



Generation  
Climate  
Europe

# The Hidden Species of Freshwater Ecosystems

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## Introduction

Freshwater environments such as rivers, lakes, streams, wetlands and ponds cover less than one percent of the Earth's surface, yet they are home to [around 125,000 species](#). This represents roughly a tenth of all known species. These ecosystems play an essential role in **regulating the water cycle, filtering pollutants, storing carbon, and providing food and livelihoods for millions of people**. Despite their importance, freshwater habitats are among the most threatened on the planet, [facing pressures](#) from **pollution, invasion, habitat fragmentation and climate change**.

This article introduces three species that can offer insights into the health of freshwater ecosystems: the **freshwater pearl mussel, siphonoperla torrentium**, and the **louisiana crawfish**.

## Freshwater pearl mussels: meet the hard-working engineers of Europe's rivers

### Freshwater pearl mussel (*Margaritifera margaritifera*)



- **Size:** Up to 16 cm
- **Lifespan:** Over 280 years
- **Habitat:** Clean, fast-flowing rivers
- **Role:** Ecosystem engineer, water filter
- **Why it matters:** Keeps rivers clean; signals long-term river health

Source : Freshwater pearl mussels (*Margaritifera margaritifera*) on river bed, Ennerdale Valley, Lake District NP, Cumbria, England, UK, October 2011, Author: Linda Pitkin / 2020VISION

The freshwater pearl mussel has many unique traits! It can grow up to **16 cm long** and live for over **280 years**, making it one of Europe's longest-living freshwater species. These mussels are sedentary bivalves that live buried in riverbeds, lakes and streams. Interestingly, they have two sexes, and females can even become **self-fertile hermaphrodites**. Throughout their life span, they can produce **hundreds of millions of larvae**. Sadly, its population has [declined by over 90% in Europe](#) over the past 90 years, primarily due to habitat loss. This has led to its listing as a "Critically Endangered" species in Europe on the [IUCN Red List](#), which provides the official conservation status of species worldwide.

Their survival and reproduction are highly dependent on the quality and stability of the ecosystem, but they also filter up to **50 litres of water each day**, helping to keep rivers clean and healthy. Therefore, this species plays a key ecological function as the *ecosystem engineer* of the freshwater ecosystem.

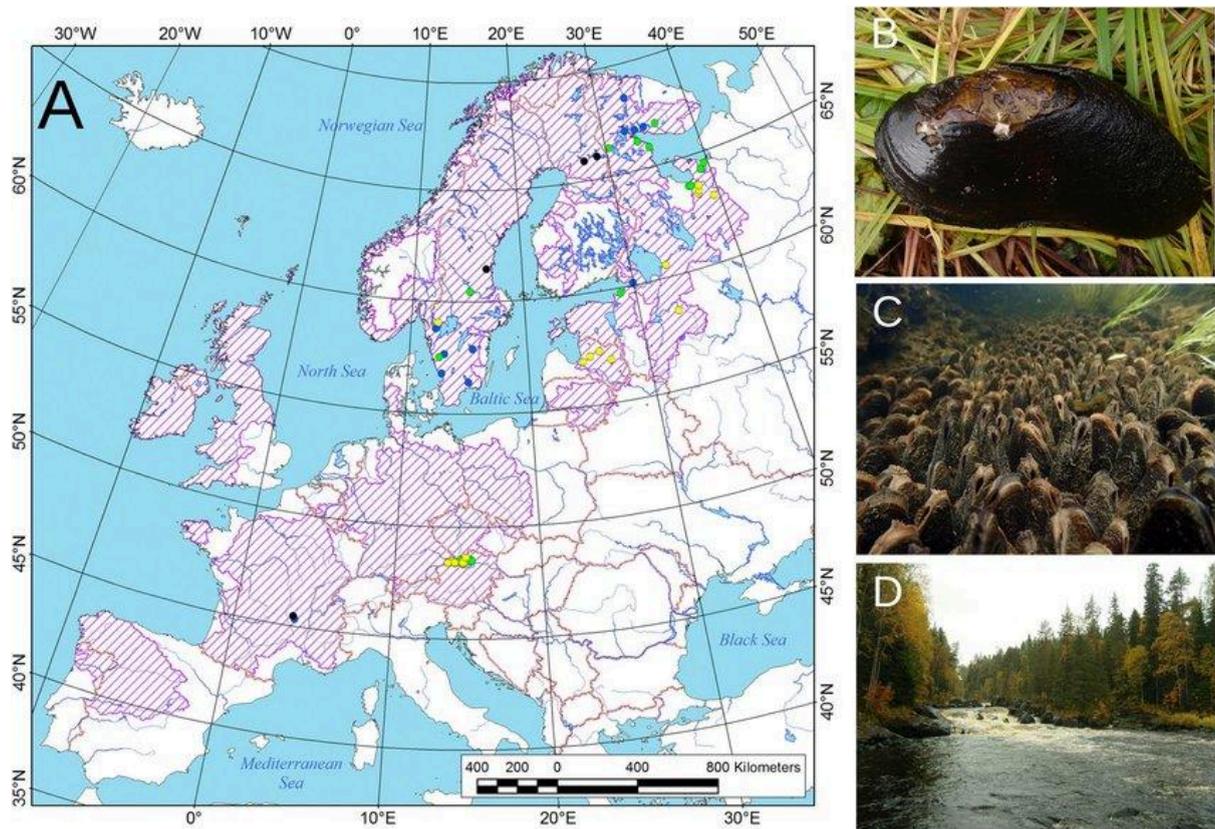
An [ecosystem engineer](#) is a species that contributes to the **creation and modification of a habitat while also maintaining its health and stability**. This important role supports other organisms and contributes to species richness.

During reproduction, freshwater mussels produce larvae (*glochidia*) that must temporarily attach to the gills or fins of specific host fish species to complete development. This obligate parasitic stage enables dispersal and colonisation of new habitats. Consequently, declines or shifts in host fish populations caused by habitat degradation, pollution, or [rising environmental temperatures associated with climate change](#) can directly threaten mussel reproduction and distribution.

As ecosystem engineers, freshwater mussels filter large volumes of water daily, consuming microscopic algae and organic particles. This filtration improves water clarity and quality by removing suspended matter and excess nutrients, thereby supporting aquatic ecosystem balance. In addition, mussels contribute to nutrient cycling, enriching sediments and creating [habitat structure](#) for other organisms, including insect larvae and small crustaceans.

Europe's waterways are intensively used for commercial and recreational purposes, often negatively impacting aquatic life, including freshwater mussels. Populations of freshwater pearl mussels have [declined significantly](#) over time. Recreational activities, such as kayaking or wading in shallow mussel habitats, can [dislodge individuals from the substrate](#) and disturb their natural behaviour. These disturbances can also affect host fish interactions that are essential for mussel reproduction.

Fortunately, conservation actions are underway across Europe. In the [Šumava National Park](#), Czech Republic, park managers are working to balance recreational activity with freshwater pearl mussel conservation. However, achieving this balance is challenging: while experiencing nature benefits human wellbeing, recreational activities can unintentionally harm the ecosystem. By engaging in dialogue with local river users and conducting scientific studies on the impacts of human activity on pearl mussels, progress is being made towards finding a sustainable and much-needed compromise.



European distribution range of *Margaritifera margaritifera* with our sampling localities, adult mussels and their habitat.

Source: Bolotov, Ivan et al. (2018). Climate Warming as a Possible Trigger of Keystone Mussel Population Decline in Oligotrophic Rivers at the Continental Scale. *Scientific Reports*. 8. 35. 10.1038/s41598-017-18873-y.

## *Siphonoperla torrentium* and its role in healthy streams

**Stonefly Nymph:** (*Siphonoperla torrentium*)



- **Size:** 5–12 mm
- **Habitat:** Oxygen-rich streams
- **Role:** Bioindicator of water quality
- **Why it matters:** Indicates clean water for people and wildlife

**Source:** © **Author:** Miroslav Deml, species, *Siphonoperla torrentium* (Pictet, 1841), <https://www.biolib.cz/en/taxonimage/id123652/?taxonid=100471&type=1>

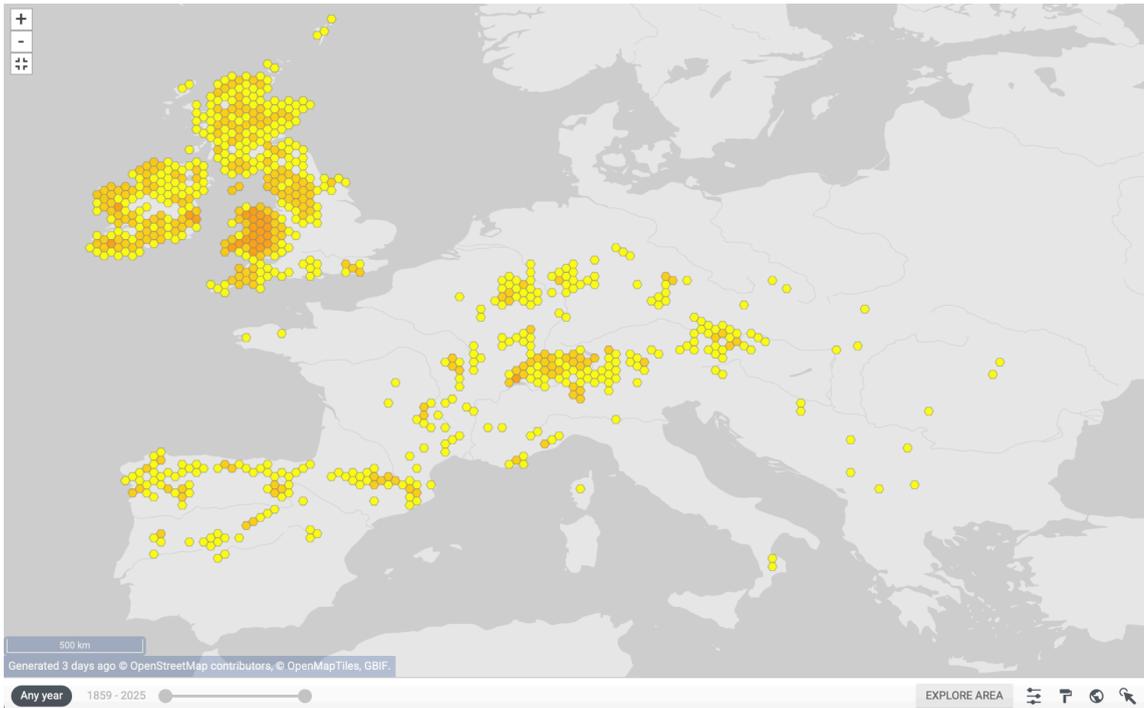
Freshwater ecosystems are home to many species that act as [bioindicators](#), which help us to understand the health of rivers and streams. Among these is *Siphonoperla torrentium*, a tiny nymph with a big role to play. [It thrives in well-oxygenated, fast-flowing streams](#), and its presence is a strong sign of clean water and a healthy aquatic environment.

Nymphs live under stones and feed on algae, decaying plant material, and small invertebrates, helping **recycle nutrients** and support freshwater food webs. [Studies in the Danube basin](#) show that adults feed mainly on **pollen and occasionally on small arthropods**. They remain active throughout their life cycle, reflecting changes in environmental conditions, a trait that demonstrates how valuable they are as **bioindicators**.

While we are highlighting this species, it's important to note that in large-scale freshwater monitoring, scientists usually consider **whole communities of stoneflies (order Plecoptera)** rather than a single species. Studying multiple species together provides a **more reliable picture of water quality and ecosystem health**. Tools such as the **EPT index** (Ephemeroptera, Plecoptera, and Trichoptera) are widely used to assess stream health, as research shows that these aquatic insects collectively provide [strong indications of ecological status](#).

This tiny insect also has clear connections to humans. By indicating healthy streams, *Siphonoperla torrentium* indirectly supports the identification of clean drinking water, sustainable fisheries, and safe recreational areas. Monitoring their populations helps scientists and communities track water quality, linking human wellbeing directly to the state of freshwater ecosystems.

*Siphonoperla torrentium* is a gentle reminder that even the smallest creatures can play an **essential role in maintaining healthy rivers and streams**. Protecting them safeguards freshwater habitats, wildlife, and [human communities](#) alike.



Visual presentation showing presence of *Siphonoperla torrentium* (Pictet, 1841) (yellow/orange hexagons) in Europe: GBIF Backbone Taxonomy. <https://www.gbif.org/species/2003833>

## Louisiana Crawfish: the crustacean that conquered a new continent



- **Size:** Up to 12 cm
- **Origin:** North America
- **Habitat:** Rivers, lakes, wetlands
- **Role:** Invasive species
- **Why it matters:** Damages habitats and threatens native species

Source: Louisiana Crawfish: (*Procambarus clarkii* (Girard, 1852) Photo © Casey D. Swecker (Aquaportail.com)

Do you know who hides behind the innocent name *Procambarus clarkii*? **The red swamp crayfish, native to North America and Mexico, is considered one of Europe's least wanted species.** It is considered an invasive species: a non-native organism

that spreads rapidly in a new environment, often causing harm to ecosystems and human activities.

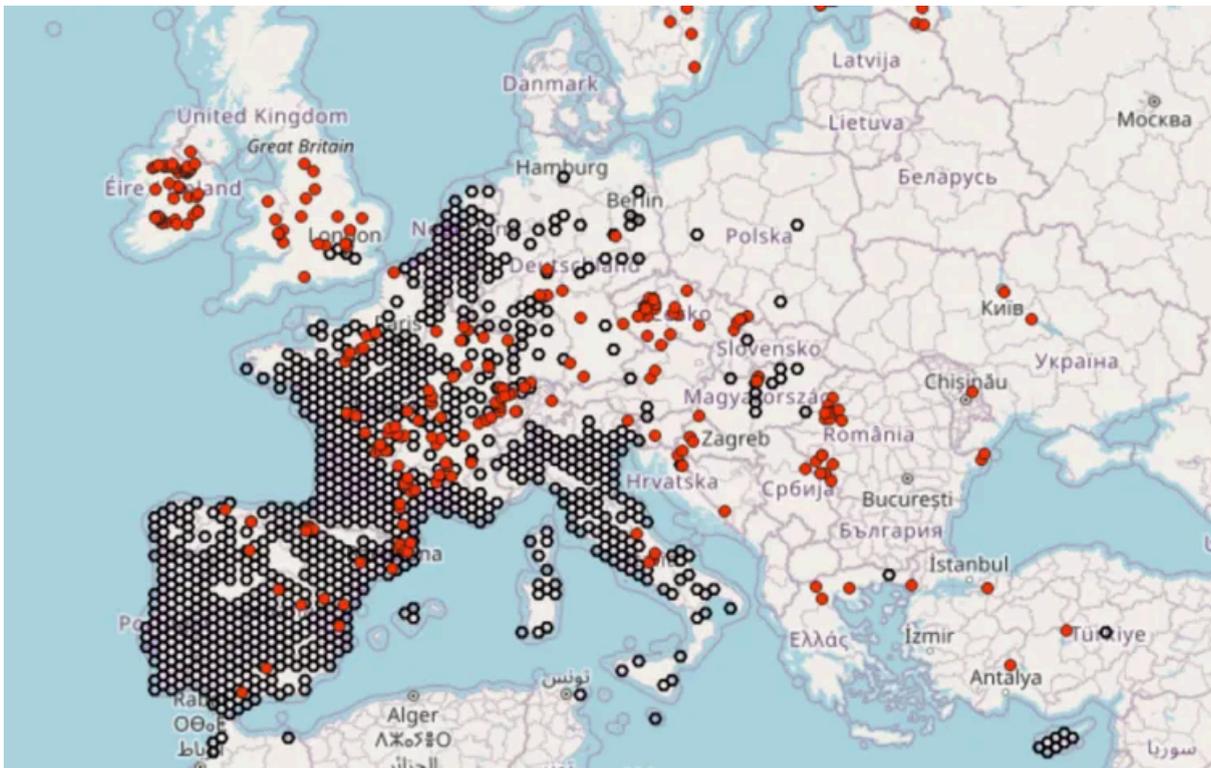
Controlling it is challenging. The crayfish survives in oxygen-poor and saline waters, burrows into banks, and lays up to 600 eggs in spring, meaning that the population grows rapidly. It also carries the [crayfish plague](#), which endangers the native European white-clawed crayfish (*Astacus astacus*). Some predators like herons and foxes eat the invaders, slowing their spread, but human intervention will likely be needed to control them.

**Ironically, the invasion was intentional.** After the European white crayfish population was devastated by the plague in the 19th century, *P. clarkii* was introduced to [Spain in 1973](#), and later to other countries, as a supposed solution.

Was this introduction the solution? Not really. Despite being resistant to the plague, the Louisiana crawfish can still transmit the disease to native crayfish, worsening the decline of *Astacus astacus*. It highlights how human intervention in nature can lead to unintended consequences and long term negative effects.

The Louisiana crawfish has even invaded cities. Since 2015, thousands have been reported in [park waters in Berlin](#). Current management focuses on capture, but their rapid spread continues, threatening native populations and carrying disease. Some restaurants serve them, but customers are skeptical.

This story highlights a key lesson: **introducing non-native species** to replace declining populations can have unintended, **long-term consequences** for ecosystems and humans alike.



Visual presentation showing presence of invasive crayfish (black hexagons) and pathogen (red circles) in Europe. *Image credit: Mihaela Ion and Caitlin Bloomer.*  
 Source: <https://xray-mag.com/content/global-crayfish-map-launched>

## Conclusion

Freshwater habitats may cover less than one percent of the Earth's surface, yet they're packed with life and particularly important for keeping our planet healthy.

From mussels that clean the water to tiny insects that signal how things are going, these ecosystems quietly do a lot of heavy lifting. The crayfish story is a perfect example of how trying to fix one problem can accidentally create a bigger one.

Freshwater systems sustain water quality, cycle nutrients, and underpin livelihoods, reminding us that conservation of even the smallest streams carries vital benefits for people and wildlife alike.

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