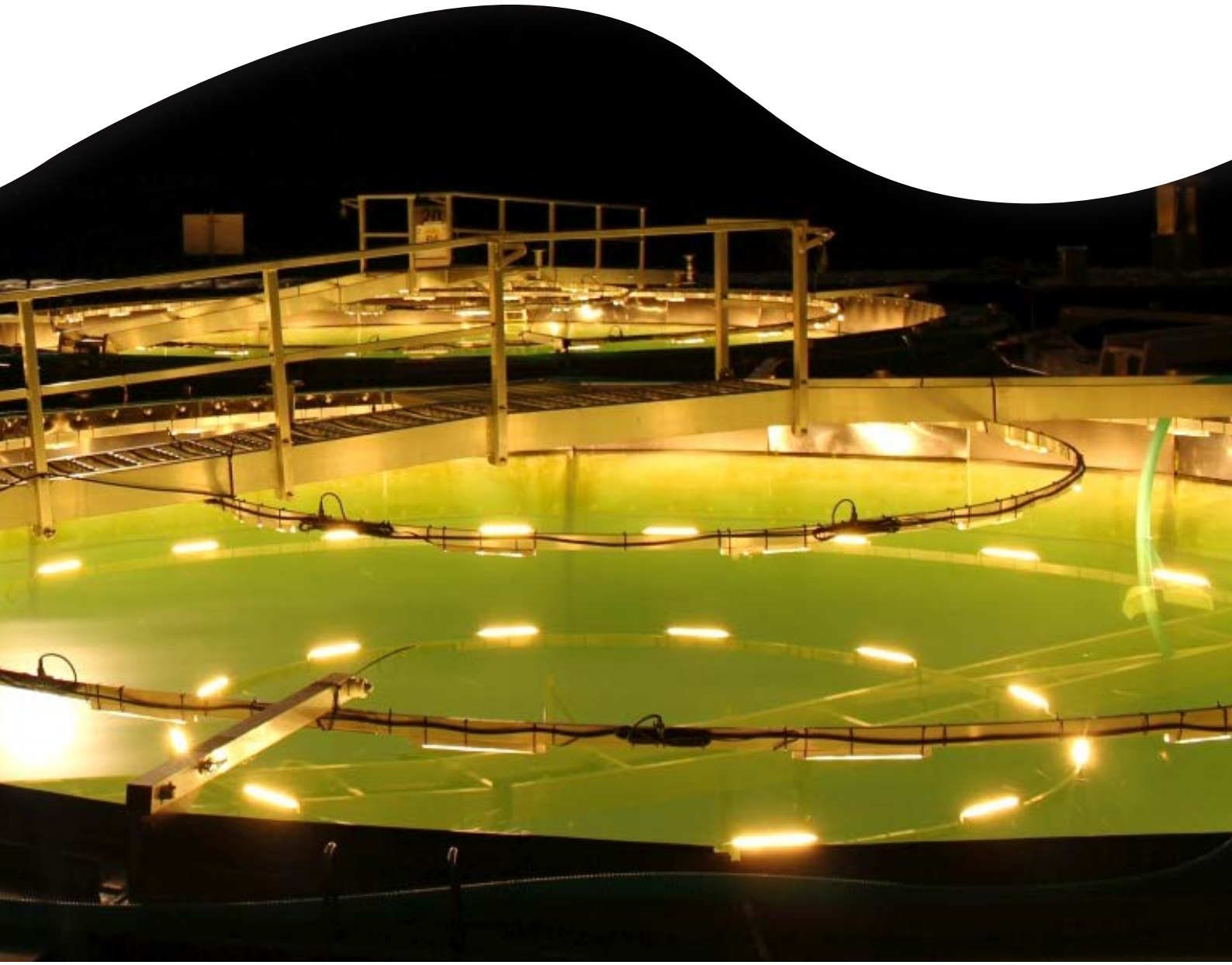
IGB

Leibniz-Institute of
Freshwater Ecology
and Inland Fisheries

Freshwater Research 2017

IGB Annual Report



Use & Management
New approaches to water management and species protection

Water & Matter Cycles
Greenhouse gases from freshwaters

Aquaculture & Aquaponics
Research for sustainability – from feed to fillet

Angling

Aquaculture & Aquaponics

Biodiversity

Dialogue & Transfer

Freshwater Ecosystems

Use & Management

Multiple Stressors & Pollutants

Environmental Change

Behavioural Ecology & Swarm Intelligence

Water & Matter Cycles

Research for the Future of our Freshwaters

IGB is Germany's largest research centre for freshwaters, where scientists from a broad range of disciplines work under the same roof. Forces are joined to investigate the fundamental processes governing rivers, lakes and wetlands, and to develop measures leading to sustainable water management.

On the following pages we present selected research results, projects and events that represent highlights of the year 2017. The content is organised in ten overarching topics, in which we hope will be of particular interest to you. For each topic, you will find further information, materials, contact details of experts as well as background information and news on our website.

www.igb-berlin.de

On Teams and Big Pictures

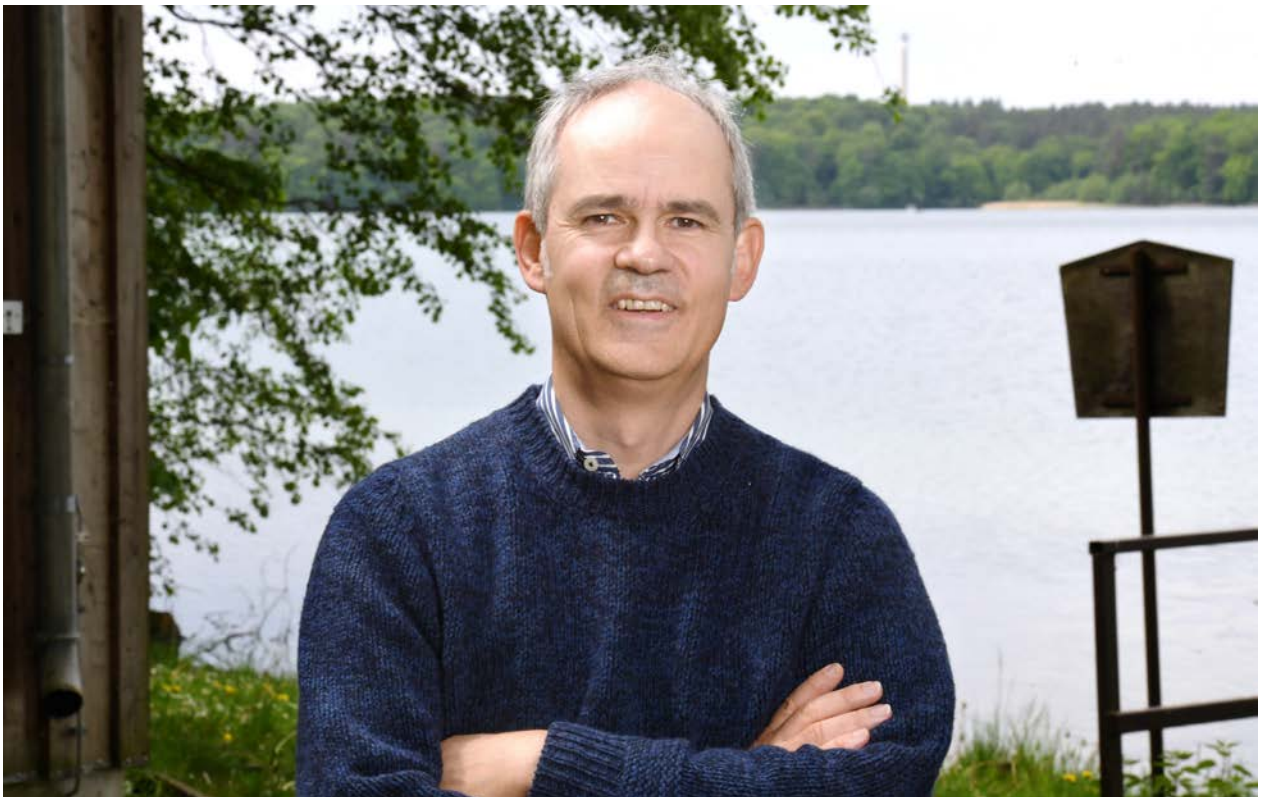


Foto: David Ausserhofer

Thinking out of the box with the big picture in mind is one of the important precepts in today's research environment. This is due to the ever-increasing specialisation that prevents a clear vision of the whole, and to the growing expectations of society for science to develop cross-disciplinary approaches that address global challenges. Teamwork is vital in this context. It offers unfamiliar perspectives beyond individual disciplines and opportunities to promote basic knowledge and to develop solutions to pressing problems facing society.

Many regret the vanishing of the polymath. Alexander von Humboldt is often cited as a shining example of such scholars, as is Gottfried Wilhelm Leibniz, the namesake of our association. And yet we all too often forget that Leibniz and Humboldt were by no means alone in their interdisciplinary and transdisciplinary endeavours. On the contrary, lively exchange with their peers from diverse scientific disciplines and with numerous other correspondents in politics and society at large was a mainstay of their success. Both scholars thus clearly exemplify the archetype of the international networker. This is testified not only by their extensive body of correspondence.

Humboldt in particular is remarkable not just on account of the many years of field investigations he is so well known for. He also travelled extensively as a lecturer and valued discussion partner and spent extended research stays at scientific institutions in Europe and America, where he conducted comparative empirical research – in direct collaboration with colleagues – to derive general principles. Clearly, teamwork in networks and research alliances that bring together complementary expertise and ingenuity is by no means a new phenomenon. Now, however, following the footsteps of the polymaths, teamwork has become essential for environmental research to make new discoveries, understand the big picture and apply the knowledge for the benefit of society.

The IGB Annual Report 2017, which you hold in your hands, will often use words like "interdisciplinary" and "transdisciplinary." And you will find hints to the networks and cooperations, large and small, within which much of IGB's research is organised – whether at institute or elsewhere in Germany or abroad. Indeed, major international collaborations are not the only way to take a broad view and think out of the box. Scientific

exchange and collaboration with colleagues in the lab or office next door can be equally fruitful. After all, scientists with notably different backgrounds work under a single roof at IGB. Leibniz and Humboldt would have envied us.

The collaborative project "Illuminating Lake Ecosystems" (page 56) is one such example: more than 50 participants from virtually all IGB departments have been contributing, plus various international partners. The project involves large-scale experiments in IGB's LakeLab supported by teams of scientists with complementary expertise. The unique opportunities that this facility offers are also one of the reasons why IGB plays a key role in the EU-funded infrastructure project AQUACOSM (page 54), which is coordinated at IGB and seeks to achieve a conceptual, methodological and practical fusion of experimental ecosystem research in oceans, lakes and flowing waters.

The BAGGERSEE project (page 13) is an example of innovative transdisciplinary research. In collaboration with representatives of a Nature Conservation Foundation in Berlin and the Angling Association of Lower Saxony, which unites 20 fishing clubs, the project investigates how water-related recreation and nature conservation can be reconciled. The AQUATAG project (page 12) pursues a similar objective, exploiting new means of communication by analysing Twitter data to gain insights into water-related leisure activities.

IGB has collaborated with partners in science, policy, businesses and civil society for a long time, including in the past year. The goals are to develop solutions and recommendations for action to mitigate pressing environmental issues and, thus, to support decision-making processes at the local, national and international level. As part of our Science Society Interface (SSI) strategy, IGB continued in 2017 to engage in dialogues with stakeholders and the public. This involved activities such as organising events on light pollution and freshwater biodiversity (page 46). In addition, IGB was instrumental in launching the Alliance for Freshwater Life (page 55), which aims to give freshwater biodiversity a voice at the global and regional level by promoting both coordinated scientific research into and effective conservation of biodiversity in inland waters.

Attention is given to interdisciplinarity and transdisciplinarity at IGB also when it comes to training early-career scientists. For example, IGB is currently involved in a project named Euroflow (EUROpean training and research network for environmental FLOW management in river basins; page 11), which intends to convey important aspects of river management to young researchers. The Innovative Training Network MANTEL (Management of Extreme Climatic Events in Lakes and Reservoirs for the Protection of Ecosystem Services; page 14) and the Urban Water Interfaces (UWI) Research Training Group (pages 29 and 42), in which IGB has been involved for several years, aim to draw attention to the bigger picture beyond the individual research questions of the doctoral students.

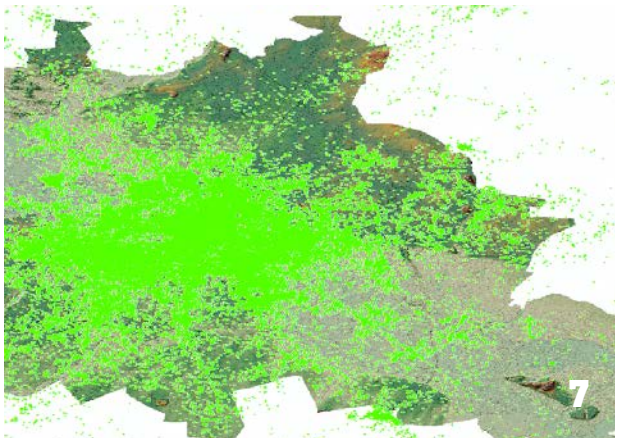
The appointment of the new IGB director also reflects the institute's focus on teamwork and cooperation across disciplinary boundaries. Professor Victoria Braithwaite will start in her new role at IGB and as a professor at the Freie Universität Berlin in summer this year. The British scientist with experience in research and teaching in the UK, Norway and, for the last 10 years, at Penn State University in Pennsylvania, USA, is well familiar with interdisciplinary and cooperative research. Trained as a behavioural ecologist, she has quickly established cross-disciplinary links with neurosciene and other disciplines and has assumed leadership roles as a coordinator of such collaborations. She is also no stranger to Germany, having spent two years in Berlin as a fellow of the renowned Institute for Advanced Study. We are delighted that IGB is now set to benefit from her professional and personal skills and her leadership experience.

I am most grateful to our partners for accompanying and supporting IGB on our interdisciplinary, transdisciplinary and also disciplinary journeys in 2017. These partners include, foremost, the three large universities in Berlin as well as the University of Potsdam, our close allies in teaching and research; our Scientific Advisory Board; the Forschungsverbund Berlin; and the Leibniz Association. My equally sincere thanks go to the representatives of the Senate Chancellery of the Federal State of Berlin and the German Federal Ministry of Education and Research (BMBF) for enabling IGB's accomplishments last year by providing a solid base funding and non-material support. Some of these achievements are outlined in this Annual Report. Besides the financial contributions, I particularly appreciate the open and constructive dialogue, which helps us to overcome the occasional adversities befalling science management. Last but not least, I would like to thank the entire IGB team – our many staff members who engage in research, administration or technical activities. Without their commitment the institute would merely be an empty shell.

Yours,

Mark Gessner
Acting Director

Contents



innovative

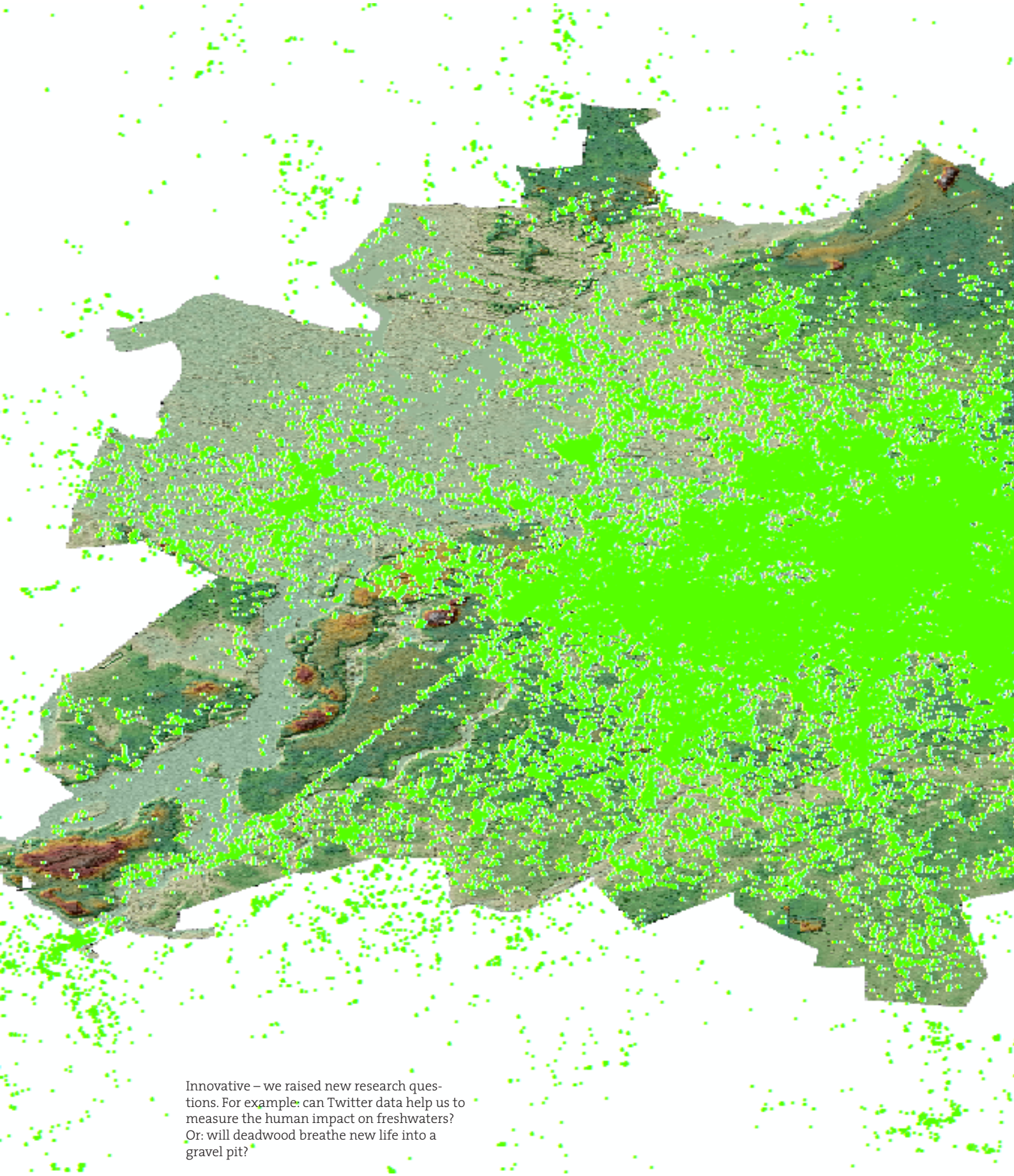
curious

sought-after

interconnected

committed

annex



Innovative – we raised new research questions. For example: can Twitter data help us to measure the human impact on freshwaters? Or: will deadwood breathe new life into a gravel pit?

innovative

New Projects and Initiatives

Tweets of Berlin, 2011-2015. Background: Geoportal Berlin

“The things we enjoy doing produce better results”

Photo: private

Professor Dörthe Tetzlaff has been Head of IGB’s Department of Ecohydrology since August 2017, and Professor of Ecohydrology at Humboldt-Universität zu Berlin. Prior to this, she worked as Professor of Hydrology and Landscape Ecology at the University of Aberdeen in Scotland.

What is the focus of your research?

The fundamental objective of my research is to better understand the temporal and spatial variabilities in the ecohydrological “behaviour” of catchment areas. I analyse the physical processes that cause runoff into freshwaters to find out how these processes influence the hydrochemistry and hydroecology of freshwaters. One of the key questions is: “What happens when it rains?” In my research, I integrate empirical and modelling approaches to quantify the interactions between physical and ecological processes and to assess sensitivities of catchment areas in light of environmental changes.

Why do you find your area of research so fascinating?
I love nature and I love water. My area of research always gives me a wonderful "excuse" to spend a lot of time in and with both of these. I find it fascinating how our complex natural world can be described by relatively "simple" laws of physics, but also how important it is to know the study area and to have actually experienced it. Such an understanding then forms the basis for the sustainable management of our water resources.

What brought you to IGB in Berlin?
The interdisciplinarity and opportunities IGB offers, including its central location in the Berlin scientific milieu. Its location in the heart of Germany and Europe offers unique opportunities. IGB is internationally renowned for its freshwater research, and I was delighted to be given the opportunity to become a member of this interdisciplinary team.

What attracted your attention first, (second, third) at IGB?
The friendly and collegial atmosphere struck me right away. You just love going to work at IGB – which is wonderful!

There must be things you miss when you think of Scotland, though, aren't there?
What I miss the most are the beautiful river landscapes and the lakes, the possibility to see wild salmon jumping in the rivers, the blue sky (when the sun is shining), the clear air, the mountains, the light green beech trees in spring, the purple flowering heathlands in summer and the orange-yellow birches in autumn – and the emptiness of the landscape. I am aware that this probably sounds excessively romantic, but Scotland is a beautiful country – a dream for any natural or environmental scientist.

What makes research such an exciting occupational field?
Research is incredibly diverse and exciting for curious people who simply cannot (and don't want to) stop exploring and who always want to know something new. It's fun to learn how nature "works". You usually discover something totally different than you had expected. In my view, every measurement is a good measurement and all data is interesting data.

What constitutes a good research and working environment?
Opportunities, trust and reliability: opportunities to implement ideas and visions. Trust in colleagues and cooperation partners. Reliability – knowing that you can unthinkingly rely on one another without a second thought. This is the basis for good research that is enjoyable to do. And the things we enjoy doing produce better results. Is there anything more enjoyable than looking forward to project meetings, if it means you see your friends again and learning more about our environment, enabling us to better manage our environment and freshwaters – and this is called "work"?

What do you think – what are the current challenges research policy has to face?
For 15 years, I worked and conducted research in a country where financial support for research was limited. Germany therefore seems to be a "land of milk and honey for science" for me. However, good financial support and equipment are not guaranteed on a long-term basis, which poses risks. In addition, I think too much bureaucracy acts as a barrier: innovative, ground-breaking research often needs quick and prompt actions and reactions.

Which question by students do you like to answer the most?
I have mainly worked in geosciences so far. In this area, there is still a considerable imbalance in senior positions regarding gender distribution. The majority of female PhD students (and female post-docs) do not have female supervisors or superiors. I try to encourage these young women to ask questions they usually would not or cannot ask. For example, I am often asked: "Is it possible to strike a balance between career and family, and if so, how?" I like this question, because it gives me the opportunity to say: "Of course! Be aware that you can get everything, if you want to. Pursuing a career does not exclude leading a normal family life. However, it is essential to possess creativity and flexibility, and to be able to set priorities so as to strike a balance between them. 'Lean in,' as Sheryl Sandberg would say, and do what you want to do!" It goes without saying that it helps when you have a partner who supports you.

What do you want for your department?
I very much appreciate and respect all the employees in my department. Each and every individual is important to ensure that everything works well. I want to support the excellent research of my colleagues and strengthen our position as a world-leading centre of excellent science in ecohydrological research. I hope that we will be able to maintain the motivating, collegial and inspiring work atmosphere for all employees in our department. There are so many wonderful and fascinating ideas: I am convinced that together we will be able to implement them and carry them out.

The interview was conducted by Nadja Neumann

Kontakt: Prof. Dörthe Tetzlaff,
Head of Department "Ecohydrology"

Photo: fotolia.com/MK

New IGB research group: Landscape Ecohydrology

We aim to understand how catchments function ecohydrologically at different spatio-temporal scales; linking landscapes and riverscapes by understanding the physical processes that generate stream flow, and the way these processes influence the hydrochemistry and ecohydrology of streams. We integrate insights from both field and modelling approaches. Crucially, one of our main tools is the use of stable isotope tracers as "fingerprints" of waters to quantify internal processes of water storage, transmission and release. We integrate such data into models to parameterise ecohydrological interactions in a physically-based way to quantitatively assess the effects of climate and landuse change. At present, the group is pursuing a strong focus on monitoring of soil-vegetation-athmosphere-water dynamics through tracers and tracer-aided modelling to identify how plant water use will affect and possibly alter signals of potential climate change. We conduct international inter-catchment comparison using insights from different geographical environments to synthesise a more holistic understanding of hydrological and ecological function. Most members of the working group are involved in the ERC-project VeWa (Vegetation effects on water flow and mixing in high-latitude ecosystems) at the University of Aberdeen, Scotland. Within this project, we are hoping to find out how plant water use will affect and possibly alter signals of potential climate change. Also, the comparisons made within this project will provide a base-line for evaluating how vegetation affects floods and droughts in northern environments.

"Understanding storage and pathways of water helps to predict and prevent major flooding." ***Dörthe Tetzlaff***

Dörthe Tetzlaff

IGB research group: Landscape Ecohydrology
Research group lead: Prof. Dörthe Tetzlaff
Main actual projects: VeWa – Vegetation effects on water flow and mixing in high-latitude ecosystems, funded by the European Research Council (ERC) at the University of Aberdeen (Scotland) and IGB; Linking small-scale hydrological flow paths, connectivity and microbiological transport to protect remote private water supplies, funded by Scottish Government at the University of Aberdeen, Scotland.
Current members of the research group: Dr. Audrey Douinot (Postdoctoral Research Fellow); Prof. Dr. Chris Soulsby (Professor at the University of Aberdeen, Scotland, UK; IGB Senior Visiting Fellow); Most members of the group are still based at the University of Aberdeen as part of the ERC funded project "VeWa".

Project: EUROFLOW

“Water is an important resource – for us humans and for the environment. Tomorrow’s river managers know exactly when and where how much water must flow.” ***Gabriel Singer***

The regulation of river discharge is one of the largest stressors affecting river ecosystems around the world: animal and plant species not only rely on a sufficient amount of water flowing, but also on the discharge behaviour following certain dynamics. Water abstraction and temporal water retention, such as for potable water supply or energy generation, reduce flow rates and change the flow behaviour, culminating in entire rivers temporarily running dry.

In addition to legislation, major efforts are underway to support the development of new approaches to mitigate the negative impacts of river flow regulation in many western countries. Such approaches are mainly based on optimising the management of river flows to maintain services to humans, while still protecting the aquatic ecosystem. However, to do this, it is necessary to have an adequate quantity and quality of water at a certain place and time – referred to as “environmental flows” or “e-flows”. One field of applied aquatic research revolves around the generation of the necessary empirical knowledge and expertise to develop the best management strategies. The EUROFLOW project, in which we are involved, will train a cohort of 15 researchers for exactly this job.
These early-stage researchers will gain new theoretical and empirical insights, via innovative experiments, large-scale field studies and cutting-edge models. This knowledge will enable them to support the management of river ecosystems and flow behaviour at the level of entire catchment areas. Training includes not only ecological aspects, but also elements to promote interdisciplinary and inter-sectoral collaboration. For this purpose, active networking between 15 individual projects and 23 participating institutions provide ideal conditions.

EUROFLOW is divided into four work packages: abiotic environmental dynamics, aquatic biodiversity, ecosystem processes, and the development of integrative models. The final work package brings together the findings of the first three work packages to bolster socioeconomic and political decision-making. The river systems used in the study include rivers in alpine environments as well as in hilly areas and plains, which are used for potable water supply, energy generation and irrigation.
We have been able to offer two doctoral students the opportunity to pursue their work within the EUROFLOW project as of February 2018. The first PhD project will examine changes in temperature conditions as a direct consequence of changes in river flow rates. The second project will focus on the conversion of organic carbon in scenarios of dynamic flow.

We expect EUROFLOW to break new ground in water supply, in energy generation and in relevant industrial sectors. In addition, the results of the project will be of major benefit to environmental agencies and policymakers – for example, to develop sustainable management of water resources at the EU level.

Gabriel Singer

Project: Euroflow – EUROpean training and research network for environmental FLOW management in river basins
Duration: 9/2017-9/2021
Funded by: EU Horizon 2020, Marie Sklodowska-Curie Innovative Training Network, Grant No 676108
Direction at IGB: Dr. Gabriel Singer (Dept. 1), Dr. Jörg Lewandowski (Dept. 1), 2 work packages with one early-stage researcher = PhD student each
Overall coordination: University of Leeds (United Kingdom)

Photo: David Ausserhofer

Photo: Andy Küchenmeister

"Twitter data offers exciting insights into water leisure." ***Markus Venohr***

Project: AQUATAG

The AQUATAG project aims to gain a better understanding of how rivers and lakes are used for leisure activities, and to find out whether, and to what extent, the ecology of these waters suffers at peak periods. The use of freshwaters for recreational activities is spatially and temporally very heterogeneous: we particularly enjoy spending time at lakes and rivers in summer, at the weekends and when the weather is nice, often spontaneously or just on a day trip. For this reason, averaged values are of no use when assessing whether extremely high use densities and frequencies, and hence short-term local stresses, are of a greater significance to ecosystems than previously assumed.

As a novel data source we use data from the messaging system Twitter for identifying usage peaks and hot spots.

Social media like from Twitter contain information about the location where and the time when users posted a message. This can be used to derive estimates on the frequency and preferred places for water bound activities. We can even determine whether the user is on the lakeside or in the middle of the lake. In the first step, we intend to precisely evaluate the data – some 3.5 million tweets in all – with regard to its temporal and spatial distribution.

The next step will address the interlinks between leisure activities on rivers and lakes, such as swimming, angling, hiking, or canoeing. Different users involved in different activity types have a specific perception on a good water and site quality: clear water for swimming, nutrient rich water for angling, infrastructure for boating or silence and biodiversity for wildlife enthusiasts. Most of these preferred conditions do not correspond to environmental or ecological target conditions and can cause conflicts among users and between users and managers.

We also want to investigate the joint effects of different types and intensities of uses on aquatic organisms. Such factors include noise from motorboats or chemical contamination from bathers' sunscreen that finds its way into the water. In addition to focusing on lakes, we also explore Federal waterways, which are used less intensively for shipping. By taking this approach, we create an intersection to the Federal Programme "Blue Ribbon Germany" (Blaues Band Deutschland), run by the Federal Ministry of Transport and Digital Infrastructure (BMVI).

The project also aims in developing a management concept to tackle potential conflicts of use. In an effort to identify such conflicts, we have already surveyed more than 600 participants, some of them in personal interviews at the water's edge. We wanted to know what the respondents considered important about their water leisure activities, and how their responses differed according to activity and social milieu. We also ran a workshop to find out which management recommendations interest stakeholders such as nature conservation associations and water sports clubs. We considered it important to conduct the survey and workshop before embarking on our scientific study – after all, we want our findings to be useful in practice, too. *Markus Venohr*

Project: AQUATAG "Leisure activities at rivers and lakes: dynamics, environmental impacts, social significance and sustainable management"
Duration: 04/2017-12/2017
Funded by: BMBF (ReWaM: Regional Water Resources Management for Sustainable Protection of Waters in Germany)
Overall coordination: IGB, Dr. Markus Venohr (Dept. 1)
Involving: IGB Departments 1 (PD Dr. Franz Hölker, Oliver Peters), 2 (Dr. Simone Langhans) and 4 (Prof. Robert Arlinghaus, Dr. Christian Wolter)

Photo: David Ausserhofer

"Gravel pit lakes and biodiversity – an unusual pair of terms. We want to make water-based recreation, particularly angling, and nature conservation mutually compatible."
Robert Arlinghaus

Project: BAGGERSEE

Little is known about the ecological importance of small water bodies measuring less than 50 hectares since they do not fall under the European Water Framework Directive. In IGB's new project BAGGERSEE (gravel pit lake), we now analyse whether – and how – aquatic species diversity can be protected whilst retaining and enhancing the recreational quality of such lakes, particularly for recreational fishing.

Germany's 20,000 or more gravel pit lakes are used intensively for local recreation, including angling, and are usually managed by anglers. Anglers have the legal authority to maintain and manage freshwater fish stocks and the lake shorelines and they influence fish stocks, habitat structures and any aquatic biodiversity by introducing harvest regulations, stocking fish and managing habitats. Traditionally, fish stocking is the most important management measure. Although such measures may represent species conservation for fish, they tend not to benefit other species. What is more, earlier studies undertaken at IGB demonstrate that fish stocking does not necessarily help increase fish stocks, and may even pose ecological and genetic risks. For this reason, BAGGERSEE investigates the extent to which littoral habitat improvement measures may be able to partly replace fish stocking.

The shore zone of many pit lakes is steep with little structural diversity. Few aquatic plants, offering protection and food, can be found growing there. In the BAGGERSEE project, we are transforming steep shores into shallow areas that can be colonised by plants. We also introduce dead wood. The aim of the project is to encourage lots of freshwater fish, amphibians and dragonflies to lay their eggs there, helping promote fish stocks and total species diversity. Introducing dead wood also creates new habitats: young fish find food there and are sheltered from their enemies. Dragonfly larvae as well as other invertebrates, amphibians, birds and creatures are also expected to benefit from the wooded, structured shore area. In this project, we investigate whether this is the case.

In addition to these habitat improvement measures, mixed specie stocking material will be added to other water bodies. The aim is to compare the measures taken in the shore zone to the traditional management measure of fish stocking. A number of managed and unmanaged pit lakes are used as control lakes, where we refrain from any kind of intervention. In addition, we are carrying out a species inventory in eleven further water bodies in terms of how these waters are used and equipped in terms of recreational amenities (boat launches, sunbathing areas, etc.). The data collected should enable us to predict the biological diversity that can be expected at artificial waters, acting as a planning basis for fisheries management and nature conservation.

Robert Arlinghaus and Katja Wiegner

Project: BAGGERSEE
Duration: 06/2016-06/2022
Funded by: BMBF and BfN with funding from the BMUB's Federal Programme on Biological Diversity
Overall coordination: IGB, Prof. Robert Arlinghaus (Dept. 4)
Project partners: Technische Universität Berlin (TU-Berlin) and the Angling Association of Lower Saxony (AVN). Twenty angling associations within AVN, two private individuals and the Stiftung Naturschutz im Landkreis Rotenburg (Germany) are also involved in the project.

Photo: David Ausserhofer

"Extreme climatic events are more than just a storm in a teacup: they can impair important functions of water bodies." ***Rita Adrian***

Project: MANTEL

Under a changing climate, it is highly probable that the number and intensity of extreme climatic events will continue to increase. In the ITN-MANTEL project, we study how such storm events or heatwaves affect the thermal structure and plankton dynamics in lakes at the global level.

Once critical threshold values have been exceeded in lakes, their long-term changes often develop non-linearly and may destabilise the system. We know little about the time scales we need to look at to be able to understand and predict such abrupt changes. Here, we are particularly interested in the extent to which extreme events contribute to such non-linear changes and to the variability of ecosystems, and whether these events speed up or slow down such changes. Our studies are based on high temporal resolution (minute-wise) empirical data from previous decades, produced by our automatic measuring stations at Lakes Müggelsee and Stechlin as well as from stations operated worldwide within the Global Ecological Observatory Network, GLEON. Such data enables us to capture the very short-term effects of storms, which usually only last for a few hours, or heatwaves, which may persist for several days or weeks. We are mainly interested in quantifying critical threshold values of extreme events and the resilience of lakes to such episodic disturbances. Effects on metabolism (nutrient balance of lakes) and biodiversity serve as a universal proxy for ecosystem functionality. For this part of the project, IGB's Rita Adrian is supervising two doctoral students in collaboration with Bas W. Ibelings from the University of Geneva, Switzerland.

The second part of the project explores the changes in the microbial community of lakes brought about by extreme events. Above all, turbulent mixing of the water column caused by storms and input of humic substances into lakes affect microbial dynamics. In a comparative study of 65 boreal lakes (lakes with discoloured brown water) in Canada, we are attempting to explore the occurrence of certain (mixotrophic) single-cell organisms in relation to a wide range of environmental variables. This work is being undertaken in collaboration with two researchers (Beatrix Beisner and Paul del Giorgio) from McGill University in Montreal, Canada. Previous results show that the brown colour of the water caused by humic substances determines the percentage of such organisms in boreal lakes. As such, the increased input of humic substances after a storm event might be beneficial to these organisms.

Cooperating closely with our partners from Dundalk Institute of Technology in Ireland (Eleanor Jennings and Elvira de Eyto), we are also comparing the effects of storms on the diversity and activity of microbial communities in Lake Stechlin, an oligotrophic lake, to their effects on two boreal lakes in Ireland. In contrast to Lake Stechlin, which experiences fewer storms, the Irish lakes regularly encounter storms. For this reason, we assume that their microbial communities exhibit a greater level of resilience. The greenhouse gases CO_2 and CH_4 play a key role as proxies for ecosystem functioning. For this part of the project, IGB's Hans-Peter Grossart is supervising two doctoral students in collaboration with the Irish partners. The students will support each other and present their findings to developing sustainable lake management strategies.

Rita Adrian and Hans-Peter Grossart

Project: MANTEL "Management of Extreme Climatic Events in Lakes and Reservoirs for the Protection of Ecosystem Services"
Duration: 01/2017-12/2021
Funded by: EU, Innovative Training Networks (ITN), Call: H2020-MSCA-ITN-2016
Direction at IGB: Prof. Rita Adrian (Dept. 2), Prof. Hans-Peter Grossart (Dept. 3)
Overall coordination: Dundalk Institute of Technology (DkIT, Ireland)

Project: BaltRap

Climate change has been affecting our freshwaters for a long time: researches observed a distinct eutrophication trend over the last ten years in the Lake Stechlin where IGB conducts long term monitoring. The phosphorus concentration has doubled, the profundal zone is increasingly marked by a loss of oxygen, and manganese is accumulating at the sediment surface. In the new BaltRap project, our aim is to undertake an extensive exploration of how climate fluctuations and anthropogenic activities have affected marine and terrestrial systems since the Ice Age.

In the project, sediment cores from the Baltic Sea and from lakes in the adjacent southern Baltic Sea region are used as geochemical archives for determining the sensitivity of ecosystems to environmental changes as well as their response times to disturbances. In addition, pollen analysis are being conducted, and tree rings and other biological indicators assessed. IGB focuses its research on lakes in northeastern Germany, which have been affected by severe changes in water quality in recent decades due to the intensive use of the catchment area, climate change and various management measures. We are particularly interested in lakes whose development is well documented by long-term monitoring or historical records. In this way, we have the unique opportunity to make a direct comparison of the sediment stratigraphy to the documented development of all the lakes under investigation. This enables us to identify particularly suitable signals (proxies) for certain environmental conditions, and to capture how they have changed following sedimentation as a result of early diagenesis. Such a calibration of proxies enables us to transfer our findings to longer time scales for which no water data exists. Examples of the information we expect to gain from these envisaged investigations include how such changes occurred in the profundal zone of the Lake Stechlin and whether such periods of eutrophication also occurred in the past.

Michael Hupfer

Photo: David Ausserhofer

Project: BaltRap "The Baltic Sea and its Southern Lowlands: Proxy-Environment interactions in times of rapid changes"
Duration: 02/2017-01/2020
Funded by: Leibniz Association
Work package at IGB: Sedimentary proxy formation during early diagenesis
Direction at IGB: Dr. Michael Hupfer, doctoral student: Gregor Scholtysik (both Dept. 6). Furthermore involved: Dept. 3
Overall coordination: Leibniz Institute for Baltic Sea Research Warnemünde (IOW)
Project partners: Besides collaborating with the network partners – IOW, the University of Greifswald (EMAU) and the GFZ German Research Centre for Geosciences in Potsdam – IGB works closely with the University of Cologne's Institute of Geology and Mineralogy, the Senckenberg Biodiversity and Climate Research Centre, and the University of Bremen's Geopolar working group.

"Sediment cores from lakes are our archives for climate impact research."
Michael Hupfer

Photo: David Ausserhofer

"Mires can act as buffer zones mitigating freshwater eutrophication by capturing agricultural nutrients." ***Dominik Zak***

Project: CLEARANCE

The background to the CLEARANCE project is the growing global water crisis: the world population is set to grow by three billion over the next two decades. As a result, there will be an ever-greater demand for natural resources, as well as increased competition for these resources. The water sector, featuring alarming projections, reacts very sensitively in this connection: if the current development continues unchanged, the global demand for clean water will exceed available resources by 40 per cent by the year 2030. One of the main reasons for the deterioration of aquatic ecosystems is eutrophication as a result of non-point agricultural pollution. In this project, we focus on water quality and wetland buffer zones (WBZ) in particular. Our goal is to develop an integrated landscape ecological, socio-economic and political frame for the use of WBZ in a circular economy comprising water treatment, nutrient recycling and the agricultural use of river catchments.

We incorporate into the project our extensive expertise on physical, hydrological, biological and chemical processes as well as interactions in the landscape. Our knowledge of wetland rewetting, interactions between groundwater and surface water, riparian zones and matter turnover in river and lake sediments is key to the part of the project for which we are responsible, "nutrient emissions in WBZ". We use this knowledge to develop concepts for sustainable water management and for enhancing water quality. We work very closely with researchers from Denmark's Aarhus University, which is tackling the part of the project on "wetland buffer zones". Together, we intend to use and advance an empirical nutrient emissions model developed by Aarhus University in order to identify and quantify the main input sources ("hotspots") in existing WBZ and those that are yet to be established.

There are three main routes of entry for nutrients in the landscape: underground and aboveground drainage systems, diffuse nutrient emissions owing to shallow groundwater, and surface runoff. In the Clearance project, we combine our long-term measuring data on water quality and water runoff (groundwater and surface water data) with data from Aarhus University's "Danish Monitoring Programme" and the Danish database on land use, soil types, climate data and loads from catchment areas with different forms of land use. We intend to use the results at a later stage to calculate scenarios for nutrient emissions in the planned model areas.

Dominik Zak

Project: CLEARANCE "CircuLar Economy Approach to River pollution by Agricultural Nutrients with use of Carbon-storing Ecosystems"
Duration: 05/2017-05/2019
Funded by: ERA-NET COFUND WATERWORKS 2015 within the Water Joint Programming Initiative "Water challenges for a changing world"
Overall coordination: IGB, Dr. Dominik Zak (Dept. 6, Aarhus University), project collaborator: Craig Walton (Dept. 6)

“ Using genomics to improve and cost-optimise aquaculture may also reduce sturgeon poaching – which is still a serious problem – and help protecting wild populations ” ***Matthias Stöck***

Project: STURGEoNOMICS

For decades, IGB has headed the reintroduction of sturgeons, once native to Germany, in the catchment areas of the Oder and Elbe Rivers. Led by Jörn Gessner, IGB has played and is playing a major role in the protection of these archaic fish. In the future, we will also use modern, genomic methods (genomics). This will allow us to provide even greater scientific support to experts in species conservation, creating a sound foundation for sturgeon breeding, not only for the conservation and reintroduction of the species, but also for commercial aquaculture.

We have already been collaborating with experts from the University of Würzburg and Washington University in the field of sturgeon genomics for two years. 2017 saw the launch of the European joint research project STURGEoNOMICS, which extends the sturgeon genomic research at IGB.

Matthias Stöck coordinates the STURGEoNOMICS project. In collaboration with scientists from the French INRA and the Romanian Danube Delta National Institute for Research and Development, this project involves investigating two sturgeon species that are characterised by comparatively rapid growth and relatively compact genomes: Atlantic sturgeon *(Acipenser oxyrinchus)* and Beluga *(Huso huso)*. The first objective of the project is to generate high-quality genomes for both species. The second objective is to identify genetic sex determination, i.e. whether a sturgeon is male or female, using genomics and gene expression analysis from the gonads (gonadal transcriptomics). If successful, this could pave the way for the development of future molecular and biotechnological tools for commercial aquaculture and species conservation. Improved caviar aquaculture, based on cost optimisation, could reduce the protracted and serious problem of sturgeon poaching. As sturgeon aquaculture becomes more cost-effective, poaching would become less lucrative; this would help to protect wild stocks. The third goal is to characterise the population genomics of wild populations, namely, the population structure of native Atlantic sturgeons as the source of the broodstock, established for the ongoing reintroduction project of the Atlantic or “Baltic” sturgeon in Germany. Also, the small remaining Beluga population from the Danube will be genetically characterized. In both cases, the aims are to avoid inbreeding in future generations to ensure genetic diversity in restoration programmes for endangered sturgeons. The fourth part of the project involves exploring the basis for traits relevant for breeding, such as sex determination, early functionality of the immune system, and growth. In the process, positively selected genes and gene expression analyses (RNAseq) from the planned experimental work will be used to identify candidate genes for traits relevant for breeding. These will then be applied in commercial aquaculture. *Matthias Stöck, Jörn Gessner, Sven Würtz*

Project: STURGEoNOMICS
Duration: 09/2017-08/2020
Funded by: ERA-NET COFASP
Project partners : INRA (Institut National de la Recherche Agronomique, France); Dr. Yann Guiguen
DDNI (Danube Delta National Institute for Research and Development, Romania); Dr. Radu Suciu
UWB (University of Würzburg, Biocenter, Physiological Chemistry, Germany); Prof. Manfred Schartl
Overall coordination: IGB, PD Dr. Matthias Stöck (Dept. 5)
Involving: IGB Departments 4 (Dr. Jörn Gessner) and V (PD Dr. Matthias Stöck, Dr. Sven Würtz)

Photo: Solvin Zankl

curious

Current Studies and Research Results

Curiosity is the starting point of every scientific question. Once the results have been published, we hope that colleagues and other individuals are curious to want to read them. Fortunately, was it not the case that a thirst for knowledge is catching? Surely you want to find out why lakes change colour, or why fly maggots make good fish food? And what does the tube in the background photo contain*...?

* It's Daphnia - water fleas

Fish with Personality

It may be difficult for us to imagine fish being individuals with their own personality and behaviour, but this is in fact the case. Using Amazon mollies, David Bierbach and two other IGB researchers were able to show for the first time that genetically identical individuals develop different personalities even if they are reared separately under almost identical conditions. Around 60 per cent of all fish species swim in shoals. For many species, life within a community has paid off. For example, sailfish hunt in groups of around ten because it makes them unpredictable to their prey, as Ralf Kurvers and his team have now discovered. When creatures make better decisions as a collective than alone, this is known as swarm intelligence. In the case of humans, too, decisions taken collectively often turn out to be better than those made by individuals. For this reason, social networks and collective decision processes are not only interesting for ecology, but also for decision management in politics, medicine or the economy. At IGB, therefore, we explore how decision processes can be improved. The collective behaviour of fish enables us to derive models for principles such as competition, organisation, cooperation, and resource management. In 2017, Jens Krause was a highly sought-after contributor to such topics in think tanks on urban architecture and healthcare.

Sailfish hunting sardines in the open ocean off the coast of Mexico. Photo: Rodrigo Friscione

The Robofish and his live fellow fishes.

Photo: David Bierbach

A Robotic Fish Can Lead the Shoal

A robotic fish system (Robofish) – a guppy model measuring three centimetres, driven by a magnet beneath the aquarium base – swims in a tank. A computer-controlled system enables scientists to tell the Robofish how to move, and to observe how the other individuals in the shoal respond to this movement. In his experiments, David Bierbach subjects the shoal to different situations, placing food or an artificial predator in the tank, for instance. The aim is for the Robofish to lead the live fish to the food or to the predator model. The creatures' movements are captured on camera. By changing the Robofish's leading behavior, researchers hope to gain new insights into decision-making processes in animal groups. In the long-term, these insights can contribute to bio-inspired novel algorithms that help solve problems in human societies such as how to evacuate large crowds of people safely out of halls or stadiums.

Funded by: DFG, **Duration:** 2016-2019
Contact: Dr. David Bierbach
www.igb-berlin.de/projekt/robofish-o

Together they are Unpredictable

Predators and their prey evolve together: it is vital for predators to develop effective hunting strategies, whereas the prey species is intent on evading its attackers. An international team of researchers, coordinated by IGB, has investigated the predator-prey relationship between sailfish and sardines. Sailfish are large oceanic predatory fish that attack their prey with their long, sharp bills. In their study, Ralf Kurvers and his team analysed a total of 365 attacks by 73 sailfish, which occurred in 11 groups with up to 14 individuals per group in the open ocean off the coast of Mexico. In a morphological analysis, the researchers also examined signs of wear in the microteeth on the long bill used by the predatory fish to attack their prey. This analysis confirmed that most fish prefer to attack from the left or from the right. The researchers discovered that a specialisation in attacking from the left or from the right – referred to technically as laterality – has its advantages in hunting. In fact, the more strongly an individual was lateralised, the more successful it was in capturing prey. However, this is only an advantage because sailfish hunt in groups: a single sailfish that always attack from either the left or the right will have difficulty catching its prey, because the prey can then easily predict the side of attack. When hunting in a group, however, the prey species is unable to predict whether the sailfish are specialised in attacking from the left or from the right – making the predators more unpredictable to their prey. "The larger the group, the more balanced the left/right relationship is, and the more successful the sailfish are expected to be at hunting sardines," reported Kurvers. Incidentally, with around half of the sailfish preferring to attack from the right and the other half specialising in attacks from the left, laterality in sailfish differs from handedness in humans: some 90 per cent of the world's population are right-handed, with only ten per cent preferring to use the left hand. "Using the same hand is useful when it comes to cooperative activities, which is why a predominant use of one hand has developed in the course of human evolution. The fact that left-handers still exist is explained by the advantages of this alternative laterality – namely unpredictability in battle. Around half of top fencers, for example, are still left-handed, and the other half right-handed," explained Kurvers.

Ralf H. J. M. Kurvers, Stefan Krause, Paul E. Viblanc, James E. Herbert-Read, Paul Zaslansky, Paolo Domenici, Stefano Marras, John F. Steffensen, Morten B. S. Svendsen, Alexander D. M. Wilson, Pierre Couillaud, Kevin M. Boswell and Jens Krause (2017). The Evolution of Lateralization in Group Hunting Sailfish. Current Biology. 27(4):521-526

Individuality is Unavoidable

According to a long standing paradigm, individual characteristics in the behaviour of animals and humans develop from an interplay between differences in genes and the environment. But what happens when individuals whose genes are identical are reared separately in environments that are identical – do they then develop identical behavioural types? "We were very surprised to find such distinct personality differences in genetically identical animals that grew up under nearly equal environmental conditions," remarked David Bierbach, behavioural ecologist and evolutionary biologist at IGB. Amazon mollies are natural clones, meaning all the offspring of one mother have exactly the same genetic material. Newborn Amazon mollies were kept individually and raised under identical conditions, and then examined after seven weeks to determine whether and how individual fish differed in activity and exploratory behaviour. Interestingly, there were immense individual differences detectable: some fish were always more active and explored the whole tank while others were shy and swam only very cautiously through the aquarium. These findings shed new light on the question of which factors are responsible for individuality in vertebrate animals. "Our results suggest that other factors must influence the development of personality in a more substantial way than previously thought: potentially minute differences in environmental conditions, which are impossible to remove completely from any experiment, or potentially epigenetic processes, i.e. random changes of chromosomes and gene functions," explained behavioural ecologist Kate Laskowski.

David Bierbach, Kate L. Laskowski and Max Wolf (2017). Individual differences in behaviour of clonal fish arise despite near-identical rearing conditions. Nature Communications 8, art: 15361

"The potential for making optimal use of groups plays an important role in many areas of society. One example is medicine: our working group has shown, for instance, that breast cancer diagnosis can be improved considerably if several experts are involved in the process. This year, I was part of a think tank for Helios clinics, generating ideas for the future of healthcare."

Jens Krause

Photo: Andy Küchenmeister

More about this topic on our website:
www.igb-berlin.de/en/behavioural-ecology-swarm-intelligence

Rethinking Management and Water Protection

At IGB, our various working groups prepare the scientific basis for new approaches to water management and species protection. In the research approaches we adopt, humans are factored into the equation – not as a disruptive factor, but as an ally in nature conservation, such as in the transdisciplinary research on angling conducted by Robert Arlinghaus. The collective behaviour of animals may also play a role when seeking to implement conservation measures successfully, as Lysanne Snijders and her colleagues found out. And maybe lessons can also be learned from other scientific disciplines: can approaches from the field of medicine, for instance, be transferred to the revitalisation of freshwaters? This topic was addressed by an international team of researchers, including IGB's Mark Gessner. Christian Wolter and two other IGB researchers questioned the robustness of expert opinions in assessing the suitability of habitats.

River Doctors: Learning from Medicine

"The paper develops the argument that much can be learned in ecosystem management from the medical practice of diagnosing, treating and preventing disease. The medical approach has developed over millennia. Given the fundamental similarity of the problems, medicine provides a suitable conceptual template for river management, hence the call for river doctors. Key principles to consider are a solid understanding of the system, identification of the damage and cure, clear definition of the treatment goals, application of the best available methods, therapy by trained experts, and monitoring of the outcome. Effective communication of success and failures is also important. Systematically adopting these principles could greatly improve the management of ecosystems, not just of rivers." ***Mark Gessner***

Photo: David Ausserhofer

Expert Judgement is Good, Data are Better

"Expert judgement is always in demand when little data exist or when data are inconsistent, and also when extensive data cannot be collected, for whatever reason. We have investigated the reliability of expert judgements using the example of the habitat requirements of the minnow, a small fish species prevalent in Europe. All of the 13 experts surveyed were good at identifying the best habitats as well as those that were completely unsuitable. However, there were surprisingly major differences in what the experts considered to be suboptimal habitat for the minnow. Their assessments differed in particular with regard to the suitable flow velocity, which is probably because the minnow can be found in both standing and flowing waters."
Christian Wolter

Photo: Andy Küchenmeister

Arturo Elosegi, Mark O. Gessner and Roger G. Young (2017). River doctors: learning from medicine to improve ecosystem management. Science of the Total Environment. Science of the Total Environment. 595:294-302.

Johannes Radinger, Jochen Kail and Christian Wolter (2017). Differences among expert judgments of fish habitat suitability and implications for river management. River Research and Applications. River Research and Applications. 33(4):538-547.

The New Ivory Tower Stands at the Water's Edge and is Populated by Researchers and Practitioners Alike

"Sustainable fisheries and water management can only work if people are taken on board and consideration is taken of their needs – a purely scientific research approach does not go far enough. For this reason, we build bridges between fisheries ecology and applied social sciences, and also focus on the attitudes and practices of anglers and decision-makers in associations and authorities. When experiments are conducted in close collaboration between researchers and practitioners, we not only generate relevant scientific knowledge, but also solutions for greater sustainability that are directly suitable for practical application."

Robert Arlinghaus Photo: David Ausserhofer

Marie Fujitani, Andrew McFall, Christoph Randler and Robert Arlinghaus (2017). Participatory adaptive management leads to environmental learning outcomes extending beyond the sphere of science. Science Advances, 3, e1602516

Robert Arlinghaus, Josep Alós, Ben Beardmore, Katrin Daedlow, Malte Dorow, Marie Fujitani, Daniel Hühn, Wolfgang Haider, Len M. Hunt, Brett M. Johnson, Fiona Johnston, Thomas Klefoth, Shuichi Matsumura, Christopher Monk, Thilo Pagel, J. R. Post, Tobias Rapp, Carsten Riepe, Hillary Ward and Christian Wolter (2017). Understanding and managing freshwater recreational fisheries as complex adaptive social-ecological systems, Reviews in Fisheries Science & Aquaculture, 25, 1-41

Knowledge of Animal Social Networks May Help Species Protection

"Animals in groups interact completely differently with each other – they form a dynamic social network. If we are able to understand these interactions, we can derive from this knowledge information about the spread of diseases, reproduction and predator-prey relationships. The fabric of social networks may also be a decisive factor concerning the stability of a population. Such knowledge may help wildlife managers and conservationists, for example, to optimise disease management, breeding programmes or reintroduction activities. For this reason, we call on researchers and wildlife managers to cooperate more closely in order to learn more about aspects of animal social networks and to develop ideas on how greater account can be taken of collective behaviour in wildlife conservation measures." ***Lysanne Snijder*** Photo: Private

Lysanne Snijders, Daniel T. Blumstein, Christina R. Stanley and Daniel W. Franks (2017). Animal social network theory can help wildlife conservation. Trends in Ecology and Evolution.32(8):567-577.

More about this topic on our website:
www.igb-berlin.de/en/use-management

Sampling at IGB's LakeLab in Lake Stechlin.
Photo: Martina Bauchrowitz

Changing Lakes

Lakes and rivers act as early warning systems for global environmental change. IGB's long-term investigations at Lakes Müggelsee and Stechlin clearly document the physical and ecological consequences of such changes. The time series collected on these lakes for decades allow projections of how freshwaters will develop under certain scenarios. We also identify indicators of change. For example, an analysis of satellite images of 190 lakes worldwide demonstrated the influence of warming on phytoplankton levels. Another approach is taken in the IGB LakeLab, where we assess impacts of changing conditions on lakes in large-scale experiments. Testing effects of severe summer storms, which in parts of the world are expected to become more frequent in the future, is one example of this approach.

IGB's LakeLab in Lake Stechlin

The experimental facility consists of 24 experimental units separated from the lake, each nine metres in diameter, 20 metres deep and enclosing water volumes of 1,270 m^3. The enclosures reach from the water surface to the lake bottom. By building the facility in 2012 with funding from the Federal Ministry of Education and Research, IGB ventured into technologically and scientifically uncharted territory. The LakeLab has since enabled IGB to conduct for the first time ecosystem-scale experiments to assess responses of lakes to climate change.

www.lake-lab.de

"Data management plays a pivotal role in our measuring programmes at Lake Stechlin and Lake Müggelsee. Actually we enhance our database infrastructure for long-term data on German lakes (FRED – Freshwater Research and Environmental Database). Our long term research is incorporated into global data portals such as GLEON and NetLake. Such intense data exchange is enormously important to be able to determine changes that govern lake processes at the regional and global level."

Rita Adrian

Foto: David Ausserhofer

Turbid Prospects for Pristine Lakes

Climate change is expected to increase the frequency of extreme weather events such as summer storms. Two recent studies by IGB now show that such storms can have dramatic effects on clear-water lakes, where they can cause massive algal blooms. Lake Stechlin, widely known for its exceptional clarity, suddenly became turbid after a violent summer storm in July 2011. Data collected routinely as part of IGB's long-term monitoring programme in the lake enabled the reconstruction of the sequence of events: water movement induced by the storm caused phytoplankton (mainly filamentous cyanobacteria), which in highly transparent lakes often form a maximum in deeper water layers, to rise to the surface. Released from light limitation and supplied with sufficient nutrients, the algae started to grow rapidly. Their intense photosynthesis led to a strong increase in pH and thus the precipitation of large quantities of tiny calcite crystals that remained suspended in the water column for weeks. This greatly reduced water transparency. Verification of the accuracy of this interpretation was made possible by an experiment in IGB's LakeLab in Lake Stechlin. A strong summer storm involving intense water mixing was simulated in four experimental enclosures, whereas four others remained unchanged to serve as controls. By and large, the experiment supported the analysis of the observational data. Algal development in the surface water layer was boosted immediately after the simulated storm. Although pH was not sufficiently raised to induce calcite precipitataion, the increased phytoplankton activity and turbidity persisted for weeks, even though the storm lasted only four hours. These results show that extreme events can strongly affect clear-water lakes, which in the past were least affected by human activities.

What a Lake's Colour Can Tell About its Condition

The warming of large lakes amplifies their colour. Benjamin Krämer and his team used satellite images from 2002 to 2016 to evaluate around 190 of the world's largest lakes, including Lake Baikal, Lake Titicaca and Lake Victoria. Lakes that are green due to their high phytoplankton content tend to become greener in warm years as phytoplankton content increases. Clear, blue lakes with little phytoplankton, on the other hand, tend to become even bluer in warm years caused by declines in phytoplankton. Thus, contrary to previous assumptions, the warming of lakes tends to amplify their richness or poverty of phytoplankton. Declines in oceans, for example, were reported years ago. It is thought that warming strengthens a lake's thermal stratification. Nutrients then become trapped below the surface layer of lakes, leading to a decline in the growth of phytoplankton. What may sound like a change for the better at first, might present its own challenges to lake managers, such as the detrimental potential to reduce fisheries productivity. "The reduced content of phytoplankton in Lake Constance and Lake Tanganyika in Africa, for example, have led to a reduction in fisheries productivity," explained Benjamin Krämer. The researchers have now established that warm years were rather associated with higher phytoplankton biomass in almost 70 per cent of the lakes in their analysis. Benjamin Krämer explains this process as follows: "In phytoplankton-rich lakes, warming can lead to an increase in phytoplankton, perhaps because growth phases are longer or because the number of creatures that feed on phytoplankton declines." Communities with lakes that are phytoplankton-rich would therefore have to take action to reduce nutrient inputs to maintain the (existing) water quality of lakes as they warm.

Peter Kasprzak, Tom Shatwell, Mark O. Gessner, Thomas Gonsiorczyk, Georgiy Kirillin, Géza Selmeczy, Judit Padisák and Christof Engelhardt (2017). Extreme weather event triggers cascade towards extreme turbidity in a clear-water lake. Ecosystems 20, 1207-1420.

Darren P. Giling, Jens C. Nejstgaard, Stella A. Berger, Hans-Peter Grossart, Georgiy Kirillin, Armin Penske, Maren Lentz, Peter Casper, Jörg Sareyka and Mark O. Gessner (2017). Thermocline deepening boosts ecosystem metabolism: evidence from a large-scale lake enclosure experiment simulating a summer storm. Global Change Biology 23 (4), 1448-1462.

Benjamin M. Kraemer, Thomas Mehner and Rita Adrian (2017). Reconciling the opposing effects of warming on phytoplankton biomass in 188 large lakes. Scientific Reports 7: art. 10762.

More about this topic on our website:
www.igb-berlin.de/en/environmental-change

Seeking Clarity

Freshwaters are used intensively by humans, meaning that they are exposed to a number of stressors. It is often impossible to completely remove pharmaceuticals and biocides during wastewater treatment. They then end up in rivers and lakes, where they may affect aquatic organisms. We explore the complex interrelations and impacts of different stressors. Within the Erasmus Mundus Joint Doctorate Programme SMART, for example, doctoral student Anderson Abel de Souza Machado has explored the effect of the biocide Dipel ES on water fleas. And a team of researchers, including Mark Gessner, has identified synthetic chemicals as a component of climate change that has so far been underestimated.

Biopesticides: More Toxic in Water than Expected

Agriculture and forestry need pesticides. Biopesticides are considered to be environmentally friendly alternatives to traditional pesticides. Products based on bacteria (here the soil bacterium *Bacillus thuringiensis*) that act as parasites on insects are globally among the most important biocides. One of these biocides is Dipel ES, a product commonly used in the U.S. and Europe. In Germany, it is mainly used to control butterfly caterpillars such as the oak processionary moth in forest areas and parks. It is also approved for organic fruit-growing, vegetable-growing and agriculture. However, the extensive and frequent application of Dipel ES has raised concerns among researchers and environmentalists about potential toxicity to non-target wildlife. Thus, an IGB research team has investigated how biopesticides affect water organisms, in particular water fleas, using the example of the bacterial-based biocide Dipel ES. The researchers found that Dipel ES triggered an unexpected toxicity pattern on water fleas: immobilisation (i.e. loss of swimming ability) and mortality were affected in an inverted U-shaped fashion, i.e. toxicity did not always increase by increasing toxicant exposure. Whereas high concentrations had no impact on organisms, even small doses resulted in significant effects. Based on the results, this biopesticide might be tens of thousands times more toxic than reported by the manufacturer, the researchers assume. The unusual toxicity pattern casts doubts on a further assumption: regulation toxicology usually assumes that the negative effects of toxins increase with their dose. “The effect that toxicity increases with increasing amounts of the toxin is called monotony,” explained Anderson Abel de Souza Machado, doctoral student at IGB. “The effects of Dipel ES are clearly based on other mechanisms. Higher concentrations were non-toxic, which in toxicology is termed as a non-monotonic effect or an effect with an inverted U-curve,” he stated. Preliminary chemical analysis suggests that these unusual effects may be explained in part by a particular behaviour of this biocide in water solution.

The study has been published open access in Environmental Science & Technology:

Anderson Abel de Souza Machado, Christiane Zarfl, Saskia Rehse and Werner Kloas (2017). Low-dose effects: nonmonotonic responses for the toxicity of a *Bacillus thuringiensis* biocide to *Daphnia magna*. Environmental Science and Technology 51 (3): 1679-1686

Erasmus Mundus Joint Doctorate Programme

SMART

Science for MAnagement of Rivers and their Tidal systems

IGB is one of 19 partners (nine universities, four research institutes, four private companies, and two government agencies) within this inter-sectoral PhD programme funded by the EU (2011-2018). The aim of SMART is to train doctoral students in multi-disciplinary teams. SMART focuses on the core areas of natural sciences and engineering relevant to the sustainable management of river systems: ecosystem resilience to human and other stressors; the natural functioning of river-floodplain systems; and the potential to rehabilitate compromised functions in impacted systems.

Photo: pixabay

Trends in Synthetic Chemical Proliferation Steeper than for Other Agents of Global Change

The global production and diversity of synthetic chemicals has been rapidly growing for decades. As a result, an ever-increasing number of pharmaceuticals, pesticides, varnishes, synthetic fibres and other industrial chemicals find their way into the environment. They contaminate soils and freshwaters, they affect animals, plants and microorganisms, and they are absorbed by the human body via drinking water and food. In 2015, a group of alerted scientists met at IGB to analyse trends in the global production and diversity of synthetic chemicals and compare them to those of well-known drivers of global environmental change. The worrying outcome of this analysis based on public data is that the variety and use of synthetic chemicals has been growing more rapidly worldwide than metrics of other drivers, such as the atmospheric carbon dioxide concentration, land conversion to agriculture, biodiversity loss or fertilizer use resulting in nutrient inputs to soils and freshwaters. More than 80,000 such substances are now in use. "Our analysis shows that the worldwide proliferation of synthetic chemicals is a key agent of global environmental change, yet the extent of their spread is vastly underestimated even among experts," emphasised Mark Gessner, one of the authors of the study. Synthetic chemicals clearly meet the three criteria defining agents of global change: "They are globally distributed, they have known impacts on organisms, and they increase in relation to human populations and economic growth." The global scope of the problem and the rapid rates of increase call for improved collaboration between ecologists and ecotoxicologists and for a dialogue and concerted action of experts in academia, authorities and industry to curb large-scale adverse effects of synthetic chemicals in the future.

Emily S. Bernhardt, Emma J. Rosi and Mark O. Gessner (2017). Synthetic chemicals as agents of global change. Frontiers in Ecology and the Environment 15(2): 84–90

More about this topic on our website:
www.igb-berlin.de/en/multiple-stressors-pollutants

Greenhouse Gases from Freshwaters

Sonia Herrero is taking water samples in Lake Obersee, Berlin
Photo: Clara Romero

Urban Water Interfaces (UWI)

UWI is an interdisciplinary research training group of engineers and natural scientists. The overall aim is to educate excellent graduate students with a profound understanding of urban water systems. The focus is on natural and technical interfaces. This is where major processes in urban water cycles take place. UWI combines different empirical methods, experiments and models in order to develop model conceptualisations and simulation tools for predictions.

Duration: 2015-2024
Funded by: DFG (GRK 2032)
Overall coordination: Technische Universität Berlin and IGB (involving Departments 1, 2, 3 and 6)

In the past 20 years, policy makers become increasingly aware that freshwaters are also a source of greenhouse gases. According to the latest Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2014), emissions from lakes, rivers and wetlands account for one-third of greenhouse gases released from natural sources. Most of the methane, for example, is released by gas bubbles that form in the sediment of freshwaters. At IGB, Peter Casper's working group explores the release of greenhouse gases – also from urban waters. Within the international research training group "Urban Water Interfaces (UWI)", for example, they investigate the greenhouse gas fingerprint of Berlin's waters. Sabine Hilt and two early career researchers from IGB were involved in a Dutch study that revealed a distinct causality between rising temperatures and methane emissions from waters.

A Vicious Circle Involving Methane

Due to climate change, including rising temperatures, more and more methane is bubbling up from freshwaters around the world. The release of the greenhouse gas methane again leads to a further increase in temperature and an acceleration of climate change. This is the conclusion drawn by a Dutch study, involving IGB's researcher Sabine Hilt, doctoral student Garabet Kazanjian and current IGB doctoral student Susanne Stephan. According to the study, a temperature rise of just one degree Celsius leads to six to 20 per cent higher methane emissions.

The influence of rising temperature on methane release was measured in a laboratory study at the Dutch Institute of Ecology (NIOO-KNAW). In eight large tanks filled with water and sediment, the researchers mimicked the waters and environmental conditions of our latitudes over a period of one year. A simulated temperature increase of 4°C resulted in 51 per cent higher methane emissions from released gas bubbles throughout the year. "Our measurements on primary production in the tanks enabled us to conclude that the temperature effect on methane release was primarily due to increased microbial activity in the sediment," explained Sabine Hilt. Measurements in different water types and climate zones worldwide could provide more accurate predictions for future methane emissions – an important premise for forecasts of global warming trends and the ability to take countermeasures.

The study has been published open access in Nature Communications:

Ralf C. H. Aben, Nathan Barros, Ellen van Donk, Thijs Frenken, Sabine Hilt, Garabet Kazanjian, Leon P. M. Lamers, Edwin T. H. M. Peeters, Jan G. M. Roelofs, Lisette N. de Senerpont Domis, Susanne Stephan, Mandy Velthuis, Dedmer B. Van de Waal, Martin Wik, Brett F. Thornton, Jeremy Wilkinson, Tonya DelSontro and Sarian Kosten (2017). Cross continental increase in methane ebullition under climate change. Nature Communications 8: art. 1682.

Waters Cause Part of the Urban Greenhouse Gas Fingerprint

Urban waters have rarely been studied with regard to greenhouse gas emissions. And yet in Germany's three largest cities – Munich, Berlin and Hamburg – water surfaces account for 1.3 (Munich), 6.7 (Berlin) and 8.3 (Hamburg) per cent of the metropolitan area. The situation is similar in other countries, too. After all, people have always liked to settle near water, using it for multiple purposes: water supplies, transportation and recreation. Surface waters come in all shapes and sizes: lakes, ponds, basins, rivers and canals give cities their individual look. Many formerly natural freshwaters are being anthropogenically transformed: surface water and groundwater undergo many changes, the most drastic of which are caused by contamination from nutrients and chemicals. Both water quality and the hydrological regime are changing fundamentally.

IGB's research group "Microbial Ecology of Sediments", led by Peter Casper, collaborates with international partners in various studies to explore greenhouse gas releases from urban waters. A study conducted by doctoral student Karla Martinez Cruz in Mexico City revealed that lakes and chinampas – traditional floating gardens – have the highest rates of methane release into the atmosphere. In Mexico, emissions are coupled very closely to the nutrient contents of waters, which are often very high, owing to inadequate wastewater treatment.

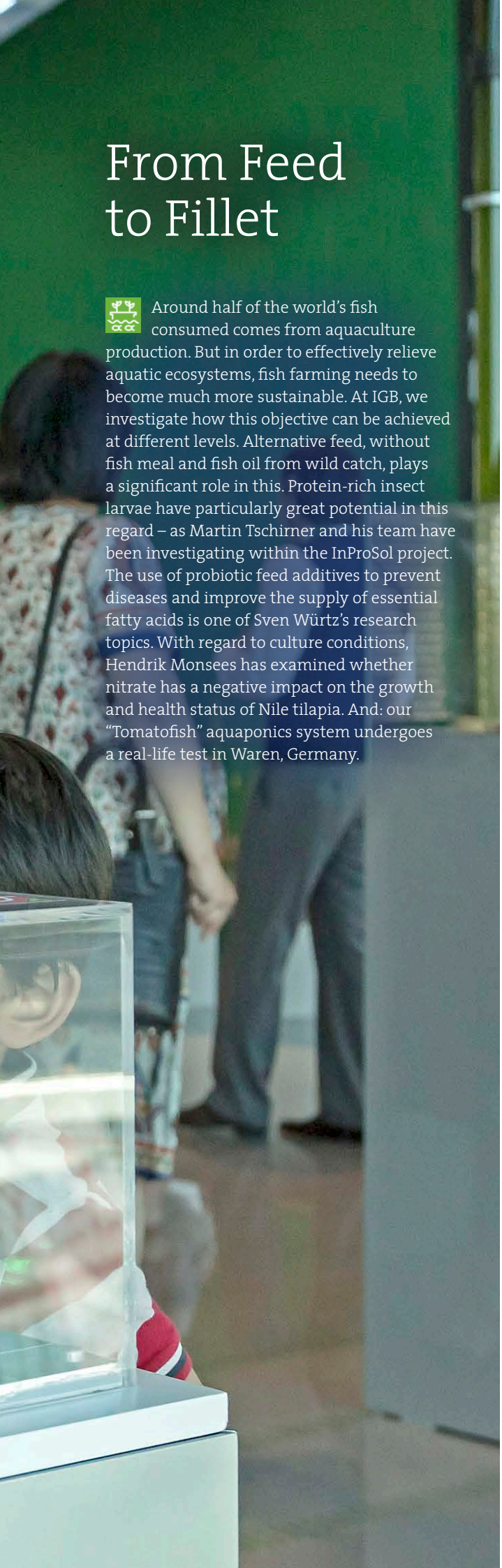
In Berlin, the working group is conducting a study on the greenhouse gas fingerprint of aquatic systems within the international research training group "Urban Water Interfaces (UWI)". Within this study, doctoral student Sonia Herrero measured the release of methane from 32 randomly selected waters during all four seasons. Small ponds were shown to have the highest emissions. Such ponds – both artificially created and of natural origin – can be found in cities as retention basins, decorative elements or bathing water. At 150 milligrammes of methane per square metre, the daily emission rates from these waters were five times higher than the 30 milligrammes of methane per square metre released from Berlin's rivers.

In a third study, researchers are collaborating with colleagues from the Chinese Academy of Sciences in Nanjing to measure greenhouse gas emissions from waters in the potential residential areas of Beijing in their pre-urbanisation state. "The waters examined have already been anthropogenically influenced to a relatively large extent; if these areas are included in the municipal area, we expect to see even more silting up of waters and a continued increase in greenhouse gas emissions. This phenomenon is set to become a problem in many other cities of the world in the future," stated Peter Casper.

Karla Martinez-Cruz, Rodrigo Gonzalez-Valencia, Armando Sepulveda-Jauregui, Fernando Plascencia-Hernandez, Yadira Belmonte-Izquierdo and Frederic Thalasso (2017). Methane emission from aquatic ecosystems of Mexico City. Aquat Sci 79:159–169.

More about this topic on our website:
www.igb-berlin.de/en/water-matter-cycles

IGB´s aquaponics system "Tomatofish" at the EXPO 2017 in Astana, Kazakhstan. Photo: IGB



From Feed to Fillet

Around half of the world's fish consumed comes from aquaculture production. But in order to effectively relieve aquatic ecosystems, fish farming needs to become much more sustainable. At IGB, we investigate how this objective can be achieved at different levels. Alternative feed, without fish meal and fish oil from wild catch, plays a significant role in this. Protein-rich insect larvae have particularly great potential in this regard – as Martin Tschirner and his team have been investigating within the InProSol project. The use of probiotic feed additives to prevent diseases and improve the supply of essential fatty acids is one of Sven Würtz's research topics. With regard to culture conditions, Hendrik Monsees has examined whether nitrate has a negative impact on the growth and health status of Nile tilapia. And: our "Tomatofish" aquaponics system undergoes a real-life test in Waren, Germany.

Bioeconomy: Insect Meal as Sustainable Aquaculture Feed

Previously, European legislation on animal feed was very restrictive. Since 1 July 2017, the EU has approved the use of several insect species as a feed in aquaculture, paving the way for the commercial use of insect protein. But first, concepts for large-scale economic production of insect-based feeds need to be developed.

The aim of the InProSol project is to investigate the commercial viability of insects as a source of protein in aquaculture from a scientific and economic perspective. Project leader Martin Tschirner stated: "A viable basic concept for the large-scale economic production of insect-based feeds is to be developed on the basis of IGB research knowledge. To achieve this, we are analysing the entire complex manufacturing process, including a new input-output calculation model. By the end of the project, a requirements catalogue will be established that defines important aspects such as production technology, product processing and material flow planning."

At IGB, Tschirner and his team are investigating the "potential for insect-based feeds" using the Black Soldier Fly *(Hermetia illucens)*, which has a high raw protein content. Also, its amino acid spectrum is relatively similar to that of fish meal. The larvae of the Black Soldier Fly feed on organic residues, such as waste and by-products from agriculture. In this way, previously unused nutrients are recycled and fed to a smart material cycle that is not only environmentally compatible, but also makes sense economically.

IGB researchers will present the core results to political actors as an evidence-based decision-making basis for further strategies in the bioeconomy. If the feasibility and profitability analysis as well as European framework legislation continue to develop positively, IGB's product idea should also be exploited commercially in the future. The IGB knowledge transfer unit supports the project in terms of consultancy on economic exploitation and policy.

Project: InProSol – Innovative Protein Solutions
Duration: 04/2017-12/2017, follow-up project is expected to start in mid 2018
Funded by: BMBF, Competition for Ideas: "New Products for the Bioeconomy"
Overall coordination: IGB, Martin Tschirner
Involving: Department 5

Excessive Nitrate in Water is Harmful

In sustainable recirculating aquaculture systems (such as in the production of Nile tilapia – *Oreochromis niloticus*) with little freshwater replacement, the growth and metabolism of fish results in the accumulation of nitrate in the process water. It is formed in the biofilter: ammonium excreted by fish as part of their normal metabolism is converted via nitrite to nitrate, by bacteria in the biofilter (nitrification). In concentration levels exceeding 125 milligrammes per litre of nitrate nitrogen, nitrate may have a negative impact on the growth and health status of fish, as has been demonstrated using the example of the turbot. In the past, no data existed on

Putting the "Tomatofish" to the Test

In a bid to examine the technical and economic feasibility of the "Tomatofish" aquaponics system under various climatic and economic conditions, aquaponics systems were established in Germany, Spain, Belgium and China within the EU-funded project INAPRO. One of the partners from the realms of practice are "die Müritzfischer", who operate an aquaponics system in Waren an der Müritz (Germany).

INAPRO: Innovative Aquaponics for Professional Application
Duration: 01/2014-12/2017
Funded by: EU's Seventh Framework Programme
Overall coordination: IGB, Prof. Werner Kloas
A total of 18 research partners

www.inapro-project.eu

The "Fish Store" of the "Müritzfischer" in Waren (Germany). Photo: IGB

nitrate toxicity for Nile tilapia, one of the most important freshwater fish produced in aquaculture, partly because nitrate was thought to be harmless to fish for a long time. In an exposure experiment in the flow-through system, a team of IGB researchers led by Hendrik Monsees recently investigated the impacts of the long-term exposure of Nile tilapia to nitrate. The 30-day study revealed that nitrate concentration levels of up to 500 milligrammes per litre of nitrate nitrogen have no negative impact on the growth or health status of the fish, enabling tilapia to be classified as a relatively robust fish species. Lower concentration levels are observed in most closed recirculating systems. In the case of systems with high stocking densities, large amounts of feed, and water exchange rates of less than two per cent, however, nitrate concentration levels of up 1,000 milligrammes per litre of nitrate nitrogen are possible. Even in Nile tilapia, such factors would stunt growth, impair health and lead to losses of fish. With nitrate concentration levels above 500 milligrammes per litre of nitrate nitrogen, practitioners are therefore recommended to reduce nitrate levels by taking measures such as increasing water exchange or using a denitrification unit, to ensure the optimal, species-appropriate production of Nile tilapia.

Hendrik Monsees, Laura Klatt, Werner Kloas, W. and Sven Wuertz (2017). Chronic exposure to nitrate significantly reduces growth and affects the health status of juvenile Nile tilapia *(Oreochromis niloticus L.)* in recirculating aquaculture systems. Aquac Res, 48: 3482–3492.
Hendrik Monsees, Werner Kloas and Sven Wuertz (2017). Decoupled systems on trial: eliminating bottlenecks to improve aquaponic processes. PLoS One. 12(9):e0183056.

Prebiotics and Probiotics Instead of Antibiotics

Disease prevention is an important topic in aquaculture research. As such, researchers are focusing on alternatives to conventional disease control using antibiotics and vaccination. As is also the case with mammals, nutrition and gut health are a significant factor in the health status of fish. Individual studies have revealed, for example, that prebiotic and probiotic feed additives optimise the intestinal flora, improve immune response and can even have a stress-reducing effect. How additives can have such short-term effects on the immune system, coupled closely to feed, has not yet been fully explained. What makes investigations more difficult is the fact that the ecology of the intestinal microbiome of fish is virtually unknown.

In their work, the scientists took cell tests and used combined feed and infection experiments to examine whether native, autochthonous bacteria isolates used as probiotic feed additives enhance fish health, and if so, how this is achieved. To this end, they investigated isolates with an inhibitory effect on pathogens in the cell test,

followed by experimental infection (infection model). In additional studies, the researchers provided evidence of the basic effects of alternative, plant-based feed on the immune system as well as of the stress axis; they also managed to show the significance of essential amino acids for immune response. On the basis of selected isolates, the researchers intend to establish a cryobank of probiotic candidate strains that can be used to positively influence the intestinal microbiome in a targeted manner.

Rita Azeredo, Marina Machado, Antonio Afonso, Camino Fierro-Castro;, Felipe E. Reyes-Lopez, Lluis Tort, Manuel Gesto, Marta Conde-Sieira, Jesus M. Miguez, Jose L. Soengas, Eva Kreuz, Sven Wuertz, Helena Peres, Aires Oliva-Teles and Benjamin Costas (2017): Neuroendocrine and immune responses undertake different fates following trytophan or methionine dietary treatment: Tales from a teleost model. Frontiers in Immunology, 8, (1226).

Rita Azeredo, Marina Machado, Eva Kreuz, Sven Wuertz and Aires Oliva-Teles (2017). The European seabass *(Dicentrarchus labrax)* innate immunity and gut health are modulated by dietary plant-protein inclusion and prebiotic supplementation. Fish Shellfish Immun, 60, 78-87.

More about this topic on our website:
www.igb-berlin.de/en/aquaculture-aquaponics

“For us fish farmers, it is more of a challenge to grow tomatoes than to produce catfish. But we managed to do both within the project period, enabling us to offer our own catfish fillets and tomatoes via our direct marketing channels. The aquaponics system is located next door to our “Fisch Kauf Haus”. Some of our guests are quite amazed when they see how production works whilst standing at the shop counter!”

Ulf Rehberg,
die Müritzfischer

Between Land and Water

Phosphorus losses from agriculture: A threat to our surface waters

The element phosphorus (P) plays a central role in agriculture – it is necessary for plant growth, and is applied to agricultural soils throughout the world as a crucial component of fertilizers, albeit often in amounts that are considerably exceeding the amount actually required by crops. Phosphorus from agriculture also reaches our surface waters through surface runoff, drainage and groundwater. In surface waters, phosphorus can trigger eutrophication processes with concomitant negative effects, such as algae blooms, loss of biodiversity and fish mortality.

As a member of Markus Venohr's working group, Peter Fischer used laboratory and data analyses to investigate the risk of phosphorus losses from arable soils in Germany. The researchers considered more than 337,000 monitoring values for their analysis. The assessment revealed that more than 75 per cent of agricultural soils have a phosphorus saturation exceeding 80 per cent, corresponding to high risks of P losses.

However, high P saturation values do not automatically result in critical P concentrations in surface waters. Whether or not agricultural areas are connected to freshwaters plays an important role in this regard. In order to be able to determine more effectively the influence of P emissions from agriculture on water quality, the results were integrated in the MONERIS model developed at IGB. The new data will enable a more accurate identification of hotspot areas of high phosphorus losses. In these areas the implementation of measures such as buffer strips which can reduce P emissions are particularly important in order to prevent the impairment of water quality of surface waters.

Peter Fischer, Rosemarie Pöthig and Markus Venohr (2017). The degree of phosphorus saturation of agricultural soils in Germany: Current and future risk of diffuse P loss and implications for soil P management in Europe. Science of the Total Environment. 599-600:1130-1139.

Beware of Secondary Effects: rewetted peatlands

Does it make sense to rewet peatlands? This question was the focus of an IGB project led by Dominik Zak. The benefits were obvious: peatlands absorb carbon, reduce overfertilisation and greenhouse gas emissions, and are hotspots of biodiversity. Owing to this "trifold benefit", efforts are now being made throughout the world to revitalise wetlands and peatlands by rewetting. The rewetting of minerotrophic peatlands (= fens), which are prevalent in Central Europe, often results in shallow lakes. Such lakes are new, highly dynamic ecosystems that often release large quantities of the greenhouse gas methane as well as dissolved organic carbon (DOC) during the first stage, initially achieving the opposite of the desired effects. In this project, IGB researchers used extensive lab and field work as a basis for developing a simplified decision support system for the restoration of peatlands, with or without the removal of topsoil. This system enables scientists to predict the effect that certain measures will have on matter flows in the peatlands. A key finding: in spite of the numerous benefits, topsoil removal is not recommended as a universal measure for peatland restoration. Detailed investigations should therefore be carried out before rewetting peatlands.

Dominik Zak, Tobias Goldhammer, Alvaro Cabezas, Jörg Gelbrecht, Robert Gurke,Carola Wagner, Hendrik Reuter, Jürgen Augustin, Agata Klimkowska and Robert McInnes (2018). Top soil removal reduces water pollution from phosphorus and dissolved organic matter and lowers methane emissions from rewetted peatlands. Journal of Applied Ecology. 55 (1): 311-320.

Algae Make it Easier for Bacteria to Decompose Carbon

Carbon breakdown is a fundamental process in aquatic systems. In a water body, the carbon pool consists of different molecules of aquatic and terrestrial origin (algae and leaves, sticks and soil). In her PhD thesis, Jenny Fabian teamed up with other researchers to investigate how the composition of the carbon pool influences the structure of the microbial community in the water body, and which bacteria and fungi are involved in the conversion of terrestrial carbon. To achieve this, sediments from a brook were incubated in the laboratory after different sources of carbon had been added to them. As their terrestrial source of carbon, the researchers used labelled leaves that had a considerably higher proportion of the heavy stable carbon isotope 13C than the other sources of carbon in the system. Using this "isotope tracer", they were able to track carbon flux throughout the duration of the test. The results showed that the composition of the carbon pool has a considerable influence on the extent to which bacteria are involved in the degradation of terrestrial carbon. As soon are algae derivatives are in the carbon pool, bacteria are able to absorb terrestrial carbon more effectively and incorporate it as biomass. In so doing, it appears that the nutrient composition of the algal material plays a role in determining the composition of the bacterial community.

Jenny Fabian, Sanja Zlatanovic, Michael Mutz and Katrin Premke (2017). Fungal-bacterial dynamics and their contribution to terrigenous carbon turnover in relation to organic matter quality. ISME Journal. 11(2): 415-425.

More about this topic on our website:
www.igb-berlin.de/en/use-management and
www.igb-berlin.de/en/water-matter-cycles

Rivers, lakes and wetlands are closely linked to their surrounding areas. At IGB, we explore complex matter cycles and interactions between water and land. Such knowledge may serve as a basis for developing concepts on integrated landscape management. In his PhD thesis, Peter Fischer created the first map of potential phosphorus losses from German agriculture, based on the degree of phosphorus saturation of agricultural soils. Dominik Zak and his colleagues developed a decision-making system for peatland restoration. In her PhD thesis, Jenny Fabian investigated the degradation of terrestrial carbon in waters.

A Loss that has Gone Unnoticed

About one third of all freshwater species around the world are threatened. But even so, it is mainly charismatic terrestrial and marine animals such as giant panda, elephants, polar bear and whales that are perceived as being worthy of protection. And yet the decline in freshwater vertebrate species is occurring around two to three times more rapidly than in their terrestrial and marine counterparts. At IGB, we investigate the causes of species loss, draw up forecasts relating to changes, and develop ideas for knowledge-based species protection. Sonja Jähnig and her international colleagues have proposed using the approach of flagship species to promote freshwater biodiversity conservation. Jörg Freyhof and his team have found out which rivers and lakes are key to protecting biodiversity in Europe. Nike Sommerwerk and her colleagues have revealed how the composition of European fish species has changed since the beginning of industrialisation.

"Freshwater Panda Bears"

Researchers at IGB and the International Union for the Conservation of Nature (IUCN) have investigated whether "large charismatic animals" in freshwaters are under particular threat and whether megafauna-based conservation actions could benefit a broader range of species.

The study shows that 83 per cent of all the world's threatened freshwater species occur in the same areas as the 132 potential flagship species examined within the study. However, almost 60 per cent of these potential flagship species that could gain a body mass of 30 kg are themselves already assessed as threatened on the IUCN Red List.

"Hippos, river dolphins, crocodiles, freshwater turtles and large fishes such as sturgeons and catfishes have the potential to raise public, scientific and, above all, political awareness of species loss and the attendant problems in freshwaters. If efficient conservation actions for these flagship species can be identified and implemented, the habitats of numerous smaller species could be preserved at the same time," emphasised IGB researcher Sonja Jähnig, the corresponding author of the study.

The Yangtze Finless Porpoise is listed as Critically Endangered on the IUCN Red List of Threatened Species
Photo: Huigong Yu

Discovery of Europe's First Cave Fish

Not only is the cave loach, measuring about eight centimetres in length, the first species of cave fish to be discovered in Europe, it is also the world's northernmost cave fish. Whereas most other European cave-dwellers are endemic to the Balkan region, this species lives in Germany. The loach went underground only relatively recently: the latest findings suggest that the loach took to the darkness and became cave-dwellers (troglodytes) after the Ice Age. Scientists are particularly interested in the young evolutionary history of this fish species. "We have come across a real gem that helps us gain a better understanding of rapid evolutionary biological adaptations," stated Jörg Freyhof, corresponding author and biodiversity expert at IGB.

Jasminca Behrmann-Godel, Arne W. Nolte, Joachim Kreiselmaier, Roland Berka and Jörg Freyhof (2017). The first European cave fish. Current Biology 27 (7): R257-R258

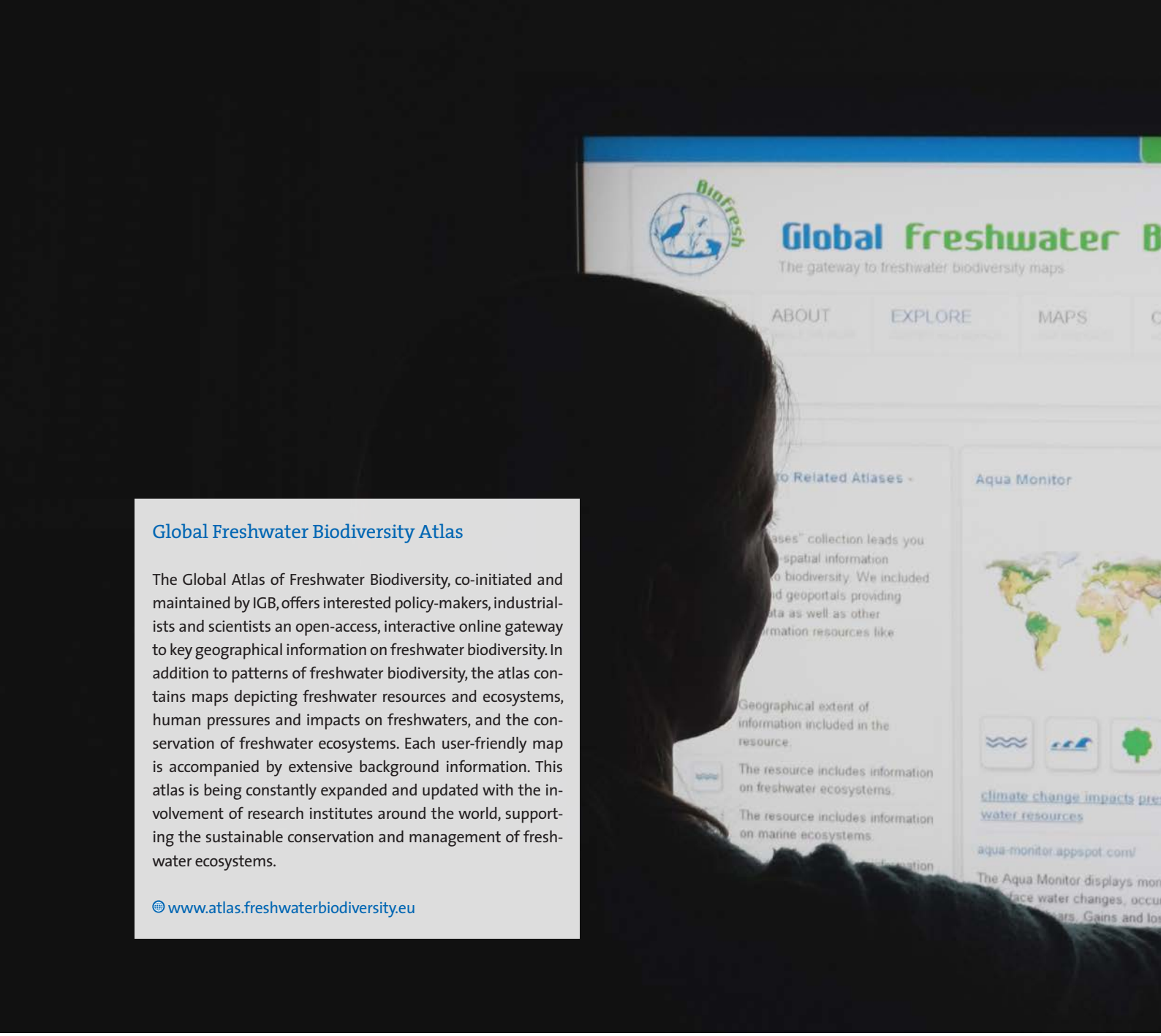
In order to protect these flagship species – and, at the same time, entire freshwater ecosystems – researchers recommend combining local protection zones, such as for spawning and breeding sites, with large-scale landscape actions operating at the catchment scale. Above all, the exploitation of these animals and the degradation of their habitats must be curbed: 94 per cent of the animal species under investigation suffer from biological resource use, such as being decimated by hunting and fishing at a faster rate than stocks are able to recover.

The study has been published open access in BioScience:
Savrina F. Carrizo, Sonja C. Jähnig, Vanessa Bremerich, Jörg Freyhof, Ian Harrison, Fengzhi He, Simone D. Langhans, Klement Tockner, Christiane Zarfl and William Darwall (2017). Freshwater Megafauna: Flagships for Freshwater Biodiversity under Threat. Bioscience. 67(10):919-927.

Fengzhi He, Christiane Zarfl, Vanessa Bremerich, Alex Henshaw, William Darwall, Klement Tockner, and Sonja C. Jaehnig (2017). Disappearing giants: a review of threats to freshwater megafauna. WIREs Water, 4: e1208.

"Protecting the biodiversity of freshwaters is a massive undertaking. For this reason, we have conducted an online survey (Freshwater-Life Survey 2017, IGB) to ask various stakeholders from research, education, politics, species protection and the general public about their priorities – and received over 900 replies from 80 countries, a fantastic response! After analysing the responses, we hope to have a better idea of the major challenges that should be on the agenda for tackling next together." ***Sonja Jähnig***

Photo: David Ausserhofer



Global Freshwater Biodiversity Atlas

The Global Atlas of Freshwater Biodiversity, co-initiated and maintained by IGB, offers interested policy-makers, industrialists and scientists an open-access, interactive online gateway to key geographical information on freshwater biodiversity. In addition to patterns of freshwater biodiversity, the atlas contains maps depicting freshwater resources and ecosystems, human pressures and impacts on freshwaters, and the conservation of freshwater ecosystems. Each user-friendly map is accompanied by extensive background information. This atlas is being constantly expanded and updated with the involvement of research institutes around the world, supporting the sustainable conservation and management of freshwater ecosystems.

www.atlas.freshwaterbiodiversity.eu

The Most Important 17 Per Cent

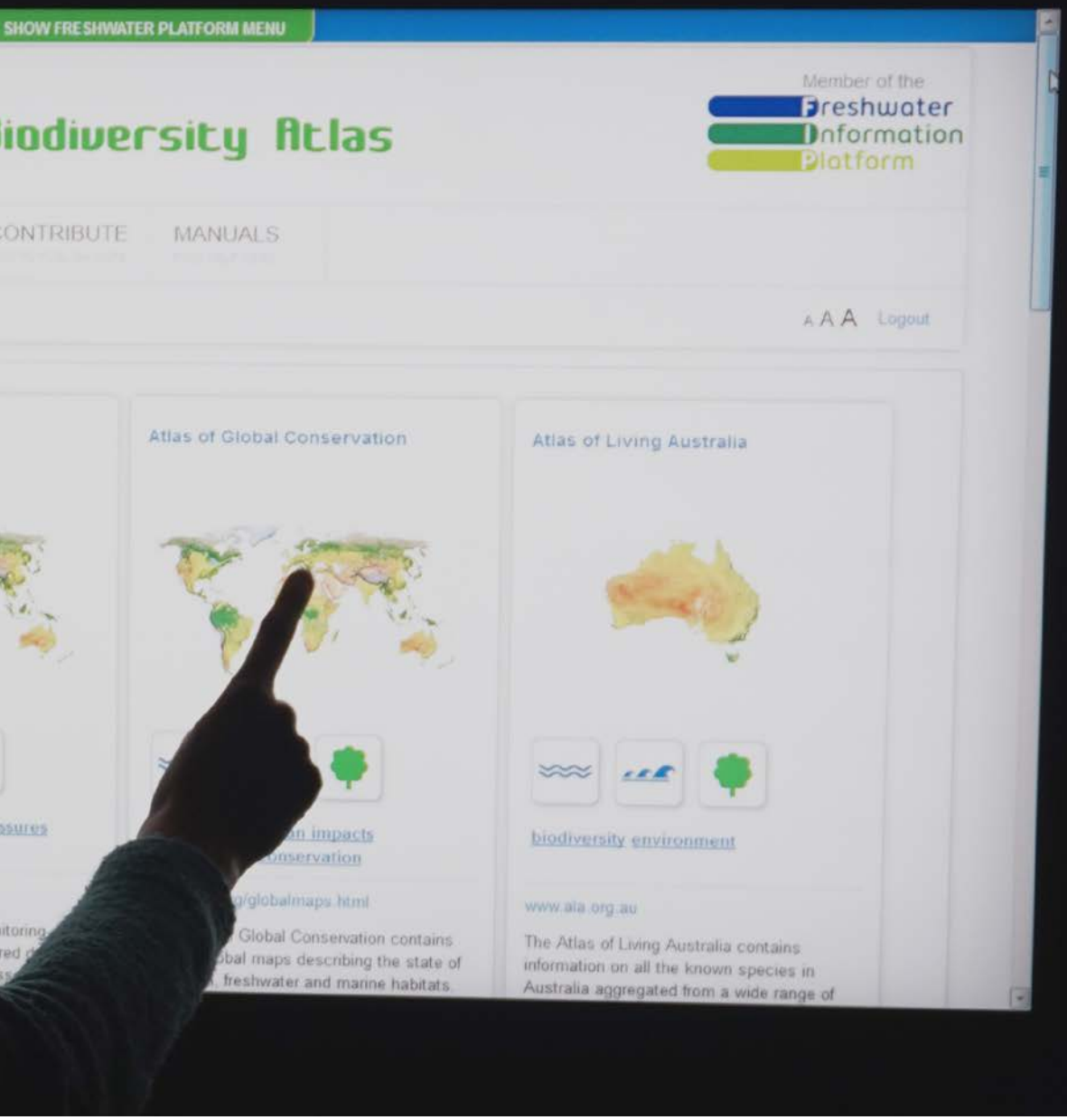
"The results of this international project should help to protect aquatic biodiversity in Europe to the greatest extent possible," stated IGB's Jörg Freyhof. The political context is the UN Convention on Biological Diversity, which has been signed by all European countries. These countries have undertaken to conserve biodiversity in at least 17 per cent of all freshwaters. Led by IGB, an international team of authors investigated which are the most important rivers and lakes with regard to protecting biodiversity in Europe. To this end, the researchers analysed the distribution data on 1,296 species of fish, bivalves, snails, dragonflies and aquatic plants from all over Europe.

In all, endangered aquatic organisms occur in 45 per cent of all European freshwaters, most of which are located in Southern Europe. In order to identify the most important 17 per cent, these freshwaters were prioritised once again, resulting in at least one freshwater for each endangered species, where possible. As a result, scientists have identified 3,492 freshwaters, primarily in Southern and Eastern Europe, that could help conserve 96 per cent of all species endangered in Europe, if protected effectively. So far, most of these "critical freshwaters" have unfortunately not been protected. The study may be useful when new protected areas are being planned, when dams destroy rivers, and when money is invested in the protection of biodiversity.

Savrina F. Carrizo, Szabolcs Lengyel, Felicia Kapusi, Marton Szabolcs, Hans D. Kasperidus, Mathias Scholz, Danijela Markovic, Jörg Freyhof, Nuria Cid, Ana C. Cardoso and William Darwall (2017). Critical catchments for freshwater biodiversity conservation in Europe: identification, prioritisation and gap analysis. Journal of Applied Ecology. 54(4):1209-1218.

More Species, But More Homogeneous Communities

Throughout Europe, humans have played a role in the loss of species for a long time whilst, however, enabling species to spread in areas where they did not occur in the past.



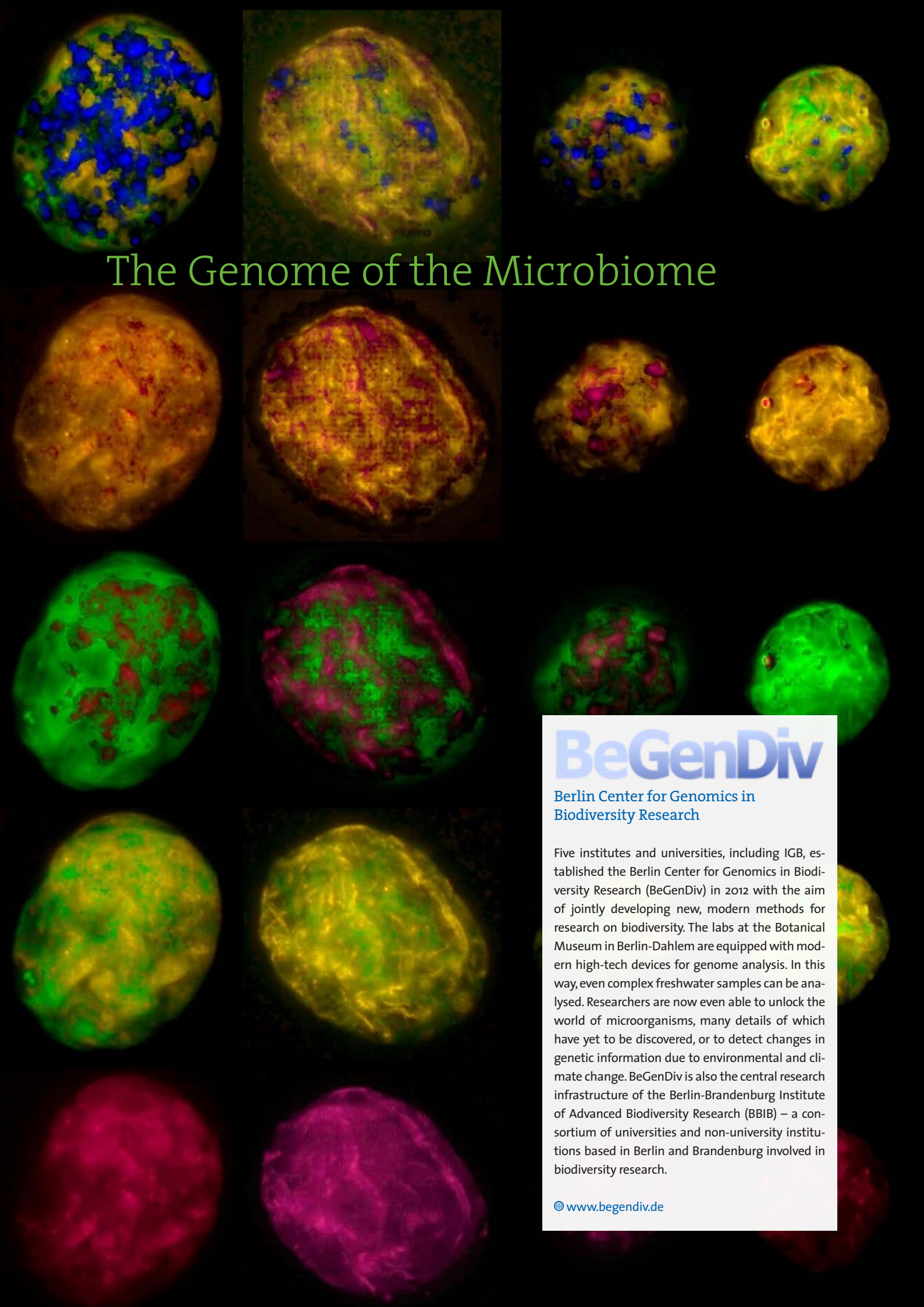
Global Freshwater Biodiversity Atlas. Photo: IGB

A study undertaken by Nike Sommerwerk and her colleagues reveals how the European fish fauna has changed since 1840. The 251 European river basins investigated in the study currently contain a total of 468 native fish species. In other words, there are 11 more species than prior to industrialisation because the number of exotic species introduced to Europe (26) exceeds the number of species that have become extinct (15). A total of 77 species of fish that were native to parts of Europe have been introduced to other European river basins where they were absent in the past. However, the change in composition of species is far more serious than suggested by the net growth of species: an average of one fifth of historic fish communities have vanished per river basin and have been replaced by new species. Consequently, fish communities in European river basins have become more similar than was originally the case. This development is known as homogenisation.

"What is special about this study is the fact that it emphasises the significance of various components of homogenisation. In contrast to general opinion, the introduction of non-native species and the extinction of migratory fish that were once widespread lead to a differentiation of river basins," Nike Sommerwerk highlighted. The spread of European fish species to other, new river basins is the main cause of faunal homogenisation. This finding is particularly relevant in the management of freshwaters because native species may be stocked in freshwaters without a permit.

Nike Sommerwerk, Christian Wolter, Jörg Freyhof and Klement Tockner (2017). Components and drivers of change in European freshwater fish faunas. J. Biogeogr., 44: 1781–1790.

More about this topic on our website:
www.igb-berlin.de/en/biodiversity



The Genome of the Microbiome

BeGenDiv

Berlin Center for Genomics in Biodiversity Research

Five institutes and universities, including IGB, established the Berlin Center for Genomics in Biodiversity Research (BeGenDiv) in 2012 with the aim of jointly developing new, modern methods for research on biodiversity. The labs at the Botanical Museum in Berlin-Dahlem are equipped with modern high-tech devices for genome analysis. In this way, even complex freshwater samples can be analysed. Researchers are now even able to unlock the world of microorganisms, many details of which have yet to be discovered, or to detect changes in genetic information due to environmental and climate change. BeGenDiv is also the central research infrastructure of the Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB) – a consortium of universities and non-university institutions based in Berlin and Brandenburg involved in biodiversity research.

www.begendiv.de

Small but powerful – microorganisms play an important role in freshwaters. As with organisms, microorganisms are responsible for organic matter conversion, and they are part of freshwater food webs, helping to preserve ecosystems. Thanks to modern genome analysis, even bacterial communities in complex freshwater samples can now be analysed with precision. Danny Ionescu and his colleagues, for instance, have shown that the sulphur bacterium *Achromatium* possesses hundreds of different genomes – important background information for assessing the diversity of bacteria in freshwaters. Researchers from Hans-Peter Grossart's team participated in a massive crowdsourcing campaign, involving over 500 scientists, to create the first reference database of the earth's microbiome.

Giant Bacterium Contains Genomes for an Entire Population

Achromatium oxaliferum is the largest (known) freshwater bacterium in the world and can be found, among other places, in Brandenburg's Lake Stechlin. It is 30,000 times larger than its "normal" counterparts that live in water and, owing to its calcite deposits, is visible to the naked eye. It is known that sulphur bacteria such as *Achromatium* may contain several genome copies. But the fact that a single bacterial cell harbours hundreds of different genomes is new – also to bacteria experts. Together with colleagues from Carl von Ossietzky University of Oldenburg and the University of Oxford, IGB researchers have found that single cells of *Achromatium* contain up to 300 DNA spots, each with an undefined number of chromosomes. Metagenomic analysis and single-cell genome sequencing have revealed that the many chromosomes of a cell are not identical copies of each other. This finding has an impact on scientific work. In the past, for example, environmental samples – such as water or soil samples – have usually been analysed using DNA/RNA sequences. In this process, the different sequences shed light on the types of bacteria contained in a sample. Until now, it was always assumed that a polyploid bacterium of a certain type has multiple identical genomes. This means that the number of different types of bacteria in a water sample would be identical to that of the different genomes. If, however, the sample also contains *Achromatium* or similar bacteria, the method used to date may lead to an overestimation of the true diversity.

The study has been published open access in Nature Communications:

Danny Ionescu, Mina Bizic-Ionescu, Nicola De Maio, Heribert Cypionka, Hans-Peter Grossart (2017). Community-like genome in single cells of the sulfur bacterium Achromatium oxaliferum. Nature Communications 8: art. 455.

The Earth's Microbiome

An international research cooperation of enormous dimensions has catalogued the microbial diversity of our earth on an unprecedented scale, creating the world's first reference database of earth's bacteria. The protagonists of microbial life on earth are bacteria, fungi, microscopic algae and other single cell organs – they represent the microbiome of our planet. Our scientific understanding of microorganisms and how they interact with the environment remains incomplete, in spite of their omnipresence. For this reason, 2010 saw the launch of the "Earth Microbiome Project" (EMP) – an enormous crowdsourcing campaign involving the participation of over 500 researchers from all over the world. Among the contributors were also researchers from Hans-Peter Grossart's team, who took monthly samples from six different lakes for the project, in some cases for longer than ten years. Using DNA analysis, the researchers examined the microbial composition of more than 27,000 samples taken from 43 countries over seven continents. The information gained was used to create the world's first reference database for earth's bacteria. This database now enables samples to be assigned to certain habitats in the world based on their respective microbiome in more than 90 per cent of cases. Not only forensic scientists, but also, above all, ecologists benefit from the data collection: certain microbial communities provide an accurate picture of the state of an ecosystem, such as a lake. The existence of such indicator organisms enables scientists to determine the potential contamination of a freshwater, such as due to toxins.

Luke R. Thompson, Jon G. Sanders [...] The Earth Microbiome Project Consortium (2017). A communal catalogue reveals Earth's multiscale microbial diversity. Nature 551, 457–463.

"There's hardly any place on earth that is without microorganisms, and no life on earth would be possible without them. Their incredible diversity and functions shape the biosphere, including humans, which means that knowledge of the microbiome is also a kind of understanding of ourselves." ***Hans-Peter Grossart***

Photo: David Ausserhofer

More about this topic on our website:
www.igb-berlin.de/en/biodiversity and
www.igb-berlin.de/en/freshwater-ecosystems

Urban Blue

Sediment Core Analysis Uncovers Historic Contamination of Berlin's Lake Tegel

Urban lakes are often affected by anthropogenic stress factors. All kinds of loadings cause water quality to deteriorate and, at the same time, complex water management measures are supposed to be used to control the water and matter balance. Lake Tegel in northwest Berlin is a prominent example of a heavily regulated urban lake. Until the mid-20th century, wastewaters in Berlin were treated on so-called sewage fields, which led to the considerable leaching of heavy metals, nutrients and organic matter into Lake Tegel. In an effort to halt the resulting severe eutrophication of the lake, a wastewater treatment plant and a phosphorus elimination plant were built at the inflow of Lake Tegel in the 1980s. An aeration system was also installed to improve oxygen conditions in the lake's deep water. This led to a reduction in the influx of phosphorus, improving the trophic state of the lake. These measures ensured that Berlin's second largest lake would remain a source of drinking water supply, via bank filtration, for future generations.

In a bid to analyse in greater detail the load history of Lake Tegel and the impact of management measures over the last 100 years, IGB researchers used sediment cores from various sampling points as an "archive". The palaeochemical data were compared with data gained from sediment cores from two other Havel lakes: the Lake Großer Wannsee, which served as an urban reference, and the Lake Useriner See, a reference for a lake with low anthropogenic impact. The application of statistical methods revealed a resemblance of the sediment composition in the younger sediment layers of Lake Tegel with that of the more or less pristine Lake Useriner See. Depositions of heavy metals have declined significantly in present times. In this way, the researchers were able to reconstruct the extent of the lake's anthropogenic load as well as the success of management measures.

Robert Ladwig; Lena Heinrich; Gabriel Singer and Michael Hupfer (2017). Sediment core data reconstruct the management history and usage of a heavily modified urban lake in Berlin, Germany. Environ Sci Pollut Res.24: 25166-25178

A Fatal Vacuum Cleaner for Insects: Light Along the Banks

"Like a moth to a flame" – an ecological effect, not just a phrase: every summer night, around a billion insects are confused by Germany's lamps – and for many of them, this is fatal. The number of flying insects has decreased in parts of Germany by over 75 per cent ("Insect decline in Germany confirmed" in PLoS ONE). Light pollution could be one reason for this decline. Alessandro Manfrin and his team have explored this phenomenon in the Westhavelland Nature Park, far away from illuminated cities. They measured the impact of street lamps on the occurrence, frequency and behaviour of insects and spiders on experimental fields close to freshwaters. One experimental field remained dark as a control field, whilst on the other experimental field, street lamps were switched on during the night. On the illuminated experimental field, considerably more insects left the water than on the unlit control field. The behaviour of spiders and insects on land also changed. Flying insects flock to the lit lamps – particularly water insects – with the result that more spiders and predatory insects came out to hunt. Some usually nocturnal animals extended their activity into the day – presumably to benefit from the large number of exhausted or dead insects close to the lamps. The number of predatory nocturnal ground beetles, however, was considerably reduced on the illuminated experimental field. "The study revealed how artificial light can change the habitats of insects and their predators across ecosystem boundaries – water and land. If we develop new lighting concepts, we must always take the possible effect on adjacent ecosystems into account," concluded Alessandro Manfrin.

The study has been published in Frontiers in Environmental Science, an open access journal, and was recently cited by the Nature News Feature "The dark side of light" (Nature 553, 268–270; 2018):

Alessandro Manfrin, Gabriel Singer, Stefano Larsen, Nadine Weiß, Roy H. A. van Grunsven, Nina-Sophie Weiß, Stefanie Wohlfahrt, Michael T. Monaghan and Franz Hölker (2017). Artificial light at night affects organism flux across ecosystem boundaries and drives community structure in the recipient ecosystem. Frontiers in Environmental Science, 5, 61.

More about this topic on our website:
wwww.igb-berlin.de/en/use-management

"We want more nature in the city AND to take into account people's wishes, which is why we seek ways in which the Water Framework Directive can help improve residents' quality of life. The "Blue Ribbon Germany" (Blaues Band Deutschland) programme, a joint initiative by the Federal Ministries of Transport and the Environment, is designed to develop subsidiary waterways in environmental terms as well as improving them for leisure and recreation. It is a great opportunity for many waters of Berlin."
Jörg Freyhof, coordinator of "Ecological Potential of Urban Waters"

Photo: David Ausserhofer

"Urban green" makes our cities more attractive and liveable. So does "urban blue" – that's what we say at IGB, and we're not alone in this respect. Humans have always settled in the vicinity of water, and almost every major city in a landlocked country has a main artery – a rushing river, such as the River Spree for those of us in Berlin. At IGB, we examine the stressors affecting urban waters and we develop scientific foundations for efficient management concepts – often in cooperation with partners from other disciplines. One example of this is our involvement in the DFG's "Urban Water Interfaces" (UWI) Research Training Group. This project has given a research group led by Michael Hupfer an opportunity to explore historical contamination of Lake Tegel in Berlin. Franz Hölker and his team have proven that artificial lighting near freshwaters greatly affects land-water interactions and primary producers. In addition, IGB is coordinating an interdisciplinary research network entitled "Ecological Potential of Urban Waters".

Swimming in the River Spree – A Dream of Many Berliners!

The interdisciplinary research network "Ecological Potential of Urban Waters" connects local, national and international stakeholder active in the field of restoration ecology, biodiversity and recreation research in aquatic urban environments. To do so, we develop an information platform to bring together knowledge and experience in restoration and recreation ecology, organise events, create information material and also encourage new research questions to restore urban waters.

Read more: urban-waters.org
Overall coordination: IGB, Dr. Jörg Freyhof
Funded by: Berlin Senate Chancellery – Science and Research (10/2016 to 10/2019).

Photo: fotolia.com/ArTo

sought-after

Dialogue and Knowledge Transfer

Questions are often put to us: by journalists, stakeholders and Grade 1b of Hauptmann-von-Köpenick Primary School. And we have the right language for every answer – regardless of our specialist vocabulary. We enjoy listening and learning about new things – about other aspects and ways of thinking about the issues that inspire us. And we don't mind where the dialogue takes place: on a night walk through Berlin, wearing rubber boots at the river bank, or standing on a soapbox.

Soapbox Science at the former Tempelhof Airport in Berlin on 4 June.
Photo: Cecilia Kruszynski

Active at the Interface between Science and Society

One of IGB's central tasks is to provide objective information and consulting to societal stakeholders from politics, authorities, associations, industry, education, organised civil society and the interested public. In order to foster this exchange, we developed an institute-wide Science-Society-Interface (SSI) strategy in 2015 that is now being gradually implemented. We collaborate in dialogue-oriented and participatory projects that include specialised interest groups or citizens from the very beginning; we promote exchange in the context of public events, we offer our own series of workshops and dialogue talks (Müggelsee Dialogue; Lake Stechlin Dialogue; IGB Academy), and publish a stakeholder publication series (IGB Outlines) to help transfer our research results to societal and political processes. In the IGB in-house series of workshops Uncharted Waters, our researchers discover how to efficiently design communication and knowledge transfer between different interest groups.

IGB Policy Brief for the Bundestag Election 2017: Five Urgent Water Issues for Policymakers

In the run-up to the Bundestag elections in 2017, we compiled facts and substantiated arguments on five water-related issues, in which the institute sees urgent need for political discussion and action:

1. **Overfertilisation:** Diffuse nutrient contamination of waters with nitrogen and phosphorus
2. **Synthetic substances:** Pharmaceuticals, microplastics, nanoparticles and hormone-active substances in water bodies
3. **Waterways:** Unprofitable extension in conflict with EU legislation
4. **Aquaculture:** Strengthening sustainable recirculation systems and self-sufficiency
5. **Hydropower:** EEG subsidisation of small hydropower plants versus water protection

"Present conflicts concerning the protection and the use of our freshwaters are often very complex and stakeholders have to deal with differing interests. Sometimes positions harden and cause a gridlock. That's why IGB strengthens its engagement in knowledge transfer. We provide objective research-based knowledge for societal debates. We also benefit from these new dialogue formats: external inputs from politics, authorities, associations or industry can spread into science and raise new research questions, foster cooperations and create new solution approaches." ***Johannes Graupner, Knowledge Transfer Officer (KTO) at IGB***

Photo: David Ausserhofer

The IGB Policy Brief for the Bundestag election 2017 – "Protection and Use of Inland Water in Germany – Status Quo, Conflicts and Political Action Options" is published within our stakeholder publication series called IGB Outlines. It can be downloaded from the IGB website.

Contact: Johannes Graupner

www.igb-berlin.de/en/news/five-urgent-water-issues-policymakers (German only)

Franz Hölker, Andreas Jechow and Sibylle Schroer talked about different aspects of astro-tourism at the ITB Berlin. Photo: IGB

Joint Efforts to Combat Light Pollution

Light pollution is a relatively new issue. All concerned players who are interested in this problem appreciate gaining new insights from research, providing them with decision support. Once again this year, Franz Hölker's and Sibylle Schroer's research group was committed to raising public awareness of the issue of light pollution, imparting scientific knowledge and connecting the various disciplines and interest groups.

IGB Academy on Light Pollution: Research Knowledge for Application in Practice

Stakeholders from environmental associations, federal politics, authorities and the economy gathered at the IGB Academy at IGB on 13th October to discuss how research results can be integrated into measures for achieving more efficient and environmentally friendly lighting. Topics included the physical basics of light pollution, the consequences for ecosystems and a workshop on common future strategies for sustainable lighting.

Lake Stechlin Dialogue: The Dark Side of Artificial Night Light

Eight lectures from the fields of research and practice provided the basis for discussion at this year's Lake Stechlin Dialogue on 14 October. Franz Hölker, Andreas Jechow and Sibylle Schroer presented the latest research and practical experience to identify and fiercly debate potential options for action and unresolved issues.
"Light pollution is a global environmental problem that affects all of us. Researchers and practitioners must work hand in hand to mitigate the problem," concluded Franz Hölker, co-organiser of the Dialogue event. "When I started exploring light pollution some twenty years ago, I was laughed at by my colleagues," reported Marita Böttcher from the Federal Agency for Nature Conservation. Although this is no longer the case, the issue is still far from the minds of policymakers: it is essential that the legislation required to fundamentally improve the situation is introduced.

Sustainable Tourism and Starry Nights

Celestial phenomena such as northern lights and clear views of the Milky Way may increasingly act as magnets for tourists in the future. This was the conclusion drawn at the 12th Pow-Wow on all aspects of astro-tourism at the ITB Berlin, the International Travel Trade Show, on 8 March. In her session, Sibylle Schroer presented pictures, videos and information about celestial phenomena such as northern lights and the total solar eclipse. The material was created on expeditions with Miguel Serra-Ricart, astronomer at the Astrophysics Institute of the Canary Islands (Instituto de Astrofísica de Canarias, IAC), within the STARS4ALL project. At the end of the day, Franz Hölker, led a panel discussion with Harald Bardenhagen from the Star Park Eifel, Andreas Hänel from the International Dark-Sky Association, Tim Horn, Director of the Zeiss Planetarium Berlin, and Sibylle Schroer. The participants agreed that protected dark areas, such as star parks or star reserves, are necessary to enable the development of sustainable astro-tourism.

Contact: Dr. Sibylle Schroer and PD Dr. Franz Hölker

Hand in Hand for Sustainable Angling

The fisheries research undertaken by Robert Arlinghaus and his team represents a transdisciplinary approach that takes on board the various players – such as anglers and river keepers – within the research process from the very outset. The benefits are obvious: scientific findings are highly relevant to fishery practice and can be implemented without delay. This close collaboration also provides important impetus for research. All findings are prepared with particular target groups in mind, and published accordingly.

Active Participation is Educational: Social-Ecological Fisheries Experiment

In cooperation with biology educationalists from Tübingen University and numerous angling clubs from Lower Saxony (Germany) in the role of practitioners, fisheries scientists from IGB and the Humboldt-Universität zu Berlin have conducted an extensive, social-ecological fisheries experiment over the period of several years. The experiment involved investigating whether stocked fish become established in their new environment, and to what extent relative to naturally reproducing stock components. The long-term ecological fish stocking experiment was combined with an environmental educational experiment on the learning success generated by collaborative research.
The researchers planned and evaluated their ecological fish stocking experiments in collaboration with anglers and water managers. One of the three groups was directly involved in the field experiment. The greatest environmental educational impact was made on the participatory group. For example, there were changes in this group's personal standards and core environmental beliefs – especially their greater acceptance of alternative management approaches involving fewer environmental risks, such as habitat enhancement or harvest regulations, rather than continuing to manage fisheries via fish stocking. "It is essential to foster the interfaces between environmental practice and research, so that transdisciplinary research based on well-evaluated field experiments can be used on a large scale," concluded Robert Arlinghaus. The results can likely be transferred to other situations where humans use and shape nature, such as in agriculture, hunting or forestry.

Marie Fujitani, Andrew McFall, Christoph Randler and Robert Arlinghaus (2017). Participatory adaptive management leads to environmental learning outcomes extending beyond the sphere of science. Science Advances 3, no. 6, e1602516.
Contact: Prof. Robert Arlinghaus

Practical Guide and Planning Software: "Sustainable Management of Angling Waters"... ... also as a Comic!

Angling associations are able to manage and shape freshwaters, fish communities and fishing conditions: for example, by determining harvest regulations, by releasing fish in a process called stocking and by taking action to improve habitats.
The practical guide entitled "Nachhaltiges Management von Angelgewässern" (Sustainable Management of Angling Waters) provides a summary of the essential foundations of fisheries management and management planning in view of the latest scientific findings. In their guide, the authors explain the conditions for or against the use of certain fish protection measures. The book is aimed at fisheries managers, angling association board members, fisheries biologists, interested anglers, conservationists, students and expert colleagues. The associated recreational fisheries simulation software newly developed by IGB offers decision support for the management of fish stocks used for recreational fisheries. The program enables the long-term effects of various fish preservation measures, such as fish stocking and harvest regulations, to be simulated. Unlike conventional models, this program's computations consider not only fish stocks, but also the behaviour of various types of anglers. The software program should help angling associations and clubs to assess the prospects of success offered by envisaged fish preservation measures, enabling them to plan more effectively.
The recommendations for action are also available as comics and cartoons – fully devoid of angling jargon!

Robert Arlinghaus, Raimund Müller, Tobias Raap and Christian Wolter (2017). Nachhaltiges Management von Angelgewässern: Ein Praxisleitfaden. Berichte des IGB, Heft 30/2017

Practical guide and fisheries management software:
www.igb-berlin.de/hegeplanung

Printed copies of the practical guide can be ordered from Robert Arlinghaus. To obtain a copy, please send him an A4-sized pre-addressed envelope with a € 1.65 stamp. Or contact Robert Arlinghaus by sending an email to: arlinghaus@igb-berlin.de

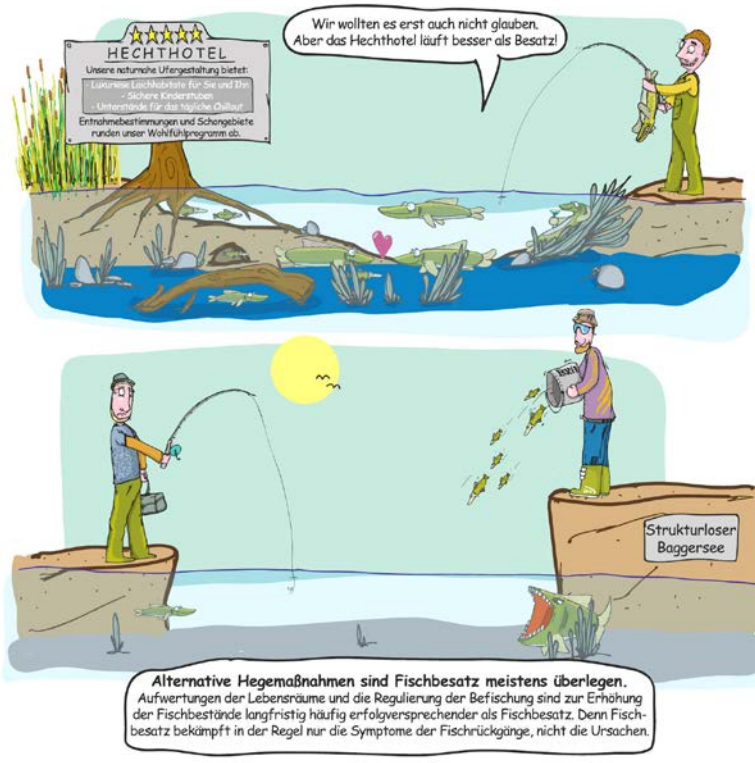


Photo: Katharina Bunk

7th Müggelsee Dialogue: Aquatic Biodiversity in Germany

The biodiversity of our freshwaters often remains hidden beneath the surface in both senses of the term. Have we managed to slow down or possibly even halt the loss of aquatic species richness in Germany? Regarding freshwaters, are the goals of the UN Convention on Biological Diversity (UN CBD) still achievable? Or have the problems got worse in recent years? These questions were discussed by the participants at this year's Müggelsee Dialogue on 14 November. Current research insights and practical knowledge from science, politics, public authorities, nature conservation and user groups were brought together to develop a better understanding of the national status of freshwater biodiversity. The participants agreed that the transdisciplinary cooperation between all protagonists has to be intensified to better balance the protection and use of aquatic ecosystems and their biodiversity. IGB is planning to publish the central points of the discussion in the institute's own stakeholder publication series IGB Outlines.

Contact: Dr. Jörg Freyhof

Uncharted Waters: What Makes Environmental Associations Tick?

Environmental associations play an important role not only when it comes to practical water protection at the local scale, but also in the representation of environmental water policy interests on a national scale. Scientists met with representatives from Friends of the Earth Germany (BUND) and the Nature and Biodiversity Conservation Union (NABU) at the IGB Workshop Discussion to find out more about the mindsets and actions of environmental associations and researchers. The participants also sounded out the opportunities and limitations of collaboration. Guests Laura von Vittorelli (national head office of BUND), Julia Mußbach (national head office of NABU) and Christiane Schröder (NABU Brandenburg regional office) talked about the projects undertaken by their respective associations in the area of practical water protection, as well as their water policy goals and activities. This enabled the IGB scientists to get a good impression of how environmental associations work. These talks were followed by a joint discussion of the water issues considered particularly important by associations and researchers. The participants also sounded out the opportunities for greater exchange and cooperation to enable the better integration of objective, evidence-based research knowledge into nature conservation practice and environmental policy discourse.

IGB's in-house series of workshops called Uncharted Waters gives our researchers the opportunity to find out how to achieve efficient communication and knowledge transfer between different interest groups.
Contact: Johannes Graupner

Being Prepared for Epidemical Outbreaks

IGB scientists are now part of the "rapid deployment expert group to combat health threats", which will enable a faster international response to outbreaks of infectious diseases. In the event of possible outbreaks of serious diseases, the "rapid deployment expert group to combat health threats" – the SEEG in German – enables the necessary experts to be quickly assembled and sent to the crisis area to provide advice and support to local helpers. IGB provides expertise for water-related problems such as water quality issues, flood hazards, flooding and drainage. These aspects are important in cases of waterborne diseases and the prevention of future outbreaks. A possible scenario: persistent drought followed by floods, livestock in the flood zone, and insufficient medical care with inadequate laboratory equipment and capacity – this combination of factors could lead to the onset of Rift Valley fever. In such a case, it is important to have an interdisciplinary group of experts that can examine the situation from different angles to provide holistic assistance. Water-relevant questions would be, for instance, the assessment of the current flooding situation and its duration, the spatial-temporal prediction of floods, their avoidance and long-term forecasts under climate change.

Recent experiences in epidemic areas, such as the 2014/2015 Ebola crisis, have shown that a faster response is required to curb disease outbreaks. As a German contribution, the Federal Ministry for Economic Cooperation and Development (BMZ) has established the SEEG within the German Corporation for International Cooperation (GIZ).
Contact: Jens Kiesel

Aquaculture Workshop: From Feed to Fillet

What are the opportunities and problems involved in aquaculture? 33 individuals participated in the citizens workshop "From feed to fillet", held at IGB on 14 January, to find out about the current state of aquaculture research. The research team, headed by project leader Hendrik Monsees, provided a generally understandable overview and gave the visitors a tour of IGB's research facilities. Then it was time for hands-on activities: participants tried their hand at filleting, frying and smoking fish, gaining first-hand experience in processing and preparing fish.

The workshop entitled "From Feed to Fillet" was one of 15 prize-winning projects funded by the university competition within Science Year 2016*17 – Seas and Oceans. In keeping with the theme "Zeigt eure Forschung!" (Show your Research!), students, doctoral students and early career researchers from all disciplines were invited to develop projects on the topic of the Science Year. The projects were to use interactive methods to highlight the societal significance of research to citizens and to provide them with relevant research findings on the topic of "Seas and Oceans". The university competition was funded by the Federal Ministry of Education and Research (BMBF).
Contact: Hendrik Monsees

Photo: Katharina Bunk

Visitors and Public Events

1 **Berlin's RiverFilmFestival** took place on 21/22 January: the audience enjoyed striking images of the underwater world. IGB assumed the role of the RiverFilmFestival's scientific partner, and also hosted a transdisciplinary RiverScientistMatinee during the festival. Citizens, environmentalists and researchers came to the cinema to watch river films together over popcorn and drinks, and to discuss them afterwards.

Eleven girls took the opportunity to look over the shoulders of researchers and technical staff during **Girls' Day** on 27 April. The emphasis was on a number of exciting research questions: How do fish tick? How do rivers flow? What has red cabbage got to do with the pH value of liquids?

2 Swimming, angling, boating or canoeing: IGB scientists are currently investigating how water-based leisure activities affect the ecological and chemical quality of rivers and lakes, their social significance, and the possibility of cross-sectoral management within two projects, AQUATAG and RESI. For this reason, five IGB researchers attended the **5th Berliner Wassersportfest** (watersports festival) in Berlin-Grünau from 28 April to 4 May to conduct a scientific survey on leisure behaviour at rivers and lakes. The findings will help integrate leisure activities into concepts for the sustainable use of waters.

3 Fish facts for all ages: at the **Long Night of the Sciences (Lange Nacht der Wissenschaften)** at the Haus der Leibniz-Gemeinschaft on 11 June, IGB provided all kinds of facts about fish, such as where the fish we eat come from, and how we can meet our needs sustainably. Other questions included: How long do fish live, and how can we identify their age? And why do some fish continually migrate between rivers and oceans? Around 1,000 visitors were encouraged to engage in discovery, hands-on activities and experimentation at a variety of stalls.

4 Once to the sea and back – on tour with sturgeon, salmon & Co: the **Wanderfisch project** was funded by the Federal Ministry of Education and Research (BMBF) within the **Science Year 2016*17 – Seas and Oceans**. Once, sturgeons belonged to Europe's endemic species but have gone extinct in Germany and other parts of Europe. Since 1996, the IGB is involved in the rearing and reintroduction of sturgeons. In the Wanderfisch project, these actions were jointly coordinated with several educational institutions in order to involve children and young adults in topics of species/ nature conservation. A film and a touring exhibition were designed, both providing a comprehensive overview of the subject. Besides the conduction of stocking activities, equipment for water sampling ("Gewässerrucksäcke") and information material ("Gewässerpäckchen") stimulated pupils and teachers to develop own projects and excursions. Due to its experience in planning and implementing new educational contents in schools, the association BildungsCent e.V. was an important partner for this project.
www.wanderfisch.info

The **Open Garden Day** was held at IGB within Friedrichshagen's festival "getrommelt und gepfiffen" on 16 September. IGB scientists shared their knowledge with some 200 inquisitive individuals of all age groups on guided tours, in info tents and during hands-on activities.

Thirteen experts from Southeast Europe visited IGB on 19 September to find out about the state of research on integrative water management and on the assessment of biodiversity and ecosystem services. The representatives from government agencies and research institutions accepted an invitation by the **Gesellschaft für Internationale Zusammenarbeit (GIZ)** to participate in an information tour to Germany. Martin Pusch, leader of IGB's "River Management" research group, and biodiversity expert Jörg Freyhof gave visitors a guided tour of the institute and introduced them to IGB's projects AQUACROSS and RESI. Both projects involve recording and assessing the biodiversity and ecosystem services of freshwaters. The participants and GIZ project leaders now intend to investigate how such acquisition and management approaches can help preserve biodiversity in Southeast Europe.

5 Two rounds of **Soapbox Science** were held at Tempelhofer Feld in Berlin on 4 June and 7 November: twelve scientists from all over Germany stood on soap boxes to present their research in areas of technology, science and medicine. The aim of Soapbox Science is to enhance the visibility of women in science and to achieve a more balanced gender distribution in scientific research. The Berlin editions are co-organised and supported by several IGB scientists.

Photos: Juliane Lutze, Katharina Bunk, IGB, Matthias Rossoll, Cecilia Kruszynski∞ Illustration: Christiane John

Networks are based on trust and commitment. Ideally, everyone involved pursues the same goal, but contributes different skills and views. Ultimately, the result is better than the sum of the single parts. At IGB, we promote such exchange and participate actively in networks – as partners or initiators. Even if it is essential to reconcile different interests. We take cooperation seriously.

interconnected

Collaborations and Scientific Events

IGB LakeLab in Lake Stechlin.
Photo: Martin Oczipka, IGB/HTW Dresden

Strong Through Collaboration

As a Leibniz Institute that benefits from joint funding by federal and state governments, we are regionally rooted, yet internationally interconnected. With ten joint professorships, we are closely linked to universities in Berlin and Brandenburg. Seventy official collaborations strengthen scientific exchange with other institutions. 73 guest researchers visited IGB in 2017 (including 57 international researchers). Since 2017, IGB has coordinated AQUACOSM, an international network with 21 partner institutions, bringing together experimental infrastructures for marine and freshwater research. The goal of the Alliance for Freshwater Life, initiated by IGB in 2017, is to connect biodiversity research more closely to species protection in the future. A DFG Roundtable discussion on this topic took place in January 2018. And already another development this year: practical knowledge transfer – when the Tomatofish came to Egypt within an Alexander von Humboldt Foundation cooperation.

European Network Connects Freshwater and Marine Large Experimental Research Infrastructures

Lakes, rivers and oceans are closely connected, yet aquatic research is often divided into the separate disciplines of marine and freshwater sciences. Both lines of research have an important common element: experimental mesocosm facilities. Mesocosms are experimental units that are filled with large volumes (1-1,000 m^3) of natural water for experimental manipulation. Such infrastructures make a decisive difference when studying the effects of future environmental changes on aquatic ecosystems in a realistic and yet experimental way. The separate and combined effects of stress factors on aquatic ecosystems can be measured in mesocosms over periods of weeks to years. Since early 2017, IGB researchers have coordinated an international network of experimental infrastructures in the EU's AQUACOSM project with 21 European partner institutions involved in marine and freshwater research. AQUACOSM allows for experimental aquatic research in different climatic zones and geographical regions, ranging from the Arctic to the Mediterranean Sea, from alpine mountains to flat coastal plains. The experimental mesocosm facilities of the partner institutions are diverse, ranging from tank systems and troughs such as in Lunz am See (Austria), to large free-floating open-ocean facilities such as the Kiel Offshore Mesocosms (KOSMOS). IGB´s LakeLab in Lake Stechlin is a flagship facility of AQUACOSM.

Project: AQUACOSM
Duration: 01/2017-12/2020
Funded by: HORIZON 2020-INFRAIA, Vertrag Nr. 731065
Overall coordination: IGB, Dr. Jens C. Nejstgaard (project leader), Dr. Stella A. Berger (Transnational Access manager).

www.aquacosm.eu

Transnational Access Program:
www.aquacosm.eu/transnational-access

"The effects of stressors can vary widely depending on the ecosystem. For this reason, they must be investigated in comparable mesocosm experiments using uniform methods, but in different climatic and geographic regions. Our AQUACOSM project creates the necessary prerequisites for such an approach. All partners involved in the project make their mesocosm facilities available to researchers from all over the world via the Transnational Access Programme."
Jens Nejstgaard, project leader Photo: David Ausserhofer

Kiel Offshore Mesocosms (KOSMOS). Photo: SIGNE CLAUSEN, GEOMAR

"Research, nature conservation and politics – they are all interested in protecting biodiversity. However, we do not work together closely enough. The Alliance for Freshwater Life is a commitment for all participants – to listen to each other, to pool our expertise and to ensure that the general public will be made aware of this topic."
Michael Monaghan, co-founder of AFL

Photo: David Ausserhofer

Establishment of the Alliance for Freshwater Life and DFG Roundtable

In October, IGB researchers invited international experts from science, nature conservation and education to participate in a three-day workshop to jointly lay the groundwork for the Alliance for Freshwater Life (AFL), a new network with global reach. Freshwater biodiversity is still poorly documented, understood and protected. The participants discussed the efforts needed to build and maintain such a network. The result was a 12-month plan to get the network up and running, which would be supported by five pillars: research; data and synthesis; outreach and education; nature conservation; and policy. Organisations across the globe from all walks of life that are involved or interested in exploring and protecting freshwater biodiversity have been called on to get involved in the Alliance for Freshwater Life. A DFG Roundtable discussion (DFG: Deutsche Forschungsgemeinschaft) on "Exploring Freshwater Life – Status, Trends, Functions" took place in January 2018. The participants discussed steps necessary to advance knowledge about the resilience – and fragility – of freshwater communities in the face of multiple stressors. Important points included: methods for the assessment of resilience; "interdisciplinary" approaches, independent of ecosystems, taxonomies and disciplines; and future processing and provision of data. A core group will further develop the project to attract funding under a DFG Priority Programme: Sonja Jähnig (IGB), Jens Nejstgaard (IGB), Daniel Hering (University of Duisburg-Essen) and Peter Haase (Senckenberg). They will be supported by the following IGB researchers: Rita Adrian, Jörg Freyhof, Hans-Peter Grossart, Jonathan Jeschke, Gregor Kalinkat and Michael Monaghan.

Contact: Dr. Michael Monaghan, Dr. Sonja Jähnig, Prof. Jonathan Jeschke

Tomatofish in Egypt: inauguration of the first aquaponics system. Photo: IGB

The Tomatofish aquaponics system in Egypt

Water policy is a controversial topic in Egypt: without the waters of the Nile, nothing is possible. Nine other countries are also reliant on the River Nile, and Egypt, located at the lower end of the river, is completely dependent on water policies pursued by neighbouring countries upstream. The use of water-saving technologies is therefore an important way the country mitigates the current situation. Knowledge and technology concerning the Tomatofish water-saving aquaponics system was recently passed on to local counterparts through an Alexander von Humboldt Foundation cooperation between IGB and Assiut University in Egypt. In joint workshops, technicians and scientists from both institutions laid the foundations for the application and use of the system in Egypt. The highlight of the collaboration was the inauguration of the first aquaponics system in Egypt, on the Assiut University campus, in December 2017. It will be used for research and training purposes in the future – and as a demonstration plant for future aquaponics systems.

Project: Transfer Aquaponic Innovative Ecotechnology to Egypt for Sustainable Aquaculture and Food Production
Duration: 07/2015-12/2017
Funded by: Alexander von Humboldt Foundation cooperation (FKZ 3.4 – IP – DEU/1074134)
Overall coordination: IGB, Prof. Werner Kloas

"To transfer research knowledge to places where it is urgently needed – this really got all the IGB technicians and researchers participating in the project excited. In addition, this strengthens the partnership of two institutions, which started with a doctoral thesis at IGB about ten years ago." ***Werner Kloas, project leader***

Photo: David Ausserhofer

Together through day and night

Setup of the lighting system to simulate skyglow at the LakeLab. Photo: Andreas Jechow

"Illuminating Lake Ecosystems – ILES" is a large collaborative project that blends expertise from most departments at IGB. Some 50 scientists and technical staff members are involved, plus several international partners. "We aim to determine the impact of light pollution through skyglow on lake ecosystems," says project co-PI Mark Gessner, "and ask how elemental cycles and the whole food web – from bacteria and algae to water fleas and fish – are affected".

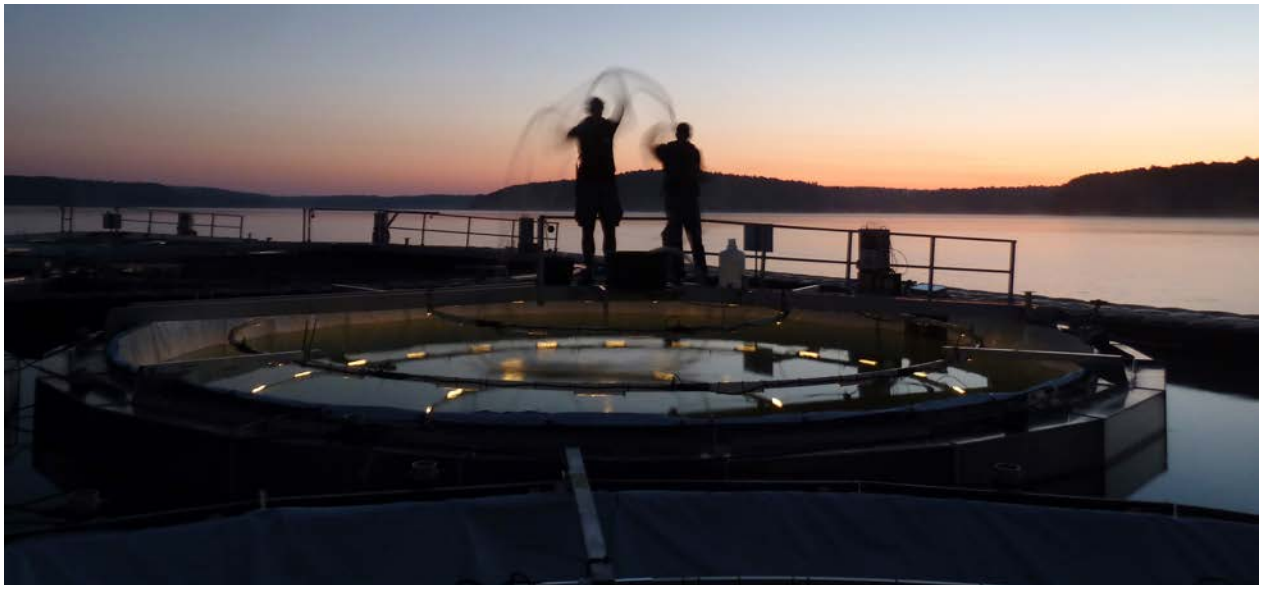
The experiments are conducted in the IGB LakeLab, a large research platform installed in Lake Stechlin. Here, the effects of light pollution can be particularly well explored, because the location is one of the darkest spots in Germany and thus offers excellent reference conditions. To simulate skyglow in the LakeLab, IGB physicist Andreas Jechow has developed a special lighting system consisting of two rings equipped with LED lights which ensure homogenous illumination already at shallow depths. Given the unique set-up to study impacts of skyglow on lakes, the ILES experiments in Lake Stechlin have been included in a recent news feature in Nature on light pollution.

Night sampling of plankton at the Lake Lab. Photo: Stella Berger

Samples are taken weekly throughout the experiments, both during the day and night. Doctoral student Jeremy Fonvielle, who is supervised by Hans-Peter Grossart and Gabriel Singer, focuses on dissolved organic carbon (DOC) and on aquatic bacteria, which decompose this organic material. Both the DOC and the bacterial communities are characterized in detail. "High concentrations of DOC available to bacteria increase bacterial activity and growth," says Gabriel Singer. The scientists expect that skyglow alters the composition of DOC and hence, indirectly, bacterial community composition and activity.

Doctoral student Susanne Stephan and her advisor Stella Berger examine the dynamics and stress physiology of phytoplankton. They collaborate closely with algal ecophysiologists at the University of Málaga (Spain). "We are curious to see whether artificially altered light regimes at night influence phytoplankton dynamics and the underlying physiological processes," says Stella Berger. Phytoplankton samples are treated with different fluorescent markers to ascertain whether a cell is dead or alive and whether it has been subject to oxidative stress. Chlorophyll content and photosynthetic activity of the phytoplankton are also determined, because physiological effects of skyglow at night could affect photosynthesis during the day and thus the production of biomass.

The biomass of phytoplankton is also influenced by the next higher level in the food web, the zooplankton. Zooplankton hide



Night shift at the LakeLab. Photo: Martina Bauchrowitz

from their fish predators in deep dark water during the day but move upwards under cover of night to feed on phytoplankton. Increased light at night by skyglow could change this day-night migration cycle and thus indirectly affect phytoplankton and other food-web components. To detect differences in such migration patterns caused by skyglow, doctoral student Tim Walles and his advisor Jens Nejstgaard use a special video camera to take images during the day and night that are subsequently analysed by using machine-learning algorithms. „With this new approach, we can detect the position of zooplankton much faster and at 10–100 times higher precision than with classical methods that use plankton nets," says Jens Nejstgaard.

Franziska Kupprat is a doctoral student advised by Franz Hölker and Werner Kloas. She studies fish responses to light pollution. As an important component of lake food webs that feed on and trigger the migration of zooplankton, fish must be added to the experimental cylinders at known and identical densities that reflect the natural situation. This is why postdoc Tom Shatwell developed a model to calculate the optimal stocking density that creates a near-natural predator pressure on the zooplankton. "We are interested in knowing whether European perch, which are normally active at daytime and during twilight, tend to prolong their feeding activity under skyglow. We use a sonar system to determine their vertical position in the water column," says Franziska Kupprat. Like for the zooplankton tracking, this method has been newly established at the IGB.

"Field experiments at this scale can only be realized by a closely collaborating team: In our experiment, sampling had to be performed not only during the day but also at night, largely in darkness. This was an additional challenge to the team. It is a very special experience to be out on the floating LakeLab in a celestially lit environment, where you barely see the shadows of your colleagues. Each move must be meticulously planned to be spot on." ***Franz Hölker, co-PI of the ILES project***

Photo: David Ausserhofer

Project: ILES – Illuminating Lake Ecosystems
Duration: 07/2015 – 06/2019
Funding: Leibniz Association
Overall coordination: IGB, Prof. Mark Gessner, PD Dr. Franz Hölker

www.lake-lab.de/index.php/iles.html

Publications:

Aisling Irwin (2018). The dark side of light: how artificial lighting is harming the natural world. Nature 553, 268–270.

Andreas Jechow, Franz Hölker, Zoltán Kolláth, Mark O. Gessner and Christopher C.M. Kyba (2016). Evaluating the summer night sky brightness at a research field site on Lake Stechlin in northeastern Germany. Journal of Quantitative Spectroscopy and Radiative Transfer 181, 24-32.

It's sampling time! The zoo- and phytoplankton team at work. Photo: IGB

Information from Other Networks

Perfoliate pondweed in Lake Stechlin. Photo: Solvin Zankl

Workshop on Current Macrophyte Development in German Freshwaters

Currently, aquatic plant (macrophyte) communities in approximately three-quarters of German lakes (covering more than 50 hectares) have not yet reached the good status required by the EU Water Framework Directive. In April, researchers of the Limnological Station of the Technical University of Munich organised a workshop on aquatic plants in German water bodies together with IGB scientist Sabine Hilt. Topics of the workshop with 30 participants from different universities and regional environmental councils were monitoring, and macrophyte responses to global change and restoration.

Contact: Dr. Sabine Hilt

International Conference: Nature and Society – Synergies, Conflicts, Trade-Offs

In May, ALTER-Net organised an international conference on "Nature and society – synergies, conflicts, trade-offs" in Ghent (Belgium): a meeting for scientists from the humanities, natural and social sciences, and for policymakers and representatives from non-governmental organisations. IGB scientists Gabriela Vostea and Simone Langhans served as members of the conference committee. ALTER-Net is a network of 26 partner institutes from 18 European countries. Topics include: research approaches which help to assess and predict changes in biodiversity and ecosystems as well as impacts on their functions; assessment criteria for socioeconomic effects and raising awareness among policymakers and the general public on the topic of biodiversity.

Contact: Dr. Sonja Jähnig (member of the Management Board of ALTER-Net, responsible for Research Projects)
www.alter-net.info

Open Science, Dark Knowledge: Science in an Age of Ignorance

In August, around sixty scientists from different disciplines, journalists and decision-makers came together in Alpbach, Austria, to discuss "Science in an Age of Ignorance" – organised by Klement Tockner (former IGB Director, now IGB guest scientists and President of the Austrian Science Fund, FWF) and IGB scientist Jonathan Jeschke. Digital networking means that we have access to more information and data than ever before. Scientific datasets are taking on previously unimaginable dimensions ("Big Data"). And yet this development appears to be almost decoupled from the knowledge that actually exists in our society: there is a gap between potential and actually existing public knowledge. We refer to this gap as "knowledge in the dark" or simply "dark knowledge." It has been the subject of exploration by a discussion group with members from IGB, Freie Universität Berlin, the Haus der Kulturen der Welt and other partners since September 2016. Representatives of the Art & Science Node, a transdisciplinary project bridging art, science and technology, also joined the group at the beginning of 2017. The Dark Knowledge group aims to develop and improve approaches that narrow the gap between potential and existing knowledge, with a particular focus on aquatic biodiversity. A manuscript is currently being prepared on the opportunities and challenges of Open Science.

Contact: Prof. Jonathan Jeschke
All lectures of the session are available online:

Dialogue on Small Water Bodies in Urban Spaces

In what condition are the more than 400 urban ponds, small lakes and ditches in Berlin? In a workshop at IGB in June 2017, the Ecological Potential of Urban Waters Research Network shed light on the situation of small water bodies in Berlin's districts. Stakeholders from government agencies, administration and science came together to discuss challenges as well as possible issues for action as well as research to foster the sustainable development of small water bodies in urban spaces. The workshop showed that actors in Berlin focus on water shortages and water quality, in particular on conservation and restoration. Water bodies are still underestimated as an opportunity to make urban districts more attractive. Consequently, hardly any new water bodies are developed and access to waters for the population is not expanded to the degree it could be.

The network is funded by the Berlin Senate Department for Economics, Technology and Research. **Overall coordination:** Dr. Jörg Freyhof

www.urban-waters.org

The Hierarchy-of-Hypotheses Approach: Exploring its Potential for Structuring and Analysing Theory, Research and Evidence Across Disciplines

The Hierarchy-of-Hypotheses (HoH) approach and its potential applications across scientific disciplines were discussed by approximately 30 participants from ecology, philosophy of science, medicine and chemistry. Tina Heger from the University of Potsdam and IGB researcher Jonathan Jeschke have developed the HoH approach to structure, compare and better understand concepts and hypotheses in invasion ecology and other disciplines. In particular, the HoH approach allows to subdivide hypotheses into overarching, general hypotheses and specific, directly testable sub-hypotheses. In the workshop, the HoH approach was discussed and compared to alternative approaches, and possible applications in several disciplines were examined. Next steps are to further refine the Hierarchy-of-Hypotheses approach and to more strongly link it to other approaches such as machine-learning techniques.

Contact: Prof. Jonathan Jeschke

More information:

Workshop on Lakes in Climate Models and Numerical Weather Prediction Models

In October, IGB scientist Georgiy Kirillin organised the fifth workshop on "Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling" with around 40 participants in Berlin. The meeting brought together specialists from various geophysical disciplines: climate research, limnology, biogeochemistry, meteorology and cryosphere research.

Contact: Dr. Georgiy Kirillin

www.flake.igb-berlin.de/Lake17

Presentation of the Kharaa-Yeröö River Basin Atlas. From left to right: Mr. Myagmar (General Director MET), Dr. Avlyush (IGG), PD Dr. Hofmann (IGB), Dr. Christian Alecke (BMBF), Prof. Borchardt (UFZ). Photo: N. Ilius

IWRM MoMo Transfer Conference in Ulaanbaatar and Kharaa Yeröö River Basin Atlas

Mongolia is characterised by water scarcity as well as highly dynamic changes and conflicts of water use in the water sector. The main objective of one project funded by the German Federal Ministry of Education and Research (BMBF), MoMo, is the development of strategies for the implementation of a sustainable IWRM (Integrated Water Resource Management) concept in this region. IGB is responsible for setting up environmental monitoring and knowledge transfer, as well as creating the Kharaa Yeröö River Basin Atlas. To ensure the transferability of experiences and approaches to solutions to other regions of Central Asia as well, the project consortium organised the IWRM MoMo Transfer Conference in Ulaanbaatar in September. About 70 invited participants from environmental agencies, international funding organisations, industry and science from Meongolia, China and Kazakhstan discussed further courses of action in four different workshops, which were then compiled in the form of policy briefs. IGB organised the "Environmental Monitoring and Information Management" workshop in cooperation with a German project partner, terrestris, and representatives of the Mongolian Ministry of Environment. During the conference, the Kharaa-Yeröö River Basin Atlas, published by IGB and a Mongolian partner, IGG (Institute of Geography and Geoecology), was presented. The Atlas is freely available on the MoMo Geo Data Portal. The goal is to document the scientific foundations of MoMo's monitoring and integrative results in particular, and to make this information available as a basis for discussion for stakeholders and decision-makers.

Contact: PD Dr. Jürgen Hofmann

www.igb-berlin.de/projekt/iwrm-verbundprojekt-momo-iii

A good working atmosphere is an important concern at IGB. We also spend a part of our leisure time together: for example at the IGB summer fair for IGB members, family and friends.
Photo: Katharina Bunk

committed

Career Development,
Awards and Honours

Working and Researching at IGB

Photo: Jörg Feryhof

IGB is an innovative, diverse place to work and conduct research. We allow our employees individual freedom, enabling them to develop and use their creativity to the best of their abilities. At the same time, we offer solid structures and an efficient administration that supports our scientific work. At IGB, we systematically continue to optimise our working conditions within the initiative "HR Excellence in Research" and through different bottom up activities.
A clear commitment to promoting the training of staff characterizes our corporate culture; Kirsten Pohlmann is responsible for the career development of IGB´s doctoral students and post-docs.

We consider it important to promote cooperation among our members of staff. In 2015, IGB was awarded the **"HR Excellence in Research"** logo by the European Commission in recognition of its exemplary staff policy and consistent optimisation of working conditions. During the period 2014-2016, our efforts in this area focused on internationalisation, transparency and developing the careers of IGB scientists. Measures to enhance family-friendliness and training opportunities for technicians take centre stage in the 2017-2020 action plan. In an effort to achieve a better gender balance in top-level science, IGB pursues the cascade model. We have also established an **Equal Opportunity Fund** for young female scientists within IGB to ensure funding for labour market reintegration measures and other incentive measures for female doctoral students and young researchers. Twice a year, we organise a **Welcome Day** for all new members of staff, offering information about their new place of work and guided tours of the premises. We foster flat hierarchies and active participation. Regular meetings are held in the research departments and research groups to enable thoughts and ideas to be exchanged. A roundup of the main information from the **monthly management meetings is sent to all**

employees in the form of short news. Once a year, all members of staff are invited to attend the **IGB Science Day**: throughout the day, the latest research highlights and projects are presented in brief lectures – without any technical jargon. We conduct **employee surveys** at regular intervals (as was also the case in 2017) to ensure that IGB continues to be a place where people enjoy working and conducting research.

We Take Further Training Seriously

Lifelong learning is a central concept to maintain enjoyment and success in research and work. For this reason, we give all our employees the opportunity to improve their skills continuously. IGB´s Carreer Development Coordinator Kirsten Pohlmann organizes the training for doctoral students and postdoctoral researchers.

Training of 70 or so **doctoral students** at IGB is, in accordance with the necessities at this career level, the most structured educational arrangement at IGB. The **IGB Doctoral Programme** offers individual coaching to doctoral students as well as a wide range of courses, from soft skills such as time management to advanced statistics, which are jointly organised by several IGB scientists. Our **Rules for Doctoral Research at IGB**, valid since June 2016, lists rights and obligations of doctoral students and their supervisors. The new **Doctoral Progress Help Tool" (DPH)** makes it easier for doctoral candidates to take the necessary steps and actions at the appropriate time in the course of their doctoral studies. It also provides doctoral students and their supervisors with all kinds of important information and useful advice.

Postdoctoral researchers determine their own training topics, the implementation of which is then organised by Kirsten Pohlmann. In 2017, the topic was the preparation of research proposals, which was addressed during three events, including the **workshop: "How to write promising grant proposals in science".**

Group leaders receive annual training on varying aspects of their leadership duties. In order to expand their practical and theoretical scientific expertise, they may apply for a sabbatical, i.e. a stay at another institute, for a semester, or even for a year. We also provide our **administrative employees** with appropriate opportunities for individual training. In addition, they can attend **in-house English courses for free**, making it easier for them to communicate with international colleagues. **International employees** receive subsidies for **German classes** at IGB.

"The biggest challenge for us all is a shortage of time. Whether technicians or scientists, we all feel we are under increasing pressure. And since advanced training is important but rarely urgent, our continuing education programme must reflect this." ***Kirsten Pohlmann, Career Development IGB***

Photo: David Ausserhofer

Photo: IGB

Active Together

The **Health Work Group**, newly established in 2017, addresses the implementation of occupational health management at IGB. In 2017, a **Health Day** was held at IGB, featuring sports classes and information concerning all aspects of healthy working. A wide range of sports groups also exist at IGB – from running to kajaking. IGB's doctoral students organise a two-day annual doctoral retreat, featuring lectures, workshops and recreational events. Postdoctoral researchers meet once a month after the colloquium to exchange thoughts and ideas among themselves. An annual summer fair and Christmas celebration promote staff cohesion throughout the institute.

Open and Interconnected

We invite external researchers to our institute: our **IGB Fellowship Programme** enables us to award grants to postdoctoral researchers and established scientists for between 6 and 24 months. Three fellows visited IGB in 2017. Every week, researchers from other institutions deliver lectures at the **IGB colloquium** – an ideal opportunity to establish and develop networks. 32 colloquia were held in 2017. We offer apprenticeship positions as well as positions for a voluntary ecological year and internships.

Contact: Ina Severin, Science Officer; Alina Hain, Head of Administration at IGB; Kirsten Pohlmann, Career Development Coordinator

Prizes and Awards

Two young scientists from the IGB received this year's **Prize for Young Academics of the German Society for Limnology (DGL)**. Second place winner was **Jenny Fabian** with her publication on the microbial decomposition of terrestrial carbon in rivers and lakes. **Andrea Fuchs** claimed the third place with her work on the relation between rising water temperatures and their effects on the concentration of greenhouse gas methane.

The "Handbook of European Freshwater Fishes" has managed to be among the **hundred most cited fish and fisheries references. Dr. Jörg Freyhof** is co-author of the book.
https://sites.google.com/a/uw.edu/most-cited-fisheries

Prof. Hans-Peter Grossart and **Dr. Danny Ionescu** awarded: The review article "Methane Production in Oxic Lake Waters Potentially Increases Aquatic Methane Flux to Air" was selected as **one of the four best** ones published in the reknown journal **Environmental Science and Technology (ES&T)** in 2016.

Dr. Sonja Jähnig is a newly appointed member of the excellence database **AcademiaNet.** The Leibniz Association nominated her for her innovative research on the global change effects in river ecosystems, river health and freshwater conservation. The excellence portal AcademiaNet was established to strengthen the visibility and presence of women in science.

For their article "Defining the Impact of Non-Native Species" **Prof. Jonathan Jeschke** and his co-authors have now been awarded with the **prize for the most cited publication** from the year 2014 of the **journal Conservation Biology**.

This **year´s Prize of the VDFF,** the German Association of Fisheries Administration Officials and Fisheries Scientists (Verband Deutscher Fischereiverwaltungsbeamter und Fischereiwissenschaftler e.V.), awarded IGB doctoral student **Dibo Liu** for his innovative research on alternative prophylaxis/disinfection in aquaculture.

Johannes Radinger won the **first Prize of the MCED Awards** (for innovative contributions to ecological modelling) at the GfÖ (GfÖ: The Ecological Society of Germany, Austria and Switzerland) Meeting in Gent, Belgium.

Ulrike Scharfenberger was nominated (one out of ten) for the **Young Researchers Award** of the **Leibniz Association** for her doctoral thesis in the research field of lake ecology.

Antonia Schraml, supervised by Robert Arlinghaus, was awarded with the **Daniel-Thaer-Prize** for her outstanding Master´s thesis at the Faculty of Life Sciences at the HU Berlin.

Dr. Sibylle Schroer was awarded with the **2017 Galileo Award by the International Dark-Sky Association (IDA)** which is combating light pollution worldwide. The Galileo Award is given in recognition of outstanding achievements in research or academic work on light pollution over a multiple year period.

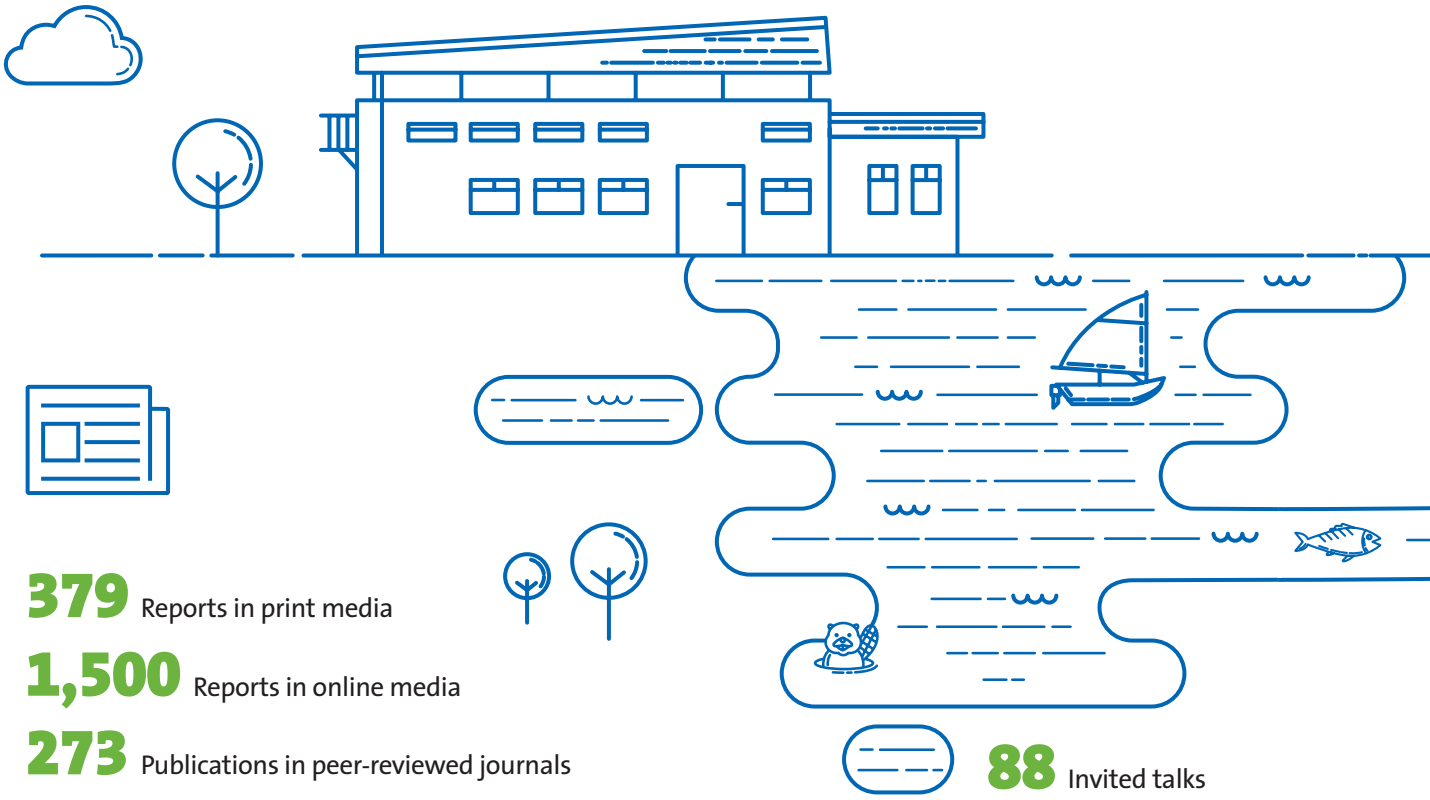
Luca Zoccarato won the **ISME Award** (ISME: International Society for Microbial Ecology) for the best contribution by a young researcher at the 15th Symposium on Aquatic Microbial Ecology in Zagreb, Croatia.

annex

Key Figures at a Glance

235 Employees
(including **143** scientists)

22 Employees active in committees and expert associations



379 Reports in print media

1,500 Reports in online media

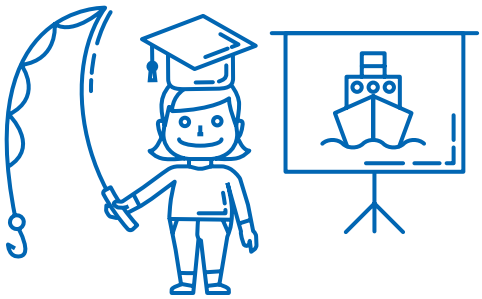
273 Publications in peer-reviewed journals

88 Invited talks
including plenary talks and keynote lectures as well as **199** other scientific talks

28 Scientific events and workshops including **12** with international participation

with in total

950 participants



Status as of 31 December 2017

35 Employees active in teaching

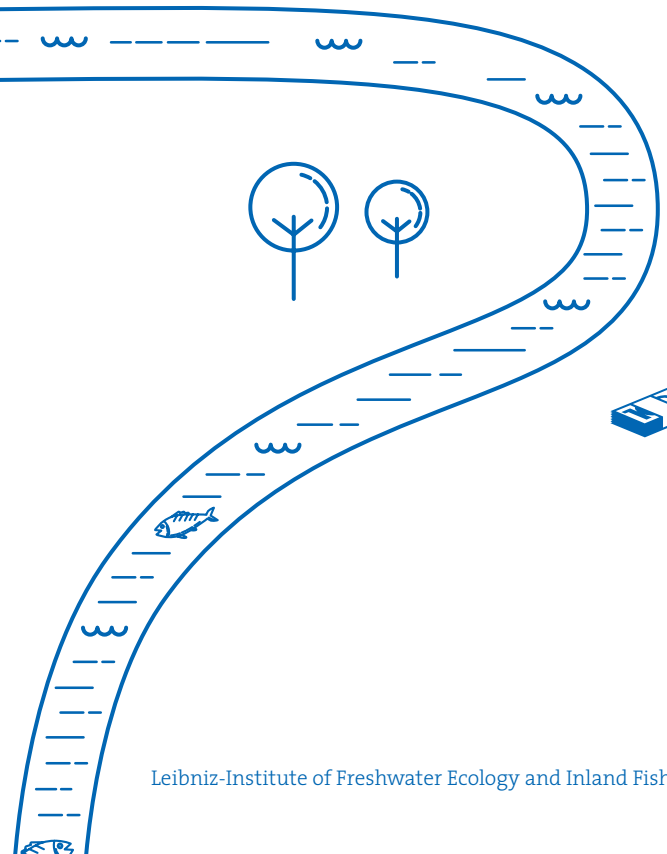
67 Doctoral students

17 Doctoral dissertations

33 Diplom, Master's and Bachelor's theses

10 Joint professorships with universities

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



External grants: **6,574,416.02 €** including **1,733,681.88 €** EU grants

Internal budget: **12,813,356.40 €**

Overall budget: **19,387,772.42 €**

Proportion of external funding: **34 %**

Structure

Leibniz-Institute of Freshwater Ecology and Inland Fisheries

Forschungsverbund Berlin e.V.

Scientific Advisory Board
Chair: Peter Grathwohl (University of Tübingen)

Director a.i.
Mark Gessner

Head of Administration Forschungsverbund Berlin e.V.
Manuela Urban

Science Officer
Ina Severin
MD 310 (1)

Public Relations & Knowledge Transfer
Katharina Bunk, Johannes Graupner
MD 310 (1)

Career Development
Kirsten Pohlmann
NGL (3)

Local Administration
Alina Hain

Purchasing, Finance, Human Resources
Alina Hain
MD 310 (1)

Information Technology
Enrico Willenbücher
MD 310 (1)

Library
Lydia Koglin
MD 310 (1)

Facility Management
Bernd Schubert
MD 301 (2)

Research Departments

1 Ecohydrology
Dörthe Tetzlaff
MD 310 (1)

2 Ecosystem Research
Rita Adrian
MD 301 (2)

3 Experimental Limnology
Mark Gessner
NGL (3)

4 Biology and Ecology of Fishes
Jens Krause
MD 310 (1)

5 Ecophysiology and Aquaculture
Werner Kloas
MD 310 (1)

6 Chemical Analytics and Biogeochemistry
Jörg Gelbrecht
MD 301 (2)

Cross-cutting Research Domains

1 – Aquatic Biodiversity
Hans-Peter Grossart & Jonathan Jeschke
NGL (3) & FU Berlin

2 – Aquatic Boundaries and Linkages
Michael Hupfer
MD 301 (2)

3 – Human-Aquatic Ecosystem Interactions
Christian Wolter
MD 310 (1)

(1) MD 310: Müggelseedamm 310, Berlin (2) MD 301: Müggelseedamm 301, Berlin (3) NGL: Neuglobsow

Status as of 1 January 2018

Departments

Department 1 – Ecohydrology

The main, overarching topic of Department 1 is an improved understanding of ecohydrological mechanisms and processes of natural and anthropogenic influenced aquatic and terrestrial ecosystems, and their interactions. To achieve this, we integrate empirical knowledge, based on quantitative measurements, and process-based modelling frameworks across different spatio-temporal scales to facilitate sustainable water management in a changing world. Aquatic and terrestrial systems are coupled at distinct interfaces and at multiple scales; thus, we integrate our departmental expertise at different scales and disciplines (environmental and engineering hydrology, ecology, geography) in collaborative projects and publications.

Contact:
Professor Dörthe Tetzlaff
d.tetzlaff@igb-berlin.de

Research Groups

- Dr. Franz Hölker: Light Pollution and Ecophysiology
- Dr. Jörg Lewandowski and Professor Gunnar Nützmann: Groundwater-Surface Water Interactions
- Dr. Gabriel Singer: Fluvial Ecosystem Ecology
- Dr. Alexander Sukhodolov: Ecohydraulics
- Prof. Dörthe Tetzlaff: Landscape Ecohydrology
- Dr. Markus Venohr: Nutrient Balances in River Basins
- Dr. Georgiy Kirillin: Lake Physics

Department 2 – Ecosystem Research

In Department 2, we investigate the effects of the trophic level, hydromorphology and climate on lake and river ecosystems, as well as their stability and long-term development. We study interactions between biotic ecosystem components (microorganisms, plankton, macrophytes, macroinvertebrates and parasites) and their physical and chemical environment as well as the key processes of physical limnology, primary production, evolution, and carbon flux. We employ techniques used in molecular biology and genomics, laboratory and field research; we exploit long-term databases and apply statistical and deterministic models. Our research, integrated into global research on the effects of climate change and biodiversity, provides the basis for developing theoretical concepts.

Contact:
Professor Rita Adrian
adrian@igb-berlin.de

Research Groups

- Prof. Rita Adrian: Long-term and Climate Impact Research of Lake Ecosystems
- Dr. Sabine Hilt: Aquatic-Terrestrial Coupling and Regime Shifts
- Dr. Sonja Jähnig: Global Change Effects on River Ecosystems
- Prof. Jonathan Jeschke: Ecological Novelty and Theoretical Ecology
- Dr. Jan Köhler: Photosynthesis and Growth of Phytoplankton and Macrophytes
- Dr. Michael T. Monaghan: Molecular Ecology and Genomics
- Dr. Martin T. Pusch: Functional Ecology and Management of Rivers and Lakeshores
- Prof. Justyna Wolinska: Disease Evolutionary Ecology

Department 3 – Experimental Limnology

Department 3 is located north of Berlin on the shores of Lake Stechlin. We focus on assessing the consequences of global environmental change on the biodiversity and functions of aquatic ecosystems. Much of our efforts is devoted to microorganisms and processes mediated by microbial activities. In addition to investigating bacteria suspended in water and associated with sediments and organisms, we study the dynamics of algae, zooplankton, fungi and viruses. Ecological models, the analysis of long-term data and field experiments, especially in a large facility, the LakeLab in Lake Stechlin, are essential elements of the research conducted in our department. We use the knowledge gained in our research to devise concepts and methods that foster the sustainable management of lakes in the light of rapidly proceeding environmental change.

Contact:
Professor Mark Gessner
stechlin@igb-berlin.de

Research Groups

- Dr. Stella Berger: Experimental Phytoplankton Ecology
- Dr. Peter Casper: Microbial Ecology of Sediments
- Prof. Mark Gessner: Ecosystem Processes
- Prof. Hans-Peter Grossart: Aquatic Microbial Ecology
- Dr. Peter Kasprzak: Water Management and Zooplankton Ecology
- Dr. Jens Nejstgaard: Experimental Zooplankton Ecology
- Dr. Sabine Wollrab: Ecological Modelling

Photos: private, David Ausserhofer, Andy Küchenmeister

Department 4 – Biology and Ecology of Fishes

In Department 4, we seek to understand the ecological and evolutionary processes that structure populations and communities of freshwater fishes and affect their functions. We use this knowledge to improve the management and conservation of wild fish populations. Our work focuses on interactions between natural and anthropogenic ecological factors and their effects on the dynamics of fish populations. The methodological approaches include hypothesis-driven laboratory research, mesocosm experimentation, lake manipulation, comparative field studies and theoretical modelling.

Contact:
Professor Jens Krause
j.krause@igb-berlin.de

Research Groups

- Prof. Robert Arlinghaus: Integrative Recreational Fisheries Management
- Dr. Jörn Geßner (50%): Reintroduction of the European Sturgeon to Germany
- Prof. Jens Krause: Collective Behaviour and Social Networks
- Dr. Thomas Mehner: Food Web Ecology and Fish Communities
- Dr. Georg Staaks: Experimental Fish Biology
- Dr. Max Wolf: Causes and Consequences of Behavioural Types
- Dr. Christian Wolter: River Revitalization

Department 5 – Ecophysiology and Aquaculture

In Department 5, we investigate the ecophysiological impacts of multiple environmental factors on aquatic vertebrates, in particular fishes and amphibians. Our goal is to create the scientific foundations for sustainable aquaculture. We seek to shed light on how biotic and abiotic factors stress or influence the various physiological functions of individual vertebrates with regard to reproduction, stress, development, growth and behaviour.

Contact:
Professor Werner Kloas
werner.kloas@igb-berlin.de

Research Groups

- Dr. Jörn Geßner: Reintroduction of the European Sturgeon to Germany
- Prof. Werner Kloas: Aquaponics & Environmental Effects of Endocrine Disruptors
- Dr. Klaus Knopf: Fish Parasitology and -immunology
- Dr. Klaus Kohlmann: Fish Genetics
- Dr. Ilka Lutz: Effects of Endocrine Active Substances
- Dr. Thomas Meinelt: Fish Pathology and Ecotoxicology / Stress Ecology
- Dr. Sven Würtz: Molecular Fish Physiology
- Dr. Matthias Stöck: Evolutionary Biology and Ecotoxicology of Amphibians and Fish

Department 6 – Analytical Chemistry and Biogeochemistry

Our research focuses on fundamental and applied research questions regarding the biogeochemical transformation of substances in aquatic interfaces (freshwater and wetlands) and of the carbon flux between terrestrial and aquatic ecosystems. This includes investigating greenhouse gas emissions from inland waters as well as developing and introducing in situ techniques for measuring matter flow in high temporal and/or spatial resolution. We also provide services for important parts of chemical analysis; implement measuring programmes for long-term experiments; and accompany PhD students in the analytical research involved in laboratory and field experiments.

Contact:
Dr. Jörg Gelbrecht
gelbr@igb-berlin.de

Research Groups

- Dr. Jörg Gelbrecht: Wetland Biogeochemistry and Restoration of Peatlands, Chemical Analytics
- Dr. Tobias Goldhammer: Nutrient Cycles and Chemical Analytics
- Dr. Michael Hupfer: Biogeochemical Processes in Lake Sediments, Lake Restoration
- Dr. Katrin Premke: Carbon Dynamics and Anthropogenic Stressors in Aquatic Systems

Photos: David Ausserhofer (1), Andy Küchenmeister (2)

Research Domains

Our three research domains are cross-disciplinary in nature and focus on very different thematic priorities. Within the research domains, our scientists perform cross-departmental work to explore issues with high scientific and/or societal relevance:

Research Domain 1 – Aquatic Biodiversity

Research Domain 1 acts as a platform that enables us to systematically tackle the broad field of 'Aquatic Biodiversity' and develop new overarching concepts. In particular, we seek to: 1) explore genetic and species diversity on various spatial and temporal scales; 2) investigate the environmental factors that determine the structure and functions of aquatic communities; 3) improve our understanding of the structure and ecological functions of aquatic communities (biocoenosis); and 4) further develop methods and research concepts. The research domain is subdivided into the thematic areas 'Functional Biodiversity', 'Genomics and Evolution' and 'Stress and Resilience of Ecosystems'. The aim of the research domain is to understand the mechanisms of dynamics and patterns of aquatic biodiversity on various spatial and temporal scales.

Contact:
Professor Hans-Peter Grossart
hgrossart@igb-berlin.de

Professor Jonathan Jeschke
jeschke@igb-berlin.de

Research Domain 2 – Aquatic Boundaries and Linkages

In Research Domain 2, scientists from four departments explore the mechanisms that control the state of aquatic ecosystems and their role in matter fluxes in the landscape. In particular, our research focuses on highly reactive interfaces such as wetlands and ponds; transition zones between ground and surface water; the littoral zones of lakes; and the sediment-water interface. One important aspect of this research domain is the interdisciplinary training of young scholars achieved by initiating and managing post-graduate schools such as the International Graduate School Aqualink; the Innovative Training Network (ITN) HypoTRAIN; and the 'Urban Water Interfaces' Research Training Group funded by the German Research Foundation (DFG).

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Research Domain 3 – Human-Aquatic Ecosystem Interactions

Waters are indispensable for meeting basic socio-economic human needs such as drinking water supply, flood protection, irrigation, inland navigation, fisheries and recreation. However, human uses often affect ecosystem functions whose importance is insufficiently known or economically underestimated in many cases. For this reason, in Research Domain 3 we investigate the (socio)ecological consequences of different human uses. Our studies on human-aquatic interactions provide an important scientific basis and recommendations for the sustainable management of rivers and lakes.

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Photos: David Ausserhofer (3), Andy Küchenmeister (1)

Scientific Advisory Board

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Prof. Bernhard Wehrli
Department Surface Waters, Eawag, Switzerland

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Biological Institute Helgoland & Wadden Sea Station Sylt, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI), Germany

Employee Representatives

Workers' Council
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Marén Lentz (Vice-Chair)
Kerstin Schäricke
Georg Staaks
Thomas Hintze
Sascha Behrens
Viola Schöning

Ombudsman
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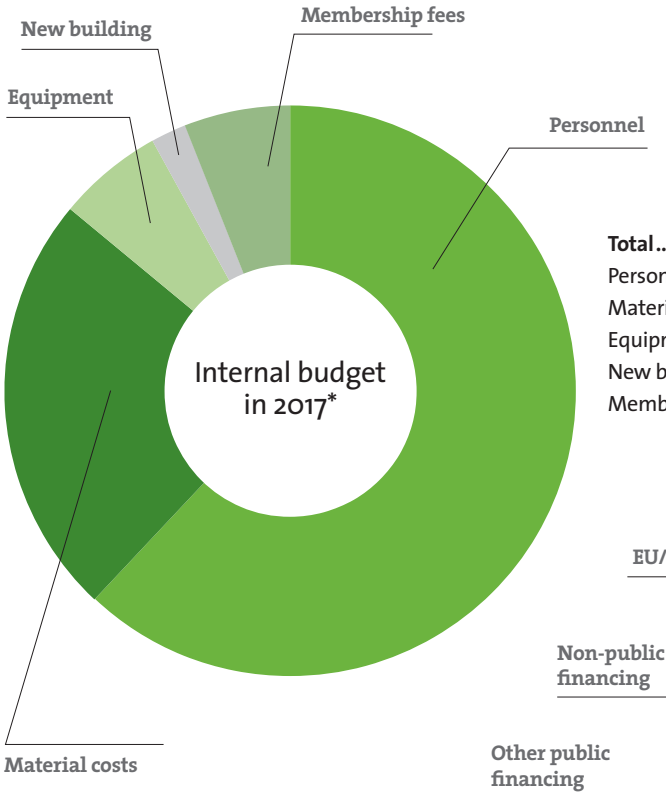
Doctoral Student Representatives
Marta Alirangues, Lisa Braun,
Susanne Stephan, Lukas Thuile Bistarelli

Postdoc Representatives
Tom Shatwell, Andreas Jechow,
Carolina Doran, Arne Schröder

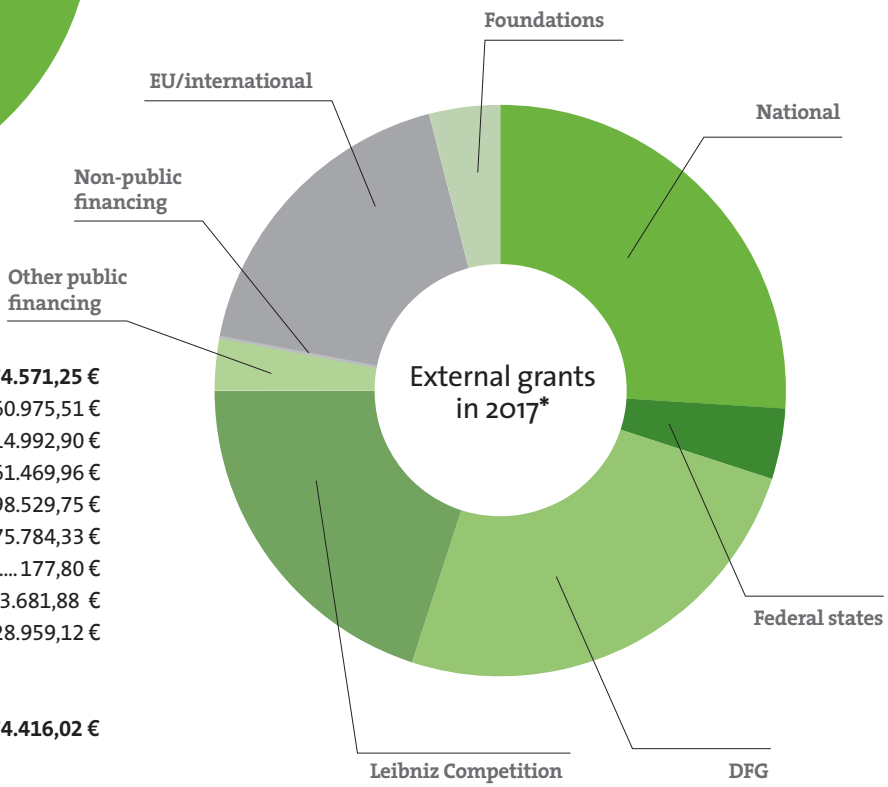
Status as of 31 December 2017

Finances

Status as of 31 December 2017



Total	**12.813.356,40 €**	
Personnel	8.705.435,66 €	
Material costs	2.884.520,23 €	(contains maintenance: 413.331,68 €)
Equipment	505.765,89 €	
New building	132.548,17 €	
Membership fees	585.086,45 €	

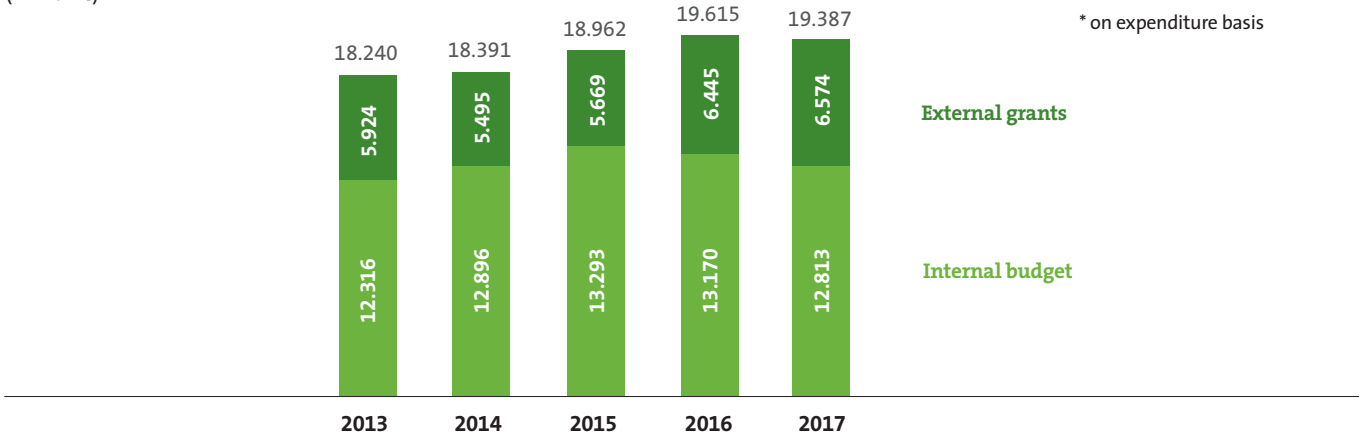


Total	**6.174.571,25 €**
National	1.760.975,51 €
Federal states	314.992,90 €
DFG	1.461.469,96 €
Leibniz Competition	598.529,75 €
Other public financing	175.784,33 €
Non-public financing	177,80 €
EU/international	1.733.681,88 €
Foundations	128.959,12 €

External grants (including externally managed funds) 6.574.416,02 €

Budget Development 2013-2017

(Million €)

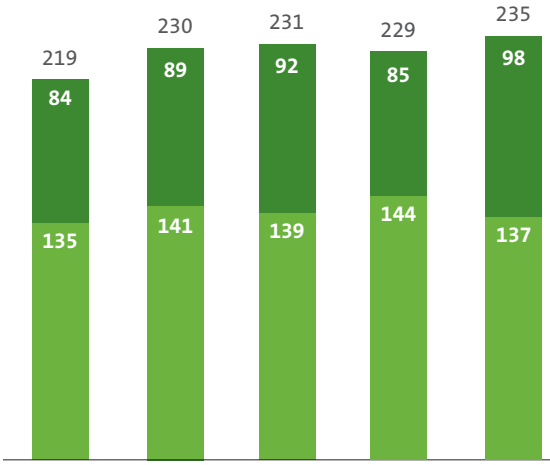


* on expenditure basis

Status as of 31 December 2017

Employees

Employee development



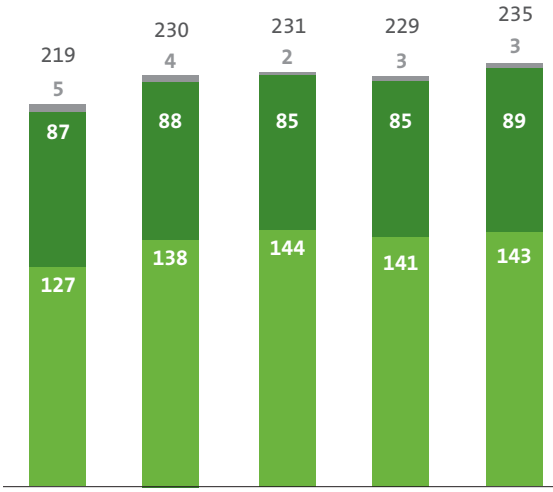
Status as of 31.12.

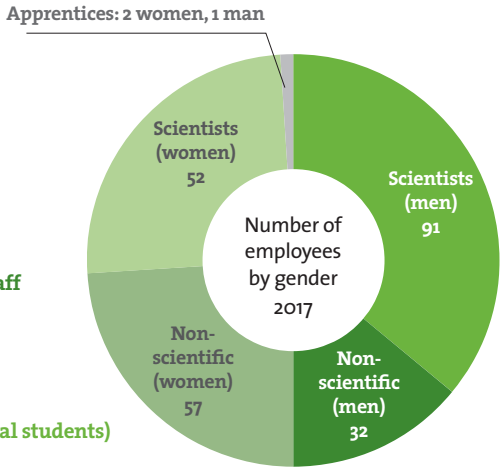
Employees at IGB 2017

Total: 235

100	Researchers
43	Doctoral students
89	Non-scientific-staff
3	Apprentices
3	Fellows
32	Assistants and temporary staff
97	Others active at the institute (visiting scientists, foreign fellows, doctoral and other students, interns)

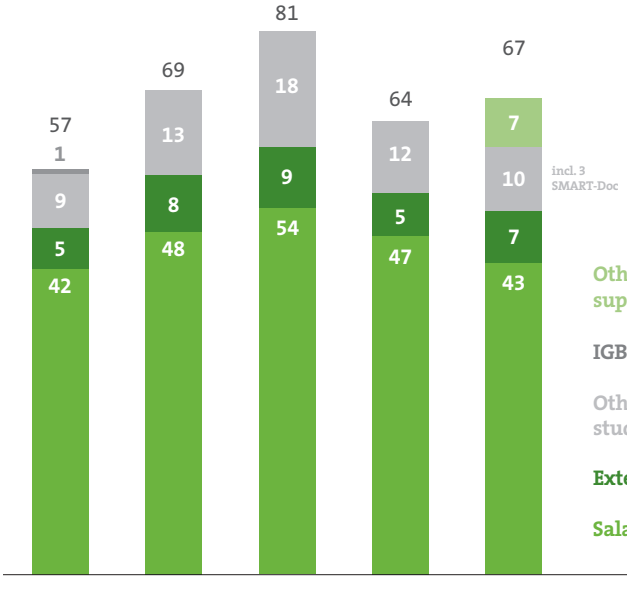
Assignment of employees

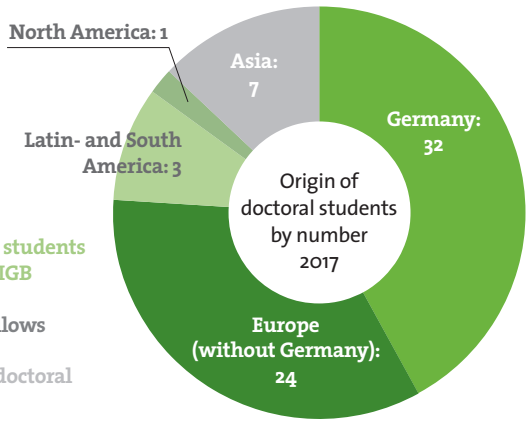




Status as of 31.12.

Docoral training development



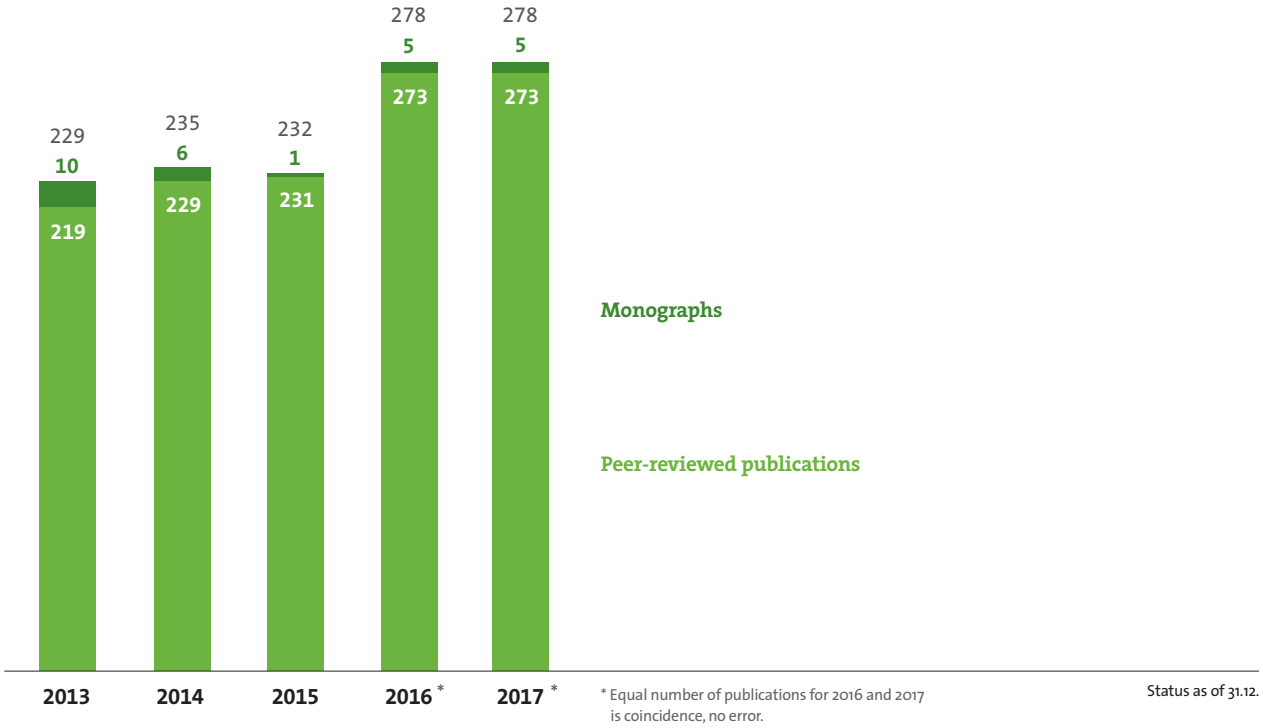


Status as of 31.12.

Status as of 31 December 2017

Activities

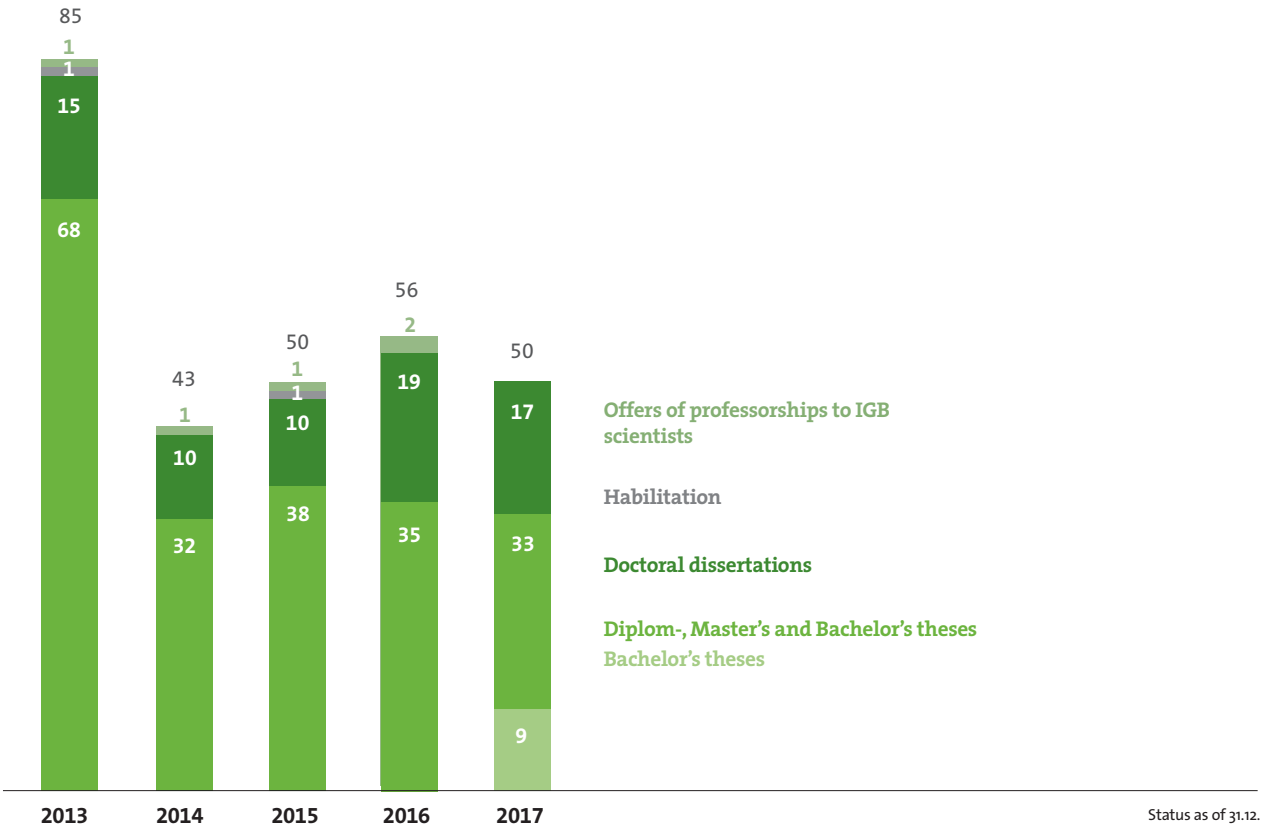
Publications Development



* Equal number of publications for 2016 and 2017 is coincidence, no error.

Status as of 31.12.

Professional Development



Status as of 31.12.

Status as of 31 December 2017

Publications

Journal contributions

Peer-reviewed publications with impact factor

Aben RCH, Barros N, Van Donk E, Frenken T, Hilt S, Kazanjian G, Lamers LPM, Peeters ETHM, Roelofs JGM, De Senerpont Domis LN, Stephan S, Velthuis M, Van de Waal DB, Wik M, Thornton BF, Wilkinson J, DelSontro T, Kosten S (2017) Cross continental increase in methane ebullition under climate change. Nature Communications. 8(1):1682.

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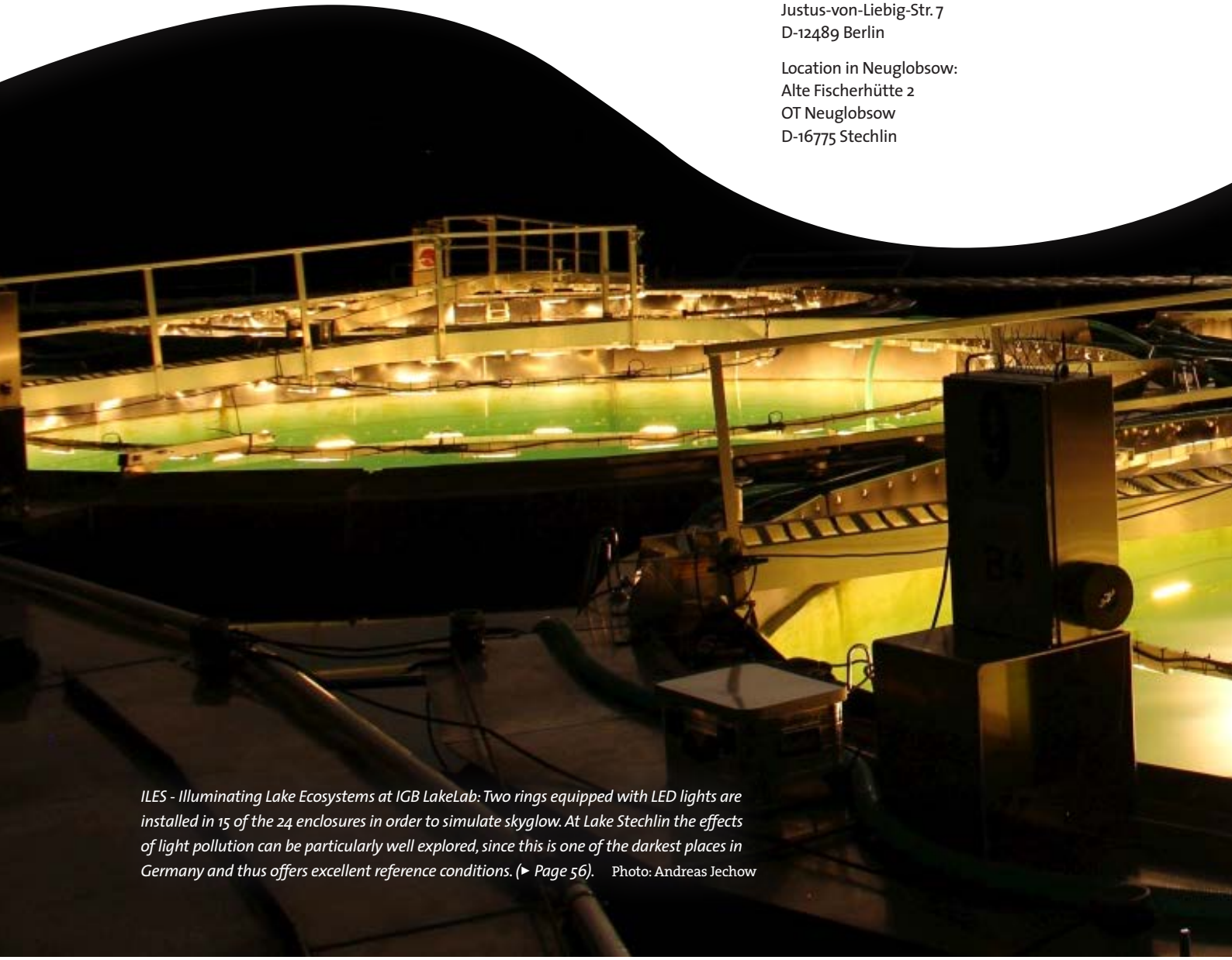

ILES - Illuminating Lake Ecosystems at IGB LakeLab: Two rings equipped with LED lights are installed in 15 of the 24 enclosures in order to simulate skyglow. At Lake Stechlin the effects of light pollution can be particularly well explored, since this is one of the darkest places in Germany and thus offers excellent reference conditions. (► Page 56). Photo: Andreas Jechow

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