

FANTASTIC FRESHWATER

50 Landmark Species for Conservation



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Produced in collaboration with more than 70 experts from 21 IUCN SSC Specialist Groups and Red List Authorities.

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Shoal is the global initiative to halt extinctions and recover populations of the most threatened freshwater species around the world. Learn more about their work at shoalconservation.org.



The Indianapolis Zoo's Global Center for Species Survival is a partnership with the International Union for Conservation of Nature's Species Survival Commission. The Global Center supports and connects thousands of conservation experts working to secure a future for animals, fungi and plants in more than 160 countries.



The IUCN Species Survival Commission (SSC) is a science-based network of more than 10,500 volunteer experts from almost every country of the world, all working together towards achieving the vision of, "a just world that values and conserves nature through positive action to reduce the loss of diversity of life on Earth".



The IUCN SSC Freshwater Conservation Committee (FCC) was established in 2010 in order to urgently address the global freshwater biodiversity crisis.

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Furthermore, more than 50 photographers allowed use of their images to help illustrate this report.

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Much of this report is directly derived from the IUCN Red List of Threatened Species, including each species' conservation status and the threat levels for each taxonomic group, and the distribution, habitat and threat information for many of the species. We thank them for providing this wealth of information.

INTRODUCTION

Water links all life. It is the one element that all species need to survive. The species richness and diversity of aquatic habitats is testament to how water encourages life: although freshwater covers less than 1% of the planet's surface, freshwater ecosystems support 5% of all plant species and 11% of all animal species, including one third of vertebrate species¹.

However, freshwater ecosystems are among the most imperilled on Earth. Humanity's ever-growing need for water means we frequently treat bodies of water as resources to drain, dam and degrade. Our actions place multiple stresses on the planet's rivers, lakes, wetlands and aquifers, which have caused a catastrophic drop in biodiversity over the past few decades. Monitored populations of freshwater vertebrates have declined on average by 83% since 1970, and freshwater biodiversity continues to decline more than twice as fast as that of marine or terrestrial ecosystems².

With up to one million species threatened with extinction, some have called this period the Age of Extinction. Freshwater species are at the sharp end of this biodiversity crisis.

And yet freshwater does not receive anywhere near the same level of conservation attention as marine or terrestrial ecosystems. The plight of the world's rainforests and coral reefs has been well known for decades, but freshwater is all too often out of sight, out of mind.

Fortunately, there are solutions. In 2020, scientists published an Emergency Recovery Plan to bend the curve on global freshwater biodiversity loss³. The six-point plan outlined what needs to be done to ensure freshwater species are given a good shot at survival:

1. Accelerate implementation of environmental flows;
2. Improve water quality;
3. Protect and restore critical habitats;
4. Manage exploitation of species and riverine aggregates;
5. Prevent and control non-native species invasions;
6. Safeguard and restore freshwater connectivity.

In addition, we also need to ramp up our communication about the plight of freshwater species and ecosystems. This report is the result of a collaboration between IUCN SSC's Freshwater Conservation Committee, SHOAL, Indianapolis Zoo's Global Center for Species Survival, and relevant Specialist Groups and Red List Authorities, and it aims to raise awareness of the richness, variety and wonder of freshwater biodiversity and the crises it faces. It is not a categorisation of the planet's most threatened freshwater species, but a selection of "flagship" species from the various taxonomic groups that make up freshwater biodiversity from around the world.

It brings together for the first time the knowledge and experience of more than 70 people from 21 IUCN Specialist Groups and Red List Authorities to highlight 50 freshwater species at very high risk of extinction. These species highlight the diversity of – and threats to – freshwater life, from vertebrate and invertebrate fauna, to flora and funga. The chosen species are a deliberately mixed selection, designed to introduce people to the geographic and ecological diversity of freshwater species, and highlight the range of threats that freshwater species face. Each of them either lives in, or spends an important part of its life in and around freshwater. This report celebrates them, and sounds the alarm that if there are not urgent concerted efforts to conserve them and their freshwater habitats, each of them could soon disappear forever.

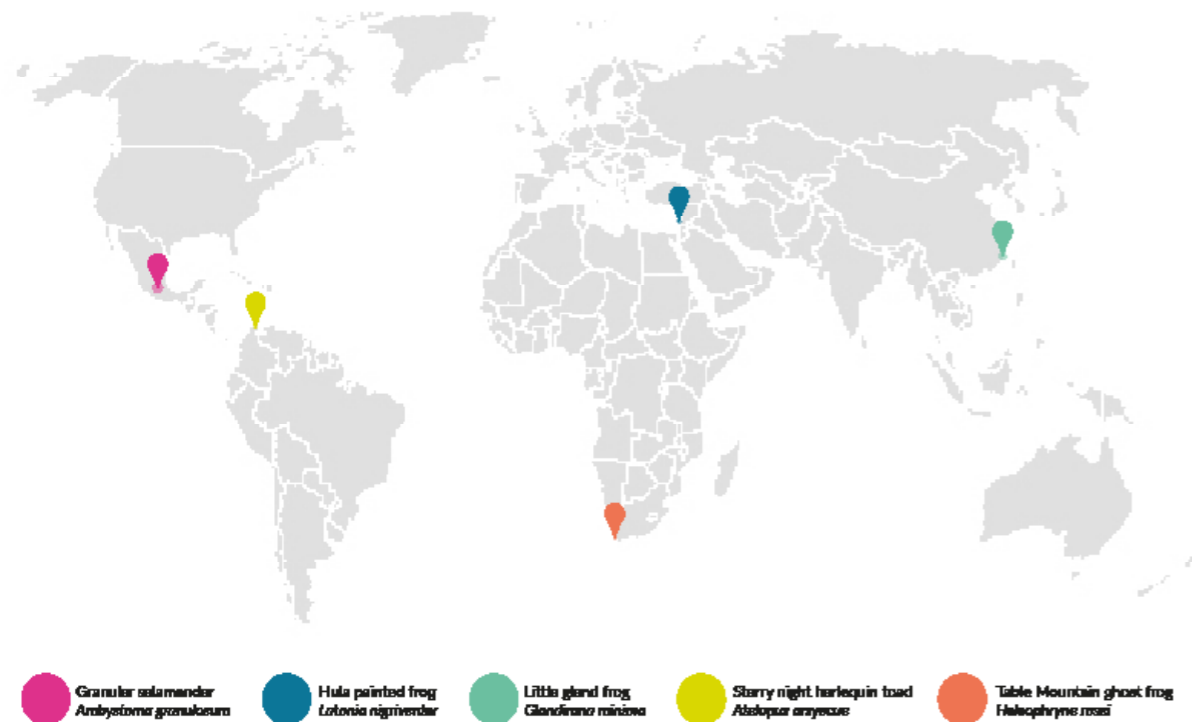
One of this report's goals is to promote conservation actions for the species highlighted. This current edition will be the first of many, with subsequent updates focusing on additional species at risk and charting conservation actions achieved for the species highlighted here.

AMPHIBIANS

Amphibians were the earliest tetrapods to evolve on Earth, with the first diverging from lobe-finned fishes approximately 390 million years ago⁴. Modern caecilians, salamanders, and frogs all evolved from these amphibian ancestors. Since then, amphibians have developed some remarkable adaptations that allow them to survive in incredibly hostile environments, from baking desert heat to the Arctic cold.

Amphibians straddle two different worlds, just as comfortable in the water as they are on land. The word 'amphibian' comes from the Greek 'amphi', meaning 'dual', or 'both', and 'bio', meaning 'life'. 'Both kinds of life'. Water and land.

But they are having a rough time of it. Facing multiple anthropogenic pressures - including pollution, disease, climate change, loss of habitat and damage to freshwater systems - a staggering 34% planet's 7,296 amphibian species that have been assessed for the IUCN Red List of Threatened Species, are threatened with extinction, making them one of the most threatened group of vertebrates⁵.

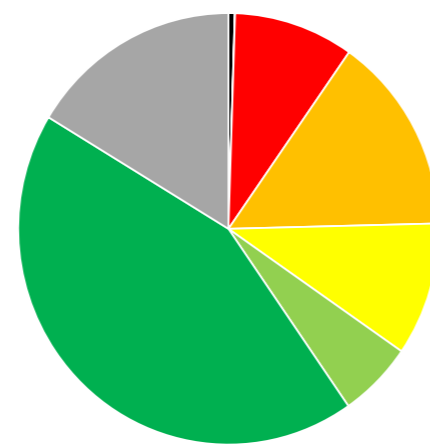


Location is approximate and intended to show geographical spread.

Species accounts with expert input from:



EX	35
EW	2
CR	673
EN	1,085
VU	730
NT	418
LC	3,160
DD	1,193
TOTAL	7,296



Total assessed amphibians

Granular salamander (*Ambystoma granulosum*)

The genus *Ambystoma* contains 33 species, six of which are listed as Endangered and six as Critically Endangered by the IUCN. Several have no conservation programmes in place, and each would benefit from immediate habitat protection and work with local communities to give them the best possible chance of survival.

Each species of *Ambystoma* highlights the devastating impacts that urban and agricultural water extraction and pollution can have on freshwater species. The threats facing these species, particularly pollution, habitat loss and the introduction of invasive species, are representative of the threats facing many freshwater species globally.

Invasive predatory fish are a major threat to the granular salamander. In the mid-1990s, the Mexican government began a programme to distribute non-native carp for local fishery projects, a project which continues to this day. Since then, granular salamander populations are estimated to have declined by more than 50%. In 2019, researchers concluded that there was only one granular salamander range site (Area Protegida Valle de Bravo) that did not have an invasive predatory carp population.

Conservation status: EN

When first listed as EN / CR: 2004



Range: Highland wetlands of México State and Michoacán, Mexico, between 2,100 meters and 3,000 meters elevation.

Size: 140mm - 170mm

Diet: Species of *Ambystoma* are carnivores, eating snails, slugs, centipedes, spiders, and other invertebrates as adults. Larvae feed on aquatic invertebrates such as fleas, copepods, small insects, and insect larvae.

Threats: Introduced predatory fish - particularly carp - and the desiccation, pollution, and conversion of former wetland habitats within the species' range.

Current conservation action: Future conservation and restoration of this and fellow *Ambystoma* species' habitats is needed. Further studies are required to locate the species in other areas where it could occur.



© Alejandro Calzada

Hula painted frog (*Latonia nigriventer*)

The Hula painted frog is the only known survivor of a Miocene frog genus that is otherwise only known from fossils⁶. Until its rediscovery in 2011 it had not been seen for 56 years, was thought to be extinct, and was only known from three specimens collected in the 1940s and 1950s⁷.

This species is of special concern given its small range and extreme risk of extinction, and species management plans should include locations of all confirmed sightings^{7,8}. The species ranks highly among the top EDGE amphibian species, meaning that not only is the species at extremely high risk of extinction, but it has few or no close relatives on the tree of life: there are no other species out there like the Hula painted frog!

Using capture-recapture and genetic techniques, it is estimated the hula painted frog population is at around 250 individuals, with about 230 individuals that have already been captured at least once.

Restoring habitat quality and connectivity is a conservation priority, particularly the establishment of a corridor between the Yesod HaMa'ala settlement and the Hula Nature Reserve, and translocation and captive breeding programme feasibility should be investigated⁹.

Conservation of the Hula painted frog is an opportunity to recover a species that was previously thought extinct.

Conservation status: CR

When first listed as EN / CR: 1986. Listed as Extinct from 1988 – 2012.

Range: Confined to a very restricted area in the south of the Hula Valley, Israel.

Size: Snout-vent length of adult females ranges from 69-130mm and males from 66-121mm.

Diet: Carnivorous, eating invertebrates in captivity. An individual was found with a fish in its mouth.

Threats: Marshland habitats were drained for agricultural use, which incidentally caused the extinction of a species of fish, the Hula Bream (*Mirogrex hulensis*). Some populations live in unprotected areas which are subject to pollution from petrol and pesticides.

Current conservation action: It is protected by national legislation and one subpopulation is located in the Hula Nature Reserve. Overall, conservation attention for this species is low and further restoration projects and research is needed.



© Laura and Bobby Bok



© Sarig Gafny

Little gland frog (*Glandirana minima*)

There are only five species in the *Glandirana* genus, which diverged from all other frog species more than 30 million years ago. Three are listed as Least Concern by the IUCN, but two, including the little gland frog, are Endangered.

The little gland frog can be found in China's eastern province of Fujian, in the east of the province and from Minhou. It has only ever been found in an area of less than 10km², and the population is decreasing. The distribution of the species is patchy, and the remaining habitat is declining both in size and quality. One of the populations in Fuzhou has already been extirpated due to habitat degradation. The species is found in rice paddies but is threatened by habitat reduction due to urban expansion and water pollution caused by pesticides and fertilisers.

The species represents the struggle of many other Asian species that are adapted to low-elevation wetland close to urban settings. As surrounding agriculture intensifies, and urban areas encroach into agricultural areas, the habitat for these species is depleted. Furthermore, rising sea levels will impact the little gland frog's coastal range.

Conservation status: EN

When first listed as EN / CR: 2004

Range: An area of less than 10km² in eastern Fujian province and Minhou in Fujian province, eastern China.

Size: Male frogs are 27mm and females are 29mm¹⁰.

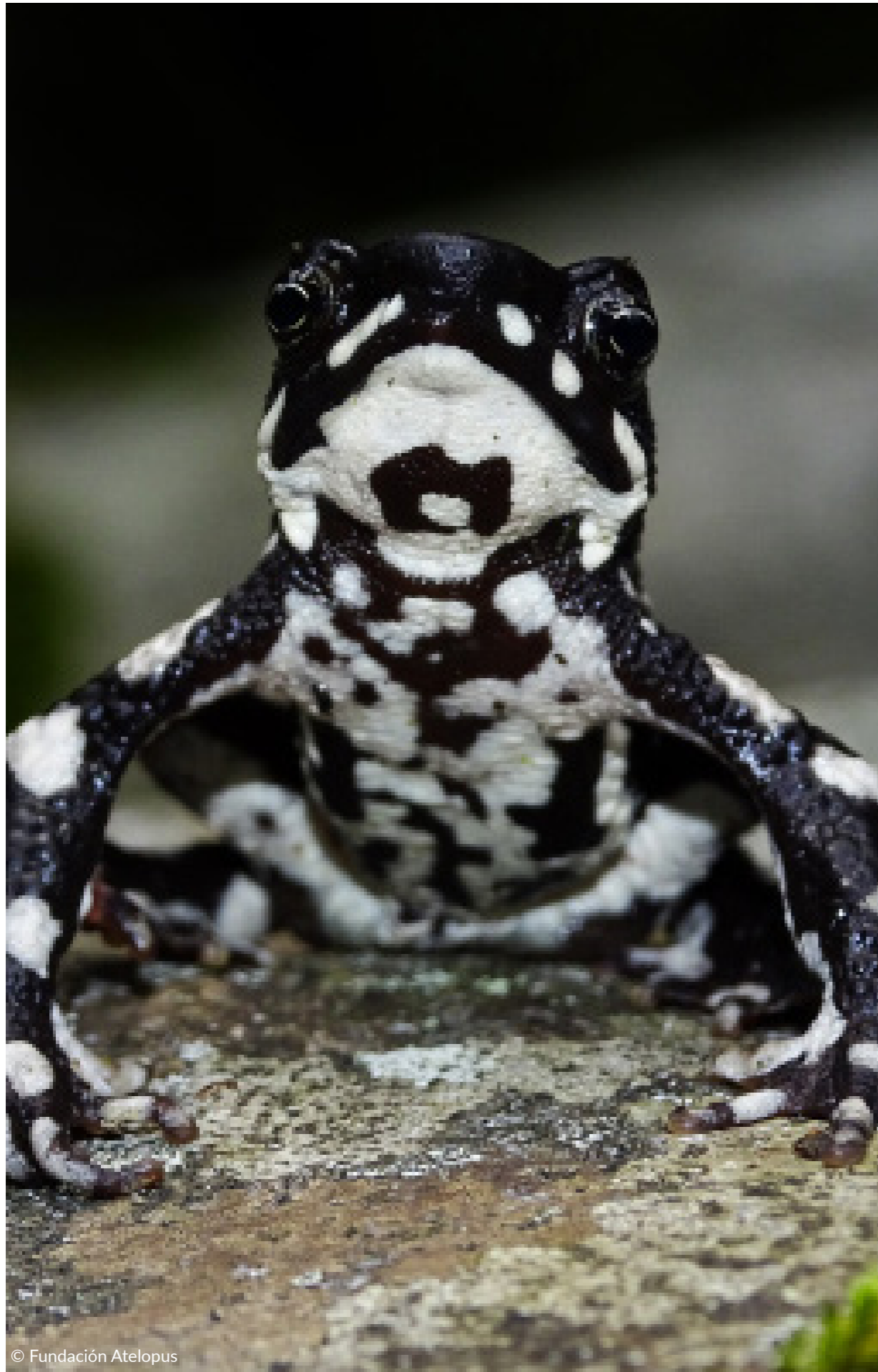
Diet: Some *Glandirana* feed on beetles, moths, butterflies, and ants in their native range¹¹.

Threats: Habitat loss caused by infrastructure development and intensification of agriculture, along with water pollution (W. Chou and J. Jiang pers. comm. June 2019).

Current conservation action: The species occurs in the protected Qishan Forest Park but further habitat protection is urgently needed.



© Geng Baorong



© Fundación Atelopus

Starry night harlequin toad (*Atelopus arsyecue*)

The starry night harlequin toad was lost to science for nearly 30 years, until late 2019 when a group of conservation biologists were allowed to enter Colombia's Sierra Nevada de Santa Marta, an area considered sacred by the indigenous Arhuaco people of the Sogrome community.

Many other harlequin toad species that inhabit high altitudes across Latin America have been wiped out by the deadly chytrid fungus, which has affected amphibians in many parts of the world, and for years it was assumed the starry night harlequin toad had met the same fate.

But throughout the 28 years that the species had fallen off scientists' radars, it was not lost to members of the Sogrome community, who consider it guardians of water and symbols of fertility. The Arhuaco people live in harmony with the toad, and have historically protected it along with its habitat and other wildlife that lives there.

The starry night harlequin toad proves how species have the chance to recover if sufficient suitable habitat is created and maintained, and it is a flagship for the power of local, indigenous knowledge in protecting and recovering species.

The next steps are to establish a monitoring program and bring together both the scientific and spiritual perspectives to best continue protecting the amphibian.

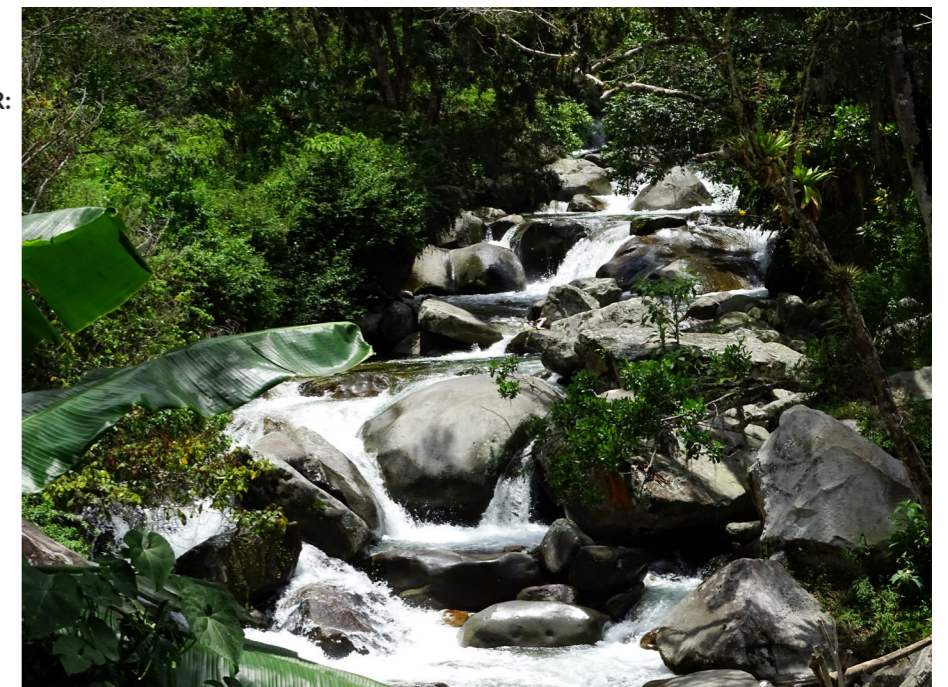
Conservation status: CR

When first listed as EN / CR:
2004

Range: Sierra Nevada de Santa Marta National Park in the department of Cesar, Colombia, altitudinal range between 2,000–3,500m above sea level.

Size: Between 2.5 - 3.8cm.

Diet: Diet includes ants, larvae of butterflies and moths, flies, and other invertebrates.



Typical starry night harlequin toad habitat. © Fundación Atelopus

Threats: Ongoing threats are habitat loss and degradation from agricultural activities including livestock, along with fire and logging. A 2004 IUCN Red List assessment found that chytridiomycosis was likely to be a major threat that has led to catastrophic population decline¹².

Current conservation action: Population resides partially in Sierra Nevada de Santa Marta National Park, but ongoing protection is needed for suitable habitats outside the park. Further surveys are required to locate the species.

Table Mountain ghost frog (*Heleophryne rosei*)

The name 'ghost frog' belongs to the *Heleophrynidae* family of frogs, and is thought to have originated from where the frog was first found, in Table Mountain's Skeleton Gorge. But it could just as easily have come from the fact that they are really rare, and the chances of you spotting one are, frankly, tiny.

The Table Mountain ghost frog has a range of just 16km², and the spread of alien vegetation, soil erosion around the trails caused by hikers, and modification of natural stream flows by water storage reservoirs all put pressures on the habitat, meaning the frog's already small home is constantly under threat.

Despite the range being in the protected Table Mountain National Park, there was limited specific management or research focus for the species until an action plan was drafted by the Endangered Wildlife Trust and South African National Biodiversity Institute in 2020. Research shows that conservation action must include removing alien invasive plant species and constructing boardwalks to stop bank erosion and reduce sedimentation. In addition, it is not the only highly threatened amphibian in the area: Rose's Mountain Toadlet (*Capensibufo rosei*) has not been found on Table Mountain itself since 1993, but still occurs in the wider area. However, the six previously known breeding sites have been reduced to two over the past twenty years, and the species is also Critically Endangered.

The Table Mountain ghost frog is an example of a species trying to survive close to a very large city, with the demands the human population places on the freshwater resource.

Conservation status: CR

When first listed as EN / CR: 1994

Range: Endemic to the southern and eastern slopes of Table Mountain, South Africa. The range is extremely restricted.

Size: Adults grow up to 5-6cm.

Diet: Tadpoles of the species feed on the algae growing on rocks. Adult feeding habitats have not been studied in detail, but they are believed to have similar feeding habitats as other frogs, hence the adult diet probably consists of a range of insects, arthropods, and snails.

Threats: Alien vegetation and the presence of water storage reservoirs pose threats. Human activity has caused soil erosion, affecting the species' stream habitat.

Current conservation action: The Table Mountain Ghost Frog Action Group was formed to review threats and establish an action-based framework for conservation. The entire range is included in the Table Mountain National Park, which does not have specific management or research focus for this species. Further research and monitoring of the species are being carried out.



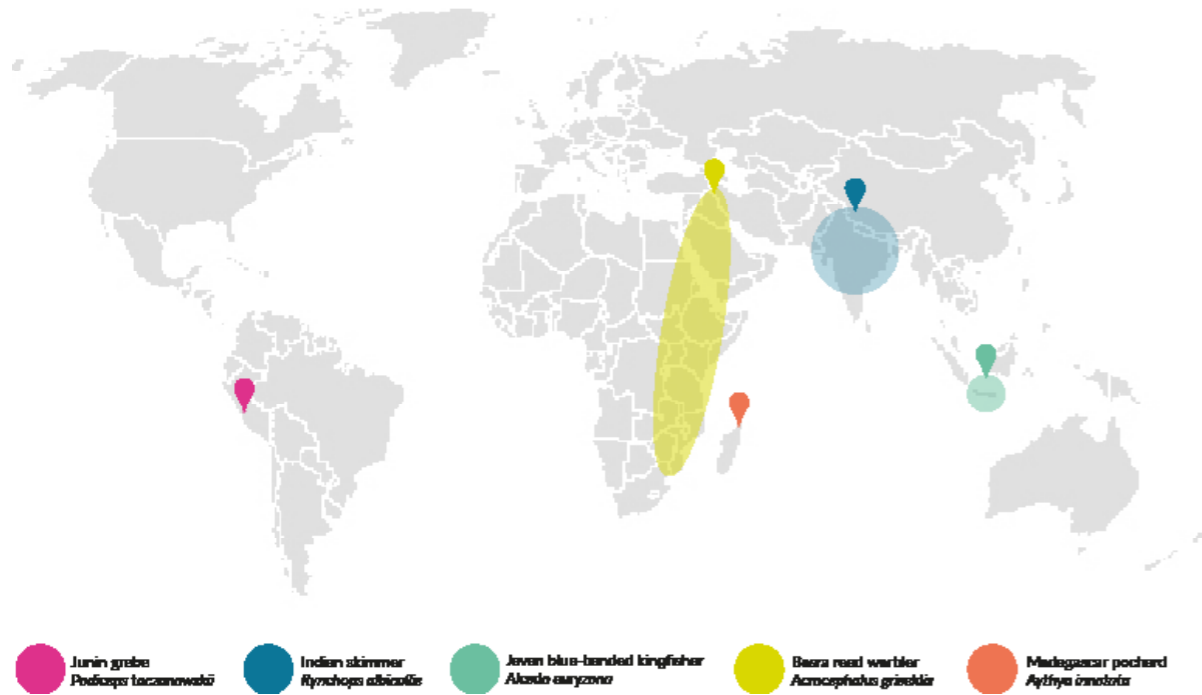
Table Mountain ghost frog habitat. © Joshua Weeber

BIRDS

There are more than 11,000 species of birds that live in practically every ecosystem of the world. Due in part to their relative visibility compared with other groups, birds are the most studied group of animals, and consequently much is known about their conservation status. Currently, 13% of bird species that have been assessed are listed as threatened by the IUCN Red List, and we know that 159 species have already become extinct since 1500, the highest documented number for any taxonomic group. Among these bird extinctions, 24 had wetlands as their main habitat.

About 20% of known bird species have evolved to live in close relationship with wetlands. Visit any river, lake or wetland and it is likely there will be birds that have made the habitat their home. Just like the creatures that swim under the surface, they are totally reliant on these freshwater ecosystems and, should the environment become degraded, these birds face many of the same threats as the subaquatic species.

Pollution, water drainage, habitat conversion and degradation caused by agriculture and urban expansion, and even invasive species outcompeting the birds for nesting sites can all put serious strains on bird populations. As freshwater habitats are drained, polluted and overfished, the birds lose their homes and the food they need to survive. Some species are able to simply fly to a more suitable habitat. But for many, there is either nowhere to go,

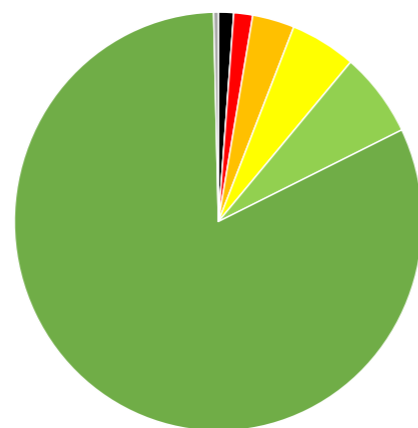


Location is approximate and intended to show geographical spread.

Species accounts with expert input from:



EX	29
EW	0
CR	36
EN	80
VU	125
NT	158
LC	1,969
DD	9
TOTAL	2,406



Total assessed freshwater-related birds

Junin grebe (*Podiceps taczanowskii*)

An elegant flightless diving bird with a bright ruby red eye, the Junin grebe spends most of its time on the open water of the lake and only goes to shore when nesting and roosting.

It is confined to Lake Junín, high in the Peruvian highlands, and this restriction is a major factor in the small population, which is estimated to be fewer than 320 individuals.

Population counts over recent years show fluctuations, but no overall decline, so numbers are considered to be stable, albeit with a high level of uncertainty.

The Junin grebe shares many threats with the Junin rail (*Laterallus tuerosi*), another endemic Lake Junín bird listed as Endangered.

Conservation status: EN

When first listed as EN / CR: 1994

Range: Lake Junín in the highlands of Junín, west-central Peru.

Size (beak to tail): 33-38cm

Diet: Feeds mainly on *Orestias* fish and invertebrate larvae and adults.

Threats: Pollution from both mining activities and sewage, plus extreme water-level fluctuations due to hydroelectric activities. Non-native species including trout are thought to outcompete the grebe for food, and gill nets used for fishing present a drowning hazard¹³.

Current conservation action: Lake Junín is an Important Bird Area, and was declared a national reserve in 1974 and a



Ramsar Site in 1996. Fishing and hunting in and around the lake is prohibited. However, these designations have not influenced mining and dam-building activities, and the laws are not strictly enforced. Local people are being engaged and educated about conservation of bird life in Lake Junín.

© Podiceps Taczanowskii

Indian skimmer (*Rynchops albicollis*)

The name 'skimmer' stems from this bird's feeding strategy: it flies low over the water surface and skims the water for fish.

This distinctive and once common species has suffered decades of population decline and is no longer breeding in formerly occupied parts of its range, for example in Myanmar. In the past 11 years – just two generations of the Indian skimmer – numbers have declined by more than 20%.

Dams, irrigation, and sand mining along the rivers of the species' range have led to increased variation in water levels, flooding nesting sites and enabling predators and people onto islands where the birds breed. In turn, this has resulted in fewer eggs hatching and fewer chicks surviving to adulthood.

The current rate of reproduction does not appear to be enough to maintain the population and, without concerted conservation action, it is estimated up to 46% of the remaining birds could be lost over the next three generations (approximately 17 years).

Conservation status: EN

When first listed as EN / CR: 2020

Range: Now almost completely restricted to India as a breeding bird, with only occasional breeding in western Bangladesh¹⁴.

Size (beak to tail): 38-43cm

Diet: Mainly crustaceans, insect larvae and small fish of 4-14cm in length¹⁵.

Threats: Increased variation in water levels, human disturbance, pollution from agricultural and industrial chemicals.

Current conservation action: The most important breeding grounds are the Rivers Chambal, Ganga, Son and Mahanadi. The Indian skimmer is recognised as a priority species for conservation by the Government of India's National Mission for Clean Ganga, and projects to conserve threatened riverine birds, with the skimmer as flagship, are being carried out on the Mahanadi, Son and Chambal Rivers. Actions include the appointment of nest site guardians and carrying out education and outreach work with the goal of protecting nests to increase breeding success.



© PS Anand



Javan blue-banded kingfisher (*Alcedo euryzona*)

With its trademark spear-like bill, the Javan blue-banded kingfisher is found on the Indonesian island of Java, where it patrols rivers in tropical moist lowland forest for fish. This habitat has been almost completely lost from Java and what remains continues to be slowly degraded. As a result, the kingfisher's population is thought to be continuing to decline.

There are very few recorded observations of the species, inferring that the population is extremely small. There are currently estimated to be between 50 – 249 mature individuals. Due to its shy nature, there is a possibility that it has been under-recorded, and if it is found to be more numerous than is currently known, it may warrant downlisting of its extinction risk in the future.

Conservation status: CR

When first listed as EN / CR: 2014

Range: Endemic to Java, Indonesia

Size (beak to tail): 17-20cm

Diet: Mostly fish, but also crustaceans, insects and small reptiles.

Threats: The burgeoning human population on Java has caused massive reduction in lowland forest habitat. Disturbance and degradation of streams through sand-mining or rock extraction further reduces the extent of suitable habitat.

Current conservation action: The species has been found within Gunung Halimun National Park, and is protected within the park. Searches in central Java have found that the species occurs along fast-flowing streams there, and action is needed to protect these sites from degradation and disturbance.



© Leonardus Adi Saktiari



© Hafezi, Macaulay Library at the Cornell Lab of Ornithology

Basra reed warbler (*Acrocephalus griseldis*)

The Basra reed warbler is a lesson in how water management affects wildlife. Major hydrological projects since the 1950s caused considerable loss of the warbler's shallow, marshy wetland habitat, whether caused by dams preventing water from entering the wetlands, or drainage of the Mesopotamian Marshes in Iraq. During this period of habitat loss, the species declined rapidly.

An extensive marsh restoration project commenced after 2003 which, coinciding with major snow melts in Turkey and Iran, recovered 58% of the original marshland area as of late 2006¹⁶. The species' population is thought to have stabilised as the habitat was restored but recent drought and continued upstream dam construction has again reduced the extent of the marshes, suggesting the population may decline rapidly again.

Conservation status: EN

When first listed as EN / CR: 2004

Range: Breeds in Iraq, Iran and Kuwait, and formerly in Israel. Non-breeding range in parts of East Africa and the Middle East.

Size (beak to tail): 17-18cm

Diet: Mainly aquatic insects. They also eat silverfish, termites, grasshoppers, other insect larvae, spiders and earthworms¹⁷.

Threats: Much of the warbler's marshy wetland habitat has been lost due to large-scale hydrological projects, and some existing habitat is threatened by large-scale conversion for agriculture.

Current conservation action: There are monitoring programmes in place in Israel and Iraq.



© Yoav Perlman, Macaulay Library at the Cornell Lab of Ornithology

Madagascar pochard (*Aythya innotata*)

The Madagascar pochard was feared extinct by many experts from 1991 to 2006. Aside from a solitary male found in 1991, there were no confirmed sightings between 1960 and 2006, when a researcher found a tiny population in a remote lake in northern Madagascar.

In 2009 it was estimated there were only around 20 Madagascar pochards left in existence, and Durrell Wildlife Conservation Trust, Wildlife & Wetlands Trust, Asity Madagascar, The Peregrine Fund and the Madagascar Government began an emergency operation to save the species from extinction.

The early signs are looking promising. And, if conservation efforts are successful, there can be hope for other Madagascan freshwater bird species, all of which are currently in decline or close to disappearance because of similar threats.

Conservation status: CR

When first listed as EN / CR: 1994

Current Range: Historically, in wetlands and lakes of Madagascar's high plateau. A small number of pochards were spotted in a crater lake northwest of the town of Bealanana in 2006, at the fringes of the species' historical range. Reintroductions have focused on Lake Sofia in the northwest of the country.

Size (beak to tail): Typical adult is 45-56cm

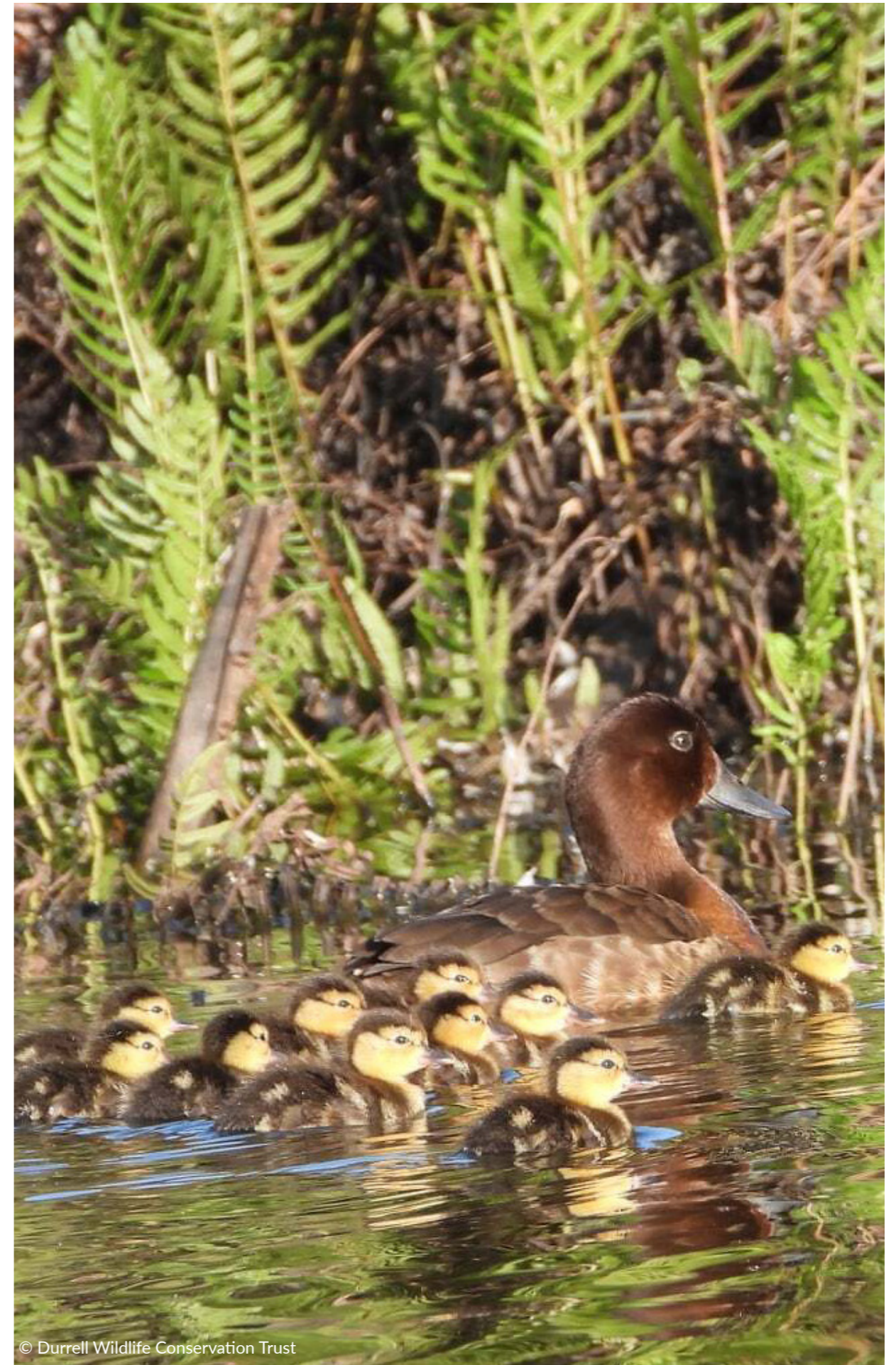
Diet: Feeds almost entirely on aquatic invertebrates and a small amount of plant matter.

Threats: The flora and fauna in and around the lakes of the pochard's historic habitat have suffered from slash and burn agriculture, which may cause ash and silt sedimentation, leaving the lakes in very poor condition with little suitable food¹⁸. Historic habitat has been lost to extensive conversion to rice production and, from the 1950s, introduction of exotic fish species to Alaotra and other wetlands has led to population declines¹⁹.

Current conservation action: Following the initiation of a captive breeding programme in 2009, 21 pochards were released into Lake Sofia in 2018 and a further 35 in 2021. Further releases are planned there from this year onwards. There is also a captive breeding centre in Antsohihy, which rears ducks annually. Released birds first bred in the wild in 2019 and have done so annually since then. Conservation of the pochard has been a successful catalyst in engaging local communities to practice sustainable strategies, which protect and improve their own livelihoods, whilst facilitating the renewal of Lake Sofia into a healthy aquatic ecosystem.



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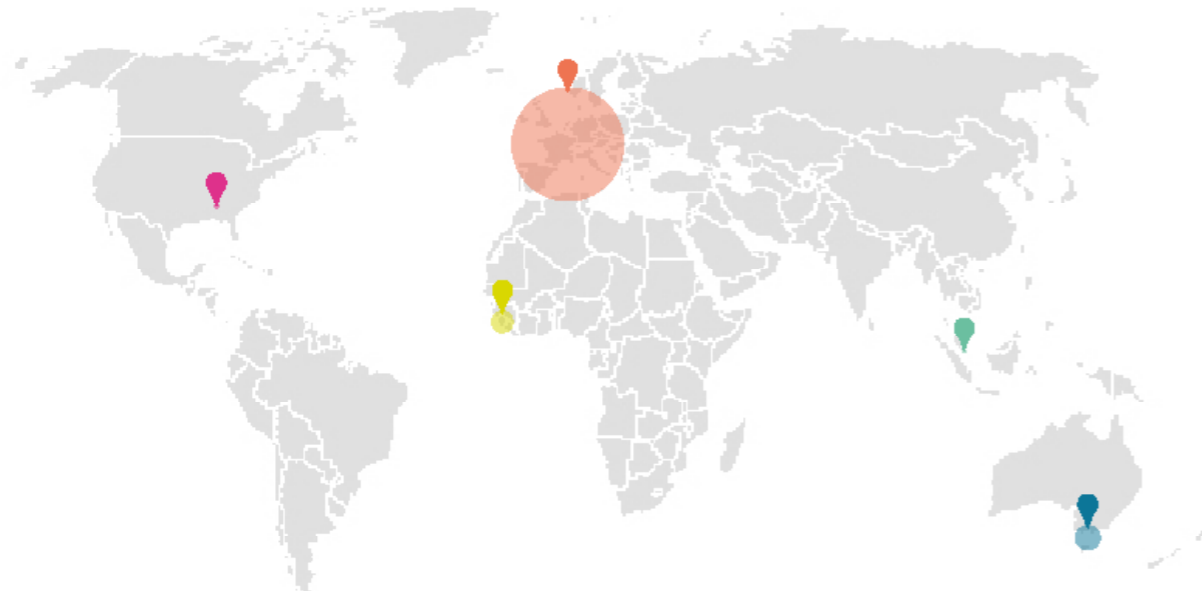
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CRUSTACEANS

Freshwater crustaceans comprise a highly diverse group of species, from tiny 'seed shrimp' (ostracods) and copepods to barnacles and the decapods: the freshwater crabs, crayfish, freshwater shrimps and aeglids. Freshwater crustaceans play vital roles in freshwater ecosystems, as indicators of water quality, controllers of food webs (they are a major food source for many vertebrates), and even ecological engineers – for example, crayfish burrows can impact the topography of riverbeds, affect sedimentation and even destabilise riverbanks. Many freshwater decapods also provide important food sources for humans.

Many of the decapod species have already been assessed for the IUCN Red List of Threatened Species, so we know more about the conservation status of these species than many other freshwater invertebrates: for example, an estimated one third of crayfish and freshwater crab species are thought to be threatened with extinction²⁰, although for freshwater crabs there is also much uncertainty due to many species being highly data poor²¹. Slightly lower threat levels of 28% were reported for freshwater shrimps²².

The five species discussed below span a range of habitats, from tiny pools in tree holes, to caves, creeks, streams and lakes: these curious crustaceans have conquered them all! However, there is a real risk of losing many of these vitally important freshwater species if we do not take concerted conservation action.

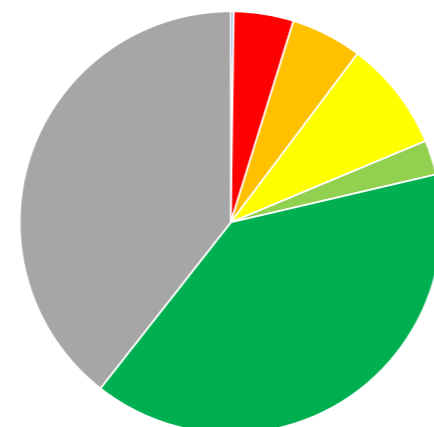


Location is approximate and intended to show geographical spread.

Species accounts with expert input from:



EX	6
EW	0
CR	121
EN	144
VU	223
NT	70
LC	1,037
DD	1,041
TOTAL	2,642



Total assessed freshwater crustaceans

Alabama cave shrimp (*Palaemonias alabamiae*)

Alabama, USA is home to more than 4,200 species-rich caves. The Alabama cave shrimp is found in the subterranean waters of four of these cave systems. It is similar in form to species of common ocean shrimps, except that its carapace is mostly transparent and colorless. The Alabama cave shrimp is one of only two species of this genus, and it differs from the other species, *P. ganteri* (assessed as Vulnerable on the IUCN Red List), in its smaller body size and smaller number of dorsal spines.

Out of sight of most people, caves are often overlooked in conservation. Currently, we have status assessments of 845 species associated with underground water systems. Unsurprisingly, many of these are Data Deficient, although 23% of species assessed are listed as Endangered or Critically Endangered. Pollution and water abstraction are the most common threats listed for these species, illustrating that our actions above ground can have an enormous impact on the species that lie beneath.

Conservation status: EN

When first listed as EN or CR: 1994

Range: This species is only known from four cave systems in Alabama, USA, including Bobcat Cave, Muddy Cave, Herring-Glover system and the connected Brazleton Cave. The species was formerly known also from the Shelta Cave, but that population is believed to have died out, with its most recent sighting in November 1983.

Size: The adult carapace length measures up to 20mm.

Diet: This species is a non-selective grazer that feeds on algae, protozoans, and fungi.

Threats: The Alabama cave systems where this shrimp resides are threatened by increasing groundwater extraction and by increasing groundwater contamination from urban development and the runoff from nearby chicken farms.

Current conservation action: Conservation action for this species has been limited, and further work is needed to address habitat and resource protection. Currently only the Shelta Cave is within a protected area because it is owned by the National Speleological Society. Other caves within the range of this species are either owned by the U.S. Army or are located on private land.



© D. Fenolio

Mallacoota burrowing crayfish (*Engaeus mallacoota*)

The Mallacoota burrowing crayfish is one of two Critically Endangered burrowing crayfish species in Victoria, Australia. The only information we have about this species comes from its type locality in a 1-2m wide creek in a temperate rainforest located in Croajingolong National Park. Because this species spends most of its time underground, surveys are difficult to conduct and very little has been confirmed regarding population dynamics or ecology.

The limited distribution of the Mallacoota burrowing crayfish puts it at greater risk of impact from local environmental disturbance. While these crayfish are found inside a National Park, their range includes grazing land, and timber harvesting and recreational fishing opportunities are permitted which have all altered their natural habitat. Their underground burrows made in the silty and sandy soil are easily disturbed. Conservation management plans are in place for this species, but further research and surveys are a top priority due to the lack of conservation information available for this population. Careful management of their river and wetland habitat is necessary in order to ensure the long-term survival of the Mallacoota burrowing crayfish.

Conservation status: CR

When first listed as EN or CR: 1996

Range: This species is endemic to Victoria, Australia, where it is only found in two sites in the western region of the Mallacoota Inlet near the Victoria-New South Wales border. Its estimated extent of occurrence is just over 15km².

Size: The carapace length of adult crayfish reaches approximately 20mm.

Diet: This species feeds on small invertebrates and plant material such as roots and decomposing leaves.

Threats: The restricted distribution of the Mallacoota burrowing crayfish leaves it vulnerable to localised catastrophic events like drought, fire, and sudden elevated sedimentation. The Mallacoota burrowing crayfish has also been affected by the loss of its riparian vegetation habitat. Changes in weather and habitat as a result of climate change could pose major threats in the future.

Current conservation action: A portion of this species' range is found in an area protected under the State Environment Protection Policy for the waters of East Gippsland. There are actions in place to address the threats posed by elevated sedimentation and turbidity in the Mallacoota Inlet. Management of this species centers around



© Jason Coughran

the topics of available moisture, soil type, and degree of disturbance of the population. Several measures have now been employed to prevent the further loss of upstream riparian habitat strips; however, it is not clear if these measures will be enough to prevent the further degradation and loss of the habitat of this Critically Endangered species. Monitoring of population trends and threats is needed because this species is vulnerable to a single threatening event that could result in its extinction.

Singapore freshwater crab (*Johora singaporensis*)

The Singapore freshwater crab is the poster species for crab conservation, being the first freshwater crab to receive direct conservation action! Located exclusively in two locations in Singapore, it is one of only three freshwater crab species found in that country. Like other crabs of this genus, it is found in areas of higher elevation, more than 100m above sea level. This crab is elusive but can be found living under rocks at the sides of a main stream or in muddy collections of leaves and detritus.

Despite the conservation measures currently being implemented for this species, more work is necessary. Recent surveys in Singapore have failed to locate it in its original location within the Bukit Timbah Nature Reserve and this population is believed to have died out due to water acidification. Future hope for the survival of this species rests on the protection and restoration of the natural habitats where it can still be found.

Conservation status: CR

When first listed as EN or CR: 2008

Range: This species is endemic to Singapore and was previously only known from Bukit Timbah Nature Reserve, although it is no longer found there. There is also a small population in a streamlet near Bukit Batok.

Size: Adult at carapace widths of around 30mm.

Diet: Detritus and oligochaete worms.

Threats: Reduced stream flow, due to lowering of the water table in Jungle Falls Valley, and acidification have limited the extent of available habitat for this species. Loss of forest cover and aquatic pollution pose additional problems.

Current conservation action: There is ongoing conservation action targeted to Bukit Timbah Hill and Jungle Falls Valley where this species resides. As a first in freshwater crab conservation, it is also the subject of captive breeding



© Heok Hui

efforts and preparation for reintroduction into suitable habitat in hopes that a stable population can be rebuilt.

Liberian tree hole crab (*Globonautes macropus*)

Freshwater habitats range from large lakes to minute and temporary puddles – some in places we don't immediately think of when considering freshwater. The Liberian tree hole crab is a tree-climbing freshwater crab endemic to the Upper Guinea forests of West Africa. These crustaceans make their home in tree holes that have filled with rainwater, a long way from permanent water sources. Crabs scurry down the tree at night to forage for food on the forest floor and climb back up the tree before the day begins.

The species was first reported in Liberia in 1898 and only rediscovered decades later in 1988. The closed canopy rainforests in Liberia that these crabs rely on have been the target of deforestation due to the region's growing population size and need for agricultural and residential development. The range of this species is not located within a protected area, and further work is necessary to prevent the destruction of the rainforest habitat that this species depends on for its survival.

Conservation status: EN

When first listed as EN or CR: 1996

Range: This species is found in the Upper Guinea rainforests of Guinea and in western Liberia, specifically Bong, Lofa, and Mesurado Counties. It has not been collected either in the Mount Nimba region or in the areas of Sierra Leone that lie between the Liberian and Guinean localities.

Size: Adult at carapace widths between 25–35mm.



© Neil Cumberlidge

Diet: Plant materials foraged from the forest floor and occasional invertebrates.

Threats: The Upper Guinea rainforest habitat has been the subject of loss and degradation due to recent human population increases, deforestation, agricultural development, regional wars, and political instability. The mature trees of the rainforest have been the target for building supplies and cleared to make way for agricultural activities.

Current conservation action: There are very few known conservation measures directed at this species and it is not found in any protected areas. Further work needs to be done to monitor its population trends and research this species' ecology and threats, to allow for future conservation measures to be taken.

White-clawed crayfish (*Austropotamobius pallipes*)

This crustacean earned its name from its claws that have pale-white undersides. Previously found in great numbers in England, Wales, Ireland, France and Italy, this species' populations have drastically declined over the past two decades. Invasive crayfish species such as the signal crayfish (*Pacifastacus lenisculus*) and the red swamp crayfish (*Procambarus clarkii*) have outcompeted the white-clawed crayfish in many of these countries, and today its largest subpopulation is in Ireland. While information on the rate of decline is not available for every country, this species is believed to have undergone a global decline of 50-80% over the past 10 years.

The white-clawed crayfish is certainly not the only freshwater species that has been negatively impacted by invasive species. Well known examples of freshwater invasive species, aside from the crayfish species mentioned above, include the zebra mussel (*Dreissena polymorpha*) and quagga mussel (*Dreissena bugensis*), fish like carp that are introduced for sport fishing, crabs such as the Chinese mitten crab (*Eriocheir sinensis*), and several species of freshwater plants, to name but a few. These non-native species may alter food webs or habitat, prey on native species, and use up the limited resources native species need to survive. This can result in the extinction of these native species and destruction of biodiversity in freshwater ecosystems as a whole. Currently, more than 3,800 freshwater species (11%), out of the 35,709 freshwater species listed on the IUCN Red List of Threatened Species, are threatened by invasive species, at least in parts of their range. Of these, 37% are either listed as Critically Endangered or Endangered; another 75 species are Extinct or Extinct in the Wild.

Conservation status: EN

When first listed as EN or CR: 2010

Range: The white-clawed crayfish has a wide distribution across continental Europe, from northwestern Spain to Montenegro, from Scotland to the south of Spain. It has been introduced to both Liechtenstein and Ireland, where the largest subpopulation of the species can now be found.

Size: Adults have a carapace length of <10cm.

Diet: This is an omnivorous species that feeds on invertebrates (including *Diptera*, shellfish, and *Tripoptera*) as well as vegetation and detritus.

Threats: The main threats to the white-clawed crayfish are two invasive crayfish species: the signal crayfish and the red swamp crayfish. These non-native species prey on the white-clawed crayfish and compete with the native species for other resources. Localised declines in white-clawed crayfish can also be attributed to agricultural pollution, sedimentation, eutrophication, and other alterations and degradations of their habitat. They are also at risk of contracting crayfish plague (*Aphanomyces astaci*), a water mold that is present around the world but most notably affects European species, killing them within a few weeks of infection. Additionally, this species may also be threatened by porcelain disease (*Thelohania contejeani*) which can afflict 10% of the population without apparent harm but could be detrimental to the population if the prevalence grows.

Current conservation action: In Ireland, this species is protected by the European Union (Natural Habitats) Regulations 1997. Action plans have been developed aiming to maintain the current distribution of the species by restricting the spread of non-native crayfish species and of crayfish plague, together with providing more suitable habitat features. This species is also part of ongoing reintroduction plans in France.



© Giuseppe Mazza

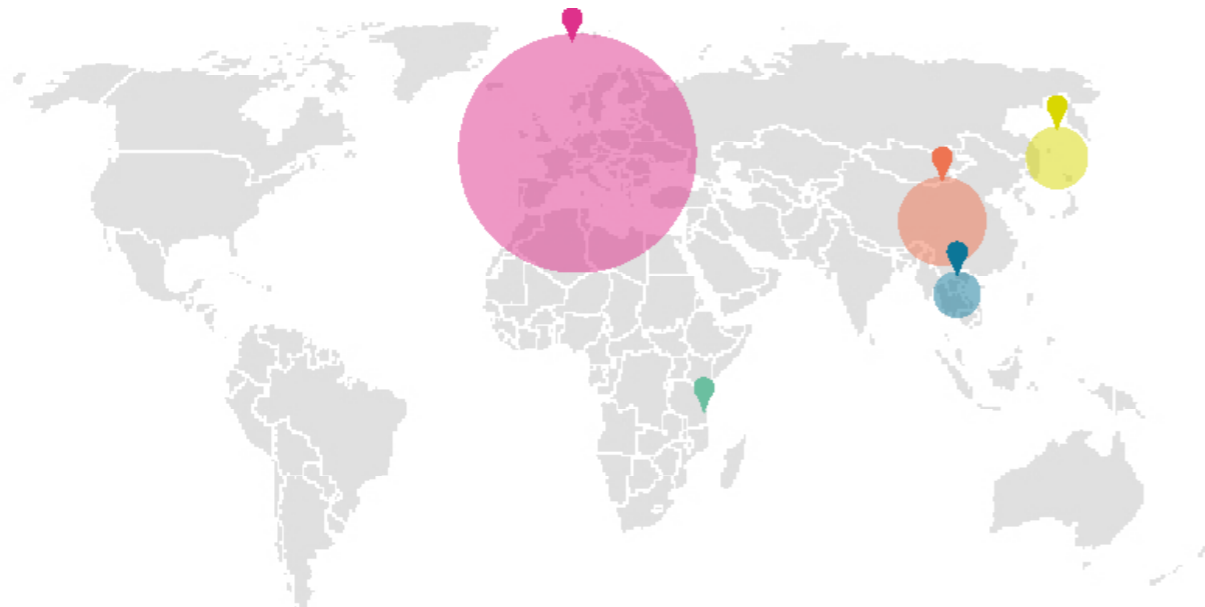
FISH

With around one in four assessed species of freshwater fish considered at risk of extinction, and 79 species having already been declared Extinct, fish bear the brunt of the many pressures put on the planet's freshwaters.

The threats are well understood. Rivers, lakes and wetlands have historically been drained, dredged, dammed and polluted, not to mention the invasive species that outcompete or eat the native fish. Humanity's relationship with freshwater has in recent history been one of exploitation.

Another issue, less tangible, is that the wonders of freshwater fish are seldom shown to audiences beyond the environment sector. Rarely do natural history programmes show the remarkable behaviours and dazzling diversity of freshwater fish and, if people don't know about them, they are unlikely to help conserve them.

Fortunately, groups of conservationists from around the world are now collaborating on an ambitious plan to elevate freshwater communication to the level of marine and terrestrial, and to help uncover the world of wonder hidden beneath the surface that will inspire meaningful changes in attitude to freshwater fish.



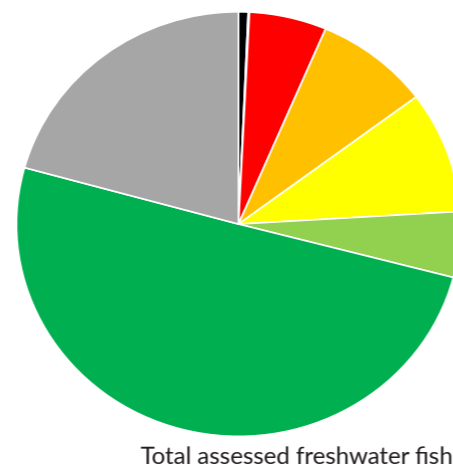
Location is approximate and intended to show geographical spread.

Location is approximate and intended to show geographical spread.

Species accounts with expert input from:



EX	79
EW	10
CR	636
EN	943
VU	1,048
NT	564
LC	5,672
DD	2,339
TOTAL	11,291



Total assessed freshwater fish

European eel (*Anguilla anguilla*)

The European eel is a conundrum. For hundreds of years, it was an important food source for many European cultures and was so common in medieval England that in the 11th century it was often used in lieu of money to pay rents to landlords. It was so important to people's daily lives that eels are a major illustrative feature on more than 50 coats of arms across Germany, The Netherlands, France, England and beyond.

Yet over the past 40 years, the number of juvenile European eels returning to continental waters has dropped by as much as 95%. The decline has been so steep that the species is now listed as Critically Endangered.

Unsustainable fishing, pollution, climate change, disease, habitat loss and barriers to migration have all put immense pressure on the species. There have even been some high-profile cases of suitcase loads of juvenile European eels being smuggled to feed an international appetite for the fish.

For the species to recover, it is essential that the available habitat for its growth and maturation is expanded by removal or adaptation of existing barriers, water quality is improved, and fisheries and trade are sustainable.

Conservation status: CR

When first listed as EN / CR: 2008

Range: Occurs in the continental waters of Europe and is distributed from northern Scandinavia, along the coast of Europe, all coasts of the Mediterranean and on the North African coast^{23,24}. They are thought to spawn in the Sargasso Sea.

Size: Adult silver eel males rarely get over 45cm in length, whereas females can measure >1m.

Diet: A wide variety depending on the life stage, including molluscs, crustaceans and fishes.

Threats: Overfishing, pollution, parasites, habitat loss and degradation, predation, and barriers to migration such as dams.

Current conservation action: The European eel is the focus of the EU Eel Regulation produced in 2007 with the aim of recovering populations. Under the Regulation, EU countries with eel fisheries must implement management plans for the recovery of the species. These plans include measures to restrict fishing and other human activities that impact European eels. In addition to this, the European eel is listed in both Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and the Convention on International Trade in



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Endangered Species of Wild Fauna and Flora (CITES), which are multilateral UN treaties that encourage international cooperation for the conservation and management of individual species.

Mekong giant catfish (*Pangasianodon gigas*)

One of the world's largest freshwater fishes, these gentle giants can reach 200kg in just six years. In 2005, a record-breaking specimen was caught that was almost three meters long, weighing nearly 300kg. The adult's diet means they have no need for teeth, and instead use rough pads inside their huge mouths to nibble away at algae and plants.

At the start of the rainy season, adult Mekong giant catfish gather in the lower Mekong River and migrate huge distances together to their spawning grounds in the northern headwaters. This epic migration is one of the factors behind their catastrophic decline: dams and fragmented habitat make it nearly impossible for them to carry out their natural lifecycle.

Four of the planet's 10 largest freshwater fish species are found in the mighty Mekong River and, as with other Mekong megafauna, e.g. Julien's golden carp (*Probarbus jullieni*), the giant pangasius (*Pangasius sanitwongsei*), the giant barb (*Catlocarpio siamensis*), the Mekong giant salmon carp (*Aptosyax grypus*), and the giant Mekong stingray (*Urogymnus polylepis*), the health of the Mekong giant catfish is inextricably linked with the health of this river. Furthermore, any impact on the ecological balance of the river also threatens the sustainability of the aquatic resources that support millions of people. Yet the Mekong giant catfish population has plummeted by as much as 90% in only two decades. There are now estimated to be just a few hundred, or even fewer, individuals surviving in the wild.

Conservation status: CR

When first listed as EN / CR: 1996

Current Range: Endemic to the Mekong River basin.

Size: up to 3m in length, weighing more than 300kg.

Diet: Fry of this species eat zooplankton and are known to be cannibalistic. The adults are herbivorous and eat filamentous algae²⁵.

Threats: The single most important threat is hydropower dams in the lower Mekong and large tributaries. These obstructions block migration routes to spawning grounds and, if the fish stop migrating, they will stop spawning. Overfishing and pollution also put tremendous pressure on the species.

Current conservation action: In some countries, capture of the species is regulated or has become illegal. Breed and release programs have been attempted in the past, but efforts to introduce these fish into the wild have largely failed.



Nothobranchius fuscotaeniatus

This dazzling beauty is the only species in the *Nothobranchius* genus that displays this intense blue-green colouration with no red on the body or fins.

In the wild, it has only ever been found in an area of 4km², in a roadside ditch on the floodplain of the Lower Rufiji River in the coastal region of Tanzania. Since the species' discovery in 1997, several surveys failed to detect its presence either where it was first discovered or elsewhere in the drainage of the Rufiji River.

This killifish species is adapted to the very specific habitat conditions of the densely vegetated edges of pools in the lower Rufiji drainage, making it highly susceptible to any habitat change. With extensive farming surrounding the pools, there is increasing pressure on the land, which is likely to result in degradation of the fish's habitat.

The species currently has no common name.

Conservation status: CR

When first listed as EN / CR: 2019

Current Range: Tanzania, lower Rufiji drainage, about 2km south of Ndundu ferry across the Rufiji River, on the road from Nyamwage to Kibiti.

Size: Maximum size reported for adult males is 45mm in length and the average for females is around 40mm²⁶.

Diet: Similar diet to other killifish, consisting of mainly aquatic arthropods, aquatic crustacean, and worms.

Threats: Suspected threats include habitat alteration from agriculture.

Current conservation action: The American Killifish Association has it listed as a species that needs special attention, but no conservation measures are yet in place. Future surveys are needed to determine if the species still exists in its range.



Sakhalin taimen (*Parahucho perryi*)

Sakhalin taimen are one of the largest salmonids in the world and are powerful apex predators with a diverse diet that includes other fishes, birds and mammals. They are relatively slow growing but can reach large sizes and live over 20 years. They are the only member in their genus and are known to migrate extensively within freshwater river systems and adjoining marine coastal habitat.

They are very popular sport fish in both Russia and Japan, and their spawning period in the spring attracts many naturalists and photographers to the headwaters of the Sarufutsu River in Hokkaido, Japan, who marvel at the bright red spawning colours while the fish swim upstream and spawn in stream channels lined with dwarf bamboo.

As a top predator, they serve as a sensitive ecosystem indicator in free-flowing, wild rivers; however, 90% of their historic abundance has been lost due to overfishing and habitat modification, and many river populations in Japan have been extirpated. Warming waters due to climate change are also a major threat: during the summer of 2021, 40 individuals were found dead in the Sarufutsu River, where the water temperature had risen above 27°C: definitely in the lethal range for the species.

To ensure the species is given the best possible chance of survival, conservation action is needed to establish fish reserves or freshwater protected areas, restrict illegal fishing practices, establish new or strengthen existing sport fishing regulations (including banning use of bait and treble hooks and establishing no-kill zones), limit bycatch in commercial fisheries, and restore degraded and fragmented habitat.

Conservation status: CR

When first listed as EN / CR: 2006

Current Range: Endemic to the Russian Far East, and Hokkaido, Japan.



© National Institute for Environmental Studies, Japan.

Size: A historical record exists of an individual captured in Japan in 1937 that was 215cm total length. There are numerous contemporary records of adults exceeding 100cm total length.

Diet: During the first 1-2 years they feed primarily on invertebrates at the bottom of the river. Adults eat crustaceans, other fishes, marine invertebrates, birds, and small mammals.

Threats: Overfishing for commercial, recreational, and illegal take is a serious threat. Sakhalin taimen are not commercially harvested but are subject to sport fishing and bycatch in commercial fisheries. The species also faces the threat of migration barriers (particularly dams), and habitat changes due to logging operations, agriculture, and other land use practices. As a cold water-adapted species, these fish are very sensitive to warming in fresh and marine waters due to climate change.

Current conservation action: Establishing reserves and freshwater protected areas is one of the most effective measures to avoid extinction. Some reserves have been established successfully in Japan and the Russian Far East. Some efforts at captive breeding and reintroduction have occurred in Japan and Russia, but these should be considered a last resort given current understanding of the negative effects of hatchery operations on wild salmonid populations.

Yangtze sturgeon (*Acipenser dabryanus*)

The Yangtze sturgeon was once abundant in the upper and middle reaches of the Yangtze River, China, but overfishing and habitat destruction have caused a dramatic decline in numbers over the past 40 years and no natural reproduction has been observed since the year 2000 – three generations of the species.

It is thought the Yangtze sturgeon's evolutionary history is paralleled with the history of the Yangtze River, making the species nearly 30 million years old. Sturgeon have long lifespans and, although there are no direct records of the age of individuals, it is likely they can live up to around 40 years, similar to the Chinese sturgeon *A. sinensis*.

The species has historically experienced unsustainable levels of fishing, and increased fishing intensity between 1950 and 1985 caused populations to plummet. A decade long fishing ban was implemented in 2021 for the Yangtze basin, covering the entire main stem of the river, seven tributaries, Poyang and Dongting lakes and 332 protected areas in the river basin. Chinese authorities hope that this protection and restocking will benefit many of the river's fishes and allow the sturgeon populations to recover throughout this 10-year window. However, as Yangtze sturgeons take nine years to reach sexual maturity, experts are concerned that populations are likely to remain way below historic numbers.

Conservation status: CR

When first listed as EN / CR: 1996

Range: The upper and middle reaches of the Yangtze River.

Size: Adults have reached up to 1.5m in length but are usually much smaller.

Diet: Demersal organisms, i.e. those that live near the bottom of the Yangtze River, including small fish, crustaceans, molluscs and aquatic insect larvae.

Threats: Like many sturgeon species, it is subject to overfishing, habitat destruction (including dams), and poor water quality. Fishing nets with reduced mesh size result in captured young.

Current conservation action: This species has been listed as a First Class Protected Animal of the State in China since 1988. It has been the subject of successful artificial propagation and restocking programmes.



© Qiwei Wei

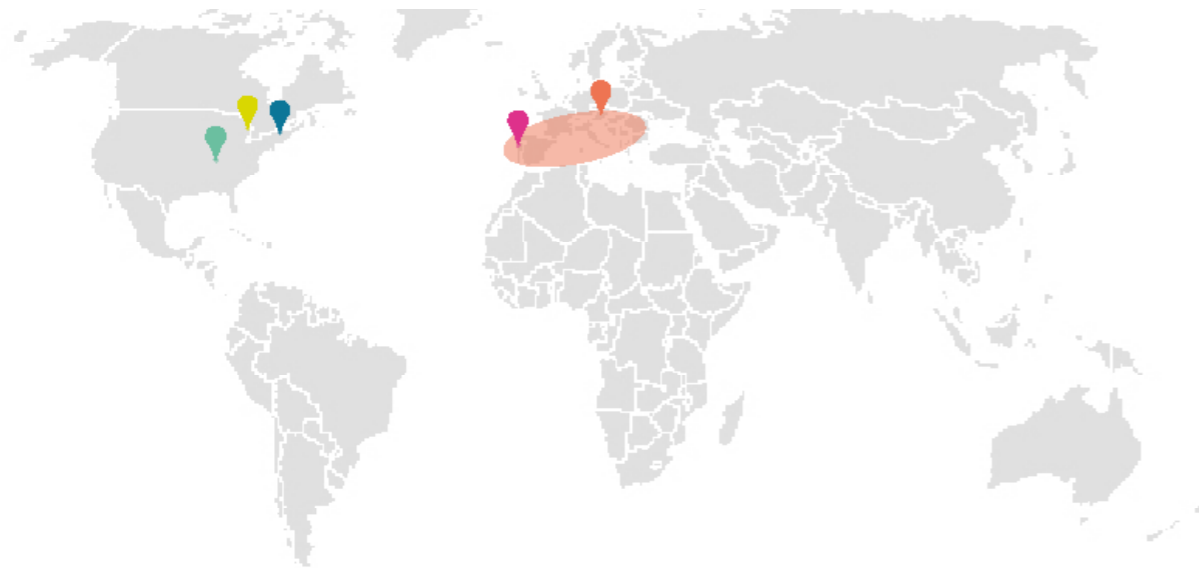
FUNGI

Fungi provide the ecological basis for other organisms to thrive. This is not just the case on land but also in freshwater. Freshwater fungi comprise several different fungal groups, from the *Ascomycota* (a familiar example from the terrestrial world includes the morel mushrooms) to microscopic species such as chytrid fungi that causes the chytrid disease - one of the major threats to amphibians worldwide. A principal role of freshwater fungi is to decompose dead plant material, though some species also attack and live in plants, animals and other fungi – some chytrid fungi for example are pathogens of algae and thus control algae blooms.

Despite their importance for freshwater ecosystems, very little is known about these species, including our knowledge on their distributions and threats. In fact, given their great diversity, there are very few experts studying these fascinating fungi, meaning they are only now entering the conservation arena. Increasing knowledge of these crucial organisms is the first step to increasing our appreciation for them.

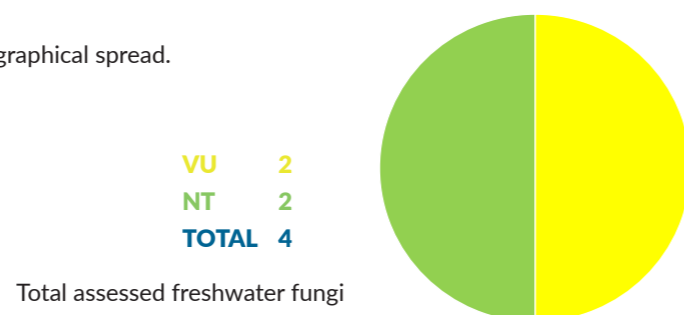
None of the ascomycete species presented here have yet had a conservation assessment, but current knowledge suggests that they are range-restricted or rare. Freshwater ascomycete fungi occur on submerged parts of emergent macrophytes and on submerged dead herbaceous and woody debris in freshwater habitats. At present, close to 3,000 species of freshwater ascomycetes are known to science²⁷. These species have been discovered by a small group of experts; with more capacity for freshwater fungi research, imagine how many species may still await discovery in our freshwaters!

We hope that learning about the five species below will spark interest in this enigmatic and fascinating group of species and aid in their inclusion in conservation decision-making.



- Moustache fungus
Collembolispora barbata
- Beautiful narrow spore
Arthrospira pallida
- Little butterfly of the swamp
Lepidopteraea palustris
- Star of the bog
Aucovegiaspora stellipola
- Little palm fungus
Tetrastichium palmatum

Location is approximate and intended to show geographical spread.



Moustache fungus (*Collembolispora barbata*)

Collembolispora barbata belongs to a group of fungi called 'aquatic hyphomycetes', which were first discovered in 1880²⁸. Growing evidence suggests diversity of these fungi in nature might influence freshwater ecosystem processes, so we would overlook these species at our peril! This group is also known as Ingoldian fungi, in honor of Cecil Terence Ingold, one of the pioneers of freshwater fungi research. Hyphomycetes produce beautiful conidia – the fungi's asexual spores. These spores are often sigmoid (S shaped) or more 'star' shaped with four or more arms radiating from the centre of the spore. *Collembolispora barbata* seems to have little moustaches from where the latin name "barbata" likely comes from.

Freshwater fungi are minute, microscopic organisms and collection and identification of species requires special techniques. Freshwater fungi researchers collect woody or herbaceous debris which has been submerged for a significant length of time. These are then incubated under lab conditions to promote reproduction. Alternatively, researchers may 'bait' for fungi. These baits are leaves, twigs, branches or wood panels which are submerged in the study area and left in place for at least several days, often months, before retrieving to check for fungi. Natural forming foam on the surface of streams is also an ideal place to look for spores, since the spores get trapped amongst the bubbles.

Conservation status: NE

Range: This species is known from a single specimen that was collected from a mountain freshwater stream in Peneda-Gerês National Park, in Northwestern Portugal.

Size: 40-50µm (for asexual spores).

Substratum: Likely leaf litter that falls from riparian vegetation.

Importance: Freshwater fungi contribute to the decomposition of dead plant material and serve as food for invertebrate shredders.

Threats: Given our limited knowledge about freshwater fungi, it is difficult to identify and understand threats to these species. The National Park where the species occurs has seen impacts from wildfires and invasive *Acacia* species, and climate change may play a major role in facilitating these disturbances. Primary threats to aquatic hyphomycetes are likely to come in the shape of the general threats that impact freshwaters all over the globe: hydrological alterations, agricultural activities, invasive species, climate change, and pollution.

Current conservation action: There are no conservation actions in place for this or any of the other freshwater fungi species. In fact, this fascinating group of organisms is only now starting to become part of the conservation agenda. The species has been found in a protected area, the first protected area created in Portugal and currently the only National Park in the country. It is also part of a UNESCO Transboundary Biosphere Reserve.



© Isabel Fernandes

Beautiful narrow spore (*Isthmosporella pulchra*)

This species was first described in 1999 after it was isolated from submerged wood in the state of New York, USA. It caught the researchers' attention because of unusual 'ascospores' – the reproductive cells of ascomycete fungi. This is reflected in its genus name – *Isthmosporella pulchra* roughly translates into "little beautiful narrow passage ascospore".

So far, the species has not been found anywhere else, although it has been found once in its original locality since its description. This is a common issue with freshwater fungi. With only a few experts in the field and the difficulty in collecting these species, our current geographic knowledge on freshwater fungi reflects where the few experts are based and work. This causes the many geographical gaps in our knowledge of these vital organisms. Most knowledge is available from Asia, Europe and North America, but even here, given the lack in people power, much more remains to be learned about freshwater fungi.

Conservation status: NE

Range: So far, this species is only known from Tupper Lake in New York State, where it was found on submerged wood.

Size: 80-105 x 8-10µm (ascospores).

Substratum: Submerged wood.

Importance: Freshwater fungi contribute to the decomposition of dead plant material and serve as food for invertebrate grazers. They play an important role in aquatic food webs.

Threats: Given our limited knowledge about freshwater fungi, it is difficult to identify and understand threats to these species. However, freshwaters face a multitude of human-made impacts.

Current conservation action: There are no conservation actions in place for this or any of the other freshwater fungal species. This fascinating group of organisms is only now starting to become part of the conservation agenda.



© Carol Shearer and Huzefa Raja

Little butterfly of the swamp (*Lepidopterella palustris*)

With reproductive cells (ascospores) that look like butterflies, this species was originally isolated from a submerged twig collected from Elvira Cypress Swamp in Illinois. It has subsequently been found at a second locality in Illinois, as well as in Florida, in both standing and running water. There is a bit more knowledge available on this species compared to many other species of fungi, as researchers have already sequenced the genome of this species.

Fungi play an important role in medical advances – a famous example was the discovery of a compound produced by the mold *Penicillium* that revolutionized 20th century medical treatment for bacterial infections. Freshwater fungi also produce secondary metabolites with antibacterial or antifungal properties. Given the increasing resistance of microbial strains to currently available antifungals and antibiotics, these novel bioactive natural products can have immense value to medical science.

Conservation status: NE

Range: This species was found on submerged wood in Elvira Cypress swamp in Illinois and has since been located in two more places: one in a creek in Illinois, the other in a swamp in Apalachicola National Forest, Florida.

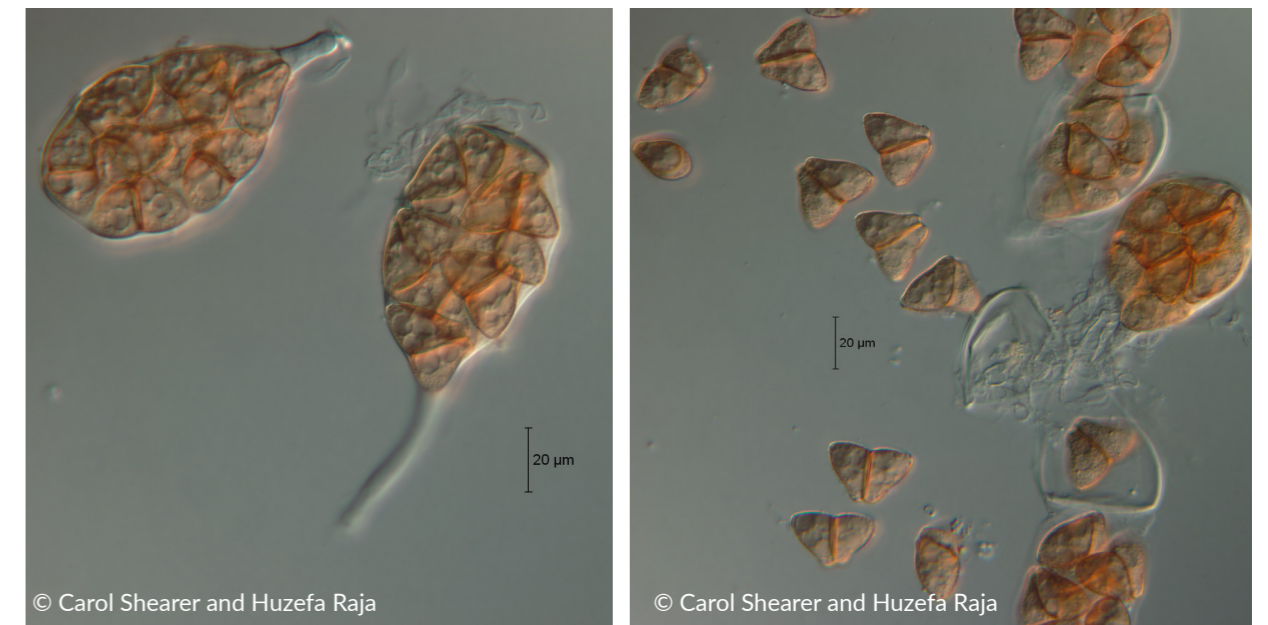
Size: 16-23µm long at septum, 25-30µm maximum width (ascospores).

Substratum: Submerged wood.

Importance: Freshwater fungi contribute to the decomposition of dead plant material and serve as food for invertebrate grazers.

Threats: Given our limited knowledge about freshwater fungi, it is difficult to identify and understand threats to these species. However, like bogs and other wetlands, swamps have been impacted by drainage and habitat loss the world over.

Current conservation action: There are no conservation actions in place for this or any of the other freshwater fungi species. This fascinating group of organisms is only now starting to become part of the conservation agenda.



© Carol Shearer and Huzefa Raja

© Carol Shearer and Huzefa Raja

Star of the bog (*Ascovaginospora stellipala*)

Freshwater fungi are in general so poorly known that, unlike many other species of vertebrates, invertebrates or plants, they do not even have common names. “star of the bog” is derived from this species’ Latin name *stellipala* and is an apt description of this species: currently only known from two bogs in Wisconsin, this species has a beautiful sheath covering its reproductive cells (ascospores) which gives it the appearance of a three-rayed star.

Ascomycete freshwater fungi play important roles in our freshwater ecosystems. These species produce several types of enzymes that help to decompose a wide variety of plant debris that falls or is washed into aquatic habitats. Sphagnum bogs, where this species was found, are freshwater wetlands characterised by spongy, poorly drained soil and a floor of sphagnum mosses. They are important as carbon sinks due to the accumulation of decayed plant material.

Conservation status: NE

Range: This species was found on submerged dead stems and leaves of the bog-sedge (*Carex limosa*), which were collected from two sphagnum bogs in Wisconsin, USA. The mud sedge, on which the star of the bog has been found, is a sedge associated with sphagnum and peat bogs and has been found widely in North America and Europe.

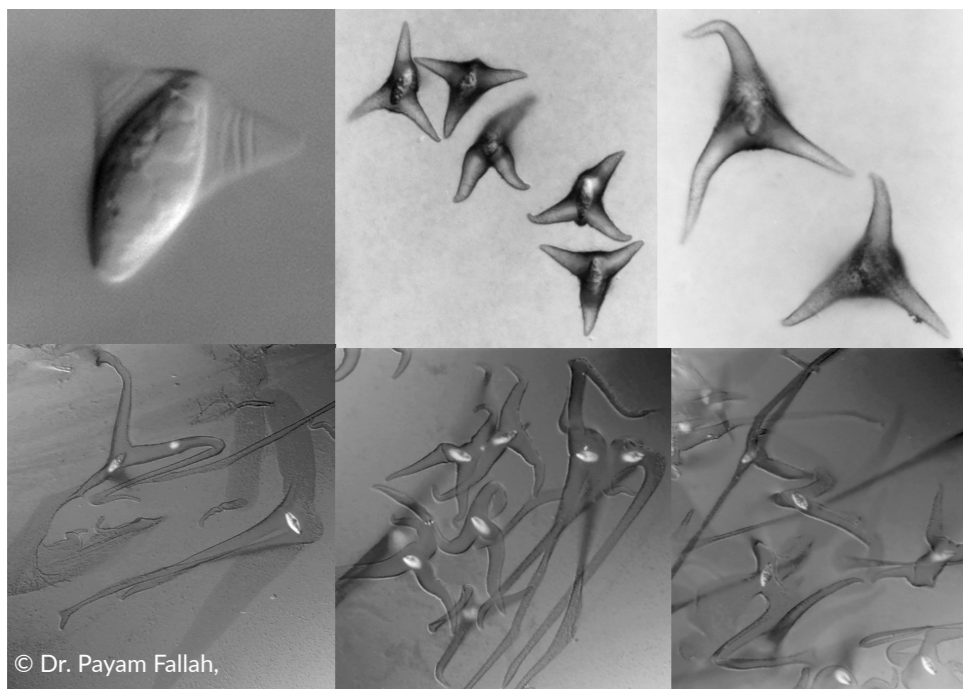
Size: 16-18 x 6-8µm (ascospores).

Substratum: Submerged dead stem and leaves of bog-sedge (*Carex limosa*).

Importance: Freshwater fungi contribute to the decomposition of dead plant material and serve as food for invertebrate grazers.

Threats: Given our limited knowledge about freshwater fungi, it is difficult to identify and understand threats to these species. However, freshwaters face a multitude of human-made impacts. Bogs in particular are impacted by drainage and habitat loss the world over.

Current conservation action: There are no conservation actions in place for this or any of the other freshwater fungi species. In fact, this fascinating group of organisms is only now starting to become part of the conservation agenda.



© Dr. Payam Fallah,

Little palm fungus (*Tetracladium palmatum*)

Unlike some of the other species of freshwater fungi featured in this report, this species with palmate spores has been reported on several occasions. For example, it has been found in northwestern Portugal alongside *Collembolispora barbata*. Although we know more than for other species, it is still considered rare and, when it is found, it is generally found in low abundance.

Overall, the genus *Tetracladium* contains eleven species, and this one currently appears to be among the few representatives of this select group that are only found in water. Many species of *Tetracladium* are also capable of living as endophytes, i.e. they can also live symbiotically inside plants, though it is not yet known how these two different lifestyles connect. How can a species that lives in rivers also live in carrots or orchids? Perhaps they are different parts of a united lifecycle? This shows that to conserve freshwater species, including freshwater fungi, conservation efforts must work across habitats: what happens on land also impacts life in our precious freshwater.

Conservation status: NE

Range: This species is thought to be found on the Iberian Peninsula, in Spain and Portugal, and has also been found in Austria, the Czech Republic and Ireland. It has been isolated from foam taken from rivers or streams.

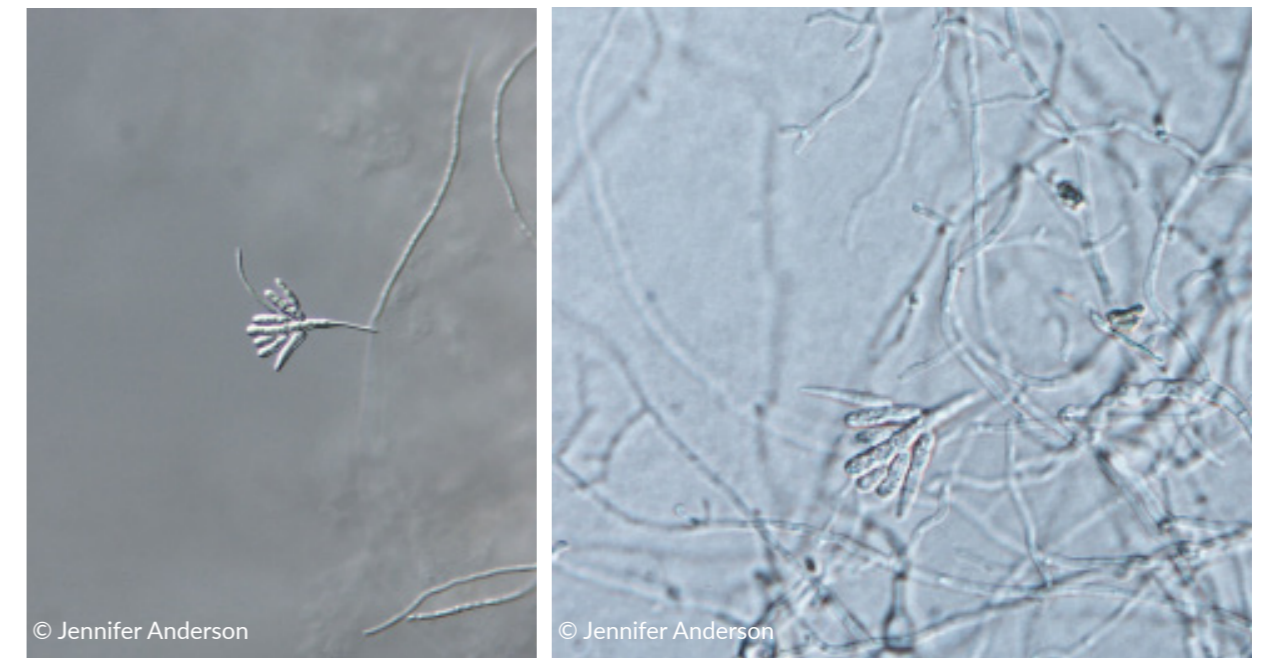
Size: Main central axis 37-51µm long²⁹.

Substratum: Likely leaf litter that falls from riparian vegetation.

Importance: Freshwater fungi contribute to the decomposition of dead plant material and serve as food for invertebrate shredders.

Threats: Given our limited knowledge about freshwater fungi, it is difficult to identify and understand threats to these species. Primary threats to aquatic hyphomycetes are likely to come in the shape of the general threats that impact freshwaters all over the globe: hydrological alterations, agricultural activities, invasive species, climate change, and pollution.

Current conservation action: There are no conservation actions in place for this or any of the other freshwater fungi species. This fascinating group of organisms is only now starting to become part of the conservation agenda.



© Jennifer Anderson

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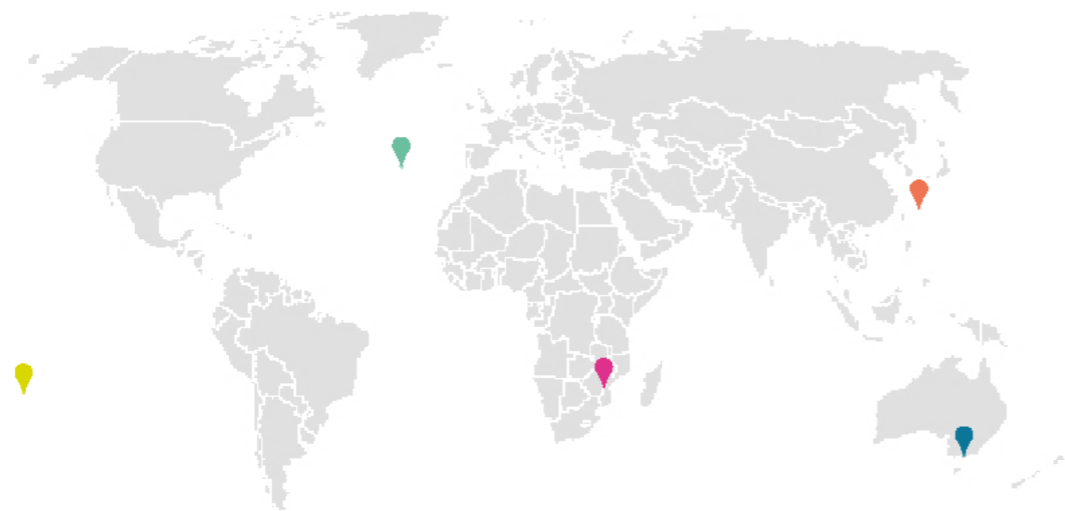
INSECTS

Aquatic insects live for some parts of their lifecycle, generally during immature stages, in freshwater. Several insect orders contain at least some aquatic (or semiaquatic) species, most prominently the stoneflies (*Plecoptera*), mayflies (*Ephemeroptera*), caddisflies (*Trichoptera*) and dragonflies and damselflies (*Odonata*). Other aquatic insects are the diving beetles (*Coleoptera*), water striders (*Hemiptera*), alderflies, dobsonflies and fishflies (*Megaloptera*), and of course species such as mosquitoes (*Diptera*). There are even some moth and firefly species with aquatic larvae!

Aquatic insects are important food sources for other species, such as fishes, amphibians and birds. They are important indicators of environmental health and are often used in environmental monitoring. Aquatic insects retain nutrients in their bodies that would otherwise be carried downstream, and return these to terrestrial systems. Some species are important for litter decomposition in freshwaters. Fly fishermen use or mimic aquatic insects as bait to catch fishes.

Dragonflies and damselflies are probably the best studied group of aquatic insects in terms of their conservation needs. The recently completed first assessment of this group of species for the IUCN Red List showed that the destruction of wetlands – mainly for agricultural expansion and urbanisation – is also driving the decline of these beautiful and charismatic insects.

In collaboration with the IUCN SSC's Dragonfly Specialist Group, Mayfly, Stonefly and Caddisfly Specialist Group, Firefly Specialist Group and Mid-Atlantic Islands Invertebrate Specialist Group, the five selected species exemplify current knowledge on aquatic insects and their threats as well as important conservation priorities.

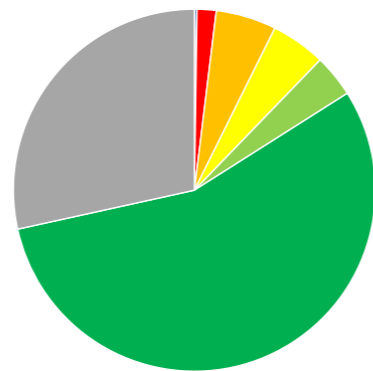


Location is approximate and intended to show geographical spread.

Species accounts with expert input from:



EX	14
EW	0
CR	105
EN	332
VU	300
NT	233
LC	3,414
DD	1,749
TOTAL	6,147



Total assessed freshwater-related insects

Rock threadtail (*Elatoneura lapidaria*)

First discovered in 2013 and described in 2015, the rock threadtail is a damselfly found at elevations as high as 1500-1600m above sea level in the Chimanimani Mountains. Here in the rocky streams of eastern Zimbabwe, this species can be seen perched on the rocks in the river.

The Chimanimani mountain range has been the subject of illegal goldmining in the past and this issue has been exacerbated over the past few years due to the COVID-19 pandemic. While Chimanimani National Park, where the rock threadtail is found, is a protected area, it has still been a target of this illegal activity. More and more people are travelling to eastern Zimbabwe hoping to find gold, including the park rangers. This activity has caused great harm to the natural water sources and biodiversity of the region and poses a major threat to the future of *E. lapidaria*.

Conservation status: CR

When first listed as EN or CR: 2017

Range: This species is endemic to Eastern Zimbabwe and is only found in the Bundi Plain and Bundi Valley in the Chimanimani Mountains, 16km east of Chimanimani Village.

Size: Hindwings are 15-22mm long.

Diet: Small insects.



Threats: There is illegal gold-mining activity taking place in Chimanimani National Park and the rest of the surrounding mountain range. This poses an immediate threat to all aquatic organisms that live in the upper streams and rivers on the Mozambique side of the range. This is believed to only have a limited impact on the general ecosystem but the effect on species like *E. lapidaria* that are tied to the streams will be much greater.



Typical rock threadtail habitat. © KD Dijkstra

Current conservation action: There are no direct conservation actions in place for this species. Further research of the habitat is necessary to address activities that are threatening the rock threadtail.

Mount Donna Buang wingless stonefly (*Riekoperla darlingtoni*)

This Critically Endangered stonefly is only found within a 1km radius of the summit of Mount Donna Buang in Victoria, Australia. It has a particularly long lifecycle, living for up to three years in its juvenile stage before emerging as an adult. This means that it requires optimum conditions for growth over at least three years. During this time, it lives in springs and rivulets and digs into moist ground when the springs dry up during the summer. The adults are wingless, and therefore cannot disperse to other areas, so they are limited to within a couple of meters of the stream edge.

This species is threatened by climate change, as these small springs and rivulets are drying out earlier in the year and for longer periods which threatens the survival of the larvae during the summer. In addition, wildfires, as we have seen recently in Australia, could have a devastating effect on this species. Other threats include increased tourism and the construction of paths and roads within the Yarra Ranges National Park, and the introduction of non-native species that impact the habitat of the stonefly. A recent study indicated a significant population decrease from 2005 to 2019 at the type locality³⁰.

Conservation status: CR

When first listed as EN or CR: 2014

Range: This species is known from the Mount Donna Buang area in the Victorian Central Highlands, Australia. Most specimens have been located within 1km of the Mount Donna Buang summit, with only one recorded 3km northeast of the summit. Excluding the site 3km northeast of the summit, the area over which the species occurs is 2km².

Size: Adult body length is around 12mm and antennae length starts at 8mm.

Diet: Larvae are thought to be detritivore-herbivores. Adults have been observed feeding on the green algal layer on the inner surface of rolled up eucalyptus leaves and on green encrusted twigs.

Threats: The main threats to this species are the effects of climate change, including reduction in precipitation and sustained drought and fire. Development for tourism has also become a problem for the Mount Donna Buang wingless stonefly, as it has resulted in loss of habitat and pollution due to storm water runoff. The fungal disease Myrtle Wilt (*Davidsoniella australis*) poses a threat for the myrtle beech understory within this species' range.

Current conservation action: An Action Statement for this species was prepared under the Victorian Flora and Fauna Guarantee Act in 2003, which determined the necessary conservation actions for this species as continued site protection, minimising the harmful effects of roads, tracks and car parks on the surrounding habitat, and listing the species under the Environment Protection and Biodiversity Conservation Act (EPBC) 1999. However, the species was rejected for EPBC Act listing and thus still urgently requires listing under national environmental conservation legislation in Australia. Novel environmental DNA (eDNA) methods have been used to search for additional localities for this species within suitable habitat, and more surveys are required to establish the distribution of this elusive insect. Further development of quantitative eDNA methods could yield a technique to monitor the population trend of this species.



Female. © Eddie Tsyrlin



Male. © Eddie Tsyrlin



Nymph. © Eddie Tsyrlin

Predacious diving beetle (*Hydroporus guernei*)

As its common name suggests, the predacious diving beetle is an active predator in both its larval and adult stage. They are adept swimmers that kick both legs simultaneously while they swim, distinguishing them from other families of water scavenger beetles that alternate legs. This species hunts for invertebrates and small vertebrates in the freshwater habitats (mainly ponds) of the Azores islands (Portugal) in the Atlantic Ocean.

The species occurs in temporary and permanent ponds. The introduction of an invasive fish species, the eastern mosquitofish (*Gambusia holbrooki*), is the main threat jeopardising predacious diving beetle populations, mostly in permanent ponds where the fish occurs. The eastern mosquitofish, like other invasive species, uses up the resources needed for native species such as the predacious diving beetle and many others. Indeed, research showed that the abundance of predacious diving beetles can be mainly explained by water conductivity and the abundance of eastern mosquitofish. These results suggest that the predacious diving beetle is a species with a narrow tolerance to environmental changes. Faced with the invasive species and several other threats, the predacious diving beetle needs further conservation action to protect its habitat and stabilise its population.

Conservation status: EN

When first listed as EN or CR: 2018

Range: This species is known from several islands in Azores (Portugal) in the North Atlantic Ocean, including Flores, Faial, Pico, São Jorge, Terceira, São Miguel, and Santa Maria. The area it occupies is estimated to be a maximum of 156km², while its extent of occurrence is 33,600km².

Size: Adult length is 2.6-7.1mm on average.

Diet: Unknown (possibly small dipteran larvae).

© Javier Torrent



Threats: Introduced species (the eastern mosquitofish) and agricultural activities (landscape transformation, herbicide pollution, and habitat destruction) have negatively impacted the predacious diving beetle's island habitat. Further threats may arise with the continued effects of climate change, such as habitat shifting and alteration.

Current conservation action: While this species is not protected by Azorean regional law, its habitat does occur in regionally protected areas (Natural Parks of Flores, Faial, Pico, São Jorge, and Terceira). Some degraded habitats are now being restored as part of two LIFE-funded projects, but a habitat management plan must be put in place specifically for this species. In order to determine the best course of action for this species, further research is needed into its life history and ecology.

Teinobasis fatakula

Often described as 'delicate' and 'pretty', only the males of this damselfly species have been observed. They are non-territorial and move with a weak flight even when disturbed. No courtship behaviors have even been witnessed for this species and it is known to be quite elusive, although what we know about it comes from only one day of observations.

This species is known to inhabit the heavily shaded forest streams of remnant forests in 'Eua Island, Tonga. As one of only two islands in Tonga with streams, 'Eua is the perfect habitat for *Teinobasis fatakula*, which likes to perch on the surrounding vegetation of the otherwise bare stream banks. They have also been seen flying around the wider parts of streams, but only where the canopy of surrounding trees was nearly complete (97-100%). Further research on the habitat and ecology of *T. fatakula*, which was first described in 2013, is desperately needed in order to learn more about this species and its potential threats.

There is currently no common name for this species.



© Milen Marinov

Conservation status: CR

When first listed as EN or CR: 2020

Range: Known only from within the borders of the 'Eua National Park, Tonga. This species occupies an actual area of 4.5km².

Size: 4-5cm

Diet: Small insects.

Threats: There have been no observable direct threats to this species but pressure on natural resources like wood and water is an ongoing issue in the species' range. The species is also at risk of being eradicated in single events related to climate change such as floods or droughts.

Current conservation action: There are no direct conservation actions in place to help this species, but it does occur in at least one protected area. Further research is desperately needed to discover and prevent potential threats that have not yet been addressed.

Kumejima firefly (*Luciola owadai*)

Discovered in 1993, the Kumejima firefly is restricted to the small island of Kume, Japan. This freshwater species is the third aquatic firefly in Japan along with *L. cruciata* and *L. lateralis*. The populations of most other firefly species in Japan are considered stable, excluding the Kumejima firefly which has been described as Critically Endangered by the Japan Ministry of the Environment. Their island home, which was once covered in fields for a flourishing rice farming industry, has been converted into sugar cane fields. This has caused the pollution and degradation of the fireflies' habitat.

Found along the streams of Kume Island, the Kumejima firefly makes its home where the riverside vegetation is dense and covered by evergreen broadleaf trees. This is a nocturnal species that uses a flash communication system to attract a mate. It is important that the adults find mates quickly, as the adult life span is less than two weeks. Females will lay an impressive 300-500 eggs, which emit a faint yellow glow.

Conservation status: Not yet assessed for the IUCN Red List; CR on Japan National Red List (2016).

When first listed as EN or CR: N/A

Range: This species is endemic to the small area (about 63km²) of Kume Island, Okinawa Prefecture, Japan. Its habitats on the island are restricted to only the middle and lower reaches of several streams near human residential areas.

Size: Adult male body length is 12.7-14.5mm. Adult female body length is 15.2-16.0mm.

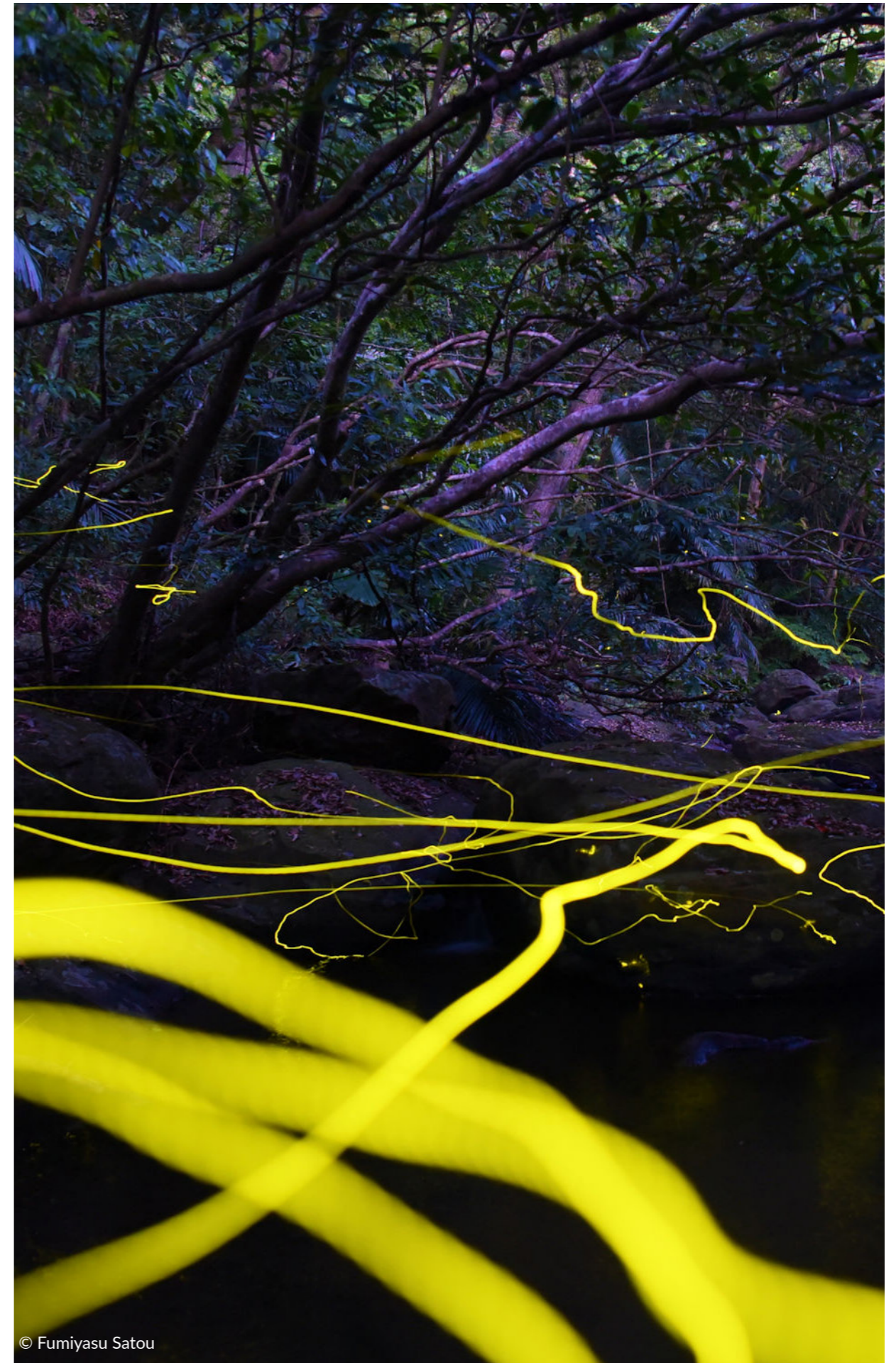
Diet: Freshwater snails.

Threats: The streams where individuals of this species reside have been subjected to water source development which has caused decreased stream flow and deterioration of riverside vegetation. The change of cultivated land in the area has also caused the runoff of large amounts of red clay that has covered the riverbed. These environmental changes may cause a decrease in *L. owadai* population size along with a decrease in their prey, freshwater snails.

Current conservation action: The Kumejima firefly Museum was established in 2000 and addresses the conservation needs of this species. The museum staff work alongside local volunteers to recover and maintain the stream and biotope environments nearby.



© Fumiyasu Satou



© Fumiyasu Satou

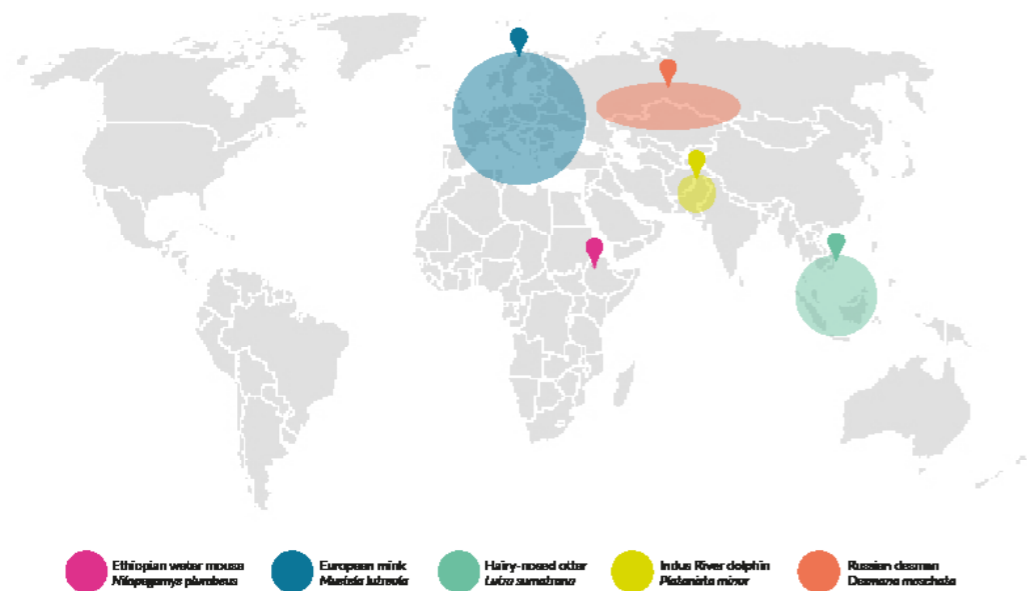
MAMMALS

There are 5,968 mammal species that have been assessed for the IUCN Red List: 22% of these are considered threatened, 85 species are listed as Extinct, and two species as Extinct In The Wild. 506 species, around 10% of all mammal species, are regarded as wetland inhabitants. Four freshwater-related mammals have already been listed as Extinct: Schomburgk's deer, auroch, Nelson's rice rat, and the broad-faced potoroo.

Freshwater mammals, semi-aquatic mammals, or mammals with strong association with wetlands are represented in every continent, except Antarctica; South America being the most diverse with 41 species, followed by Africa (38), Asia (28), North America (24), Europe (11) and Oceania (10)³¹.

Freshwater mammals include creatures that spend most of their time on land but dip into the water to hunt, such as the European mink, those that live entirely in the water, such as river dolphins, and those whose diet is dependent on freshwater species, such as fishing cats and the greater bulldog bat. Others, including otters, beavers and water voles, spend much of their time in the water. Many rivers, lakes and wetlands have historically been plentiful food sources, offering the creatures adapted to hunt and feed in them a ready supply of things to eat.

But anthropogenic pressures such as overexploitation and habitat loss and damage have caused populations of certain species to drop considerably. Fishing nets also pose a very serious risk to freshwater mammals and may bring them into conflict with humans: as air breathers, they can easily drown if they get tangled in nets set to catch fish.

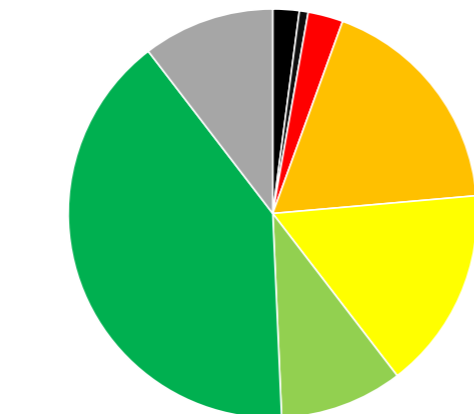


Location is approximate and intended to show geographical spread.

Species accounts with expert input from:



EX	3
EW	1
CR	4
EN	26
VU	23
NT	14
LC	58
DD	15
TOTAL	144



Total assessed freshwater-related mammals

Ethiopian water mouse (*Nilopegamys plumbeus*)

Also known as the Ethiopian amphibious rat, only one specimen of this species has ever been collected, which was back in the 1920s. Today, this remains the only source of information we have about this intriguing rodent, hence the unavailability of photographs.

This species appears to be very well adapted for living in and around water because the only known specimen has various extreme adaptations for swimming, including a large brain, swollen muzzle and extensive facial bristles which may act as sonar to help it hunt aquatic invertebrates. It also has small, densely furred ears, a soft, dense fur coat for buoyancy, and enlarged hind feet with hairy fringes. Its feet are broad enough to be used as paddles for swift, agile swimming.

The mouse was found at 2,600m above sea level, in an area of riverine habitat that had already been degraded by livestock overgrazing, and which is now completely destroyed. There have been two unsuccessful attempts to rediscover this unique species, but more research is needed to determine once and for all whether it is still alive and paddling.

Conservation status: CR

When first listed as EN / CR: 2002

Current Range: The only known specimen was trapped near the source of the Little Abbai River at Gojjam, northwestern Ethiopia, at an elevation of 2,600m above sea level.

Size: Head and body length is around 100mm and comparable to other species of water mice.

Diet: It is thought the species would mainly feed on insects.

Threats: Habitat has been degraded for use as pastureland.

Current conservation action: Any conservation action would require finding the species first. As such, there is currently no conservation action in place.



© Tony Llobet from Wilson, D.E., Lacher, T.E, Jr & Mittermeier, R.A, eds. (2017). Handbook of the Mammals of the World. Vol. 7. Rodents II. Lynx Edicions. Barcelona

European mink (*Mustela lutreola*)

The European mink was once widespread across Europe, from France in the west, deep into Finland in the north, stretching across to Russia in the east and down to Georgia, Bulgaria and Spain in the south. However, over the last 150 years it has severely declined and been extirpated or greatly reduced over most of its former range: the population is thought to have been reduced by 85% since the mid 19th century^{32,33}.

Anthropogenic alterations of the European landscape had a major impact on the European mink, and it is thought that the species has gone through one of the largest human-induced range contractions of any carnivore species globally; probably even greater than that of the tiger.

Overexploitation for fur and the introduction of the alien American mink also contributed greatly to the catastrophic drop in European mink populations.

The overwhelming majority of remaining populations are in decline.

Conservation status: CR

When first listed as EN / CR: 1994

Current Range: The current range consists of a few isolated fragments: in northern Spain and western France, in the Danube delta in Romania, in Ukraine and Russia³³. The species occurs from sea level to 1,120m. It was reintroduced to Estonia in 2000, which has resulted in a small breeding population of fewer than 100 individuals in Hiiumaa Island.

Size: Adult males measure 373-430mm and females measure 352-400mm.

Diet: Hunts in riparian zones and water for amphibians, crustaceans, fish, insects, birds, and small mammals.

Threats: Overexploitation by the fur-trapping industry, habitat loss due to human disturbance, impact from the invasive American mink.

Current conservation action: Part of the population occurs in legally protected areas. There are ongoing conservation breeding programmes in multiple range countries. American mink control and monitoring systems have been established and the species is removed when possible. Further studies have been undertaken to identify the European mink's ecological requirements, genetic variability, and whether populations in some countries suffer from inbreeding depression.



© Emin K Port

Hairy-nosed otter (*Lutra sumatrana*)

The hairy-nosed otter gets its name from the hair that coats its nose - most mammals tend to have hairless, moist noses. It is among the rarest and least known of all 13 of the world's otter species, and in 1998 it was declared extinct after there were no recorded sightings of it in a decade. However, the belief of a Thai scientist, Budsabong Kanchanasaka, that there were still some present in her country was confirmed when some individuals were discovered being kept as pets in 1999. Soon after, she found them in the peat swamp forests of southern Thailand.

Since then, these elusive otters have been recorded in Vietnam, Thailand, Peninsular Malaysia, the islands of Borneo and Sumatra, Brunei, Myanmar and Cambodia, mostly via camera traps and by roadkill.

The species inhabits lowland flooded forests, peat swamp forests, tropical rainforests, mangroves, flooded grasslands, shallow coastal waters, rivers, and wetlands, and can live solitary or in groups of up to four individuals.

The remaining populations are isolated and vulnerable, and much more research is needed to assess their basic ecology and behaviour. Scientists are calling for the species to be upgraded to CITES Appendix I, the Convention on International Trade in Endangered Species of Wild Fauna and Flora's category that prohibits any commercial trade.

Conservation status: EN

When first listed as EN / CR: 2008

Current Range: Endemic to Southeast Asia: Vietnam, Thailand, Peninsular Malaysia, the islands of Borneo and Sumatra, Brunei, Myanmar and Cambodia.

Size: Adult head-body length is 57-82cm and tail length is 35-50m. They weigh 5-8kg³⁴.

Diet: The species feeds principally on fish, followed by water snakes. The diet is supplemented with frogs, lizards, turtles, crabs, small mammals and insects.

Threats: Lowland wetland forest habitats have been threatened by clearing for plantations of oil palm and food crops. Poached for meat and medicinal use as well as the illegal wildlife trade.

Current conservation action: Legally protected in all countries where it is found. The Global Otter Conservation Strategy covers all 13 species of otter and discusses population trends, threats, and conservation actions required (free download: www.iucnosg.org).



© Nicole Duplatix

Indus River dolphin (*Platanista minor*)

The Indus River dolphin is also known as the Indus blind dolphin: due to the turbid water in which they live, they have lost the ability to see and instead use echolocation to navigate and forage. These dolphins can also swim on their sides, while trailing one flipper along the river bottom.

It has only been recognised as a distinct species since June 2021. Before then, Indus and Ganges river dolphins were lumped together as a single species - the more widely distributed South Asian river dolphin (found in Pakistan, India, Bangladesh, Nepal). As a newly 'discovered' species, they have received comparatively little conservation attention.

Dams have dramatically affected both the Indus River dolphin's and Ganges River dolphin's habitat, range and abundance³⁵. The dams act as barriers that not only fragment the population by isolating dolphins into small sections of river, they also degrade the downstream habitat and reduce discharge and sediment flow, which can affect populations of prey species.

Conservation status: EN

When first listed as EN / CR: As a subspecies of South Asian river dolphin, in 2004. The Indus River dolphin will be listed as an endangered species on the Red List in July 2022.

Current Range: Endemic to the rivers of the lower Indus basin in Pakistan, with a few isolated individuals in the Beas River, India.

Size: Male and female adult Indus River dolphins reach up to 250cm in length. The length at birth is 60-70cm.

Diet: They are piscivores that have been known to eat a number of species of fish including catfish and carp as well as invertebrates³⁶.

Threats: Fragmentation of their river habitat by dams and barrages (gated infrastructure built across a river to divert water), as well as diversion of water out of the river into canals for irrigation. Animals that remain in the fragmented and depleted habitat are further impacted by pollution and entanglement in fishing nets. Stranding in irrigation canals also puts these dolphins to risk.

Current conservation action: Legally protected in all range states and occurs in several protected areas. A long-term programme is in place to rescue dolphins trapped in irrigation canals and return them to the Indus mainstem.



Russian desman (*Desmana moschata*)

Although this species may look like a rodent, it is actually an aquatic member of the mole family and, like other moles, is functionally blind. It feels its way around its surroundings by using sensitive receptors - Eimer's organs - at the end of its long snout. It has no external ears, and tiny eyes, and its feet are webbed and its tail partly flattened, making it well adapted to its aquatic habitat.

The population was drastically reduced in the 19th century, when the species was hunted for its rich, thick fur and its musk glands, which were used in making perfume. It is now protected by Russian law.

The population status and trends across its range and the primary anthropogenic factors responsible for its decline remain unclear, and better monitoring is rapidly needed to inform and direct conservation programmes.

Conservation status: EN

When first listed as EN / CR: 2016

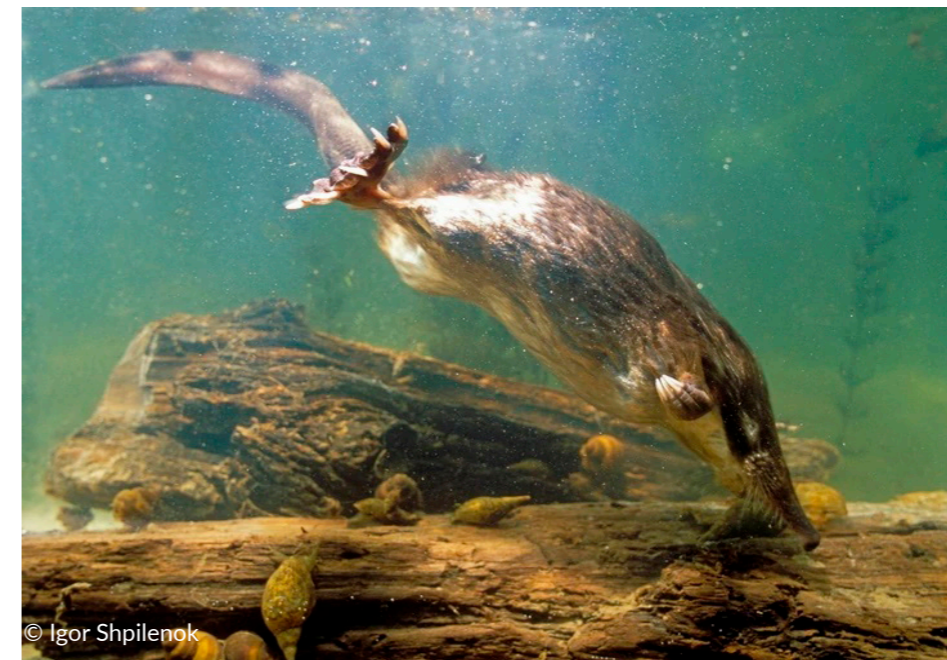
Current Range: It occurs in fragmented pockets across Russia, Ukraine and Kazakhstan. It has disappeared from many areas where it formerly occurred.

Size: The adult Russian desman's body is on average 20cm long and weighs about 500g, making it the world's largest species of mole³⁷.

Diet: Omnivorous, have been recorded feeding on 72 species of water invertebrates and 30 plant species, along with fish and amphibians.

Threats: The main threat is the widespread use of fishing nets which are left in the water for long periods of time. Desman get stuck in the nets and die within minutes. They are also indirectly affected by 'electric landing nets', which use an electric current to stun fish, which decimate fish populations the desman relies on.

Current conservation action: It is listed in the Russian Red Data Book and there have been reintroduction attempts. The Biodiversity Conservation Centre, an international environmental NGO based in Russia, has started public campaigns to ban nylon nets and electrofishing.

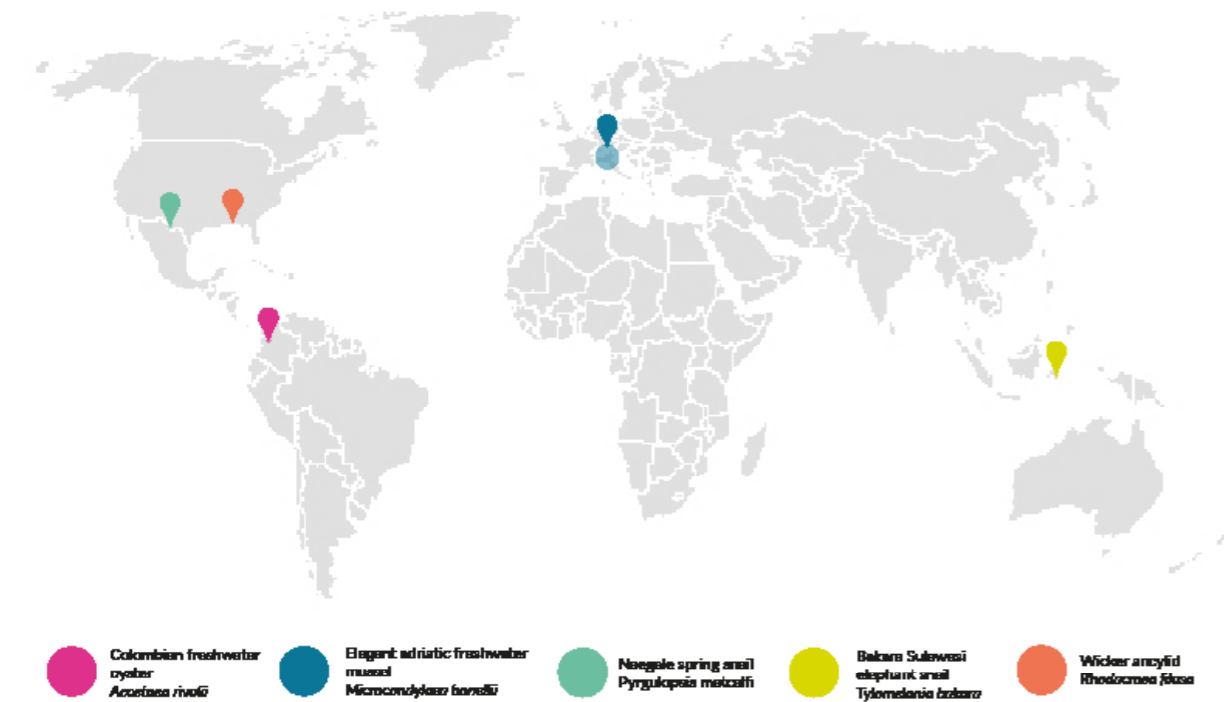


MOLLUSCS

Freshwater molluscs - comprising both snails and bivalves - are hugely important to freshwater ecosystems, providing essential services such as water filtration and nutrient cycling, and playing key roles in freshwater food webs. There are more than 6,000 species of freshwater molluscs known to science, and recent research suggests that around one third of these species are threatened with extinction³⁸.

Most of the world's freshwater molluscs are gastropods - snails - of which there are around 4,800 species, with the remainder bivalves - the mussels and clams -, with around 1,200 species. Freshwater gastropods range from tiny dwellers in seeps, springs, ephemeral pools and cave water systems to those inhabiting major rivers and lakes. Some breathe through gills, others have to come up to the surface for air. Freshwater bivalves include minute clams living in ponds, but most are large mussel species that live in rivers or lakes and that have evolved ingenious adaptations to disperse their parasitic larvae, including lures to trick suitable host fish!

With so many species worthy of attention, these five species - nominated by the IUCN SSC Mollusc Specialist Group - illustrate some key aspects of mollusc conservation, highlight some particular gaps in conservation action and in some cases represent the specific threats faced by entire lake systems or specific families or genera.

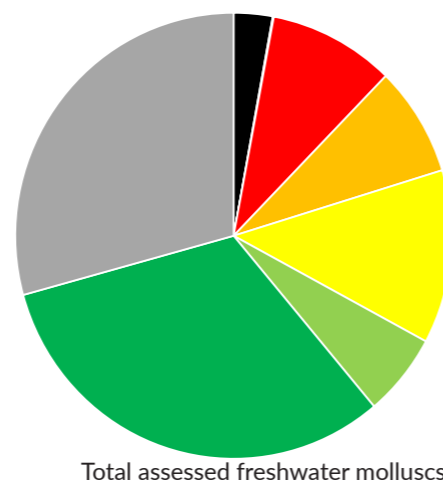


Location is approximate and intended to show geographical spread.

Species accounts with expert input from:



EX	106
EW	3
CR	344
EN	294
VU	465
NT	222
LC	1,175
DD	1,080
TOTAL	3,689



Colombian freshwater oyster (*Acostaea rivolii*)

Freshwater mussels are particularly diverse in North America, and much of our knowledge on freshwater mussels stems from there. Other regions are vastly understudied. Central and South America is one such vast region. Of the 129 currently recognized species of freshwater mussels found in South America, only 22 have been assessed by the IUCN's Red List of Threatened Species; five of them are listed as Data Deficient. The picture is even more limited in Central America.

The Colombian freshwater oyster is one of the few South American species already assessed for the IUCN Red List and may be the most threatened freshwater mussel in South America. The species is a medium-sized bivalve once thought to have belonged to the family *Etheriidae* that included other cemented bivalves (those that produce a calcareous fluid at the mantle margin that crystallises, fixing it firmly to the substrate). However, the distribution of the four species that have been placed in the family *Etheriidae* is strangely disjunct and not coherent biogeographically. Recent morphological and genetic work considers the cemented bivalves as an example of evolutionary convergence (i.e. these species are not closely related but have independently evolved similar traits). The Colombian freshwater oyster is now placed, together with other clam-like South American freshwater mussels, within the family *Mulleriidae*, the only freshwater mussel family endemic to Central and South America.

This species has great cultural value in the community where it occurs and even features in local legends. Aphrodisiac properties have also been attributed to it, making it highly desirable to eat by both tourists and local residents.

Conservation status: CR

When first listed as EN or CR: 2016

Range: The species is only known from the tributaries of the middle sections of the Magdalena River in Colombia. At present, its distribution is even more restricted to a 28km long section of the Opa River catchment, a tributary of the Magdalena River.

Size: Mature adults reach up to 9cm in length.

Diet: Mussels filter algae, phytoplankton and other small particles out of the water column.

Threats: The main threats to this species are overexploitation for food and as an aphrodisiac, pollution from agriculture and urban areas, and water abstraction and habitat modification which have led to range declines. Specifically, channelisation and water abstraction have led to disappearance of this species from many rivers.

Current conservation action: A 10-year species management plan was drawn up in 2009, the main activities of which focus on the protection of critical habitat, monitoring of the species' population, assessing the level of extraction for subsistence, conducting research to better determine the species' distribution, ecology, and threats, and implementing environmental education programmes with community participation.



Elegant adriatic freshwater mussel (*Microcondylaea bonellii*)

Freshwater mussels provide important ecosystem services, including regulating and supporting services (water purification through biofiltration, nutrient recycling and storage, habitat modification, environmental monitoring, supporting food webs), provisioning services (sources of food and tools) and cultural services (jewelry, spiritual enhancement). However, many freshwater mussel species are in decline worldwide, and this is no different in Europe.

Comparatively little is known about the elegant adriatic freshwater mussel and research is urgently required on the species' ecological requirements. For example, the larval fish hosts need to be identified to help understand what major factors are limiting the species' distribution. What is known is that the species' distribution area has dramatically declined by around 84% over the last thirty years. In addition, the population has become so spatially fragmented, that extinction risk has increased dramatically, simply because subpopulations have become isolated.

Conservation status: VU, but is currently being reassessed as CR.

When first listed as EN or CR: 2022

Range: The species is usually found in flowing waters in rivers and lakes, on sandy substrate. It originally had a wider range in south-central Europe, in northern and eastern tributaries of the Adriatic Sea, from the Po Basin in Italy and southeast to Greece. Nowadays, the species is extinct in Switzerland and as well as large parts of the rest of its range, and only occurs in ten small subpopulations in northern Italy, Slovenia, Croatia and Albania.

Size: Maximum adult size is 10cm.

Diet: Mussels filter algae, phytoplankton and other small particles out of the water column.

Threats: Water pollution, dam construction, water drainage, river channelisation and sedimentation are all factors in this species' decline. The species is likely to be sensitive and vulnerable to changes in water chemistry and to climate change. In addition, the introduction of invasive species which may compete with it (e.g. in the case of other mussel species) or prey on it (e.g. non-native crayfish, muskrats) has probably further contributed to declines of the elegant adriatic freshwater mussel.

Current conservation action: Conservation actions for freshwater mussels in Europe have so far only focused on a few species such as the freshwater pearl mussel (*Margaritifera margaritifera*) and the thick-shelled river mussel (*Unio crassus*). The elegant adriatic freshwater mussel is listed on the EU Habitats Directive as a protected species on Annex V, although this annex relates to exploitation which is not a threat to this species. It is a protected species at national or regional levels in parts of its range. A project to conserve and research the Italian, Slovenian and Croatian populations of the species is now ongoing; part of the vision of this project is to establish a breeding programme for the species.



© Vincent Prié

Naegele spring snail (*Pyrgulopsis metcalfi*)

Spring snails are a very diverse group of small and often highly range-restricted molluscs. This family comprises many highly threatened species, and the Naegele spring snail, restricted to Naegele Springs in western Texas, is no exception. Its fate resembles that of other species, such as the wonderfully-named Devil Tryonia (*Tryonia diaboli*) - also listed as Endangered - or Brune's springsnail (*Juturnia brunei*) - listed as Critically Endangered, and possibly extinct.

This species is part of the most diverse family of freshwater gastropod molluscs in North America and one of the most imperiled. Naegele's springsnail is groundwater dependent and is known from spring outflows on mud and amongst dense watercress. Spring snails may be tiny in size, but, being near the base of the food chain, they provide a vital role in support of many species higher up the food web. They are also excellent indicators of freshwater health.

Conservation status: EN

When first listed as EN or CR: 2012

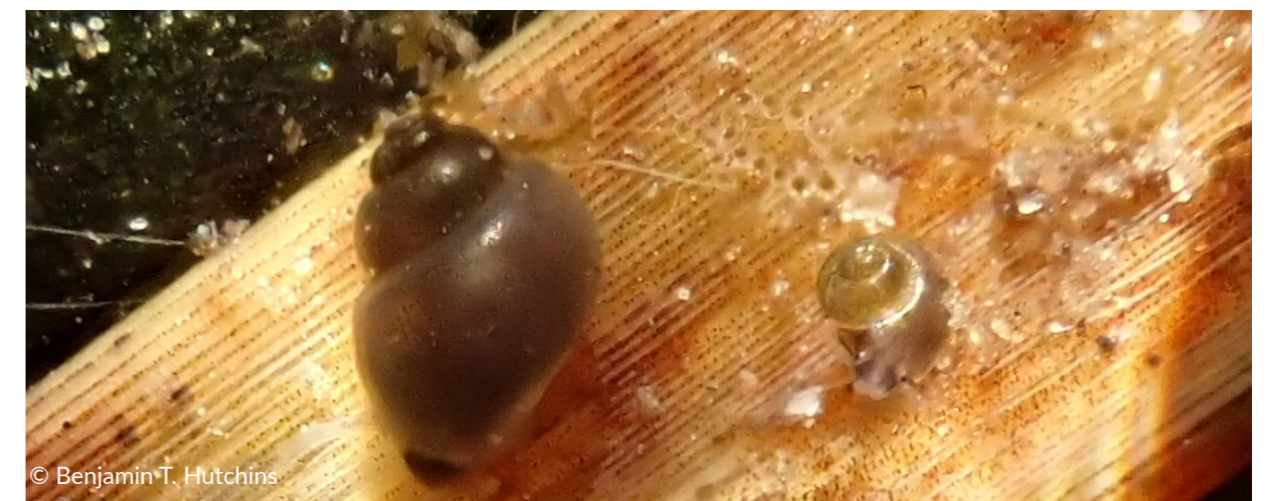
Range: This spring snail is only known from Presidio County, western Texas, where it occurs in two populations less than 1km distant from each other: one in Naegele Springs and the other in an unnamed spring that runs into the confluence of the Naegele Creek. Naegele Springs, the site from which the species was described, has been dredged and concreted in to make a spring box and pond, and the Naegele spring snail is extirpated from this site.

Size: <5mm

Diet: Algae and plant matter.

Threats: Aquifer drawdown due to the pumping of groundwater for irrigation, as well as any other processes that reduce water flow, are the main threats to this and similar species. For the Naegele spring snail, dredging and concreting of its spring habitat has led to the extirpation of this population. Threats may be exacerbated by habitat disturbance and trampling by livestock, while for other spring snail species, such as the Devil Tryonia, invasive non-native species of fishes and molluscs may pose additional problems.

Current conservation action: There is no direct conservation action focused on this species. The species has already been extirpated from one known site and the status of the population at the second site, located on private land, is undetermined. Very little is known about this species and much of the information on threats at the single, potentially remaining population comes from satellite imagery.



© Benjamin T. Hutchins

Bakara Sulawesi elephant snail (*Tylomelania bakara*)

Popular in the aquarium industry, there are around 40 species of *Tylomelania* known to science and at least 25 more waiting to be formally described. This group of species is endemic to Sulawesi in Indonesia, with most of them occurring in the 'ancient lakes' of Sulawesi. These ancient lakes were formed through tectonic activity and are estimated to be more than 1 million years old. They are the oldest island-based aquatic ecosystems in the world, and have a distinct chemical and biological composition: their chemical composition is deficient in calcium, phosphorus and nitrogen, with low levels of primary production of plants and algae, making the lakes incredibly clear.

Just like Sulawesi itself, these ancient lakes contain a vast number of species found only here and nowhere else on the planet. 28 species of *Tylomelania* have already been assessed for the IUCN Red List of Threatened Species, and nearly all as either Critically Endangered (16 species) or Endangered (11 species), with one species listed as Data Deficient. This high level of threat in these lakes is also reflected in other species groups, such as shrimp.

Sulawesi's ancient lakes are living evolutionary laboratories. Freshwater species here are often very distinctive from freshwater species elsewhere, and the lakes harbour unique species of fish, crabs, shrimps and snails. As for *Tylomelania*, their speciation is estimated to have begun 5.4 million years ago following the formation of the island of Sulawesi. *Tylomelania* are atypical amongst freshwater snails in that they give birth to live, shelled young.

Conservation status: CR

When first listed as EN or CR: 2019

Range: The Bakara Sulawesi elephant snail is endemic to Lake Towuti, which is part of the interconnected Malili Lakes system in Sulawesi, Indonesia, together with Lakes Matano, Mahalona, Wawontoa and Masapi. Here, it is found on submerged rocks in 2-40m depth. It is currently known only from one site, at and around Cape Bakara. Another 27 described species of *Tylomelania* occur within the Malili Lakes system, and the Bakara Sulawesi elephant snail commonly shares its habitat with two more widespread species.

Size: 37-46mm adult shell height

Diet: These snails are primarily detritivores, scavenging for algae and detritus in the substrate.

Threats: Given this species and other *Tylomelania* have evolved in isolation and, until recently, in a relative absence of threats, they are particularly vulnerable to changes in their environment. The main threats to this and other species is the introduction of invasive non-native species, especially the flowerhorn cichlid (*Paraneetroplus synspilus*). Originally introduced into Lake Matano, these fish have potentially serious consequences through predation of small adults and juvenile *Tylomelania*, and they have now also been confirmed in Lake Mahalona and Lake Towuti. Other threats to this species come from nickel mining and hydroelectric power installations which change the outflow and water levels of the Malili lake system. While many *Tylomelania* species are collected for the aquarium trade, the Bakara Sulawesi elephant snail does not seem to be traded yet and is unlikely to become a major target.



© Thomas von Rintelen

Current conservation action: There are no known conservation actions currently in place for this species, and any conservation action on the lakes has been limited to survey and research activities. A major project to establish an action plan for Sulawesi's ancient lakes is underway, aiming to highlight conservation priorities and key areas for conservation and bring together stakeholders such as local governments and communities, private and conservation sector individuals to develop a management and action plan for these valuable and unique treasure troves of evolution.

Wicker limpet (*Rhodacmea filosa*)

The Mobile River drainage (Alabama, USA) is a global hotspot for freshwater biodiversity, especially freshwater fishes, crayfishes and molluscs – more than 100 snail species are only found here and nowhere else in the world. At the same time, the Mobile River basin has been especially hard hit by extinction. The wicker limpet, a small air-breathing freshwater limpet (snails with conical shells), was considered extinct until a surviving population was rediscovered in Choccolocco Creek in 2011.

Previously, extensive surveys at historic collection sites had failed to find the species, and its rediscovery was somewhat surprising given that the creek had received an “officially impaired” status on the basis of mercury and PCB pollution. In fact, nearly all historic mussel fauna are missing from the creek.

The wicker limpet was rediscovered in the part of the watershed with the highest water quality remaining. They were found attached to cobbles and boulders in shallow, flowing water. Given that a third of all known freshwater mollusc extinctions worldwide have occurred within the Mobile River Basin, the wicker limpet's rediscovery is an inspiring symbol of hope and survival against the odds.

Conservation status: CR

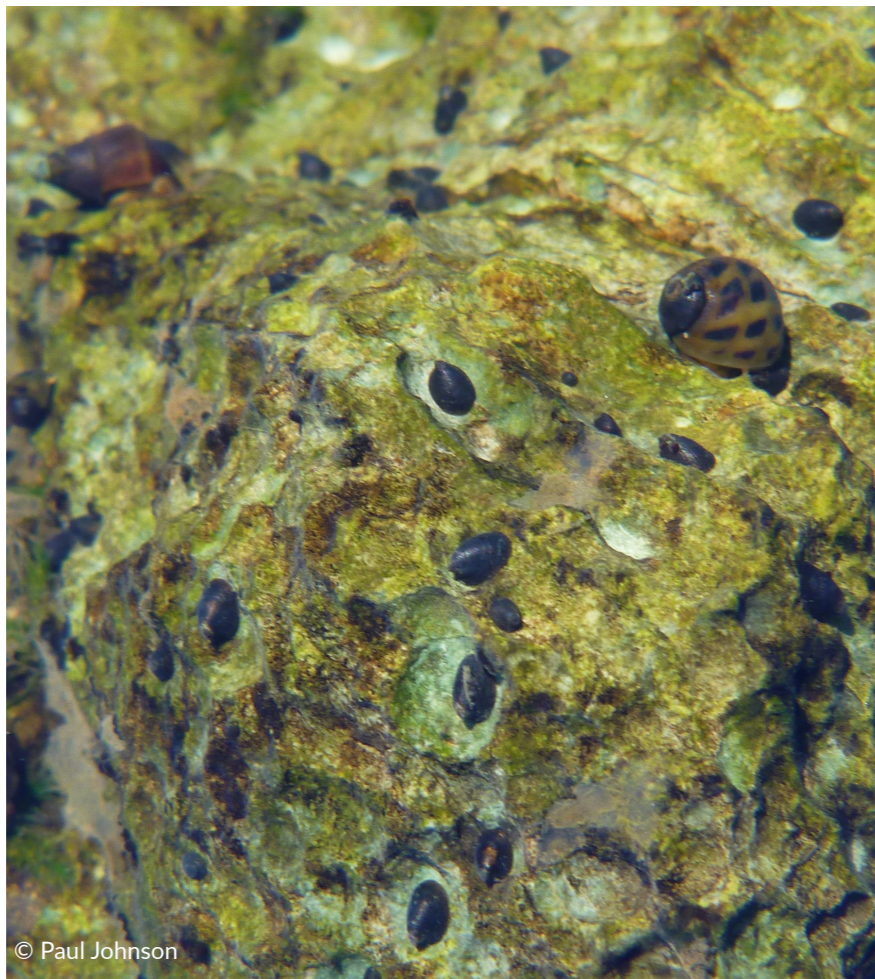
When first listed as EN or CR: 2012 (listed as Extinct in 2000)

Range: The species is only found in the Mobile River basin in Alabama, USA. Specifically, it was previously found in the Black Warrior River, the Coosa River and the Cahaba River. It is now considered restricted to the Choccolocco Creek, a 91km long tributary of the Coosa River, in central Alabama. Other species such as the threatened painted rocksnail (*Leptoxis coosaensis*) also retain their largest populations in the Choccolocco Creek.

Size: 3-4mm

Diet: Algae and biofilm (collectives of microorganisms).

Threats: The Mobile River Basin, like several other North American drainages, experienced major dam and lock construction for hydropower and transportation in the 20th century which impounded many free-flowing rivers and changed the habitats of many of its unique species. The Choccolocco Creek watershed has three substantial dams as well as a history of severe industrial pollution. Both are likely contributors to the species' decline. Pollution is the most pressing current threat to this single surviving population.



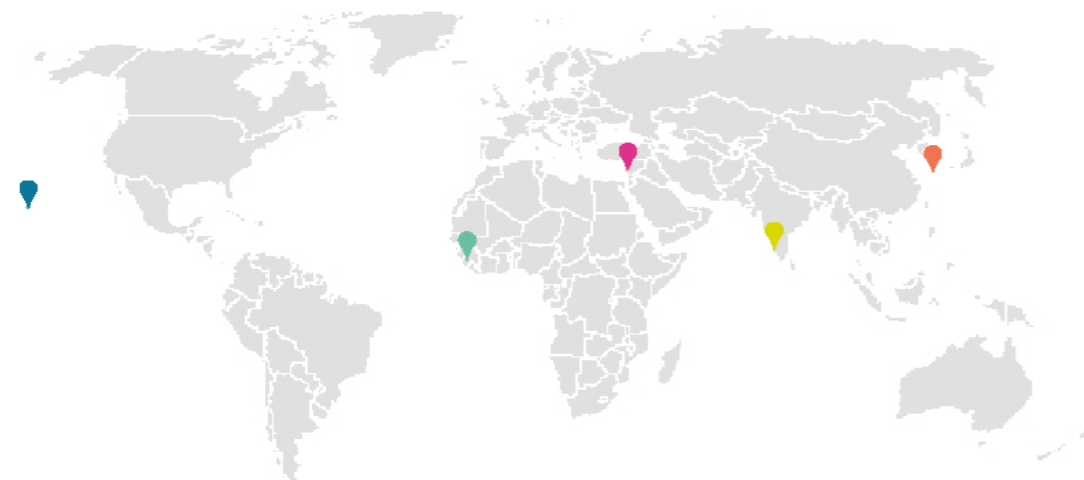
Current conservation action: There is very little direct conservation action focused on this species, and the plight of the endemic fauna of the Mobile River Basin remains under-reported. River conditions in the drainage have improved due to improved management and anti-pollution policies.

PLANTS

Of the 387,489 extant plant species, only around 5% - 19,197 species - live in freshwaters, but they are vital components of freshwater systems: they play an important role in both creating and maintaining these habitats, provide nutrients and structural support to other species and supply the primary production to sustain freshwater life. They help to oxygenate the water and reduce carbon dioxide. Aquatic and wetland-dependent plants are also important to local livelihoods through direct use (e.g., as foods, fibre, medicines, and structural materials), and help to reduce flooding risk, support nutrient cycling, and remove pollutants.

Aquatic plants evolved from terrestrial plants and so had to develop several adaptations to thrive in aquatic or semi-aquatic conditions. For example, some aquatic plants float freely on the water surface thanks to air-filled cavities in their leaves and stems that make them buoyant. Other plants are rooted in the substrate of the water body but have large, floating leaves which capture the sunlight for photosynthesis. Others again grow permanently submerged! To withstand water currents, many aquatic plants that grow in rivers and streams have very flexible stems, and while terrestrial plants often grow upwards to maximise exposure to sunlight, aquatic plants often spread laterally to achieve the same outcome.

Thanks to the work of several freshwater biodiversity assessments and the IUCN SSC Freshwater Plant Specialist Group, freshwater plant assessments have been produced for several regions of the world (for example, Africa including Madagascar, Western Ghats, Eastern Himalayas, Indo-Burma, the Mediterranean, and the Arabian Peninsula) and work is progressing to complete assessments of several taxonomic groups (for example the water trumpets *Cryptocoryne*). The five selected species provide an overview of the threats affecting freshwaters and their plant inhabitants in different parts of the world - if we continue to ignore these threats, we can expect dramatic losses of aquatic species.

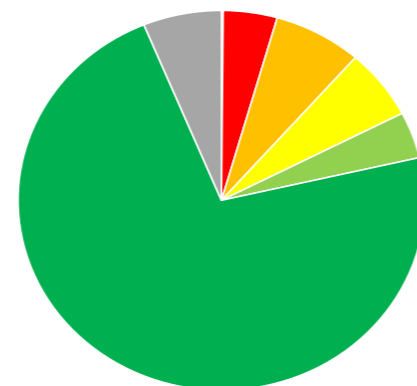


Location is approximate and intended to show geographical spread.

Species accounts with expert input from:



EX	4
EW	1
CR	155
EN	254
VU	216
NT	143
LC	2,617
DD	225
TOTAL	3,615



Total assessed freshwater plants

Diadem lady's mantle (*Alchemilla diademata*)

This member of the rose family is only found on the slopes of Mount Sannine, part of the Mount Lebanon range, in Lebanon. Recognised as a medicinal plant, extracts from this species may have some antimicrobial properties, for example against *Staphylococcus* which can be associated with skin infections and food poisoning. It also appears to work as a significant repellent of silverleaf whitefly, an agricultural pest species. The species is apparently not used at present, but appears to have been used in folk medicine in the past.

The Eastern Mediterranean Freshwater Assessment was concluded in 2014 and represents the first major assessment of the status of and threats to freshwater biodiversity, including plants, in the region. Although large parts of this region are semi-arid and arid in nature, it supports a diverse set of freshwater species and habitats which provide a wide variety of ecosystem services to the human population, including water, food, and income.

Conservation status: CR

When first listed as EN or CR: 2020

Range: This species is endemic to the Mount Lebanon range in Lebanon where it is only known from a restricted area between two summits. It occurs exclusively on wet sandstone at high altitudes between 1,700 and 1,900m. This alpine wetland microhabitat is only found in small patches.

Size: 15cm height.

Threats: Given its habitat preferences, the species is threatened by sandstone mining. In addition, overgrazing by sheep – especially during the dry season – presents another threat which may slowly impact the species and its habitat.

Current conservation action: There are currently no conservation actions in place for this species. Ideally, actions would include national regulations and ex situ conservation efforts.



Astelia waialealae

Astelia waialealae is in a very precarious situation: three subpopulations of this species remain, with only 10 mature individuals known among them (as of 2016). Found in open Hawaiian montane bogs, it is associated with several other native and endemic plants, some of which are also threatened.

This species is thus not alone in this precarious situation: Hawaii has many rare plant and animal species that are wetland dependent, and there is evidence in the fossil record of extinction (for example for wetland birds) and precipitous declines on the islands. Native species are outnumbered by introduced and invasive species in the wetlands of Hawaii and this continues to pose threats to the unique flora, fauna and fungi of the archipelago. Liliwai (*Acaena exigua*) is a wetland-associated plant of Hawaiian bogs that is now listed as Extinct on the IUCN Red List of Threatened Species – although the cause for the extinction is not fully understood, introduced feral pigs are likely to have contributed at least in part to its extinction.

Conservation status: CR

When first listed as EN or CR: 2003

Range: This species is endemic to Hawaii, specifically to high elevations on Kaua'i island. It is found in montane bogs in association with other native and often endemic plants, many of which are themselves wetland-associated and threatened.

Size: Around 20cm in height.

Threats: The bogs have been heavily damaged by feral pigs and despite some fencing, this has remained an issue. In addition, fire has affected at least one bog over recent years and invasive plants also pose a threat. The species is reliant on pollination which may be reduced due to threats also affecting Hawaiian pollinator species.

Current conservation action: This species has been listed as endangered under the United States' Endangered Species Act of 1973. It is part of the Hawaii State Plant Extinction Prevention Program's monitoring efforts, and all remaining known individuals are in small, fenced areas which are managed and weeded.



Eriocaulon petraeum

Eriocaulon petraeum is a perennial herb endemic to a single river system in the Sula Mountains of Sierra Leone. It is found in dense clumps on bedrock and boulders in the bed of the Tonkolili River. It is a rheophyte, which is a plant species found in rapidly moving water. A closely related species, *Eriocaulon solanum*, is confined to the same river and is also listed as Critically Endangered. Both species are threatened by mining activities in the catchment.

Based on an assessment of selected species in continental Africa, one in five species of freshwater plants are threatened with extinction, mainly due to habitat loss and pollution caused by agriculture, settlement expansion, industry, domestic effluents, and mining runoff.

Conservation status: CR

When first listed as EN or CR: 2015

Range: This species is only known from a single short stretch of river in the Sula Mountains in the north of Sierra Leone, West Africa. It occurs in the waterfalls and rapids of the river, clinging to the bedrock and boulders in the riverbed.

Size: 20-25cm high.

Threats: There are planned mining activities near the site where the species occurs. These are likely to impact both quality and quantity of water in the Tonkolili River where this species occurs. Declines in water quality have already been observed.

Current conservation action: The previous mining company active in the area supported some conservation actions, such as seed banking and species surveys elsewhere in the Sula Mountains, although there is no information on how successful these activities were. In 2014, surveys in the same and other river systems did not find evidence of this species. With the change in ownership of the mining company, any previous activities are now likely to have ceased and the future of conservation action is uncertain.



Malabar rotala (*Rotala malabarica*)

This species is endemic to the Kannur District of Kerala, India, where it has been recorded in a total of 22 ponds, with more than half of the known population in a single pond. All of the known populations are highly threatened.

The Western Ghats, which run along the coast of western India, support a very wide range of wetland-dependent plants, many of which are threatened. The range of mountains and adjacent laterite hills represent one of the global centres of diversity of aquatic and wetland plants. Many of the threatened species occur in seasonal pools and streams which are vulnerable to a wide range of threats, particularly during the dry season.

Wetlands are very sensitive ecosystems and rely on specific environmental conditions; the animals and plants that they support are often adapted to specific water quality and chemistry. Any disruption of these specific conditions can pose serious threats to freshwater flora. Mining, while often not immediately thought of by most people as affecting freshwater, can have serious impacts through leakage of mining waste into wetlands and habitat conversion and destruction, as in the case of this species. The iron and aluminium-rich deposits on which this species thrives are a prime target for mining exploitation. The area in which Malabar rotala occurs is also heavily threatened by quarrying of the laterite bedrock which hold the seasonal pools where it occurs. Some species of *Rotala* are also used as aquarium plants.

Conservation status: CR

When first listed as EN or CR: 2011

Range: This species is endemic to a small area in Kannur District, Kerala, in Southern India. It is found in seasonal pools in depressions of iron and aluminium rich rocks (lateritic rocks).

Size: Up to 15cm tall.

Threats: The habitat conditions in which the species occurs, specifically the iron and aluminium rich lateritic rocks, are the target of mining activities. In addition, there is some herbicide pollution from nearby cashew plantations in the area.

Current conservation action: There are currently no conservation actions in place for this species. More research is needed on it, as is the case for many other freshwater plants, to increase our knowledge of its ecology, threats, habitat and population trends, so that effective conservation actions can be taken.



courtesy of Vinayaraj, via Wikimedia



Mankyua chejuense

Mankyua chejuense is an evergreen perennial fern associated with wetlands. It is very rare and mostly occurs in three scattered subpopulations, each containing very few individuals. This species belongs to the plant family *Ophioglossaceae*, which contains the wonderfully-named adder's-tongue ferns. This species, however, is placed in its very own subfamily and is the only species in the genus *Mankyua*.

This species was described in 2001, when it was discovered in a small area of lowland swamp on Jeju Island in the Republic of Korea. The population involved only around 20 individuals. They were found in shady, wet places under evergreen broad-leaved forest. Apart from this, not much is known about this species, but it is declining due to several threats which impact the small population.

Conservation status: CR

When first listed as EN or CR: 2016

Range: This species has a very restricted distribution on Jeju Island in South Korea. It is restricted to a lowland swampy area with very specific soil characteristics.

Size: 10-12cm tall.

Threats: Future land development and the introduction of invasive species are threats to this species. Currently it is likely to be protected from local developments, but given its restriction to a very small area of no more than 8km², any threats could quickly impact the entire population of the species.

Current conservation action: The Republic of Korea lists this species as at risk in the category of Special Protection. There are no conservation actions in place for it, but several have been proposed, including protection of species sites (including through fencing) from threats of habitat loss, fragmentation, collection and overgrazing, and ex situ conservation efforts through seed collection, artificial propagation, and reintroductions.



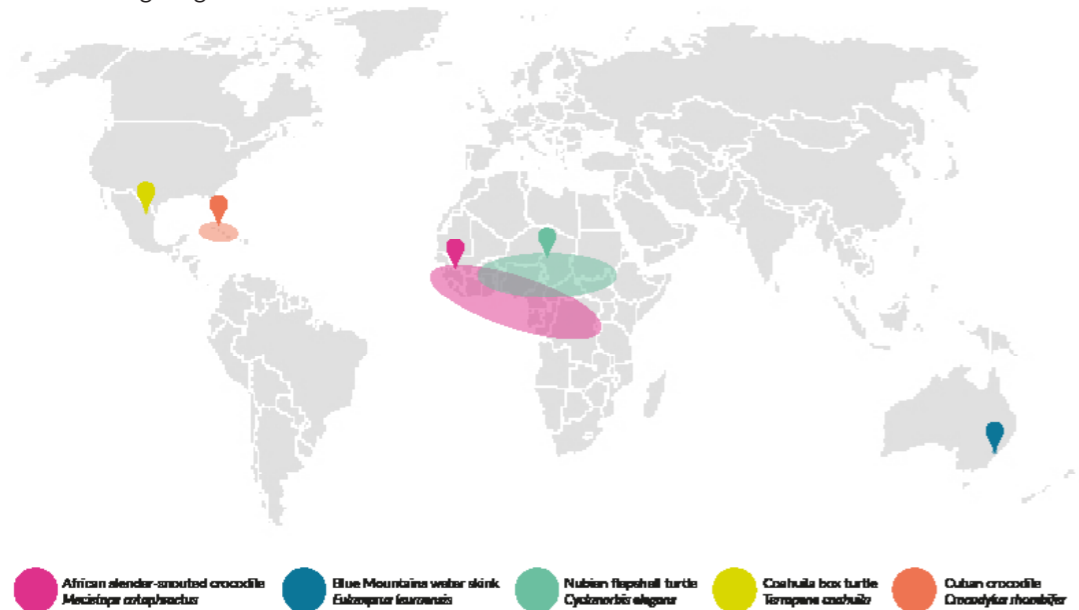
REPTILES

If you look back far enough, all life originated in water. Amphibians evolved from fish and more than 300 million years ago, during the Carboniferous Period, reptiles evolved from an amphibian ancestor. These early reptile pioneers went on to spawn the first dinosaurs about 50 million years later.

Of the total 11,690 reptile species described so far, 10,148 have been assessed for the IUCN Red List, and 1,839 (18%) of those assessed are listed as threatened³⁹. There are 32 species that have gone Extinct, and two are regarded as Extinct In The Wild. The Red List recognises 840 species (8.2%) as being related to freshwater habitats, 51 of these species are considered Critically Endangered, 68 as Endangered, and 57 as Vulnerable.

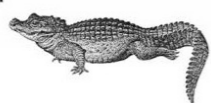
Human threats that increase the extinction risk for reptiles include habitat destruction from agricultural expansion, urban development, logging, and the introduction of invasive species. Crocodiles and turtles are most frequently affected by hunting, which includes commercial harvest and trade.

Turtles are a truly ancient order of animals, having originated around 230 million years ago. Crocodiles, although appearing much later at around 95 million years ago, have also been around for a long time. But the two species of turtle, two species of crocodile and one skink species profiled on the following pages all face the very real threat of extinction due to pressures put on them by human activity. Each of them desperately need conservation action if they are to have a fighting chance of survival.

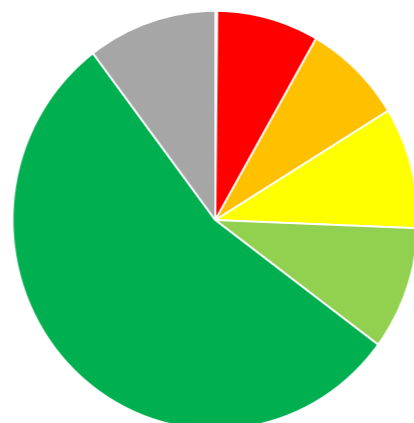


Location is approximate and intended to show geographical spread.

Species accounts with expert input from:



EX	1
EW	0
CR	52
EN	51
VU	60
NT	61
LC	349
DD	66
TOTAL	640



Total assessed freshwater reptiles

African slender-snouted crocodile (*Mecistops cataphractus*)

The long, slender snout that gives this species its name is well adapted to catching fish – its main source of food. It lives in forested rivers and other densely vegetated bodies of water such as freshwater lagoons.

It is a shy and elusive species, and was historically hunted for its skin which, along with loss of habitat, is a major cause of the species' population decline^{40,41}.

Recent research has revealed the West African populations of slender-snouted crocodile to be genetically distinct from the Central African populations, with the two populations diverging 6-8 million years ago. As a result, the West African slender-snouted crocodile is now considered a distinct species awaiting formal description. This listing will make it the most threatened crocodylian in Africa.

Conservation status: CR

When first listed as EN / CR: 2014

Current Range: Distributed throughout western tropical Africa from Lake Tanganyika and Lake Mweru in the east / southeast to the Gambia River in the west, from sea level up to 600m.

Size: Most individuals are 3 - 3.5m, although can grow up to 4m.



Diet: Young feed on small fish and invertebrates. Adults are piscivorous but also consume mammals, turtles, and birds.

Threats: Past decline is attributed to commercial skin hunting. Modern anthropogenic factors include small-scale, subsistence fisheries and habitat modification.

Current conservation action: The only conservation action affecting this species is not directly targeted at it, but is aimed at communities and landscapes.



A recently renewed initiative in Côte d'Ivoire is looking at captive breeding and reintroduction. The species is listed on CITES Appendix I, so commercial international trade in the crocodile is prohibited by the multilateral Convention on International Trade in Endangered Species of Wild Fauna and Flora agreement.

Blue Mountain water skink (*Eulamprus leuraensis*)

A bold, charismatic and attractive skink species, the Blue Mountain water skink is common in, but highly restricted to, the few known localities in the Blue Mountains of Australia. In the Newnes Plateau region, population declines have been found to correlate with the drying of swamps, a consequence of longwall mining in the underlying rock⁴². At some sites the species has entirely disappeared, and further losses are projected as mining is ongoing.

The Blue Mountain water skink exhibits extremely high habitat specificity and avoids ecotonal areas (i.e. where one type of habitat meets another), and they have only very rarely been found to migrate between swamps. It is consequently close to qualifying as a severely fragmented population, as the ongoing loss of patchily distributed swamps is likely to break habitat connectivity, prevent movement of individuals between patches, and thus increase the lizard's likelihood of extinction⁴³.

The species is a flagship for the Blue Mountains region, as it occurs in a threatened wetland habitat and is an indicator for the health of the broader region.

Conservation status: EN

When first listed as EN / CR: 1994

Current Range: This species is restricted to fewer than 60 hanging swamps on sandstone in the Blue Mountains and Newnes Plateau west of Sydney, Australia.

Size: A maximum total length of around 200mm, weighing up to 10g.

Diet: The species forages for grasshoppers, flies, moths, weevils, and wasps.

Threats: The major threats include altered hydrology and habitat degradation caused by inadvertent draining of swamps and source streams for longwall coal mining activities (G. Shea, H. Cogger and M. Greenlees pers. comm. 2017). Other identified threats include pollution and infrastructure development.

Current conservation action: This species has been part of an action plan which included targeted surveys, population monitoring, threat and habitat management, environmental planning, impact assessment and development consent, management of cat predation and fire, public awareness and involvement. Some of the populations occur in a protected area.



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Nubian flapshell turtle (*Cyclanorbis elegans*)

One of Africa's largest freshwater turtles, the Nubian flapshell was rediscovered in 2017 in South Sudan after having not been seen in the wild for decades.

In a study published in *Oryx* in 2021, researchers interviewed more than 300 local fishermen about the species. They discovered that four Nubian flapshell turtles captured around Mongalla, South Sudan, were sold by local fishermen to expatriate Chinese residents, who paid up to EUR 400 per turtle for food⁴⁴. Prices this high make a strong incentive for impoverished fishing communities to catch these turtles. Considering the already small population size of this species, this additional threat could push the species towards extinction.

The study authors recommended the creation of a protected area for this species and monitoring and mitigating the potential detrimental effects that the Asian export market may have on this species. The fate of this species could mirror that of other turtle species that are often exploited for the Asian food market.

Conservation status: CR

When first listed as EN / CR: 2016

Current Range: The species is known from fragmented pockets of habitat in Ghana and northern Togo, central Nigeria, the Niger River, southern Chad, northern Central African Republic, and the White Nile basin of South Sudan and Sudan.

Size: May reach up to 70cm.

Diet: Similar omnivorous diet to other flapshell turtles, including shrimp, frogs, snails, plant leaves, flowers, and other vegetation.

Threats: Habitat destruction from sand mining, damming, channelisation, and pollution. The species is also collected for human consumption.

Current conservation action: Not currently protected or regulated under any international legislation. Surveys of population status, trends, and distribution are needed.



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Coahuila box turtle (*Terrapene coahuila*)

The Cuatro Ciénegas valley, where the Coahuila box turtle is found, is a famous and important freshwater wetland ecosystem in the Chihuahuan desert of northern Mexico, where many endemic plant and animal species thrive in ponds fed by underground water percolating up through the desert floor. Although it is a protected area, species in the Cuatro Ciénegas are threatened by habitat loss caused by drainage to help meet the increasing water needs of the nearby human population.

A 2002 survey indicates the Coahuila box turtle has disappeared from about 40% of its 1960s range, and changes in the vegetation have made the remaining wetland habitat less suitable for the species.

With the turtle's marshland home drying out, urgent habitat protection is needed to prevent further losses of endemic species and damage to the ecosystem. If the water levels are stabilised, it is expected that at least 10 endemic fish species, three endemic turtle species, and many other animals and plants would be protected.

Conservation status: CR

When first listed as EN / CR: 1996

Current Range: Restricted to the Cuatro Ciénegas basin, Coahuila, Mexico.

Size: Males can reach up to 16.8cm.

Diet: Omnivorous, feeds on plants and animals including fly larvae, beetles, true bugs, reptiles, fish, crayfish, and more⁴⁵.

Threats: The Cuatro Ciénegas habitat has been extensively altered by canal digging and groundwater pumping. Roads, railroads, pipelines, and other infrastructure have created direct mortality impacts on the turtles.

Current conservation action: Turtles are protected from exploitation under Mexican wildlife and natural resource legislation. The entire range of the species falls in the Cuatro Ciénegas Flora and Fauna Protected Area. They are an Appendix I species on the CITES list, meaning commercial international trade in the species is prohibited by the multilateral Convention on International Trade in Endangered Species of Wild Fauna and Flora agreement.



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Cuban crocodile (*Crocodylus rhombifer*)

Although these crocs used to be found in the Cayman and Bahamian islands, they are now only found in two Cuban swamps, making their range the smallest of any crocodile^{46,47}.

They are noted for being well-suited to land and can walk faster and more comfortably than other crocodile species. They have also been recorded hunting arboreal mammals by using powerful tail thrusts to leap out of the water and grabbing prey from overhanging tree branches!

The population has declined by more than 80% in just three generations, mainly due to the decline in habitat quality, exploitation, and effects of hybridisation⁴⁸. Illegal hunting of the species increased substantially from the 1990s to the present, principally for the sale of meat to private restaurants serving the tourist industry or for local consumption.

They are listed under Appendix I of CITES, so commercial international trade in the crocodile is prohibited by the multilateral Convention on International Trade in Endangered Species of Wild Fauna and Flora agreement, but further harvest management is required to reduce the rate of population decline currently occurring.

Conservation status: CR

When first listed as EN / CR: 1982

Current Range: Restricted to two relatively small areas in Cuba: the Zapata Swamp and the Lanier Swamp.

Size: Adults of this species typically do not exceed 3.5m in length and males are larger than females, although rare individuals of up to 5m have been found.

Diet: Preys on small mammals (specifically native hutias), as well as freshwater turtles.

Threats: Exploitative illegal hunting for the sale of meat to serve the tourist industry and local populations is occurring. There is also strong evidence that the species is hybridising with the American crocodile.

Current conservation action: Direct conservation measures include captive breeding programmes, reintroductions, and protected areas.

NOTABLE MENTIONS

Narrowing down more than 100 nominations from more than 70 scientists was always going to be challenging. The final list was chosen to reflect a range of threats, and to give a diverse geographic spread, and many excellent choices did not make the final cut.

This report will be an ongoing project, with further editions to be released in future. A selection of some species that could have easily made it into this report is presented in the table below, along with associated Red List status and major threats, and these species will be considered for future editions.

SPECIES	STATUS	TAXONOMIC GROUP	MAIN THREATS
Togo slippery frog (<i>Conraua derooi</i>).	CR	Amphibian	Habitat loss.
Chinese giant salamander (<i>Andrias davidianus</i>).	CR	Amphibian	Commercial over-exploitation for human consumption.
El Ricon stream frog (<i>Pleurodema somuncurensis</i>).	CR	Amphibian	Introduced species and impacts from agriculture
Blakiston's eagle-owl (<i>Bubo blakistoni</i>).	EN	Bird	Loss of habitat and overharvesting of the species' food fishes.
Marsh antwren (<i>Formicivora paludicola</i>).	CR	Bird	The species marshland home has been almost completely lost over past 100 years.
Dwarf ibis (<i>Bostrychia bocagei</i>).	CR	Bird	Hunting by humans.
<i>Afrithelphusa afzelii</i> .	CR	Crustacean	Habitat loss and degradation from human population increases.
<i>Louisea balssi</i> .	EN	Crustacean	Unknown.
Corfu Valencia (<i>Valencia letourneuxi</i>).	CR	Fish	Water abstraction.
<i>Ptychochromis insolitus</i> .	CR	Fish	Lack of water at certain times of year, largely due to upstream regulation by a dam.
Aci Göl killifish (<i>Aphanius transgrediens</i>).	CR	Fish	Climate change-induced reduction in rainfall and water abstraction.
<i>Hyalorostratum brunneisporum</i>	Not Evaluated	Fungi	Poorly known
Giant torrent midge (<i>Edwardsina gigantea</i>).	EN	Insect	Dams causing changes to water flow.
Irrawaddy dolphin (<i>Orcaella brevirostris</i>).	EN	Mammal	Entanglement in fishing gear and degradation from declining or altered freshwater flows.
<i>Pleiodon ovatus</i> .	CR	Mollusc	Unknown. Perhaps due to increase in use of pesticides
Brune's springsnail (<i>Juturnia brunei</i>).	CR	Mollusc	Significant decline in freshwater flow due to irrigation and urban use.

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