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THREATENED FRESHWATER FISHES OF THE MEDITERRANEAN BASIN BIODIVERSITY HOTSPOT

Distribution, extinction risk and the impact of hydropower

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Contents

List of Acronyms

IUCN	International Union for Conservation of Nature
MBBH	Mediterranean Basin Biodiversity Hotspot
MW	Megawatts (installed power)
GBIF	Global Biodiversity Information Facility
GIS	Geographic Information System
HH	Hydropower Hazard


Project area
Existing dam
Under implementation
Planned dam
Installes Megawatts (MW)
0,1 - <1
1 - <10
10 - 50
50 - 100
>100

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Preface

This book is an obligatory resource for those who develop hydropower projects, study and work in wetland and species conservation; those who plan, develop and manage protected natural areas and resources; those responsible for Environmental Impact Assessments; those who plan for land use management; and those who authorise investment projects in freshwater ecosystems.

We live in times of strong and rapid change which bring more wealth and development to the countries of North Africa, Europe, and the Middle East. Talk to your parents and grandparents; their life was very likely not better than yours today. Economies have grown considerably. People live longer, can afford better education and a healthier life allowing them to look optimistically into their future and that of their children. Countries and their citizens have made great efforts to improve living conditions and are increasingly successful.

Change however comes with a price as development affects biodiversity and drives climate change. Citizens and countries are concerned and great efforts are underway aiming to balance the negative effects of development with climate change and biodiversity loss. **Never before have so many people cared for a healthy environment**, been active at different scales, and are educated about climate change, pollution, the destruction of nature and the loss of biodiversity. Awareness of biodiversity and climate issues are rising and this comes absolutely in time. We see plenty of new activities to protect nature, save rivers and fishes, and designate protected areas. **These actions strongly support the fight against climate change**. As change comes increasingly fast, more effort is needed to balance nature with human development than ever before. But, there is good reason to look positively into the future - much will be left of our wonderful nature for our children to enjoy, although it will be quite different from today. We only need to be able to act.

Every effort and every species counts and still the glass is more than half-full. When it comes to freshwater fish, which is the most strongly-impacted vertebrate group in our study area, only 19 out of almost 800 species have gone extinct. This is just 2.4%, meaning that 97.6% have been able so far, to cope (somehow) with the changes humans brought to their rivers, springs and lakes. **Following the prognosed future hydropower development, our study suggest as many near-time extinctions might happen as in the last two centuries**, without taking unpredictable efforts of serious climate change into account. However, we remain optimistic, that most, if not all species can be saved if informed action is taken.

It is time to act on an informed background. While climate change has been well- researched, biodiversity is lost at a local scale and often unnoticed by local and national representatives. This is partly due to the lack of available information on biodiversity loss, where important areas for biodiversity are and where developmental activities are and will be most detrimental.

Only this book makes detailed information about the Mediterranean Basin Biodiversity Hotspots's threatened freshwater fish species accessible to experts and nonexperts alike. It brings together relevant and authoritative information that is required to understand and protect the diversity of freshwater fishes in the region.

The aim of this book is to raise awareness of the diversity of freshwater fishes and the threats they face, especially from uninformed development of hydropower. It fills an important gap because freshwater fishes represent an oft-forgotten but highly endemic and at-risk element of Mediterranean biodiversity. They and their ecosystems are also often ignored when conservation priorities are set, infrastructure projects are planned and water resources are managed. Finally, **it allows those who care for biodiversity to make wise decisions**.

Dr. Jörg Freyhof

IUCN SSC/WI Freshwater Fish Specialist Group, Chair for North Africa, Europe and the Middle East

A run of river hydropower plant and diversion canal on the Soča River in Slovenia.

Executive summary

The **Mediterranean Basin Biodiversity Hotspot** is among the most biologically diverse regions worldwide and renowned for its richness of endemic freshwater species. But the hotspot's lakes, rivers and wetlands are **seriously threatened** by an unprecedented boom in hydropower development. As a result, aquatic ecosystems have become increasingly degraded due to construction of dams and other infrastructure, compounded by a range of other threats.

Advocates of this flawed development model repeatedly **overestimate economic benefits** and ignore severe environmental consequences. In particular, the impacts of small (<10 MW) hydropower plants are disproportionately high when offset against their minuscule contribution to global energy production.

At least 5,269 hydropower plants are already operating in the region, with 202 currently under construction. **A further 6,393 are proposed**, including 5,962 small projects, while **1,579 exist and 2,091 are planned within the boundaries of national parks, biosphere reserves, and other protected areas**.

In order to anticipate the biodiversity impact of this widening hydropower infrastructure it is essential to understand where threatened species are distributed. This report presents detailed range maps for all **251 freshwater fish species** presently recognised as **threatened** in the Mediterranean Basin Biodiversity Hotspot alongside an updated evaluation of their respective extinction risks.

The results suggest that an alarming **63% of all threatened freshwater fish species** have already been driven closer to extinction by existing hydropower plants, with **55% of all Critically Endangered species highly impacted**.

Should hydroelectric expansion in the region go ahead as planned, **74% of all threatened freshwater fish species** will be negatively impacted, with 65% set to decline due to small projects alone. At least seven of these **could become globally extinct in the wild as a result**. Hydropower projects, particularly **small schemes, are therefore the most important driver of potential fish species extinctions in the Mediterranean Basin Biodiversity Hotspot**.

Impoundments created by dams and other hydroelectric infrastructure are also the key pathway by which **non-native fish species, another major cause of freshwater fish declines, enter fluvial ecosystems**.

Moreover, if the hydroelectric schemes planned in the Mediterranean Basin Biodiversity Hotspot are implemented, **nations will be unable to comply** with the

United Nations 2030 Agenda for Sustainable Development or binding international biodiversity targets agreed by parties to the Convention on Biological Diversity and European Union member states.

There is an urgent need to mitigate the escalating ecological damage triggered by the hydropower binge through preservation and restoration of free-flowing rivers. Rapid and significant action underpinned by sound scientific evidence is required to **safeguard freshwater ecosystems** and the incredibly rich biodiversity they support throughout the region. By improving the state of the natural environment, the **impacts of ongoing climate change would also be reduced**.

It is hoped that **this report will help inform** nature conservation, governments and policy-makers to make the right political, financial and consumer choices to reverse the trend of freshwater biodiversity decline throughout the Mediterranean Basin Biodiversity Hotspot.

Key findings

In the Mediterranean Basin Biodiversity Hotspot...

...there are at least **5,269** hydropower plants already operating.

...there are **6,393** planned hydropower plants, including **5,962** small schemes.

251 freshwater fish species are threatened with global extinction.

63%

of threatened freshwater fish species have been **negatively** impacted by existing hydropower infrastructure.

55%

of Critically Endangered freshwater fish species have been **highly** impacted by existing hydropower infrastructure.

74%

of all threatened freshwater fish species will be driven **further towards extinction** if hydropower expansion continues as planned.

65%

of threatened freshwater fish species will be negatively impacted by planned small hydropower plants.

The Voidomatis River, a tributary within the Aoös (aka Vjosa) drainage in northwestern Greece, is one of the most unspoiled rivers in the Mediterranean Basin Biodiversity Hotspot.

1. BACKGROUND

1. 1. The Mediterranean basin

A global biodiversity hotspot under threat

Human society is built on resources provided by nature, and natural systems are critical for our long-term health, wealth, food and security[1,2]. However, the increased demand for energy, land and water driven by human population growth is causing ecosystems and biodiversity to disappear at an alarming rate[3,4,5].

A growing body of evidence suggests that the current rate of species extinctions is at least 1,000 times greater than the natural background rate[6,7]. This catastrophic decline is altering key processes essential for the productivity and sustainability of Earth's ecosystems[8].

Biodiversity and its loss are not uniformly distributed across the world, and 36 biogeographical regions have been recognised as global biodiversity hotspots and prioritised for conservation measures[9,10]. These areas are defined as being outstandingly rich in endemic species undergoing significant habitat loss due to human activities[11,12].

The Mediterranean Basin Biodiversity Hotspot (hereafter MBBH) is the second largest in the world, spanning more than 2 million square kilometres. It stretches eastwards from Portugal to Eastern Turkey and southwards from Italy to the Cape Verde archipelago, including parts of the Iberian Peninsula, France, the Balkan States, Greece, the Middle East, Egypt and the Maghreb. Altitude ranges from mountain peaks exceeding 4,500 metres in the Alps to the shores of the Dead Sea, the lowest point on Earth at 430 metres below sea level[12,13,14].

The MBBH is the only region on Earth where three continents meet and this interaction has produced highly distinctive geological features. The often spectacular present-day scenery is largely the result of the mid-Tertiary collision of the African and Eurasian Plates, but also a complex mosaic of migrating island arcs, fragmenting tectonic belts, and extending back-arc basins. Tectonic uplift and rapid erosion are ongoing in areas such as Sicily and the Apennine Mountains. In some parts of the basin, especially Spain, the eastern Adriatic coast and the Anatolia plateau, large karstic landforms have developed, where rainwater infiltrates rapidly and emerges in vauclusian springs at the base of mountain ranges[15-18].

The climate is largely characterised by cool, humid winters and hot, dry summers. Rainfall in the region is subject to high inter-annual and seasonal variability, and there exist a wide range of local climates with mean annual precipitation ranging from 100 mm to more than 3,000 mm. Most rainfall occurs during the autumn, winter, and spring, and there are regular long and intense dry periods with intermittent extreme storms and floods. In

The Campillos River in the Guadalhorce River drainage, southwestern Spain.

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general, the MBBH is wetter in the northwest and becomes progressively more arid to the south and east[12,19].

The MBBH harbours an exceptionally diverse and highly distinctive flora and fauna characterised by a unique mixture of temperate and subtropical elements with a large proportion of endemic species. Evolution and speciation have been driven by tectonic movement, earthquakes and volcanic activity, the near-desiccation of the Mediterranean Sea during the Messinian Salinity Crisis 5-6 million years ago, and the region's location at the intersection of Europe, Asia and Africa. This complex paleogeography resulted in biotas repeatedly fragmenting and merging as dispersal barriers opened and closed over time[20,21,22].

Although most well known for its floral diversity, with around 25,000 species of vascular plant of which approximately half are found nowhere else on Earth, the MBBH also supports important numbers of endemic reptiles, amphibians, freshwater fishes and invertebrates. The hotspot is critical during the annual migration of hundreds of millions of birds[23-26].

However, the MBBH is also a region of global political and economic prominence that must provide livelihoods for hundreds of millions of people. The majority of ecosystems have already been intensively modified, sparking declines in the number and distribution of many species. Extinction risk assessments for 5,785 species native to the MBBH have been carried out by the IUCN, with 23% found to be threatened with extinction[13,27].

Further reading

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BIODIVERSITY LOSS: Brooks et al. (2006)[3], Díaz et al. (2006)[4], Hooper et al. (2012)[5].

SPECIES EXTINCTIONS: Pimm et al. (1995, 2014)[6,7], Ceballos et al. (2015)[8].

BIODIVERSITY HOTSPOTS: Myers (1990)[9], Myers et al. (2000)[10], Mittermeier et al. (2004, 2011)[11,12].

MBBH: Cuttelod et al. (2009)[13], Hewitt (2011)[14].

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CLIMATE: Lionello (2012)[19].

BIOGEOGRAPHY: Woodward (2004)[20], Médail & Diadema (2009)[21], Allen (2014)[22].

SPECIES DIVERSITY: Blondel & Aronson (1999)[23], Hahn et al. (2009)[24], De Figueroa et al. (2013)[25], Feliner (2014)[26].

EXTINCTION RISK: IUCN (2019)[27].

1. 2. The hydropower paradox

An exploding human population, rapid economic development and increased demand for renewable energy have established hydropower as a worldwide phenomenon since the mid-20th century[1-3]. In 2018 it contributed 16% to the global energy mix, accounting for 62% of electricity derived from renewable resources[4]. **Current capacity is set to be at least doubled by 2030 with more than 3,700 large hydroelectric plants planned or under construction worldwide**[5,6].

Consistently touted as a clean and sustainable energy source, hydropower is a mature technology that has become a key element of many national socio-economic strategies as countries seek to comply with the United Nations Sustainable Development Goals and other international agreements[4]. **Yet while freshwater is renewable, hydropower development triggers far-reaching economic, environmental and social impacts** at odds with such targets[5].

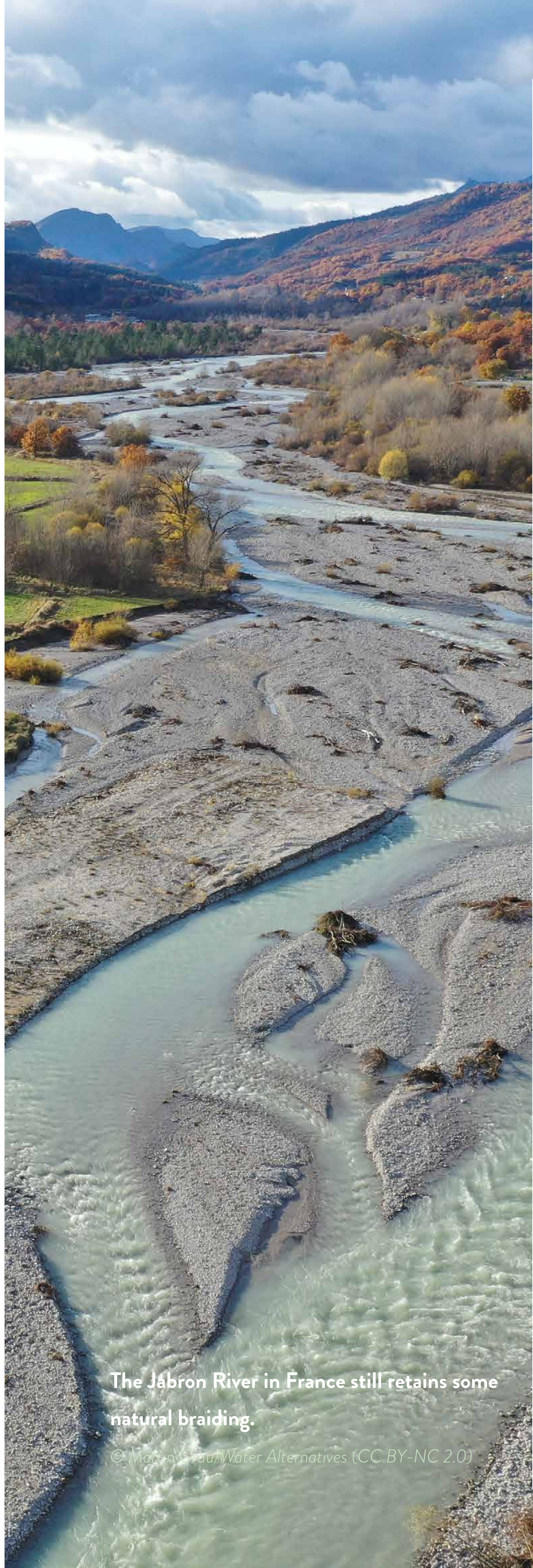
Ecological consequences of hydropower infrastructure include fragmentation of free-flowing rivers (Box 1), drastic alterations of flow and temperature regimes, diminished water quality, severe reductions in sediment transport, and land degradation[7-14]. **The devastating repercussions on biodiversity, natural water resources, and ecosystem processes and services have been widely reported**[15-18]. Some large hydropower projects have even been linked to the generation of earthquakes[19].

Hydropower is also a significant contributor to global warming, with the world's hydroelectric dams annually discharging more greenhouse gases than Canada, and some reservoirs rivalling the emissions of coal-fired power plants[20-21]. But the Intergovernmental Panel on Climate Change, which sets standards for measuring nations' greenhouse gas emissions, does not include artificial lakes in its calculations[22].

Negative social ramifications of hydropower include forced displacement and inhumane or unjust treatment of sometimes very large human populations, loss of livelihoods, abandonment of traditional lands and practices, flooding of cultural heritage assets including indigenous territories, increased risk of water-borne illness, political corruption, and disproportionate distribution of economic benefits[23-27].

Large hydropower projects make little economic sense, with an average cost overrun of 96% before the effects of inflation and debt servicing are included[28]. They also take a long time to build and suffer typical delays of 44% on projected schedules, making them ineffective at solving urgent energy crises[28].

Public support for large hydroelectric dams has plummeted yet national administrations continue to commission new projects, particularly in countries with emerging



The Jabron River in France still retains some natural braiding.

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Box 1: Go with the flow[51-59]

Economies and societies need to re-evaluate the benefits of free-flowing rivers

Freshwaters are among the most complex and productive ecosystems on the planet. Global inland fisheries account for 12% of the world's annual catch, supporting low income communities and boosting economies. Rivers deliver sediment and nutrients to sustain fertile deltas and floodplains, providing food and livelihoods for hundreds of millions of people. Functioning floodplains act as natural flood defence systems, while healthy wetlands act as carbon sinks, purify water, and replenish the aquifers from which springs flow.

For these and other benefits to people, economies and nature to be delivered, rivers must remain free-flowing.

A river is defined as free-flowing when natural ecosystem functions and services are largely unaffected by changes to fluvial connectivity, allowing unimpeded movement and exchange of water, energy, material and species within the river system and with surrounding landscapes. Fluvial connectivity comprises longitudinal (up- and downstream), lateral (floodplains and riparian areas), vertical (groundwater and atmosphere) and temporal (seasonal flows) elements.

Studies have revealed that only one-third of the world's rivers longer than 1,000 kilometres remain entirely free-flowing. These are mostly restricted to remote regions of the Arctic, Amazon and Congo, with very few in densely-populated areas. Dam construction is the overwhelming driver of this connectivity loss, with the impacts often evident for hundreds of kilometres downstream.

economies[29-32]. Meanwhile, approval for small 'run of river' (Box 2) hydropower projects with capacities of less than 10 MW has soared. It has been estimated that there are currently around 83,000 operating or under construction in upwards of 150 countries[33]. **Small plants account for more than 90% of all hydropower schemes worldwide but their contribution to global electricity generation is less than 2%**[33,34].

Small-scale projects are favoured because they are relatively cheap to install, straightforward to maintain, have few safety risks, assist nations' progress towards renewable energy targets, and are perceived as being environmentally friendly[33,34]. Some countries have systematically prioritised their expansion by introducing incentives such as favourable feed-in tariffs or exemption from Environmental Impact Assessment procedures[34].

The impacts of small hydropower plants were until recently understudied, and their rapid spread has on the whole taken place indiscriminately and in the absence of scientifically-informed regulations[35]. Facilities can vary markedly in dam or weir size, reservoir area, storage capability, outlet structure, and operating procedure, all of which affect their ecological footprint[33,35]. This diversity creates an array of negative consequences which mirror those associated with larger plants[36].

In some cases a series of small plants may be installed in a single river drainage or downstream of a larger reservoir, resulting in a cumulative impact[37]. Others cause major ecosystem alterations by using water artificially transferred from elsewhere[38]. They are often located on vulnerable minor rivers or headwater streams in rural sites with high biodiversity value, including protected areas[39,40].

Legislation regarding minimum downstream flow rates is regularly inadequate or non-existent, while cumulative or transboundary impacts are often not assessed at all[41]. **Research has shown that the collective social and environmental conflicts created by small hydropower plants are more substantial per generated MW than for large projects**[33,35,37,42].

Moreover, hydropower cannot be considered a long-term solution to global energy needs[43]. Construction of large plants slowed in developed nations after all the most suitable sites were exploited, and some are now being removed after outliving their usefulness[44,45]. Over time they become increasingly inefficient, unsafe and expensive to repair, while reservoirs fill with sediment, reducing their productivity and capacity for water storage[46]. This pattern is set to repeat itself across the planet as the infrastructure of the current boom also ages. The likelihood of climate change inducing longer droughts and more intense floods in some parts of the world further undermines the myth that hydropower is sustainable[47-50].

While hydropower projects may offer short- and medium-term benefits, they tend to be followed by serious and unacceptable longer-term economic, environmental, and social costs that far outweigh the net gains[5,17,22,24,29,34,43]. Yet the perception of hydroelectricity as clean and sustainable is still actively promoted by industry lobbyists and government energy authorities, a paradox that has seen environmental and human rights laws steamrollered as the hydropower spree continues.

Further reading

HYDROPOWER BOOM: Koch (2002)[1], Pazheri et al. (2014)[2], Grill et al. (2015)[3], IHA (2019)[4], Zarfl et al. (2015)[5], Schulz & Adams (2019)[6].

ENVIRONMENTAL IMPACTS: Williams & Wolman (1984)[7], Ward & Stanford (1995)[8], Vörösmarty et al. (2003)[9], Nilsson et al. (2005)[10], Olden & Naiman (2010)[11], Poff & Zimmermann (2010)[12], Seitzinger et al. (2010)[13], Sternberg (2010)[14], Aristi et al. (2014)[15], Jager et al. (2015)[16], Lees et al. (2016)[17], Botelho et al. (2017)[18], Zhang et al. (2019)[19].

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SMALL HYDROPOWER: Couto & Olden (2018)[33], Kelly-Richards et al. (2017)[34], Premalatha et al. (2014)[35], Anderson et al. (2015)[36], Kibler & Tullos (2013)[37], Anderson et al. (2006)[38], Şekercioğlu et al. (2011)[39], Lange et al. (2018)[40], Bidoglio et al. (2019)[41], Gleick (1992)[42].

AGEING DAMS: Moran et al. (2018)[43], Poff & Hart (2002)[44], Stanley & Doyle (2003)[45], O'Connor et al. (2015)[46].

CLIMATE CHANGE: Palmer et al. (2008)[47], Tarroja et al. (2016)[48], van Vliet et al. (2016)[49], Turner et al. (2017)[50].

ECOSYSTEM SERVICES: Sparks (1995)[51], Tockner & Stanford (2002)[52], Hoeinghaus et al. (2009)[53], Ziv et al. (2012)[54], Giosan et al. (2014)[55], Nicholls et al. (2018)[56].

FREE-FLOWING RIVERS: Poff et al. (1997)[57], Auerbach et al. (2014)[58], Grill et al. (2019)[59].

TYPES OF HYDROPOWER: Egré & Milewski (2002)[60], Paish (2002)[61], McManamay et al. (2016)[62], Breeze (2018)[63].

Box 2: Types of hydropower[60-63]

The general principle of modern hydropower systems is the use of hydroturbines to convert pressure from flowing water into mechanical shaft power which is used to drive a generator. All hydropower plants rely on exploiting a hydraulic head, meaning the vertical change in elevation between the upper and lower limits of the infrastructure. Hydropower facilities are categorised according to their basic design, but in some cases can be classed as intermediate because they control the flow only during certain time periods.

Storage hydropower

Storage hydropower plants rely on water stored in a reservoir created by a dam, offering the flexibility to generate electricity on demand and reducing dependence on natural hydrological inflow. The hydraulic head is usually created by the height of the dam itself. Water is extracted from the reservoir via an intake called the headrace, from where it falls steeply into an enclosed pipe known as a penstock, passes through the hydroturbines and exits via an outlet structure called the tailrace. River flow downstream of the dam is controlled, and the routine of discontinuous electricity production based on demand brings about artificial fluctuations in discharge and water levels known as hydropeaking. The water must also be managed via a spillway so that the dam does not overflow during flood conditions, and periodic flushing of the reservoir is required to prevent excessive build-ups of sediment. Very large reservoirs can retain years' worth of water from tributary streams and rivers, and may also be multipurpose projects involving flood protection, irrigation, drinking water, fisheries and recreation.

Run-of-river hydropower

Most small hydropower projects fall into this category. The hydraulic head is created by diverting water from the natural channel to a hydropower plant before returning it to the river at some point downstream, or in some cases transferring it to a different drainage. A weir or small dam is normally built to aid the diversion, and output from the plant often fluctuates since it depends entirely on natural discharge. Non-diversion run of river schemes use water from a barrage located adjacent to the plant, whereas diversion schemes transport water to a distant generator through an extended headrace. In the latter scenario, the river or stream is dewatered to an extent between the headrace and tailrace. Depending on the project, the dewatered stretch may be very short or tens of kilometres in length, and flow can be severely reduced to nonexistent. Some run-of-river projects involve short-term water storage whereas others do not.

Pumped storage hydropower

Pumped storage plants use relatively cheap surplus energy to pump water from a lower reservoir into an upper storage reservoir during off-peak hours. When demand is highest, electricity is generated by releasing water from the upper reservoir to the hydroturbines through a penstock. When installed on rivers such schemes are often based on a standard storage dam design with an additional reservoir at the end of the tailrace, and can also operate as conventional plants when required. Others are isolated but require a source of water to fill and replenish them. They are usually constructed in mountainous regions although a handful are built on coastal cliffs and use the open sea as the lower reservoir. The use of abandoned mines and underground quarries in pumped storage schemes is currently being explored.

The Cavallers hydroelectric dam is a large storage plant on the Noguera de Tor River within the Ebro River drainage in northern Spain.

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1.3. Water in dry lands

Hydropower and a growing challenge

Freshwater ecosystems contain proportionately more species than marine or terrestrial environments, harbouring around 10% of all known animals including one third of all vertebrates despite covering less than 1% of the Earth's surface[1,2,3]. **The economic value of ecosystem services generated naturally by global rivers, lakes and wetlands such as deltas, peatlands, swamps, fens, and springs is higher than any other inland landscape at an estimated $47.4 trillion annually at the global scale**[4,5].

Yet escalating human demands have led to freshwater habitats becoming increasingly threatened, with alarming trends worldwide. According to the most recent Living Planet Index freshwater species have declined by 83% since 1970, while an estimated 50% of global wetlands have been lost since the beginning of the 20th century[6,7].

In the MBBH freshwater has been the single most important resource from the time of the earliest-known civilisations in the valleys of the Euphrates and Tigris rivers. Societies have since undertaken enormous efforts to harness the power of rivers, and modern water policies within the region are dominated by efforts to increase agricultural, domestic and industrial water supplies while producing hydroelectricity through the construction of dams and other infrastructure[8,9,10].

A total of 5,269 hydropower plants are known to be operating in the MBBH, with a further 202 being built and 6,393 proposed, of which around 90% qualify as small projects. The Balkan peninsula alone accounts for 78% of plants under construction and 58% of those planned. Many rivers have already been converted into chains of storage reservoirs and run-of-river plants with no fast-flowing reaches remaining[11,12].

Major rivers in the MBBH include the Ebro, Rhône, Po and Nile, all of which flow into the Mediterranean Sea. Tributaries of the Danube, Euphrates and Tigris also lie within its boundaries. The majority of river drainages are much smaller, however, and many flow only on a seasonal basis. The few large permanent natural lakes in the region are clustered in the Italian and Swiss Alps, the Balkan Peninsula, southwestern Turkey and Israel. Most are connected to rivers but the majority of the Turkish lakes are closed systems. There are also a multitude of temporal salt lakes and freshwater wetlands, smaller natural ponds, coastal lagoons and endorheic springs scattered throughout the hotspot. Among these varied ecosystems, 385 have been identified as Key Biodiversity Areas, defined as areas contributing significantly to the global persistence of biodiversity[13-17].

The MBBH is among the most densely inhabited regions of the world but there are substantial subregional discrepancies in terms of politics, demographics and socio-economics. Whereas European Union candidacy or

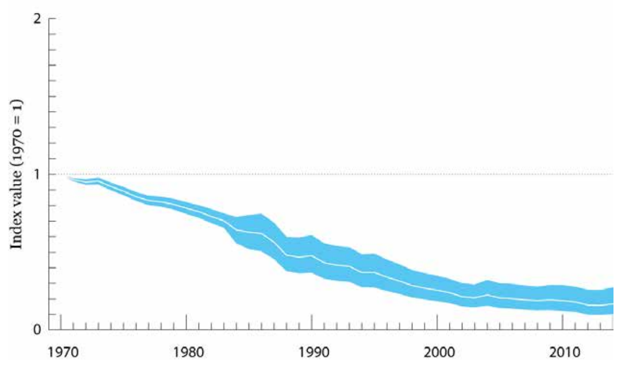

Figure 1: The latest freshwater Living Planet Index indicates a dramatic decline in freshwater species populations since 1970 © WWF, 2018

membership has driven integration in the northwest, much of the south and east remains relatively poor and politically unstable. North African and Middle Eastern countries are experiencing rapid demographic growth and are expected to account for 75% of the regional population by 2025[18,19].

Freshwater resources are also distributed unevenly. With the exception of Spain, all northwestern countries in the MBBH are considered to have sufficient renewable freshwater, but this is not the case elsewhere. Around 60% (180 million) of the global population considered to be 'water-poor' (having access to less than 1000 m^3 $person^{-1}$ $year^{-1}$) lives in the region, and this is projected to rise to 250 million by 2025. At least 60 million are living with extremely limited (less than 500 m^3 $person^{-1}$ $year^{-1}$) water resources, and 20 million have no access to treated drinking water[20,21].

Mediterranean economies are highly-dependant on irrigated agricultural production which has doubled since the 1960s and is currently responsible for 70-80% of water consumption[22,23]. Urbanisation has been rapid during the same period leading to increased demands for water and energy[24,25]. The MBBH is also a major tourist destination, attracting around 330 million visitors representing more than 30% of international holidaymakers worldwide as of 2015. Despite the significant economic benefits tourism is highly seasonal and drives an annual surge in summer electricity and water consumption[26,27,28].

These factors combine with the largely arid climate to place enormous pressure on the region's freshwater resources[29-33]. The Middle East essentially ran out of water during the 1970s, leading to shocking rates of groundwater depletion and raised political tensions (Box 3). Poor water management decisions, inadequate planning, uncontrolled abstraction, and policy errors, such as the use of inefficient irrigation methods or provision of subsidies for water-intensive monocultures, are rampant. Problems with waterlogging and soil salinisation are increasingly common in arid portions of the region due to saline groundwater coming to the surface when floodplain water is no longer recharged, or through constant irrigation of low permeability soils[34,35,36].

The MBBH is among the regions of the world most vulnerable to climate change, and this will further impact on the capacity of freshwater ecosystems to provide goods and services to human society. Observed and projected impacts include a greater rise in temperature than the European average and a significant decrease in rainfall, leading to increasing wildfires, desertification and biodiversity loss[37,38].

Based on an intermediate emissions scenario, temperatures in the Eastern Mediterranean, Middle East and North Africa could be 3.5 to 7°C higher than the 1961-1990 average by the end of the century. **Under a high emissions scenario, hydropower production across the region will slump by a projected 40%**[39]. These changes will further disrupt agricultural systems, reduce food security and place upland ecosystems under extreme pressure. Low-lying coastal areas are threatened by rising sea levels worsened by coastal erosion due to sediment retention in reservoirs[40-45] (Box 4).

Most experts agree that the physical, socioeconomic and environmental limits of supply-based water policies across most of the MBBH have been reached and in some cases exceeded[41,43,45]. Freshwater ecosystems in all parts of the hotspot have been lost, degraded or fragmented with a significant loss of biodiversity[16,17]. The construction of more than 6,300 additional hydropower plants in the region would undoubtedly speed up these processes and place the long-term food and water security of hundreds of millions of people at risk.

Further reading

FRESHWATER BIODIVERSITY: Denny (1994)[1], Dudgeon et al. (2006)[2], Strayer & Dudgeon

Box 3: Hydropolitics in the Middle East[45-55]

In the Middle Eastern portion of the MBBH all major rivers are transboundary systems and this has underpinned a series of political disputes. Comprehensive treaties on how these resources should be managed and shared have to date not been agreed, and water development projects have largely been carried out on a unilateral and uncoordinated basis.

For example, the highly controversial Southeastern Anatolia Project (*Güneydoğu Anadolu Projesi*, or GAP) in Turkey will eventually comprise 22 dams and 19 hydropower plants in the upper Euphrates and Tigris river drainages. The project has been underway since the 1960s and was estimated to be 74% complete as of 2017. It has significantly reduced discharge of the rivers in Syria and Iraq, leading to decades of friction. Similar quarrels have erupted over hydroelectric dam construction on tributaries of the Tigris draining from Iran to Iraq. The Euphrates-Tigris system is today among the most highly-regulated large river drainages in the world and the lack of flow has sparked a slew of environmental and social challenges in its lower reaches.

Turkey, Syria, and more recently Lebanon have also disagreed regarding use of the Orontes (Asi) River. Elsewhere, there have been long-standing tensions between Israel, Jordan and Syria over exploitation of the Jordan River and its main tributary the Yarmouk. As a result of dams and diversions the surface of the Dead Sea, into which the Jordan flows, is now more than 40 metres lower than in the 1970s, and thousands of hazardous sinkholes have formed around its shores.

The Al-Wehda dam on the Yarmouk River at the border between Syria and Jordan.

(2010)[3].

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MIDDLE-EASTERN HYDROPOLITICS: Kliot (1994)[46], Cooley & Gleick (2011)[47], Comair et al. (2013)[48], Dohrmann & Hatem (2014)[49], Gleick (2014)[50], Hassan et al. (2014)[51], Issa et al. (2014)[52], Hommes et al. (2016)[53], Conker & Hussein (2019)[54].

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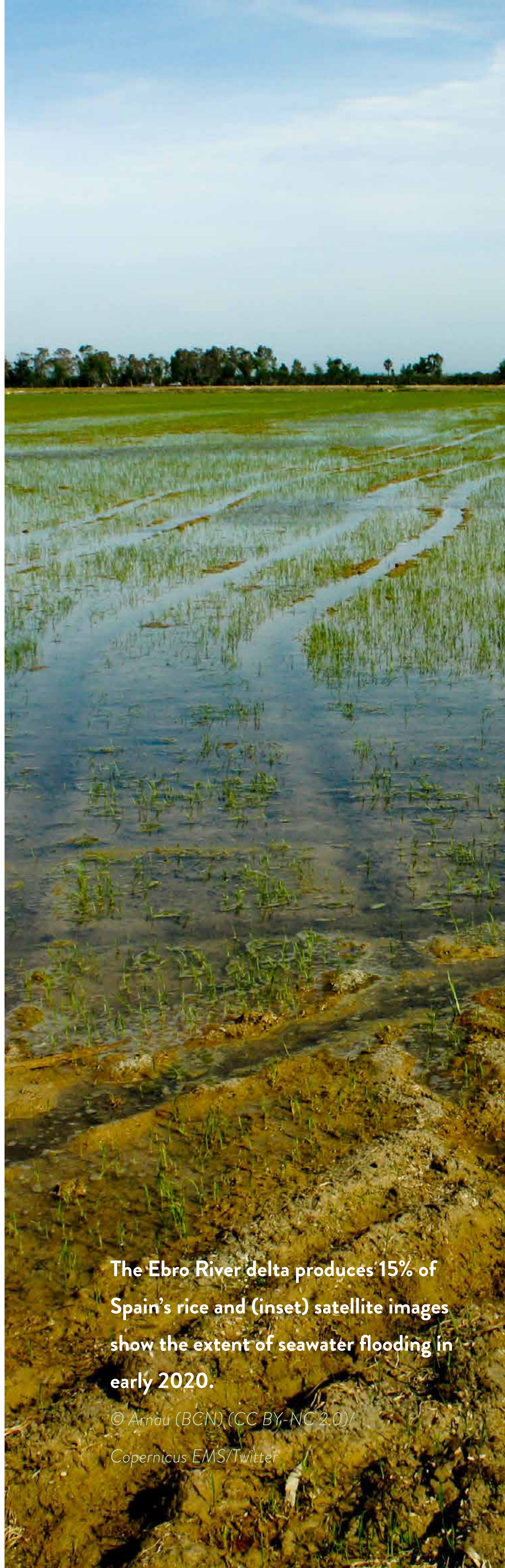
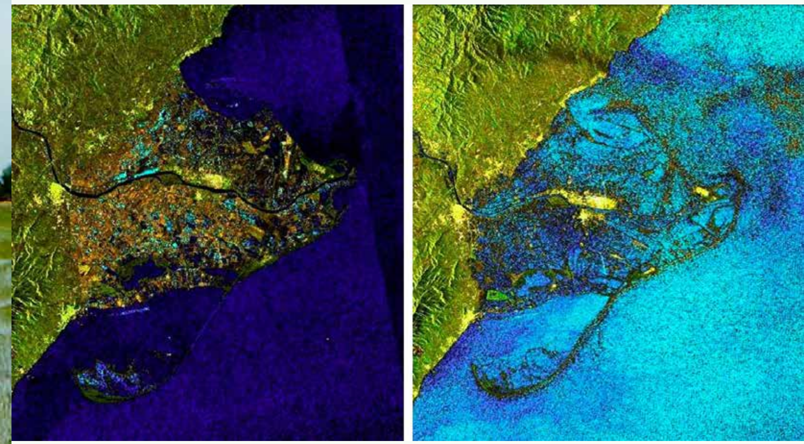
EBRO RIVER: Ibàñez et al. (1996)[57], Day et al. (2006)[58], Fatorić & Chelleri (2012)[59].



Box 4: The 2020 Ebro disaster[56-58]

A hydroelectric horror story



In early 2020 a storm surge saw seawater flood thousands of hectares of rice fields and coastal lagoons in the Ebro River Delta, Spain, a Ramsar wetland of international importance and part of the European Union's Natura 2000 network of nature protection areas. The site is responsible for producing 15% of the country's rice, provides critical habitat for 180,000 overwintering birds and harbours populations of two threatened freshwater fish species. Estimates place the cost of the devastation at €9.5 million.

Yet the catastrophe had been predicted for years and could have been prevented. The delta currently receives less than 1% of the 20-30 million tonnes of sediment it did on an annual basis prior to construction of a chain of three large hydroelectric dams on the lower reaches of the Ebro River, and in total the 930-kilometre system is dammed 181 times. The delta's shoreline had in some areas been receding by as much as five metres per year due to this reduced input, making the disaster inevitable.

The Ebro River delta produces 15% of Spain's rice and (inset) satellite images show the extent of seawater flooding in early 2020.

Summer refuge pools for several native fish species including the threatened Saramugo (*Anaecypris hispanica*) in the Sotillo River, a typical intermittent river in the Guadalquivir drainage, southern Spain.

© Matthew Ford

1.4. Life in fragile waters

Freshwater fishes in the MBBH

Freshwater fishes are the most diverse and threatened group of vertebrates on the planet, with almost 18,000 known species[1]. Around one third of these are endangered according to the IUCN, and during the 20th century their global extinction rate was greater than for any other vertebrate group[2,3].

In the MBBH native fishes can be found in most inland water bodies, being absent only from hypersaline lakes. The majority of species have Palearctic relationships, and there is a high level of endemism in the region comprising more than 70% of species in certain river systems. Some are highly localised while others are naturally wide-ranging[4-12]. They exhibit a number of typical life history strategies, and a basic knowledge of these is crucial to understanding the nature of the threats posed by hydropower and other forms of habitat degradation.

While some species are resident in nature most make migratory movements over a range of spatial and temporal scales. These shifts are typically related to feeding and growth, refuge from harsh environmental conditions or spawning, and might occur on a regular basis during an individual's lifetime. They sometimes include large proportions of a species' population and can take place at different life stages[13-15].

The majority of migratory species inhabiting the MBBH are potadromous, meaning they spend their entire life cycle in freshwater, and may move several to hundreds of kilometres within a lake or river drainage. A handful are diadromous and undertake long distance migrations of up to several thousand kilometres, splitting their life cycle between freshwater and saltwater[13-15].

While larger river channels and lakes hold water all year round, many smaller river drainages and tributaries in the MBBH are of a temporal nature and flow only for part of the year. This period typically extends from autumn to spring, with resident fishes surviving the summer months in pools or short reaches that retain water when the rest of the river dries out[16-18].

Species inhabiting such systems are naturally opportunistic and adapted to cope with extreme seasonal changes in conditions such as flow rate, temperature and food availability. Their population size fluctuates depending on the time of year and they often mature early in order to spawn ahead of the dry season. In some cases there is variation between populations of the same species, with those inhabiting temporal environments maturing at smaller sizes than in perennial waters[16-18].

Further reading

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Box 5: Unique habitats[19-22]

Cave biodiversity of the Dinaric karst

The Dinaric karst is a limestone area covering about 60,000 km^2, stretching along the eastern coast of the Adriatic Sea from the Bay of Trieste in the north, to the Drin River basin in the south, and the Western Morava River valley in the east. It is unique due to its geological and hydrological complexity, and globally significant for the number of endemic fish species that have adapted to its subterranean water bodies.

Aquatic habitats in the area comprise isolated river drainages, some of which flow across karstic plateaus known as poljes before draining into swallow holes or ponors and reappearing elsewhere. Following heavy rainfall the poljes naturally flood and form important spawning habitat for native fishes, which retreat underground or into perennial springs for periods of several months each year.

Some of the most intact rivers in the MBBH are found in this area, but they are threatened by the construction of several thousand hydropower schemes. A number of existing plants have already interfered with the complex groundwater balance in some parts of the region.

The source of the Cetina River in the the Dinaric karst, Croatia. Five threatened freshwater fish species are native to the Cetina system.

1.5. Dams, humans and aliens

Freshwater fishes at risk

Native freshwater fishes are undergoing dramatic declines throughout the MBBH, and a number of species are known to have become extinct since the start of the 20th century. **The overwhelming drivers are introduction of non-native fish species and anthropogenic modification of natural systems, in particular the construction of dams and other barriers**[1-8].

Hydroelectric structures alter and fragment habitats, inhibiting the movement of fishes and other aquatic organisms. They limit reproduction and longevity by physically blocking fish migration routes to spawning and feeding habitats. Even low weirs can constitute major barriers to upstream migration, while during downstream movements individuals are often injured or killed as they are forced to pass through hydropower turbines or down spillways[9-12].

Dams further hinder the life cycles of those species adapted to seasonal flood pulses by interfering with flow regimes, artificially controlling the quantity, timing and variability of water discharge. Natural flow cycles in the MBBH revolve around seasonal rainfall, with high water levels triggering many species to migrate and breed. **Dams and weirs curb these processes and have repeatedly driven the extirpation of entire fish stocks or confined species to breed only in restricted locations**, even in the presence of mitigating structures such as fishways[9-17] (Box 6).

Some dams release no water at all and prevent the formation of summer refuge habitats in temporal rivers. This is particularly true of the thousands of water retention dams built throughout the MBBH (Box 7). Others diminish or eliminate inundation of floodplains which provide vital nursery and spawning habitat for many fish species during high-water periods[11,12,17].

Hydropeaking, the intermittent release of water from reservoirs for hydropower production, brings about extreme fluctuations in discharge over sub-daily timescales. These unnatural modifications in flow commonly lead to substantial downstream declines in fish abundance, diversity, and reproductive success. Although conventionally linked to high-head storage facilities, significant short-term flow variation has also been observed below some run-of-river hydropower plants[18-21].

The negative effects of hydropeaking are often worsened by abrupt and simultaneous water temperature fluctuations referred to as thermopeaking. Depending on the depth or time of year, water drawn from behind a dam may be several degrees cooler or warmer than that in the river below, provoking massive drift responses in the macroinvertebrate communities that constitute the primary food source for many fishes.

The Ataturk Dam in Turkey was completed in 1990 and completely blocks the Euphrates River.

Box 6: Going nowhere[44-52]

The false promise of fishways

While the number of anadromous long-distance migratory species in the MBBH is limited, many riverine fishes undertake temporal movements for feeding, refuge or spawning that are crucial for population processes. The installation of fishways on dams and other barrages has been the principal method employed to mitigate their impacts since the 19th century.

In theory fishways maintain bidirectional movement of fishes by allowing them to pass obstructions. A number of different designs exist, including technical fishways such as pool, vertical slot, Denil (counter-flow), or surface-collector structures, special-purpose installations like eel ladders, fish locks or lifts, and nature-like bypasses or rock ramps built to resemble natural channels. The alternative term "fish pass" is often used, but this can sometimes give rise to false implications of efficient functioning.

In fact, **fishways have largely failed to support riverine fish communities** due to substandard design, insufficient structural integrity or a lack of long-term servicing. They have also tended to focus on the upstream migration of commercially important fishes such as salmonids or eels, and do not benefit the majority of species. Downstream movement does not tend to be taken into account at all, leading to deaths and injuries when fishes are forced through turbines or over spillways.

Moreover, the majority of hydropower facilities are not designed to support effective fishways, and even when successful they can never compensate for the negative consequences of habitat loss resulting from impoundment. Although longitudinal connectivity might be restored, the reservoirs and other artificial waterbodies created by dams and weirs act as additional barriers to the migration, dispersal and recruitment of native fishes due to the lack of natural flow and gradient. These harmful effects become dangerously cumulative when a river or stream is obstructed multiple times.

The majority of large dams in the MBBH do not include any fish passage facilities, blocking fish movement entirely and often dramatically altering upstream communities. Fishways are increasingly included in the design of smaller structures, however, and in some countries have been added retrospectively.

A slot-style fish pass on a tributary of the Danube River.

Downstream water chemistry can also deteriorate since thermal stratification in deep reservoirs sometimes leads to discharges of deadly anoxic water. Surface water released through spillways often becomes supersaturated with atmospheric gases, inducing gas bubble disease which can be lethal for fishes[21,22,23].

The conversion of free-flowing river stretches to static artificial lakes with unstable downstream flow reduces the extent of suitable habitat for riverine fishes, particularly affecting rheophilic species adapted to fast-flowing reaches. The trapping of nutrients and sediment in reservoirs degrades floodplains and deltas, and alters the morphology of river beds and channels due to increased erosion. The most typical effects below dams are narrowing and deepening of channels, enlarged substrate size and reduced braiding. Such physical remodelling tends to drive an ecological regime shift whereby dynamic systems with high structural and functional complexity become relatively homogenous and less productive[9,24,25,26].

The continued introduction of non-native freshwater species is driving collapses in natural fish communities throughout the MBBH (Box 8). **Hydropower schemes strongly encourage catastrophic biological invasions** due to the lentic environmental conditions they create, coupled with the human tendency to exploit artificial lakes for commercial or recreational fishing by releasing certain favoured species.

Other forms of river engineering also exert a negative effect on fish communities. Canalisation, the process of installing locks and weirs to a river to ensure sufficient depth for navigation, can fragment rivers and block migrations in a similar way to damming if not designed to include efficient mitigation measures. Channelisation, whereby a river channel is modified and straightened for flood control or land drainage, speeds flow and aggravates the impacts of hydropeaking. Such modifications often include lining the channel with concrete to prevent erosion, obliterating structural heterogeneity and riparian habitats[27,28].

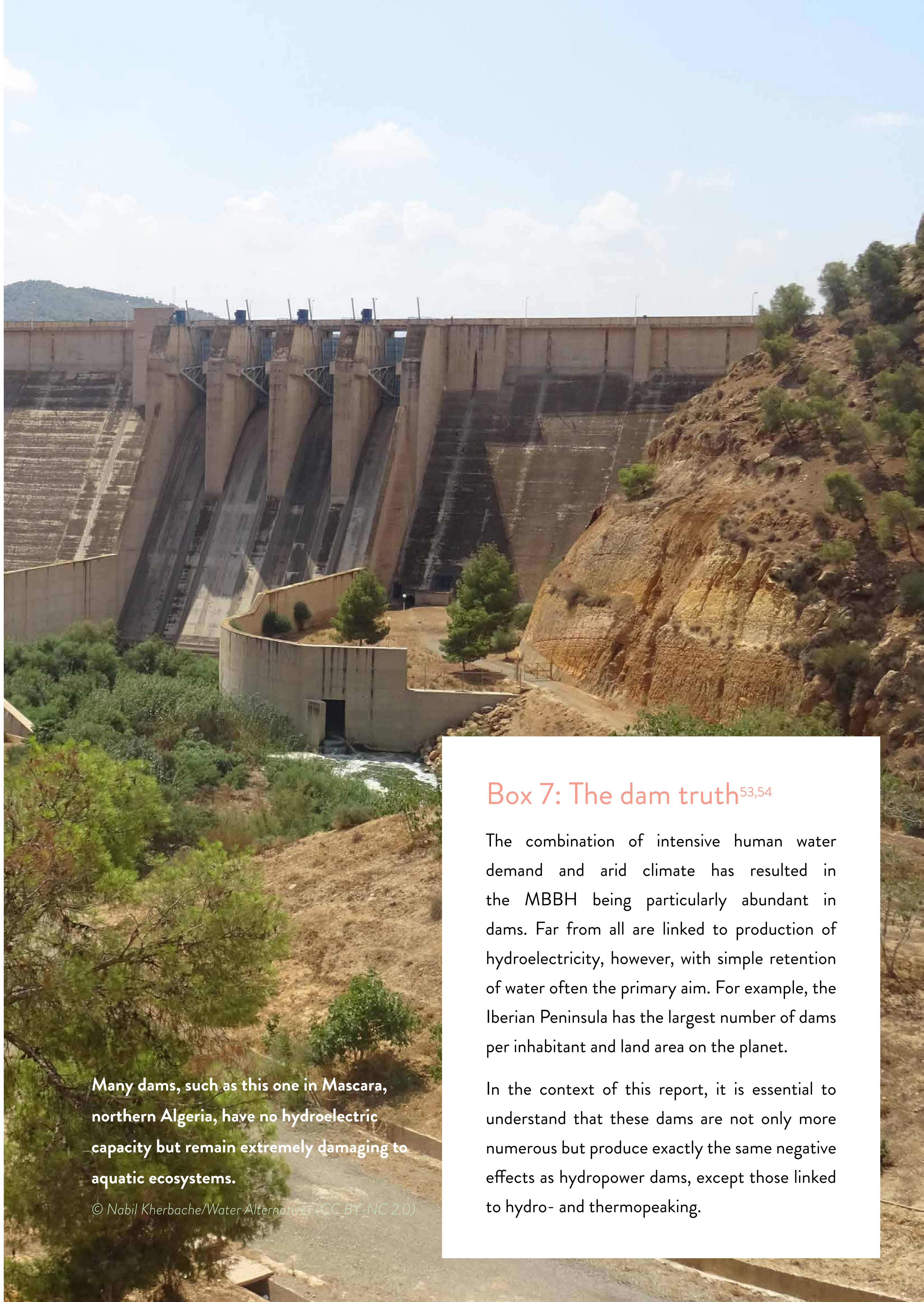
The mining of fluvial aggregate such as sand or gravel disrupts river bank and channel morphology, produces sediment deficits and slows natural flow. Habitat quality is reduced with natural riffle-pool-run sequences replaced by continuous pools, leading generalist and invasive species to displace native habitat specialists[29,30,31].

Freshwater ecosystems across the MBBH are also impacted by increasing withdrawal and consumption of surface water for a variety of uses but dominated by irrigated agriculture. Intensive and often uncontrolled water abstraction has already prompted a serious decrease in groundwater levels in some areas, reduced flows in rivers and wetlands, and brought about a massive loss of suitable fish habitat. Hydropower development has contributed by reducing perennial surface flows, obliging affected rural and urban communities to seek water from other sources. Some formerly permanent rivers now flow only on an intermittent basis or have dried out completely[32,33,34].

Pollution of both ground and surface water is also a concern, with rivers still used as a waste disposal system in some parts of the MBBH. The main sources of contamination are raw or insufficiently treated domestic sewage and wastewater, fertilisers and pesticides from agriculture, veterinary drugs, industrial discharges or accidents involving heavy metals and oils, toxic chemicals from mining operations, and uncontrolled dumping of solid waste from a variety of sources[35,36,37].

Although overfishing is not a major threat in most of the MBBH, it is one of the primary drivers of the devastating crash in sturgeon populations, and there is evidence of certain species being overharvested in some rivers of the Middle East[38,39,40].

Freshwater fishes in the MBBH are thus exposed to multiple stressors, and there is growing evidence that these act synergistically to worsen biodiversity loss and ecological degradation by amplifying the direct single consequence of each threat. Although not currently a major issue in most of the region, climate change is likely to be superimposed on these hazards in the near future[41,42,43].



Many dams, such as this one in Mascara, northern Algeria, have no hydroelectric capacity but remain extremely damaging to aquatic ecosystems.

Box 7: The dam truth[53,54]

The combination of intensive human water demand and arid climate has resulted in the MBBH being particularly abundant in dams. Far from all are linked to production of hydroelectricity, however, with simple retention of water often the primary aim. For example, the Iberian Peninsula has the largest number of dams per inhabitant and land area on the planet.

In the context of this report, it is essential to understand that these dams are not only more numerous but produce exactly the same negative effects as hydropower dams, except those linked to hydro- and thermopeaking.

Box 8: Alien invasion[55-81]

Exotic species drive declines

Hydroelectric dams and other impoundments are the most important gateway for invasions by non-native fish species, which in the MBBH mainly occur via the recreational fisheries sector. The most successful of these exotics have broad environmental tolerances with a preference for lentic conditions and can quickly eradicate native species through competition, hybridisation, predation or habitat modification.

It is already common for non-native fish species richness in lakes, reservoirs and regulated rivers to be greater than that of their native counterparts in Spain, Italy, North Africa and the Middle East. The magnitude of decline tends to be more acute when several alien species are present, and in some cases native fish communities have been replaced by fully exotic assemblages. In smaller reservoirs and intermittent river systems where resident fishes spend part of the year confined in refuge pools this can occur very quickly, especially during periods of extended drought.

Intentional introductions of non-native fish species to create more diverse recreational fisheries, for aquaculture, or to establish and support commercial fisheries continue to occur. Accidental releases may be made as bycatch among other species or more rarely via man-made water transfer channels or escapes from aquaculture facilities. In some cases species with restricted natural ranges have been translocated from their native rivers to other drainages in the same country.

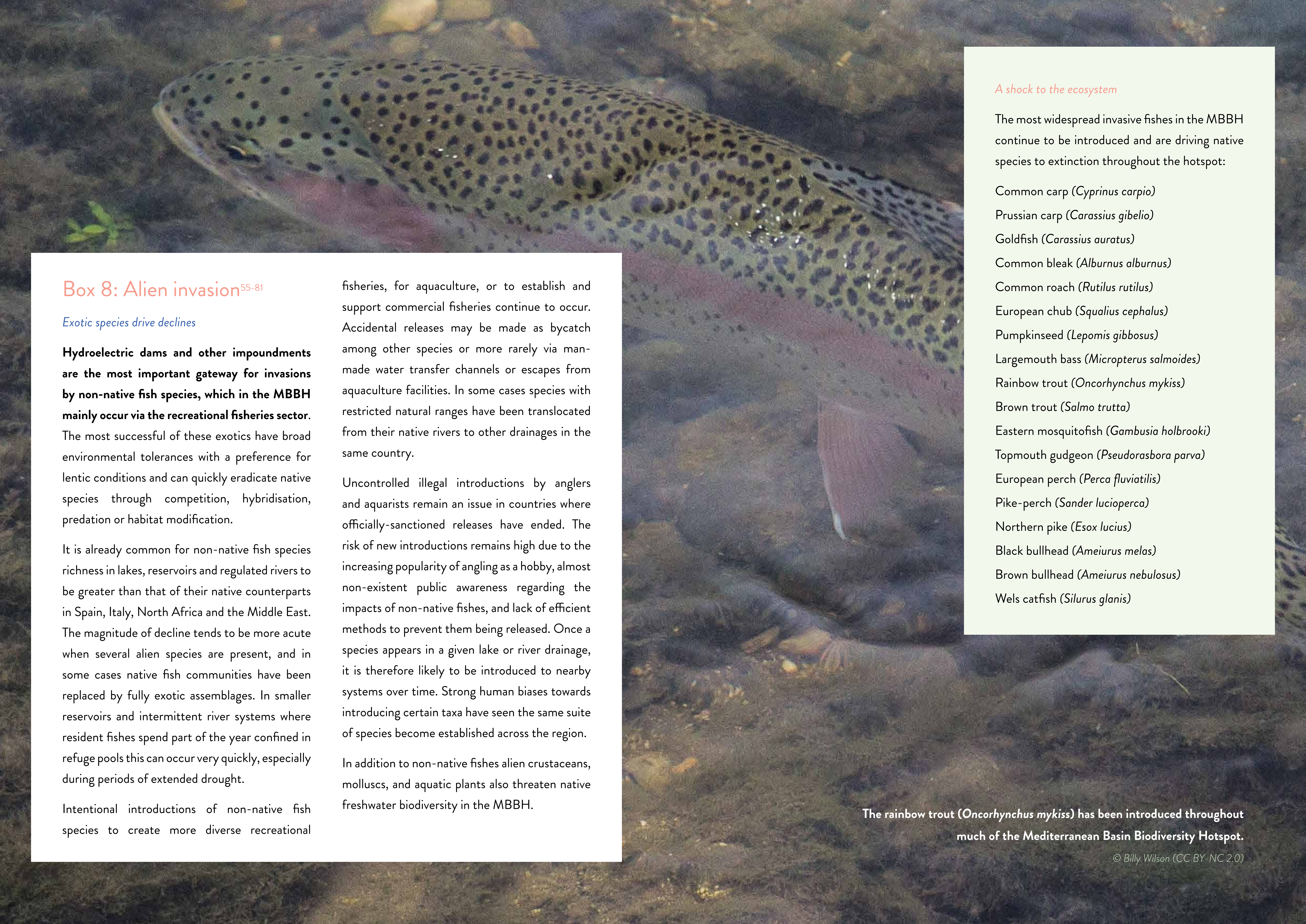
Uncontrolled illegal introductions by anglers and aquarists remain an issue in countries where officially-sanctioned releases have ended. The risk of new introductions remains high due to the increasing popularity of angling as a hobby, almost non-existent public awareness regarding the impacts of non-native fishes, and lack of efficient methods to prevent them being released. Once a species appears in a given lake or river drainage, it is therefore likely to be introduced to nearby systems over time. Strong human biases towards introducing certain taxa have seen the same suite of species become established across the region.

In addition to non-native fishes alien crustaceans, molluscs, and aquatic plants also threaten native freshwater biodiversity in the MBBH.

A shock to the ecosystem

The most widespread invasive fishes in the MBBH continue to be introduced and are driving native species to extinction throughout the hotspot:

Common carp *(Cyprinus carpio)*
Prussian carp *(Carassius gibelio)*
Goldfish *(Carassius auratus)*
Common bleak *(Alburnus alburnus)*
Common roach *(Rutilus rutilus)*
European chub *(Squalius cephalus)*
Pumpkinseed *(Lepomis gibbosus)*
Largemouth bass *(Micropterus salmoides)*
Rainbow trout *(Oncorhynchus mykiss)*
Brown trout *(Salmo trutta)*
Eastern mosquitofish *(Gambusia holbrooki)*
Topmouth gudgeon *(Pseudorasbora parva)*
European perch *(Perca fluviatilis)*
Pike-perch *(Sander lucioperca)*
Northern pike *(Esox lucius)*
Black bullhead *(Ameiurus melas)*
Brown bullhead *(Ameiurus nebulosus)*
Wels catfish *(Silurus glanis)*



The rainbow trout (*Oncorhynchus mykiss*) has been introduced throughout much of the Mediterranean Basin Biodiversity Hotspot.

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A groundwater well with pump powered by a diesel engine in El Haouaria, northern Tunisia.

2. METHODOLOGY

For the purposes of this report, the geographical extent of the MBBH was modified in order to mirror that used in related studies, from which the dam data utilised here were drawn[1,2]. The revised hotspot includes all river systems draining into the Mediterranean Sea except the Nile, of which only the delta region is considered. It also incorporates Balkan tributaries of the Danube, rivers lying within the Mediterranean climatic zone in Turkey and the Middle East, and those draining to the Atlantic Ocean from the Iberian Peninsula and Morocco. The Macaronesian islands were omitted since they have no native freshwater fishes.

An exhaustive literature review and consultations with national and regional experts were carried out before an inventory of all potentially threatened native freshwater fish species within the region was compiled.

It must be noted that the negative effects of hydropower on most freshwater fish species native to the MBBH have not been scientifically quantified due to the failure of governments to adapt their investments in freshwater conservation research to the needs of the ongoing biodiversity crisis. Expert opinion was therefore essential throughout this study.

All available occurrence records for each species were downloaded as digital shapefiles from GBIF, the primary international resource offering access to species occurrence records derived from a variety of sources[3]. The spatial data were carefully checked for credibility and taxonomy. Records with questionable dates, taxonomy, or mismatches between coordinates and country of origin were removed.

The corrected data were then combined with field sampling records contributed by experts plus georeferenced information from existing published literature. The final data set was visualised on an individual map for each species using the open-source software QGIS version 3.4[4]. Species range polygons were mapped using the spatial data layer HydroBASINS, a global standardised hydrological framework that delineates catchments at 12 resolutions and includes information on network hydrological connectivity[5]. The majority of these polygons use level 12, the highest resolution, with level 8 used for species with particularly wide ranges.

Although the most comprehensive ever produced for freshwater fishes of the MBBH, these **maps still cannot be considered exhaustive due to remaining knowledge gaps** in under-sampled areas. Nor do they replace existing site-scale records which are crucial when carrying out project-specific Biodiversity Impact Assessments.

Species' global conservation status was evaluated by applying IUCN Red List Criteria, the most widely accepted methodology for determining relative extinction risk[6] (Figure

1). The IUCN has devised a series of formal criteria for Red List assessments among which the delineation of a species' geographic extent is a central component. Furthermore, three of the five IUCN criteria call for population data which is rarely available for freshwater fishes, meaning most species are assessed based on their distributions. It is important to note that the Area of Occupancy, a scaled metric used in IUCN assessments that represents the area of suitable habitat currently occupied by a given taxon, is calculated using 2 × 2 kilometre grid cells which tend to artificially expand the size of fluvial channels, springs and small wetlands.

All European and North African species were assessed with the help of regional experts at workshops held in Morocco, France and Italy during 2018 and 2019. Assessments for Turkish and Middle Eastern species were published in 2013 and 2014 and could not be updated within the scope of this project. In addition, several potentially threatened species described to science within the last five years have not yet been assessed and are therefore not included.

Assessed species are placed into one of eight IUCN categories, but only those falling into the three threatened categories were considered for this study. These are defined as follows:

CRITICALLY ENDANGERED (CR): species considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN): species considered to be facing a very high risk of extinction in the wild.

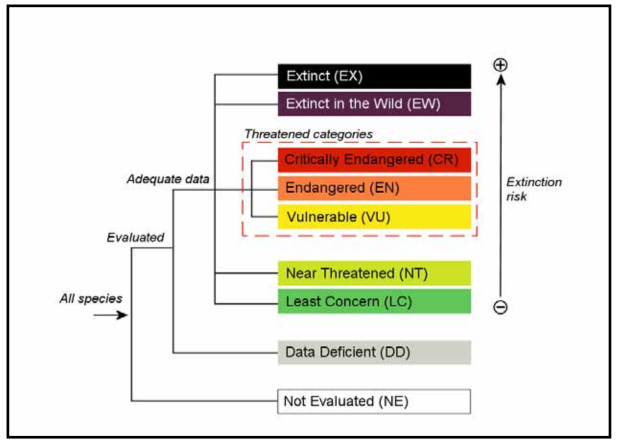


Figure 2: Structure of the IUCN Red List categories © IUCN, 2012

VULNERABLE (VU): species considered to be facing a high risk of extinction in the wild.

The IUCN results were plotted on a pie chart (Figure 2) displaying the number of species in each of the three categories, and a stacked bar chart (Figure 3) to visualise the number of threatened species known to inhabit each country in the MBBH.

In addition to the IUCN category, each species assessed as threatened was assigned a '**Hydropower Hazard**' (HH) status of low, moderate, or high. This designation was estimated from species' perceived sensitivity to hydropower development plus the current threat from existing hydropower within their respective ranges. Each species' ecological requirements were carefully considered. For example, rheophilic specialists are strongly impacted by loss of fluvial habitat. On the other hand, generalists possess different combinations of traits that affect their relative ability to survive alongside non-native species that often come to dominate artificial reservoirs and slow-moving river reaches after being introduced for angling.

The number of species falling into the moderate or high HH categories were summed to obtain the proportion of all threatened freshwater fishes in the MBBH that have been negatively impacted by operational hydropower plants. Those in the high HH category were combined with their respective IUCN Red List categories to explore the extinction risk ratio of the species most impacted by existing hydropower projects. The two sets of HH results were visualised on pie charts (Figure 4). The number of high HH species in each IUCN Red List category was calculated as a percentage of the overall number of species to measure the respective proportions of CR, EN and VU species in the MBBH that have been highly impacted by existing hydropower projects.

The potential future impact of planned small (1-<10 MW installed capacity) and medium/large (>10 MW) hydropower projects on population trends was assessed separately by comparing the number and installed capacity of schemes in each size class falling within, upstream and downstream of each species' range with the current and historic impacts. Although it is not possible to calculate the precise length of river or stream reaches that would be affected by future projects, a visual inspection of each map permitted a coarse evaluation of the likelihood that species will be driven further towards extinction if planned hydropower schemes are completed. The future impact was rated as 'None' if no schemes are planned within a species' range, 'Minor' if ~<10%, 'Serious' if ~10- 50%, and 'Severe' if ~>50% of a species' range will be impacted. The results were plotted on separate pie charts (Figure 5) then combined to provide the total number of species that will be driven further towards extinction should expansion continue as planned.

In the wake of the latter appraisal, the potential of species to become globally extinct in the wild due to hydropower development and ignoring other threats was considered, based on current extinction risk, known range size and the probable severity of future impacts.

The number of operational and under-construction small (<10MW) and medium-large (10+ MW) hydropower plants was summed and plotted against the tally of threatened species occurring in each country to offer a national and regional overview, and this process was repeated for planned hydropower schemes (Figure 6).

Further reading

STUDY AREA: Weiss et al., 2018[1], Schwarz (2020)[2].

RAW OCCURRENCE DATA: GBIF (2020)[3].

MAPS: QGIS Development Team (2019)[4].

HYDROBASINS: Lehner et al. (2008)[5].

RED LIST CATEGORIES AND CRITERIA: IUCN (2012)[6].

A diversion run-of-river hydropower plant on the Ugar River in Bosnia-Herzegovina with very little water below the weir.

© Ulrich Eichelmann

3. RESULTS AND DISCUSSION

A total of 251 freshwater fish species native to the MBBH are currently threatened with extinction, of which 27% (67) are assessed as Critically Endangered, 45% (114) Endangered, and 28% (70) Vulnerable (Figure 3).

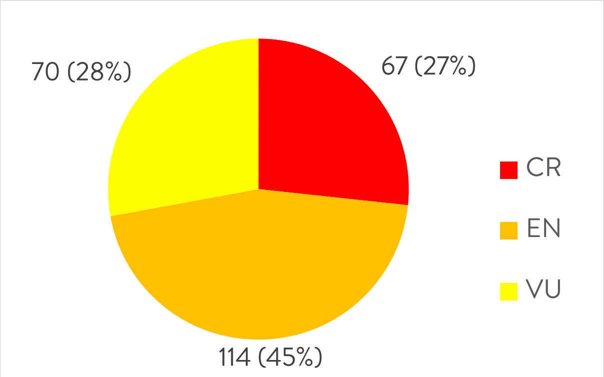


Figure 3: IUCN Red List status of threatened freshwater fishes in the MBBH (see Figure 2 for abbreviations).

At the national scale, Turkey harbours 86 threatened species, followed by Greece with 48 and Croatia 38 (Figure 4). Spain, Italy, Bosnia-Herzegovina and Syria are the only other countries with more than 20 threatened species, while the average across the MBBH is 16.5.

Among the threatened freshwater fish fauna of the MBBH, 51% (127) of all species fell into the High HH class and are considered to have been highly impacted by existing hydropower projects, while 12% (31) were placed into the

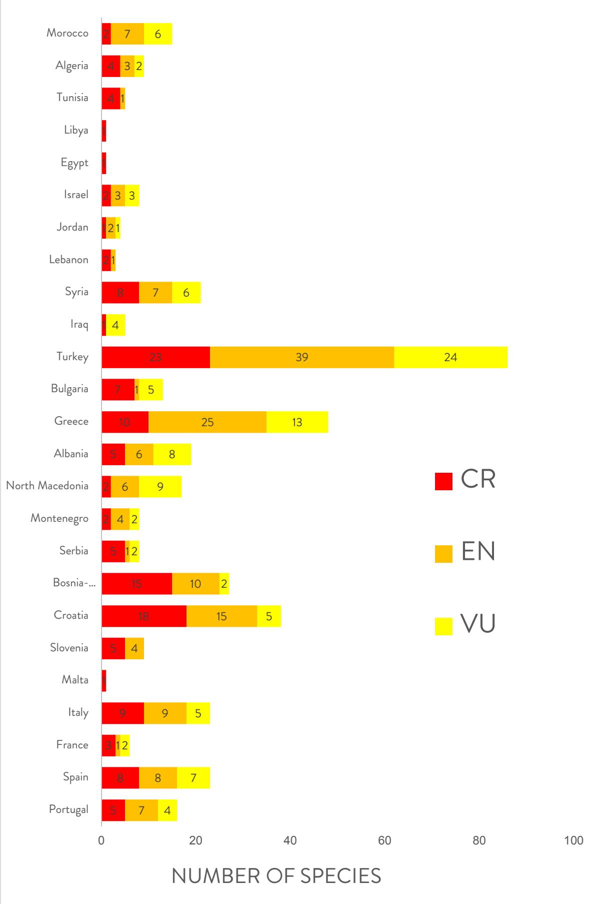


Figure 4: Threatened freshwater fish species richness per country in the MBBH.

Moderate class (Figure 5.1). Hence, **63% of all threatened freshwater fish species in the MBBH have already been driven closer to extinction by currently operational hydropower schemes**.

Within the group of species that have been highly impacted by existing hydropower schemes, i.e., those in the high HH category, 29% (37) are Critically Endangered, 43% (55) Endangered, and 28% (35) Vulnerable (Figure 5.2). Therefore, **55% of all Critically Endangered, 47% of Endangered and 53% of all Vulnerable species in the MBBH**

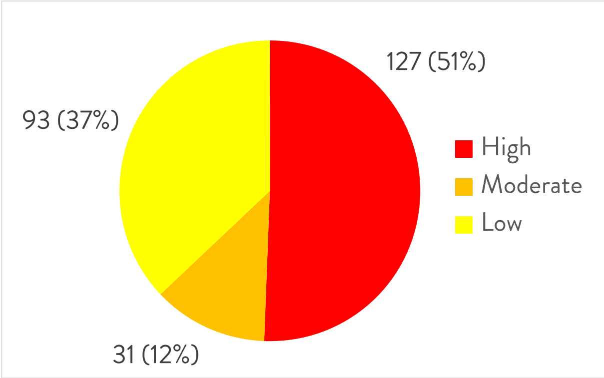
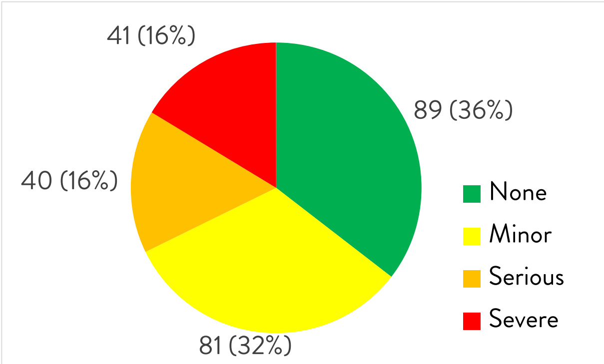


Figure 5.1.: The extent to which all threatened freshwater fish species in the MBBH have been affected by existing hydropower infrastructure...

have been highly impacted by currently operational hydropower schemes.

In terms of future impact, 16% (40) of threatened freshwater fish species in the MBBH will be severely impacted by small hydropower projects if all planned schemes are implemented, with a further 16% (41) seriously impacted (Figure 6.1). Among the species in the Severe class, 12% (5) are Critically Endangered, 49% (20) Endangered and 39% (16) Vulnerable. Similarly, 17% (7) of seriously impacted species are Critically Endangered, 50% (21) Endangered and 33% (14) Vulnerable.

Figure 6.1.: The extent to which small...



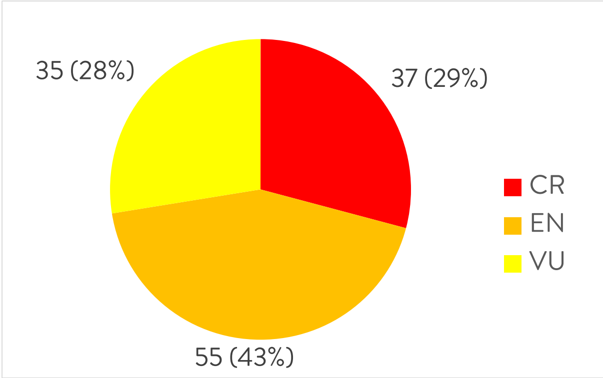
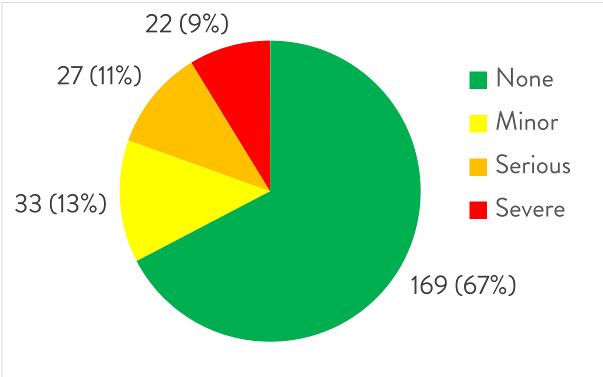


Figure 5.2.: ...and the IUCN status of the highly-impacted species

By comparison, 9% (22) of all threatened species will be severely impacted by future medium and large hydropower projects, with 11% (27) seriously impacted (Figure 6.2). A total of 36% (8) severely impacted species are Critically Endangered, 23% (5) Endangered and 41% (9) Vulnerable, whereas 11% (3) of seriously impacted species are Critically Endangered, 37% (10) Endangered and 52% (14) Vulnerable.

When the data for all planned hydropower projects are combined, 74% (185) of all

Figure 6.2.: ... and medium-to-large (5.2) hydropower plants will negatively impact threatened freshwater fishes in the future if all planned schemes are implemented in the MBBH.



threatened freshwater fish species in the MBBH will be negatively impacted to some extent if all plants are implemented. These include 63% (55) of the 87 species that have not declined due to existing operational hydropower schemes. Only 26% (64) are expected to suffer no effects, mostly comprising species with restricted ranges that inhabit single lake basins or isolated springs with no potential for hydroelectric development. Planned small hydropower projects will prompt population declines in 65% (161) and medium to large plants in 33% (81) of threatened freshwater fish species.

A total of **seven threatened freshwater fish species could conceivably become globally extinct in the wild, all of which have restricted ranges and will be severely impacted by future hydropower projects (Box 9), while 178 others stand to be driven substantially further towards extinction** if expansion goes ahead as planned.

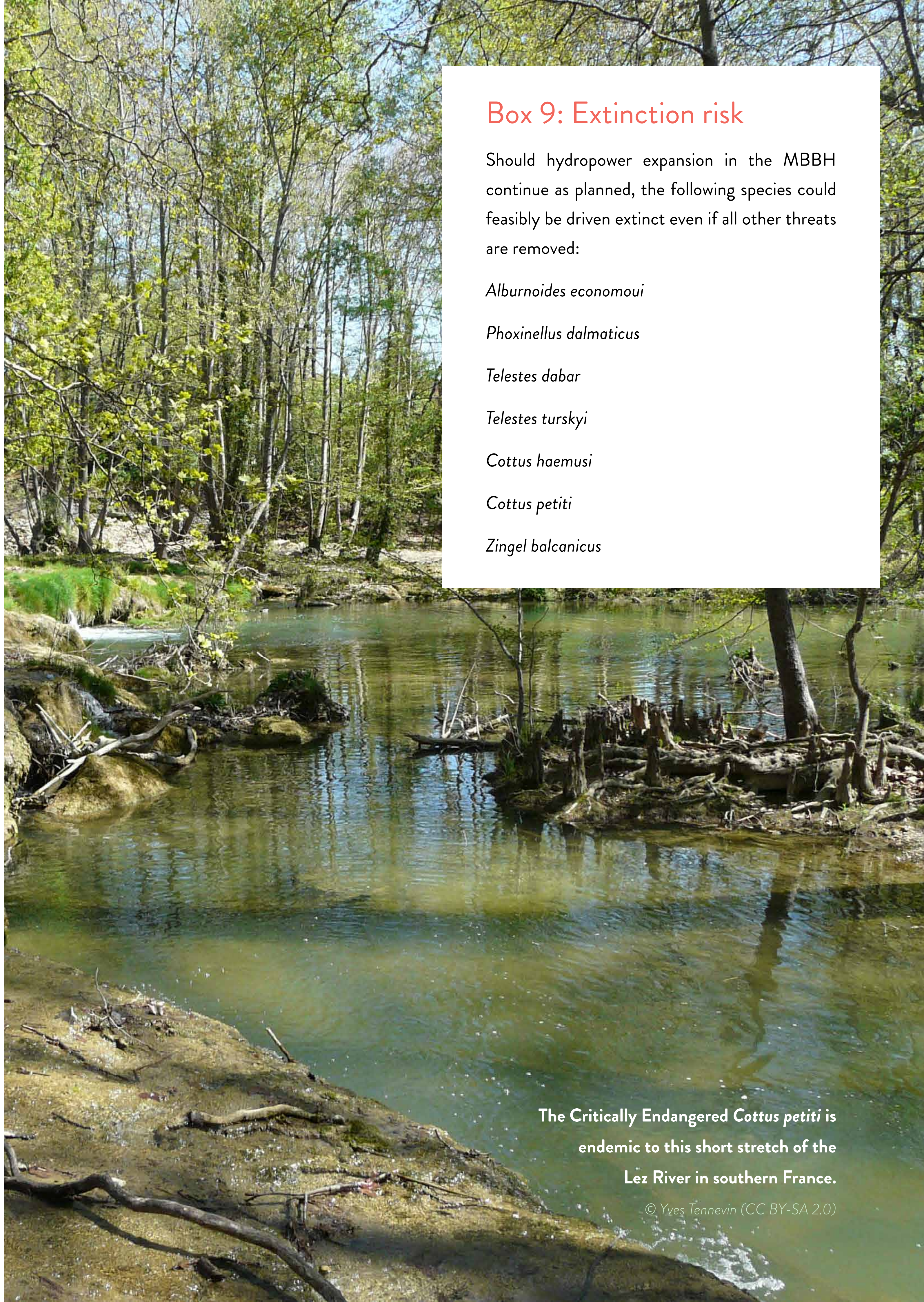
At least 5,269 hydropower plants are already operating in the MBBH, with 202 under construction, and a further 6,393 are planned, among which 5,962 qualify as small plants[1]. Existing and under-construction hydropower projects are clustered in France, the Iberian, Italian and Balkan peninsulas, Turkey and to a lesser extent the Maghreb (Figure 7.1). These are also the regions with the greatest diversity of threatened freshwater fishes, and this trend is set to continue if planned plants are constructed (Figure 7.2). The positive relationship between fish species richness and hydropower projects also suggests that physical characteristics of the river drainages which contain the greatest biodiversity render them the most suitable for development.

Given the clear negative repercussions of the existing hydropower network on native freshwater fish populations throughout the MBBH, the future outlook is alarming. More than doubling the current number of hydropower plants will trigger widespread riverine habitat loss and further block access to feeding and spawning areas, driving an exponential decline in fish populations.

The increased number of impoundments will aid the ongoing invasion of non-native species, and research has demonstrated that river fragmentation by dams and alien species are the primary significant factors in riverine fish extinctions[2].

A greater proportion of nutrients and sediment will be trapped in reservoirs, further reducing the ecosystem dynamics and productivity of deltas and floodplains, and increasing the likelihood of disastrous coastal flooding under current sea-level rise scenarios[3,4]. Reductions in river flow through rural areas will encourage an increasingly unsustainable reliance on groundwater and lead to rising habitat degradation.

In the MBBH, 1,579 dams are already operating and 2,091 are planned within the boundaries of national parks,



Box 9: Extinction risk

Should hydropower expansion in the MBBH continue as planned, the following species could feasibly be driven extinct even if all other threats are removed:

Alburnoides economoui

Phoxinellus dalmaticus

Telestes dabar

Telestes turskyi

Cottus haemusi

Cottus petiti

Zingel balcanicus

The Critically Endangered *Cottus petiti* is endemic to this short stretch of the Lez River in southern France.

© Yves Tennevin (CC BY-SA 2.0)

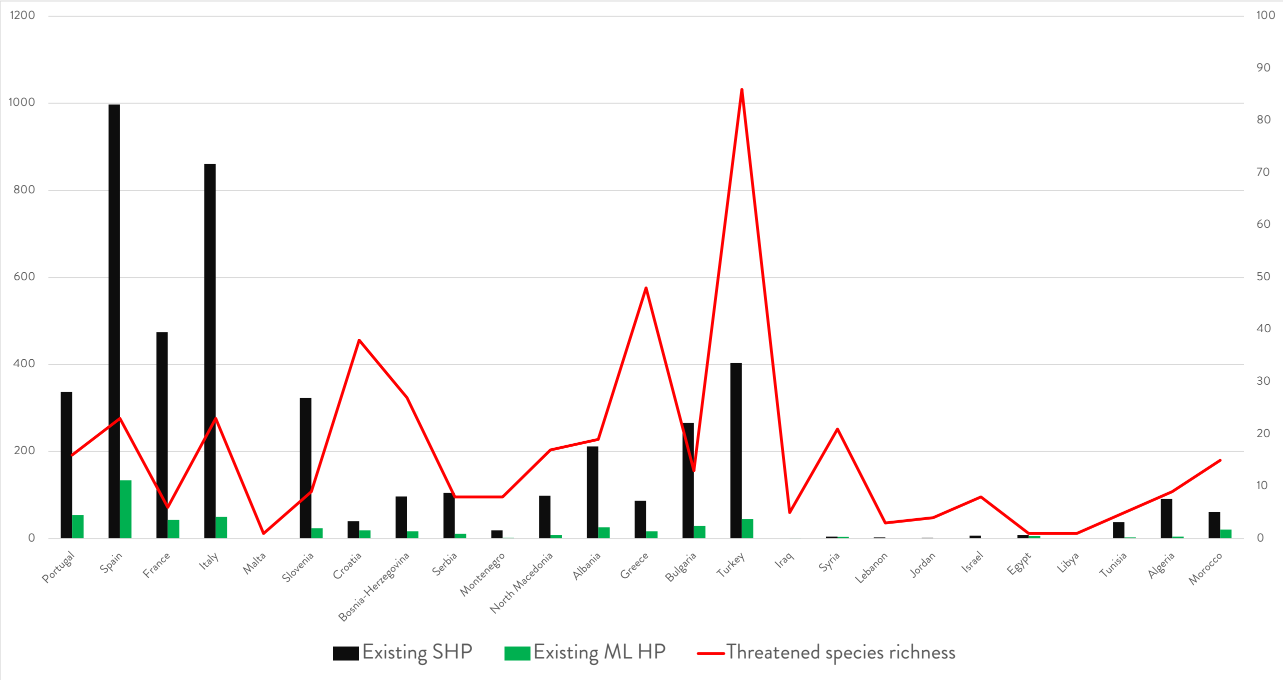


Figure 7.1.: The number of existing...

biosphere reserves, and other protected areas. A further 1,394, of which 825 are planned, are located inside Key Biodiversity Areas[1].

All countries in the MBBH are members of the United Nations and parties to the Convention on Biological Diversity, therefore by committing to construct additional hydropower plants at the expense of globally threatened species they will be unable to meet targets set out by the 2030 Sustainable Development Goals and Post-2020 Global Biodiversity Framework. European Union member countries have additional responsibilities linked to the bloc's own sustainable development policy and Water Framework Directive which will also be neglected should hydropower plants continue to be built.

The projected growth of hydropower in the MBBH cannot be considered sustainable and a major shift will be required to meet these international targets and address the ongoing decline in native freshwater fishes of the region. **Rivers have to be managed as crucial ecosystems for human life support that are essential for biodiversity and proper ecological function, and must therefore remain free-flowing**.

Renewable energy sources have been identified as a significant driver in economic growth, and have the potential to provide over 3,000 times the current global energy needs. The cost per megawatt-hour of hydropower is comparable to solar photovoltaic and slightly more expensive than wind. Alongside other advances such as grid integration and improved storage technologies countries can meet energy objectives with less hydropower, and fewer dams, than currently planned.

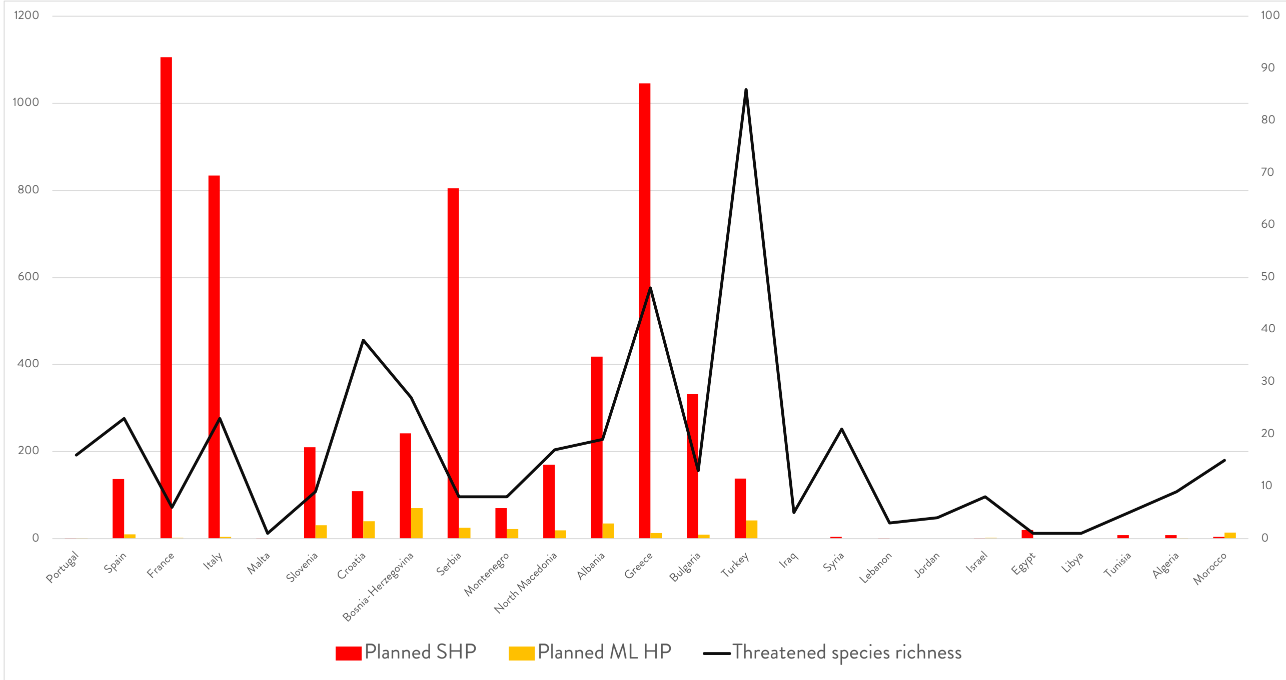


Figure 7.2.: ... and planned small and medium-to-large hydropower plants in each MBBH country (left axis) plotted against threatened species richness (right axis).

Depending on siting, solar and wind also offer environmental advantages, while hydropower in the MBBH is projected to become increasingly unreliable due to climate change and fluctuating rainfall[5-9].

For rivers with existing hydropower projects in the MBBH, mitigation measures should include alleviation of hydropeaking effects accompanied by appropriate monitoring to evaluate ecological success. Research into appropriate fishway design taking into account downstream migration and core traits for a selection of drainage-specific fish species with representative life histories is urgently needed. Environmental flows have to be ensured, if necessary by altering patterns of water release from reservoirs. Political and public awareness concerning the importance of free-flowing rivers, sustainable freshwater ecosystems and the threats facing native freshwater fishes remains limited and must be improved[10-21].

The removal of older dams and other infrastructure is becoming more commonplace in western Europe, but is not progressing quickly enough anywhere within the MBBH. Rivers tend to recover their original morphology and sediment flows within a few years of dam removal, while fishes readily colonise former habitat[21,22,23]. **The demolition of obstructions and installation of modern fishways on river stretches in the Rhône River, France, resulted in the endemic apron (*Zingel asper*) being downlisted from Critically Endangered to Vulnerable on the IUCN Red List within a decade**[24].

If careful planning is not implemented,

species extinctions and drainage-level declines in critical ecosystem services are certain to accompany the expansion of hydropower in the MBBH. Strategic, systematic conservation planning based on scientific evidence is required for rivers throughout the region. Multiple stakeholders and a wide range of disciplines and skills should be involved in the necessary policy and preparation in order to establish a rational approach[25,26,27]. Methods should incorporate longitudinal, lateral, vertical and temporal aspects while accounting for threatening processes and climate change.

Further reading

MBBH DAM STATISTICS: Schwarz (2020)[1].

FISH EXTINCTIONS: Dias et al. (2017)[2].

SEA-LEVEL RISE: Day et al. (1995, 2011)[3,4].

RENEWABLE ENERGY: Panwar et al. (2011)[5], Saidur et al. (2011)[6], Ellabban et al. (2014)[7], Hernandez et al. (2014)[8], Bhattacharya et al. (2016)[9].

CONSERVATION AND RESTORATION: Trussart et al. (2002)[10], Poff et al. (2003)[11], Richter et al. (2003)[12], Richter & Thomas (2007)[13], Palmer et al. (2009)[14], Kondolf et al. (2013)[15], Arthington et al. (2016)[16], Bruder et al. (2016)[17], Cooke et al. (2016)[18], Hauer et al. (2017)[19], Reid et al. (2019)[20].

DAM REMOVAL: Bednarek (2001)[21], Bellmore et al. (2017)[22], Schiermeier (2018)[23].

APRON: Episse et al. (2017)[24].

PLANNING: Tickner et al. (2017, 2020)[25,26], Darwall et al. (2018)[27].

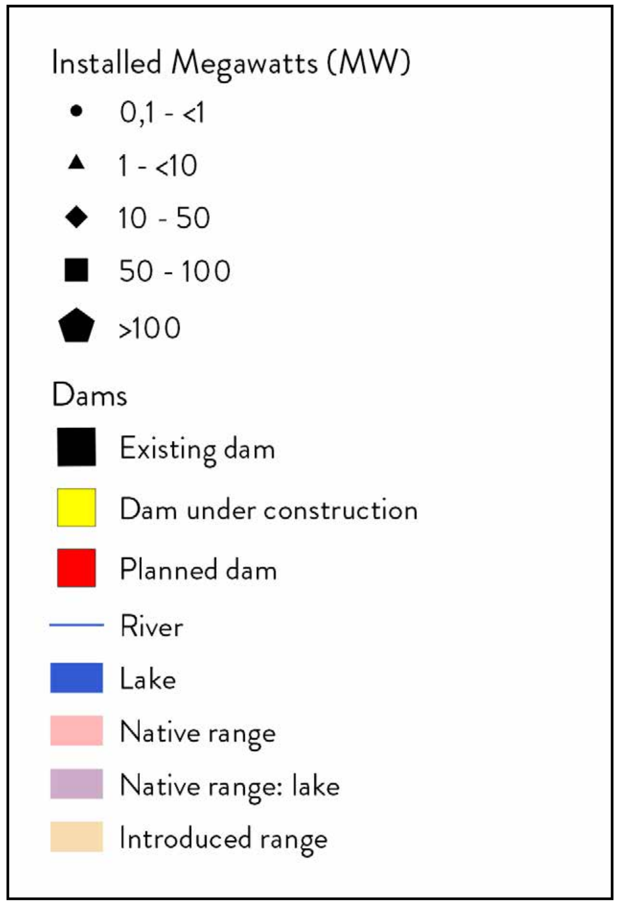
Native cichlids and garra in the Nahal Kibbutzim spring, Beit She'an, Israel.

© Matthew Ford

4. SPECIES PROFILES

A checklist of all 251 threatened freshwater fish species native to the MBBH, including their respective threats from existing and future hydropower development is arranged by family in the Annex of this report. Nomenclature and taxonomy follows Eschmeyer's Catalog of Fishes[1].

Individual species accounts are presented in this section, each of which is accompanied by a GIS range map. The maps include all known, under-construction and planned hydropower projects within a given species' range, using the following symbology:



In addition to each species' IUCN and Hydropower Hazard categories, information on the following international conventions is included where relevant.

The **European Union Habitats Directive** ensures the conservation of a wide range of rare, threatened or endemic animal and plant species. It forms the cornerstone of Europe's nature conservation policy with the Birds Directive and establishes the EU wide Natura 2000 ecological network of protected areas, safeguarded against potentially damaging developments. Some threatened fish species native to the MBBH are listed under Annex II (species of community interest, for which protection areas must be assigned), Annex IV (strictly protected species), or Annex V (species whose exploitation is compatible with a favourable conservation status).

The Bern Convention on the Conservation of European Wildlife and Natural Habitats aims to conserve wild flora and fauna and their natural habitats, as well as to promote European cooperation in this field. Within the MBBH, the European Union countries, Balkan states (except Kosovo), Turkey, Tunisia and Morocco are parties. Algeria has observer status at meetings. Some threatened fish species native to the MBBH are listed under Appendix II (Strictly Protected Fauna) or Appendix III (Protected Fauna).

The Habitats Directive was adopted in 1992 while the Bern Convention came into force in 1982, and neither have been regularly

updated to reflect taxonomic changes. In cases where an included species has been split into several taxa, all are covered by the original designation[2,3].

Further reading

TAXONOMY: Fricke et al. (2020)[1].

CONVENTIONS: Díaz (2010)[2], Cardoso (2012)[3].

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Caspiomyzon graecus

Epirus brook lamprey

Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

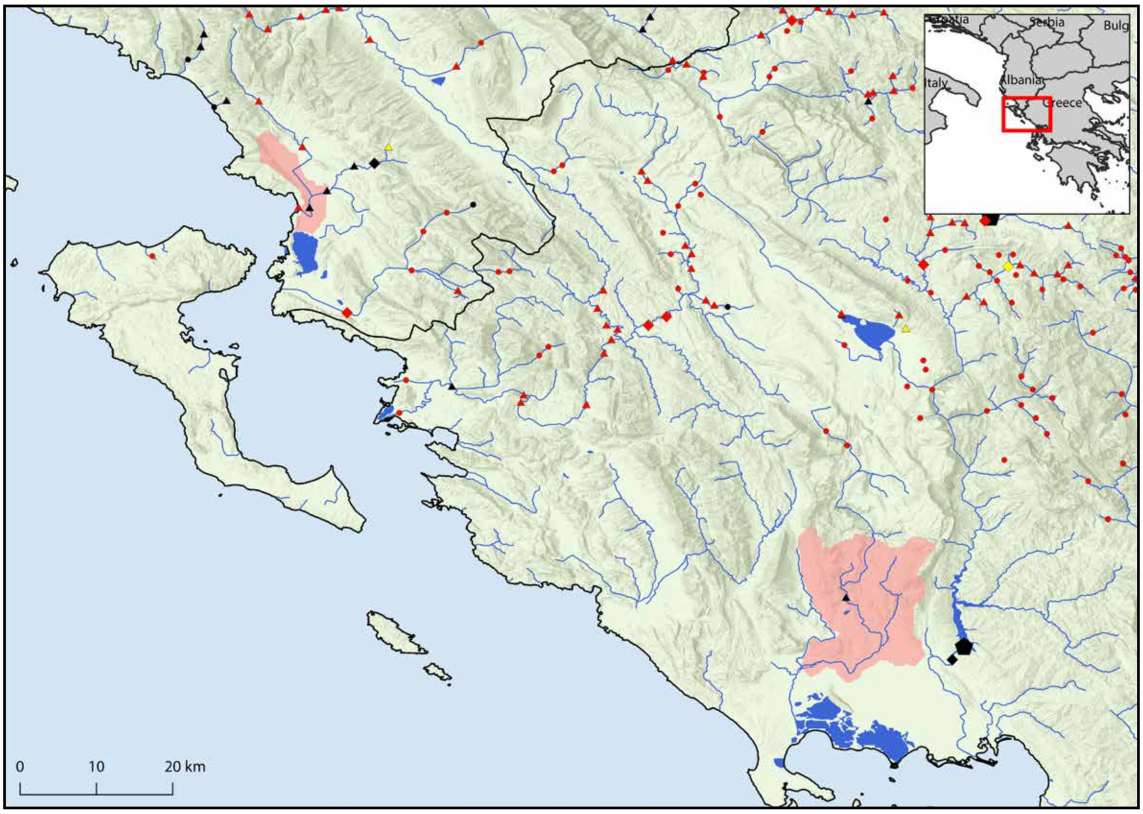
Bern Convention: *APPENDIX III ***

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Albania and Greece

Known only from a handful of locations in the lower Louros River drainage, northwestern Greece, and a single site in the Lake Butrint basin, southwestern Albania. This species is threatened by excessive water abstraction, agricultural and domestic pollution and canalisation of streams and rivers. There is a dam upstream of the Albanian population, which is assumed to have driven a reduction in its original range.

* as *Eudontomyzon* spp.   ** as *Eudontomyzon hellenicum*



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Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III ***

IUCN Red List: *CRITICALLY ENDANGERED*

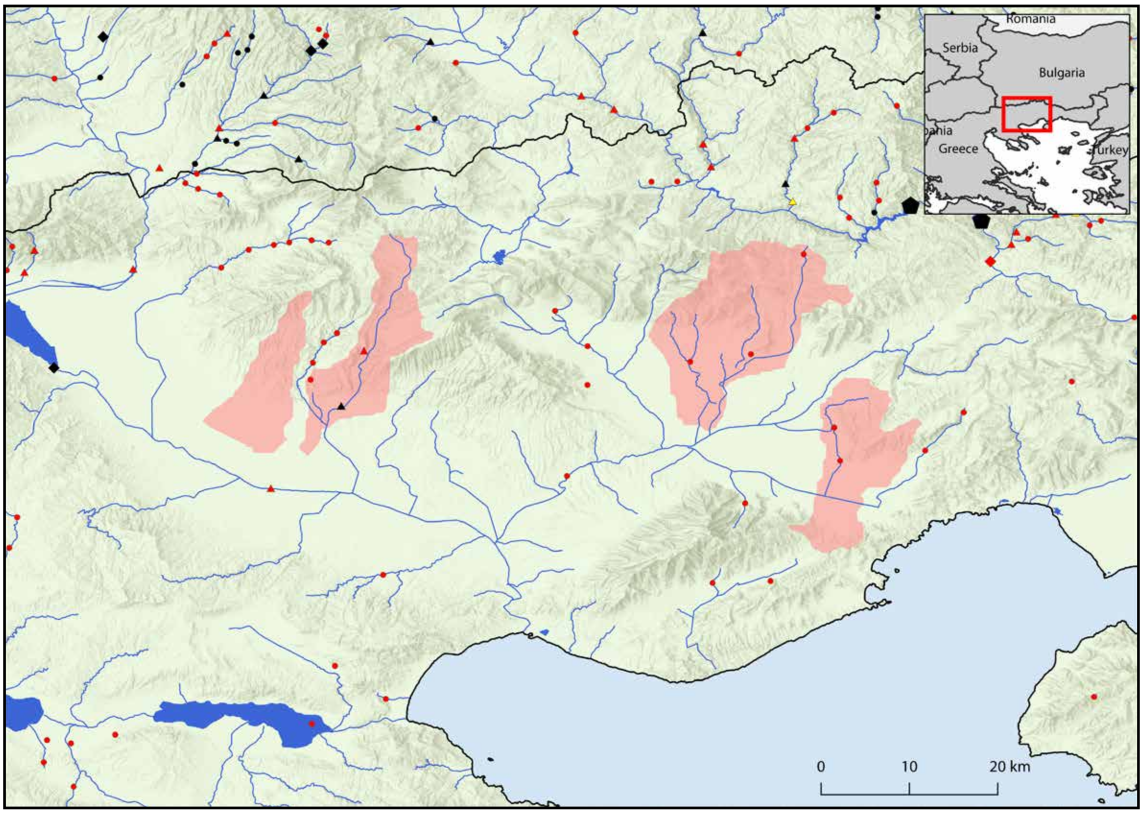
Caspiomyzon hellenicus

Greek brook lamprey

Distribution: Greece

Restricted to a few small sites near the towns of Serres (Agios Ioannis village) and Drama (Milopotamos and Kephalári villages) in the lower Strymon (bg. Struma) River drainage, northeastern Greece. This species is threatened by water abstraction, pollution and canalisation of streams and rivers. There is a dam downstream of the Milopotamos population, which is assumed to have driven a reduction in its original range.

* as *Eudontomyzon* spp.   ** as *Eudontomyzon hellenicum*



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Hydropower Hazard:
HIGH

EUR-HAB-DIR:
*ANNEX II **

Bern Convention:
*APPENDIX III **

IUCN Red List:
CRITICALLY ENDANGERED

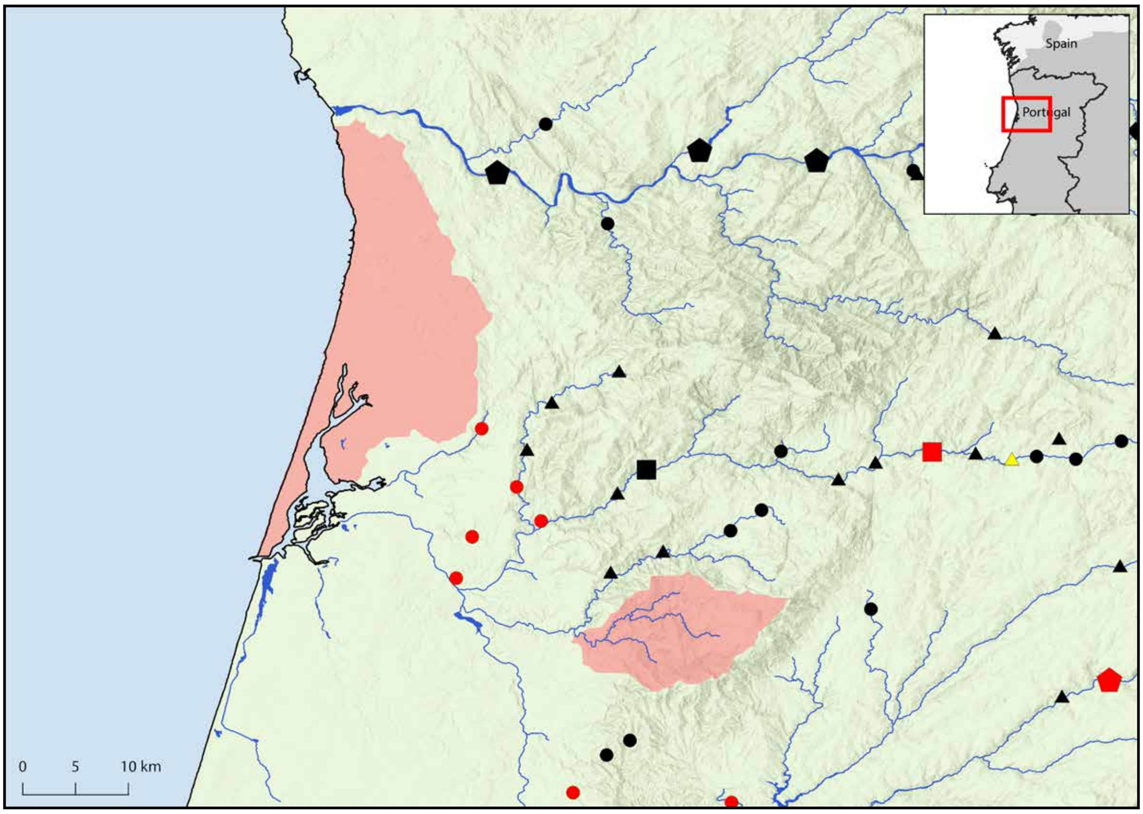
Lampetra alavariensis

Costa de Prata lamprey

Distribution: Portugal

Known only from the Esmoriz and Vouga coastal river drainages in northwestern Portugal. The Esmoriz population is mostly threatened by encroaching urbanisation, while in the Vouga industrial pollution, channel and bank regulation and construction of weirs are widespread. An exisiting hydroelectric dam on the Vouga is likely to have reduced the extent of suitable habitat due to the reservoir it created.

* as *Lampetra planeri*



© Catarina Mateus

Lampetra auremensis

Nabão lamprey

Distribution: Portugal

Endemic to the Nabão River drainage, a right-bank tributary within the lower Tagus River basin in central Portugal. This species is threatened by domestic pollution, water abstraction for agriculture and habitat modification, particularly regulation of channels and banks plus construction of small dams and weirs.

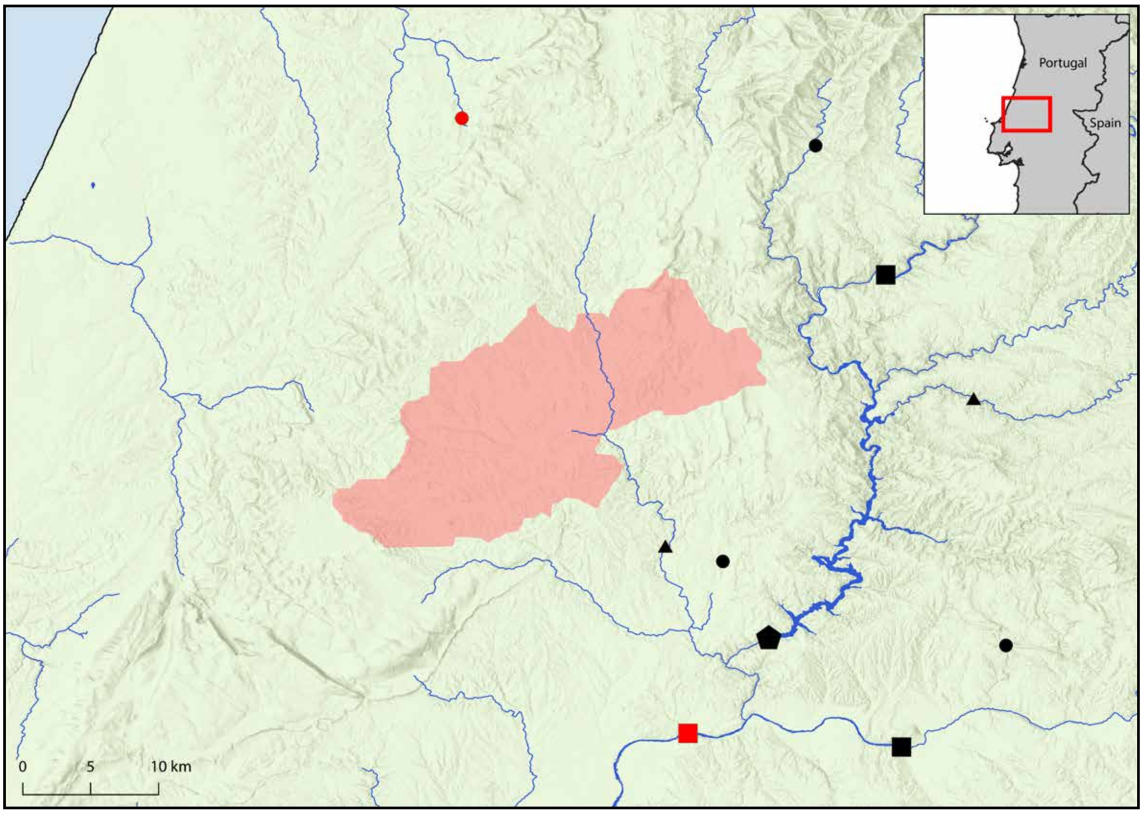
* as *Lampetra planeri*

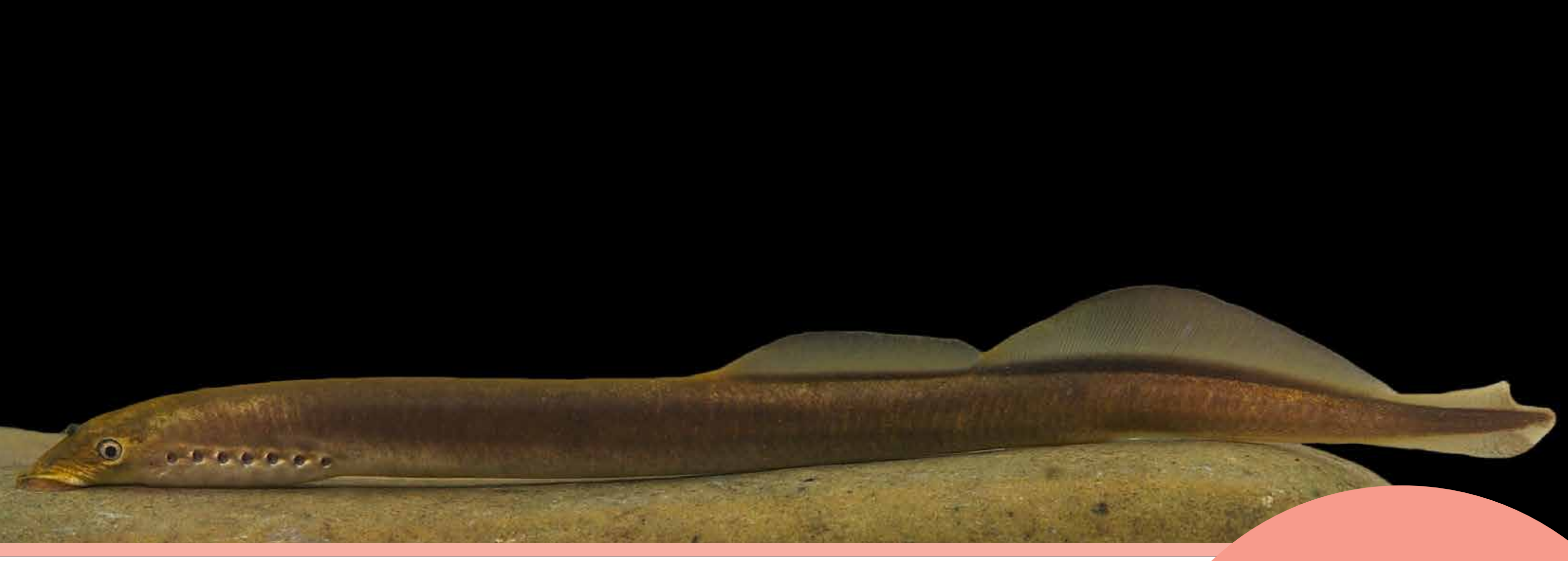
Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *CRITICALLY ENDANGERED*





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Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *CRITICALLY ENDANGERED*

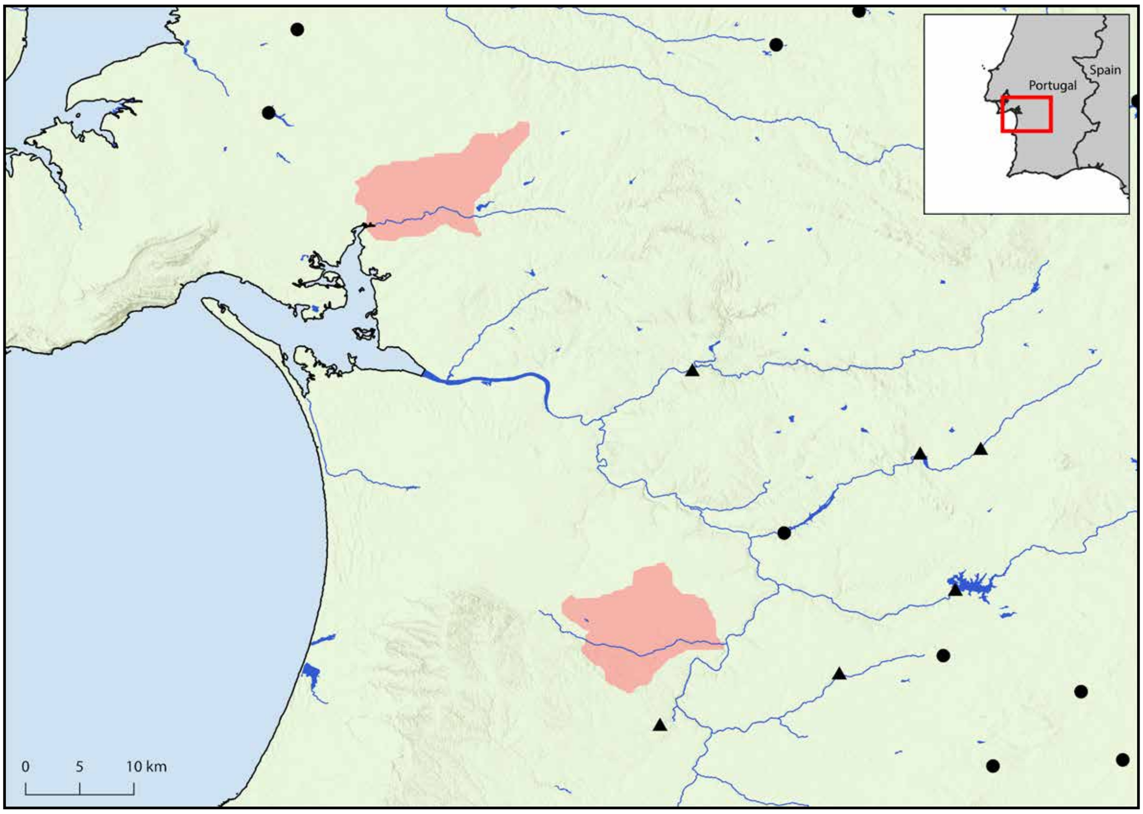
Lampetra lusitanica

Sado lamprey

Distribution: Portugal

Restricted to the Sado River drainage in southwestern Portugal. Discharge in the Sado naturally varies inter- and intra-annually, and this species is threatened by excessive water abstraction reducing the available flow and increasing concentration of pollutants, especially during dry periods, plus agricultural pollution and canalisation. A number of dams already exist on tributaries of the river and are likely to have significantly reduced the extent of suitable habitat due to the decreased discharge and reservoirs they have created.

* as *Lampetra planeri*



Hydropower Hazard:
HIGH

EUR-HAB-DIR:
*ANNEX II **

Bern Convention:
*APPENDIX II * + III ***

IUCN Red List:
ENDANGERED

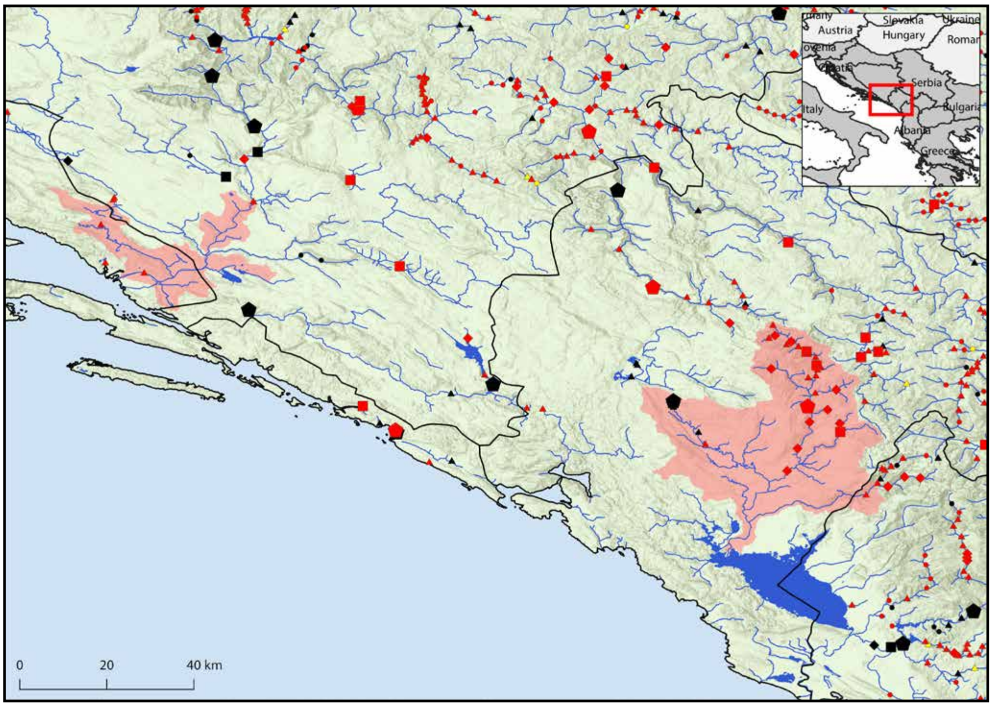
Lampetra soljani

Neretva lamprey

Distribution: Bosnia-Herzegovina, Croatia and Montenegro

Native to the lower Neretva River drainage in Bosnia-Herzegovina and Croatia. It has been recorded in the main channel plus a number of tributaries including the Norin, Bregava, Trebižat and Vrgoračko Matica systems, plus the Krupa River and associated Hutovo Blato wetland. A second population inhabits the Morača River drainage within the Lake Skadar basin, Montenegro. It has probably vanished from some of its former range in the Neretva River due to dam construction. Additional threats include gravel extraction and excessive siltation provoked by local agricultural practices.

* as *Lethenteron zanandrai* ** as *Lampetra zanandreai*



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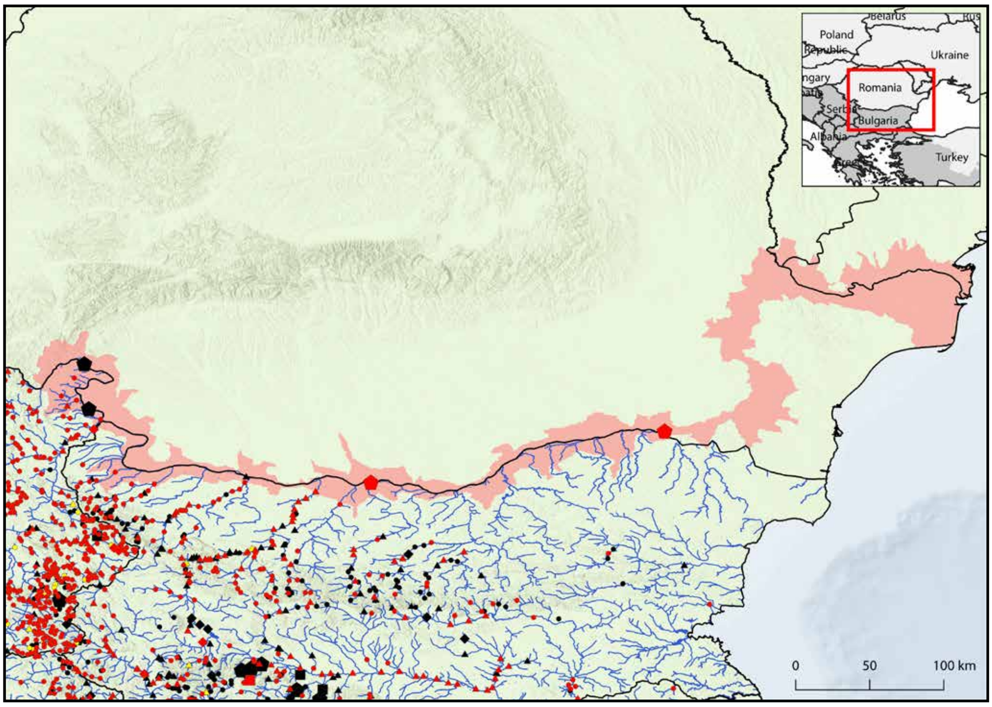
Hydropower Hazard:
HIGH
EUR-HAB-DIR:
ANNEX V
IUCN Red List:
CRITICALLY ENDANGERED

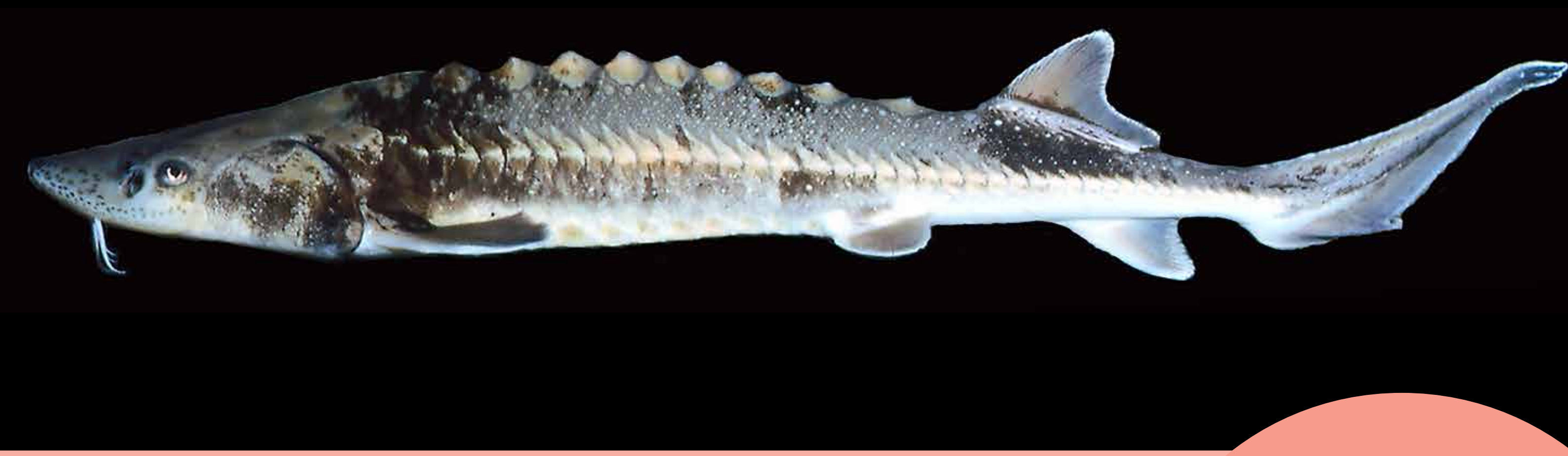
Acipenser gueldenstaedtii

Russian sturgeon

Distribution: Bulgaria, Romania, Ukraine, Russia, Georgia, Turkey, Kazakhstan, Turkmenistan, Iran, Azerbaijan, Moldova, Romania, Serbia, Bosnia-Herzegovina, Croatia, Hungary, Slovakia, Austria, Germany

Native to the Caspian, Black and Azov sea basins, where it once occurred in all major tributaries. It is anadromous, with adults foraging at sea and undertaking annual spawning migrations up rivers. This species' wild populations have undergone a drastic decline and it breeds on a regular basis only in the Volga (Russia) and Ural (Russia and Kazakhstan) river drainages in the Caspian basin, plus the Rioni River (Georgia) in the Black Sea. Small numbers occasionally spawn elsewhere, such as the Sakarya River in Turkey, while it was last recorded to reproduce in the Danube during 2006. The precise status of the natural popuation is difficult to determine since millions of captive-bred juveniles have been released each year. The major drivers for its collapse are continued illegal overfishing and river modification, especially the construction of dams and hydroelectric power stations which have cut off access to spawning sites.





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Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II + IV*

Bern Concention: *APPENDIX II*

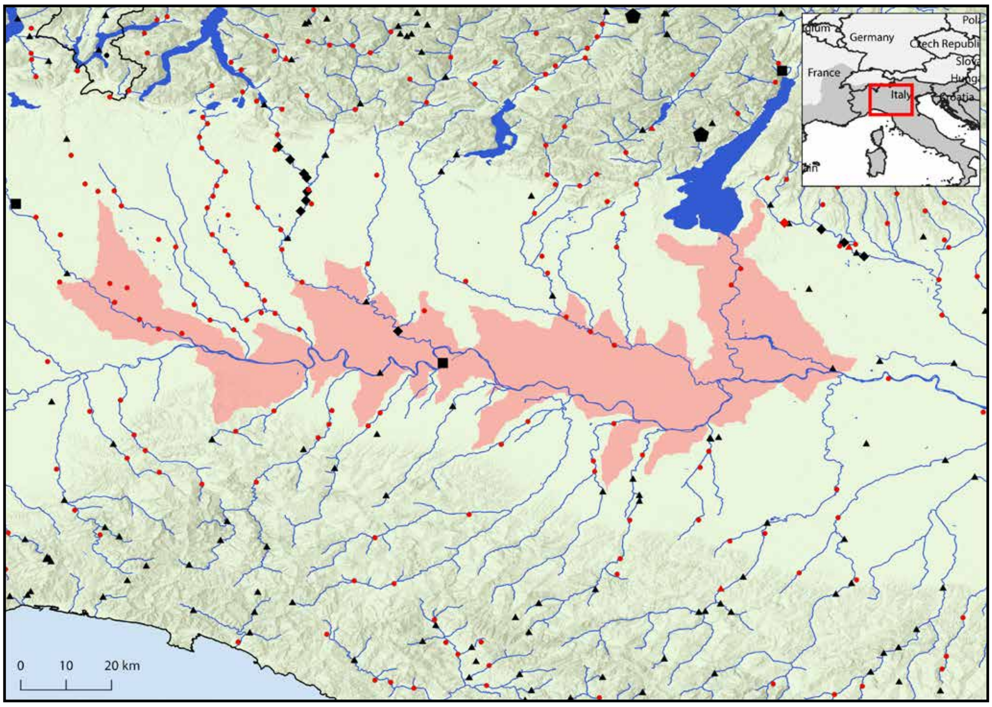
IUCN Red List: *CRITICALLY ENDANGERED*

Acipenser naccarii

Adriatic sturgeon

Distribution: Italy, Slovenia, Croatia, Montenegro, Bosnia-Herzegovina, Albania, Greece

Native to the Adriatic Sea basin, with historicial records of occurences in the majority of large river drainages from the Po in northern Italy to the Vjosa in Albania. There is also some evidence that it occurred in the Kalamas (aka Thyamis) River drainage and around the islands of Corfu and Lefkas in northern Greece. This species' wild populations have undergone a drastic decline and it might now only still breed at two very small sites in the Po River. The major drivers for this collapse are continued illegal overfishing and river modification, especially construction of dams and hydroelectric power stations which have cut off access to spawning sites.



© Jörn Gessner

Hydropower Hazard:
HIGH

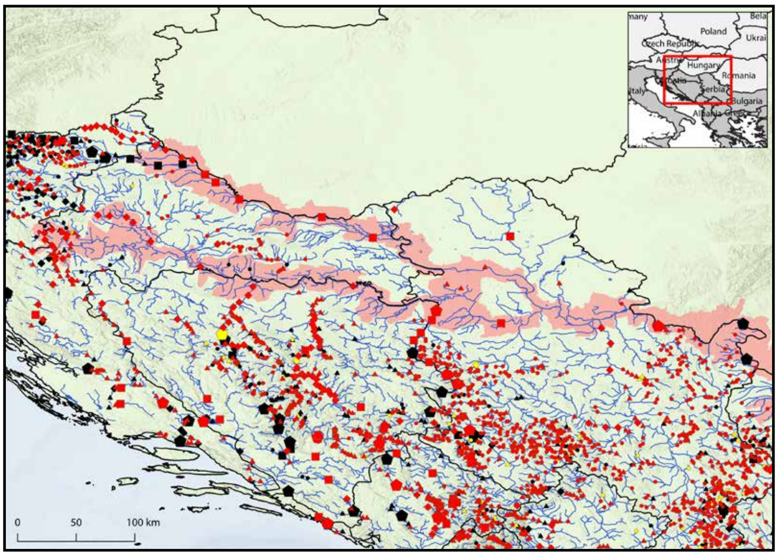
EUR-HAB-DIR:
ANNEX V

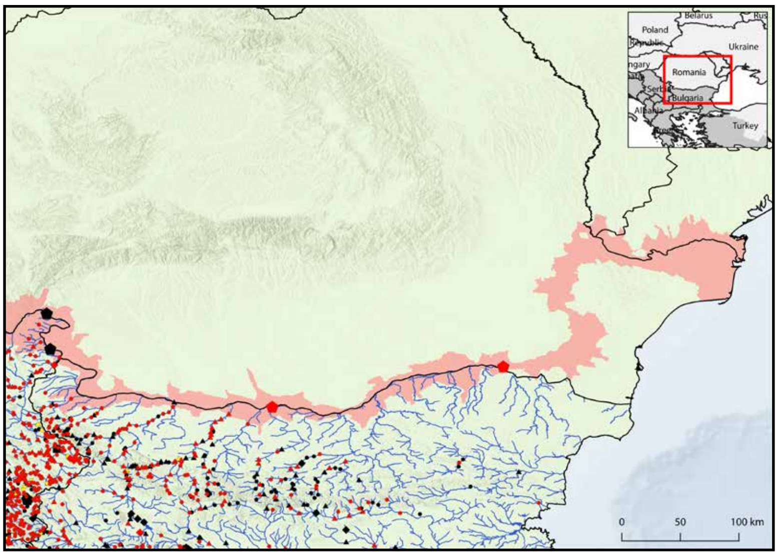
IUCN Red List:
CRITICALLY ENDANGERED

Acipenser nudiventris

Ship sturgeon

Distribution: Bulgaria, Romania, Ukraine, Russia, Georgia, Turkey, Kazakhstan, Uzbekistan, Turkmenistan, Iran, Azerbaijan, Moldova, Romania, Serbia, Bosnia-Herzegovina, Croatia, Hungary, Slovakia





Native to the Black, Azov, Caspian and Aral sea basins, where it once occurred in all major tributaries. Its wild populations have virtually disappeared with only sporadic records since the turn of the century and it is now thought to breed only within its introduced range in Central Asia. Isolated wild adult individuals may still survive in its natural range, but the precise status of the popuation is difficult to determine since a limited number of captive-bred juveniles stocked in the Azov and Caspian basins each year, particularly in Russia and Iran. The major drivers for its collapse are widespread illegal overfishing and river modification, especially construction of dams and hydroelectric power stations which have cut off access to spawning sites.

© Vladimir Wrangel

Hydropower Hazard:
HIGH

EUR-HAB-DIR:
ANNEX V

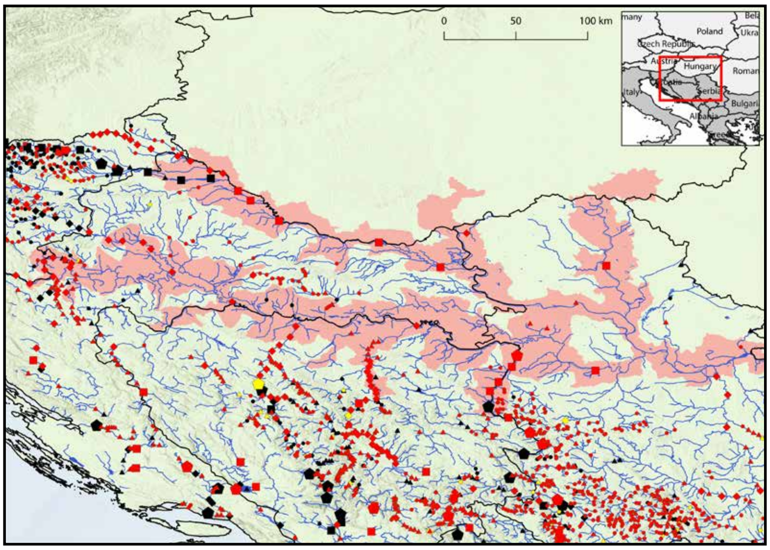
Bern Convention:
APPENDIX III

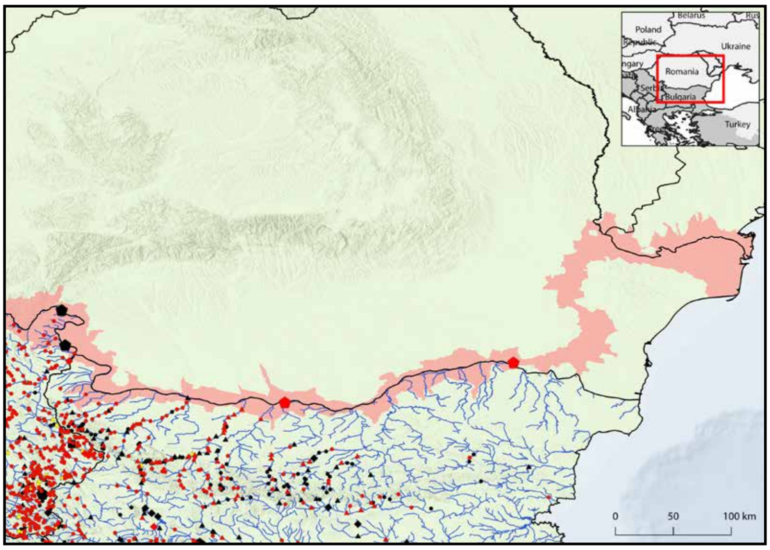
IUCN Red List:
VULNERABLE

Acipenser ruthenus

Sterlet

Distribution: Bulgaria, Romania, Ukraine, Russia, Georgia, Turkey, Moldova, Romania, Serbia, Bosnia-Herzegovina, Croatia, Hungary, Slovakia, Austria, Germany





Native to the Black, Azov and Caspian sea basins, plus the Ob and Yenisei river drainages which flow into the Artic Ocean in northern Siberia. While it has declined significantly throughout its range many populations remain viable, although they are largely isolated from one another by dams and other obstructions. The current strongholds are understood to be the Danube, Kuban, Volga, Ural, Ob and Yenisei rivers. It remains threatened by widespread illegal overfishing, pollution and river modification, especially construction of dams and hydroelectric power stations which have blocked former migration routes and cut off access to spawning sites.

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Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX V*

Bern Concention: *APPENDIX III*

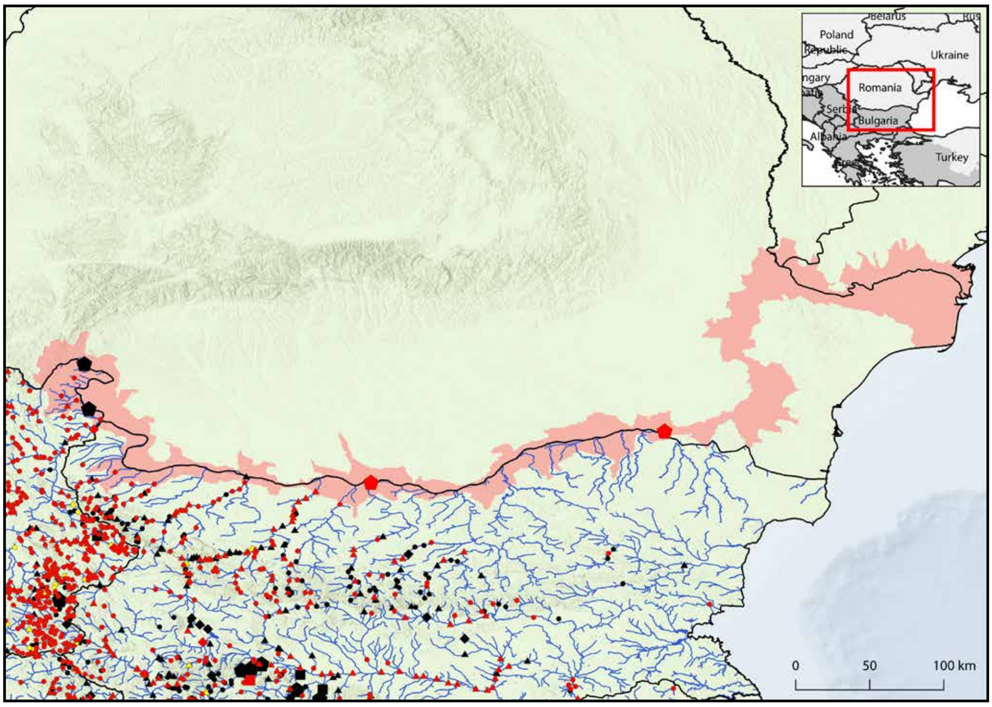
IUCN Red List: *CRITICALLY ENDANGERED*

Acipenser stellatus

Stellate sturgeon

Distribution: Greece, Bulgaria, Romania, Ukraine, Russia, Georgia, Turkey, Kazakhstan, Turkmenistan, Iran, Azerbaijan, Moldova, Romania, Serbia, Bosnia-Herzegovina, Croatia, Hungary, Slovakia, Austria, Germany

Native to the Black, Azov, Caspian and northern Aegean sea basins, with some evidence suggesting it might once have been present in the southern Adriatic Sea. It formerly ascended all large river drainages and was recorded as far upstream as Germany in the Danube. This species is anadromous, with adults foraging at sea and undertaking annual spawning migrations up rivers. Wild populations have undergone a drastic decline and it currently breeds on a regular basis only in the Danube, Sakarya and Rioni rivers in the Black Sea plus the Ural, Volga, and Sefīd systems in the Caspian. Most populations are very small, with the Ural considered the last remaining stronghold. The major drivers for this collapse are continued illegal overfishing and river modification, especially the con-struction of dams and hydroelectric power stations which have cut off access to spawning sites.



© Jörg Freyhof

Hydropower Hazard:
HIGH

EUR-HAB-DIR:
ANNEX V

Bern Concention:
APPENDIX II + III

IUCN Red List:
CRITICALLY ENDANGERED

Acipenser sturio

Atlantic sturgeon

Distribution: Russia, Norway, Iceland, United Kingdom, Republic of Ireland, Denmark, Germany, Netherlands, Belgium, France, Spain, Portugal, Morocco, Algeria, Tunisia, Italy, Slovenia, Croatia, Bosnia-Herzegovina, Albania, Greece, Turkey, Bulgaria, Romania, Ukraine, Georgia

This species no longer occurs in the MBBH. It is native to the White and North seas, the European Atlantic coastline, and northern Mediterranean basin as far east as Rhodes and the Black Sea basin, with occasional records from Morocco, Algeria and Tunisia. It is anadromous, with adults foraging at sea and undertaking annual spawning migrations up rivers. This species' wild populations have been more-or-less completely extirpated since the start of the 20th century. Small numbers now breed with decreasing success in the Garonne River drainage, France. Restocking attempts are underway, most notably in France and Germany. The major drivers for the species' collapse are continued illegal overfishing, pollution and river modification, especially construction of dams and hydroelectric power stations which have cut off access to spawning sites.

© Perica Mustafić

Hydropower Hazard:
HIGH

EUR-HAB-DIR:
ANNEX V

Bern Concention:
APPENDIX II + III

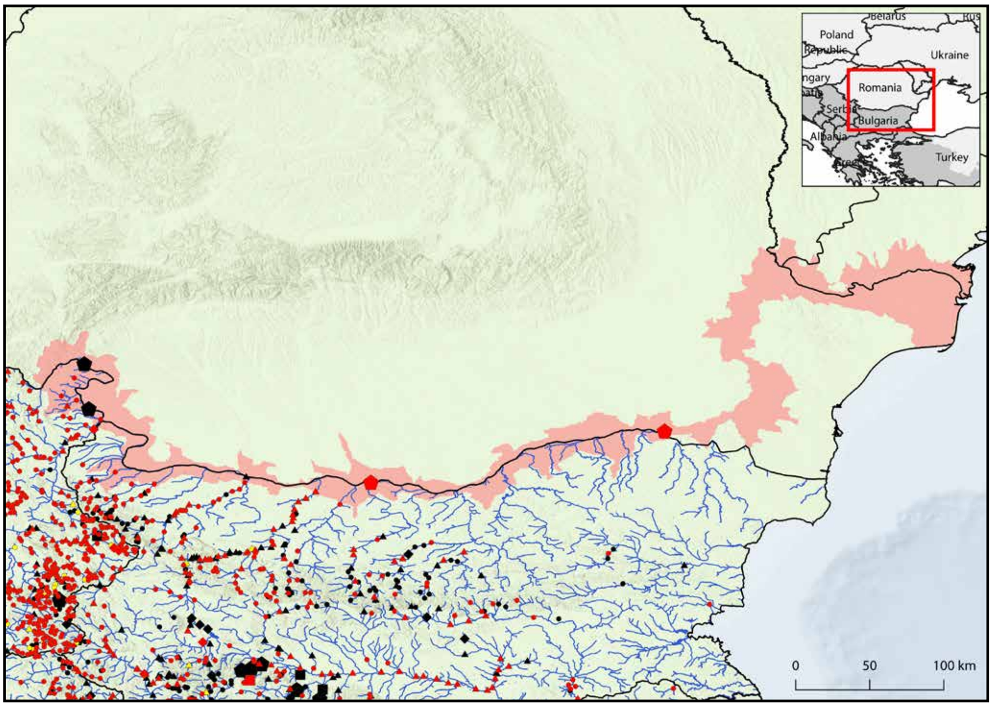
IUCN Red List:
CRITICALLY ENDANGERED

Huso huso

Beluga

Distribution: Bulgaria, Romania, Ukraine, Russia, Georgia, Turkey, Kazakhstan, Turkmenistan, Iran, Azerbaijan, Moldova, Romania, Serbia, Bosnia-Herzegovina, Croatia, Hungary, Slovakia, Austria, Germany, Greece, Albania, Slovenia, Italy

Native to the Caspian, Black, Azov and Adriatic sea basins, where it formerly occurred in the largest affluent river drainages. It is anadromous, with adults foraging at sea and undertaking annual spawning migrations up rivers. This species' wild populations have undergone a drastic decline and it was extirpated from most of its range during the 20th century, with remnant spawning populations still entering the Danube and Rioni rivers in the Black Sea plus the Volga and Ural in the Caspian. The major drivers for this collapse are continued illegal overfishing and river modification, especially the con-struction of dams and hydroelectric power stations which have cut off access to spawning sites.



© Jörg Freyhof

Anguilla anguilla

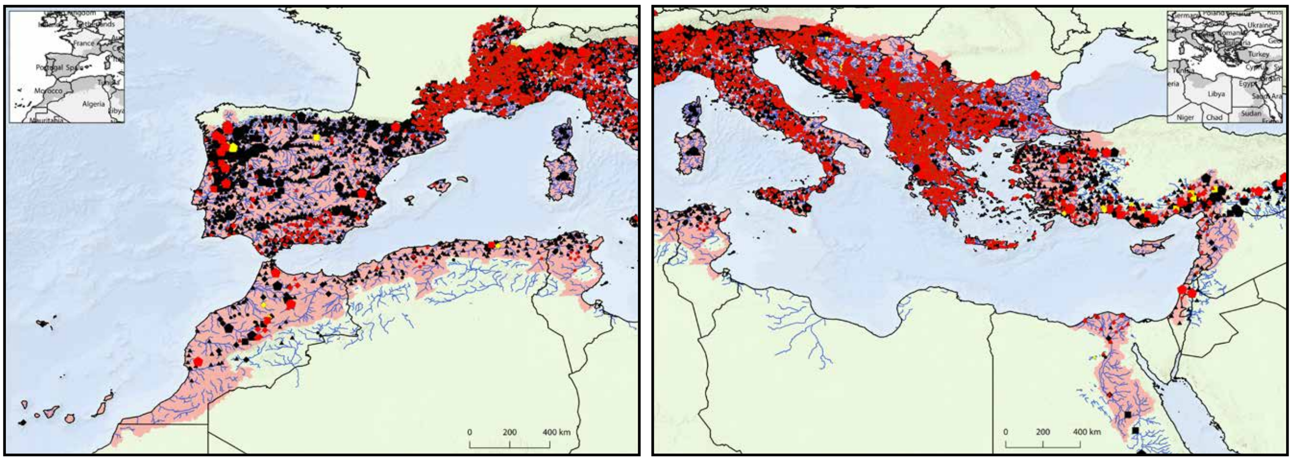
European Eel

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Albania, Algeria, Austria, Belarus, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Georgia, Germany, Greece, Guernsey, Iceland, Ireland, Israel, Italy, Latvia, Lebanon, Libya, Lithuania, Luxembourg, Malta, Mauritania, Moldova, Montenegro, Morocco, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Syria, Tunisia, Turkey, Ukraine, United Kingdom

Distributed from northern Norway to the Canary Islands in the eastern Atlantic Ocean, including the Baltic Sea basin and British Isles, throughout the Mediterranean Sea basin and in the Black and Azov seas. Studies suggest that in Western Europe recruitment of glass eels has plummeted by at least 90% since the early 1980s, with population declines of more than 50% estimated throughout the species' range. Although the major drivers are not fully understood, they have been identified as commercial and illegal overfishing, pollution, habitat loss, dam construction and other forms of river obstruction, disease, parasitism and environmental changes both in its native rivers and the Sargasso Sea. Hydropower turbines and their associated infrastructure and water management systems are known to kill eels and prevent their migration within rivers.



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Alosa algeriensis

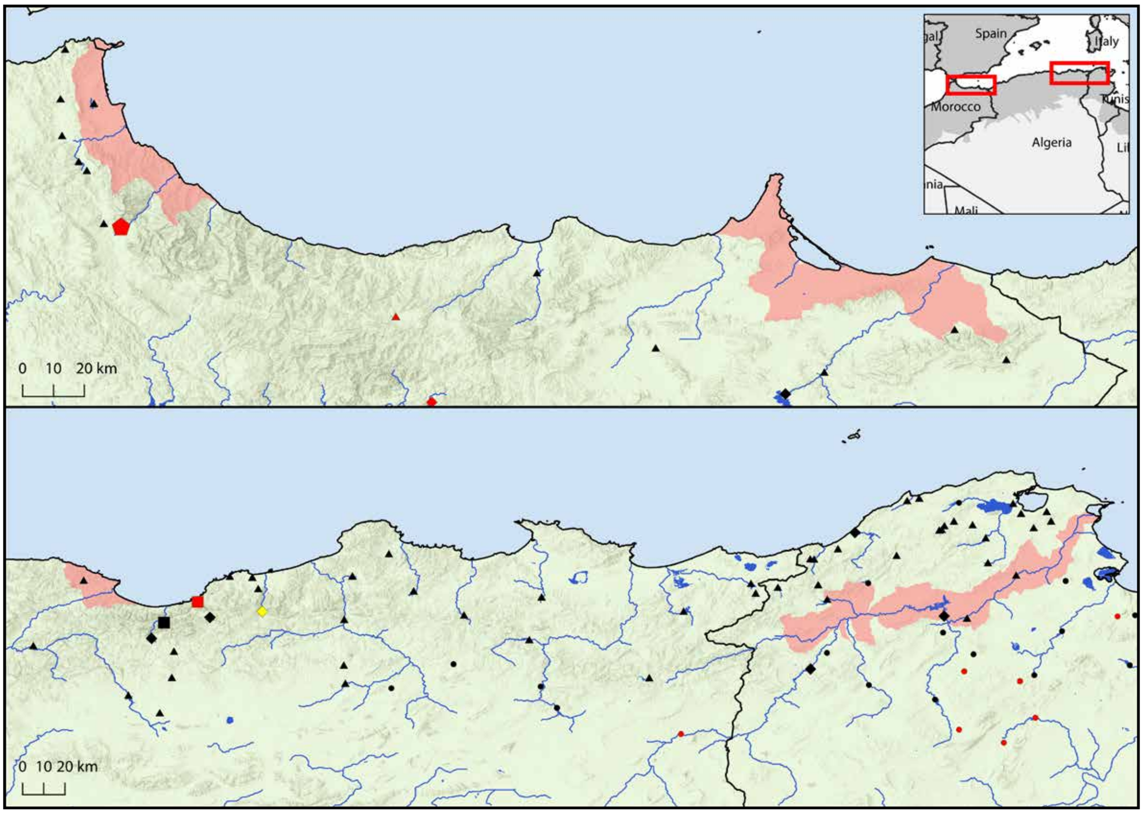
North African shad

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Morocco, Algeria and Tunisia, potentially Sardinia

Native to the Mediterranean coastline of North Africa. This species is diadromous and primarily threatened by construction of dams which have largely blocked its migration routes and apparently caused the overall population size to plummet since the mid-20th century. Virtually all rivers within its range also suffer from widespread pollution and excessive water abstraction.



© Rob Hillman

Alosa alosa

Allis shad

Hydropower Hazard: *HIGH*

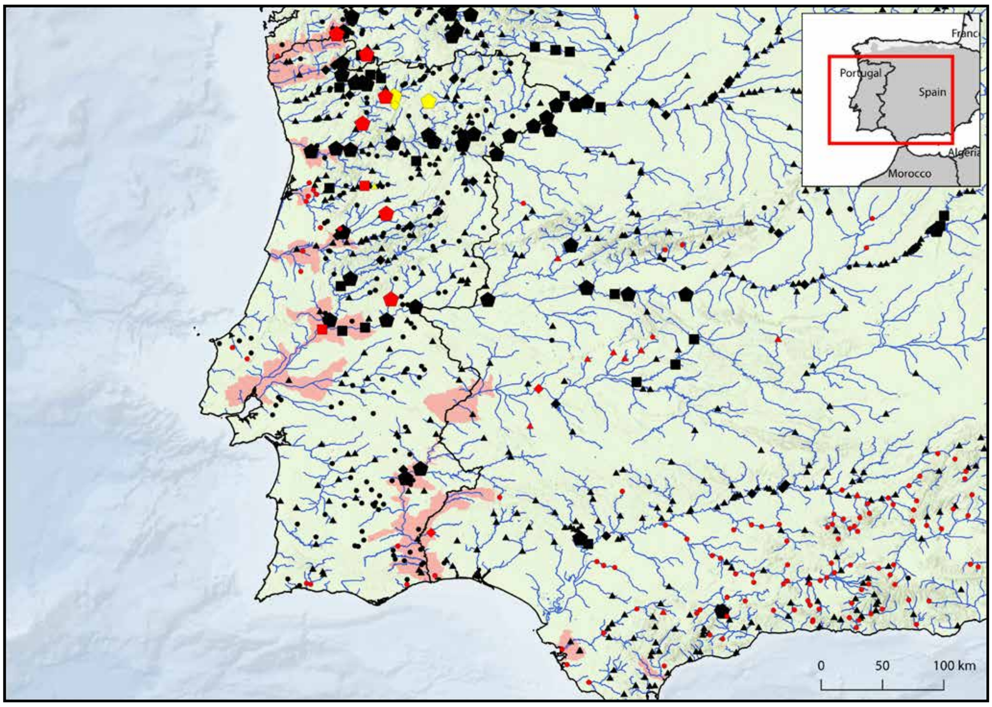
EUR-HAB-DIR: *ANNEX II + V*

Bern Concention: *APPENDIX III*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Morocco, Spain, Portugal, France, Great Britain, Belgium, Denmark, Germany, Ireland, Netherlands, Norway

Native to western Europe and Atlantic North Africa, from Scotland and Norway south to Spain and Morocco. This species is diadromous and primarily threatened by construction of dams which have largely blocked its migration routes and apparently caused the overall population size to plummet since the mid-20th century. More recent declines, particularly in France, are poorly understood and might be linked to climate change-driven habitat alterations. Virtually all rivers within its range also suffer from widespread pollution and excessive water abstraction. Removing dams to allow this species to enter rivers further north could strongly aid its long-term survival.



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Alosa macedonica
Macedonian shad

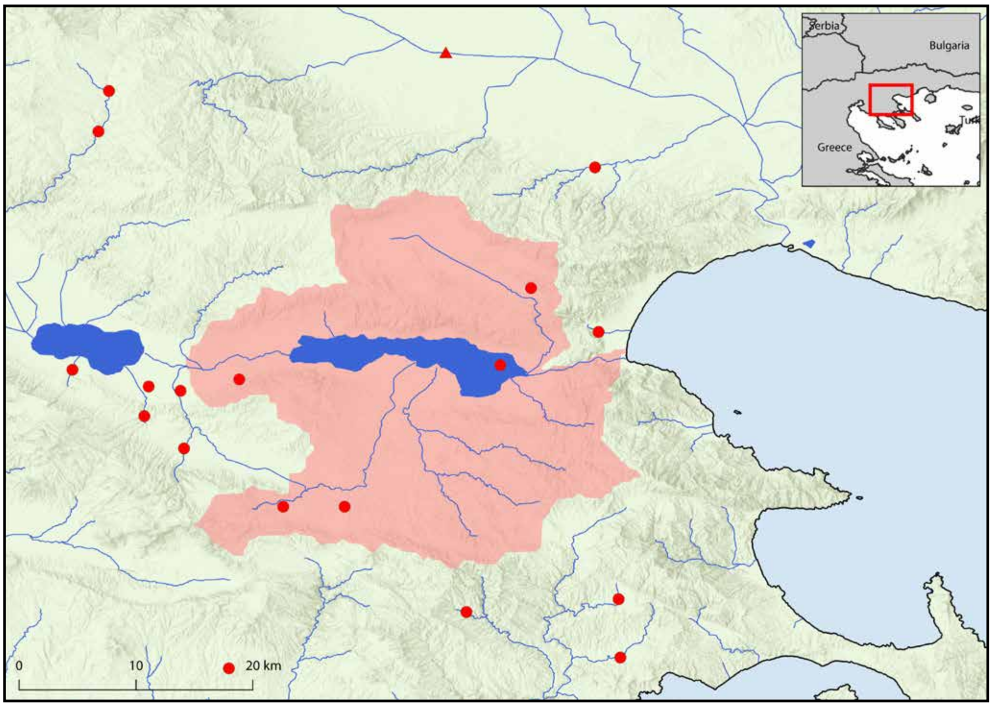
Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II + V*

IUCN Red List: *VULNERABLE*

Distribution: Greece

Restricted to Lake Volvi in Thessaloniki, northern Greece. It was extirpated from nearby Lake Koronia (aka Koroneia), which drains into Volvi, after it became hypertrophic and almost completely dried out during the 1990s. This species is lacustrine and does not ascend tributaries or migrate to the sea as part of its life cycle. It was formerly harvested intensively on a commercial basis, but in recent decades much of this pressure has been reduced as a result of local fishermen being encouraged to target introduced non-native species. The lake has lost around 1% of its size since the mid-20th century, and the major threat is acceleration of this process, most likely via a combination of increasing sedimentation from surrounding agriculture plus climate change.



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Arabibarbus grypus

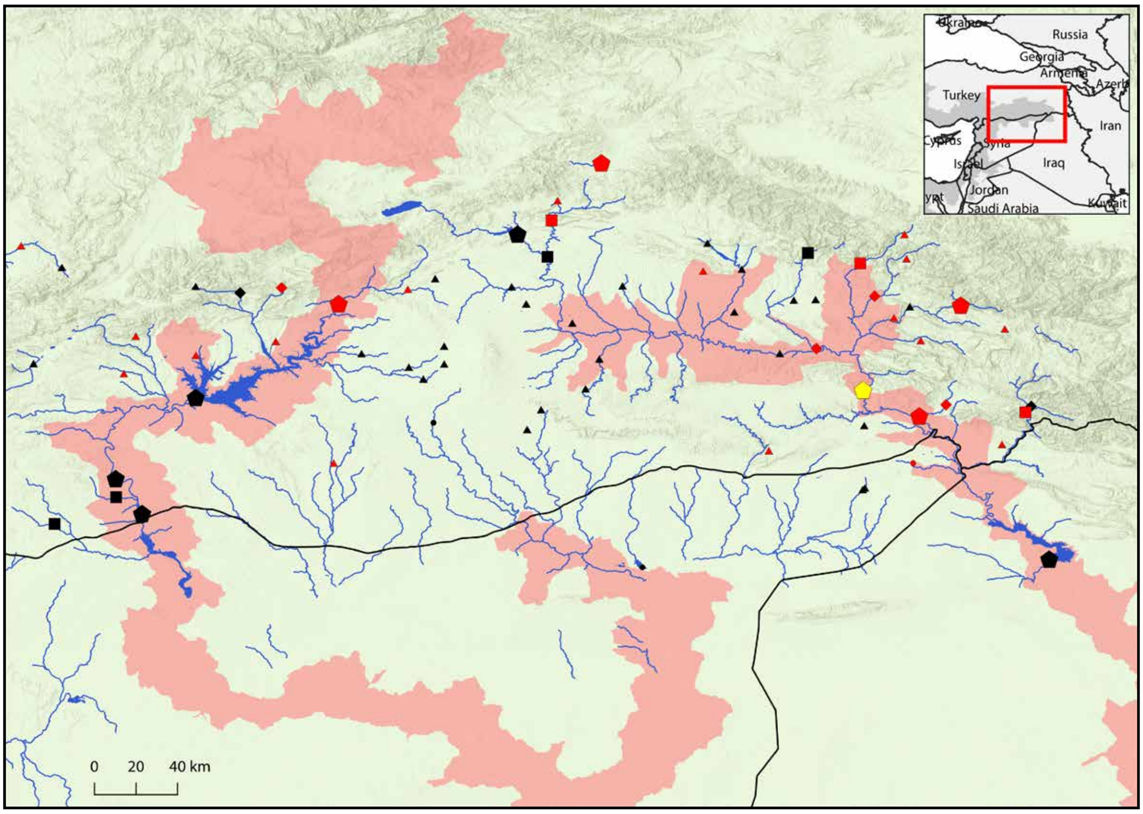
Shabout

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Turkey, Syria, Iraq and Iran

Native to the Euphrates and Tigris river drainages, from their upper reaches in southeasten Turkey to the Shatt al-Arab River after their confluence. It also occurs in the Heleh and Mond rivers which drain into the Persian Gulf in Iran. It is threatened mostly by overfishing plus excessive water abstraction, pollution, commercial, extended periods of drought and construction of dams. However, it can colonise and even thrive in reservoirs.



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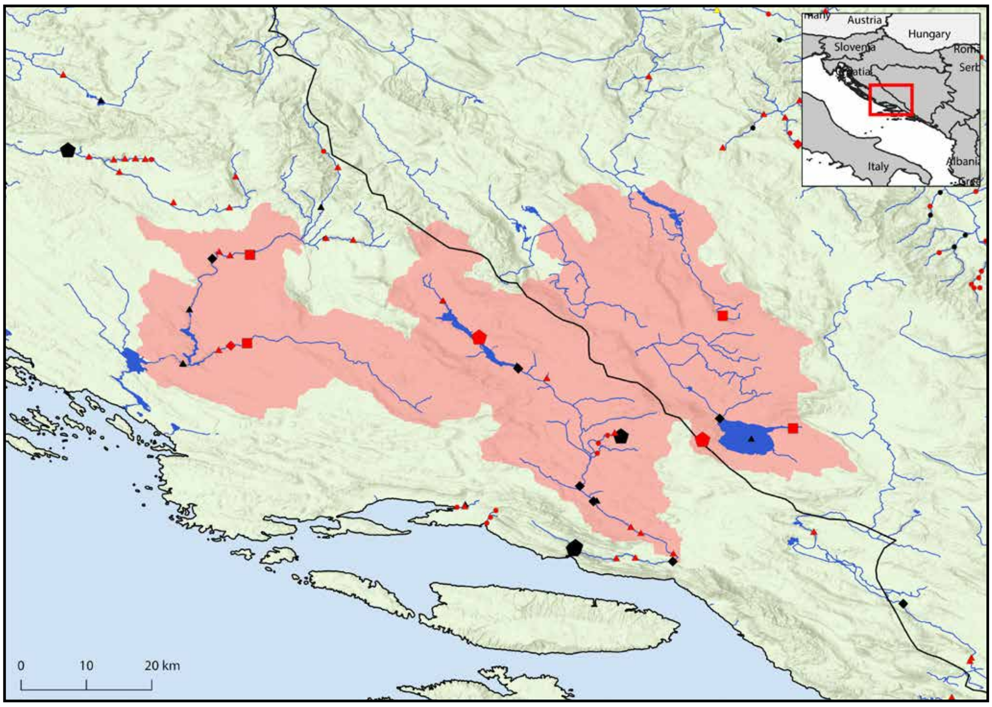
Hydropower Hazard:
HIGH
EUR-HAB-DIR:
ANNEX II
Bern Concention:
APPENDIX III
IUCN Red List:
ENDANGERED

Aulopyge huegelii

Dalmatian Barbel-gudgeon

Distribution: Bosnia-Herzegovina and Croatia

Known from the Krka and Cetina river drainages in Croatia plus the Glamočko, Livanjsko and Duvanjsko poljes and the Buško Blato artificial lake basin in Bosnia-Herzegovina. It has apparently been introduced to lakes Blidinje and Šatorsko in Bosnia-Herzegovina. This species' populations have declined drastically over the last few decades, with major threats including excessive water abstraction, pollution, dam construction and introduction of non-native fish species. Dams have been built on all its native rivers, blocking its migration routes, interfering with groundwater hydrology and favouring establishment of alien species. Populations have plummeted at the local scale with at least a 90% decline in the Buško Blato basin since the early 20th century, when the lake was heavily stocked with alien species.



© Jörg Freyhof

Barbus caninus

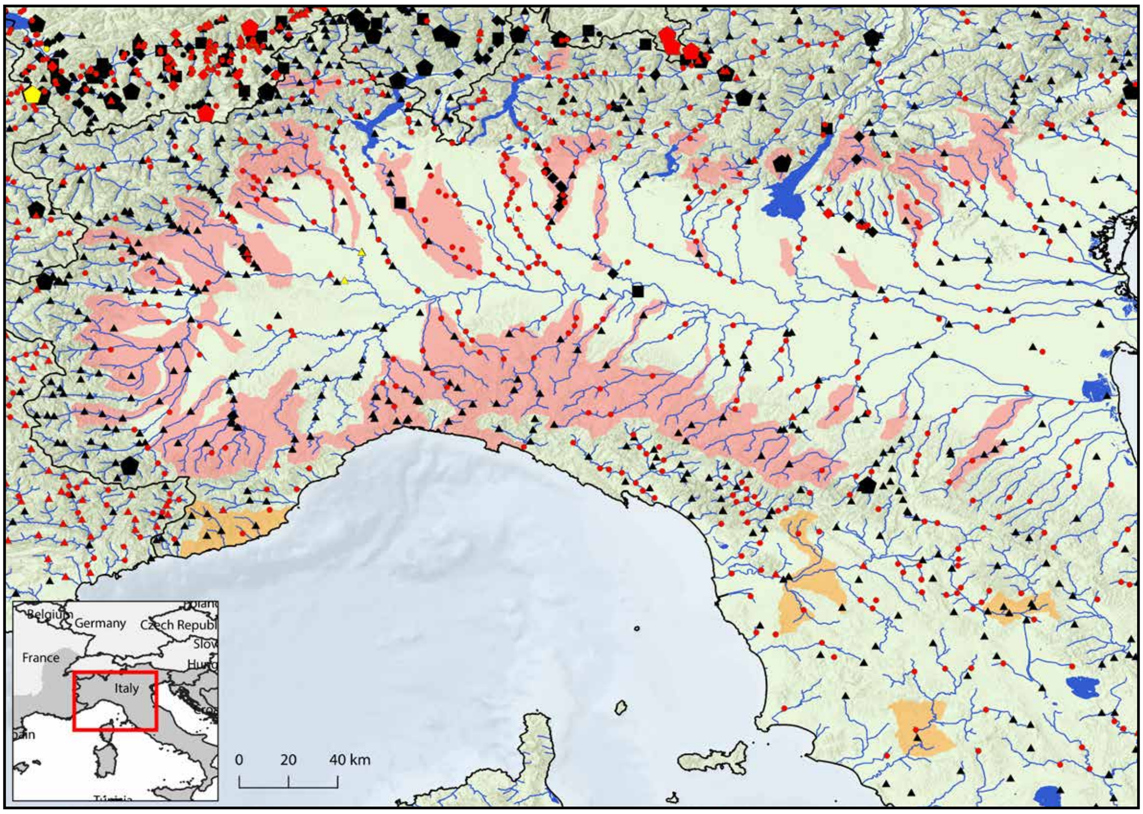
Insubrian barbel

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Italy and Switzerland

Endemic to rivers draining into the Adriatic Sea from the Marecchia to the Brenta, and including the Po. It has been introduced to river drainages elsewhere in Italy, including the Arno and Ombrone, but may not have become established. This species is rheophilic and inhabits the upper reaches of fast-flowing, clear mountain rivers and streams at altitudes of 800–1000 metres AMSL. It is threatened by dam construction, flow regulation, pollution, water abstraction and introduction of non-native fish species such as the related common barbel (*Barbus barbus*).



© Jörg Freyhof

Barbus euboicus

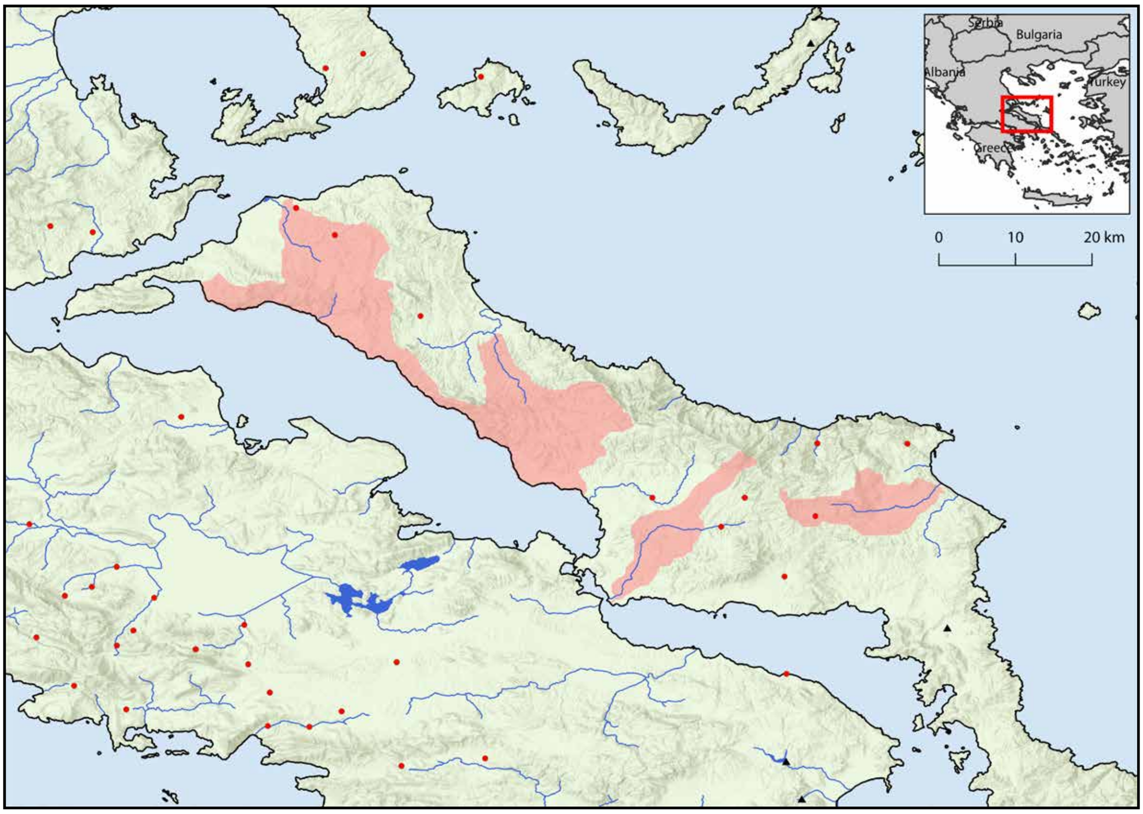
Evia barbel

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Greece

Endemic to the island of Evia (aka Euboea) where it is known from five small river drainages. These typically dry out in summer, with the fish surviving in remnant pools. This species is threatened by excessive water abstraction, pollution, construction of weirs and other barriers, and increasing frequency and intensity of droughts. Large hydropower development is unlikely within its native range.



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Barbus meridionalis

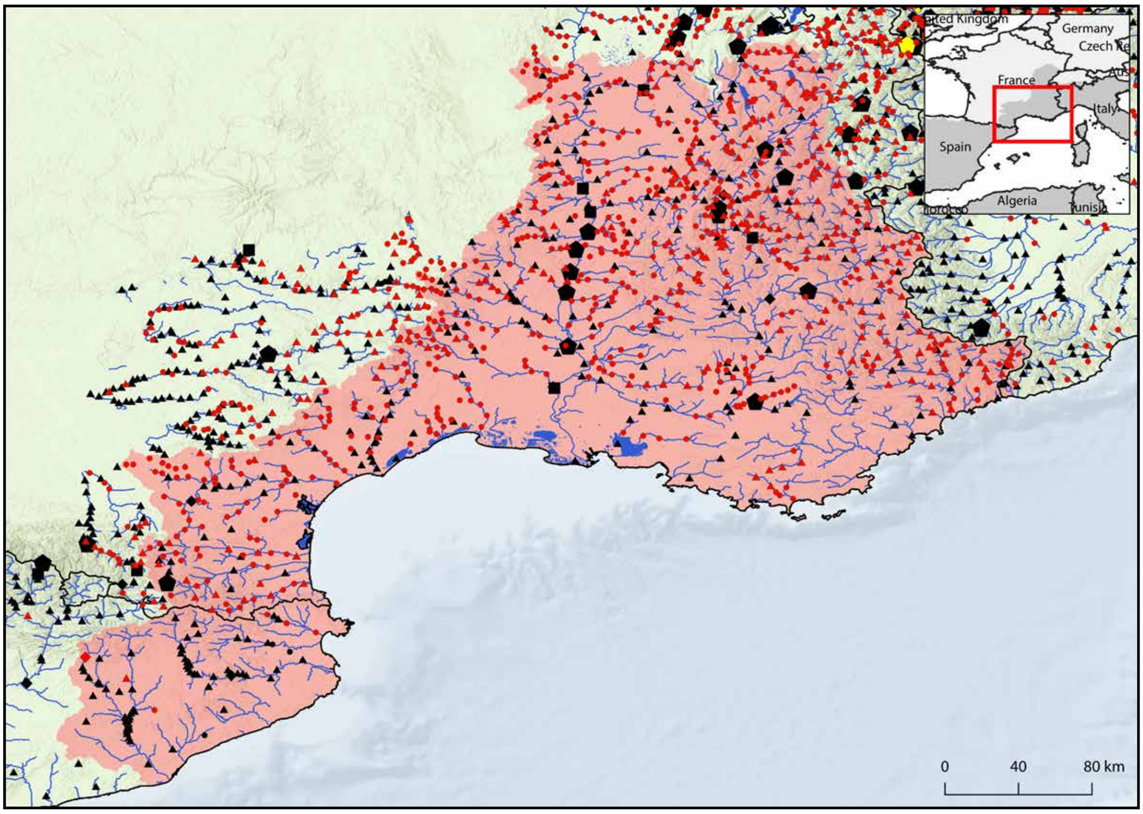
Mediterranean barbel

Distribution: France and Spain

Hydropower Hazard:
HIGH

IUCN Red List:
VULNERABLE

Restricted to the middle and lower Rhône River drainage and a number of small coastal rivers in southern France and northern Catalonia, Spain. It inhabits upper and middle courses with clear, flowing and well-oxygenated water. Most of the short coastal drainages partially dry up in summer, with the fish surviving in remnant pools. This species is threatened by habitat modification, dam construction, water abstraction and pollution, and it is likely to be impacted by climate change as the frequency and longevity of droughts increases.



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Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II + V*

Bern Concention: *APPENDIX III*

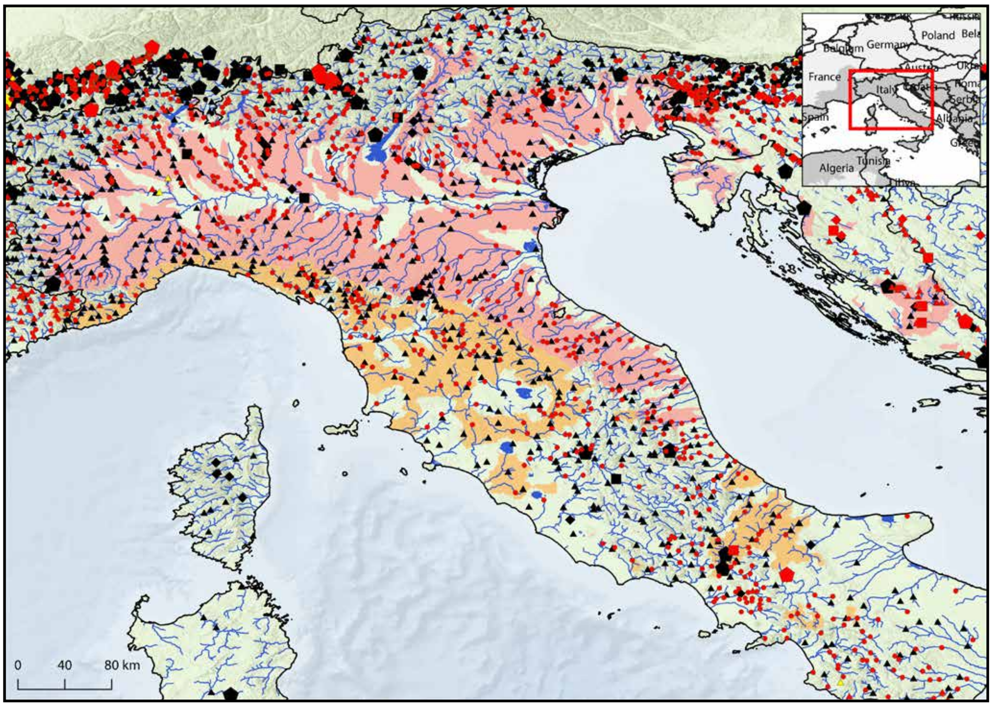
IUCN Red List: *ENDANGERED*

Barbus plebejus

Padanian barbel

Distribution: Croatia, Italy, Slovenia, Switzerland

Native to the northern Adriatic Sea basin. Its range extends from the Reno River in Italy to the Krka River in Croatia, including the Po River, where it occurs in some tributaries in Switzerland. This species has been introduced to many rivers in central Italy for angling and is often itself a conservation threat since it readily hybridises with related native species. It prefers relatively deep, slow-moving, well-oxygenated river channels but also inhabits some lakes, including artificial reservoirs. It is primarily threatened by introduction of non-native fish species, particularly through hybridisation with the common barbel (*Barbus barbus*) and predation by Wels catfish (*Silurus glanis*).



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Barbus tyberinus

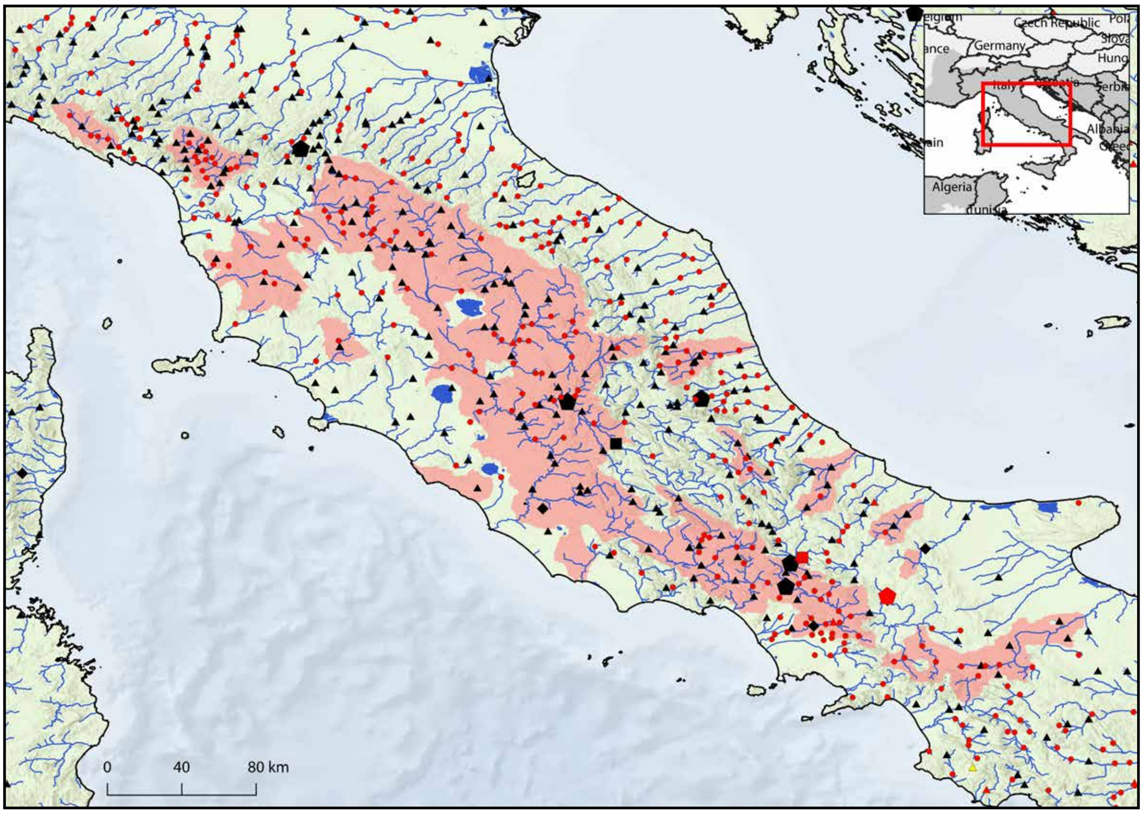
Horse barbel

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Italy

Endemic to rivers draining to the middle Tyrrhenian Sea basin from the Serchio River to the Tiber River. It has been introduced elsewhere in the country, including to some Adriatic river drainages, but has vanished from large parts of its former range since the 1990s. This species prefers relatively deep, slow-moving, well-oxygenated river channels but also inhabits some lakes, including artificial reservoirs. It is primarily threatened by hybridisation with introduced species including common barbel (*Barbus barbus*), Padanian barbel (*Barbus plebejus*), and Iberian barbel (*Luciobarbus graellsii*) plus predation by Wels catfish (*Silurus glanis*).



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Capoeta antalyensis

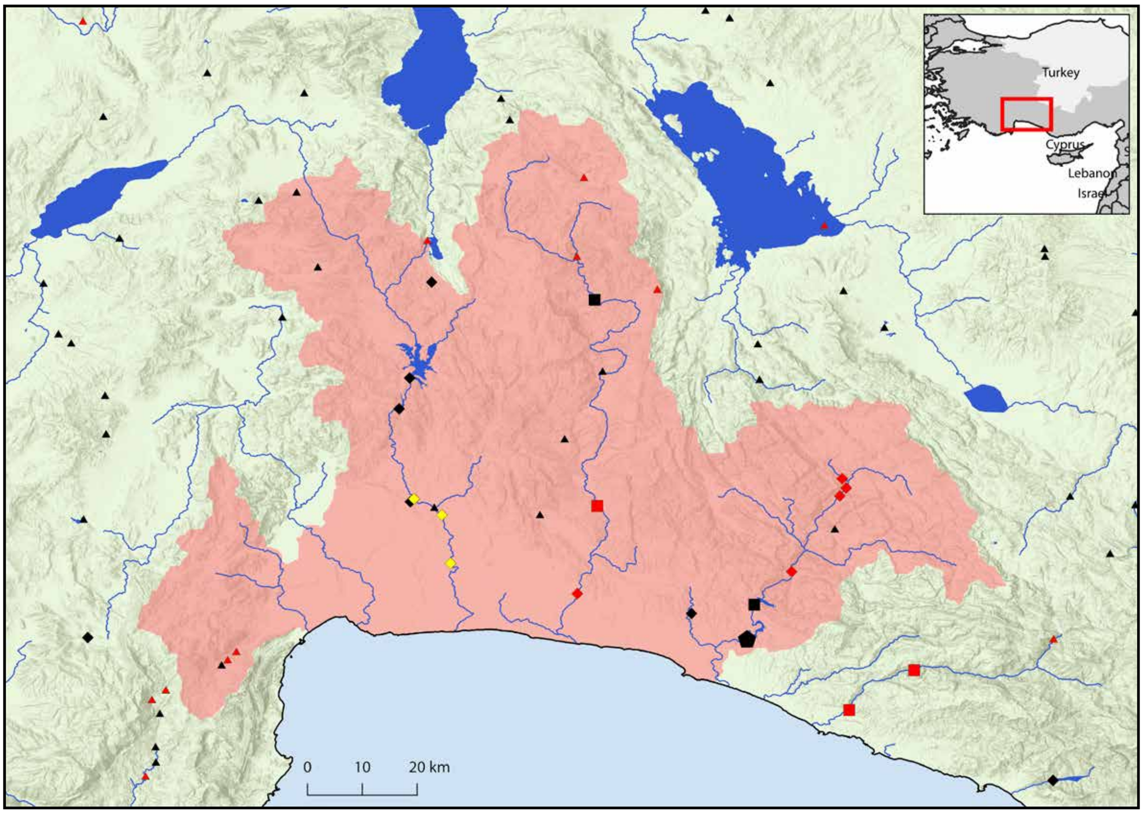
Pamphylian scraper

Hydropower Hazard: *MODERATE*

IUCN Red List: *VULNERABLE*

Distribution: Turkey

Known only from the Boğa, Aksu and Köprüçay river drainages which flow into the Gulf of Antalya in the Mediterranean Region of southern Turkey. It inhabits fast-flowing, clear rivers and streams with substrates of sand and pebbles. This species is threatened by pollution, water abstraction, dam construction and hydropower development. It has apparently been extirpated from the Boğa River. The Aksu River has been dammed several times, modified along much of its lower course and is heavily contaminated. A hydroelectric dam has been constructed on the upper Köprüçay.



© Jörg Freyhof

Capoeta barroisi

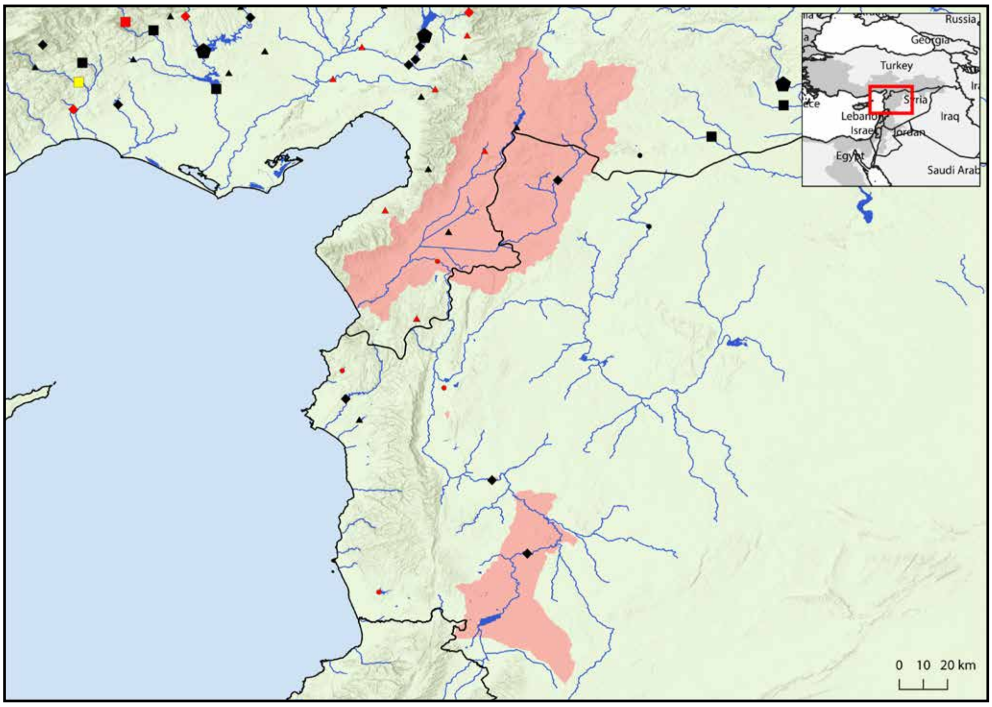
Orontes scraper

Hydropower Hazard:
LOW

IUCN Red List:
ENDANGERED

Distribution: Syria and Turkey

Endemic to the Orontes (tr. Asi) River drainage where it is now restricted to a handful of known locations including the lower river Afrin and Karasu (Lake Balık and Tahtaköprü dam) tributary drainages in Turkey, plus Lake Homs (aka Qattinah) in Syria. It inhabits larger river channels, lakes and man-made reservoirs. Dam construction throughout the Orontes system has led to the drying of many river stretches, while excessive water abstraction and pollution are also widespread. Lake Balık lost more than 60% of its surface area between 1957 and 2007, and a number of non-native fish species have been introduced, while Tahtaköprü is polluted and also shrinking due to prolonged periods of drought. Especially during periods of low rainfall very little water from the Orontes and its affluents may reach Turkey due to the number of dams in Syria.




© Jörg Freyhof

Capoeta pestai

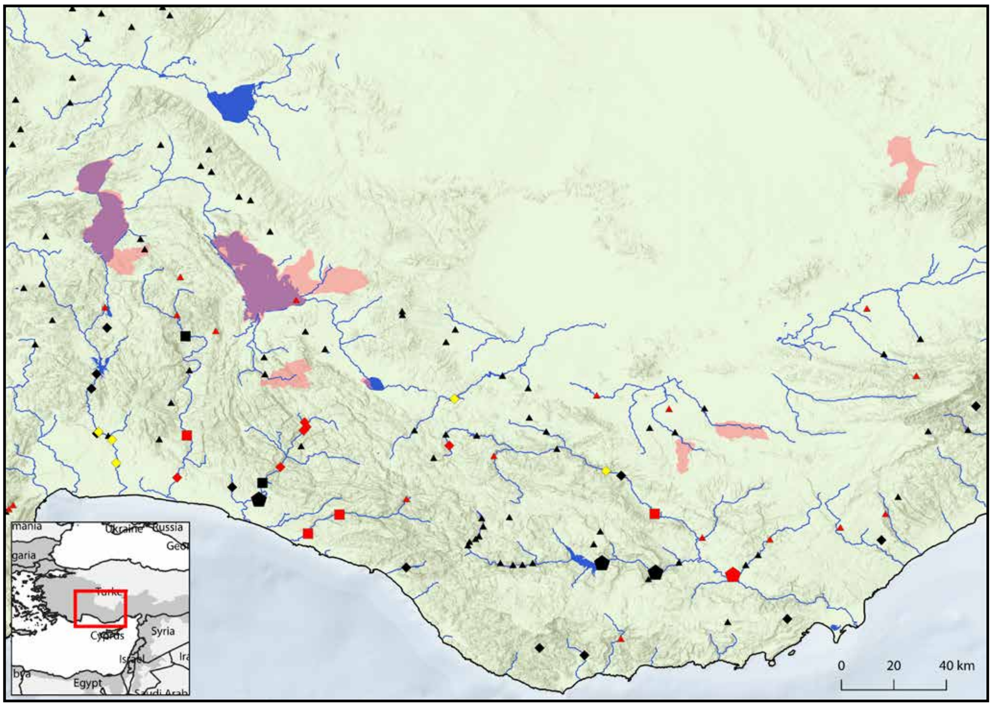
Eğirdir Longsnout scraper

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Native to the Eğirdir, Beyşehir, Tuz and Karaman endorheic basins. In Eğirdir it is restricted to the short inflowing Çayköy Stream and the southern portion of the lake. Within the Tuz basin it has been recorded from the Melendiz River and in the Karaman basin from a stream near Taşkale. With the exception of the Beyşehir and Eğirdir populations, much of which were lost following the introduction of predatory non-native pike-perch (*Sander lucioperca*), this species inhabits streams and minor rivers. In addition to the threat of invasive species it is at risk from excessive water abstraction, pollution and dam construction. In the Melendiz native fishes are now restricted to a stretch of around 30 kilometres above a man-made reservoir since the river typically runs dry beneath the dam that created it.



© Jörg Freyhof

Carasobarbus harterti

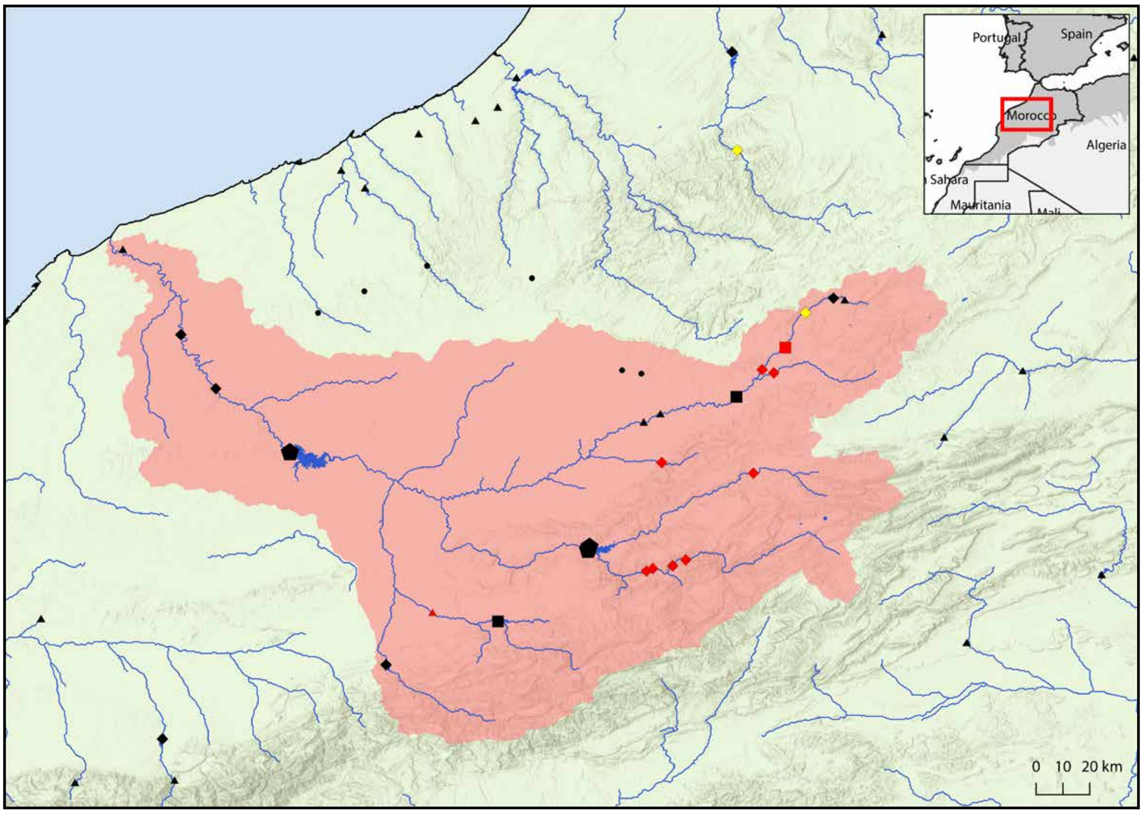
Stripeless himri

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Morocco

Endemic to the Oum Er-Rbia River drainage in central Morocco, and might now occur only above the Al Massira hydroelectric dam. Little is known of its biology, but it has only been recorded from lower and middle courses of the river. This species appears to have declined significantly and has been recorded on very few occasions in recent years. Although the precise reasons are unclear, excessive water abstraction, domestic pollution, introduction of alien species, subsistence fisheries and dam construction are widespread throughout its known range.



© Jörg Freyhof

Carasobarbus kosswigi

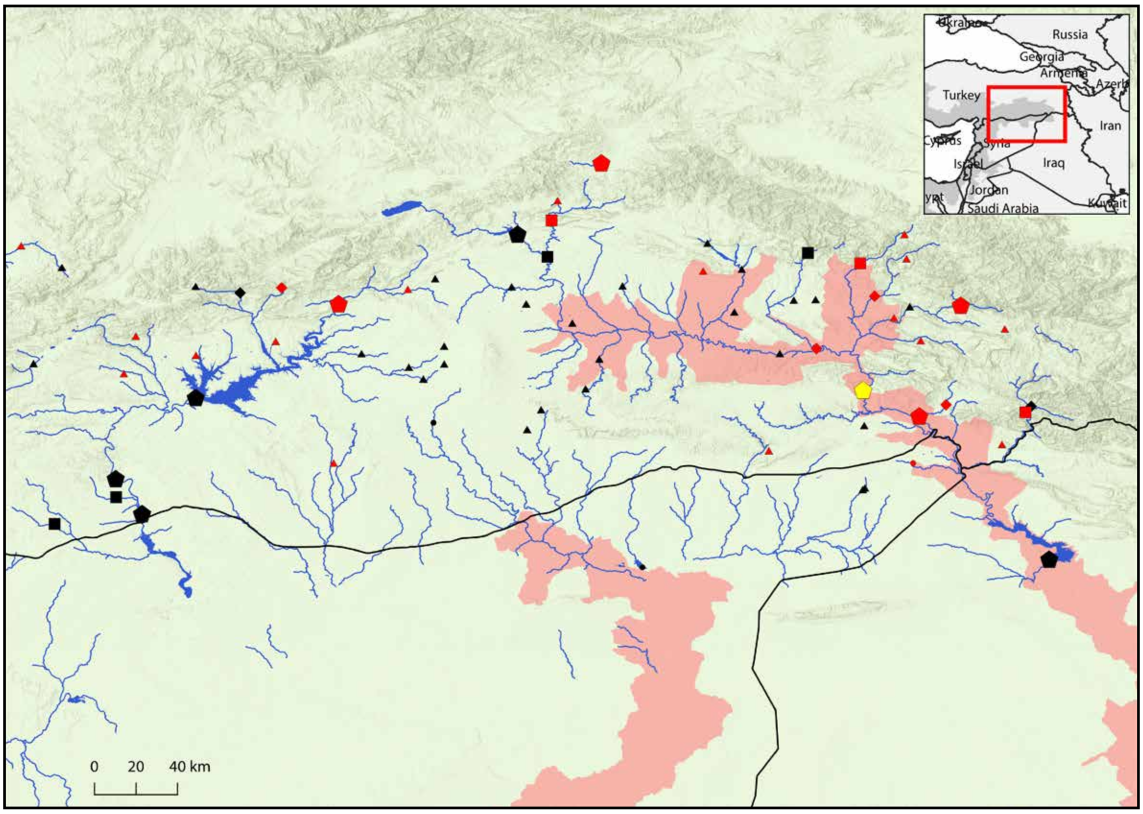
Kiss-lip himri

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Turkey, Syria, Iraq, Iran

Restricted to the Euphrates and Tigris river drainages, although the precise extent of its range is unknown. Its biology is poorly understood, but it appears to prefer larger, free-flowing river channels. It is threatened by widespread pollution, water abstraction and dam construction. There exist numerous large hydroelectric dams throughout its known range.



© Jörg Freyhof

Garra festai

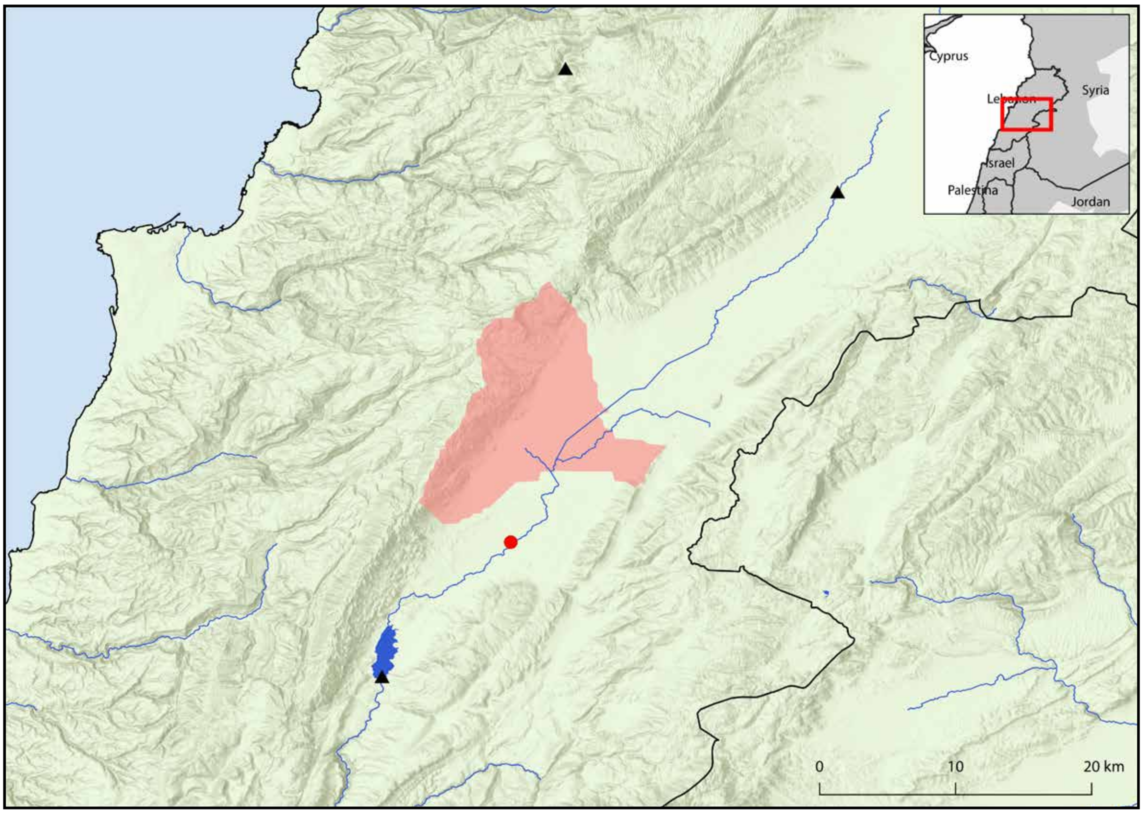
Aammiq garra

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Lebanon

Endemic to the Aammiq wetland in the upper Litani River drainage at the western edge of Mount Lebanon. These marshes are a remnant of what was formerly a much larger wetland, and this species inhabits a tiny perennial freshwater spring. It is threatened by water abstraction and increasing frequency and intensity of droughts due to climate change.



© Jörg Freyhof

Garra ghorensis

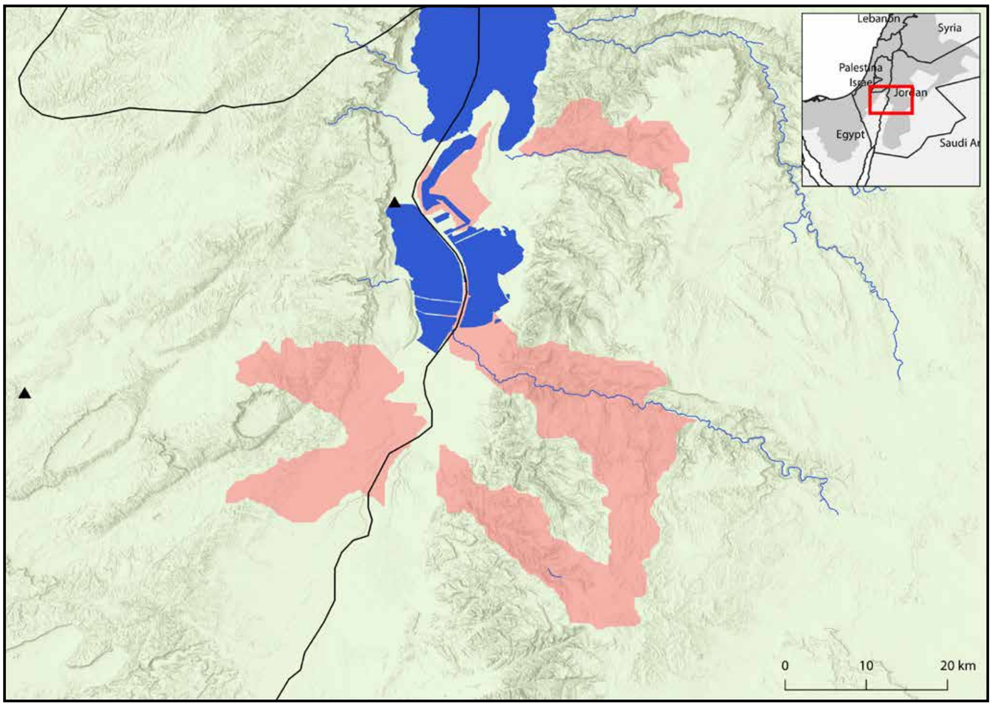
Dead Sea garra

Hydropower Hazard: *MODERATE*

IUCN Red List: *ENDANGERED*

Distribution: Israel and Jordan

Now restricted to freshwater springs and a small river in the southern Dead Sea basin, Jordan, where its range extends south from Wadi Bin Hammad to Wadi Khneizerah. Populations formerly inhabiting the Israeli side of the Dead Sea have been extirpated. This species inhabits small streams and hot springs with rocky substrates, characterised by low flow for much of the year. It is threatened by habitat modification, water abstraction for agricultural and domestic use, and introduction of non-native fish species to reservoirs and small impoundments created by dams. The relatively large Tannur Dam on the Wadi Al-Hassa, which harbours the largest garra population, was completed in 2005 with seasonal flooding controlled as a result.



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Garra kemali

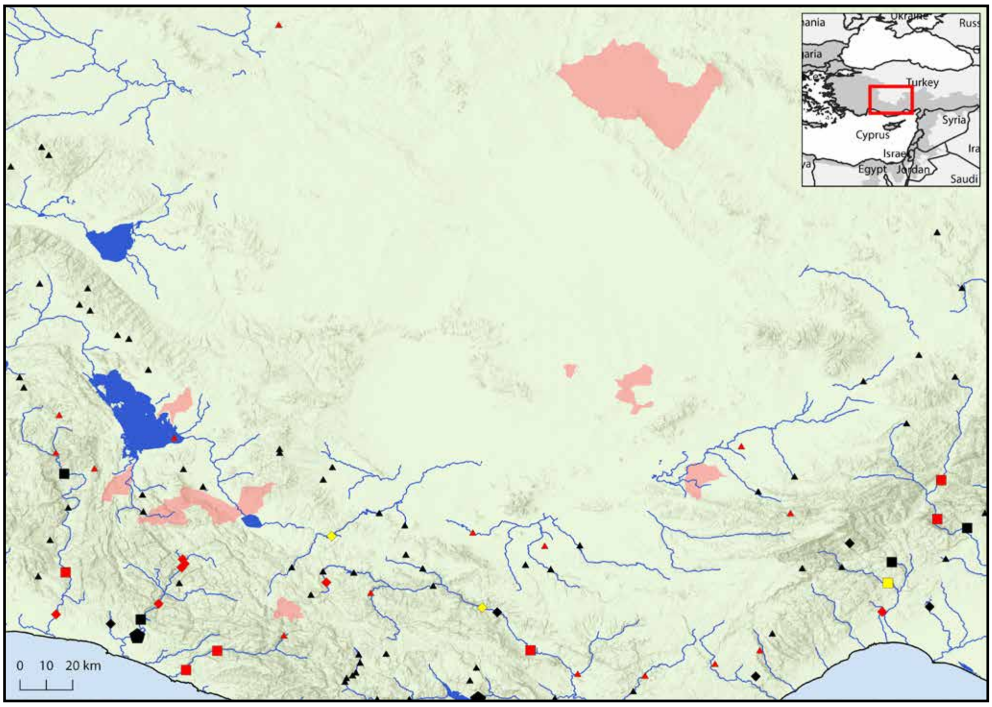
Tuz golden barb

Distribution: Turkey

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Known from marshes associated with the Gökdere Stream close to Ereğli, plus Lake Meyil, Lake Beyşehir and Hirfanlı reservoir. Lake Meyil is a sinkhole lake in the Lake Tuz basin, while in the Beyşehir basin populations are known from the Eflatun Pınar spring and at the outflow of the lake. Hirfanlı is a large hydroelectric dam on the Kızılırmak River, which flows to the Black Sea. This species inhabits springs and bodies of standing water, including the artificial dam lake. It is threatened by excessive water abstraction, pollution and introduction of non-native fish species. The Ereğli population might already have been extirpated after the marshes were largely drained, with the little remaining water channelled towards a small reservoir, while the water level at Lake Meyil is reported to be falling rapidly.



© Jörg Freyhof

Garra klatti

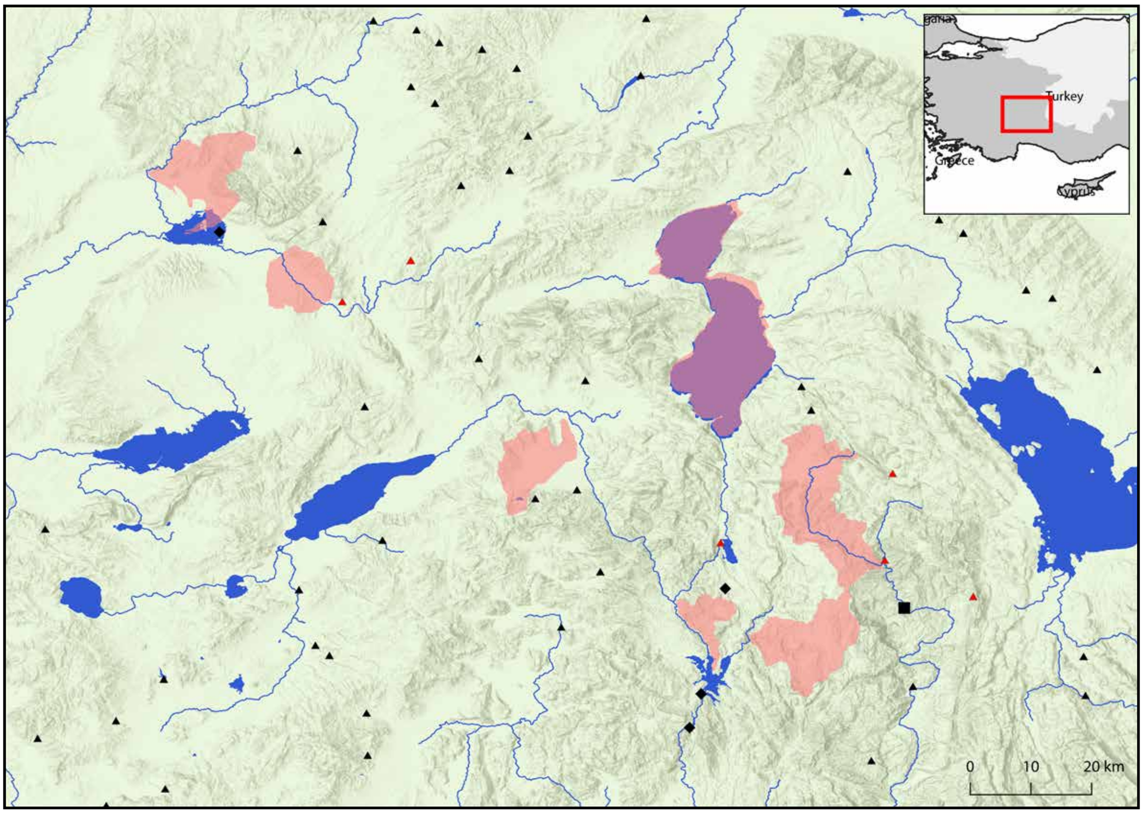
Anatolian golden barb

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Restricted to the Lake Isıklı basin and Küfü Stream within the upper Büyük Menderes River drainage, plus the upper Aksu and Küprü rivers. This species inhabits springs, streams and vegetated shorelines of lakes. It is threatened by water abstraction, pollution and introduction of alien fish species. Populations from the Eğirdir and Gölcük lake basins appear to have been eradicated after non-native species were introduced.



© Jörg Freyhof

Luciobarbus esocinus

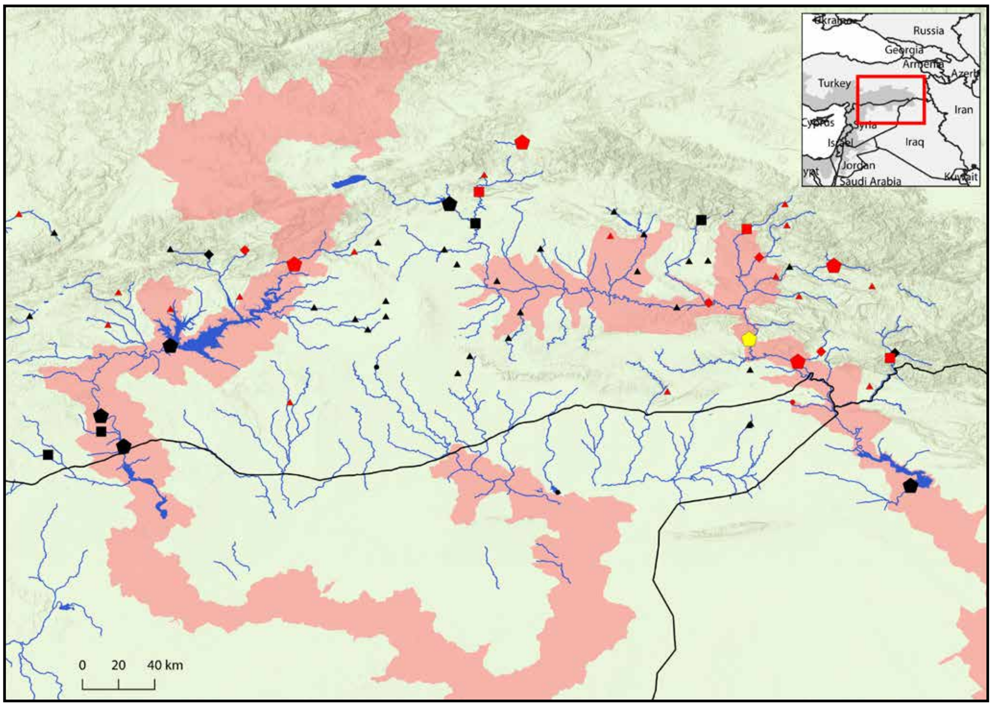
Pike barbel

Hydropower Hazard: *MODERATE*

IUCN Red List: *VULNERABLE*

Distribution: Turkey, Syria, Iran and Iraq

Native to the Euphrates and Tigris river drainages. It inhabits deep, flowing sections of large river channels, plus lakes and artificial reservoirs. Under natural circumstances adults migrate annually to spawn in headwaters and tributaries. This species is threatened mostly by overfishing which includes the use of poison and explosives, but also by water abstraction and pollution. The limited fisheries data available suggests that catches have declined considerably since the mid-1960s, and it has disappeared from many former locations. Widespread construction of dams has blocked access to migration routes and destroyed large portions of suitable riverine habitat due to reduced discharge. Although it adapts to man-made lakes when introduced, it is likely that reproductive success is inhibited to a large extent under such conditions.



© Jörg Freyhof

Luciobarbus figuiguensis

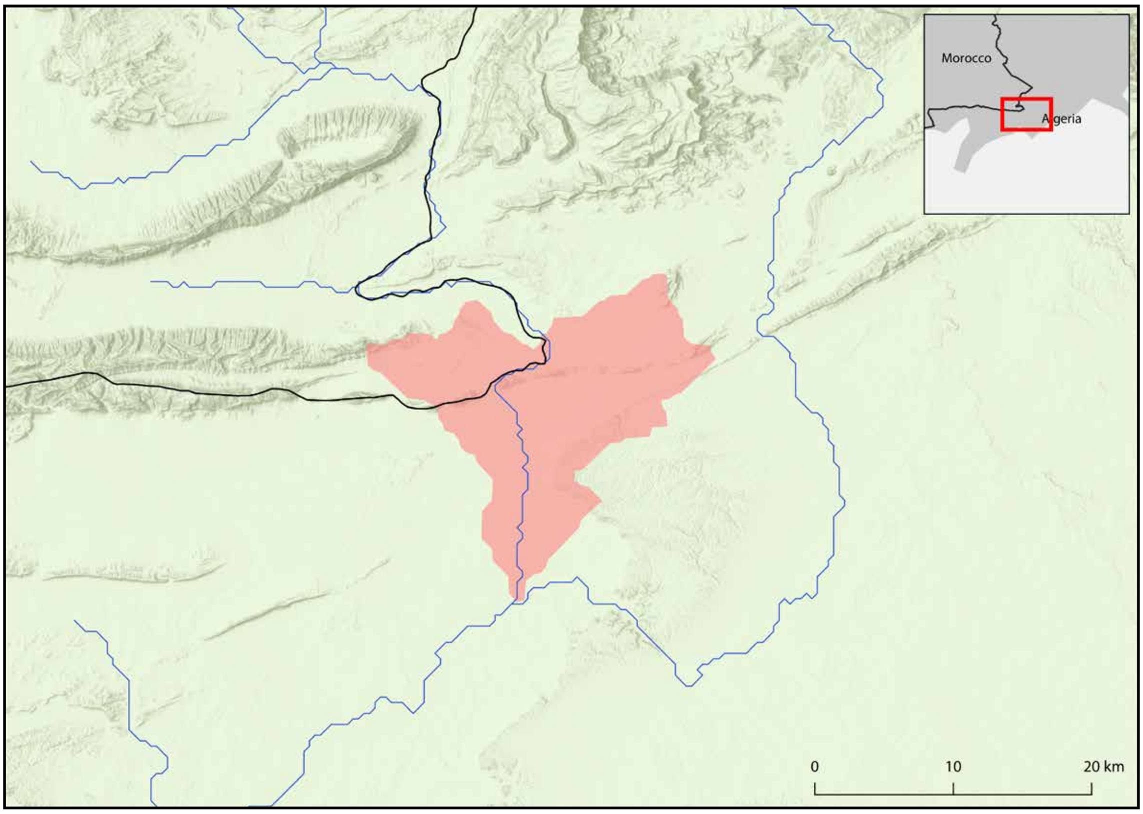
Figuig barbel

Hydropower Hazard: *LOW*

IUCN Red List: *VULNERABLE*

Distribution: Morocco

Endemic to a single hot spring within the Zouzfana River drainage in eastern Morocco. It mostly inhabits subterranean channels where the spring flows beneath the city of Figuig, but is also found in an artificial pond which impounds the spring when it appears above ground. This species is potentially threatened by water abstraction and increasing frequency and intensity of droughts due to climate change. Two dams built on the upper Zouzfana River could conceivably be driving changes in the local hydrological regime.



© Jörg Freyhof

Luciobarbus graecus

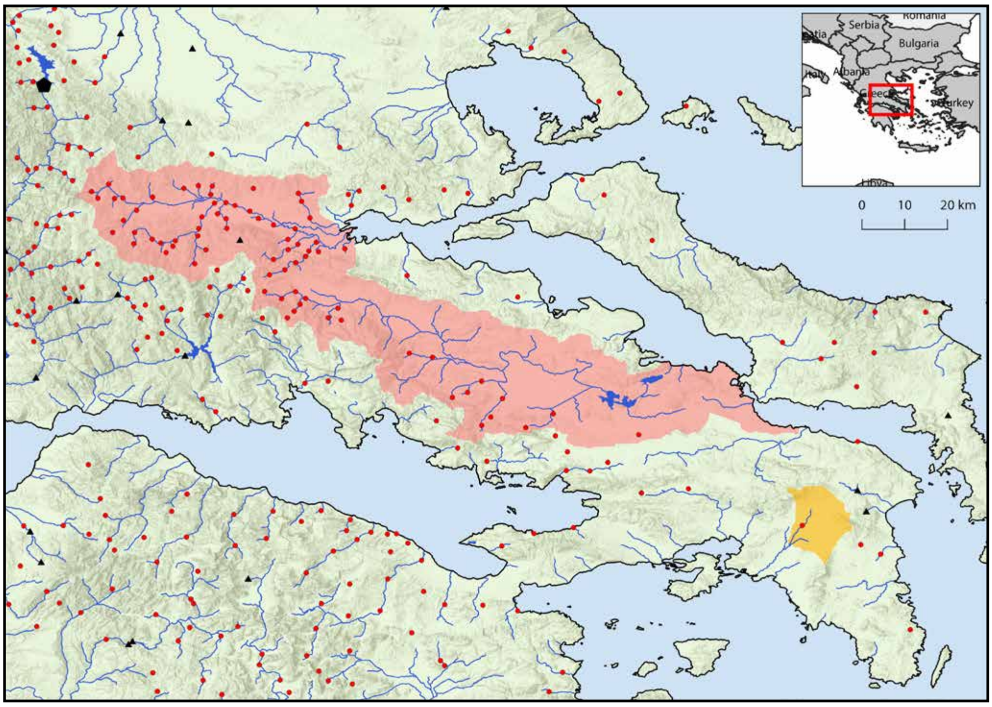
Greek barbel

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Greece

Endemic to lakes Yliki and Paralimni plus the Sperchios River drainage in southwestern Greece. It was probably extirpated from Lake Paralimni when the basin was largely drained to provide water for crop irrigation, while close to Athens putatively introduced populations are known from the artificial Beletsi and Marathon reservoirs plus the Kifissos River drainage. This species inhabits lowland lakes and larger rivers and streams. It is threatened by excessive water abstraction and pollution, while extended periods of climate change-induced drought could affect riverine populations. Lake Yliki provides drinking water to Athens via a closed gravity aqueduct and the average water level is reported to be decreasing. Hydropower development on the Sperchios River could affect its reproductive cycle.



© Jörg Freyhof

Luciobarbus guercifensis

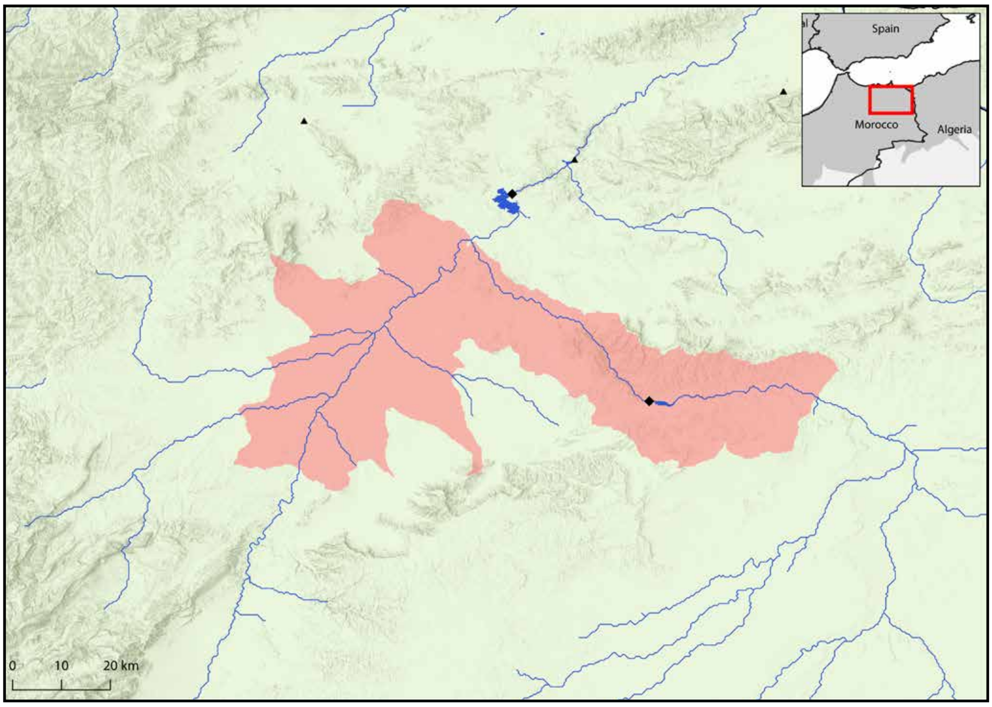
Moulouya riffle barbel

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Morocco

Restricted to the Moulouya River drainage in northern Morocco. It is known only from a small area around the village of Guercif, where the Melloulou, Msoun and Za rivers flow into the Moulouya. This species inhabits riffles and fast-flowing stretches of these larger river channels and is not thought to enter small tributaries or artificial reservoirs. It is threatened by excessive water abstraction, pollution, and habitat loss due to climate change. Two hydroelectric dams have been constructed on the Moulouya. The first of these is around 55 kilometres downstream of Guercif and likely to constitute the limit of this species' range if it does prove to have a wider distribution.



© Jörg Freyhof

Luciobarbus kottelati

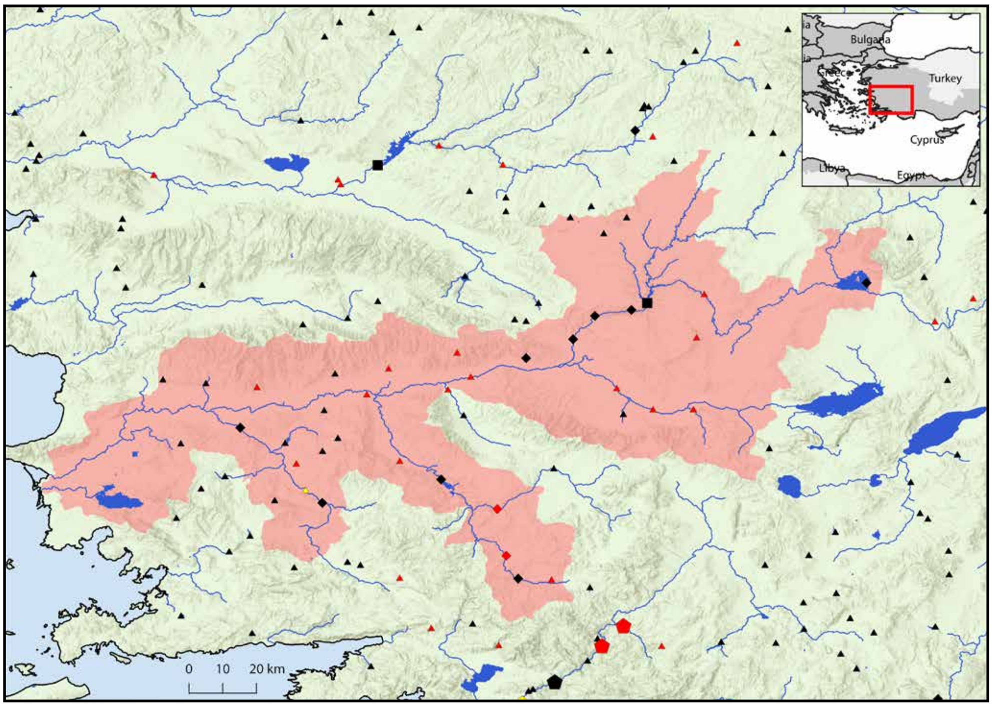
Menderes barbel

Distribution: Turkey

Hydropower Hazard: *MODERATE*

IUCN Red List: *VULNERABLE*

Endemic to the Büyük Menderes River drainage, and has been recorded throughout much of the system. It inhabits medium to large-sized rivers and streams with a slow or moderate current, and has colonised several artificial lakes. This species is threatened by widespread agricultural and industrial pollution, excessive water abstraction of ground and surface water, and is in the future likely to be impacted by increasing longevity of droughts. Although it can adapt to survive in man-made reservoirs the construction of numerous dams throughout the upper and middle Büyük Menderes is likely to have significantly reduced access to suitable spawning sites.



© Amina Brahimi

Luciobarbus lanigarensis

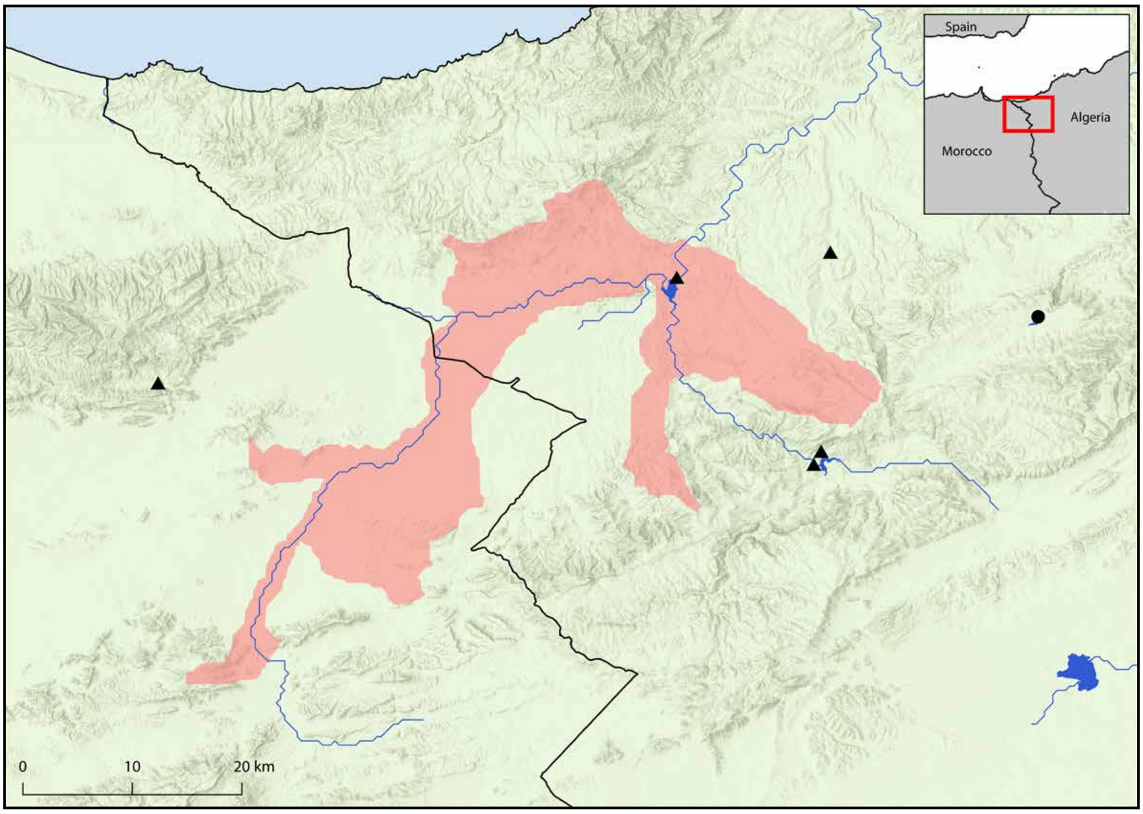
Lanigar barbel

Hydropower Hazard: *MODERATE*

IUCN Red List: *VULNERABLE*

Distribution: Algeria and Morocco

Known only from five locations within the Isly River, a headwater tributary of the Tafna River drainage in northeastern Morocco. It is expected to occur elsewhere in the Tafna system. Little is known of this species' biology, but the Isny is a typical small Mediterranean river and largely drys out in summer, with the fish likely to survive in remnant pools. It is threatened by water abstraction, pollution and increasing longevity of droughts, while the construction of a number of dams within the Tafna system is likely to have reduced the extent of suitable habitat.



© Jörg Freyhof

Luciobarbus leptopogon

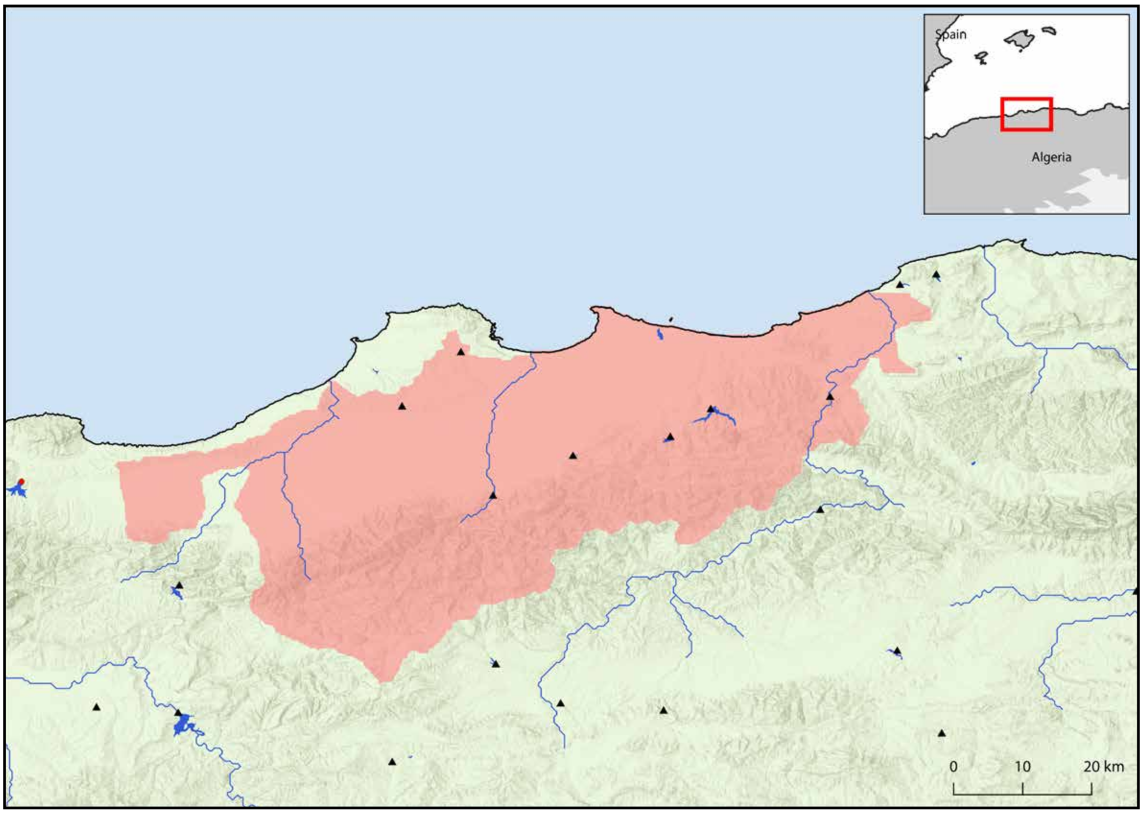
Algier barbel

Hydropower Hazard: *MODERATE*

IUCN Red List: *ENDANGERED*

Distribution: Algeria

Known from four short coastal river drainages close to the city of Algiers in northern Algeria. All run dry to some extent during the summer or periods of drought, and the fish survive in remnant pools. This species has also colonised at least one man-made reservoir. It is threatened by water abstraction, pollution and increasing longevity of droughts. Although it is apparently able to adapt to artificial reservoirs, its range is likely to have been significantly reduced due to the construction of dams on all its native rivers.



© Jörg Freyhof

Luciobarbus longiceps

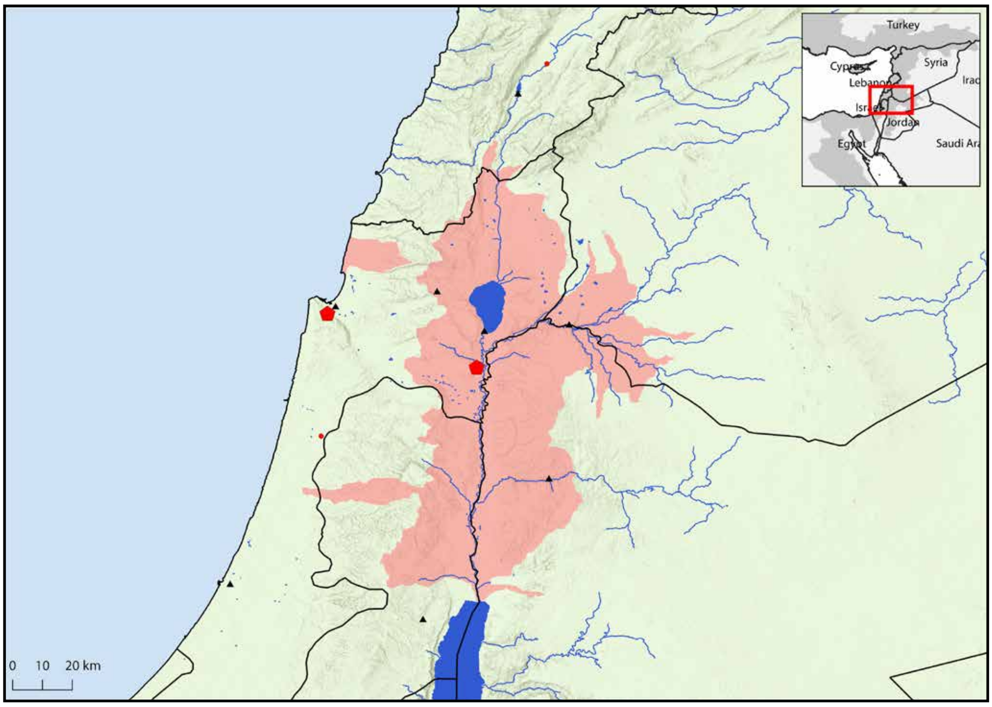
Jordan barbel

Hydropower Hazard: *MODERATE*

IUCN Red List: *ENDANGERED*

Distribution: Israel, Syria and Jordan

Endemic to the Jordan River drainage, with records from Lake Kinneret (aka Sea of Galilee or Lake Tiberias), the river itself from its headwaters until it enters the Dead Sea, isolated springs in the Beit She'an Valley, and its largest tributary the Yarmouk River. This species inhabits slowly-flowing parts of rivers and streams and natural lakes. It migrates annually into upstream tributaries to breed, but very little suitable spawning habitat remains. The Lake Kinneret ecosystem has deteriorated substantially since the 1950s, when the drainage of the upstream Lake Hula wetland provoked a series of subsequent anthropogenic modifications. The Yarmouk has been dammed more than 40 times and thousands of illegal wells have been drilled to pump groundwater. Its discharge into the Jordan has plummeted from an annual average of four hundred billion litres to zero since the 1960s. Additional threats include widespread pollution, increased intensity of droughts due to climate change and introduction of non-native fish species.



© Jörg Freyhof

Luciobarbus magniatlantis

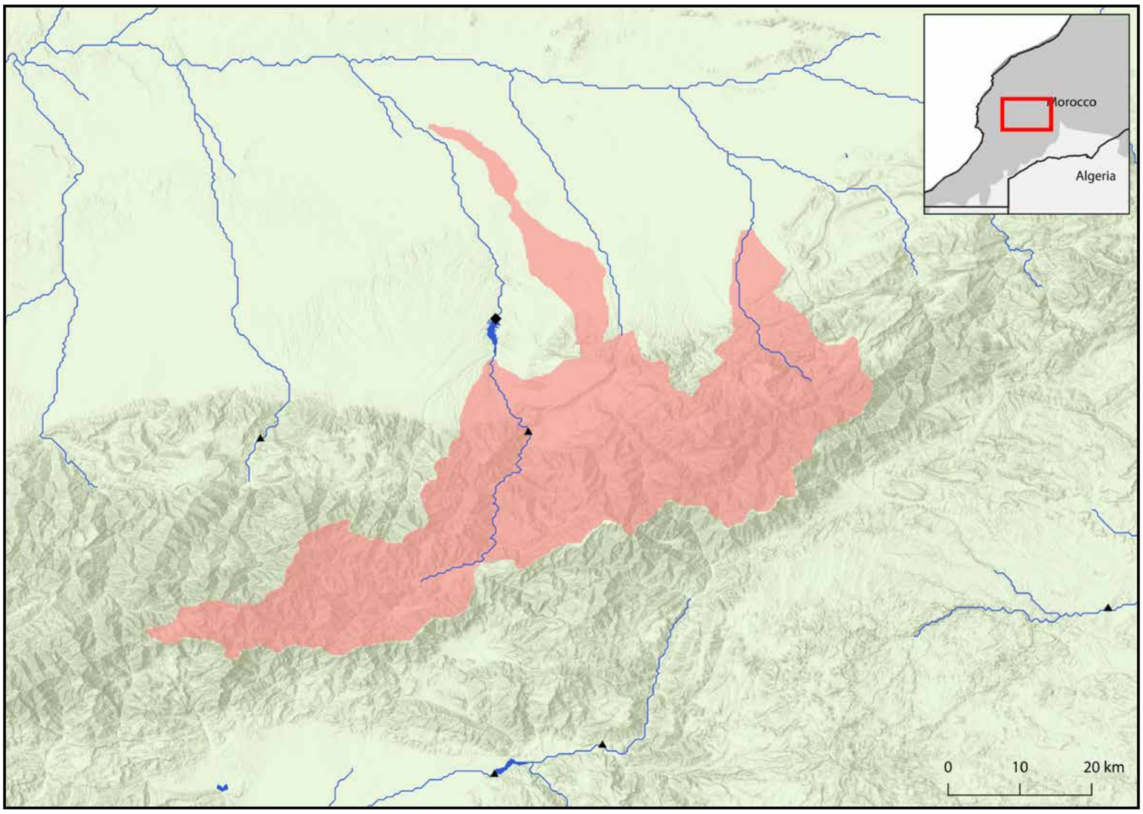
Tensift riffle barbel

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Morocco

Endemic to the Tensift River drainage in central Morocco, where it is restricted to upper reaches of the Ourika and N'Fis tributary systems. It is apparently extirpated from the Rheraya River, located between the two remaining populations. This species inhabits flowing stretches for part of the year, but spends the summer months in remnant pools when the rivers largely dry out. It is threatened by excessive water abstraction and pollution, and the area in which it occurs is likely to be heavily-impacted by climate change. Construction of two large dams on the N'Fis River has significantly reduced the extent of suitable habitat.



© Jörg Freyhof

Luciobarbus mascarensis

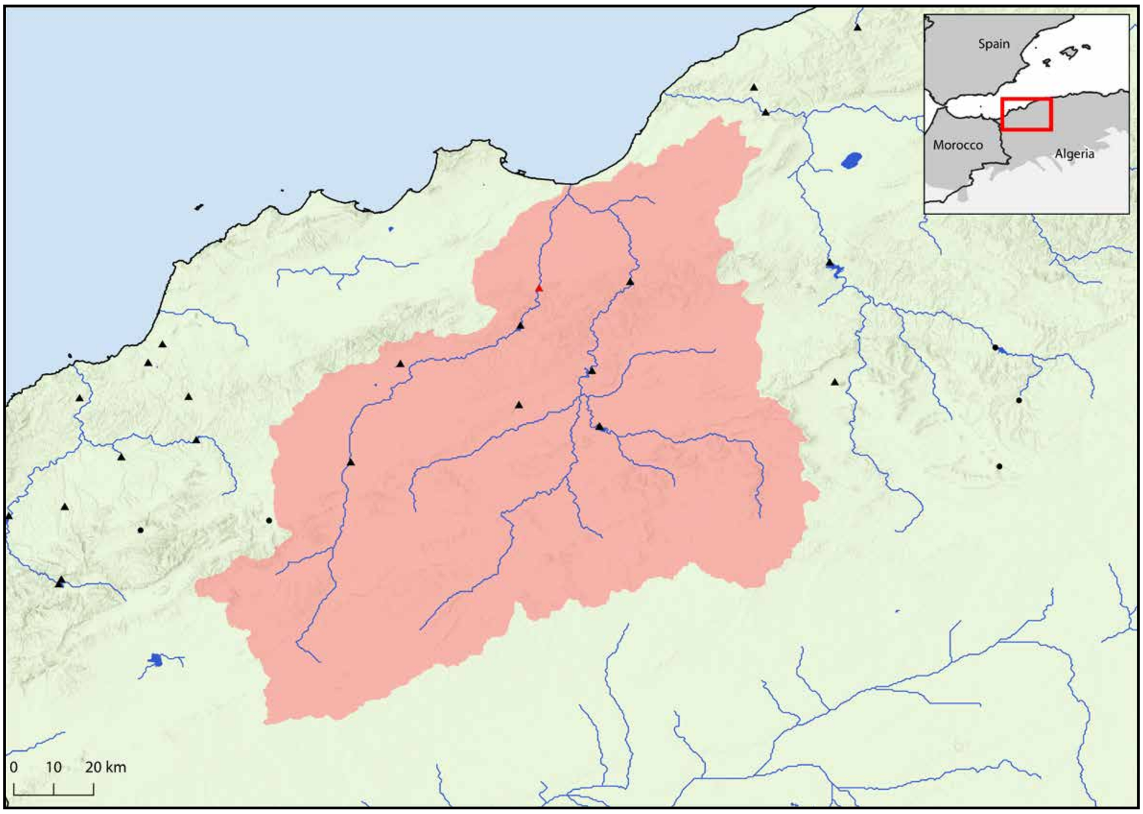
Tifrit barbel

Hydropower Hazard: *MODERATE*

IUCN Red List: *ENDANGERED*

Distribution: Algeria

Known only from the Tifrit River, a tributary within the El Hammam River drainage in northern Algeria. This species inhabits flowing stretches which typically dry out in summer, when it survives in remnant pools. It is threatened by excessive water abstraction and widespread pollution, while the construction of a series of dams on the El Hammam River may have limited its downstream distribution.



© Amina Brahimi

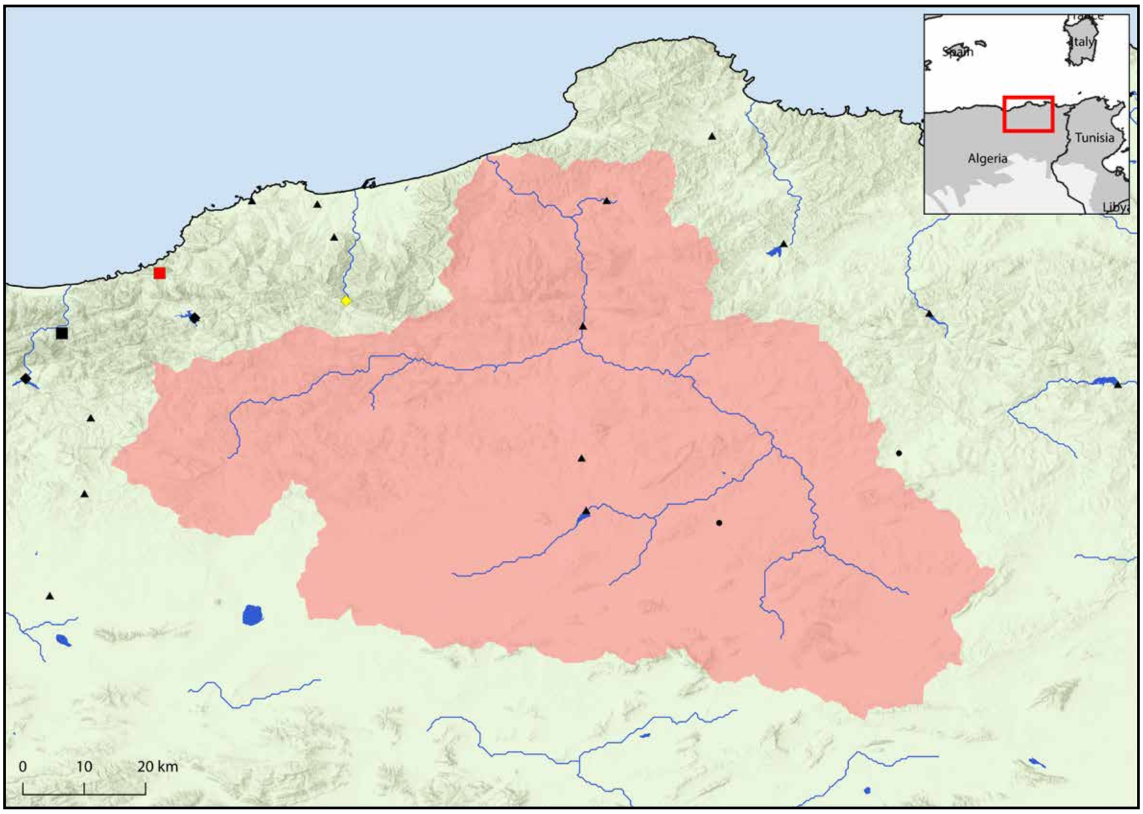
Luciobarbus numidiensis
Numidian barbel

Distribution: Algeria

Restricted to the El Kebir River in northeastern Algeria. It inhabits the river both above and below the Beni Haroun hydroelectric dam, and has colonised the associated artificial lake. It is threatened by water abstraction, pollution, introduction of non-native species and droughts driven by climate change. Although it occurs within a dam lake its population may still have been adversely affected by natural habitat loss and competition with alien species.

Hydropower Hazard: *LOW*

IUCN Red List: *VULNERABLE*



© Erhan Ünlü

Luciobarbus subquincunciatus

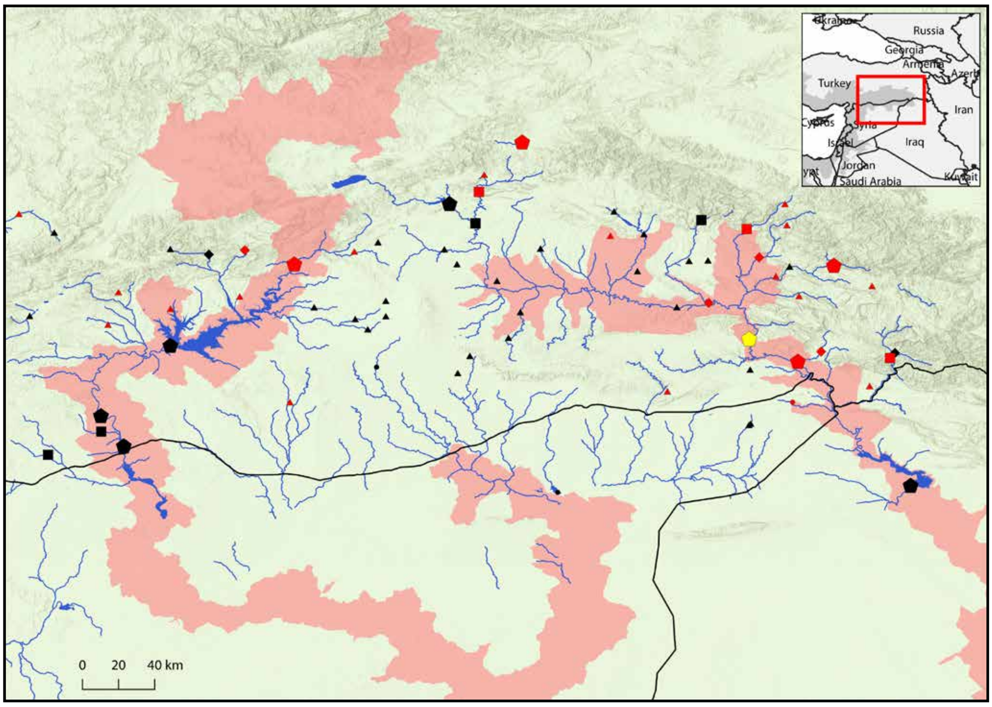
Leopard barbel

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey, Syria, Iraq and Iran

Native to the Euphrates and Tigris river drainages, from their upper reaches in southeasten Turkey to the Shatt al-Arab River after their confluence. It inhabits large lowland rivers and undertakes short annual migrations into tributaries to spawn over shallow gravel beds. This species has been reported from a handful of man-made reservoirs, but does not appear to successfully colonise them. It has declined catastrophically in recent decades, with very few records anywhere within its range since the 1990s. It is threatened by pollution, water abstraction and commercial overfishing, while widespread dam construction has blocked access to many spawning sites.



© Jörg Freyhof

Luciobarbus xanthopterus

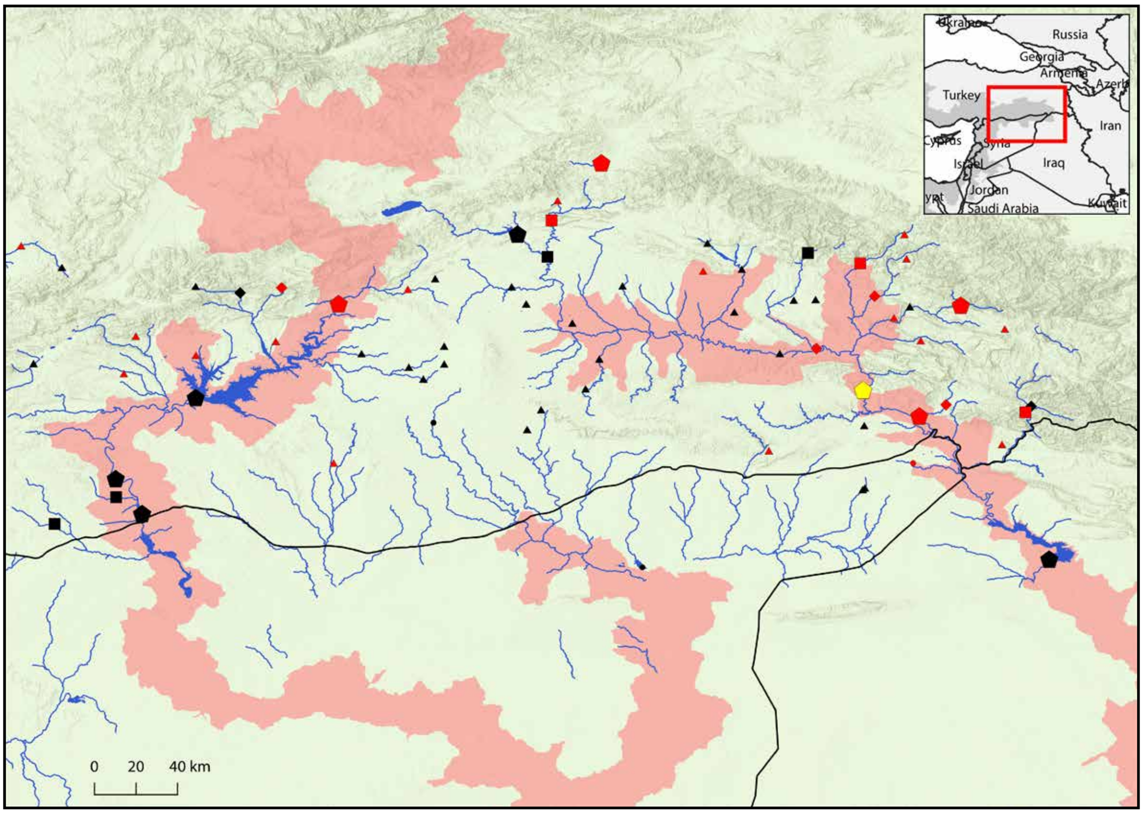
Yellowfin barbel

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Turkey, Syria, Iraq and Iran

Native to the Euphrates and Tigris river drainages, from their upper reaches in southeasten Turkey to the Shatt al-Arab River, formed by their confluence at Al-Qurnah in southern Iraq. There also exist records from the Karun River in Iran, a tributary of the lower Shatt al-Arab. It inhabits large lowland rivers and lakes, preferring deeper water, and migrates into floodplain wetlands to feed and upstream tributaries to spawn. This species is threatened by pollution, water abstraction and commercial overfishing, while widespread dam construction has blocked access to many spawning sites.



© Jörg Freyhof

Luciobarbus zayanensis

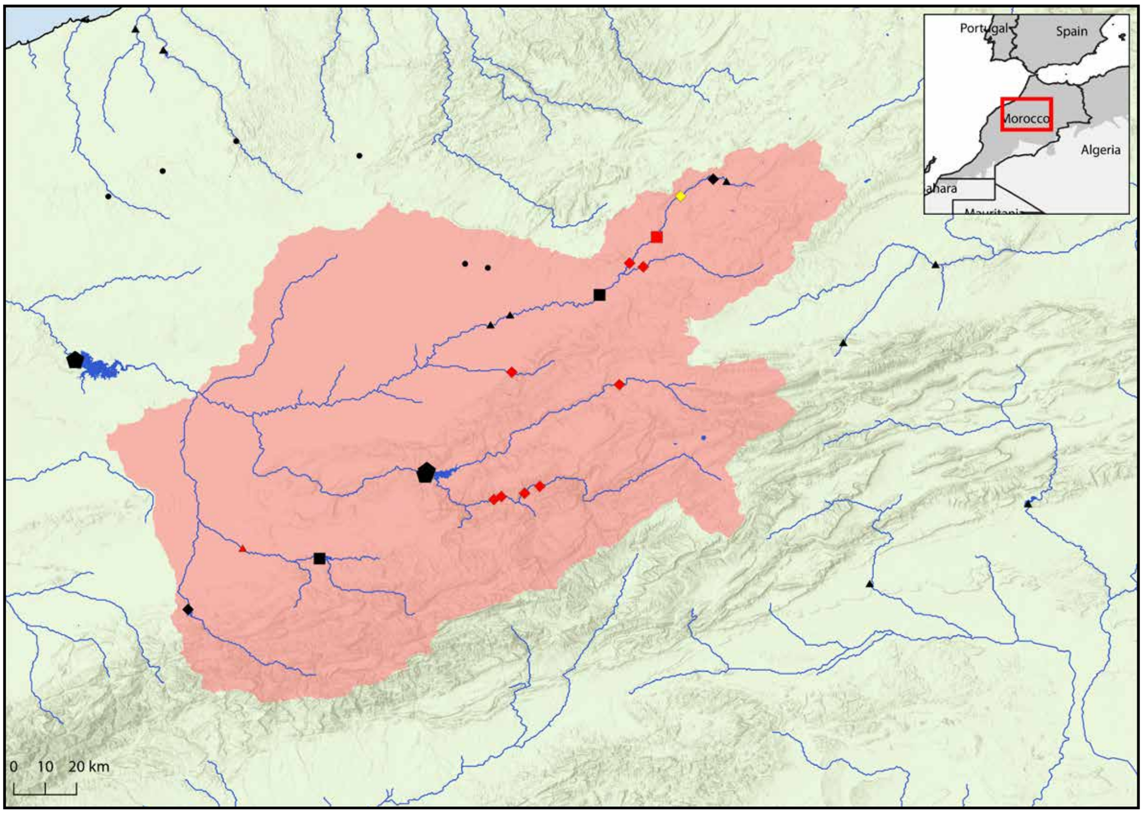
Riffle barbel

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Morocco

Endemic to the upper Oum Er-Rbia River drainage in northern Morocco, where it has been reported from the main river channel above the El-Hansali hydroelectric dam plus a series of small tributaries draining the Atlas Mountains. It is rheophilic, inhabiting riffles and fast-flowing stretches with substrates of gravel and rocks. This species is threatened by dam construction, water abstraction, pollution and increasing frequency of droughts. Hydropower development is likely to have significantly reduced its original range and may have limited its downstream dispersal.



© Jörg Freyhof

Pterocapoeta maroccana

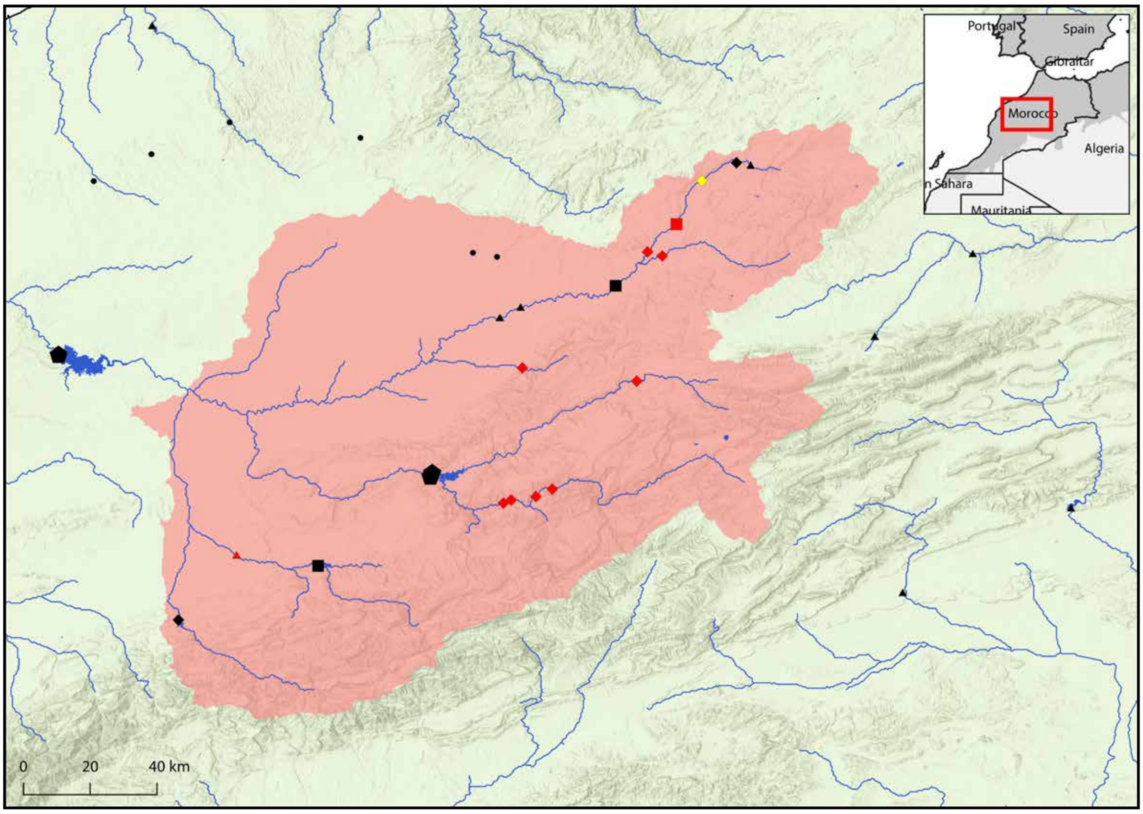
Atlas scraper

Distribution: Morocco

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Endemic to the upper Oum Er-Rbia River drainage in northern Morocco, where it is restricted to tributaries above the Al Massira hydroelectric dam. It is rheophilic, inhabiting riffles and fast-flowing stretches of headwaters. It is threatened by dam construction, water abstraction, agricultural and domestic pollution, gravel extraction and increasing frequency of droughts. There are a number of existing hydroelectric and retention dams within the Oum Er-Rbia drainage, and these are likely to have significantly reduced its original range.



© Jörg Freyhof

Gobio feraeensis

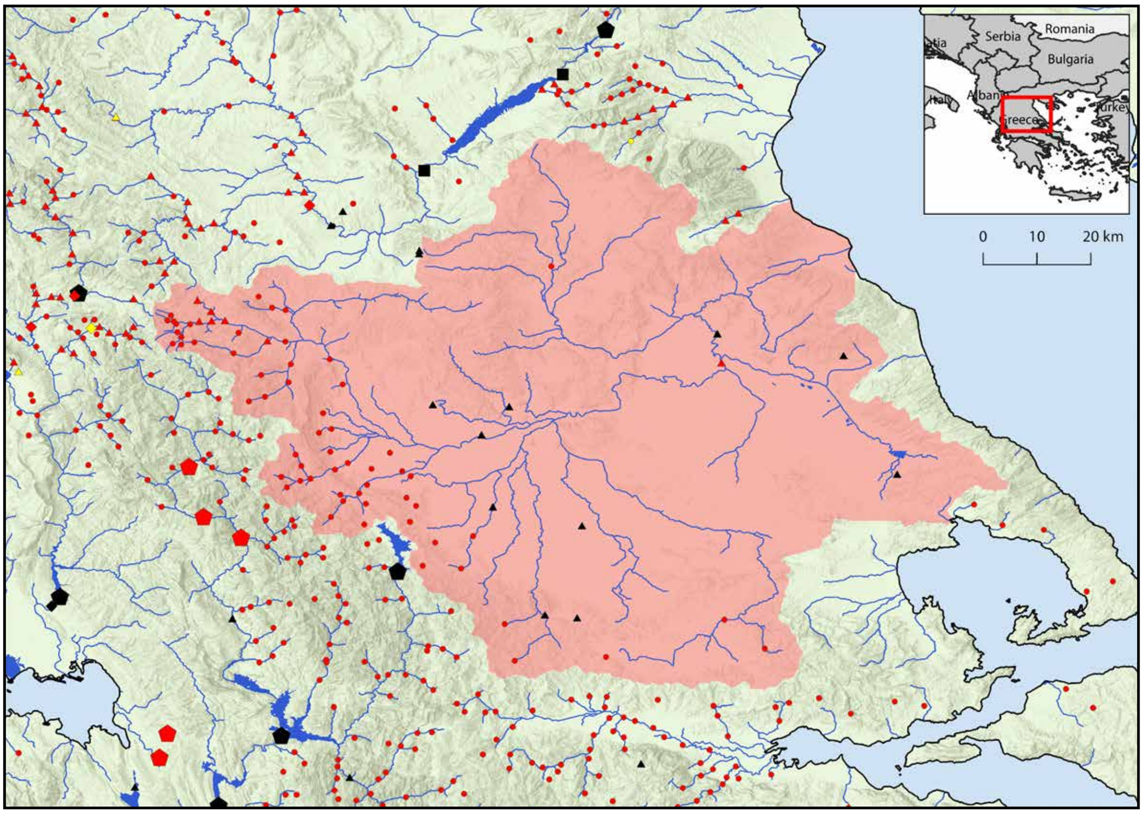
Thessaly gudgeon

Distribution: Greece

Hydropower Hazard: *MODERATE*

IUCN Red List: *VULNERABLE*

Endemic to the Pinios River drainage in the Thessaly Region of Greece. This species is threatened by excessive water abstraction, agricultural and domestic pollution, and increasing frequency of droughts. Dam construction in the area would favour establishment of non-native fish species and alter the local hydrological regime.



© Jörg Freyhof

Gobio gymnostethus

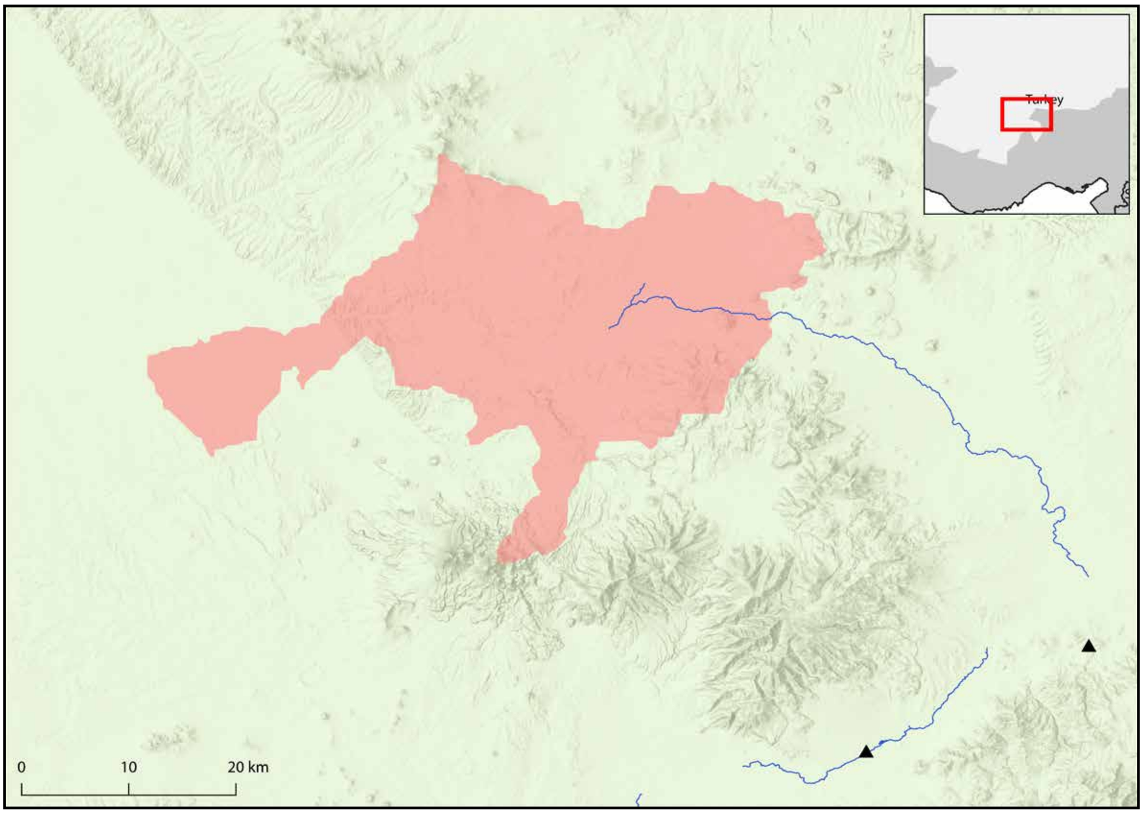
Cappadocian gudgeon

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey

Endemic to Melendiz Çayı, a small river draining into the southeastern portion of the endorheic and hypersaline Lake Tuz. The Melendiz has already been dammed and the gudgeon is now restricted to a stretch of around 30 kilometres above the artificial reservoir, with the river often running dry beneath it. It is unlikely to occur in the reservoir itself since it prefers flowing water. Additional threats include water abstraction, increasing frequency of droughts and introduction of non-native fish species.



© Jörg Freyhof

Gobio hettitorum

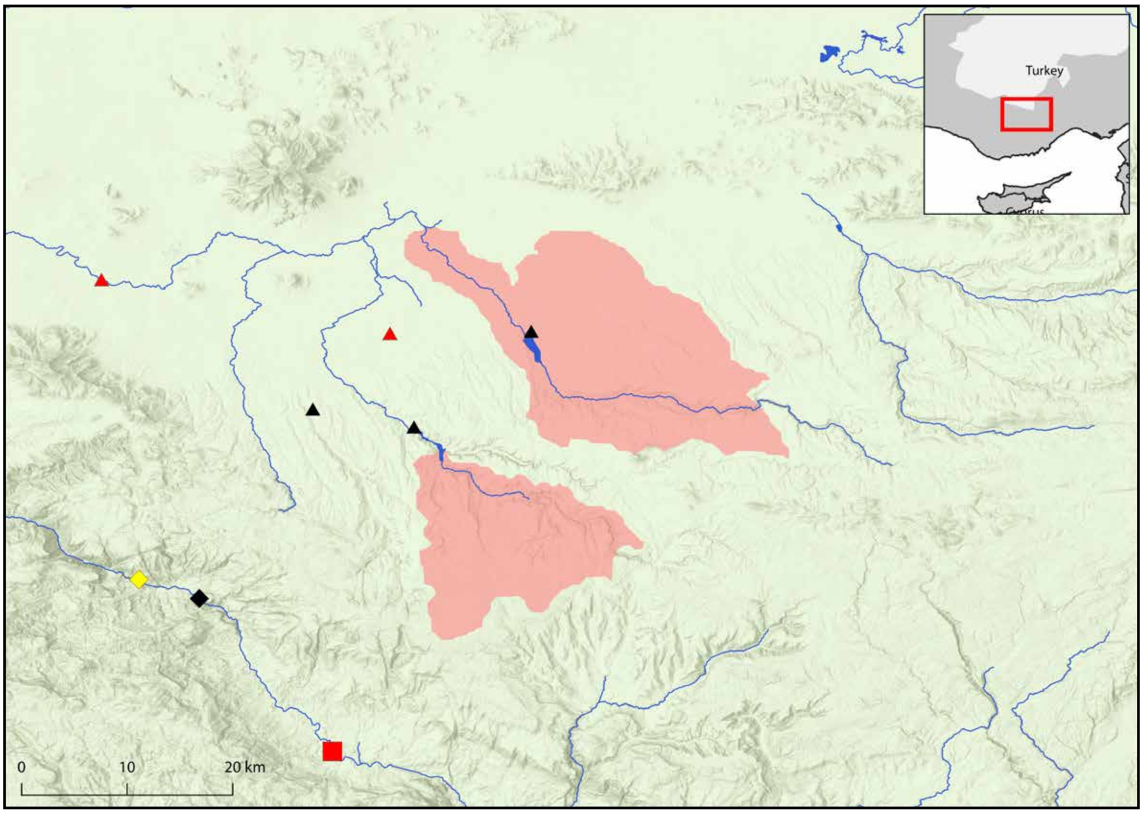
Taurus gudgeon

Distribution: Turkey

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED*

Known only from the 15-kilometre Gökdere Stream and associated marshes close to Ereğli in Central Anatolia. This species inhabits flowing stretches with substrates of gravel and stones. Excessive water abstraction led to desiccation of the marshes which had almost completely dried out by the mid-1990s. A series of small dams constructed on the stream have restricted water flow and may have fragmented the remaining population, while pollution is also ubiquitous.



© Jörg Freyhof

Gobio intermedius

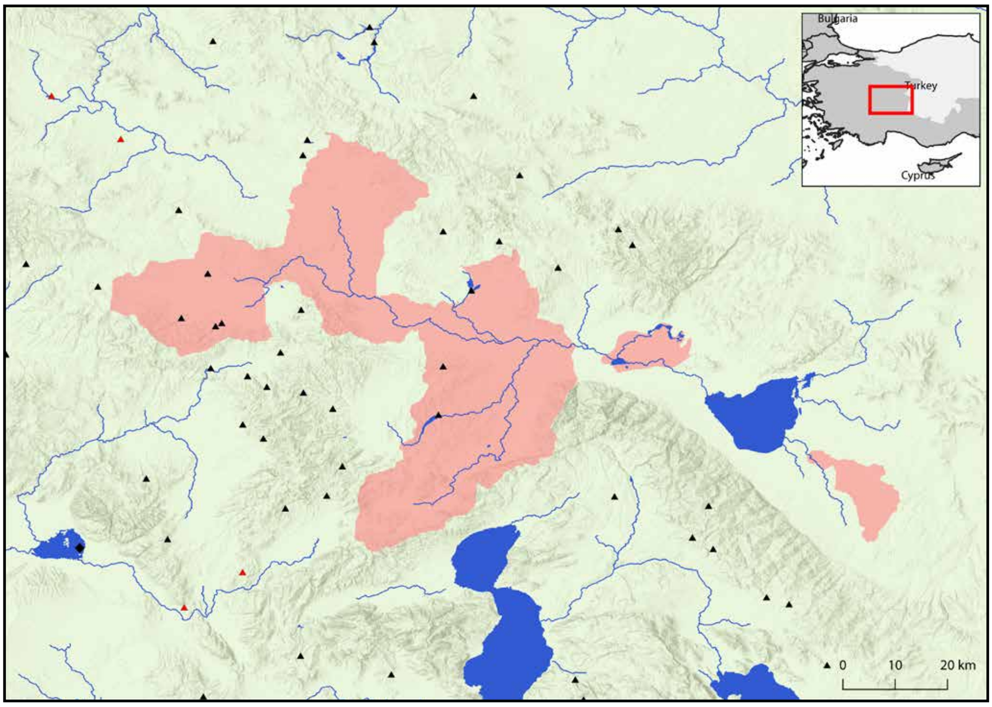
Eber gudgeon

Distribution: Turkey

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Endemic to the Akarçay River drainage in Central Anatolia. It originally inhabited tributaries flowing into endorheic lakes Eber and Akşehir plus the lakes themselves. However decades of pollution and gradual dessication of the lakes due to excessive water abstraction since the mid-1970s have seen the species now restricted to five small streams. Lake Akşehir lost its surface connection with Lake Eber in 1990 and temporarily dried out in 2008, while Eber was reported to be completely dry in 2018. The streams holding the remaining gudgeon populations suffer from pollution, continued abstraction of water and increasing lack of rainfall. Construction of water retention dams, irrigation canals and regulators has further reduced the amount of suitable habitat in some of them.



© Jörg Freyhof

Gobio maeandricus

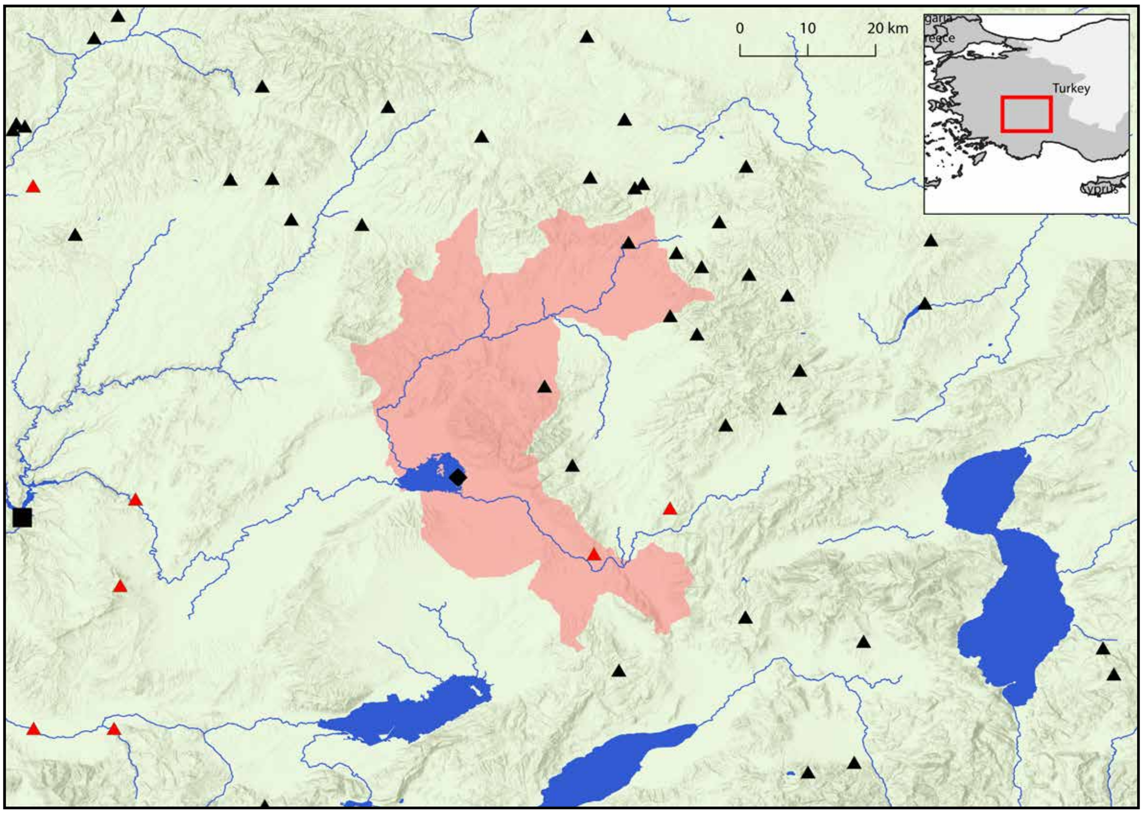
Isıklı gudgeon

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Endemic to the Lake Isıklı basin within the upper Büyük Menderes River drainage. It prefers flowing water and appears to be restricted to small tributaries near the settlements of Isıklı, Sandıklı and Dinar. It has not been recorded from the lake itself. Major threats facing this species include water abstraction and pollution. A number of small water retention dams have been built on one of the streams, reducing the extent of suitable habitat.



© Jörg Freyhof

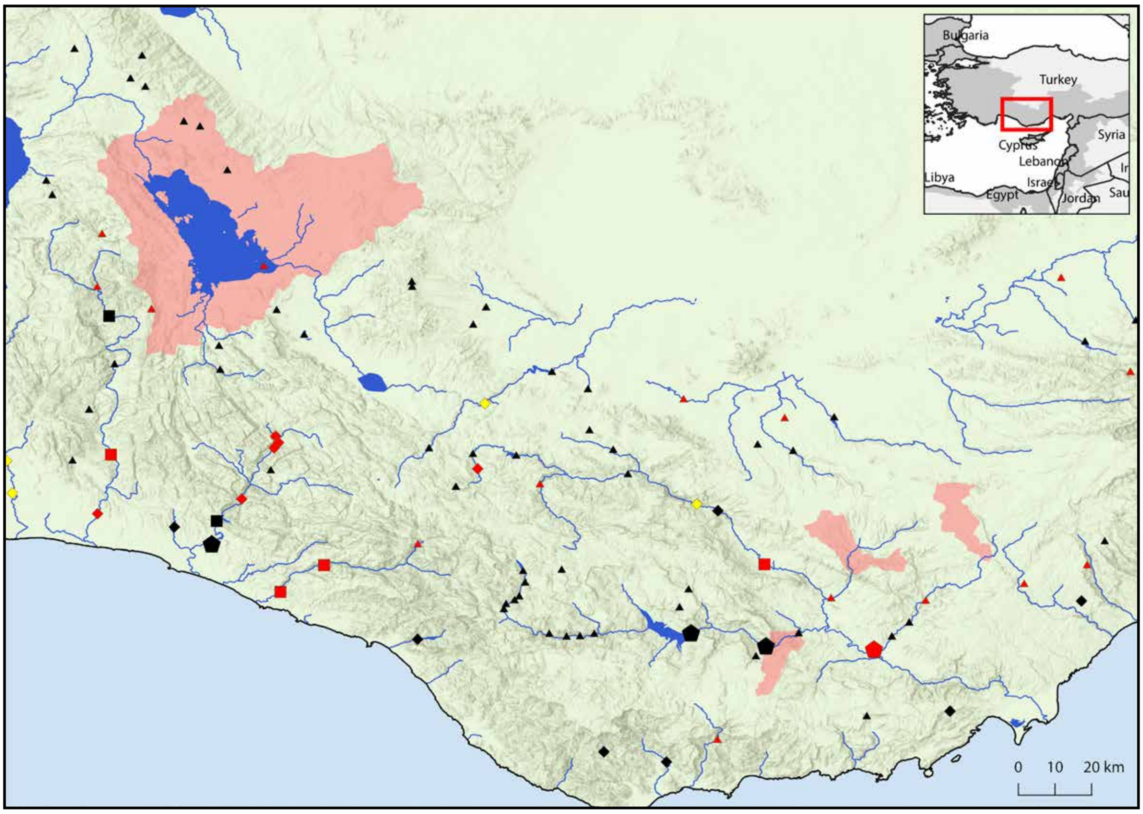
Gobio microlepidotus
Beyşehir gudgeon

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Turkey

Endemic to tributary streams flowing into Lake Beyşehir and in the Göksu River drainage. This species has been recorded mostly in flowing stretches, but it might also occur in the lake itself. It is threatened by excessive water abstraction, pollution, construction of small dams reducing the extent of suitable habitat and introduction of non-native predatory fish species such as pike perch (*Sander lucioperca*).



© Jörg Freyhof

Gobio ohridanus

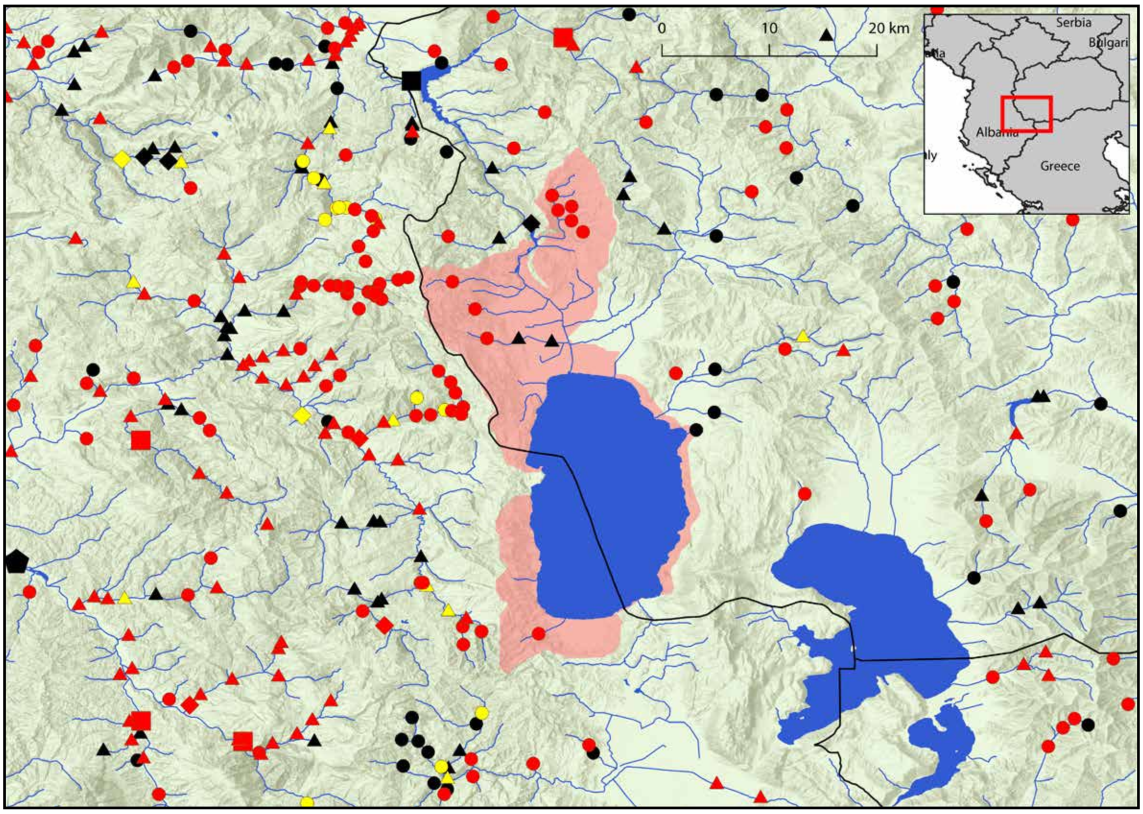
Ohrid gudgeon

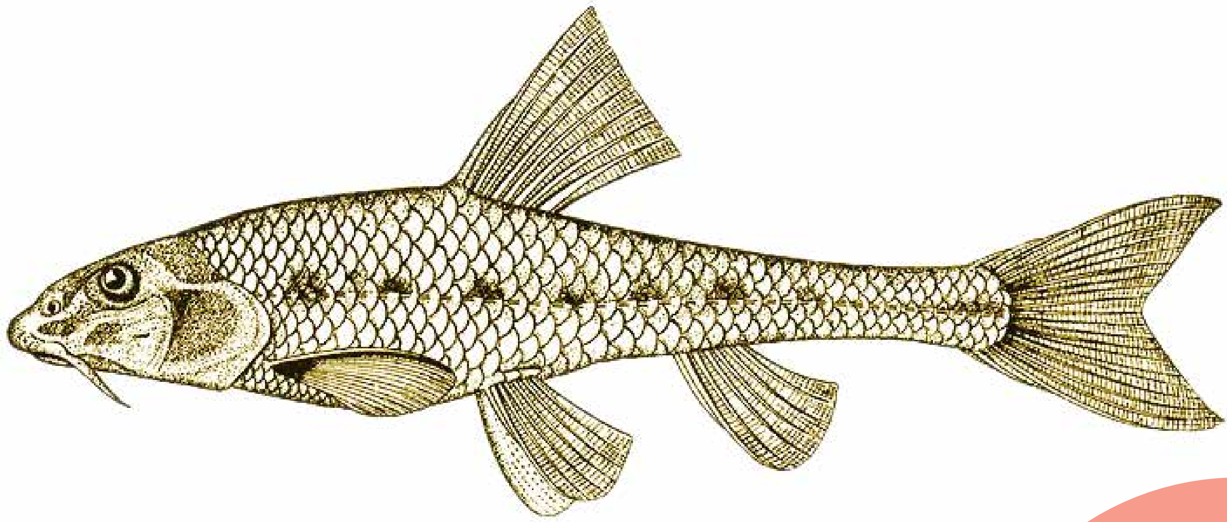
Distribution: Albania, North Macedonia

Endemic to the oligotrophic transboundary Lake Ohrid. It is threatened by introduction of non-native fish species and decreasing water quality. Hydropower development on inflowing tributaries would undoubtedly be detrimental.

Hydropower Hazard:
LOW

IUCN Red List:
VULNERABLE





© Banarescu (1964)

Romanogobio antipai

Danube delta gudgeon

Hydropower Hazard: *LOW*

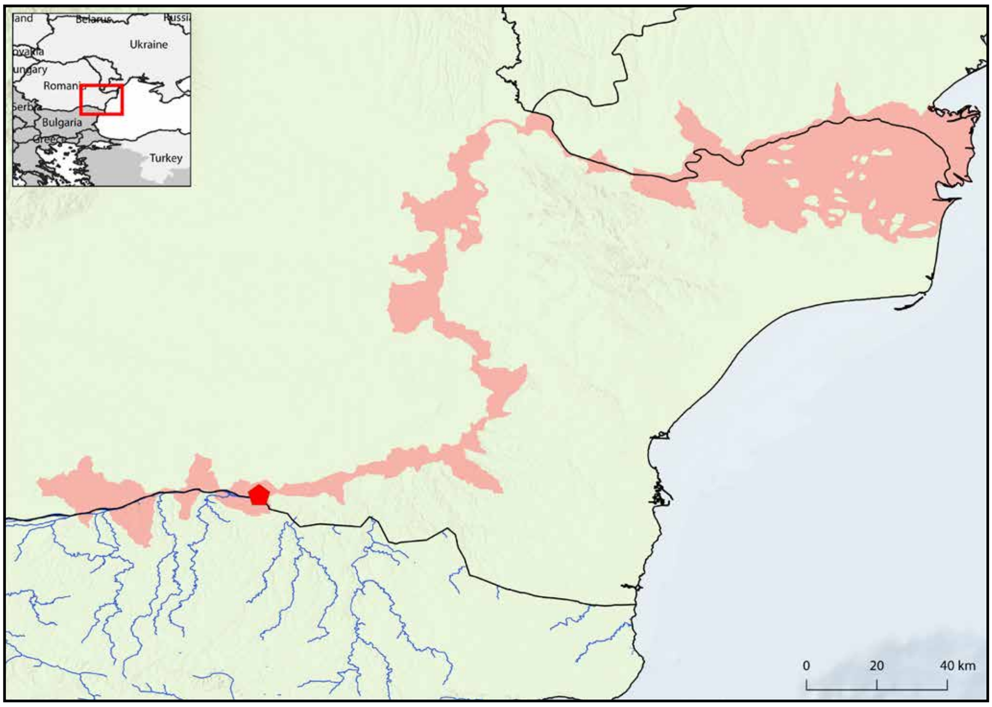
Bern Convention: *APPENDIX III*

IUCN Red List: *VULNERABLE*

Distribution: Bulgaria, Romania, Ukraine

Originally known from the the lower Danube River drainage, from its confluence with the Arges downstream to the river's delta. It was for decades considered extinct but in 2016 a single specimen was collected from the Bulgarian stretch of the Danube near the village of Vetren. The individual was caught at a depth of eight metres and it is possible that this species inhabits the deep central part of the main Danube channel and larger tributaries. It is expected to occur in a stretch of around 350 km along the lower Danube between the towns of Oltenisa/Tutrakan and the upper portion of the delta. It is threatened by gravel extraction and dredging to maintain shipping lanes.

* as *Gobio kessleri*



© Jörg Freyhof

Romanogobio banarescui

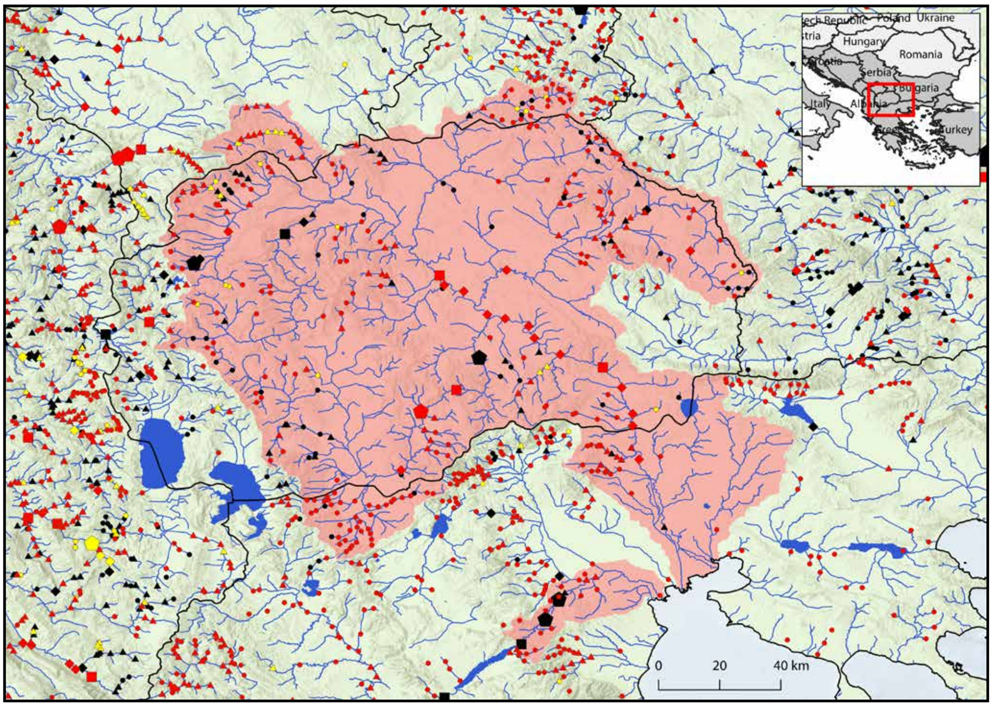
Vardar gudgeon

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Greece and North Macedonia

Formerly common throughout the Vardar (gr. Axios) River drainage in North Macedonia and Greece. In recent years it has been collected only from a single location in the middle Vardar, although it might still occur at a few sites within the lower basin in Greece. Additional populations have been identified in the lower Haliacmon (gr. Aliakmon) River which enters the Thermaic Gulf of the Aegean Sea a few kilometres west of the Vardar. This species inhabits flowing stretches with clear water. It is threatened by discharge of agricultural and industrial pollutants plus untreated domestic sewage, extraction of gravel and introduction of non-native fish species. There are at least 120 dams within the Vardar drainage in North Macedonia alone, and these are likely to have significantly reduced the extent of suitable habitat. Construction of two large hydroelectric dams at Sfikia and Veria on the lower Haliacmon River on may have similarly depleted its range in that drainage.



© Jörg Freyhof

Hydropower Hazard: *MODERATE*

EUR-HAB-DIR: *ANNEX II*

Bern Concention: *APPENDIX III*

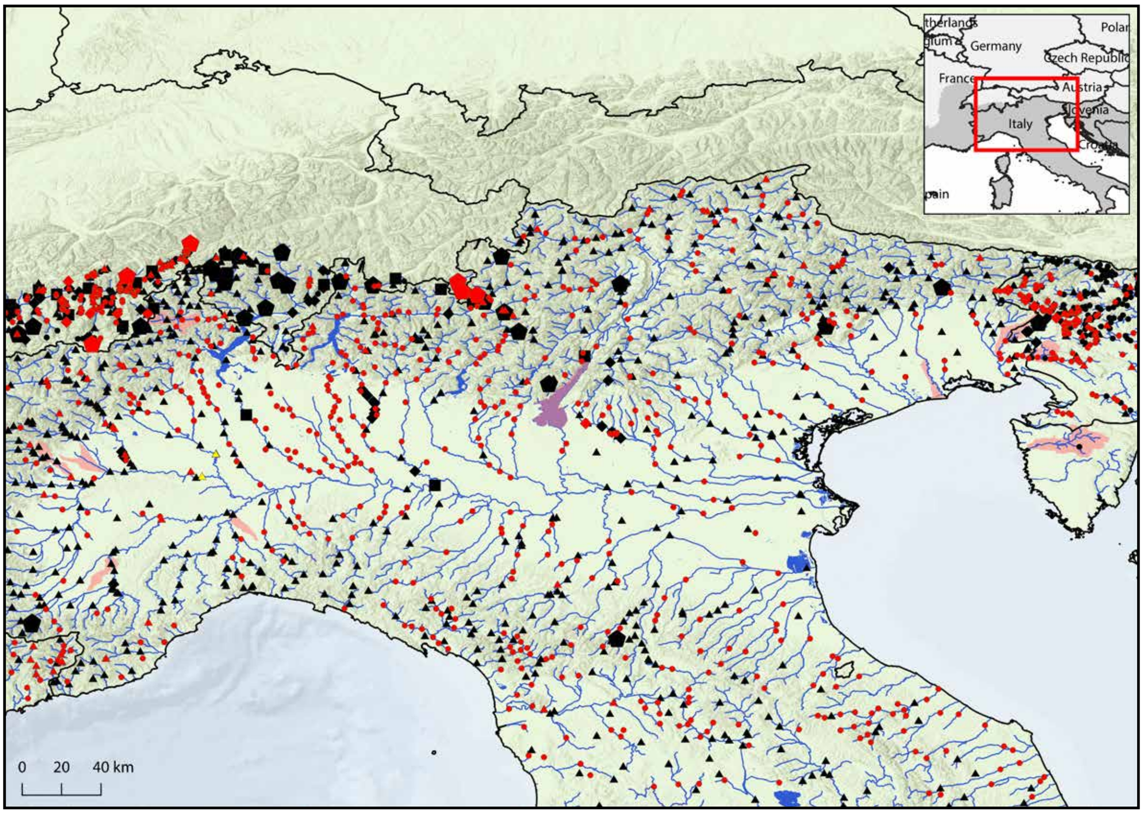
IUCN Red List: *ENDANGERED*

Romanogobio benacensis

Italian gudgeon

Distribution: Italy, Slovenia and Croatia

Known from rivers draining to the northern Adriatic Sea basin including the Marecchia, Po, Adige, and Tagliamento drainages in Italy, the transboundary Soča (It. Isonzo) River in Slovenia and Italy, and the Mirna River in Croatia. It has disappeared from many locations and may have already been extirpated from the Po. This species inhabits slow-flowing lowland rivers and lakes. Threats include pollution, riverbed modification and competition with introduced Gudgeon (*Gobio gobio*). Dam construction throughout its range has reduced the extent of suitable habitat.



© Matthew Ford

Acanthobrama telavivensis

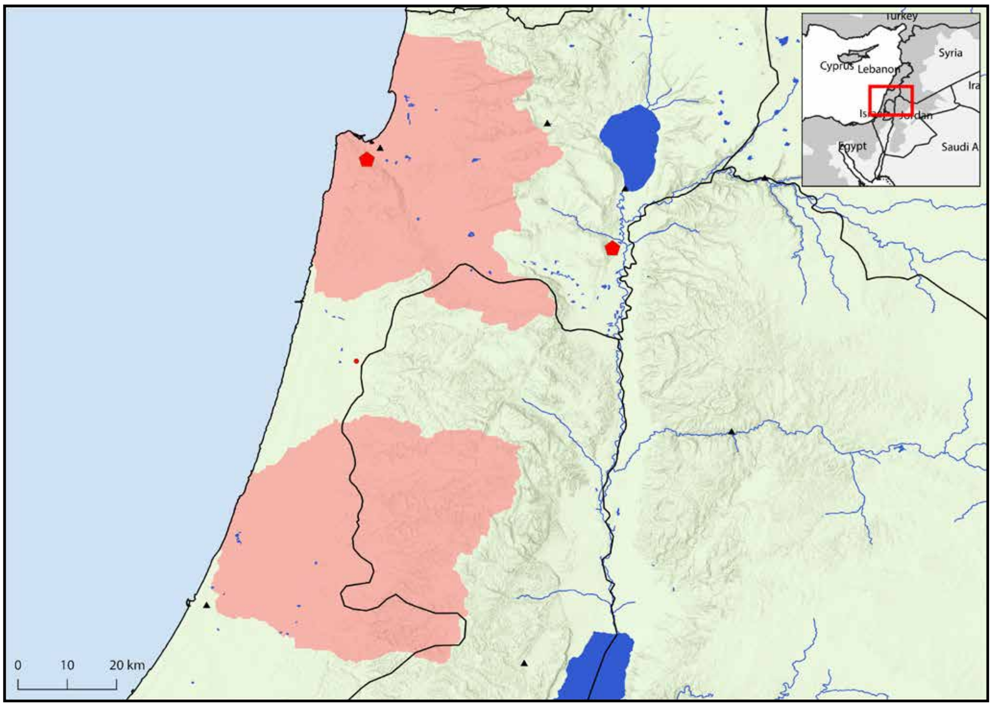
Yarkon bream

Hydropower Hazard: *LOW*

IUCN Red List: *VULNERABLE*

Distribution: Israel

Once abundant in coastal rivers of Israel but declined sharply between 1950 and 1970. The last few individuals were removed from the wild in 1999 due to the threat of drought driving the species extinct. An ex situ breeding project was set up and in 2006 fish were re-introduced to 12 sites, comprising both restored natural habitats and man-made ponds located in the Yarkon and Tut river drainages. Established, self-sustaining populations now exist at all these sites. The primary threat to the species was excessive water abstraction but this has been reduced due to Israel's investment in desalinisation plants for freshwater resources. Pollution is a potential threat.



© Hans Esterbauer

Acanthobrama tricolor

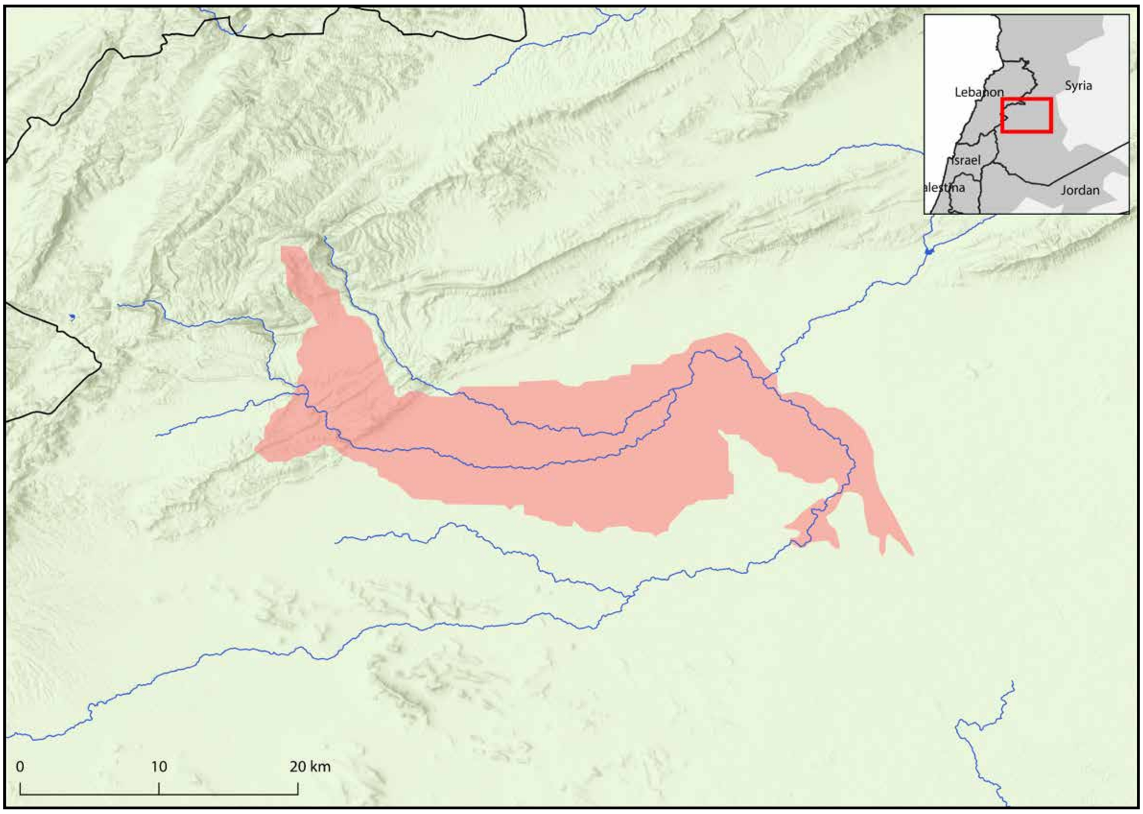
Damascus bream

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED (Possibly Extinct)*

Distribution: Syria

Endemic to southwestern Syria, where it was described from the lower Barada River drainage near Damascus. It is apparently extirpated from the Barada having last been recorded in 1908. During the late 1980s two specimens were collected from Masil Al Fawar, a small stream near Harfa just outside the United Nations-supervised neutral buffer zone between Syria and Israeli-occupied territory in the Golan Heights. It is possible that a small population still exists in the area. The zone is currently under Syrian government control, and hydropower development is unlikely.



© Jörg Freyhof

Achondrostoma arcasii

Iberian dwarf nase

Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

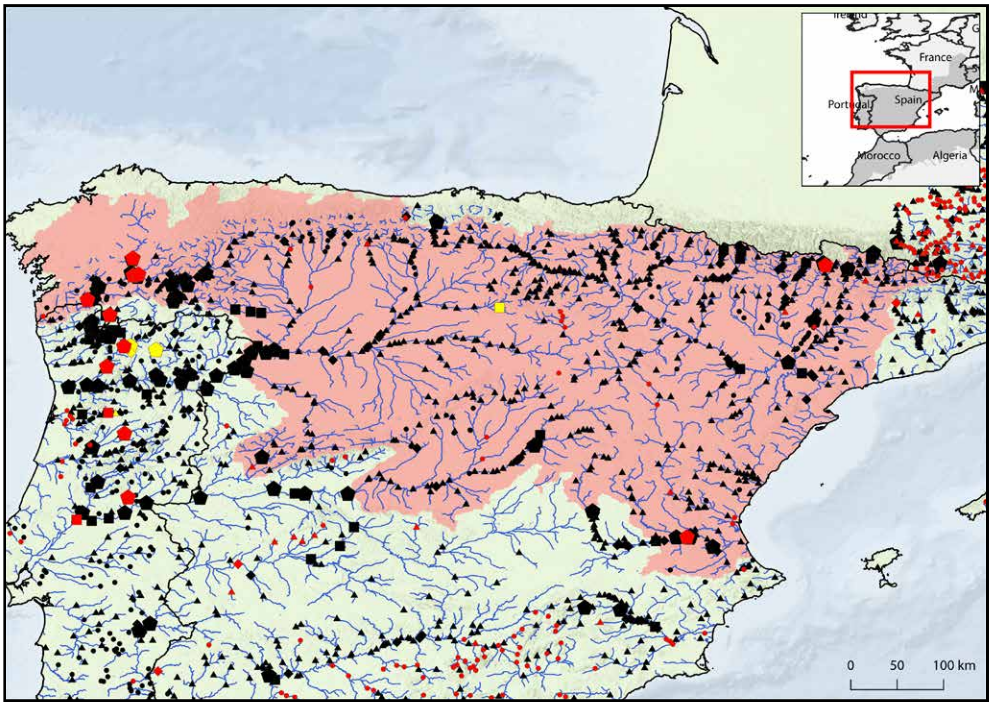
Bern Convention: *APPENDIX III **

IUCN Red List: *VULNERABLE*

Distribution: Portugal and Spain

Native to central and northern parts of the Iberian Peninsula. It has been recorded from the Miño (pt. Minho), Ulla, Umia, Mandeo, Duero (pt. Douro), and Tagus (pt. Tejo) rivers in the eastern Atlantic basin and the Ebro, Mijares, Palancia, Turia and Júcar rivers in the Mediterranean basin. This species is particularly associated with flowing rivers and streams containing clean, clear water and submerged aquatic vegetation. Many of the its populations have declined dramatically in recent decades due to a range of threats including dam construction, introduction of non-native fish species, widespread agricultural, domestic and industrial pollution, gravel extraction, increasing frequency of droughts and introgression with sympatric related species.

* as *Rutilus arcasii*



© Jörg Freyhof

Achondrostoma occidentale

Western dwarf nase

Distribution: Portugal

Hydropower Hazard: *LOW*

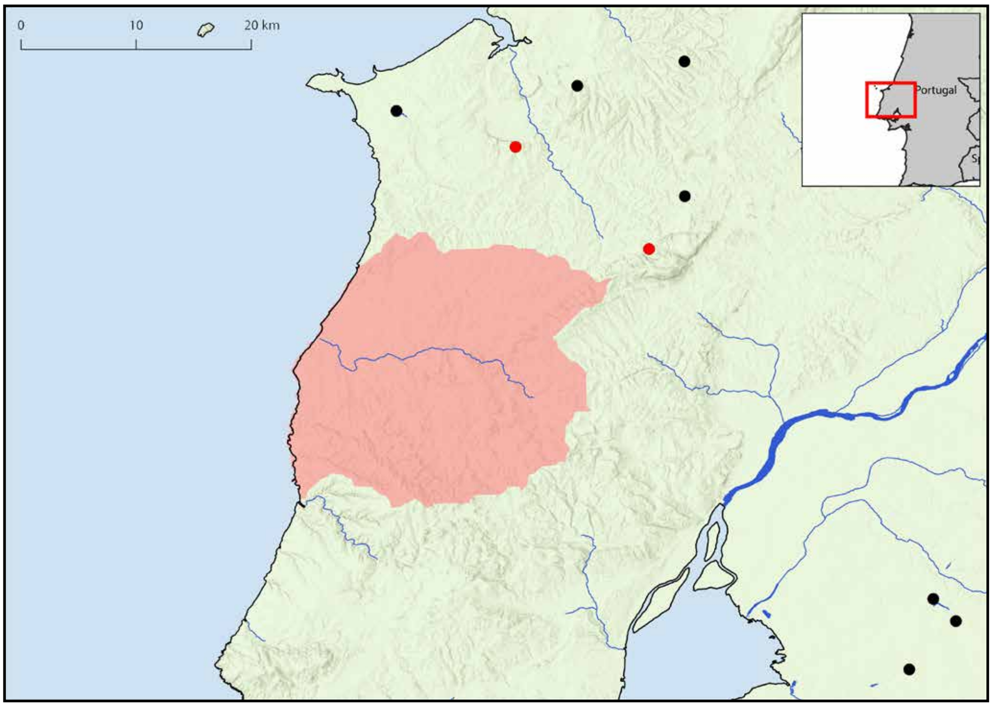
EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Restricted to the Sizandro, Alcabrichel and Safarujo rivers north of Lisbon in western Portugal. These are all small coastal drainages which largely dry out during the summer, with the fish surviving in small pools. It is threatened by untreated discharge of agricultural and domestic sewage, abstraction of groundwater and increasing frequency of drought. All populations have undergone significant declines and are now restricted to relatively small areas upstream of the main sources of pollution. Hydropower development is unlikely within the species' range.

* as *Rutilus macrolepidotus*



© Jörg Freyhof

Hydropower Hazard:
LOW
EUR-HAB-DIR:
*ANNEX II **
Bern Convention:
*APPENDIX III **
IUCN Red List:
ENDANGERED

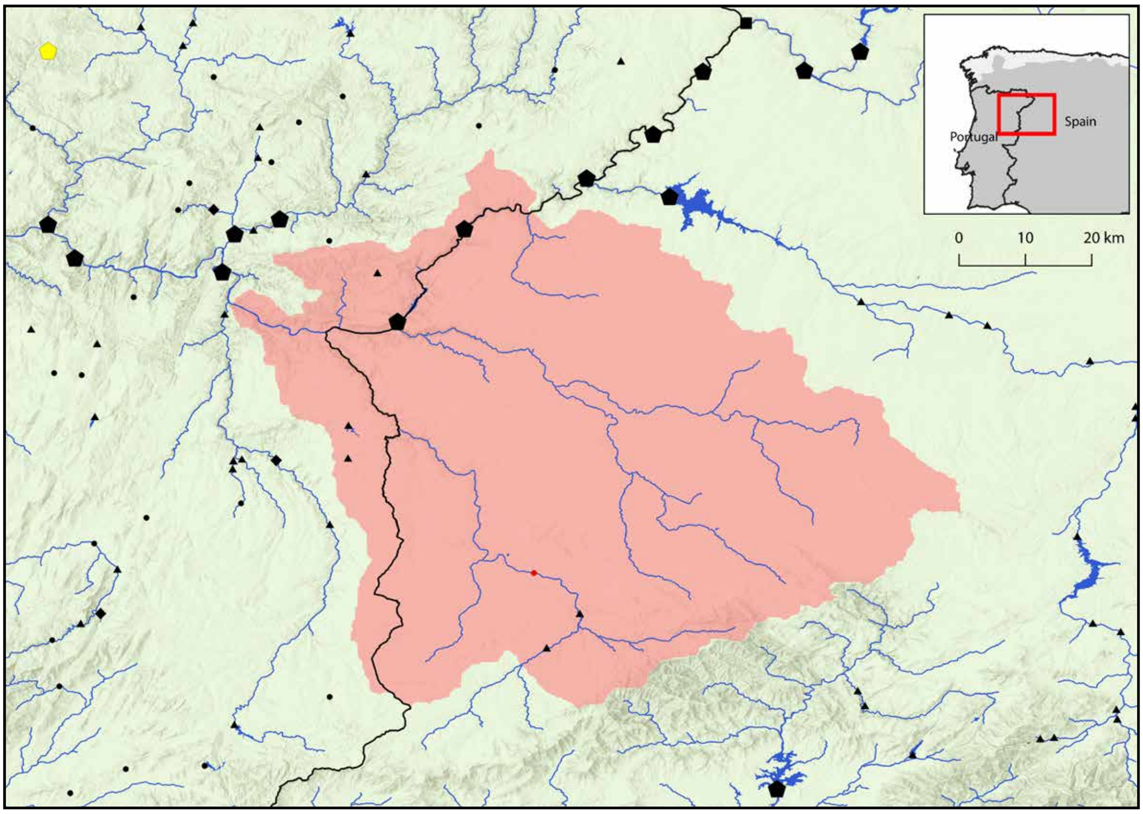
Achondrostoma salmantinum

Duaro dwarf nase

Distribution: Spain, potentially Portugal

Reported from the Huebra, Águeda, Yeltes, Turones and Uces tributaries within the Duero (pt. Douro) River drainage in western Spain. It inhabits seasonal streams with clear water and sandy substrates, and is most often found in slow-flowing stretches with abundant aquatic vegetation. During summer most of these dry out with the fish surviving in remnant pools. This species is threatened by unmanaged water abstraction, construction of dams and weirs and introduction of non-native fish species.

* as *Rutilus arcasii*



© David Koutsogiannopoulos

Alburnoides economoui

Spercheios spirlin

Hydropower Hazard: *LOW*

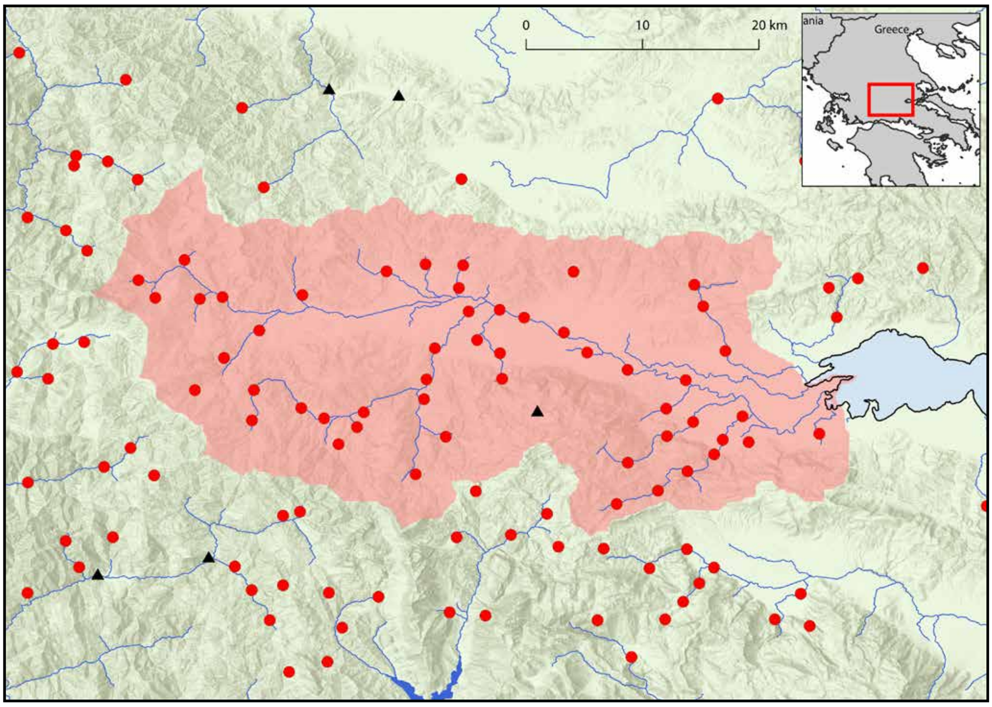
Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Distribution: Greece

Endemic to the Spercheios River drainage in Phthiotis, Central Greece. It is most typically found in fast-flowing, well-oxygenated waters, but also occurs in canals and spring-fed ditches in the lower Spercheios floodplain. It is chiefly threatened by water abstraction, introduction of non-native fish species and construction of dams on tributaries blocking access to its preferred habitats. If all hydropower plants planned in the Spercheios drainage are built, this species could be driven to extinction.

* as *Alburnoides bipunctatus*



© Jörg Freyhof

Alburnoides prespensis

Prespa spirlin

Hydropower Hazard: *HIGH*

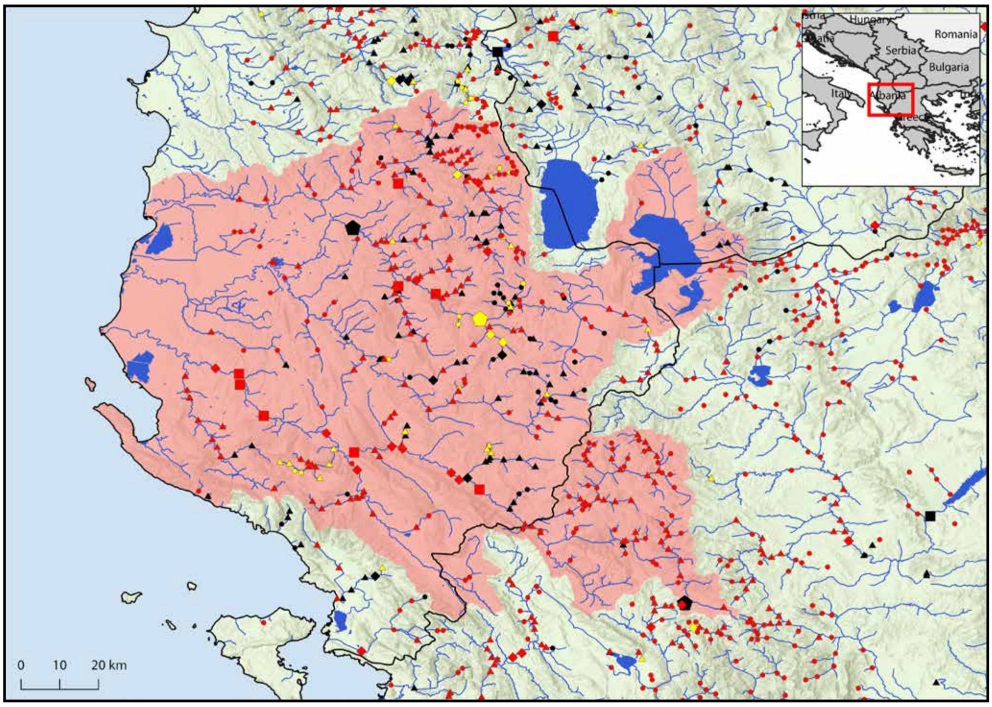
Bern Convention: *APPENDIX III* *

IUCN Red List: *VULNERABLE*

Distribution: Albania, North Macedonia and Greece

Native to the transboundary Prespa Lakes basin and a number of rivers flowing mostly through Albania, from the Shkumbin south past the Vjosa (gr. Aoos) to the Dukati and Borshi coastal drainages. Major threats include water abstraction, pollution, channelisation, dam construction and introduction of non-native fish species. Recent studies suggest the resident fish community in the Prespa Lakes is increasingly dominated by invasive aliens, while the water level has decreased by around eight metres since the mid-1980s and eutrophication is ongoing.

* as *Alburnoides bipunctatus*



© Jörg Freyhof

Alburnoides strymonicus

Struma spirlin

Hydropower Hazard: *HIGH*

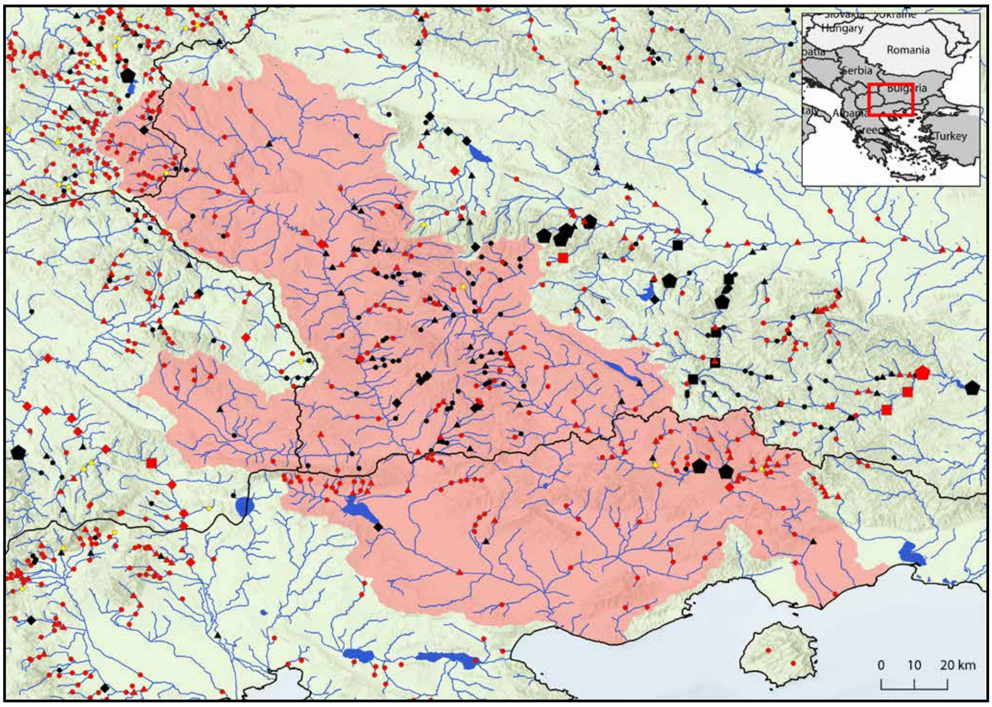
Bern Convention: *APPENDIX III **

IUCN Red List: *VULNERABLE*

Distribution: Bulgaria, Greece and North Macedonia

Native to the Struma (gr. Strymónas) River in North Macedonia, Bulgaria and Greece, the Mesta (gr. Nestos) in Bulgaria and Greece and the coastal Marmaras stream in Greece. It typically inhabits moderate to fast-flowing stretches of both main river channels and tributaries. Dam construction is considered a significant threat due to the associated risk of invasion by predatory non-native fish species, while the species is also at risk from water abstraction plus agricultural and industrial pollution.

* as *Alburnoides bipunctatus*



© Jörg Freyhof

Alburnoides tzanevi

Western Black Sea spirlin

Distribution: Bulgaria and Turkey

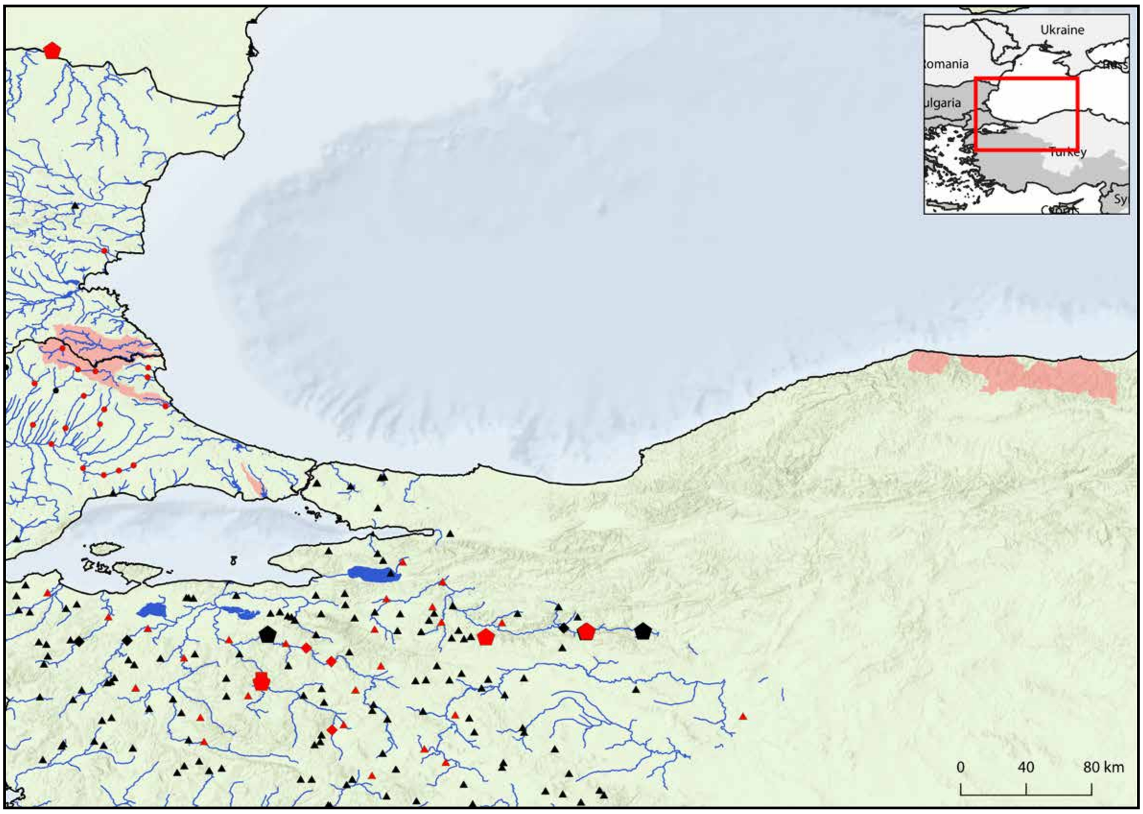
Restricted to a series of relatively short river systems draining into the Black Sea, from the transboundary Veleka River to the Yenice River in Turkey. It inhabits flowing, well-oxygenated stretches of small rivers and streams. This species is threatened by water abstraction, pollution and habitat degradation due to construction of dams and weirs, particularly in the Turkish portion of its range.

Hydropower Hazard: *LOW*

Bern Convention: *APPENDIX III **

IUCN Red List: *VULNERABLE*

* as *Alburnoides bipunctatus*



© Jörg Freyhof

Alburnus albidus

Italian bleak

Hydropower Hazard: *HIGH*

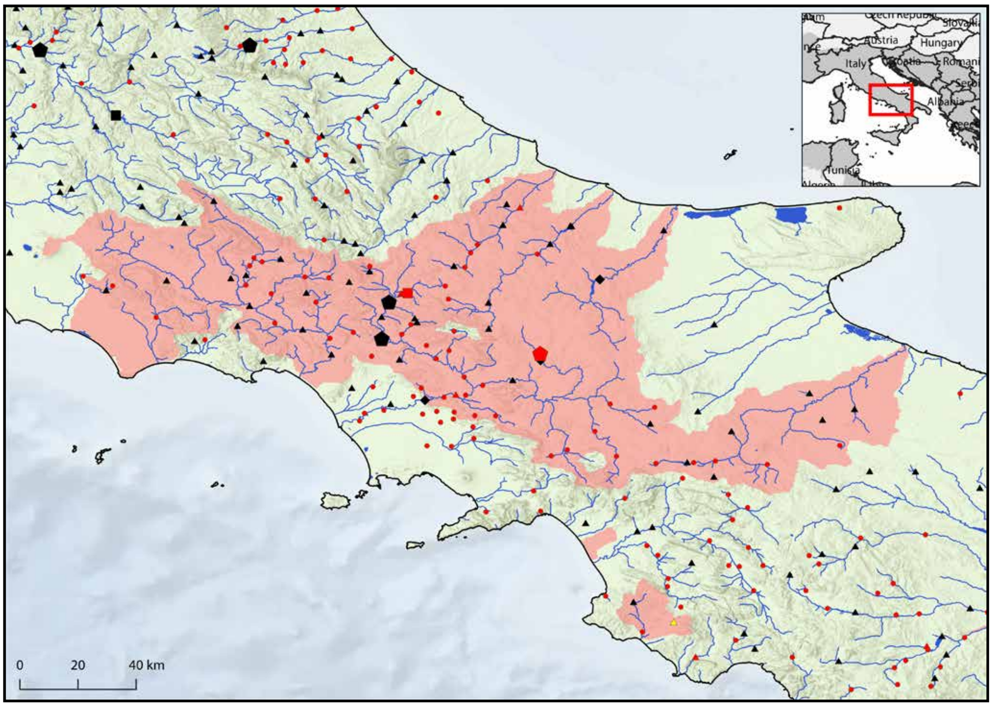
EUR-HAB-DIR: *ANNEX II*

Bern Convention: *APPENDIX III*

IUCN Red List: *VULNERABLE*

Distribution: Italy

Endemic to Italy and naturally distributed from the Trigno to the Basento river drainages on the Adriatic and Ionian coasts, and from the Volturno to the Alento river drainages on the Tyrrhenian slope. Introduced populations are known from the Mingardo, Bussento, Lao, and Savuto rivers. This species has declined sharply in recent decades as a result of extensive habitat modification including dam construction, canalisation, pollution and introduction of invasive alien fish species. Perhaps the single biggest threat is hybridisation and genetic introgression with the related Alborella (*Alburnus arborella*), which has been widely introduced from northern Italy, and to a lesser extent the naturally sympatric Cavedano chub (*Squalius squalus*). A recent study showed that all Italian bleak populations are introgressed with one or both of these species to some extent.



© Jörg Freyhof

Hydropower Hazard:
HIGH
EUR-HAB-DIR:
*ANNEX II **
Bern Convention:
*APPENDIX III **
IUCN Red List:
ENDANGERED

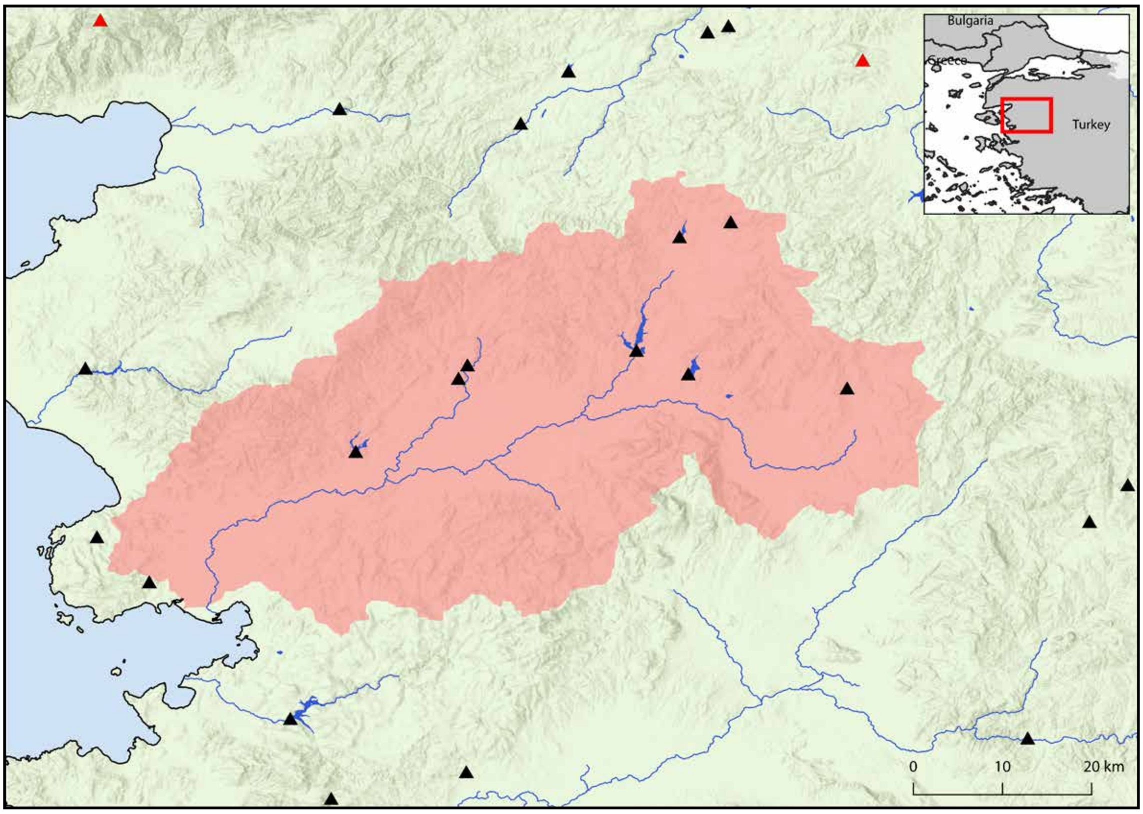
Alburnus attalus

Bakır shemaya

Distribution: Turkey

Endemic to the Bakır River drainage in the Aegean Region of western Turkey, where it is now restricted to a handful of tributaries. It inhabits stretches with flowing water and gravel substrates. This species' original range within the Bakır system was probably more extensive, but the river has been heavily polluted for decades. Additional threats include water abstraction and habitat conversion due to dams.

* as *Chalcalburnus chalcoides*



© Jörg Freyhof

Hydropower Hazard: *MODERATE*

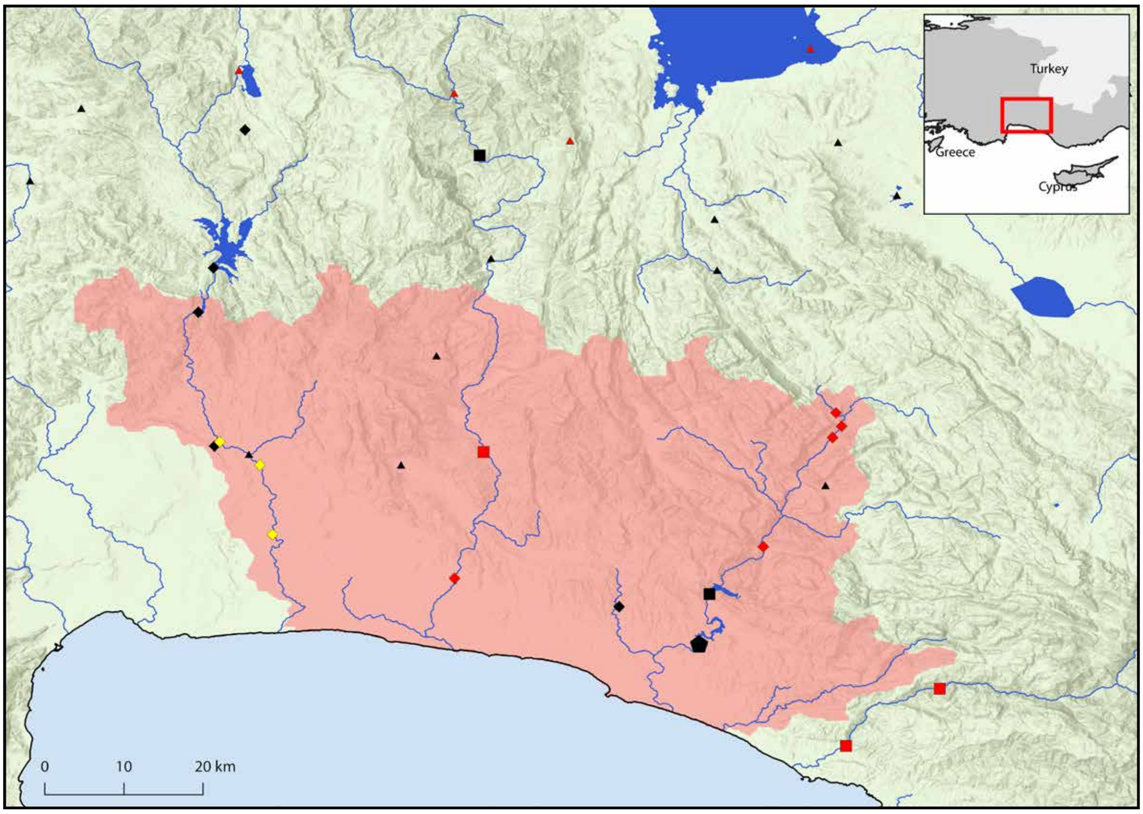
IUCN Red List: *ENDANGERED*

Alburnus baliki

Antalya bleak

Distribution: Turkey

Known only from a series of four coastal rivers draining to the Levantine Sea between the towns of Aksu and Manavgat in the Mediterranean Region of western Turkey. It is threatened by excessive water abstraction and pollution. Although apparently adaptable to dam lakes within its range the rivers below them now contain very little water for long periods of the year, meaning the extent of suitable habitat has been significantly reduced.



© Jörg Freyhof

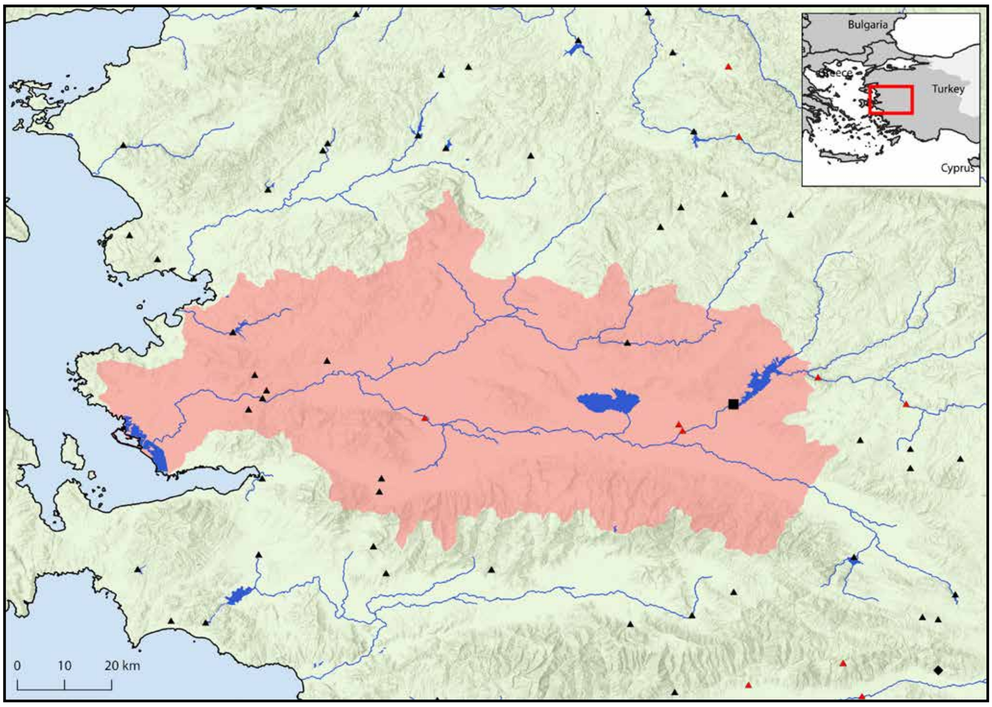
Alburnus battalgilae

Gediz shemaya

Distribution: Turkey

Hydropower Hazard: *HIGH*
EUR-HAB-DIR: *ANNEX II **
Bern Convention: *APPENDIX III **
IUCN Red List: *VULNERABLE*

Native to the Gediz and nearby Koca river drainages in the Aegean Region of Western Turkey. It is currently restricted to a few tributaries of the Gediz, including Lake Marmara, but formerly occurred throughout much of the system. The Gediz main channel is heavily polluted and the river has been further degraded by construction of three dams. One of these is located above Lake Marmara, which has suffered from decades of modification and pollution, mostly related to agriculture, and is becoming increasingly eutrophic. Its surface area also shrank by almost 40% of its surface area between 2011 and 2018, with the loss attributed to a combination of poor management and climate change. A number of non-native fish species have also been introduced to the lake, including common carp (*Cyprinus carpio*) plus the predatory pike perch (*Sander lucioperca*) and Wels catfish (*Silurus glanis*). The Koca is a short coastal river heavily impacted by the Güzelhisar Dam.



* as *Chalcalburnus chalcoides*

© Jörg Freyhof

Alburnus belvica

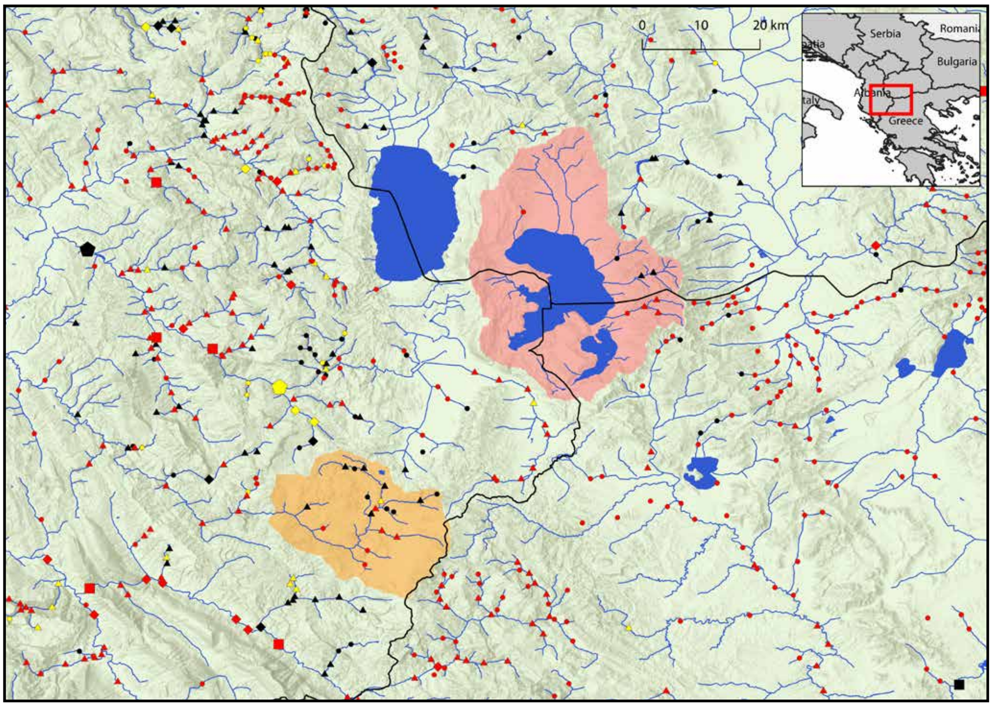
Prespa bleak

Hydropower Hazard: *MODERATE*

IUCN Red List: *VULNERABLE*

Distribution: Albania, North Macedonia and Greece

Restricted to the Prespa lakes at the border between North Macedonia, Albania and Greece. A population inhabiting the Gjancit reservoir in the upper Osum River, Albania, is probably introduced. It is a pelagic, planktivorous species spawning around the shores of the lakes and in some tributaries of Great Prespa. Water abstraction, pollution and especially introduction of several non-native fish species are the main threats facing the Prespa lakes' endemic fish fauna, despite the area being surrounded by three national parks. Recent studies suggest the resident fish community is increasingly dominated by invasive aliens, while the water level has decreased by around eight metres since the mid-1980s and eutrophication is ongoing. Existing small hydropower plants and dams built to retain water for agriculture on streams flowing into Great Prespa are likely to have adversely affected those populations entering the tributaries to spawn. A number of future projects planned on the Agios Germanos tributary stream are likely to block access to important spawning grounds for several endemic fish species.



© Jörg Freyhof

Alburnus carinatus

Manyas shemaya

Hydropower Hazard: *HIGH*

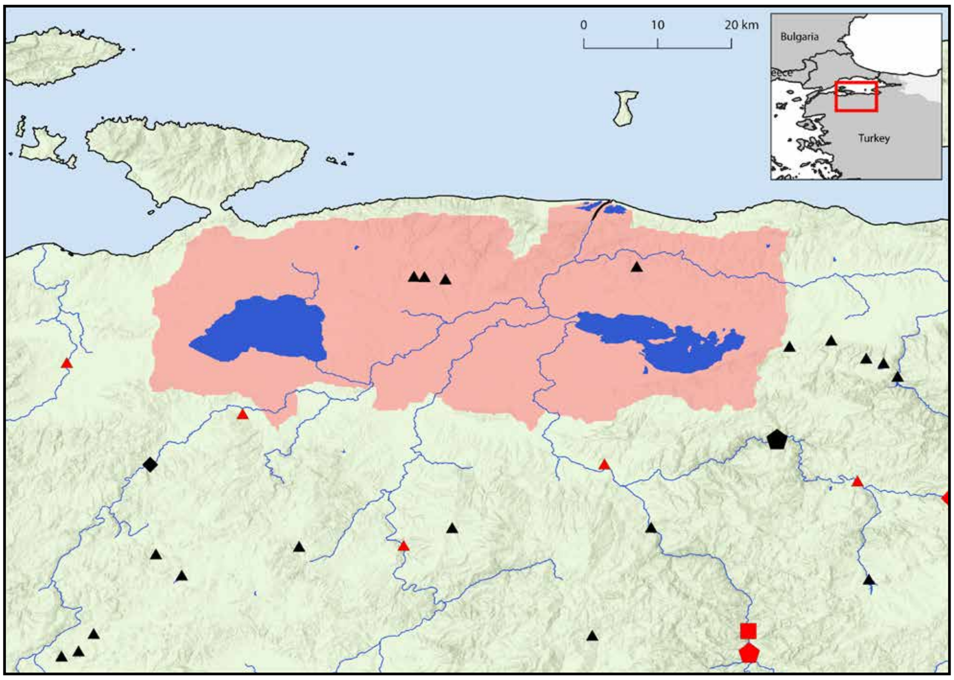
EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Known only from lakes Manyas (aka Kus) and Apolyont (aka Uluabat), located within the Simav River drainage in the Marmara Region of northwestern Turkey. It is a lacustrine species which migrates into affluent streams and rivers where it spawns in fast-flowing stretches. The lakes are both eutrophic due to long-term discharge of agricultural chemicals plus untreated domestic and industrial waste from a rapidly expanding urban population. They have also suffered from overfishing, increased erosion driven by mining activities, land reclamation, water abstraction, construction of dykes and canals. In Lake Manyas a regulator to artificially control the water level has been installed on the outflowing river meaning fish can no longer pass, and the lake's natural annual flood cycle has been altered. A hydroelectric station supplied with water from a dam on one of Lake Apolyont's two main tributaries was commissioned in 2010 and is located on the southern shore, receiving water via an 11 kilometre tunnel which is then discharged into the lake. Native fishes are apparently no longer able to migrate upstream to spawn.



* as *Chalcalburnus chalcoides*

© Jörg Freyhof

Alburnus demiri

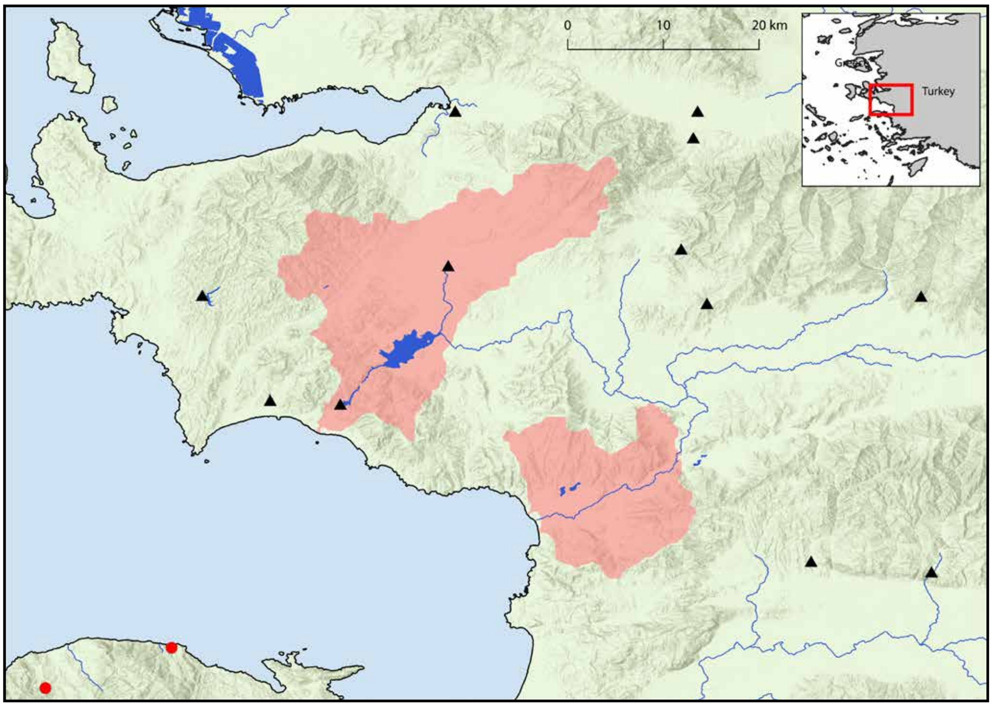
Eastern Aegean bleak

Hydropower Hazard: *MODERATE*

IUCN Red List: *VULNERABLE*

Distribution: Turkey

Native to the Gümüldür River drainage in the Aegean Region of western Turkey. It may once have also occurred in the Küçük Menderes River, but any formerly suitable habitat has now either disappeared due to water abstraction or is too polluted to support fishes. This species appears to be relatively adaptable, however, since it has been collected from main river channels, tributaries and artificial lakes created by dams. The major threats in the area are water abstraction for agriculture and urban use, pollution driven by discharge of agricultural, industrial and domestic effluents, and increasing frequency of droughts, which in 2008 caused the Tahtalı reservoir on the Gümüldür River to almost completely dry out. Although the species can adapt to reservoirs, there is little doubt that dam construction has severely reduced the extent of suitable habitat.



© Jörg Freyhof

Alburnus macedonicus

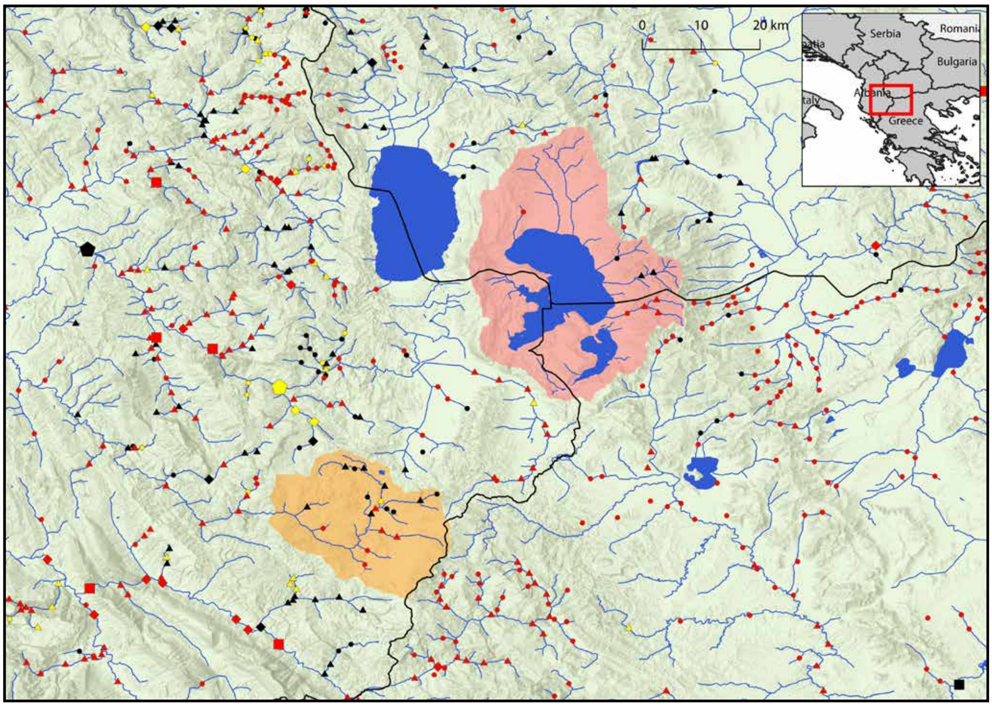
Doiran bleak

Hydropower Hazard: *LOW*

IUCN Red List: *VULNERABLE*

Distribution: Greece and North Macedonia

Endemic to the Lake Doiran (mk. Dojran) basin. It inhabits both the endorheic lake itself and inflowing tributaries, and breeds in shallow water close to the shoreline. Excessive water abstraction for irrigation combined with a prolonged period of drought caused the surface area of the lake to decrease from 42 km^2 to 29 km^2 between 1988 and 2002 with a concurrent increase in eutrophication. The fish community has also come to be dominated by non-native species, but population trends of the native species have not been studied. Construction of a system to pump and transport water into the basin from nearby aquifiers plus an increase in rainfall has seen water levels increase since 2003 and fish stocks are assumed to have stablised, but water quality and climate change remain serious issues.



© Jörg Freyhof

Alburnus mandrensis

Mandras shemaya

Distribution: Bulgaria

Hydropower Hazard: *LOW*

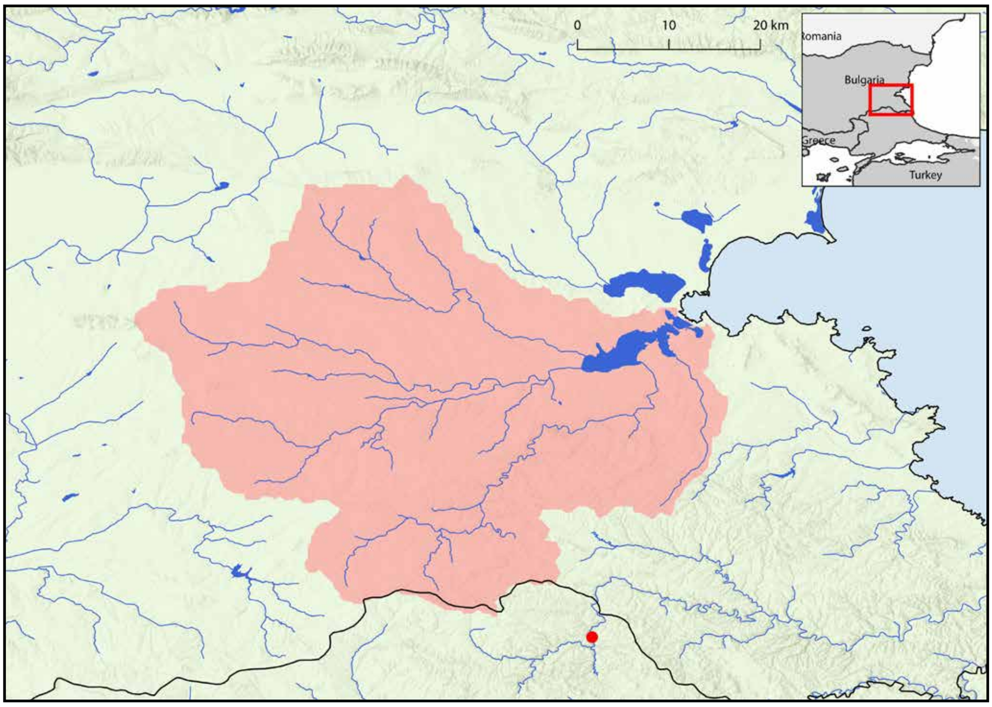
EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Endemic to the Lake Mandrensko (aka Mandra) drainage basin in eastern Bulgaria. It was once restricted to the four major inflowing tributaries but colonised the previously brackish lake itself after it was dammed during the 1960s to prevent seawater from entering. Individuals inhabiting the lake now annually migrate up the tributaries to spawn. This species is threatened by domestic and industrial pollution, overfishing and introduction of non-native species, particularly the related common bleak (*Alburnus alburnus*). Construction of dams and weirs on the lake's tributaries has blocked access to some former spawning sites.

* as *Chalcalburnus chalcoides*



© Jörg Freyhof

Alburnus nasreddini

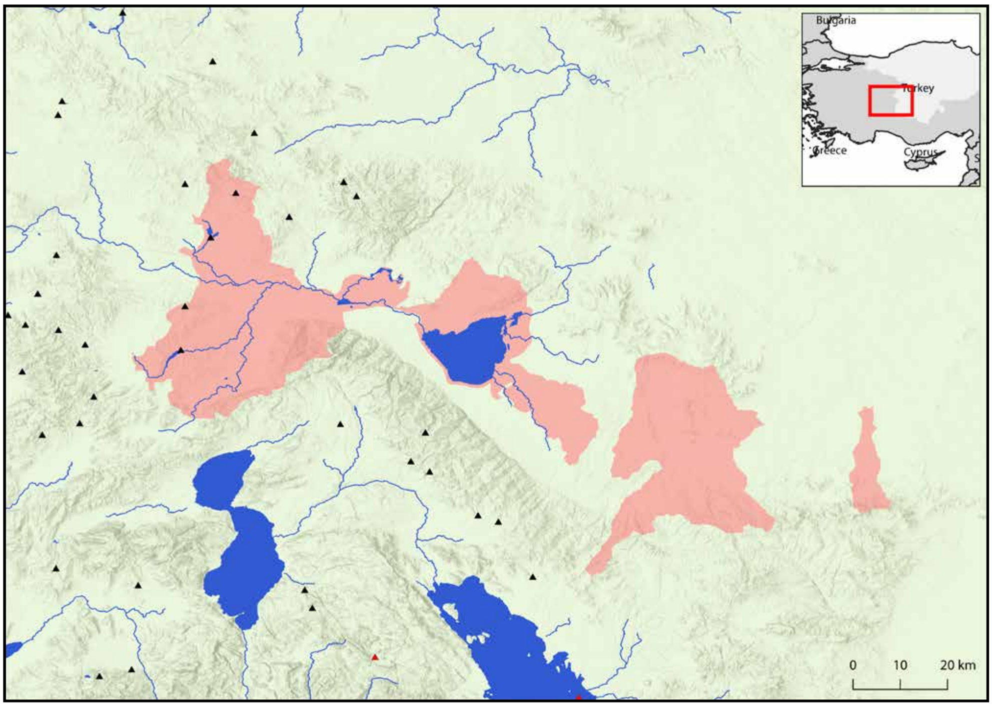
Central Anatolian bleak

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey

Endemic to a series of endorheic basins in Central Anatolia. This species was formerly lacustrine and migrated to tributaries to spawn, but its native rivers have been subjected to decades of modification, pollution and water abstraction, particularly since the mid-1970s. Widespread installation of small water retention dams, irrigation canals and regulators has further reduced the amount of suitable habitat. Lake Akşehir lost its surface connection with Lake Eber in 1990 and temporarily dried out in 2008, while in 2018 Eber was also reported to be without water. All streams where the bleak still occurs continue to be polluted and exploited for irrigation water and these pressures are likely to intensify with an expanding human population and greater frequency of climate change-induced droughts. Although it has successfully colonised two larger dam lakes there are no fishways and these populations are now essentially isolated.



© Jörg Freyhof

Alburnus orontis

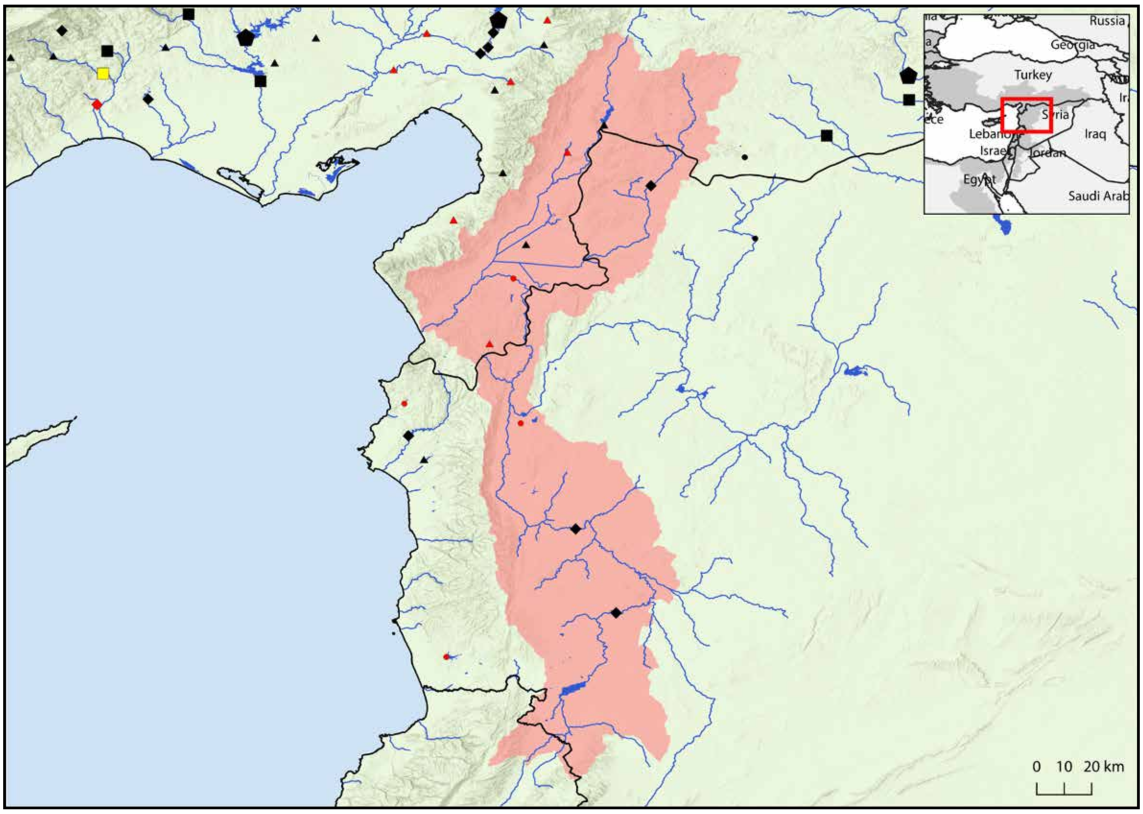
Orontes spotted bleak

Hydropower Hazard: *MODERATE*

IUCN Red List: *VULNERABLE*

Distribution: Turkey and Syria

Endemic to the Orontes (tr. Asi) River drainage in Syria and Turkey. It is relatively adaptable and has been collected from natural river channels plus man-made canals and reservoirs created by dams. However, dam construction has also led to the drying of many river stretches and significantly reduced the extent of suitable habitat, while excessive water abstraction and pollution are widespread throughout the Orontes drainage. This species tends to be most plentiful where freshwater springs enter the river, mitigating the effects of pollution to an extent.



© Jörg Freyhof

Alburnus qalilus

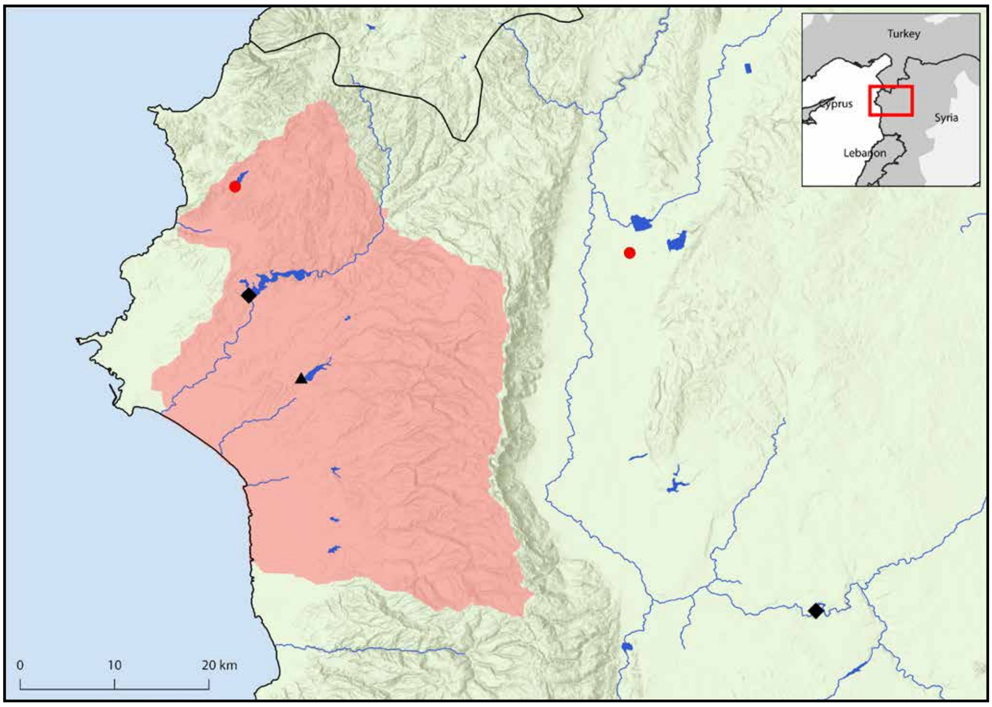
Syrian spotted bleak

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Syria

Restricted to the Al-Kabir al-Shamali, Al-Sanawbar and Al-Hwaiz river drainages, all of which are relatively short and drain the Coastal Mountain Range in northwestern Syria. All three rivers already have large dams built on them, but this species has only become established in Lake Tishreen on the Al-Kabir al-Shamali, which currently harbours the largest population. In recent years it has only been found in small numbers in the lower Al Sanawbar and a small spring-fed area in the lower Al-Hwaiz, and these populations may be on the verge of extirpation. It is apparently absent elsewhere in these drainages. In addition to a reduced lack of flow below the dams the major threats are excessive water abstraction and pollution throughout the species' range.



© Müfit Özulug

Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *VULNERABLE*

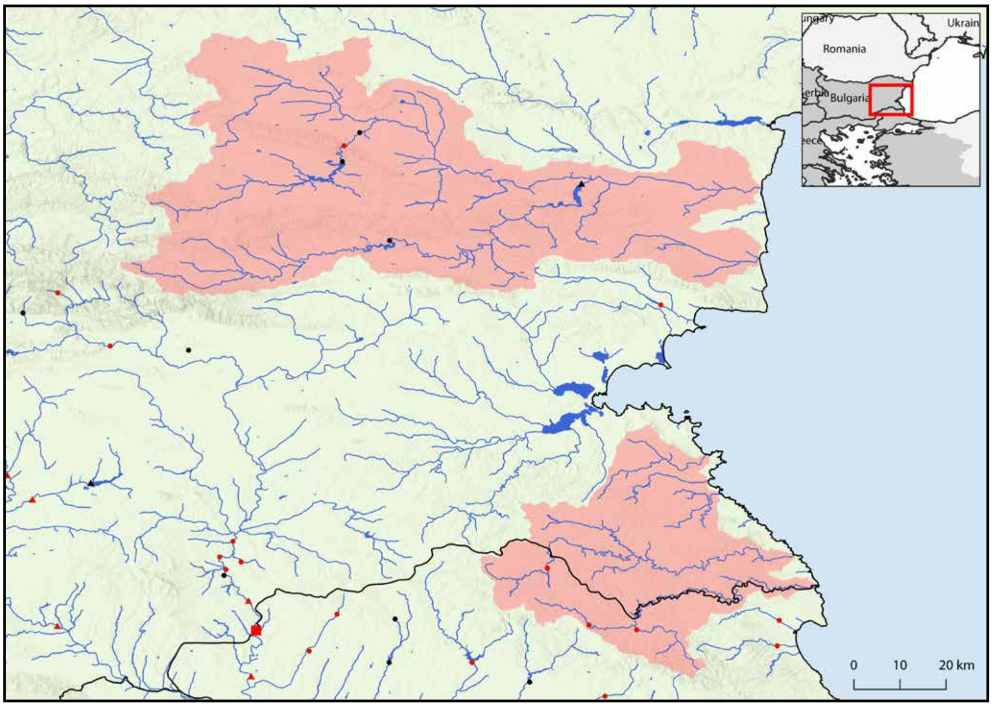
Alburnus schischkovi

Rezovo shemaya

Distribution: Bulgaria and Turkey

Native to a series of rivers draining to the southwestern Black Sea basin. Its range extends northwards from the transboundary Rezovo (aka Rezovska) River in Turkey and Bulgaria and includes the Veleka, Ropotomo, Karaagach, Dyavolska, Dvoynitza, and Kamchiya (aka Kamchia) rivers. Some individuals have been recorded around shorelines of the Black Sea itself. This species is threatened by illegal overfishing, water abstraction, construction of dams and weirs, increasing frequency of droughts and, in the Kamchiya River, introduction of the non-native common bleak (*Alburnus alburnus*). Since it migrates upriver to spawn it is extremely vulnerable to future hydropower development.

* as *Chalcalburnus chalcoides*



© Jörg Freyhof

Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

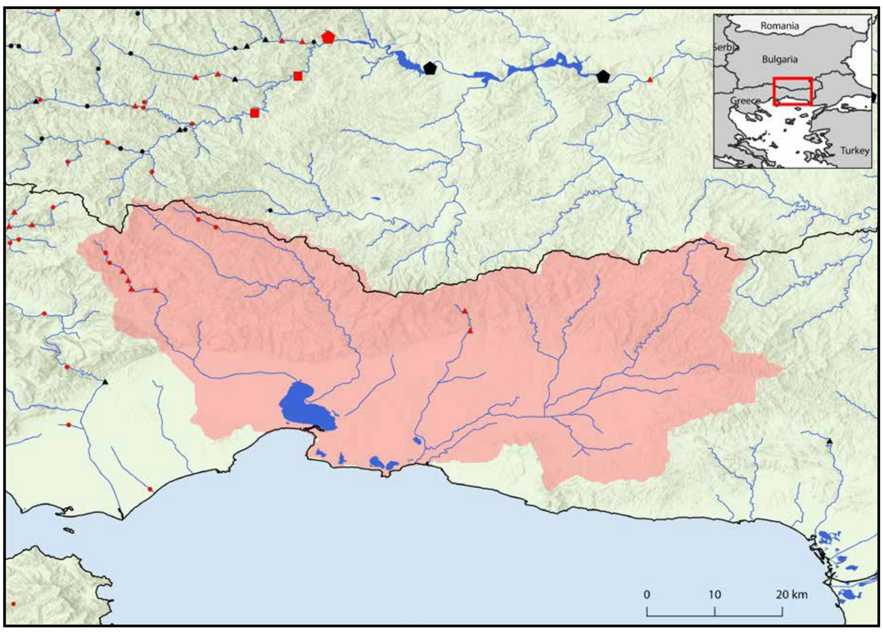
IUCN Red List: *ENDANGERED*

Alburnus vistonicus

Vistonida shemaya

Distribution: Greece

This species was formerly considered endemic to Lake Vistonida, a brackish coastal lagoon in northeastern Greece, and its main tributaries. Additional populations have subsequently been identified in the nearby Lake Mitrikou (aka Ismarida) basin, including the affluent Vosvosis River drainage, and the Filiouris (aka Lissos) River drainage. Vistonida has an open connection to the sea, and this species is known to congregate around freshwater inflows in the northern part of the basin where conditions are less saline. It migrates up two major tributaries, the Kosnythos and Kompsatos rivers, to spawn over gravel beds in fast-flowing stretches. Most of these routes have been compromised by dams constructed to retain water for agriculture, and it is now only able to disperse around 8-10 kilometres upstream. The associated reduction of freshwater flowing into the lake has also driven an increase in salinity and this population is therefore expected to be in decline. Additional threats in the Vistonida basin and elsewhere in this species' range include excessive water abstraction and pollution due to intensive farming. Despite Vistonida's status as a national park there are a number of hydroelectric plants planned on the Kosynthos and Kompsatos rivers. The Vosvosis and Filiouris are currently without major dams.



* as *Chalcalburnus chalcoides*

© Jörg Freyhof

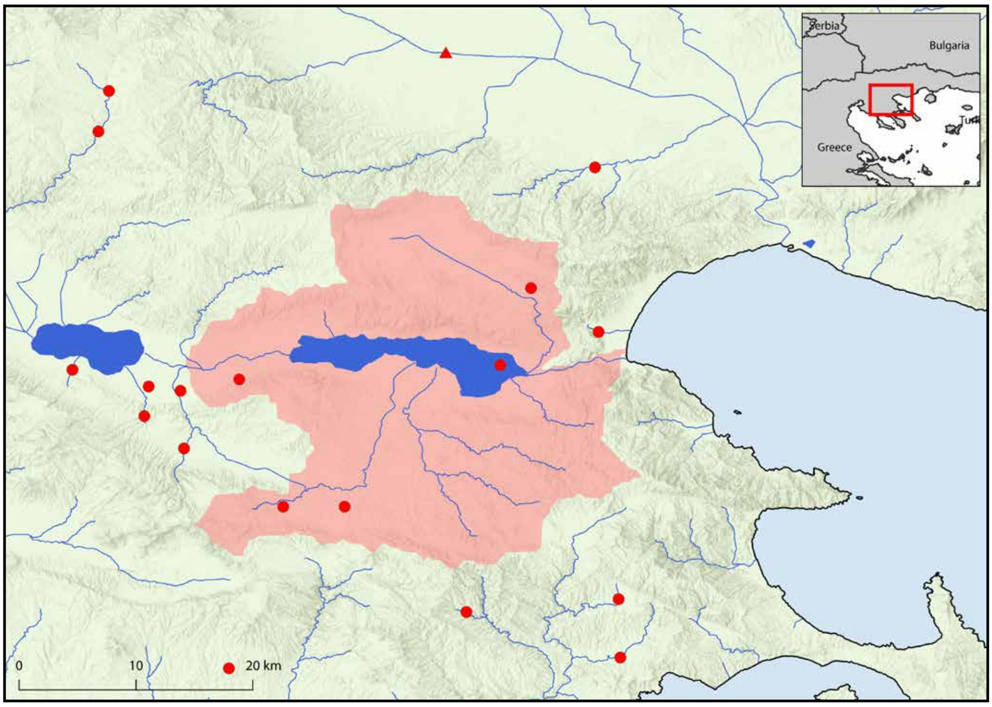
Hydropower Hazard:
LOW
EUR-HAB-DIR:
*ANNEX II **
Bern Convention:
*APPENDIX III **
IUCN Red List:
VULNERABLE

Alburnus volviticus

Yelartza

Distribution: Greece

Currently restricted to Lake Volvi and its tributaries. It was extirpated from Lake Koroneia, which was connected to Volvi by a river channel, after the lake became hypertrophic and underwent a massive decrease in volume between the late 1980s and early 2000s. This led to a series of extensive fish-kills and it eventually dried out temporarily in 2002. In the Volvi basin this species is predominantly lacustrine but migrates up inflowing tributaries to spawn in fast-flowing reaches. Although the Volvi population currently appears stable there are a number of ongoing threats including the presence of several non-native fish species, increasing eutrophication driven by pollution from agriculture and industry, excessive water abstraction for irrigation which has caused the lake level to drop, and construction of dams and other barriers blocking access to some spawning sites.



* as *Chalcalburnus chalcoides*

© Jörg Freyhof

Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II + IV*

Bern Convention: *APPENDIX III **

IUCN Red List: *VULNERABLE*

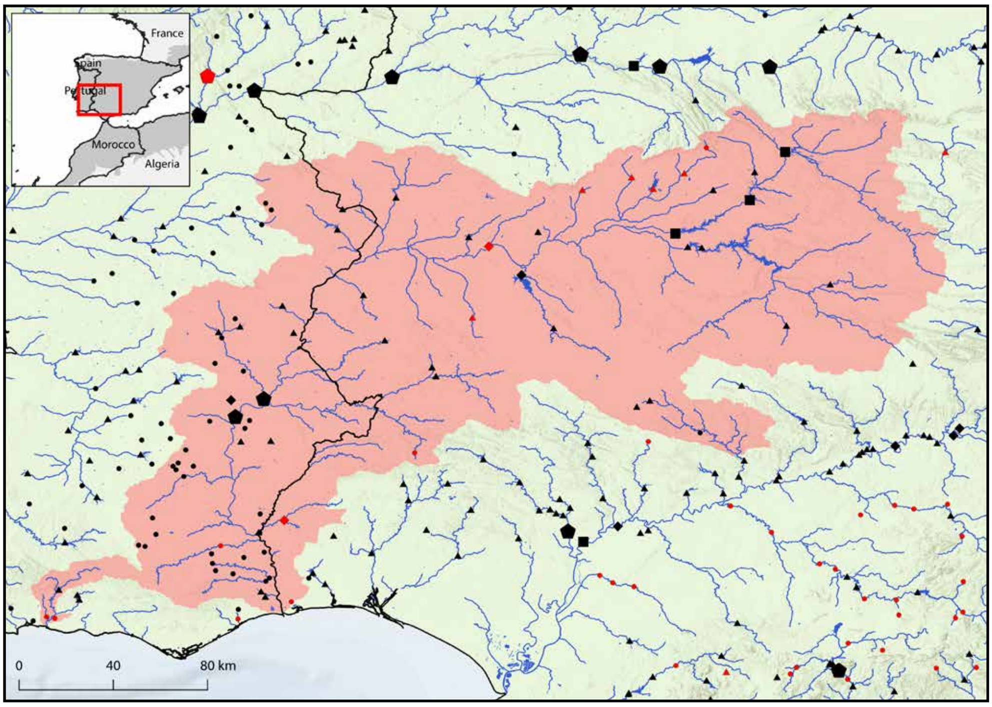
Anaecypris hispanica

Saramugo

Distribution: Portugal and Spain

Native to the Guadiana River drainage in Spain and Portugal and the Bembézar River within the Guadalquivir River drainage in Spain. It mostly inhabits smaller temporal streams and rivers which undergo significant intra- and inter-annual flow variations. Resident fishes typically spend several months per year in remnant pools in the otherwise dry river beds. This species is threatened by water abstraction, pollution, construction of barriers such as dams and weirs, and introduction of non-native fish species. It is not adaptable to reservoirs created by larger dams.

* as *Phoxinellus hispanicus*



© Jörg Freyhof

Anaecypris punica

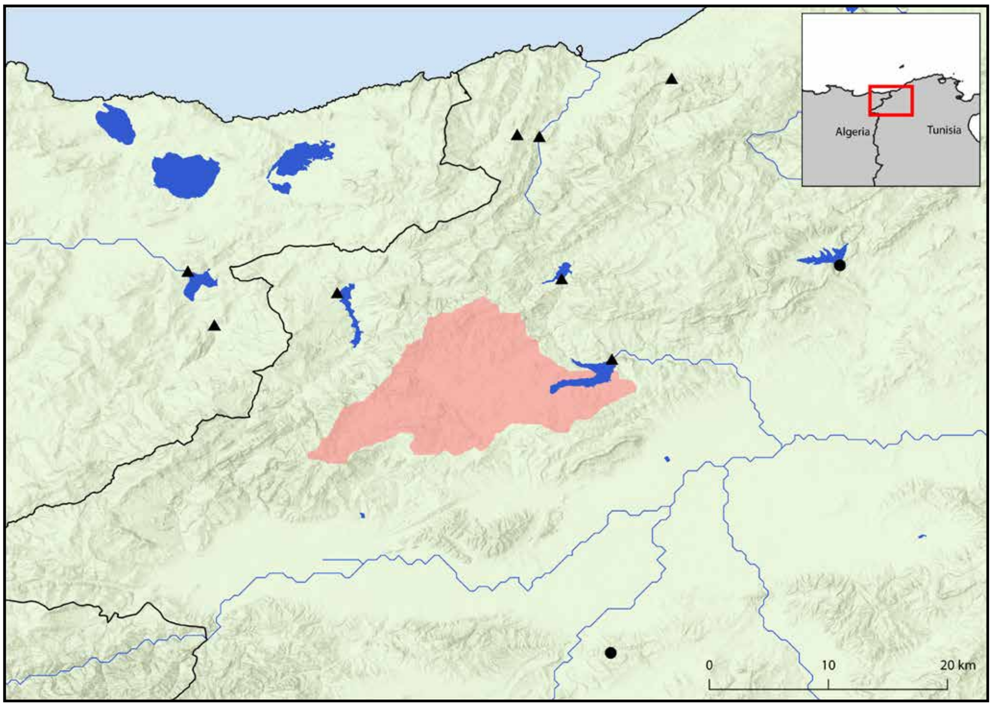
Punican bleak

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Tunisia, potentially Algeria

Endemic to the upper Medjerda River in northeastern Algeria and Tunisia. It is currently known to survive at only two locations in Tunisia and has been extirpated elsewhere. The full extent of its distribution is poorly understood, however, and it might occur elsewhere in the area. It inhabits small, forested hill streams which are probably temporal in nature, with remnant populations surviving in leftover pools during dry periods. Major threats include water abstraction, pollution, introduction of non-native invasive fish species and changing drought regimes driven by an increasingly unpredictable climate. While further research on the species' range is urgently required, future hydropower projects in the area could significantly impact its survival.



© Jörg Freyhof

Chondrostoma beysehirense

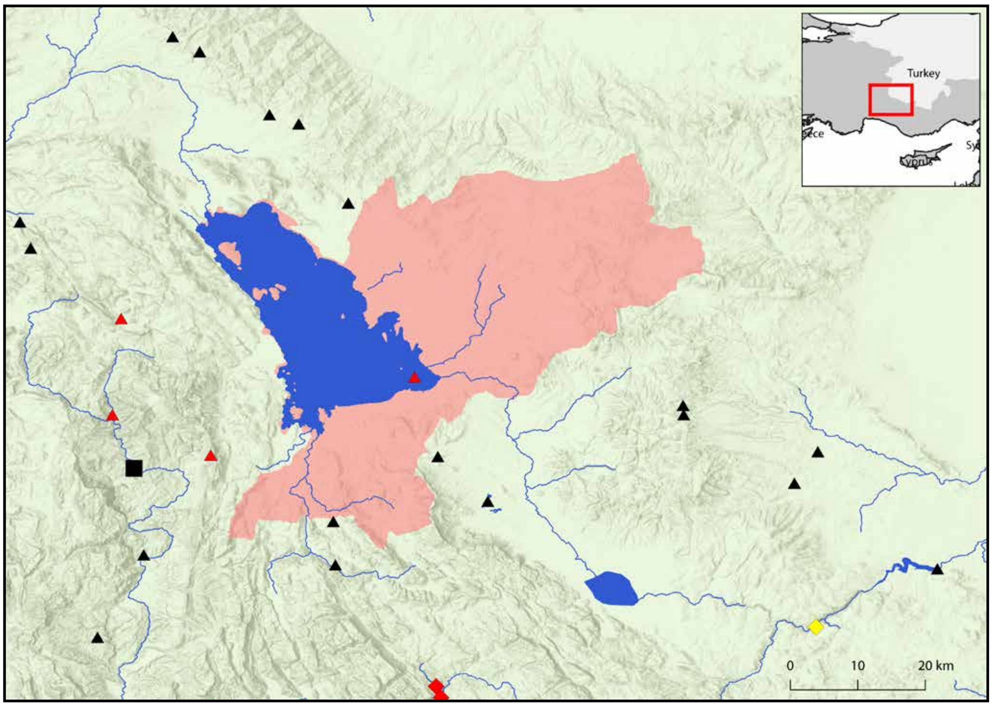
Beyşehir nase

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Endemic to the Lake Beyşehir basin. It is currently restricted to three inflowing tributaries, but is assumed to have once occurred throughout the basin. Beyşehir is the largest natural freshwater lake in Turkey and is surrounded by two national parks, but is also fished commercially. This has led to the introduction of several non-native fishes including the predatory pike perch (*Sander lucioperca*), which is presumed to have driven the decline and disappearance of some native species. Additional threats include pollution, increasingly severe droughts and an ongoing shrinkage of the lake due to excessive water abstraction and dam construction on tributaries.



© Jörg Freyhof

Hydropower Hazard: *HIGH*

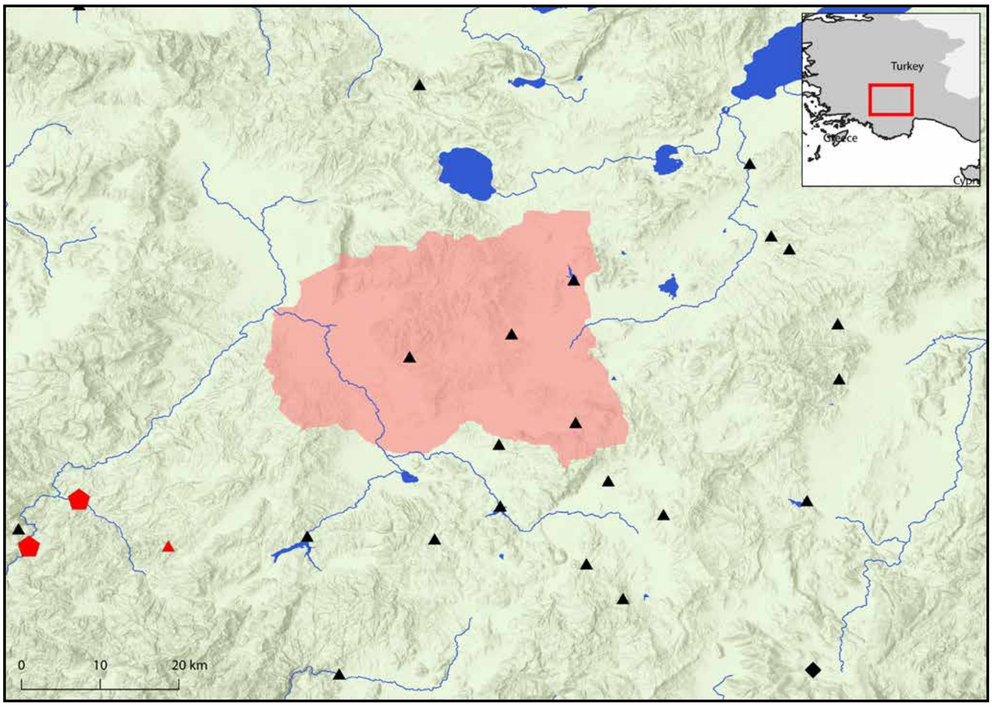
IUCN Red List: *ENDANGERED*

Chondrostoma fahirae

Tefenni nase

Distribution: Turkey

Known only from Kırkpınar spring in Karamusa village, which lies within the Dalaman River drainage, plus the Değirmendere stream, which flows into the man-made Karamanlı reservoir, and Lake Karatas within the Lake Burdur basin. All three sites suffer from intensive water abstraction, pollution and habitat modification. Moreover, non-native rainbow trout (*Oncorhynchus mykiss*) is present in Değirmendere stream. Water stress in the area is likely to increase with extended periods of drought becoming more frequent. While large-scale development is unlikely in this species' range, it could be severely impacted by installation of small hydroelectric plants or additional water retention dams.



© Jörg Freyhof

Chondrostoma holmwoodii

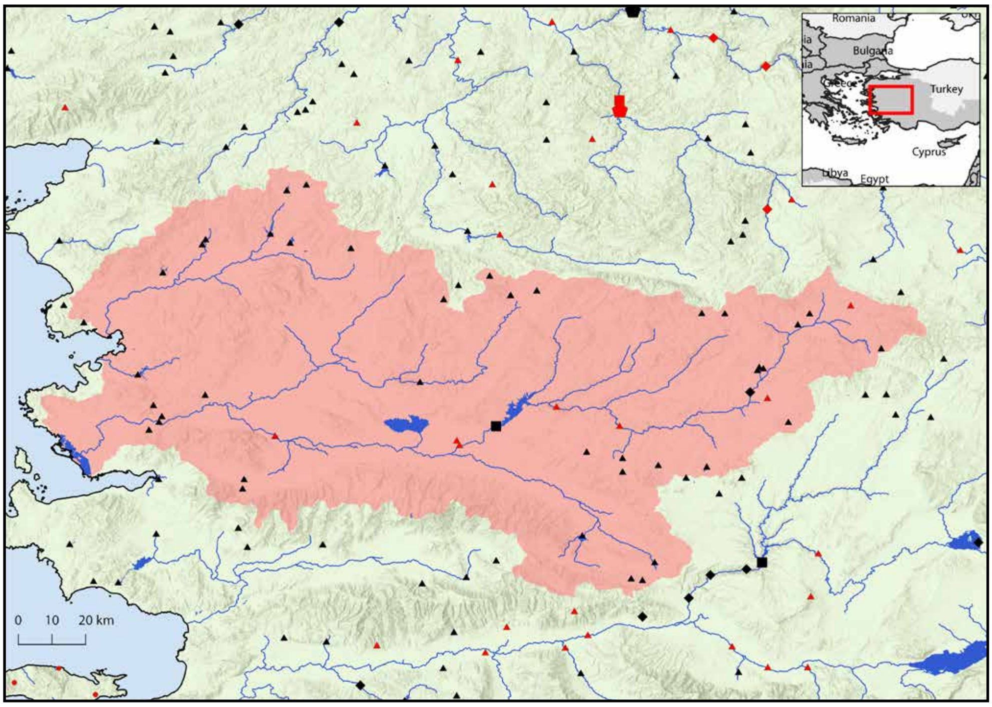
Eastern Aegean Nase

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Turkey

Native to the Bakırçay, Gediz, Gümüldür and Küçük Menderes river drainages in the Aegean Region of western Turkey. This species typically inhabits larger river channels with flowing water and substrates of rock or gravel, but most such stretches within its range have already been lost. It appears to have vanished from the Küçük Menderes, which has suffered from severe and widespread ecological degradation, while the Bakırçay and Gediz main channels are also heavily polluted. The major threats in the area are water abstraction for agriculture and urban use, discharge of agricultural, industrial and domestic effluents, and dam construction. Greater frequency of droughts is increasingly an issue, and in 2008 the Tahtalı reservoir on the Gümüldür River almost completely dried out.



© Jörg Freyhof

Chondrostoma kinzelbachi

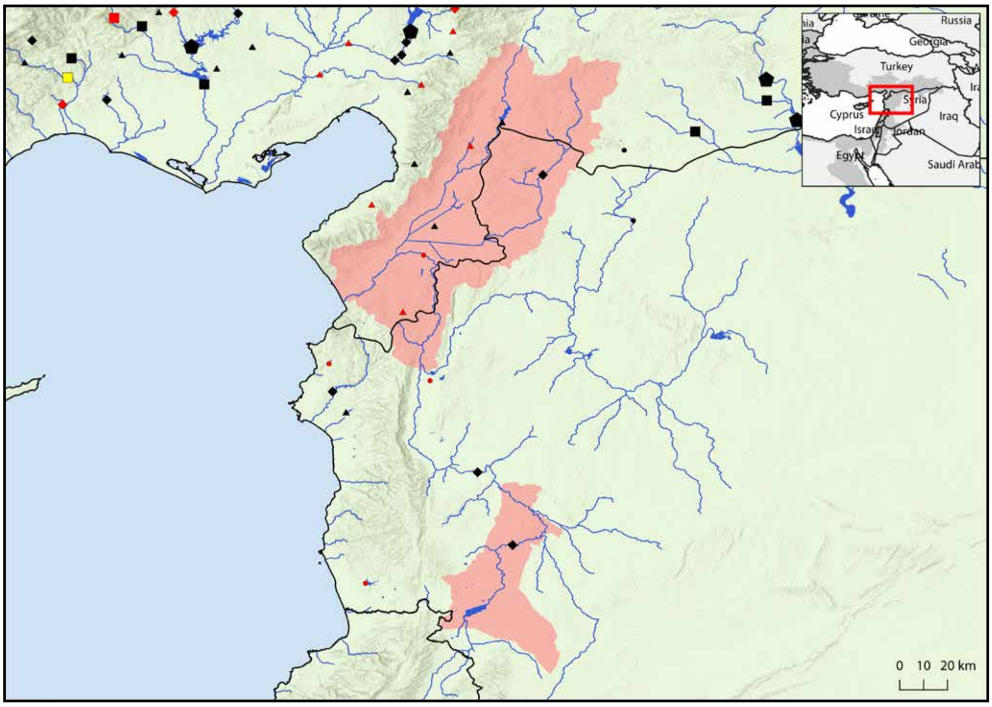
Levantine nase

Hydropower Hazard: *MODERATE*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Endemic to the Orontes (tr. Asi) River drainage. While it was once widespread in the system, it now appears to be extirpated in Syria and restricted to Tahtaköprü reservoir in the upper Karasu Çayi River plus the spring-fed Lake Balık wetland. Both sites are close to the Syrian border in the Mediterranean Region of southern Turkey. This species is likely to have inhabited larger river channels in the past, but has also been recorded from several artificial lakes. Its decline has apparently been driven by water abstraction, pollution and dam construction. Lake Balık shrank by more than 60% between 1957 and 2007, and a number of non-native fish species have been introduced, while Tahtaköprü is polluted and also shrinking due to prolonged periods of drought.



© Jörg Freyhof

Chondrostoma knerii

Dalmatian nase

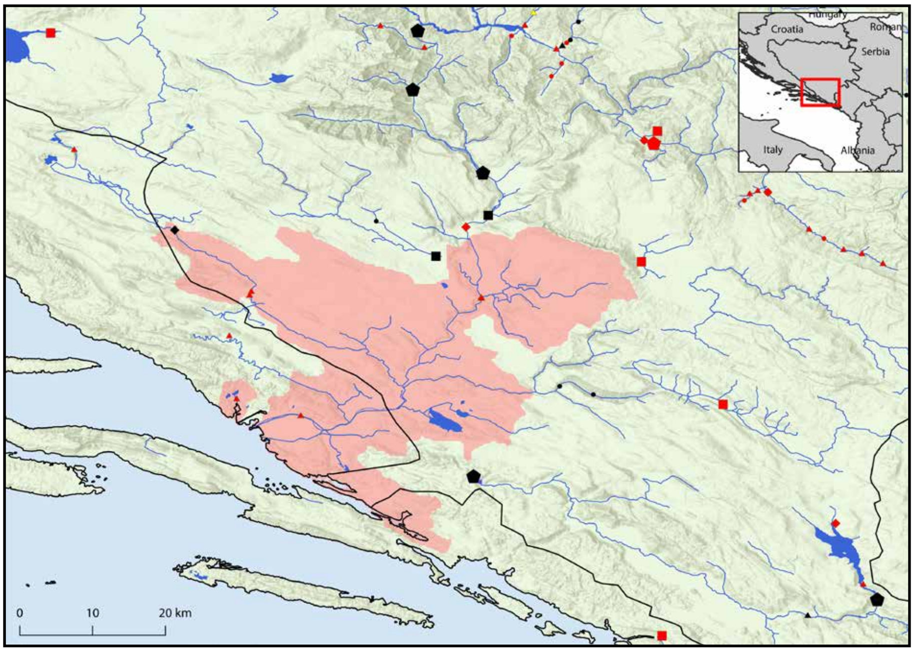
Hydropower Hazard:
HIGH

Bern Convention:
APPENDIX III
(as Chondrostoma kneri)

IUCN Red List:
ENDANGERED

Distribution: Bosnia-Herzegovina and Croatia

Restricted to the middle and lower Neretva River drainage in Croatia and Bosnia-Herzegovina, but may have occurred further upstream prior to the construction of four large hydroelectric dams. It inhabits karstic rivers, lakes, sinkholes and springs, and undertakes annual spawning migrations into small streams when water levels are high, with springs around Hutovo Blato especially important. Formerly abundant, the overall population appears to have declined steeply since the turn of the century. The chief threats are dam construction and modification of river channels leading to fluctuating water levels, pollution and introduction of non-native fish species. It now regularly fails to spawn in the majority of springs around Hutovo Blato due to reduced flow, although in years when spring flooding conditions resemble the previous natural situation the fish are observed to return. Introduced non-native fish species include the predatory pike-perch (*Sander lucioperca*) and pumpkinseed (*Lepomis gibbosus*) plus the Eurasian ruffe (*Gymnocephalus cernua*). Future hydropower projects planned in the lower Neretva would further block access to this species' spawning grounds and favour downstream alien species invasions. A plan, ongoing as of late 2019, to divert significant volumes of water from Hutovo Balto is also likely to have serious detrimental consequences for native fish populations.



© Jörg Freyhof

Chondrostoma meandrense

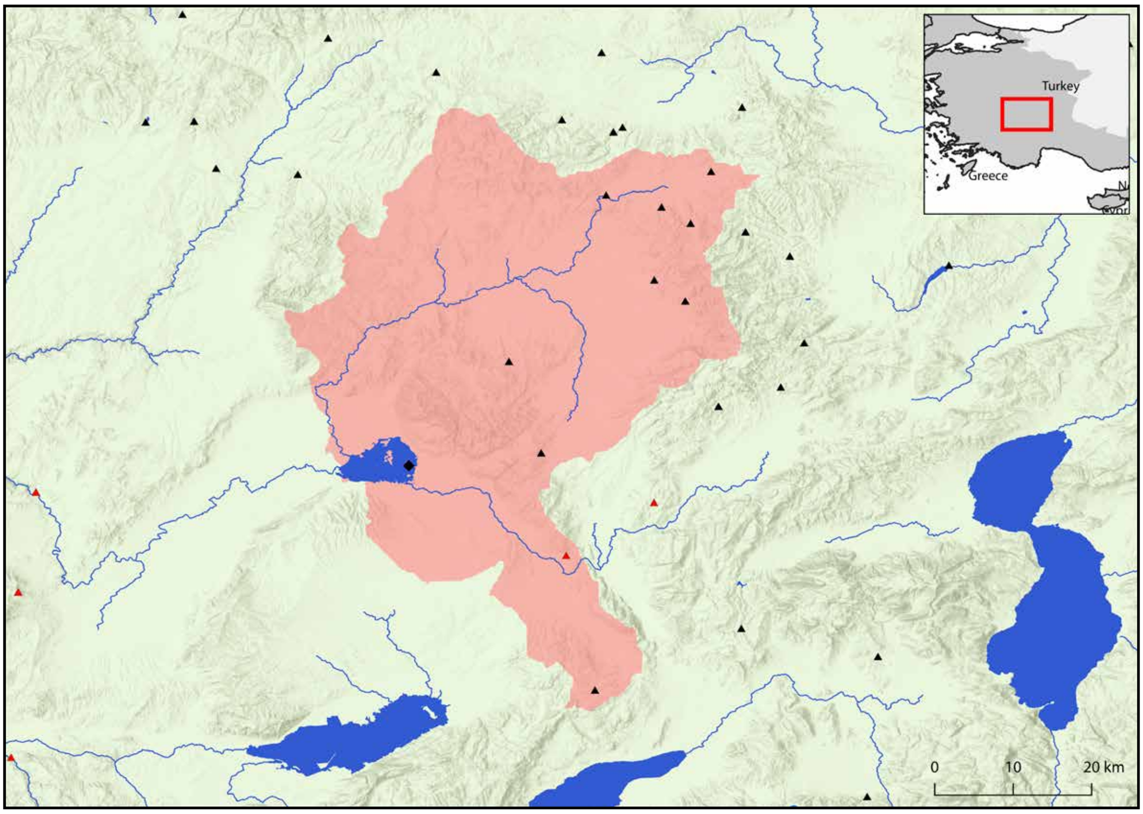
Isıklı nase

Hydropower Hazard: *MODERATE*

IUCN Red List: *VULNERABLE*

Distribution: Turkey

Endemic to the Lake Isıklı basin and upper Büyük Menderes River drainage. It has been recorded from the Küfü and Karadirek streams above the lake, and the Büyük Menderes main channel downstream from the lake to Çal. This species prefers stretches with perennial flowing water and substrates of rocks or gravel. Threats in the area include water abstraction, pollution and increased longevity of droughts.



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Chondrostoma phoxinus

Minnow nase

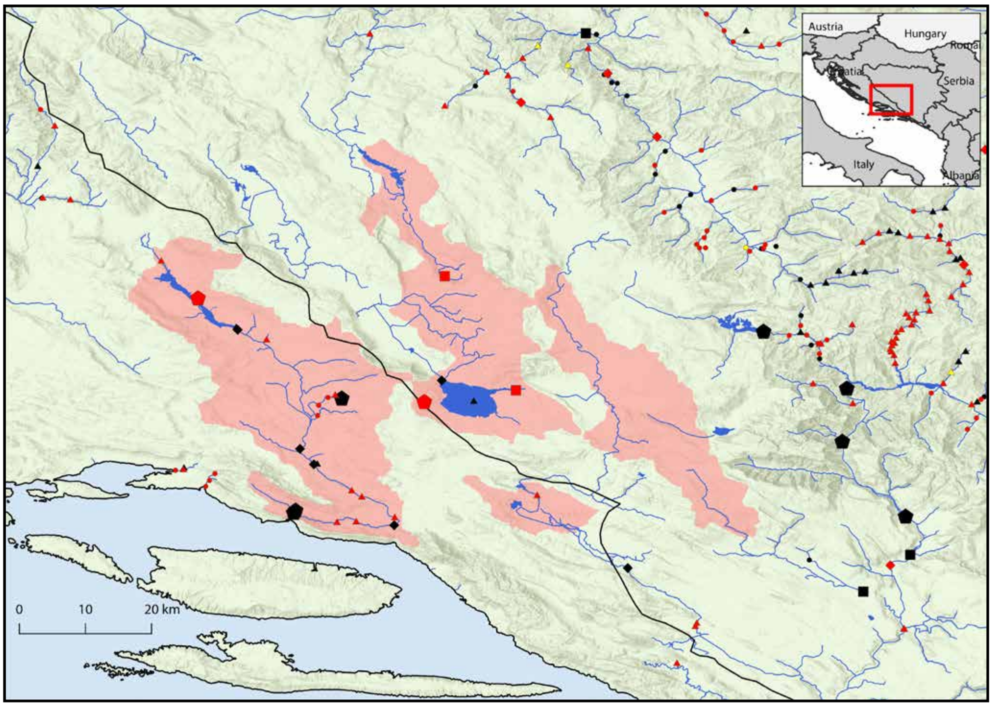
Hydropower Hazard: *HIGH*

Bern Convention: *APPENDIX III*

IUCN Red List: *VULNERABLE*

Distribution: Bosnia-Herzegovina and Croatia

Native to the Cetina River drainage and Prološko Blato karstic basin in Croatia, plus the Glamoč, Livno and Duvno karst fields and Lake Buško Blato (aka Buško Jezero) in Bosnia-Herzegovina. It inhabits karstic streams and rivers. It is threatened by water abstraction, pollution, habitat modification and introduction of non-native fishes typically associated with dam construction. At least seven alien fish species now occur in Buško Blato, whch once held a very large population, including the predatory pike perch (*Sander lucioperca*), Wels catfish (*Silurus glanis*) and pumpkinseed (*Lepomis gibbosus*). Studies indicate these now dominate the fish community, with a corresponding drastic decline in native species. A number of new hydropower projects are planned in the area.



Chondrostoma prespense

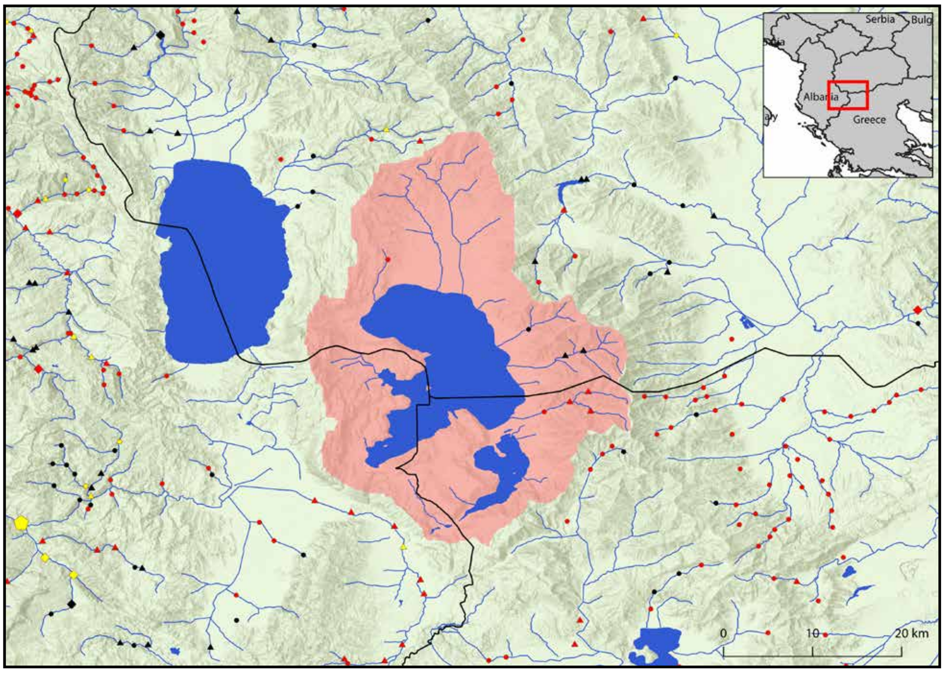
Prespa nase

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Albania, North Macedonia and Greece

Restricted to the Prespa lakes at the border between North Macedonia, Albania and Greece. Lake Great Prespa is shared between all three countries, while Lake Little Prespa is divided between Greece and Albania. It is a pelagic, planktivorous species which in Great Prespa migrates to inflowing tributaries to spawn. Water abstraction, pollution and especially introduction of non-native fish species are the main threats facing the Prespa lakes' endemic fish fauna. Recent studies suggest the nase population represents only a small proportion of the overall community which is increasingly dominated by invasive aliens. Moreover, the water level has decreased by around eight metres since the mid-1980s and eutrophication is ongoing. Commercial fishing is now banned in the Greek portion of Little Prespa but continues throughout Great Prespa, where poaching is also an issue. Existing small hydropower plants and dams built to retain water for agriculture on streams flowing into Great Prespa are likely to have adversely affected those populations entering the tributaries to spawn. Despite the area being surrounded by three national parks, a series of new projects planned on the Agios Germanos tributary stream would block access to one of the species' primary spawning grounds.



© Jörg Freyhof

Hydropower Hazard:
HIGH

EUR-HAB-DIR:
ANNEX II

Bern Convention:
APPENDIX III

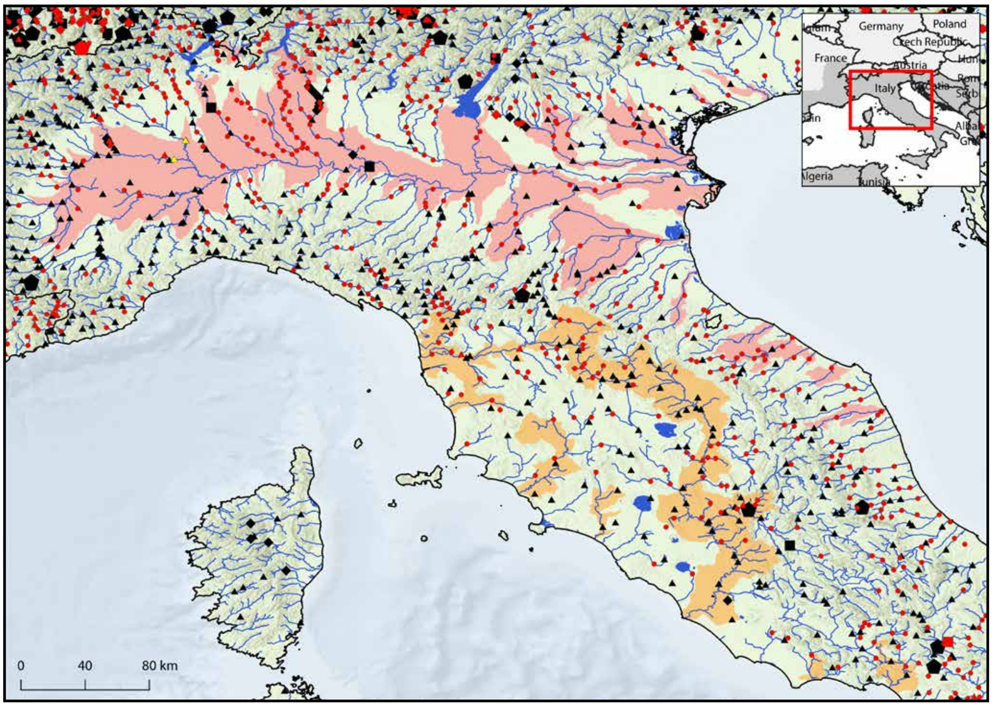
IUCN Red List:
CRITICALLY ENDANGERED

Chondrostoma soetta

Italian nase

Distribution: Italy, Switzerland and Slovenia

Native to the northern Adriatic basin from the Po River drainage in northern Italy and southern Switzerland to the transboundary Soča (it. Isonzo) River in Slovenia and Italy, including the the Adige, Livenza, Brenta and Tagliamento river drainages. It has been widely introduced further south on the Italian Peninsula. This species is an inhabitant of lowland rivers and lakes, from which it migrates to tributaries to spawn. It has declined significantly across its native range in recent decades, and only isolated, highly localised populations remain. It has been extirpated from the Soča/Isonzo and is also disappearing from its introduced range. The primary drivers are loss of spawning habitat due to dam construction, water abstraction and pollution, plus introduction of non-native fish species.



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Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III ***

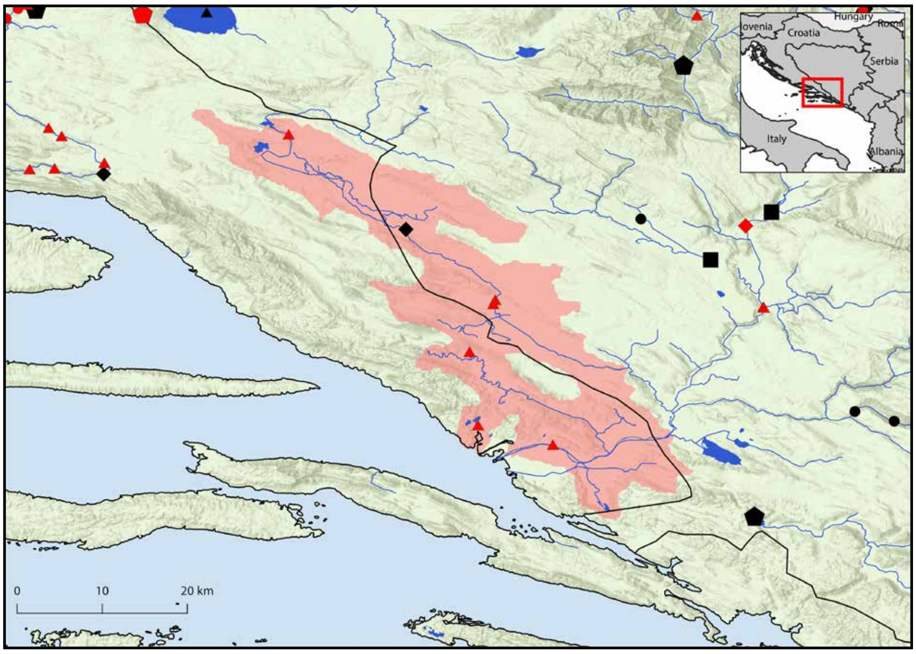
IUCN Red List: *ENDANGERED*

Delminichthys adspersus

Spotted minnow

Distribution: Bosnia-Herzegovina and Croatia

Restricted to tributaries of the lower Neretva River drainage. It inhabits the sinking Vrljika/Matica/Tihaljina/Trebižat system in Bosnia-Herzegovina and Croatia, including lakes Crveno and Prološko Blato. Elsewhere in Croatia it occurs in the Vrgorska Matica River and Rastočko karst field, the Baćina lakes and Lake Kuti on the left bank of the Neretva. The major threats are habitat loss due to modification, pollution, water abstraction, plus introduction of non-native fish species. Construction of dams for water retention or hydropower within its range, such as on the Vrljika River at Ričice, has probably interfered with the complex natural hydrology of the area while reducing downstream flow and encouraging establishment of alien species. Most karst fields in the area have also been modified to reduce the extent of the annual flooding process and provide reclaimed land for agriculture, which has vastly reduced the extent of available spawning habitat for native fish species. Many water courses have been channelised, insufficiently treated domestic and industrial effluents are discharged in places, and agricultural pollutants drain directly into groundwater and lakes.



* as *Phoxinellus* spp.

** as *Phoxinellus adspersus*

© Jörg Freyhof

Hydropower Hazard:
HIGH

EUR-HAB-DIR:
*ANNEX II **

Bern Convention:
*APPENDIX III ***

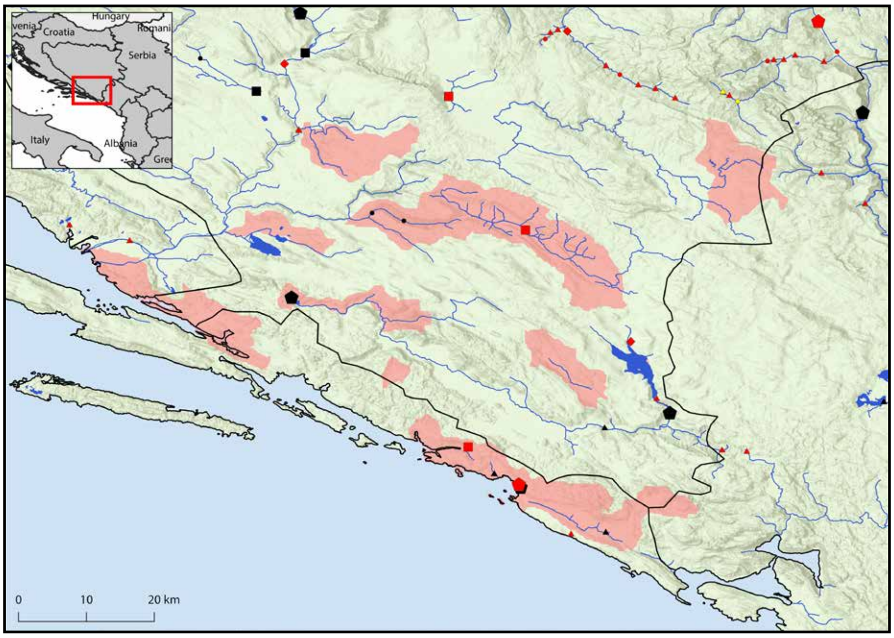
IUCN Red List:
CRITICALLY ENDANGERED

Delminichthys ghetaldii

Southern Dalmatian minnow

Distribution: Bosnia-Herzegovina and Croatia

Known from the Ljubomir, Dabarsko, Fatničko and Popovo karst fields within the Trebišnjica River drainage in Bosnia-Herzegovina, plus the Ombla spring in Croatia. Elsewhere in Bosnia-Herzegovina it has been recorded from the Buna River in the Neretva River drainage and Kasindolka stream south of Sarajevo, while in Croatia it also occurs in springs of the Konavle Valley east of Dubrovnik. It is threatened by habitat loss through pollution, drying or channelisation of karstic watercourses and introduction of non-native fish species, and has already disappeared from many locations. The Trebišnjica drainage has already been hugely modified, with several dams and three hydroelectric power plants in operation. Since 1978 the main channel has also flowed through a 65 km concrete canal designed to prevent loss of water into the karst and ease seasonal drying. This has caused annual discharge from the downstream Ombla spring to decrease by almost 20%, and groundwater circulation in the area has been severely altered with presumed negative effects on local biodiversity. The proposed installation of an underground dam and hydroelectric power plant 200 metres behind the existing karst outflow at Ombla spring has been predicted to lead to extremely dangerous technical and environmental consequences, including the loss of endemic fauna.



* as *Phoxinellus* spp.

** as *Phoxinellus adspersus*

© Jörg Freyhof

Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III ***

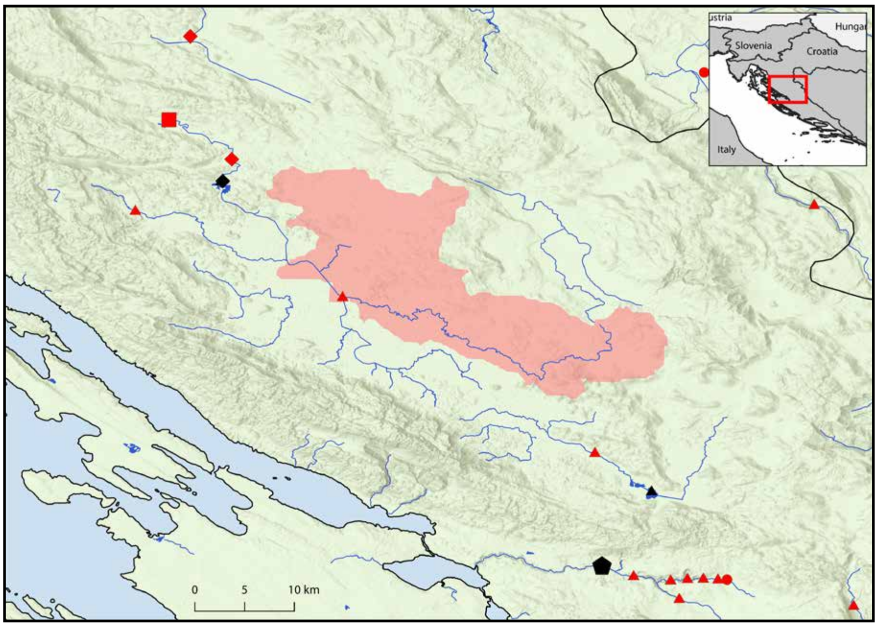
IUCN Red List: *CRITICALLY ENDANGERED*

Delminichthys jadovensis

Jadova minnow

Distribution: Croatia

Now restricted to upper reaches of the Jadova River, a temporal tributary within the Lika River drainage in central Croatia. The Jadova undergoes large annual flow variations and often runs dry during the summer, while the Lika is one of the largest karstic sinking rivers in Europe and flows for around 75 km before disappearing into a series of ponors. This species has vanished from some former locations such as Balatin Stream, and is threatened by pollution, water abstraction, increasing frequency of droughts, construction of small retention dams and most importantly introduction of non-native fish species. The latter became established in the lower Lika following completion of the Kruščica dam and hydroelectric plant, and presumably drove extirpation of the minnow and other native fishes from most parts of the drainage. Larger predators such as northern pike (*Esox lucius*) and European perch (*Perca fluviatilis*) are present in Kruščica resrevoir and pools formed by retention dams in the Lika main channel but have not yet become established in smaller tributaries. Others, including pumpkinseed (*Lepomis gibbosus*), common roach (*Rutilus rutlilus*), and common chub (*Squalius cephalus*) have been more successful and are now the most abundant species in the lower Jadova. Additional hydropower schemes on the Lika are supposedly being planned.



* as *Phoxinellus* spp.
** as *Phoxinellus adspersus*

© Jörg Freyhof

Hydropower Hazard:
LOW

EUR-HAB-DIR:
*ANNEX II **

Bern Convention:
*APPENDIX III ***

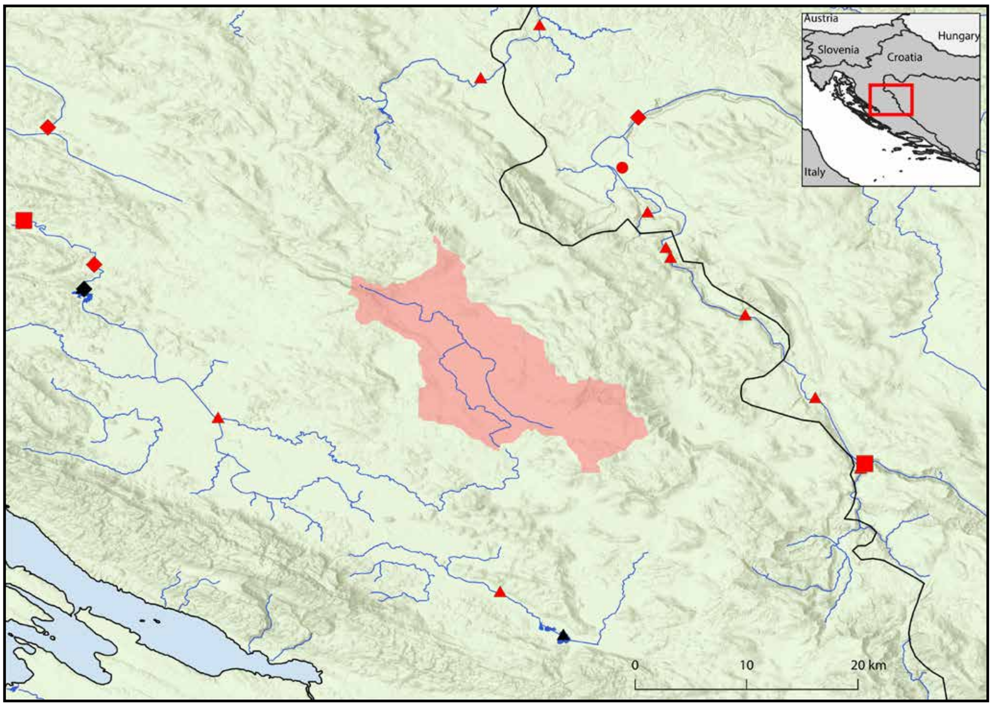
IUCN Red List:
CRITICALLY ENDANGERED

Delminichthys krbavensis

Krbava minnow

Distribution: Croatia

Endemic to the Krbava polje in central Croatia, where it occus only in the very short Krbavica River drainage. Much of the area floods to form a large temporary lake during high water levels which usually occur between December and April, and as the water dries up this species is known to retreat into subterranean water bodies, often spending 8-10 months underground. However there also exist a number of perennial ponds, springs and cave systems where it occurs throughout the year, including Suvaja Mekinjarska, Pećine, Vukova pećina, Hrnjakova pećina and sinkholes around Podlapača. A potential future threat is establishment of non-native fish species, of which several are already present in small numbers. Although hydropower development in the immediate area is unlikely, projects in adjacent drainage basins could interfere with groundwater circulation and the discharge of springs.



* as *Phoxinellus* spp.
** as *Phoxinellus adspersus*

© Jörg Freyhof

Iberochondrostoma almacai

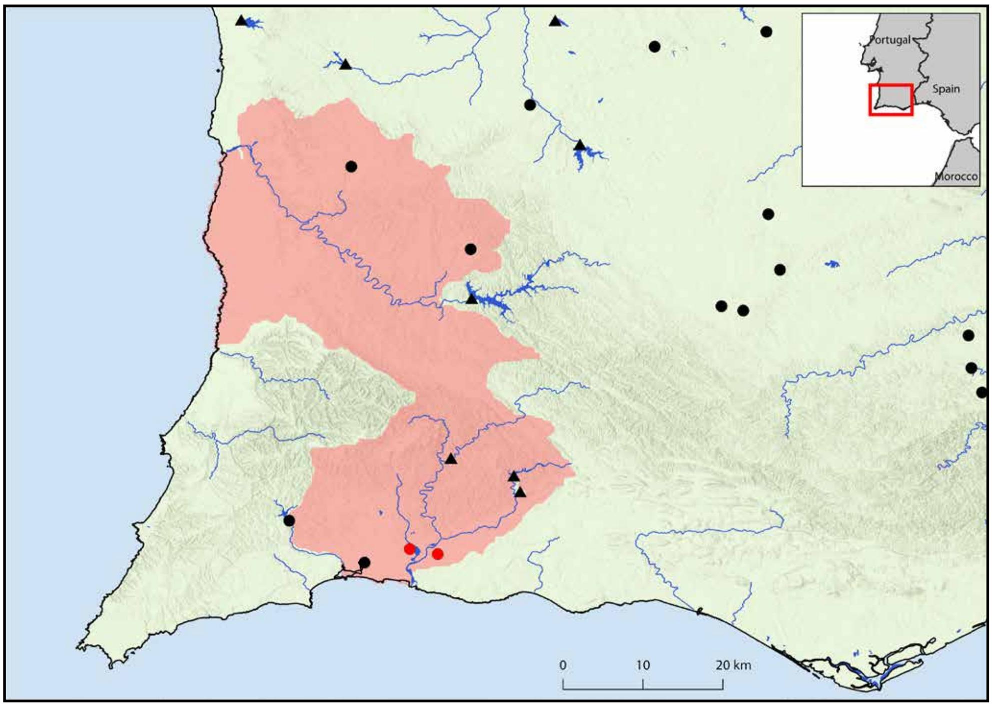
Algarve nase

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Portugal

Restricted to the Mira, Arade and Bensafrim river drainages in southern Portugal. It inhabits slow-moving stretches of temporal streams and headwaters which mostly dry out in summer leaving surface water restricted to a few pools which act as refuges for native fishes. It is threatened by water abstraction and introduction of alien fish and crayfish species, some of which are adapted to lentic environments and are able to survive the summer in the same pools as native species, increasing competition and the risk of predation. Construction of a large hydroelectric dam on the Odelouca River in the Arade drainage is thought to have eradicated a significant proportion of the local nase population since 2012.



© Jörg Freyhof

Hydropower Hazard:
HIGH

EUR-HAB-DIR:
*ANNEX III **

Bern Convention:
*APPENDIX II **

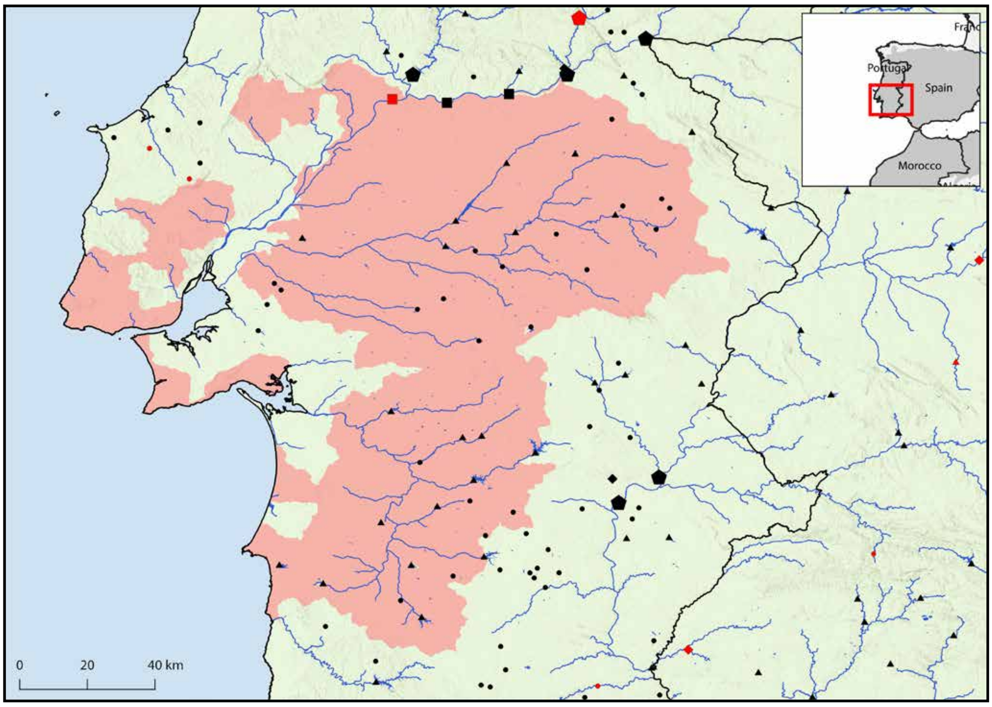
IUCN Red List:
VULNERABLE

Iberochondrostoma lusitanicum

Arched-mouth nase

Distribution: Portugal

Endemic to Portugal, where it is known from tributaries of the lower Tagus (pt. Tejo) River drainage plus a number of short, coastal systems including the Sado, Samarra, Colares and Ossos rivers. It has been extirpated from some former locations. This species inhabits upper stretches of slow-flowing, often vegetated, seasonal streams and small rivers which typically dry out in summer, with the fish surviving in remnant pools. It is threatened by pollution-driven eutrophication from pig farms, distilleries, agricultural runoff and discharge of raw domestic sewage, plus construction of dams and weirs. Introduced non-native fish species, including the eastern mosquitofish (*Gambusia holbrooki*), pumpkinseed (*Lepomis gibbosus*) and largemouth bass (*Micropterus salmoides*) are also likely to be impacting this species.



* as *Chondrostoma lusitanicum*

© Hugo Gante

Iberochondrostoma olisiponensis

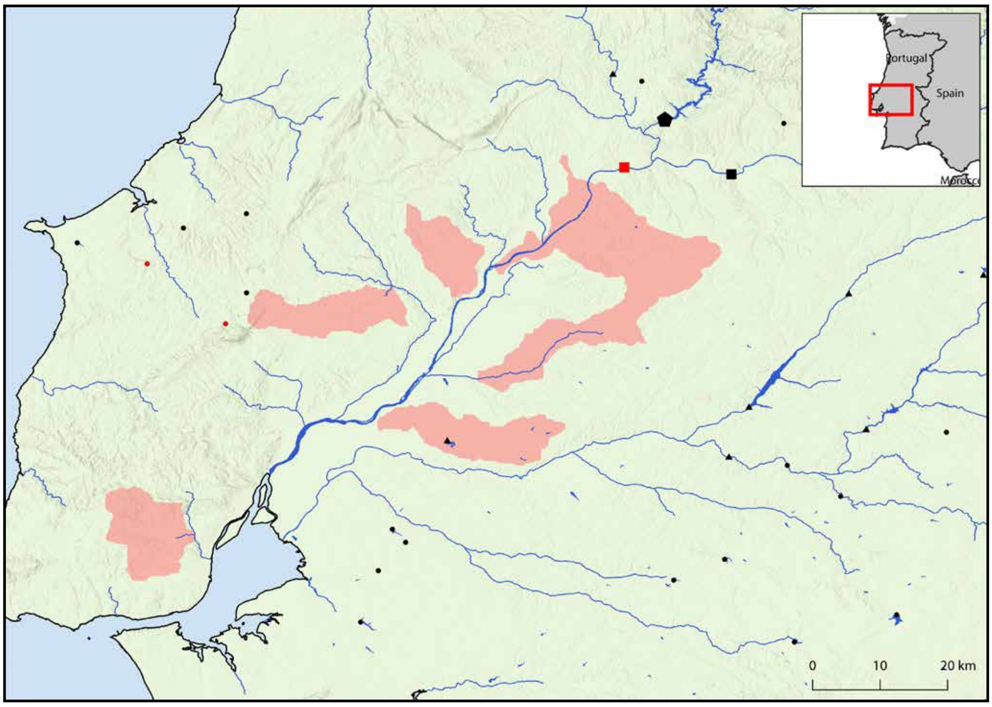
Lisbon arched-mouth nase

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Portugal

Occurs in the lower Tagus (pt. Tajo) River drainage close to Lisbon, Portugal. It is currently known from the Trancão, Ribeira de Muge and Cabanas tributarie systems as well as the Tagus main channel, and has been extirpated from a number of former sites, including the Maior, Ribeira de Ulme and Ribeira de Magos rivers. This species inhabits streams and minor rivers in a floodplain, and typically survives dry periods in remnant pools before dispersing across the area during high water levels. It is threatened by water abstraction, land reclamation, pollution from agricultural, domestic and industrial sources, planned canalisation of the Tagus main channel, extended droughts driven by climate change and introduction of non-native fish species.



© Maurice Kottelat

Iberochondrostoma oretanum

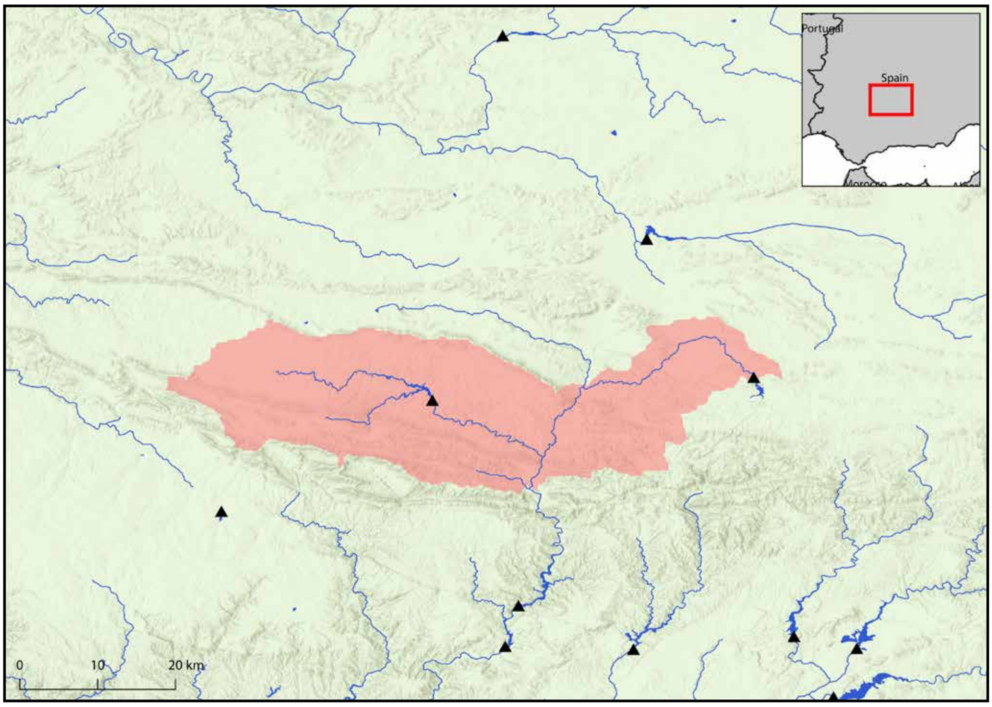
Jándula nase

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Spain

Currently known only from the Montoro and Robledillo rivers, both small tributaries of the Jándula River within the Guadalquivir River drainage in southern Spain. It was extirpated from the nearby Fresnada River in the early 2000s. The majority of the Robledillo population inhabits a short stretch above a small dam constructed to capture drinking water. Construction of the dam destroyed the majority of available habitat since there is no fish pass and the river is completely dry downstream unless there is heavy rain. Two similar dams built on the Fresnada River contain introduced alien fish species including eastern mosquitofish (*Gambusia holbrooki*), pumpkinseed (*Lepomis gibbosus*) and largemouth bass (*Micropterus salmoides*), and these are thought to have directly influenced extirpation of that population. Additional threats include excessive water abstraction and increasingly prolonged droughts.



© Jörg Freyhof

Parachondrostoma arrigonis

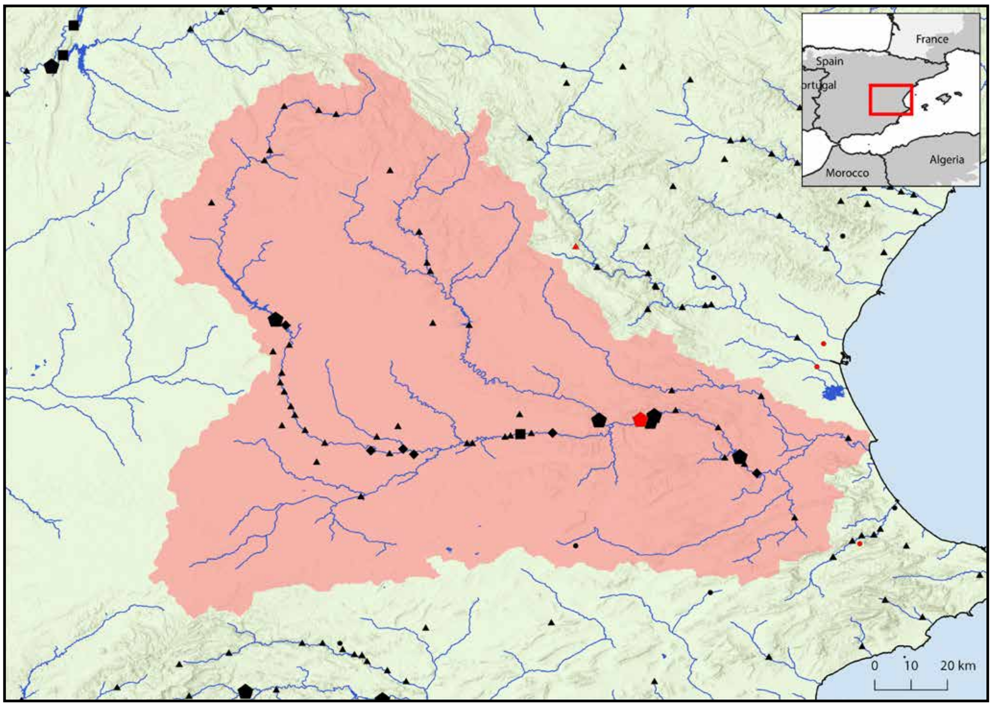
Júcar nase

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Spain

Endemic to the Júcar River drainage in eastern Spain. It has disappeared from most of its range and is now restricted to a few isolated stretches, mostly in the Cabriel and Magro tributary systems. It inhabits fast-flowing water over rocky substrates, but can survive in backwaters and man-made reservoirs provided there are unobstructed upstream tributaries into which it can migrate to spawn. This species is threatened by agricultural, domestic and industrial pollution, water abstraction, construction of hydroelectric dams and weirs blocking access to spawning grounds, channelisation of rivers and introduction of non-native fish species. The Iberian nase (*Pseudochondrostoma polylepis*) has been introduced to the Júcar drainage through the man-made Tagus-Segura Water Transfer system, and is both hybridising and competing for resources with the Júcar nase. Several other non-native species are widespread and dominant, especially in the numerous artificial reservoirs and below the dams which created them.



Parachondrostoma turiense

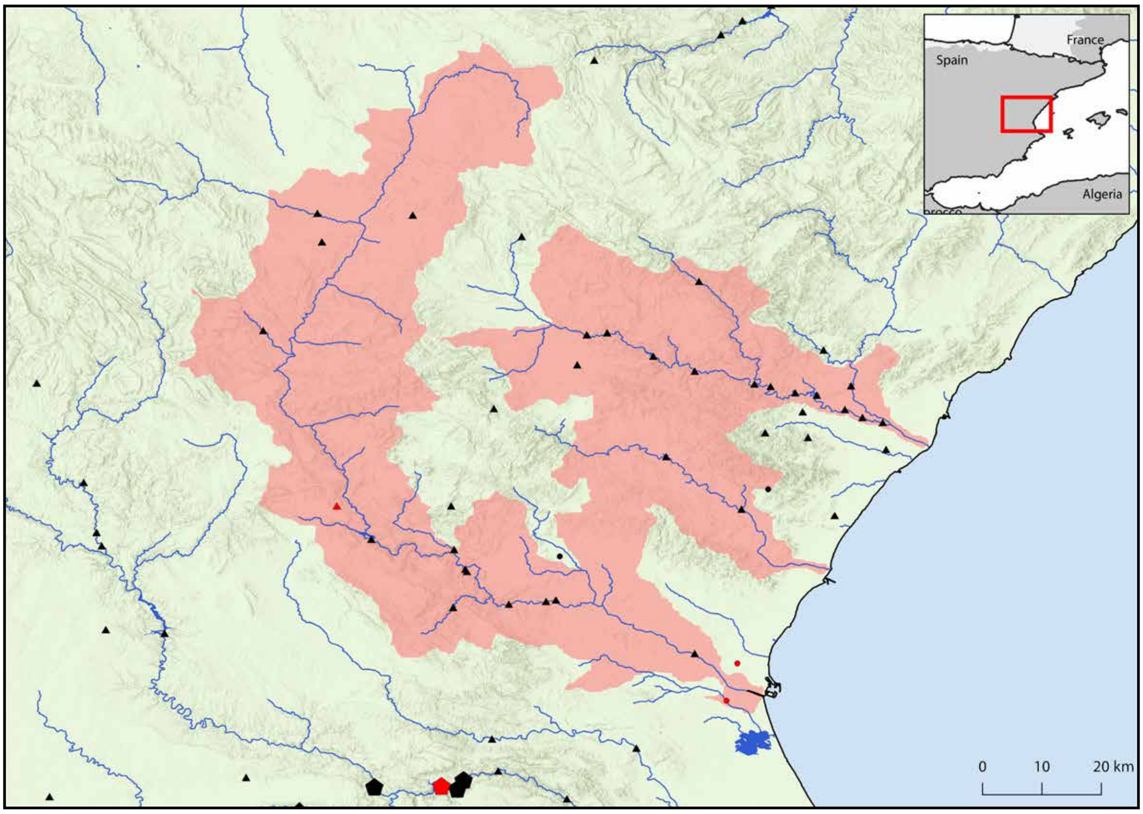
Turia nase

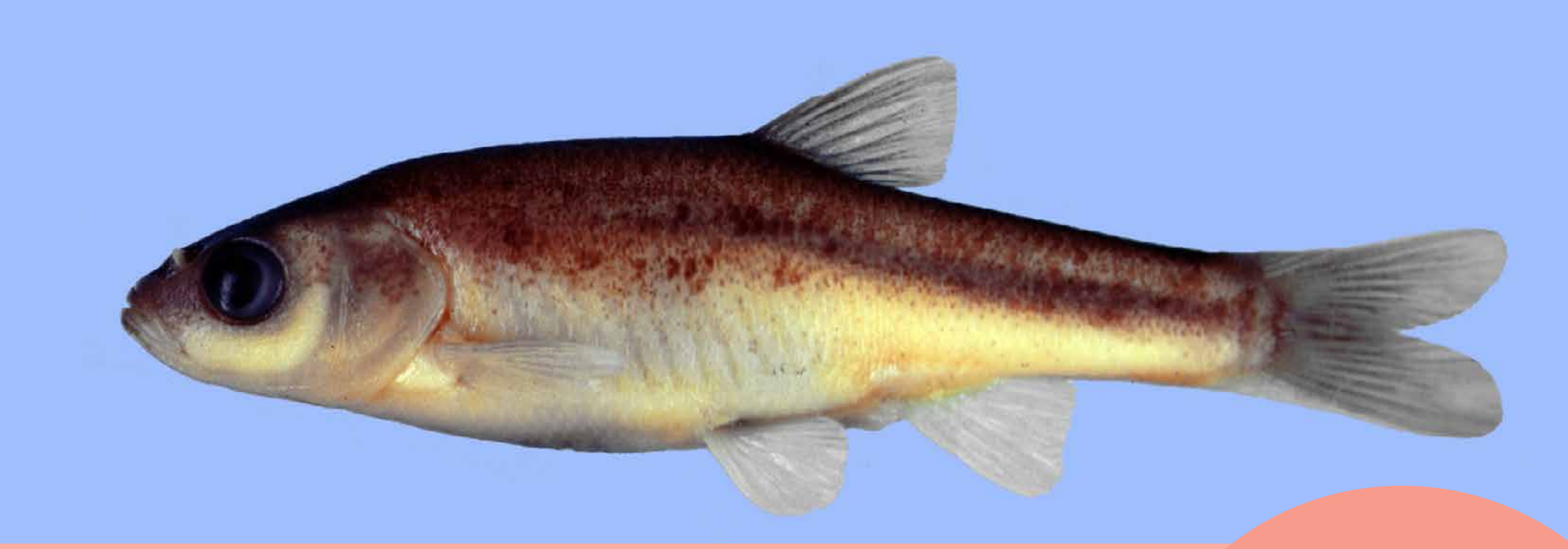
Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Spain

Endemic to the Mijares, Palancia and Turia River drainages in the autonomous communities of Aragon and the Valencian Community, eastern Spain. This species is threatened by agricultural, domestic and industrial pollution, water abstraction, construction of hydroelectric dams and weirs blocking access to spawning grounds, channelisation of rivers and introduction of non-native fish species. It inhabits fast-flowing water over rocky substrates, but can survive in backwaters and man-made reservoirs provided there are unobstructed upstream tributaries into which it can migrate to spawn.





© Maurice Kottelat

Hydropower Hazard:
LOW

EUR-HAB-DIR:
*ANNEX II **

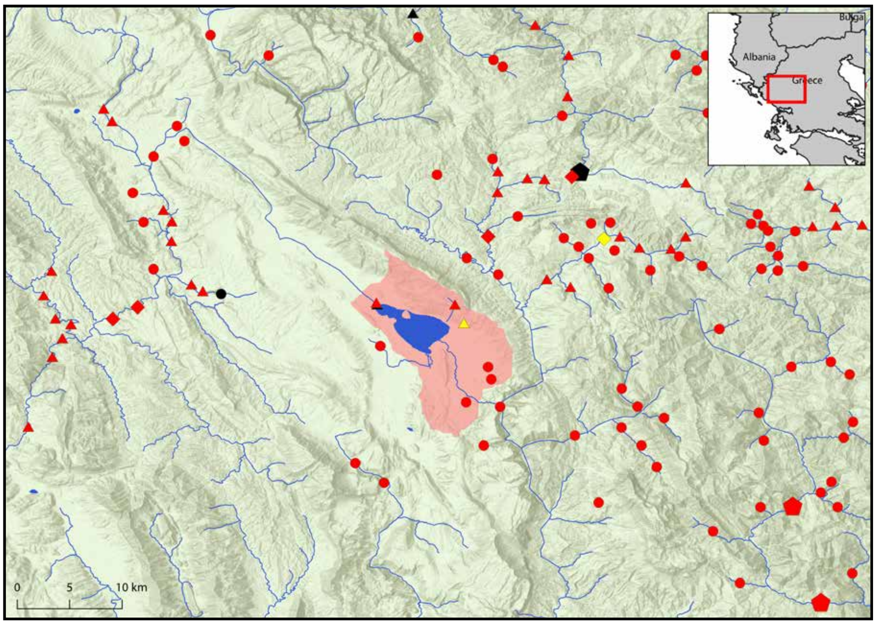
IUCN Red List:
CRITICALLY ENDANGERED
(Possibly Extinct)

Pelasgus epiroticus

Epirus minnow

Distribution: Greece

Only known with certainty from karstic Lake Pamvotida in Epirus, northern Greece. It might also occur in three freshwater springs which feed the lake and in Lake Zaravina (aka Nintzeros) further north, but these reports are unconfirmed. The Pamvotida population plummeted catastrophically during the 1990s, with only single individuals reported on a handful of occasions since, and it might already be extinct. The collapse was driven by deteriorating water quality in the lake due to a series of events which include draining of the formerly connected Lake Lapsista, development of intensive agriculture around the basin, construction of dykes which altered the hydraulic connection between the lake and its karstic aquifer, and direct discharge of untreated agricultural, domestic and industrial waste until 1990. The lake became severely eutrophic in the mid-1980s and is currently hypertrophic for several months each year because the water level is reduced due to excessive abstraction in summer. The non-native eastern mosquitofish (*Gambusia holbrooki*) and several carp species have also been introduced, all of which are known to have damaging effects on native fish populations. Several small hydropower projects are apparently planned around the lake alongside a plan to divert millions of litres of water from the Aoos River to the Pamvotida basin.



* as *Phoxinellus* spp.

© Jörg Freyhof

Pelasgus laconicus

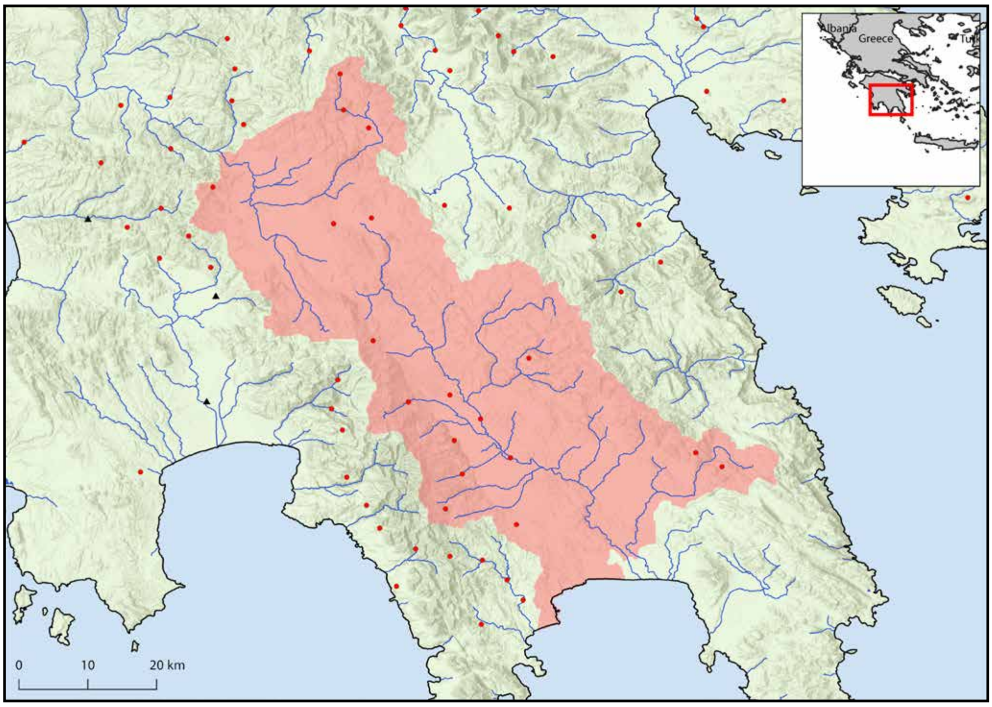
Evrotas minnow

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Greece

Restricted to the Evrotas (aka Eurotas) and Vasilopotamos River drainages, plus a portion of the upper Alfeiós River drainage on the Peloponnese Peninsula, southern Greece. It has disappeared from smaller tributaries and is now found only in main river channels which retain some perennial water, where it tends to inhabit slower-flowing stretches and pools close to the banks. During periods of drought it retreats to remnant pools which act as refuges in the otherwise dry river beds. This species is threatened by excessive water abstraction, reduced flow and pollution related to intensive agriculture in the area, while the construction of small dams and weirs prevents dispersal and is driving fragmentation in the last remaining populations.



Pelasgus minutus

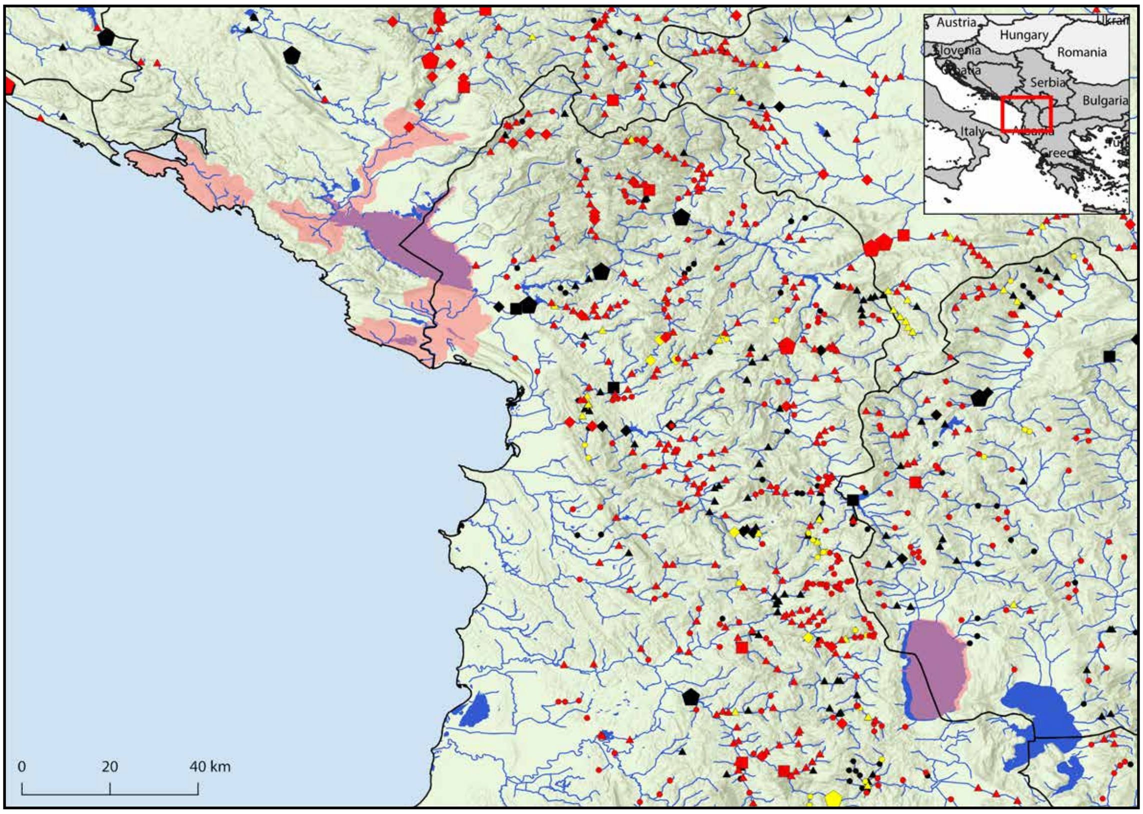
Ohrid minnow

Hydropower Hazard: *LOW*

IUCN Red List: *VULNERABLE*

Distribution: Albania, North Macedonia and Montenegro

Restricted to the basins of lakes Ohrid and Skadar plus several small streams draining to the Bay of Kotor in Montenegro. While populations in both lake basins appear to be stable, coastal populations have declined significantly due to habitat loss associated with tourism developments. These populations are already fragmented by reservoirs and additionally threatened by pollution and other forms of habitat modification.



© Maurice Kottelat

Pelasgus prespensis

Prespa minnow

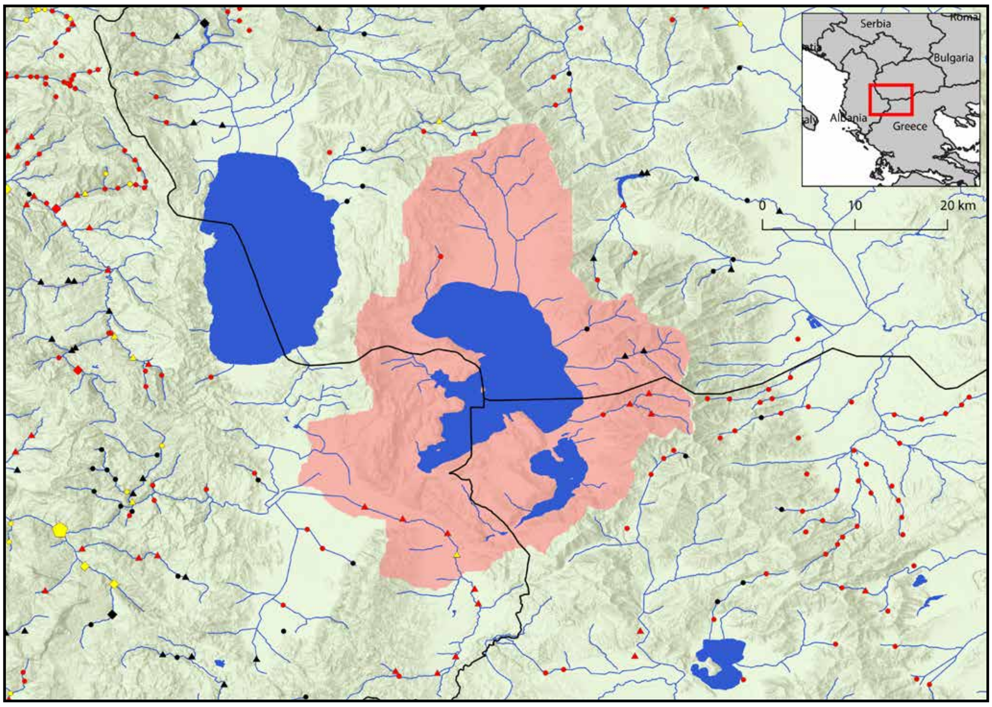
Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *ENDANGERED*

Distribution: Albania, Greece, North Macedonia

Native to the Prespa lakes at the border between North Macedonia, Albania and Greece. Lake Great Prespa is shared between all three countries, while Lake Little Prespa is divided between Greece and Albania. An additional population close to Little Prespa is known from the Devoll River, a tributary within the Seman River drainage in southern Albania. In the two lakes it occurs in quiet, highly-vegetated littoral zones, while the riverine population is associated with marshes in a disused artificial floodplain. Water abstraction, pollution and introduction of non-native fish species are the main threats facing the Prespa lakes' endemic fish fauna, despite the area being surrounded by three national parks. Hydroelectric plants installed on some tributaries have reduced discharge into the lake, with several more planned. Recent studies suggest the resident fish community is increasingly dominated by non-native species, while the water level has decreased by around eight metres since the mid-1980s and eutrophication is ongoing.



* as *Phoxinellus spp.*

© Jörg Freyhof

Pelasgus thesproticus

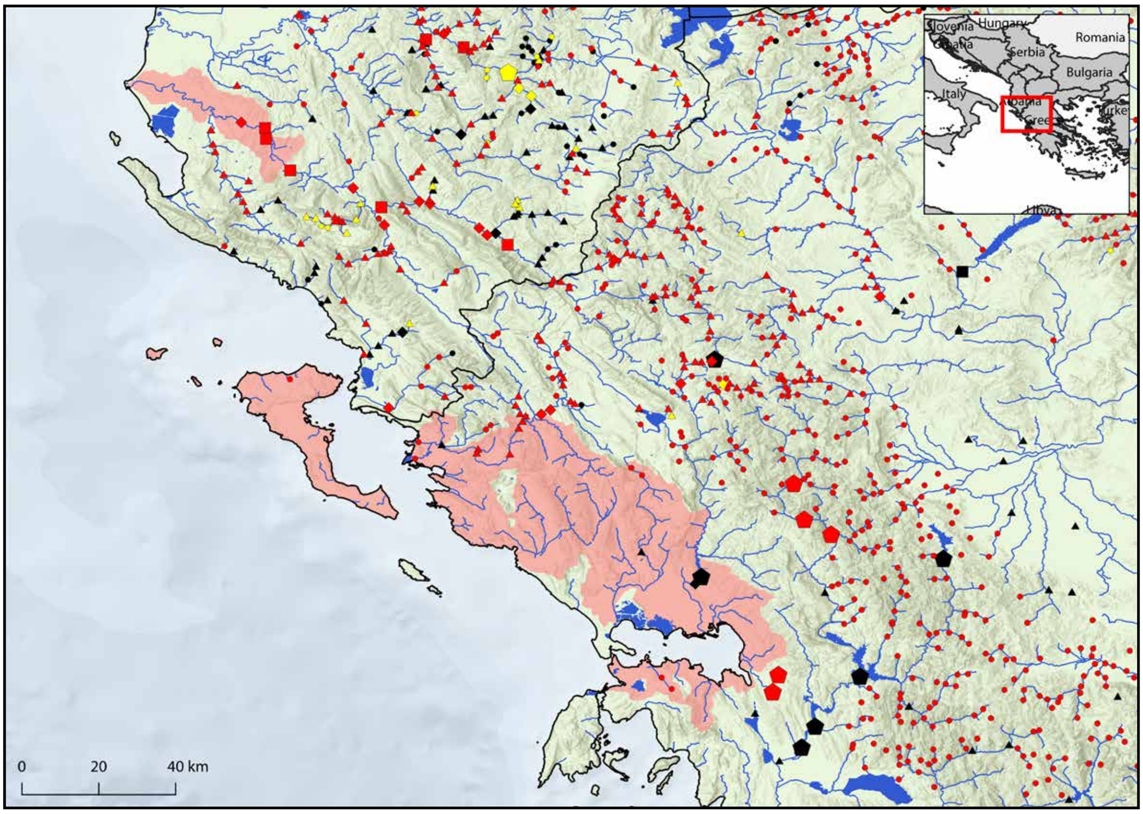
Epiros minnow

Hydropower Hazard:
LOW

IUCN Red List:
VULNERABLE

Distribution: Albania and Greece

Native to the Louros, Acheron, Arachthos and Kalamas (aka Thyamis) river drainages plus the island of Corfu in western Greece, and the Lake Butrint basin and lower Vjosa (gr. Aoos) River drainage in southern Albania. This species mostly inhabits floodplains and springs, particularly where submerged vegetation proliferates. It is threatened by excessive water abstraction, reduced flow and agricultural pollution, while the construction of dams and weirs prevents dispersal and is driving fragmentation.



Phoxinellus alepidotus

Dinaric minnow

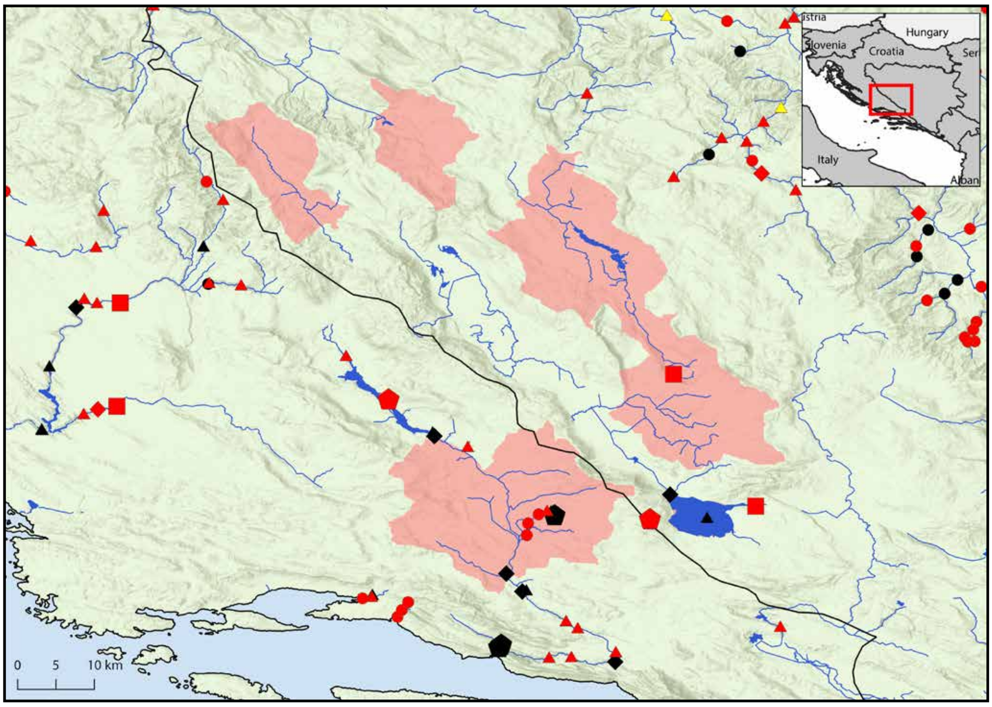
Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Bosnia-Herzegovina and Croatia

Native to the central portion of the Dinaric karst region, but the full extent of its distribution is unclear. In Bosnia-Herzegovina it has been recorded from the Livno, Duvno and Glamoč poljes, lakes Buško Blato and Blidinje, and the Korana River close to Bosansko Grahovo, where it has also been introduced to nearby Lake Šatorsko. In Croatia it is known from the Sinj polje in the Cetina River drainage, including Lake Stipančevo. This species inhabits still to slow-moving karstic springs, ponds and lakes and some populations retreat underground during summer dry periods or cold winters. It is threatened by water abstraction, pollution, habitat modification and introduction of non-native fish species, particularly European chub (*Squalius cephalus*) at certain locations in Bosnia-Herzegovina. It has vanished from a number of known locations and appears to have been extirpated from Croatia. Hydropower development in the area could interfere with groundwater circulation, hydraulic connectivity and the discharge of springs.



* as *Phoxinellus* spp.

© Jörg Freyhof

Phoxinellus dalmaticus

Dalmatian minnow

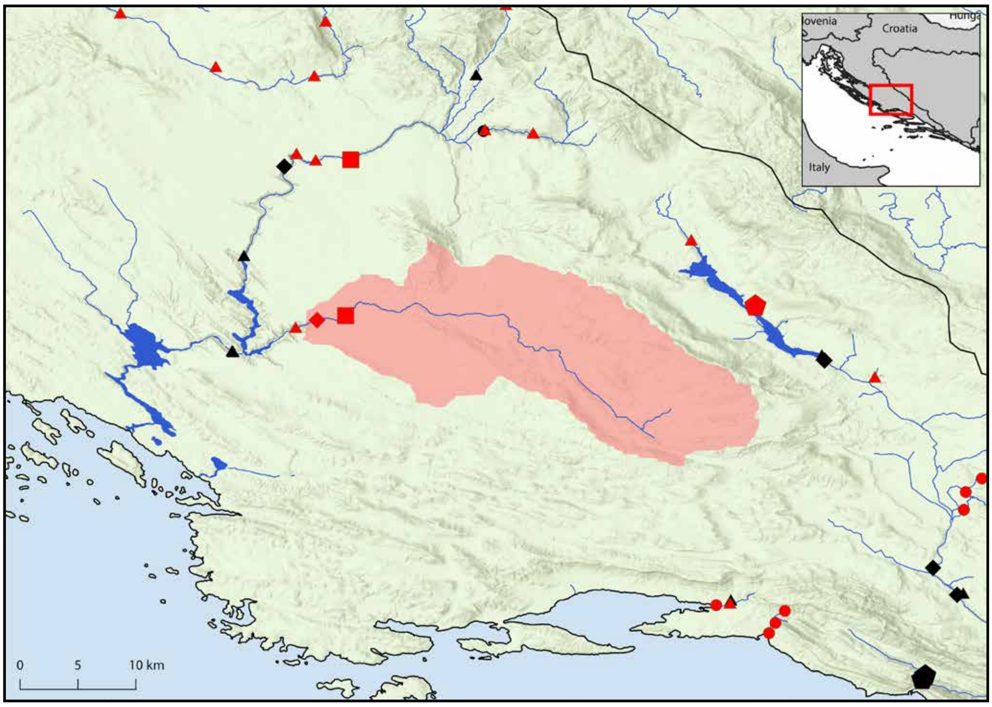
Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Croatia

Endemic to the Čikola River in the Krka River drainage. This species inhabits still to slow-moving karstic springs, ponds and lakes, and since 2010 has vanished from some former locations. The Čikola River is intermittent with a heavily-reduced flow during the summer or periods of drought, and local populations may thus spend several months per year in remnant pools or even subterranean waters. The source of the Čikola River is exploited for drinking water with four extraction wells installed, and the river is heavily modified by tunnels and pipelines that have reduced the discharge of springs feeding formerly perennial left-bank tributaries. Several non-native fish species are also present in the system. At least three hydroelectric plants are planned on the Čikola River and could drive the minnow to extinction if they are built.



* as *Phoxinellus* spp.

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Hydropower hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II* (as *Phoxinellus* spp.)

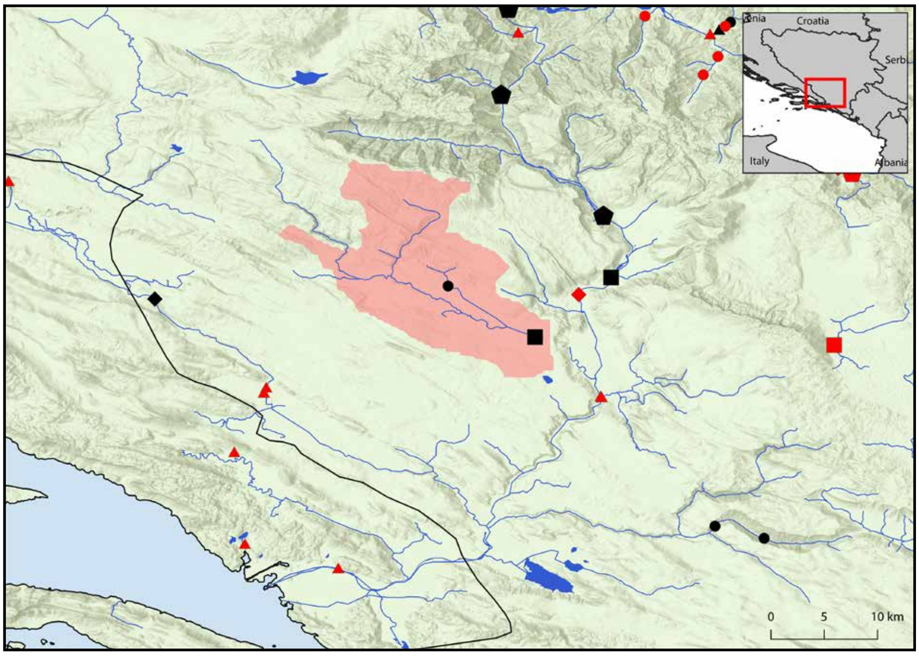
IUCN Red List: *CRITICALLY ENDANGERED*

Phoxniellus pseudalepidotus

Mostar minnow

Distribution: Bosnia-Herzegovina

Only known from the Lištica River drainage in the Mostarkso Blato polje, which floods to form a large wetland during high water levels. In 1947 a drainage tunnel was excavated through the limestone hill beneath which the Lištica River passes to reduce flooding, although it did not prove particularly efficient. A 9.5 km drainage channel was later excavated through the middle of the karst field to collect water for irrigation. During the early 2000s the last few hundred metres of the river in the karst field were modified to direct water towards a hydroelectric power plant. This has been operational since 2010 and has significantly reduced both the expanse and duration of flood events with a sizeable reduction in the extent of available spawning habitat for native fishes. A reservoir associated with the plant collects water in the lowermost part of the Lištica and is likely to favour introduced alien fish species that were already present in the river. Extraction of gravel and sand from the Lištica which continued until at least the mid-2000s and might be ongoing has caused widespread habitat degradation in the western portion of Motarsko Blato. Household sewage was discharged directly into groundwater for decades and this may still be the case since it is unclear whether a water treatment plant due to be built in 2010 was completed.



© Nina Bogutskaya

Phoxinus krkae

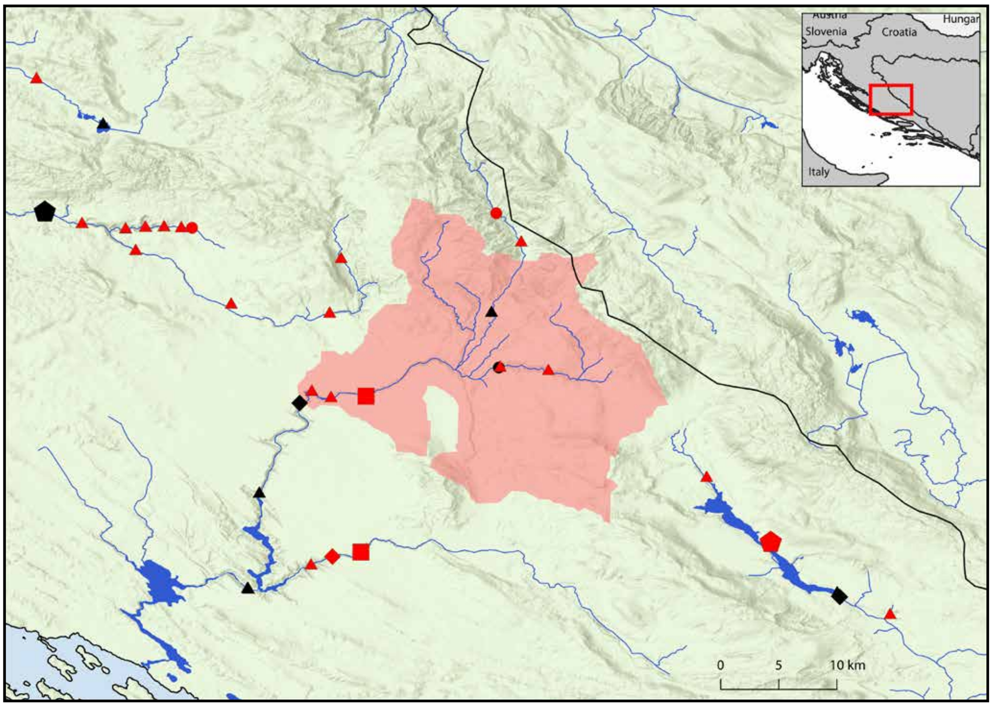
Krka minnow

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Croatia

Endemic to the upper Krka River drainage. It inhabits a series of small tributaries and the main river channel itself. Insufficiently treated domestic and industrial wastewater from the town of Knin is pumped directly into the Krka within its known range, while additional pollutants enter via agricultural runoff from surrounding fields. A number of small hydroelectric plants which do not include dams have been constructed in different parts of the drainage. Non-native fish species introduced to the Krka system include the invasive eastern mosquitofish (*Gambusia holbrooki*) and predatory northern pike (*Esox lucius*). Hydropower development in the area could interfere with groundwater circulation, hydraulic connectivity and the discharge of springs.



© Jörg Freyhof

Phoxinus strymonicus

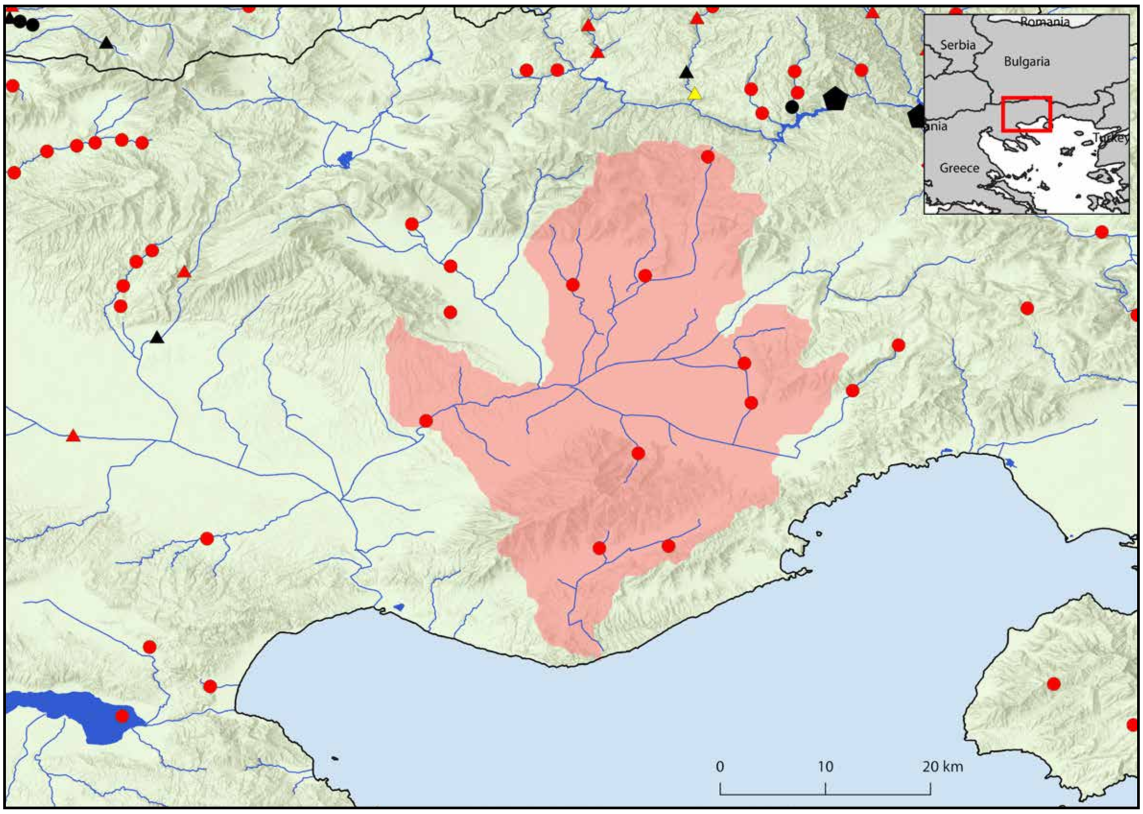
Aegean minnow

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Greece

Known only from the Aggitis (aka Angitis) River in the lower Strymon (Struma) River drainage, and the coastal Marmaras stream in Greece. It inhabits small streams with cool, flowing water but has also been collected in irrigation canals occasionally. The main threats in the area are excessive water abstraction and pollution, plus increasing frequency of droughts. It is considered highly sensitive to hydropower development since this would favour the development of lentic conditions and estabishment of non-native fish species.



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Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II*

Bern Convention: *APPENDIX III*

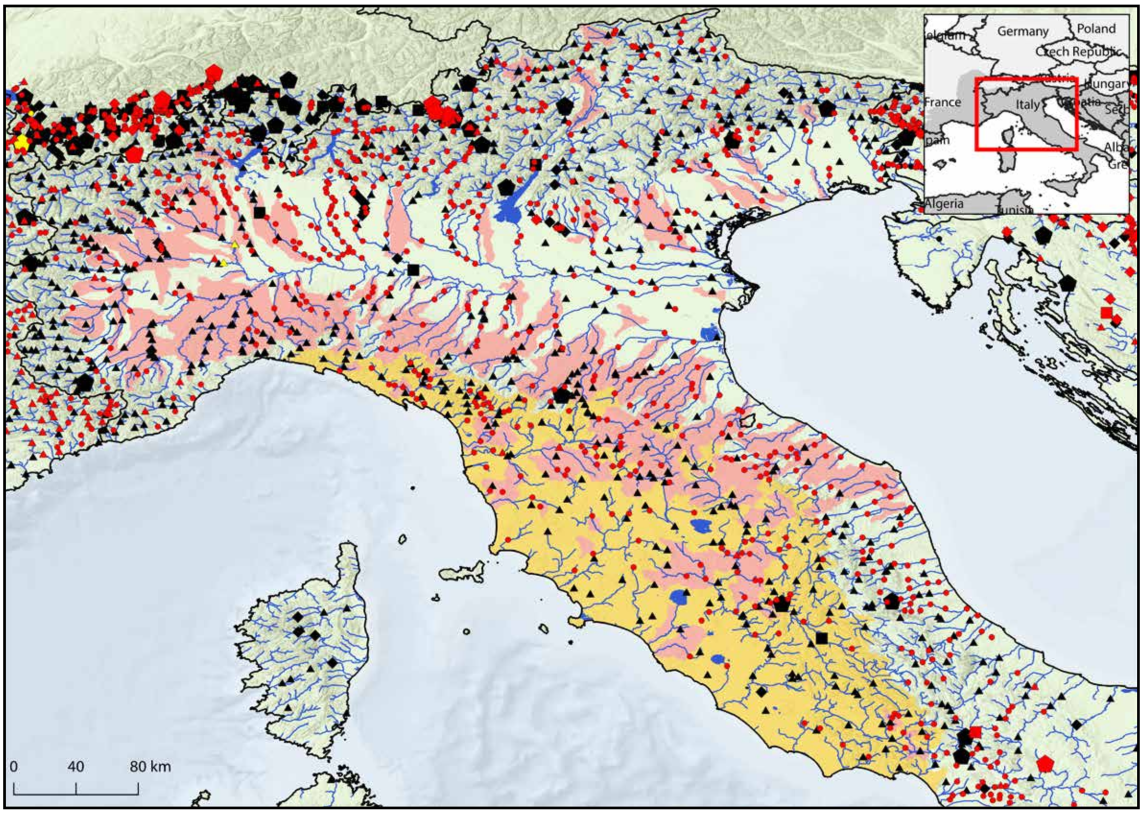
IUCN Red List: *ENDANGERED*

Protochondrostoma genei

Aegean minnow

Distribution: Italy, Slovenia

Native to the northern Adriatic basin. It is primarily threatened by the introduction and ongoing expansion of of alien species within its range. In addition, dam construction has largely blocked its migration routes and appears to have contributed significantly to the overall population decline. This species has been widely introduced in Central Italy, where it has become established, and these populations are much larger than those remaining in its native range.



© Jörg Freyhof

Pseudochondrostoma duriense

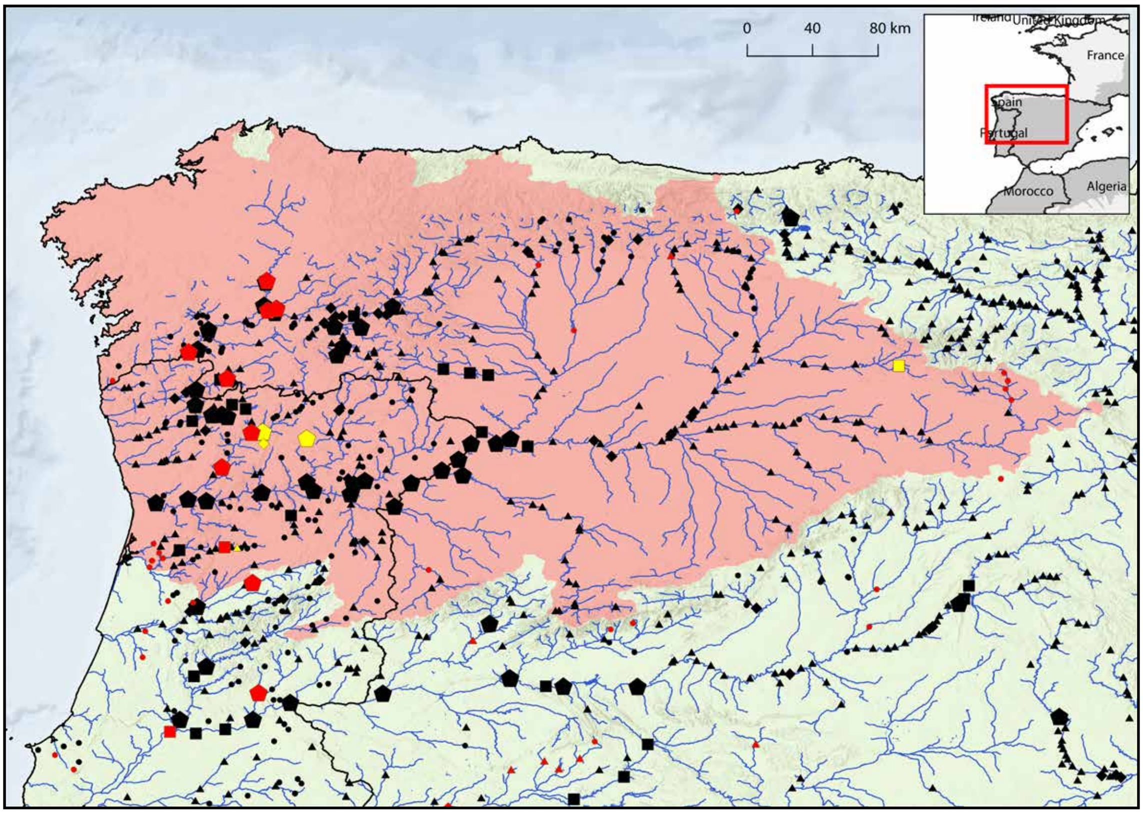
Douro nase

Distribution: Portugal and Spain

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Native to the northwestern Iberian Peninsula, where it occurs in the majority of Atlantic basin river drainages between the Douro and Navia rivers. Under natural conditions it prefers flowing middle stretches, but it is also abundant in many artificial reservoirs. This species is threatened by water abstraction, pollution, increasing frequency of droughts and introduction of invasive fish species. Although it occurs in dam lakes, these also block access to tributaries in which this species spawns, leading to fragmentation of populations, and favour establishment of alien fishes.



© Jörg Freyhof

Pseudochondrostoma willkommii

Guadiana nase

Hydropower Hazard: *HIGH*

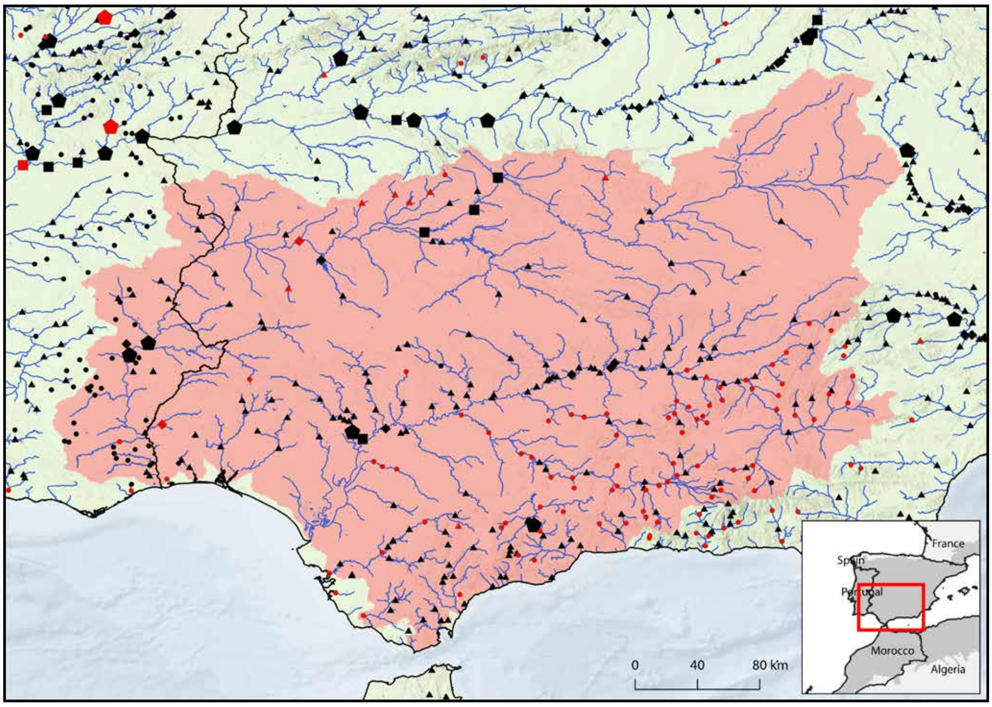
Bern Convention: *APPENDIX III **

IUCN Red List: *VULNERABLE*

Distribution: Portugal and Spain

Native to the southwestern Iberian Peninsula, where it has been recorded from the Guadiana, Odiel and Guadalquivir river drainages, plus the majority of Spanish coastal systems from the Guadalete River in Cádiz province to the Vélez River in Málaga. It is normally found in flowing middle stretches of small-to-medium-sized river channels, but has also colonised a number of artificial dams. However, dam construction has also blocked access to spawning grounds while favouring the establishment of invasive species, and many populations have now been extirpated. Additional threats include water abstraction, pollution, drought and overfishing by recreational anglers.

* as *Chondrostoma wilkommi*



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Pseudophoxinus alii

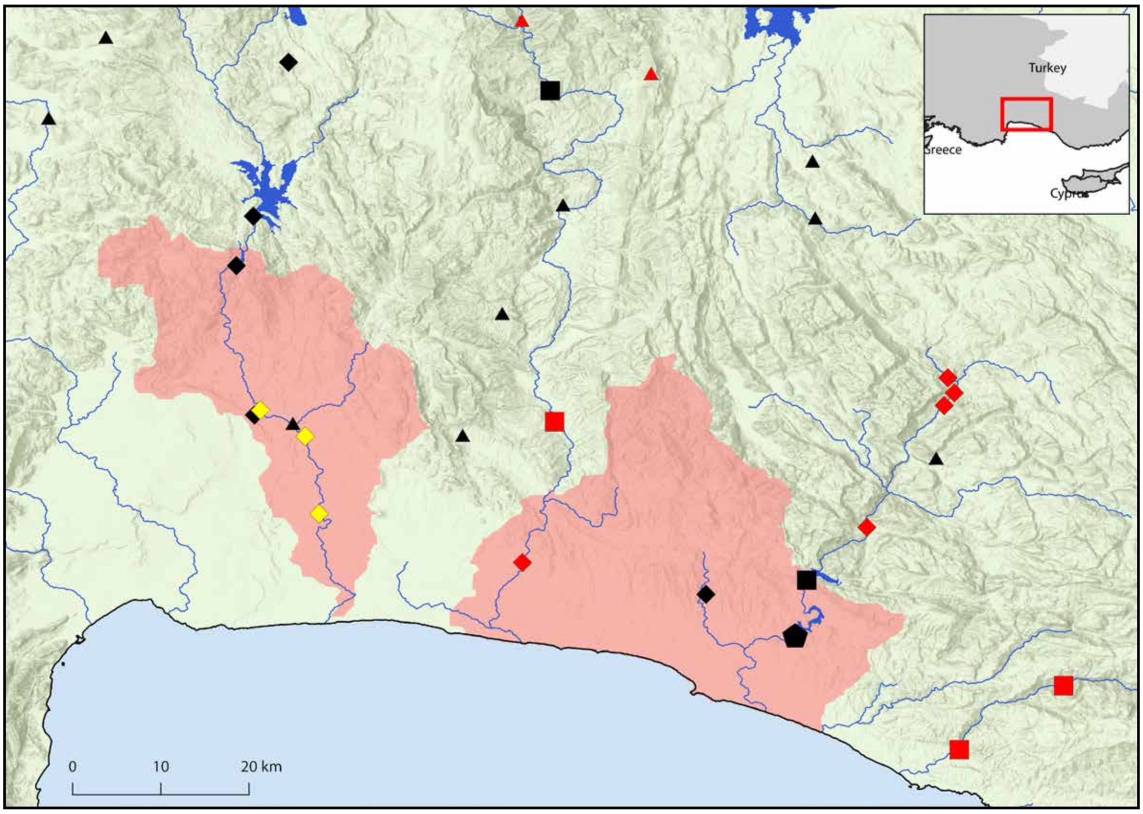
Pamphylian spring minnow

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Known only from the Ilıca and Kömürcüler coastal streams plus the lower portion of the Aksu River drainage. This species is particularly threatened by excessive water abstraction for a rapidly expanding urban population plus tourist development, with a number of golf courses in the area. Pollution and increasing frequency of droughts are also serious issues. The Aksu population now appears restricted to a relatively small area between the polluted urban coastal belt and two large hydroelectric dams which cause much of the river to run dry during summer.



© Jörg Freyhof

Pseudophoxinus anatolicus

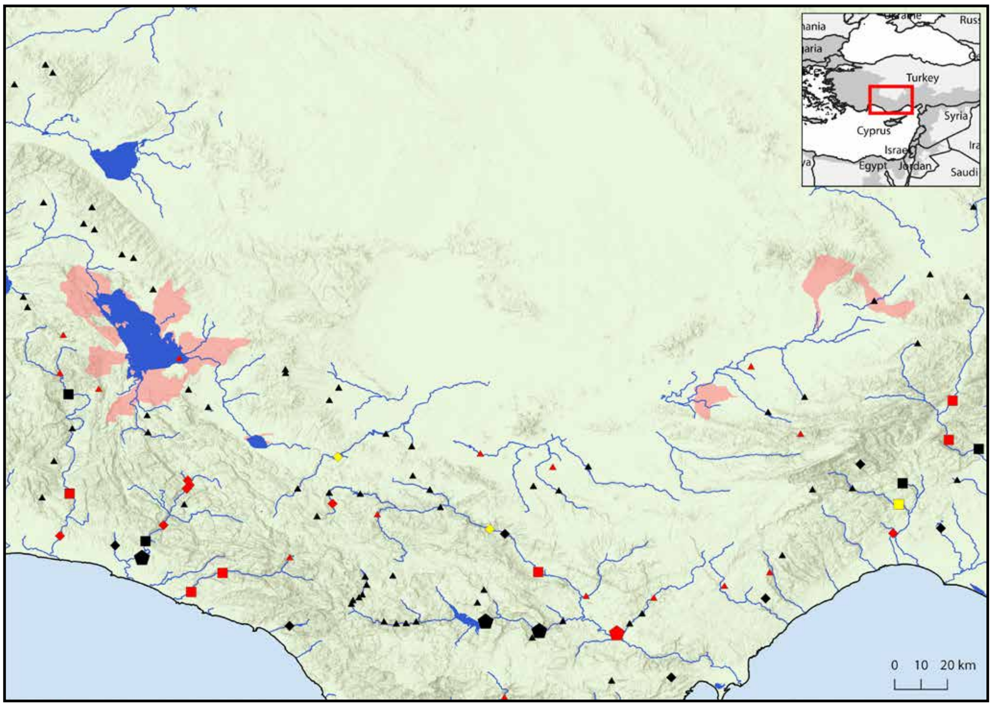
Giant spring minnow

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Recorded from streams and other water bodies around lakes Beyşehir and Suğla, plus the Ereğli plain. It has been extirpated from the Ereğli area but still occurs in at least three streams in the Beyşehir basin and one in the Suğla basin. Two of the three drainage basins in which it occurs have already been drained for agriculture, with rivers and streams channelised to prevent flooding and aid irrigation. Additional threats include construction of water retention dams, pollution and increasingly prolonged droughts. Despite its national park status, Lake Beyşehir has suffered from an extensive invasion of alien fish species, including predatory pike perch (*Sander lucioperca*), and the water level is decreasing due to excessive abstraction.



© Jörg Freyhof

Pseudophoxinus antalyae

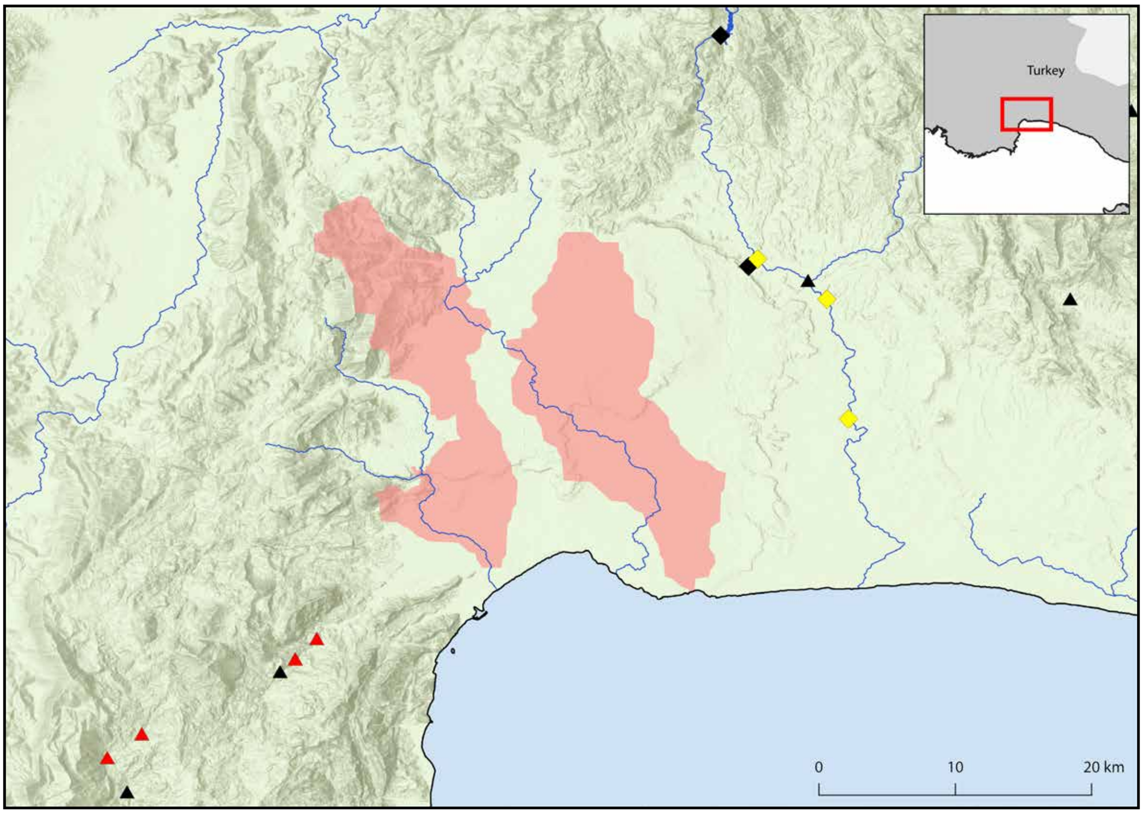
Antalya spring minnow

Hydropower Hazard: *LOW*

IUCN Red List: *VULNERABLE*

Distribution: Turkey

Restricted to the karstic Düger and Kirkgöz coastal springs close to Antalya. It occurs in springs and outflowing streams with clear water and sometimes dense vegetation. Düger spring is a popular recreation spot with local people and mostly flows through an urban area, while the outflow from Kirkgöz spring has been modified into a concrete canal and a number of invasive fish species have become established. This species is sensitive to habitat modification, and hydropower development in adjacent river drainages could affect groundwater circulation, hydraulic connectivity and the discharge of its native springs.



© Jörg Freyhof

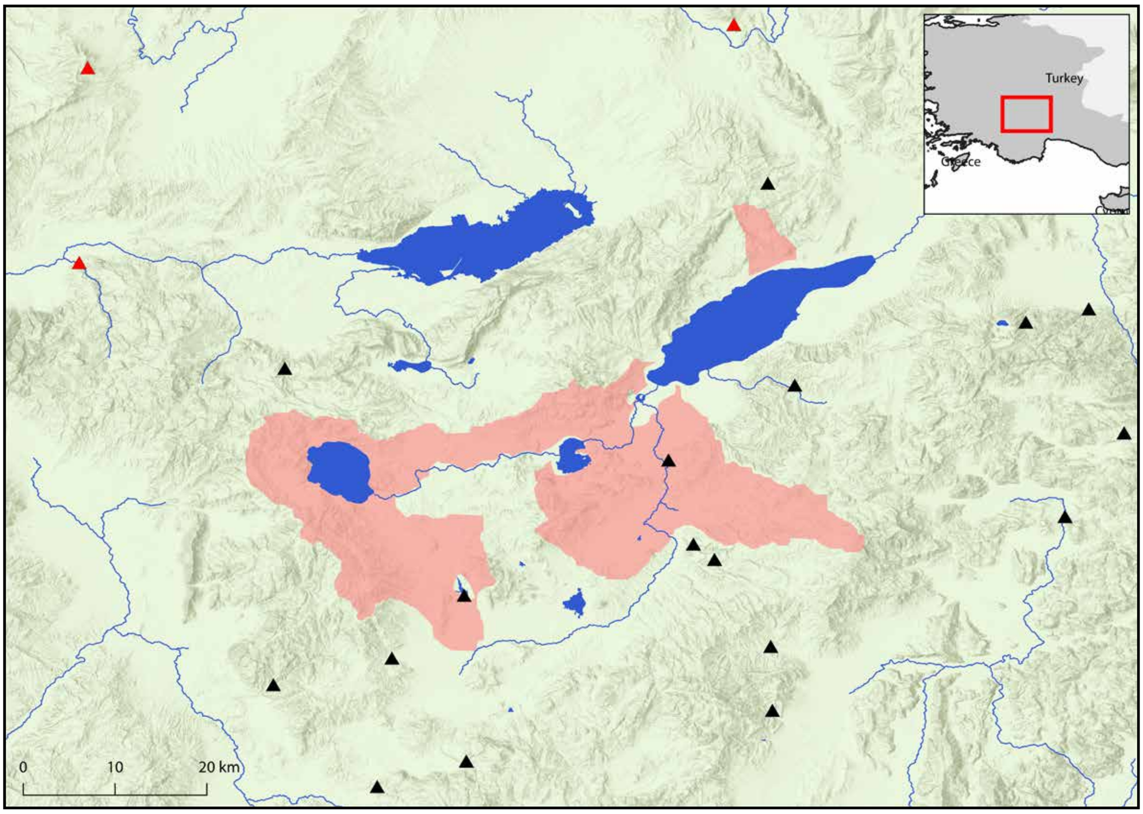
Pseudophoxinus burduricus
Antalya spring minnow

Distribution: Turkey

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Native to streams in the endorheic lakes Salda, Yarıslı and Burdur basins. In the Burdur basin it occurs in tributaries of the Karatas dam lake, but does not occur in Lake Burdur which is too saline. This species inhabits slowly-flowing or standing water with substrates of gravel, rocks or mud and shallow shorelines of man-made lakes. It is threatened by water abstraction, pollution and drought in an area where hydropower development is unlikely.



© Jörg Freyhof

Pseudophoxinus crassus

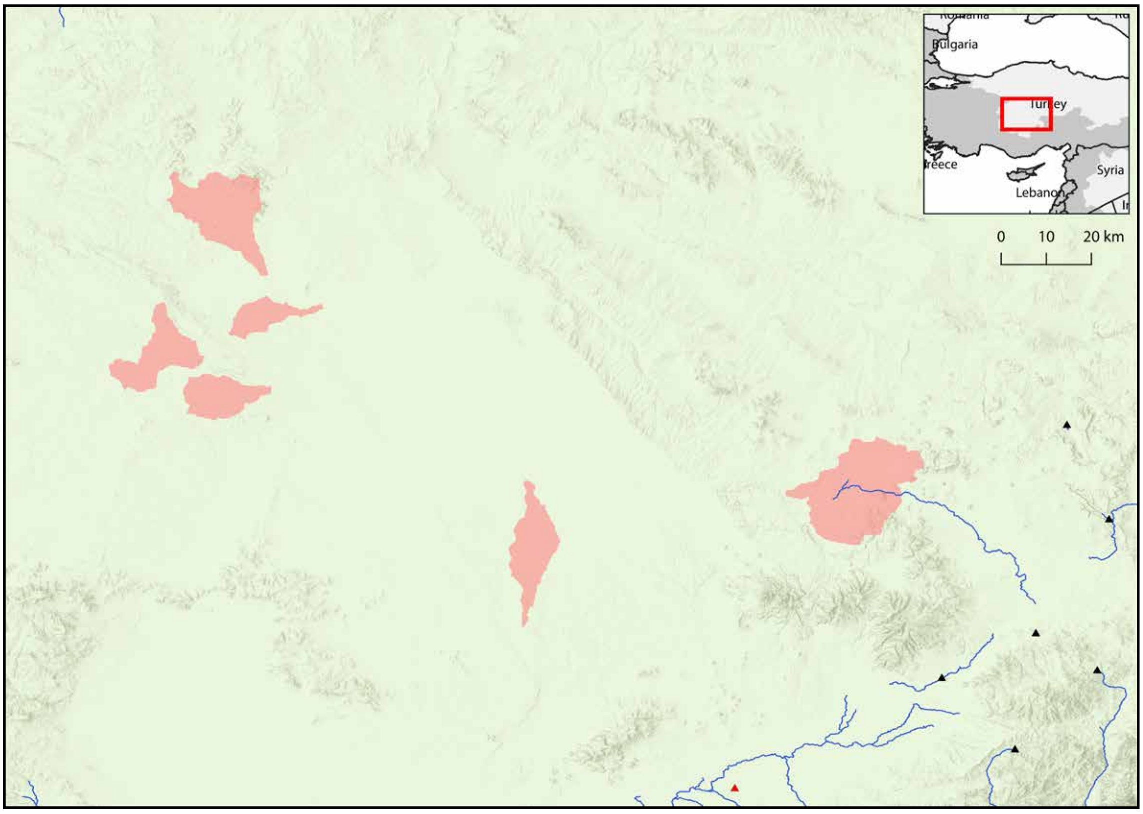
Fat spring minnow

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Native to Central Anatolia, where it is known from İnsuyu Creek and Lake Gök to the west of the Lake Tuz basin, plus springs close to the towns of Eşmekaya, Aksaray and Niğde to the south. This species is threatened by water abstraction, pollution and construction of dams and weirs. Some of the springs where it occurs are very small, and it probably inhabited Samsam Lake to the north of Gök before it was drained during the 1970s.



© Jörg Freyhof

Pseudophoxinus drusensis

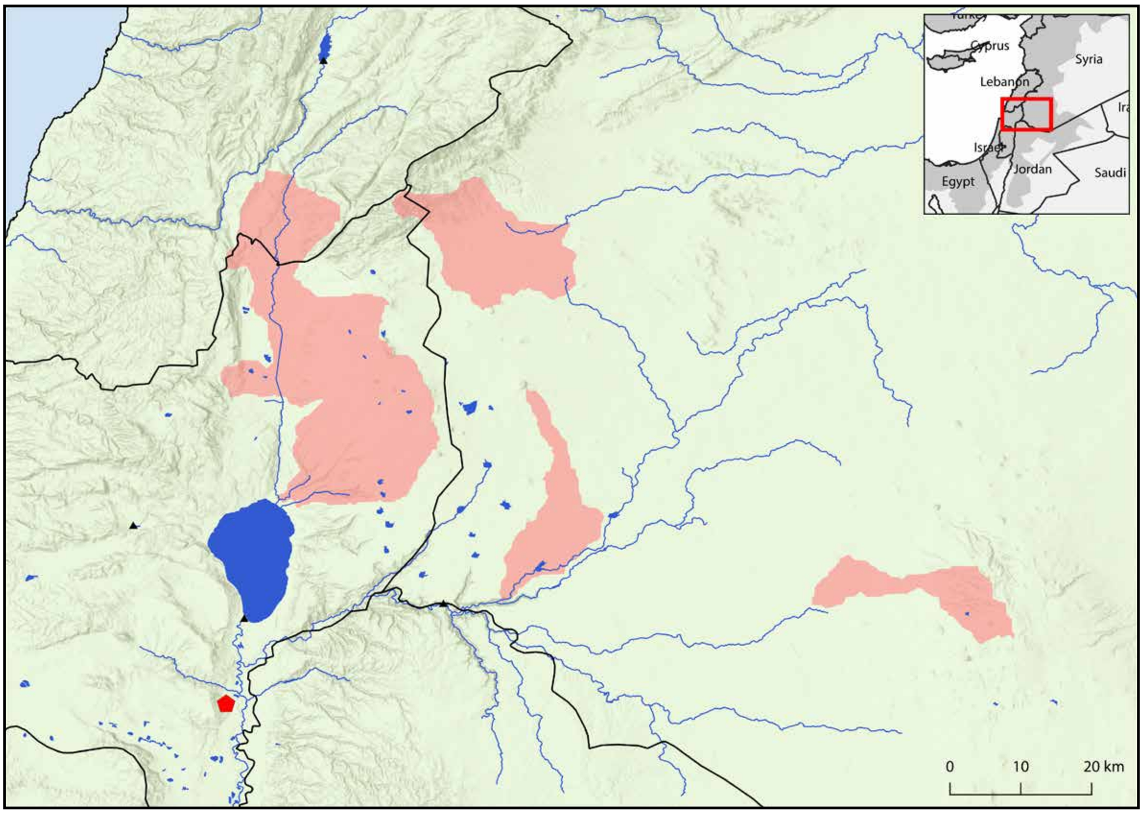
Drusian spring minnow

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Israel and Syria

Endemic to the Golan Heights and Jabal al-Druze region in the northeastern Jordan River drainage. This species is mainly threatened by water abstraction, pollution and introduction of non-native fish species. It is considered highly sensitive to hydropower projects which would fragment its populations and favour the establishment of exotic species.



© Jörg Freyhof

Pseudophoxinus egridiri

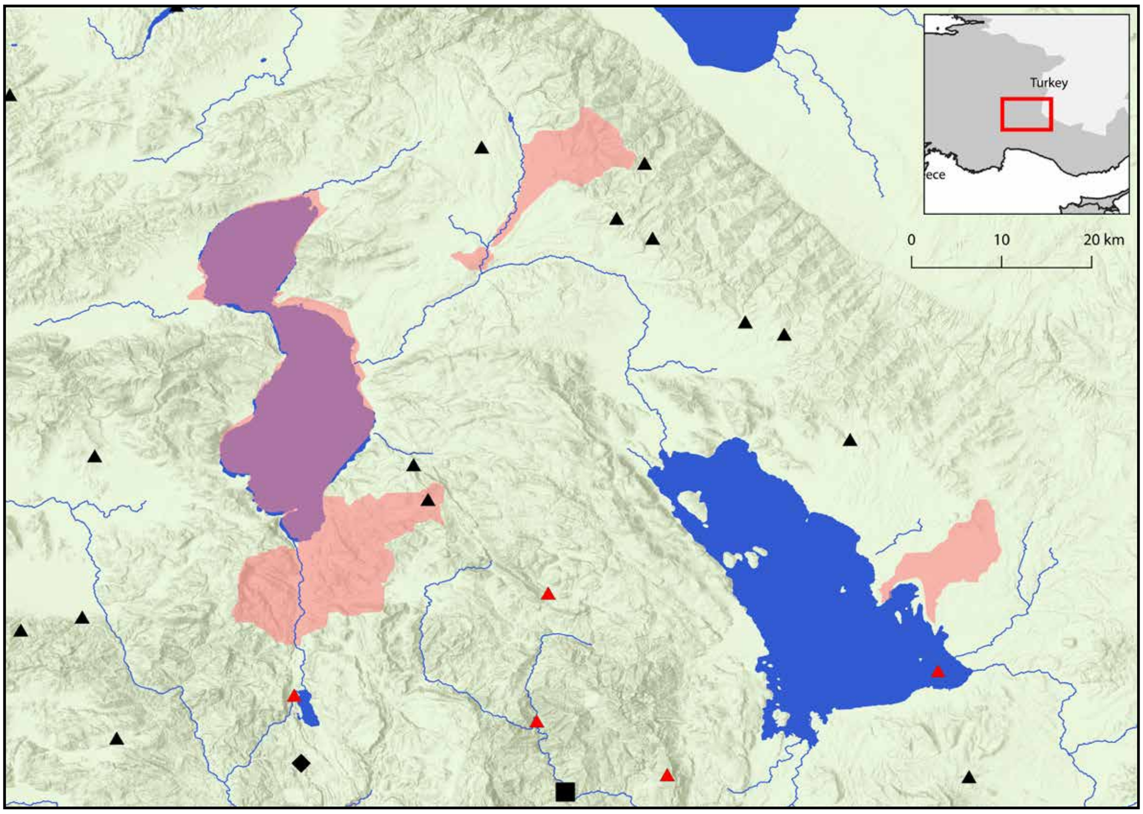
Eğirdir spring minnow

Distribution: Turkey

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Endemic to the Eğirdir and Beyşehir lake basins, where it is restricted to two inflowing streams and springs. This species is threatened by water abstraction, pollution and introduction of alien fish species. It formerly occurred throughout the Eğirdir basin including the lake but was largely eradicated after the non-native and predatory pike-perch (*Sander lucioperca*) was introduced. Hydropower development on the lake's tributaries could have serious consequences for locally endemic fish species.



© Jörg Freyhof

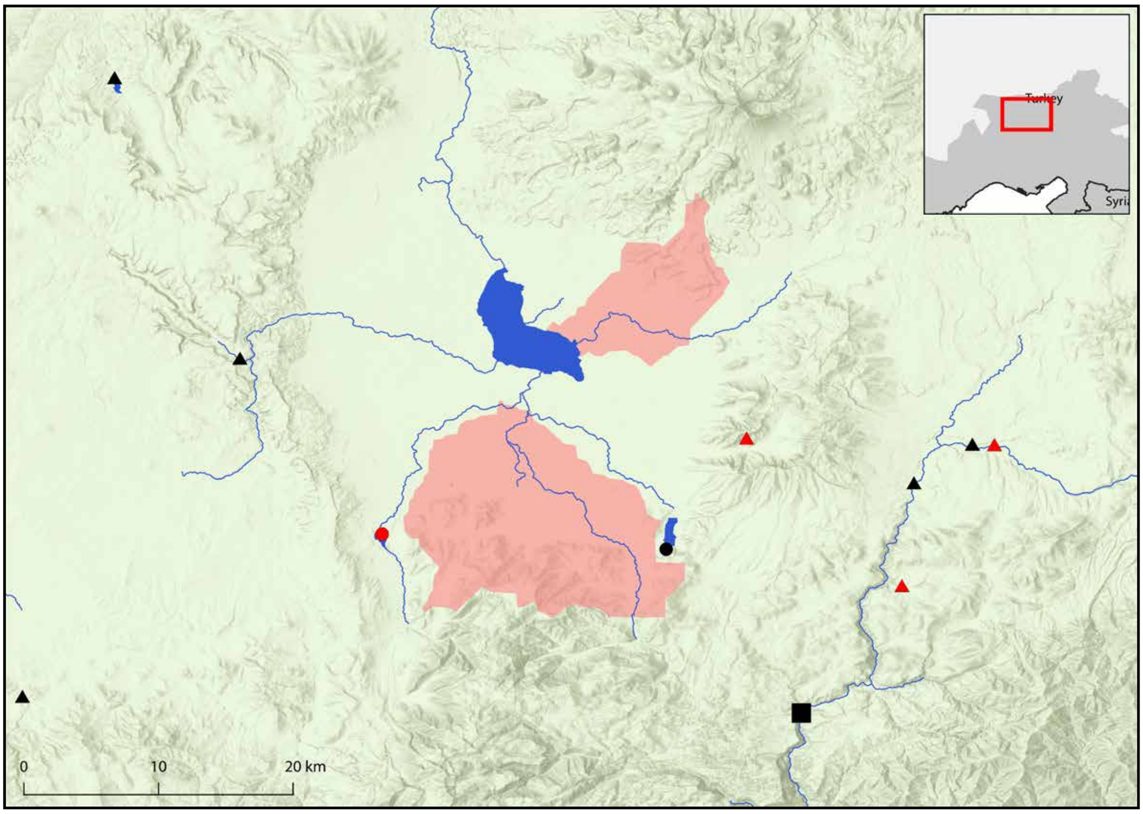
Pseudophoxinus elizavetae
Sultan Sazlığı spring minnow

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey

Endemic to the Sultan Sazlığı marshes. Located in an endorheic geological depression, this wetland consists of a series of spring-fed lagoons containing fresh to saline water and has been largely drained. It is threatened by continued water abstraction, introduction of non-native fish species and drought. Hydropower development in the immediate area is unlikely.



© Jörg Freyhof

Pseudophoxinus evliyae

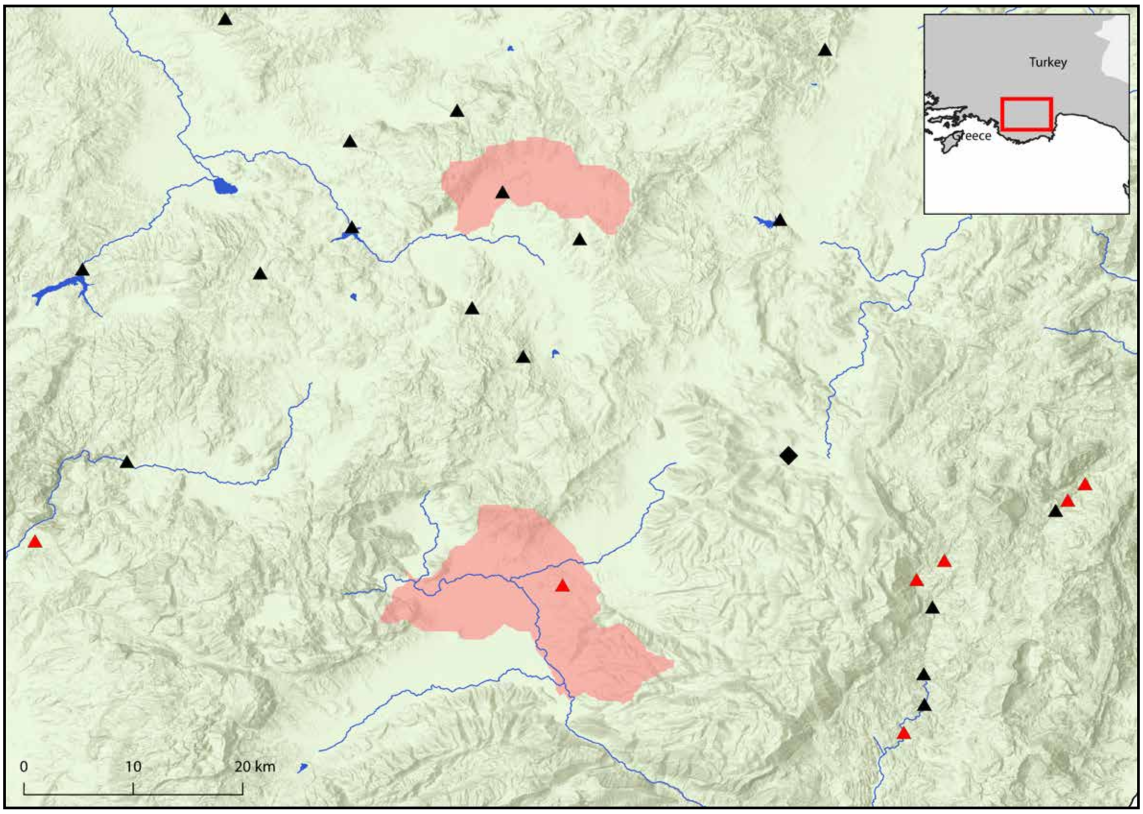
Lycian spring minnow

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Known only from the Avlan and Söğüt lake basins in the Mediterranean Region of southwestern Turkey. Both lakes were drained for agriculture several decades ago but Avlan was refilled in 2001 after local residents reported serious environmental issues, and it now floods on a seasonal basis. This species occurs in three springs in the Avlan basin and a handful of drainage canals fed by a single spring in the Söğüt basin. Water abstraction and prolonged periods of climate change-induced drought are the principle threats, but any hydropower development in the area could threaten its global survival.



© Jörg Freyhof

Pseudophoxinus fahrettini

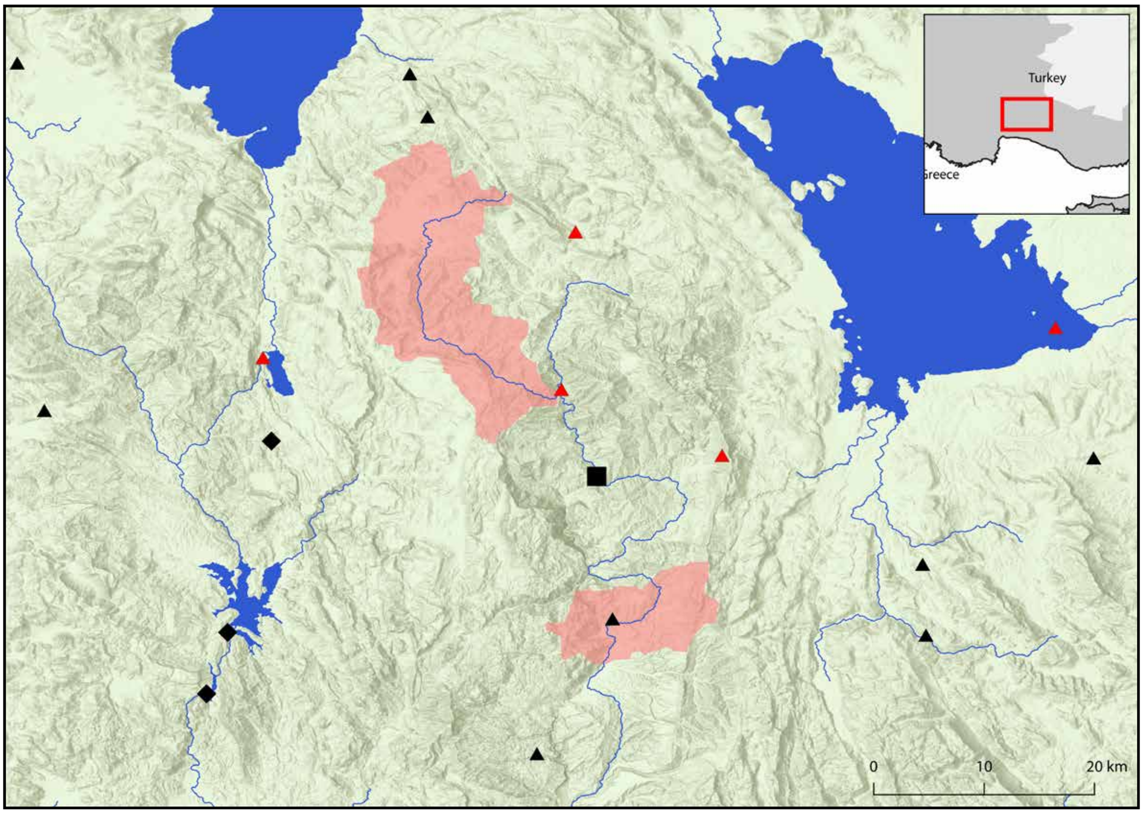
Pisidian spring minnow

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Endemic to the Köprüçay River drainage in the Mediterranean Region of southern Turkey. It has been recorded from headwater tributaries and a single spring near the town of Değirmenözü, where it inhabits clean, cool water. This species is threatened by water abstraction, pollution, introduction of non-native fish species and dam construction. One large hydroelectric dam has already been built on the upper Köprüçay.



© Jörg Freyhof

Pseudophoxinus firati

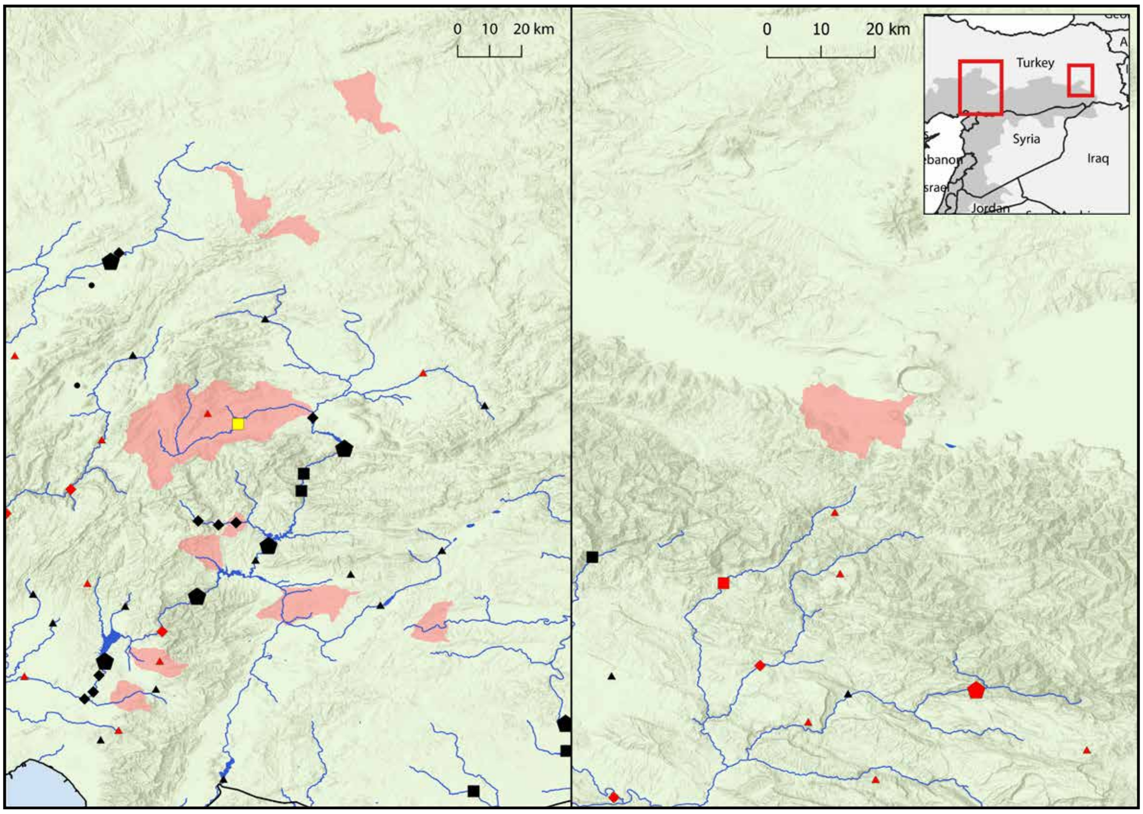
Euphrates spring minnow

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Known from a number of locations in the upper Euphrates, upper Seyhan and upper Ceyhan river drainages in southern Turkey. It inhabits small, clear, flowing streams and spring lakes. Major threats include pollution, water abstraction and predation by introduced rainbow trout (*Oncorhynchus mykiss*). It is considered highly susceptible to hydropower development given its habitat requirements and the potential for establishment of additional non-native fish species.



© Jörg Freyhof

Pseudophoxinus hasani

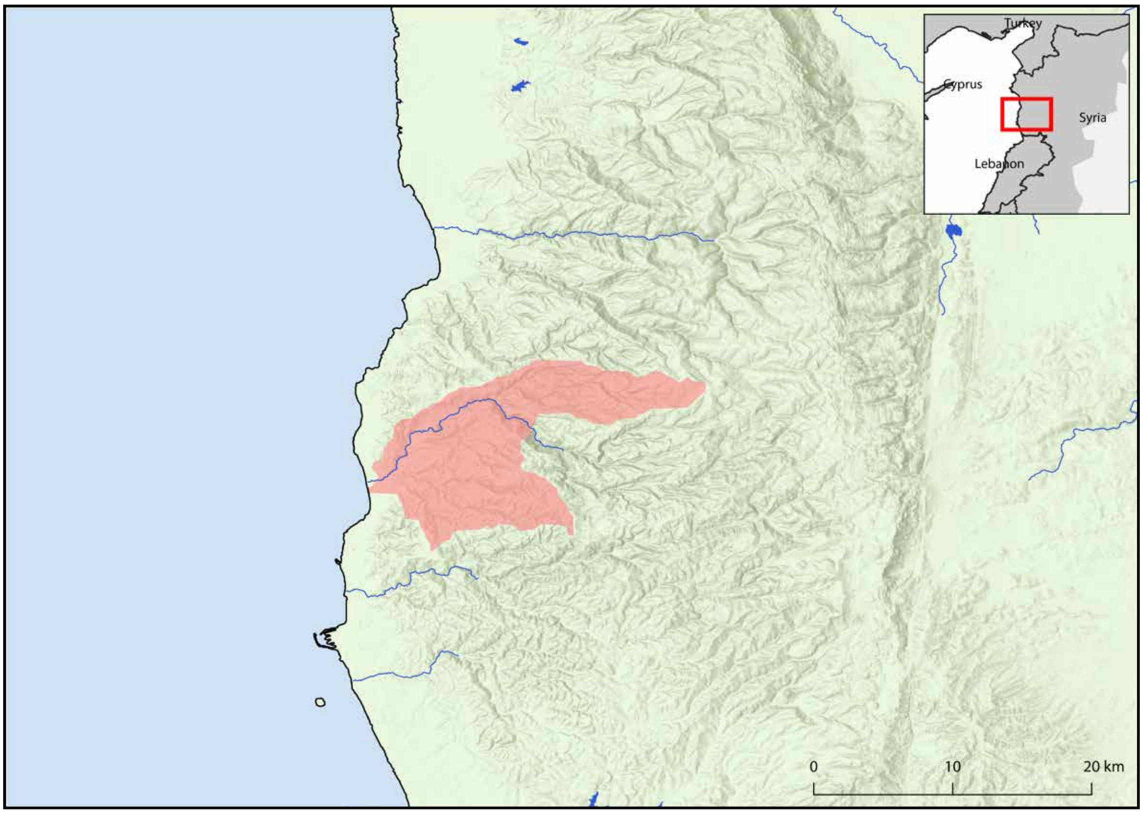
Marqīyah spring minnow

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Syria

Known only from the Nahr Marqīyah, a coastal stream located north of Tartus in western Syria. This species is threatened by water abstraction, construction of small water retention dams and direct discharge of industrial and agricultural effluents into the stream channel. It is considered vulnerable to hydropower development since it is restricted to a single small stream that has already been modified to an extent.



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Pseudophoxinus hittitorum

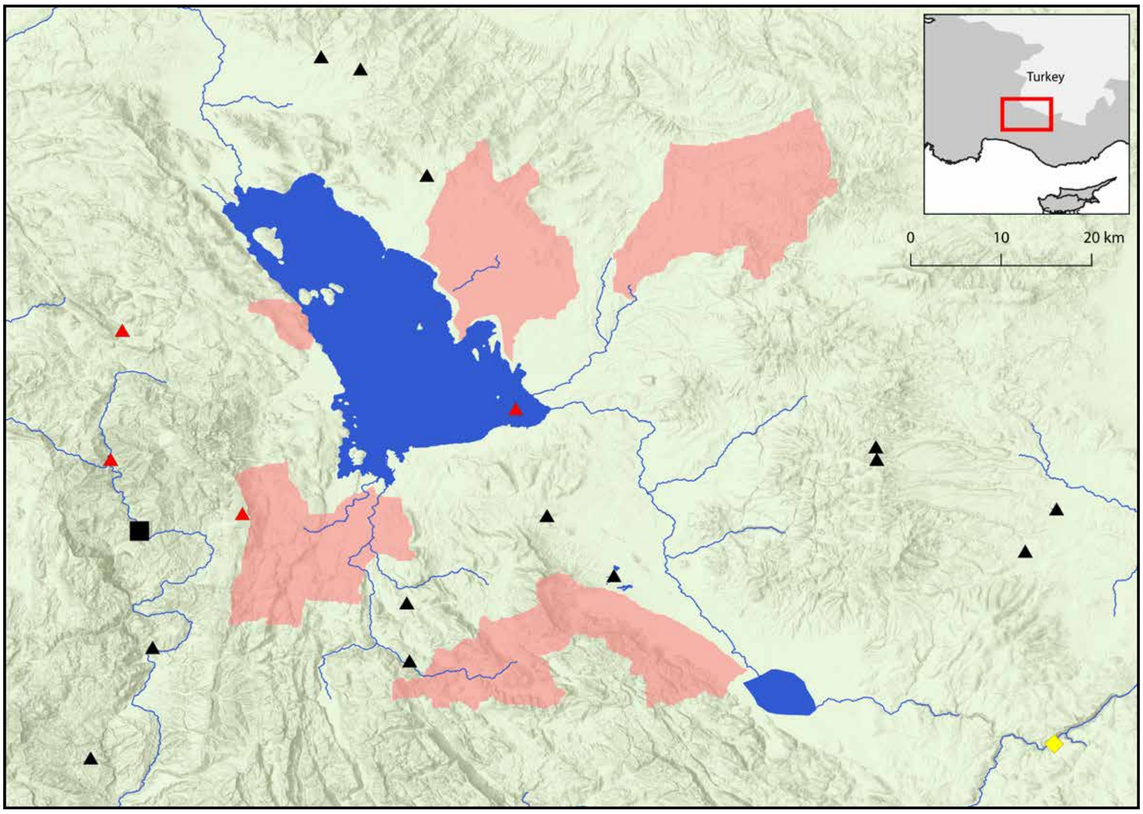
Hittitic spring minnow

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Endemic to the Lake Beyşehir basin. Beyşehir is the largest natural freshwater lake in Turkey and is surrounded by two national parks, but is also fished commercially. This has led to the introduction of several non-native fishes including the predatory pike perch (*Sander lucioperca*), which is presumed to have driven the decline and disappearance of some native species. Additional threats include pollution, increasingly severe droughts and an ongoing shrinkage of the lake due to excessive water abstraction and dam construction on tributaries.



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Pseudophoxinus maeandri

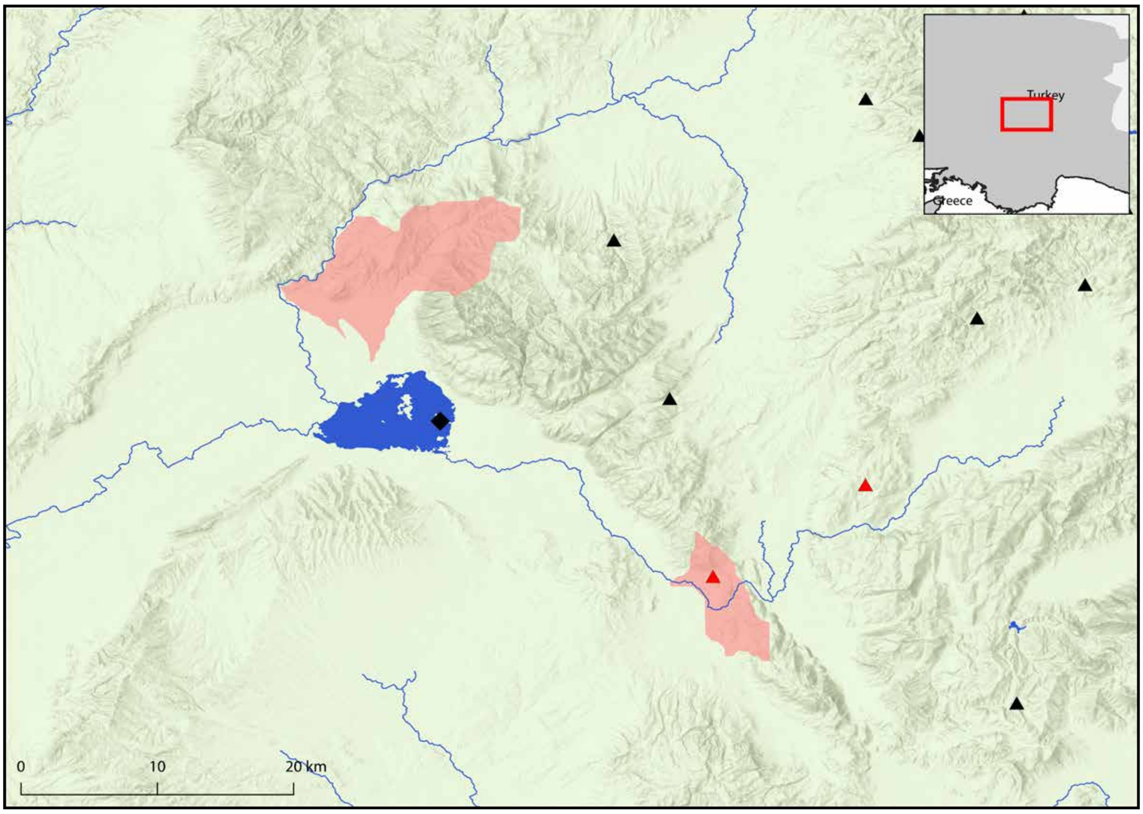
Apamean spring minnow

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Known only from springs near the towns of Isıklı and Dinar within the upper Büyük Menderes River drainage in the Aegean Region of western Turkey. Both habitats contain clear, slowly-flowing water and abundant aquatic vegetation. This species is threatened by water abstraction, construction of dams at the outflows of the springs and increasingly frequent droughts reducing spring discharge.



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Pseudophoxinus maeandricus

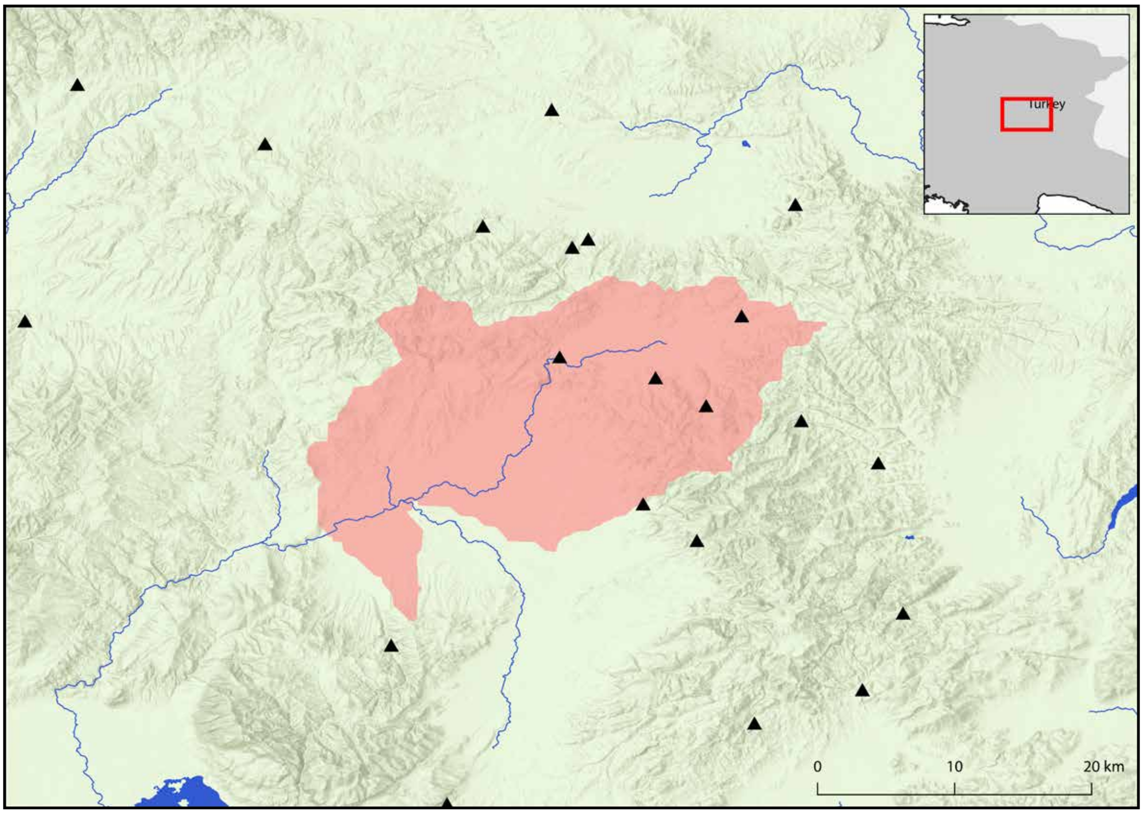
Sandıklı spring minnow

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey

Endemic to the upper Büyük Menderes River drainage in the Aegean Region of western Turkey where it is currently known only from the Karadirek and Küfü streams near the town of Sandıklı. These form an isolated basin with a subterranean connection to the remainder of the drainage. Major threats include water abstraction and pollution. A number of small dams designed to hold water for irrigation have been built on one of the streams, reducing the amount of suitable habitat.



© Jörg Freyhof

Pseudophoxinus ninae

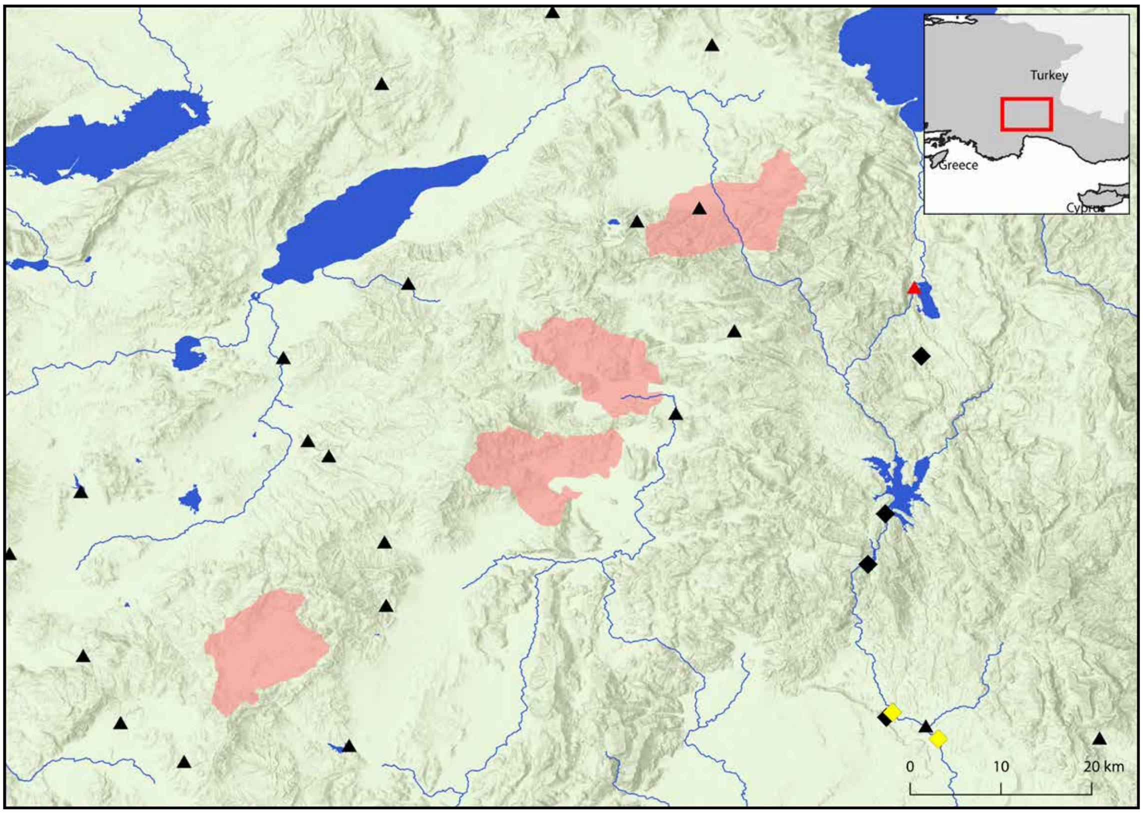
Onaç spring minnow

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey

Endemic to the Onaç River drainage and small springs in the Lake Karaevli basin. The lake was dried out for agriculture several decades ago and it is currently restricted to small springs and streams with sluggish flow. The main threats in the area are abstraction of water for agriculture and dam construction.



© Jörg Freyhof

Pseudophoxinus syriacus

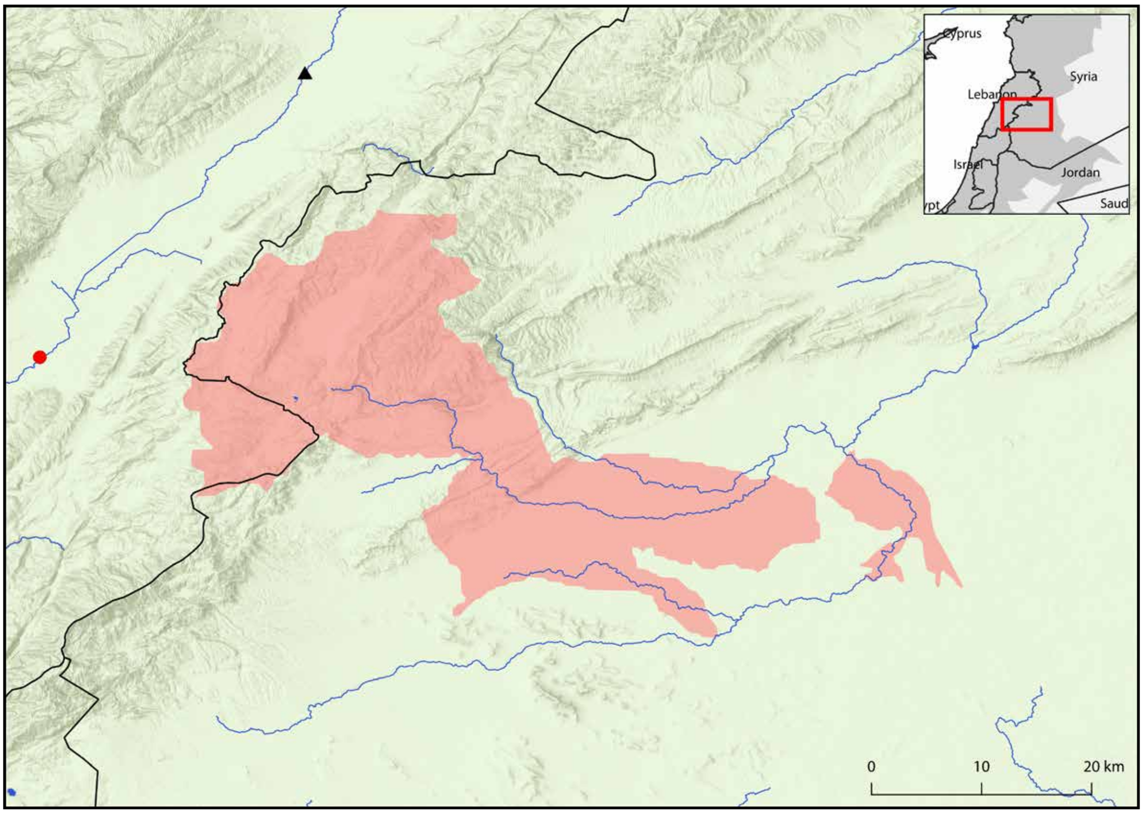
Barada spring minnow

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Syria

Known only from a spring at the source of the Barada River in Ain al-Fijah, southern Syria. It is threatened by water abstraction, channelisation and urbanisation and is now restricted to a tiny stretch of the heavily-modified spring, which was drained almost entirely in 2008. Hydropower development is unlikely to affect the species and it may already be extinct.



© Jörg Freyhof

Pseudophoxinus zekayi

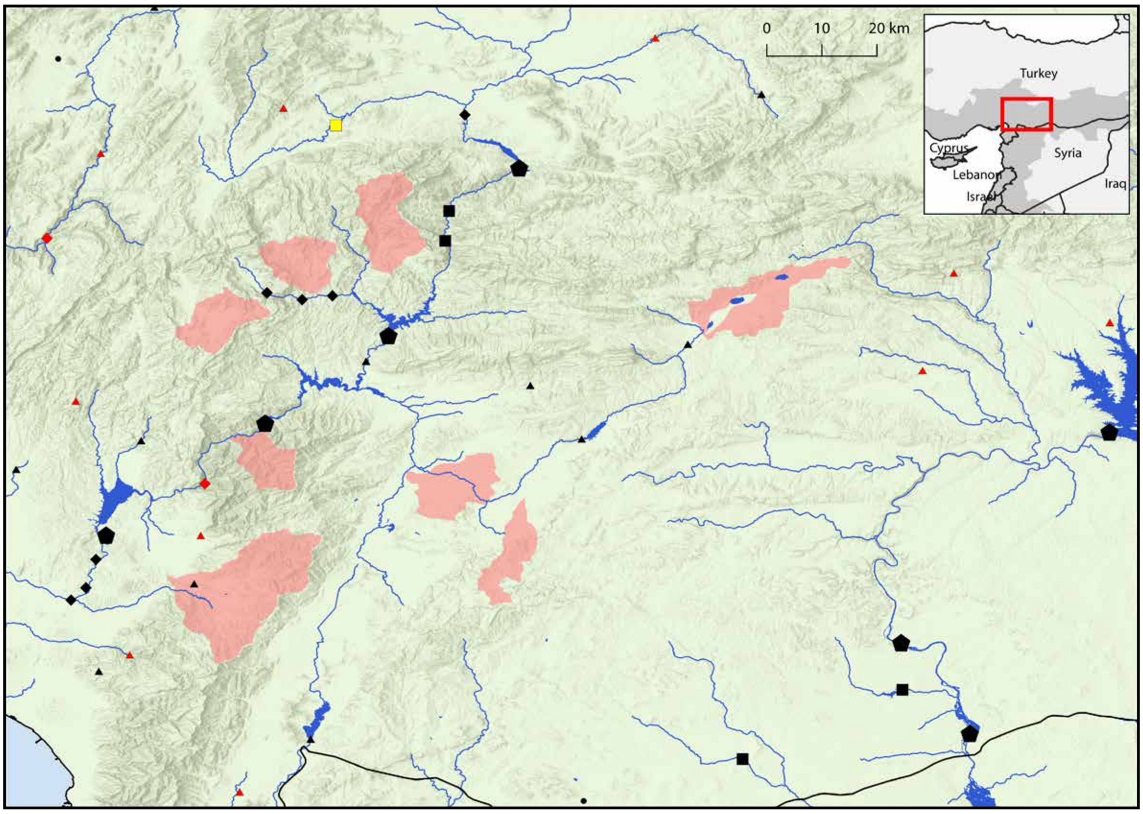
Ceyhan spring minnow

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Turkey

Restricted to a series of sites within the middle Ceyhan River drainage in the Mediterranean Region of southern Turkey. It has mostly been collected from springs and streams both above and below the Sır and Menzelet reservoirs. This species is threatened by abstraction of surface and groundwater, pollution, and introduction of non-native fish species. Its populations have been fragmented and the extent of suitable habitat reduced by construction of the hydroelectric dams which created the artificial lakes.



© Jörg Freyhof

Rutilus aula

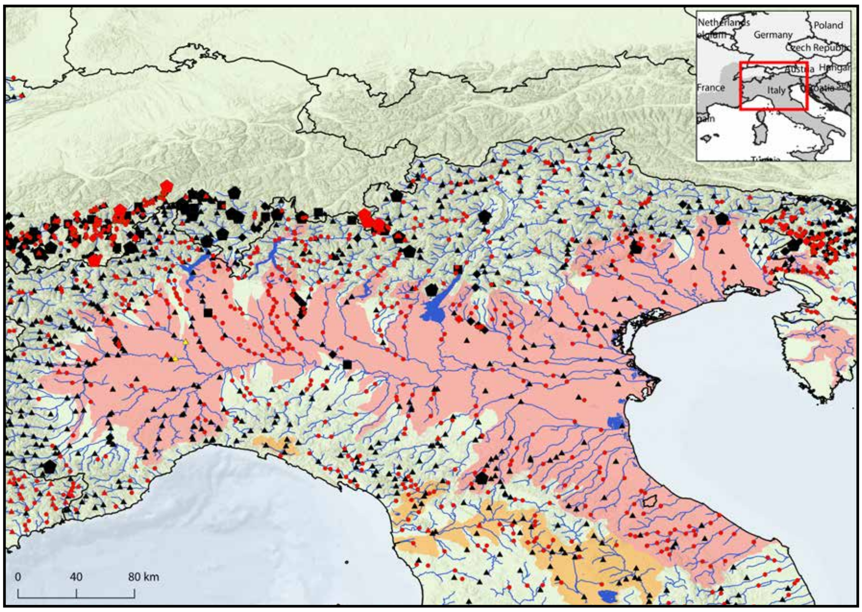
North Italian roach

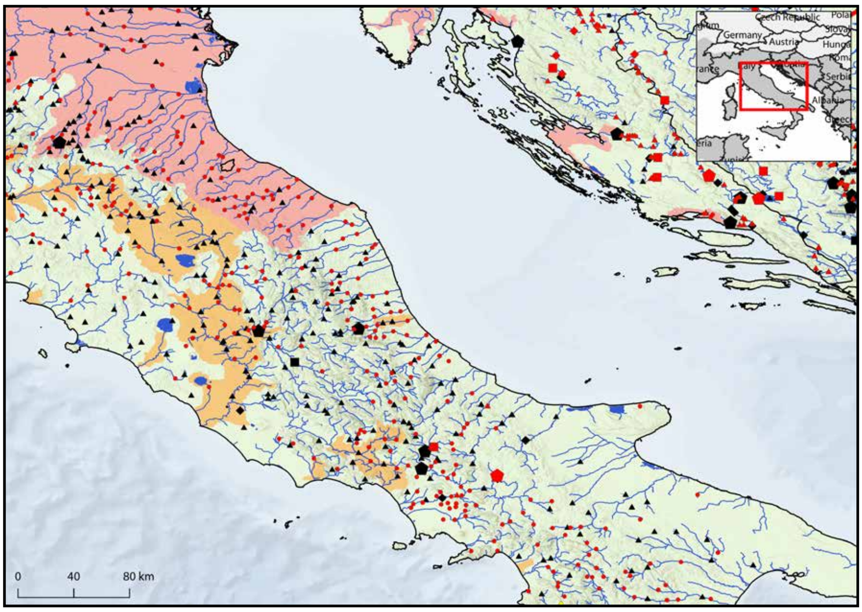
Hydropower Hazard:
MODERATE

EUR-HAB-DIR:
*ANNEX II **

Bern Convention:
*APPENDIX III **

IUCN Red List:
ENDANGERED





Distribution:
Croatia, Italy,
Slovenia, Switzerland

Native to rivers draining into the northern Adriatic basin. This species was once one of the most common and widespread freshwater fishes of the northern Adriatic basin. However, since the middle of the 20th century it has drastically declined due to the introduction of non-native common roach (*Rutilus rutilus*), which was introduced for angling. Both species hybridise and compete with each-other, except in Croatia, where the common roach has not been widely introduced.

* as *Rutilus rubilio*

© Eugenio Miotti

Hydropower Hazard:
MODERATE

EUR-HAB-DIR:
*ANNEX II + V **

Bern Convention:
*APPENDIX III **

IUCN Red List:
VULNERABLE

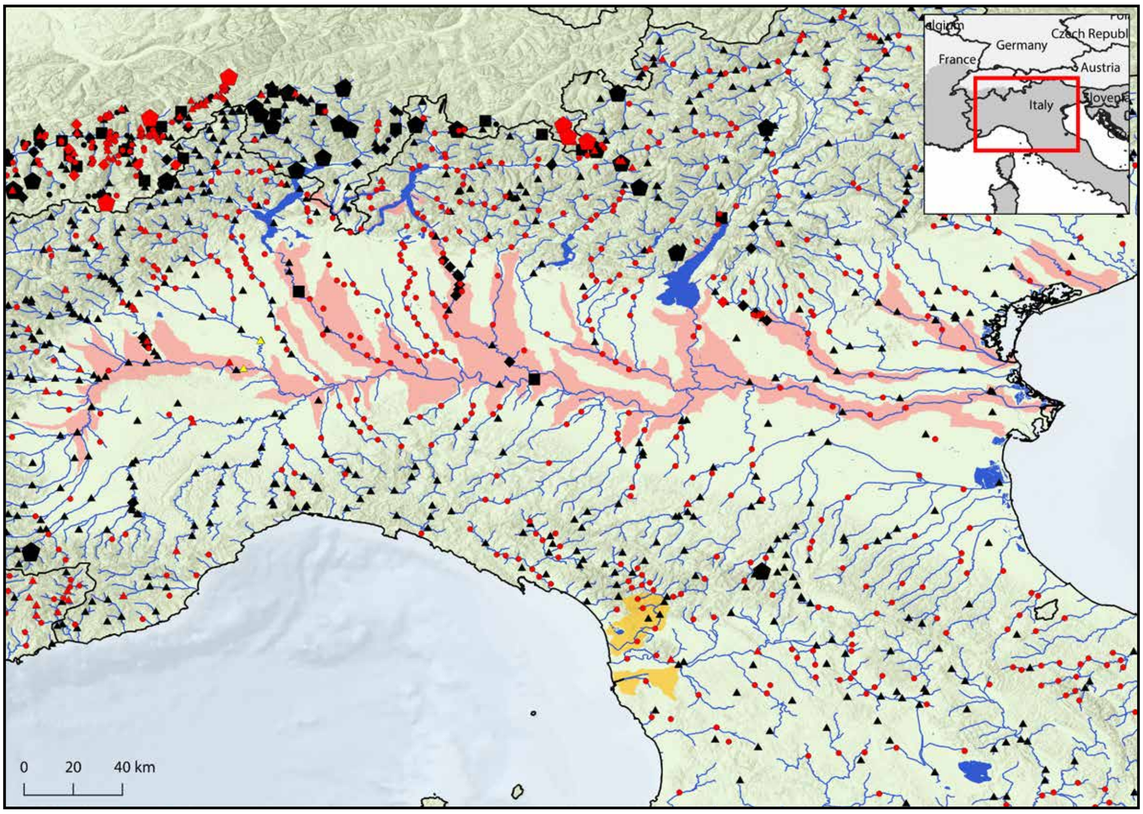
Rutilus pigus

Pigo

Distribution: Italy, Switzerland

Endemic to the northern Adriatic Sea basin, where it occurs from the Livenza to the Po river drainages. It has been introduced to the Arno and other rivers in central Italy. This species inhabits larger river channels and fluvial lakes. It appears to have declined significantly throughout the majority of its range, with only a handful of genetically-pure populations thought to remain. The primary threats are modification of river channels and hybridisation with introduced non-native species, especially the common roach (*Rutilus rutilus*).

* as *Rutilus virgo*



© Jörg Freyhof

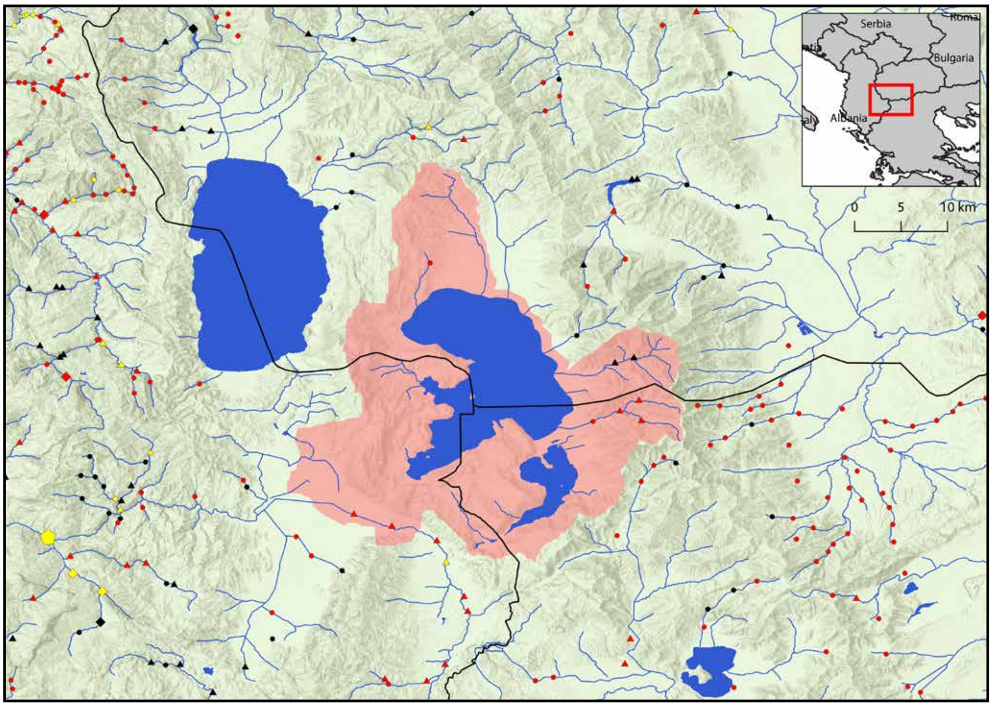
Hydropower Hazard:
MODERATE
EUR-HAB-DIR:
*ANNEX II **
Bern Convention:
*APPENDIX III **
IUCN Red List:
VULNERABLE

Rutilus prespensis

Prespa roach

Distribution: Albania, Montenegro and North Macedonia

Restricted to the Prespa lakes at the border between North Macedonia, Albania and Greece. Lake Great Prespa is shared between all three countries, while Lake Little Prespa is divided between Greece and Albania. It tends to inhabit areas near shorelines and breeds in the shallows. Water abstraction, pollution and introduction of non-native fish species are the main threats facing the Prespa lakes' endemic fish fauna, despite the area being surrounded by three national parks. Recent studies suggest the resident fish community is increasingly dominated by invasive aliens, while the water level has decreased by around eight metres since the mid-1980s and eutrophication is ongoing. This species is completely lacustrine but small hydropower plants on the Prespa lakes' inflowing streams reduce discharge and play a role in threatening the ecosystem.



* as *Rutilus rubilio*

© Jörg Freyhof

Rutilus ylikiensis

Yliki roach

Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II **

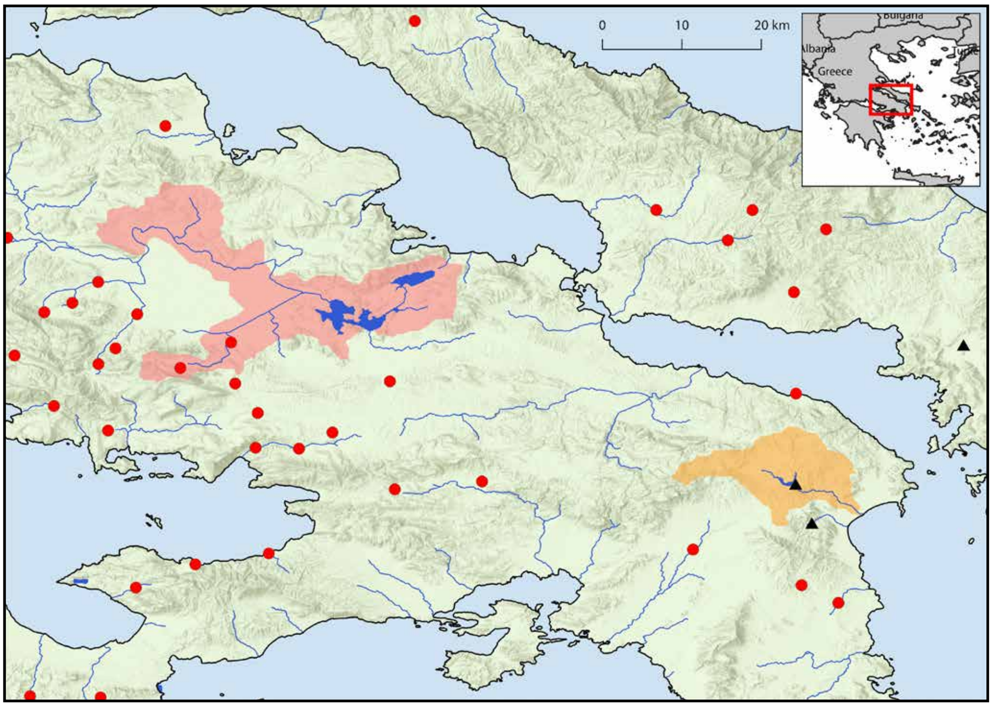
Bern Convention: *APPENDIX III **

IUCN Red List: *VULNERABLE*

Distribution: Greece

Native to the Boeotian Kifisos (aka Cephissus) River drainage in central Greece, including lakes Yliki and Paralimni. A population in Lake Marathon, an artificial reservoir further south, is assumed to have been introduced. It inhabits the lakes themselves plus lower stretches of inflowing tributaries and some man-made drainage canals. The threats to this species have not been well-studied, but abstraction of groundwater, modification of waterways and non-native fish species are all widespread in the area, while unregulated fishing might also be an issue. This species is lacustrine by nature and unlikely to be adversely affected by hydropower development.

* as *Rutilus rubilio*



© Jörg Freyhof

Scardinius elmaliensis

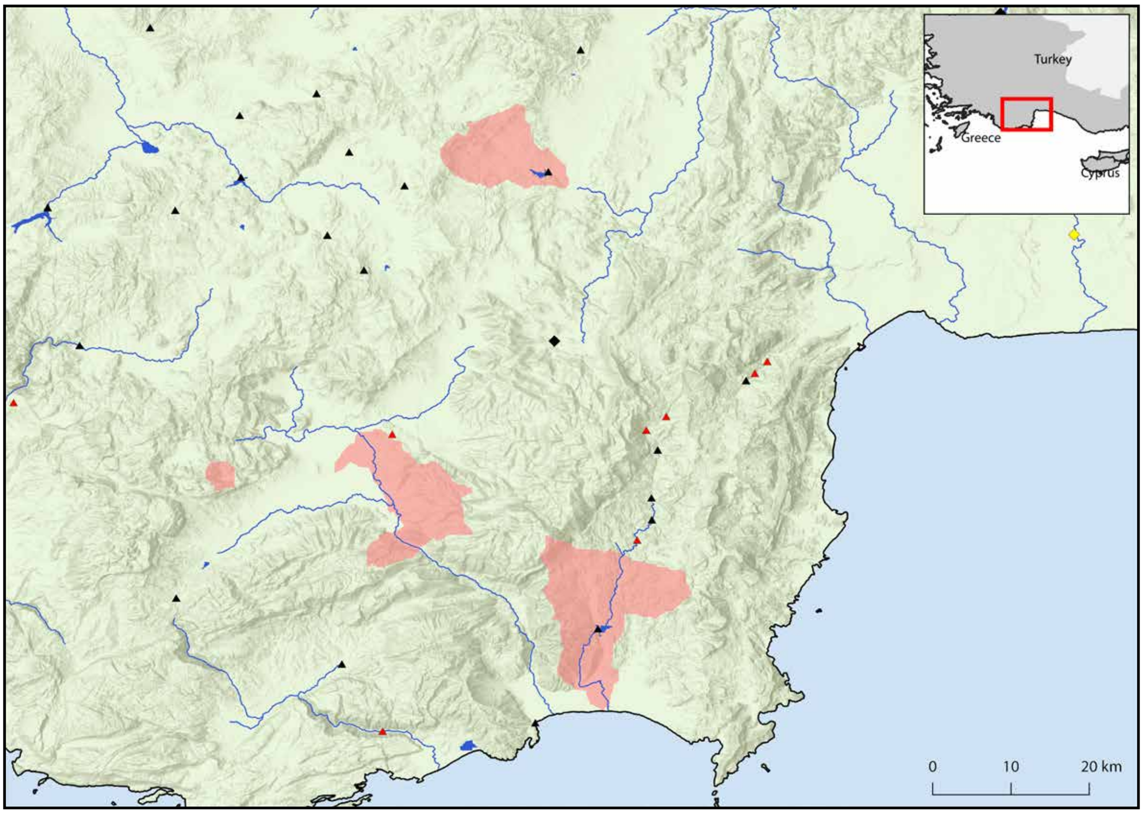
Elmalı rudd

Hydropower Hazard: *MODERATE*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Described from the Lake Avlan basin in the Mediterranean Region of southern Turkey, where it occurs in modified channels associated with the Karagöl temporal floodplain and the manmade Çayboğazı reservoir near the town of Elmalı. It has also been recorded from Lake Gölhisar plus the artificial Korkuteli, Osmankalfalar, Yapraklı and Çavdır dam lakes in the surrounding area. It is threatened by excessive water abstraction, pollution and increasing frequency of droughts. It can only be considered moderately vulnerable to hydropower development since it readily colonises dam lakes despite them reducing the extent of its natural habitat.



© Jörg Freyhof

Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II*

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

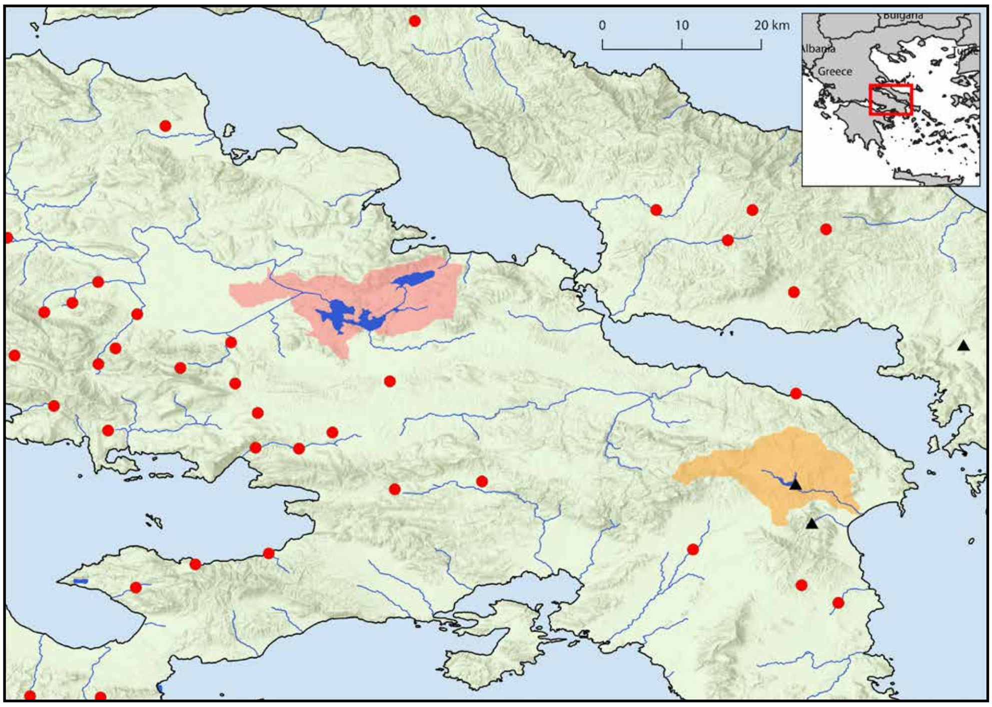
Scardinius graecus

Greek rudd

Distribution: Greece

Endemic to to the lower Boeotian Kifisos (aka Cephissus) River drainage in central Greece, including lakes Yliki and Paralimni. Introduced populations exist in artificial lakes Beletsi and Marathon further south. In the Kifisos this species inhabits the lakes themselves plus lower stretches of slow-moving tributaries and some man-made drainage canals. The threats to this species have not been well-studied, but abstraction of groundwater, modification of waterways and non-native fishes are all widespread in the area, while unregulated commercial fishing might also be an issue. This species is lacustrine by nature and unlikely to be adversely affected by hydropower development.

* as *Rutilus graecus*



© Jörg Freyhof

Hydropower Hazard:
HIGH
Bern Convention:
*APPENDIX III **
IUCN Red List:
ENDANGERED

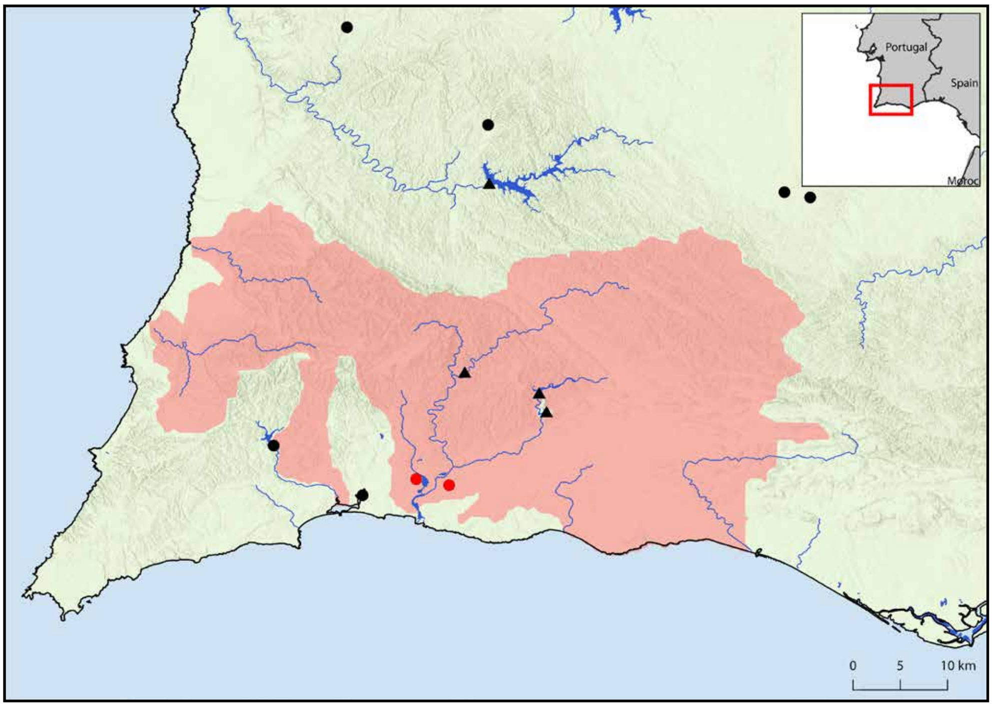
Squalius aradensis

Arade chub

Distribution: Portugal

Endemic to southwestern Portugal, with records from the Quarteira, Arade, Alvor, Bensafrim, Aljezur, Carrapateira, Bordeira and Seixe river drainages. It inhabits small coastal river systems and prefers stretches with slower flow, many of which dry out in summer with the fish surviving in remnant pools. This species has declined significantly since the turn of the century, particularly in the eastern portion of its range. The primary drivers are construction of dams such as the controversial Odelouca hydroelectric dam in the Arade drainage, which became operational in 2012, plus introduction of alien fish and crayfish species.

* as *Leuciscus pyrenaicus*



© Jörg Freyhof

Squalius cappadocicus

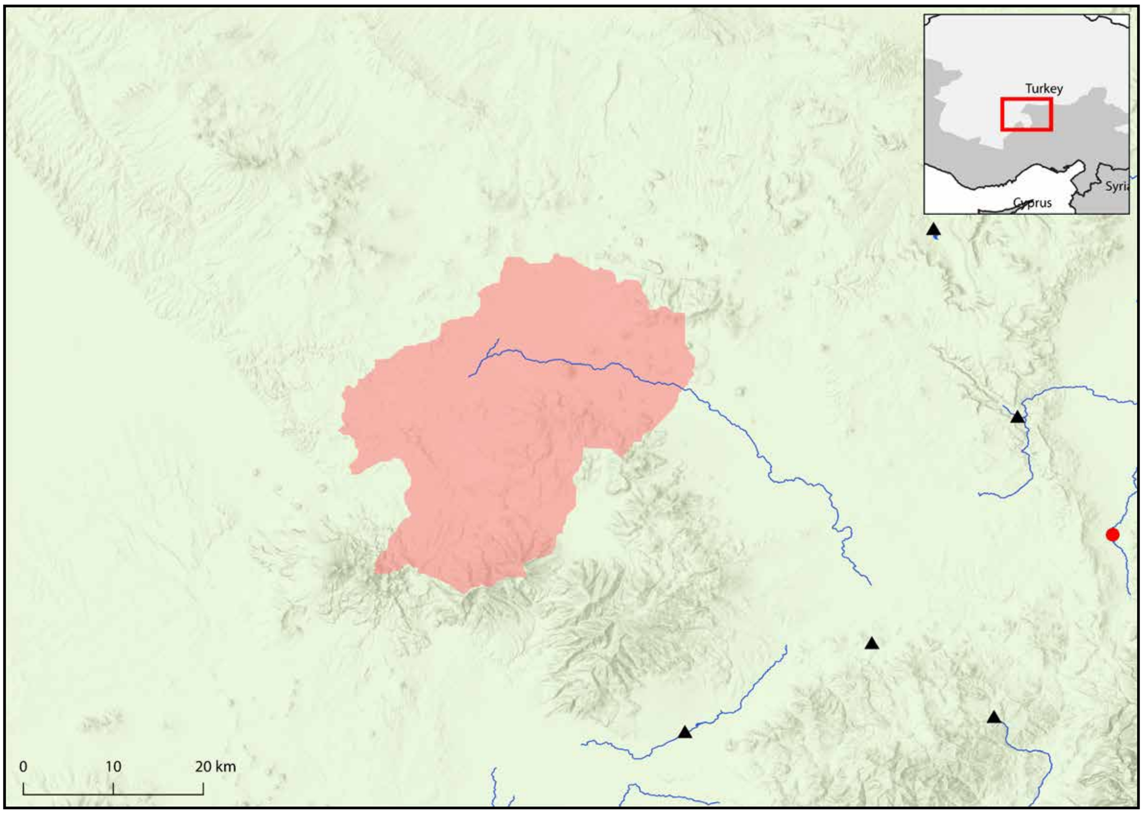
Cappadocian chub

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey

Known only from the Melendiz, a small river draining into the southeastern portion of the endorheic and hypersaline Lake Tuz in Central Anatolia. The Melendiz has already been dammed and the chub is now restricted to a stretch of around 30 kilometres above the reservoir since the river often runs dry beneath it. Additional threats include excessive water abstraction and increasing prevalence of droughts.



© Jörg Freyhof

Squalius carinus

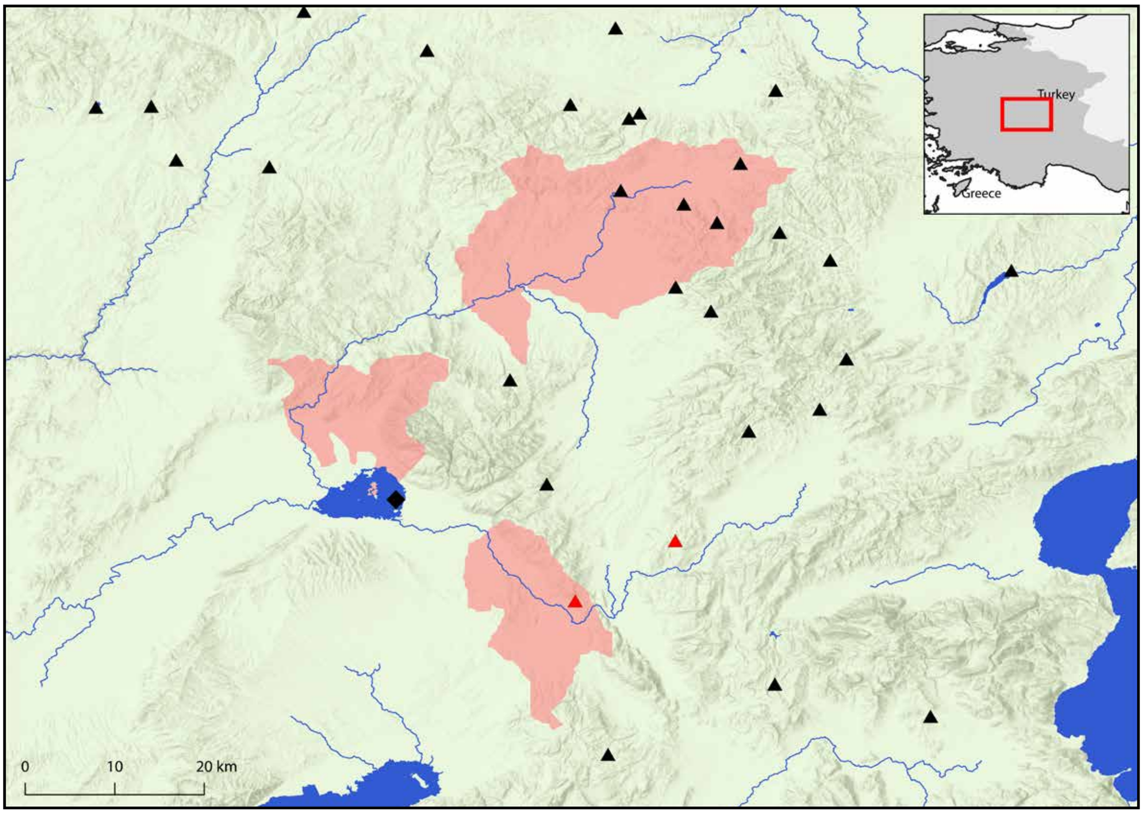
Chocolate chub

Distribution: Turkey

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Native to the Lake Isıklı basin and upper Büyük Menderes River drainage. It appears to be restricted to the lake plus small inflowing tributaries plus the Isıklı spring at Isıklı and the Karadirek and Küfü streams near Sandıklı. Major threats include water abstraction and pollution. A number of small dams designed to hold water for irrigation have been built on one of the streams, reducing the amount of suitable habitat.



© Ignacio Doadrio

Squalius castellanus

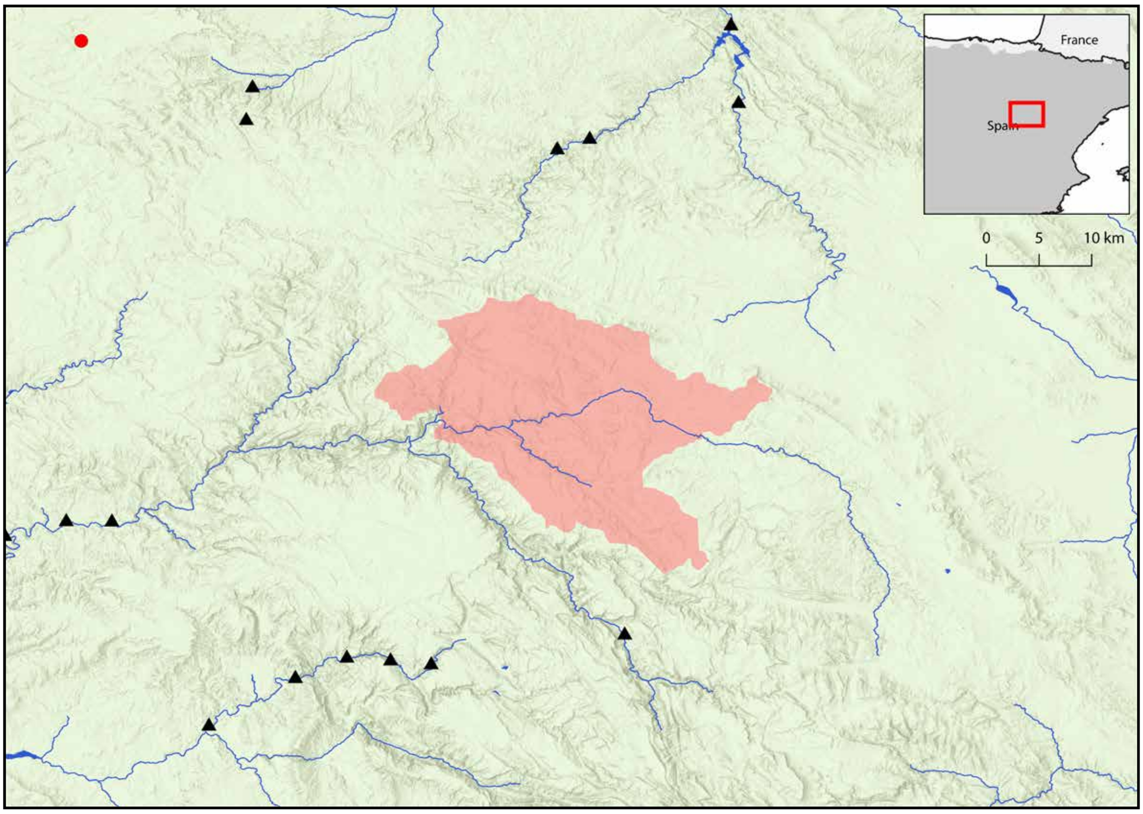
Gallo chub

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Spain

Known only from the the Gallo River and its tributaries within the upper Tagus River drainage in central Spain. Very little is known about this species' biology, but it has been collected from deep pools containing cool water and sparse aquatic vegetation. It is threatened by pollution from the town of Molina de Aragon, fluctuations in water flow and introduction of non-native rainbow trout (*Oncorhynchus mykiss*). Very few individuals have been seen in recent decades and the species is considered highly vulnerable to any form of habitat modification since it appears to be on the brink of extinction.



© Jörg Freyhof

Squalius cephaloides

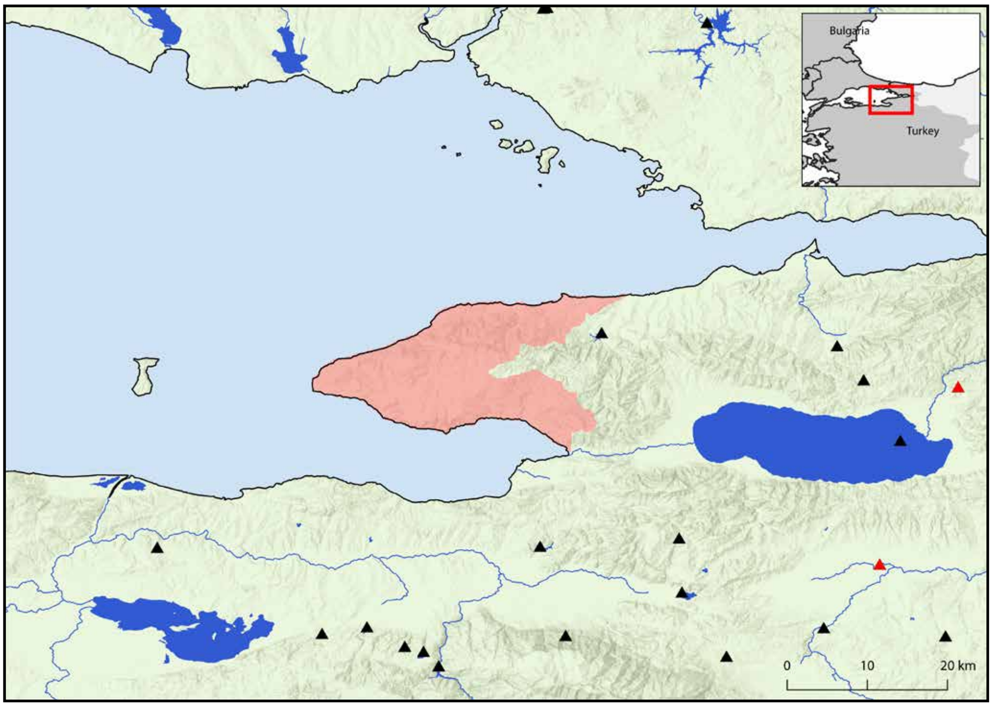
Thick-lipped chub

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY VULNERABLE*

Distribution: Turkey

Endemic to the Armutlu Peninsula in the Marmora Region of northwestern Turkey. This species has been recorded from two small, forested streams draining into the Sea of Marmara at the towns of Armutlu and Tesvikiye, respectively. It appears to have been extirpated from the Armutlu site, while the Tesvikiye drainage has been heavily chanalised with a series of small dams constructed in its lower section. The upper portion lies within a protected area which holds the last remaining chub population, and although there are no current threats, increased longevity of droughts caused by climate change could affect discharge in the future.



© Jörg Freyhof

Squalius illyricus

Illyrian chub

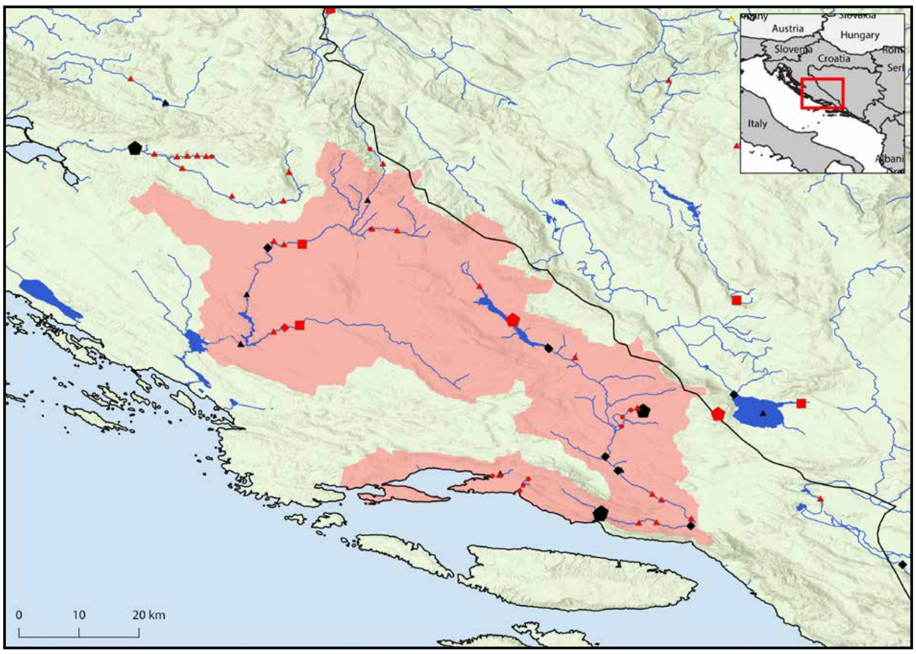
Hydropower Hazard:
HIGH

Bern Convention:
*APPENDIX III **

IUCN Red List:
VULNERABLE

Distribution: Croatia

Restricted to the Cetina and upper/middle Krka river drainages in southern Croatia. There are questionable records from the Soča (It. Isonzo) River in Slovenia and Italy. It inhabits clear, flowing karstic rivers and streams plus fluvial and artificial lakes. This species is threatened by water abstraction, pollution, habitat modification and introduction of non-native fishes typically associated with dam construction and the creation of reservoirs. For example, insufficiently treated domestic and industrial wastewater from the town of Knin is pumped directly into the Krka main channel, while additional pollutants enter via agricultural runoff from surrounding fields. A large hydroelectric dam is already in place in the upper reaches of the Cetina River, which has interfered with downstream discharge and groundwater hydrology, and favoured establishment of non-native fish species. The Zakučac hydropower plant, Croatia's largest in terms of installed capacity, is located near the river's mouth and research suggests it has reduced discharge by 40-70% since becoming operational in 1980. Excessive water abstraction is also an issue in some parts of the Cetina drainage, and the chub is illegally fished for food.



* as *Leuciscus illyricus*

© Jörg Freyhof

Squalius keadicus

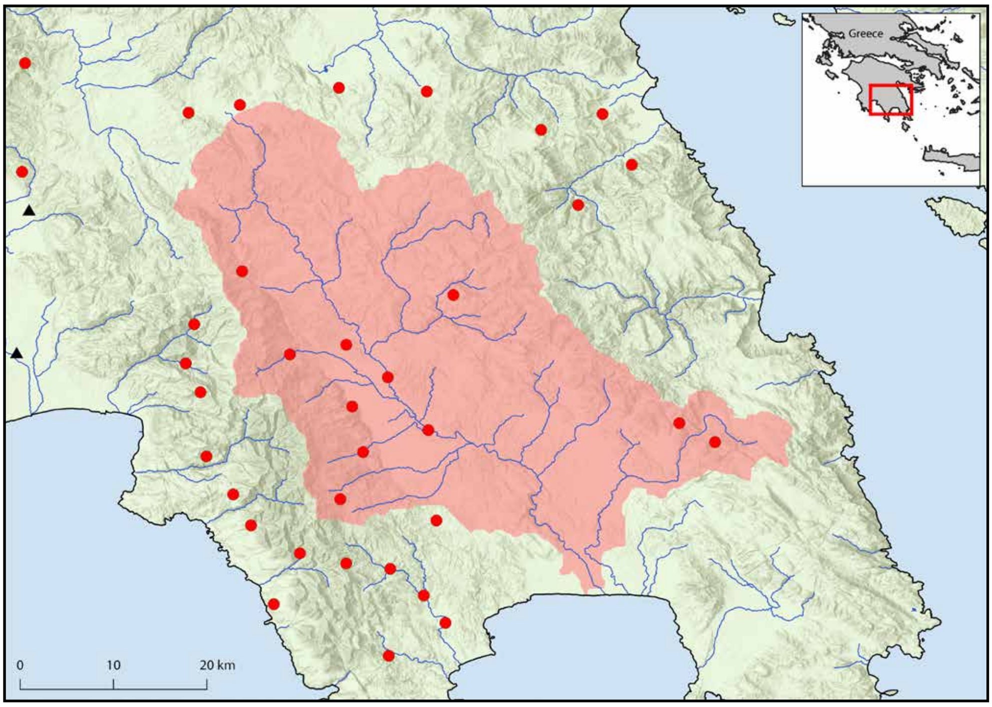
Evrotas chub

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Greece

Endemic to the Evrotas (aka Eurotas) River drainage on the Peloponnese Peninsula in southern Greece, including the Vassilopotamos stream in the river's delta. It occus in deeper, slow-moving pools and ditches as well as shallower stretches with flowing water, but may be confined to remnant areas of permanent water during periods of low rainfall when much of the river dries out. This species is threatened by water abstraction, agricultural and industrial pollution and increasing frequency of droughts. Since it is known from only a single temporal river it is extremely vulnerable to hydropower development which would interfere with the system's delicate water cycle.



© Jörg Freyhof

Squalius kosswigi

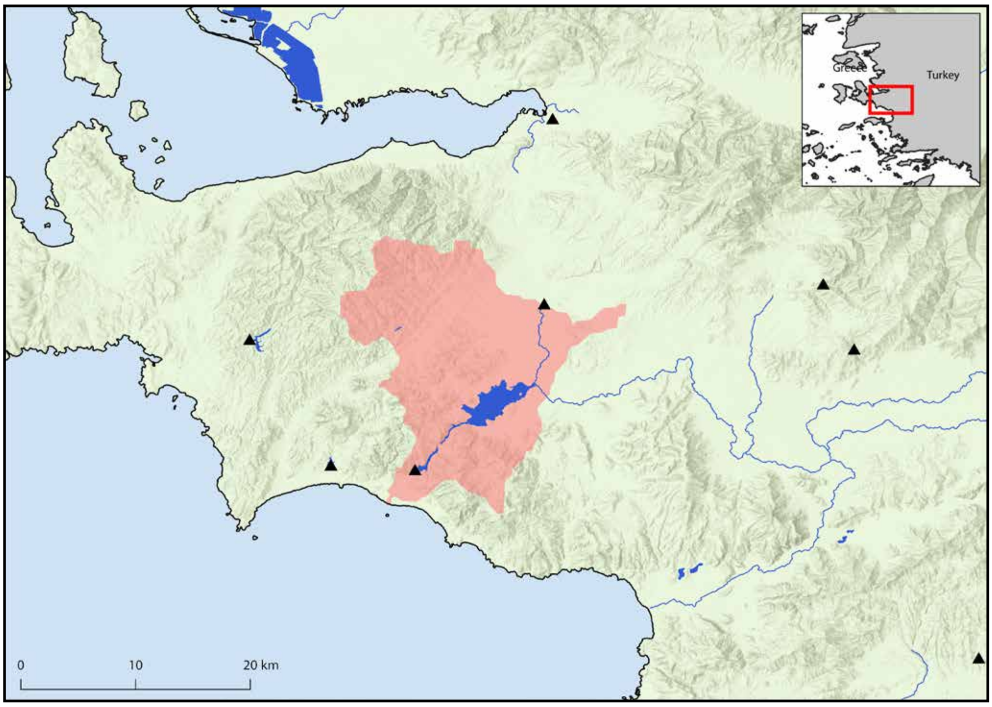
Striped chub

Distribution: Turkey

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Currently known only from the Gümüldür River drainage in the Aegean Region of western Turkey. It may once have also occurred in the adjacent Küçük Menderes River but any formerly suitable habitat has now either disappeared due to water abstraction or is too polluted to support fishes. The Gümüldür is a short coastal river and much of its lower course is taken up by a reservoir created by the Tahtalı dam, which became operational in 1999. This species can be found in upper and middle parts of the river and the dam lake. The major threats in the area are water abstraction for agriculture and urban use, pollution driven by discharge of agricultural, industrial and domestic effluents and increasing frequency of droughts. In 2008 the Tahtalı reservoir almost completely dried out.



© Jörg Freyhof

Squalius lucumonis
Toscana stream chub

Hydropower Hazard: *HIGH*

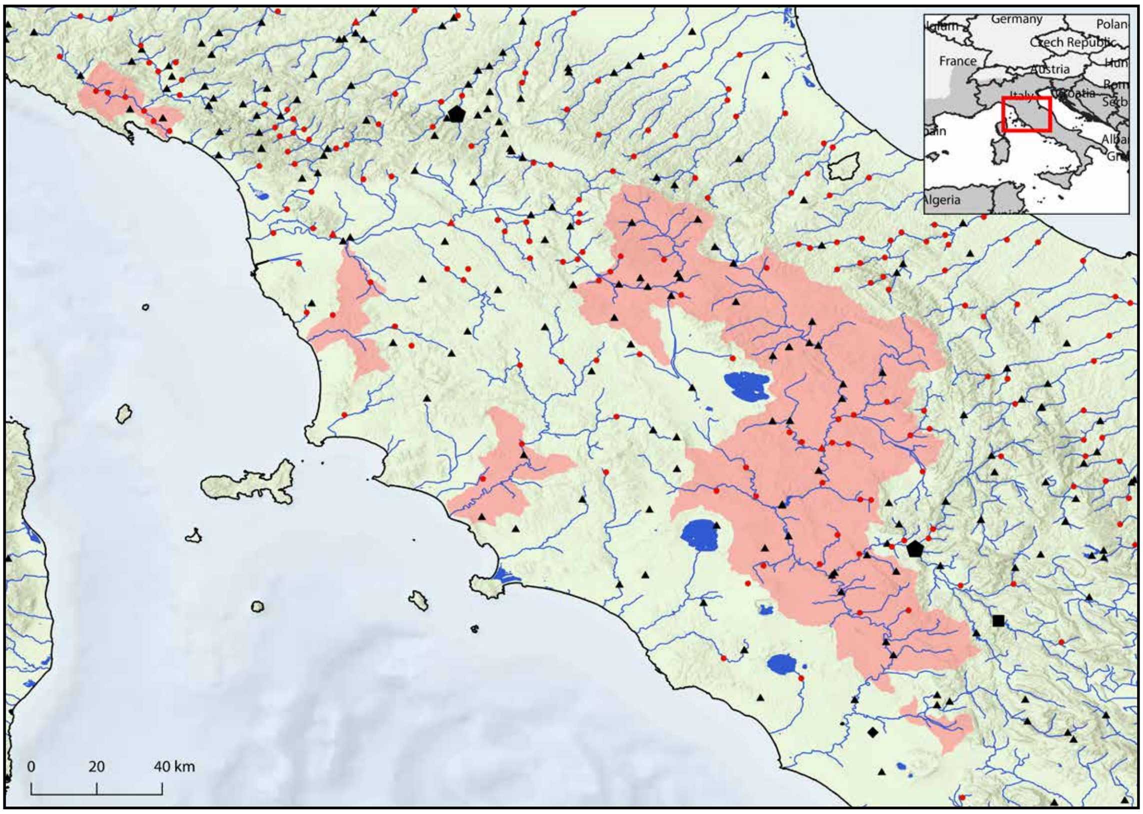
EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *ENDANGERED*

Distribution: Italy

Native to rivers draining the Ligurian/Tyrrhenian slope of western Italy, including the Vara, Serchio, Arno, Ombrone, and Tiber drainages. This species inhabits streams, small brooks and the upper parts of rivers, and does not normally occur in larger, deeper channels. It has already vanished from large portions of its range and continues to be threatened by habitat modification, water abstraction, dam construction and introduction of non-native fish species.

* as *Leuciscus lucomonis*



© Andreas Hartl

Squalius malacitanus

Málaga chub

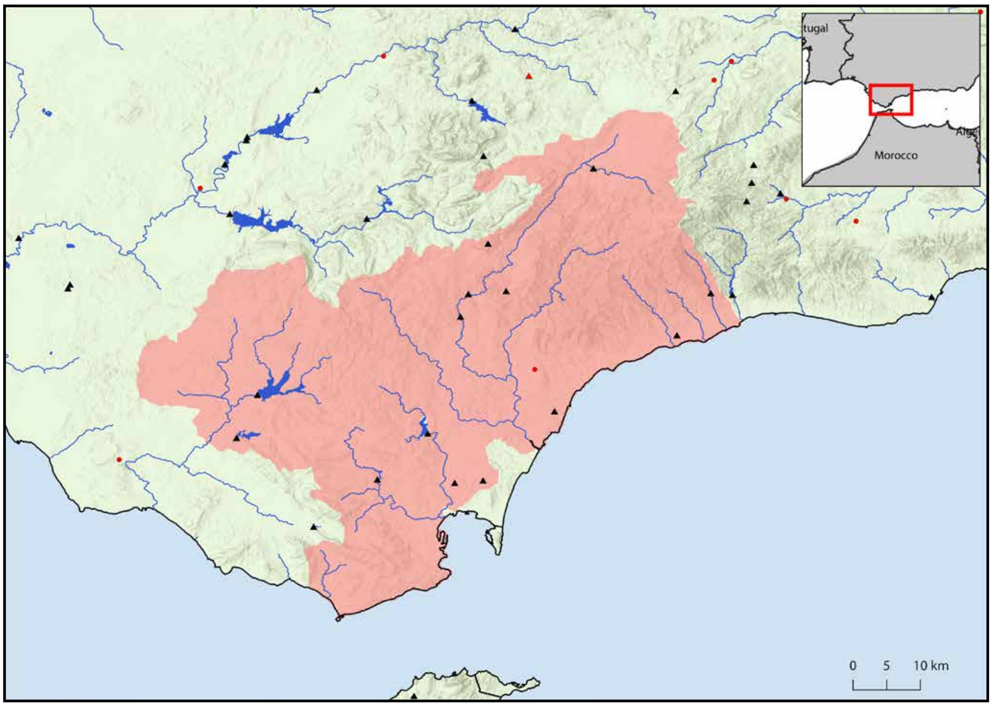
Hydropower Hazard: *HIGH*

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Distribution: Spain

Restricted to a series of relatively small river drainages in southwestern Spain, including the Guadaiza, Guadalmina and Guadiaro on the Mediterranean slope and the Guadalete, Barbate, Valle, Jara, Vega and Miel on the Atlantic slope. Some of these rivers are temporal in nature, with their middle and upper sections drying out to an extent during periods of low rainfall when the fish survive in remnant pools. This species inhabits slow-flowing stretches and riverine pools with clear water and often dense riparian vegetation. The main threats in the area are water abstraction for agriculture and golf, introduction of non-native fish and crayfish species, and increasing frequency of drought. Most of the rivers in which it occurs are already dammed and this has significantly reduced the extent of suitable habitat.



* as *Leuciscus pyrenaicus*

© Jörg Freyhof

Squalius microlepis

Imotski chub

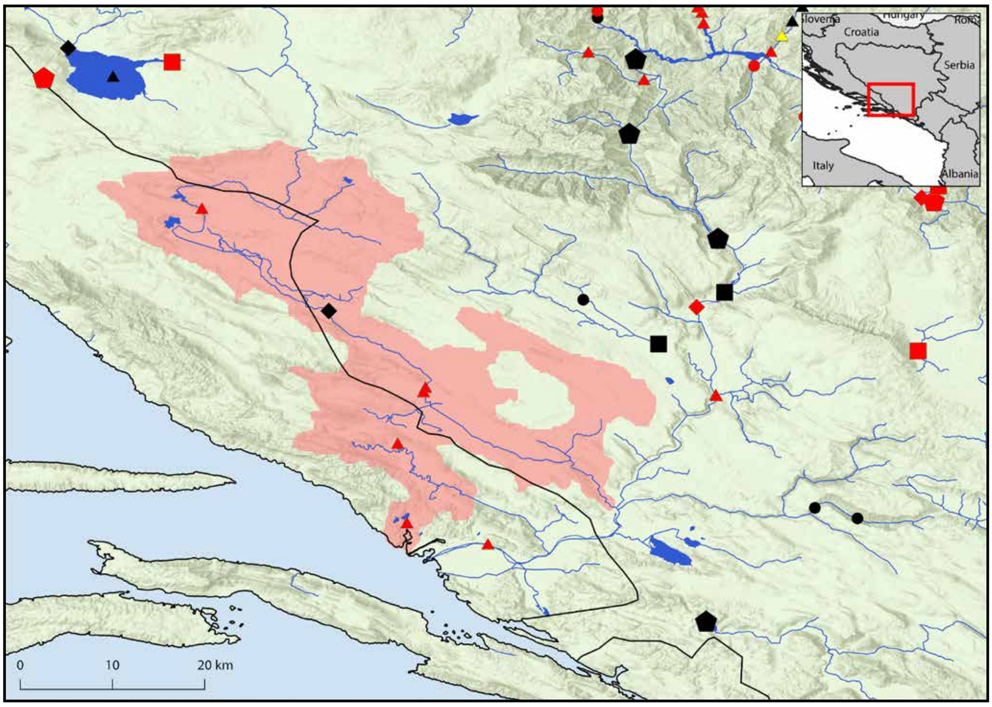
Hydropower Hazard: *HIGH*

Bern Convention: *APPENDIX III* *

IUCN Red List: *ENDANGERED*

Distribution: Bosnia-Herzegovina and Croatia

Endemic to the lower Neretva River drainage in Croatia and Bosnia-Herzegovina. In Croatia it has been recorded from the Baćina lakes near the Neretva delta plus the sinking Vrgorska Matica and transboundary Suvaja-Vrljika (including the Zeleno reservoir, sinkhole lakes Galjipovac, Knezovìća and Mamića, and Pološko Blato wetland, which is connected to the Vrljika by an artificial canal) river drainages. In Bosnia-Herzegovina it is known from Lake Krenica plus the Matica-Tihaljina-Trebižat (the continuation of the Vrljika once it crosses the border, referred to by a series of different local names along the remainder of its course) and Ričina (a tributary of the Suvaja) rivers, including Tribistovo reservoir in the latter. The Kravice waterfalls are hypothesised to represent its downstream limit in the Trebižat. This species is threatened by habitat loss through pollution, drying or channelisation of karstic watercourses and widespread introduction of non-native fish species.



* as *Leuciscus microlepis*

© Jörg Freyhof

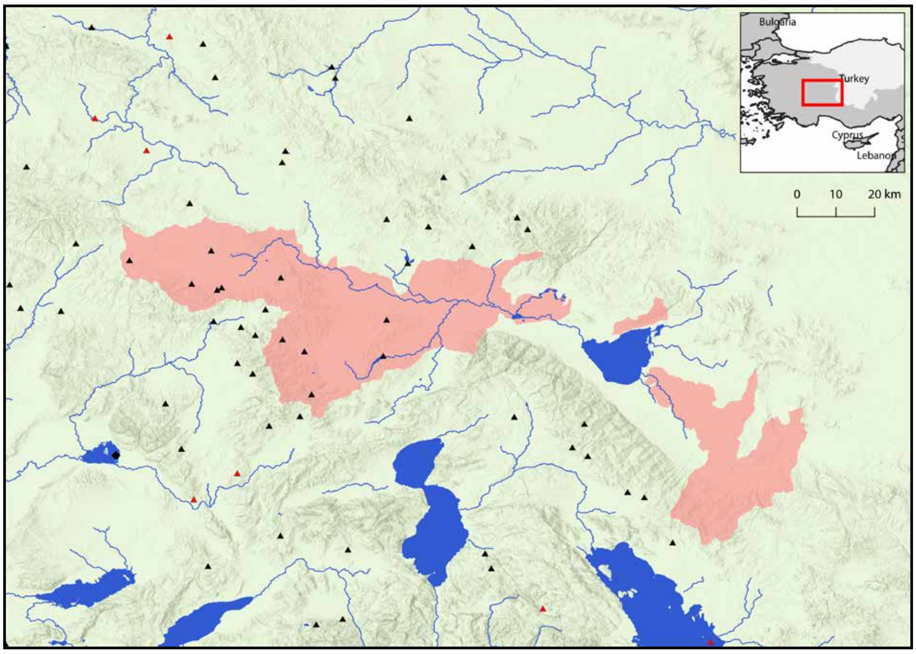
Hydropower Hazard:
HIGH

IUCN Red List:
VULNERABLE

Squalius recurvirostris
Akşehir Chub

Distribution: Turkey

Native to the Akarçay River drainage and Lake Çavusçu (aka Ilgın) basin. In the Akarçay system it originally inhabited tributaries flowing into endorheic lakes Eber and Akşehir plus the lakes themselves. However decades of pollution and gradual dessication of the lakes due to excessive water abstraction since the mid-1970s have seen the species now restricted to five small streams. Lake Akşehir lost its surface connection with Lake Eber in 1990 and temporarily dried out in 2008, while Eber was reported to be completely dry in 2018. The streams holding the remaining populations suffer from pollution, continued abstraction of water and increasing lack of rainfall. Construction of water retention dams, irrigation canals and regulators has further reduced the amount of suitable habitat in some of them. The largest population now inhabits the Akdeğirmen reservoir in the upper Akarçay, plus it is apparently still present in Lake Çavusçu.



© Jörg Freyhof

Squalius tenellus

Livno chub

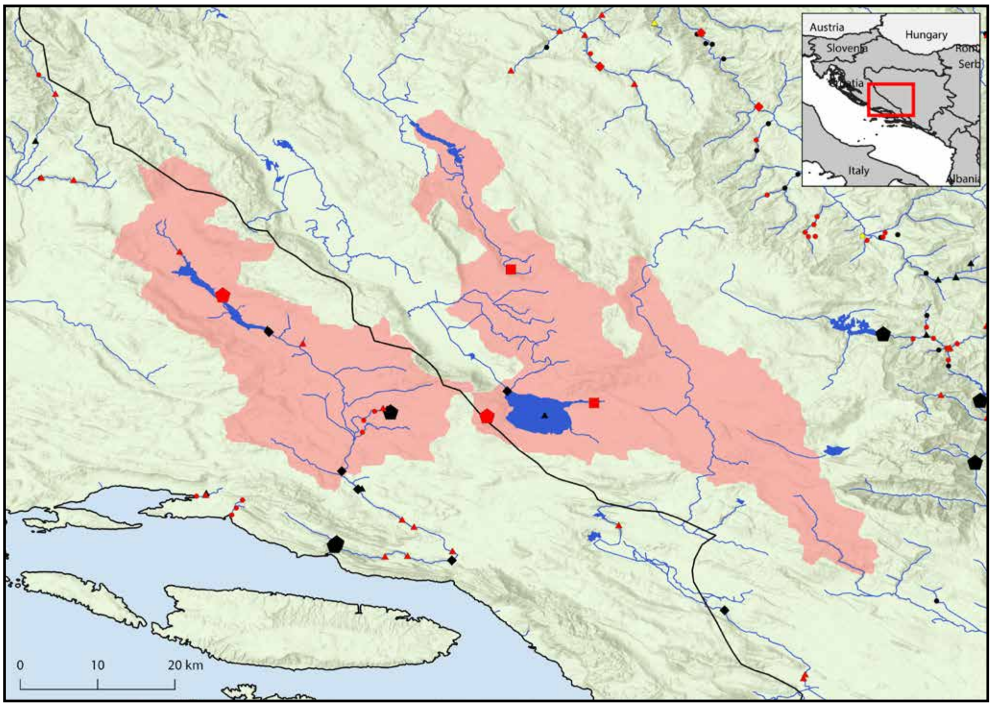
Hydropower Hazard: *HIGH*

Bern Convention: *APPENDIX III **

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Bosnia-Herzegovina and Croatia

Native to the the Glamočko, Duvanjsko and Livanjsko poljes in southern Bosnia-Herzegovina, including the Buško Blato and Mandek reservoirs. The Livanjsko population has declined dramatically in recent years and it has been extirpated from Buško Blato. This species also occurs in the upper Cetina River in Croatia, but appears to have entered the drainage via the Orlovac hydroelectric plant which draws water from Buško Blato through a pipeline. A population in Lake Blidinje to the east of Buško Blato is also assumed to be introduced. It is threatened by water abstraction, pollution, habitat modification and introduction of non-native fishes. At least seven alien fish species now occur in Buško Blato, which was converted into an artificial lake with hydroelectric plant in 1974. Studies indicate these now dominate the fish community with a corresponding decline in native species. New hydropower projects in the area, a number of which are planned, would enable their continued spread and could also interfere with groundwater dynamics and spring discharge.



* as *Leuciscus microlepis*

© Jörg Freyhof

Squalius torgalensis

Torgal chub

Distribution: Portugal

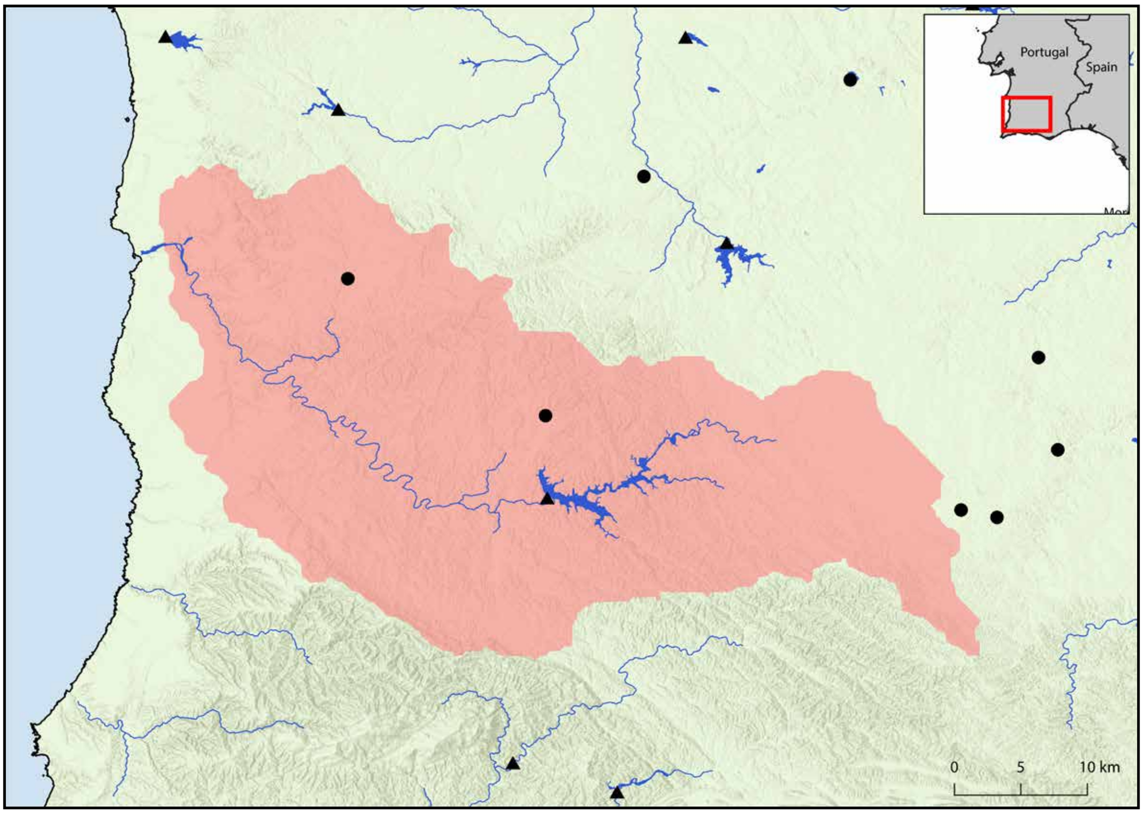
Hydropower Hazard: *HIGH*

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Endemic to the Mira River drainage in southwestern Portugal, a relatively small, naturally intermittent system. It is chiefly threatened by increasing frequency and longevity of droughts plus habitat loss and changes in environmental conditions brought about by construction of the Santa Clara hydroelectric dam in the upper part of the river. Native fishes are now mostly found below the dam, where flow has been greatly reduced, and the reservoir it created is popular with recreational anglers after a number of non-native fish species were introduced.

* as *Leuciscus pyrenaicus*



Telestes beoticus

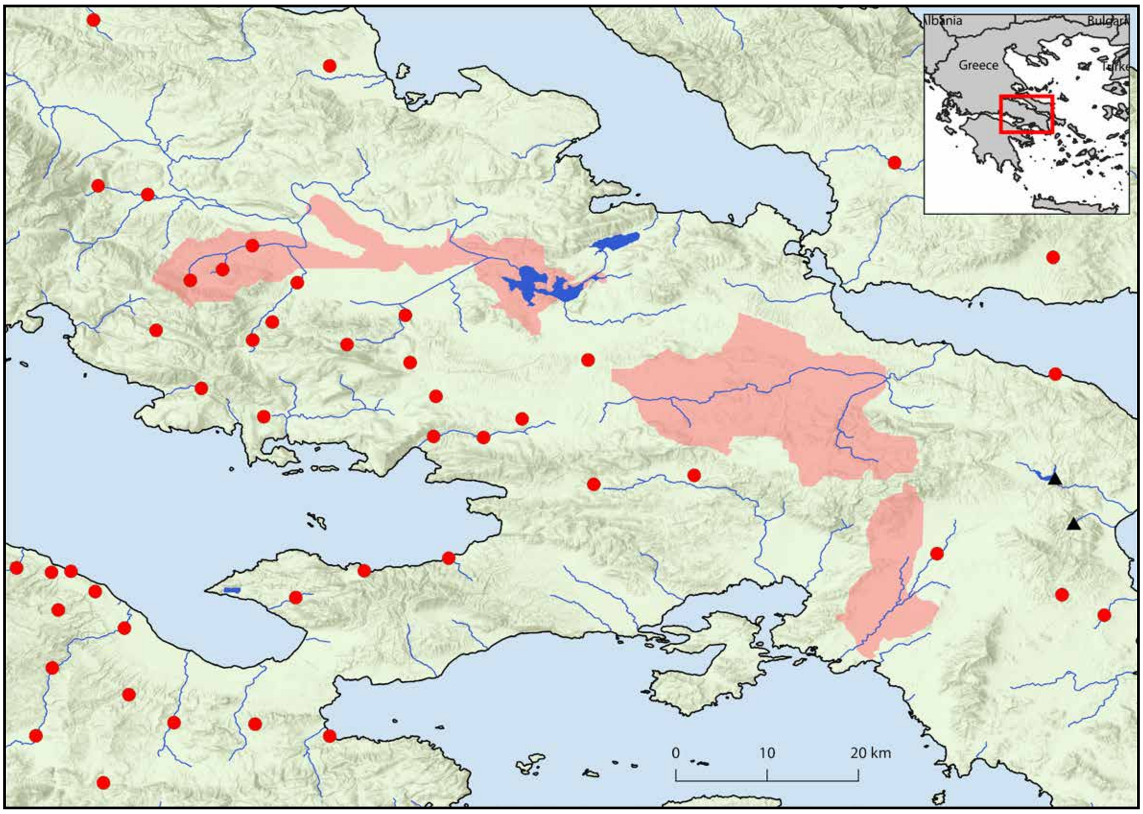
Boeotian riffle dace

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Greece

Endemic to to the Boeotian Kifisos (aka Cephissus) River drainage, including the Lake Yliki basin, plus the Asopós River in Central Greece. This species is threatened by water abstraction, pollution, habitat modification, and increasing frequency of climate change-induced droughts. It is extremely vulnerable to hydropower development since it occurs in an area where water stress is already high.



© Jörg Freyhof

Telestes croaticus

Croatian pijor

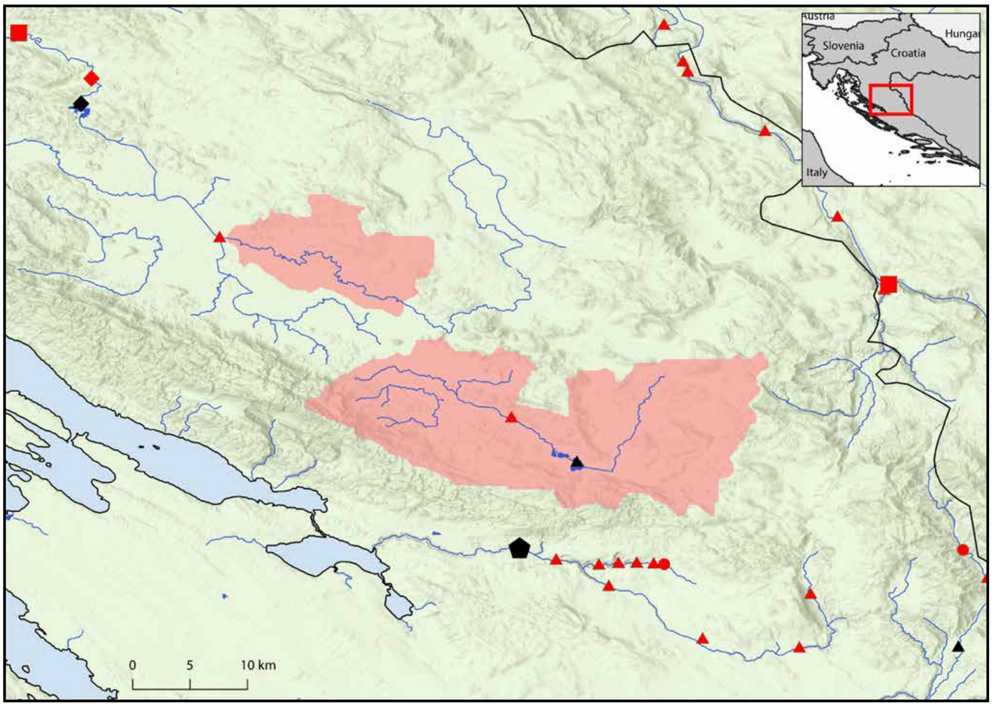
Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *ENDANGERED*

Distribution: Croatia

Currently restricted to upper parts of the Jadova River, a temporal tributary within the Lika River drainage, and the adjacent Ričica River. The Jadova undergoes large annual flow variations and often runs dry during the summer, while the Ričica is a karstic sinking river. This species has vanished from many former locations including the entire Gacka River drainage, and is threatened by agricultural pollution, excessive water abstraction, dam construction, drought and particularly introduction of non-native fish species. The latter became established following completion of dams and hydroelectric plants on its native rivers. Larger predators such as northern pike (*Esox lucius*) are present in the reservoirs but have not become established in smaller tributaries. Others, including pumpkinseed (*Lepomis gibbosus*), alborella (*Alburnus arborella*), common roach (*Rutilus rutilus*) and common chub (*Squalius cephalus*) have been more successful and are now the most abundant species in the lower Jadova, for example. New hydropower schemes are supposedly being planned.



* as *Phoxinellus* spp.

© Primož Zupančič

Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *CRITICALLY ENDANGERED*

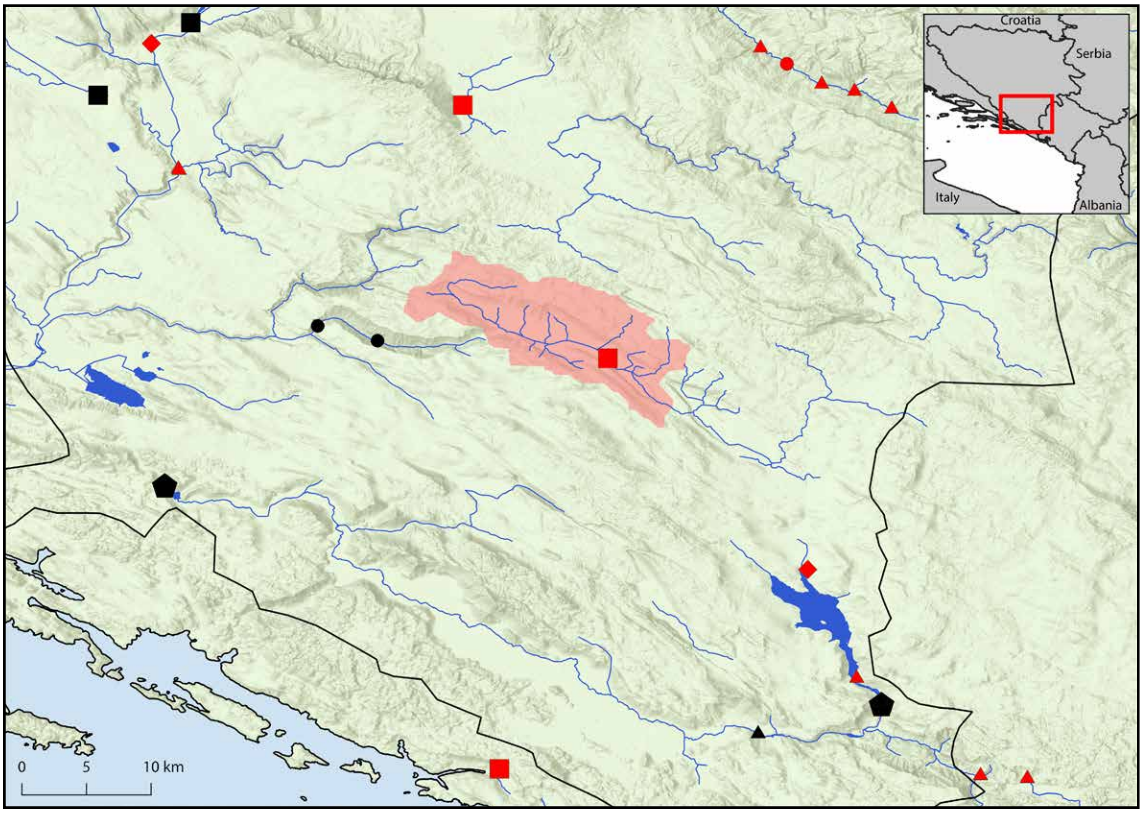
Telestes dabar

Dabarsko dace

Distribution: Bosnia-Herzegovina

The Dabarsko dace is known only from the Opačica, Pribitul, Suški Potok and Vrijeka river drainages in the Dabarsko polje, southern Bosnia-Herzegovina. These small rivers are connected to the larger Trebišnjica River drainage via subterranean flows. Threats in the area include introduction of non-native fish species and increased frequency and longevity of droughts due to climate change. If a large hydropower plant is built as planned within this species' range, it could be driven to extinction.

* as *Phoxinellus* spp.



© Jörg Freyhof

Hydropower Hazard:
LOW

EUR-HAB-DIR:
*ANNEX II **

IUCN Red List:
CRITICALLY ENDANGERED

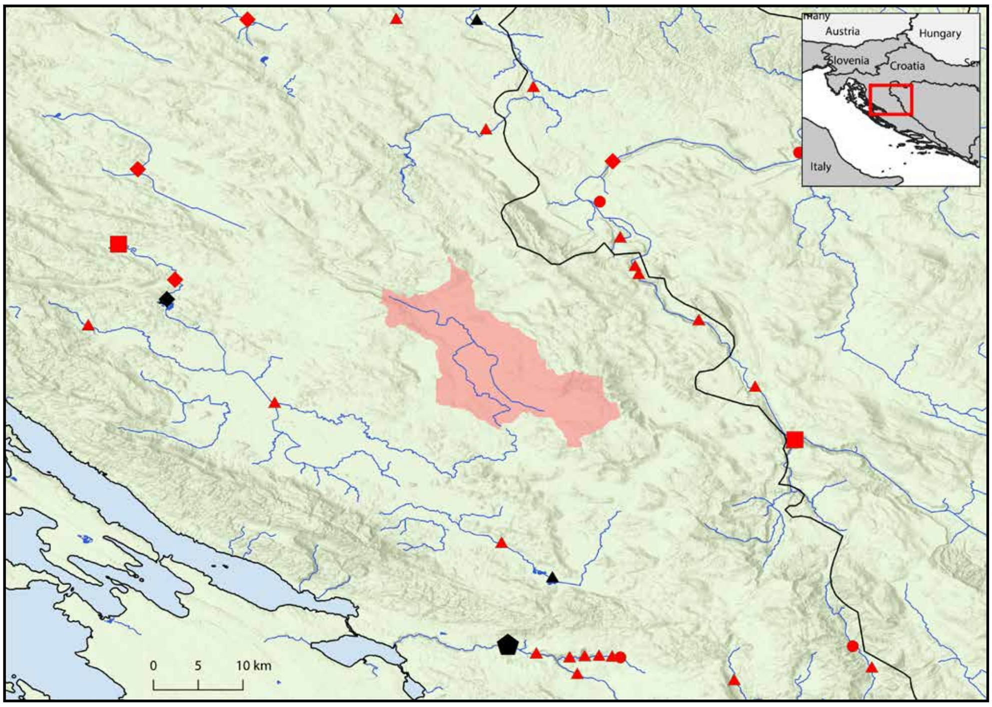
Telestes fontinalis

Krbava dace

Distribution: Croatia

Endemic to the Krbava polje in central Croatia where it occurs only in the very short Krbavica River drainage. It is found in a number of perennial ponds, springs and cave systems, including Suvaja Mekinjarska, Pećine, Vukova pećina, Hrnjakova pećina, Laudanov gaj and sinkholes around Podlapača. This species is threatened by water abstraction, pollution and construction of roads. A major threat is the introduction of alien fish species, of which several are already present in small numbers. Although hydropower development in the immediate area is unlikely, projects in adjacent drainage basins could interfere with groundwater circulation and the discharge of springs.

* as *Phoxinellus* spp.



© Jörg Freyhof

Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II*

Bern Convention: *APPENDIX III*

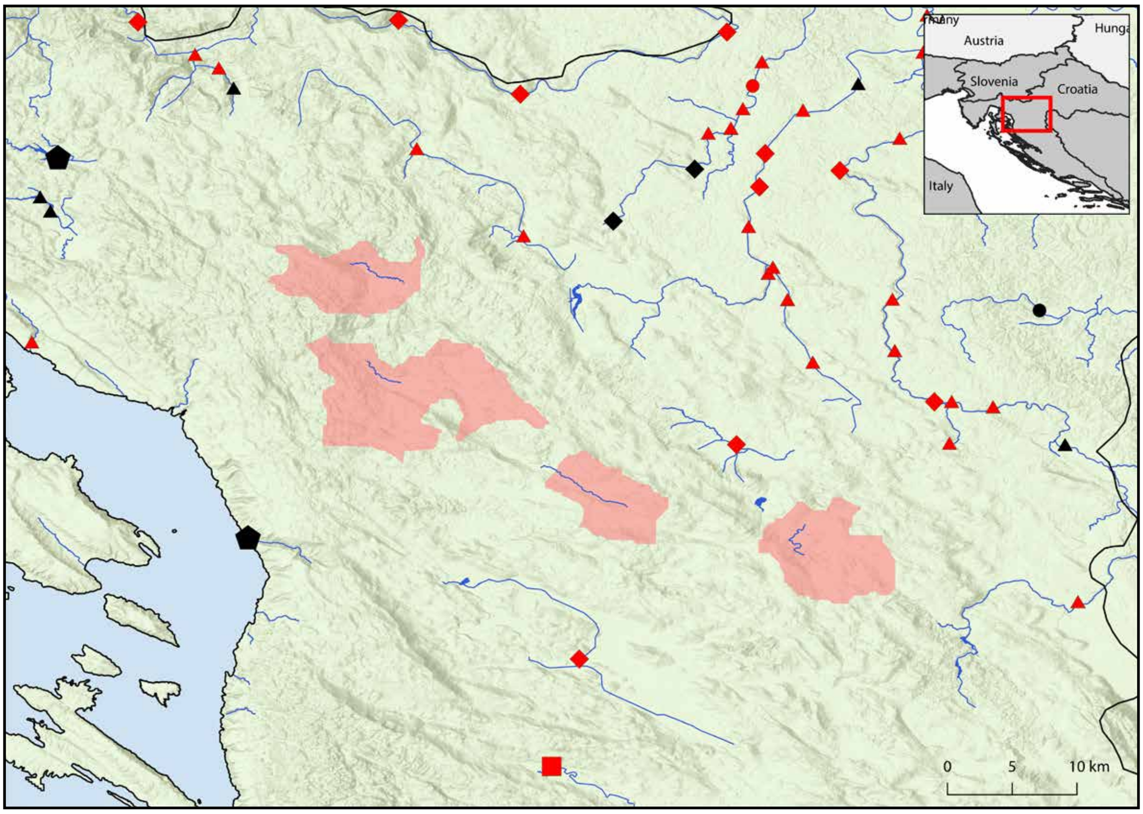
IUCN Red List: *ENDANGERED*

Telestes karsticus

Karst dace

Distribution: Croatia

Known from the Stajnica, Lug, Drežnica and Jasenak poljes on the southwestern side of Velika Kapela and Mala Kapela mountains in central Croatia. It is threatened by water abstraction, pollution and introduction of non-native fish species, the latter of which may already have driven its extirpation from some sites in the area. For example, it has not been found in the Stajnica polje in recent years. Although hydropower development in the immediate area is unlikely, projects in adjacent drainage basins could interfere with groundwater circulation and the discharge of springs.



© Jörg Freyhof

Telestes metohiensis

Striped dace

Hydropower Hazard: *LOW*

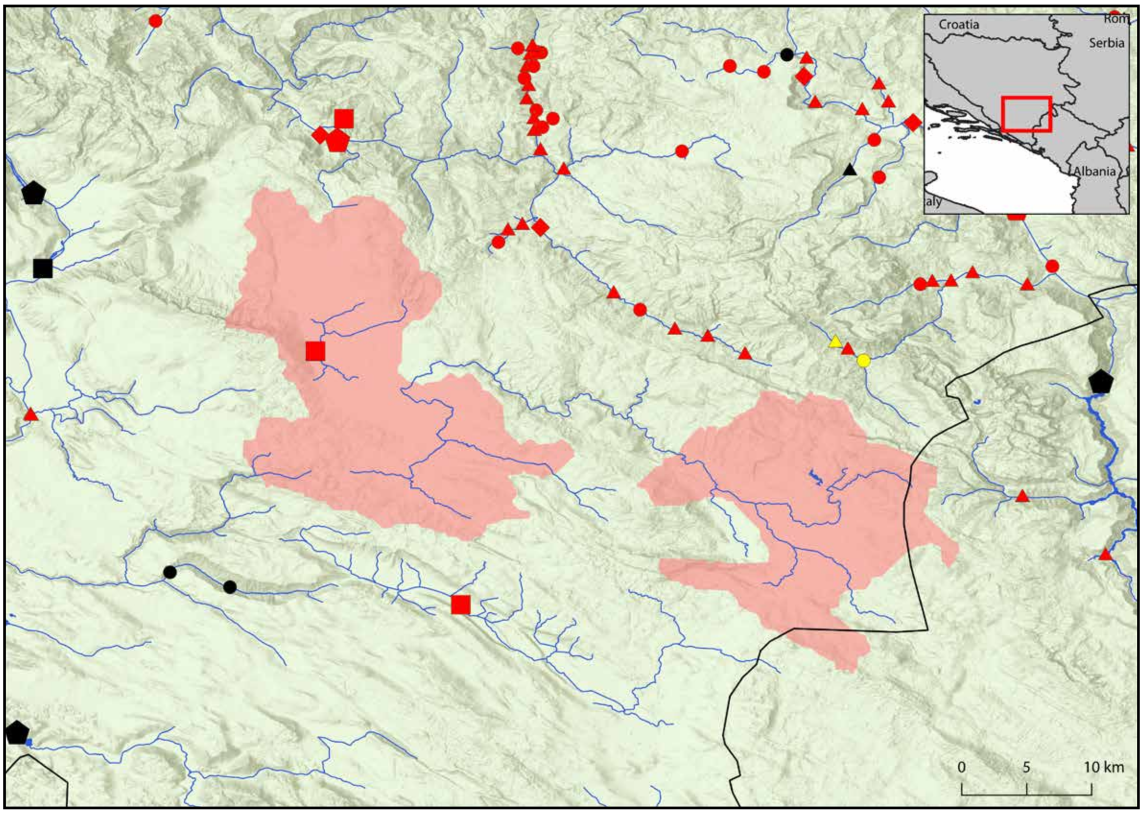
EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *ENDANGERED*

Distribution: Bosnia-Herzegovina

Natiuve to the Gatačko (Mušnica River), Cerničko (Ključka River in Vilina Pećina), and Nevesinjsko (Zalomka River) poljes in Bosnia-Herzegovina. This species is threatened by water abstraction, habitat modification and introduction of non-native fish species. Hydropower projects in adjacent drainage basins could interfere with groundwater circulation and the discharge of springs.

* as *Phoxinellus* spp.



© Perica Mustafić

Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

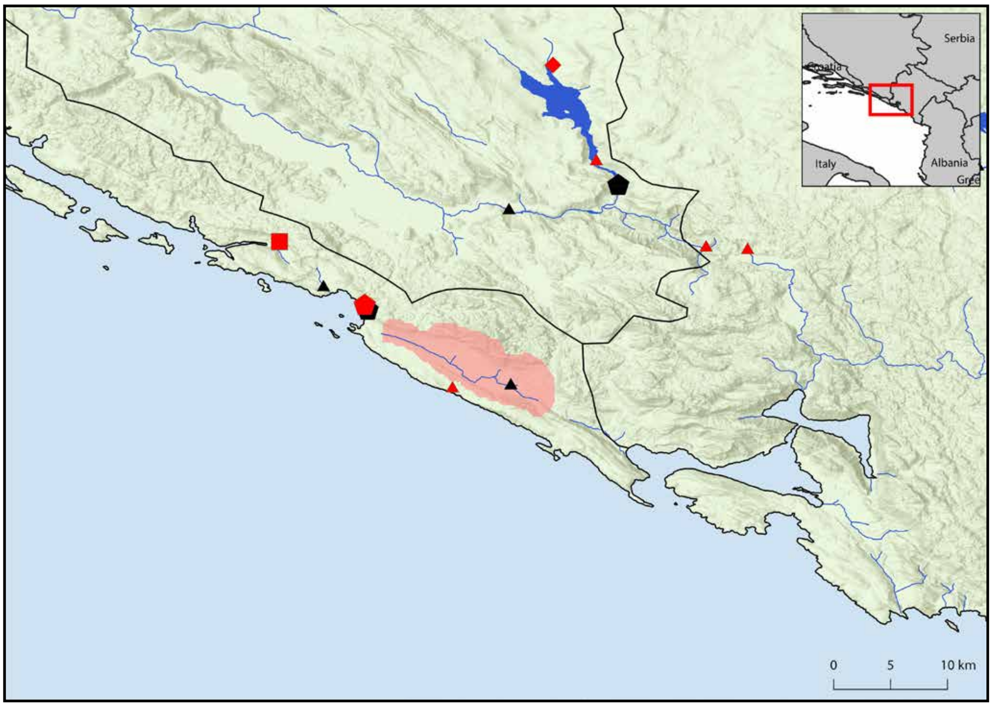
IUCN Red List: *CRITICALLY ENDANGERED*

Telestes miloradi

Konavle dace

Distribution: Croatia

Endemic to the Ljuta River drainage in the Konavle (aka Konavosko) polje , southern Croatia. It was thought to have gone extinct more than a century ago but was rediscovered in the Dragić Stream tributary system during 2013. It is threatened by habitat modification, with around 70% of the stream habitat modified into a concrete channel in 2014, while the natural flood cycle of the karst field has been completely altered by construction of a tunnel to drain water away. The predatory non-native rainbow trout (*Oncorhynchus mykiss*) and black bullhead catfish (*Ameiurus melas*) also occur in the Ljuta River. Although hydropower development in the immediate area is unlikely, projects in adjacent drainage basins could interfere with groundwater circulation and the discharge of springs.



* as *Phoxinellus* spp.

© Perica Mustafić

Hydropower Hazard:
HIGH

Bern Convention:
*APPENDIX III **

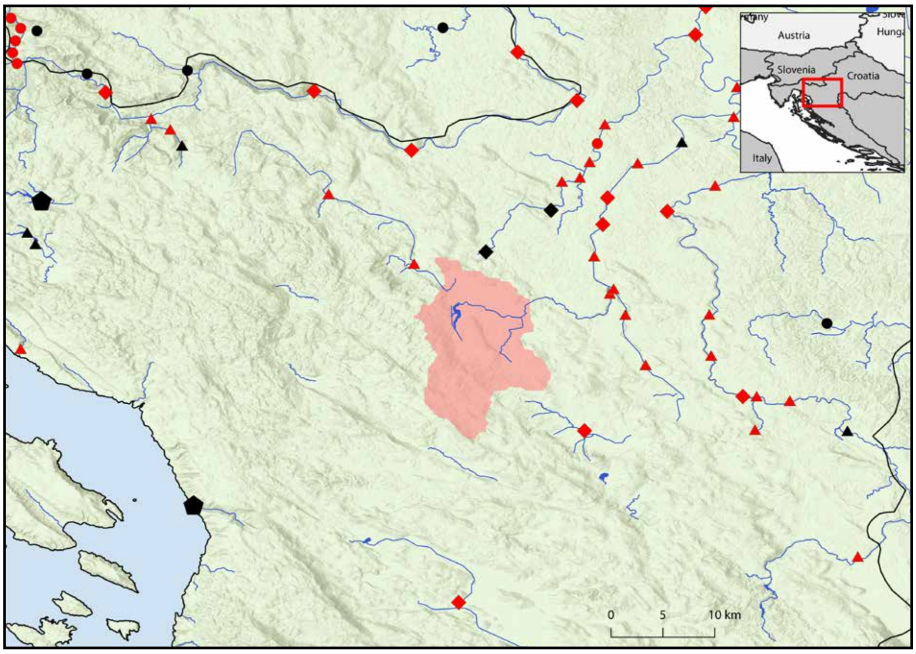
IUCN Red List:
CRITICALLY ENDANGERED

Telestes polylepis

Croatian dace

Distribution: Croatia

Formerly occurred thoughout the Dobra and Zagorska Mrežnica rivers in the Ogulin-Modruš valley. It is now restricted to Lake Zeleno (aka Šmitovo) and Rupećica spring near the village of Desmerice. These tiny remaining habitats form part of a karst system consituting the source of the Zagorska Mrežnica and share a subterranean connection, with the fish able to move between surface and ground water. The Zagorska Mrežnica emerges from the ground around a kilometre from the spring lake and is immediately dammed, forming the Sabljaci reservoir. Most of the outlowing water from this lake is diverted to a second dam built on the Dobra River just before it enters Ogulin, where it naturally disappears underground. This water is then used to power the Gojak hydroelectric power plant located on the Dobra after it returns to the surface north of Ogulin. It is likely that construction of these dams and subsequent invasion of non-native fish species has resulted in the extirpation of most Croatian dace populations in the area. Only around 100 individuals are thought to remain in the wild, and these are threatened by predation and competition with at least six other fish species that probably invaded the Zeleno-Rupećica system from the Sabljaci dam lake.



* as *Leuciscus polylepis*

© Jörg Freyhof

Telestes turskyi

Čikola riffle dace

Hydropower Hazard: *LOW*

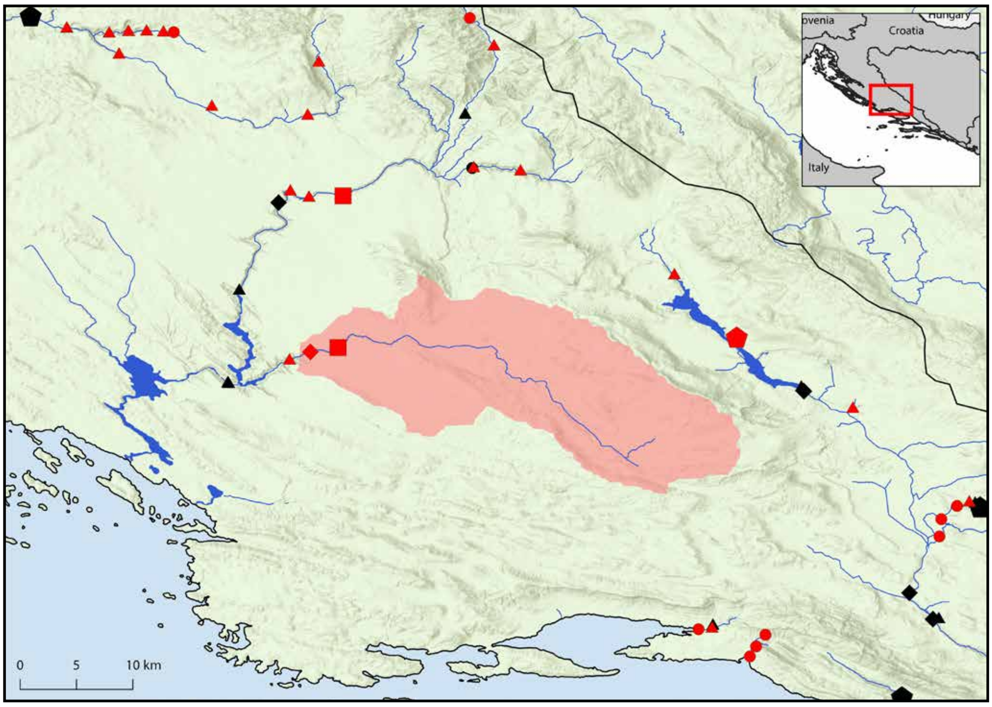
Bern Convention: *APPENDIX III **

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Croatia

Endemic to the Čikola River, a tributary within the Krka River drainage in southern Croatia. This species inhabits small karst streams with slow-moving water and may retreat into subterranean water bodies during periods of low rainfall. It is threatened by water abstraction, pollution, habitat modification and introduction of non-native fish species. Hydropower development in the area could interfere with groundwater circulation, hydraulic connectivity and the discharge of springs. At least three new plants are planned on the Čikola River, which is already heavily modified by dams, tunnels and pipelines that have reduced spring discharge from formerly perennial left-bank tributaries. Their construction could drive the species to extinction.

* as *Leuciscus turskyi*



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Tropidophoxinellus spartiaticus

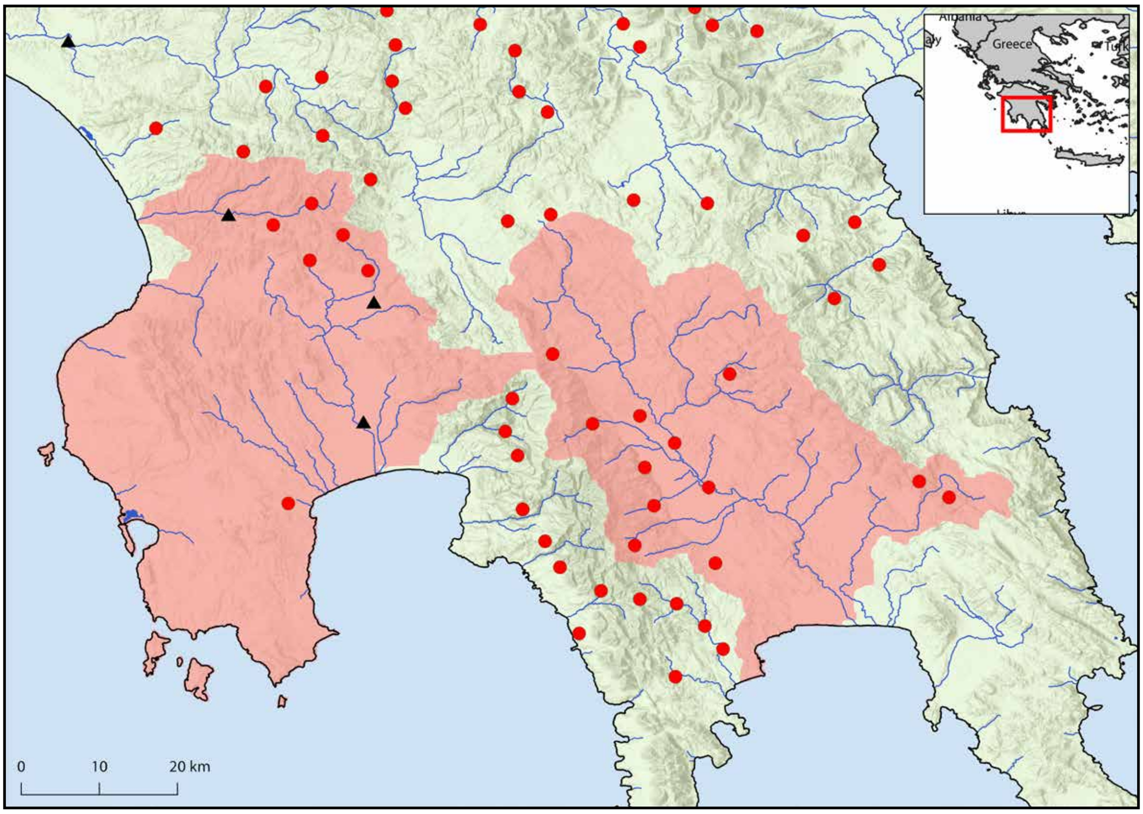
Spartian minnowroach

Hydropower Hazard: *MODERATE*

IUCN Red List: *VULNERABLE*

Distribution: Greece

Endemic to the southern portion of the Peloponnese Peninsula in Greece, where its range extends eastwards from the Neda River to the Evrotas (aka Eurotas) River drainage. It inhabits sluggish lowland rivers, streams, and man-made canals, often with dense aquatic vegetation. Some of these flow intermittently and naturally dry out during summer, when the fish survive only in remnant pools. This species is threatened by water abstraction, drainage of wetlands, pollution from agriculture and industry, and construction of small dams and weirs which impede access to tributaries.



© Jörg Freyhof

Hydropower Hazard: *MODERATE*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

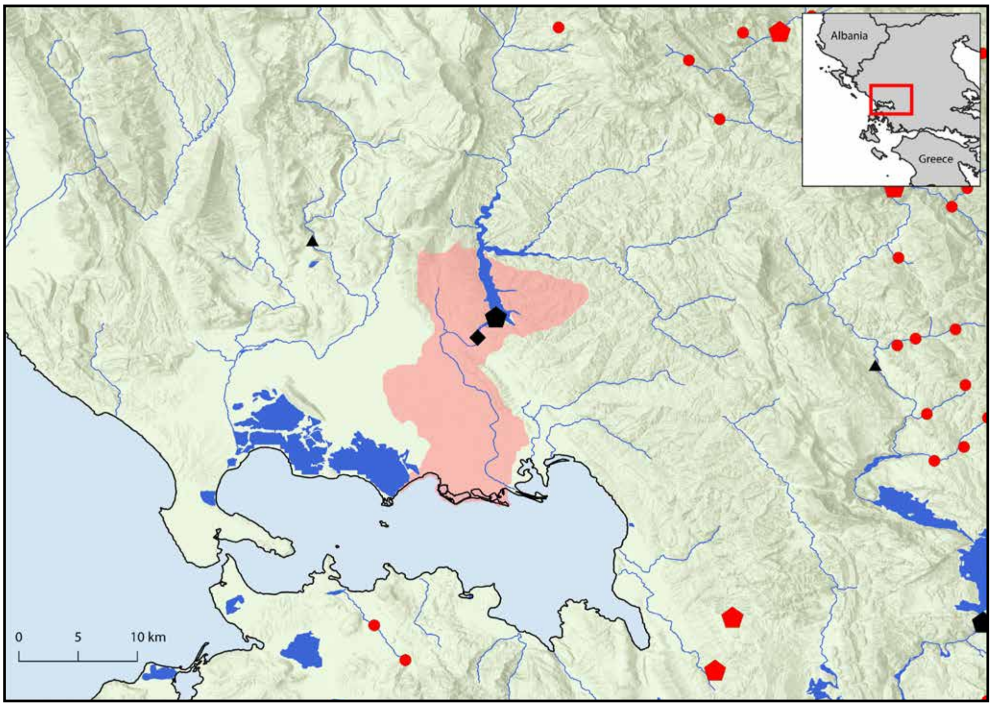
Cobitis arachthosensis

Arachthos spined loach

Distribution: Greece

Endemic to the lower Arachthos river drainage in western Greece. This species is threatened by water extraction plus pollution and construction of weirs and other barriers. There is a large hydroelectric dam upstream of the species' known habitats, which has significantly altered the downstream flow regime. Artificial canals linking the lower Arachthos with the neighbouring Louros River raise the threat of hybridisation with the closely-related Louros spined loach (*Cobitis hellenica*). Aquaculture is common in the area so there is also potential for introduction of non-native fish species.

* as *Cobitis taenia*



Cobitis battalgilae

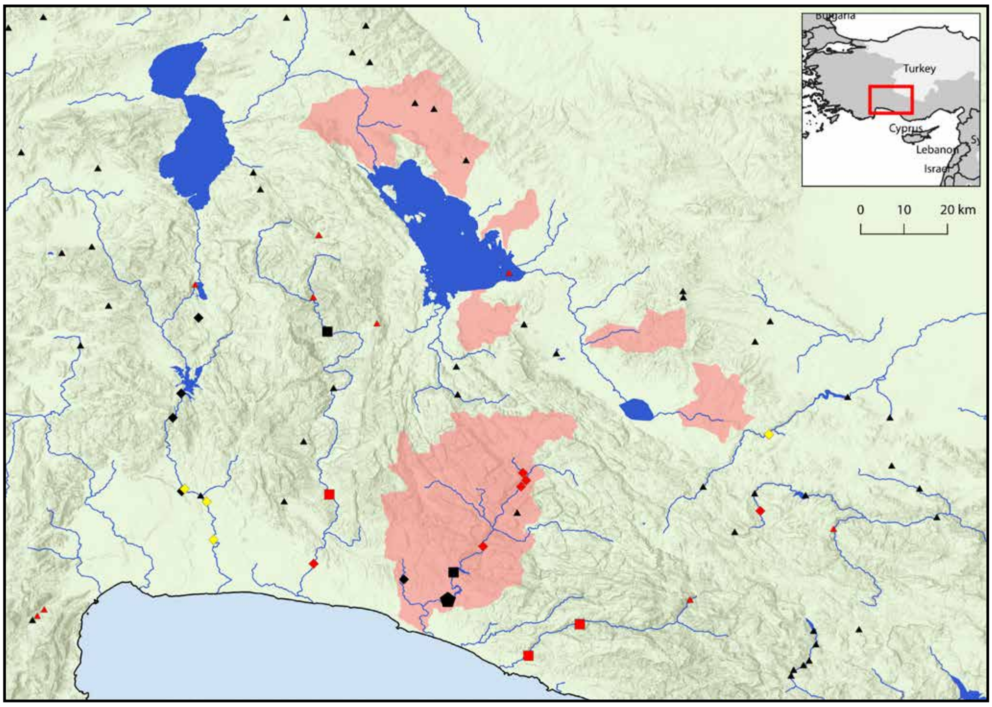
Beyşehir spined loach

Hydropower Hazard: *MODERATE*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Known from Çeltek Stream and Eflatun Pınarı spring in the Lake Beyşehir basin, southwestern Turkey. It also occurs in Çarsamba Stream below the artificial Apa reservoir, which is partially fed by overflow from Beyşehir after passing through the heavily-modified Lake Suğla via a long man-made channel. An additional population inhabits the Manavgat River, which flows into the Mediterranean Sea. Lake Beyşehir is shrinking due to excessive water abstraction, including construction of dams on its tributaries. A reservoir on the Manavgat River has submerged the Dumanlı Spring, thought to be the largest karst spring in the world by discharge, and adversely affected the river below the dam. Additional threats include widespread pollution and introduction of non-native fish species.



© Jörg Freyhof

Cobitis bilseli

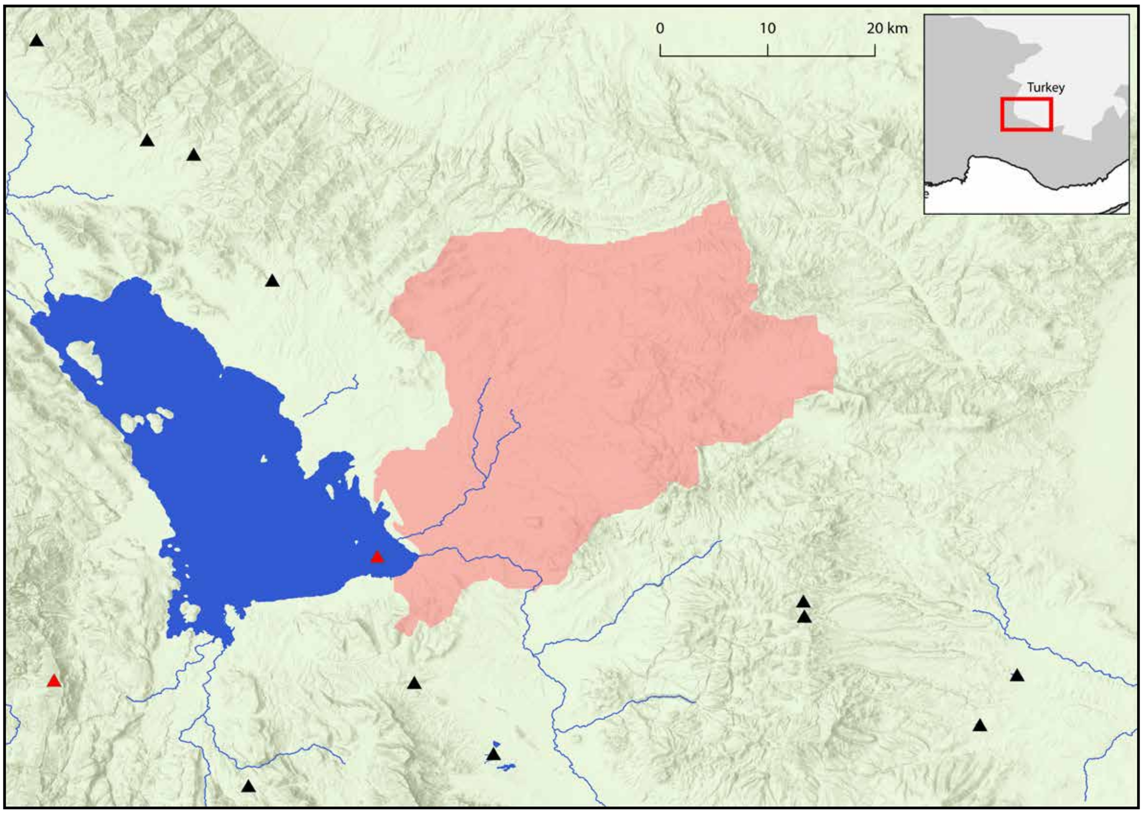
Great Beyşehir spined loach

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Known only from the Sarıöz and Sarıçay streams flowing to the east of Lake Beyşehir in southwestern Turkey, but might be more widespread in the area. It has also been recorded from the man-made Beyşehir channel which provides an overflow from the lake to nearby Lake Suğla during periods of high water. This species inhabits small rivers and streams and has not been recorded from the lakes themselves. It is threatened by widespread pollution, excessive water abstraction and introduction of non-native fish species.



© Jörg Freyhof

Cobitis evreni

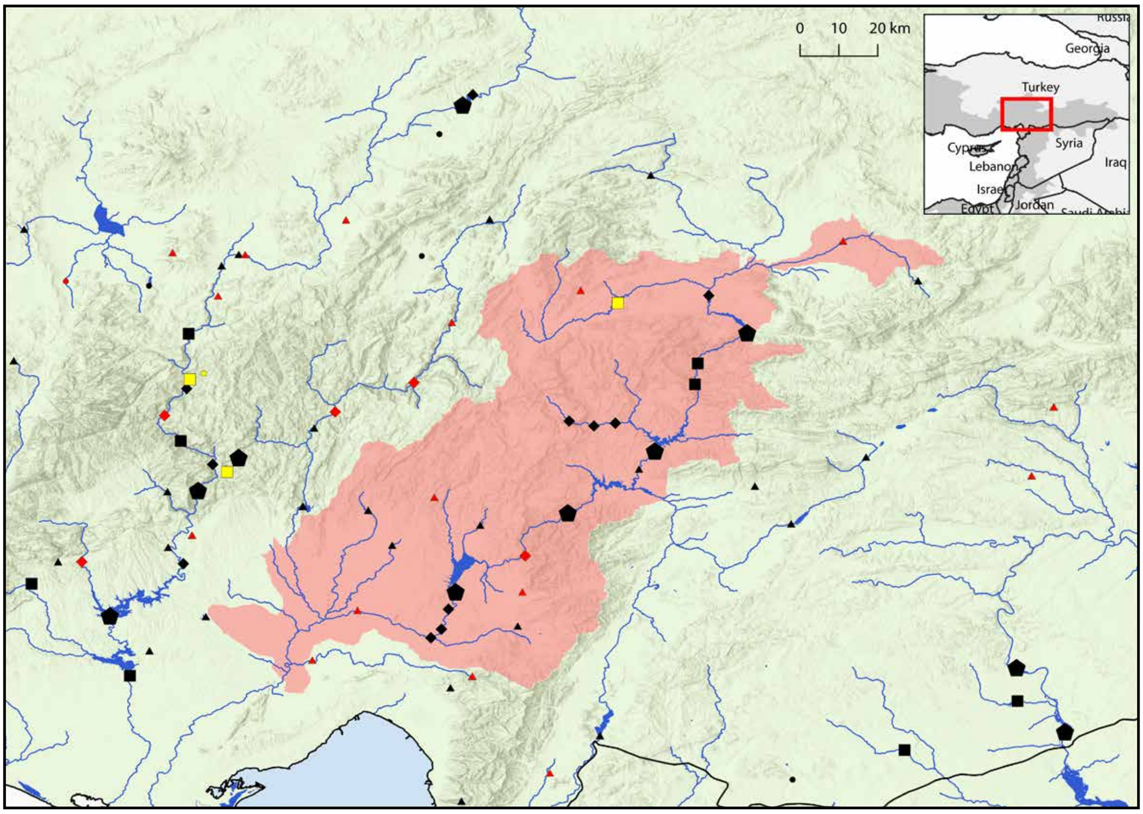
Ceyhan spined loach

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Apparently restricted to the middle Ceyhan River. This species is threatened by pollution, water abstraction, dam construction and other forms of habitat modification such as channelisation of natural channels. The Adatepe Dam on the Göksun Stream was completed in 2002, and there are two major hydroelectric dams on the main Ceyhan channel immediately below its confluence with the Göksun. A small hydroelectric dam has been constructed in the upper Savrun tributary drainage, and there is at least one retention dam on the Hamus. The three known subpopulations have thus been fragmented and suffered a significant reduction in suitable habitat.



© Jörg Freyhof

Hydropower Hazard: *MODERATE*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

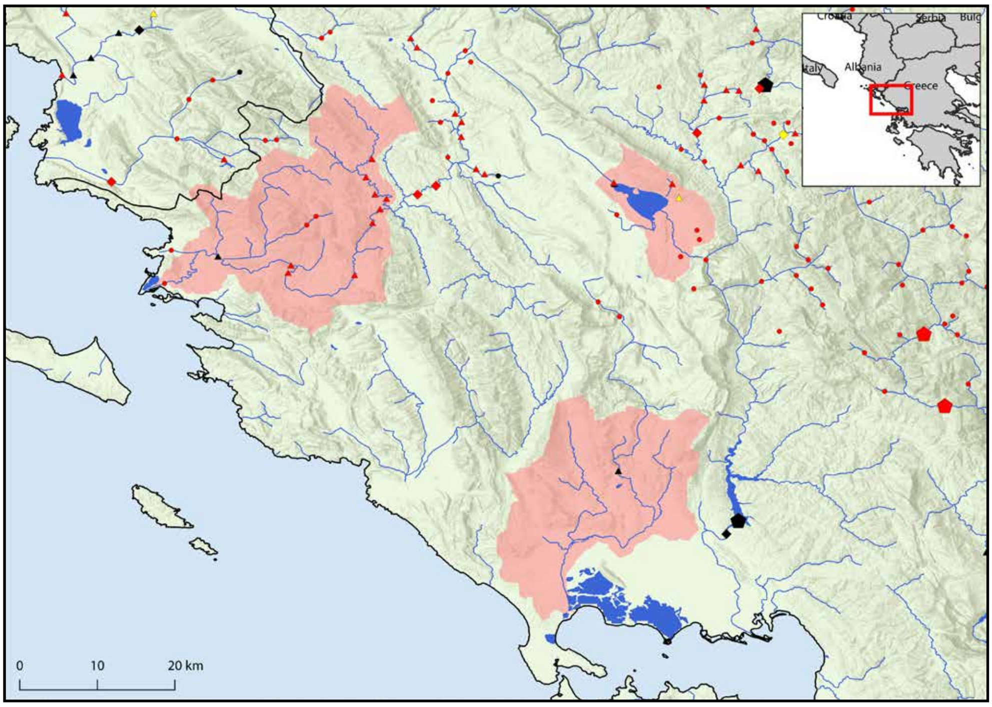
Cobitis hellenica

Louros spined loach

Distribution: Greece

Endemic to the Louros and Kalamas (aka Thyamis) river drainages in western Greece, and colonised nearby Lake Pamvotida after a man-made tunnel and canal built in the 1960s created a connection to the Kalamas River. This species is threatened by water abstraction, pollution, drainage of wetlands, introduction of non-native fish species and potential hybridisation with the closely-related Arachthos spined loach (*Cobitis arachthosensis*) via artificial canals linking the lower Louros with the adjacent Arachthos River. There is a hydroelectric dam on the upper Louros and another above the Kalamas delta. Lake Pamvotida became severely eutrophic in the mid-1980s and is currently hypertrophic for several months each year.

* as *Cobitis taenia*



© Jörg Freyhof

Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

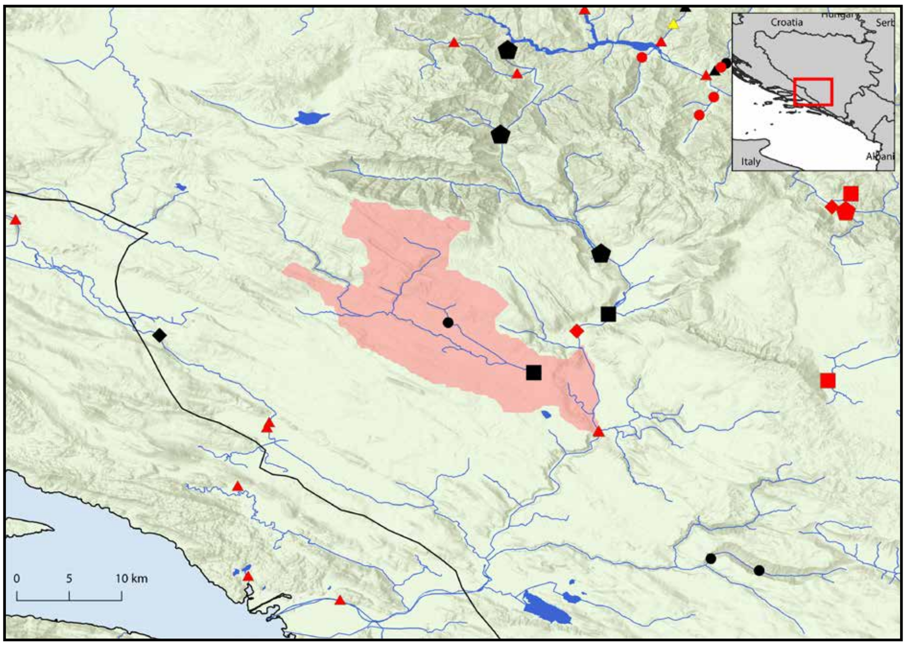
IUCN Red List: *CRITICALLY ENDANGERED*

Cobitis herzegoviniensis

Mostarsko spined loach

Distribution: Bosnia-Herzegovina

Only known from the Lištica River drainage in the Mostarkso Blato polje, which floods to form a large wetland during high water levels. In 1947 a drainage tunnel was excavated through the limestone hill beneath which the Lištica River passes to reduce flooding, although it did not prove particularly efficient. A 9.5 km drainage channel was later excavated through the middle of the karst field to collect water for irrigation. During the early 2000s the last few hundred metres of the river in the karst field were modified to direct water towards a hydroelectric power plant. This has been operational since 2010 and has significantly reduced both the expanse and duration of flood events with a sizeable reduction in the extent of available spawning habitat for native fishes. A reservoir associated with the plant collects water in the lowermost part of the Lištica and is likely to favour introduced alien fish species that were already present in the river. Extraction of gravel and sand from the Lištica which continued until at least the mid-2000s and might be ongoing has caused widespread habitat degradation in the western portion of Motarsko Blato. Household sewage was discharged directly into groundwater for decades and this may still be the case since it is unclear whether a water treatment plant due to be built in 2010 was completed.



* as *Cobitis taenia*

© Jörg Freyhof

Cobitis illyrica

Illyrian spined loach

Hydropower Hazard:
HIGH

EUR-HAB-DIR:
*ANNEX II **

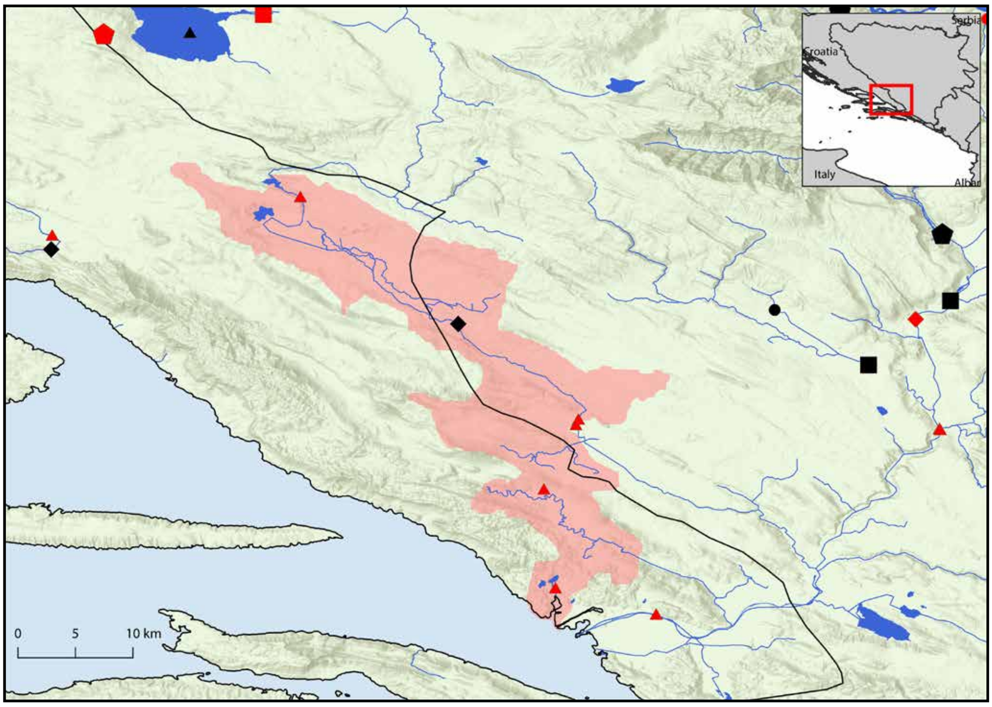
Bern Convention:
*APPENDIX III **

IUCN Red List:
ENDANGERED

Distribution: Bosnia-Herzegovina and Croatia

Restricted to right-bank tributaries of the lower Neretva River drainage. In Bosnia-Herzegovina it occurs in Lake Krenica, while in Croatia it is known from the Vrgorska Matica River plus Lake Prološko Blato and the Baćina lakes near the Neretva delta. It is threatened by habitat loss through pollution, drying or channelisation of watercourses and introduction of non-native fish species. One hydroelectric dam already exists on the Vrljika River at Ričice, reducing downstream flow and encouraging the spread of alien species, and several smaller plants have apparently been installed on the Trebižat section.

* as *Cobitis taenia*



© Perica Mustafic

Hydropower Hazard:
HIGH

EUR-HAB-DIR:
*ANNEX II **

Bern Convention:
*APPENDIX III **

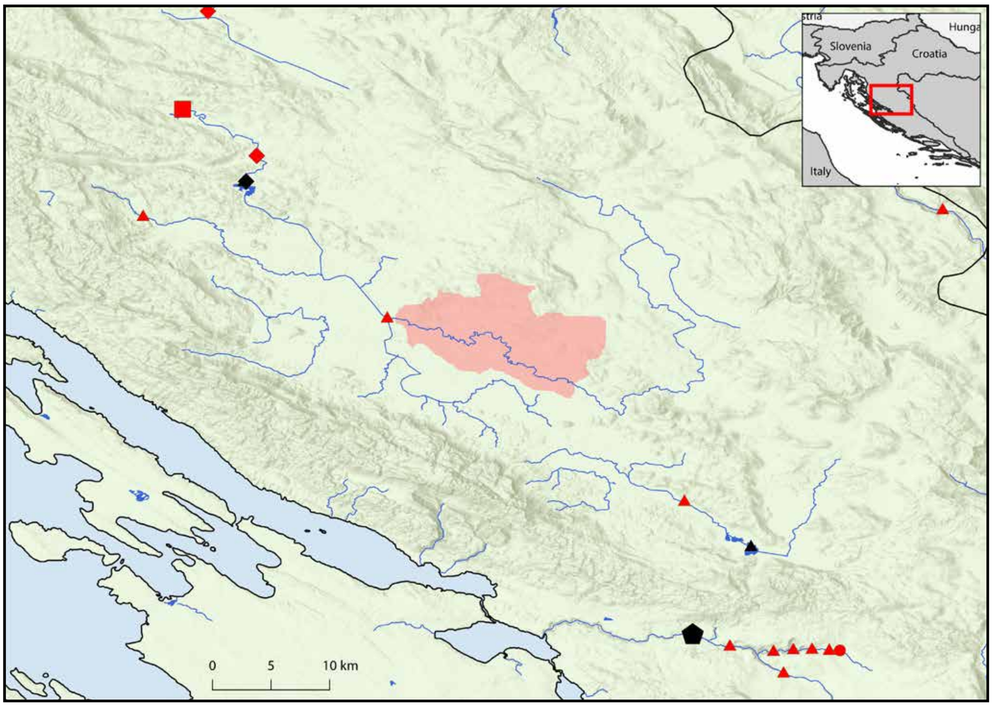
IUCN Red List:
CRITICALLY ENDANGERED

Cobitis jadovaensis

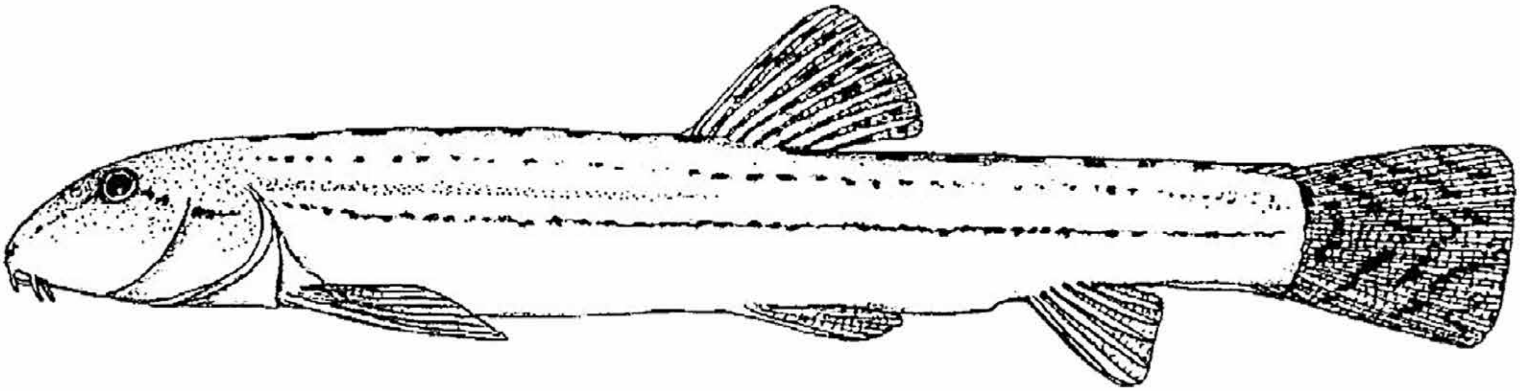
Jadova spined loach

Distribution: Croatia

Now restricted to upper parts of the Jadova River, a temporal tributary within the Lika River drainage in central Croatia. It has vanished from some former locations such as the Balatin stream, and is threatened by pollution, water abstraction, drought due to climate change, construction of small retention dams and most importantly introduction of non-native fish species. The latter became established in the lower Lika following completion of the Kruščica dam and hydroelectric plant, and presumably drove extirpation of the minnow and other native fishes from most parts of the drainage. Larger predators such as northern pike (*Esox lucius*) and European perch (*Perca fluviatilis*) are present in Kruščica resrevoir and pools formed by retention dams in the Lika main channel but have not yet become established in smaller tributaries. Others, including pumpkinseed (*Lepomis gibbosus*), common roach (*Rutilus rutlilus*), and common chub (*Squalius cephalus*) have been more successful and are now the most abundant species in the lower Jadova. Additional hydro-power schemes on the Lika are reportedly being planned.



* as *Cobitis taenia*



© Banarescu (1964)

Cobitis kellei

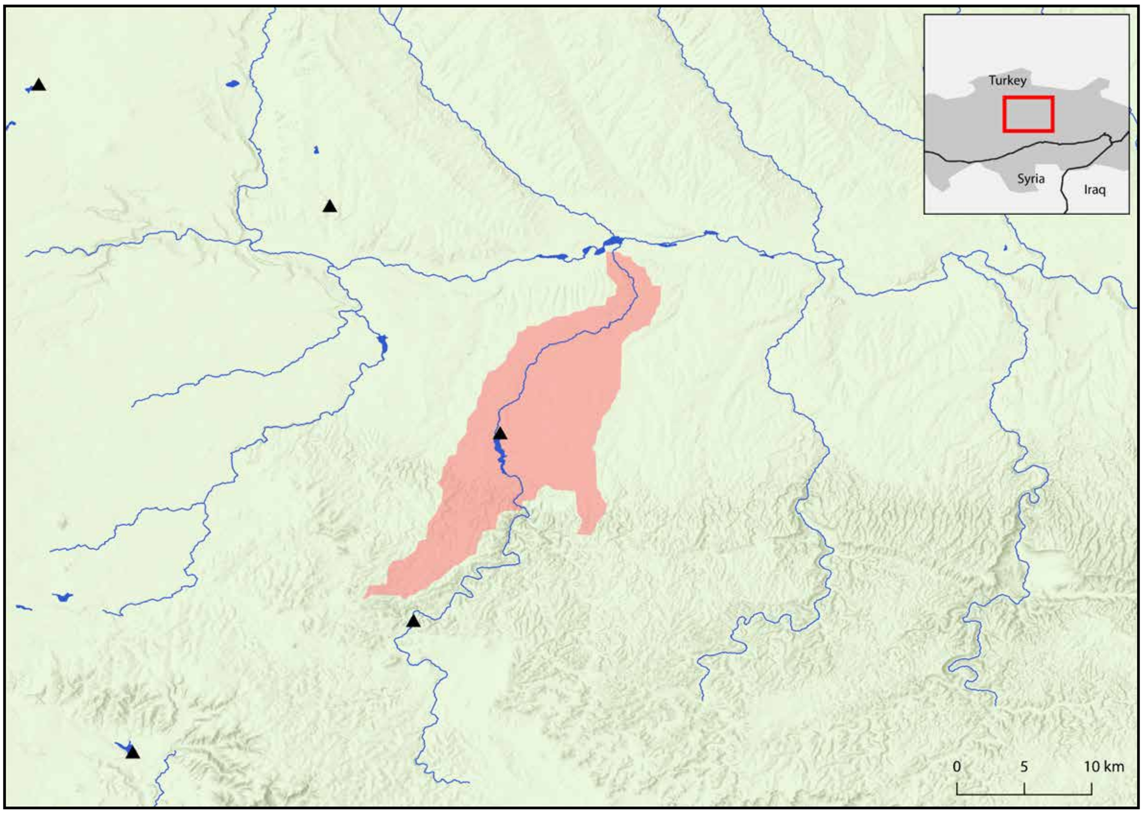
Diyarbakir spined loach

Distribution: Turkey

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED (Possibly Extinct)*

Known only from the Göksu stream near the town of Çınar within the upper Tigris River drainage in eastern Turkey. It was last collected there in 1974 despite subsequent attempts, but might occur elsewhere in the area. The Göksu Dam was completed in 1991 a few kilometres upstream of this species' type locality and is likely to have adversely affected the flow regime.



© Michel Bariche

Cobitis levantina

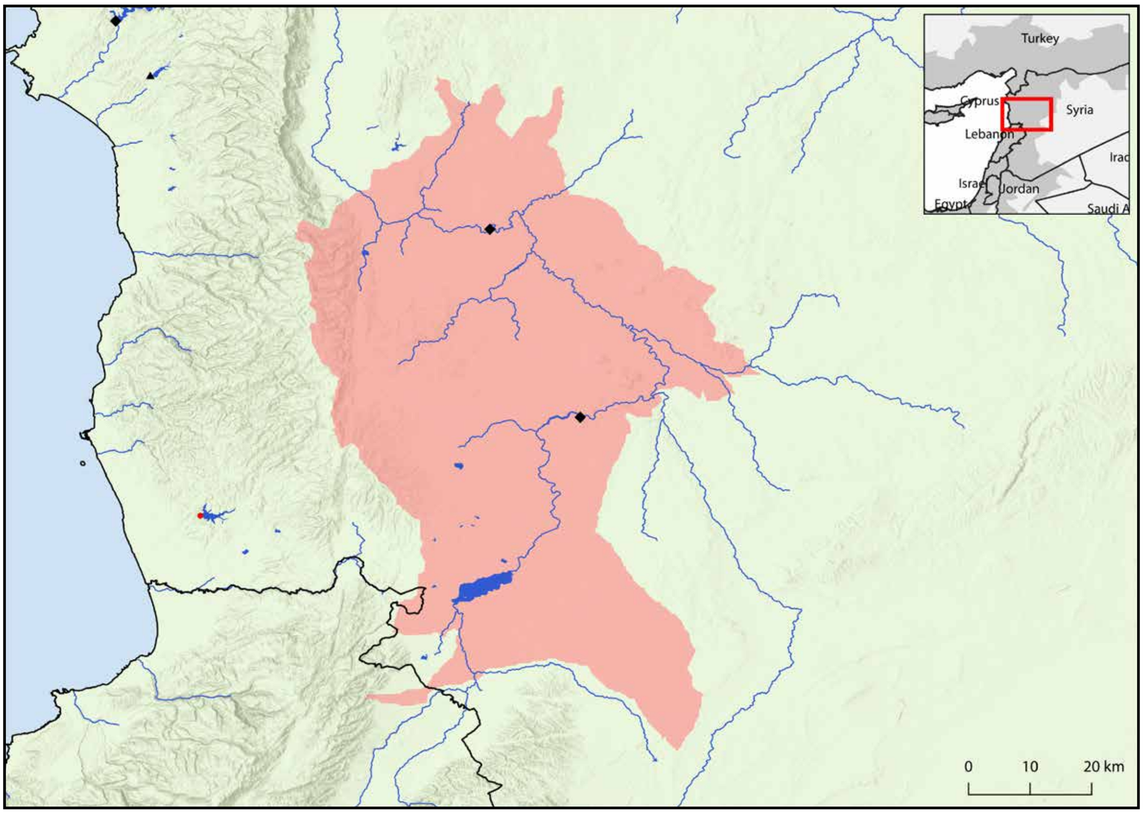
Orontes spined loach

Hydropower Hazard: *MODERATE*

IUCN Red List: *ENDANGERED*

Distribution: Lebanon and Syria

Restricted to the upper Orontes River (tr. Asi) drainage in Syria and at least one location within the Litani River drainage in Lebanon. Dam construction has led to the drying of many river stretches and significantly reduced the extent of suitable habitat, while excessive water abstraction and pollution are widespread throughout its range.



© Jörg Freyhof

Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

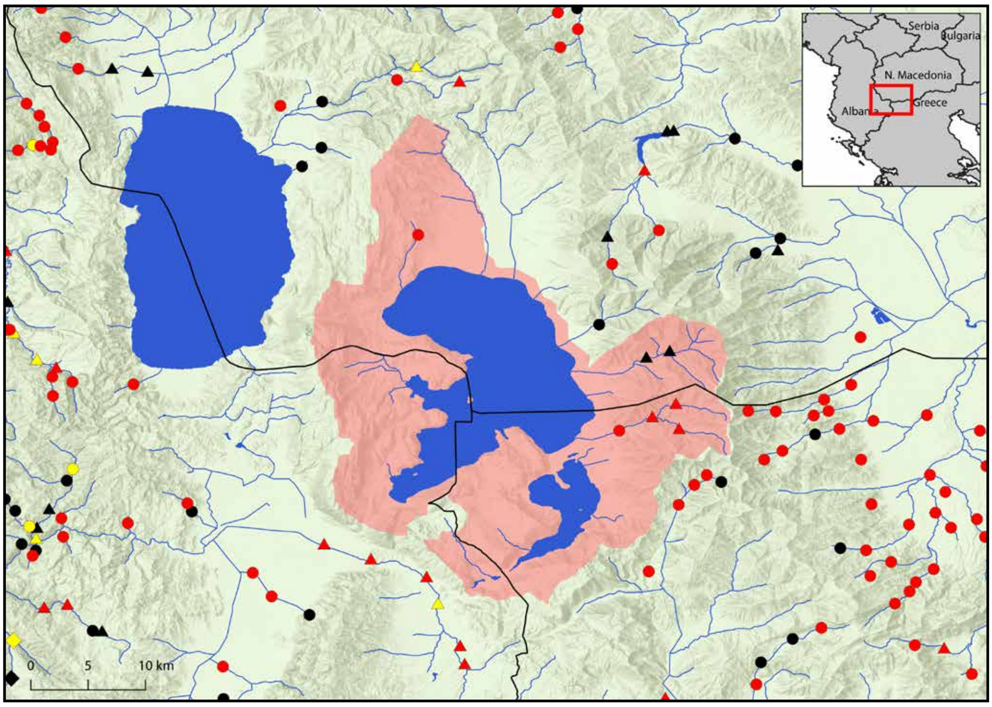
IUCN Red List: *ENDANGERED*

Cobitis meridionalis

Prespa spined loach

Distribution: Albania, North Macedonia and Greece

Endemic to the two transboundary Prespa Lakes in northwestern Greece, Albania, and North Macedonia. It inhabits shallow shorelines and tributary streams with substrates of sand or mud, and is often associated with aquatic vegetation. Water abstraction, pollution and especially introduction of several non-native fish species are the main threats facing the Prespa lakes' endemic fish fauna, despite the area being surrounded by three national parks. Recent studies suggest the resident fish community is increasingly dominated by invasive aliens, while the water level has decreased by around eight metres since the mid-1980s and eutrophication is ongoing. There are a number of existing small hydropower plants and retention dams on streams flowing into Great Prespa and several future projects are planned.



* as *Cobitis taenia*

© Jörg Freyhof

Cobitis phrygica

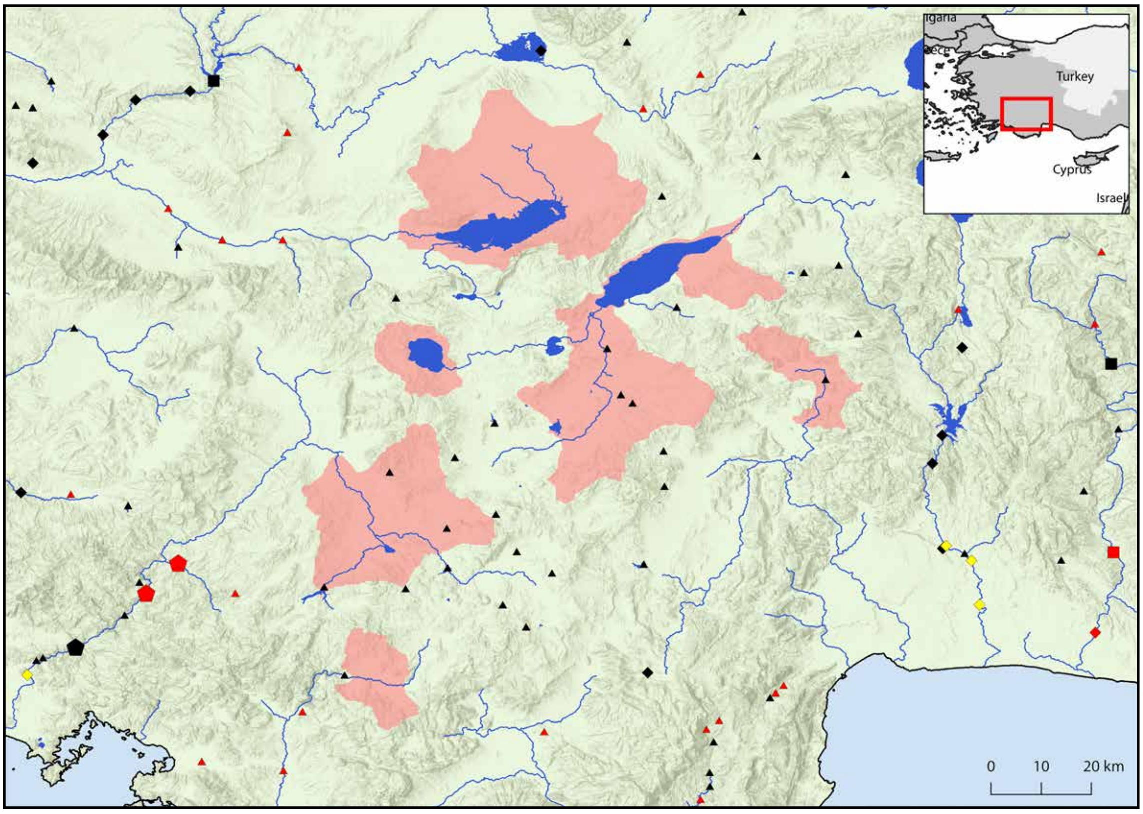
Phrygian spined loach

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Native to southwestern Turkey, where it occurs in the Acı, Burdur, Salda and Sögüt lake basins, the Aksu endorheic stream north of Bucak, and the Esen and upper Dalaman River drainages which flow to the Aegean Sea. It inhabits both flowing and standing waters with substrates of silt or sand, and often aquatic vegetation. This species is threatened by pollution, excessive water abstraction, dam construction and increasing frequency and intensity of droughts.



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Hydropower Hazard: *MODERATE*

EUR-HAB-DIR: *ANNEX II*

Bern Convention: *APPENDIX III*

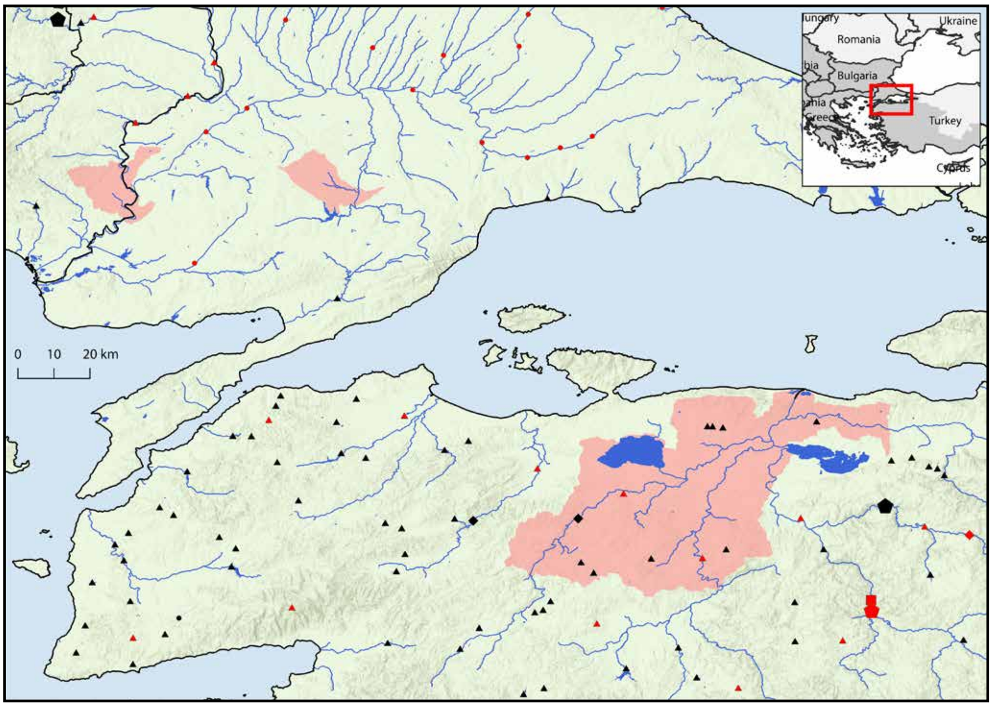
IUCN Red List: *ENDANGERED*

Cobitis puncticulata

Brown spined loach

Distribution: Greece and Turkey

Native to the lower Simav River (Turkey) and the lower Evros (bg. Maritsa) River in Turkey and Greece. This species is primarily threatened by water abstraction, pollution and habitat modification. Lakes Manyas and Apolyont are both eutrophic due to long-term discharge of agricultural chemicals plus untreated domestic and industrial waste. They have also suffered from overfishing, increased erosion driven by mining activities, land reclamation, water abstraction, and construction of dykes and canals. The natural annual flood cycle of Lake Manyas was altered after a regulator to artificially control the water level was installed on the Kara River. A hydroelectric station supplied with water from a dam on one of Lake Apolyont's two main tributaries was commissioned in 2010 and is located on the southern shore, receiving water via an 11 kilometre tunnel which is then discharged into the lake.



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Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

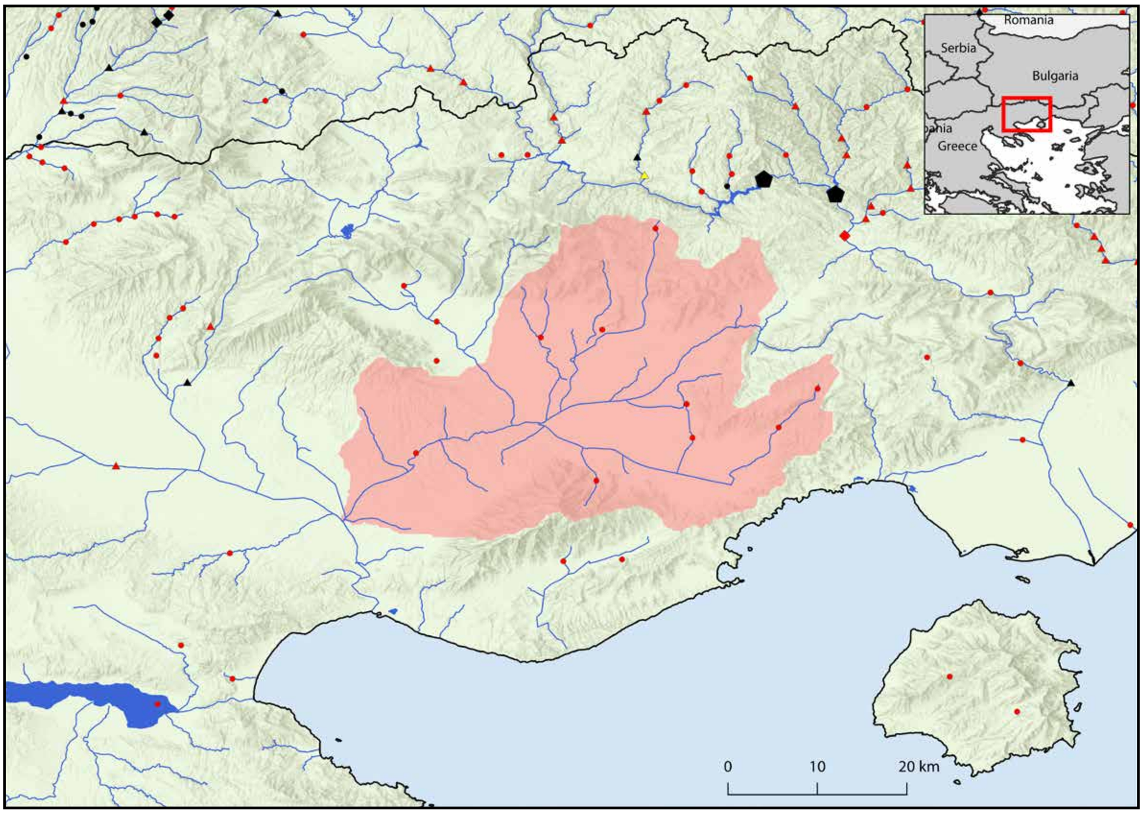
Cobitis punctilineata

Aggitis spined loach

Distribution: Greece

Restricted to the Aggitis (aka Angitis) River drainage and associated wetlands, a tributary of the Struma (gr. Strymon) River in northern Greece. This species is threatened by habitat degradation, in particular channelisation of streams, water abstraction, agricultural pollution, and increasing frequency and intensity of drought. There are currently no hydropower plants on the Aggitis River.

*as *Cobitis taenia*



© Jörg Freyhof

Cobitis trichonica

Trichonis spined loach

Hydropower Hazard: *LOW*

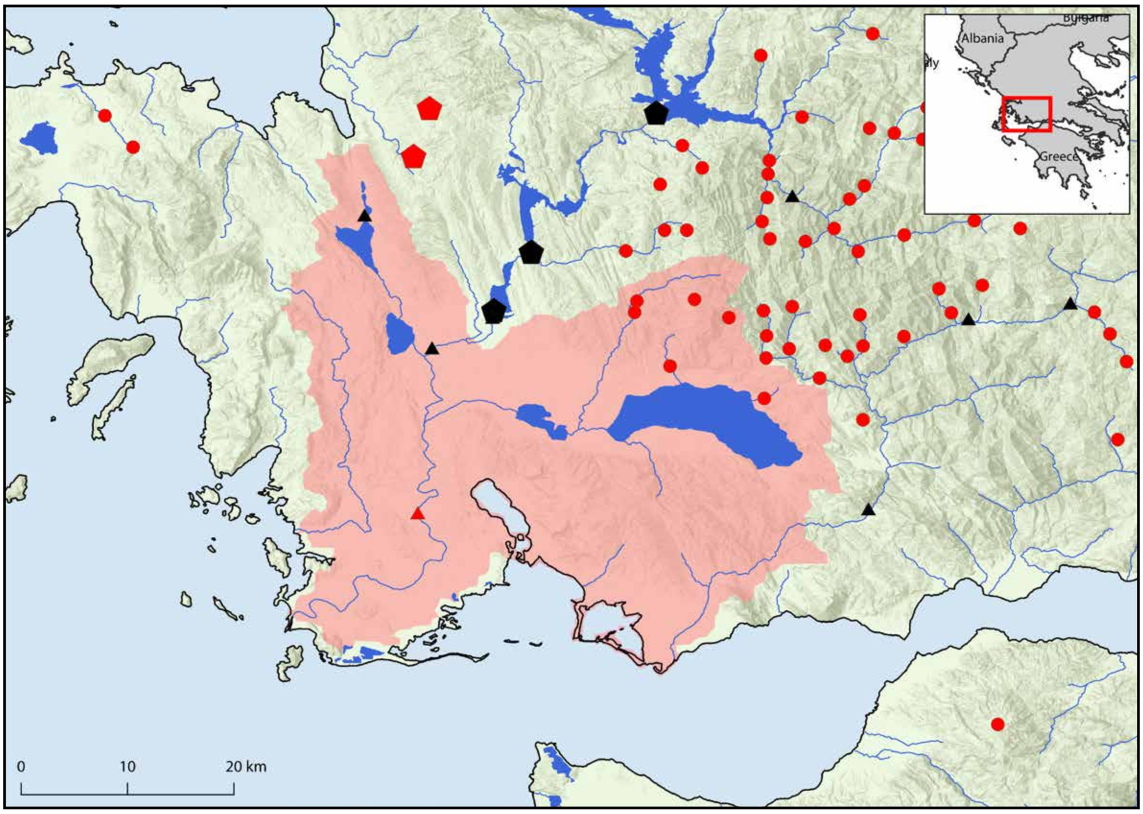
EUR-HAB-DIR: *ANNEX II*

Bern Convention: *APPENDIX III*

IUCN Red List: *ENDANGERED*

Distribution: Greece

Restricted to Lakes Trichonida, Lyssimachia, Ozeros and Amvrakia, plus the lower Acheloos (aka Achelous) river drainage in western Greece. This species is threatened by excessive water abstraction, pollution and climate change, while several non-native fish species have also been introduced within its range. Four hydroelectric dams have already been constructed on the Acheloos River and its tributaries, and two more are partially complete with construction stalled due to a series of legal challenges. The hydrological regime in the lower part of the river has been completely altered as a result.



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Hydropower Hazard: *MODERATE*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

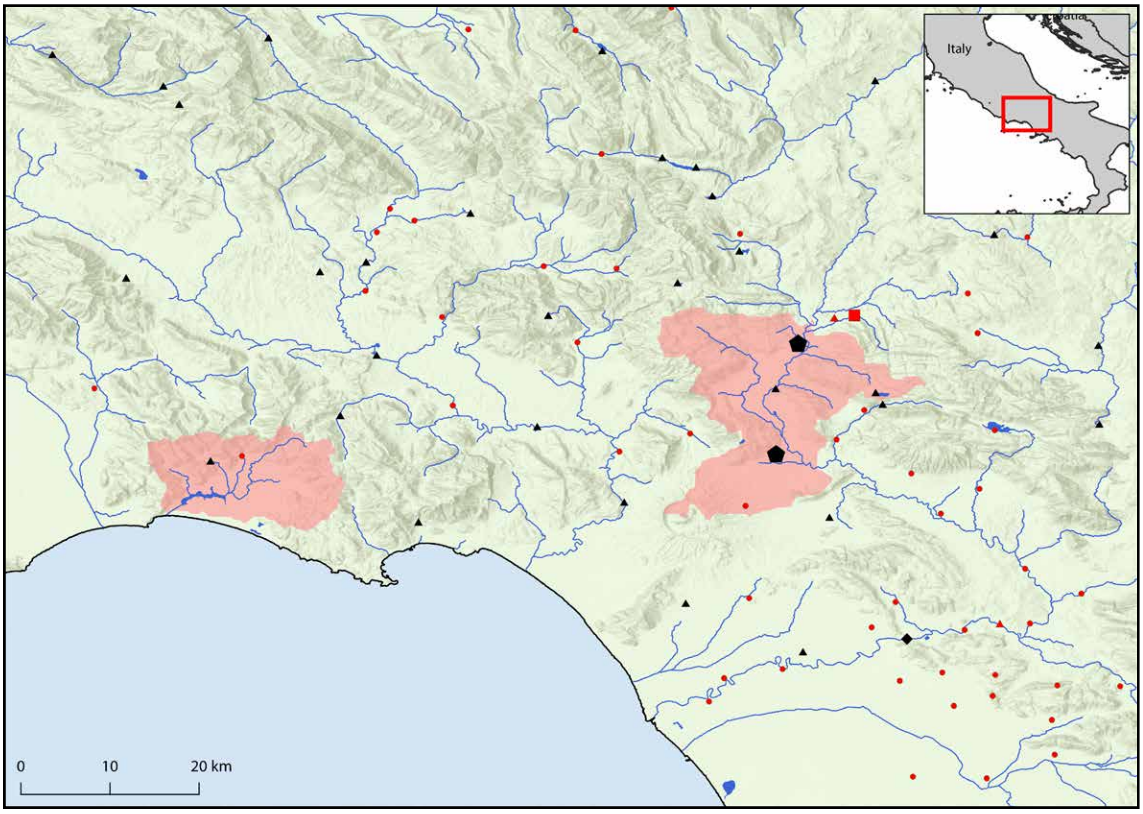
Cobitis zanandreai

Volturno spined loach

Distribution: Italy

Known only from a short stretch of the Volturno River drainage plus the Lake Fondi basin in central Italy, where it has been found in two small tributary streams. It potentially occurs in other wetlands nearby but these records require confirmation. It inhabits streams and artificial canals with sand or mud substrates, and is often found near riparian vegetation. It is threatened by climate change and associated droughts, habitat degradation, water abstraction, and introduction of non-native species including the congeneric Italian spined loach (*Cobitis bilineata*).

* as *Cobitis taenia*



© Jörg Freyhof

Sabanejewia larvata

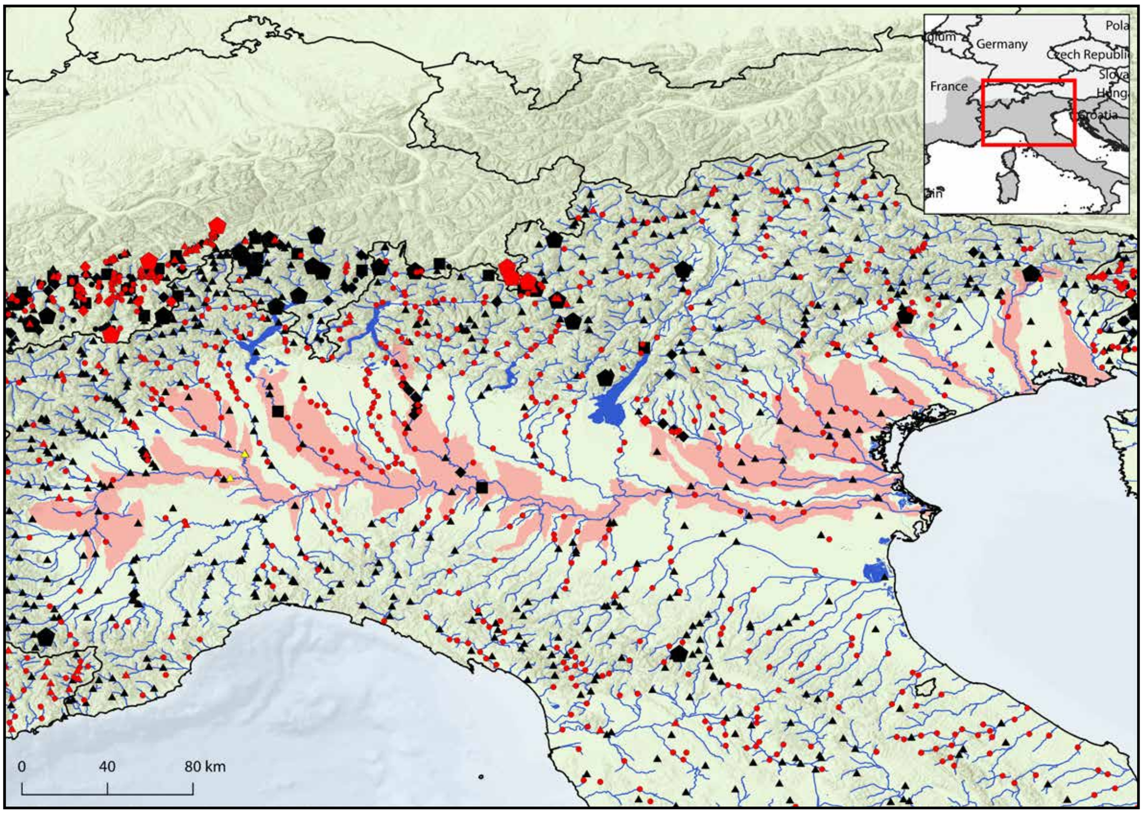
Italian golden loach

Distribution: Italy

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Widespread but not abundant in northern Italy, where populations are relatively small and geographically fragmented. It has reportedly been introduced to Lake Trasimeno plus the Tiber and Ombrone river drainages but it remains unclear if it has become established there. This species is threatened by habitat destruction, drought, water abstraction and pollution, but it is believed that extensive introduction of non-native fish species represents the most significant risk.



© FDAAPPMA 66

Barbatula leoparda

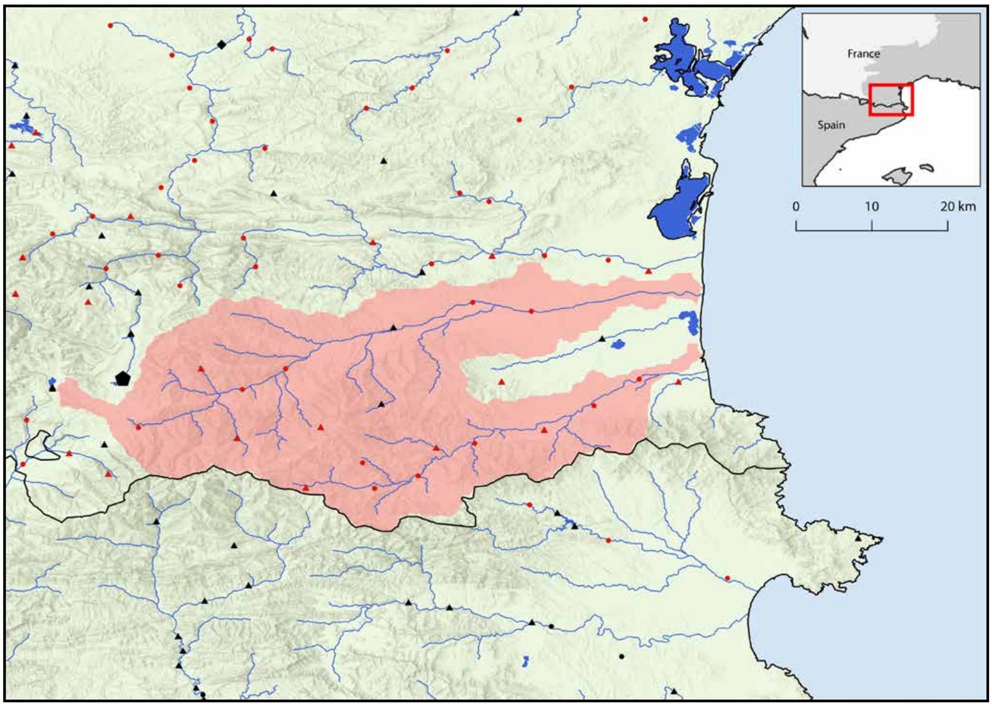
Leopard stone loach

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: France

Known only from the Têt and Tech river drainages on the Mediterranean slope of southern France. It primarily inhabits foothill streams with running water and substrates of rocks and stones, while smaller populations occur in lowland habitats. This species is mostly threatened by reduced discharge and habitat fragmentation caused by construction of dams and weirs designed to both moderate the threat of flash floods and increase the amount of available irrigation water. Additional pressures include pollution plus extraction of sand and gravel. One hydroelectric dam already exists on the upper Têt and further development would have a detrimental effect on this species' populations.



© Alena Sediva

Barbatula sturanyi

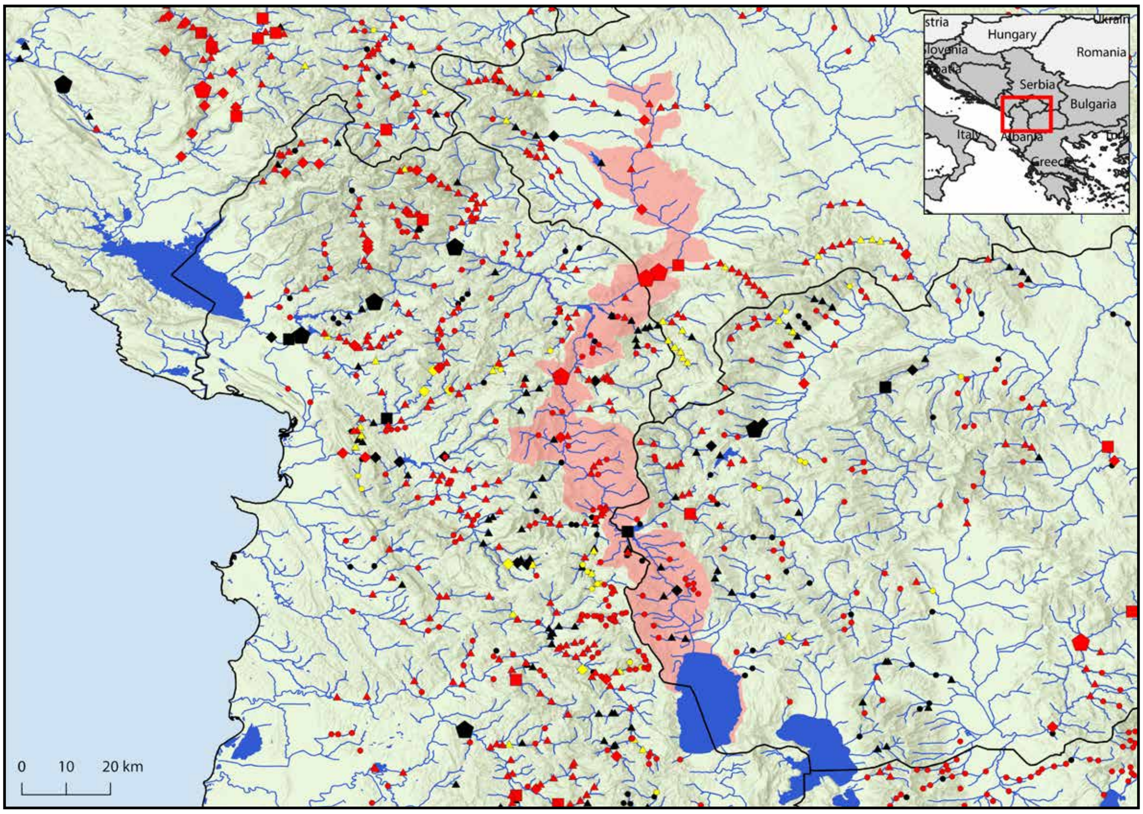
Ohrid stone loach

Hydropower Hazard: *MODERATE*

IUCN Red List: *VULNERABLE*

Distribution: Albania, North Macedonia and Serbia (Kosovo)

Native to the Lake Ohrid basin and upper Drin River drainage, but the full extent of its distribution remains unclear. It primarily inhabits foothill streams with running water and substrates of rocks and stones. This species is mostly threatened by reduced discharge and habitat fragmentation due to construction of dams, particularly in the Drin River. Additional pressures include pollution.



© Jörg Freyhof

Barbatula zetensis

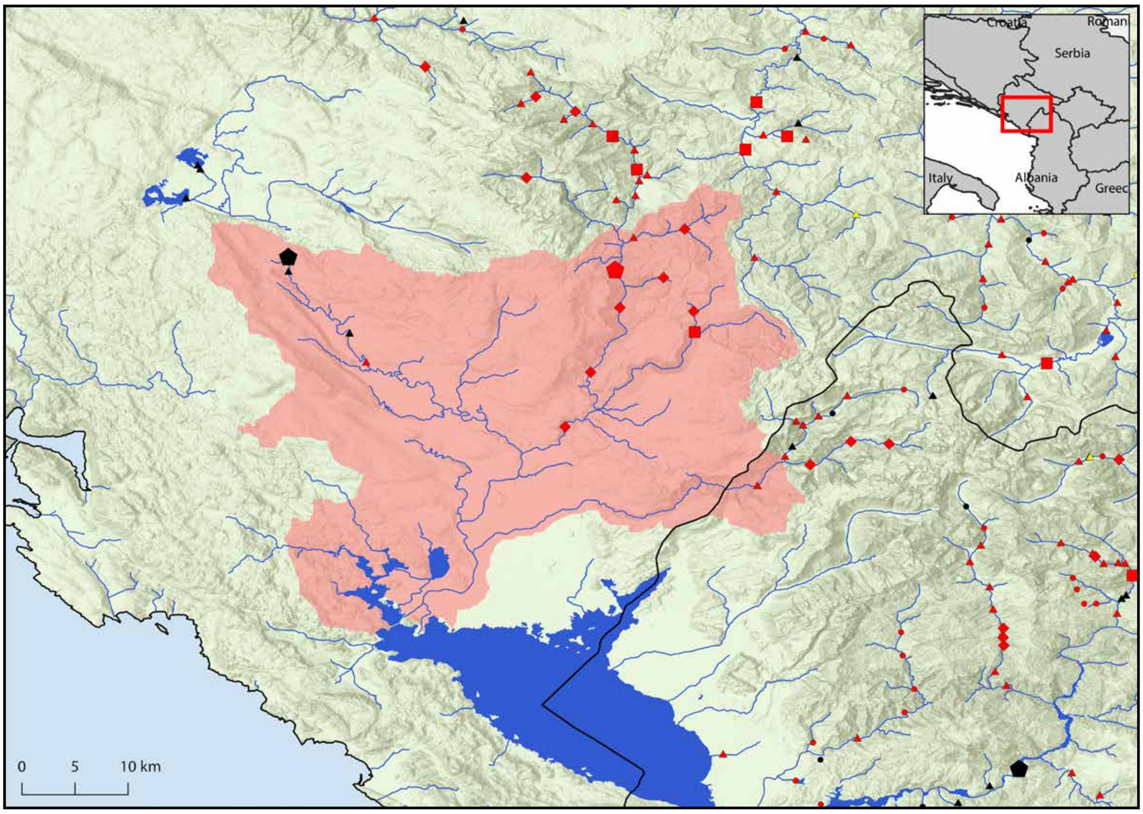
Zeta stone loach

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Montenegro

Endemic to the Morača River drainage in Montenegro, where it occurs in the middle and lower basins including the affluent Zeta and Civenja rivers. It primarily inhabits foothill streams with running water and substrates of rocks and stones. This species is mostly threatened by reduced discharge and habitat fragmentation due to construction of dams. Additional pressures include pollution, and future hydropower development is a major threat.



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Oxynoemacheilus anatolicus

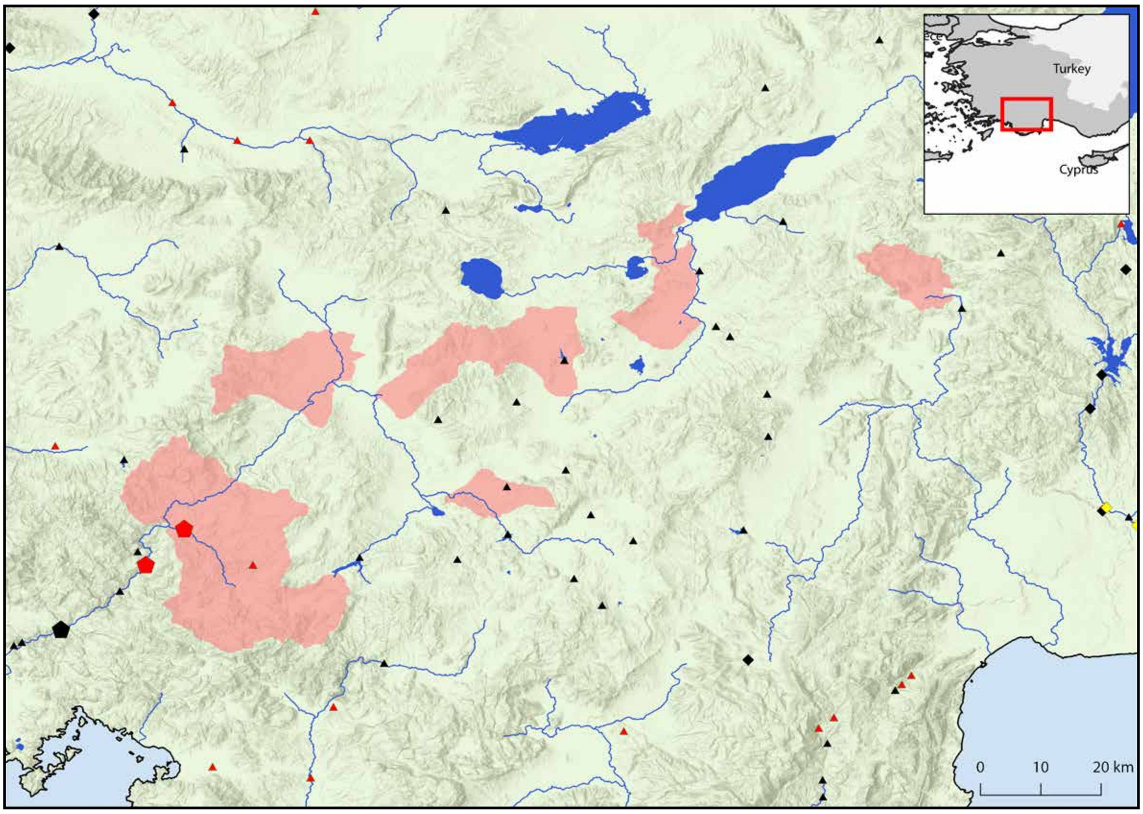
Burdur loach

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Endemic to the Lake Burdur basin, the upper Dalaman River drainage and the Değirmendere stream flowing into the artificial Karamanlı reservoir. None of these tributaries now reach Lake Burdur, which has lost around 30% of its surface area since the mid-1970s due to excessive water abstraction and damming of its affluents. Additional threats in the area include pollution, introduction of non-native species and increasing frequency of droughts.



© Jörg Freyhof

Oxynoemacheilus eregliensis

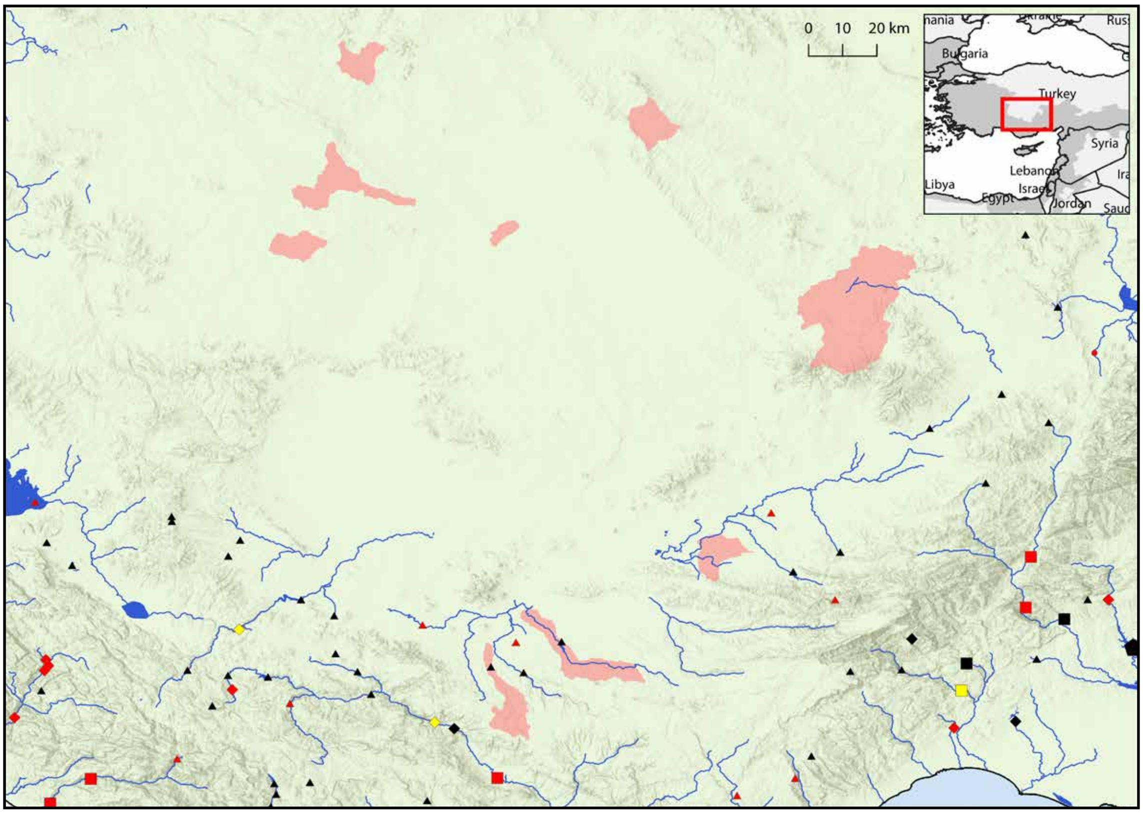
Central Anatolian loach

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Turkey

Endemic to the Lake Tuz basin, with records from Lake Gök, İnsuyu Creek and Gölyazı to the west, Melendiz Stream to the east, and Ybrala Stream at Yesildere, plus Gökdere Stream and associated marshes near Ereğli to the south. It inhabits small rivers, streams and springs with slowly-flowing water and substrates of sand or gravel, and one small lake with emergent aquatic vegetation. This species is threatened by water abstraction, pollution, dam construction and increasing frequency of droughts.



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Oxynoemacheilus galilaeus

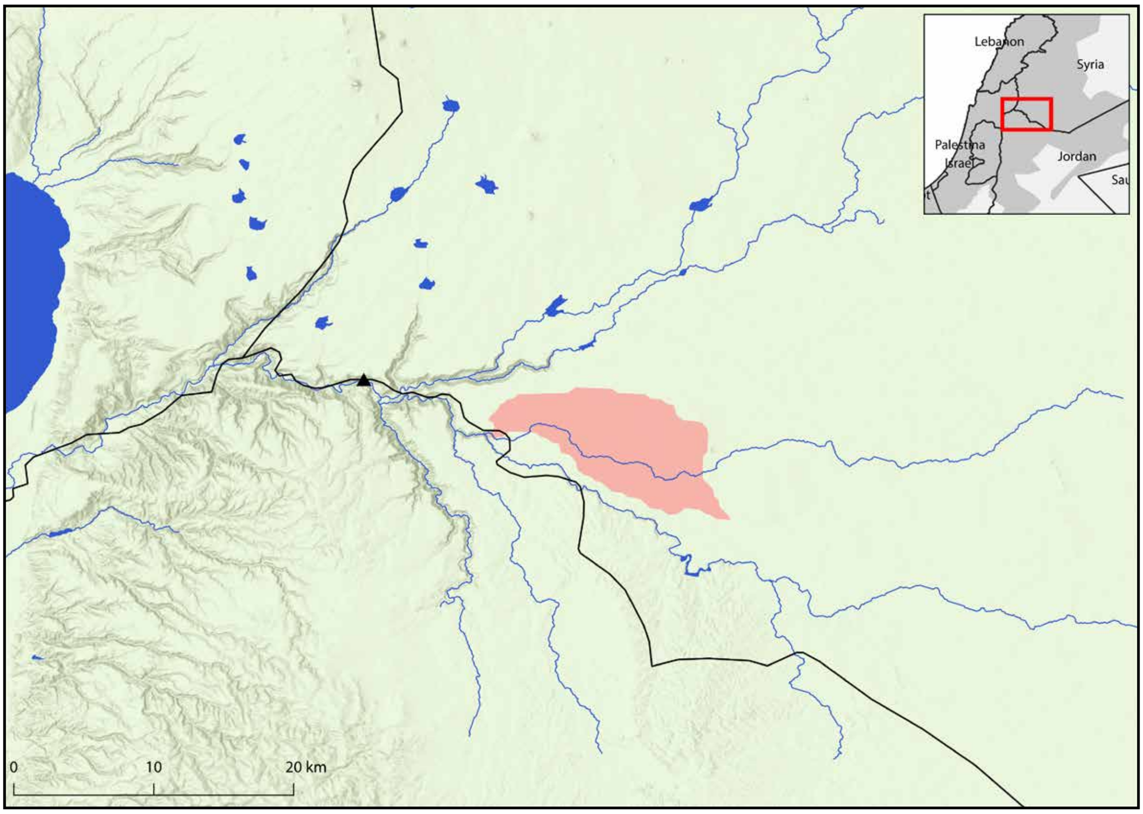
Galilean loach

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Syria

Known only from the Lake Hula and Lake Muzayrib basins, both located within the Jordan River drainage in Israel and Syria, respectively. Lake Hula was drained in the 1950s and the species is thought to be extirpated there. The shallow, spring-fed Lake Muzayrib dried out almost entirely between 2016 and 2018 after the Syrian Civil War prompted the unregulated excavation of thousands of wells in the surrounding area and subsequently depleted the local aquifer. If this species is still extant, it is unlikely to be affected by hydropower development.



© Jörg Freyhof

Oxynoemacheilus germencicus

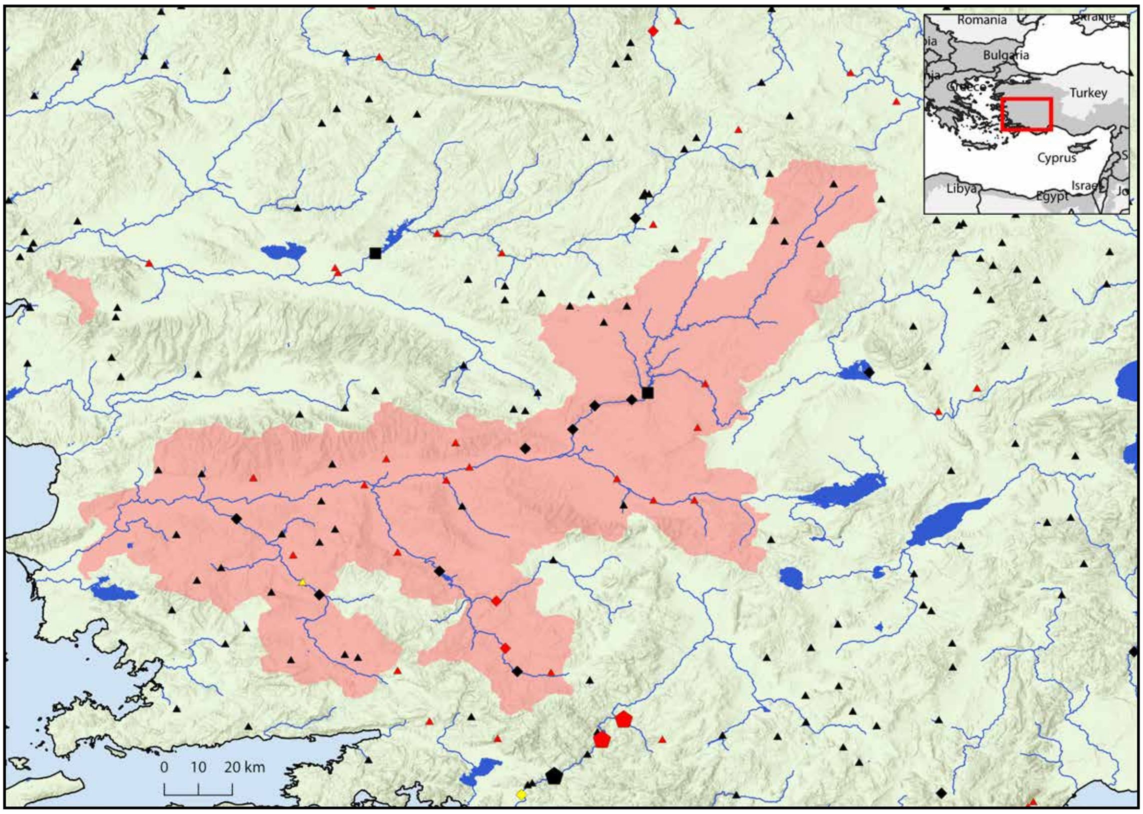
Carian loach

Distribution: Turkey

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Native to the Gediz and Büyük Menderes river drainages in the Aegean Region of western Turkey. The main channels of both rivers are heavily polluted and have been further degraded by construction of multiple dams. The major threats in the area are water abstraction for agriculture and urban use, pollution driven by discharge of agricultural, industrial and domestic effluents, and increasing frequency of droughts.



© Jörg Freyhof

Oxynoemacheilus hamwii

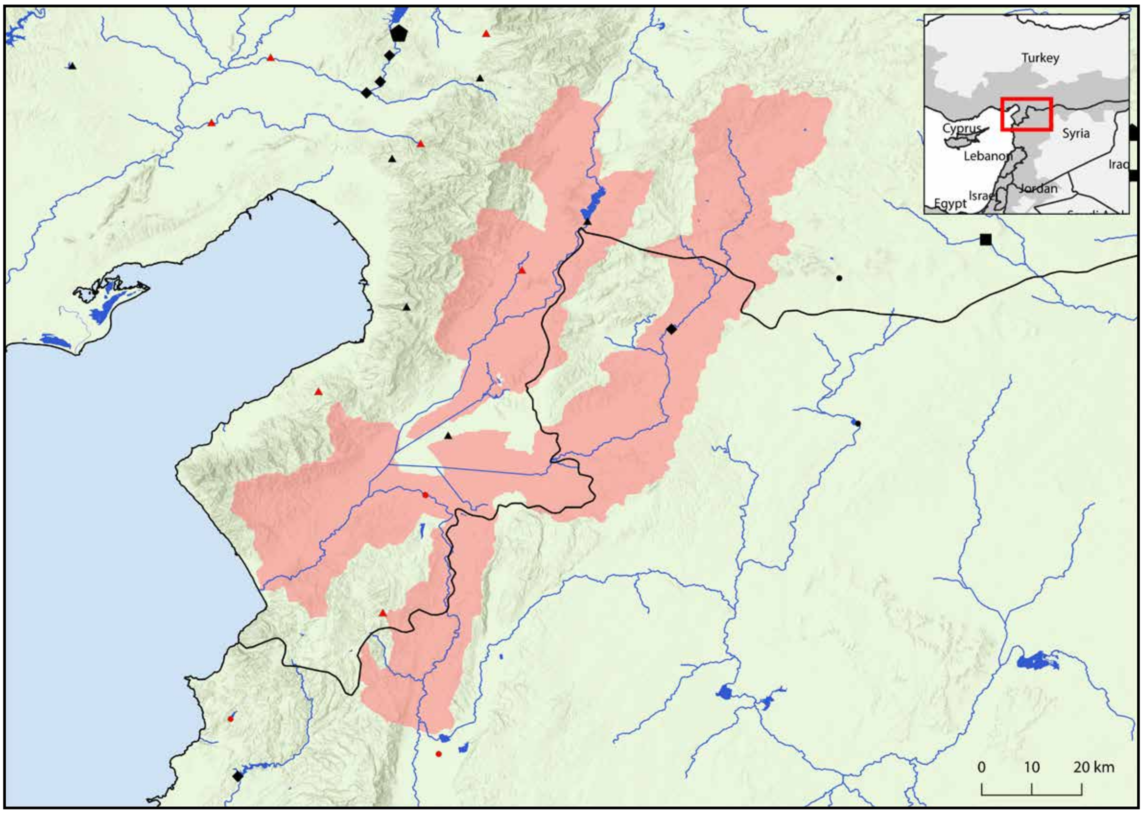
Orontes sportive loach

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey and Syria

Restricted to the Orontes (tr. Asi) River drainage in southern Turkey and western Syria. It was formerly widespread but is currently known only from the Yıldırım, Büyükkara and Küçük Karaçay tributary systems in Turkey, and the upper Afrin River in Turkey and Syria. It inhabits relatively clean, flowing rivers and streams with substrates of mud or gravel. This species is threatened by water abstraction, pollution and dam construction, especially in the upper Afrin. Especially during periods of low rainfall very little water from the Orontes and its affluents may reach Turkey due to a series of dams in Syria.



Oxynoemacheilus mesudae

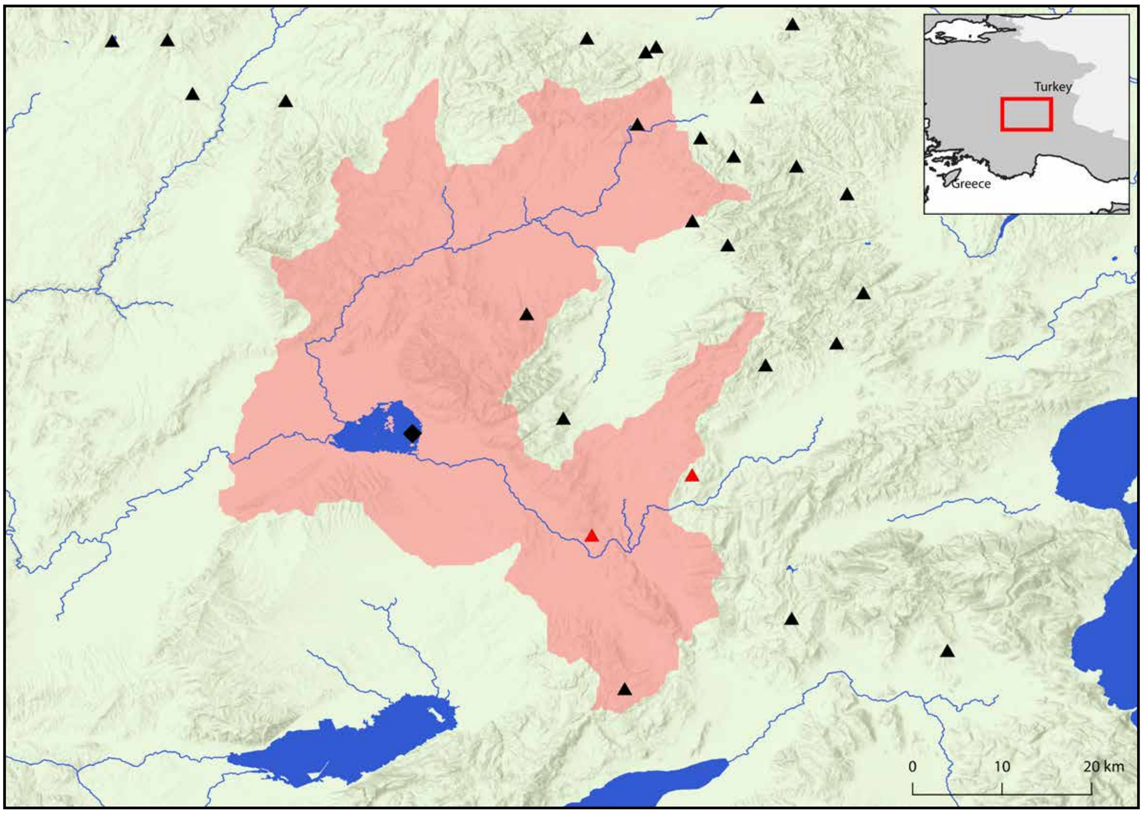
Isıklı loach

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Endemic to the Lake Isıklı basin within the upper Büyük Menderes River drainage. It appears to be restricted to tributaries flowing into the lake and is currently known from four such sites. This species prefers stretches with perennial flowing water and substrates of rocks or gravel. The major threats in the area include water abstraction and pollution, with these issues likely to be compounded due to increased longevity of climate change-induced droughts. A number of small dams designed to hold water for irrigation have been built on some of the streams, reducing the extent of suitable habitat.



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Oxynoemacheilus panthera

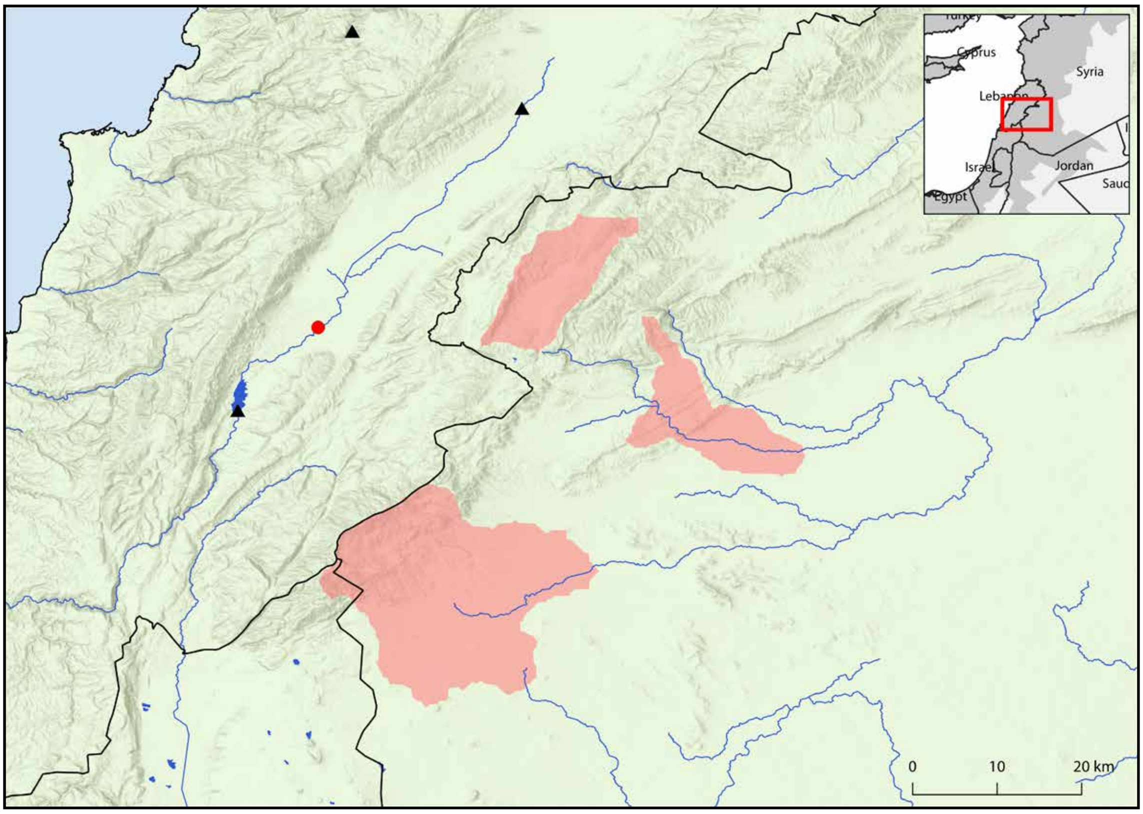
Damascus loach

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Syria

Known only from the endorheic Barada and Awaj river drainages in southwestern Syria. This species is threatened by excessive water abstraction and pollution, and has vanished from the majority of its assumed historical range. Moreover, a large proportion of the remaining upper Barada population was lost in 2008 when the river's source spring at Ain al-Fijah was modified, with most of the water now withdrawn directly to the water supply of Syria's capital city Damascus. As a result of these pressures it now occurs only in a very short stretch in the upper Barada and is also restricted to headwaters of the Awaj.



© Jörg Freyhof

Oxynoemacheilus pindus

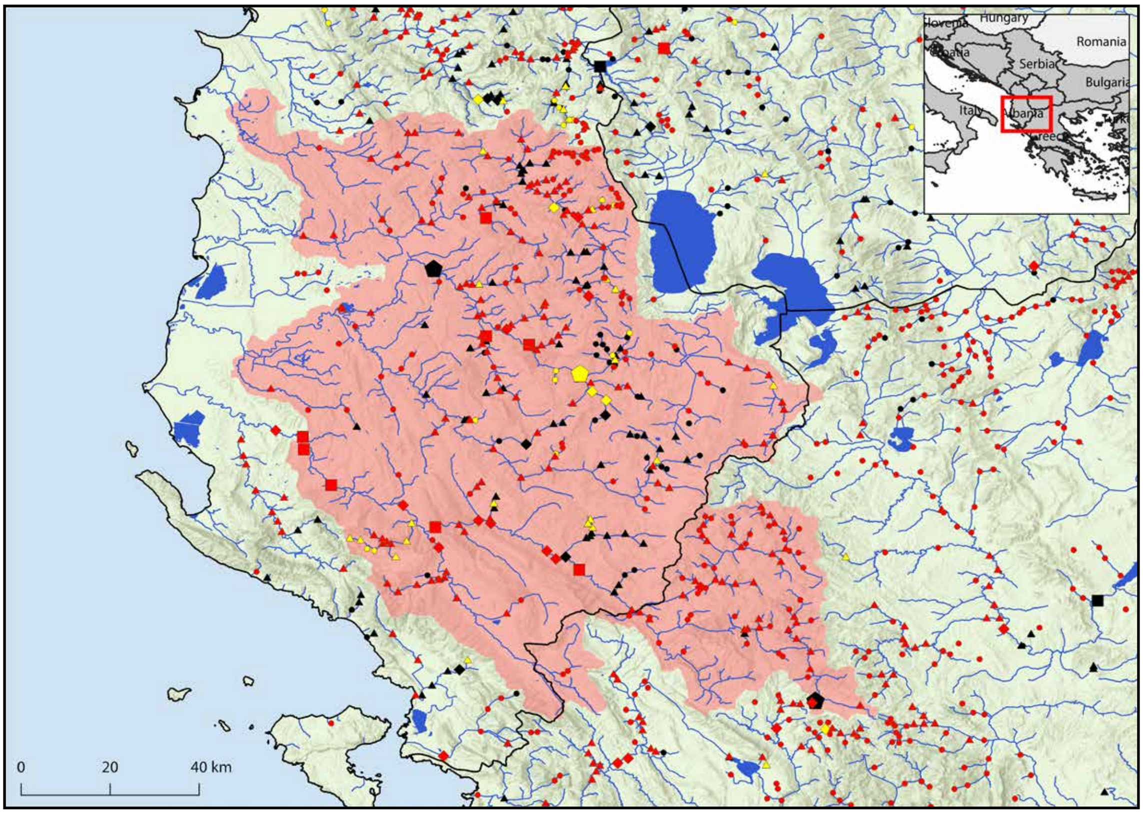
Pindus stone loach

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Albania and Greece

Occurs throughout the Seman, Shkumbin, Erzen and Vjosa river drainages in Albania, including the upper Vjosa (gr. Aoos) in Greece. This species is rheophilic and inhabits larger river channels in stretches with fast-flowing water. Some populations are threatened locally by water abstraction and pollution, but it is most at risk from widespread construction of hydroelectric plants across its range since it is unlikely to survive in the reservoirs created. Some of these are already operational with more than a hundred still planned.



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Oxynoemacheilus seyhanensis

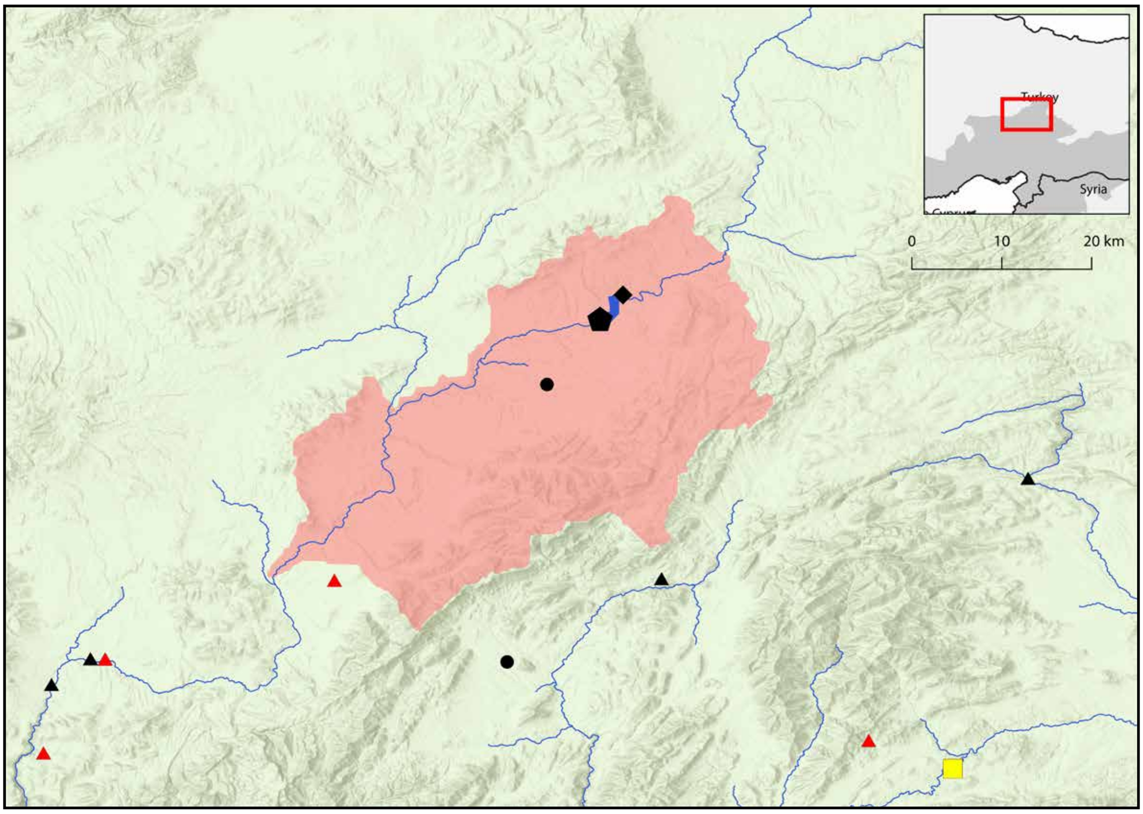
Zamantı loach

Distribution: Turkey

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED*

Currently known only from a short stretch of the Zamantı River, a headwater tributary within the Seyhan River drainage in the Mediterranean Region of southern Turkey. While the area near the river's source is relatively pristine, it becomes increasingly polluted as it passes through a series of dams, some hydroelectric, downstream, with additional threats including increasing frequency of droughts, installation of a fuel pipeline and introduction of non-native fish species such as the predatory northern pike (*Esox lucius*).



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Oxynoemacheilus seyhanicola

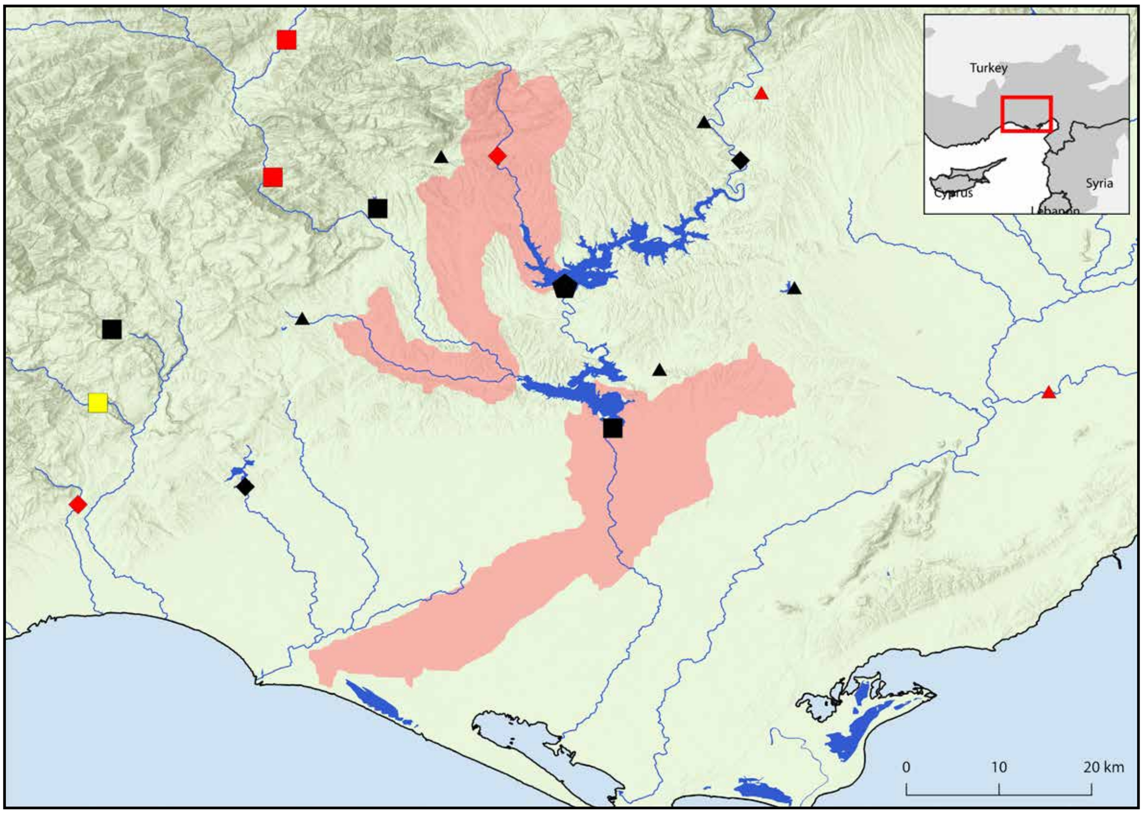
Cilician loach

Distribution: Turkey

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Endemic to the lower Seyhan River drainage in the Mediterranean Region of southern Turkey, both above and below Seyhan reservoir which was formed by construction of a large hydroelectric dam in the 1950s. There is a single record from the Ceyhan River drainage further east, but this requires confirmation. This species occurs in stretches with flowing water and gravel substrates. It is threatened by water abstraction and pollution from agriculture and the city of Adana, plus reduced water flow below the dam during periods of drought.



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Oxynoemacheilus theophilii

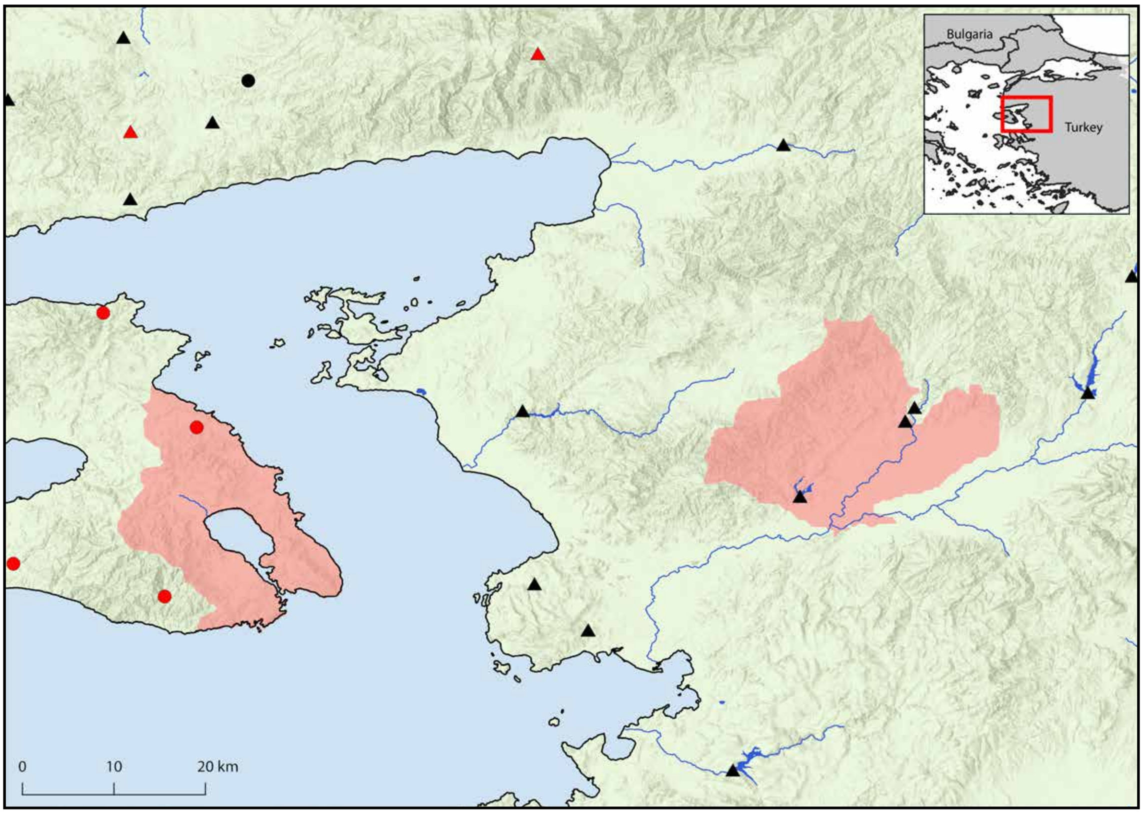
Lesbos Stone Loach

Distribution: Greece and Turkey

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Known from the Greek island of Lesbos and the Bakir River drainage in Turkey, where it is restricted to a handful of tributaries. A number of Turkish populations have been extirpated due to excessive water abstraction, damming of rivers and heavy pollution. Future hydropower development in the Bakir system is likely.



© Jörg Freyhof

Oxynoemacheilus tigris

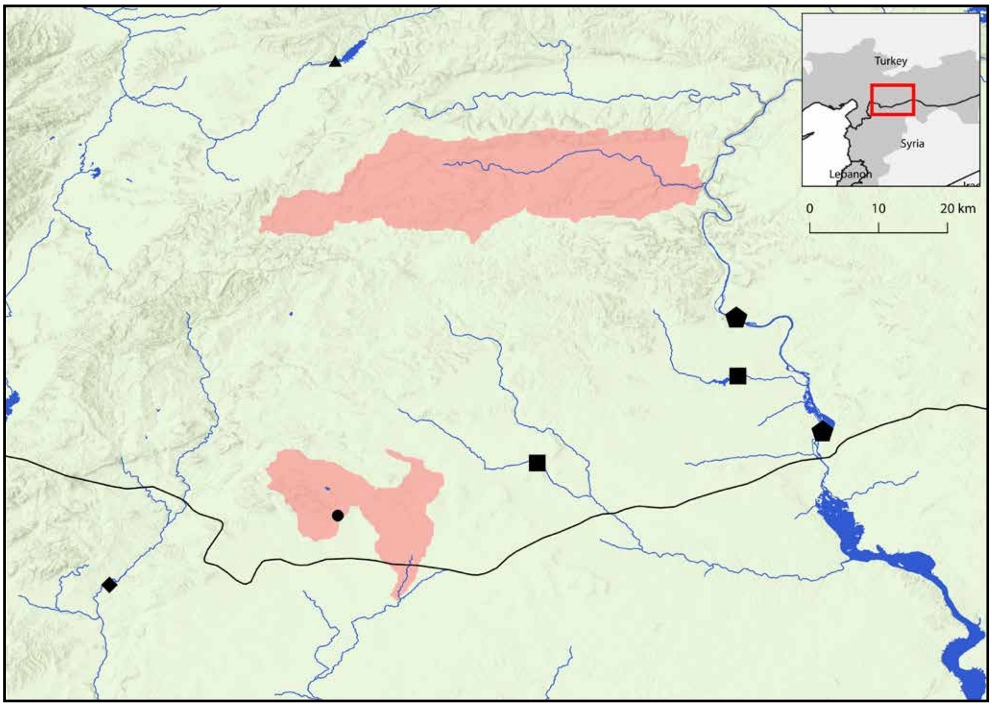
Halap loach

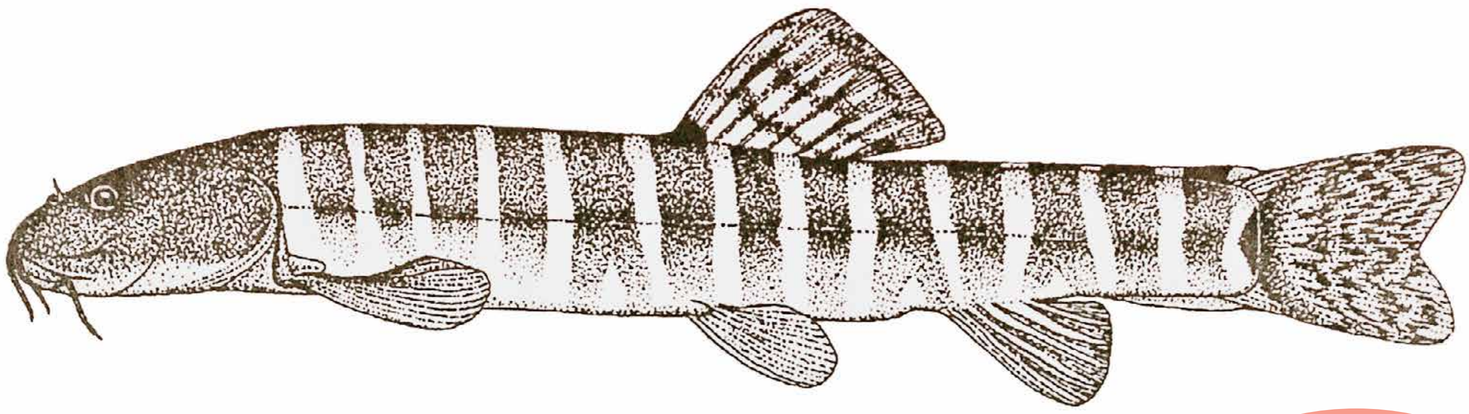
Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey and Syria

Currently known only from a single headwater stream in the Queiq River drainage plus Merziman Creek, a tributary of the upper Euphrates River that flows into Birecik reservoir. Both sites are in southern Turkey, near the Syrian border. It was formerly reported from several locations within the Queiq drainage in Syria, but the river is now completely dry there and it is probably extirpated from the country. It inhabits both standing and flowing stretches with substrates of gravel or mud. The Queiq population inhabits a few hundred metres of stream located between two dams, and both populations are threatened by excessive water abstraction and increasing frequency of droughts.





© Banarescu (1964)

Paraschistura chrysicristinae

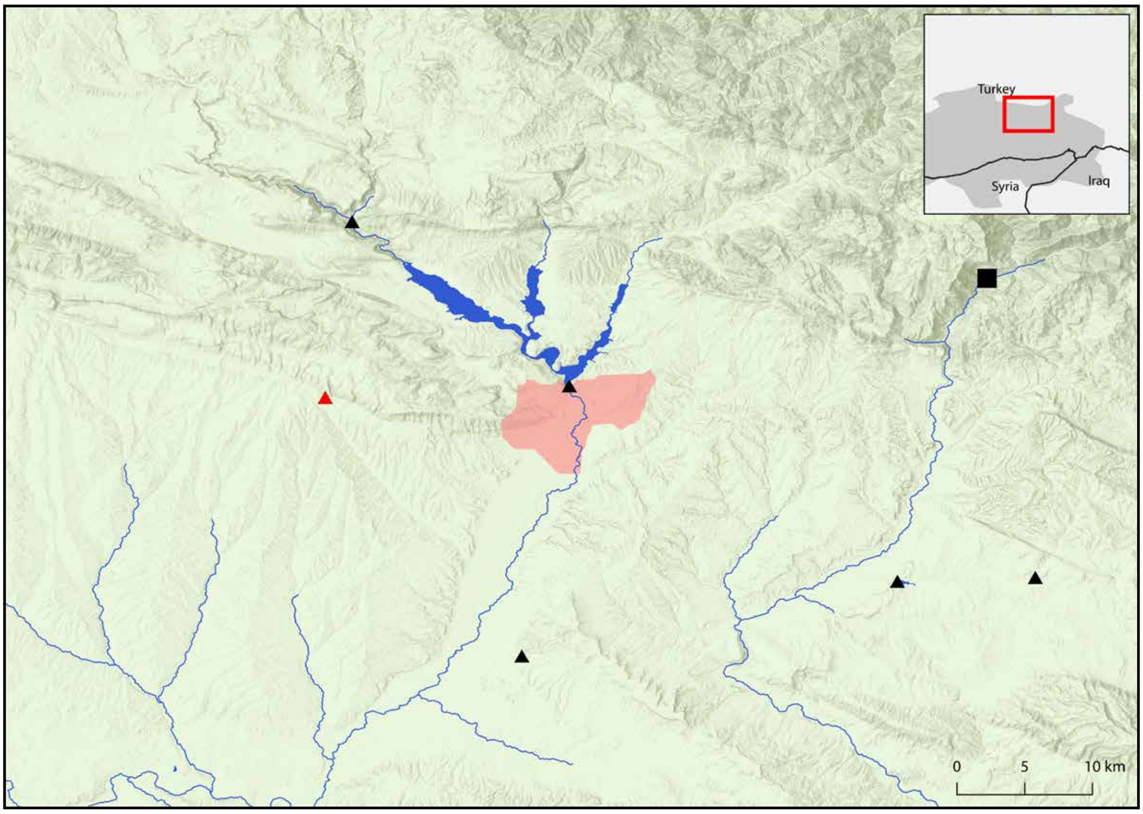
Diyarbakır loach

Distribution: Turkey

Hydropower Hazard: *HIGH*

IUCN Red List: *CRITICALLY ENDANGERED (Possibly Extinct)*

Known only from two sites within the Batman River drainage, a major tributary of the upper Tigris River in southeastern Turkey. The Batman hydroelectric dam was completed in 1999 and flooded much of the river's upper reaches while significantly reducing downstream flow during the summer months. This species could not be found during recent intensive surveys in the area and was last seen alive during the 1970s.



© Jörg Freyhof

Seminemacheilus ispartensis

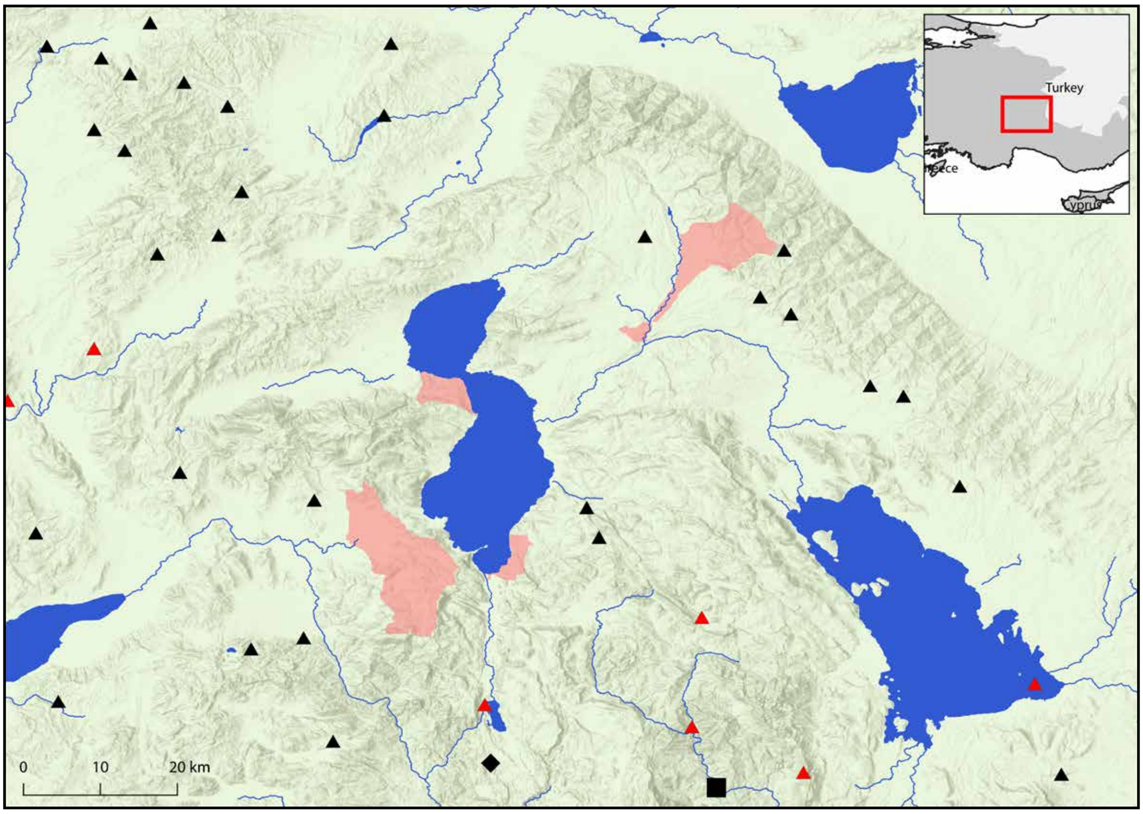
Southern pond loach

Distribution: Turkey

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Native to the Lake Eğirdir basin where it is found in several tributaries. Major threats in the area include extensive habitat modification, pollution and water abstraction. Widespread installation of small water retention dams, irrigation canals and regulators has further reduced the amount of suitable habitat. These pressures are likely to intensify with an expanding human population and greater frequency of climate change-induced droughts.



© Jörg Freyhof

Seminemacheilus lendlii

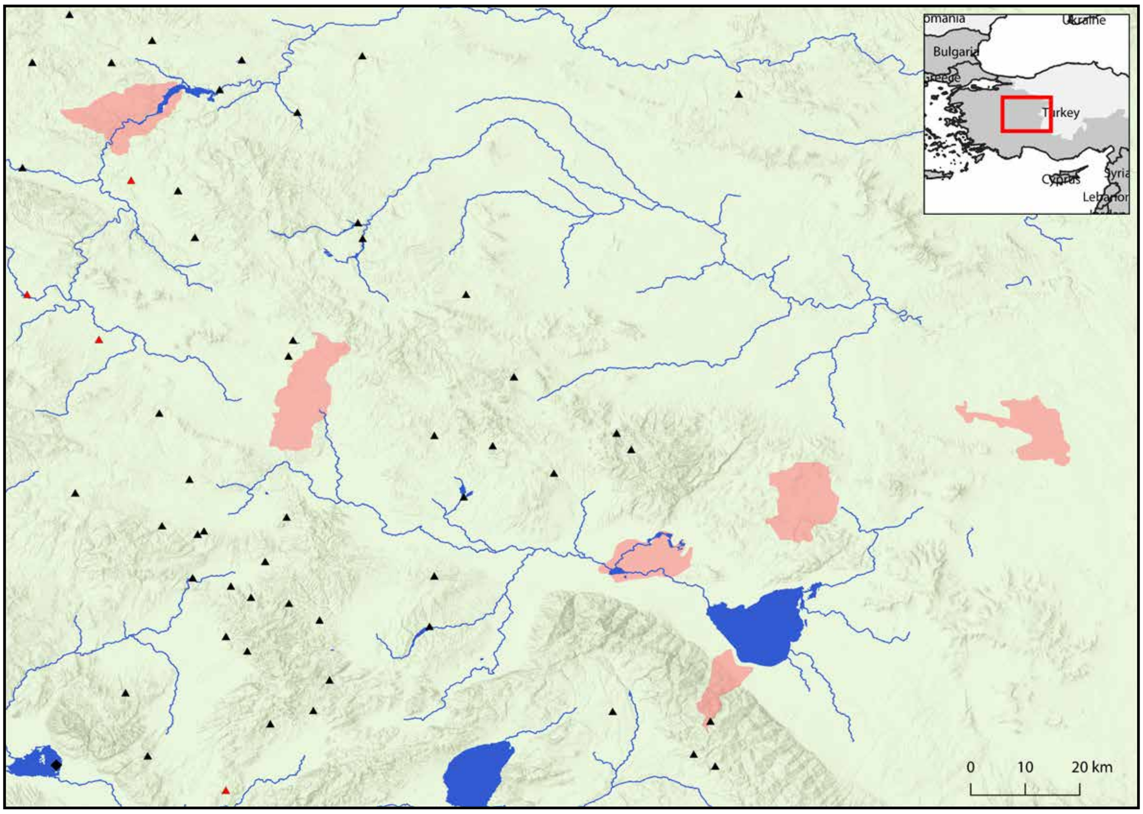
Northern pond loach

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Turkey

Native to the Porsuk River, a tributary of the Sakarya and the endorheic Akarçay River drainage, including the Eber and Akşehir lake basins. The native lacustrine populations are now likely to have been extirpated after Lake Akşehir lost its surface connection with Lake Eber in 1990 and temporarily dried out in 2008, while in 2018 Eber was also reported to be without water. This species is threatened by water abstraction, pollution, introduction of non-native fish species, dam construction and increasing frequency of droughts.



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Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II*

Bern Convention: *APPENDIX III*

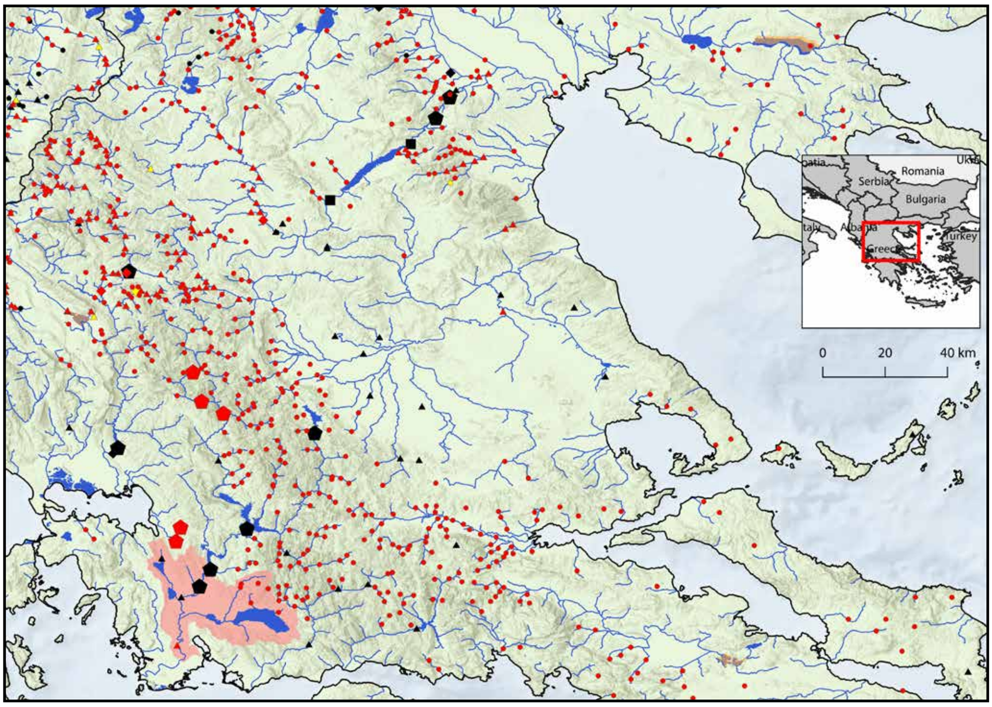
IUCN Red List: *ENDANGERED*

Silurus aristotelis

Aristotle's catfish

Distribution: Greece

Native to the lower Acheloos (aka Achelous) River drainage in western Greece, including the natural lakes Trichonis, Lysimachia, Ozeros and Amvrakia, and artificial reservoirs within the system. Outside this range it was introduced to lakes Pamvotida and Volvi during the 1950s but had disappeared by the mid-1990s, and the Boeotian Kifisos River drainage, including lakes Yliki and Paralimni, where it still occurs. It has also been translocated to at least one man-made lake in Bulgaria. In its native range it is threatened by water abstraction, fluctuating water levels, agricultural and domestic pollution, overfishing via illegal methods and potentially competition or hybridisation with the non-native Wels catfish (*Silurus glanis*), which has been introduced to Lake Trichonis. It is unlikely to be adversely affected by hydropower development since it is well-adapted to lentic conditions created by dams.

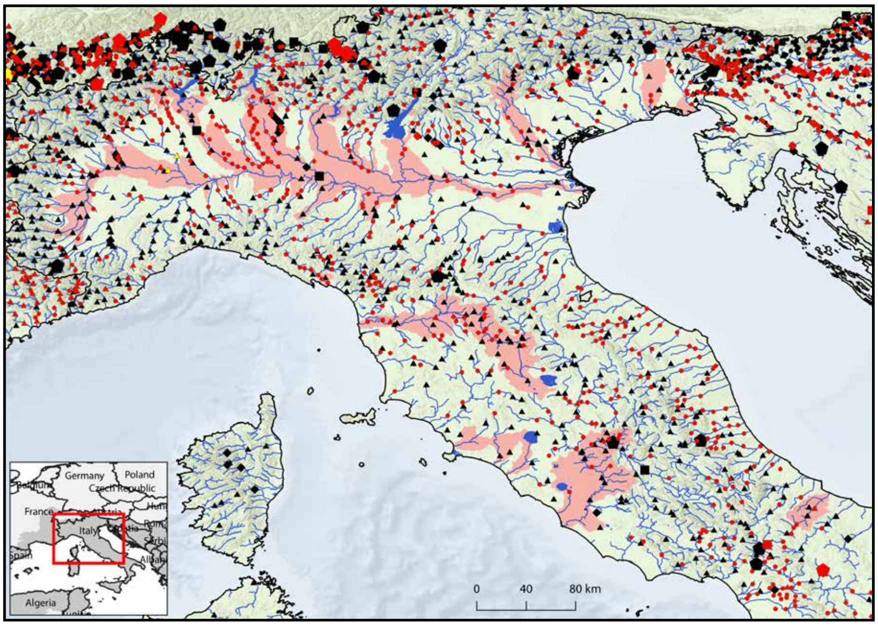


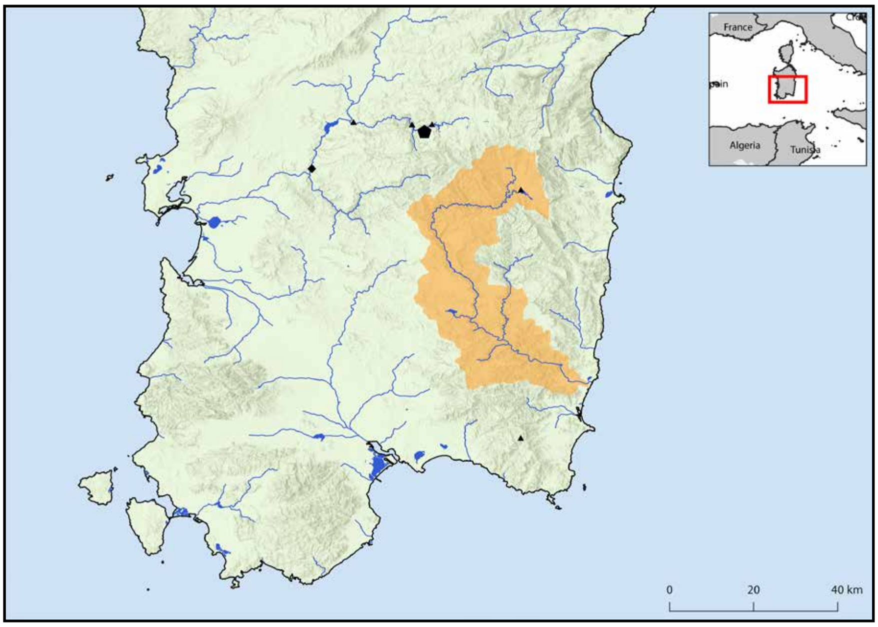
Esox cisalpinus

Italian pike

Hydropower Hazard:
LOW

IUCN Red List:
ENDANGERED





Distribution: Italy

Endemic to northern and central parts of Italy, including all major river drainages as far south as the Tiber but its actual distribution is poorly understood. This species is mostly threatened by hybridisation with non-native northern pike (*Esox lucius*), with which it was assumed to be conspecific prior to 2011. It is thought that very few genetically-pure populations remain, and farmed hybrids have also been widely introduced elsewhere in Italy and throughout much of Europe and the Mediterranean basin. This species is not threatened by hydropower development.

© Andreas Hartl

Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II + V*

Bern Convention: *APPENDIX III*

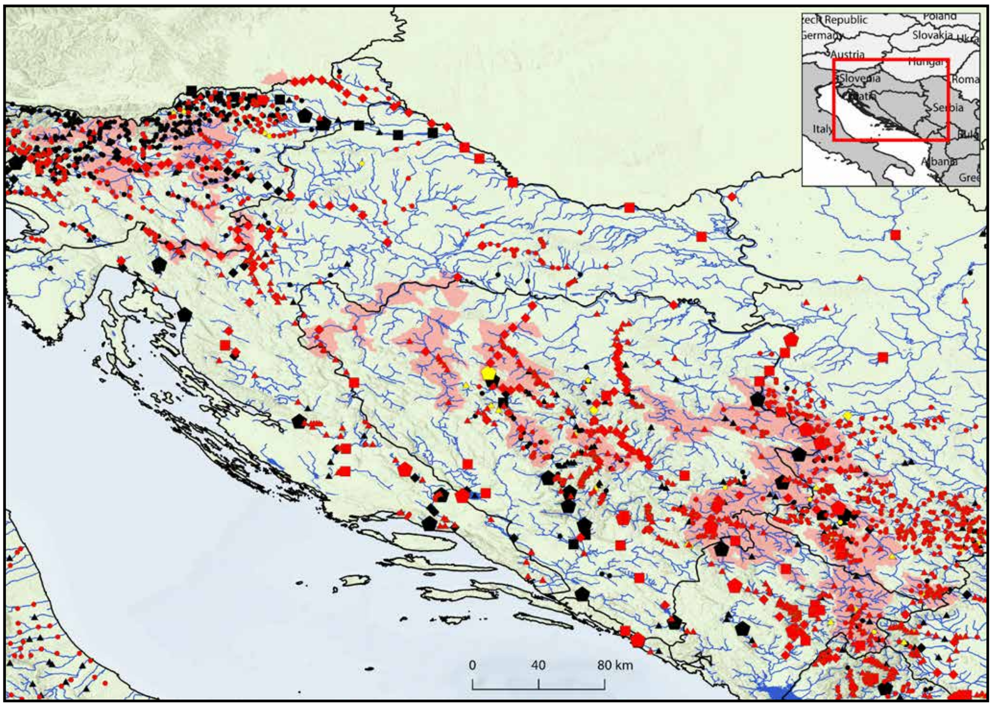
IUCN Red List: *ENDANGERED*

Hucho hucho

Danube salmon

Distribution: Austria, Bosnia-Herzegovina, Croatia, Czech Republic, Germany, Hungary, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia, Ukraine

Endemic to the Danube River drainage where it occurs in submontane tributaries draining the Alps, Dinaric Alps, and Carpathian mountain ranges, plus parts of the Bohemian-Moravian Highlands, Bohemian Forest and Weinsberger Wald plateau. It inhabits deep, free-flowing stretches of larger rivers which maintain cool temperatures throughout the year, and migrates up tributaries to spawn over clean gravel beds. This species has declined dramatically since the late 19th century and has been eradicated from at least 70% of its original range including most of the Danube main channel and many major tributaries. The primary causes include pollution, commercial overfishing, and since the latter was banned, poaching. Weirs and dams block access to spawning sites, reduce discharge and disrupt free river flow, and planned hydroelectric projects threaten most of the remaining populations.



© Jörg Freyhof

Salmo akairos

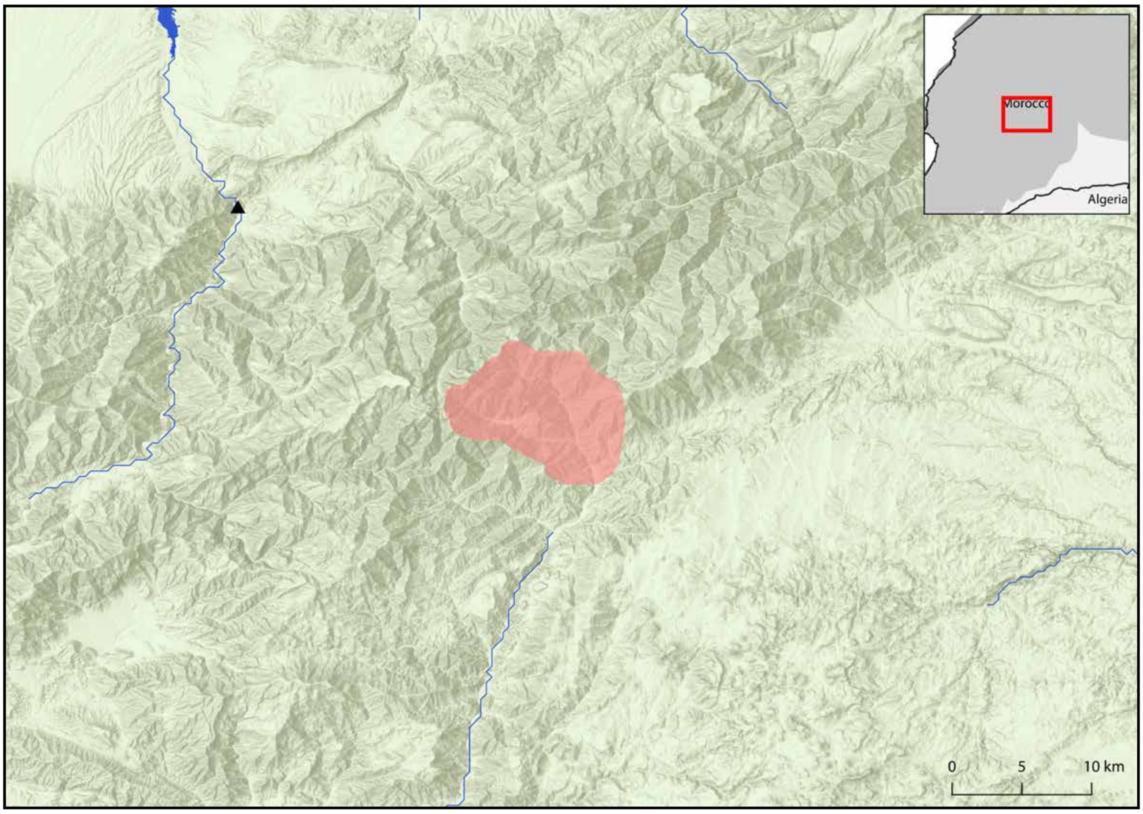
Lake Ifni trout

Hydropower Hazard: *LOW*

IUCN Red List: *VULNERABLE*

Distribution: Morocco

Endemic to Lake Ifni in the High Atlas mountains. Ifni is located at 2,320 metres AMSL, and when its water level is sufficiently high temporary springs emerge from the mountainside almost two kilometres away and flow into the river below. It is oligotrophic and has a small surface area but is up to 50 metres deep. This species is fished non-intensively for local consumption, and is potentially threatened by excessive water abstraction for irrigation and a warming climate which has already caused most of the nearby glacier to melt. Hydropower development in the area is unlikely.



© Jörg Freyhof

Salmo carpio

Garda trout

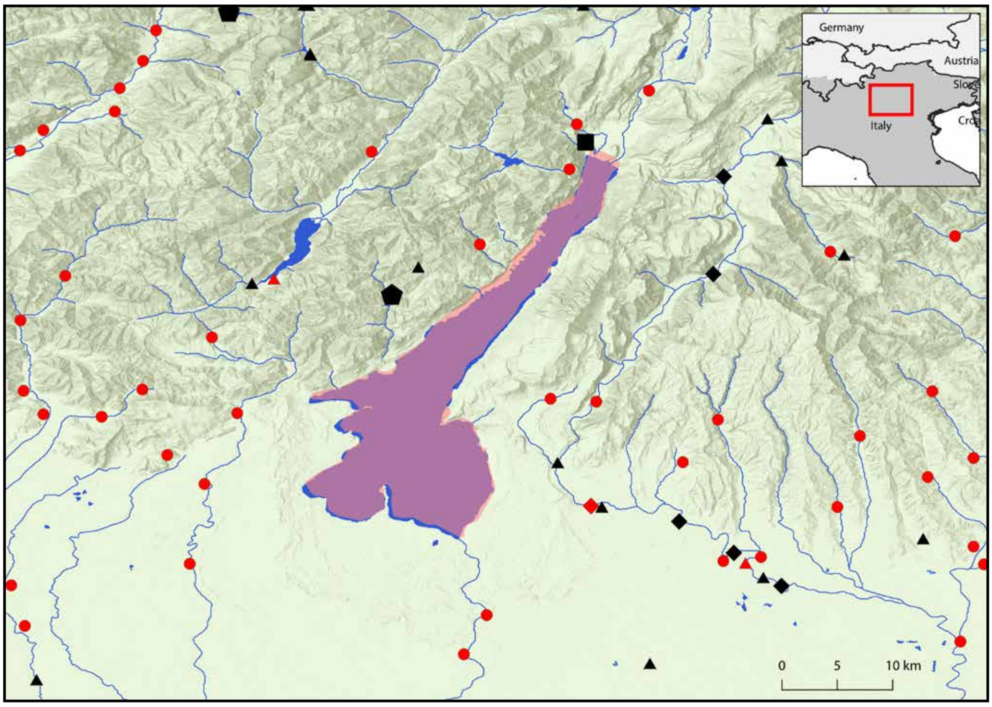
Distribution: Italy

Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *CRITICALLY ENDANGERED*

Endemic to Lake Garda in northern Italy. It has been introduced into other lakes in Italy, Germany and New Zealand but does not appear to have become estalished in any of them. It was formerly an important commercial species, with up to 20 tonnes per year landed during the mid-20th century, but at least 80% of the population has been lost since the 1990s. The lake is very deep and the trout has been recorded up to 300 metres from the surface. This species' decline is assumed to have been caused by historic overfishing during reproductive periods plus introduction of non-native *Coregonus* species. A seasonal fishing ban has seen the population stablise at a comparatively low level in recent years. Lake Garda is protected at national and international level but several hydropower projects are planned within the basin.



* as *Salmo macrostigma*

© Jörg Freyhof

Hydropower Hazard:
MODERATE
EUR-HAB-DIR:
*ANNEX II **
IUCN Red List:
CRITICALLY ENDANGERED

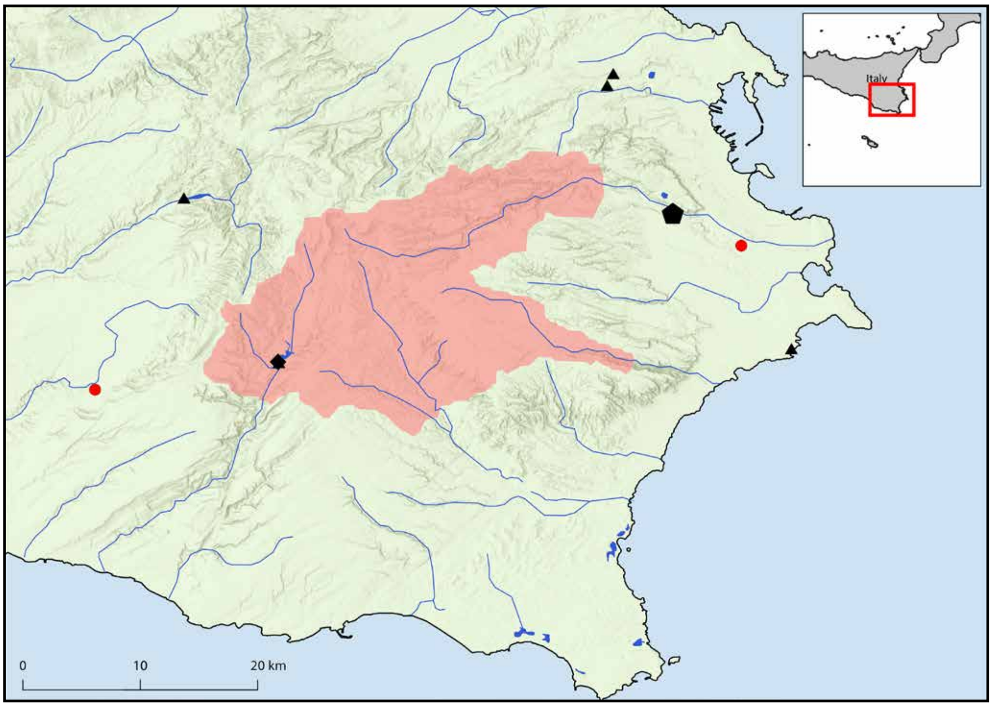
Salmo cettii

Mediterranean trout

Distribution: Italy and Algeria

Now restricted to southern Sicily, where a single genetically-pure population inhabits the 15-kilometre Tellaro River drainage. It formerly occurred throughout the eastern part of the island, but has been eradicated from the north and the remaining populations in the south have hybridised with introduced brown trout (*Salmo trutta*). A known population from North Africa has also been extirpated. This species is threatened by pollution, poaching, introduction of non-native species and droughts driven by climate change. Its stronghold in the Tellesimo tributary drainage is now protected meaning hydropower development is ulikely.

* as *Salmo macrostigma*



© Jörg Freyhof

Salmo chilo

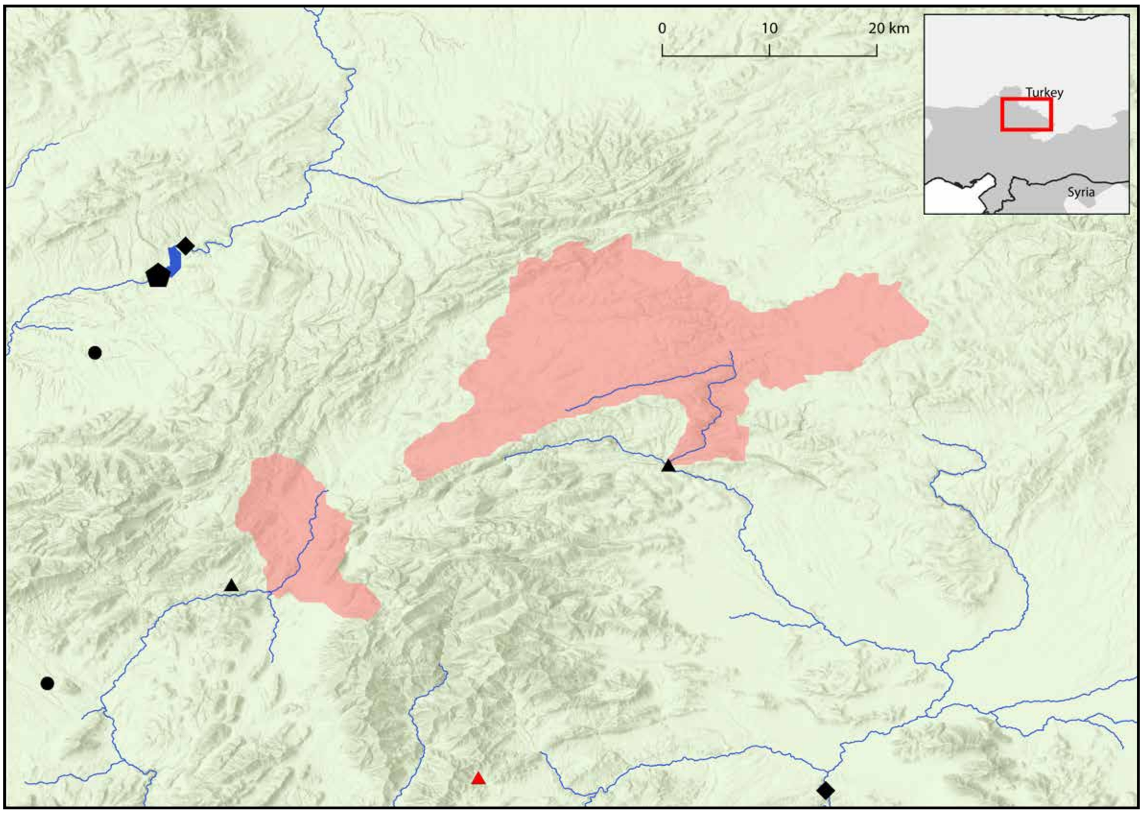
Akdere trout

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Distribution: Turkey

Known only from the Akdere stream, a headwater tributary within the Ceyhan River drainage in the Mediterranean Region of southern Turkey. It may be threatened by illegal overfishing and water abstraction, while plausible future threats include a reduction in stream discharge due to droughts, dam construction and introduction of non-native trouts. This species' habitat requirements dictate that hydropower development would have a seriously detrimental effect on its only known population.



© Johannes Schöffmann

Salmo fibreni

Fibreno trout

Hydropower Hazard: *LOW*

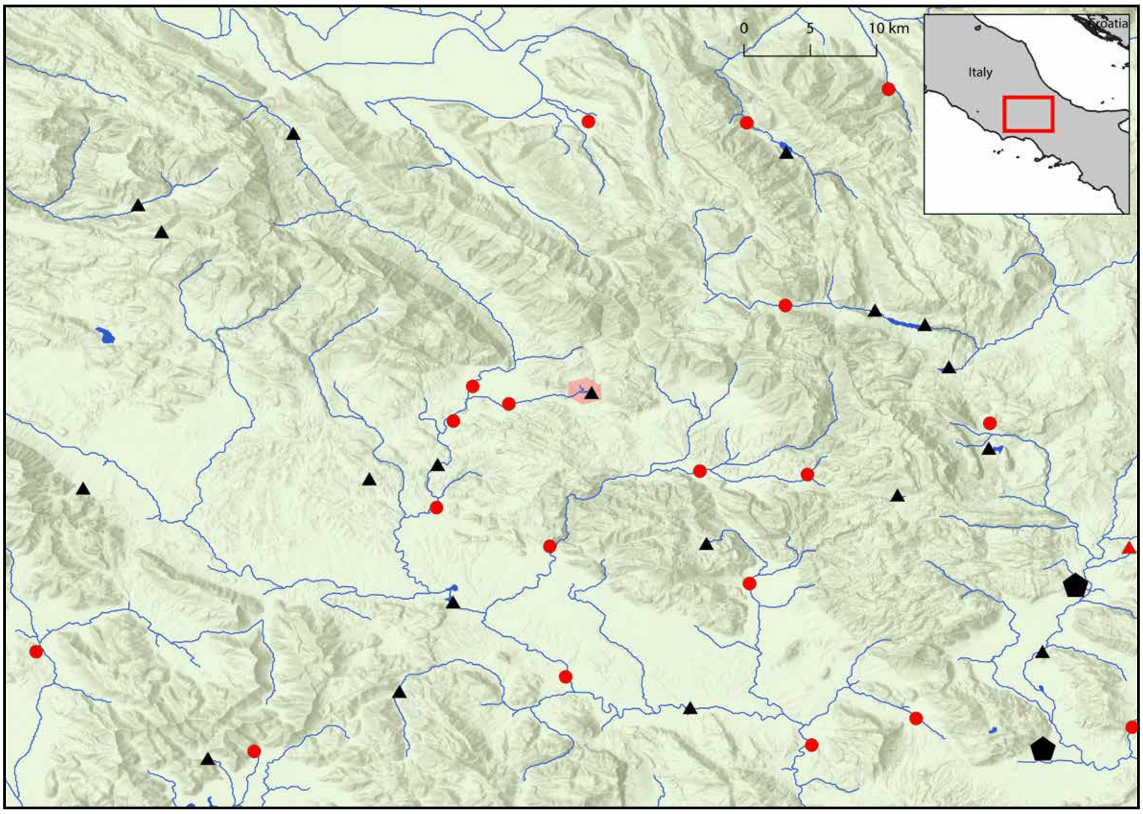
EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *VULNERABLE*

Distribution: Italy

Endemic to the Lago di Posta Fibreno lake basin in central Italy. It occurs within the spring-fed karstic lake and its tributaries, all of which are enclosed within a nature reserve and contain clear water with abundant aquatic vegetation. This species is threatened by poaching, and the fact it occurs at a single site renders it vulnerable to pollution or introduction of non-native fish species.

* as *Salmo macrostigma*



© Jörg Freyhof

Salmo labecula

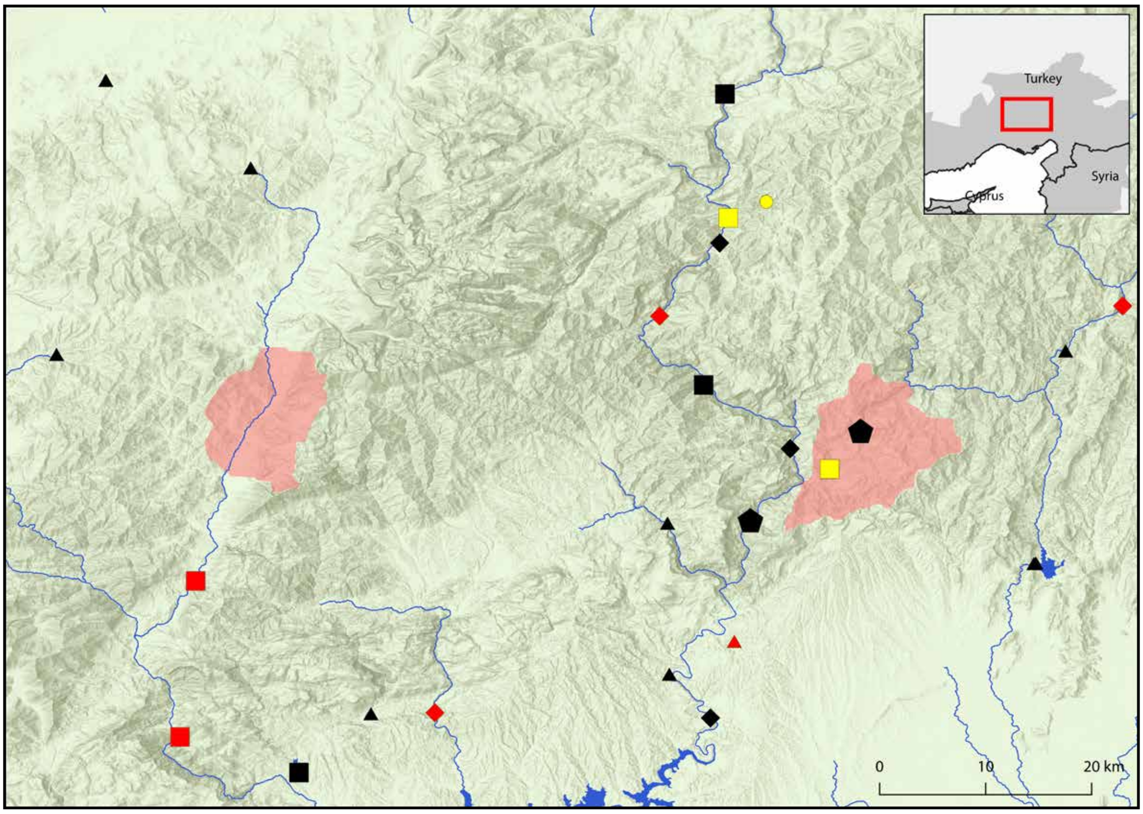
Eastern Mediterranean trout

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Known only from Ecemis stream in the Seyhan River drainage plus the Kartoz and Zinda streams in the Köprüçay River drainage in southern Turkey. This species is threatened by water abstraction, dam construction, increasing frequency of droughts and possibly illegal overfishing. It is considered highly vulnerable to hydropower development which would further reduce the extent of suitable habitat and favour establishment of non-native fish species.



Salmo letnica

Ohrid trout

Distribution: Albania and North Macedonia

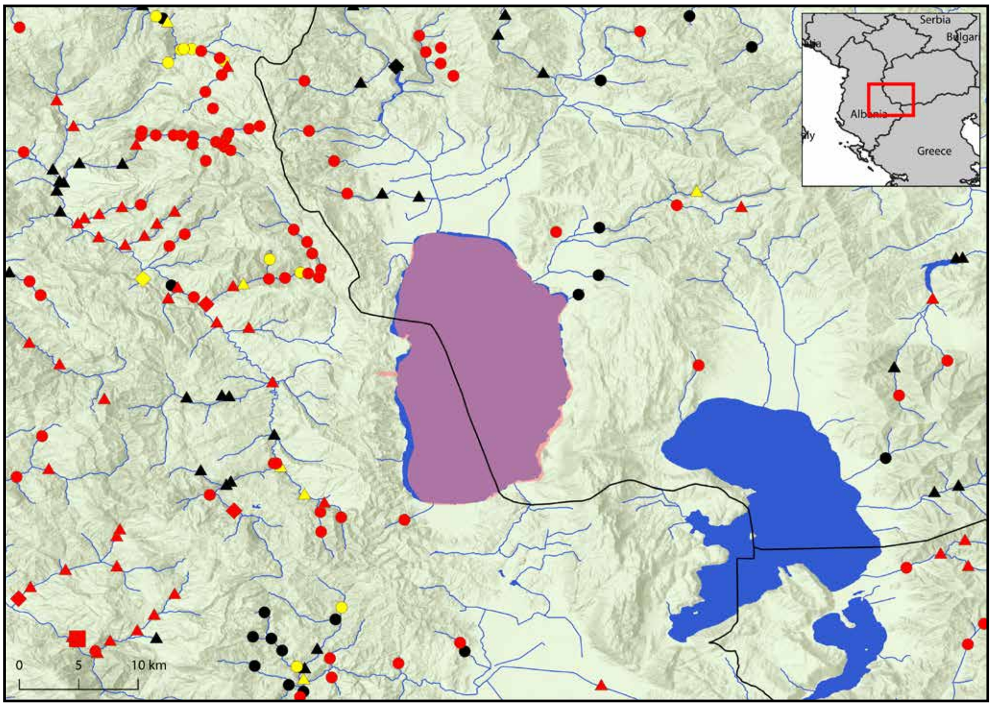
Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *VULNERABLE*

Endemic to the oligotrophic transboundary Lake Ohrid which is shared by North Macedonia and Albania. It is pelagic and entirely lacustrine, tends to occur at depths of 60-80 metres and was formerly an important component of the local commercial fishery. It has undergone a serious decline since the mid-1990s with overfishing considered to be the primary driver, and is no longer considered common in the lake despite annual stocking efforts. Additional threats include pollution, water abstraction and introduction of non-native fish species. Hydropower development on inflowing tributaries would undoubtedly be detrimental but is unlikely.

* as *Salmo macrostigma*



© Jörg Freyhof

Salmo lourosensis

Louros trout

Hydropower Hazard: *HIGH*

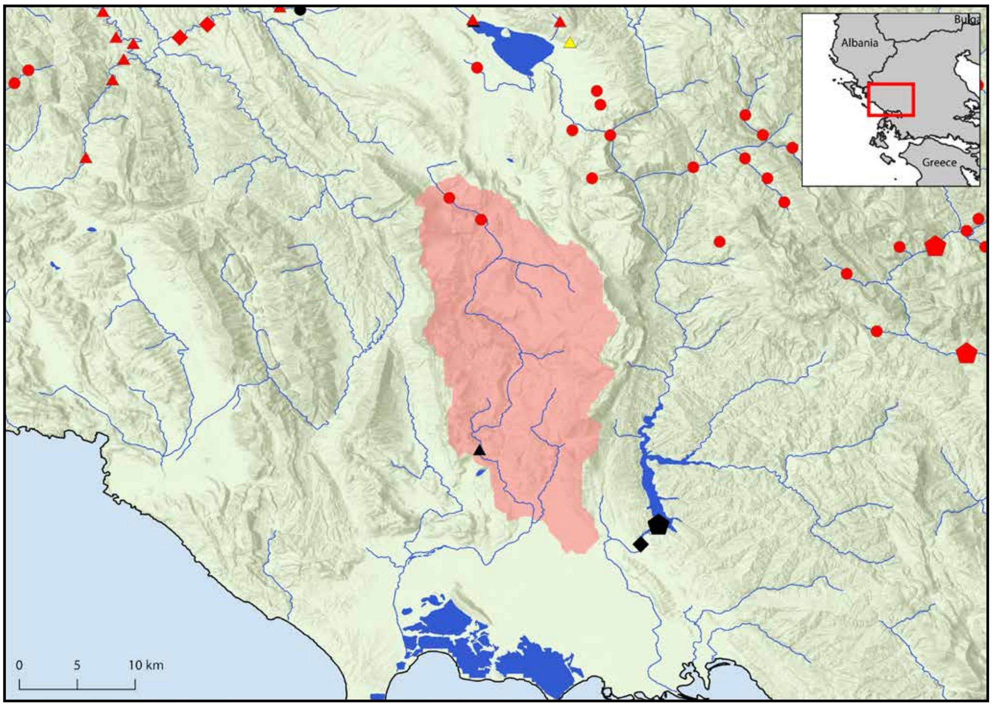
EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Greece

Restricted to a short section of the Louros River drainage in western Greece. It occurs between the source of the river at Vouliasta and the village of Agios Georgios, where its downstream limit is marked by the Louros hydroelectric dam. This species occurs both in the river and a small reservoir created by the dam. It is threatened by overfishing by recreational anglers and introduction of non-native rainbow trout (*Oncorhynchus mykiss*) which is produced in local aquaculture facilities. The Louros dam has no fishway and the trout is considered highly vulnerable to additional hydropower development.

* as *Salmo macrostigma*



© Miguel Clavero

Salmo multipunctatus

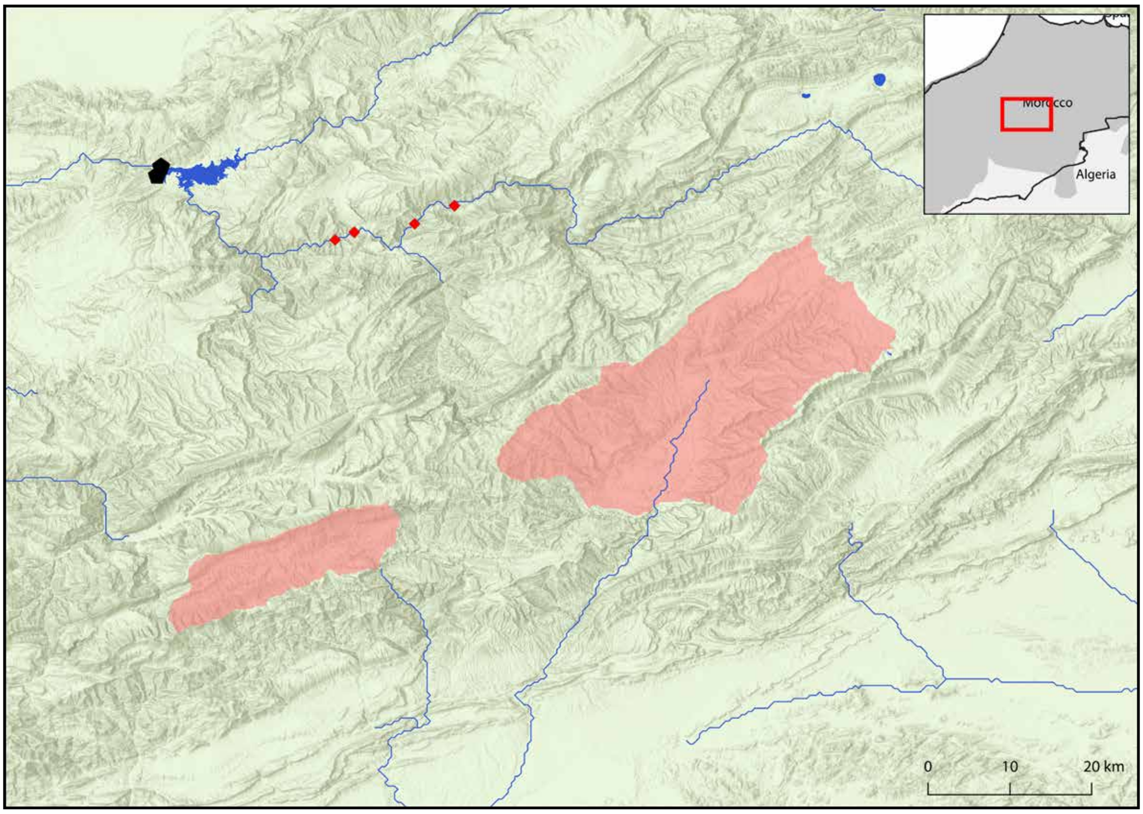
Draa trout

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Morocco

Known only from headwaters of the Dades and M'Goum rivers, both tributaries within the Draa River drainage in southern Morocco. This species is primarily threatened by loss of riparian vegetation leading to erosion of stream channels during flood events, and overfishing at the local scale. Hydropower development in the area is unlikely.



© Johannes Schöffmann

Salmo obtusirostris

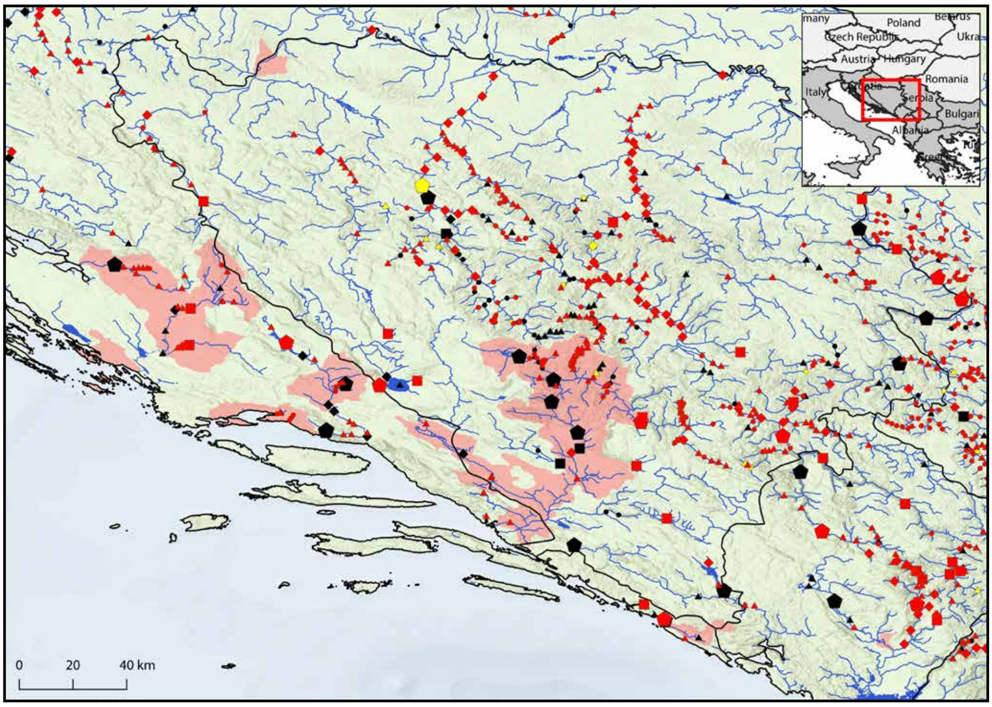
Soft-mouthed trout

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Bosnia-Herzegovina, Croatia and Montenegro

Known from the Krka, Jadro and Neretva river drainages in Croatia and Bosnia-Herzegovina, plus the Zeta River drainage within the Lake Skadar basin in Montenegro. In the lower Neretva it occurs in the sinking Bregava and Vrljika/Matica/Tihaljina/Trebižat tributary systems, the latter of which repeatedly disappears underground and is referred to by a series of different local names. An introduced population also exists in the Žrnovnica River, Croatia, after being translocated from the Jadro in 1965. It is now very rare in the Krka and Zeta rivers and has been eliminated from an estimated 85% of its original range in the Neretva drainage. The major drivers for this decline are fragmentation of habitats due to construction of hydroelectric dams, illegal overfishing, pollution and introduction of alien fish species. In particular, it is known to hybridise with non-native brown trout (*Salmo trutta*).



© Primož Zupančič

Salmo ohridanus

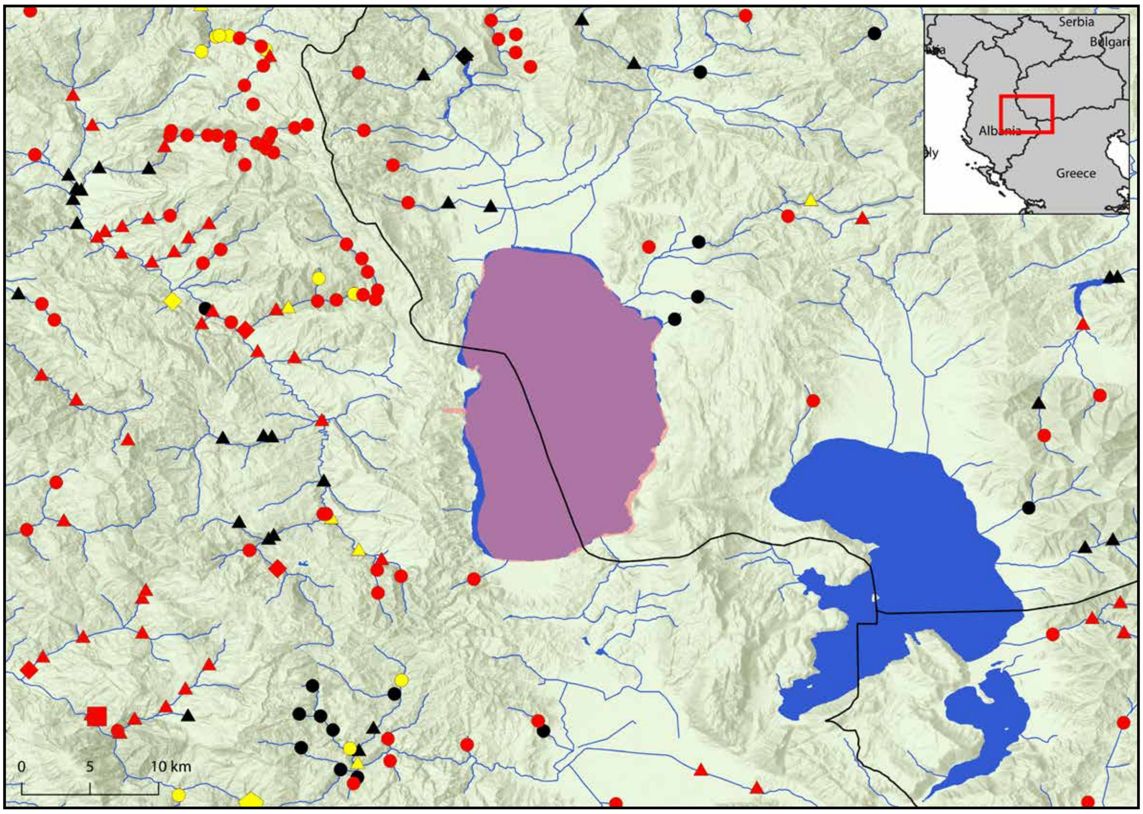
Belvica

Hydropower Hazard: *LOW*

IUCN Red List: *ENDANGERED*

Distribution: Albania and North Macedonia

Endemic to the oligotrophic transboundary Lake Ohrid. It is pelagic and entirely lacustrine, tends to occur at depths of 40-60 metres and is an important component of both the local commercial fishery and aquaculture industry. This species appears to have undergone a serious decline since the mid-1990s with overfishing considered to be the primary driver, and is no longer considered common in the lake despite annual stocking efforts. Additional threats include agricultural and industrial pollution, water abstraction and introduction of non-native fish species. Hydropower development on inflowing tributaries would undoubtedly be detrimental.



© Jörg Freyhof

Salmo opimus

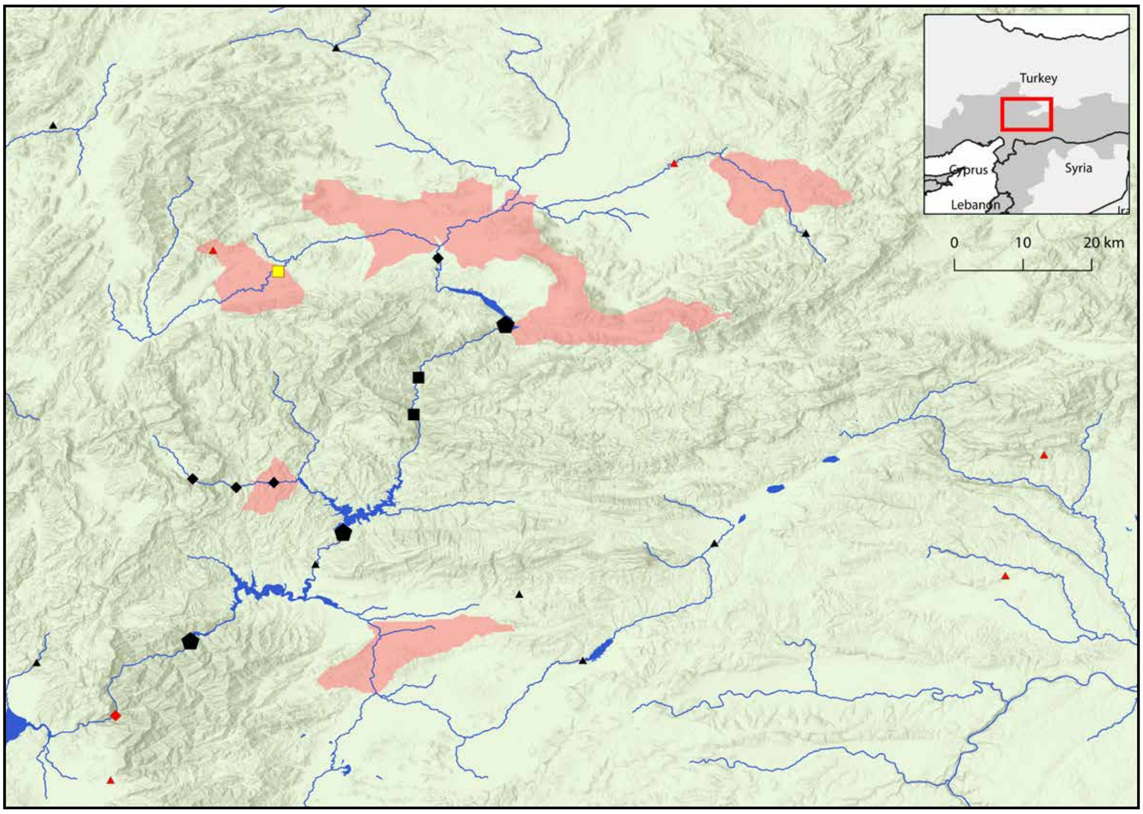
Ceyhan trout

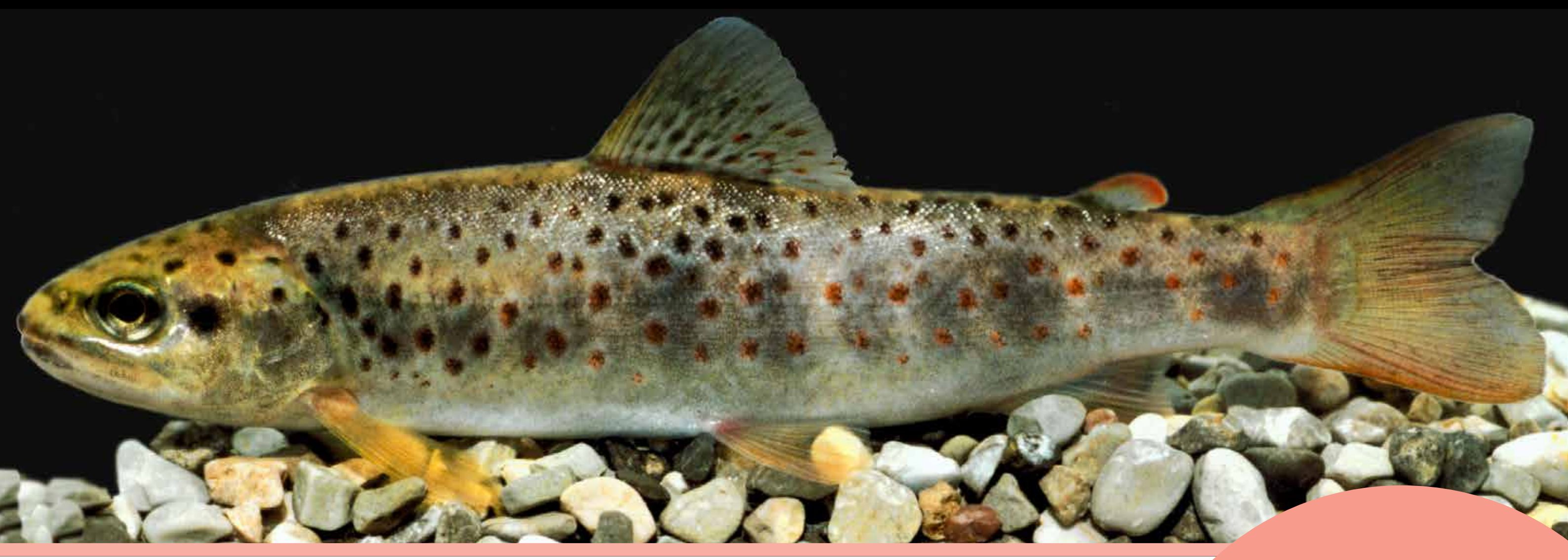
Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Known from the Tekir, Fırnız and Göçüksu headwater streams in the lower Ceyhan River drainage and the coastal Alara River in the Mediterranean Region of southern Turkey. It may be threatened by illegal overfishing and water abstraction, while plausible future threats include climate change-induced droughts reducing stream discharge, dam construction and introduction of non-native trouts. This species' habitat requirements dictate that hydropower development would have a seriously detrimental effect on its only known population.





Salmo pelagonicus

Pelagonian trout

Hydropower Hazard: *HIGH*

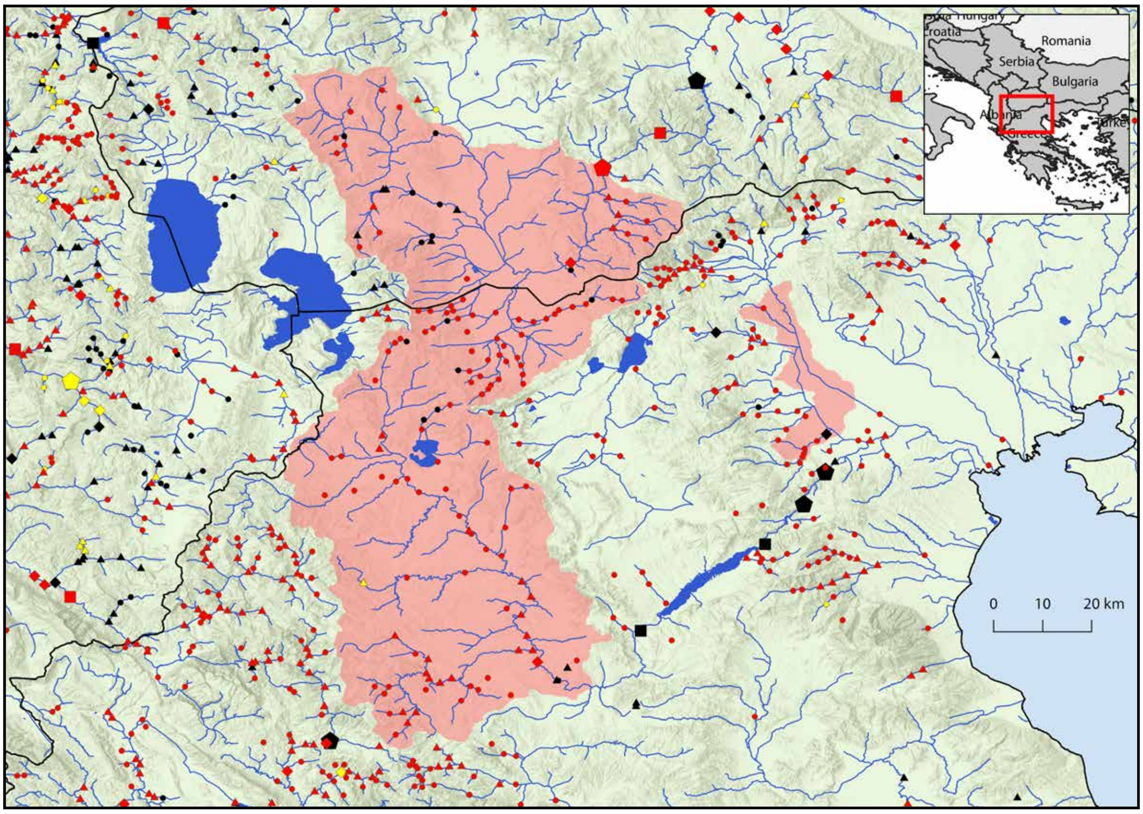
EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *VULNERABLE*

Distribution: Greece and North Macedonia

Native to the Crna River drainage, a right bank tributary within the transboundary Vardar (gr. Axios) River in North Macedonia, and the adjacent Haliacmon (aka Aliakmon) River in Greece. This species is threatened by water abstraction, construction of dams and weirs, and genetic introgression with introduced non-native trouts.

* as *Salmo macrostigma*



© Jörg Freyhof

Salmo pellegrini

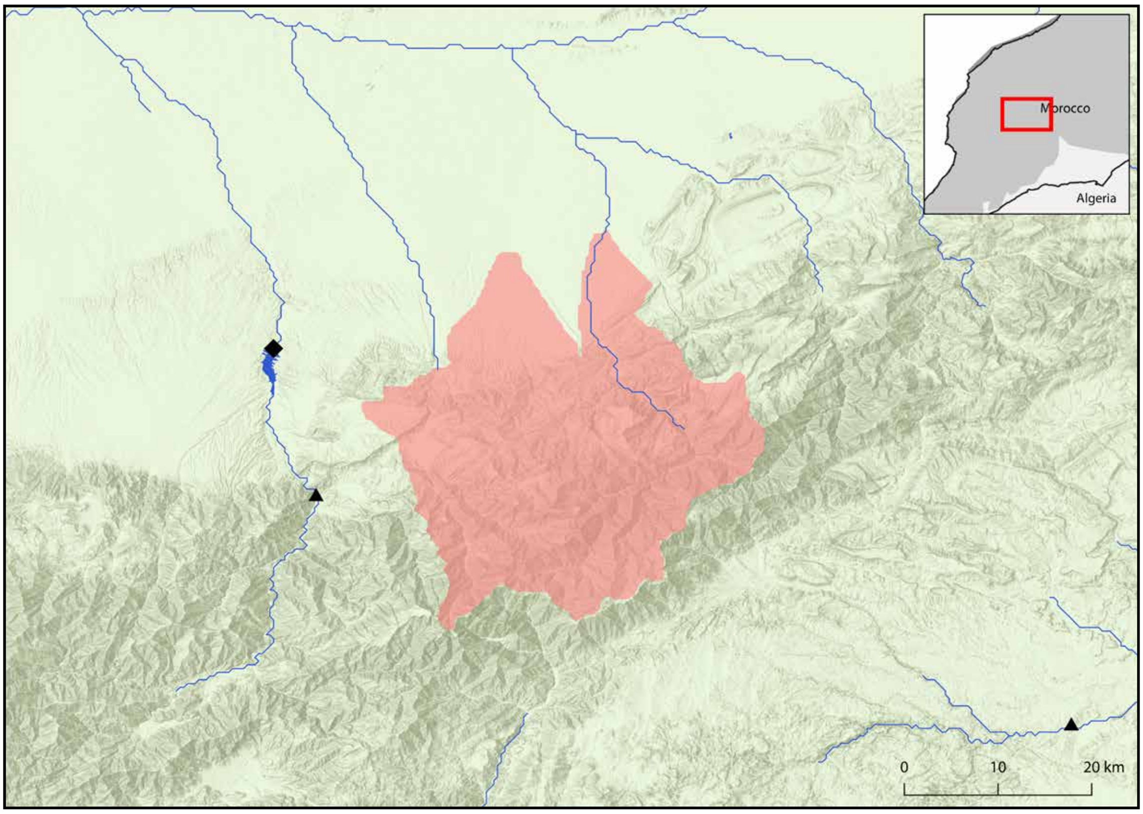
Atlas trout

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Morocco

Restricted to the Ourika and Rheraya rivers, both of which are headwater tributaries within the Tensift River drainage in northwestern Morocco. This species is fished for food on a small scale, but is principally threatened by tourism development driving increases in construction, climate change driven droughts, and pollution on both rivers. It now occurs only upstream of the most popular areas with populations thought to have plummeted by 50-80% since 2009. Hydropower development in the area would constitue a serious additional threat to this species' global survival.



© Jörg Freyhof

Salmo peristericus

Prespa trout

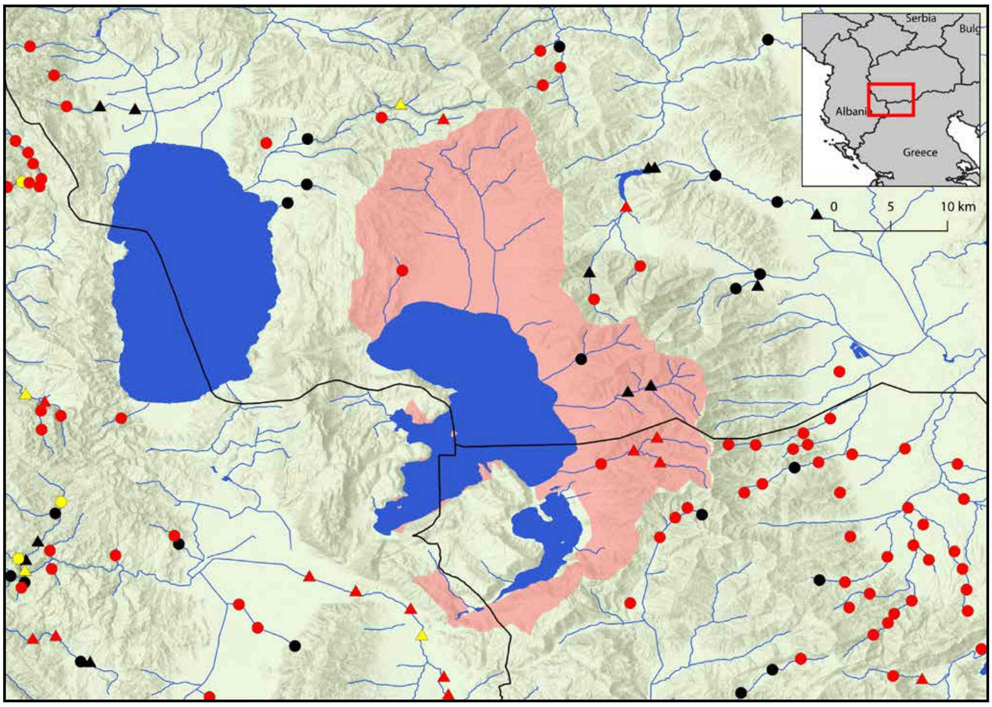
Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

IUCN Red List: *ENDANGERED*

Distribution: Albania, North Macedonia and Greece

Restricted to the Lake Great Prespa basin. It is currently restricted to the Brjchinska, Kranska River and Golema Reka inflowing tributaries in North Macedonia and the Agios Germanos affluent in Greece. Water abstraction, pollution and especially introduction of non-native fish species are the main threats facing the Prespa lakes' endemic fish fauna. Moreover, the water level has decreased by around eight metres since the mid-1980s and eutrophication is ongoing. Existing small hydropower plants and dams built to retain water for agriculture on streams flowing into Great Prespa are likely to have adversely affected those populations entering the tributaries to spawn. Despite the area being surrounded by three national parks, a series of new projects planned on the Agios Germanos tributary stream would block access one of the species' primary spawning sites.



* as *Salmo macrostigma*

© Jörg Freyhof

Salmo platycephalus

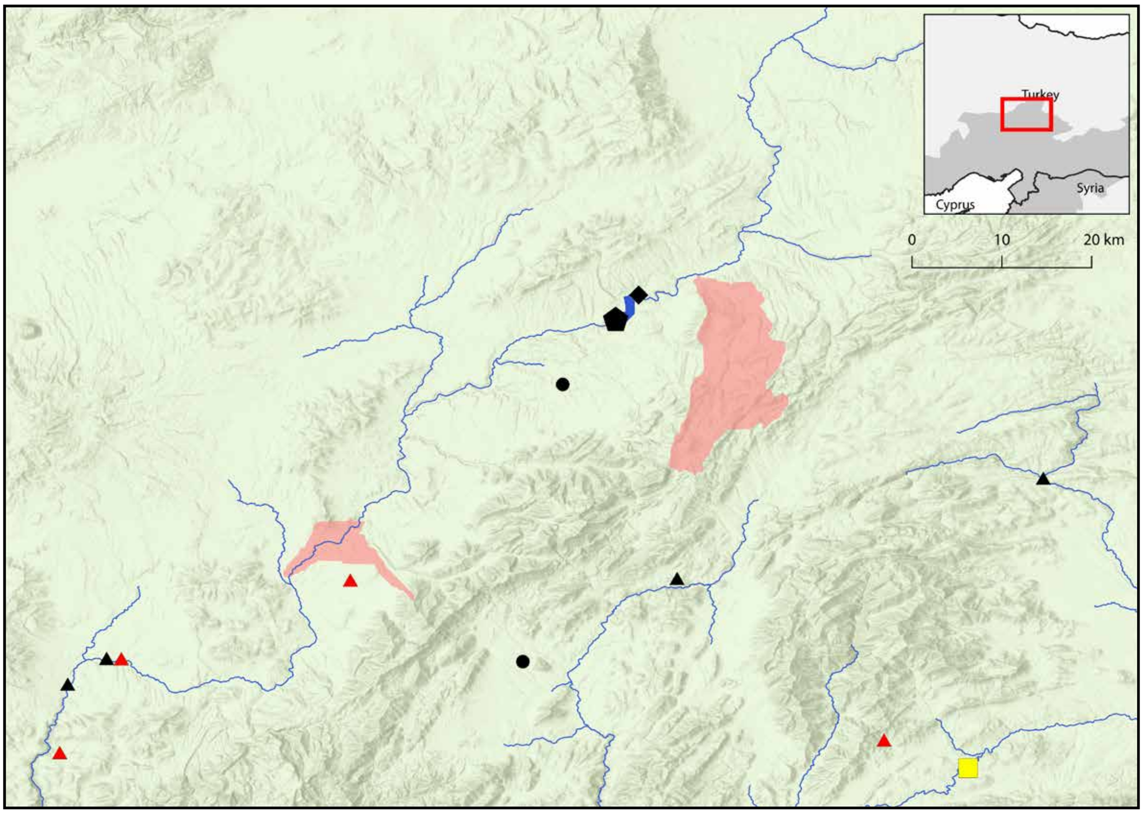
Flathead trout

Hydropower Hazard: *HIGH*

IUCN Red List: *ENDANGERED*

Distribution: Turkey

Known only from the Karagöz, Soğuksu and Uzunyayla rivers, all tributaries of the Zamantı River in the upper Seyhan River drainage in the Central Anatolia Region of southern Turkey. It inhabits cool, clear, flowing stretches of mainly spring-fed hill streams with substrates of gravel and pebbles. Although locally abundant, this species has a highly restricted range and is potentially threatened by introduction of non-native rainbow trout (*Oncorhynchus mykiss*) and reductions in spring discharge driven by climate change-induced droughts. Hydropower development on its native streams could have a serious detrimental impact.



© Ignacio Doadrio

Salmo viridis

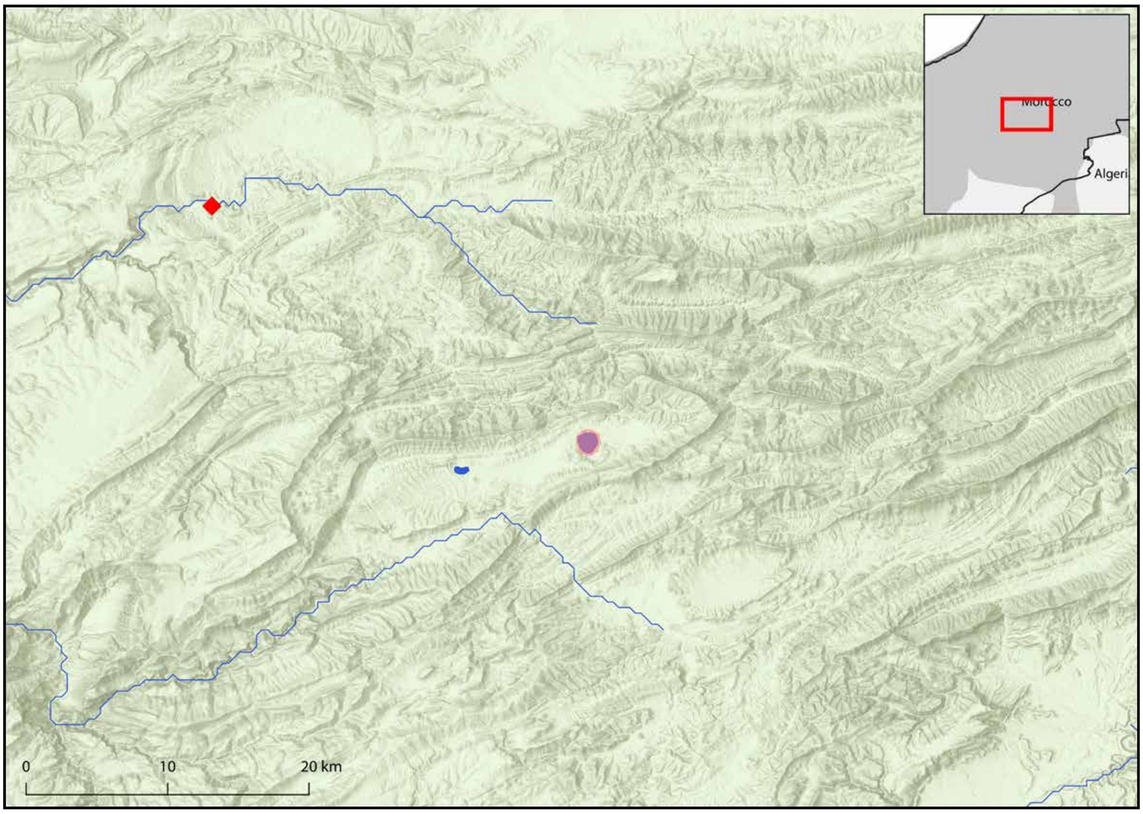
Isli trout

Hydropower Hazard: *LOW*

IUCN Red List: *VULNERABLE*

Distribution: Morocco

Endemic to Lake Isli near the town of Imilchil in the High Atlas mountains of central Morocco. It is the only fish species inhabiting the oligotrophic lake, which is located at 2,270 metres AMSL, around two kilometres in diameter and up to 92 metres deep. This species is threatened by increasing erosion, eutrophication and siltation of its breeding sites around the lake's shallow shores driven by intensive grazing of livestock in the basin. Hydropower development in the immediate area is not feasible.



© Cesare Puzzi

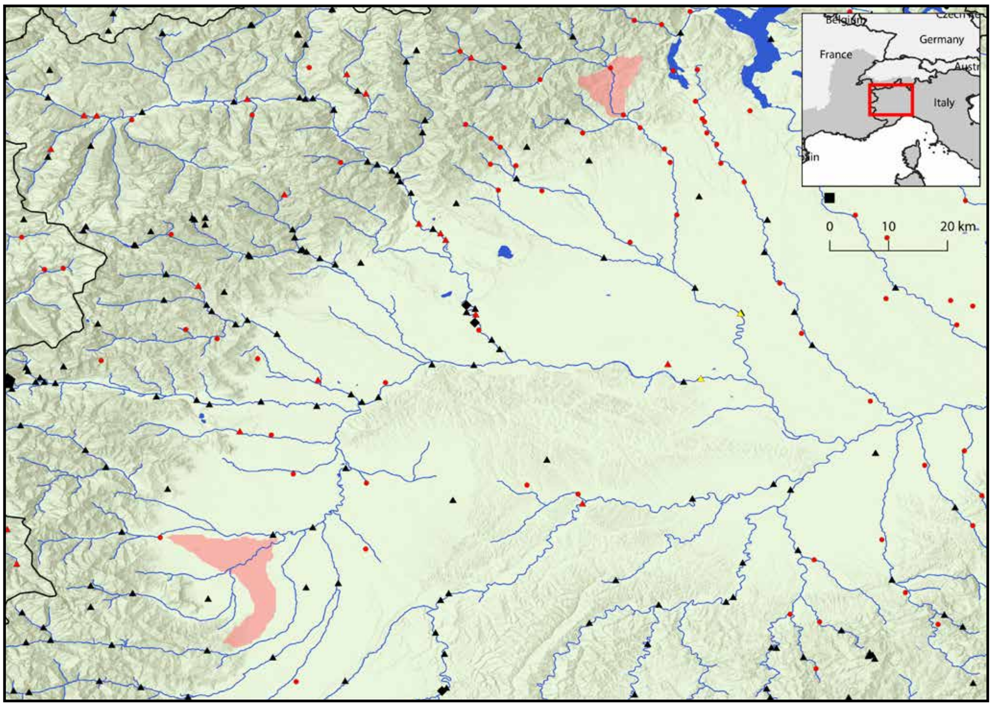
Hydropower Hazard:
HIGH
IUCN Red List:
CRITICALLY ENDANGERED

Thymallus aeliani

Adriatic grayling

Distribution: Italy

Formerly distributed throughout left-bank tributaries of the Po River drainage in northern Italy, plus a series of coastal drainages east of the Po including the Adige, Livenza, Brenta, and Tagliamento plus the transboundary Soča (it. Isonzo) River in western Slovenia. It has experienced a massive reduction in population size throughout the majority of this range, with the only genetically pure populations now inhabiting the Sesia tributary drainage plus a section of the upper Po which is isolated by a dam. It is primarily threatened by hybridisation with the European grayling (*Thymallus thymallus*). The latter has been widely introduced to the north Adriatic basin from the Danube River drainage for at least 40 years in order to maintain stocks for recreational angling, resulting in extensive introgression. Additional threats include water abstraction and diversion, pollution and dam construction.



© Matthew Ford

Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II*

Bern Convention: *APPENDIX II*

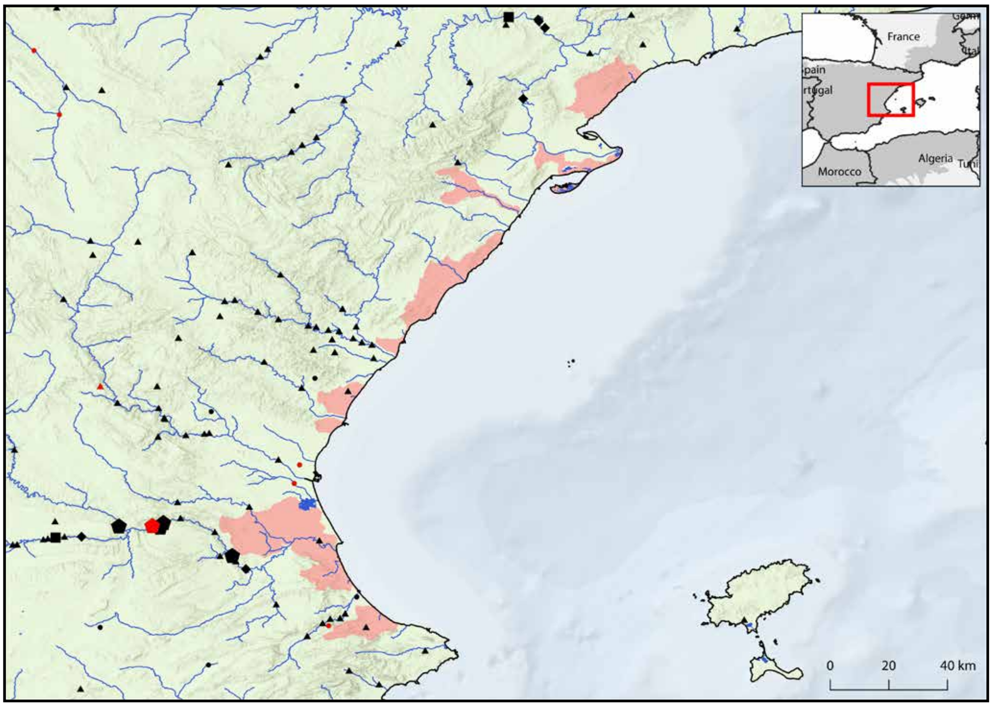
IUCN Red List: *CRITICALLY ENDANGERED*

Valencia hispanica

Spanish valencia

Distribution: Spain

Occurs naturally at nine locations between the Ebro River delta in Catalonia and the Pego-Oliva natural park in the Valencian Community, eastern Spain. It has been extirpated from a number of former sites, and has been introduced to a number of locations within and slightly north of this range, with a stable population having become established in at least one of these. This species inhabits spring-fed marshes, minor rivers and coastal lagoons, with a strong preference for extremely clean, well-oxygenated freshwater with dense growth of aquatic vegetation. It is threatened by water abstraction for agriculture, drying of wetlands, domestic and agricultural pollution and introduction of non-native fish species. Its habitats are unsuitable for hydropower development.



© Jörg Freyhof

Hydropower Hazard: *LOW*

Bern Convention: *APPENDIX II*

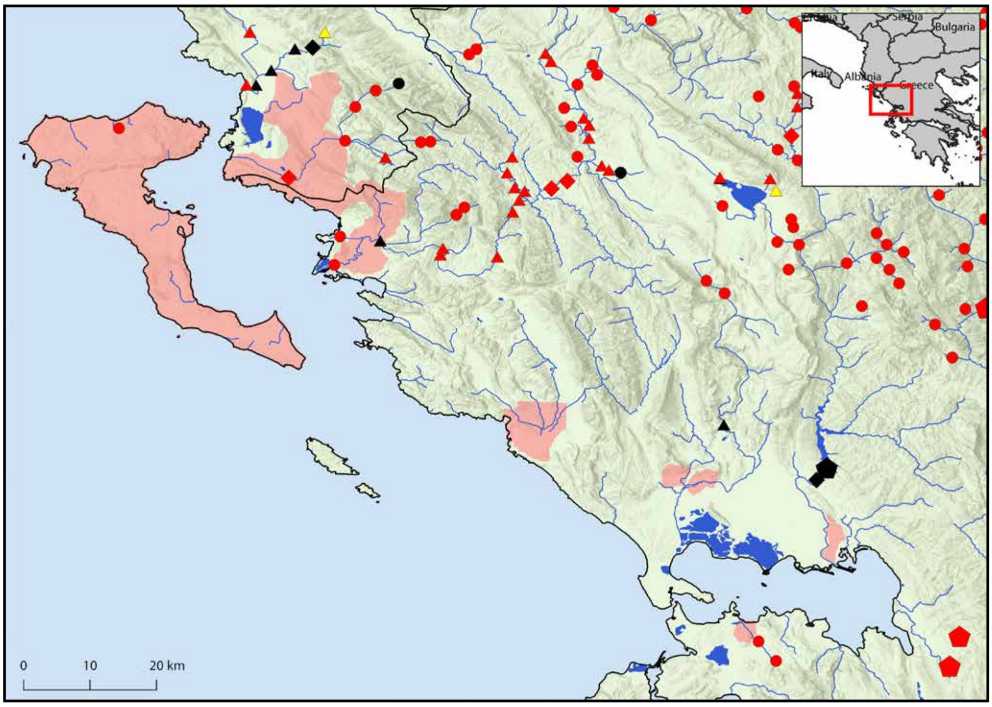
IUCN Red List: *CRITICALLY ENDANGERED*

Valencia letourneuxi

Corfu valencia

Distribution: Albania and Greece

Endemic to the west coast of Greece and adjacent Lake Butrint basin in southern Albania. In Greece it has been extirpated from some former localities such as Lefkas Island, but small populations remain in the Kalamas, Acheron, Louros and Arachthos river drainages, as well as at Vlychos springs. It was recently rediscovered in the Melissoudi stream on Corfu Island and may possibly survive at one additional site on the island. In Albania it appears to be restricted to a single small stream. This species mostly inhabits spring-fed lowland wetlands and tributaries with slow-moving clear water and abundant aquatic vegetation, but is occasionally found in brackish water around the edges of coastal lagoons. It is threatened in particular by water abstraction, domestic and agricultural pollution and introduction of non-native fish species, but is unlikely to be affected by hydropower development.



© Jörg Freyhof

Hydropower Hazard: *LOW*

Bern Convention: *APPENDIX II **

IUCN Red List: *CRITICALLY ENDANGERED*

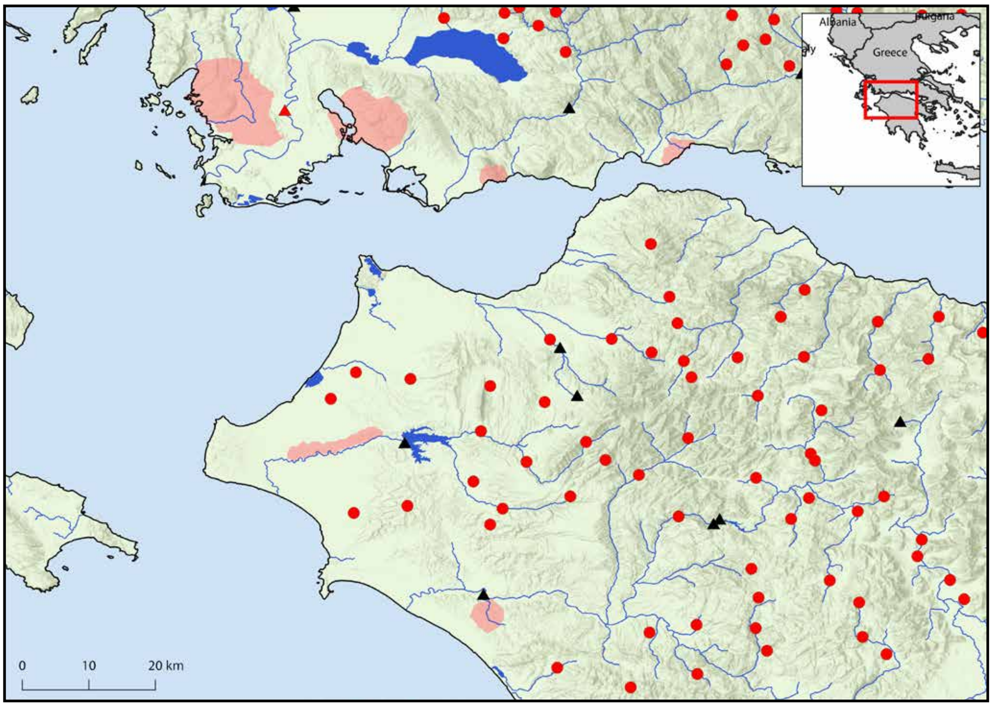
Valencia robertae

Peloponnese valencia

Distribution: Greece

Endemic to western Greece. It has been recorded from a few small sites along the coast of the Ionian Sea in the lower Pinios and Alfios river drainages on the Peloponnese peninsula (likely to be extirpated), plus the Mornos (Chiliadou stream), Acheloos (Agios Dimitrios), Astakos springs and Evinos (Kryoneri spring) drainages. It inhabits unpolluted freshwater springs and deep canals with sluggish water and dense aquatic vegetation. This species is threatened by excessive water abstraction, pollution, drought and channelisation, plus spatial and trophic competition with non-native fish species. Its habitats are unlikely to be targeted for hydropower development.

* as *Valencia letourneuxi*



© Jörg Freyhof

Hydropower Hazard: *LOW*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX II + III **

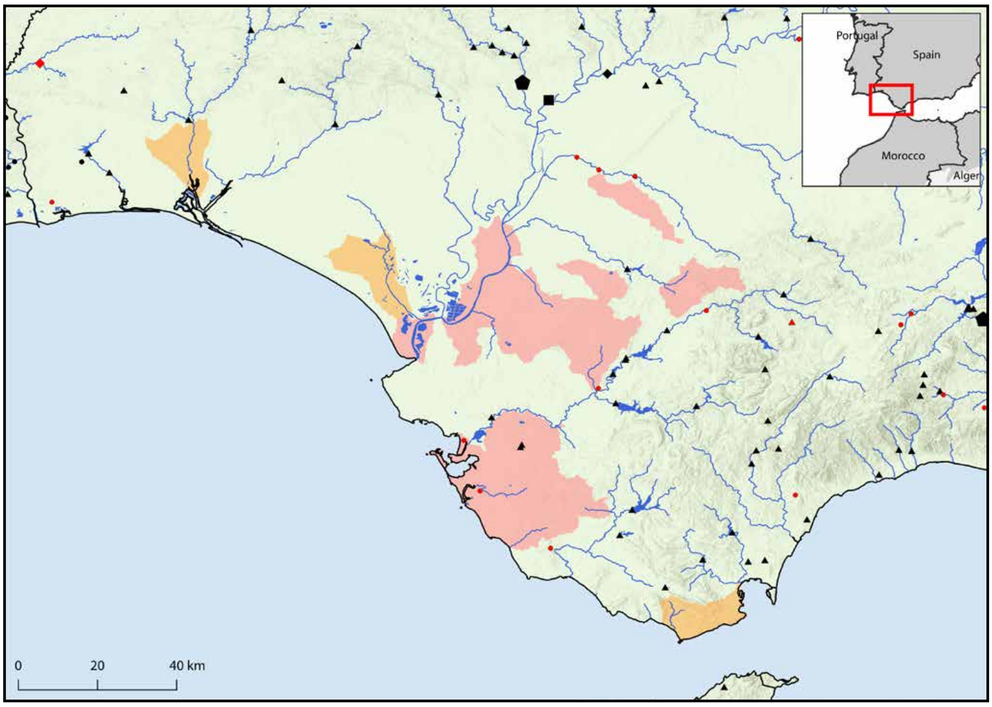
IUCN Red List: *ENDANGERED*

Aphanius baeticus

Baetic killifish

Distribution: Spain

Endemic to the lower Guadalquivir River drainage plus a handful of small coastal rivers in the southern provinces of Sevilla and Cádiz. It inhabits freshwater to hypersaline lagoons, tidal channels, streams, and the lower reaches of small rivers. This species is characterised by a short lifespan and large annual fluctuations in population size depending on environmental conditions. For example, some of its habitats are prone to drying out in summer with the fish surviving in remnant pools. It disappeared from some former locations when the Spanish government authorised the large-scale drying of coastal wetlands for malaria control, agriculture or construction during the 19th and 20th centuries. Current threats include water abstraction, pollution, habitat modification, introduction of non-native fish and crayfish species and increased frequency of droughts.



* as *Aphanius iberus*

© Jörg Freyhof

Aphanius danfordii

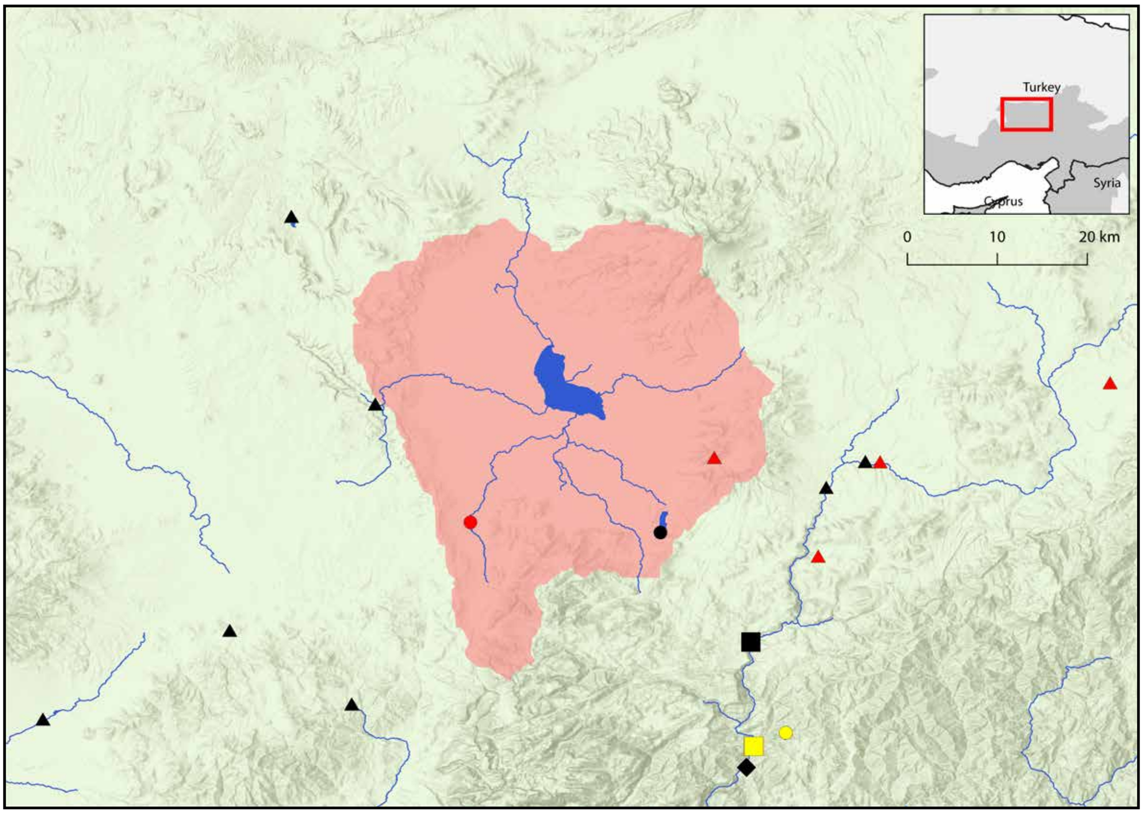
Sultan Sazlığı killifish

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey

Endemic to the Sultan Sazlığı marshes. Located in an endorheic geological depression, this wetland consists of a series of spring-fed lagoons containing fresh to saline water and has been largely drained. It is threatened by continued water abstraction, introduction of non-native fish species and drought. There is also a possible risk of hybridisation with the congener *Aphanius marassantensis* (Kızılırmak killifish) due to construction of a canal linking Sultan Sazlığı to the nearby Kızılırmak River.



© Matthew Ford

Aphanius iberus

Spanish killifish

Hydropower Hazard: *LOW*

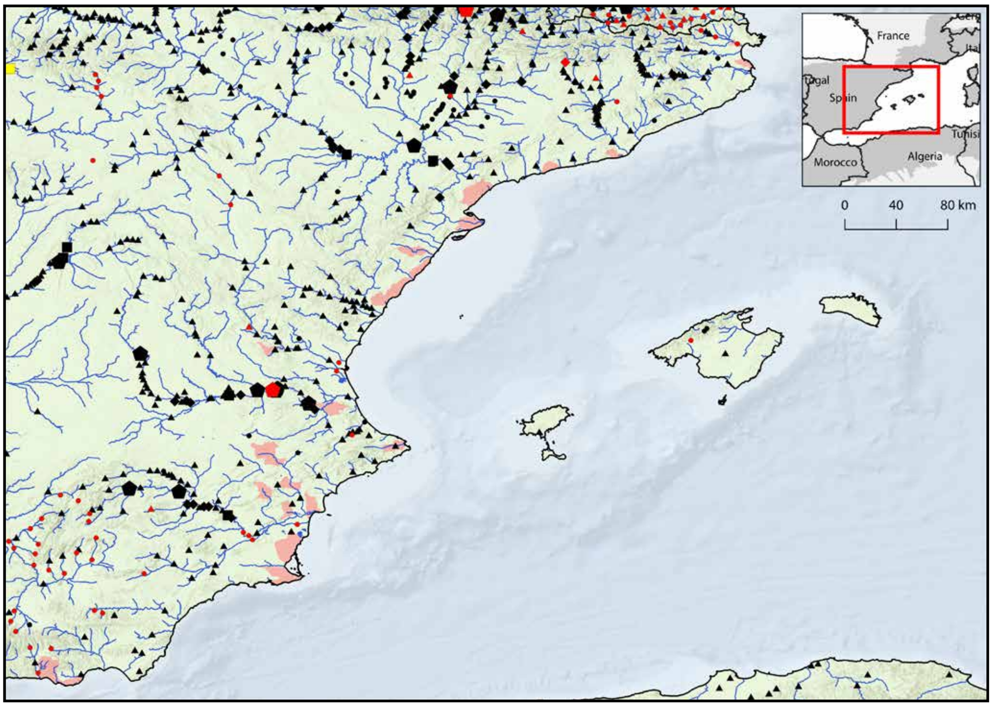
EUR-HAB-DIR: *ANNEX V*

Bern Convention: *APPENDIX II + III*

IUCN Red List: *ENDANGERED*

Distribution: Spain

Restricted to the Spanish Mediterranean coastline in the autonomous communities of Catalonia, Valencia and Murcia, with a single population in Andalucía. This species inhabits freshwater to hypersaline lagoons, tidal channels, small streams, the lower reaches of small rivers and artificial salt pans. It is characterised by a short lifespan and large annual fluctuations in population size depending on environmental conditions. For example, some of its habitats are prone to drying out in summer with the fish surviving in remnant pools. It disappeared from many former locations when the Spanish government authorised the large-scale drying of coastal wetlands for malaria control, agriculture or construction during the 19th and 20th centuries. Current threats include water abstraction, pollution, habitat modification, introduction of non-native fish and crayfish species and increased frequency of droughts.



© Matthew Ford

Aphanius richardsoni

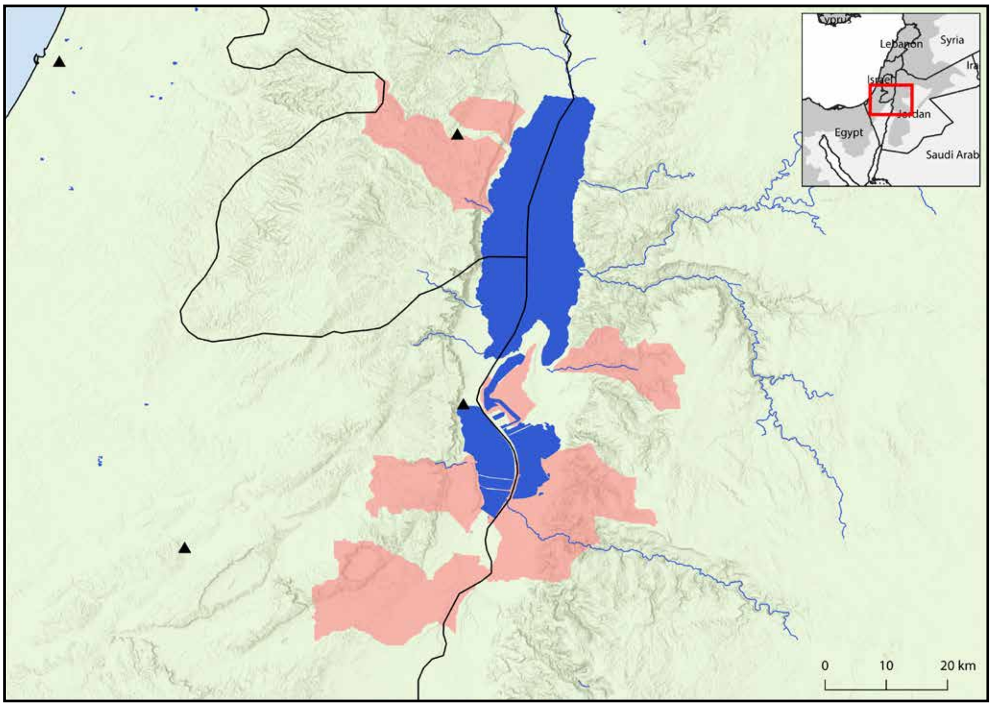
Dead Sea killifish

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Israel and Jordan

Endemic to the Dead Sea basin. This species inhabits pools formed by perennial freshwater and brackish springs and is currently restricted to three small locations at Ein Feshka (aka Einot Tzukim), Ein Samar and Ne'ot Hakikar in Israel and a single nature reserve at Fifa in Jordan. The Dead Sea is an endorheic hypersaline lake fed mostly by the inflowing Jordan River, and its surface is the lowest point on Earth. However, dam construction on the river and its tributaries plus water abstraction for agriculture have reduced its flow by at least 75% since the 1960s. The lake's level has consequently fallen from 392 to 430 metres below sea level and continues to subside by around a metre per year. This has driven the formation of thousands of sinkholes around the shorelines and is the principal threat to the killifish, which has already disappeared from several former locations.



© Matthew Ford

Aphanius saldae

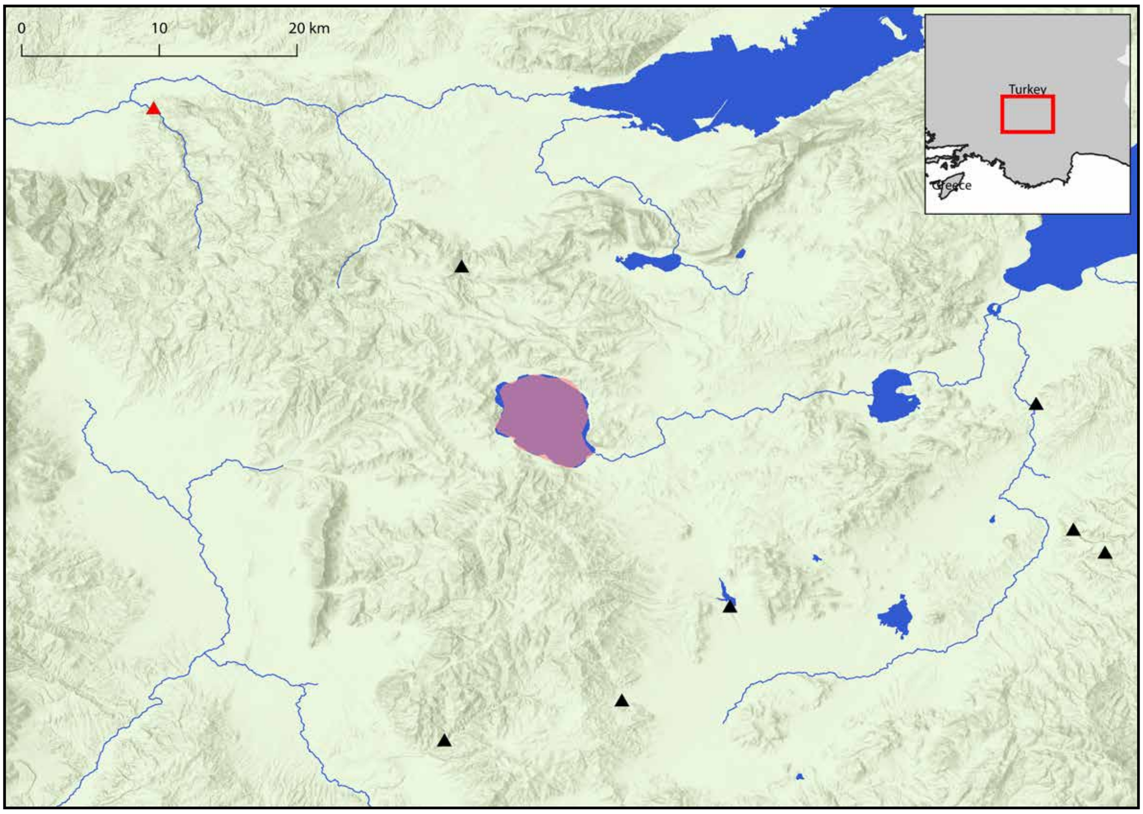
Salda killifish

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey

Endemic to Lake Salda in the Mediterranean Region of southwestern Turkey. The lake has a surface are of less than 45 km^2, is endorheic, oligotrophic and contains extremely alkaline water that is particularly rich in magnesium and sodium. The killifish inhabits the lake's shorelines plus the mouths of a few freshwater springs which drain into it. It is threatened by water abstraction in the catchment of the lake, increased frequency and duration of droughts due to climate change and introduction of non-native species.



© Jörg Freyhof

Aphanius sirhani

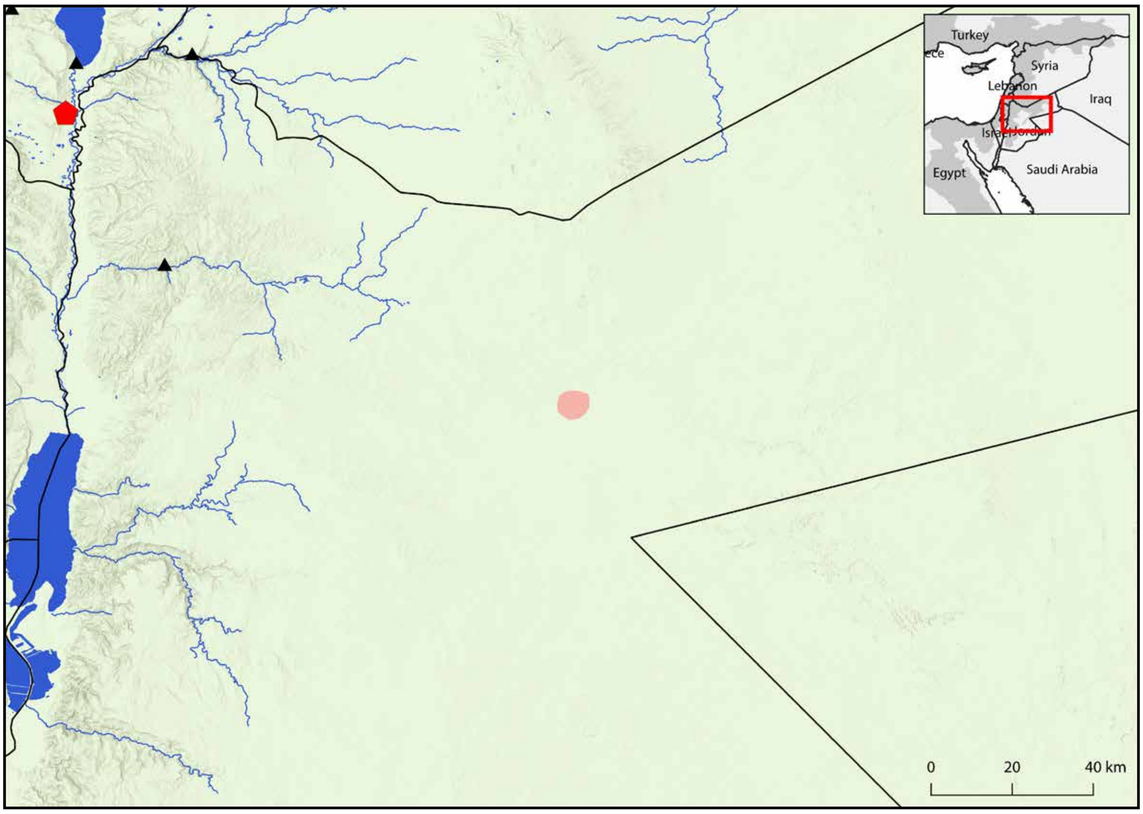
Azraq killifish

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Jordan

Endemic to the Azraq Oasis in the Wadi Sirhan basin. The oasis once comprised a spring-fed lake where this species was the only fish present. However excessive groundwater abstraction to provide drinking water to urban areas coupled with illegal drilling of artesian wells for irrigation led to the system drying out between the early 1980s and 1992. A handful of fish were taken from the wild and bred in captivity before being reintroduced in 2006 after the site was partially restored. However the wetland is now maintained only by artificial pumping of water and a non-native fish species has been introduced.



© Murat Sağdıç

Aphanius sureyanus

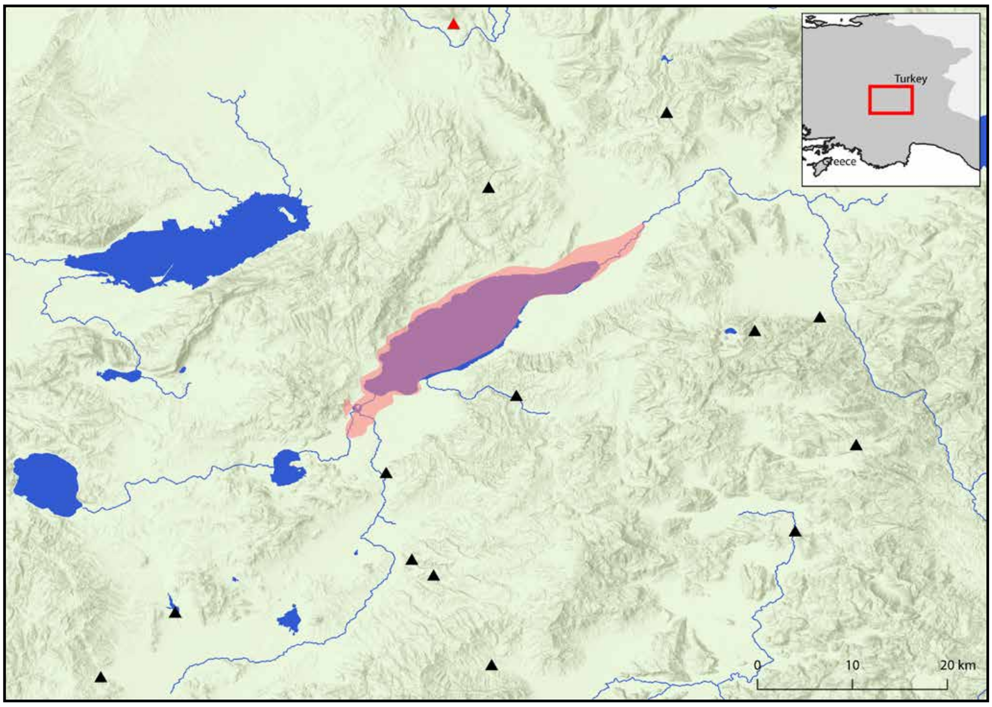
Burdur killifish

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey

Endemic to Lake Burdur, an alkaline and naturally oligotrophic lake. This species inhabited the lake's shorelines but is now restricted to the mouths of a few freshwater springs and streams which drain into it. The lake has lost at least 30% of its surface area and become increasingly saline since the mid-1970s due to construction of dams on all its major tributaries. Furthermore, many illegal wells have been drilled in the area and one important spring is exploited for drinking water. Untreated domestic, industrial and agricultural wastewater has also been discharged directly into the lake for decades, causing it to become eutrophic. The invasive eastern mosquitofish (*Gambusia holbrooki*) has been introduced to what remains of the freshwater inflows. Whereas the killifish was abundant in the early 2000s it is now scarce and several mass die-off events associated with cyanobacteria blooms have been observed.



Aphanius transgrediens

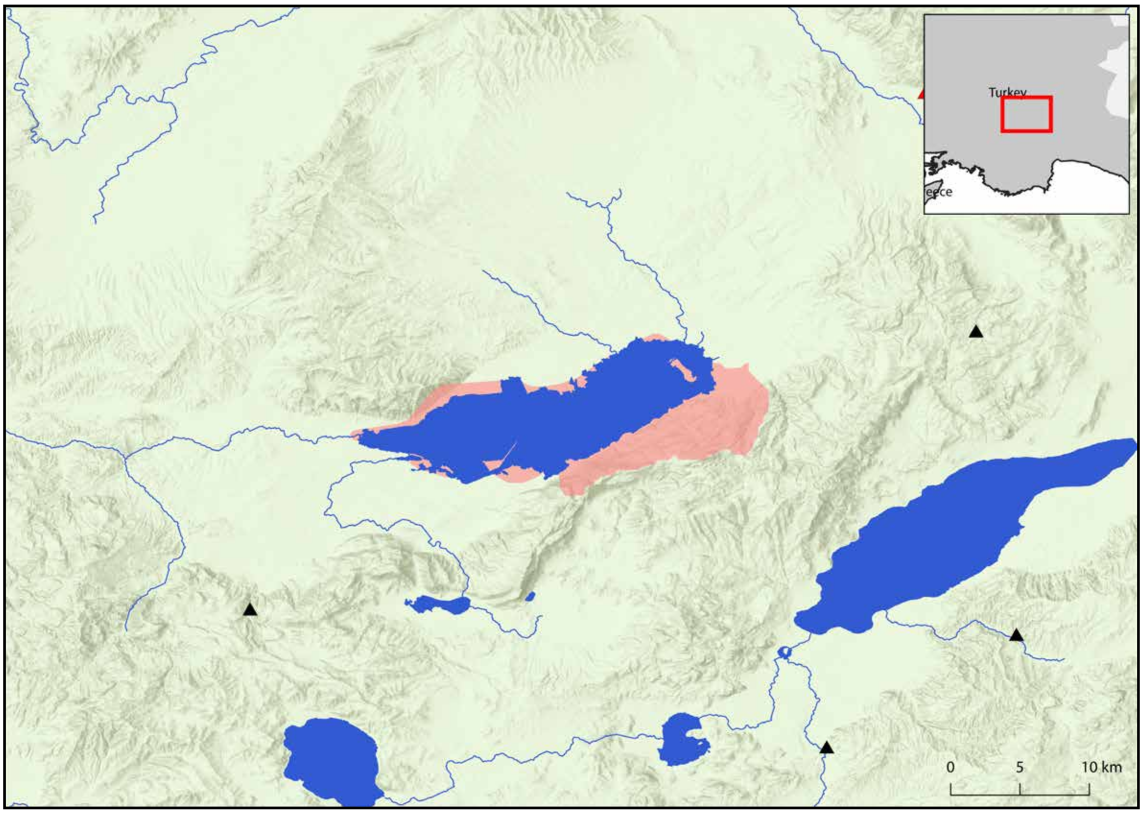
Acıgöl killifish

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Turkey

Endemic to hypersaline Lake Acıgöl in the Aegean Region of southwestern Turkey. This species is restricted to a series of small perennial springs distributed mostly along the lake's southern shoreline, and between which there may be a degree of connectivity during periods of extreme flooding. The population has declined catastrophically since the 1990s, when the non-native eastern mosquitofish (*Gambusia holbrooki*) was introduced and colonised all the remaining springs. It is further threatened by droughts which are becoming more frequent in the area.



© Jörg Freyhof

Pungitius hellenicus

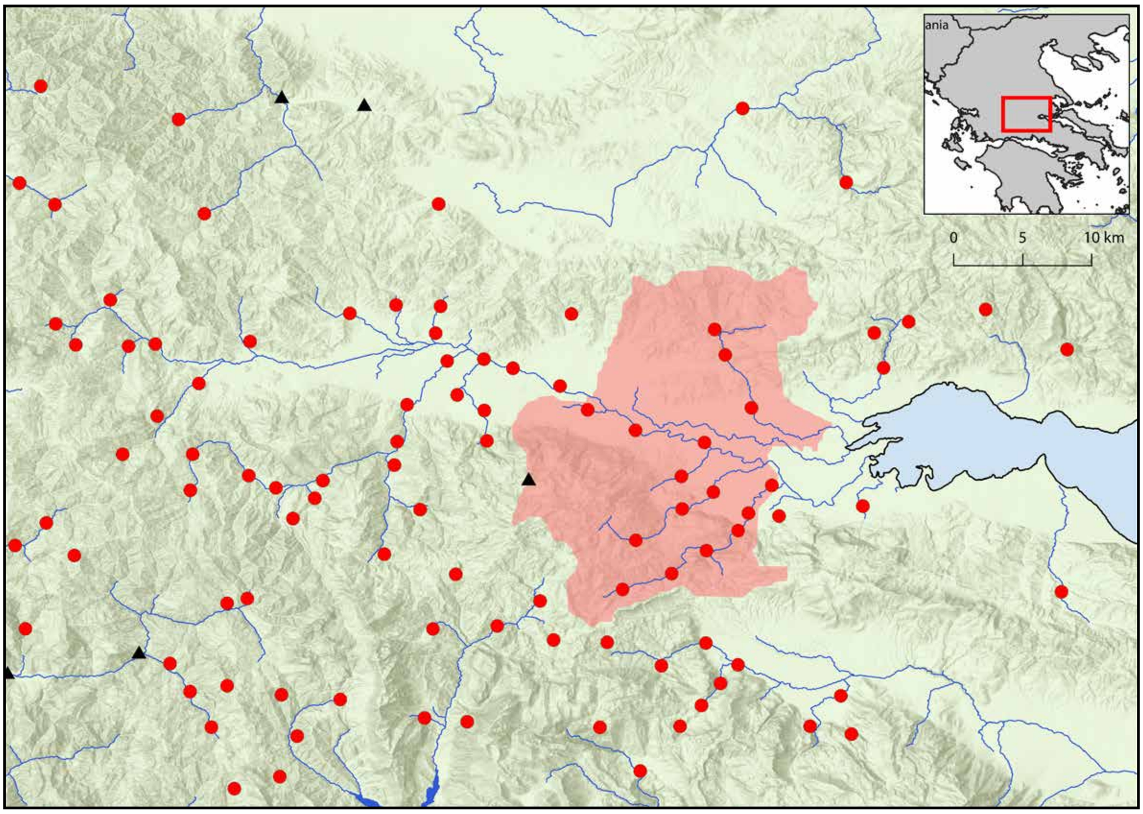
Greek ninespine stickleback

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*

Distribution: Greece

Endemic to the lower Sperchios River drainage in western Greece. Confirmed localities include the Agia Paraskevi spring east of Lamia, a number of drainage channels close to Moschochori and a handful of natural karstic sinkhole pools near Kompotades village. It has been extirpated from Mexiates wetland. It is threatened by abstraction of water for irrigation, pollution from agriculture and habitat modification since some drainage channels and springs are regularly disturbed for maintenance. Hydropower development on the Sperchios River could affect discharge of the groundwater which supplies its only known habitats.



© Eliza Uzunova

Hydropower Hazard:
HIGH

EUR-HAB-DIR:
*ANNEX II **

Bern Convention:
*APPENDIX III **

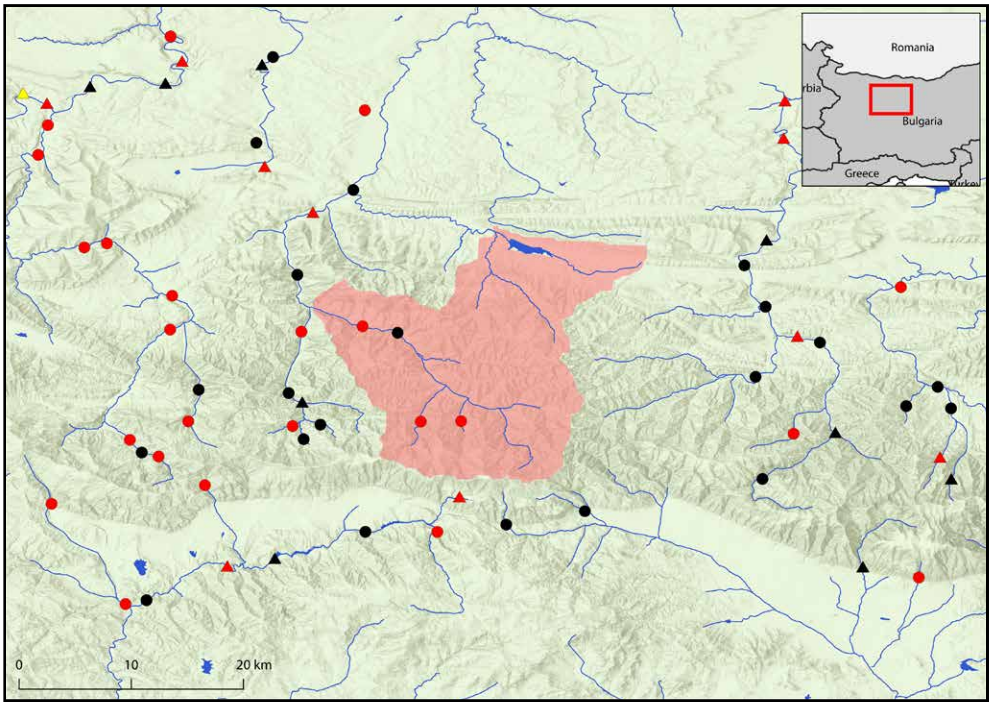
IUCN Red List:
CRITICALLY ENDANGERED

Cottus haemusi

Vit sculpin

Distribution: Bulgaria

Known only from the Vit River drainage. In 2011 it could only be collected from two small headwater tributaries, the Kostina and Toplja, where it was restricted to stretches of 500 metres and 1000 metres, respectively. This species inhabits small, fast-flowing streams with clear water and substrates of gravel or stone. It is thought to have been most heavily-affected by a combination of hotel construction and subsequent discharge of untreated wastewater into the Vit River plus fragmentation of its habitats due to construction of weirs. Stocking of brown trout (*Salmo trutta*) for recreational angling may also have exerted a negative effect. If all hydropower plants planned in the upper Vit drainage are built, this species could be driven to extinction.



* as *Cottus goibo*

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Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II*

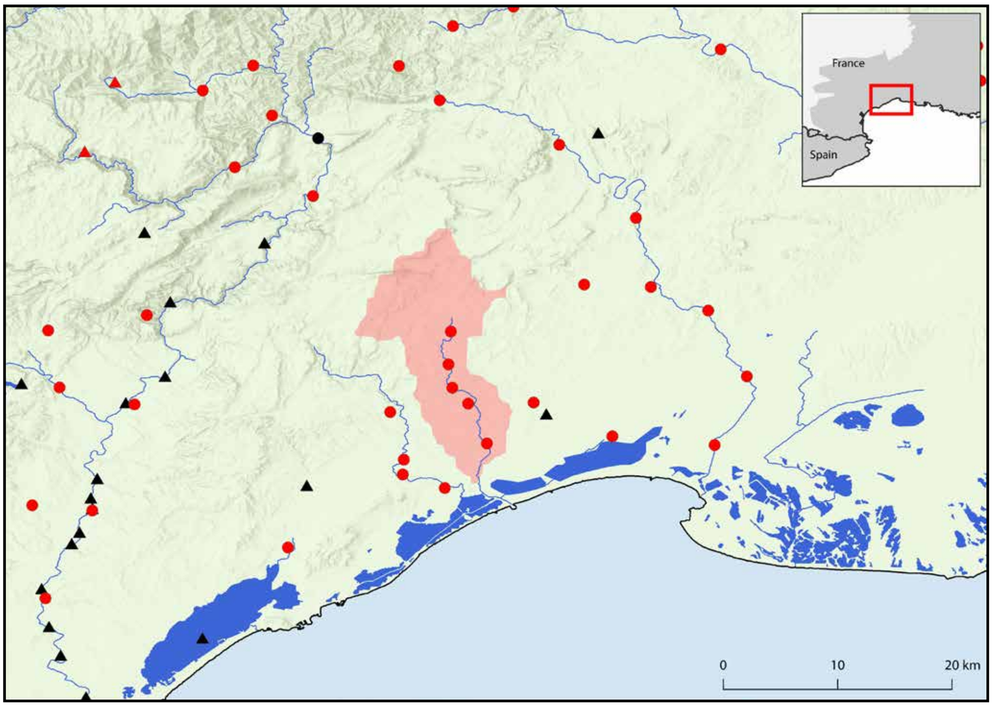
IUCN Red List: *CRITICALLY ENDANGERED*

Cottus petiti

Lez sculpin

Distribution: France

Known from only a short (~5 km) stretch of the upper Lez River near Montpellier in southern France, where it has also been recorded from the lower reaches of at least two small tributaries. It prefers shallow, running stretches with mixed substrates of gravel, rocks and stones. The Lez has been exploited as a drinking water resource for the nearby city of Montpellier since the mid-1800s, but the volume abstracted increased significantly in 1982 when deep drilling began. Water from the Rhône drainage is also transferred to the lower Lez downstream of the species' habitats to increase the supply, which could lead to invasion of non-native species. An increase in organic pollution has driven eutrophication leading to some stretches being choked by filamentous algae or emergent aquatic plants such as watercress. If all hydropower plants planned in the Lez drainage are built, this species could be driven to extinction.



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Hydropower Hazard: *HIGH*

EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *VULNERABLE*

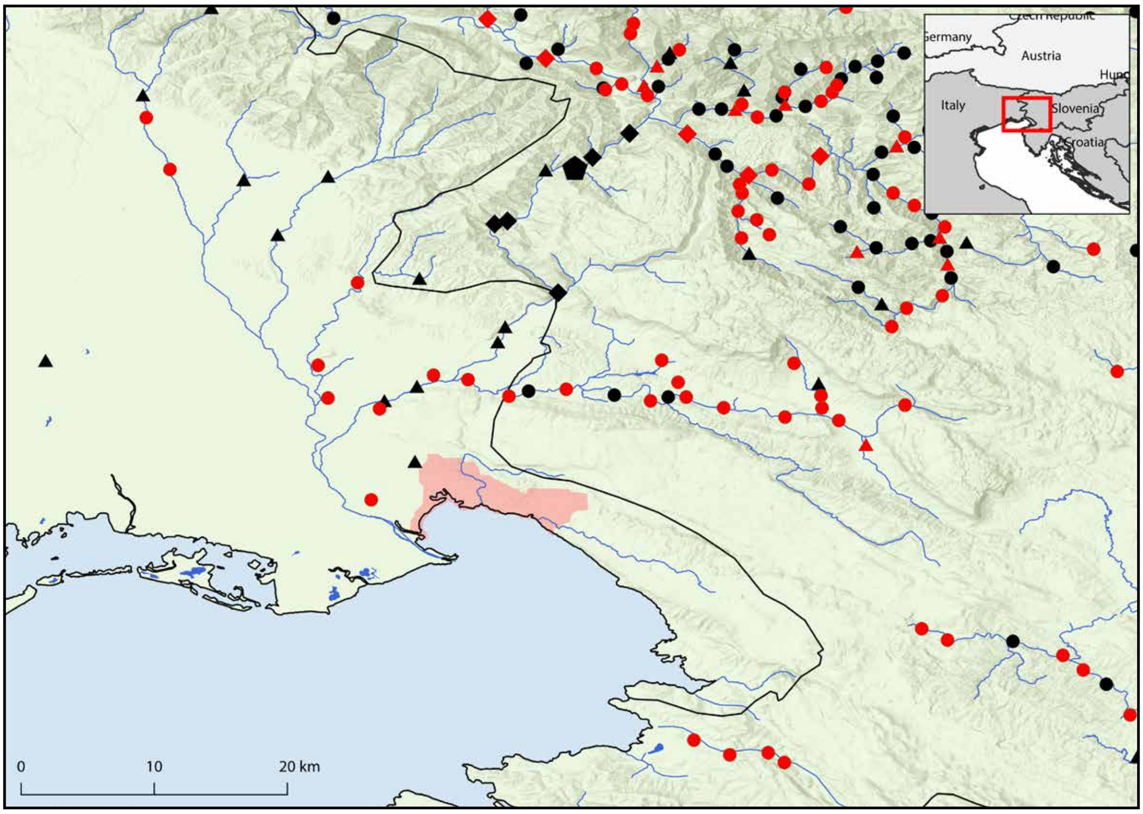
Cottus scaturigo

Timavo sculpin

Distribution: Italy

Endemic to Timavo spring near Trieste in northern Italy. The spring is the resurgence of the sinking Reka River, which flows underground for 35 km through the Kras karst plateau from Slovenia. This species inhabits the freshwater section of the spring, which flows for around two kilometres before entering a marina connected to the Adriatic Sea. The spring's discharge is sensitive to hydrological regime shifts in its affluent rivers, such as those typically triggered by hydropower development.

* as *Cottus gobio*



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Zingel asper

Apron

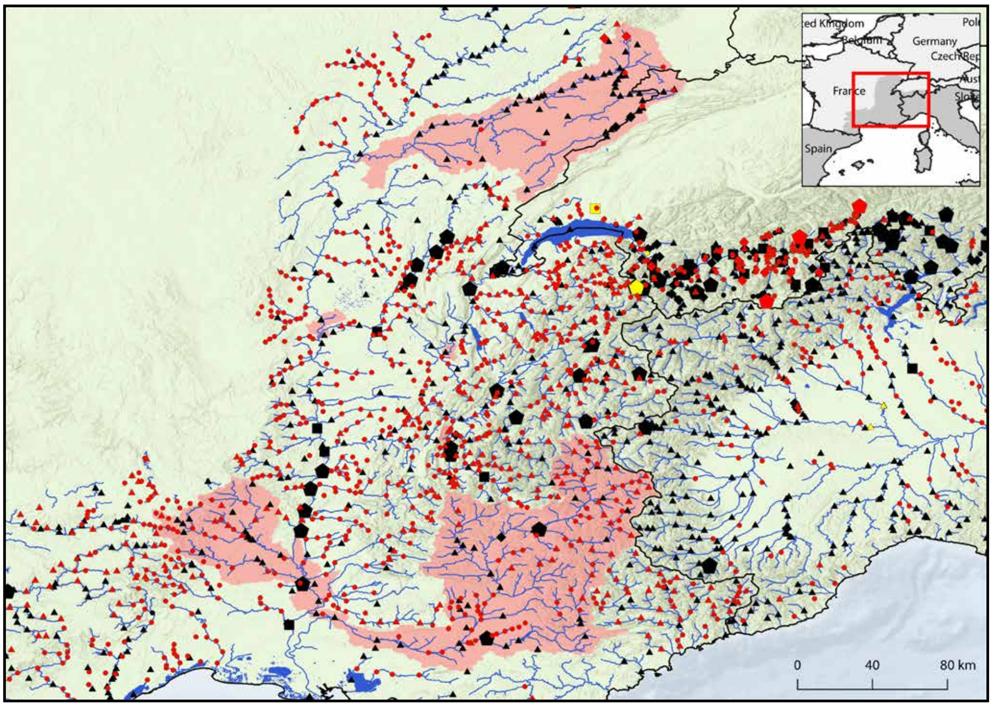
Hydropower Hazard: *HIGH*

Bern Convention: *APPENDIX II*

IUCN Red List: *VULNERABLE*

Distribution: France and Switzerland

Endemic to the Rhône River drainage, but it has disappeared from much of its former range since the beginning of the 20th century. Six sub-populations remain, the largest of which inhabits the Durance drainage. This species is rheophilic, inhabiting fast-flowing clear water with substrates of rocks and boulders. It is threataned by pollution, water abstraction and construction of dams and weirs leading to populations becoming isolated from one another. Previously assessed as Critically Endangered by the IUCN, a conservation management plan which started in 2012 led to its range increasing by around a third by 2017. Specific actions included removal of man-made obstructions, and the fish were quickly able to colonise previously inaccessible stretches. It only occupies a small fraction of its original range, however.



© Vasil Kostov

Hydropower Hazard: *HIGH*

Bern Convention: *APPENDIX III **

IUCN Red List: *CRITICALLY ENDANGERED*

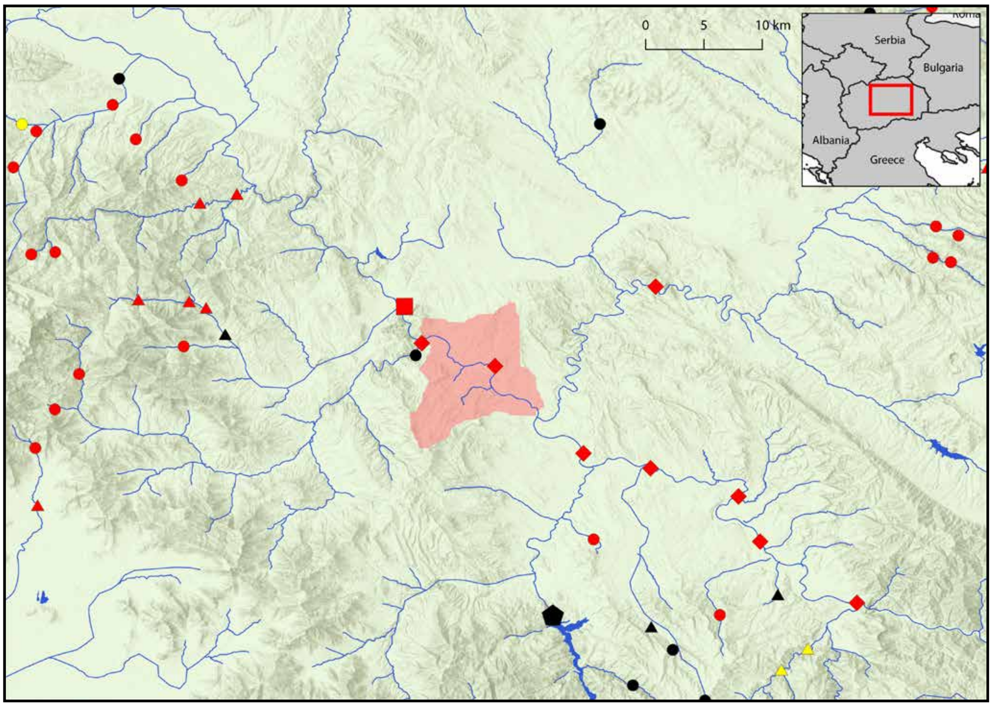
Zingel balcanicus

Vardar streber

Distribution: North Macedonia

Currently known only from a short section of the Beleshnica River, a tributary within the Treska River drainage. This species is rheophilic and inhabits fast-flowing water with substrates of rocks and boulders. It appears to have disappeared from the remainder of its assumed historical range in the middle Vardar River, although it might still occur elsewhere since some tributaries remain poorly sampled. In the Treska its range is limited by a series of three dams built on the river's main channel downstream of its confluence with the Beleshnica, all of which include hydroelectric power plants. Additional threats include pollution, gravel extraction and introduction of non-native fish species.

* as *Zingel streber*



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Haplochromis desfontainii

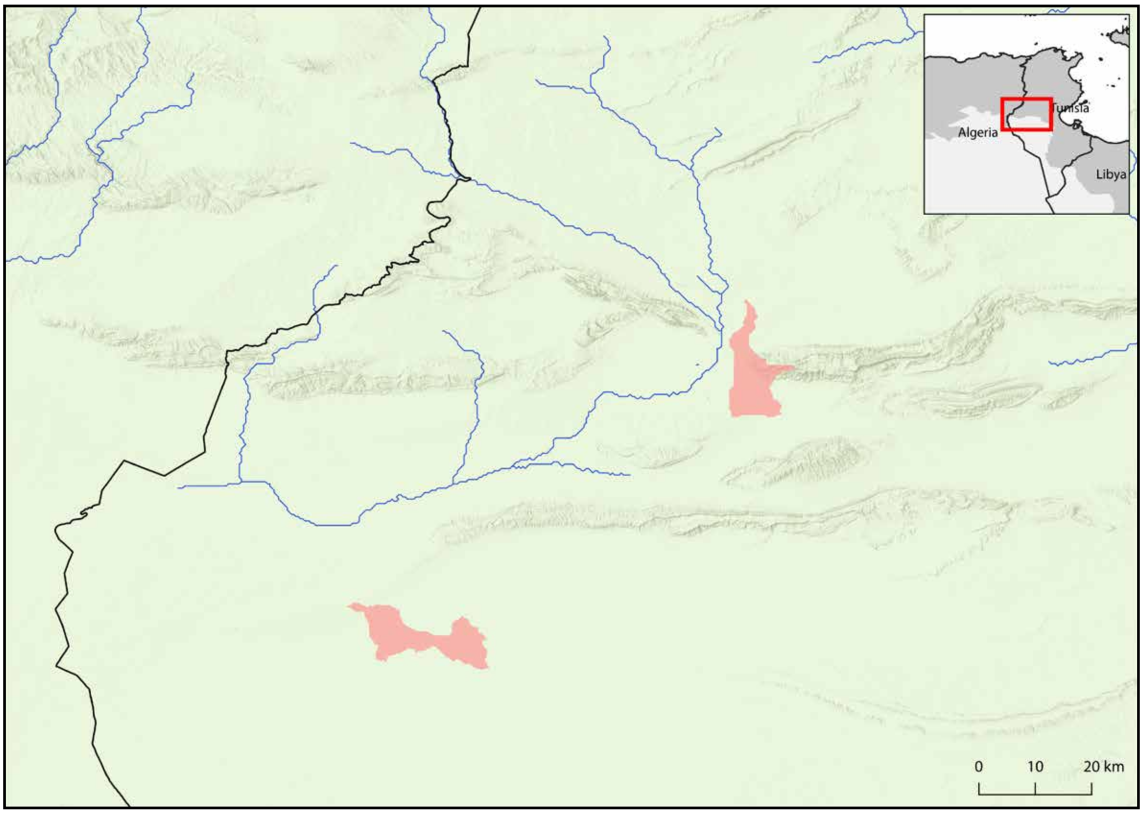
Blue lip cichlid

Distribution: Algeria and Tunisia

Hydropower Hazard:
LOW

IUCN Red List:
CRITICALLY ENDANGERED

Has been recorded from Tolga and the Ziban Oasis in northeastern Algeria, and from several locations north of the endorheic Chott el Djerid salt lake in central Tunisia. However, it has been extirpated from the majority of its range and now appears restricted to a single location close to Tozeur in the Chott el Djerid basin. Its decline has been driven by unsustainable abstraction of groundwater for irrigation, and the last remaining population survives only due to water being artificially pumped into a stream channel.



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Haplochromis flaviijosephi

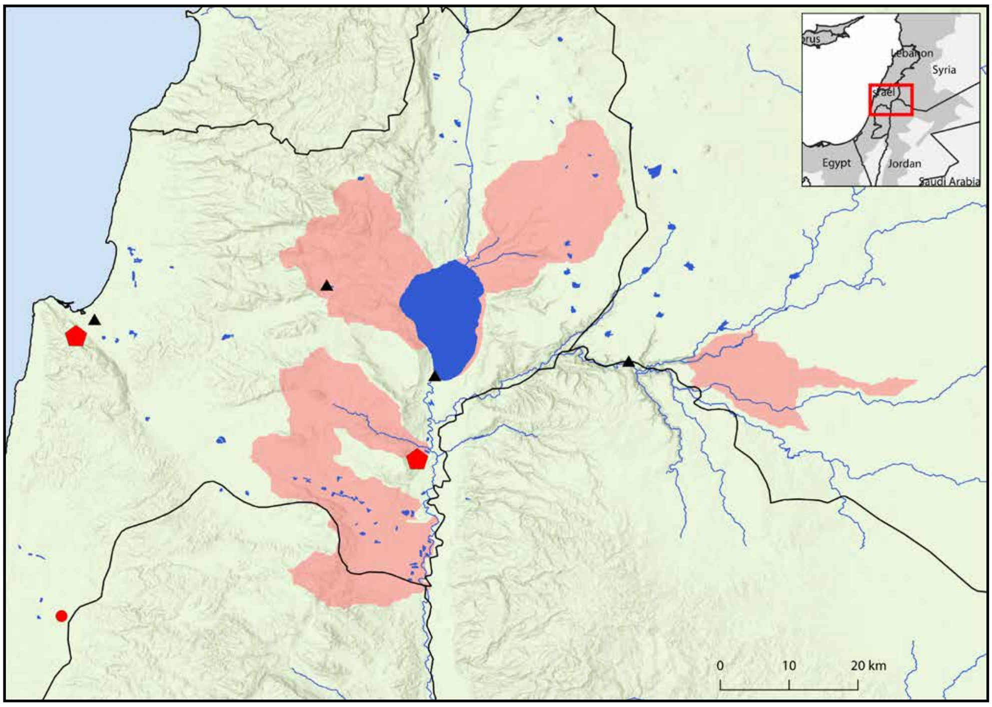
Jordan mouthbrooder

Distribution: Israel and Syria

Hydropower Hazard: *HIGH*

IUCN Red List: *VULNERABLE*

Endemic to the Jordan River drainage. Populations in Israel appear to be relatively stable although the Lake Kinneret ecosystem has deteriorated substantially since the 1950s, when the drainage of the upstream Lake Hula wetland provoked a series of subsequent anthropogenic modifications. In Syria all records are from the Yarmouk River, the largest tributary in the Jordan drainage. The Yarmouk has been dammed more than 40 times and thousands of illegal wells have been drilled to pump groundwater. Its discharge into the Jordan has plummeted from an annual average of four hundred billion litres to zero since the 1960s. The small, spring-fed Lake Muzayrib dried out almost entirely between 2016 and 2018 after the local aquifer was completely depleted, and it is unclear if any fishes survive there. Other than water abstraction, this species is also threatened by introduction of non-native fish species, increased intensity of droughts due to climate change and widespread pollution.



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Tristramella simonis

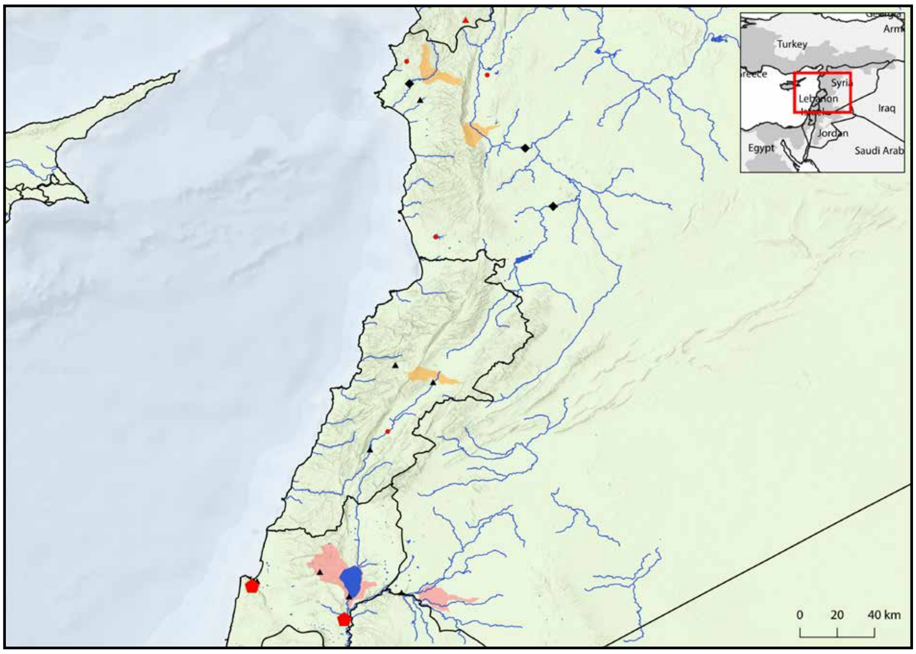
Short jaw tristramella

Hydropower Hazard: *LOW*

IUCN Red List: *VULNERABLE*

Distribution: Israel and Syria

Native to the transboundary Jordan River drainage plus the Barada and Awaj rivers, which together comprise the Damascus basin. In Israel it remains extant in Lake Kinneret (aka Sea of Galilee or Lake Tiberias) but was extirpated from Lake Hula after the wetland was drained during the 1950s. In Syria it is known from a series of locations within the Yarmouk River drainage, the largest tributary in the Jordan system, including a canal at Alashaary, Lake Muzayrib and an artificial reservoir near the city of Daraa, but has vanished from the Barada and Awaj rivers. Introduced populations have been reported from the Orontes and Nahr al-Kabir al-Shamali rivers in northwestern Syria. This species displays a preference for standing water and is apparently able to colonise dam lakes. It is however at risk from excessive water abstraction, particularly in the Yarmouk basin where thousands of illegal wells have been drilled to exploit groundwater. The small, spring-fed Lake Muzayrib dried out almost entirely between 2016 and 2018, and it is unclear if any native fishes survive there. Additional threats include widespread pollution, introduction of non-native fish species and increased intensity of droughts due to climate change.



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Salaria atlantica

Moroccan freshwater blenny

Hydropower Hazard: *HIGH*

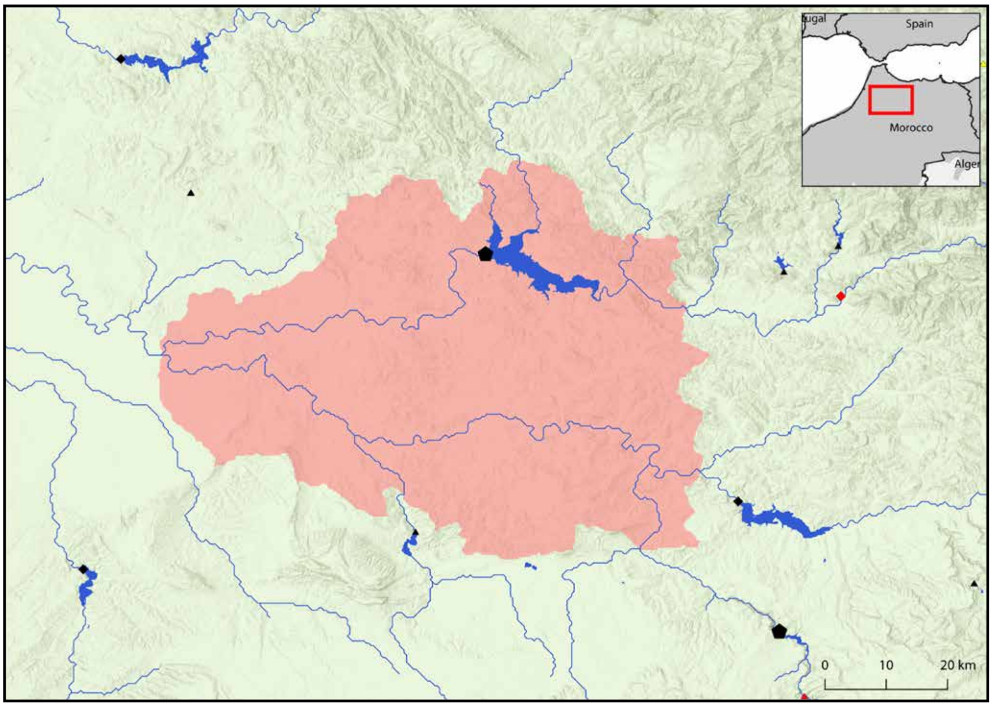
Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Distribution: Morocco

Known only from three locations within the Sebou River drainage in northern Morocco. This species inhabits stretches with shallow, fast-flowing water and substrates of gravel and stones. Three major dams, two of which are hydroelectric, were constructed on the river's tributaries between the 1970s and 1990s. These have significantly reduced the extent of suitable habitat while favouring the establishment of non-native fish species. Additional threats include excessive water abstraction plus ongoing pollution from agricultural runoff and discharge of untreated domestic sewage.

* as *Blennius fluviatilis*



© Jörg Freyhof

Salaria economidisi

Trichonis blenny

Distribution: Greece

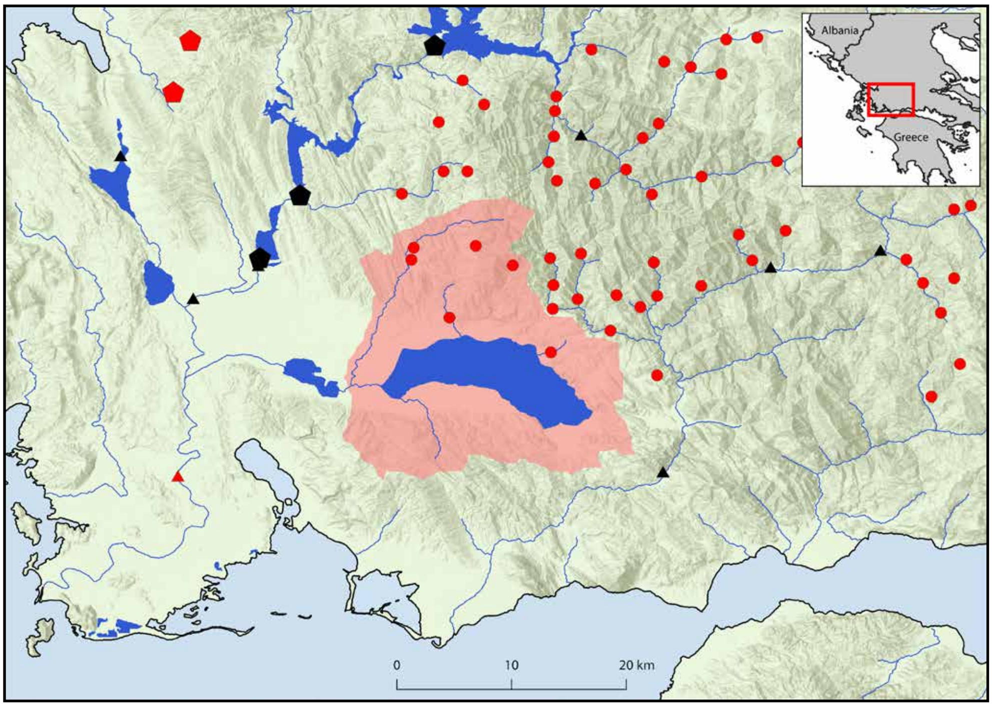
Hydropower Hazard: *MODERATE*

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Endemic to Lake Trichonida (aka Trichonis) within the Acheloos (aka Achelous) River drainage in western Greece. This benthic species typically inhabits the lake's shorelines in areas where the substrate is composed of sand, gravel or rocks alongside large stones, often among vegetation. The main threats are agricultural pollution, which is slowly driving eutrophication of the lake, plus reclamation of land for agricultural use. Several non-native fish species are also established in the basin, while climate change or construction of new hydropower plants in the Acheloos River could alter the local hydrological regime.

* as *Blennius fluviatilis*



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Hydropower Hazard:
HIGH

EUR-HAB-DIR:
*ANNEX II **

Bern Convention:
*APPENDIX III ***

IUCN Red List:
ENDANGERED

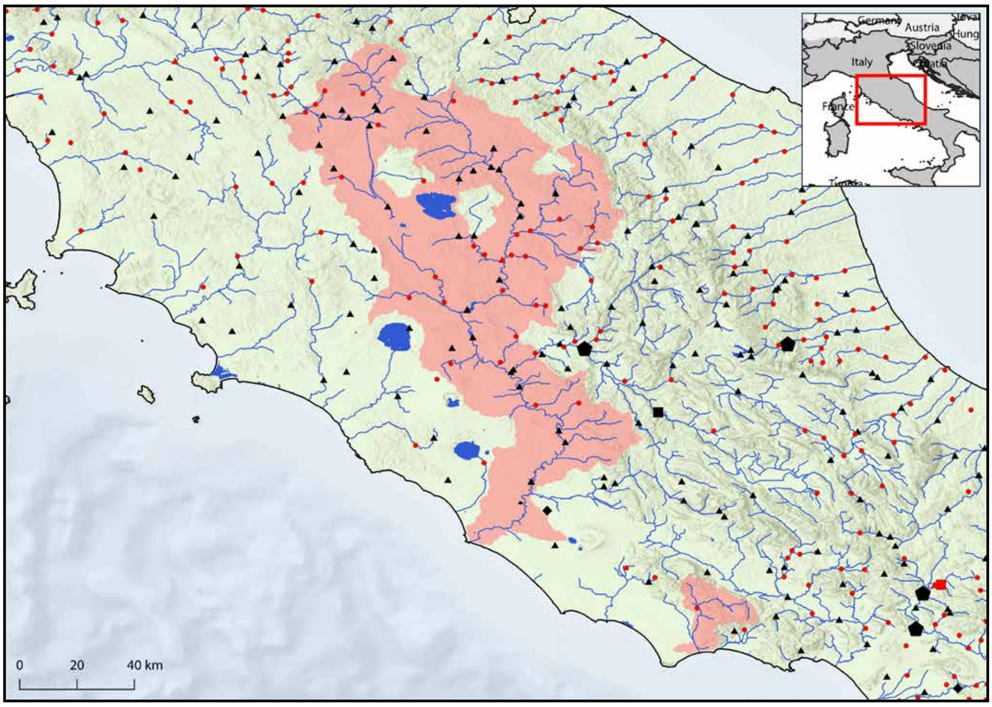
Neogobius nigricans

Arno goby

Distribution: Italy

Endemic to the Ligurian and Tyrrhenian slopes of eastern Italy, where its range extends south from the Arno to the Amaseno river drainages. It mostly inhabits small tributaries with flowing water and stony substrates, but is also known from two natural lakes. This species is threatened mainly by introduction of the Padanian goby (*Padogobius bonelli*) from the north Adriatic basin, which outcompetes it for resources and breeding sites. Some populations in the Ombrone, Mignone, Tiber and Amaseno drainages have been extirpated as a result. It is also threatened by construction of dams and weirs which reduce the extent of suitable habitat.

* as *Padogobius nigricans*   ** as *Gobius nigricans*



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Hydropower Hazard: *MODERATE*

EUR-HAB-DIR: *ANNEX V*

Bern Convention: *APPENDIX II + III*

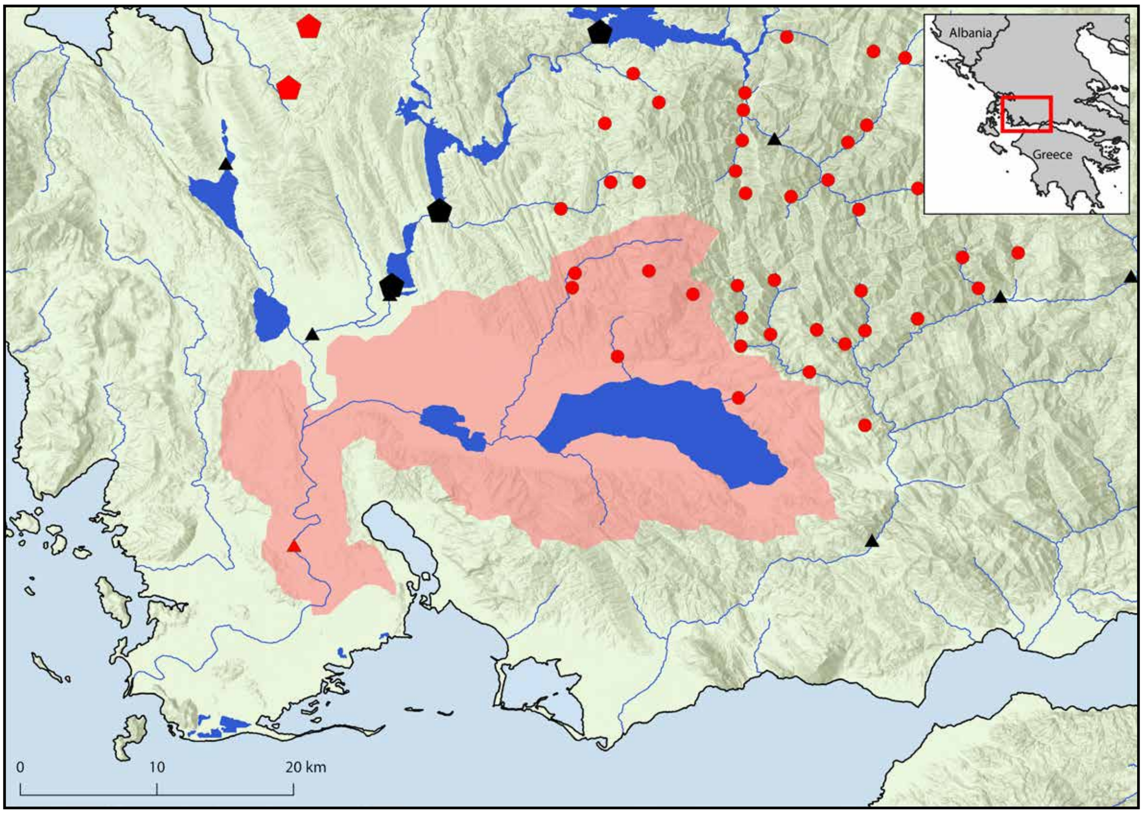
IUCN Red List: *ENDANGERED*

Economidichthys trichonis

Trichonis dwarf goby

Distribution: Greece

Native to Lakes Trichonis and Lyssimachia within the Acheloos (aka Achelous) River drainage, western Greece. It has only been recorded in the river itself on a single occasion. This species inhabits the lakes' shorelines and is typically associated with submerged vegetation. It is threatened by agricultural pollution, which is slowly driving eutrophication of the lake, plus reclamation of land for agricultural use. Several non-native fish species are also established in the basin, while climate change or construction of new hydropower plants in the Acheloos River could alter the local hydrological regime.



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Knipowitschia mermere

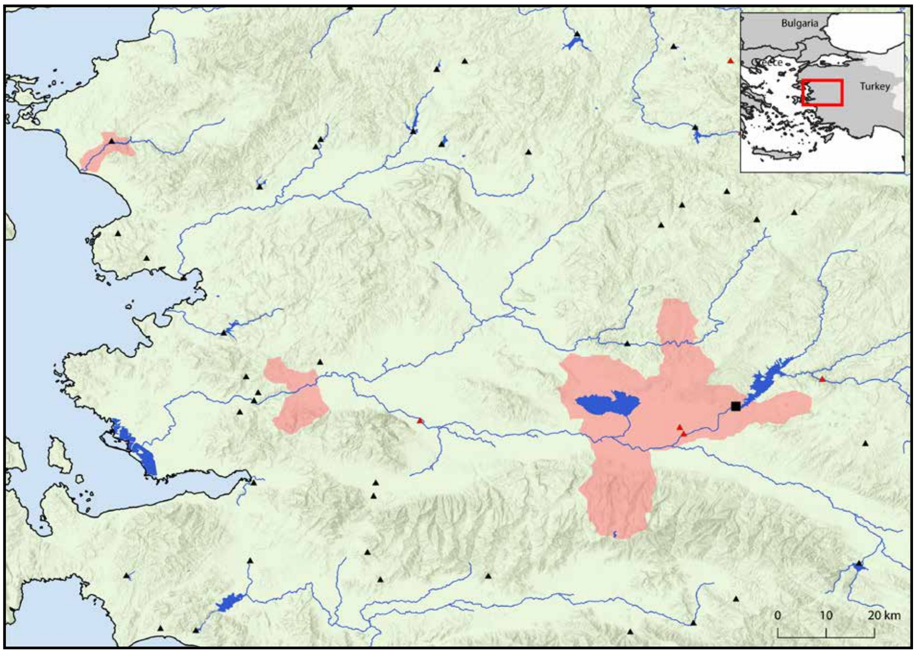
Gediz dwarf goby

Hydropower Hazard: *LOW*

IUCN Red List: *VULNERABLE*

Distribution: Turkey

Native to Lake Marmara plus the lower courses of the Gediz and Madra river drainages in the Aegean Region of western Turkey. It might also occur in the area between the two rivers. The Gediz main channel is heavily polluted and the river has been further degraded by construction of three dams. One of these is located above Lake Marmara, which has suffered from decades of modification and pollution, mostly related to agriculture, and is becoming increasingly eutrophic. Its surface area also shrank by almost 40% of its surface area between 2011 and 2018, with the loss attributed to a combination of poor management and climate change. A number of non-native fish species have also been introduced to the lake and have negatively affected native fish populations. The Madra is dammed a few kilometres before its estuary and its lower course is mostly channelised, vastly reducing the quality of habitat for native fishes.



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Knipowitschia milleri

Acheron spring goby

Distribution: Greece

Hydropower Hazard: *LOW*

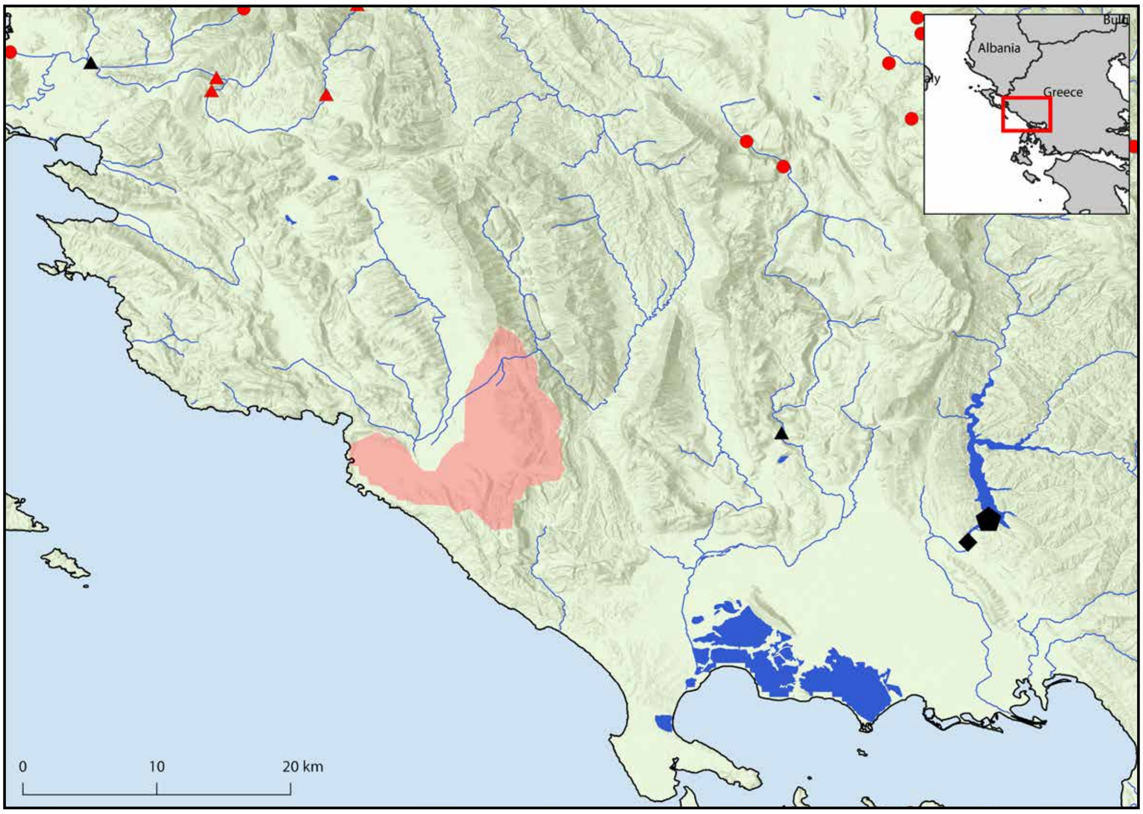
EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Endemic to the lower Acheron River drainage in western Greece. It mostly inhabits slow-moving, highly-vegetated freshwater habitats with substrates of mud or sand, but also occurs in brackish coastal lagoons and salt marshes. This species is threatened by habitat loss due to land reclamation in the Acheron delta region, pollution due to discharge of untreated sewage from nearby villages, and introduced non-native fish species. Dam construction in the area would favour further establishment of the latter and interfere with the local hydrological regime.

* as *Padogobius panizzai*



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Hydropower Hazard:
LOW

EUR-HAB-DIR:
*ANNEX II **

Bern Convention:
*APPENDIX III **

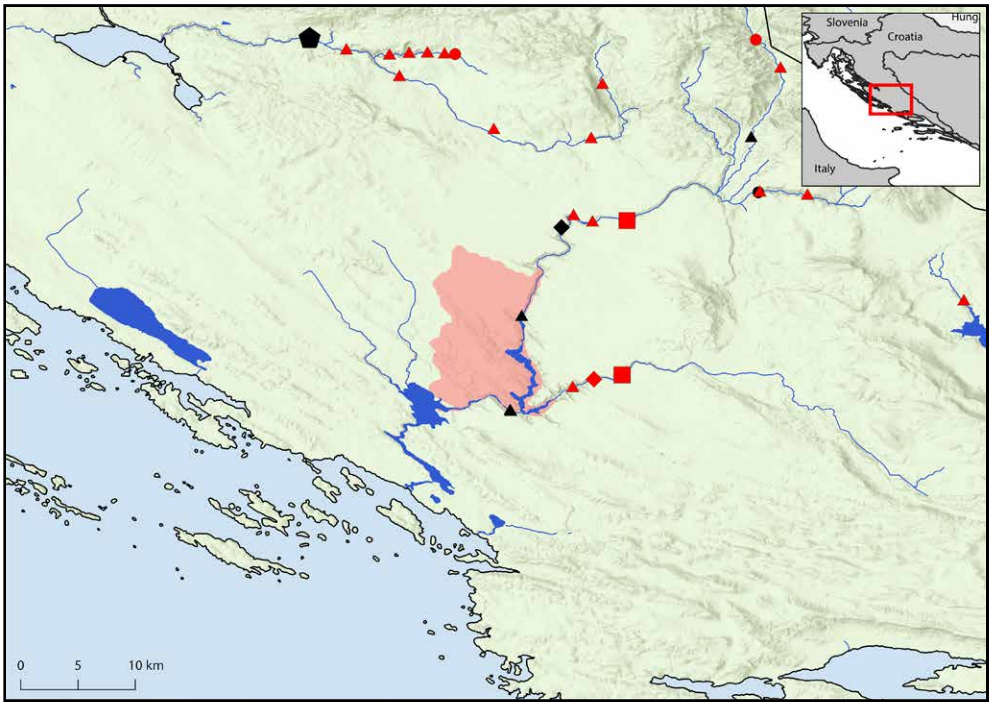
IUCN Red List:
VULNERABLE

Knipowitschia mrakovcici

Visovac goby

Distribution: Croatia

Known only from the Krka River drainage in southern Croatia, where it is restricted to Lake Visovac and a short stretch of the main river channel. Its downstream range is limited by the Skradinski Buk waterfalls, below which the river becomes brackish. Unlike some congeners this species occurs only in pure freshwater where it typically inhabits shallow, sluggish, marginal habitats, often with dense growths of riparian or aquatic vegetation. In Lake Visovac it has occasionally been observed at depths of up to 15 metres, however. Non-native fish species introduced to the Krka system include the invasive eastern mosquitofish (*Gambusia holbrooki*) and predatory northern pike (*Esox lucius*). Hydropower development in the area could interfere with groundwater circulation, hydraulic connectivity and the discharge of springs.



* as *Padogobius panizzai*

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Knipowitschia radovici

Norin goby

Hydropower Hazard: *MODERATE*

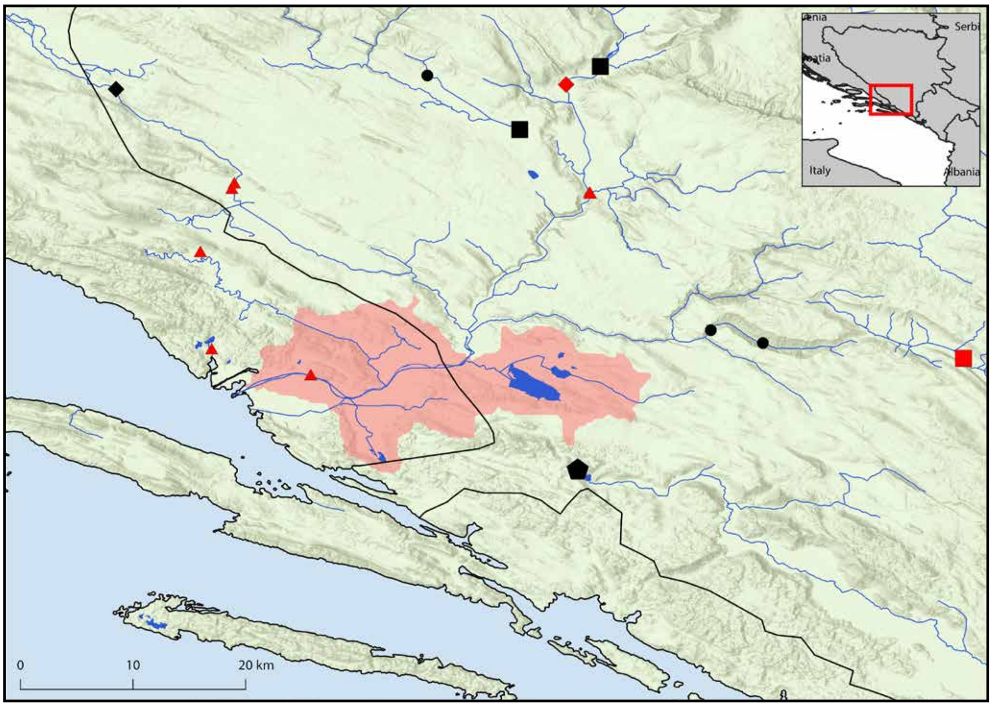
EUR-HAB-DIR: *ANNEX II **

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Distribution: Croatia and Bosnia-Herzegovina

Endemic to the lower Neretva River drainage in Croatia and Bosnia-Herzegovina, where it is known only from Lake Modro oko and the Norin River on the right bank and Hutovo Blato wetland on the left bank. It inhabits karstic, oligotrophic streams and channels with running to standing water and substrates of gravel, mud or silt, often with aquatic vegetation or woody debris. The main threats include construction of dams and modification of river channels, pollution and introduction of non-native fish species. Hutovo Blato naturally floods on an annual basis but the extent to which it does so has decreased significantly due to reduced flow driven by hydroelectric development in the upper Neretva basin. A plan (ongoing as of late 2019) to divert significant volumes of water from Hutovo Balto is also likely to have serious detrimental consequences for native fish populations, while the main spring feeding the Norin River is exploited for drinking water.



* as *Padogobius panizzai*

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Knipowitschia ricasolii

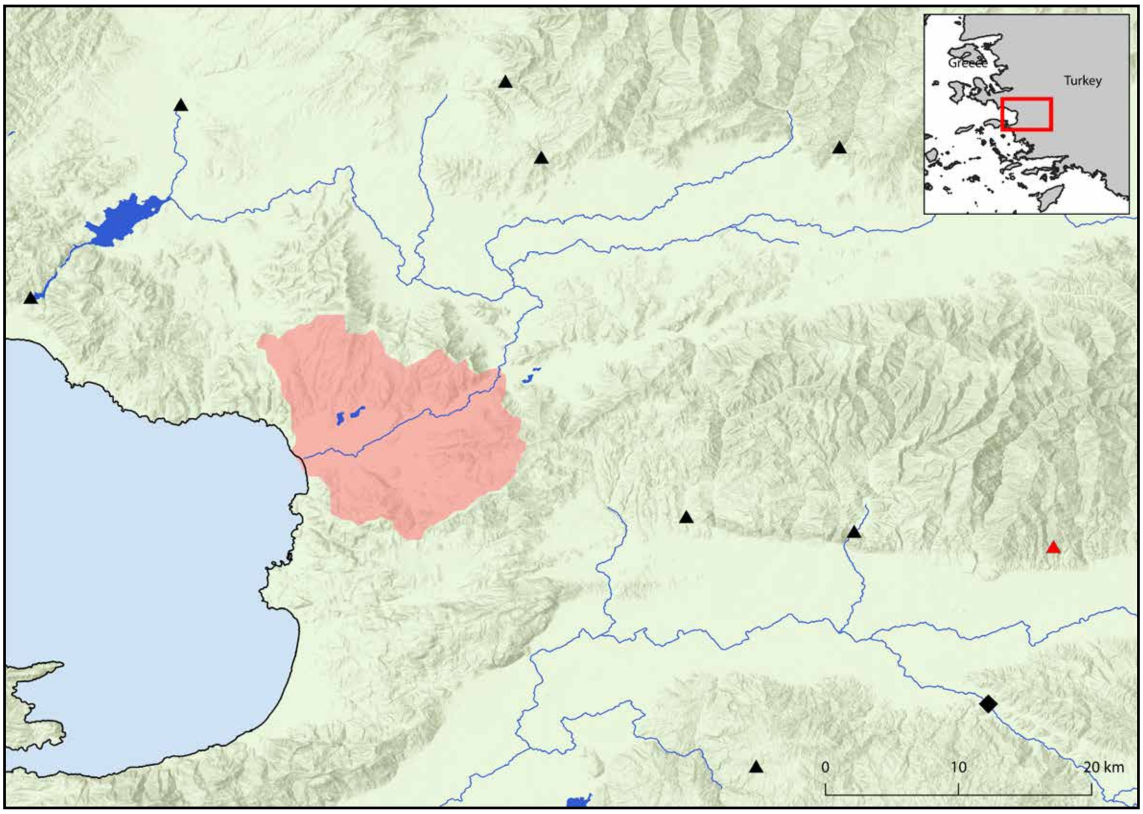
Ephesus dwarf goby

Distribution: Turkey

Endemic to the lower Küçük Menderes River drainage. It inhabits lakes within the river's delta, formerly an extensive wetland. This species is threatened by water extraction, pollution, and further modification of its few remaining habitats. It is unlikely to be at risk from hydropower development unless the local groundwater regime is severely affected.

Hydropower Hazard: *LOW*

IUCN Red List: *CRITICALLY ENDANGERED*



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Knipowitschia thessala

Thessaly goby

Hydropower Hazard: *LOW*

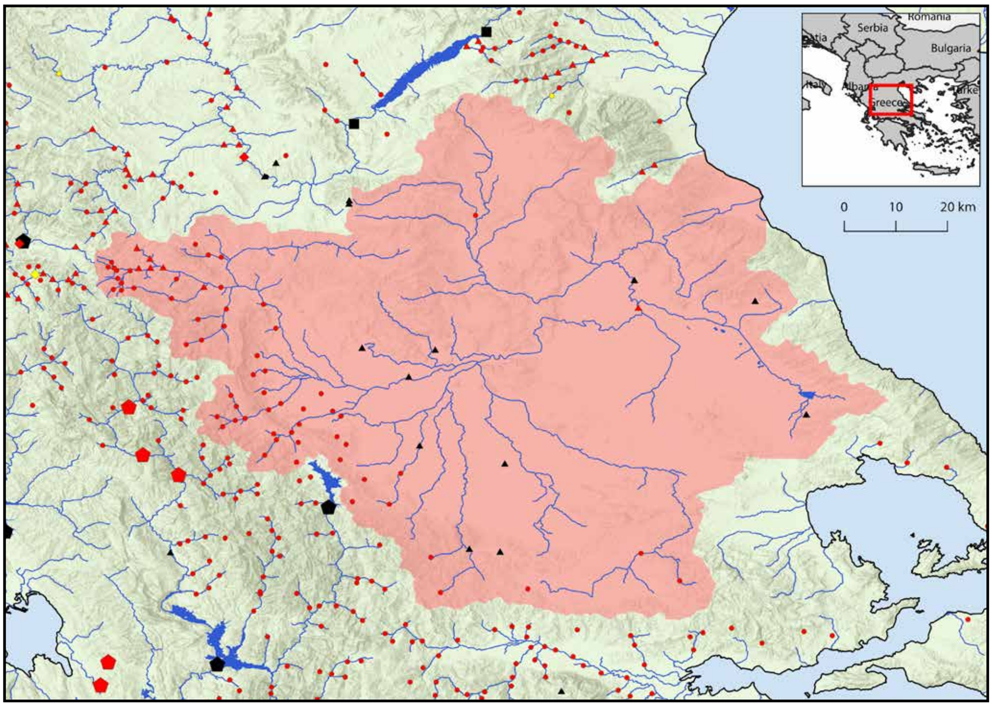
Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Distribution: Greece

Endemic to the Pinios River drainage in Thessaly, central Greece. It can be found throughout the lowland portion of the Thessaly plain, including the former Lake Karla basin which was drained for agricultural purposes in 1962 but has since been partially restored. It inhabits larger river channels, streams, drainage channels and man-made reservoirs. This species is threatened by pollution and water abstraction, and some populations have already been extirpated. Dam construction in the area would favour establishment of non-native fish species and alter the local hydrological regime.

* as *Gobius thressalus*



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Orsinigobius croaticus

Neretva dwarf goby

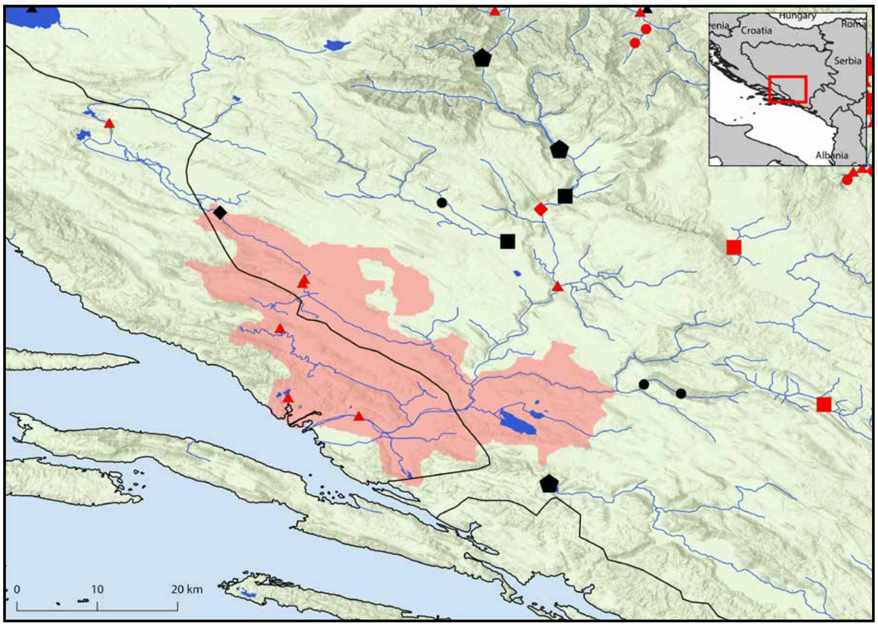
Hydropower Hazard: *HIGH*

Bern Convention: *APPENDIX III **

IUCN Red List: *ENDANGERED*

Distribution: Bosnia-Herzegovina and Croatia

Restricted to tributaries of the lower Neretva River drainage. In Bosnia-Herzegovina it occurs in the Trebiža, Bregava and Krupa river drainages, plus the Hutovo Blato wetland. Sites in Croatia include the Vrgorska Matica River and Rastočko karst field, Norin River, Lake Modro oko and the Baćina lakes. The major threats are habitat loss due to pollution, modification or water abstraction, plus introduction of non-native fish species, particularly pumpkinseed (*Lepomis gibbosus*), eastern mosquitofish (*Gambusia holbrooki*) and European chub (*Squalius cephalus*). The construction of several dams for water retention or hydropower within its range, such as on the Vrljika River at Ričice, has interfered with the complex natural hydrology of the area while reducing downstream flow and encouraging establishment of alien species. Most karst fields have also been modified to reduce the extent of the annual flooding process and provide reclaimed land for agriculture, which has altered hydrological regimes and vastly reduced the number of available spawning sites for native fish species. Many water courses have been channelised, insufficiently treated domestic and industrial effluents are discharged into some rivers and streams, and agricultural pollutants drain directly into groundwater, lakes and wetlands. An increasing frequency of climate change-induced droughts is likely to exacerbate several of these threats.



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6. ANNEX

Table 1: Threatened freshwater fishes of the MBBH, arranged by family. IUCN acronyms are CR (Critically Endangered), EN (Endangered), VU (Vulnerable). Species highlighted in red are those which could feasibly be driven extinct if all planned hydropower expansion in the region is completed.

Family	Species	IUCN Red List	EUR-HAB-DIR	Bern Convention	Hydropower Hazard	Future impact small	Future impact medium/large
Petromyzontidae							
	Caspiomyzon graecus	EN			High	Serious	Minor
	Caspiomyzon hellenicus	CR	Annex II	Appendix II	High	Minor	Minor
	Lampetra alavariensis	EN	Annex II	Appendix II	High	Minor	Minor
	Lampetra auremensis	CR	Annex II	Appendix II	High	Minor	Minor
	Lampetra lusitanica	CR	Annex II	Appendix II	High	Minor	Minor
	Lampetra soljani	EN	Annex II	Appendix II	High	Serious	Serious
Acipenseridae							
	Acipenser gueldenstaedtii	CR	Annex V		High	None	None
	Acipenser naccarii	CR	Annex II, IV	Appendix II	High	None	Serious
	Acipenser nudiventris	CR	Annex V		High	None	None
	Acipenser ruthenus	VU	Annex V	Appendix III	High	None	Severe
	Acipenser stellatus	CR	Annex V	Appendix III	High	None	Severe
	Acipenser sturio	CR	Annex V	Appendix II, III	High	None	None
	Huso huso	CR	Annex V	Appendix II, III	High	None	Severe
Anguillidae							
	Anguilla anguilla	CR			High	Serious	Severe
Clupeidae							
	Alosa algeriensis	EN			High	None	Serious
	Alosa alosa	CR	Annex II, V	Appendix III	High	None	None
	Alosa macedonica	VU	Annex II, V		Low	Minor	None
Cyprinidae							
	Arabibarbus grypus	VU			High	Minor	Serious
	Aulopyge huegelii	EN	Annex II	Appendix III	High	Serious	Serious
	Barbus caninus	EN			High	Severe	None
	Barbus euboicus	EN			Low	Minor	None
	Barbus meridionalis	VU			High	Severe	None
	Barbus plebejus	EN	Annex II, V	Appendix III	Low	Severe	Minor
	Barbus tyberinus	EN			Low	Severe	None
	Capoeta antalyensis	VU			Moderate	Severe	Serious
	Capoeta barroisi	EN			Low	Minor	None
	Capoeta pestai	EN			Low	Minor	None
	Carasobarbus harterti	EN			High	Minor	Severe
	Carasobarbus kosswigi	VU			High	Serious	Severe

Family	Species	IUCN Red List	EUR-HAB-DIR	Bern Convention	Hydropower Hazard	Future impact small	Future impact medium/large
	Garra festai	CR			Low	None	Minor
	Garra ghorensis	EN			Moderate	None	None
	Garra kemali	EN			Low	Minor	Minor
	Garra klatti	EN			Low	Serious	None
	Luciobarbus esocinus	VU			Moderate	Serious	Severe
	Luciobarbus figuigensis	VU			Low	Minor	Serious
	Luciobarbus graecus	EN			Low	Severe	None
	Luciobarbus guercifensis	EN			High	None	None
	Luciobarbus kottelati	VU			Moderate	Severe	Serious
	Luciobarbus lanigarensis	VU			Moderate	None	None
	Luciobarbus leptopogon	EN			Moderate	None	None
	Luciobarbus longiceps	EN			Moderate	None	Serious
	Luciobarbus magniatlantis	EN			High	None	None
	Luciobarbus mascarensis	EN			Moderate	Minor	None
	Luciobarbus numidiensis	VU			Low	None	None
	Luciobarbus subquincunciatus	CR			High	Minor	Serious
	Luciobarbus xanthopterus	VU			High	Minor	Serious
	Luciobarbus zayanensis	VU			High	Minor	Severe
	Pterocapoeta maroccana	VU			High	Minor	Severe
Gobionidae							
	Gobio feraeensis	VU			Moderate	Serious	None
	Gobio gymnostethus	CR			Low	None	None
	Gobio hettitorum	CR			High	Minor	None
	Gobio intermedius	EN			High	None	None
	Gobio maeandricus	EN			High	Minor	None
	Gobio microlepidotus	VU			High	Minor	Minor
	Gobio ohridanus	VU			Low	Minor	None
	Romanogobio antipai	VU		Appendix III	Low	None	Serious
	Romanogobio banarescui	EN			High	Severe	Serious
	Romanogobio benacensis	EN	Annex II	Appendix III	Moderate	Severe	Serious
Leuciscidae							
	Acanthobrama telavivensis	VU			Low	None	Minor
	Acanthobrama tricolor	CR			Low	None	None
	Achondrostoma arcasii	VU	Annex II	Appendix III	High	Minor	Minor
	Achondrostoma occidentale	EN			Low	None	None
	Achondrostoma salmantinum	EN	Annex II	Appendix III	Low	Minor	None
	Alburnoides economoui	EN		Appendix III	Low	Severe	None
	Alburnoides prespensis	VU		Appendix III	High	Severe	Serious
	Alburnoides strymonicus	VU		Appendix III	High	Severe	Minor
	Alburnoides tzanevi	VU		Appendix III	Low	Minor	None
	Alburnus albidus	VU	Annex II	Appendix III	High	Severe	Minor
	Alburnus attalus	EN			High	None	None
	Alburnus baliki	EN			Moderate	Minor	Severe
	Alburnus battalgilae	VU			High	Minor	None

Family	Species	IUCN Red List	EUR-HAB-DIR	Bern Convention	Hydropower Hazard	Future impact small	Future impact medium/large
	Alburnus belvica	VU			Moderate	Serious	None
	Alburnus carinatus	EN			High	Minor	Serious
	Alburnus demiri	VU			Moderate	None	None
	Alburnus macedonicus	VU			Low	Serious	None
	Alburnus mandrensis	EN	Annex II	Appendix III	Low	None	None
	Alburnus nasreddini	CR			High	None	None
	Alburnus orontis	VU			Moderate	Minor	None
	Alburnus qalilus	EN			High	Serious	None
	Alburnus schischkovi	VU	Annex II	Appendix III	High	Serious	None
	Alburnus vistonicus	EN	Annex II	Appendix III	Low	Serious	None
	Alburnus volviticus	VU	Annex II	Appendix III	Low	Serious	None
	Anaecypris hispanica	EN	Annex II, IV	Appendix III	High	Minor	Minor
	Anaecypris punica	CR			High	None	None
	Chondrostoma beysehirense	EN			Low	Minor	None
	Chondrostoma fahirae	EN			High	None	None
	Chondrostoma holmwoodii	VU			High	Serious	None
	Chondrostoma kinzelbachi	EN			Moderate	Minor	None
	Chondrostoma knerii	EN		Appendix III	High	Minor	Minor
	Chondrostoma meandrense	VU			Moderate	Minor	None
	Chondrostoma phoxinus	VU		Appendix III	High	Serious	Serious
	Chondrostoma prespense	EN			High	Serious	None
	Chondrostroma soetta	CR	Annex II	Appendix III	High	Serious	None
	Delminichthys adspersus	EN	Annex II	Appendix III	High	Serious	None
	Delminichthys ghetaldii	CR	Annex II	Appendix III	High	Minor	Severe
	Delminichthys jadovensis	CR	Annex II	Appendix III	High	Serious	None
	Delminichthys krbavensis	CR	Annex II	Appendix III	Low	None	None
	Iberochondrostoma almacai	EN			High	Minor	None
	Iberochondrostoma lusitanicum	VU	Annex III	Appendix II	High	None	Minor
	Iberochondrostoma olisiponensis	EN			Low	None	Minor
	Iberochondrostoma oretanum	CR			High	None	None
	Parachondrostoma arrigonis	EN	Annex II	Appendix III	High	None	Minor
	Parachondrostoma turiense	EN	Annex II	Appendix III	High	Minor	None
	Pelasgus epiroticus	CR	Annex II		Low	Serious	None
	Pelasgus laconicus	EN			Low	Severe	None
	Pelasgus minutus	VU	Annex II		Low	Minor	Serious
	Pelasgus prespensis	EN	Annex II		Low	Minor	None
	Pelasgus thesproticus	VU	Annex II		Low	Severe	Severe
	Phoxinellus alepidotus	CR	Annex II		High	Severe	Severe
	Phoxinellus dalmaticus	CR	Annex II		Low	Serious	Severe
	Phoxinellus pseudalepidotus	CR	Annex II		High	None	None
	Phoxinus krkae	VU			High	Severe	Serious
	Phoxinus strymonicus	EN			Low	Severe	None
	Protochondrostoma genei	EN	Annex II		High	Severe	Minor
	Pseudochondrostoma duriense	VU			High	Minor	Serious

Family	Species	IUCN Red List	EUR-HAB-DIR	Bern Convention	Hydropower Hazard	Future impact small	Future impact medium/large
	Pseudochondrostoma willkommii	VU		Appendix III	High	Serious	Minor
	Pseudophoxinus alii	EN			High	Severe	Serious
	Pseudophoxinus anatolicus	EN			Low	Minor	None
	Pseudophoxinus antalyae	VU			Low	None	None
	Pseudophoxinus burduricus	EN			Low	None	None
	Pseudophoxinus crassus	EN			Low	None	None
	Pseudophoxinus drusensis	EN			Low	None	None
	Pseudophoxinus egridiri	EN			Low	None	None
	Pseudophoxinus elizavetae	CR			Low	Minor	None
	Pseudophoxinus evliyae	EN			High	Minor	None
	Pseudophoxinus fahrettini	EN			High	Minor	None
	Pseudophoxinus firati	EN			High	Minor	Minor
	Pseudophoxinus hasani	CR			Low	None	None
	Pseudophoxinus hittitorum	EN			High	Minor	None
	Pseudophoxinus maeandri	EN			Low	Serious	None
	Pseudophoxinus maeandricus	CR			High	None	None
	Pseudophoxinus ninae	CR			High	None	None
	Pseudophoxinus syriacus	CR			Low	None	None
	Pseudophoxinus zekayi	VU			High	None	Minor
	Rutilus aula	EN	Annex II	Appendix III	Moderate	Severe	Minor
	Rutilus pigus	VU	Annex II	Appendix III	Moderate	Serious	Minor
	Rutilus prespensis	VU	Annex II	Appendix III	Moderate	Minor	None
	Rutilus ylikiensis	VU	Annex II	Appendix III	Low	Severe	None
	Scardinius elmaliensis	EN			Moderate	Minor	None
	Scardinius graecus	EN	Annex II	Appendix III	Low	Severe	None
	Squalius aradensis	EN		Appendix III	High	Minor	None
	Squalius cappadocicus	CR			Low	None	None
	Squalius carinus	EN			High	Minor	None
	Squalius castellanus	CR			High	None	None
	Squalius cephaloides	VU			Low	None	None
	Squalius illyricus	VU		Appendix III	High	Serious	Serious
	Squalius keadicus	EN			Low	Severe	None
	Squalius kosswigi	EN			High	None	None
	Squalius lucumonis	EN	Annex II		High	Severe	None
	Squalius malacitanus	VU		Appendix III	High	Minor	None
	Squalius microlepis	EN		Appendix III	High	Serious	None
	Squalius recurvirostris	VU			High	None	None
	Squalius tenellus	CR		Appendix III	High	Minor	Serious
	Squalius torgalensis	EN		Appendix III	High	None	None
	Telestes beoticus	EN			Low	Serious	None
	Telestes croaticus	EN	Annex II		High	Serious	None
	Telestes dabar	CR	Annex II		Low	None	Severe
	Telestes fontinalis	CR	Annex II		Low	None	None

Family	Species	IUCN Red List	EUR-HAB-DIR	Bern Convention	Hydropower Hazard	Future impact small	Future impact medium/large
	Telestes karsticus	EN	Annex II	Appendix III	Low	None	None
	Telestes metohiensis	EN	Annex II		Low	None	Serious
	Telestes miloradi	CR	Annex II		High	None	None
	Telestes polylepis	CR		Appendix III	High	None	None
	Telestes turskyi	CR		Appendix III	Low	Serious	Severe
	Tropidophoxinellus spartiaticus	VU			Moderate	Serious	None
Cobitidae							
	Cobitis arachthosensis	EN	Annex II	Appendix III	Moderate	Minor	None
	Cobitis battalgilae	EN			Moderate	Minor	Severe
	Cobitis bilseli	EN			Low	Minor	None
	Cobitis evreni	EN			High	Serious	Minor
	Cobitis hellenica	EN	Annex II	Appendix III	Moderate	Serious	None
	Cobitis herzegoviniensis	CR	Annex II	Appendix III	High	None	None
	Cobitis illyrica	EN	Annex II	Appendix III	High	Serious	None
	Cobitis jadovaensis	CR	Annex II	Appendix III	High	Serious	None
	Cobitis kellei	CR			High	None	None
	Cobitis levantina	EN			Moderate	None	None
	Cobitis meridionalis	EN	Annex II	Appendix III	Low	Minor	None
	Cobitis phyrgica	EN			High	None	None
	Cobitis punticulata	EN	Annex II	Appendix III	Moderate	Minor	None
	Cobitis punctilineata	EN	Annex II	Appendix III	Low	Serious	None
	Cobitis trichonica	EN	Annex II	Appendix III	Low	Minor	None
	Cobitis zanandreai	EN	Annex II	Appendix III	Moderate	Minor	Minor
	Sabanejewia larvata	VU	Annex II		High	Severe	Minor
Nemacheilidae							
	Barbatula leoparda	EN			High	Severe	None
	Barbatula sturanyi	VU			Moderate	Severe	Severe
	Barbatula zetensis	VU			High	Severe	Severe
	Oxynoemacheilus anatolicus	EN			High	Minor	Minor
	Oxynoemacheilus eregliensis	VU			High	Minor	None
	Oxynoemacheilus galilaeus	CR			Low	None	None
	Oxynoemacheilus germencicus	VU			High	Severe	Serious
	Oxynoemacheilus hamwii	EN			High	Minor	None
	Oxynoemacheilus mesudae	EN			High	Serious	None
	Oxynoemacheilus panthera	EN			Low	None	None
	Oxynoemacheilus pindus	VU			High	Severe	Severe
	Oxynoemacheilus seyhanensis	CR			High	Minor	None
	Oxynoemacheilus seyhanicola	EN			High	Minor	Serious
	Oxynoemacheilus theophilii	EN			High	Minor	None
	Oxynoemacheilus tigris	CR			High	None	None
	Paraschistura chrysicristinae	CR			High	Minor	None
	Seminemacheilus ispartensis	VU			High	Minor	None
	Seminemacheilus lendlii	VU			High	Minor	None

Family	Species	IUCN Red List	EUR-HAB-DIR	Bern Convention	Hydropower Hazard	Future impact small	Future impact medium/large
Siluridae							
	Silurus aristotelis	EN	Annex II	Appendix III	Low	Serious	None
Esocidae							
	Esox cisalpinus	EN			Low	Severe	None
Salmonidae							
	Hucho hucho	EN	Annex II, V	Appendix III	High	Severe	Severe
	Salmo akairos	VU			Low	None	None
	Salmo carpio	CR	Annex II		Low	Minor	None
	Salmo cettii	CR	Annex II		Moderate	Minor	None
	Salmo chilo	VU			High	None	None
	Salmo fibreni	VU	Annex II		Low	None	None
	Salmo labecula	EN			High	None	Minor
	Salmo letnica	VU	Annex II		Low	Minor	None
	Salmo lourosensis	CR	Annex II		High	Serious	None
	Salmo multipunctatus	EN			Low	None	None
	Salmo obtusirostris	EN			High	Severe	Severe
	Salmo ohridanus	EN			Low	Minor	None
	Salmo opimus	EN			High	Minor	Minor
	Salmo pelagonicus	VU	Annex II		High	Severe	Serious
	Salmo pellegrini	EN			High	None	None
	Salmo peristericus	EN	Annex II		High	Serious	None
	Salmo platycephalus	EN			High	Minor	None
	Salmo viridis	VU			Low	None	None
Thymallidae							
	Thymallus aeliani	CR			High	Severe	None
Valenciidae							
	Valencia hispanica	CR	Annex II	Appendix II	Low	None	None
	Valencia letourneuxi	CR		Appendix II	Low	Minor	None
	Valencia robertae	CR		Appendix II	Low	None	None
Aphaniidae							
	Aphanius baeticus	EN	Annex II	Appendix II, III	Low	Minor	None
	Aphanius danfordii	CR			Low	Minor	None
	Aphanius iberus	EN	Annex V	Appendix II, III	Low	Minor	None
	Aphanius richardsoni	CR			Low	None	None
	Aphanius saldae	CR			Low	None	None
	Aphanius sirhani	CR			Low	None	None
	Aphanius sureyanus	CR			Low	None	None
	Aphanius transgrediens	CR			Low	None	None
Gasterosteidae							
	Pungitius hellenicus	CR			Low	Severe	None
Cottidae							
	Cottus haemusi	CR	Annex II	Appendix III	High	Severe	None
	Cottus petiti	CR	Annex II		High	Severe	None

Family	Species	IUCN Red List	EUR-HAB-DIR	Bern Convention	Hydropower Hazard	Future impact small	Future impact medium/large
	Cottus scaturigo	VU	Annex II	Appendix III	High	None	None
Percidae							
	Zingel asper	VU	Annex II		High	Severe	Minor
	Zingel balcanicus	CR		Appendix III	High	Severe	Severe
Cichlidae							
	Haplochromis desfontainii	CR			Low	None	None
	Haplochromis flavijosephi	VU			High	None	Minor
	Tristramella simonis	VU			Low	None	Minor
Blenniidae							
	Salaria atlantica	EN		Appendix III	High	Minor	None
	Salaria economidisi	EN		Appendix III	Moderate	Minor	None
Gobiidae							
	Neogobius nigricans	EN	Annex II	Appendix III	High	Severe	None
	Economidichthys trichonis	EN	Annex V	Appendix II, III	Moderate	Minor	None
	Knipowitschia mermere	VU			Low	Minor	None
	Knipowitschia milleri	CR	Annex II	Appendix III	Low	None	None
	Knipowitschia mrakovcici	VU	Annex II	Appendix III	Low	Serious	Serious
	Knipowitschia radovici	EN	Annex II	Appendix III	Moderate	Minor	None
	Knipowitschia ricasolii	CR			Low	None	None
	Knipowitschia thessala	EN		Appendix III	Low	Serious	None
	Orsinigobius croaticus	EN			High	Serious	None

With a focus on impacts of the ongoing hydropower boom, this publication presents for the first time a photographic guide, detailed range maps and an updated evaluation of extinction risk for all 249 threatened freshwater fish species native to the Mediterranean Basin Biodiversity Hotspot. It is intended to further knowledge of the unique ichthyofauna in the region while informing multi-scale infrastructure planning and priority conservation management for those species being driven to extinction by hydroelectric expansion and other anthropogenic threats.

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