Surveying microplastic release from aquaculture nets and ropes using different technologies for emission reduction (SMARTER)

Andy M. Booth, Nina Bloecher, Alessio Gomiero, Pavel Stránský, Stefania Piarulli, Heidi Moe Føre, Torstein Kristensen, Astrid Lunde, Stephan Kubowicz, Hanne Hjelle Hatlebrekke

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Technology for a better society

Aquaculture Nets and MP

- Nets considered a significant source of MP emissions.
- ~75% of all submerged surfaces at a farm site.
- Often with wax-, resin-, or acrylic-based coatings:
  - Protection from UV degradation
  - Facilitate in-situ cleaning
  - Reduce abrasion
- Coatings erode over time, exposing the underlying net material to degradation and release of MP.
- Coatings may also represent a source of MP emissions.

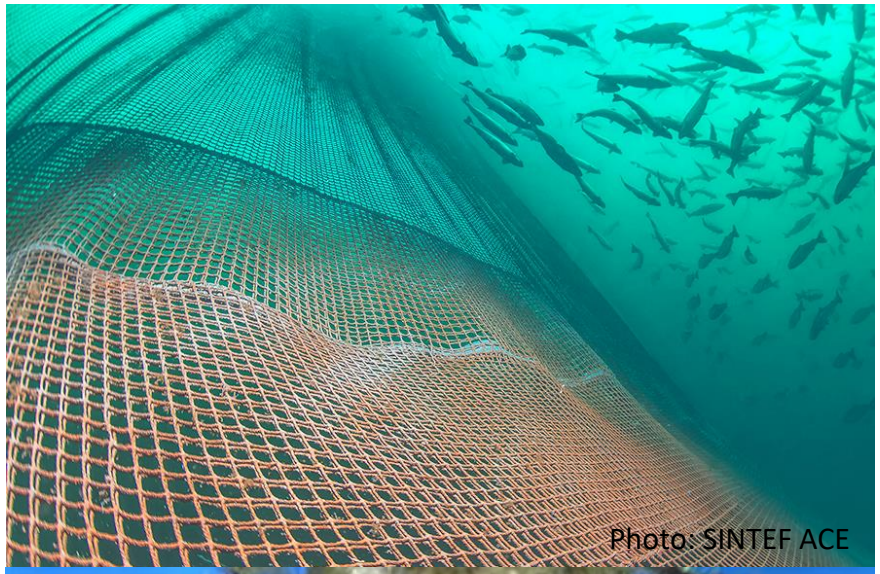
Photo: SINTEF ACE

Wear on aquaculture nets from high pressure cleaning.

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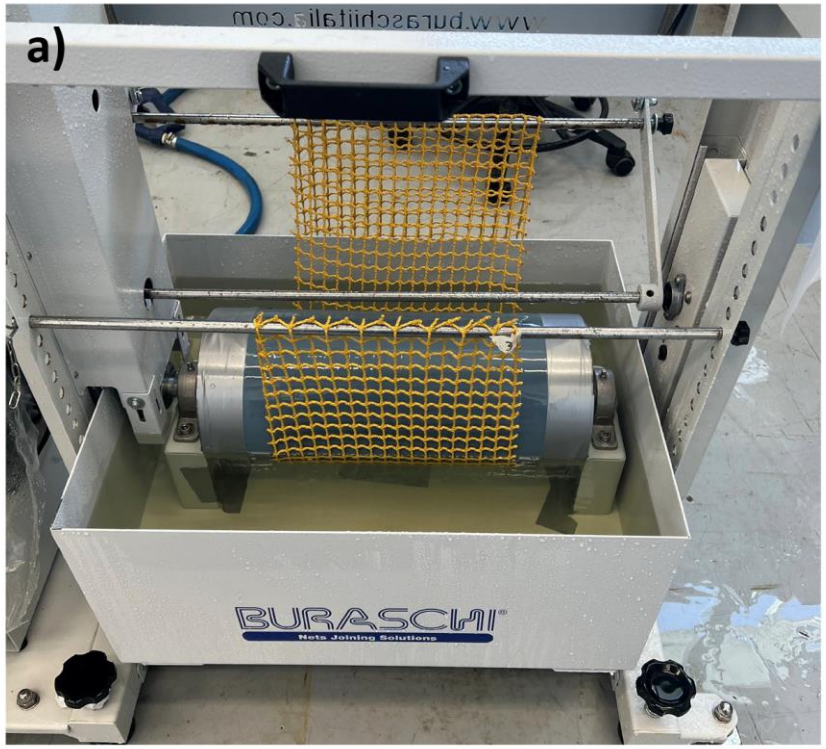
SMARTER

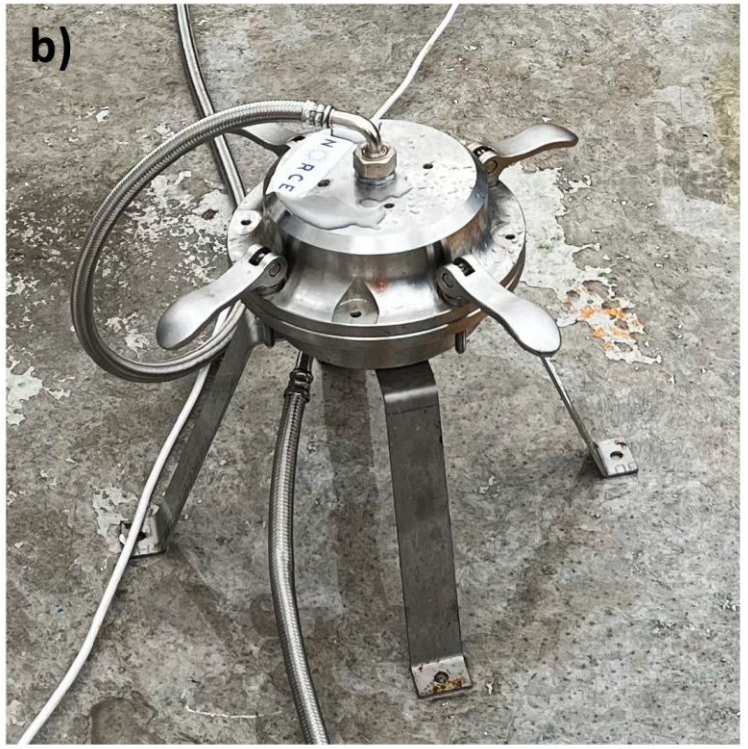
The main goal of SMARTER is to assess and model MP release from aquaculture structures and to quantify the reduction of MP emissions by introducing feasible measures under relevant environmental conditions.

Net abrasion – Lab testing

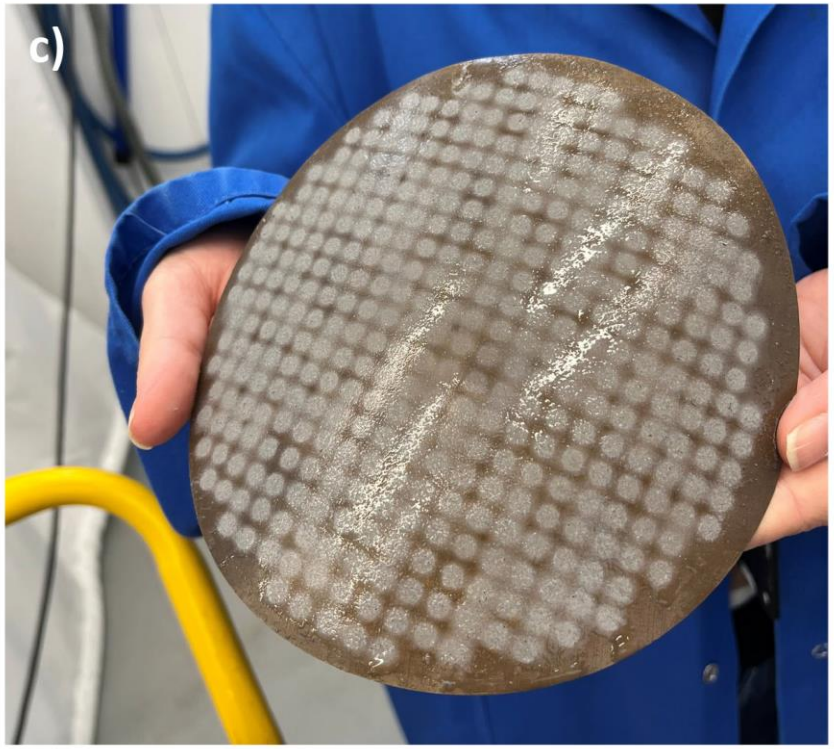
500 µm 10 µm



Buraschi abrasion equipment



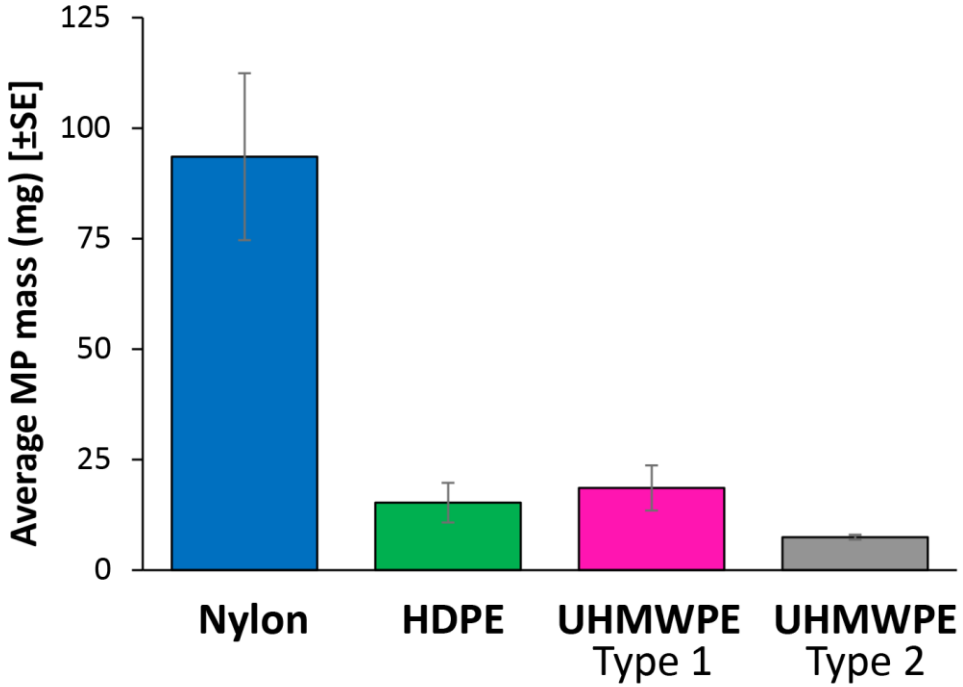
Filtration unit used for all MP sampling



Filter with collected particles

Effect of material and coating

Effect of **MATERIAL**



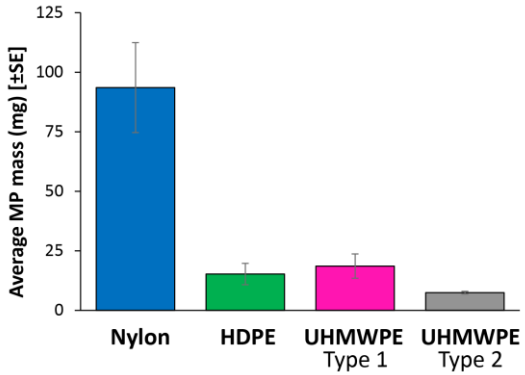
Nylon nets release more MP than HDPE and UHMWPE

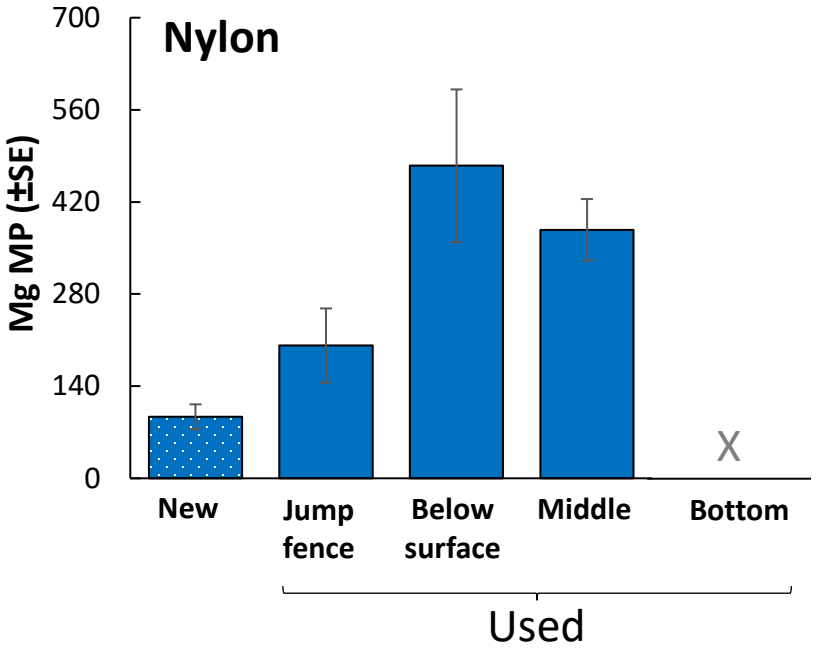
Effect of **COATING**

Coating leads to increased MP release

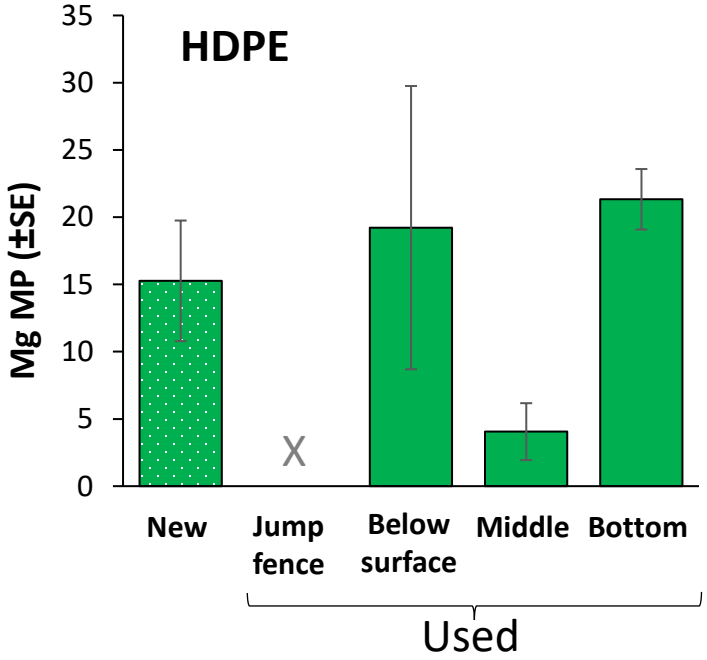
No effect of coating

Effect of age

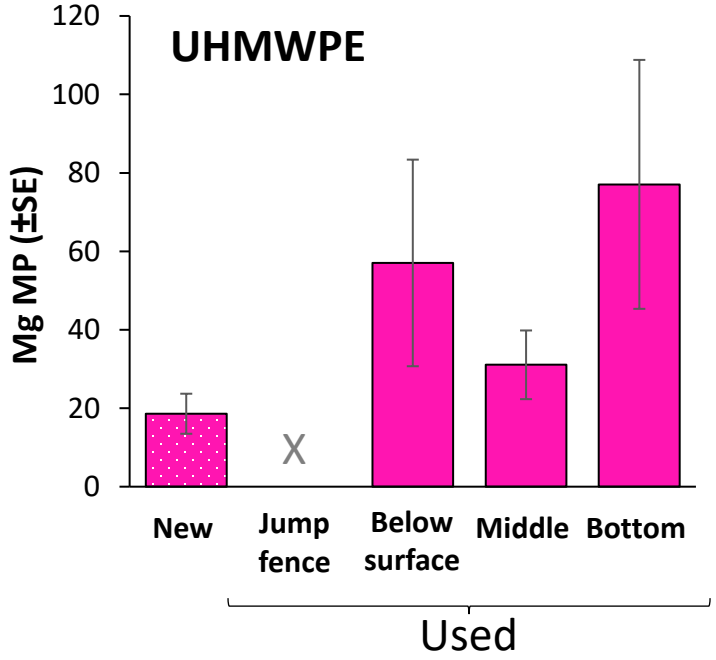




Age leads to increased MP release



Little effect of age
(! Test net was not very old !)



Age leads to increased MP release?
(! Copper coated net !)

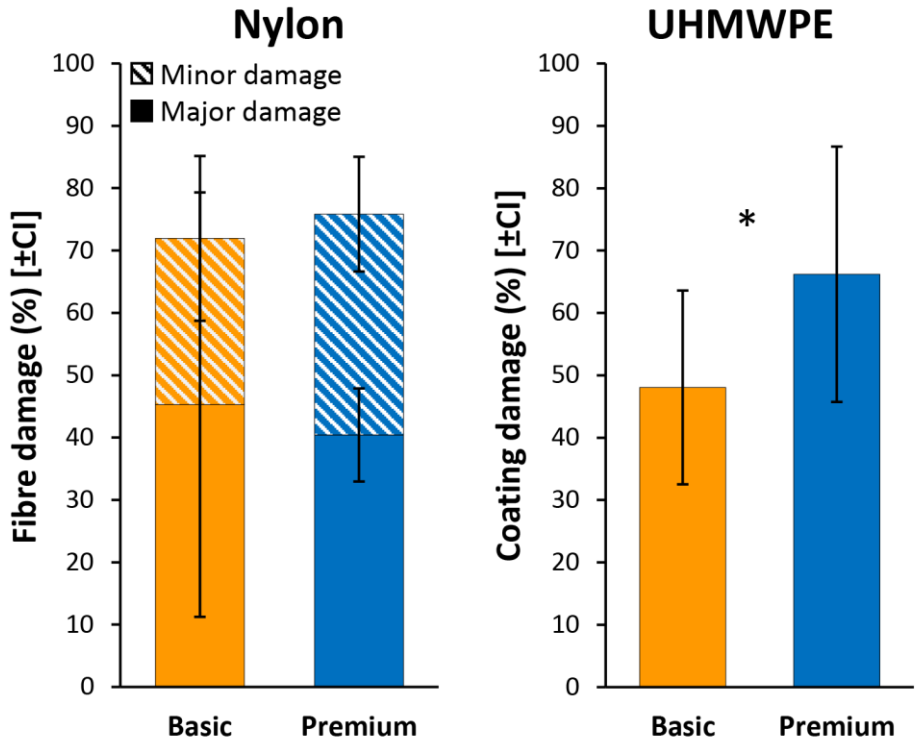
Microscopic assessment of the damage

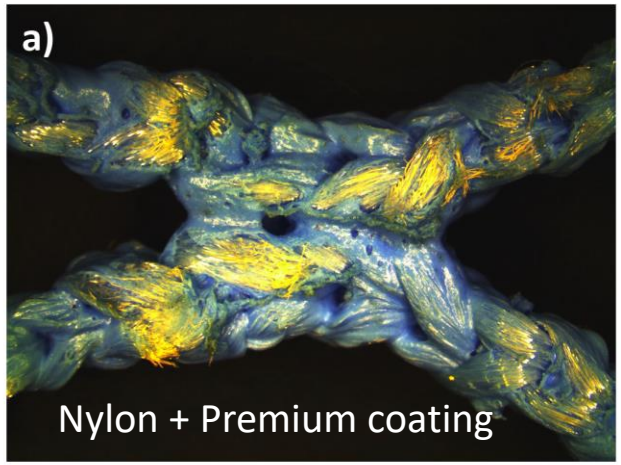
Nylon

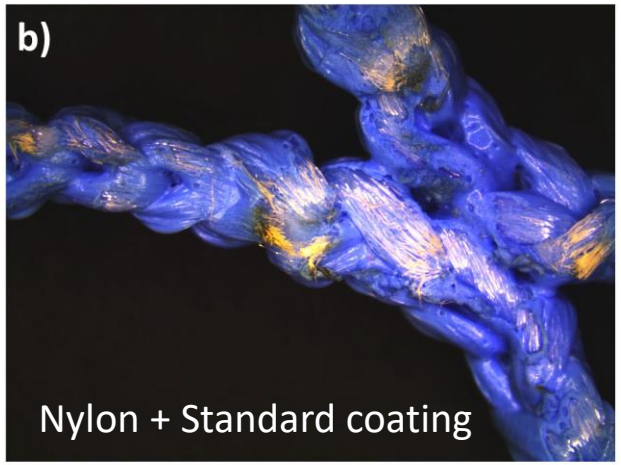
Damage to fibres, no difference between coatings

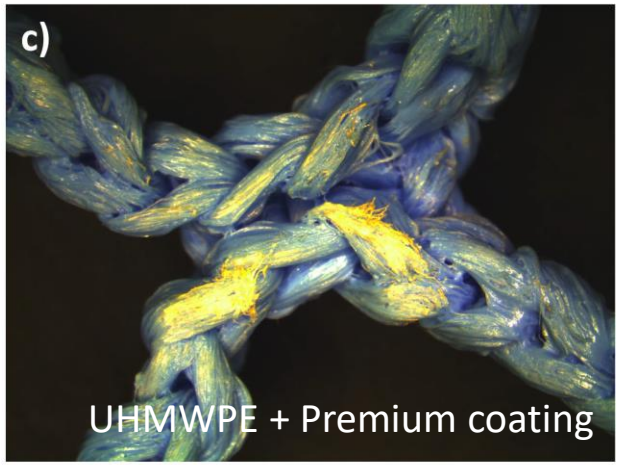
UHMWPE

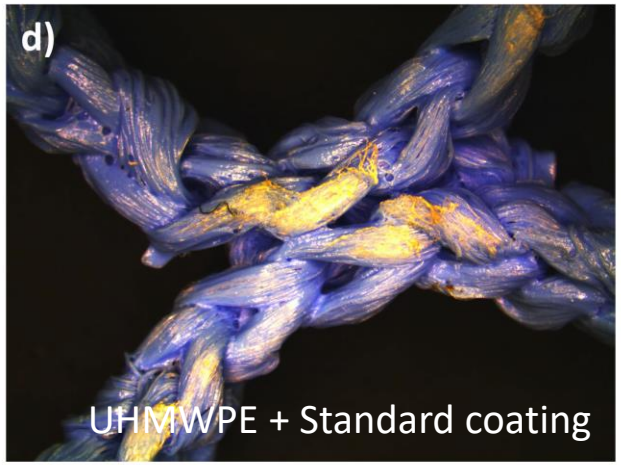
Mostly coating damage, more visible for the premium coating











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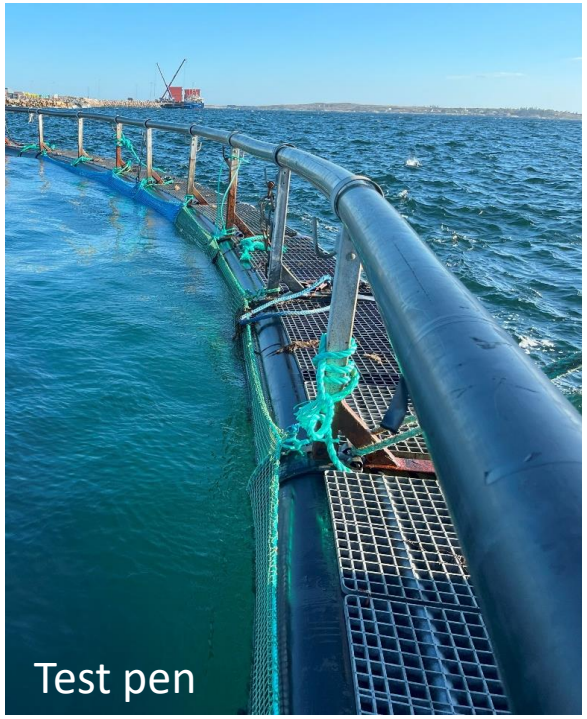
Accelerated field test



Pressure cleaning	Cavitation cleaning	AUV brushing
70 passes 93 bar, 600 L/min	70 passes 148 bar, 200 L/min	300 passes Horsehair brushes, both sides

10m

10m

Used Nylon

New, coated Nylon

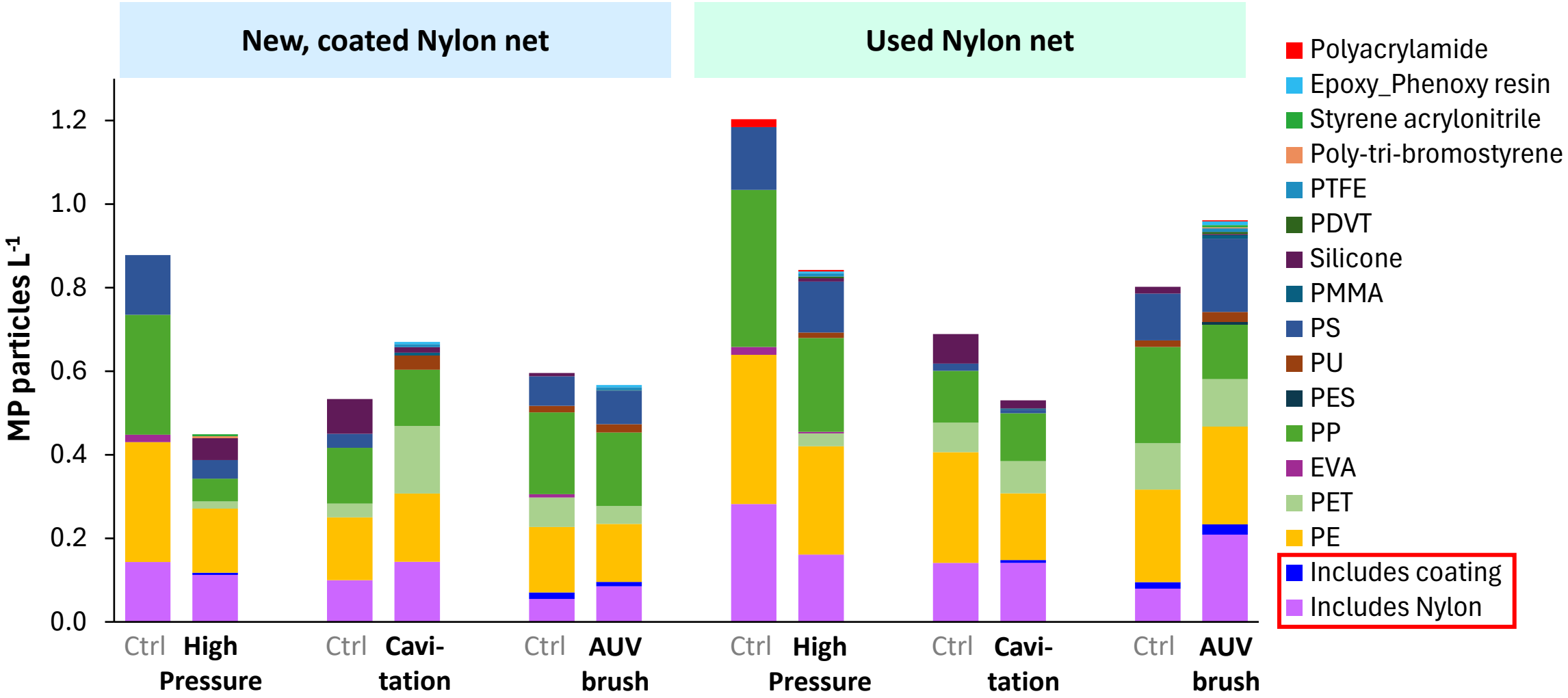
Repl. 1

Repl. 2

Repl. 3

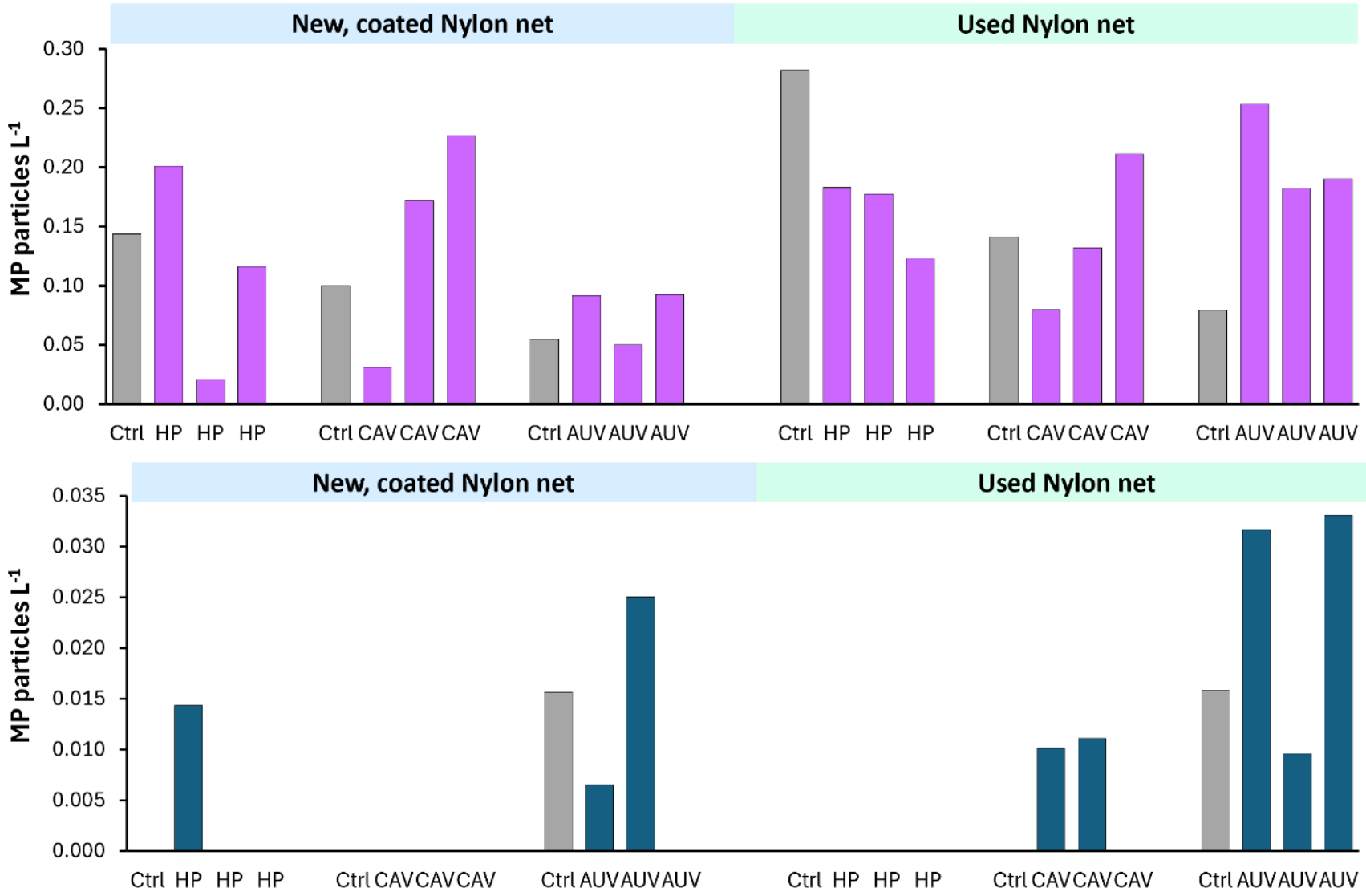
Schematised experimental set-up to simulate 10 months of net cleaning at sea testing three technologies on two net materials.

Effect of cleaning technology



MP particles per Liter collected during the accelerated cleaning experiment

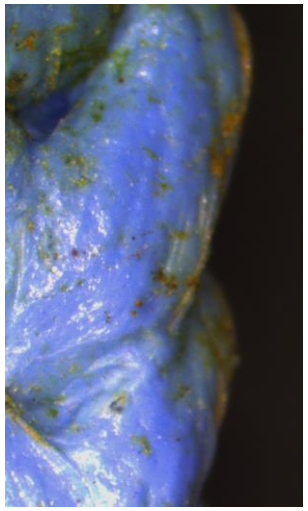
Effect of cleaning technology



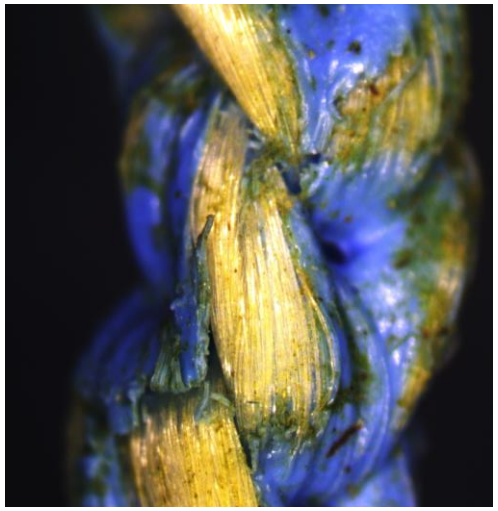
→ No difference between control and washing, or the technologies

Net samples (50 x 50 cm) taken from
3 m depth after final cleaning

T1.2 Effect of cleaning technology



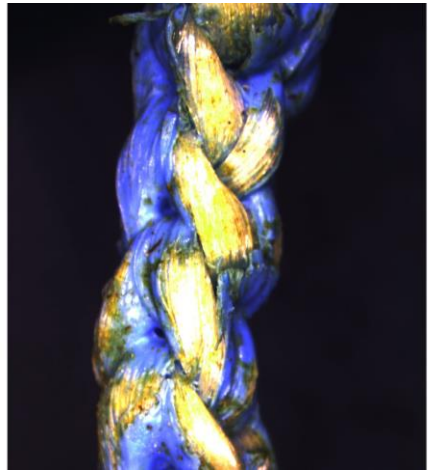
Intact



Broken

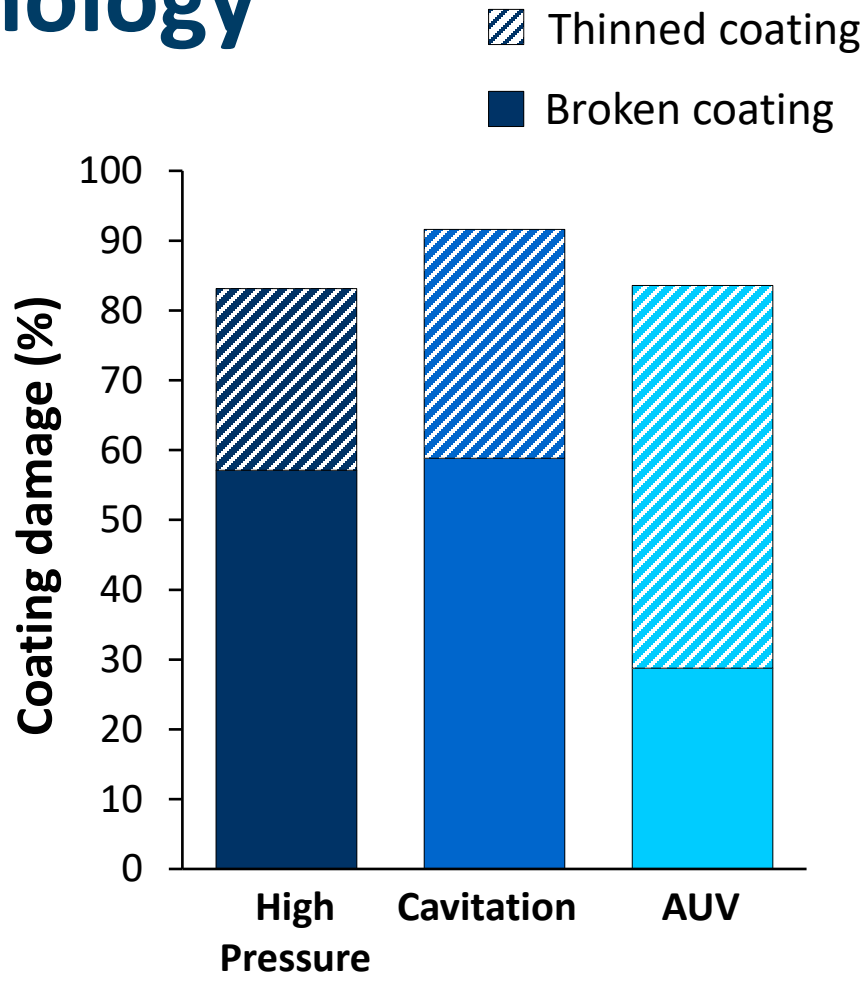
Thinned

Pressure cleaning



Cavitation cleaning

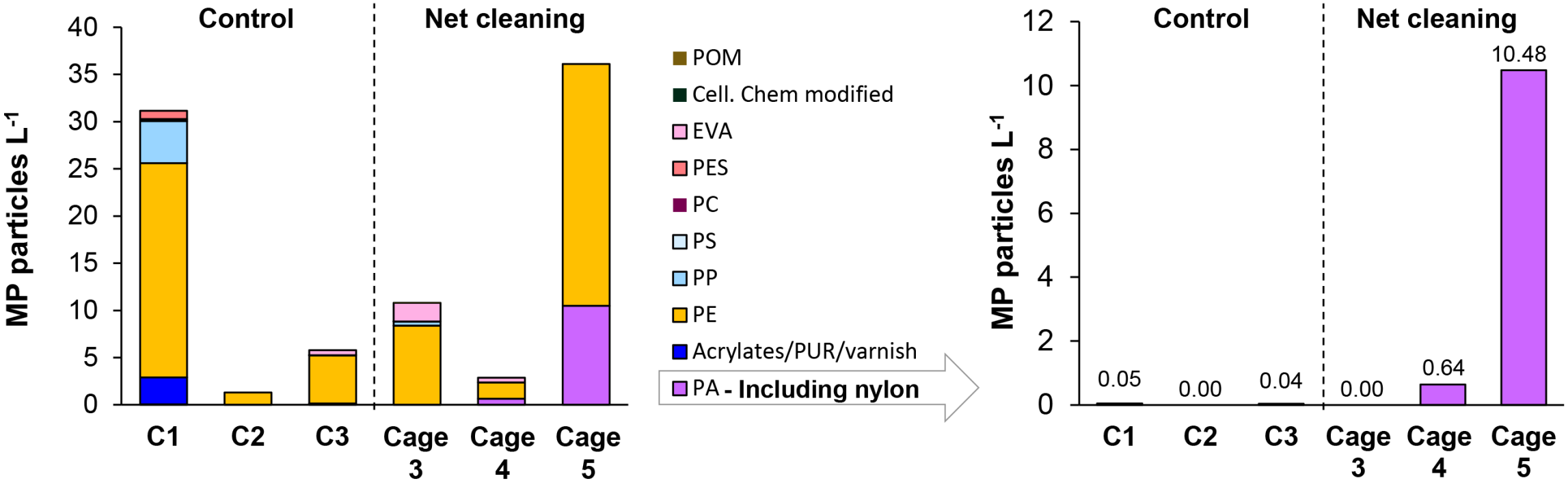
AUV brushing



→ Total affected area is similar, but damage is less severe after AUV brushing (NP?)

→ No damage to the net fibres

Field sampling



- Samples from an active net cleaning operation at a commercial salmon farm using two Manta units.
- Variability in MP concentrations and polymer compositions across the water samples collected during pressure washing of 3 aquaculture cages and 3 control samples collected at the same site.
- The presence of lice skirts on Cage 3 and Cage 4 may have impacted the amount of MP sampled.

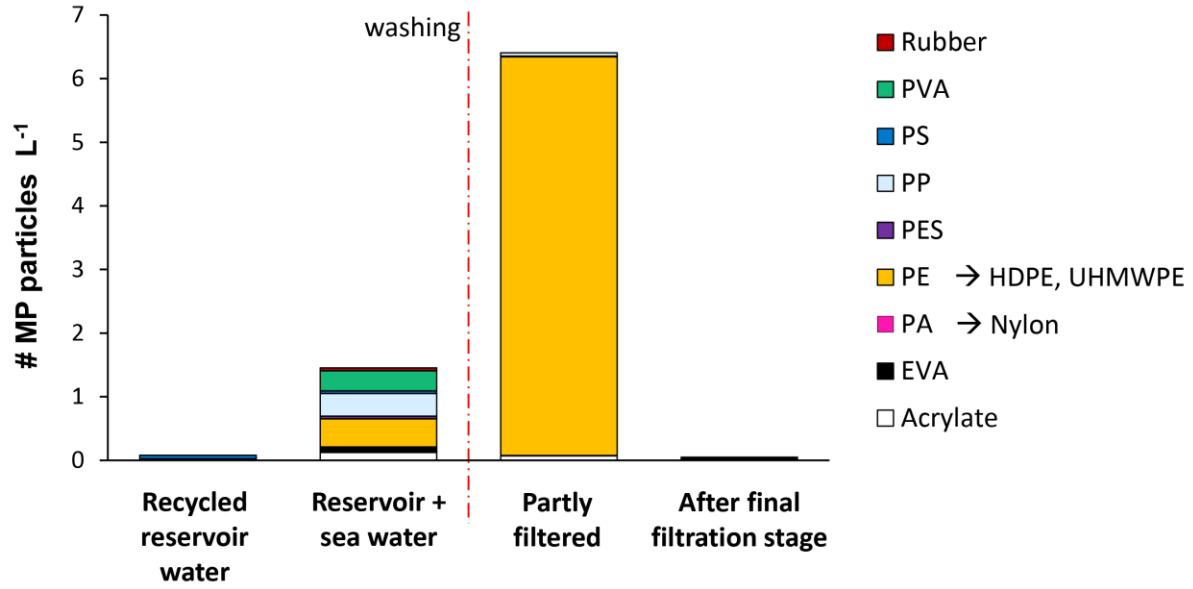
Service site as potential source for MP

Sampling conducted at 4 time points and 3 locations:

- Initial reservoir sample
- Reservoir sample post-seawater addition
- Intermediate filter stage
- Post-filtration discharge tank

MP

Filter → Seawater?



Drum washing does cause abrasion, but no release into the water if filtration applied

Summary

- Nylon nets may release significantly more MP than HDPE and UHMWPE under regular pressure cleaning .
- Coating performance differs strongly between net materials:
  - Coatings increased MP release from nylon nets, especially premium coatings.
  - Coatings on UHMWPE nets did not significantly affect MP release.
- Alternative net cleaning technologies showed promise:
  - Pressure and cavitation cleaning caused more severe coating damage.
  - AUV brushing caused a more uniform thinning of the coating → Possible nanoplastic emissions.
  - Actual MP particle counts were generally low and often indistinguishable from background MP levels.
- Used nets appeared to release more MP than new ones, especially in areas prone to abrasion. Residual coating may have influenced the amount of MP measured.
- Filtration systems at service sites are effective at retaining MP.
- MP were measured at an actual site, so there is release from aquaculture farms.

Knowledge gaps - SMARTER

- How much MP is released at sea vs. during landbased washing?
- Further combinations of net and coating materials should be tested to gain a better understanding of MP emissions
- More reliable emission data under different washing technologies
  - Controlled mesoscale lab studies?
- Effect of net age on MP release
  - Better knowledge of net history needed
  - Follow same net over longer period of time (e.g., full working life), sampling at different life stages
- Conduct longitudinal studies in operational aquaculture sites to track MP release and concentrations in both water and sediments over multiple seasons and under varying environmental conditions (e.g., UV exposure, temperature, salinity, biofouling).
  - Ideally at new aquaculture locations to include baseline mapping

Thanks for your attention!

Access the SMARTER final report here!

Research

SINTEF NORCE

Industry

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Communication

NCE AQUATECH CLUSTER
Norwegian Aquaculture Technology

Reference Group

SjømatNorge Grieg Seafood AKVA GROUP

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