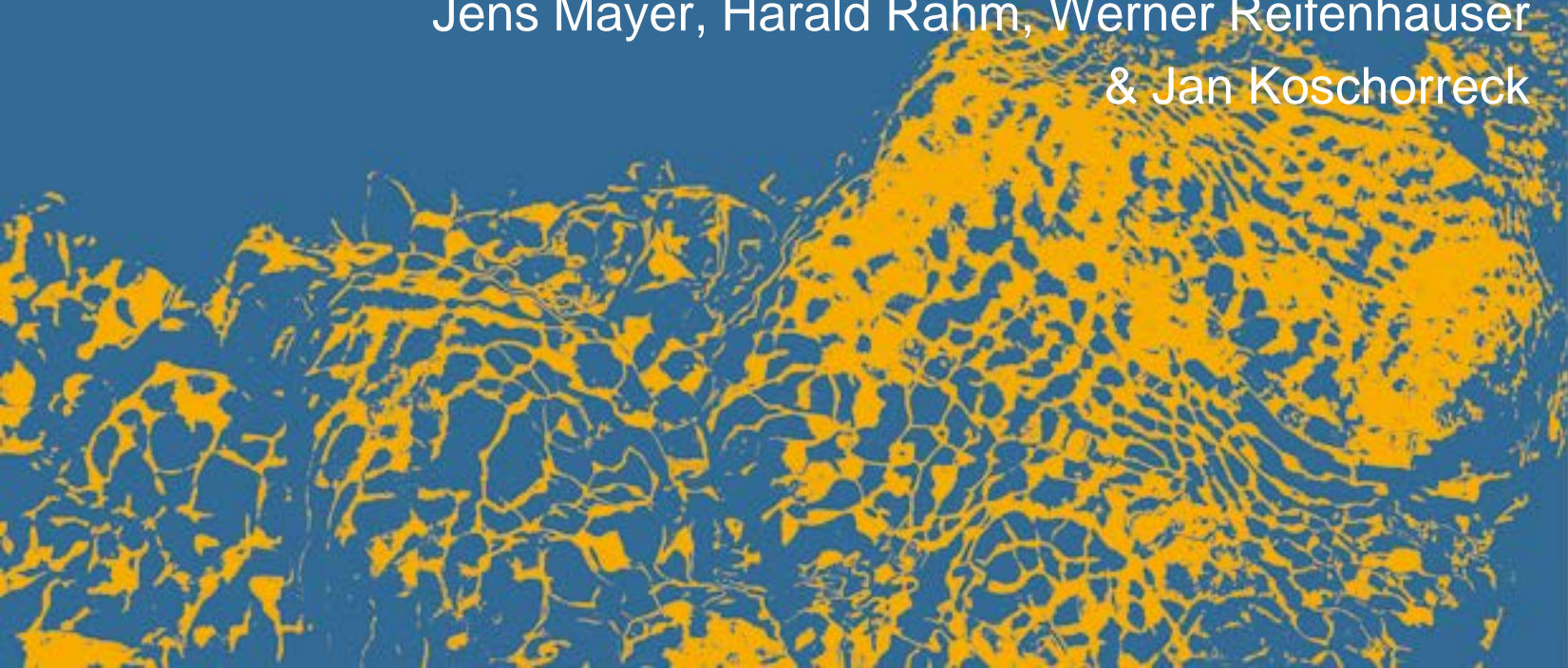




# Monitoring activities for plastics in rivers and lakes in Germany

Julia Schwaiger, Peter Diehl, Maren Heß, Kurt Kreimes,  
Jens Mayer, Harald Rahm, Werner Reifenhäuser  
& Jan Koschorreck



# Common practice to „reduce“ plastics in marine beach sediments?



Photos: J. Schwaiger





- Organisation according to federal principles.
- Consists of 16 partly sovereign federal states which themselves have their own national tasks and a certain independence from the State Government.
- Enforcements of provisions relating to water are under the control and administration of the states.



# River basins in Germany according to WFD



- Rhine
  - Elbe
  - Maas
  - Ems
  - Eider
  - Weser
- North Sea
- Oder
  - Warnow-Peene
  - Schlei-Trave
- Baltic Sea
- Danube
- Black Sea
- Combined length: 400,000 km
- 2.4 % of the total area of Germany accounts for water.



# Microplastics in freshwater environments - a new issue in ecotoxicology -

## “Key publication”

- Imhof, H.K. et al.  
Contamination of beach  
sediments of a subalpine  
lake with **microplastic**  
particles. (2013). Current  
Biology, 23(19) R867-868



Increasing concern on the microplastic load of  
freshwater environments and the possible  
consequences on

- flora
- fauna
- humans

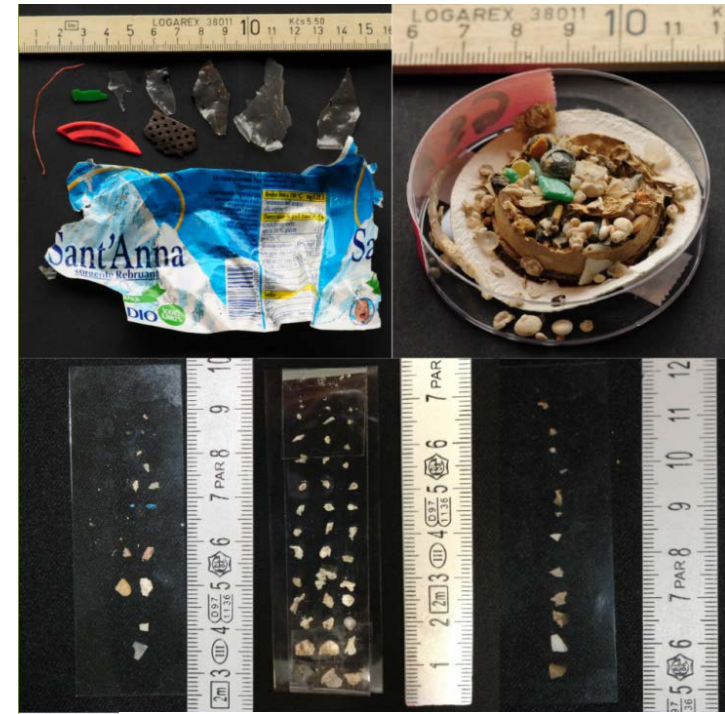


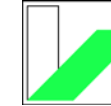
Photo: Chair Animal Ecology, University of Bayreuth

### Memorandum

- Accumulation of microplastic in the marine ecosystem has been demonstrated.
- Accumulation of microplastic in rivers and lakes is indicated by few investigations and has to be accepted as a nationwide phenomenon.
- There are no standardised analytical methods. Therefore, the results of the current studies are not mutually comparable.
- Microplastics are taken up by organisms - very little is known about their effects.



Kick-off for investigations  
by regulatory agencies of  
the federal states of  
Germany.



UNIVERSITÄT  
BAYREUTH



# Federal states of Germany

## Workshop on 10<sup>th</sup>/11<sup>th</sup> March, 2016

### Topics

- Current status of research and water management activities related to plastics in rivers and lakes in Germany  
→ evaluation of a nation wide survey
- Critical review of analytical methods
- First analytical data provided by the federal states
- Future coordination and harmonisation of different federal activities
- Identification of knowledge gaps
- Possibilities for cooperation



Photo: LfU

Organisation:

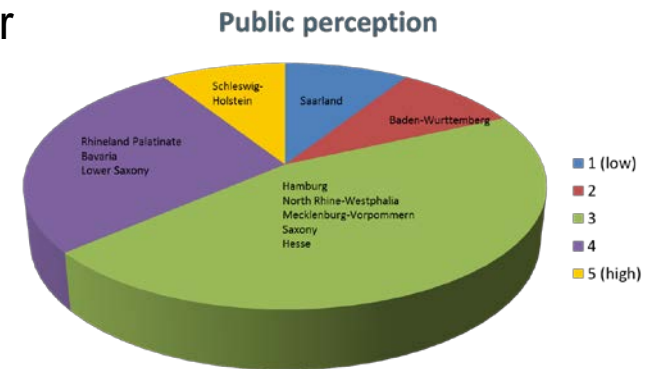
German Environment Agency (UBA) &  
Bavarian Environment Agency at  
Wielenbach (LfU)



# Nation-wide survey: Questions on risk perception – management options



- Public perception of the issue “plastics in freshwater environment” varies considerably between the federal states.
- Most states discuss possible measures to reduce plastics in inland waters:  
governmental authorities > media > NGOs > industry  
> public
- Ca. 50% of the federal states are planning or even implement measures in order to reduce the input of plastics into inland waters.
- Significantly less states are planning or have already implemented measures to remove plastic waste from inland waters.





# Nation-wide survey: Questions on monitoring activities

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- 5 regulatory environment agencies perform monitoring programs on plastics in inland waters.
- Currently, there is no reliable evidence on diffuse sources and pathways for plastics in inland water systems as well as on the riverine load of plastics.
- 2 federal states have funded investigations on potential microplastic discharge via sewage treatment plants.
- There are no data on the riverine inputs into marine environments.
- 3 federal states intend to carry out further studies on the occurrence of plastic in inland waters. Two of these states are already active in investigating plastics in rivers, lakes, or sewage treatment plants, respectively.
- 1 state performs systematic studies on the possible effects of microplastic in biota.

## **Regulatory agencies of the following federal states have started monitoring programs:**

- Bavaria
- Baden-Wurttemberg
- Rhineland-Palatinate
- Hesse
- North Rhine-Westphalia

In addition:

Several projects at universities and other research institutions.

# Monitoring studies of the federal states:

## What do they have in common?



Photo: LANUV

# Cooperation - contract partner



Landesamt für Natur,  
Umwelt und Verbraucherschutz  
Nordrhein-Westfalen



## Contract partner:

Prof. Dr. Ch. Laforsch, Department of  
Animal Ecology I, University of Bayreuth

## Comparable methods

- Sampling
- Processing of samples
- Analysis of microplastic by FTIR-Spectroscopy



# Monitoring studies of the federal states:



## What do they not have in common?

- Preliminary overview on the occurrence of microplastic in rivers and lakes
- River Rhine and its major tributaries
  - densely populated areas
  - potential hot spots (e.g. plastic industry)
- Influence of WWTP effluents
  - Waste water fraction
  - Catchment area / population equivalent of WWTP
- Different aquatic compartments under consideration



# Current monitoring activities

Total number of samples: 163

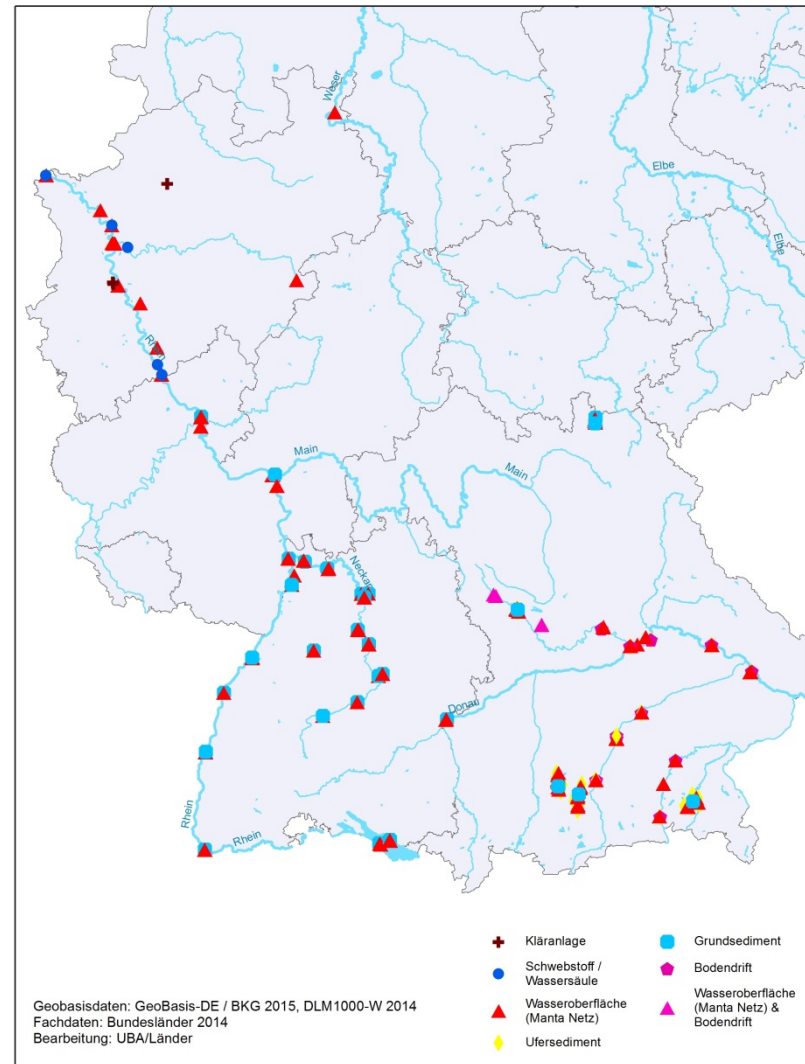
- **Rivers**

- Water surface 54
- Water column 5
- Shore sediment 8
- River sediment 21
- Soil drift 15

- **Lakes**

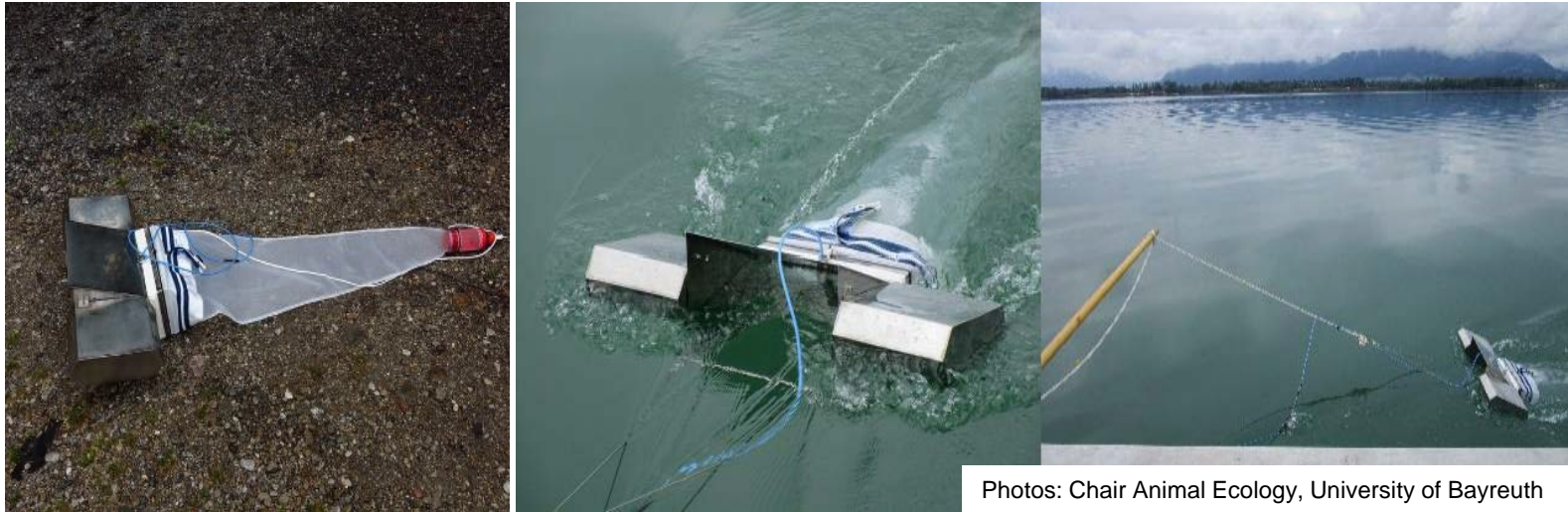
- Water surface 17
- Water column 5
- Shore sediment 25
- Ground sediment 7

- **WWTP effluents** 6





Large Microplastic particles (L-MPP; size fraction 1 mm – 5 mm)



- 54 Samples
- 4744 Particles
- 2955 Plastic particles (~63%)



# Relevance of analytical data – risk assessment

## Systematic studies on the effects of microplastic in biota





# Studies on the effects of microplastics in biota – exposure under laboratory conditions

## Test organisms:

- River mussel (*Unio spec.*)
- Rainbow trout (*Oncorhynchus mykiss*)

## Test Polymer

- Virgin PVC
- PVC + additive DINP (Di-iso-nonylphtalate)

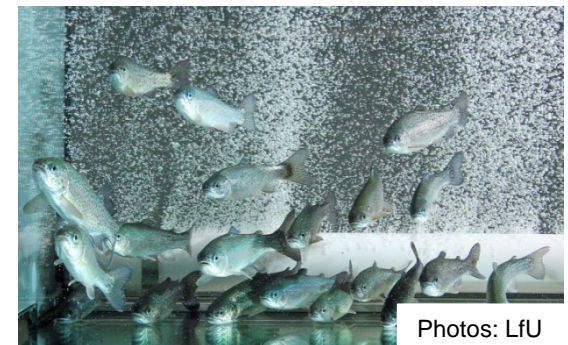
## Test conditions (Flow-through exposure system)

- Mussels:
  - 4-week exposure via the water phase
  - 4-week depuration phase in spring water
- Fish:
  - 8-week oral exposure (PVC-spike food, 10%)

**Endpoints:** uptake / release of PVC particles, accumulation, effects

## Investigations applied:

- Microplastic analysis by Raman-Spectroscopy  
(Dr. Ivleva, Institute of Hydrochemistry, TUM Munich)
- Histology, clinical chemistry, hematology, biomarker



Photos: LfU

**Test organism:** River mussel (*Unio* sp.)

**Location:** municipal waste water treatment plant (WWTP)

## Exposition

- effluent WWTP
- upstream WWTP
- downstream WWTP
- control (spring water)

## Duration of exposure

- 28 days
- 8 months

**Endpoints:** accumulation of microplastic particles, effects

## Investigations applied:

- Microplastic analysis by Raman-Spectroscopy  
(Dr. Ivleva, Institute of Hydrochemistry, TUM Munich)
- Histology



Photos: LfU



## Conclusion - what have we achieved so far?

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- First official monitoring programs have been initiated by 5 federal states of Germany.
- More than 160 samples from 26 rivers, 6 lakes, and 6 WWTPs have been taken so far.
- The official contract partner, University of Bayreuth, ensured the application of comparable methods concerning sampling, sample preparation and analytic methods (FTIR-Spectroscopy).
- Currently, comparable analytical data are available for water surface samples of rivers (preliminary results: size class 1 mm – 5 mm only!)
- For 2 important river basins - Rhine and Danube – there is some information available.





- Early technical networking of federal states would improve and accelerate the outcome of monitoring activities.
- To increase comparability of data, the following aspects are in need of coordination for future work:
  - Choice of relevant aquatic departments
  - Relevant focus of monitoring programs
  - Dependent on analytical capacities, early prioritisation of samples
- Further opportunities for cooperation and the possible use of synergies should be checked and established.

→ **Communication!**



- Analytical capabilities are currently insufficient for monitoring purposes (e.g. extremely cost, stuff and time consuming).
- Detailed investigations on “hot spots” are necessary to identify
  - relevant pathways (e.g. littering, WWTP, industrial emission)
  - to develop measures to reduce the microplastic load of inland waters.
- For a risk assessment of environmental data, studies on possible effects of microplastic particles on freshwater organisms are urgently required.
- The possibility of modelling of plastics in freshwater environments should be checked to cover the fate of microplastic particles.
- The Freshwater community should initiate discussions on sources with colleagues responsible for plastic waste management and circular economy.

# Thank you for cooperation!



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Für eine lebenswerte Zukunft

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German Environment Agency (UBA), Berlin





# Thank you for your attention!

Bavarian Environment  
Agency



Photo: LfU