IGB
Leibniz Institute of Freshwater Ecology and Inland Fisheries

Resilient yet vulnerable
When adaptation strategies fail

Essential, but often devastating
Algae and cyanobacteria

Hidden crises
Underestimated consequences of climate change

ANNUAL RESEARCH REPORT 2024

One year of freshwater research

~

Research for the future of our freshwaters

Through innovative research on the structure and functioning of freshwaters, their biodiversity, ecosystem services and responses to global change, we make a relevant contribution to a better understanding of these ecosystems and to sustainable freshwater management.

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, science at IGB covers a wide range of disciplines.

Together, we want to understand: What ecological and evolutionary dynamics do aquatic organisms undergo? What are the drivers and implications of changes in biodiversity? How can we safeguard the ecosystem services provided by freshwater systems, ranging from water security and natural flood protection to fisheries and positive effects on human health? And what role can nature-based solutions play in this?

Some answers are presented on the following pages. They are allocated to our four programme areas, each containing a wealth of interesting information that we have compiled for you. For each programme area, you will find further information, materials, experts, background information and the latest news on our website.

We wish you an informative dive into the fascinating world of freshwaters!

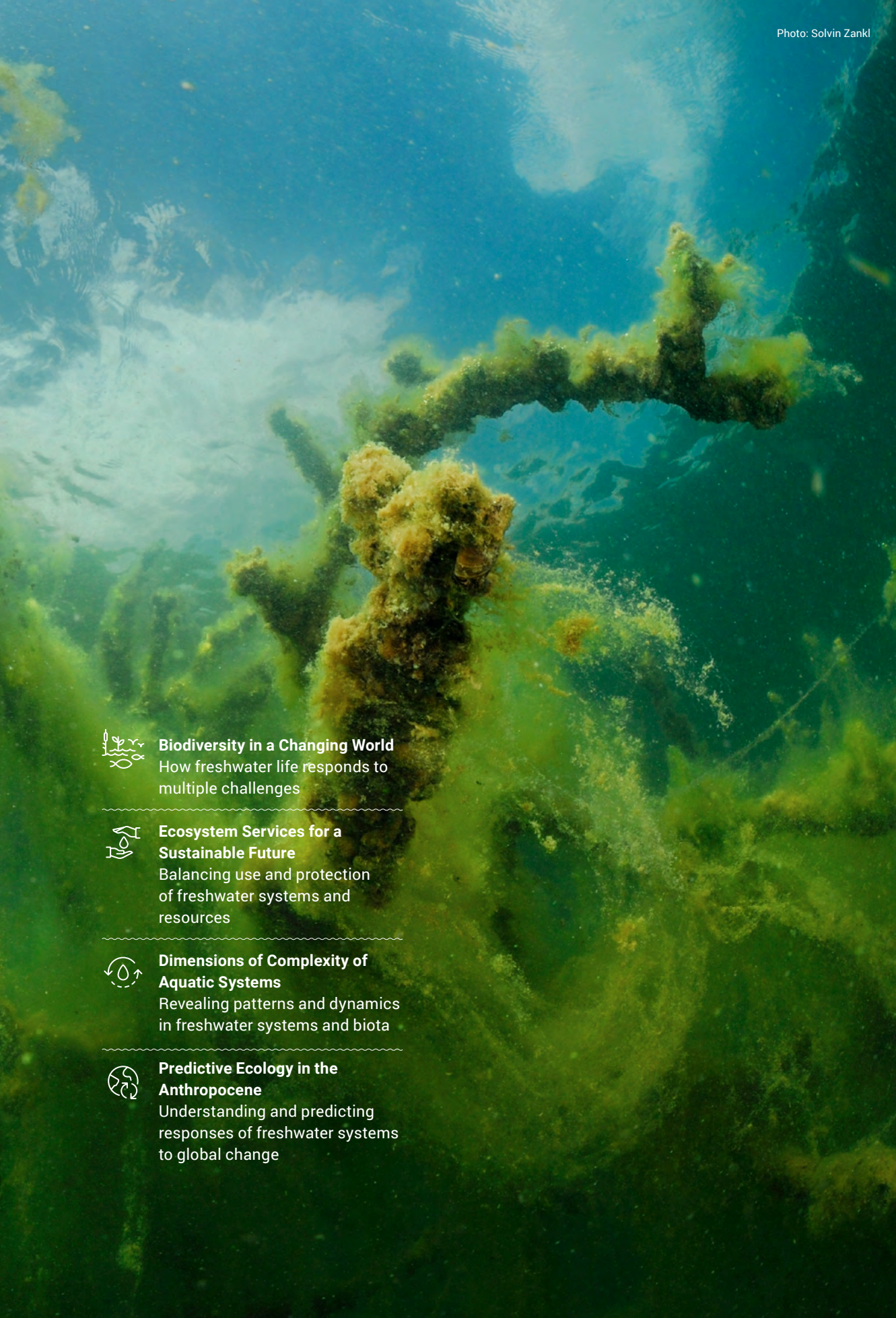

Photo: Solvin Zankl

Biodiversity in a Changing World
How freshwater life responds to multiple challenges

Ecosystem Services for a Sustainable Future
Balancing use and protection of freshwater systems and resources

Dimensions of Complexity of Aquatic Systems
Revealing patterns and dynamics in freshwater systems and biota

Predictive Ecology in the Anthropocene
Understanding and predicting responses of freshwater systems to global change

Dear Reader,

Photo: David Ausserhofer/IGB

Looking back at my previous prefaces, I have noticed a recurring theme: I tend to begin by acknowledging that we live in a world full of challenges, conflicts and crises. Each time, I hoped that I would soon be able to say that some of these problems have been resolved. But reality tells a different story. Climate change is undeniable, and the state of biodiversity is even more alarming. Around the world, including in Europe, the line between opinion and truth is becoming increasingly blurred, and researchers are facing growing concerns about their academic freedom.

In times like these, it is all the more heartening to report on IGB – an institute in excellent shape. Our interdisciplinary research explores theoretical foundations, develops innovative methods and addresses pressing societal challenges related to our freshwaters. Research at IGB is as diverse as the freshwater ecosystems we study – and more relevant than ever in the face of the climate and biodiversity crises.

In 2024, we focused intensively on the less visible impacts of climate change on our freshwater ecosystems (p. 12). Among many issues, a major area of research was the increasing occurrence of algal blooms, the causes and effects of which we studied in detail (p. 32). A key achievement was the sequencing of the genome of the brackish water alga *Prymnesium parvum* – the micro-organism whose toxins caused a massive fish kill in the Oder River in the summer of 2022 (p. 9). As well as focusing on threats, our research has also explored the remarkable adaptability of aquatic organisms, investigating the survival strategies they have developed – and why these sometimes fail in a rapidly changing environment (p. 18).

There are several positive developments and achievements of which we can be proud, so we begin this Annual Report with some good news (p. 6). And 2025 promises to be an exciting year: with our new building in Berlin-Dahlem, we will expand to an additional site and create more space for outstanding research. The establishment of a new programme area Predictive Ecology further strengthens our strategic profile (p. 40). At the same time, we are preparing for our forthcoming Leibniz evaluation. All three aspects are important steps in shaping our future.

None of these achievements would be possible without close collaboration with our partners and stakeholders. Your trust and support is essential to our success. For this, I would like to express my sincere thanks!

Yours,

Luc De Meester
Director

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Good news

Texts: Angelina Tittmann

Ecological stepping stones for urban waters

In cities, along urban rivers and canals, there are very few near-natural banks and shallow water zones. For many kilometres, sheet piling and stone walls separate the banks from the river. Ecological stepping stones can be used to create minimal habitats that allow a variety of species to stay and migrate. IGB has teamed up with a specialist engineering company to develop a solution: vertical wetlands. The test in a pilot project in Berlin went well. Within a few days of installation, fish spawn was found on the modules, and within a few weeks, coots made first nesting attempts. The freely available *IGB Manual* gives interested parties and authorities an insight into the construction method and authorisation requirements.

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Vertical wetlands: ecological stepping stones for urban waters | IGB

Photo: Ralf Steeg

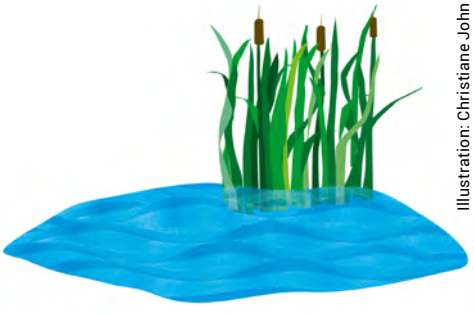

Illustration: Christiane John

How to foster pondscapes

The *PONDERFUL* project has compiled open knowledge resources on how ponds and pondscapes can be used as nature-based solutions (NBS) for climate change adaptation. After all, these small freshwaters play a crucial role at catchment, landscape and potentially continental scales, in particular due to their abundance, heterogeneity and exceptional biodiversity and biogeochemical potential. The materials and webinars are available in English and other languages, and can be freely downloaded and distributed.

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Nature-based solutions: How to foster ponds and pondscapes | IGB

Less phosphorus in Lake Stechlin

In Lake Stechlin, where IGB has operated a research station for decades, the concentration of the plant nutrient phosphorus has halved since 2020. Previously, it had quadrupled in just a decade, leading to algal blooms, oxygen depletion in deep water and other signs of eutrophication. Whether this positive development is sustainable remains to be seen. However, researchers have been able to gain a deeper insight into the causes of these dynamics. They found that the shallow zones of the lake play a crucial role in natural phosphorus retention. Changes in underwater vegetation and reduced sediment binding capacity have significantly influenced internal phosphorus dynamics. These results are likely to be applicable to similar lakes worldwide, as many stratified lakes, despite their depth, have a high proportion of shallow water.

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→ Shallow water areas are crucial for the nutrient balance of a lake | IGB

Gonsiorczyk et al. (2024) Rapid Eutrophication of a Clearwater Lake: Trends and Potential Causes Inferred From Phosphorus Mass Balance Analyses. Global Change Biology. http://dx.doi.org/10.1111/gcb.17575

Photo: Solvin Zankl

Photo: BMUV/Sascha Hilgers

Sturgeon offspring for the Elbe River

With the ambitious aim of establishing a self-sustaining European sturgeon population in the Elbe river system, one hundred young fish of this rare species were released near Magdeburg in September 2024 as part of the reintroduction project coordinated by IGB in the presence of the German Environment Minister, Steffi Lemke. It was the first sturgeon offspring for the river since 2015. The stocking was only possible because the first offspring from a French broodstock population had finally reached spawning age. Despite this interim success, the challenges remain considerable: of the 20 returnees that have been documented in the Elbe system since 2020, 18 have been found dead. They died from mechanical injuries or suffocated in the low-oxygen summer conditions below the Port of Hamburg. Although the exact number of returnees is unknown, these observations are serious warning signals for how we treat the river and its organisms.

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→ Species conservation: First sturgeon offspring since 2015 released into the Elbe River | IGB

New street lamps, fewer dead insects

Many nocturnal species are guided by the stars and the moon – and are thrown off course by artificial light. The disoriented insects often circle around the light sources until they die of exhaustion or are eaten. A research team led by IGB has successfully tested how to light roads and paths in a more insect-friendly way. They have developed special LED luminaires that provide more focused light and minimise spill light – the deadly attraction for insects. The researchers recommend retrofitting lamps, especially near nature reserves, freshwater ecosystems and other areas of high biodiversity.

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New street lamps, fewer dead insects | IGB

Dietenberger et al. (2024) Reducing the fatal attraction of nocturnal insects using tailored and shielded road lights. Communications Biology. http://dx.doi.org/10.1038/s42003-024-06304-4

Photo: IGB

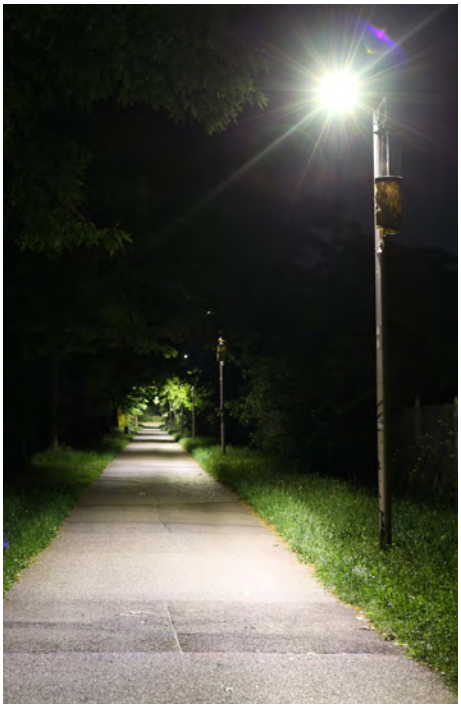
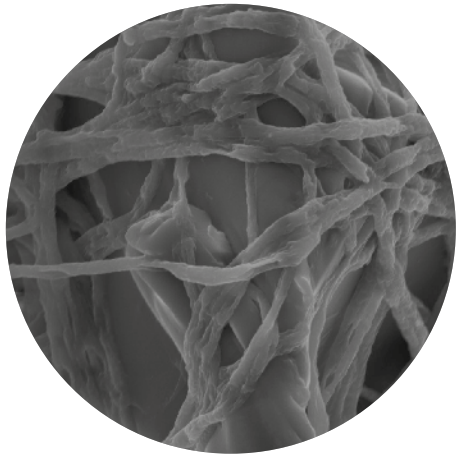


Photo: Sabreen Samuel Ibrahim Dawoud/IGB



These fungi are particularly good plastic recyclers

Plastics often persist for decades in the environment. This is because their polymers are not, or are only very slowly, broken down by bacteria in soil and water. A new study by scientists from IGB and the University of Potsdam offers some hope: the researchers have identified fungi that under optimal growth conditions can efficiently degrade plastic polymers made of polyurethane, polyethylene and tyre rubber. Contrary to previous assumptions, no pre-treatment of the plastics is necessary. It remains to be seen how much plastic can be degraded in the natural environment, where fungal growth is often limited by difficult growth conditions.

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Efficient plastic-feeding fungi in freshwater ecosystems identified | IGB

Ibrahim et al. (2024) Tapping into fungal potential: Biodegradation of plastic and rubber by potent Fungi. Science of the Total Environment. http://dx.doi.org/10.1016/j.scitotenv.2024.173188

Genome and toxin genes of *Prymnesium parvum* decoded

When masses of fish and molluscs died in the Oder River in the summer of 2022, the immediate cause of their death was quickly identified: the toxin of a microalga with the scientific collective name *Prymnesium parvum*, often referred to as 'golden algae'. It has since colonised the entire river course. In order to enable the early identification of risk factors under which the microalga multiplies and produces its toxin, a research team led by IGB has sequenced the complete genome of *Prymnesium parvum*. They were able to identify the gene sequences that encode the toxins, which could be an important contribution to the development of an early warning system. The IGB team's next goal is to analyse toxin production at the molecular level by determining the expression of these toxin synthesis genes.

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Complete genome and toxin genes of the microalgae from the Oder disaster decoded | IGB

Kuhl et al. (2024) The haplotype-resolved *Prymnesium parvum* (type B) microalga genome reveals the genetic basis of its fish-killing toxins. Current Biology. http://dx.doi.org/10.1016/j.cub.2024.06.033

Photo: David Ausserhofer/IGB

Photo: Buendia22

EU Nature Restoration Law (NRL)

The NRL, approved by the EU Parliament, aims to restore 25,000 km of free-flowing rivers by 2030. From an aquatic ecological point of view, the NRL is very welcome – but there are challenges to its implementation that could jeopardise its success. This is the conclusion of a scientific analysis carried out by a team of European researchers led by IGB and the University of Natural Resources and Life Sciences, Vienna. The scientists identify ambiguities in the proposed legislation and the potential consequences of leaving these aspects open to interpretation during the implementation process. They also suggest possible solutions to help achieve the objectives of the legislation.

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EU Nature Restoration Law | IGB

Stoffers et al. (2024) Reviving Europe's rivers: Seven challenges in the implementation of the Nature Restoration Law to restore free-flowing rivers. WIREs Water. http://dx.doi.org/10.1002/wat2.1717

A striped marlin attacking a prey school.

Photo: Matthew Hansen

How marlins make a fast kill

A large and fast fish is the focus of researchers in the Cluster of Excellence *Science of Intelligence* (SCIoI), in which Humboldt-Universität zu Berlin and IGB are involved: using the example of the striped marlin, they examine the advantages and mechanisms of group hunting. In terrestrial predators, there is evidence that capture success increases when groups of prey flee, because weaker group members may become isolated and defenceless. In a field study off the coast of Mexico, the research team has now demonstrated this effect underwater: the faster the prey school moves, the higher the capture rate of the striped marlin. And prey isolated from the swarm are caught by the non-attacking marlins – an advantage of group hunting for the predatory fish.

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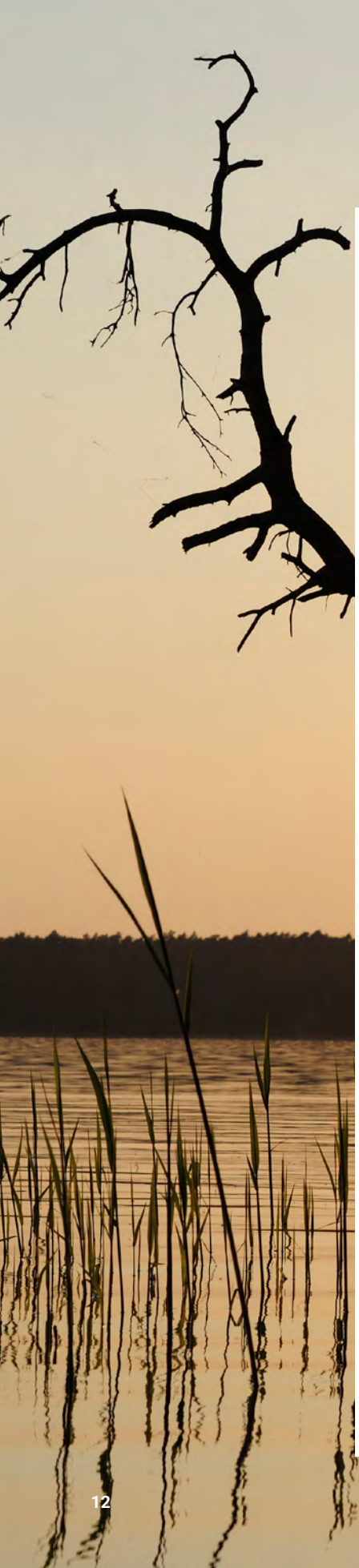
Fast prey: Even non-attacking predatory fish benefit from group hunting at high speed | IGB

Pacher et al. (2024) Evidence for a by-product mutualism in a group hunter depends on prey movement state. Functional Ecology. http://dx.doi.org/10.1111/1365-2435.14638



Hidden crises

Underestimated impacts of climate change

Questions to 7 experts

Climate change also leaves deep traces in inland waters, often more diverse and far-reaching than it appears at first glance. For example, rising temperatures, changing water levels or new ecological dynamics can lead to the development of extensive oxygen-free zones in lakes, a change in the composition of species communities or animals that adapt their behaviour – and consequently find it harder to obtain sufficient food. For invertebrates, warming could make infections caused by bacteria or fungi more deadly. And we humans are confronted with shrinking and increasingly fragmented water reservoirs in the landscape. Researchers at IGB are trying to better understand these developments and identify ways to meet these challenges.

Photo: Fallen tree on the shore of Lake Stechlin. Solvin Zankl

PROFESSOR MICHAEL HUPFER

You are investigating how climate change affects oxygen levels in lakes. What observations have you made and what recommendations do you have?

Long-term studies show that the warming of lakes is leading to a worrying decline in oxygen levels, especially in deeper layers. In a study for Germany, we showed that the surface temperature of 46 lakes analysed increased by 0.5°C per decade between 1990 and 2020. This increases temperature stratification in summer and hinders the exchange of oxygen between surface and deep water. Critical oxygen levels are already below 2 mg/L in more than half of the summer and autumn measurements, which is life-threatening for many organisms. Our model projections to 2099 show that under a pessimistic climate scenario (RCP 8.5), the summer stratification period could increase by up to 38 days. This would further reduce oxygen concentrations in deep water and threaten the habitats of many organisms. During the autumn months, large parts of deep zones could even become completely oxygen-free, with drastic consequences for fish, other organisms and the chemical processes in lake sediments. One possible solution is to reduce nutrient inputs such as nitrate and phosphate, which are often discharged from agricultural and urban sources. Our calculations show that reducing nutrient pollution could improve oxygen concentrations even under the pessimistic climate scenario mentioned above. This approach could make a significant contribution to minimising the negative effects of climate change on the oxygen supply of lakes.

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PROFESSOR MARK GESSNER

Many streams and rivers dry up periodically. You were part of an international consortium that investigated the impact on the biodiversity of these waters. What did you find?

More than half of the world's rivers periodically run dry. The resulting exposed sediments are a highly dynamic but poorly understood system. By analysing environmental DNA, we were able to comprehensively assess the biodiversity of microbes, invertebrates and plants in such sediments from 84 intermittent rivers in 19 countries. A key finding is that biotic interactions between bacteria, fungi, algae and protozoa influence the covariation of community composition more than environmental gradients. This outcome is surprising, because abiotic factors such as climatic conditions or nutrient availability were previously thought to dominate. Instead, we found that interactions between organisms are crucial for the stability and adaptability of the communities in dry river sediments. We also found evidence that prolonged drought favours microorganisms that are particularly efficient at using scarce resources, and that these may play a key role in the functioning of these ecosystems. Although it is unclear how these communities will evolve in the long term under the influence of global changes, our results suggest that rivers and streams that are subject to periodic drying need to be explicitly included in river conservation strategies. At the same time, our data show that dry riverbeds are complex systems whose biodiversity is more strongly influenced by biotic processes than previously thought. These findings should be taken into account in future models aimed at predicting the impacts of climate change.

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DR SAMI DOMISCH

Climate change is known to alter the regional distribution of freshwater species in many ways. Should the biological indices used for the ecological assessment of European rivers also be adapted as a result?

Benthic macroinvertebrates, for example, are used as biological indicators for the assessment of European watercourses. The composition of the species community of a water body type is compared with a reference state, i.e. the species community of a similar, natural water body type. If the distribution of species changes as a result of climate change, such a comparison may become difficult in the future, as the species communities in these natural, unpolluted water bodies may also change. There is a risk in focusing solely on the number of species, as 'more is not necessarily better': Within a species community, individual species can be unique in their ecological function, but also very similar to each other. A change in species distribution may be accompanied by a visible change (e.g. a species may no longer be observed in an area), but its ecological function may be taken over by another species, making the ecosystem equally resilient to environmental change. Of course, this is only possible to a certain extent. Conversely, a new species can only take on a few new ecological functions regionally. At present, the assessment indices correlate strongly with species occurrence, i.e. taxonomic diversity, but in order to be able to assess the ecological status of a water body in the future, it is important to also analyse functional resilience on the basis of species communities.

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DR GREGOR KALINKAT

Fish change their behaviour in warmer conditions. You have documented this in terms of hunting behaviour. What are the implications for the survivability of the species concerned and the stability of ecosystems?

In a study we conducted together with the German Centre for Integrative Biodiversity Research (iDiv) and the Friedrich Schiller University Jena, we have shown that climate change is indeed altering the foraging behaviour of fish such as cod and flounder in the Baltic Sea: As temperatures rise, the metabolism of these fish increases, which means that they actually need more food. However, instead of hunting larger, more energy-rich prey, they eat more small and common prey such as small crustaceans, worms or brittle stars. This 'flexible foraging' turns out to be inefficient in the long term. Our modelling suggests that it increases mortality and makes extinction more likely for species at the top of the food web. In particular, larger predatory fish species could starve because they cannot consume enough calories despite high food intake. This inefficient adaptation also has far-reaching consequences for the communities: If predatory fish become extinct or severely depleted, the balance of the entire food web is upset. Smaller prey species may proliferate excessively, affecting habitat structure and resource availability. Our observations of Baltic Sea fish may also help to explain why their stocks have not recovered much recently, despite much reduced fishing quotas. However, similar behavioural adaptations could also occur in other groups of animals. This could make entire ecosystems more vulnerable to the effects of climate change.

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PROFESSOR JUSTYNA WOLINSKA

Your research focuses on the relationships between parasites and their hosts. What does this actually have to do with climate change?

In a meta-analysis of 60 studies, we showed that global warming significantly increases mortality from infections in cold-blooded animals such as crustaceans, fish and molluscs. As these animals are dependent on the ambient temperature, they are particularly sensitive to rising temperatures. In the case of bacterial infections, mortality increases with rising temperatures because the animals' metabolism is accelerated and pathogens often grow faster in warmer conditions. In the case of fungal infections, the mortality rate of infected animals increases mainly at the thermal optimum of the fungus, i.e. it decreases when the temperature becomes too high. As a result, increased mortality of aquatic animals destabilises food webs and disrupts ecological processes such as the decomposition of organic matter. In addition, pathogens could spread as a result of warming, posing new risks to other species and potentially to humans. It is important that we continue to study the complex interactions between climate change, pathogens and hosts to better assess the long-term consequences for ecosystem function and stability.

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PROFESSOR SONJA JÄHNIG

Climate change requires a shift towards the increased use of renewable energies, including hydropower. How will this affect the water bodies concerned?

In a review study, we have shown how diverse and numerous the negative impacts of hydropower on river biodiversity are. Using international examples, the study shows that this damage is caused by changes in river continuity, water flow, connectivity with floodplains and terrestrial habitats, and sediment and nutrient transport. Genetic exchange between populations is also affected by hydropower. In addition, dams act as physical barriers that impede species migration and disrupt their life cycles, while turbines significantly increase mortality rates – around one in five fish perish during passage. Hydropower plants also affect temperature and seasonal water flows, creating a mismatch between environmental conditions and a species' reproductive cycle. It is therefore best not to build any new hydropower plants in biodiversity hotspots. We recommend the STREAM concept, which includes systematic planning, dismantling of redundant infrastructure, comprehensive socio-environmental impact assessment, participatory decision-making, and continuous monitoring and adaptive management. This is the only way to better understand and reduce the negative impacts of hydropower.

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PROFESSOR DÖRTHE TETZLAFF

You and your colleagues coined the term 'eco-hydrological resilience' this year. What do you mean by this and how can this concept help us to better deal with the consequences of climate change?

When climate extremes such as droughts or floods are discussed, the water already stored in our landscapes is often ignored. Under normal humid conditions, underground reservoirs are interconnected and extend both vertically and horizontally. Surface reservoirs, i.e. surface water, upper soil, but also vegetation, are sufficiently replenished by regular rainfall. In times of drought, surface reservoirs are depleted. Especially in dry periods, access to the so-called storage continuum, i.e. the amount of water stored underground in the soil and in the aquifers below, is crucial. This is because the volume and accessibility of this storage continuum determines whether water-related ecosystem services can be provided at landscape level at all times, from the wettest to the driest periods. In general, the greater the diversity of the landscape, the more connections to the storage continuum are potentially available. This increases hydrological resilience. The storage continuum ranges from areas with high storage capacity and ecohydrological resilience, such as wetlands, to areas with low storage capacity and low ecohydrological resilience, such as agricultural land and forest monocultures. It is therefore not only topography, soil types and geology that determine where water is stored in the landscape, but also the type of land use. In fact, the extent of a drought is largely determined by land cover, as different types of vegetation have different rates of evaporation and transpiration, which in turn depend on the availability of water in the subsoil. Droughts therefore do not affect whole regions or landscapes in the same way, but the effects of drought are specific and vary from one part of the landscape to another.

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Questioned by Angelina Tittmann.
Photos: David Ausserhofer/IGB

Find out more at www.igb-berlin.de/en:

- German lakes under climate change | IGB
- When the swimming hunter becomes exhausted | IGB
- Climate change increases risk of severe infections in cold-blooded animals | IGB
- How water storage dynamics in landscapes strengthen our ability to cope with extreme droughts | IGB

Schwefel et al. (2024) Temperatures and hypolimnetic oxygen in German lakes: Observations, future trends and adaptation potential. Ambio. http://dx.doi.org/10.1007/s13280-024-02046-z

Foulquier et al. (2024) Unravelling large-scale patterns and drivers of biodiversity in dry rivers. Nature Communications. http://dx.doi.org/10.1038/s41467-024-50873-1

Polazzo et al. (2024) A modelling approach to assess climate change impacts on taxonomic and functional diversity of European stream macroinvertebrates: Implications for water quality monitoring. Ecological Indicators. https://doi.org/10.1016/j.ecolind.2024.112404

Gauzens et al. (2024) Flexible foraging behaviour increases predator vulnerability to climate change. Nature Climate Change. http://dx.doi.org/10.1038/s41558-024-01946-y

Li et al. (2024) Excess mortality of infected ectotherms induced by warming depends on pathogen kingdom and evolutionary history. PLoS Biology. http://dx.doi.org/10.1371/journal.pbio.3002900

He et al. (2024) Hydropower impacts on riverine biodiversity. Nature Reviews: Earth & Environment. http://dx.doi.org/10.1038/s43017-024-00596-0

Tetzlaff et al. (2024) Ecohydrological resilience and the landscape water storage continuum in droughts. Nature Water. http://dx.doi.org/10.1038/s44221-024-00300-y

To revitalise natural areas and increase biodiversity, beavers can be used in restoration projects.

Photo: Shutterstock 1527324593

Read more about the beaver:

- The beaver, a controversial mammal | IGB

Large animals promote freshwater biodiversity

The population abundance of large freshwater animals such as sturgeons, giant catfish, river dolphins, hippos, crocodiles and large turtles has declined sharply worldwide, as has the size of their distribution areas. The causes have been widely studied, but our understanding of the impacts of megafaunal loss in freshwater ecosystems remains limited. IGB researchers, in collaboration with colleagues from Humboldt-Universität zu Berlin, Aarhus University, Senckenberg Nature Research Society and the University of Granada, have shown how native megafauna can shape habitat structure and promote biodiversity in freshwaters. They do this by building dams, creating channels and altering bank structures, thereby increasing the water storage volume of water bodies. Protecting and reintroducing these species can therefore contribute to the restoration of freshwater ecosystems.

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- **Troublemakers wanted | IGB**

He et al. (2024) Freshwater megafauna shape ecosystems and facilitate restoration. Biological Reviews. https://doi.org/10.1111/brv.13062

Illustration: Christiane John

Resilient yet vulnerable

When adaptation strategies fail

To survive as a species, aquatic organisms have developed a wide variety of strategies. Millions of years ago, sturgeons used their bony shells to fend off predators and relocate their habitats, sulphur mollies survive in toxic, almost oxygen-free water, and fish stocks in the River Oder are gradually recovering from the 2022 disaster. However, there are limits to the resilience of organisms, and these can be seen even in the tiniest single-celled creatures.

Sturgeons have lived on Earth for around 250 million years. In that long time, their appearance has changed very little. Their skin is covered with long rows of bones that protect them from predators.

There is literally no place on earth, no matter how inhospitable, where life does not exist. Take the river in Mexico where David Bierbach is researching the lives of two species of fish. This river is fed by springs of volcanic origin that are very rich in hydrogen sulphide. “This makes the water highly toxic to anything with more than one cell,” explained the biologist. Since hydrogen sulphide and oxygen react in the water, it is oxygen-free, which can be seen with the naked eye by its milky colour. In the organism, hydrogen sulphide binds to the same proteins as oxygen, preventing cells from producing adenosine triphosphate (ATP) and therefore from functioning. However, two species of fish – the sulphur molly (*Pocilia sulphuraria*) and the widemouth gambusia (*Gambusia eurystoma*) – have adapted to these hostile conditions: They have a protein adaptation that prevents hydrogen sulphide from binding to proteins in the mitochondria. This makes the water less toxic for both species. These fish have existed in this body of water, which is roughly the size of Lake Müggelsee, for several 100,000 years and they can only survive in this water – their organism is highly adapted.

Photo: Sulphur molly. Matthias Schulze

SUCCESSFUL STRATEGIES AGAINST SULPHUR AND PREDATORS

Of course, these fish species also need oxygen. They have developed larger heads with larger gills for this purpose. There is a thin, slightly oxygenated film on the surface of the water, which the fish allow to pass over their gills, absorbing the oxygen it contains. They need a lot of it because the water temperature is also extreme at well over 30 degrees. At such high temperatures, metabolic processes speed up and cellular respiration increases. Oxygen is also needed to cope with the sulphur that

Photo: Juliane Lukas

*The springs of Baños del Azufre, near the Mexican town of Teapa, form a harsh and inhospitable habitat. As volcanic springs, their water has a high concentration of toxic hydrogen sulphide and very little oxygen. Only specially adapted fish, such as the sulphur molly (*Poecilia sulphuraria*), can survive under these conditions. When attacked by birds, sulphur mollies perform collective wave-like movements that resemble La-Ola waves.*

penetrates through the gills and body surface. Food, on the other hand, is plentiful: Because the sulphurous water is rich in bacteria, the fish are found in very high densities – which in turn attracts birds. The fish have also developed a counter-strategy. "Hiding is not an option because the fish have to be on the surface. To reduce the pressure from predators, the fish dive up and down in rapid, coordinated repetitions. From the outside, it looks like a giant Mexican wave running through the river, made up of hundreds of thousands of tiny fish. This 'wave' deters the birds and extends the time before the next attack," explained David Bierbach.
It will be difficult for the fish if temperatures continue to rise. "Since the environment to which they have adapted is extremely hostile, they are already at their limit," commented David Bierbach. The researchers were able to observe this when the banks of one section of the river were dredged. A large surge of warm spring water entered the river, temporarily warming it by one degree and introducing more sulphur into the river. "As a result, a wave of death swept through the river because these small changes were unbearable for most individuals," reported the researcher. The conditions only lasted for a short time, and some fish survived. However, the scientist predicts that if climate change causes temperatures to rise slightly in the long term, the two species are likely to become extinct.

ARMOURED WANDERER: THE STURGEON

Sturgeons have been proving their resilience for around 250 million years. They have a bone armour that repels predators – even if today's armour does not resemble that of the past. "The five-row bone shield is just a remnant, made of the same material but much smaller," stated Jörn Geßner. However, it does not help much against humans, who quickly learned to hunt sturgeon successfully: by the end of the 19th century, fishermen were catching 10,000 sturgeon a year in the River Elbe, a highly coveted prize, as each of the fish, which can grow to four-and-a-half metres in length, can yield up to 300 kg of meat.

"For millions of years, the sturgeon's strategy was to reproduce at different times and places in freshwater and then migrate to the sea to live and grow. This was ideal for building up large populations over the long term," explained Jörn Geßner. The migrations are genetically pre-programmed and not an individual decision by the sturgeon. Most fish always return to the river where they hatched. However, sturgeon can change their habitat over long periods of time. The European sturgeon, for example, migrated north past the Iberian Peninsula after the last Ice Age. "It took the sturgeon 800 years just to get from the Seine to the Rhine. There are always just a few strays that escape and build up new populations over the centuries," remarked Jörn Geßner.

However, this only works as long as the adult sturgeon are not caught – and the watercourses are intact. To spawn, the sturgeon needs clean gravel, free of sand and organic material, so that water can flow through it and the eggs, which adhere to the gravel, are supplied with oxygen-rich freshwater. As industrialisation has progressed, water quality has deteriorated and eggs have died in the spawning grounds due to pollutants, which in turn have been lost as rivers have been dredged to allow larger ships to pass. Climate change is also affecting the sturgeon's habitat. Spring floods clean the gravel banks, but these periods are becoming increasingly shorter or are shifting, further reducing the conditions for successful reproduction. In some regions, summer temperatures are already reaching the tolerance limits of juvenile fish, which means that entire regions of the species' historical distribution will be lost in the future. "These changes are now occurring at a high rate, leaving too little time for long-lived species with long generation cycles to adapt," stated Jörn Geßner. Whether it will be possible to reintroduce the sturgeon to the Baltic Sea and the River Oder is still uncertain. Its defensive shell, that much is certain, will be of little use.

FEEDBACK MECHANISMS INFLUENCE POPULATION RESILIENCE

Lynn Govaert studies unicellular ciliates to find out what conditions the organisms need to live and reproduce – and what stresses them. With *Colpidium striatum* and *Paramecium aurelia*, she has selected two species that compete with each other for the same food, but have contrasting preferences for their optimal ambient temperature: While *Paramecium* likes it warm in order to divide, *Colpidium* prefers lower

Photo: Daniela Pezetta

"Hiding is not an option. To reduce the pressure from predators, the fish dive up and down in rapid, coordinated repetitions. From the outside, it looks like a giant Mexican wave running through the river."

Dr David Bierbach

Photo: Jacobia Dahm

"These changes are now occurring at a high rate, leaving too little time for long-lived species with long generation cycles to adapt."

Dr Jörn Geßner

temperatures. In her experimental set-up, Lynn Govaert put the two species in a system and varied the temperature and salinity of the water. "We wanted to know what happens when two environmental parameters change at the same time and the organisms also have to compete for food," she said. The researchers measured how cell size and population density changed in both ciliate species: Normally, cell size determines when an individual divides. If there are many individuals in a habitat, their cell size decreases and the reproduction rate, and thus the population density, decreases accordingly. However, this is not always the case; environmental conditions also have an influence on the reproduction rate and thus on the resilience of organisms, as Lynn Govaert was able to show. "We observed, for example, that *Colpidia* had very large cell sizes at one point, but the population density did not increase because the organisms did not divide. They were obviously stressed by changes in their environment – in this case, higher temperatures," reported the researcher. Fewer individuals and higher temperatures also provide good growth conditions for the bacteria that the protozoa feed on – yet cell division rates did not increase in the experiment.

A feedback between the population density and certain characteristics of the ciliates can be disrupted depending on the environmental conditions. "This suggests that these organisms are less resilient," commented Lynn Govaert. Her work shows that living organisms do not 'simply' react to environmental changes: Environmental change can also trigger changes in feedbacks within species' populations, which can either amplify or counteract their responses to environmental change.

2022 RIVER ODER DISASTER: RESILIENT FISH STOCKS WHEN THE RIVER FLOWS FREELY AND PROVIDES REFUGES

Around 1,000 tons of fish died in the Oder ecological disaster in the summer of 2022. A team led by Christian Wolter investigated the resilience of fish stocks in Europe's last permeable river system in the aftermath of these events. The researchers assessed the decline rates of the stocks, taking into account natural population fluctuations: Depending on the section of the Oder, fish density declined by up to 76 per cent. "The first piece of good news is that all species survived," noted the researcher. Larger fish species and those that tend to live in the middle channel of the river were more likely to be affected. Species that prefer to live near the banks fared better because the golden algae was not as abundant there as in the deeper water. The declines recorded are relative; tens of thousands of individuals per hectare were affected in the case of smaller species, but only a few specimens were affected in the case of large fish.

Another piece of good news: the populations have continued to recover. "In 2023, there was a prolonged spring flood and therefore good growth conditions. There was also a moratorium on industrial fishing, so no fish were caught in the Oder. That's why we had a great starting cohort with lots of young fish," reported Christian Wolter. The researchers expect all stocks to have recovered by 2026 or 2027. Some fish species have already reached this stage: the gudgeon, for example, reached its previous population size in just one year.

Photo: A vimba bream from the Oder River. Lena Giovanazzi

Photo: Ciliate. Silke Kusters

In addition to the good external conditions, the fish are helped by two mechanisms: they have a very high reproductive potential and they are mobile. One fish can produce up to a million eggs, from which many fish can hatch if there is sufficient spawning area, as was the case in 2023. “This means that you only need a few individuals and can still have a good year if the conditions are right,” explained Christian Wolter. Fish reproduce for about ten to 15 years, so the chance of at least one good year is high, which contributes to the resilience of the species.

In 2022, the mobility combined with the passability of the Oder meant that fish were able to move from sections with deteriorating water quality to safe areas such as clean tributaries or riverbanks. “We don’t know to what extent individual experiences played a role in the evasive movements,” said Christian Wolter. For example, low water levels in the summer of 2018 led to fish migrating downstream into the Lower Oder.

Overall, therefore, the fish stocks in the River Oder are very resilient and the creatures have many characteristics that favour their survival. “However, fortified banks and migration barriers in the river, which prevent fish from moving to secondary waters, significantly limit the resilience of the fish,” commented Christian Wolter. The naturalness of the environment in which individuals and populations live largely determines their resilience.

Text: Wiebke Peters

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Find out more at www.igb-berlin.de/en:

- Why Mexican fish swim the Mexican wave | IGB
- Two years after the environmental disaster of the Oder | IGB

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Angling fish for food

Rod and reel fishing is much more than a recreational activity: It makes an important contribution to the diet in many regions of the world. This is shown by an international team of researchers, including IGB researcher Robert Arlinghaus. In the study published in *Nature Food*, the research team estimates that recreational fishing in lakes and rivers accounts for more than eleven per cent of the annually reported catches in inland fisheries worldwide. The total annual consumption value of harvested fish is estimated at around US$10 billion. However, climate change and the degradation of freshwater systems could affect fishing yields in many regions in the future.

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Angling fish for food | IGB

Lynch et al. (2024) Inland recreational fisheries contribute nutritional benefits and economic value but are vulnerable to climate change. Nature Food. http://dx.doi.org/10.1038/s43016-024-00961-8

By country, Canada, Poland and Argentina consume the most freshwater fish per angler. Germany is also in the top ten in sixth place.

Photo: Falk Weiß

Is the image of the industrious cleaner outdated?

Freshwater mussels and the invasive quagga mussel

Questions to 5 experts

We have all collected mussels from the shore, but do they also exist in freshwater ecosystems? Just how many of these inconspicuous mussels can be found beneath the surface of inland waters became apparent during the Oder River disaster in 2022, when tons of mussels perished. Empty mussel shells still line the banks of the Oder. Freshwater mussels are the industrious cleaners of lakes and rivers, filtering small algae out of the water and keeping it clear. This positive image has suffered since the spread of the invasive quagga mussel. The voracious appetite of this newly introduced species means that fish in Lake Constance and other water bodies are deprived of plankton as a source of food. Keeping them in check also costs a lot of money: masses of quagga mussels clog up pipes and boats. We put five questions to IGB researchers to find out more about these industrious filter feeders.

Photo: Invasive zebra mussels in Lake Stechlin. Solvin Zankl

DR CHRISTIAN WOLTER

PROFESSOR SONJA JÄHNIG

In 2022, vast numbers of mussels in the Oder River were killed by the toxin from the brackish water algae *Prymnesium parvum*. You primarily investigate the recovery of fish stocks in the river after the disaster through regular fishing, but also monitor mussels. What is the status of the stocks and the possibility of recovery?

Around 63 per cent of the mussels – of the *Anodonta* and *Unio* genera – were killed in the Oder disaster. Our spot checks after the major fish and mussel die-offs have shown that fish stocks are recovering faster than mussels and snails. We expected this because fish are much more mobile (p. 22). In general, mussels have a hard time in our rivers: dredging and other water management practices have greatly reduced mussel populations in many running waters. For one thing, mussels are swept up with the dredged material. For another, hydraulic engineering generally results in increased sediment transport, which mussels do not tolerate very well. If, then, the Oder is developed further as a waterway, mussel populations will not recover. In fact, many river mussels are protected by the Federal Ordinance on the Protection of Species (BArtSchV), which means that their habitat should be protected as a matter of priority. However, this is often not the case. Mussels have no lobby.

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Dr Wolter has already touched on this: Many river mussel species are endangered. But they are not the focus of species protection measures. You study biodiversity in freshwater ecosystems. What is so special about mussels?

Mussels are inconspicuous but fascinating. A mussel, for example, can survive for several days without water if it closes up, which is its natural defence mechanism. Mussels can be very small, some pea clams (*Pisidium*) have an adult size of only 3 millimetres. Another interesting mussel species is the freshwater pearl mussel (*Margaritifera margaritifera*). This mussel can produce pearls and was also used as a source of mother-of-pearl. It can live up to 280 years and reproduce for up to 75 years. The offspring of the freshwater pearl mussel live parasitically on the gills of brown trout for several months. This dependence on a single fish species is one of the reasons why the mussel is highly endangered. In Europe, its population has unfortunately declined by more than 90 per cent in the last 90 years. This is why the species is classified as critically endangered on the Red List of the International Union for Conservation of Nature (IUCN). It is also listed in Annex IV of the Habitats Directive (FFH Directive) as a species that is also protected outside Natura 2000 sites. The native freshwater mussels are therefore not doing particularly well.

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DR SABINE HILT

You study the interactions between algae, aquatic plants and organisms in lakes. What role do freshwater mussels play in this?

Mussels feed on small algae. They filter them out of the surrounding water and in turn release nutrients into the water. They also eat cyanobacteria, which can produce toxins. When there are lots of mussels, the water is clearer. Sunlight can penetrate deeper and aquatic plants grow better. These in turn produce oxygen for other organisms. So mussels generally have a positive effect on water quality. However, invasive species such as the zebra mussel (*Drissena polymorpha*) or the quagga mussel (*Drissena rostriformis bugensis*) can form mass populations and, for example, displace native mussel species by taking over their habitats and food sources. The quagga mussel is particularly successful because it does not require a hard substrate and can live on sandy or muddy ground. The species was first recorded in Germany in 2005. It is usually introduced by various means, such as boats or other equipment used by people in water. It is also introduced through the trade in plants and animals for garden ponds. The quagga mussel is now the species with the highest biomass in many water bodies. In Lake Michigan in the USA, the mussel now accounts for around 90 per cent of the water's biomass.

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PROFESSOR JONATHAN JESCHKE

DrHilt has just mentioned the massive spread of invasive freshwater mussels. You conduct research on invasive species and novel communities. Why is it important to be able to assess the risks as quickly as possible?

In a study, we analysed the long-term population dynamics of the quagga mussel and the invasive zebra mussel in Europe and North America. We found that populations of both species can grow very rapidly in the first 1-2 years after their arrival. This is, of course, a challenge for control, as the establishment of new mussel species often goes unnoticed for some time, particularly because there is typically no targeted monitoring. In order to establish a scientific early warning system and to study the long-term dynamics of invasive species, we have established the *Invasion Dynamics Network*. We also developed a classification scheme that systematically organises publications and hypotheses in invasion science. This framework helps to transform data and information into actionable knowledge, while identifying specific knowledge gaps. With the growing importance of artificial intelligence, such classification systems could become key references for organising scientific information. Moreover, our approach provides a basis for tools that are more tailored to the needs of stakeholders involved in invasive species management.

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JONAS MAUCH

The quagga mussel can also be found in Berlin's Lake Müggelsee. Mr Mauch, you are investigating how the mussel affects its habitat there. What is particularly striking?

Since the quagga mussel has spread to Lake Müggelsee, it has become so dense that the entire volume of water in the lake is filtered up to twice a day. This has changed many processes in the lake. The water is clearer and more aquatic plants are growing again, such as stonewort for the first time in decades. We have now also shown that the quagga mussels have helped to reduce the biomass of cyanobacteria in Lake Müggelsee, but only at temperatures below 28 degrees. At higher temperatures, the mussels close their shells and stop filtering. They also do not filter all types of cyanobacteria equally. The potentially toxic cyanobacteria species *Anabaena flos-aquae* is filtered at high rates, while another common and potentially toxic species, *Microcystis aeruginosa*, for example, is hardly filtered at all. Therefore, it cannot be said that quagga mussels reduce all cyanobacterial blooms. It depends very much on the species composition. The influence of climate change, with rising temperatures and more frequent hot spells, which can counteract mussel filtration, must also be taken into account.

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Paraqua podcast with Jonas Mauch:
- https://podcasts.apple.com/de/podcast/the-paraqua-podcast/id1745404714?i=1000671954958

Questioned by Nadja Neumann.
Photos: David Ausserhofer/IGB

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Knowledge discovery in invasion biology

Invasive animal and plant species are increasingly found in many freshwater ecosystems. Invasion science is therefore a thriving research field. To make the growing amount of data and information in this field more accessible, a team led by IGB has developed an innovative web-based application. With just a few clicks, the *Hi Knowledge* tools allow users to, for example, create knowledge maps based on keywords and linked to scientific publications. The literature database created by the team contains over 50,000 publications related to biological invasions.

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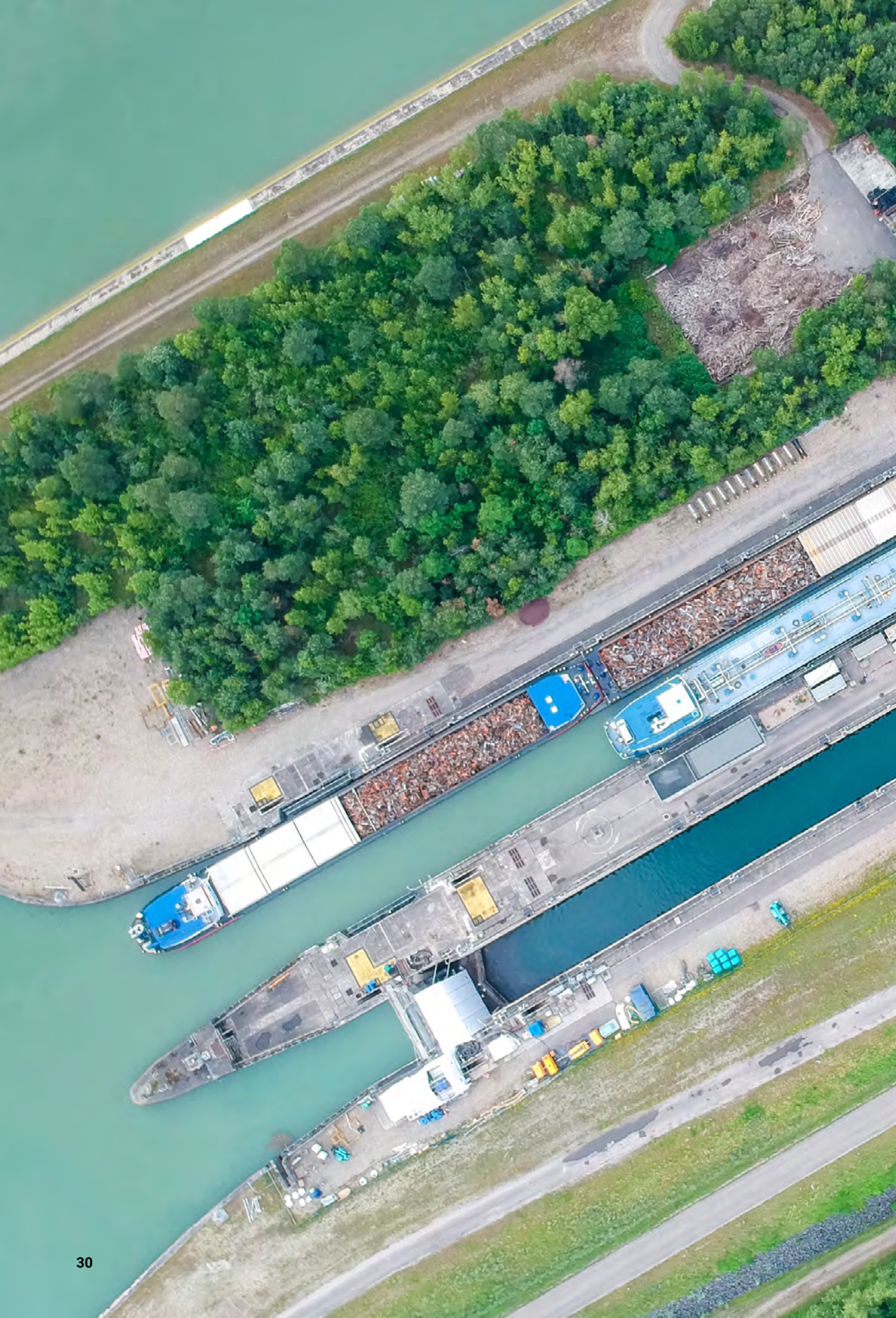
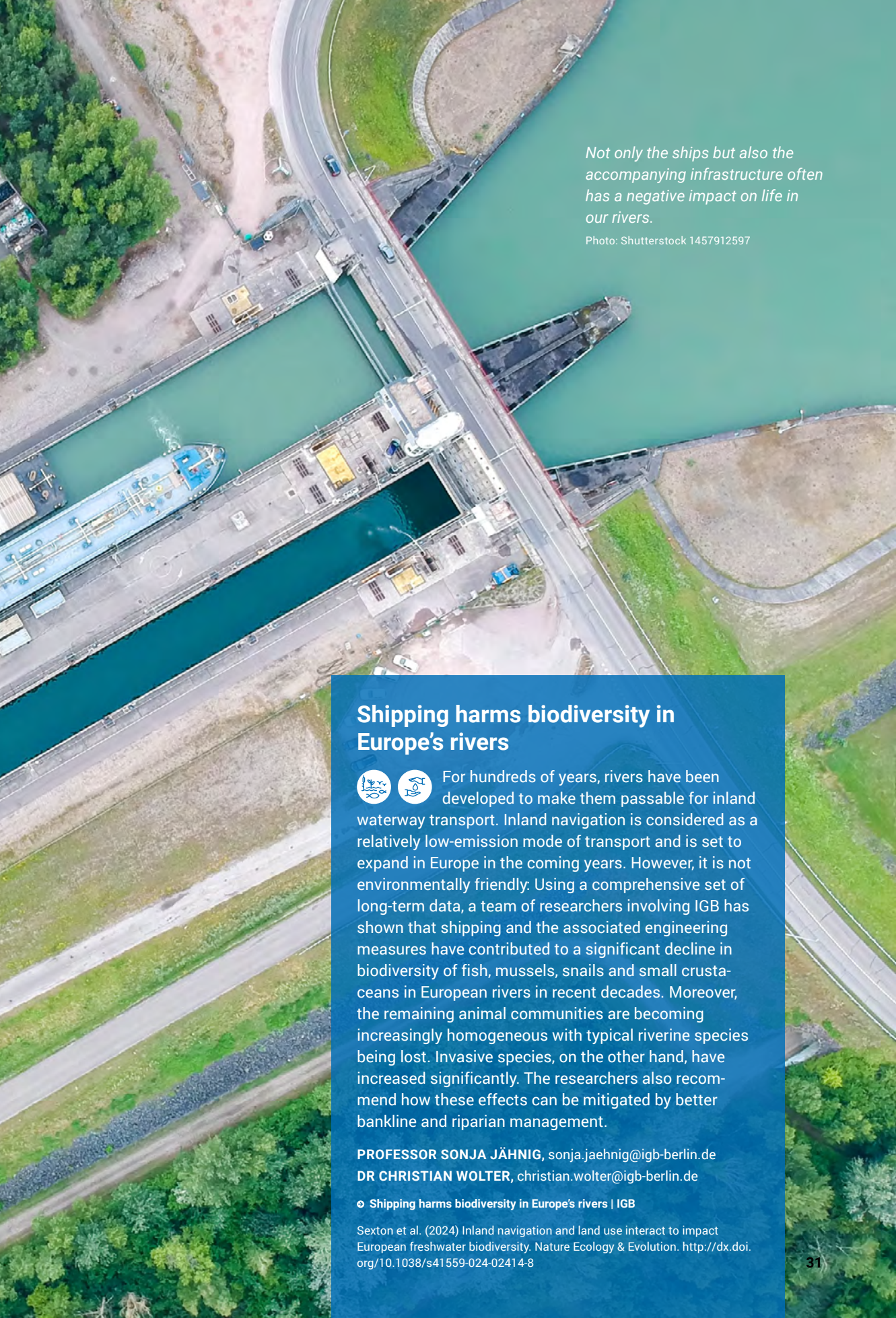
Find out more at www.igb-berlin.de/en:
- Hi Knowledge – Smart tools to discover insights from invasion biology and beyond | IGB





Not only the ships but also the accompanying infrastructure often has a negative impact on life in our rivers.

Photo: Shutterstock 1457912597

Shipping harms biodiversity in Europe's rivers

For hundreds of years, rivers have been developed to make them passable for inland waterway transport. Inland navigation is considered as a relatively low-emission mode of transport and is set to expand in Europe in the coming years. However, it is not environmentally friendly. Using a comprehensive set of long-term data, a team of researchers involving IGB has shown that shipping and the associated engineering measures have contributed to a significant decline in biodiversity of fish, mussels, snails and small crustaceans in European rivers in recent decades. Moreover, the remaining animal communities are becoming increasingly homogeneous with typical riverine species being lost. Invasive species, on the other hand, have increased significantly. The researchers also recommend how these effects can be mitigated by better bankline and riparian management.

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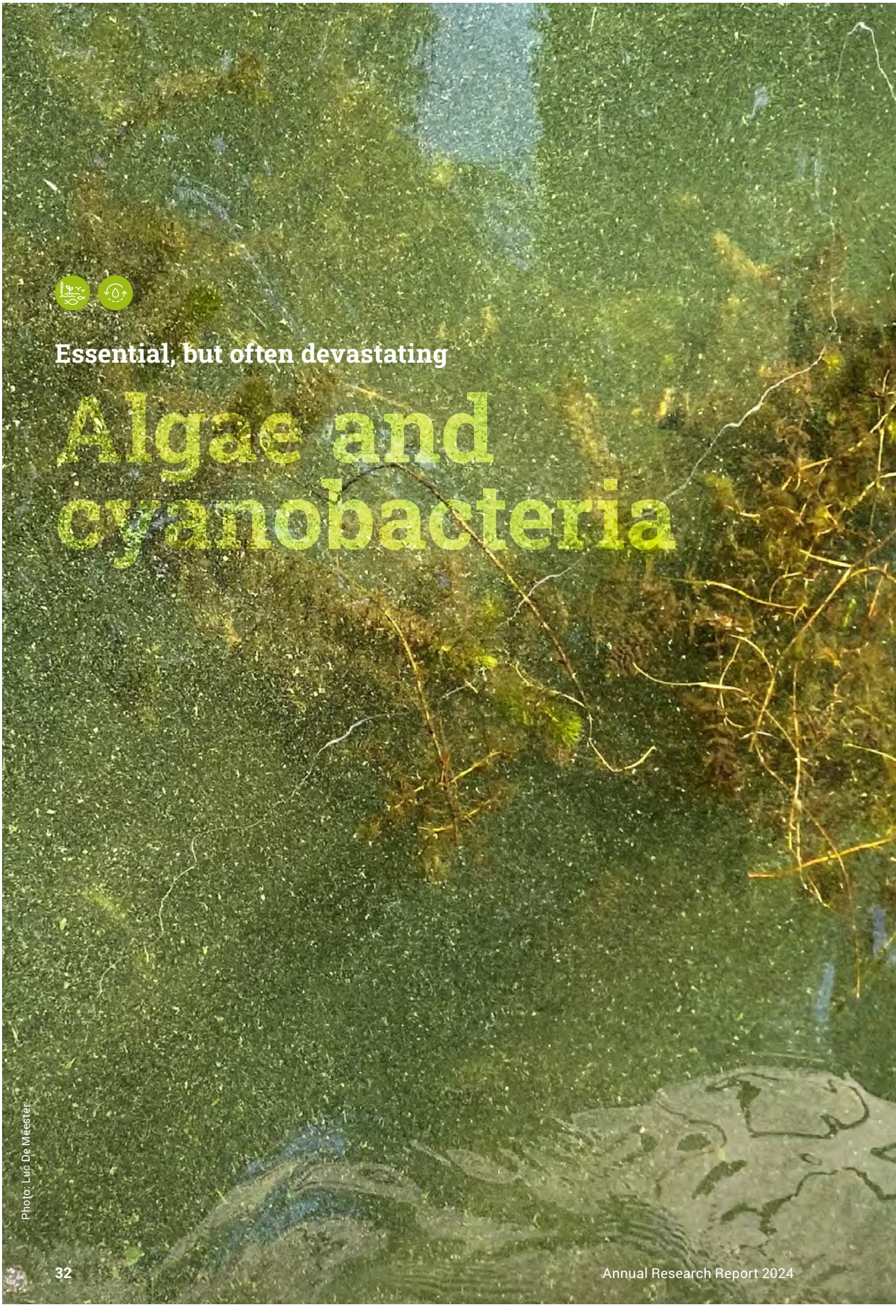
Shipping harms biodiversity in Europe's rivers | IGB

Sexton et al. (2024) Inland navigation and land use interact to impact European freshwater biodiversity. Nature Ecology & Evolution. http://dx.doi.org/10.1038/s41559-024-02414-8



Essential, but often devastating

Algae and cyanobacteria

Photo: Luc De Meester

Without algae, little would function in aquatic ecosystems: they are a key component of the aquatic food web and provide oxygen for respiratory animals. But there is ample evidence that their abundance and composition are shifting as a result of climate change. This often has alarming consequences for the communities that live in rivers and lakes – and for us humans.

A legend seems to have come to life in Lake Stechlin: since the turn of the year 2019/2020, the clear water lake north of Berlin has been dominated by the algae species *Planktothrix rubescens*, also known as the burgundy blood alga. During thermal stratification in summer, this purple-reddish microorganism lives in the deeper layers of the lake. When full circulation is restored in autumn, during mild winters (without ice cover) and in spring, *Planktothrix rubescens* is distributed throughout the water column.

This is reminiscent of the legend of the Red Rooster in Lake Stechlin. It sits at the bottom of the lake, but when provoked, it rises, red and angry, and beats the lake with its wings until it foams and surges, taking everything on the surface down with it (as described in Theodor Fontane's 'Wanderungen aus der Mark Brandenburg' (Ramblings through Brandenburg). Fortunately, this has not yet happened in the real Lake Stechlin. *Planktothrix rubescens* is a cyanobacteria species and an important component of phytoplankton – the primary producers in aquatic ecosystems. "We can see the long, relatively thin filaments of *Planktothrix rubescens* immediately after sampling Lake Stechlin by using new analytical methods such as image-based flow cytometry," reported Stella Berger, phytoplankton ecologist at IGB.

'Algae' is more of a collective term (from the Latin alga). It is used to refer to a variety of eukaryotic (nucleated) organisms, most of which live in water and carry out photosynthesis, producing about half of the oxygen in the Earth's atmosphere. Algae can be divided into two groups based on size: microalgae and macroalgae. Microalgae are microscopically small, mostly single-celled species, but they can also form colonies and long filaments. As primary producers, they are at the base of the aquatic food web. Cyanobacteria also play a role in the food web, but are procaryotes (single-celled organism whose cell lacks a nucleus and other membrane-bound organelles). Like other microalgae, they can be ingested by zooplankton. Macroalgae (large algae) are visible to the naked eye and range in length from a few millimetres to 60 metres. Most macroalgae live in the sea (kelp). Stoneworts are an example of freshwater macroalgae. They provide shelter and habitat for a variety of aquatic organisms, such as juvenile fish and small crustaceans.

THE PROBLEM OF ALGAL BLOOMS

Algae become a problem when they suddenly multiply very rapidly, resulting in so-called algal blooms. The main cause of this rapid growth is nutrients, especially phosphorus. These nutrients are discharged into water bodies, for example from agriculture or municipal sewage. Heat also plays an important role, as many algae prefer warm water. "But heat is not the only decisive factor," stated Karla Münzner, who conducts research into plankton ecology at IGB. It is therefore difficult to say to what extent human-induced global warming is responsible for the mass development of algae. Heavy rainfall events, which are increasing as a result of climate change, also contribute to algae growth by washing more nutrients from the environment into the water. Strong storms in summer are another factor, as they stir up

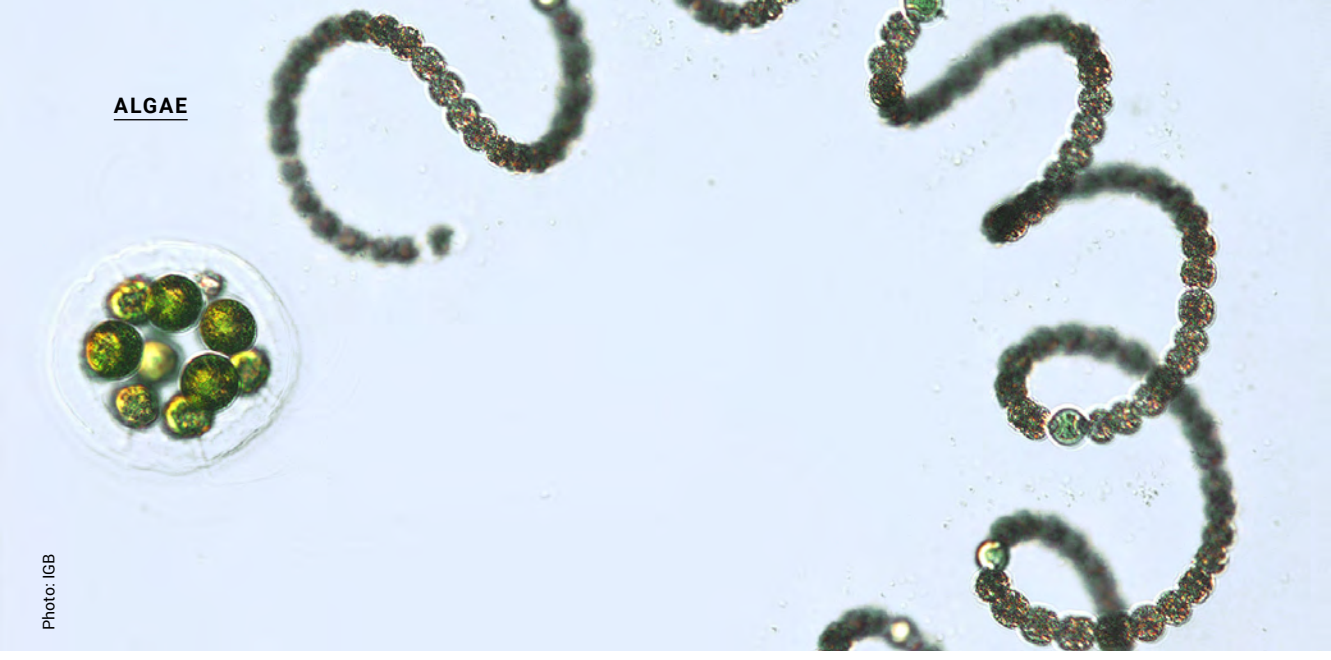


Photo: IGB

A green alga (left) and the cyanobacterium Anabaena solitaria *from Lake Stechlin.*

nutrients from the depths into the upper layer of water, where most algae are found. In addition, recent results from IGB researchers show that cyanobacteria also thrive at low temperatures (below 15°C), even in winter under ice and snow. "This means that cyanobacteria can adapt very quickly to changing environmental conditions," summarised Stella Berger.

Cyanobacterial blooms have a negative impact on the ecosystem: other species of algae are displaced or inhibited by a lack of resources (light, nutrients), and when the dead organisms are decomposed by bacteria after an algal bloom, oxygen consumption and oxygen deficiency can occur. This then affects animals such as fish, mussels and insects. Metabolites or toxins produced by cyanobacteria can have negative effects on fish and other species such as mussels, or on certain zooplankton that feed directly on the algae. For humans, massive growth of algae means that we can no longer use a lake as we would normally: for swimming, angling or letting our dogs bathe. Although waterworks can filter cyanobacteria out of drinking water, the cost of doing so has to be borne by the public.

Previously neglected factors may also contribute to the growth of cyanobacteria. For example, they benefit indirectly from compounds leached from cigarette butts. These include metals and nicotine, which can inhibit the infection of cyanobacteria by parasitic chytrid fungi. "This inhibition in turn indirectly promotes the growth of cyanobacteria, revealing previously unknown ecological effects of cigarette waste on the aquatic environment," explained Erika Martinez-Ruiz from the Disease Evolutionary Ecology research group at IGB.

Algal blooms are not only caused by cyanobacteria. Diatoms, which prefer cooler temperatures and act as a food source for zooplankton, especially in spring, can also proliferate in large numbers if sufficient nutrients are available. These blooms are part of the natural plankton succession and form a so-called spring bloom in many lakes which are usually short-lived as they are either attacked by fungi, sink as aggregates or are consumed by zooplankton.

The best way to prevent unwanted algal blooms is to reduce nutrient inputs. "Agriculture is an important driving force. There are many things that can be done in this area, such as choosing the right fertiliser and adjusting the amount, dosage and timing, i.e. how often and when it is applied: for example, fertiliser should not be applied shortly before the arrival of a rain

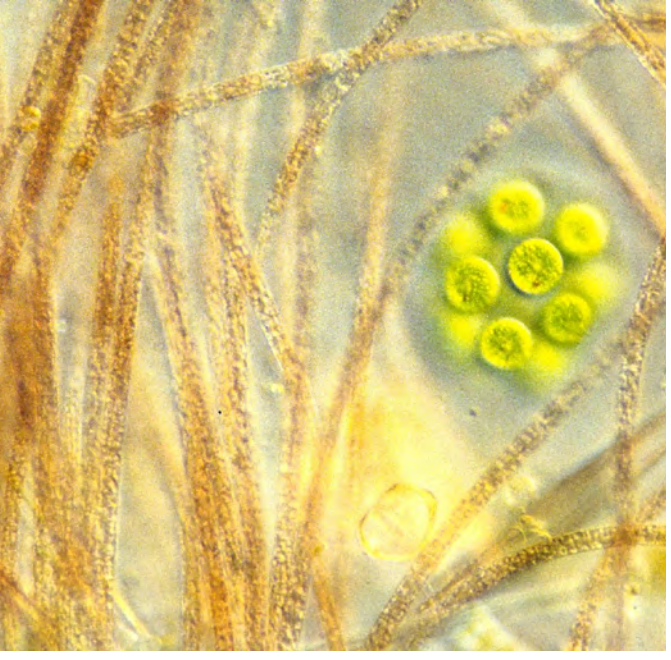


Photo: Kreinitz

The red cell filaments of Planktothrix rubescens *next to* Pandorina sp.*, a green alga.*

Photo: David Ausserhofer

"Cyanobacteria can adapt very quickly to changing environmental conditions."

Dr Stella Berger

Photo: David Ausserhofer/IGB

Photo: David Ausserhofer/IGB

Several prymnesium cultures (here the UTEX 2979 strain from Texas) grow in the laboratory under controlled conditions. Researchers are studying how different salt and nutrient concentrations affect growth. The algae strains can also be sequenced for genetic analysis and used for toxicity tests.

front," said Karla Münzner. Vegetated buffer strips between fields and water bodies can bind a large proportion of nutrients. It can also help to introduce aquatic plants, which take away some of the light needed by algae and reduce nutrients, or to plant trees along the banks to provide shade.

NEW INSIGHTS INTO GOLDEN ALGAE IN THE ODER RIVER

The major fish kill in the Oder River in the summer of 2022 demonstrated the potential impact of toxic algae on a river ecosystem. According to IGB research, the golden algae *Prymnesium parvum* proliferated there again in 2024. "This was due to similar conditions as in 2022: there are still a lot of nutrients in the Oder, and the conductivity, i.e. the salt content, increased again. The big difference to 2022 was that the river was flowing faster," remarked Karla Münzner. The researchers have not yet found out why the algae were not toxic this year. "We suspect that they were less stressed in 2024," stated the biologist. New insights into the golden algae are also provided by the decoding of its entire genetic material, the genome. In the genome sequence of the type of algae found in the Oder River, an IGB team has identified genes that play an important role in toxin production (p. 9). On

Photo: David Ausserhofer/IGB

"In 2024, we had similar conditions as in 2022. The big difference to 2022 was that the river was flowing faster."

Dr Karla Münzner

this basis, Karla Münzner can carry out laboratory tests to determine whether these genes show increased activity when the algae produce their toxins (prymnesins), or under which conditions the activity is low or no toxin is produced. These findings could also contribute to an early warning system for future blooms.

TRACKING DOWN TOXIC CYANOBACTERIA ON WATER PLANTS IN LAKE TEGEL

Toxic organisms are also the focus of a team led by Sabine Hilt, which is exploring cyanobacteria-covered aquatic plants in Lake Tegel, north of Berlin. Since 2017, several dogs have died there after coming into contact with water moss that was washed ashore. "It was covered with cyanobacteria, which are not suspended in the water," reported Sabine Hilt. The water moss has no firm roots and can drift. It was the toxin

Photo: Andreas Jechow/IGB

Aerial view during the large-scale experiment at the IGB LakeLab.

Brown lakes, blue-green algae?

Not only higher temperatures, but also extreme weather events can disrupt the stratification of deep lakes, leading to increased algal blooms, especially of toxic cyanobacteria. However, as experiments at the IGB LakeLab have shown, the input of terrestrial substances can also slow down the growth of blue-green algae by browning lakes with humic substances because less light is available in the water column for photosynthesis. Compared to lakes rich in humic substances, clear water lakes are more sensitive to nutrient pollution and can develop algal blooms at lower phosphorus concentrations. These findings may help to adapt nutrient thresholds to lake types in order to better control blue-green algal blooms.

Lyche Solheim et al. (2024) Lake browning counteracts cyanobacteria responses to nutrients: Evidence from phytoplankton dynamics in large enclosure experiments and comprehensive observational data. Global Change Biology. https://doi.org/10.1111/gcb.17013

anatoxin produced by the cyanobacteria that killed the dogs.

At first it was thought to be a random, one-off phenomenon. But the toxic cyanobacteria on the aquatic plants have appeared every year since, and some shores of Lake Tegel have even had to be temporarily closed. In a joint project involving experts from the Federal Environment Agency, Technische Universität Berlin and the Leibniz Research Centre for Working Environment and Human Factors, Sabine Hilt wants to investigate the ecology of the organisms that grow on the plants and clarify the conditions that lead to the emergence of plant-associated toxic cyanobacteria in lakes. "Our aim is to enable better risk assessment. We are also gathering information on this little-studied association, which has also been found in other countries," she stated.

What seems clear so far is that there are several variants of these cyanobacteria with different toxin patterns. Hotspots are also formed in the lake: "The toxic biofilm is not evenly distributed in a lake, there are places with high concentrations," explained Sabine Hilt. This makes monitoring and sampling more difficult because even if no toxic material is found in one place, the situation may be completely different a few metres away.

POTENTIAL USE OF CYANOBACTERIA

"Whether there will be more cyanobacterial blooms in the future or whether such blooms will decrease due to improved management of water bodies and their catchments is currently under discussion," commented Stella Berger. There is general agreement that increased nutrient inputs and warming waters favour the development of cyanobacterial blooms, which can be toxic. In addition to climate change, the rapid growth of the world's population also plays a role. However, there are also some positive prospects: novel concepts for the use of cyanobacteria in the field of cancer research are currently being investigated. "We also need innovative and solution-oriented projects in the field of freshwater ecology to preserve our water bodies for future generations," stated Stella Berger.

Text: Wiebke Peters

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Find out more at www.igb-berlin.de/en:

- What can stop blue-green algae blooms? | IGB
- Toxic waste: cigarette butts harm the environment twice | IGB
- A chemical cocktail of micropollutants amplified the effect of algal toxins causing mass fish mortality on the River Oder in 2022 | IGB
- Cyanobacterial blooms also like it cold – and not exclusively warm | IGB

Kuhl et al. (2024) The haplotype-resolved *Prymnesium parvum* (type B) microalga genome reveals the genetic basis of its fish-killing toxins. Current Biology. https://doi.org/10.1016/j.cub.2024.06.033

Köhler et al. (2024) Unpredicted ecosystem response to compound human impacts in a European river. Scientific Reports. https://doi.org/10.1038/s41598-024-66943-9

Harris et al. (2024) What makes a cyanobacterial bloom disappear? A review of the abiotic and biotic cyanobacterial bloom loss factors. Harmful Algae. https://doi.org/10.1016/j.hal.2024.102599

Reinl et al. (2023) Blooms also like it cold. Limnology and Oceanography Letters. https://doi.org/10.1002/lol2.10316

Otto et al. (2023) Tracking a broad inventory of cyanotoxins and related secondary metabolites using UHPLC-HRMS. Journal of Hazardous Materials Advances. https://doi.org/10.1016/j.hazadv.2023.100370

Photo: shutterstock 1896646831

Rivers as CO_2 sources

High nutrient levels and rising temperatures accelerate the decomposition of organic matter in rivers, thereby increasing CO_2 emissions. This is the conclusion of the international CELLDEX (CELLulose Decomposition EXperiment) consortium, in which IGB researchers are involved. In a global study, the team mapped decomposition rates in freshwater ecosystems, including areas such as the tropics that have been underrepresented in prior studies. The study used data from 550 rivers, based on standardised tests with small strips of cotton fabric. Using machine learning algorithms, the researchers identified temperature and nutrient concentration as the key drivers of decomposition. The results are available through an online tool that shows how quickly different types of leaves are decomposing in specific rivers.

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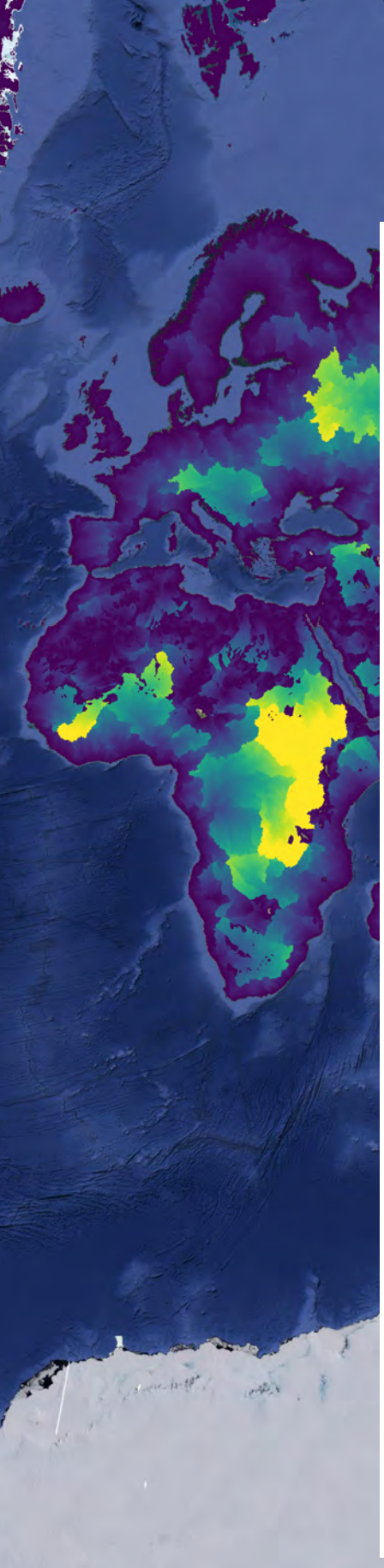
Researchers map stream ecosystems as sources of CO_2 | IGB

Tiegs et al. (2024) Human activities shape global patterns of decomposition rates in rivers. Science. http://dx.doi.org/10.1126/science.adn1262



Predictive Ecology in the Anthropocene

IGB launches new programme area

Questions to 3 experts

Global change poses immense challenges to our society – particularly with regard to the sustainable use and protection of our lakes, rivers and wetlands. Drught, flooding, changing land use, and ongoing urbanisation are having a dramatic impact on the quality and availability of water resources and the state of freshwater ecosystems. To better understand and address these challenges, IGB has launched a new, visionary programme area: Predictive Ecology in the Anthropocene. As a result, additional expertise will be built up in at least eight new research groups. Three of these groups are already up and running. We asked them what topics they are focusing on and what challenges they face in the process.

Global datasets are used, for example, to model river basins, runoff and potential impacts on biodiversity. Image: Sami Domisch/IGB

DR SAMI DOMISCH

You are one of the speakers for the new programme area and your group is conducting research on global freshwater biodiversity. In order to be able to predict changes, species and habitats must first be documented. This is particularly challenging underwater. What approach do you take?

Our group takes the spatial approach, because the spatial distribution of species is usually the most basic and best-available information: where do species occur, and what factors contribute to their distribution? There are two caveats to answering these questions: first, freshwater biodiversity monitoring is unevenly distributed around the world, which means that such species occurrence data first needs to be mobilised or even digitised for further analysis. Secondly, and perhaps even more fundamentally, we need standardised information on the distribution of freshwater bodies worldwide, together with environmental information describing their characteristics. We focus on such data mobilisation and data generation on a global scale. By combining these two approaches, we perform biogeographic analyses of spatial freshwater biodiversity in different parts of the world. These analyses can then be used, for example, to detect changes in species distributions, to identify possible environmental factors contributing to such changes, to assess differences in taxonomic or functional biodiversity, or to use spatial prioritisation to identify areas that are important for supporting freshwater biodiversity.

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DR ANNE MCLEOD

You recently established the new Computational Ecology research group at IGB. What challenges and opportunities do you see for the use of such methods in ecological research, particularly in terms of better predictions?

We are in the midst of a data revolution, where it is becoming easier and easier to obtain and analyse data, whether from remote sensing, permanent in-situ sensors or R packages. More data is not necessarily better data, just as the use of remote techniques is not a replacement for fieldwork, but rather a complement. Luckily, we are seeing simultaneous improvements in computing power and computer-based methods that are accessible to ecologists. This means you don't need a degree in computer science to work with a multitude of data sources, from satellite imagery to routine water quality surveys. Instead, we can focus on being ecologists, because the reading and research still needs to be done – there are no large datasets or sophisticated analyses to overcome poorly thought-out questions and ill-defined hypotheses. However, the combination of increasing computing power, open-source science, and high-resolution data is very exciting for predictive ecology. It means we can be more ambitious with our predictions, balancing our longer-term expectations and models of equilibrium dynamics with short-term iterative forecasts, similar to those used in meteorology, where models are continually tested, updated, and improved as new data becomes available and further insights are gained.

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DR DANIEL STOUFFER

You study complex systems ecology, such as the emergent phenomena that arise from interactions between species. How do theoretical and data-driven approaches help unravel these dynamics?

In ecology, essentially everything is connected. Just as what happens in one place can ripple through to another, something that happens to one population can percolate through a community both directly (e.g. to the predator of that species) and indirectly (e.g. to a 'superpredator' of that predator). For more than a century, ecologists have used mathematical models to try to better understand the consequences of these direct and indirect interactions, in particular to explore what makes a community stable or resilient to disturbance. Despite this rich history, there are still many unknowns regarding the extent to which such models match what happens between real species in the laboratory or in the field. To conserve biodiversity in the face of global change, practitioners will ultimately need specific insights tailored to specific systems of interest, and we expect these will shine brightest when they are guided by theory. In our group, we therefore combine data with theory to develop more realistic mathematical models, while striving to make these models tractable enough to be applied to diverse real-world communities. Indeed, theory can also help us to make the best use of all the hard-won data at our disposal, and can provide crucial predictions for phenomena that we have never really been able to test experimentally or quantify observationally.

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Questioned by Angelina Tittmann.
Photos: David Ausserhofer/IGB

Find out more at www.igb-berlin.de/en:

- www.igb-berlin.de/en/domisch
- www.igb-berlin.de/en/mcleod
- www.igb-berlin.de/en/stouffer
- Programme areas | IGB

Micropollutants amplify the effect of algal toxins

In the summer of 2022, around 1,000 tonnes of fish, mussels and snails died in the River Oder. Although the disaster was man-made, the immediate cause of death was the toxin of a microalgae with the scientific collective name *Prymnesium parvum*, often referred to as 'golden algae'. An international research team, to which IGB contributed, identified more than 120 organic micropollutants in the river water at the time of the disaster – all (unfortunately) typical of European rivers. The scientists investigated whether these substances play a role in harming aquatic organisms. And it turns out that the high concentrations of organic micropollutants exacerbated the lethal effects of the algal toxins.

DR STEPHANIE SPAHR, stephanie.spahr@igb-berlin.de
DR JÖRN GESSNER, joern.gessner@igb-berlin.de

A chemical cocktail of micropollutants amplified the effect of algal toxins causing mass fish mortality on the River Oder in 2022 | IGB

Escher et al. (2024) Mixtures of organic micropollutants exacerbated in vitro neurotoxicity of prymnesins and contributed to aquatic toxicity during a toxic algal bloom. Nature Water. http://dx.doi.org/10.1038/s44221-024-00297-4

Photo: Luc De Meester/IGB

Professor Robert Arlinghaus

IGB researcher Robert Arlinghaus has been honoured with the Research with Responsibility science award by Stifterverband for his work on the ecological, economic and social aspects of recreational fishing. This science award is conferred on the recommendation of the Leibniz Association for outstanding research achievements.

PROFESSOR ROBERT ARLINGHAUS, robert.arlinghaus@igb-berlin.de

- Research in Responsibility | IGB

Professor Mina Bizic

IGB researcher Mina Bizic has been appointed to the Chair of Environmental Microbiomics at Technische Universität Berlin. As already at IGB, she will study the smallest organisms in water, i.e. bacteria, viruses, fungi and phytoplankton. She focuses not only on the individual organisms, but also on their interactions.

PROFESSOR MINA BIZIC, mina.bizic@igb-berlin.de

- "They are in every drop of water on our planet" | IGB

Professor Michael Hupfer

IGB researcher Michael Hupfer has been elected as a member of the Leibniz-Sozietät der Wissenschaften zu Berlin e.V. in recognition of his scientific achievements in the field of aquatic ecology and his commitment to water protection. He has also been appointed to the Scientific and Technical Advisory Board on Water Management Measures of the Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft mbH (LMBV).

PROFESSOR MICHAEL HUPFER, michael.hupfer@igb-berlin.de

- Michael Hupfer elected member of the Leibniz-Sozietät der Wissenschaften zu Berlin | IGB
- Michael Hupfer appointed to the Scientific and Technical Advisory Board of the LMBV | IGB

Dr Nedim Tüzün

Postdoctoral researcher Nedim Tüzün's new research project ECO-EVO ALAN is funded by a Marie Skłodowska-Curie Action. The project focuses on how artificial light at night (ALAN) affects aquatic ecosystems, in particular urban ponds.

DR NEDIM TÜZÜN, nedim.tuezuen@igb-berlin.de

- IGB researcher Nedim Tüzün receives MSCA grant from the EU | IGB

Photos: Stefan Klenke (1), David Ausserhofer/IGB (3), private (1)

Professor Dörthe Tetzlaff

Dörthe Tetzlaff has been awarded the Rüdiger Kurt Bode Foundation's Water Resources Award 2024 for her pioneering research on the interactions between climate, land use, water quality and the ecohydrological processes that control water dynamics in landscapes. She also received the Polubarinova-Kochina Hydrologic Sciences Mid-Career Award from the American Geophysical Union (AGU), named after a pioneer in theoretical hydrology. The award recognises the innovative work of mid-career scientists, their achievements in supervision and mentoring, and the societal relevance of their work. Dörthe Tetzlaff was also named one of Berlin's "Top 100 Minds in Science" by the Tagesspiegel newspaper.

PROFESSOR DÖRTHE TETZLAFF, doerthe.tetzlaff@igb-berlin.de

- Dörthe Tetzlaff receives the Water Resources Award 2024 | IGB
- Dörthe Tetzlaff honoured with Polubarinova-Kochina Hydrologic Sciences Mid-Career Award | IGB

Also honoured

Luc De Meester, Jens Krause, Hans-Peter Grossart, Mark Gessner, Robert Arlinghaus and **Jonathan Jeschke** are among the 100 most cited researchers in the field of ecology and evolution in Germany. They were honoured with the Ecology and Evolution in Germany Leader Award.

Oleksandra Shumilova has been selected as a founding member of the Young Network TransEurope established by the Berlin-Brandenburg Academy of Sciences and Humanities (BBAW). The network brings together outstanding young and mid-career scholars from different academic fields and diverse European regions, whose research addresses emerging challenges to prosperity, freedom and democracy in Europe.

Early-career scientist **Songjun Wu**, a member of the research group led by Dörthe Tetzlaff, has been awarded the 2024 Dissertation Prize of the German Hydrological Society. His dissertation is entitled "Tracer-aided modelling of hydrological and biogeochemical processes in mixed land-use, lowland catchments".

Olga Lukyanova has been awarded one of three Interdisciplinary Aquatic Ecosystem Research Awards by the Water Science Alliance e. V. and the Center for Water and Environmental Research at the University of Duisburg-Essen for her master's thesis entitled "Biotelemetry-based study of northern pike (*Esox lucius*) movement in the Southern Baltic Sea: space use, connectivity, and implications for conservation and management".

Lisa Grof received the same award for her bachelor's thesis on "Impacts of beaver population changes on hydrological processes in a lowland catchment in Brandenburg, Germany". The award is worth €500.

Phillip Roser has been awarded the Thaer Master's Degree Award from Humboldt-Universität zu Berlin for his master's thesis on angling-induced timidity in pike.

A team of authors including **Martin Pusch** has been awarded the publication prize of the Association of Engineers for Water, Waste and Cultural Heritage Management (BWK) for a study on the ecological impact of hydroelectric power plants.

Stephanie Spahr has been honoured with the Outstanding Review Award for an article on urban stormwater in the journal *Environmental Science: Water Research & Technology*.

Angelina Tittmann has been elected to the spokesperson team of the Leibniz Association's Communications Working Group.

Review of the year 2024

PROJECT LAUNCH

APRIL Urban ponds are becoming increasingly important as nature-based solutions for managing climate-related hydrological risks while promoting biodiversity and human well-being. The *POUNDER* project investigates pollution, eco-evolutionary dynamics and factors that improve the resilience of these ecosystems.

DR STEPHANIE SPAHR
DR LYNN GOVAERT

MAY The aim of the *HaffStör* project is to investigate the habitat utilisation of Baltic sturgeon in the Szczecin Lagoon and the Lower Oder and to determine the factors influencing their survival during migration to the Baltic Sea.

DR JÖRN GESSNER

JUNE From waste to resource: The *CYCLOLIVE* project focuses on the recycling of by-products from olive oil production and their impact on aquatic ecosystems.

DR JENS C. NEJSTGAARD
DR STELLA A. BERGER

www.cyclolive.eu

SEPTEMBER The BMBF-funded *DIVATOX-2* project is investigating the diversity of aquatic plants and associated neurotoxic cyanobacteria and their impact on human and animal health.

DR SABINE HILT
DR SVEN MEISSNER

SEPTEMBER The new DFG research group *PlantsCoChallenge*, led by Kiel University with the participation of IGB, is investigating the physiological and evolutionary adaptation of plants to interacting abiotic and biotic factors.

DR SABINE HILT

Photo: Christian Birkel

NOVEMBER The *ECCO* project aims to understand how climate variability and changes in land cover affect the eco-hydrological distribution of water in the soil-plant-atmosphere continuum.
PROFESSOR DÖRTHE TETZLAFF

DECEMBER The EU-funded OSCARS project *AQUANAVI* is developing a navigation platform representing aquatic mesocosm facilities and their research, providing points of contact and knowledge for future experiments and collaborations.
DR TINA HEGER
DR STELLA A. BERGER
PROFESSOR JONATHAN JESCHKE
DR JENS C. NEJSTGAARD

ADVICE

FEBRUARY A new *IGB Fact Sheet* summarises the current state of scientific knowledge on the toxic brackish water alga *Prymnesium parvum* in a generally understandable way. The alga played a central role in the summer of 2022, when a man-made environmental disaster occurred in the River Oder. The researchers explain countermeasures that can be taken to prevent or contain toxic *Prymnesium* blooms in the Oder and other water bodies, e.g. by reducing salt and nutrient discharges.
DR STELLA A. BERGER
DR JÖRN GESSNER
DR JAN KÖHLER
DR KARLA MÜNZNER
DR JENS C. NEJSTGAARD
DR MARTIN PUSCH
DR MATTHIAS STÖCK
DR CHRISTIAN WOLTER
DR SVEN WÜRTZ

MARCH IGB researchers provide feedback in the EU Consultation on the Nitrates Directive. They emphasise that the framework legislation is appropriate from a scientific point of view, but that the existing problems are mainly due to the lack of practical implementation in the Member States – a parallel to other EU legislation such as the Water Framework Directive. However, a possible opening and revision of the Nitrates Directive should in no way lead to a further weakening of the limit values and regulations, but rather strengthen them and promote practical implementation.

DR MARKUS VENOHR
DR JAN KÖHLER

- IGB Feedback on EU Consultation "Protecting waters from pollution caused by nitrates from agricultural sources"

MARCH 64 experts, including many IGB researchers, publish the "10 must-knows from biodiversity research" for 2024. With the new report, the Leibniz Research Network on Biodiversity shows policymakers and society concrete ways to effectively conserve biodiversity at the local, national and European level and to use it sustainably while protecting the climate.

DR SIBYLLE SCHROER
PROFESSOR HANS-PETER GROSSART
DR FRANZ HÖLKER
PROFESSOR MICHAEL T. MONAGHAN

- 10 must-knows from biodiversity research 2024

APRIL In a consultation organised by the Federal Ministry for the Environment, IGB provides feedback on the draft bill to amend the Water Resources Act (WHG), which aims to regulate the reuse of municipal wastewater for agricultural irrigation. As the research-based assessment emphasises, the precautionary principle should play a key role in the reuse of water resources, as the standards of wastewater technology currently in use are not sufficient to rule out long-term damage to ecosystems.

DR TOBIAS GOLDHAMMER
PROFESSOR HANS-PETER GROSSART
DR JÖRG LEWANDOWSKI
CHRISTOPH REITH
DR STEPHANIE SPAHR
PROFESSOR DÖRTHE TETZLAFF
PROFESSOR WERNER KLOAS

- Municipal wastewater in agricultural irrigation | IGB

APRIL IGB researchers developed vertical wetlands in collaboration with the specialist engineering company WITE GmbH. These planting modules provide a transferable and scalable way to create minimal habitats along remote and artificial waterways, providing ecological stepping stones for various species to stay and migrate. Information on the construction method and authorisation requirements was published in the new *IGB Manual* publication format.

DR CHRISTIAN WOLTER

- Vertical wetlands: ecological stepping stones for urban waters | IGB

MAY In an EU Consultation, IGB researchers provide feedback on the use of so-called renure fertilisers in agriculture, which are obtained by processing and converting animal manure. In their assessment, they stress that the current nitrate limits should be respected as a matter of urgency and that renure fertilisers should not benefit from any exemptions. The current limit of 170 kg nitrogen per hectare should therefore be regarded as a maximum value that is only acceptable if it is applied in areas with sufficient denitrification potential in soils and groundwater.

DR MARKUS VENOHR
DR JAN KÖHLER

EU Consultation IGB Feedback Nitrate Directive Renure

JUNE Near-natural moors and floodplains protect the climate by storing carbon. However, around 94 per cent of Germany's peatlands have been drained and almost all floodplains have been cut off from rivers. This is why the German National Academy of Sciences Leopoldina has published the statement "Climate – Water Balance – Biodiversity: Towards an integrated utilisation of peatlands and floodplains". The researchers involved, including some from IGB, emphasise the urgent need to rewet peatlands and renaturalise floodplains, and identify options for action to reconcile protection and use.

PROFESSOR DÖRTHE TETZLAFF

Moors and floodplains

AUGUST DrChristoph Donner, CEO of Berliner Wasserbetriebe, meets IGB researchers as part of his "Water Dialogue Tour". At the Erpe River, where IGB is researching the interaction between groundwater and surface water, they discuss Berlin's water balance and the challenges of drinking water production.

CHRISTOPH REITH
DR STEPHANIE SPAHR

SEPTEMBER Lakes are essential elements of the landscape, but are subject to a wide range of utilisation demands and pressures. Eutrophication, in particular, can be a major disturbance that often requires complex and costly measures to eliminate or minimise. Lake therapy must also increasingly take into account the consequences of the climate crisis, as water quality is increasingly influenced by water quantity problems and numerous effects of climate change. The DWA leaflet "Basics and measures of lake therapy" was extensively revised with the involvement of IGB and provides an overview of the methods and options available for treating eutrophic lakes.

PROFESSOR MICHAEL HUPFER

OCTOBER The "Biodiversity Fact Check" is presented, providing a comprehensive analysis of the state of biodiversity in Germany, highlighting major trends in species decline and making specific recommendations to halt the loss of biodiversity. IGB is involved in the water body and floodplain theme.

PROFESSOR SONJA JÄHNIG

- www.feda.bio/en/faktencheck-artenvielfalt

DECEMBER Ponds are particularly important for biodiversity conservation. Due to their abundance, heterogeneity, exceptional biodiversity and biogeochemical potential, they play a crucial role in catchment areas and landscapes. The EU *PONDERFUL* project has developed, among other things, a policy guide and a technical manual to promote and facilitate the use of ponds and pond landscapes as nature-based solutions.

DR THOMAS MEHNER

DR SABINE HILT

- Ponderful Technical Handbook and Policy Guidance Document
- Page 6

EVENTS

JANUARY – DECEMBER IGB'S two travelling exhibitions on light pollution and migratory fish visit 14 schools, nature park centres, town halls and other public institutions across Germany throughout the year. From 2025, additional content on the River Oder will also be available. Borrowing is free of charge.

NADJA NEUMANN

DR SARAH KIEFER

- Travelling exhibitions | IGB

Photo: Angelina Tittmann/IGB

APRIL From "Yuck! to Ohhh" is the motto for 12 students on Girls' and Boys' Day at IGB. They learn about the important role insects play in our ecosystems and why we need to protect them better from light pollution. The girls and boys also see how a water sample is taken, and analyse it themselves. The boat takes them out to the measuring station on Lake Müggelsee.

NADJA NEUMANN

MAY On the International Day for Biological Diversity, IGB participates in the Leibniz Biodiversity Research Network's virtual webinar on the 10MustKnows24. Four lead authors of the report present key findings on climate and biodiversity, undiscovered biodiversity, linguistic, cultural and biological diversity as well as transnational cooperation and education for sustainable development. The webinar is available online.

DR SIBYLLE SCHROER

- Exploring the "10 Must Knows from Biodiversity Science 2024" | Future Earth

JUNE On behalf of the Federal Agency for Nature Conservation, IGB is developing regulatory approaches to protect plants and animals from light emissions. People who create, plan or design lighting are invited to several workshops. They discuss how lighting can be regulated to minimise the impact on animals and plants.

DR SIBYLLE SCHROER
DR FRANZ HÖLKER

JUNE Together with the Leibniz Biodiversity Research Network, IGB is represented at Environment Week 2024. A specialist forum, interactive games and a virtual adventure in biodiversity allow visitors to understand the scientific work from the different perspectives of the 18 partner institutes in the network.

DR SIBYLLE SCHROER

Photo: Katja Czerwinski

JUNE What is green and floats in the water? Visitors young and old can find out at the Nature Discovery Day in Kienbergpark. Numerous families from Marzahn-Hellersdorf and other Berlin districts take the opportunity to identify native aquatic plants, marvel at how mussels filter, and test their knowledge of different types of fish and algae. The bravest grabbed a landing net and a magnifying glass and examined insects and leeches in the small water bodies on site.

NADJA NEUMANN
ANGELINA TITTMANN

JUNE At *The Nature of Cities (TNOC)* Festival, IGB researchers, experts and decision-makers hold a session dedicated to the complex relationships between biodiversity and human health in urban areas.

PROFESSOR JONATHAN JESCHKE

- TNOC Festival 2024: Untangling the Interconnectedness of Biodiversity and Human Health

JUNE Around 70 teachers from primary and secondary schools attend the conference entitled “Urban nature and education for sustainable development” organised by Campus StadtNatur. IGB offers two workshops on river ecosystems, where participants not only learn exciting facts about rivers and their organisms, but can also take away specific ideas for school projects and excursions.

ANGELINA TITTMANN
NADJA NEUMANN

All materials for teaching | IGB

SEPTEMBER Children go to university: Schoolchildren are invited to the Berlin Transfer and Science Festival *Transferale*. IGB gives a lecture on “Fascinating fish”, which can make noises, change sex and have other amazing characteristics.

NADJA NEUMANN

Photo: OderHive

SEPTEMBER The boundaries between art and science merge in a format consisting of an installation, concert and discussion. With *OderHive*, the Berlin-based artist collective *FrauVonDa//* opens ears, eyes and minds to the underwater world of the River Oder, bringing the sounds, vibrations and images of this diverse habitat ashore. IGB researchers, whose work on the river was closely followed, provide inspiration and enter into dialogue with the audience.

DR GABRIELA COSTEA
DR CHRISTIAN WOLTER

OCTOBER The DOKUMENTALE, Berlin’s documentary and media festival, offers an exciting selection of films on art, nature, science and social issues. Among the films is the documentary *Hidden Dance of Eels*, which follows researchers in their search for the exact birthplace of eels. In a round table discussion, IGB provides background information on the unique lifestyle of this species.

DR FABIAN SCHÄFER

Secrets of nature

OCTOBER The performance *Endemité*: Tales of Disappearance, which premiered in Berlin and Prague, tells the story of shrinking lakes, talking fish and the hopeless search for answers. It was preceded by exploratory sessions between the *Futur II Konjunktiv* theatre group and IGB researchers.

NADJA NEUMANN
ANGELINA TITTMANN

- Ufer des Verschwindens | FUTUR II KONJUNKTIV

OCTOBER IGB offers a teachers' workshop on the topic of migratory fish on Science Day for classes 5 and 6 at the Emmy Noether Grammar School in Berlin.

ANGELINA TITTMANN
NADJA NEUMANN

NOVEMBER Lake Stechlin has been at the centre of limnological research for 65 years. To mark this special anniversary, IGB, together with guests from science, administration, politics, business, alumni and citizens, takes a look back at the history and a look forward to the future of limnology at Lake Stechlin.

PROFESSOR MARK GESSNER

NOVEMBER As part of the *CCC Climate Science Days*, IGB presents current research on ecohydrological scenario modelling and climate adaptation in Berlin and Brandenburg.

PROFESSOR DÖRTHE TETZLAFF

- Ecohydrological scenario modelling & climate adaptation | Climate Change Center

Photo: C. Laschitzki

NOVEMBER What do communities in and around rivers look like? As part of Berlin Science Week 2024, IGB researchers, artists and the public immerse themselves in the diverse habitats of the Oder and Spree rivers. Four formats offer insights into the fragile balance of ecosystems, the delicate relationships between species, human responsibility and the unifying power of art and science.

ANGELINA TITTMANN
NADJA NEUMANN

- Art and science open up new perspectives on the interplay between humans and nature | IGB

Photo: Fritz Feldhege/IGB

NOVEMBER The first results of the *Waidgerecht* project are presented to the angling public at ANGELWELT Berlin. The project is developing knowledge-based recommendations for the more humane and fish-friendly release of fish for all relevant species in Germany.

PROFESSOR ROBERT ARLINGHAUS

Photo: FrauVonDa//

DECEMBER Art and science in the carriage: on the cultural train from Berlin to Wroclaw, a soundscape of environmental noises and diary entries blends with live compositions and free improvisations by the artist collective *FrauVonDa//*. IGB researchers contribute their knowledge of the River Oder and its biocoenoses to the *OderHive*.

DR CHRISTIAN WOLTER

GUESTS

JANUARY "Research Diversity in Berlin" is the name of a supporting event organised by Freie Universität Berlin to introduce students to possible careers in the fields of biology, chemistry and pharmacy. Around 20 students get an insight into the work of IGB.

DR LYNN GOVAERT

DR MARIA MAGDALENA WARTER

APRIL | JUNE Schoolchildren explore microorganisms: Müggelheim Primary School and the Karlshorst Creativity School look through a microscope on Water Project Day and observe the diversity of life in a drop of water.

NADJA NEUMANN

ANGELINA TITTMANN

Photo: Angelina Tittmann/IGB

MAY Together with Federal Environment Minister Steffi Lemke, researchers from IGB and the Mecklenburg-Western Pomerania State Research Institute for Fisheries stock around 600 young Baltic sturgeon into the Oder as part of the reintroduction programme.

DR JÖRN GESSNER

- 600 Baltic Sea sturgeons released into the River Oder | IGB

JUNE At the exchange meeting between the Berlin Plant Protection Office and IGB researchers, common topics are quickly identified: How does light pollution affect insects and the annual cycle of urban trees, and what is the current state of Berlin's landscape water balance?
DR MARIA MAGDALENA WARTER
DR GREGOR KALINKAT

JULY Choosing the right apprenticeship is not easy for schoolchildren. Students at the Wilhelm-Bölsche-Schule in Friedrichshagen learn from our biology lab technician trainer about the exciting career prospects in environmental research.
WIBKE KLEINER

Photo: Lego Robotics AG/Archenhold Gymnasium

JULY Have you heard of the Lego League? The international educational programme of the American foundation FIRST (For Inspiration and Recognition of Science and Technology) and LEGO aims to inspire schoolchildren to take up STEM subjects. This year's theme brings participants to IGB to compete for the best building block solution to a water-related problem.
DR JÖRG LEWANDOWSKI

SEPTEMBER 45 Guests from the Julius Kühn Institute come to IGB, as there are a number of points of contact with the topic of crops: Aquaponics research, for example, or the role of blue and green infrastructure in the face of scarce water resources in a city like Berlin.
DR MARIA MAGDALENA WARTER
PROFESSOR WERNER KLOAS

SEPTEMBER The excursion "Oh radiant Stechlin", which is part of an artistic research project of the new Gesellschaft der bildenden Künste Berlin (nGbK), leads to the IGB site in Neuglobsow. Guests learn interesting facts about climate impact research on Lake Stechlin and the surrounding lakes.
DR SABINE WOLLRAB

SEPTEMBER One hundred young European sturgeon (*Acipenser sturio*) are released into the River Elbe near Magdeburg in the presence of Federal Environment Minister Steffi Lemke as part of the reintroduction programme. They are the first sturgeon offspring for the river since 2015.
DR JÖRN GESSNER

- Species conservation: First sturgeon offspring since 2015 released into the Elbe River | IGB
- Page 7

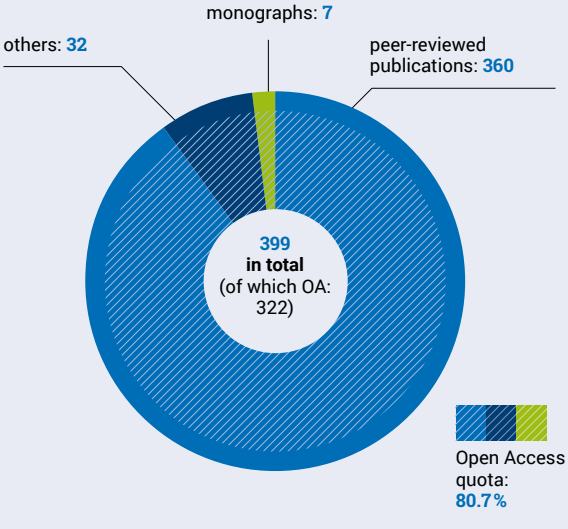
2024 in numbers

FINANCES

Overall budget	**€ 25,928,363**
Proportion of third-party funding*	**38 %**
Institutional funding from the federal government	**€ 16,295,900**
of which core budget	€ 15,677,000
of which Leibniz Competition levy	€ 177,000
of which for major construction projects	€ 50,000
Third-party funding**	**€ 9,519,950**
of which from the DFG	€ 3,036,601
of which from the EU	€ 2,054,035
of which from the federal government	€ 2,917,603
of which from the federal states	€ 182,316
of which from the Leibniz Competition	€ 380,825
of which from other public funding	€ 436,664
of which from foundations	€ 504,329
of which from non-public funding	€ 7,578
Other earnings	**€ 64,256**
Externally managed third-party funds	**€ 652,680**

* related to the core budget
** on an earnings basis

PUBLICATIONS



INTERNATIONALITY

55.9 %
scientists

5.2 %
science supporting staff

Scientific highlights:
www.igb-berlin.de/en/selected-publications

JANA RUMLER
library@igb-berlin.de

INSTITUTE MEMBERS

145
scientists including
35 leading scientists
50 postdoctoral scientists
36 doctoral candidates

127
science supporting staff
including
3 apprentices
24 student assistants

33
scholarship holders
including
5 postdoctoral scientists
26 doctoral candidates

118
guests
including
26 postdoctoral scientists
17 doctoral candidates

423
in total

BY GENDER

Scientists:

40.7 %
women

58.6 %
men

0.7 %
diverse

Science supporting staff:

61.9 %
women

38.1 %
men

0 %
diverse

BY FUNDING

Scientists:

45.4 %
funded from core budget

54.6 %
third-party funded

Science supporting staff:

85.4 %
funded from core budget

14.6 %
third-party funded

To find out more about working at IGB, take a look at our website
www.igb-berlin.de/en/career

DEGREES & CO.

10
Bachelor theses

10
Master's theses

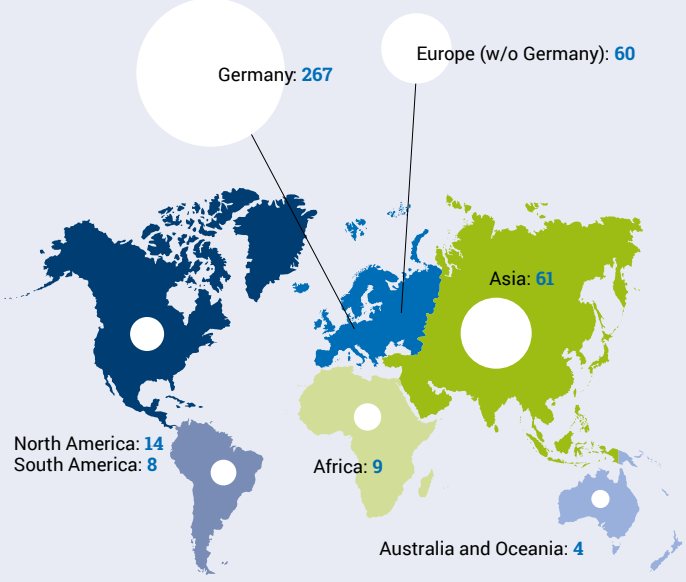
10
dissertations

PROFESSORSHIPS

9
joint professorships with
4 universities

2
honorary professorships with
2 universities

ORIGIN OF THE INSTITUTE MEMBERS



STATUS AS OF 31 DECEMBER 2024

Structure

Always up-to-date on our website:
www.igb-berlin.de/en/organisation

STATUS AS OF 31. DECEMBER 2024

Scientific Advisory Board

Chair

Gabriele Gerlach

Management

Director

Luc De Meester

Managing Director in the Forschungsverbund Berlin e.V.

Martin Böhnke

Staff units

Science Officer	Communications and Knowledge Transfer	Career Development	Sustainability Research
Ina Severin	Angelina Tittmann	Kirsten Pohlmann	Sibylle Schroer

Administration

Head of Administration: Gwendolyn Billig

Procurement, Finance, Personnel	Library	IT	Technical Services
Gwendolyn Billig	Jana Rumler	Christian Baal	Bernd Schubert

Research departments

1 Ecohydrology and Biogeochemistry	2 Community and Ecosystem Ecology	3 Plankton and Microbial Ecology	4 Fish Biology, Fisheries and Aquaculture	5 Evolutionary and Integrative Ecology
Dörthe Tetzlaff	Sonja Jähnig	Mark Gessner	Jens Krause	Jonathan Jeschke

Programme areas

PA1 Biodiversity in a Changing World	Justyna Wolinska | Franz Hölker
PA2 Ecosystem Services for a Sustainable Future	Martin Pusch
PA3 Dimensions of Complexity of Aquatic Systems	Tobias Goldhammer | Stephanie Spahr
PA4 Predictive Ecology in the Anthropocene	S. Domisch | L. Govaert | M. Venohr | S. Hilt

Representatives

Ombudsperson
Sami Domisch and Sabine Wollrab (deputy)

Equal Opportunities Officer
Kirsten Pohlmann and Justyna Wolinska (deputy)

Diversity Officer
Kirsten Pohlmann

Disability Representative
Torsten Preuer and Sylvia Kanzler (deputy)

Works Council
Wibke Kleiner (chair)

Animal Welfare Officer
Nadja Neumann

All members of the works council, and the representatives of doctoral candidates and postdocs on our website:
www.igb-berlin.de/en/organisation

Imprint

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

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We would like to thank all colleagues who contributed to this annual research report and supported us!

Publisher:
Forschungsverbund Berlin e. V., Rudower Chaussee 17, 12489 Berlin
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Responsible according to the German Press Law:
Professor Luc De Meester, Martin Böhnke

Responsible Institute:
Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB)

Register of Associations:
Forschungsverbund Berlin is entered in the Register of Associations of Amtsgericht Berlin-Charlottenburg (Berlin-Charlottenburg Local Court) under Register Number VR 12174 B.

Editorial staff: Angelina Tittmann
Translation: Teresa Gehrs | LinguaConnect
Design: Studio GOOD, Berlin

Printed by: dieUmweltDruckerei GmbH
Printed on Recycling Circle Offset Premium White.

DOI: https://doi.org/10.4126/FRL01-006510675

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