



AWI

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HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG

Distribution & pathways of plastic debris in the Arctic

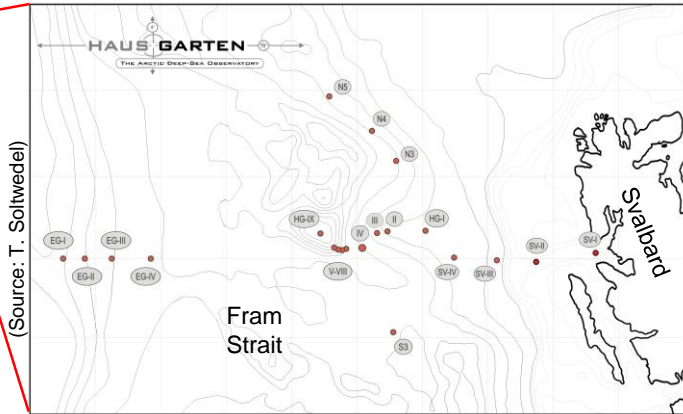
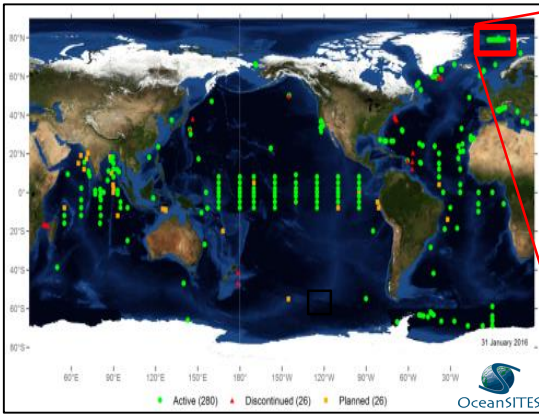


Melanie Bergmann

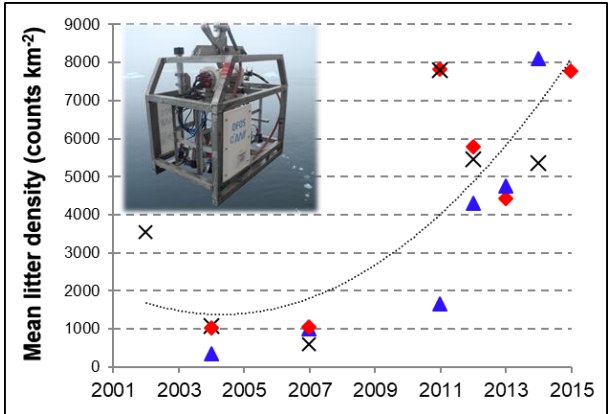
Photo: JM Weslawski
Prins Karls Forlandet

HELMHOLTZ

Ocean observation: HAUSGARTEN



(Source: T. Soltwedel)



(Bergmann & Klages 2012, Tekman et al. 2017)

Strong increase in litter quantities on deep Arctic seafloor
between 2002 – 2014

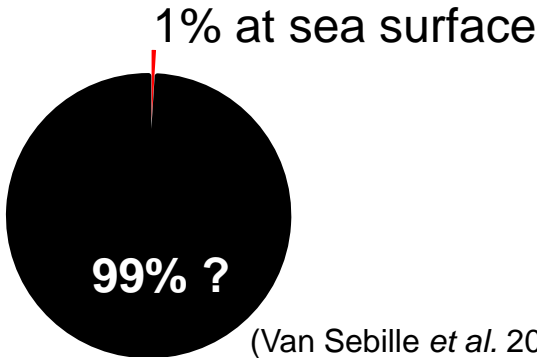
FRAM Pollution Observatory

(Frontiers in Arctic Marine Monitoring)

Lost at Sea: Where Is All the Plastic?

Richard C. Thompson^{1,*}, Ylva Olsen¹, Richard P. Mitchell¹, Anthony Davis¹, Steven J. Rowland¹, Anthony W. G. John², Daniel McGonigle³, Andrea E. Russell³

¹ University of Plymouth, PL4 8AA, UK.



Aim:

- ❖ Sample litter and microplastic in all ecosystem compartments to identify sinks and pathways
- ❖ Assess temporal trends through repeated measurements



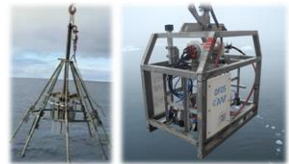
Ice cores & snow



Sea surface: observer, UAV, neuston nets



Water column: particle traps, pumps

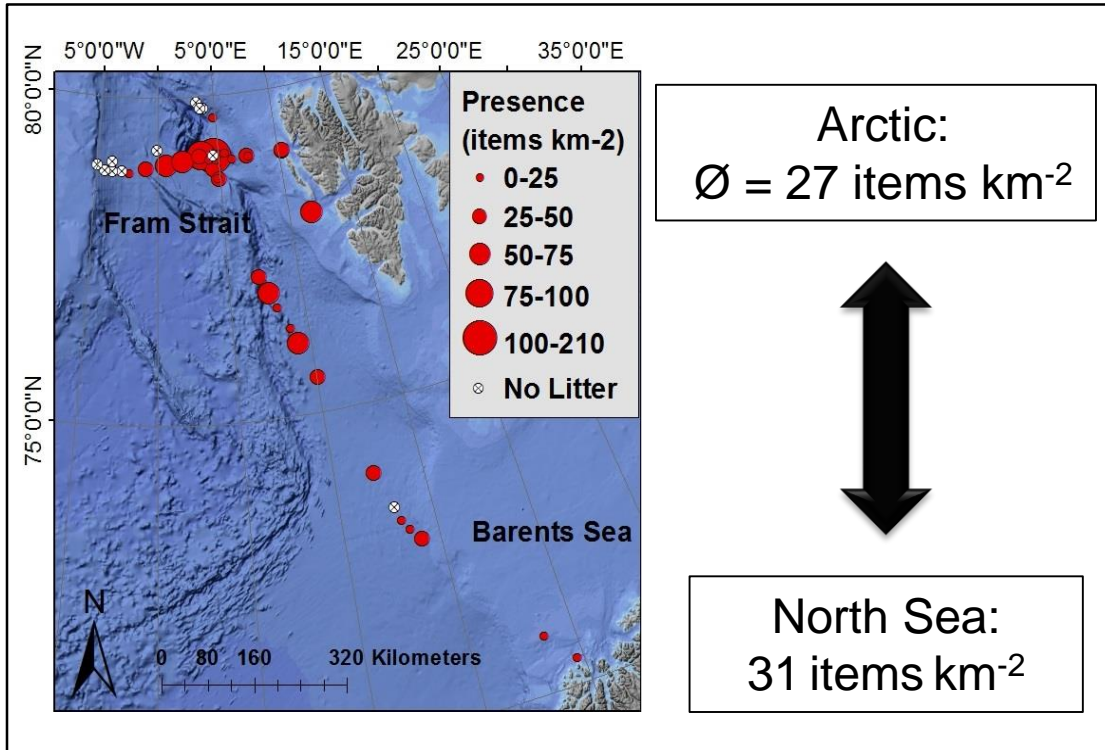


Seafloor: multi corer, OFOS



Beach: citizen clean ups

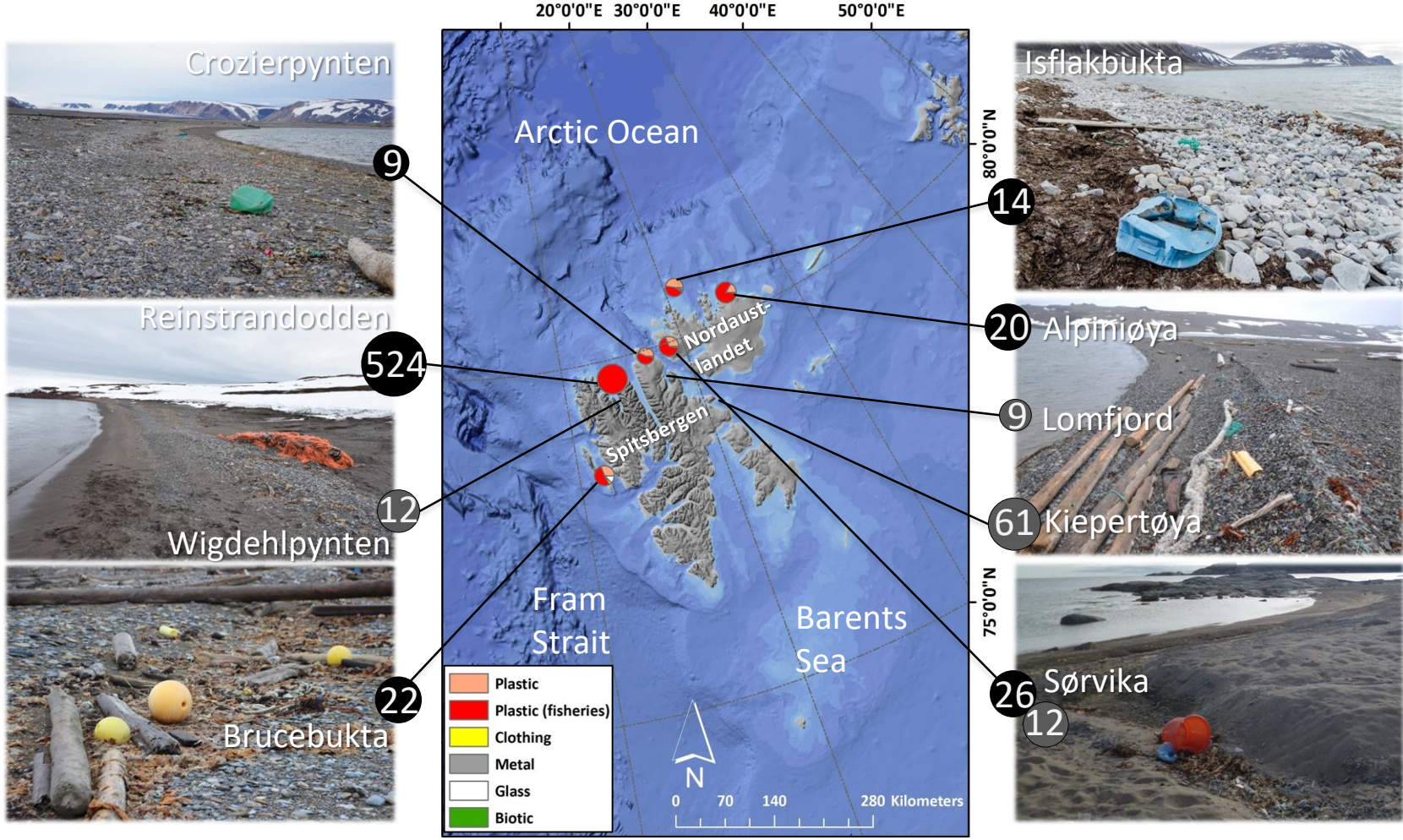
Litter at the sea surface



(Tekman, Gutow & Bergmann, Bergmann *et al.* 2015, Polar Biol; Gutow *et al.* 2018)

Similar quantities of litter floating in the Arctic and North Sea

Beached litter



(Bergmann et al. 2017 and unpubl.)

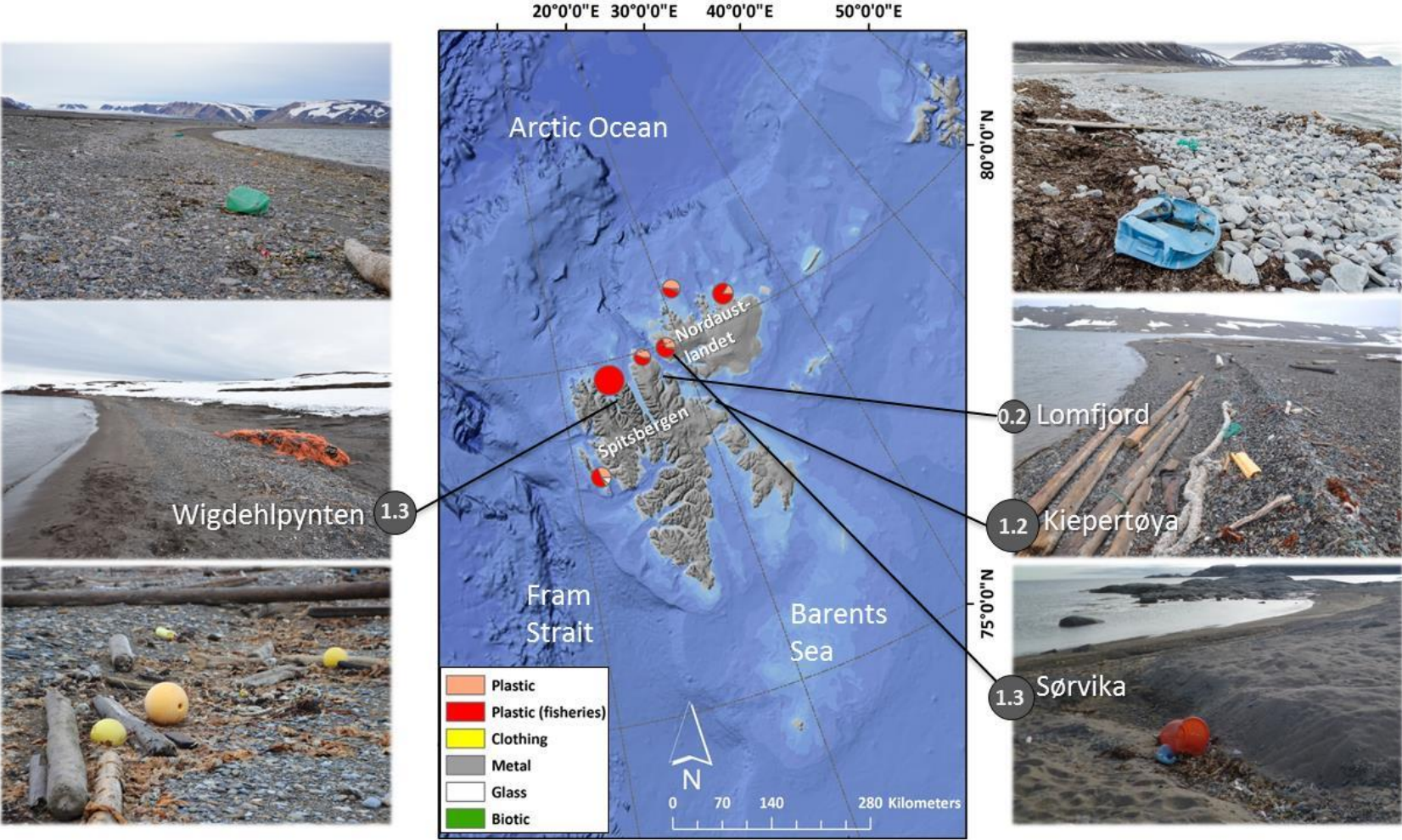
(9 in $g\ m^{-2}$)

Svalbard beaches:
9 - 524 $g\ m^{-2}$



S China, India, Japan
3 - 29 - 5,800 $g\ m^{-2}$

Beached litter: item number per m²

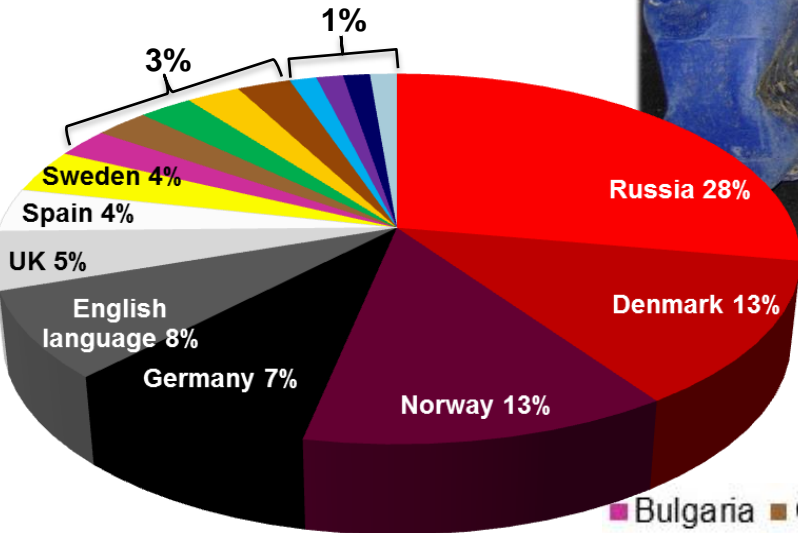
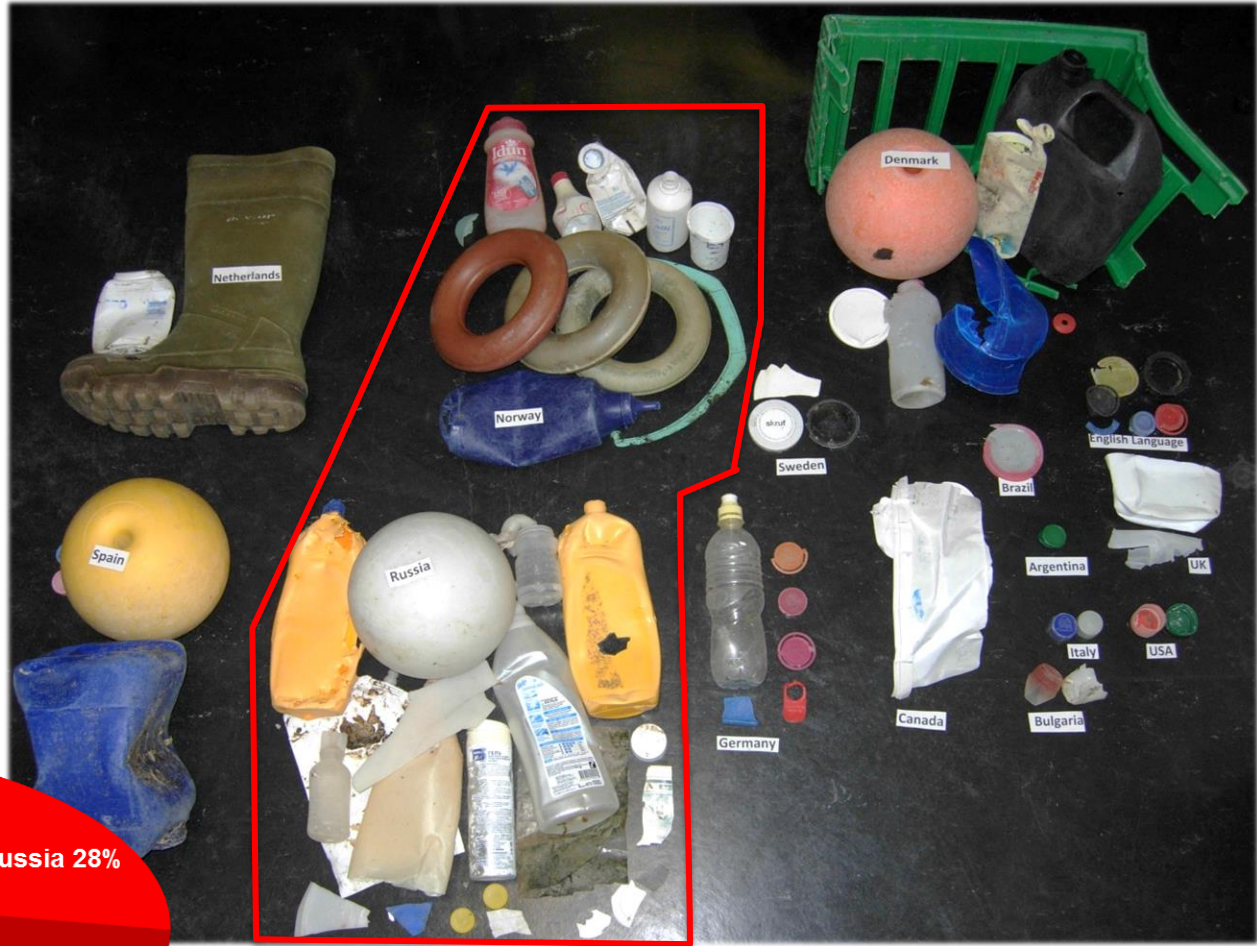


(Bergmann et al., unpubl.)

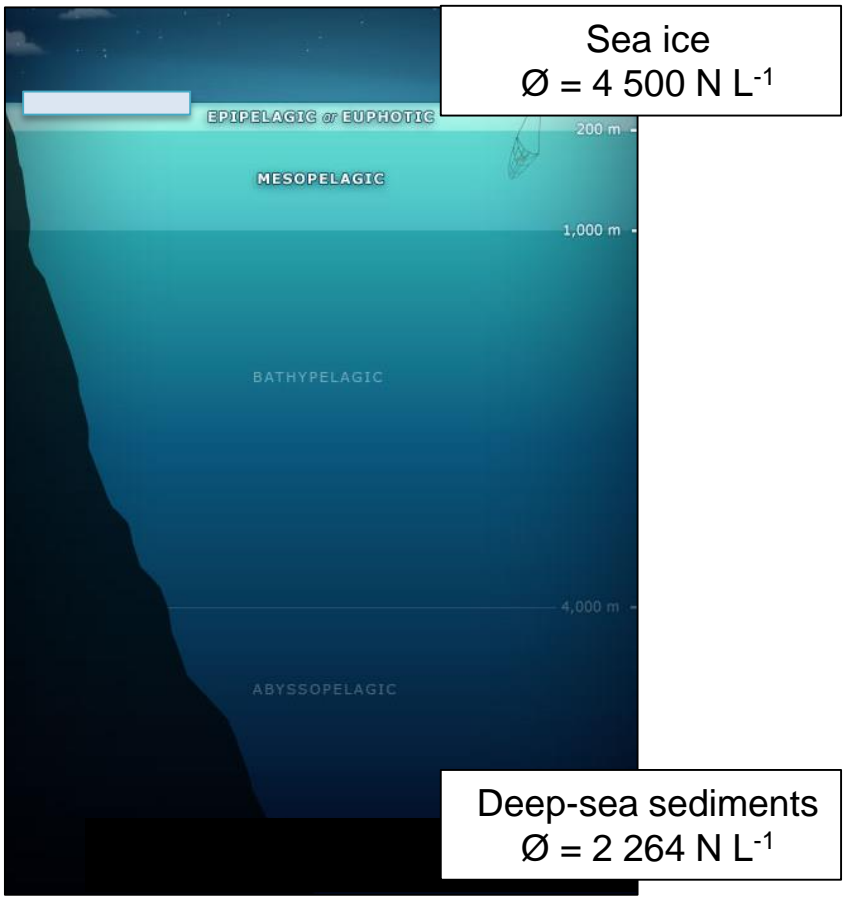
(© in items m⁻²; Bergmann et al. 2017)

Beached litter: sources

- 41% 'Local' sources
- 9% distant sources
- 43% European sources



Microplastic sinks



ARTICLE
 DOI: 10.1038/s41467-018-03825-5 OPEN
 Arctic sea ice is an important temporal sink and means of transport for microplastic



High Quantities of Microplastic in Arctic Deep-Sea Sediments from the HAUSGARTEN Observatory
 Melanie Bergmann,^{*†,||} Vanessa Wirzberger,^{‡,§,||} Thomas Krumpen,[‡] Claudia Lorenz,[‡] Sebastian Primpke,[‡] Mine B. Tekman,[‡] and Gunnar Gerds^{*}



Ice cores & snow



Sea surface: observer, UAV, neuston nets



Water column: particle traps, pumps



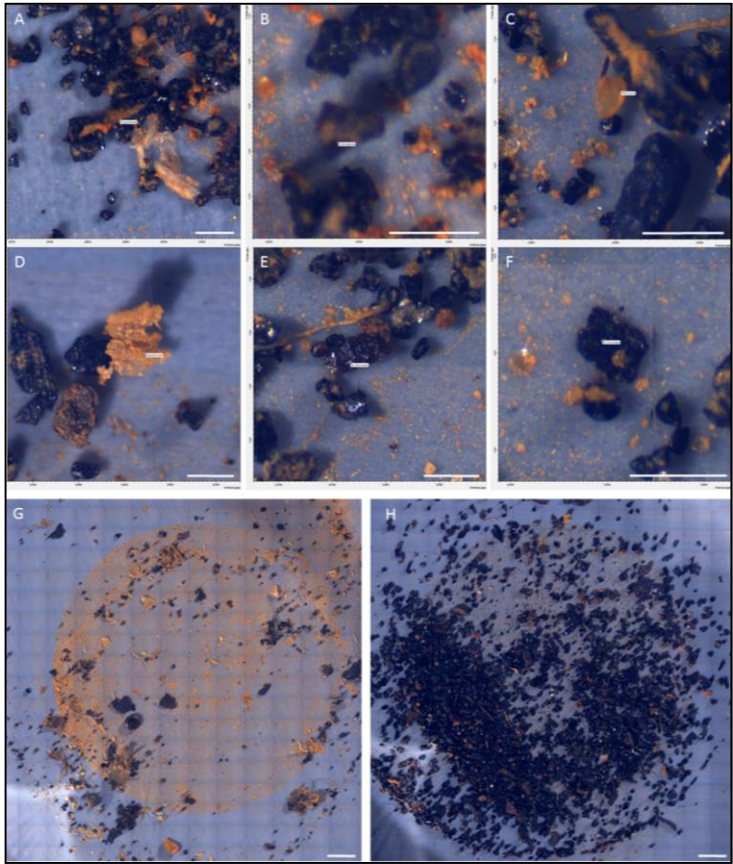
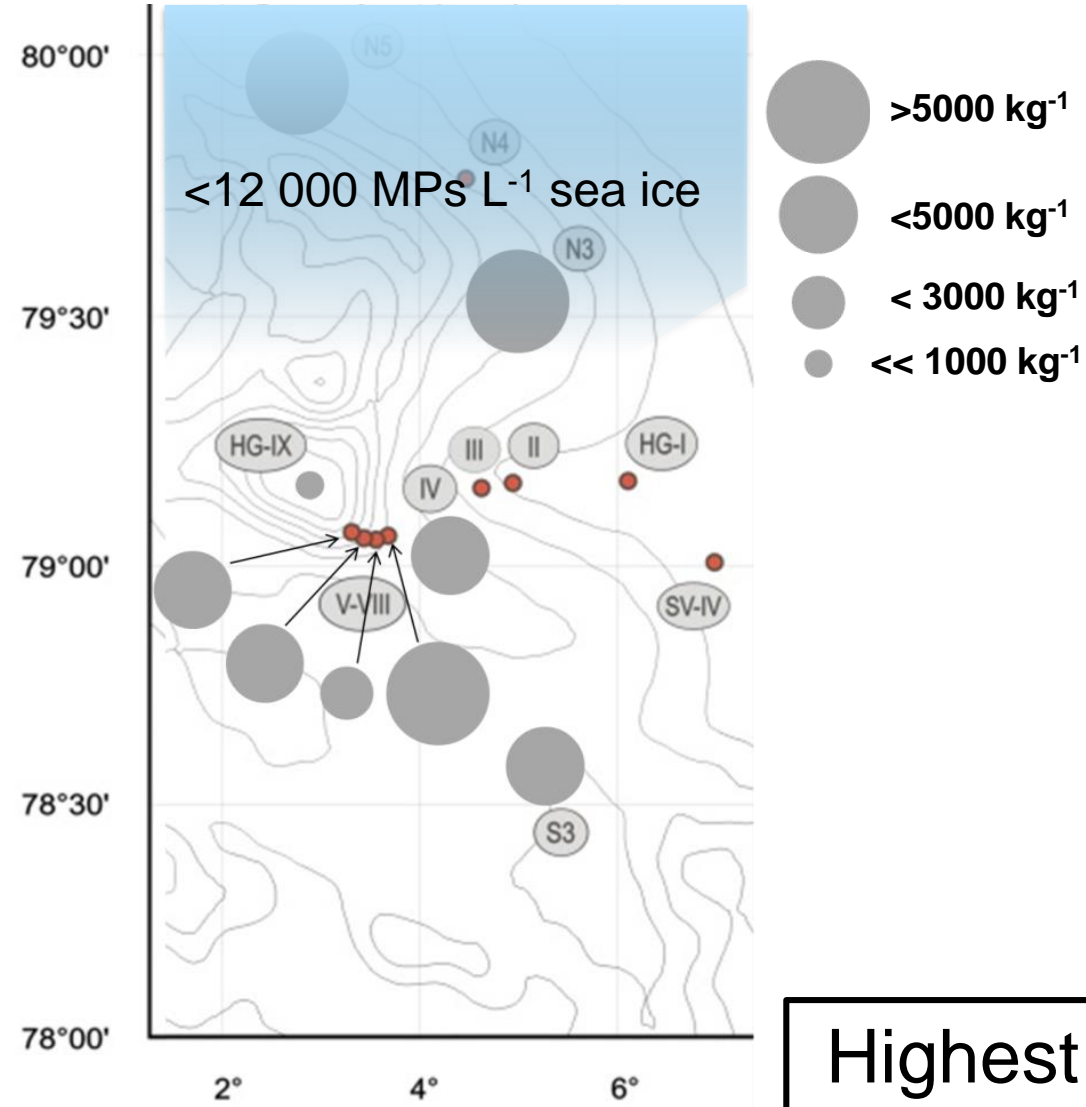
Seafloor: multi corer, OFOS camera



Beach: citizen clean ups

Deep-sea sediments and sea ice are sinks for microplastic

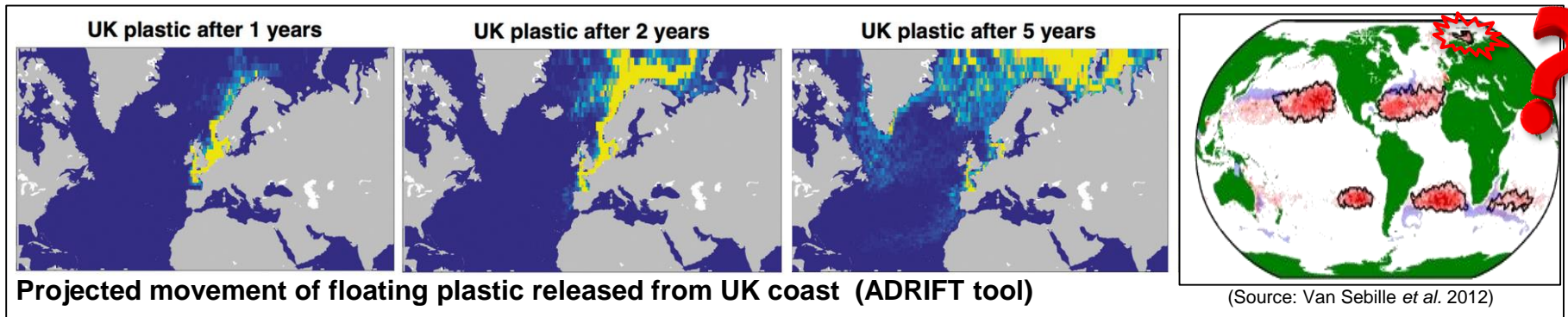
Spatial distribution of microplastic



(Bergmann et al. 2017, Env Sci Technol)

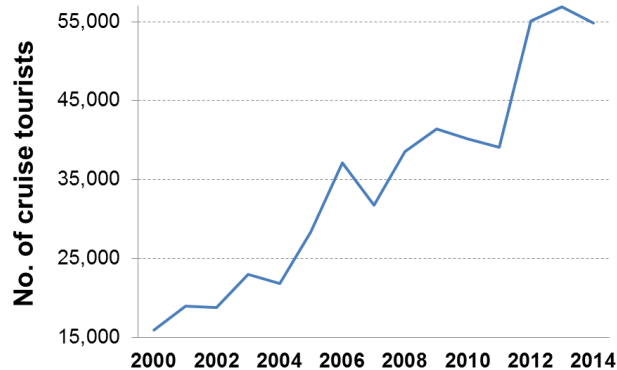
Highest quantity ($6,595\text{ N kg}^{-1}$)
in the North (MIZ)

Possible sources and pathways

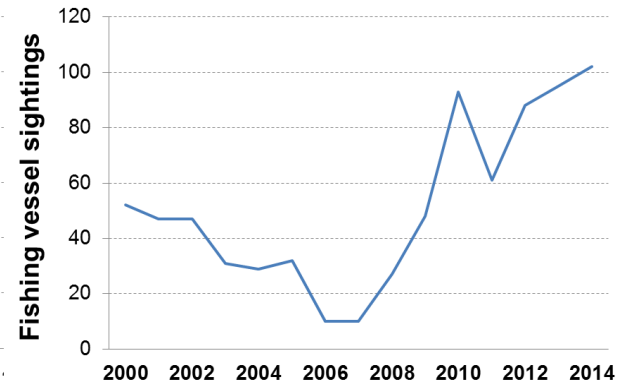
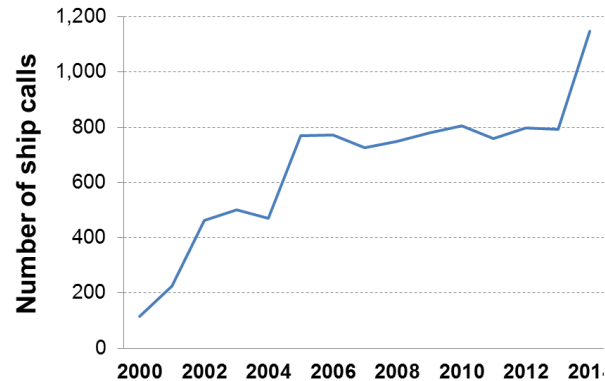


- Build up of plastic debris from distant Atlantic sources

Possible sources and pathways



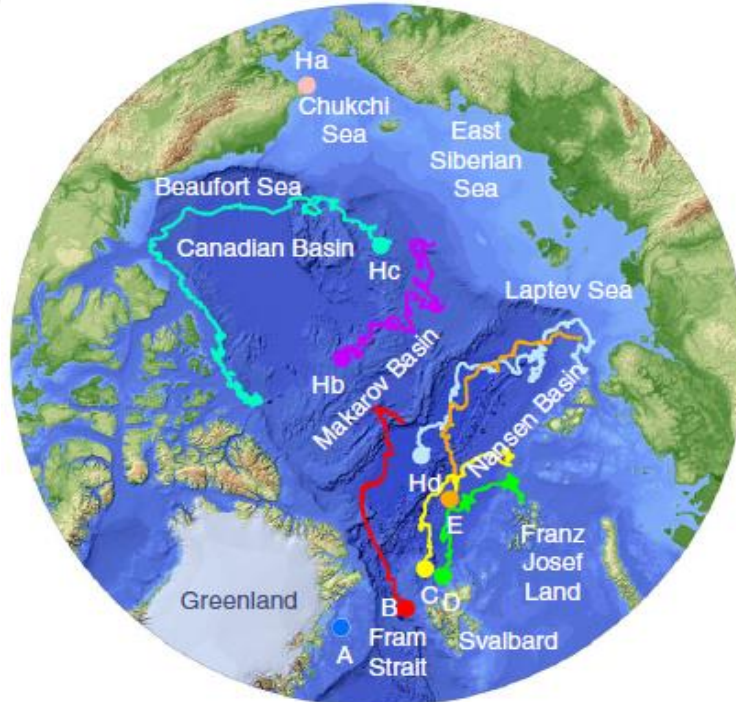
(Data: Harbourmaster of Svalbard)



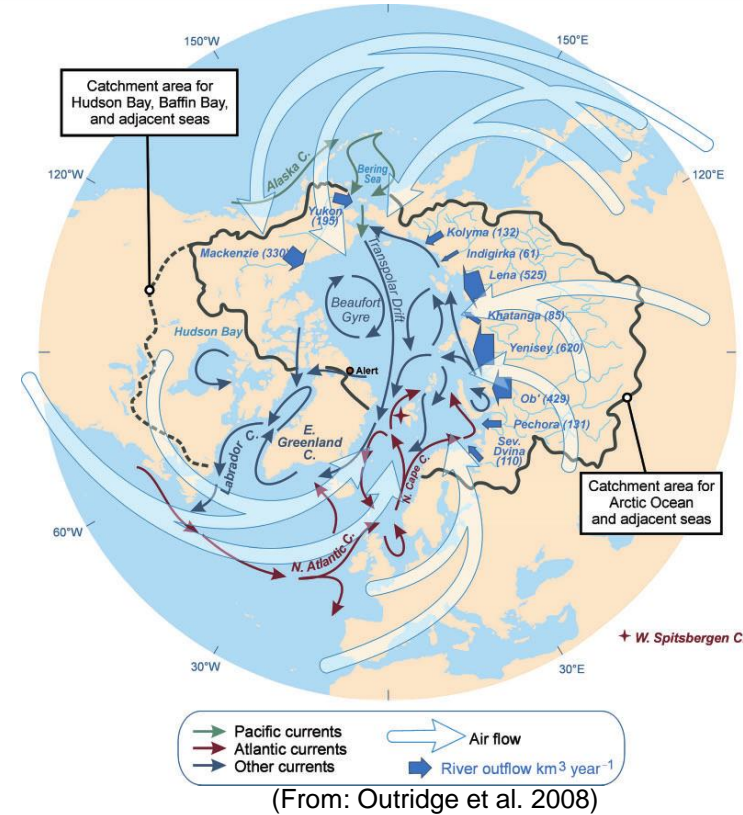
(Data: Norwegian Fisheries Directorate)

- Build up of plastic debris from distant Atlantic sources
- Increasing local emission because of increased Arctic traffic (tourism, fisheries, merchant shipping) due to retreating sea ice

Possible sources and pathways



(Peeken et al. 2018)



(From: Outridge et al. 2008)

- Build up of plastic debris from distant Atlantic sources
- Increasing local emission because of increased Arctic traffic (tourism, fisheries, merchant shipping) due to retreating sea ice
- Leakage from Arctic rivers and north Pacific ?
- Atmospheric transport and deposition ?



(Credit: J. Lemburg)

Many microplastics in snow samples

- Build up of plastic debris from distant Atlantic sources
- Increasing local emission because of increased Arctic traffic (tourism, fisheries, merchant shipping) due to retreating sea ice
- Leakage from Arctic rivers and north Pacific ?
- Atmospheric transport and deposition: snow!

Distribution of litter: LITTERBASE



LITTERBASE [Litter Distribution](#) [Biological Impacts](#) [About us](#)

Distribution of litter types in different realms (821 p)

Marine Anthropogenic Litter
Melanie Bergmann
Lars Gutow
Michael Klages
Editors

AWI ALFRED-WEGENER-INSTITUT
FÜR POLARFORSCHUNG UND
HIGHLANDRESEARCH

Springer

www.litterbase.org

Vast blind areas: need to fill our gaps!

Impacts of litter: LITTERBASE

LITTERBASE



Litter Distribution

Biological Impacts

About us

Deutsch

1,472 species are affected by litter (1,065 publications)



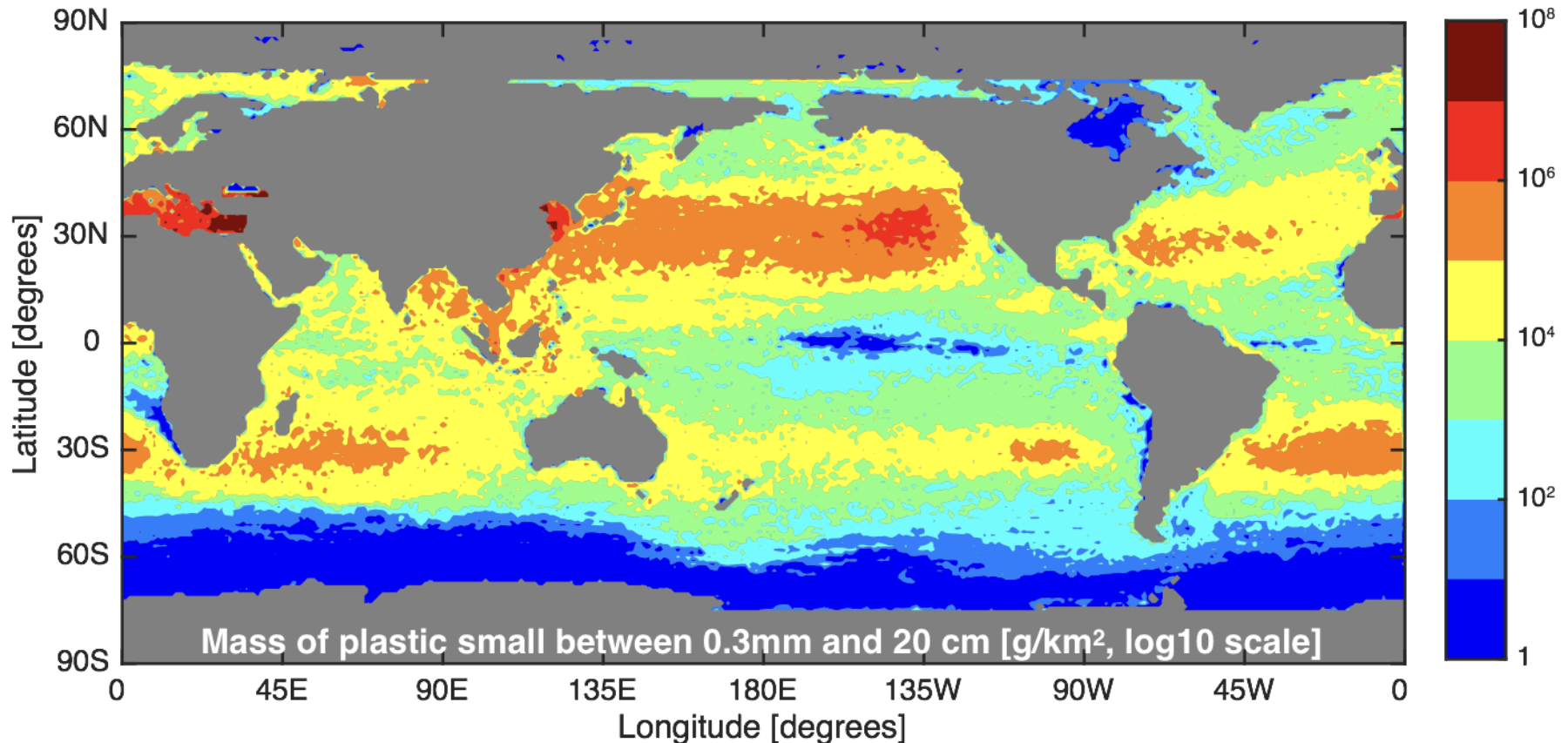
● Colonisation ● Entanglement ● Ingestion ● Other



www.litterbase.org

Vast blind areas: need to fill our gaps!

Tracking Of Plastic In Our Seas (TOPIOS.org)



Erik van Sebille

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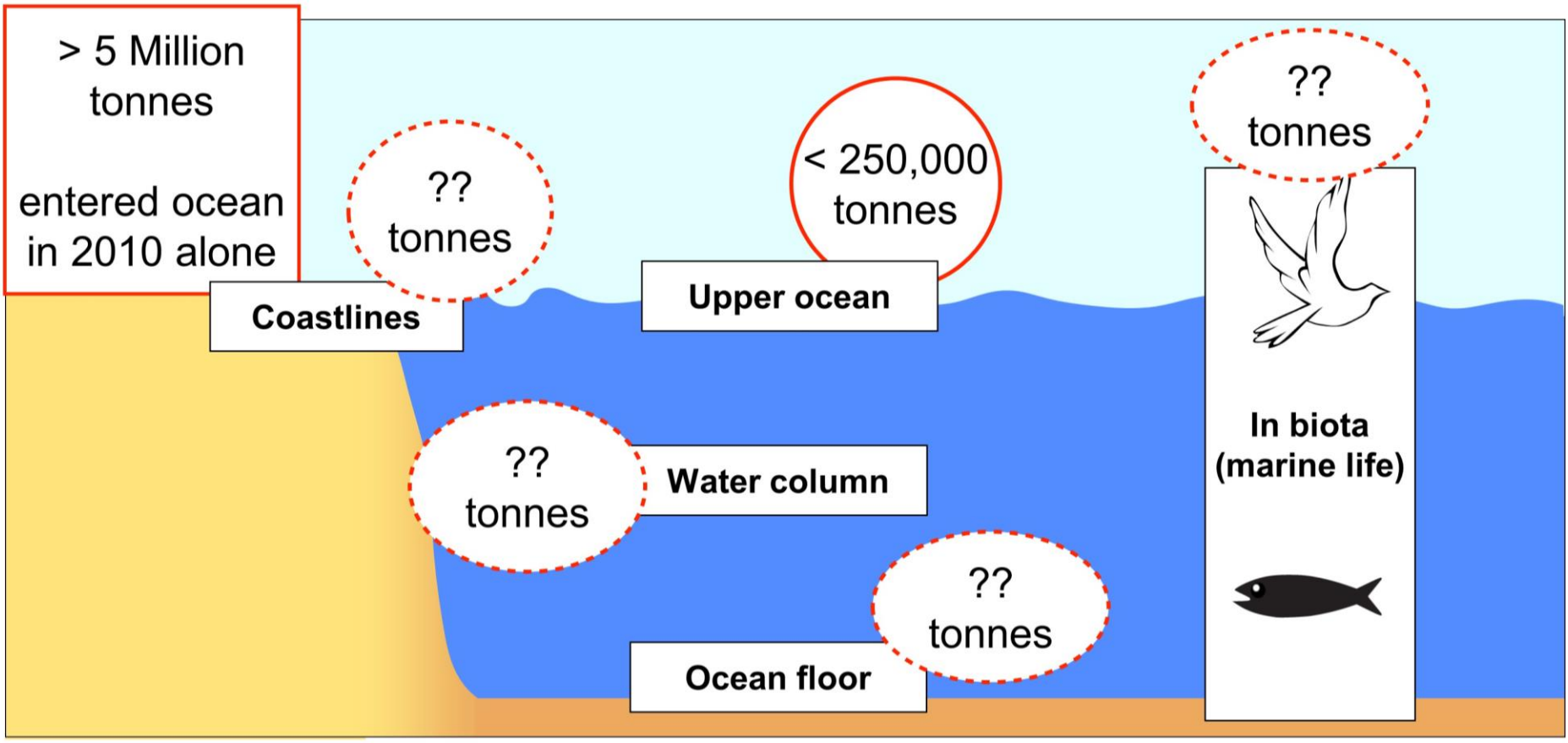


Utrecht University



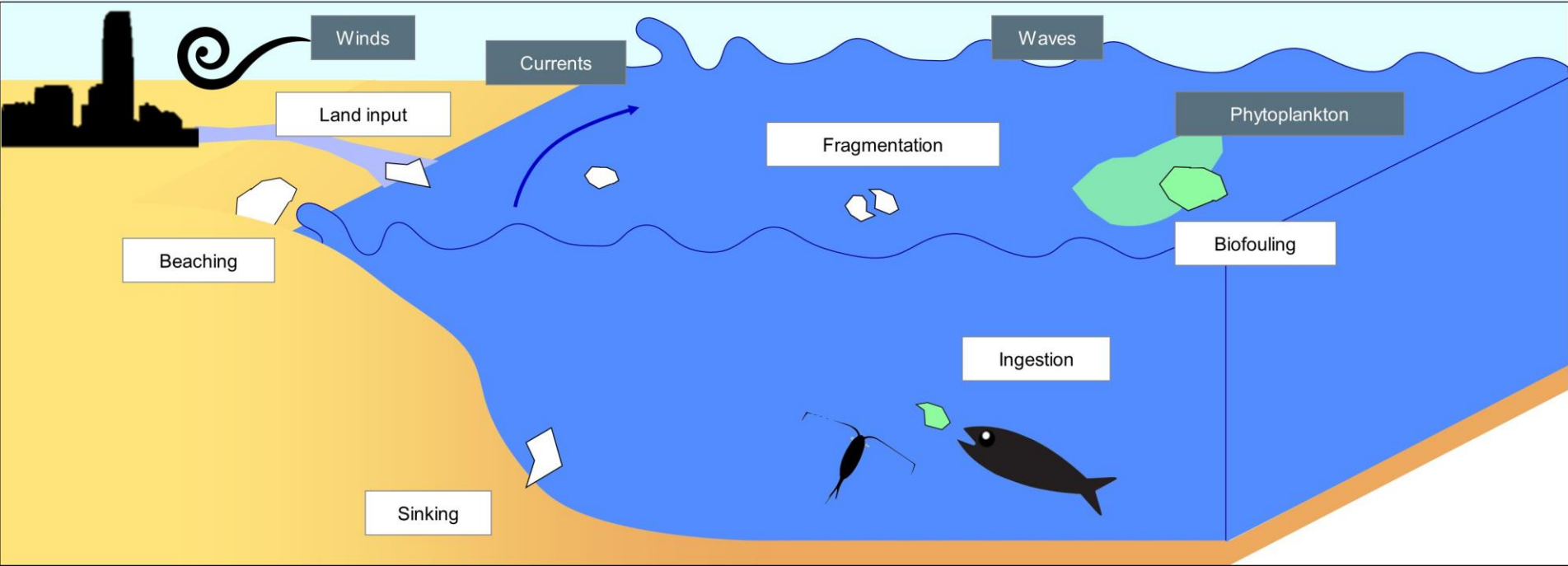
European Research Council
Established by the European Commission

The case of our 99% missing plastic



Hardesty, Harari, Isobe, Lebreton, Maximenko, Potemra, Van Sebille, Vethaak, and Wilcox, 2017, *Frontiers in Marine Science*

Simulating the full marine fate of plastic

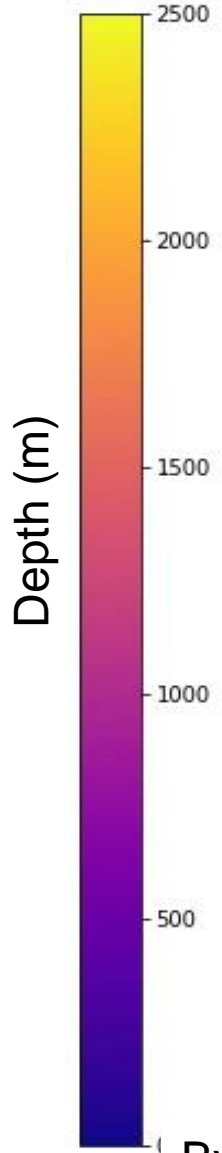
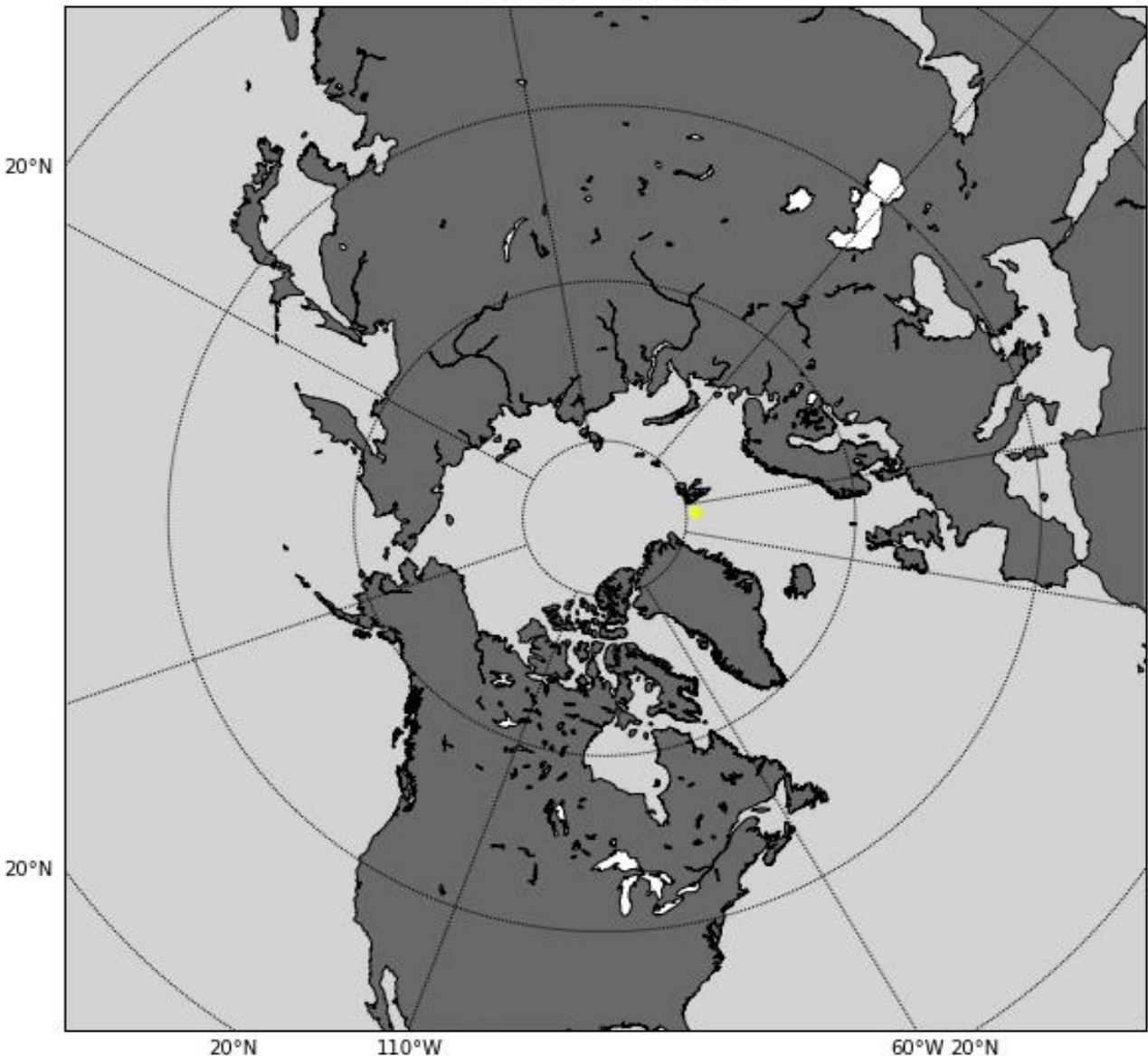


Tracking Of Plastic In Our Seas (TOPIOS.org) - ERC Starting Grant (2017-2022)

Inverse tracking of seafloor litter



2005-12-01



Backwards in time from the HAUSGARTEN observatory

- 100 particles
- Released within 600 days on seafloor
- Rise speed $w = 9 \text{ m/day}$
- Backtracking using nemo flow fields

By van Sebille *et al.*

Thank you!

Co-workers: Tekman, Gerdts, Gutow, Lutz, Lorenz, Primpke, Peeken, Wirzberger, CITIZENS

 **FRAM**
Frontiers in Arctic
Marine Monitoring

BASEMAN
MICROPLASTICS ANALYSES
IN EUROPEAN WATERS

eskp.de
Earth System Knowledge Platform
Wissensplattform Erde und Umwelt



Landfill at Ilulissat, west Greenland (© Alamy Stock Photo)