Leibniz Institute of Freshwater Ecology and Inland Fisheries

IGB MAGAZINE #1

MOVEMENT

Moving times:
Investing in the future of our freshwaters

The urge to move:
A journey from source to mouth and the obstacles along the way

The pike in the cage:
Journeying between culture and nature

Movement

»You cannot step into the same river twice.«

— Heraclitus

Hardly anything stays where it is. Movement is visible everywhere in nature. Water flows, creating habitats and transforming entire landscapes. Fish follow migration routes and gather to form shoals. Molecules are constantly rearranging themselves. All of this shapes the function and the biodiversity of freshwater systems.

However, currents also carry traces of human activity further afield. Sunken ammunition can drift downstream for decades and pollutants can spread over vast distances. Invasive species travel around the globe with us humans. Movement connects, and it spreads risks.

Movement does not stop at what is visible. It continues in our thinking, in the changing way we view nature, and in research itself.


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Why we need to talk about freshwaters.

Freshwaters underpin our way of life every day, often without us even realising it. They provide us with drinking water, regulate the water cycle, and support a wide variety of animal and plant species. However, we only tend to recognise their importance once the balance has been disrupted, for example when rivers dry up, floods cause damage, or water becomes scarce.

The numbers show just how great the challenge is: In Europe alone, more than a million instream barriers impede the natural flow of rivers. Around 90 per cent of original floodplains have already been degraded and only around 44 per cent of European rivers meet the targets set out in the EU Water Framework Directive. The crisis facing our freshwater systems is much more than just an environmental issue. It affects our health, our economy, and the future of our society.

The causes of this trend are complex, and the solutions must be too. They require collaboration between the natural and social sciences and engineering, as well as ongoing dialogue with politics, public administration, economy and civil society. After all, it is not new findings alone that change the world. The impact of research is felt when knowledge is shared, perspectives are brought together, and solutions are implemented jointly.

This magazine invites you to take part in this exchange. It presents scientific findings in an accessible way and uses concrete examples to demonstrate how research and practice can find new ways to restore river connectivity, strengthen ecosystems, and support European targets for restoring natural habitats.

Freshwaters sustain our lives. Whether they will still be able to fulfil this role in the future depends on how we act today. Therefore, talking about freshwaters also means talking about our future, about resilience and responsibility, and about how we want to live in a changing environment.

Professor Sonja Jähnig
Director *a. i.*

Preface

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Contents

Free-flowing

is a term used to describe waters that are not impeded by artificial barriers and are not separated from their floodplains. This ensures the free movement of water, sediments, fish and other organisms.

(>) EC, Joint Research Centre, van de Bund et al. 2024

The Tagliamento River flows freely for long stretches, making it a major exception in Europe. IGB operates a river lab on its banks.

Find out more:
Leibniz-Magazin:
Das Flusslabor

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Moving times

Investing in the future of our freshwaters

These are turbulent times for our inland waters: they are under pressure from man-made climate change and increasing demands for their use. Yet the laws designed to protect our waters and enable their recovery in the future are being called into question. In Germany and Europe, there is open discussion about watering down the Water Framework Directive (WFD) and the Nature Restoration Regulation (NRR). The argument often put forward is that the economy needs to be strengthened because it is supposedly unable to develop positively due to overly strict regulations. We at IGB take the opposite view.

Up until 2020, Lake Stechlin experienced a significant deterioration in water quality. However, since 2021, phosphorus concentrations have been falling, which is a positive but as yet uncertain sign.

Particularly in economically and geopolitically challenging times, the protection of our inland waters is an important investment in the future. This is also true in times of climate crisis. Protecting our waters is an active public service. Corresponding legislation and initiatives should consequently be understood as an opportunity rather than an obstacle.

No political priority despite high relevance

From our perspective, the shortcoming lies not in the legislation itself, but in its inadequate practical implementation. At present, only eight per cent of watercourses in Germany achieve the “high” or “good” ecological status required under the WFD, or demonstrate the corresponding potential. For lakes, the figure is just under 25 per cent. The situation is not much better in many other European countries. Yet all water bodies subject to reporting under the WFD should have achieved this target by 2027 – in other words, by next year.

This is unrealistic and demonstrates that there has been a significant shortfall in the implementation for two decades now. The reasons for this are well known: above all, there is a lack of funding, staff and land. Sustainable water management does not have the political priority commensurate with its importance. Other policy areas – such as agriculture, industry, transport and energy – which often have a negative impact on water and water bodies, receive considerably more attention. Yet revitalisation projects could be planned in such a way as to fulfil several objectives simultaneously.

Resilient ecosystems and the services they provide are priceless

It is often argued that the economy and society need to become more resilient in times of major international crises. This also applies to inland waters: a revitalised water body is more resilient – and contributes to mitigating the effects of climate change. The closer a water body is to its natural state, the greater its biodiversity and the more extensive its ecosystem services – for example, drinking water resources, natural water retention and thus flood protection, pollutant retention, recreational areas, and fisheries resources. These are irreplaceable, priceless and cannot be provided by any technical infrastructure.

The revitalisation of water bodies and sustainable management can also provide economic impetus and establish new sustainable markets – much as has happened in the field of renewable energy. This innovative expertise also holds international value-added potential, enabling Germany and Europe to take a pioneering role on the global stage.

Research-based knowledge for the water and freshwater transition

Through our research at IGB, we aim to support new approaches to water management – whether by raising awareness or by providing practical assistance.

One key topic, for example, is lake restoration: in 2025, we published an IGB Dossier on Lake Arendsee, the largest natural lake in Saxony-Anhalt. Due to its size, Lake Arendsee falls under the WFD and should actually achieve good ecological status. However, like many other lakes, it is affected by eutrophication: Excessive phosphorus in the lake leads to algal blooms and fish mortality. The negative effects can only be mitigated by a significant reduction in phosphorus concentrations.

For decades, phosphorus levels have been four to five times higher than those that would correspond to the lake's natural state. With climate change progressing, the situation is also expected to worsen further; since 1980, the summer stratification period in Lake Arendsee has already lengthened by more than 30 days. The oxygen situation in deep water becomes even more critical due to the prolonged periods of stratification in summer. Reducing nutrient concentrations is the only realistic lever for action.

Remediation and restoration – not the same thing, but a sensible combination

In lake therapy, a fundamental distinction can be made between remediation and restoration measures. Remediation measures are external measures that tackle the causes of high phosphorus levels. Restoration measures, on the other hand, address the symptoms but do not eliminate the causes. Restoration measures are carried out within the lake (in-lake measures) and often aim to reduce the phosphorus concentration in the lake. From our perspective, a combination of restoration and remediation is necessary to achieve both a rapid and a long-term, sustainable effect – not least to comply with legal requirements.

According to IGB researchers Michael Hupfer and Jörg Lewandowski, a recommended first step is the use of a precipitation agent suitable for aquatic ecosystems, which would bind the phosphorus from the open water and cause it to sink into deeper layers. This would mean it would no longer be available to microalgae, inhibiting problematic mass growth.

The IGB Dossier summarises the research findings on the state of the lake, identifies sources of phosphate, and outlines options for action for policymakers and authorities. However, whether, when and which specific measures will ultimately be chosen is a political and administrative decision to be taken by the Federal State of Saxony-Anhalt.

Landscape water balance in the context of climate change

Water does not just accumulate in lakes, however; on a larger scale, it accumulates across entire landscapes. In another IGB Dossier, Dörthe Tetzlaff's research group has summarised how the landscape water balance is changing in the context of climate change and what this means for land and water use. Longer dry spells, more frequent heavy rainfall, lower winter precipitation and rising evaporation rates are putting pressure on agricultural and forestry operations in Brandenburg and other regions of the North German Plain. Groundwater levels are falling, surface waters are temporarily drying up, and plants are withering. Conflicts between conservation and use – but also between different land-use interests – are on the rise.

In order to deal with extreme climate conditions, it is necessary to adapt land use. Land and water management must be considered jointly in order to ensure greater long-term resilience. This includes adapting crop rotations to drier conditions, introducing agroforestry systems, and the deliberate conversion of coniferous forests into mixed forests. Furthermore, water must be retained more effectively within the landscape. This requires, above all, larger-scale land-use concepts and measures, such as the rewetting of moors and wetlands

A collective effort with no alternative

Such measures represent a major undertaking, but are absolutely essential. Naturally, the new approaches must be able to develop in an economically viable manner, but current farming practices will no longer work in many cases – and increased irrigation is not an option, given the scarcity of water. According to the researchers, the commitment shown so far by individual farms is very much to be welcomed, but it is not enough. Agricultural and forestry interest groups are also called upon to promote new approaches and solutions both internally and externally, to test them more extensively, and to create suitable framework conditions in dialogue with policymakers.

Aquatic plants: Less management can be better management

An IGB study on the Spree River shows that less management is sometimes the better option. Using long-term data, Jan Köhler and Jörg Lewandowski found that aquatic plants can compensate for falling water levels in lowland rivers in a drier climate. Over recent summers, aquatic plants in the lower Spree have caused water levels to rise by around 50 to 60 centimetres compared with a situation without aquatic plants. As a result, the water level has remained constant on average, even though, according to the study, the volume of water flowing downstream has fallen by an average of almost 50 per cent since the 1980s.

The advantage is that plant growth is at its peak from June to August – precisely the period when drought, reduced outflow and increased evaporation place particular strain on the Spree. Whilst artificial barriers or deadwood in the riverbed have a similar damming effect to aquatic plants, they also raise the water level even during periods of high outflow and potential flooding in winter and spring.

Aquatic plants not only retain water in the riverbed but also in the adjacent groundwater, thereby stabilising the water balance of floodplain areas. The study revealed that the retention effect of aquatic plants increased the volume of water in the river by almost 20 per cent and, in addition, by one and a half times in the floodplain's aquifer.

Mowing aquatic plants in summer reduces the positive water retention effect for the rest of the season

Aquatic plants are mowed repeatedly in the Spree River. The researchers showed that mowing in July reduced the positive water retention effect in the Spree River for the rest of the season; in other words, it was counterproductive for water retention. Mowing in September, on the other hand, had no impact on the water retention effect, given that many aquatic plants die off naturally at that time of year.

Whether aquatic plants really need to be mowed should be carefully considered, particularly in light of increasingly prolonged periods of drought. High discharge rates are very rare in summer for rivers in temperate lowland areas. Most flood events occur in winter and spring, when no plants are growing. This also applies to other rivers, streams and drainage systems, and should be given greater consideration by the relevant management bodies – such as water and soil associations. Where the flood risk is low or the potential damage is manageable, the many positive effects of aquatic vegetation can clearly outweigh the negative ones.

Text: Johannes Graupner

Aquatic plants play a vital role in maintaining the water balance by compensating for falling levels and retaining water in the river and adjacent groundwater.

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IGB (2025) Die Nährstoffbelastung des Arendsees. Wissensstand und Handlungsoptionen. IGB Dossier. https://doi.org/10.4126/FRL01-006489467

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Köhler & Lewandowski (2026) Dense stands of aquatic plants retain water in lowland rivers and in adjacent floodplain aquifers. Journal of Hydrology. http://dx.doi.org/10.1016/j.jhydrol.2025.134882

Artefacts


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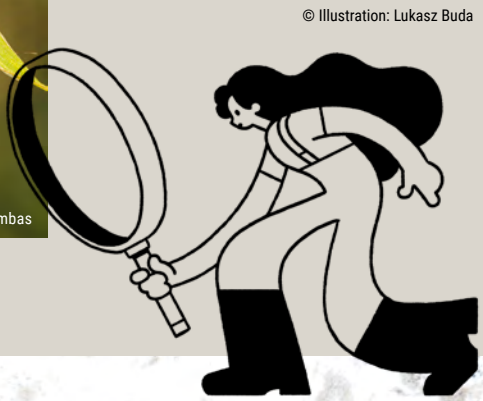
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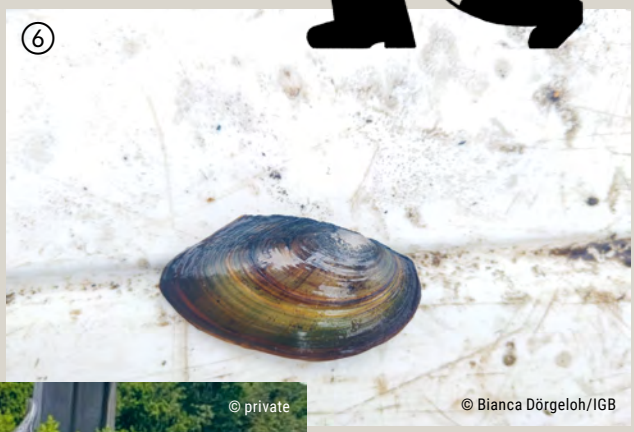
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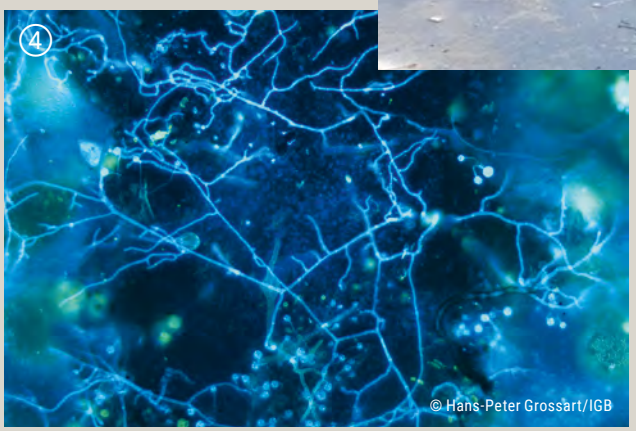
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① Benthic cyanobacteria

A “Yuck!” is certainly called for here, given that these green slimy blobs are cyanobacteria growing on aquatic plants. They can produce neurotoxins that make dogs ill if they lap up the fishy-smelling algae. In DIVATOX, a team of ecologists and health researchers is investigating the environmental conditions under which cyanobacteria grow on aquatic plants, when the toxins are produced, and their effects on humans and animals.

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Read more:
DIVATOX | IGB

② Gharial

The gharial is the “sheep in wolf’s clothing” of the animal kingdom. This harmless crocodilian is highly social: up to 1,000 young grow up in communal nurseries. Unfortunately, these giant “nurseries” are becoming increasingly rare, as the number of gharials is steadily declining due to watercourse alterations and water abstraction. According to the “Green Status” criteria, the International Union for Conservation of Nature (IUCN) has now classified the gharial as “critically endangered”, based on its population size and habitat. Phoebe Griffith is one of the authors of this assessment.

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Read more:
Non-dangerous crocodilian in danger | IGB

Khadka et al. (2025) Population Changes in Gharials (Gavialis gangeticus) Vary Spatially in Chitwan National Park, Nepal. Reptiles & Amphibians. http://dx.doi.org/10.17161/randa.v31i1.21018

③ Cuban damselfly

A living flag: This species is endangered and was previously known from only two localities in the mountains of central Cuba. However, an ambitious team led by Yusdiel Torres Cambas discovered an additional population during an expedition in the same region. The damselfly *Protoneura caligata* is now considered an unofficial national animal because its colours – blue, red and white – match those of the Cuban national flag, as the scientist’s impressive photos show.

DR YUSDIEL TORRES-CAMBAS

④ Aquatic fungi

Aquatic fungi as a visual work of art with a scientific background by Hans-Peter Grossart: At Expo 2025, the film “Fungal Entanglement” by artist Helga Griffiths was screened in the German Pavilion, raising awareness of these tiny organisms that are essential for maintaining the ecological balance of our waters. These fungi live in puddles, lakes, ice and snow, breaking down organic material and forming symbiotic networks. They can even degrade plastic.

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Read more:
Fungal Entanglement: Aquatic fungi as a visual work of art | IGB

⑤ Bull shark

Bull sharks are large predators that are extremely well adapted to a variety of environmental conditions. They can survive in both saltwater and freshwater. In 2025, an individual originating from the Pacific was recorded for the first time in Lake Gatún, a freshwater section of the Panama Canal. For researchers, this is more than just a curious encounter; it provides further evidence that the canal has long connected not only shipping routes but also increasingly the Pacific and Atlantic biota.

DR GUSTAVO A. CASTELLANOS-GALINDO

Read more:
Not only ships, but also many fish use the Panama Canal | IGB

Castellanos-Galindo et al. (2026) First Confirmed Record of a Bull Shark in Lake Gatun, the Freshwater Body of the Panama Canal. Ecology and Evolution. https://doi.org/10.1002/ece3.73114

⑥ Freshwater mussel

Vanished “cleaners”: Freshwater mussels normally colonise long stretches of the Oder River. However, following the environmental disaster of 2022, their populations have plummeted dramatically. While there were previously on average 65 to 90 individuals per square metre, by 2024 this figure had dropped to just 29 to 38 mussels. Some local populations were wiped out completely. This drastic decline means the loss of the most effective natural filter-feeders, and the consequences are likely to be felt for a long time to come. This creates the conditions for increased algae growth in the river.

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Read more:
BfN-Schriften 777 | BfN

The catfish is one of 93 megafauna species that have been introduced outside their natural range.

The urge to move

A journey from source to mouth and the obstacles along the way

Humans often determine where and how far fish can swim. Dams and other barriers fragment rivers and block the path of migratory species, while invasive species often benefit from the freedom of movement that humans create. Recent studies by IGB show how human intervention can influence the spread of species and how rivers can be restored to their natural flow.

Rivers are the lifelines of the planet. Yet in Europe alone, more than one million barriers and fragmented floodplains disrupt natural river dynamics.

This is set to change, however, as the EU's Nature Restoration Regulation aims to restore at least 25,000 kilometres of rivers in Europe to free-flowing conditions by 2030. However, achieving this goal remains challenging, as interests regarding renaturation vary depending on ecological, social, economic and political contexts.

How to give rivers more freedom to move again

A study published in the journal Nature Communications Earth & Environment outlines a practical process through which the EU and its member states could better achieve this goal. Bringing together the expertise of researchers and specialists in water management, politics and associations from 45 countries, the study identifies priorities for successfully restoring rivers.

"Our work shows that river restoration is a socio-ecological process. This means defining shared restoration goals that integrate social and ecological perspectives, and then translating these goals into collective action underpinned by sound scientific evidence," emphasised IGB researcher Phoebe Griffith, co-author of the study.

Read more:
How transdisciplinary science can foster the restoration of free-flowing rivers in Europe | IGB

From source to mouth: A huge gap in protection

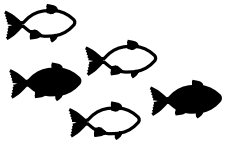
However, rivers need more than just greater freedom for movement – they also need protection. Although nature reserves could make a decisive contribution, they often fall short. This is the conclusion of a study published in Nature Communications and led by the Senckenberg Society for Nature Research, in which IGB was involved. For this purpose, data from over 1,700 river sites across ten countries and spanning four decades were analysed.

There are often major gaps in protection between the source and the mouth of a river. In order to improve biodiversity and water quality, rivers must be considered as ecosystems along their entire length. However, protected areas are usually designated to safeguard terrestrial ecosystems, such as forests, or the habitats of rare birds and mammals.

"The connectivity of rivers is of central importance. Instead of small, individual protected areas, large parts of a river's entire catchment area must be considered – from source to mouth. This includes riparian zones, tributaries and adjacent landscapes," stated IGB researcher Sami Domisch, who contributed to the study.

The research team investigated how the diversity and composition of river organisms, particularly small invertebrates such as insects and mussels, have developed in protected and unprotected areas. These indicators provide insight into the health of a river. In most cases, there were hardly any differences between protected and unprotected freshwater systems; improvements were only observed in heavily polluted rivers, and even then, only when protection covered a large part of the catchment area.

Read more:
Europe's protected areas provide limited benefit to river ecosystems | IGB

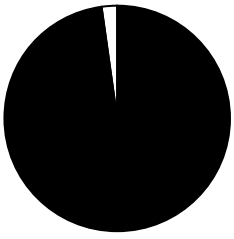


Taking Colombia as an example

A concrete example is provided by Colombia's rivers. A study by IGB, published in Diversity and Distributions, shows that only 25 per cent of areas worthy of protection overlap with currently designated protected areas. "This gap highlights the importance of revising existing conservation strategies to conserve freshwater biodiversity more effectively," remarked Thomas Tomiczek, the study's lead author and IGB researcher.

For the study, the researchers examined 1,313 species of freshwater fish across 38,000 sections of river. In doing so, they also came across a positive case study: in north-eastern Colombia, on the border with Venezuela, 72 per cent of the relevant areas identified in the study overlap with existing nature reserves on the Rio Bita.

Read more:
Only one quarter of Colombia's protected areas effectively protect freshwater fishes | IGB



The Bonn Convention on the Conservation of Migratory Species of Wild Animals (CMS) covers 1,100 animal species, including just 23 migratory freshwater fish species.

As long-distance migrants, both sturgeons and eels depend on free-flowing river systems.

Migratory fish: A blind spot in species conservation

For many aquatic species, it is not only the lack of protected areas that is crucial, but also the lack of freedom of movement between them. Migratory fish populations have declined sharply by around 80 per cent over the last 50 years. One reason for this decline is the presence of barriers in rivers. Dams, weirs and hydroelectric power stations fragment watercourses and disrupt migration routes. In Germany, a structure blocks the free flow of a river every 1.4 kilometres. However, migratory fish depend on free-flowing watercourses to enable them to migrate to the sea and swim upstream or downstream to spawn.

Despite this alarming decline, migratory freshwater fish are poorly represented on conservation lists. As they often migrate across national borders, they are dependent on internationally coordinated conservation measures. To address this, the Bonn Convention on the Conservation of Migratory Species of Wild Animals (CMS) was established in 1983. This international agreement, which has been signed by 132 countries and the European Union, covers 1,100 species of animal. However, there is a significant omission in the agreement with regard to migratory freshwater fish, as only 23 species are included.

There are three reasons why migratory fish constitute this blind spot:

1. There is a lack of comprehensive assessments of how many fish species migrate across borders during their lifetime.
2. For species on the Red List, the data often only indicates “Not evaluated” or “Data deficient”; however, without data, it is impossible to assess which species meet the criteria.
3. Many countries with transboundary rivers, particularly in North America and Asia, are not party to the Bonn Convention.

At the 15th Conference of the Parties (COP 15) to the CMS in Brazil in March 2026, a UN report recommended adding a further 325 freshwater fish species to the CMS appendices.

“The report highlights a lack of implementation above all for Europe and the 50 species identified here. The scientific evidence is available, but river systems are heavily fragmented by migration barriers such as dams built for water storage and hydropower generation. A CMS listing would strengthen international coordination and introduce more binding measures to restore connectivity, as well as giving the issue greater political priority,” stated IGB Director Sonja Jähnig.

Read more:
COP15: Better protection for migratory fish as key umbrella species | IGB

Invasive species spread due to human activity

While native species are finding it increasingly difficult to migrate to their feeding and spawning grounds, humans are introducing other species to new habitats, either deliberately or accidentally, with far-reaching consequences for local ecosystems. Over 60 years ago, for instance, British colonial officials released the Nile perch into Lake Victoria. The aim was to boost the fishing industry. The species subsequently multiplied rapidly, severely disrupting the previously highly diverse ecosystem: local species disappeared, fish stocks declined, and with them the livelihoods of the local population. This resulted in chronic malnutrition among the local people.

A study by researchers of IGB and the Institute of Geography and Agroecology of the Chinese Academy of Sciences examined species introduced for economic reasons that end up causing harm rather than bringing the hoped-for benefits. More than 40 per cent of large freshwater animal species (megafauna) living today, including carp, catfish, salmon, crocodiles, beavers and hippos, have been deliberately introduced outside their natural range. The researchers categorised and quantified the positive and negative impacts of these species.

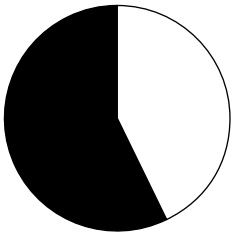
They demonstrated that many of the species known for their beneficial qualities also have negative impacts on the ecosystem. These risks include food insecurity, health risks to humans, safety risks posed by aggressive or poisonous species, and damage to property and infrastructure.

"Such harmful effects of introduced large freshwater animals, particularly on vulnerable or marginalised local communities, are often complex and require long-term monitoring to understand their extent," stated Fengzhi He from the Institute of Geography and Agroecology at the Chinese Academy of Sciences.

Read more:
Over 40% of freshwater megafauna species introduced outside their native range | IGB

Rivers thrive on movement – and so do many species. Studies show that when river courses and migration routes are disrupted or species are introduced artificially, the ecological balance is disturbed. Protecting rivers therefore also means restoring and maintaining their natural dynamics and those of their inhabitants.

Text: Adela Lukasczyk



43 per cent of the large freshwater animal species (megafauna) living today have been deliberately introduced outside their natural range; specifically, 93 out of 216 existing species.

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1) Stoffers et al. (2026) A collaborative research agenda for restoring free-flowing rivers. Communications Earth & Environment. http://dx.doi.org/10.1038/s43247-026-03428-9

2) Sinclair et al. (2025) Current protected areas provide limited benefits for European river biodiversity. Nature Communications. http://dx.doi.org/10.1038/s41467-025-67125-5

3) Tomiczek et al. (2026) The Spatial Discrepancy Between Colombian Freshwater Fish Suitable Habitats and Existing Protected Areas. Diversity and Distributions. http://dx.doi.org/10.1111/ddi.70168

4) Chen et al. (2026) Global assessment of alien freshwater megafauna reveals complex socio-economic impacts. One earth. http://dx.doi.org/10.1016/j.oneear.2026.101623

① ② ③ ④

Telemetry: This is how we track fish movement

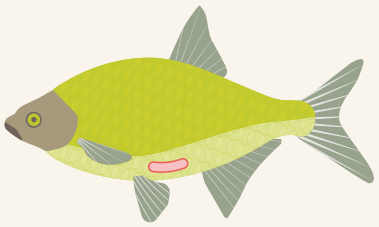
Acoustic telemetry is a method used to track the movement and behaviour of aquatic animals. Animals are fitted with small electronic tags that emit unique acoustic signals at regular intervals. These signals are detected by underwater receivers at known locations, which record the identity of the tagged animal and the time of detection, allowing researchers to reconstruct individual movement paths over time.

Preparation

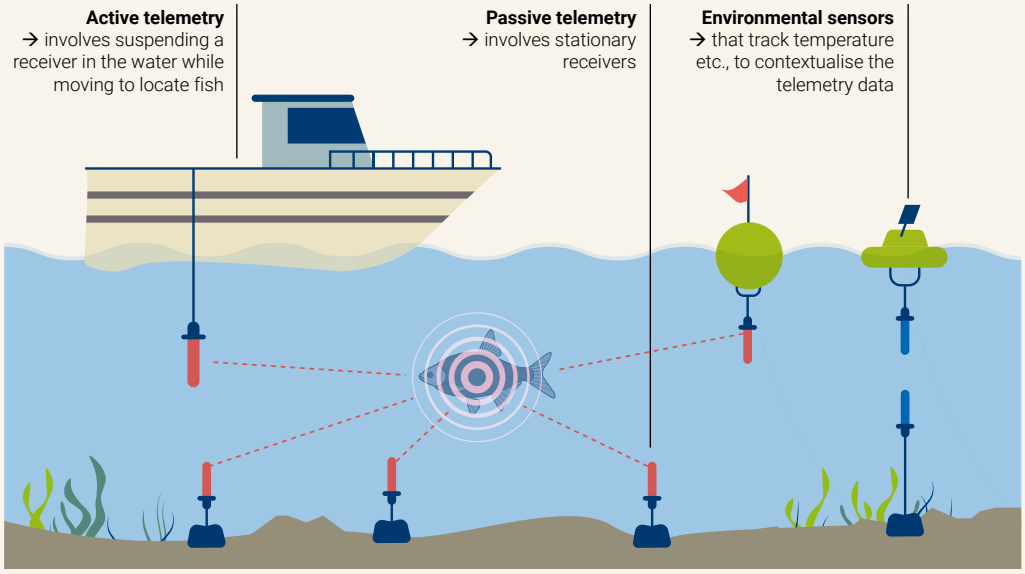
Fish are tagged internally or externally. Prior to release, additional methods are applied, e. g., sampling of fin clips, blood, muscle, or scales. Standard additional datapoints such as length, mass and sex help to pair movement information with determinants of movement.

Sensors can be added to tags including information on

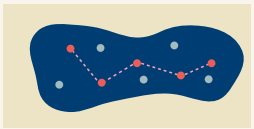
- temperature
- depth
- acceleration
- predation



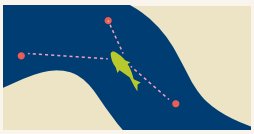
Set-Up



Method can be used on various scales



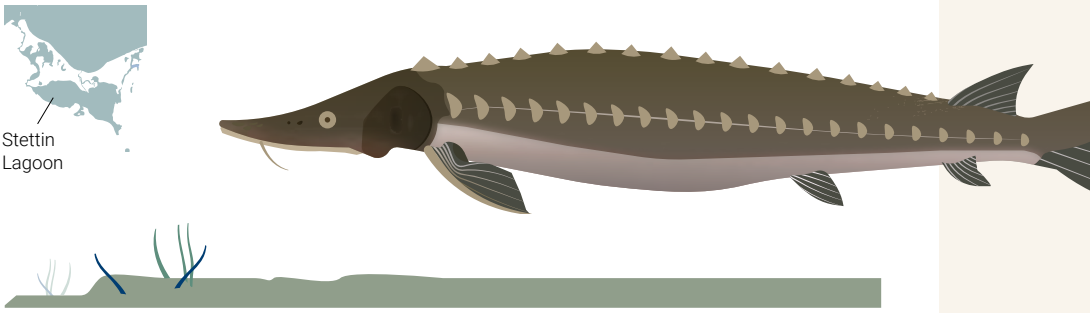
Coarse scale. Widespread receivers enable the detection of individuals and the analysis of their large-scale movements between habitats.



Fine-scale/high resolution. Simultaneous detection of an individual by multiple receivers enables its position to be geolocated precisely.

How does this method help us?

These research methods can help us address key fundamental and applied research questions related to animal movement and behaviour, species interactions, habitat use and connectivity, conservation and management, and the impacts of environmental change and human activities on aquatic ecosystems.



One example: Researchers involved in the HaffStör project are using acoustic telemetry to track the migratory movements of the strictly protected Baltic sturgeon (*Acipenser oxyrinchus*). The aim is to find out which habitats the fish use following restocking, and whether their routes overlap with areas affected by fishing or shipping. The data collected can be used to identify periods and regions of increased risk. This allows conservation measures to be tailored effectively and supports the sustainable management of the habitats in question.

Knowledge in a nutshell

© Illustration: Larissa Lachmann

Why large schools of fish make faster and more accurate decisions

Sulphur mollies exhibit interesting shoaling behaviour. As oxygen is scarce in Mexico's sulphurous springs, they must always swim close to the surface. This makes them vulnerable to birds of prey. To avoid predators, they swim in "Mexican waves", diving at lightning speed as a shoal the moment a bird approaches. But is it really a bird, or just a harmless shadow? The decision to stay or dive can prove fatal. This may be because the decision is made too late, or because a threat is mistakenly judged to be harmless. A study by the Cluster of Excellence *Science of Intelligence* (SCIoI), in which IGB is also involved, has shown that larger shoals of fish make such decisions faster and more effectively than smaller groups. This is the first piece of evidence obtained in natural conditions to show that large groups of animals can overcome two classic trade-offs: recognising genuine dangers without reacting to every disturbance and making quick decisions without compromising accuracy.

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Read more:
Better together: Bigger fish shoals make smarter moves | IGB

Pacher et al. (2025) Better and faster decisions by larger fish shoals in the wild. Science Advances. http://dx.doi.org/10.1126/sciadv.adt8600

Why fish need messy nurseries

Diverse and well-connected habitats in river floodplains are essential for maintaining or restoring stable fish populations and high biodiversity. This is the conclusion of a study by researchers from Wageningen University in the Netherlands and IGB. The researchers investigated which habitats young fish use in the Lower Rhine region. To this end, they analysed a three-year dataset comprising more than 1.4 million fish larvae and juveniles in 18 renaturalised floodplains. Over 60 per cent of the fish species moved between five different habitat types during their development – habitats which, in theory, should be available in the river and floodplain – yet human intervention has drastically altered and homogenised European river landscapes. The researchers therefore conclude that this positive "disorder" and diversity must be restored to the fish's nursery habitats.

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Read more:
Why fish need many and "messy" nurseries | IGB

Stoffers et al. (2025) Ontogenetic shifts by juvenile fishes highlight the need for habitat heterogeneity and connectivity in river restoration. Limnology and Oceanography. http://dx.doi.org/10.1002/lno.12797

How bacteria drive the marine carbon pump

Oceans are important carbon sinks, absorbing around a third of human-generated carbon dioxide each year. Bacteria play a central role in this process by breaking down more organic material than all other marine organisms combined. This activity acts as a "carbon pump", ensuring that life in the deep sea is possible. A study led by the Mediterranean Institute of Oceanography (MIO), in collaboration with IGB, has quantitatively assessed the impact of bacteria in the middle layers of the ocean, known as the twilight zone. The twilight zone extends from a depth of around 100 to 1,000 metres. The study shows that the bacterial communities found there are important for both the degradation of sinking biomass and the fixation of inorganic carbon, despite the fact that very little light reaches this depth. Consequently, the role of bacteria in the carbon pump is at least as significant as that of carbon fluxes driven by hydrological processes and gravity.

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Read more:
The important role of bacteria in the marine carbon pump | IGB

Le Coq et al. (2026) Distinct contributions of suspended and sinking prokaryotes to mesopelagic carbon budget. Nature Geoscience. http://dx.doi.org/10.1038/s41561-025-01888-w

The pike in the cage

Journeying between culture and nature

The pike in the cage on a Berching pfennig coin.

For millennia, humans have been shaping water bodies, and in turn, water bodies and the creatures that inhabit them have been shaping us. Aquatic animals and plants have become an integral part of our culture and art. This even applies to non-native species, such as the raccoon. Our relationship with nature has also evolved culturally. For example, this helps to explain why fishing practices differ between the eastern and western federal states of Germany. Cultural influences also shape our approach to nature conservation and species protection, thereby either promoting or hindering these efforts.

The legend of the pike from Berching goes like this: a long time ago, the Sulz River in Bavaria burst its banks during a flood. When the waters receded, the residents of Berching found a strange creature in their meadows. They took it to the town hall to debate what it might be. Ultimately, they all agreed that it was a bird and locked it in a cage. But it was actually a pike. When the pike opened its mouth to take its last breath, the people of Berching cried out, "Hush, it's going to sing!". The pike in the cage appears on a 10-pfennig coin from 1920. It was 'emergency currency', issued by the local authorities to make up for a shortage of official money. For this reason, such coins often featured local references.

The drowned eel: Banknote from Fockbek.
© Schleswig-Holstein State

In ancient stories, eels or pikes make people look foolish

"There are a surprising number of humorous stories about fish in Germany, particularly pikes and eels. They often feature people who misunderstand the nature of the fish and therefore treat them oddly. Another example is the tale of the eel that is drowned in a lake as a punishment. These traditions reveal two things. Firstly, we are less familiar with the biodiversity beneath the water's surface than we are with land animals. However, they also demonstrate that economically important or particularly charismatic species have always been reflected in our culture and art," said Phoebe Griffith. The IGB researcher explores the cultural significance of freshwater and its inhabitants.

Deep-rooted perspectives shape our relationship with nature

She analyses ancient, handed-down stories from various countries to see how they reflect our view of aquatic ecosystems and the creatures that inhabit them. These perspectives can vary greatly. One example is the cultural approach to flooding. In New Zealand culture, for instance, rivers are considered living entities with the right to behave as rivers should, including bursting their banks. In contrast, consider the cultural mindset of the people of the Frisian Islands. There, protecting people from flooding has always been essential. According to many old stories, God

would punish the people with a flood if the dykes were not properly maintained. "These cultural roots cannot be cast aside overnight, and often – at least in Europe – we are no longer even aware of them because such stories are no longer told or passed on," explained Phoebe Griffith. This can also make it difficult for nature conservation or species protection initiatives, for example, when priority is still given to technical rather than natural flood protection.

Nature conservation is based on values, which are shaped by culture and are never universal

Phoebe Griffith therefore argues that we should pay more attention to the cultural aspects of species conservation. "The loss of biodiversity in freshwater ecosystems cannot be viewed as a purely ecological problem. It is inextricably linked to the social relationships, meanings, political systems and power structures that characterise these ecosystems." Although social science aspects are increasingly being considered in species conservation, the focus remains on individual decision-making rather than collective cultural influences.

According to the scientist, nature conservation is based on values that are never universal. In industrialised nations, for instance, the focus is on protecting certain endangered animal species, whereas in other cultures the aim is to preserve the relationship with the living environment. "These are completely opposed approaches that can give rise to major conflicts," said Phoebe Griffith. "For example, when species conservation prohibits this relationship with nature, such as when the local population's hunting of endangered animals in reserves is criminalised."

An example from the Amazon in Brazil shows that there is another way

The Amazon in Brazil is home to the arapaima, a giant fish threatened by overfishing. Here, a community-based approach was adopted to save the stocks. People drew on traditional practices for managing fish stocks and combined them with their knowledge of the animals' biology and physiology. This approach was successful in sustaining the fishery. At the same time, arapaima stocks recovered and increased tenfold. "Such nature conservation and species protection approaches are not only ecologically, but also ethically, more responsible," said Phoebe Griffith.

Cultural value can also be harmful to species

However, there is also a downside, as the scientist explained: "The cultural significance of living creatures can threaten their very existence." This applies to animals that are considered a delicacy, believed to have special powers or seen as a status symbol. One example of this is the Chinese giant salamander. Regarded as a symbol of wealth, it is used for food and medicine. Consequently, it is now classified as critically endangered on the Red List of Threatened Species. The same applies to sturgeon, which have been intensively fished for their caviar. Today, 25 out of the 26 species of sturgeon worldwide are under threat.

Invasive species and their cultural integration

Another aspect to consider is how invasive species become integrated into a culture, and the challenges this poses for nature conservation measures. IGB researcher Jonathan Jeschke has explored this topic. One of his studies shows how some invasive species can be accepted by the local population as valued and familiar elements of their environment. "Whether it's a plant species used in traditional recipes or an animal species celebrated at local festivals, cultural acceptance changes the way people interact with invasive species, even when they cause problems," he explained. For example, after the invasive cattail species *Typha domingensis* was commodified as a popular handcraft resource, local communities in Mexico began to intentionally facilitating its invasion, which has had a negative impact on the native California bulrush *(Schoenoplectus californicus)*, a culturally valuable and important wetland plant.

Taking the cultural aspect into account when managing invasive species

If an invasive species is culturally integrated, it becomes much more difficult for conservationists to curb its spread. Public resistance can block important management measures. In another study, Jonathan Jeschke showed that the charisma has an impact on the introduction and image of alien species and can even hinder their control. "A prominent example is the raccoon, whose cute appearance makes control more difficult because public support is often lacking," said Jonathan Jeschke. In Italy, management actions to control the invasive grey squirrel – and to protect the native red squirrel – were prevented by protests from interest groups using cute cartoon characters of the animals.

Like Phoebe Griffith with regard to species conservation, Jonathan Jeschke believes that a sensitive approach is advisable when dealing with invasive species that are culturally integrated. "When dealing with invasive species, it is important to consider not only the scientific perspec-

tive, but also the social, cultural and economic aspects," he said.

An example from Germany: Catch and release – an angling practice shaped by culture

Another example of how cultural factors influence the treatment of aquatic animals can be seen in fishing practices in Germany. A study by IGB researcher Robert Arlinghaus found that anglers in Mecklenburg-Western Pomerania are more likely to keep fish for consumption, whereas in Lower Saxony, releasing caught fish is more common. This highlights how cultural differences can influence behaviour with regard to the use of natural resources. "This finding from our diary study can be explained by differing values and norms in western and eastern Germany. In particular, there is a stronger focus on subsistence fishing in eastern Germany, as evidenced by earlier studies," said Robert Arlinghaus.

Germans know little about fish species…

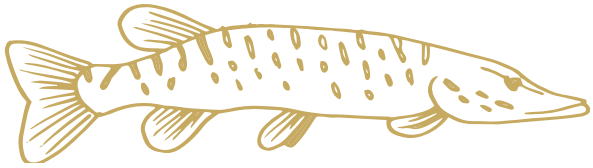
In many respects, the researcher explores the motivations behind why and how people feel connected to fish. For example, in a large-scale study, his team surveyed 1,000 people in Germany and three other European countries about their perceptions of biodiversity in rivers. The result is that the German public has rather limited knowledge of freshwater fish. Rainbow trout and brook trout, introduced from North America in the 19th century, are widely considered native species. In contrast, the Atlantic salmon, once native to the region, is primarily associated with Scandinavia rather than Germany. "This surprised us, because in species conservation circles, the salmon is often used as a flagship species for river protection and is being reintroduced through restocking in both the Rhine and the Elbe," said Robert Arlinghaus.

… nevertheless, water protection is a high priority for them

He draws conclusions from the study regarding communication in nature conservation: "Anyone wishing to raise awareness of the threats to fish must consider their cultural significance. In countries such as Norway, where river fish such as salmon are of great economic and cultural importance, and where the threat to wild fish stocks is widely covered by the media, it makes sense to develop water protection projects centred on fish as flagship species." In countries such as Germany, however, where the population tends to have a rather abstract interest in an intact natural environment and possesses little knowledge of fish, raising public awareness of water and fish species conservation projects is more successful when the benefits of an ecologically healthy ecosystem for individuals and society are emphasised. Ultimately, clean water and free-flowing rivers required for this benefit threatened migratory fish such as salmon and sturgeon.

Phoebe Griffith also identifies important lessons for the field of research: "As humorous as the story of the pike in the cage may be, it is not far from our current reality. So, as researchers, we should be more daring and engage with the emotional connection that links us to water and its creatures. This will encourage others to want to know and learn more about the fascinating biodiversity beneath the water's surface," she stated.

Text: Nadja Neumann



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Birdsong et al. (2025) Culture, context, and fish length drives voluntary catch-and-release behaviour of recreational anglers. Reviews in Fish Biology and Fisheries. https://doi.org/10.1007/s11160-025-09971-6

Jarić et al. (2025) Cultural integration of invasive species. npj biodiversity. https://doi.org/10.1038/s44185-025-00097-3

Knowledge in a nutshell

© Illustration: Larissa Lachmann

Rubbish in water bodies: from microplastics to macroplastics

Plastic has no place in freshwaters, whether in the form of large pieces of waste or microparticles. A study by IGB on litter in the Spree River has shown that 96 per cent of the litter in the river and on its banks consists of plastic. Food packaging accounts for around one third of this. One issue is that, due to the sheet piling in many areas, rubbish cannot be washed back onto the riverbanks, where it would be easier to collect.

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Read more:
Plastic dominates the waste in Berlin's River Spree | IGB

Blettler et al. (2026) Macroplastic in urban waterways: assessing storage in Berlin's Spree River. Environmental Research. http://dx.doi.org/10.1016/j.envres.2026.123990

Environmental scientists are adept at developing detection methods for microplastics due to their prevalence in the environment, and these methods may also be relevant for medical biomonitoring in humans. In their article in *Nature Medicine*, a research team led by IGB emphasises the importance of following standardised quality control guidelines in studies quantifying microplastic particles in biological tissues. These include clear strategies for identifying false positives, consistent use of blank and control samples, and better contamination control.

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Read more:
Quality assurance for the biomonitoring of microplastics | IGB

Monikh et al. (2025) Challenges in studying microplastics in human brain. Nature Medicine. http://dx.doi.org/10.1038/s41591-025-04045-3

To what extent do animals suffer from biological invasions?

Competition for food and attacks by invasive species can cause severe suffering to native wild and farmed animals. Until now, however, it has been difficult to assess the extent of this suffering accurately. Researchers from Freie Universität Berlin, IGB and the University of Bristol, England, have developed a solution in the form of an assessment framework that considers the physical and mental state of individual animals. The "Animal Welfare Impact Classification for Invasion Science" (AWICIS) records characteristics such as the nutritional status, health and behaviour of animals affected by invasive species. The severity of the animals' suffering is classified into five levels. Initial analyses show that invasive ant species, such as the Argentine ant and the red fire ant cause particular distress to native birds, reptiles, young turtles, lizards and crustaceans. As the authors emphasise, published cases tend to describe severe effects, meaning that less dramatic consequences are likely to be under-reported.

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Read more:
Measuring the negative impacts of biological invasions on animal welfare | IGB

Evans et al. (2026) Quantifying and categorising the animal welfare impacts caused by biological invasions. Nature Communications. http://dx.doi.org/10.1038/s41467-026-72154-9

The Northern Aral Sea has oxygen again

The Aral Sea has become increasingly saline due to mismanagement since the 1960s, eventually drying up by almost 90 per cent. In an attempt to save parts of the lake, the Kokaral Dam was built in 2005, creating a division between the northern and southern sections. A study led by IGB documents the Northern Aral Sea's physical recovery: thanks to this measure, it has returned to a state similar to that before it dried up. The increase in water volume and reduction in salinity have significantly improved oxygen levels throughout the lake. The lake's water layers are once again continuously mixed, supplying the upper layers with nutrients and the lakebed with oxygen. However, the researchers warn that even small changes in water level or transparency, for example caused by algae, can throw the lake out of balance.

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Read more:
After northern Aral Sea restoration: lake physics similar to before drying up | IGB

Kirillin et al. (2025) Consequences of the Aral Sea restoration for its present physical state: temperature, mixing, and oxygen regime. Hydrology and Earth System Sciences. http://dx.doi.org/10.5194/hess-29-3569-2025

The hidden costs of hydropower

Rivers around the world are increasingly being fragmented and dammed instead of being allowed to flow freely. One of the main reasons for this is the generation of hydropower. There are more than 2,800 known reservoirs, covering an area of over ten square kilometres, which are often linked to large hydropower plants. Small hydropower plants do not usually create large reservoirs, so they are largely overlooked. Many of these plants are located in freshwater biodiversity hotspots, including the basins of the Amazon, Congo, Ganges and Mekong rivers. A study led by IGB summarises the damage to biodiversity caused by hydropower. According to the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species, dams endanger almost 4,000 aquatic, semi-aquatic and terrestrial species. This widespread threat stems from a multitude of negative effects. Of particular concern are the loss of connectivity and the disruption to flow and temperature regimes.

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Read more:
The hidden cost of hydropower. Biodiversity at risk | IGB

Altanov et al. (2025) A systematic map of hydropower impacts on megafauna at the land-water interface. Biological Conservation. http://dx.doi.org/10.1016/j.biocon.2025.111092

The path of molecules

How the tiniest particles profoundly shape our waters

On nature's scale, chemical elements and the smallest molecules may be at the very bottom, but without them, life on Earth would not exist. In their work, four researchers from IGB demonstrate the importance of unravelling the complex interactions between molecules in order to improve our understanding of aquatic ecosystems and enhance water quality.

Within a system, various elements are interconnected and influence one another. The same applies to aquatic ecosystems, where many biological, chemical and hydrological relationships remain unknown, and where processes are often "hidden". For example, how long does it take for last week's rain to reach our rivers, and what substances are found in our waters?

Those seeking answers to questions like these quickly move from the macro level – such as landscape, aquatic fauna and rivers – to the biogeochemical and molecular level. At that level, IGB researchers use modern methods, technologies and models to gain valuable insights into a range of key research topics. In this article, we present four fascinating examples. Anne McLeod deduces how ecosystems function from large-scale interactions between elements. Erika Freeman studies the pathways of carbon molecules in freshwater systems. Dörthe Tetzlaff uses stable water isotopes to predict how well landscapes can cope with extreme weather, such as floods or droughts. Stephanie Spahr focuses on the fate of trace organic contaminants such as biocides and flame retardants in water, and investigates processes for removing these chemicals from water and wastewater.

Interactions between elements shape ecosystems

Although there are 92 naturally occurring chemical elements on our planet, living organisms are built from no more than 25 of them. How are these building blocks of life distributed across the landscape, and to what extent are they available to living organisms? In her research, Anne McLeod addresses these questions to understand how biological communities are structured and function.

To this end, she analyses interactions on a large spatial scale: animals transport, metabolise and concentrate nutrients; plants alter soil chemistry; and microbes influence nutrient availability. In turn, organisms react to these distributions of elements and molecules. This creates feedback loops between living organisms and the environment. "Our aim is to improve our understanding of the interactions between biotic and abiotic elements in order to predict future developments in ecosystems," stated Anne McLeod.

To do so, the researcher employs methods from community and landscape ecology. Together with her team, she has developed a model that uses data covering large spatial and temporal scales to represent the traces of living organisms in spatial patterns. "This makes it possible to compare different areas and predict how an ecosystem will develop or where conservation measures are needed," explained the scientist. The model can also identify "hotspots" based on data. Hotspots are areas that contribute disproportionately to the chemical diversity of an ecosystem and are therefore particularly worthy of protection and conservation. Examples include the boundary zones between aquatic and terrestrial habitats.

Future developments should incorporate pollutants such as heavy metals and toxic chemical compounds, as these have a significant impact on biological and geochemical processes. Anne McLeod's new approach can contribute to a better understanding of how material cycles are changing and how ecosystems are responding to climate change and altered land use.


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»Analysing natural organic matter at the molecular level can provide early indications of changes in the catchment area. First, a chemical signal appears, and only then do changes in the ecosystem become apparent.«

Dr Erika Freeman

Diverse molecules and biodiversity go hand in hand

In her research, Erika Freeman focuses on the molecular diversity of natural organic matter in our waters. She looks at the thousands of different carbon molecules it is made up of, and how their molecular composition determines their behaviour and fate in organic matter depending on their molecular structure. “Examining the molecular level helps us to understand how nature is structured. Our understanding of how chemical compounds interact and drive ecological processes is still incomplete,” she stated.

The scientist pays particular attention to the fate of organic carbon as it travels from forests and soils into streams, rivers and lakes. Where it ends up, and in what form, depends heavily on the composition of the organic matter. “These relationships are important to us because carbon in the atmosphere can negatively impact our climate, whereas in a bound form, such as in river sediments, it can be stored over the long term and therefore does not contribute to climate warming,” explained the biogeochemist. How much hydrogen a molecule contains, for example, shapes its structure. However, she added: “At present, the identification of mixtures is still imprecise. If you view all carbon molecules as a vast space, we have only scratched the surface so far,” noted Erika Freeman.

Reading carbon’s chemical fingerprint

The researcher uses ultra-high-resolution mass spectrometry to analyse the composition of thousands of organic compounds present in the water. From this data, she hopes to create “chemical fingerprints” that reveal the origin of the carbon, how it transforms, and its ultimate destination. Fascinatingly, carbon molecules exhibit consistent patterns across space, time and various stages of transformation. Take a raindrop, for example: although the molecules within it change as it moves, this change can be predicted. “If we find out more about this mechanism, we can use or influence it,” remarked the researcher.

Erika Freeman has already gained an important insight: a habitat characterised by a diverse range of molecules also features biological diversity. Furthermore, human interventions in water systems have a significant and lasting effect on the composition of molecules, and thus on the communities living there. “Every time it rains or after an agricultural harvest, nutrient-rich soil enters the water body, partly due to underground drainage systems. This completely changes the mixing ratio in the water. The water does not recover quickly,” reported Erika Freeman.

These findings are useful. “Analysing natural organic matter at the molecular level can provide early indications

At the Demnitz Mill Creek, IGB is tracking the path of water through the landscape. Researchers are documenting how precipitation seeps into the soil and groundwater, evaporates, is absorbed by plants or enters surface waters. They are also investigating how climate change and changes in land use affect these processes.

of changes in the catchment area. First, a chemical signal appears, and only then do changes in the ecosystem become apparent," stated Erika Freeman.

Water isotopes enable a better understanding of hydrological processes

Hydrologist Dörthe Tetzlaff also uses the "fingerprints" of water in her research. In her work, these are the signatures left behind by stable water isotopes as water flows through soil, surface water or groundwater. Isotopes are atoms of the same element that differ in the number of neutrons they contain. "Water isotopes are different forms of water molecules that occur naturally throughout the environment. This allows us to use them as tracers or markers to trace the source areas and movements of water across the landscape," she stated. What makes isotopes special is that they are conservative tracers. This means that their signature only changes through evaporation or mixing with already-present water, and not through chemical reactions.

Every component of the water cycle, such as precipitation, soil water, groundwater or surface water, has a specific signature. Sampling water at a specific location and time enables us to deduce where the water droplet came from, where it has flowed, how long it was stored for, and which processes have influenced it. For instance, in summer, "heavy" isotopes tend to appear in precipitation due to evaporation, whereas "light" isotopes are more prevalent in winter. However, these fluctuations are greatly reduced in groundwater due to its longer mixing period. The water in our freshwaters is usually a mixture of precipitation, soil water and groundwater. Isotopic signatures can also be used to calculate the proportion of young precipitation water compared to older groundwater, for example.

Long-term measurement series involving water samples from different stages of the water cycle are crucial for recording climatic fluctuations and changes to the cycle itself. Isotope data are typically collected alongside other water quality parameters, such as nitrate, carbon and electrical conductivity. These data become particularly valuable when integrated into tracer-informed models. "IGB is a world leader in the development and use of such models," remarked Dörthe Tetzlaff. Unlike most precipitation-runoff models, they enable the calculation of runoff volumes and provide a better understanding of all hydrological processes. How much water is stored in the landscape? When and how quickly is it released again? What are the flow paths of water? How is rainfall divided between evaporation, plant water uptake, groundwater and soil water? How old are

these different types of water? One particularly novel approach is to integrate tracer-informed hydrological models with water quality models. These models can be used to determine which flow paths influence the connection of nitrate reservoirs to the water network, and when and where this occurs.

In addition, Dörthe Tetzlaff and her research group use scenario analyses of changes in climate or land use to investigate the effects of temperature changes, droughts, heavy rainfall and different land-use types on water availability, storage, evaporation, infiltration and groundwater recharge. In her current work, the researcher combines isotopes with other methods, such as environmental DNA. "Combining different 'markers' in this way is particularly informative, as different parameters or molecules provide different insights into otherwise 'hidden' interactions and processes in landscapes. We can thus provide important insights into climate resilience, as well as sustainable water and land use management, helping to make landscapes more resilient to extreme events," explained Dörthe Tetzlaff.

Removing trace organic contaminants from water and wastewater

Stephanie Spahr takes a different approach to examining molecules: she investigates which synthetic – i.e. man-made – chemicals, such as pesticides, pharmaceuticals and industrial chemicals, are present in water bodies and the urban water cycle, and studies how these chemicals can be removed from wastewater, stormwater runoff and even drinking water. These chemicals are also called trace organic contaminants and can cause adverse effects on aquatic organisms or human health even at low concentrations. "Substances that are persistent, mobile and potentially toxic are of particular concern, as they are poorly biodegradable and hard to remove from water through sorption processes. Such substances can accumulate in the water cycle, posing a threat to ecosystems as well as to our drinking water," noted the researcher.

Organic contaminants can, for example, be washed off from roads by rainfall and carried into freshwaters. To purify contaminated road runoff, Stephanie Spahr tested various materials, such as biochar, which can adsorb different trace organic contaminants and remove them from water. However, trace organic contaminants that adsorb poorly onto activated carbon require special attention and could be removed from water using oxidative processes. To this end, the researcher uses chemical oxidants such as peroxydisulfate. "We have demonstrated in the laboratory that peroxydisulfate can be activated by biochar to produce chemically highly reactive oxygen species that react with various trace organic contaminants in the water and thereby remove them," explained the scientist. Further laboratory and pilot-scale experiments are needed before this process can be applied in practice. Subsequently, decentralised systems for treating contaminated stormwater runoff could be improved, so that less persistent and mobile contaminants enter the water cycle and safe water reuse can be achieved.

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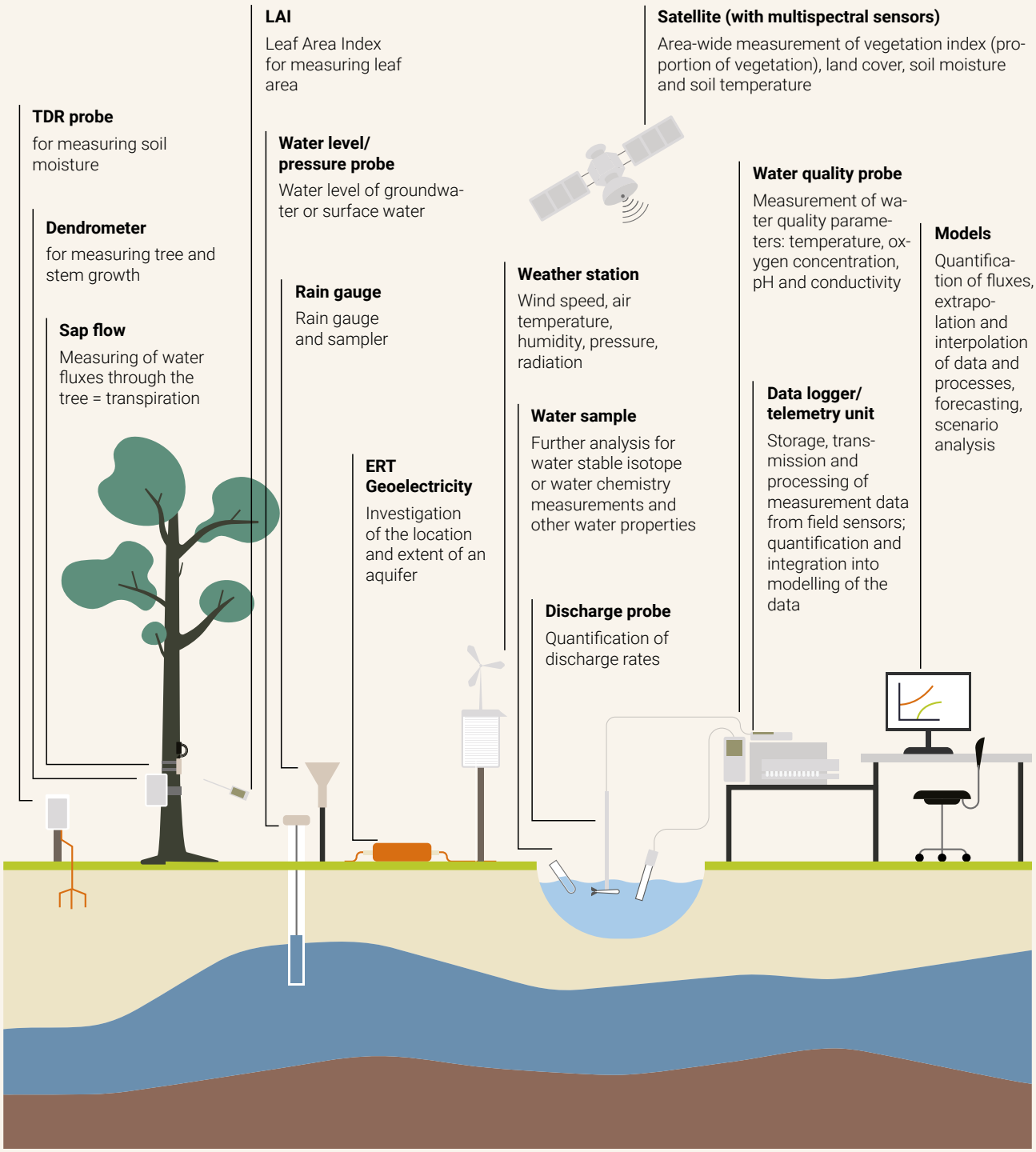
Ecohydrology
This is how we track the path of water

In order to understand landscapes, their processes and interrelationships as a whole, we require a wide range of data on water bodies and their surrounding landscapes. Combining spot surveys conducted during intensive measurement campaigns with long-term measurements provides a comprehensive picture of the ecohydrology within the catchment area. These are the data sources we use:



Knowledge in a nutshell

© Illustration: Larissa Lachmann

Specialists and generalists strengthen community resilience

In order to understand the importance of individual variations within a species for biodiversity, researchers have developed the concept of structural stability. This concept describes an ecosystem's ability to maintain its structure and function despite disturbances over long periods of time. The mathematical model underlying this concept was validated using field data from Spain's Doñana National Park. During the flowering season, the researchers documented visits by pollinators to the plants. The interaction between pollinator and plant, whereby both benefit, is known as mutualism. Within a single plant species, there were significant differences in the degree of specialisation with regard to pollinators.

Some plants attracted only a few pollinator species due to their isolated location or low flower production, while others were visited by a wide variety of insects. The greatest stability for the survival of this mutualistic community was provided by the coexistence of specialised and generalist individuals within the population.

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Read more:
McLeod et al. (2025) Quantifying elemental diversity to study landscape ecosystem function. Trends in Ecology and Evolution. http://dx.doi.org/10.1016/j.tree.2024.09.007

Winter provides an indication of how dry the summer will be

A study by IGB shows that the winter North Atlantic Oscillation (NAO) – fluctuations in atmospheric pressure between the Icelandic Low and the Azores High over the North Atlantic – can provide important information about the availability of water the following summer. A positive NAO phase initially brings mild and wet winters to Central Europe. However, up to ten months later, it can lead to significantly drier conditions. Soil moisture, surface runoff and groundwater levels decline, increasing the risk of summer droughts. This is driven by a combination of direct meteorological changes and indirect effects on the landscape. Milder winters promote earlier vegetation growth. Consequently, vegetation consumes more water before summer, reducing soil moisture and making the landscape more susceptible to a lack of precipitation. At the same time, winter atmospheric circulation influences precipitation patterns in spring. This long-term seasonal connection provides a fresh approach to drought forecasting. It could inform early planning for water management, land use, and freshwater conservation, strengthening resilience to drought.

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Read more:
Is winter climate the key to earlier summer drought forecasting? | IGB

Jiang et al. (2026) A positive phase of the winter North Atlantic oscillation is associated with drought in Central Europe the following summer. Nature Communications Earth & Environment. http://dx.doi.org/10.1038/s43247-026-03729-z

Night-time sky glow encourages the growth of blue-green algae

From afar, they are visible in the form of “light domes”, indicating areas where cities are brightly lit at night. This is artificial light that has been scattered in the atmosphere and brightens the night sky. This phenomenon is also known as skyglow. Skyglow can affect biodiversity over long distances, including in lakes, because living organisms follow a day-night cycle. A study by IGB researchers shows that artificial light at night promotes the proliferation of cyanobacteria. These microorganisms, also known as blue-green algae, can produce toxic substances. Furthermore, skyglow stimulates the carbon cycle in water. For this experiment, the research team used the unique LakeLab at Lake Stechlin. The site offers ideal conditions for large-scale experiments of this kind, as it enables cause-and-effect relationships to be identified by comparing the reactions of illuminated and unilluminated test cylinders in complex field conditions.

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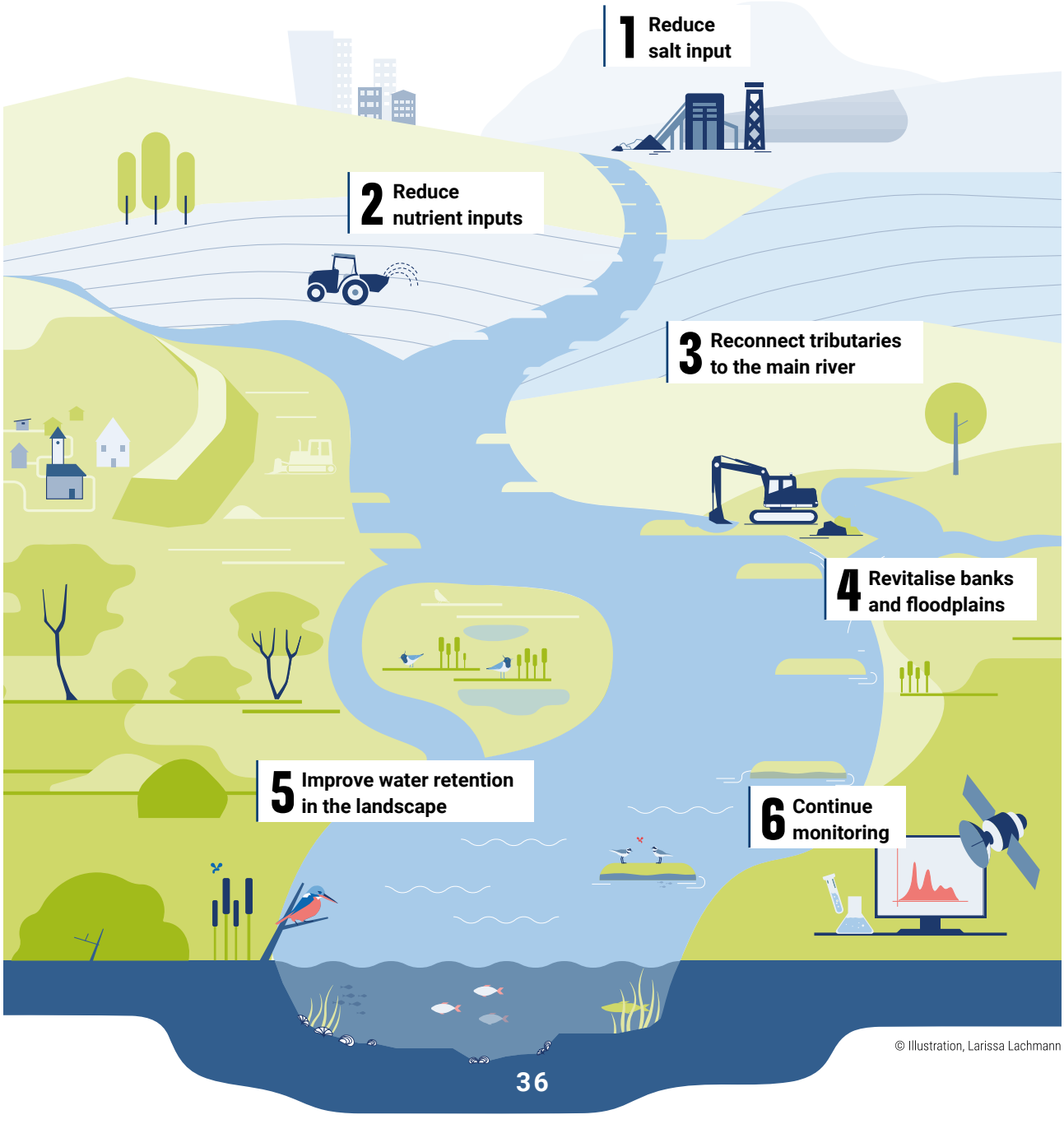
Read more:
Light pollution stimulates cyanobacterial growth and metabolic processes in lakes | IGB

Fonvielle et al. (2025) Skyglow increases cyanobacteria abundance and organic matter cycling in lakes. Water Research. http://dx.doi.org/10.1016/j.watres.2025.123315

Between collapse and a turnaround

What lies ahead for the Oder River?

The environmental disaster on the Oder River has become a symbol of a man-made crisis. Since then, researchers have been investigating how climate change, pollution and hydraulic engineering measures have brought the river to the brink of collapse – and what opportunities might arise from this.



In the summer of 2022, over 300 kilometres of the river turned into a death zone. A massive bloom of the toxin-producing brackish-water alga *Prymnesium parvum* killed an estimated 1,000 tons of fish, countless mussels, and other aquatic life within a matter of days. The ODER~SO research project has since investigated how the Oder's ecosystem has recovered and how its resilience can be strengthened further. Whether this crisis will become a turning point, however, is also a matter for policymakers. The key recommendations:

1. Reduce salt input

Prymnesium parvum has now become established in the Oder River. As long as the algae occur in low densities, they cause very few problems. Dangerous mass blooms only occur when favourable growth conditions are present, particularly when salinity is high. The most important measure to prevent another fish kill is therefore to reduce the discharge of saline wastewater. Researchers recommend limiting the salinity of the Oder's water to an electrical conductivity of less than 1,000 microsiemens per centimetre.

2. Reduce nutrient inputs

High levels of plant nutrients are associated with a high risk of Prymnesium blooms. It is therefore essential to reduce both point-source and diffuse inputs of the nutrients nitrogen and phosphorus. As nitrogen predominantly originates from diffuse sources, improving sewage treatment plants alone is not enough; extensive agricultural measures are also necessary to reduce the load.

3. Reconnect tributaries to the main river

Research findings show that near-natural river structures are essential for the resilience of fish stocks to disturbances of any kind. This includes variations in river width and depth, as well as tributaries that are more or less connected to the main river. Such structures provide important habitats for refuge, reproduction, growth and feeding, even at low water levels. At the same time, they increase the animals' chances of survival during environmental disasters, facilitating the subsequent repopulation of damaged river sections.

4. Revitalise banks and floodplains

Floodplains – the natural flood zones of the Oder River – are also important breeding and refuge areas for fish and other freshwater organisms. These habitats could be expanded by removing bank reinforcements, reconnecting tributaries and keeping the polders in the Lower Oder Valley National Park open all year round. Dynamic structures close to the banks, such as flooded gravel banks, are particularly important for species of river fish such as barbel and nase. To promote such near-natural riparian habitats, existing groynes should be redesigned to be more ecologically friendly, for example by adding generous notches. This would benefit not only fish populations but also invertebrates and insects. However, further hydraulic engineering measures, such as the construction or upgrading of standard groynes, would reduce structural diversity and thus the ecological resilience of the river ecosystem.

5. Improve water retention in the landscape

The embankment and drainage of the Oder floodplains has impaired, and continues to impair, important natural ecosystem services such as stabilising the water balance of the landscape and retaining carbon, phosphorus and nitrogen. In floodplain areas where low agricultural yields are expected despite these interventions, whilst high greenhouse gas emissions, significant habitat loss and high maintenance costs occur simultaneously, the focus should be on restoring regulatory and cultural ecosystem services. This can be achieved through tried-and-tested measures such as relocating dykes, opening polders year-round, and raising the groundwater level.

6. Continue monitoring

Unfortunately, once one crisis has passed, another is often looming around the corner. Accordingly, the researchers recommend continuing and expanding monitoring programmes to enable the risks of harmful algal blooms to be identified much earlier and more effectively. Integrating remote-sensing methods into official monitoring programmes enables satellite-based chlorophyll data to be linked to other relevant water body parameters. In addition, continuous toxicity tests can be incorporated, such as those using Daphnia toximeters. When this information is consolidated into a catchment-wide data platform, it can provide both authorities and the public with a spatially differentiated assessment of the situation, thereby going beyond isolated data collection from individual monitoring stations.

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Download the final report:
https://bfn.bsz-bw.de/frontdoor/deliver/index/docId/2199/file/Schrift777.pdf

Sunken burden
Rivers in a state of war

Even decades after the end of a war, rivers still bear its scars in the form of contaminated sites or destroyed ecosystems. In a joint interview, two artists and two researchers discuss why war never really ends, how rivers become 'witnesses' and 'victims', and the connections between the 'fates' of individual rivers. Claudia van Hasselt, Oleksandra Shumilova, Nicolas Wiese and Christian Wolter have had their perspectives incorporated into the art & science project 'PEACES so far'. This transdisciplinary project, under the artistic direction of FrauVonDa//, seeks new ways to reflect on war along rivers and promote understanding across river borders.

When you hear news reports such as the evacuations in Berlin after a bomb was found in the Spree River in 2025, what are your first thoughts?

Nicolas Wiese: We had an event very close to where the bomb was found that day and we wondered if it would have to be cancelled. Such events generally amaze me because of how dangerous bombs can still be, even many decades after they were dropped.

Claudia van Hasselt: I am always shocked by how long we have to deal with the consequences of wars that still affect our everyday lives. Bombs are weapons that, in addition to their mechanical dimension, cause problems primarily in chemical terms, such as phosphorus leaking from ammunition remnants in the Baltic Sea.

Christian Wolter: Finding ammunition remnants has also become part of everyday life on the Oder River. The area was a front line for such a long time that explosive ordnance still has to be cleared whenever houses are built near the riverbank or groynes are constructed in the river. The main problem is containers of explosive ordnance rotting in the water and leaking dangerous substances.

Oleksandra Shumilova: It strikes me again that the past of war remains particularly present in rivers. Sunken, unexploded mines can move and end up in areas that were previously safe. For example, there are cases in the Western Balkans where people are injured by mines left behind after the war in the former Yugoslavia 30 years ago.

Mr Wolter, do you come across any traces of past wars while working on the Oder and Spree rivers?

Christian Wolter: Not just like that, you have to look for them. During the Oder flood in 1997, weapons and ammunition were washed out in places where the summer dyke had broken. This area of the national park is now in the core zone and is closed to visitors because clearing it would be too costly. When we monitored the construction of the parallel construction near Reitwein between 2017 and 2019 from a fish ecology perspective, the explosive ordnance disposal team was on site and identified over 1,500 suspected items. While there were a few bombs and grenades, most of the items that set off the metal detectors were stones from the rockfill that came from mines near Aue.

Ms Shumilova, why is it still difficult to detect the consequences of war in rivers?

Oleksandra Shumilova: My research focuses on the impacts of the ongoing conflict in Ukraine on rivers and water infrastructure. There, due to the danger of drone attacks or landmine explosions, it is often too risky for us to take samples. That is why we frequently resort to remote sensing and mathematical modelling.

What parallels do you see when you compare past wars with today's wars?

Oleksandra Shumilova: Warfare today is very different from 80 years ago – drones and missiles are mainly used for attacks, while ground operations are relatively limited. However, the similarity is that rivers play role as frontlines, while dams of large reservoirs are used as weapons of war. Damaged dams, for example, prevent troops from crossing rivers. This already happened during the Second World War on the Dnipro, when the dam of the Dnipro hydroelectric power station was attacked several times. And it happened again in 2023, when the dam of the Kakhovka reservoir broke and many other dams on other rivers were also damaged.

The Kakhovka reservoir has run dry following the destruction of the dam. According to media reports, trees are growing in the area of the former reservoir. Is this a sign that nature is returning?

Oleksandra Shumilova: The ecosystem is re-establishing rapidly, which is one of the main arguments used by environmental activists against rebuilding the reservoir. However, as our study published in the journal *Science* in 2025 shows, the sediments of the former reservoir bed contain thousands of tonnes of heavy metals that accumulated at the bottom of the reservoir during its operation. These sediments formed a huge "toxic sponge" that has now been exposed. Currently, we do not know how much of these heavy metals are being absorbed by vegetation. We therefore propose erecting some temporary barriers to prevent the remobilisation and transport of pollutants from areas that are particularly prone to flooding due to seasonal floods and rainfall.

What other long-term consequences can we expect after the war ends?

Oleksandra Shumilova: The impacts of wars on rivers are associated with the long-lasting legacies of toxic pollution from sunken military munition containing heavy metals, explosives, fuel and other toxic components. Over time, these substances can be released into the aquatic environment when munitions corrode, affecting organisms and becoming incorporated into food chains. There are also many indirect effects on freshwater ecosystems. I would like to highlight the ongoing conflict in eastern Ukraine – the Donbass region – which began in 2014. The region was known for its mining industry. After many mines were closed down, the rising mine water had to be pumped out to prevent flooding. Attacks on the energy infrastructure interrupted this process, and many mines were flooded. This has led to the contamination of surface water and groundwater. There may be further consequences of which we are not yet aware of, given that the mines are located underground.

Christian Wolter: The accumulation of certain pollutants such as heavy metals and PCBs in the food web can cause widespread problems in war zones. But destruction also present opportunities: for example, if ecologically harmful infrastructure is destroyed in floodplains, it can be rebuilt elsewhere to minimise damage.

Claudia van Hasselt: I find this aspect particularly exciting, that opportunities are opening up for nature to reclaim "lost" areas. Take the Oder, for example. As a border river, it was never really suitable for commercial navigation anyway.

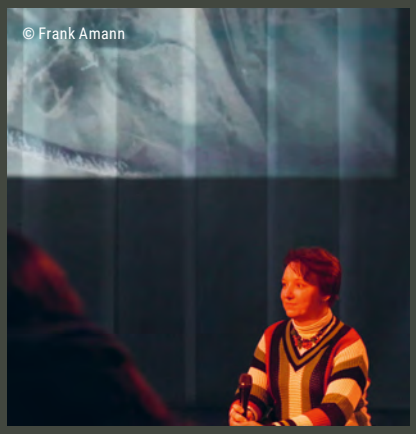
Christian Wolter: I think the point about the changed or reduced economic use of river ecosystems is important. We have demonstrated in numerous studies what leads to the degradation of water bodies. However, rivers have the ability to regenerate. It would be interesting, for instance, to remove the groynes from the Oder and see how the river forms its new bed.

What do you expect?

Christian Wolter: The river would erode laterally. In the case of the Oder, the material moved by the river is mainly sand. The Oder would flatten out and form more sandbanks. It would also develop a wider bed with a multitude of channels, and areas with different flow velocities would emerge.

So, measures that appear to be economically necessary, such as straightening and deepening rivers for inland navigation, actually harm the river and the people living alongside it?

Christian Wolter: Yes. Straightening rivers causes the water to flow faster. This artificially deepens them, meaning that when the water level is low, more groundwater flows into the river, making the surrounding landscapes drier.



»Sunken, unexploded mines can move and end up in areas that were previously safe. For example, there are cases in the Western Balkans where people are injured by mines left behind after the war in the former Yugoslavia 30 years ago.«

Dr Oleksandra Shumilova

Oleksandra Shumilova has been awarded the 2025 Caroline von Humboldt Prize

The €15,000 prize recognises her scientific achievements to date. It will also enable her to undertake a research stay at Humboldt-Universität zu Berlin. While there, she intends to link information from remote sensing imagery with biodiversity patterns in river floodplains. Remote sensing is often the only reliable research tool in conflict-affected areas. Interpreting such data allows recommendations to be made for the management of these areas.

Oleksandra Shumilova: Rivers and river landscapes are dynamic and constantly changing – due to human influence, as well as extreme events such as military conflicts, but also floods and droughts. These changes influence whether people stay in a region or settle elsewhere. This has an impact not only locally, but also globally. We are working on new approaches to better predict how ecosystems re-establish after such events, and how knowledge obtained from studying floodplain ecosystems in Europe can be transferred to understand recovery of nature in Ukraine after military impacts.

Ms van Hasselt, Mr Wiese, in your work you translate partly invisible phenomena into images, sound and vibration. How do you artistically capture the image of the 'damaged river'?

Claudia van Hasselt: A good example is the Gleiwitz Canal, a tributary of the Oder River where fish deaths occur repeatedly. We made sound and underwater video recordings there. There was a distinct smell of chemicals, and the pollution of the water was immediately apparent. In the sound recordings, we could clearly hear insects' activities underwater and in the sediment. Subsequent analysis showed that these frequencies corresponded exactly to those amplified by salinity, mainly high frequencies. We use these recordings in our work.

Nicolas Wiese: The damage to the water was also visually apparent when compared to 'healthy' water. Visibility was very low and the water was brownish-green in colour. We captured and depicted this artistically in *OderHive*, another joint project with IGB: we used the video recordings to highlight the differences between healthy and unhealthy rivers. In doing so, we created an immersive experience for the audience, who were surrounded by underwater sounds, textures and visuals.

Wars also leave their mark on the those involved in acts of war. Ms van Hasselt, you have compared documents from then and now. What did you find?

Claudia van Hasselt: An existential fear is always expressed in them. For example, in the Shukow bunker, we found quotes from Russian officers who were lying there in fear towards the end of the Second World War. This is understandable because, at the end of armed conflicts, the aim is always to cause as much destruction as possible. I also find it interesting that war reporting is universal. We

»The accumulation of certain pollutants such as heavy metals and PCBs in the food web can cause widespread problems in war zones. But destruction also present opportunities: for example, if ecologically harmful infrastructure is destroyed in floodplains, it can be rebuilt elsewhere to minimise damage.«

Dr Christian Wolter

compared reports on acts of war from different centuries, from Caesar's 'Bellum Gallicum' to the present day. When written accounts are stripped of contemporary data such as places and numbers, we found that the choice of words is always the same. We don't evolve; we don't learn …

Nicolas Wiese: … also because language shapes collective thinking and actively influences it. Warlike language creates the awareness of being at war – not only that, it mobilises people. It creates a warlike state of mind.

In your project *PEACES so far*, you specifically address the question of how rivers can be made visible as victims, while also serving as places of regeneration and understanding. An excerpt from your work was on display at Berlin Science Week. What did the visitors experience?

Claudia van Hasselt: For example, there were recordings from floodplains, including sounds recorded underground. We also work with vibrations and want to explore the topic in a more associative way to show: What does it sound like when a bomb falls into the water, and what is it like in the moments that follow? The impact creates a zone in which sound cannot be transmitted – similar to the area beneath the waves of the sea. This creates complete silence for a brief moment. What impact does this have on life forms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Performances of the two Art & Science projects, *OderHive* and *PEACES so far*, provide a common ground for dialogue and reflection between art, science, and the audience.


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in the water, particularly in areas where rivers repeatedly become combat zones?

Christian Wolter: Such strong shock waves can cause barotrauma in fish, meaning their swim bladders can rupture, damaging their eyes and organs. The effects depend on the size of the explosive charge, reaching up to 390 metres with 55 kg of TNT, for example.

Claudia van Hasselt: Another aspect of our project concerns how communities organise themselves along rivers that often cross national borders. While there are transnational communities in most border areas, this is less common on the Oder River. Why is that? To what extent can this be explained by the legacy of the Second World War? For example, there are no bridges at all over long distances on the section between Hohenwutzen and Schwedt. Does this reflect the lack of exchange, even during the East German era? How can a community be established here? The way the river is managed, particularly following the fish kill in 2022, is also intriguing: in Poland, there are numerous NGOs along the riverbanks, whereas in Germany, political pressure is more prevalent. We are building a transnational network with the aim of forming an Oder community. There are many individual initiatives, but they are only partially networked.

Nicolas Wiese: That's why we always seek to engage in dialogue with visitors at our events. We've already had positive experiences of this at *OderHive*. It's important to show the people living by the river that we are taking their concerns seriously, because most of them know more about 'their' river than we do.

What specifically do you want to convey in your performances?

Claudia van Hasselt: To Nicolas and me as FrauVonDa//, art is a mediator between science and society. It can translate things into a more accessible language, albeit a simplified one. Take the universality of rivers as weapons, for example. People tell us that our work has given them an understanding of the Oder and a connection to the ecosystem, even though they have never visited the river. That's what we're all about: making content transferable to as many people's environments as possible. We are driven by the idea of combining emotion and cognition, and of making science a sensory experience, thereby making it accessible to as many people as possible.

What is the most important thing we should learn from the stories of the rivers?

Nicolas Wiese: That we cannot continue with economisation. Using rivers as borders or lines of defence is also fundamentally abusive.

Christian Wolter: Geologically, we know the history of rivers ...

Claudia van Hasselt: … and that's why the question actually needs to be asked the other way around: human history has played out alongside rivers …

Christian Wolter: … and we are still deeply dependent on rivers, even if most people are not aware of this. We must prioritise rivers in our conservation efforts because without them, we will not achieve any climate or biodiversity goals. If river systems continue to be damaged – whether by wars, construction or nutrient inputs – their ecosystems will collapse. Freshwater resources are scarce on our planet, and rivers are where they come together. They provide everything necessary for life.

The interview was conducted by Wiebke Peters.

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Read more on the Kakhovka Dam:
1) Water at war: the long-term environmental consequences of the destruction of the Kakhovka Dam in Ukraine | IGB

2) Shumilova et al. (2025) Environmental effects of the Kakhovka Dam destruction by warfare in Ukraine. SCIENCE. https://doi.org/10.1126/science.adn8655

Read more on FrauVonDa//:
3) https://frauvonda.de

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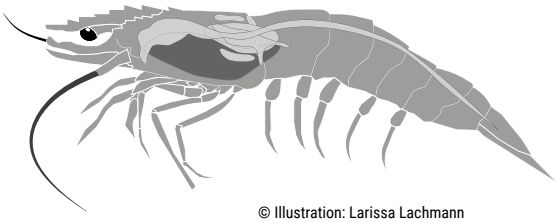

© Illustration: Larissa Lachmann

Best Practice

1) German Sustainability Award for insect-friendly road lighting

The “Tal Shield” lighting system from Selux, developed in collaboration with IGB and Technische Universität Berlin, won the German Sustainability Award in the “Nature Transformation Products” category. The system reduces light spill precisely where insects are active – making the lamp significantly less attractive to them. Field studies by IGB showed that the attraction to insects can be reduced by up to 92 per cent compared with conventional LED lighting, without compromising road safety. The luminaire uses specially designed reflectors that direct the light specifically onto roads and paths, combined with “circular light profiles” that adapt the light colour and intensity to the activity patterns of nocturnal insects. The scalable concept is already in practical use and offers local authorities a solution for biodiversity conservation and sustainable urban development.

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Read more:
German Sustainability Award for insect-friendly road lighting | IGB

2) Recommendations for action to reintroduce charophytes in lakes

Charophytes are particularly prevalent in nutrient-poor hard water lakes, where they are extremely beneficial as they improve water quality and biodiversity. However, many freshwaters have lost their underwater meadows or seen them decline considerably. In collaboration with the Feldberg-Uckermärkische Seenlandschaft e. V. support association, a team from IGB has published recommendations for the reintroduction of charophytes. The publication contains a decision-making framework comprising 26 questions to guide users in selecting the most appropriate of the 17 different measures. It also briefly describes the background, methodology and lessons learnt from the project for each measure. The framework is intended for water and nature conservation authorities, local authorities, private lake owners, and nature conservation organisations. It summarises the current state of knowledge and highlights any gaps in understanding.

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Read more:
Recommendations for reintroducing charophytes | IGB

3) Open polders strengthen the Oder floodplains

A team led by IGB, working in close collaboration with the Lower Oder Valley National Park, has investigated the role played by the extensive floodplains of the Oder River in regulating the water balance, as well as the cycling of nutrients and pollutants. Their findings suggest that permanently opening the flood control weirs could benefit the diverse ecosystems of the floodplains by keeping them in contact with the river for longer periods of the year, while also preserving their key functions, such as water purification and storage. Reduced water flows during dry periods and increased evaporation losses are reducing the connection between the floodplain and the river, thereby impairing these processes. The national park administration now intends to keep one of the polders studied open all year round for five years, allowing more water to flow in over a longer period.

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Read more:
More connection for more protection: Open polders strengthen the floodplains of the Oder River | IGB

Zheng et al. (2025) Hydrological connectivity and biogeochemical dynamics in the function and management of the lower Oder floodplain. Journal of Hydrology. http://dx.doi.org/10.1016/j.jhydrol.2025.132708

4) Assessment criteria for animal welfare in crustacean farming

Crustaceans are a popular food. Many of the animals consumed are farmed in aquaculture facilities rather than being caught in the wild. This is particularly true of prawns, whose production has almost doubled over the last ten years. However, there is room for improvement in terms of sustainability and animal welfare. The problem is that relatively little is known about the sentience and stress responses of these decapods, which are invertebrates and are therefore treated differently under the Animal Welfare Act and other standards. For this reason, as part of the CrustaWohl project, researchers from IGB and the Alfred Wegener Institute (AWI) have developed an assessment system to improve animal welfare and health. Appropriate stocking density, nitrate concentration and salinity were identified as key factors. These results are being made available to farmers to help them improve animal welfare.

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Read more:
CrustaWohl | IGB

New faces at IGB

IGB is growing. Seven new group leaders have recently taken up their posts. What drives them? How do they view their new research home in Berlin? And how might their findings make the future of our freshwaters just a little bit better? We put these questions to them.

Natalie Klinard
Read the interview
"Movement is a fundamental part of life for all organisms" | IGB

Your research focuses on the movement of fish. Why?

Movement is a fundamental part of life for all organisms. It plays a pivotal role in ecological and evolutionary processes, determining the structure of populations, communities and ecosystems. Studying animal movement can teach us a great deal about how animals interact with their environment and adapt to environmental changes. Due to their long-standing ecological, economic, social and cultural significance, there is a widespread desire to improve our understanding of their ecology and role in different ecosystems.

Natalie Klinard uses modern tracking and telemetry technologies to study the behaviour and movements of wild fish.

all photos: © David Ausserhofer/IGB

You specialise in the “ecology of molecules”. Which is your favourite molecule?

Caffeine. It drives science and scientists. It also appears in rivers, serving as an indicator of human impact on freshwater systems. So it’s relevant to my work in more than one way. If I may give a second answer, I would say molecules derived from lignin. Lignin is one of the most abundant organic polymers on Earth. It gives trees their strength. When it breaks down, it releases phenolic compounds that end up in streams and rivers. Whenever I see the distinctive peaks of these compounds in a mass spectrum, I am reminded of the molecular legacy of trees that have withstood various influences for decades.

Erika Freeman leads the new IGB research group, “Aquatic Biogeochemistry of Carbon”. She combines molecular-level insights with an investigation into how freshwater ecosystems regulate carbon flux under changing conditions.

Erika Freeman

Read the interview

“I study the hidden chemical biodiversity” | IGB

Tom Shatwell

Read the interview

“It would be great to have a water quality forecast, just like the weather forecast” | IGB

How could your research make the world a little bit better?

In 30 years’ time, I hope that our research will have significantly improved our understanding of ecological processes in lakes and enabled us to model them more reliably, including both short-term dynamics and long-term changes. Combined with in-situ measurements and remote sensing, such models could one day provide a kind of “forecast” for lakes, similar to a weather forecast. For example, it would then be possible to estimate a few days in advance when and where problematic algal blooms might develop. Ultimately, I hope this knowledge will be used in practice to protect and manage drinking water reservoirs, bathing waters and other important lakes more effectively.

Tom Shatwell, who previously completed his PhD at IGB, is returning as a group leader. His research focuses on how lakes and reservoirs are changing in response to climate change, nutrient pollution and other stress factors, and how their vital functions can be preserved.

Daphne Cortese

Read the interview
"Since I first started observing fish underwater, I was hooked" | IGB

You come from a background in marine sciences. What is the difference between that and research into inland waters?

The water chemistry, spatial extent, connectivity and environmental variability of marine and freshwater ecosystems differ. These factors, in turn, influence the ecology and physiology of the species that inhabit them. I was impressed by just how dynamic inland waters can be. For instance, the temperature of the water in ponds and shallow lakes can fluctuate by several degrees within a few hours or days, especially during heatwaves. In the ocean, temperature changes occur much more slowly due to the greater volume of water, meaning that fish experience environmental changes quite differently. Furthermore, freshwater systems offer several practical advantages: for instance, equipment corrodes much less due to the lower salinity.

Daphne Cortese is setting up the Fish Ecophysiology research group, with the aim of discovering how environmental factors and animal interactions influence fish physiology.

Find out more about working at IGB:
Career | IGB

Maria Warter

Read the interview
"Berlin needs more blue-green infra-structure" | IGB

Which water body in Berlin is particularly good for relaxing or experiencing nature?

I personally find the area around Lake Tegel very beautiful. The sprawling Tegeler Forst is a magnificent woodland area with beautiful beech forests, perfect for forest bathing all year round. Although the lake gets very busy in summer, there are also a few small, secluded coves where you can enjoy a lovely day in the summer sun if you know where to look. I also find that the Wuhle offers a wonderful opportunity to experience nature despite its proximity to the city. You can find grey herons, beavers, a wide variety of bird species and even otters there.

Maria Warter researches the ecohydrological processes of urban systems, exploring ways in which we can utilise and protect these water bodies more effectively in the future. Her junior research group is funded by the Kurt Eberhard Bode Foundation.

all photos: © David Ausserhofer/IGB

What do you particularly like about IGB?

One of the key aspects is, of course, the topic of water, which brings us together at IGB. We are united by our shared goal of using our research to protect our freshwaters and their biodiversity. I also particularly appreciate the diversity here, in terms of both the international and cultural backgrounds of the staff and the broad scope of research, ranging from basic to applied research, which provides ample opportunity for collaborative projects.

Dagmar Frisch studies the eggs of water fleas, which act as tiny, living time machines. Through this research, she explores how past populations differ from those of today, and how well plankton can adapt to environmental changes.

Dagmar Frisch
Read the interview
"Lake sediment as a time capsule" | IGB

Christian Birkel
Read the interview
"Most countries share concerns about the water balance" | IGB

You have previously conducted research in Scotland and Costa Rica, and now also in Germany. How does your location influence your research focus?

Most countries are concerned about hydroclimatic extremes and their impact on our water balance due to environmental change. However, hydrology, climate, socio-economic conditions, and all other biogeophysical processes can vary greatly, even within a small area. Therefore, even when research questions are similar, modelling approaches must be adapted to the specific environment in question. I have adapted core models for tropical ecohydrological conditions – with no snow or sub-zero temperatures, but ten times the annual rainfall of Berlin.

Christian Birkel is a hydrological modeller. He conducts measurements and modelling in a variety of geographical contexts, ranging from tropical regions to local floodplain forests.

Epilogue

Who needs **IMMORTALITY**, when there is **FREEDOM**?

© Marco Papajewski

Sophia Kimmig
is a scientist and writer. As a biologist, she combines her passion for wildlife with her expertise in urban ecology, invasion biology, and citizen science, bringing environmental research to life in new ways.

If we look at the kingdoms of multicellular eukaryotic organisms on Earth, we find two that share fundamental similarities, and one whose creatures have forged new paths. Plants and fungi have produced only sessile organisms or those carried along by external forces, such as winds and currents. Their modular structure enables them to constantly renew themselves. This is a life based on the building-block principle, in which an organism can lose large parts of its body without perishing. Consider, for example, a felled tree that sprouts anew. Animal life is quite different: most of its representatives carry their existence. Locomotion, or the ability to move actively, has apparently been crucial in the history of life, as the animal kingdom has produced the most complex living beings and the greatest biodiversity by far. However, a body adapted for mobility is more vulnerable, its lifespan shorter. Metaphorically speaking, animals traded potential immortality for freedom at an evolutionary level.

Mobility is of central importance to life on Earth today. Countless species rely on migratory movements as part of their life cycles. This also makes them vulnerable on an individual level. During their travels, they face many dangers, and their survival depends not only on the condition of a single patch of land, but on the state of many locations, some of which are widely scattered. In a world dominated by humans, where landscapes have been transformed and rivers fragmented by barriers, it is precisely these species that are at greatest risk: one in five migratory species is on the brink of extinction. The eel genus, for example, has existed for over 50 million years. It took science almost 2,000 years to discover where the eels in our waters come from. Now, we have far less time to save them. This makes it all the more important that we investigate the complex interplay between movement and biodiversity, from the individual to the ecosystem level. IGB is dedicated to this topic, drawing on many disciplines.

The leap to mobility was an evolutionary gamble that resulted in a species-rich, vibrant world. Our research into movement can help us identify cycles, understand interdependencies, and develop sustainable solutions to ensure the preservation of this diversity – and ultimately, the foundation of our own existence.

DR SOPHIA KIMMIG
sophia.kimmig@igb-berlin.de

Book recommendation:
'Move!' on page 55


© David Ausserhofer/IGB

Resources

READ

1. IGB Outlines und IGB Feedbacks

Reversal of the trend at Lake Stechlin
Lake Stechlin is one of the largest and deepest clear-water lakes in northern Germany. Until 2020, the lake's ecological status deteriorated progressively and unexpectedly rapidly. However, since 2021, a reversal of this trend has been observed, suggesting that the situation has stabilised for the time being. Researchers at IGB present their latest findings on these dynamics in an IGB Dossier.

IGB Dossier: The ecological development of Lake Stechlin since 2021

Excessive phosphorus in Lake Arendsee
Lake Arendsee is the largest natural lake in Saxony-Anhalt. Like many other lakes in Germany and Europe, it is affected by eutrophication: too much phosphorus in the lake leads to algal blooms, particularly in the spring and summer months, and severely impairs not only the lake's ecological status but also its appeal to visitors. An IGB Dossier summarises the sources of the high phosphorus load and the appropriate countermeasures.

IGB Dossier: Phosphorus pollution in Lake Arendsee: researchers recommend countermeasures

Germany's rivers
River revitalisation is a crucial long-term investment in the future that politicians and authorities should not overlook, even during periods of economic and security challenges. In the run-up to the 2025 federal election, researchers at IGB have emphasised this aspect. In an IGB Policy Brief, they recommended that the federal government significantly increase its prioritisation of river revitalisation and provide greater support for it in close cooperation with the federal states.

IGB Policy Brief: Germany's rivers – Researchers recommend more revitalisation measures to federal policymakers

Drought and heavy rainfall in Brandenburg
Prolonged dry spells, more frequent heavy rainfall, lower winter precipitation and increased evaporation rates are putting pressure on agricultural and forestry operations in Brandenburg and other regions of the North German Plain. Conflicts between conservation and use, as well as between different user interests, are becoming increasingly common. An IGB Dossier summarises the findings and recommendations for action.

IGB Dossier: Climate change and water scarcity in Brandenburg

EU Water Resilience Strategy
Europe is facing major challenges in protecting its freshwater ecosystems and water resources. IGB researchers have contributed their expertise to the development of the EU Water Resilience Strategy, identifying pathways towards more sustainable management.

IGB Feedback: European Water Resilience Strategy – Identifying research needs

GreenData4All
Data for the environment: The EU's GreenData4All initiative aims to make environmental data more accessible. While IGB researchers emphasise the importance of this initiative, they also highlight the technical and political-strategic hurdles involved.

IGB Feedback: GreenData4All – A chance for better research, more predictive power and socio-ecological innovation

EU Bioeconomy Strategy
There can be no bioeconomy without water. While the EU is committed to a sustainable circular economy, a key bottleneck remains. Researchers explain why water must be given greater prominence in the strategy.

IGB Feedback: Towards a circular, regenerative and competitive bioeconomy – No biomass without water

EU Ports Strategy
Between use and pressure: Ports are economic hubs, but they also put pressure on the marine and river systems that provide them with ecosystem services. In their feedback, researchers explain why nature conservation should be better integrated.

IGB Feedback: EU ports strategy: better consideration of environmental impacts

EU Water Framework Directive
A tried-and-tested instrument under pressure: The Water Framework Directive (WFD) is regarded as a milestone in water policy. Researchers at IGB argue that its objectives and standards should be consistently pursued beyond the 2027 deadline. This applies even if the targets have not been met by then.

IGB Feedback: Call for Evidence – EU water policy – targeted revision of the Water Framework Directive

Help for lakes in poor condition
Sometimes, lakes seem to lose their balance. This suddenly raises many questions: What has happened, and is this a serious problem that requires action? The very beginning of such a process can be particularly confusing. This is why IGB has published a guide offering initial guidance to interested parties and those affected.

IGB Manual: What to do when a lake is in poor health?

2. „Move!“

From a flap of the wings to a migration or a leap into the unknown, animal mobility is both fascinating and risky. IGB researcher Sophia Kimmig takes us on an impressive journey through the world of movement, showing how it enables life while also making it vulnerable.

Move! – Sophia Kimmig

3. „Understanding Recreational Fishers”

This book takes an interdisciplinary look at recreational anglers as part of complex socio-ecological systems. It presents modern methods for understanding and predicting behaviour, and for integrating this understanding into sustainable fisheries management. These methods are practical, well-founded, and applicable to many areas of environmental management.

Pope et al. (2025) Understanding Recreational Fishers: Disciplinary and Interdisciplinary Approaches for Fisheries Management. http://dx.doi.org/10.1007/978-3-031-99739-6

⑥

4. „Wetlands in a Changing Climate: Restoring Coasts and Floodplains”

This special issue explains in detail why Europe’s wetlands urgently need greater protection and restoration in the face of climate change. Contributors to the volume include more than 100 authors from across Europe, such as Sonja Jähnig and Martin Pusch from IGB. All articles are freely accessible via open access.

Wetlands in a Changing Climate: Restoring Coasts and Floodplains

VIEW

5. Fish die-off in the Oder River

What conditions allow the alga *Prymnesium parvum* to grow? This alga produces a toxin that caused a fish die-off in the summer of 2022. How can we monitor whether a new mass bloom of Prymnesium is developing in the Oder River today? Which organisms were affected by the disaster, to what extent, and how are they recovering? How can the Oder River’s ecosystem become more resilient? Four short films provide answers to these key questions about one of the most devastating extreme events ever to occur in a river.

Fischsterben in der Oder – YouTube

USE

6. Travelling exhibitions

IGB’s travelling exhibitions, which can be borrowed free of charge, bring research into water bodies to life in the classroom. “Migratory Fish” uses the example of the sturgeon to illustrate the fascinating yet endangered migrations of fish, while also highlighting ways to protect our rivers. The accompanying exhibition, “The Oder”, sheds light on the events leading up to the 2022 environmental disaster and illustrates the vulnerability of river ecosystems to human intervention.

Travelling exhibitions | IGB

7. “Living Floodplains” Toolbox

Experience knowledge, understand floodplains: this interactive toolbox, developed as part of the Restore4Life project, clearly explains why river floodplains and wetlands are so important for the climate, biodiversity and society. With scientifically sound content, playful elements and practical materials, the platform encourages users of all ages to learn, think critically and get involved.

https://edu4life-wetlands.vercel.app

8. “Water” Discovery Calendar

Where do raindrops come from, and what causes the tides to rise and fall? This calendar takes schools and nurseries on an exciting journey through water bodies, the water cycle and environmental issues. Through playful experiments and clear examples, it brings water to life. The calendar was developed and produced by Pindactica e.V., in collaboration with IGB, Berliner Wasserbetriebe, the Berlin Nature Conservation Foundation, and other partners.

www.pindactica.de/entdecke-kalender-2026

9. “Environment90m” database

Environmental data for global water research: The Environment90m database, developed by IGB, provides high-resolution, standardised information on climate, landscape, soils and hydrology for 726 million sub-catchment areas worldwide. The database enables detailed analyses and modelling of freshwater habitats, and is closely linked to the Hydrography90m river network dataset – a vital foundation for biogeographical and ecological research in the context of global change.

FRED | Freshwater Research and Environmental Database

García-Márquez et al. (2026) Environment90m – globally standardized environmental variables for freshwater science at high spatial resolution. Earth system science data. http://dx.doi.org/10.5194/essd-18-1541-2026

10. Platform for satellite-based algal monitoring

Use the ODER~SO dashboard to detect algal blooms earlier: As part of the ODER~SO project, scientists have developed a platform that uses satellite data to show the development of algal blooms in the Oder River in near real time. The platform is available for public use.

Oder Dashboard

Stelzer et al. (2025) Einsatz von Satellitendaten zur Erfassung der Wasserqualität in großen Flusssystemen am Beispiel der Oder. Deutsche Gesellschaft für Limnologie (DGL) Ergebnisse der Jahrestagung 2024 (Dresden), Essen.

Research for the future of our freshwaters

IGB is Germany's largest and one of the leading international centres for freshwater research. It is also one of the oldest institutions in this field. The roots of the predecessor institutions can be traced back to the end of the 19th century.

Today, our research focuses on how inland waters function and how they are altered by natural and anthropogenic processes. We want to predict how they will respond to global change. Building on this knowledge, we seek to develop scientifically sound approaches for their protection, restoration, and sustainable use.

Imprint

The IGB magazine gives you an insight into the research work of our Institute. For more information, please visit our website or contact us directly at:

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Research spectrum

We study inland waters in all their ecological complexity, from the level of molecular processes and organisms to that of communities and aquatic systems within landscapes.

Contact persons, structure and numbers always up-to-date on our website:
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