Micro- & Macro-Litter Monitoring and Protection in Semi-Enclosed Seas

-Mediterranean & Baltic Sea-

How to face the Marine Litter Challenge:

Cooperation science, industry, civil society and public authorities through innovative methods

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MARITIME FORUM: EU China Blue Year Event – forecasting, data, monitoring, planning, indicators

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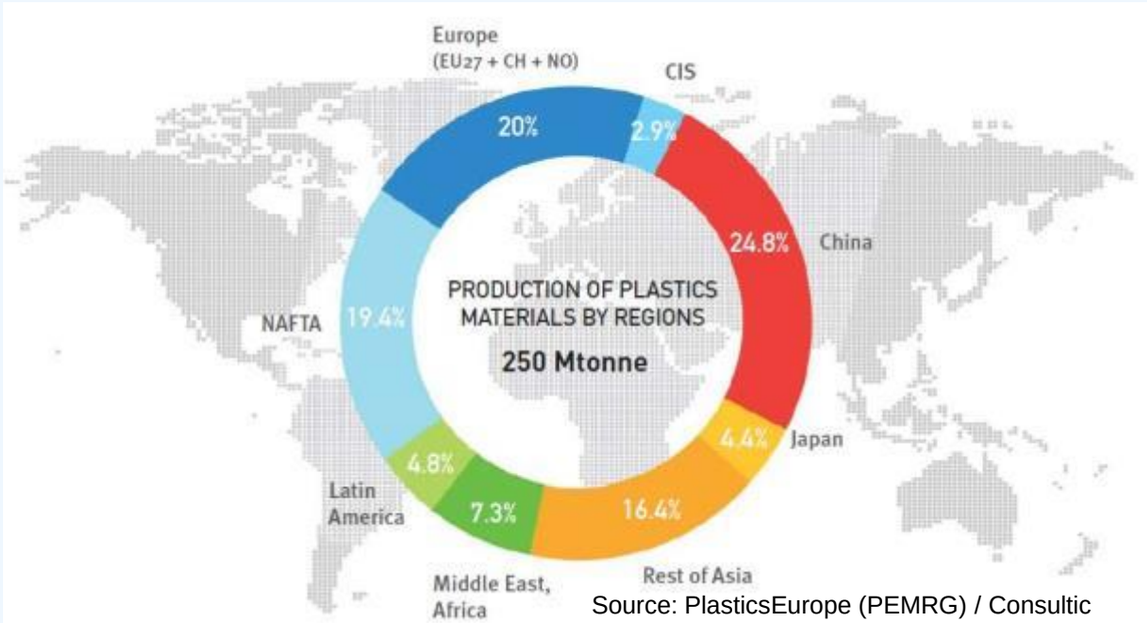
LITTER FACTS

Global Plastic Production

•Increased 20 folds in 50 yrs **•300mil tones in 2015** **•Expected increase 4x**



Source: PlasticsEurope (PEMRG) / Consultic

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Plastic Waste in Marine Environment

- **2010:** between 4.8 and 12.7 mil tones of plastics entered (Jambeck et al. 2015)
- **2015:** 180 marine species absorbed litter (UNEP, 2015)
- **Mediterranean Sea:** has one of the highest concentrations of macro litter globally (Leberton et al., 2015, Cozar et al. 2015, Suaria et al. 2016)
- **Baltic Sea:** annual release is up to 40 tones of micro plastic (<5mm); concentration levels is 5-10 higher than in the Med Sea (Broeg 2015)

MARINE LITTER IN THE ENVIRONMENT

Macro litter

Beach litter

Source: www.pintrest.com/

Floating

Source: https://www.haikudeck.com

On the seafloor

Source: www.eurolenta.com/

Ingestion

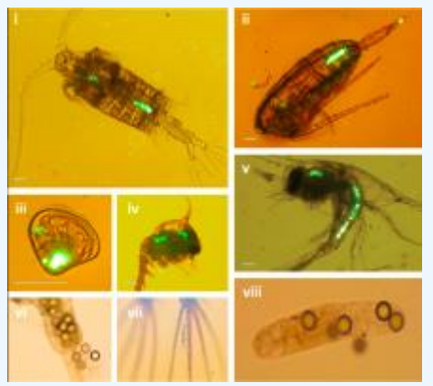
Source: www.texasenvironment.org

Micro litter

Beaches & sediments

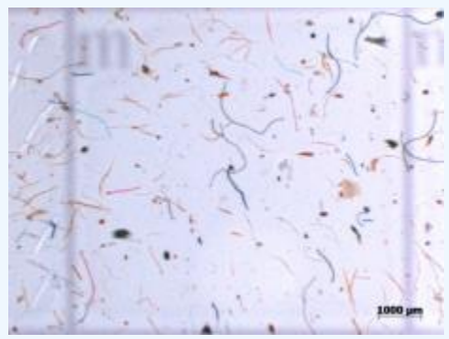
Source: http://www.green4ema.org

In marine biota



Source: Matthew, et al. 2013

In water column



Source: Vancouver Aquarium

SOURCES OF MARINE LITTER

Origin of Main Sources

	Sea based	Land based
Macro	Merchant shipping, ferries and cruise liners	Municipal Landfills
	Fishing vessels	Riverine transport of waste
	Military fleets and research vessels	Discharges untreated municipal sewage & storm water
	Pleasure craft	Industrial facilities
	Offshore oil and gas platforms	Tourism and other recreational activities
	Aquaculture installations	
Micro	progressive fragmentation already present in the sea	Synthetic textile fragments, plastic particles used in cosmetic, or industrial cleansers, etc.

Main Sources

	Global Scale	Semi-Enclosed European Seas
Macro	80% land-based sources	Mediterranean Sea: 80% land-based
		Baltic Sea: vary in different areas of the sea
Micro	unknown	Mediterranean Sea: unknown
		Baltic Sea: unknown

EU MARINE LITTER PROGRAMS

MONITORING:

MARINE Clean

Fishing For Litter

DeFishGear

marlin
BALTIC MARINE LITTER

BIO CLEAN

MARLISCO
Stopping Marine Litter Together

SMILE

CleanSea

PLASTOX

WEATHER-MIC

BASEMAN
Defining the baselines and standards for microplastics analyses in European waters

EPHEMARE
Ecotoxicological effects of microplastics in marine ecosystems

METHODS & TECHNOLOGIES: Sea Litter Critters, The Ocean Clean up

ADDRESSING THE CHALLENGES

1. Development of practical methods and innovative technologies for

   a) determining **litter pathways** and **accumulation areas** on a Sea Basin Scale

   b) detecting, monitoring and **calculating litter concentration** locally and on a Sea Basin Scale

   c) preventing and **cleaning litter at its source before entering** the sea

   d) handling litter close to the collection area

2. Ecosystem Approach: effects on ecosystem services

3. Economic feasibility and policy recommendations related to the developed methods and technologies

4. Social acceptance, awareness and responsibility

SHIPS OF OPPORTUNITY (SOOP)

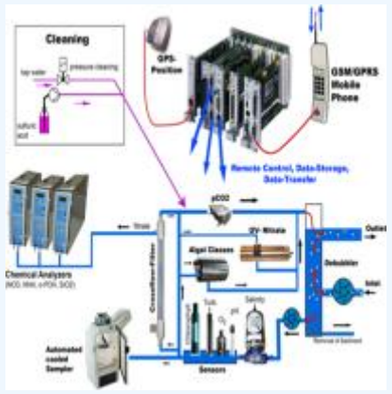
Challenges: 1b) Method – detecting, monitoring and calculating concentrations

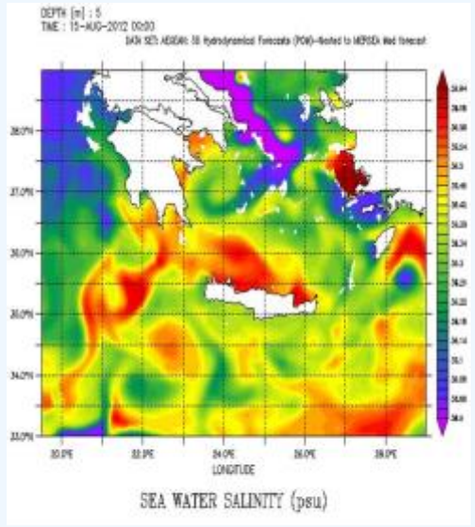
Baltic Sea

Mediterranean Sea

FerryBox systems on board SOOPs

- water loop brings water from the outside
- a data management system for control
- data acquisition, storage, transmitting





Surface Salinity Minimum: an indicator of Black Sea Water (BSW) flowing in the Aegean Sea.

Advantages:

- the system **is protected against harsh environment**
- no energy
- **easier maintenance** when ferry comes back "to our doorstep”
- **lower running costs** since the operation costs of the ship do not need to be calculated
- instead of point measurements (buoys) **transects** yield much more information.

EMODnet European Marine Observation and Data Network

SeaDataNet

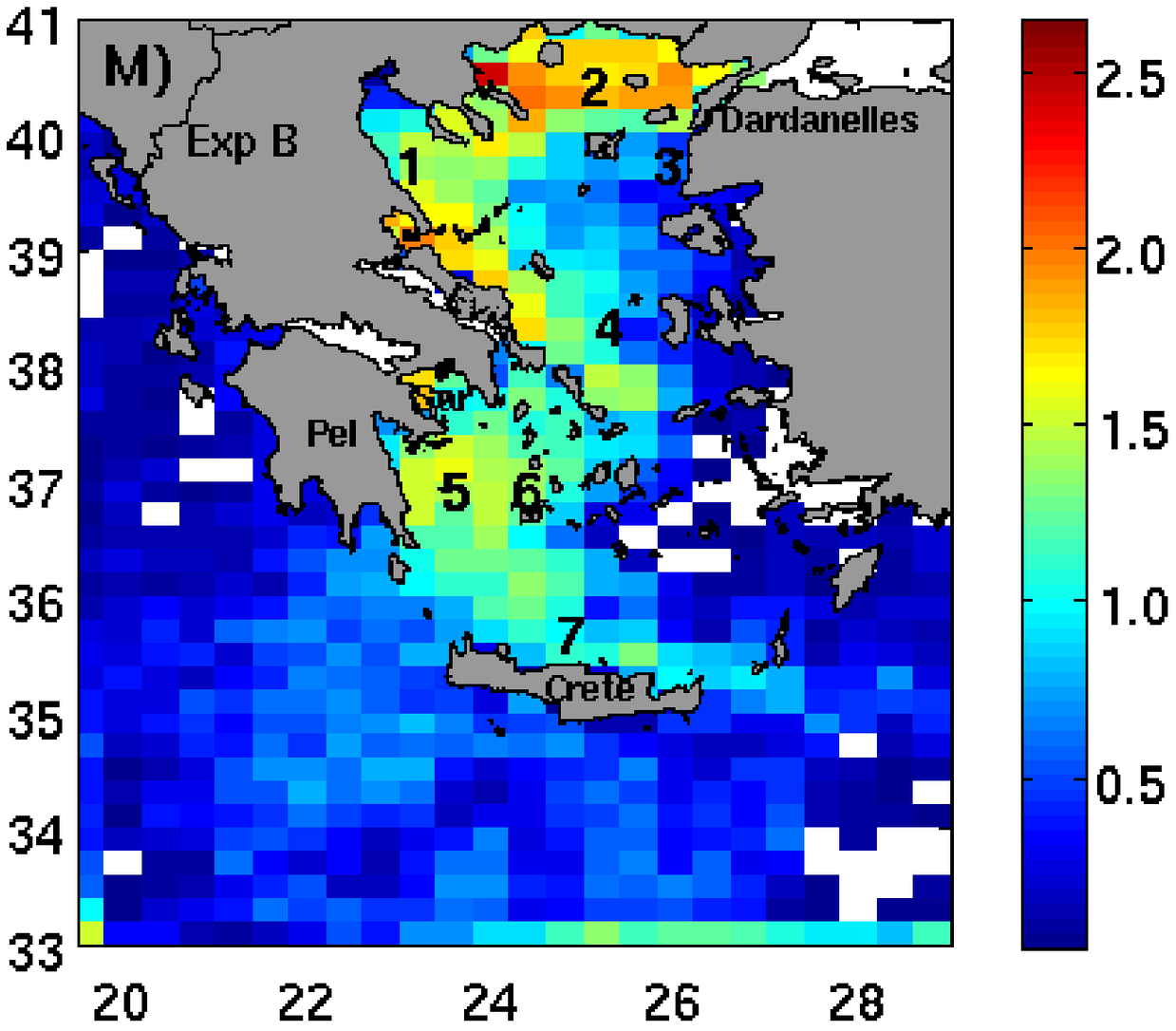
myOcean

Solution: Developing measuring system and micro litter detecting method for SOOPs

MODELLING

Challenges: 1a) Method – litter pathways & accumulation areas

2) Ecosystem Approach



Source: Politikos et al. (submitted Frontiers in Marine Science)

Advantages:

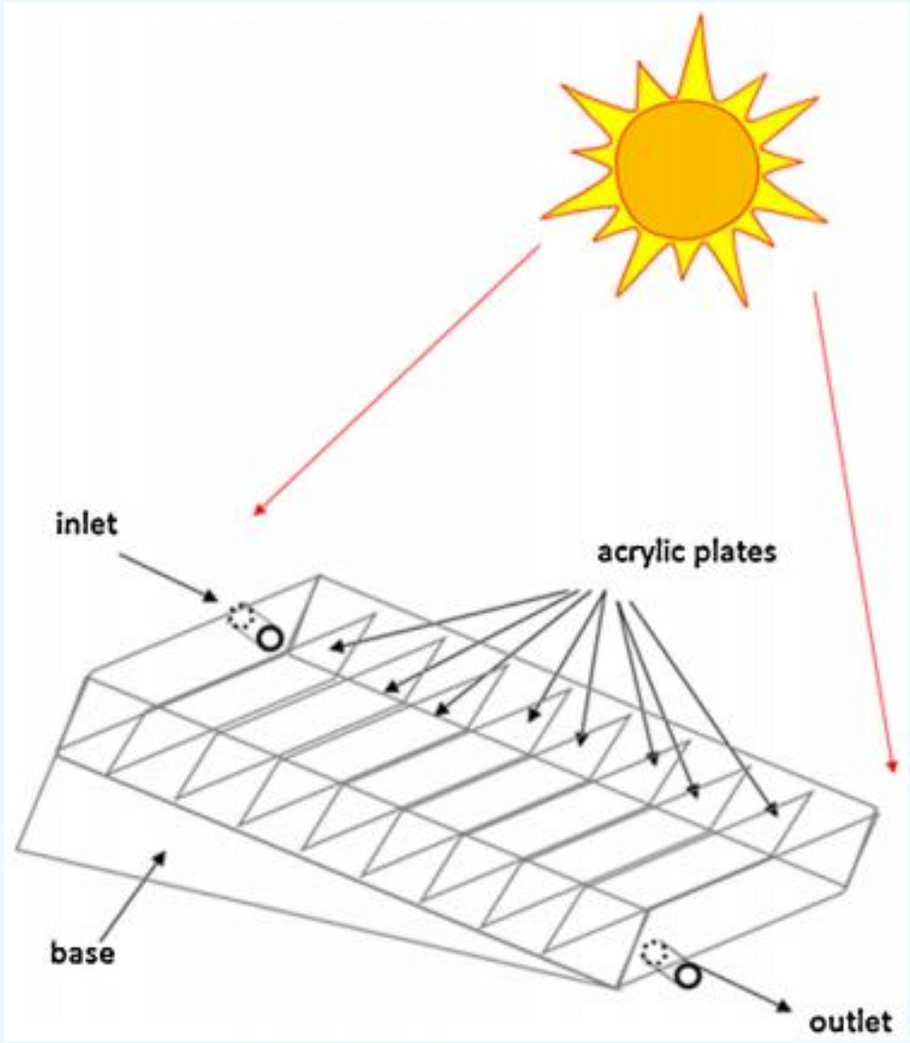
- Observational marine litter data are scarce
- Overcoming marine litter data scarcity and ocean variability
- Enabling prediction of litter **distribution**, transport and concentration
- Identification of **accumulation zones** and relate them to **Ecosystem Services**
- Scenario assimilations (Litter Sources, Cleaning Methods applied)

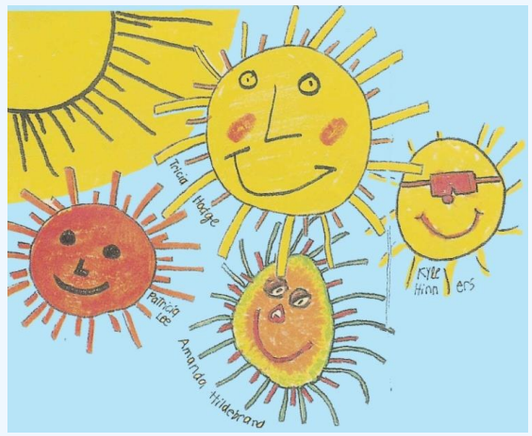
Solution: Developing modelling tools to describe litter pathways and hot spot areas

Using modelling tools for ecosystem approach (e.g. aquaculture)

WASTE WATER TREATMENT PLANTS

Challenges: 1c) Preventing & cleaning at the source

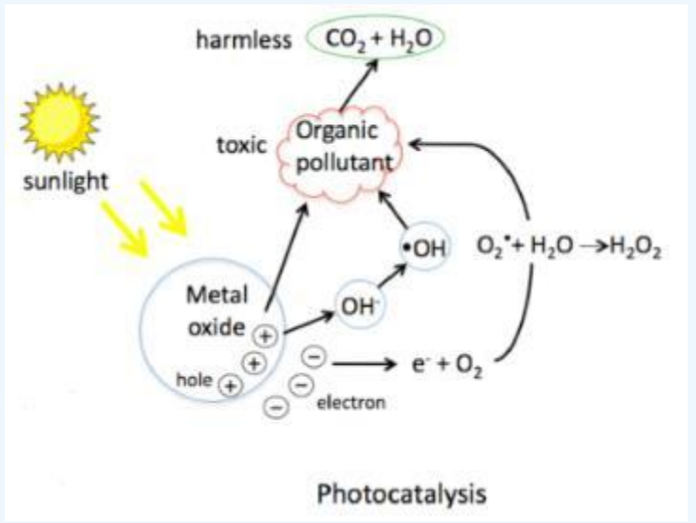




Advantages:

- Environmental friendly
- Low energy consumption
- Cost effective
- Measuring concentration before and after treatment
- Providing data for models and data bases

Photo-catalytic reactions



Innovative method of photocatalysis using metal oxide nanoparticles (Copyright: Prof. Dutta Joy)

Solution: Applying developed innovative method in water treatment processes

RIVER DISCHARGES

Challenges: 1c) Preventing & cleaning at the source

- Booms at river mouths
- In cooperating several steps for collecting litter
- Environmental data collection
- Contingency plan for extreme weather events

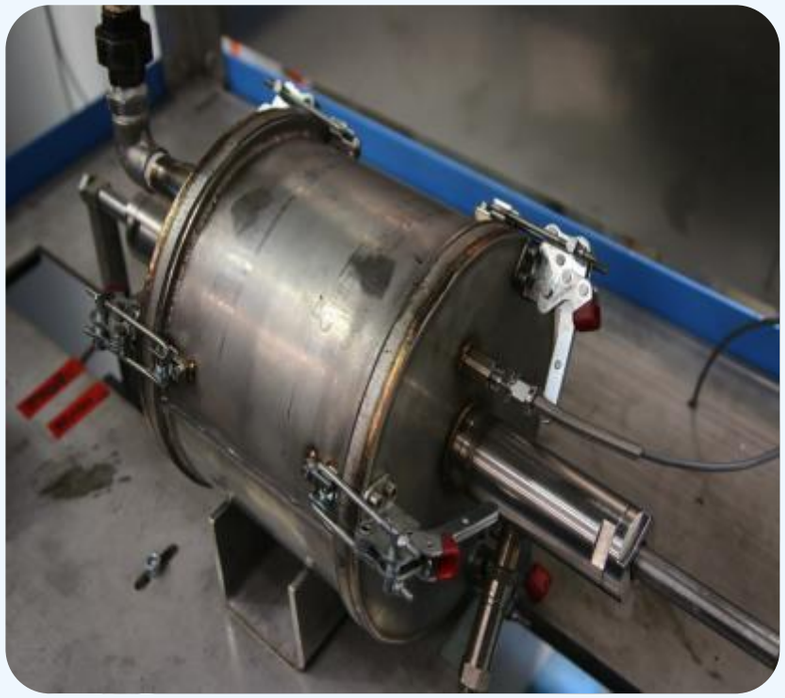
Advantages:

- Environmental friendly
- Cost effective
- Low cost maintenance
- Measuring concentration of collected litter
- Providing data for models and data bases

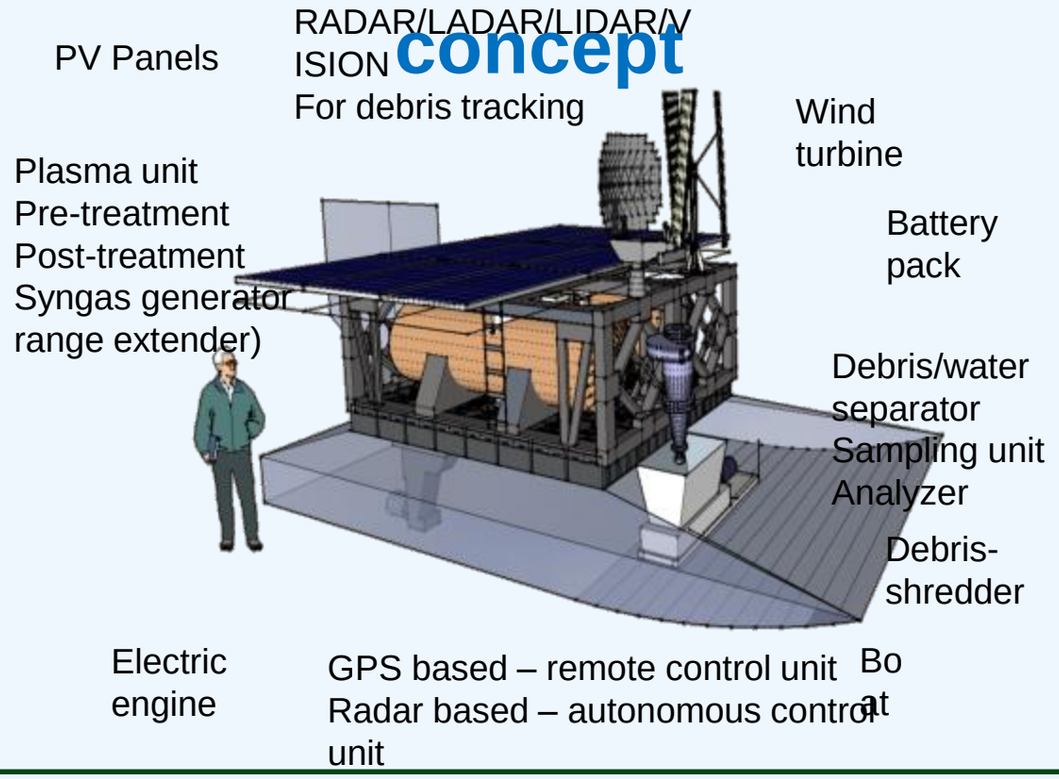
Solution: Development of innovative litter containment barriers
Contingency plan for policy makers

LITTER AS ENERGY

Challenges: 1d) Handling litter close to the collection area



SEA LITTER CRITTERS



Advantages:

- pyrolises the waste breaking down chemical bonds
- exploitable syngas (**electricity** and heat production) - a recyclable residue with no harmful emissions
- **ideal for situations where the cost of waste collection is very high**, like mountain villages and islands.

Solution: further development of method to be used

a) on board a collection vessels at ports or river mouths

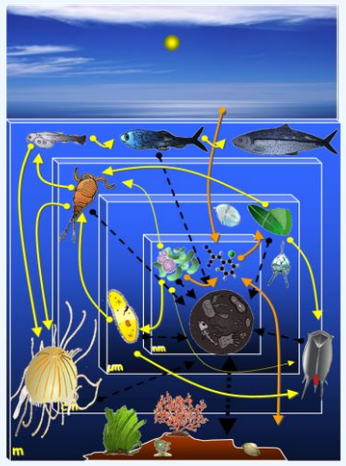
b) either in a auxiliary motor or generator to supply electricity to the vessel itself

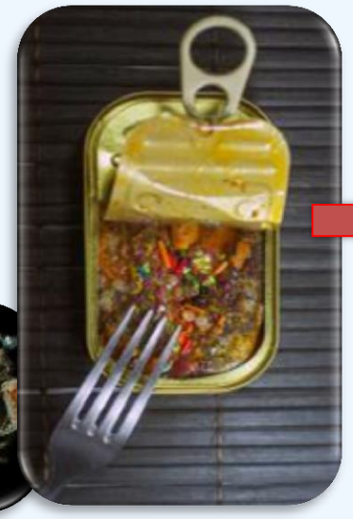
c) for heat production in ports

collaboration with local port authorities to identify their needs

Micro litter environmental impact and assessment

Challenges: 1a) detecting, monitoring and calculating litter concentration locally
4) Social acceptance, awareness and responsibility





Assess risk for the human health

To **understand** the visible and invisible litter **impact** on specific **ecosystem services** (commercial fisheries and aquaculture), as well as recreational areas

Identify areas and services under threat from visible and invisible plastic pollution as well as **assess** the degree of **threa**t they are experiencing at **present,** and **past** and **future** impacts

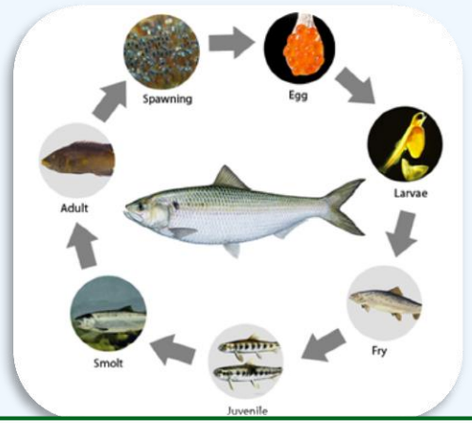
Advantages:

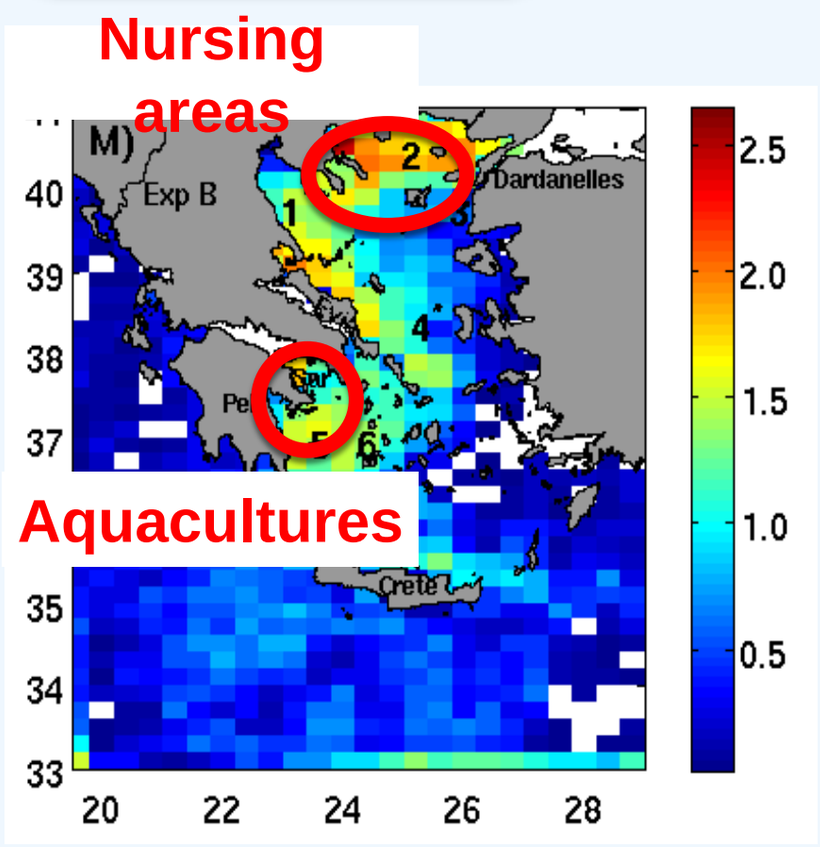
- Determine litter impact
- Concentration data to be used in models
- Data to be used for scenarios
- Determine efficiency of innovative cleaning methods

Solution: Review current methods, guidelines and regulation for litter monitoring
Estimating **influence of litter** on habitat quality and organisms
Communicating to society and train stakeholder groups

ECOSYSTEM APPROACH

Challenges: 1b) determining litter pathways and accumulation areas
1c) detecting, monitoring and calculating litter concentration
3) Ecosystem Approach: effects on ecosystem services





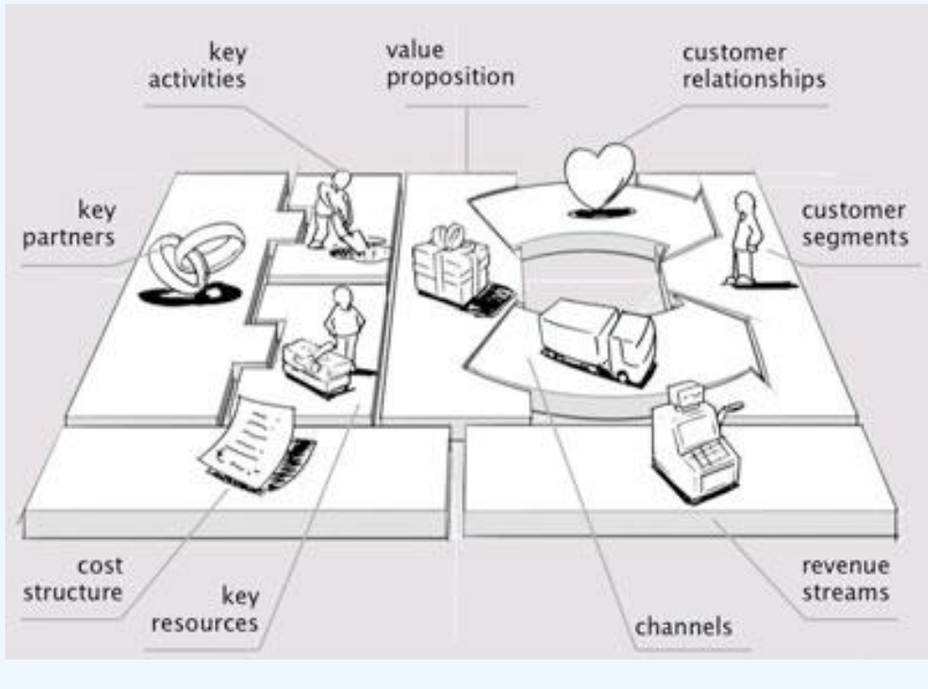
Advantages:

- **Identify areas of ecosystem services under threat of litter**
- **Determining impacts** of litter in the identified areas
- Identify areas where the **proposed interventions** will have **impact**
- Identify where **mitigation** is likely to be most **effective** in ecological and economic terms

Solution: Mapping litter overlaps with ecosystem services
Communicating to society and train stakeholder groups

MARKET UP-TAKE OF INNOVATIVE METHODS

Challenges: 3) Economic feasibility and policy recommendations related to the developed methods and technologies



Advantages:

- **ensuring up-take** and **up-scaling** of innovative methods in relation to **legal and policy framework**
- **gauge stakeholder for** acceptance of these technologies
- **assess** the integrated **impacts** and **foster** the exploitation of R&D results

Solution: Development of **business models** for each innovative methods under different future scenarios
Multi-criteria decision analysis (MCDA) (environmental, social and economic criteria for policy recommendations)

SCIENCE, SOCIETY, INDUSTRY & POLICY PERCEPTION

Science & Civil Society

Science & Industry

Science & Public Authorities

Cooperation Science, Industry, Civil Society & Public Authorities

- **Development and applying Innovative Methods** (Science & Industry)
- **Foster exploitation of project result considering the device value and solution obtained** (Science & Industry & Stakeholders**)**
- **Cost-effective analysis and business models** (Science & Industry & Stakeholders)
- **Engage stakeholders & deliver "lessons learned" to policy platforms and society** (Science & Industry & Civil Society & Stakeholders)
- **Societal Responsibility** (Science & Industry & Civil Society & Stakeholders)

Integrated assessment to face the Marine Litter Challenge

Thank you!

謝謝

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