



UNDERWATER HULL CLEANING: An overview

LEGISLATIVE CONTEXT

International Regulations:

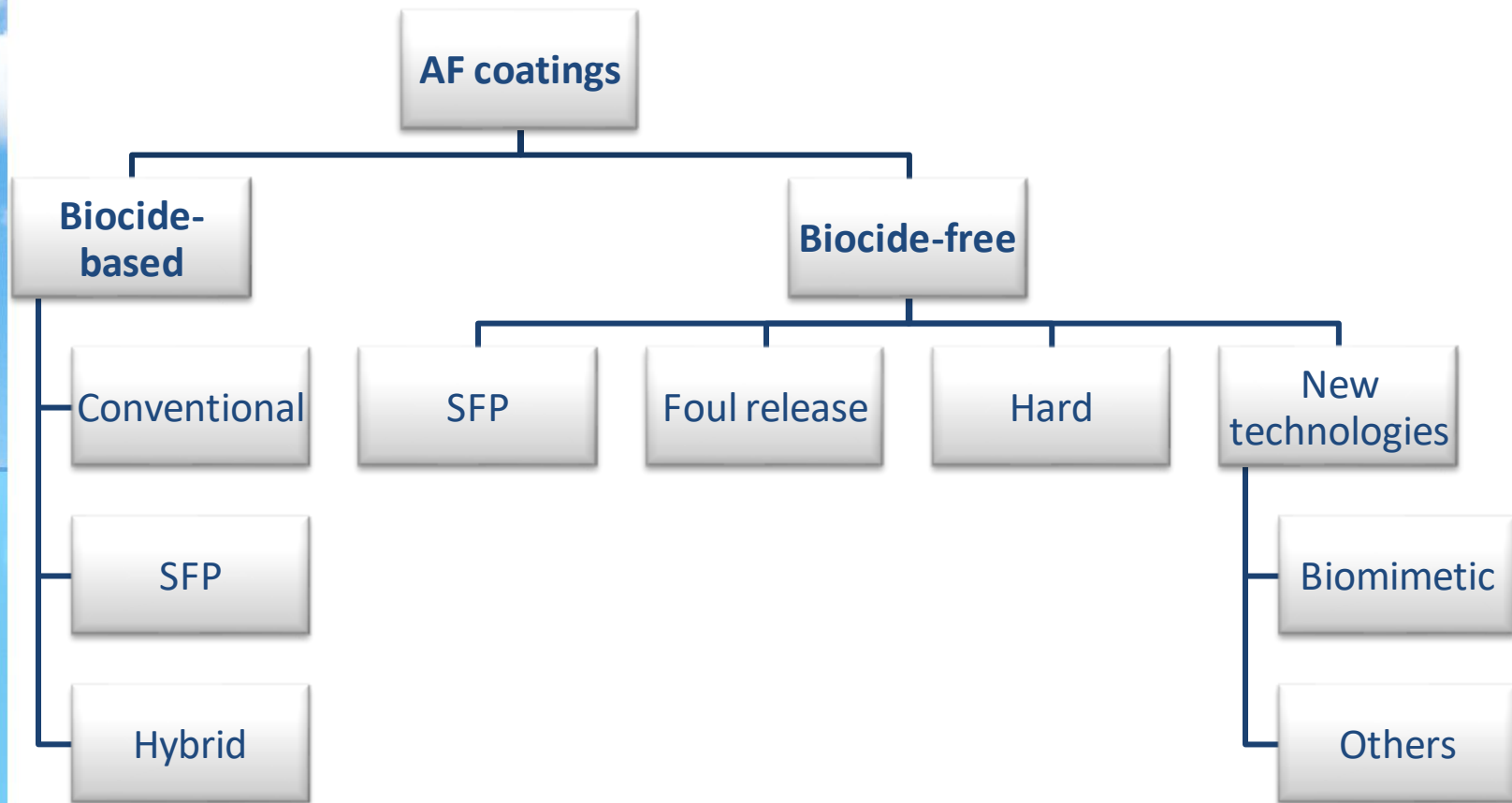
- IMO International Convention (2001) - in full force since 1 January 2008

European Policies:

- Reg.(EC) No 782/2003; Reg. 536/2008/EC
- BPR Reg. (EU) 528/2012
- Water Framework Directive (WFD) 2013/39/EU

PROACTIVE ANTIFOULING SYSTEMS

Proactive systems prevent or clean new fouling and slime

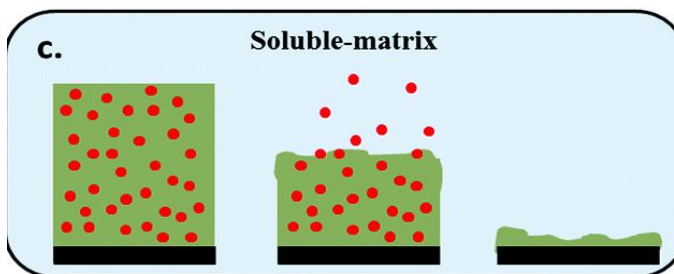
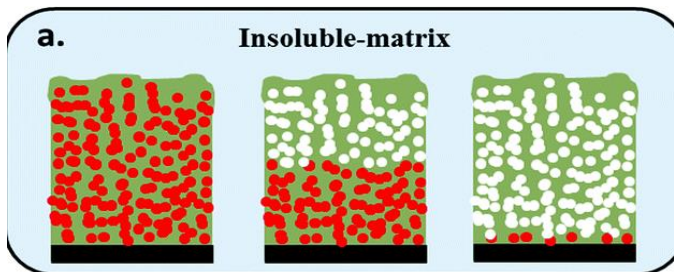


MAIN ANTIFOULING COATINGS

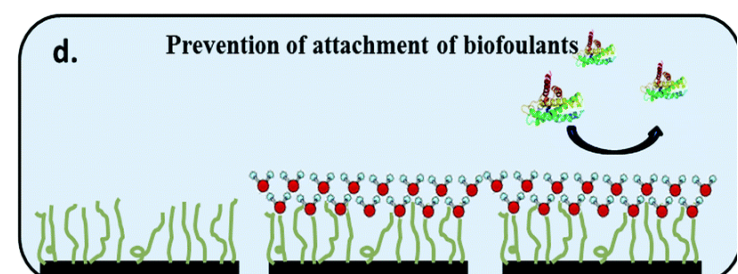
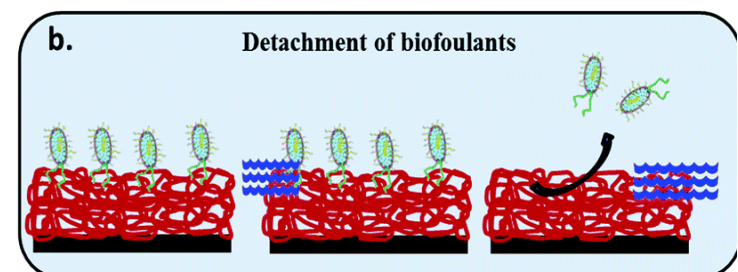
Biocide-based



Biocide-free



- Coating matrix
- Pigments
- Holes



- H_2O molecules
- Hydrophobic structure
- Hydrophilic structures
- Marine biofoulants
- Proteins
- Flow of water



ANTIFOULING RESTRICTIONS AND BANS

TBT ban

Asia: Some SA countries have not ratified IMO convention (Hong Kong, Thailand, Philippines, Cambodia, Laos, Myanmar, Taiwan and Brunei.)

Only few local restrictions exist.

Rest of the world: 79 countries ban the use TBT on boats with the country flag and boats accessing their harbours and ports

Copper restrictions

Copper based AFPs are allowed in most of the world without restrictions including USA, South America, Europe and Asian countries.

However some restrictions are in place in some countries:

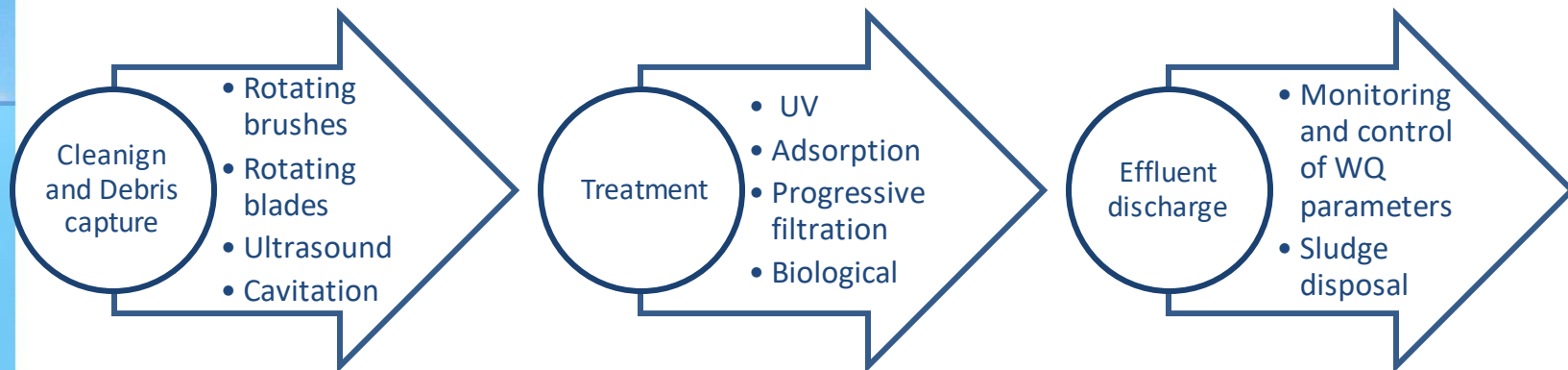
Scandinavia and The Netherlands:


- Maximum content of copper for usage in leisure boats
- Only certain copper biocides are allowed: Copper (I) oxide and copper thiocyanate
- Initiatives to ban copper.

ANTIFOULING SYSTEMS

Reactive react and clean macrofouling where prevention hasn't worked:

- Traditional dry docking cleaning
- In-water hull cleaning systems:



An underwater photograph showing a large, dark, cylindrical shipwreck resting on a sandy ocean floor. The water is clear and blue. In the foreground, a large, dark stingray is resting on the sand. Several colorful fish, including striped tangs and yellow tangs, are swimming around the wreck and the stingray. A thought bubble is overlaid on the right side of the image, containing the text "Where does Copper go and what does it do?".

**Where does
Copper go and
what does it
do?**

Environmental Impact

Main chemical release

- Cu and Zn other heavy metals (Pb, Ni, Sn, Fe, Al)
- Organic compounds, polymer backbones, solvent residue, etc.
- Biofouling

Speciation and Toxicity

- Cu^+ Cu^{2+} , inorganic and organic complexation, transchelations, etc.
- Sludge and solid residues
- important? complex kinetics
- Will depend on the Lab vs real complex environmental specifics of the system conditions

Fate

- Accumulation in sediments and biota
- Water pollution – enclosed harbours and marinas
- Invasion of non-indigenous species

CLEANING AND DEBRIS CAPTURE

Environmental concerns:

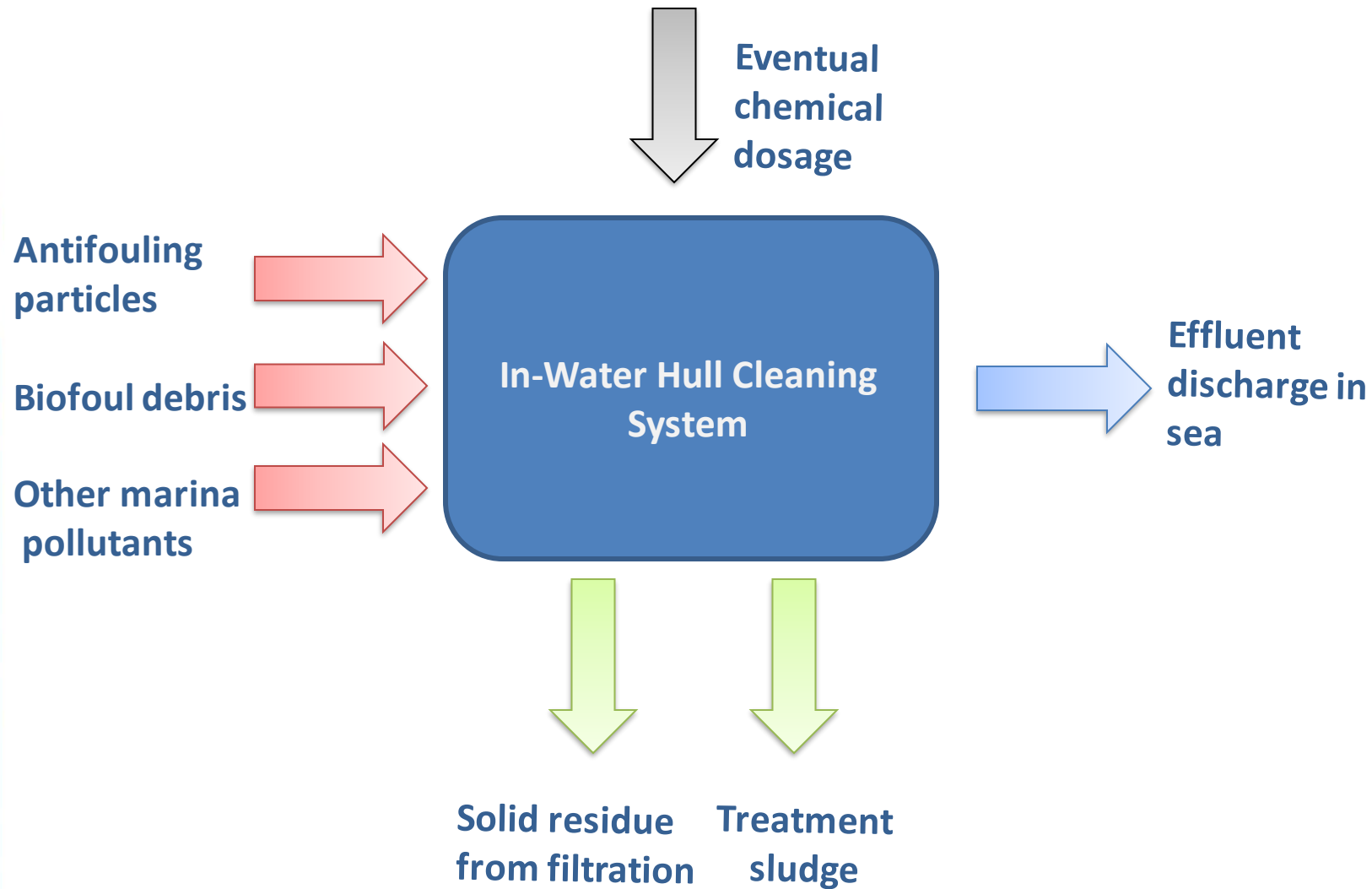
- Capture debris efficiency
- Monitoring of surrounding water quality and debris loss

Technical concerns:

- Biofouling characterization and removal efficiency
- Monitoring of coating surface and potential damage



TREATMENT AND DISPOSAL



TREATMENT AND DISPOSAL

Key aspect of the treatment and removal of pollutants from water:

- Discharge standards and removal efficiency
- Targeted and specialized for fouling and AFP type or adaptable
- Energy consumption and chemical dosage for environmental compliance
- Waste classification according to the EWC
- Characterization of waste flows for a correct disposal favouring the Enviromental and Circular Economy frameworks
- Cost and feasibility





TecHullClean (Spain +international partners)

Approved by AFP companies like Jotun (Norway) for ships and large vessels

- Semi-Hybrid moving systems for hull and niche areas
- Rotating brushes
- Progressive filtration

Current status: Active in +7 ports

KeelCrab and UltraCrab (Italy)

- ROVs for small boats
- Rotating brushes or ultrasound
- Small nylon container for debris capture, no water treatment

Current status: Commercially available and customizable





Envirocart (Australia)

Award-winning

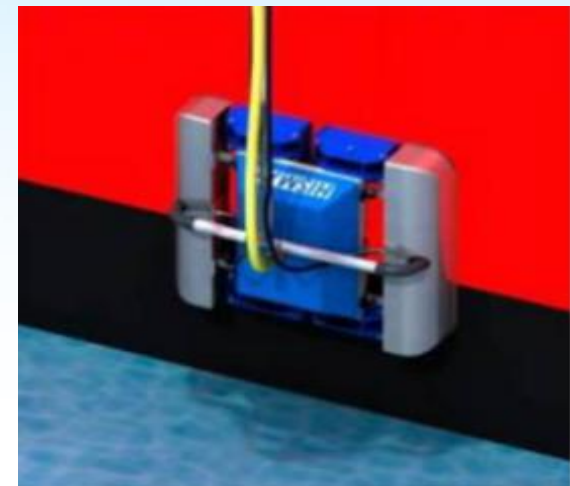
- Diver-driven
- Rotating brushes or blades
- Can treat various AFPs
- Filtration + UV

Current status: Active

Whale Shark and Beluga propeller (Canada)

- ROV
- Filtration

Current status: Active in the port of Vancouver





HISMAR (Public-private
European partnership)
For ships and large vessels

- Water jets
- Filtration

Current status: unknown

ECOStation (Norway)
Award-winning for ships
and large vessels

- ROV
- Rotating brushes
- Filtration + UV
sterilization

Current status: Active





MARAD (USA)

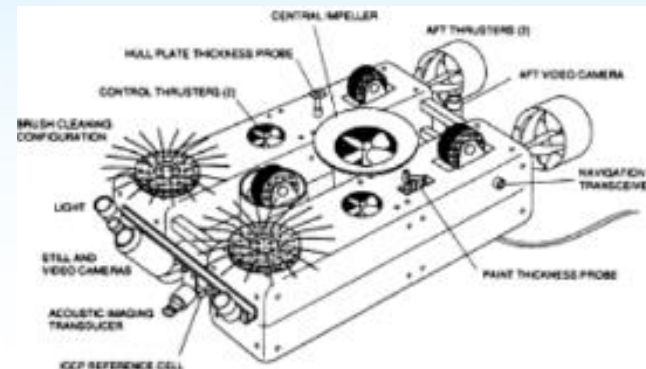
- Diver-driven
- Rotating brushes
- Progressive filtration + Organoclay adsorption

Current status: Ongoing

Testing results not compatible with discharge standards and hull protection

US Navy's AHMV and AHCS (USA)

- ROV
- Filtration



KEY TECHNICAL AND SCIENTIFIC ASPECTS FOR FURTHER STEPS

Policies and technical standards:

- Complex systems need an integrated risk assessment (biosecurity, fate and ecotoxicology) and evaluation.
- Standards, evaluation procedures and criteria are missing.

The leading countries in these matters are USA, NZ, AUS, NOR, SWE, DEN and NED.



KEY TECHNICAL AND SCIENTIFIC ASPECTS FOR FURTHER STEPS

Research

Valid and complete data are missing so further research initiatives are required:

- Involving of stakeholders; IWC operators, producers, boat owners, scientists and policy-makers.
- Tests of different types of treatments, cleaning and capture units.
- Testing in real environmental conditions.
- Developing of BMP and BTA.





THANK YOU FOR YOUR ATTENTION



UNIONE EUROPEA
EVROPSKA UNIJA

Interreg

ITALIA-SLOVENIJA



GreenHull