SCALE AQ

Microplastics in Aquaculture

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Why focus on Microplastics?

Microplastics (MPs) = particles < 5mm.

- Aquaculture in Norway generates roughly 30 000 tonnes of plastic waste per year.
- MPs have been identified in over 300 marine fish species (80% are of commercial importance).
- 2024 UN treaty on plastic pollution.

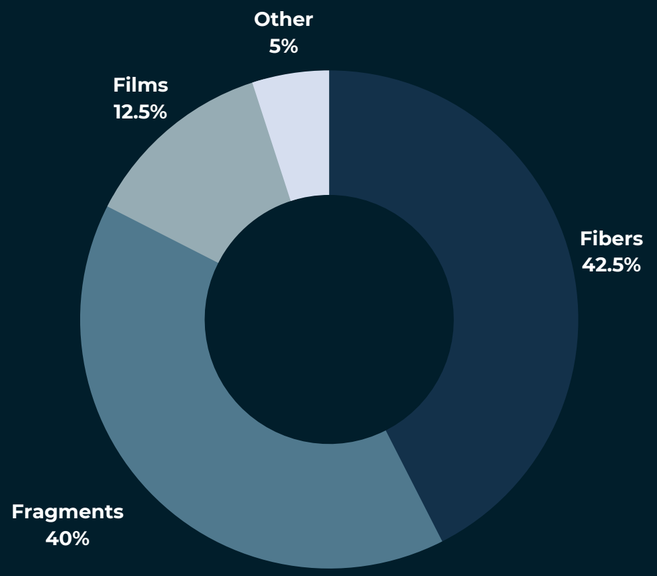
Goal

Identify the sources and occurrence of MPs from aquaculture activities and discuss their ecotoxicological risks, with a focus on ScaleAQ operations.

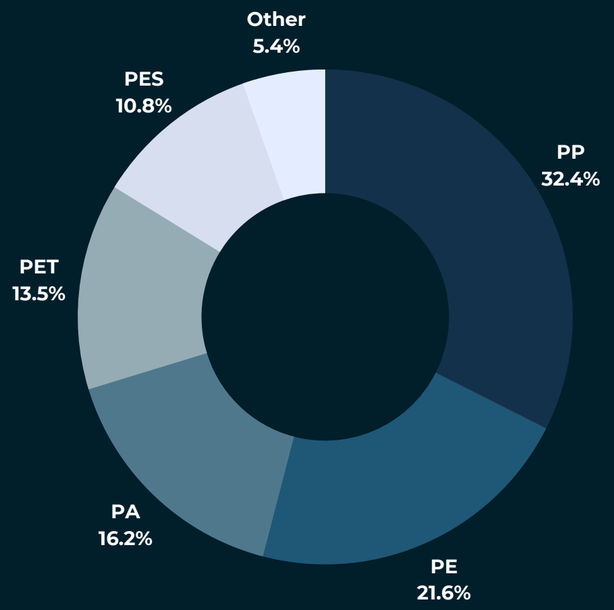
Methodology

- Literature research.
- Interviews with different experts in ScaleAQ and research specialists in MP pollution from SINTEF and NTNU.

A) Shape



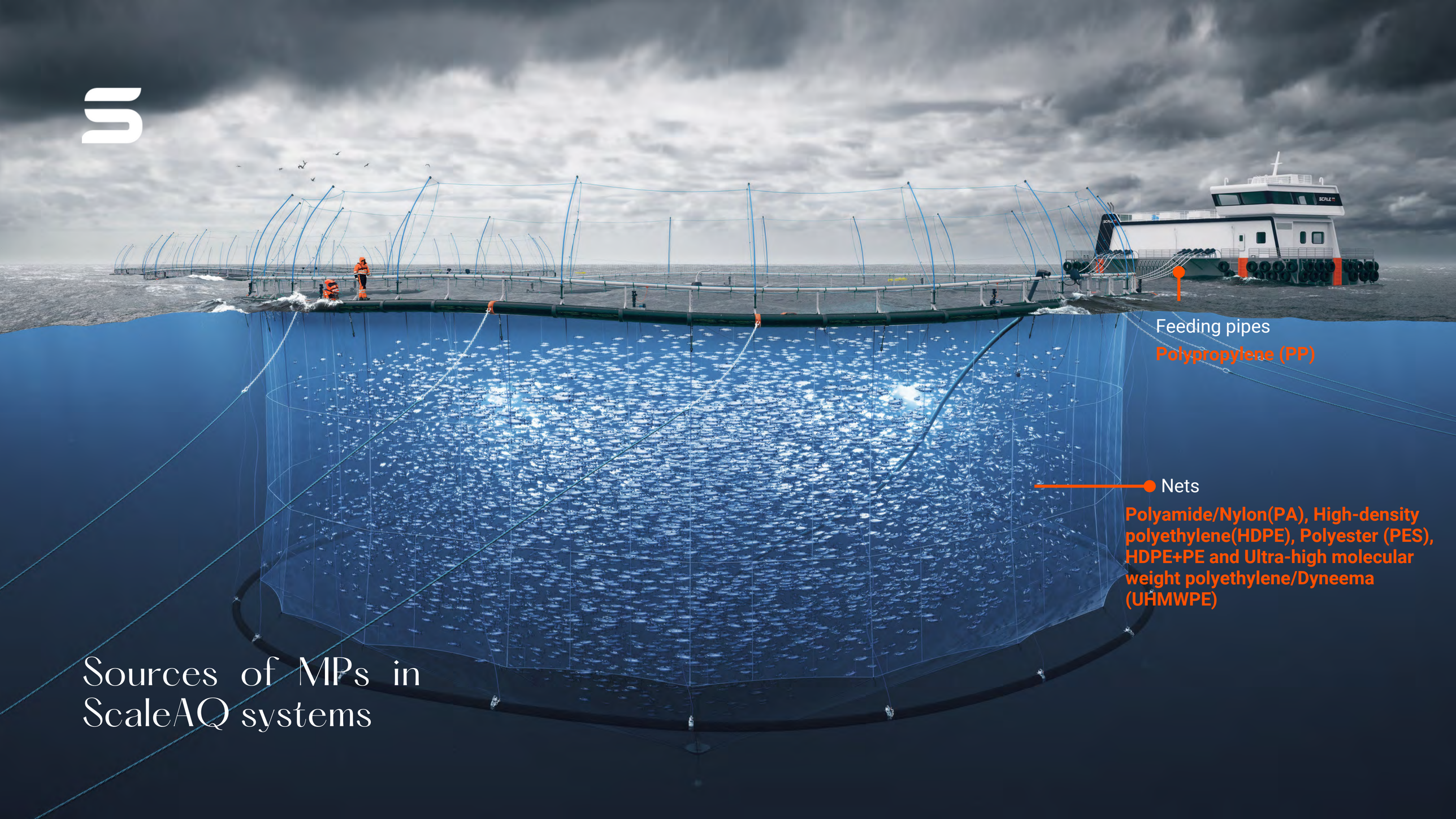
B) Polymer type



*PP =Polypropylene, PE =Polyethylene, PA= Polyamide/nylon,
PET= Polyethylene terephthalate, PES= Polyester

MPs types found in ScaleAQ regions

- MPs have been recently reported in all ScaleAQ regions with variable concentrations.
- This suggests that MPs originate from secondary sources.
- Hard to trace where they come from.



Sources of MPs in ScaleAQ systems

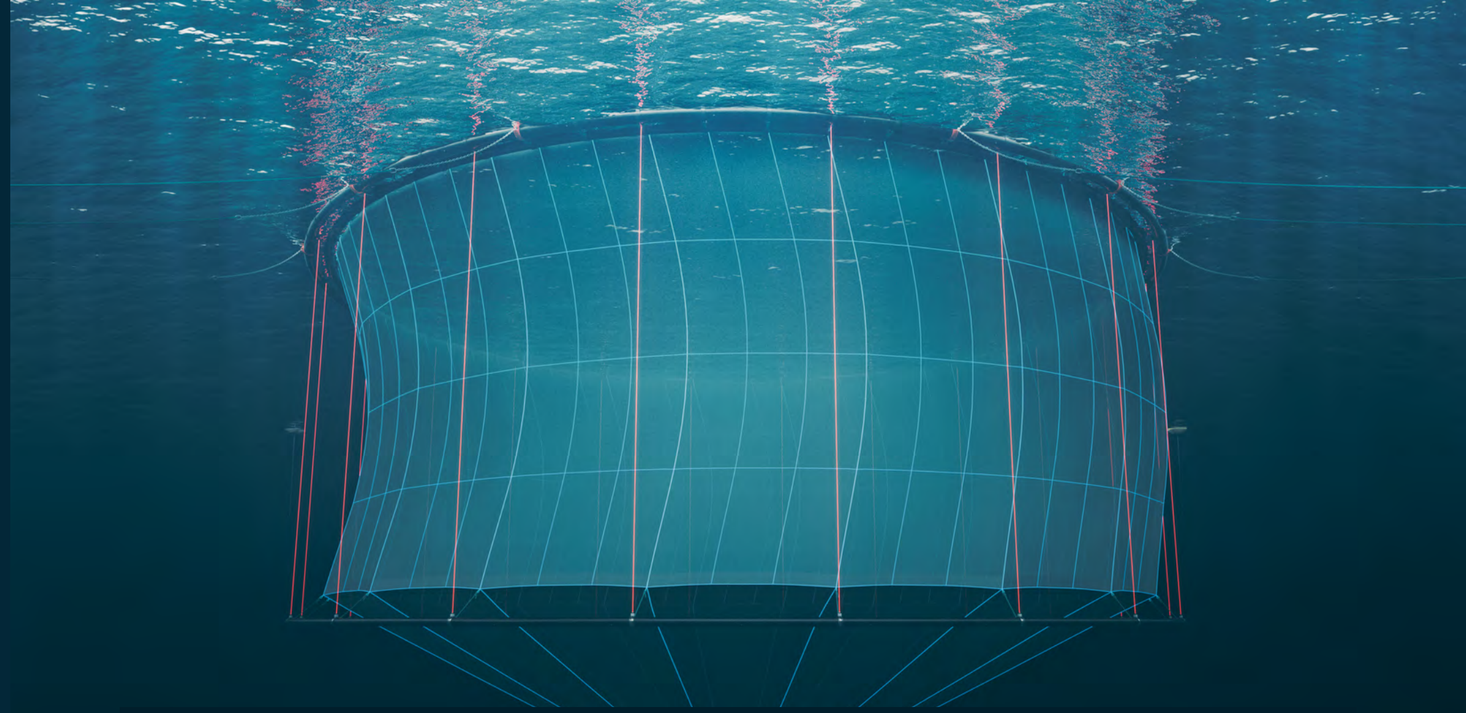
Feeding Pipes

- The outer layer contains at least 2% carbon black = preventing UV-induced degradation.
- The pallets that pass through the feed pipes under high pressure wear the inside walls of the plastic structure.

Weight loss: 36.5 – 146 g/m/year.
Annual SAQ sell: 519 504 m/year
SAQ MPs footprint: 152 – 608 tonnes/year.

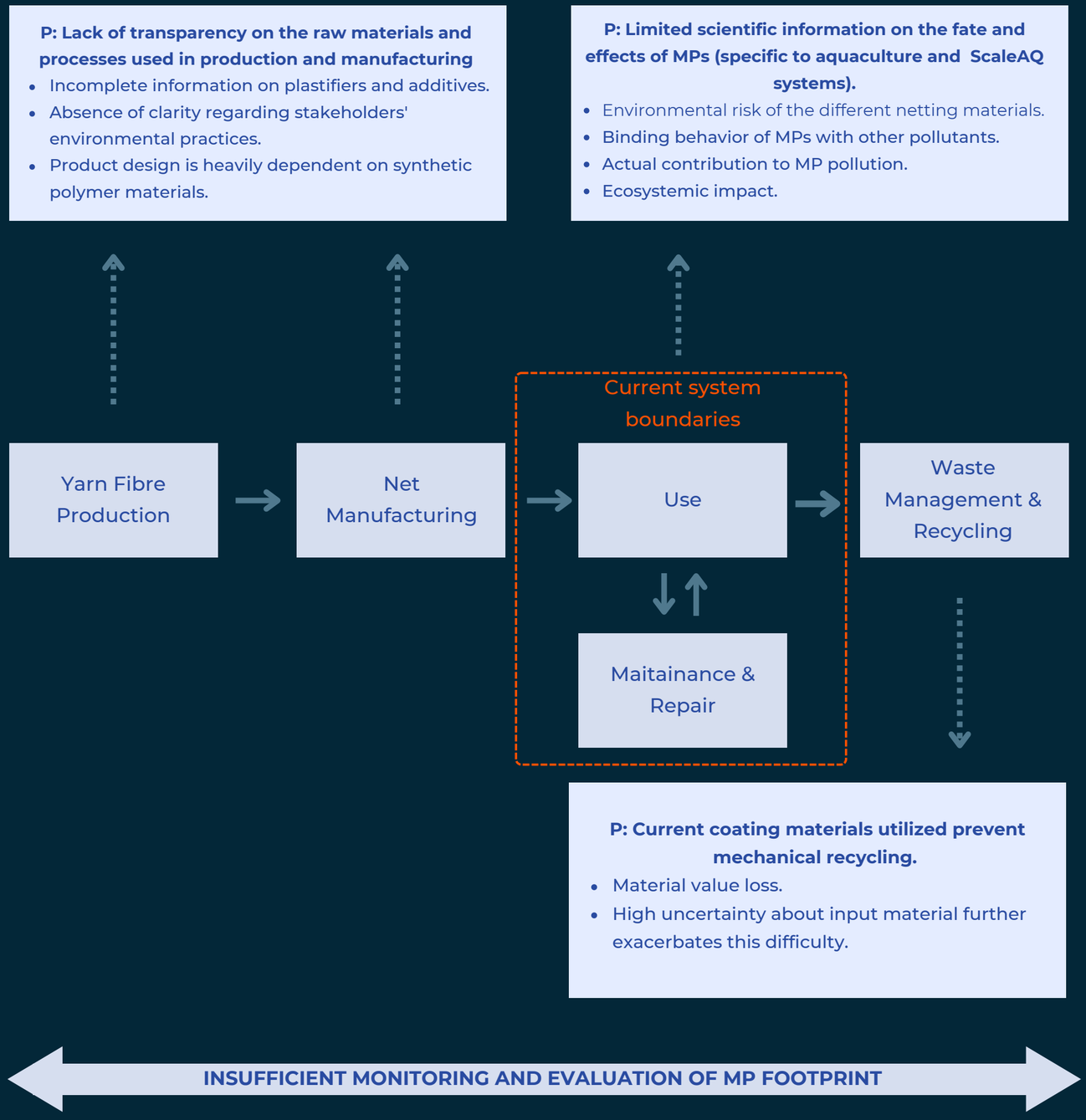
Nets

- Probably the most significant source of MPs.
- Nylon nets are the most frequently sold and the least resistant to abrasion and UV degradation compared to the other materials.
- Require antifouling coating and thus represents increased environmental risks.

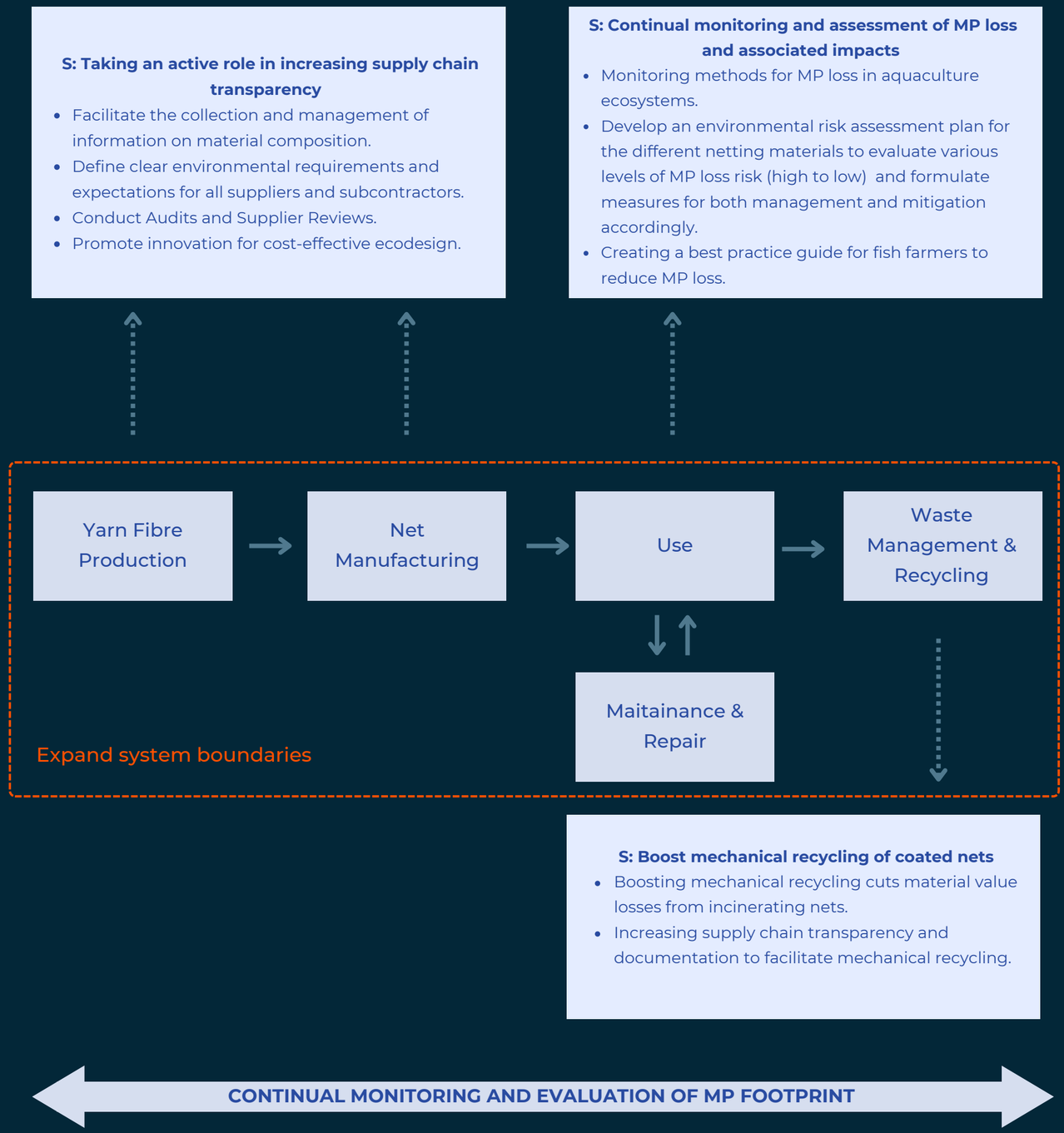


MPs emissions: 0.11–0.75 fib/kg/net.
Midgard's mean weight: 3 487 kg.
Annual SAQ sell: 171 nets.
SAQ MPs footprint: 66 783 – 447 207 fibers/year.

Challenges Across the Life Cycle of Nets



Potential Strategies Across the Life Cycle of Nets



MPs in Aquaculture systems

- Concentration is generally higher than in surrounding environments.
- Enclosed or semi-enclosed aquaculture habitats prevent the transfer of MPs to other areas.
- Fish feed, medicine, and antibiotics are other sources of MP pollution in aquaculture environments.

Ecotoxicological Effects

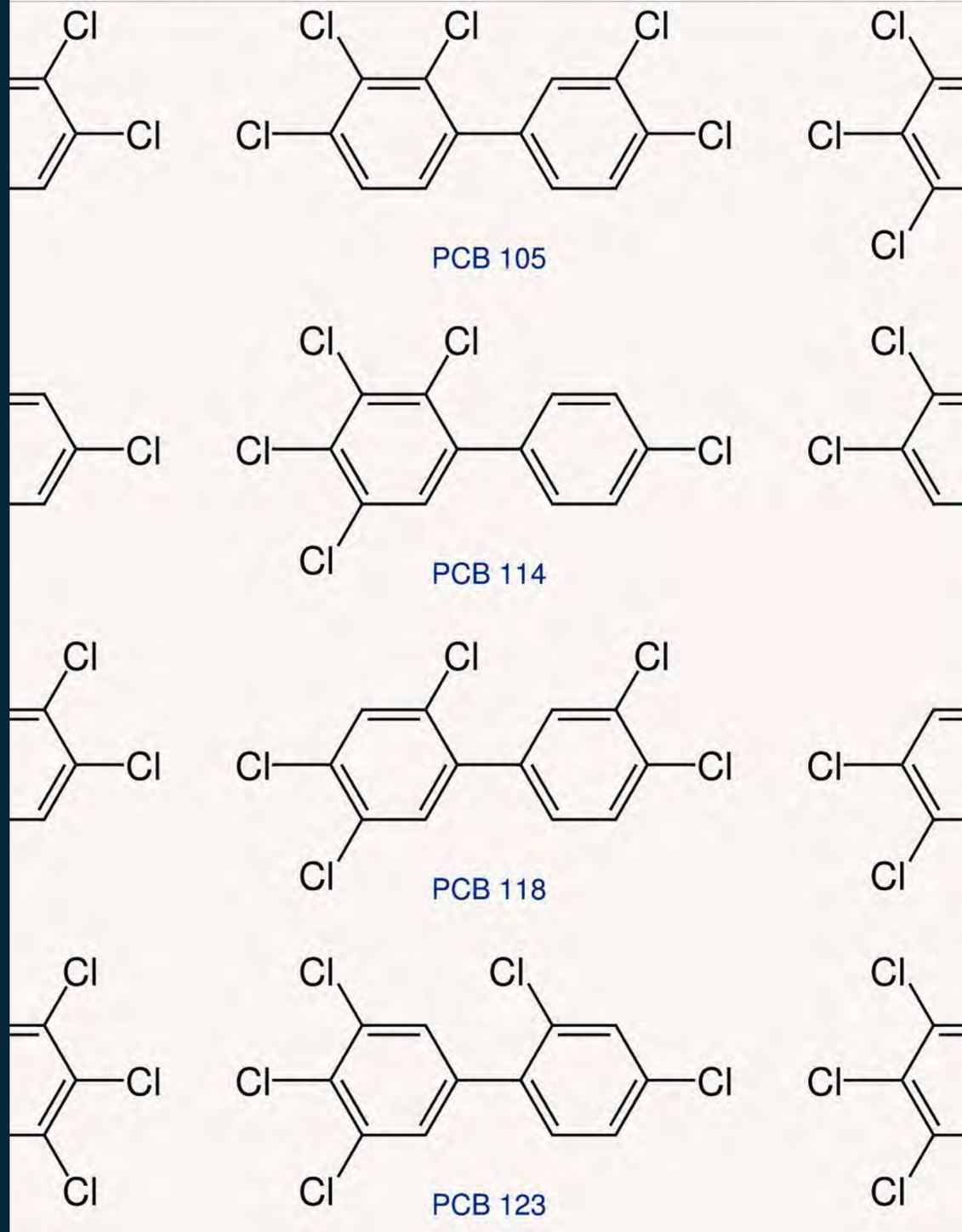
- Gastrointestinal tract.
- Reduced Immunity.
- Reduced feeding and interrupted digestion.
- Impact on reproduction.
- Neurotoxicity
- Cell absorption and organ transfer.

Combined effects of MPs with heavy metals (HMs)

- MPs can act as magnets for other hazardous pollutants, and further concentrate them to very elevated levels.
- By attaching to MPs, the contaminants can enter and accumulate in tissues.
- A study on blackspot seabream exposed to MPs and copper revealed that combined exposure during early development can severely affect fish survival, which may have implications for population health (1).

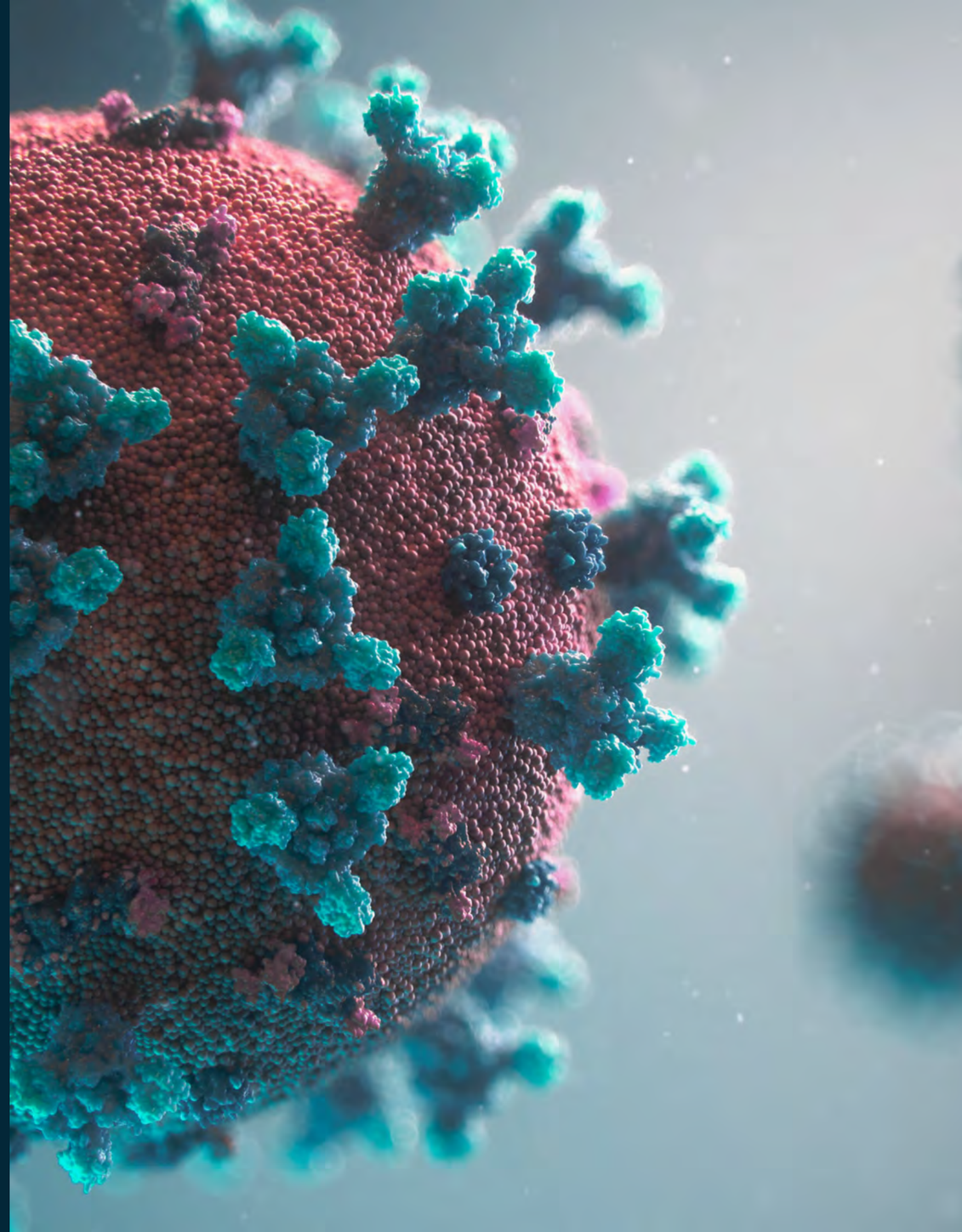
Combined effects of MPs with organic pollutants

- Fish feed is a source of organic pollutants, including PAHs and PCBs (in low concentrations).
- A study found that MPs have the potential to enrich PAHs at considerably higher concentrations within 45 min (2).
- Another study on Atlantic cod showed that PCB-126 spiked to PE were accumulated in the liver and muscle and produced an increased expression of the CYP1A enzyme.



Other effects

- MPs provide a hydrophobic surface for the attachment of microbes.
- May function as vectors for the transport of bacteria, including fish pathogens, in the oceans.
- A study showed show the presence of virulence genes and new variants of antibiotic resistance genes in *A.salmonicida* isolated from MPs collected from the West coast of Norway (4).



Trophic chain transfer

Through the food web, MPs and associated contaminants can transfer and bioaccumulate in high trophic organisms, posing a serious threat to aquaculture products and potential human health risks.

Recommendations

01. Nets

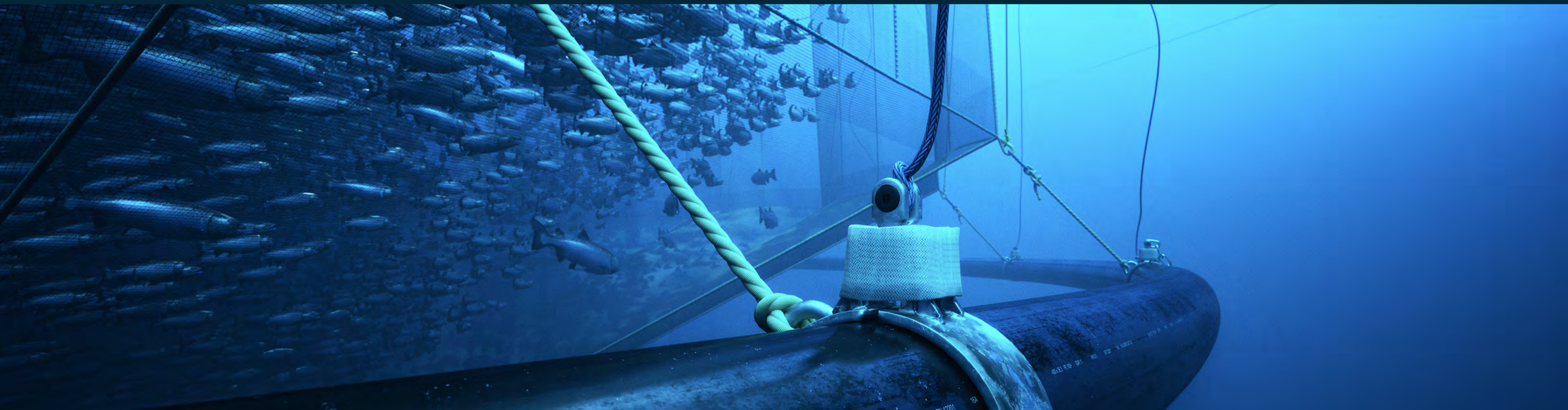
- Focus on polymer materials with thicker fibers and lower degradation rates.
- Avoid mixing polymers for better recyclability.
- Promote new-generation washing technologies such as cavitation-based washing and brush-based grooming.

02. Feeding pipes

- Implement waterborne systems.
- Reduce curving and length.

Conclusion

- Studies regarding the relationship between microplastics, aquaculture products, and their potentially detrimental impacts on human and ecological health remain limited.
- ScaleAQ is focusing on reducing MPs emissions from feeding pipes, but more effort is required for nets.
- Likewise, the understanding of MPs' footprint from feeding pipes has grown, but information remains scarce about the nets (the company is actively addressing this).



Thank you

Any questions?

References

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3. Bogevik AS, Ytteborg E, Madsen AK, Jordal AEO, Karlsen OA, Rønnestad I. PCB-126 spiked to polyethylene microplastic ingested by juvenile Atlantic cod (Gadus morhua) accumulates in liver and muscle tissues. Marine Pollution Bulletin. 2023 Feb 1;187:114528.
4. Radisic V, Nimje PS, Bienfait AM, Marathe NP. Marine Plastics from Norwegian West Coast Carry Potentially Virulent Fish Pathogens and Opportunistic Human Pathogens Harboring New Variants of Antibiotic Resistance Genes. Microorganisms. 2020 Aug;8(8):1200.

Systemic - and Ecodesign Aquaculture

SCALE AQ

The Project

A presentation by
Janne Fagerli Isaksen

Field of study
Master's degree Industrial Design
NTNU, Department of Design

In collaboration with
Norwegian Retailers' Environment Fund, which funds the project Circular Plastics 2023-2026

SirkAQ
In December 2022, the "Circular solutions for the aquaculture industry" project (SirkAQ) was awarded a grant of almost NOK 70 million from the government's Green Platform support scheme.

Aim
Aims to encourage more circular usage of plastics.

My Task
Contribute to creating a common understanding, within ScaleAQ and SirkAQ, of the current situation and increase awareness regarding the importance of including ecodesign.

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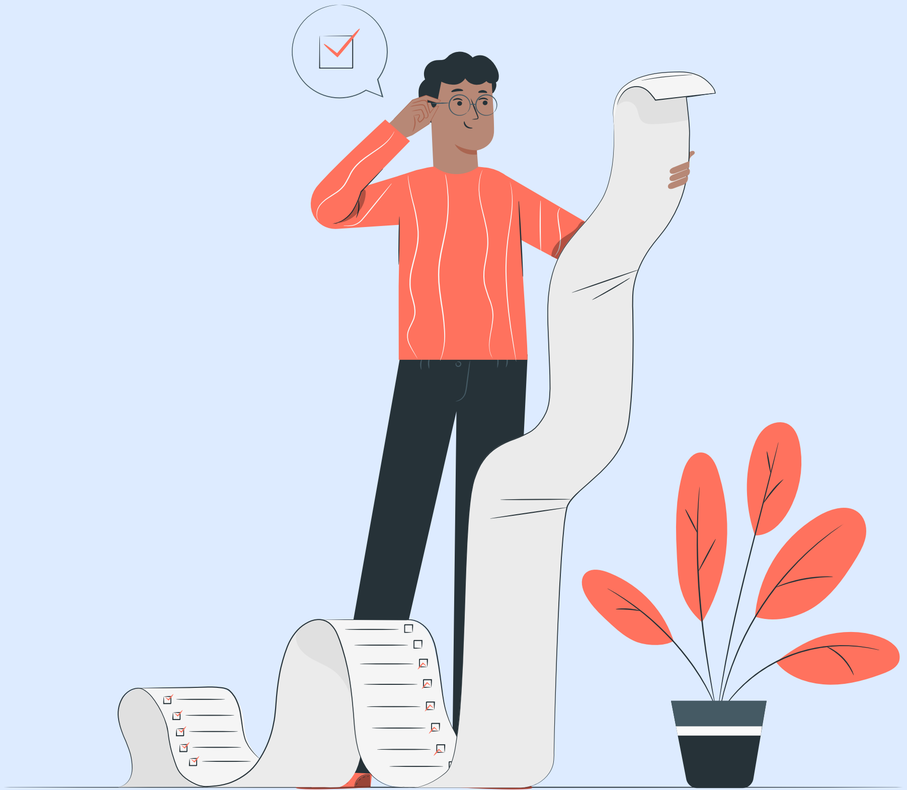


What Is The Challenge?

The Challenge

- Lack of ecodesign.

Therefore, I have

- Worked on analyzing and uncovering where sustainable measurements should be considered.
- Vortex has been a starting point for the analysis.

The Approach

System Thinking and Design Thinking

- Gigamapping as process tool

Co-Design

- Involving stakeholders

Ecodesign

- System thinking uncover opportunities

What actually is..?

What actually is system thinking?

- Method for understanding complex systems
- Wholes and relationships.

Why do system thinking?

- Shift the thinking, patterns, and culture of organizations or even societies.

What actually is Gigamapping?

- Mapping across multiple layers to construct a rich picture of real-life complexity.

Why do Gigamapping?

- Super for sharing views, getting teams on the same page and for co-design (actively involving stakeholders in the design process)

What actually is Ecodesign?

- Optimize, have the same functionalities, while reducing impact on the environment.

Why do Ecodesign?

- Better overall performance of the product over its entire life cycle.

What Is The Current Situation?

Mapping of Current Situation

Semi — structured interviews

- Key people ScaleAQ
- Costumer
- Recycler

Waste management aquaculture

- Existing literature
- Ecodesign check list — Co-design

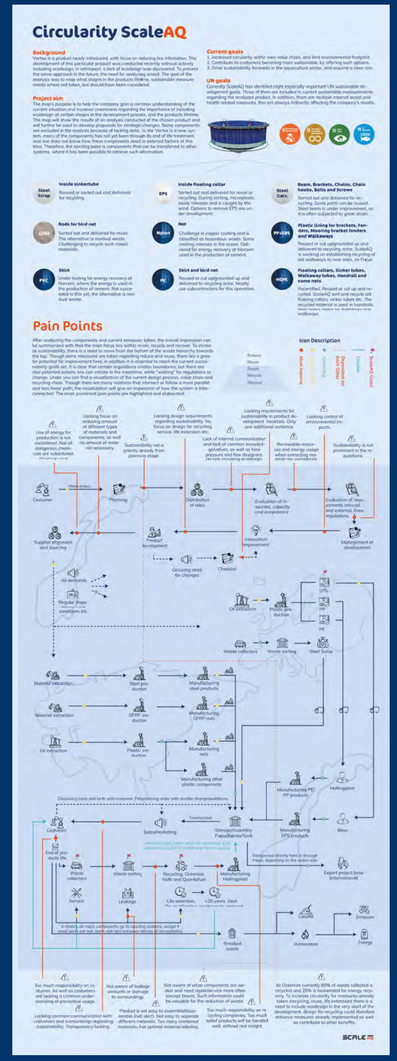
ScaleAQ and SirkAQ

- Mission
- Vision
- Value
- Goals

Connected together in gigamap

Current Waste management

Across many sections, layers and scales with the goal of investigating relations between seemingly separate categories



Background and goals

Identified Pain Points

Interconnections design process, value chain and recycling chain

Key Findings

- Variety of measures taken from value chain to recycling chain, with most focus on end of life treatment.
- Little to no measures taken in development process, with few people on development.
- Regulations and requirements (internal and external) little to no focus on sustainability.
- **Including ecodesign in the start of the development process is key to create chain reaction**

Below The Surface

Root Cause

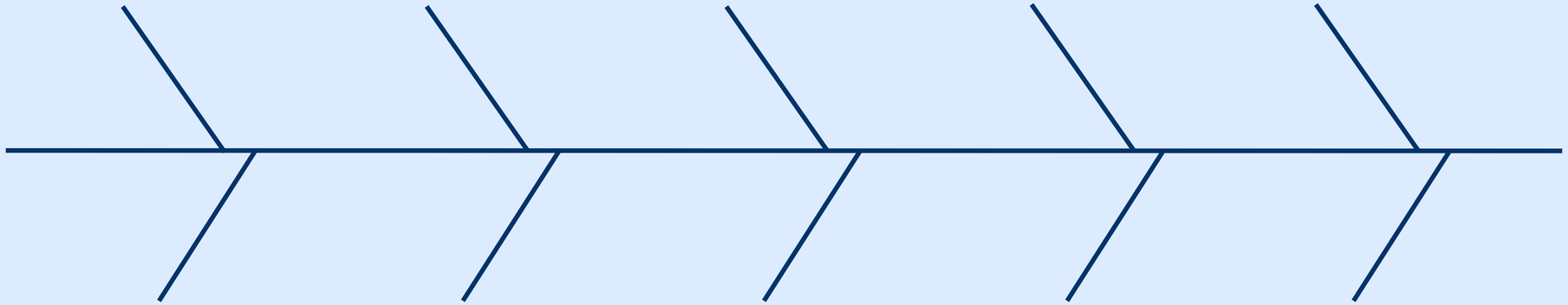
Sustainability team is separated from development team

Already experiencing time pressure and few people working with the product development

Perception that ecodesign is time and resource demanding

Stuck in “old” habits, not open for change. “Lets not change it because it works”

Economic motivation. Does not see many economic benefits from ecodesign



Ecodesign is implemented too late

Lack of awareness/ knowledge, of the benefits ecodesign can have for an organization

Perception of ecodesign increasing possibility of more responsibility

Lacking a common understanding of what is important in the organization

Technical requirements and regulations are the first priorities (little to no paragraphs' sustainability)

Afraid ecodesign will result in lower function and quality and drive big costumers to competitors

What Is The Goal?

SirkAQ

- Promote the **transition from linear to circular economy in aquaculture.**
- Especially with focus on plastics from equipment that has reached **it’s end-of-life.**

Vision

- **"Zero plastic waste by 2030".**

ScaleAQ

Vision

- ScaleAQ = Aquaculture.
- Want to create the **aquaculture of the future**.

How To
Move Forward?

Leverage Points

These are areas within a complex system, in this case an organization, where small changes at one area can lead to big changes in the whole system.

2. The mindset/paradigm.
- Lacking common mindset

3. The goal of the system.
- Lacking common goal.

5.The rules of the system.
- It does not help to change the players if the game stays the same.

6.The structure of information flows.
- Lacking common knowledge.

Current Situation

Mostly linear economy with focus on improving recycling, reuse and lifetime extension.

Current Situation

1.

Short Term

Awareness

Creating awareness around benefits ecodesign has, not not only for the environment, but for the organization.

Milestone 1

2.

Mid Term

Mindset Change

Mindset change from impro-ved awareness. Ecodesign will be bene-ficial for both organi-zation and environment. Requirements for design and environment improves.

Milestone 2

3.

Long Term

Include Eco-design From Start

Including ecodesign at the start of deve-lopment to increase circular economy.

Milestone 3

4.

Ideal Future

Circular economy as far as possible.

Ideal Future

5.

Conclusion

- Currently, the focus in both ScaleAQ and SirkAQ remains material, major focus on the end of life treatment.
- Though this is important. This might not be the key to create a bigger change towards circularity, that they clearly want, in the long run.
- The mapping shows: to be able to reach the goals set, a bigger non — materialistic mindset change is essential. Changing the rules of the system and the information flow can contribute.
- Change in mindset, and including ecodesign at the start phase it will create a chain reaction affecting the end of life treatment as well.

Change of Focus

Reduce

Reuse

Repair

Recycle

Recover

Thank You For Listening!