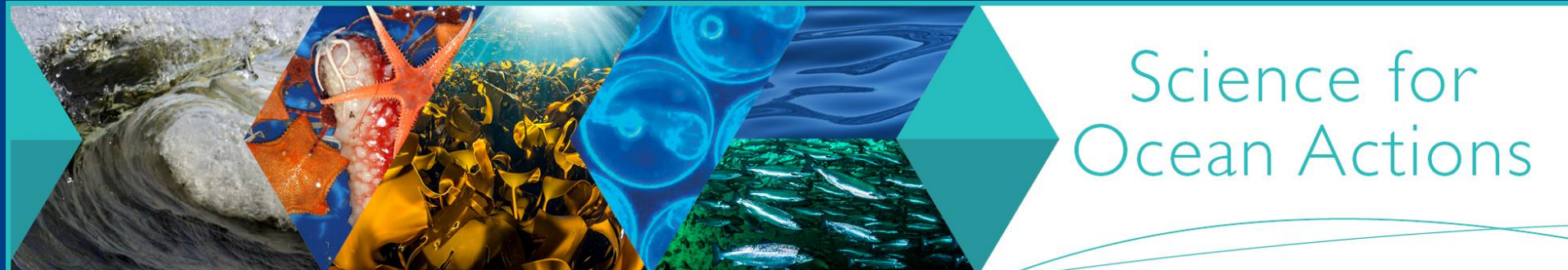


Emerging pollutants in the marine environment

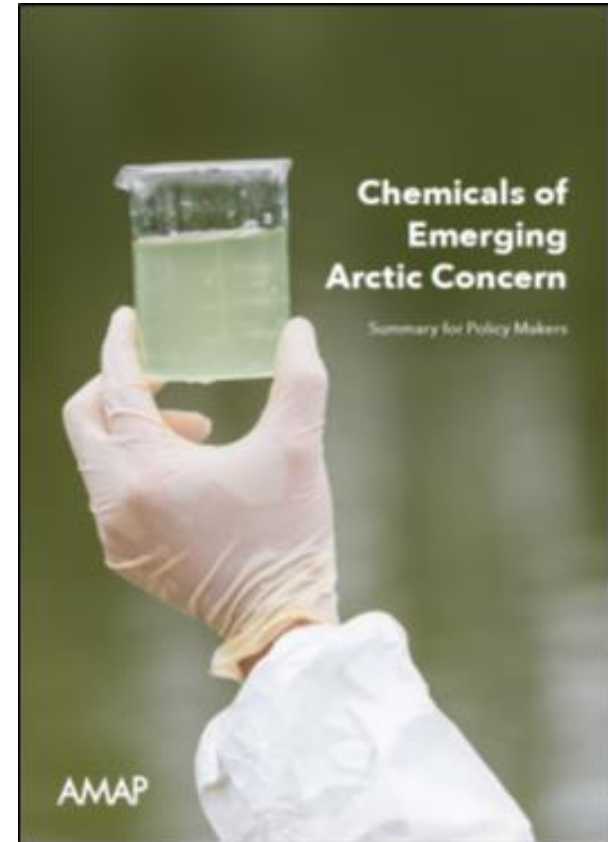
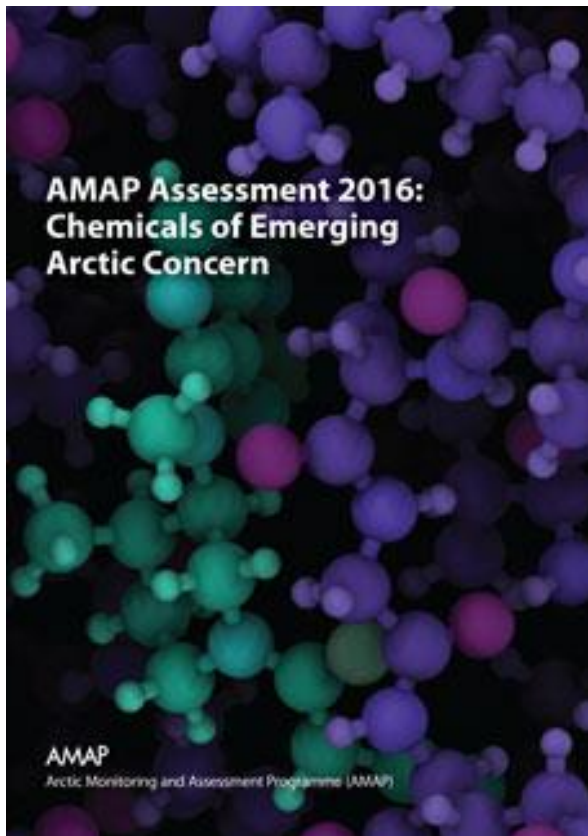
Katrin Vorkamp

Aarhus University, Department of Environmental Science, Denmark



AMAP Assessment Report on Contaminants of Emerging Arctic Concern

AMAP: One of six working groups under the Arctic Council

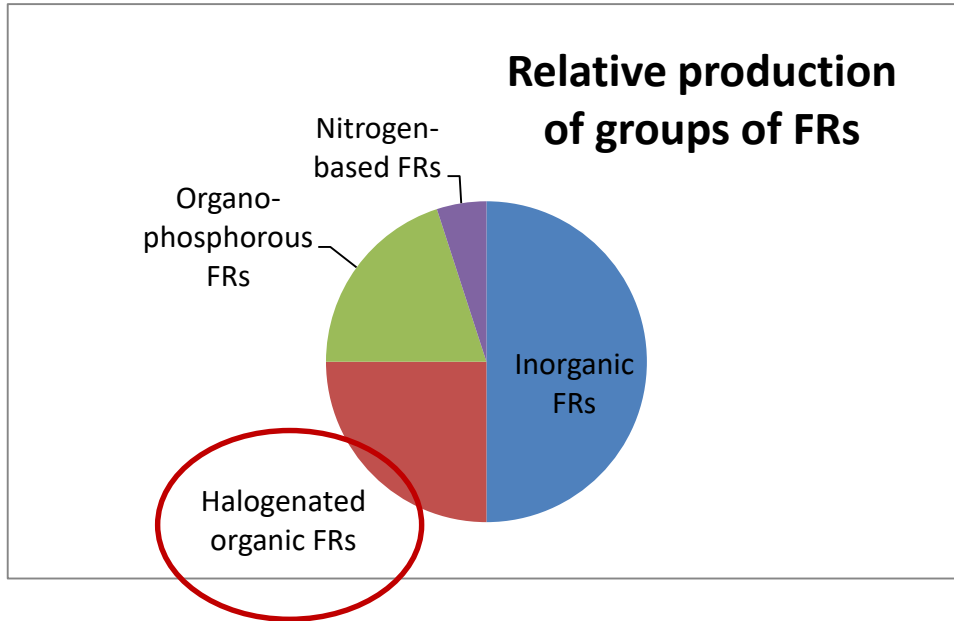


Chapter 2: List of content

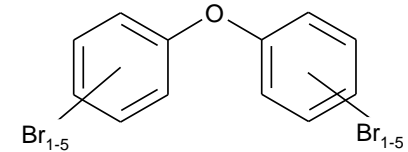
Compound group	Lead author	Compound group	Lead author
Per- and perfluoroalkylated substances	D. Muir	Hexachlorobutadiene	J. Balmer
Novel brominated flame retardants	K. Vorkamp	Current-use pesticides	J. Balmer
Chlorinated flame retardants	K. Vorkamp	Pentachlorophenol and pentachloroanisole	H. Kylin
Organophosphorous flame retardants	R. Letcher	Organotins	J. Kucklick
Phthalates	E. Bromström-Lundén	Polycyclic aromatic hydrocarbons	J. Balmer
SCCPs	J. Balmer	Byproduct PCBs	P. Bartlett
Siloxanes	N. Warner	Halogenated natural products	T. Bidleman
Pharmaceutials and personal care products	R. Kallenborn	Plastics	C. Halsband
Polychlorinated naphthalenes	K. Vorkamp		

Replacement compounds

1. Flame retardants



Katrin Vorkamp



Halogens are effective in capturing free radicals.
→ Flames do not propagate.

Alaee et al., 2003. *Environ. Int.* 29, 683;
Stockholm Convention: www.pops.int.

2004: Ban of **PentaBDE** and **OctaBDE** in the EU.

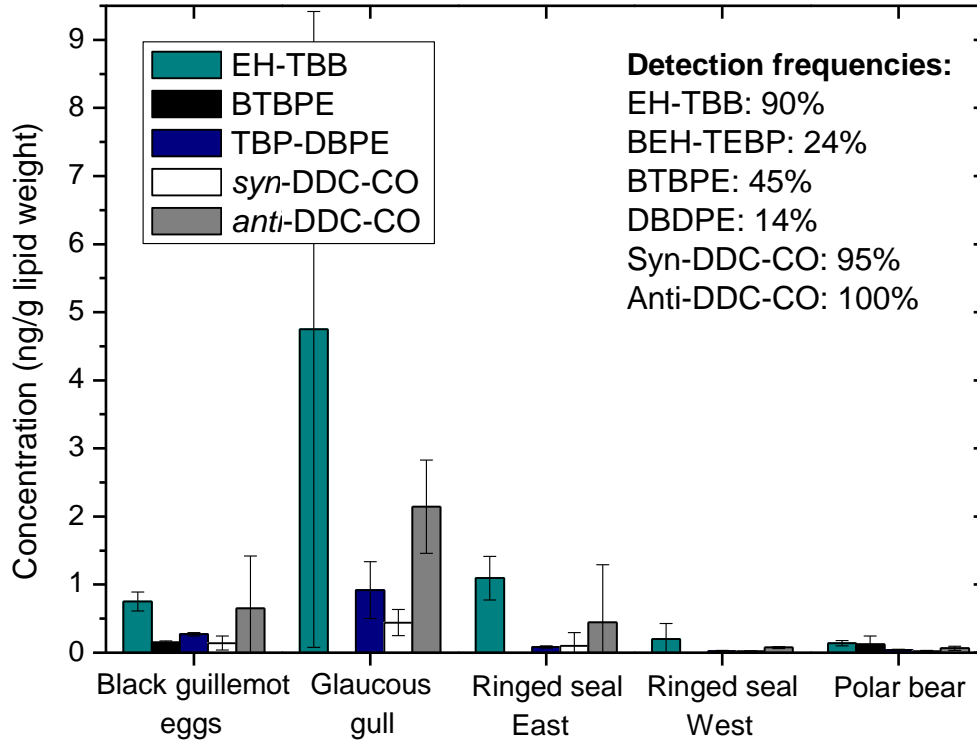
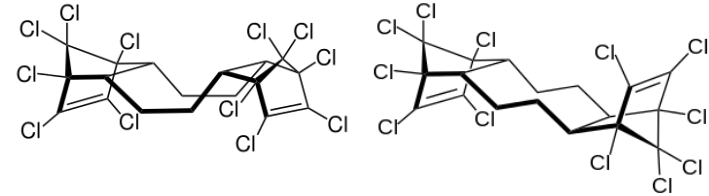
2008: Ban of **DecaBDE** in electronic equipment in the EU

2009: Global regulation of **PentaBDE** and **OctaBDE** through the Stockholm Convention on Persistent Organic Pollutants.

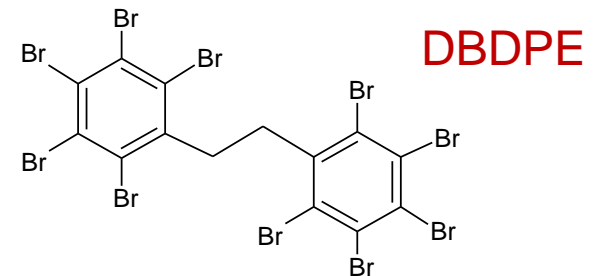
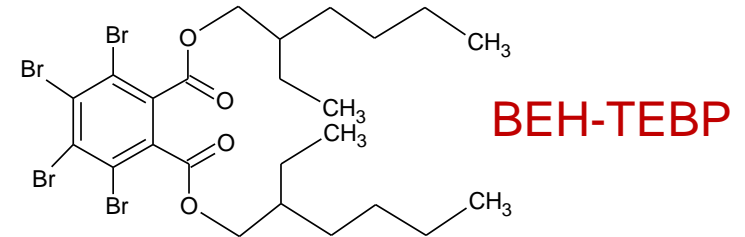
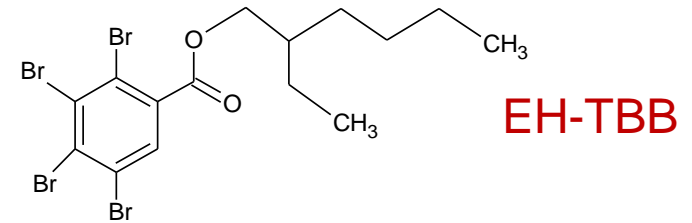
2017: Global regulation of **DecaBDE** through the Stockholm Convention.

Novel brominated and chlorinated flame retardants

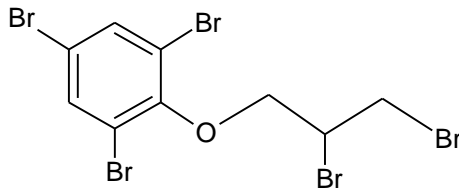
Dechlorane plus (DDC-CO)



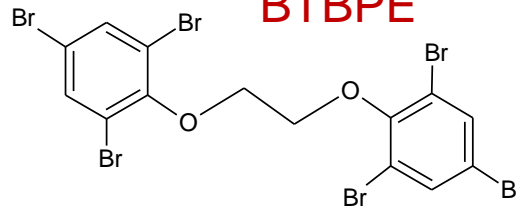
Detection frequencies:
 EH-TBB: 90%
 BEH-TEBP: 24%
 BTBPE: 45%
 DBDPE: 14%
 Syn-DDC-CO: 95%
 Anti-DDC-CO: 100%



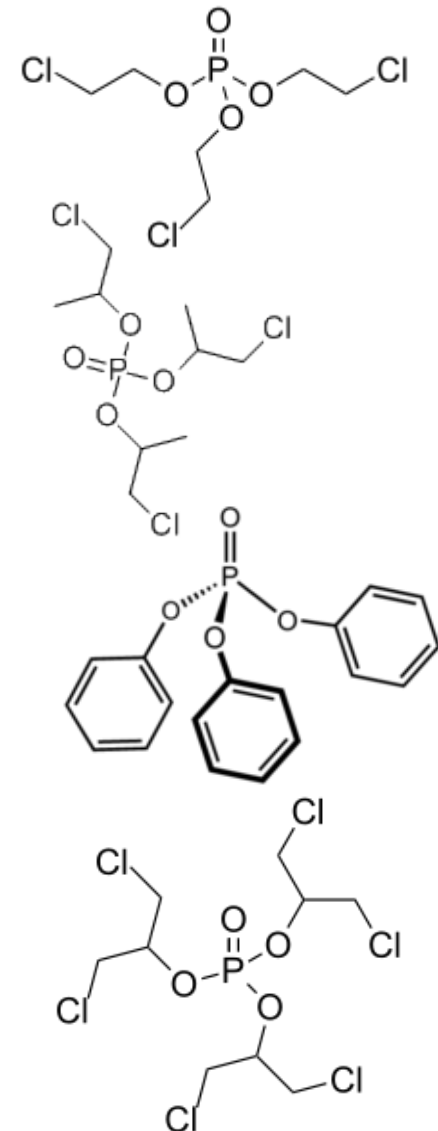
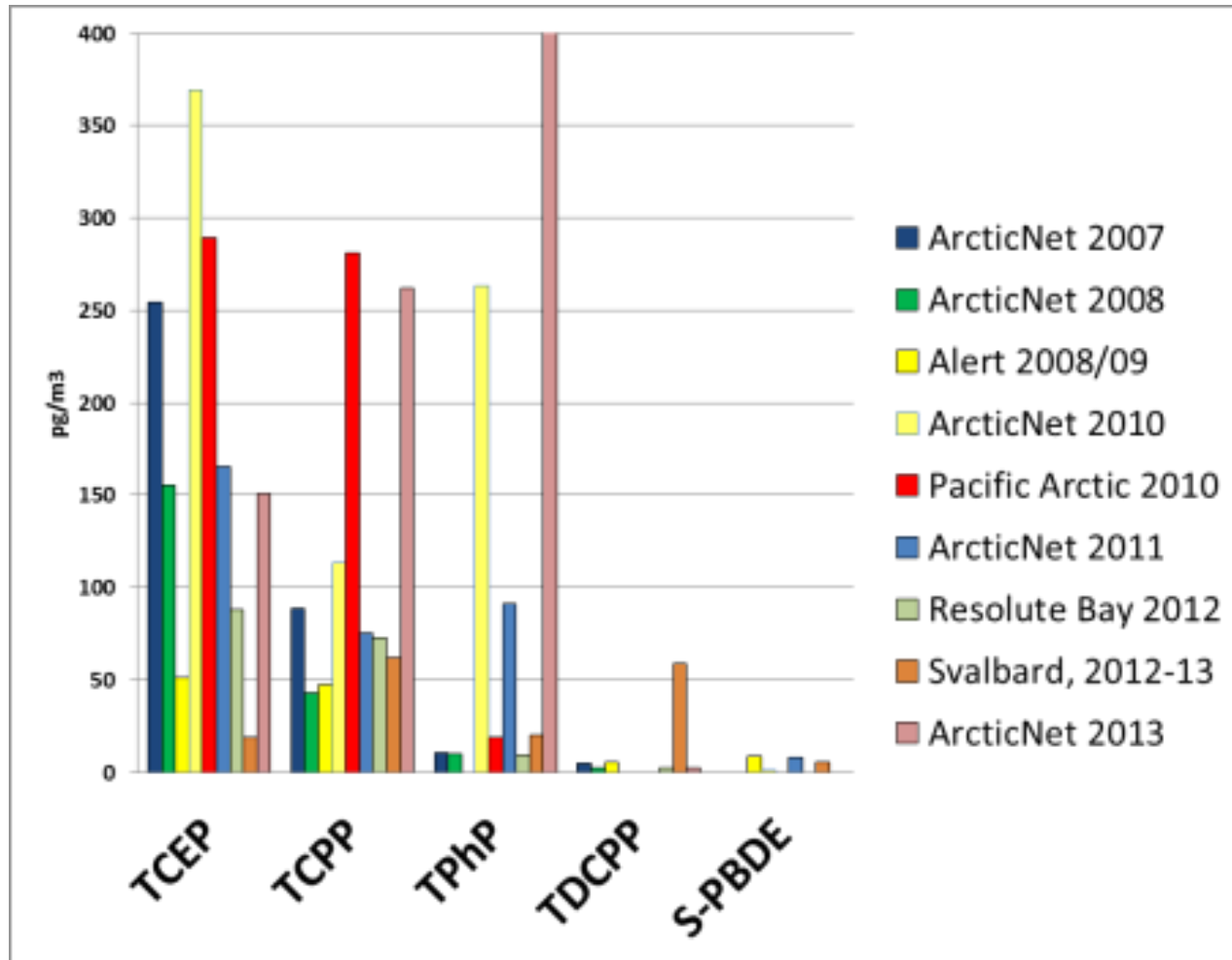
TBP-DBPE



BTBPE

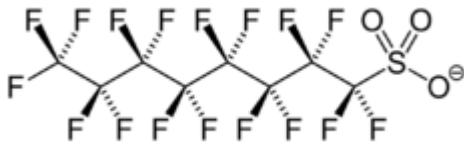


Organophosphorous flame retardants

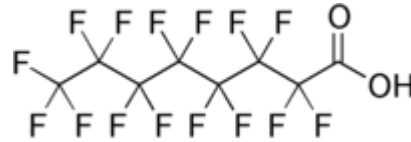


Replacement compounds

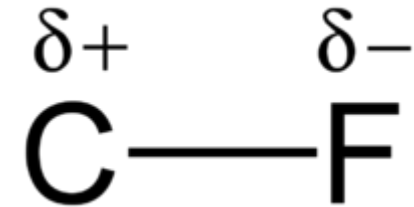
2. Perfluorinated alkylated substances



Perfluorooctane sulfonate (PFOS)



Perfluorooctanoic acid (PFOA)

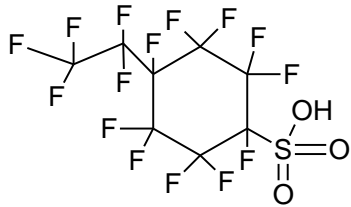


- Persistent in the environment, in animals and humans.
- Bioaccumulation (in liver, blood and kidneys).
- Toxic effects: Liver toxicity, developmental and hormonal effects, immunotoxicity etc.

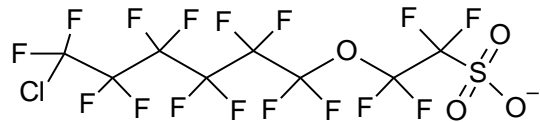
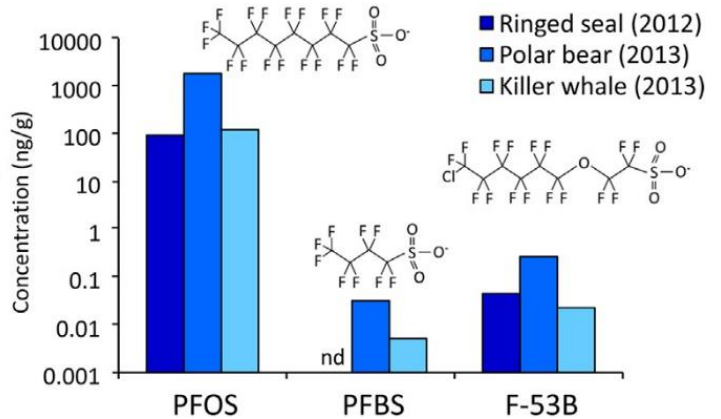
2009: PFOS was included in the Stockholm Convention.

2017: PFOA was proposed to be included.

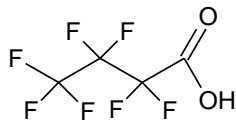
Perfluorinated alkylated substances



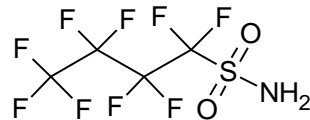
Perfluoro-4-ethylcyclohexane (PFECHS)



6:2-Chloro-polyfluorinated ether sulfonic acid (F-53B)



Perfluorobutanoic acid (PFBA)



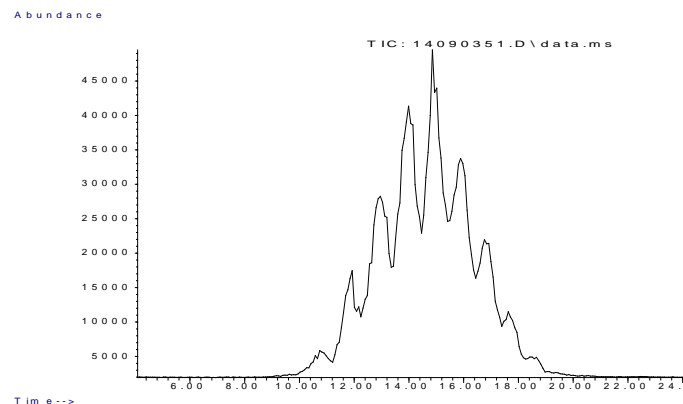
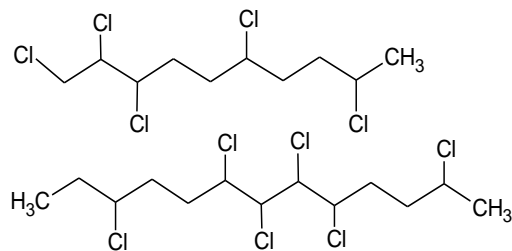
Perfluorobutane sulfonamide (FBSA)



Replacement compounds

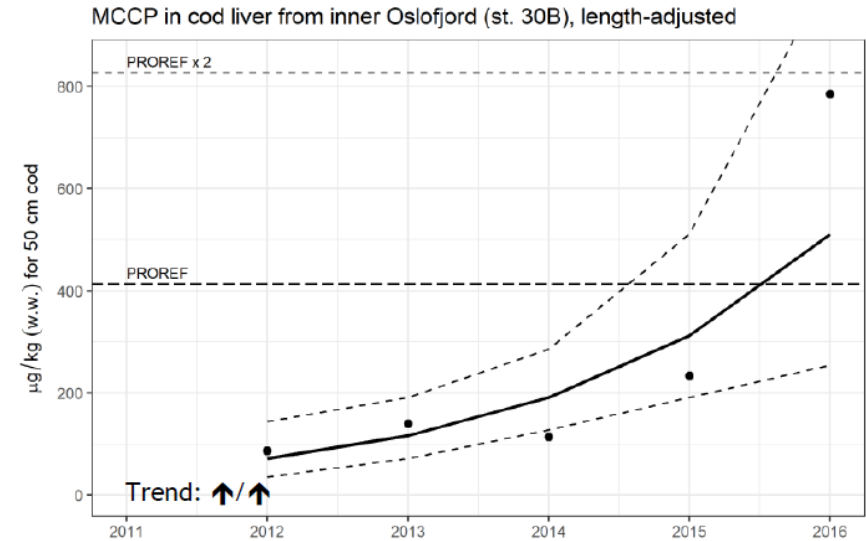
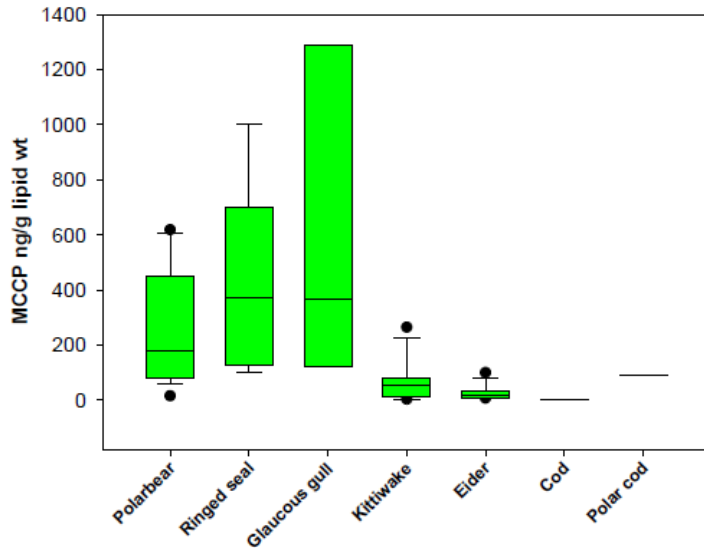
3. Chlorinated paraffins

High volume production chemicals (> 1 million tons/year)
Used in metal working fluids, as flame retardants etc.



- › SCCPs proposed to Stockholm Convention in 2006
- › Presentation of AU's and other Arctic results at the meeting of the POP Review Committee in 2015.
- › SCCPs included in Stockholm Convention in 2017 (However, MCCPs and LCCPs are not)

Medium-chain chlorinated paraffins



Norwegian program for environmental quality

Perfluorinated alkylated substances, brominated flame retardants and chlorinated paraffins in the Norwegian Environment - Screening 2013



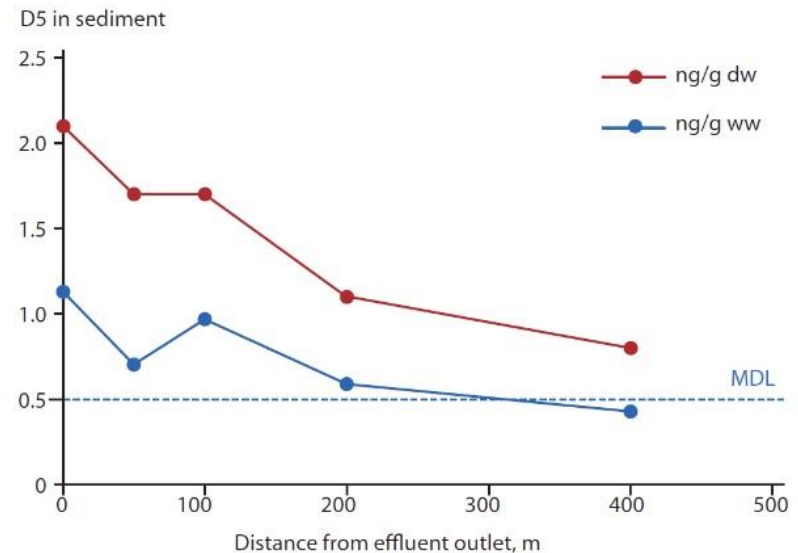
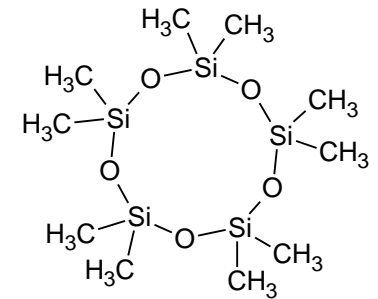
Contaminants in coastal waters of Norway 2016
Miljøgifter i norske kystområder 2016



Pathways into the marine environment

Wastewater treatment plants as local sources?

- › Pharmaceuticals and personal care products, siloxanes, phthalates, flame retardants etc.
- › "Pseudo-persistent" compounds
- › Environmental stability might be enhanced by low temperatures and absence of light in the winter
- › Calls for management and technological solutions



Emerging issues from closed cases

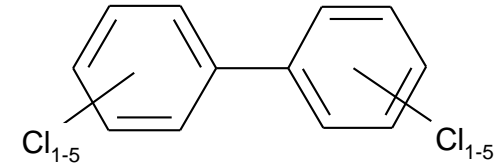
1. Unintentionally produced PCB congeners

Total production of PCBs: 1.3 million tons

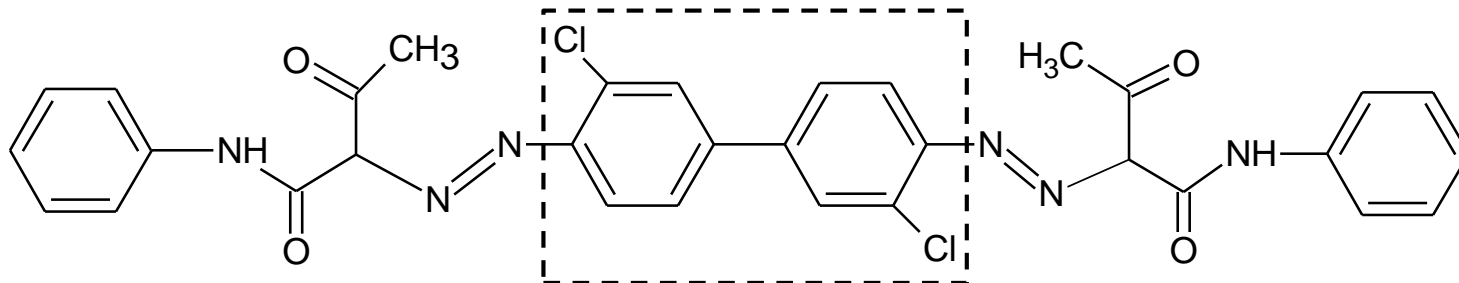
Main use in 1950-80, in transformers and capacitors, as additives to sealants and paints

Phased out in most industrial countries in the 1970s/1980s

2004: Stockholm Convention on POPs.

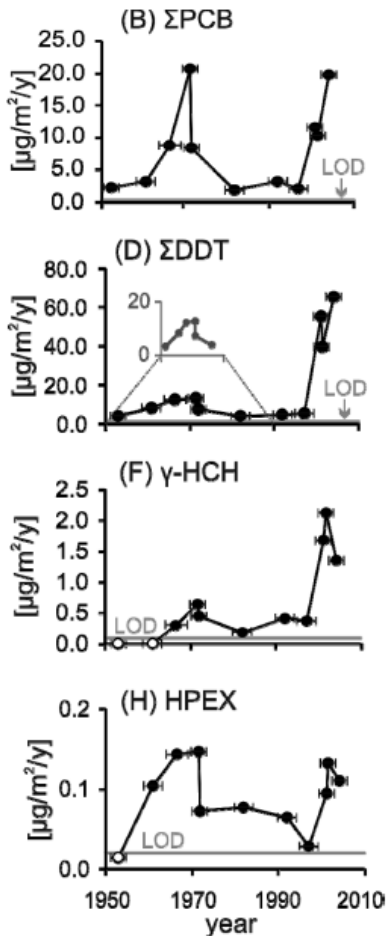


Pigment Yellow 12:



Emerging issues from closed cases

2a. Release of legacy POPs from melting ice



2b. Volatilisation of legacy POPs as sea ice decreases

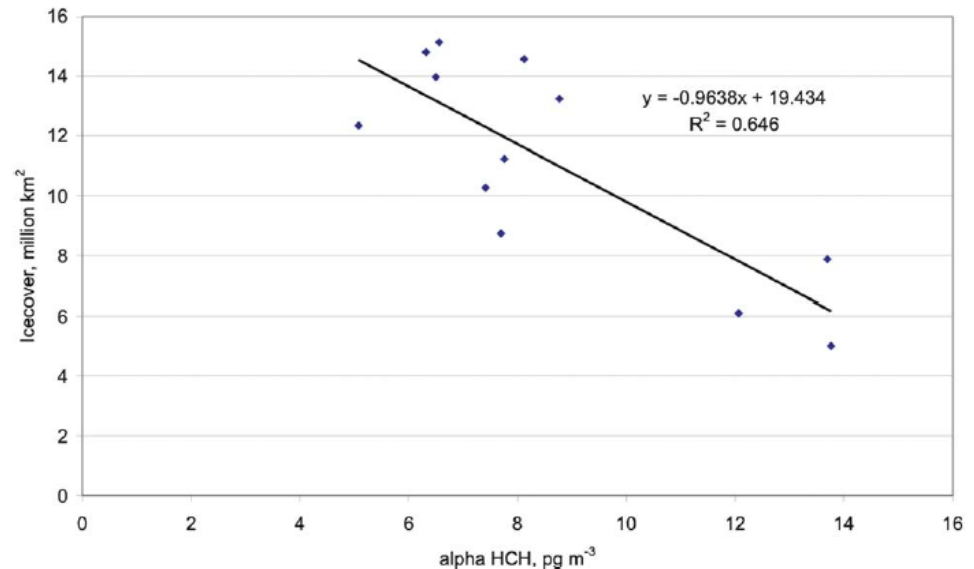


Fig. 3 Correlation between ice cover and α -HCH concentration.

Emerging issues from closed cases

3. Weapons dumped at sea



EU Water Framework Directive

Emerging contaminants: Watch list 2018

Substance	CAS no.	Use
17-beta-Estradiol (E2)	50-82-2	Hormone
17-Ethinylestradiol (EE2)	57-63-6	Hormone
Estrone (E1)	53-16-7	Hormone
Methiocarb	2032-65-7	Insecticide/herbicide
Imidacloprid, Thiacloprid, Thiamethoxam, Clothianidin, Acetamiprid	105827-78-9/138261-41-3, 111988-49-9, 153719-23-4, 210880-92-5, 135410-20-7	Insecticide
Erythromycin, Clarithromycin, Azithromycin	114-07-8, 81103-11-9, 83905-01-5	Antibiotics
Metaflumizone	139968-49-3	Insecticide
Amoxicillin	26787-78-0	Antibiotics
Ciprofloxacin	85721-33-1	Antibiotics

Conclusions

- **Replacement chemicals: We do not know enough about their use, environmental occurrence and environmental and human health risks.**
- **Pathways into the marine environment: Wastewater treatment plants and landfills/dumps can release pollutants into the environment. Management and technological solutions are needed.**
- **Emerging issues from closed cases: New challenges caused by unintentional production of unwanted chemicals (PCB-11), climate change (release of trapped chemicals) and potential risks of weapons dumped at sea.**
- **Awareness of emerging issues in environmental monitoring programmes (AMAP, EU WFD, OSPAR).**