Measuring the pulse
of European biodiversity

European Red List of Freshwater Fishes

Matthew Ford, Colin Adams, Susana Amaral, Oleg Artaev, Doru Bănăduc, Roberta Barbieri, Colin Bean, Jernej Bravničar, Ivana Buj, Marko Ćaleta, Antonella Carosi, Gaël Denys, Alexander Didenko, Ignacio Doadrio, Ana Filipa Filipe, Jörg Freyhof, Dragojla Golub, Vasil Kostov, Massimo Lorenzoni, Maria Filomena Magalhães, Zoran Marčić, Saša Marić, Anthi Oikonomou, Silvia Perea, Filipe Ribeiro, Radek Šanda, Ole Seehausen, Oliver Selz, Spase Shumka, Predrag Simonović, Tihomir Stefanov, Joanna Clay, Catherine A. Sayer, Mahboobeh Shirkhorshidi, and Aurore Trottet.

European Commission

Freshwater Fish Specialist Group

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Back page picture credit: Eurasian Rudd (*Scardinius erythrophthalmus*) in an artificial lake near Cologne, Germany. © Metalimnion

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Aim

The European Red List provides a scientifically rigorous and evidence-based assessment of the regional extinction risk of selected European taxa. This includes all vertebrate species - fishes, amphibians, reptiles, birds, and mammals - as well as a wide range of invertebrates, such as terrestrial and aquatic molluscs, dragonflies, butterflies, bees, grasshoppers, crickets and bush-crickets, hoverflies, selected saproxylic beetles, and moths. It also covers various plant groups, including trees, endemic shrubs, medicinal plants, bryophytes (mosses, liverworts, and hornworts), pteridophytes (ferns and lycopods), and selected vascular plants, such as crop wild relatives and species tied to international policy frameworks like the Kunming-Montreal Global Biodiversity Framework and EU Biodiversity Strategy for 2030.

This publication of the European Red List focuses specifically on freshwater fishes - the most diverse group of vertebrates globally. It represents a fully revised second edition, incorporating new data, recent taxonomic revisions, and updated threat assessments, building upon the foundation of the first *European Red List of Freshwater Fishes* published in 2011.

The core objectives of this updated assessment are: to revise the baseline extinction risk for each species by integrating recent data, newly-identified threats, and emerging trends; to identify priority geographic areas, habitats, and species requiring urgent protection to prevent extinctions and support favourable conservation status; to assess the principal ongoing threats and review both existing and prospective conservation actions; to strengthen the network of freshwater fish experts across Europe; and to mobilise the compiled data as a basis for regional conservation planning for freshwater fishes and inland water ecosystems, within the context of global and regional biodiversity strategies - thereby contributing to bending the curve of freshwater biodiversity loss.

Scope

The geographical scope of this regional assessment covers the entire continent of Europe. The Canary Islands, Madeira, and Cyprus are incorporated within the assessment area, while the Ciscaucasia region is excluded. Individual Red List species assessments are made at two regional levels: for geographical Europe as a whole and for the 27 current Member States of the European Union.

All 559 species meeting the IUCN Species Survival Commission Freshwater Fish Specialist Group's definition of freshwater fishes and identified as native to the region are included in the European Red List. One species, however, has only a marginal occurrence in Europe and is therefore considered Not Applicable for regional assessment. Within the EU-27 Member States, 438 species are regarded as native; of these, two are deemed Not Applicable due to their marginal occurrence, and five are classified as Not Applicable because they were introduced by humans, despite being native to the broader European region. Consequently, this publication focuses on the 558 species (431 within the EU-27) for which extinction risk assessments were carried out.

The data underpinning the assessments summarised in this report were compiled in 2022 and include information submitted by the 27 EU Member States under Article 17 of the Habitats Directive. To ensure the most robust and comprehensive evidence base, this dataset was supplemented with a wide range of additional sources - such as scientific and fisheries reports, national handbooks and monographs, national Red Data Books and Red Lists, and peer-reviewed literature - prior to undergoing detailed expert evaluation.

Results

At the European regional level, the best available estimate indicates that more than 42% of freshwater fish species are assessed as threatened. Among extant taxa, this includes approximately 9% (46 species) classified as Critically Endangered, 19% (101 species) as Endangered, and 14% (75 species) as Vulnerable. A further 18% (94 species) are categorised as Near Threatened. Taken together, this means that almost two-thirds (around 59%) of Europe's freshwater fish species are of elevated conservation concern, either already threatened or close to meeting the criteria for a threatened category. Since the previous assessment in 2011, the proportion of threatened species among all assessed taxa has increased by 5%.

A total of 20 species are now considered globally Extinct, while one species is Regionally Extinct and another is classified as Extinct in the Wild.

Regarding population trends, 20% of species are in decline, nearly 5% show stable or fluctuating trends, and less than 1% are increasing. The population trend remains unknown for almost 75% of species, highlighting a critical knowledge gap.

Changes in Red List category status were documented for 224 species, with 113 species uplisted to a higher extinction risk category and 84 species downlisted to a lower one. Fewer than 5% of these changes reflect genuine improvements or declines in population status, while the remainder are due to non-genuine factors, such as previous under- or overestimations of population size or distribution. Only three species showed a genuine improvement in extinction risk, whereas eight have experienced genuine declines since the previous assessment.

Additionally, 77 species were assessed for the first time, primarily as a result of taxonomic revisions.

At the EU-27 regional level, the best available estimate show that more than 41% of freshwater fish species are threatened, with around 10% of extant taxa Critically Endangered, 20% Endangered, 12% Vulnerable, and a further 18% Near Threatened.

At both the European and EU levels, all species of sturgeons, European toothcarps, freshwater eels, and mudminnows are classified as threatened. Among more taxonomically diverse groups, the salmons, trouts, and whitefishes exhibit the highest proportion of threatened species. However, nearly half of all true loaches, true minnows, stone loaches, freshwater blennies, and sheatfishes are also at risk.

Declining population trends are observed among a markedly higher proportion of migratory freshwater fishes (close to 39%) than non-migratory species (approximately 14%). Among habitat types, karst systems (over 90%), freshwater springs (54%), and intermittent rivers and streams (almost 54%), support the highest proportions of threatened species within their respective freshwater fish communities and therefore warrant particular conservation attention.

Key drivers of decline in European freshwater fishes include dams and other natural system modifications, pollution, invasive species, and climate change. While the negative impacts of these pressures on freshwater fish habitat quality across Europe are well understood, their precise effects on individual species often remain unclear.

Conclusions/Recommendations

The 2026 update of the *European Red List of Freshwater Fishes* is released at a pivotal moment, coinciding with the long-overdue recognition of inland waters - including freshwater ecosystems - as critical components within both global and regional biodiversity frameworks.

Freshwater fishes are vital ecological indicators and providers of key ecosystem services. Yet this second regional assessment reveals that many native species across Europe remain threatened, with little evidence of recovery since the last evaluation nearly 15 years ago. These findings highlight the urgent need for increased investment in freshwater biodiversity research and Red Listing efforts, which remain significantly underfunded. Strengthening the scientific foundations of conservation

- including monitoring, assessment, and adaptive feedback mechanisms - is crucial to support evidence-based management and deliver measurable outcomes for both biodiversity and society.

While targeted interventions remain necessary for certain threatened or declining species, freshwater fish conservation should primarily adopt an integrated, cross-sectoral, basin-scale approach. Such strategies will support the persistence of Key Ecological Attributes and deliver broader ecosystem resilience while facilitating progress towards global and regional biodiversity targets.

Effective restoration and reversal of biodiversity loss will require not only policy implementation but also inclusive governance, public engagement, and Nature-based Solutions - such as restoring free-flowing rivers. A series of promising initiatives have the potential to help reconnect fragmented freshwater habitats and improve long-term ecosystem functionality. A key priority is to determine the most effective means of communicating the urgency and benefits of action to diverse audiences - including governments at all levels, other decision-makers, and the wider public. Furthermore, there is an urgent need to embrace diverse knowledge systems, including local and stakeholder expertise, to identify the most appropriate management strategies for specific contexts.

In the EU, nearly a third of native freshwater fish species identified as being of elevated conservation concern are unprotected under existing legislation. This underscores the need to further strengthen efforts for robust science-based policy-making.

Inconsistencies in the use of the terms “freshwater” and “inland waters” across policy and conservation frameworks may hinder coherence. Notably, the IUCN’s definition of freshwater fishes aligns more closely with the Convention on Biological Diversity’s broader classification of inland waters, which includes species inhabiting brackish, freshwater, and even hypersaline environments. Future editions of the European Red List may therefore benefit from adopting the term “Inland Water Fishes” to better reflect the ecological scope of assessed species.

Looking forward, the data, insights, and recommendations provided through this assessment must be translated into practical conservation and policy actions. These should be embedded across local, national, and regional governance structures to safeguard Europe’s freshwater heritage and halt ongoing biodiversity declines - for nature, for people, and for the planet.

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Any errors or omissions are the responsibility of the authors.

Acronyms and abbreviations

BDS2030 EU Biodiversity Strategy for 2030	**CBD** Convention on Biological Diversity
CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora	**CMS** Convention on Migratory Species
CoF (Eschmeyer's) Catalog of Fishes	**CR** Critically Endangered
DD Data Deficient	**EFI+** European Fish Index
EN Endangered	**EC** European Commission
EEA European Environment Agency	**EU** European Union
EW Extinct in the Wild	**EX** Extinct
FFSG Freshwater Fish Specialist Group	**GBIF** Global Biodiversity Information Facility
HD Habitats Directive	**IUCN** International Union for Conservation of Nature
IWRM Integrated Water Resources Management	**KBA** Key Biodiversity Area
KEA Key Ecological Attribute	**GBF** (Kunming-Montreal) Global Biodiversity Framework
LC Least Concern	**NA** Not Applicable
NE Not Evaluated	**NRR** Nature Restoration Regulation
NT Near Threatened	**OECM** Other effective area-based conservation measures
PA Protected area	**PCA** Protected and conserved area
PEW Possibly Extinct in the Wild	**RBMP** River Basin Management Plan
RLI Red List Index	**SAC** Special Area of Conservation
SCP Systematic Conservation Planning	**SDG** Sustainable Development Goal
SIS Species Information Service	**SSC** Species Survival Commission
TEN-S Trans-European Swimways Programme	**UN** United Nations
UNESCO United Nations Educational, Scientific and Cultural Organization	**UNFCCC** UN Framework Convention on Climate Change
VU Vulnerable	**WD-OECM** World Database on OECMs
WDPA World Database on Protected Areas	**WFD** Water Framework Directive

Basins, catchments and watersheds

In this report, "basin" denotes a hydrographically defined area - comprising both land and water - that drains into a particular water body. Basins vary markedly in scale, from those feeding the smallest first-order streams to vast systems such as the Danube basin, which covers over 800,000 square kilometres. Except for endorheic basins with no external outflow and those discharging directly into the sea, all basins are nested within larger hydrological units; therefore, no distinction is made here between basins and sub-basins.

Although the terms "watershed" and "catchment" are often used interchangeably with "basin", this report adopts "basin" throughout for consistency and to align with European regional frameworks, such as river basin management planning.

Freshwater biodiversity remains largely overlooked in public discourse. Image shows European Grayling (*Thymallus thymallus*), which has declined significantly since the 19th century but is currently assessed as LC. © Jenny Stock

1 Background

1.1 The European context

Continental Europe is the westernmost peninsula of Eurasia, situated within the Palearctic region. It is bordered to the north by the Arctic Ocean, to the west by the Atlantic Ocean, to the south by the Mediterranean Sea, to the east by the Ural Mountains and the Caspian Sea (which mark the boundary between Europe and Asia), and to the southeast by the Black Sea and the Caucasus Mountains. Europe is the world's second smallest continent by area, covering approximately 10.18 million square kilometres, or 2% of the Earth's surface (6.8% of its land area). Despite its modest size, Europe's population stood at roughly 742 million in 2024, making it the third most populous continent after Asia and Africa, and home to about 9% of the world's population. Additionally, Europe is the second most urbanised continent after North America and the second most densely populated after Asia (UN World Population Dashboard, 2024).

Europe displays marked cultural, demographic, socioeconomic and political gradients. A significant part of the continent is governed by the European Union (EU), whose executive arm is the European Commission (EC). As of 2025, the EU comprises 27 Member States and represents Europe's largest political and economic entity, with a GDP of approximately USD 18.6 trillion. Several Member States rank among the world's highest in per capita GDP, accompanied by correspondingly high levels of resource consumption and waste production. Notably, the EU's ecological footprint surpasses its biocapacity - the area of cropland, pastures, forests and fishing grounds available to supply renewable resources and to absorb waste - largely due to the expansive demands of its agri-food system (Murphy et al., 2021; Galli et al., 2023; International Monetary Fund, 2025; The World Bank, 2025).

Europe's freshwater habitats have been extensively modified for human use. Image shows an aerial view of the Netherlands. © Water Alternatives, CC BY-NC 2.0

Europe's diverse climates are shaped by factors such as altitude, latitude, and continentality, with only 7% of the region situated above 1,000 metres. The southern part of the continent generally experiences a Mediterranean climate, while central-western regions have a temperate maritime climate, central-eastern areas feature a temperate continental climate, and the northern regions are classified as boreal. Europe also boasts an extensive and intricate river network, including over 150 transboundary basins. The largest navigable waterways are primarily located on the North and East European Plains, though further south they also include the Danube - the world's most international river basin, shared by over 80 million people across 19 countries. These waterways are widely interconnected by artificial canals, enhancing their accessibility and economic significance. The region has been divided into 38 freshwater ecoregions, whose boundaries largely align with individual basins (Abell et al., 2008; Murphy et al., 2021; Tockner et al., 2022).

Europe boasts a rich and diverse natural heritage, ranging from the forests of Scandinavia to the wetlands of the Danube Delta, and the coastlines and islands of the Mediterranean Sea. The continent is home to at least 20,000 species of vascular plants, more than 800 species of birds and mammals, at least 300 species of amphibians and reptiles, around 1,800 species of fishes (spanning both freshwater and marine environments), and well over 100,000 species of invertebrates. Mediterranean Europe is exceptionally rich in endemic plant and animal species and is internationally recognised as a global biodiversity hotspot (Myers et al., 2000; Cuttelod et al., 2009).

Despite Europe's inherent natural richness, its ecosystems face significant pressures due to the region's historical and socio-economic context. For centuries, much of the region's land has been altered and exploited by humans to produce resources like food, timber, and fuel, as well as to provide living space. As a result, Europe has arguably the most fragmented natural landscape of any continent, with only a small fraction of its terrestrial and freshwater ecosystems remaining pristine. In 2024, the European Environment Agency (EEA) reported that around 80% of land in Europe is used for anthropogenic purposes (EEA, 2020, 2024a).

Consequently, European species are largely dependent on semi-natural habitats that are shaped by human activities, particularly traditional and non-intensive forms of land management. These habitats are under threat from various factors, including agricultural intensification, urban sprawl, infrastructure development, land abandonment, acidification, eutrophication, and desertification. Many species are directly affected by overexploitation, persecution, and the spread of invasive taxa. Climate change is also an escalating threat. While substantial efforts have been made to protect and conserve Europe's habitats and species, biodiversity loss and the associated decline in vital ecosystem services - such as water purification, crop pollination, and carbon sequestration - remain major concerns across the continent (EC, 2020; EEA, 2020).

1.2 The European policy context

1.2.1 Global commitments

Biodiversity underpins human well-being and societal resilience by providing indispensable goods and services - ranging from food, fuel and medicine to clean air, water and climate regulation. Yet all global indicators of biodiversity continue to show persistent declines, with freshwater ecosystems among the most severely affected (Albert et al., 2021; WWF, 2024).

As the natural world forms a continuous system that is often fragmented by political boundaries and human activities, international cooperation is crucial for the effective protection of biodiversity at the appropriate scale. In response, nations worldwide have established multilateral conventions and commitments aimed at halting and reversing biodiversity loss, several of which are particularly relevant to the conservation of freshwater fishes and their habitats.

Freshwater ecosystems comprise a subset of 'inland waters', recently recognised as a distinct realm under the United Nations Convention on Biological Diversity. Image shows the Cetina River, Croatia. © Goran Šafarek

Adopted in 2022 under the United Nations (UN) Convention on Biological Diversity (CBD), the Kunming-Montreal Global Biodiversity Framework (GBF) formally recognised inland waters as a distinct realm within global area-based conservation targets - marking a significant shift following years of advocacy by freshwater scientists and practitioners. Previously grouped under the terrestrial realm, the CBD now defines inland waters as "aquatic-influenced environments located within land boundaries," encompassing fresh, saline, and brackish waters, including those in coastal areas adjacent to marine environments (CBD, 2022).

Inland waters are explicitly addressed in Targets 2 and 3 of the GBF, which call for the restoration of 30 per cent of degraded ecosystems and the conservation of 30 per cent of land, water and seas by 2030 (the '30 x 30' target), respectively. Freshwater ecosystems - defined as non-saline aquatic environments - constitute a subset of inland waters. However, the IUCN's definition of "freshwater fishes" (see Box 1) aligns with the CBD's broader classification, encompassing species found in brackish, freshwater and even hypersaline habitats.

Progress on Targets 2 and 3 will also advance several other GBF objectives that benefit freshwater fishes: halting extinctions and safeguarding genetic diversity (Target 4); ensuring the sustainable, safe and legal use of wild species (Target 5); preventing and controlling invasive alien species (Target 6); reducing pollution (Target 7); mitigating the effects of climate change on biodiversity (Target 8); sustainably managing wild species for human benefit (Target 9); promoting biodiversity and sustainability in aquaculture and fisheries (Target 10); and restoring, maintaining and enhancing nature's contributions to people (Target 11) (CBD, 2022).

Among the UN's 17 Sustainable Development Goals (SDGs), Goal 6 is dedicated to ensuring the availability and sustainable management of water and sanitation for all, including Target 6.6, which focuses on protecting and restoring water-related ecosystems. The fulfilment of Goal 6 is closely linked with Goal 15, which seeks to conserve terrestrial and freshwater ecosystems. This connection is reflected in Indicator 15.1.2, which measures the proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type (UN General Assembly, 2015, 2017).

Since 2023, the UN Framework Convention on Climate Change (UNFCCC) has explicitly included the protection of inland waters within its thematic targets related to ecosystems and biodiversity. That same year, the Freshwater Challenge was launched at the UN Water Conference - the first such meeting in nearly half a century. By the end of 2024, 49 countries and the EU had joined this country-led initiative, which aims to restore 300,000 kilometres of degraded rivers and 350 million hectares of depleted wetlands by 2030 (Cooke et al., 2023; Sayer et al., 2025).

Two global treaties provide a framework for the cooperative use, management, and conservation of transboundary freshwater systems. The UN Convention on the Law of the Non-Navigational Uses of International Watercourses (UN Watercourses Convention), which came into force in August 2014, and the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), which was adopted in 1996 and initially applied to members of the UN Economic Commission for Europe, but opened for global accession in 2016. The UN Watercourses Convention outlines a general obligation for countries to collaborate on the protection of international watercourses, while the Water Convention obligates parties to take appropriate actions to ensure the conservation and, if necessary, the restoration of aquatic ecosystems (UN, 1992; UN General Assembly, 2014).

The Ramsar Convention on Wetlands is an intergovernmental treaty that promotes the conservation, sustainable use, and management of wetlands globally through the designation of "Wetlands of International Importance" (Ramsar sites). Likewise, the United Nations Educational, Scientific and Cultural Organization (UNESCO) designates sites of outstanding cultural and natural significance under the World Heritage Convention. Furthermore, through its Man and the Biosphere Programme, UNESCO enables states to voluntarily nominate sites that balance biodiversity conservation with sustainable use for inclusion in the World Network of Biosphere Reserves (UNESCO, 1972, 2017; Ramsar Convention Secretariat, 2016).

A small number of European freshwater fish species are protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which seeks to ensure that trade in wild animals and plants does not endanger their survival, and the Convention on Migratory Species (CMS), which focuses on conserving migratory species throughout their ranges (CITES, 1973; CMS, 1979).

1.2.2 Regional agreements

At the continental scale, a range of policy instruments and legal frameworks have been established to strengthen biodiversity conservation efforts in Europe and contribute to global objectives.

The Bern Convention on the Conservation of European Wildlife and Natural Habitats is a binding international legal instrument that covers much of Europe's natural heritage and extends to some African states. The Convention encourages parties to conserve wild flora and fauna, along with their habitats, particularly focusing on threatened species. These species are listed in four appendices, with Appendix II (Strictly Protected Fauna Species) and Appendix III (Protected Fauna Species) specifically including 12 and 162 freshwater fish species, respectively. To further support the implementation of the Convention and its appendices, the Bern Convention established the Pan-European Emerald Network of Areas of Special Conservation Interest through Recommendation No. 16 (1989) of the Standing Committee to the Bern Convention. This network serves as a key tool for parties to fulfil their conservation obligations under the Convention. The Standing Committee approved a series of reference documents outlining the Emerald Network and its establishment, with the most relevant to freshwater fishes being Resolution No. 6 (1998). This resolution lists species that require specific habitat conservation actions and was updated prior to its adoption in 2011 (Díaz, 2010; Council of Europe, 2011).

The Italian Barbel (*Barbus plebejus*), assessed as NT, is listed in Appendix III of the Bern Convention, and Annexes II and V of the EU Habitats Directive. © Samuel Betschart

In the EU, the Habitats Directive (HD; Council Directive 1992/43/EEC) is the principal legislative instrument for the conservation of freshwater fish species. Alongside the Birds Directive (Council Directive 2009/147/EC), it shapes the Natura 2000 ecological network, which covers over 18% of the EU's land area - including rivers and wetlands - and around 9% of its marine territory. By the end of 2023, Natura 2000 comprised more than 27,000 individual sites, making it the largest coordinated network of protected areas globally (EEA, 2024b).

The primary objective of Natura 2000 is to protect and enhance Europe's most valuable and threatened habitats and species. Both the Birds and Habitats Directives, along with the Natura 2000 network, were devised to fulfil the EU's commitments under the Bern Convention. Natura 2000 sites also constitute the EU Member States' contribution to the Emerald Network; the two networks are fully harmonised, employing a shared methodology and common information systems (Evans, 2012; EEA, 2024b).

The HD comprises 24 legislative articles that all EU Member States must adhere to. Article 17 of the Directive outlines the requirements and standards for reporting on the habitats and species listed in the annexes by each Member State. The conservation status assessments set out in the Habitats Directive differ considerably from those of the IUCN Red List. While IUCN assessments focus on the risk of extinction, the EU approach evaluates the "distance to target" from a defined "favourable" conservation status, which takes into account a species' natural range, population size, habitat, and future prospects. There are three categories of conservation status: favourable (FV), unfavourable-inadequate (U1), and unfavourable-bad (U2).

The species protected under the HD are listed in three of the Directive's six annexes: Annex II (species that require Member States to establish designated protected areas known as Special Areas of Conservation (SACs), which form part of the Natura 2000 network), Annex IV (species that require strict protection), and Annex V (species for which Member States have the flexibility to decide how to manage the population, provided the species' conservation status is considered FV). Following the most recent taxonomy review, the HD currently covers more than 230 freshwater fish species (EEA, 2025).

The Water Framework Directive (WFD; Council Directive 2000/60/EC) establishes a comprehensive EU-wide framework for Integrated Water Resources Management (IWRM), with the overarching aim of achieving "Good Ecological Status" for all surface water bodies by 2027 at the latest. Ecological status is assessed using biological, physicochemical, and hydromorphological quality elements. In freshwater systems, these encompass fishes, macroinvertebrates, and aquatic flora, supported by abiotic indicators such as nutrient concentrations, water transparency, oxygen levels, flow conditions, and riparian structure. The WFD also makes specific provisions for Artificial Water Bodies and Heavily Modified Water Bodies, recognising that achieving Good Ecological Status in such cases would necessitate hydromorphological alterations likely to cause significant adverse impacts on the wider environment or on essential human uses, including navigation, water supply, hydropower, irrigation, and flood protection. For these categories, the Directive sets a different management objective: "Good Ecological Potential", which is to be achieved through the application of all technically feasible and environmentally sustainable mitigation measures. Building on earlier legislation, notably the Urban Wastewater Treatment Directive (Council Directive 91/271/EEC) and the Nitrates Directive (Council Directive 91/676/EEC), the WFD introduced a multidimensional and integrated approach to ecological assessment and management, organised at the scale of individual River Basin Districts. Its principal implementation instruments are the River Basin Management Plans (RBMPs) and their associated Programmes of Measures. Widely recognised as a landmark piece of environmental legislation, the WFD has substantially advanced both the evaluation and management of European freshwater ecosystems, while simultaneously stimulating globally influential research at the science–policy interface (Reyjol et al., 2014; Carvalho et al., 2019; van Rees et al., 2021).

A number of additional policies implicitly contribute to the objectives of the WFD. For instance, the Large Combustion Plants Directive (Council Directive 2001/80/EC) has played a key role in reducing pollutant levels in surface waters. The Invasive Alien Species Regulation (Regulation (EU) No 1143/2014) establishes common standards to prevent the introduction and spread of invasive non-native taxa. The Floods Directive (Council Directive 2007/60/EC) sets out an adaptive management approach for assessing and mitigating flood risks associated with rivers, lakes, and coastal areas. Furthermore, the European Eel Regulation (Council Regulation (EC) No 1100/2007) obliges Member States to implement national management plans for this globally threatened species, including structural interventions to improve habitat quality and restore river connectivity (van Rees et al., 2021).

Fish species that enter or primarily inhabit marine environments may benefit from measures implemented under the EU Marine Strategy Framework Directive (Council Directive 2008/56/EC), which seeks to enhance the protection of Europe's marine environment. This directive requires Member States to achieve Good Environmental Status by adopting an ecosystem-based approach, addressing 11 descriptors related to ecosystem features, human activities, and pressures. The EU Maritime Spatial Planning Directive (Council Directive 2014/89/EU) complements these efforts by coordinating maritime activities to ensure they are conducted efficiently, safely, and sustainably, while protecting marine biodiversity. In parallel, the EU's Common Fisheries Policy sets out rules for the sustainable management of European fishing fleets and the conservation of fish stocks. Additionally, Europe's marine environment is subject to a range of subregional governance frameworks, including the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention), the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention), the Mediterranean Action Plan (Barcelona Convention), the Convention on the Protection of the Black Sea Against Pollution (Bucharest Convention), and the Conservation of Arctic Flora and Fauna working group of the Arctic Council (EC, 2025a).

Some species included in this assessment, such as the NT Thinlip Grey Mullet (*Chelon ramada*), primarily inhabit marine environments. © Goran Šafarek

EU environmental policy also encompasses several directives concerning environmental assessment and liability in spatial planning. These directives aim to minimise the environmental impacts of planned or existing infrastructure projects, including those that affect freshwater fish habitat quality (e.g., Council Directive 2001/42/EC, Council Directive 2004/35/EC, Council Directive 2014/52/EU).

In 2024, the EU adopted the Nature Restoration Regulation (NRR), a landmark piece of legislation that sets binding ecological restoration targets to address biodiversity loss and ecosystem degradation. The NRR supports the EU Biodiversity Strategy for 2030 (BDS2030) by mandating the restoration of degraded ecosystems, including rivers, wetlands, and coastal and marine habitats. A central objective is to enhance the connectivity and resilience of these ecosystems through the creation of habitat networks and ecological corridors - for example, by restoring 25,000 kilometres of free-flowing rivers through the removal of primarily obsolete barriers and the rehabilitation of floodplains and wetlands. Launched in 2020 under the banner *Bringing Nature Back into Our Lives*, the BDS2030 forms a cornerstone of the European Green Deal, which aims to make the EU climate-neutral and pollution-free by 2050. The Green Deal also serves as the EU's key contribution to global biodiversity efforts under the GBF (EC, 2020; Hering et al., 2023; EU, 2024).

The EU is a major source, destination and transit area for numerous CITES-listed species. To implement CITES provisions uniformly across its Member States, the EU has enacted Council Regulation (EC) No 338/97, which regulates the trade of certain wild fauna and flora. This framework is supported by several implementing acts, including Commission Regulation (EC) No 865/2006, Commission Implementing Regulation (EU) No 792/2012 (the Permit Regulation) and the most recent Suspension Regulation (2023/2770). Regulation 338/97 sets out rules governing the import, export, re-export and intra-EU trade of protected species, categorising them into four annexes. Notably, these annexes include the same ten European freshwater fish species afforded protection under CITES.

Appendix 1 of this report provides an overview of freshwater fish taxa referenced in the Bern Convention, HD, CITES, EU wildlife trade regulations, and CMS, excluding species classified as Extinct in the current assessment. It is important to note that some species names and taxonomic concepts in these international policy instruments differ from current usage and do not incorporate recent taxonomic revisions (see Section 1.3.2).

To set priorities, guide conservation investments, and track progress toward biodiversity agreements, both governmental and non-governmental organisations require reliable, up-to-date information and analyses on the status, trends, and threats to biodiversity. One of the primary tools used to inform these efforts is The IUCN Red List of Threatened Species™ (hereafter referred to as the 'Red List'), the leading global authority on species extinction risk. The Red List serves as a vital indicator of global biodiversity health. It is frequently referenced to update annexes of key international agreements, such as CITES, and to monitor progress toward global biodiversity and sustainable development targets. Data from the Red List also underpin the Red List Index (RLI), a key biodiversity indicator for the GBF (Butchart et al., 2025).

In addition to evaluating the risk of global extinction, it is crucial to assess species' extinction risk at national and regional levels, where conservation policies are typically developed and implemented. Regional Red Lists play a key role in reporting progress towards biodiversity targets under multilateral agreements such as the GBF, NRR and BDS2030. The *European Red List of Freshwater Fishes* serves as a regional assessment, with the current update marking the first comprehensive revision since its original publication in 2011. The findings of this assessment support science-based decision-making by informing the setting of biodiversity conservation targets and helping to identify research and conservation priorities, particularly for threatened species.

1.3 European freshwater fishes

1.3.1 Diversity and endemism

Freshwater ecosystems directly or indirectly support most life on Earth, despite covering only a small fraction of its surface. They are disproportionately rich in biodiversity and are home to nearly 19,000 recognised fishes (see Box 1), representing over half of all known fish species and more than a quarter of all vertebrates. This remarkable richness continues to expand at a rapid pace, with more than 200 new freshwater fish species being described each year since 2020 (Su et al., 2021; Edmondstone, 2024; Fricke et al., 2024).

Freshwater fishes drive key ecological processes in aquatic habitats, contribute significantly to global food security, and provide a range of highly valued cultural and recreational services to humans. They also exhibit a broad spectrum of responses to anthropogenic stressors, making them important indicators for evaluating the biological and ecological health of freshwater ecosystems and their surrounding basins. For example, the European Fish Index (EFI+) is a multimetric tool used to assess the ecological status of riverine freshwater sites in some European countries, using fish-based biological assessment as a major input towards WFD reporting (Holmlund & Hammer, 1999; Schiemer, 2000; Pont et al., 2007; EFI+ Consortium, 2009; Villéger et al., 2017; Reid et al., 2019; Lynch et al., 2020; Aparicio et al., 2023; WWF, 2024).

The modern diversity of European freshwater fishes was largely established during the current interglacial period, which began approximately 10-12 thousand years ago. As ice sheets retreated, northern and western Europe were recolonised from the Ponto-Caspian region - a major glacial refugium - whereas post-glacial expansions from the Iberian, Apennine and Balkan peninsulas were constrained by the Pyrenees, Alps, Dinarides, and Balkan Mountain ranges. These barriers fostered the evolution of distinctive, geographically isolated fish assemblages in southern Europe (Griffiths, 2006; Levêque et al., 2008; Filipe et al., 2009; Oikonomou et al., 2014; Perea et al., 2021).

Consequently, Europe supports relatively fewer freshwater fish species than most other continents. Nevertheless, taxonomic richness has increased markedly since the late 20th century: around 200 native species were recognised west of the Urals in the 1990s, but by the end of 2022 that number had risen to over 550, spanning 29 families and 19 orders (Kottelat, 1997; Maitland, 2000; Nelson et al., 2016; Fricke et al., 2022).

Box 1. What is a freshwater fish?

The term "fish" is not a formal taxonomic category but rather a broad, convenient label for various aquatic vertebrates, including jawless hagfishes and lampreys, cartilaginous sharks and rays, primitive bony fishes such as coelacanths and lungfishes, and advanced ray-finned fishes. Among these, ray-finned fishes are by far the most diverse, comprising the majority of living freshwater species. This Red List assessment follows the definition of freshwater fishes provided by the IUCN Species Survival Commission (SSC) Freshwater Fish Specialist Group (FFSG). The grouping thus includes all fish taxa that live in freshwater or brackish water, as well as diadromous species - those that migrate between freshwater and marine environments as part of their life cycle. Additionally, it encompasses some primarily marine species that regularly enter coastal lagoons, estuaries, and the lower reaches of rivers. This interpretation broadly aligns with the commonly used biogeographic divisions of freshwater fishes, which classify them as primary if they are strictly confined to freshwater, secondary if they exhibit some salt tolerance, and peripheral if they are recently derived from marine families or spend part of their life in the ocean. The peripheral category often does not include all members of a particular family (Darlington, 1948; Berra, 2001; Levêque et al., 2008; Facey et al., 2022).

Most species included in this assessment are considered primary freshwater fishes. Image shows a nuptial male Vimba Bream (*Vimba vimba*), assessed as LC. © Benedikt Reisner

European freshwater fishes exhibit remarkable diversity. Image shows: A. Spanish Killifish (*Apricaphanius iberus*, NT), B. Three-Spined Stickleback (*Gasterosteus aculeatus*, LC), C. Corfu Dwarf Goby (*Knipowitschia goerneri*, NT), D. Rhodes Minnow (*Ladigesocypris ghigii*, VU), E. Southern Straight-Mouth Nase (*Pseudochondrostoma willkommii*, NT), F. Trichonida Blenny (*Salariopsis economidisi*, EN), G. Italian and Corsican Mediterranean Trout (*Salmo ghigii*, EN), and H. Corfu Valencia (*Valencia letourneuxi*, CR). © Matthew Ford / Davide Bellucci / Riccardo Novaga

Around 50% of these species belong to the order Cypriniformes, the largest group of freshwater fishes in the world. Meanwhile, many species considered endemic to the European region, and found nowhere else on Earth, have restricted ranges within specific lakes or rivers. The Valenciidae family (European toothcarps), with three species, is the only one entirely endemic to Europe, but endemism is notably high in several other families, including Petromyzontidae (northern lampreys), Gobionidae (gudgeons), Cyprinidae (carps and relatives), Leuciscidae (true minnows), Cobitidae (true loaches), Nemacheilidae (stone loaches), Umbridae (mudminnows), Salmonidae (salmons, trouts, and whitefishes), and Cottidae (sculpins). In addition, nine of the world's 28 sturgeon species, belonging to the Acipenseridae family, are native to Europe (see Table 1).

Almost half of European freshwater fish species belong to just two families: Leuciscidae, with 170 native species, and Salmonidae, which includes 119 native species. Leuciscidae is particularly diverse in southern Europe, while Salmonidae is more prominent in central and northern Europe (Perea et al., 2010; Whiteley et al., 2019; Alexander & Seehausen, 2021).

The diversity of European freshwater fishes is further highlighted by the fact that several genera are regional endemics. These include *Aulopyge* (family Cyprinidae), *Achondostroma*, *Delminichthys*, *Iberochondrostoma*, *Leucos*, *Pachychilon*, *Parachondrostoma*, *Pelasgus*, *Phoxinellus*, *Protochondrostoma*, *Pseudochondrostoma*, *Sarmarutilus*, and *Telestes* (all Leuciscidae), *Valencia* (Valenciidae), *Romanichthys* and *Zingel* (Percidae), and *Economidichthys*, *Ninnigobius*, *Orsinigobius*, and *Padogobius* (Gobiidae, but see Section 1.3.2).

Table 1. *Diversity and endemism of European freshwater fishes at the regional and EU-27 levels, arranged alphabetically by family.*

Family	Number of species	Endemic Europe	Endemic EU-27
Acheilognathidae	2	1 (50%)	0 (0%)
Acipenseridae	9	1 (11%)	0 (0%)
Anguillidae	1	0 (0%)	0 (0%)
Aphaniidae	4	2 (50%)	2 (50%)
Atherinidae	2	0 (0%)	0 (0%)
Blenniidae	2	1 (50%)	1 (50%)
Clupeidae	13	3 (23%)	3 (23%)
Cobitidae	35	28 (80%)	14 (40%)
Cottidae	18	17 (94%)	10 (56%)
Cyprinidae	37	31 (84%)	16 (43%)
Esocidae	3	2 (67%)	1 (33%)
Gasterosteidae	8	5 (63%)	4 (50%)
Gobiidae	42	20 (48%)	7 (17%)
Gobionidae	29	26 (90%)	6 (21%)
Leuciscidae	170	141 (83%)	80 (47%)
Lotidae	1	0 (0%)	0 (0%)
Moronidae	1	0 (0%)	0 (0%)
Mugilidae	5	0 (0%)	0 (0%)
Nemacheilidae	10	8 (80%)	3 (30%)
Osmeridae	3	1 (33%)	0 (0%)
Percidae	15	9 (60%)	2 (13%)
Petromyzontidae	17	13 (76%)	5 (29%)
Pleuronectidae	4	2 (50%)	0 (0%)
Salmonidae	119 [1]	106 (89%)	20 (17%)
Siluridae	2	1 (50%)	1 (50%)
Syngnathidae	2	0 (0%)	0 (0%)
Tincidae	1	0 (0%)	0 (0%)
Umbridae	1	1 (100%)	0 (0%)
Valenciidae	3	3 (100%)	2 (67%)

Note: The number of Not Applicable (NA) species at the European regional level is listed in [brackets]. NA species refer to those that occur in Europe only as a very marginal part of their global range.

1.3.2 The changing taxonomic landscape

Significant advances in resolving the systematics and taxonomic diversity of European freshwater fishes have been made since the turn of the century, driven by comprehensive revisions, evolving species concepts, the extensive application of modern molecular methods, and an increasingly integrative approach to taxonomy that combines genetic, morphological, and ecological data (Kottelat, 1997; Kottelat & Freyhof, 2007, 2009; Buj et al., 2014; Geiger et al., 2014; Selz & Seehausen, 2023).

Since the publication of the first *European Red List of Freshwater Fishes* (Freyhof & Brooks, 2011), with assessments largely completed between 2004 and 2006, more than 110 accepted taxonomic changes have occurred. These include new species descriptions, the synonymisation of previously valid species with congeners, the reclassification of species into different genera, and the splitting of established families into multiple groupings. A complete list of changes affecting species assessed for this updated European Red List can be found in Appendix 2 of this report, with further comments in Section 2.2.

As a result, 37 species previously assessed have undergone revisions in their taxonomic concepts since the last assessment was published. These include well-known taxa such as the Channel (formerly Common) Minnow (*Phoxinus phoxinus*), European Bullhead (*Cottus gobio*), Northern Pike (*Esox lucius*), European Brook Lamprey (*Lampetra planeri*), Arctic Charr (*Salvelinus alpinus*), and European Grayling (*Thymallus thymallus*). These revisions have, in some cases, had significant impacts on previously established range sizes. For example, the Channel Minnow, once thought to inhabit much of northern Eurasia, is now recognised as being limited to continental rivers flowing into the North Sea and English Channel in Western Europe (Denys et al., 2020).

Although the taxonomy of European freshwater fishes is becoming increasingly well understood, previously overlooked - and often remarkable - diversity continues to be identified (see Box 2). In some cases, further research is still required to clarify taxonomic relationships, particularly within families such as Leuciscidae and Salmonidae.

Since the completion of this Red List assessment, several taxonomic revisions have been adopted. These include the splitting of the Twaite Shad (*Alosa fallax*) following the revalidation of the Baltic Shad (*Alosa baltica*); the synonymisation of the Siberian Spined Loach (here listed as *Cobitis granoei*) with the Huang He Spined Loach (*Cobitis melanoleuca*); and the reassignment of most European sturgeons from the genus *Acipenser* to *Huso* (Dyldin et al., 2022, 2023; Fricke et al., 2024; Brownstein & Near, 2025).

At the family level, Clupeidae (as recognised in this assessment) has been split into several smaller families, and a number of species previously included in Gobiidae have now been reassigned to the revalidated family Oxudercidae (Wang et al., 2022; Johnson et al., 2025).

The European Brook Lamprey (*Lampetra planeri*) is among the species for which the taxonomic concept has changed since the previous Red List assessment. It is assessed as NT. © Samuel Betschart

1.3.3 Habitats and ecology

Freshwater fishes inhabiting seasonal and intermittent rivers and streams often survive the dry season in remnant pools. Image shows a summer refuge habitat for several endemic species in the Bembézar River, a tributary of the Guadalquivir in southern Spain.
© Matthew Ford

In Europe, freshwater fishes occupy most inland aquatic habitats that retain liquid water year-round, from thermal springs and flooded caves to fast-flowing rivers and deep, high-altitude lakes. These habitats are distributed across the continent, with variations in both their characteristics and geographical distribution. Permanent water bodies are predominantly found in northern, western, central, and eastern Europe, while non-perennial habitats are more widespread in southern and southeastern Europe. Some of these habitats are part of large ecosystems, such as extensive rivers or large lakes, while others consist of smaller, localised areas like springs or ponds. Many have undergone various forms of structural modification by humans (Kottelat & Freyhof, 2007; Janssen et al., 2016).

All European freshwater fishes are ectothermic (maintaining a temperature like that of their surrounding water), mobile organisms that depend on a variety of resources and habitats throughout their lifetimes. Their adaptations range from tolerance of extreme temperatures to specialisation for flowing or still environments. Conversely, certain species are ecological generalists, capable of occupying a broad spectrum of habitats (Griffiths, 2006; Wolter et al., 2021; Facey et al., 2022).

Most species inhabit river networks, which generally exhibit variable flow regimes shaped by climatic and geomorphological conditions. For instance, Alpine tributaries, fed by melting snow, experience peak flows in late spring and minimal discharge during winter, while lowland rivers tend to have their highest flows in winter and lowest in summer due to cyclonic rainfall. In the Mediterranean region, many springs and smaller rivers are intermittent, ceasing to flow for weeks or months on a seasonal or occasional basis. Numerous fish species have evolved life-history strategies specifically adapted to these pulsing hydrological regimes (Olden & Kennard, 2010; McIntyre et al., 2016; see Box 3).

Box 2. Recently discovered fish species diversity in Switzerland's large lakes

Ole Seehausen[1,2], *Oliver Selz*[1,2,3]

[1] Eawag Swiss Federal Institute of Aquatic Science and Technology, [2] Institute of Ecology and Evolution, University of Bern, [3] Aquatic Restoration and Fisheries section, Federal Office for the Environment (FOEN), Switzerland

Switzerland, with over 120 freshwater fish species recorded, ranks among Europe's most diverse countries for this group. Eleven new species have recently been described, several more are under review, and a similar number are awaiting taxonomic investigation. But what explains this unexpected concentration of diversity in Switzerland?

The answer lies in the biogeography of the Alps and the exceptional diversity of macrohabitats, including numerous large, deep, thermally stratified lakes connected to major rivers. These fjord-like basins, carved into the rock by the slow flow of glacial masses over millions of years, are spread across the upper basins of four major European rivers - the Rhine, the Rhone, the Po, and the Danube - which belong to distinct freshwater ecoregions. The recolonisation of Swiss lakes and streams occurred from Pleistocene refugia in the lower reaches of these rivers, leading to the development of distinct fish communities. Additionally, some species crossed between major watersheds, as certain lakes and their associated rivers were captured by adjacent basins during the Holocene.

The highest richness of endemic lacustrine species is found in the whitefish (genus *Coregonus*) populations in the lakes on the northern side of the Alps. Several phylogenetically independent adaptive radiations occurred in these lakes soon after the glacial retreat, at a time when some of the modern lakes were still interconnected, forming much larger bodies of water. These radiations led to the emergence of around 34 known endemic species, each confined to one or two lakes, with up to six species coexisting in a single lake. Despite their small geographical ranges, many of these species are locally abundant, occupying distinct depth zones ranging from shallow areas to depths of over 250 metres. As such, they are of great ecological and economic importance for both ecosystems and fisheries. However, these endemic species are highly sensitive to lake eutrophication and warming, and nearly a third of them have gone extinct in recent decades. Smaller, less studied radiations also exist within the charrs (genus *Salvelinus*), though detailed taxonomic work is still pending.

While the rich diversity of whitefishes and charrs in the deep perialpine lakes of Switzerland has been known for over a century, taxonomic efforts to diagnose and describe these species have only recently gained momentum. More unexpectedly, detailed studies of benthic fish communities in Swiss lakes and rivers conducted between 2009 and 2022 revealed that fishes from lake and stream habitats often belong to separate species derived from different, only distantly related refugial lineages. For example, distinct species of minnows (genus *Phoxinus*) originating from refugia in the Rhône and Danube rivers now coexist in large parts of northern Switzerland, with one species occupying streams and rivers and the other inhabiting the shores of large lakes. Several new species of stone loach (genus *Barbatula*) are currently being described and exhibit similar patterns of old genetic lineages mapped to large lakes versus streams. Additionally, sculpins (genus *Cottus*) from lakes and streams also belong to phenotypically and genetically distinct taxa. Future research will reveal whether this pattern of coexistence between distinct refugial lineages in Switzerland occurs in other genera as well.

VULNERABLE
VU

Lake Lucerne, Switzerland, hosts five endemic whitefish species, each occupying a distinct ecological niche. All are classified as VU in this Red List assessment. Pictured from top to bottom: Benthic-Intermediate Whitefish (*Coregonus intermundia*), Shore Whitefish (*C. litoralis*), Müller's Whitefish (*C. muelleri*), Noble Whitefish (*C. nobilis*), and Pelagic-Intermediate Whitefish (*C. suspensus*). © Oliver Selz, Eawag / Gindegg, Wikimedia Commons, CC BY-SA 4.0

While some European fish species that inhabit standing or slow-flowing water bodies are sedentary, most of those living in river systems undertake migratory movements across various spatial and temporal scales. Such migrations are driven by factors such as feeding, growth, reproduction, or escaping harsh environmental conditions, and typically occur regularly throughout an individual's lifetime. These movements can involve large portions of a species' population and may take place at different life stages (Brönmark et al., 2014; Freyhof et al., 2020).

Most freshwater fish species are potamodromous, meaning they complete their entire life cycle within freshwater systems, traveling distances from a few metres to hundreds of kilometres within rivers or lakes. A smaller group of diadromous species undertake migrations of up to several thousand kilometres between freshwater and saltwater. Diadromous fishes are further divided into anadromous species, such as some salmonids, shads, and sturgeons, which reproduce in freshwater but spend most of their lives feeding at sea, and catadromous species, like the European Eel (*Anguilla anguilla*), which migrate from freshwater to spawn in the sea. Anadromous fishes often exhibit strong homing behaviour, returning to their natal rivers to spawn (Facey et al., 2022).

Some species, such as Brown Trout (*Salmo trutta*), exhibit intraspecific variation in their migratory behaviour, with some subpopulations being either potamodromous or anadromous. In addition, migration patterns can vary considerably depending on environmental conditions. For example, species that typically show limited movements in temperate regions may undergo extensive migrations at Arctic and subarctic latitudes (Lucas & Baras, 2001; Jonsson et al., 2019).

European freshwater fishes exhibit a diverse range of body forms, with sizes ranging from the tiny Trichonida Dwarf Goby (*Economidichthys trichonis*), which reaches a maximum total length of just three centimetres, to the Beluga Sturgeon (*Huso huso*), the largest and most commercially valuable freshwater fish on earth, growing up to 8.6 metres long and weighing as much as 1,300 kilograms (Barbieri et al., 2015; Facey et al., 2022).

Accompanying the morphological diversity of European freshwater fishes is a wide variety of feeding habits, with species represented across nearly every trophic level, from detritivores to herbivores and tertiary predators. Many species exhibit trophic flexibility, feeding at different levels depending on life stage, adjusting their diets based on the availability of resources, or adopting opportunistic feeding strategies. For instance, herbivores may switch to carnivory during colder months when plant resources are scarce (Noble et al., 2007; Vejříková et al., 2016; Vagenas et al., 2022).

All native European freshwater fishes lay eggs, and their life history strategies are shaped by environmental conditions. Three main approaches are recognised: opportunistic species, which thrive in unpredictable environments, are typically smaller, with rapid growth, early maturation, and short lifespans, producing many offspring to maximise reproductive success in fluctuating conditions; periodic strategists, found in variable but predictable environments, tend to be larger, more fecund, long-lived, and often migratory, with a higher investment in offspring to ensure survival in dynamic habitats; and equilibrium species, adapted to more stable environments, generally produce fewer but larger offspring, often engage in parental care, and their life history strategies are focused on maximising juvenile survival in more constant conditions. Some species spawn in open water, while others require specific substrates like permeable, well-oxygenated gravel beds or inundated vegetation for egg deposition. Most riverine species depend on a network of interconnected functional habitats, including access to upstream tributaries or shallow, slow-flowing littoral zones such as floodplains, which serve as crucial spawning or nursery habitats (Winemiller & Rose, 1992; Schiemer et al., 2002; Blanck et al., 2007; Stoffers et al., 2022a,b).

Freshwater fishes play vital roles in sustaining the structure and function of aquatic ecosystems. Their contributions include nutrient cycling, where fish excretion, particularly phosphorus, promotes algal growth and affects nutrient balance. Certain anadromous species, such as Atlantic Salmon (*Salmo salar*), serve as vectors, transporting energy and nutrients from marine to freshwater environments, as well as to nearby terrestrial areas. Benthic fishes, living near the bottom, disturb sediments as they forage, releasing nutrients into the water column. Some species alter their physical environment; for example, salmon and trouts create nests (redds) that redistribute gravel in riverbeds, and burrowing lamprey larvae modify substrate composition and oxygenation. Fish species that are top predators regulate populations of other organisms, triggering trophic cascades that can affect primary producers and other species lower in the food web (Holmlund & Hammer, 1999; Jonsson & Jonsson, 2003; Facey et al., 2022).

The Common Nase (*Chondrostoma nasus*), assessed as NT, is one of many European freshwater fish species that undertake migratory movements as part of their life cycle. © Benedikt Reisner

Box 3. Unique adaptations in the Dinaric Karst

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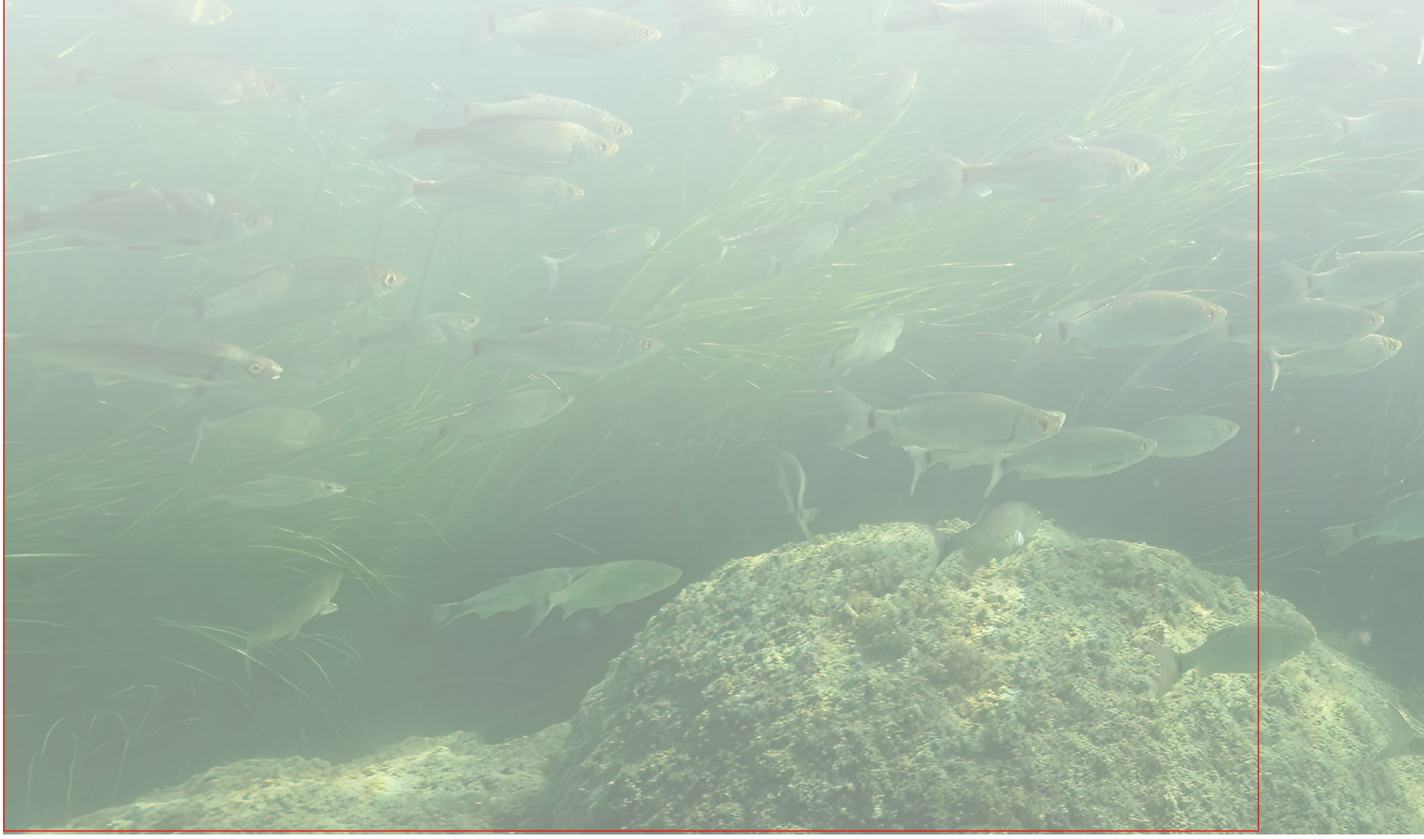
The Dinaric Karst is a limestone region spanning approximately 60,000 square kilometres along the eastern coast of the Adriatic Sea. It stretches from its border with the Alps in Slovenia, through Croatia, a large part of Bosnia and Herzegovina, and Montenegro, reaching the north of Albania. The region is marked by the Dinarides, a central mountain range that extends into Serbia, Kosovo, and North Macedonia (Zupan Hajna, 2019).

It is Europe's largest continuous karstic area, characterised by a highly complex hydrological network that includes sinkholes, chasms, sinking and losing streams, underground rivers, both permanent and intermittent springs, labyrinthine cave systems, and other unique features. Despite surface water flows being relatively scarce due to the porosity of the underlying rock, it is the most water-rich region in the Mediterranean in terms of freshwater ecosystems, supporting a remarkable diversity of endemic fish species. These species have evolved primarily in response to the region's intricate geological history, where the karstification process has led to the isolation of numerous short rivers, driving allopatric speciation. Additionally, most resident fish populations were not affected by Pleistocene glaciations, enabling uninterrupted evolutionary processes (Zupan Hajna, 2019; Buj et al., 2022).

In karst landscapes, groundwater and surface water form an interconnected and dynamic system. Smaller riverbeds are often intermittent, drying out during the summer months. These seasonal, typically spring-fed watercourses tend to be separated by steep limestone ridges and flow short distances across flat, enclosed karstic depressions known as *polje*, before vanishing into swallow holes or ponors, only to reappear elsewhere. After heavy rainfall or snowmelt, the *polje* naturally flood due to rising groundwater or when the inflow of water exceeds the capacity of underground drainage channels. These processes create expansive temporary wetlands that serve as vital habitats for endemic fish species, enabling them to move from more confined perennial water sources to forage and breed (Bonacci, 2015; Milanović, 2015).



Many fish species endemic to the Dinaric Karst have developed traits suited to life in unstable aquatic environments, such as early sexual maturity, small adult body sizes, and, in some cases, unexpectedly high intraspecific genetic diversity. However, perhaps the most remarkable adaptation is their ability to survive in subterranean habitats. In particular, several minnow-like species from genera such as *Delminichthys*, *Phoxinellus*, and *Telestes* are known to retreat to underground caves for periods of weeks or months when surface waters recede. Although they do not breed underground and lack typical cave adaptations, such as reduced eyes and pigmentation, growing evidence suggests that some of these species may also regularly migrate through subsurface channels as part of their biological cycle. They can thus be referred to as *subtroglophiles*, as they exhibit behaviours and adaptations that allow them to thrive in both surface and subterranean environments (Palandačić et al., 2012; Buj et al., 2022, 2024; Reier et al., 2022).

The Dinaric Karst region supports numerous endemic freshwater fish species, including the NT Dalmatian Rudd (*Scardinius dergle*), pictured here in the Krka River, Croatia. The inset shows an individual of the VU Southern Dalmatian Minnow (*Delminichthys ghetaldii*) in the subterranean waters of Ombla Spring, close to the city of Dubrovnik. © Goran Šafarek / Dušan Jelić

1.4 Assessment of species extinction risk

The conservation status of plants, animals, and fungi serves as a key indicator for evaluating the health of ecosystems and their biodiversity. The Red List is globally regarded as the most authoritative source of information on species' extinction risk. Although Red List assessments are highly valuable for guiding conservation planning and setting priorities, they are not designed to dictate specific policies or function as a standalone framework for biodiversity protection. Furthermore, these assessments must be conducted objectively, free from commercial, emotional, or political influence (Collen et al., 2016; IUCN, 2022a).

The *Red List Categories and Criteria* are designed to assess the relative risk of extinction faced by species, with a primary focus on identifying those under significant threat. These categories are underpinned by quantitative criteria that evaluate factors such as population size and trend, demographic structure, threats, and geographic distribution. Assessors use this information to determine the overall extinction risk (IUCN, 2012a).

Species are classified into one of nine categories, with those listed as Vulnerable (VU), Endangered (EN), or Critically Endangered (CR) regarded as "threatened". A species is assigned to the Near Threatened (NT) category if it is close to meeting the criteria for VU. Species classified as Least Concern (LC) do not meet the thresholds for any threatened category or for NT. Where insufficient information exists to evaluate extinction risk, species may be designated as Data Deficient (DD). For regional or national assessments, the Red List regional guidelines are applied enabling the use of two additional categories: Regionally Extinct (RE) and Not Applicable (NA) (IUCN, 2012a,b; see Figure 1).

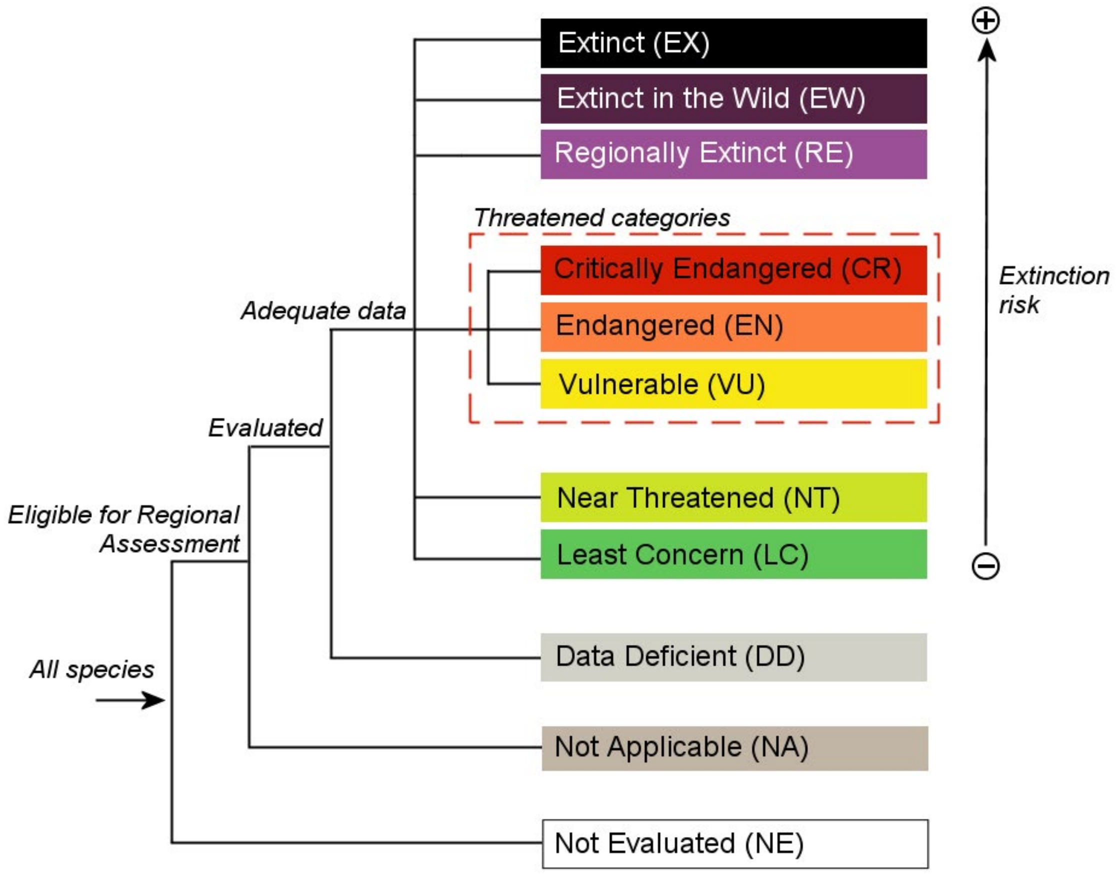


Figure 1. *The IUCN Regional Red List Categories (IUCN, 2012b).*

Extinction risk can be assessed at global, regional, or national levels, and a species' classification may vary depending on the geographic scope and the population assessed. For example, a species listed globally as Least Concern (LC) may be classified as EN at a regional level if it faces significant local threats. Each assessment includes a justification outlining the rationale behind the assigned Red List category.

In Europe, species endemic to the EU-27 are typically subject to a single assessment that also includes their global and European status, since their entire range is confined to this region.

1.5 Objectives of the assessment

Five core objectives guided the preparation of this updated European Red List assessment of freshwater fishes:

- To revise the baseline extinction risk for each species by integrating recent data, newly-identified threats, and emerging trends since the previous assessment.
- To identify priority geographic areas, habitats, and species requiring urgent protection to prevent extinctions and support the achievement of favourable conservation status for European freshwater fishes.
- To assess the principal ongoing threats and review both current and prospective conservation actions in order to address them effectively.
- To strengthen the network of freshwater fish experts across Europe, supporting knowledge exchange and capacity to address conservation priorities.
- To mobilise the compiled data as a foundation for regional conservation planning for freshwater fishes and inland water ecosystems, within the context of global and regional biodiversity strategies - thereby contributing to bending the curve of freshwater biodiversity loss.

The updated *European Red List of Freshwater Fishes* delivers three main outputs:

- The present summary report.
- An update to the Red List website (www.iucnredlist.org), offering free access to the compiled baseline data on the threat status and current distribution of European freshwater fishes.
- A data repository on the Red List website (www.iucnredlist.org/resources/data-repository) presenting these data as individual factsheets for all European freshwater fish species included in the assessment, along with background and other interpretative materials.

IUCN will facilitate broad dissemination of these outputs to relevant decision makers, non-governmental organisations, research institutions and other stakeholders to inform the planning and implementation of conservation actions throughout the European region. The data presented in this report provide a snapshot based on available knowledge at the time of assessment drafting and the expert review process. The individual species assessments will continue to be updated on a periodic basis by IUCN and the IUCN SSC FFSG as new information becomes available.

2 Assessment methodology

2.1 Geographic scope

The geographical scope of the European Red List spans the entire continent - from the Svalbard and Franz Josef Land archipelagos in the north to the Azores in the west, the Spanish territories in North Africa and the Bosporus Strait in the south, and the Ural Mountains in the east (see Figure 2). It encompasses the European Macaronesian and Mediterranean islands (including the Canary Islands, Madeira, and Cyprus) but excludes Ciscaucasia (the Russian Northern Caucasus), which was part of the previous assessment.

For species moving between fresh and marine waters, the assessment region also covers adjacent seas - the Mediterranean, Black, Baltic and North Seas - and the European Atlantic (as defined by the EU Marine Strategy Framework Directive), as well as the Volga River delta in the Caspian Sea.

Red List assessments were conducted at two regional levels: 1) for geographical Europe (as outlined above), and 2) for the area comprising the 27 Member States of the EU. Unlike the previous *European Red List of Freshwater Fishes*, the EU region now includes Croatia but no longer encompasses the United Kingdom. Contrary to Freyhof and Brooks (2011) who took a catchment-based approach that extended the assessment region to Kazakhstan and the Russian Northern Caucasus, the terrestrial assessment area shown in Figure 2 was followed in this reassessment.

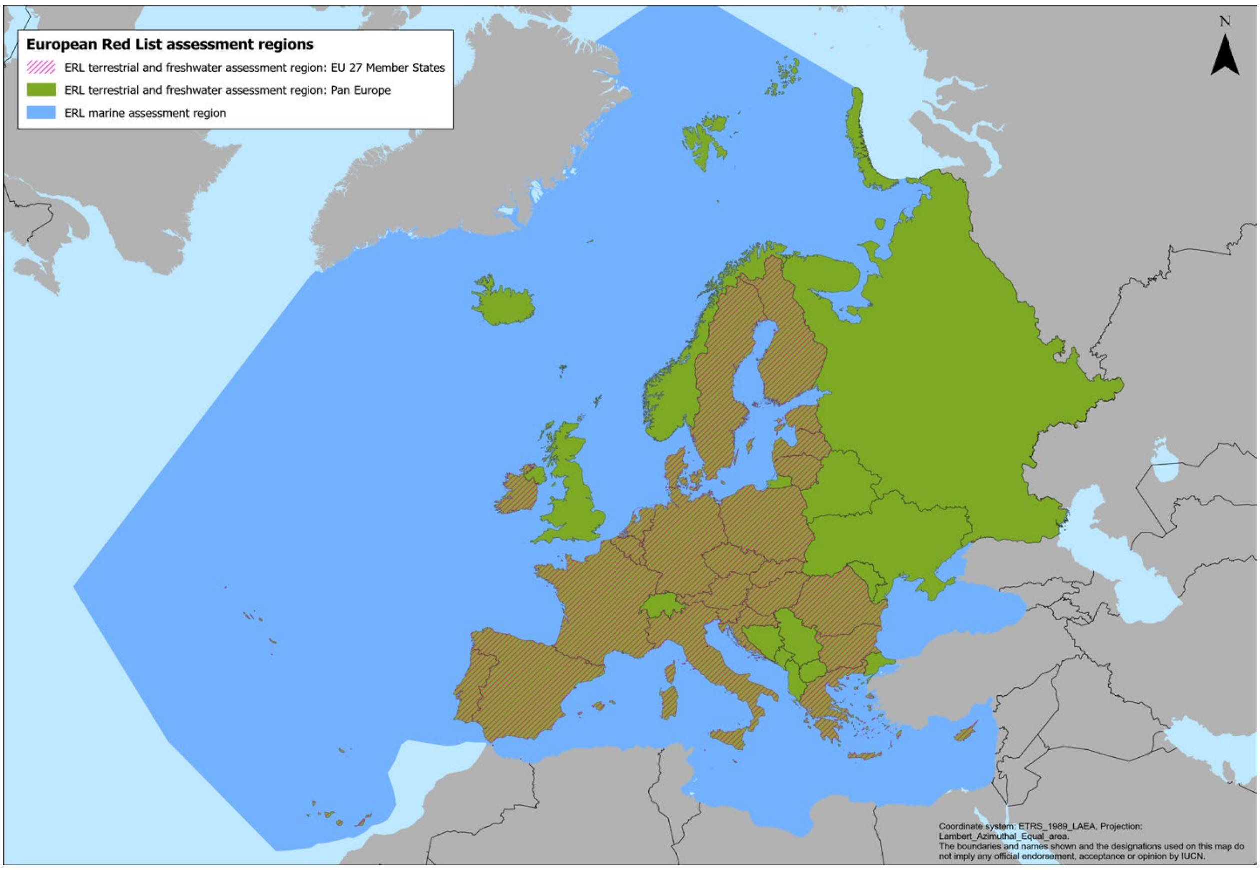


Figure 2. *The European Red List assessment boundaries, showing the extent of the terrestrial area (green), the marine area (blue), and the EU-27 Member States (hatched area).*

2.2 Taxonomic scope

This second edition of the *European Red List of Freshwater Fishes* includes all 559 species that are considered to occur naturally within the European region as of 31 December 2022. Of these, 438 species are native to the EU-27 Member States. This represents an increase of 28 species in the European region and 57 species in the EU-27 compared to the previous European Red List, which assessed 531 and 381 species, respectively (Freyhof & Brooks, 2011; Fricke et al., 2022).

The species list has been updated to reflect recent taxonomic revisions (see Appendix 2). It is based objectively on *Eschmeyer's Catalog of Fishes* (CoF), which serves as the taxonomic authority for fishes on the Red List. However, a small number of nominal taxa listed as valid in the CoF are not currently recognised by the IUCN SSC FFSG. These taxa are summarised in Table 2, which also includes their alternative designations as used within the framework of the European Red List. In this update, a total of 77 species have been assessed for the first time, among which are 13 species that were previously listed as Not Evaluated (NE).

Furthermore, the Caspian Ratan Goby (*Ponticola ratan*) has been added to the species list, as it was previously not considered to inhabit freshwater environments. The Mushroom Goby (*Ponticola eurycephalus*) and Arctic Flounder (*Liopsetta glacialis*), which were assessed in the past, have been reclassified as marine species and are therefore no longer included on the species list. In addition, 26 species that were assessed for the prior European Red List have been excluded due to adjustments in assessment geographic boundaries, as outlined in Section 2.1.

Assessments have been conducted at the species level only. In accordance with current IUCN recommendations, no undescribed taxa have been included. However, exceptions to the cutoff date for accepted taxonomic changes have been made for several recently described species within the families Cobitidae and Salmonidae, as well as for a revision of the genus *Salvelinus* in Ireland (Barthelemy et al., 2023; Selz & Seehausen, 2023; Vasil'eva & Vasil'ev, 2023).

Descriptions of certain Mediterranean taxa from the families Cobitidae and Leuciscidae, published between 2023 and 2025, could not be incorporated into this update. Red List assessments for these species are currently in progress and are expected to be published later in 2026.

Among native European freshwater fishes, the Broad Whitefish (*Coregonus nasus*) is classified as NA at the European level due to its marginal presence in the region. Within the EU-27, two species - Black Sea Roach (*Rutilus frisii*) and Arctic Lamprey (*Lethenteron camtschaticum*) - are deemed NA for the same reason. Additionally, five species - Livno Chub (*Squalius tenellus*), Arctic Whitefish (*Coregonus muksun*), Three Lakes Whitefish (*Coregonus palaea*), Sarnen Whitefish (*Coregonus sarnensis*), and Enduring Whitefish (*Coregonus supersum*) - are categorised as NA in the EU-27 because they were introduced by humans, despite being native to the broader European region. These species are omitted from the further analyses and discussion presented in this report. As a result, the IUCN Red List criteria were applied to a total of 558 species at the European regional level, and 431 species at the EU-27 level.

The full list of species assessed, along with their individual Red List Categories and Criteria, as well as their endemic status at both the European and EU-27 levels, is available for free download from the European Red List Data Repository.

Table 2. *Taxonomic differences between the CoF and the IUCN SSC FFSG, resulting in disparities in species nomenclature used on the European Red List (ERL). Species are arranged alphabetically by family.*

Family	Designation in CoF	Designation in ERL	IUCN SSC FFSG Reasoning	Source
Acipenseridae	*Acipenser colchicus* Marty 1940	*Acipenser gueldenstaedtii* Brandt & Ratzeburg 1833	Taxon's status is unclear, integrative taxonomic review required	Kuljanishvili et al., 2020
Clupeidae	*Alosa baltica* Kukuev & Orlov 2018	None	Taxon described as a subspecies of *Alosa fallax* (Lacepède 1803) on the basis of morphological characters, integrative taxonomic review required	Dyldin et al., 2022
Cobitidae	*Cobitis megaspila* Nalbant 1993	None	Probable hybrid-origin taxon	Kottelat, 2012
Cottidae	*Cottus ferrugineus* Heckel & Kner 1857	Synonym of *Cottus gobio* Linnaeus 1758	Taxon not considered valid by the majority of authors, and is omitted from recent National Red Lists	Lorenzoni et al., 2019
Cyprinidae	*Barbus oscensis* Rossi & Plazzi 2021	Synonym of *Barbus fucini* Costa 1853	Taxa are conspecific, but *B. fucini* takes precedence since its description was published prior to that of *B. oscensis*	Lorenzoni et al. 2021
	Barbus thessalus Stephanidis 1971	Synonym of *Barbus macedonicus* Karaman 1928	Synonymy supported by molecular data	Barbieri et al. 2015
	Barbus waleckii Rolik 1970	None	Probable hybrid-origin taxon	Kotlik et al., 2002
Gobiidae	*Hyrcanogobius bergi* Iljin 1928	*Knipowitschia bergi* (Iljin 1928)	Otolith data support placement of taxon in *Knipowitschia*, integrative taxonomic review required	Zarei et al., 2023
	Synonym of *Knipowitschia milleri* (Ahnelt & Bianco 1990)	*Knipowitschia goerneri* Ahnelt 1991	Morphological data support separation into two species but some mtDNA analyses suggest synonymy, integrative taxonomic review required	Parenti, 2021
	Synonym of *Knipowitschia panizzae* (Verga 1841)	*Knipowitschia mrakovcici* Miller 2009	Morphological data support separation into two species but some mtDNA analyses suggest synonymy, integrative taxonomic review required	Parenti, 2021
Gobionidae	Synonym of *Gobio tauricus* Vasil'eva 2005	*Gobio delyamurei* Freyhof & Naseka 2005	Taxa are conspecific, but *G. delyamurei* takes precedence since its description was published prior to that of *G. tauricus*	Kottelat & Bogutskaya, 2006
	Romanogobio banaticus (Bănărescu 1960)	None	Taxon possibly synonymous with *Romanogobio carpathorossicus* (Vladykov 1925), integrative taxonomic review required	Friedrich et al., 2018
Leuciscidae	*Alburnus maximus* Fatio 1882	Synonym of *Alburnus arborella* (Bonaparte 1841)	Taxon has never been confirmed as valid, integrative taxonomic review required	Lorenzoni et al., 2019
	Rutilus caspicus (Yakovlev 1870)	*Rutilus lacustris* (Pallas 1814)	Taxa cannot be separated by mtDNA analyses, integrative taxonomic review required	Levin et al., 2017
	Rutilus heckelli (Nordmann 1840)	*Rutilus lacustris* (Pallas 1814)	Taxa cannot be separated by mtDNA analyses, integrative taxonomic review required	Levin et al., 2017
	Leucos panosi (Bogutskaya & Iliadou 2006)	*Rutilus panosi* Bogutskaya & Iliadou, 2006	Taxon retained in the genus *Rutilus* pending an integrative taxonomic review	Barbieri et al. 2015
	Leucos ylikiensis (Economidis 1991)	*Rutilus ylikiensis* Economidis 1991	Taxon retained in the genus *Rutilus* pending an integrative taxonomic review	Barbieri et al. 2015
	Telestes alfiensis (Stephanidis 1971)	None	Taxon has never been formally described	Barbieri et al. 2015
	Telestes comes (Costa 1838)	Synonym of *Telestes muticellus* (Bonaparte 1837)	Synonymy supported by molecular data	Lorenzoni et al., 2019
	Telestes savigny Bonaparte 1840	Synonym of *Telestes muticellus* (Bonaparte 1837)	Synonymy supported by molecular data	Lorenzoni et al., 2019
Salmonidae	*Salmo visovacensis* Taler 1950	None	Taxon possibly valid, integrative taxonomic review required	Schöffmann, 2021
	Salmo zetensis (Hadžišče 1960)	None	Taxon possibly valid, integrative taxonomic review required	Schöffmann, 2021
	Salmo zrmanjaensis Karaman 1938	None	Taxon possibly valid, integrative taxonomic review required	Schöffmann, 2021

Note: Taxonomic changes published after 31 December 2022 are not reflected in this summary.

2.3 Assessment protocol

The *European Red List of Freshwater Fishes* assessment follows the *IUCN Red List Categories and Criteria* (version 3.1, second edition; IUCN 2012a), along with the *Guidelines for Using the IUCN Red List Categories and Criteria* (version 15.1 ; IUCN, 2022b) and the *Guidelines for Application of IUCN Red List Criteria at Regional and National Levels* (version 4.0 ; IUCN, 2012b). Proper interpretation of the terms and the application of criteria were ensured through training workshops.

The following data were compiled for all species assessments, depending on availability:

- Taxonomic classification, including notes and common names in countries of occurrence.
- Distributional range and list of countries of occurrence, including Area of Occupancy, Extent of Occurrence, and number of locations.
- Population information, including overall population sizes and trends.
- Habitat preferences and primary ecological requirements, including relevant biological details (e.g., generation length, extended larval stage, migratory life cycle, etc.).
- Major threats, including their timing, scope, severity, and related stresses.
- Species use and trade.
- Conservation actions (both current and recommended), including identified research gaps.
- IUCN Red List Category and Criteria at three geographic levels (Global, Europe and, where applicable, EU-27), including rationale.
- Key bibliographic references.

The assessment is based on data reported by EU Member States under Article 17 of the EU HD (for methodology, see Röschel et al., 2020). Additionally, scientific and fisheries reports, national handbooks and monographs, Red Data Books, Red Lists, and peer-reviewed literature were thoroughly reviewed to ensure that the most recent data were considered. The IUCN Species Information Service (SIS) online database was used to store relevant information for each species.

Draft assessments were revised following consultations with experts from across the European region. Throughout the project, the assessors and regional experts worked closely - with support from IUCN staff - to discuss species selection, taxonomic issues, distribution maps, and other technical matters. This collaborative approach led to the development of assessments and distribution maps that reflect the current state of knowledge for each species.

Where a reassessment results in a species moving to a different Red List Category compared to the first *European Red List of Freshwater Fishes*, the assessment specifies whether this change is due to genuine or non-genuine reasons:

Genuine reasons:

- The main threats are no longer present, or conservation actions (e.g., reintroduction, habitat protection or restoration, legal protection, harvest management, etc.) have successfully improved the species' status enough to warrant a 'downlisting' to a lower category of threat.
- The main threats have persisted, worsened, or new threats have emerged, leading to a deterioration in the species' status, resulting in an 'uplisting' to a higher category of threat.

Non-genuine reasons:

- New information has become available since the last assessment (e.g., updated or more recent data on population sizes, threats, rates of decline or recovery, etc.).

- A taxonomic revision has occurred, causing the species to no longer represent the same concept as before (e.g., it may now be split into several species, each with smaller ranges or populations, or it may have been merged with other species, resulting in a larger range and population size).

- An error was discovered in the previous assessment (e.g., incorrect information was used, or the Categories and Criteria were misapplied).

- Revisions to the Red List Guidelines or differing assessor perspectives have led to a new interpretation of the Categories and Criteria.

A final peer-review process was conducted, with all assessments reviewed by external experts who had not been involved in the drafting process. The IUCN Red List Unit staff ensured consistency in the application of the categories and criteria. As a result, the final set of Red List assessments represents a product of scientific consensus on species extinction risk, supported by relevant data, literature, and peer review.

The Emerald Gudgeon (*Romanogobio skywalkeri*), a species endemic to Austria and described in 2018, is named after the Star Wars character Luke Skywalker. It has been assessed for the first time in this European Red List update and is classified as EN. © Clemens Ratschan

2.4 Species mapping and spatial analyses

Species occurrence records were compiled from published literature, ichthyological specimen collections (both public and private), field surveys by research institutions, and online platforms such as the Global Biodiversity Information Facility (GBIF). All records were checked for accuracy and plausibility, and draft maps were refined through expert review.

Distribution records were mapped using a geographic information system (ESRI ArcMap) to Level 08 or Level 12 HydroBASINS units (Lehner & Grill, 2013), depending on the spatial extent of each species' range. For marine species, distributions were standardised using a coastal basemap defined by a maximum depth of 200 m and a 100 km buffer from the shoreline. While this approach may overestimate the range of species restricted to very shallow waters and underestimate those occurring at greater depths, it provides a consistent representation of most coastal distributions (Comeros-Raynal et al., 2012).

Metadata coding was applied to distinguish between 'presence', 'origin', and 'seasonality' across the species' distribution range. These codes allow differentiation of:

- The species' presence (options include 'extant', 'possibly extant', and 'extinct').
- The seasonal presence of the species at the location (with 'resident' being the default setting).
- The origin of the species (options include 'native', 'introduced', 'reintroduced', or 'origin uncertain').

Full coding details are available in the most recent version of the *Mapping Standards and Data Quality for IUCN Red List Spatial Data* (IUCN, 2024a).

Spatial data on protected area boundaries were sourced from the World Database on Protected Areas (WDPA), the most comprehensive global repository for marine, terrestrial, and inland water protected areas (UNEP-WCMC and IUCN, 2024). Boundaries for Natura 2000 sites were obtained from the EEA Datahub (EEA, 2024c). All data were first clipped to the extent of the European Red List assessment and then intersected with each species' final range map to determine occurrences within protected and conserved areas.

For the spatial analyses, species distributions with the following presence, origin, and seasonality codes were included: presence = extant, possibly extinct; origin = native, reintroduced, assisted colonisation; and all seasonality codes (resident, breeding season, non-breeding, passage, seasonal occurrence uncertain).

Species richness patterns were mapped by totalling the number of species in each HydroBASIN. Endemic species richness patterns were mapped by summing the number of species in each HydroBASIN flagged as endemic to the European region, as defined in this project. Threatened species (categories CR, EN, and VU) richness patterns were mapped by counting the number of threatened species in each HydroBASIN. Data from the Global Runoff Data Centre (GRDC, 2020) were also incorporated to support visualisation of species richness across major river basins.

2.5 Threatened species reporting

The proportion of threatened species within a given group cannot be reported precisely because the threat status of DD species is unknown. As a result, threat levels are calculated as an estimated mid-point, along with a range defined by a lower bound and an upper bound (IUCN, 2022a). These bounds are defined as follows:

- **Lower bound**: percentage of threatened species among all species assessed, i.e., number of threatened species divided by the total number of species assessed [(EW+CR+EN+VU) / (assessed - EX)]. This corresponds to the assumption that none of the DD species are threatened.
- **Mid-point**: percentage of threatened species among those for which threat status could be determined, i.e., number of threatened species divided by the number of data sufficient (non-DD) species [(EW+CR+EN+VU) / (assessed - EX - DD)]. This corresponds to the assumption that DD species have the same fraction of threatened species as data sufficient species.
- **Upper bound**: percentage of threatened or DD species among those assessed, i.e., number of threatened species plus DD species, divided by the total number of species assessed [(EW+CR+EN+VU+DD) / (assessed - EX)]. This corresponds to the assumption that all the DD species are threatened.

These bounds provide a range for the possible threat levels within a group of species, depending on the assumptions made regarding the status of DD taxa. In this report, the mid-point figure is considered the most reliable estimate of extinction risk, as it focuses on extant species for which sufficient data are available, offering a more accurate overview of current conservation status (IUCN, 2022a).

Note that EX species are excluded from all calculations of the proportion of species threatened, as they are no longer considered in the context of threat assessment. However, EW species are included in the threatened categories, because following a successful reintroduction, an EW species would be downlisted to a threatened category, reflecting its recovery and reduced risk of extinction. Similarly, RE species are also included in the threatened categories, as they remain extant elsewhere in the world and could be downlisted following successful reintroduction or recolonisation in the region.

3 Assessment results and discussion

3.1 Overview

3.1.1 Red List status of European freshwater fishes

At the European regional level, the best available estimate indicates that 42.1% of native freshwater fish species are classified as threatened. Details of the methodology used to derive this estimate are provided in Section 2.5. Among extant taxa - that is, excluding species assessed as Extinct (EX), Extinct in the Wild (EW) or Regionally Extinct (RE) - 8.6% (46 species) are assessed as CR, 18.8% (101 species) as EN, and 14.0% (75 species) as VU (see Figure 3a). A further 17.5% (94 species) are considered NT, meaning that almost two-thirds (58.9%) of Europe's extant fish fauna is of elevated conservation concern, either being threatened or NT.

By comparison, within the EU-27 region an estimated 41.4% of native freshwater fish species are threatened. Of extant taxa, 9.9% (41 species) of extant taxa CR, 19.5% (81 species) EN, and 11.5% (48 species) VU (see Figure 3b). A further 17.8% (74 species) are NT. Consequently, almost two-thirds (58.7%) of freshwater fish species in the EU-27 are of elevated conservation concern.

Compared to the 2011 European Red List, there have been pronounced shifts in the distribution of species across Red List categories (see Section 3.1.2 for further details). Overall, the proportion of threatened species among all assessed taxa in the European region has increased by 5.1% (from 37% to 42.1%). Within the threatened categories, the proportion of species classified as CR has decreased by 3.4% (from 12% to 8.6%), while the proportion assessed as EN species has increased markedly by 8.9% (from 9.9% to 18.8%). The proportion of VU species has declined slightly by 1.1% (from 15.1% to 14.0%). Notably, the proportion of NT species in Europe has risen substantially by 13.3% (from 4.2% to 17.5%).

At the EU-27 level, broadly similar trends are observed. In particular, the proportion of threatened species has increased by 2.4% (from 39.0% to 41.4%), while the proportion of NT species has risen sharply by 13.6% (from 4.2% to 17.8%).

A total of 20 species recorded in the European region are currently classified as EX (since the year 1500), including 13 species native to the EU-27 region (see Table 3). Additionally, the Aral Barbel (*Luciobarbus brachycephalus*) is RE in Europe, while Racovitza's Rudd (*Scardinius racovitzai*) is EW. At the EU-27 level, two species are EW: Racovitza's Rudd and the Ship Sturgeon (*Acipenser nudiventris*).

Among the EX taxa, the Thracian Shad (*Alosa vistonica*), Volga Shad (*Alosa volgensis*), Jándula Chub (*Squalius palaciosi*), Chiem Whitefish (*Coregonus hoferi*), Starnberg Whitefish (*Coregonus renke*), Ören Whitefish (*Coregonus trybomi*), Zug Whitefish (*Coregonus zugensis*), May Trout (*Salmo schiefermuelleri*), and Orkney Charr (*Salvelinus inframundus*) have all been confirmed as EX, having formerly been assessed as CR or DD. While it is believed that all of these species were already EX at the time of their earlier assessments, Racovitza's Rudd became EW during 2014, making it the only European freshwater fish species to be extirpated from the wild since the previous Red List assessment (see Box 4).

Table 3. *Globally Extinct (EX) and Extinct in the Wild (EW) European freshwater fish species at the regional and EU-27 levels, arranged alphabetically by family.*

Family	Species	Red List Category	
		Europe	EU-27
Acipenseridae	*Acipenser nudiventris*	CR	EW
Clupeidae	*Alosa vistonica*	EX	EX
Clupeidae	*Alosa volgensis*	EX	-
Gasterosteidae	*Gasterosteus crenobiontus*	EX	EX
Cyprinidae	*Luciobarbus brachycephalus*	RE	-
Leuciscidae	*Alburnus danubicus*	EX	EX
Leuciscidae	*Chondrostoma scodrense*	EX	-
Leuciscidae	*Scardinius racovitzai*	EW	EW
Leuciscidae	*Squalius palaciosi*	EX	EX
Salmonidae	*Coregonus bezola*	EX	EX
Salmonidae	*Coregonus fera*	EX	EX
Salmonidae	*Coregonus gutturosus*	EX	EX
Salmonidae	*Coregonus hiemalis*	EX	EX
Salmonidae	*Coregonus hoferi*	EX	EX
Salmonidae	*Coregonus obliterus*	EX	-
Salmonidae	*Coregonus oxyrinchus*	EX	EX
Salmonidae	*Coregonus renke*	EX	EX
Salmonidae	*Coregonus restrictus*	EX	-
Salmonidae	*Coregonus trybomi*	EX	EX
Salmonidae	*Coregonus zugensis*	EX	-
Salmonidae	*Salmo schiefermuelleri*	EX	EX
Salmonidae	*Salvelinus inframundus*	EX	-
Salmonidae	*Salvelinus neocomensis*	EX	-

Note: Blank entries indicate that the species does not occur within the specified region.

New field data has also led to the reassessment of three species previously classified as EX: the Danube Delta Gudgeon (*Romanogobio antipai*), Cetina Dace (*Telestes ukliva*), and Constance Deepwater Charr (*Salvelinus profundus*), with the former now categorised as VU and the latter two as EN. Similarly, the Caspian Inconnu (*Stenodus leucichthys*), formerly assessed as EW, is now classified as NT. Another three species are CR (Possibly Extinct): the Epirus Minnow (*Pelasgus epiroticus*), Ammer Whitefish (*Coregonus bavaricus*), and Struga Trout (*Salmo balcanicus*). The Atlantic Sturgeon (*Acipenser oxyrinchus*) is CR (Possibly Extinct in the Wild).

Approximately three-quarters of Europe's freshwater fishes (422 species) are endemic to the region. Of these, nearly three-quarters (285 species) are assessed as threatened or NT and are of elevated conservation concern. In the EU-27, fewer than half (177 species) of freshwater fish species are endemic, but more than three-quarters (146 species) of these are of elevated conservation concern.

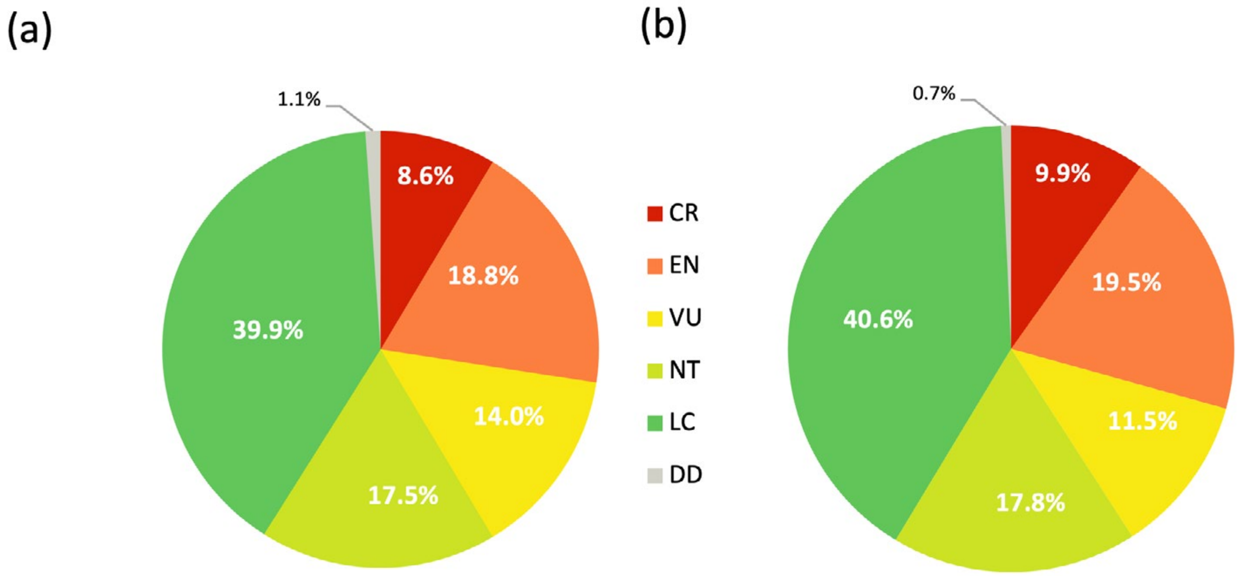


Figure 3. *Proportion of extant freshwater fish species in each Red List category: (a) in Europe and (b) in the EU-27 Member States. Species assessed as EX, EW, or RE are excluded.*

Box 4. Racovitza's Rudd: recently Extinct in the Wild

This species was endemic to a single location: a small lake fed by a geothermal spring in northwestern Romania. The area is protected and has been included in the EU's Natura 2000 network since 2007. Its wild population was declared extinct in September 2014 when the lake dried up, following a long-term decline in habitat quality primarily caused by the extraction of thermal groundwater for recreational tourism. The introduction of non-native fishes and aquatic plants may have also played a role in its extinction.

The lake was home to two other endemic taxa: the aquatic snail *Microcolpia parreyssii*, which became globally extinct in the mid-2010s, and the water lily subspecies *Nymphaea lotus* var. *thermalis*, small numbers of which still survive in the nearby Peța River.

As of 2024, captive colonies of Racovitza's Rudd were preserved at facilities in Romania, Hungary, and Austria, with the goal of restoring its habitat to enable reintroduction (Ford, 2024a).

A. A captive colony of Racovitza's Rudd (*Scardinius racovitzai*) in Oradea, Romania, and the species' habitat in B. 2014, C. 2021, and D. 2022, respectively. © Peter Lengyel /Andrei Togor'

3.1.2 European freshwater fishes with changing Red List categories

Since the previous assessment in 2011, a total of 224 species have experienced a change in their Red List status at the European level, excluding those previously assessed as NA or moving from CR to CR(PE) (see Appendix 3). Of these, more than half (129 species) shifted by one category, with the remainder changing by two or more. Overall, 113 species are now uplisted to a higher extinction-risk category, with eight of these changes resulting from genuine population declines. For example, fisheries data indicate that the Three Lakes Whitefish (*Coregonus palaea*) has undergone a genuine decline in lakes Neuchâtel and Biel, Switzerland - the last two remaining extant subpopulations - leading to its uplisting from LC to EN (Ford, 2024b).

On the other hand, 84 species have been downlisted to lower Red List categories. In most cases, however, this does not reflect an actual improvement in extinction risk, as around 95% of the 224 species were reclassified due to non-genuine factors, such as previous over- or underestimation of their geographic range or population trends, or being transferred from DD to another category. An example is the Dalmatian Minnow (*Phoxinellus dalmaticus*), where the use of an updated extent of occurrence value has led to its status being revised from CR to EN (Ford, 2024c).

Non-genuine category changes are also driven by improved scientific understanding, often stemming from advances in research methodologies. For instance, molecular studies have demonstrated that the Almiri Killifish (*Aphanius almiriensis*) is far more widely distributed across the Aegean Sea basin than previously thought. Originally believed to be confined to just two sites in Greece, it is now known to occur at multiple locations, including one in southern Italy - though its native status there remains unconfirmed. As a result of this expanded range, the species has been downlisted from CR to LC, despite evidence of an overall population decline (Freyhof & Ford, 2024).

Only three of the changes in Red List category reflect a genuine improvement in extinction risk status, of which two are attributed to targeted conservation actions. Despite doubts about its taxonomic validity, Lonsdale's Charr (*Salvelinus lonsdalii*) has been downlisted from CR to VU, as there is no longer evidence of ongoing population decline, thanks to management actions implemented since the 1990s. This underscores the importance of maintaining such efforts over the long term, until the threats to the species are eradicated or sufficiently reduced, ensuring their populations no longer depend on conservation interventions (Ford, 2024d).

However, efforts are still needed for the Pearlfish (*Rutilus meidingeri*), which has been downlisted from VU to NT. While the species has benefited from habitat improvement and stocking with captive-bred individuals, which have helped to slow its population decline, many of the underlying pressures remain and ongoing conservation management is essential (Ford, 2024e).

In the case of the Caspian Lamprey (*Caspiomyzon wagneri*), the rate of population reduction has slowed to the point where it no longer meets the criteria for being classified as NT, and it is now assessed as LC. However, this follows a sharp decline during the mid-to-late 20th century, and there is no indication that its abundance is recovering to previous levels (Freyhof, 2024).

Box 5. Species with notable change in their European Red List status

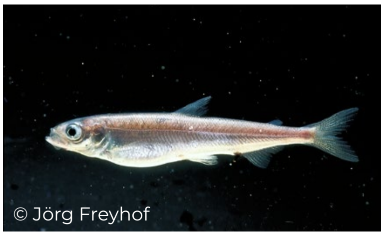
Allis Shad *Alosa alosa* LC ▶ CR

This anadromous species has undergone a marked decline since the mid-20th century, including an estimated 80% reduction over the past 20 years, with some subpopulations already extinct. It continues to spawn in at least 30 rivers but remains abundant only in the French Atlantic basin, where numbers have fallen sharply since the early 2000s. The timing of this decline indicates that the observed change in its Red List category is non-genuine. Although conservation measures have led to partial recovery in some countries, ongoing threats persist, and there is no evidence that the overall trend has been arrested (Ford, 2024f).

Lez Sculpin *Cottus petiti* VU ▶ CR

A change in the Red List category for this small, benthic species does not reflect a genuine shift in its status, but rather results from a more precise assessment of its extremely restricted range, which is confined to a single, small site in southern France. The species depends on clean, stony substrates for successful reproduction; however, these are increasingly degraded by organic pollution. Its habitat lies within a Site of Community Importance designated under the Natura 2000 network, and management measures are currently in place (Ford, 2024g).

Stechlin Cisco *Coregonus fontanae* LC ▶ CR



This species is endemic to the oligotrophic Lake Stechlin in northeastern Germany, where its population has almost certainly declined since around 2010 as a result of eutrophication and warming of the lake due to climate change, representing a genuine change in its Red List status. These pressures are reducing the cold, oxygen-rich deepwater habitats on which it depends and are diminishing its ecological separation from the sympatric European Cisco (*Coregonus albula*), potentially increasing the risk of hybridisation. The lake is legally protected, and management measures are currently under consideration (Ford, 2024h).

Skadar Gudgeon *Gobio skadarensis* EN ▶ LC

This non-genuine change reflects improved knowledge of the species' geographic range. Once believed to be restricted to two tributaries of Lake Skadar in Montenegro, it is now recognised to have a broader distribution stretching southward to Albania and Greece. Despite some localised declines in abundance over the past decade, the species no longer qualifies for listing in any threatened category at the European regional level. However, it is classified as VU within the EU-27 (Ford, 2024i).

Italian Roach *Rutilus pigus* LC ▶ VU

A non-genuine change in Red List category for this species, which is endemic to rivers of the northern Adriatic Sea basin, has resulted from updated information on threats - particularly the scale of hybridisation with the introduced and non-native Common Roach (*Rutilus rutilus*). In certain areas, such as Lake Maggiore within the Po River system, the Common Roach has become one of the most abundant fishes, increasing concerns over genetic integrity and competition (Ford, 2024j).

3.2 Population trends of European freshwater fishes

Excluding species assessed as EX, EW, or RE, 74.6% (400 species) of European freshwater fishes currently have an unknown population trend (see Figure 4). Of the remainder, 20.3% (109 species) are believed to have decreasing populations, 4.7% (25 species) are considered stable, and fewer than 1% (two species) are showing an increasing trend. Further discussion of this significant shortfall in demographic data is provided in Section 3.7.

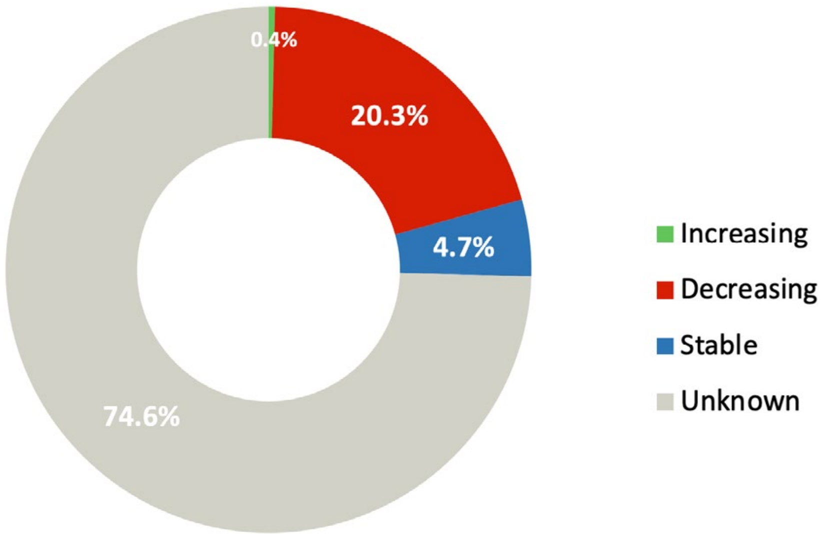


Figure 4. *Population trends of European freshwater fish species at the regional level. Species assessed as EX, EW, or RE are excluded.*

3.3 Status and trends of European freshwater fishes by taxonomic and functional group

Of the 29 families of European freshwater fishes, 19 (65.5%) include at least one species classified as threatened, with an additional three families containing species assessed as NT (see Figure 5). As a result, 22 families (75.9%) are represented by species of elevated conservation concern.

The proportion of threatened species varies considerably across families. All sturgeons (Acipenseridae) and European toothcarps (Valenciidae) are classified as threatened, as are the monospecific freshwater eel (Anguillidae) and mudminnow (Umbridae) families. Among more species-rich families, salmons, trouts, and whitefishes (Salmonidae) are the only group in which more than half of the species are threatened.

Approximately 40-50% of species within the true loaches (Cobitidae), true minnows (Leuciscidae), stone loaches (Nemacheilidae), freshwater blennies (Blenniidae), and sheatfishes (Siluridae) are also considered threatened. The Leuciscidae and Salmonidae - Europe's most species-rich freshwater fish families - account for the highest absolute numbers of threatened species, with 75 leuciscids and 74 salmonids assessed as threatened.

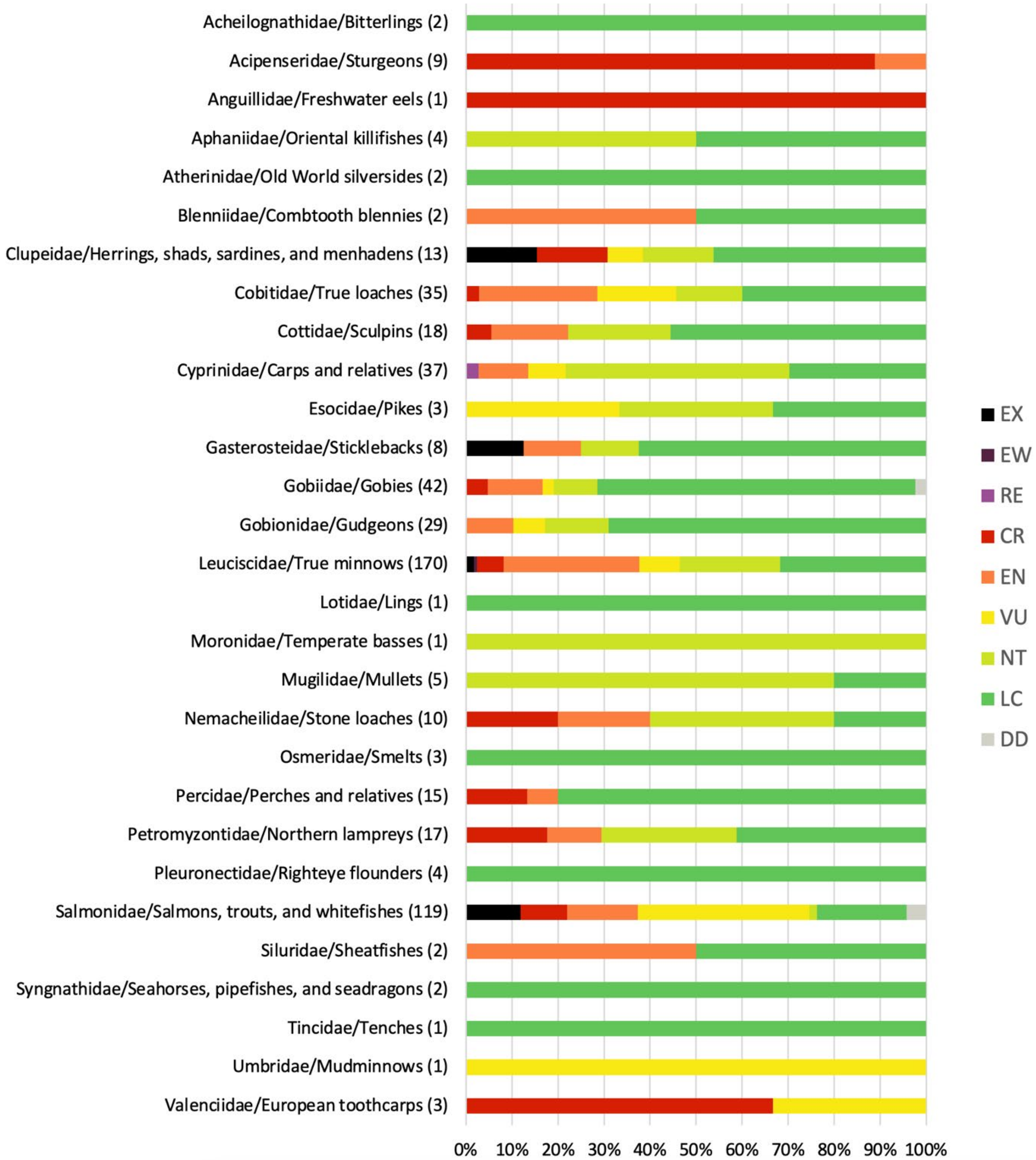


Figure 5. *Red List status of European freshwater fishes at the regional level, presented as the percentage of total species per family in each Red List category. Families are listed alphabetically by their scientific names. Numbers in brackets indicate the total number of species assessed per family.*

In addition, a relatively higher proportion of declining population trends are observed among migratory freshwater fishes (38.8%) compared to non-migratory species (14.3%) (see Figure 6).

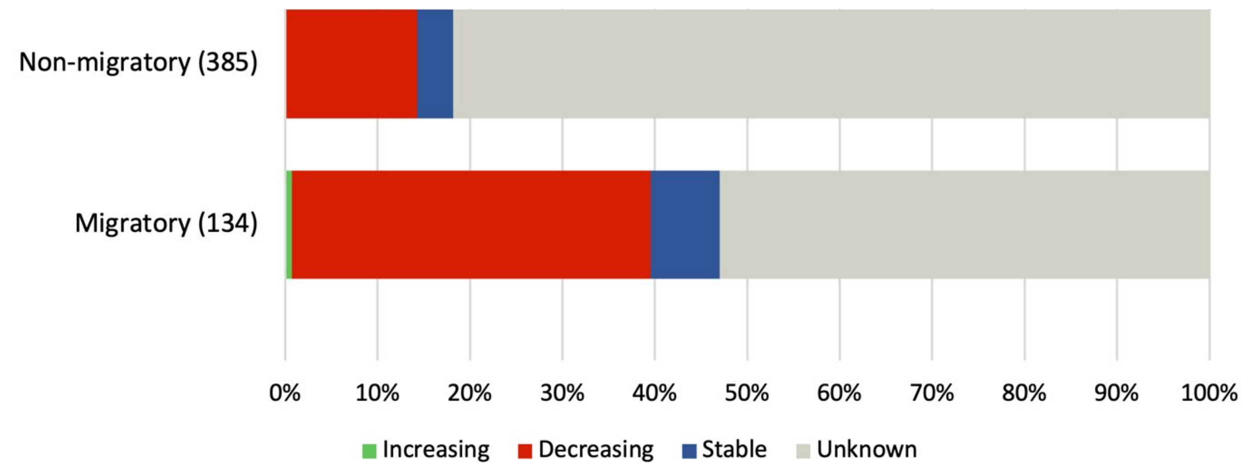


Figure 6. *Population trends of European freshwater fishes by migratory behaviour, including both diadromous and potamodromous taxa. Species assessed as EX, EW, or RE are excluded. Numbers in brackets indicate the total number of species assessed per group.*

3.4 Status and trends of European freshwater fishes by habitat type

A comparison of key freshwater fish habitat types across Europe - specifically those deemed 'suitable' for more than ten species in the current Red List assessment - shows that karst and other subterranean hydrological systems (90.9%), freshwater springs and oases (54.0%), and seasonal or intermittent rivers, streams and creeks (53.7%) support the highest proportions of threatened species (see Figure 7). When NT species are included, the proportions of freshwater fish of elevated conservation concern in these habitats increase to 100%, 82.1%, and 82.0%, respectively.

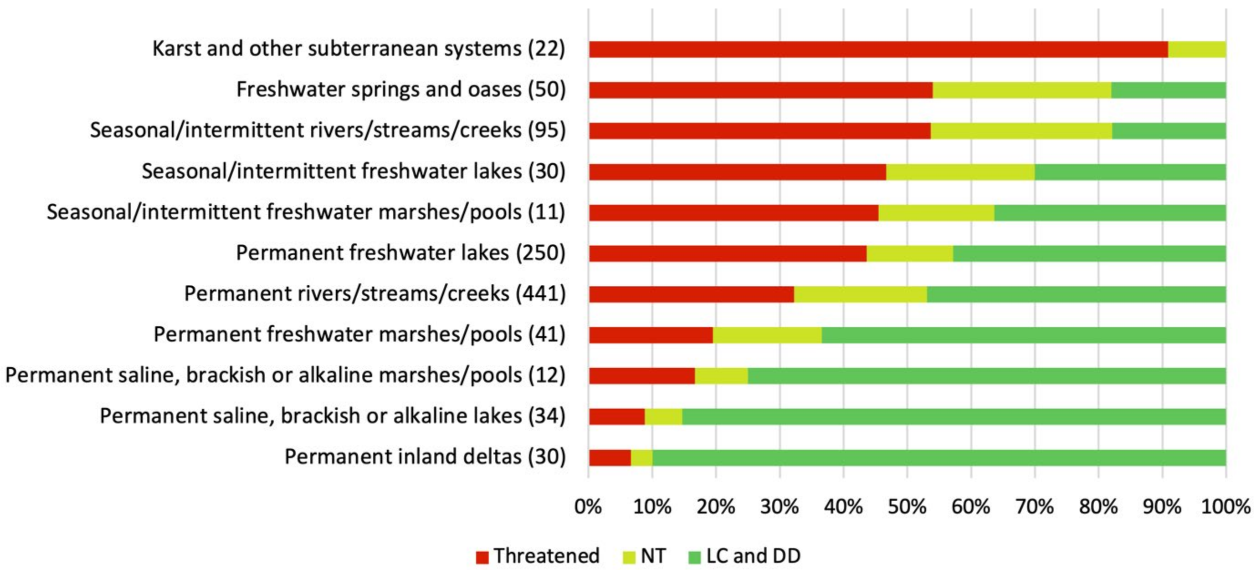


Figure 7. *Red List status of European freshwater fish species across major habitat types at the regional level, arranged in descending order by the proportion of threatened (those assessed as CR, EN, and VU) species within each habitat type. Species assessed as EX, EW, or RE are excluded. Numbers in brackets indicate the total number of species assessed per habitat type.*

The LC Wels Catfish (*Silurus glanis*) is both native and invasive in Europe. © Metalimnion

A similar pattern emerges when examining the distribution of population trends among freshwater fish species across habitat types (see Figure 8). The highest proportion of declining trends (32.6%) is observed among species associated with seasonal, intermittent, or irregular rivers, streams, and creeks. Strikingly, in these systems - as well as in seasonal or intermittent marshes, pools, and freshwater lakes; freshwater springs and oases; and karst or other subterranean hydrological systems - every species for which a population trend is known is reported to be in decline. For the remaining species linked to these habitats, population trends are currently unknown.

It is important to interpret these figures with caution, as population trends could be confidently assessed for only a small number of species in some habitat types. For example, just 3 out of 22 species linked to karst and subterranean hydrological systems had sufficient data to determine a trend.

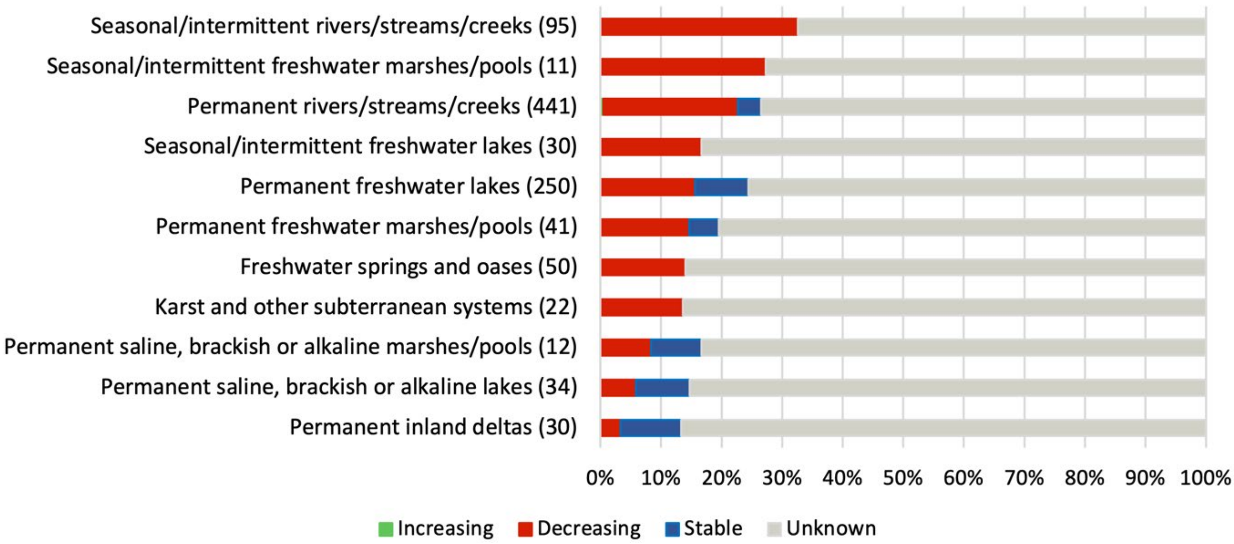


Figure 8. *Population trends of European freshwater fishes across major habitat types at the regional level, arranged in descending order by the proportion of species exhibiting a declining trend. Numbers in brackets indicate the total number of species assessed per habitat type. Species assessed as EX, EW, or RE are excluded.*

3.5 Spatial patterns of European freshwater fishes

3.5.1 Species richness

The geographic distribution of freshwater fish species richness in Europe, based on the results of this Red List assessment, is illustrated in Figure 9. Taxonomic changes accepted since the previous European Red List assessment have not significantly altered the overall pattern (see Section 2.2).

There is a clear gradient of increasing species richness from north to south, with the glacial refugia of the Ponto-Caspian region and the western Balkan Peninsula serving as prominent centres of diversity. Species richness gradually diminishes towards the west and north of Europe, as well as in the south along the Mediterranean coastlines and within the Iberian and Apennine Peninsulas, reflecting the biogeographic isolation of these southern regions. This outcome aligns with established evidence, indicating that the previously glaciated areas of Europe were recolonised in a north-westerly direction during the interglacial and post-glacial periods. This dispersal largely originated from the Ponto-Caspian region, with particular emphasis on the middle and lower reaches of the Danube River basin (Griffiths, 2006; Reyjol et al., 2007).

Rivers of the western Balkan Peninsula are renowned for their abundance of endemic species (see Section 3.5.2), while the heat map also highlights considerable species richness in right-bank tributaries of the Danube that originate in the eastern Alps.

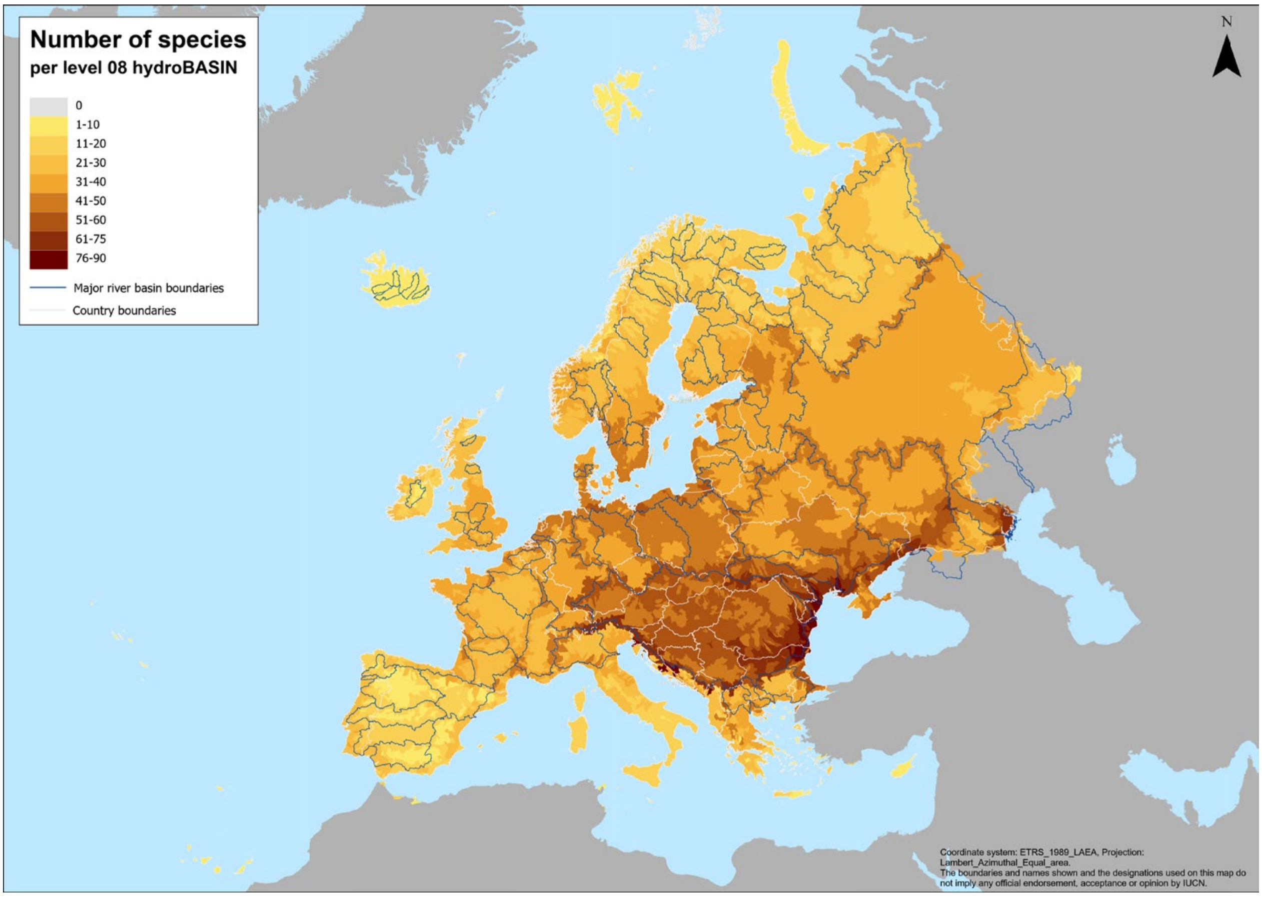


Figure 9. *Species richness of European freshwater fishes per level 08 HydroBASIN.*

3.5.2 Endemic species distribution

Figure 10 illustrates the geographic distribution of regionally endemic freshwater fish species in Europe. As more than three-quarters of European freshwater fish species are endemic to the region, the observed pattern somewhat reflects overall species richness. In the Alps, species numbers are bolstered by endemics confined to specific subalpine lake basins, alongside fluvial taxa inhabiting Danube tributaries. In contrast, the lakes and rivers of the Balkan Peninsula west of the Dinarides and Hellenides mountain ranges have likely remained isolated since the Miocene. This long-term isolation has contributed to a high level of endemism, potentially further enhanced by faunal exchange during the Last Glacial Maximum, when the northern Adriatic Sea dried out (Oikonomou et al., 2014; Skoulikidis et al., 2022).

It is also important to note that, although the number of endemic species in the Iberian and Apennine Peninsulas is comparatively low, both regions served as glacial refugia and were not naturally colonised by most species occurring north of the Pyrenees and Alps. As a result, despite relatively low species diversity, levels of endemism in these areas are in fact very high (Doadrio et al., 2011; Bianco, 2014).

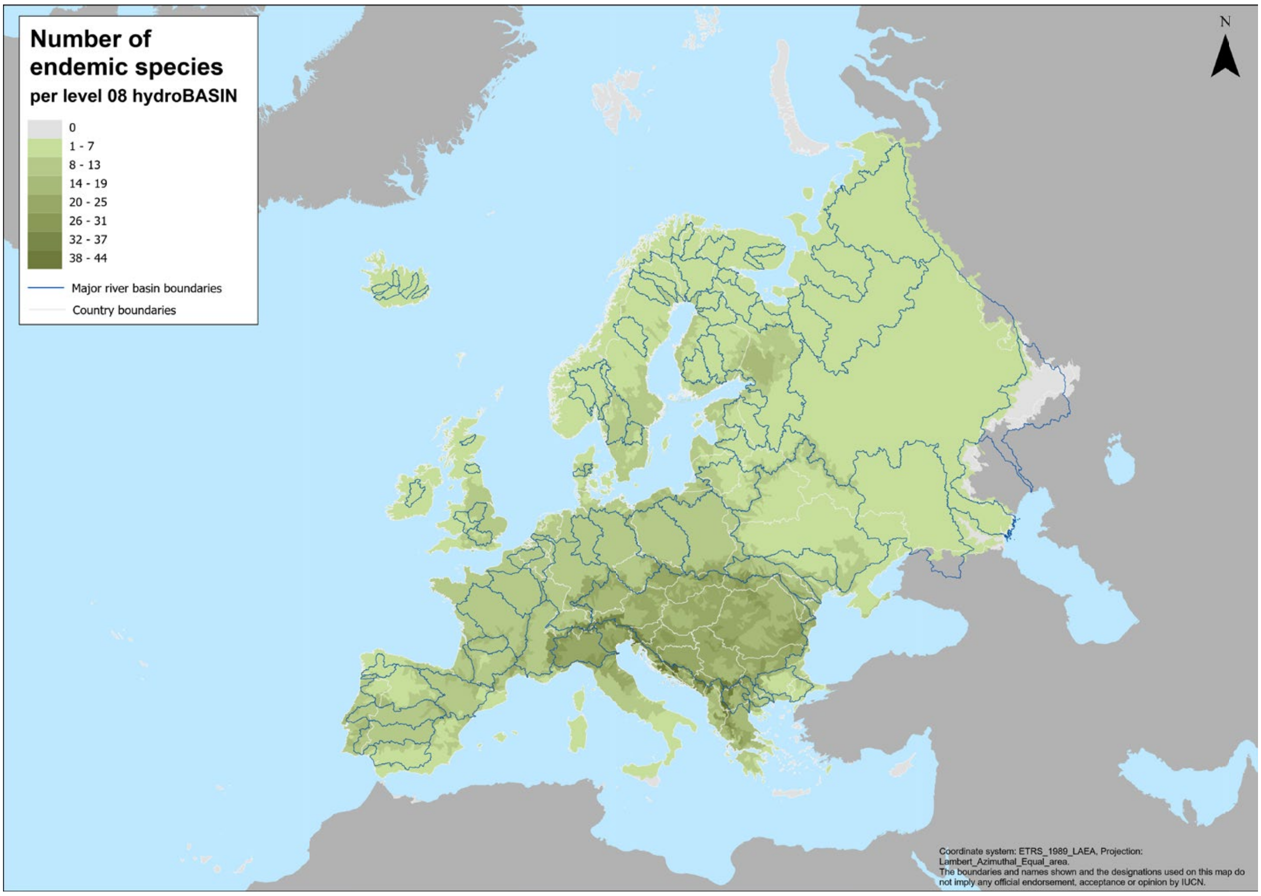


Figure 10. *Species richness of endemic European freshwater fishes per level 08 HydroBASIN.*

3.5.3 Threatened species distribution

The geographic distribution of threatened freshwater fish species in Europe is presented in Figure 11. The highest concentrations of threatened species are found towards the south of the continent, including parts of the Douro and Tagus river systems in the Iberian Peninsula, a series of rivers draining into the Adriatic Sea from the Apennine and Balkan peninsulas (Italy, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro), the ancient Ohrid and Prespa lake basins (Albania, North Macedonia, Greece), the Achelous River system and associated water bodies (Greece), the lower Danube River (Serbia, Romania, Bulgaria, Moldova, Ukraine), the southeastern extremity of the Crimean Peninsula, and parts of the lower Don and Volga river systems (Russian Federation). An important caveat to this pattern is that, although the overall number of threatened species is somewhat low in parts of the Iberian, Apennine, and Balkan peninsulas, the proportion of threatened species within specific freshwater fish communities is often very high in these areas, where many endemic taxa have narrow geographic ranges or small population sizes (Smith & Darwall, 2006; Clavero et al., 2010; Costa et al., 2021).

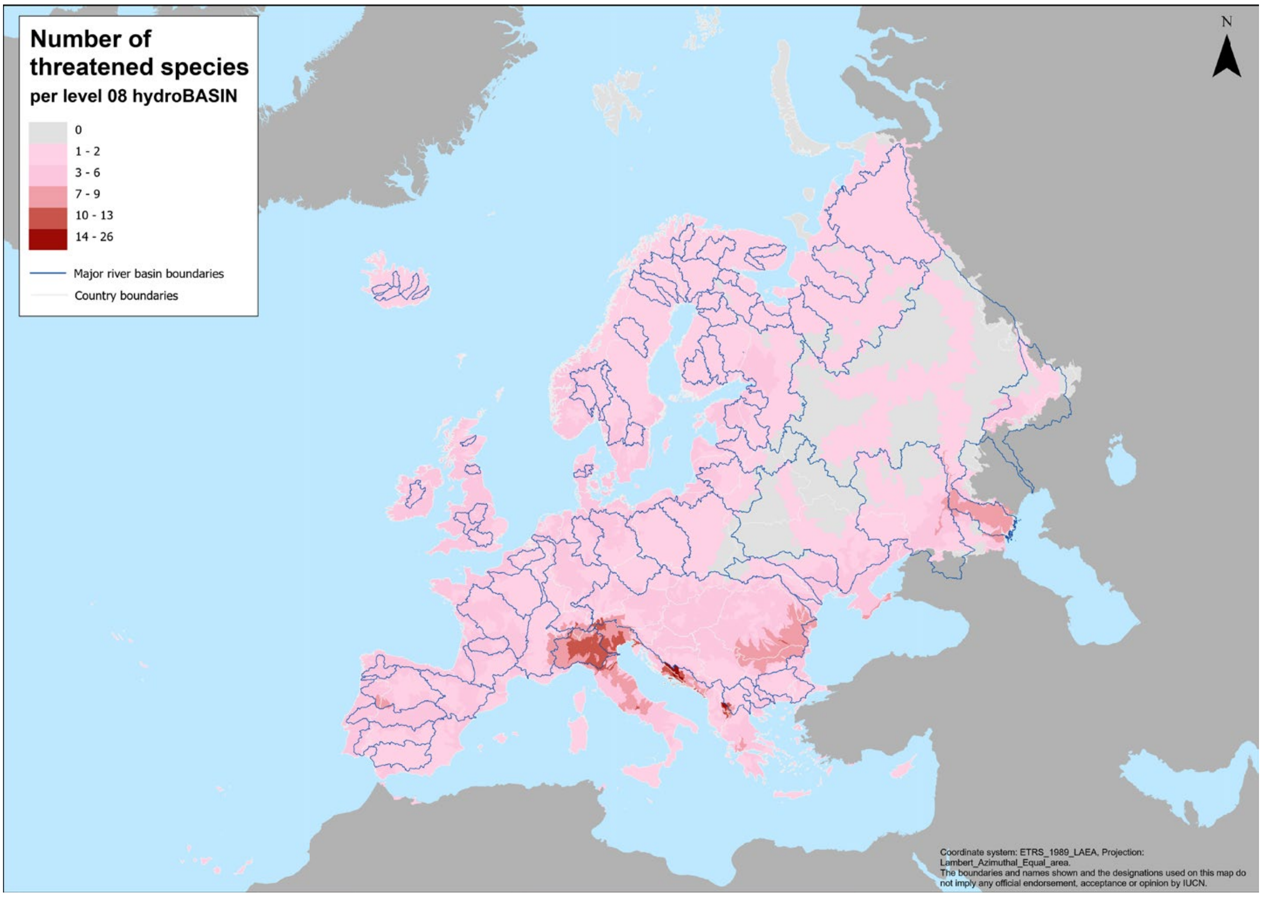


Figure 11. *Species richness of threatened European freshwater fishes per level 08 HydroBASIN.*

3.5.4 Protected and conserved area coverage

The geographic distribution of freshwater fish species richness in Europe in relation to recognised protected and conserved areas is mapped in Figure 12, and the proportion of European freshwater fish species - excluding those assessed as EX, EW, and DD - occurring within such areas is summarised in Figure 13.

They include global designations such as Ramsar Sites and UNESCO Biosphere Reserves; regional frameworks such as Natura 2000 (comprising 27,165 sites) and the Emerald Network; as well as National Parks, other nationally designated areas, and other effective area-based conservation measures.

Importantly, most of these areas were established based on criteria unrelated to freshwater fish conservation, instead prioritising the protection of specific habitat types or other taxonomic groups, such as mammals, birds, or plants. These priorities tend to be reflected in their management approaches (Hermoso et al., 2015; Szabolcs et al., 2022).

See Section 4 for further discussion on protected areas and the conservation of freshwater fishes in Europe.

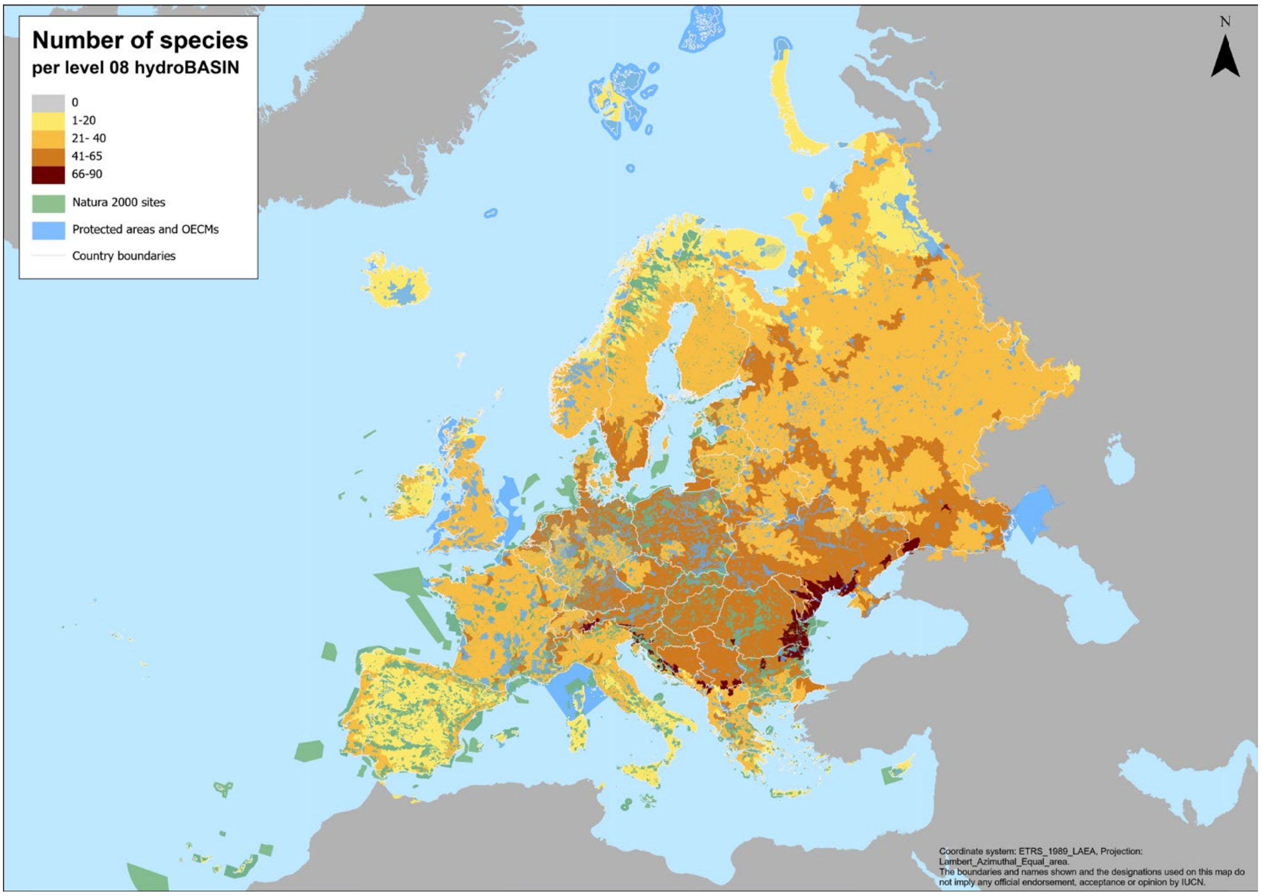


Figure 12. *Species richness of European freshwater fishes, based on the results of this Red List assessment, overlaid with the locations of protected and conserved areas across the region.*

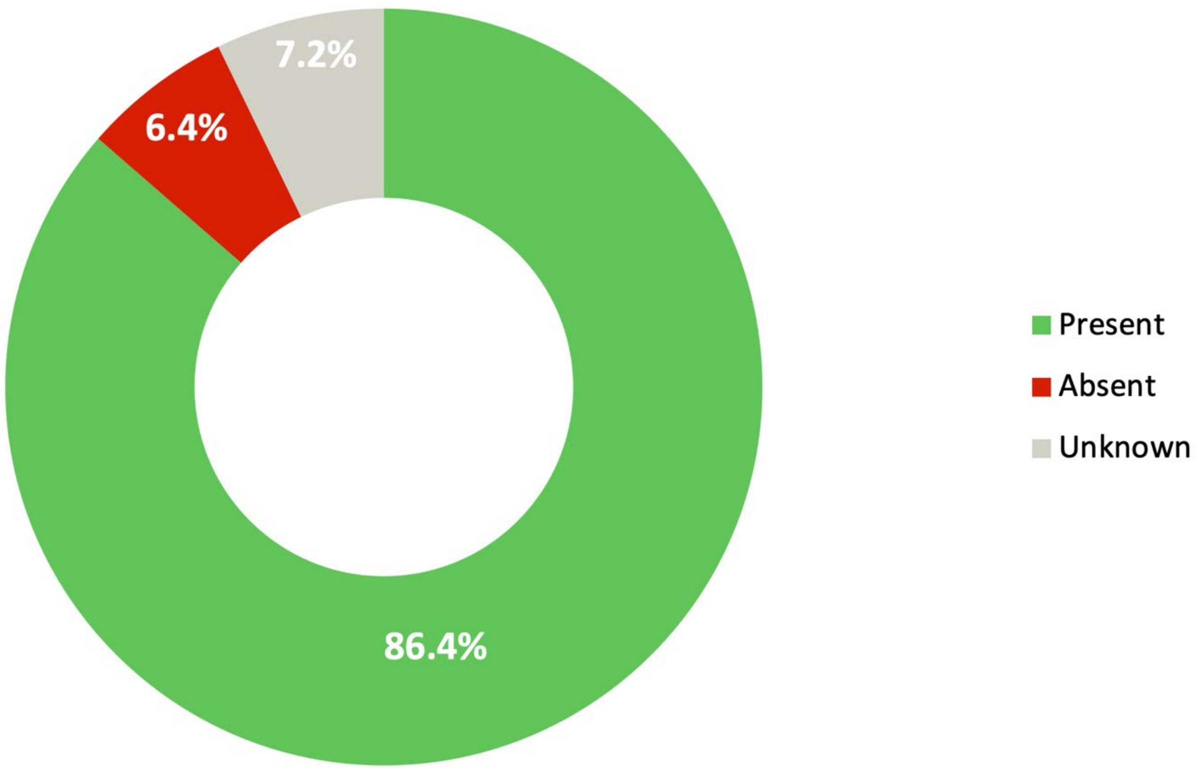


Figure 13. *Occurrence of European freshwater fish species within the boundaries of protected and conserved areas at the regional level. Species assessed as EX, EW, or RE are excluded.*

The CR European Eel (*Anguilla anguilla*) requires free-flowing rivers to complete its catadromous life cycle. It is widely translocated and restocked across Europe for management purposes, although the conservation benefits remain uncertain. © Metalimnion

3.6 Persistent threats to freshwater fishes in Europe

The IUCN Red List assessment process uses a Threats Classification Scheme, within which threat types are organised in a hierarchical structure. The threats listed in this scheme are regarded as direct threats, as they consist of immediate human activities or processes that have affected, are affecting, or may affect the status of the taxon being assessed.

The most persistent threats to European freshwater fishes - defined here as those affecting more than 25 species in this Red List assessment - are summarised in Figure 14. Principal drivers of decline include dams and other natural system modifications, pollution, the introduction of invasive and other problematic species and genes, climate change, and biological resource use. These drivers correspond closely to the key causes of global biodiversity loss identified by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019).

While the detrimental impacts of these pressures on freshwater habitat quality across Europe are well documented, their specific effects on individual species often remain poorly understood due to limited population trend data (see Section 3.2). This is further complicated by the ecological diversity of freshwater fishes and the fact that threats may affect species variably across different life stages. In addition, freshwater ecosystems are frequently subject to multiple, interacting stressors, which may operate in additive, antagonistic, or synergistic ways, thereby increasing uncertainty. Freshwater habitats are also closely linked to their surrounding basins, meaning that changes in the terrestrial environment often directly impact aquatic systems (Schinegger et al., 2016; Birk et al., 2020; Tockner et al., 2022).

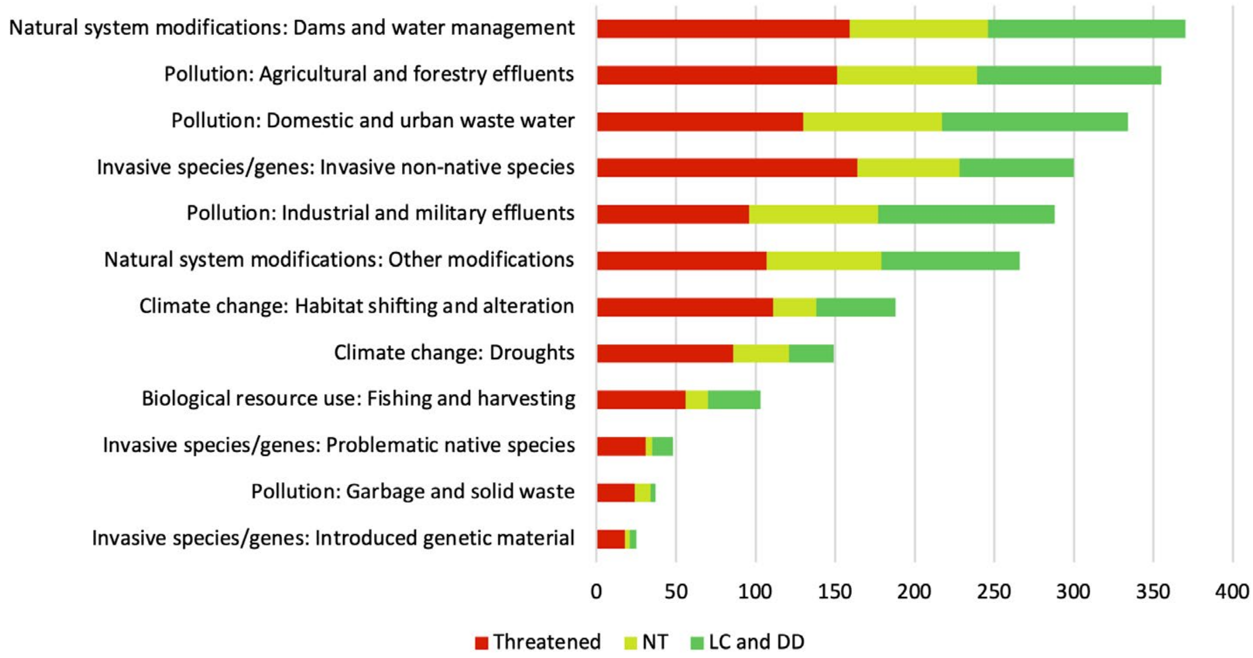


Figure 14. *Persistent threats to European freshwater fishes at the regional level, arranged in descending order by the number of impacted species. Threatened species includes those assessed as CR, EN, and VU. Species assessed as EX, EW, or RE are excluded.*

3.6.1 Natural system modifications

Key IUCN Threat Categories:

7.2 Dams & Water Management/Use -> 370 species/69.0% of European freshwater fishes

7.3 Other Ecosystem Modifications -> 266 species/49.6 % of European freshwater fishes

European freshwater systems are extensively modified and regulated for purposes such as electricity generation, flood control, irrigation, shipping, urban expansion, and water supply. These alterations have led to significant fragmentation by an estimated total of at least 1.2 million dams, barrages, and weirs, restricting the longitudinal and lateral movement of resident fishes and contributing to the widespread regional decline of migratory species, which ranks among the steepest on the planet (Belletti et al., 2020; Deinet et al., 2024).

Natural river stretches have been extensively transformed into artificial lakes, disrupting temporal flow patterns that are crucial for triggering fish life-history behaviours, while reducing the availability of key foraging, spawning, and recruitment habitats. A recent surge in hydropower infrastructure, particularly in the Balkans and Alps, has aggravated these issues. Among larger rivers, only a few Arctic and Fenno-Scandinavian systems remain entirely free-flowing from source to sea (Grill et al., 2019; van Puijenbroek et al., 2019; Tockner et al., 2022).

Water abstraction for agriculture and other human needs also diminishes natural flow regimes, sometimes resulting in the dewatering of downstream river stretches. These challenges are often compounded by channelisation and the physical restrictions imposed by dykes, embankments, and concretised riverbanks or beds, which further reduce flow complexity, eliminate fish habitat diversity and frequently sever vital floodplain connections. Furthermore, around half of Europe's population now resides on former floodplains, resulting in the loss of up to 95% of these areas and 50% of their associated wetlands. Activities such as riparian deforestation, dredging or the commercial extraction of gravel, sand, and other riverine substrates directly remove habitats that are essential for many European freshwater fish species (Aarts et al., 2004; Arthington et al., 2016; Dudgeon, 2019; Tockner et al., 2022).

Dams restrict the lateral and longitudinal movements of riverine fish species, reducing the availability of suitable habitat and disrupting natural flow patterns. Image shows the Talave Dam on the Mundo River, Spain. © Javier Rodríguez / Water Alternatives, CC BY-NC 2.0

3.6.2 Pollution

Key IUCN Threat Categories:

9.1 Domestic & Urban Wastewater -> 334 species/62.3% of European freshwater fishes

9.2 Industrial & Military Effluents -> 288 species/53.7% of European freshwater fishes

9.3 Agricultural & Forestry Effluents -> 355 species/66.2% of European freshwater fishes

In Europe, freshwater fishes are exposed to pollution from a diverse array of sources, many of which are associated with both historical and ongoing land-use changes. These threats range from basin-wide pressures - such as nutrient enrichment - to localised impacts arising from site-specific mixtures of contaminants. Pollution may also involve alterations to the physical characteristics of water bodies, including abrupt temperature fluctuations caused by hydropower releases, and increased siltation linked to agricultural runoff (Grizzetti et al., 2017; Dudgeon, 2019).

Pollution sources can be point-based, such as discharges from factories or water treatment plants, or diffuse, like runoff from agricultural or urban areas. Pollution may comprise both organic and inorganic compounds, including agrochemicals, livestock waste, sewage, industrial effluents, landfill leachate, runoff from roads and impermeable surfaces, and emerging contaminants such as pharmaceuticals, illicit drugs, additives in personal care products, modern pesticides, endocrine disruptors, nanomaterials, and microplastics. The impacts of pollutants on freshwater fish species vary, ranging from direct to indirect and lethal to sub-lethal, with interactions between them often being unpredictable (Dudgeon, 2019; Reid et al., 2019).

The most common types of pollution across Europe differ by location. In Scandinavian rivers, acidifying air pollutants remain a major issue, while in western and central Europe, eutrophication and nitrate deposition are the primary challenges. In southern and eastern Europe, organic matter loads, pesticides, and nitrogen inputs are key concerns (Tockner et al., 2022).

3.6.3 Invasive and other problematic species, genes and diseases

Key IUCN Threat Categories:

8.1 Invasive Non-Native/Alien Species/ Diseases -> 300 species/56.0% of European freshwater fishes

Invasive species, defined as organisms causing ecological or economic harm outside their natural geographic ranges, are widely distributed across Europe. In freshwater systems, they include non-native fishes and other aquatic vertebrates, arthropods, molluscs, and plants, mainly from Asia and North America, as well as European species introduced outside their native ranges. Their abundance and diversity are greatest in Mediterranean Europe, where they sometimes outnumber native taxa (see Box 6). The ongoing spread of invasive species is leading to the homogenisation of many European freshwater fish communities, whereby native species are being progressively replaced (Clavero & García-Berthou, 2006; Sommerwerk et al., 2017; Su et al., 2021).

Some invasive species have been deliberately introduced for aquaculture, inland fisheries, or biological control, and occasionally by aquarium hobbyists releasing individuals into the wild. Unintentional introductions also occur, facilitated by ballast water discharge, artificial canals connecting river basins, bait-bucket releases, and escapes from the ornamental trade or fish farms. These species often establish and spread rapidly, particularly in modified environments such as dammed rivers. In some cases, management actions aimed at reinforcing fisheries have led to the introduction of non-native genetic material (Clavero et al., 2013; Nunes et al., 2015; Arthington et al., 2016; Gandolfi et al., 2017; Berrebi et al., 2022; Zogaris et al., 2023; Arthur, 2025).

The impact of invasive species on European freshwater fishes depends on the traits of the invaders and the characteristics of the receiving ecosystems. These effects can include competition for food or habitat, predation on different life stages, pathogen transmission, the erosion of native gene pools through introgressive hybridisation with closely related species or subpopulations, and detrimental changes to ecosystem functioning or habitat structure (Strayer, 2010; Keller et al., 2011; Bernery et al., 2022).

The ‘Common Carp’, shown here in a German lake, is considered invasive across much of Europe, having first been introduced by the Romans around 2,000 years ago. It is now widely exploited for recreational angling and, in some cases, as a food source. Most introduced subpopulations are of uncertain ancestry, comprising hybrids or genetically altered individuals derived from the Eurasian Carp (*Cyprinus carpio*) - native to the Black, Azov, Caspian and Aral Sea basins, and possibly north-eastern Greece - and various related species from eastern Asia. © Metalimnion

Box 6. Invasive species drive native fish declines in Italy

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Italy, like other Mediterranean peninsulas such as Iberia and the Balkans, harbours numerous endemic freshwater species owing to its complex orography and the legacy of Pleistocene glaciations. The Mediterranean Sea and the Alps form formidable barriers to dispersal from continental Europe, while these peninsulas functioned as refugia for fish populations during glacial periods, promoting species diversification. The natural isolation of freshwater ecosystems, which function as discrete "ecological islands," renders these environments particularly vulnerable. As on true islands, inland aquatic biodiversity faces disproportionate threats (Bianco & Ketmaier, 2015).

Bony fishes and freshwater lampreys are the vertebrate groups most at risk of extinction in Italy. Habitat alterations and biological invasions are the most significant anthropogenic stressors affecting native fish biodiversity, often leading to synergistic effects that amplify their impacts. The checklist of freshwater fish species present in Italy includes 97 alien species, 62 of which are considered established with self-sustaining populations (Lorenzoni et al., 2019).

The interactions between invasive species and the native fish fauna encompass a wide range of mechanisms, including predation, competition for food and reproductive sites, transmission of pathogens or parasites, habitat alterations, and more. The tendency of many fish species to hybridise readily, promoting genetic introgression, is also one of the most frequent mechanisms impacting native fish biodiversity. This phenomenon, traditionally linked to restocking activities for sport fishing, is primarily responsible for the poor conservation status of most Italian native species belonging to the genera *Salmo*, *Thymallus*, and *Esox*. More recently, introgressive hybridisation with alien genomes has also impacted many other taxa, such as species from the genera *Alburnus*, *Barbus* and *Squalius* (Meraner & Gandolfi, 2012; Bianco, 2014; Rossi et al., 2016, 2021; Zaccara et al., 2021; Carosi et al., 2025).

Zoogeography of the Italian peninsula adds complexity to invasion processes: the impacts on Italian endemic species do not necessarily stem from invasive species originating in distant geographical regions but can also arise from native species translocated between different ichthyogeographic districts within the country. For example, the unintentional introduction of *Padogobius bonelli*, a goby endemic to the Padano-Venetian ichthyogeographic district, into the Tyrrhenian basins of central Italy (Tuscany-Latium district), has led to the near extinction of the native *Padogobius nigricans*. The two species compete for trophic resources and breeding areas, with the aggressive behaviour of *P. bonelli* often driving site-scale extinctions of *P. nigricans* (Pompei et al., 2014, 2016). A similar negative interaction is observed between other Italian endemic species, such as *Leucos aula* (Padano-Venetian district) and *Sarmarutilus rubilio* (Tuscany-Latium district), as well as *Alburnus arborella* (Padano-Venetian district) and *Alburnus albidus* (Apulia-Campania district).

The outlook for the future is unfortunately pessimistic. The synergistic effect of climate change and biological invasions presents an additional concern. Climate models predict an intensification of extreme events in the Mediterranean region, a significant reduction in summer flows, and rising temperatures. Native fauna, largely displaced from the main watercourses by invasive species, have sought refuge in headwaters, where isolation has so far limited the spread of invasive species. As a result, the secondary hydrographic network has played a vital role in safeguarding native fish biodiversity. However, these smaller watercourses, characterised by their modest size and often low flows, are now particularly vulnerable to the impacts of climate change. This further diminishes the prospects for the future conservation of the aquatic fauna that rely on these habitats.

Introduction of the Padanian Goby (*Padogobius bonelli*) from other parts of Italy is a major threat to the Arno Goby (*P. nigricans*), assessed as EN and pictured here alongside one of its few remaining habitats. © Davide Bellucci / Riccardo Novaga

3.6.4 Climate change and severe weather

Key IUCN Threat Categories:

11.1 Habitat Shifting & Alteration -> 188 species/35.1% of European freshwater fishes

11.2 Droughts -> 149 species/27.8% of European freshwater fishes

Water stress is already a major concern in Europe, impacting around 20% of the continent's territory annually. Almost half of European freshwater fish species, particularly in the Mediterranean, are identified as vulnerable to human-induced climate change. Rising temperatures, altered rainfall patterns, glacial melt, and increased extreme weather events are expected to further disrupt natural flow, sediment, and thermal regimes while degrading water quality. These changes will drive shifts in species ranges, altering the diversity and composition of freshwater fish communities due to their physiological dependence on local climate and flow conditions (Radinger et al., 2017; Jarić et al., 2019, EEA, 2024d).

Migration to cooler, perennial habitats - either at higher elevations or latitudes - may become essential for some species. Yet the inherently discrete nature of freshwater systems, compounded by land-use change, topography, limited habitat connectivity, and barriers such as dams, severely restricts such movements. Species confined to isolated lakes or springs that cannot disperse through river networks, and cold-water taxa in southern Europe face particular difficulty in tracking suitable conditions. Under the higher warming scenarios projected for the coming century, many European freshwater fishes are unlikely to adapt or relocate rapidly enough to avoid significant range contractions (Comte & Grenouillet, 2013; Filipe et al., 2013; Dudgeon, 2019; Radinger & García-Berthou, 2020).

Climate change is also expected to facilitate the spread of invasive freshwater species into areas where they were previously unable to survive, creating new opportunities for establishment beyond their native ranges - particularly for those favouring warm-water conditions (Walther et al., 2009; Bellard et al., 2018).

3.6.5 Biological resource use

Key IUCN Threat Categories:

5.4 Fishing & harvesting aquatic resources -> 103 species/19.2% of European freshwater fishes

Despite the implementation of management actions across much of the region, inland fisheries - spanning commercial, recreational, and subsistence sectors - continue to threaten more than a fifth of European freshwater fish species. Key contributing factors include overharvesting, habitat and ecosystem alterations, bycatch and release mortality, illegal fishing, destructive practices such as poisoning, the introduction and spread of non-native species, and weak enforcement of regulations (Cooke & Cowx, 2006; Hegediš & Krpo-Ćetković, 2024; Arthur, 2025).

Since the 1980s, commercial inland fisheries in Europe have increasingly been replaced by recreational fisheries. With an estimated 30 million participants across the region annually, recreational catches of freshwater fishes now surpass those of commercial fishing in many countries, making a substantial contribution to total fisheries harvests. While catch-and-release is widely practised in recreational fisheries, fishes are also retained for consumption, particularly in Northern and Eastern Europe. The impact of recreational fishing is often underestimated, even in well-managed systems, due to insufficient reporting on harvest and consumption, the absence of historical baselines, fishery subsidies through hatchery stocking, and the challenge of distinguishing between recreational and subsistence fisheries (Cowx, 2015; Nyboer et al., 2022; Arthur, 2025).

3.7 Gaps in knowledge

Red Lists are dynamic tools that evolve over time as species are reassessed based on new information or changing circumstances. They are designed to promote and support research, monitoring, and conservation efforts at local, regional, and international levels, particularly for species that are threatened, NT, or DD. The process of compiling data for the *European Red List of Freshwater Fishes* has highlighted several knowledge gaps.

Although Europe has a long history of biological data collection and environmental monitoring, there remains significant scope for improving its understanding of freshwater fishes. Across the continent, there are notable geographic, geopolitical, and taxonomic biases in the quality of data available on species distribution and status. Field surveys are often conducted sporadically unless the species in question are part of a specific monitoring or management programme. Furthermore, these efforts tend to prioritise certain species based on existing knowledge or preconceptions, such as their importance to conservation or fisheries (Belle et al., 2019; Radinger et al., 2019).

A key concern is the paucity of demographic data on the population sizes and trends of European freshwater fish species. Throughout the Red List assessment presented here, such data were frequently found to be obsolete, repeatedly reused, or reliant solely on expert opinion. In some cases, the most recent details dated back to the 1990s or early 2000s. As a result, the available data are often too outdated, uncertain, or incomplete to enable a reliable evaluation, leading to the population status of many species being classified as unknown.

On occasion, outdated or poor-quality population data lead to assessments defaulting to a classification of LC. However, with accurate and up-to-date trend data, some of these species might actually qualify as NT or threatened. Alternatively, assessments may be based on suspected population declines of uncertain magnitude, resulting in a range of plausible categories. In such instances, only one category is selected, which may not accurately reflect the true extent of the decline.

The shortfall of population data is emphasised by the fact that, of the 222 freshwater fish species classified as threatened at the European regional level in this assessment, only around 36% (80 species) were evaluated using population-based criteria, with the remainder assessed on geographic range size.

It is important to recognise that monitoring trends in freshwater fish populations poses significant challenges, largely due to the considerable logistical, financial, and temporal resources required to obtain robust data series. In contrast to many terrestrial taxa, fishes cannot readily be surveyed through visual observation, and the scope for citizen science involvement is comparatively limited. Stock assessments based on catch statistics - a common approach in marine systems - are problematic for inland fisheries, where much of the harvest derives from artisanal, recreational, or illegal fishing and is frequently under-reported. Historical declines in freshwater fish stocks are also poorly documented, with catch records rarely disaggregated at the species level. Within the EU-27, monitoring programmes established under the WFD evaluate the status of freshwater fish subpopulations using community-scale ecological indices (e.g. EFI+). These indices draw on information about the abundance, age structure, and composition of fish communities, but they do not directly capture demographic trends. The lack of information may also arise from insufficient cooperation between governments, institutions, and organisations, which can be particularly relevant for species inhabiting transboundary lakes and river systems. In some cases, data may be limited because species inhabit inaccessible locations, such as the profundal zone of deep lakes (Allan et al., 2005; Radinger et al., 2019; Pont et al., 2021; Arthur, 2025).

Compared to the previous European Red List assessment, where 27 species were classified as DD, only six species are assessed as DD in this update (with just three species in the EU-27). Of these, two species - the Dentex Trout (*Salmo* *dentex*) and the Montenegro Trout (*Salmo montenigrinus*) - have a questionable taxonomic status. The remaining four species - the Small-Spine Tadpole-Goby (*Benthophilus mahmudbejovi*), Arctic Whitefish (*Coregonus muksun*), Siberian Taimen (*Hucho taimen*), and Ferox Trout (*Salmo ferox*) - could not be assessed under Red List criteria due to a lack of demographic and/or distributional data. The Azov Shad (*Alosa maeotica*) is classified as DD for the EU-27, as both LC and RE are plausible categories due to the lack of recent sampling.

The population trends of most European freshwater fish species remain unknown. Image shows a Common Bullhead (*Cottus perifretum*), United Kingdom, assessed as LC. © Jack Perks

The Eurasian Tench (*Tinca tinca*) is native to much of Europe and parts of northern, western and central Asia, although the precise limits of its natural range have been obscured by extensive human-mediated translocations over several centuries. It is currently assessed as LC, but localised declines have been reported in several European countries. © Metalimnion

4 Conservation actions

The conservation of freshwater fishes is closely linked to the integrity of their ecosystems, which in turn depends on five Key Ecological Attributes (see Box 7). These attributes are shaped by broader basin and landscape factors, including geology, topography, land cover, land and water use, and climate. While species-specific conservation is valuable in certain contexts (see Section 4.4), ecosystem-level approaches provide broader and more lasting benefits, supporting multiple aspects of freshwater biodiversity while also delivering vital services to people (Maceda-Veiga, 2013; Hermoso et al., 2016; Moberg et al., 2024; Piczak et al., 2024).

As a result of their interconnected and dynamic nature, as well as their interaction with surrounding terrestrial landscapes, freshwater ecosystems require specialised conservation approaches. Their protection and restoration is further complicated by competing water demands across multiple sectors, the transboundary nature of many rivers, lakes, and other wetlands, and adaptations to climate change (Dudgeon et al., 2006; Albert et al., 2021; Moberg et al., 2024).

Historically, freshwater ecosystems have been overlooked in water resource planning and environmental governance, with human needs often prioritised over biodiversity. A persistent misconception is that terrestrial conservation alone is sufficient to safeguard freshwater habitats and species (Tickner et al., 2020; Birnie-Gauvin et al., 2023).

The prevailing view is that addressing these complex issues requires an integrated, basin-scale approach that blends scientific research, local ecological knowledge, inclusive engagement with public and private stakeholders, sustainable resource use, and robust policy frameworks. However, the equitable decision-making advocated by governance models such as IWRM often contrasts with the highly technical, expert-driven tools - such as environmental flow assessments - that increasingly underpin freshwater conservation planning (van Rees et al., 2021).

In the face of these challenges, conservation actions supporting freshwater fishes are being carried out across Europe at various geographic and administrative levels, employing a diverse range of strategies.

4.1 Law and policy

While the international policies outlined in Section 1.2 set common objectives and a shared vision, national legislation ultimately shapes species and habitat protection frameworks. To enhance the conservation and management of transboundary water bodies, several international commissions have been established to coordinate efforts among co-riparian European states. These cover major river systems including the Danube and Rhine, as well as transboundary lakes like Geneva, and have resulted in improved ecological conditions for some native fish species (Wantzen et al., 2022; Sommerwerk et al., 2022; Rogissart et al., 2024).

In the EU, regional policies such as the WFD and its predecessors have played a crucial role in improving freshwater habitat quality over the past 50 years. Key successes include advancements in wastewater treatment and stricter controls on airborne contaminants, resulting in reduced organic pollution and acidification, as well as measurable improvements in freshwater fish habitat quality, particularly in Western Europe. On the other hand, the WFD's goal of achieving good ecological status (or higher) in all EU waters by 2027 - except where exemptions are duly justified - remains largely unfulfilled in most Member States.

Box 7. Key ecological attributes for freshwater ecosystems

The ability of freshwater ecosystems to withstand and recover from natural or human-induced disturbances relies on key ecological attributes (KEAs). If compromised, these attributes also disrupt native fish communities, making them crucial for designing and evaluating conservation actions (Parrish et al., 2003; Higgins et al., 2021; Moberg et al., 2024).

Hydrological regime

The hydrological regime refers to the characteristic patterns of water flow - including quantity, timing, and variability - in lakes, rivers, and other wetlands. It is typically defined by factors such as magnitude, timing, frequency, duration, and rate of change. Many fish species have life histories synchronised with these patterns across various timescales (McIntyre et al., 2016; Moberg et al., 2024). A key dimension of the hydrological regime is the concept of environmental flows (also referred to as ecological flows or e-flows), which specify the quantity and timing of water flows required to maintain ecosystem functions, biodiversity, resilience, ecosystem services, and dependent livelihoods.

The EU's Water Framework Directive promotes the integration of this concept into Member States' River Basin Management Plans (RBMPs), although it remains an emerging field of practice for non-perennial rivers (EC, 2015; Leone et al., 2023).

Connectivity

The natural connectivity of freshwater ecosystems, particularly rivers, is crucial for most fish species to complete their life cycles and supports key processes such as the cycling and transport of nutrients and sediments. Connectivity functions across four dimensions: longitudinally (from source to sea), laterally (between water bodies, floodplains, and riparian zones), vertically (linking groundwater and surface water), and temporally (influencing ecosystem and habitat dynamics over time) (Ward, 1989; Moberg et al., 2024).

Unimpeded connectivity is central to the concept of free-flowing rivers, which is gaining recognition in European environmental policy. Free-flowing rivers are defined as those "where ecosystem functions and services are largely unaffected by changes to fluvial connectivity, allowing unobstructed movement and exchange of water, energy, material, and species within the river system and with surrounding landscapes" (Grill et al., 2019; EC, 2024).

The relatively pristine Valbona River, a tributary in the Drin River system, Albania. © Goran Šafarek

Water Quality

Water quality refers to the physical, chemical, and, in some cases, biological properties of water. Under natural conditions, it is influenced by factors such as the weathering of bedrock minerals, wind-borne deposition of dust and salt, leaching of organic matter from soil, hydrological regime, and certain biological processes. Different freshwater fish species have varying water quality requirements, with some dependent on specific ranges of temperature or dissolved oxygen, for example (Facey et al., 2022; Moberg et al., 2024).

Physical habitat

Physical habitat comprises the resources and structural complexity present at a given location. It is defined by factors like water depth, flow velocity, cover availability, and substrate type, which, in turn, are affected by geology, climate, landform, soils, vegetation, and basin position. Greater habitat diversity or complexity generally supports higher fish species richness by offering more food, space, refuge, and other resources to sustain diverse ecological needs (Smokorowski & Pratt, 2007; Moberg et al., 2024).

Biotic composition

Biotic composition refers to the diversity and abundance of species within an ecosystem. The assemblage of freshwater fishes inhabiting a river reach, lake, spring, or wetland is shaped by biophysical processes at multiple scales, from mountain building and glaciation to local climate and physiographic patterns. These communities are defined by taxonomic richness, species composition, endemism, and adaptive strategies - the behavioural, morphological, and ecological traits evolved for specific habitat niches. As a key indicator of ecosystem health, biotic composition reflects the overall condition of the other four KEAs (Abell et al., 2008; Moberg et al., 2024).

This is mostly due to discrepancies in implementation and management, as EU directives are transposed, applied, and enforced by each Member State individually (Voulvoulis et al., 2017; Haase et al., 2023; EEA, 2024d).

Legislative efforts to improve freshwater habitats have also been introduced in some non-EU countries. For instance, in Switzerland, enhanced wastewater treatment combined with a ban on phosphate-containing detergents has effectively controlled nutrient concentrations in many subalpine lakes that became eutrophic during the 20th century, restoring them to mesotrophic or even oligotrophic conditions. In some cases, these actions have supported the recovery of locally endemic fish species (Alexander & Seehausen, 2021).

Across most European countries, national and local regulations govern inland fisheries to prevent overharvesting and support long-term freshwater fish population sustainability. These regulations define who can fish, as well as when, where, and how fishing is permitted. Common measures include restricting access to certain areas, enforcing closed seasons or fishing bans, setting catch limits and minimum size requirements, and regulating fishing gear type. However, these actions do not always foster broader sustainability goals or resolve stakeholder conflicts, and most recreational fisheries remain unregulated and unmonitored (Cowx, 2015; Arlinghaus et al., 2019; Arthur, 2025).

Additional legal actions at the national or local level may include blanket protection for certain freshwater fish species, requirements for provision of fish passage at hydropower sites, and restrictions on introducing non-native aquatic taxa (Copp et al., 2005; Ćaleta et al., 2015; Dekić et al., 2024).

4.2 Land/water protection and management

Also referred to as area-based conservation, land and water protection involves actions to conserve biodiversity and ecosystem services within defined geographic boundaries, typically guided by specific criteria for designation, management, and governance (Maxwell et al., 2020; Moberg et al., 2024).

Designation ranges from formal international and national mechanisms - such as Ramsar and Natura 2000 sites, national parks, nature reserves, and protected landscape monuments - to informal, community-led initiatives. Multiple approaches may apply to a single site, with some officially recognised as protected areas (PAs) or other effective area-based conservation measures (OECMs), while others operate outside these classifications. Collectively, these sites are referred to as protected and conserved areas (PCAs), for which IUCN maintains a Green List of sites certified against a Global Standard (IUCN & WCPA, 2017; Moberg et al., 2024; UNEP-WCMC & IUCN, 2024).

Management scales vary widely, from large transboundary initiatives - such as the Mura-Drava-Danube Biosphere Reserve, established in 2021 as the world's first spanning five countries and the largest riverine protected area in Europe - to whole-lake ecosystems, small wetlands, and river reaches dedicated to protecting endemic or range-limited fish species. Areas may also be managed as privately-owned conservation sites, including some recreational fishing reserves (Stolton et al., 2014; Moberg et al., 2024; Simić et al., 2024).

Governance structures are equally diverse, encompassing national and state authorities, collaborative or shared governance models, private governance, and community-driven projects. Conservation objectives also differ, ranging from the protection of entire ecosystems to targeted efforts focused on specific threatened species (Borrini-Feyerabend et al., 2013; Arthington et al., 2016; Moberg et al., 2024).

Area-based conservation actions play a central role in international biodiversity and site-based conservation strategies, including the CBD's GBF and the EU's BDS2030. With inland waters now recognised as a distinct realm in the latest area-based coverage targets, habitats critical for freshwater fish conservation will, for the first time, be tracked separately from terrestrial areas as progress is made toward the 2030 global and regional targets. In response, IUCN has published detailed guidance for practitioners involved in designing, designating, and managing PCAs to support inland water ecosystems (Maxwell et al., 2020; Cooke et al., 2023; Moberg et al., 2024).

Part of the Mura-Drava-Danube Biosphere Reserve, which spans five countries. © Goran Šafarek

4.2.1 Protected areas

IUCN defines a PA as "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values". To account for variations in management, governance, and human use, IUCN also established the Protected Area Management Categories - an internationally recognised framework - to classify different PA types and conservation objectives (Dudley, 2008; Moberg et al., 2024).

Integrating freshwater ecosystems into conventional PA networks is challenging due to their distinct characteristics. While aquatic connectivity supports vital processes such as fish migration, water flow, and sediment transport, it also enables the spread of threats and disturbances from upstream, downstream, or external drainage areas. Effective PA design requires a thorough understanding of how these threats impact freshwater KEAs, alongside basin-scale interventions to address pressures beyond PA boundaries. Additionally, establishing interconnected PA networks that link terrestrial, freshwater, coastal, and marine environments is essential to preserving natural ecosystem functions and services (Hermoso et al., 2021; Higgins et al., 2021; Moberg et al., 2024).

Despite nearly 90% of European freshwater fish species being recorded within at least one PA, most sites across the region have been designated primarily for terrestrial habitats. Consequently, freshwater ecosystems are often included incidentally or merely serve as boundary markers. While these terrestrial-focused PAs offer some protection to aquatic environments, they generally overlook freshwater KEAs, and may permit harmful activities such as the introduction of non-native species, unregulated fishing, sewage discharge, barrier construction, hydropower development, and large-scale water withdrawals (Acreman et al., 2020; Freyhof et al., 2020; Moberg et al., 2024).

Furthermore, many PAs across the European region have been designated opportunistically, without systematic regional or national planning. As a result, there is a spatial mismatch between areas of high freshwater fish diversity and the existing PA network, particularly in Southern and Eastern Europe (Carrizo et al., 2017; Vavalidis et al., 2021; Szabolcs et al., 2022; Miqueleiz et al., 2023).

In the EU, endemic and threatened freshwater fish species remain underrepresented within the Natura 2000 network. Many species listed under the Habitats Directive are either not listed as target species at all Natura 2000 sites where they are present, or continue to lack designated SACs. Where sites have been designated for freshwater fishes, their effectiveness is often constrained by several factors: the absence of dedicated management structures, limited development of site management plans with explicit freshwater objectives, weak coordination both within and between Member States, inconsistent enforcement, and a persistent funding gap (Rosso et al., 2018; EEA, 2020; Spiliopoulou et al., 2021; Gavioli et al., 2023).

Despite these challenges, PA-based conservation solutions for freshwater ecosystems are increasingly being implemented across Europe, with notable innovations. In 2023, Albania designated the Vjosa River as Europe's first protected wild river national park (see Box 8). Similarly, Estonia's Pärnu River, an award-winning Natura 2000 site, has undergone extensive restoration, with over 3,300 kilometres of river reaches rehabilitated to support migratory freshwater fish species (Moberg et al., 2024).

Efforts to integrate EU area-based conservation policies with other directives have also yielded some success. For example, the Landshuter Modell (Landshut Model) in Bavaria, Germany, incorporates Natura 2000 objectives into RBMPs to enhance the ecological functions of surface waters. Likewise, Austria's National Framework Plan aligns the HD and WFD by prioritising river connectivity, improving flow dynamics, and enhancing the condition of aquatic habitats and species protected under Natura 2000 (Sundseth, 2015; Rehklau et al., 2017).

4.2.2 Other effective area-based conservation measures

OECMs comprise area-based interventions that effectively conserve biodiversity outside traditional PAs, including sites not primarily focused on biodiversity but where management still supports its conservation. Recognised by the CBD since 2018, and later by the GBF and EU BDS2030, OECMs complement PAs in meeting area-based conservation targets. However, most countries have yet to submit data to the World Database on OECMs (WD-OECM). To support their implementation, IUCN has developed best practice guidelines and a site-level identification tool (Jonas et al., 2023, 2024).

Several types of OECMs have the potential to support freshwater fish conservation, though most have yet to be formally recognised in national PCA documentation. These include:

- Sites designated under international conventions or programmes that are not classified as PAs, such as UNESCO Biosphere Reserve buffer or transition zones and certain Ramsar sites.
- Provisioning, regulating, or supporting area-based approaches, including source water protection areas, government-mandated riparian strips, water reserves, carbon capture areas, aquifer recharge zones, fisheries reserves, coastal marshlands, protected floodplains, and pollution controls such as EU nitrate exclusion zones.
- Recreational sites, such as natural lakes and rivers used for fishing and boating, as well as wetland/game hunting reserves.
- Military areas and buffer zones where restricted access reduces human impact.
- Connectivity-based approaches, including migratory swimways, river corridors, and free-flowing rivers or river stretches.

4.2.3 Emerging PCA actions

A variety of emerging area-based mechanisms show promise for addressing the specific conservation needs of freshwater fishes and inland aquatic ecosystems in Europe, provided they effectively target KEAs and associated threats. Whether these mechanisms are classified as PAs, OECMs, or neither will depend on their incorporation into national PCA frameworks (Moberg et al., 2024).

One such mechanism is the concept of migratory pathways, or *swimways*, for freshwater fishes, which draws inspiration from the flyway approach used for migratory birds. Swimways refer to river systems and their connected ecosystems that facilitate the uninterrupted movement of biologically or socioeconomically important migratory freshwater fish species. Alongside the Global Swimways Initiative, the Trans-European Swimways Programme (TEN-S), launched in 2022, supports the recovery of migratory freshwater fish populations through coordinated policy efforts, advocacy, capacity building, and targeted restoration actions across key Swimways of European Importance (Worthington et al., 2022; Wetlands International, 2023, 2024).

Fluvial reserves are designed to safeguard the natural flow regimes, connectivity, and ecological integrity of selected rivers or river stretches. These reserves are defined by precise geographic boundaries encompassing the river channel, the entire riverbed, and designated portions of the riparian zone and/or floodplain. Notable examples include the Blanice River Reserve in the Czech Republic and the Natural River Reserves network in Spain, some of which are part of the Natura 2000 network (Staponites et al., 2022; López-Rodríguez et al., 2024).

Box 8. The Vjosa - Europe's first Wild River National Park

Spase Shumka

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In March 2023, the Vjosa River - one of Europe's last free-flowing rivers - was officially designated as Europe's first Wild River National Park, gaining IUCN Protected Area Management Category II status. This pioneering commitment to preserving the river's pristine nature was achieved through a unique collaboration involving the Albanian Government, local and international experts, IUCN, environmental NGOs from the Save the Blue Heart of Europe campaign, and outdoor clothing company Patagonia. It followed a decade-long effort to protect the river's vital ecosystem from development threats, some of which remain ongoing (Döbbelt-Grüne et al., 2025).

The Vjosa River and its tributaries stretch over 400 kilometres, originating in the Pindus Mountains of northern Greece - where it is called the Aoös - and flowing to the Adriatic Sea in southern Albania. This wilderness area comprises an extensive mosaic of diverse habitat types, ranging from narrow gorges in the upper reaches to wide, braided river sections in the middle stretch, and a near-natural delta at its mouth. The middle stretch alone contains at least eight distinct habitat types of the highest conservation significance.

The Vjosa watershed supports more than 1,100 species, including 26 native fish species, nine of which are endemic to the Balkan region. Of these, two are assessed as Critically Endangered and 13 as Near Threatened on the current European Red List.

Phase I of the National Park designation process secured protection for the main river channel downstream of the Greek border, along with four tributaries. Phase II, planned for the coming years, will extend protection to additional free-flowing tributaries and areas critical to the river's ecosystem, as well as incorporating some private land, following stakeholder consultations. Plans are also underway for a transboundary Aoös-Vjosa park in collaboration with the Greek government, aiming to protect the entire river system from source to sea.

A Wild River National Park is a conservation initiative designed to safeguard rivers and their threatened habitats. The primary objectives of these parks include protecting natural biodiversity, preserving ecological processes, and promoting education and recreation. The Vjosa River sets an important precedent in Europe, demonstrating the potential of such conservation actions and serving as a model for future efforts.

The Vjosa River Wild River National Park in Albania supports several regionally endemic freshwater fish species, including the NT Ohrid Spined Loach (*Cobitis ohridana*). © Gernot Kunz / Riccardo Novaga

The Krupa River in Croatia has been designated as a nationally protected site of cultural heritage. © Goran Šafarek

In parallel, several European countries have adopted legal measures to maintain the free-flowing character of rivers. However, these often lack explicit provisions to safeguard the volume of water necessary for ecological and social functions. Incorporating specific environmental flow requirements into the designation of *water flow reserves* offers potential for protecting the hydrological and ecological integrity of freshwater systems, particularly in areas where hydropower development and water diversions are major threats (Schäfer, 2021; Moberg et al., 2024).

Groundwater ecosystems are frequently overlooked in both conservation research and policy. However, they play a crucial role, providing clean water for downstream habitats and human use, while supporting a high proportion of range-restricted, endemic species. Advancing the conservation of these ecosystems requires the early integration of groundwatersheds into river and wetland conservation planning. This can be facilitated through mechanisms such as source water protection, groundwater regulation, sustainable water management policies, and regenerative agriculture. In the context of freshwater fish conservation in Europe, such approaches will be particularly useful in regions like the Western Balkans, where a variety of endemic and range-restricted species depend on subterranean water bodies during parts of their life cycle (Fišer et al., 2022; Huggins et al., 2023; see Box 3).

The *Rights of Nature* concept recognises that natural entities possess inherent rights - including the right to exist, thrive, and regenerate. A notable example is Spain's Mar Menor lagoon - critical habitat for the threatened Spanish Killifish (*Apricaphanius iberus*) - which was granted legal personhood in 2022. This status provides enforceable rights to protection, conservation, maintenance and, where necessary, ecological restoration, with full legal implementation approved in early 2025. In Serbia, the concept was successfully applied in a tribunal to halt further hydropower development on headwater streams in the Kopaonik mountain range (Cyrus R. Vance Center for International Justice et al., 2020; BOE, 2022, 2025; Simonović et al., 2022).

Freshwater ecosystems hold significant *cultural heritage* value, serving as places for learning, inspiration, tourism, and recreation. Many local communities and religious groups maintain strong emotional and spiritual ties to these environments and can play a key role in their long-term stewardship. In Croatia, for instance, the Krupa River - a short tributary of the Zrmanja River and habitat to several NT fish species, including the endemic Zrmanja Chub (*Squalius zrmanjae*) - was granted protected status by the Ministry of Culture in 2019, following nearly two decades of advocacy by local residents (Ćaleta et al., 2019; Moberg et al., 2024).

Community-based inland fishery reserves have the potential to sustain or enhance freshwater fish assemblages that local communities depend on. A recent literature review found that most such reserves had beneficial effects on fisheries; however, their implementation and study remain limited within Europe. *Privately owned river sections and wetlands*, especially those managed for recreational fishing, may also offer important conservation benefits when focussed on native species (Karres et al., 2022; Moberg et al., 2024).

Climate adaptation corridors are increasingly acknowledged for their role in enhancing biodiversity resilience in the face of climate change. Riparian habitats, in particular, are expected to serve as vital dispersal corridors for species shifting their ranges, as these areas stretch across climatic gradients and offer cool, moist microclimates compared to their surrounding environments. Conserving these corridors could contribute to freshwater fish conservation by improving connectivity and habitat quality (Krosby et al., 2018).

4.2.4 Spatial planning tools

The *Key Biodiversity Area* (KBA) approach offers a standardised method for identifying sites that contribute significantly to the global persistence of biodiversity. Each KBA is defined using ecological, physical, administrative, or management boundaries that allow for actual or potential management as a single unit, although formal designation as a protected area is not required. To support this process, IUCN has developed a global standard and comprehensive guidelines for KBA identification (IUCN, 2016; KBA Standards and Appeals Committee of IUCN SSC/WCPA, 2022).

In Europe, some KBAs have been identified for freshwater fish species in the overlapping Mediterranean Basin Biodiversity Hotspot. These KBAs were informed in part by the previous European Red List, though many of these sites have yet to be reviewed and validated. The EC has recommended that EU Member States use KBAs as a scientific foundation for the expansion of existing PA networks (Darwall et al., 2014; Máiz-Tomé et al., 2017; EC, 2022a).

Systematic Conservation Planning (SCP) is a data-driven decision-support framework used to design PA networks across various scales. Its core objective is to ensure that crucial biodiversity components - such as species, ecosystems, and ecological processes - are adequately represented within PAs. SCP helps guide choices about where to focus conservation efforts in order to maximise biodiversity outcomes while minimising societal costs (Margules & Pressey, 2000; McIntosh et al., 2017).

Freshwater fishes have been integrated into regional SCP analyses to identify spatial priorities for aquatic biodiversity conservation in Europe. Drawing on data from the previous European Red List, the findings indicate that parts of southern and eastern Europe require particularly urgent attention (Szabolcs et al., 2022).

While there are some methodological differences between the KBA and SCP approaches, there is considerable potential for synergy. Conservation planners are encouraged to incorporate KBA data into SCP frameworks, applying context-specific targets for different types of KBAs. Likewise, SCP tools can assist planners and donors in prioritising among KBAs when allocating resources and implementing management actions (Smith et al., 2019).

4.3 Habitat and natural process restoration

As outlined in Section 3.5, human activities most commonly impact freshwater fish habitats through fragmentation (reduced connectivity), degradation (declining quality), and outright loss (diminished extent), often compounded by the cumulative effects of multiple, interacting stressors (Dudgeon, 2019; Piczak et al., 2024).

As key components of aquatic biodiversity and widely used indicators of ecosystem health, European freshwater fish communities can inform the design and prioritisation of effective response options. To maximise restoration benefits, it is crucial to understand the environmental requirements of different fish species - particularly with respect to spatial scale, flow regimes, and the configuration of habitats necessary for shelter, feeding, reproduction, and recruitment (van Looy et al., 2019; Stoffels et al., 2022; Stoffers et al., 2022b).

Although full recovery to pre-disturbance conditions is rarely achievable, efforts to restore degraded rivers, lakes, and wetlands through management actions have expanded significantly across Europe since the late 20th century. Over the past 30 years, more than 1,400 river restoration projects have been implemented across 31 countries. This growth has been driven in part by the WFD, which shifted the focus from water quality and fisheries management to a broader, ecosystem-based approach. Additionally, the restoration of inland water ecosystems is now a central priority under both the EU's NRR and Target 2 of the GBF (Smith et al., 2014; EEA, 2024d; River Restoration Centre, 2025).

Habitat restoration actions differ widely in scope, ranging from local, reach-level interventions to large, transboundary initiatives. Strategies and outcomes likewise differ substantially depending on site- or basin-specific ecological conditions, leading to the need for evidence-based and adaptive management approaches to ensure effectiveness (Piczak et al., 2024).

Fishways - such as this slot-style facility on the Steyr River, Austria - often fail to address the broader ecological impacts of fluvial barriers and typically benefit only a limited number of species. © SPARE (INTERREG Project) / Simone Sozzi / Water Alternatives, CC BY-NC 2.0

Modern restoration initiatives are increasingly aligned with freshwater KEAs, aiming to enhance ecological processes and hydromorphological conditions - including flow regimes and the structure of riverbeds, banks, and riparian zones - while improving habitat quality at the basin scale. This functional perspective underpins major policy commitments such as the EU BDS2030 and its target to restore at least 25,000 kilometres of free-flowing rivers in the EU, an objective supported by the NRR and the recently-developed European Water Resilience Strategy (EC, 2024, 2025c).

The removal of dams, weirs, and other barriers - particularly those considered obsolete and obstructive to the migration routes of diadromous fishes - is among the most effective actions for restoring longitudinal connectivity. Between 2020 and 2023, at least 1,152 physical barriers were removed across 17 European countries, with the highest numbers reported in France, Spain, Denmark, and Sweden. Such decommissioning projects are ideally coordinated within a socio-ecological framework, considering factors such as cost, public approval, safety concerns (e.g., flood risk), sediment release, and the potential for aiding the spread of invasive species (Foley et al., 2017; Habel et al., 2020; EC, 2022b; Mouchlianitis, 2024).

A conventional mitigation measure aimed at enabling riverine fishes to overcome barriers is the installation of fish passage facilities, typically referred to as fishways. These are often constructed retrospectively and encompass a variety of designs, including technical (e.g., pool, vertical slot, Denil) and special-purpose (e.g., fish ladders, lifts or locks) structures, nature-like bypasses, and ramps, culverts, and hybrid systems. A traditional focus on the upstream migration of anadromous fishes has frequently resulted in limited effectiveness for other species, although there is a growing trend towards multispecies arrangements. Solutions for downstream and lateral passage - which also involve passively drifting eggs and larval stages - remain less developed and require further research and practical refinement, especially in rivers with diverse fish communities. Furthermore, while fishways can help to re-establish longitudinal connectivity, they typically fail to address the broader ecological consequences of barriers, such as the loss of natural flow gradients and the availability of suitable upstream habitats (Silva et al., 2018; Birnie-Gauvin et al., 2019; Thieme et al., 2024).

Lateral habitat connectivity can be improved by restoring degraded floodplains and riparian zones and reconnecting them to river systems. This may involve removing bank protection structures (e.g., revetments, rip-rap), embankments, levees, and flood dykes; reinstating historical channels; re-meandering straightened reaches; infilling or widening incised channels; and creating new wetlands. While the ecological importance of the dynamic, bidirectional interaction between land and water is increasingly acknowledged in restoration efforts, further research is needed to assess the effectiveness of specific management actions for native fishes (Friberg et al., 2016; Mason et al., 2025).

To enable effective, climate-resilient restoration of free-flowing rivers and their fish communities, the recovery of longitudinal and lateral structural connectivity must be accompanied by the re-establishment of functional flow regimes that reflect natural spatiotemporal patterns. In this context, accelerating and scaling up the implementation of environmental flows is gaining recognition as a strategic priority. To support this, a pan-European environmental flows group has developed guidance linked to the WFD. These principles extend beyond rivers and connected waterbodies to include the maintenance of ecologically appropriate water levels in lakes, wetlands, and aquifers (EC, 2015; Tickner et al., 2020; Arthington et al., 2024).

Complementary actions, such as reducing the impacts of urbanisation, agriculture, forestry, or mining, are critical for improving water quality and natural hydrological processes. The restoration of riparian vegetation further supports these efforts by stabilising banks and shorelines, enhancing habitat complexity, and filtering pollutants (Riis et al., 2020; Piczak et al., 2024).

Site-scale restoration efforts can also play a valuable role in enhancing freshwater habitat quality, although their overall effectiveness may be constrained if broader-scale pressures are not simultaneously addressed. Examples include the creation of pool-riffle sequences, the addition of boulders or woody structures, the provision of coarse substrata for fish spawning, and the establishment of shallow littoral zones (Grabowski et al., 2019; Taylor et al., 2019; Radinger et al., 2023).

Management techniques aimed at improving habitat quality through the control of non-native aquatic species include mechanical removal (e.g., nets, traps, electrofishing, hand-pulling of plants), chemical treatments (e.g., antimycin, rotenone, herbicides), biological control (e.g., introduction of diseases or predators/consumers), and habitat manipulation (e.g., draining of lakes and wetlands, flow management, physical alteration). However, as intact freshwater systems tend to exhibit greater resilience to biological invasions than those altered by human activities, the conservation and restoration of such habitats remains the preferred management approach (Rytwinski et al., 2019; Bernery et al., 2022; Britton et al., 2023).

Despite the growing number of freshwater restoration initiatives, comprehensive evaluations of project outcomes remain relatively uncommon. This gap is largely attributable to the limited resources allocated for post-restoration monitoring and assessment, which, in turn, hampers the ability to evaluate the long-term effectiveness of various techniques. Nevertheless, comparative analyses of efforts across Europe suggest that habitat restoration generally yields positive - albeit highly variable - effects on fishes and other freshwater biodiversity (Kail et al., 2015; Rodeles et al., 2017; England et al., 2021).

4.4 Species management

Targeted strategies and action plans may be developed and implemented to conserve priority freshwater fish species that are threatened at national, regional, or global levels. These initiatives typically integrate the area-based and *in situ* habitat management approaches discussed in previous sections with population- or subpopulation-level interventions. Such interventions aim to enhance species abundance at sites where natural recruitment has been impaired due to overfishing or environmental degradation, or to reintroduce taxa to basins from which they have been extirpated.

These actions can be applied across a wide range of geographic scales - from current international frameworks, such as the Pan-European Action Plan for Sturgeons, to national programmes like Norway's National Salmon Fjords and Rivers scheme, and highly localised initiatives focused on range-restricted species, such as the Asprete (*Romanichthys valsanicola*) in Romania (Forseth et al., 2017; Friedrich et al., 2018; Burlacu et al., 2024).

The most widely employed enhancement strategy involves the stocking of captive-reared individuals, typically at juvenile or subadult life stages. Historically, such efforts have focused on commercially important species, especially migratory salmonids, shads, and sturgeons. However, stocking has also been used to augment wild subpopulations of non-commercial species, including the European Weatherfish (*Misgurnus fossilis*) in Germany, Rhône Streber (*Zingel asper*) in France, and both the Spanish Killifish and Valencian Toothcarp (*Valencia hispanica*) in Spain, among others (Hundt et al., 2015; Schreiber et al., 2018; Brevé et al., 2025; Centro Acuícola de El Palmar, 2023; see Box 10).

Captive breeding or artificial propagation for *ex situ* conservation and stocking may take place in commercial hatcheries or in specialised conservation aquaculture facilities. Profit-oriented hatchery programmes are also widely used to support restocking efforts for commercial and recreational fisheries, including a number of threatened species. However, such practices carry ecological risks, particularly where non-native genetic lineages are introduced and become admixed with locally-endemic populations. This has occurred, for example, in native pikes in France and Italy, whitefish populations in Swiss lakes, Danube Salmon (*Hucho hucho*) in several countries, and trouts (*Salmo* spp.) throughout southern Europe. Beyond genetic concerns, stocking can lead to increased competition and predation, the introduction of parasites and pathogens, and may have limited long-term success if underlying ecological conditions remain unfavourable. As a result, an increasing number of studies now advise avoiding stocking unless absolutely necessary, and recommend discontinuation once natural recruitment is evident (Simonović et al., 2015, 2025; Alexander & Seehausen, 2021; Kuciński & Fopp-Bayat, 2021; Snoj et al., 2022; Ford, 2024k,l,m).

Museums, public aquaria, and zoological institutions also contribute to *ex situ* conservation by maintaining captive assurance colonies. These efforts are particularly critical in cases where the wild population is extinct, as with Racovitza's Rudd, for which no viable reintroduction option currently exists (Reid et al., 2013; Correia et al., 2024; Ford, 2024a).

Alternatively, translocation to other suitable natural or artificial habitats may serve as a conservation measure, and IUCN has published guidelines to inform such initiatives. Notable examples include the successful relocation of whitefish in the United Kingdom; Lake Minnow (*Rhynchocypris percnurus*) in Poland; European Mudminnow (*Umbra krameri)* in Austria, Hungary, and Slovakia; and Corfu Valencia (*Valencia letourneuxi*) and Rhodes Minnow (*Ladigesocypris ghigii*) in Greece. A particularly prominent case is that of the European Eel, for which millions of wild-caught individuals of various life stages and origins are translocated to sites across Europe each year. This large-scale restocking effort seeks to offset low natural recruitment and support local fisheries. However, it is seldom accompanied by rigorous scientific monitoring, and its conservation benefits remain uncertain and contested (Winfield et al., 2013; Tatár et al., 2017; Lyle et al., 2019; Rohtla et al., 2021; Kalogianni et al., 2022; Wolnicki et al., 2022).

In parts of its range, conservation of the VU Danube Salmon (*Hucho hucho*) relies largely on captive broodstocks - an approach increasingly regarded as a threat to the integrity of natural gene pools due to the translocation of unique local lineages between river systems. © Benedikt Reisner

Box 9. Where there's LIFE, there's hope

European funds boost freshwater fish conservation

Established in 1992, the LIFE programme is the EU's key financing tool for nature conservation. Over the past three decades, LIFE has supported more than 6,000 projects across the EU contributing to the conservation of over 1,800 species of wild animals and plants listed under the HD while also bolstering the development of the Natura 2000 network. For the 2021-2027 funding period, the programme's budget increased to €5.4 billion, representing a rise of over 60% compared to the previous seven-year cycle (EC, 2025b).

Between 1992 and 2017 (the most recent period for which published reporting is available), LIFE provided funding for 161 projects specifically targeting 60 freshwater fish species, albeit with a clear focus on a relatively small number of species groups, including sculpins (*Cottus* spp.), true loaches (*Cobitis* spp.) and Atlantic Salmon (EASME, 2020).

These projects were implemented in 21 of the 27 EU Member States, with Italy, Germany, Spain, Austria and France being the most prominently represented. In Italy, for example, recent projects have focused on controlling non-native freshwater fish (e.g., LIFE Predator: Ref. LIFE21/NAT-IT-PREDATOR/101074458) or recovering endemic species and fish communities (e.g., LIFE GrayMarble: Ref. LIFE20 NAT/IT/001341; LIFE Minnow: Ref. LIFE21-NAT-IT-LIFE-Minnow/101074559).

Several other EU funding instruments administered by the EC and its executive agencies also support freshwater conservation initiatives. For instance, the Interreg programme - financed through the European Regional Development Fund - promotes cross-border, transnational and interregional cooperation across a range of sectors. One notable project, MEASURES (2018-2021), developed a strategy for the conservation and restoration of ecological corridors in the Danube River and its major tributaries, including the production of a habitat manual for migratory fishes.

In Poland, the Wisłoka Without Barriers initiative (2018-2021) received substantial funding from the EU Cohesion Fund, enabling the restoration of migratory routes for fishes and other aquatic organisms along the Wisłoka River and its tributaries.

Under Horizon Europe - the EU's flagship research and innovation programme - multiple projects have contributed outputs for freshwater conservation. These include the AMBER project (2016-2020), which produced a pan-European database of artificial in-stream barriers, and the ongoing Danube4All initiative (2023-2027), which seeks to restore freshwater ecosystems throughout the Danube River Basin.

The Brook Barbel (*Barbus caninus*) in the foreground and the Italian Barbel (*Barbus plebejus*) behind, pictured here in an upper tributary of the Po River, were target species of the LIFE Barbie project (ref. LIFE13 NAT/IT/001129). Both are currently assessed as NT. © Samuel Betschart

4.5 Red List status versus conservation priority

The assessment of extinction risk and the setting of conservation priorities are closely linked yet fundamentally distinct processes. Red List categories provide a relative estimate of the likelihood that a species will become extinct. In contrast, the prioritisation of conservation action must consider Red List assessments alongside additional factors, including the urgency and nature of threats, ecological function, phylogenetic distinctiveness, historical and cultural relevance, and the feasibility of implementing management actions (IUCN, 2012b).

Regional assessments should also consider the proportion of a species' global population occurring within a given area, as this can significantly influence conservation priorities. A species may be assessed as having favourable conservation status at the global or regional level, yet still face acute threats at national or subnational scales. In such cases, geographically targeted interventions may still be necessary. For instance, the European Mudminnow is classified as VU at global and regional levels, and nationally in Serbia, yet it is assessed as CR in Austria, Slovakia, Slovenia, and Bulgaria, and as EN in Hungary. These discrepancies underscore the importance of developing and maintaining National and Regional Red Lists to effectively address localised conservation needs (IUCN, 2012b; Ford, 2024n; Hegediš & Krpo-Ćetković, 2024).

It is equally important that Red List outcomes are interpreted correctly and not used as proxies for the general ecological health of Europe's freshwater ecosystems. For example, a designation of LC does not equate to a species achieving Favourable Conservation Status under the EU HD, nor does it imply Good Ecological Status as defined under the WFD. Instead, Red List outcomes should be used to complement broader, multivariate assessments of ecological condition (Nunn et al., 2023).

Box 10. Conservation case study: the Rhône Streber

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The Rhône Streber (*Zingel asper*) is an endemic fish species of the Rhône River basin in France and Switzerland, inhabiting well-oxygenated waters with stony or rocky substrates. Historically, it was widely distributed across the basin, occupying over 2,200 kilometres of waterways at the start of the 20th century. However, its population has significantly declined, largely due to hydroelectric dams that have disrupted ecological continuity, altered water quality and flow, raised water temperatures, and degraded habitat quality through the accumulation of sediment. Additionally, the species is highly sensitive to agricultural, domestic, and industrial pollution. Water abstraction for agriculture and increasingly severe low water levels further exacerbate the species' decline.

At present, only six known subpopulations of the Rhône Streber remain, found in rivers including the Loue, Ardèche, Durance, and Verdon, collectively covering a reduced range of just 380 kilometres. Severe fragmentation and low abundance render most of these subpopulations non-viable, with some - particularly those in the Doubs and Drôme rivers - at imminent risk of extinction.

Conservation efforts have been underway since 1998, including two LIFE programs (1998-2001 and 2004-2010) and two National Action Plans (2012-2016 and 2020-2030). These initiatives have aimed to improve knowledge of the species, map its distribution along the Rhône axis, restore ecological continuity and suitable habitats, carry out genetic studies, implement captive breeding and restocking programs, and raise awareness among decision-makers and the public. These actions have contributed to more informed management strategies.

Although the Rhône Streber was classified as Critically Endangered in the early 2000s, it is now listed as Endangered, reflecting the progress achieved through sustained conservation actions. Nevertheless, continued monitoring and action are essential, as certain subpopulations remain at extremely high risk of local extinction.

The Durance River, a tributary of the Rhône in southeastern France, supports the largest remaining subpopulation of the EN Rhône Streber (*Zingel asper*). © Chabe01, Wikimedia Commons, CC BY-SA 4.0 / Jordi Gil

5 Prospects and recommendations

5.1 Policy and practice

The publication of this updated *European Red List of Freshwater Fishes* is particularly timely, coinciding with the growing recognition of freshwater ecosystems within global and regional biodiversity frameworks. Freshwater fishes are integral components of these ecosystems, and the current convergence of international strategies - including the GBF, the UNFCCC, and the EU BDS2030 - in acknowledging inland waters as a distinct and critical realm for conservation presents an unprecedented opportunity to elevate freshwater biodiversity alongside traditional terrestrial and marine priorities (Cooke et al., 2023).

This global momentum has been catalysed by a series of scientific publications and expert recommendations, most notably the widely endorsed Emergency Recovery Plan for freshwater biodiversity. Spearheaded by the World Wide Fund for Nature, this plan outlines six priority actions to halt and reverse biodiversity loss in freshwater ecosystems, while emphasising the importance of public education, engagement, and support (see Figure 15). Since its release, a series of studies have expanded upon these actions, identifying practical approaches to "bending the curve" of freshwater biodiversity loss. The Plan's priorities have proven instrumental in shaping policy and have directly influenced the embedding of inland water objectives within current global and regional initiatives (Tickner et al., 2020; Britton et al., 2023; Arthington et al., 2024; Cooke et al., 2024; Lynch et al., 2024; Piczak et al., 2024; Thieme et al., 2024)

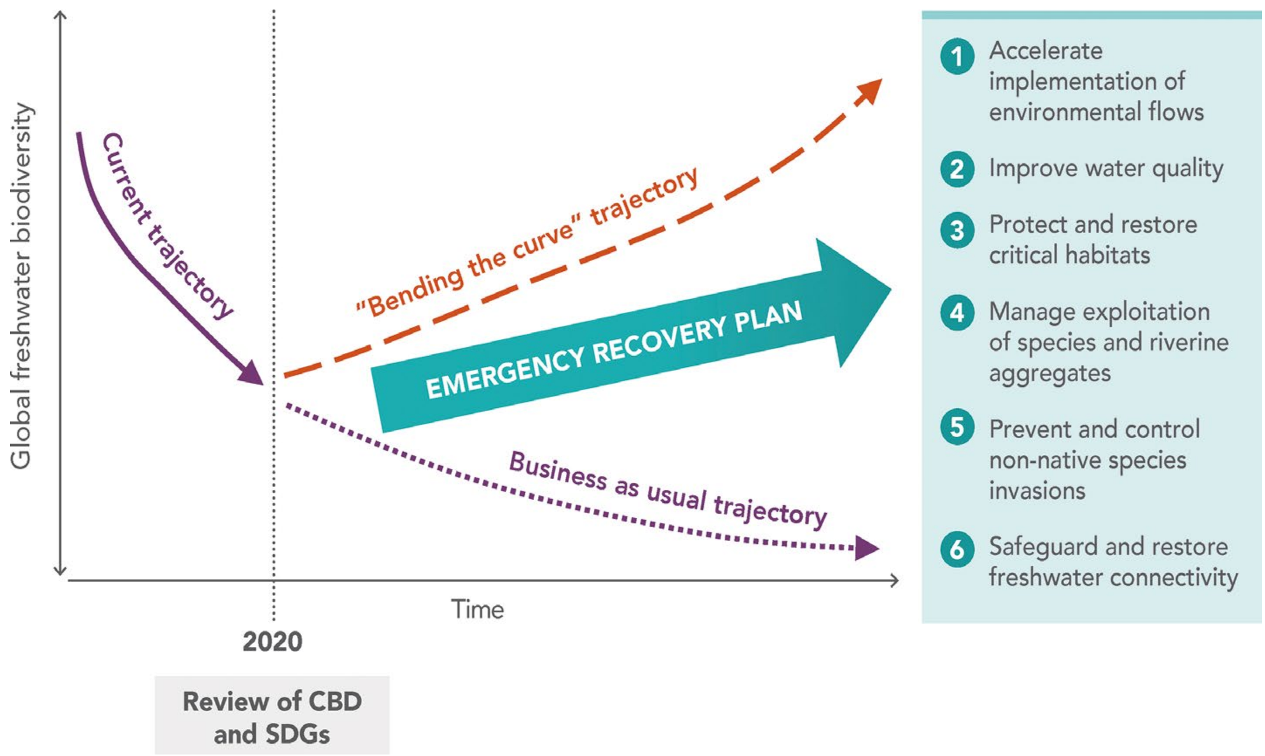

Figure 15. *The Emergency Recovery Plan for freshwater biodiversity (Tickner et al., 2020).*

Meeting these objectives requires a fundamental transformation in how freshwater biodiversity and water resources are managed, valued, and integrated across multiple sectors - particularly in the context of accelerating climate change. As freshwater ecosystems are coupled socio-ecological systems, the development and implementation of effective, future-proofed management strategies must involve broad engagement and collaboration among diverse stakeholders - from policymakers and scientists to local communities and the general public. This is essential for aligning conservation goals with social and economic development priorities and for ensuring that freshwater biodiversity is embedded not only within policy frameworks but also in coordinated, on-the-ground action (van Rees et al., 2019; Twardek et al., 2021; Lynch et al., 2023, 2024).

The current European policy landscape - including the EU BDS2030, the European Green Deal, and the NRR - offers a renewed opportunity to integrate freshwater biodiversity more effectively into key sectors such as irrigation, hydropower, and public water supply. Unlocking this potential will require governance frameworks that promote coherent, cross-sectoral collaboration and explicitly acknowledge the interdependence of ecological integrity, sustainable resource use, and shared data systems (Bieroza et al., 2021; Hermoso et al., 2022).

Importantly, the outcomes of these European initiatives may also inform biodiversity strategies in other regions, particularly where governance frameworks for freshwater biodiversity conservation and restoration are lacking. In this context, IUCN Red List assessments remain vital - not only for monitoring progress towards global biodiversity targets, but also for underpinning conservation planning across geographic scales.

The European Weatherfish (*Misgurnus fossilis*) is reported to be declining across much of its European range but is not currently assessed as threatened - at least partly due to a lack of robust quantitative data on its population trend. © Niklas Banowski

Despite Europe's long-standing commitment to environmental planning and nature conservation, the findings of this Red List assessment reveal a continuing rise in the number of threatened freshwater fish species across the region. Furthermore, many species previously identified as declining show no signs of recovery 15 years on. This does not necessarily indicate a deterioration in conditions at all sites, but instead reflects a critical limitation: the persistent lack of population-level data, which undermines effective management and impedes accurate detection of demographic trends.

Most threatened European freshwater fishes are currently assessed under IUCN criteria B or D2, based on their restricted ranges and the presence of plausible threats, rather than documented population declines or small population sizes (criteria A, C, D1, or E). This is partly a consequence of naturally narrow distributions - particularly among southern European endemics - but also of insufficient quantitative monitoring across much of the region.

Improving species-specific population data is essential for reducing uncertainty, strengthening the rigour of extinction risk assessments, and generating a more accurate picture of freshwater fish conservation status. In the EU, monitoring under the WFD has largely focused on community-level ecological indices, including fish assemblages. While informative, these indices must be complemented by targeted population-level monitoring to detect trends and support mitigation of species-specific threats (Radinger et al., 2019; van Rees et al., 2021).

Ideally, a coordinated, pan-European monitoring programme should be aligned with Red List assessment cycles, underpinned by harmonised national surveillance schemes and strong institutional communication. The development of regionally standardised monitoring protocols, along with a centralised, open-access data repository, would greatly improve data accessibility and knowledge exchange. Achieving this will require sustained financial and institutional commitment at local, national, and regional levels. EU legislation such as the HD and the WFD provides a strong foundation, along with mechanisms such as the LIFE Programme. However, additional incentives are needed to support long-term data collection. Citizen science initiatives - particularly those involving the angling community - and strategic outreach via social media could significantly enhance data collection efforts, especially where resources are constrained (Gundelund et al., 2020; Arthington, 2021; Harper et al., 2021; van Rees et al., 2021).

In parallel, emerging technologies such as environmental DNA (eDNA), camera traps, and remote sensing, offer cost-effective, scalable tools to augment traditional monitoring. Access to hydrological and physical data will also be critical - both to implement environmental flows and to evaluate the effectiveness of restoration actions through the design of indicators designed to capture real-world impacts. Together, these efforts will enhance research capacity, inform evidence-based decision-making, and enable more robust tracking of progress toward freshwater biodiversity targets (Pochardt et al., 2020; Harper et al., 2021; Hermoso et al., 2022).

Many of the primary threats identified in this assessment - such as habitat modification and pollution - are systemic in nature and thus require strategic, basin-scale mitigation frameworks. Therefore, while targeted conservation actions remain vital for certain threatened or declining species, the management of freshwater fishes should, in most cases, be grounded in an evidence-based, ecosystem-oriented approach that delivers broader benefits through the maintenance and restoration of freshwater KEAs. Such frameworks should prioritise the preservation or restoration of a dynamic mosaic of natural flow regimes, sediment processes, and habitat heterogeneity to support native fish assemblages and broader freshwater biodiversity. These efforts must integrate freshwater biodiversity focal areas with riparian zones, upstream habitats, and the wider basin landscape, and be guided by Nature-based Solutions - such as environmental flows and the restoration of free-flowing rivers. This multihabitat approach moves beyond conventional site-based protection by explicitly managing the hydrological and ecological linkages between freshwater habitats and their surrounding terrestrial environments (Arthington, 2021; Higgins et al., 2021; van Rees et al., 2021).

The Swimways of European Importance initiative presents a promising framework for restoring migratory fish populations, particularly within the broader regional goal of reestablishing free-flowing rivers. Article 4 of the NRR provides a specific legal mandate for freshwater ecosystems, including species conservation. Aligning restoration efforts under the NRR with WFD processes offers a significant opportunity to create synergies that can enhance both habitat quality and connectivity. This alignment could improve the implementation of the WFD, which - despite broad consensus on the benefits of IWRM - remains especially challenging in large, transboundary river basins.

The WFD's emphasis on basin-scale management has delivered important successes, most notably in fostering international collaboration in water governance. However, the translation of conservation assessments and technical tools - such as environmental flow models - into accessible, decision-relevant formats remains limited. These tools must be adapted for use by diverse stakeholder groups, including landowners, water users, and local authorities, to ensure broad uptake and practical utility, such as their streamlining into the planning and execution of RBMPs (van Rees et al., 2019).

The PCA targets within the GBF and EU BDS2030 provide impetus for nations to significantly expand and strengthen formal protection of inland water ecosystems. This includes enhancing the ecological representation, connectivity, and governance of existing PCAs. Where current land and water uses are misaligned with these conservation objectives, management plans must be upgraded to explicitly incorporate freshwater priorities (van Rees et al., 2021).

The Pumpkinseed (*Lepomis gibbosus*), native to eastern North America, has been widely introduced across Europe and is listed as an invasive alien species of Union concern under EU regulation. © Metalimnion

To be effective, the design, designation, and management of PCAs must be context-specific, reflecting the ecological, hydrological, and socio-political realities of each basin. In many cases, successful conservation outcomes will depend on a nuanced combination of legal designations, governance models, and financial mechanisms, all underpinned by strong public support and inclusive stakeholder engagement. Positive socio-economic outcomes are more likely when PCAs adopt co-management regimes (e.g., for fisheries), empower local communities, reduce inequality, and respect cultural and livelihood values. Importantly, area-based targets must go beyond mere spatial coverage. They should address management effectiveness, institutional coordination, ecological connectivity, and focus on sites with high biodiversity value and real potential to halt and reverse freshwater biodiversity loss. Present evidence suggests that abiotic factors alone are poor surrogates for freshwater species targets in spatial conservation planning. This reinforces the importance of using up-to-date, evidence-based Red List data to guide site selection and management priorities (Spiliopoulou et al., 2023; Watson et al., 2023; Moberg et al., 2024; Sayer et al., 2025).

Invasive non-native species are among the most significant threats to European freshwater fishes identified in this Red List assessment, posing serious risks to the ecological integrity and functioning of freshwater ecosystems across the continent. Both the GBF and EU BDS2030 include explicit targets to manage established non-native species, and the EU maintains a list of species of concern based on formal risk assessments. However, their management remains the responsibility of individual Member States, and non-native species are not explicitly recognised as a quality element for assessment within the WFD. This leads to inconsistencies in how non-native species data are incorporated into assessments of ecological status. To address this gap, the IUCN's Environmental Impact Classification for Alien Taxa (EICAT) offers a robust, standardised framework for evaluating the environmental impacts of non-native species. Broader adoption of EICAT across Europe could support the development of harmonised management objectives and more coherent response strategies at regional and national scales (Carvalho et al., 2019; Boon et al., 2020; IUCN, 2020; van Rees et al., 2021).

Given the species-level differences between this and the previous assessment, the data generated through this European Red List must now be disseminated and embedded into planning and decision-making processes at all levels - from local conservation action to international policy frameworks. Integration with sectors such as agriculture and energy is vital, given their direct impacts on freshwater ecosystems, and tools like the Integrated Biodiversity Assessment Tool (IBAT) allow private sector users to assess species risk at key locations and inform development decisions, including country-level biodiversity reporting which may be useful for reporting on national biodiversity strategies and action plans (Sayer et al., 2025).

Within the EU, reporting under the HD could be updated to reflect the most recent Red List assessments and taxonomic revisions. Of the 246 EU-native freshwater fish species identified as of elevated conservation concern in this assessment, 72 species (around 30%) are not currently listed under the HD annexes. Conversely, 68 species included in the HD are assessed as LC, highlighting the importance of periodic review and alignment of policy instruments with best-available scientific evidence. In addition, research indicates that existing Natura 2000 sites could substantially improve freshwater fish conservation outcomes with only modest updates to their target species lists. Regardless of EU-level listings, Member States also retain the ability to strengthen legal protection for unlisted species through national mechanisms - such as National Biodiversity Strategies and Action Plans under the CBD, the LIFE Programme, or Prioritised Action Frameworks within Natura 2000 (Hermoso et al., 2019, 2022).

Finally, during the compilation of this report, it became apparent that the terminology used to describe the target ecosystem - specifically "freshwater" versus "inland waters" - is increasingly inconsistent across policy and scientific frameworks. This lack of clarity can lead to confusion, particularly when engaging with legislation or policies that interpret these terms differently. To improve coherence and align with international usage, future iterations of the *European Red List of Freshwater Fishes* may benefit from adopting more inclusive and consistent terminology, such as "Inland Water Fishes". This would better reflect the scope of the assessment - which includes species found in brackish, transitional, and even marine waters - and enhance alignment with global biodiversity and water-related policy instruments.

5.2 Future research and action

Despite encouraging progress in policy regarding the inclusion of inland waters in international biodiversity frameworks - freshwater conservation research remains markedly underrepresented within the broader biodiversity science landscape. Therefore, it is to be hoped that the renewed political momentum will also stimulate increased research investment and capacity-building focused specifically on freshwater biodiversity (Tydecks et al., 2018).

In this context, national-level conservation planning must be strengthened through regular Red List reassessments, particularly for freshwater fishes and other understudied groups. Moreover, while broader extinction risk status can help inform priority-setting where local data are lacking, countries should be encouraged and supported to generate their own national assessments. This will provide a more accurate understanding of national conservation needs and improve alignment between species' legal protections and their actual risk status - addressing discrepancies that still exist in many national legislations.

Seasonal and intermittent rivers and streams remain underrepresented in legislation and conservation planning. Image shows the Spercheios River, Greece, which supports several NT and threatened fish species. © Robin Iversen Rönnlund /Wikimedia Commons, CC BY-SA 3.0

The IUCN RLI is a global biodiversity indicator relied upon to track trends in extinction risk, yet it depends on taxa being assessed for the Red List at least twice to detect genuine changes in status. Therefore, timely reassessments are essential - not only to reflect shifts in population status and emerging threats, but also to account for ongoing taxonomic revisions. Moreover, under GBF Goal A, countries are explicitly tasked with using RLIs to evaluate national progress. However, reassessments remain constrained by limited freshwater monitoring capacity in many European countries. Expanding this capacity is a critical prerequisite for tracking freshwater biodiversity change and informing effective conservation action.

In addition to reassessments under the Red List framework, new tools like the IUCN Green Status of Species provide an opportunity to evaluate conservation success and recovery potential. While only a small number of freshwater fish species have undergone Green Status assessment to date, preliminary evidence from this European Red List suggests that genuine improvements in extinction risk may already be emerging for some species - offering a powerful incentive for continued and targeted conservation interventions. However, this again hinges on the availability of robust species-level population data, which remains patchy across much of the region.

An additional challenge lies in the longstanding biases within freshwater research and policy, which have tended to focus on perennial rivers and large lakes, often to the detriment of other ecologically significant habitats. Small lentic systems such as ponds, as well as springs, intermittent rivers, and artificial wetlands, remain underrepresented in legislation and conservation planning, despite supporting high levels of endemism and being particularly vulnerable to environmental change. This issue is especially acute in southern Europe, where karstic and intermittent systems harbour some of the continent's highest concentrations of threatened endemic freshwater fishes. However, these habitats are seldom included in standard monitoring frameworks, and research into appropriate environmental flow regimes or effective restoration strategies remains extremely limited. The *IUCN Global Ecosystem Typology*, which classifies 39 mutually exclusive ecosystem functional groups within the freshwater (e.g., rivers and lakes) and related transitional (e.g., palustrine and subterranean) realms, provides a globally consistent structure to guide research and inventory efforts for these overlooked systems. Moreover, the data presented in this freshwater fishes report could inform priorities for evaluation under the *IUCN Red List of Ecosystems Categories and Criteria*, the application of which remains largely incomplete for European freshwater ecosystems (Keith et al., 2020; Arthington, 2021; van Rees et al., 2021; IUCN, 2024b).

To advance area-based targets under the GBF and EU BDS2030, the updated Red List data for freshwater fishes can inform the identification and reassessment of freshwater KBAs across Europe. These data are expected to play a key role in the application of forthcoming regional KBA guidelines. This process is essential to determine whether existing PAs and other conservation mechanisms adequately capture sites of high freshwater biodiversity value, and to identify critical protection and restoration gaps. The expansion of PCAs should be guided not merely by spatial targets, but by biodiversity needs, ensuring high-priority freshwater sites are safeguarded and that management effectiveness is maximised (Spiliopoulou et al., 2023).

At the same time, scientific knowledge and policy tools alone are insufficient to drive large-scale conservation gains. A growing body of evidence underscores the need to shift societal values, perceptions, and behaviours to unlock transformative change. Freshwater biodiversity remains largely invisible in public discourse, often valued only for provisioning services like drinking water, energy, and fisheries, rather than for its intrinsic ecological importance. There is an urgent need for smarter and more strategic communication, grounded in principles from conservation psychology, to reframe public understanding of freshwater ecosystems and galvanise action. Initiatives such as the "World's Forgotten Fishes" campaign, which reached more than 2 billion people through over 400 media outlets across 45 countries, demonstrate the powerful impact that targeted outreach can have (WWF, 2021; Birnie-Gauvin, 2023)

By collaborating with natural resource managers, policymakers, and the public through co-production processes, inland water specialists can connect people with freshwater resources and present scientific arguments in ways that are credible, relevant, legitimate, and solutions-focused. It is time to shift the narrative: freshwater biodiversity must no longer be invisible and overlooked, but valued, protected, and conserved (Birnie-Gauvin et al., 2023).

5.3 Conclusions

Freshwater fishes represent the most diverse group of vertebrates on Earth, inhabiting ecosystems that are not only essential to their survival but also critical to human development and well-being. As key ecological indicators, they help signal the health of freshwater systems and underpin a broad range of ecosystem services - including food provision, recreation, and cultural heritage. Yet, despite their significance, over 40% of Europe's freshwater fishes are currently threatened with extinction, and almost two-thirds are of elevated conservation concern, being classified as either threatened or NT.

These findings underscore a clear and urgent need for increased investment in the currently underfunded research and Red Listing efforts for freshwater biodiversity in Europe. Strengthening the scientific foundations of conservation - through improved monitoring, assessment, and feedback mechanisms - will be essential to support evidence-based management and achieve international biodiversity targets.

A paradigm shift is needed across Europe: one that redefines our relationship with freshwater ecosystems - not as extensions of terrestrial landscapes or mere commodities, but as biodiverse, dynamic, and indispensable living systems that sustain all life. Encouragingly, this need is increasingly reflected in international biodiversity strategies, presenting a critical opportunity that must be seized.

Looking ahead, it is essential that the insights and recommendations from this *European Red List of Freshwater Fishes* are translated into practical conservation and management actions. These must be embedded across policy frameworks at local, national, and regional levels to effectively safeguard Europe's freshwater heritage and reverse the ongoing decline of inland water biodiversity - for nature, for people, and for the planet.

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Appendices

Appendix 1

Overview of European freshwater fish species listed under the Bern Convention, EU Habitats Directive, CITES, and European Wildlife Trade regulations, listed alphabetically by species name.

*Note: Parentheses indicate species that are not explicitly listed but are considered to have inherited listed status due to taxonomic revisions (e.g., following the splitting of a parent taxon) or other circumstances, such as Croatia's accession to the European Union. Species marked with ° are included in the Revised Annex I of Resolution 6 (1998) of the Bern Convention, which identifies species requiring specific habitat conservation measures. Species marked with * are not formally listed in the EU Habitats Directive itself but are accepted for reporting under Article 17 and are therefore assumed to be covered by the Directive. Species assessed as EX in the current Red List assessment have been excluded from the table. For further details regarding the scope and provisions of these international agreements, please refer to Section 1.2 of this report.*

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Achondrostoma arcasii	III°	II	-	-	-
Achondrostoma occidentale	(III)	II*	-	-	-
Achondrostoma oligolepis	(III)°	II*	-	-	-
Achondrostoma salmantinum	(III)	II*	-	-	-
Acipenser gueldenstaedtii	-	V	II	B	II
Acipenser naccarii	II°	II, IV	II	B	II
Acipenser nudiventris	-	V	II	B	II
Acipenser oxyrinchus	-	(II, IV)*	II	B	-
Acipenser persicus	-	-	II	B	II
Acipenser ruthenus	III	V	II	B	II
Acipenser stellatus	III	V	II	B	II
Acipenser sturio	II°	II, IV	I	A	I
Alburnoides bipunctatus	III	-	-	-	-
Alburnoides devolli	(III)	-	-	-	-
Alburnoides economoui	(III)	-	-	-	-
Alburnoides fangfangae	(III)	-	-	-	-
Alburnoides maculatus	(III)	-	-	-	-
Alburnoides ohridanus	(III)	-	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Alburnoides prespensis	(III)	-	-	-	-
Alburnoides rossicus	(III)	-	-	-	-
Alburnoides strymonicus	(III)	-	-	-	-
Alburnoides thessalicus	(III)	-	-	-	-
Alburnoides tzanevi	(III)	-	-	-	-
Alburnus albidus	III°	II	-	-	-
Alburnus chalcoides	III°	-	-	-	-
Alburnus danubicus	(III)	(II)	-	-	-
Alburnus istanbulensis	(III)	-	-	-	-
Alburnus leobergi	(III)	-	-	-	-
Alburnus mandrensis	(III)	II*	-	-	-
Alburnus mento	(III)	II*	-	-	-
Alburnus mentoides	(III)	-	-	-	-
Alburnus sarmaticus	(III)	II*	-	-	-
Alburnus sava	(III)	II*	-	-	-
Alburnus schischkovi	(III)	II*	-	-	-
Alburnus vistonicus	(III)	II*	-	-	-
Alburnus volviticus	(III)	II*	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Alosa agone	-	II, V	-	-	-
Alosa alosa	III°	II, V	-	-	-
Alosa caspia	°	-	-	-	-
Alosa fallax	III°	II, V	-	-	-
Alosa immaculata	(III)°	II, V	-	-	-
Alosa kessleri	°	-	-	-	-
Alosa killarnensis	°	II, V	-	-	-
Alosa macedonica	°	II, V	-	-	-
Alosa maeotica	°	(II, V)	-	-	-
Alosa tanaica	°	II, V	-	-	-
Alosa vistonica	°	II, V	-	-	-
Alosa volgensis	°	-	-	-	-
Alpinocottus poecilopus	III	-	-	-	-
Anaecypris hispanica	III°	II, IV	-	-	-
Anguilla anguilla	-	-	II	B	II
Aphanius almiriensis	(II, III)	II*	-	-	-
Aphanius fasciatus	II, III°	II	-	-	-
Apricaphanius baeticus	(II, III)	II*	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Apricaphanius iberus	II, III°	II	-	-	-
Aulopyge huegelii	-	II	-	-	-
Ballerus ballerus	III	-	-	-	-
Ballerus sapa	III	-	-	-	-
Barbus balcanicus	(III)	II, V*	-	-	-
Barbus barbus	-	V	-	-	-
Barbus bergi	(III)	II, V*	-	-	-
Barbus caninus	(III)	II, V*	-	-	-
Barbus carpathicus	(III)	II, V*	-	-	-
Barbus cyclolepis	(III)	II, V*	-	-	-
Barbus euboicus	(III)	II, V*	-	-	-
Barbus fucini	(III)	(II, V)	-	-	-
Barbus haasi	-	V*	-	-	-
Barbus macedonicus	-	V*	-	-	-
Barbus meridionalis	III°	II, V	-	-	-
Barbus peloponnesius	(III)	II, V*	-	-	-
Barbus pergamonensis	(III)	II, V*	-	-	-
Barbus petenyi	(III)	II, V*	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Barbus plebejus	III°	II, V	-	-	-
Barbus prespensis	(III)	II, V*	-	-	-
Barbus samniticus	(III)	(II, V)	-	-	-
Barbus sperchiensis	(III)	II, V*	-	-	-
Barbus strumicae	(III)	II, V*	-	-	-
Barbus tyberinus	(III)	II, V*	-	-	-
Caspiomyzon graecus	(III)°	II*	-	-	-
Caspiomyzon hellenicus	III	II*	-	-	-
Chondrostoma knerii	III	II	-	-	-
Chondrostoma nasus	III	-	-	-	-
Chondrostoma phoxinus	III	II	-	-	-
Chondrostoma soetta	III°	II	-	-	-
Cobitis arachthosensis	(III)	II*	-	-	-
Cobitis bilineata	(III)	II*	-	-	-
Cobitis calderoni	III	II*	-	-	-
Cobitis dalmatina	(III)	II*	-	-	-
Cobitis elongata	III°	II	-	-	-
Cobitis elongatoides	(III)°	II*	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Cobitis hellenica	(III)	II*	-	-	-
Cobitis herzegoviniensis	(III)	-	-	-	-
Cobitis illyrica	(III)	II*	-	-	-
Cobitis jadovaensis	(III)	II*	-	-	-
Cobitis meridionalis	(III)	II*	-	-	-
Cobitis narentana	(III)	II*	-	-	-
Cobitis ohridana	(III)	II*	-	-	-
Cobitis paludica	III	II*	-	-	-
Cobitis pontica	(III)°	II*	-	-	-
Cobitis puncticulata	(III)	II*	-	-	-
Cobitis punctilineata	(III)	II*	-	-	-
Cobitis stephanidisi	(III)	II*	-	-	-
Cobitis strumicae	(III)°	II*	-	-	-
Cobitis taenia	III°	II	-	-	-
Cobitis tanaitica	(III)°	II*	-	-	-
Cobitis taurica	(III)	-	-	-	-
Cobitis trichonica	III°	II	-	-	-
Cobitis vardarensis	(III)	II*	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Cobitis vettonica	(III)	II*	-	-	-
Cobitis zanandreai	(III)	II*	-	-	-
Coregonus acrinasus	III	-	-	-	-
Coregonus albellus	III	-	-	-	-
Coregonus albula	III	V	-	-	-
Coregonus alpinus	III	-	-	-	-
Coregonus arenicolus	III	V	-	-	-
Coregonus atterensis	III	V	-	-	-
Coregonus austriacus	III	V	-	-	-
Coregonus autumnalis	III	-	-	-	-
Coregonus baerii	III	-	-	-	-
Coregonus bavaricus	III	V	-	-	-
Coregonus bezola	III	-	-	-	-
Coregonus brienzii	III	-	-	-	-
Coregonus candidus	III	-	-	-	-
Coregonus clupeoides	III	-	-	-	-
Coregonus confusus	III	-	-	-	-
Coregonus danneri	III	V	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Coregonus duplex	III	-	-	-	-
Coregonus fatioi	III	-	-	-	-
Coregonus fera	III	-	-	-	-
Coregonus fontanae	III	V	-	-	-
Coregonus gutturosus	III	-	-	-	-
Coregonus heglingus	III	-	-	-	-
Coregonus hiemalis	III	-	-	-	-
Coregonus hoferi	III	-	-	-	-
Coregonus holsatus	III	V	-	-	-
Coregonus intermundia	III	-	-	-	-
Coregonus kiletz	III	-	-	-	-
Coregonus ladogae	III	-	-	-	-
Coregonus lavaretus	III	V	-	-	-
Coregonus litoralis	III	-	-	-	-
Coregonus lucinensis	III	V	-	-	-
Coregonus lutokka	III	-	-	-	-
Coregonus macrophthalmus	III	V	-	-	-
Coregonus maraena	III	V	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Coregonus maraenoides	III	V	-	-	-
Coregonus maxillaris	III	V	-	-	-
Coregonus megalops	III	V	-	-	-
Coregonus muelleri	III	-	-	-	-
Coregonus muksun	III	-	-	-	-
Coregonus nasus	III	-	-	-	-
Coregonus nilssoni	III	V	-	-	-
Coregonus nobilis	III	-	-	-	-
Coregonus obliterus	III	-	-	-	-
Coregonus palaea	III	-	-	-	-
Coregonus pallasii	III	V	-	-	-
Coregonus peled	III	-	-	-	-
Coregonus pennantii	III	-	-	-	-
Coregonus pidschian	III	V	-	-	-
Coregonus pollan	III	V	-	-	-
Coregonus profundus	III	-	-	-	-
Coregonus renke	III	-	-	-	-
Coregonus restrictus	III	-	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Coregonus sarnensis	III	-	-	-	-
Coregonus steinmanni	III	-	-	-	-
Coregonus stigmaticus	III	-	-	-	-
Coregonus suidteri	III	-	-	-	-
Coregonus supersum	III	-	-	-	-
Coregonus suspensus	III	-	-	-	-
Coregonus trybomi	III	V	-	-	-
Coregonus vandesius	III	-	-	-	-
Coregonus vessicus	III	-	-	-	-
Coregonus wartmanni	III	V	-	-	-
Coregonus widegreni	III	V	-	-	-
Coregonus zuerichensis	III	-	-	-	-
Coregonus zugensis	III	-	-	-	-
Cottus aturi	-	II*	-	-	-
Cottus duranii	-	II*	-	-	-
Cottus gobio	°	II	-	-	-
Cottus haemusi	-	II*	-	-	-
Cottus hispaniolensis	-	II*	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Cottus koshewnikowi	-	II*	-	-	-
Cottus metae	-	II*	-	-	-
Cottus microstomus	-	II*	-	-	-
Cottus perifretum	-	II*	-	-	-
Cottus petiti	°	II	-	-	-
Cottus rhenanus	-	II*	-	-	-
Cottus rondeleti	-	II*	-	-	-
Cottus sabaudicus	-	II*	-	-	-
Cottus transsilvaniae	-	II*	-	-	-
Delminichthys adspersus	III	II*	-	-	-
Delminichthys ghetaldii	-	II*	-	-	-
Delminichthys jadovensis	(III)	II*	-	-	-
Delminichthys krbavensis	-	II*	-	-	-
Economidichthys pygmaeus	(II, III)	II*	-	-	-
Economidichthys trichonis	(II, III)	II*	-	-	-
Eudontomyzon danfordi	°	II	-	-	-
Eudontomyzon mariae	III°	II	-	-	-
Eudontomyzon stankokaramani	°	-	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Eudontomyzon vladykovi	III°	II	-	-	-
Gymnocephalus ambriaelacus	(III)	(II, IV)	-	-	-
Gymnocephalus baloni	III°	II, IV	-	-	-
Gymnocephalus schraetser	III°	II, V	-	-	-
Hucho hucho	III°	II, V	-	-	-
Huso huso	II, III	V	II	B	II
Iberochondrostoma almacai	(III)	II*	-	-	-
Iberochondrostoma lemmingii	III°	II	-	-	-
Iberochondrostoma lusitanicum	III°	II	-	-	-
Iberochondrostoma oretanum	(III)	II*	-	-	-
Knipowitschia goerneri	(II, III)	II*	-	-	-
Knipowitschia milleri	(II, III)	II*	-	-	-
Knipowitschia montenegrina	(III)	-	-	-	-
Knipowitschia mrakovcici	(II, III)	(II)	-	-	-
Knipowitschia panizzae	III°	II	-	-	-
Knipowitschia radovici	(II, III)	(II)	-	-	-
Knipowitschia thessala	III	-	-	-	-
Ladigesocypris ghigii	°	II	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Lampetra alavariensis	(III)	II*	-	-	-
Lampetra auremensis	(III)	II*	-	-	-
Lampetra fluviatilis	III	II, V	-	-	-
Lampetra lusitanica	(III)	II*	-	-	-
Lampetra planeri	III	II	-	-	-
Lampetra soljani	(II, III)	(II, V)	-	-	-
Lampetra zanandreai	II, III°	II, V	-	-	-
Leucaspius delineatus	III	-	-	-	-
Leuciscus aspius	III°	II, V	-	-	-
Leucos albus	(III)	-	-	-	-
Leucos aula	(III)	(II)	-	-	-
Leucos basak	(III)	(II)	-	-	-
Luciobarbus albanicus	-	V*	-	-	-
Luciobarbus bocagei	III	V*	-	-	-
Luciobarbus capito	°	-	-	-	-
Luciobarbus comizo	III	II, V	-	-	-
Luciobarbus graecus	-	V*	-	-	-
Luciobarbus graellsii	-	V*	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Luciobarbus guiraonis	-	V*	-	-	-
Luciobarbus microcephalus	III	V*	-	-	-
Luciobarbus sclateri	III	V*	-	-	-
Luciobarbus steindachneri	III	V*	-	-	-
Misgurnus fossilis	III°	II	-	-	-
Myoxocephalus quadricornis	III	-	-	-	-
Neogobius fluviatilis	III	-	-	-	-
Ninnigobius canestrinii	II, III°	II	-	-	-
Ninnigobius montenegrensis	(II, III)		-	-	-
Orsinigobius croaticus	-	II	-	-	-
Pachychilon macedonicum	III	-	-	-	-
Pachychilon pictum	III	-	-	-	-
Padogobius bonelli	(III)	-	-	-	-
Padogobius nigricans	III°	II	-	-	-
Parachondrostoma arrigonis	(III)	II*	-	-	-
Parachondrostoma miegii	(III)	II*	-	-	-
Parachondrostoma toxostoma	III°	II	-	-	-
Parachondrostoma turiense	III°	II	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Pelasgus epiroticus	-	II*	-	-	-
Pelasgus laconicus	-	II*	-	-	-
Pelasgus marathonicus	III	II*	-	-	-
Pelasgus prespensis	-	II*	-	-	-
Pelasgus stymphalicus	III	II*	-	-	-
Pelasgus thesproticus	(III)	II*	-	-	-
Pelecus cultratus	III°	II, V	-	-	-
Petromyzon marinus	III°	II	-	-	-
Phoxinellus alepidotus	°	II	-	-	-
Phoxinellus dalmaticus	°	II	-	-	-
Phoxinellus pseudalepidotus	°	-	-	-	-
Pomatoschistus microps	III	-	-	-	-
Ponticola kessleri	III	-	-	-	-
Ponticola syrman	III	-	-	-	-
Protochondrostoma genei	III°	II	-	-	-
Pseudochondrostoma duriense	(III)	II*	-	-	-
Pseudochondrostoma polylepis	III°	II	-	-	-
Pseudochondrostoma willkommii	III	II	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Pungitius hellenicus	III	-	-	-	-
Pungitius platygaster	III	-	-	-	-
Rhodeus amarus	III°	II*	-	-	-
Rhodeus meridionalis	(III)	II*	-	-	-
Rhynchocypris percnurus	°	II, IV	-	-	-
Romanichthys valsanicola	II°	II, IV	-	-	-
Romanogobio albipinnatus	III°	-	-	-	-
Romanogobio antipai	(III)	(II)	-	-	-
Romanogobio banarescui	(III)	(II)	-	-	-
Romanogobio belingi	(III)	II*	-	-	-
Romanogobio carpathorossicus	(III)	(II)	-	-	-
Romanogobio elimeius	(III)	II*	-	-	-
Romanogobio kesslerii	III°	II	-	-	-
Romanogobio skywalkeri	(III)	II*	-	-	-
Romanogobio tanaiticus	(III)	-	-	-	-
Romanogobio uranoscopus	III°	II	-	-	-
Romanogobio vladykovi	(III)	II*	-	-	-
Rutilus frisii	III	-	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Rutilus meidingeri	-	II, V	-	-	-
Rutilus panosi	(III)	II*	-	-	-
Rutilus pigus	III°	II, V	-	-	-
Rutilus virgo	(III)	II*	-	-	-
Rutilus ylikiensis	(III)	II*	-	-	-
Sabanejewia balcanica	(III)	II*	-	-	-
Sabanejewia baltica	(III)	II*	-	-	-
Sabanejewia bulgarica	(III)	II*	-	-	-
Sabanejewia larvata	III°	II	-	-	-
Sabanejewia maeotica	(III)	(II)	-	-	-
Sabanejewia vallachica	(III)	II*	-	-	-
Salariopsis economidisi	(III)	-	-	-	-
Salariopsis fluviatilis	III	-	-	-	-
Salmo cettii	-	II*	-	-	-
Salmo farioides	-	II*	-	-	-
Salmo fibreni	-	II*	-	-	-
Salmo lourosensis	-	II*	-	-	-
Salmo macedonicus	-	II*	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Salmo marmoratus	°	II	-	-	-
Salmo obtusirostris	-	II	-	-	-
Salmo pelagonicus	-	II*	-	-	-
Salmo peristericus	-	II*	-	-	-
Salmo salar	III°	II, V	-	-	-
Sander volgensis	III	-	-	-	-
Sarmarutilus rubilio	III°	II	-	-	-
Scardinius graecus	III°	II	-	-	-
Scardinius racovitzai	III	-	-	-	-
Silurus aristotelis	III°	II, V	-	-	-
Silurus glanis	III	-	-	-	-
Squalius alburnoides	III°	II	-	-	-
Squalius aradensis	(III)	-	-	-	-
Squalius castellanus	(III)	-	-	-	-
Squalius illyricus	III	-	-	-	-
Squalius keadicus	(III)	II*	-	-	-
Squalius lucumonis	III°	II	-	-	-
Squalius malacitanus	(III)	-	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Squalius microlepis	III	II	-	-	-
Squalius palaciosi	-	II	-	-	-
Squalius pyrenaicus	III	-	-	-	-
Squalius svallize	III	II	-	-	-
Squalius tenellus	(III)	-	-	-	-
Squalius torgalensis	(III)	-	-	-	-
Squalius valentinus	(III)	-	-	-	-
Squalius zrmanjae	(III)	-	-	-	-
Syngnathus abaster	III	-	-	-	-
Telestes beoticus	-	II*	-	-	-
Telestes croaticus	-	II*	-	-	-
Telestes fontinalis	-	II*	-	-	-
Telestes karsticus	-	(II)	-	-	-
Telestes miloradi	-	II*	-	-	-
Telestes muticellus	(III)	II*	-	-	-
Telestes pleurobipunctatus	-	II*	-	-	-
Telestes polylepis	III	(II)	-	-	-
Telestes souffia	III	II	-	-	-

Species	Bern Convention	Hab. Directive	CITES	EU Wildlife Trade regulations	CMS
Telestes turskyi	III	-	-	-	-
Telestes ukliva	III	(II)	-	-	-
Thymallus aeliani	(III)	(V)	-	-	-
Thymallus ligericus	(III)	(V)	-	-	-
Thymallus thymallus	III	V	-	-	-
Tropidophoxinellus hellenicus	(III)	II*	-	-	-
Tropidophoxinellus spartiaticus	(III)	II*	-	-	-
Umbra krameri	II°	II	-	-	-
Valencia hispanica	II°	II, IV	-	-	-
Valencia letourneuxi	II°	II, IV	-	-	-
Valencia robertae	(II)	II, IV*	-	-	-
Vimba vimba	III	-	-	-	-
Zingel asper	II°	II, IV	-	-	-
Zingel balcanicus	(III)°	II*	-	-	-
Zingel streber	III°	II	-	-	-
Zingel zingel	III°	II, V	-	-	-

Appendix 2

Overview of nomenclatural and taxonomic changes affecting European freshwater fishes since the previous European Red List (Freyhof & Brooks, 2011), arranged alphabetically by family.

Note: This list primarily includes changes accepted up to 31st December 2022. For clarification of exceptional cases included despite publication after this date, please refer to Section 2.2 of this report.

Family	Species	Taxonomic action	Source
Acheilognathidae	All member species	Family change from Cyprinidae	Tan & Armbruster, 2018
Aphaniidae	All member species	Family change from Cyprinodontidae	Freyhof et al., 2017
	Apricaphanius baeticus	Generic change from *Aphanius*	Freyhof & Yoğurtçuoğlu, 2020
	Apricaphanius iberus	Generic change from *Aphanius*	Freyhof & Yoğurtçuoğlu, 2020
Atherinidae	*Atherina caspia*	Removed from synonymy with *Atherina boyeri*	Esmaeili et al., 2010
Blenniidae	*Salariopsis economidisi*	Generic change from *Salaria*	Vecchioni et al., 2022
	Salariopsis fluviatilis	Generic change from *Salaria*	Vecchioni et al., 2022
Clupeidae	*Clupeonella caspia*	Synonymised with *Clupeonella cultriventris*	Dyldin et al., 2020
	Clupeonella tscharchalensis	Synonymised with *Clupeonella cultriventris*	Dyldin et al., 2020
Cobitidae	*Cobitis herzegoviniensis*	New species description	Buj et al., 2014
	Sabanejewia maeotica	New species description	Vasil'eva & Vasil'ev, 2023
Cottidae	*Alpinocottus poecilopus*	Generic change from *Cottus*	Bogdanov, 2023
	Cottus cyclophthalmus	New species description	Sideleva et al., 2022

Family	Species	Taxonomic action	Source
Cottidae (cont.)	*Cottus gratzianowi*	New species description	Sideleva et al., 2015
	Cottus sabaudicus	New species description	Sideleva, 2009
	Cottus scaturigo	Synonymised with *Cottus gobio*	Bravničar et al., 2021
	Myoxocephalus quadricornis	Generic change from *Triglopsis*	Mecklenburg et al., 2011
Cyprinidae	*Barbus biharicus*	New species description	Antal et al., 2016
	Barbus fucini	Removed from synonymy with *Barbus tyberinus*	Lorenzoni et al., 2021
	Barbus samniticus	New species description	Lorenzoni et al., 2021
Esocidae	*Esox aquitanicus*	New species description	Denys et al., 2014
	Esox cisalpinus	New species description	Bianco & Delmastro, 2011
Gasterosteidae	*Gasterosteus gymnurus*	Synonymised with *Gasterosteus aculeatus*	Denys et al., 2015
	Pungitius vulgaris	Removed from synonymy with *Pungitius laevis*	Denys et al., 2017
Gobiidae	*Knipowitschia cameliae*	Synonymised with *Knipowitschia caucasica*	Iftime & Oţel, 2021
	Orsinigobius croaticus	Generic change from *Knipowitschia*	Geiger et al., 2014
	Orsinigobius punctatissimus	Generic change from *Knipowitschia*	Geiger et al., 2014
	Ninnigobius canestrinii	Generic change from *Pomatoschistus*	Geiger et al., 2014
	Ninnigobius montenegrensis	Generic change from *Pomatoschistus*	Geiger et al., 2014
Gobiidae	*Ponticola odessicus*	Removed from synonymy with *Ponticola eurycephalus*	Parin et al., 2014

Family	Species	Taxonomic action	Source
Gobionidae	All member species	Family change from Cyprinidae	Tan & Armbruster, 2018
	Gobio balcanicus	Removed from synonymy with *Gobio gobio*	Geiger et al., 2014
	Romanogobio banarescui	Removed from synonymy with *Romanogobio elimeius*	Geiger et al., 2014
	Romanogobio carpathorossicus	Removed from synonymy with *Gobio kesslerii*	Friedrich et al., 2018
	Romanogobio skywalkeri	New species description	Friedrich et al., 2018
Leuciscidae	All member species	Family change from Cyprinidae	Tan & Armbruster, 2018
	Alburnoides devolli	New species description	Bogutskaya et al., 2010
	Alburnoides economoui	New species description	Barbieri et al., 2017
	Alburnoides fangfangae	New species description	Bogutskaya et al., 2010
	Alburnoides strymonicus	Removed from synonymy with *Alburnoides bipunctatus*	Geiger et al., 2014
	Alburnoides thessalicus	Removed from synonymy with *Alburnoides bipunctatus*	Jouladeh-Roudbar et al., 2016
	Alburnoides tzanevi	Removed from synonymy with *Alburnoides bipunctatus*	Turan et al., 2013
	Alburnus danubicus	Removed from synonymy with *Alburnus chalcoides*	Freyhof & Kottelat, 2007
	Alburnus sava	New species description	Bogutskaya et al., 2017
	Iberochondrostoma olisiponense	New species description	Gante et al., 2007
	Leuciscus aspius	Generic change from *Aspius*	Perea et al., 2010
	Leucos albus	New species description	Marić, 2010

Family	Species	Taxonomic action	Source
Leuciscidae (cont.)	*Leucos aula*	Generic change from *Rutilus*	Bianco & Ketmaier, 2014
	Leucos basak	Generic change from *Rutilus*	Bianco & Ketmaier, 2014
	Phoxinus csikii	Removed from synonymy with *Phoxinus phoxinus*	Palandačić et al., 2017
	Phoxinus dragarum	New species description	Denys et al., 2020
	Phoxinus fayollarum	New species description	Denys et al., 2020
	Phoxinus karsticus	New species description	Bianco & De Bonis, 2015
	Phoxinus krkae	New species description	Bogutskaya et al., 2019
	Phoxinus marsilii	Removed from synonymy with *Phoxinus phoxinus*	Palandačić et al., 2017
	Rutilus karamani	Synonymised with *Leucos basak*	Bianco & Ketmaier, 2014
	Rutilus ohridanus	Synonymised with *Leucos basak*	Bianco & Ketmaier, 2014
	Rutilus prespensis	Synonymised with *Leucos basak*	Bianco & Ketmaier, 2014
	Sarmarutilus rubilio	Generic change from *Rutilus*	Bianco & Ketmaier, 2014
	Squalius alburnoides	Generic change from *Iberocypris*	Collares-Pereira & Coelho, 2010
	Squalius fellowesii	Removed from synonymy with *Squalius cephalus*	Turan et al., 2009
	Squalius janae	Synonymised with *Squalius squalus*	Buj et al., 2019
	Squalius palaciosi	Generic change from *Iberocypris*	Collares-Pereira & Coelho, 2010
	Squalius ruffoi	Removed from synonymy with *Squalius squalus*	Bianco & Delmastro, 2011
	Telestes dabar	New species description	Bogutskaya et al., 2012

Family	Species	Taxonomic action	Source
Leuciscidae (cont.)	*Telestes karsticus*	New species description	Marčić et al., 2011
	Telestes miloradi	New species description	Bogutskaya et al., 2012
Mugilidae	*Chelon auratus*	Generic change from *Liza*	Durand et al., 2012
	Chelon ramada	Generic change from *Liza*	Durand et al., 2012
	Chelon saliens	Generic change from *Liza*	Durand et al., 2012
Nemacheilidae	All member species	Family change from Cyprinidae	Tan & Armbruster, 2018
	Barbatula hispanica	Removed from synonymy with *Barbatula quignardi*	Denys et al., 2021
	Barbatula leoparda	New species description	Gauliard et al., 2019
	Barbatula vardarensis	Removed from synonymy with *Barbatula barbatula*	Geiger et al., 2014
Petromyzontidae	*Caspiomyzon graecus*	New species description	Renaud & Economidis, 2010
	Caspiomyzon hellenicus	Generic change from *Eudontomyzon*	Barbieri et al., 2015
	Lampetra alavariensis	New species description	Mateus et al., 2013
	Lampetra auremensis	New species description	Mateus et al., 2013
	Lampetra lusitanica	New species description	Mateus et al., 2013
	Lampetra soljani	New species description	Tutman et al., 2017
Pleuronectidae	*Platichthys luscus*	Removed from synonymy with *Platichthys flesus*	Fricke et al., 2007
	Platichthys solemdali	New species description	Momigliano et al., 2018

Family	Species	Taxonomic action	Source
Salmonidae	*Coregonus acrinasus*	New species description	Selz et al., 2020
	Coregonus austriacus	Removed from synonymy with *Coregonus renke*	Kottelat & Freyhof, 2007
	Coregonus brienzii	New species description	Selz et al., 2020
	Coregonus duplex	Removed from synonymy with *Coregonus zuerichensis*	Kottelat & Freyhof, 2007
	Coregonus holsatus	Removed from synonymy with *Coregonus widegreni*	Kottelat & Freyhof, 2007
	Coregonus intermundia	New species description	Selz & Seehausen, 2023
	Coregonus kiletz	Removed from synonymy with *Coregonus albula*	Kottelat & Freyhof, 2007
	Coregonus litoralis	New species description	Selz & Seehausen, 2023
	Coregonus maraenoides	Removed from synonymy with *Coregonus lavaretus*	Bogutskaya & Naseka, 2004
	Coregonus muelleri	New species description	Selz & Seehausen, 2023
	Coregonus obliterus	New species description	Selz & Seehausen, 2023
	Coregonus profundus	New species description	Selz et al., 2020
	Coregonus sardinella	Synonymised with *Coregonus albula*	Borovikova & Artamonova, 2021
	Coregonus sarnensis	New species description	Selz & Seehausen, 2023
	Coregonus steinmanni	New species description	Selz et al., 2020
	Coregonus supersum	New species description	Selz & Seehausen, 2023
	Coregonus suspensus	New species description	Selz & Seehausen, 2023
	Salmo farioides	Removed from synonymy with *Salmo trutta*	Kottelat & Freyhof, 2007
	Salmo lourosensis	New species description	Delling, 2011

Family	Species	Taxonomic action	Source
Salmonidae (cont.)	*Salmo montenigrinus*	Removed from synonymy with *Salmothymus obtusirostris*	Kottelat & Freyhof, 2007
	Salvelinus colii	Synonymised with *Salvelinus alpinus*	Barthelemy et al., 2023
	Salvelinus fimbriatus	Synonymised with *Salvelinus alpinus*	Barthelemy et al., 2023
	Salvelinus grayi	Synonymised with *Salvelinus alpinus*	Barthelemy et al., 2023
	Salvelinus obtusus	Synonymised with *Salvelinus alpinus*	Barthelemy et al., 2023
	Salvelinus umbla	Synonymised with *Salvelinus alpinus*	Fricke et al., 2022
	Thymallus aeliani	Removed from synonymy with *Thymallus thymallus*	Bianco, 2014
	Thymallus ligericus	New species description	Persat et al., 2019
Syngnathidae	*Syngnathus caspius*	Removed from synonymy with *Syngnathus abaster*	Esmaeili et al., 2010
Tincidae	All member species	Family change from Cyprinidae	Tan & Armbruster, 2018
Valenciidae	*Valencia robertae*	New species description	Freyhof et al., 2014

Appendix 3

Species with revised European Red List categories since the previous assessment, arranged alphabetically by family and excluding those previously assessed as NA or moving from CR to CR(PE). For a full description of the Red List Categories and the criteria for reasons of change, see sections 1.4 and 2.3 of this report, respectively.

Note: Species presented in ***bold*** *have been assessed under a different Red List category within the EU-27 region. Species marked with * were first assessed for the IUCN Red List after the previous European Red List was published, but have been assigned to a different category in the present update.*

Family	Species	Red List Category		Reason for change
		2011	2025	
Acipenseridae	***Acipenser ruthenus***	VU	EN	Non-genuine
Aphaniidae	*Aphanius almiriensis*	CR	LC	Non-genuine
Aphaniidae	*Apricaphanius baeticus*	EN	NT	Non-genuine
Aphaniidae	*Apricaphanius iberus*	EN	NT	Non-genuine
Blenniidae	*Salariopsis economidisi*	CR	EN	Non-genuine
Clupeidae	*Alosa alosa*	LC	CR	Non-genuine
Clupeidae	*Alosa fallax*	LC	NT	Non-genuine
Clupeidae	*Alosa immaculata*	VU	LC	Non-genuine
Clupeidae	*Alosa kessleri*	LC	NT	Non-genuine
Clupeidae	*Alosa killarnensis*	CR	VU	Non-genuine
Clupeidae	*Alosa macedonica*	VU	CR	Non-genuine
Clupeidae	*Alosa vistonica*	CR(PE)	EX	Non-genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Clupeidae	*Alosa volgensis*	EN	EX	Non-genuine
Cobitidae	*Cobitis calderoni*	EN	VU	Non-genuine
Cobitidae	*Cobitis dalmatina*	VU	EN	Non-genuine
Cobitidae	*Cobitis hellenica*	EN	NT	Non-genuine
Cobitidae	*Cobitis illyrica*	CR	EN	Non-genuine
Cobitidae	*Cobitis meridionalis*	VU	EN	Non-genuine
Cobitidae	***Cobitis narentana***	VU	NT	Non-genuine
Cobitidae	***Cobitis ohridana***	LC	NT	Non-genuine
Cobitidae	*Cobitis paludica*	VU	LC	Non-genuine
Cobitidae	*Cobitis puncticulata*	CR	EN	Non-genuine
Cobitidae	*Cobitis punctilineata*	VU	EN	Non-genuine
Cobitidae	*Cobitis stephanidisi*	CR	EN	Non-genuine
Cobitidae	*Cobitis taurica*	CR	EN	Non-genuine
Cobitidae	*Cobitis trichonica*	EN	NT	Non-genuine
Cobitidae	*Cobitis vettonica*	EN	VU	Non-genuine
Cobitidae	*Sabanejewia larvata*	LC	VU	Genuine
Cobitidae	*Sabanejewia romanica*	NT	VU	Genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Cobitidae	*Sabanejewia vallachica*	NT	VU	Genuine
Cottidae	*Cottus aturi*	LC	NT	Non-genuine
Cottidae	*Cottus duranii*	DD	LC	Non-genuine
Cottidae	*Cottus haemusi*	DD	EN	Non-genuine
Cottidae	*Cottus hispaniolensis*	LC	NT	Non-genuine
Cottidae	*Cottus metae*	LC	NT	Non-genuine
Cottidae	*Cottus petiti*	VU	CR	Non-genuine
Cottidae	*Cottus rondeleti*	CR	NT	Non-genuine
Cottidae	*Cottus transsilvaniae*	DD	EN	Non-genuine
Cyprinidae	*Barbus bergi*	LC	NT	Non-genuine
Cyprinidae	*Barbus caninus*	EN	NT	Non-genuine
Cyprinidae	*Barbus euboicus*	CR	EN	Non-genuine
Cyprinidae	*Barbus haasi*	VU	LC	Non-genuine
Cyprinidae	*Barbus macedonicus*	DD	LC	Non-genuine
Cyprinidae	*Barbus plebejus*	LC	NT	Non-genuine
Cyprinidae	***Barbus prespensis***	LC	NT	Non-genuine
Cyprinidae	*Barbus rebeli*	LC	NT	Non-genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Cyprinidae	*Barbus strumicae*	LC	NT	Non-genuine
Cyprinidae	*Barbus tauricus*	VU	NT	Non-genuine
Cyprinidae	*Barbus tyberinus*	NT	EN	Non-genuine
Cyprinidae	*Cyprinus carpio*	VU	NT	Non-genuine
Cyprinidae	*Luciobarbus albanicus*	LC	NT	Non-genuine
Cyprinidae	*Luciobarbus bocagei*	LC	NT	Non-genuine
Cyprinidae	*Luciobarbus brachycephalus*	CR	RE	Non-genuine
Cyprinidae	*Luciobarbus comizo*	VU	NT	Non-genuine
Cyprinidae	*Luciobarbus graecus*	EN	LC	Non-genuine
Cyprinidae	*Luciobarbus graellsii*	LC	NT	Non-genuine
Cyprinidae	*Luciobarbus guiraonis*	VU	NT	Non-genuine
Cyprinidae	*Luciobarbus microcephalus*	VU	NT	Non-genuine
Cyprinidae	*Luciobarbus sclateri*	LC	NT	Genuine
Cyprinidae	*Luciobarbus steindachneri*	VU	NT	Non-genuine
Gasterosteidae	*Pungitius hellenicus*	CR	EN	Non-genuine
Gobiidae	*Benthophiloides brauneri*	DD	LC	Non-genuine
Gobiidae	*Benthophilus mahmudbejovi*	LC	DD	Non-genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Gobiidae	*Economidichthys pygmaeus*	LC	NT	Non-genuine
Gobiidae	*Knipowitschia goerneri*	DD	NT	Non-genuine
Gobiidae	*Knipowitschia montenegrina*	DD	NT	Non-genuine
Gobiidae	*Knipowitschia radovici*	VU	EN	Non-genuine
Gobiidae	*Ninnigobius montenegrensis*	LC	NT	Non-genuine
Gobiidae	*Orsinigobius punctatissimus*	NT	LC	Non-genuine
Gobiidae	*Padogobius nigricans*	VU	EN	Non-genuine
Gobiidae	*Proterorhinus tataricus*	CR	EN	Non-genuine
Gobionidae	*Gobio delyamurei*	CR	EN	Non-genuine
Gobionidae	*Gobio kovatschevi*	VU	LC	Non-genuine
Gobionidae	*Gobio krymensis*	VU	NT	Non-genuine
Gobionidae	*Gobio ohridanus*	VU	EN	Non-genuine
Gobionidae	***Gobio skadarensis***	EN	LC	Non-genuine
Gobionidae	*Romanogobio antipai*	EX	VU	Non-genuine
Gobionidae	*Romanogobio benacensis*	EN	NT	Non-genuine
Gobionidae	*Romanogobio elimeius*	LC	NT	Non-genuine
Leuciscidae	*Achondrostoma arcasii*	VU	NT	Non-genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Leuciscidae	*Achondrostoma occidentale*	EN	CR	Non-genuine
Leuciscidae	*Alburnoides maculatus*	VU	EN	Non-genuine
Leuciscidae	*Alburnoides ohridanus*	VU	NT	Non-genuine
Leuciscidae	*Alburnoides prespensis*	VU	EN	Non-genuine
Leuciscidae	*Alburnus albidus*	VU	EN	Non-genuine
Leuciscidae	*Alburnus arborella*	LC	NT	Non-genuine
Leuciscidae	*Alburnus belvica*	VU	EN	Non-genuine
Leuciscidae	*Alburnus leobergi*	LC	VU	Non-genuine
Leuciscidae	*Alburnus macedonicus*	CR	EN	Non-genuine
Leuciscidae	*Alburnus mandrensis*	CR	EN	Non-genuine
Leuciscidae	*Alburnus neretvae*	LC	NT	Non-genuine
Leuciscidae	*Alburnus schischkovi*	EN	NT	Non-genuine
Leuciscidae	*Alburnus scoranza*	LC	NT	Non-genuine
Leuciscidae	*Alburnus vistonicus*	CR	EN	Non-genuine
Leuciscidae	*Anaecypris hispanica*	EN	NT	Non-genuine
Leuciscidae	*Chondrostoma knerii*	VU	EN	Non-genuine
Leuciscidae	*Chondrostoma nasus*	LC	NT	Non-genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Leuciscidae	*Chondrostoma prespense*	VU	EN	Non-genuine
Leuciscidae	*Chondrostoma soetta*	EN	CR	Genuine
Leuciscidae	*Chondrostoma vardarense*	NT	LC	Non-genuine
Leuciscidae	*Delminichthys adspersus*	VU	EN	Non-genuine
Leuciscidae	*Iberochondrostoma almacai*	CR	EN	Non-genuine
Leuciscidae	*Iberochondrostoma lemmingii*	VU	NT	Non-genuine
Leuciscidae	*Iberochondrostoma lusitanicum*	CR	NT	Non-genuine
Leuciscidae	*Iberochondrostoma olisiponense*	CR	EN	Non-genuine
Leuciscidae	*Iberochondrostoma oretanum*	CR	EN	Non-genuine
Leuciscidae	*Leuciscus bearnensis*	LC	NT	Non-genuine
Leuciscidae	*Leuciscus burdigalensis*	LC	NT	Non-genuine
Leuciscidae	*Leucos aula*	LC	NT	Non-genuine
Leuciscidae	*Pachychilon macedonicum*	DD	LC	Non-genuine
Leuciscidae	***Pachychilon pictum***	LC	NT	Non-genuine
Leuciscidae	*Parachondrostoma arrigonis*	CR	VU	Non-genuine
Leuciscidae	*Parachondrostoma miegii*	LC	NT	Non-genuine
Leuciscidae	*Parachondrostoma toxostoma*	VU	NT	Non-genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Leuciscidae	*Parachondrostoma turiense*	EN	VU	Non-genuine
Leuciscidae	*Pelasgus laconicus*	CR	EN	Non-genuine
Leuciscidae	*Pelasgus minutus*	DD	VU	Non-genuine
Leuciscidae	*Pelasgus stymphalicus*	LC	NT	Non-genuine
Leuciscidae	*Phoxinellus dalmaticus*	CR	EN	Non-genuine
Leuciscidae	*Phoxinellus pseudalepidotus*	VU	EN	Genuine
Leuciscidae	***Phoxinus strandjae***	EN	LC	Non-genuine
Leuciscidae	*Protochondrostoma genei*	LC	VU	Genuine
Leuciscidae	*Pseudochondrostoma duriense*	VU	NT	Non-genuine
Leuciscidae	*Pseudochondrostoma polylepis*	LC	VU	Non-genuine
Leuciscidae	*Pseudochondrostoma willkommii*	VU	NT	Non-genuine
Leuciscidae	*Rutilus meidingeri*	EN	NT	Genuine
Leuciscidae	*Rutilus panosi*	VU	EN	Non-genuine
Leuciscidae	*Rutilus pigus*	LC	VU	Non-genuine
Leuciscidae	*Sarmarutilus rubilio*	NT	VU	Non-genuine
Leuciscidae	*Scardinius acarnanicus*	NT	EN	Non-genuine
Leuciscidae	*Scardinius graecus*	CR	EN	Non-genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Leuciscidae	*Scardinius knezevici*	LC	VU	Non-genuine
Leuciscidae	***Scardinius plotizza***	LC	NT	Non-genuine
Leuciscidae	*Scardinius racovitzai*	CR	EW	Genuine
Leuciscidae	*Squalius alburnoides*	VU	LC	Non-genuine
Leuciscidae	*Squalius albus*	LC	EN	Non-genuine
Leuciscidae	*Squalius carolitertii*	LC	NT	Non-genuine
Leuciscidae	*Squalius laietanus*	LC	VU	Non-genuine
Leuciscidae	*Squalius lucumonis*	EN	CR	Non-genuine
Leuciscidae	*Squalius palaciosi*	CR	EX	Non-genuine
Leuciscidae	*Squalius pamvoticus*	LC	NT	Non-genuine
Leuciscidae	*Squalius prespensis*	LC	EN	Non-genuine
Leuciscidae	*Squalius pyrenaicus*	NT	VU	Genuine
Leuciscidae	***Squalius svallize***	VU	NT	Non-genuine
Leuciscidae	*Squalius valentinus*	VU	NT	Non-genuine
Leuciscidae	*Telestes metohiensis*	VU	EN	Non-genuine
Leuciscidae	*Telestes montenigrinus*	LC	NT	Non-genuine
Leuciscidae	*Telestes turskyi*	CR	EN	Non-genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Leuciscidae	*Telestes ukliva*	EX	EN	Non-genuine
Leuciscidae	*Tropidophoxinellus hellenicus*	LC	NT	Non-genuine
Leuciscidae	*Tropidophoxinellus spartiaticus*	VU	NT	Non-genuine
Leuciscidae	*Vimba melanops*	DD	LC	Non-genuine
Moronidae	*Dicentrarchus labrax*	LC	NT	Genuine
Mugilidae	*Chelon auratus*	LC	NT	Non-genuine
Mugilidae	*Chelon labrosus*	LC	NT	Non-genuine
Mugilidae	*Chelon ramada*	LC	NT	Non-genuine
Mugilidae	*Chelon saliens*	LC	NT	Non-genuine
Nemacheilidae	*Barbatula quignardi*	LC	CR	Non-genuine
Nemacheilidae	*Barbatula sturanyi*	LC	NT	Non-genuine
Nemacheilidae	*Barbatula zetensis*	LC	EN	Non-genuine
Nemacheilidae	***Oxynoemacheilus pindus***	VU	NT	Non-genuine
Percidae	*Gymnocephalus ambriaelacus*	CR	LC	Non-genuine
Percidae	*Percarina demidoffii*	NT	LC	Non-genuine
Percidae	*Zingel asper*	CR	EN	Non-genuine
Percidae	*Zingel balcanicus*	DD	CR	Non-genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Petromyzontidae	*Caspiomyzon hellenicus*	CR	EN	Non-genuine
Petromyzontidae	*Caspiomyzon wagneri*	NT	LC	Genuine
Petromyzontidae	*Eudontomyzon stankokaramani*	LC	NT	Non-genuine
Petromyzontidae	*Lampetra fluviatilis*	LC	NT	Non-genuine
Petromyzontidae	*Lampetra planeri*	LC	NT	Non-genuine
Petromyzontidae	*Lampetra zanandreai*	LC	NT	Non-genuine
Salmonidae	*Coregonus albellus*	LC	VU	Non-genuine
Salmonidae	*Coregonus alpinus*	LC	VU	Non-genuine
Salmonidae	*Coregonus arenicolus*	VU	EN	Non-genuine
Salmonidae	*Coregonus atterensis*	VU	CR	Non-genuine
Salmonidae	*Coregonus baerii*	DD	LC	Non-genuine
Salmonidae	*Coregonus candidus*	VU	EN	Genuine
Salmonidae	*Coregonus danneri*	VU	CR	Non-genuine
Salmonidae	*Coregonus fatioi*	LC	VU	Non-genuine
Salmonidae	*Coregonus fontanae*	LC	CR	Genuine
Salmonidae	*Coregonus heglingus*	DD	VU	Non-genuine
Salmonidae	*Coregonus hoferi*	CR	EX	Non-genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Salmonidae	*Coregonus lucinensis*	VU	CR	Genuine
Salmonidae	*Coregonus macrophthalmus*	LC	EN	Non-genuine
Salmonidae	*Coregonus maraena*	VU	LC	Non-genuine
Salmonidae	*Coregonus nobilis*	LC	VU	Non-genuine
Salmonidae	*Coregonus palaea*	LC	EN	Genuine
Salmonidae	*Coregonus pennantii*	CR	EN	Non-genuine
Salmonidae	***Coregonus pollan***	EN	VU	Non-genuine
Salmonidae	*Coregonus renke*	DD	EX	Non-genuine
Salmonidae	*Coregonus stigmaticus*	EN	VU	Non-genuine
Salmonidae	*Coregonus suidteri*	LC	VU	Non-genuine
Salmonidae	*Coregonus trybomi*	CR	EX	Non-genuine
Salmonidae	*Coregonus vessicus*	LC	CR	Genuine
Salmonidae	*Coregonus wartmanni*	LC	EN	Non-genuine
Salmonidae	*Coregonus widegreni*	DD	LC	Non-genuine
Salmonidae	*Coregonus zuerichensis*	LC	VU	Non-genuine
Salmonidae	*Coregonus zugensis*	LC	EX	Non-genuine
Salmonidae	***Hucho hucho***	EN	VU	Non-genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Salmonidae	*Salmo aphelios*	DD	EN	Non-genuine
Salmonidae	*Salmo balcanicus*	DD	CR(PE)	Non-genuine
Salmonidae	*Salmo carpio*	CR	EN	Non-genuine
Salmonidae	*Salmo cettii*	NT	CR	Non-genuine
Salmonidae	*Salmo fibreni*	VU	CR	Non-genuine
Salmonidae	*Salmo letnica*	DD	EN	Non-genuine
Salmonidae	*Salmo lumi*	DD	EN	Non-genuine
Salmonidae	*Salmo macedonicus*	DD	LC	Non-genuine
Salmonidae	*Salmo marmoratus*	LC	VU	Non-genuine
Salmonidae	*Salmo obtusirostris*	EN	VU	Non-genuine
Salmonidae	*Salmo ohridanus*	VU	EN	Non-genuine
Salmonidae	***Salmo pelagonicus***	VU	LC	Non-genuine
Salmonidae	*Salmo rhodanensis*	DD	LC	Non-genuine
Salmonidae	*Salmo schiefermuelleri*	DD	EX	Non-genuine
Salmonidae	*Salmo taleri*	DD	EN	Non-genuine
Salmonidae	*Salvelinus inframundus*	DD	EX	Non-genuine
Salmonidae	*Salvelinus lonsdalii*	CR	VU	Genuine

Family	Species	Red List Category		Reason for change
		2011	2025	
Salmonidae	*Salvelinus murta*	LC	VU	Non-genuine
Salmonidae	*Salvelinus profundus*	EX	EN	Non-genuine
Salmonidae	*Salvelinus thingvallensis*	LC	VU	Non-genuine
Salmonidae	*Salvelinus willoughbii*	EN	CR	Non-genuine
Salmonidae	*Stenodus leucichthys*	EW	NT	Non-genuine
Salmonidae	*Thymallus aeliani**	CR	EN	Non-genuine
Siluridae	*Silurus aristotelis*	DD	EN	Non-genuine
Valenciidae	*Valencia hispanica*	CR	VU	Genuine

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SSC
Species Survival Commission

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Freshwater Fish Specialist Group