Mikroplast i sjømat

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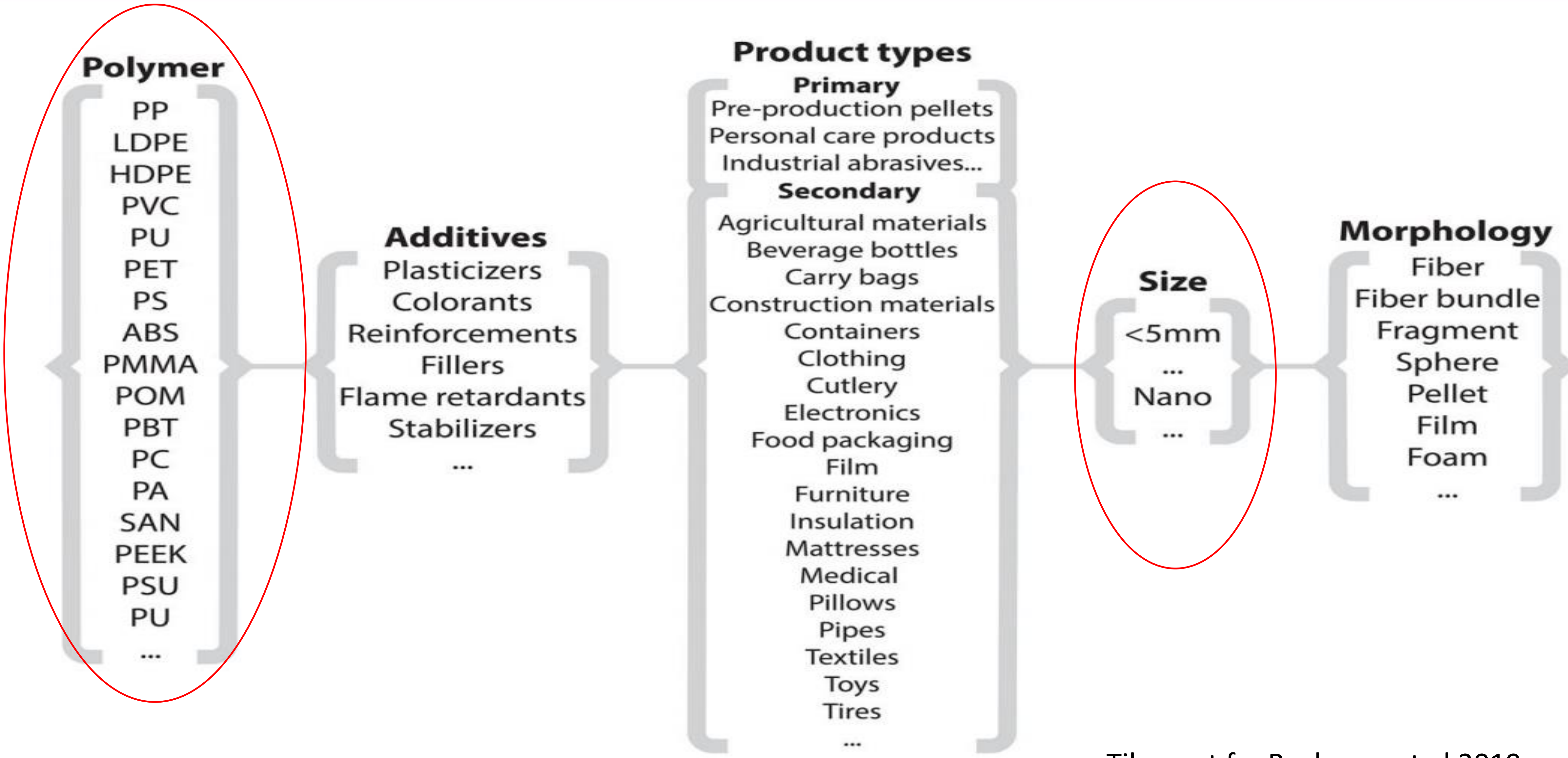
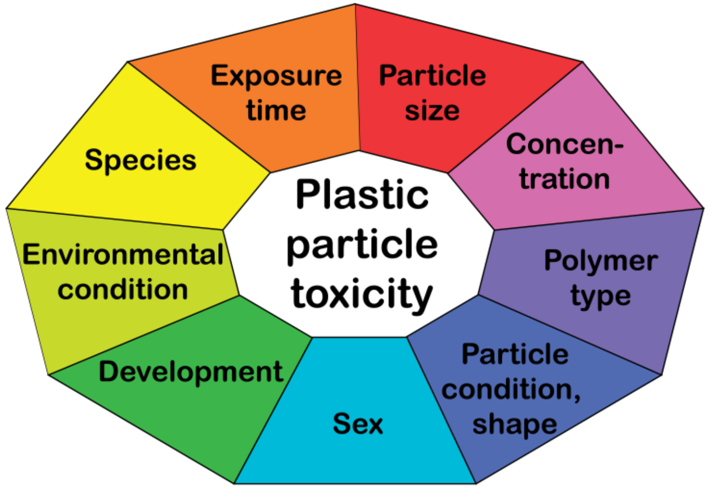
INSTITUTE OF MARINE RESEARCH

Hva er plast? - Mangfold

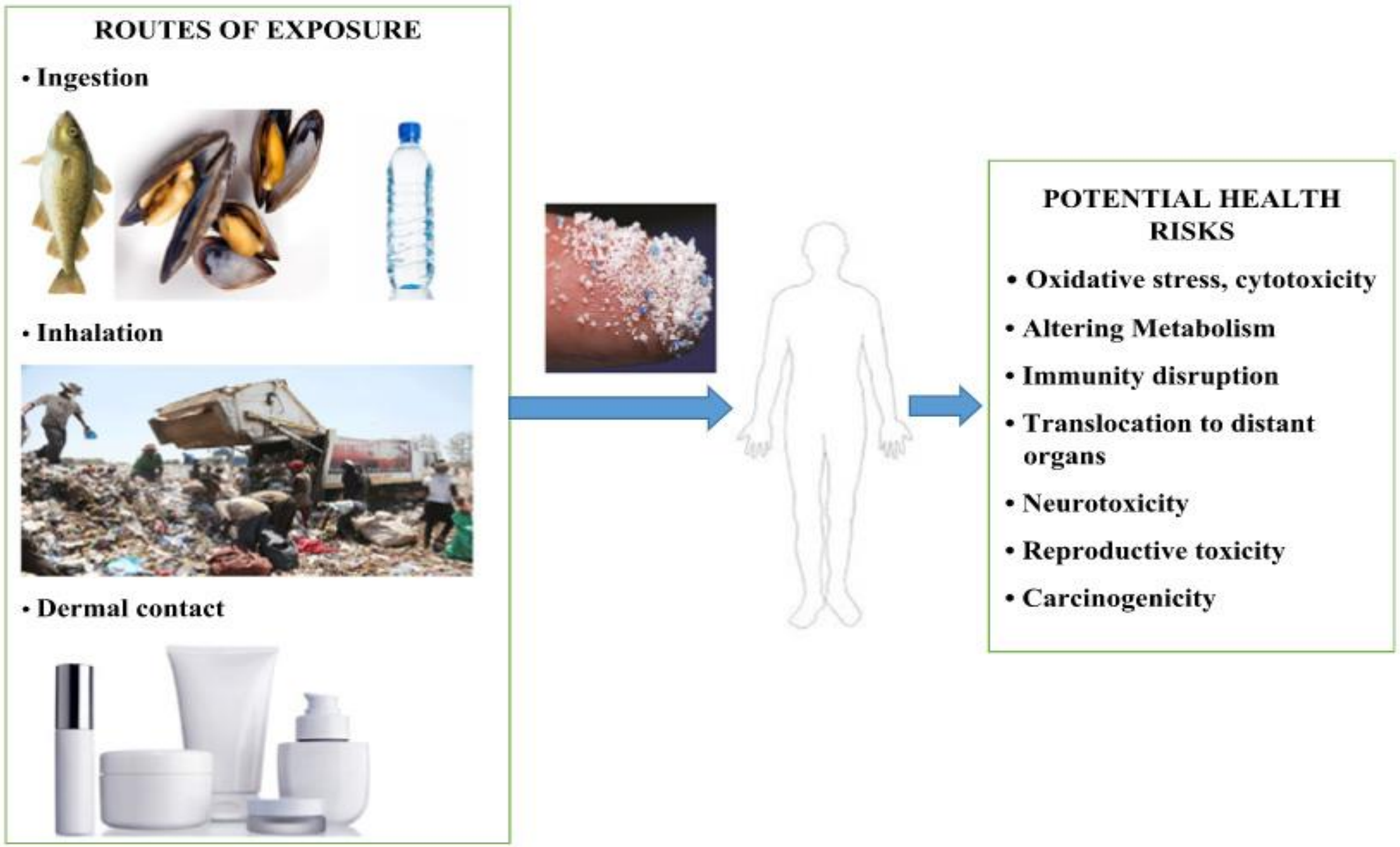


Tilpasset fra Rochman et al 2019

Effects	Reduced body growth or energy	Reduced population growth or survival	Reduced activity	Physiological stress, hormonal disregulation	Cell death, general toxicity	Aberrant development	Altered lipid metabolism	Increased body growth or food consumption	Neuropathology	Liver or kidney pathology	Intestinal damage	Affected photosynthesis, chlorophyll	Other
<10 µm													
Crustaceans	9	14	9	4	4	4	1		2		1		3
Gastropoda	8	3	2	6	4	2	1	2	1				1
Fishes	5	1	8	5	3		5	2	2	4	1		3
Animals, other	4	1	1	3	2	4							1
Phytoplankton		7		3	1	1						5	1
sum	26	26	20	21	14	11	7	4	5	4	2	5	9
≥10 µm													
Crustaceans	5	7	3	1			1	2		1			
Gastropoda	2				1	1							2
Fishes	4	1	5	5	1		1	2	2	1	4		
Animals, other	3		1		1	2	1						2
Phytoplankton								1					1
sum	14	8	9	6	3	3	3	5	2	2	4	0	5



Kögel et al. 2020 Micro-and nanoplastic toxicity on aquatic life: Determining factors, STOTEN.



Rahman et al. 2021 Potential human health risks due to environmental exposure to nano-and microplastics and knowledge gaps. STOTEN

Risikoanalyse

- MP konsentrasjoner i vev av sjømat
  - Kjemisk idenditet
  - og størrelse!
  - måleusikkerhet: prøvetaging + nedbryting + analyse.

x mg/kg ± x mg/kg

Relateres til:
- Opptak og utskilling
- Mengde transfer til vev og opphoping

- Toksisitet relatert til størrelse og dosis ved langtidseksponering

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Review

Current efforts on microplastic monitoring in Arctic fish and how to proceed

Tanja Kögel Bonnie M. Hamilton, Maria E. Granberg, Jennifer Provencher, Sjúrður Hammer, Alessio Gomiero, Kerstin Magnusson, and Amy L. Lusher

Arctic Science
19 July 2022

https://doi.org/10.1139/as-2021-0057

Table 1. Overview of available analysis data of MPs in Arctic fish.

Location	Species	Fish (N)	FO (%)	MP per individual (N)	Recovery analysis	Methodology with lower detection limit	Reference
Eurasian Basin, Svalbard, Norway	Arctic/polar cod (*Boreogadus saida*)	72	2.8	0–1	no	Stomach content, visual inspection, suspected MP by FTIR, fibres not included, >35 μm	(Kühn et al. 2018)
North-eastern Greenland	Arctic/polar cod	85	18	1–2	no	GIT and content alkaline digested, visual inspection,	(Morgana et al. 2018)
Northern Greenland	Sculpin (*Triglops nybelini*)	71	34	0–1		>700 μm by FTIR	
Newfoundland, Canada	Atlantic cod (*Gadus morhua*)	205	2.4	0–2	no	GIT content, visual sorting, >1 mm	(Liboiron et al. 2016)
Newfoundland, Canada	Atlantic cod	216	1.4	0–1	no	GIT content, visual sorting, suspected MP by Raman, >1 mm	(Saturno et al. 2020)
Varangerfjord and Lofoten,	Atlantic cod	58	0	n/a	no	Stomach content, visual inspection,	(Bråte et al. 2016)
Northern Norway		56				suspected MP by FTIR, >3.2 mm reported	
Newfoundland, Canada	Atlantic cod	1010	1.68	0–2	no	GIT content, visual sorting, >1 mm	(Liboiron et al. 2019)
	Atlantic salmon (*Salmo salar*)	69	0				
	Capelin (*Mallotus villosus*)	350	0				
Iceland	Atlantic cod	39	20.5	0.23	no	GIT and content alkaline digested, visual inspection → FTIR, >80 μm	(de Vries et al. 2020)
	Saithe/pollock (*Pollachius virens*)	46	17.4	0.28 overall average			
Western Greenland	Greenland cod (*Gadus ogac*)	9	100	12 ± 6	no	GIT and content, enzymatic digestion, visual and FTIR on selected particles, >20 μm	(Granberg et al. 2020), report
East, West, Southwest Greenland	Greenland shark (*Somniosus microcephalus*)	30	3.33	0–1	no	Stomach content, visual examination, >1 mm	(Nielsen et al. 2014)
Iceland	Atlantic mackerel (*Scomber scombrus*)	50	12	1.3	no	GIT and content, alkaline digestion, filtration, visual examination → Raman, >2.7 μm filtration, visually detected particles chemically identified	(Malinen 2021), thesis
	Blue whiting (*Micromesistius poutassou*)	40	6	1			
Beaufort Sea	Polar/Arctic cod	20	15	1 ± 0		GIT and content alkaline digested, microscope aided visual inspection, 20 μm filtration, suspected MP that could be handled with tweezers were analyzed by FTIR	(Moore et al. 2022)
	Saffron cod (*Eleginus gracilis*)	35	34	1.92 ± 1.19			
		26	19	1.2 ± 0.4			
	Arctic cisco (*Coregonus autumnalis*)	28	7	2 ± 0			
		7	43	1 ± 0			
	Capelin (*Mallotus villosus*) Four-horn sculpin (*Myxocephalus quadricornis*)			0.37 ± 0.16 overall average			

Note: FTIR, Fourier-transform infrared spectroscopy; GIT, gastrointestinal tract; MPs, microplastics.

Trender

Fysiologisk relevans?

Fish (N)	FO (%)	MP per individual (N)	Recovery analysis	Methodology with lower detection limit
72	2.8	0–1	no	Stomach content, visual inspection, suspected MP by FTIR, fibres not included, >35 μm
85	18	1–2	no	GIT and content alkaline digested, visual inspection,
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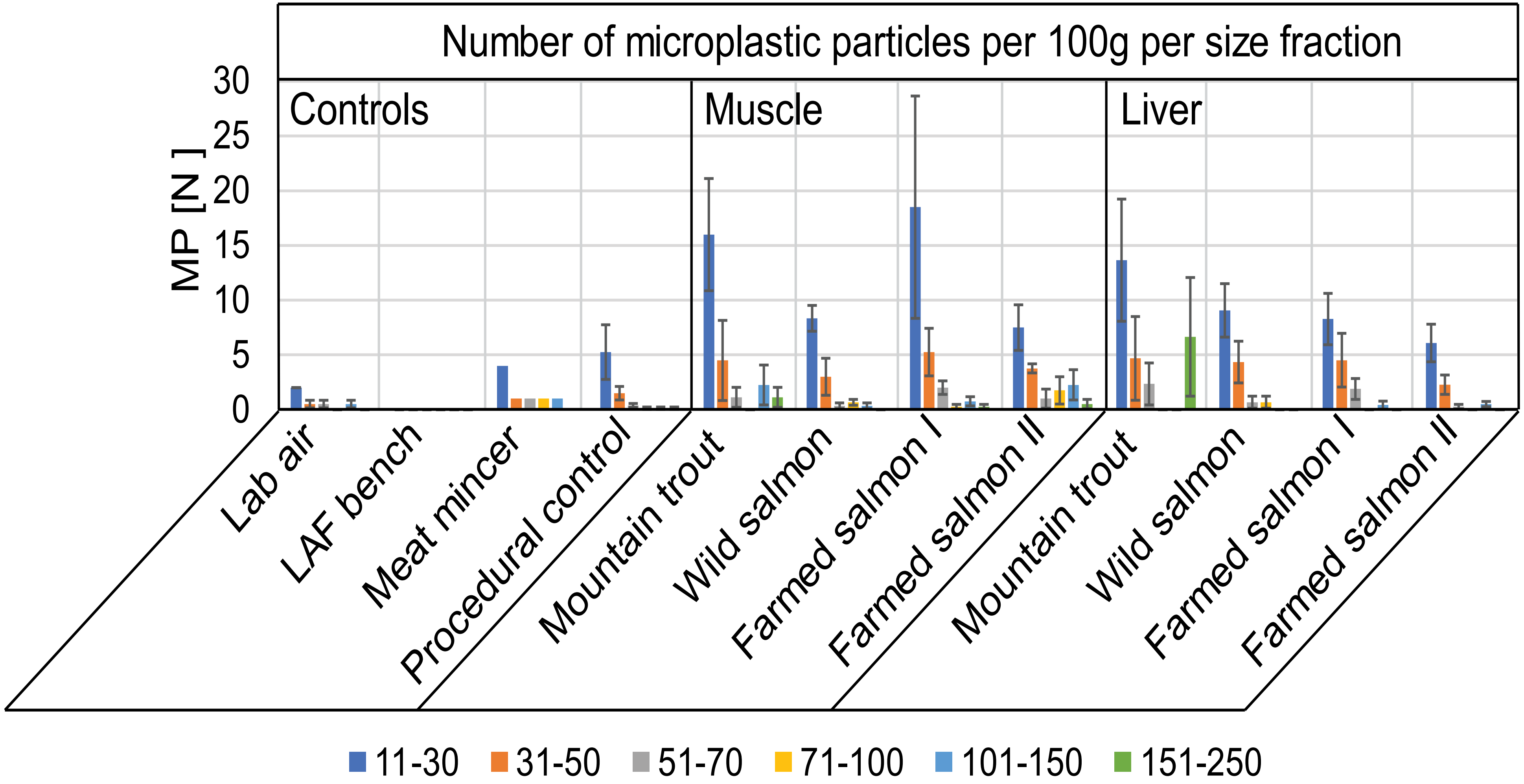
205	2.4	0–2	no	GIT content, visual sorting, >1 mm
216	1.4	0–1	no	GIT content, visual sorting, suspected MP by Raman, >1 mm
58	0	n/a	no	Stomach content, visual inspection,
56				suspected MP by FTIR, >3.2 mm reported
1010	1.68	0–2	no	GIT content, visual sorting, >1 mm
69	0			
350	0			
39	20.5	0.23	no	GIT and content alkaline digested, visual inspection → FTIR, >80 μm
46	17.4	0.28 overall average		
9	100	12 ± 6	no	GIT and content, enzymatic digestion, visual and FTIR on selected particles, >20 μm
30	3.33	0–1	no	Stomach content, visual examination, >1 mm
50	12	1.3	no	GIT and content, alkaline digestion,

SalmoDetect

FHF: NORCE, IMR and NILU



https://www.hi.no/resources/Salmodetect-report-final.pdf

Science of The Total Environment 2023 Liu et al.

Detection of various microplastics in placentas, meconium, infant feces, breastmilk and infant formula: A pilot prospective study

Figure S2. Distributions of particle size (unit: µm) of Microplastics in

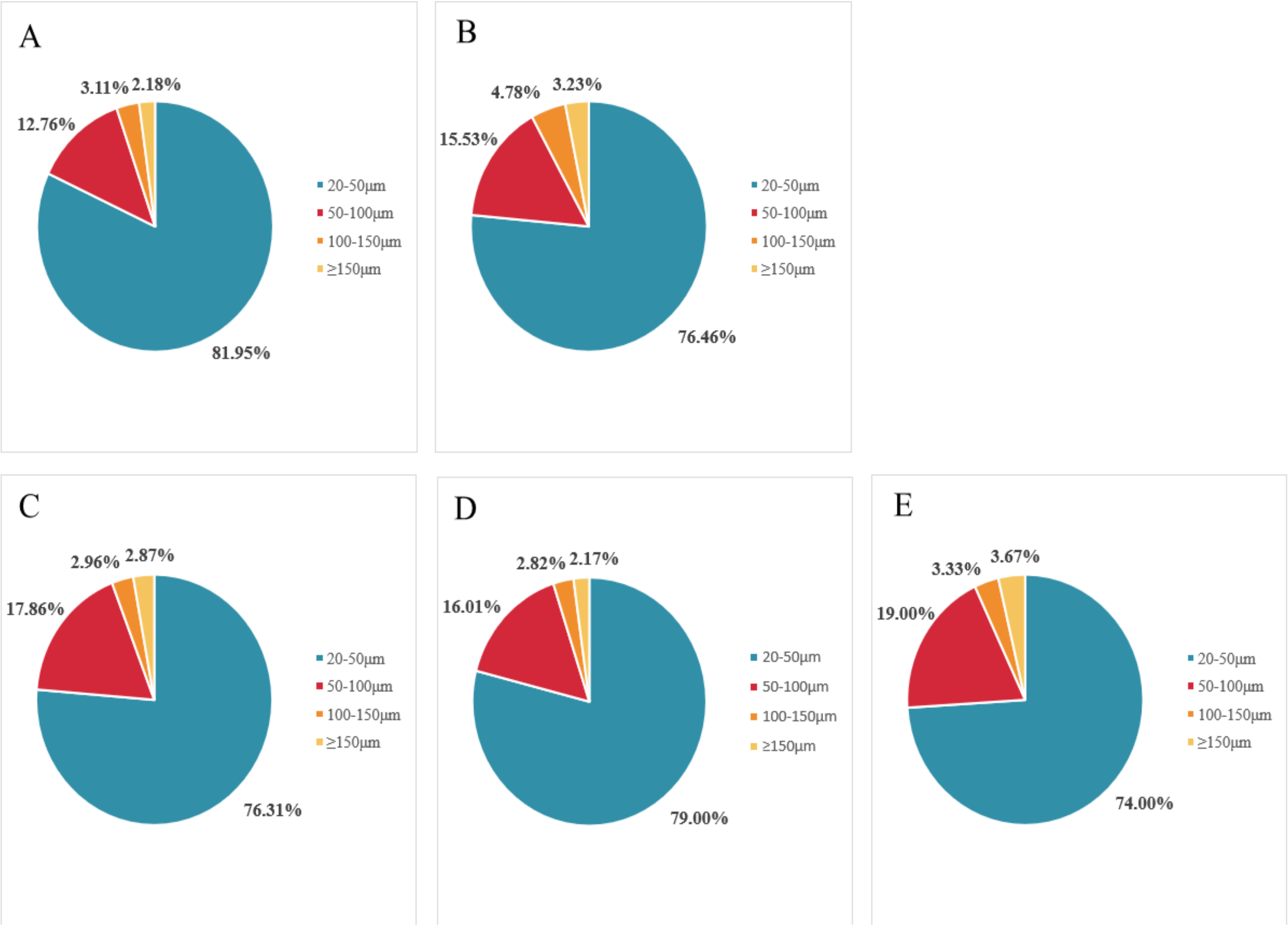
placenta (A)

meconium (B)

infant feces (C)

breast milk (D)

infant formula (E)



	~3 mm [a,e]	1 mm [a,d]	400-500 µm [b,e]	100-150 µm [b,e]	63-80 µm [c,f]
PA-66				n/a	2)
PC	1)	n/a	2)	n/a	5)
PE				n/a	
PET				n/a	4)
PMMA		n/a	3)	n/a	2)
PP		n/a		n/a	
PS					
PVC	n/a	n/a	n/a		

Gjenfinning:

Mørkegrønn: 80-100%

Lysegrønt: 50-79%

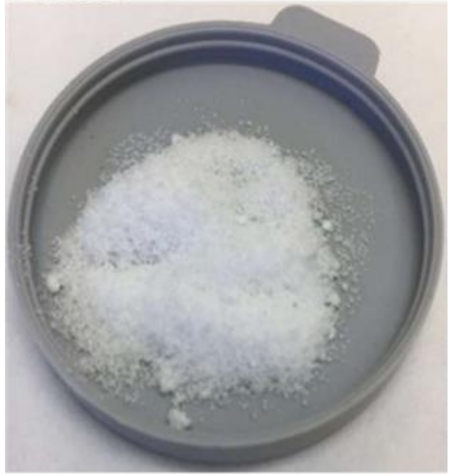
Gult: 30-49%

Rødt: < 30%

H. Hove, T. Naesheim, Ø. Bjorøy, T. Kögel, manuscript in preparation. Do not share.

Andre artikler med gjenfinning

Lievens et al. 2022: A simple, rapid and accurate method for the sample preparation and quantification of meso- and microplastics in food and food waste streams	PVC, PE, PP, PS, PET ca. 100 µm 90-110%	Mikrobølgeassistert HNO_3, 5 min 170°C
Clæssens et al. 2013: New techniques for the detection of microplastics in sediments and field-collected organisms	PS 10 µm, 30 µm, Nylon 100*400 µm (90-100%), Nylon 30*200 (0%)	20 mL HNO_3 (22.5 M) RT, 2 h 100 °C
Silva et al. 2022: Optimization of an Analytical Protocol for the Extraction of Microplastics from Seafood Samples with Different Levels of Fat	PE, PP, PET, PS, AC, lycra (89-100%) Integrity test without matrix below 5 mm	30% H_2O_2 65 ◦C, 24 - 48 h
Ourgaud et al. 2022: Identification and Quantification of Microplastics in the Marine Environment Using the Laser Direct Infrared (LDIR) Technique	PP, PE, PS, PVC, PET (80-100%) 200 to 500 µm	30 mL of KOH (10%) 48-72 h at 60 °C, different filters evaluated
Catarino et al. 2016: Development and optimization of a standard method for extraction of microplastics in mussels by enzyme digestion of soft tissues	PET, HDPE, or nylon 85-100% <500 µm	1M NaOH, 35% HNO_3, and protease at 9.6 UHb/mL
Karlsson v 2017: Screening for microplastics in sediment, water, marine invertebrates and fish: Method development and microplastic accumulation	PP, PE 3 mm PA, EPS, PET, PE 250µm 100% PA 80% (mistet 1 partikkel)	proteinase K (3.0–15.0 unit/mg, T. album, with $CaCl_2$
Bianchi et al. 2020: Food preference determines the best suitable digestion protocol for analysing microplastic ingestion by fish	Nylon PVA, PE 330 µm – 1 mm 90-100%	
Lopez-Rosales et al. 2022: A reliable method for the isolation and characterization of microplastics in fish gastrointestinal tracts using an infrared tunable quantum cascade laser system	PS, PP, PVC, PET, PE and PA6.6) plus 20 PET fibres 200-300 µm/PVC 70 µm 90%, PET 76%	enzymatic



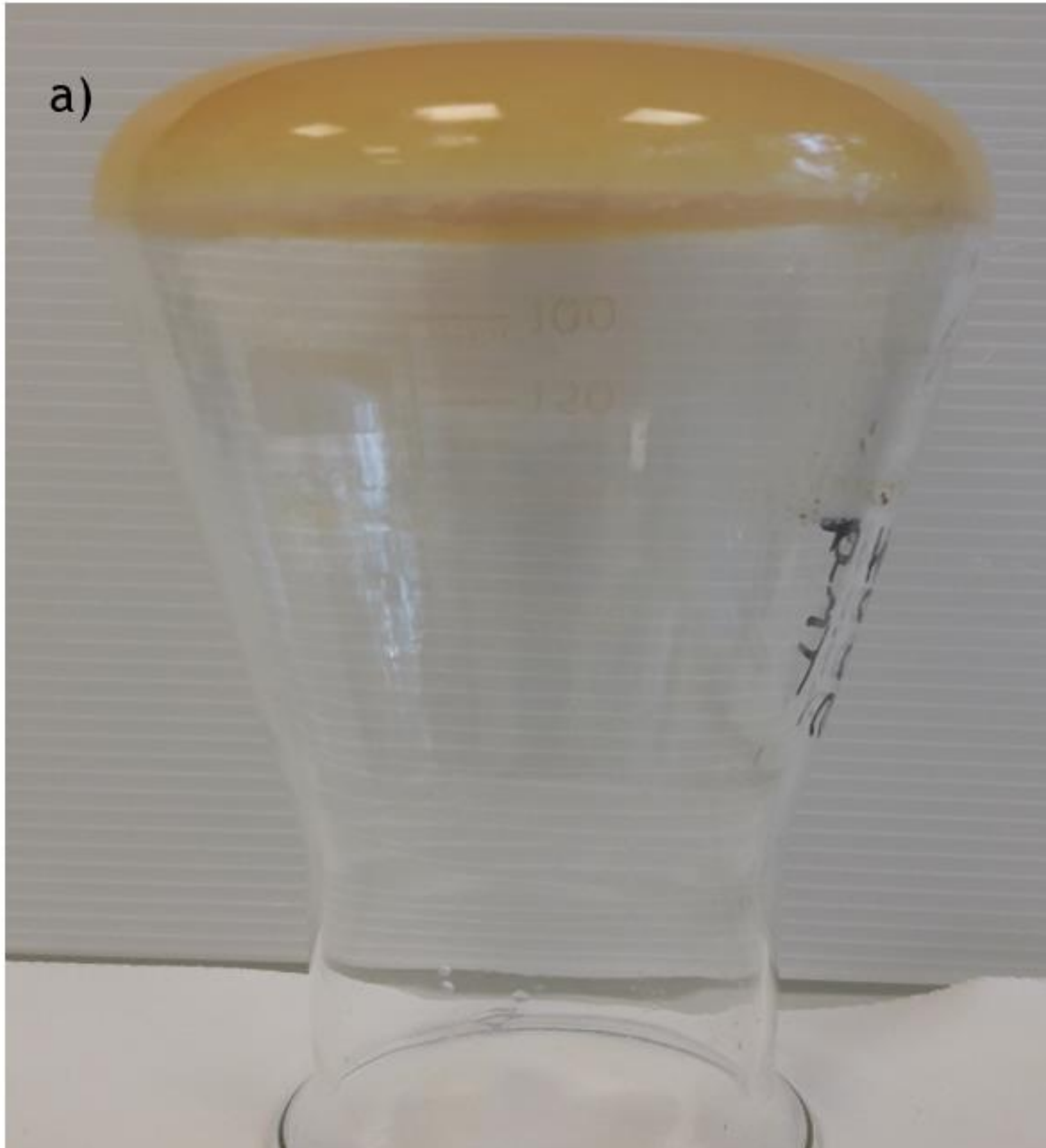
Size distribution

Size fractionated cryo-milled polymer material

Refosco et al. Ongoing study

Vanlige mangler

- Kontaminasjonsbeskyttelse
  - Ingen kontaminasjonsbeskyttelse beskrevet
  - Kontaminasjonsbeskyttelse beskrevet men ikke kontrollert (mangel på prosedyrekontroll, mangel på luftblank)
  - Utfordring: Høy kontaminering av luft, vann, kjemikalier
- Gjenfinningsanalyse
  - Ingen
  - Bare på noen polymer typer
  - På større partikler enn minste analytt
  - Utfordring: Ingen standardmateriale kan kjøpes
  - Utfordring: Nedbryte vev uten å nedbryte plast



Efficient microplastic isolation from fish tissues by sur
digestion (manuscript in preparation)
Hove H, Næsheim T, Bjorøy Ø and Kögel, T

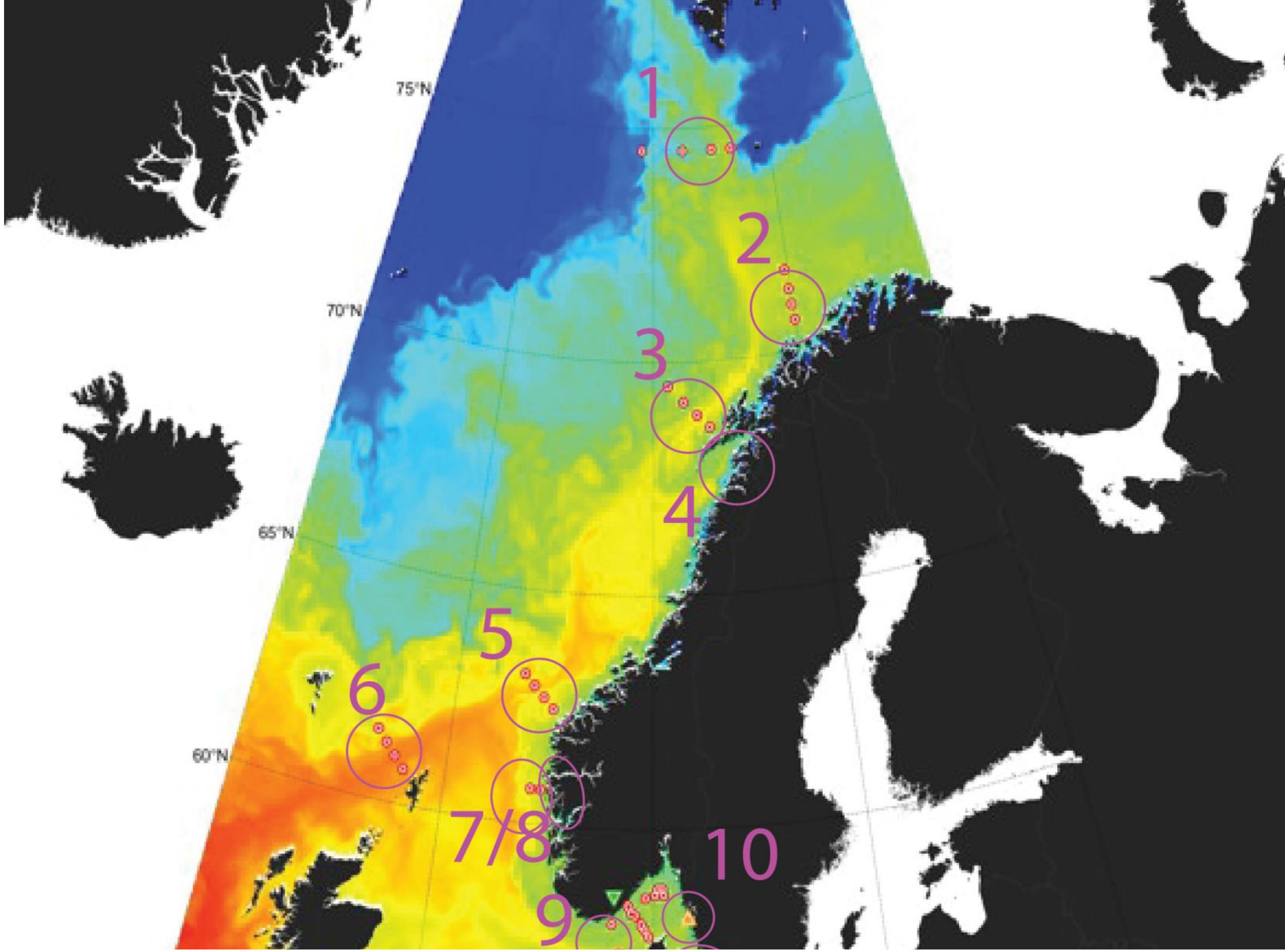
Per stasjon

20 torsk
(*Gadus morhua*)

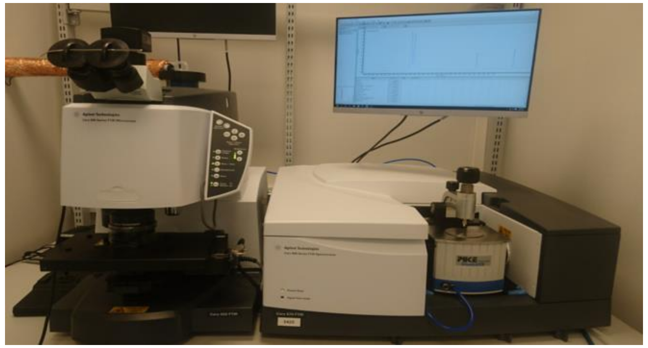
and/or

20 brosme
(*Bosme brosme*)

-med referanseflåten/
forskningstokt/ privat fisker



https://laboratorier.hi.no/plastlab/



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ATR-FTIR summit pro	**Micro-FTIR Microscope Agilent Cary 620/670**	Micro -high-brightness tunable laser (larger spectrum) microscope	**Pyrolysis-GC/MS Orbitrap Thermo QExactive**
Macro down to 300 µm En partikkel om gangen Lett opplæring	Micro 300-10 µm (3 µm) FPA 128*128	Micro 300-10 µm (3 µm) No liquid nitrogen required Faster: FPA 480*480	Micro, nano <ca.1 mm /0.5 mg LOD <0,5 µg
N and size →N/kg	N and size →N/kg	N and size →N/kg	Mass → mg/kg

1-6 MP per gram over og under 3 µm

Contents lists available at ScienceDirect

Environmental Pollution

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

First report on the presence of small microplastics ($\leq$ 3 µm) in tissue of the commercial fish *Serranus scriba* (Linnaeus. 1758) from Tunisian coasts and associated cellular alterations☆

Nesrine Zitouni [a], Noureddine Bousserrhine [b], Sabrina Belbekhouche [c], Omayma Missawi [a], Vanessa Alphonse [b], Iteb Boughatass [a], Mohamed Banni [a, *]

[a] *Laboratory of Biochemistry and Environmental Toxicology, Higher Institute of Agronomy, University of Sousse, Tunisia*
[b] *Laboratory Water, Environment and Urban Systems, University Paris-Est Créteil. Faculty of Science and Technology, Créteil Cedex, France*
[c] *CNRS, University Paris-Est Créteil, ICMPE, UMR7182, 94320, Thiais, France*

70 000 – 90 000 MP per g,
median 1,8- 2.5 µm
ingen polymertype nevnt, metode- patent

ELSEVIER

Contents lists available at ScienceDirect

Environmental Research

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

Microplastics in fillets of Mediterranean seafood. A risk assessment study

Margherita Ferrante [a], Zuccarello Pietro [a], Chaima Allegui [b], Fiore Maria [a], Cristaldi Antonio [a], Eloise Pulvirenti [a], Claudia Favara [a], Copat Chiara [a], Alfina Grasso [a], Missawi Omayma [b], Oliveri Conti Gea [a,**], Mohamed Banni [b,*]

[a] *Environmental and Food Hygiene Laboratory (LIAA), Department of Medical, Surgical Sciences and Advanced Technologies G. F. Ingrassia, Catania University, Via Santa Sofia 87, 95123, Catania, Italy*

[b] *Laboratory of Biochemistry and Environmental Toxicology, Sousse University, Chott-Mariem, 4042, Sousse, Tunisia, Higher Institute of Biotechnology, Monastir University, Tunisia*

HAVFORSKNINGSINSTITUTTET

LOD 2 ng -180 ng (1 ng = 1 terning 10 µm)
LOQ 1.2 to 5.8 µg (ca. x 1000)
ingen partikkelstørrelse

Environmental Chemistry

Microwave-Assisted Extraction for Quantification of Microplastics Using Pyrolysis–Gas Chromatography/Mass Spectrometry

Ludovic Hermabessiere* and Chelsea M. Rochman

Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, Ontario, Canada

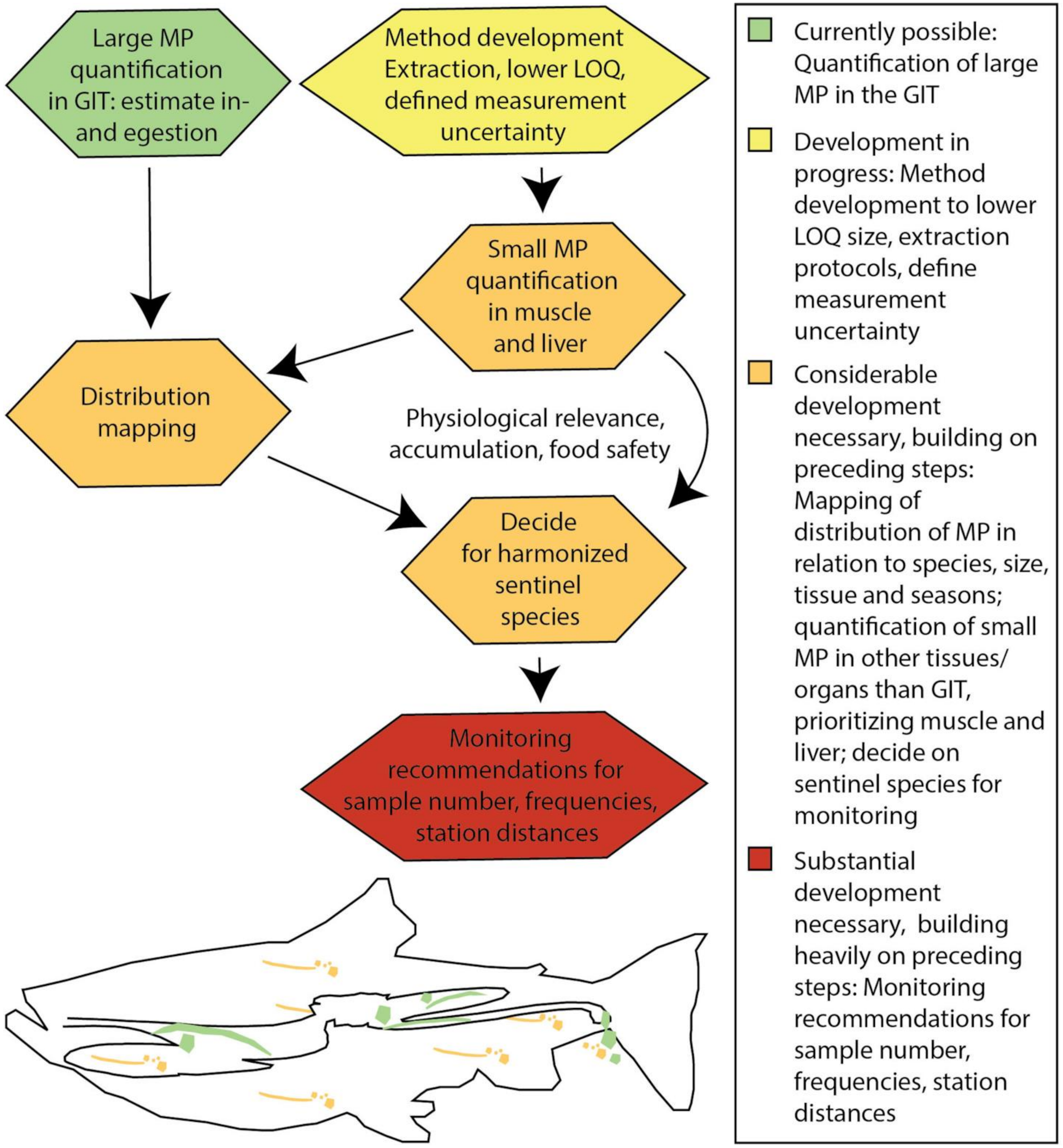
HAVFORSKNINGSINSTITUTTET

Basisundersøkelser←→ Risikoevaluering

- Stoffkonsentrasjon
  - Variasjon med
    - Art/vev
    - Størrelse
    - Sted
    - Sesong

- Langtidseffekter
  - EU Maximum level
  - EFSA tolerable intake (TWI/TDI)/Scientific opinion on…
  - MOE (margin of exposure,

  based on $BMLD_{10}$)



~~Overvåking?~~

Kartlegging!

OPEN ACCESS

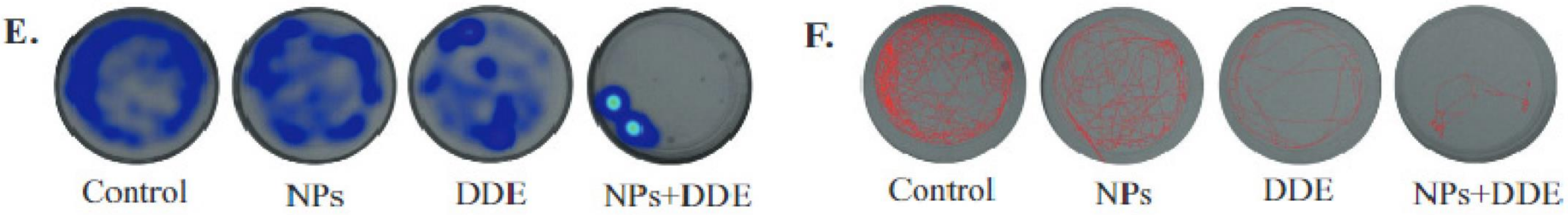
Review

Current efforts on microplastic monitoring in Arctic fish and how to proceed

Tanja Kögel Bonnie M. Hamilton, Maria E. Granberg, Jennifer Provencher, Sjúrður Hammer, Alessio Gomiero, Kerstin Magnusson, and Amy L. Lusher

Arctic Science 19 July 2022
https://doi.org/10.1139/as-2021-0057

Ingen effekt av PS alene, men øker DDE toksisitet Tilleggseffekt av DDE hvis kombinert med PS: redusert bevegelse

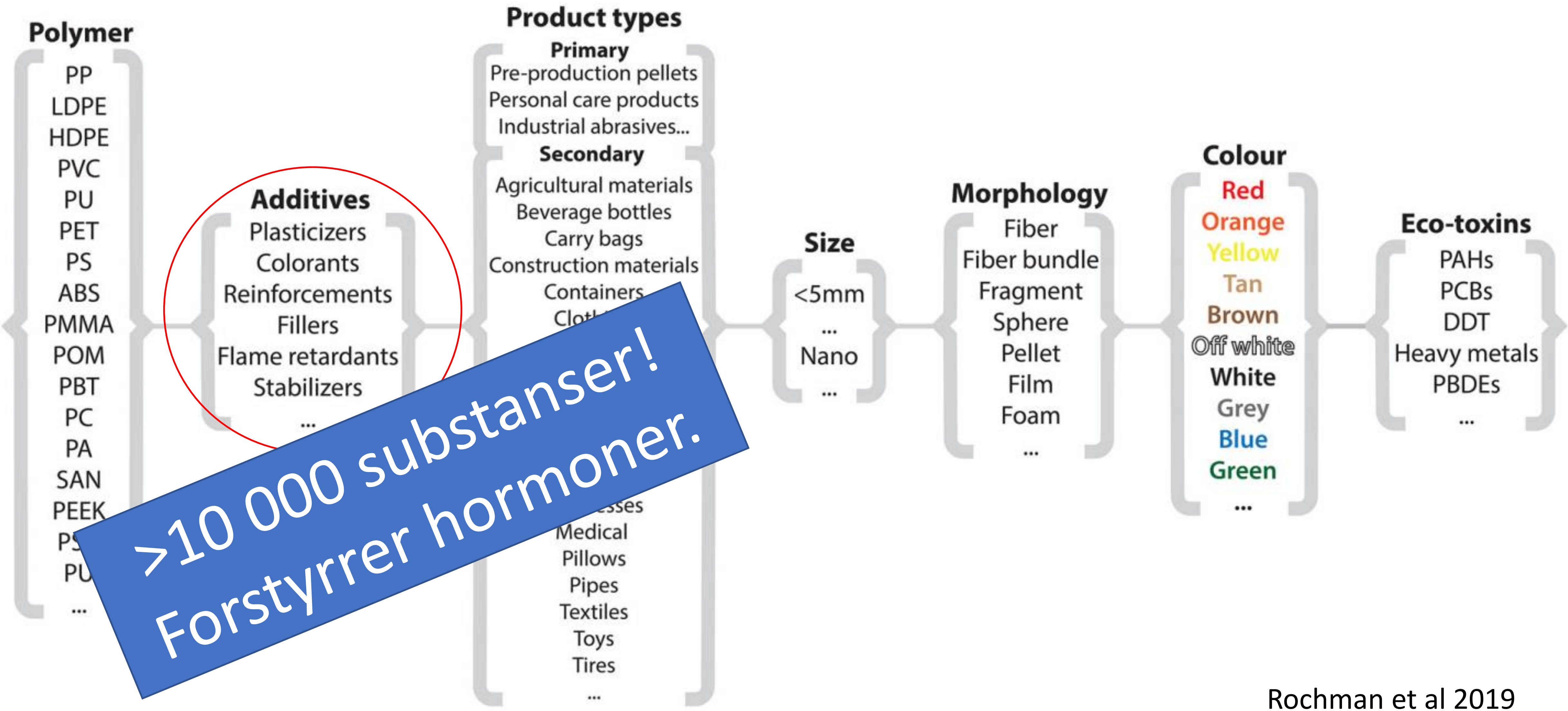


Polystyrene nanoplastics enhance the toxicological effects of DDE in zebrafish (*Danio rerio*) larvae

Shubham Varshney [a], Adnan H. Gora [a], Viswanath Kiron [a], Prabhugouda Siriyappagouder [a], Dalia Dal
Tanja Kögel [b,c], Robin Ørnsrud [b], Pål A. Olsvik [a,b,*]

[a] *Faculty of Biosciences and Aquaculture, Nord University, Bodø, Norway*
[b] *Institute of Marine Research, Bergen, Norway*
[c] *Faculty of Mathematics and Natural Sciences, University of Bergen, Norway*

Hva er plast? - Mangfold



Rochman et al 2019

Litteratur om emnet

- Coverage of microplastic data underreporting and progress toward standardization. Fermín Pérez-Guevara, Priyadarsi D. Roy et al. Science of The Total Environment 2022
- Monitoring of microplastic pollution in the Arctic: recent developments in polymer identification, quality assurance and control, and data reporting. Sebastian Primpke, Andy M Booth, Gunnar Gerdts, Alessio Gomiero, Tanja Kögel, Amy Lusher, Jakob Strand, Barbara M Scholz-Böttcher, Francois Galgani, Jennifer Provencher, Stefano Aliani, Shreyas Patankar, Katrin Vorkamp. Arctic Science 2022
- Moving forward in microplastic research: A Norwegian perspective. Amy L Lusher, Rachel Hurley, Hans Peter H Arp, Andy M Booth, Inger Lise N Bråte, Geir W Gabrielsen, Alessio Gomiero, Tânia Gomes, Bjørn Einar Grøsvik, Norman Green, Marte Haave, Ingeborg G Hallanger, Claudia Halsband, Dorte Herzke, Erik J Joner, Tanja Kögel, Kirsten Rakkestad, Sissel B Ranneklev, Martin Wagner, Marianne Olsen. Environment International 2021
- Surveillance of Seafood for Microplastics. Tanja Kögel, Alice Refosco, Amund Maage. Handbook of Microplastics in the Environment. Springer, Cham. 2020

Finansiering

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HAVFORSKNINGSINSTITUTTET

FHF

DET KONGELIGE NÆRINGS- OG FISKERIDEPARTEMENT

FACTS

JPI OCEANS