Overview on plastics in European freshwater environments - Results of a survey

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German Federal Institute of Hydrology

- is a supreme federal agency within the portfolio of the Federal Ministry of Transport and Digital Infrastructure (BMVI)
- is responsible for the German waterways in federal ownership
- advises federal ministries (e.g. the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, BMUB) and their subordinate bodies, particularly the Waterways and Shipping Administration (WSV) of the BMVI

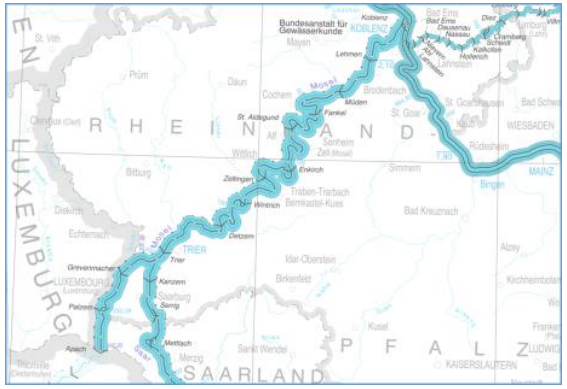
Motivation for the plastic topic

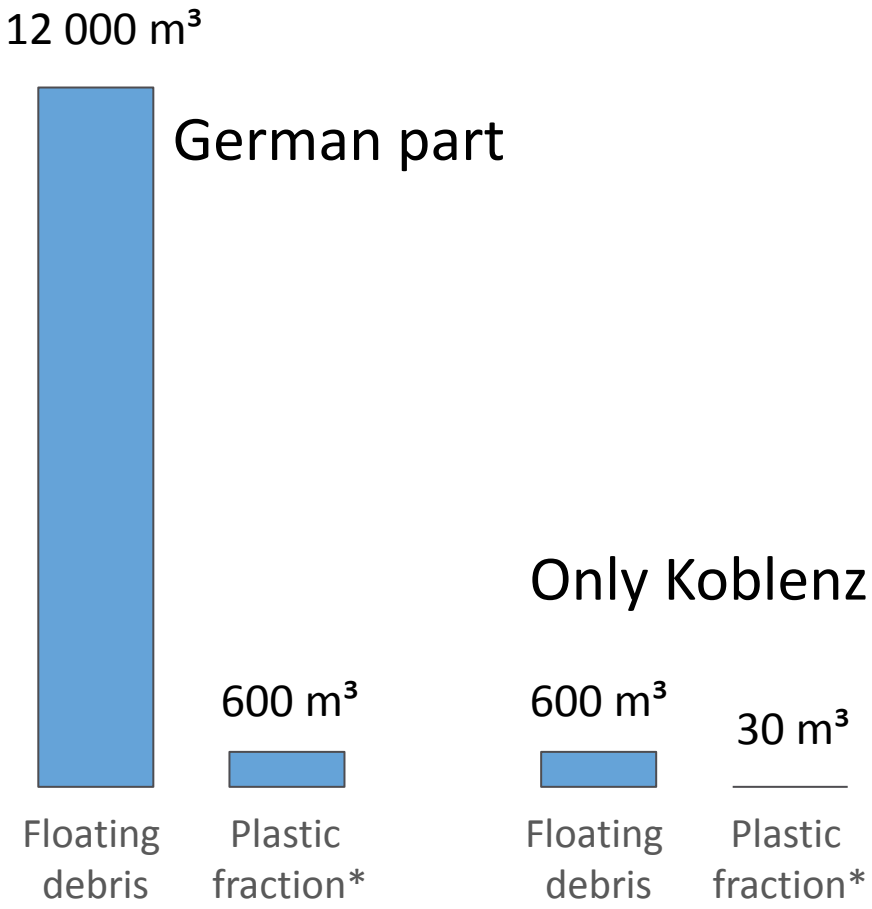
- Increasing risk perception of plastics in surface waters
- Contribution of rivers to the marine plastic pollution
- Contribution of ship traffic
- Contaminations of dredged materials

Plastics pollution concerns both: marine and freshwater environments

Barrages along the Moselle, Koblenz

Removal of floating debris - plastics in German Moselle

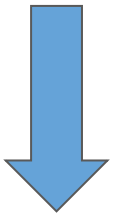




* RWE estimation

Studies on freshwater environments

So far knowledge on occurrence and ecological risks of plastics in European rivers and lakes is limited.



An overview on the current status of monitoring, risk perception and management options was required.

A survey in European countries was conducted.

Conduct of a European survey

A questionnaire was addressed to the 28 EU members and 6 other European countries.

Addressees: representatives of the European countries in the Strategic Coordination Group (SCG) (WFD Common Implementation Strategy)

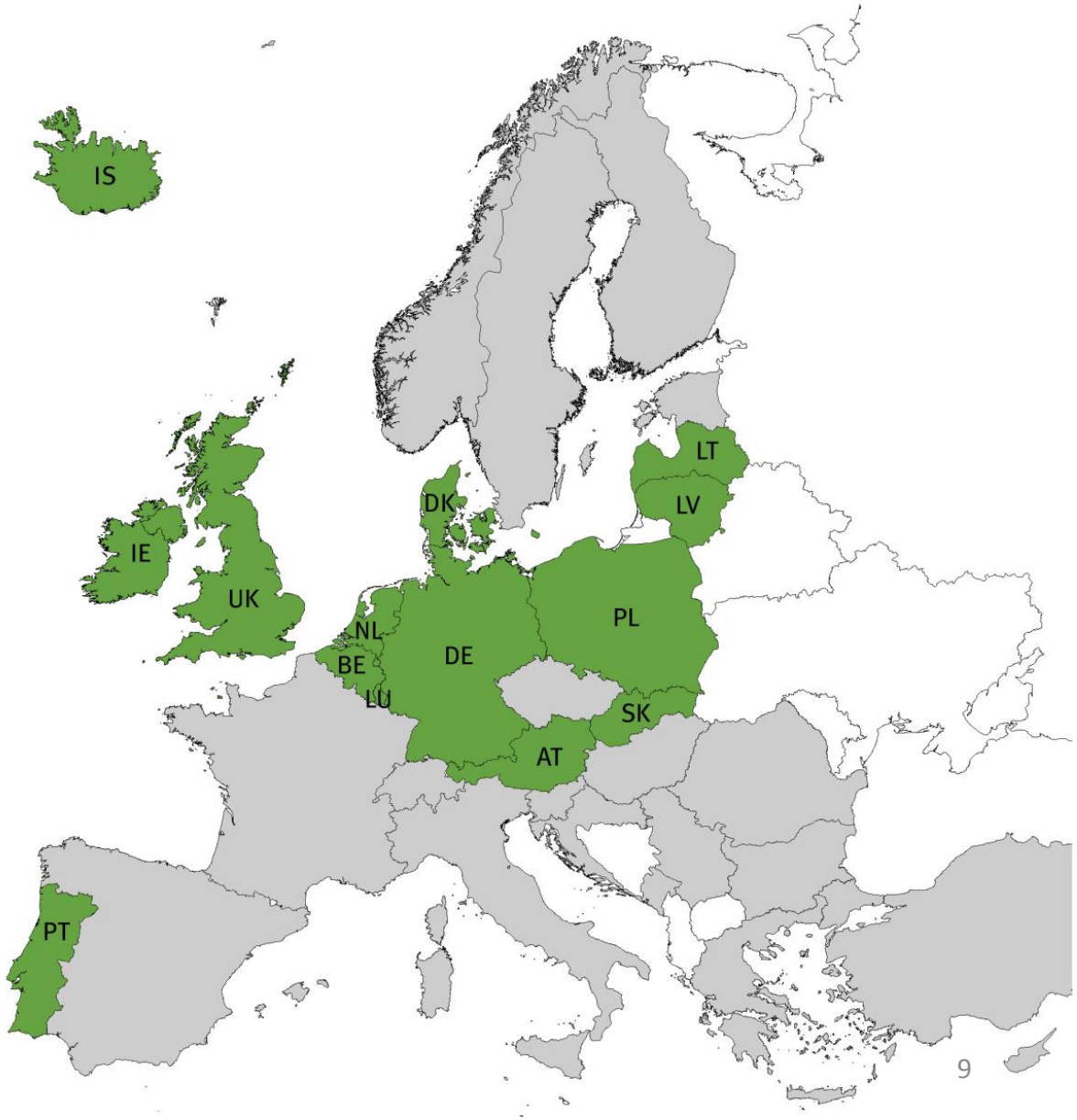
Responses: from 14 countries

Additional information sources:

- Results of a German survey
- Results of a literature research (additional examples)

European Survey

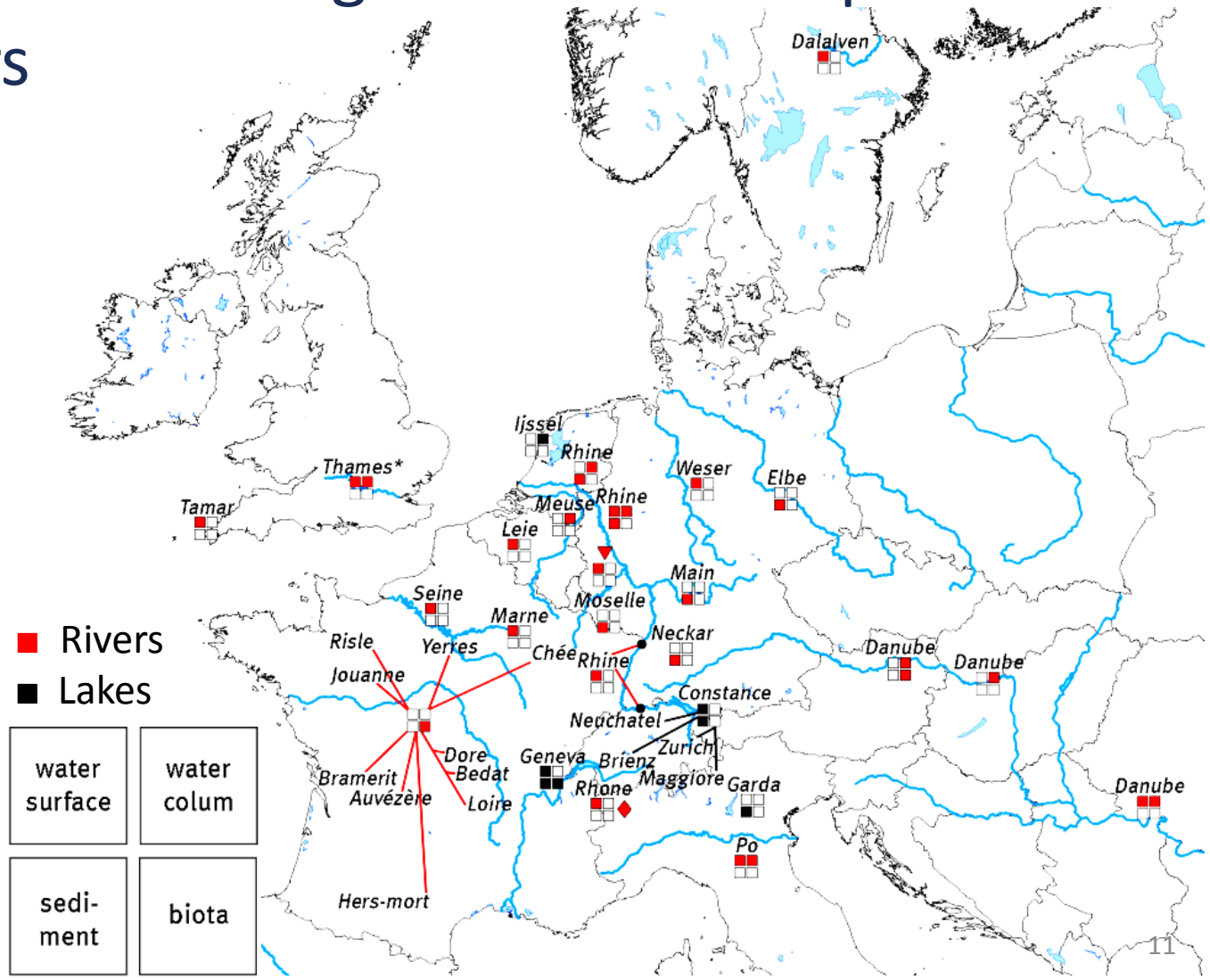
- Addressed countries
- Participating countries



Topics raised in the questionnaire

- Completed, ongoing and planned monitoring studies on plastics in freshwater environments
- Riverine loads of plastics and riverine inputs into the marine compartment
- Main sources and pathways for plastics in the freshwater environments
- Effect studies
- Risk perception and management options to reduce plastics inputs and remove litter from freshwater environments

Completed monitoring studies in European freshwaters



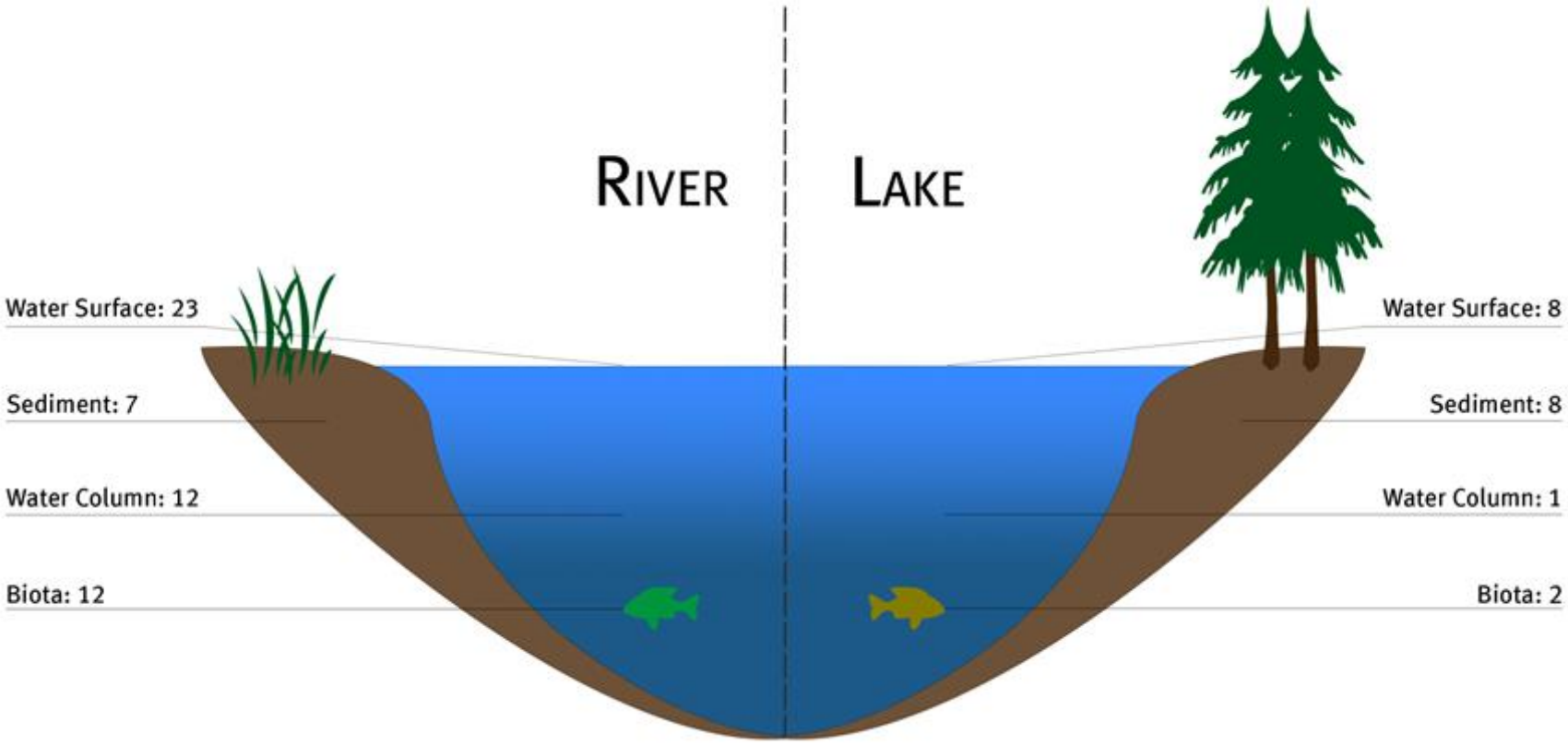
Data sources:
European survey, scientific literature

Completed monitoring studies in European freshwaters

Countries	Rivers/Lakes	References
AU	Danube	Hohenblum et al. (2015)
BE	Leie	Craenenbroeck et al. (2014)
DE	Rhine & tributaries, Weser	Laforsch (2015)
NL	Rhine estuaries	Leslie et al. (2013)
Transboundary studies		
CH, FR, DE, NL	Rhine	Mani et al. (2015)
DE, NL	Rhine, Meuse	Urgert (2015)
IT, NL, RO, SE	Po, Rhine, Danube, Dalålven	EC (2015)
DE, NL	Rhine, Lake Ijssel	Brandsma et al. (2013, 2015)

Studies reported by the participants of the European survey

Compartments investigated in studies on European freshwaters



Sources: survey, scientific literature

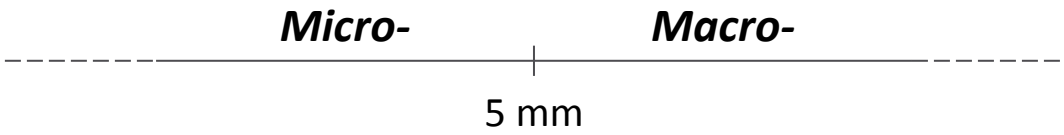
Current and future monitoring studies in European freshwaters

Studies are ongoing, planned or under discussion in 10 countries:

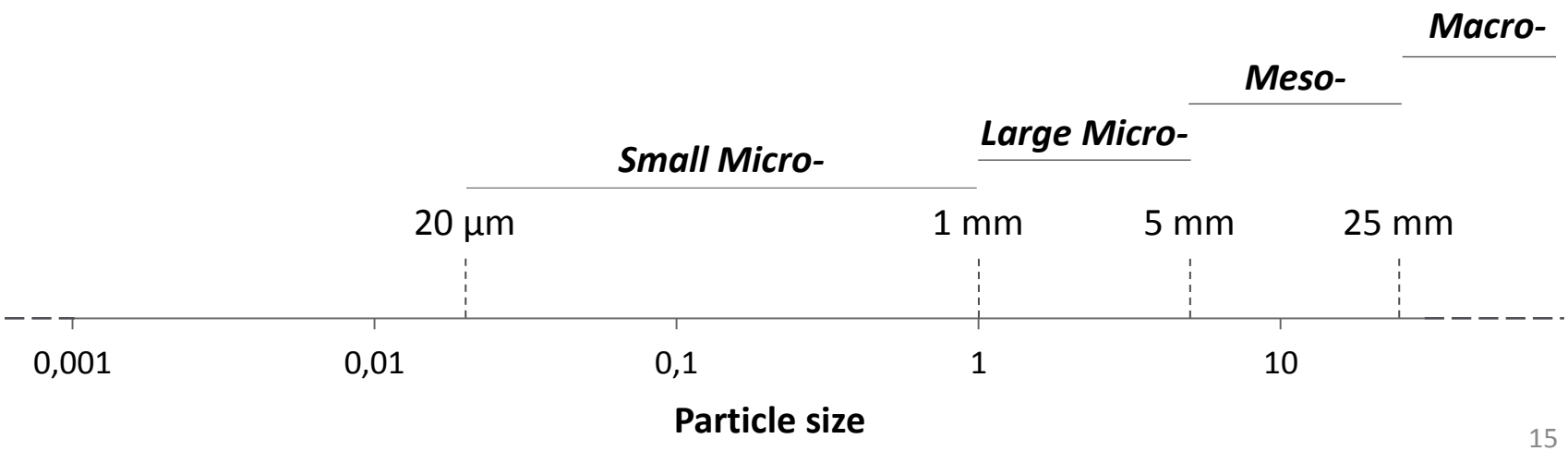
- Austria, Belgium, Denmark, Germany, Ireland, Lithuania, Luxembourg, the Netherlands, Portugal, and UK

Diversity of size

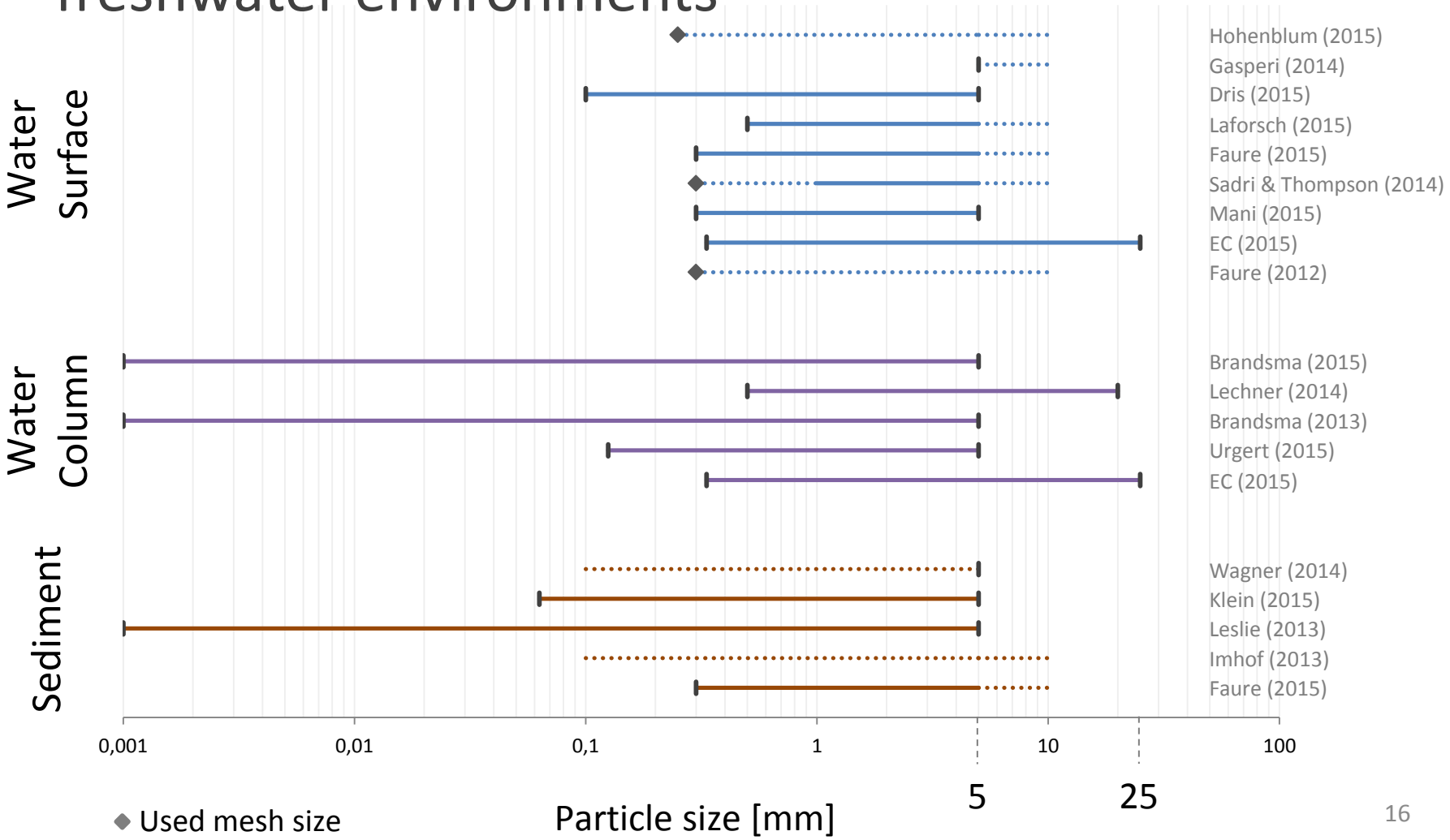
Marine Strategy Framework Directive Task Group 10 (Galgani et al. 2010)



Guidance on Monitoring of Marine Litter in European Seas (Galgani et al. 2013)



Size ranges of plastics detected in European freshwater environments



Diversity of shapes

Categories of microplastics	
Fragments	Rounded, angular
Pellets	Cylinders, disks, spherules, ovoids
Filaments	Fibres
Plastic films	
Foams	
Granules	
Styrofoams	

Source: Guidance on Monitoring of Marine Litter in European Seas (Galgani et al. 2013)

Hohenblum et al. (2015), Lumesberger-Loisl & Gumpinger (2015), Sanchez et al. (2013), Dris et al. (2015), Wagner et al. (2014), Klein et al. (2015), Laforsch (2015), Imhof et al. (2013), Leslie et al. (2013), Brandsma et al. (2013, 2015), Faure et al. (2012, 2013, 2015), Sadri &Thompson (2014), Lechner et al. (2014), Mani et al. (2015), Urgert (2015), EC (2015)

Diversity of materials

Most common polymers found in the aquatic environment
Polyethylene (PE)
High density (HD-PE)
Low density (LD-PE)
Polyethylene terephthalate (PET)
Polypropylene (PP)
Polystyrene (PS)
Polyvinylchlorid (PVC)

Source: Wagner et al. (2014)

Hohenblum et al. (2015), Gasperi et al. (2014), Klein et al. (2015), Laforsch (2015), Imhof et al. (2013), Faure et al. (2013, 2015), Sofra et al. (2010), Sadri & Thompson (2014), Mani et al. (2015), Urgert (2015), EC (2015)

Diversity of additives

Classes of additives	
reinforcing fibres	ultraviolet absorbers
fillers	biological preservatives
coupling agents	processing aids
plasticizer	flame retardants
colorants	peroxides
stabilizers	antistats
Antioxidants	

Source: Verschoor (2015)

Analysis of additives and pollutants:

Faure et al. (2015): PCBs, OCPs, PAHs, PBDEs, BPA, Nonylphenol, Phtalates

Riverine plastic loads and riverine inputs into the marine compartment

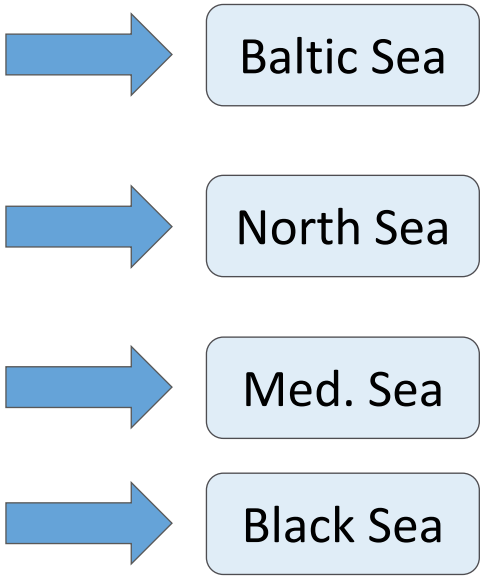
Availability of data

- on riverine loads of plastics was indicated by 4 countries (Austria, Belgium, Germany, the Netherlands)
- on riverine inputs into the marine compartment was reported by 4 countries (Denmark, Germany, Latvia, and the Netherlands

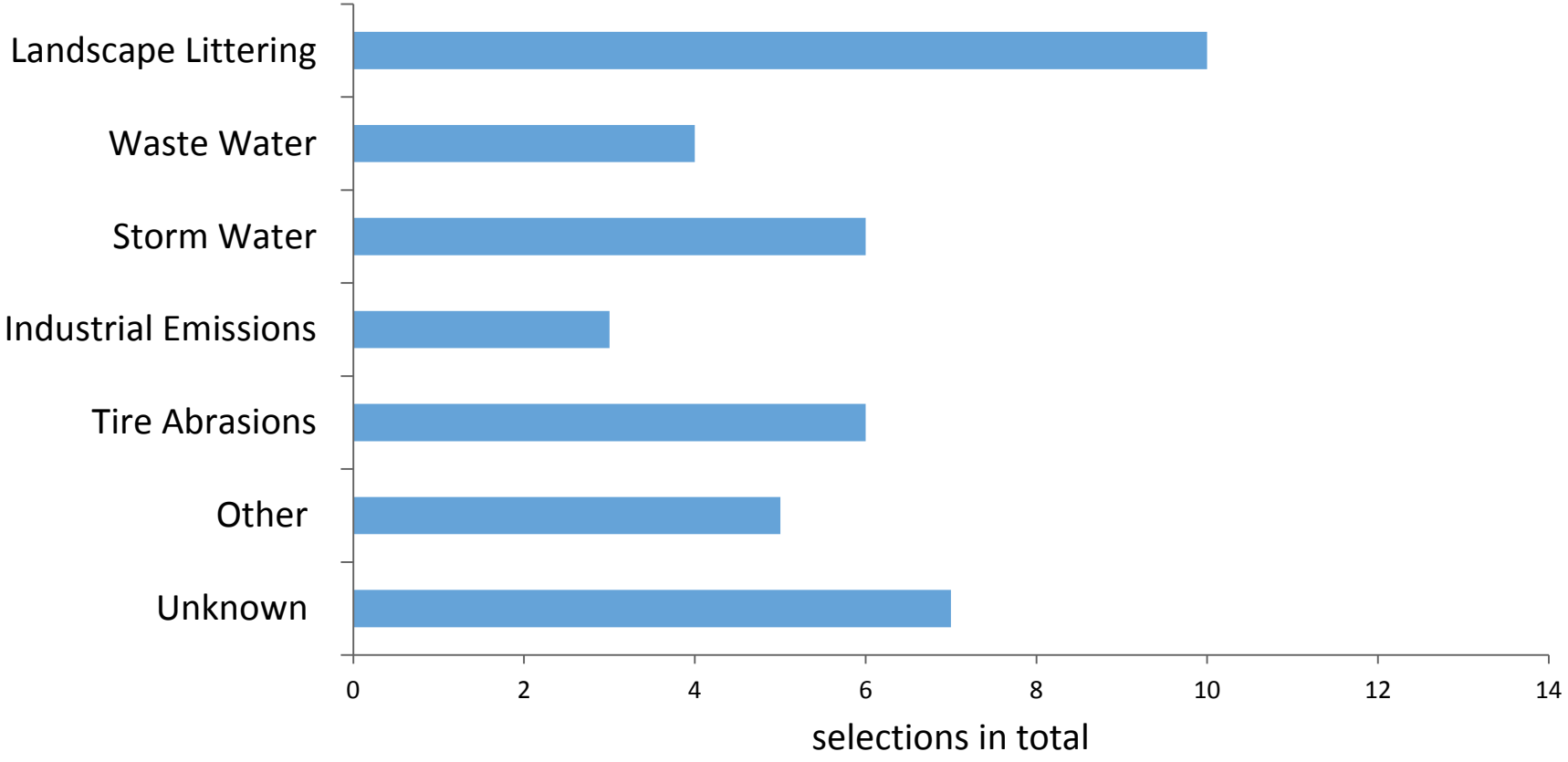
Conduct of an international study on riverine inputs on behalf of the European Commission DG Environment (EC 2015)

International study on riverine inputs into four connecting seas (EC 2015)

River	Microplastics	Mesoplastics	
	Particles/year	Particles/year	tonnes/year
Dalåven (SE)	$5 * 10^{10}$		
Rhine (NL)	$30 * 10^{10}$ $10 * 10^{10}$	$3 * 10^{8}$ $0.8 * 10^{8}$	20 31
Po (IT)	$70 * 10^{10}$	$7 * 10^{8}$	120
Danube (RO)	$200* 10^{10}$	$100 * 10^{8}$	530

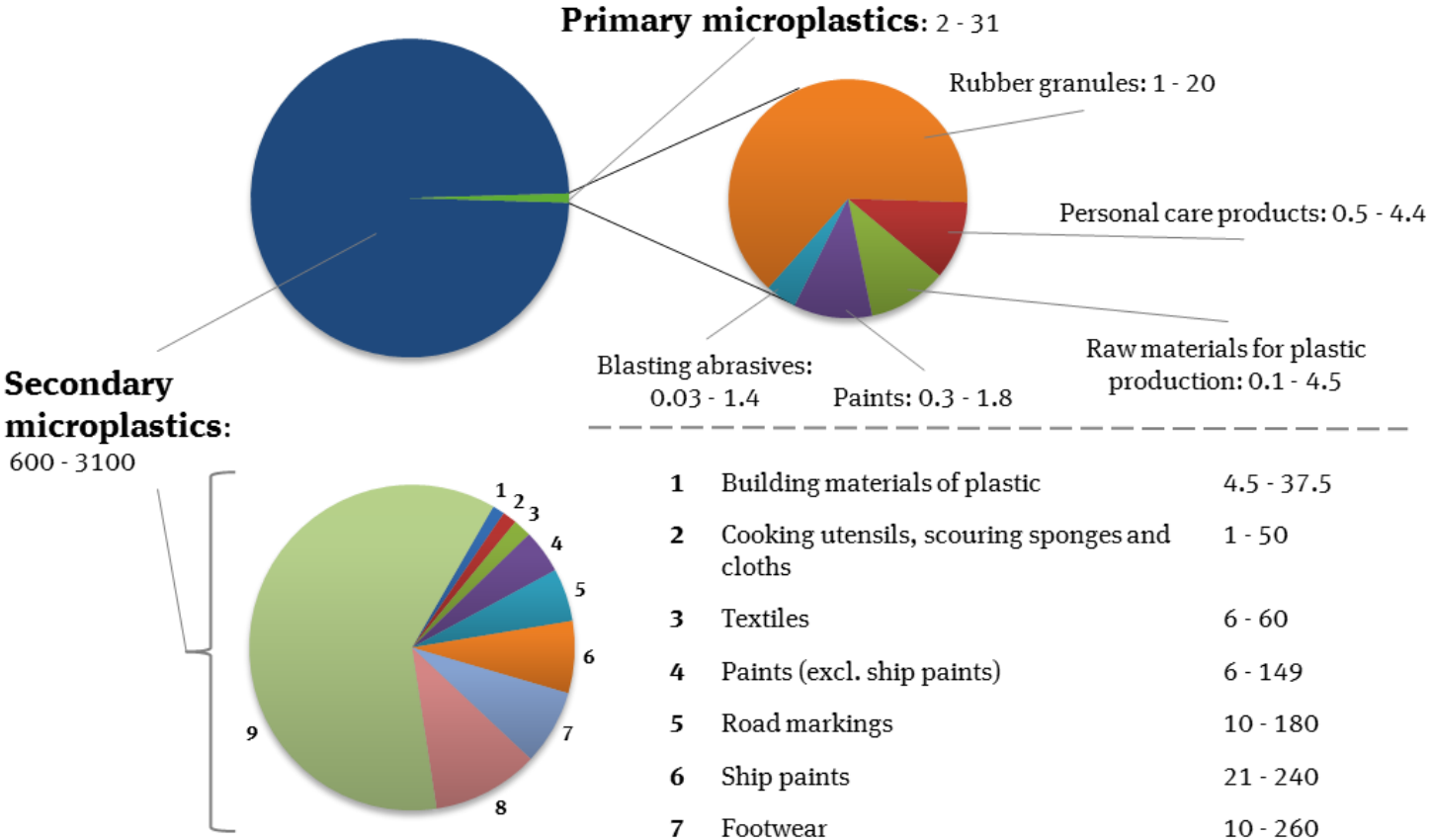


Main sources and pathways for plastics in the freshwater environments



Source: Results of the European survey

Main sources and pathways for plastics in the aquatic environment: estimation of MP releases in Denmark



1	Building materials of plastic	4.5 - 37.5
2	Cooking utensils, scouring sponges and cloths	1 - 50
3	Textiles	6 - 60
4	Paints (excl. ship paints)	6 - 149
5	Road markings	10 - 180
6	Ship paints	21 - 240
7	Footwear	10 - 260
8	Other uses	8 - 375
9	Tires	500 - 1700

All data in t/year

Data source: Lassen et al. (2015)

Effect and biota monitoring studies

Completed biota monitoring studies:

- Two studies reported by the Austrian participant of the survey
  (Hohenblum et al. (2015), Lumesberger-Loisl & Gumpinger (2015))

Biota monitoring studies reported in scientific literature:

- Fish monitoring in 10 French rivers (Sanchez et al. 2013)
- Biota monitoring in the Lake Geneva (Faure et al. 2012, 2015)

Potential Impacts

Uptake of plastic materials

External impacts

Uptake of plastic additives

→ On organisms

Long-range transport of plastics

Covering of surface grounds and biocoenoses

→ On ecological systems

Potential Effects

- Morphology
  e.g. blockage (intestinal, breathing apparatus)
- Physiology
  e.g. metabolism, inflammation
- Behaviour
  e.g. mobility, feeding
- Life Cycle
  e.g. reproduction, growth, fitness

- Exposure
  to pathogens, pollutants and invasive species in remote areas
- Depletion of habitats
- Changes of biodiversity

Effect and biota monitoring studies

Completed biota monitoring studies:

- Two studies reported by the Austrian participant of the survey
  (Hohenblum et al. (2015), Lumesberger-Loisl & Gumpinger (2015))

Studies reported in scientific literature:

- Fish monitoring in 10 French rivers (Sanchez et al. 2013)
- Biota monitoring in the Lake Geneva (Faure et al. 2012, 2015)

Studies on effects or bioaccumulation are currently ongoing, scheduled or under discussion in Denmark, Germany, Ireland, and the Netherlands.

Effects studies on freshwater organisms

Effect caused by uptake of MP	Species investigated	References
Inhibits hatching, decreases growth rates, alters feeding preferences and innate behaviours	European perch (*Perca fluviatilis*) larvae	Lönnstedt & Eklöv (2016)
Inflammation and lipid accumulation in fish liver, oxidative stress, disturbed lipid and energy metabolism	zebrafish (*Danio rerio*)	Lu et al. (2016)
Decreased growth and reproduction when exposed to polyethylene particles, less growth when exposed to polypropylene fibres	freshwater amphipod *Hyalella azteca*	Au et al. (2015)
Immobilisation	cladoceran *Daphnia magna*	Rehse et al. (2016)
Elevated mortality, increased inter-brood period and decreased reproduction	cladoceran *Daphnia magna*	Ogonowski et al. (2016)

Conclusions on plastics in freshwaters

- Knowledge of distribution and abundance is incomplete, further investigations is required.
- Monitoring studies cover only a part of European freshwaters and provide only a snapshot.
- A broadly accepted definition for the lower size boundary of microplastics is missing.
- Sampling, sample treatment and identification methods have not been harmonized.
- Knowledge of accumulation, sources, pathways, and environmental impacts is limited.
- Data on complete riverine inputs into the marine environments are not available.
- Research on effects of micro- and mesoplastics is just at the beginning.

Thank you very much for your attention!