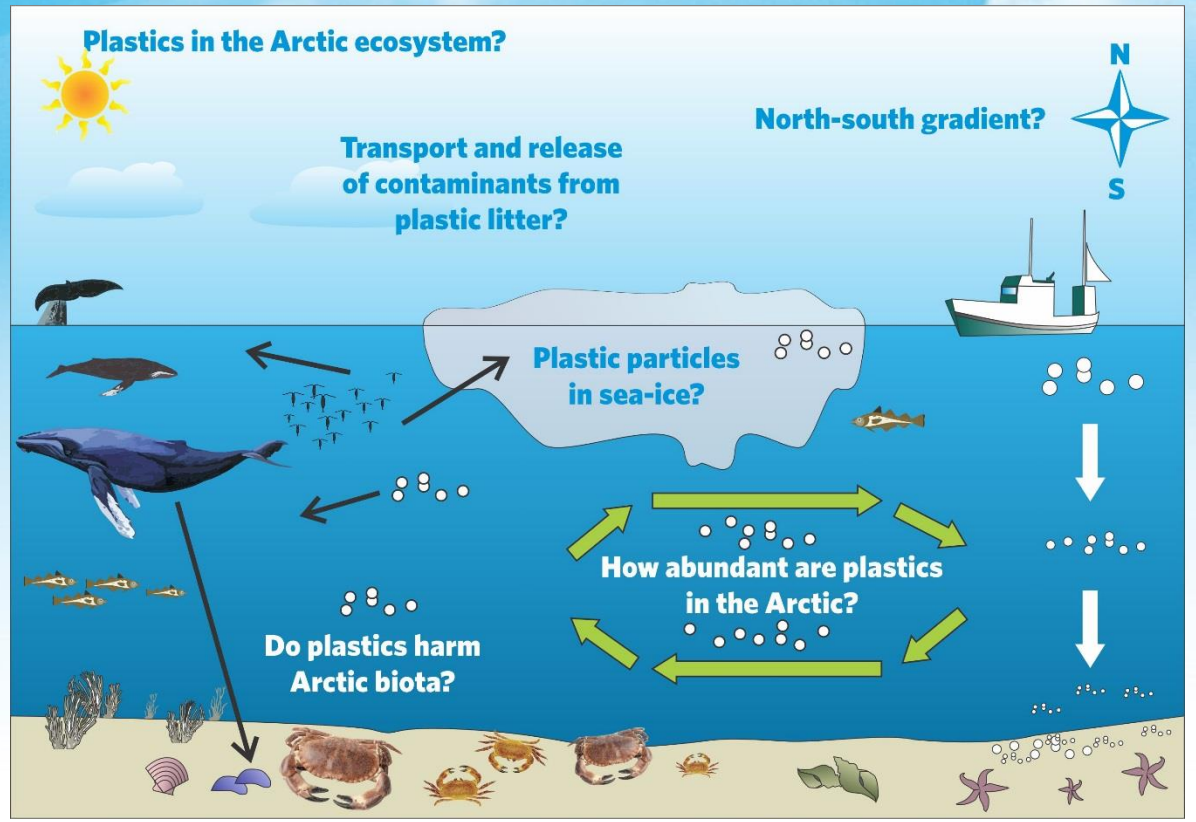
Miljøgifter forbundet med plastforurensning – hva og hvordan de kan påvirke miljøverdiene på Svalbard og i Arktis

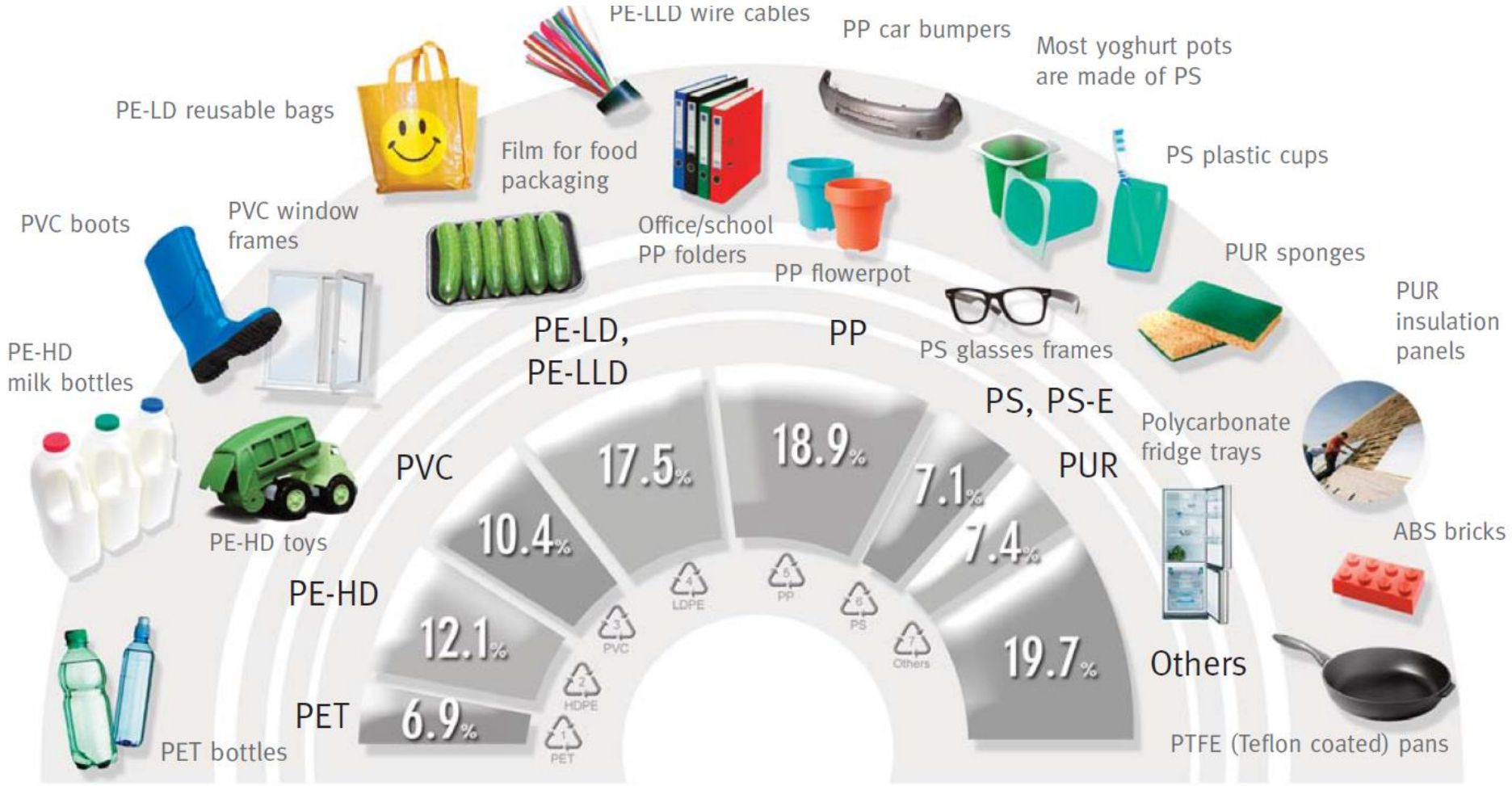
Dorte Herzke

dhe@nilu.no



NILU Norsk institutt for luftforskning

Hva er plastikk?



European plastics demand* by polymer type 2013
Source: PlasticsEurope (PEMRG) / Consultic / ECEBD
* EU-27+NO/CH

…Men ikke bare en karbon-hydrogen-kjede

Farge, stabilisatorer, mykgjører, flammehemmere, processing aids, impact modifiers

Kompleks blanding av mange kjemikalier

Additiver

Eksempel PVC:

Without **additives** PVC would not be a particularly useful substance, but its compatibility with a wide range of additives – **to soften it, colour it, make it more processable or longer lasting**, results in a broad range of potential applications from car underbody seals and flexible roof membranes to pipes and window profiles. PVC products can be **rigid or flexible, opaque or transparent, coloured and insulating or conducting**. There **is not just one PVC but a whole family of products tailor-made** to suit the needs of each application. Unlike most other thermoplastics, **the majority of PVC applications have a lifetime of between 10 and 100 years**. This requires proven durability **and stabilisers play an important part** in achieving such performance. **All polymers require stabilisers of one sort or another**; PVC is no different in this respect. (http://www.pvc.org/en/p/pvc-additives)

PVC ≠ PVC

NILU

Utvalg av additiver i PVC

POLYMET

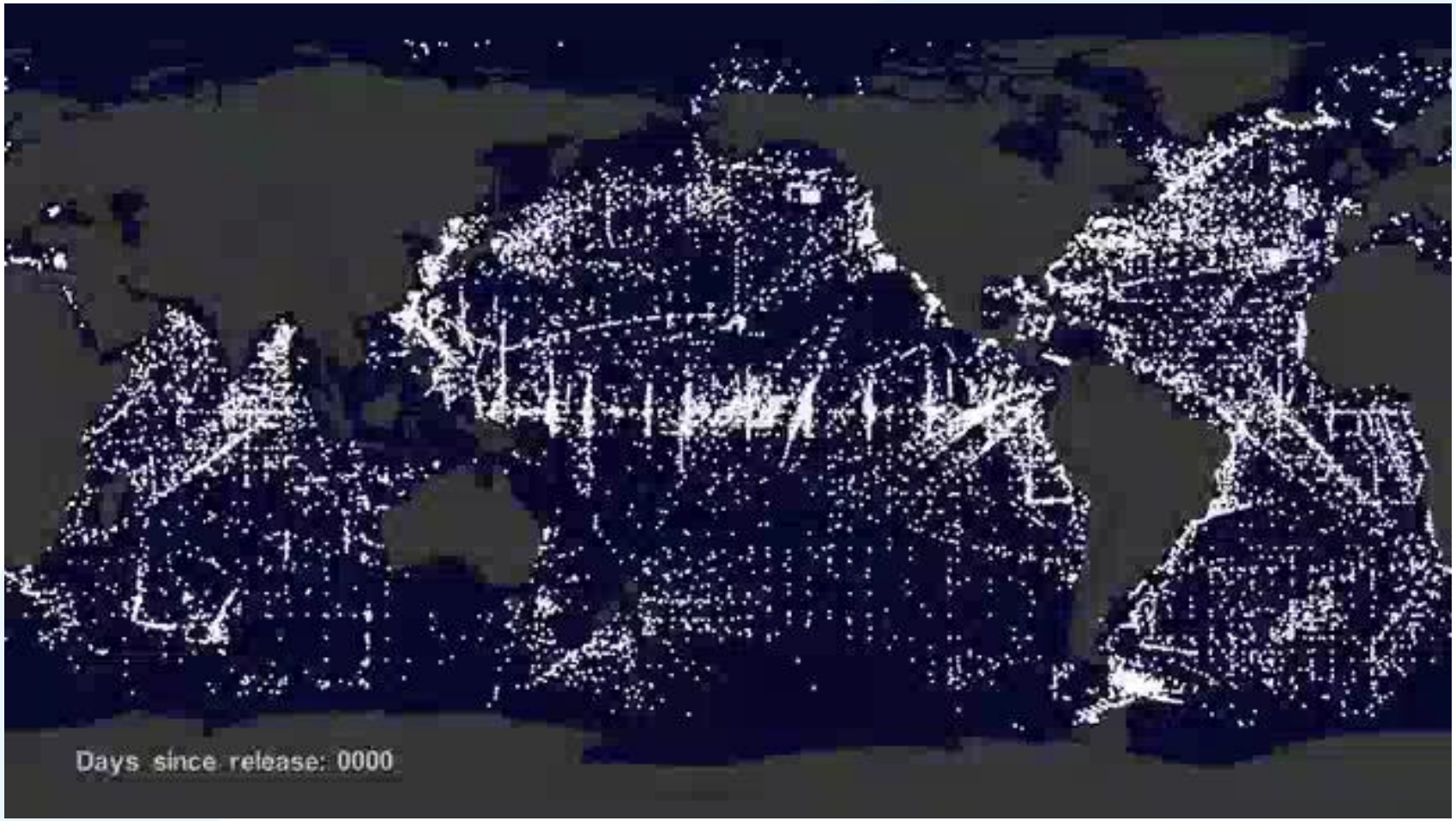
Plastic Additives Series

Classification	Additive Name	Appearance
Heat Stabilizer	Lead Sulfate Tribasic (TBLS)	Powder
	Dibasic Lead Phosphite (DBLS)	Powder
	One Pack Stabilizer	Powder
	Ca/Zn Composite Stabilizer	Powder
	Ca/Zn Composite Stabilizer	Liquid
	Ba/Cd/Zn Stabilizer	Liquid
	Ba/Zn Stabilizer	Liquid
	Methyl Tin Mercaptide (MTM)	Liquid
Plasticizer	Dioctyl phthalate (DOP)	Liquid
	Diisononyl Phthalate (DINP)	Liquid
	Dioctyl Terephthalate (DOTP)	Liquid
	Dioctyl Adipate (DOA)	Liquid
	Dioctyl Sebacate (DOS)	Liquid
	Dibutyl Phthalate (DBP)	Liquid
	Dibutyl Maleate (DBM)	Liquid
	Tri Octyl Trimellitate (TOTM)	Liquid
	Epoxidized Soybean Oil (ESBO)	Liquid
	Chlorinated Paraffin Wax (CPW)	Liquid
	Epoxy Fatty Acid Methyl Ester (EFAME)	Liquid
Lubricant	Stearic Acid	Powder
	Paraffin Wax	Powder
	Polyethylene Wax PE Wax	Powder
	Oxidic Polyethylene OPE	Powder
	Calcium Stearate	Powder
	Barium Stearate	Powder
	Lead Stearate	Powder
	Zinc Stearate	Powder
Flame Retardant	Antimony Trioxide (Sb2O3)	Powder
	Zinc Borate	Powder
	Aluminum Hydroxide	Powder
	Tricresyl Phosphate (TCP)	Liquid
	Triphenyl Phosphate (TPP)	Powder

Pigment	PVC Optical Brightener (OB-1)
	Titanium Dioxide (TiO2)
	Carbon Black
Impact Modifier	Chlorinated Polyethylene (CPE-135A)
	MBS Resin
Coupling Agent	Titanate Coupling Agent
	Aluminic Ester Coupling Agent
Processing Acids	Acrylic Processing Acids (ACR-401)
Filling Agent	Calcium Carbonate (CaCO3)
Foam Agent	Azodicarbonamide (AC Foam Agent)

http://www.alibaba.com/product-detail/PVC-Additives_60329591596.html

De fem svømmende plastikk øyer i verden



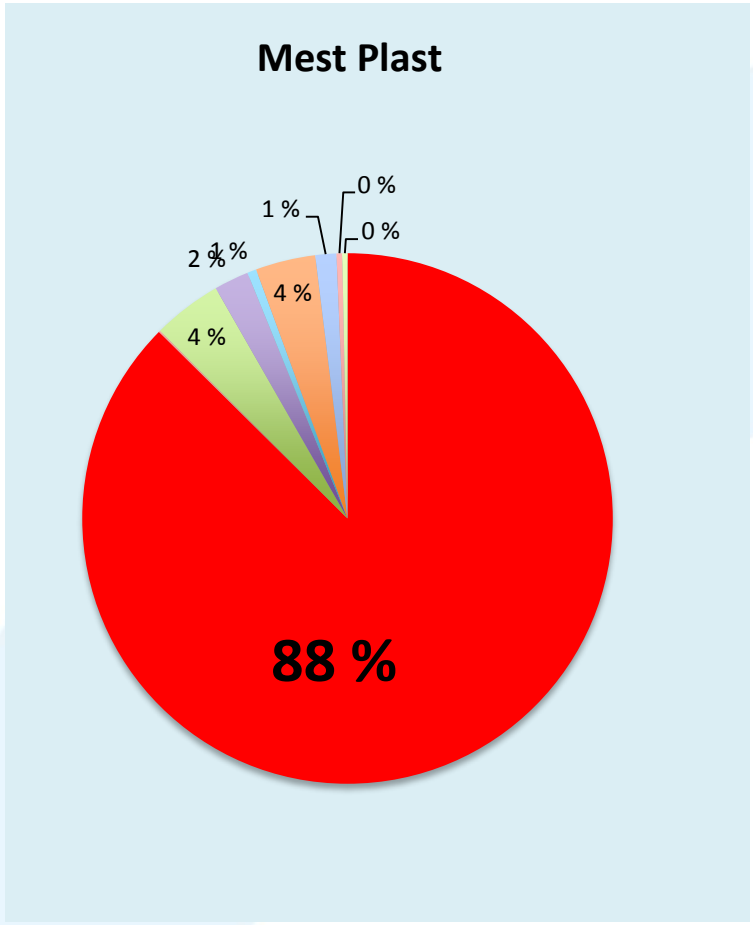
→ **Reisen til hav virvlene tar ca 6 år**

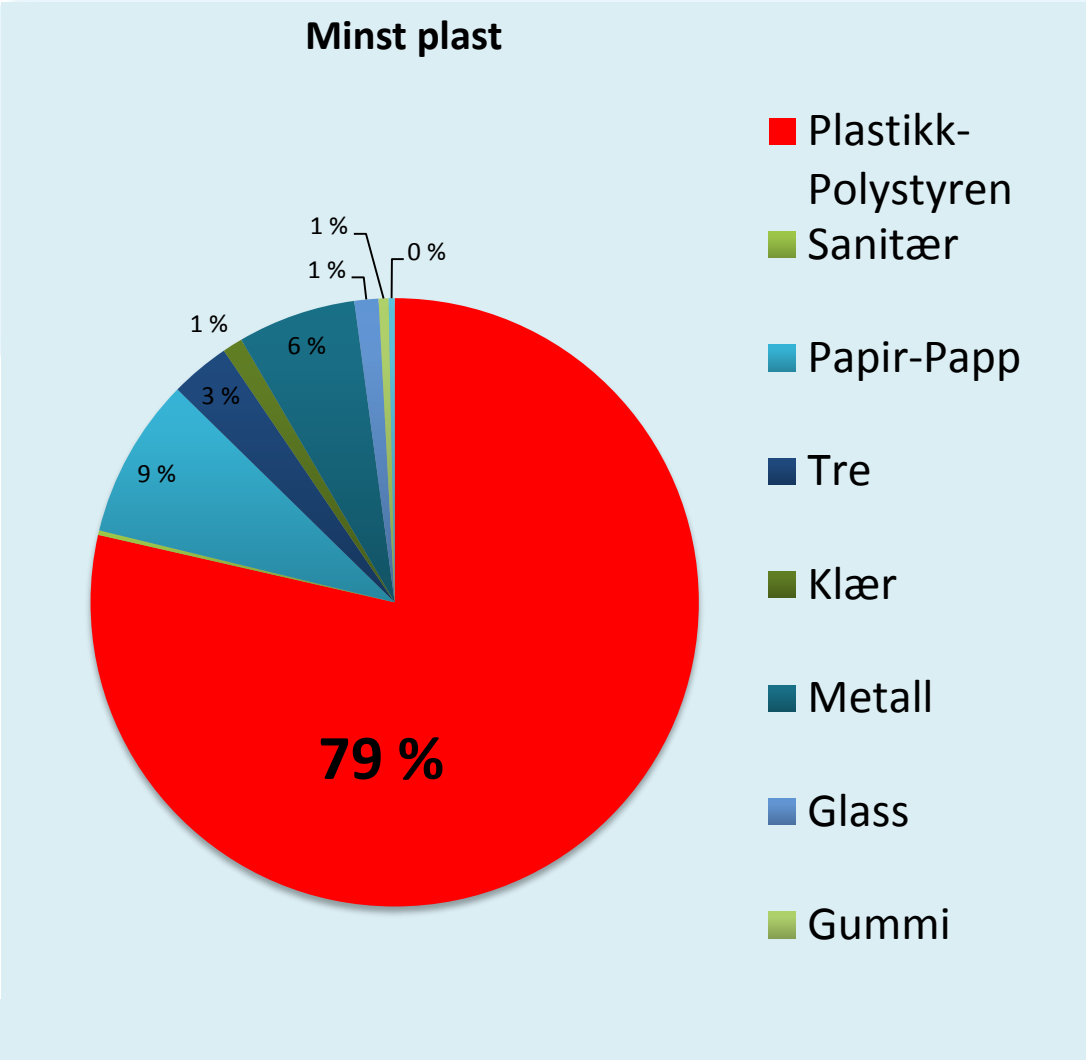
NASA, 2015

Kysten i Troms…

Bilder av Bo Eide

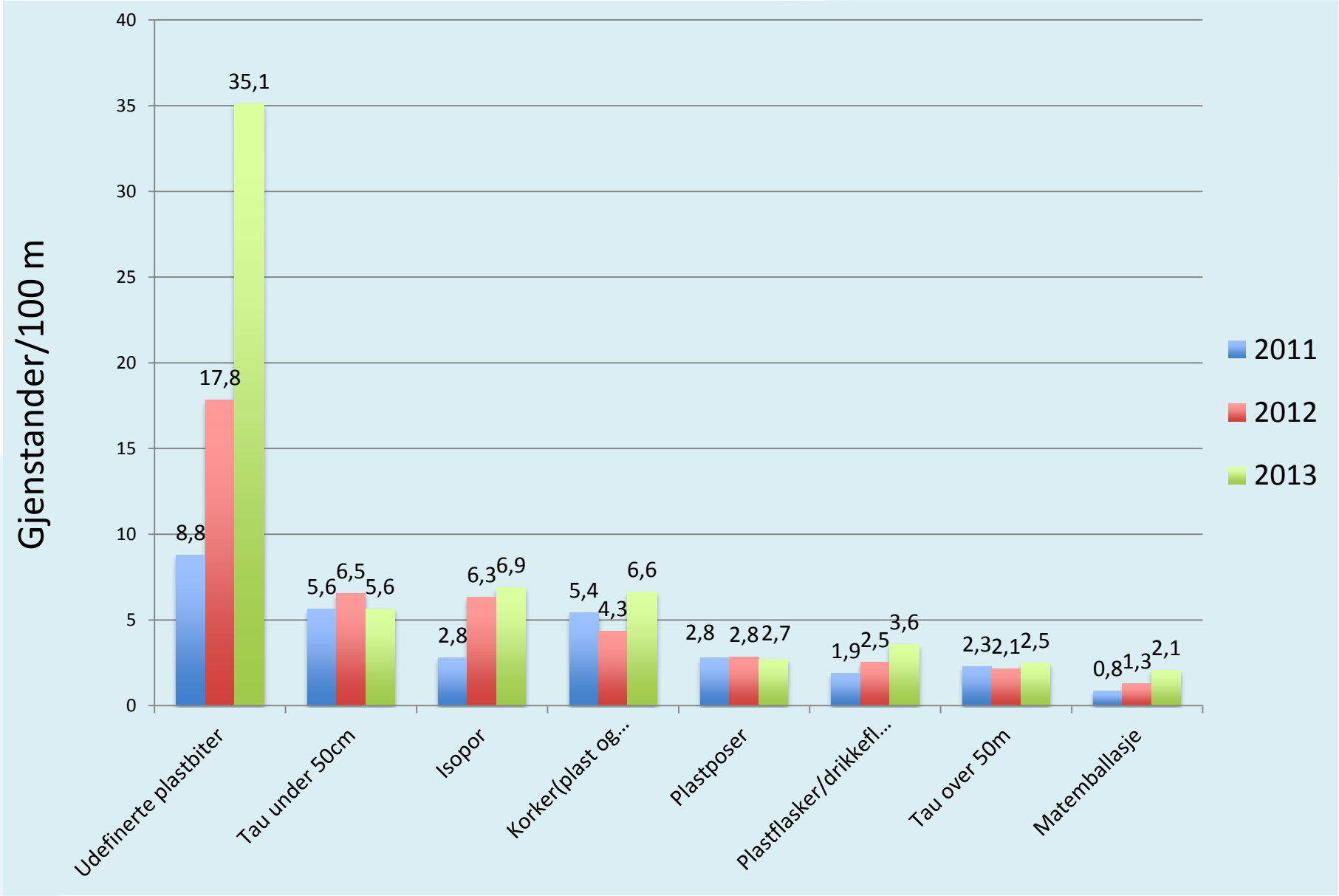
Strandryddedagen 2012; et eksempel på anvendt forskning



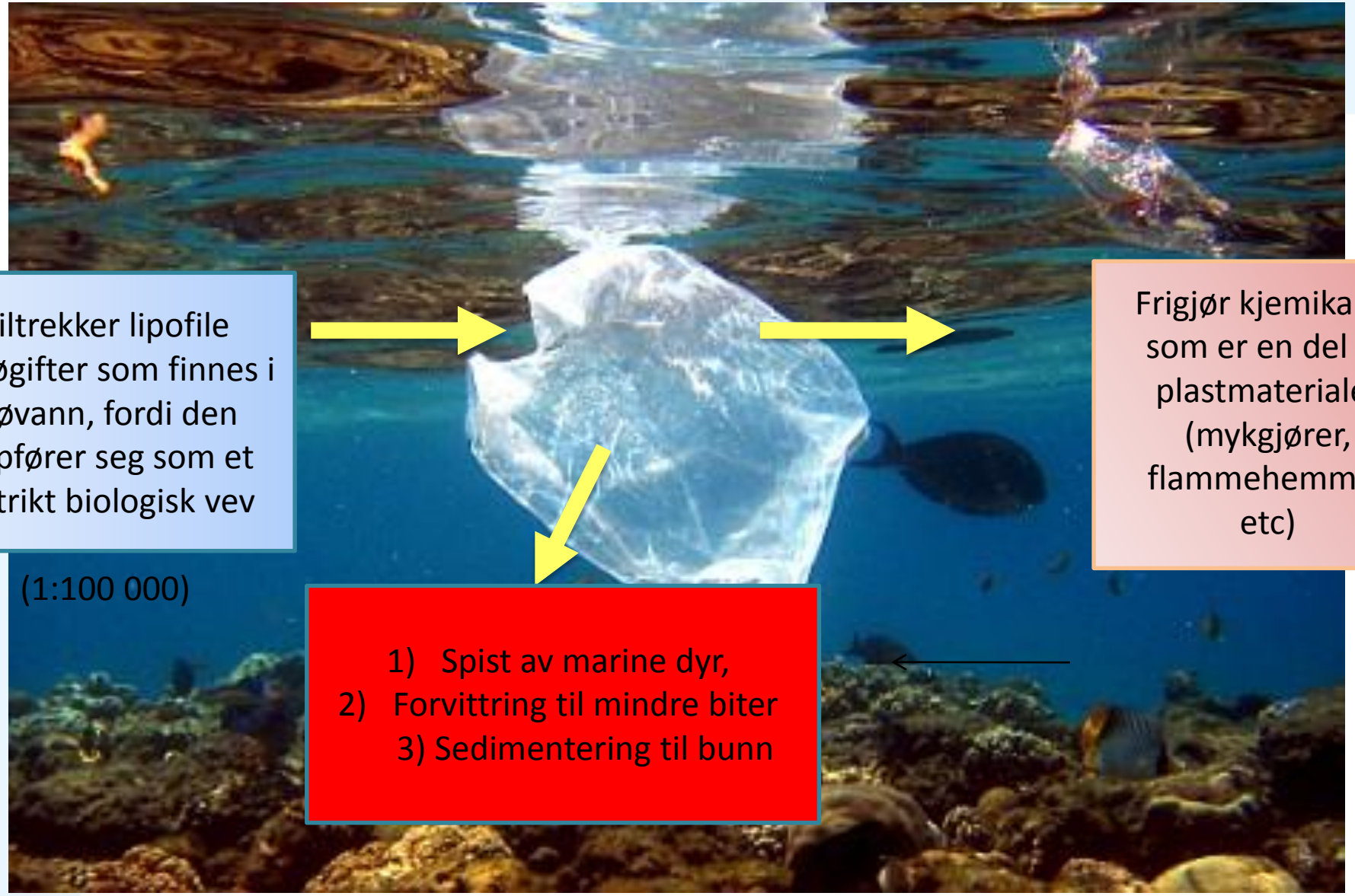


- Totalt 100.543 meter ryddet strandlinje
- Totalt 141.370 innsamlede avfallsartikler
- Tilsvarer mellom 49 og 55 plastartikler per 100 meter strandlinje

Hvilke typer plast? ; Strandryddedagen 2011-2013



Hva skjer når plastikk havner i havet?



Tiltrekker lipofile miljøgifter som finnes i sjøvann, fordi den oppfører seg som et fettrikt biologisk vev

(1:100 000)

Frigjør kjemikalier som er en del av plastmaterialet (mykgjører, flammehemmer etc)

1) Spist av marine dyr,
2) Forvittring til mindre biter
3) Sedimentering til bunn

Hva skjer når plastikk havner i havet?

Tiltrekker lipofile miljøgifter som finnes i sjøvann, fordi den oppfører seg som et fettrikt biologisk vev

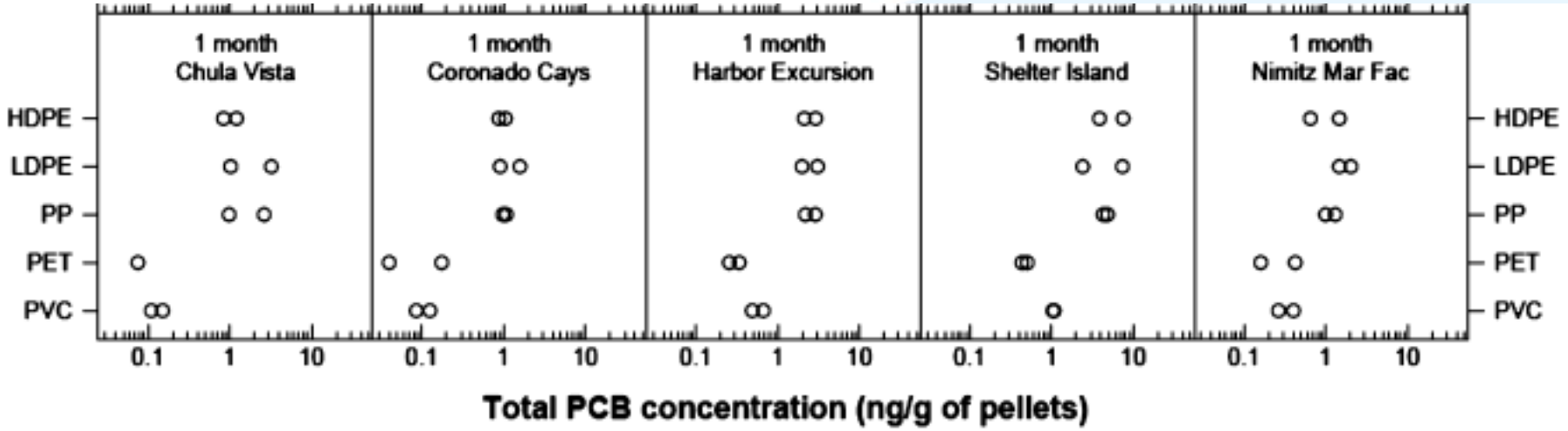
(1:100 000)

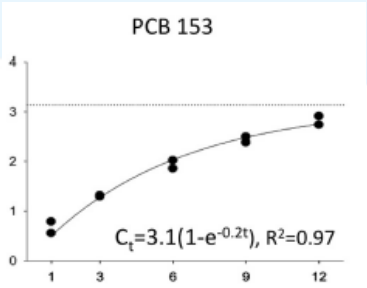
MP adsorberer POPer fra sjøvann

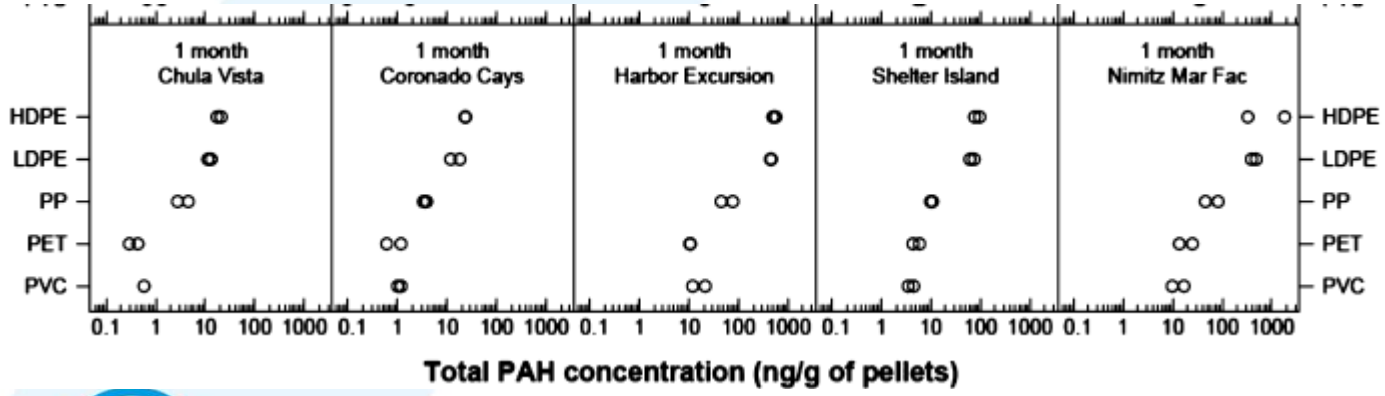
Environmental Science & Technology
Article
pubs.acs.org/est

Long-Term Field Measurement of Sorption of Organic Contaminants to Five Types of Plastic Pellets: Implications for Plastic Marine Debris

Chelsea M. Rochman,[†,*] Eunha Hoh,[‡] Brian T. Hentschel,[†] and Shawn Kaye[‡]





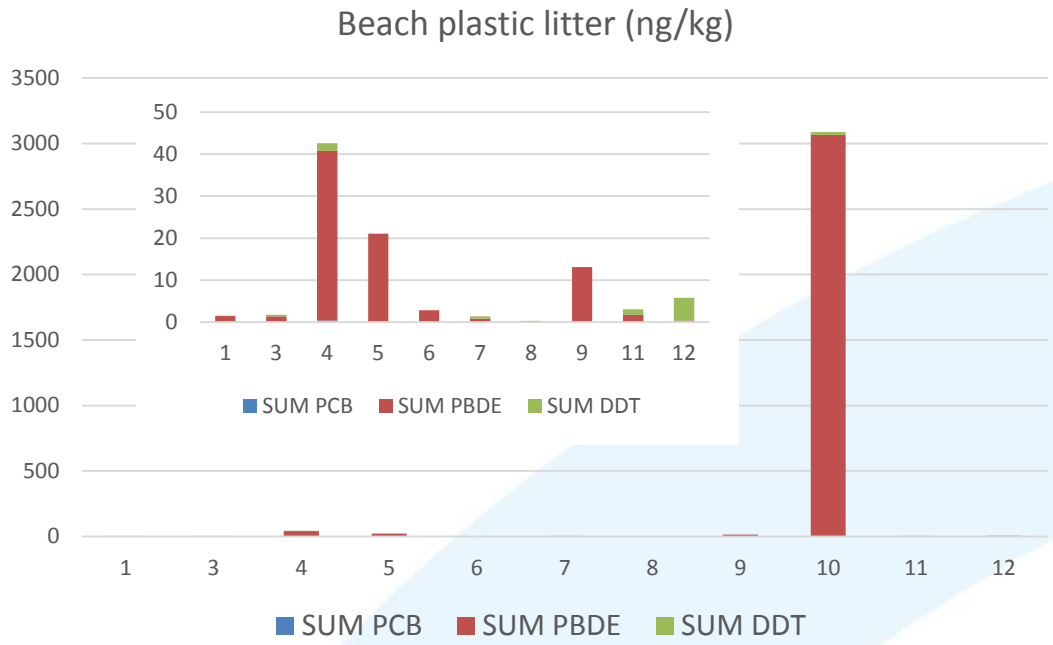


→ Plastikk tiltrekker POPer forskjellig :

- PET og PVC når likevekt fortere enn HDPE, LDPE og PP
- HDPE, LDPE og PP er mer effektive å tiltrekke PCB og PAH
- PAH blir adsorbert mer enn PCB

NILU

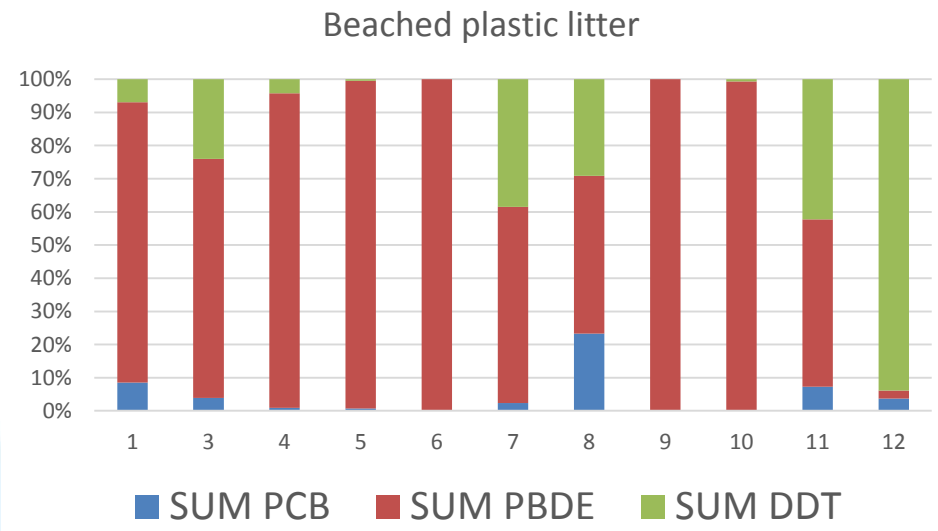
Plast søppel fra 100 m strand i Troms



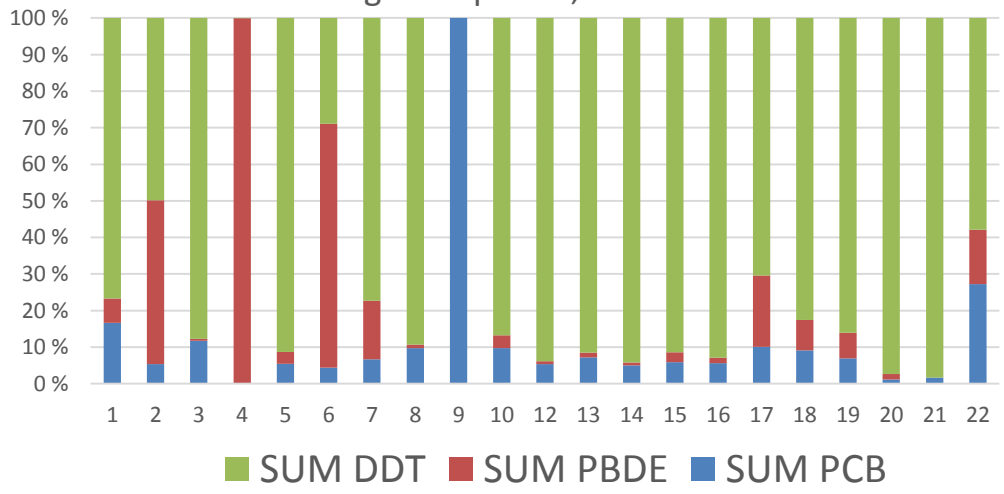
Sample # 10

Sample # 12

Sample #4



BP ≠ IP



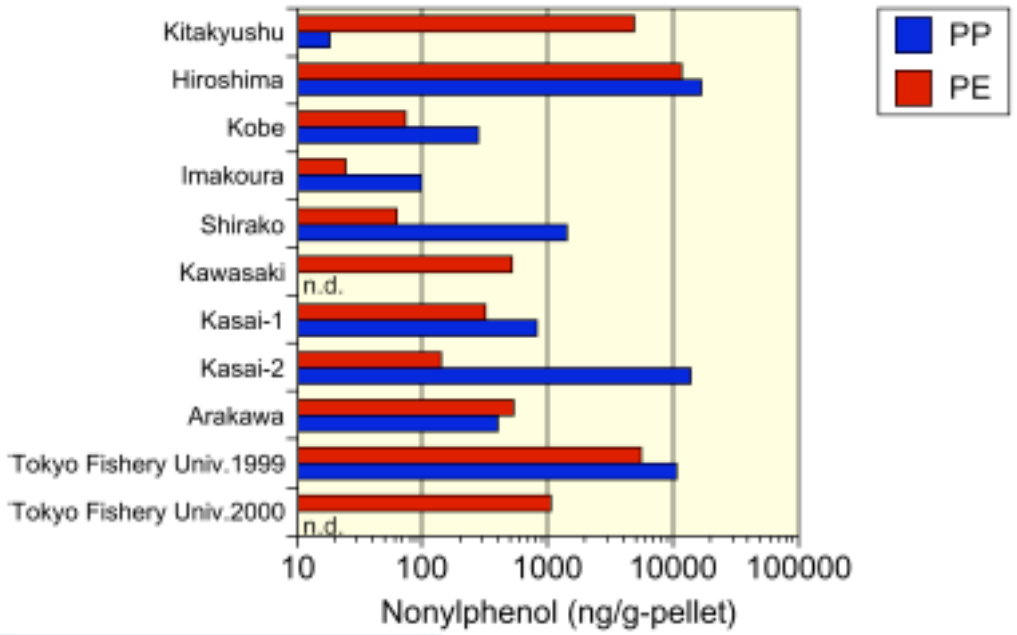
Hva skjer når plastikk havner i havet?

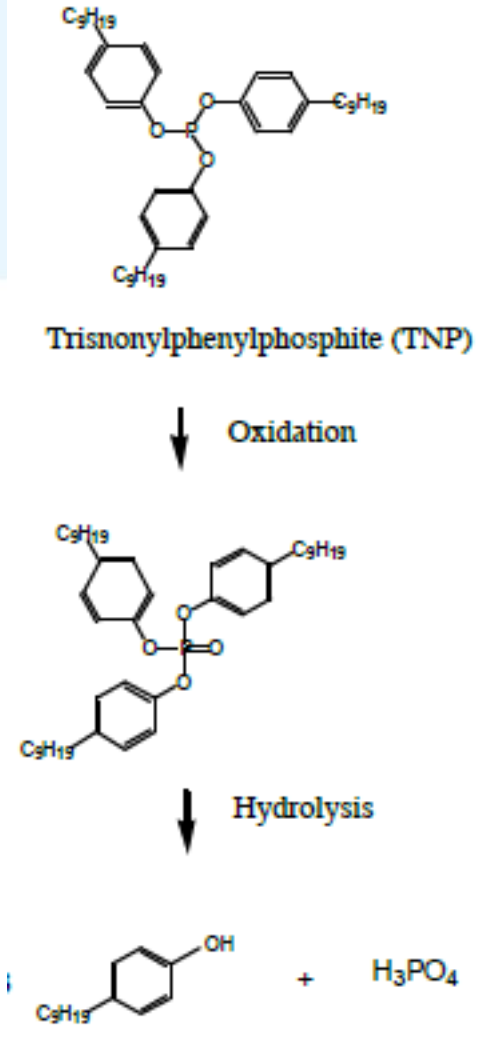
Frigjør kjemikalier som er en del av plastmaterialet (mykgjører, flammehemmer etc)

MP frigjør miljøgifter

Pellet Watch : Global Monitoring of Persistent Organic Pollutants (POPs) using Beached Plastic Resin Pellets.

Hideshige TAKADA[1], Yukie MATO[1], Satoshi ENDO[1], Rei YAMASHITA[2], Mohamad Pauzi ZAKARIA[3]

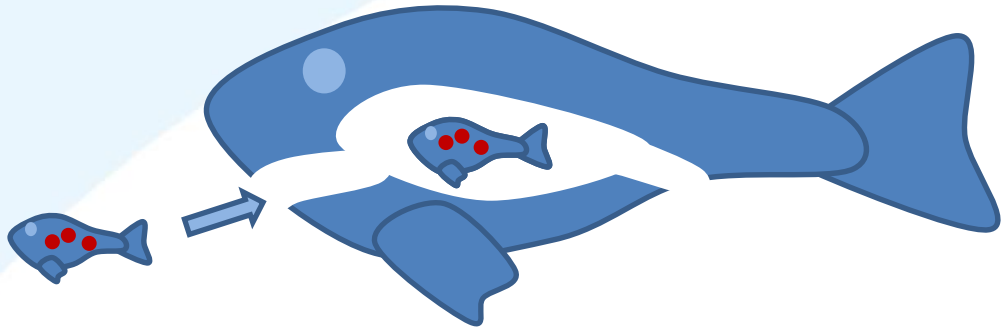




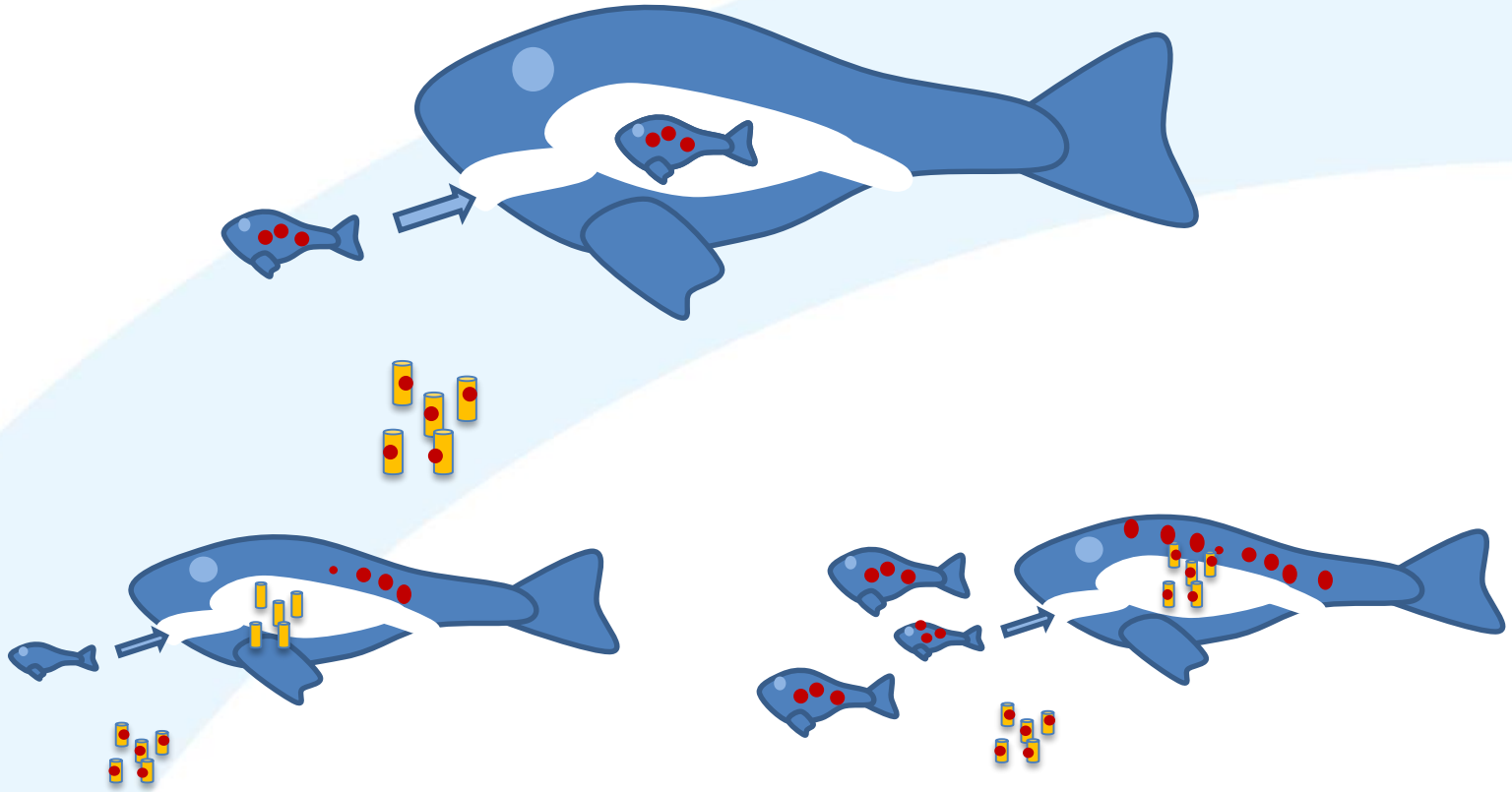
Alle additiver kan lekke ut av plastikk over tid og/ eller frigjøres gjennom kjemiske prosesser i miljøet

Hva skjer når plastikk havner i havet?

Bioakkumulasjon av lipofile miljøgifter



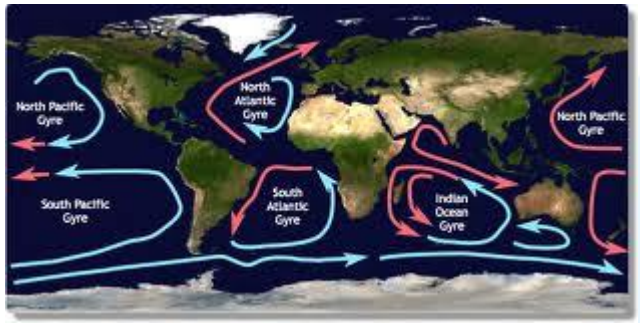
Hva skjer når plastikk er involvert??

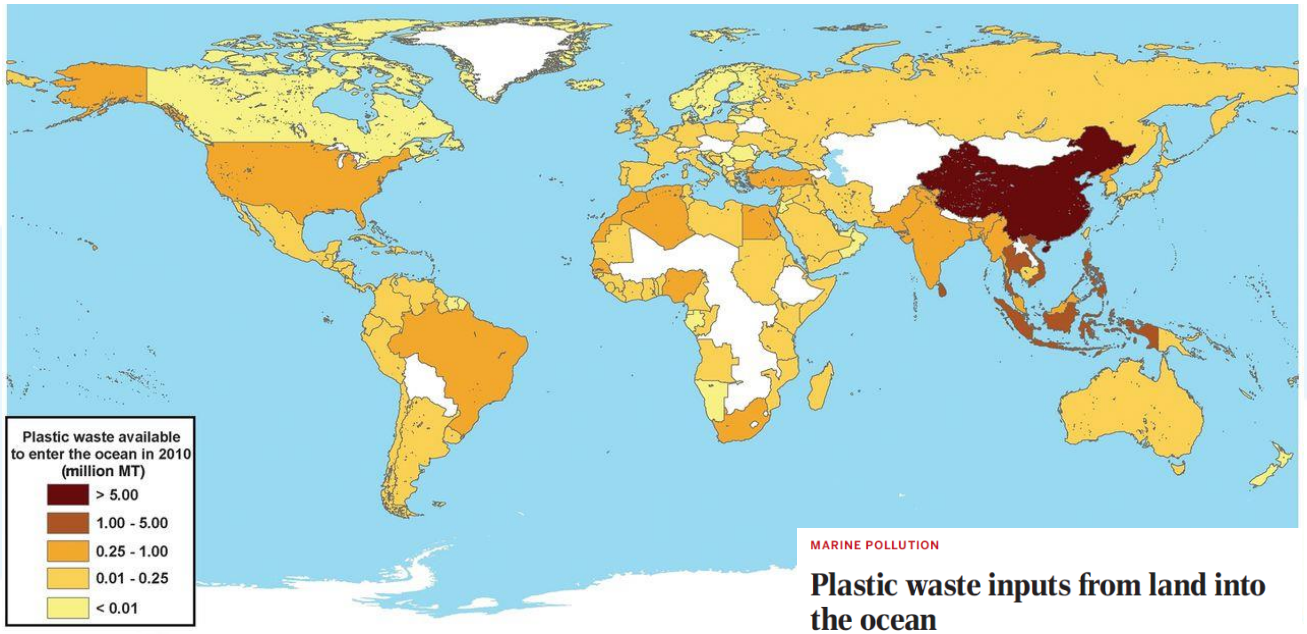


Bidrag fra mat er liten og plastikk frigjør POPer etter opptak

Bidrag fra mat er stor og plastikk tiltrekker POP fra maten i magen

Hvor kommer plasten ifra?

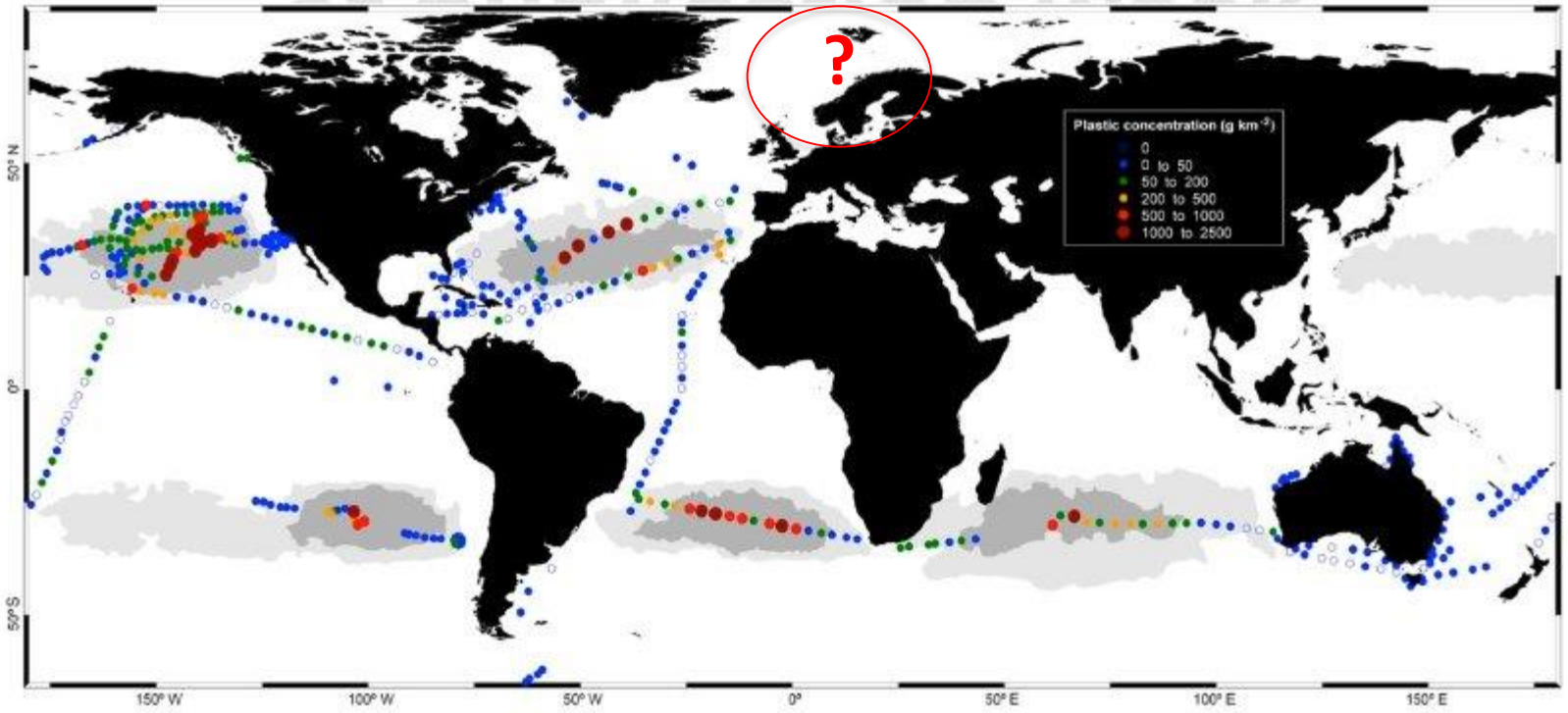




MARINE POLLUTION

Plastic waste inputs from land into the ocean

Jenna R. Jambeck,[1]* Roland Geyer,[2] Chris Wilcox,[3] Theodore R. Siegler,[4] Miriam Perryman,[1] Anthony Andrady,[5] Ramani Narayan,[6] Kara Lavender Law[7]



Store data hull for Arktiske områder både på forekomst, kilder og sammensetning av MP

Stor usikkerhet i estimatene

Hvor stor er andelen av miljøgifter transportert via plastikk til Arktis sammenlignet med andre transport veier? → Vi vet ikke!

Fysisk transport + Biomasse transport + Menneskelig aktivitet

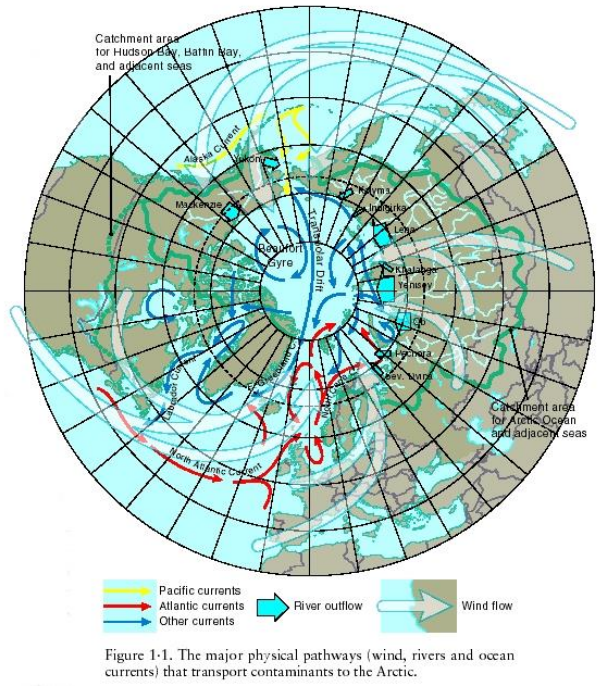
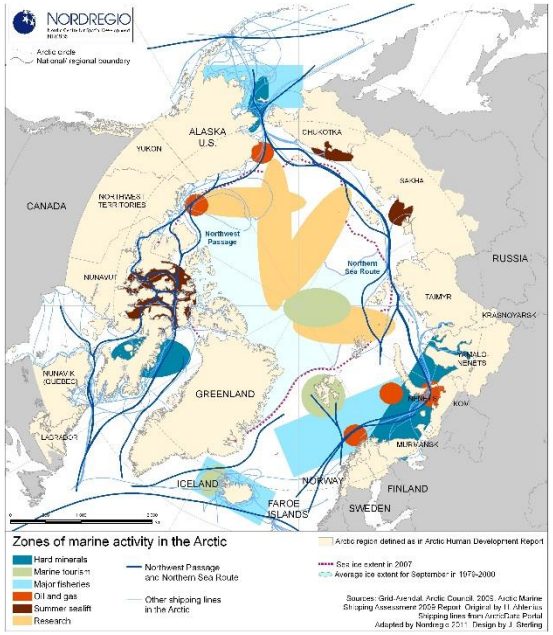


Figure 1·1. The major physical pathways (wind, rivers and ocean currents) that transport contaminants to the Arctic.

The major physical pathways (wind, rivers, ocean) to the Arctic; taken from AMAP

The major migratory routes of bird species to the Arctic in summer; taken from Figure 9.1 of (Blix, 2005).



Grid-Arendal. Arctic Council. 2009. Arctic Marine Shipping Assessment 2009 Report. Original by H. Ahlenius. Shipping lines from ArcticData Portal., 2011

Transport av POPs via plastikk til Arktis gjennom havstrømmer

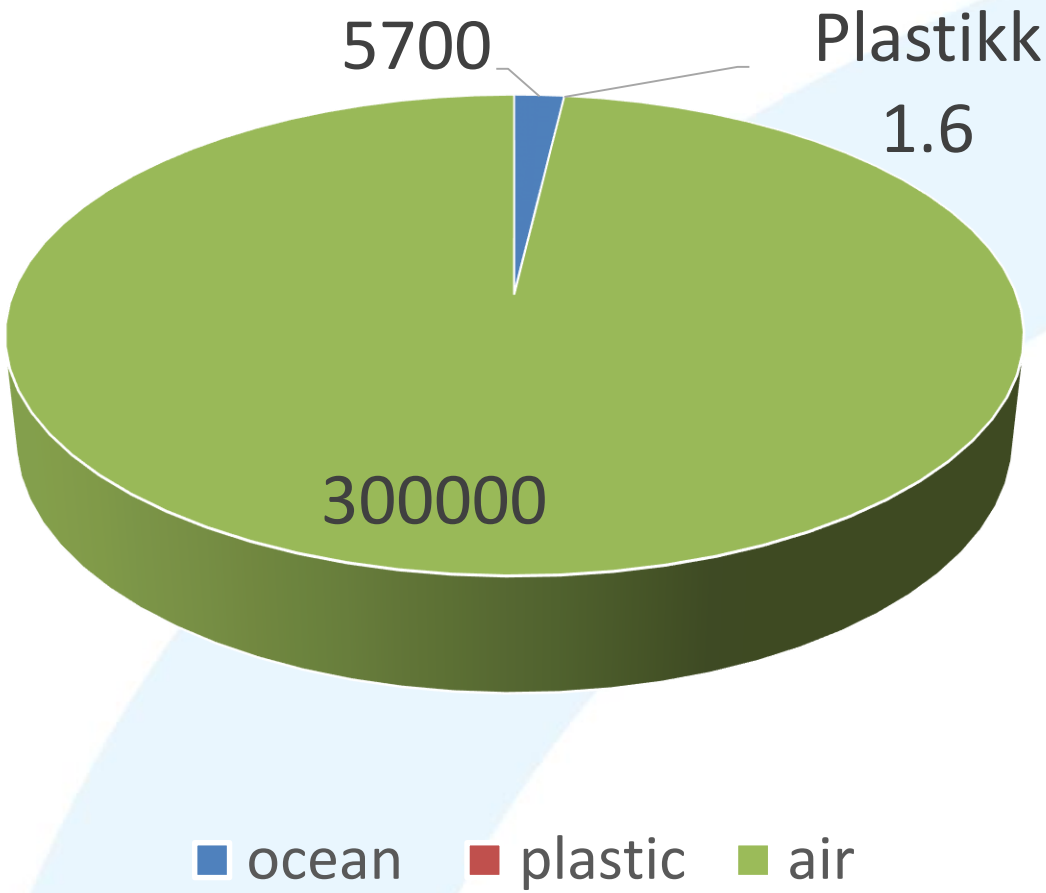
- Estimert transport av 62 000 til 105 000 tonn plast per år til polhavet (basert på average quantities of plastic floating on the world's ocean surface, reported by the United Nations Environment Program (''exceeding 13,000 pieces per km2", UNEP, 2005)
- Estimert PCB fluks av 1 g til 1.6 kg per år
- Estimert PBDE fluks av 25 g til 5.9 kg per år
- Estimert PFOA fluks av opp til 4.6 kg per år

→ Mye usikkerhet i datamaterialet pga lite felt data på både MP og POP data

→ Hva med andre miljøgifter?

NILU

Andel av PCB transport til Arktiske områder i kg/år




Marine Pollution Bulletin 60 (2010) 1810–1814

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Are marine plastic particles transport vectors for organic pollutants to the Arctic?

Christiane Zarfl, Michael Matthies*

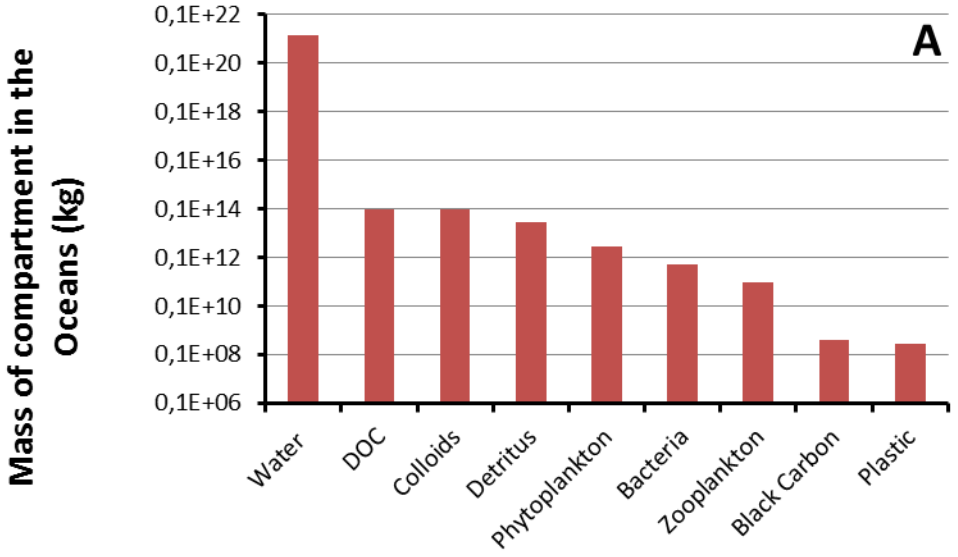
→ Ikke nok data for PBDE og PFOA

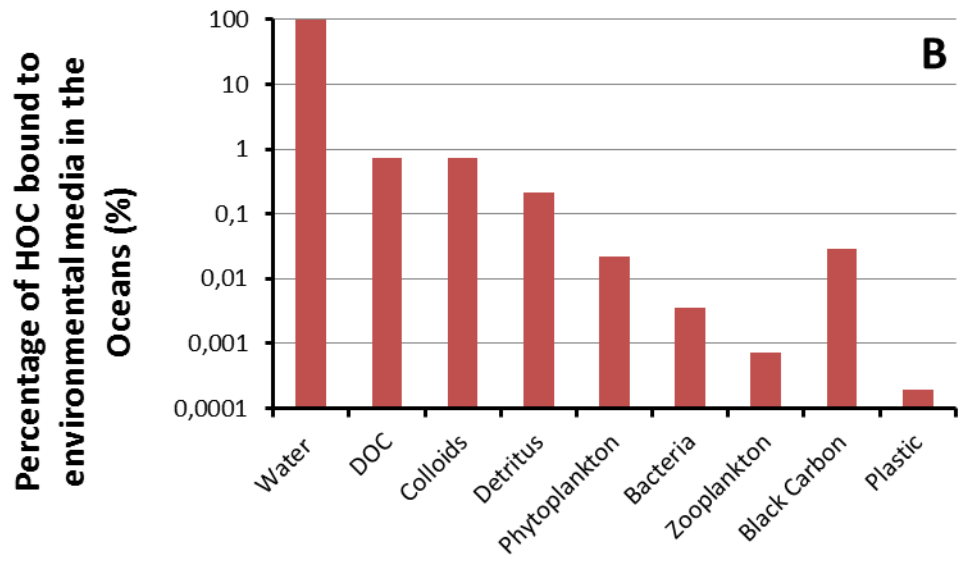
(PFOA sjøvann/ plastikk ratio er 100000 : 1)

→ Ingen data for andre miljøgifter

NILU

Hva betyr det?





→ Plastikk danner et nytt medium i havet av betydelig størrelse

→ Bidraget av marin plast til organiske miljøgift belastning til havet er relativt lite

Microplastic as a Vector for Chemicals in the Aquatic Environment: Critical Review and Model-Supported Reinterpretation of Empirical Studies

Albert A. Koelmans,*,†,‡ Adil Bakir,§ G. Allen Burton,∥ and Colin R. Janssen#

Men…

I. Plastikk kan transportere konvensjonelle miljøgifter til steder/ arter i økosystemet som har vært tidligere skjermet (bunndyr, strandsoner etc)

II. Plastikk kan transportere nye miljøgifter til Arktis som ikke følger LRT mønster (additiver, stoffer som ellers er bundet til sediment)

III. Plastikk kan gjøre et nytt sett av miljøgifter bio-tilgjengelig i Arktis

NILU

Hva er det ellers vi trenger?

- ☑ MP data fra Arktis (kilder, forekomst, sammensetning)
- ☑ Harmoniserte målemetoder for MP i vann, sediment og biota
- ☑ MP relaterte miljøgift data fra Arktis
- ☑ Hvordan påvirker arktiske forhold forvitring og frisetting/ adsorption av kjemiske stoffer
- ☑ Gode modeller for å beregne mengder MP, transport og skjebne i Arktis
- ☑ Forståelse av samfunns påvirkning og sosio-økonomiske konsekvenser
- ☑ Håndtering av MP (søppel mottak ++)

Hva skjer nå nasjonalt?

1) FRAM Senter

Flagship prosjekt 2014 – 2016

MP in the arctic marine food chains; biological uptake pathways and socio-economic consequences (NILU, APN, NIVA, NP, HI, NINA; SALT, NORUT, UNIS, Tromsø kommune)

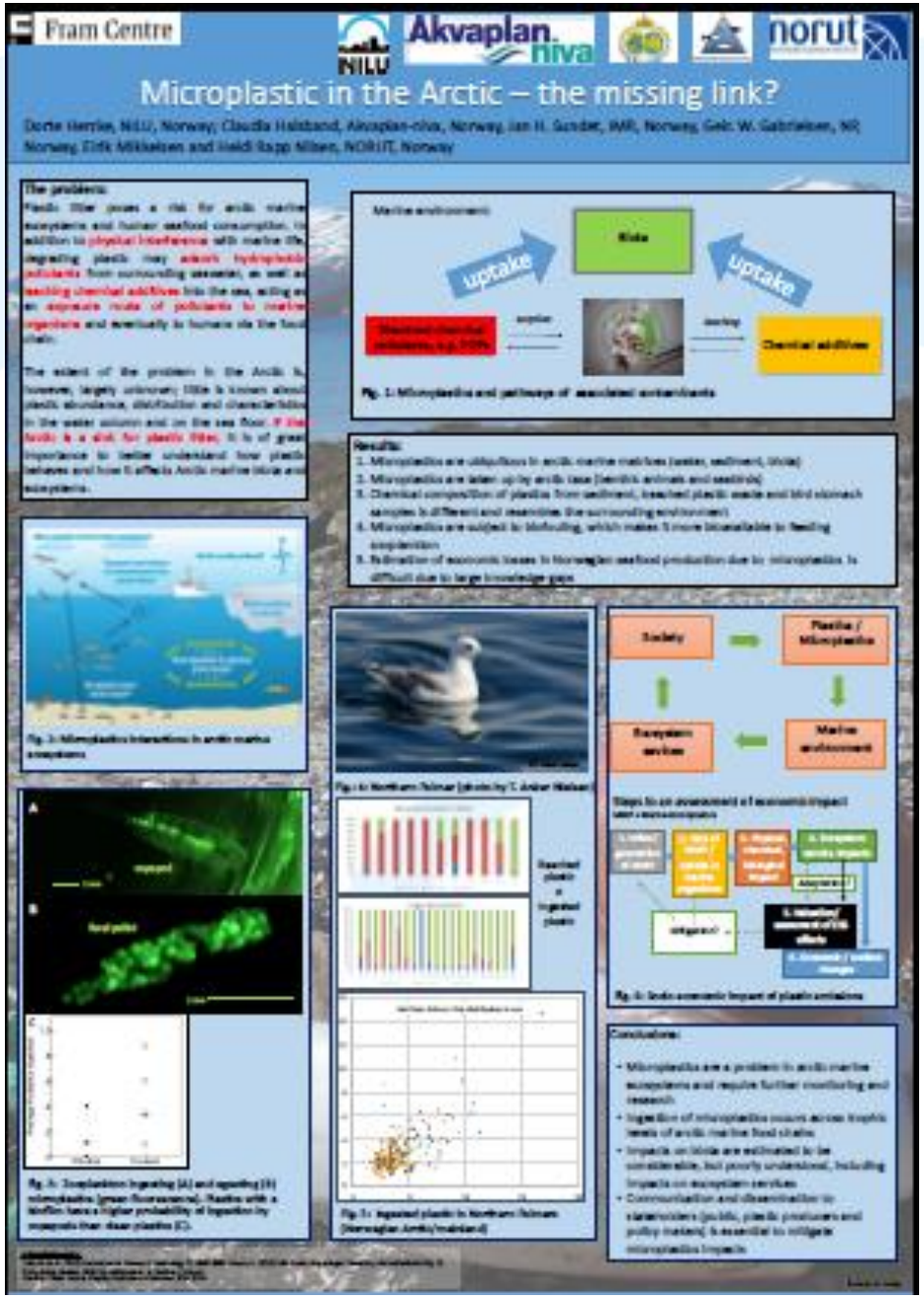
→ Kombinerer både samfunn- og naturvitenskap

2) **NFR prosjekter**

NIVA/ MIME; NIFES: MP in cod ; sosio økonomisk effekt (NORUT)

3) **Svalbard forskningsfond:**

CleanCrab (HI, NILU) MP in sediments and crabs, biological uptake and pollutants transfer



Andre nasjonale aktiviterer:

- MAREANO (HI, NGU)
- Økotokt (HI, PINRO)
- Plast i havhest (NP, NINA)
- Sysselmann Svalbard (strandrydding)
- Fiskeridirektoratet (opprydding av tapte fiskeriredskaper)
- Strandryddedagen (Hold Norge rent)
- Fishing for Litter (MILDIR og SALT)
- ++

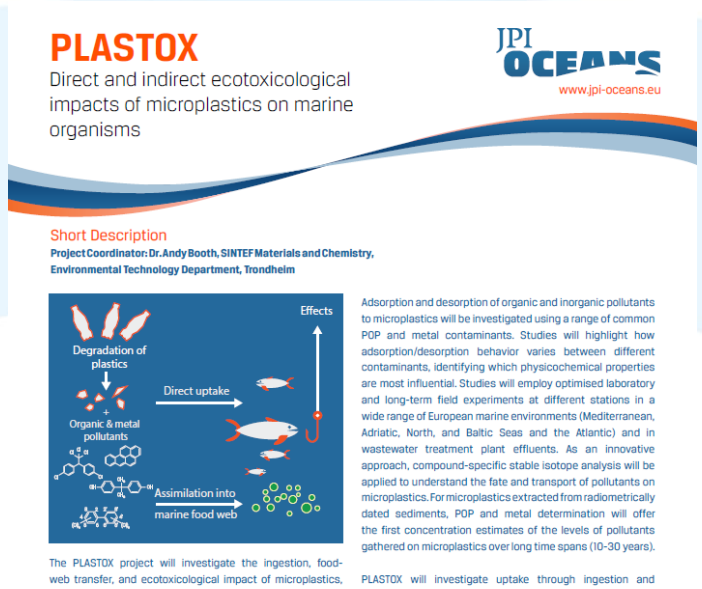
Mange formidlings aktiviteter over hele Norge

→ Fragmentert og lite utveksling av kunnskap

Hva skjer nå? Internasjonalt

JPI Ocean/ NFR støtter 4 prosjekter med fokus på MP; alle har norske partnere; oppstart 2016

- Definerer metoder
- Økotoks
- Toksikologi inkl. miljøgifter
- Forvitring



PLASTOX

Direct and indirect ecotoxicological impacts of microplastics on marine organisms

JPI OCEANS
www.jpi-oceans.eu

Short Description

Project Coordinator: Dr. Andy Booth, SINTEF Materials and Chemistry, Environmental Technology Department, Trondheim

Adsorption and desorption of organic and inorganic pollutants to microplastics will be investigated using a range of common POP and metal contaminants. Studies will highlight how adsorption/desorption behavior varies between different contaminants, identifying which physicochemical properties are most influential. Studies will employ optimised laboratory and long-term field experiments at different stations in a wide range of European marine environments (Mediterranean, Adriatic, North, and Baltic Seas and the Atlantic) and in wastewater treatment plant effluents. As an innovative approach, compound-specific stable isotope analysis will be applied to understand the fate and transport of pollutants on microplastics. For microplastics extracted from radiometrically dated sediments, POP and metal determination will offer the first concentration estimates of the levels of pollutants gathered on microplastics over long time spans (10-30 years).

The PLASTOX project will investigate the ingestion, food-web transfer, and ecotoxicological impact of microplastics,

PLASTOX will investigate uptake through ingestion and
ntrolled exposures. Microplastic
organism tissues, caused by
d cell boundaries, will be studied
ntify microplastics accumulation
ytical approaches. The acute and
effects of microplastics will be
sms from phyto- and zooplankton
, representative of the full range
marine living resources in the EU.
e generated in these studies, a
g of the potential for microplastics
vels, and the subsequent impacts
ed. Finally, PLASTOX will culminate
bringing together the knowledge
stics and POPs/metals to study
cts of these marine contaminants
knowledge generated will be
document for development of
ial efforts.

BASEMAN

Defining the baselines and standards for microplastics analyses in European waters

JPI OCEANS
www.jpi-oceans.eu

Short Description

Project Coordinator: Dr. Gunnar Gerdts, Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Germany

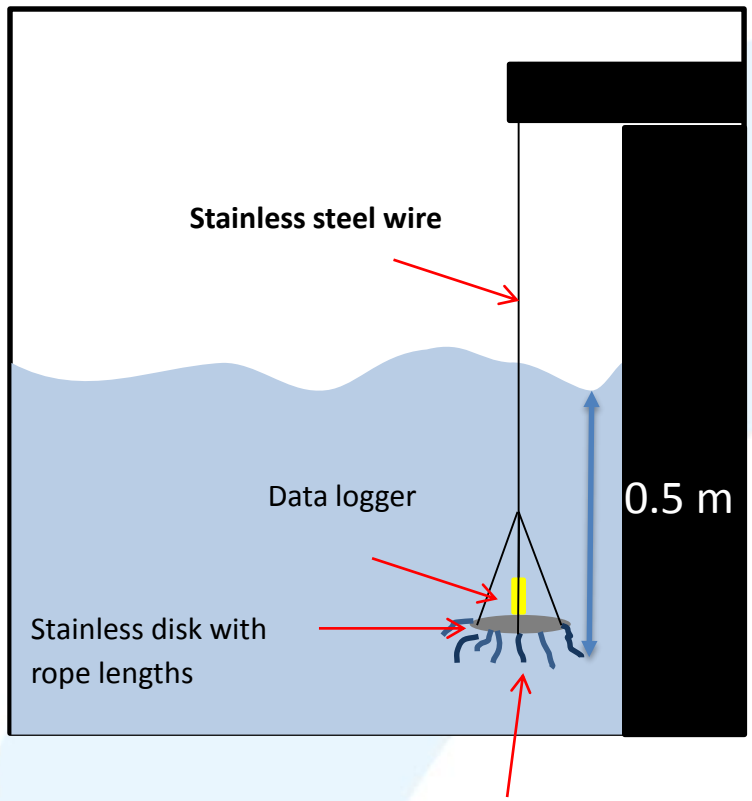
Since the middle of last century rapidly increasing global production of plastics has been accompanied by an accumulation of plastic litter in the marine environment. Dispersal by currents and winds does not diminish the persistence of plastic items which degrade and become fragmented over time. Together with micro-sized primary plastic litter from consumer products these degraded secondary micro-fragments lead to an increasing amount of small plastic particles (smaller than 5 mm), so called "microplastics". The ubiquitous presence and massive accumulation of microplastics in marine habitats and the uptake of microplastics by various marine biota is now well recognized by scientists and authorities worldwide.

Although awareness of the potential risks is emerging, the impact of plastic particles on aquatic ecosystems is far from understood. A fundamental issue precluding assessment by a huge variety of different methods, each generating data of extremely different quality and resolution. Although microplastics are recognized as an emerging contaminant in the environment, currently neither sampling, extraction, purification nor identification approaches are standardised, making the increasing numbers of microplastics studies hardly -if at all- comparable.

BASEMAN is an interdisciplinary and international collaborative research project that aims to overcome this problem. BASEMAN teams experienced scientists (from different disciplines and countries) to undertake a profound and detailed comparison and evaluation of all approaches from sampling to identification of microplastics. BASEMAN deploys cutting-edge approaches to tackle the two major themes of the call: 1) "The validation and harmonisation of analytical methods" which is indispensable for 2), the "identification

NILU

Felt eksperimenter under Arktiske forhold



- 12 måneder
- Uttak hver 4. uke
- Både pellets og micro plast
- Parallelle eksperimenter i Bay of Marseille, Ireland (Nord Atlantic og Irskesjøen), Nord sjøen, Atlanta havet, Baltiske havet, Adria

→ Analyse av metaller, PAH, PCB, DDT, PBDE, additiver o.m.

Vår rolle i NILU/ Fram Senter

Undersøke hvordan arktiske forhold påvirker:

- Transport
- Forvitring
- Utlekking av miljøgifter
- Tiltrekking av miljøgifter
- Opptak av organismer
- Effekt på økosystemet
- Er klimaforandring en viktig faktor for MP i Arktis?
- Estimere framtidig utvikling og påvirkning på samfunnet

Fram Centre

norut NORTHERN RESEARCH INSTITUTE

NILU

Akvaplan niva

NORSK-POLARINSTITUTT

HAVFORSKNINGSINSTITUTTET

….. Vi har bare så vidt begynt

Takk for oppmerksomhet