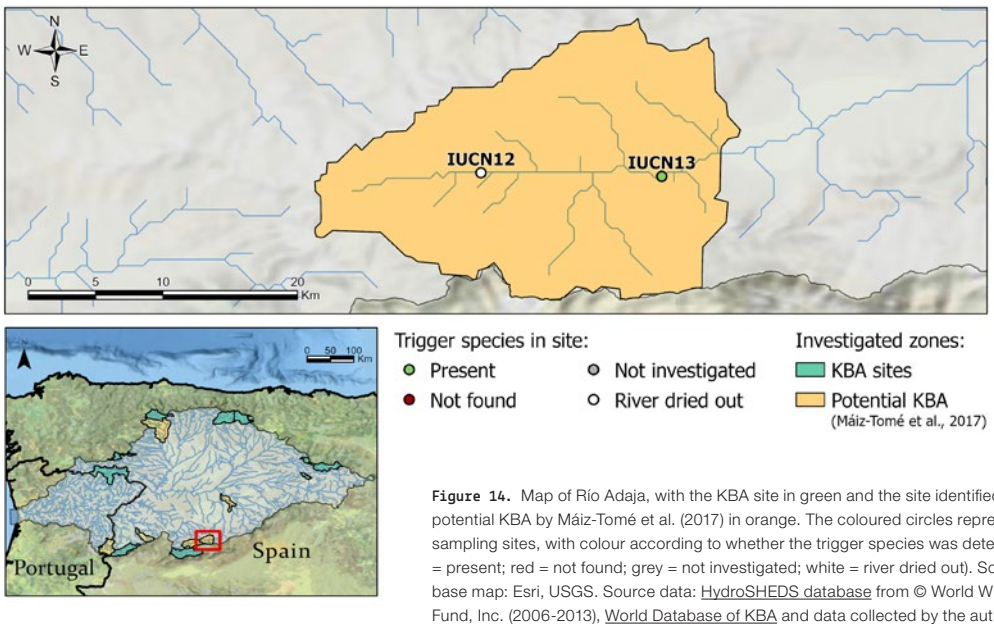

Figure 14. Map of Río Adaja, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

The fish communities were composed of abundant populations of *C. calderoni* and *A. arcasii* and two other species, one native, i.e. *Squalius carolitertii* and one non-native, *Gobio lozanoi*. No bivalves, odonates or crayfish species detected. The macroinvertebrate community exhibited very low diversity metrics possibly due to the low water quality and the high concentration of fish.

Trigger species: Southern iberian spined-loach (*Cobitis paludica*) © David Perez (DPC), Wikimedia Commons, License CC BY-SA 4.0

Species richness (Non-native/Threatened)	**Sampling sites**	
Taxa	IUCN12	IUCN13
Fish	🪶	4(1/2)
Bivalves	🪶	✕
Gastropods	🪶	1
Odonates	🪶	✕
Crayfish	🪶	✕
Aquatic plants	-	-
TOTAL	🪶	**5(1/2)**
Macroinvertebrates		
Families	🪶	8
Shannon-Weiner Diversity	🪶	0,34

Source: data collected by the authors.

- not sampled ✕ no species found 🪶 dried out river

Habitat

The habitat quality of the river was very low with a single pool presenting water. The water quality was low and conductivity was high (Annex C).

	Sampling sites	
River Habitat Survey (RHS)	IUCN12	IUCN13
Habitat Quality Assessment (HQA)	🪶	33
Habitat Modification Score (HMS)	🪶	460

Source: data collected by the authors.

- not sampled 🪶 dried out river

Threats

The river Adaja suffers from water extraction for agricultural purposes and is mostly dry during the summer months. The few permanent pools concentrate large abundance of fish. The pool numbers seem to be decreasing and the river will possibly dry completely in the summer over the following years.

Water extractions for agriculture leading to dried up rivers in the Rio Adaja region

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Conservation guidance

The area is a Natura 2000 site and still holds important populations of threatened species, but is in need of urgent measures for protection. A water management plan should be implemented to keep the required ecological water level in the remaining pools sufficient for fish. Riparian buffers should be implemented around deeper pools to reduce evaporation.

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4.4 **Río Eresma** potential KBA site

Trigger species presence and abundance			Sampling sites IUCN16	IUCN17
Fish	*Cobitis calderoni*	EN	×	×
Fish	*Achondrostoma arcasii*	VU	131	198

Source: data compiled by the authors with categories from IUCN Red List. - not sampled × no species found dried out river

Description

The Río Eresma region was adopted due to the reported presence of important populations of the fish *C. calderoni* and *A. arcasii* in this river. It is composed of a small intermittent Mediterranean climate river and its tributaries. The diversity of all taxa was low in both sites, except for fish, including one of the possible trigger species, *A. arcasii*, that was found in high abundances. No aquatic plants were surveyed.

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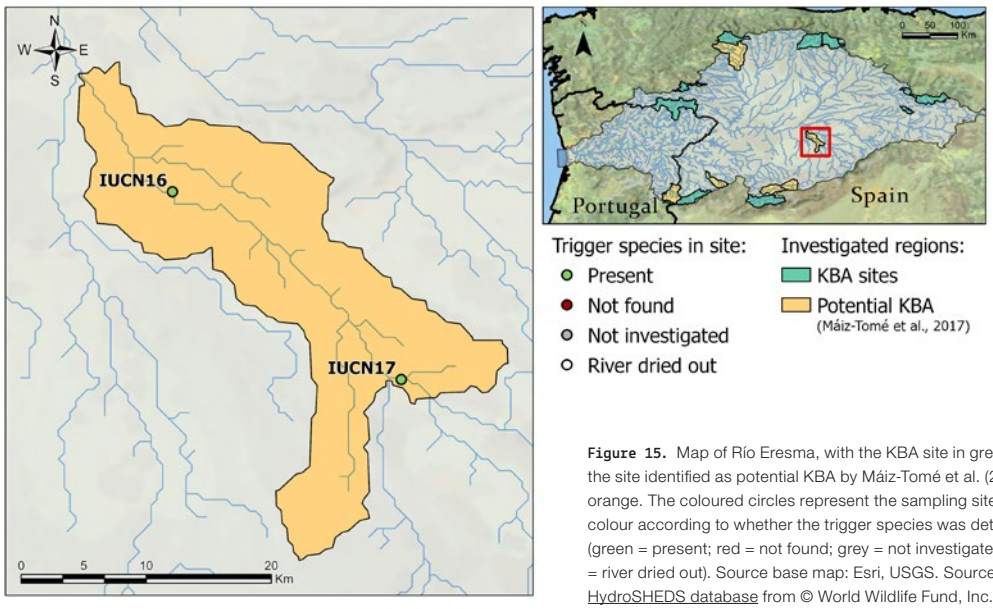

Figure 15. Map of Río Eresma, with the KBA site in green and the site identified as potential KBA by Máiz-Tomé et al. (2017) in orange. The coloured circles represent the sampling sites, with colour according to whether the trigger species was detected (green = present; red = not found; grey = not investigated; white = river dried out). Source base map: Esri, USGS. Source data: HydroSHEDS database from © World Wildlife Fund, Inc. (2006-2013), World Database of KBA and data collected by the authors.

Diversity

The fish communities were composed of abundant populations of *A. arcasii,* the common iberian barbel *Luciobarbus bocagei*, and the non-native species *Gobio lozanoi.* Two other species were detected at lower quantities, *Pseudochondrostoma duriense* (VU) and *Squalius carolitertii.* No bivalves were detected, except for the non-native asian clam *Corbicula fluminea,* found in high abundances. Only one common odonate species and no crayfish species were detected. The macroinvertebrate community exhibited very low diversity metrics.

Douro nase (*Pseudochondrostoma duriense*) © David Perez (DPC), Wikimedia Commons, License CC BY-SA 4.0

Species richness (Non-native/Threatened)	**Sampling sites**	
Taxa	IUCN16	IUCN17
Fish	5(2)	5(2)
Bivalves	1	✕
Gastropods	✕	✕
Odonates	1	1
Crayfish	✕	✕
Aquatic plants	-	-
TOTAL	**7(1/2)**	**6(2)**
Macroinvertebrates		
Families	6	13
Shannon-Weiner Diversity	1,14	1,64

Source: data collected by the authors. - not sampled ✕ no species found dried out river

Habitat

The physical habitat quality of the river was good, but we observed a high siltation/sedimentation and increased conductivity that should be related with sediment inputs from agriculture fields (Annex C).

	Sampling sites	
River Habitat Survey (RHS)	IUCN16	IUCN17
Habitat Quality Assessment (HQA)	54	57
Habitat Modification Score (HMS)	250	370

Source: data collected by the authors. - not sampled dried out river

Threats

The Eresma river suffers from water shortage probably due to extraction for agriculture purposes. It is also affected by sediment inputs from agriculture activities.

Non-native species: Asian clam (*Corbicula fluminea*) © Björn S., Wikimedia Commons, License CC BY-SA 2.0

Conservation guidance

A water management plan should be implemented to keep the required ecological water flow for the fish communities. Riparian buffers should be increased around the deeper pools to reduce evaporation and retain loose sediments from the surrounding fields.

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Threats

There is quite a difference in the freshwater biodiversity found in the distinct investigated sites. Consequently, the necessary measures to conserve the threatened biodiversity can be quite different between regions. An overview of identified threats can be found here:

- Agricultural and forestry effluents: Eutrophication happening as a consequence of agricultural activities.
- Droughts: mainly occurring in the tributaries in the middle part of the drainages (upper part in Portugal).
- Dams and water management/use: several dams have been built to regulate the water flow, generate hydroelectric power, and allow navigation through locks.
- Non-native species: several non-native fishes have invaded this river basin (*Lepomis gibbosus*, *Gambusia holbrooki*, *Ameiurus melas*, *Sander lucioperca*, *Alburnus alburnus, Phoxinus bigerri and Barbatula barbatula*).
- Housing and urban areas.
- Annual and perennial non-timber crops: the Spanish River Douro valley has great relevance from the point of view of agriculture with important cereal crops (wheat and barley), legumes, vineyards, sugar beets and alfalfa.
- Livestock farming and ranching: in the Spanish River Douro valley, livestock is an important resource. It includes the exploitation of extensive sheep, pigs and cows.
- Shipping lanes: the main Douro River in the Portuguese part, has a series of navigable locks, that impairs the river connectivity and has a severe impact on the migratory species populations (*Petromyzon marinus*, *Alosa* sp., *Anguilla anguilla*, *Salmo trutta*).
- Hunting terrestrial animals: Hunting is an important activity in the region of Castilla.

In general, the most common human-induced threats to the freshwater ecosystem are the effects from agricultural practices, namely sedimentation, euthrophication, and water usage causing water shortage and droughts. The large amount of dams negatively affect the water flow and are disruptive for potamodromous migratory fish. Finally, the increase of non-native species are outcompeting and causing harms to the native freshwater biodiversity. Several non-native species were detected, including four fish species (*Barbatula barbatula*, *Phoxinus bigerri*, *Gobio lozanoi*, *Gambusia holbrooki*), two crayfish species (*Pacifastacus leniusculus*, *Procambarus clarkii*) and a mollusc species (*Corbicula fluminea*). Non-native species were detected in almost all the investigated regions with the exception of the KBA sites Malcata, Sierra de Gredos y Candelario, Cañón del Río Lobos and potential KBA sites Río Corneja and Río Eresma. All of these regions are located in the southern part of the Douro river basin, with the exception of KBA Cañón del Río Lobos. The highest number of non-native species was detected in the northern regions, with KBA Fuentas Carriones exhibiting a higher number of non-native than native species.

The situation of the KBA sites in the northwestern part of the Douro river basin is particulary alarming, as besides the high number of non-native species, there was a low number of native species and no trigger species were detected in the five KBA sites in this part of the Douro river basin (Babia-Somiedo, Fuentes Carrionas, Sierras de Peña Labra y del Cordel, Sierras de Urbión, Cebollera y Neila, Cañón del Río Lobos). Many of the native fish populations seem to be isolated from the middle and lower sections of the Douro river basin due to the barriers built on the Douro main channel, causing the fish communities of the remaining river sub-basins to decline at an alarmingly fast rate and being replaced by non-native species. Furthermore, these KBA sites suffer from siltation and increased conductivity caused by eutrophication due to nutrients and sediment loads from agriculture practices.

The eastern part of the Douro river basin is equally alarming, not solely for the presence of non-native species but particularly for the high occurrence of freshwater threatened species. The northeastern KBA sites Serras de Montesinho e Nogueira and Sierra de la Cabrera are mostly threatened by the physical barriers that were built along the Spanish-Portuguese border, isolating freshwater species populations and making them more prone to genetic erosion and exposure to local extinction. In the southeastern KBA sites El Rebollar and Malcata, increased water usage and climate change have caused water shortage and droughts, and sedimentation caused by summer fires is negatively affecting the freshwater diversity in these sites.

Finally, the southern KBA site Sierra de Gredos y Candelario and the southern potential KBA sites of Río Yeltes, Río Adaja, Río Corneja and Río Eresma exhibited high numbers of threatened species, with a relatively lower number of non-native species, except for some invertebrate species. Trigger species were found in all of the potential KBA sites. This part of the Douro river basin regions seem to be more affected by water shortage and sediment inputs from agriculture activities. Special attention should be given to the potential KBA site Río Adaja, that is mostly dry during the summer months, but the few permanent pools that remain, concentrate large abundances of fish. The pool numbers seem to be decreasing and the river will possibly dry completely over the course of the following years.

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Conservation guidance

This study provided an overview of the status of freshwater biodiversity in the Douro river basin, and on the effectiveness of KBA sites in conserving the trigger species and other threatened freshwater species. In the majority of sampling sites the freshwater trigger species were not recorded, and in half of the KBA sites the freshwater trigger species were not detected at all. In contrast, trigger species were detected in all four potential KBA sites (Máiz-Tomé et al., 2017). A more detailed and comprehensive survey on trigger species is needed to detect and assess the abundance of these species for each KBA site. An update of the status of the KBA sites is necessary if the results show an absence or low abundance of the trigger species or any other threatened species. Furthermore, the investigated sites that were delineated as potential KBA (Máiz-Tomé et al., 2017) should be nominated as KBA sites to conserve the high number of threatened freshwater species present. Other threatened species found in the KBA sites should be added as additional trigger species during the updating. Additionally, the area for some KBA sites (Babia-Somiedo, Malcata, Serras de Motesinho e Nogueira) has to be extended to include locations where trigger species occur.

Further recognition of the high conservation importance of freshwater KBA sites is needed to strengthen the measures to preserve the freshwater biodiversity in the KBA sites. An intial step should be to include the KBA trigger species in the management plans of existing protected areas (Ramsar Sites, Natura 2000 sites, other national or regional protection schemes). It would be good to analyse the feasibility and convenience of including their monitoring as an indicator of conservation status of the site. KBA sites should also be included in the River Basin Management Plans, either as water bodies or as protected areas, to ensure that an appropriate planning of the basin is done and to ensure that enough water is allocated for the conservation of these sites and that no other measures in the plan harm these sites. One project in the Douro river basin already started with the protection and the recovery of native endemic fish populations: the Project Cipriver in the southwest of Salamanca. By captive breeding and adaptation of the riverine habitat conditions, they aim to restore the natural populations of native endemic fish species.

Several conservation measures can be taken to improve the conditions of the freshwater biodiversity in the Douro river basin. One of the main threats are the non-native species that have been introduced in the river basin and are outcompeting the native endemic species. Management measures aiming to contain, control or even eradicate these non-native species should be implemented in order to conserve the native endemic species. Another threat are the large amount of dams and weirs that are obstructing the river connectivity. As many of the smaller dams and weirs are no longer in use, a survey should be undertaken to assess the removal of many obsolete barriers and the required measures to increase the riverine connectivity for the freshwater biodiversity in the existing dams. Particularly, in the KBA site Sierra de la Cabrera, special effort should be made to increase the connectivity of the river Tera to the Douro River, by selecting obsolete dams and barriers for decommissioning and building fish passages on barriers impermeable to fish. Finally, agricultural practices with high water consumption should be avoided to keep required ecological water levels high in the rivers and streams. A water management plan is needed to avoid part of river Ulcero within the KBA site Cañón del Río Lobos to dry out in the summer.

7

Conclusions

This study assessed the status of freshwater biodiversity in ten Key Biodiverisity Areas of the Douro river basin and four potential Key Biodiversity Areas (Máiz-Tomé et al., 2017). The findings paint a somber picture of the situation in the Douro river basin. The native and endemic species are being outcompeted by non-native species, and suffering from habitat eutrophication and sedimentation due to agricultural and forestry activities. High water consumption and climate change have caused water shortage and droughts, leaving several streams and pools dry during the summer months. Physical barriers and dams are blocking the migration of many endemic species, isolating freshwater species populations and making them more prone to genetic erosion and local extinction.

No trigger species were found in 43% of all investigated sites. Especially, the situation of the KBA sites in the northwestern part of the Douro river basin is alarming and a further investigation is needed to assess trigger species abundance and to re-evaluate their status as KBA site. The southwestern part of the Douro basin is characterized by a high number of trigger and threatened species, and several investigated regions in this part of the Douro basin should be recognized as KBA site to protect the existing freshwater biodiversity. Freshwater KBA sites have a high conservation importance, but clear distribution data for the trigger species is necessary and active monitoring and coordination are needed to better conserve the present biodiversity.

Sampling along the Douro river © Ronaldo Sousa

References

Andresen, T., De Aguiar, F. B., & Curado, M. J. (2004). The Alto Douro wine region greenway. *Landscape and urban planning*, 68(2-3), 289-303. https://doi.org/10.1016/S0169-2046(03)00156-7

BirdLife International (2021). *The World Database of Key Biodiversity Areas*. Developed by the KBA Partnership: BirdLife International, International Union for the Conservation of Nature, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Global Wildlife Conservation, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, Wildlife Conservation Society and World Wildlife Fund. Available at www.keybiodiversityareas.org

Bordalo, A. A., Teixeira, R., & Wiebe, W. J. (2006). A water quality index applied to an international shared river basin: the case of the Douro River. *Environmental Management*, 38(6), 910-920. https://doi.org/10.1007/s00267-004-0037-6

Cortes, R. M., Peredo, A., Terêncio, D. P., Sanches Fernandes, L. F., Moura, J. P., Jesus, J. J., ... & Pacheco, F. A. (2019). Undamming the Douro River catchment: A stepwise approach for prioritizing dam removal. *Water*, 11(4), 693. https://doi.org/10.3390/w11040693

Cummings, K. S., Jones, H. A., and Lopes-Lima, M. (2016). Rapid bioassessment methods for freshwater molluscs*. Core Standardized Methods*, 186.

Darwall, W., Carrizo, S., Numa, C., Barrios, V., Freyhof, J. and Smith, K. (2014). *Freshwater Key Biodiversity Areas in the Mediterranean Basin Hotspot: Informing species conservation and development planning in freshwater ecosystems*. Cambridge, UK and Malaga, Spain: IUCN. x + 86pp. https://doi.org/10.2305/IUCN.CH.2014.SSC-OP.52.en

Instituto da Água (INAG), I.P. (2008) *Manual para a avaliação biológica da qualidade da água em sistemas fluviais segundo a Directiva Quadro da Água: protocolo de amostragem e análise para a fauna piscícola*. Ministério do Ambiente, do Ordenamento do Território e do Desenvolvimento Regional.

IUCN (2016). *A Global Standard for the Identification of Key Biodiversity Areas*, Version 1.0. First edition. Gland, Switzerland: IUCN. https://portals.iucn.org/library/node/46259

Lourenço-Gomes, L., Pinto, L. M., & Rebelo, J. (2015). Wine and cultural heritage. The experience of the Alto Douro Wine Region. *Wine Economics and Policy*, 4(2), 78-87. https://doi.org/10.1016/j.wep.2015.09.001

Máiz-Tomé, L., Darwall, W., Numa, C., Barrios, V. and Smith, K. G. (2017). *Freshwater Key Biodiversity Areas in the north-western Mediterranean sub-region*. Gland, Switzerland, Cambridge, UK and Málaga, Spain: IUCN. viii + 48 pp. https://doi.org/10.2305/IUCN.CH.2017.SSC-OP.64.en

Nogueira, J. G., Sousa, R., Benaissa, H., De Knijf, G., Ferreira, S., Ghamizi, M., ... & Lopes-Lima, M. (2021). Alarming decline of freshwater trigger species in western Mediterranean key biodiversity areas. *Conservation Biology*, 35(5), 1367-1379. https://doi.org/10.1111/cobi.13810

Raven, P. J., Holmes, N. T. H., Dawson, F. H., and Everard, M. (1998). Quality assessment using river habitat survey data. *Aquatic conservation: marine and freshwater ecosystems*, 8(4), 477-499. https://doi.org/10.1002/(SICI)1099-0755(199807/08)8:4<477::AID-AQC299>3.0.CO;2-K

Raven, P.J., Fox, P.J.A., Everard, M., Holmes, N.T.H., and Dawson, F.H. (1997). 'River Habitat Survey: a new system for classifying rivers according to their habitat quality.' In Boon, P.J., and Howell, D.L. (ed.), *Freshwater Quality: Defining the Indefinable?*, pp. 215-234. Edinburgh: The Stationery Office.

Annexes

ANNEX A

Site location for the surveys of the distinct freshwater groups (Macroinvertebrates, Fish, Bivalves, Gastropods, Crayfish, Odonata, and Plants) and habitat assessments (River Habitat Survey – RHS), and water physical-chemical parameters. (✔ Sampled; -- Not Sampled)

SITE	DATE	HABITAT	LATITUDE	LONGITUDE	M. INVERTS.	FISH	BIVALVES	GASTROPODS	CRAYFISH	ODONATA	AQ. PLANTS	RHS	PHYSICAL CHEMICAL
KBA. **BABIA - SOMIEDO**													
D515	04/06/2018	River Omaña	42.78925	-6.02739	✔	✔	✔	✔	✔	✔	--	✔	✔
D517	03/06/2018	River Luna	42.95090	-6.02674	✔	✔	✔	✔	✔	✔	--	✔	✔
D518	04/06/2018	Acequia de la Fábrica de Luz	42.72932	-5.79437	✔	✔	✔	✔	✔	✔	--	✔	✔
D585	04/06/2018	River Órbigo	42.51045	-5.87351	✔	✔	✔	✔	✔	✔	--	✔	✔
D590	04/06/2018	River Omaña	42.71992	-5.92806	✔	✔	✔	✔	✔	✔	--	✔	✔
KBA. **FUENTES CARRIONAS**													
D0524b	02/06/2018	River Carrión	42.93941	-4.65710	✔	✔	✔	✔	✔	✔	--	✔	✔
D0553	02/06/2018	River Pisuerga	42.96462	-4.49022	✔	✔	✔	✔	✔	✔	--	✔	✔
D2018	02/06/2018	River Rivera	42.89063	-4.59463	✔	✔	✔	✔	✔	✔	--	✔	✔
KBA. **SIERRA DE GREDOS Y CANDELARIO**													
IUCN10	01/06/2018	River Tormes	40.38515	-5.52018	✔	✔	✔	✔	✔	✔	--	✔	✔
IUCN11	01/06/2018	River Tormes	40.34793	-5.29192	✔	✔	✔	✔	✔	✔	--	✔	✔
KBA. **SIERRAS DE PEÑA LABRA Y DEL CORDEL**													
D0569	04/06/2018	River Pisuerga	42.85484	-4.45881	✔	✔	✔	✔	✔	✔	--	✔	✔
D0570	04/06/2018	River Rubagon	42.84852	-4.25044	✔	✔	✔	✔	✔	✔	--	✔	✔
D0597	04/06/2018	River Camesa	42.80252	-4.21368	✔	✔	✔	✔	✔	✔	--	✔	✔
KBA. **SIERRAS DE URBIÓN, CEBOLLERA Y NEILA**													
D0543	10/06/2017	River Douro	41.91948	-2.85543	✔	✔	✔	✔	✔	✔	--	✔	✔
IUCN9	26/09/2019	River Razon	41.92206	-2.55628	✔	✔	✔	✔	✔	✔	--	✔	✔
KBA. **CAÑÓN DEL RÍO LOBOS**													
IUCN5	26/09/2019	River Ucero	41.72055	-3.04812	✔	✔	✔	✔	✔	✔	--	✔	✔
IUCN6	26/09/2019	River Lobos (DRY)	41.74138	-3.05968	--	--	--	--	--	--	--	--	--
KBA. **SERRAS DE MONTESINHO E NOGUEIRA**													
D0019	27/06/2017	Tuela River	41.89905	-6.93740	✔	✔	✔	✔	✔	✔	--	✔	✔
D0097	27/06/2017	River Mente	41.86599	-7.19390	✔	✔	✔	✔	✔	✔	--	✔	✔
D0098	27/06/2017	River Rabacal	41.88178	-7.13948	✔	✔	✔	✔	✔	✔	--	✔	✔
IUCN1	28/06/2017	River Sabor	41.89626	-6.72739	✔	✔	✔	✔	✔	✔	--	--	--
IUCN2	28/06/2017	River Sabor	41.90842	-6.75597	✔	✔	✔	✔	✔	✔	--	--	--
IUCN3	28/06/2017	River Baceiro	41.93221	-6.84956	✔	✔	✔	✔	✔	✔	--	--	--
IUCN4	28/06/2017	River Baceiro	41.83137	-6.94136	✔	✔	✔	✔	✔	✔	--	--	--
MON1	25/09/2019	Ribeira de Santa Catarina	41.85338	-6.78891	--	--	--	--	--	--	✔	--	--
MON2	24/09/2019	River Sabor	41.90336	-6.72938	--	--	--	--	--	--	✔	--	--

SITE	DATE	HABITAT	LATITUDE	LONGITUDE	M. INVERTS.	FISH	BIVALVES	GASTROPODS	CRAYFISH	ODONATA	AQ. PLANTS	RHS	PHYSICAL CHEMICAL
KBA. **SIERRA DE LA CABRERA**													
D0502	05/06/2018	River Tera	42.11138	-6.67414	✔	✔	✔	✔	✔	✔	--	✔	✔
D0587	05/06/2018	River Tera	42.12322	-6.74816	✔	✔	✔	✔	✔	✔	--	✔	✔
SAN001	24/09/2019	River Tera	42.12430	-6.74805	--	--	--	--	--	--	✔	--	--
KBA. **EL REBOLLAR**													
Dou218	09/06/2017	River Agueda	40.30175	-6.81172	✔	✔	✔	✔	✔	✔	--	✔	✔
Dou221	09/06/2017	River Malavao	40.37512	-6.57641	✔	✔	✔	✔	✔	✔	--	✔	✔
REB001	26/09/2019	River Agueda	40.30180	-6.81124	--	--	--	--	--	--	✔	--	--
KBA. **MALCATA**													
D0038	22/06/2017	River Coa	40.48592	-6.99021	✔	✔	✔	✔	✔	✔	✔	✔	✔
D0576	22/06/2017	River Coa	40.28811	-6.93500	✔	✔	✔	✔	✔	✔	--	✔	✔
IUCN7	12/10/2019	River Coa	40.39023	-7.05460	✔	✔	✔	✔	✔	✔	--	✔	✔
RÍO CORNEJA													
IUCN8	01/06/2018	River Corneja	40.49542	-5.30118	✔	✔	✔	✔	✔	✔	✔	✔	✔
D0564	01/06/2018	River Corneja	40.46934	-5.43397	✔	✔	✔	✔	✔	✔	--	✔	✔
RÍO YELTES													
D0508	12/06/2017	River Yeltes	40.70091	-6.34474	✔	✔	✔	✔	✔	✔	✔	✔	✔
D0513	10/06/2017	River Morasverdes	40.64401	-6.30880	✔	✔	✔	✔	✔	✔	--	✔	✔
RÍO ADAJA													
IUCN12	27/09/2019	River Adaja (DRY)	40.55986	-5.05170	--	--	--	--	--	--	--	--	--
IUCN13	27/09/2019	River Adaja	40.55750	-4.93099	✔	✔	✔	✔	✔	✔	--	✔	✔
RÍO ERESMA													
IUCN16	25/09/2019	River Eresma	41.35672	-4.68675	✔	✔	✔	✔	✔	✔	--	✔	✔
IUCN17	25/09/2019	River Eresma	41.22177	-4.52236	✔	✔	✔	✔	✔	✔	--	✔	✔

ANNEX B

Detected species presence and abundance per sampling site in the different (potential) KBA sites, including the Red List Category for each species. Green values corresponds to native species and red values to non-native species. (✖ Not species detected; - Not Sampled). IUCN Red List Categories: CR Critically Endangered, EN Endangered, VU Vulnerable, NT Near Threatened, LC Least Concern, DD Data Deficient, NE Not Evaluated

KBA. **BABIA - SOMIEDO**			D515	D517	D518	D585	D590
Fish	Cobitis calderoni	EN	✖	✖	✖	✖	✖
	Achondrostoma arcasii	VU	✖	✖	✖	3	13
	Salmo trutta fario	LC	27	32	32	31	20
	Barbatula barbatula	LC	✖	✖	51	69	20
Gastropods	Ancylus fluviatilis	LC	✖	✖	1		
	Peregriana peregra	NE	18	12	8	1	2
Crayfish	Pacifastacus leniusculus	LC	✖	✖	1	✖	✖
Odonata	Calopteryx virgo	LC	1	✖	✖	✖	✖

KBA. **FUENTES CARRIONAS**			D0524b	D2018	D0553
Fish	Pseudochondrostoma duriense	VU	✖	✖	✖
	Achondrostoma arcasii	VU	✖	3	✖
	Salmo trutta fario	LC	15	4	✖
	Phoxinus bigerri	LC	✖	173	77
	Gobio lozanoi	LC	✖	35	1
Crayfish	Pacifastacus leniusculus	LC	✖	✖	1

KBA. **SIERRA DE GREDOS Y CANDELARIO**			IUCN10	IUCN11
Gastropods	*Iberhoratia aurorae*	DD	✖	✖
Fish	*Cobitis paludica*	VU	1	1
	Pseudochondrostoma duriense	VU	15	1
	Squalius alburnoides	VU	12	✖
	Salmo trutta fario	LC	2	4
	Squalius carolitertii	LC	2	✖
Gastropods	*Ancylus fluviatilis*	LC	7	✖
	Lymnaea peregra	LC	✖	6
Bivalves	*Unio delphinus*	LC	10	✖
	Pisidium casertanum	LC	✖	16
Odonata	*Macromia splendens*	VU	1	✖
	Cordulegaster boltoni	LC	1	1
	Gomphus simillimus	LC	3	✖
	Onychogomphus forcipatus	LC	4	✖
	Onychogomphus uncatus	LC	24	7

KBA. **SIERRAS DE PEÑA LABRA Y DEL CORDEL**			D0569	D0570	D0597
Fish	*Pseudochondrostoma duriense*	VU	✖	✖	✖
	Achondrostoma arcasii	VU	✖	2	10
	Salmo trutta fario	LC	3	✖	✖
	Phoxinus bigerri	LC	51	1	35
	Gobio lozanoi	LC	✖	✖	16
Bivalves	*Pisidium casertanum*	LC	2	1	✖
Gastropods	*Ancylus fluviatilis*	LC	3	✖	3
	Lymnaea peregra	LC	1	✖	✖
	Planorbidae sp.		1	✖	✖
Crayfish	*Pacifastacus leniusculus*	LC	1	✖	1

KBA. **SIERRAS DE URBIÓN, CEBOLLERA Y NEILA**			D0515	D0517
Fish	*Cobitis calderoni*	EN	✖	✖
	Achondrostoma arcasii	VU	✖	✖
	Pseudochondrostoma duriense	VU	✖	✖
	Salmo trutta fario	LC	10	23
	Phoxinus bigerri	LC	93	✖
Bivalves	*Pisidium casertanum*	LC	✖	1
Crayfish	*Pacifastacus leniusculus*	LC	2	✖
Odonata	*Calopteryx virgo*	LC	5	✖

KBA. **CAÑÓN DEL RÍO LOBOS**			IUCN5	IUCN6
Fish	*Achondrostoma arcasii*	VU	✖	-
	Pseudochondrostoma duriense	VU	✖	-
	Salmo trutta	LC	32	-
Gastropods	*Ancylus fluviatilis*	LC	4	-

KBA. **SERRAS DE MONTESINHO E NOGUEIRA**			D0019	D0097	D0098	IUCN1	IUCN2	IUCN3	IUCN4	MON1	MON2
Fish	*Cobitis calderoni*	EN	✖	✖	21	✖	✖	✖	✖	-	-
Bivalves	*Margaritifera margaritifera*	EN	51		188	✖	✖	✖	✖	-	-
Fish	*Pseudochondrostoma duriense*	VU	18	39	27	1	✖	✖	4	-	-
	Luciobarbus bocagei	LC	2	✖	✖	✖	✖	✖	✖	-	-
	Salmo trutta fario	LC	28	55	38	10	7	82	12	-	-
	Squalius carolitertii	LC	30	6	18	55	6	✖	✖	-	-
Gastropods	*Lymnaea peregra*	LC	✖	147	✖	✖	✖	✖	✖	-	-
Crayfish	*Pacifastacus leniusculus*		✖	6	1	✖	✖	✖	✖	-	-
Odonata	*Boyeria irene*	LC	2	1	1	✖	✖	✖	✖	-	-
	Platycnemididae sp.	LC	✖	✖	1	✖	✖	✖	✖	-	-
	Gomphidae sp.	LC	10	18	3	✖	✖	✖	✖	-	-
	Coenagrionidae sp.	LC	✖	56		✖	✖	✖	✖	-	-
Aquatic plants	*Agrostis stolonifera*	LC	-	-	-	-	-	-	-	✖	<0.1
	Apium nodiflorum	LC	-	-	-	-	-	-	-	1	✖
	Athyrium filix-femina	LC	-	-	-	-	-	-	-	✖	0.1-1
	Carex paniculata lusitanica	LC	-	-	-	-	-	-	-	20	✖
	Cyperus longus	LC	-	-	-	-	-	-	-	7	✖
	Epilobium hirsutum	LC	-	-	-	-	-	-	-	10	✖
	Filipendula ulmaria	LC	-	-	-	-	-	-	-	0.1-1	✖
	Fontinalis antipyretica	LC	-	-	-	-	-	-	-	0.1-1	0.1-1
	Fontinalis hypnoides	LC	-	-	-	-	-	-	-	✖	0.1-1
	Fraxinus angustifolia	LC	-	-	-	-	-	-	-	10	✖
	Juncus acutiflorus	LC	-	-	-	-	-	-	-	8	✖
	Juncus inflexus	LC	-	-	-	-	-	-	-	10	✖
	Lemna minor	LC	-	-	-	-	-	-	-	✖	0.1-1
	Lycopus europaeus	LC	-	-	-	-	-	-	-	0.1-1	✖
	Lythrum hyssopifolium	LC	-	-	-	-	-	-	-	<0.1	✖
	Lythrum salicaria	LC	-	-	-	-	-	-	-	2	✖
	Mentha pulegium	LC	-	-	-	-	-	-	-	0.1-1	✖
	Mentha suaveolens	LC	-	-	-	-	-	-	-	<0.1	✖
	Myosotis secunda	LC	-	-	-	-	-	-	-	✖	<0.1
	Osmunda regalis	LC	-	-	-	-	-	-	-	✖	<0.1
	Persicaria hydropiper	LC	-	-	-	-	-	-	-	✖	<0.1
	Platyhypnidium riparioides	LC	-	-	-	-	-	-	-	✖	0.1-1
	Ranunculus cf. peltatus	LC	-	-	-	-	-	-	-	✖	3
	Ranunculus flammula	LC	-	-	-	-	-	-	-	<0.1	✖
	Solanum dulcamara	LC	-	-	-	-	-	-	-	0.1-1	0.1-1
	Veronica catenata	LC	-	-	-	-	-	-	-	<0.1	✖
	Callitriche sp.	LC	-	-	-	-	-	-	-	✖	<0.1
	Carex sp.	LC	-	-	-	-	-	-	-	✖	1
	Gongrosira sp.	LC	-	-	-	-	-	-	-	✖	5
	Salix sp.	LC	-	-	-	-	-	-	-	10	✖
	Zygnematalean algae	LC	-	-	-	-	-	-	-	✖	60

KBA. **SIERRA DE LA CABRERA**			D0587	D0502	SAN001
Fish	*Cobitis calderoni*	EN	19	26	-
	Achondrostoma arcasii	VU	42	✖	-
	Anguilla anguilla	CR	2	✖	-
	Pseudochondrostoma duriense	VU	5	1	-
	Gobio lozanoi	LC	39	2	-
	Luciobarbus bocagei	LC	3	✖	-
	Salmo trutta fario	LC	2	2	-
Odonata	*Calopteryx virgo*	LC	2	1	-
	Onychogomphus uncatus	LC	1	✖	-
	Boyeria irene	LC	✖	2	-
Aquatic plants	*Baldellia repens*	NT	-	-	5

KBA. **SIERRA DE LA CABRERA** (cont.)			D0587	D0502	SAN001
	Agrostis canina	LC	-	-	0.1-1
	Apium inundatum	LC	-	-	3
	Calliergonella cuspidata	LC	-	-	<0.1
	Callitriche brutia	LC	-	-	2
	Carum verticillatum	LC	-	-	2
	Galium palustre	LC	-	-	<0.1
	Glyceria fluitans	LC	-	-	2
	Juncus bulbosus	LC	-	-	4
	Juncus effusus	LC	-	-	<0.1
	Lythrum portula	LC	-	-	0.1-1
	Mentha pulegium	LC	-	-	<0.1
	Myosotis sicula	LC	-	-	0.1-1
	Myriophyllum alterniflorum	LC	-	-	20
	Pellia epiphylla	LC	-	-	<0.1
	Ranunculus flammula	LC	-	-	3
	Sphagnum denticulatum	LC	-	-	0.1-1
	Veronica scutellata	LC	-	-	0.1-1
	Hypericum undulatum	NE	-	-	<0.1

KBA. **EL REBOLLAR**			Dou218	Dou221	REB001
Fish	*Cobitis vettonica*	EN	✖	14	-
	Cobitis paludica	VU	✖	3	-
	Pseudochondrostoma duriense	VU	✖	10	-
	Squalius alburnoides	VU	✖	64	-
	Luciobarbus bocagei	LC	✖	4	-
	Salmo trutta fario	LC	51	7	-
Odonata	*Calopteryx virgo*	LC	1	✖	-
Crayfish	*Procambarus clarkii*	LC	✖	5	-
Aquatic plants	*Apium nodiflorum*	LC	-	-	3
	Bryum pseudotriquetrum	LC	-	-	<0.1
	Fontinalis antipyretica	LC	-	-	0.1-1
	Juncus effususu	LC	-	-	<0.1
	Mentha suaveolens	LC	-	-	<0.1
	Oenanthe crocata	LC	-	-	2
	Persicaria hydropiper	LC	-	-	<0.1
	Cratoneruon filicinum	NE	-	-	<0.1
	Scapania sp.		-	-	<0.1

KBA. **MALCATA**			D0038	D0576	IUCN7
Aquatic plants	*Eryngium viviparum*	EN	✖	-	-
Fish	*Cobitis paludica*	VU	38	✖	✖
	Pseudochondostroma duriense	VU	4	✖	73
	Squalius alburnoides	VU	163	1	15
	Luciobarbus bocagei	LC	19	✖	✖
	Salmo trutta fario	LC	✖	5	4
	Squalius carolitertii	LC	13	✖	7
Gastropods	*Physella acuta*	LC	36	✖	✖
Bivalves	*Unio delphinus*	NT	137	✖	✖
	Anodonta anatina	LC	54	✖	✖
Odonata	*Boyeria irene*	LC	2	4	✖
	Calopteryx virgo	LC	✖	4	✖
	Cercion lindeni	LC	5	✖	✖
	Coenagrion puella	LC	13	1	✖
	Cordulegaster boltoni	LC	✖	2	✖
	Gomphus simillimus	LC	2	✖	✖
	Onychogomphus forcipatus	LC	7	✖	✖
	Cordulegaster boltoni	LC	✖	2	✖
Crayfish	*Procambarus clarkii*	LC	10	✖	✖
Aquatic Plants	*Alisma plantago-aquatica*	LC	<0.1	-	-
	Alnus glutinosa	LC	0.1-1	-	-
	Apium nodiflorum	LC	1	-	-
	Bidens cernua	LC	<0.1	-	-

KBA. **MALCATA** (cont.)			D0038	D0576	IUCN7
	Bidens frondosa	LC	<0.1	-	-
	Cyperus longus	LC	<0.1	-	-
	Eleocharis palustris	LC	3	-	-
	Galium palustre	LC	<0.1	-	-
	Juncus articulatus	LC	<0.1	-	-
	Lemna gibba	LC	0.1-1	-	-
	Lemna minor	LC	<0.1	-	-
	Leptodictyum riparium	LC	0.1-1	-	-
	Ludwigia palustris	LC	0.1-1	-	-
	Lunularia cruciata	LC	<0.1	-	-
	Lycopus europaeus	LC	<0.1	-	-
	Myriophyllum alterniflorum	LC	<0.1	-	-
	Oenanthe crocata	LC	<0.1	-	-
	Paspalum distichum	LC	5	-	-
	Potamogeton berchtoldii/pusillus	LC	<0.1	-	-
	Ranunculus penicillatus	LC	0.1-1	-	-
	Sparganium erectum ssp. *oocarpum*	LC	1	-	-
	Typha latifolia	LC	0.1-1	-	-
	Veronica catenata	LC	0.1-1	-	-
	Veronica × *lackschewitzii*		<0.1	-	-
	Azolla sp.		<0.1	-	-
	Callitriche sp.		0.1-1	-	-
	Stigeoclonium sp.		<0.1	-	-
	Vaucheria sp.		<0.1	-	-

RÍO CORNEJA			IUCN8	D0564
Fish	*Achondrostoma arcasii*	VU	14	4
	Pseudochondrostoma duriense	VU	✖	1
	Squalius alburnoides	VU	✖	3
Gastropods	*Planorbidae* sp.	LC	✖	1
Aq. plants	*Alisma lanceolatum*	LC	<0.1	-
	Corrigiola litoralis	LC	<0.1	-
	Eleocharis palustris	LC	<0.1	-
	Gnaphalium uliginosum	LC	<0.1	-
	Juncus effusus	LC	<0.1	-
	Lythrum portula	LC	<0.1	-
	Scirpoides holoschoenus	LC	<0.1	-
	Veronica catenata	LC	<0.1	-
	Sysimbrella aspera	NE	<0.1	-
	Ranunculus Sect. Batrachium sp.		<0.1	-

RÍO YELTES			D0508	D0513
Fish	*Achondrostoma salmantinum*	EN	17	35
	Cobitis paludica	VU	32	1
	Pseudochondrostoma duriense	VU	29	✖
	Squalius alburnoides	VU	1	✖
	Salmo trutta	LC	4	1
	Squalius carolitertii	LC	147	9
	Luciobarbus bocagei	LC	5	✖
	Gambusia holbrooki	LC	1	✖
Gastropods	*Ancylus fluviatilis*	LC	3	5
Odonata	*Calopteryx virgo*	LC	✖	1
	Gomphidae sp.		✖	1
Crayfish	*Procambarus clarkii*	LC	20	✖
Aquatic Plants	*Cyperus longus*	LC	0.-1-1	-
	Epilobium hirsutum	LC	0.-1-1	-
	Equisetum ramosissimum	LC	0.-1-1	-
	Galium palustre	LC	0.-1-1	-
	Hypericum undulatum	LC	<0.1	-
	Juncus articulatus	LC	0.-1-1	-
	Juncus effusus	LC	<0.1	-
	Lycopus europaeus	LC	0.-1-1	-
	Mentha pulegium	LC	<0.1	-

RÍO YELTES (cont.)			D0038	D0576	IUCN7
	Mentha suaveolens	LC	<0.1	-	
	Persicaria salicifolia	LC	0.-1-1	-	
	Scirpoides holoschoenus	LC	<0.1	-	
	Typha angustifolia	LC	<0.1	-	
	Veronica catenata	LC	<0.1	-	
	Filago lutescens	NE	<0.1	-	
	Hypericum undulatum	NE	<0.1	-	
	Salix sp.		30	-	

RÍO ADAJA			IUCN12	IUCN13
Fish	*Cobitis paludica*	VU	-	181
	Achondrostoma arcasii	VU	-	119
	Squalius carolitertii	LC	-	19
	Gobio lozanoi	LC	-	17
Gastropods	*Lymnaea peregra*	LC	-	2

RÍO ADAJA			IUCN16	IUCN17
Fish	*Cobitis calderoni*	EN	✖	✖
	Achondrostoma arcasii	VU	131	198
	Pseudochondrostoma duriense	VU	2	9
	Luciobarbus bocagei	LC	11	42
	Squalius carolitertii	LC	3	2
	Gobio lozanoi	LC	136	162
Bivalves	*Corbicula fluminea*	LC	44	✖
Odonata	*Gomphidae* sp.	LC	3	1

Source: data compiled by the authors with categories from IUCN Red List.

ANNEX C

Habitat parameters measured per sampling site in the different (potential) KBA sites. (– Not sampled).

	River Habitat Survey (RHS)		Macroinvertebrates		Physical-Chemical			
SITE	Habitat Quality Assessment (HQA)	Habitat Modification Score (HMS)	Biotic Index (IBMWP)	% of Individuals - EPT	Dissolved Oxygen (mg/L)	pH	Conductivity (µS)	Temperature (ºC)
KBA. **BABIA - SOMIEDO**								
D515	33	460	145	89.81	10.58	7.81	65	8.7
D517	38	990	103	88.54	13.32	8.19	204	10.8
D518	55	530	127	79.63	9.04	7.83	239	9.9
D585	41	940	97	25.25	10.06	8.02	173	12.2
D590	48	190	134	82.99	10.48	7.8	62	10.2
KBA. **FUENTES CARRIONAS**								
D0524b	41	100	151	54	12.5	7.59	48	11.2
D0553	50	260	104	25.16	13.04	8.08	256	11.8
D2018	38	560	147	89.61	12.7	7.77	128	13.2
KBA. **SIERRA DE GREDOS Y CANDELARIO**								
IUCN10	65	100	156	33.11	7.89	6.34	17.5	12.6
IUCN11	72	1280	199	50.11	7.21	6.49	22.8	13.5
KBA. **SIERRAS DE PEÑA LABRA Y DEL CORDEL**								
D0569	54	610	141	57.68	7.68	7.57	140.2	12.2
D0570	62	1890	62	17.61	10.58	7.81	65	8.7
D0597	49	1130	106	11.08	7.30	7.51	220.1	13.5
KBA. **SIERRAS DE URBIÓN, CEBOLLERA Y NEILA**								
D0543	55	0	93	23.35	6.38	-	47	16.6
IUCN9	43	270	86	16.01	6.86	-	86.9	14.3
KBA. **CAÑÓN DEL RÍO LOBOS**								
IUCN5	53	100	108	28.82	7.48	-	434	11.8
IUCN6	-	-	-	-	-	-	-	-

	River Habitat Survey (RHS)		Macroinvertebrates		Physical-Chemical			
SITE	Habitat Quality Assessment (HQA)	Habitat Modification Score (HMS)	Biotic Index (IBMWP)	% of Individuals - EPT	Dissolved Oxygen (mg/L)	pH	Conductivity (µS)	Temperature (ºC)
KBA. **SERRAS DE MONTESINHO E NOGUEIRA**								
D0019	59	135	154	64.92	6.83	6.25	57.6	18.9
D0097	59	465	197	41.23	6.84	6.4	48.2	19.6
D0098	60	100	203	62.75	7.05	6.44	38	20.5
IUCN1	-	-	117	59.26	-	-	-	-
IUCN2	-	-	233	23.03	-	-	-	-
IUCN3	-	-	126	54.67	-	-	-	-
IUCN4	-	-	126	81.56	-	-	-	-
MON1	-	-	-	-	-	-	-	-
MON2	-	-	-	-	-	-	-	-
KBA. **SIERRA DE LA CABRERA**								
D0502	41	360	147	48.03	9.92	7.4	14	11.4
D0587	39	10	149	31.08	9.89	7.41	15	12.9
SAN001	-	-	-	-	-	-	-	-
KBA. **EL REBOLLAR**								
Dou218	73	1580	187	35.73	8.59	-	18.9	12.6
Dou221	84	420	235	56.2	8.46	-	16.6	17.9
REB001	-	-	-	-	-	-	-	-
KBA. **MALCATA**								
D0038	60	2200	159	45.53	-	6.63	48.9	27.6
D0576	63	1130	263	48.55	-	5.50	17.5	16.5
IUCN7	-	-	114	45.83	-	-	-	-
RÍO CORNEJA								
IUCN8	65	340	110	48.61	7.14	6.78	83.9	14.3
D0564	67	1330	40	47.3	7.35	7.20	108	13.4
RÍO YELTES								
D0508	78	710	121	85.04	8.23	5.95	71.7	24.5
D0513	81	1400	140	56.12	7.67	-	25.5	20.9
RÍO ADAJA								
IUCN12	-	-	-	-	-	-	-	-
IUCN13	33	460	21	0	13.29	-	530	17.1
RÍO ERESMA								
IUCN16	54	250	23	3.38	9.10	-	466	17.6
IUCN17	57	370	64	30.86	10.32	-	432	16.4

Source: data compiled by the authors.

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