IGB

Leibniz Institute of
Freshwater Ecology
and Inland Fisheries

One Year of Freshwater Research

Annual Research Report 2020

Ecosystem services

How we can better protect and sustainably manage freshwaters

Biodiversity

How aquatic organisms survive and what threatens freshwater diversity

Global change

How ecosystems and biotic communities become more resilient

Angling

Aquaculture and Aquaponics

Biodiversity

Dialogue and Transfer

Freshwater Ecosystems

Use and Management

Multiple Stressors and Pollutants

Environmental Change

Behavioural Ecology and Swarm Intelligence

Water and Matter Cycles

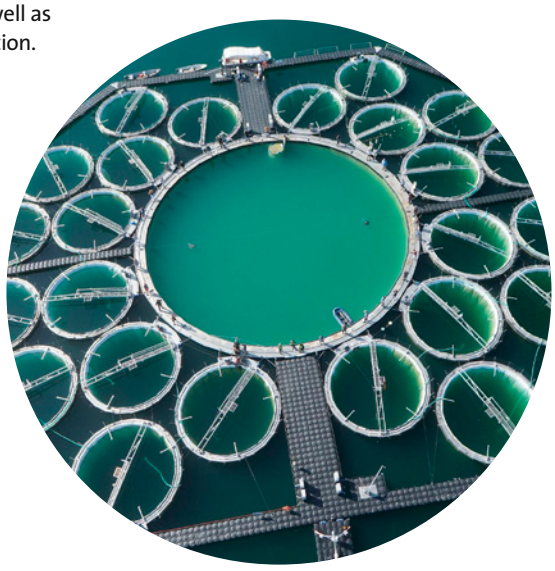
Research for the future of our freshwaters

IGB is the largest German and one of the leading international centres for freshwater research. Our vision is to understand aquatic systems in all their complexity and to use this research knowledge to support the sustainable management of water-based resources and ecosystems. We think: scientific findings gained through excellent research provide a basis for wise decisions. A better understanding of freshwaters and all their ecological aspects supports policy-makers and society in coping with global challenges and in managing and conserving water bodies for the benefit of people and nature.

On the following pages we present selected research findings and activities from 2020. They are allocated to ten topics, each of which contains all kinds of interesting information that we have compiled for you. For each topic, you will find further information, materials, experts as well as background information and the latest news on our website.

We hope you enjoy reading and exploring!

Contents



Dear Reader,

I did give it quite a bit of thought: coronavirus or no coronavirus in this preface? Do I really have to tell people that 2020 was the (first) coronavirus year, and that this also affected IGB? That suddenly things had to be done in another way? That I had pictured my first year at IGB somewhat differently? Well, I came to the conclusion that I cannot get around it, because the coronavirus did and will impact our research and how we think about crises.

For me, two words sum up the coronavirus period quite well: hope and despair. Hope, as we noticed that IGB's functioning was very resilient in coronavirus times – we were flexible in reorganising our work, developing protocols to deal with the pandemic, supporting people working from home, and keeping essential features functioning. Hope, as this reflects the professionalism and engagement of all staff. Yet, I would have liked to have started off my first year with a lot more options for personal meetings and engaged brainstorm sessions in larger groups – aspects of our work that did suffer from our screen-based way of working. I only had a few chances to sit down for lunch in one of the Institute's social rooms before IGB's corridors became very empty and quiet. And even though many people took the opportunity to dive into data analysis and writing, COVID-19 still deeply affected our research. As an ecological institute, we rely heavily on field work and experiments, including large-scale experiments with international guest scientists. And people who had just started their doctoral thesis or postdoc and needed to collect empirical data suffered a lot. We will feel this in the coming years. And sure, many colleagues had to juggle work and care duties more than before.

The global pandemic made many people aware of the importance of reliable scientific insights and advice. At the same time, two key challenges that the world is facing have temporarily slipped the radar somewhat – even though they are more imminent than ever: climate change, and the deep biodiversity and nature crisis. For me, 2019 and 2020 felt like two years in which climate change showed its ugly face even more than before – with the ever-increasing fires in California, Australia and the Amazon, the heat waves and the prolonged droughts, one temperature record after the other. It was devastating to see how

Photo: Portrait De Meester © David Ausserhofer

the Pantanal, the world's largest wetland and one of the most biodiverse systems worldwide, was burning. Freshwater systems are among the most threatened habitats in the world. Data show a steep decline of freshwater biodiversity in the last few decades. Not a pretty picture! These crises are likely to be more harmful than COVID-19. They impact us in a less acute way, but gradually are making the world a much less pleasant place to live. Their cumulative effect may make it more difficult to achieve the numerous societal reforms that are needed to reorganise our energy supply and massively reduce the pressure we put on natural systems.

But there is some hope. First, the pandemic may have led to an increased awareness that the globalised world is a fragile place, and it showed that it is actually possible to implement changes that, before, would have been considered impossible. Second, there is at least an intention to guide our economy towards more sustainability as it begins its reboot. Hopefully this will translate into more than a bit of nudging, but will represent a real push closer to a sustainable equilibrium with our global natural resources and the world's ecosystems. In this effort, it will be very important not to rely on technical solutions alone, but also to improve regulating ecosystem services, and thus foster resilience. Freshwaters play a key role in these regulating ecosystem services. IGB is happy to support this transition with its expertise.

On the following pages, we outline some of our results that encapsulate the major topics that are central to IGB's mission. They show some of the key scientific insights we have gained into how natural systems function and how they respond to stressors and management. The outlines also illustrate how important these insights and activities are to achieving the goals of sustainability.

Starting on → **page 9**, we focus on the ecosystem services of our rivers, floodplains and water-based resources. What phenomena are putting them under pressure, but also what can be done to conserve and sustainably manage them? Just one example: Europe's rivers are fragmented by not less than one million barriers, which, as one can imagine, have tremendous effects on their structure and function, and put many species at risk. Our findings are important in helping to reconcile the conflicting goals of inland navigation, energy generation, and food production on the one hand, and environmental protection and the conservation of nature and biodiversity on the other.

On → **page 19**, our attention turns to the drivers and consequences of aquatic biodiversity. Researchers at IGB unravel the mysteries and adaptation strategies of very different freshwater organisms – from giant bacteria like *Achromatium oxaliferum* to aquatic megafauna such as sturgeons. What enhances or threatens their diversity? Our work contributes to developing a scientific basis for taking greater account of freshwater biodiversity in national and international regulatory frameworks.

Global change and how it affects ecosystems and biotic communities is an important focus of research at IGB. Where is the water during a drought? Have we underestimated CO_2 emissions from dry inland waters? Can fungal parasites help to curb blooms of blue-green algae in increasingly warmer lakes? And how can phosphorus be retained in water bodies to avoid eutrophication? We present our latest findings on topics such as these starting on → **page 27**.

Research at IGB is rooted in the understanding that the results of scientific projects should generally become available to everyone who is interested in using them. This annual research report is one attempt – among many others – to achieve this. We will be happy if it generates some feedback from the scientific community and other stakeholders in society. And we will be even happier if it leads to new partnerships, and helps us translate our research knowledge into practice.

Speaking of practice, it has been a pleasure to collaborate with so many dedicated partners and stakeholders that have supported and inspired our research, teaching and transfer activities, and have made use of the knowledge generated by us. Which leads me to another acknowledgement: it is only thanks to the financial and practical support of Berlin's Senate Chancellery for Higher Education and Research and of the Federal Ministry of Education and Research (BMBF) that IGB can operate in the first place. After one year, mostly in front of the computer screen, I am still fairly new to the German and Berlin research system. However, I have already experienced the great support of the Institute's Scientific Advisory Board, with whom we have already had some very inspiring discussions. I have also experienced the strong added value of the associations and networks we are embedded in, most prominently the professional Joint Administration of the Forschungsverbund Berlin and the Leibniz Association.

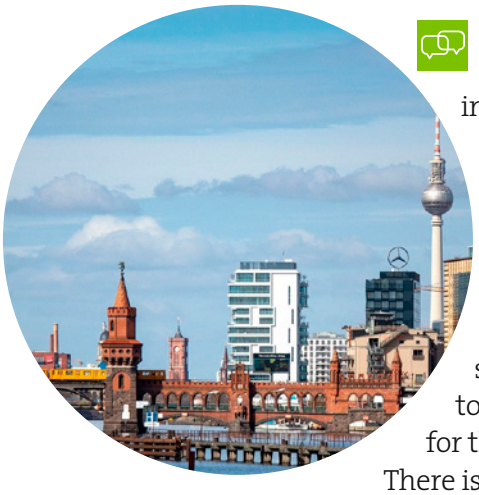
We at IGB are proud of what we do. This year in particular, it cannot be stressed enough that everyone at IGB did an excellent job in taking care of their colleagues, in keeping their spirits up, in supporting me in my first year, in welcoming other new members in the best possible way, and in "just" doing their job, despite missing out on the day-to-day social interactions – from chitchatting to brainstorming – that make this job so much more rewarding.

So let me wish you a pleasant and inspiring experience as you read through this annual research report, either as one of the printed copies or as an electronic version.

Yours,

Luc De Meester
Director

Non-university research in and for Berlin



In February 2020, almost all non-university research institutes and centres in the Berlin area joined forces to form the BR50 (Berlin Research 50) initiative. Its aim is to promote local cooperation with universities and exchange with society and politics, and also to provide a dialogue platform for the participating institutions. There is great interest in this networking – especially in order to be able to act jointly on overarching issues. However, not only the research institutions themselves will benefit from this cooperation, but also politicians, universities and the general public. BR50 is a contact, multiplier and catalyst for current scientific and also social issues. IGB is one of the member institutions.

Learn more → www.br50.org

Professor Luc De Meester, luc.demeester@igb-berlin.de

querFELDein

The Leibniz Association's online knowledge hub querFELDein brings together facts, news and ideas about the agriculture of the future. What do sustainable farming systems look like? What does digitalisation contribute to the field, what does organic farming do? What will aquaculture of the future look like? What impact will light pollution have on agriculture? You guessed it: IGB is in on the action. The project was initiated by the Leibniz Centre for Agricultural Landscape Research (ZALF).

Find knowledge → https://quer-feld-ein.blog

IUCN EICAT standard launched

Better manage invasive species to protect biodiversity

Invasive alien species are one of the main causes of biodiversity loss worldwide. In order to prioritise management actions to protect native biodiversity, we need to know more about their impacts. For example, if resources are scarce, it makes sense to give priority to the management of those alien species that have the most detrimental impacts.

For this reason, the International Union for Conservation of Nature (IUCN) has developed the Environmental Impact Classification for Alien Taxa (EICAT). EICAT is a simple and objective tool that classifies alien species according to the severity and type of their known environmental impacts. The EICAT Authority is responsible for the development and implementation of the new standard. It currently consists of ten international experts on biological invasions, including IGB scientists Thomas Evans and Jonathan Jeschke.

IUCN presents the new EICAT standard in a video
→ https://youtu.be/7GAax3xakJs

Dr. Thomas Evans, evans@igb-berlin.de

Professor Jonathan Jeschke, jeschke@igb-berlin.de

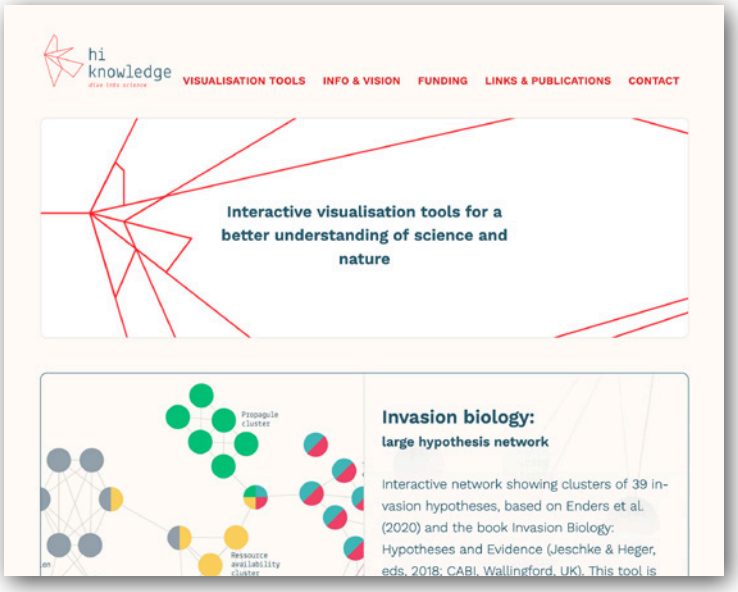
Photos: Berlin © Werner März/Pixabay; ZALF © suze/photocase; IUCN © IUCN YouTube Channel/Animation Riccardo Scalera; First stone © Glass Kramer Loebbert BDA Gesellschaft von architekten; Invasion biology © hi-knowledge.org

The first stone

In December 2020, the foundation stone for the Joint Biodiversity Science Building on the Berlin-Dahlem research campus was laid. The cooperation project between Freie Universität Berlin and IGB seeks to integrate and strengthen research and teaching on the future issue of biodiversity. So far, it is mainly the joint professorships through which the spontaneous exchange of expertise takes place on site. The new, pentagonal building is intended to give this exchange literally more

space and to bring together more than 100 biodiversity researchers and students. When the keys will be handed over in 2023, it will not only serve environmental research, but also follow strict environmental standards. Meanwhile, biodiversity research continues at the current locations. We are looking forward to a joint, interdisciplinary future.

Professor Luc De Meester,
luc.demeester@igb-berlin.de



Navigating the jungle of hypotheses

How and why do some alien species become invasive, but others do not? The field of invasion biology has accumulated many hypotheses and concepts on this and other questions – some of them are overlapping, some even contradictory. An international team led by IGB and Freie Universität Berlin provides scientific guidance.

The researchers defined 39 invasion hypotheses and grouped them in clusters, each sharing a particular perspective on biological invasions. For example, the trait cluster combines hypotheses that focus on the biological characteristics of invasive species, whereas the propagule cluster contains hypotheses that relate to the human factor, in particular how often and in what numbers individuals or populations of alien species are introduced by humans. This resulted in an interactive overview map for invasion biology, which has been freely available online since June 2020. Users can zoom in on the most important concepts and hypotheses and find studies and meta-data.

In September 2021, the team will start a new project that will result in the knowledge portal enKORE (Evolving Knowledge Resource). EnKORE will use state-of-the-art visualisation techniques, artificial intelligence and novel methods for knowledge synthesis. Navigation aids for related disciplines such as urban ecology, restoration ecology or other subfields of biodiversity research are also conceivable.

Hi Knowledge 2.0 is available online at
→ www.hi-knowledge.org

Professor Jonathan Jeschke, jeschke@igb-berlin.de

Enders, M., et al. (2020). A conceptual map of invasion biology: integrating hypotheses into a consensus network. **Global Ecology and Biogeography**, **29**(6), 978-991. https://doi.org/10.1111/geb.13082

Citizen Science project honoured

The project "Species Protection through Environmentally Friendly Lighting" (AuBe) was nominated an official UN Decade of Biodiversity project in October 2020.

"Better a breath-taking starry sky than species-taking street lights" is the credo of the AuBe team, which includes researchers and citizen scientists alike. In the municipalities of Neuglobsow and Gülpe (both BB), Krakow am See (MV) and Fulda (HS), they are investigating which insect species are affected by street lighting and how future environmentally friendly lighting solutions will be designed. Together with citizen scientists, insect monitoring traps are set up and emptied, insects are identified and night sky brightness is measured. Interviews will be conducted to find out how residents and visitors perceive the street lighting design. The researchers hypothesise that less artificial light at night is better for everyone's well-being – for insects and for people.

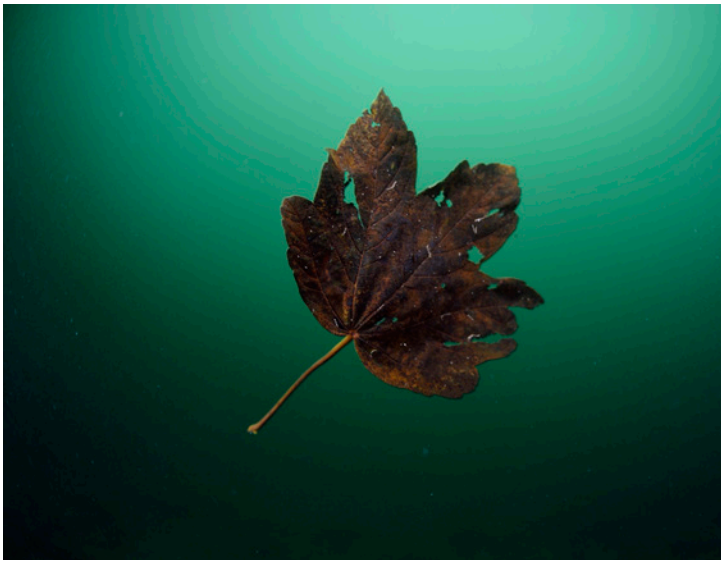
More information at
→ www.tatort-strassenbeleuchtung.de/en
Twitter → @AubeNews
Facebook → @AubeProjekt
Instagram → @aubenews

Dr. Sibylle Schroer,
schroer@igb-berlin.de

PD Dr. Franz Hölker,
hoelker@igb-berlin.de

Project: AuBe – Species Protection through Environmentally Friendly Lighting, **Duration:** 06/2019-05/2025, **Funded by:** BfN and BMU

The team received the award in Neuglobsow at the project's kick-off event.



Practical guide on litter decomposition in freshwaters

Just withered leaves? Next to the production of plant biomass, the decomposition of plant litter is the second most important ecosystem process in the biosphere. Mark Gessner has teamed up with colleagues from Canada and Portugal to publish a new edition of their comprehensive methods book on litter decomposition in freshwaters. The practical guide entitled Methods to Study Litter Decomposition is intended for students as well as researchers who want to expand their methodological toolbox. The greatly expanded and revised 2nd edition places a special focus on streams. In 63 chapters spanning 600 pages, the authors address the turnover of plant litter in ecosystems, chemical and physical litter properties, the determination, quantification and activity of microorganisms (fungi and bacteria) and litter-consuming invertebrates, and data analysis.

Professor Mark Gessner, gessner@igb-berlin.de

Bärlocher, F. et al. (Eds.). (2020). **Methods to study litter decomposition. A practical guide** (2nd ed.). Springer International Publishing.

FRESHWATER NEWS

Are you interested in freshwater research and would like to learn about new activities at IGB? Then simply subscribe to our newsletter, which will be sent to your mailbox every two months, packed with information about IGB and our topics.

Subscribe now
→ www.igb-berlin.de/en/newsletter

Photos: AuBe © David Ausserhofer; Litter decomposition © Solvin Zankl

Europe's fragmented rivers
→ page 10

The risks of hydropower
→ page 14

Recommendations for angling
→ page 16

Controversial regulation of the Oder River
→ page 16

Sustainable therapies for aquariums and aquaculture
→ page 17

Aquaculture with growth potential in Germany
→ page 17

News about light pollution
→ page 18

Ecosystem services

Conservation and sustainable use of freshwaters

More than a million barriers fragment Europe's rivers – just one example of the extent to which humans use and impact water-based resources and ecosystems. Researchers at IGB want to know exactly which ecosystem services are provided by lakes, rivers and their floodplains; how these freshwaters react to different types of use; and how we can better protect them. Our findings should help pave the way for a future in which natural resources are managed sustainably – in fisheries and aquaculture production, in inland navigation and energy generation, and in recreational activities.

Photo: Frank Masese

Broken lifelines: too many barriers in Europe's rivers

In the Lim River (Bosnia and Herzegovina), a rope with canisters prevents dumped waste from entering the turbines of a downstream hydropower plant.

In 2020, the EU research project AMBER revealed the true extent of river fragmentation: Europe's rivers are fragmented by at least 1.2 million instream barriers, around 225,000 of which in Germany. Helena Huđek and Martin Pusch undertook ground-truthing travels in 15 countries to determine the extent to which official records correspond to the real number of barriers. The doctoral student and her scientific supervisor report on the state of rivers, and how to get them flowing again.

Ms. Huđek, Mr. Pusch, you were involved in counting instream barriers in river courses throughout Germany and 14 other European countries for AMBER. What was the reason for this?

Martin Pusch: The aim of the project was to create a European atlas of instream barriers. The official number of barriers reported by the EU Member States was 630,000. Knowing from experience that authorities' statistics are incomplete, we set about recording the true number of structures in 15 countries by conducting surveys along selected river sections. The findings were used to calculate a more realistic, but still conservative figure: there are 1.2 million barriers in Europe's rivers, including 225,000 in Germany, 179,000 of which were known to the authorities.

Helena Huđek: I documented the barriers encountered along a 20 km stretch of 25 different rivers, respectively, in Germany, the Czech Republic, Hungary and six Balkan countries. We recorded all of the barriers, i.e. the type of barrier, its use, and whether the river still had sufficient water.

What did your exploration reveal?

Helena Huđek: We discovered many more barriers than we had anticipated. In the Czech Republic in particular, we found lots of small barriers, around one metre in height, that had been self-constructed to make angling or swimming easier. Nobody was aware that these barriers existed.

What impacts do barriers have on river systems?

Helena Huđek: They fragment the river, making it impossible for fish to pass the barriers. Migratory fish species need to swim upstream in order to spawn, but they are no longer able to reach their spawning grounds...

Martin Pusch: ... and most fish ladders are not effective. They frequently have an insufficient water depth and are often too steep, and fish find it difficult to locate the passage entrance. Dams and weirs also have the effect of interrupting sediment transport. This prevents the formation of new gravel banks in the riverbed, which represent a prerequisite for the successful reproduction of trout, and also for the natural self-purification processes in rivers.

Why were so many barriers built in Europe's rivers?

Martin Pusch: The oldest transverse structures, dating back to the Middle Ages, were used to power mills. From the 20th century onwards, these mills were often converted into small hydropower plants . Many more barriers were

Photos: Lim River © Helena Huđek; Portrait Pusch © David Aussenhofer; Portrait Huđek © private

built to compensate for the effects of river regulation, often carried out during agricultural land improvement operations. Straightening of a stream or river inevitably leads to incision because of the steeper slope, i.e. sediment is transported downstream. As a result, the river becomes deeper, causing unstable banks and bridge foundations. To avoid this, many bottom sills were installed, increasing the number of barriers in the river.

Which current developments are particularly problematic?

Helena Huđek: In the Balkans, there were 590 weirs for small hydroelectric plants in 2015. There are now more than 1,300, meaning that the number of such plants has more than doubled in five years. There are plans to build a further 3,000 hydroelectric power plants over the next few years. Most of these planned hydroelectric power plants are small, with a capacity of up to ten megawatts, i.e. they do not generate much electricity. And yet they have a disastrous effect because they often redirect the entire river discharge to the turbines via long canals, causing extensive river stretches to run dry. This has a devastating impact on all riverine life. Unfortunately, state subsidies are still granted for the construction of small hydropower structures, also in Germany, incidentally.

Ms. Huđek, how would you describe the general situation you encountered?

Helena Huđek: Compared to the rivers in Central Europe, there are more unspoiled rivers in the Balkans. However, these river systems are currently being destroyed very quickly by a "wave" of hydroelectric power plant construction. We saw river forest clearances, the straightening of natural river beds, the construction of new barriers, the canalisation of rivers, water pollution, and waste dumped into rivers; we also came across dried-up river beds. In the Balkan region, these problems are spreading like a disease, with pristine rivers vanishing before our very eyes.

You and your colleagues propose the removal of as many instream barriers as possible, particularly small ones. Where can barriers be removed most effectively?

Martin Pusch: Since many transverse structures are actually no longer in use, they could be systematically dismantled. It would also be relatively simple to replace many of the 72,000 or so stream pipings in this country with larger passageway profiles, or to uncover streams again. Such pipe systems exist wherever roads cross streams, or where streams were in the way of other uses. The smooth surface of these pipings scares off fish, as well as other animals such as otters. However, when larger transverse structures are demolished, there is often a need to reverse historic river straightening. This then calls for the complete restoration of the stream or river, to make it longer and shallower again. To do this, riparian areas need to be purchased, watercourses widened and river bends created. The most important example of such a restoration project in Germany is the Lippe River in North Rhine-Westphalia (NRW), which now once again features long channel sections harbouring a variety of fish populations and very interesting dynamic floodplains.

The results of this river inventory were fed directly into the EU Biodiversity Strategy for 2030: the aim is for 25,000 km of Europe's rivers to be freed from barriers by then. Is it a realistic goal?

Martin Pusch: It is an ambitious goal because many of the rivers need to be restored to their natural state, but we believe it can be done! We have already identified 27 rivers in Europe, with a total length of 5,500 km, where instream barriers can be removed with relatively little effort.

What costs would be involved?

Martin Pusch: It would cost around €315 million to restore the 27 rivers mentioned, which equates to 70 cents per citizen, based on the number of EU residents. As a comparison, agriculture costs each EU citizen approximately €100 per year. Even so, the costs of river restoration seem high at first sight. In a new EU project proposal, we therefore suggest how to increase the acceptance of restoration measures among the population. The idea is to make people aware of the benefits they would have if a lot of money was spent on restoring "their" river. Examples of these so-called ecosystem services include the retention of floodwaters, the stabilisation of groundwater levels during dry periods, more effective self-cleaning, and enhanced recreational value for walkers, anglers and swimmers. A positive example: a restored section of the Ruhr River in Arnsberg (NRW) has become a popular backdrop for newlywed photos!

The interview was conducted by Wiebke Peters.

PD Dr. Martin Pusch, pusch@igb-berlin.de
Helena Huđek, hudek@igb-berlin.de

Belletti, B., et al. (2020). More than one million barriers fragment Europe's rivers. **Nature, 588,** 436–441. https://doi.org/10.1038/s41586-020-3005-2

Project: Adaptive Management of Barriers in European Rivers (AMBER), **Duration:** 06/2016-09/2020, **Funded by:** EU Horizon 2020

Throughout the world, wild animals are being displaced by cattle breeding, as the example of hippos being displaced by herds of cattle in Kenya shows. | Photo: Frank Masese/Clara Romero González-Quijano

A heap of dung

In savannahs, terrestrial nutrients and organic carbon enter water bodies through the dung of large grazers such as hippos. If hippos are displaced by large herds of cattle, this changes the type and amount of manure that enters the water. As a team from IGB and the Universities of Innsbruck (Austria) and Eldoret (Kenya) found out, this has consequences for ecosystem functions in rivers. Although a cow introduces less dung into the water body than a hippopotamus, large numbers of cattle increase the influence of this animal group. Experiments on the Mara River in Kenya also showed that more nutrients enter the water body with the cattle dung, which leads to more algae growth. The input of hippos rather serves the growth of bacteria and promotes algae with an only indirect and delayed effect.

Professor Gabriel A. Singer, gabriel.singer@igb-berlin.de
Clara Romero González-Quijano, romero@igb-berlin.de

Masese, F. O., et al. (2020). Hippopotamus are distinct from domestic livestock in their resource subsidies to and effects on aquatic ecosystems. **Proceedings of the Royal Society of London: Ser. B, Biological Sciences, 287**(1926), Article 20193000. https://doi.org/10.1098/rspb.2019.3000

Renewable energies and barriers endanger fish diversity

Hydropower plants, dams and weirs fragment aquatic habitats. How this affects the fish living and migrating in rivers has been investigated by IGB researchers in several projects. The central results: Small hydropower plants are in particular ecologically problematic – and usually would be unprofitable if they were equipped with the necessary fish protection. Weirs and dams contribute to the decline of native fish species and might facilitate the spread of invasive fish species, as a study in the Ebro River in Spain shows. Researchers led by IGB developed a method for assessing fish mortality at hydropower plants and the European Fish Hazard Index (EFHI). Both help to classify the risks of hydropower plants.

Hydropower is a renewable energy source, but it is not necessarily environmentally friendly: hydropower plants have a strong impact on the river ecosystems in which they are built. Turbine operation in particular is a threat to many fish species. In planning and approval procedures, this mortality provides conflict potential, because until now there have been no standardised objective procedures to assess mortality risks of a whole hydropower plant.

Turbine hazard: New index assesses mortality risk for fish

Christian Wolter's team has developed an assessment index for the mortality risk of fish caused by hydropower plants on behalf of the Federal Agency for Nature Conservation. In the first step, the researchers defined the general mortality risk for all native fish and lamprey species occurring in freshwater. In the second step, the team assessed how great the mortality risk of different fish species is depending on the type of hydropower plant. In the case of turbine passage, for example, the probability of fatal injury to migrating fish species increases with body size. However, mortality rates also depend on the type of turbine or the hydraulic head.

According to the study, the mortality risk at hydropower plants can only be reduced if effective fish protection is installed. This includes, for example, mechanical barriers (e.g. fine screens) as well as upstream and downstream fish migration facilities, with their functionality tested and maintained. This is often not worthwhile for small hydropower plants with an installed capacity of less than one megawatt, of which there are more than 7,000 in Germany. Together, these small hydropowers produce about 14 per cent of total electricity from hydropower, while the latter accounts for about three per cent of total electricity production. Thus, the contribution of small hydropower to the energy transition is low, while the damage caused to water ecosystems and fish stocks is comparatively high.

As part of the international, EU-funded project FIThydro (coordinated by TU Munich), an index was developed, also under the leadership of Christian Wolter's team, to help objectively assess the environmental impact of individual hydropower plants. Such assessment aid is urgently needed: Soon, a considerable proportion of all hydropower plants worldwide will have to be retrofitted or modernised – about 65 per cent of small hydropower plants in Western Europe and 50 per cent in Eastern Europe are over 40 years old.

The European Fish Hazard Index (EFHI) can be applied to a wide range of plant types and makes it possible to assess the mortality risk of 168 fish species native to European waters. The EFHI supports the planning of protective measures by mapping their effects in a hazard score. In doing so, the index takes into account locally relevant water body or fish protection objectives and applicable European regulations. The researchers hope that widespread use of the EFHI will systematically identify potentially serious negative impacts of hydropower and thus effectively support efforts to protect Europe's rivers.

No way out: Dams exacerbate the consequences of climate change

Another project with IGB participation deals with the consequences of barriers such as dams and weirs for fish: The resulting fragmentation means that native fish along a river are often unable to colonise new habitats, even if the effects of climate change, such as changes in water temperature and quality, force them to do so. IGB researchers, together with a team from the University of Girona, have studied how habitats of native and alien fish species change under different climate scenarios and what role dams play in this process, using the example of the Ebro River in north-eastern Spain. There, fish are particularly affected by the impacts of climate change and the invasion of alien fish species. In addition, the Ebro is interrupted by 300 large dams and many small transverse structures.

Photos: Hydropower plant Santa Ana (l.) © Manuel Portero; Hydropower plant Chile © FranciscoKemeny/Unsplash

Johannes Radinger, leading author of the study, and the project team found that dams often do not prevent the spread of invasive species such as mosquitofish, catfish and carp. In fact, alien fish may even colonise more easily due to altered flow and habitat conditions that result from damming rivers. Fish communities in highly fragmented rivers affected by climate change are particularly at risk of species loss.

Dr. Christian Wolter, wolter@igb-berlin.de
Dr. Johannes Radinger, jradinger@igb-berlin.de
Ruben van Treeck, van.treeck@igb-berlin.de

Van Treeck, R., et al. (2021). The European Fish Hazard Index – An assessment tool for screening hazard of hydropower plants for fish. **Sustainable Energy Technologies and Assessments, 43,** Article 100903. https://doi.org/10.1016/j.seta.2020.100903

Van Treeck, R., et al. (2020). Fish species sensitivity classification for environmental impact assessment, conservation and restoration planning. **Science of the Total Environment, 708,** Article 135173. https://doi.org/10.1016/j.scitotenv.2019.135173

Radinger, J., et al. (2020). The role of connectivity in the interplay between climate change and the spread of alien fish in a large Mediterranean river. **Global Change Biology, 26**(11), 6383-6398. https://doi.org/10.1111/gcb.15320

Project: FIThydro – Fish-friendly Innovative Technologies for Hydropower, **Duration:** 11/2016-03/2021, **Funded by:** EU Horizon 2020

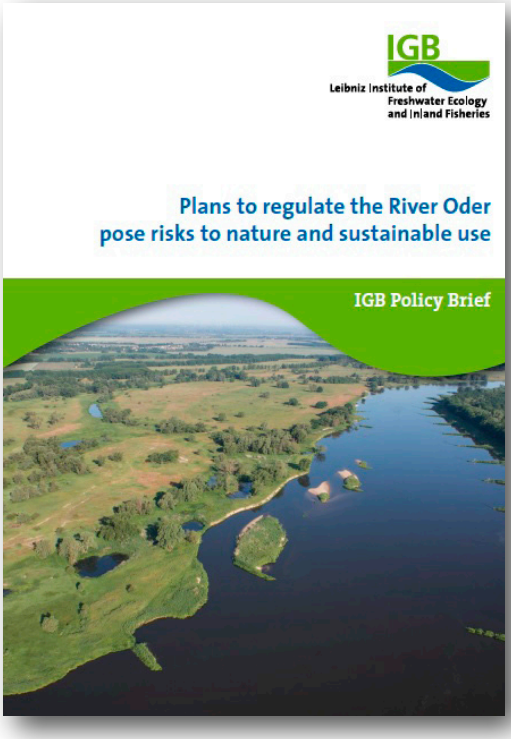
Read the BFN script on the assessment index at
→ www.bfn.de/fileadmin/BfN/service/Dokumente/skripten/Skript561.pdf

Case study: Fish in the Andean Amazon

Climate change and physical barriers such as dams also threaten fishes of the Andean part of the Amazon. This is shown by a study with IGB participation that combined species distribution models with functional characteristics of fishes of the Andean Amazon and coupled this with dam locations and climate projections. The team was able to show that climate change will lead to a range contraction for most Andean Amazon fish species. However, the models did not indicate that dams will severely limit future range shifts for most species. However, some of these barriers are likely to prevent upstream dispersal for many species. In the long term, river fragmentation, together with climate change, will lead to a considerable decrease in the likelihood of species persisting in the long term.

Dr. Johannes Radinger, jradinger@igb-berlin.de

Herrera-R, G. A., et al. (2020). The combined effects of climate change and river fragmentation on the distribution of Andean Amazon fishes. **Global Change Biology, 26**(10), 5509-5523. https://doi.org/10.1111/gcb.15285



IGB Policy Brief on the plans to regulate the Oder River

The Oder River is one of the last large, relatively near-natural rivers in Europe – for the time being. After all the government of the Republic of Poland is planning to develop the river, and Germany has also committed itself to this in a bilateral agreement.

In a policy brief, IGB experts Christian Wolter and Jörn Geßner point out that the measures will irretrievably destroy valuable habitats of many rare and endangered animal and plant species. According to the researchers, the plans violate EU law in several respects and endanger not only the environment, but also agriculture on both sides of the Oder. The arguments put forward in favour of the development cannot be substantiated. The researchers recommend instead the preservation and expansion of floodplain retention areas on the Oder. And they urgently recommend taking political steps against the development project and for the preservation of the Oder as an ecological focus area.

You can download the IGB Policy Brief at:
→ https://bit.ly/IGBPolicyBrief_river_oder_regulation

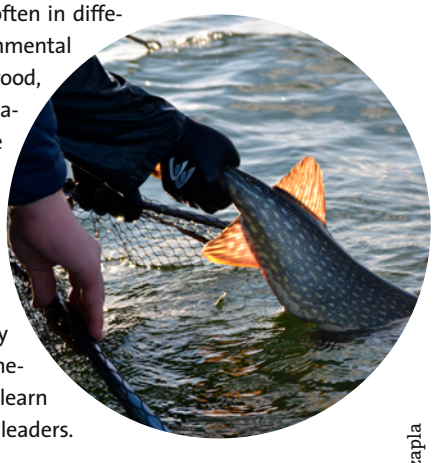
Save the oldies! Harvest slots protect fish stocks

Measures against overfishing have so far spared the young fish with the "minimum-landing size". However, a team of researchers led by Robert Arlinghaus recommends keeping alive not only the young but also the particularly large megaspawners. This type of management achieves a good compromise between the demands of commercial and ang-ling fisheries and the natural reproductive capacity of fish populations.

With fisheries biologists from the universities of Florida and Vancouver, Robert Arlinghaus investigated the optimal harvest regulations for a wide range of fish species. They compared the effect of classical minimum-length limits with a less popular harvest regulation: harvest slots, in which only medium-sized fish are taken.

The researchers found that harvest slots stabilise the stock dynamics without relevant losses in yields and increase the average size in the catch. Harvest slots can outperform the classic minimum-length limit, especially when intensively exploited stocks are fished jointly by commercial and recreational fishers.

Large spawning fish should not be missing in a population, because a single particularly large female can compensate for the egg count of many small fish. Moreover, fish of different sizes and ages reproduce at different times, and often in different places. If environmental events destroy the brood, a mixed-age population can still ensure offspring and thus contribute to more stable populations. In addition, old and young have different habitats, migratory routes and feeding schedules, and young fish learn from the experienced leaders.



Professor Robert Arlinghaus,
arlinghaus@igb-berlin.de

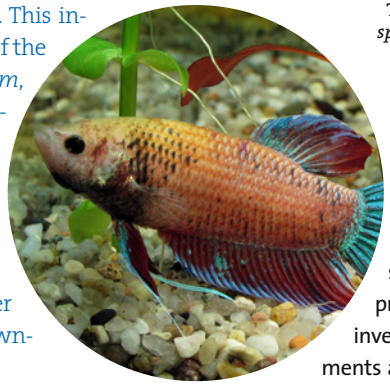
Project: BODDENHECHT, **Duration:** 01/2019-06/2023, **Funded by:** EU and Federal State of Mecklenburg-Western Pomerania

Ahrens, R. N. M., et al. (2020). Saving large fish through harvest slots outperforms the classical minimum-length limit when the aim is to achieve multiple harvest and catch-related fisheries objectives. **Fish and Fisheries, 21**(3), 483-510. https://doi.org/10.1111/faf.12442

Photos: Oder © Harald Schulz; big pike © Philipp Czapla

Aquaculture: environmentally friendly treatment for fish diseases required

Velvet disease is a dreaded ailment. This infection is caused by dinoflagellates of the genera *Amyloodinium* and *Piscinoodinium*, and affects freshwater and marine ornamental and food fish. In aquariums and aquaculture, the disease invariably causes considerable mortality, and thus financial losses. In her doctoral thesis, Thora Lieke combined the risks and benefits of current treatment options and new approaches. Her article has been acknowledged as a top downloaded paper.



Tropical fish such as the Siamese fighting fish *(Betta splendens)* shown here are more often at risk because the pathogen reproduces more rapidly in higher temperatures.

When fish develop a velvet covering, this should be seen as an alarm signal. In many cases, they have velvet disease, a highly infectious parasitic disease that is fatal if left untreated. Therapeutants containing copper, malachite green or methylene blue were traditionally available. However, their residues are discharged into the environment, and are highly toxic to other organisms. As a result, these chemicals have been banned for use in aquaculture in several European countries; a prohibition for commercial ornamental fishkeeping is expected to follow.

This has led to an intensive search for alternative treatment options, also to combat other pathogens. In *Reviews in Aquaculture*, Thora Lieke and her colleagues provide an overview of traditional and new therapeutants for the treatment of various parasitic diseases. In the search for environmentally friendly treatments for fish diseases, they recommend concentrating on two aspects: treating parasites using residue-free or naturally occurring substances; and enhancing the immune system of fish.

These residue-free, "alternative" therapeutants include hydrogen peroxide and peracetic acid, which have been proven to be effective against a variety of aquatic pathogens, also in the treatment of velvet disease. However, they may add to the stress level of the infected fish. The use of natural feed supplements such as vitamins, plant extracts, prebiotics and probiotics is therefore being investigated in numerous studies. These supplements activate the immune system and increase animal welfare, making fish less vulnerable to diseases. Humic substances are also known to act as immunostimulants, and are the subject of research throughout the world. As a natural part of aquatic ecosystems, they can be ingested via the gills, as proven by Thora Lieke and her colleagues in another study.

Thora Lieke, lieke@igb-berlin.de
Dr. Thomas Meinelt, meinelt@igb-berlin.de

Project: Development of humic substance-based products to increase resistance against stress and diseases in aquaculture, **Duration:** 08/2017-01/2020, **Funded by:** AiF Projekt GmbH, Federal Ministry of Economics and Technology (BMWi)

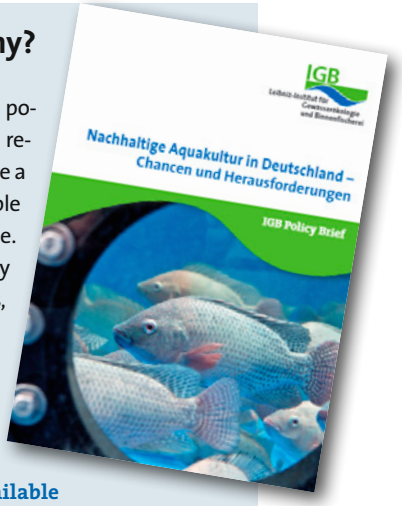
Lieke, T., et al. (2020). Sustainable aquaculture requires environmental-friendly treatment strategies for fish diseases. **Reviews in Aquaculture, 12**(2), 943-965. https://doi.org/10.1111/raq.12365

Lieke, T., et al. (2021). Phenol-rich fulvic acid as a water additive enhances growth, reduces stress, and stimulates the immune system of fish in aquaculture. **Sci Rep, 11**(1), Article 174. https://doi.org/10.1038/s41598-020-80449-0

IGB Policy Brief: Does sustainable aquaculture have a future in Germany?

Aquaculture is considered the fastest growing branch of food production worldwide – in Germany it ekes out a niche existence. Less than 3 per cent of fish consumption is currently covered by domestic aquaculture. The potential for greater self-sufficiency and for the export of fish could be developed using sustainable processes instead of shifting the pressure of use on aquatic ecosystems and possible environmental consequences abroad.

Consumers often only know fish as a processed and ready-to-eat product on the shelves, which in most cases has been imported. Aquaculture production often takes place abroad under lower social or environmental standards. This could be changed, say IGB researchers Fabian Schäfer and Werner Kloas. Germany in principle would have sufficient resources in terms of water, area, technology, know-how and purchasing power to significantly increase its own production of edible fish species for the domestic and export markets using sustainable methods. In an policy brief, the authors point out the potential of land-based (partially) closed recirculation systems (RAS) and stimulate a societal discussion. After all, sustainable fish from RAS production has its price. Without a greater willingness to pay on the part of trade and consumers, this form of aquaculture will probably not be established nationwide in Germany.



Since the IGB Policy Brief refers to the situation in Germany, it is available in German only:
→ https://bit.ly/IGBPolicyBriefNachhaltigeAquakultur

Dr. Fabian Schäfer, schaefer@igb-berlin.de
Professor Werner Kloas, werner.kloas@igb-berlin.de

Light pollution

Light domes like the one here over Berlin appear when too much artificial light is emitted into the night sky.

More stars due to coronavirus?

As a measure against the COVID-19 pandemic, public life was severely restricted for the first time in March 2020. Has this also altered light pollution – the brightening of the night sky caused by too much artificial light?

IGB scientists Andreas Jechow and Franz Hölker were curious and analysed the skyglow in the Berlin region. To do so, they compared data on sky brightness from March 2017 with those from March 2020, in each case under the almost identical conditions of a moonless, clear night.

Under normal conditions – without the coronavirus – the night sky over the city would have become brighter. As long-term satellite data show, artificial lighting is increasing here, as it is almost everywhere in the world. But the opposite was the case: the skyglow over Berlin decreased by 20 per cent in the city centre and even by more than 50 per cent at a distance of about 60 kilometres. Despite increased light emissions directly upwards, less light was scattered back downwards in the atmosphere.

The researchers suspect that the cause is improved air quality due to less air and road traffic. Their hypothesis is supported by statistical data and detailed satellite image analyses. Other possible causes are changes in private lighting and reduced horizontal light due to less car traffic. Air pollution seems to play a larger role in brightening the night sky than previously thought. This makes it an important factor in better understanding and reducing light pollution.

Dr. Andreas Jechow, jechow@igb-berlin.de
PD Dr. Franz Hölker, hoelker@igb-berlin.de

Jechow, A., et al. (2020). Evidence that reduced air and road traffic decreased artificial night-time skyglow during COVID-19 lockdown in Berlin, Germany. **Remote Sensing,** Article 3412. https://doi.org/10.3390/rs12203412

What are light domes?

Domes of light are formed when artificial light shines into the sky at night and is scattered back to earth by clouds and particles in the atmosphere. They form mainly above and around urban areas. Large areas worldwide are affected by this type of light pollution, because light domes can still be seen from many kilometres away. They restrict astronomical observations and have a negative effect on the day-night rhythm of animals and humans.

How bright is 1 lux?

On a starry night, the illuminance is less than 0.001 lux. On a full moon night, it reaches a maximum of 0.3 lux. The light dome of a city can reach illuminance levels of up to 1 lux and more, street lighting even up to 150 lux.

Does light affect sleep in urban fish?

The hormone melatonin controls our internal clock. High melatonin levels make us feel tired in the evening. However, it is also important for the biorhythm of animals. Artificial light at night can suppress the production of melatonin in fish even at very low light intensities, researchers at IGB have discovered.

Fish spend much of their lives asleep, although this is not apparent because they don't have eyelids. As with other creatures, sleep helps them to regenerate. But what happens when fish are exposed to too much artificial light at night? To find out, the research team investigated melatonin production in European perch. During the day, all fish were exposed to daylight; at night, the lighting varied depending on the group: the control group spent the night in complete darkness, the other three groups were exposed to light intensities of 0.01, 0.1 or 1 lux. After ten days, the researchers measured the melatonin concentrations at three-hour intervals over 24 hours. The result: even the lowest light intensity of 0.01 lux reduced melatonin production; at higher light intensities, melatonin was increasingly suppressed. The low light intensities of skyglow are thus sufficient to suppress melatonin production in fish.

Whether urban fish therefore experience a lack of sleep cannot be assessed with this method. However, it is known that melatonin is an important factor influencing sleep in fish and that other body functions such as immune defence, growth and reproduction can be disturbed by altered melatonin production.

PD Dr. Franz Hölker, hoelker@igb-berlin.de
Professor Werner Kloas,
werner.kloas@igb-berlin.de

Project: ILES – Illuminating Lake Ecosystems, **Duration:** 07/2015-06/2018, **Funded by:** Leibniz Competition 2015

Kupprat, F., et al. (2020). Can skyglow reduce nocturnal melatonin concentrations in Eurasian perch? **Environmental Pollution, 226**, Article 114324.
https://doi.org/10.1016/j.envpol.2020.114324

Photo: Andreas Jechow

Biodiversity

Understanding the causes and effects of aquatic diversity

Freshwaters are home to an unparalleled diversity of organisms that form complex communities. But they are under threat: freshwater genes, populations, entire species and habitats are disappearing much more quickly than their terrestrial or marine counterparts. Although this loss also endangers human welfare, too often it goes unnoticed. In order to protect and conserve biodiversity, IGB scientists are unravelling the mysteries and adaptation strategies of a wide range of freshwater organisms – from the aquatic bacterium *Achromatium oxaliferum* to the sturgeon and entire schools of fish. They explore factors that facilitate or threaten freshwater diversity, such as how invasive species manage to become established, or how the coronavirus pandemic affects global fish stocks.

Sex determination in sturgeon
→ page 20

Better protect biodiversity
→ page 21

Invasive species with charisma
→ page 22

Master of adaptation *Achromatium oxaliferum*
→ page 22

Collective behaviour in shoals
→ page 23

Development of fish stocks during lockdown
→ page 26

Photo: Solvin Zankl

Genetic sex marker discovered in sturgeons

Whether male or female, sexing of sterlets *(Acipenser ruthenus)* is now easier and more reliable.

Within the international STURGEoNOMICS project led by IGB, scientists have discovered a molecular marker for sexing of sturgeons. This is a scientific breakthrough for evolutionary biology, species conservation and caviar-producing aquaculture. The genetic evidence characterises the oldest known system of genetic sex determination in vertebrates with microscopically indistinguishable sex chromosomes. The short sex-specific DNA sequence has been detected in several sturgeon species and dates back to a common sturgeon ancestor 180 million years ago.

For decades, there has been an international search for sex-linked genetic markers in sturgeons, because they cannot be sexed by any external characteristics. As in many fish and amphibians, their sex chromosomes differ only at the DNA level. The genomicist Heiner Kuhl and the evolutionary biologist Matthias Stöck have succeeded in discovering a tiny genetic region, specific to female sturgeons. With the discovery of this genetic element, the researchers likewise demonstrated the oldest known sex-determining system with undifferentiated sex chromosomes in vertebrates – it is around 180 million years old.

So far, the sex of sturgeons has been detected by ultrasonic diagnosis or biopsies. In the future, with the help of the developed marker, a skin swab with a cotton bud will be sufficient to distinguish females from males on the basis of their DNA. Such a test is more reliable and easier to perform than the previous methods.

Important progress for species conservation and aquaculture

Many sturgeon species are highly endangered worldwide. For sturgeon conservation, the marker is a good tool for determining the sex of breeding animals for reintroduction programmes. Fish that are not selected for broodstock development could be released into the wild.

In aquaculture, the method could be used in the future for early sexing of fish, intended for rearing. This makes it possible to focus on production of caviar by the females and on production of meat by the males. However, the test should by no means lead to the culling of male sturgeons, as the scientists explicitly emphasise.

The mystery of sex evolution in sturgeon

Today, there are 27 species of sturgeon and paddlefish, which branched off from the root of the 31,000 living bony fishes about 330 million years ago, according to an earlier publication of the first sturgeon genome (Kang et al. 2020), to which IGB scientists provided major contributions. Unlike many other vertebrates, the evolution of sturgeons was characterised by astonishingly slow changes in the genome and the morphology. The conservation of the female-specific sequence over 180 million years of sturgeon evolution and despite polyploidisation – a multiplication of chromosomes in the sturgeon family – raises many interesting biological questions: How did the sex locus survive the genome duplication? Why has genetic sex determination apparently been conserved in sturgeons, while many fish species have evolved multiple different and independent sex determination systems?

Dr. Heiner Kuhl, kuhl@igb-berlin.de
PD Dr. Matthias Stöck, matthias.stoeck@igb-berlin.de
Dr. Jörn Geßner, sturgeon@igb-berlin.de

Project: STURGEoNOMICS, **Duration:** 09/2017-12/2020, **Funded by:** COFASP/ERA-NET

Kuhl, H., et al. (2020). A 180 My-old female-specific genome region in sturgeon reveals the oldest known vertebrate sex determining system with undifferentiated sex chromosomes. **bioRxiv.** https://doi.org/10.1101/2020.10.10.334367

Du, K., et al. (2020). The sterlet sturgeon genome sequence and the mechanisms of segmental rediploidization. **Nature Ecology & Evolution, 4**(6), 841-852. https://doi.org/10.1038/s41559-020-1166-x

Photo: Sterlet © Andreas Hartl

Better protect biodiversity in inland waters

Globally, biodiversity is declining at an alarming rate. The UN Convention on Biological Diversity (CBD) outlined in its September 2020 report that none of its 20 targets for the period from 2011 to 2020 had been met. A follow-up agreement is in progress. The European Union's biodiversity strategy is also currently being redrafted. IGB researchers have teamed up with other biodiversity experts in order to develop recommendations for both international regulations to better protect biodiversity, especially in freshwaters.

One of the two studies, published in Science, outlines scientific recommendations for redesigning the goals of the UN Convention. More than 60 researchers from 26 countries suggest that three points should be taken into account when setting the new biodiversity targets. First of all, no target should be issued that is based on only one facet of biodiversity: genes, species, ecosystems and ecosystem services for human well-being require several different targets. Second, since all biological and ecological processes in nature are closely interconnected and influence each other, these goals would have to be interwoven and implemented holistically. As a third point, the authors stress that the individual goals should be set extremely ambitiously. Only then we will have a realistic chance of halting the rapidly progressing loss of genes, species and ecosystems by 2050. "Biodiversity is a multidimensional feature. The different dimensions must be synergistically targeted to achieve our goal of biodiversity conservation. We are doomed to fail if we do not take this multidimensionality into account," states IGB Director Luc De Meester.

In another paper, an international team led by IGB formulates 14 recommendations for follow-up political agreements to protect biodiversity in and near inland waters. The recommendations for the global conservation of freshwater biodiversity are based on current research knowledge and practical experience and are addressed to European politics and administration.

"Policies and decisions need to take much greater account of the unique ecology of freshwater life and its multiple threats. Populations of freshwater vertebrates have declined most dramatically compared to marine or terrestrial vertebrates between 1970 and 2016 – by 84 per cent. Our recommendations can help to improve the political framework for the protection of aquatic biodiversity," emphasises Sonja Jähnig, who led the study.

A central recommendation of the authors is to consider inland waters as a separate ecological "third realm" with special management requirements in future biodiversity agreements, alongside the land and the sea. Freshwater monitoring programmes should be expanded, coordinated and better financed at national and international level. Furthermore, biodiversity experts recommend managing hydrological and biological data on inland waters according to FAIR principles (findable, accessible, interoperable and reusable) to facilitate access and use. Monitoring and management of invasive freshwater species also need to be improved, according to the researchers.

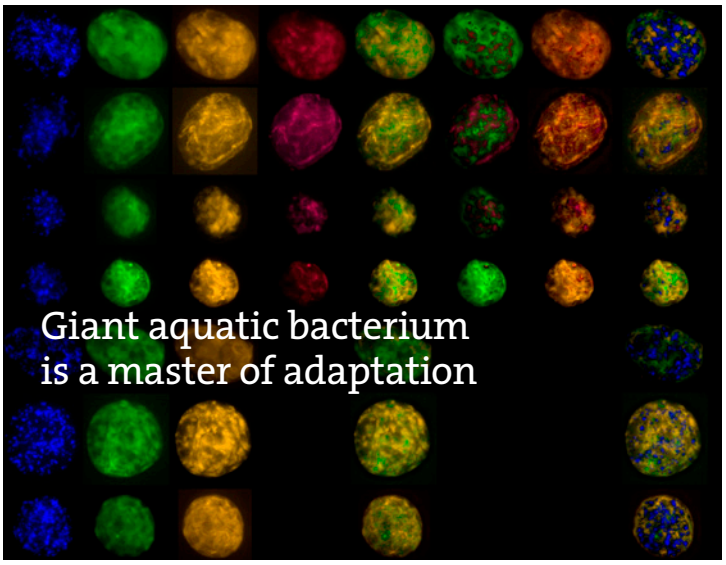
Professor Luc De Meester, luc.demeester@igb-berlin.de
Professor Sonja Jähnig, sonja.jaehnig@igb-berlin.de

Díaz, S., et al. (2020). Set ambitious goals for biodiversity and sustainability. **Science, 370**(6515), 411-413. https://doi.org/10.1126/science.abe1530

Van Rees, C. B., et al. Safeguarding freshwater life beyond 2020: Recommendations for the new global biodiversity framework from the European experience. **Conservation Letters**, Article e12771. https://doi.org/10.1111/conl.12771,

The moor frog *(Rana arvalis)* is rarely found in Germany and is currently classified as endangered. During the mating season, the males turn violet to light blue. The loss of its habitats such as floodplains, riparian forests and wet grasslands due to large-scale drainage is a particular threat to this species. When protected or restored, such wetlands not only provide various biodiversity benefits but also positively influence carbon storage as a measure against climate change.

Photo: Moor frog © Solvin Zankl



Giant aquatic bacterium is a master of adaptation

Images of fluorescent in-situ hybridisation of dyed *Achromatium oxaliferum*.

The largest freshwater bacterium, *Achromatium oxaliferum*, is extraordinarily flexible in its requirement: It does not care where it lives, thriving across habitats characterised by extremely different environmental conditions. Adaptation is probably achieved by a process that is unique to these bacteria: relevant genes become enriched and get transcribed in the genomes, while unnecessary genes are kept archived in cell compartments, just in case.

Achromatium is special in many respects: it is 30,000 times larger than other bacteria living in water and, thanks to its calcium deposits, can even be seen with the naked eye. It has several hundred chromosomes that are most likely not identical. This makes *Achromatium* the only known bacterium with several different sets of genomes.

Under the coordination of IGB, researchers have analysed sequence archives of sediments and shown that *Achromatium* is distributed worldwide in many ecosystems. It is found in hot springs and ice-cold water; in acidic and alkaline environments and in particularly saline waters. Typically, such a wide range of environmental conditions would lead to the establishment of new species with significantly different genomes, each well adapted to the particular environment. However, *Achromatium* is special: bacteria from different ecosystems have the same set of functional genes, but differ in their gene expression patterns by transcribing only the relevant genes. The team suspects that *Achromatium* organises its many genomes in compartments, some of which can function as "archives" of genes that have no immediate use. As a result, each cell contains a large number of functional genes and can quickly adapt to very different environmental conditions. This finding has far-reaching implications for possible evolution of multicellularity in prokaryotic and likely also in eukaryotic organisms.

Mina Bizic is not only a dedicated researcher, but also a passionate diver and mother of two little explorers. She tells us more about her path into science and her life beyond research in the **Marthe Vogt Podcast of the FVB**
→ http://bit.ly/Podcast_Mina_Bizic

Dr. Danny Ionescu, ionescu@igb-berlin.de
Professor Hans-Peter Grossart, hgrossart@igb-berlin.de
Dr. Mina Bizic, mbizic@igb-berlin.de
Dr. Luca Zoccarato, zoccarato@igb-berlin.de

Ionescu, D., et al. (2020). Heterozygous, polyploid, giant bacterium, Achromatium, possesses an identical functional inventory worldwide across drastically different ecosystems. **Molecular Biology and Evolution**, Article msaa273. https://doi.org/10.1093/molbev/msaa273

It's easier for invasive species with charisma

Appearances count: Their charisma can affect the introduction and image of alien species and can even hinder containment. An international team of scientists, led by the Biology Centre of the Czech Academy of Sciences and IGB, has investigated the influence of charisma on the management of invasive alien species.

More and more animals and plants are being taken from their native range by humans – consciously and unconsciously. Most of them are unable to adapt to the new living conditions, but some become firmly established. Some cause serious problems for native species – as predators, competitors for food and habitat, or vectors of diseases. Charismatic species are more often deliberately introduced as ornamental plants, aquarium inhabitants or exotic pets than inconspicuous species, as the researchers make clear.

The social acceptance of attractive invasive species with charisma is generally higher than that of unattractive invasive species. This can, for example, hamper conservation measures aimed at containing the spread of a species: A perceived beautiful or cute appearance can make management more difficult because public support is lacking.

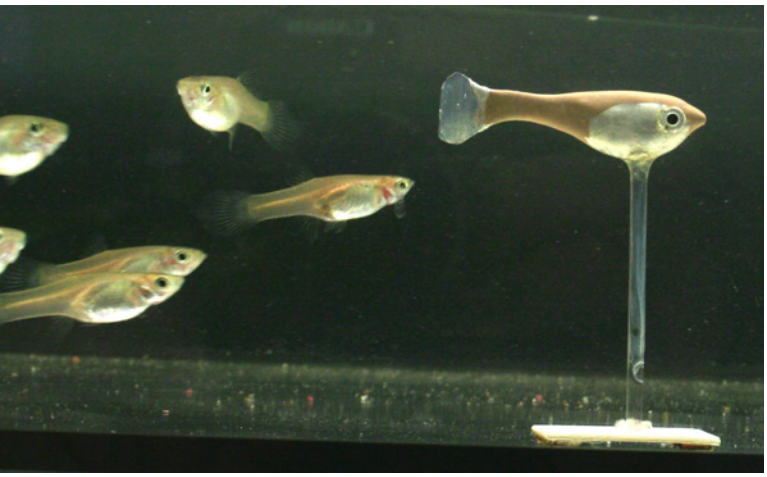
The European spread of the raccoon, which originated in North America, is subject of controversy, as the cute mammals have fans who oppose their control.

Research often focuses on those alien species that are particularly problematic ecologically or economically. And yet there is a greater focus on invasive vertebrates and on large and charismatic species. Conclusion: The interest of the public and also of research is disproportionately concentrated on such species. This can cause biased knowledge gaps and misleading conservation priorities.

Professor Jonathan Jeschke, jeschke@igb-berlin.de
Dr. Gregor Kalinkat, kalinkat@igb-berlin.de

Jarić, I., et al. (2020). The role of species charisma in biological invasions. **Frontiers in Ecology and the Environment, 18**(6), 345-353. https://doi.org/10.1002/fee.2195

Photos: Racoon © shutterstock; bacterium © Mina Bizic



The Robofish with real guppies.

The fast ones lead the way

A research team from the University of Konstanz, the Cluster of Excellence "Science of Intelligence" and IGB is using state-of-the-art robotics to show that the individual speed of single animals within a group can explain collective behavioural patterns, and that group behaviour is determined by the faster individuals.

To specifically control the behaviour of individual animals in a social group and thus test theories on general mechanisms in collective behaviour, the research team built the "Robofish", a robot-controlled artificial fish. It looks like a guppy – a small tropical freshwater fish – and interacts with the real fish in a natural way. The team used high-definition video tracking and a feedback system to let the Robofish react to the living fish's actions in real time.

First, the natural movement speed of the guppies was measured. When the fish then came into contact with the Robofish, the fish and Robofish swam together as a pair. However, there were big differences in social behaviour between the pairs: pairs with a faster live guppy swam much more aligned, but less closely together, and the live guppy emerged as a clearer leader – unlike pairs with a slower guppy. This shows that individual speed is a fundamental factor in the emergence of collective behaviour patterns.

Future studies with the interactive Robofish will investigate how an entire shoal can move almost simultaneously, even though the individual animals only respond to the actions of their neighbours. Jens Krause's team has described exactly how this can be done in a review article.

Professor Jens Krause, j.krause@igb-berlin.de
Dr. David Bierbach, bierbach@igb-berlin.de

Jolles, J. W., et al. (2020). Group-level patterns emerge from individual speed as revealed by an extremely social robotic fish. **Biol Lett, 16**(9), Article 20200436. https://doi.org/10.1098/rsbl.2020.0436

Landgraf, T., et al. (2021). Animal-in-the-Loop: Using Interactive Robotic Conspecifics to Study Social Behavior in Animal Groups. **Annual Review of Control, Robotics, and Autonomous Systems**, **4**. https://doi.org/10.1146/annurev-control-061920-103228

Slowed down by parasites

Many prey animals react collectively to predators. For example, they transmit information about potential predators in no time at all to trigger and coordinate escape behaviours. Jens Krause and IGB guest scientist Ralf Kuvers, together with colleagues, found out that parasite infections can disrupt this transmission in a swarm.

Group living has many advantages, for example it reduces the risk of being eaten. But some parasites can influence how animals react to attacks by predators. The researchers were therefore interested in whether infected, behaviourally altered individuals affect the spread of escape reactions within a swarm. They infected sticklebacks with the tapeworm *Schistocephalus solidus*, because this increases risk-taking behaviour and reduces the social responsiveness of its host. Then they confronted the sticklebacks with an artificial bird attack, with one group containing infected individuals and the other not.

With uninfected sticklebacks, the waves of escape quickly spread through the entire shoal and the fish sought shelter at depth for prolonged periods. With infected sticklebacks, the escape wave was interrupted and uninfected fish also returned to the water surface more quickly. They are thus exposed to a higher risk when they join infected individuals. The observed processes could also play a role in many other prey species and their parasites.

Professor Jens Krause, j.krause@igb-berlin.de

Demandt, N., et al. (2020). Parasite infection disrupts escape behaviours in fish shoals. Proceedings of the Royal Society of London: Ser. B, **Biological Sciences, 287**(1938), Article 20201158. https://doi.org/10.1098/rspb.2020.1158

Photos: Sticklebacks © David Ausserhofer; Robofish © David Bierbach

Tireless efforts

245,000 small Baltic sturgeons *(Acipenser oxyrinchus)* reclaimed their original habitat – the Oder River – in 2020. The aim of the stocking is to one day reintroduce parent stocks of this endangered species to the entire Baltic Sea area. Until then, the sturgeon offspring will come from farms in Brandenburg and Poland. The project requires not only cross-border cooperation, but above all patience: it will be around 15 years before the released sturgeons return as parents to their home waters – if all goes well. The reintroduction programme is coordinated by IGB scientist Jörn Geßner.

Dr. Jörn Geßner, sturgeon@igb-berlin.de

Master's student
Janina Fuest supports
the stocking operation
on the Oder. | Photo: Jörn Geßner

Potential impacts of the COVID-19 pandemic on freshwater ecosystems and fisheries

Will freshwater environments and fish populations benefit from the global COVID-19 pandemic and the resulting restrictions on the economy and society? Yes, in the short term, but probably not in the longer term – this is the conclusion of an international team of experts, including IGB scientist Robert Arlinghaus. The researchers have compiled the potential negative and positive effects of the pandemic on freshwater fish biodiversity.

Even before COVID-19, freshwater ecosystems and fish populations were subject to high exploitation pressures and varied threats. And yet these threats could change in the long term as a result of the pandemic, at least if economic and social recovery is prioritised. This dynamic is particularly likely in developing regions, whereas in Europe, for example, the EU Water Framework Directive and the Biodiversity Strategy will probably mitigate many of the threats. Some examples:

1. Invasive species, for example, are considered one of the most significant drivers of aquatic biodiversity decline. Reductions in travel will also diminish the unintended introduction of such species, but only in the short term. As the economy recovers, the pace of invasions will increase again. To make matters worse, COVID-19 has led to significant budget reductions for controlling the spread of invasive species all over the world; not only monitoring and regulatory measures, but also scientific programmes have been reduced in many places.

2. Another example is the fragmentation of freshwater ecosystems due to the construction of dams. There has in fact been a slowdown in construction activities. However, if regions prioritise economic recovery post-pandemic, regulations and environmental protection measures could be side-stepped and controversial projects pushed forward faster than ever – especially in countries where environmental issues played a subordinate role even before the pandemic. Environmental issues and funding for restoration projects could be deferred or held back.

3. In the commercial fisheries, pressure on fish stocks declined temporarily during the lockdown. In many cases, markets have collapsed, especially in direct marketing. However, interruptions to other food production sectors and income losses may lead communities to rely more heavily on freshwater fisheries as a food source, especially in developing and emerging countries. The researchers are also concerned about a reduction in monitoring capacity. At the same time, the pandemic has generated a noticeable increase in angling interest in many regions. This may even have increased fishing pressure, particularly on many small lakes and river sections. In contrast, fishing participation has declined in tourist areas, especially during periods of lockdown. This is likely to have a positive impact on fish populations.

4. The finding with regard to climate change is similarly ambivalent: although the decrease in global emissions could reduce climate impacts in the short term, the timescale of these reductions is too short to reverse damaging trends. The decisive factor will therefore be whether economic recovery efforts follow a return to "business as usual", or instead, embrace the implementation of new climate policies that drive shifts to clean energy.

The experts recommend adapting management measures and policy decisions in such a way that they preserve biodiversity. In practical terms, this means reviewing and effectively shaping environmental regulations; integrating large-scale restoration and monitoring programmes into economic stimulus packages; and preventing a return to high emission levels. They also call for a rigorous examination and assessment of the impacts on fish biodiversity as lockdowns are lifted.

Professor Robert Arlinghaus, arlinghaus@igb-berlin.de

Cooke, S. J., et al. (2021). A global perspective on the influence of the COVID-19 pandemic on freshwater fish biodiversity. **Biological Conservation, 253**, Article 108932.
https://doi.org/10.1016/j.biocon.2020.108932

Photo: © Krisztian Tabori/unsplash

Global change

Assessing changes in aquatic ecosystems

Not only do freshwaters respond sensitively to climate and environmental change, e.g. rising temperatures and extreme weather events, they are also affected by the discharge of excess nutrients and contaminants into rivers and lakes. Some water bodies dry out temporarily or shrink, others disappear forever. Some have problems with overfertilisation, and experience prolific algal blooms. Other freshwaters emit greenhouse gases, further accelerating global warming. We want to understand what promotes the resilience of ecosystems and communities, and how to adapt successfully to climate change. Researchers at IGB analyse issues such as how, during a drought, the limited available water is distributed, and what might help prevent the eutrophication of lakes and the mass development of cyanobacteria.

Resilience of landscapes during drought
→ page 29

Phosphorus retention in sediments
→ page 28

Greenhouse gases from dry waters
→ page 30

Water bodies under multiple stress
→ page 30

Fungal parasites as a source of hope
→ page 32

New Climate Change Center Berlin-Brandenburg
→ page 35

Species distribution in a changing world
→ page 35

Extra: The internet – a wealth of data
→ page 36

Long-term binding of phosphorus in lake sediment

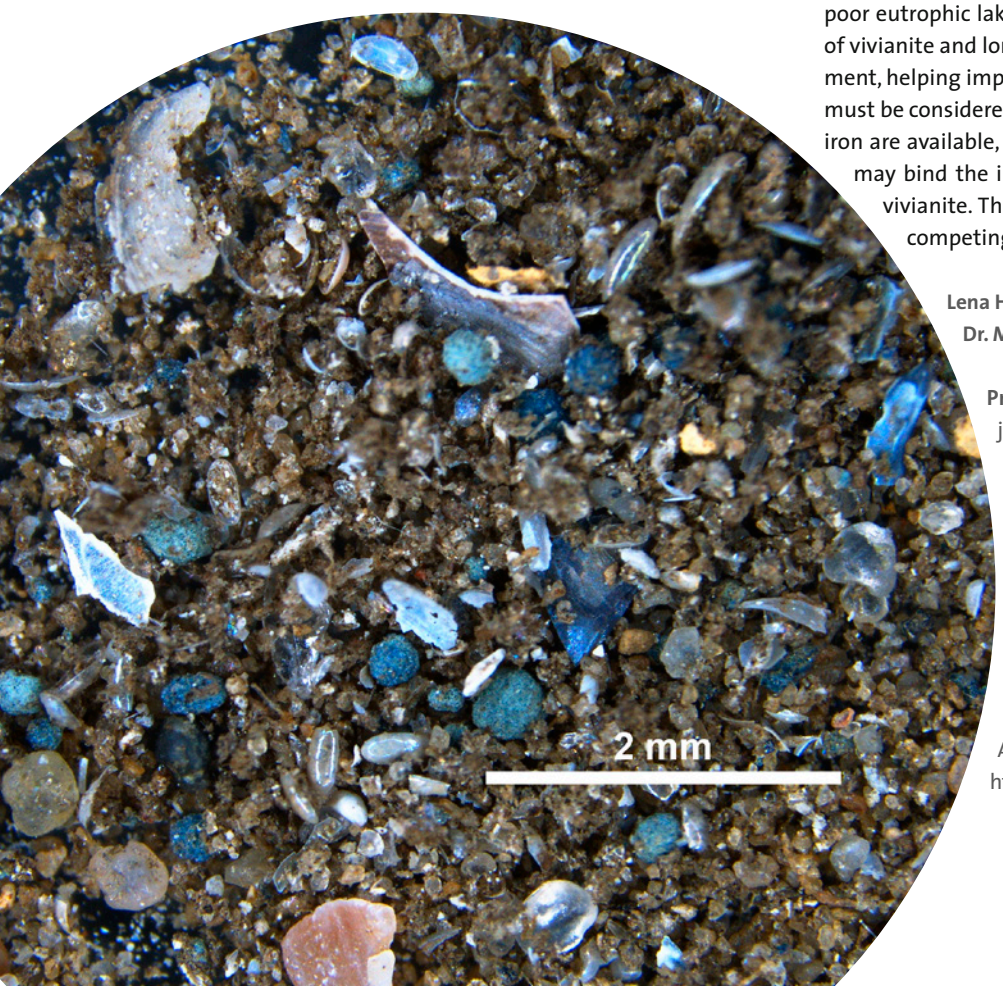
Excessive phosphorus loading from agriculture and sewage treatment plants lead to the accumulation of this nutrient in water bodies. Lake sediments are able to retain phosphorus. The long-term retention helps to prevent eutrophication. In laboratory experiments, an IGB team has investigated a process that is able to bind phosphorus in sediment long-term.

When phosphorus is released into the lake, one of the processes that occur is the formation of iron hydroxide-bound phosphorus at the sediment–water interface under oxygen-rich conditions. In the presence of oxygen, iron forms rust-coloured particles, and phosphorus adsorbs to the surface of these particles. Organic matter (e.g. from dead algae) accumulates at the bottom of the lake, where it decomposes. Oxygen is consumed in the process, resulting in oxygen depletion or the complete absence of oxygen – anoxia. Under these conditions, the iron hydroxides that bind the phosphorus are not stable long-term. For this reason, Lena Heinrich and Michael Hupfer have conducted laboratory experiments to investigate what happens to the iron hydroxides and the phosphorus adsorbed to them under anoxic conditions. Using a self-contained deoxygenated box, they simulated the conditions at the bottom of a lake. The researchers observed the transformation of iron hydroxide-adsorbed phosphorus, which they had added to natural sediments, into vivianite. Since, under laboratory conditions, the transformation occurred within weeks, the scientists assume that vivianite may also be formed under seasonal anoxia.

Binding iron and phosphorus to form vivianite is particularly interesting for long-term phosphorus immobilisation in lake sediment. After all, not only does the mineral form under oxygen-free conditions, it is also stable under such conditions. As a result, iron and phosphorus remain bound in the sediment in particle form; the phosphorus is unable to return to the water column and is unavailable for algae growth long-term. When vivianite forms, lake sediment therefore acts as a long-term phosphorus sink, even under anoxic conditions. The experimental condition shows that the availability of oxygen at the sediment–water interface, at least seasonally, promotes the formation of vivianite. Under this condition, iron precipitates can form, and phosphorus can adsorb to the precipitated iron. When anoxia occurs, these compounds are then transformed into vivianite.

Scientists are aware that this process does not occur in or affect all lakes. One reason for this could be a lack of iron. In iron-poor eutrophic lakes, adding iron may promote the formation of vivianite and long-term phosphorus immobilisation in sediment, helping improve the condition of the lake. However, this must be considered carefully. After all, even if large amounts of iron are available, competing reactions (such as with sulphur) may bind the iron first, leaving none for the formation of vivianite. The IGB researchers are keen to explore these competing reactions in the next step.

Blue mineral grains at the bottom of Lake Müggelsee: blue vivianite is an iron phosphate that forms in sediments under oxygen-free conditions. For better visibility, the relatively heavy vivianite particles were enriched by density separation.



Lena Heinrich, heinrich@igb-berlin.de
Dr. Michael Hupfer, hupfer@igb-berlin.de

Project: Urban Water Interfaces (UWI), subproject "Controlling of phosphorus fluxes in urban systems: Analogous processes in limnic sediments and sewage sludges" (F3), **Duration:** 10/2018-09/2021, **Funded by:** Deutsche Forschungsgemeinschaft (DFG), GRK 2032/2

Heinrich, L., et al. (2021). Transformation of redox-sensitive to redox-stable iron-bound phosphorus in anoxic lake sediments under laboratory conditions. **Water Research, 189**, Article 116609.
https://doi.org/10.1016/j.watres.2020.116609

Dried out river bed in Demnitz, Germany.

Drought: How landscapes become more resilient towards climate extremes

How water is distributed across the landscape after a rain event depends largely on soils and land use. A research team led by Dörthe Tetzlaff studied landscapes in Brandenburg that are typical of the Northern European Plain. They found that in this region too much precipitation water evaporates, hardly any groundwater is recharged and periods of drought can therefore be poorly bridged. Particularly affected: forests on sandy soils. They store water even more poorly than grassland.

Dörthe Tetzlaff and her team investigated how much precipitation evaporates directly and how much groundwater is recharged under different soils and types of land use. To do this, the researchers chose two sites on the Demnitzer Mühlenfließ in Brandenburg, a drought-sensitive sub-catchment of the Spree: one a mixed forest with sandy soils and a deep rooting zone, the other grassland with loamier soil and a shallow root system.

There, they analysed the water flows between the canopy and groundwater during and shortly after the great drought 2018, using stable isotopes, which serve as "markers" to determine flow paths, age and origin of water. When this information is coupled with data on vegetation dynamics, it is possible, for example, to determine where, when and at what rate plants obtain their water.

The results show that the forest floor was much drier. It contained only 37 litres of water per square metre in the uppermost metre of sandy soil, because the canopy of the trees shielded part of the rain, which evaporated directly and never reached the ground. The remaining precipitation that penetrated deeper into the soil was absorbed by trees during the growing season, even before it reached the groundwater table. Under the grassland, on the other hand, precipitation seeped continuously towards the groundwater reservoir, which is so important for such ecosystems. The soil itself was also able to absorb more water: 146 litres per square metre.

The study exemplifies that landscapes in the Northern European Plain can poorly store precipitation water and compensate for periods with less rain. To improve the resilience of these ecosystems to drought and other climate changes in the long term, soil properties must be created that allow more water to be stored, for example through higher humus contents and improved soil structure. In addition, land use plays a central role: it is necessary to reduce soil evaporation in agroforestry and to shift from intensive monocultures to lower vegetation densities. This could reduce evaporation rates and promote groundwater recharge.

Professor Dörthe Tetzlaff, d.tetzlaff@igb-berlin.de
Dr. Aaron Smith, smith@igb-berlin.de
Lukas Kleine, l.kleine@igb-berlin.de

Project: VeWa, **Duration:** 10/2013-03/2019, **Funded by:** European Research Council

Smith, A. A., et al. (2020). Isotope-aided modelling of ecohydrologic fluxes and water ages under mixed land use in Central Europe: the 2018 drought and its recovery. **Hydrological Processes, 34**(16), 3406-3425. https://doi.org/10.1002/hyp.13838

Kleine, L., et al. (2020). Using water stable isotopes to understand evaporation, moisture stress, and re-wetting in catchment forest and grassland soils of the summer drought of 2018. **Hydrology and Earth System Sciences, 24**(7), 3737-3752. https://doi.org/10.5194/hess-24-3737-2020

Too much of everything: climate change and nutrient loads

What happens when multiple stressors affect aquatic ecosystems simultaneously? A large collaborative study conducted by the University of Duisburg-Essen, IGB and other partners investigated how elevated nutrient loads, run-off regulation and altered river morphology as well as climate change interact to exacerbate the negative consequences of individual stressors.

The outcome was that the joint action of different stressors often have much stronger impacts than would be expected based on the sum of the individual effects. The researchers studied lakes and flowing waters throughout Europe, conducted experiments (e.g. at the IGB LakeLab in Lake Stechlin) and undertook comprehensive Europe-wide modelling on nutrient emissions, in-stream retention and resulting loads for natural, current and climate change conditions.

As the broad synthesis shows, nitrogen inputs from agriculture and phosphorus inputs from urban areas put particular pressure on inland water bodies. If rising temperatures or water scarcity are added, the negative effects of the individual stressors are reinforced. Therefore, sustainable water management must not be limited to addressing single stressors, but needs to identify the local combination of active stressors and approach these simultaneously.

Dr. Markus Venohr, m.venohr@igb-berlin.de
Professor Mark Gessner, gessner@igb-berlin.de

Project: MARS, **Duration:** 03/2014-02/2018, **Funded by:** European Union

Lake Stechlin was one of many research objects in the MARS project.

Underestimated: CO_2 emissions from dry inland waters

Inland waters such as rivers, lakes or reservoirs play an important role in the global carbon cycle. In calculations of carbon dioxide emissions from land and water surface areas, temporarily dry zones of water bodies are usually not taken into account. The actual emissions are thus significantly underestimated, as a research team found out, in which IGB played a major role.

A team of six German and Spanish scientists from the Helmholtz Centre for Environmental Research (UFZ), IGB and the Catalan Institute for Water Research (ICRA) launched the *dryflux* research project in 2016, which focuses on greenhouse gas emissions from intermittently dry freshwaters. In the course of the project, 24 research teams examined the carbon dioxide emissions of almost 200 water bodies worldwide. From samples of the dry sediment, they determined the humidity, organic matter and salt contents as well as temperature and pH value.

IGB researcher Hans-Peter Grossart takes an ever closer look at the microorganisms, because CO_2 is produced during their respiration processes. The greater the food supply – the organic matter in the soil – and the higher the temperature and soil moisture, the more active these microorganisms are and the more carbon dioxide is released from the sediments.

Across all climate zones, the researchers found significant carbon dioxide emissions from the dry-fallen zones of water bodies. These were often even higher than the emissions from average water surfaces of comparable size. Several studies at IGB have already shown that freshwaters are a significantly underestimated source of climate-relevant gases such as methane or carbon dioxide. The scientists' recommendation is to include dry areas of freshwaters in future global calculations. This could increase carbon dioxide emissions by a total of six per cent.

Professor Hans-Peter Grossart,
hgrossart@igb-berlin.de

→ https://gleon.org/research/projects/dryflux

Keller, P. S., et al. (2020). Global CO2 emissions from dry inland waters share common drivers across ecosystems. **Nature Communications, 11**, Article 2126. https://doi.org/10.1038/s41467-020-15929-y

Photo: Stechlin © Solvin Zankl

For four whole weeks, scientists took samples in Antarctica – and came across some curious observers such as this Gentoo penguin. | Photo: Hans-Peter Grossart

Nothing but ice?

Where it is cold and harsh throughout the year – in Antarctica – very few species were suspected for a long time. Today, we know better: there are even parasites in the ice. As part of an international team, Hans-Peter Grossart and Alexandra Livenets travelled to Potter Cove, a cove on the southwest coast of King George Island in the South Shetland Islands archipelago, to study benthic polar algae, parasites and their adaptive strategies. Benthic algae are at the bottom of the polar food chain and thus indirectly affect the lives of penguins and elephant seals. Higher temperatures could lead to higher parasite infestations of these algae and thus fundamentally change the food webs.

Professor Hans-Peter Grossart, hgrossart@igb-berlin.de

To see more photos from the expedition, visit
→ www.igb-berlin.de/en/news/igb-scientists-impermanent-ice

Disease can also be something positive

Justyna Wolinska and Ramsy Agha study organisms that until now have largely been consigned to the shadows in the scientific world: parasites. In the interview, the two scientists explain why it may be worthwhile to look for the good in what appears to be bad, and how conclusions about global climate change can be drawn from artificially heated lakes.

Ms. Wolinska, Mr. Agha, your work involves exploring parasites, a very particular group of organisms. What do you find fascinating about them?

Ramsy Agha: We biologists usually neglect parasites because we consider them to be an exceptional case in nature. We now know, however, that they occur frequently and in large numbers. That's why I consider it important to pay greater attention to this previously overlooked group of organisms: What role do they play in ecosystems? We want to bring parasites out of the shadows into the spotlight.

Justyna Wolinska: One reason parasites have been overlooked until now is that they are difficult to handle. Parasites are usually very small, and even when this is not the case, we cannot see them because they usually live within another organism. So you have to look inside to uncover the prevalence of parasites. A key reason why I became interested in parasites was the negative attitude we have towards them: since parasites cause disease, we see them as something bad.

But parasites are not always bad, right?

Justyna Wolinska: Exactly! Our group discovered that, quite the contrary, parasites may well play a positive role in the ecosystem. That was a completely unexpected finding, it was really fascinating!

Ramsy Agha: It's a kind of paradigm shift. Disease is something negative, but in an ecological context it can also be something positive.

What did you investigate?

Ramsy Agha: We looked at the relationship between parasites and their host, which, in our case, were fungal parasites and cyanobacteria. In the process, we discovered that this parasite also has an effect on a third organism, namely *Daphnia* – one of the most important

"It's a kind of paradigm shift. Disease is something negative, but in an ecological context it can also be something positive."
Ramsy Agha

Photos: Daphnia © David Ausserhofer; Portrait Agha © private

“Until now, aquatic food webs were considered as a simple cascade: phytoplankton, zooplankton and fish are linked by predator-prey interaction. But then along comes this widespread parasite, infecting a very common phytoplankton species – cyanobacteria – and it transpires that the food web is much more complex than we thought.”
Justyna Wolinska

zooplankton species in aquatic ecosystems. We observed that *Daphnia* benefit from infected cultures of the cyanobacterium. This is interesting because this type of prey is usually nutritionally inadequate for this organism. The zooplankton uses the parasite as prey, and, because it contains important fatty acids, *Daphnia* get a dietary upgrade. This can be seen from the fact that *Daphnia* populations grow strongly.

Justyna Wolinska: The fungal infestation also enables *Daphnia* to consume cyanobacteria more efficiently. Cyanobacteria consist of long filaments, making them a less palatable food source: the filaments block the filtering apparatus of *Daphnia*, which they use to ingest food in the water. The parasitic infection causes the fragmentation of filaments into shorter lengths, as we observed, making them easier to ingest by *Daphnia*.

Ramsy Agha: Let me illustrate this with an example: In summer, Berlin’s lakes are often green, rather than blue, because masses of phytoplankton, often cyanobacteria, float on the surface. Why is this the case? One important reason for this is that cyanobacteria are not consumed efficiently, that is, they are not very palatable for their predators. Thanks to the parasite, this source of food improves in quality, keeping cyanobacteria better at bay.

Does this mean that our lakes would be even more contaminated in summer in the absence of these parasites?

Justyna Wolinska: Yes, this could very much be the case. These parasites are a group of very primitive fungi that exist almost anywhere and can be very virulent, i.e. they would be able to eliminate cyanobacteria populations in no time. This gave us the idea that these parasites have a major impact on carbon transfer in their respective ecosystem. Since these parasites can infect any phytoplankton group, and since phytoplankton accounts for around half of the world’s carbon fixation, such infections are likely to have an impact on the global carbon cycle and climate regulation.

What finding surprised you the most?

Ramsy Agha: That parasites also act as prey! And that besides providing nutrition, the infection also makes it easier for another prey to be ingested. Parasites therefore have very complex effects: they act as an additional link in the food web, but also modulate existing ones.

Justyna Wolinska: Until now, aquatic food webs were considered as a simple cascade: phytoplankton, zooplankton and fish are linked by predator-prey interaction. But then along comes this widespread parasite, infecting a very common phytoplankton species – cyanobacteria – and it transpires that the food web is much more complex than we thought.

Do you have any idea what impact your findings could have in times of global warming?

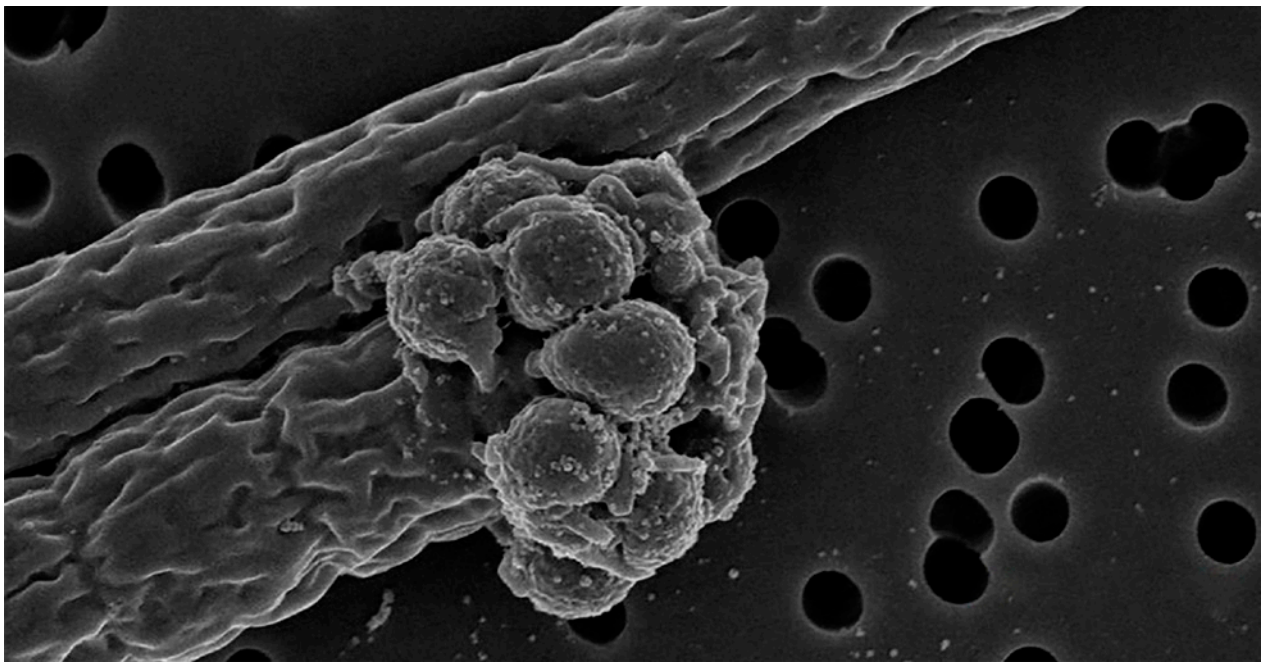
Ramsy Agha: We can’t say much about that yet, but it’s an issue that we are keen to address. We know that cyanobacteria will become more common as a result of climate change. In the laboratory, we investigated what happens at different temperatures, and discovered that infections also increase with a rise in temperature. But that’s not what happens in nature, where temperatures rise slowly, over longer periods of time, giving host and parasite organisms time to adapt. We want to simulate such conditions in the laboratory, and investigate them using approaches from experimental evolution, that is, we allow organisms to adapt to new conditions over a longer period of time, and then compare the resulting disease dynamics. These experiments are particularly exciting because they enable us to observe evolution in real time! We are planning a year-long study for this.

What issue will you address in the process?

Justyna Wolinska: Our goal is to gain a better understanding of the fundamental processes the parasites are involved in; we will additionally investigate other parasites that have an impact of zooplankton. We are also planning more complex experiments, which may enable us to look into the future. A number of lakes in Poland have experienced discharge of cooling water from coal-fired power plants for 60 years, causing a total increase in water temperature of 4 degrees. This temperature increase makes them perfect models for what to expect in future decades. As part of a large-scale project, we collect samples of phytoplankton and zooplankton from these lakes and compare them with control lakes, i.e. other nearby lakes that have not been fed with warm water. In particular, we compare how parasitic epidemics spread in heated lakes compared to the control lakes.

Ms. Wolinska, in addition to your research, you are also involved in IGB’s Inclusion and Diversity Group, which was established in 2019. Why is this issue important to you?

Justyna Wolinska: In my opinion, institutes that pay more attention to inclusion and diversity provide a friendly and safe environment. Diversity means



Cyanobacterial filaments infected with a chytrid parasite are visible under the scanning electron microscope.

differences that constitute our respective identity, such as geographical or ethnic origin, gender, age, skills or religion, and it is important to recognise these. All individuals contribute unique perspectives, and this mix of perspectives paves the way for smarter decisions, better ideas and outcomes, greater innovation; you maximise a group's potential. So if we pay more attention to diversity and inclusion, we can benefit enormously, enhancing not only our culture at the Institute, but also our scientific work.

What have you achieved so far?

Justyna Wolinska: Research shows that a long list of requirements in job advertisements makes women less likely to apply for the job. We spoke to the institute management, and suggested advertising IGB vacancies differently in the future, and reducing the number of requirements to a reasonable amount. This suggestion has already been implemented. We also organised a colloquium that addressed the issue of subconscious prejudices, and how to overcome them. After all, even if we have good intentions, we are often guided by attitudes that influence our judgement, such as in application procedures. Incidentally, the same applies to scientific work, as I discovered while teaching a class for 200 students a long time back...

Tell me more.

Justyna Wolinska: We had prepared an experiment to measure the reactivity of two different groups of *Daphnia:* one group had experience with predators, whereas the other had none. The students were asked to determine how strongly *Daphnia* react when threatened with a needle inserted into the Petri dish, i.e. to measure the distance they shrank back.

And?

Justyna Wolinska: In the experiment, 80 per cent of the students proved that *Daphnia* with "predator experience" responded more strongly. But the point was that there were no differences between the two groups – all *Daphnia* had been reared under the same conditions. A clear case of observer bias that shocked me at the time: for a while, I even toyed with the idea of abandoning science. Today, I see that experiment as a convincing example of the need to maintain sample blinding at all times, and I mean at all times. Greater impartiality would be important in other areas of scientific life, too.

The interview was conducted by Wiebke Peters.

Professor Justyna Wolinska, wolinska@igb-berlin.de
Dr. Ramsy Agha, agha@igb-berlin.de

Project: Paradapt, **Duration:** 06/2020-06/2023, **Funded by:** NCN-DFG funding initiative

Project: Parasites in food webs, **Duration** 03/2019-03/2022, **Funded by:** Deutsche Forschungsgemeinschaft (DFG)

Frenken, T., et al. (2020). Infection of filamentous phytoplankton by fungal parasites enhances herbivory in pelagic food webs. **Limnology and Oceanography, 65**(11), 2618-2626. https://doi.org/10.1002/lno.11474

Dziuba, M. K., et al. (2020). Countergradient variation concealed adaptive responses to temperature increase in Daphnia from heated lakes. **Limnology and Oceanography**, Early View. https://doi.org/10.1002/lno.11680

Photo: SEM Cyanobacteria © Ramsy Agha

A new model to better understand the spatial distribution of species

How do different species distribute between patches or habitats in a landscape, and what about the dynamics of their dispersal? These questions are addressed by the meta-community theory, on which work is also being done at IGB. Sabine Wollrab and Rajat Karnatak have developed a new, probability-based formalism for modelling species distribution as part of the Bridging in Biodiversity Science (BIBS) project. It is called Network-based Probabilistic Connectivity (NPC).

The approach promises to capture important characteristics of dispersal, which is stochastic in nature, meaning that individual events of species dispersal are unpredictable. In addition, the new formalism allows a more general description of the process than previous models, which often oversimplify the spatial structure of the landscape and assume that the dispersal process is deterministic. In particular, the new approach can provide predictions about the distribution and persistence of species at different time scales, and their dependence on patch distribution and patch density in the landscape.

The results obtained by Rajat Karnatak and Sabine Wollrab using the NPC formalism demonstrate that dispersal rates do indeed affect species persistence. Depending on the balance between local growth and in-coming versus out-going biomass, beyond a certain threshold, an increase in dispersal rates will strongly decrease the probability of persistence. While this seems to be logical, it is actually not captured by traditional approaches (Deterministic Spatially Implicit Approaches) due to an inherent mathematical symmetry. Furthermore, the two researchers were able to show that patch density critically affects the probability of species persistence, with greater patch densities increasing it because even at low dispersal rates, individuals are more likely to reach other habitats.

Schematic representation of the probabilistic connectivity network using the example of kettle holes in northern Brandenburg: The lines between the patches show whether the probability of dispersal is rather high (solid line) or low (dashed line). Besides taking into account the spatial distance between patches, the calculation using the NPC approach also considers the species-specific dispersal ability and the size of the patches.

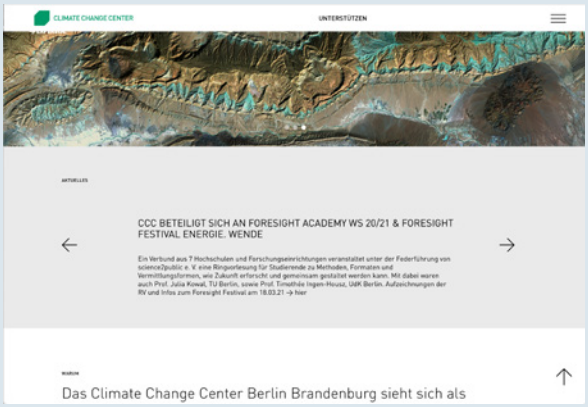
Connectivity between patches, the extent and nature of habitat connectivity, is ephemeral and highly variable. The spatio-temporal flexibility of the NPC formalism promises to better capture this and makes it broadly applicable. For example, the NPC approach can be used to predict the influence of climate and land use changes on species distribution patterns.

Dr. Rajat Karnatak, karnatak@igb-berlin.de
Dr. Sabine Wollrab, wollrab@igb-berlin.de

Karnatak, R., et al. (2020). A probabilistic approach to dispersal in spatially explicit meta-populations. **Scientific Reports**, **10**, Article 22234. https://doi.org/10.1038/s41598-020-79162-9

Partner of the Climate Change Center Berlin Brandenburg

The new Climate Change Center Berlin Brandenburg (CCC) went public with a website and a series of events called CLIMATE:Lab in December 2020. The CCC is a joint initiative of Technische Universität Berlin, Freie Universität Berlin, Charité – Universitätsmedizin Berlin, Berlin University of the Arts, the University of Potsdam and the Potsdam Institute for Climate Impact Research. Other research institutions are also involved, including IGB. The joint initiative sees itself as a transdisciplinary center for research and knowledge transfer concerning all aspects of climate change and climate change adaptation.



→ www.climate-change.center

Figure: © Sabine Wollrab/Rajat Karnatak

EXTRA

IGB researchers use social media data, for example, to draw conclusions about recreational behaviour at freshwaters.

The internet – a wealth of data

How IGB researchers harness the online world to generate research findings

Researchers need data to generate scientific findings. Two new research methods – culturomics and iEcology – use the internet for this purpose. These approaches offer many opportunities, especially for the exploration of aquatic habitats.

Enormous quantities of photos, videos and texts of all kinds are posted on the internet every day. On YouTube alone, users upload 500 hours of video material per minute; the English version of Wikipedia now contains in excess of 6,000,000 articles. For a while now, scientists have also been taking advantage of big data on the internet: the term "culturomics" first appeared in an article on digitised books published in Science in 2010; in the past five years, the new line of research has also gained in importance in biodiversity research.

"Culturomics involves analysing how humans react to the environment, whereas iEcology focuses on the nature side of data. For example, we search for indications of how populations of certain species are developing or how ecological states are changing," explained Gregor Kalinkat, a postdoctoral fellow belonging to the Light Pollution and Ecophysiology research group.

The researcher has already used the new methods in a number of studies. For one study, the results of which were published in summer 2020, a team led by Ivan Jarić from the Institute of Hydrobiology of the Academy of Sciences of the Czech Republic, former IGB researcher, analysed German, British and French websites that reported on species on the Red List of Threatened Species. "We were interested in finding out which threat factors the reports focused on, and particularly the importance assigned to invasive alien species," stated Ivan Jarić. The most frequently mentioned threat factor was climate change, whereas reports on the role of invasive alien species were rare. "It had already been assumed that much more is known about the impact of climate change on species loss, resulting in more frequent reports. But our analysis has now enabled us to prove this in a simple, quick and cost-effective way," Gregor Kalinkat remarked.

Key areas would be species monitoring, ecosystem status and anthropogenic impacts

The example highlights the potential of culturomics and iEcology. Gregor Kalinkat and Ivan Jarić are convinced that the new, internet-based methods offer many possibilities to investi-

Photo: Social Media © Dmytrenko Vlad/Shutterstock

"Culturomics is about analyzing how people react to the environment, while iEcology focuses on the nature of the data."
Gregor Kalinkat

gate aquatic habitats. Together with other researchers, the two scientists have written an overview study in which they identify key areas where culturomics and iEcology can provide particularly valuable insights. These include the distribution of threatened, rare and alien species, ecosystem status and anthropogenic impacts. Gregor Kalinkat sees great potential in the area of monitoring: "We envisage automated species recognition to analyse background information in digital data, such as species captured unintentionally in the background of photos and videos. That would make it much easier to monitor less conspicuous elements of biodiversity, such as vegetation," he remarked.

The study, published in late October 2020, also identifies some of the problems associated with the new, internet-based methods. For example, data becomes sparse as the distance from shore and water depth increases. In addition, social media users represent specific groups of the population, meaning that material posted online by tourists may contradict assessments and behaviours of local residents. One of the main problems is significant bias in the selection of species: while there are countless videos and photos of birds, amphibians and mammals, little material exists on fish and invertebrates. Data retrieval also poses difficulties. With commercial platforms such as Twitter, Google and Facebook, researchers use an interface to download the required data. "If these services change their interface, it causes us problems. Altered algorithms make temporal analysis difficult because data collected before and after the change can only be compared to a certain extent," stated Ivan Jarić.

A comparison with offline data helps to validate the results

Simone Podschun, Project Coordinator of AQUATAG, has also encountered this problem. The aim of this project is to identify when and where particularly intensive use is made of freshwaters for recreational activities and to find out how recreational use can be managed more efficiently. The team uses social media data to determine visitor numbers – and it is repeatedly the case that code developed to retrieve data no longer works or overall data structure changed. The researchers analyse data from platforms such as Twitter and Strava, which is an app for runners, cyclists and water sports enthusiasts. "We are particularly interested in geo-referenced tweets, which enable us to see when and where they were posted. Data from Strava are a good addition because they provide us with extra information such as distances, times and the types of activities as well as the number of athletes in a specific area," stated Simone Podschun.

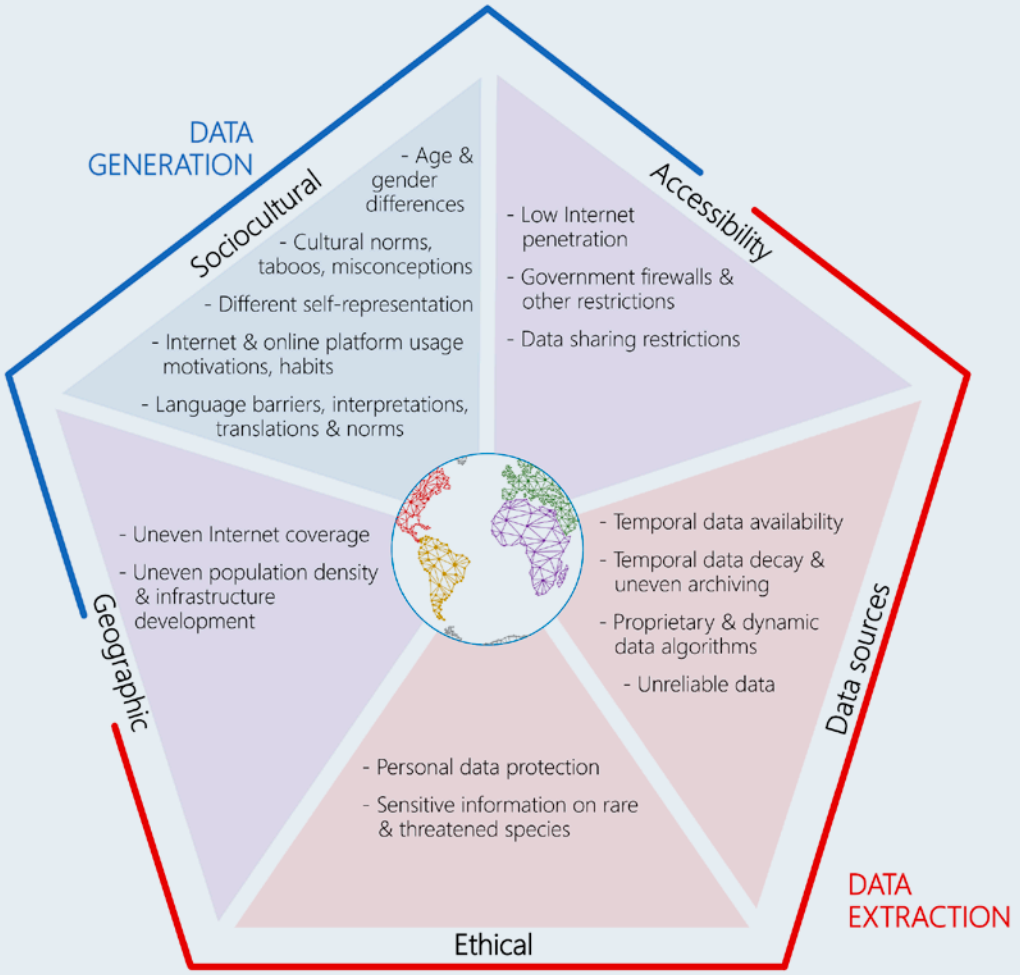
"Online services provide us with information almost in real time: We could immediately see that the coronavirus increased leisure activities at the rivers Spree and Havel this summer." ***Simone Podschun***

Since the number of social media users has increased, previous years can only be compared with caution: "More and more people use fitness trackers and post their data online," commented the biologist and expert in geographic information systems. For this reason, the team led by Markus Venohr pays particular attention to relations – how many come when it is warm, and how many when temperatures drop? The benefits of using social media data are very clear to Simone Podschun: "On-site counts are tremendously time-consuming and only provide a snapshot of reality. In contrast, online services provide us with information almost in real time: we were immediately able to see that the coronavirus led to an increase in the number of leisure activities of locals in the Spree-Havel area," she stated. Nonetheless, "we are aware that social media data are prone to outliers, e.g. when a marathon is held or in areas with no cell phone connection." The researchers do not rely solely on data available on Twitter and Strava. The AQUATAG team also compares the numbers of tweets from bathing lakes around Berlin with information provided by Berliner Bäder-Betriebe on the use of lidos. And the numbers of cycling activities are matched with electronic counts introduced by the city of Berlin for cyclists, the researcher reported.

Using YouTube to detect species distribution or to gain knowledge about recreational fishing

Two recent studies conducted by former IGB researcher Valerio Sbragaglia in collaboration with the fisheries professor Robert Arlinghaus from IGB show how video analysis provides valuable insights. Together with other researchers, the behavioural ecologist analysed YouTube videos that had been posted online by recreational anglers. One of the studies involved comparing recreational anglers and spearfishers. To this end, the team scrutinised videos of Italian recreational fishers who had caught an iconic Mediterranean fish species, the common dentex. The researchers were interested in how the size of the fish caught correlates with YouTube users' social feedback. "To do this, we searched YouTube for videos that were appropriate for our research question, and then analysed the metadata, i.e. details such as the title and the description of the videos. We also looked to see how many likes, views and comments the videos received," reported the researcher, who completed a Leibniz-DAAD postdoc fellowship in the group of Robert Arlinghaus in 2017, and now works for the Spanish National Re-

EXTRA



Both branches of research face challenges and obstacles that can be divided into 5 groups: sociocultural issues, accessibility issues, geographic factors, data sources, and ethical issues.

search Council's Institute of Marine Sciences. The search was performed by a script developed in R (a free programming language), which simplified the process enormously, given that more than 20,000 videos had to be analysed.

The second study focused on the macroecological patterns in groupers, with a specific focus on the dusky grouper and the white grouper. In this case, too, the team led by Valerio Sbragaglia analysed a large volume of videos published by Italian recreational fishers on YouTube. "To ensure the correct classification of species, we also watched some of the videos for this study, but we are now trying to automatise this process as well," the researcher explained. The team discovered that the body mass of the dusky grouper is often higher at deeper depths, but such a pattern does not seem to be exclusively related to exploitation, adding a new perspective to a controversial discussion in fishery science. In addition, the researchers were able to use the digital information extracted from YouTube to quantitatively measure the recent northward expansion of the white grouper in the Mediterranean. The analysis therefore provided valuable insights – without the researchers actually setting eyes on a single fish.

Gregor Kalinkat is convinced that these new methods are here to stay: "The potential of culturomics and iEcology is growing so rapidly that current problems will become less important," the researcher commented. However, it will not be possible to completely do away with traditional research methods: sampling cannot be replaced by photos of anglers which are analysed to learn more about the state of a lake.

Dr. Gregor Kalinkat, kalinkat@igb-berlin.de
Professor Robert Arlinghaus, arlinghaus@igb-berlin.de
Dr. Simone Podschun, podschun@igb-berlin.de
Dr. Markus Venohr, m.venohr@igb-berlin.de

Project: AQUATAG, **Duration:** 03/2019-02/2022, **Fundes by:** BMBF

Jarić, I., et al. (2020). Expanding conservation culturomics and iEcology from terrestrial to aquatic realms. **PLoS Biology, 18**(10), Article e3000935. https://doi.org/10.1371/journal.pbio.3000935

Review of the year

2020 at IGB

IGB Academy: Sustainable hygiene management for aquaculture practice

The IGB Academy in January was devoted to knowledge sharing between researchers and aquaculture practitioners. Special emphasis was placed on highlighting the potential of the use of peracetic acid (PAA), an efficient way of reducing germs in the water and minimising fish losses – without having a negative impact on the environment, fish, consumers, and farms that use PAA.

Dr. Dibo Liu, liu@igb-berlin.de
Dr. Thomas Meinelt, meinelt@igb-berlin.de

Consultation: EU Biodiversity Strategy

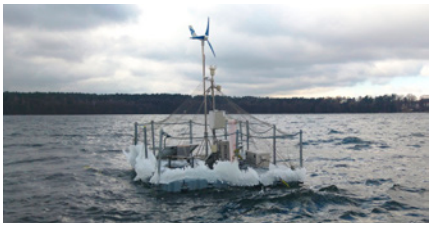
IGB contributed to the EU consultation on its Biodiversity Strategy. Sonja Jähnig, Michael Monaghan, Jonathan Jeschke and Hans-Peter Grossart contributed their expertise to the discussions. The researchers stressed the fact that the high ecological, economic and social relevance of freshwater ecosystems and their aquatic biodiversity is often overlooked, even in biodiversity policy. They recommended integrating science-based evidence in this area not only into the Roadmap EU Biodiversity Strategy to 2030, but also into the Strategy itself.

JANUARY

Internal matters: New Director at IGB

The Belgian aquatic ecologist and evolutionary biologist Luc De Meester became the new Director of IGB and was appointed Professor of Freshwater Science at Freie Universität Berlin in January 2020. Prior to his arrival, Mark Gessner, Head of the Department of Experimental Limnology, served as the interim director of IGB.

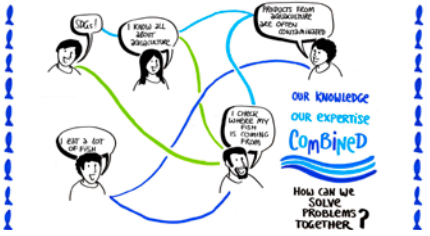
Professor Luc De Meester,
luc.demeester@igb-berlin.de



Project launch: Long-term development of lakes as a result of climate change

What effect does climate change have on the physical processes of lakes? Researchers are investigating this question in a new IGB project. Various lakes are being instrumented with logger chains to investigate how temperatures and stratification behaviour develop, and how waterbodies react to shifting meteorological boundary conditions. Changes in physical conditions can affect aspects such as the nutrient balance and the greenhouse gas balance. Recommendations for nationwide climate monitoring in lakes will be derived from the results.

Dr. Michael Hupfer, hupfer@igb-berlin.de



Event: Moving aquaculture into more sustainable waters

In view of the growing demand for protein, both freshwater and marine aquacultures will play an increasingly important role. To address this issue, IGB teamed up with the Leibniz Centre for Tropical Marine Research (ZMT) to host a workshop called *The Blue Sector at the Crossroad – Moving Aquaculture Into More Sustainable Waters*. A total of 31 participants from various Leibniz institutes, universities and the Food and Agriculture Organization (FAO) discussed new research approaches and strategies that may foster sustainable and diverse growth in the blue sector.

Dr. Hendrik Monsees,
monsees@igb-berlin.de

Project launch: AQUA-KI

Microorganisms such as phytoplankton and zooplankton play an important role in aquatic ecosystems. So far, however, there is a lack of suitable methods to examine them in their natural environment with sufficiently high spatial and temporal resolution. This challenge is being met by an interdisciplinary research team in the AQUA-KI project, which will combine artificial intelligence with novel ecological approaches. The aim is to develop complete automated systems that detect planktonic microorganisms in situ and in the laboratory, contributing to the improvement of early warning systems for algal blooms or invasive species.

Dr. Stella A. Berger, berger@igb-berlin.de
Dr. Jens C. Nejstgaard,
nejstgaard@igb-berlin.de

MARCH

Out and about: Research on the Tagliamento

Alexander Sukhodolov travelled to one of the last free-flowing Alpine rivers, the Tagliamento (Italy). There he documented the effects of a flood on the morphology of the floodplain, such as vertical and planar riverbed deformations caused by erosion and deposition around driftwood and riparian vegetation.

Dr. Alexander Sukhodolov,
sukhodolov@igb-berlin.de

Project launch: ITN RIBES

Alexander Sukhodolov's research group is involved in two sub-projects within the RIBES (River flow regulation, fish BEhaviour and Status) European Training Network. The aim of the network is to train early-stage researchers in ecohydraulics in a bid to develop solutions for the protection of rivers and fish populations. The reason for the network is the increasing fragmentation of rivers by small hydropower plants, which endanger endemic fish species such as the marble trout.

Dr. Alexander Sukhodolov,
sukhodolov@igb-berlin.de

Photos: Tagliamento & ITN RIBES © Alexander Sukhodolov; Workshop on aquaculture © Gabriele Heinzel

Project launch: Freshwater megafauna futures

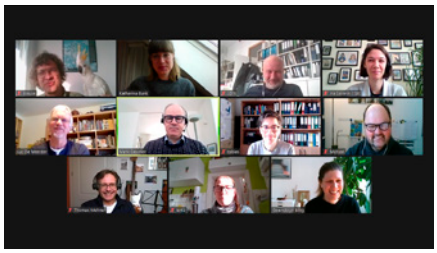
Big, bigger, gone? Freshwater megafauna – i.e. organisms found in freshwater with a body mass of more than 30 kg, such as hippos, turtles and sturgeons – are particularly at risk of extinction. But what would happen to ecosystems if these very large species disappeared? How do humans perceive these species, and can this perception be exploited for the benefit of conservation? The IGB project entitled *Freshwater Megafauna Futures*, funded by the Leibniz Competition, aims to fill these knowledge gaps, build an international, interdisciplinary collaborative network, and support freshwater biodiversity conservation.

Professor Sonja Jähnig,
sonja.jaehnig@igb-berlin.de

Event: Leibniz at the Bundestag

The *Leibniz at the Bundestag* event gives parliamentarians the opportunity to book consultation sessions with Leibniz researchers. Markus Venohr explained how sewage leakage contaminates groundwater with nutrients; Gösta Baganz and Hendrik Monsees provided information on the combined production of fish and vegetables (aquaponics).

MARCH APRIL MAY



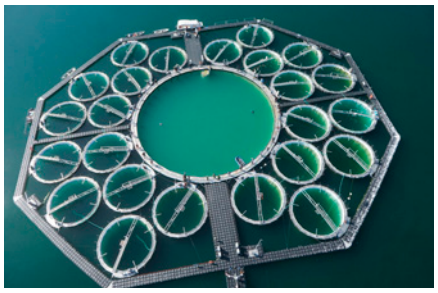
Internal matters: IGB Coronavirus Task Force

The first coronavirus lockdown also marked the birth of another series of videos: initially daily, but now weekly, representatives from all areas and sites meet to discuss the implementation of coronavirus prevention measures at IGB and to find solutions to tackle the adversities caused by the pandemic. Since March 2020, IGB has been working closely together – at a distance – to ensure the health and safety of us all. Despite the restrictions in place on research activities that cannot be undertaken at home, we are glad to set a good example using positive, socially distanced approaches.

Project launch: AQUACOSM-plus

AQUACOSM-plus combines experimental research on marine and freshwater ecosystems in Europe. The aims of the EU-funded infrastructure project, involving 31 partners, include promoting access to experimental research facilities, and consolidating expertise, data and capacity. Together, the researchers want to co-design future aquatic research actions and their research infrastructure requirements, and cooperate more closely with other research infrastructures (e.g. LTER). The network is coordinated by IGB.

Dr. Jens C. Nejstgaard, nejstgaard@igb-berlin.de
Dr. Katharina Makower, makower@igb-berlin.de
Dr. Stella A. Berger, berger@igb-berlin.de



Photos: Alligator gar © Zeb Hogan; Aquacosm © Frederico Cheda

Project launch: IDES

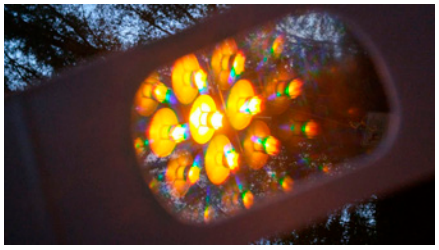
July saw the start of the collaborative research project IDES, funded under the EU's *INTERREG Danube Transnational Programme*. Taking the Danube as an example, the project explores how floodplains can help to improve water quality using nature-based solutions such as the retention of plant nutrients. This involves applying the River Ecosystem Service Index (RESI), developed under the leadership of IGB, to the entire river basin area. Building on this, existing evaluation methods will be harmonised to create an IDES tool. The tool will then be used in pilot regions to show the impact of different management scenarios on the ecosystem services of the river and its floodplains.

PD Dr. Martin Pusch, pusch@igb-berlin.de

Event: ARS ELECTRONICA

ACTION! Our ACTION LAB calls for more participatory science against environmental pollution. Anyone interested was able to listen, watch and participate in a wide range of public live streams during the ARS ELECTRONICA Festival between 9 and 11 September.

Dr. Kat Austen, austen@igb-berlin.de
Dr. Sibylle Schroer, schroer@igb-berlin.de



JUNE JULY AUGUST SEPTEMBER

Consultation: Chemicals in the environment

What are the dangers of hormone-disrupting chemicals in the environment and in water? Werner Kloas reported on this issue to the German Bundestag's Committee on the Environment on 17 June.

Professor Werner Kloas,
werner.kloas@igb-berlin.de

Visit by: State Secretary Silvia Bender

Silvia Bender, State Secretary of Brandenburg's Ministry of Agriculture, Environment and Climate Protection, visited IGB at Lake Stechlin on 20 August. Mark Gessner informed the politician about the alarming degradation of water quality of the famous clear-water lake.

Professor Mark Gessner,
gessner@igb-berlin.de

Event: Soapbox Science

Berlin Central Station was the scene of a series of fascinating short presentations, delivered comprehensibly, free and outdoors by female scientists on 19 September. Among the speakers were IGB early-stage researchers Mina Bižić and Marta Alirangues. The Soapbox Science initiative promotes greater gender equality in science. IGB provides support by co-organising the series of events.

→ Twitter: @berlin_soapbox

Photos: IDES © Martin Pusch; Visit by Bender © Sarah Bude; Ars Elcetronica © Charis Dittmar; Soapbox © soapbox science

Project launch: BiCEST

A DFG-funded research training group on Biota-mediated effects on Carbon cycling in Estuaries (BiCEst) was launched in October. A total of 26 early-stage researchers are investigating the effects of plants, animals and microorganisms on carbon cycling at the Elbe estuary. Their goal is to better illustrate these processes in Earth system models, and to document the effects of climate change on the carbon cycle. The project is led by Universität Hamburg. Other participating institutes alongside IGB are the Institute of Coastal Research at the Helmholtz-Zentrum Geesthacht, the Max Planck Institute for Meteorology and the Federal Waterways Engineering and Research Institute (BAW).

Professor Hans-Peter Grossart,
hgrossart@igb-berlin.de
Sven Hünefeldt, sven.huenefeldt@igb-berlin.de

Event: Citizen Science

Members of the public were invited to join the hybrid event to kick off the citizen science project AuBe on 30 October. Information was presented on the issues of light pollution and environmentally friendly lighting. Professor Beate Jessel, President of the German Federal Agency for Nature Conservation (BfN), also joined the event live, and presented policy recommendations from a national perspective. → page 8

PD Dr. Franz Hölker, hoelker@igb-berlin.de
Dr. Sibylle Schroer, schroer@igb-berlin.de

SEPTEMBER

Event: UWI conference

The first conference of the DFG research training group Urban Water Interfaces (UWI), organised jointly by IGB and Technische Universität Berlin, was held in September. The 53 presentations and five keynote presentations delivered by experts in water research and management highlighted recent advances on urban water management. Around 170 participants took part in the online event – more than could have been accommodated at the originally planned face-to-face meeting in Berlin.

View presentations at
→ http://bit.ly/UWI-Konferenz

PD Dr. Sabine Hilt, hilt@igb-berlin.de
Professor Mark Gessner,
gessner@igb-berlin.de

Urban Water Interfaces (UWI)

OCTOBER

Event: Second National Water Forum

The Second National Water Forum, organised by the Federal Ministry for the Environment (BMU) and the Federal Environment Agency (UBA) in October, marked the conclusion of a two-year dialogue process on the future of water management in Germany. IGB's Jörg Lewandowski, Martin Pusch and Markus Venohr contributed to the expert panels. The results will be incorporated into the draft National Water Strategy, which the Federal Government plans to present in 2021.

→ www.bmu.de/wasserdialog

Photos: BiCEST © Gaby Stein/pixabay; AuBe © David Ausserhofer

Internal matters: Seeking greater equality

In November, IGB adopted an Equal Opportunities Plan for the next two years. The Plan consists of core principles, objectives and measures to promote equal opportunities for women and men. Examples of areas of action include improving the gender balance among researchers at all stages of their careers, and promoting more family-friendly working conditions at the Institute.

Dr. Kirsten Pohlmann,
kpohlmann@igb-berlin.de

Project launch: Ponderful

IGB became involved in the EU-funded PONDERFUL project in December. The name says it all, given that the project is all about pond ecosystems. Studies suggest that, because of their abundance, heterogeneity, biodiversity and biogeochemical potency, ponds play an important role in mitigating the impacts of climate change. Under the leadership of the University of Vic (Spain), researchers from eleven countries – including Thomas Mehner and Luc De Meester – are investigating what benefits ponds and pondscapes have to offer in tackling climate change, conserving biodiversity and providing ecosystem services to mankind.

PD Dr. Thomas Mehner, mehner@igb-berlin.de
Professor Luc De Meester, luc.demeester@igb-berlin.de

NOVEMBER

Event: Book a Scientist

During *Book a Scientist* – speed dating with science – anyone interested had the opportunity to talk to an expert from the Leibniz Association about their research topics for 25 minutes. IGB researchers Sibylle Schroer, Gregor Kalinkat, Ruben van Treeck and Fabian Schäfer were involved in the event.

Event: Falling Walls

The Falling Walls Conference in Berlin took place digitally this year – but not without embracing IGB topics: Sonja Jähnig and Robert Arlinghaus were among the finalists of the Science Breakthroughs of the Year. In five-minute videos, they explained which walls their research seeks to tear down.

All finalists
→ https://falling-walls.com/remote2020/finalists/

DECEMBER

Consultation: National Strategy Plan for Aquaculture

The National Strategy Plan for Aquaculture in Germany (NASTAQ) was revised and updated in 2020. IGB also contributed to the process. For example, Fabian Schäfer attended the Aquaculture Round Table of the Federal Ministry of Food and Agriculture (BMEL) and reported on the experience of consumer perception and consumer information related to the IGB portal www.aquakulturinfo.de.

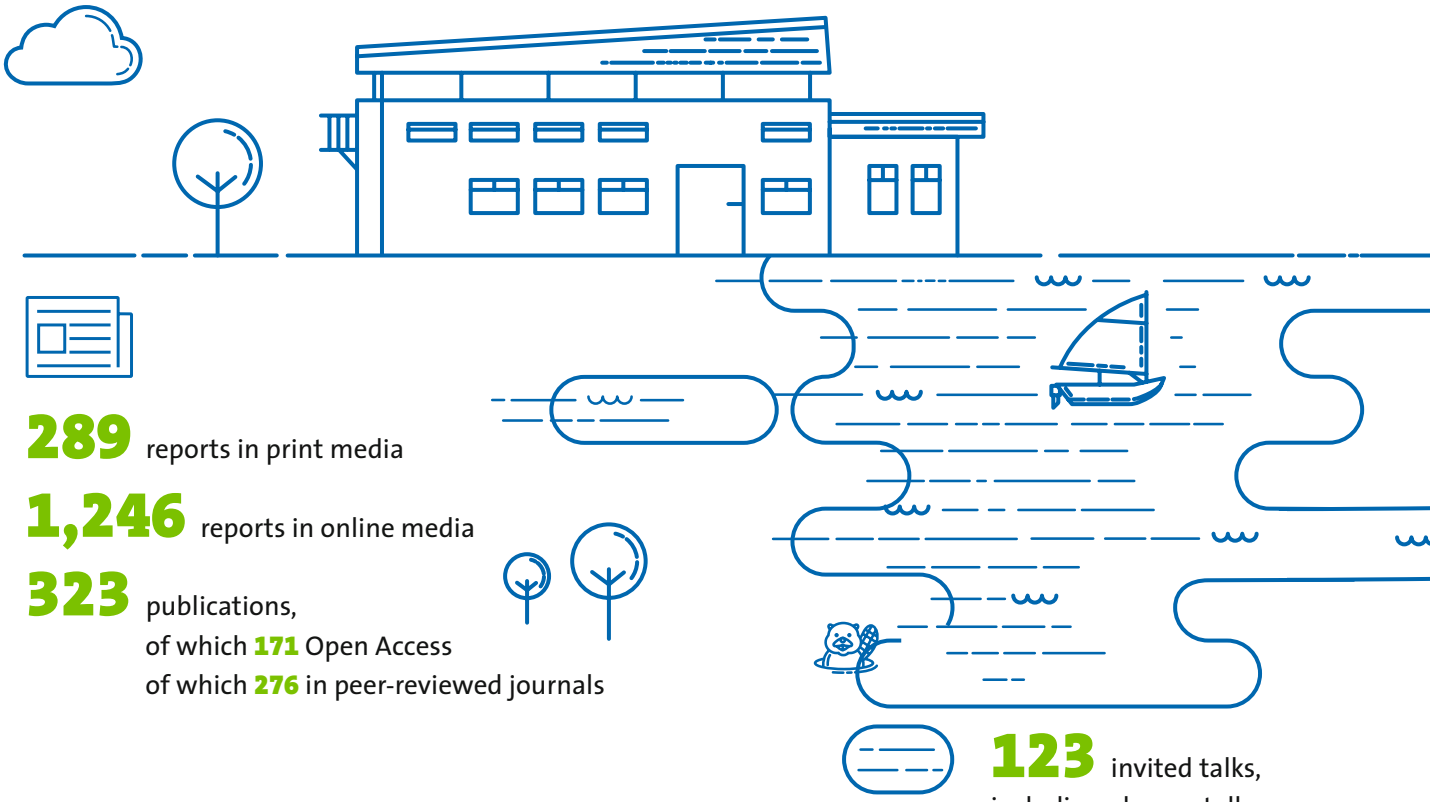
Read more information in the related IGB Policy Brief
→ page 17

Dr. Fabian Schäfer,
schaefer@igb-berlin.de

About us

2020 in numbers

365 employees,
including **155** scientists
and **94** science supporting staff,
114 guests and other people working at IGB



289 reports in print media

1,246 reports in online media

323 publications,
of which **171** Open Access
of which **276** in peer-reviewed journals

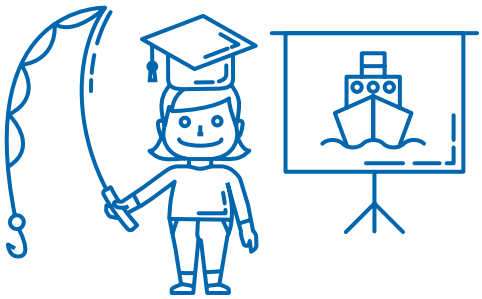
123 invited talks,
including plenary talks,
keynote lectures and
other scientific talks

32 scientific events and workshops,

including **17** with
international participation

and

1,550
participants in total



Status as of 31 December 2020

25 employees active in teaching

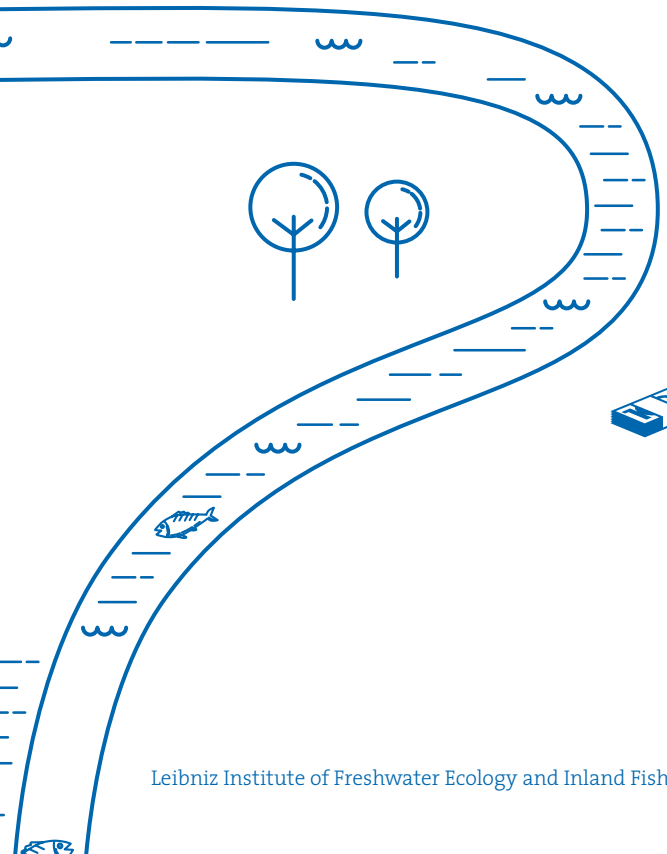
54 doctoral students

9 doctoral dissertations

19 *Diplom*, Master's and Bachelor's theses

12 joint professorships with universities

28 IGB colloquia (public scientific talks with internal and external speakers)



External funding: **€7.474 m**

Institutional funding: **€16.161 m**

Overall budget: **€23.635 m**

Proportion of external funding: **32%**

People

New professorship

IGB has a new professor: **Sonja Jähnig** was a successful candidate in the Leibniz Programme for Women Professors, and was jointly appointed Professor of Aquatic Ecogeography by IGB and the Humboldt-Universität zu Berlin in April 2020. As part of the funding, she is exploring large freshwater species (megafauna) such as sturgeons, beavers or river dolphins and how their disappearance affects the stability and functions of freshwater ecosystems. She is also investigating society's perception of these species and how findings on this can be used for nature conservation. The *Leibniz Programme for Women Professors* is aimed at top international female scientists from all disciplines. Sonja Jähnig is co-founder of the *Alliance for Freshwater Life* and is considered an excellent scientist within the field of limnology.

→ page 42

Professor Sonja Jähnig,
sonja.jaehnig@igb-berlin.de

German Communicator Prize

Robert Arlinghaus received the German Communicator Prize 2020 from the *Deutsche Forschungsgemeinschaft* (DFG, German Research Foundation) for his multifaceted commitment. The highest national award for science communication is endowed with €50,000, and is intended to strengthen exchange between research and society. The prize honours him for his outstanding communication on sustainable fisheries, navigating the tension between the use and the conservation of underwater biodiversity. He succeeds in "linking an apparently special topic such as recreational fisheries with the socially relevant issues of sustainability, environmental protection and the responsible use of nature," the jury commented.

Unfortunately, the award ceremony had to be cancelled due to COVID-19. Instead, the DFG presented a film about the award winner
→ https://youtu.be/zifRTURfk7c.

→ pages 16 and 26

Professor Robert Arlinghaus,
arlinghaus@igb-berlin.de

Central Equal Opportunities Officer

The IGB early-stage researcher **Marta Alirangues** was elected as the first Central Equal Opportunities Officer by all female employees of the *Forschungsverbund Berlin* (FVB) in November 2020. With the newly created position, the FVB is significantly stepping up its efforts towards gender equality. Over the next four years, Marta Alirangues will

Photos: Portraits Arlinghaus, Jähnig © David Ausserhofer; Portrait Alirangues © private

primarily be responsible for promoting the strategic development in the areas of gender equal opportunities and work-life balance in science. "I want to improve the situation of women in science. And I believe that big changes can only be achieved together. That's why I want to build up a network and an exchange platform with representatives of other national and international research institutions," she said about her new task.

Marta M. Alirangues Núñez,
alirangues@igb-berlin.de

Further information on equal opportunities in the FVB
→ https://www.fv-berlin.de/en/careers/chancengleichheit

Employees at IGB in 2020

155 scientists
including **57** postdoctoral scientists
including **36** doctoral students
94 science supporting staff
2 apprentices
1 IGB-funded fellow
24 assistants and temporary staff
114 guests (other people working at the Institute such as guest researchers, third-party fellows, students, interns, environmental sector volunteers (FÖJ))
365 **in total**

Share by gender

Science:

Science supporting staff:

We also congratulate:

- **Dörthe Tetzlaff** was elected as a Fellow of the *Geological Society of America* (GSA) in April 2020. This recognises her lasting contribution to the geosciences. The renowned expert is also a member of the ERC Advanced Grant Panel 2020.
- **Fengzhi He** took 1st place in the student competition of the *International Society of Limnology* (SIL), which awards the prize every two years for the three best publications in the field of limnology. Fengzhi He received the award for his article on the worldwide decline of large freshwater animal species.
- **Mandy Velthuis** received 2nd place in the same competition for her publication on the influence of global warming on the carbon cycle in shallow waters.
- **Philipp Wolke**, former Master's student at IGB, took 3rd place in the Schwoerbel-Benndorf Young Scientist Award of the *German Society for Limnology* (DGL). He was awarded for his Master's thesis and a technical article on the influence of the migration speed of bed forms on the oxygen dynamics in the hyporheic zone.
- **Mina Bizic** is one of 25 women selected for the 16-month *Leibniz Mentoring Programme*. The programme supports excellent female postdoctoral researchers on their way to a leading position or professorship.
- **Hans-Peter Grossart** was honoured by the journal *Limnology and Oceanography* (L&O) as "Outstanding Associate Editor". He supervised more than 35 manuscripts for the flagship of the *Association for the Sciences of Limnology and Oceanography* (ASLO) in 2020.
- **Robert Schwefel**, postdoctoral researcher at IGB, was highlighted by the L&O as "Outstanding Reviewer".
- **Alexander Sukhodolov** has been elected to the leadership team of the Fluid Mechanics Committee of the *International Association for Hydro-Environment Engineering and Research* (IAHR).
- **Klement Tockner**, who led the IGB from 2007 to 2016, is the new Senckenberg Director General. We are delighted to see our former director and guest scientist back at the Leibniz Association!

Award-winning human resources development at IGB

The "HR Excellence in Research Award" has been conferred on us by the European Commission in recognition of our HR development strategy. Every three years, we commit to new tasks, the implementation of which is assessed externally on a regular basis. Kirsten Pohlmann, our Career Development Coordinator, explains the process behind the "Human Resources Strategy for Researchers" (HRS4R).

IGB is currently being assessed under the European Commission's HRS4R for the third time. The first question is a simple one: Why?

Kirsten Pohlmann: The answer is also simple: We want to make sure that good employees enjoy working with us under the best possible conditions – and that those starting out on a career in research or related areas are well prepared for the task.

Why did IGB choose the more difficult path of an EU programme?

When I came to IGB as a postdoctoral researcher, there were not as many doctoral students and postdocs as there are today, so it was easier for the supervisors to ensure their individual professional development. Then, fortunately, there was a steady growth in the number of early-stage researchers who joined us, and the staff body became increasingly international, resulting in more diverse educational backgrounds. What started out as statistics courses evolved into the IGB doctoral programme. And this led, in turn, to our recognition of the need for systematic career support for all IGB employees.

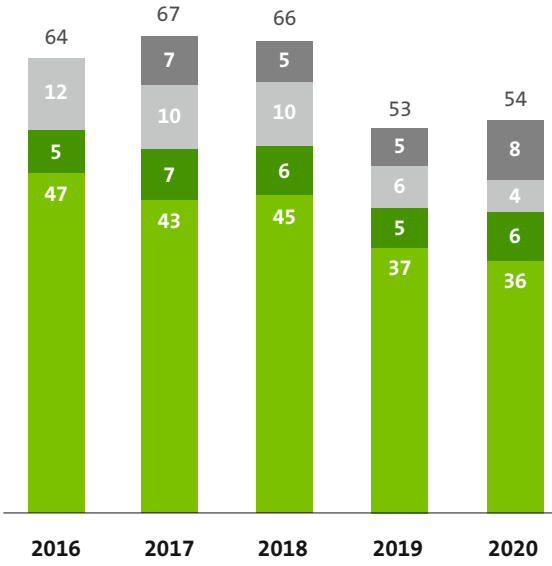
In other words, the statistics course got promoted...

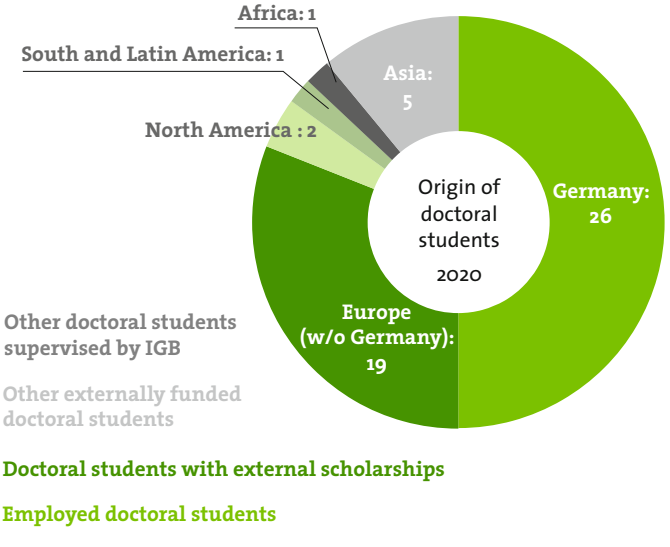
...and paved the way for other centrally organised professional development measures. What followed was training for junior group leaders, and then training for all group leaders – and finally the need for greater urgency and commitment. Given that IGB is a research institute with an international outlook, we opted for the EU's HRS4R programme. An additional advantage is that we can learn a lot from other European institutions that started the process before us or have even better measures in place.

How has the HRS4R process changed things for staff at IGB?

We could, of course, have continued to work on our improvement of our own accord. But the official process means that HR Development was further prioritised at IGB, enabling us to drive the necessary changes in a more systematic way. Development of the measures takes place in a highly participatory manner: the decision to improve our HR development strategy was taken by the IGB management. But the actual measures are developed by representatives from all staff groups, and

Doctoral education





Status as of 31.12.

are agreed with the management. An excellent division of tasks, which guarantees that everyone backs the measures. This process requires us to honestly ask ourselves, time and again and in a structured way, where we see potential for improvement.

And where is there potential for improvement at IGB?

Initially, examples included the issues of internationalisation and the need to communicate in two languages at IGB; the "overlooked" postdoctoral researchers; and the lack of transparency in recruitment and tenure track procedures. We are now well prepared when it comes to English, and need to start focusing on German-language content again – in other words, it will still take some time for us to implement bilingualism to suit everyone. For postdocs, we now have a Postdoc Society, a training budget and annual networking meetings in place. What's more, we have introduced clearly structured and binding recruitment guidelines and a tenure track procedure that other institutes use as templates.

Which measures have made it to the current action plan?

We now interpret "4R" – i.e. "for researchers" – much more broadly, and also focus on academic support staff, who are vital to research at IGB. Our goal is to pool our technical and methodological skills more effectively, and to support further training of our staff in this field. We also want to develop a diversity concept for IGB by 2023, and significantly step up our gender equality efforts once again. We have almost completed our policy against sexual harassment, which will be accompanied by training activities. Other key areas for the next three years are the topics of Open Science, our internal communication, and the renewal of our IT infrastructure, which should facilitate hybrid working, among other things. The plan also includes support for international research internships for our early-stage researchers – just to mention a few of the 70 or so measures.

Are you concerned about the results of the current evaluation?

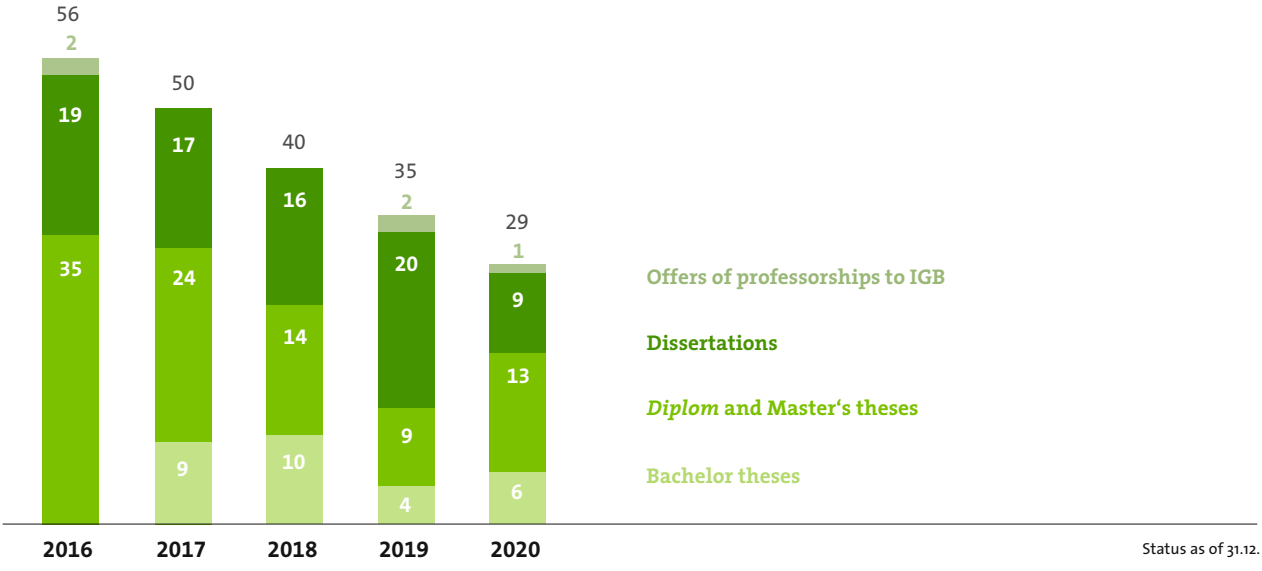
Well, does anyone like being evaluated? Actually, I'm intrigued, more than anything else. The experts look to see whether we have successfully implemented our 2017-2020 Action Plan. And they assess whether our plans for 2021-2023 are overly ambitious or not ambitious enough, whether the measures seem promising, and whether we have dropped important aspects from the agenda. Of course, we would love them to conclude that everything has been thought through and implemented perfectly. But as we all know, there is always room for improvement. We are therefore eager to find out how and where they propose further improvements. The experts have considerable experience from their own research institutions as well as other facilities in Europe, so we can expect all sorts of good ideas.

The interview was conducted by Katharina Bunk.

Dr. Kirsten Pohlmann, kpohlmann@igb-berlin.de

To find out more about our philosophy and about the work and research conducted at IGB, take a look at our website, which also features our current vacancies
→ www.igb-berlin.de/en/career

Degrees & Co.



Status as of 31.12.

Photo: Portrait Pohlmann © David Ausserhofer

Publications

Scientific highlights

On the IGB website we present a new overview of selected publications, which you can filter according to topics, departments and cross-cutting research domains.

→ www.igb-berlin.de/en/selected-publications

In 2020, there was a total of 323 publications by IGB authors, including 276 articles in peer-reviewed journals. All publications were listed and searchable in the IGB Library online catalogue (OPAC).
→ www.igb-lib.igb-berlin.de

IGB supports the principles of open science. Our Open Access Policy reflects our commitment to providing free access to knowledge and research results. 171 IGB publications were published directly in open access in 2020, bringing the open access rate to 53 per cent.

We participate in various transformative agreements and were thus able to publish 27 articles in hybrid open access. In addition, the IGB Publication Fund covered the article processing charges (APC) for 25 publications in gold open access. We also work towards making all closed access articles that originated at IGB accessible in green open access via the repository PUBLISSO. This was the case for 14 publications in 2020.

The most cited article from 2020

Wijayawardene, N. N., et al. (2020). Outline of fungi and fungus-like taxa. **Mycosphere, 11**(1), 1060-1456. https://doi.org/10.5943/mycosphere/11/1/8

Library

The IGB Library is specialised in limnological literature and holds a stock of about 46,000 print media and extensive electronic licences. It offers a wide range of services and advises on publishing and open access.

The library primarily serves the IGB staff. It is open to the public by appointment only.
→ www.igb-berlin.de/en/library

Dr. Thomas Gerdes and Caroline Schmunck,
library@igb-berlin.de

Transformative agreements

One path towards more open science is to transform the subscription models of established journals into open access models. Transformative agreements, such as DEAL, contain read and publish components. By paying publish and read fees, articles published in closed access journals by IGB authors become accessible in hybrid open access.

List of all IGB publications from 2020

→ bit.ly/IGB-Publications-2020

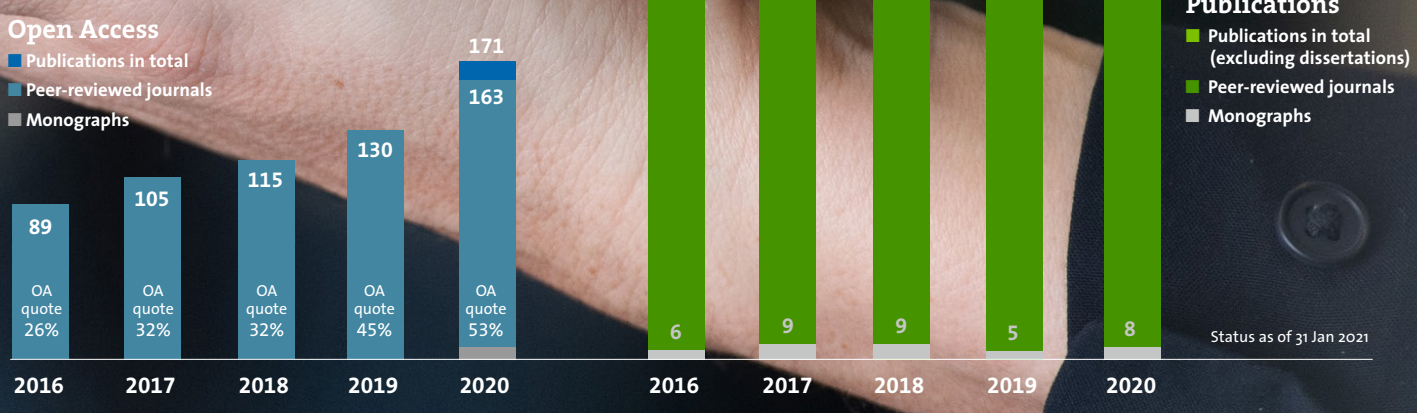
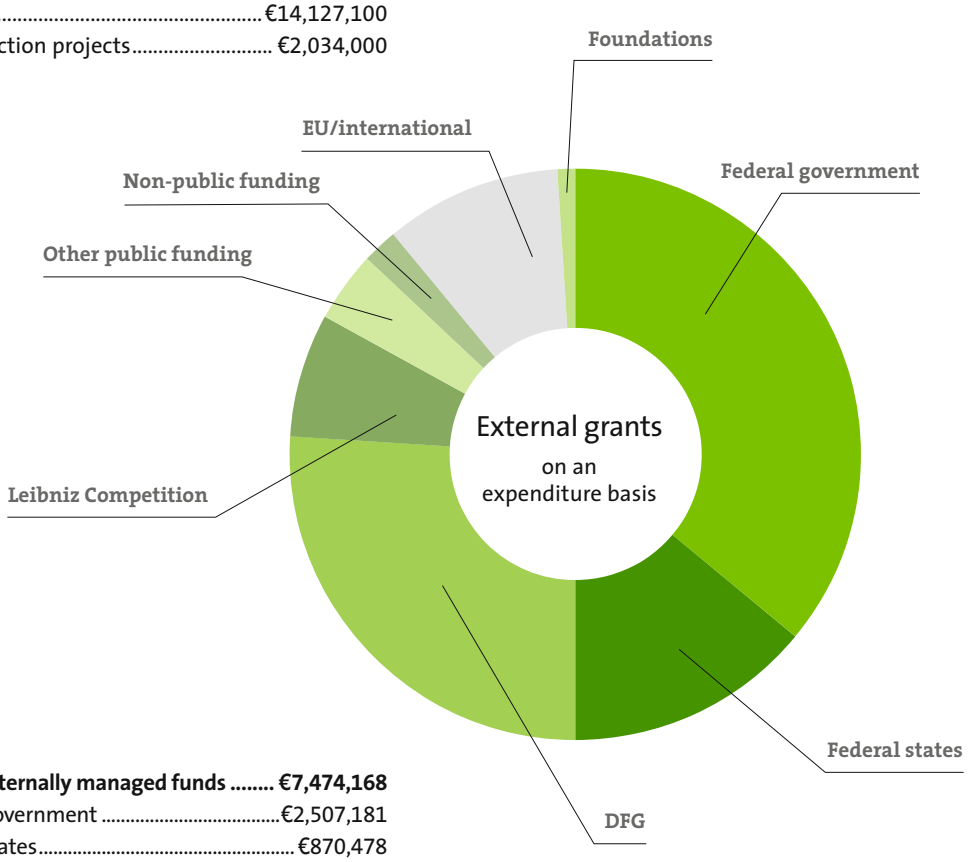


Photo: David Ausserhofer

Funding in 2020

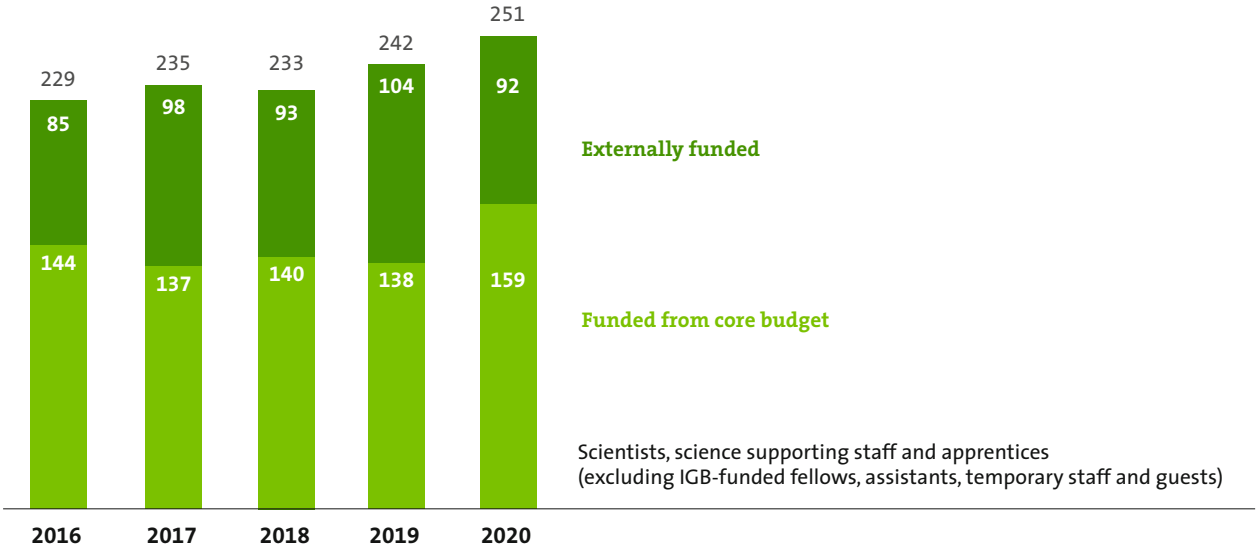
Status as of 31 December 2020

Institutional funding from the federal government €16,161,100
of which core budget €14,127,100
of which for major construction projects..... €2,034,000



External grants, incuding externally managed funds €7,474,168
of which from the federal government €2,507,181
of which from the federal states..... €870,478
of which from the DFG.....€1,751,530
of which from the Leibniz Competition..... €531,728
of which from other public funding..... €158,629
of which from non-public funding..... €111,242
of which from the EU/international €961,934
of which from foundations.....€84,865

Employees broken down by funding

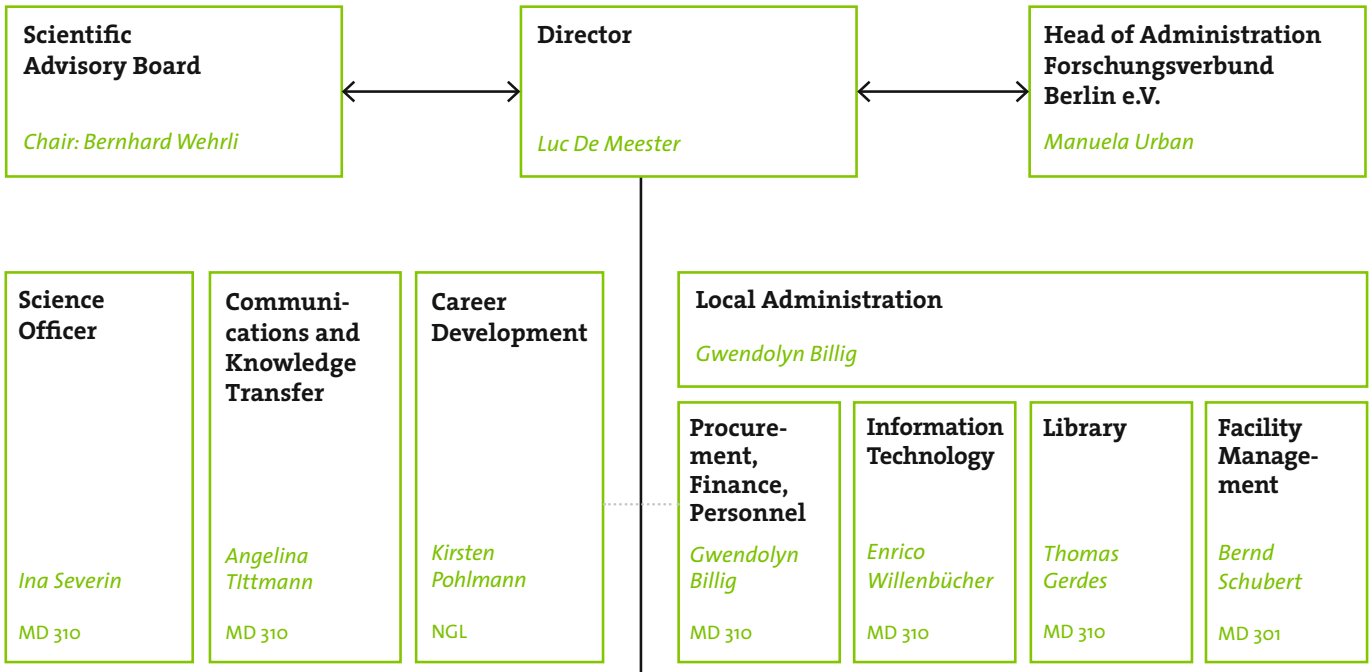


Structure

Always up-to-date on our website
→ www.igb-berlin.de/en/structure

Leibniz Institute of Freshwater Ecology and Inland Fisheries

Forschungsverbund Berlin e.V.



Research departments

Cross-cutting research domains

CCRD 1 – Aquatic Biodiversity

Hans-Peter Grossart and Jonathan Jeschke
NGL & FU Berlin

CCRD 2 – Aquatic Fluxes under Global Change

Tobias Goldhammer (a.i.) and Sabine Hilt (a.i.)
MD 301

CCRD 3 – Human-Aquatic Ecosystem Interactions

Christian Wolter
MD 310

MD 310: Müggelseedamm 310, Berlin | MD 301: Müggelseedamm 301, Berlin | NGL: Neuglobsow, Stechlin

Status as of February 2021

Scientific Advisory Board of IGB

Professor Bernhard Wehrli
Chair of the Scientific Advisory Board
Department Surface Waters Research & Management, Eawag, Switzerland

Professor Christoph Schneider
Deputy Chair of the Scientific Advisory Board
Geography Department, Humboldt-Universität zu Berlin, Germany

Professor Beatrix Beisner
Département de Sciences Biologiques, Université du Québec à Montréal, Canada

Professor Petra Döll
Institute of Physical Geography, Johann Wolfgang Goethe-University Frankfurt am Main, Germany

Professor Nelson G. Hairston Jr.
Frank H. T. Rhodes Professor of Environmental Science, Emeritus, USA

Professor Ken Irvine
UNESCO-IHE Institute for Water Education, the Netherlands

Dr. Anita J. T. Narwani
Department Aquatic Ecology, Eawag, Switzerland

Professor Gunilla Rosenqvist
Uppsala University - Campus Gotland, Sweden

Representatives at IGB

Ombudsperson
Sabine Hilt and Sabine Wollrab (deputy)

Equal Opportunities Officer
Kirsten Pohlmann and Justyna Wolinska (deputy)

Disability Representative
Georg Staaks

Doctoral Student Representatives
Benjamin Archer, Laura Jentzsch, Birgit Müller, Hanna Schulz, Kai-Ti Wu

Postdoc Representatives
Andreas Jechow (speaker), Gregor Kalinkat, Renee van Dorst, Simone Podschun, Kingsly Chuo Beng

Works Council
Sascha Behrens (chair), Thomas Hintze, Eva Kreuz, Marén Lentz, Kerstin Schäricke, Claudia Schmalsch, Viola Schöning, Georg Staaks, Antje Tillack

Always up-to-date on our website
→ www.igb-berlin.de/en/structure

Status as of February 2021

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:

Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB)
in the Forschungsverbund Berlin e.V.
Müggelseedamm 310
12587 Berlin, Germany

www.igb-berlin.de/en
Telephone: +49 30 64181-500
Email: info@igb-berlin.de
Facebook: IGB.Berlin
Twitter: @LeibnizIGB
Newsletter: www.igb-berlin.de/en/newsletter

Imprint

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

Publisher: Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB)
Responsible according to the German Press Law: Luc De Meester, Manuela Urban
Editorial staff: Angelina Tittmann
Design: Stephen Ruebsam

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

https://dx.doi.org/10.4126/FRL01-006426602

Leibniz Forschungsverbund Berlin e.V.

Leibniz Association

Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB)
Forschungsverbund Berlin e.V.

Locations in Berlin-Friedrichshagen:
Müggelseedamm 301 & 310
D-12587 Berlin

Location in Berlin-Adlershof:
Justus-von-Liebig-Str. 7
D-12489 Berlin

Location in Stechlin:
Zur alten Fischerhütte 2
16775 Stechlin OT Neuglobsow

www.igb-berlin.de/en