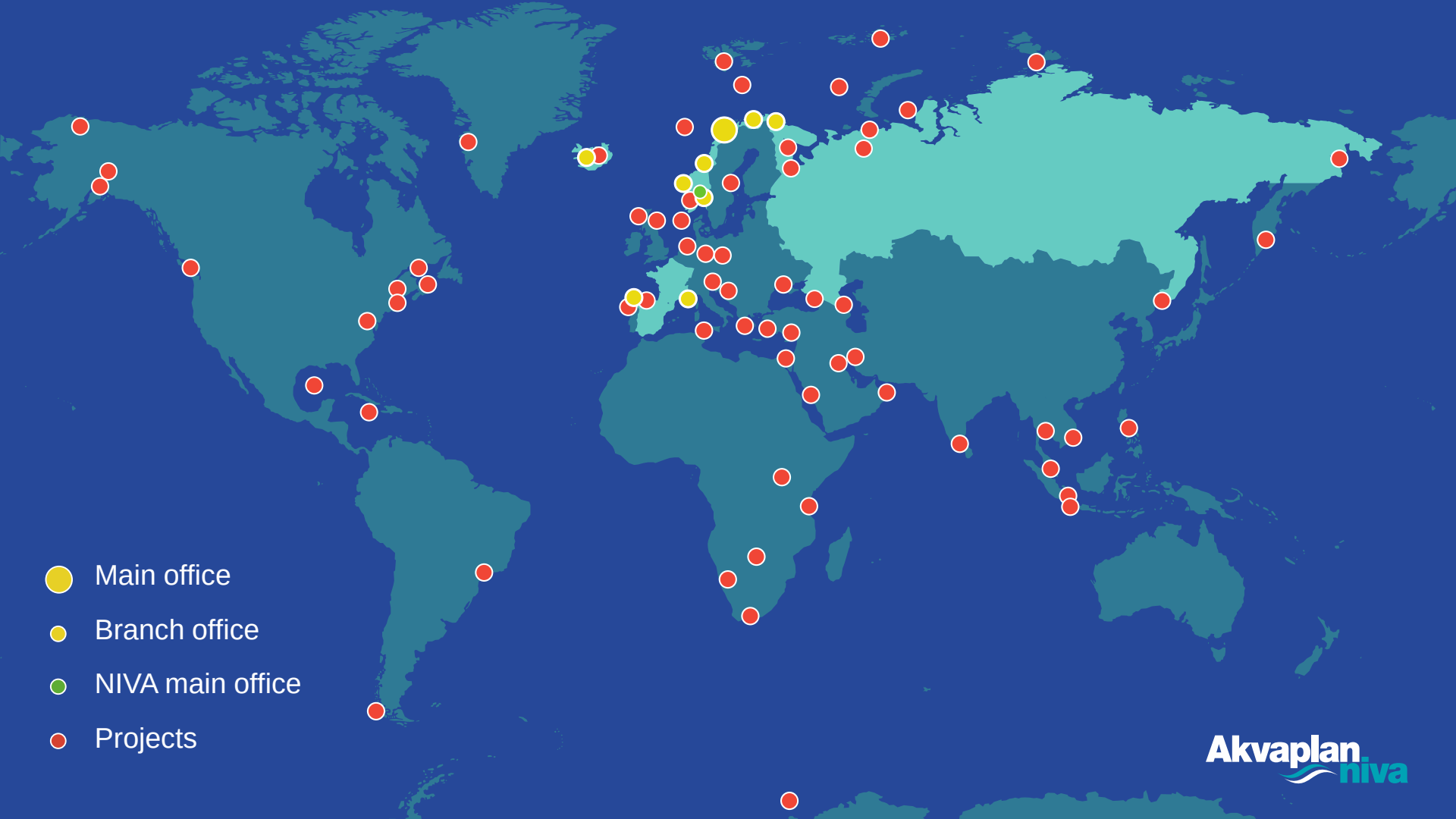
Mikroplast – en ny miljøgift?

Dr. Claudia Halsband
Planktonøkolog

Akvaplan niva

Akvaplan-niva AS

- forskningsbasert aksjeselskap i NIVA-gruppen (Norsk Institutt for Vannforskning)
- hovedkontor i Framsenteret i Tromsø
- Miljøforskning, Akvakulturforskning, Miljøovervåking,…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Arktisk kunnskap

- Biologisk mangfold
- Fysisk oseanografi
- Klima og økosystemer
- Petroleum og miljø
- Økotoksikologi

Akvaplan niva

Det er meg:

- PhD i oseanografisk biologi 2001
- Ekspert i marin plankton
- Ved Akvaplan-niva siden 2011
- Jobber med mikroplast siden 2010
- Leder mikroplast prosjekter i Framsenter flaggskip og er veilder av flere PhD prosjekter innenfor mikroplastforskning

Framsenteret

Framsenteret: Flaggskip Miljøgifter

- Mikroplast i arktiske marine næringskjeder
- Sammensetning, fordeling, transport og nedbryting (NILU, SINTEF)
- Opptak i næringskjeden (APN)
- Opptak i sjøfugl (NPI)
- Opptak i bunndyr (HI)

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Hva er mikroplast?

- Plast biter < 5 mm
- Primær mikroplast: produsert små i utgangspunktet for anvendelser innenfor kosmetikk, medisin, sandblåsing
- Sekundær mikroplast: nedbrytingsprodukter av større plastbiter (= makroplast)
- Unntak: cellulose, men er også knapt biologisk nedbrytbart: rayon > cotton ≫ acetate

MICROPLASTICS ARE PIECES OF PLASTIC 5 MILLIMETRES OR SMALLER.

5 mm scale

Common microplastics:

FRAGMENTS

Small pieces of a larger plastic object.

FIBRES

The most common type of microplastic. Plastic strands from clothing.

FOAM

Pieces of food containers and coffee cups.

NURDLES

Plastic pellets usually used in manufacturing.

MICROBEADS

Beads used in soaps and cosmetics. Now labelled "toxic" in Canada, soon to be banned in personal care products. Look for "poly" on the label.

MACROPLASTICS ARE ANY PLASTICS LARGER THAN 5 MILLIMETRES.

Examples: plastics bags, bottle lids, bottles, food wrappers, etc.

© Lake Ontario Waterkeeper

Temaer som tas opp

1. Degradasjon fra makro til mikroplast, kilder, varighet
2. Krav til tilsatser, pigmenter osv. til plast
3. Miljøgifter inn og ut av plast (utluting og adsorpsjon)
4. Farlighet og sammenheng med miljøgifter

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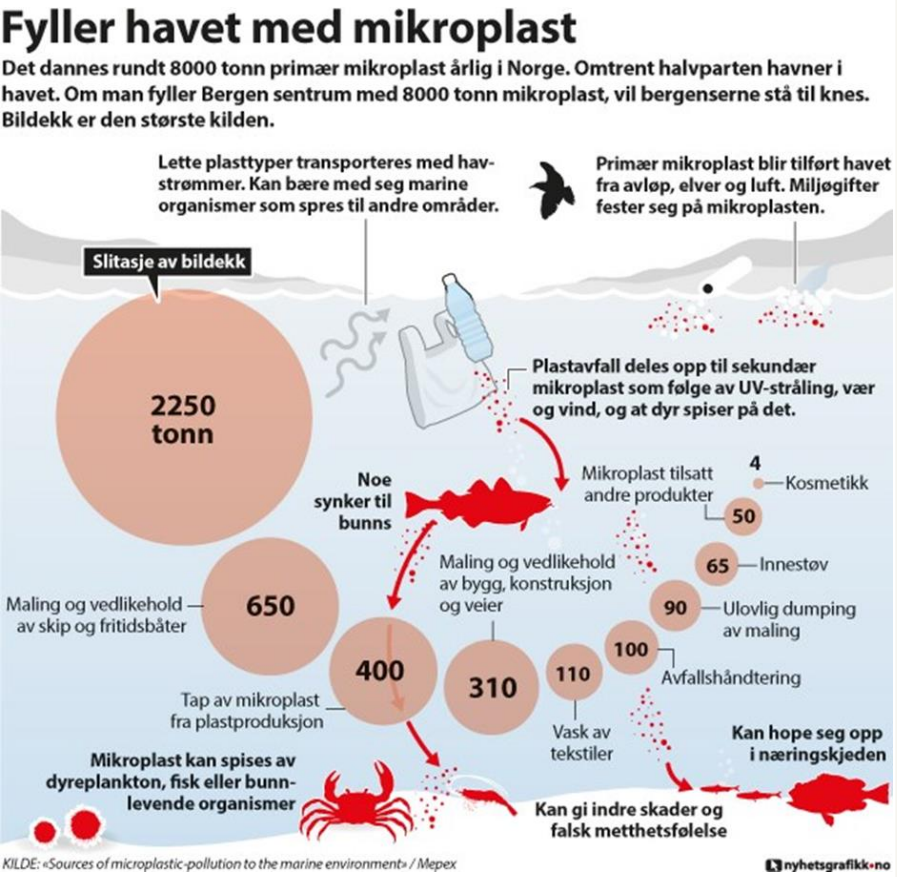
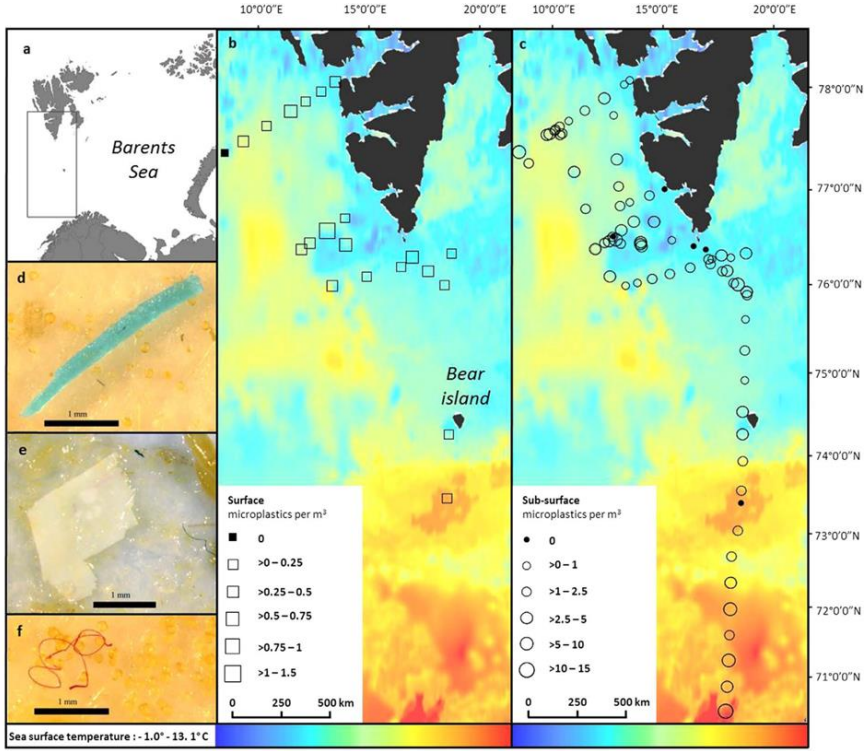
Akvaplan niva



Mikroplast i Norge

Akvaplan niva



Mikroplast i Norge

Location	Number of fish analysed	Individuals with (FTIR) plastic	Amount of plastic items found
Bergen City Harbour	30	8	14*
Karihavet	12	1	2
Svolvær Lofoten	56	0	0
Varangerfjorden	58	0	0
Indre Sørfjord	50	0	0
Oslofjord	96	0	0
Total	302	9	16

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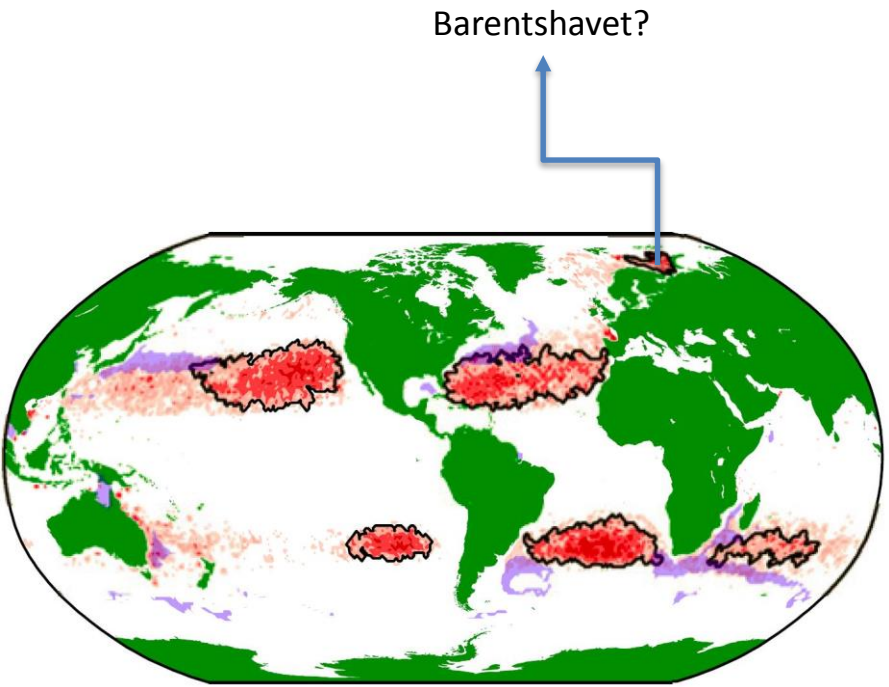
De seks globale søppel patches



Plast/mikroplast globalt

- Transporteres med havstrømmer
- Konsentreres i 6 globale søppel patcher

→inkludert en i Barents Havet?!

Se NASA visualisering på

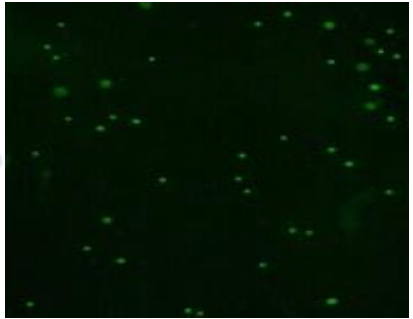
https://www.youtube.com/watch?v=xKRIE_Oiu94

Akvaplan niva

makroplast

mesoplast

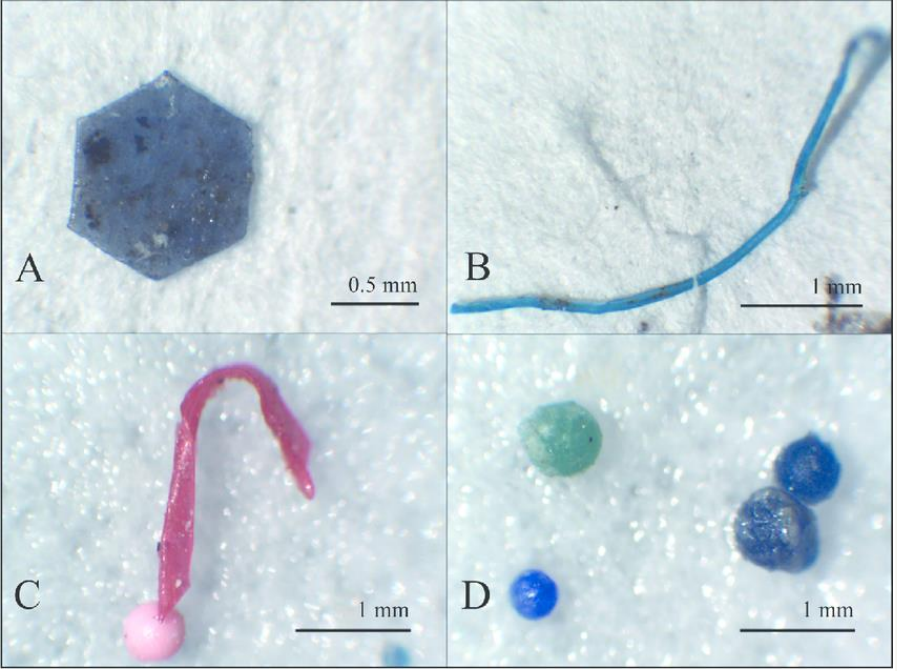
mikroplast



Kunnskapshull og utfordringer

- Identifikasjon og kvantifisering av kilder
- Utbredelse, egenskaper og transport fra land og i vannsøylen
- data vanskelig å sammenligne; mangler standardiserte metoder
- Nordiske miljøforholdene (temp, lys,…)
- Virkning av mikroplast på næringskjeder
- Rensing og unngåelse av plastforurensning

Akvaplan niva



Photos of microplastics found in the solid fraction taken from a secondary wastewater treatment works (WwTW).
(A) Alkyd fragment taken from the sludge cake (SC) fraction
(B) Polypropylene fiber taken from the grit fraction
(C) A single polyethylene microbead and red PET fragment taken from the grease fraction
(D) Four polyethylene microbeads extracted from the grease fraction

Murphy et al. 2016, Marine Pollution Bulletin

Kilder av mikroplast

- Utslipp og forsøpling på land
- Avløpsvann og kloakkslam
- Større plastbiter og plastsøppel i havet
- lokalt eller fra hvor som helst
- brytes ned etter hvert

Akvaplan niva

Environmental Science & Technology
Article
pubs.acs.org/est

Wastewater Treatment Works (WwTW) as a Source of Microplastics in the Aquatic Environment

Fionn Murphy,[*,†] Ciaran Ewins,[‡] Frederic Carbonnier,[§] and Brian Quinn[†]

[†]Institute of Biomedical and Environmental Health Research (IBEHR), University of the West of Scotland, Paisley PA1 2BE, Scotland
[‡]University of the West of Scotland, Paisley PA1 2BE, Scotland
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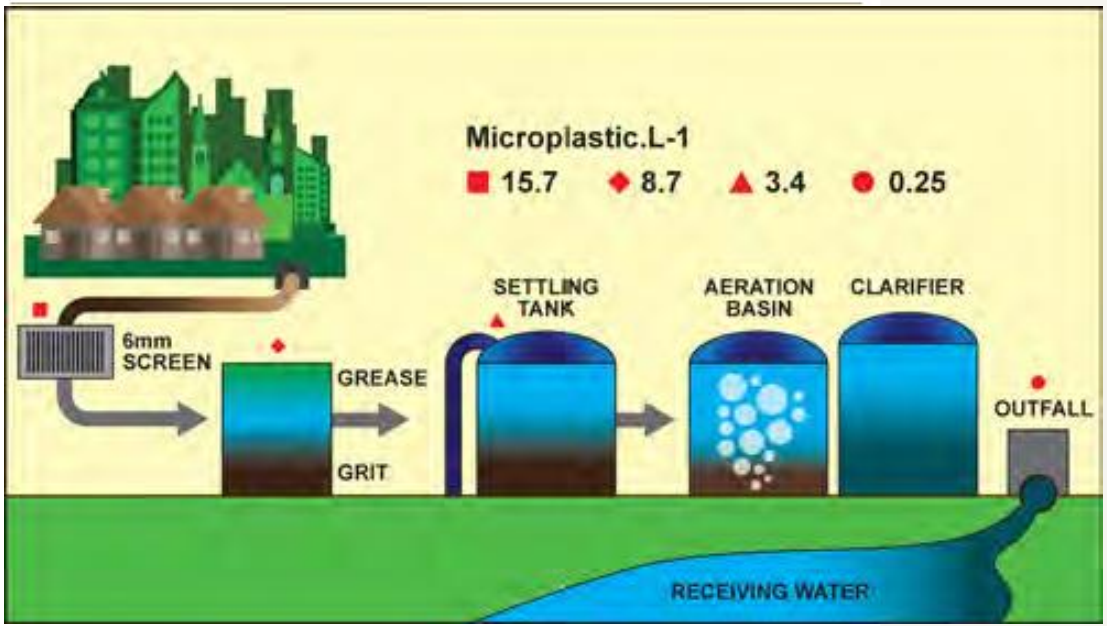
Supporting Information



Avløpsrensing

Ca. 1,5% av mikroplast i behandlet vann slipper ut

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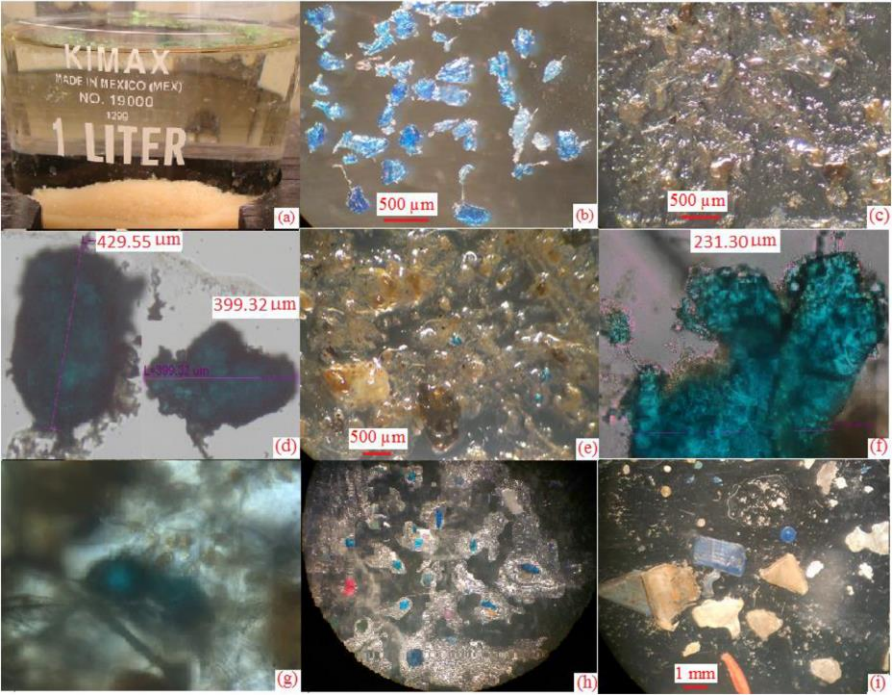


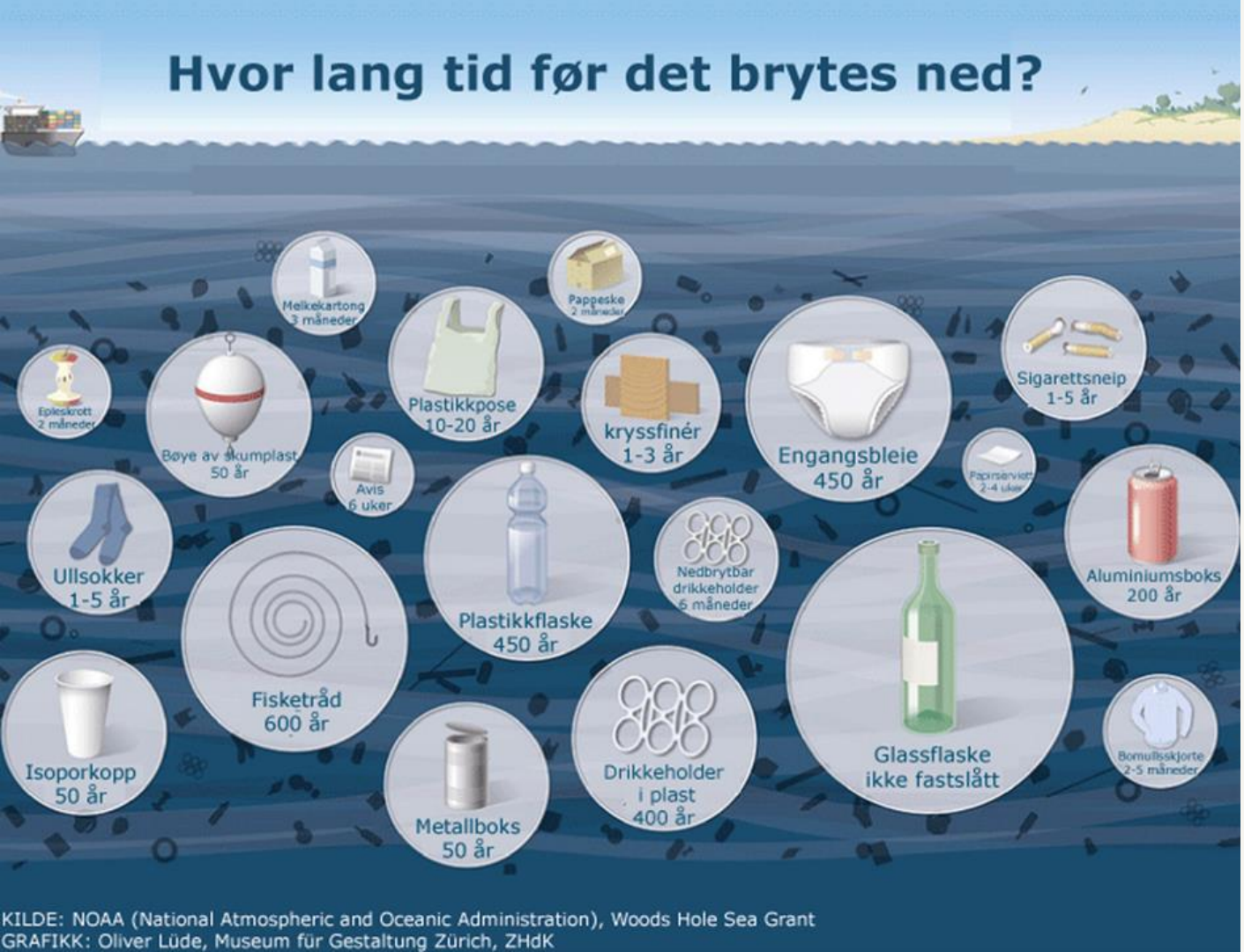
(a) Distribution of microbeads in mixed liquor. (b) MPPs in a toothpaste. (c) Bio-residues in 180 mm sieve without MPPs. (d) Blue MPPs in a sample from skimming troughs at a WRP. (e) Blue MPPs and bio-residues in 180 mm sieve atWWTP. (f) Blue MPPs found in final effluent atWWTP. (g) Blue microplastics covered with brownish biofilms. (h) MPPs in a primary skimming sample at WWTP. (i) MPPs in the centrate at WWTP.

Carr et al. 2016, Water Research

Kilder av mikroplast

- Kloakkslam gjenbrukes som gjødsel i landbruket → selv om avløpsrensing lykkes havner mikroplast i vannkretsløp igjen!

Akvaplan niva



- Fra plast til CO_2 + vann
- Fra makro til mikroplast: **?**

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JPI OCEANS

BASEMAN

Defining the baselines and standards for microplastics analyses in European waters

WEATHER-MIC

To assess how weathering processes influence the transport, fate and toxicity of microplastics (MPs) and their leachates in the marine environment

Nedbryting av plast

- Rollen av miljøbetingelsene for skjebnen og transporten av marine plast i (sjø)vann
- Forsøk pågående i Tromsø og Svalbard (NILU)

- kunnskapshull på jord og i ferskvann

Akvaplan niva

Temaer som tas opp

1. Degradasjon fra makro til mikroplast, kilder, varighet
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4. Farlighet og sammenheng med miljøgifter

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European Commission

FOOD

European Commission > Food Safety > Food > Chemical safety > Food Contact Materials

HEALTH | FOOD | ANIMALS | PLANTS | AMR

CHEMICAL SAFETY

- Contaminants
- Residues of Veterinary Medicines
- Hormones in Meat
- Pesticide Residues
- Food Contact Materials
  - Legislation
  - Authorisations
  - Non-harmonised
  - Consultation

ALL TOPICS

Food Contact Materials

Food comes into contact with many materials and articles during its production, processing, storage, preparation and serving, before its eventual consumption. Such materials and articles are called **Food Contact Materials (FCMs)**. Food contact materials are either intended to be brought into contact with food, are already in contact with food, or can reasonably be brought into contact with food or transfer their constituents to the food under normal or foreseeable use. **This includes direct or indirect contact.** Examples include:

- containers for transporting food
- machinery to process food
- packaging materials
- kitchenware and tableware

The term **does not cover fixed public or private water supply equipment**.

FCMs should be sufficiently inert so that their constituents neither adversely affect consumer health nor influence the quality of the food. To ensure the safety of FCMs, and to facilitate the free movement of goods, EU law provides for binding rules that business operators must comply with.

The EU Rules on food contact materials can be of general scope, i.e. apply to all FCMs or apply to specific materials only. EU law may be complemented with Member States national legislation if specific EU rules do not exist.

The safety of FCM is evaluated by the **European Food Safety Authority** (EFSA). At EFSA's website you can search for opinions on substances to be used in food contact materials.

The safety of Food Contact Materials is tested by the business operators placing them on the market, and by the competent authorities of the Member States during official controls. Scientific knowledge and technical competence on testing methods is being maintained by the **European Reference Laboratory for Food Contact Materials (EURL-FCM).** Its website provides guidelines and other resources concerning the testing of food contact materials.

Share

RELATED LINKS

- Food Contact Materials Database
- Multi-language versions of brochures and guidance

RELATED DOCUMENTS

- EU guidelines on conditions and procedures for the import of polyamide and melamine kitchenware originating in or consigned from China and Hong Kong
- EU Guidance to the Commission Regulation (EC) No 450/2009 on active and intelligent materials and articles intended to come into contact with food

QUICK LINKS

- Rapid Alert for Food and Feed (RASFF)
- Health and food audits and analysis
- European Food Safety Authority (EFSA)

Sammensetning og tilsatser

1. Stockholm konvensjon (POPs)
2. REACH (EU)
3. generelle prinsipper for sikkerhet og inerthet for alle matvareprodukter (EU)
4. Ellers: ikke mange regler!

Eksempel: resirkulert bildekk som kunstgress

Kanskje dere kan hjelpe oss å finne ut av det?

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Temaer som tas opp

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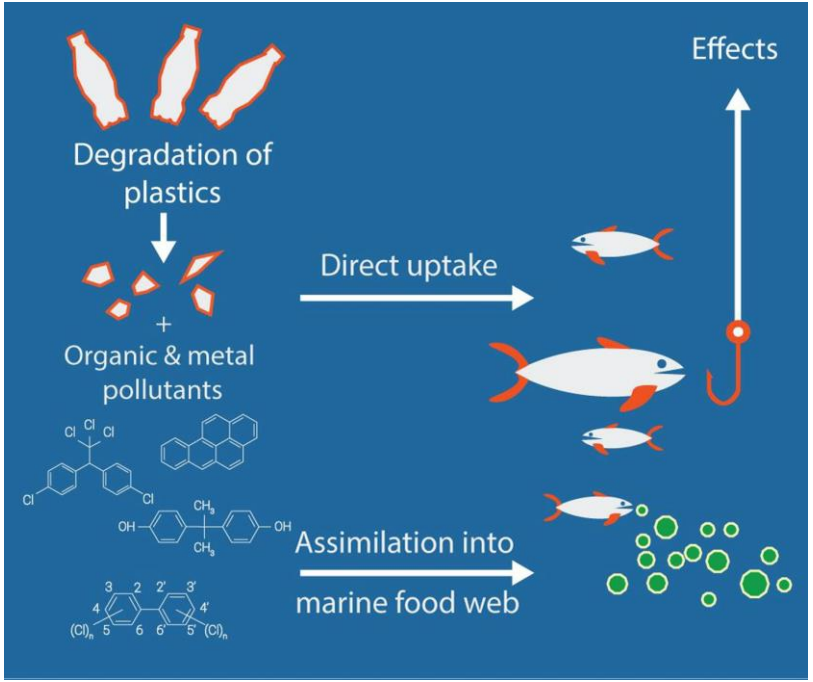
PLASTOX

Direct and indirect ecotoxicological impacts of microplastics on marine organisms

JPI OCEANS
www.jpi-oceans.eu



Miljøgifter i (mikro)plast

- Giftige additiver kan lekke ut, f. eks. tungmetaller, mykgjørere, UV stabilisatorer osv.
- Sekundær adsorpsjon av miljøgifter på overflaten av plastikken kan skade dyr hvis de blir spist
- Nedbrytningsstoffer fra plastikk kan være farlig for miljøet

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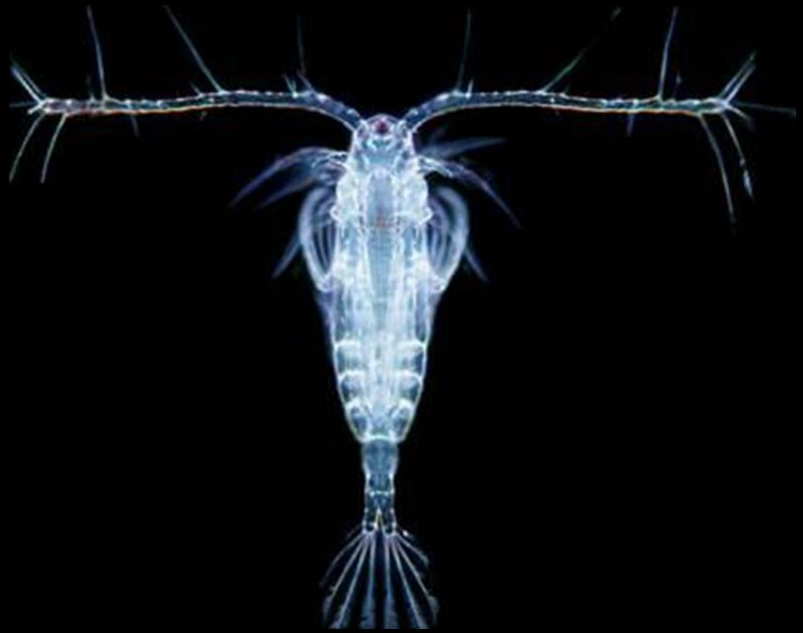
PLANKTON MØTER MIKROPLAST

+



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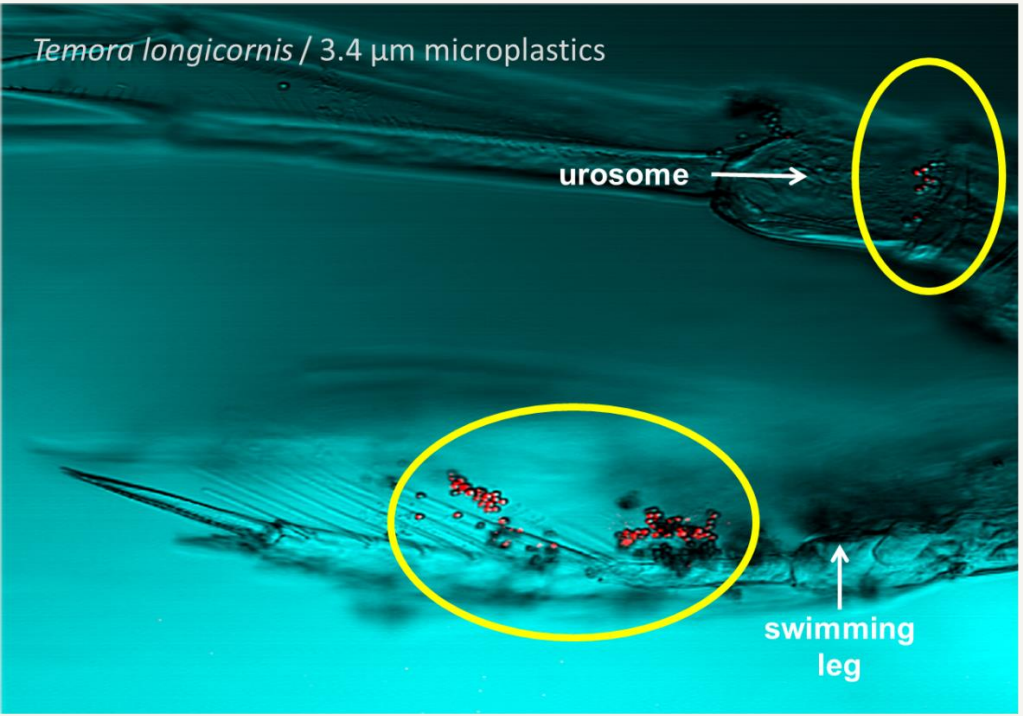


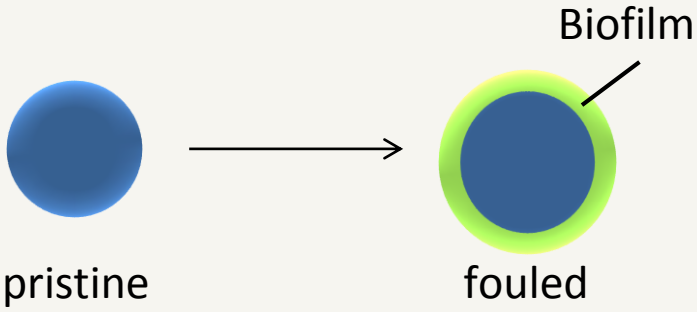
Innvikling og adhesjon

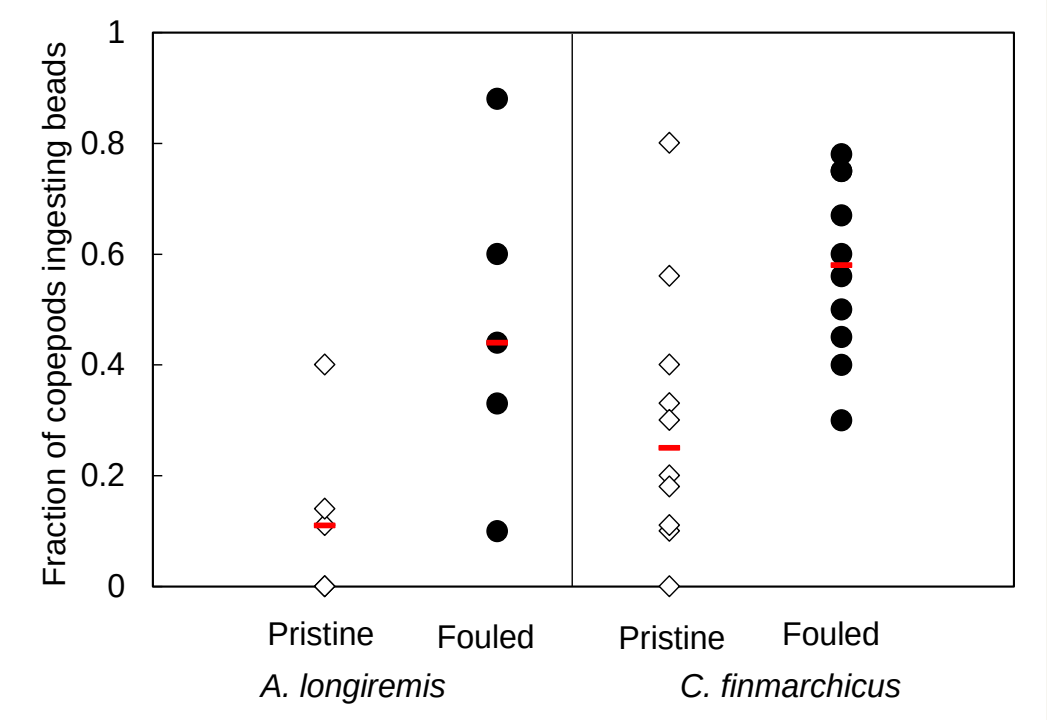
- plast biter setter seg ned på kroppsoverflaten og inn i/mellom appendikser (svømme bein, buster, antenner, …)

Inntak

- dyreplankton spiser plast, fordi de filtrerer vann
- biofilm 'smaker' godt!

© Vroom et al. 2017





Makro- og mikrokroplast funnet i marin næringskjeden

- Dyreplankton (hoppekreps, krill)
- Skalldyr (blåskjell)
- Fisk (torsk)
- Sjøfugl (havhest)
- Marine pattedyr (hval)

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Leaching of plastic additives to marine organisms

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ABSTRACT

It is often assumed that ingestion of microplastics by aquatic species leads to increased exposure to plastic additives. However, experimental data or model based evidence is lacking. Here we assess the potential of leaching of nonylphenol (NP) and bisphenol A (BPA) in the intestinal tracts of *Arenicola marina* (lugworm) and *Gadus morhua* (North Sea cod). We use a biodynamic model that allows calculations of the relative contribution of plastic ingestion to total exposure of aquatic species to chemicals residing in the ingested plastic. Uncertainty in the most crucial parameters is accounted for by probabilistic modeling. Our conservative analysis shows that plastic ingestion by the lugworm yields NP and BPA concentrations that stay below the lower ends of global NP and BPA concentration ranges, and therefore are not likely to constitute a relevant exposure pathway. For cod, plastic ingestion appears to be a negligible pathway for exposure to NP and BPA.

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1. Introduction

Pollution with plastic debris and microplastic fragments has been recognized as a major problem in fresh and marine water systems (Derraik, 2002; Andrady, 2011; Koelmans et al., 2014). Negative effects may relate to entanglement in plastic wires or nets, or to ingestion, which has been reported for benthic invertebrates, birds, fish, mammals and turtles (Laist, 1997; Besseling et al., 2013; Wegner et al., 2012; Foekema et al., 2013). It is generally assumed that microplastics may increase exposure of marine aquatic organisms to chemicals associated with the plastic, like persistent organic pollutants (POPs) or plastic additives (Gouin et al., 2011; Teuten et al., 2009; Hammer et al., 2012; Browne et al., 2013). In recent model analyses however, it was shown that the effects of plastic on bioaccumulation of POPs may be small, due to a lack of gradient between POPs in plastic and biota lipids, and that a cleaning mechanism is likely to dominate at higher Log K_{OW} values (Gouin et al., 2011; Koelmans et al., 2013a,b). For additives, monomers or oligomers of the component molecules of the plastics (hereafter referred to as 'additives') this issue has hardly been addressed. It is known that plasticizers may have biological effects already at low concentrations in the ng/L or μg/L range, especially for molluscs, crustaceans and amphibians (Oehlmann et al., 2009). It has been argued that one should expect low exposure to plastic additives because of the low diffusivities of chemicals like bisphenol A (BPA) or nonylphenol (NP) in plastics (Berens, 1997). For NP in polyvinyl chloride (PVC) and high-density polyethylene (HDPE) bottles, release half-lives to water of about 4–5 day were reported, albeit at elevated temperature (Loyo-Rosales et al., 2004). On the other hand, release rates may be higher for aged and brittle plastics (Koelmans et al., 2013; Artham and Doble, 2009; Sajiki and Yonekubo, 2003; Rochman et al., 2013) or in gastrointestinal gut fluids where high levels of DOC and surfactants facilitate exchange (Koelmans et al., 2013; Endo et al., 2013). For additives, plastic ingestion by marine organisms may be more relevant than for diffusely spread POPs because the plastic would still be a source of the additives (Teuten et al., 2009; Hammer et al., 2012; Koelmans et al., 2013a,b). Furthermore, compared to worms, leaching of additives may be more relevant for larger and longer living species, with longer gut retention times, such as fish. Interestingly, if microplastic ingestion would lead to increased bioaccumulation of plastic additives but to decreased bioaccumulation of traditional POPs at the same time (Gouin et al., 2011; Koelmans et al., 2013), there might be a trade-off between these positive and negative effects. We conclude that it is insufficiently clear whether additives should be a concern when addressing the impacts of marine plastics.

Aim of the present paper is twofold. First aim was to assess the plausibility of leaching of additives from plastic as a relevant exposure pathway for marine worms and fish. Second aim was to further elaborate a previously published biodynamic plastic-

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E-mail address: bart.koelmans@wur.nl (A.A. Koelmans).

Påvirkning av mikroplast gifter på organismer

- Model studie fra Koelmans et al.
- Trenger bekreftelse gjennom analyser av felt- og vevprøver av målarter
- Bakgrunnsforurensning i miljøet er avgjørende → mest høyere enn i plast partikler

Akvaplan niva

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ENVIRONMENTAL Science & Technology

Article

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Negligible Impact of Ingested Microplastics on Tissue Concentrations of Persistent Organic Pollutants in Northern Fulmars off Coastal Norway

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Supporting Information

ABSTRACT: The northern fulmar (*Fulmarus glacialis*) is defined as an indicator species of plastic pollution by the Oslo-Paris Convention for the North-East Atlantic, but few data exist for fulmars from Norway. Moreover, the relationship between uptake of plastic and pollutants in seabirds is poorly understood. We analyzed samples of fulmars from Norwegian waters and compared the POP concentrations in their liver and muscle tissue with the corresponding concentrations in the loads of ingested plastic in their stomachs, grouped as "no", "medium" (0.01−0.21 g; 1−14 pieces of plastic), or "high" (0.11−0.59 g; 15−106 pieces of plastic). POP concentrations in the plastic did not differ significantly between the high and medium plastic ingestion group for sumPCBs, sumDDTs, and sumPBDEs. By combining correlations among POP concentrations, differences in tissue concentrations of POPs between plastic ingestion subgroups, fugacity calculations, and bioaccumulation modeling, we showed that plastic is more likely to act as a passive sampler than as a vector of POPs, thus reflecting the POP profiles of simultaneously ingested prey.

INTRODUCTION

Marine litter and especially plastic debris has emerged as a major environmental concern worldwide and has been recognized as a threat to marine ecosystems due to its large abundancy.[1] The yearly production rates of plastics have increased more than a hundredfold from the onset of plastic plastic pollution.[9] Climate change and increased ice melt may be an additional source by releasing currently ice-bound plastic particles into the water column.[10] As could be expected from the extensive presence of plastics in the marine environment, plastic fragments have been found in the gut of a wide range of marine species, from plankton to top predators.[4,11−13]

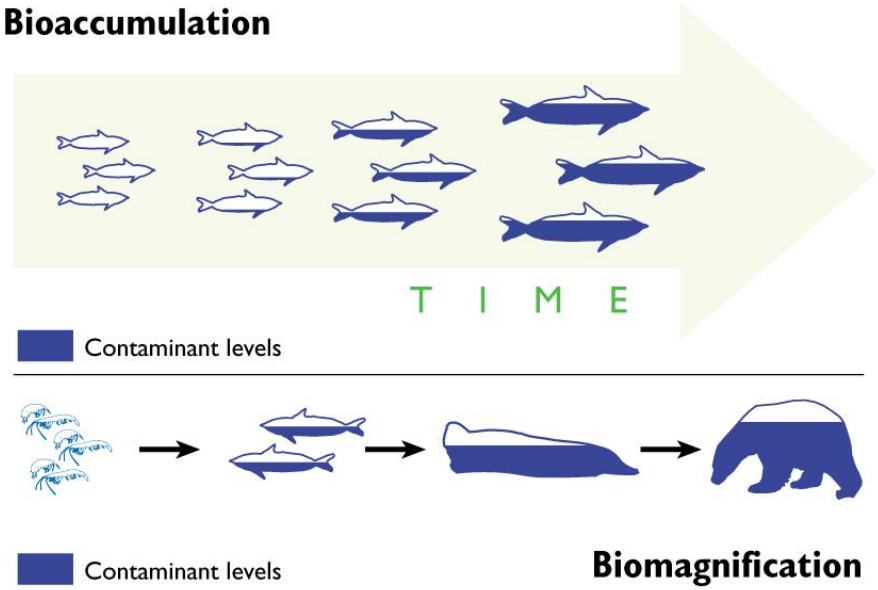
Påvirkning av mikroplast gifter på organismer

- Ubetydelig påvirkning av inntatt mikroplastikk på vevskonsentrasjoner av POPs i havhesten, fordi den spiser mye fisk som også inneholder miljøgifter

→ Plast er ikke den eneste kilde av miljøgifter!

→ Men: andre dyr (som plankton) lav i næringskjeden kan støte på store mengder mikroplast og 1) blir påvirket; 2) gi den videre

Akvaplan niva



Bioakkumulasjon & biomagnifikasjon?

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Mikroplastfunn i

- Luft
- Koksalt
- Øl
- Honning
- Sjømat
- Legemidler/klinisk diagnostikk
- …

© Nordsee

Matsikkerhet/eksponering av mennesker

- Summering av opptak fra flere kilder?
- avhengig av miljøgiftsammensetning og dosis?
- i dag er det ingen systematiske studier på påvirkninger i mennesker

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